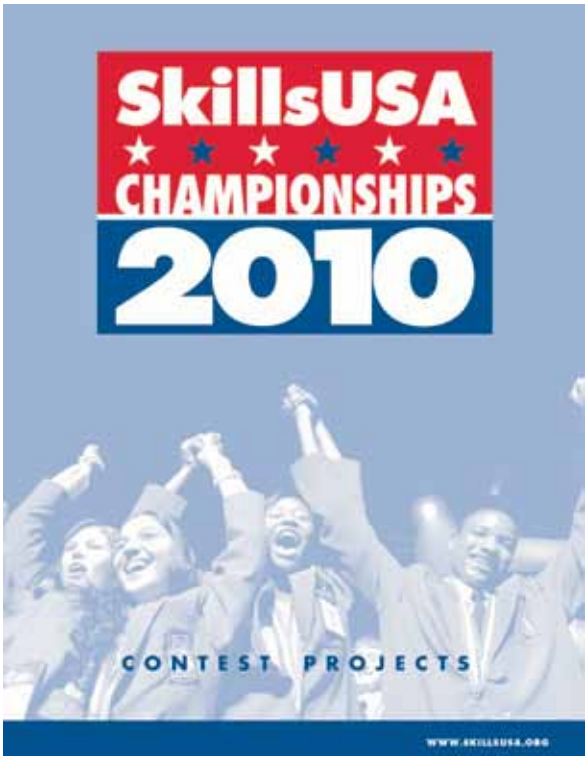


2010 Contest Projects

To print all of the contest projects at once, click the button below.

Warning: This document has 1,897 pages. Be sure you have enough paper to print the entire document.

SkillsUSA
2010 Contest Projects

3-D Visualization and Animation

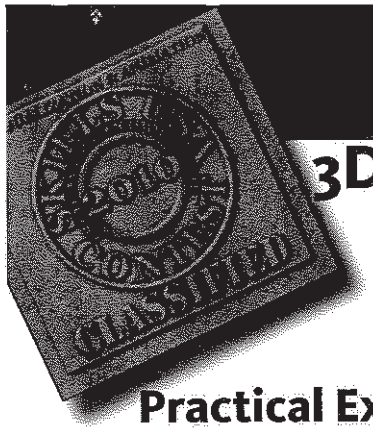
Click the “Print this Section” button above to automatically print the specifications for this contest. Make sure your printer is turned on before pressing the button.

3D Visualization and Animation Contest

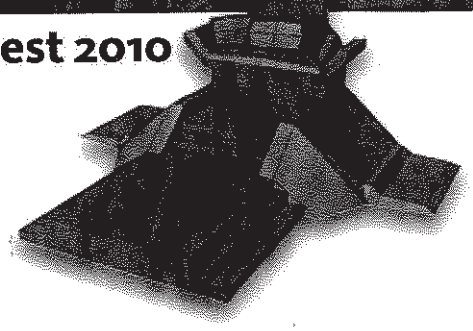
The world of 3D is rapidly expanding, and career opportunities exist in a wide range of fields – including architecture, games, product and industrial design, civil engineering, and film and television animation. This contest allows students to step into a real world 3D production environment where creative output must be accomplished within specific timeframes, resources and design constraints. This is a two-person team event and includes a preliminary written exam. Contestants must produce high quality images and an animated short subject using 3D computerized images. Students are evaluated on their technical knowledge, production skills and creative abilities – including visual development and storyboarding. They will also have the opportunity to interface with and get feedback from high-profile judges with successful careers in 3D animation and visualization.

DECLARATION OF INDEPENDENCE
IN CONGRESS, JULY 4, 1776
THE UNANIMOUS DECLARATION OF THE THIRTEEN UNITED STATES OF AMERICA
WHEN IN THE COURSE OF HUMAN EVENTS

Autodesk®



3D Visualization and Animation Contest 2010



Practical Exercise: Storytelling

Background Information: Storytelling

All of you see movies, play video games, and watch television. Oftentimes, photographs and paint¬ings include no characters, yet you still understand what is happening and are moved by these images.

- In a movie, the camera may lead you through a space – focusing on objects that tell you who has been there, unveiling a portion of the story with no character in the scene, and revealing clues that may play a role later on in the movie.

- In games, you often have to discover what is happening by traveling through the environment as visual clues unveil the story.

- In an architectural visualization, the designer tells a story to the cli¬ent about what the space will look and feel like, conveying a mood.

If I walk into the room you live in, I would see things that tell me about you. That is the goal of today's challenge: tell us a story about a space. We need to be able to look at the rendered im-ages and animation and know exactly what is happening, just happened, or is about to happen.

The Task: Create an Environment that Tells a Story

These are the story concepts you may choose from:

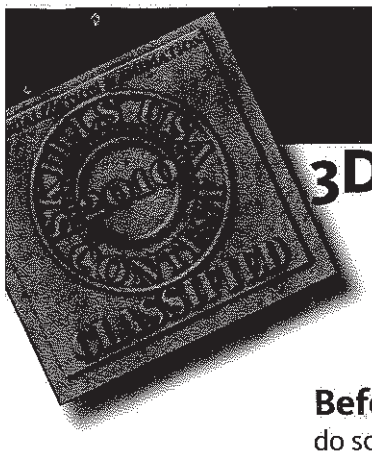
- The living room of a superhero in the year 2050 (futuristic)
- The laboratory of a mad scientist who is inventing a way to time travel (sci-fi)
- The secret hide out of an international spy (present)

(See the following pages for more in-depth story information on the three concepts)

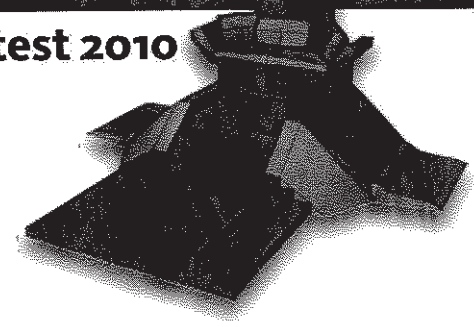
What we want you to do is tell us a story using a room. This may sound constraining, but use your imagination. Rooms can be made from many things. They can be round or square; ceilings can be high or low; there may be steps that lead down or up. Light may play a role. Maybe you have windows, skylights or huge doors. All of these features depend on who lives there and the story you are telling.

By looking at your final images and animation, we should be able to answer these questions:

- Who lives or works here?
- What do they do?
- What is the general time period: past, present, future, fantasy?
- What type of a person is he/she?
- What just happened in this space? Are things knocked over, broken, or neat? What is the light like? Is it clean or dirty?



3D Visualization and Animation Contest 2010



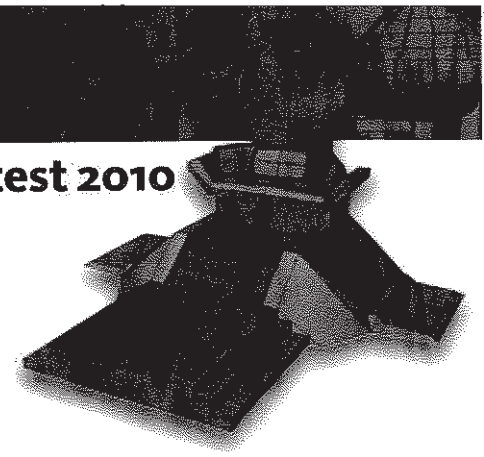
Before you begin to model in 3D, you will need to do some research and sketches so that you can tell your story the way you want the audience to see it. These are some steps that may be helpful before you start modeling.

- Make a list of all the objects you plan to place in the room.
- Lay out a floor plan of where everything will go, where the entry is, etc.
- Sketch some of the more complex objects and think about how they are made.
- Consider color and lighting that fits the mood you want to set.
- Think about your final short animated walk through, and sketch a storyboard of how the camera will move around the room and what you want the viewer to see.

Parameters for the Project: IMPORTANT!

- The room size is **15 x 20 feet (300 square feet)**
- Maximum top to bottom height of **20 feet.**
- The room can be any shape, but you must stay within this square footage. You may make it small¬er, but no larger. It may step down or up slightly, but may not be a two-story space.
- You may include any number of openings. While the outside may be visible through windows and doors, all the action must take place within the space. Be clever with how you use the "outside" space if you choose to incorporate it.
- You may use sound effects if you think that will enhance the storytelling.

3D Visualization and Animation Contest 2010



The Requirements

REQUIRED:

- At least one opening in the room
- General lighting and mood lighting
- A minimum of **three (3)** things must animate
- A minimum of **one (1)** use of "effects"
- The scene must include interesting use of textures

You may NOT use or include:

- A portrait or photograph of the person who lives here
- Characters of any type, human or animal
- Music

Work will be checked off on this Timeline:

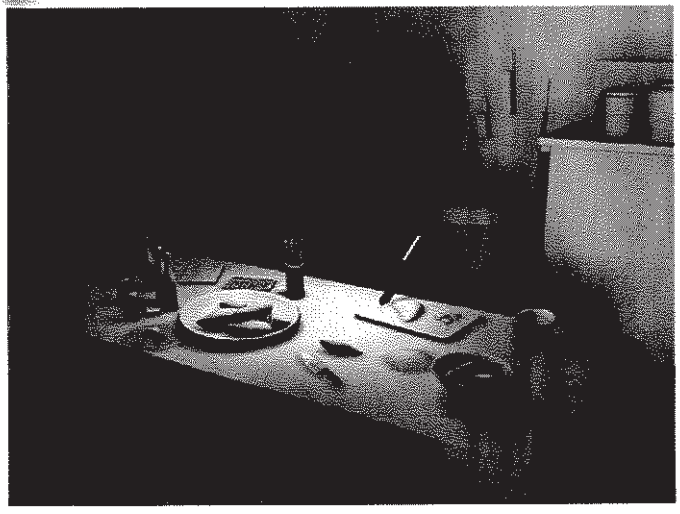
1. Concept statement, Work Breakdown and Storyboard due at **10:00am**
2. Compositional Block in and first lighting pass due at **1:00pm**
3. Modeling and texturing complete **3:00pm**
4. Animation and Lighting Complete **4:00pm**
5. Rendering Complete **5:00pm**

Final Work to Turned in for Project:
ALL FILES DUE ON the USB drives (provided) AT 5:00PM CST

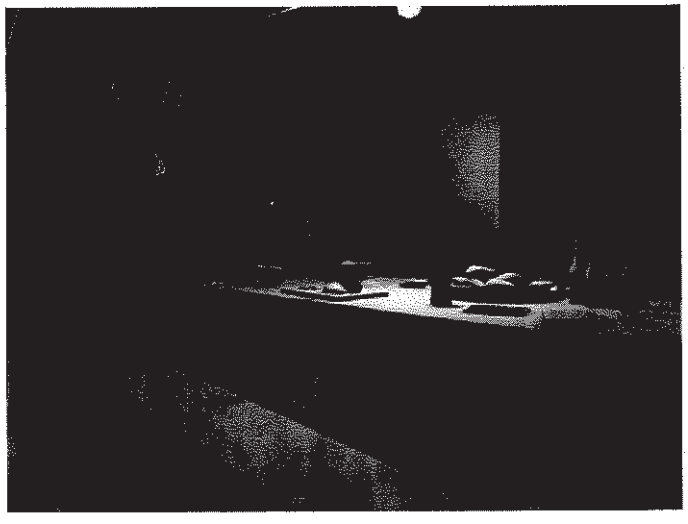
- Title and Concept Statement (3 sentences, the TV Guide version.) Use template
- Team Work Breakdown (Who will do what?) Use template provided.
- Storyboard/ Use template provided
- Floor Plan/ Use template provided
- Work in Progress renders (640x480 jpg) in a folder titled **"WIP"**
  - 3 Composition Block-ins with lighting, no textures jpg (see example)
  - 2 Wireframe renders jpg (see example)
- 10 still renders including close up and distance showing the room and details (640 x480 jpg) in a folder titled **"Shots"**
- Eye level Fly through/Walk through of the space telling the story (showing us the details)
  - 30 to 60-second rendered animation; 640x480 AVI file or Quick Time
  - Include Title page withTeam number
  - Include Credit Page withTeam number

3D Visualization and Animation Contest 2010

Block in examples



Composition Block in shots with lighting

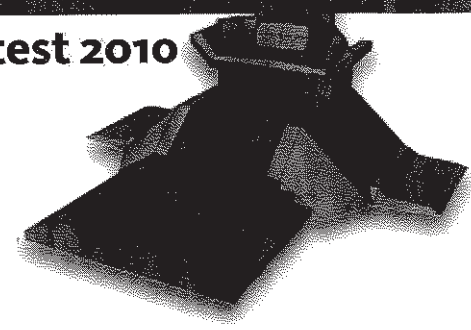


Wireframe

3D Visualization and Animation Contest 2010

Character Profiles

3D Visualization and Animation Contest 2010



Title and Concept

Team Number: _____

Project Title: _____

Superhero ☐

Mad Scientist ☐

Spy ☐

Concept Statement:

_____

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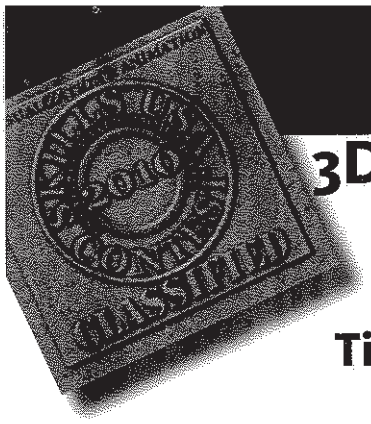
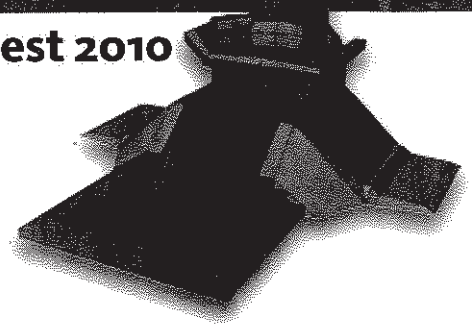


3D Visualization and Animation Contest 2010



Title and Concept

Team Number: _____

Project Title: _____

Superhero ☐

Mad Scientist ☐

Spy ☐

Concept Statement:

_____

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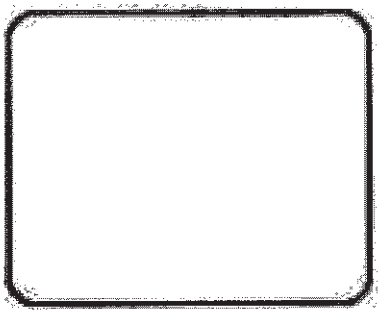
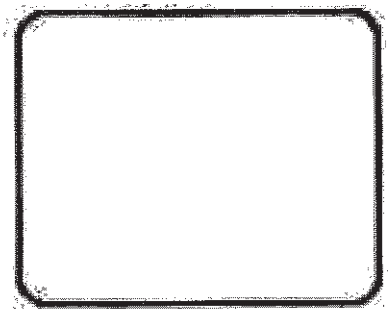
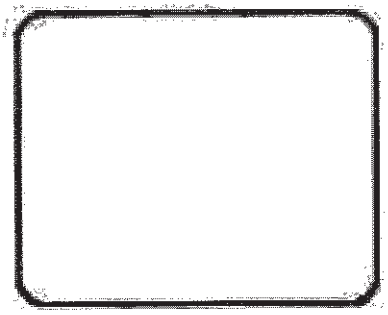
Team Number: _____

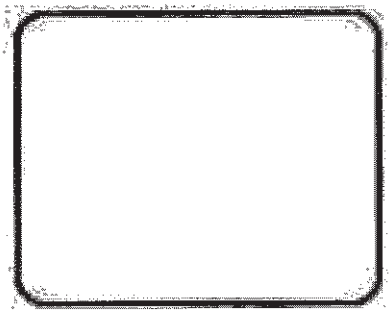
Storyboard

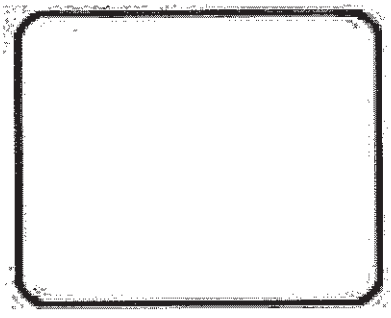
Project Title: _____

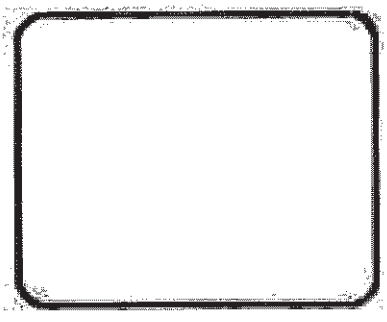


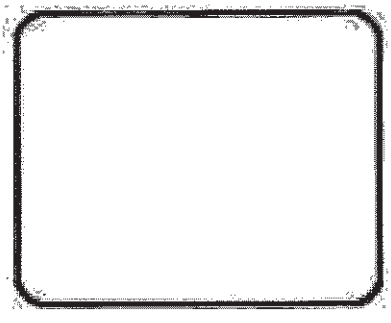


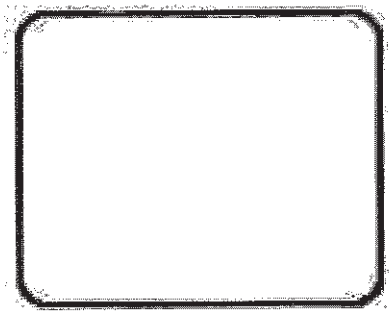


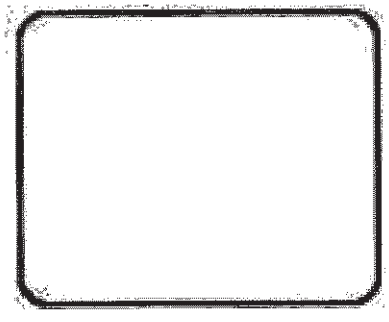








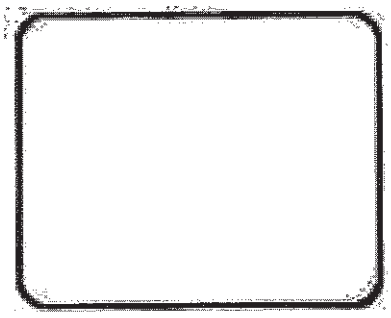




Team Number: _____

Storyboard

Project Title: _____



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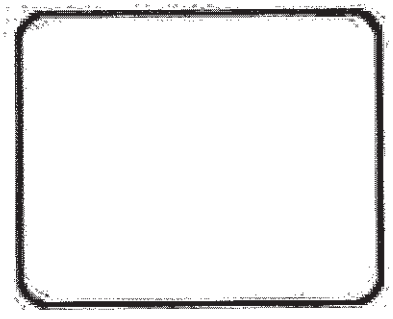

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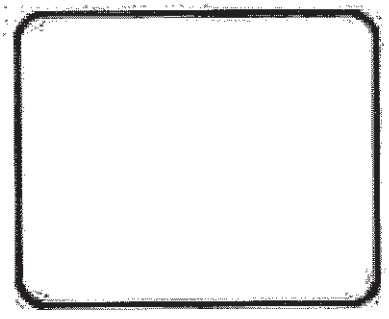

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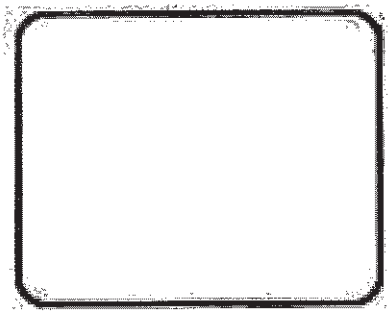

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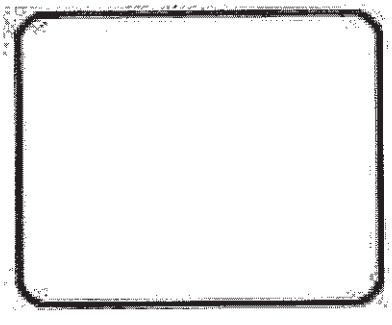

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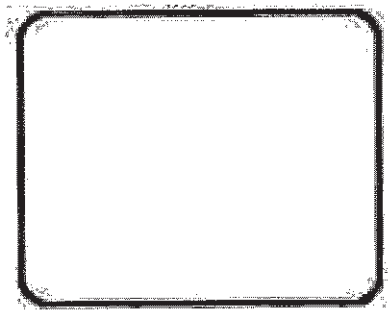

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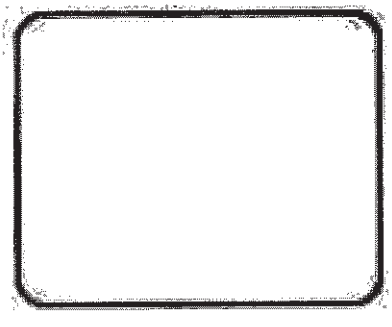

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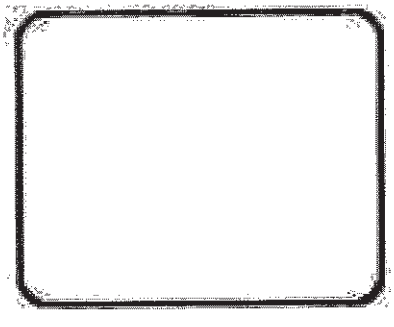

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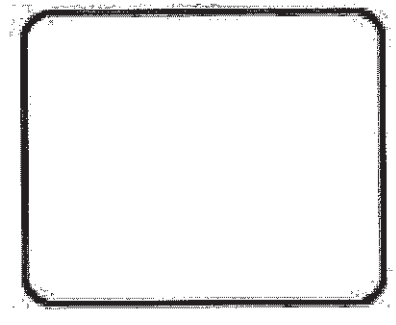

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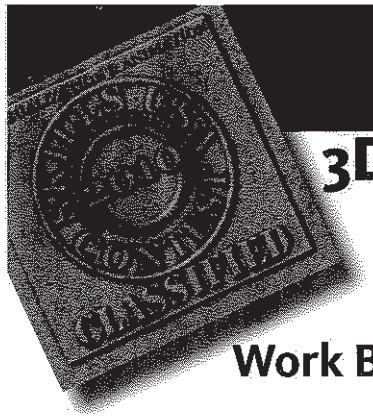
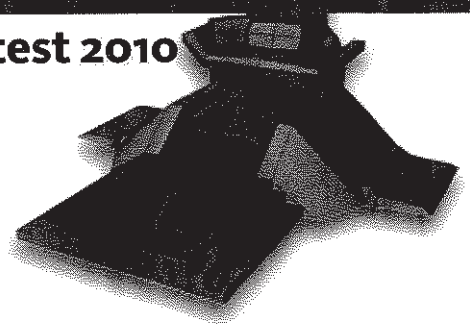


3D Visualization and Animation Contest 2010

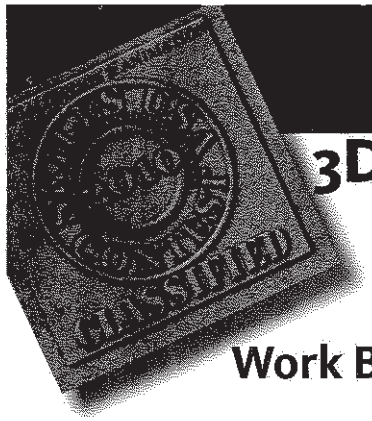


Work Breakdown by Team Members

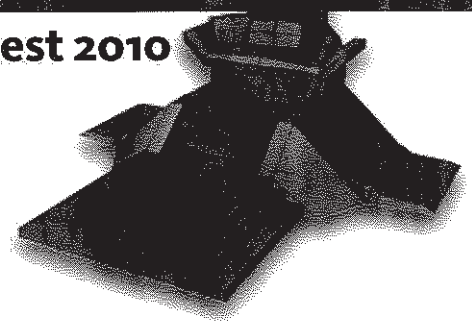
Team Number: _____

Project Title: _____

	Team Member 1	Team Member 2
Storyboard		
Modeling		
Texturing		
Lighting		
Rigging		
Animation		
Cameras		
Rendering		
Presentation		



3D Visualization and Animation Contest 2010



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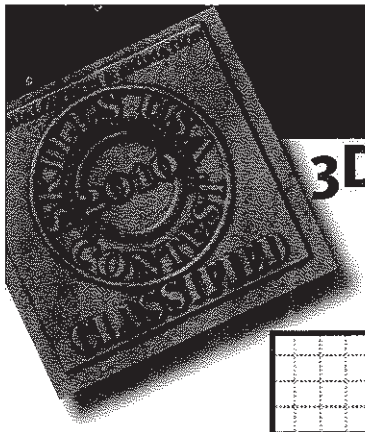
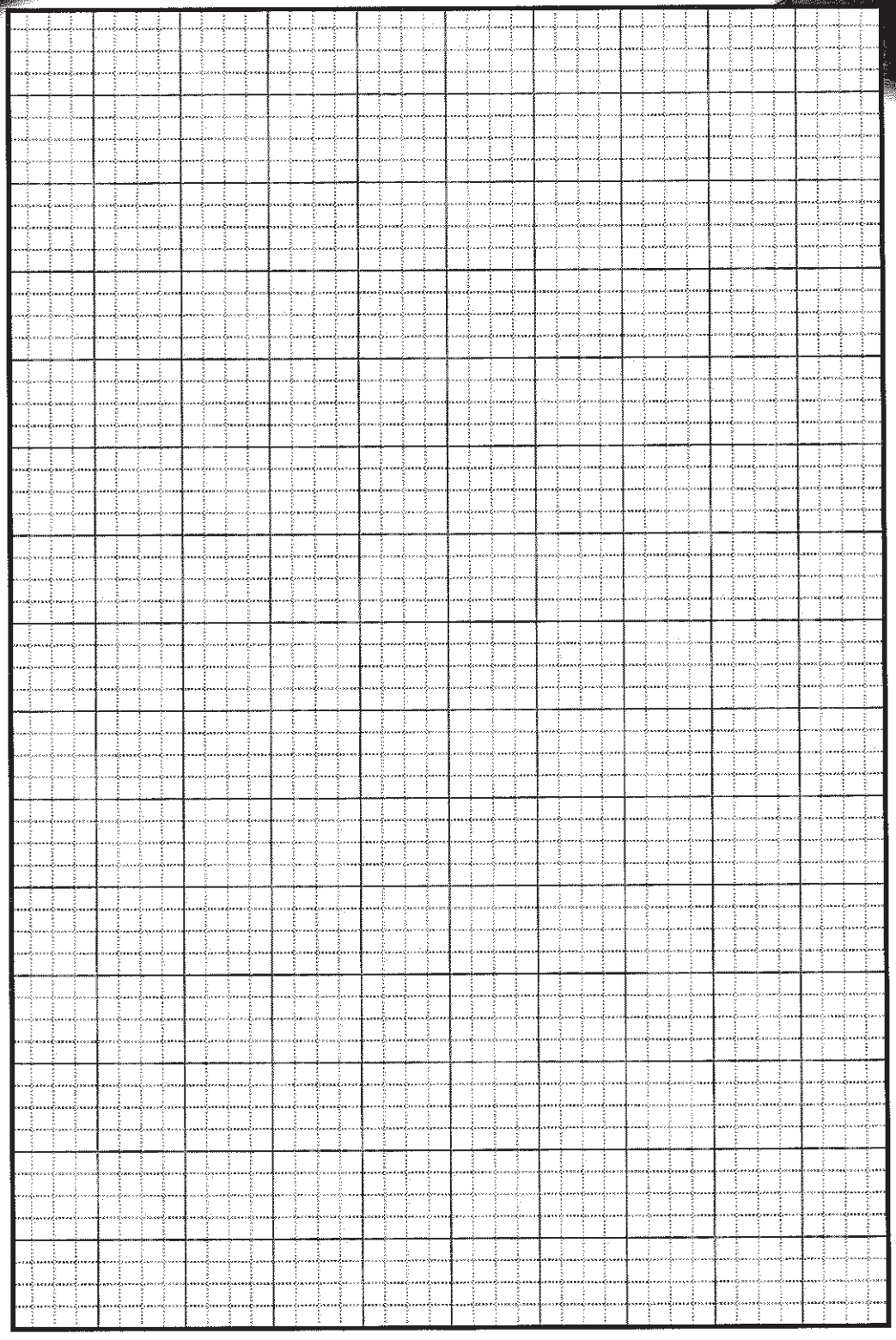


3D Visualization and Animation Contest 2010

Floor Plan

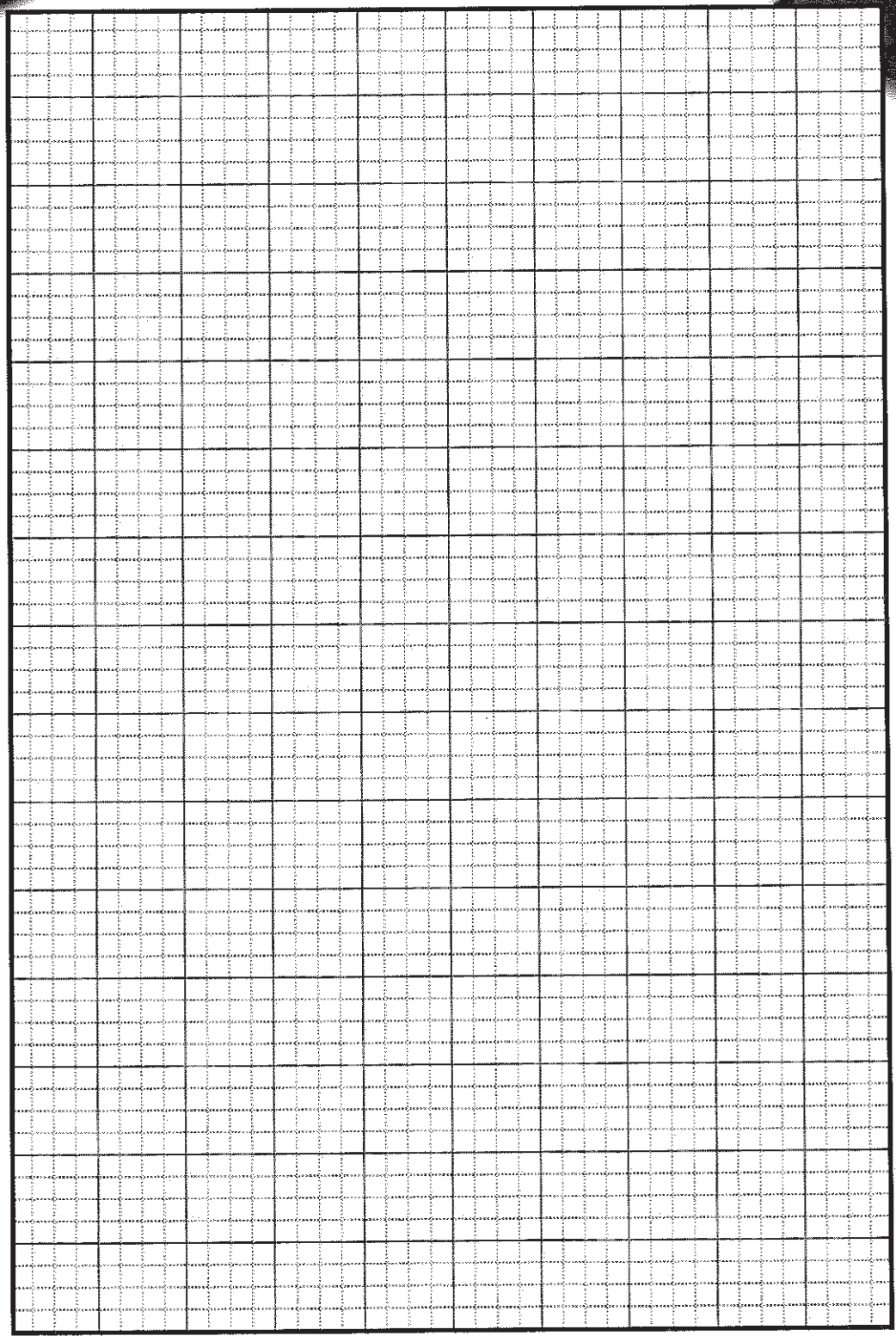


Team Number: _____

Project Title: _____

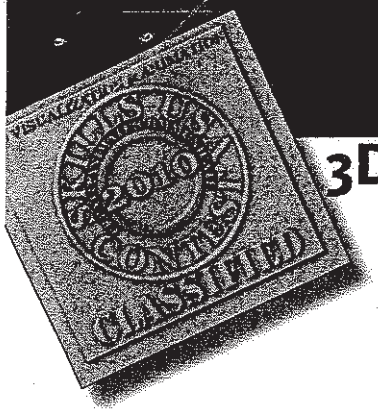
3D Visualization and Animation Contest 2010

Floor Plan



Team Number: _____

Project Title: _____



3D Visualization and Animation Contest 2010

Written Test

Identification: _____

1. Adding your objects, lights, cameras etc. in layers allows you to:

   a. Organize your scene better and hide/unhide objects quickly

   b. Become a better 3D artist

   c. Link your files back to Photoshop

   d. Link your objects together

2. Setting a project folder is important because:

   a. It saves multiple file formats for your scene

   b. It organizes your scenes, rendered images, and other important data in respective folders

   c. You can't work in 3d before setting one

   d. Projects can be too large if you don't set one

3. Once objects are grouped, you can:

   a. Move, rotate, or scale them as a single entity

   b. Texture them easily

   c. Perform better modeling

   d. Never ungroup them

4. The reason for creating a pre-visualization of a scene is:

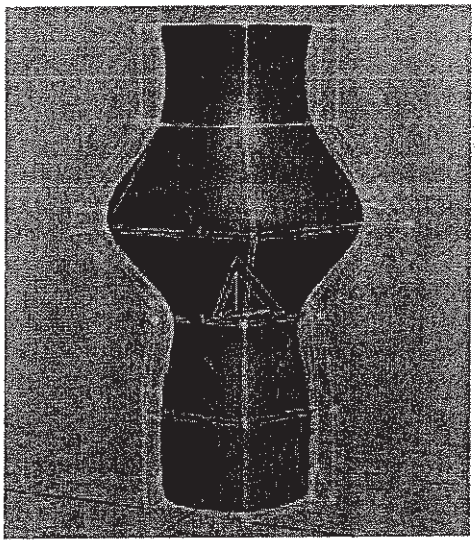
   a. so that lighting, camera placement, and animation can be planned before actual production begins, saving time and reducing errors

   b. to determine how much money to charge the client for the work

   c. to create accurate models for the production

   d. to create content that will be used later in the production phase of the project

9. The following image shows the object making use of:



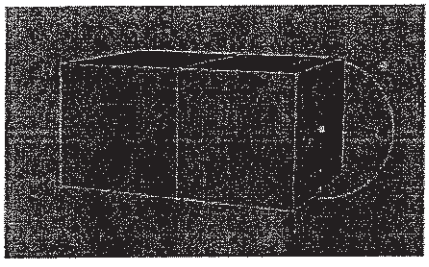
a. Bend

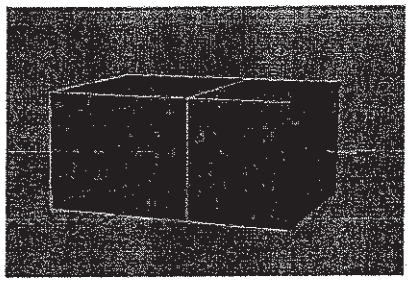
b. Taper

c. Twist

d. Lattice/FFD

10. Which operation is being performed in the following image:





a. Flip Normals

b. Bridge

c. Extrude Face/Extrude Polygon

d. Smoothing

14: Clipping planes allow you to:

a. Exclude polygon objects from the scene while rendering

b. Exclude textures from the scene while rendering

c. Exclude lights and animated objects while rendering

d. Exclude certain portions of the scene while rendering

15: Which of the following is a post effect:

a. Modeling

b. Graph editor

c. Dope sheet

d. Glow

16: Making an explosion simulation look realistic would require what kind of effect :

a. Cameras

b. Lightning

c. Smoke

d. Rendering

17: The following image shows an example of what effect:

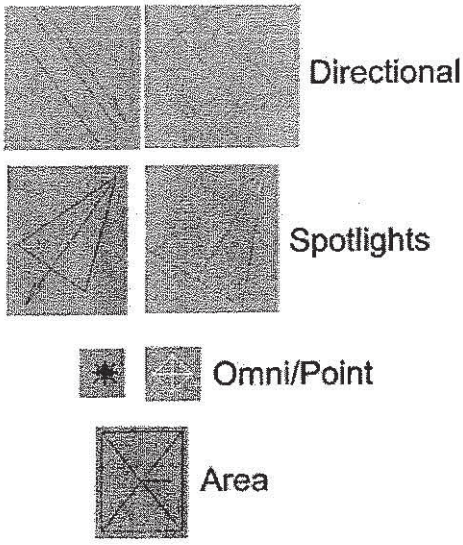
a. Explosion

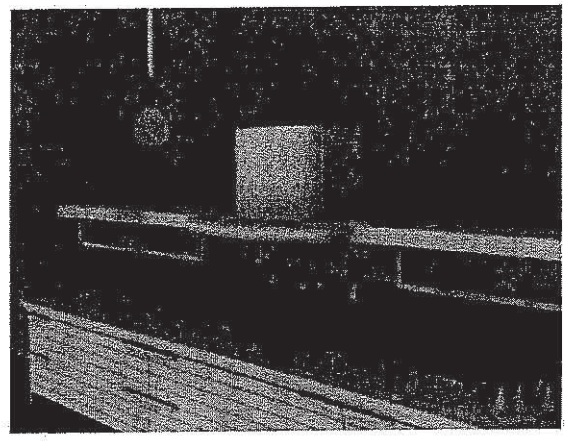
b. Sparks

c. Glow

d. Particle

22. Which light type would be used for the Light Bulb in the following example to go in six directions:





a. Area

b. Spotlight

c. Omni/Point

d. Directional

23. You can convert a sequence of rendered images into:

a. Obj

b. Max

c. Mov

d. Mb

24. AVI stands for:

a. Alternate Visual Interface

b. Audio Visual Interaction

c. Audio Video Interleave

d. Alternate Video Interface

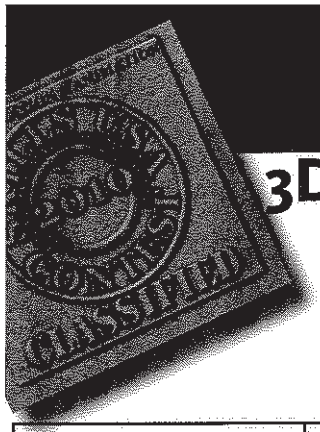
25. The render resolution for a digital standard definition video for NTSC is:

a. 720x480

b. 1920x1080

c. 270x840

d. 768x576



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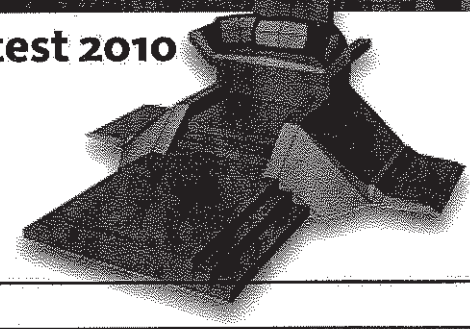

Judge _____

Team Number				
Topic	**Sub-Topic**	**Points**	**Points Awarded**	**Comments**
Design	Concept	100		
	Floor Plan	50		
	Storyboard	50		
	Creativity	100		
	Production	50		
3D Execution	Modeling	100		
	Texturing	100		
	Lighting	100		
	Camera	100		
	Animation	100		
	Rendering	100		
Test	Written Test	50		
Total		1000		

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	Animation	100		
	Rendering	100		
Test	Written Test	50		
Total		1000		

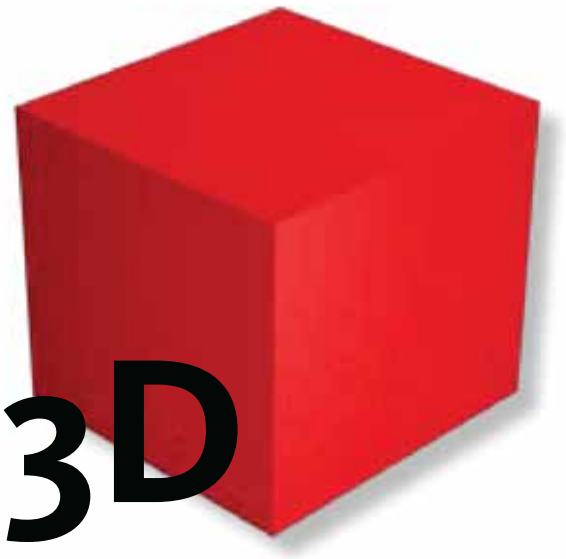
Workbook

SkillsUSA™ CHAMPIONSHIPS

2010

3D Visualization & Animation Competition

This Workbook provided through a generous grant from Autodesk®



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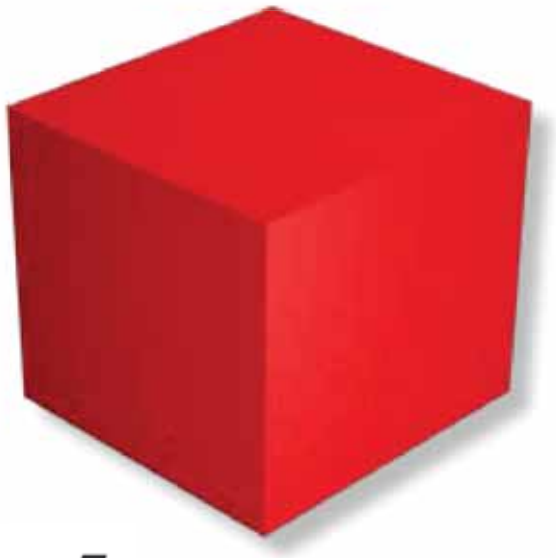


Ideas and Concepts

A good idea that is not well executed is no longer a good idea, but a bad idea well executed is still a bad idea.

So how do you come up with good concepts especially when you have to meet tight deadlines?

Each project you begin has an infinite number of design possibilities. As a artist working with CG software you are also a storyteller, and a technician.

Always start with writing down your ideas and doing rough sketches, this is always a good start! You should be able to explain your concept in a clear and concise way to get the point across, think about reading the short summary about a movie online, what makes you want to go see the movie?

Sketches regardless to how rough are also a great place to begin. Whether it's a character or environment, setting the stage in the earliest stages of the idea will help you flush out what is important and what's not.

Storyboards are very important for organizing how you will tell your story in animation and organize your shots, they will help you bring your ideas to life.

- What are the basics of a good storyline?
- How do I develop an environment that matches my storyline?
- What am I trying to tell my audience?
- How can I make it effective enough so that the audience will understand my story?

In the early stages of concept development you should ask yourself these questions:

- Who?
- Why?
- Where?
- What?
- When?

The story you choose to pursue will be based as much on chance as on research. Your imagination takes every bit of your experience from a daily walk to a favorite film and makes sense of it, combining it in ways no one else can, because no else has your knowledge, personality or experience. The magic of the ideation process is that you start in a familiar place, but then twist that into a new direction.

Let's start with an environment. Suppose we are going to create a set based around one of these ideas?

- The living room of a Superhero in the year 3000
- The Wizard's room
- The Mad Scientist's laboratory, who is inventing a new way to time travel

For our example we will use the Mad Scientist's laboratory!

Brainstorming your idea:

- How will you convey the concept while just showing the lab and not the scientist?
- Is the room scary or a funny?
- What is the time period? Past, present, future?
- Does the room look realistic or more fantastic?
- What are the elements you might find in a laboratory for example test tubes, flasks, beakers, etc.?

Using the concept of a "Mad Scientists Laboratory" or come up with your own idea and write a short paragraph describing the space, then make a list of what you might see in that space after you have answered the questions above.

The environment should give your audience clues about who the space belongs to and make it convincing.

- Think about your target audience and how to will attract their attention.
- Do some quick sketches to illustrate the objects in the space.
- Try to set a mood and tone about the space.
- Things like a rough floor plan can help
- Also create a prop list of what would be good to have in the space.

Ideas and Concepts

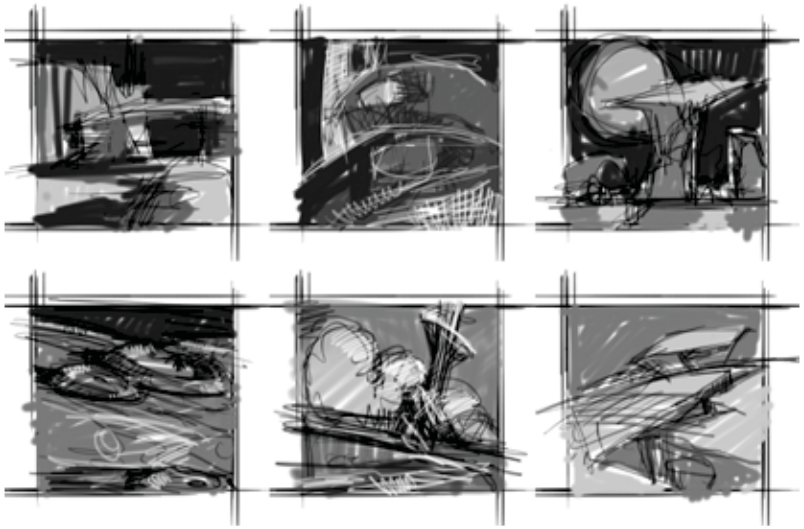
Good brainstorming clearly leads to a good project!

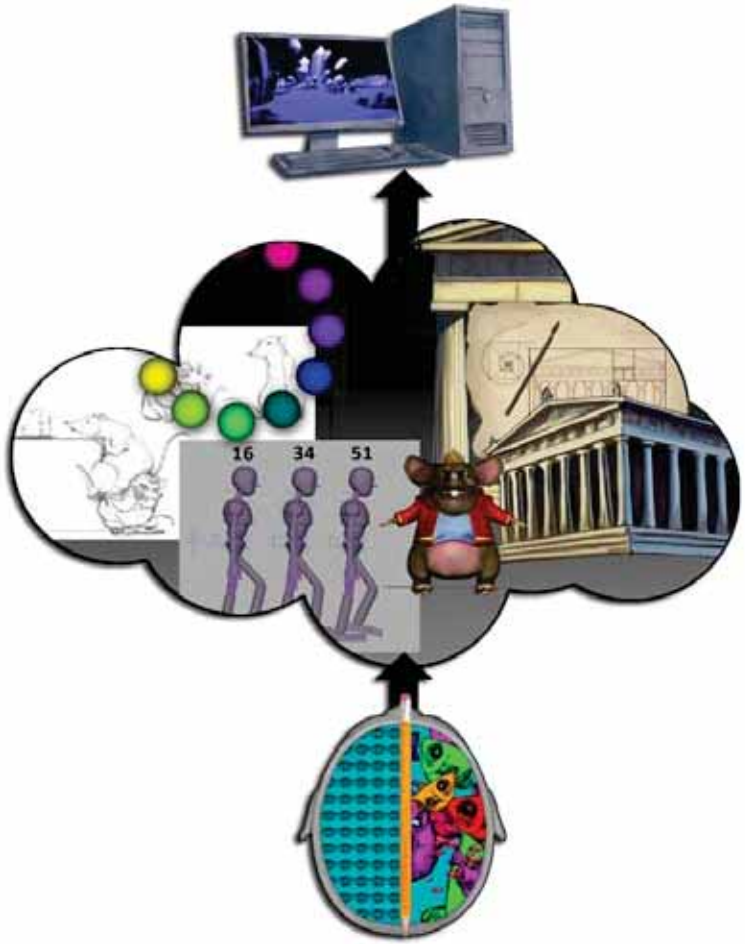
Good ideas are not always your first ideas, it's a process of many iterations and trial and error to get to a great project. Creativity requires a willingness to boldly say what you think, but it also requires a willingness to let ideas evolve, if you are working on a team make sure to have everyone participate and share their ideas, you never know what will be the spark that makes the idea come alive!

Generating ideas

The discussion process can help shape an idea into something it didn't have the potential to be when just one mind was contemplating it. Two minds or three, or eight, or twelve, pursuing the same problem can present hundreds of possibilities for its solution. Even designers who don't normally think out loud can benefit from this process, simply because one idea has the potential to multiply once a group starts discussing it. In this way of working and discussing ideas out loud also helps you as a designer to start to understand the ideas yourself.

Remember without a good idea there is nothing but technique!





Storytelling

Telling stories is as old as music, drawing, and perhaps even speech. We all love stories and we never outgrow them. We go to movies and read novels and even gossip because we want to be told stories and we want to tell stories.
All of us watch movies, play videos games, and watch television. We look at photographs and paintings, and often there will be no character, yet we understand what is happening and can be moved by these images.

- In a movie the camera may lead you through a space glancing at objects that tells us who has been there, unveiling a portion of the story with no character in the scene, showing clues that may play a role later on in the movie.

- In games you often have to discover what is happening by traveling through the environment as the visual clues unveil the story.

- In an architectural visualization of an environment the designer also tells a story to the client about how the space will look and feel like, conveying a mood.

If I walk into the room you live in I would see things around the space that would tell me who lives there. This is what we want you to do here, tell us a story using a place, a room. We need to be able to look at the rendered images and animation and know exactly what is happening, just happened, or is about to happen.

Let's take the example of the Mad Scientist's Laboratory, who is inventing a new way to time travel.

By looking at the images and animation we should be able to answer these questions:

- Who lives or works here?
- What do they do?
- What is the general time period, past, present, future, is it fantasy?
- What type of a person are they?
- Think of the elements you may find in a laboratory for example test tubes, flasks, beakers, etc. to help convey the story.
- The environment should give your audience convincing clues about the mad scientist.
- Light may play a role; maybe you have windows, or skylights or huge doors.

Below are a few more things to consider about storytelling:

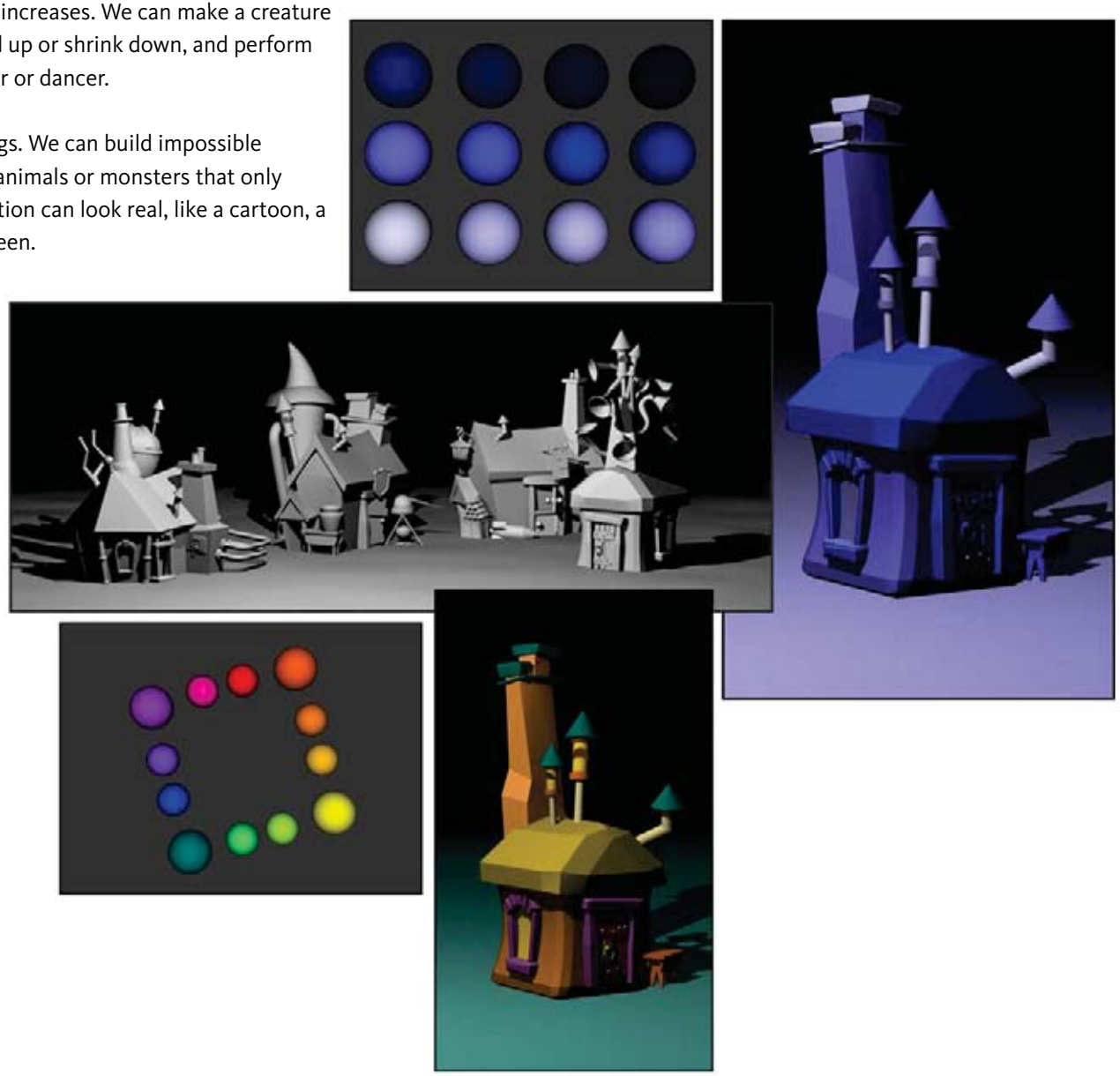
- Storytelling is an art in itself.
- It is based on an idea you want to convey to your audience.
- The idea develops into narratives and visual treatments.
- A script is developed which may consist of characters, scenes, props, etc.
- Storyboard the script.
- Think of camera angles to tell a visually compelling story.
- Lighting can set up the mood for your story.
- Audio can play an integral part in storytelling.
- Transitions from one scene to another along with staging are thought of.
- Timing will play an important role in every visual involved in the storytelling process.
- Dramatic appeal along with a well developed plot that engages the audience is key.
- A story has a beginning, a middle and an end. You can break them down as setup, conflict and outcome. You should have a structure to a story:
    - Character goes on a skydiving trip
    - Character's parachute is entangled in mid air
    - Character has a safe landing
- 3D animation is a great medium for storytelling.

You can show anything you want in the world of animation which can help you think about the impossible while telling a story.

Storytelling

Another strength of animation is that it gives us more freedom to use color, movement, and style. We can make a chase scene more exciting by making the colors get redder as the heat of the moment increases. We can make a creature or vehicle move at exaggerated speeds, swell up or shrink down, and perform moves that would be impossible for any actor or dancer.

We aren't limited to real actors or real settings. We can build impossible landscapes and populate them with mutant animals or monsters that only exist in our imaginations. As for style, animation can look real, like a cartoon, a combination of the two, or anything in between.



Design

Having good design is extremely important in any work of art as it makes something easier to understand and also serves as a visual reference for the information you are trying to provide. Good use of color is an important factor for good design. Composition and focal point are other factors to consider while coming up with good design.

The elements of design are the foundation to all visual imagery including traditional painting, illustration, architecture, graphic design, and 3D art. Think of elements as ingredients such as flour, baking soda, water or vinegar. Principles are the wisdom of how to combine these ingredients or elements. If you want a mild combination, mix water and flour. If you want an exciting combination, mix baking soda and vinegar.

- **Elements of design - These are the building blocks to all visual imagery, from traditional painting to 3D. Below are a few elements of design.**

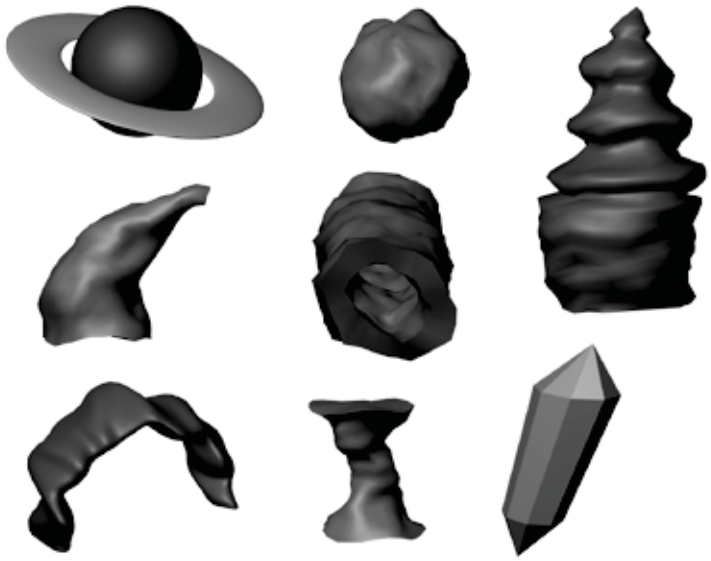
  - **Point** - A point is the most basic of design elements and can be defined as the smallest area of visual attraction in a composition.
  - **Line** - Line could be considered one of the most powerful elements of design. Line is used to define a shape, describe a contour, or be implied by the outside edge of a form.
  - **Shape** - When a line encloses a space, it creates a shape. Shape is two-dimensional only, meaning that it has height and width, but no depth.
  - **Space** - Space is the expanse or area in which all objects and events take place.
  - **Direction** - Horizontal lines suggest stability and project calmness and peacefulness. Vertical lines depict power and height, and diagonal lines can have the feeling of action, movement, or instability.
  - **Size** - Size is simply the how one shape occupies an area with respect to another shape.
  - **Texture** - Texture is the surface quality of an object. Texture can be rough and prickly, like the surface of a cactus, or it can be soft like the fur on a cat.
  - **Color** - Color is the most complex of all the elements. It has a physical presence and creates a psychological response in the viewer.
  - **Value** - Value can be thought of as the darkness and the lightness of color.

- **Principles of design - These can be thought of as how we combine the elements of design to make great art. Below are some principles of design.**

  - **Balance** - Balance is the visual arrangement of elements or objects in a composition that creates a sense of equilibrium. Balance can be symmetrical, asymmetrical, or radial.
  - **Emphasis** - Emphasis creates a focal point or points in a design. It serves as a marker to show what in a composition has hierarchy or importance.
  - **Economy and Continuation** - Economy is a principle of design which emphasizes the simplification of elements to express a message. Only the elements required to express the idea are used. Continuation refers to the “lining up” of visual elements in a design. When elements are placed in a continuous fashion, the viewer’s eye will transition from one element to the next with a feeling of unity.
  - **Rhythm** - Rhythm refers to the repetition of shapes or elements in a design. Rhythm also refers to the movement of the viewer’s eye through a design.
  - **Unity** - Unity refers to visual harmony and agreement among the elements in a design. When the parts work together to create a whole, you have unity.

Design

- **Proportion** - Proportion is the relationship of elements in comparison with each other, or with aspects of a single element or object.
- **Contrast** - Contrast is used to create emphasis through the use of contrasting elements. Elements with strong contrast stand in opposition to one another: light against dark, large against small, round against square, smooth against rough, etc.
- **Repetition** - There are different types of repetition:
  - **Regular** - Regular or systematic repetition is created when the elements and intervals between the elements have a consistency with very little change.
  - **Flowing** - Flowing rhythm is more organic and can have more variation in the elements used to create the composition, much like a winding natural stone walkway or waves of meandering wire.



As you learn to model, texture, and animate in 3D, think about how the elements and principles of design, color theory, and composition apply to your scene.

- **Are your objects interesting shapes?**
- **Are the scale and proportion working?**
- **Are there areas where your eyes can rest?**
- **Are there focal points to draw the viewer to?**
- **Are you using color to tell your story?**

Working in 3D allows you to view your objects in orthographic and perspective views. You are able to create objects and render them from different camera angles. Design, color, and composition are important factors and a larger challenge to control in a 3D space. As you start to layout your project, think about what story you want to tell and how to apply the theories learned to create a clear message for the final viewer of your project.

Storyboarding Techniques

Good quick storyboarding techniques are easier than you think and can really help you visualize your final animation.

Storyboards are sequential drawings that help us understand the story. Animation is hard work. Drawing is hard work, too, but it's much easier to draw out shots to see how they look than to create an animation from start to finish. Storyboards are used during the pre-visualization phase. It's extremely important to have a rough storyboard for your project so that the 3D team understands the process and can communicate it to others.

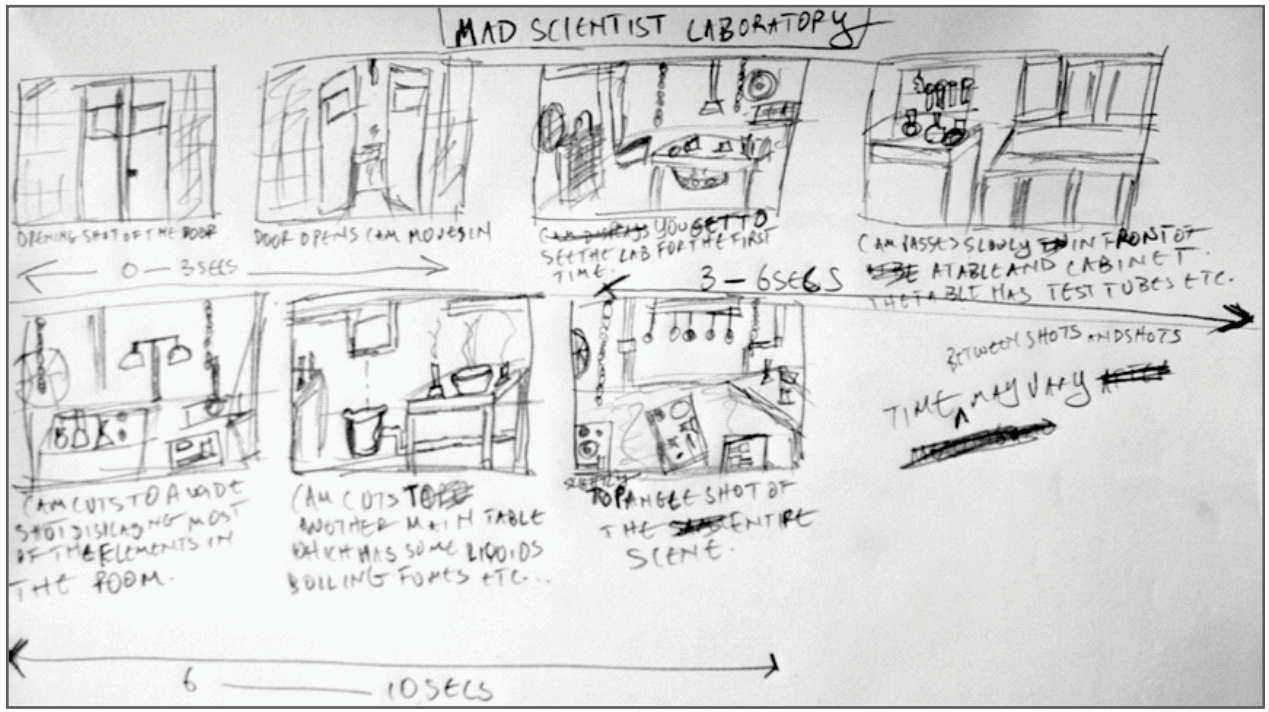
Storyboard help communicate how an animated sequence will look before any work is started on the computer. They make the movie without all the work of making the movie. However, storyboards lack two critical things: movement and sound.

Comics can include word balloons and sound effects because that's part of their style, but storyboards represent the design of film shots, so storyboard artists usually write the dialogue and sound effects below each drawing, and often indicate movement with descriptions or multiple drawings.

One needs to understand animation to make a convincing storyboard. Try getting an idea of where everything is and how the animation can be staged as you read the script. If there is a character involved try envisioning the character as you read the script. After reading the script, try to envision how to expand on it to make it more interesting. You should be excited on starting the storyboarding process after you read the script and should have some idea on the images you are going to create.

Think of camera angles. The shots should tell the story, transitions are important in storyboards. Give a small description for each image.

Storyboards can be loose and sketchy or fully developed and in color. Either way, they are only preliminary. They allow an artist to explore options, to tell the story from one point of view or another and to play with various approaches before committing to one.
Below is an example of a rough, initial storyboard for a 10 second animation of the Mad Scientist's Laboratory. The rough storyboard gives us an early idea of what the animation will look like. It also serves as a foundation for modeling the scene to make it look like a mad scientist's laboratory.



Creating a Digital Presentation

Once your project is complete you will need to create a presentation to turn in, here are some suggestions for example of what might be due as part of a final presentation for our Mad Scientists Laboratory.

A word document explaining your project.
- A maximum of 3 sentences which will help describe your concept (a TV Guide version). Make sure to include the title for your story at the beginning. and the names of all the team members, it's also good to include your email address etc.
- A prop List

A storyboard of rough illustrations explaining the storyline.
- This should be a complete as you can make it in the time allowed to get your point across.
- You can also include any other sketches you may have created.
- A floor Plan Sketch is good to have to explain how you decided to lay out the space, this will also help with your storyboard

Composition Block-in
- These are work in progress (WIP) renders at 640x480 .jpeg images of your process. Two for modeling, two for lighting, two for texturing, Try to maintain a smooth transition for these for example choose two shots and show them from the modeling, texturing and lighting stages.

Ten still renders including a close up and distance showing the room and details (640 x 480 .jpeg)
- These are great for storytelling and process is always good to show.

Ten seconds of an Eye Level Fly-through/Walk-through of the space telling the story showing the details. Ten seconds is 300 frames.
- Render the animation at a maximum of 640x480.
- Render as .tga image sequence; this will give you the best quality.
- Use QuickTime Pro, or some other editing software, to make a movie out of the sequential images.

When you turn in your final presention you will have:
- Concept and Title document
- Prop List document
- Floor Plan Sketch
- Prop Sketches
- Rough Storyboard
- Six Work in Process Renders-Block ins
- Final 300 Frame animation render-10 seconds
- 10 Still Renders showing details

Completing your Project on Time

Tips for completing your project on time:

- Make sure to consider the time you will have to spend rendering the animation
- Check how long one frame of the animation takes to render and then estimate the total time. For example, if one frame takes 10 seconds then 300 frames will take 10x300=3000 seconds, which is 3000/60=50 minutes
- Make sure to go through every setting in the render setting window within your 3D software

Another strength of animation is that it gives us more freedom to use color, movement, and style. We can make a chase scene more exciting by making the colors get redder as the heat of the moment increases. We can make a creature or vehicle move at exaggerated speeds, swell up or shrink down, and perform moves that would be impossible for any actor or dancer.

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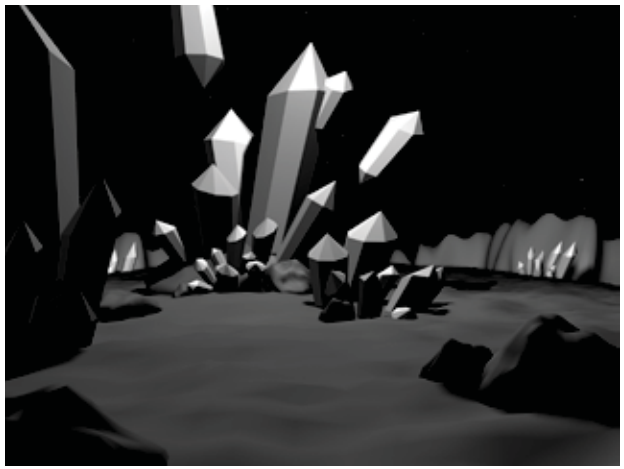


What makes a good project?

- Good design
- Good concept art
- Good story
- Storyboards/Animatics
- Project management
- Workflow techiniques
- Creating a final digital output

A good project starts with focusing on pre-visualization and conceptual design techniques. One needs to understand the importance of concept art and how it will support the storyboarding for an animated sequence. Why story is important and how your audience understands your story is key to keep in mind. Make sure that your audience can easily relate to aspects of storytelling for example characters and emotion, movement, timing and pacing, lights and camera angles all set the mood to tell a story. Story is the backbone and foundation of your project.

Other building blocks to create any work of art are the elements and principles of design. Focusing on the elements and principles of design will allow you to describe the concept with enough artistic depth visually and verbally to allow the viewer to accurately visualize the final 3D output.

Project management can consist of working smart within the software to managing a production schedule to make sure you meet deadlines for the project. Proper workflow techniques are extremely important in a 3D production. Making sure your fundamental concepts in 3D are clear becomes extremely important for any 3D production.

Final presentation is extremely important as that is the final output your audience will see. Making sure you leave enough time for rendering and any post production will play a key role in creating that final impact.

Workflow and Helpful Tips

Having a good pipeline as to how you should approach your workflow is extremely important for a successful project and should be thought out in advance before the production process. This will help in a smooth workflow and you will find yourself on track in a tight deadline driven project.
Below is an example of a workflow and tips related to each element in the pipeline:

Idea and Concept Art

- Spend time on story and concept sketches.
- Remember a story should have a beginning, middle and an end.
- You can break them down as setup, conflict and outcome.

Storyboarding

- Make sure you read the script well before you start making your storyboards.
- In a tight deadline driven project rough sketches will help convey the story best; quickly illustrate the main points to convey the story.

3D modeling

- Importance of pivot points while making 3D models from 2D curves
- Unit setup for scene creation
- Make sure you model from the world origin
- Maintain a good edge loop workflow in your 3D models
- Maintain overall good topology
- Pay attention to quads and tris
- Model with symmetry/mirror
- Smooth only when needed

Lighting

- Make use of basic light theory
- Use three point lighting
- Use lighting linking/include-exclude
- Use shadows effectively

Texturing

- Understand the importance of mapping
- Use 2D and 3D procedural textures
- Understand the importance of UV Texture editor/UVW Unwrapping
- Use Photoshop to make your textures or enhance your existing images
- Understand different shaders

Animation

- Understand set key and autokey
- Path animation
- The importance of curve editor/graph editor
- The importance of dope sheet
- Principles of animation
- Safe frames for animation

Effects

- Have a good knowledge of any effects within your 3D software and use them wisely while keeping render times in mind.

Rendering

- Make sure you understand render resolutions to estimate the amount of time it will take to render animation as still images.

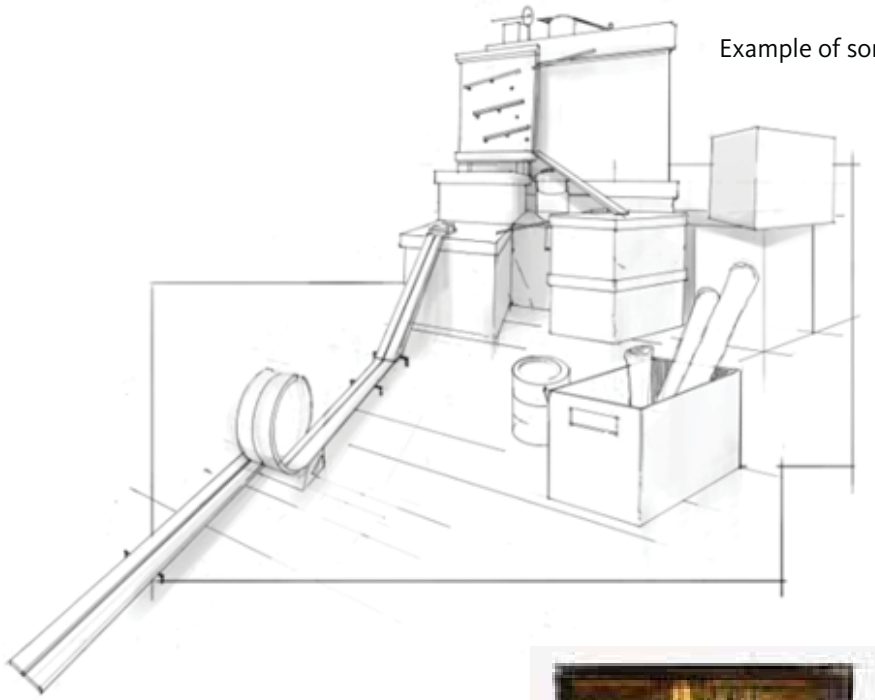
Managing Your Time

Managing your project and staying on your timeline with your production schedule is crucial to completing a great project. Let's look at an example of a project that's worked on and completed over an eight hour period of time.

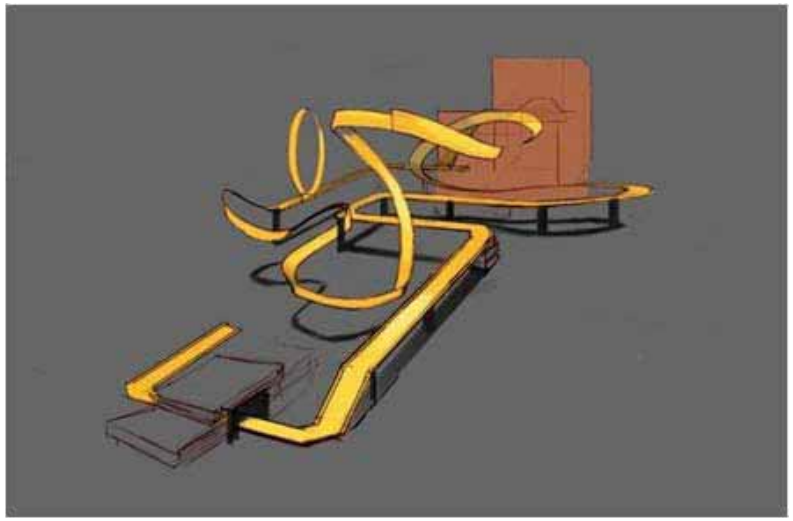
In this example we are going to use the "Mad Scientists Laboratory" as the example, we will just be working on the environment for this part of the project beause characters can be very complicated and take much more time.
The most important thing for any project is to be managed effectively so that you can meet your necessary deadlines. Having a production schedule will help you meet these deadlines in a timely manner. Not following a production schedule will often lead to either an incomplete or an average project. Here is the breakdown for the schedule.

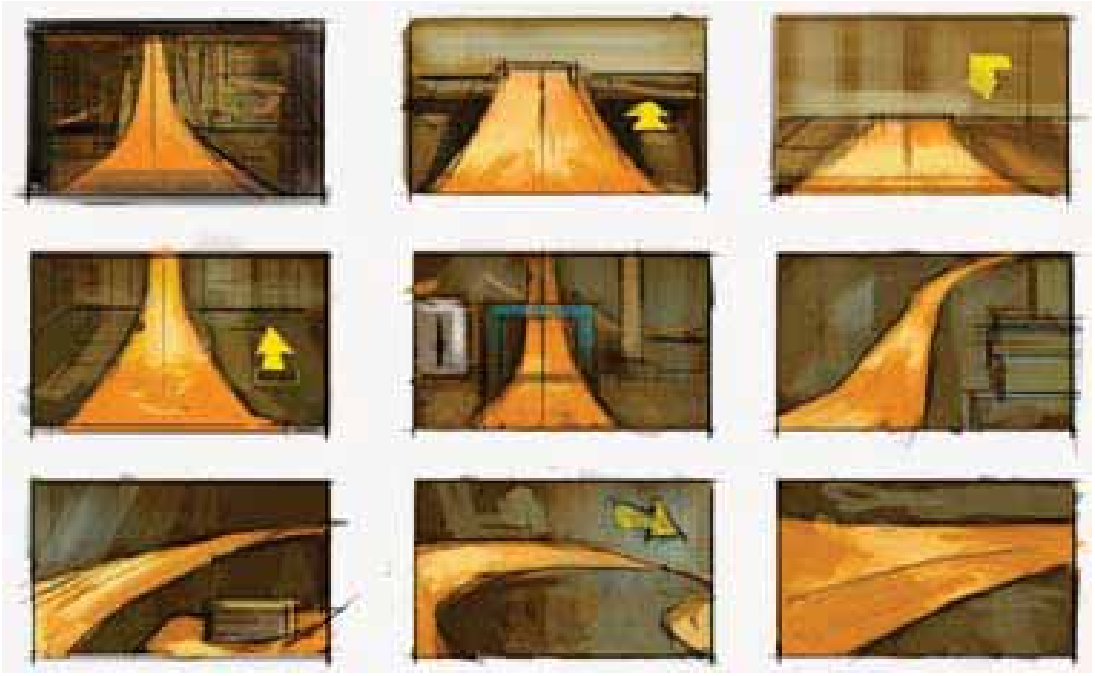
Production Schedule	Time	Managing your project
Come up with a concept, write down your ideas and create some rough sketches.	8:00-8:30 am	Have your project title, descriptive paragraph and some rough sketches complete.
Team breaks out responsibilities to decide who will be doing what tasks. Begin the storyboards and plan camera shots along with a prop list.	8:30-9:30 am	Assign a deadline for each task for example storyboards, modeling (working from prop list), lighting, animation, etc. along with coimpleting storyboards.
Concept, Sketches, Storyboard and Schedule/Workbreakdown are complete at 9:30 am		
Modeling begins, block in environment with basic shapes for composition and set up first lighting pass as team members create assests.	9:30-10:30 am	First pass Lighting set up and environment blocked in. Make sure to establish a proper project pipeline to flow from one task to another and that you will have time to complete all your assets.
Modeling completed, replace block in objects with final objects Review models. Refine second lighting pass thinking about your story.	10:30am to 1:30 pm	All Modeling complete, make sure you followed proper naming conventions. Add objects in layers to manage your scenes.
All Modeling complete! Be Save files often and also back up multiple files in increments.		
Begin Texturing objects, adding simple object animation, effects and final lighting pass.	1:30-3:30 pm	Texturing, object animation and effects complete (Make sure to group objects within your 3D scene to manage the scene better.)
Using your storyboard set up your camera to complete your 10 second fly through animation.	3:30-4:00 pm	Check a test version of the fly through. Keep making animation previews/playblasts to check your animations. 640x480. Render one frame and estimate how much time it will take for the entire animation.
Work Complete Begin Rendering and Presentation!!!		
Render your final animation and complete still images for your presentation.	4:00-4:45 pm	Make sure you can render in this amount of time! Prepare your still images, storyboard, and project description for presentation following the guidelines.
Rendering done! Make the movie and submit your presentation.	5:00 pm	Congratulations!

Process



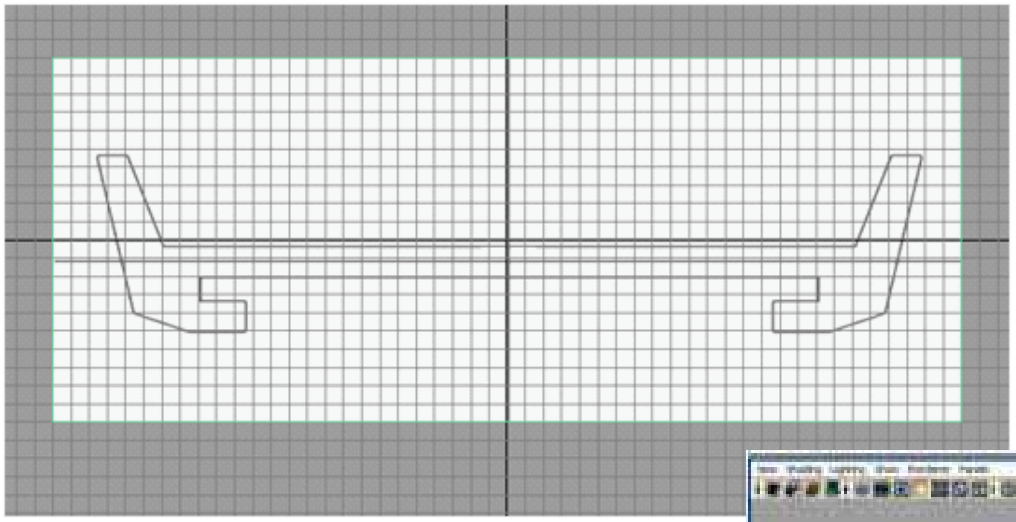
Example of some initial ideas.



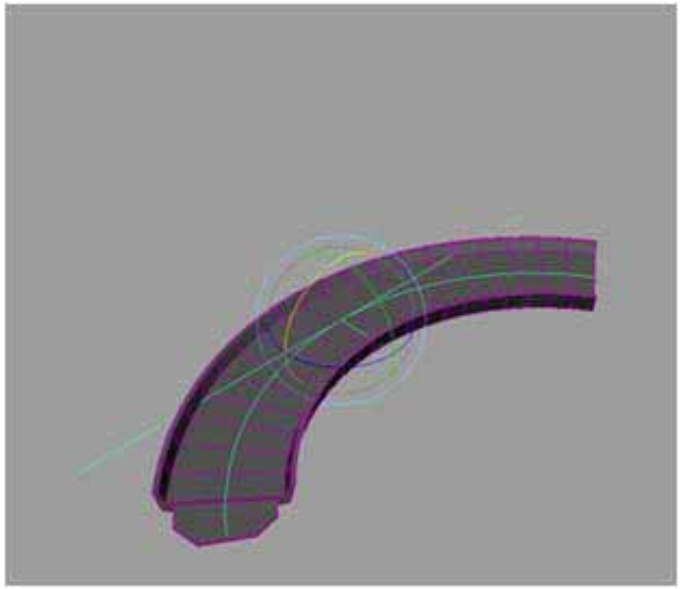


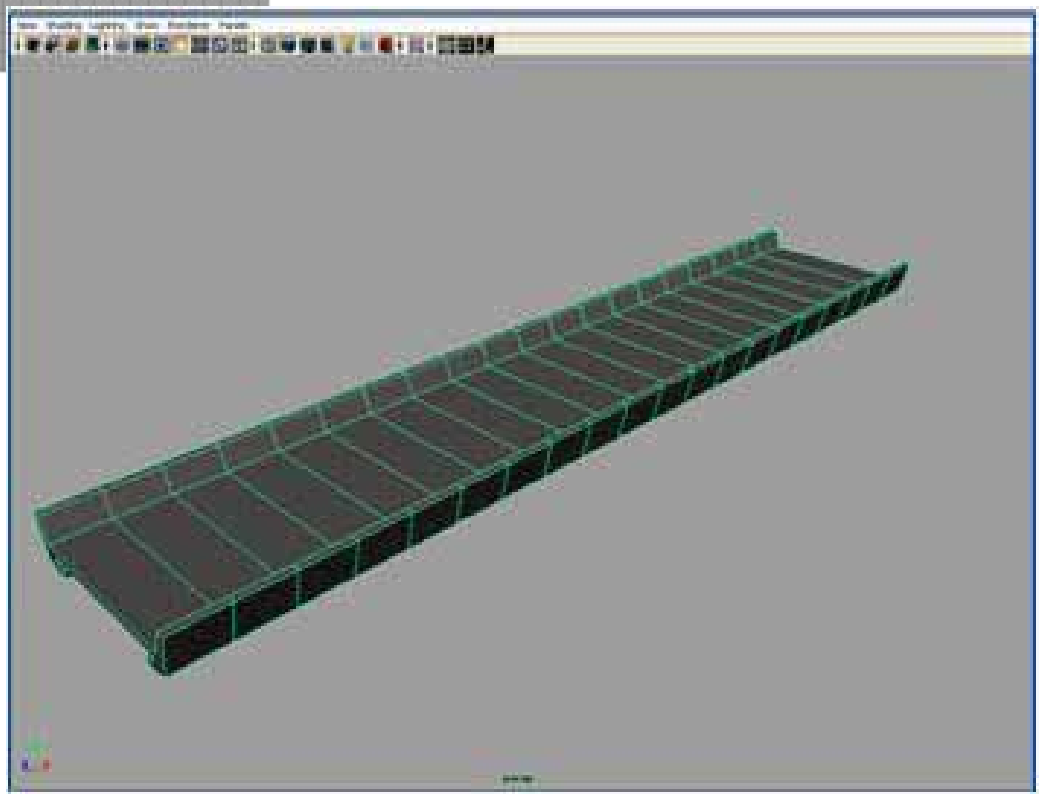
A storyboard displaying the track

Process

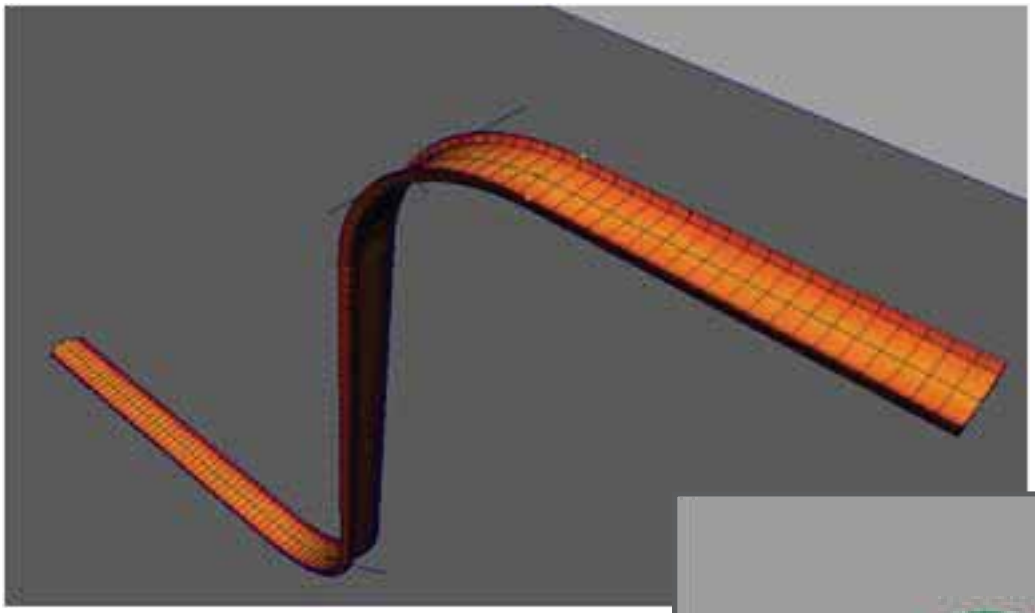


Modeling the track getting the reference images in your 3D software

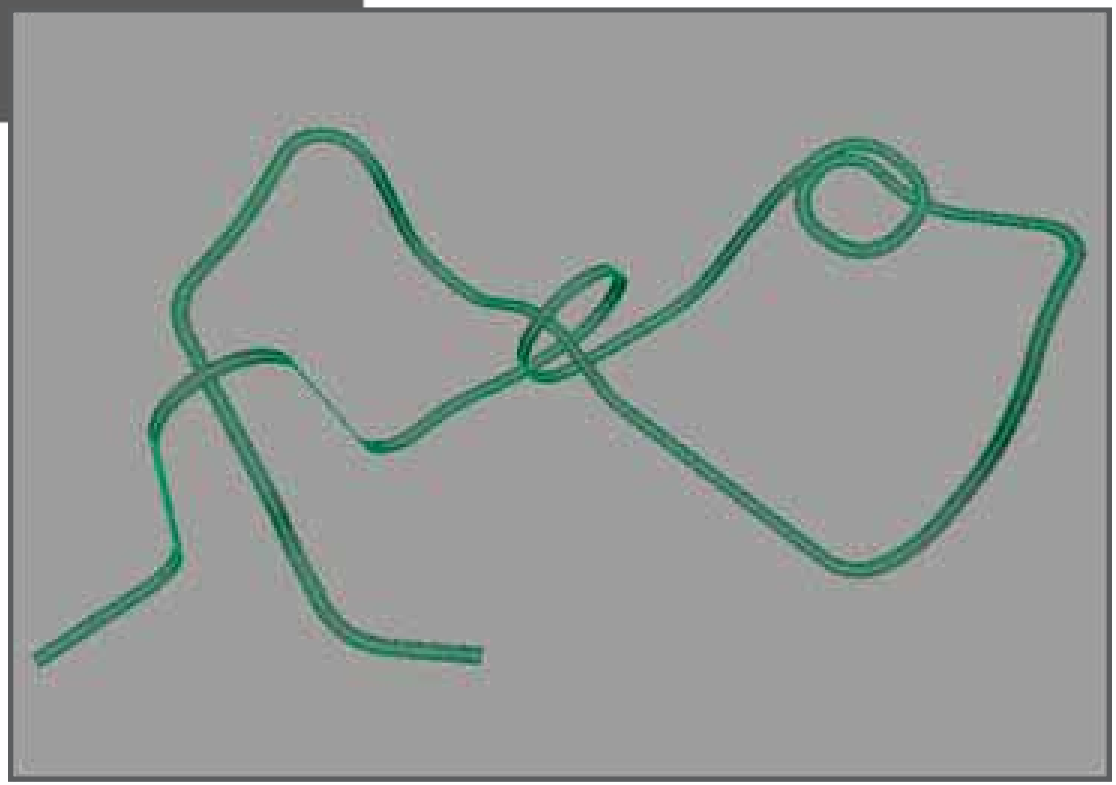




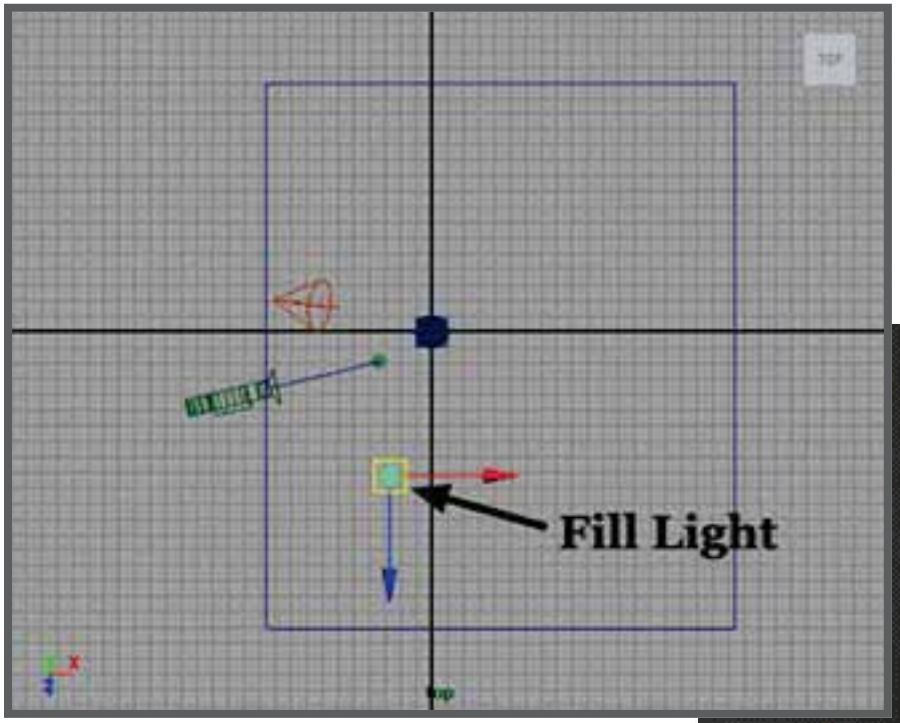
Process

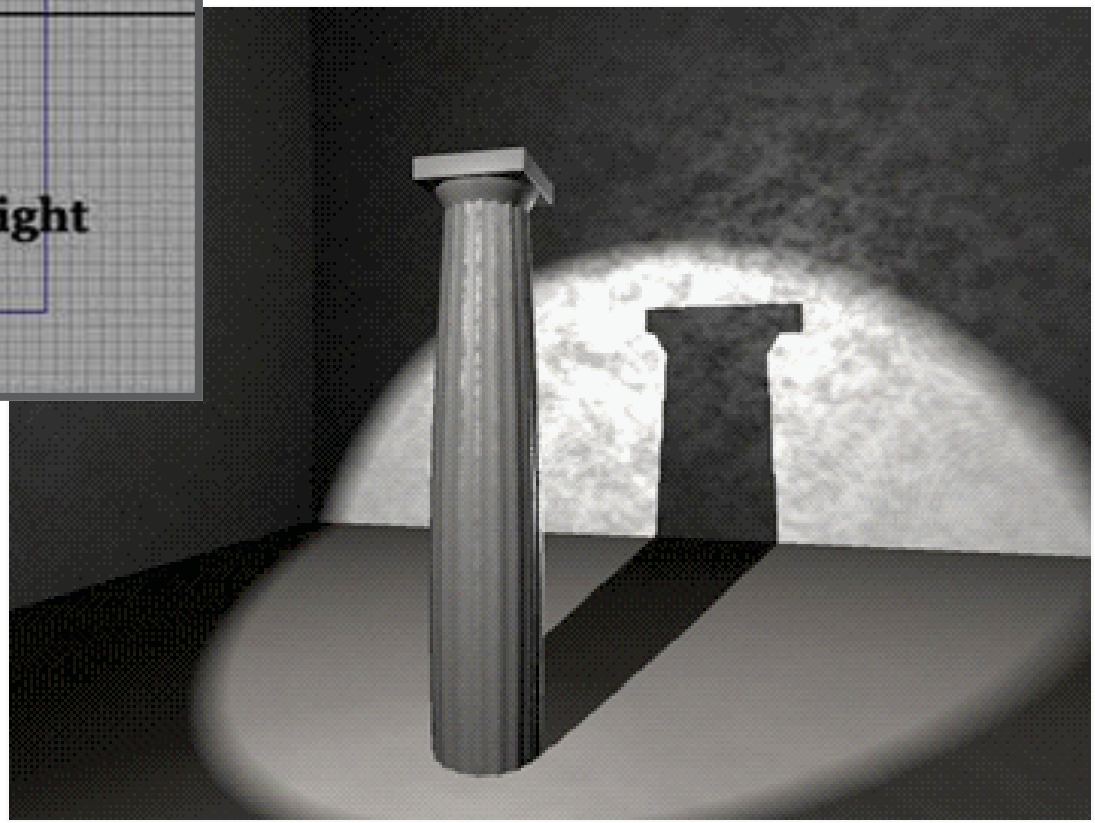


Assembling the track to curve it



Process



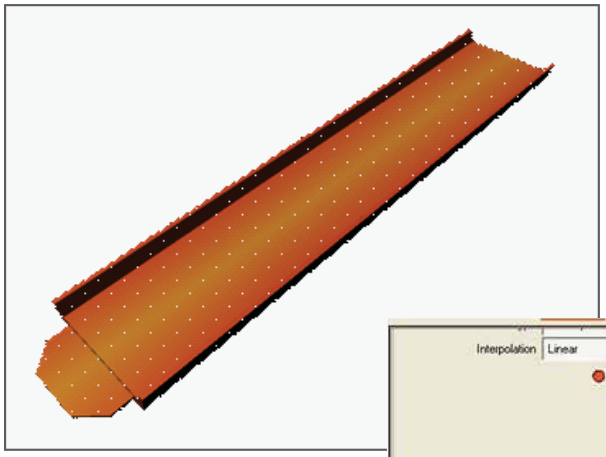


Some lighting studies before you begin lighting the entire scene (The entire scene will be lit not just the track)

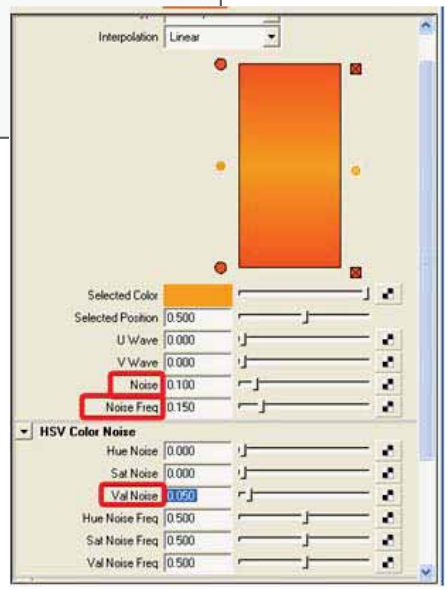
Process

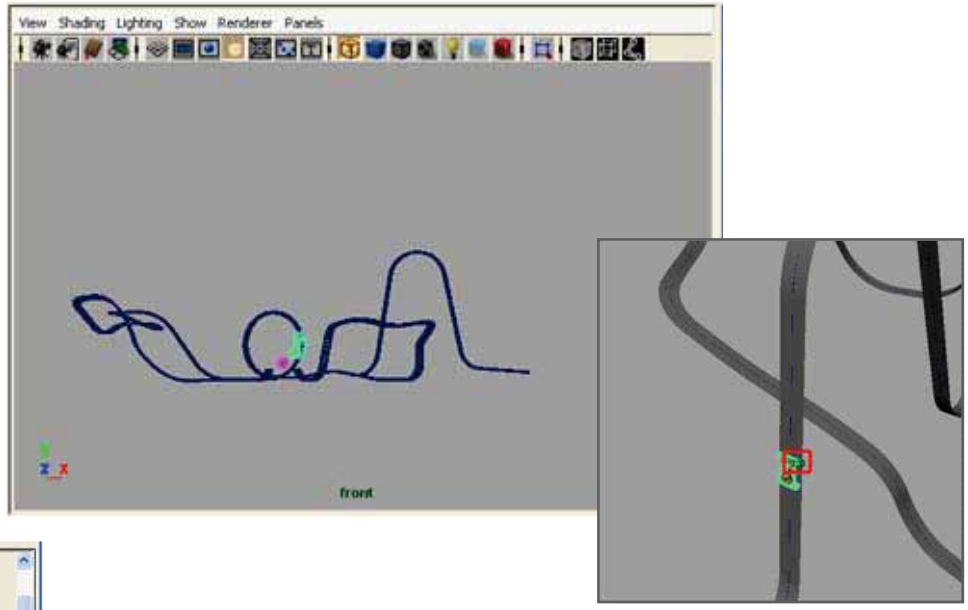
Track lit with the entire scene

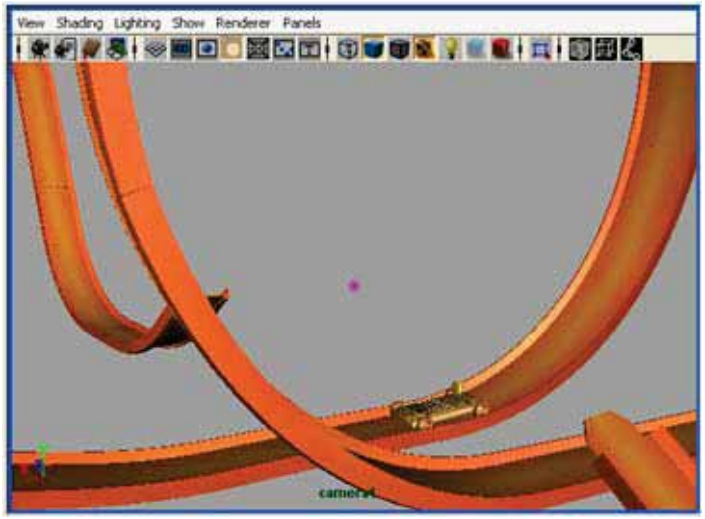
Process



Creating materials for the track



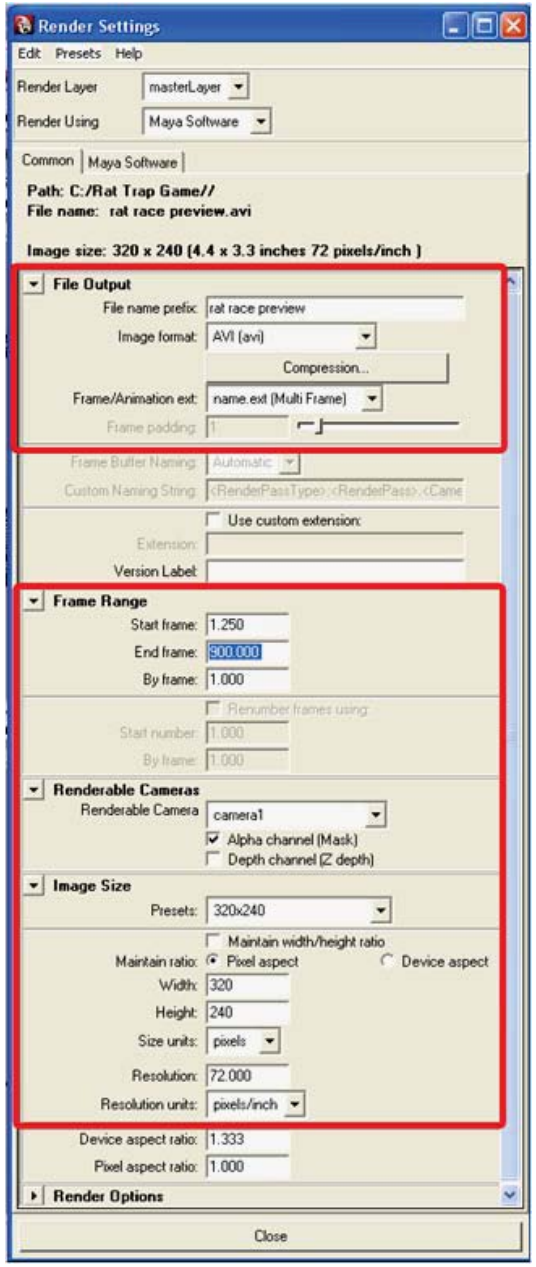




The track used for animating the vehicle

Process

Rendering the scene

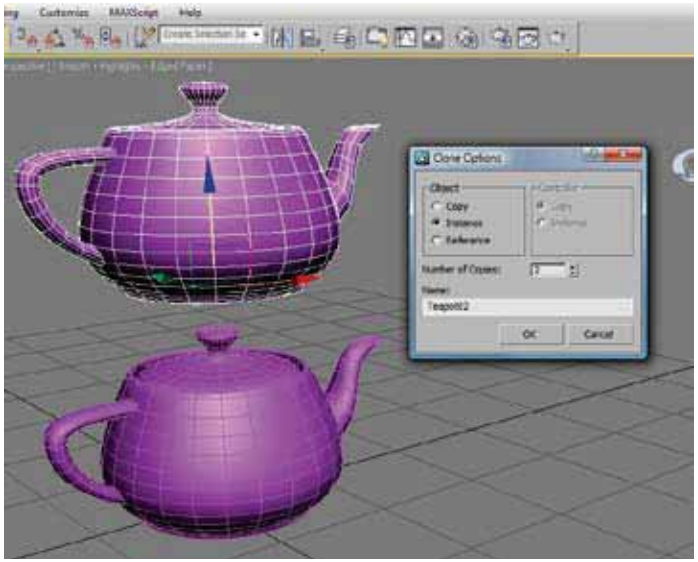


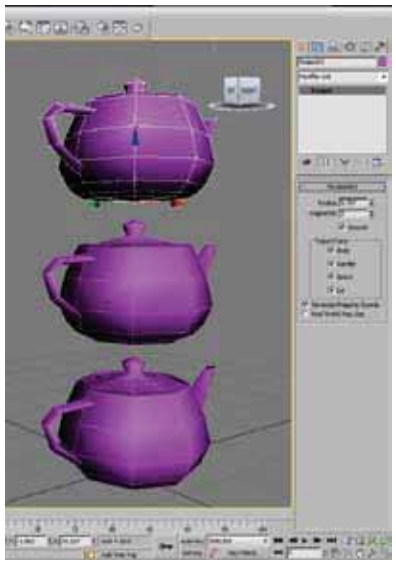
Final Render

Workbook

Interface/Menus

Autodesk® 3ds Max®





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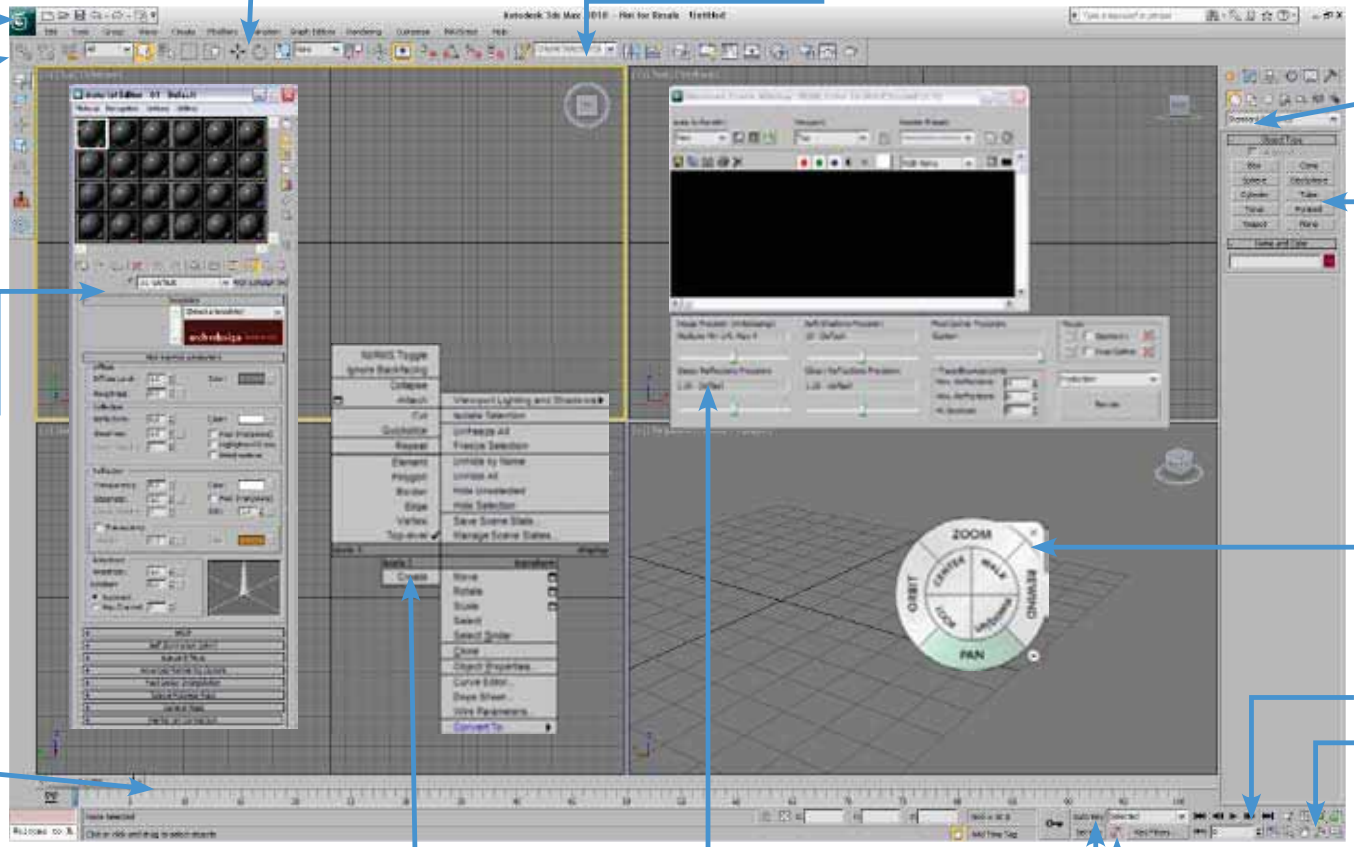
3dsMax Interface

1 - Setting a Project
When you start up 3DS Max, it is best practice to set up a project file. This will allow you to always save work to a specific directory.

2 - Transform, Rotate, Scale
These tools allow you to Select, Transform, Rotate and Scale objects in the scene.

3 - Layers and Selection Sets
Layers allow you to manage the objects in your scene. Selection Sets allow you to add objects to sets for easy selection.

4 - Primitives
In 3DS Max you create primitive 3D geometry as a starting block to modeling detailed 3D objects.



5 - Material Editor
The Material Editor is where all materials and maps are created. It's easy to use and materials can be dragged and dropped onto objects in the scene.

6 - Viewport Navigation
Using the viewport Tools, you can orbit, Pan and Zoom the Viewports.

7 - Quad Menu
The Quad menu can be accessed in the viewport by right clicking the mouse. You will get a different menu dependent on what objects you are working with.

8 - Rendering
When you render, 3DS Max converts a 3D Scene into a 2D Image.

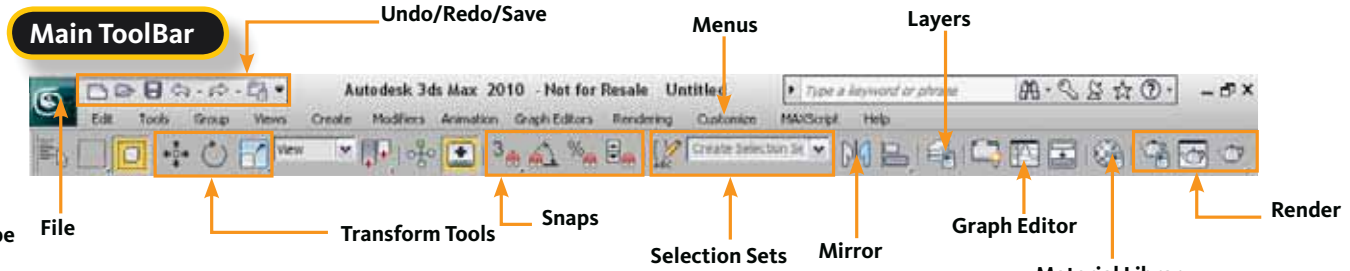
9 - Auto Key
Auto Key allows you to automatically key objects as you scrub through the timeline making transform, Rotate and Scale changes. Any change you make a key will be created.

10 - Animation Settings
Animation Settings allow you to take control over all aspects of your animation setup, from Frame Rate to Number of Frames.

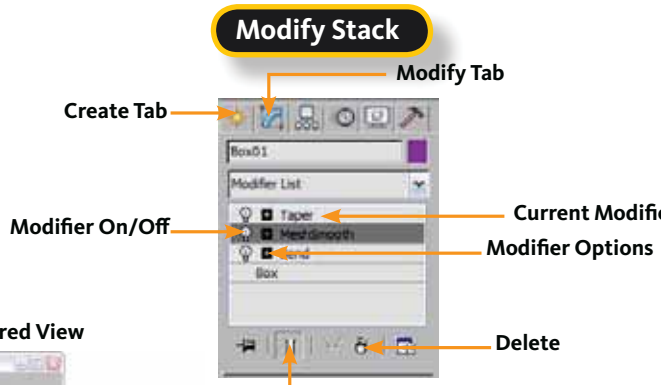
3dsMax Menus

Material Editor

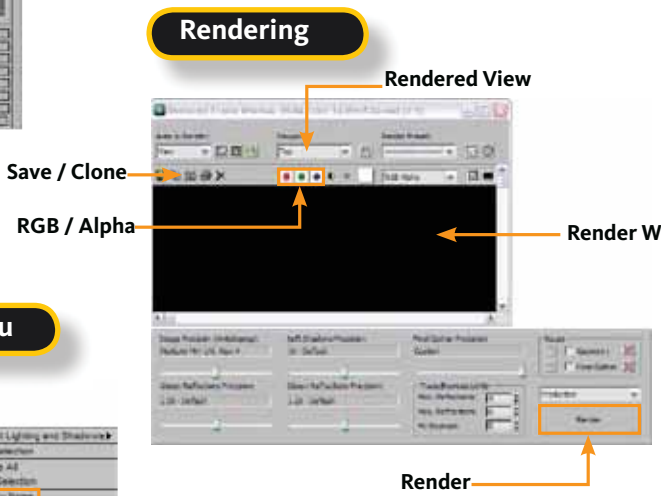
Main ToolBar



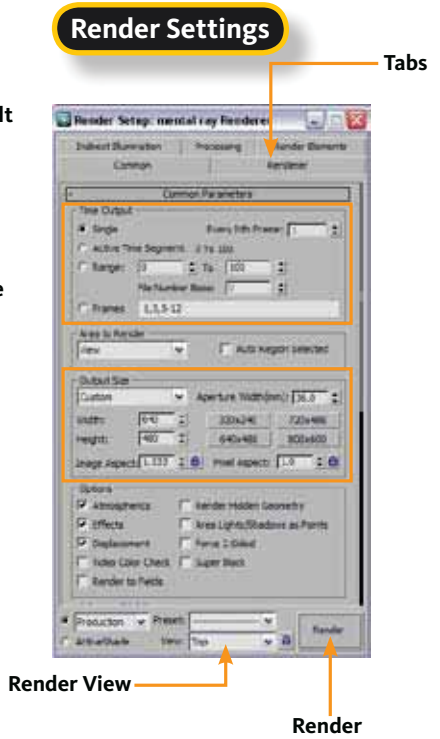
Modify Stack



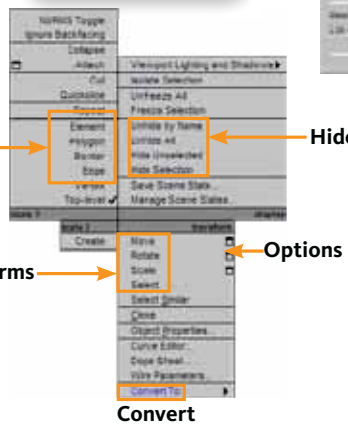
Rendering



Render Settings



Quad Menu

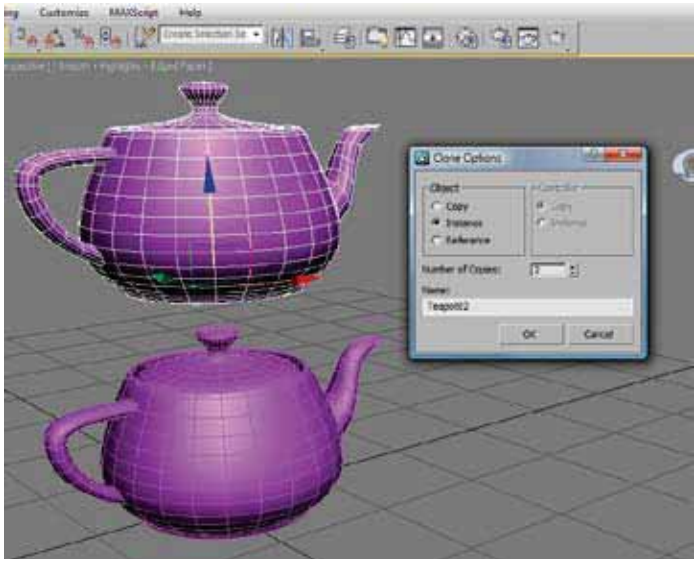


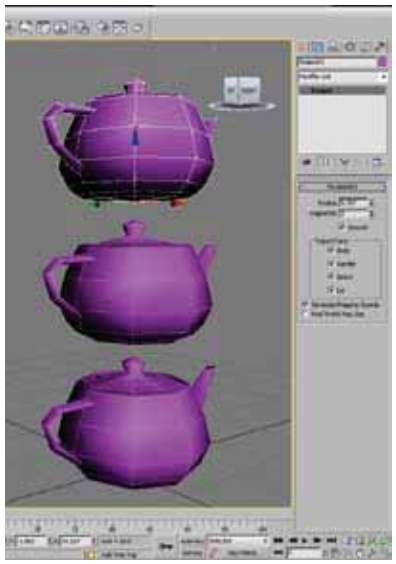
Modifiers

Workbook

Getting Started Tutorials

Autodesk® 3ds Max®





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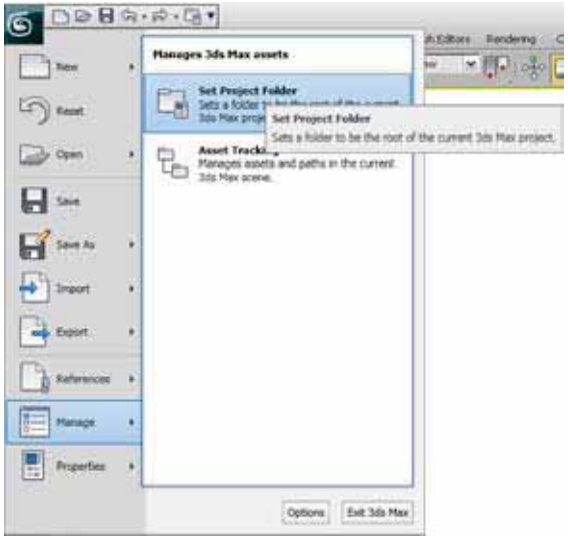
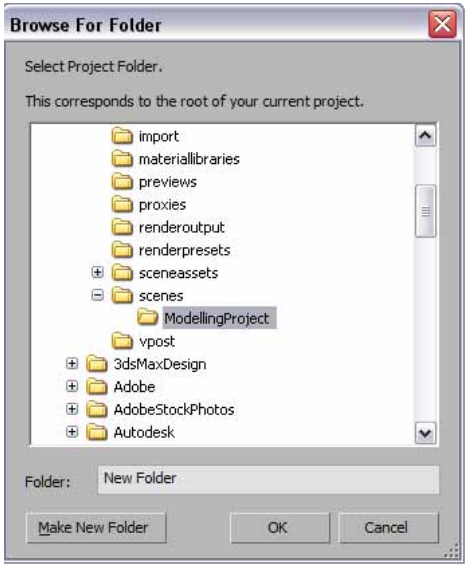
3dsMax Setting Up a Project

1



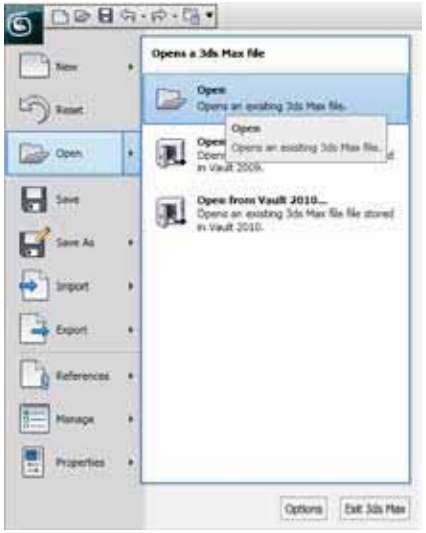
File Management is crucial to the success of any 3D project. By setting a project folder, you are always making sure that files get saved to specific and relevant directories. For example when you set up a project all scene files you save are saved to the Scenes Folder, any materials you save are saved to the Materials Folder etc. First got to File›Manage›Set Project Folder.

2



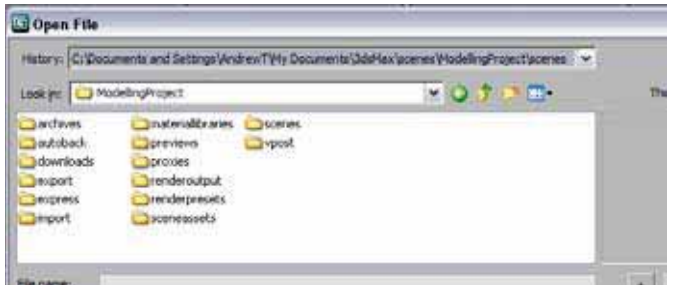
Click on Set project Folder. In the Browse For Folder dialog that appears, navigate to a directory and create a new Folder. This folder should have a name relevant to the project. Once you have created the project folder, click OK. Your project Folder is now set. Every time you hit save the current scene will get saved to this directory.

3



With your project folder now set, if you go to File›Open you will bring up the Open File dialog.

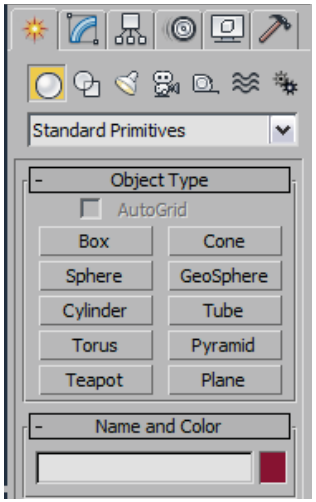
4



The Open file dialog, navigates you directly to the Scenes Folder, in the project Folder you set up earlier. Notice that all your files are laid out in an organized manner. Any files you save, Export, Render are all saved to their relevant Folders making it really easy for you to manage your project and ensure that data doesn't get lost.

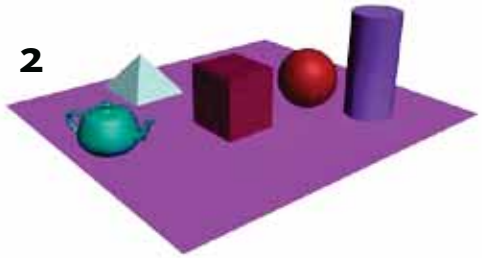
3dsMax Working with Primitives & Editable Polygons

1



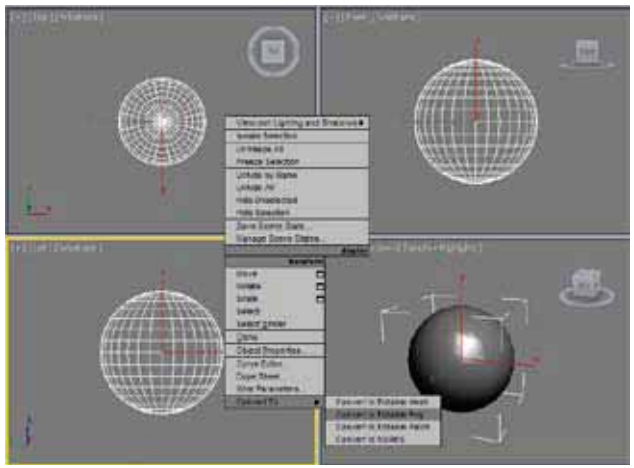
You can create primitive objects by going to the Create Tab in the Command Panel

2



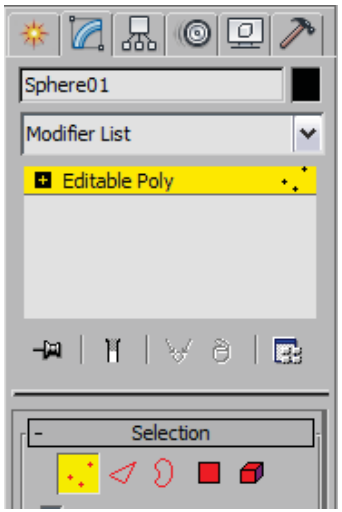
Primitive objects consist of Boxes, Spheres, Cones, Planes, Pyramids and Cylinders. They are easy to create, generally with a 2 click mouse operation

3



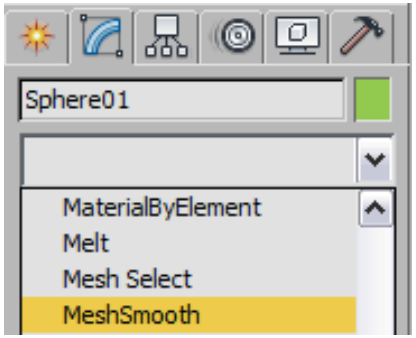
Once you have created a primitive object as your starting block you can convert it to an Editable Poly and then start using some of the Sub-Object modeling tools to develop and refine your model. Any primitive can be converted to an Editable Poly just as a shape can be converted to an Editable Spline. All Editable Polys allow you access to Sub-Object modes.

4



An Editable Poly has 5 Sub-Object levels, Vertex, Edge, Border, Polygon and Element. Each of these levels allows you access to different elements of the Poly.

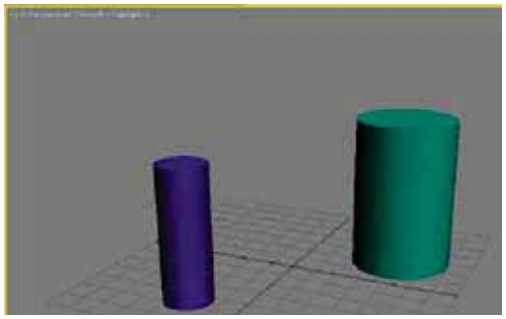
5



Modifiers can also be applied to objects in the Modify Tab, through the Modifiers List. When a modifier is added, it appears above the Editable Poly in the Modifier Stack.

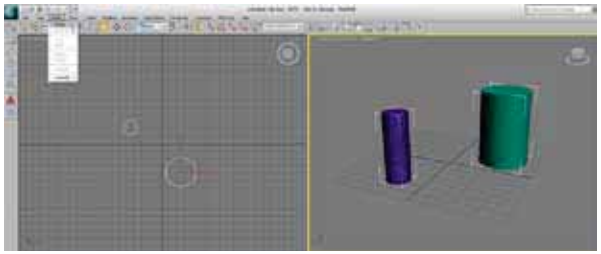
3dsMax Grouping vs. Selection Sets

1



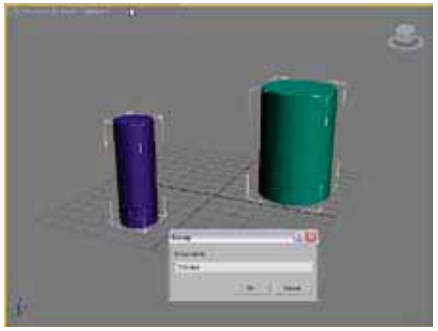
In this tutorial you will get started with creating simple groups and selection sets. It is important to understand the differences between the two, and when to use them. To add objects to a group you will first create two Cylinders in the viewport.

2



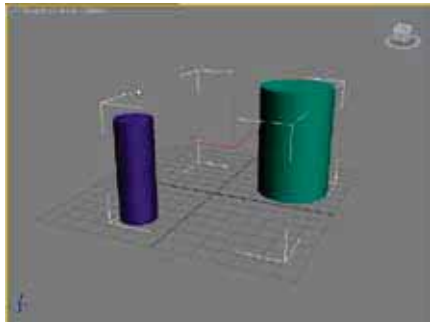
Select the two objects using the Select Object tool from the Main ToolBar. On the Menu Bar go to group Menu>Group.

3



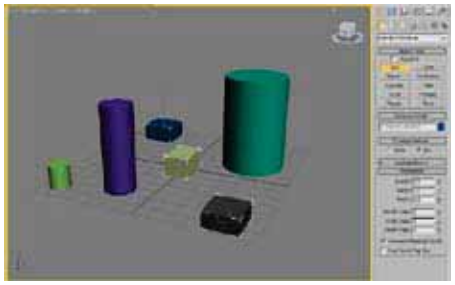
The Group Dialog appears. Give your group a name.

4



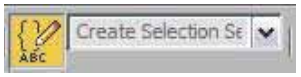
Now if you select either one of the two cylinders they both become selected as a group. With Groups you can only select the objects as a whole group. You can't go in and select individual components of a group. That's where Selection Sets come in handy.

5



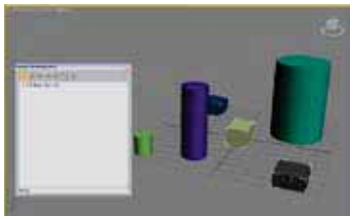
Selection sets let you add objects to sets and select them. This is helpful when objects are hard to see. Create a series of Boxes and Cylinders in the Viewport.

6



From the Main ToolBar hit the Selection Sets Button

7

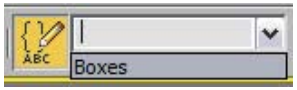


The Selection Sets Dialog Appears. Select the Boxes and hit the + sign in the dialog. This adds the Boxes to a Selection Set.

8

You will see a new Set appears, Double click on it to Rename it. Give it a logical name.

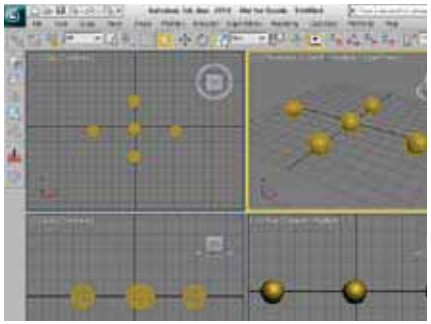
9



From the Selection Set Filter on the Main Toolbar, hit the drop Down Arrow and you will be able to select the boxes easily.

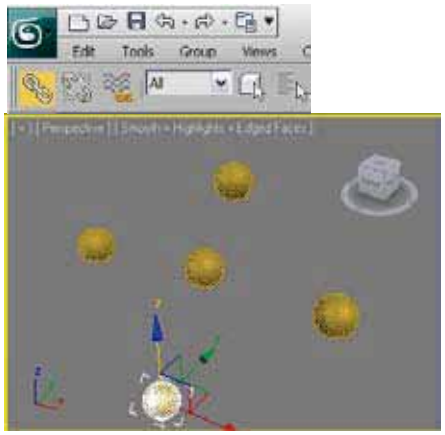
3dsMax Linking & Parenting Primitives

1



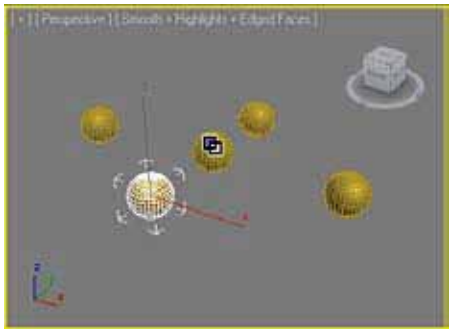
When you link objects in 3DS Max, you create Child-Parent relationships, where the child will always follow the movements of the parent. You will create a set of primitive spheres. You can copy the arrangement you see here or you can follow along. We will link all the outside spheres to the central sphere and have that sphere act as the parent.

2



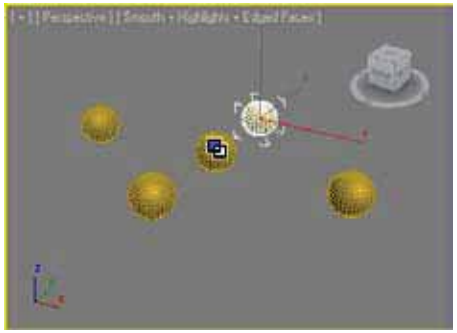
Select the sphere as shown, and from the Main Toolbar go to the Select and Link Tool. Drag from the Sphere to the central sphere. The outer sphere becomes the child and the central sphere becomes the Parent. Always select the Child first.

3



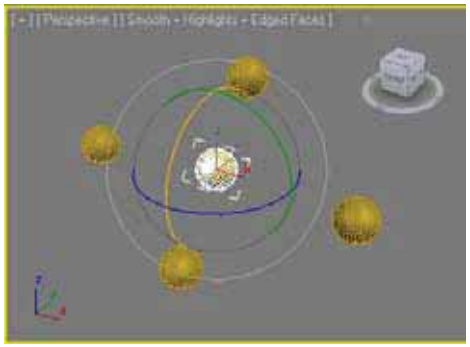
When you drag from the Child to the Parent, you will see a rubber band drawn between the two spheres. Release the mouse over the Parent.

4



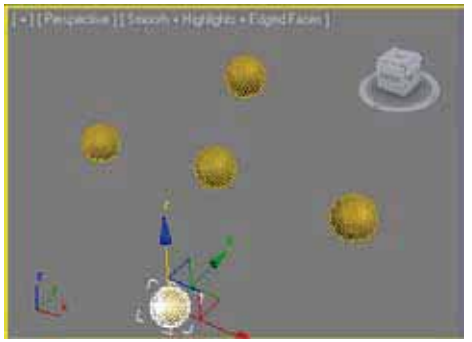
You can now select all the remaining outer spheres and drag to the central sphere, the Parent.

5



Now that you have linked all the outside spheres to the central sphere, or the Children to the Parent. If you select the parent and rotate it in the X-Axis, all the Children will follow.

6



If you select one of the children and move it, it will move independently of the parent. However, when you select the Parent again and rotate it, the Child will be bound to it from its new position.

7

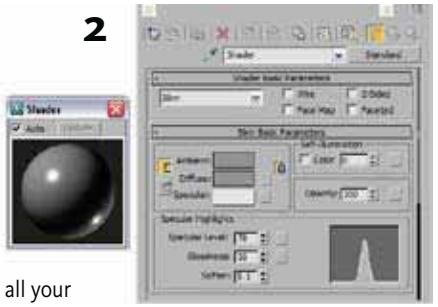
If at any time, you wish to unlink objects, you can do so by selecting all the objects you wish to unlink, and from the Main Toolbar select the Unlink button. This will unlink all Children from the Parent.

3dsMax Creating Materials & Textures

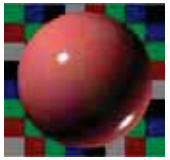
1

The Material Editor is an Easy to use dialog. This is where all your scene materials and textures will be created. The Material Editor allows you to manage individual scene materials in their own individual material slots. You can create Procedural Materials. These are materials created parametrically within 3DS Max. You can also create Bitmap Materials. These use external image files.

2



First you will create a simple Procedural Material. To do this click on an empty material slot. Click the Arch and Design Slot, and from the Material/Map browser select Standard. You are now working with a simple Standard Material. Click the Diffuse Color Swatch and change it to Red.

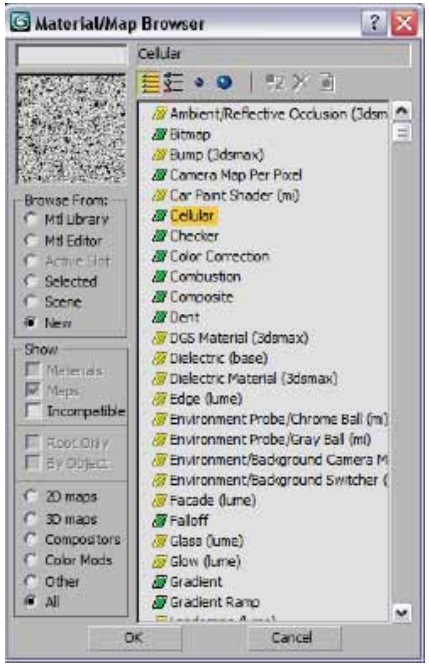


You have created a simple material that is now ready to be dragged and dropped onto an object in your scene.

3

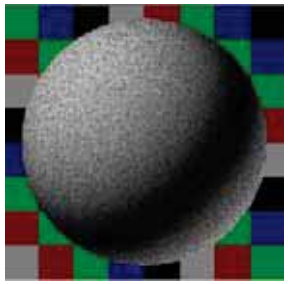
You will now create a material with a Texture Map applied to it. Select an empty material slot, and change it to standard. Click the little grey Map button next to the Diffuse Slot. This will bring up the Material/Map browser and will allow you to select a map for your material.

4



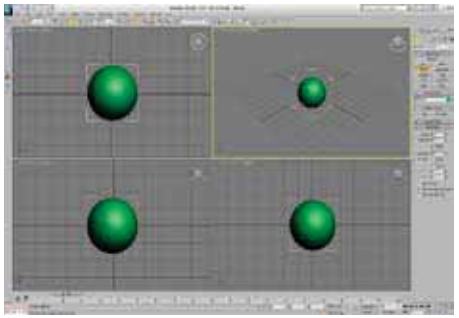
From the Material/Map Browser, select a Cellular Map. This is a procedural texture map, meaning that the texture is controlled via sets of parameters within the Material Editor. If you select a Bitmap file, it is best to save the image to your Images Folder in your Project Directory , and load it from there. This file will also need to be supplied with the scene file when you transfer to another computer.

5

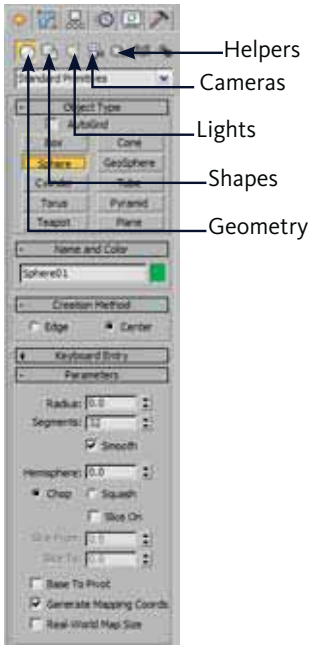


If you double click on the Cellular Map, you will notice it is added to the Diffuse slot of your Standard Material, and the material takes on a new appearance. Maps are great for creating realistic looking textures.

3dsMax Basic Animation

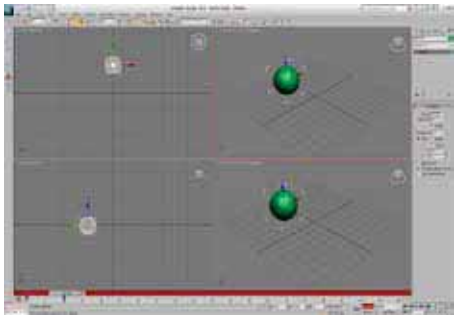


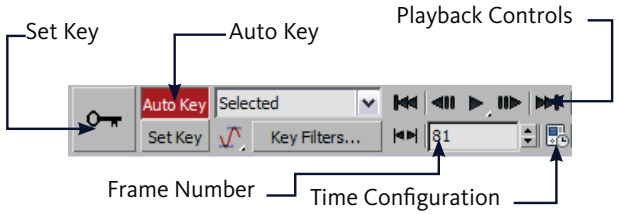
In this tutorial, you will create a simple animation of a sphere moving across the viewport. To start, go to the Command Panel>Create>Geometry>Sphere. Left Click in the viewport and drag out a Sphere. Right click when you are done. Go to the Main Toolbar and select the Move Tool. Select the Sphere. You are now ready to start animating.



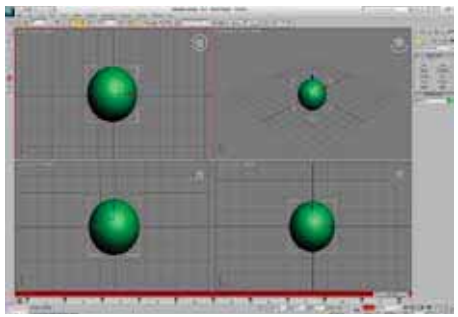
The Command Panel is a very important part of 3DS Max. Its where all objects are created and modified. It is made up of Tabs that are arranged in an easy to use layout. Most object parameters can also be animated using Auto key or Set Key. Lights and Cameras can also be animated.

Go to the bottom right of the interface and hit the Auto Key button. Move the Time Slider to Frame 10 and then move the Sphere to a new position. Notice that two key frames are created. One at frame 1 and one at Frame 10. Move the Time Slider to Frame 20 and move the Sphere.

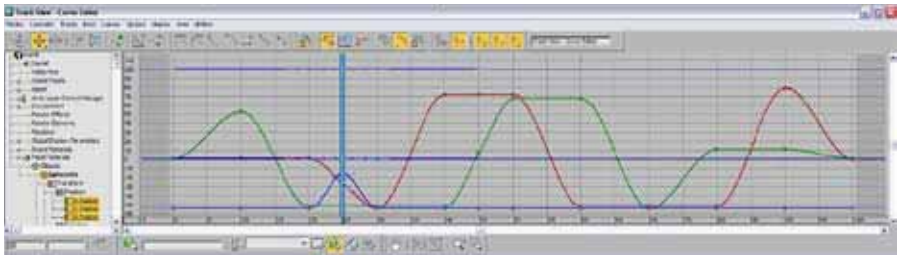




The animation and Playback controls allow you to play your animation in real-time in the 3DS Max viewports. Auto Key, allows you to set an initial key, scrub through the timeline, move your object, and the object will be automatically keyed. It's a quick and easy way to animate objects in 3D space



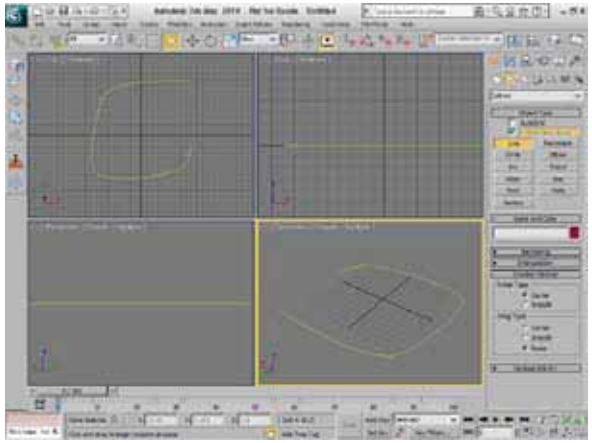
As you move the Time Slider across the Time Line and move the Sphere you will see new keys are created. Set new Keys at Frames 30, 40, 50 etc until you reach 100. When you are done be sure to turn off Auto Key.



Once you have animated your Sphere, Go to Graph Editors>Track View - Curve Editor. With your object selected you will see the animation curves that were created. You can refine your animation using these curves.

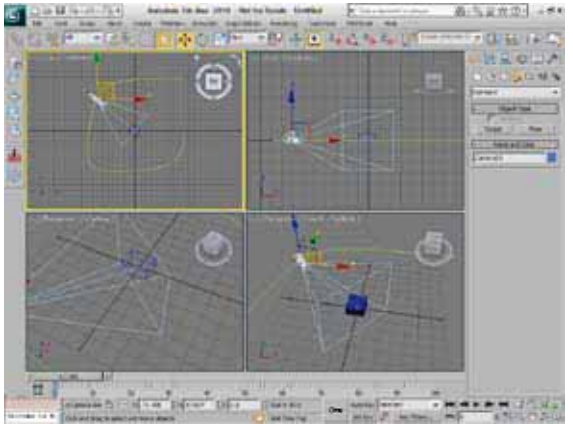
3dsMax Animating a Camera Along a Path

1



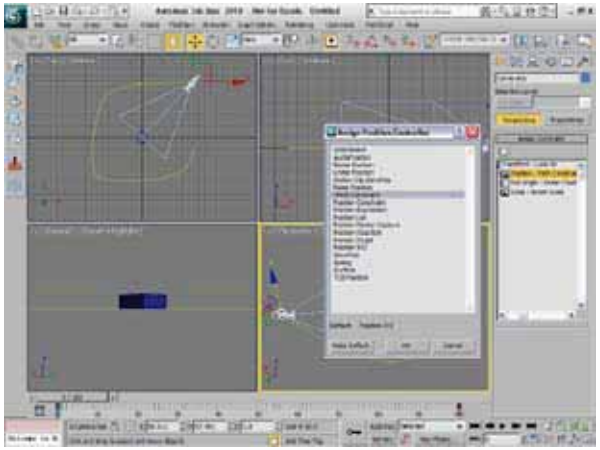
In this tutorial, you will animate a camera along a path. This is a great way of creating camera walkthroughs. You can attach either a Free Camera or a Target Camera to a path. First go to Command panel›create›Shapes›Line and create an open spline. This will be used as the path. The next step will be to create a target camera and an object in the scene for the camera to look at.

2



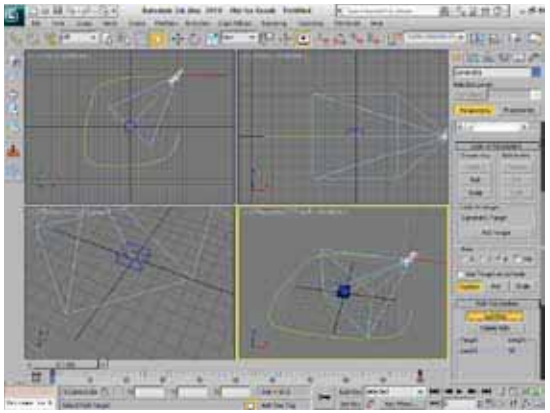
Create a box and put it at the centre of the path. To create the Camera, go to Command Panel›Create›Cameras›Target Camera. In the Top view, place your Camera over the path and drag until the target is over the box. In the next step, you will attach the camera to the path. You will do this using a Transform Controller called a Path Constraint.

3



To create the Path Constraint Controller, select the camera and go to the Command Panel›MotionTab. In the Motion Tab, Click on the Position option in the Assign Controller Rollout so it becomes highlighted in yellow. Next Click on the little button in the rollout to bring up the Assign Position Controller dialog. You will select Path Constraint. You won't see much happen yet other than the Path Controller being added to the Position Transform.

4

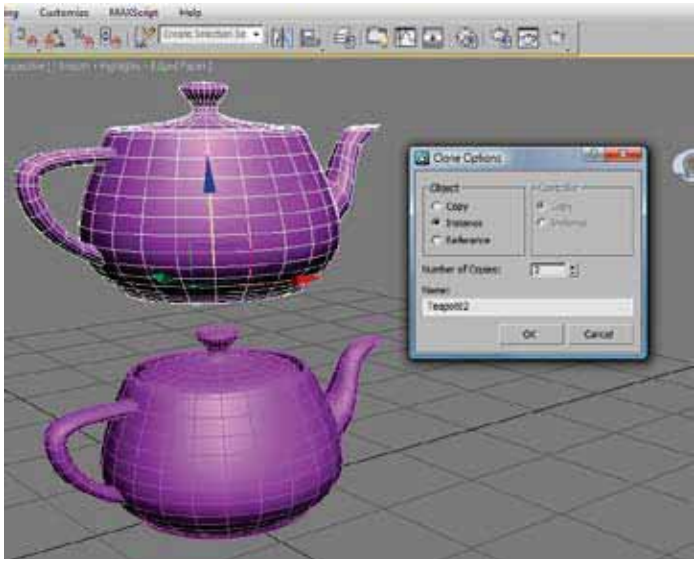


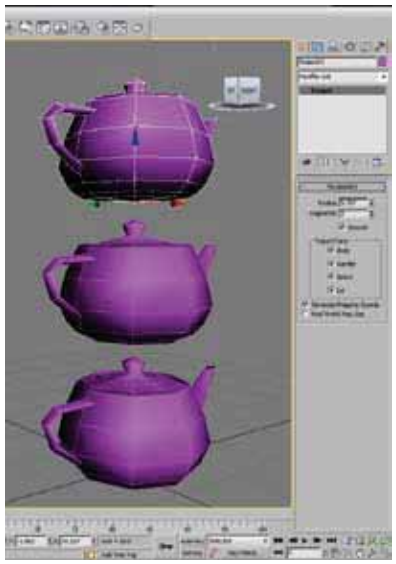
Scroll down the Rollout to the Get Path Button. Press the button, and with the cross hair, click on the path. You will notice the camera jump to the start of the path whilst the target remains over the box. You will also notice that two key frames have been added at the start and end of the Time Line. If you press play in the play back controls you will see the camera move along the path, whilst the target remains over the Box. Press C on your keyboard to go to the Camera View. You cannot move the camera directly anymore, you must move the path and the camera will move with it. Go ahead and try adding a Free Camera to the Path

Workbook

Learning

Autodesk® 3ds Max®





2010

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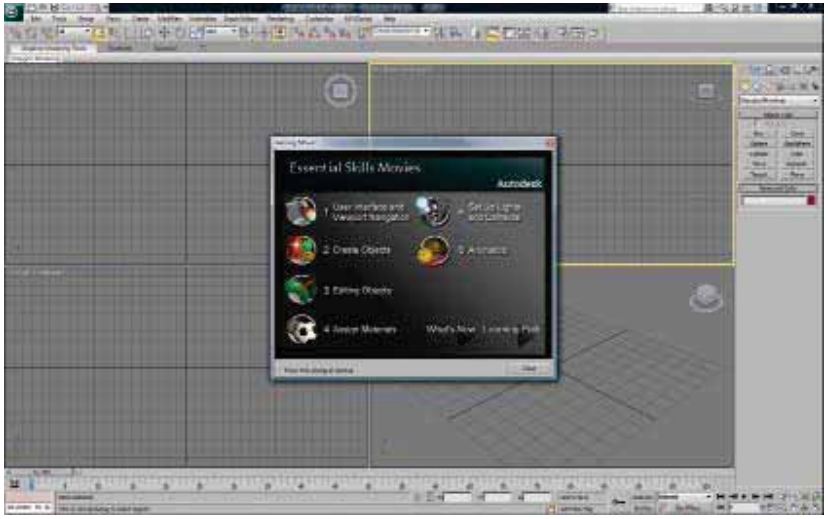
Opening Autodesk 3ds Max 2010

After installing 3ds Max 2010 you can open it two separate ways. One is by simply double-clicking on the icon that 3ds Max will have generated during installation on your desktop.

Alternatively, you can navigate to 3ds Max in Windows® by navigating to **Start→Programs→Autodesk→Autodesk 3ds Max 2010**. Upon launch you should be given two options. If you have purchased 3ds Max 2010 you will have an activation code that came with the software documentation. Follow the steps on-screen during the activation process to launch the software. If you are using 3ds Max on a trial basis, choose that option and the software should load with a 30-day trial that has all of the features of the regular version for a limited time. Once the software loads, you will see 3ds Max software's first splash screen.



3ds Max 2010 startup splash screen.

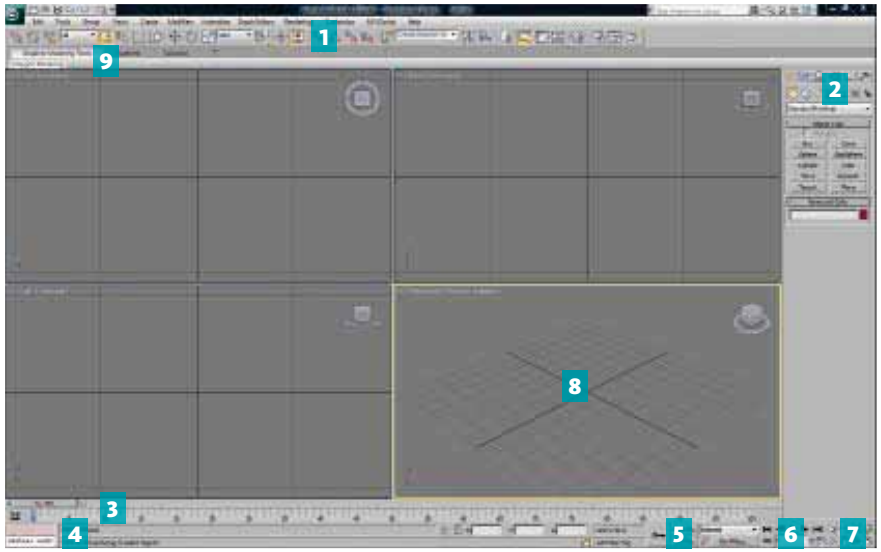
Here you will find that the first splash screen points you in the direction of Essential Skills Movies. These short movies are designed to jump start you in the direction of whatever it is you are using 3ds Max 2010 for. By clicking on any of the six movie choices, 3ds Max will automatically launch your default Internet browser and begin playing a short video, giving you some basic instruction on your topic of choice. These video clips are just a small taste of the help that is available for you when learning the software.

The **What's New** option will launch your default Internet browser and take you to the Autodesk website dedicated to explaining the newest features in this version of 3ds Max. If you are familiar with previous versions of 3ds Max, this site will provide you with additional training and videos on the most recent additions to the software.

The **Learning Path** option will launch your default Internet browser and take you the Autodesk 3ds Max Service and Support website. This site can point you in the direction of a multitude of topics regarding 3ds Max, including tutorials, discussion forums, additional help and documentation, as well as events and seminars. If you are new to 3ds Max, this is a great resource for furthering your education or finding answers to questions you may have while learning the software.

Lastly, on the bottom left of the box you can check on or off under **Show this dialog at startup** to show this popup when you launch 3ds Max or not. If you decide to not have the box pop up at launch, but would like access to any of these features, you can find them under the **Help** menu on the main toolbar. Once you have clicked **Close**, you are looking at the default 3ds Max 2010 interface. Take a moment to get familiar with the basics of the interface as we start to address some of the key

3dsMax Skills



The 3ds Max 2010 interface.

Key Interface Elements

Using the image above as a guide, let's look at some of the main UI elements in 3ds Max 2010.

1 Main Toolbar

The main toolbar provides quick access to tools and dialog boxes for many of the most common tasks in 3ds Max 2010.

2 Command Panel and Menu Bar

The command panel comprises six user-interface panels that give you access to most of the modeling features of 3ds Max 2010, as well as some animation features, display choices, and miscellaneous utilities. To switch to a different panel, **LMB** click the tab at the top of the command panel.

3 Time Slider

The time slider lets you navigate along the timeline and jump to any animation frame in your scene. You can quickly set position and rotation or scale keys by **RMB** clicking the time slider and choosing the desired key from the Create Key dialog box. We will discuss animation and the time slider further in Lesson 11, as well as Projects 5 and 6.

4 Status Bar Controls

The 3ds Max 2010 window contains an area at the bottom for prompt and status information about your scene and the active command. To its right/left is the coordinate display area, in which you can manually enter transform values. To its left, is the MAXScript listener window, where you input single-line scripts.

5 Animation and Time Controls

Between the status bar and the viewport navigation controls are the animation controls, along with the time controls for animation playback within viewports.

Use these controls to affect your animation over time. We will discuss animation and the time controls further in Lesson 11, as well as Projects 5 and 6.

6 Animation Playback Controls

Use these buttons to see your scene in motion through time. We will discuss animation and the playback controls further in Lesson 11, as well as Projects 5 and 6.

7 Viewport Navigation Controls

Use these buttons to navigate your scene within the viewports. As we progress further in this lesson we will explore these features more.

8 Viewport

When you start 3ds Max 2010, the main screen contains four viewports showing the scene from different angles. By default you are looking at the Top, Front, Left, and Perspective views respectively. The Top, Front, and Left views are 2D representations of your scene, also referred to as Orthographic views.

The Perspective viewport, by contrast, most closely resembles human vision in 3D. We will cover viewport navigation further in this lesson.

9 Graphite modeling tools

The graphite modeling tools menu is new with 3ds Max 2010, and it combines a wealth of new polygon-modeling features, including freeform sculpting and powerful loop-modeling tools, with the tried-and-true toolset in a dynamic, configurable new ribbon interface. By clicking the small arrow button at the end of the bar you can minimize and maximize the toolbar.

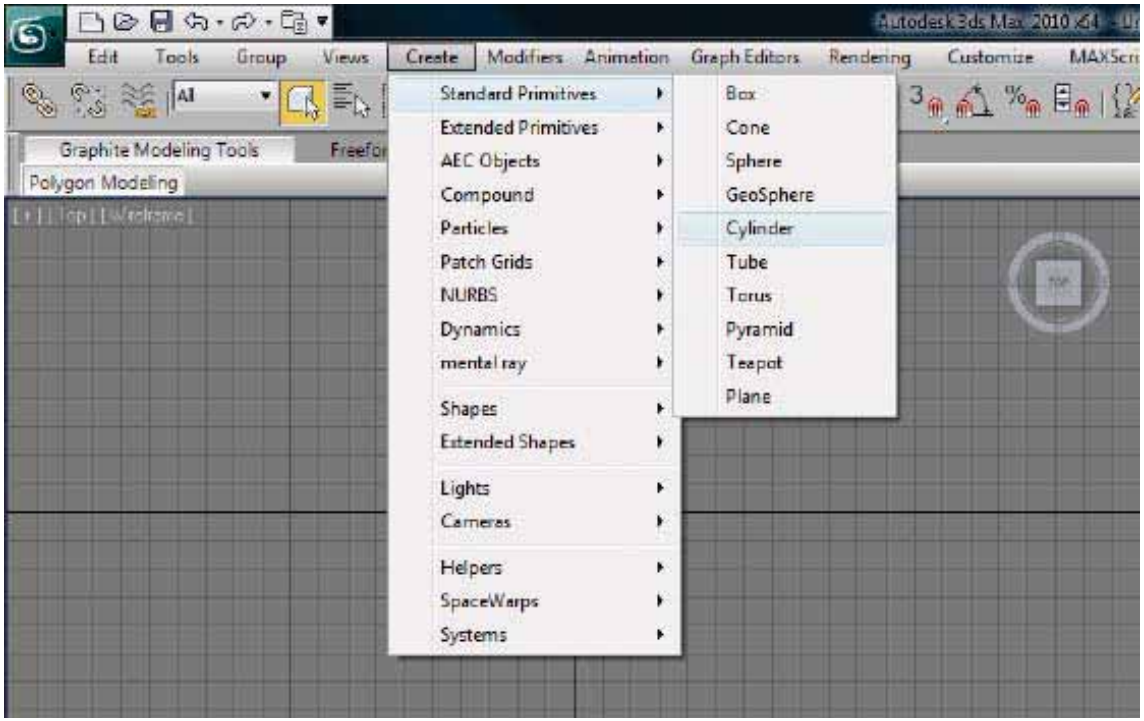
Navigating the viewports, Interface, and 3D Space

Now that we have the very basics of what each element in the UI is, let's focus a little more on some specific tips for navigation and getting around.

Menus, Features, and Moving Around

The menu bar along the top of the interface contains a large number of the most commonly used functions in 3ds Max. For almost every single button or icon you can click on, there is likely a menu function associated with it. As we move forward in the lessons, menu items are referenced as **Menu Name→Submenu→Menu Item**. For example, if you needed to create a cylinder, you could do so by **LMB** clicking **Create→Standard Primitives→Cylinder** in the menu bar.

The default Main toolbar found under the menu bar.



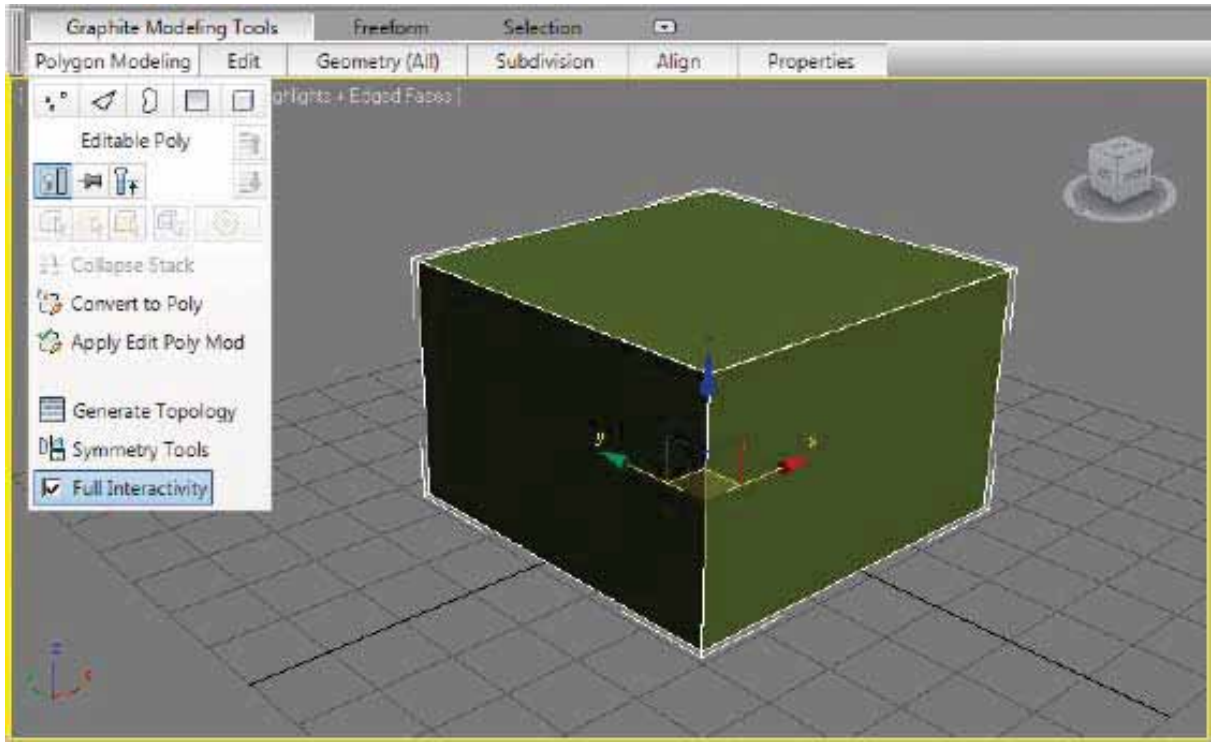
Creating a cylinder using the menu bar.

Directly underneath the menu bar is the Main toolbar. It is primarily a series of icons that take some memorizing to get used to, but handle a large number of the most commonly used 3ds Max functions. These functions are accessed by **LMB** clicking on them. Some of the buttons along the Main toolbar have additional functions by **RMB** clicking on them as well. We will discuss several of these additional features throughout this book.

3dsMax Skills

Directly underneath the Main toolbar are the graphite modeling tools. This new toolset contains a series of tools new to 3ds Max 2010, as well as a neatly organized collection of some of the most commonly used functions while creating 3D geometry. Without having created anything yet you will not see many options, but as you begin to build your assets these tools will come to life with all sorts of features and functions to improve your modeling speed and quality. To expand the menus, simply **LMB** click on any of the tabs to access their features.

A small example of the many features in the graphite modeling toolset.
As you have already noticed, the predominant real estate on screen is four separate windows into 3D space, called viewports. These windows each represent a different view of your scene or asset. To access any of the viewports individually, you do so by **LMB**, **RMB**, or **MMB** clicking the desired viewport. You will see a yellow highlight along the border of the viewport you currently have selected.



Tip:

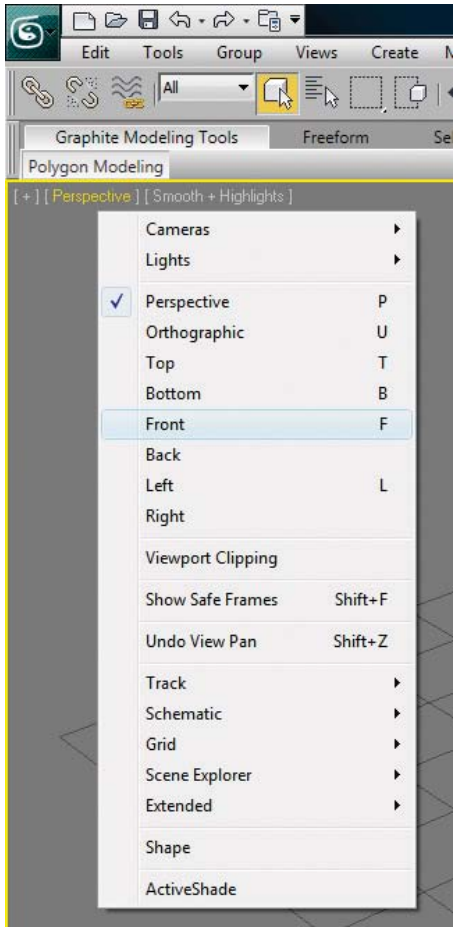
Hovering your mouse over a vast majority of the icons and buttons in the Main toolbar will show you the name of that button. If you wonder what that button does specifically, try looking it up in the Help menu.

3dsMax Skills

If you would like to maximize any of the views on your screen, rather than working with all four of them open, you can do so by first accessing your desired viewport and then pressing **Alt** + **W** on your keyboard. Alternatively, at the very bottom right corner of the UI you can also press the **Maximize Viewport Toggle** to maximize or minimize the currently accessed viewport.

Press Alt + W or use the Maximize Viewport Toggle to maximize your selected viewport.

Working with a maximized viewport is a personal preference, but it definitely increases the visual workspace of your scene or asset. To quickly move back and forth between the various viewport options, you have more than one way to do it. **RMB** clicking on the Perspective title in the upper right-hand corner of your viewport can allow you to **LMB** click any of the desired views to choose them. Alternatively, using the hotkeys can be a quick option as well.



RMB click on the name of your current viewport to bring up additional view choices.

3dsMax Skills

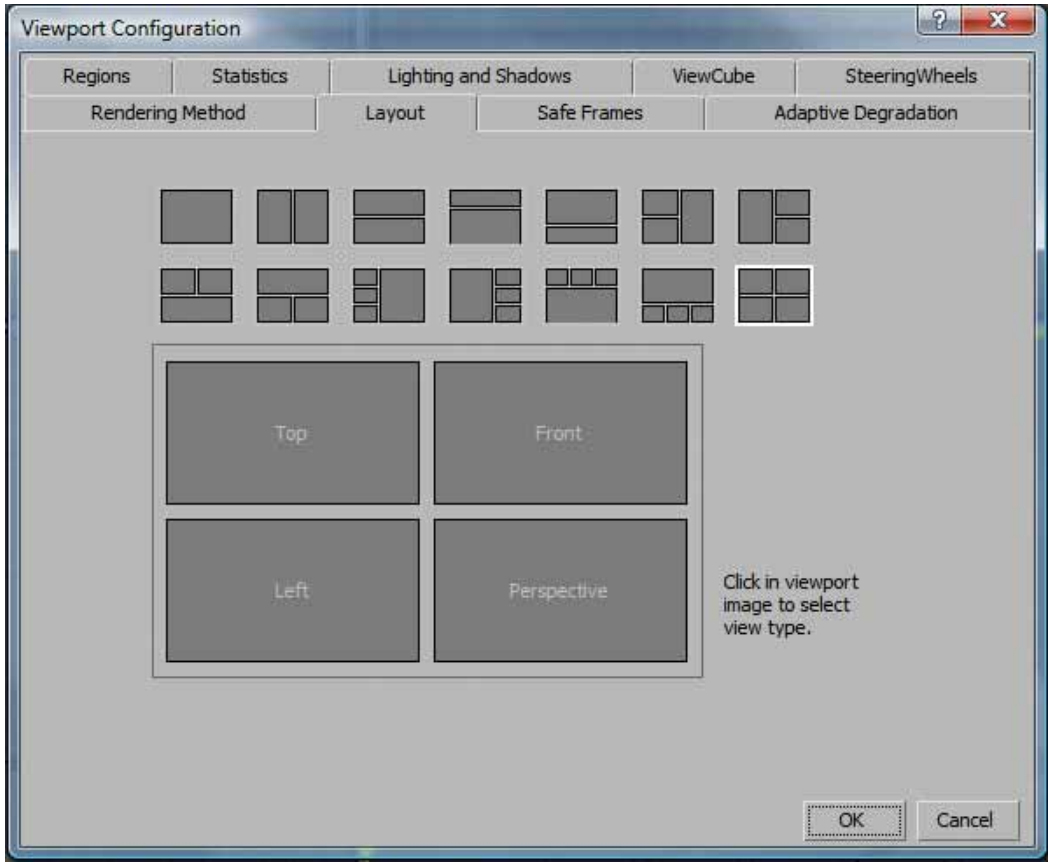
In any viewport, to drag the camera around freely, **MMB** click and hold anywhere in any of the viewports left, right, or up and down, and you will drag the camera in that direction. Keep in mind that this does not actually move anything in your scene, it simply moves the camera that is pointed at your scene.

Tip:

If you want to work with multiple viewport windows, there are a couple options to customize the look of them. LMB click on the very center of the four viewports and you will see the icon change, allowing you to drag the windows to the size you deisre.

Also, you can access preset configurations by clicking the + button at the top of any of the viewport windows and choosing Configure, and choosing the Layout tab. Here you can choose any of the premade layouts and then click OK.

You can also access this window under Views → Viewport Configuration.



The Viewport Configuration window with the Layout tab selected.

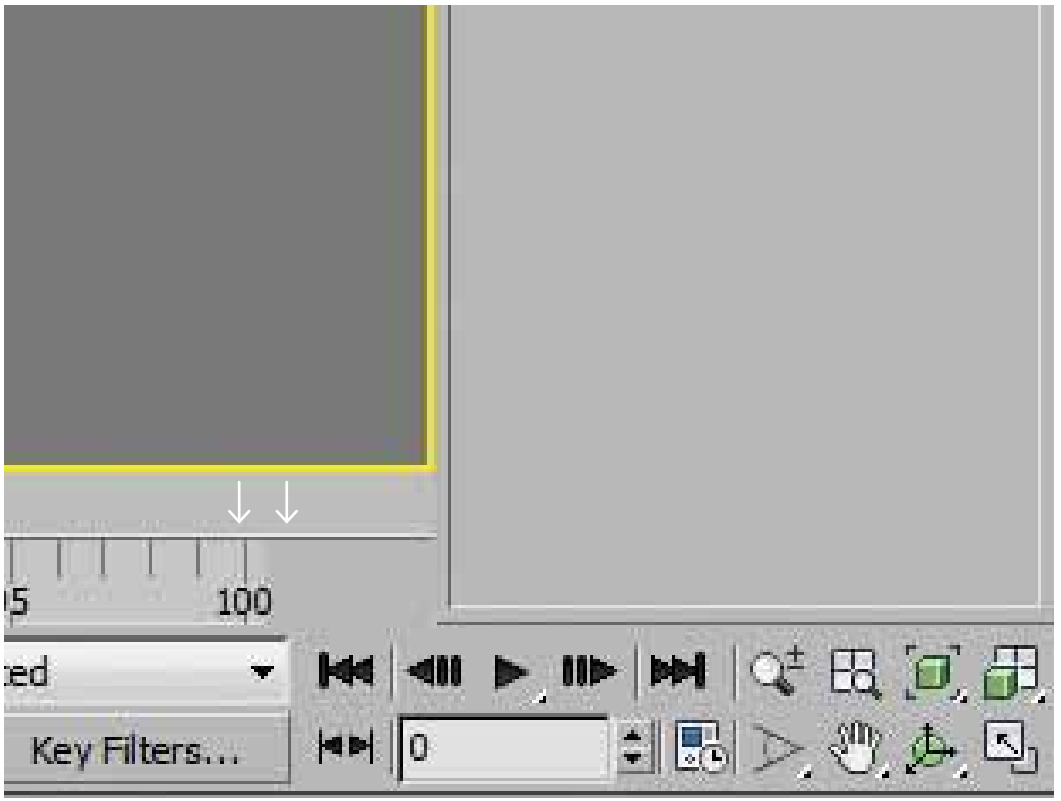
Rolling the **MMB** up or down will cause your camera to zoom forward or back. Holding down the Alt button while rolling the **MMB** will slow the speed of zoom.

Holding down the **Alt** and the **MMB** simultaneously will cause your camera to roll around the object in 3D space.

If at any time during your camera movements you want to get back to the center of the grid (known as 0,0,0) or frame the camera on your selected object(s) you can either click the Zoom Extents to center in just one currently active viewport, or the Zoom Extents All option will frame all of the viewport windows you currently have open.

Tip:

The Z key is the default hotkey for Zoom Extent All Selected. Get used to quickly moving around in 3D Space and then tapping the Z hotkey to quickly reframe your scene.



Use the Zoom Extents or Zoom Extents All choices to frame your selection inside the current viewport.

Navigating the Command Panel

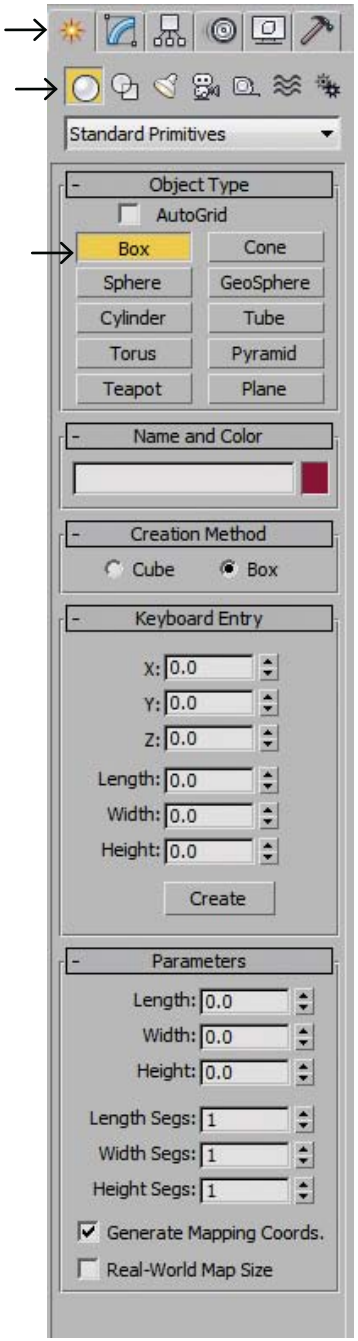
The **Command Panel** along the right side of the UI is where a large number of creation and adjustments are made to geometry. Aside from the new **graphite tools**, this is also where the majority of the polygonal mesh functions are found as well. While there are a large amount of tools to cover, for the first project we will focus on just a few.

To access the various tabs, pull-down, or objects from the **Command Panel**, simply hover your mouse over the desired selection and **LMB** click it.

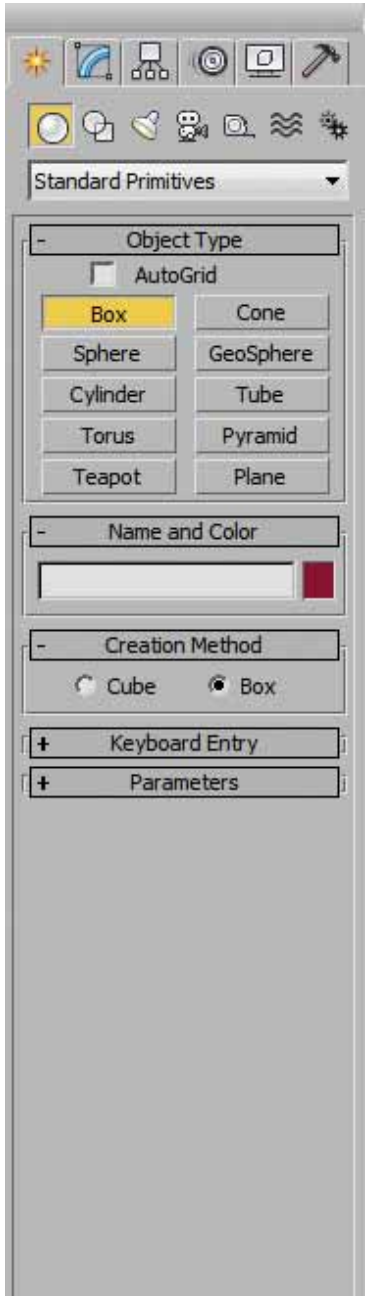
The **Create** tab features the majority of objects to create, ranging from various 3D and 2D shapes, cameras, lights, and more. Under the Create tab there are many other subgroups as well as pull-down menus for all the different things you can create. Keep in mind that any of these shapes or objects are simply building blocks for the objects we will be creating.

The **Modify** tab is where specific adjustments are made to the specific selected objects, as well as the many modifiers we will use when working with 3D. If you have nothing selected it will be blank, because you have nothing selected to modify.

The **Hierarchy** tab is where adjustments to an object's pivot point can be made, or we can utilize the working pivot. We will dive further into this later.
The **Motion** tab is focused more for animation and trajectories.
The **Display** tab allows you to quickly filter what is being shown on screen with various category options.



The Command Panel, with the Create tab selected, Geometry option chosen, and Box selected.



The Command Panel, with several of the submenus collapsed.

The **Utilities** tab has a preset collection of various unique tools and functions. As you may notice, there are several submenus in the Command Panel. In the example to create a Box, you can see **Object Type**, **Name and Color**, **Creation Method**, **Keyboard Entry**, and **Parameters** as the submenus. To expand or collapse submenus inside of the Command Panel, simply hover your mouse over the name of the submenu, and **LMB** click to expand or collapse.

Creating and naming objects in 3ds Max 2010

Now that you understand the very basics of the interface as it pertains to game asset modeling, let's go ahead and create our first object in 3D space. Keep in mind that we will be exploring a large amount of the interface as we move forward, but hopefully you are starting to get familiar with it.

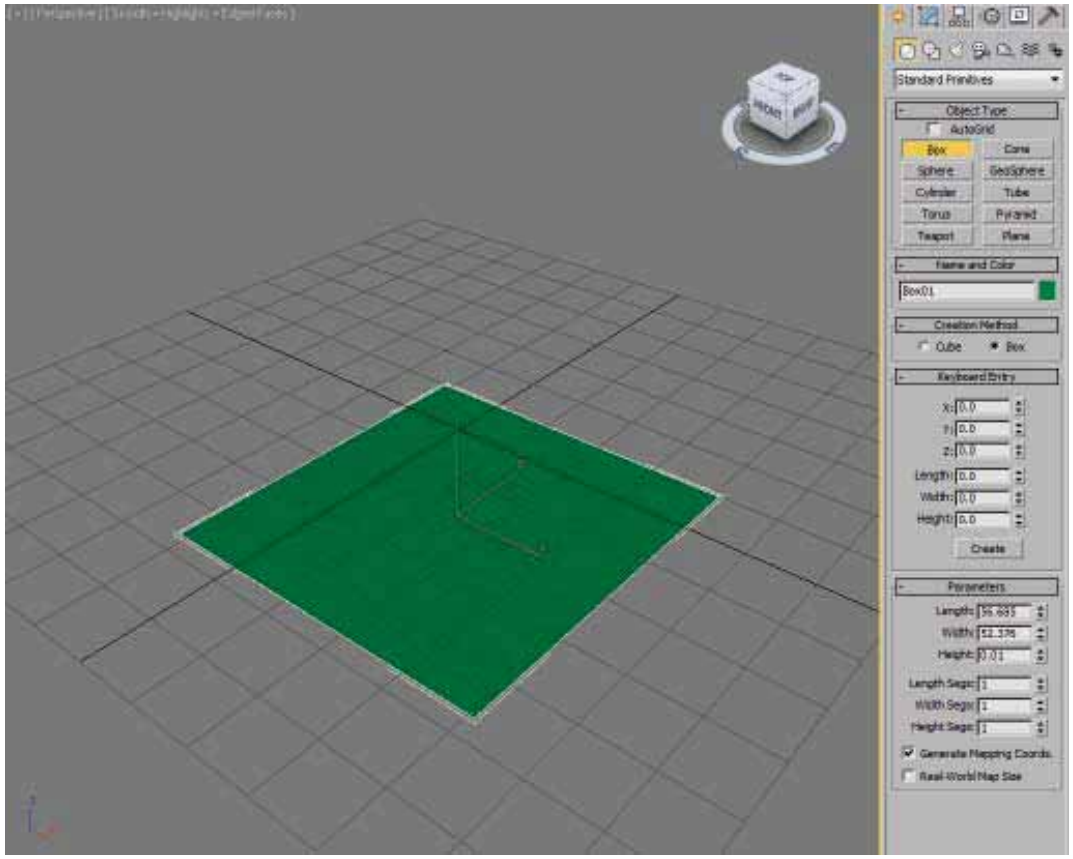
Create a geometry box.

For your first object, let's create a simple box.
In the Command Panel, select the **Create** tab, the **Geometry** option, and the **Box** as the Object type.

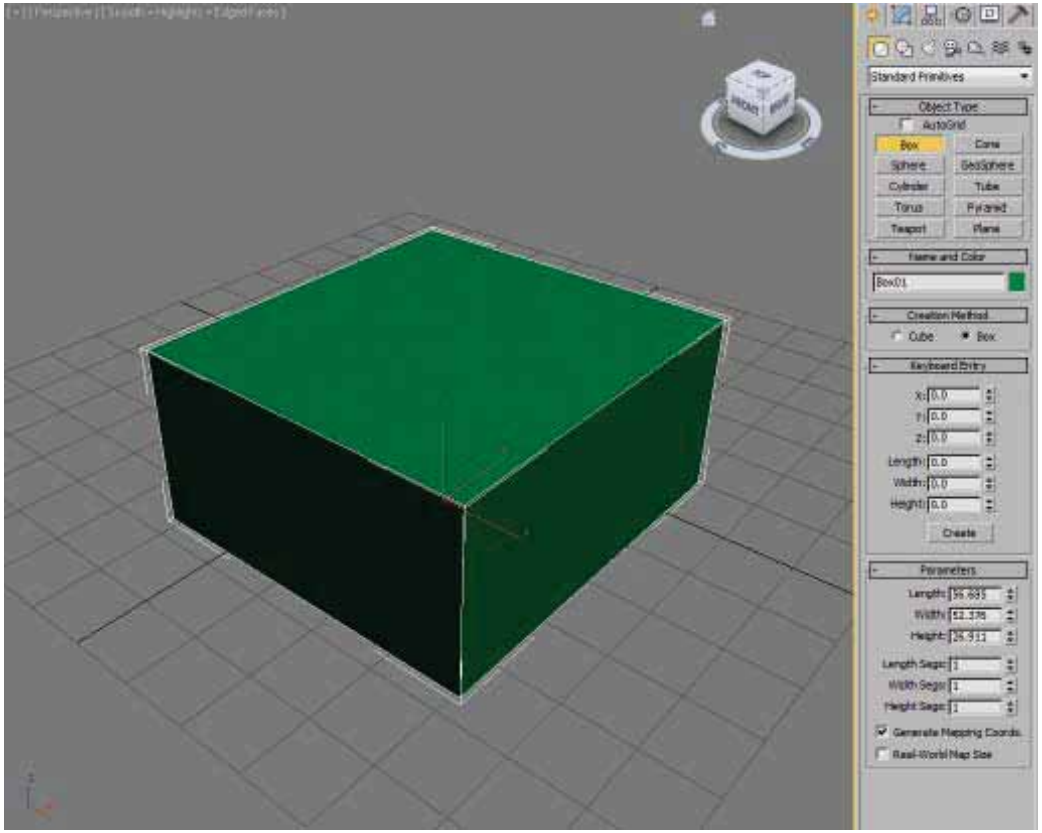
In the **Perspective** viewport, hold the **LMB** and drag it around anywhere in the viewport. As you are moving the box around in the viewport, you are identifying its length and width.

Release the **LMB**, and move the mouse up or down in the viewport. This is identifying the object's height.

When you get a height you are happy with, click the **LMB** again.



Start by dragging the box in the Perspective viewport.



Move the mouse up to identify the box height.

Name the box and change its color.

Now that you have created your first box, let's name it something and change its color.

Start by selecting your box. You do this by **LMB** clicking on the box in the viewport.

In the Command Panel, under the **Name and Color** submenu, type in a new name for your box.

Next to the name, you should see a color box. In my example you can see it as a green box. Yours might be a different color because by default 3ds Max will randomly choose a color for you when you create a new object.

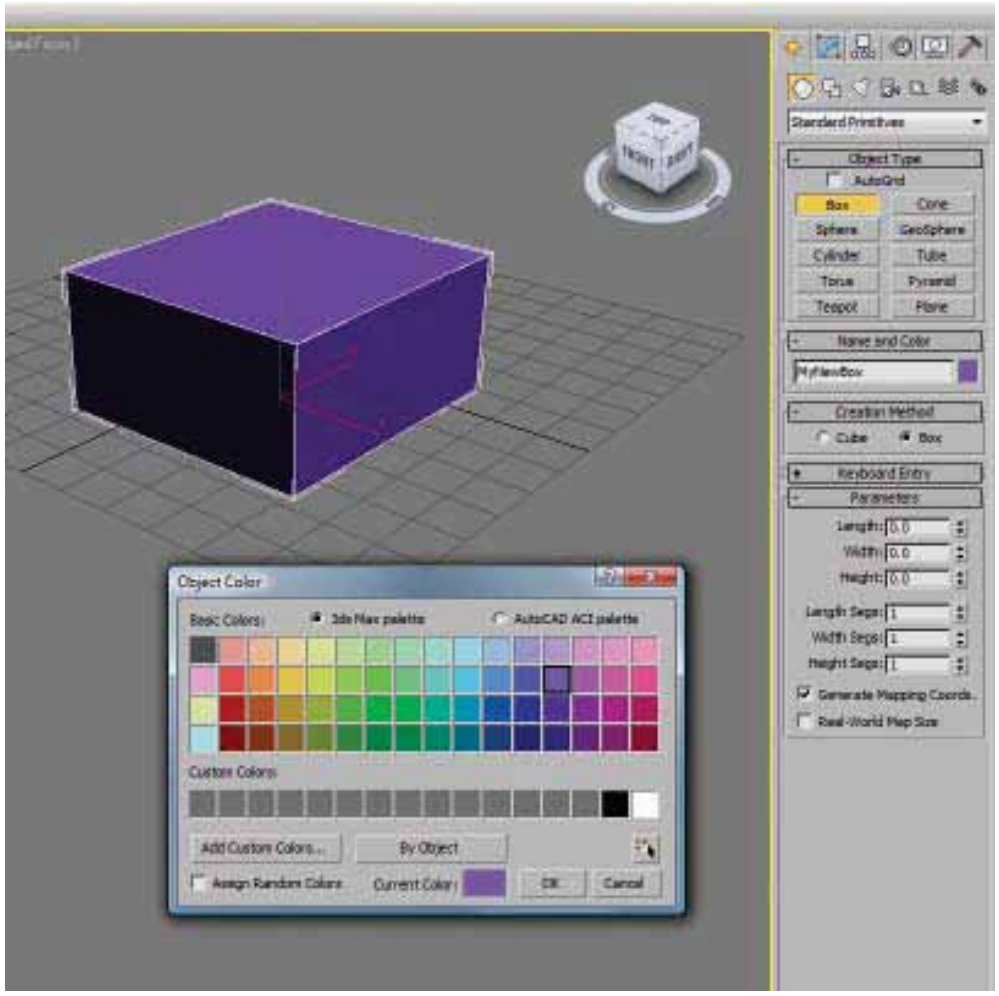
Click the color box using the **LMB** and a new window should appear.

In the **Object Color** window, pick any color you want to change the color of your box.

Tip:

In the Object Color window, you can turn off the random color generation by unchecking the box next to Assign Random Colors. Any color you choose will be the default color of all of your objects you create from now on.

Changing the display of objects you create

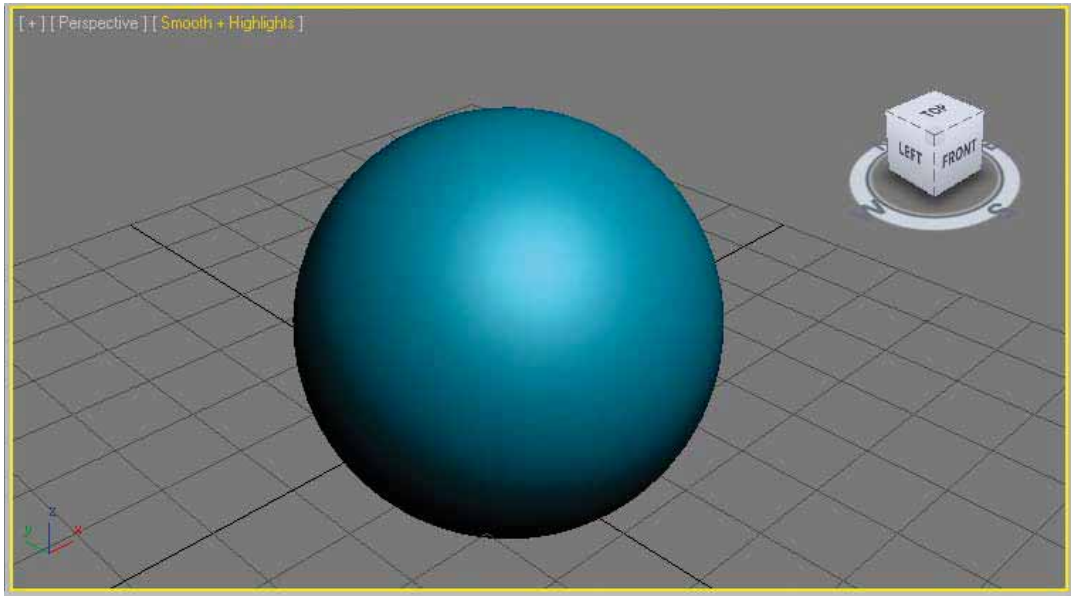


Change the color and name of your box.

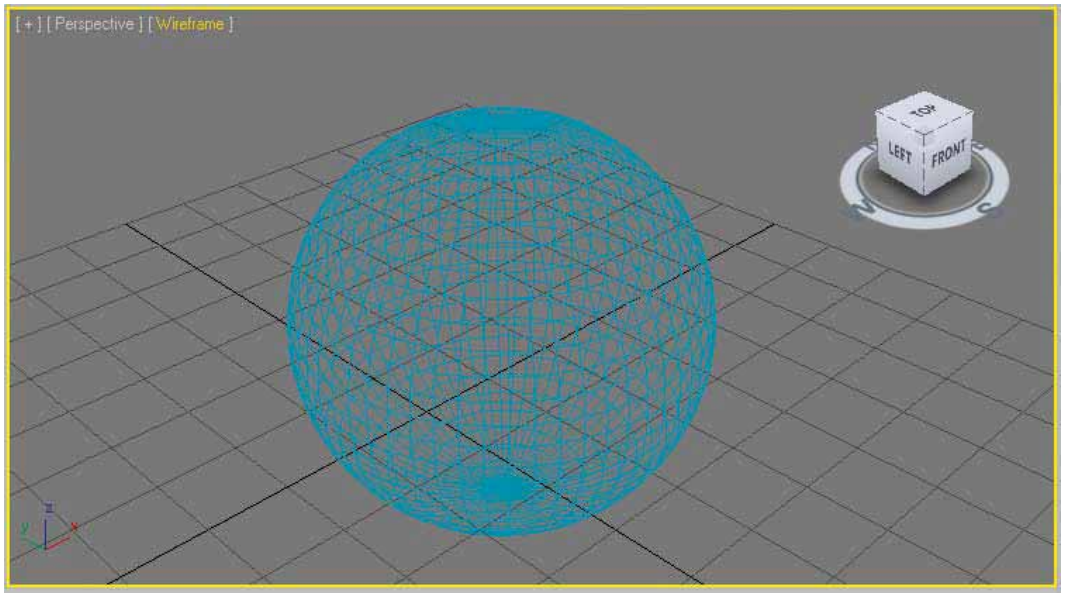
Now that you have created your first object in 3D space, feel free to play around with other shapes. The creation method for many of them is very similar and we will further explore more primitives in the next chapter. Regardless of which shape you create, there are a few methods to adjusting how you view objects in 3D space.

For whichever viewport you are in, you will notice there are several different viewport options in the top left-hand corner of the viewport itself. By default when you start max, the setting should be **[Smooth + Highlights]**, as indicated between the two **[ ]** brackets. This setting is how the object inside the viewport is rendered, in this case, you can see smoothing on rounder or softer geometry, and there will be a lighting highlight. You can change this by **LMB** clicking on the [Smooth + Highlights] option and selecting a different view as you choose.

3dsMax Skills



The Default [Smooth + Highlights] viewport setting on a sphere.

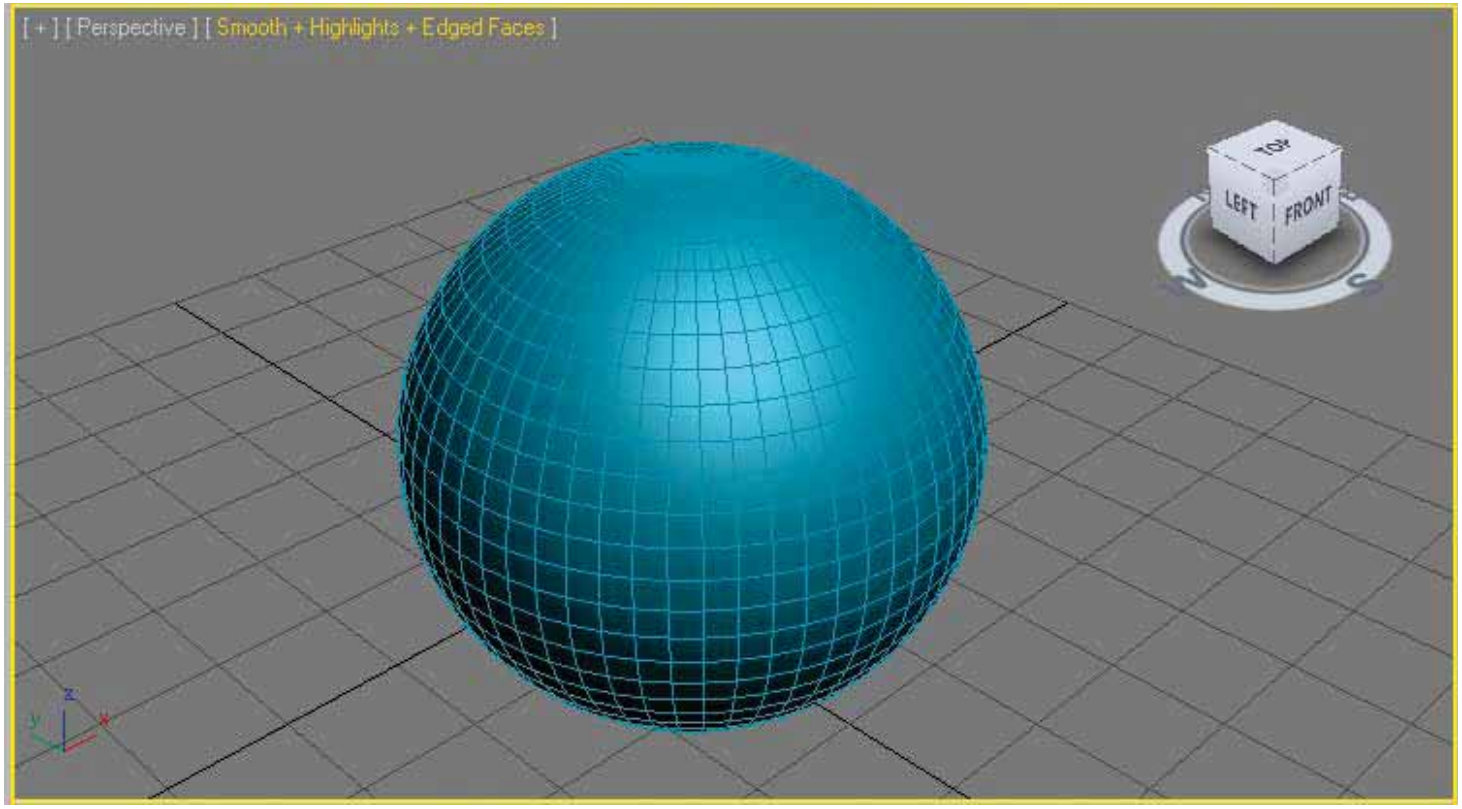


The option changed to [Wireframe] viewport setting on a sphere.

It is also possible to select **[Smooth + Highlights]** and **[Edged Faces]** at the same time as well.

The default hotkey to toggle back and forth between **[Smooth and Highlights]** and **[Wireframe]** view modes is **F3**.

The default hotkey to turn **[Edged Faces]** on and off is **F4**.



The [Smooth + Highlights] and [Edged Faces] both selected in the viewport.

Tip:

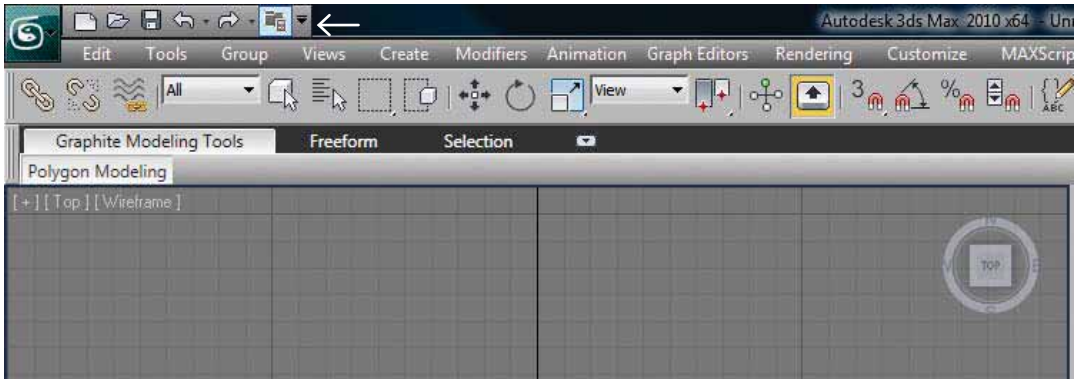
While it is possible to change these visual choices in the drop-down menu, getting used to using the hotkeys for them will greatly speed up your workflow. As you start working with more complex scenes and objects, you will constantly be going back and forth between wireframe, flat shaded, and shaded + edge faces.

Setting a project folder

When you start working with a scene in 3Ds Max, either through the course of this book or on your own, it is a good idea to start getting into the habit of setting up your project folders before you begin. While at first it is simply good to keep track of your 3ds Max files, as your scenes start to get bigger and bigger and contain multiple different assets, you will definitely want to keep track of all of them.

Set your project path.

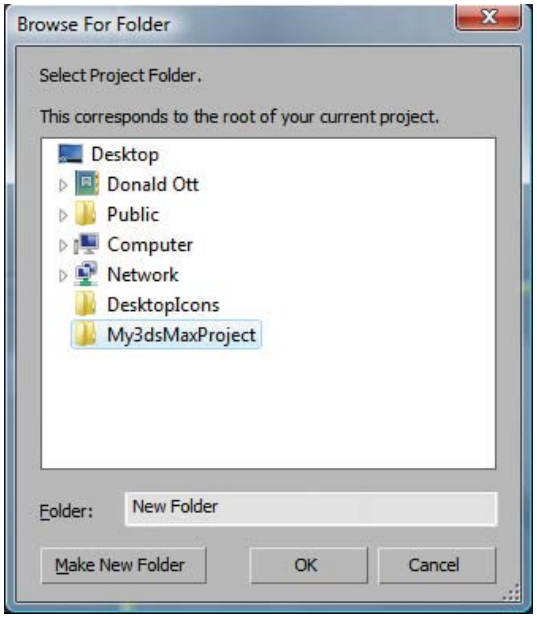
To set up your project path, click the icon in the upper-left corner.



Clicking this icon in the upper-left corner if your UI will allow you to set a path for your project.

Create a new folder for your project.

After clicking this, the Browse For Folder window will pop up asking you for where you want to set the root of your project folder. Think of this as the place on your computer where you want to store everything associated with this project. Navigate to where you want to store your project, **LMB** click the Make New Folder button and rename the folder.



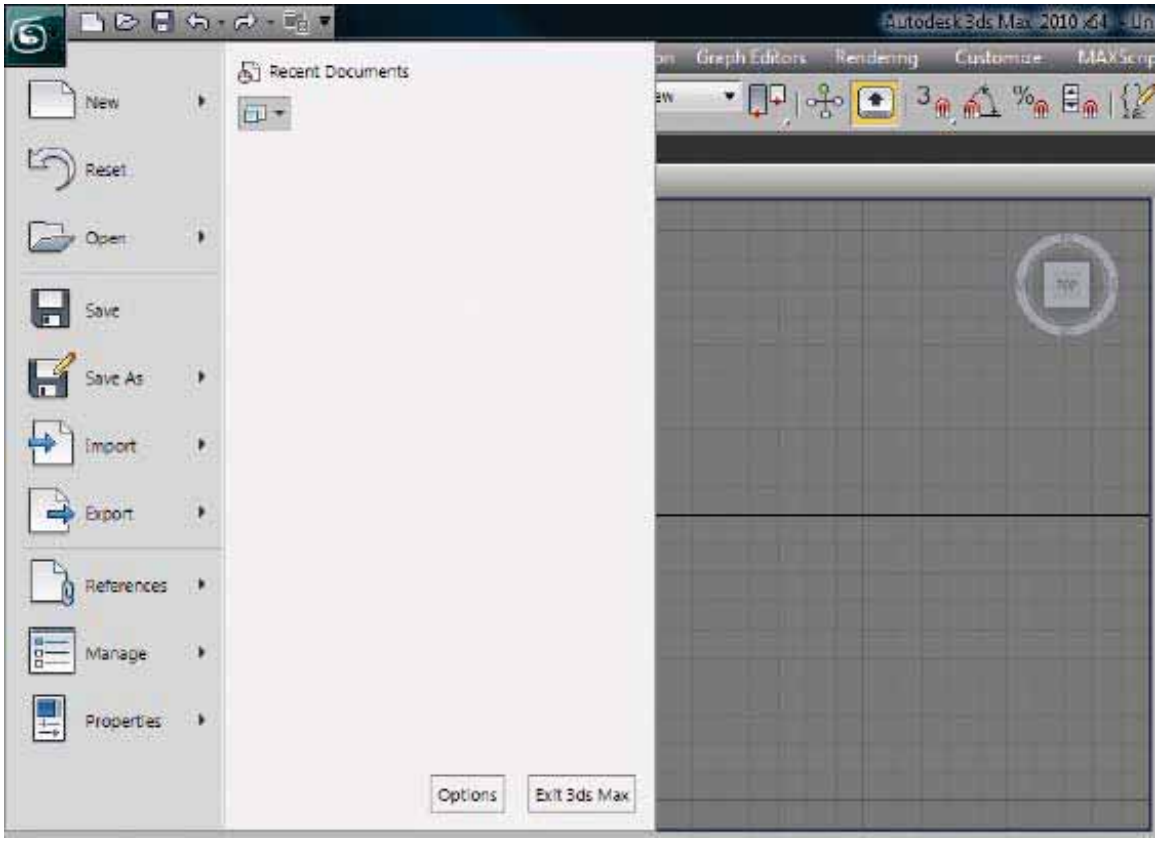
Create a new project folder named My3dsMaxProject on the desktop.

Saving your scene

Few things are more important than saving and backing up your work. Since we set up a project folder, by default when you attempt to save your scene it will drop it under the **scenes** folder inside of your project.

Click the 3ds Max icon to access your file options.

To start with, click the **File** icon (which is the large 3ds Max icon) in the top-left corner of the menu bar to bring up your file options.



Clicking the 3ds Max icon will bring up your file options.

Choose your file options.

As you hover over the different menu items under the File Options, you will see additional options and explanations pop up in the right side of the menu. Some of the more common file options you should be familiar with are as follows.

New—These options can maintain some of your current scene settings, but will create a new 3ds Max scene for you.

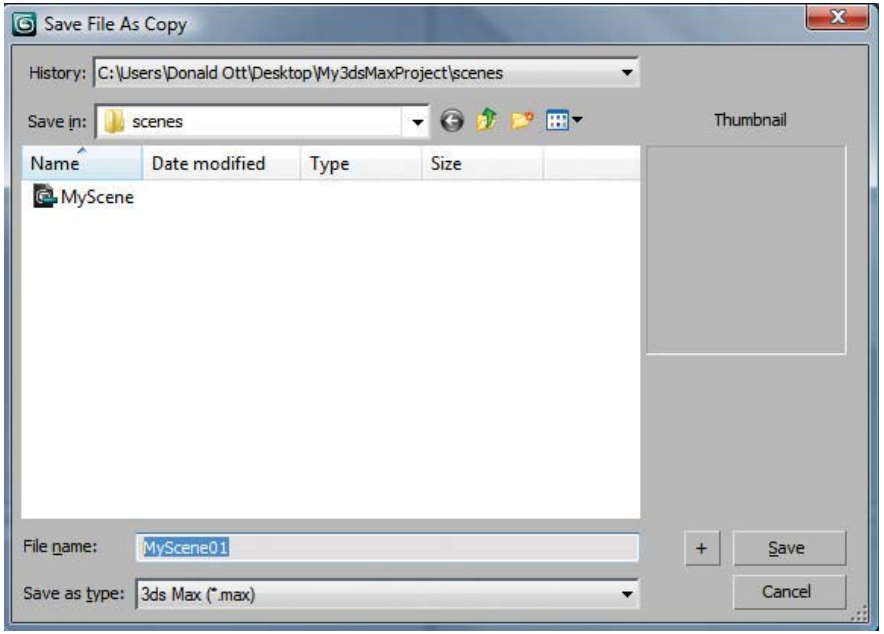
Reset—Think of **Reset** as a whole fresh new scene. This is the same as restarting 3ds Max. You will lose all of your current settings and they will go back to the default.

Open—As expected, this is the option to open previous 3ds Max files.

Save—The default save. The first time you Save it will direct you to the scene folder of your project folder structure. You can, however, choose to save your scene anywhere you wish.

Save As—Similar to the normal Save, but also includes the options to use an incremental save as well as saving only selected objects in your scene. The **Save As→Save Selected** option will take only what you currently have selected in your scene and save that as a completely unique file. The **Save Copy As** option will automatically add a numeric extension to the end of your file. For example, if your scene is called MyScene, using the **File→Save As→Save Copy As** will automatically attempt to save your scene as MySceneo1. This is optional, but it is definitely helpful when you want to be able to save your scenes in chronological order or have a safe point to go back to later.

Import / Export—The **Import** and **Export** options are useful when working with various file types that may have been exported from other software packages, as well as merging 3ds Max files together. We will cover this more in Chapter 6.



File→Save As→Save Copy As will automatically add a numeric extension to your file name.

3dsMax Skills

What primitives are

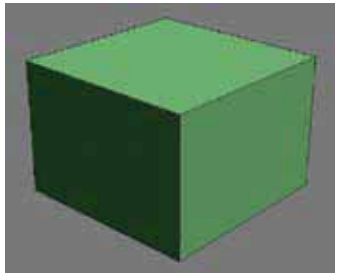
Before you can start building the world's best game level, or the coolest game character anyone has ever seen, the forms and shapes to make those things almost always start with primitives. Primitives are the very basic 3D shapes that make up the foundations of more complex shapes. In 3D modeling, primitives are used as the rough first-pass shapes that an artist may create before adding to the model to make it more complex. For example, a skyscraper or a might start with a box. A fireman's pole might start as a cylinder. A bed sheet—a plane.

Look at the world around you. You are surrounded by boxes, cylinders, spheres, planes, and tubes. This very book you are holding is made up of a series of primitives! Whether you are creating props for a game or a game level, primitives are the building blocks that every artist must control before moving on to more complex 3D modeling. Even Michelangelo started with a box.

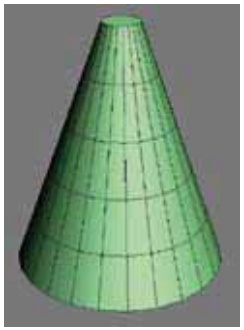
Standard primitives

Let's take a look at some of the more commonly used primitives and a brief description of them. While this is not all of the primitives you can create in 3ds Max 2010, these are some of the more commonly used ones you will want to familiarize yourself with as you begin to work in 3D.

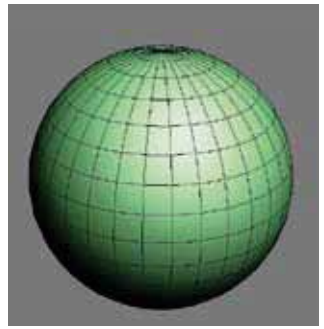
Box—The box is the simplest and most primitive of them all, but from which an enormous amount of shapes can ultimately emerge. Also known as a cube, the box is created with a default six sides.



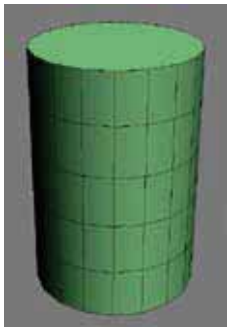
Cone—The cone is a slightly tapered cylinder that can either have two flat ends, or one flat end and one sharp point.



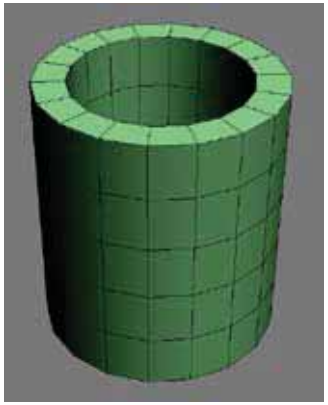
Sphere—The sphere is a round ball. By default, the sphere has a uniform circumference and radius.



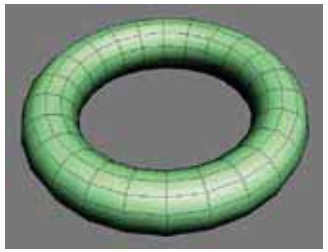
Cylinder—The cylinder is a round primitive that extends along a height parameter, and the radius can be adjusted as well.



Tube—The tube is a hollowed out cylinder that has geometry along the outside as well as the inside.

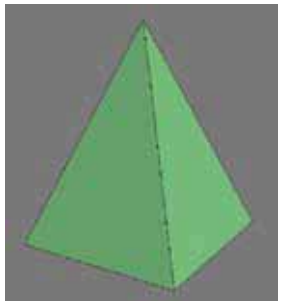


Torus—The torus primitive is a wheel or tube shape that forms a circle.

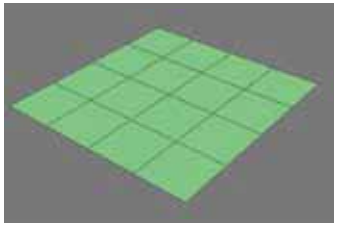


3dsMax Skills

Pyramid—The pyramid is a simple five-sided shape, with four of the sides meeting at a point.



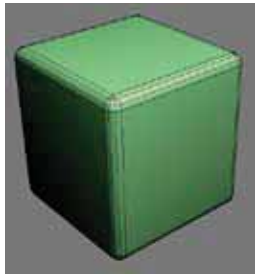
Plane—The plane is a very simple flat piece of geometry with no height or width. Think of it as a flat sheet of polygons.



Extended Primitives

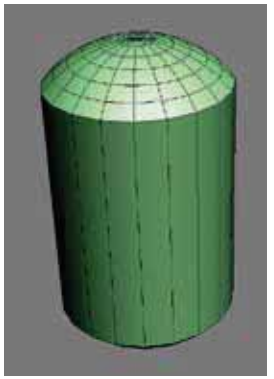
A bit more complex are the extended primitives. These shapes attempt to bridge the gap between the basic primitives and editable polygon objects, which we will discuss further in Lesson 5. We will not list all of them here, but there are a few shapes you might fight useful as you begin to use primitives.

Chamfer Box—The chamfer box is very similar to the regular box primitive, but you have the ability to round off the edges—also known as chamfering.



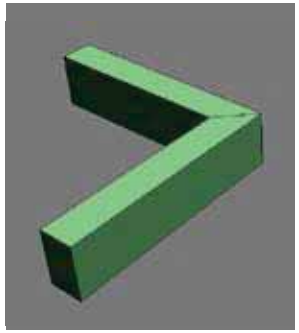
Chamfer Cylinder—The chamfer cylinder is very similar to the regular cylinder primitive, but just like the chamfer box, you can chamfer the edges as well.

Oil Tank—The oil tank is a cylindrical shape with rounded caps on both ends.

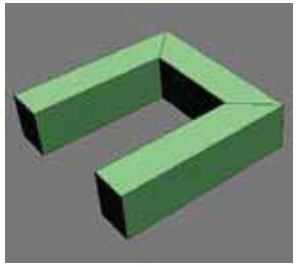


Capsule—The capsule is similar to the oil tank, but fully rounds off the ends.

L-Extent—The L-extent extended primitive creates an elbow joint shape similar to the letter L.



C-Extent—The C-extent extended primitive creates a corner joint shape similar to the letter C.

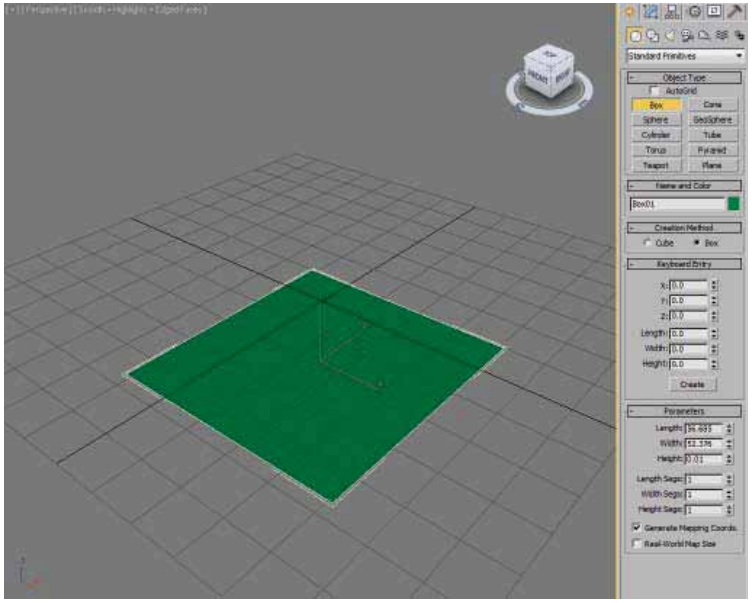


Creating Standard Primitives

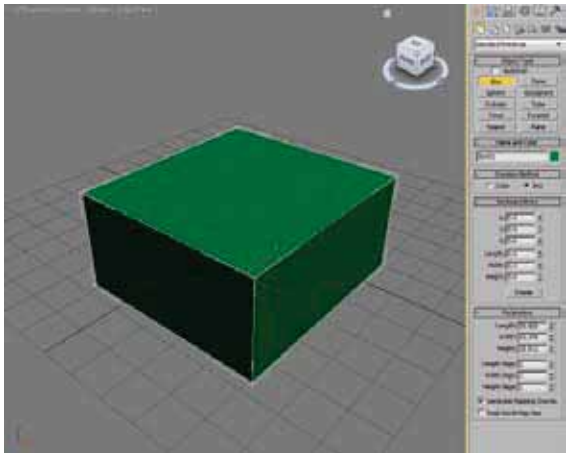
In the previous chapter we briefly discussed how to create your first box. Many other primitives are created in a very similar fashion. Let's discuss some of the more commonly used primitives and identify exactly how to create them.

1. **Create a primitive box.**
   For our first primitive, let's create that simple box again.

- In the Command Panel, select the **Create tab**, the **Geometry** option, and choose the **Box** as the Object Type.
- In the **Perspective** viewport, hold the **LMB** and drag it around anywhere in the viewport. As you are moving the box around in the viewport, you are setting its length and width.
- Release the **LMB**, and move the mouse up or down in the viewport. This is setting the object's height.
- When you get a height you are happy with, click the **LMB** again.



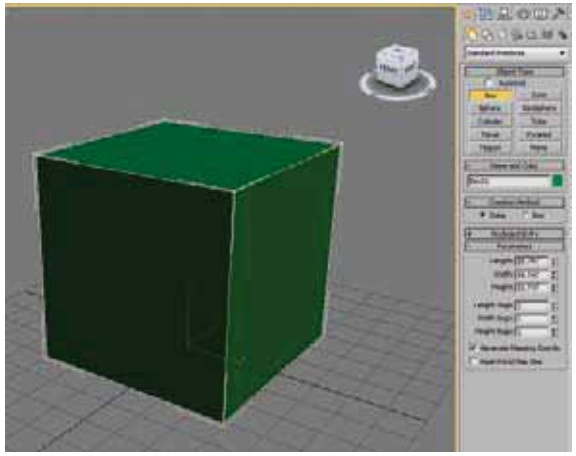
Start by LMB dragging the box in the Perspective viewport.



Move the mouse up to set the box's height.

Tip:

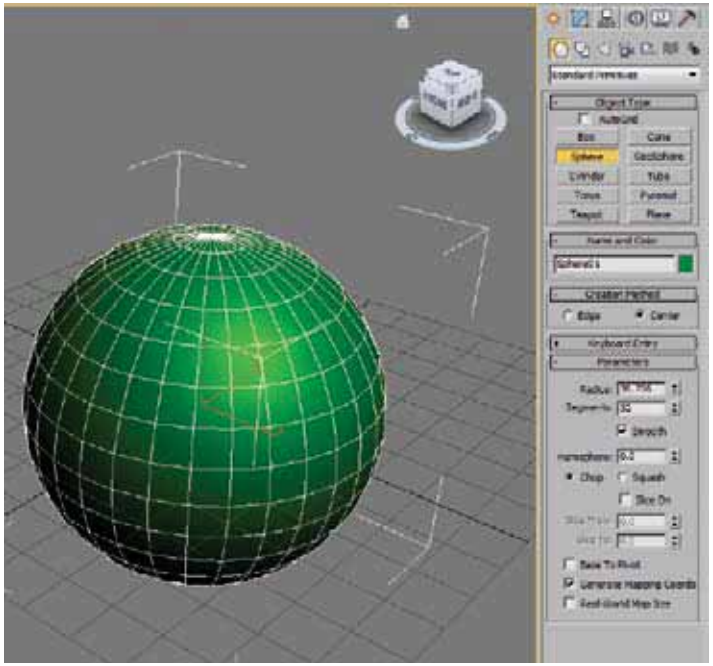
From the Creation Method submenu for the Box, you can choose the option of **Cube** instead of **Box**, and when you **LMB** drag in the viewport, all of the parameters (length, width, height) will be uniform.



Choosing Cube from the Creation Method submenu.

2. Create a primitive sphere.
For our second primitive, let's create a sphere.

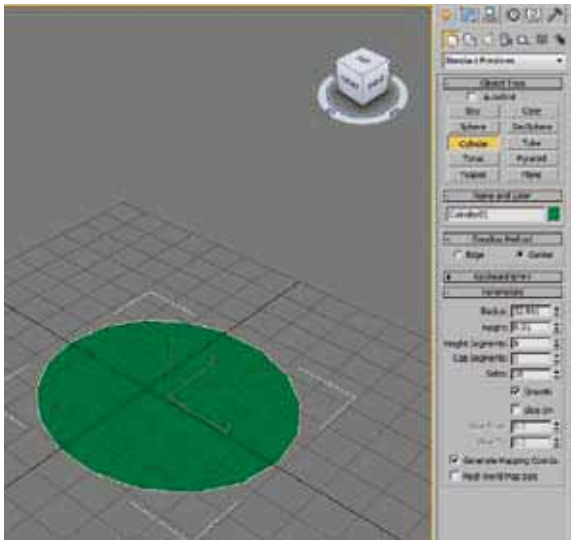
- Select the **Geometry** option and choose **Sphere** as the Object Type.
- In the **Perspective** viewport, hold the **LMB** and drag it around anywhere in the viewport. As you are moving your mouse around in the viewport, you are setting the sphere's radius.
- When you get a radius you are happy with, release the **LMB**.



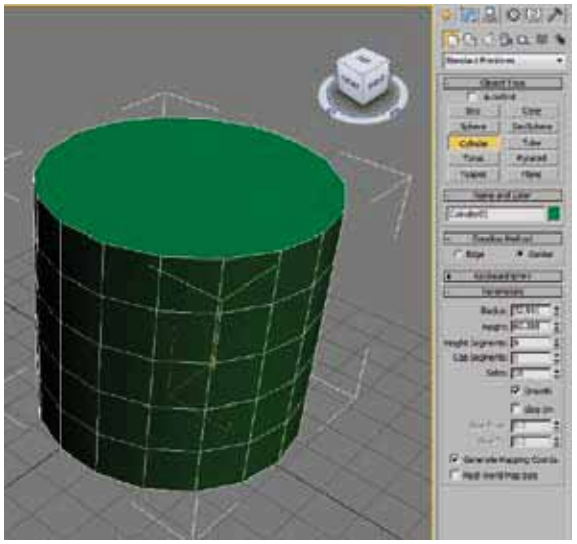
3. Create a primitive cylinder.
For our next primitive, let's create a cylinder.

- Select the **Geometry** option and choose **Cylinder** as the Object Type.
- In the **Perspective** viewport, hold the **LMB** and drag it around anywhere in the viewport. As you are moving the shape around in the viewport, you are setting the cylinder's radius.
- Release the **LMB**, and move the mouse up or down in the viewport. This is setting the cylinder's height.

- When you get a height you are happy with, click the **LMB** again.



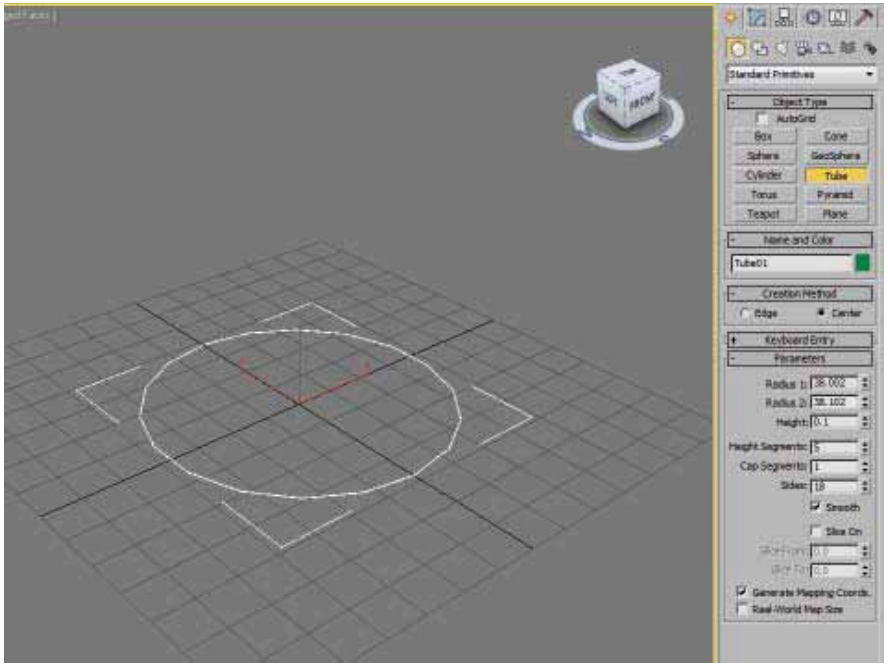
Start by LMB dragging the cylinder in the Perspective viewport.



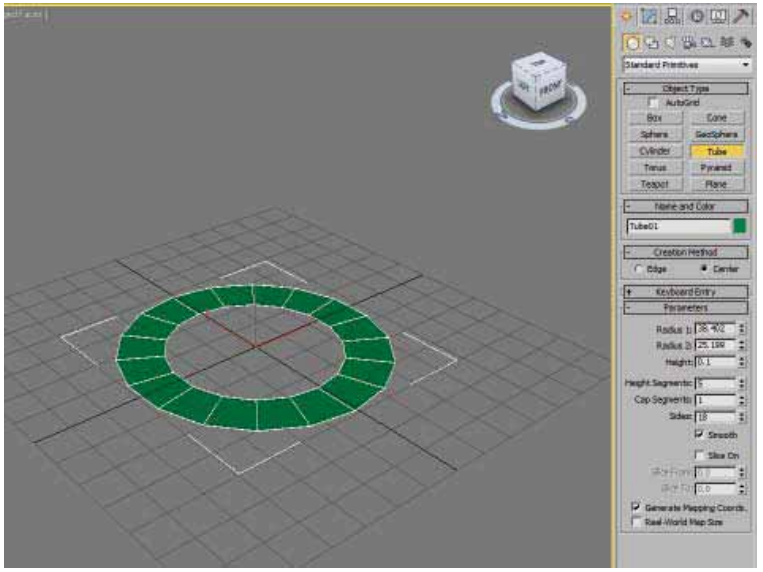
Move the mouse up to set the cylinder's height.

4. Create a primitive tube.
For our next primitive, let's create a tube.

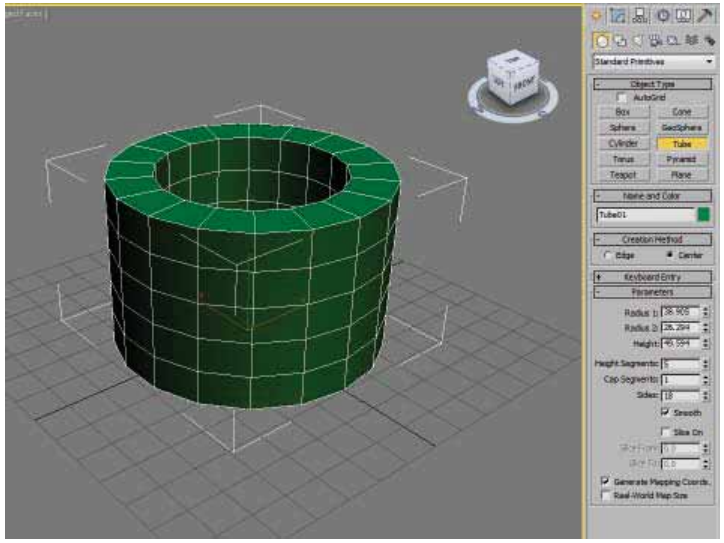
- Select the **Geometry** option and choose **Tube** as the Object Type.
- In the **Perspective** viewport, hold the **LMB** and drag it around anywhere in the viewport. As you are moving the shape around in the viewport, you are setting the tube's **Radius 1**, which ultimately can be either the inner or outer radius.
- Release the **LMB**, and then move the mouse left or right in the viewport. This will determine the tube's **Radius 2** parameter, which is either the inner or outer radius.
- When you get a radius you are happy with, click the **LMB** again.
- Move the mouse up or down in the viewport to determine the tube's height.
- When you get a height you are happy with, click the **LMB** again.



Start by LMB dragging the tube in the Perspective viewport to set the Radius 1.



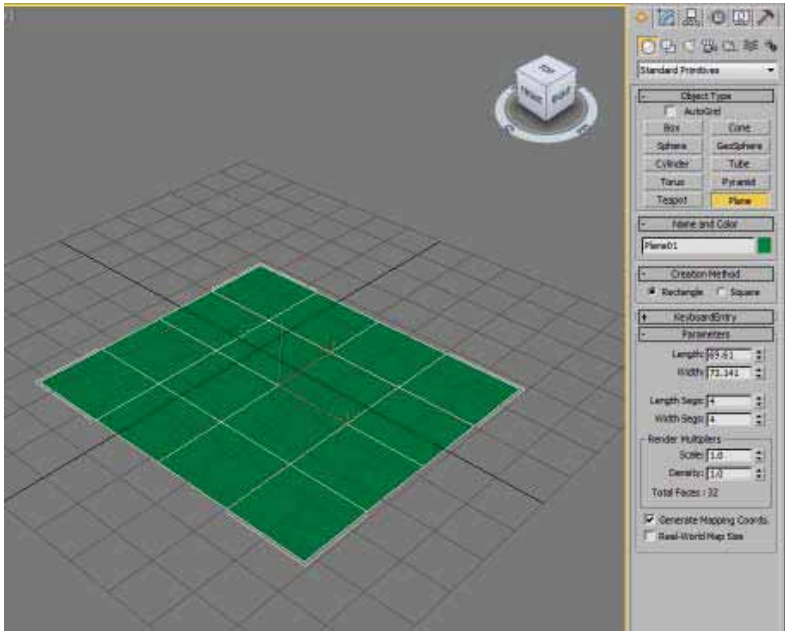
Move the mouse left or right to set the tube's Radius 2.



LMB click, and then move the mouse up or down to set the tube's height.

5. **Create a primitive plane.**
For our next primitive, let's create a plane.

- Select the **Geometry** option and choose **Plane** as the Object Type.
- In the **Perspective** viewport, hold the **LMB** and drag it around anywhere in the viewport. As you are moving your mouse around in the viewport, you are setting the plane's length and width.
- When you get a size you are happy with, release the **LMB**.



Creating the plane in the Perspective viewport.

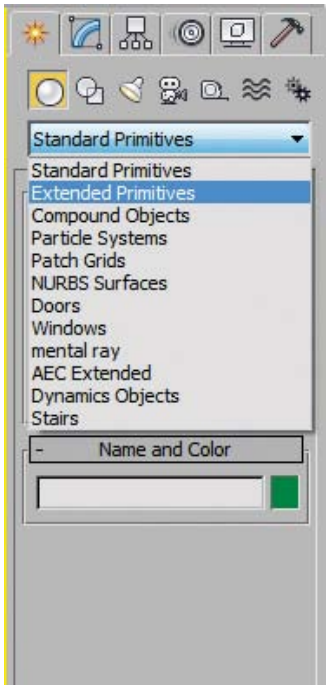
Tip:

From the Creation Method submenu for the Plane, you can choose the option of **Square** instead of **Rectangle**, and when you **LMB** drag in the viewport, both of the parameters (length and width) will be uniform.

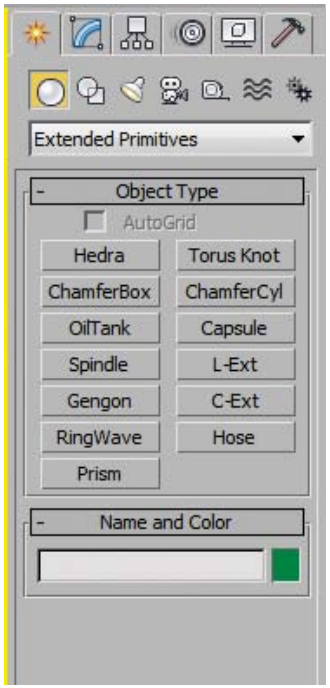
Creating Extended Primitives

Creating extended primitives works very similarly to standard primitives. Like the standard ones, some of the parameters have specific creation requirements depending on the primitive you are trying to make.

As you may have noticed, the extended primitives are not in the same creation area as the standard primitives. To access the Extended Primitives, or other geometric shapes to create, in the Command Panel, select the Geometry option and **LMB** click on the drop-down menu. By default it should be set to **Standard Primitives**. Select **Extended Primitives** to change the different object types and reveal a new set of primitives.



LMB click the drop-down menu and choose Extended Primitives.



A new list of primitives appears.

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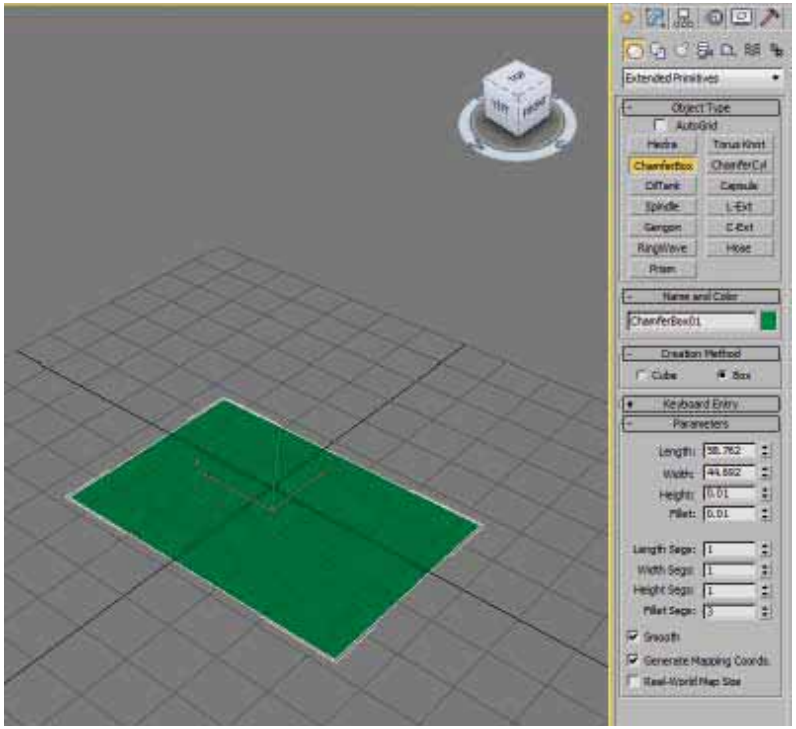
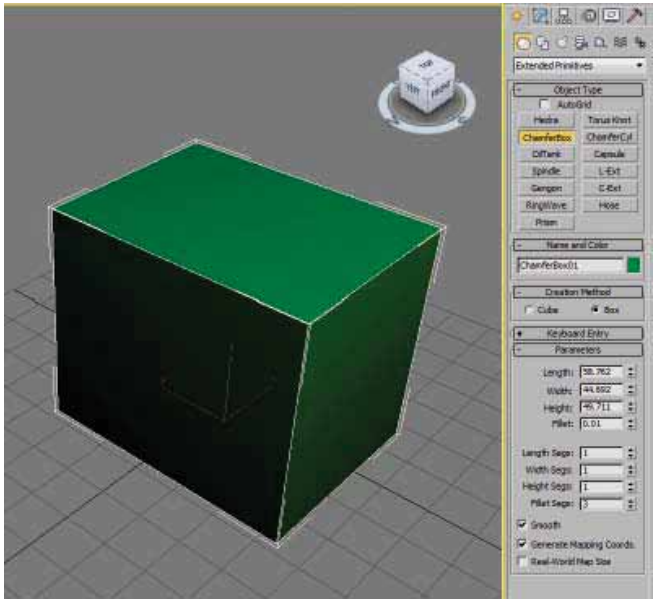
1. **Create an extended primitive chamfer box.**
   For our first extended primitive, let's create a chamfer box.

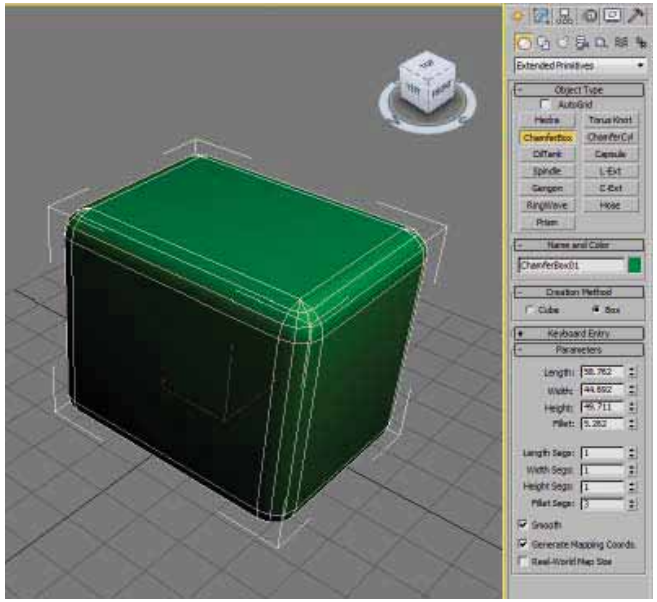
- From the Command Panel, select the **Create tab**, the **Geometry** option, **Extended Primitives** drop-down, and choose **ChamferBox** as the Object Type.
- In the **Perspective** viewport, hold the **LMB** and drag it around anywhere in the viewport. As you are moving the object around in the viewport, you are setting the chamfer box's length and width.
- Release the **LMB**, and move the mouse up or down in the viewport. This is setting the object's height.
- When you get a height you are happy with, click the **LMB** again.
- After clicking the **LMB** to get the height, move the mouse left-to-right to determine the Fillet amount, also known as the chamfer amount.



Start by LMB dragging the box in the Perspective viewport.



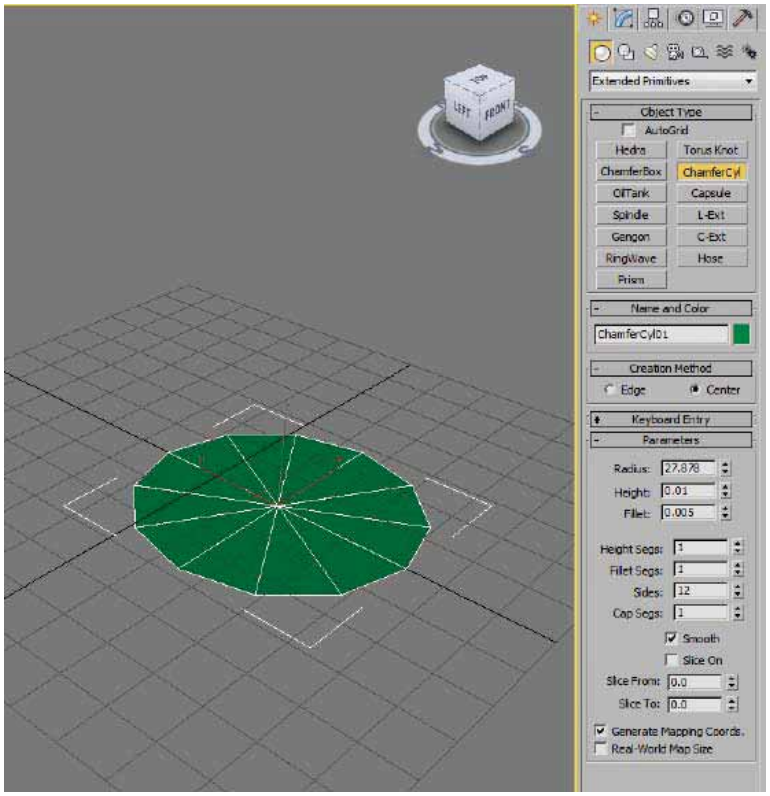
Move the mouse left to right to set the fillet amount.



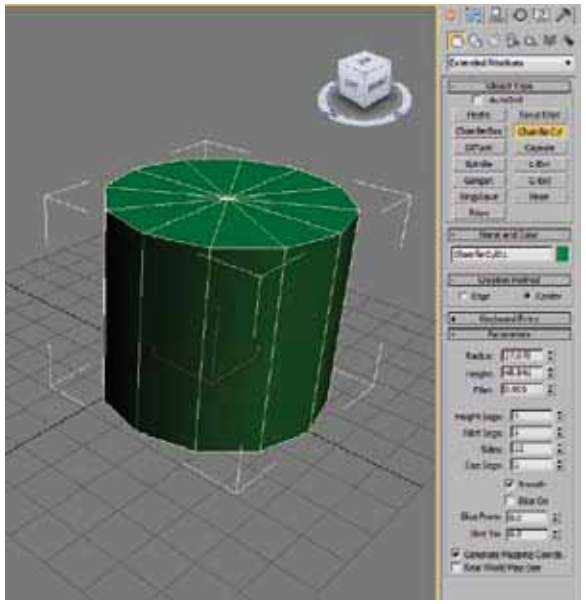
Move the mouse up to set the box height.

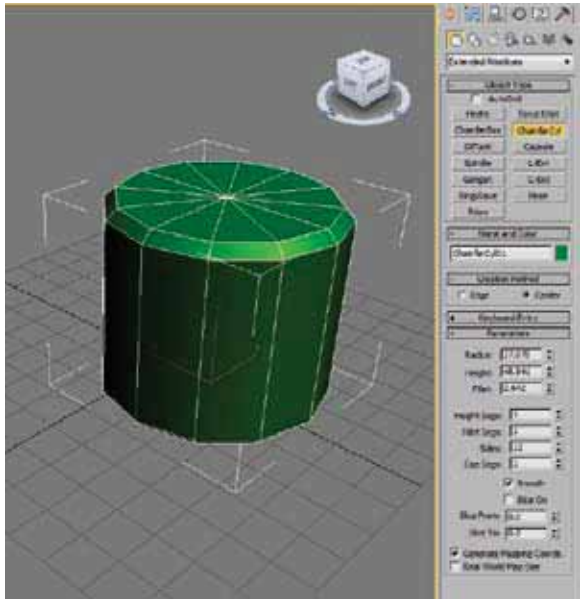
2. Create an extended primitive chamfer cylinder.
For our next extended primitive, let's create a chamfer cylinder.

- Select the **Geometry** option and choose **ChamferCyl** as the Object Type.
- In the **Perspective** viewport, hold the **LMB** and drag it around anywhere in the viewport. As you are moving the object around in the viewport, you are setting the chamfer cylinder's radius.
- Release the **LMB**, and move the mouse up or down in the viewport. This is setting the object's height.
- When you get a height you are happy with, click the **LMB** again.
- After clicking the **LMB** to get the height, move the mouse left-to-right to determine the **Fillet** amount, also known as the chamfer amount.



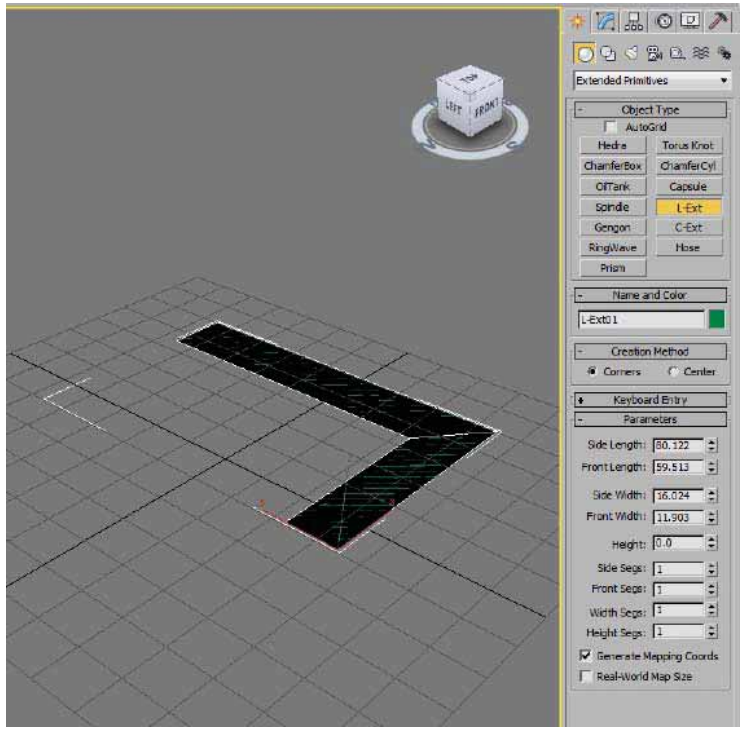
Start by LMB dragging the chamfer cylinder in the Perspective viewport.


Move the mouse left to right to set the fillet amount.

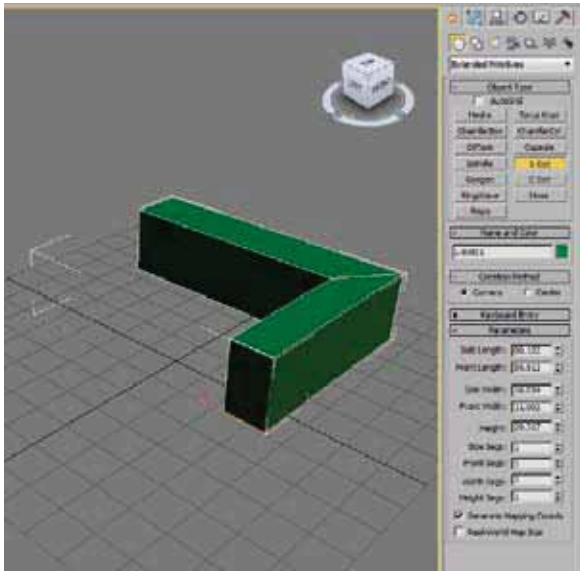

Move the mouse up to set the chamfer cylinder's height.

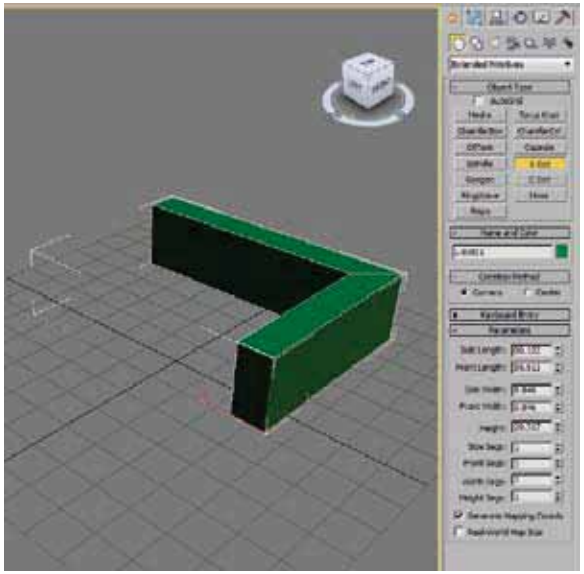
3. Create an extended primitive L-extent.
For our next extended primitive, let's create an L-extent.

- Select the **Geometry** option and choose the L-Ext as the Object Type.
- In the **Perspective** viewport, hold the **LMB** and drag it around anywhere in the viewport. As you are moving the object around in the viewport, you are setting the L-Ext's Side and Front lengths.
- Release the **LMB**, and move the mouse up or down in the viewport. This is setting the object's height.
- When you get a height you are happy with, click the **LMB** again.
- After clicking the **LMB** to get the height, move the mouse left-to-right to determine the Side and Front widths.
- When you get a width you are happy with, click the **LMB** again.



Start by LMB dragging the L-extent in the Perspective viewport.


Move the mouse up to set the L-extent's height.


Move the mouse left to right to set the L-extent's width.

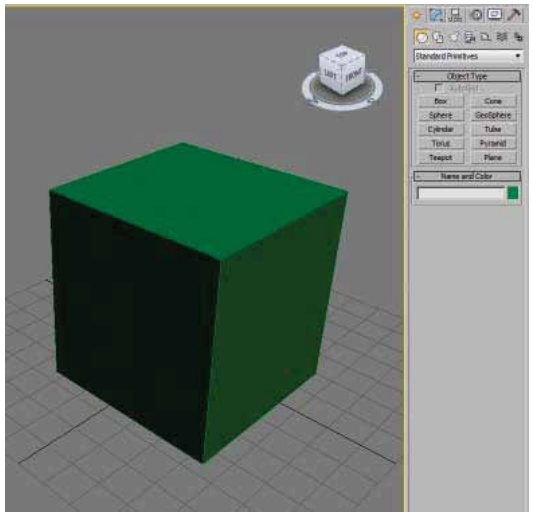
How to alter the parameters of the primitives you create

Regardless of which primitive you create, all of them have parameters that you can adjust. As you can expect, not all of the parameters are going to be the same, but the method for changing various parameters is.

Whatever setting you create a primitive to begin with can be altered to reach your desired result. Adding additional polygons, changing the height or radius, or even the overall scale can all be done even after you have created the primitive. Let's look at how to adjust some of those parameters after you have created a primitive.

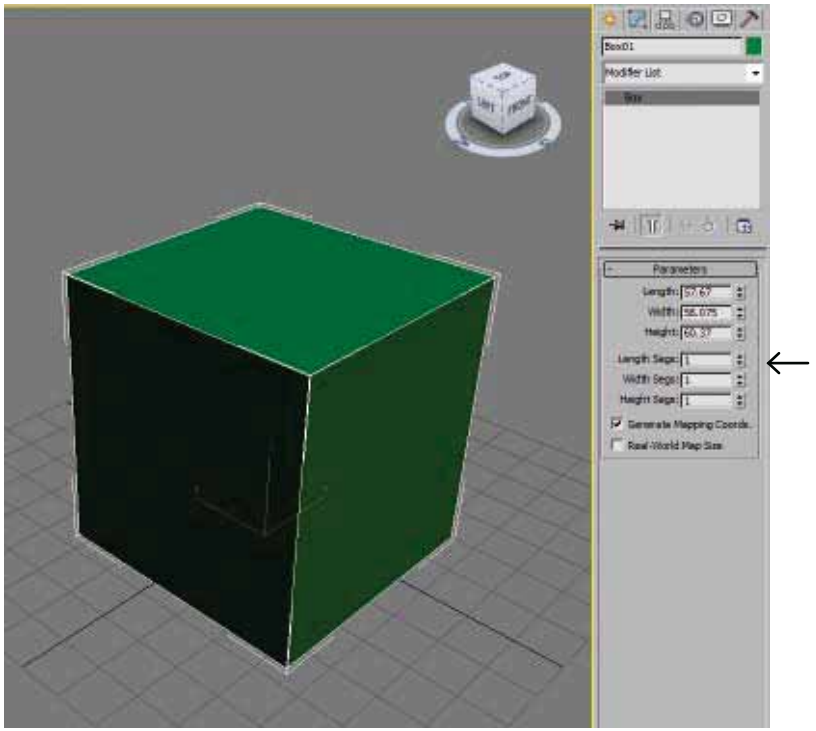
1. **Adjust parameters of a primitive box.**
   For our first test, let's change some parameters of a basic box.

- Start by creating a standard primitive **Box** in the Perspective viewport.
- After you have created the box, **RMB** click anywhere in the viewport to end the creation process. After you do this, you will notice that you no longer have any parameters under the **Create tab**. This is because the creation process is done. Now it is time to edit the object.



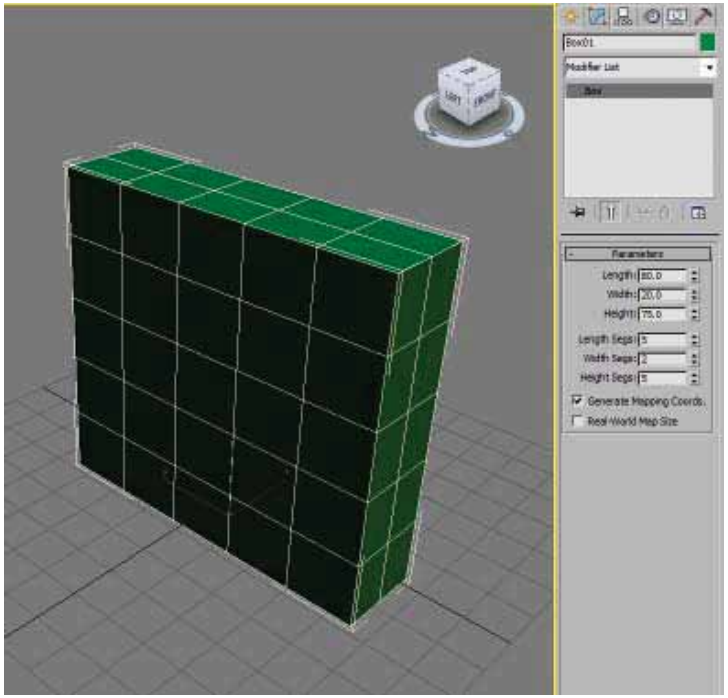
After creating a box, RMB click in the viewport to end the creation process.

- Next to the **Create tab** in the Command Panel is the **Modify tab**. If you have nothing selected you will not see much other than the Modifier List, but by **LMB** clicking on the box, many of the original parameters we saw when we created the box are back.

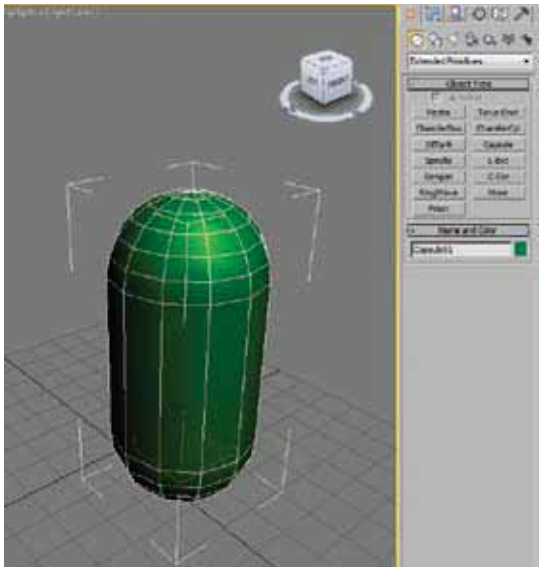


Under the Modify tab, many of the creation parameters are back.

- From the **Parameters** submenu, **LMB** click on any of the Parameter values and type in some numbers in the box, or use the small arrow icon next to the parameter numbers to drag the values up and down with the **LMB**. This is the same as typing the numbers in manually, but is obviously less accurate. You can also add numbers to the length, width, or height segments to change those values as well.



Changing the parameters of the same box to create a customized shape.

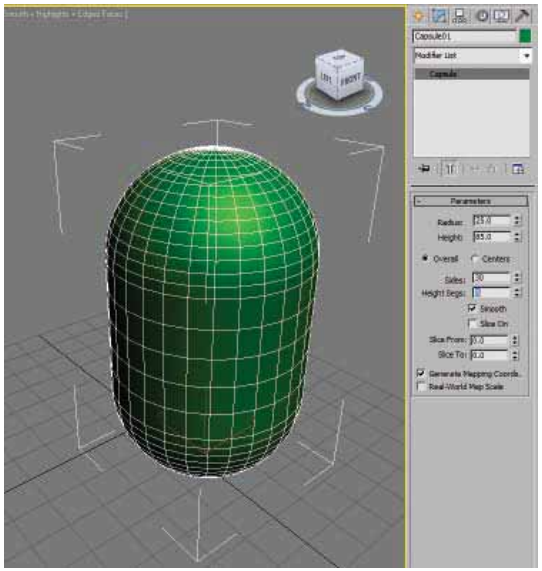


After creating a capsule, RMB click in the viewport to end the creation process.

2. Adjust parameters of a capsule.
For our next object, let's change some parameters of an extended primitive **Capsule**.

- Start by creating an extended primitive **Capsule** in the Perspective viewport.
- After you have created the capsule, **RMB** click anywhere in the viewport to end the creation process.

- Switch to the **Modify tab** and randomly alter the Parameters to get a different shape. Yours might look different than mine, depending on what you type in.

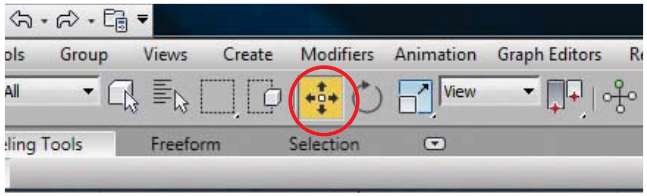


Moving, rotating, and scaling primitives in your scene

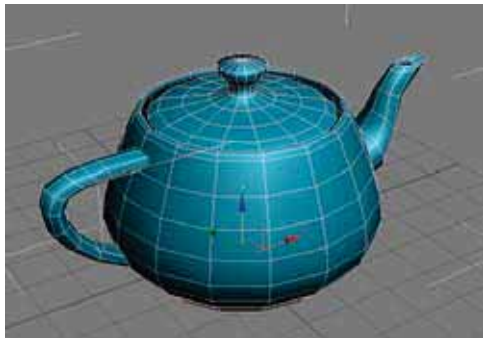
Now that you understand the basics of creating primitives, it is important that you understand how to manipulate them. Once you have created them, you will want to move and alter them around in 3D space, and you can do that with the **move**, **rotate**, and **scale** tools.

1. **Move a primitive.**
   For our next exercise, let's **move** a primitive around in 3D space.

- Select the **Geometry** option, select and create any primitive you want to **move**.
- Ensuring you have the primitive selected, press the **Move** tool on the Main toolbar, or use the **W** hotkey on your keyboard. You will notice an icon appear on your primitive. This is known as the Move *gizmo* or *widget*.



The Move tool selected on the Main toolbar.

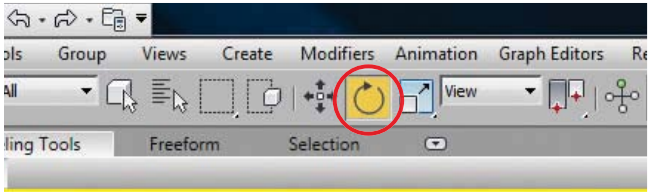


The Move gizmo appears with our Teapot primitive selected.

- **LMB** click and hold the **Move** gizmo on any of the small directional arrows.
- Move the mouse in the direction that the arrow is pointing to move your object in 3D space.

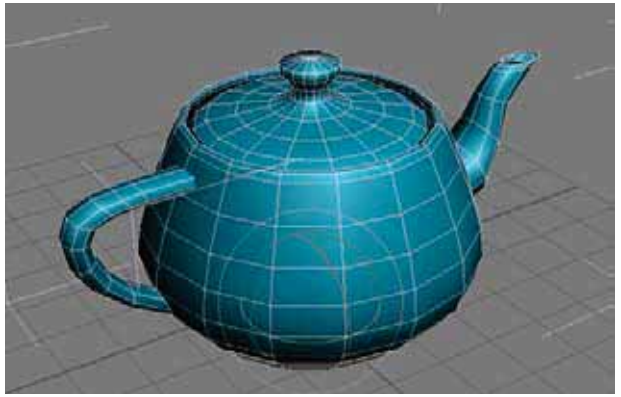
2. **Rotate a primitive.**
   Next, let's **rotate** a primitive around in 3D space.

- Select the **Geometry** option, select and create any primitive you want to **rotate**, or use the same object as before.
- Ensuring you have the primitive selected, press the **Rotate** tool on the Main toolbar, or use the E hotkey on your keyboard. You will notice the icon change to the **Rotate** gizmo on your primitive.



The Rotate tool selected on the Main toolbar.

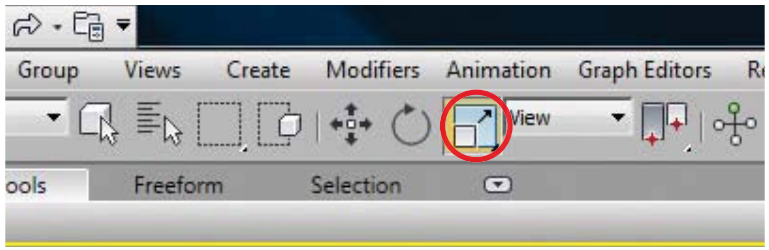
- **LMB** click and hold the **Rotate** gizmo on any of the colored lines to select that direction for rotation.
- Move the mouse in the direction that the arrow is pointing to move your object in 3D space.



The Rotate gizmo appears with our Teapot primitive selected.

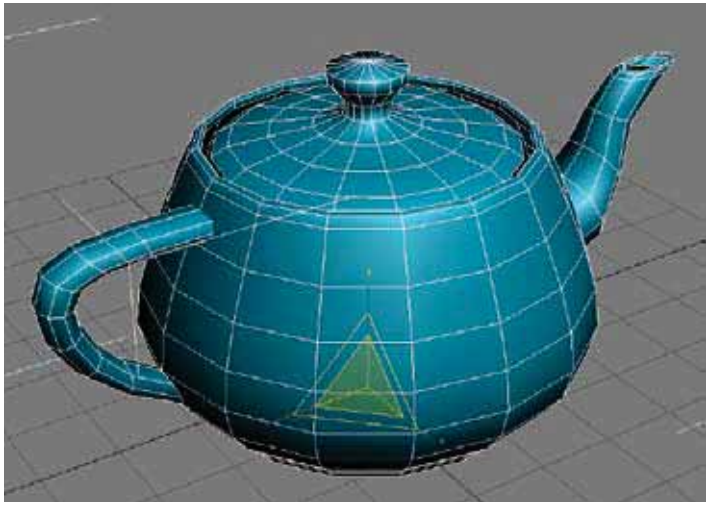
3. Scale a primitive.
Next, let's **scale** a primitive.

- Select the **Geometry** option, select and create any primitive you want to **scale**, or use the same object as before.
- Ensuring you have the primitive selected, press the **Scale** tool on the main toolbar, or use the **R** hotkey on your keyboard. You will notice the icon change to the **Scale** gizmo on your primitive.



The Scale tool selected on the main toolbar.

LMB click and hold on the **Scale** gizmo on any of the colored directional lines to select that direction for scaling.
Move the mouse in the direction that the line is pointing to scale your object in 3D space.
To do a Uniform scale, **LMB** click and hold on the yellow center of the gizmo and drag the mouse in any direction.


The Scale gizmo appears with our Teapot primitive selected.

What modifiers are

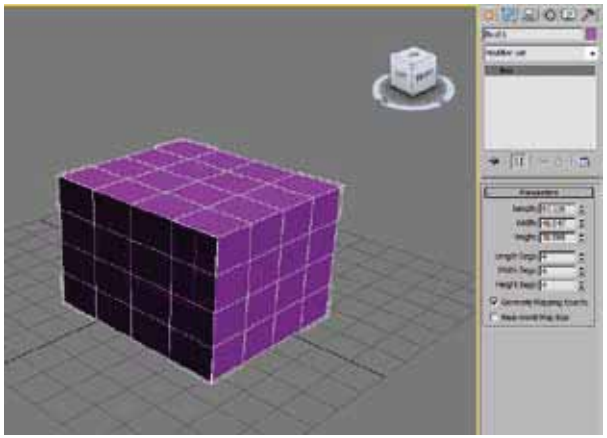
When you start to build geometry in 3D space, you may find yourself wanting to add a little more to the objects you create. You may also find that the default shapes are not exactly giving you the results that you want. Modifiers are tweaks and features that you can add to primitives or geometry in order to alter their original state, and give you a different result from the original.

For example, a Bend modifier may allow you to take a cylinder you made and put a curve into it. One of the FFD modifiers could allow you to stretch and skew your mesh all you want. The Symmetry modifier could save you a considerable amount of time by mirroring your geometry over to the other side so you only have to model half of it. These are just a few examples of the different results you can achieve with modifiers.

How to apply a modifier

While the list of all the different modifiers is quite extensive and their results can be vastly different from each other, the way to apply any modifier to an object is the same. Let's start with a very simple shape, apply a modifier, and then adjust some parameters.

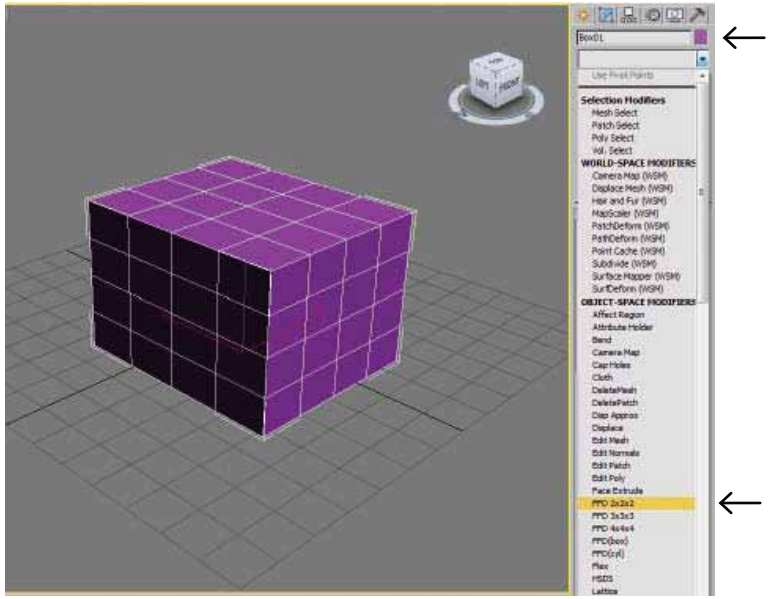
1. **Create a primitive box.**
   For our first modifier, let's add one to a simple box with four length, width, and height segments. Start by creating that box.



Create a box primitive with four length, width, and height segments.

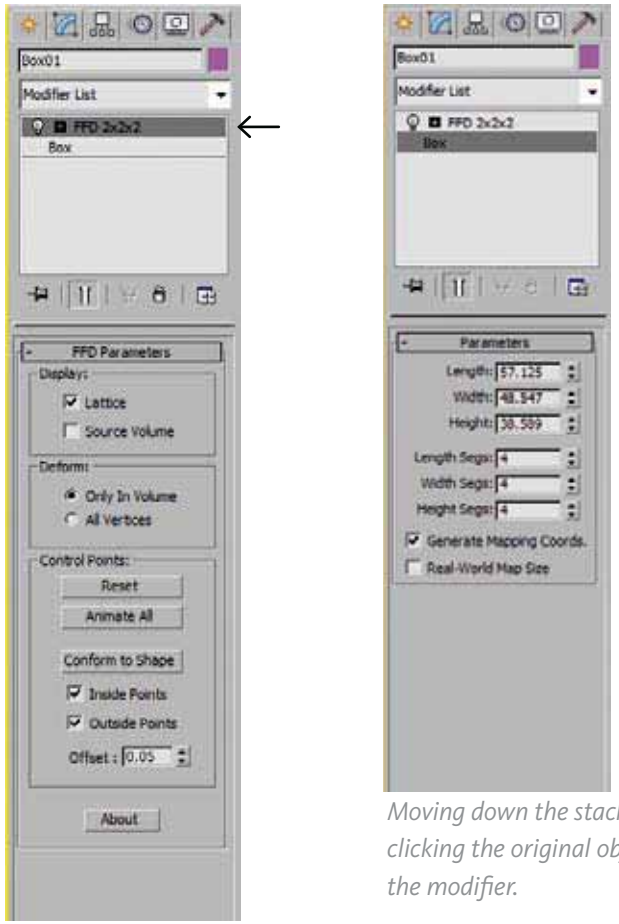
2. **Select the box, and then apply a modifier to it.**
   As you may have noticed, at the top of the Command Panel in the **Modify tab** under the name of the object, there is a drop-down menu titled **Modifier List**. **LMB** clicking anywhere on the **Modifier List** will expand it, and the available modifiers will appear.

- With the box you created selected, **LMB** click the **Modifier List** to expand the available modifiers.
- From the available modifiers listed, scroll down until you find the **FFD 2x2x2** modifier and **LMB** click it to apply it to your box.



Expand the modifier list and select FFD 2x2x2 to apply it to your box.

- Now that you have applied the modifier to your box, there is a new set of available options. You will also notice that the name of the modifier FFD 2x2x2 has appeared above your object's name in the Command Panel. This is known as the **modifier stack**. At the top of the stack we can see that we have the FFD 2x2x2 modifier, and underneath it is the original box. Think of modifiers as "extras" that we are adding to the original object, without losing any of the information of it unless we want to. The original box will stay exactly the same regardless of what we do to the modifier above the stack.



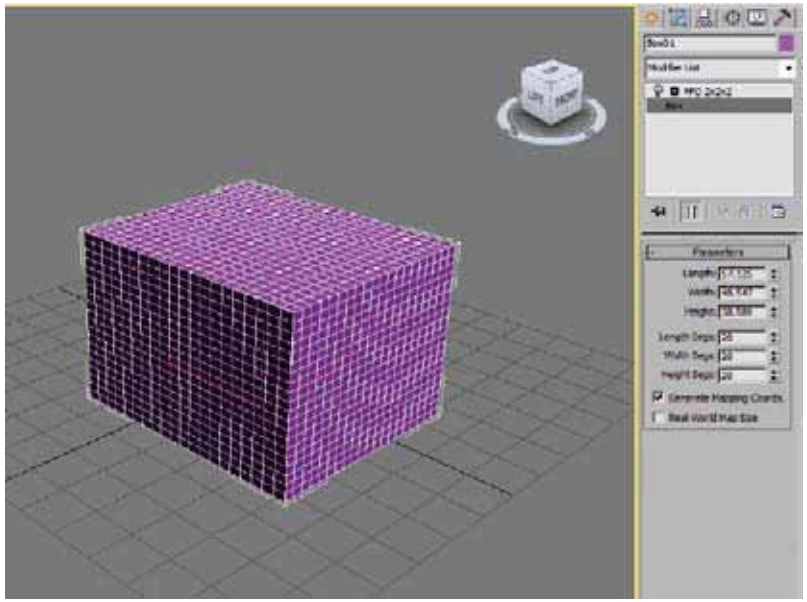
A modifier has been applied to the box, creating a modifier stack.

Moving down the stack by LMB clicking the original object underneath the modifier.

- Currently the top level of the stack is selected, and as you can see the parameters in the Command Panel are specific for the FFD 2x2x2 modifier. However, if we would like to go back down and adjust the parameters of the original box, we can do that by **LMB** clicking the word Box under the FFD 2x2x2 modifier. This is called "Moving down the stack."

3. Move down the modifier stack and adjust the parameters of the original box.
Now that you know how to move down the stack, let's adjust the original box parameters.

- With the box you created selected, **LMB** click on the word Box in the Command Panel to move down the modifier stack.
- Change the Parameters to 20 length, width, and height segments.



Move down the stack and change the parameters to 20 length, width, and height segments.

4. Make some adjustments to the object with the FFD 2x2x2 modifier.
After changing the original box's parameters, go back up to the top of the stack and let's change the shape of the box using the FFD 2x2x2 modifier.

- With the box selected, at the top of the modifier stack with FFD 2x2x2 selected, press the small plus sign next to the name of the modifier to expand the subobject options and select **Control Points**. This is a subobject mode selection of the modifier. We will discuss subobject modes extensively in future chapters.

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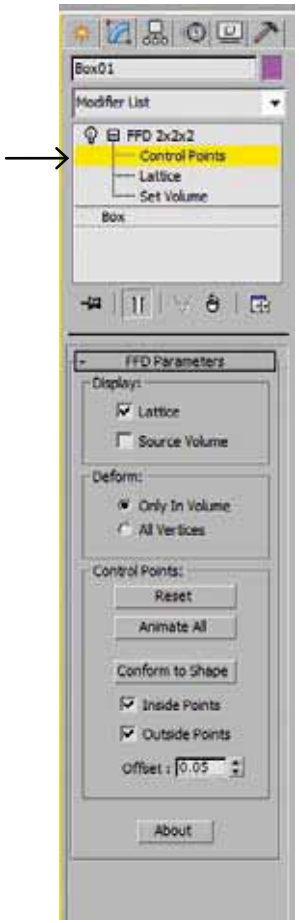
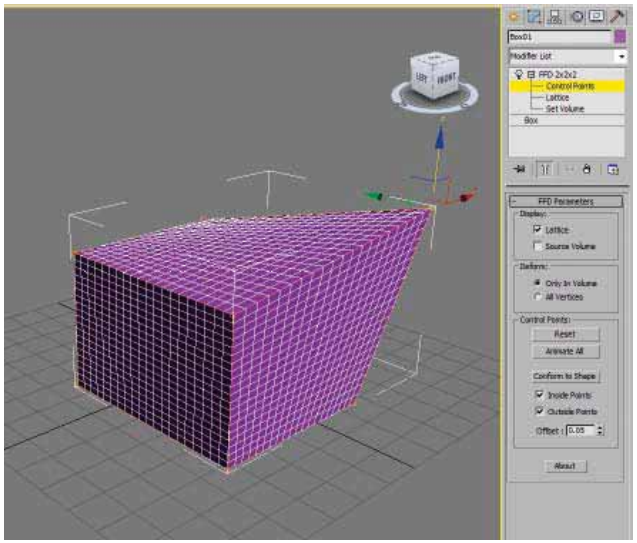


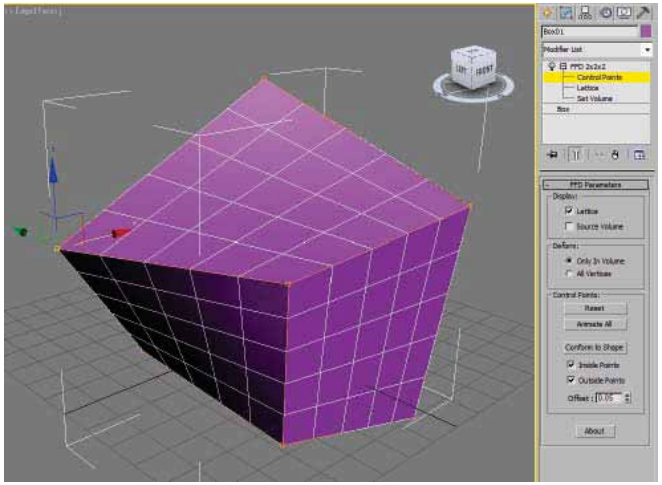
Press the small plus sign next to the name of the modifier to expand its subobject selection modes. When expanded, it will change to a minus sign.

- With **Control Points** option selected, hold the **LMB** and drag select a control point at any of the corners of your object to select them. The FFD modifier has added these control points to allow you to make changes to your object as you wish. Next, with a control point selected, use the **Move tool** to move the control point in any direction, changing the shape of the box entirely.



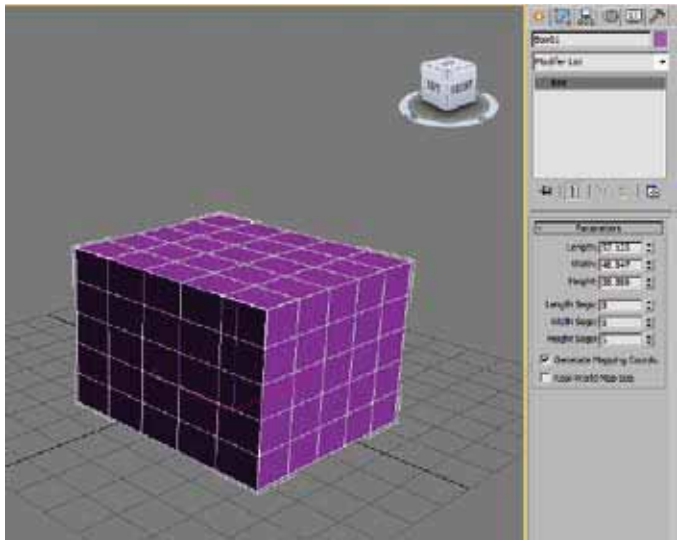
Moving a control point to change the shape of the box.

- Now that you have made an adjustment to your mesh with your first modifier, feel free to move other control points and adjust parameters of the original object and see what sort of results you get with the object.



Random parameter changes and adjustments to the control points to get a different shape.

- If you decide you do not want to use the modifier anymore and wish to go back to the original object, you can delete the modifier by **RMB** clicking on the top of the modifier stack on the name of the modifier, and **LMB** clicking Delete. Alternatively, you can **LMB** select the modifier in the stack, and then **LMB** click on the small Trashcan icon under the modifier stack. Keep in mind that deleting the modifier will remove it forever, and you will not have your custom shape anymore.



Deleting the modifier; going back to the default primitive.

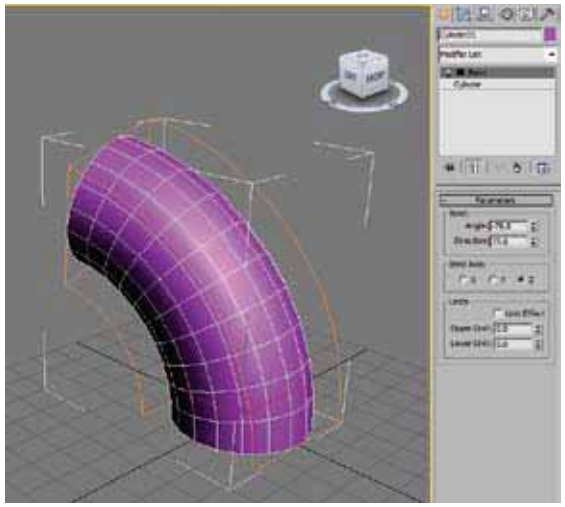
Using Modifiers in your workflow

While we will not cover every single modifier in this book, let's look at just a couple of the commonly used modifiers and a brief description of them.

1. **Apply the Bend modifier.**
   For our next primitive, create a cylinder and add a **Bend** modifier. The Bend modifier attempts to do just like what it sounds like: bend your geometry any way you want it to.

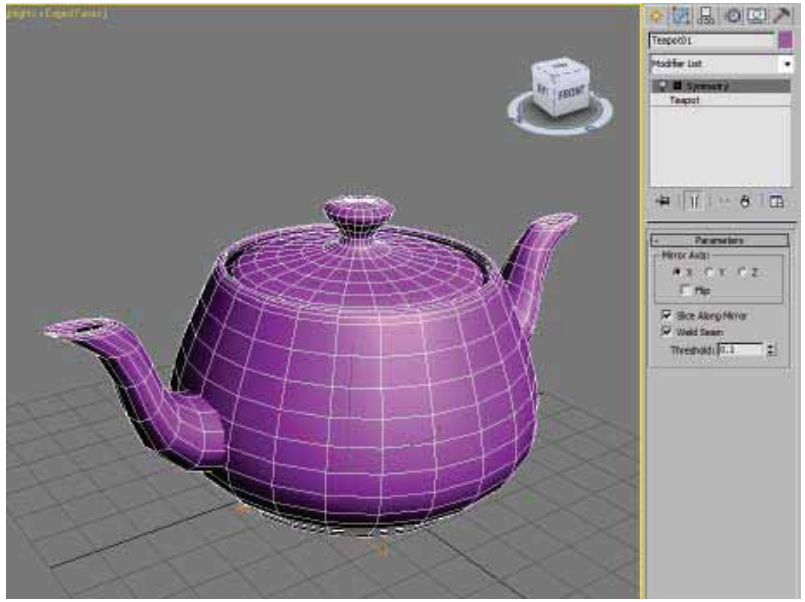
- From Standard Primitives, create a Cylinder and set it to a radius of 20, height of 80, height segments 10, cap segments 1, and sides 18.
- **LMB** click the Modifier List drop-down and choose the **Bend** modifier.

- From the Parameters submenu select the Bend modifier, **LMB** click and hold the small spinners next to Angle and Direction and drag them up or down to randomly change the parameters of the Bend modifier. You can also type in parameters and see what your results are.



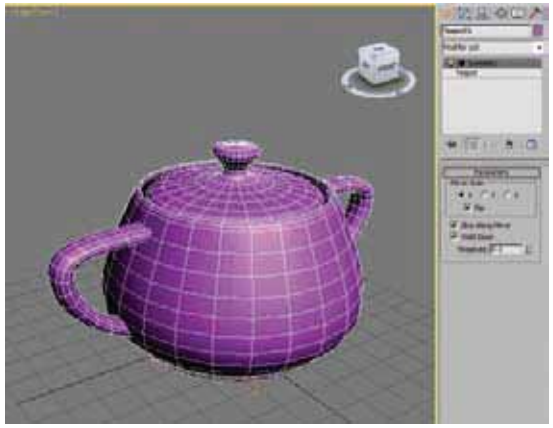
2. **Apply the Symmetry modifier.**
Next, create a teapot and apply a **Symmetry** modifier. The Symmetry modifier works like a mirror along the axis of an object, copying what you have on one side over to the other.

- Select Standard Primitives and create a Teapot with **Radius** set to 40 and Segments set to 6.
- **LMB** click on the Modifier List drop-down and choose the **Symmetry** modifier.



Creating a teapot and applying the Symmetry modifier to it gives it two spouts.

- By default, the Symmetry modifier is set to mirror along the axis of X, and your teapot should have two spouts and no handle. **LMB** click the Flip box under the Parameters to flip the symmetry to the other side, giving the teapot two handles instead.

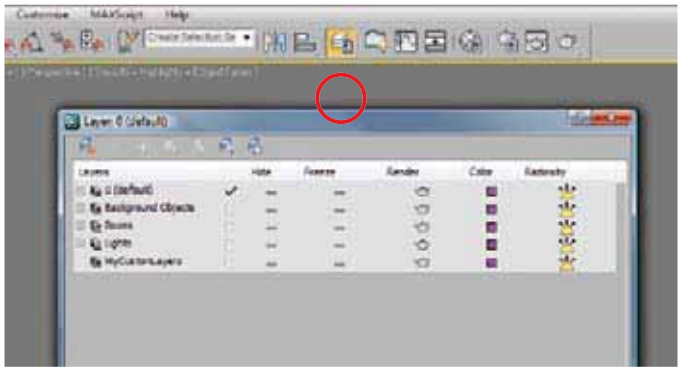


Flipping the Symmetry modifier gives us a teapot with two handles.

Layers

Another important feature of working with 3ds Max 2010 is the built in Layer Manager. Layers play an important role in working with 3ds Max, because they allow you to work with multiple objects or pieces of your scene without having all of them visible all the time. The objects still exist in your scene, but layers allow you to quickly and easily hide or unhide objects in the scene as you wish.

The Layer Manager, available by **LMB** clicking the icon on the Main toolbar, is a tool where you can create and delete layers. You can also view and edit the settings for all of the layers in your scene, as well as the objects associated with them. You can specify the name, visibility, renderability, color, and more.



Access the Layer Manager by LMB clicking the icon on the Main toolbar.

Layer Manager Interface Elements

Create New Layer—Creates a new layer containing any selected objects. The new layer's name is generated automatically (Layer01, Layer02, and so on) but you can change it by clicking the label. Note: The new layer becomes the current layer.

Delete Highlighted Empty Layers—Deletes highlighted layers if they are empty. Note: This button is unavailable if the highlighted set of layers contains any of the following: nothing (that is, no layers are highlighted), the active layer, objects, Layer 0, or nonempty layers.

Add Selected Objects to Highlighted Layer—Moves currently selected objects into the highlighted layer. Note: This button is unavailable if nothing is selected or if more than one layer is highlighted.

Select Highlighted Objects and Layers—Selects all of highlighted objects, as well as all objects contained in any highlighted layers. Note: This button is unavailable if nothing is highlighted.

Highlight Selected Objects' Layers—Highlights layers containing the currently selected objects and automatically scrolls so that highlighted layers are visible in the layer manager. Note: This button is unavailable if nothing is highlighted.

Hide/Unhide All Layers—Toggles the display of all layers.

Tip:

This is most useful if you hide all layers and then display only the layers you want to work on.

Freeze/Unfreeze All Layers—Toggles the frozen state of all layers.

Tip:

This is most useful if you freeze all layers and then unfreeze only the layers you want to work on.

List of Layers—Displays layers, their associated objects, and their properties. To expand or collapse the object list for each layer, click + (plus sign) or - (minus sign), respectively. To modify a property, click its icon. To select all layers quickly, **RMB** click and choose Highlight All. To open the Object/Layer Properties dialog box, **LMB** click on the icon next to the layer or object.

Tip:

You can sort the layers by any of their properties by clicking on the column name.

Layers—Displays the names of the layers/objects. Click a name to select the layer, or to
rename the layer.

> Note:
>
> Clicking the layer icon opens the Layer Properties dialog box for all highlighted layers. Clicking the object icon opens the Object Properties dialog box for all highlighted objects.

Current Layer Toggle—The unlabeled column to the right of the layer name indicates the current layer and lets you make a different layer current. A check mark appears next to the current layer. **LMB** click the check box next to another layer name to make it current.

Hide—Hides and unhides layers. When a layer is hidden, it is invisible. You might want to hide layers that contain construction or reference information.

Freeze—Freezes layers. You cannot select or edit objects on a frozen layer. Freezing a layer is useful if you want to view information on a layer for reference but do not want to edit objects on that layer.

Render—When on, objects appear in the rendered scene. Nonrendering objects do not cast shadows or affect the visual component of the rendered scene.

Color—Changes the color associated with the highlighted layers. You can select another color by **LMB** clicking the color swatch to display either the Object Color dialog box (for objects), or the Layer Color dialog box (for layers). You can set an object's color independently, or turn on ByLayer in the Object Color dialog box to use the associated layer's color.

Radiosity—When on, objects are included in the radiosity solution. Objects not included in the radiosity solution do not contribute to indirect illumination. If these objects are lights, only their direct contribution will be used for rendering.

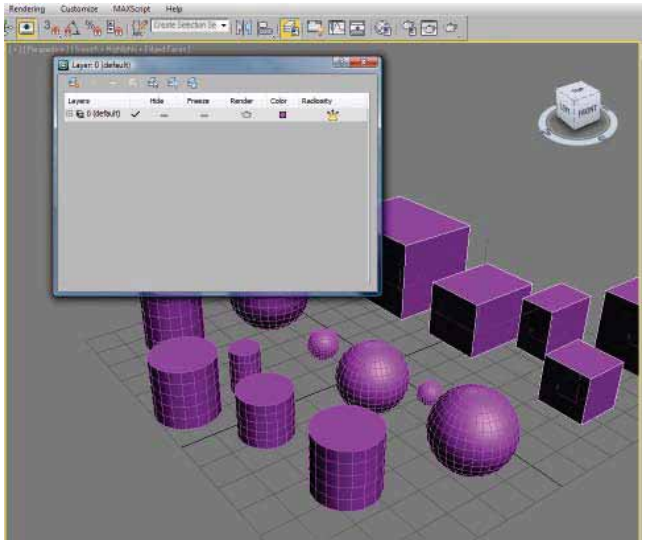
> Note:
>
> Removing objects from the radiosity solution can significantly decrease radiosity processing and rendering time, however it does sacrifice some accuracy in the solution. It can be useful for creating quick test renders.

Working with layers

Now that we have looked at the interface of the Layer Manager, let's create a few pieces of geometry and add them to layers.

1. Create a collection of geometry we will add to layers.

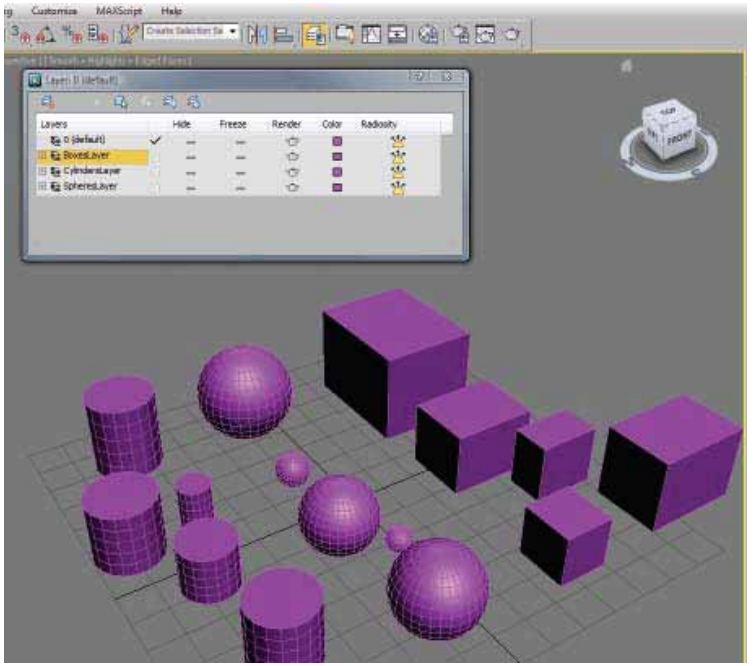
- Using what you have learned, create five standard primitive **Boxes**, **Cylinders**, and **Spheres** in the Perspective viewport.
- **LMB** drag select the boxes in your scene, and bring up the Layer Manager by **LMB** clicking on the icon in the Main toolbar.



Start by LMB dragging the box in the Perspective viewport.

2. Create a new layer and rename it.
Next, let's add the boxes to a new layer.

- **LMB** click on the **Create New Layer** icon.
- A new layer appears on the list, named *Layer01*. By default, since you had the boxes selected, the boxes are now added to this layer.
- **RMB** click on our new Layer01 layer, and then **LMB** click Rename.
- Rename the layer *BoxesLayer*.
- Repeat the same steps for the spheres and cylinders, and create new layers for them called *SpheresLayer* and *CylindersLayer*.

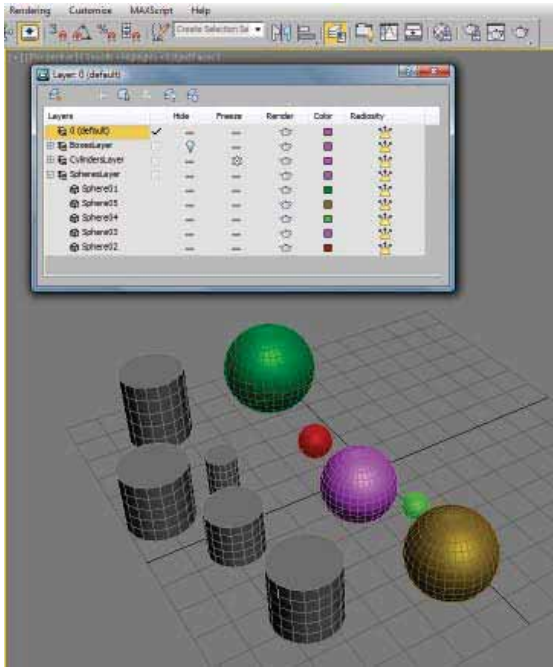


Each of the layers renamed and objects added to them.

3. Adjust the settings of various objects in the layers.
Lastly, let's adjust some parameters of the various layers and the objects inside of them.

- Under the *BoxesLayer* select the icon to hide the layer group. Notice that the layer group disappears. The objects are not lost, but will remain hidden from view until we unhide.

- For the *CylindersLayer*, select the icon to freeze the layer group. Notice that after we freeze this layer the color has changed to gray. This is indicating to us visually that the layer is frozen and we can no longer adjust it until we unfreeze that layer.
- Expand the *SpheresLayer* to reveal the objects in that layer, and change the colors of some of the spheres.



Adjusting the parameters of the various layers and objects inside of them.

Copies, instances, and references

As you start to create more and more geometry, you may find yourself wanting to copy geometry, rather than having to create brand new geometry all the time and trying to match up the parameters. Trying to make 50 spheres one at a time could get rather frustrating! Aside from simply making a copy of an object, you can also create a version of the object that will allow you to adjust parameters of one and have it propagate to the other versions of itself. In 3ds Max 2010, these cloning methods are known as copies, instances, and references.

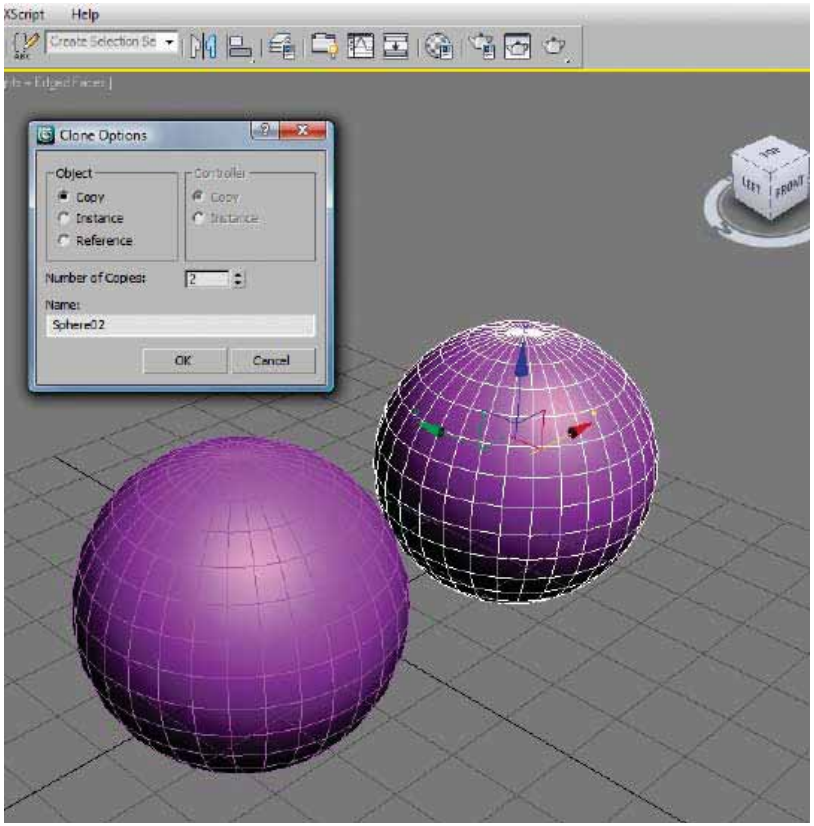
A **copy** is simply a duplicate of an object. The new version will only retain the original shape of the object when copied, but after that it is completely independent of any other object in the scene. Think of a copy just like you would with a copy machine in an office. Once you have that copied piece of paper, if you make changes to the original or the copy, it will not affect the other one.

An **instance** is a duplicate of the original object, but will simultaneously mirror any changes to either versions of the object. For example if I have a Box primitive, I make an instance of that box, and then change parameters of either object, both objects will change together at the same time. The exception to this is moving, rotating, and scaling with the gizmos.

A **reference** is almost identical to an instance in that any changes to one will be applied to both objects. The difference, however, is that a reference can have additional modifiers applied to it, without affecting the other versions of the object, and give you an idea of what the final result will be after those modifiers are applied further down the stack. For example, if I have a Box primitive, I make a reference of that box, I can then apply additional modifiers to that box without affecting the other versions of it.

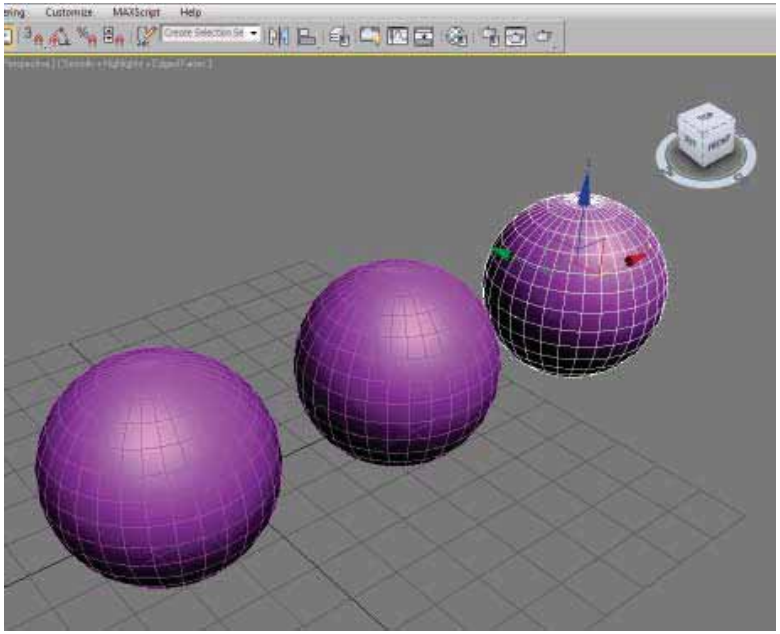
1. **Make a copy of an object.**
   Let's start with making a copy of an object.

- Start by creating a Standard Primitive **Sphere** in the Perspective viewport.
- After you have created the sphere, select the sphere and then select the **Move** tool, or use the **W** hotkey.
- With the sphere selected, choose any direction of the Move tool, and while holding down the Shift button on your keyboard, **LMB** drag that direction, and once you have a distance you are happy with, release the **LMB**.
- The **Clone Options** dialog box will pop up. Make sure that **Copy** is selected, type in **2** for **Number of Copies**, and then **LMB** click **OK** to create the copies.



Hold down Shift and drag the Move tool to bring up the Clone Options.

- You will now have three spheres in the scene—the original sphere you created, and the two copies you made. You should also notice how the spheres are spaced. However far you drug the sphere the first time before releasing the **LMB** is how far apart each of the copies will be from each other.

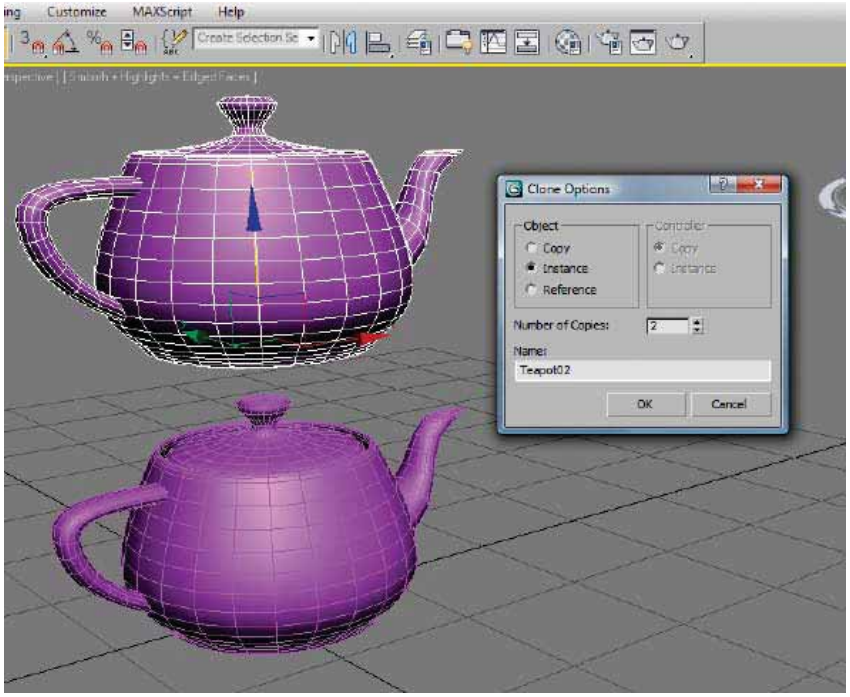


Three spheres will now be in the scene, evenly spaced.

2. Make an instance of an object.
Next, let's do the same method, but this time choose instance.

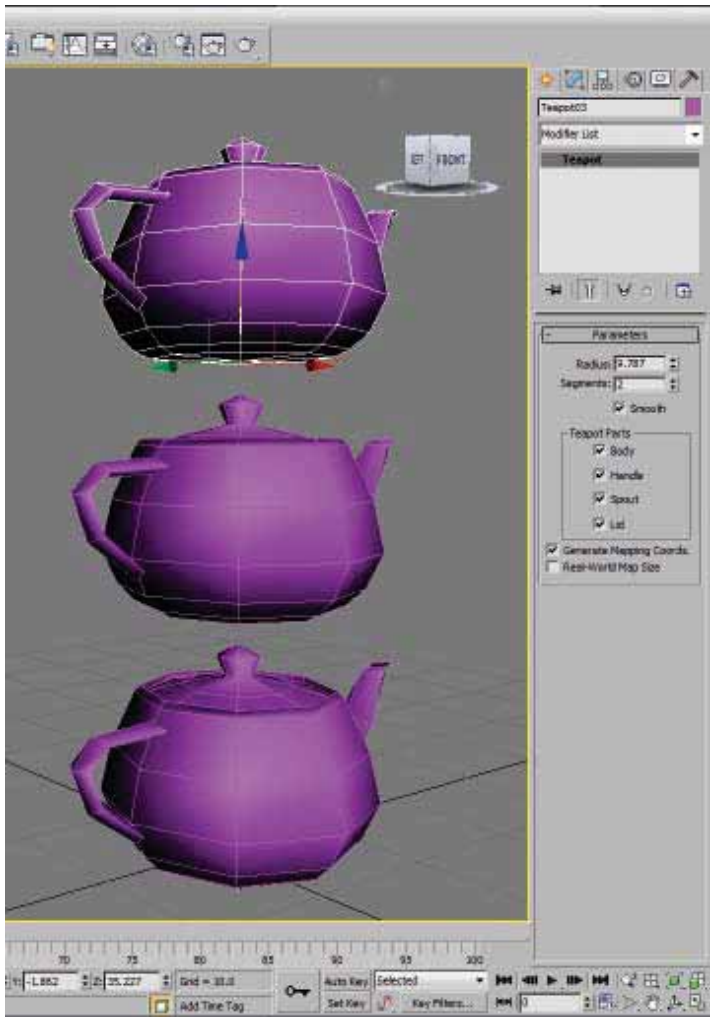
- Start by creating a standard primitive **teapot** in the Perspective viewport.
- With the teapot selected, hold down the **Shift** button on your keyboard, **LMB** drag that direction using the **Move** tool, and once you have a distance you are happy with, release the **LMB**.
- When the **Clone Options** dialog box pops up, choose **Instance**, and type in **2** for the **Number of Copies**.

3dsMax Skills



Create a teapot and make two instances of it.

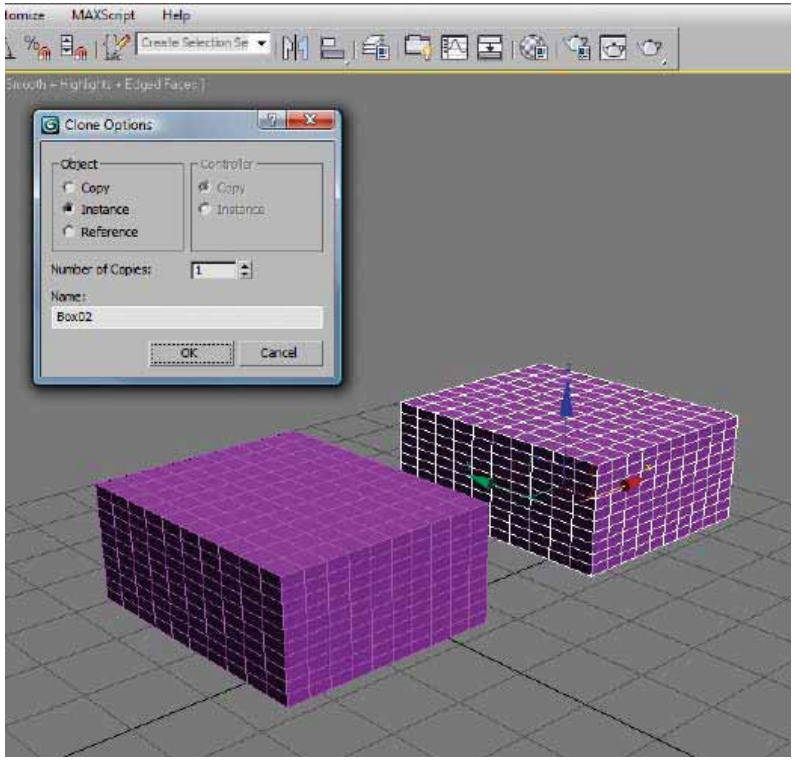
- Several things will have changed as you will notice. The object name in the Command Panel under the Modifier List has been bolded, and any adjustments you make to the teapot's radius or segments will apply to all three of the teapots. If you were to add a modifier to any of the teapots, it too would affect all of the other instances.



Changing the parameters of one instance affects them all.

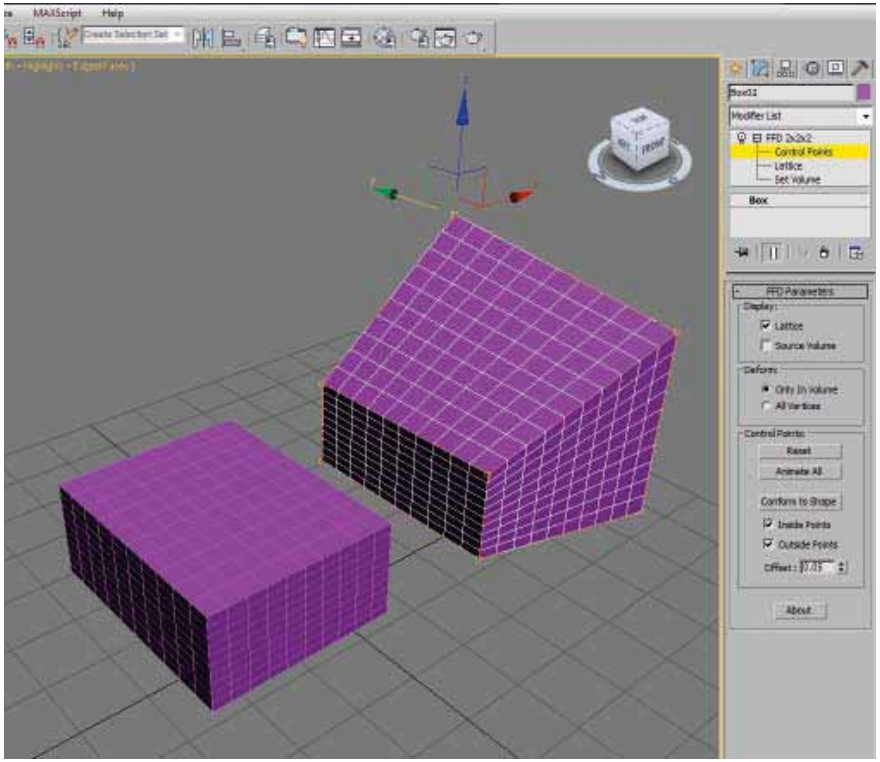
3. Make a reference of an object.
Finally, let's create a reference. A reference will work almost exactly the same as an instance, but we can add modifiers to the reference and see what the final outcome will be as we adjust parameters of the other version of the object.

- Start by creating a standard primitive **Box** in the Perspective viewport, and give it **10** length, width, and height segments.
- With the box selected, hold down the **Shift** button on your keyboard, **LMB** drag that direction using the **Move** tool, and once you have a distance you are happy with, release the **LMB**.
- When the **Clone Options** dialog box pops up, choose **Reference**, and leave the **Number of Copies** at **1**.



Create a Box and make 1 Reference of it.

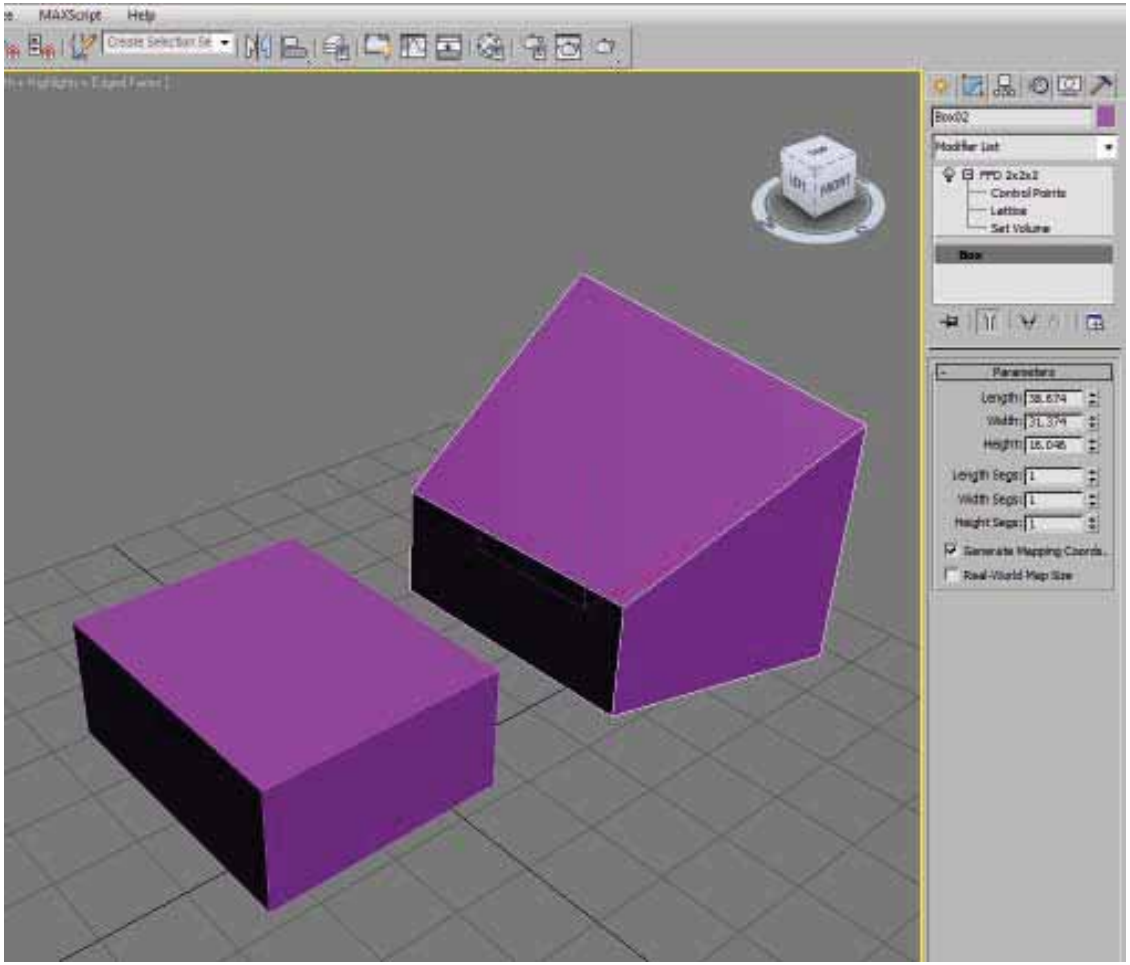
- As you will notice, the object name in the Command Panel from the Modifier List has been bolded just like an Instance, and a new dark gray bar has appeared. This is where new modifiers will appear if you add them to either one of the two references. Add an **FFD 2x2x2** modifier to either of the references and adjust the control points. The gray bar will stay on the modifier stack as an indication that it is used in conjunction with the reference. But, as you notice, the modifier is only affecting one of the boxes.



Changing the parameters of one instance affects them all.

3dsMax Skills

- Lastly, go down the modifier stack by **LMB** clicking the Box in the modifier stack, and change the length, width, and height segments back down to 1. As you see, both of the objects' default settings change, but the version with the modifier on it also retains the effects of the modifier itself.



Changing the parameters of one instance affects them all.

What editable polygon objects are

While each of the basic primitives are a great building block when working with geometry in 3D, even with modifiers they will never give you complete capabilities to create everything you could possibly think of. Editable polygon objects are objects that have been converted to take advantage of the subobject modes that make up those objects.

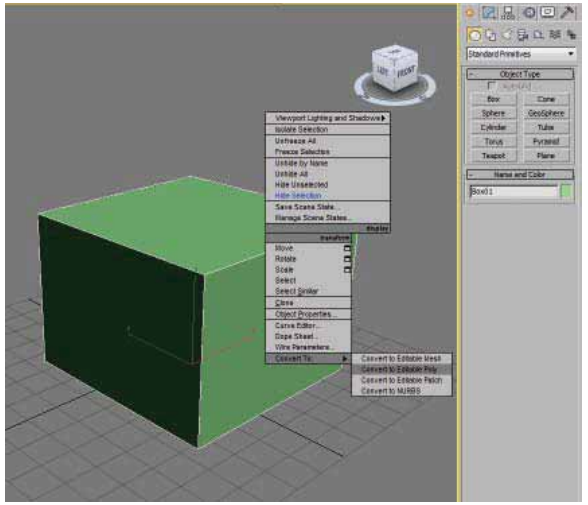
The five subobjects that make up an editable poly are vertices, edges, borders, polygons, and elements. While these subobjects exist on all 3D objects, you can only manipulate them individually by converting your object to a polygonal surface. Cutting up your geometry and adding to it beyond the basic primitives is realistically only achievable with a polygonal object, such as converting it to an editable polygon.

How to convert a primitive to an editable polygon object

There are at least two quick and easy methods to converting your objects to an editable polygon object. Once you have converted them to an editable poly, you will notice the entire Command Panel will change to access new features for the new editable poly object.

1. **Access the Quad menu.**
   The first method to converting an object to an editable polygon object is to use the **Quad** menu.

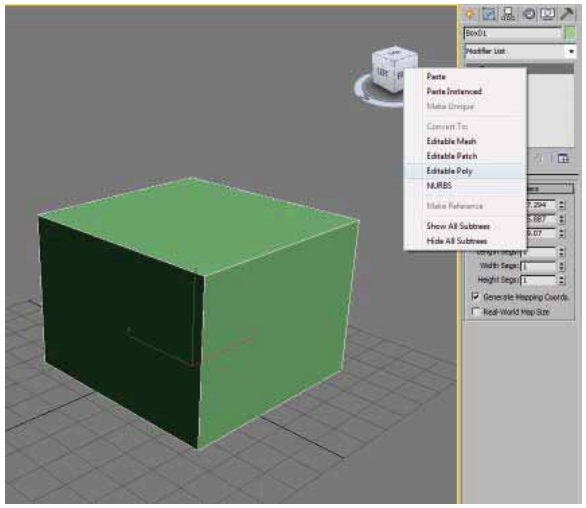
- Create a Box primitive in the Perspective viewport, and then **RMB** click it to bring up the Quad menu.
- At the bottom of the menu, move your mouse down to the **Convert To** option to extend that menu, and **LMB** click **Convert to Editable Poly**.



RMB click on a primitive and choose Convert to Editable Poly.

2. **Change it from within the Command Panel.**
   Another method is to simply convert it in the Command Panel.

- From within the Command Panel, **RMB** click Object from the Modifier List and **LMB** click **Editable Poly** to convert it.

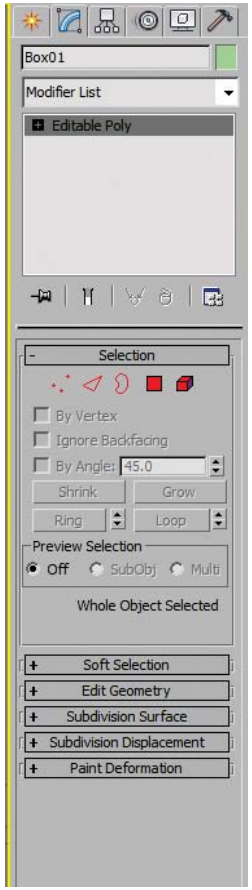


RMB click the object mode from the Modifier List, then LMB click the Editable Poly option.

Navigating the newly changed command panel

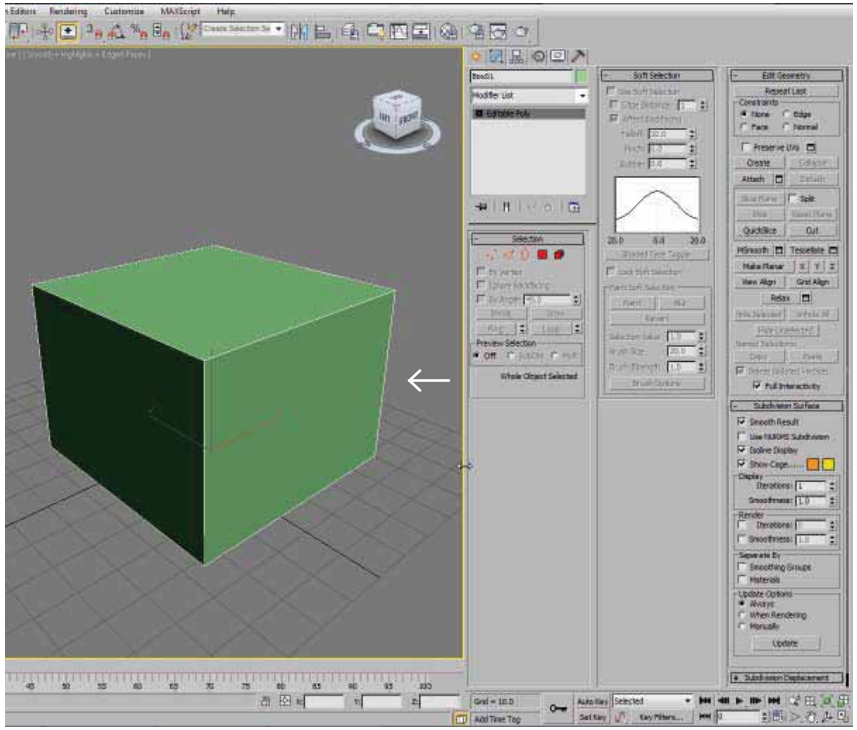
You may have noticed a large amount of new menu items appear after converting your primitive to an editable poly. Do not worry—you will not have to master each and every single piece of information to be a decent 3D artist. But it is important to understand many of the features in order to successfully create the objects you set out to make. There are also several tips you will need to know about navigating this newly changed Command Panel.

Minimize and maximize submenus—We have mentioned this before, but it is important to remember that in order to expand or collapse the submenus in the Command Panel, all you need to do is **LMB** click the box that has the name of the submenu. You will find that when working with editable poly objects you will not need every single menu expanded, so it might be a good idea to collapse the ones you do not need.



The Command Panel with all but one submenu collapsed.

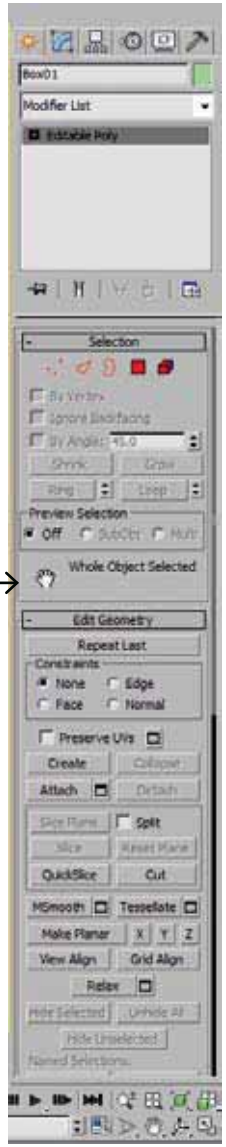
Increase the width of the Command Panel—Another tip for maximizing the Command Panel is to expand the panel altogether. Along the edge of the Command Panel, where the panel meets the viewport, if you hover your mouse slightly you will see the mouse icon change. Holding down the **LMB** and dragging it to the left will allow you to "pull" the Command Panel out further to give more screen space to the different menu options.



Holding the LMB and dragging left at the edge of the Command Panel allows you to stretch its width.

Put the submenus in your preferred order—When it comes to modeling in 3D for games and working with subobject modes, there are some common submenus you will use more often than others. One feature to help with this is to **LMB** click and hold any of the submenu titles, and then drag it up or down to your preferred order. So whether you choose to have expanded the Command Panel or to keep it small, you can choose which order your menus are in.

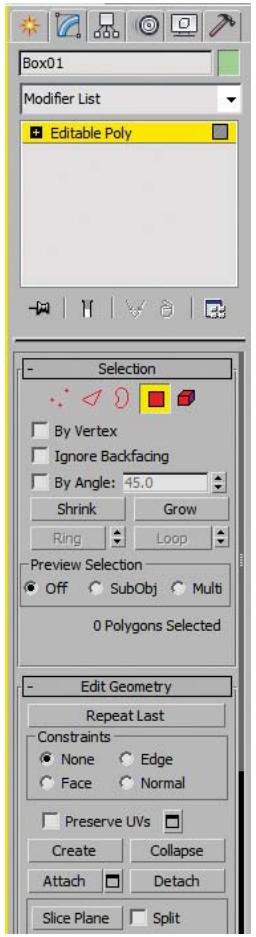
Drag the Command Panel up or down—Lastly, it is important to know how to drag the Command Panel up or down if you choose not to expand it out. If you hover your mouse over any area that is not a button or a submenu, your icon will change to a small hand, allowing you to "grab" the panel and pull it up or down. Alternatively, there is a very small traditional scrollbar at the very furthest left side of the Command Panel. Either of these methods will drag the panel up or down.



When hovering your mouse over the Command Panel, a small hand icon appears allowing you to drag the panel up or down.

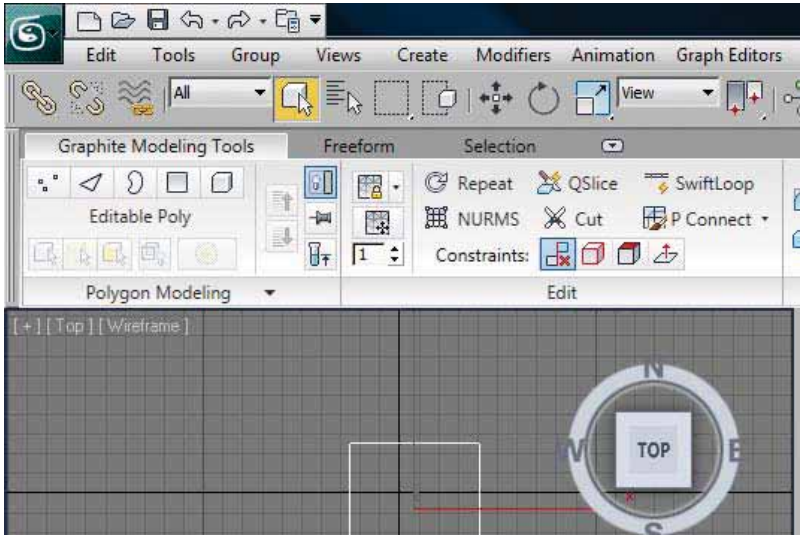
How to change between subobject modes

As you may have guessed, there are multiple ways to switch between the subobject modes. Depending on whether you are taking advantage of the vertex toolset or the polygon toolset, you will want to be able to quickly switch between the different subobjects to take advantage of specific tools available to each of the subobjects.
Using your keyboard, pressing 1-5 will switch between each of the subobject modes.
If you have an Editable Poly object selected, pressing the icon for any of the five subobjects under the Selection submenu will change between them.



An Editable polygon object with the Polygon subobject mode selected.

In the **Graphite Modeling Tools** menu, select the icons for the various subobject modes.



The various subobject modes can be selected from within the Graphite Modeling Tools menu.

Subobject modes

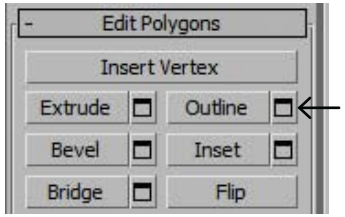
There are literally hundreds of various tools associated with each of the subobject modes. If you have looked at the different submenus under each of them, it is easy to become somewhat confused at the vast amount of options. It is not required to master them all, but feel free to experiment and see what you get! You can always utilize the powerful Help Menu by pressing **F1**, typing in the command you want to learn more about and experimenting on your own.

As you may have noticed as well, once you have converted an object to editable poly, the graphite modeling tools start to spring to life. This handy tool provides graphical icons and drop down menu descriptions that make understanding each of the functions of editable polygons that much easier. For many of the subobject tools, we will identify the name of the function and which submenu it falls under. Whether you choose to access it via the classic Command Panel or the new graphite tools is entirely up to you. The graphite tools do organize them a little more than the Command Panel does as well as provide a graphical icon for many of the functions, so it definitely makes a good learning tool for beginners and advanced modelers alike.

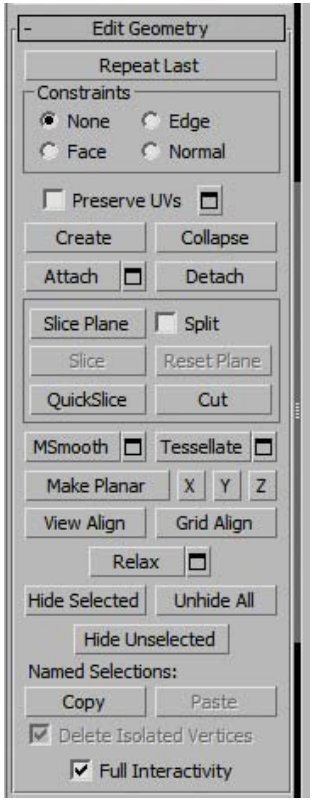
Here we will focus on three of the five subobject modes: Vertex, Edge, and Polygon. As we move throughout the book, we will utilize tools specific to the other subobject modes as well.

Tip:

When we describe the various functions, some of them also contain a dialog box that allows for additional functions or settings than the default function. The dialog box is brought up by clicking the small box icon next to the normal function's name.



To access a dialog box, LMB click on the small box next to the function you are using.



The Edit Geometry options are available to all of the subobjects, and can change slightly depending on the subobject.

Features of the Edit Geometry submenu

The Edit Geometry rollout provides global controls for changing the geometry of the poly object, at either the top (object) level or the subobject levels. The controls are the same at all levels, except as noted in the descriptions below.

Tip:

To select multiple subobject pieces, hold down the **Control** button on your keyboard and then **LMB** click the desired element on your object. For example, to select more than one polygon, switch to the Polygon subobject mode, **LMB** click one polygon, hold down **Control** on your keyboard, and then **LMB** click another polygon to select more than one. To deselect the element, hold down the **Alt** key and **LMB** click or drag the subobject selection to deselect it.

Repeat Last—Repeats the most recently used command.
Constraints—Lets you use existing geometry to constrain subobject transformation.
Choose the constraint type:
None—No constraints. This is the default option.

Edge—Constrains subobject transformations to edge boundaries.

Face—Constrains subobject transformations to individual face surfaces.

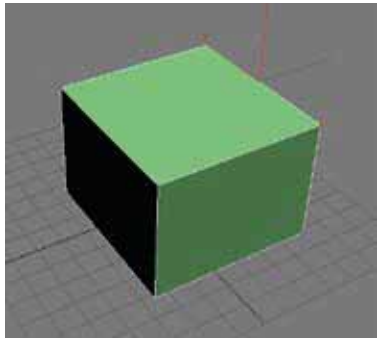
Normal—Constrains each subobject's transformations to its normal, or the average of its normals. In most cases, this causes subobjects to move perpendicular to the surface.

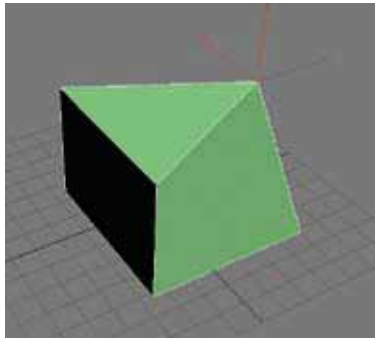
Create—Lets you create new geometry. How this button behaves depends on which level is active:
Object, Polygon, and Element—Lets you add polygons in the active viewport. After you turn on Create, click three or more times in succession anywhere, including on existing vertices, to define the shape of the new polygon. To finish, **RMB** click. While creating a polygon at the Polygon or Element level, you can delete the most recently added vertex by pressing **Backspace**. You can do this repeatedly to remove added vertices in reverse order of placement. You can start creating polygons in any viewport, but all subsequent clicks must take place in the same viewport.

Vertex—Lets you add vertices to a single selected poly object. After selecting the object and **LMB** clicking **Create**, **LMB** click anywhere in space to add free-floating (isolated) vertices to the object. The new vertices are placed on the active construction plane.

Edge and Border—Lets you create an edge between a pair of nonadjacent vertices on the same polygon. **LMB** click **Create**, **LMB** click a vertex, and then move the mouse. A rubber-band line extends from the vertex to the mouse cursor. **LMB** click a second, nonadjacent vertex on the same polygon to connect them with an edge. Repeat, or, to exit, **RMB** click anywhere in the viewport or **LMB** click **Create** again.

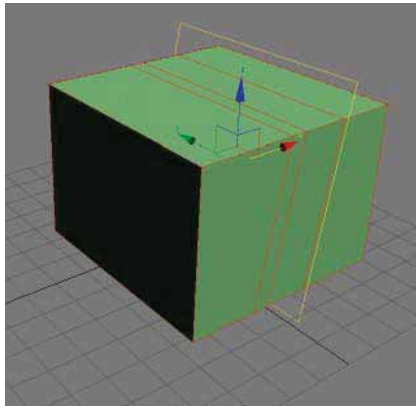
Collapse— (Vertex, Edge, Border, and Polygon levels only) Collapses groups of contiguous selected subobjects by welding their vertices to a vertex at the selection center.





Attach—Lets you attach other objects in the scene to the selected poly object. After activating **Attach**, **LMB** click on another object to attach it to the selected object. The **Attach** operation remains active, so you can continue clicking on other objects to attach them as well. To exit, **RMB** click anywhere in the active viewport or click the **Attach** button again. Attaching a non-mesh object automatically converts it to the editable-poly format.

Detach— (subobject levels only) Detaches the selected subobjects and the polygons attached to them as a separate object or element(s). With an editable poly object, when you **LMB** click **Detach**, 3ds Max prompts for those options in the **Detach Dialog**.



Slice Plane— (subobject levels only) Creates a gizmo for a slice plane that you can position and rotate to specify where to slice. Also enables the **Slice** and **Reset Plane** buttons. **LMB** click Slice to create new edges where the plane intersects the geometry. To perform the slice, **LMB** click the **Slice** button.

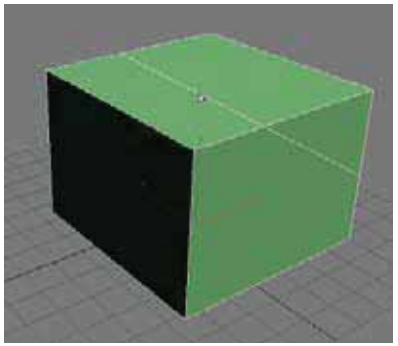
Slice—(subobject levels only) Performs the slice operation at the location of the slice plane.

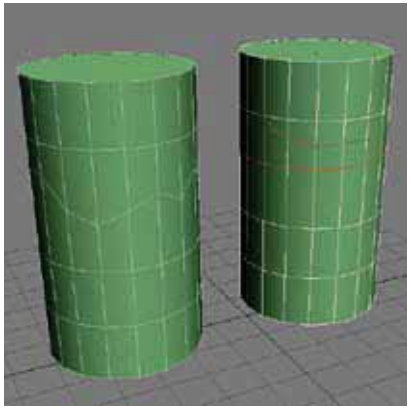
Reset Plane—(subobject levels only) Returns the slice plane to its default position and orientation. Available only when Slice Plane is on.

QuickSlice—Lets you quickly slice the object without having to manipulate a gizmo. Make a selection, **LMB** click **QuickSlice**, and then **LMB** click once at the slice start point and again at its endpoint. You can continue slicing the selection while the command is active. To stop slicing, **RMB** click anywhere in the viewport, or click **QuickSlice** again to turn it off.

Cut—Lets you create edges from one polygon to another or within polygons. **LMB** click at the start point, move the mouse and **LMB** click again, and continue moving and clicking to create new connected edges. **RMB** click once to exit the current cut, whereupon you can start a new one, or **RMB** click again to exit Cut mode. While cutting, the mouse cursor icon changes to show the type of subobject it is over, to which the cut will be made when you click.

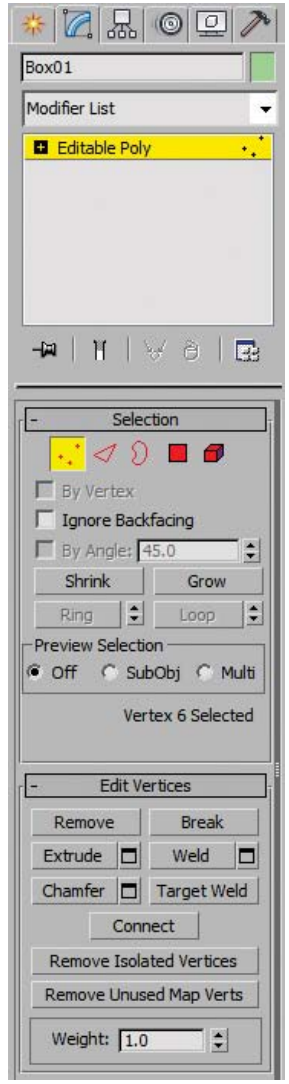
X/Y/Z—Makes all selected subobjects planar and aligns the plane with the corresponding plane in the object's local coordinate system. The plane used is the one to which the button axis is perpendicular; so, for example, clicking the X button aligns the object with the local YZ axis. At the Object level, makes all vertices in the object planar.





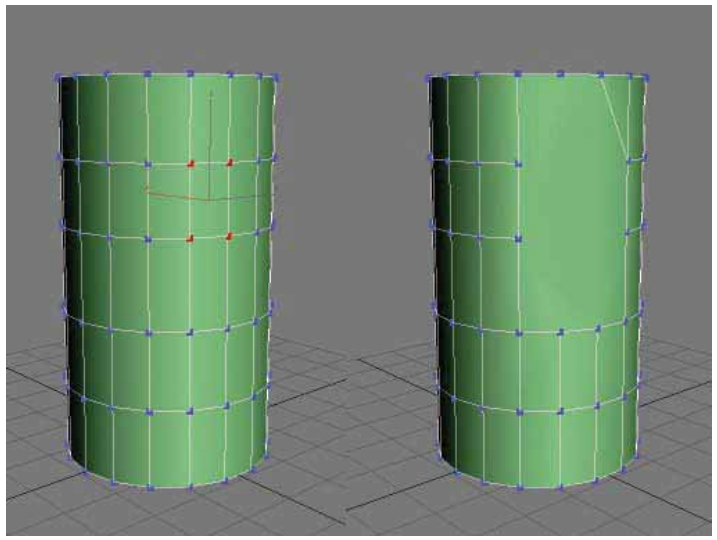
Features of the Vertex subobject mode

Vertices are points in space. They define the structure of other subobjects (edges and polygons) that make up the polygon object. When you move or edit vertices, the connected geometry is affected as well. Vertices can also exist independently; such isolated vertices can be used to construct other geometry but are otherwise invisible when rendering. Some of the vertex-specific tools are as follows.



The Vertex subobject mode.

Remove—Deletes selected vertices and combines the polygons that use them. The keyboard shortcut is **Backspace**.

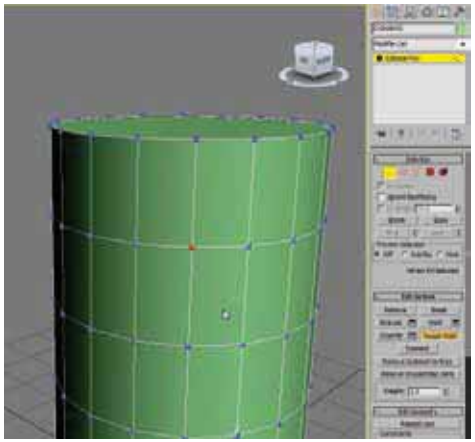


A selection of vertices removed with the Backspace hotkey.

Break—Creates a new vertex for each polygon attached to selected vertices, allowing the polygon corners to be moved away from each other where they were once joined at each original vertex. If a vertex is isolated or used by only one polygon, it is unaffected.

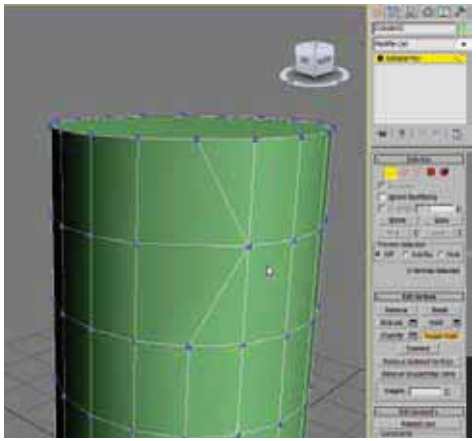
Weld—Combines contiguous, selected vertices that fall within the tolerance specified in the **Weld dialog** box. All edges become connected to the resulting single vertex. Inside of the **Weld dialog box**, you can specify the weld threshold - a number that represents the distance between vertices. The smaller the number, the closer the vertices need to be in 3D space for the weld to work. Weld is best suited to automatically simplifying geometry that has areas with a number of vertices that are very close together. Before using **Weld**, set the Weld Threshold via the **Weld dialog box**.

Target Weld—Allows you to select a vertex and weld it to a neighboring target vertex.Target Weld works only with pairs of contiguous vertices; that is, vertices connected by a single edge. In **Target Weld** mode, the mouse cursor, when positioned over a vertex, changes to a + cursor. **LMB** click and then move the mouse; a dashed, rubber-band line connects the vertex to the mouse cursor. Position the cursor over another, neighboring vertex and when the + cursor appears again, click the mouse. The first vertex moves to the position of the second and the two are welded. Target Weld remains active until you click the button again or **RMB** click in the viewport.

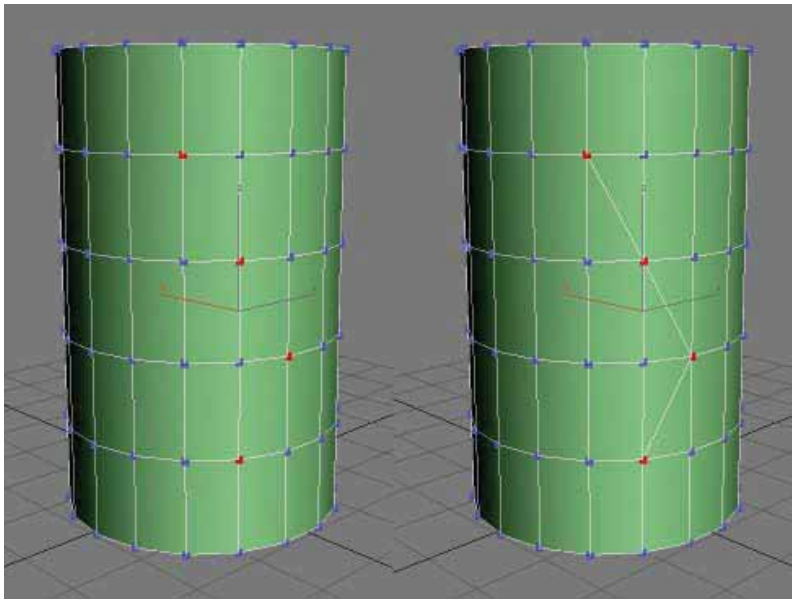


Using the Target Weld to pick the original vertices to weld over.

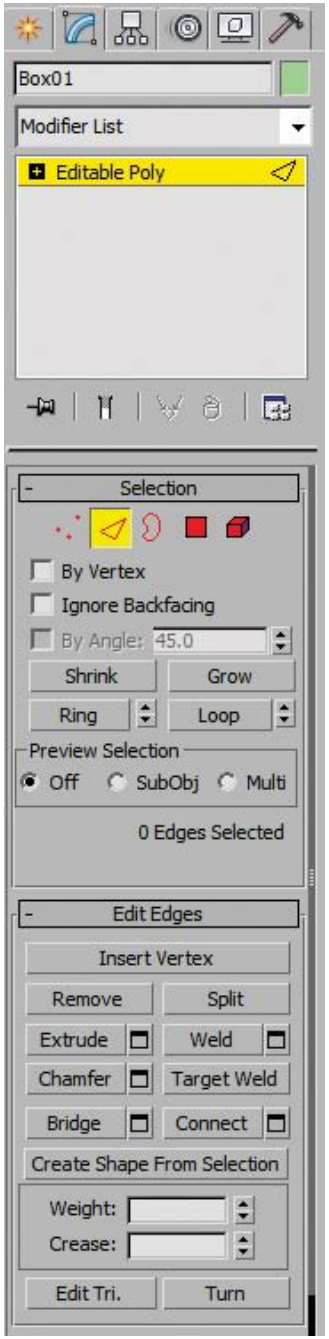
Using Target Weld, the vertex is welded over to the vertex next to it.



Connect—Creates new edges between pairs of selected vertices. Connect does not let the new edges cross. For example, if you select all four vertices of a four-sided polygon and then click **Connect**, only two of the vertices will be connected.



Selecting a series of vertices and using the connect tool.

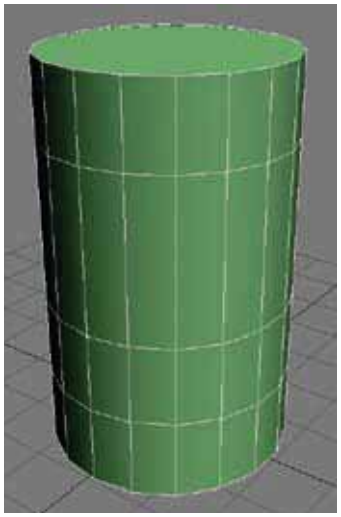


The Edge subobject mode.

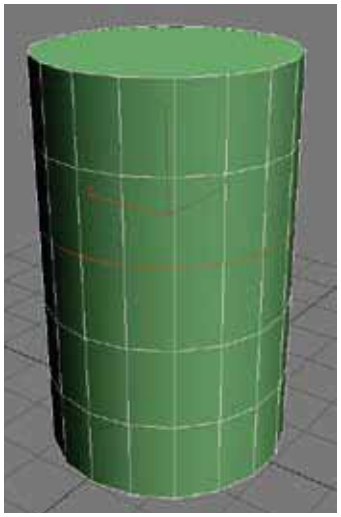
Features of the Edge subobject mode

An edge is a line connecting two vertices that forms the side of a polygon. An edge cannot be shared by more than two polygons. Some of the Edge subobject tools are as follows.

Remove—Deletes the selected edges and combines the polygons that use them. Removing one edge is like making it invisible. The mesh is affected only when all or all but one of the edges depending on one vertex are removed. At that point, the vertex itself is deleted and the surface is retriangulated. To delete the associated vertices when you remove edges, press and hold **Ctrl** while using the **Remove** operation, either by mouse or with the **Backspace** key. This is called a Clean Remove, and it ensures that the remaining polygons are planar.



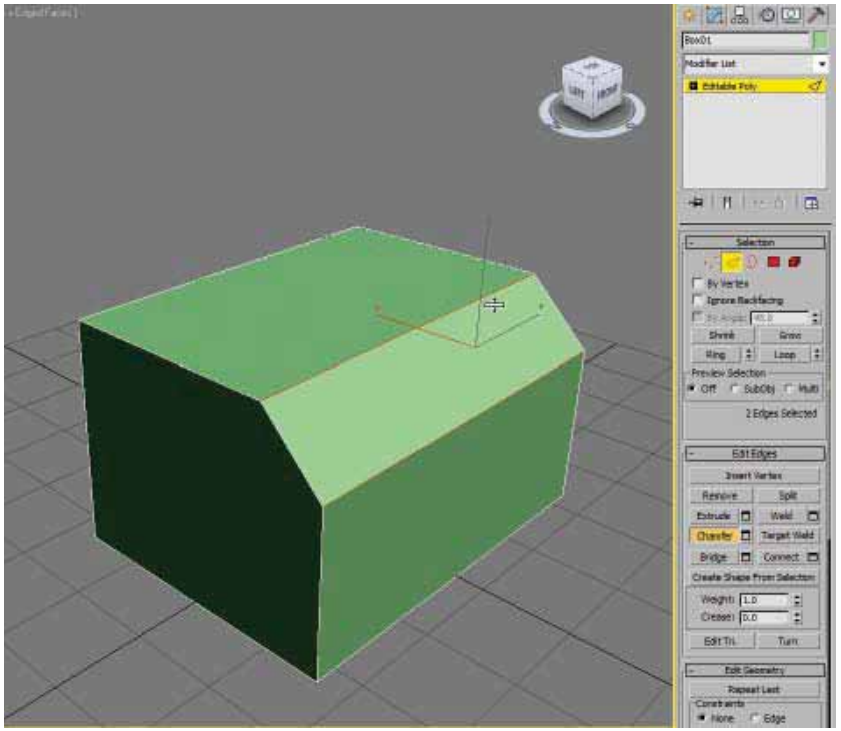
Performing a clean remove of the edges with the Ctrl + Backspace hotkey.



Selecting a series of edges for removal.

Chamfer—Click this button and then drag edges in the active object to execute a **Chamfer**. To chamfer edges numerically, **RMB** click the **Chamfer Dialog** button and change the **Chamfer** `Amount` value. If you chamfer multiple selected edges, all of them are chamfered identically. If you drag an unselected edge, any selected edges are first deselected.

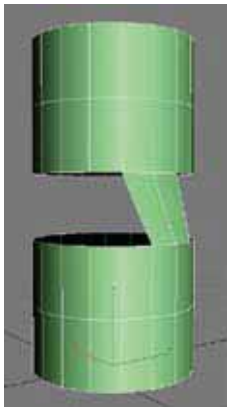
An edge chamfer "chops off" the selected edges, creating a new polygon connecting new points on all visible edges leading to the original vertex. The new edges are exactly *‹chamfer amount›* distance from the original edge along each of these edges. For example, if you chamfer one edge of a box, each corner vertex is replaced by two vertices moving along the visible edges that lead to the corner. Outside faces are rearranged and split to use these new vertices, and a new polygon is created at the corner.



Chamfering the edge of a box.

Chamfer Settings—Opens the **Chamfer Edges** dialog box, which lets you chamfer edges via interactive manipulation and toggle the **Open** option. If you click this button after performing a manual chamfer, the same chamfer is performed on the current selection as a preview and the dialog box opens with Chamfer Amount set to the amount of the last manual chamfer.

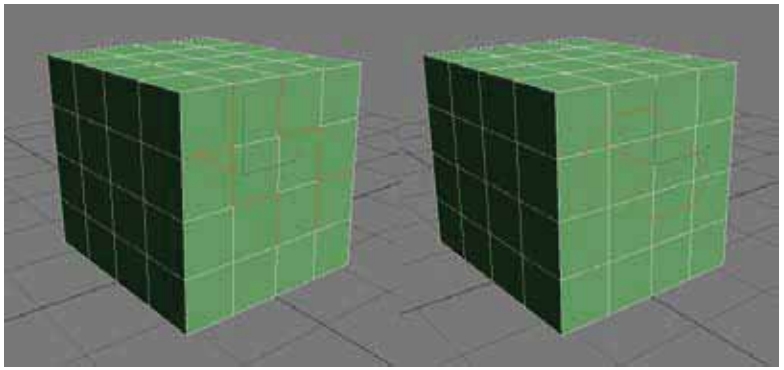
Bridge—Connects border edges on an object with a polygon "bridge." Bridge connects only border edges; that is, edges that have a polygon on only one side. This tool is particularly useful when creating edge loops or profiles.
Using the bridge tool to connect two sets of disconnected edges.



Connect—Creates new edges between pairs of selected edges using the current **Connect Edges** dialog box settings. **Connect** is particularly useful for creating or refining edge loops.

Note:

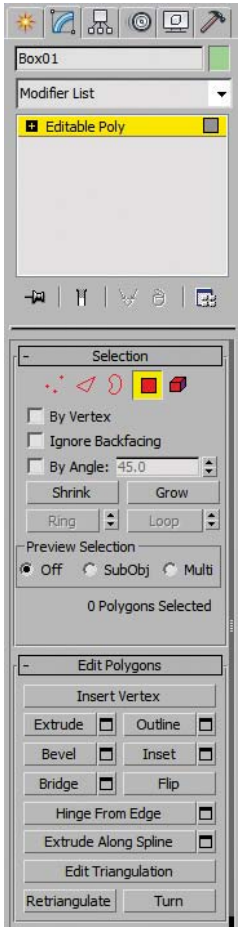
You can connect only edges on the same polygon. Also, Connect will not let the new edges cross. For example, if you select all four edges of a four-sided polygon and then click **Connect**, only neighboring edges are connected, resulting in a diamond pattern.



Performing the Connect function on a series of selected edges.

Features of the Polygon subobject mode

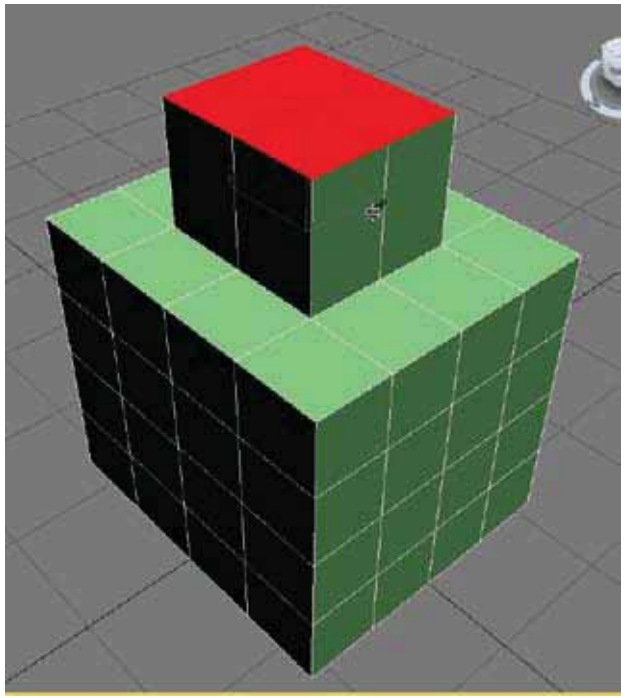
A polygon is a closed sequence of three or more edges connected by a surface. Polygons provide the renderable surface of editable poly objects. Some of the polygon subobject
tools are as follows.



The Polygon subobject mode.

Extrude—Lets you perform manual extrusion via direct manipulation in the viewport. **LMB** click the button, and then drag vertically on any polygon to extrude it. Extruding polygons moves them along a normal and creates new polygons that form the sides of the extrusion, connecting the selection to the object. Following are important aspects of polygon extrusion:

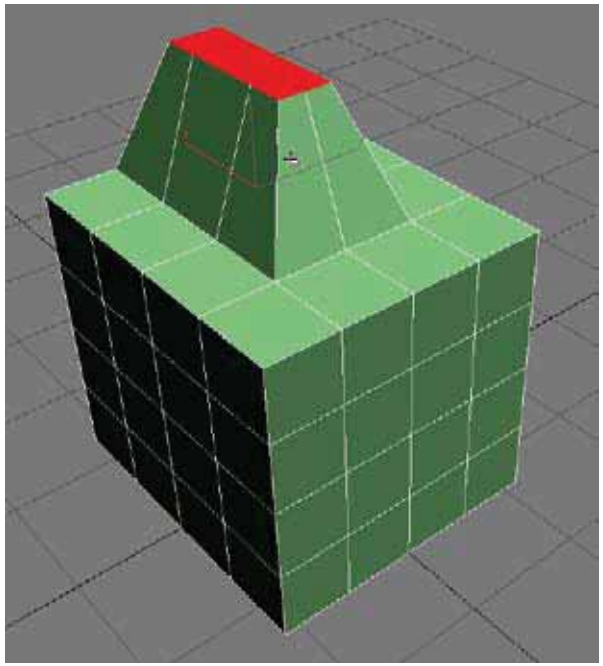
- When hovering over a selected polygon, the mouse cursor changes to an **Extrude** cursor.
- Drag vertically to specify the extent of the extrusion, and horizontally to set the size of the base.
- With multiple polygons selected, dragging on any one extrudes all selected polygons equally.
- You can drag other polygons in turn to extrude them while the **Extrude** button is active. **LMB** click **Extrude** again, or **RMB** click anywhere in the active viewport to end the operation.



Performing the Extrude function on a group of polygons.

Bevel—Lets you perform manual beveling via direct manipulation in the viewport. Click this button, and then drag vertically on any polygon to extrude it. Release the mouse button and then move the mouse vertically to outline the extrusion. **LMB** click again to finish.

- When over a selected polygon, the mouse cursor changes to a **Bevel** cursor.
- With multiple polygons selected, dragging on any one bevels all selected polygons equally.
- You can drag other polygons in turn to bevel them while the **Bevel** button is active. **LMB** click **Bevel** again or **RMB** click in the active viewport to end the operation.

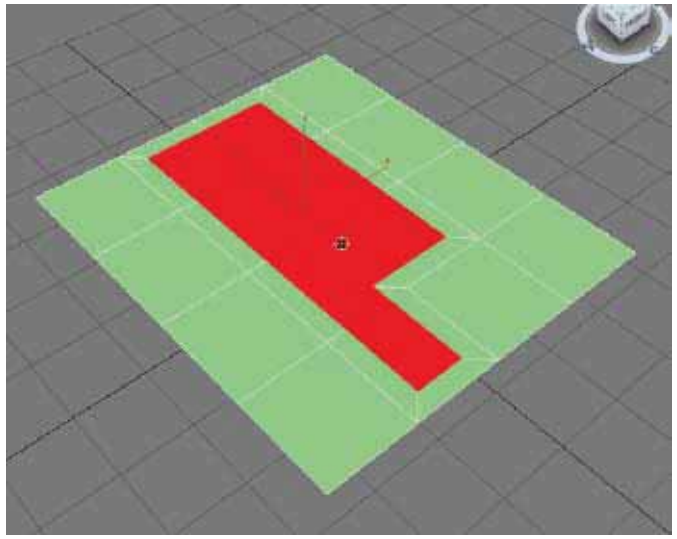


Performing the Bevel function on a group of polygons.

3dsMax Skills

Inset—Performs a bevel with no height; that is, within the plane of the polygon selection. **LMB** click this button, and then drag vertically on any polygon to inset it.

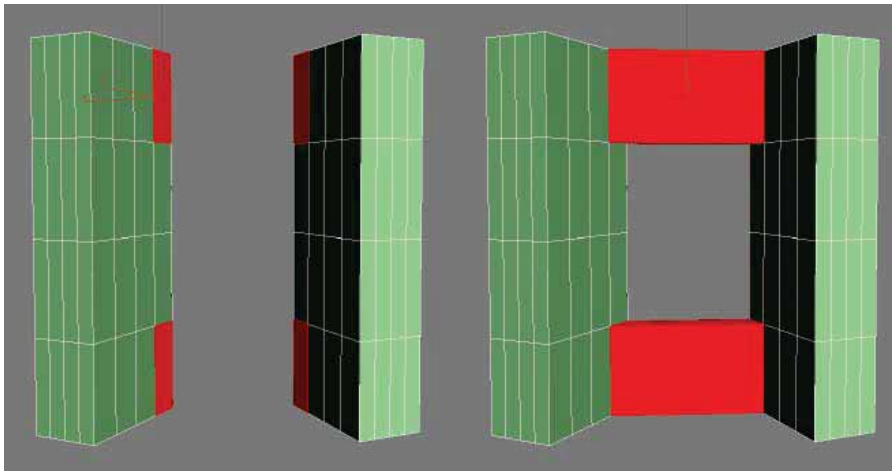
- When over a selected polygon, the mouse cursor changes to an **Inset** cursor.
- With multiple polygons selected, dragging on any one insets all selected polygons equally.
- While the **Inset** button is active, you can drag other polygons in turn to inset them. To end the operation, **LMB** click Inset again, or right-click anywhere in the active viewport.



Performing the Inset function on a group of polygons.

Bridge—Connects two polygons or polygon selections on an object with a polygon "bridge." There are two ways to use Bridge in Direct Manipulation mode (that is, without opening the Bridge **Dialog Box.**)

- Make two separate polygon selections on an object, and then **LMB** click **Bridge**. This will create the bridge immediately, using the current **Bridge** settings, and then deactivates the **Bridge** operation.
- If no qualifying selection exists (that is, two or more discrete polygon selections), **LMB** clicking Bridge activates the button and places you in **Bridge** mode. First, **LMB** click a polygon and move the mouse; a rubber-band line connects the mouse cursor to the clicked polygon. Click a second polygon to bridge the two. This creates the bridge immediately using the current Bridge settings; the Bridge button remains active for connecting more pairs of polygons. To exit **Bridge** mode, **RMB** click anywhere in the active viewport or **LMB** click the **Bridge** button again.



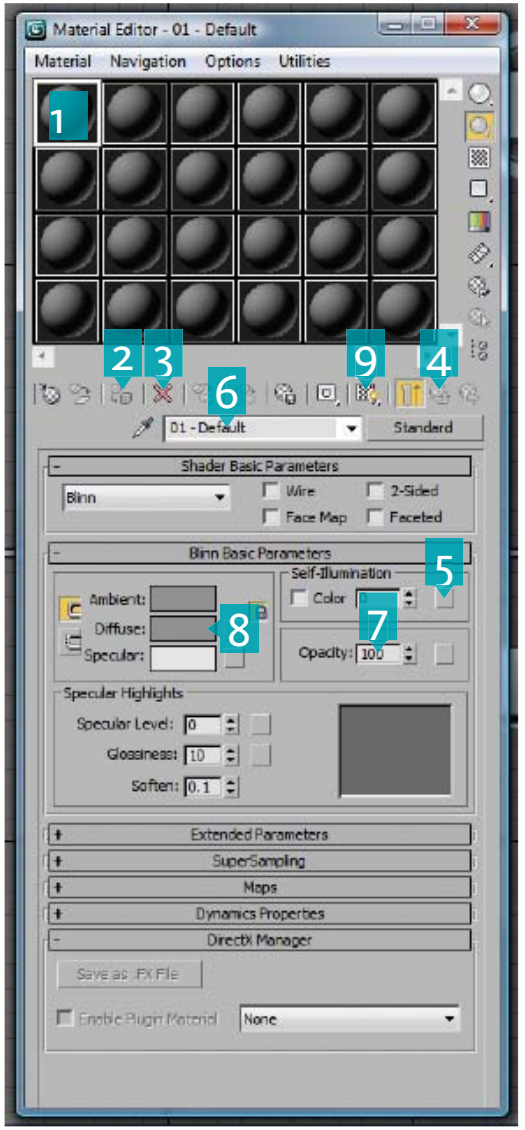
Selecting a series of adjacent polygons and using the bridge tool to connect them.

Working with the Material Editor

Let's start by opening the Material Browser. You can find the icon along the top of the Main toolbar, or use the keyboard hotkey **M**.

Tip:

It is easy to get lost with all the buttons and menus with the Material Browser when you are first getting started. When in doubt, you can always use the Go to Parent button to find your way back to the top of a material node. You can also simply delete the material and start over.



The Material Browser interface.

When you first open the Material Browser, there are plenty of new options and buttons to greet you. First, let's get familiar with some of the most important buttons as they apply to this book, and a description of their usage.

1 **Material Node**—These are the icons that act as a visual representation of your material, with a small preview of what the material looks like. Double-clicking the **LMB** will bring up a scalable pop-up window that allows you a closer look at your material.

2 **Assign Material to Selection**—Once you have a material created, this button will apply it to the object you have selected in your viewport.

3 **Reset Map/Mtl to Default Settings**—This button will essentially delete your material and all of the setups in it back to the default state.

Tip:

Remember that with any submenu in 3ds Max 2010, you can expand and collapse the menu by clicking anywhere on the box that has the name of the submenu. You can also "drag" the menu up and down by clicking anywhere in the gray area of the interface that is not a button and **LMB** click dragging it up or down. The icon will change to a hand when your mouse is anywhere that you can drag in a menu.

4 **Go to Parent**—This button is basically the "go back to the beginning" button that will take you to the very top level of your material. As you begin to work with materials and textures, and the more complicated your materials are, you will want to remember this button to get back to the top level

5 **Empty Box Input Nodes**—any of these empty boxes represent a map or input that can be used for that parameter. For example, if we have created a diffuse (also known as color) map, **LMB** clicking the small box next to Diffuse" will give us the ability to add that map. When you have a map or a parameter value plugged into these nodes, the letter **M** will appear over these otherwise empty boxes. You can also **RMB** click on these nodes and choose **Clear** to remove the maps completely. This is helpful if you have accidentally clicked a node and added something you did not intend to.

6 **Material Name**—Each of the materials will have a number and the word Default next to it when you first begin work on your scene. If you wish to rename your material to something more relevant, simply replace the text in this box with the name of your choosing to replace it.

7 **Opacity**—Adjusting this value will alter how see-through your material is. 100 is the default meaning it is not see-through at all, and the closer you get to 0 the less visible the material is.

8 **Default Color Picker**—These gray boxes are color pickers. If you would like to create a material with just a color value, **LMB** click the gray box next to the word Diffuse to bring up the color picker and select a color of your choice.

9 **Show Standard Map in Viewport**—Causes the material to show on the 3D object in the viewport. When rendered the material will generally always show up, but this button allows you to see it in 3D.

Creating your first material

For our first material, we will set up a simple ground texture that could be used as a ground or floor piece in a level. Before we can even begin to texture our object we need to think about the surface it is going to be. If I am making something out of stone, a marshmallow texture might not work!

So, the first thing I might do is find a 2D image that looks close to what I am attempting to re-create. In future chapters we will discuss further some of the art involved with texture painting, but for now let's start with a simple image.

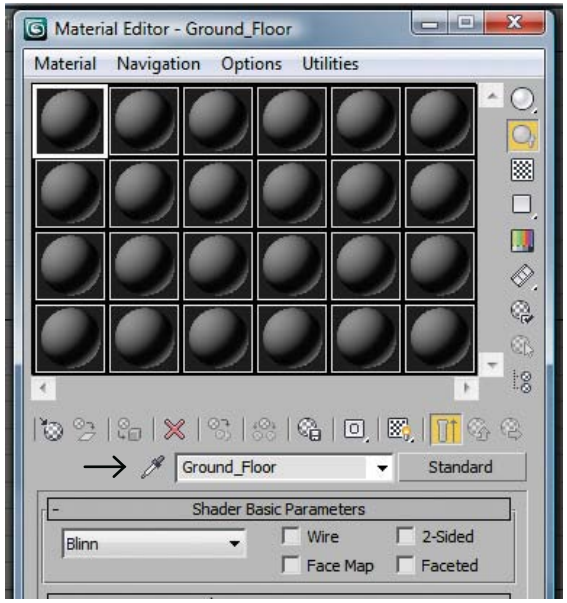
A basic cobblestone ground texture.

This texture works well because it is flat, does not have many sharp or harsh shadows on the surface, and is not warped by any sort of odd perspective problems. Looking at this image alone, you could almost imagine it being laid out flat on geometry to create a road. Quality texture maps do not need a lot of cleanup or fixing to start with. If the image had a sharp shadow in it, what would happen in your game if you shined a flashlight on that spot? The shadow would show up and that would spoil the sense of reality on the surface.
The next important step of texture maps is to ensure that the size remains relatively close to the size of the target geometry. If we took this square shaped picture and tried to squeeze it into a really long and thin picture frame, it would not look right at all.

So for our first texture, we will take a square 2D image and put it onto a square shape in 3D.

1. Set up a new material node.

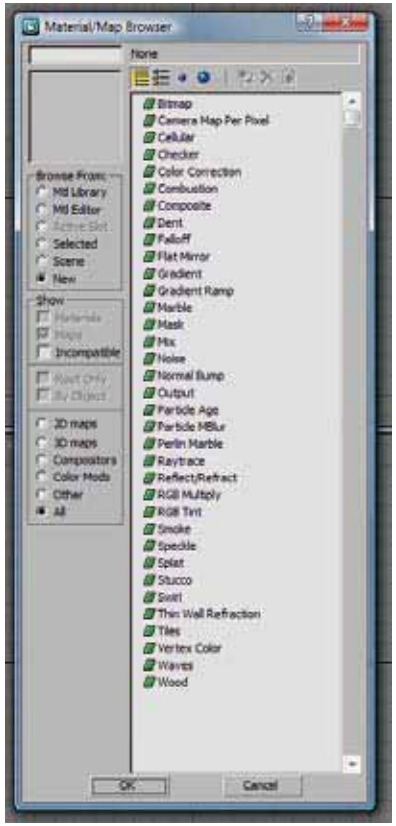
- Press the **M** hotkey on your keyboard to open the Material Browser, or **LMB** click the icon on the Main toolbar.
- On the very top-left blank material node, **LMB** click it to select it. A white outline appears over the material node to indicate it is your currently selected node.
- Rename this material *Ground_Floor*. After you have entered the new name, you should also see the name appear at the top of the Editor window, indicating it is the current material node selected.



Select a new node and rename it.

2. Import your diffuse color map.

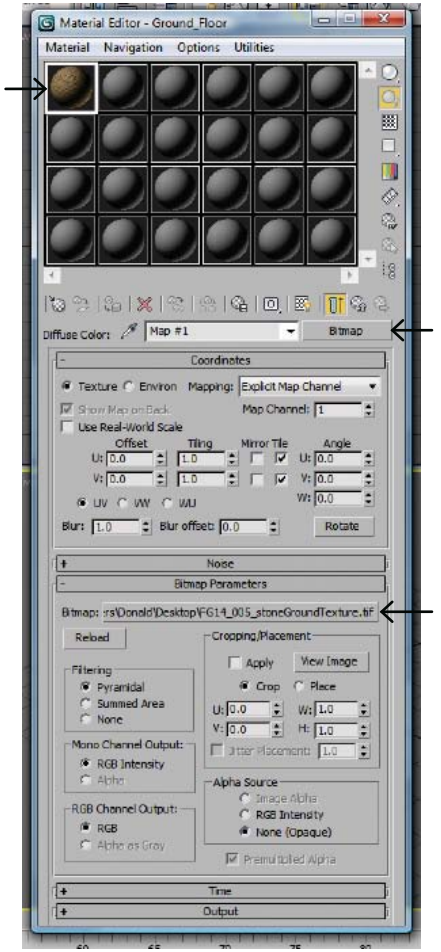
- Under the submenu **Blinn Basic Parameters**, next to the diffuse, **LMB** click the empty node (the small empty box next to the gray color). This brings up a new window called the Material/Map Browser.



Select a new node and rename it.

- The Material/Map Browser contains a multitude of various types of prebuilt maps, parameters, and input types; 2D texture maps are called bitmaps.
- Select Bitmap at the top of the Material/Map Browser by double-clicking the **LMB**.
- After you have clicked it, a browser pops up asking you where the image is.
- Navigate to *support_files/Project1/Lesson6/FG06_Ground.tif* on the DVD for this ground texture to select it.

- You should now see the surface of the ground replace the gray sphere in the Material Editor, giving you a small representation of what it looks like.
- You will also see that you are in a different set of menus than previously. This is because you are now looking at the exclusive parameters of that diffuse texture and not the material as a whole. You will also see that the icon changed from Standard to Bitmap, indicating that you are working with a 2D bitmap, and not a standard material.

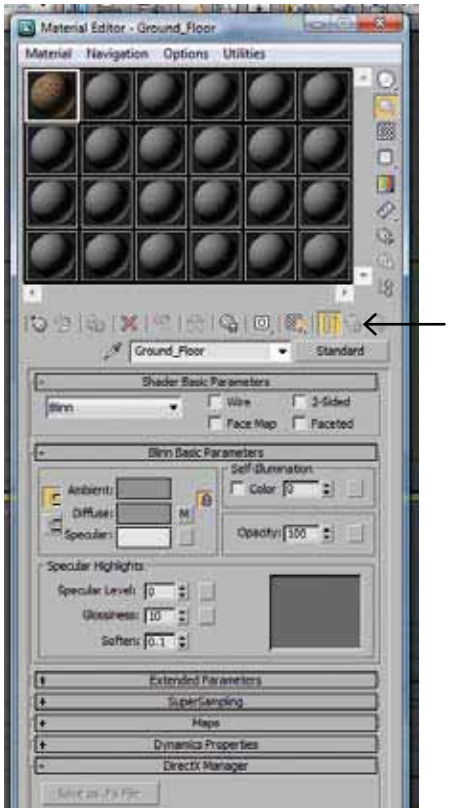


Select a new node and rename it.

- Under the Bitmap Parameters submenu, you also notice that the path to the image is listed here. If you want to change it to a different texture, you could do so by **LMB** clicking on the box and redirecting the path.

3. Go back to the parent of the material.

- Under the collection of material nodes, **LMB** click the **Go to Parent** icon to get back to the top of the material.



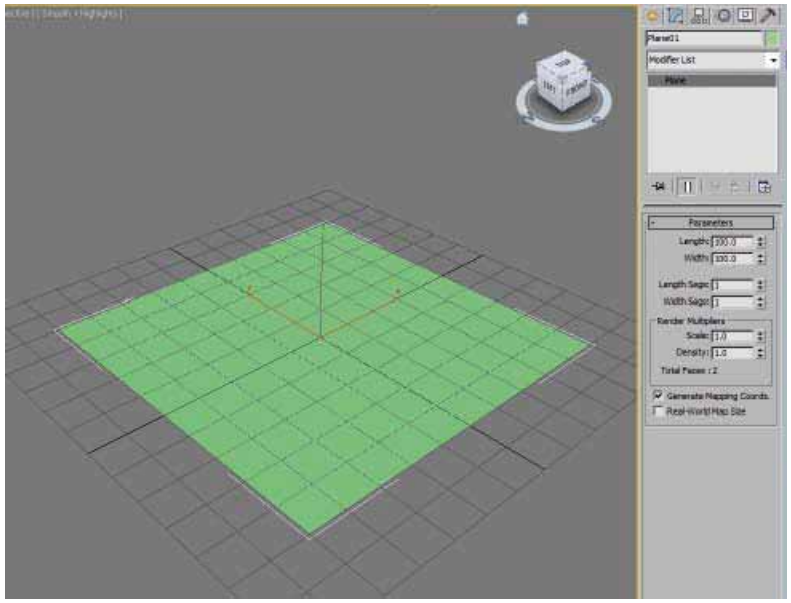
Creating the sphere in the Perspective viewport.

How to apply a material to an object

Now that we have created our first material, let's create a simple plane apply the material to.

1. Create a standard primitive plane.

- In the Perspective viewport, create a plane and give it a length and width value of **100**.
- Set the length and width segments to **1**.

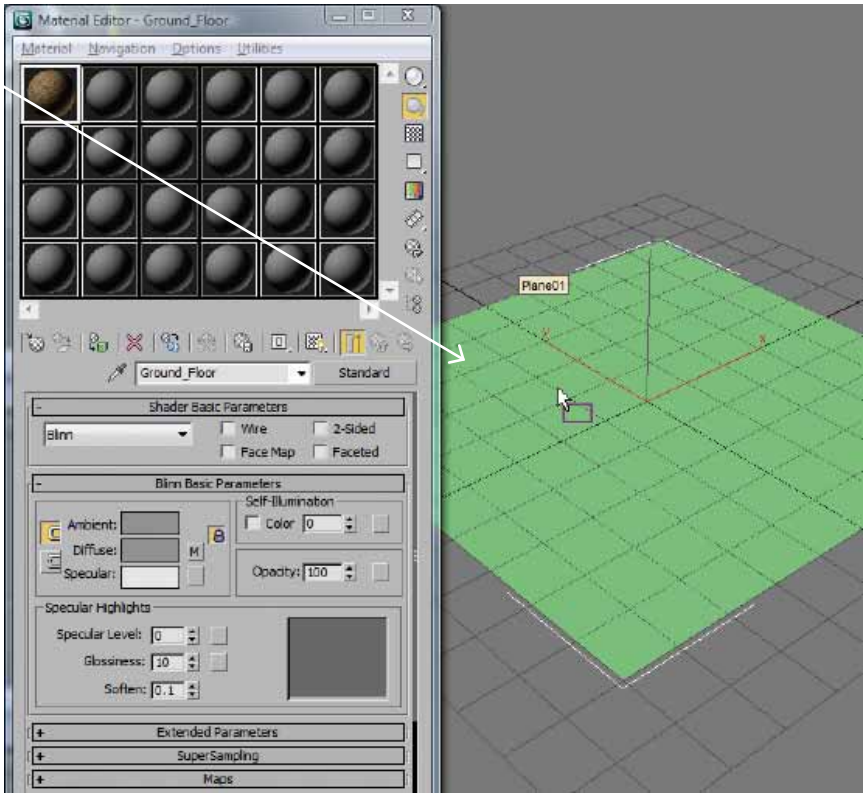


Create a standard primitive plane in the Perspective viewport.

2. Apply the material to the plane by dragging it.
There are two quick methods for applying a material to an object. The first method is to drag the material node onto the object.

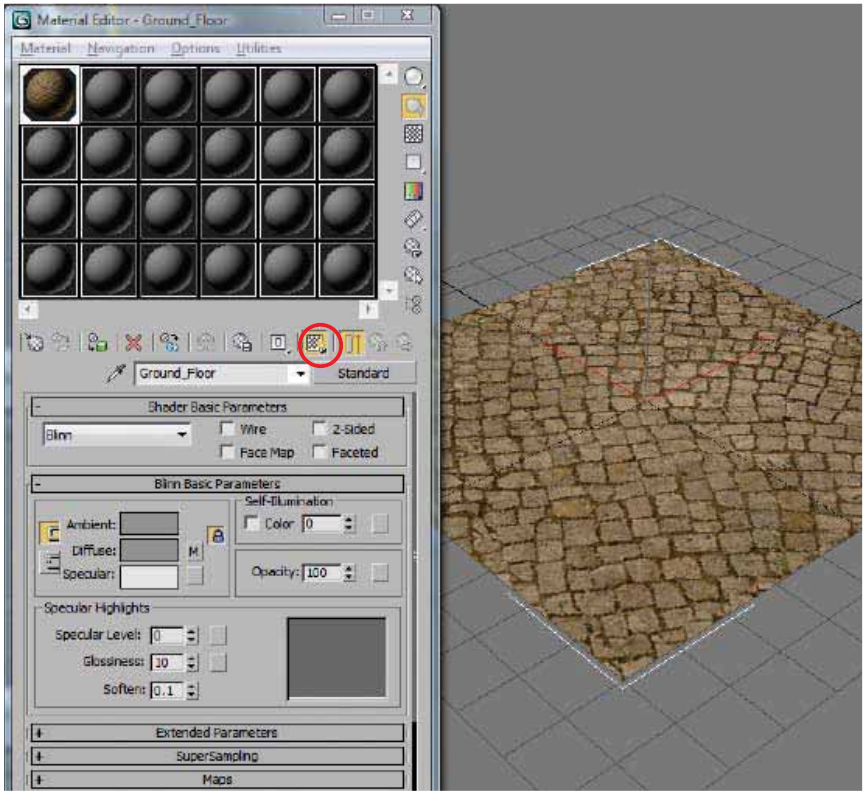
- Open the Material Editor window if you have closed it with the keyboard hotkey **M**.
- In the **Perspective** viewport, ensure that the plane primitive you created is in view.

- While holding the **LMB**, click and drag the *Ground_Floor* material onto the plane. When you do this, you will notice the icon change to a small square. Release the **LMB** to apply it.



LMB click and drag the material onto the plane.

- After you drop the material onto the object, your plane should turn gray. This is because we have not turned the material on to show up in the viewport. We do that by **LMB** clicking on the **Show Standard Map in Viewport** icon. This works as sort of an on and off switch to show the texture in the scene.

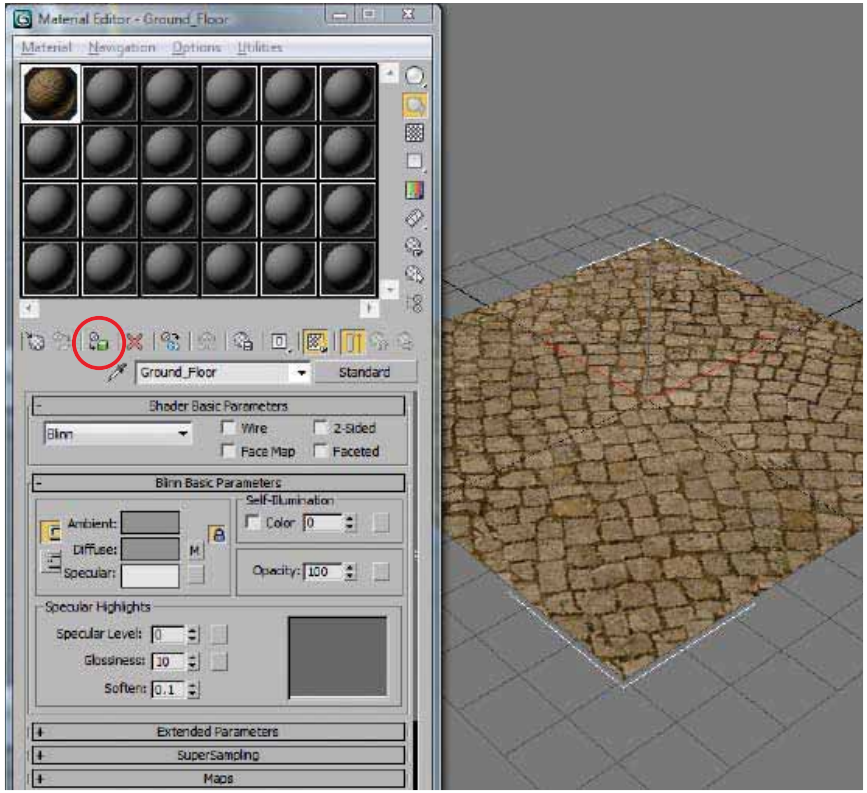


After applying the material, turn on the Show Standard Map in Viewport to have to appear.

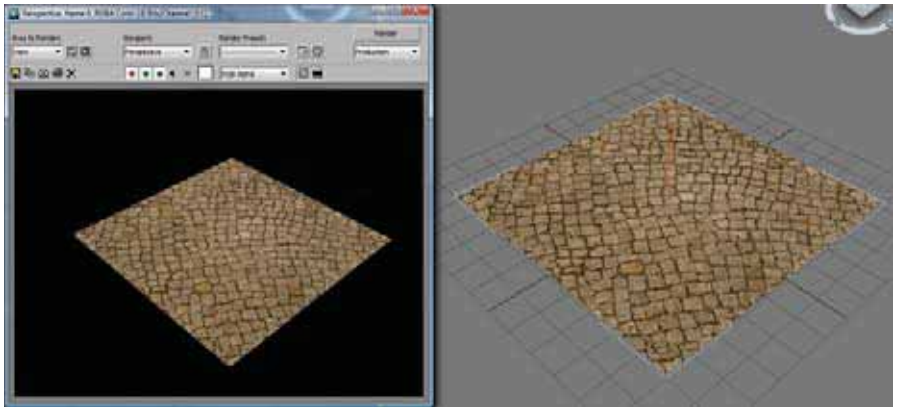
3. Apply the material to the plane with the Assign Material to Selection function. The second method to applying a material works almost exactly the same as the previous. The only difference is that you do not need to drag the material node at all, simply select the object and apply it.

- Open the material editor window if you have closed it with the keyboard hotkey **M**.
- In the **Perspective** viewport, ensure that the plane primitive you created is in view.
- With the plane selected, **LMB** click the **Assign Material to Selection** button to apply the material to the plane.

- If you have not already, make sure you turn **Show Standard Map in Viewport** on to see it.



LMB click the Assign Material to Selection to apply the material to a selected object.



A standard render of the plane, next to the viewport view of the object.

- Close the **Material Browser**. You have now correctly applied a material, composed of a diffuse color map, to an object.
- You can render the object with the keyboard hotkey **F9** to see what it would look like at its highest quality, but we will cover more on rendering and composition in later chapters.

Unwrap UVW Key Interface Elements

The Unwrap UVW modifier works just like any other modifier to apply it. After you apply it, you are given three subobject modes **Vertex**, **Edge**, and **Face**. These are the three editable elements you will work with when it comes to UVs. Just like most all windows in Autodesk® 3ds Max® 2010 software, you can **LMB** click and hold along the border of the window to resize it as needed. You can also move the window to another monitor if you have that. Let's look at some of the key elements of the interface to get started.

1 Edit UVW Window

This is the primary window where you will be working with the UVs of your object. To bring up the window, click the **Edit...** button under the Parameters rollout.

2 Currently Selected Subobject

When working with UVs, the subobject you select in the Edit UVW window will also appear shaded on your geometry in the 3D viewport. Switching between subobject modes works the same as an editable poly using the **1**, **2**, and **3** hotkeys.

3 Move, Rotate, Scale, Freeform, and Flip Tools

These are some of the most commonly used tools in the set. As with many features in 3ds Max, **LMB** clicking them and holding down the button will reveal a rollout of various other tools as well. Similar to working in 3D, the hotkeys for **Move**, **Rotate**, and **Scale** are the same in the UV tools.

4 Quick Planar Map

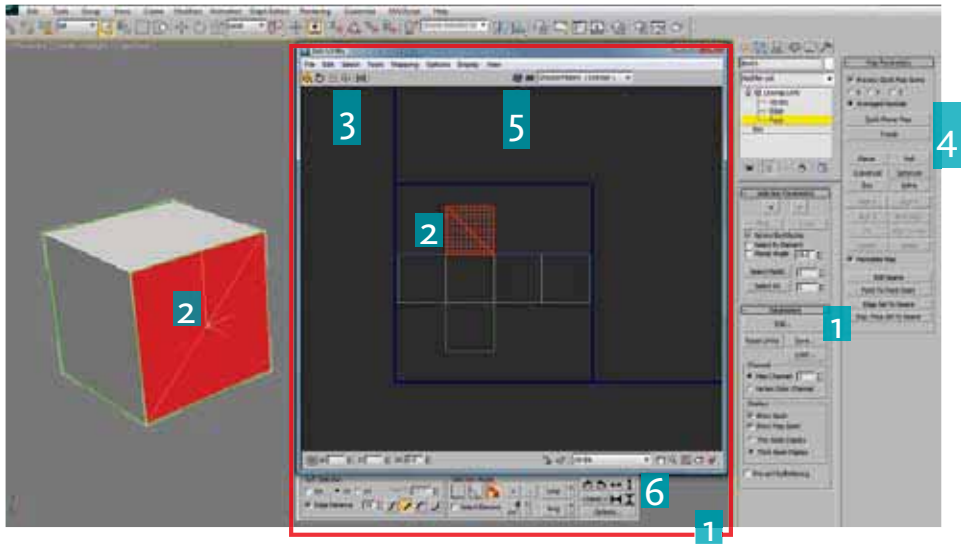
We will be using this tool quite a bit when working with Unwrapping. Using the X, Y, or Z axis in 3D, we can use this tool to quickly lay out a selection of UVs.

5 Show Map Toggle

This toggle will show a selected image in the window, or a checkerboard pattern by default.

6 Rotate and Align UV Tools

Use these tools to rotate UV chunks, or align subobject selections. Hover over each of them for a description.



The Unwrap UVW Interface

Tip:

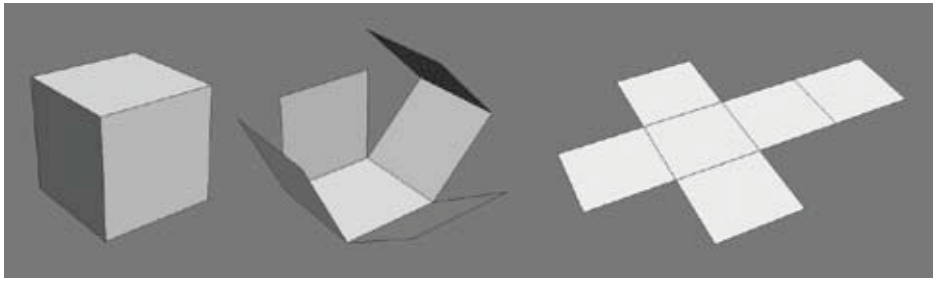
While inside the Edit UVW window, hold down the **MMB** to drag the viewport around, and scroll the **MMB** up and down to zoom in and out .

UVW unwrapping explained

When working in 3D, UVW unwrapping is used to describe the process of laying your object's faces out flat into an informational 2D plane so that you can apply textures and materials to your object. The UVW coordinates of an object are basically a set of stored information inside of a piece of geometry that defines how a texture will look if applied to it.

The UVW coordinate system with regards to 3D is similar to the XYZ coordinate system you should be familiar with when modeling. However, when it comes to UVW unwrapping, the U and V axis of a texture map correspond to the X and Y axis, while the W axis correspond to the Z axis, and is generally only used for procedural maps, which we will not cover here. This is also why it is sometimes referred to as UV mapping or working with UVs and the W is omitted.

When unwrapping an object, you do not physically modify the actual geometry itself, you are simply modifying the UVW coordinates , which is what all of the object's faces might look like in 2D if they were rolled out flat. To illustrate, imagine a simple box made up of six polygons. To easily paint a texture map onto that box, imagine the box unfolding and laid out completely flat. Since texture painting is done in 2D, we could then take all six of those flattened faces of that box and paint them with the UVW coordinates of the box accurately, and then apply the texture to the box. This is the process of UVW unwrapping.

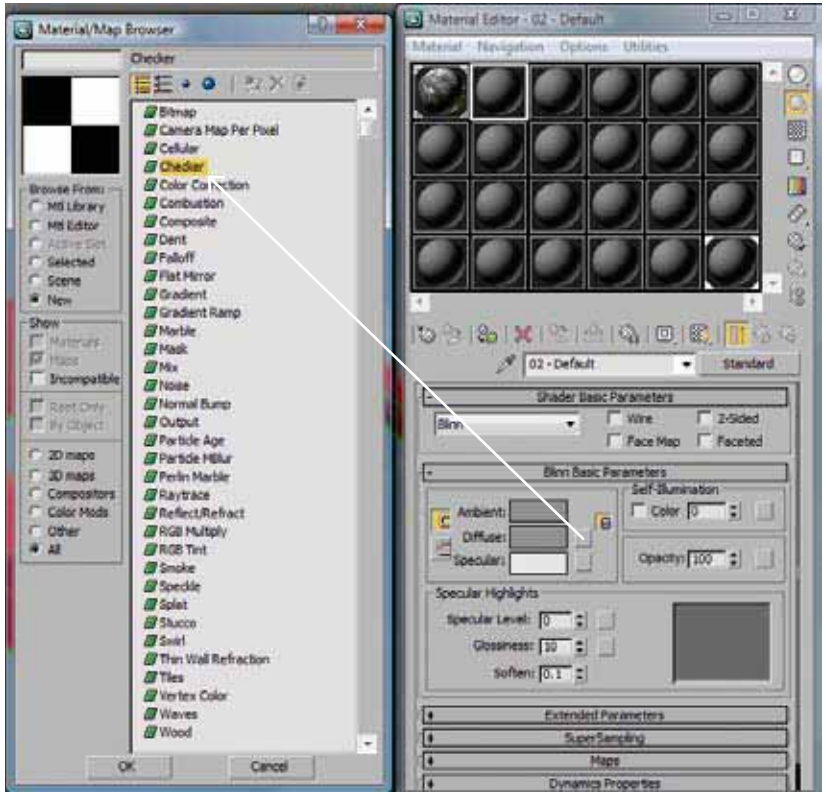


When unwrapping, imagine a box being split apart and laid down flat. We will not actually change the original geometry, but when working with UVs, this is the goal in order to get a clean and easy surface to paint a texture on.

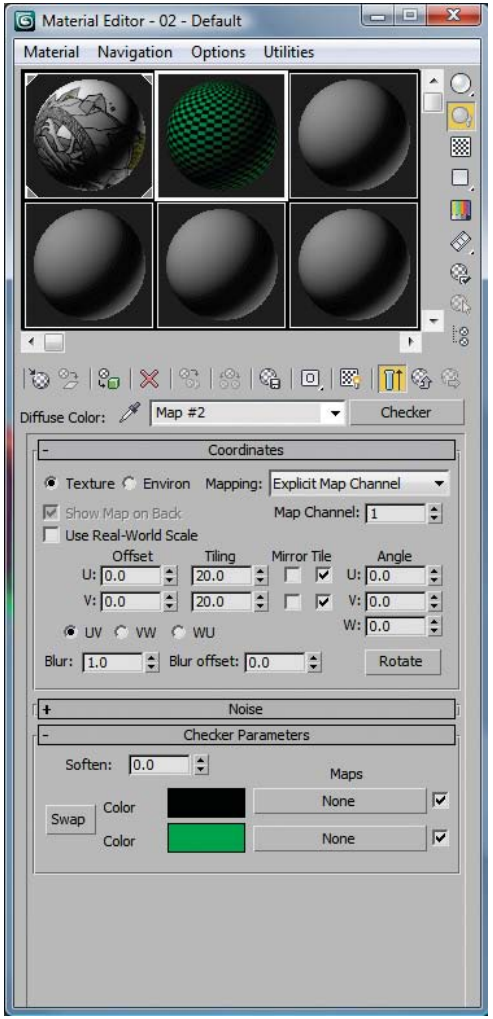
Create a checkerboard texture

As we begin to texture, we will want to assign a checkerboard pattern to our objects to make sure that there is not any unusual stretching or skewing of our UVs. Imagine for a moment that you make that box again, but the UVs are stretched and not laid out flat. The texture of that object would also look skewed and stretched if the UVs are not relatively the same dimensions of the object itself. A checker pattern will allow you to visually ensure there is no unusual stretching or skewing of the UVs.

- Start by opening the Material Editor.
- Select an unused Material node, and **LMB** click on the box next to the Diffuse slot.
- When the **Material/Map Browser** window pops up, choose Checker as the map type by double-**LMB** clicking it.



Click the box next to the Diffuse slot and choose Checker as the map type.



- By default, it is a black-and-white checker pattern with only a 1x1 tiling. The more you tile the texture, the smaller it will be repeated across the surface, which is fine for a checker pattern. So for now, change the tiling to 20x20. Under the **Checker Parameters** rollout,
  feel free to change the colors as you desire by **LMB** clicking the color box and choosing your own.

Animation concepts

Animation is based on a principle of human vision. If you view a series of related still images in quick succession, you perceive them as continuous motion. Each individual image is referred to as a frame.

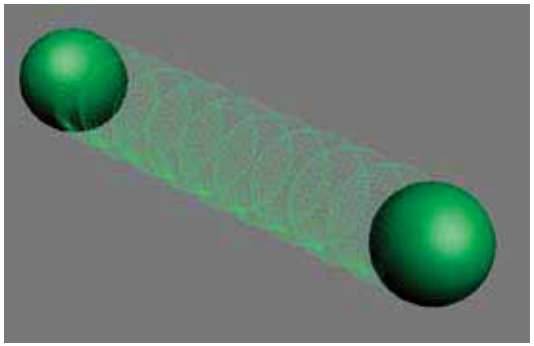
Historically, the main difficulty in creating animation has been the effort required of the animator to produce a large number of frames. One minute of animation might require between 720 and 1800 separate images, depending on the quality of the animation. Creating images by hand is a big job. That is where the technique of keyframing comes in.

Most of the frames in an animation are routine, incremental changes from the previous frame directed toward some goal. Traditional animation studios realized they could increase the productivity of their master artists by having them draw only the important frames, called keyframes. Assistants could then figure out what belonged on the frames in between the keyframes. The in-between frames were called tweens.

Once all of the keyframes and tweens were drawn, the images had to be inked or rendered to produce the final images. Even today, production of a traditional animation usually requires hundreds of artists to generate the thousands of images needed.

How it works in 3ds Max

3ds Max 2010 is your animation assistant! As the master animator, you create the keyframes that record the beginning and end of each animated sequence. The values at these keyframes are called **keys**. 3ds Max calculates the interpolated values between each key to produce the completed animation.



In traditional animation, the master animator could determine the keyframes at the beginning and end of the ball rolling, and the assistant would fill in the frames with the tweens. In 3ds Max, you identify the keyframes and 3ds Max fills them in for you!

3dsMax Skills

Autodesk 3ds Max can animate just about any parameter in your scene. You can animate modifier parameters, such as a bend angle or a taper amount, material parameters, such as the color or transparency of an object, and much more. Once you have specified your animation parameters, the renderer takes over the job of shading and rendering each frame. The result is a high-quality animation.

The majority of the animation tools can be found along the bottom of the UI.

Key Interface Elements

Let's look at some of the main animation tools in 3ds Max 2010, and a brief explanation of them.

1 Time Slider

The Time Slider is along the top of the Track Bar, and shows the current frame of animation you are on. It also lets you move to any frame in the active time segment. To move the Time Slider along the Track Bar, **LMB** click it and hold, while moving left or right along the Track Bar. **RMB** clicking the slider bar opens the Create Key dialog box, which lets you create position, rotation, or scale keys without using the Auto Key button.

2 Auto Key and Set Key Modes

Auto Key mode toggles the keyframing method that when turned on, any changes made to the object's position, rotation, and scale are automatically keyframed (recorded). Set Key mode allows you to create keys only when you want. Unlike Auto Key, Set Key mode gives you control over what you key and when.

3 Set Keys

When in Set Key modes, use this button to create a keyframe with the selected object.

4 Animation Controls

These controls include **Go To Start**, **Previous Frame/Key**, **Play/Stop**, **Next Frame/Key**, and the **Go To End** functions respectively. Hover over each for their function.

5 Time Configuration

This will launch the Time Configuration window that will allow you to adjust the Frame Rate, Time Display, Playback options, and more. This is also where you can specify the animation Start, End, Length, and Frame counts.

SKILLS

Lighting Basics

The 3D artist is a lot like a photographer. The 3D artist has the ability to arrange the lights in a scene to suit their needs. In fact, the 3D artist has significantly more freedom than a photographer. The 3D artist is not constrained by gravity. They can place their lights anywhere in the environment without worrying about them tipping over, if the extension cord is long enough to reach the light, if the heat of the light is going to set things on fire, and how long the light bulb will last before burning out. In fact the 3D artist can also have lights that cast shadows or not, lights that remove light from their scene, and lights that simulate a specific time of day or natural effect. In essence the 3D artist has much more creative freedom than a photographer because of their ability to determine the light in a scene.

Lighting is the basis of a great looking image or animation. Lighting sets the mood and gives the viewer clues about what may or may not happen in both still images and animations. At its foundation the lighting in a scene will tell the viewer whether it is day or night. Just as good value relationships in an image can save an average image, good light in a 3D scene can make models and textures appear much better.

Here you will take a look as some of the traditional light arrangements you might use as a starting point when lighting a scene. We will then take a scene that lacks any light at all and show you how effective lighting is built and why each step works. We will take a look at how the color of a light affects the objects in a scene. Finally, we will take a look at some of the lighting features that are found in Autodesk®3ds Max®.

There are a few basic things every 3D artist should consider before beginning the process of lighting a scene.

- What mood are you trying to create in your scene or animation? In many cases this is the first question you should ask yourself because it will determine where in the scene you place the light or lights.
- What colors should your lights be? Colored lights will affect all the models and textures in a scene. It does you no good to light a scene with orange and red lights if the textures on your models are predominately green and blue.
- Do you want harsh or soft lighting? Often the feeling of how harsh or soft the light in a scene is depends on how the shadows being cast appear. Sharp shadows tend to indicate harsh lighting and softer shadows indicate softer light sources.

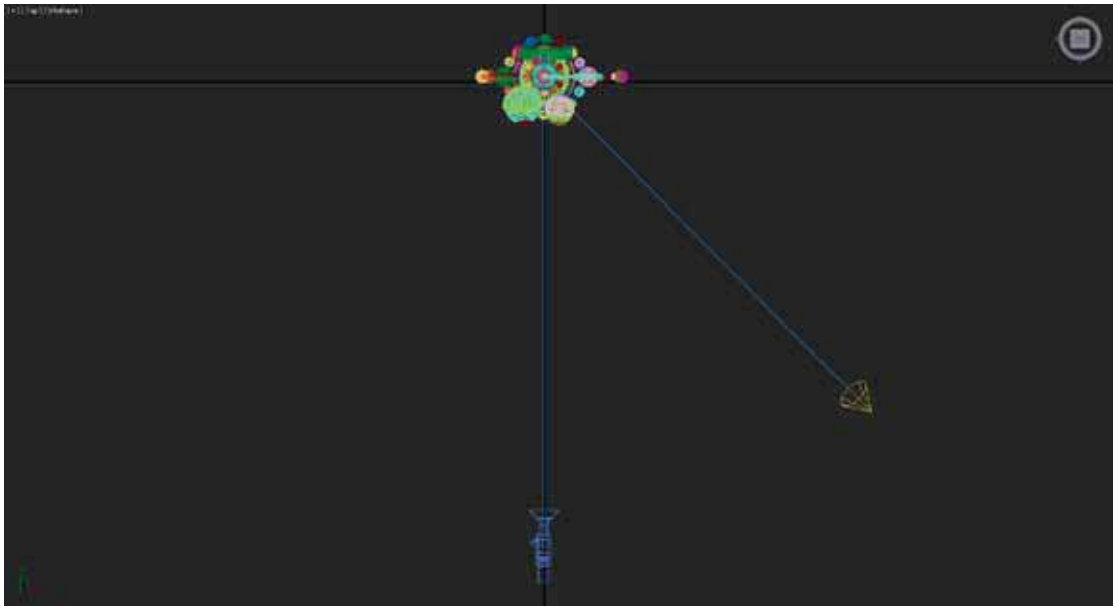
Adding Lights to a 3D Scene

The types of lights you create are determined by the menus in an application and the type of rendering you plan on using and can include spot lights, Omni lights, distant lights, and so on. Lights in a photographer's studio and in a 3D scene are referred to by specific names that indicate their function. The function of the lights you create is determined by their placement in a scene. In the following each function (name) or a light will be described.

Once the light's functions are described, some general lighting schemes will be diagramed that will give you a good starting point when it comes to lighting your own scenes.

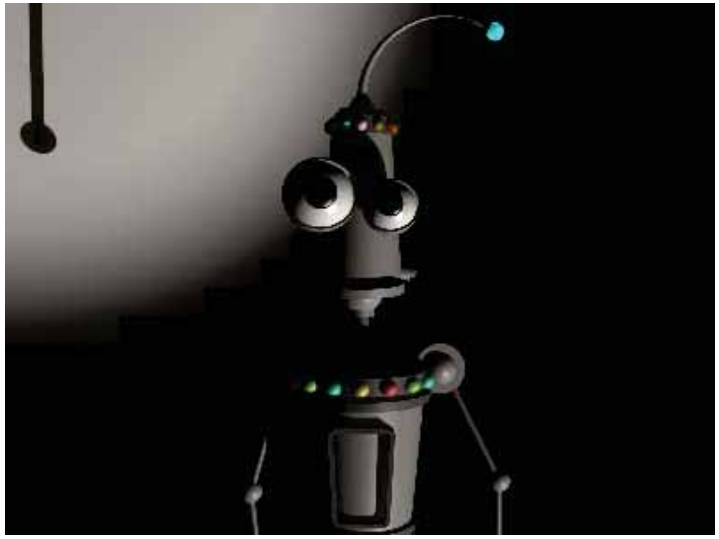
Types of Lights

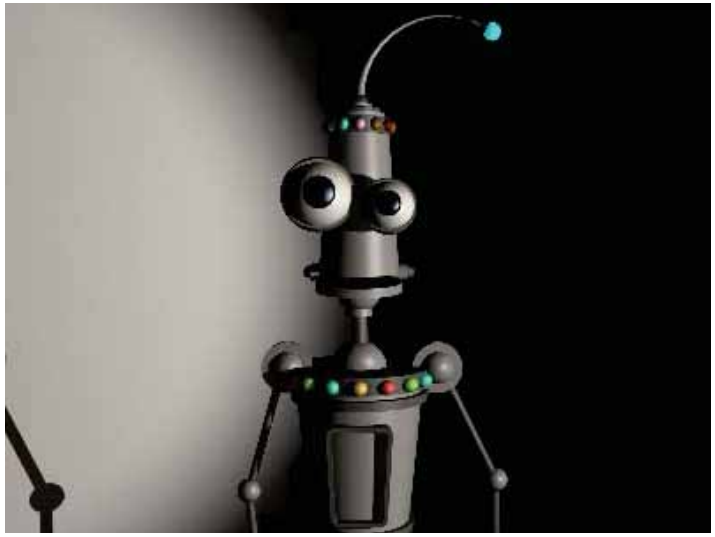
- Key or main light. This is the predominant and brightest light in most scenes. Every 3D scene will probably have a key light. The position of the light depends on what you, the artist, are trying to say. Traditionally, the key light is positioned at a 45-degree angle from a line drawn directly between the camera and subject.



Figureo1b

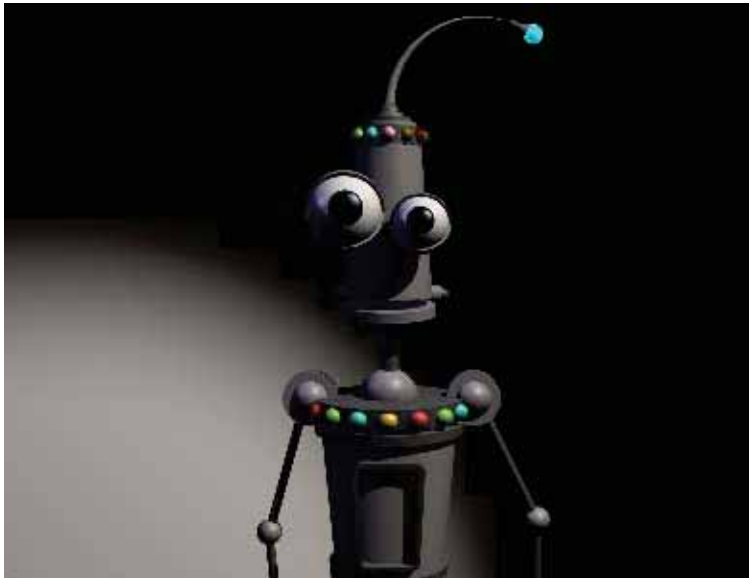
3dsMax Skills





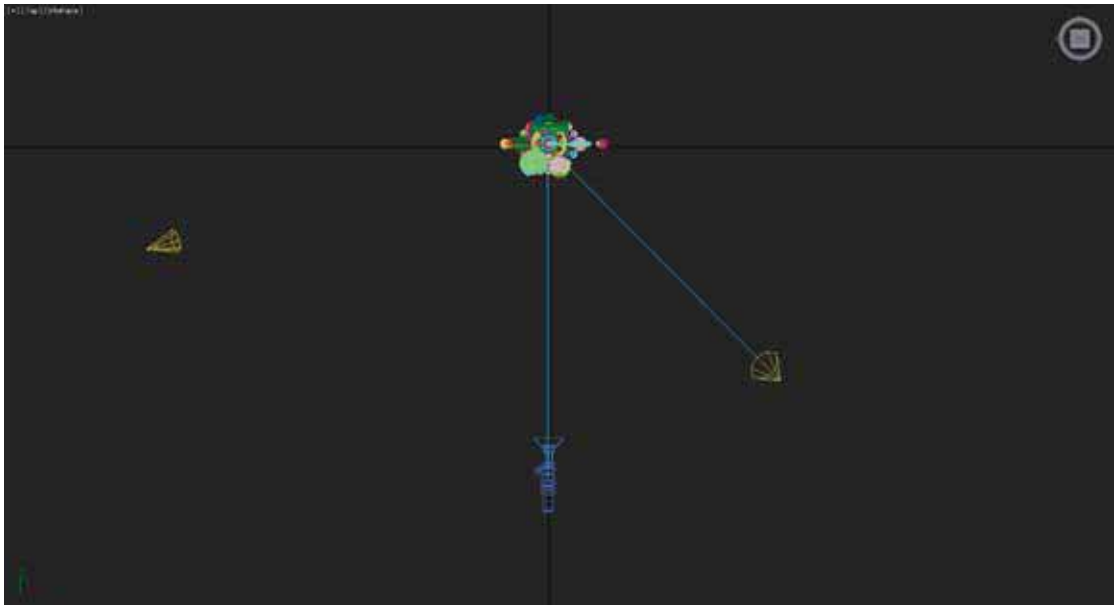
Positioning the key light in the vertical plane relative to the subject will depend on the mood of the scene

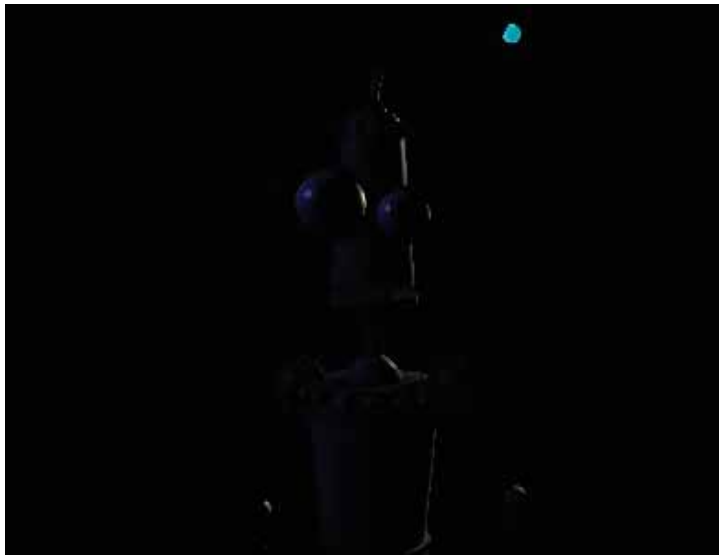
- A higher light will appear quite natural, like sunlight
- A lower-positioned light will appear more theatrical
- A key light that is positioned at eye level will look slightly strange



Fill or secondary light

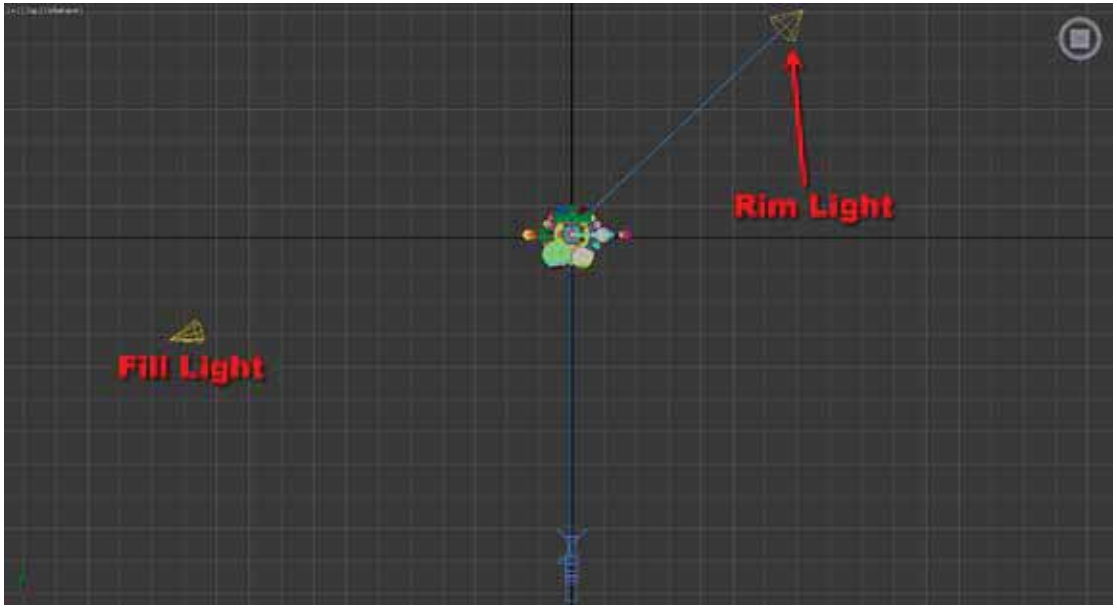
The fill light is positioned opposite the key light. Without a fill light in a scene the shadows on objects would be too dark and opaque. The fill light should be significantly less intense than the key light. While there is no set percentage for its intensity, generally it will be less than 50 percent as intense as the key light.

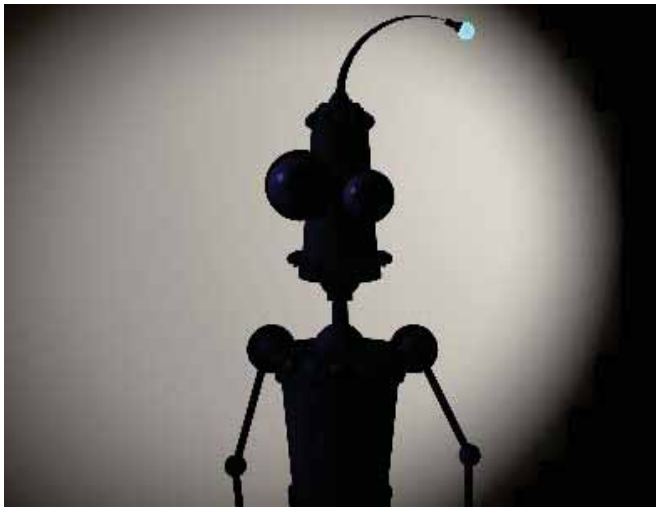




Rim lights

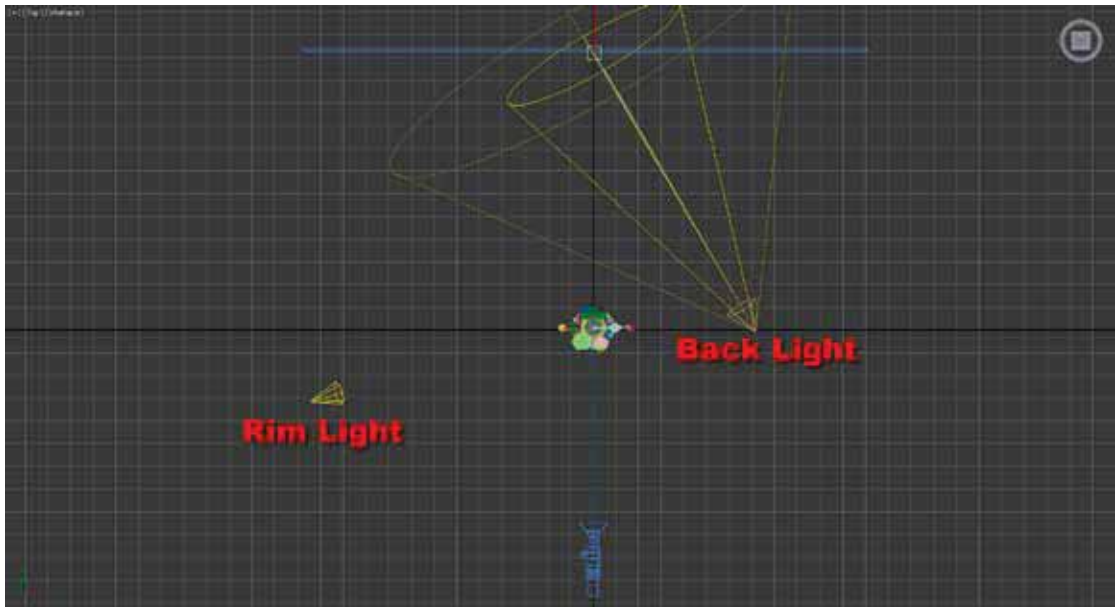
If there is a light source in view in a scene, you will probably want to add a rim light to the scene. Placing this light at a 135-degree angle behind your subject on the side of the visible light is a good starting point. Rim lights are used extensively and can add a nice border between the subject and background.

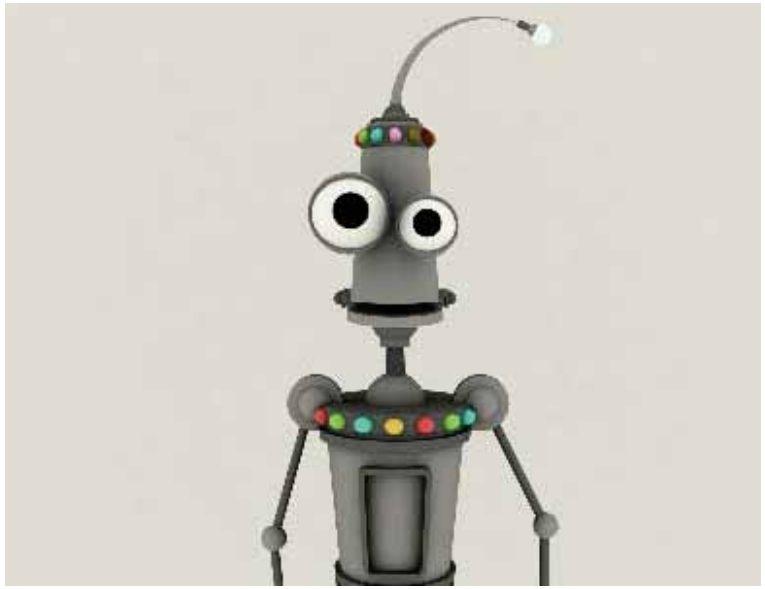




Backlights

Generally backlights are used to separate the main subject from the background. They are pointed at an object in the background, throwing the subject into a higher-contrast relationship.

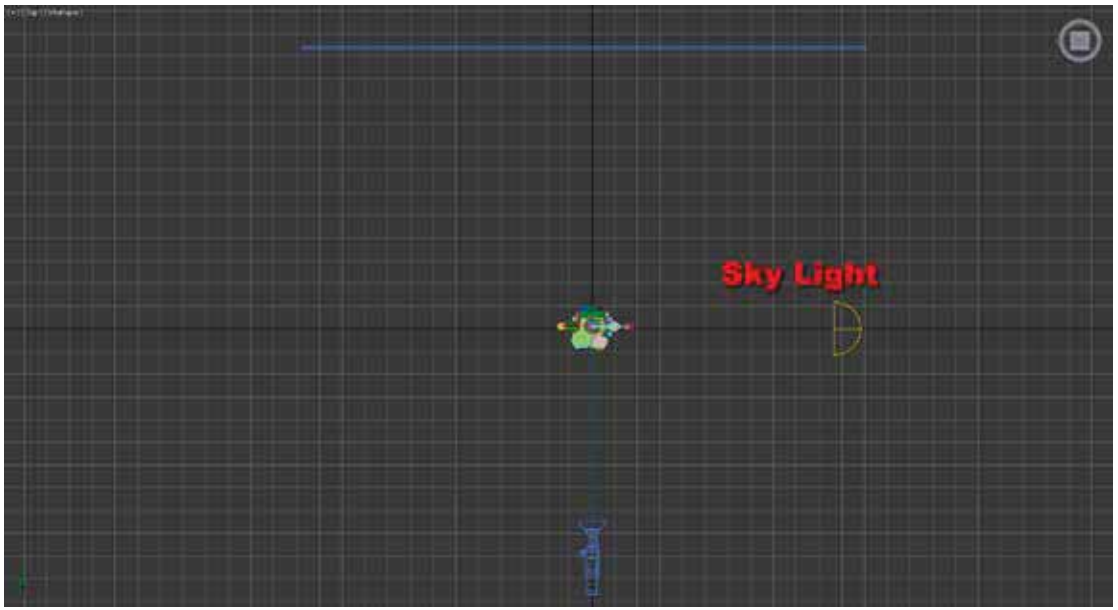




Sunlight light

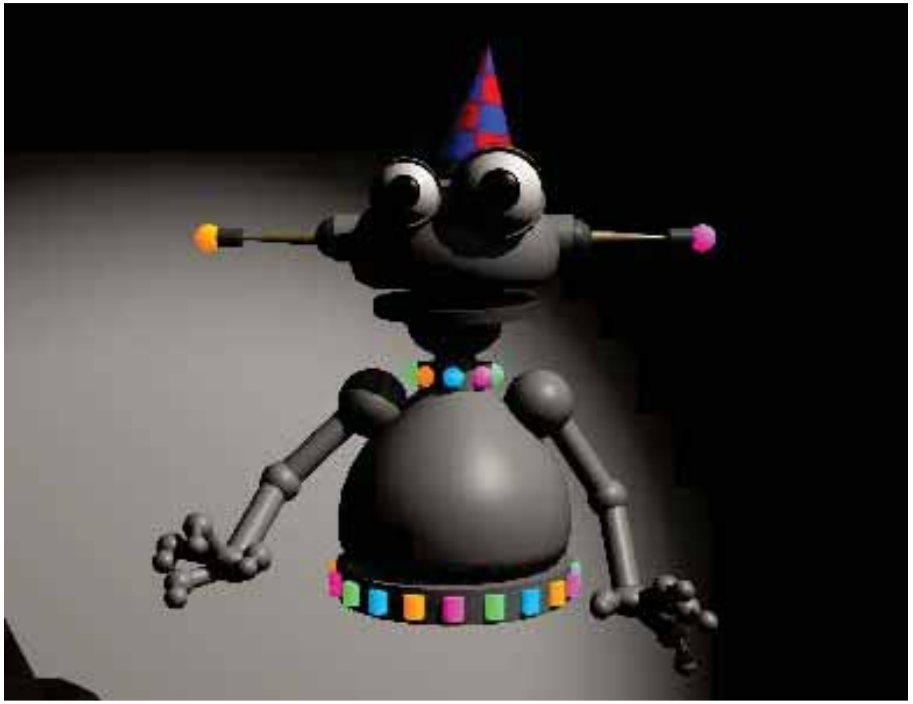
There is usually a light in 3D programs that simulates sunlight. In 3ds Max, sunlight is called *skylight*. Skylight light is one of the ways it is possible in 3ds Max to imitate daylight in a scene. You can set the color of the sky or assign a map to it. The sky is represented as a dome above the scene. The position of the skylight and how far it is located from objects has no effect on how bright the lighting appears. The skylight object is simply a representation of the lighting that always comes from above.

Skylight should be used with the light tracer. The light tracer produces soft-edged shadows and bleeds an object's color into the surrounding for bright scenes. A sunlight scene would be considered a bright outdoor scene. The light tracer does create an accurate representation of sunlight, but it is easier to use than some of the other ways of imitating sunlight.



3dsMax Skills

Ambient light. While not actually a light source, it is intended to simulate the natural light that bounces around a scene. Intense light will need less ambient light than weaker lights. Figure07 shows the ambient light in the scene increased from nothing to a dark blue.

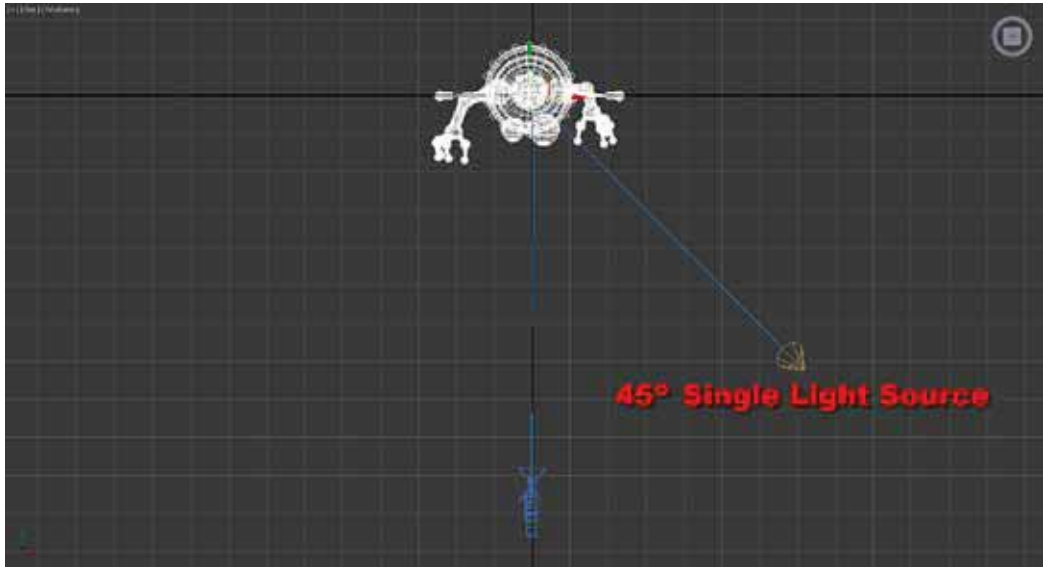


Standard Lighting Schemes

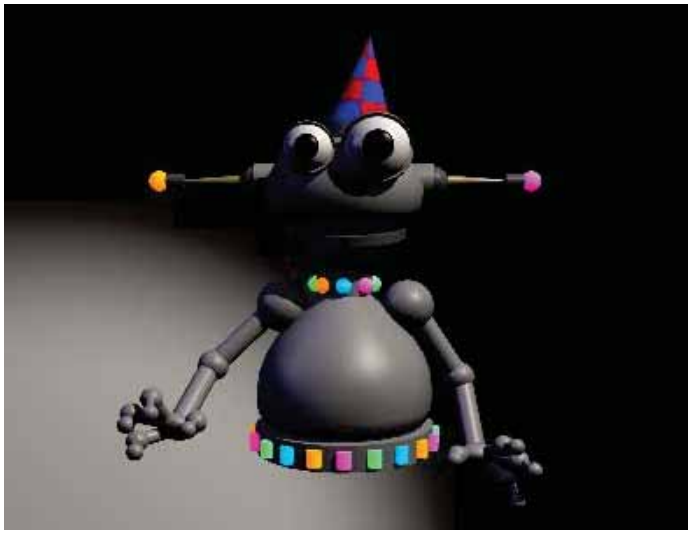
This section shows some basic lighting setups often used in photography studios. These arrangements are good starting points for the 3D artist when deciding how to light a scene they are creating.

These lighting setups are pretty self-explanatory and will not need much description, if any at all. Each image shows the subject, camera, and lights along with a rendered version.

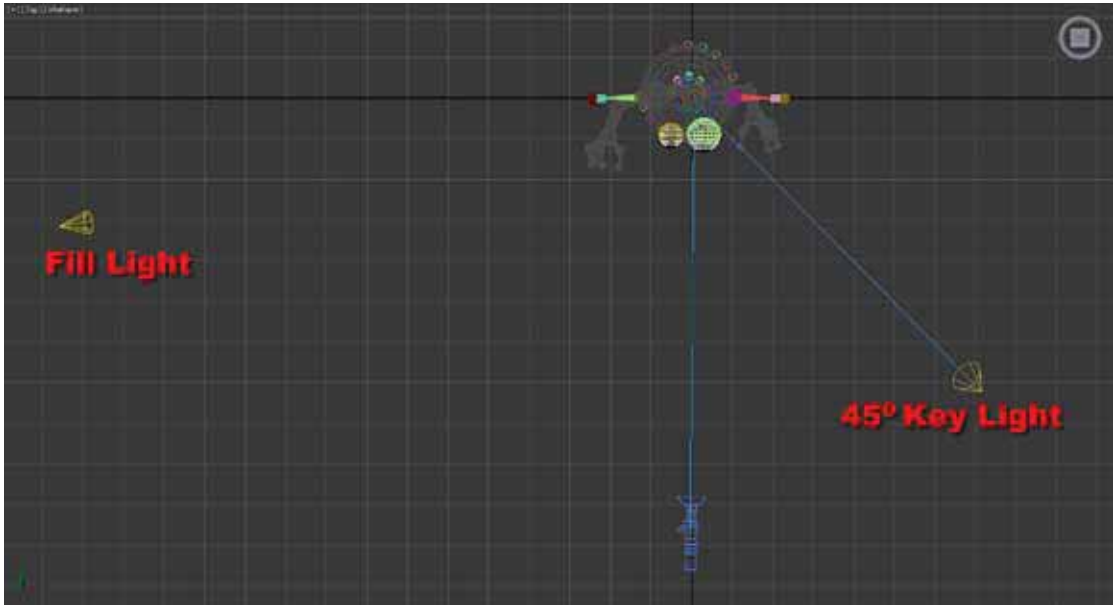
- 45-degree single light source.



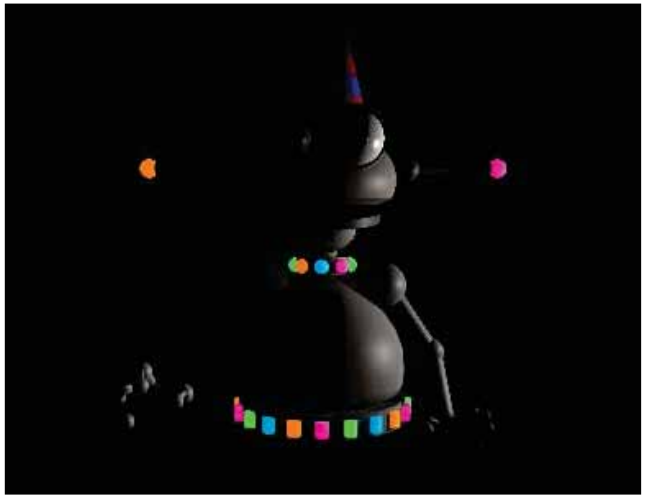
3dsMax Skills



- 45-degree key light with additional fill light.

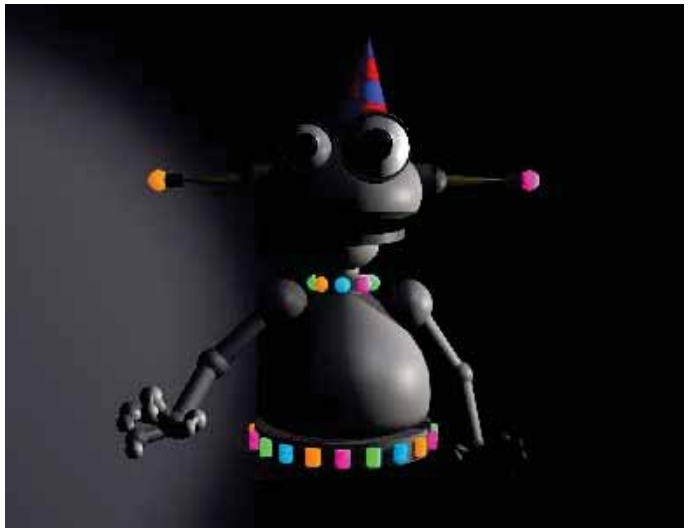


3dsMax Skills

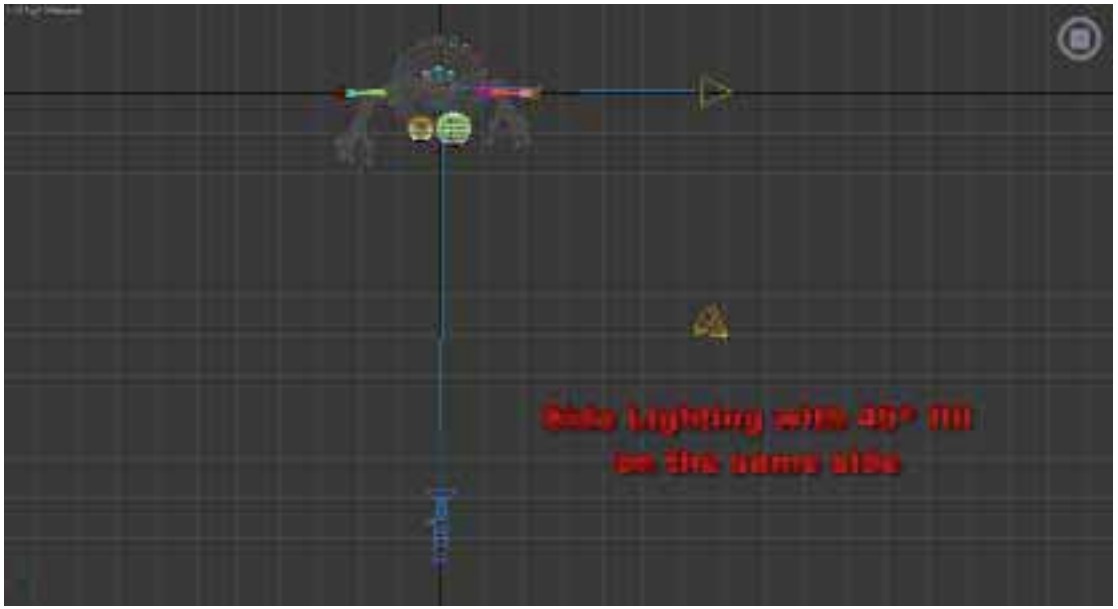


- 90-degree single light source (side lighting).

3dsMax Skills



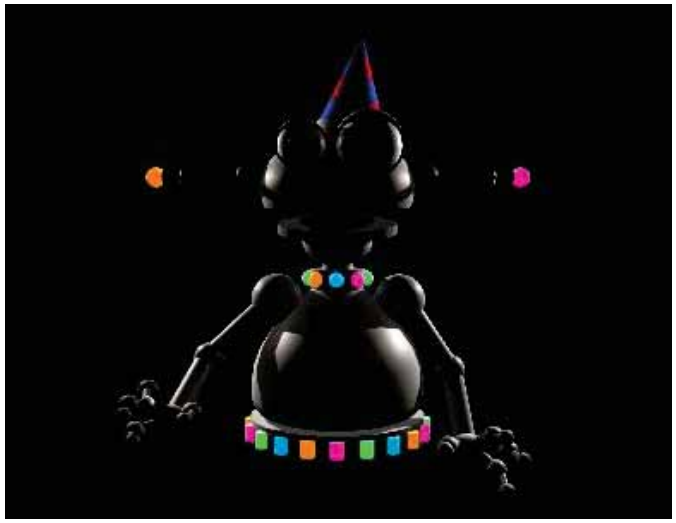
- 90-degree single light source with 45-degree fill light.



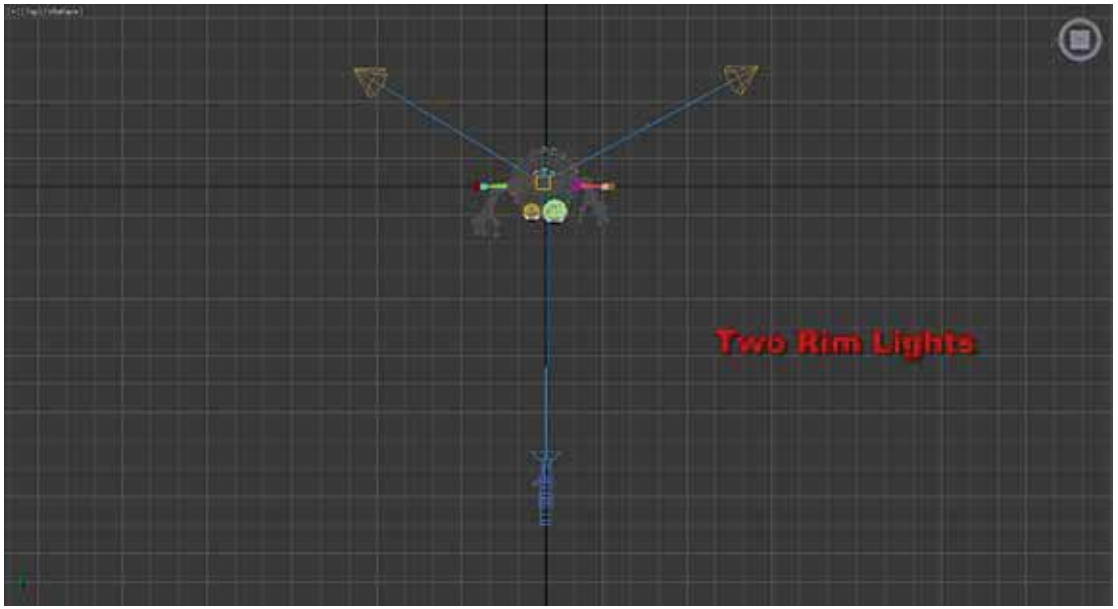
3dsMax Skills

- 135-degree rim light source.

3dsMax Skills

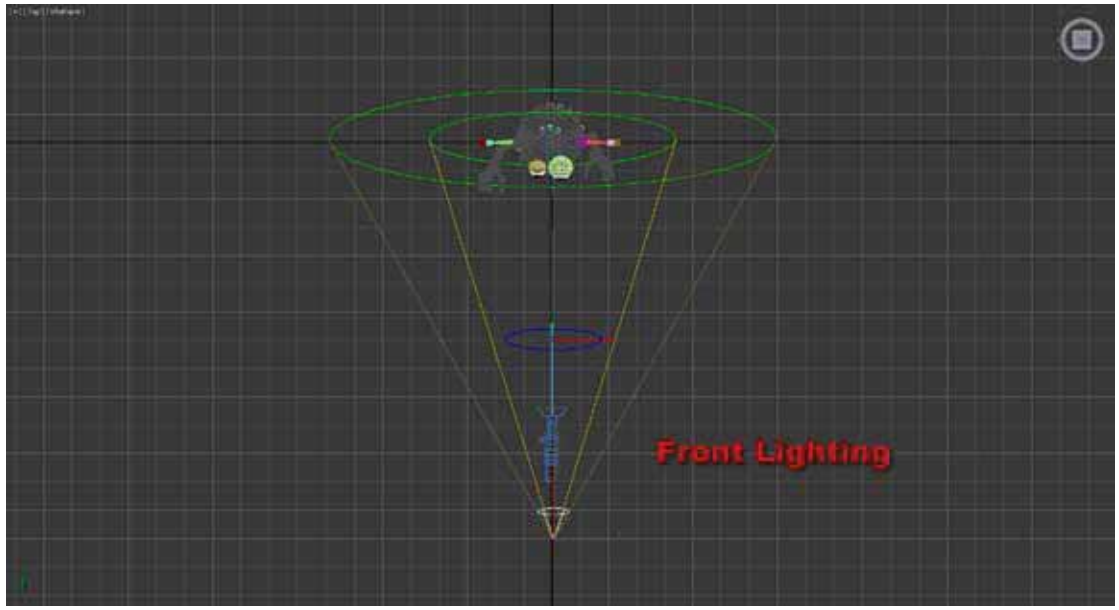


- Two 135-degree rim light sources produce very harsh and stark images. Great for intense action shots where silhouette is important.

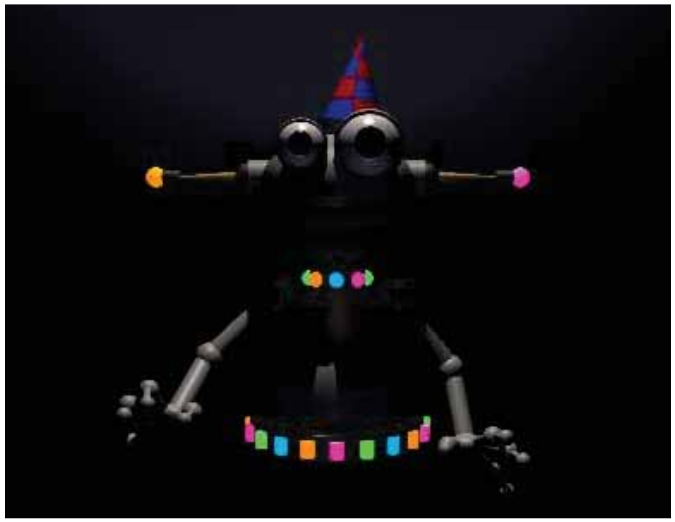


3dsMax Skills

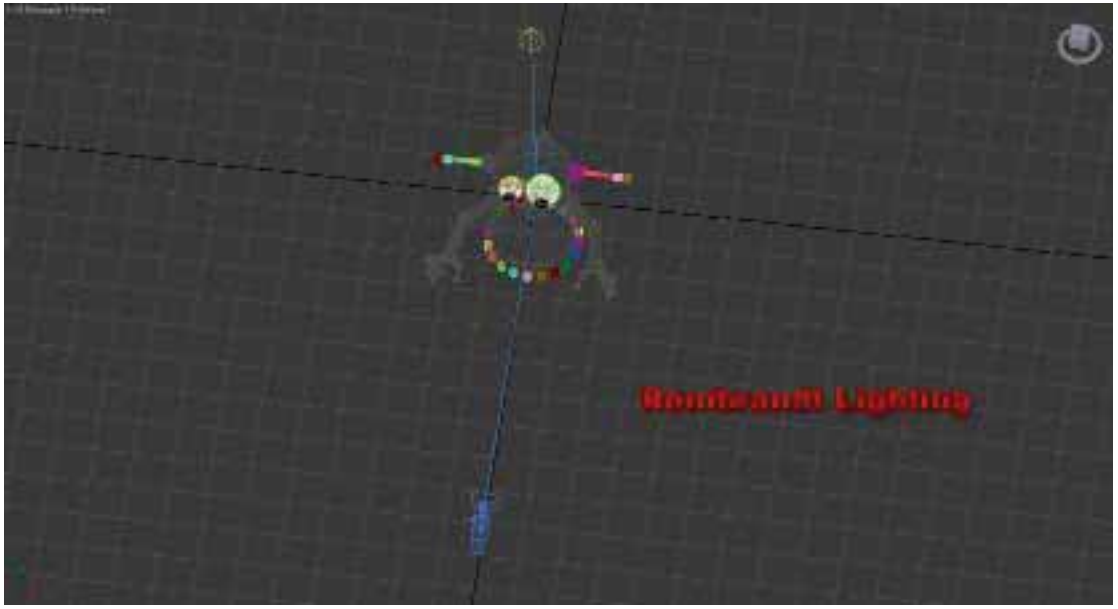
- Frontal lighting at camera level, produces a very flat image.



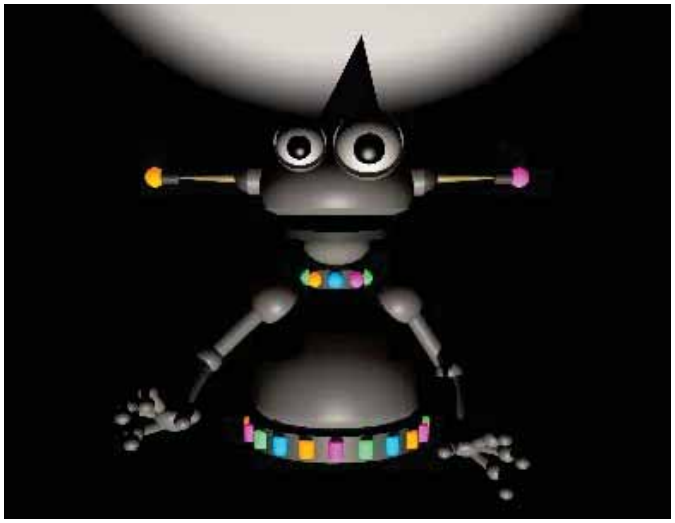
3dsMax Skills



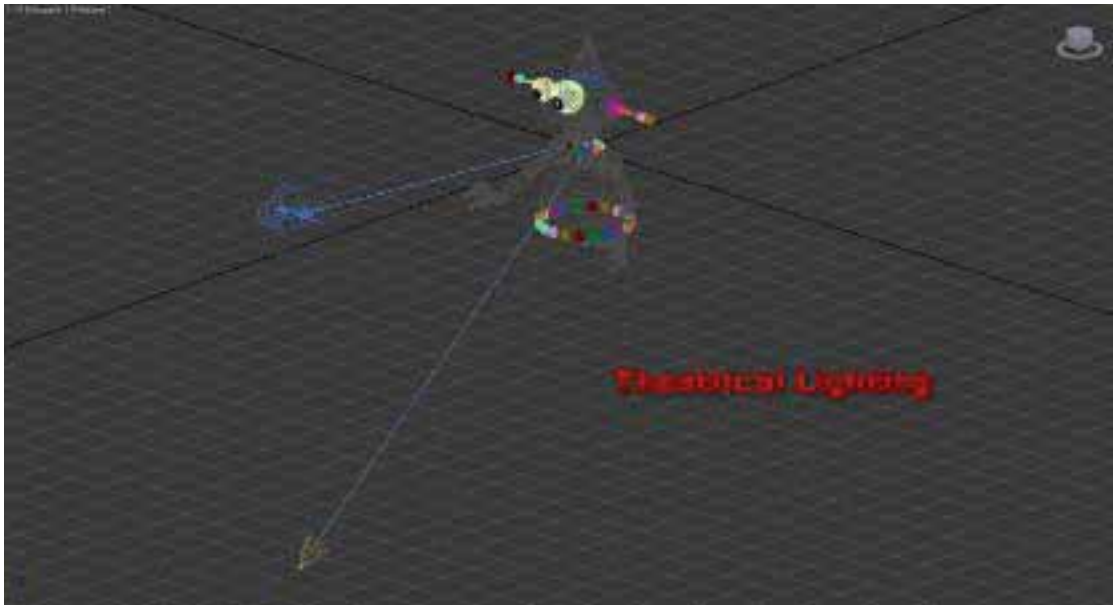
- Rembrandt lighting where the light source is almost directly above the subject and shadows are left very dark and opaque.



3dsMax Skills



- Theatrical lighting where the light source is placed low in comparison to the subject. Generally shadows are also very dark and opaque.



3dsMax Skills

Here we will look at how lighting affects a scene beginning without any light source at all.

- In the beginning when there is no light, we cannot see anything in the scene. We have no idea where objects are located or if something is going to reach out and grab us.
    - Figure 01

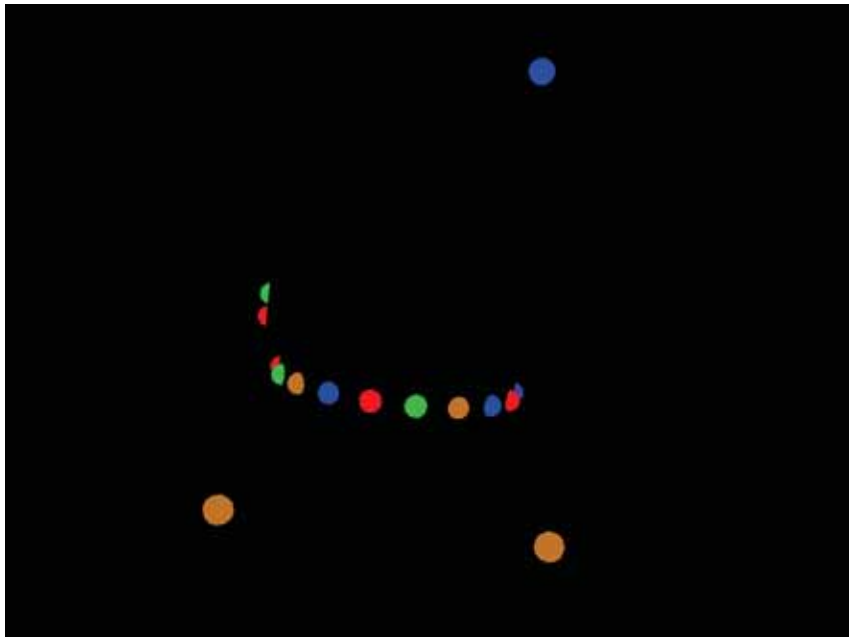


Figure 01

- So, let's add a light. Right now it is a white light without any color. Now you can tell there is an object on some kind of surface but very little beyond that. You can tell that the object is opaque or very nearly so since there is a cast shadow on the flat surface. Since you can see the object, you may be able to make some assumptions about its nature.
    - Figure 02

Figure1 02

- Up to this point the image is only various shades of gray. So, let's add some color to the object. It makes the image more interesting to look at but having only a single color in a scene looks rather strange.
    - Figure 03

Figure 03

- Add a fill light opposite the key light and low to the ground. Because we are in a colored environment at this point, make the fill light lean slightly toward the color of the environment. This light will help lighten the stark contrast of the shadows and add a touch of color to them, imitating color being reflected from the light bouncing around the environment.
    - Figure 04

Figure 04

- The scene is looking more natural at this point. We still do not have any visual clues to the nature of the material composing the object. We could change the surface characteristics of the object to gives us an idea of what it is made of but this will be covered more in the next section on texture, so we will leave things as they are right now.

- Let's change the color of the light and see what happens.
    - Figure21

While the object has a local color (just like an apple is red), you can see that changing the color of the light dramatically changes the color of the object. If the reflected light is strong enough, you may see some of the object's local color but very subdued. You may also be able to see some of the object's local color along the terminating edge between the light and shadow side.

Just for fun, let's continue to change the color of the light source and see the effect on the object. We will pick colors for the light from around a standard 12-spot color wheel. We will change the color of the fill light to the complement of the key light color.

The next six images show the influence of colored lights on our scene. Both the environment and object can be effected in unexpected ways. When you plan your light scheme you absolutely must take into consideration the color of the lights you use.

- Figures 05-09

Figure 03

Figure 06

Figure 07

Figure 08

Figure 09

Figure 10

Figure 11

Summary

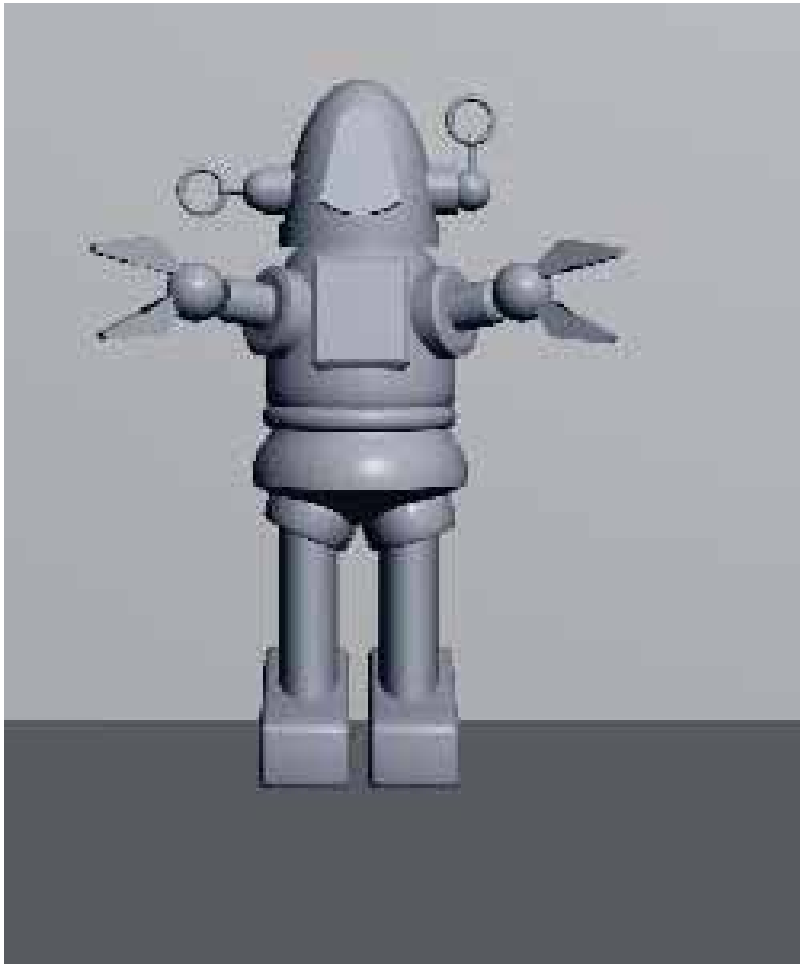
In this section we looked at lighting and some basic arrangements that could be used as a starting point in a scene. We also looked at the influence the color of lights can have on objects within your work.

Careful planning when adding lights will give your images and animations that extra something special and take your work above the mundane.

Setting Up the Basic Scene

Setting Up the Basic Scene

When you start 3ds Max it automatically creates a scene with some default lighting, so you can at least see what you are doing. However, it is not a lighting scheme that you probably want to use for your final scene.



Let's add a general lighting scheme to the scene that contains a key light, fill light, rim light, and an additional light at or below the ground plane to simulate light from the ground plane bouncing back into the shadows created by the other lights.

Autodesk 3ds Max comes with two types of lights: photometric lights and standard lights.

Photometric lights let you more accurately simulate light in a real-world environment. You can set many different parameters to control such things as intensity, color, color temperature, and so on. To get the most accurate real-world simulation, use the mental ray® renderer with photometric lights.

Standard lights will do for most situations. They can simulate almost any kind of light you can think of from the sun to flashlights. They are not meant to accurately simulate real-world lighting.

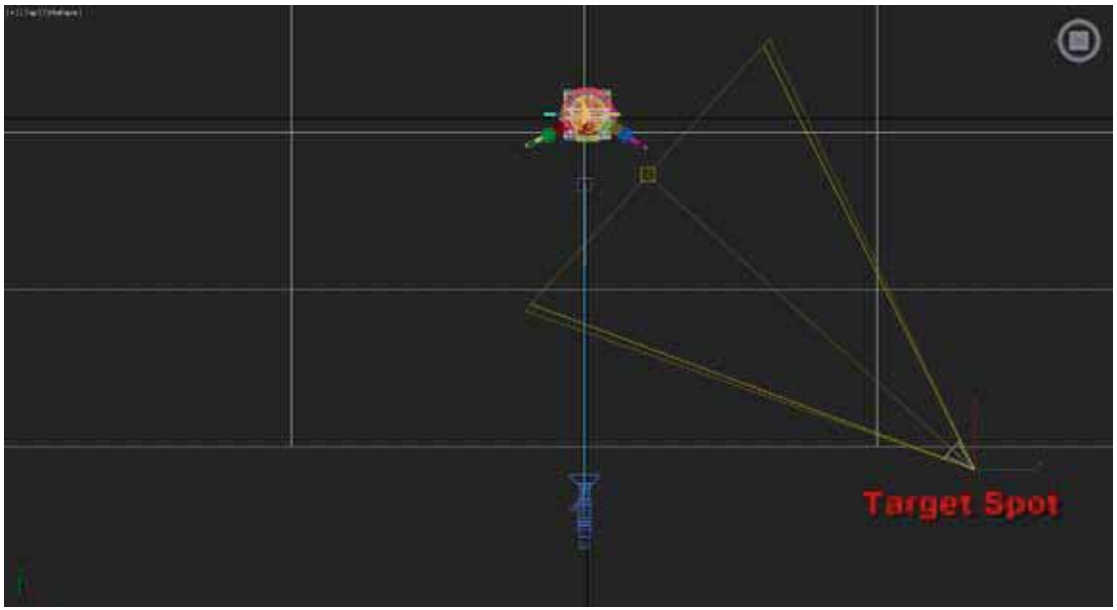
All the different types of lights are displayed as objects when added to a scene. Most of the lights have many of the same controls, so as you learn to use one kind the others will not be difficult to use when needed.

Adding Lights

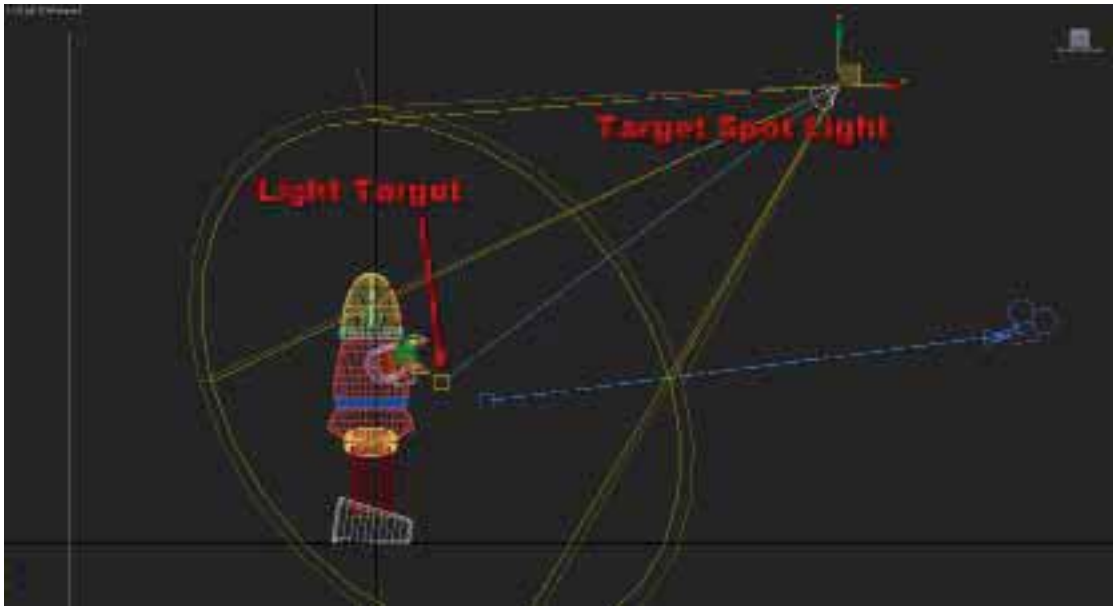
The Key Light

To begin, we will add a key light using a spotlight. Remember that the key light is usually the brightest light in the scene and is the light that will be responsible for the shadows of the different objects.

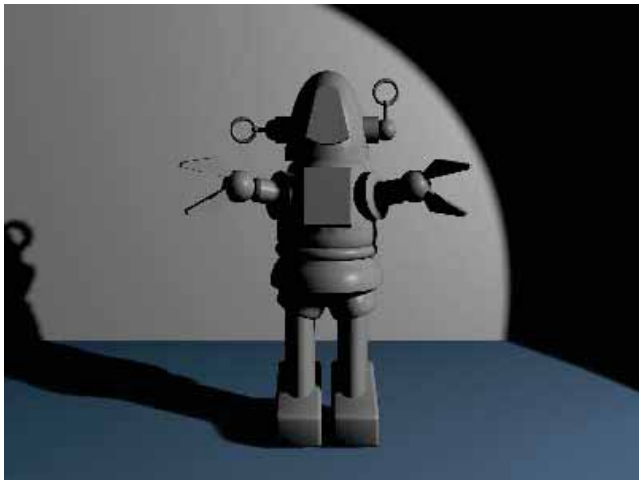
From the create panel, select lights and either a Target Spot or a Free Spot to add to your scene. Make sure that you check the on box in the General Parameters/Shadows rollout that appears when you select the Target Spot or Free Spot light.



- In the top viewport, place the light at about a 45-degree angle from the line of sight between the robot and the camera. If you use a Target Spot, it is recommended that you do not place the light target directly over the object. It is just easier to select the target should you need to move it if it is not directly on top of the object.



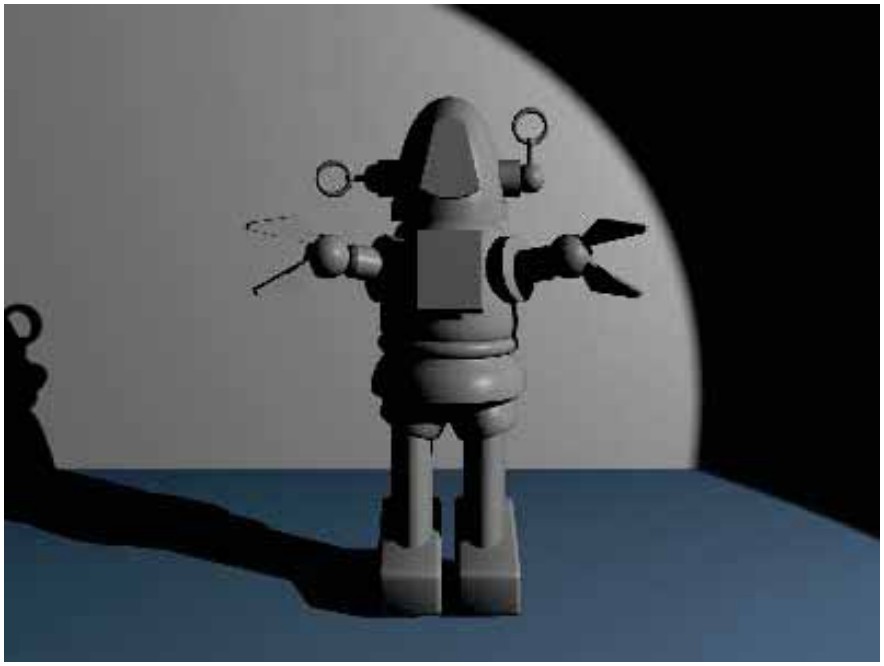
- From the Left or Right viewport, place the target object about midway up on your object. Raise the Target Spot light to about 45 degrees above the object.



When you begin to add your own lights, the default lights created when a scene is created are removed.

- Render from the camera view to see how the addition of a key light has changed the scene.

The edge of the light on the back plane is a bit harsh and the curve of the light comes very close to the right clamp hand of the robot, creating a tangent which in turn creates a point of tension in the image. We will fix this, but first we should look at and evaluate the shadow of the object itself.



Creating good shadows is a critical skill you need to master when working in 3D. While it is beyond the scope of this section to go deeply into each shadow type, it is worthwhile to show a few renders using each shadow type.

Creating Shadows

The shadow of the robot itself is acceptable, but where it is cast on the vertical wall it becomes a bit blocky and does not represent the objects casting the shadow well. There are a number of different ways for 3ds Max to create shadows. These methods include:

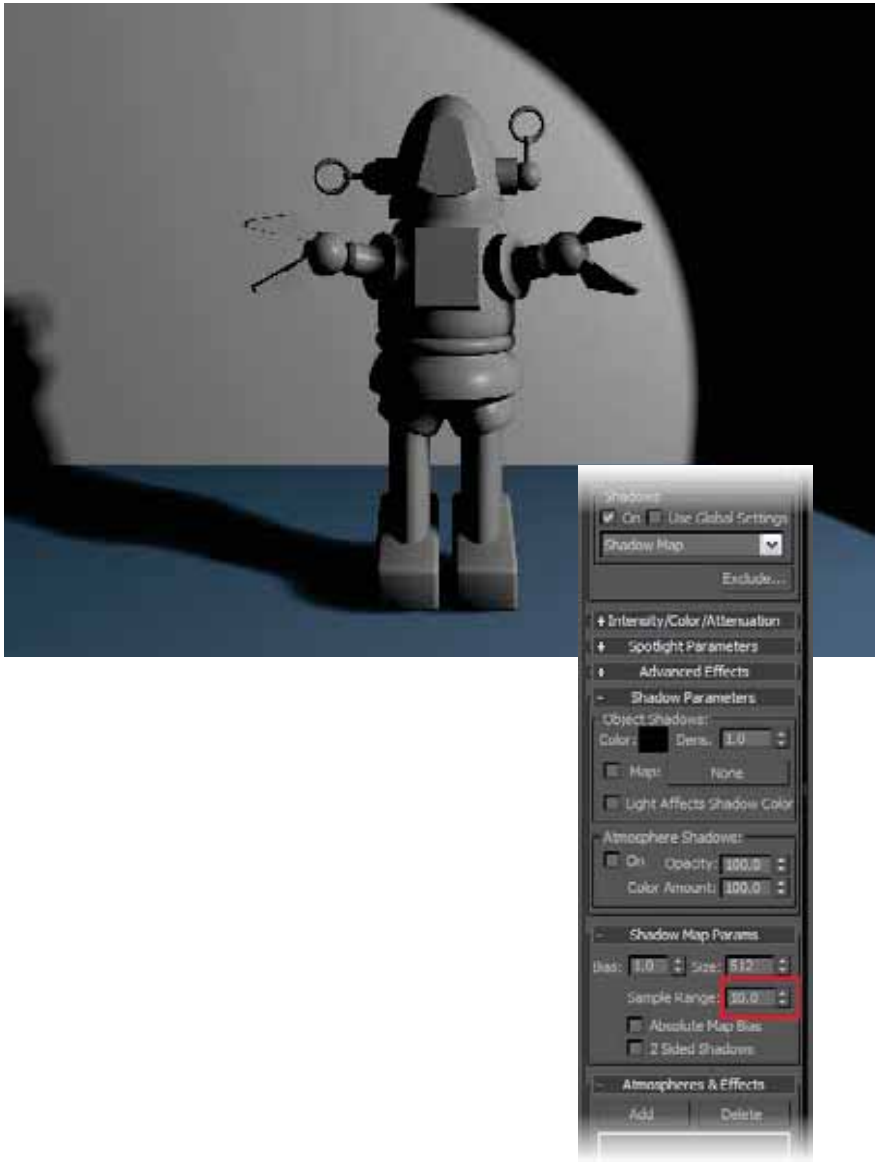
- Area Shadows
- Ray-Traced Shadows
- Advanced Ray-Traced Shadows
- Shadow Maps
- mental ray Shadow Maps

In the rendering that was just finished, the shadow was created using Shadow Maps. Shadow Maps are real bitmap images that 3ds Max renders and then combines into the finished render to create the shadow.

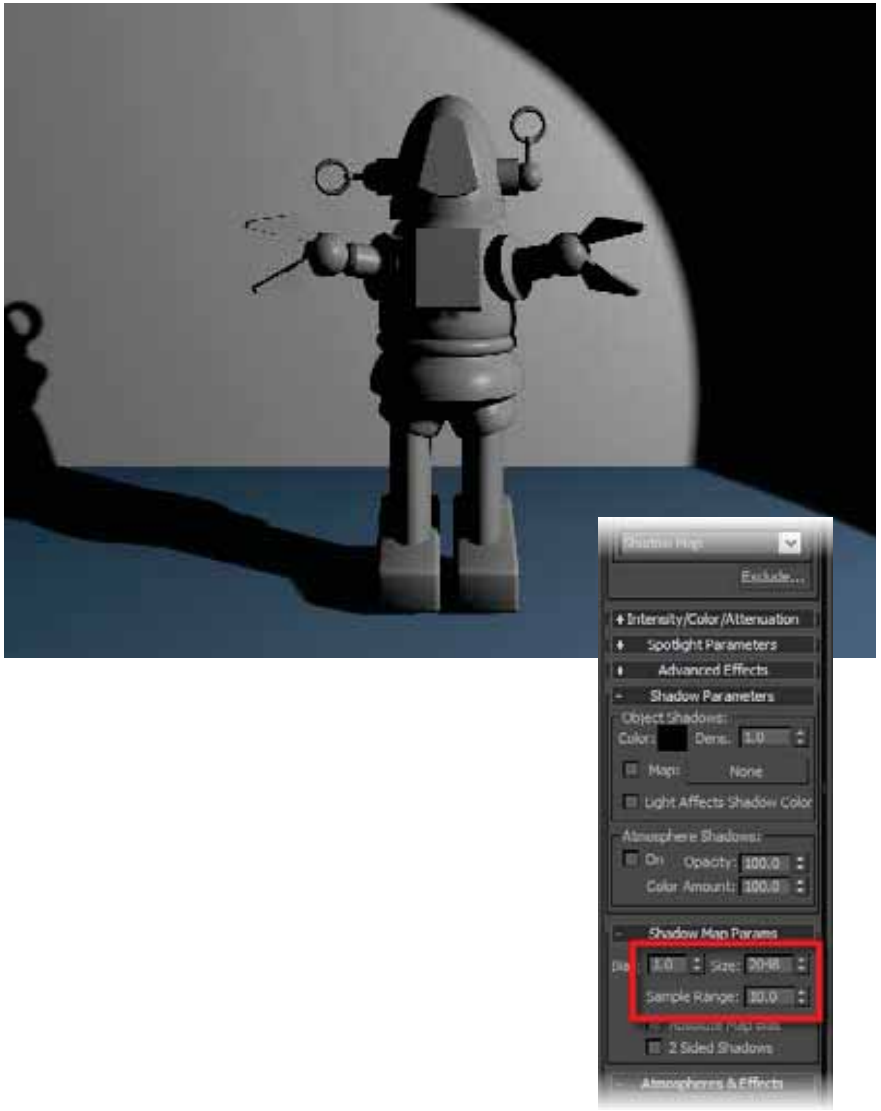
There are several things you can do to change the way the Shadow Maps appear:

- Increase the size of the Shadow Map. This does require more memory to calculate, so if you are not on a computer with lots of memory, be careful doing this. The figure shows the difference in the rendered shadows when the Shadow Map size increased from 512 to 2048.

- You can also smooth out the shadows if you increase the Sample Range of the Shadow Map, which will smooth their appearance.



- You can, of course, increase both the Sample Range and Size to get very nice results.



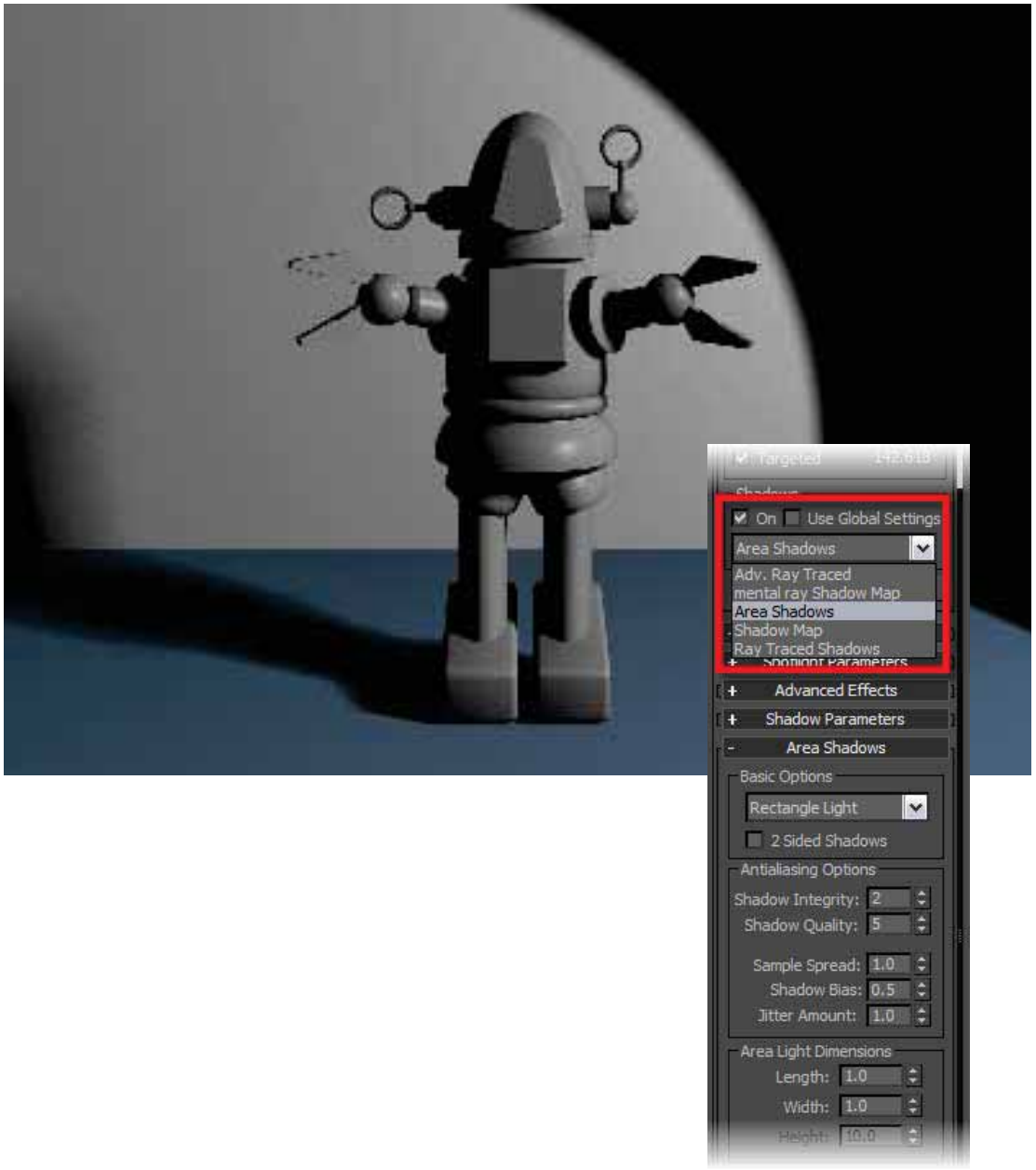
3dsMax Skills

One disadvantage of Shadow Maps is that they will not render as expected when using transparent objects. Specifically, they treat all objects as opaque.

So let's change the shadow type and see what happens with the rendered robot.

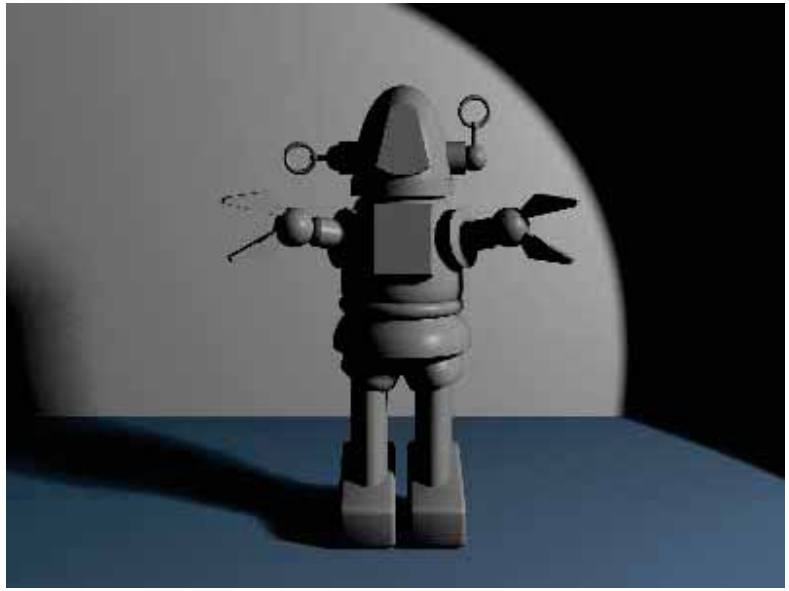
To change the shadow type you do not need to change the current light source.

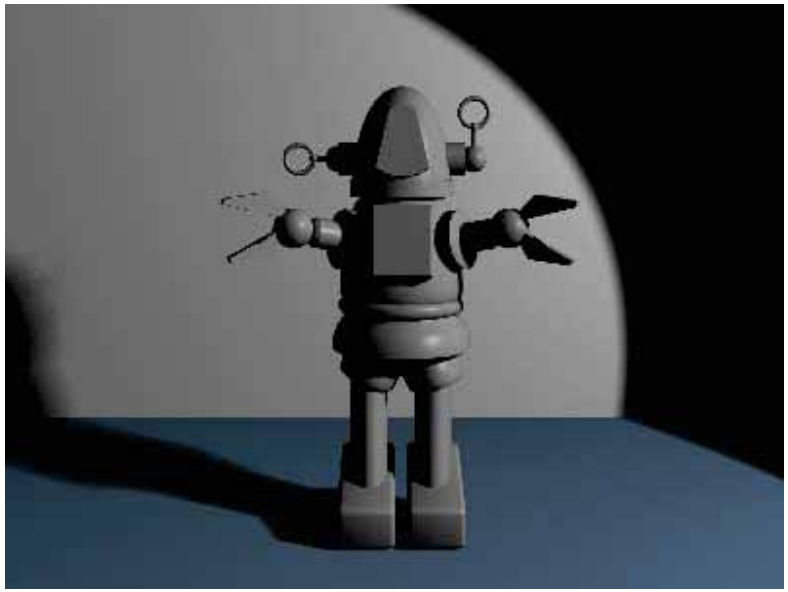
- Select the Shadow drop-down menu, and choose Area Shadows. Leave everything at the default settings and render the robot.

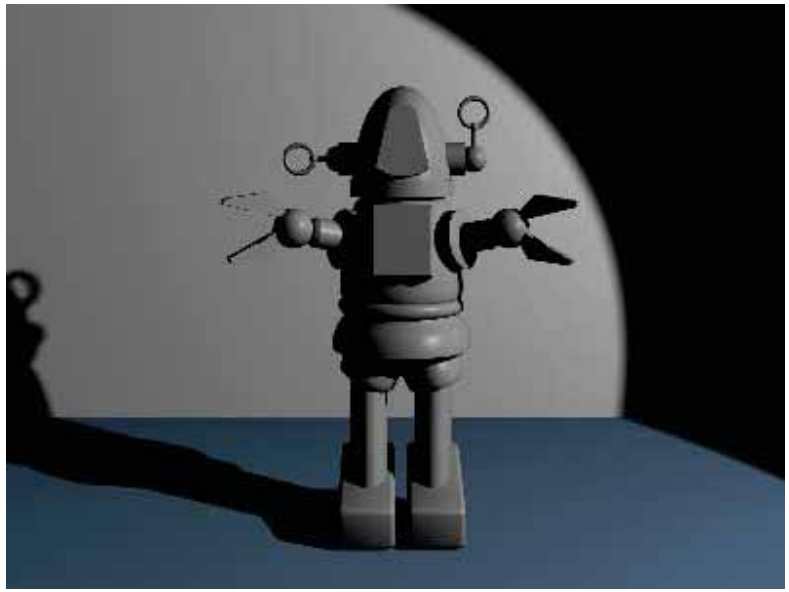


3dsMax Skills

Area Shadows can take a long time to render. They produce very soft shadows; and they get softer as the shadow gets further from the object. There are a number of different options with this shadow, including the basic shape of the light the shadow is calculated from. You should spend some time exploring the various settings. Changing the Area Light Dimensions will have a dramatic effect on the softness of the shadow. The following shadows were rendered with Area Light Dimensions at the default 10 for the length and width (Figure10a), changed to 5 in both the height and width (Figure10b), and finally with the settings at 1 (Figure10c). As you can see from the images, the lower the setting, the sharper the shadow.



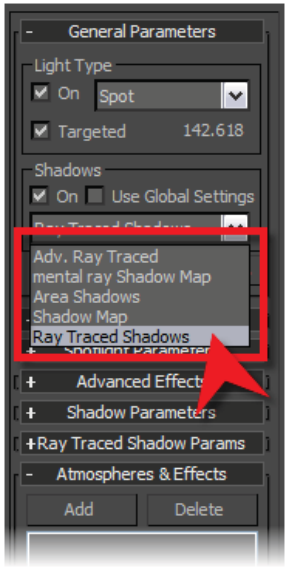


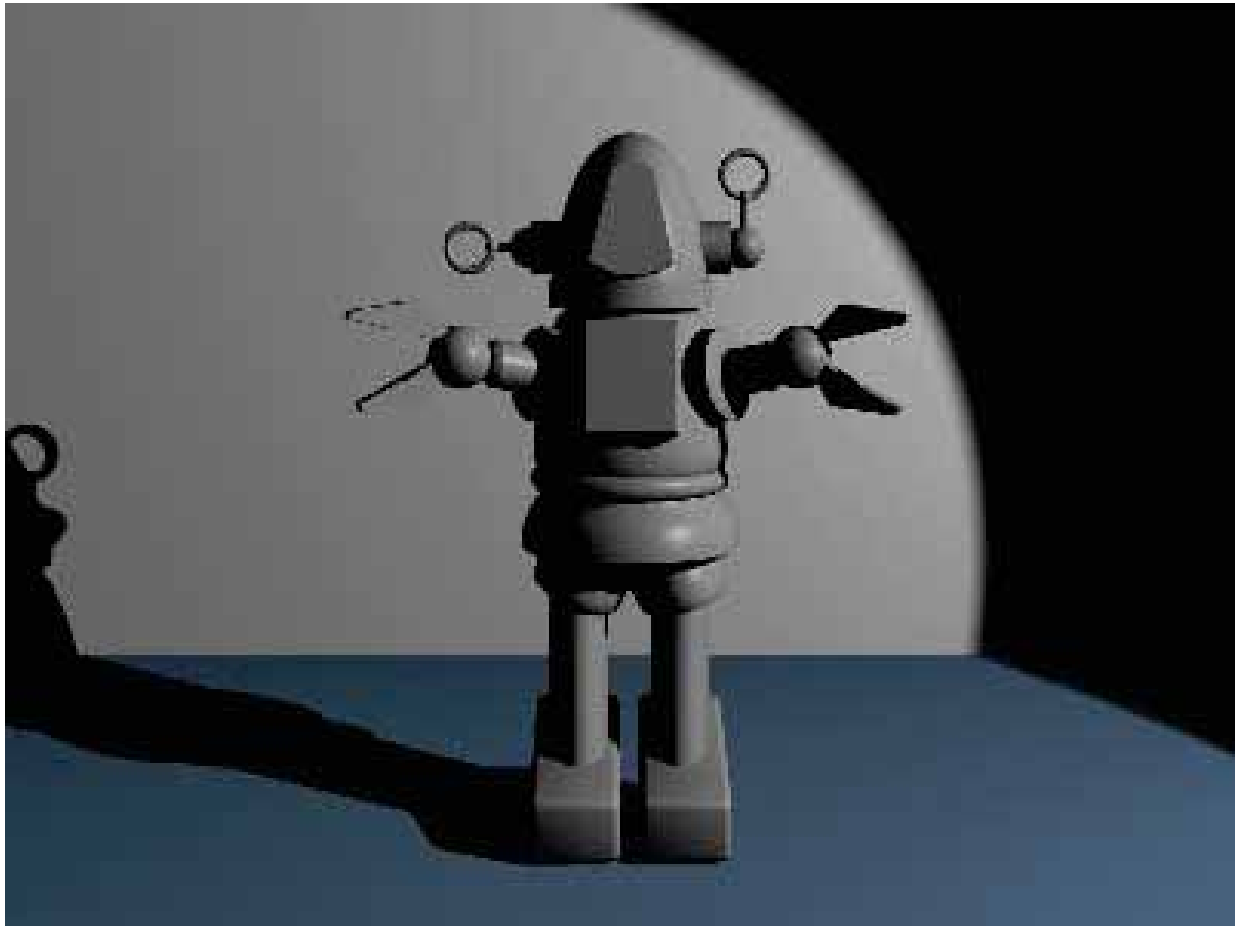


3dsMax Skills

Now let's look at Ray-Traced Shadows. Ray-Traced Shadows are calculated by tracing the ray of light's path from the light source to and beyond the object. Ray-Traced Shadows are more precise than shadow-mapped ones, though they always create a shadow with a hard edge. Ray-Traced Shadows work with transparent, translucent, and wireframe objects in a scene.

- Select Ray Traced Shadows from the Shadows drop-down menu.
- The robot is rendered with Ray-Traced Shadows. Notice how crisp the shadows are along their entire length when compared to Area and Shadow Map shadows.

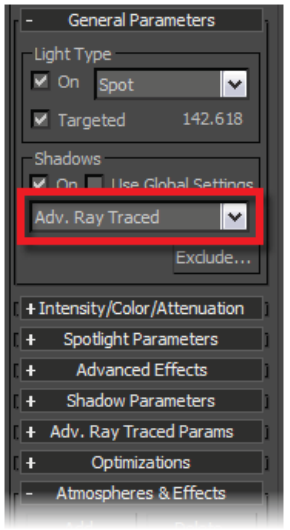


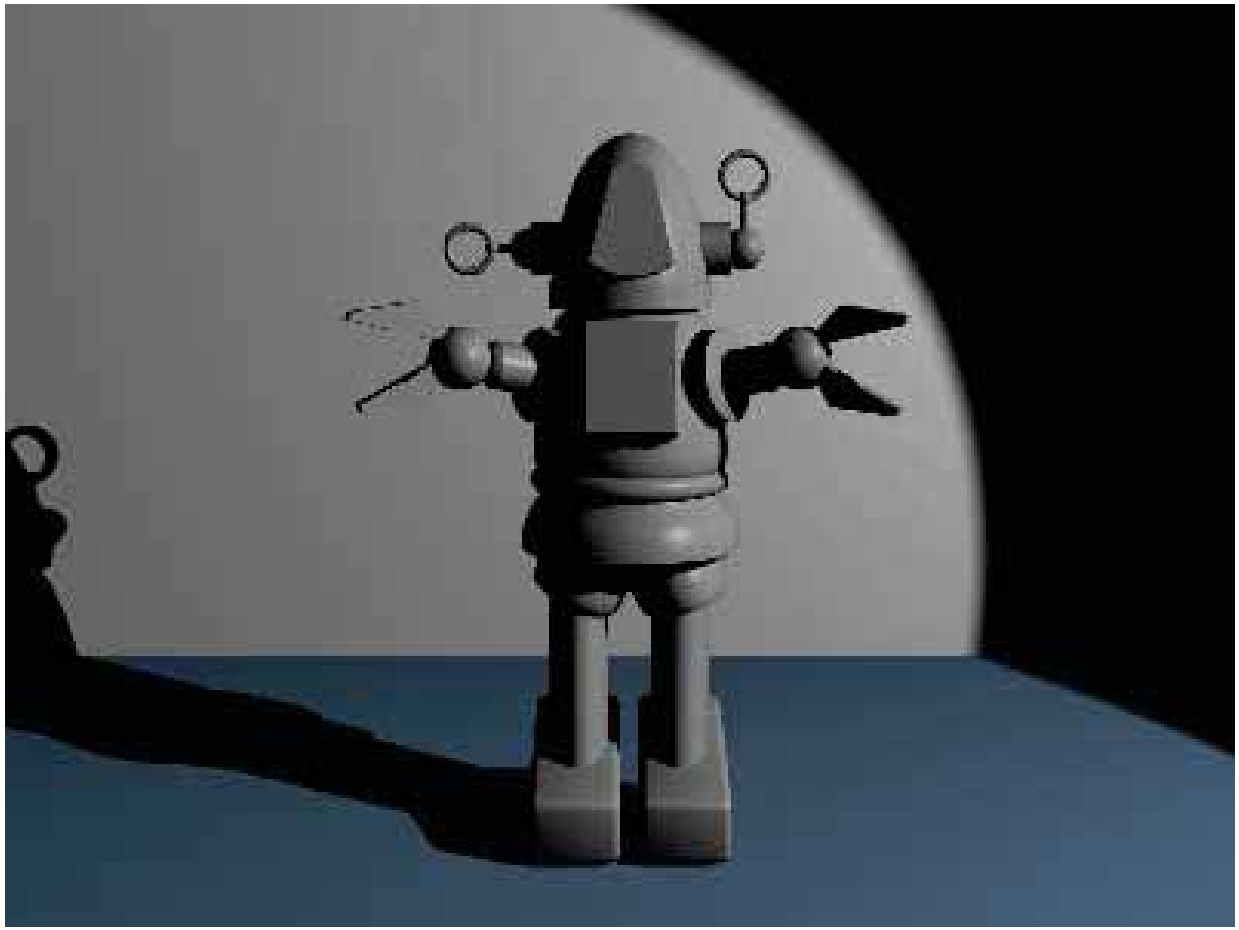


3dsMax Skills

Let's now choose Advanced-Ray-Traced Shadows. Advanced Ray-Traced Shadows are like Ray-Traced Shadows, but you have more control over how the shadows look. One of the major differences is the ability to soften the edges of the shadows so they are not so crisp and sharp.

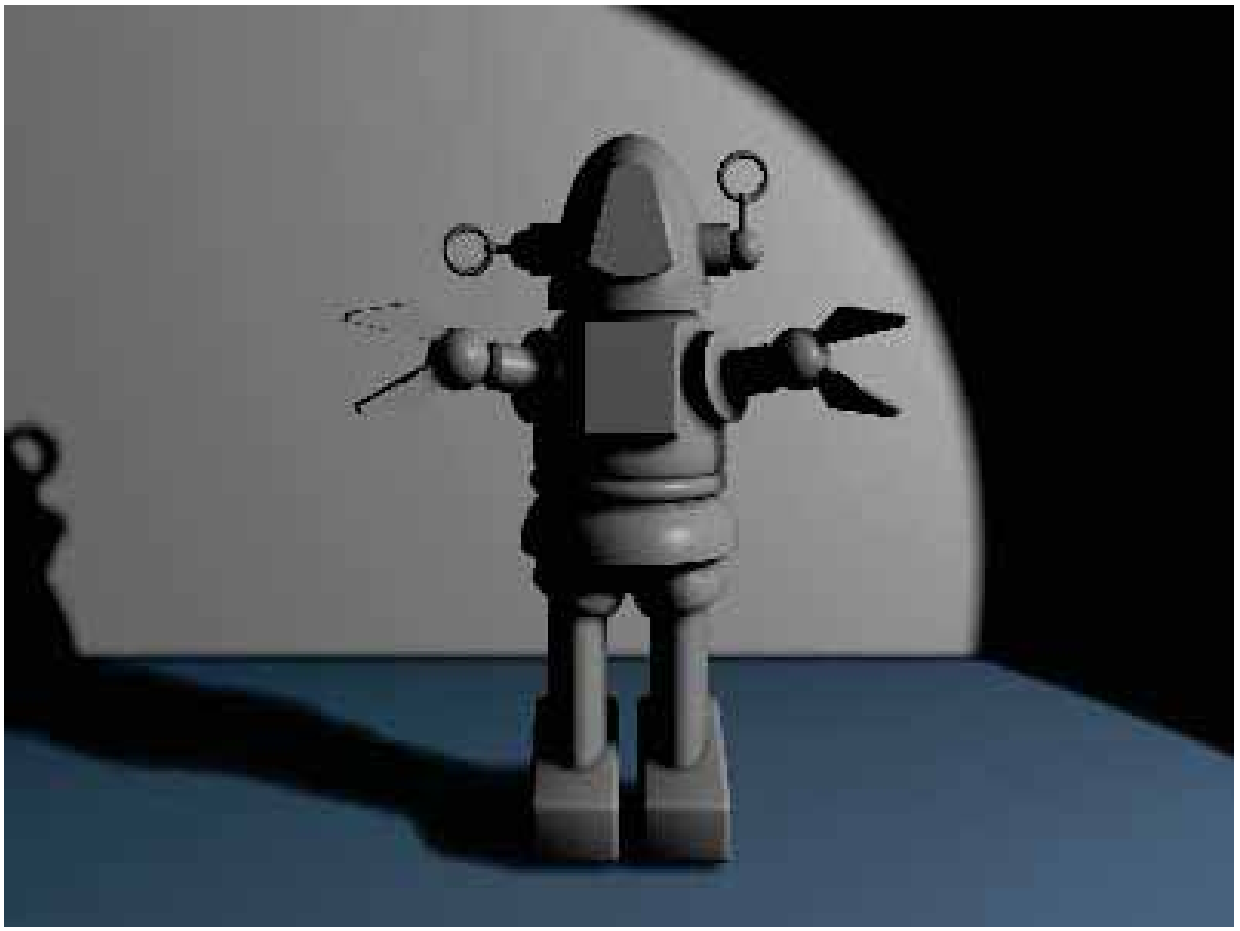
- Choose Advanced Ray Traced shadows from the Shadow drop-down menu.
- The robot is rendered with Ray -Traced Shadows. With the default settings, the shadows are still very crisp along their edges.

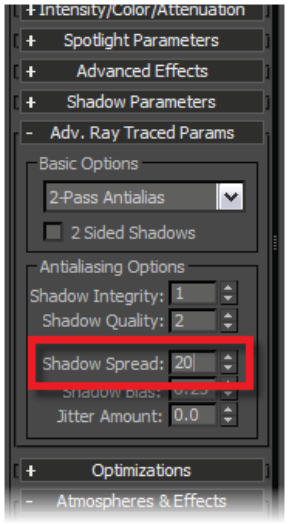




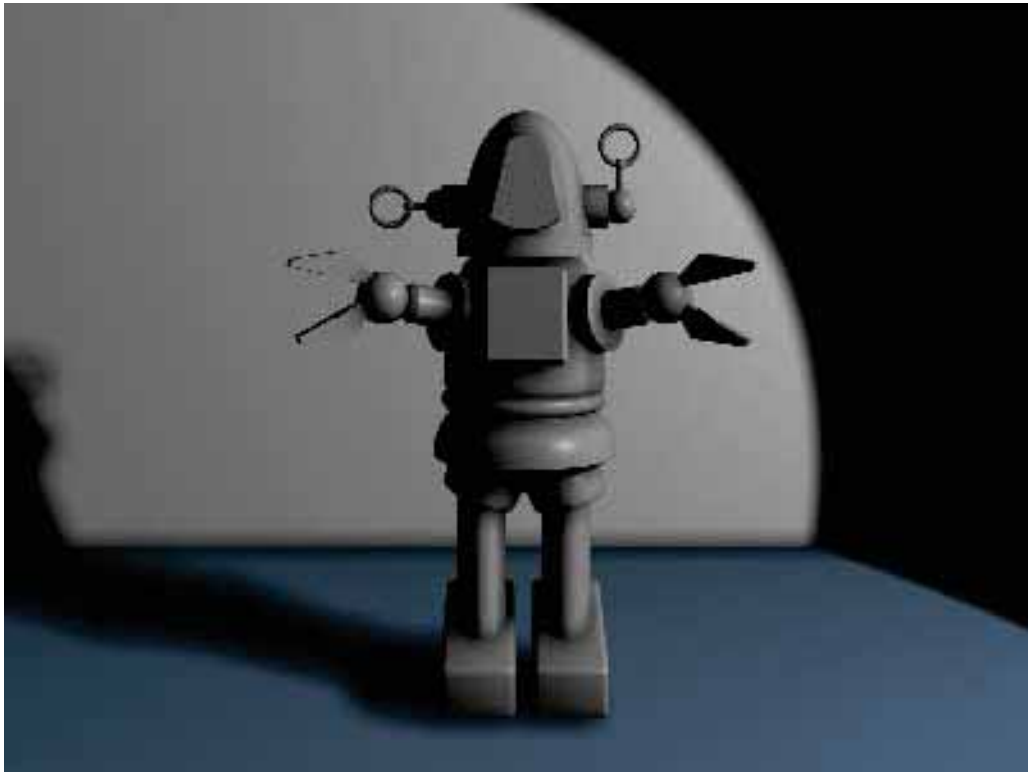
3dsMax Skills

- By increasing the Shadow Spread value, the edges of the shadows can be softened. When you do increase the Shadow Spread, you also need to increase the Shadow Integrity, Shadow Quality, and Jitter Amount. Figure 14 shows the robot rendered with the Shadow Spread value of 20, Shadow Integrity to 6, Shadow Quality to 6, and Jitter Amount to 2.





- Figure 15 shows the Shadow Spread value set to 50. The other settings have been left as they were in the previous image. Raising the Shadow Integrity and Shadow Quality settings can significantly increase the render time required.

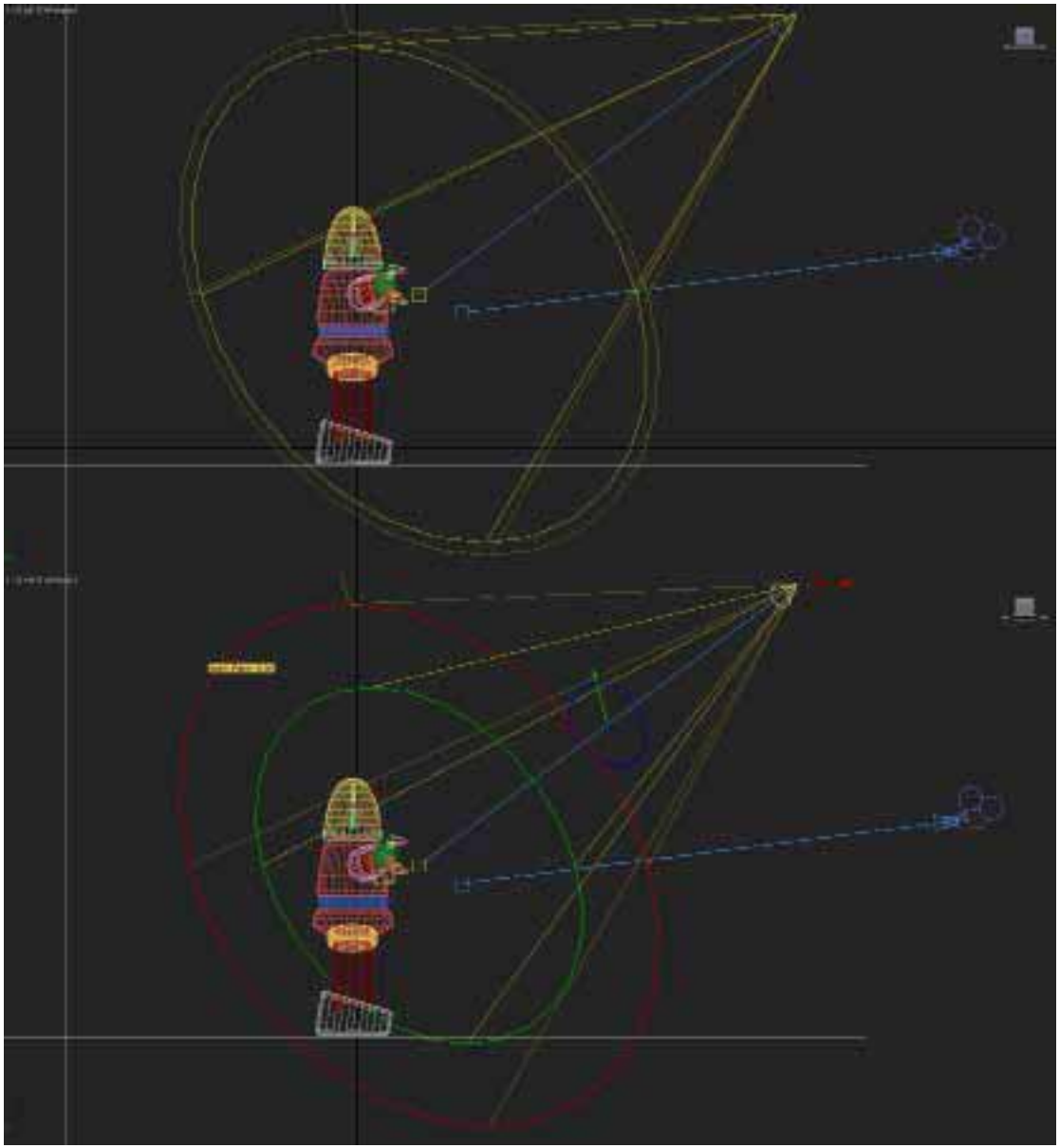


Before we add any more lights, let's adjust the softness of the edge of the spotlight so the light shining on the back vertical surface is not so harsh.

The transition between the light and shadow of the Spot Light is called falloff. It is represented in the scene when the spotlight is selected and Light Cone is visible. The light cone is visible by default. Adjusting the falloff of the spotlight is easy and can be done using the Hot Spot and Falloff spinners located in the Spotlight Parameters rollout or using manipulators located on the default Main Toolbar.

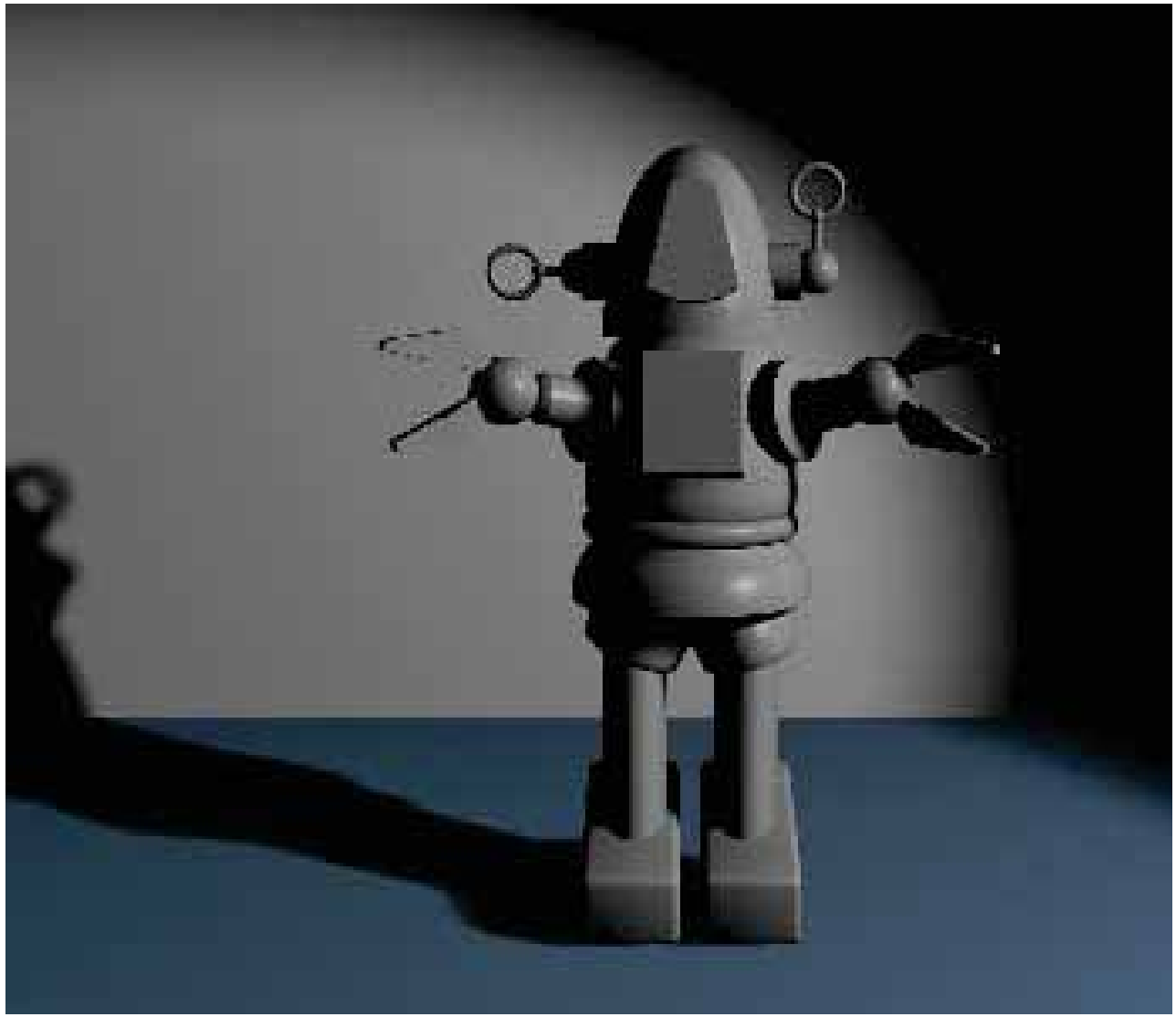
3dsMax Skills

Click and activate Select And Manipulate. As you move the cursor over the light cone in the viewports, the hotspot and falloff circles will temporarily turn red. When the circle is red, you can adjust the size of the spotlight falloff, hot spot, or both. The larger the gap between the two circle representations, the softer the transition between the shadow and light will appear in the render.



3dsMax Skills

This image shows the robot render with the falloff between the light and shadow increased. The transition is much wider and softer than the original.



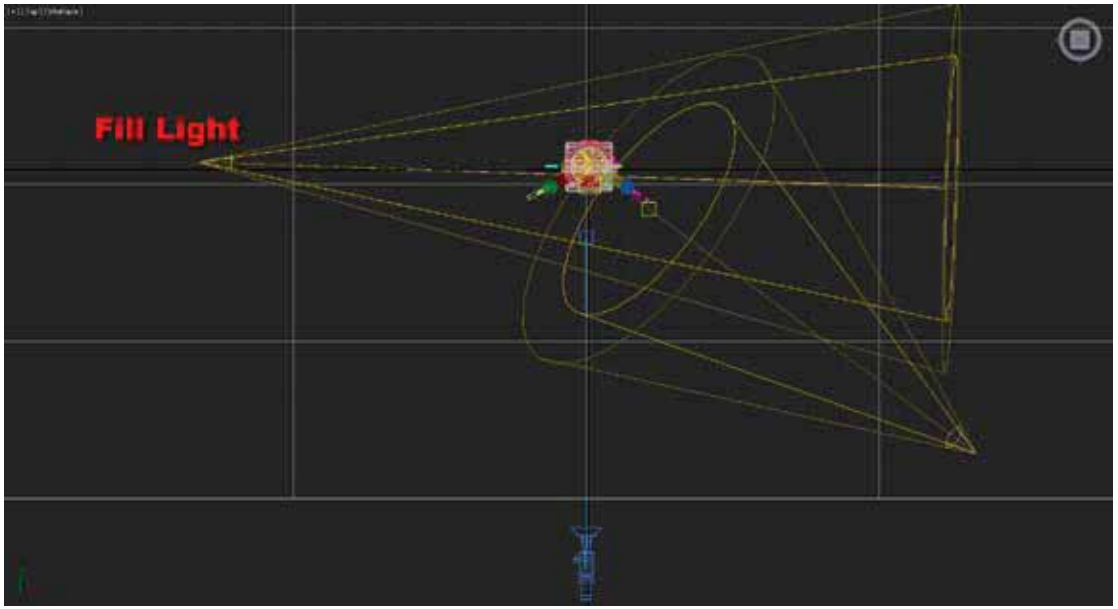
3dsMax Skills

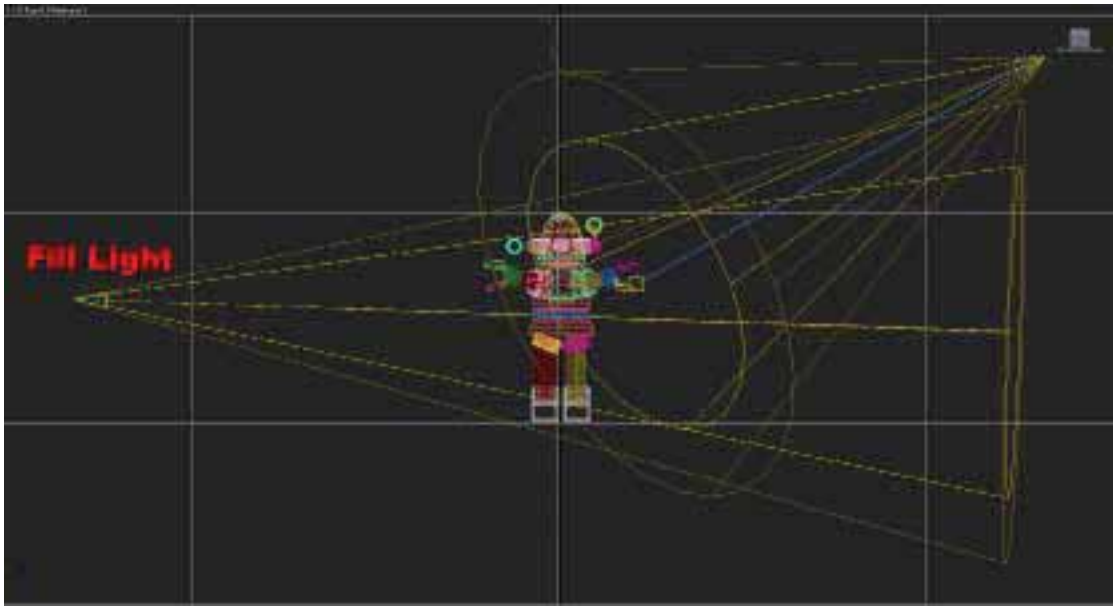
Now let's get back to adding lights to our scene.

The Fill Light

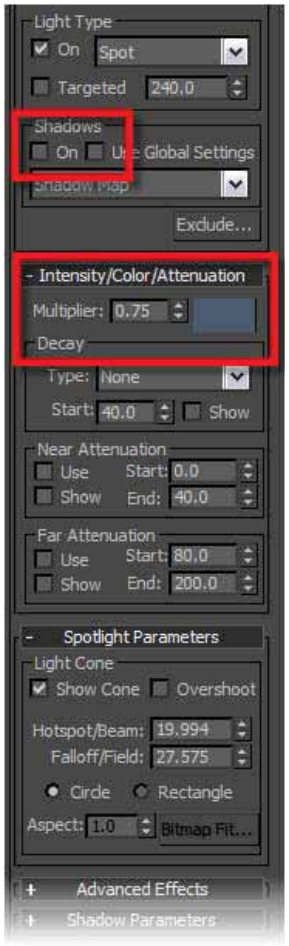
We will now add a fill light to the robot scene. Remember that the goal of the fill light is to lighten the very opaque, dark, and dense shadows created by the key light.

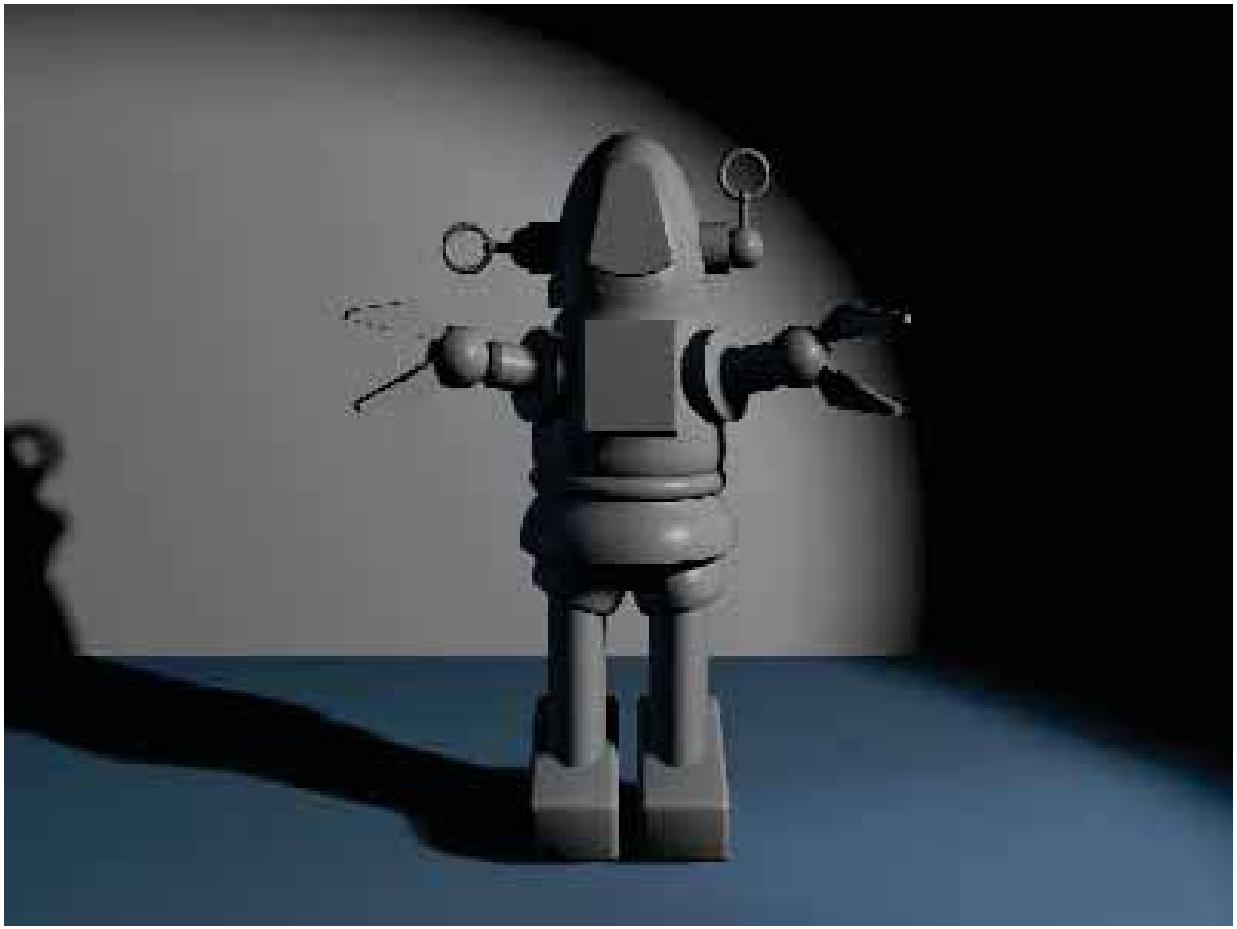
- Add either a Target Spotlight or a Free Spotlight to the scene placed on the opposite side of the key light at about half the height of the robot object.
- Drag the target or point the light at the robot.
- Adjust the falloff of the light to your liking. There is no right or wrong setting.



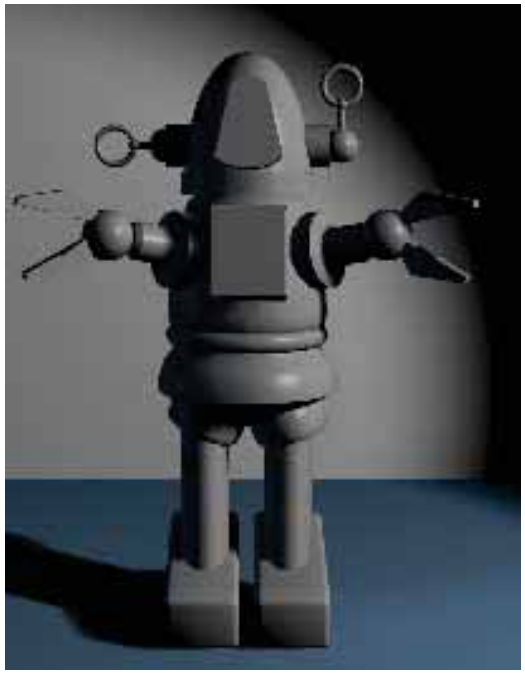


- Leave the Shadows box unchecked in the General Parameters rollout.
- In the Intensity/Color/Attenuation rollout, set the Multiplier value to a setting between .5 and .75
- Click the Color preview to open the color picker, and using the Dropper tool, select the bluish color from the floor plane. Lighten the color if it is in the darker range of values.
- Render the robot. The shadows are lighter and there is some of the ground color in the fill light simulating light reflecting from the ground into the robot object.





Finally, we will add a rim light to further separate the robot from the background.

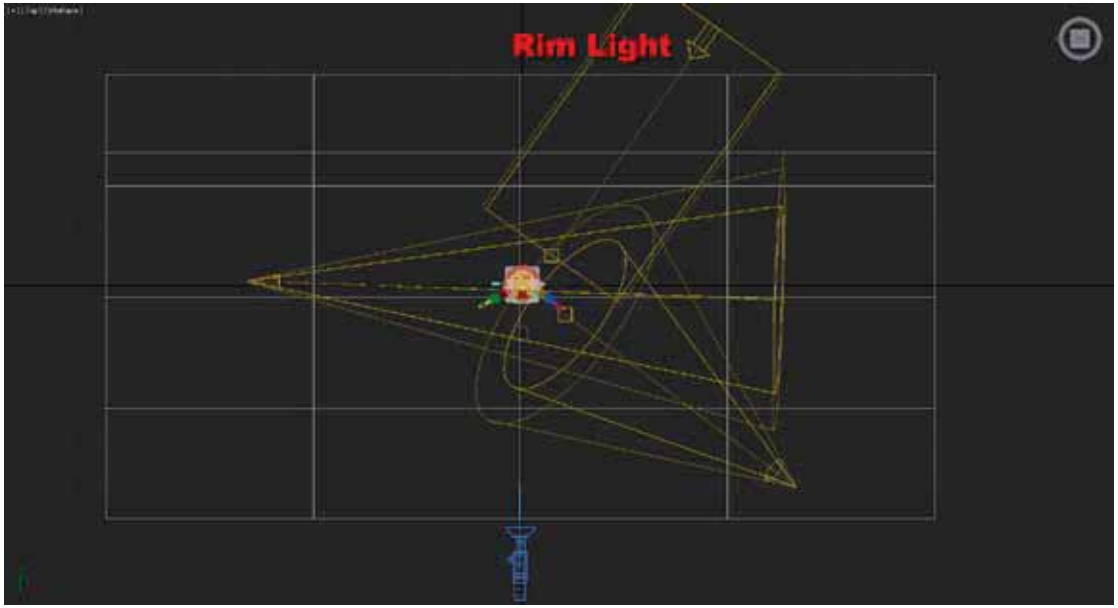


The Rim Light

The rim light is used to separate the object from the background. It can be placed on either side of the object. As the artist, you will need to decide which side would light most effectively. In this particular scene, we will place the rim light behind the robot on the same side as the key light. In this particular instance, this is done because the values of the light side of the robot are very similar to the values on the background plane.

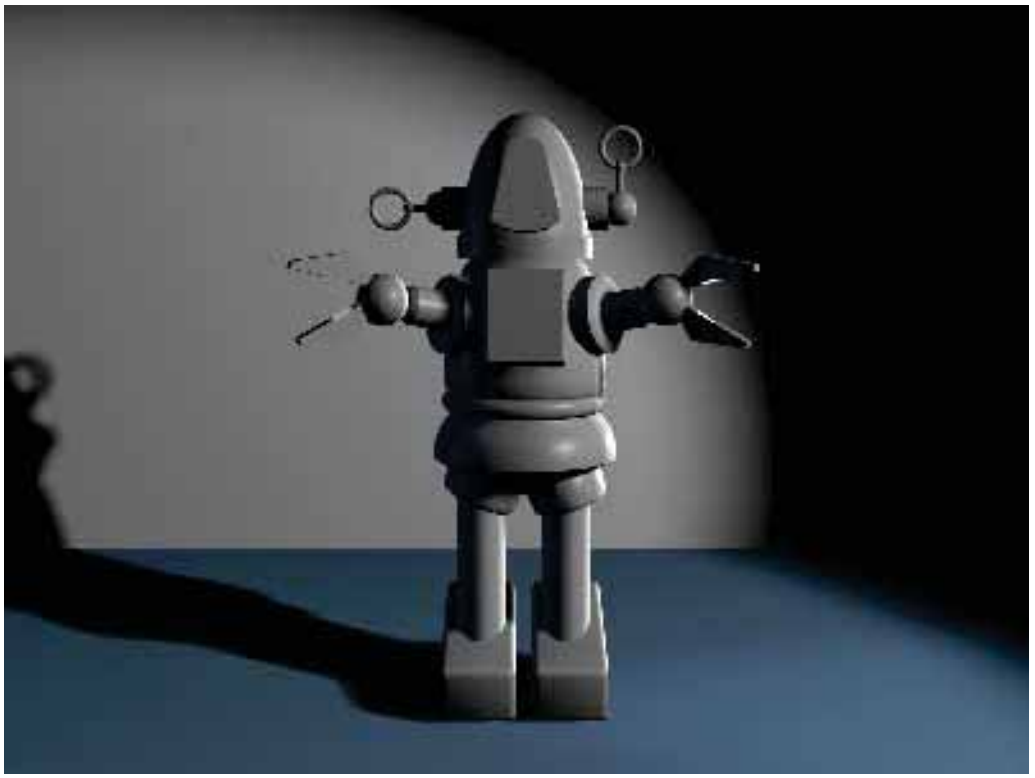
To place the rim light, do the following:

- Add either a Target Direct or a Free Direct light to the scene. We use the direct light because it has parallel rays and can be places such that it does not light the ground plane. Place it on the same side as the key light at about half the height of the target object, slightly behind the robot, and so the rays of the light are moving parallel to the floor surface. It does not matter if it is positioned behind the rear plane. The light will shine through that object.
- Turn off shadows if they are on.
- Drag the target or point the light at the robot.
- Adjust the falloff so there is very little since we do not need a smooth and gradual transition between the light and shadow.



3dsMax Skills

- This time increase the multiplier value to 2 and change the color or the light back to white. This will give a very intense light that will serve as a rim light quite adequately.
- Render the robot.

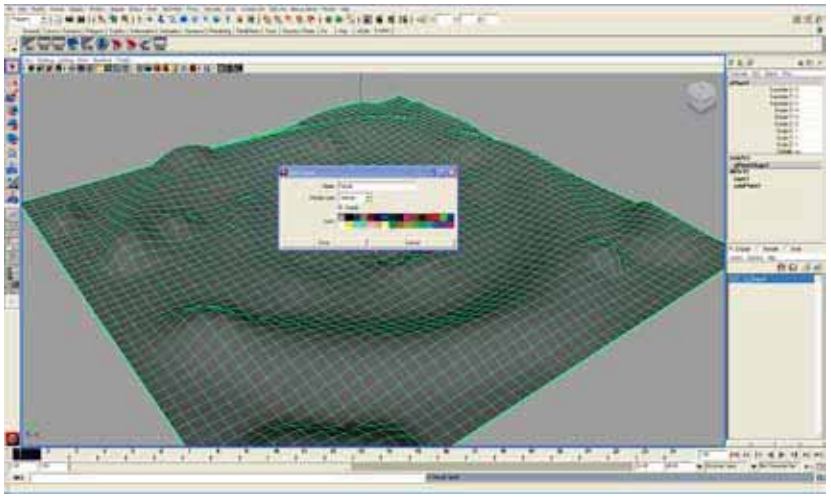


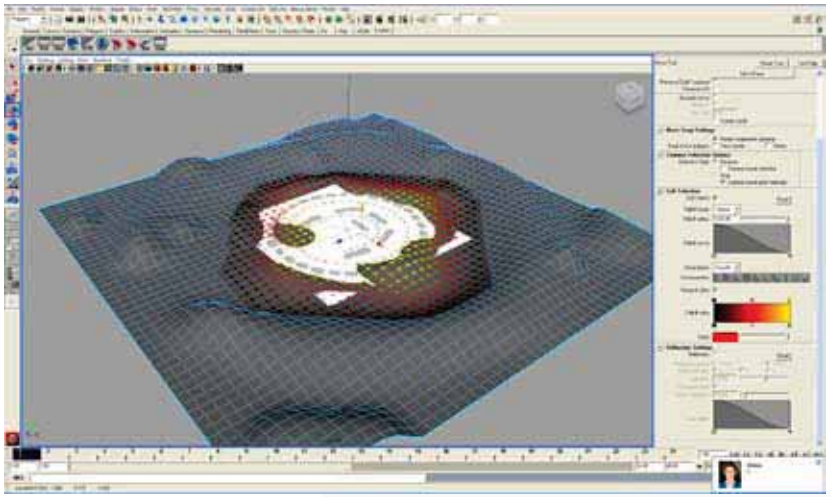
As you can see, the added contrast between the robot and the background nicely separates the two and makes the object more the focal point.

Workbook

Interface/Menus

Autodesk® Maya®





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Maya Interface

1 - Setting a Project
When you start up Maya, it is best practice to set up a project file. This will allow you to always save work to a specific directory.

2 - Primitives
In Maya you create primitive 3D geometry as a starting block to modeling detailed 3D objects

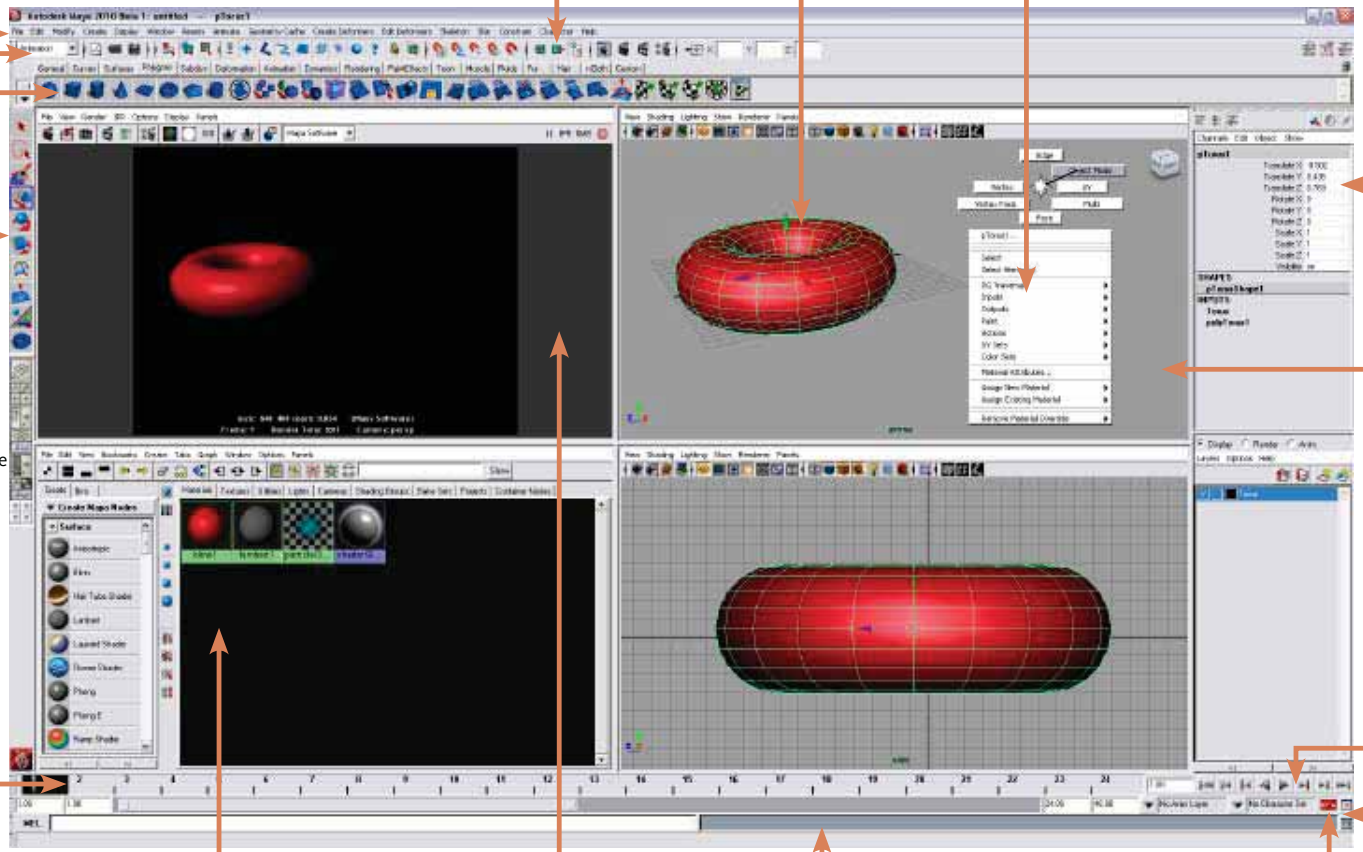
3 - Marking Menus
Marking Menus allow you quick access to editing your mesh objects. You can select different components to allow you to start modeling.

4 - Channel Box
The channel box gives you quick and easy access to the Transform, Rotate and Scale channels of an object

Status Bar

Menu Sets

Shelf



5 - Tool Box
The ToolBox holds all the Transform, Scale and Rotate tools, as well as other tools used for selecting objects.

6 - Viewports
Using the viewport Tools, you can Tumble, Pan and Zoom the Perspective Viewport

Playback Controls

Time Slider

Feedback Editor

7 - Hypershade
The Hypershade is where you will create all your materials for your scene objects. Its clean layout makes it easy to use.

8 - Rendering
When you render, Maya converts a 3D Scene into a 2D Image.

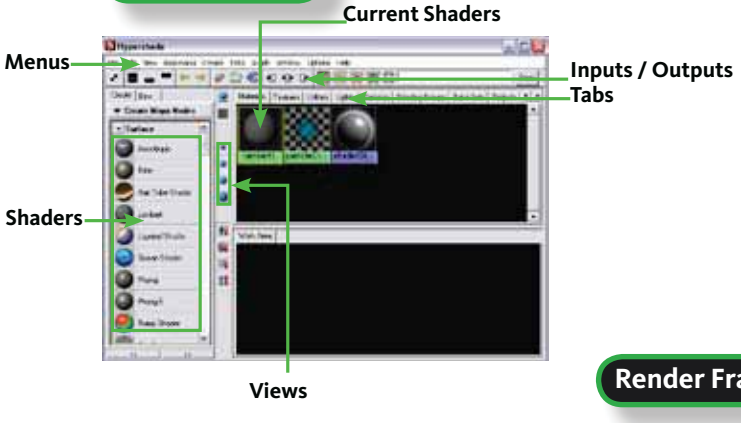
9 - Auto Key
Auto Key allows you to automatically key objects as you scrub through the timeline making transform, Rotate and Scale changes. Any change you make a key will be created

10 - Animation Settings
Animation Settings allow you to take control over all aspects of your animation setup, from Frame Rate to Number of Frames.

Maya Menus

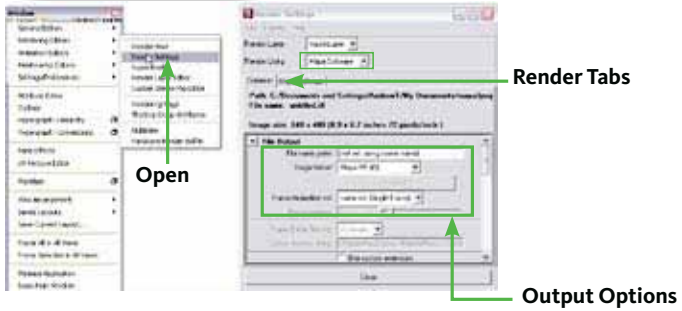
Status Bar

Hypershade

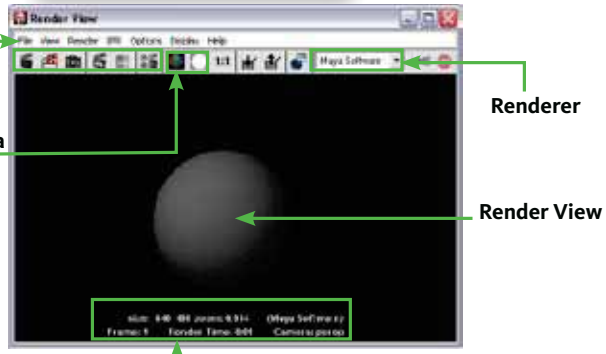


Shelves

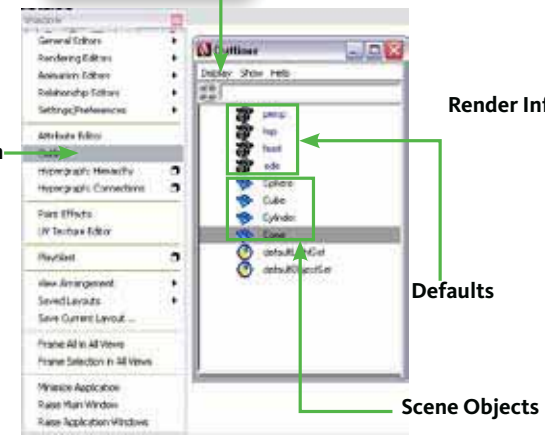
Render Settings



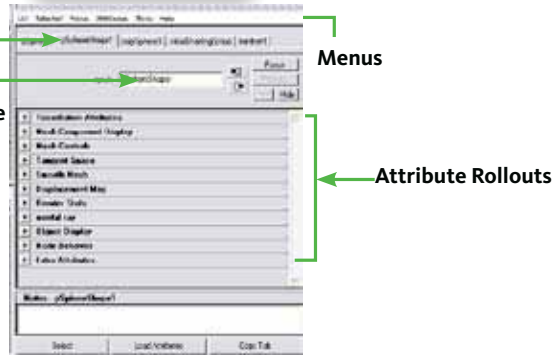
Render Frame Window



Outliner



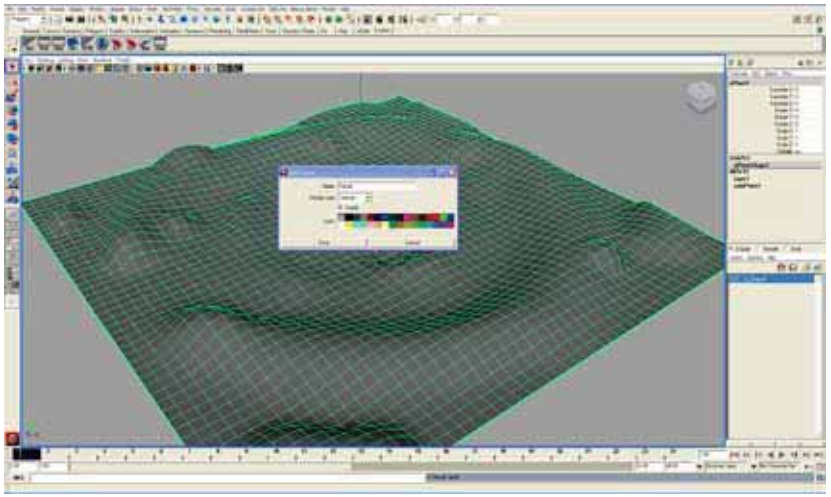
Attribute Editor

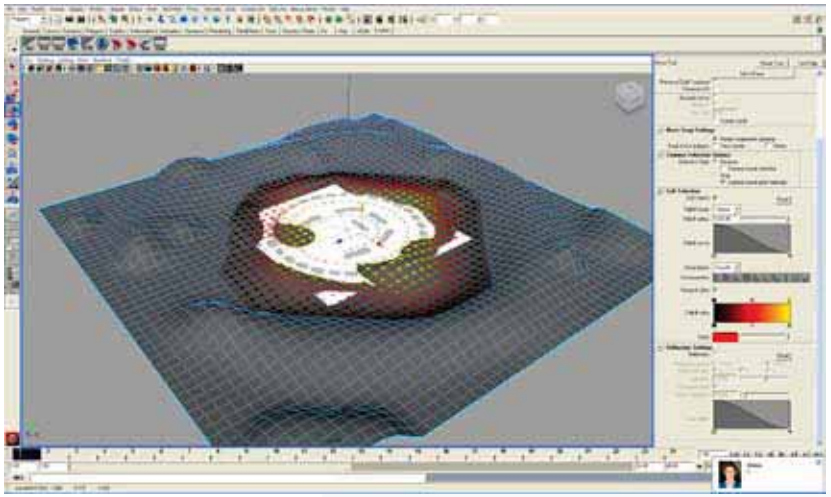


Workbook

Getting Started Tutorials

Autodesk® Maya®





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Maya Setting Up a Project

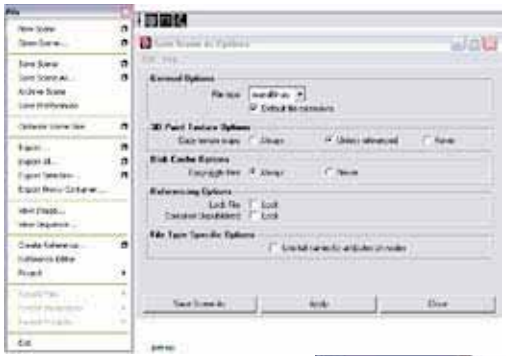
1

File Management is crucial to the success of any 3D project. By setting a project folder, you are always making sure that files get saved to specific and relevant directories. For example when you set up a project all scene files you save are saved to the Scenes Folder, any materials you save are saved to the Materials Folder etc. First got to File›Project›New.

2

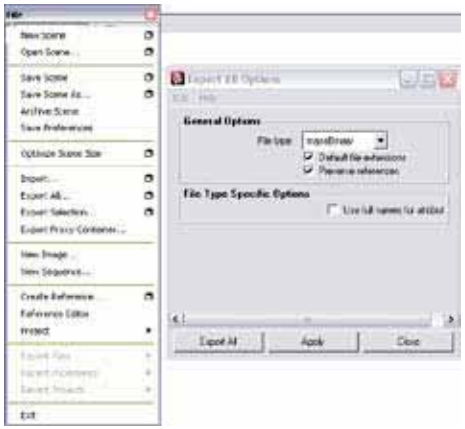
When you Click on New under Project, The Set Project Dialog will appear. This simply allows you to name the relevant folders you will require for your project. You will just click Use Defaults then click Accept. The Browse For Folder Dialog will appear. Here you will select the directory to which all project files will be saved.

3



The Open file dialog, navigates you directly to the Scenes Folder, in the project Folder you set up earlier. Notice that all your files are laid out in an organized manner. Any files you save, Export, Render are all saved to their relevant Folders making it really easy for you to manage your project and ensure that data doesn't get lost.

4



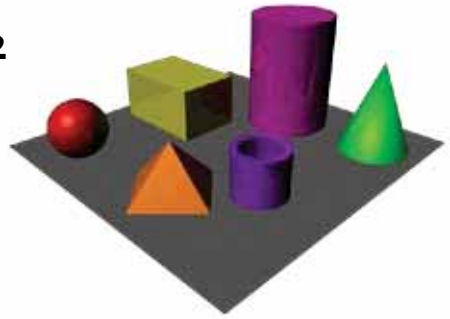
If you go to File›Import, you will notice that an Import Folder was created in your project directory. It is best to save any data from another application that you wish to import in this folder. Maya will always navigate to the import Folder when you click Import. Notice what happens if you go to File›Export you will notice that you will be taken to the project folder again. All major folders that are required are set up for you in an easy to manage way.

Maya Primitives & Editable Polygons

1

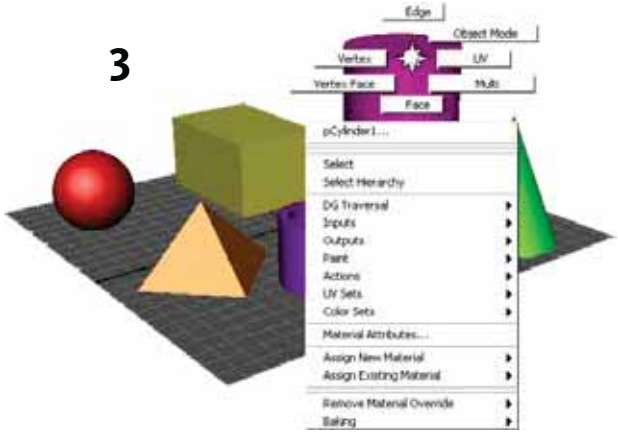
In Maya you generally create new primitive objects using the Shelf, or the Create menu. Primitive objects are used to block out your model. You then go into the different sub-object modes to model the primitive into shape.

2



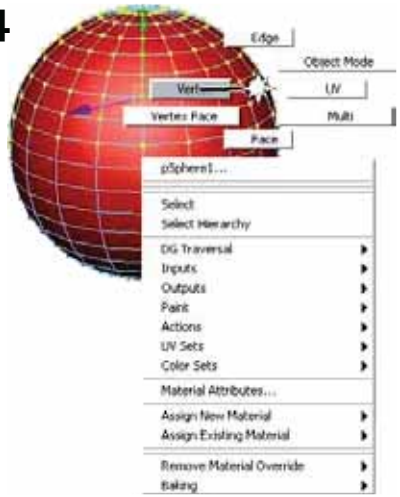
Primitive objects consist of Boxes, Spheres, Cones, Planes, Pyramids and Cylinders. They are easy to create, generally with a 2 click mouse operation.

3



Once you have created a primitive object as your starting block you can immediately work with it as an Editable Poly by right-clicking over the object and bringing up the marking menu. You can start using some of the Sub-Object modeling tools to develop and refine your model.

4



An Editable Poly has 7 Sub-Object levels, Vertex, Face, Multi, UV, Object Mode. Each of these levels allows you access to different elements of the Polygon.

5

Deformers can also be applied to objects in the Animation Menu›Create Deformers›Nonlinear Deformers. When a deformer is added you have the ability to Bend, Squash and Twist the shape.

Maya Creating Materials & Textures

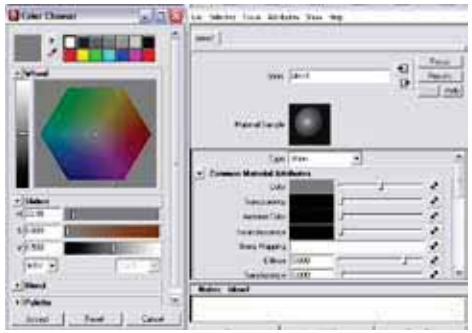
TUTORIALS

1

The Hypershade is an easy to use dialog. This is where all your scene materials and textures will be created. The Hypershade allows you to manage individual scene materials in their own individual material slots. You can create Procedural Materials. These are materials created parametrically within Maya. You have different types of shaders available that act as a starting point for creating a particular look for a material. Examples of shader types are Blinn and Anisotropic. You can also create Bitmap Materials. These use either parametric image maps or external image files.

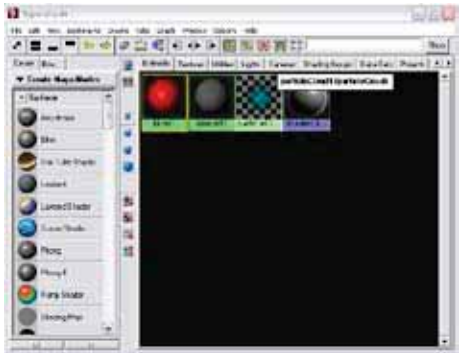
2

First you will create a simple Procedural Material. To do this click on Blinn to create a new Shader. Double click the new shader and in the attribute editor you will Change the color to Red.



In the Attribute Editor, double click the Diffuse color swatch to bring up the Color Chooser Select a light red using the Sliders.

3

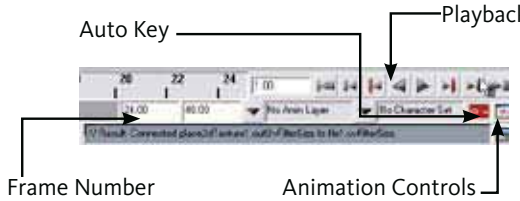


In the scene, create a Sphere and with it selected go into the Hypershade, Right Click over the Material Slot and from the Marking Menu, select Assign InitialShadingGroup To Selection

4

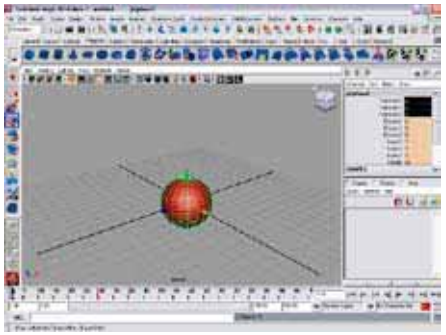
Now you will create a material with a texture on it. Create a new Blinn Material, double click it, and in the Attribute Editor Click the Map Button next to the Diffuse Slot. Select Checker from the Create render Node Dialog. Apply the shader to the object and press 6 on the Keyboard to view the texture in the viewport.

Maya Animation



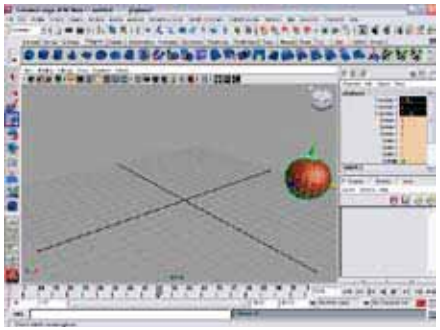
The Animation and Playback controls allow you to play your animation in real-time in the Maya viewports. Auto Key, allows you to set an initial key, scrub through the timeline, move your object, and the object will be automatically keyed.

1



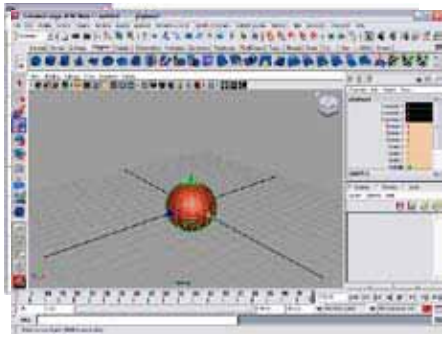
In this tutorial, you will create a simple animation of a sphere moving across the viewport. To start, go to the Polygon Shelf and click on the Sphere. Left Click in the viewport and drag out a Sphere. Go to the Toolbar and select the Move Tool. Select the Sphere. You are now ready to start animating.

2



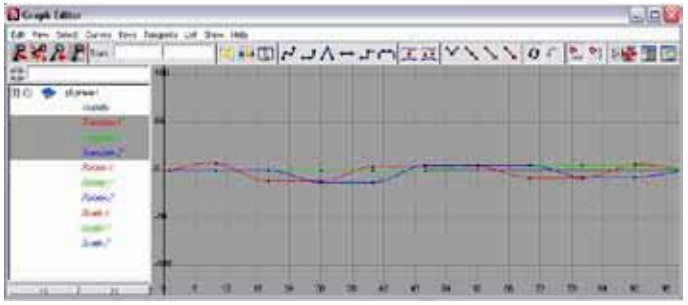
Go to the bottom right of the interface and hit the Auto Key button. Move the Sphere on Frame 1, then press S to set a key, this creates a key at frame 1. Now go to Frame 10 and then move the Sphere to a new position. Notice that a new key frame is created. Move the Time Slider to Frame 20 and move the Sphere, another new key frame is created.

3



As you move the Time Slider across the Time Line and move the Sphere you will see new keys are created. Set new Keys at Frames 30, 40, 50 etc until you reach 100. When you are done be sure to turn off Auto Key.

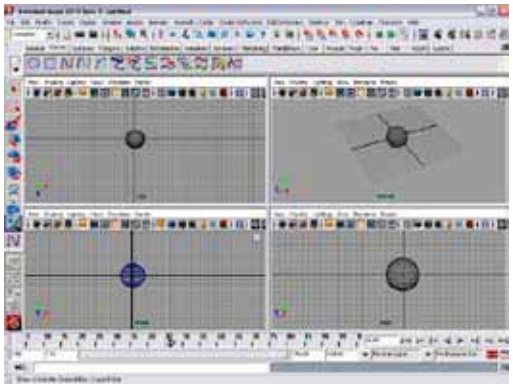
4



Once you have animated your Sphere, Go to Window›Animation Editors›Graph Editor - Curve Editor. With your object selected you will see the animation curves that were created. You can refine your animation using these curves.

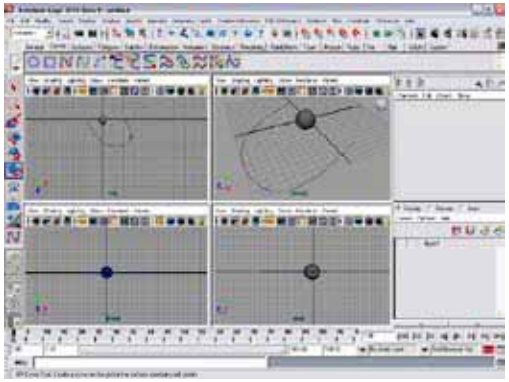
Maya Animating a Camera Along a Path

1



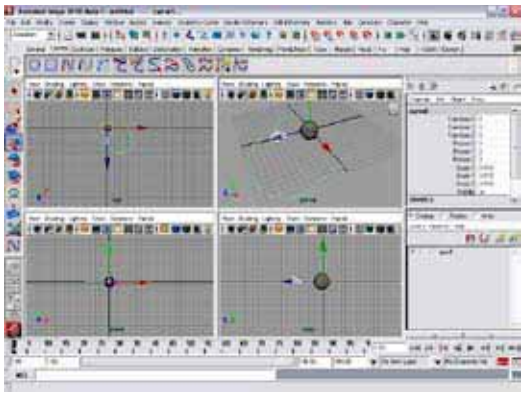
In this tutorial, you will animate a camera along a path. This is a great way of creating camera walkthroughs. You can attach either a Free Camera or a Target Camera to a path. First go to Polygon Shelf>Sphere. Drag out a Sphere in the perspective viewport. The next step will be to create a Path and a Camera in the scene.

2



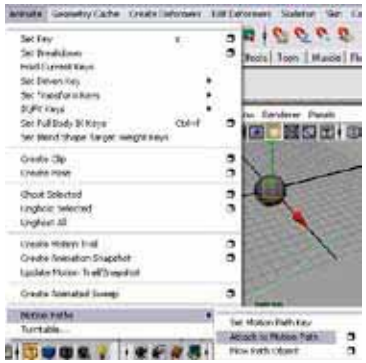
Go to Curves Shelf>EP Curve Tool, and create a curve in the top view around the Sphere. In the next step you will create a camera

3



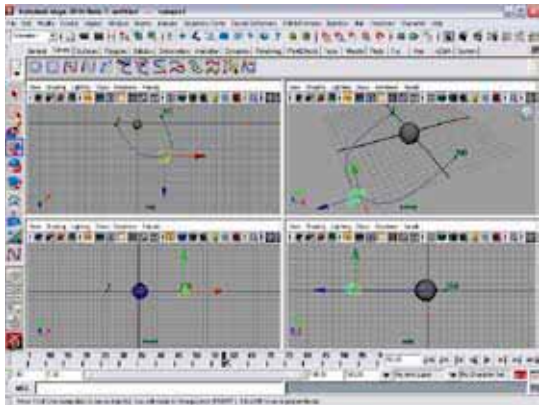
To create the Camera, go to Create Menu>Cameras>Camera. Place your Camera over the path. In the next step, you will attach the camera to the path. You will do this using a Motion Path Controller.

4



To create the Motion Path Controller, first select the Camera, then select the Path. Go to Animate>Motion Paths>Attach to Motion Path. This will attach the camera to the path.

5

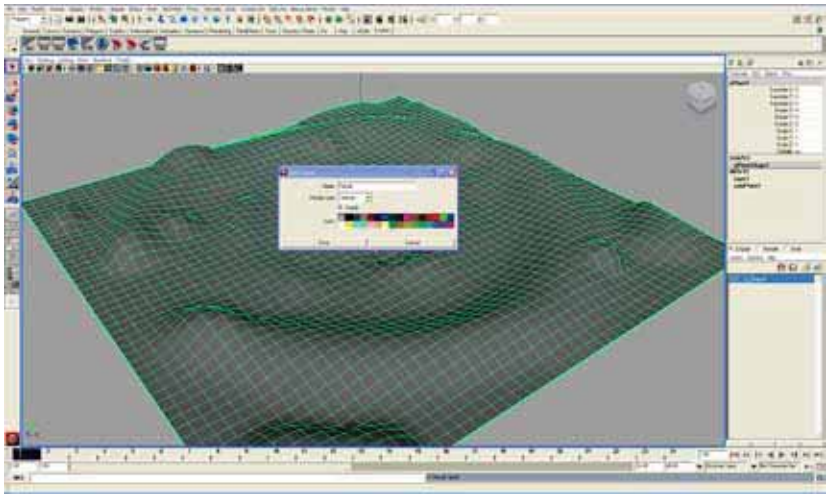


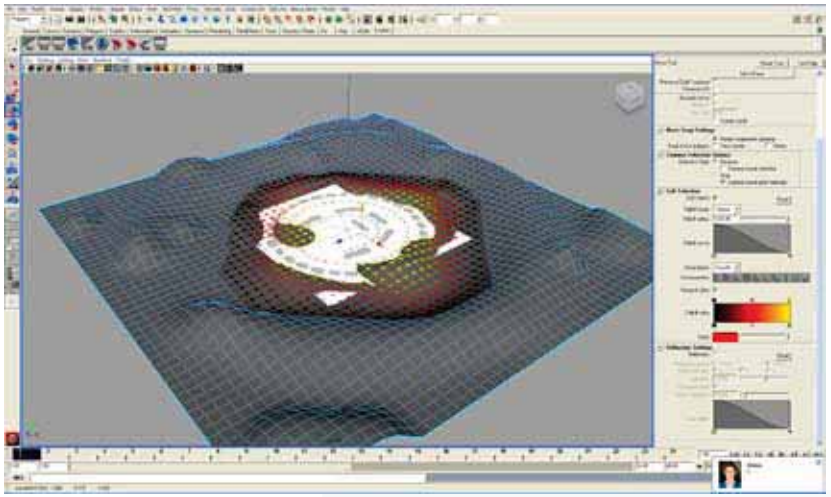
You will notice the camera jumps to the beginning of the path. Also key frames are created at the beginning and end frames. If you scrub through the time line you will see the camera sweep along the path

Workbook

Learning

Autodesk® Maya®





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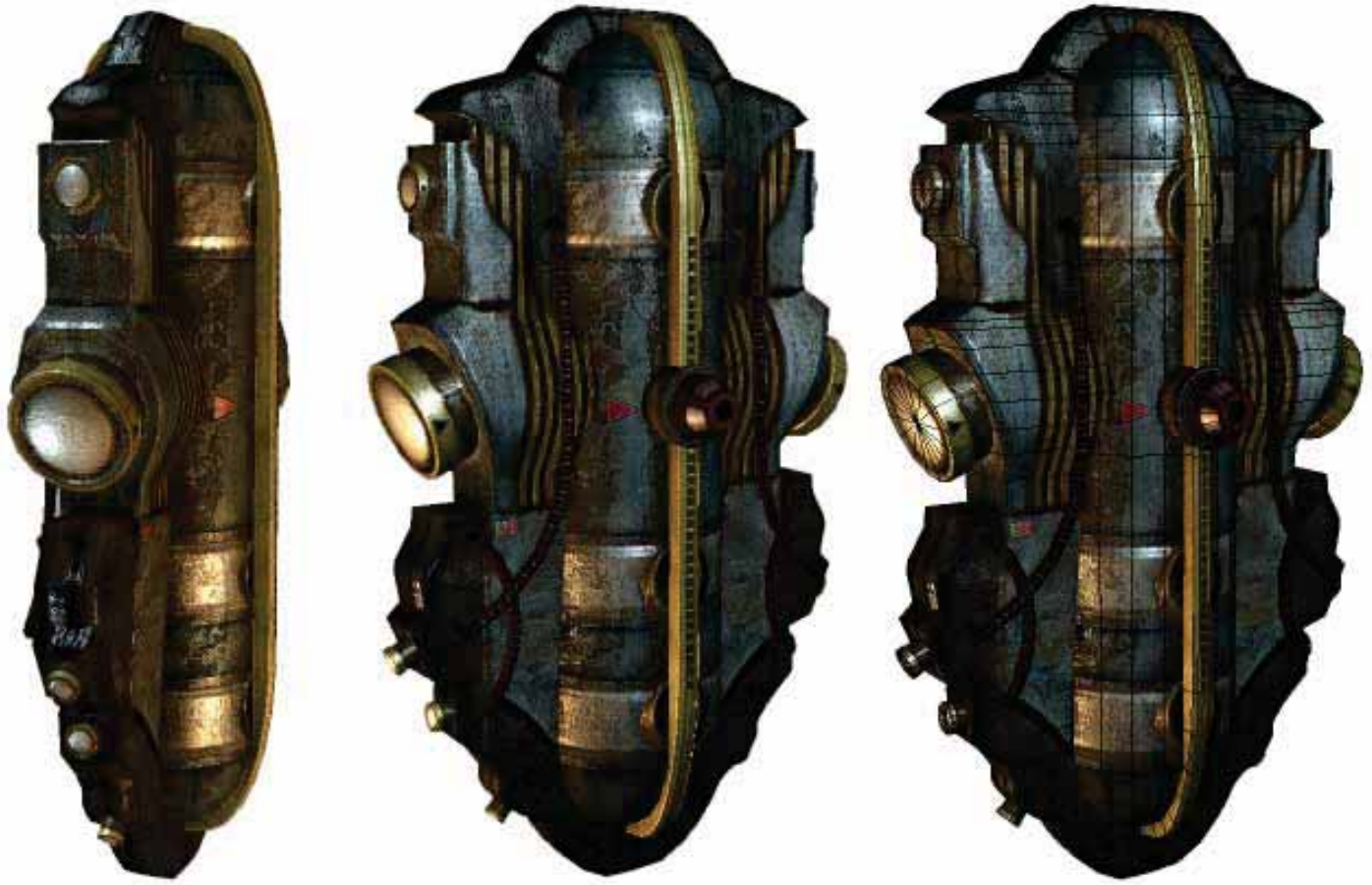
Getting Started with Maya

This is a "Getting Started" introduction for Maya basics, you will want to become familiar with all of tools in this section and if you need more information refer to the help Menu in Maya.



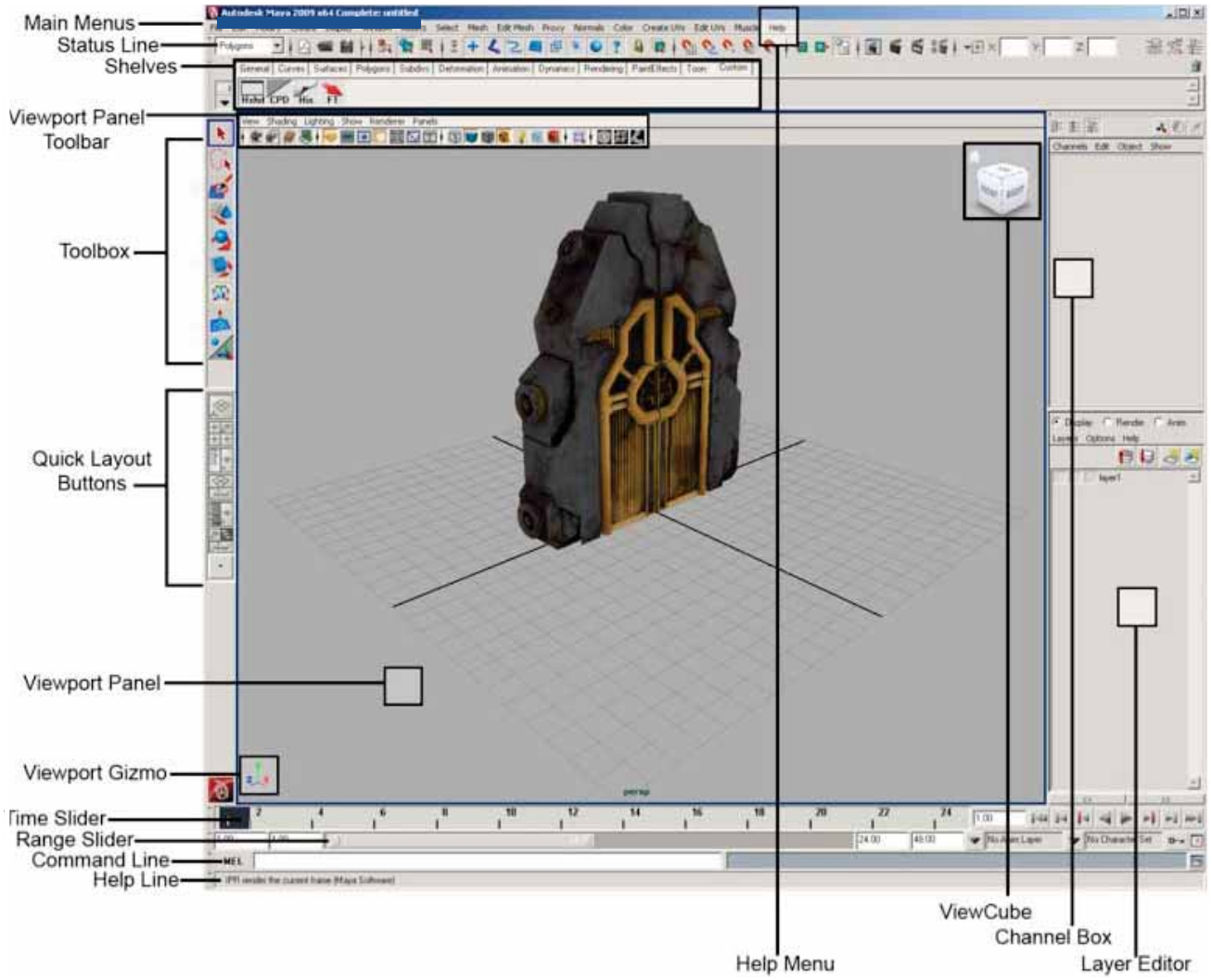
Maya Getting Started

Main Menus
The Maya user Interface

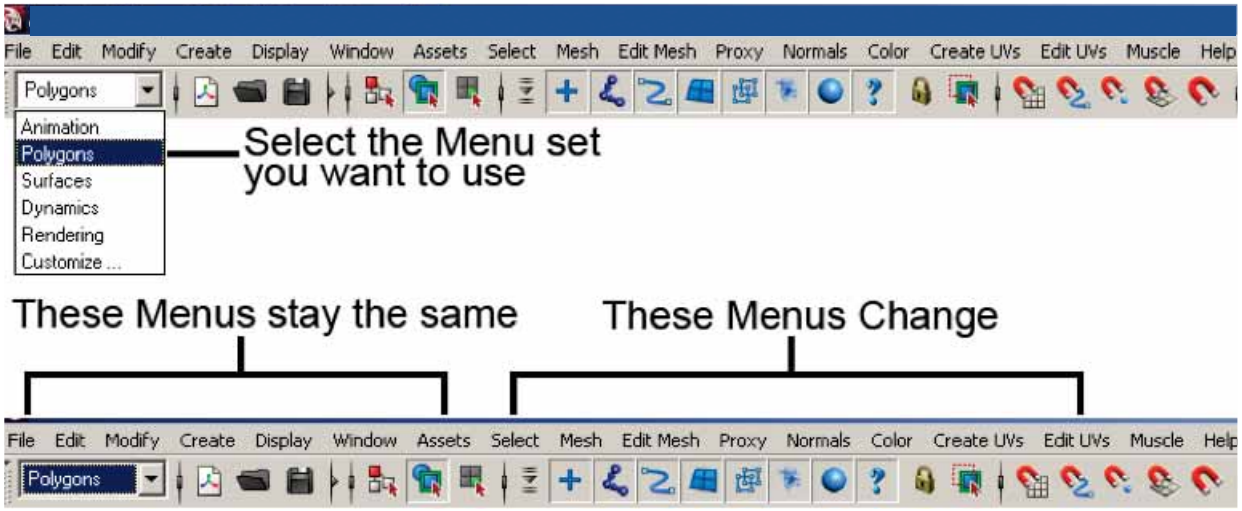
We are going to cover the most commonly used menus, commands and hotkeys. The Maya User Interface is shown here in its default configuration, and can be customized to fit your workflow. There are many menus in this interface, some for modeling and some for animation. They are grouped into different shelves, so that you can open them individually. Maya is a very big program and you will not need to memorize everything in this layout. Just explore as much as possible and try to get a sense of the overall interface and as you learn more you will begin to see how the tools all work together.

The **Main Menus** are located at the very top of the Maya Interface. It is the top bar that starts with **File** and ends with **Help**. The main Toolbar also has other menus that are always visible, such as **Edit**, **Modify, Create, Display, Window and Assets**. These Menus will always stay visible.

The **Status Line Toolbar** is the top toolbar. This Toolbar has several category settings that you can choose from, such as Animation or Polygons for instance. When you switch between the categories, the top right section of the tool bar will change with new categories specific tools.



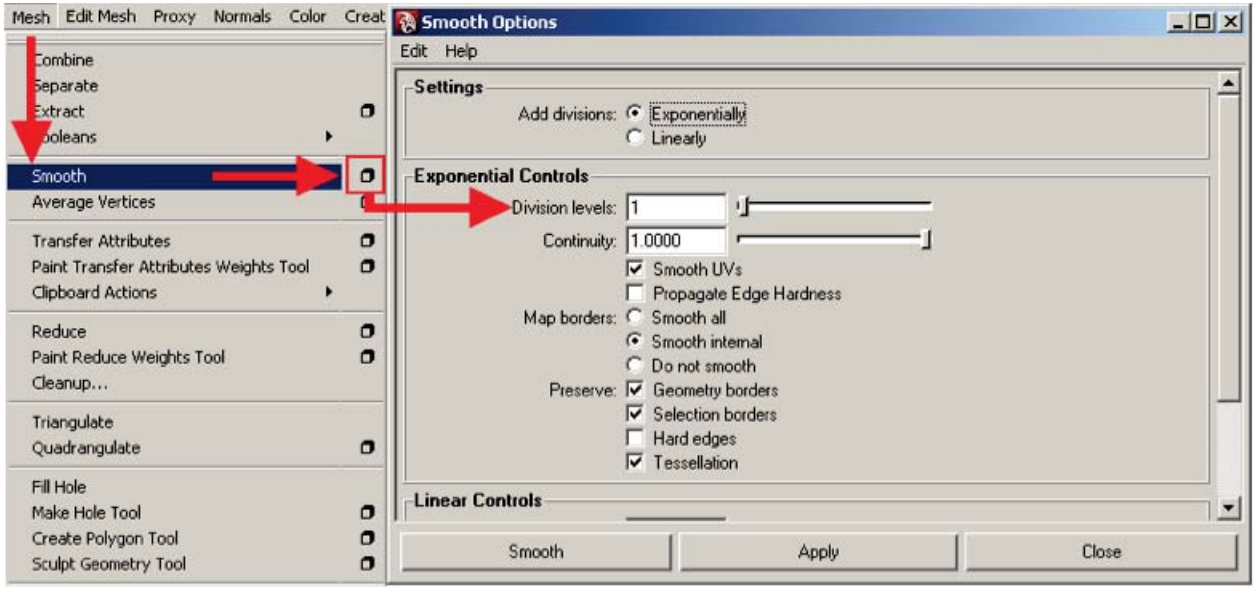
It also contains another set of icons below that are status line icon commands.



All of the commands can be accessed in the drop down menus by default, pictured here is the **Mesh** menu.

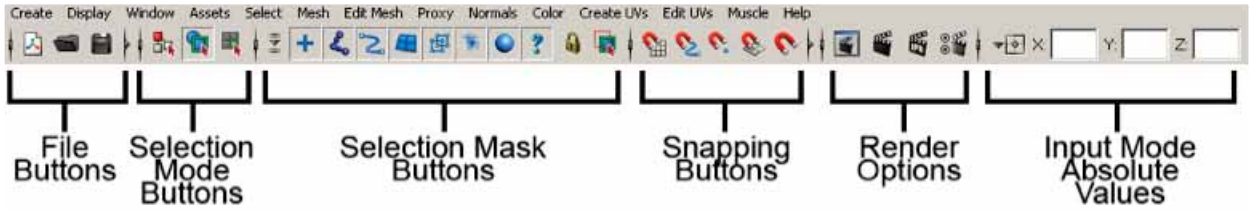
This is the main area for the commands you will probably use most often. On the end of each command menu there is a black square Options Box, this contains additional Options which can be setup before the command is executed.

Inside the **Smooth Options** box there are sliders and check boxes that can be adjusted.



Maya Getting Started

Status Line Icon Commands are a set of icons that help with selecting groups and common settings.



- **File Buttons** are used to create and save scenes.
- **Selection Mode Buttons** let you select between object hierarchy.
- **Selection Mask Buttons** let you make specific object component types selectable or un-selectable.
- **Snapping Buttons,** toggles snapping objects to grid, points, and curves.
- **Render Options Buttons**, are used to open the render window, settings, and to perform an IPR render.
- **Input Mode**, allows you to input absolute values for the selected transform of an object.

You can also use the option box to rename multiple selected objects.

The **Shelves** toolbar holds creation items and tools, each categorized in tabs.

The Polygons tab is selected in the image below. There are icons to create a polygon spheres and cubes, also on this toolbar there are other commonly used objects and features.

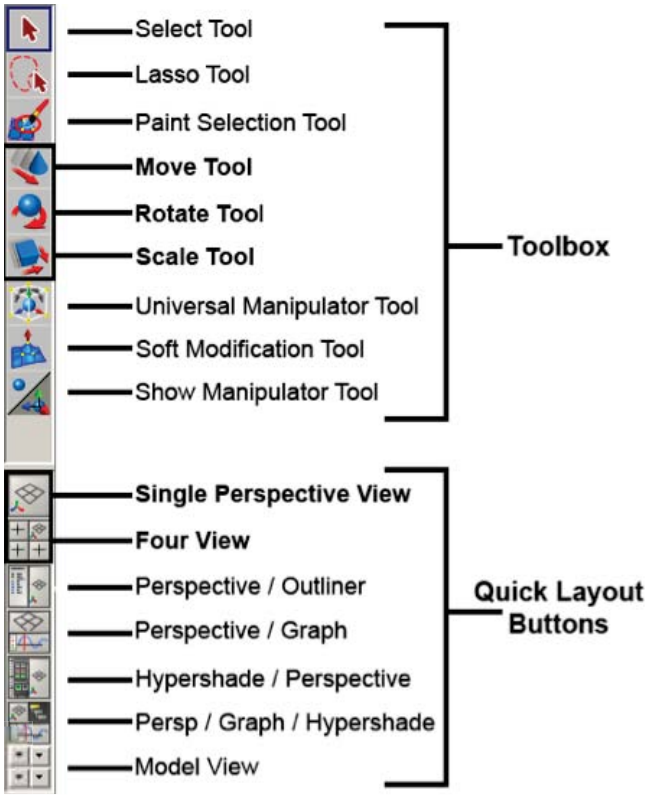
You can add icons to the **Custom Shelf** tab, by pressing **Alt + Left Mouse Button**, while selecting a command.

The **Toolbox** is located on the left side of the user interface and contains useful object transform tools.

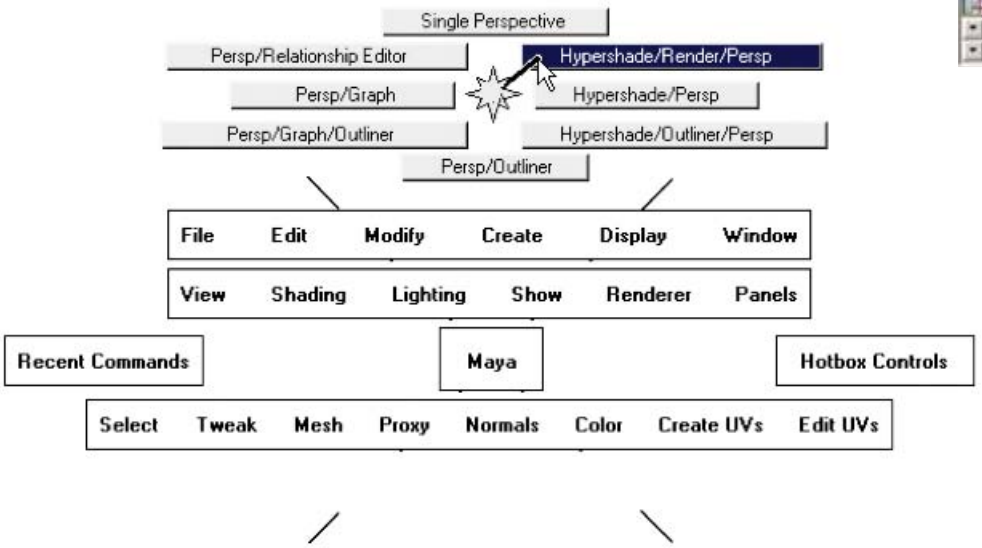
The select tool is used when you want to select an object, or to get out of a transform mode. Below that are the **Move, Rotate** and **Scale** Icons. These are used to manipulate any object or component, such as polygons or edges.

Maya Getting Started

The **Quick Layout Buttons** are used to change the viewport configuration. Sometimes you want to have a view of the Hypershade and just a perspective window. This depends on your own preferences or workflow and there is an icon to change this view quickly. You can also change back and forth from **Four View** and **Single View** by using the icons, or using the **Spacebar** hotkey.



The **Hotbox Shortcut Menu** can be accessed by holding **Spacebar** in any Panel viewport window. Once the menu is visible, you just **Left Mouse Click** to the desired command, another menu will also pop up with a square options. This menu is commonly used for advanced menu navigation, but even new users can access this powerful tool.

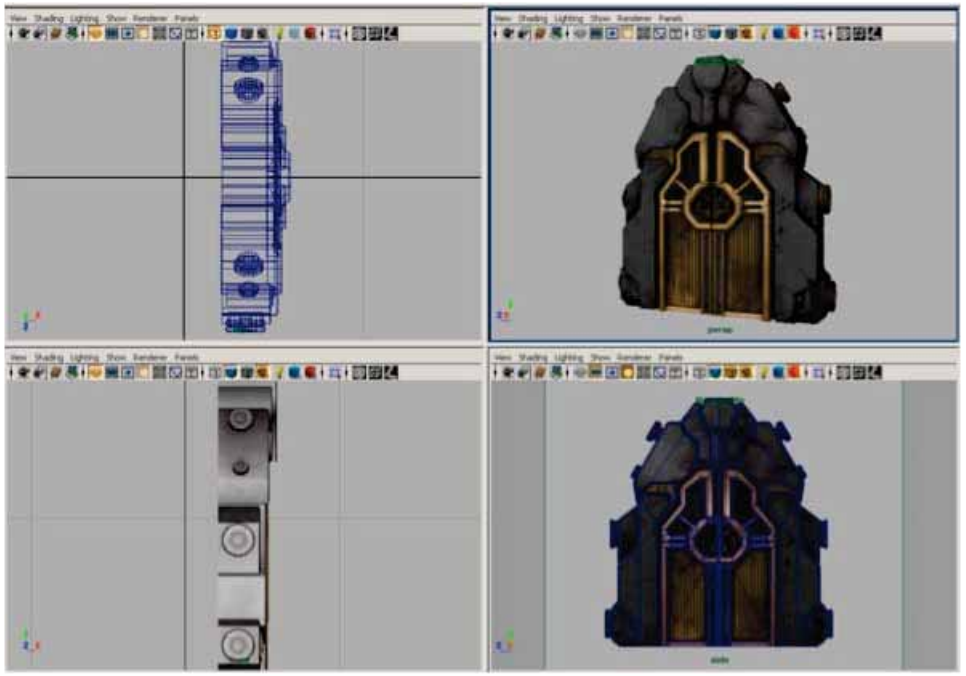


Maya Getting Started

Viewport Panel

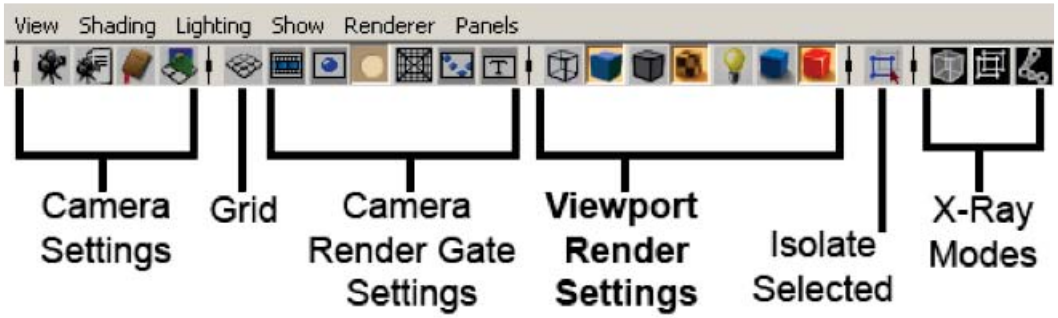
The **Viewport Panel** is the main navigation window where you will be working. This is like the desktop on your monitor. Everything you design will be represented in these areas.

The Orthographic panel viewports support up to four simultaneous views, by default it is set to Top, Perspective, Front and Side.



The **Viewport Panel Toolbar** is located inside each viewport panel. This is commonly used to change the current viewport render settings. It has icons to toggle between different lighting and camera options. There is a drop down menu right above this panel with additional functions, think of these as options boxes. They contain various options to customize everything that is visible in each viewport.

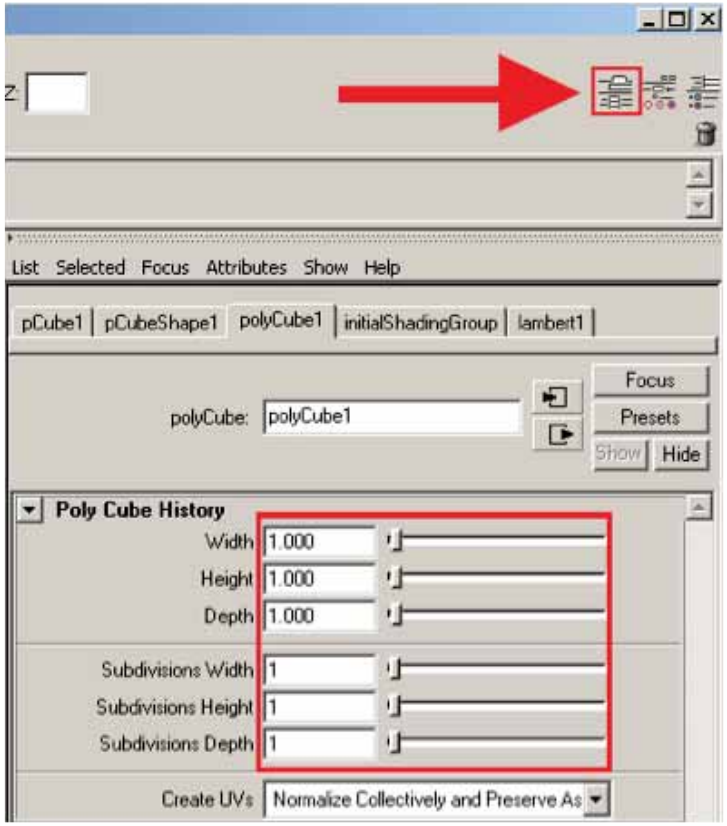
Every viewport can have custom settings.



Panel Viewport Camera Navigation

You can move the camera around an object when it is selected. To do this just select an object and hold **Alt key + mouse button** you can maneuver the camera, around, sideways, and zoom. These same key commands are also used for navigation inside the Hypershade and UV Texture Editor. However the rotate function is disabled because you will be dealing with 2D space.

- Holding Alt + Left mouse button and dragging will rotate around the object in the viewport.
- Holding Alt + Middle mouse button and dragging will move the camera with the model in the viewport.
- Holding Alt + Right mouse button and dragging will zoom the camera in and out from the model in the viewport.



The Attribute Editor is on the top right section and gives you full graphical controls for adjusting objects. It is located above the Channel Box Menu. This is a great way to set the exact parameters of your primitive objects, such as a cube. When you want to set values for things this is also done here.
All you have to do is move the slider to the right or left, or input a numerical value to the box.

Maya Getting Started

The **View Cube** is located in the top corner of the selected viewport. Clicking on a particular face, corner or edge of the cube automatically adjusts the camera's view so it matches that face. The viewing camera animates in real-time during the transition between views so you can see how the orientation of the camera changes in relation to the 3D scene. There are 26 standard views available. You can turn off the View Cube and edit options for the View Cube by selecting **Window > Settings/Preferences > Preferences**, and selecting the View Cube category.

3D Space is the ability to see and manipulate an object in all three coordinate spaces. In computer based 3D we use the Coordinate System to model our objects.

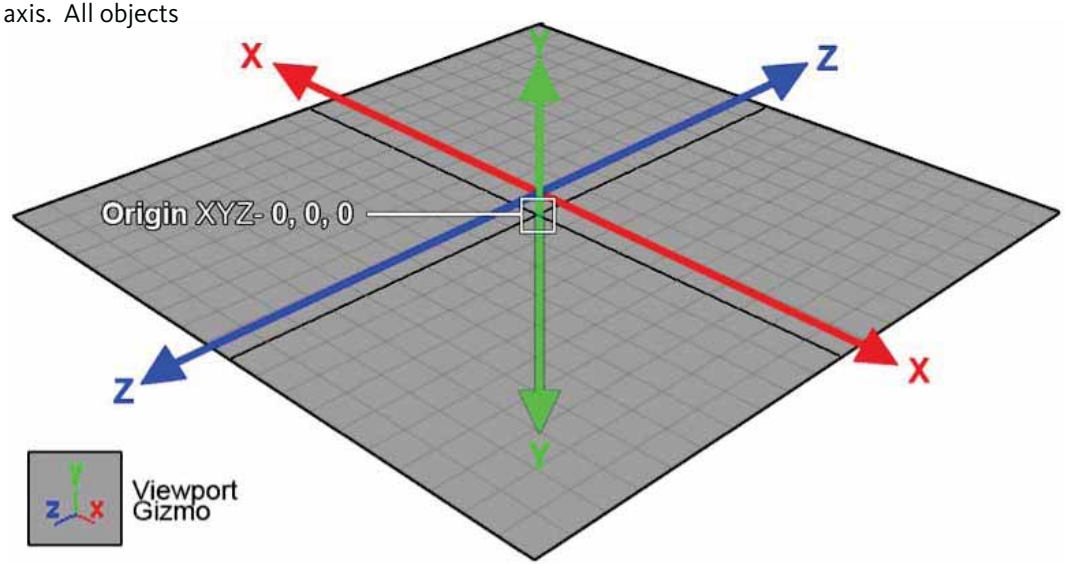
XYZ Coordinate System

In Maya, 3D space is measured using the **XYZ Coordinate System**, it is defined by three axis; the X-axis, the Y-axis and the Z-axis. If you imagine looking into a movie screen, the width would be the X-axis, the height would be the Y-axis and the depth would be the Z-axis. In Maya, these axis are presented with X and Z on the ground, represented as the grid, and Y as the height.

You can find any point in a 3D world by defining a coordinate for each of the axes. To help you visualize the three axes, each is given a corresponding RGB color. **X is Red, Y is Green, Z is Blue**.

Maya Getting Started

The Viewport Gizmo is located in the lower left corner of the viewport. It will tell you which direction is up, depending on the camera. The **Origin** is the center point of the world; it is located at **o, o, o,** of the XYZ axis. All objects and transforms are measured from this location.

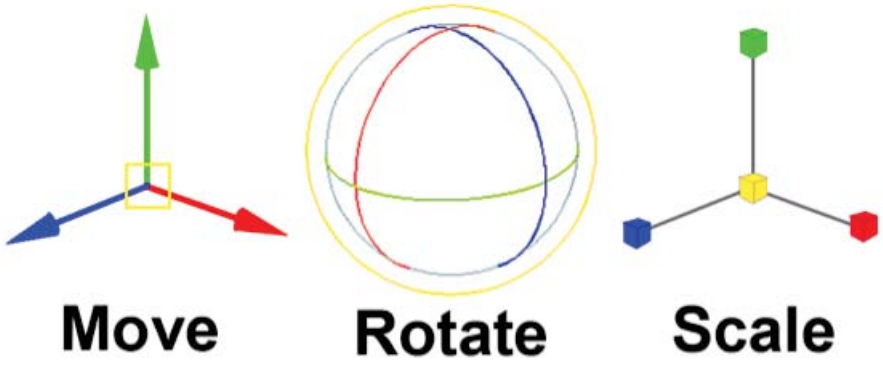


Viewport Manipulator Gizmos are visual handles that allow for transformation of an object, by either move, rotate or scale. The yellow square allows for movement on all axis at once.

Move an object by pressing hotkey W to bring up the gizmo handles. Using the Left mouse button and dragging on the colored arrows will move it on the desired axis.

Rotate an object by pressing hotkey R to bring up the orbital gizmo handles. Using the Left mouse button and dragging on the colored arrows will rotate it on the desired axis.

Scale an object by pressing hotkey E to bring up the gizmo handles. Using the Left mouse button and dragging on the colored arrows will scale it on the desired axis.

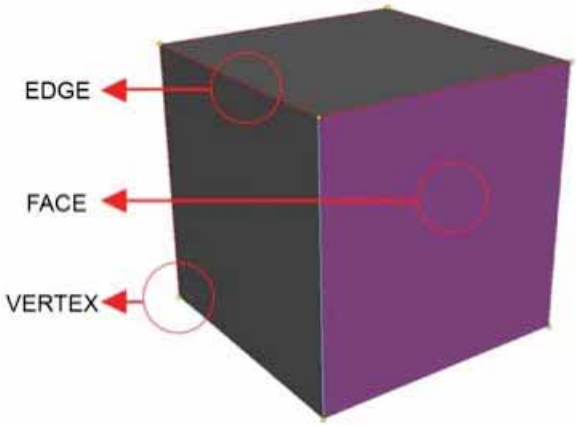


Undo Command is Ctrl + Z. This will allow you to go back previous steps.

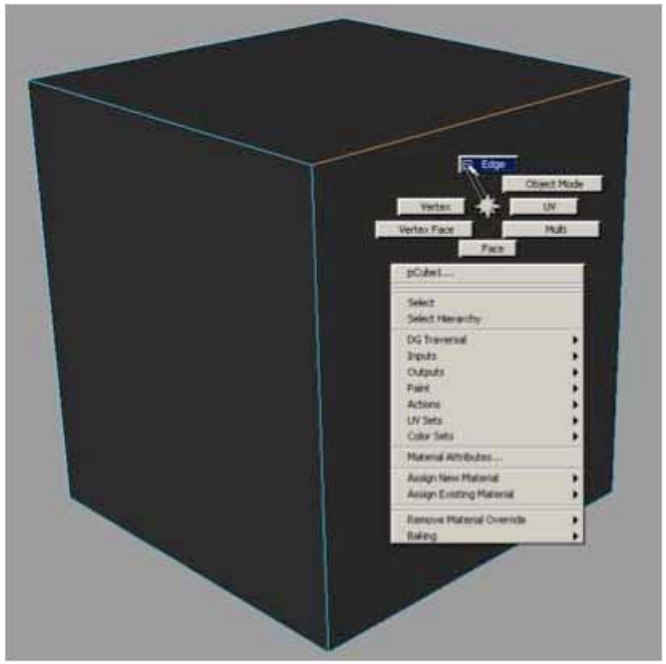
Polygon Components

Polygon Components are Edges, Faces, Vertex, and Polygons. They can be accessed by **Holding Right Mouse Button** while you have an object selected. This will bring up a options box that will allow you to select from the various object components, such as Edges, Faces, or Vertex.

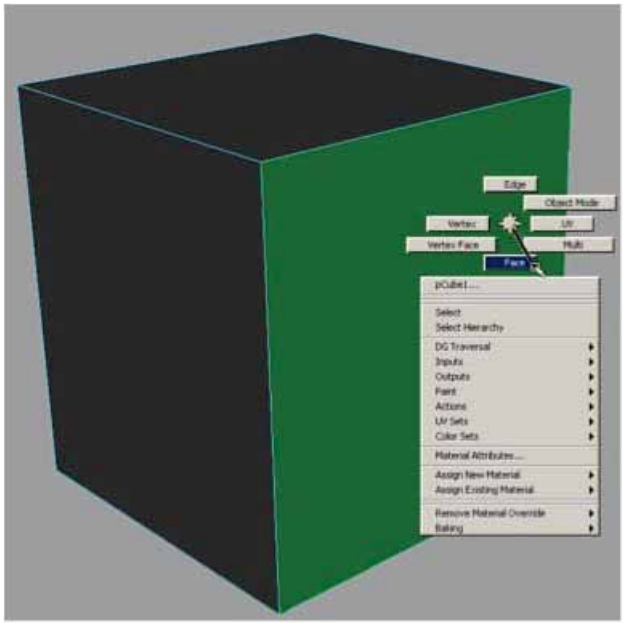
The **Multi Component** will allow you to select more than one component at the same time while using the **Shift Key** during selecting. Once you have your selection you can manipulate each of these components using your transform tools.



Polygon Components, Edge, Face and Vertex.

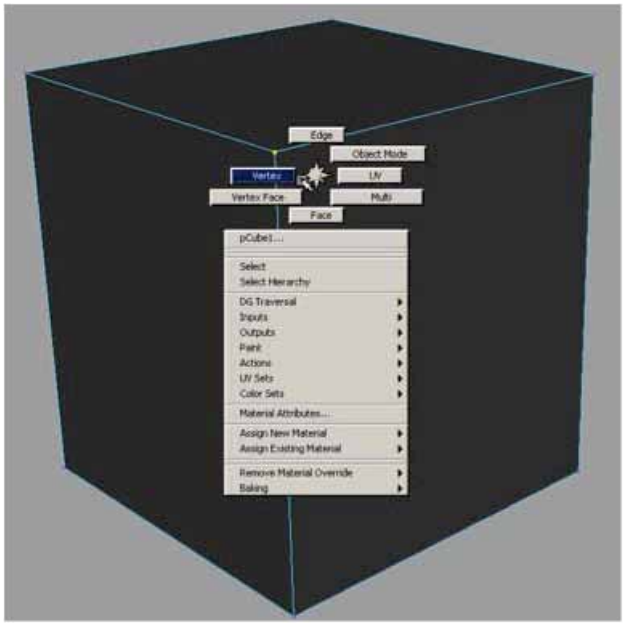


Edges Component Selection



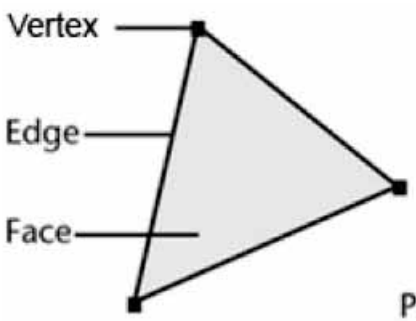
Faces Component Selection

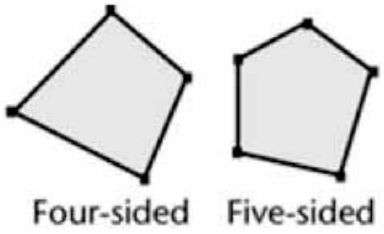
Maya Getting Started

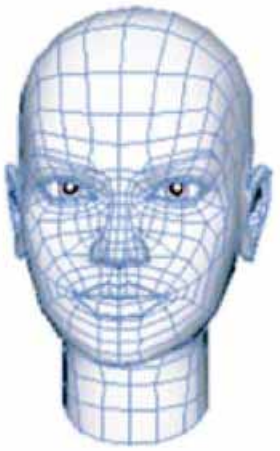


Vertex Component Selection

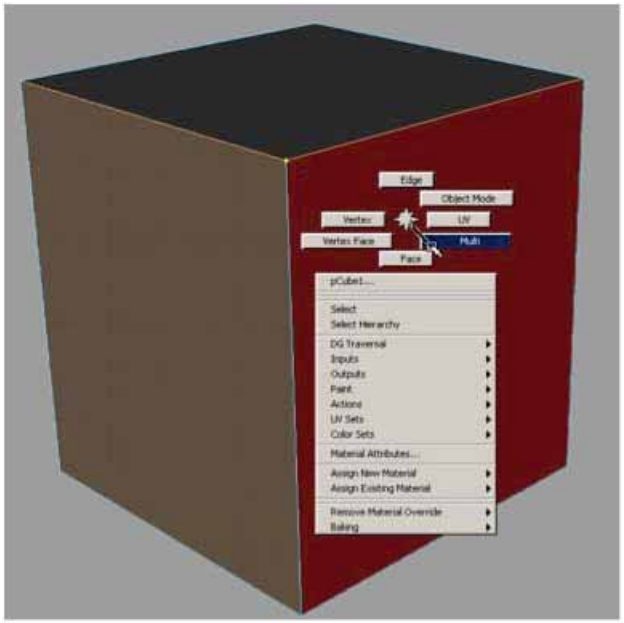
A polygon is any 3 or more-sided 2D object and when it's composed with more polygons, it can create a 3D object.







Polygonal models are composed of many separate polygons combined into a polygon mesh.



Multi Component Selction

Maya Hypershade

The **Hypershade Toolbar** is where you will create a material and shading network.

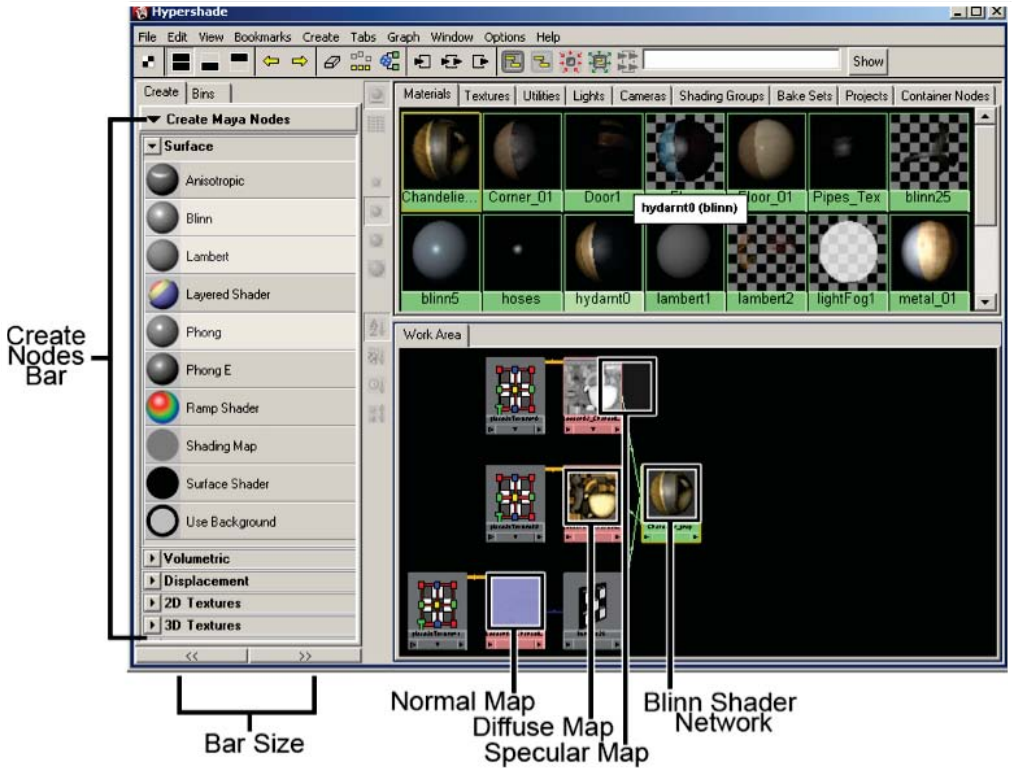
Window > Rendering Editors > Hypershade.

A material type is also referred to as a shading model or shading network. The shading model determines how the surface simulates a natural reaction to light. Some of the most common materials are Blinn, Phong and Lambert. They are located in the **Create Nodes Bar**. You can also create Maya, Mental Ray and other nodes here.

Maya Getting Started

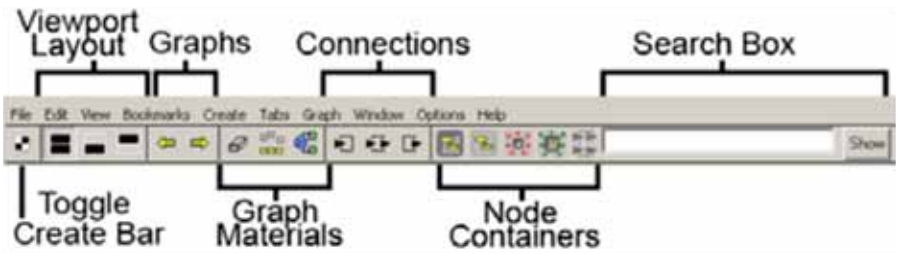
The Hypershade Viewport area contains the **Materials Tab**, pictured below. The **Work Area** is where all the shader connections can be made using a visual drag and drop method. This is done by using the middle mouse button to drag from a material to a surface property. Pictured is a **Blinn Shader Network**.

It has connections made for a Diffuse, Specular and Normal Map. The **Bar Size** buttons make the tab larger or smaller.



At the top is the **Hypershade Main Toolbar**. It contains some key commands for navigating the Hypershade.

- **Viewport Layout** will change the work area between a top and bottom configuration.
- **Graph Materials** buttons will show the shading network of a selected material when selected.
- The **Connections** buttons will show you all input and output connections to a node.



Think of **Node Containers** as folders for Materials, Lights or Shading Groups. They help you keep organized. The **Search Box** is used to separate materials with a certain prefix or to find a specific texture.

UV Texture Editor

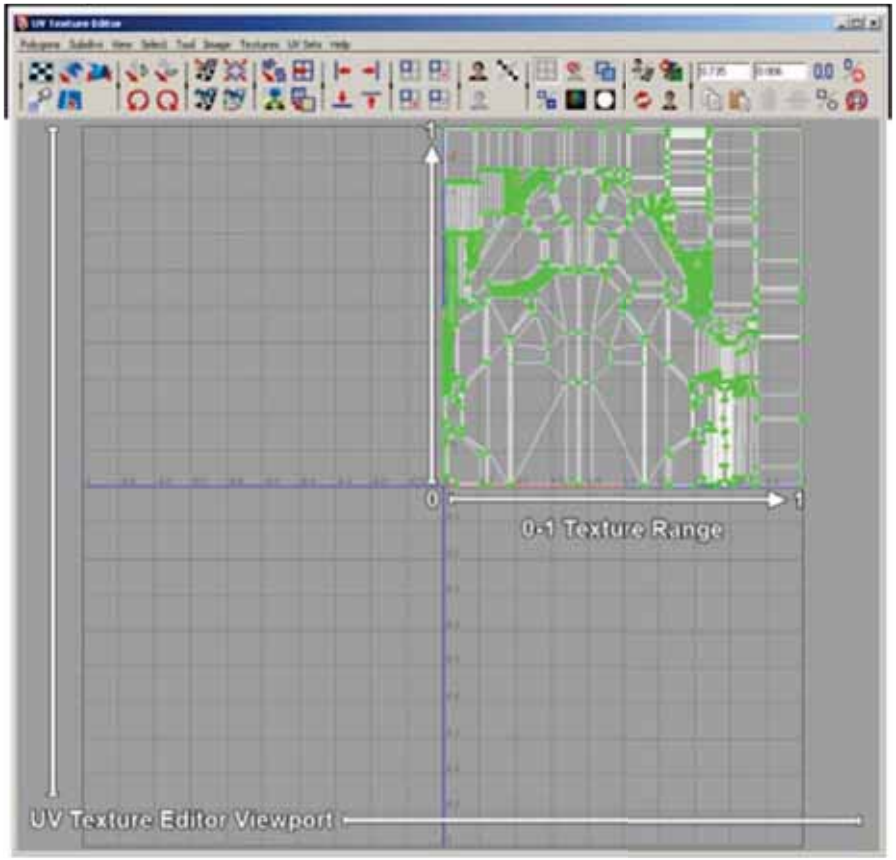
The **UV Texture Editor** is where we do our UV Texture mapping.

A **UV** is a point that matches up with a **Vertex** on the surface of a 3D model.

To open the UV Texture Editor, **Window > UV Texture Editor**. You have the **UV Texture Editor Toolbar** that contains all of the UV layout commands.

The UV **Texture Editor Viewport** is similar to the 3D viewport, expect it only works on X and Y axis. It is essentially a 2D representation of the 3D models surfaces. The top right quadrant is referred to as the **0-1 Texture Range**. All of the UV's should end up in there for most cases. However there are tiling methods that allow for placement outside of the 0-1 Texture Range.

UV's are marked as green points. UV's can be edited by **holding Right Mouse Button and selecting UV**.

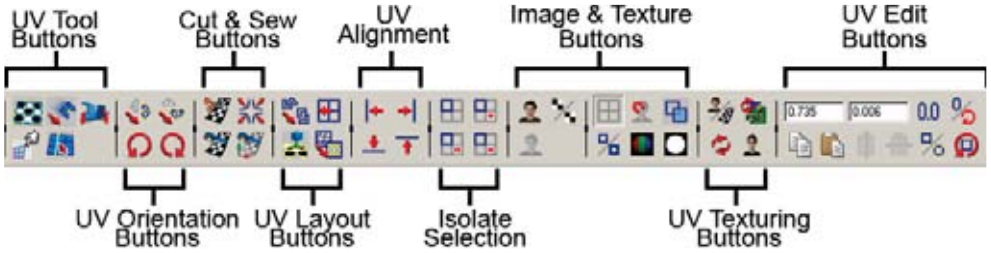


UV Texture Editor Toolbar

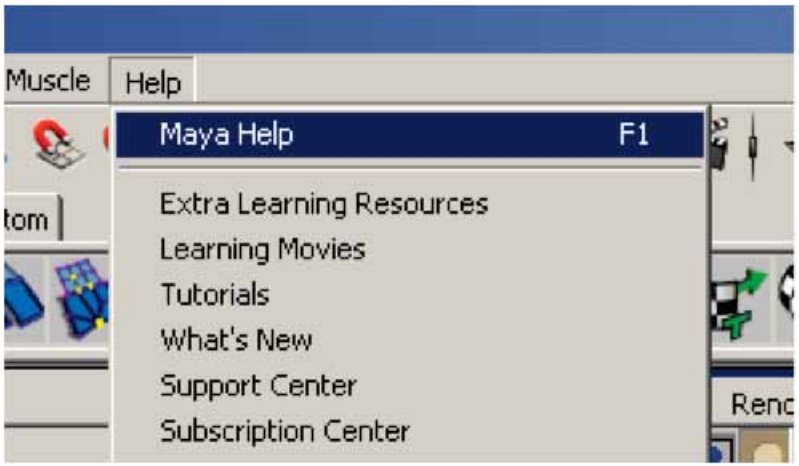
Maya Getting Started

The **UV Texture Editor Toolbar** is similar to the other menus in Maya. You can **Right Mouse Click** on the Icon to open the options box for that tool. There is also a drop down menu on the top with every command, and a black options box.

Below we have a row of icons that are shortcuts to the most used layout commands.



- The **UV Tool Buttons** will allow you to manipulate and layout UV's.
- The **UV Orientation Buttons** let you flip UV's and rotate by 45 degrees.
- The **Cut and Sew Buttons** allow you to cut and sew UV shells. A shell is a bunch of attached UV's.
- The **UV Layout Buttons** will layout UV's in a cleaner more optimized way.
- The **UV Alignment Buttons** will align the selected UV's to the minimum or maximum U or V value. It is a good tool to make UV's flush to the left, right, top or bottom edges.
- The **Isolate Selection Buttons** allow you to work on a subset or shell of UV's while hiding the rest.
- The **Image & Texture Buttons** allow you to control the display of images and textures in the UV Texture editor Viewport.
- The **UV Texturing Buttons** are used for texture baking and changing the viewport image ratio.
- The **UV Edit Buttons** are used to show the location of UV's and allows you to copy & paste UV's.



Maya Help can be accessed on the Main menu or by pressing hotkey F1 and is a very useful resource guide. Refer back to it if you want to learn more about the tools and commands we have covered.

Simple Mass Modeling

Overview

This exercise covers the creation and editing of simple primitives and how they can be moved, rotated, scaled, duplicated, and assembled to gain a greater understanding of architectural form and space. You will also look at various concepts of pattern, scale, and proportion and explore additive and subtractive forms. Universal design themes will also be covered, including the creation of centralized, linear, radial, clustered and grid forms; space; and planes and plutonic forms.

In this lesson you will learn the following:

- How to set up a scene with preferences
- How to create building blocks from simple primitives
- How to move, rotate and scale objects
- How to split and cut polygons
- How to extrude surfaces
- How to chamfered vertices and bevel edges
- How to assemble forms
- How to assemble space

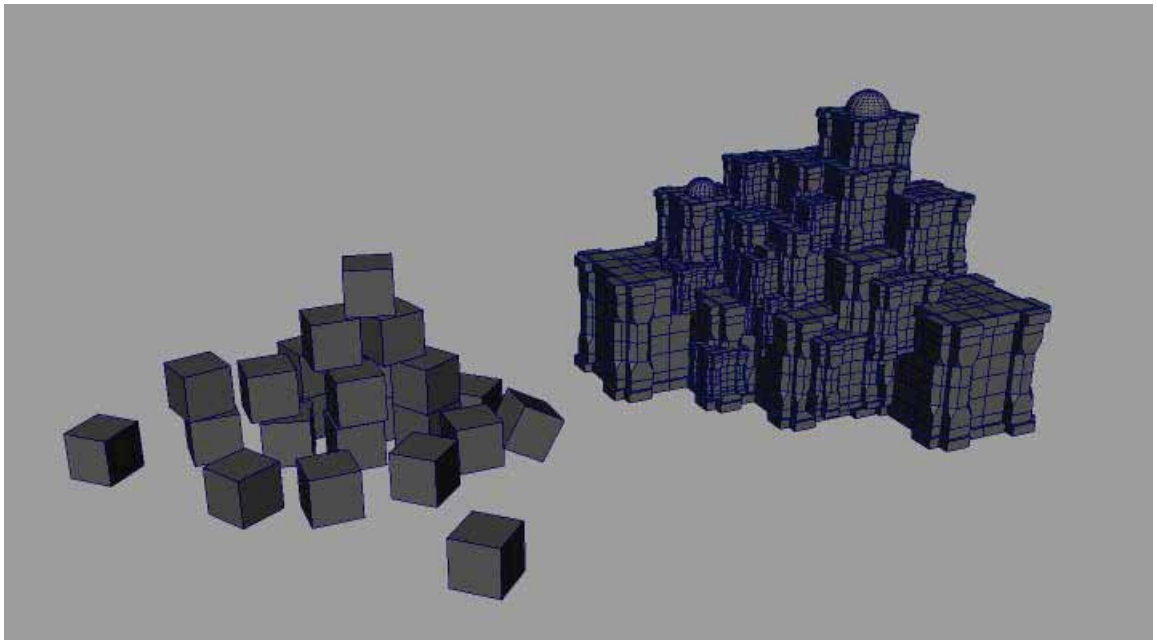
Getting Started

1. Set preferences

Before you create your polygon architecture, you will need to change some of the default settings to a more suitable environment for this type of work.

- Select **Window > Settings/Preferences > Preferences**.
  The Autodesk® Maya® software user preferences window appears.
- In the Preferences window choose **Categories > Polygons**
- In the Polygon Display settings, set the following:
  - **Border Edges: On**
  - **Edge Width: 4**

This displays border edges more prominently on polygon meshes and helps to identify the edge conditions of any open geometry.

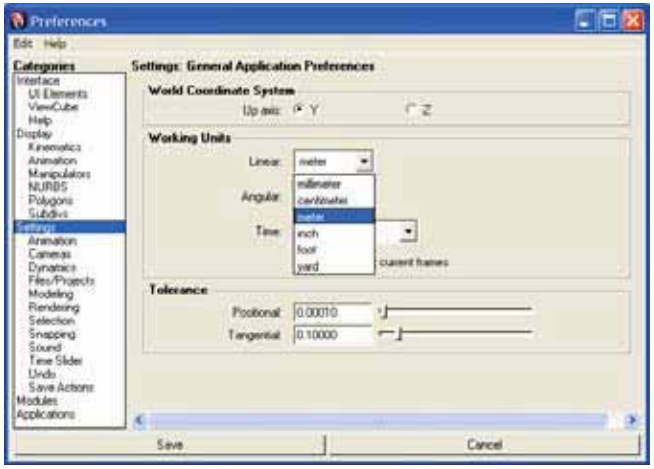


Toy Blocks Are the Basis of Form and Space

- In **Preferences** window, choose **Categories > Selection**
- In the **Polygon Selection** settings, set the following:
  - **Select faces with: Whole face**

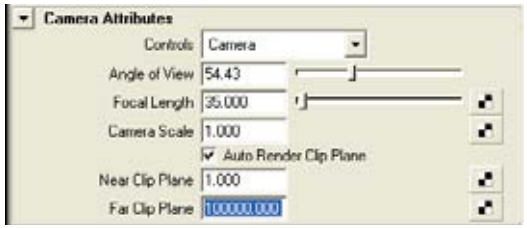
The Whole face setting lets you select polygon faces by clicking on any part of the face rather than on a center dot as with the center setting.

- In **Preferences** window, choose *Categories > Settings*
- In the **Working Units dialog box**, select the **Linear** drop down-menu **choose meter**



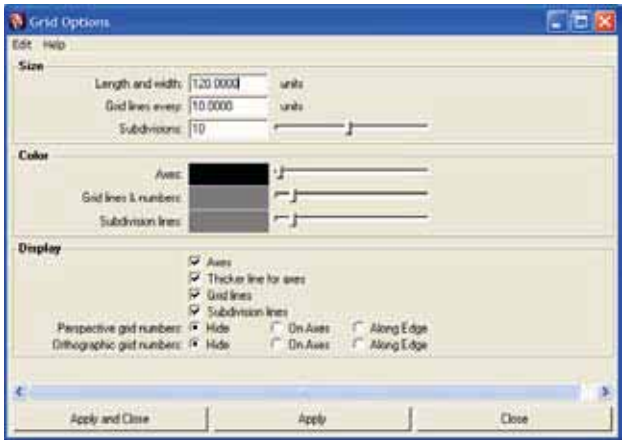
Preferences Dialog Box

- Click the **Save** button to close the settings window
- Open the Outliner and select each camera one at a time: top, side, front, and perspective then change the **Near Clip Plane** to **1** and the **Far Clip Plane** to **100000** for each of them. This will ensure the scene is visible at long and short distances



Camera Attributes

- Select **Create > Polygon Primitives** and turn off the **Interactive Creation** option for primitives
- Select **Display > Grid** and in the **Grid Options** dialog box change the grid size for **length and width** to **120** with the **Gridlines** and **Subdivisions** at **10**



Grid Options Dialog Box

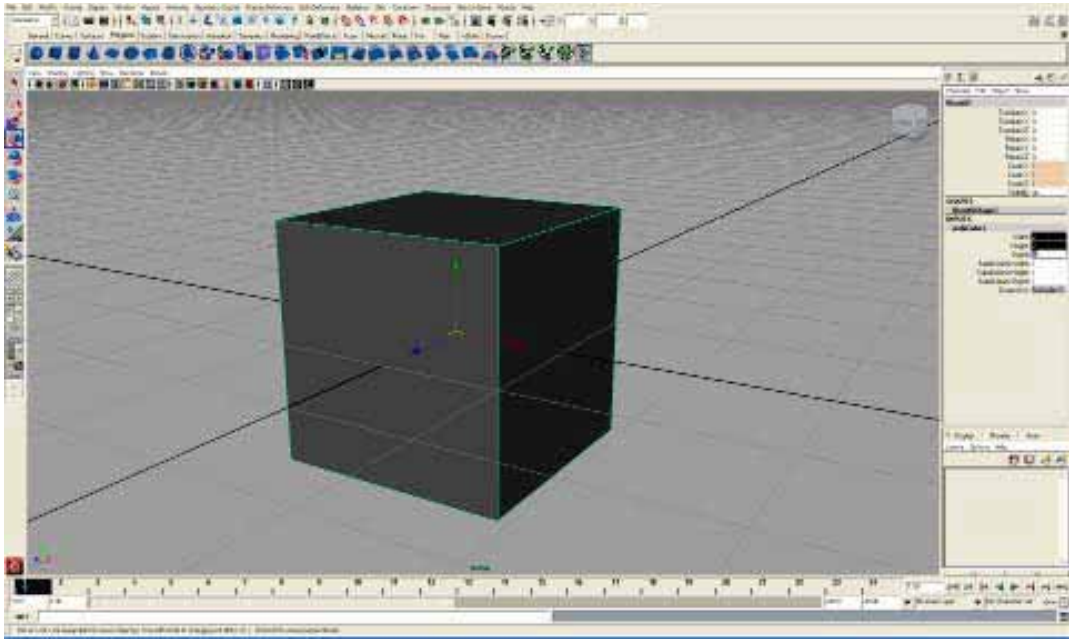
Creating the Building Blocks

Once your workspace is ready, create a new scene and name it.

1. Create a file

- Select **File > Save Scene As...**
- Name the file *Architecture01_Form_Space_Mine*

File Save Menu



2. Create cube primitive as the building block form

- Ensure you are working in the perspective view
- Select **Create > Polygon Primitives > Cube**
- In the **Channels** dialog box to the right, select the input node **polyCube1** and highlight all three fields by holding down the **Ctrl** key and change the width, height, and depth to 2
- In the **Channels** dialog box rename the mesh *Block01*

3. Adjust pivot for easy movement within the scene

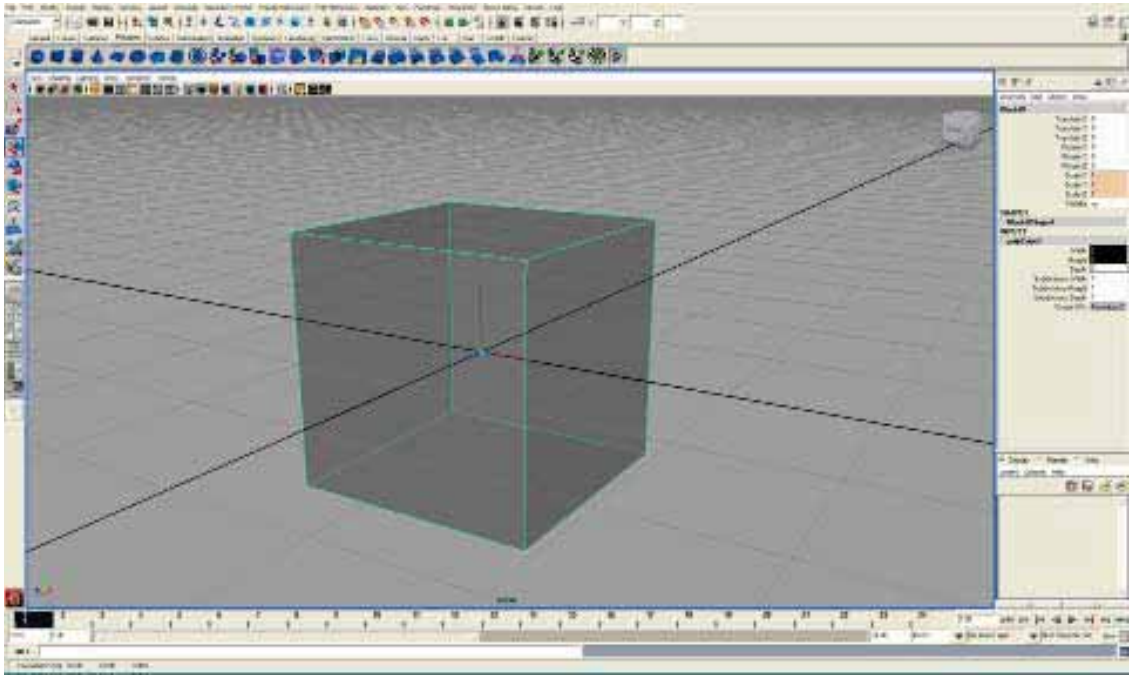
It is always a good practice to position the pivot of an object at the center of its base. By default the pivot of most primitives exist at the center of the volume but having it at the center of the base can be very handy when snapping an object or scaling it.

- Select the new building block *Block01*
- Select the **move tool** (hotkey: W) to enter move mode *(this will allow you to see the pivot) (Using the + or – hotkey will scale the manipulator larger or smaller)*
- In the **viewport menu** Select **Shading > X-Ray**
  See how the pivot sits at the center of the block. This makes it difficult to move precisely on a grid.

- Enter Edit mode for the pivot point by pressing the Insert key

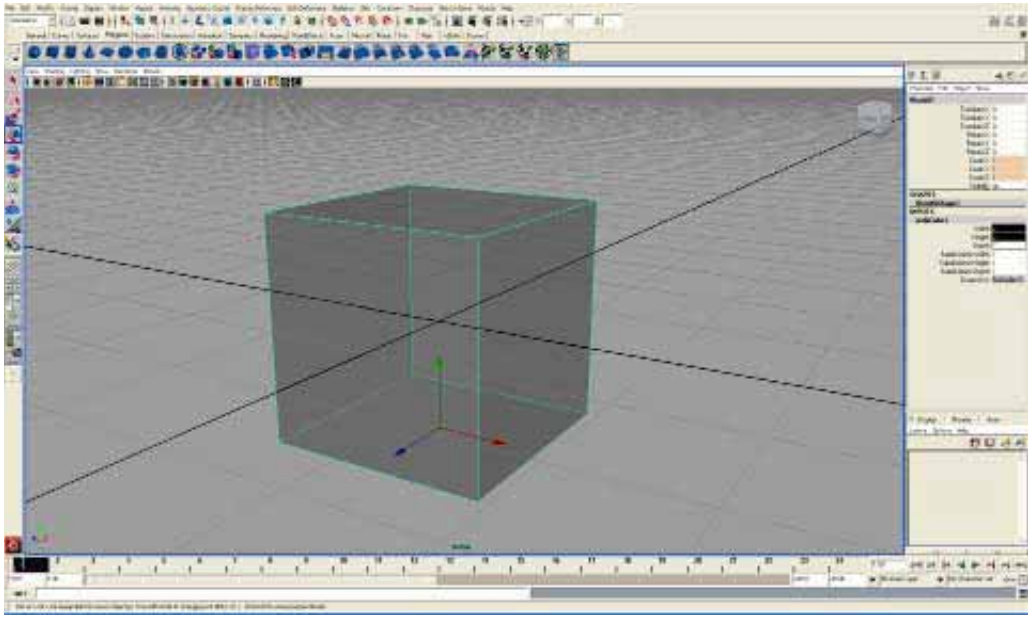
Tip:

Notice how the manipulator loses its arrows.



X-Ray Mode and Pivot Adjust Mode On

- Snap the pivot to the base of the cube by holding down the **V key** (Snap to Points mode) and click dragging the pivot along the Y-Axis to one of the bottom corners of the cube; this should place the pivot directly at the center spot underneath the cube
- Exit Edit mode for the pivot point by pressing the **Insert key** again



Pivot Moved to Center of Base

- Now move the cube onto the grid by holding down the **X key** (Snap to Grids mode) and click dragging the mesh over the origin of the grid
- Save the scene

Now the block is better suited for architectural placement, scaling, and rotation within the scene. Placing the pivot at the center and base of the mesh helps when positioning forms upon a surface and is an excellent practice when creating architectural form.

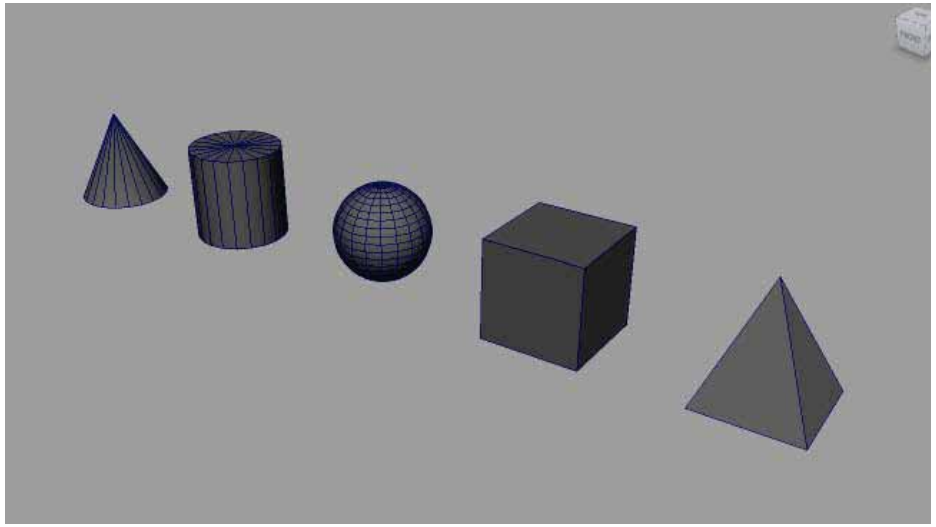
4. Create the rest of the primitives

Create the rest of the plutonic forms but using a sphere, cylinder, cone, and pyramid. Make a few duplicates of the cube and make a flat square platform, a post, and a beam. Keep them relatively similar in size.

- Select **Create › Polygon Primitives › Sphere**
- Select **Create › Polygon Primitives › Cylinder**
- Select **Create › Polygon Primitives › Cone**

Tip:

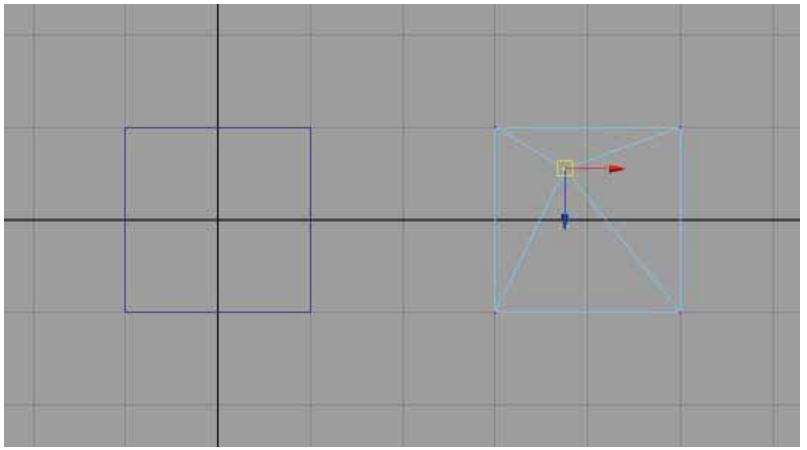
Holding down the **V Key** will let you snap to any vertex in the scene and is extremely helpful when moving objects or adjusting the pivot of an object or group.



The Plutonic Forms

For the pyramid, duplicate the form and simply collapse the top surface.

- Select Block01 then select **Edit > Duplicate**
- Select top face then select **Edit Mesh > Collapse**
- In the top viewport select the vertex that is off-center, and snap it to the grid by holding down the **X key** (Snap to Grids mode) and click dragging it to the center of the mesh



Pyramid tip adjustment

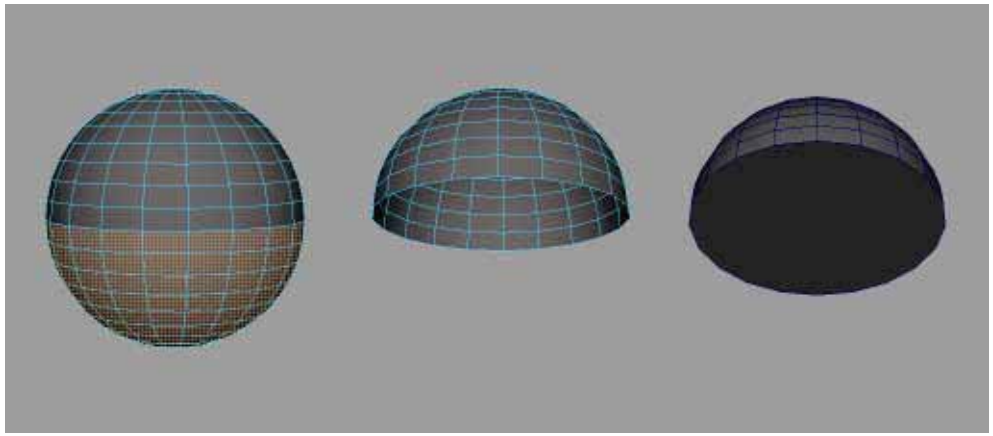
Creating the Additive and Subtractive Forms

Use new—or copies of—the sphere, cylinder, cone, and pyramid.

1. Create Subtractive Forms by Deleting Faces

For the sphere, you will simply delete faces and fill in the missing surface.

- Select **Create > Polygon Primitives > Sphere**
- Select the faces of the lower half of the sphere and delete them
- Select **Mesh > Fill Hole** to close the new dome



Sphere Subtractive Form

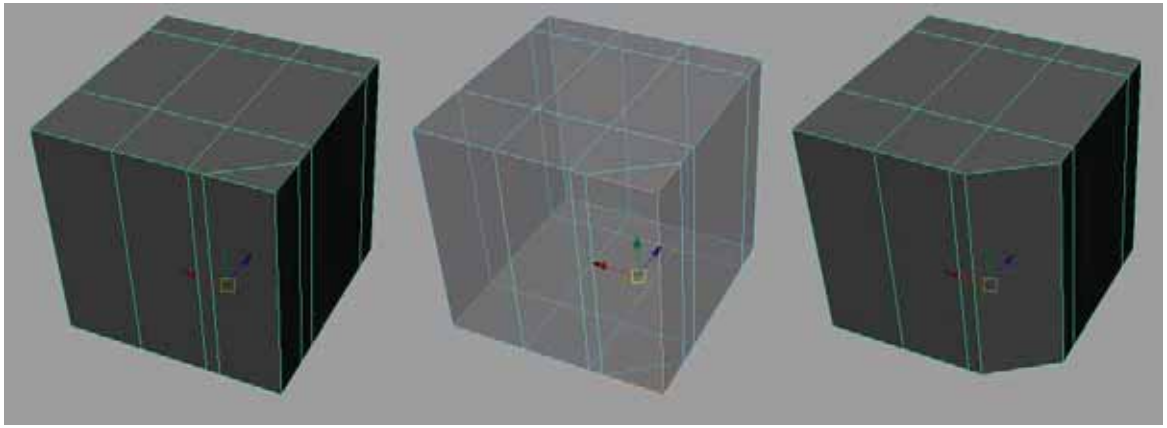
Tip:

You can use the Ctrl+D hotkey to duplicate the selected geometry without going into the menu each time.

2. Create subtractive forms by deleting edges and vertices

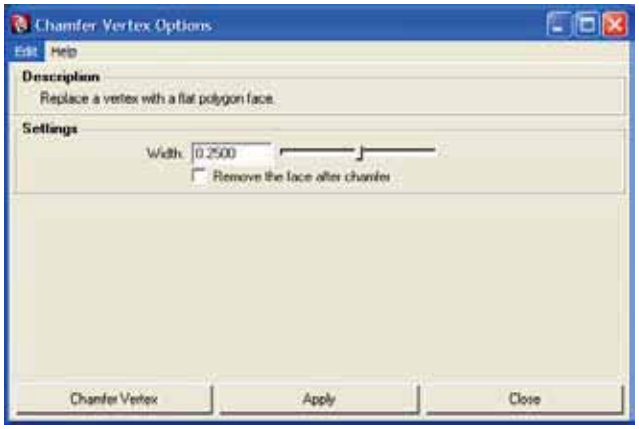
For the cube, you will cut the faces of the object and delete the edges along with the vertices.

- Using the cube in the scene, **select Edit > Duplicate** and create a copy to modify
- Select the new cube and select **Edit Mesh > Cut Faces Tool**
- Subdivide the cube a few times in the top viewport holding down the Shift key to constrain the action in the x and z axis



Cube Subtractive Form

- Subdivide the cube in the top viewport at an angle at one of the corners
- Select the edges of the corner
- Select **Edit Mesh > Delete Edger / Vertex** and the entire corner edge will be removed without leaving stay vertices



Chamfer Dialog Box

3. Create subtractive forms by chamfering

Chamfering vertices is another method to create subtractive forms. Using the cube, you will bevel edges and chamfer vertices of the object to create new forms

- Using the cube in the scene select **Edit > Duplicate** and create a copy to modify
- Select the top four vertices and select **Edit Mesh > Chamfer Vertex Tool Box** and set the width to **0.25**. Be sure to leave the Remove Face After Chamfer box unchecked and press **Apply**
- If the edges of the newly formed object looks awkward, it may be that they are soft; to harden them, select **Normals > Harden Edge**

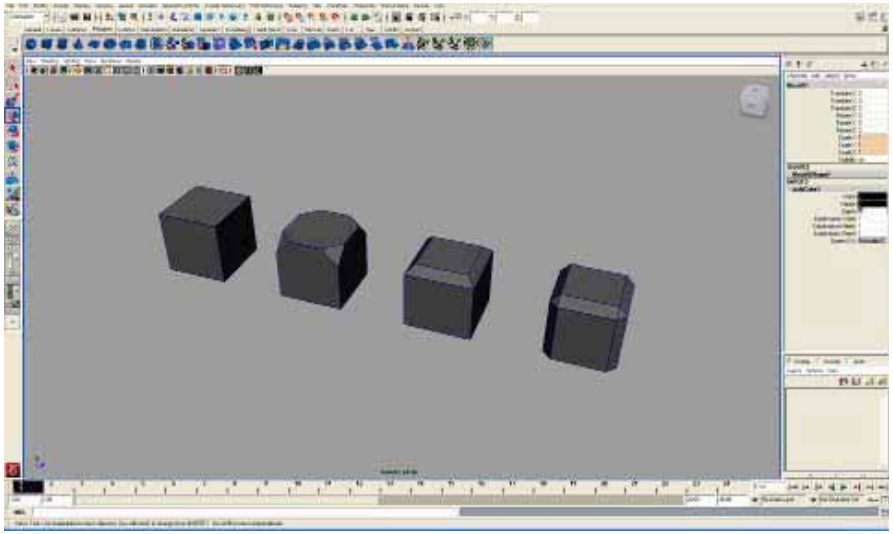
Tip:

You can use the G hotkey after each operation to use the tool over and over again.

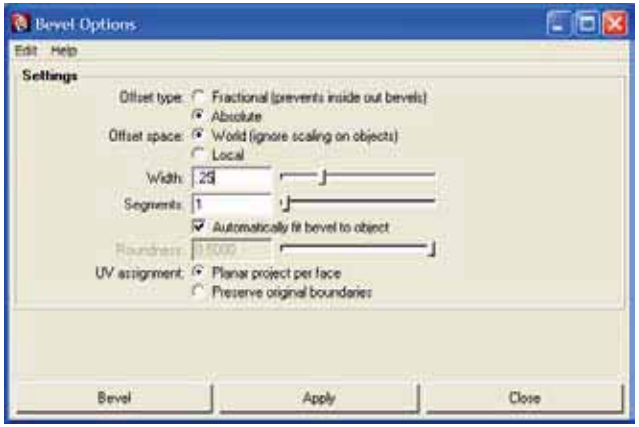
4. Create subtractive forms by beveling

Beveling edges is yet another method to create subtractive forms. Using the cube, you will bevel edges and chamfer vertices of the object to create new forms.

- Using a cube in the scene select **Edit > Duplicate** and create a copy to modify
- Select the top four edges and the side edges and select **Edit Mesh > Bevel Tool Box**
- Set the **Offset type** to **Absolute** and **Offset Space** to **World** with the width at **0.25** and then press **Apply**



Cubes with Chamfered Vertices and Beveled Edges

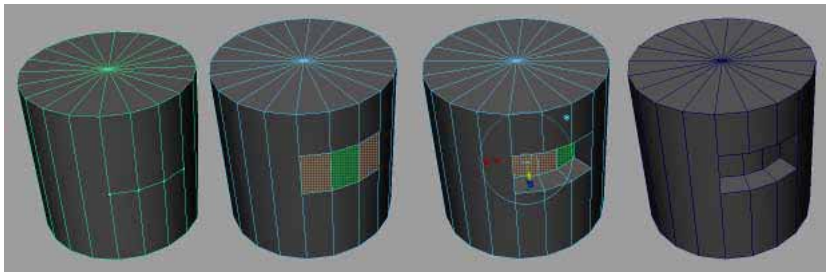


Bevel Dialog Box

5. Create subtractive forms by splitting polygons and extruding

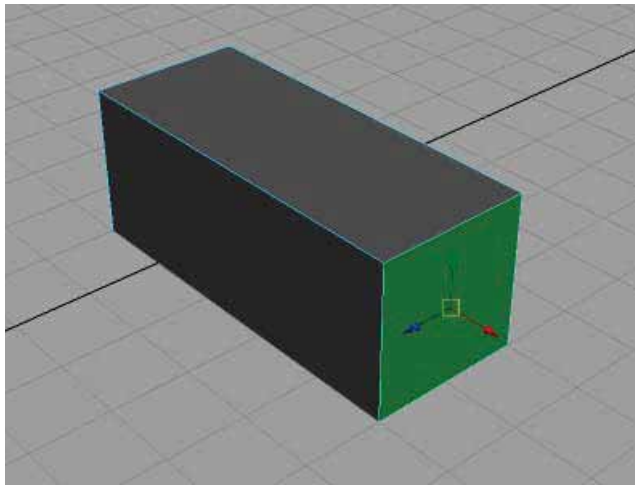
Scaling or extruding parts inward of a pure form is yet another method to create subtractive forms. Using the cylinder, you will subdivide the object and extrude parts inwardly to create new forms.

- Duplicate a cylinder in the scene using the **Control + D Hotkey**
- Select the cylinder and then **Edit Mesh > Split Polygon Tool**
- Set the **snapping tolerance** to **100**
- Split the cylinder along the side faces twice to create additional faces
- Select **Edit Mesh > Extrude** and push the faces inward



Cube with Chamfered Vertices and Beveled Edges

> **Tip:**
>
> Continue to create subtractive forms by moving or extruding faces inward to the pure form. You can also use other methods, such as **Control + Right Click** on an Edge and select **Edge Ring Utilities > To Edge Ring and Split** to subdivide objects more quickly.



Using the Grid to Snap Movement of Faces

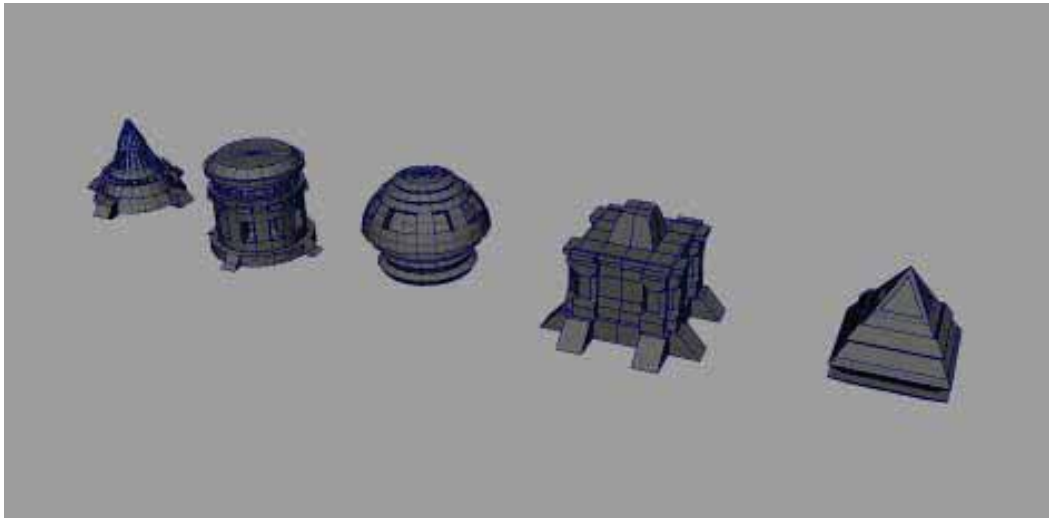
6. Create additive forms by combining objects

Additive forms are much easier as they simply require extruding faces outward from the form or combining various simple forms into a more substantial form.

- Duplicate a cube in the scene using the **Control + D** Hotkey
- Select a face and move it in the scene while holding down the **X** Key; you will find that you can scale cubes while keeping them of the grid. This makes it very easy to create forms and align them.
- Subdivide the cube using the various methods, and extrude single or groups of faces to create an additive form
- Duplicate some of the cubes and other primitives in the scene, and scale some of them to different sizes vertically and horizontally
- If you decide to use more than one object to achieve this, you should assemble them together and select **Mesh > Combine** to create a new additive form

Assembling the Building Blocks

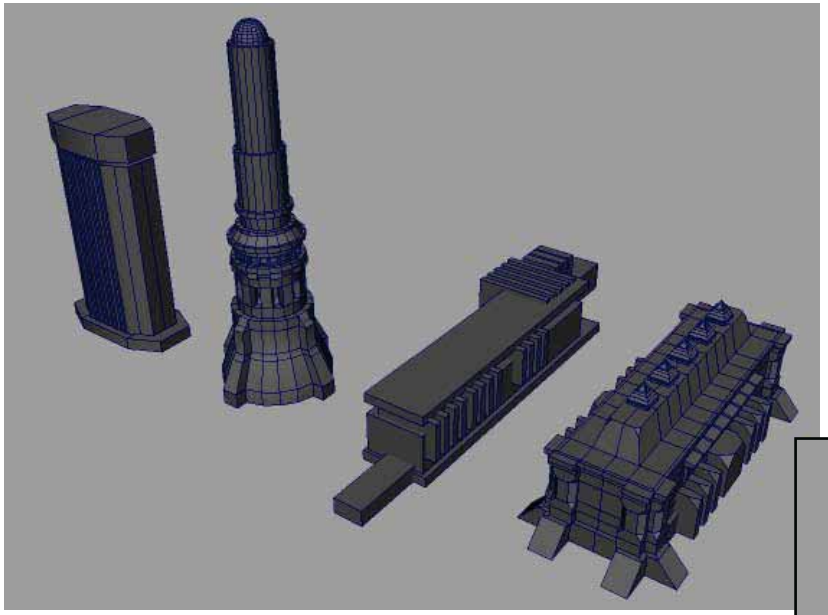
Through simple Tools and Methods like Scale, Duplicate, Move, Polygon Face Cut, Split Polygon, and Combine you can really get a lot of curious forms. Select Face and Edge Loops or Rings to extrude or split to offer you more and more choices while you try to create the following fundamental architectural forms:



Centralized Forms

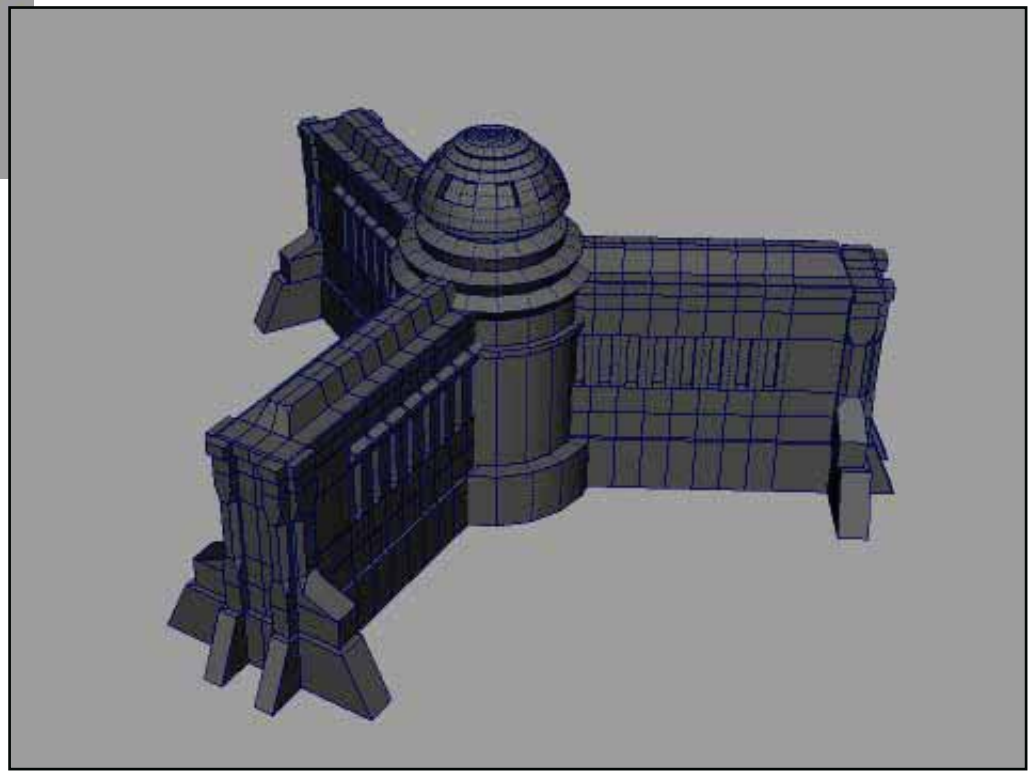
1. Create centralized forms

2. Create linear forms



Linear Forms

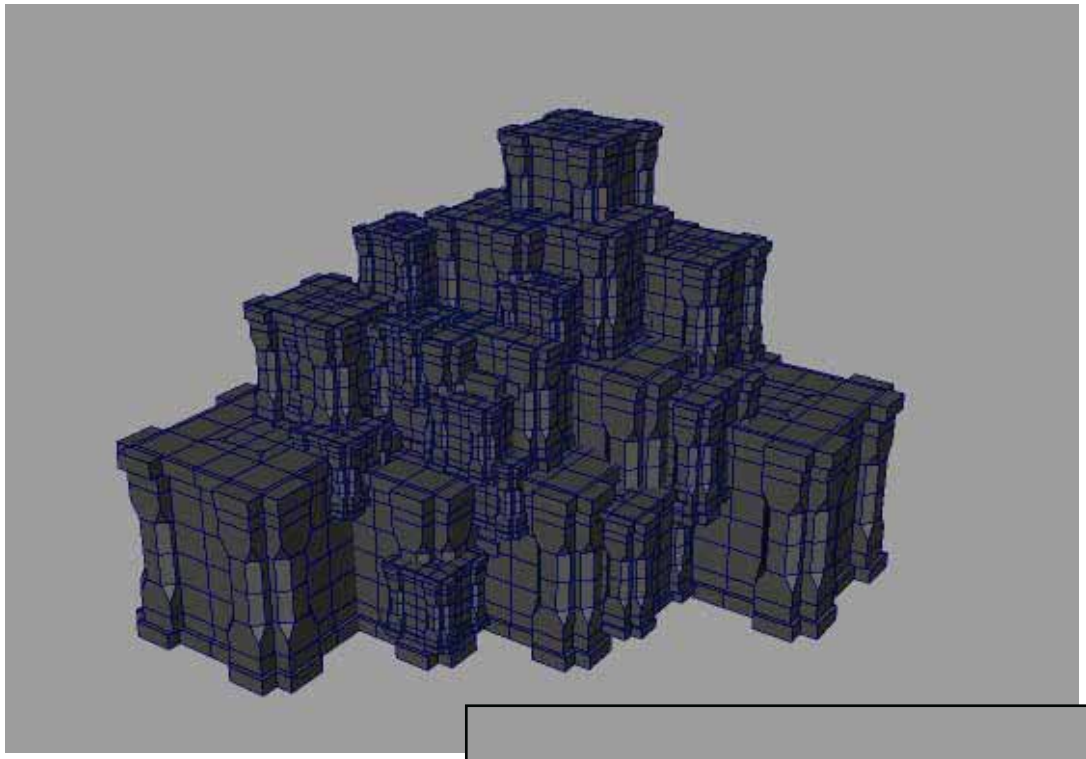
3. Create radial forms



Radial Form

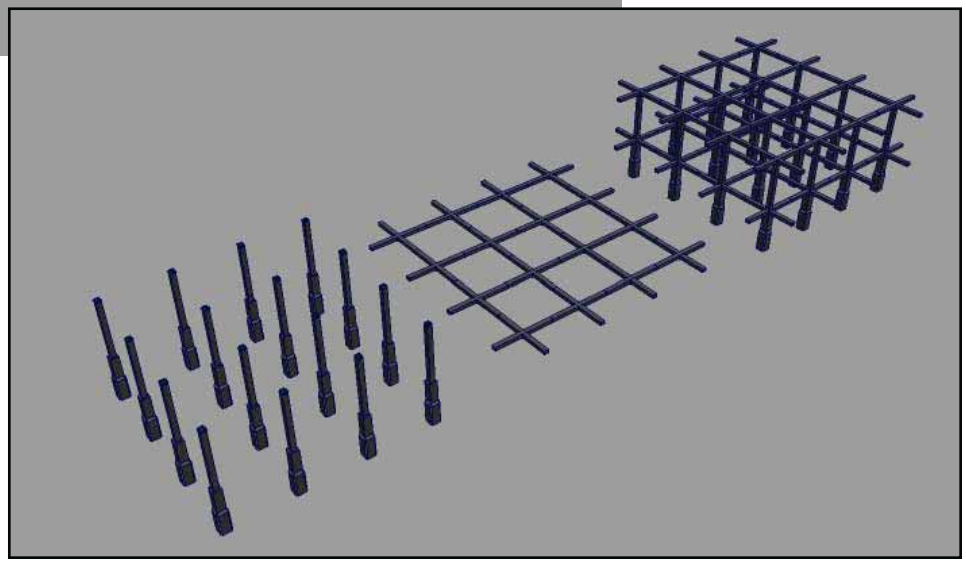
Maya Form & Space

4. **Create cluster forms**



Clustered Form

5. **Create grid forms**



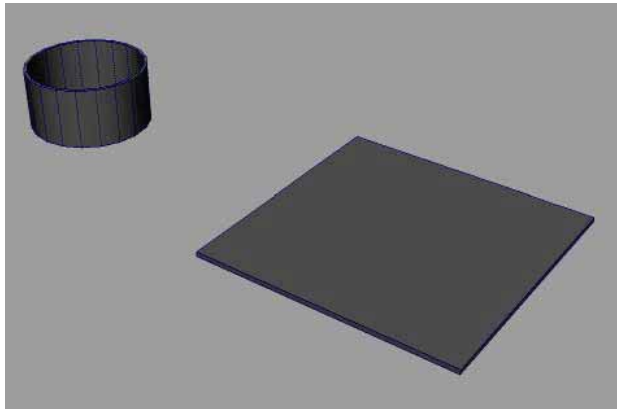
Grid Form

Defining Space

Defining space simply involves the use of a plane or repeating elements to create ideas of closure. Columns work well when spaced evenly in enclosing a space.

1. **Create a plane and pipe**

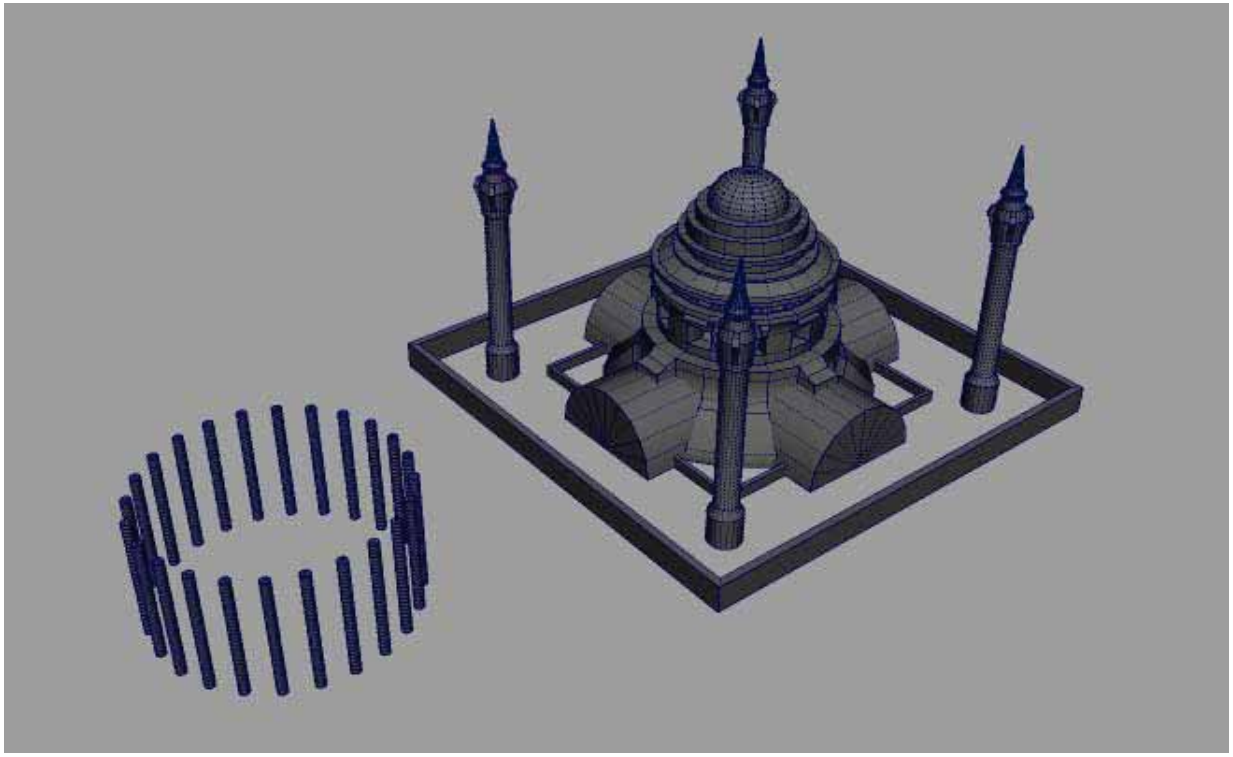
   - Select **Create > Polygon Primitives > Plane**
   - Input length and width of **4**
   - Extrude the plane by 0.05 to create a ground surface with a bit of thickness
   - Duplicate the plane and rotate it so that it becomes a wall
   - Select **Create > Polygon Primitives > Pipe**
   - Input a thickness of 0.05



Pipe and Plane

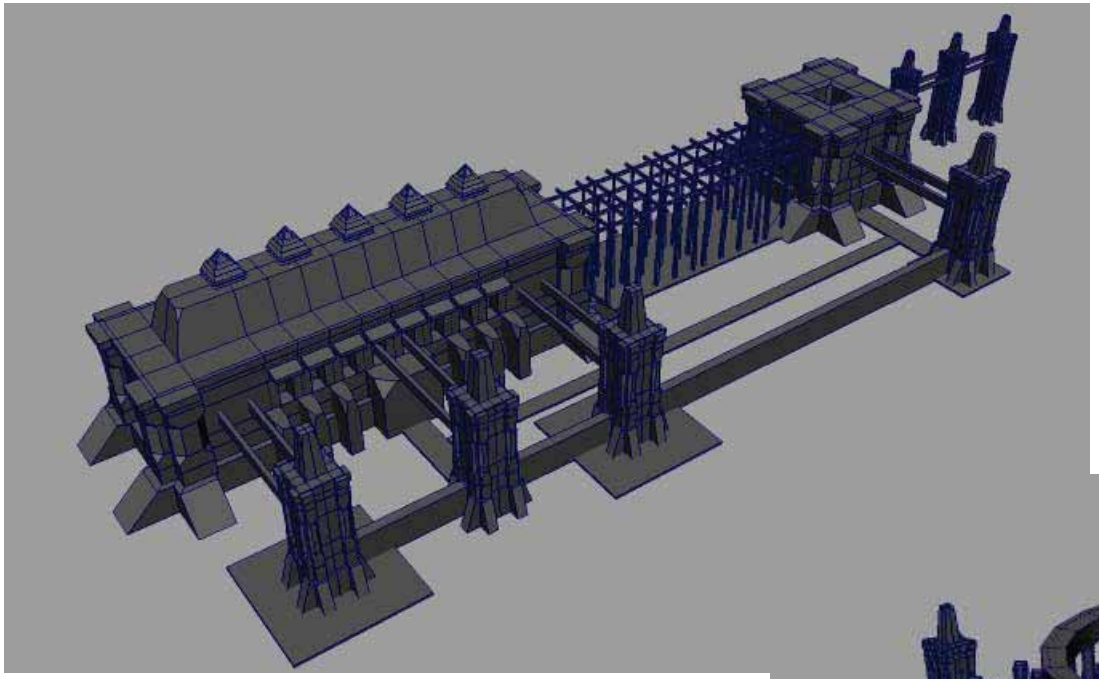
Spatial themes can easily be explored now by assembling various walls, ceiling, or floors to create the following fundamental architectural spaces:

2. **Create centralized space**



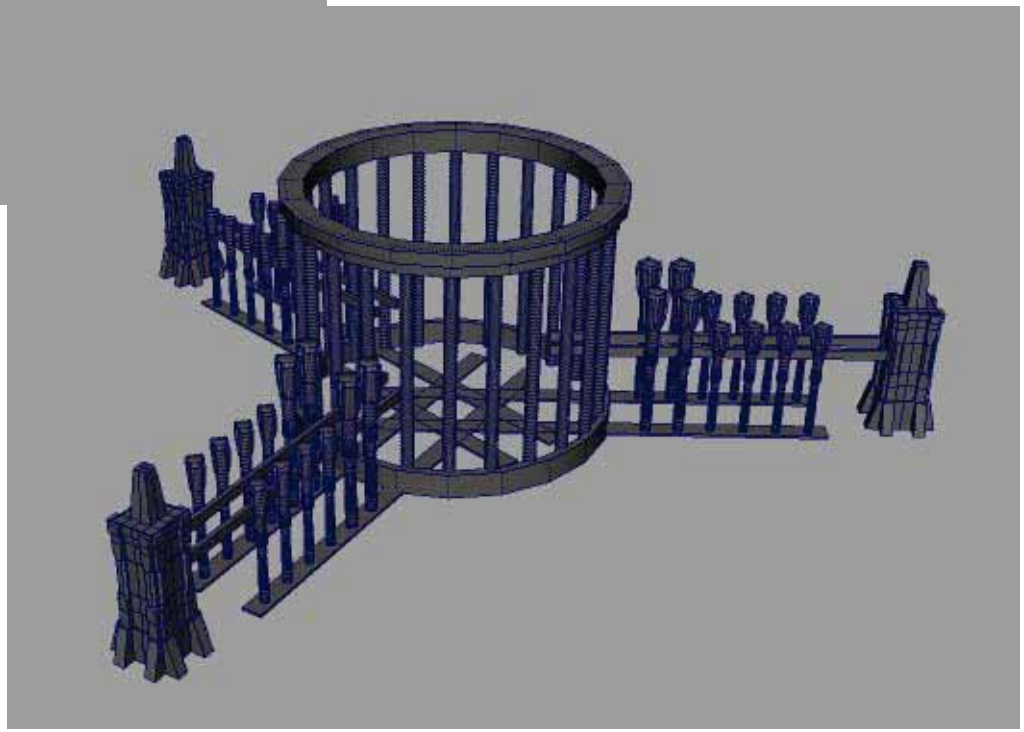
Centralized Space

3. **Create linear space**



Linear Space

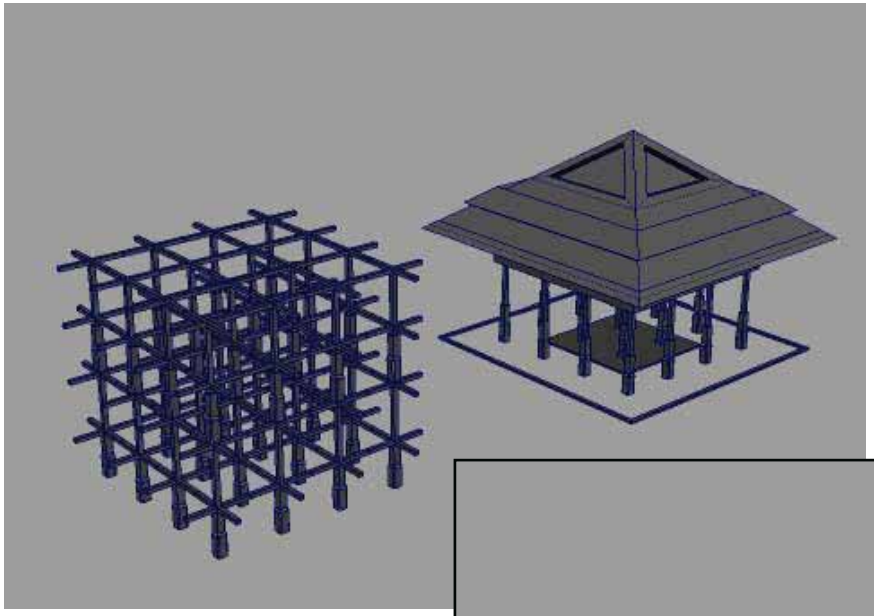
4. **Create radial space**



Radial Space

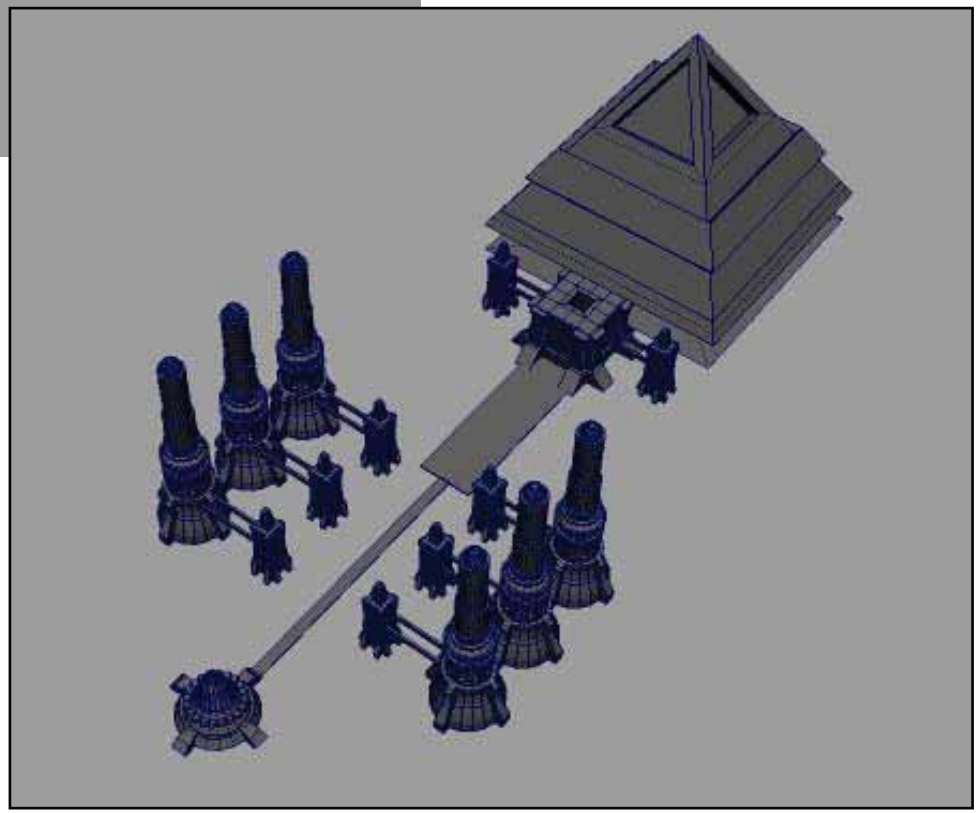
Maya Form & Space

5. Create grid space



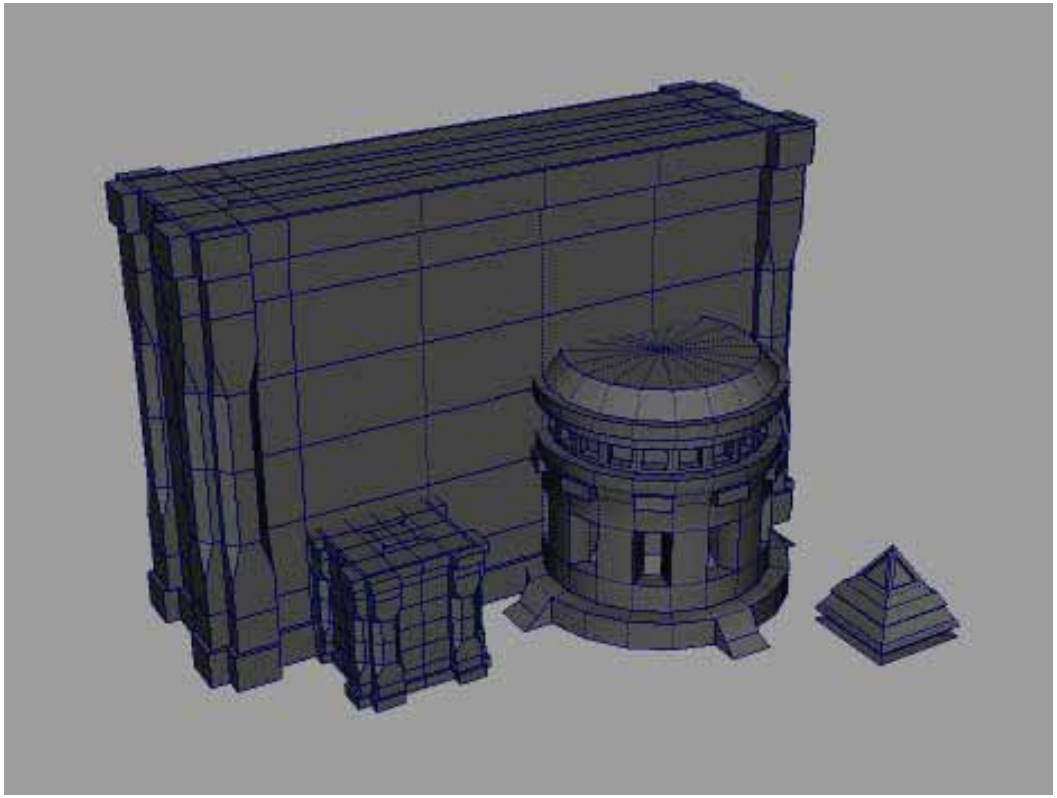
Grid Space

You can create symmetry through spacing and mirroring elements or explore ideas about axis by setting up a linear space that ends at a structure. You can even make a datum.



Axis Through Symmetry

Maya Form & Space



Datum

Concepts Explored

- Pattern, Scale and Proportion
- Subtractive and Additive forms
- Architectural themes of Form
- Architectural themes of Space
- Orders of Space and Form

This exercise provided you with the essential tools and procedures to create form and space. It is easy to see that by practicing these techniques you will be able to create almost any type of architecture. Remember that selecting rings and loops of edges and faces is a powerful method that allows you to subdivide an object quickly before you extrude. Master this skill and you will be able to mass modeling quickly.

The fundamental forms and space will be invaluable when considering types or styles of architecture. Using the additional files provided with this exercise will help you to continue thinking about how these architectural themes have been used throughout historical form and space.

Historical.ma provided for further exploration of architectural form and space.

Playing Outside—Stonehenge

Being told to go play outside is a frequent occurrence growing up. Anywhere from a backyard sandbox or schoolyard field to a dense nearby forest or sandy beach, children have found a place to build forts or sand castles. This desire to dwell in the landscape is a universal theme that started centuries ago and grew from the simplest meeting under a tree or baptism by a lake. Site is the foundation of ritual, and choosing the best location or altering it to suit an architect's needs is often a very important part of establishing a sense of place.

Overview

This lesson covers the creation of Stonehenge. It will involve the editing of a plane that will eventually become the site for this prehistoric example of space and ritual. This exercise will teach you how to model a basic terrain and model simple organic forms.

In this lesson you will learn the following:

- How to set up a scene with preferences
- How to use a 2D plane as a reference to construct and assemble a site
- How to edit geometry with Smooth Selection
- How to use the Sculpt Geometry Tool
- How to create polygons
- How to work with polygon modeling techniques
- How to smooth polygon meshes
- Explore architectural themes of site

Stonehenge

Getting Started

1. Set preferences

Before you create your polygon architecture, you will need to change some of the default settings to a more suitable environment for this type of work.

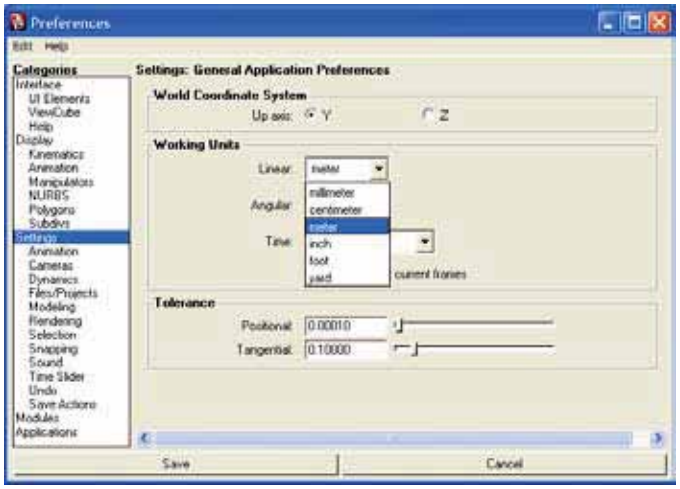
- Select **Window › Settings/Preferences › Preferences**
  The Autodesk® Maya® software user preferences window appears.
- In the Preferences window choose Categories › Polygons
- In the Polygon Display settings, set the following:
  - Border Edges: On
  - Edge Width: 4

  This displays border edges more prominently on polygon meshes and helps to identify the edge conditions of any open geometry.

- In **Preferences** window, choose **Categories > Selection**
- In the Polygon Selection settings, set the following:
  - Select faces with: Whole face

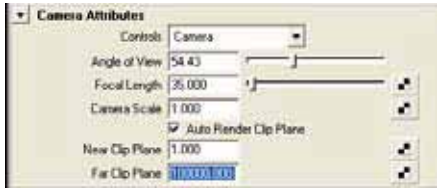
The Whole face setting lets you select polygon faces by clicking on any part of the face rather than on a center dot as with the center setting.

- In **Preferences** window, choose **Categories > Settings**
- In the **Working Units** dialog box, in the Linear drop-down menu choose **meter**



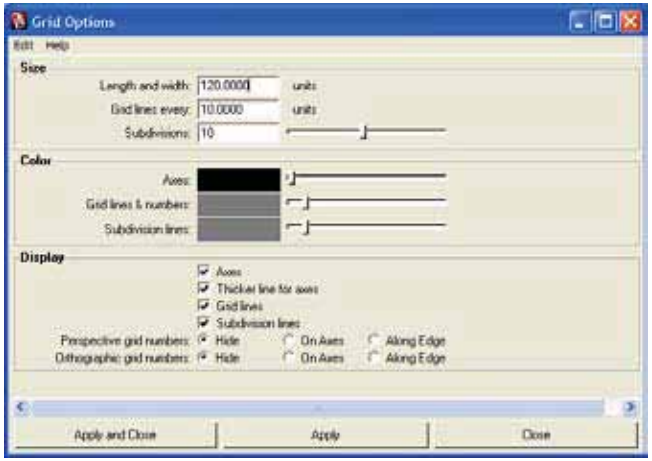
Preferences Dialog Box

- Click the **Save** button to close the settings window
- Open the Outliner and select each camera one at a time: *top, side, front, and perspective*, then change the **Near Clip Plane** to **1** and the **Far Clip Plane** to **100000** for each of them. This will ensure the scene is visible at long and short distances



Camera Attributes

- Select **Create > Polygon Primitives** and turn off the **Interactive Creation** option for primitives
- Select **Display > Grid** and in the **Grid Options** dialog box change the grid size for **length and width** to **120** with the **Gridlines** and **Subdivisions** at **10**



Grid Options Box

Creating the Site with the Use of a Projection Plane

You can use various viewports to display drawings, sketches, or photographs to help visualize your models in Maya; much like an architect creates their designs from the plan, section, and elevation views of a blueprint.

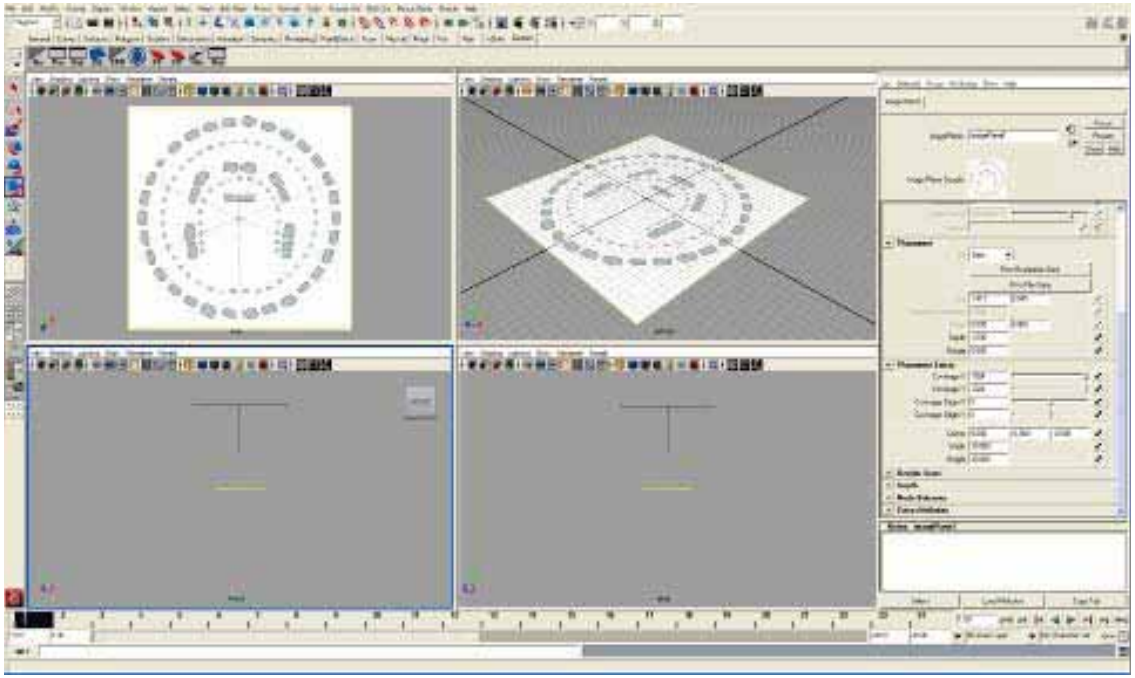
1. Create a file

- Select **File > Save Scene As**...
- Name the file *Architecture02_Site_Ritual_Mine*

2. Create a projection plane

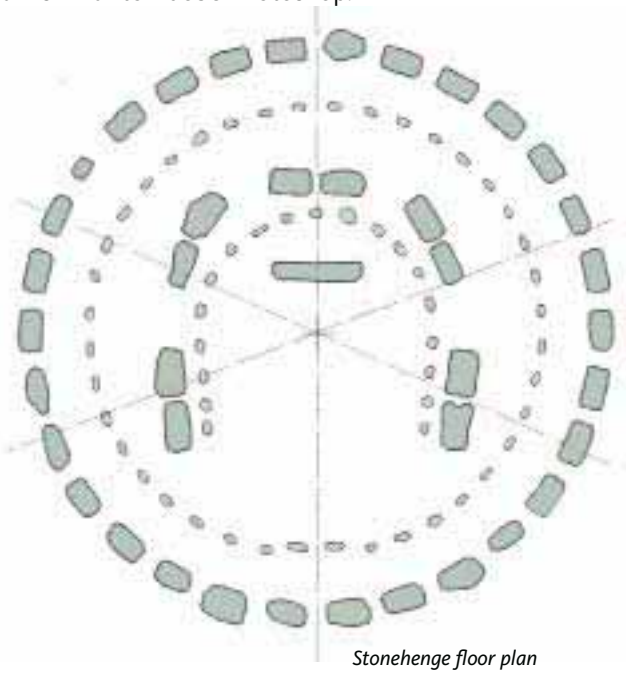
You can import 2D images into any orthographic camera view as *image planes*. An *image plane* is a 2D object (plane) that places an image file in the scene view.

You can move the image plane, change its transparency, or turn it off.



Projection Plane

For this exercise you need to load an image similar to this, you can create this by hand or in a program similar to Adobe Photoshop.



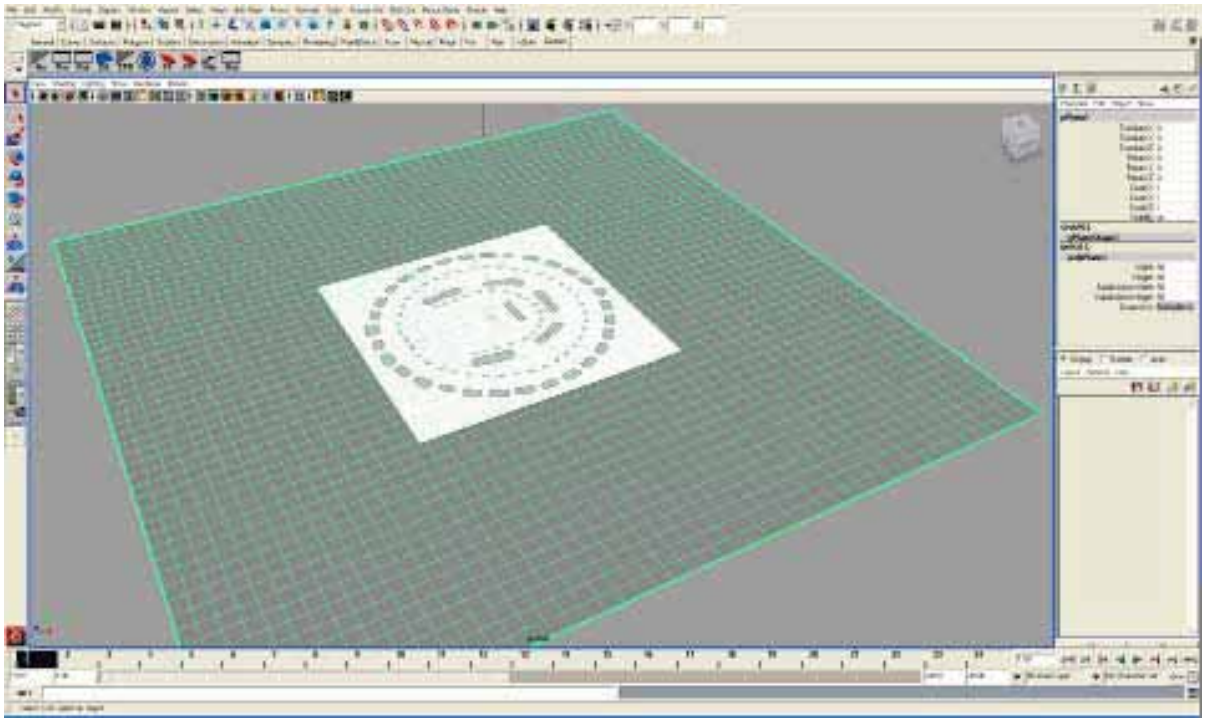
Stonehenge floor plan

- Ensure you are working in the top view.
- In the top view panel select **View > Image Pane > Import Image**
- Select your image file
- The image should now appear in the Top Viewport

3. Adjust the size and transparency of the image plane

- In the top view panel menu, select **View > Image Pane > Image Plane Attributes** to display the Attribute Editor on the right
- Scroll down to find and expand the **Placement Extras** tab and set both the width and height to 30 to scale the image plane to be the proper size for something like Stonehenge
- Under the **Inputs Image Plane Attributes** set the Alpha Gain attribute to a value of 0.25 to make the image partially transparent for easy working

Inputs Image Plane Attributes



The Plane

Creating the Terrain

The basis for Salisbury Plain where Stonehenge is found will be a simple plane. The sculpting of that terrain will reveal the organic features of the site.

1. Create a plane

- Select **Create > Polygon Primitives > Plane**
- Set the height and width to 50 and the subdivisions both at 50

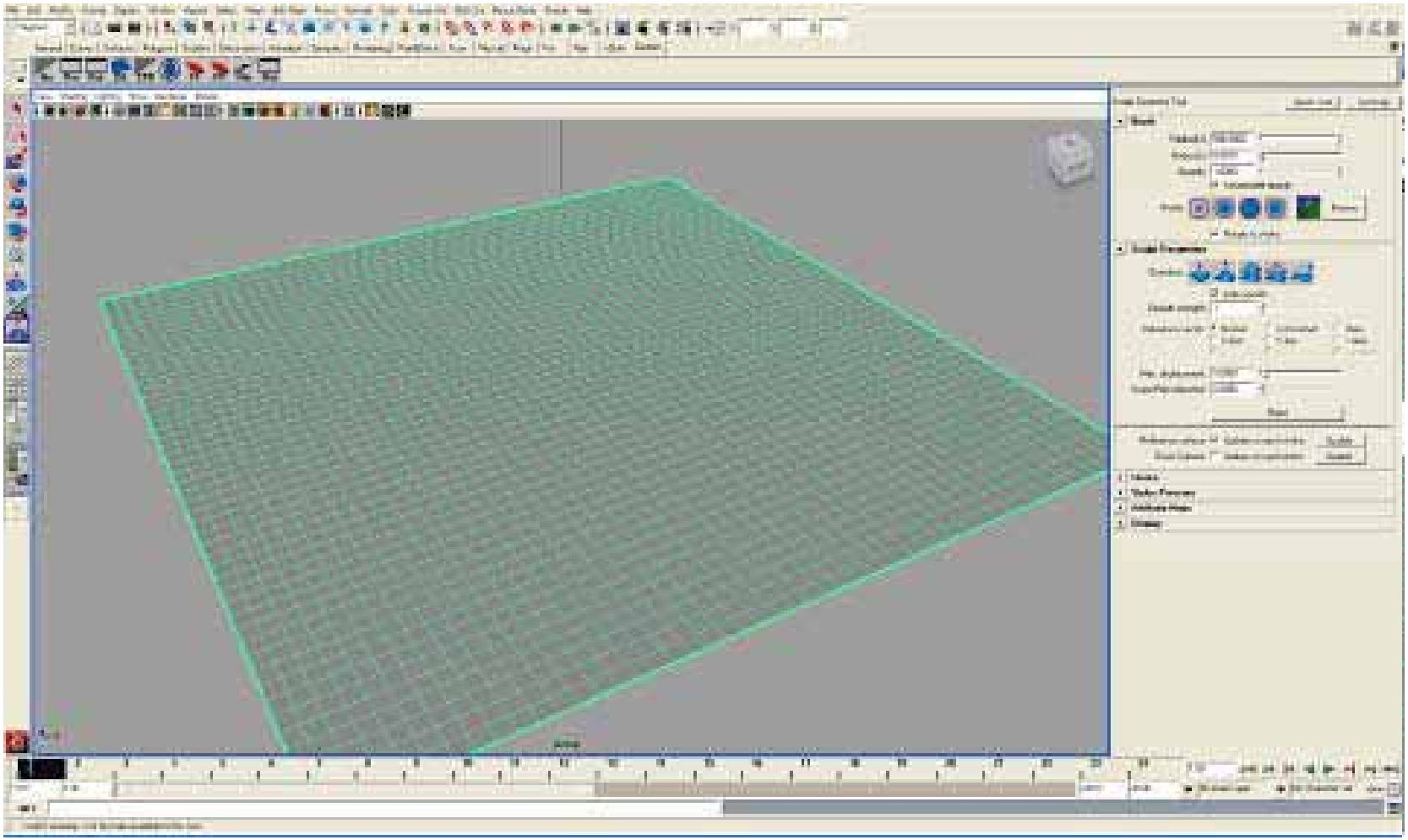
Tip:

To hide the image plane in the perspective viewport access it through **View > Image Pane > Image Plane Attribute**s and switch the **Display** to **Looking Through Camera.**

Maya Project

2. Sculpt the terrain

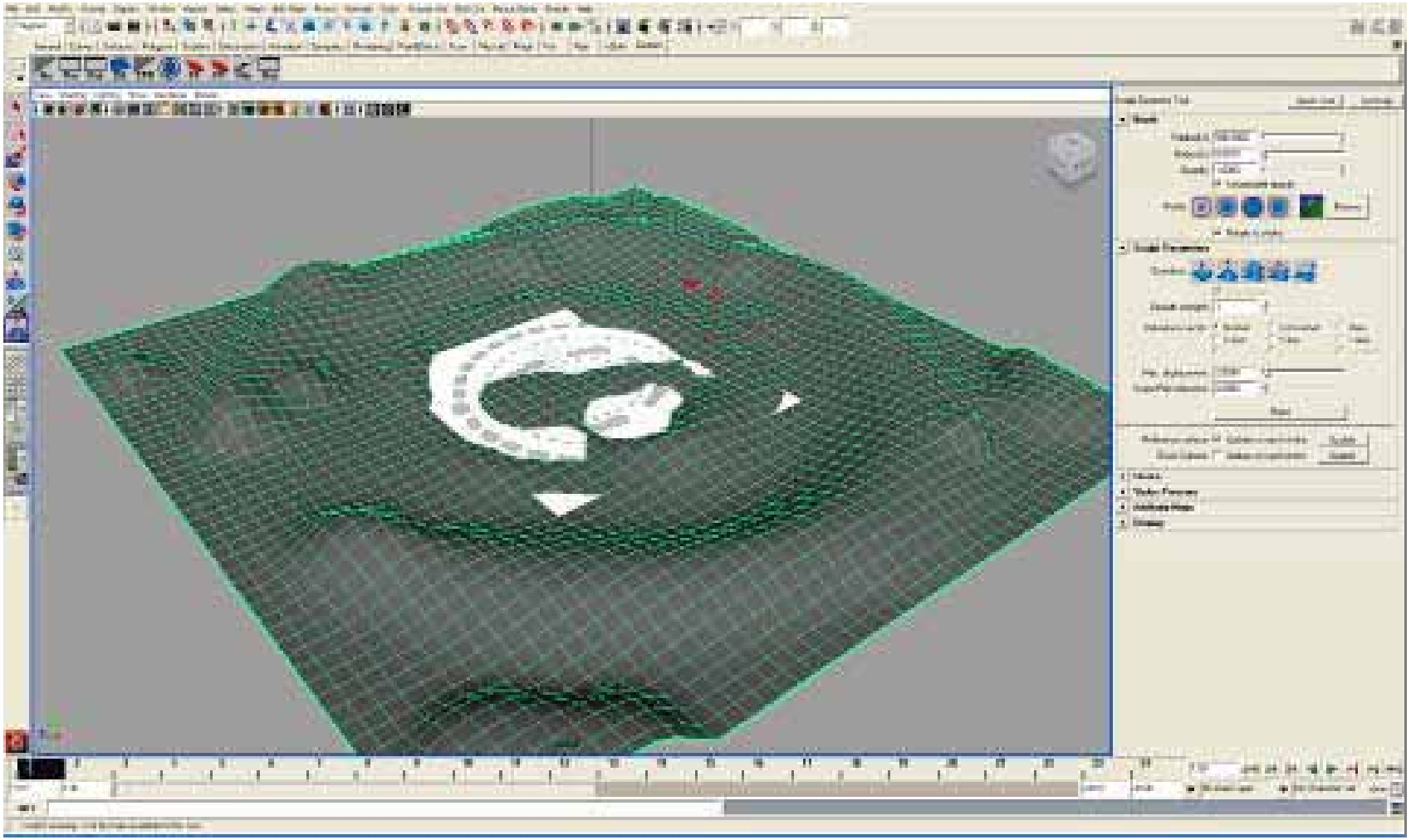
- Select the plane
- Select **Mesh > Sculpt Geometry Tool**
- Click the **Tool Setting** on the far right of the **Status Bar**
- Under the **Sculpt Parameters** select **Operations > Up Icon**
- Set the Max displacement to 5.0



Sculpt Geometry Tool

Maya Project

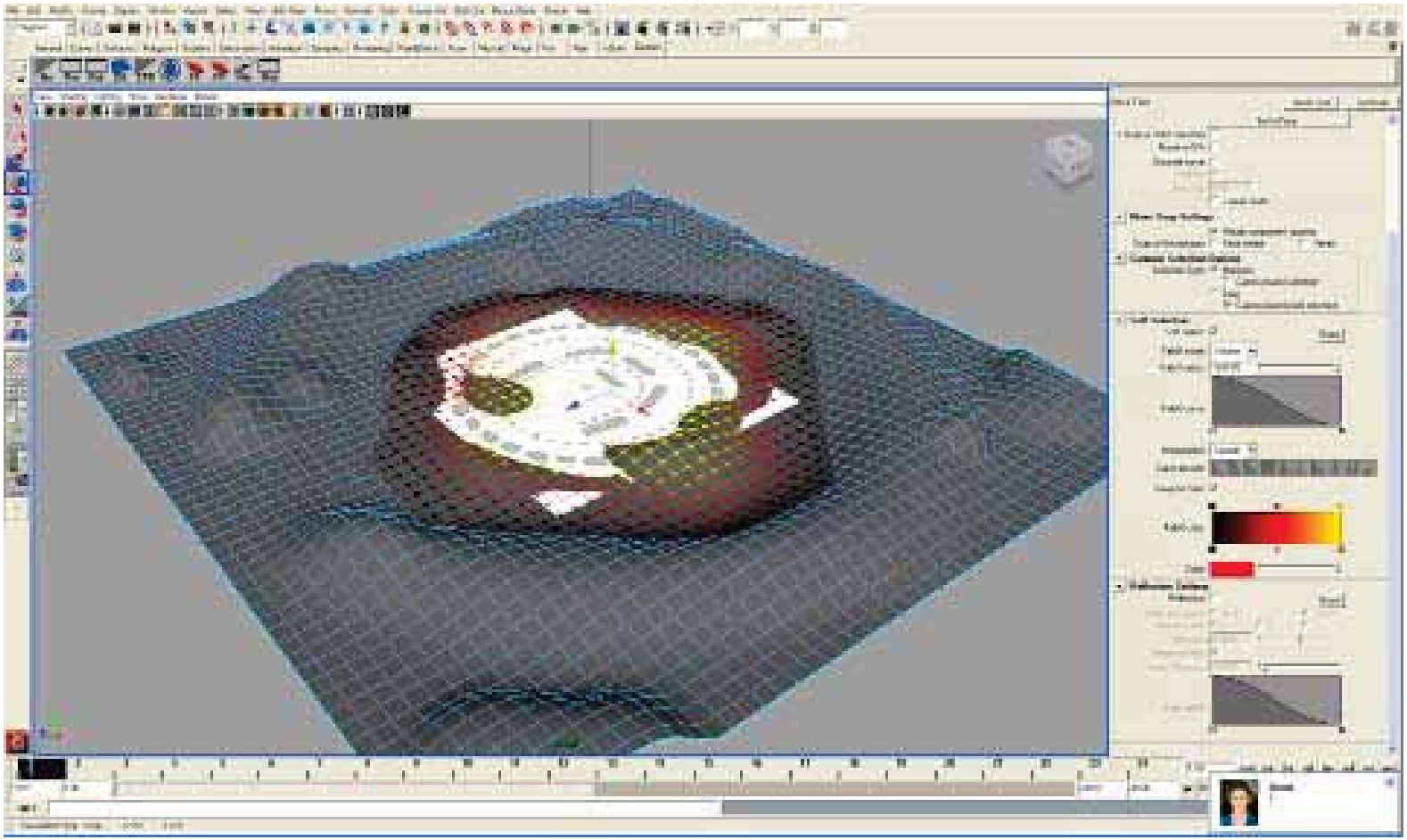
- Holding down the **B** key adjust the size of the brush with which you will be sculpting.
- Begin to pull up the terrain geometry to form a general site of concentric circle patterns.
- By adjusting the smoothing and trying out some of the other buttons you should be able to create a convincing terrain.
- Use different brushes sizes, and relax to get a convincing undulating field.



Sculpted Terrain

3. Adjust the grade of the terrain

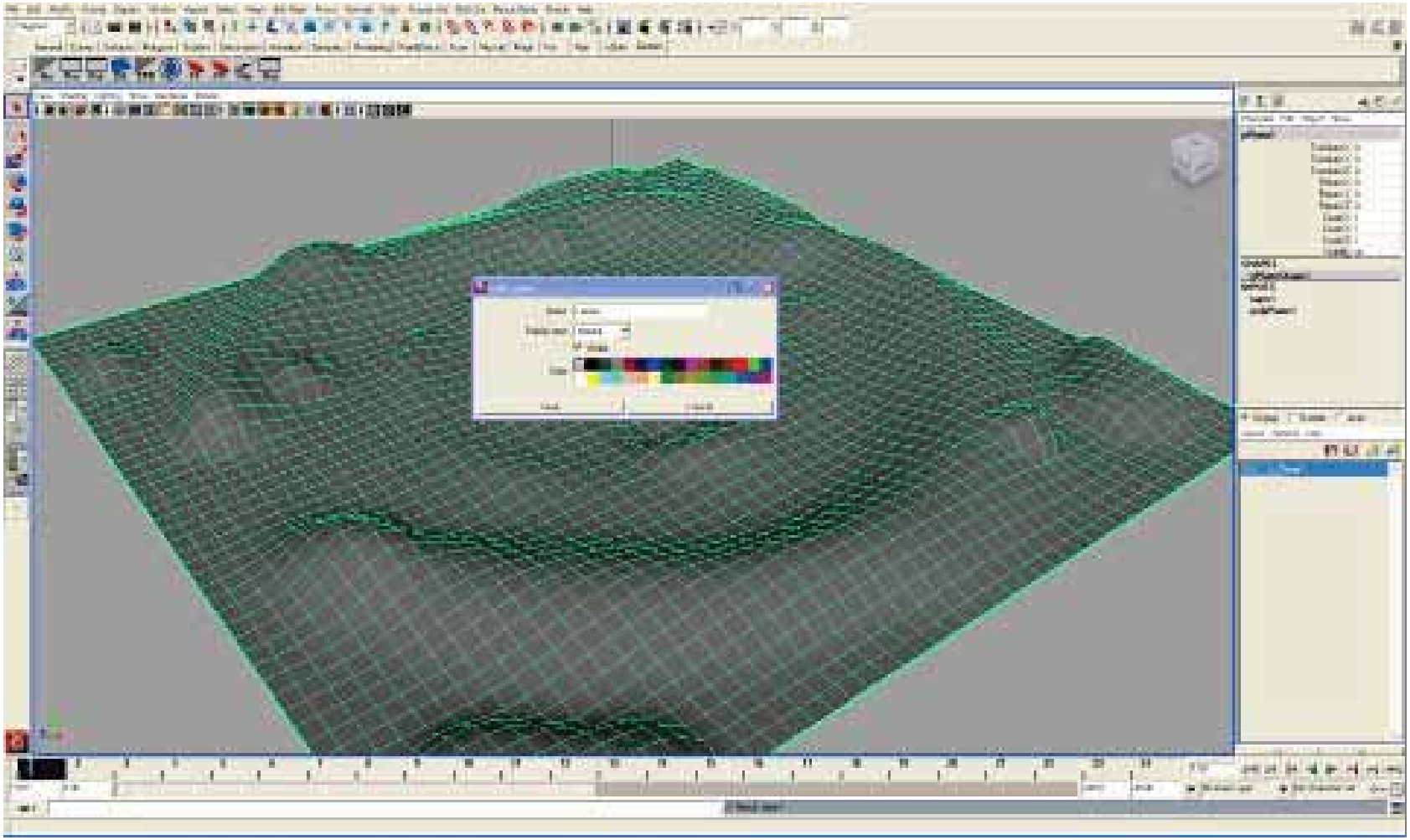
- Go to the Select mode and access the Tool Settings from the far right of Status Line and under the **Soft Selection** tab turn on **Soft Select**
- Go to the Vertex mode and select a group of vertices at the center
- Hold down the B key just as you did before and adjust the size of the field you are selecting, and you should notice the color gradient of what will be influenced by the soft selection you have made



Soft Adjustment to Terrain

4. Create a new layer and assign the terrain

- Access the **Channels** dialog box by clicking on the icon in the top-right corner of the Status Line
- Select the terrain you have just made and click the **Create a New Layer and Assign Selected Objects** button on the far right of the layer area
- Double-click on the newly formed layer, and give it a name such as *Terrain*

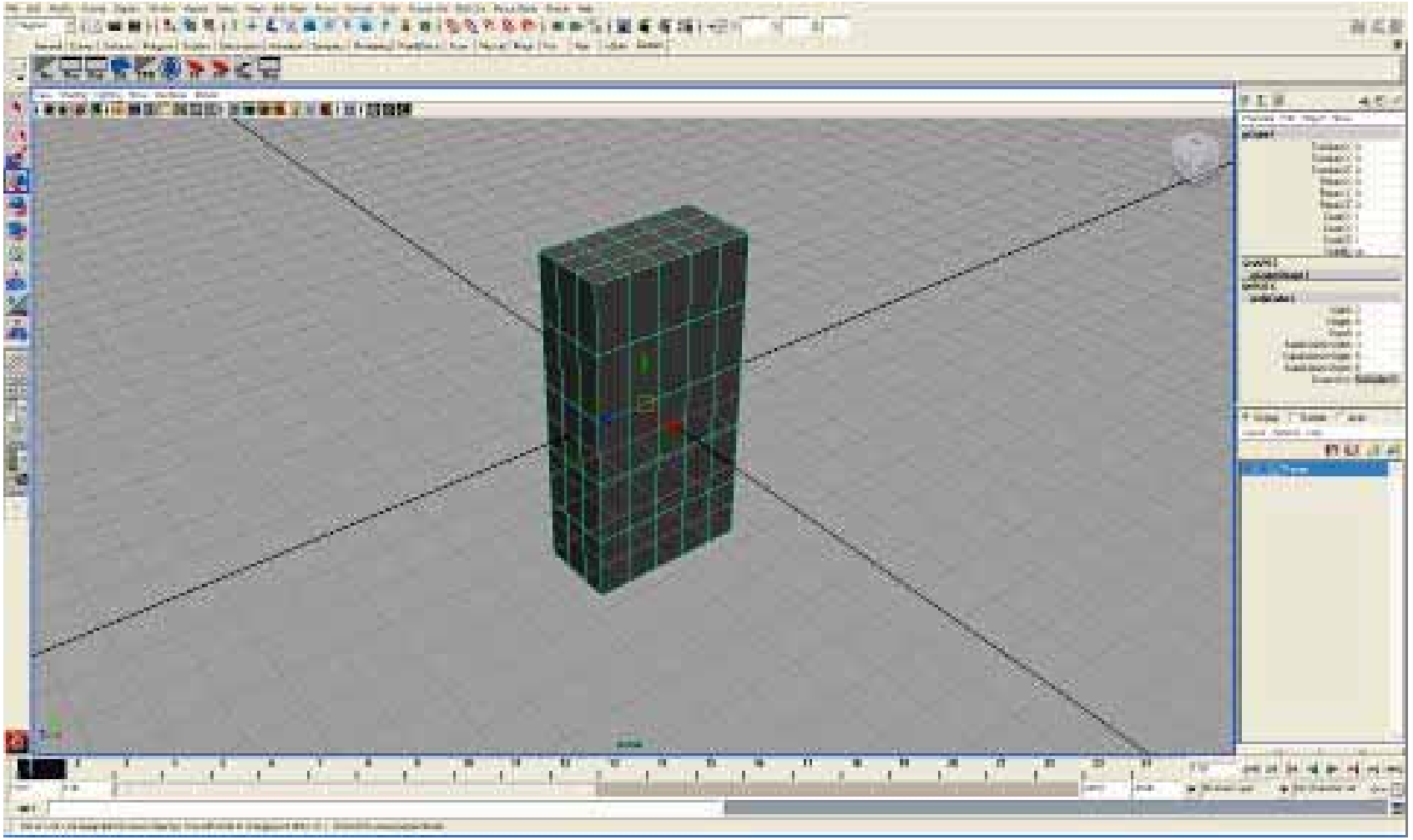


Assign Terrain to Layer

Creating the Monolithic Stones

Stonehenge would not be much without stones, so you will be creating a few monolithic stones to add to the scene.

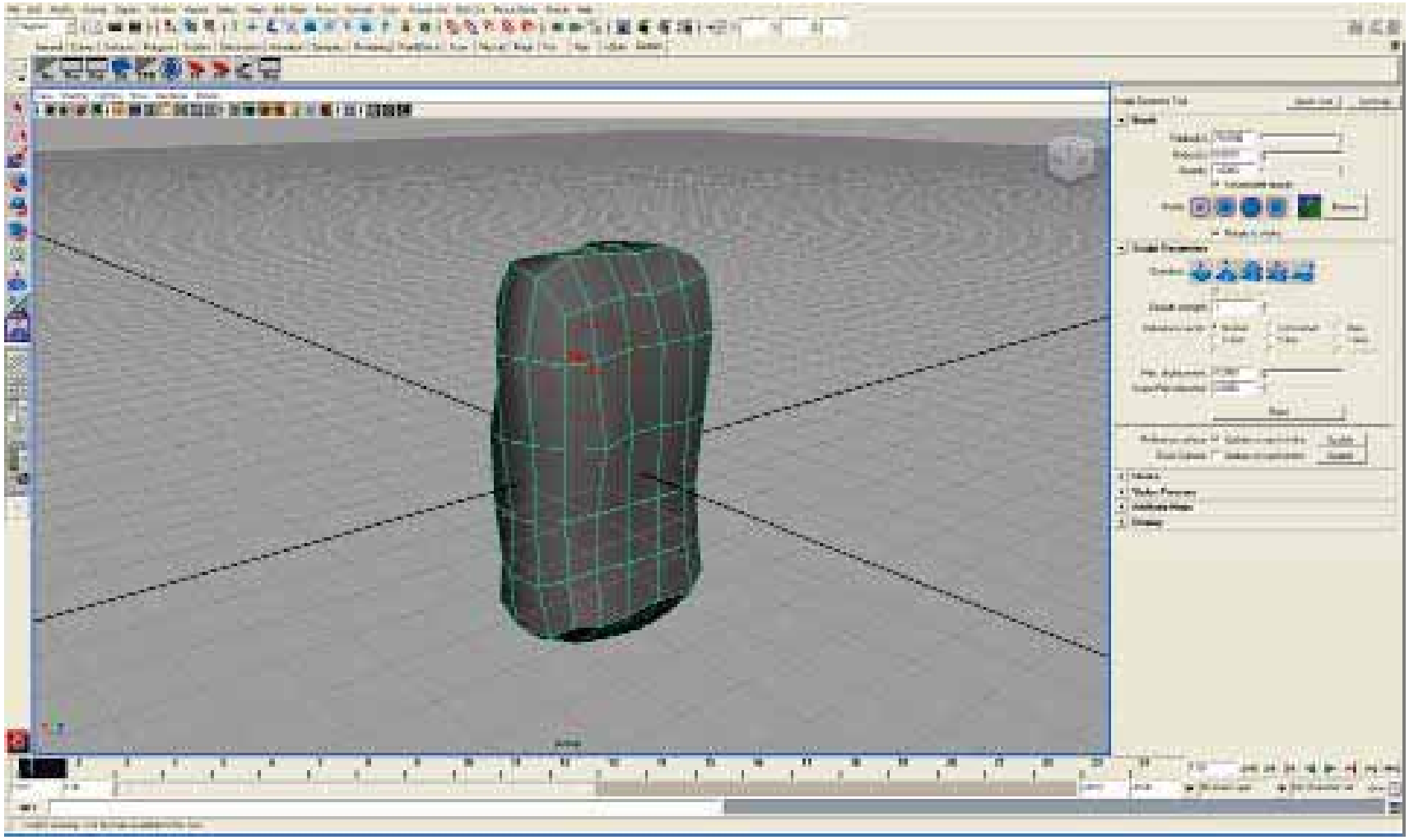
1. **Create a cube**
   - Select **Create > Polygon Primitives > Cube**
   - Set the width to 2, the height to 8, and the depth to 4
   - Set both the Subdivisions to Subdivisions width 3, Subdivisions height 5, and Subdivisions depth 5



Create Basis Form for Stone Slab

2. Sculpt the stone

- Select the plane
- Go to **Mesh > Sculpt Geometry Tool**
- Click the **Tool Setting** on the far right of the **Status Bar**
- Under the **Sculpt Parameters** choose **Operations > Up Icon**
- Set the **Max. displacement** to 0.5
- Holding down the **B** key adjust the size of the brush with which you will be sculpting
- Begin to pull up the surface geometry to form an interesting stone slab
- By adjusting the smoothing and trying out some of the other buttons you should be able to create a convincing eroded stone form
- Use different brushes sizes and relax to get a smooth feel to the mesh



Sculpt Geometry Tool for Stone

3. **Sculpt the altar and lintels**

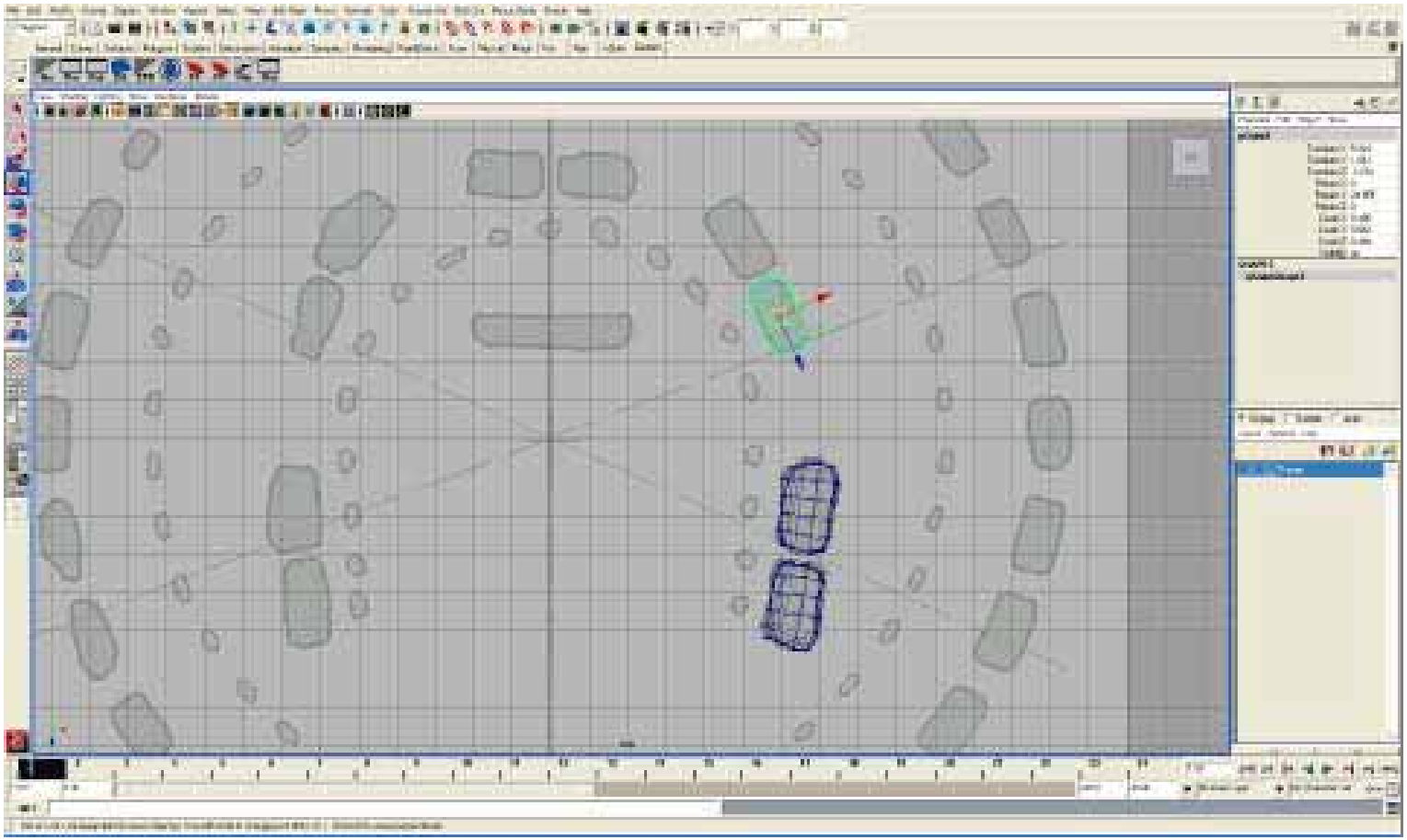
   - Continue sculpting the alter and lintels for this mysterious architecture using some of the techniques you learned in earlier lessons, such as splitting polygons and extrude, if you would like.
   - Use duplicates of the stone already in the scene or practice creating new ones.

Assembling Stonehenge

Now that you have Salisbury Plain hidden away you can begin placing your objects around the site like the ancient did but with much more ease.

1. **Assemble the stones**

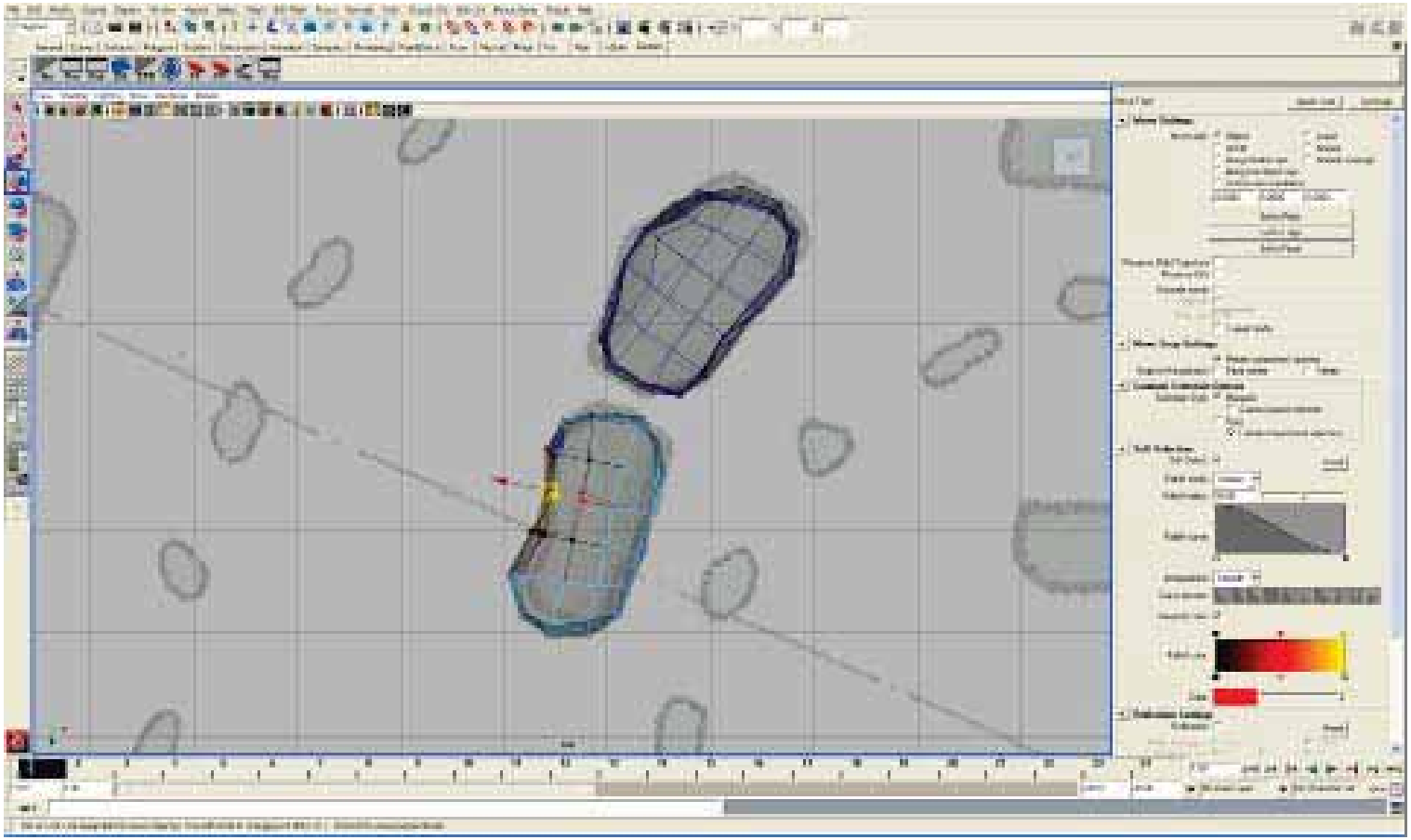
   - In the top viewport is the easiest way to move, scale, rotate, and position your new forms.
   - Use the image plane as a reference to where the stones should be placed.



Assemble the Geometry Using the Image Plane as Reference

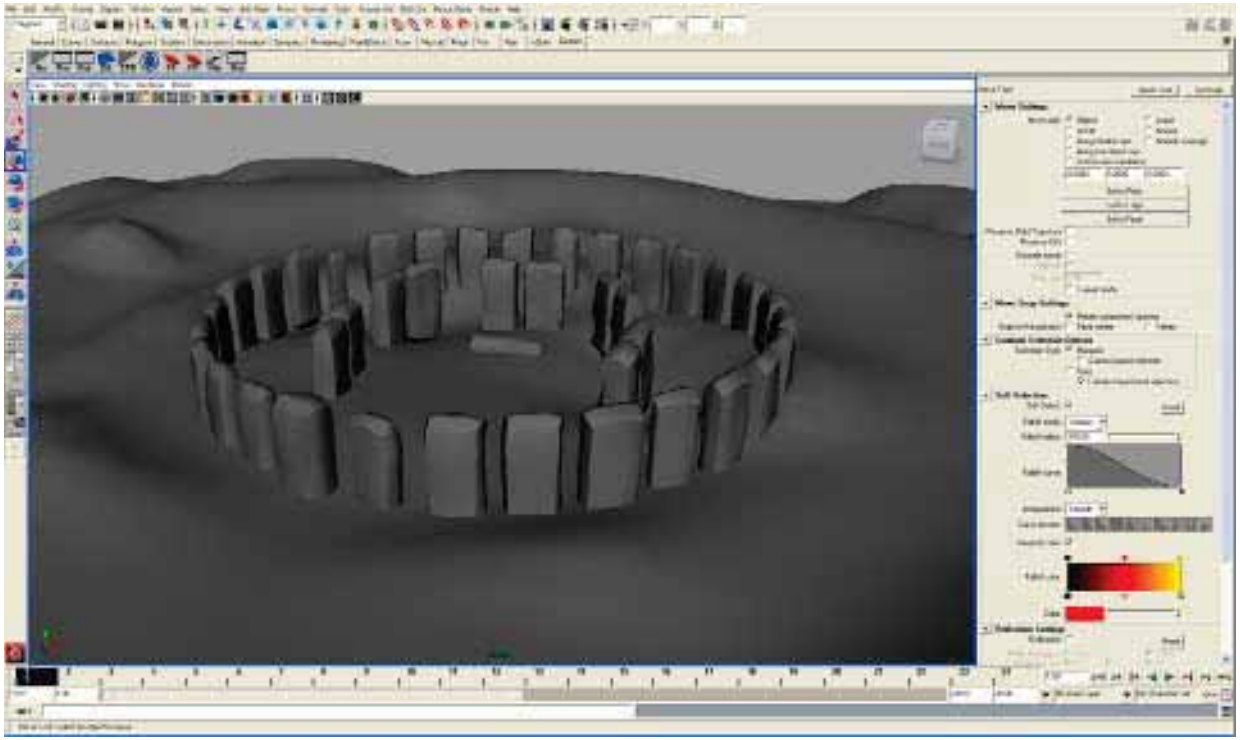
2. Adjust the stones

- Using the soft selection at a lower falloff radius in vertex mode will allow you to gently massage the forms to each be unique and fitting to the plan visible in the image plane
- Continue to follow the plan and position the rest of the stone
- Add the lintels and scale them to be appropriate
- Duplicate and Scale some of the stone to be smaller stones to match the plan
- Save your scene



Adjust the Forms Using the Image Plane as Reference

Maya Project



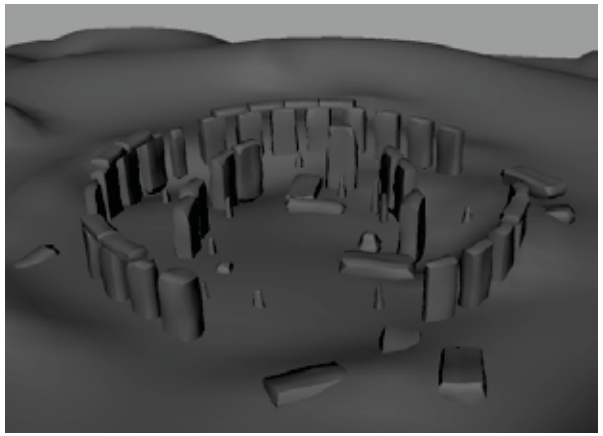
Top Viewport Showing Image Plane and Placement of Stones

After the Exercise

Understanding the ideas behind establishing a site will help you when approaching any architectural problem. Now that Stonehenge is set up, continue to assemble the structure and consider researching this particular ritualistic architecture and try to reassemble the pieces to how it presently stands with broken stones and buried eroded elements. You could also raise the mound high and situate the stone up high or dig a hole and position them around the edge to see how site can vary with the same architectural elements at your disposal.

Concepts Explored

- Creating Terrain
- Staging primitive ritual
- Ceremony in the landscape
- Architectural themes of Site and Place



Stonehenge after many years

Finished Model

Workbook

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2010

3D Visualization & Animation Competition

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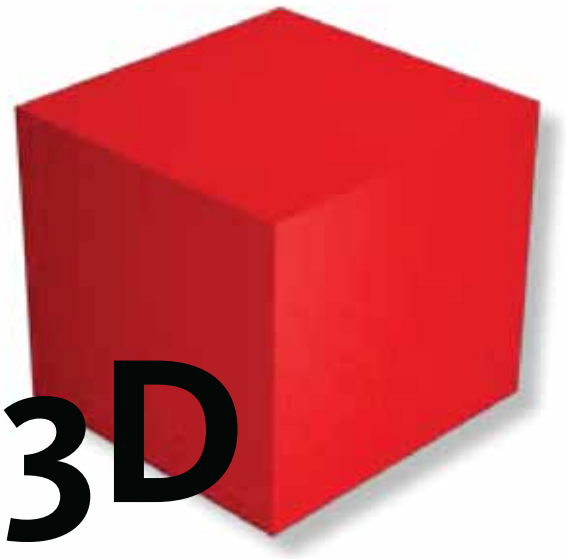

Workbook

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SkillsUSA™ CHAMPIONSHIPS

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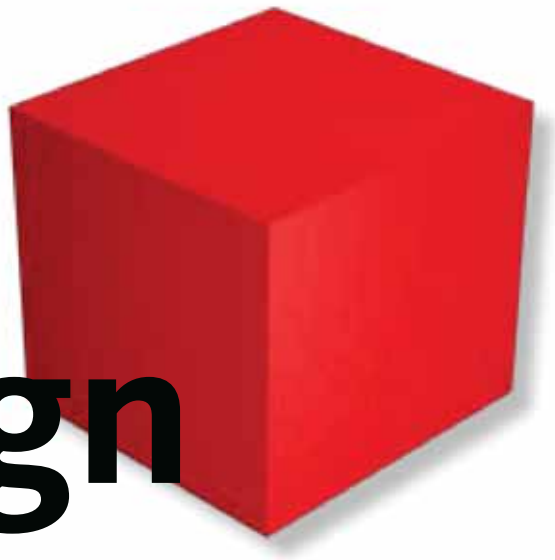

Design

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The Elements and Principles of Design

The elements of design are the foundation to all visual imagery including traditional painting, illustration, architecture, graphic design and 3D art.

Think of elements as ingredients such as flour, baking soda, water or vinegar.

Principles are the wisdom of how to combine these ingredients, or elements. If you want a mild combination, mix water and flour. If you want an exciting combination, mix baking soda and vinegar.

It's the same with the elements and principles of design. Lines are elements. Everyone uses lines when they draw a picture. But an artist may draw a group of people using wobbly or energetic lines to give the picture a repetitive pattern. That's the principle of rhythm. The artist may also use stiff lines to make one person stand out of that group. That's the principle of contrast.

A comic book works the same way, but over a series of pages. Let's look at another element: the point. In a picture, a point may be just a dot. In a comic book panel, it may be "the most important point" in the panel, like a light on a control panel. On a comic book page, it may be a series of panels that make "points" to tell the story. For example, one panel shows a red light to make the point that the character is in danger; the next panel shows her face to make the point that she isn't afraid, and so on.

But not every point needs a panel. One panel may show a key entering a car's ignition. The next may show the character arriving at a destination. We don't need to show her putting the car into gear, using the blinker, or adjusting the radio – only enough to make the point that she drove there. That's the principle of economy.

Knowing the elements and applying the principles can help you direct an animated story. If you consistently place the camera at medium distance (the element of space), you've applied the principle of unity: "one-ness" of camera placement. If you think it's better to simply return to that position every few shots, you create rhythm. If that always-the-same position gets boring, a final close-up on a character's face creates emphasis. It also creates contrast. We pay attention because it's different from what we're used to. It also creates balance. We had a big dose of medium shots, and we "balanced it out" with a close-up shot.

The following are additional examples of how using design principles can help you tell stories:

With color, you can give a story unity and economy by choosing a limited palette.

You can create emphasis and contrast by using a dull palette to set the stage for a sudden bright color to pop out.

You can create balance by using cool colors, like blue and green, for scenes that feel calm; and warm colors, like reds and oranges, for scenes that feel as if “the heat is on”.

With lines, you can design your shots with horizontal and diagonal angles until your character stands strong. Then you can introduce vertical lines, which give us contrast and balance.

With texture, you can emphasize smooth surfaces until “the going gets rough” in your story. Then you can introduce rough surfaces for contrast. Be careful, though. if those surfaces look like they don’t belong in this story, you my lose unity.

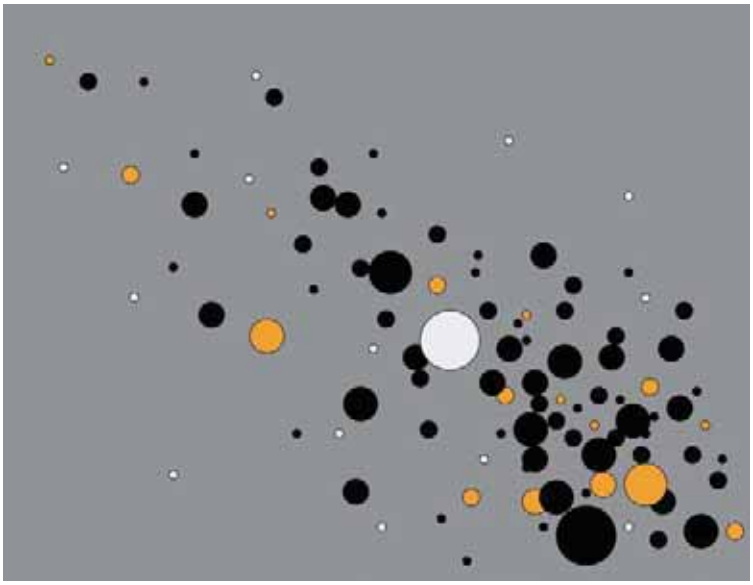
If you’ve ever wondered how great artists, animators and filmmakers make their decisions, here’s the answer: they follow their instincts. They feel as if the picture or story “ought” to be this way. They feel that a close-up shot reveals the character’s feelings better than a distant shot, or that a distant shot shows the character’s predicament better than a close-up. These decisions may be based on instinct, but sometimes our instincts get muddled, or they need guidance. The principles of design remind us that good decisions have common qualities. They are the short list of wisdom that help us make good choices.

Below are the elements of design we will be exploring. Remember they are the ingredients.

- Point
- Line
- Shape
- Form
- Space
- Value
- Texture
- Color

Point

A point is the most basic of design elements and can be defined as the smallest area of visual attraction in a composition. Point is just that, it is a point or mark. But, a single point can also be used to create a focal point and attract a viewer's attention to a specific area, emphasizing the story. A point can define a location in space, and it can create an illusion if there are multiple lines. When there are several points near each other, the human mind starts to create a visual connection. If there are very many, more complex shapes can be seen and we can even begin to assign mass and a sense of weight to the grouping of points.



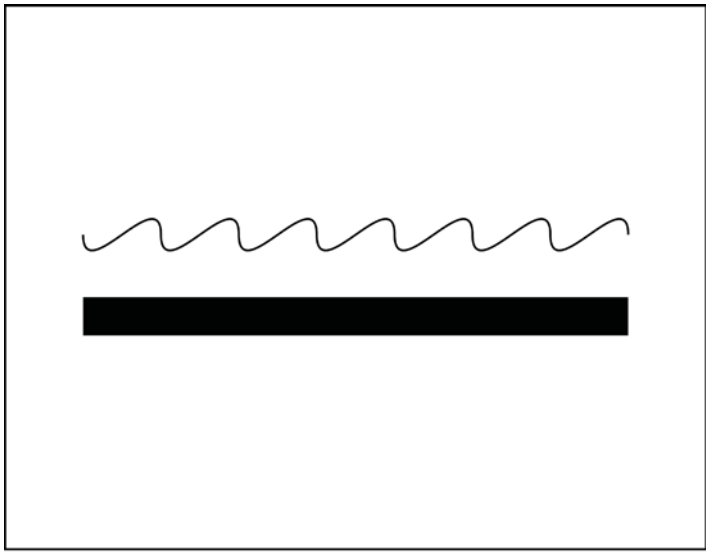
Line

Line could be considered one of the most powerful elements of design. Line is used to define a shape, describe a contour, or be implied by the outside edge of a form. With line, you are able to create and describe much of what we understand about 2D and 3D space. A simple line can describe a horizon in a landscape, a road disappearing into the distance, or even something as complicated as an expressive quality such as energy or mood.

Characteristic of Line are:

Width or Weight

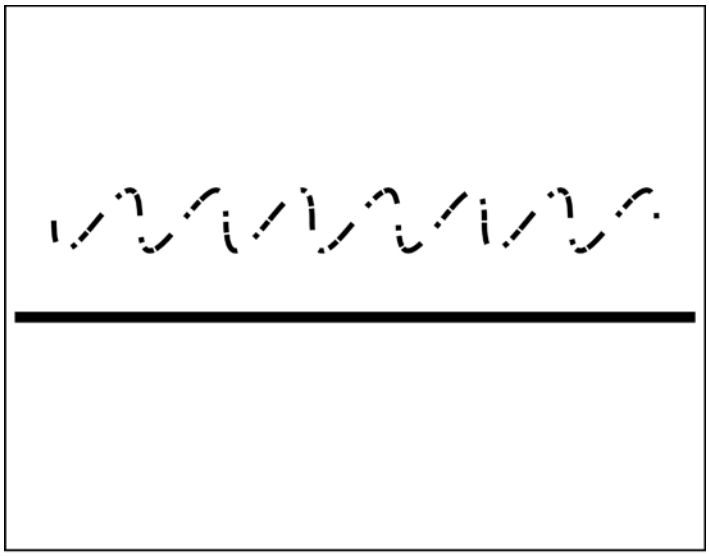
Heavy lines can be used to indicate a feeling of power or of a close proximity while light lines can indicate delicacy or distance.



Width or Weight

Length

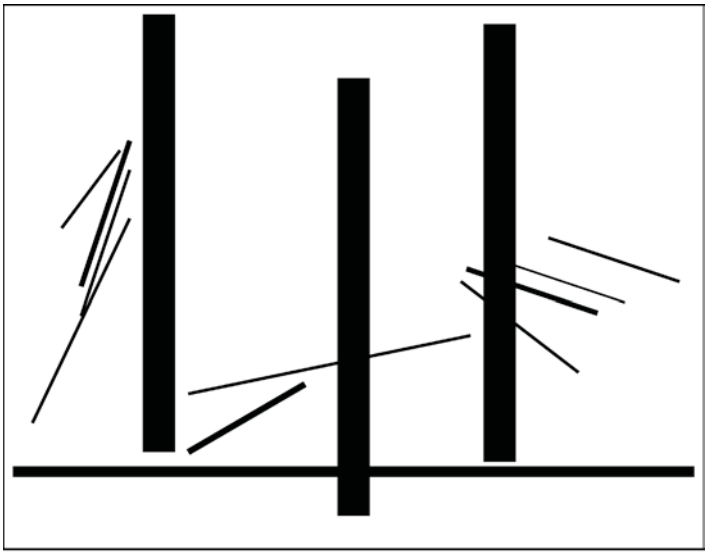
Long lines can give a feeling of continuity, while short, broken lines have a nervous tempo or pattern to them.



Length

Direction

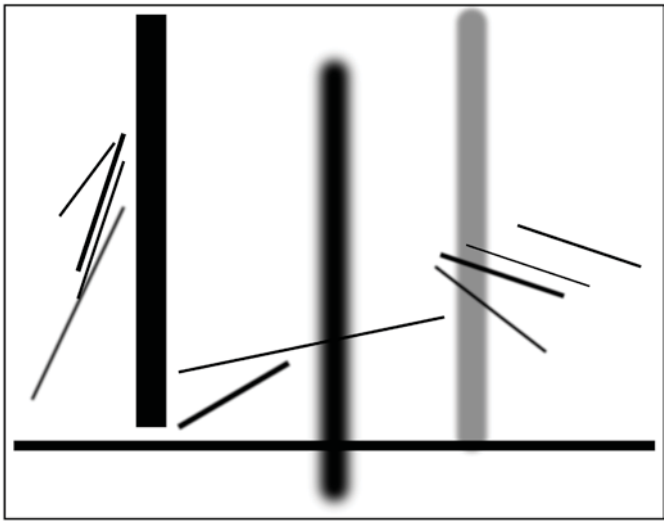
Horizontal lines suggest stability and project calmness and peacefulness. Vertical lines depict power and height, and diagonal lines can have the feeling of action, movement, or instability.



Direction

Focus

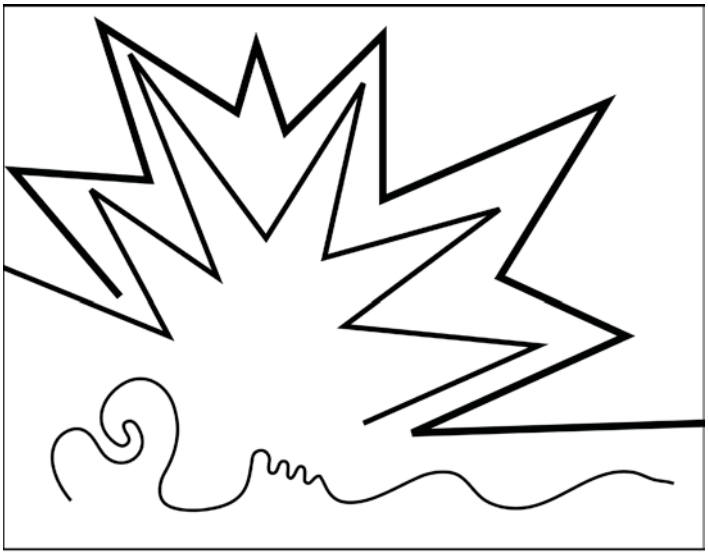
Sharp lines give the appearance of clarity and decisiveness, while blurry or fuzzy lines give the feeling of softness, gentleness, or a dreamlike quality.



Focus

Feeling

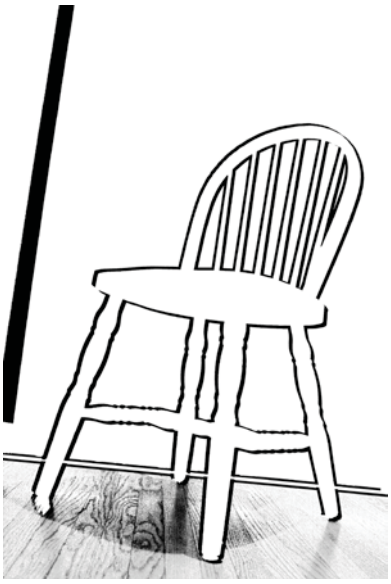
Sharp, jagged lines can express speed, anger, aggression, or nervousness while graceful, smooth, or meandering lines can suggest slowness, elegance and romance.



Feeling

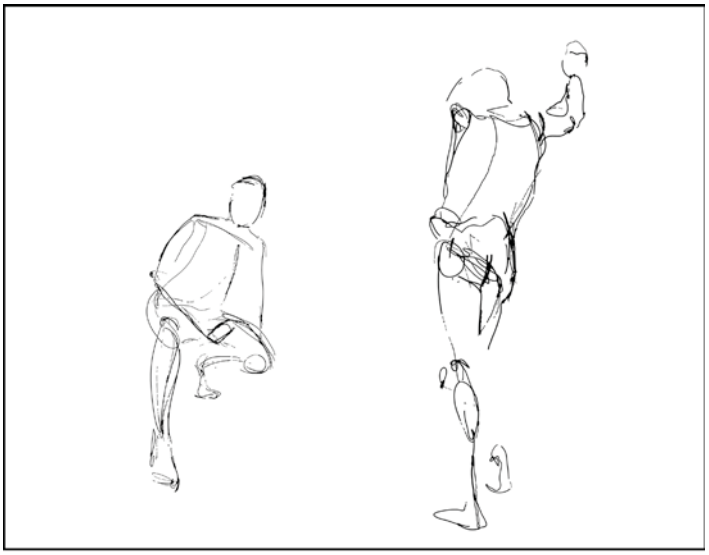
Contour

Contour lines describe the shape of an object and the interior detail – basically any edge – be it the edge of a shadow or the edge of plane.



Gesture Lines

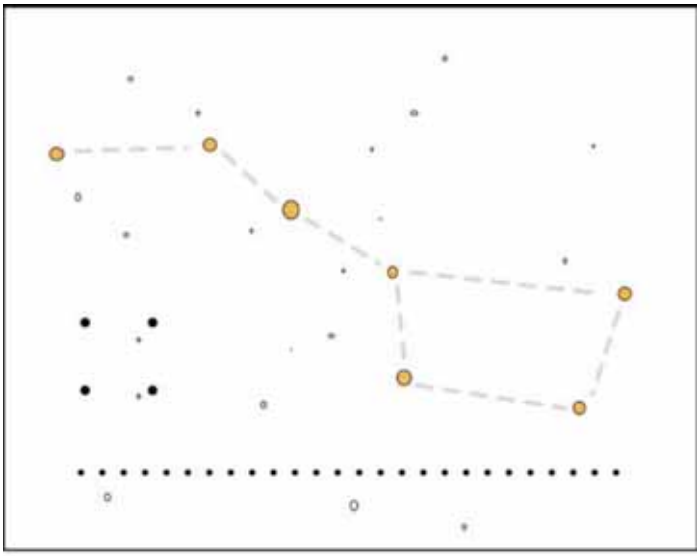
A Gesture line catches the movement or "essence" of an active figure or scene.



Gesture

Implied Line

When points or objects are in close proximity, implied lines are created. An implied line is also created by the point of view (POV) of an object or character.

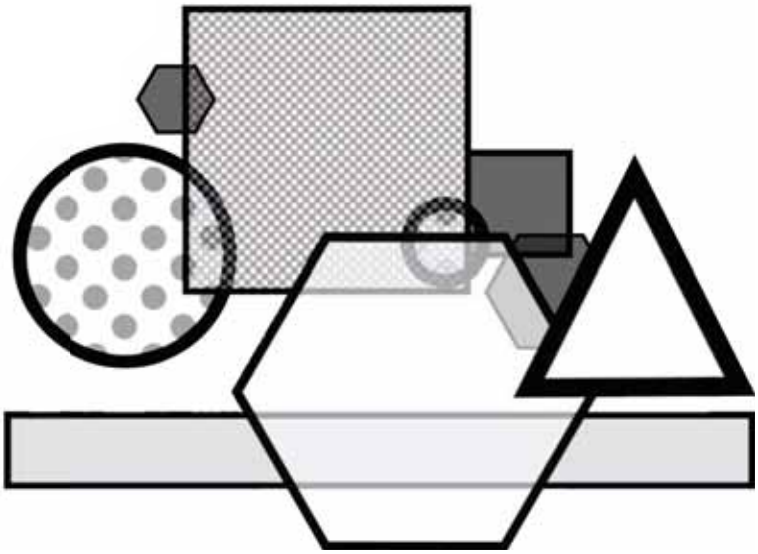


Implied Line

Shape

When a line encloses a space, it creates a shape. Shape is two-dimensional only, meaning that it has height and width, but no depth. Depth of a shape can be implied, but it is not real; therefore it is illusionistic.

Shapes can be broken down into the following categories:

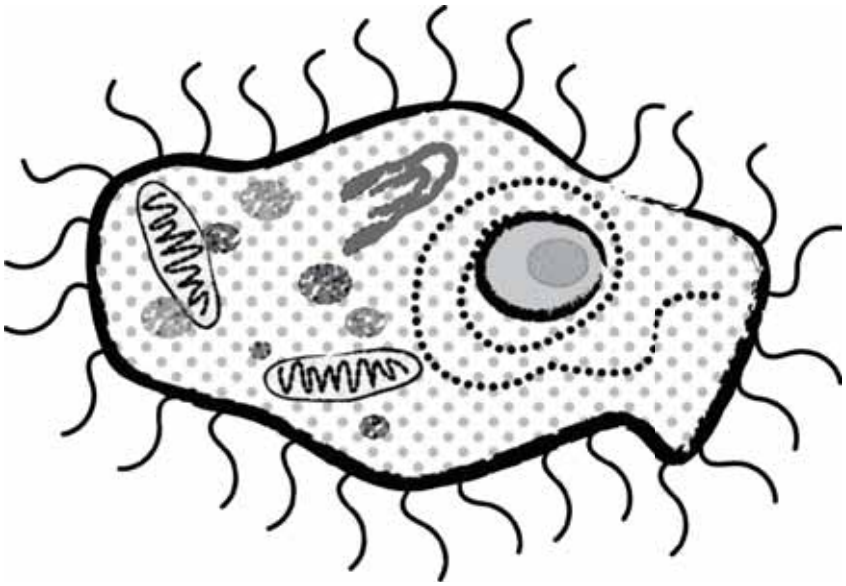


Geometric Shapes

Circles, squares, rectangles and triangles are the most familiar to us. We see them in nature and in the manmade realm, ranging from crystals and snowflakes to architecture and machine parts. Rectilinear shapes fall into this category as well, since they are angular or straight.

Organic Shapes

Organic shapes are often found in the natural world. Trees, rocks, and cells are all examples of organic shapes as are all animal and human forms. But we can also see them in the manufactured world in anything that is free-flowing or irregular, such as drapery, overstuffed furniture and many stained-glass windows. Curvilinear shapes refer to the use of curved, rounded forms.



Positive Shape

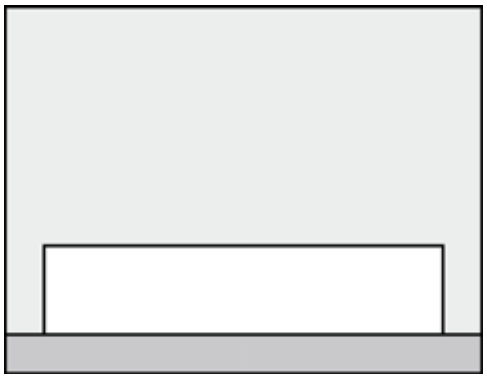
A positive shape is the object within a picture plane, such as a chair.

Negative Shape

A negative shape is the space around and in between (the openings within) the positive shape.

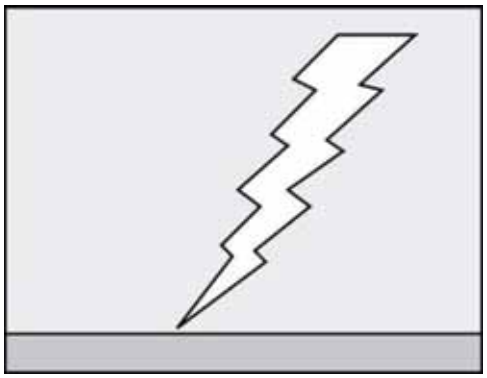
Static Shape

A static shape appears stable and unmoving, such as a mountain or a simple block.



Dynamic Shape

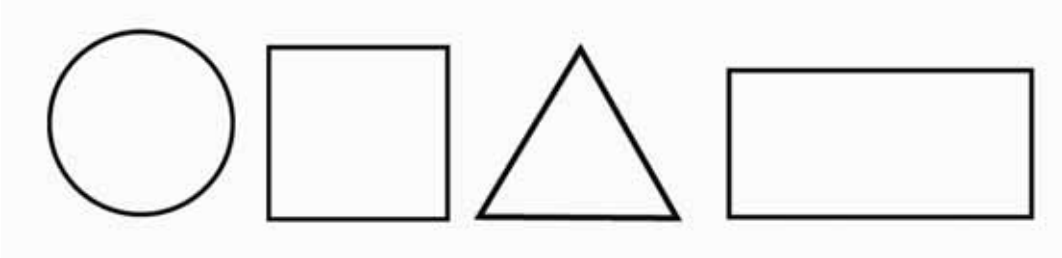
A dynamic shape appears to be moving and is active, such as the cloud formations around the mountain or a lightning bolt.



Form

Form is the three-dimensionality of a shape. Shape is only two-dimensional, lacking depth; form is three-dimensional, having depth. Form can exist in real space, and it can exist in virtual space. With a form, you move around in it and, in the case of a building, walk into it. To imply form of a shape in 2D space, you can use shading or perspective drawing. By creating a light source for a circle and casting a gradation shadow, you can turn a flat circle into an illusionistic sphere. By using vanishing points, you can create the illusion of a flat square becoming a 3-diminsional cube. Any shape can be made into a form by adding depth.

Shape

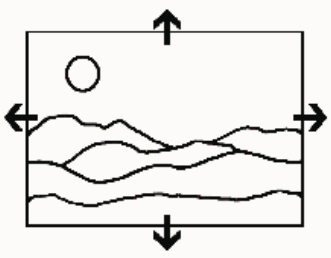


Form

Space

Space is the expanse or area in which all objects and events take place. Space has three-dimensions; width, length, and depth. Space can also be considered to have a fourth dimension of time. With an environment you are able to walk through and explore the space. With an object, you are able to walk around the object, look above it and under it. In the case of architecture, there is exterior space, and there is interior space.

Two-dimensional space



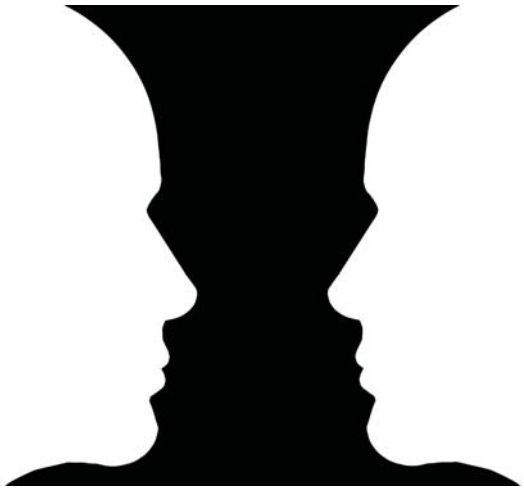
Types of space:

Positive Space

Positive space is like a positive shape, in that it refers to the shape of the object in space.

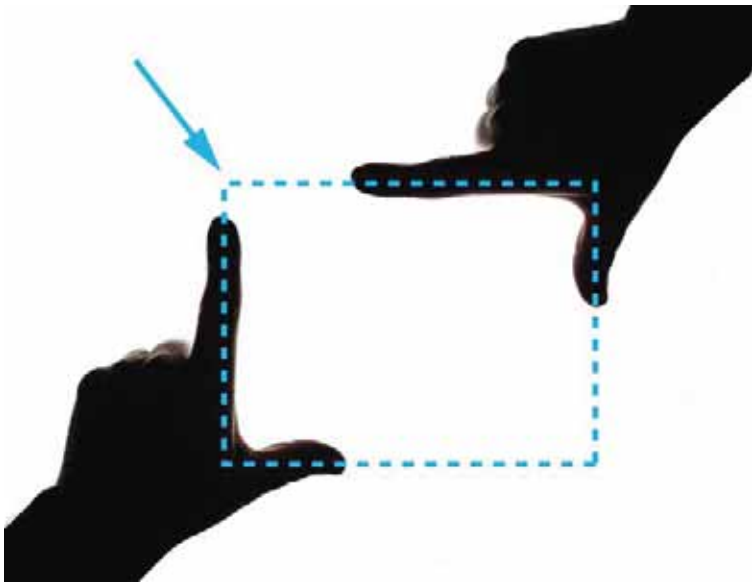
Negative Space

Negative Space is the space around the object. Negative space, as seen here in the space around the vase above, can also have a recognizable shape. Playing with these two spaces can create interesting results.



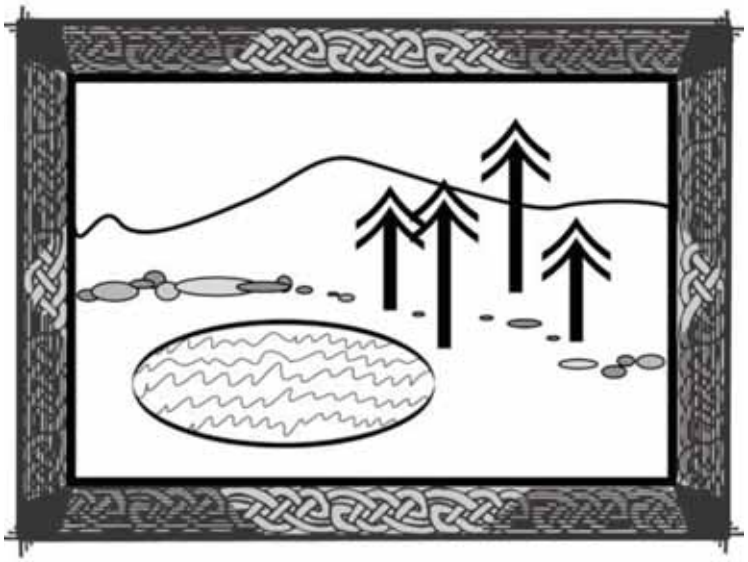
Picture Plane

The picture plane is the flat constraints of your composition; a space having width and height, but no depth.



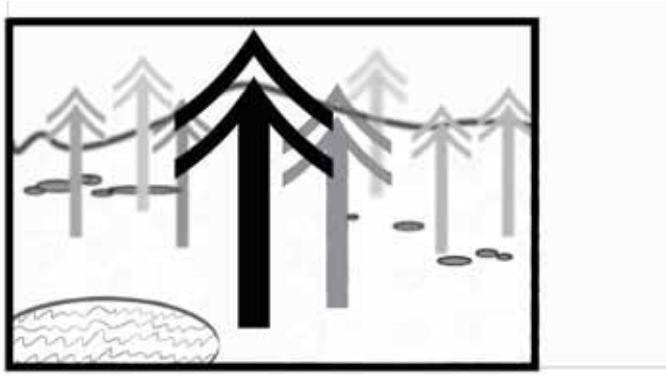
Composition

Composition is the arrangement of your design elements within the picture plane.



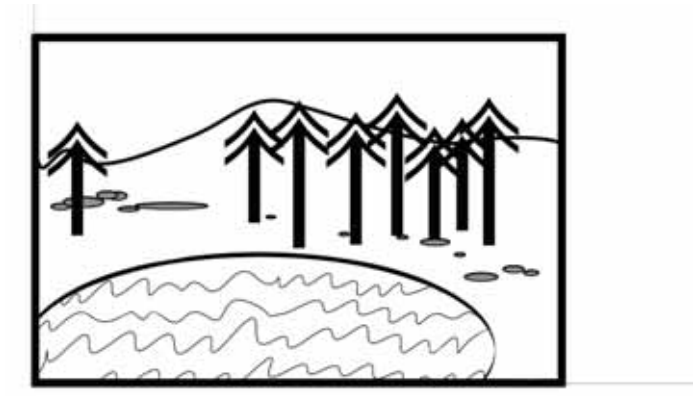
Focal Point

The focal point is the area of your composition that you want to have priority over the rest of the composition. The focal point has a dominant presence. In other words, it has hierarchy over the other elements.



Proximity

Proximity is the space in between shapes or forms. Proximity can create tension or balance by the positioning of the shapes or forms in relationship to each other.



Value

Value is a range of lightness and darkness within a composition or within a shape or form. Value ranges from pure light to complete darkness, with all of the scale ranges in between.

Elements of Value:

Tint

Tint is the white added to a color or value. By adding white to a green, you tint the green to a white. By adding white to a medium grey, you change the medium grey to a lighter tint of grey.

Shade

Shade is the opposite of tint. By adding black to a color or value, you change its shade. A night sky would be a dark shade of blue. Black added to a medium grey would be a dark shade of grey.

Contrast

Contrast is the difference between values. The larger the difference between values, the higher the contrast will be. The closer the values, the lower the contrast will be.

Gradation

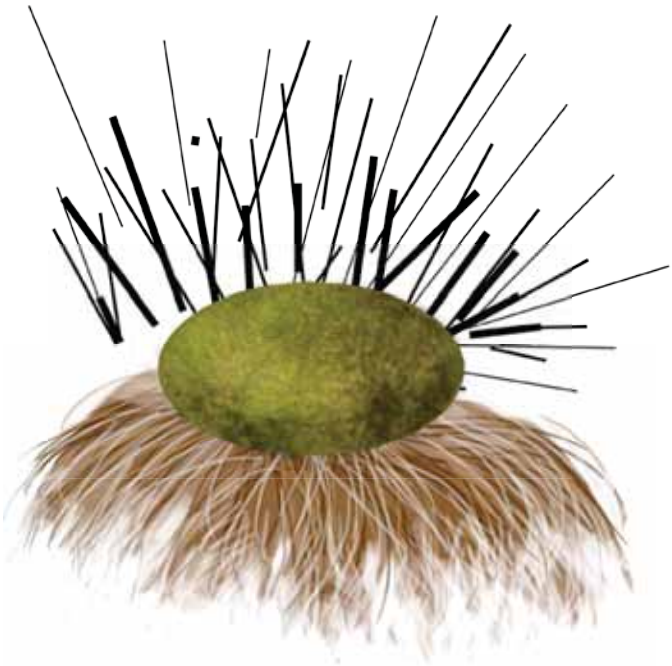
Gradation is the change in value ranges over a composition or an object.

Scale

Scale is the range of pure light/white to pure dark/black of any color.

Texture

Texture is the surface quality of an object. Texture can be rough and prickly, like the surface of a cactus, or it can be soft like the fur on a cat. It can be woven like a basket, or it can be smooth like glass. Texture can be real – something you can touch and feel on an object. It can also be implied by the use of pattern and value, as in a drawing/painting of an object's surface or skin.



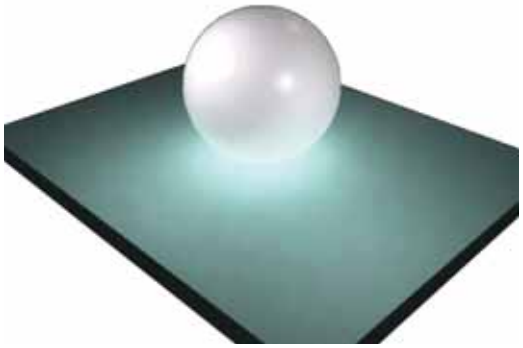
Color

Color is the most complex of all the elements. It has a physical presence and creates a psychological response in the viewer. Did you know that color comes from light? Did you ever examine the colors coming from a rainbow? You can see how it was formed if you understand the principles of a prism. With the rainbow, the small drops of water in the atmosphere refract the light into the separate color spectrums. While a rainbow is refracted light, the color of an object is determined by reflected light. What color we see is determined by which light waves or color spectrums are absorbed and which color spectrums are reflected back and picked up by the human eye. In pure black, all color is absorbed, and in pure white, all color is reflected back.

Besides the color being reflected, the luminosity (light intensity) of the color is affected as well. When light hits an object, the color is either reflected back **specularly**, **scattered**, or it is **absorbed**. More often than not, it is a combination of the three.

Specularity

Specularity is reflection that has a high sheen or mirror-like quality to it. The light reflection has a focused quality to it.

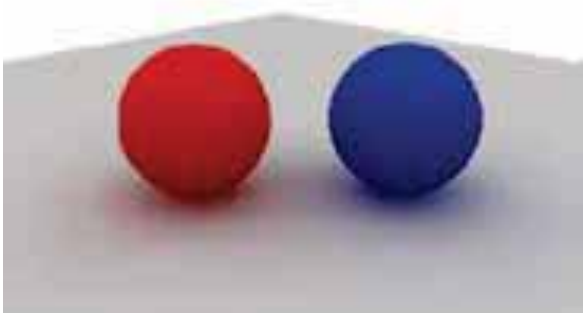


Scattered

Scattered refers to reflection that is usually uniform in nature due to the light leaving the object in an unfocused radial path.

Absorbed

When light is absorbed, the reflective quality of the color is low and therefore has a soft matt surface. A non-glare monitor screen is a good example of this quality.



Now that you have learned about the elements of design here are some exercises to work on.

The Principles of Design

The principles of design are the ways in which we organize the elements of design to create a cohesive composition.

The principles of design we will be exploring are:

- Balance
- Emphasis
- Economy and Continuation
- Rhythm
- Unity
- Proportion
- Contrast

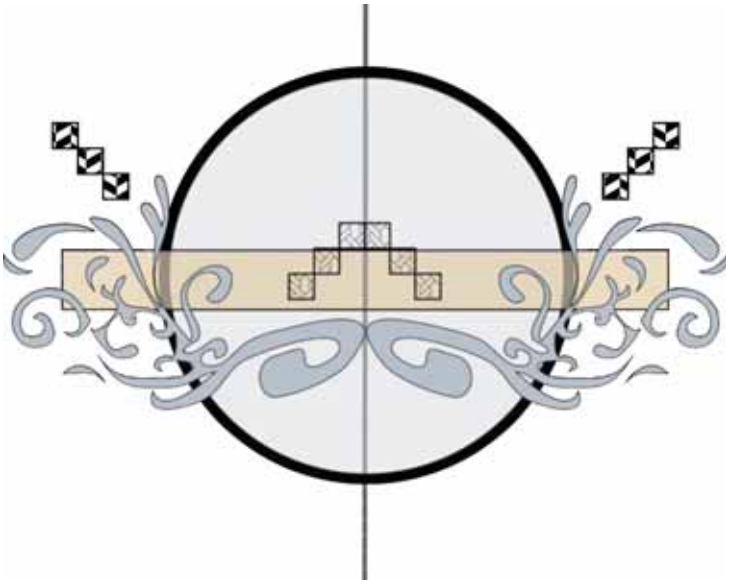
Balance

Balance is the visual arrangement of elements or objects in a composition that creates a sense of equilibrium. Balance can be symmetrical, asymmetrical, or radial.

Symmetrical

Symmetrical balance means both sides of an imaginary line are the same. Symmetrical balance is another term for symmetry. A composition has symmetry elements are repeated in a mirror-like fashion, usually on a vertical axis. This mirror-like symmetry is also known as bilateral symmetry.

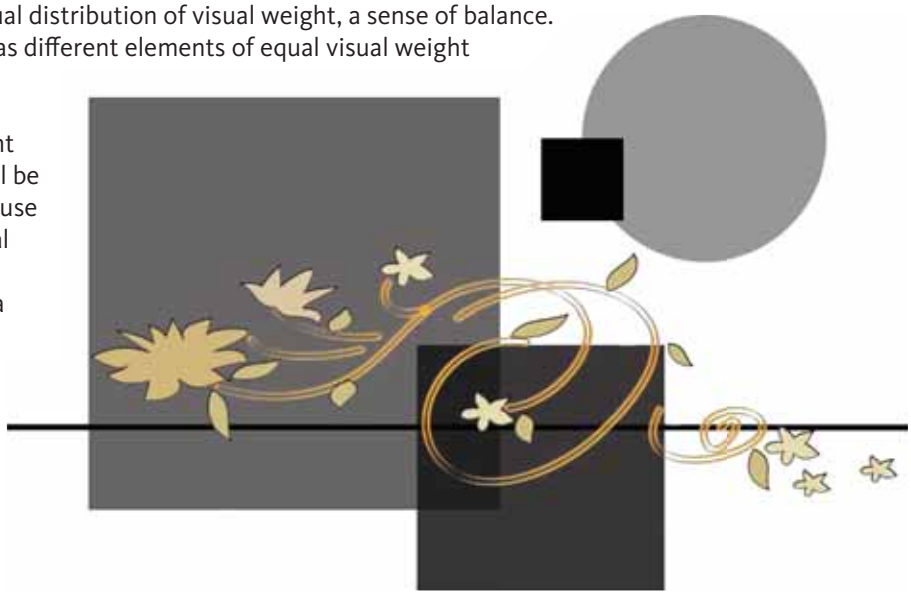
Symmetry appeals to our innate sense of balance. We see symmetry in our bodies, as well as throughout out natural and man-made environment. We observe symmetry on a daily basis in the world around us. For this reason, it can be a valuable tool in design as it can evoke a feeling of predictability and stability in the viewer.



Asymmetrical

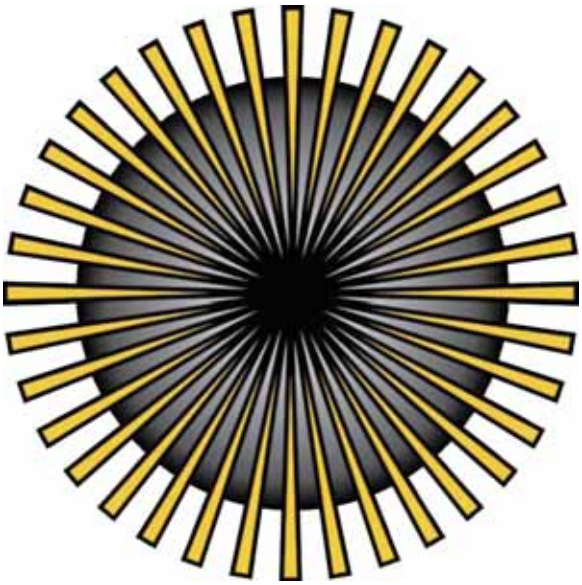
Asymmetrical balance means each side of an imaginary line is different yet equal. Asymmetrical balance, or informal balance, refers to the creation of visual balance through the use of contrasting elements. These elements may include different sizes, shapes, values or colors yet still provide, through the equal distribution of visual weight, a sense of balance. This sense of balance is created when a design has different elements of equal visual weight distributed on either side of a central axis.

Large, dark shapes always "feel" heavier than light shapes. The lower portion of a picture format will be viewed as nearer to the ground and heavier because of our innate sense of gravity. An element's visual weight will also vary according to size, texture, complexity of shape, contrast and placement in a design format.



Radial

Radial balance, or radial symmetry, is when elements emanate from or are arranged around a common central point. Radial symmetry often incorporates the use of diagonal elements that extend from a focal point. Flowers and other natural forms often exhibit this kind of balance. Radial symmetry is used in many circular designs. The attention is drawn to the center by the elements and principles used in the design.

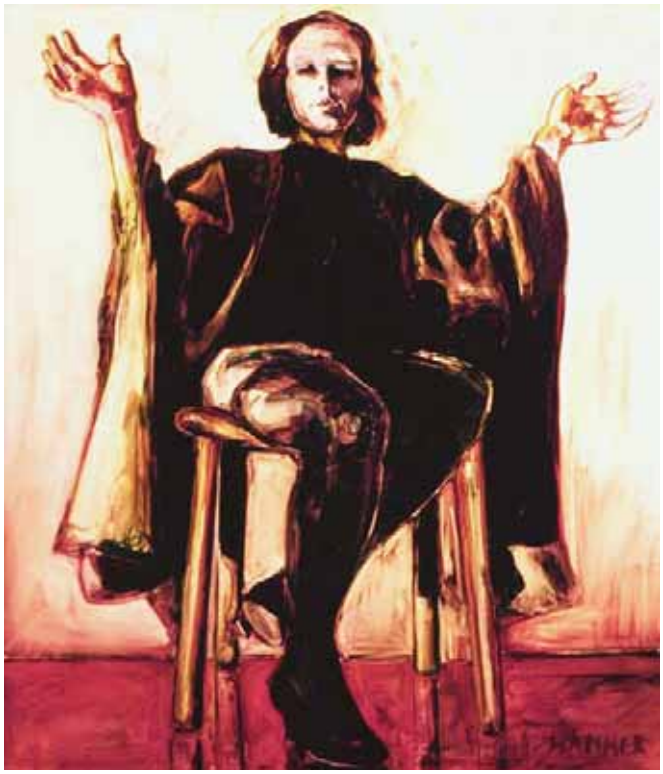


Emphasis

Emphasis creates a focal point or points in a design. It can serve as a marker to show what in a composition has hierarchy or importance. Levels of emphasis can work as road signs to guide the viewer through the multiple levels of a composition. You can create emphasis by making something dominant or by creating a focal point.

Dominance

An object or element has dominance when it has priority over surrounding objects either through the use of color, size, position, or proximity.



Focal Point

A focal point in a composition can be created by light and dark (contrast), line movement (either implied or real), the level of saturation of colors, and by the use of dominance as described above.

Economy

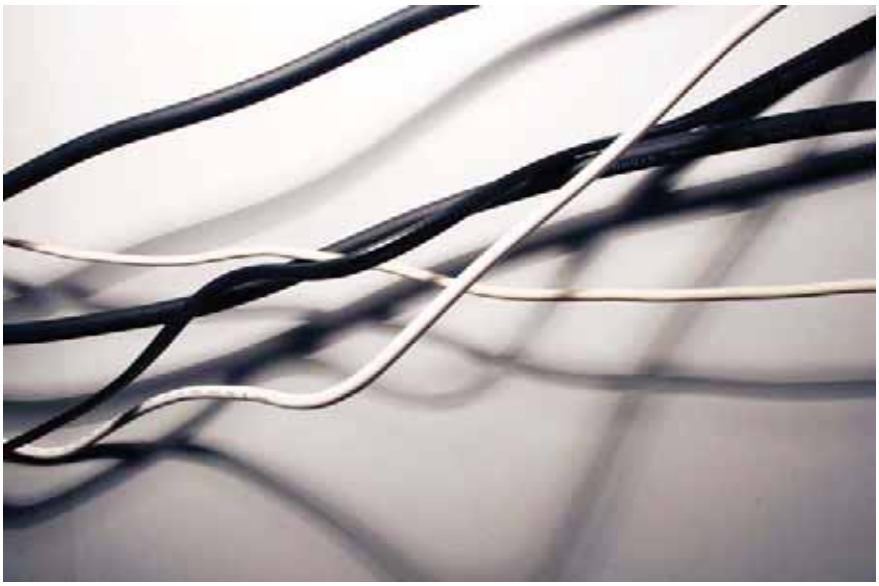
Economy is a principle of design which emphasizes the simplification of elements to express a message. Only the elements required to express the idea are used. The use of too many elements or contrasts in a design may distract viewers from the message, or cause them to disengage completely from the viewing experience. To understand economy in design, think about and remember the phrases “less is more,” and “in simplicity there is beauty.”

Continuation

Continuation refers to the "lining up" of visual elements in a design. When elements are placed in a continuous fashion, the viewer's eye will transition from one element to the next with a feeling of unity. Continuation can also be created by tangible lines that you can see, such as on the edges of a tall building shooting up into the sky, and from implied lines, such as the direction a person in a composition may be looking. The viewer's eye naturally follows both to the natural conclusion.

Rhythm

Rhythm refers to the repetition of shapes or elements in a design. Rhythm also refers to the movement of the viewer's eye through a design. Often, the repetition of shapes can serve as a tool to create this visual pathway. This repetition may be random or planned, forming a pattern. It can also create a sense of tempo, or time, in the composition.

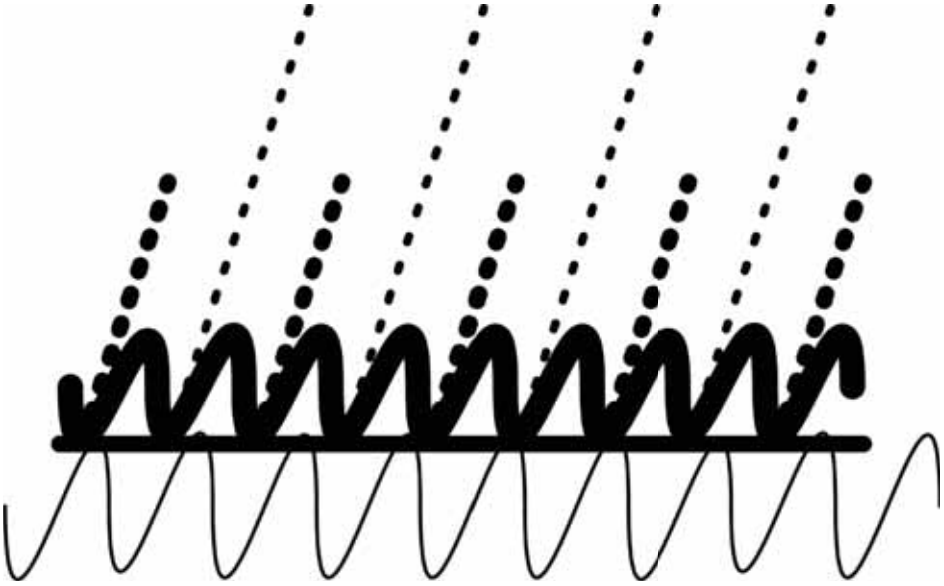


Repetition

There are different types of repetition.

- **Regular**

  Regular or systematic repetition is created when the elements and intervals between the elements have a consistency with very little change.

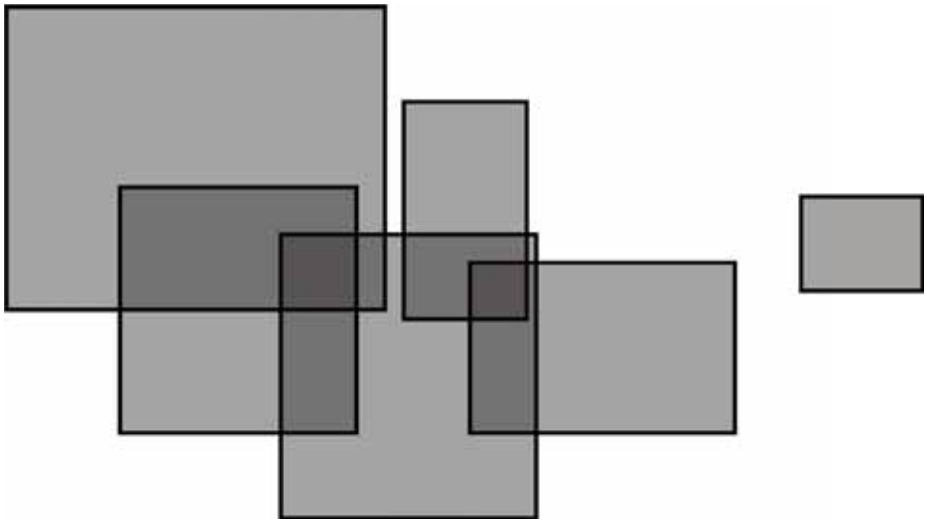


- **Flowing**

  Flowing rhythm is more organic and can have more variation in the elements used to create the composition, much like a winding natural stone walkway or waves of meandering wire.

- **Progressive**

A progressive rhythm sets up anticipation of continuation. This is done by the progression of sequential elements, like the scene layouts in a comic book or buildings in a city skyline.

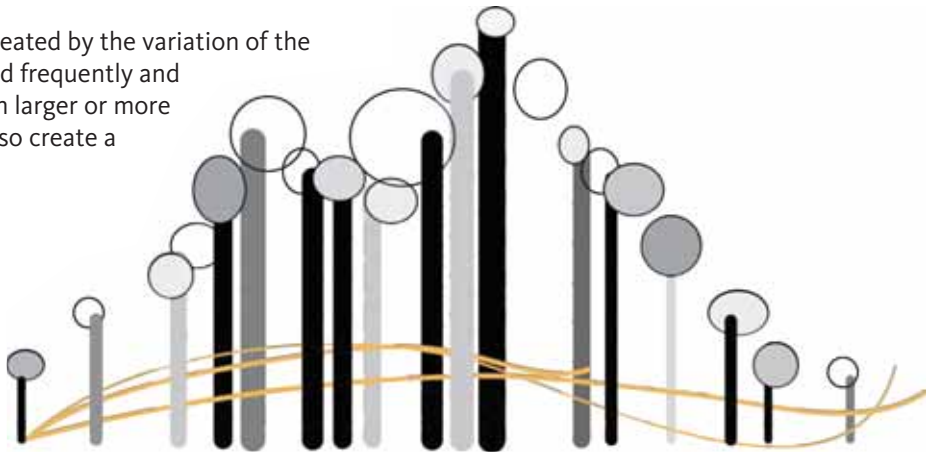


Pattern

Pattern is created by elements being repeated in a predictable fashion. The repeating element or elements work together to create an overall pattern.

Tempo

The tempo of the rhythm in a composition is created by the variation of the repetition of elements. Small elements repeated frequently and close together create a faster visual tempo than larger or more fluid elements spaced further apart. This can also create a sense of time in the composition.

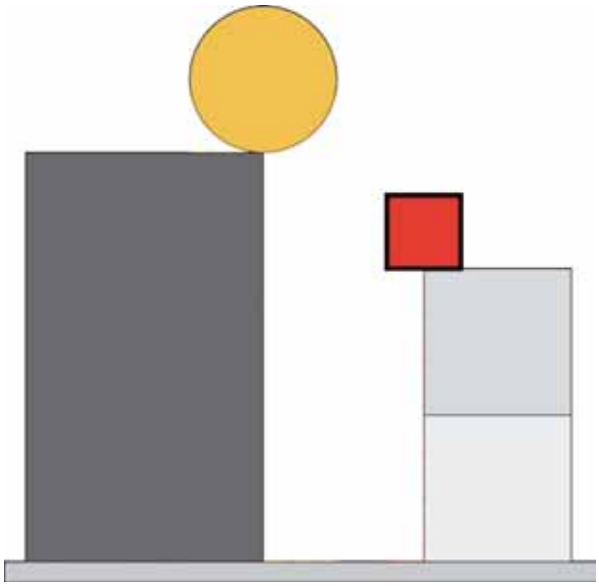


Unity

Unity refers to visual harmony and agreement among the elements in a design. When the parts work together to create a whole, you have unity. This is also called Gestalt. Gestalt is complex. Simply put, it means that the whole is greater than the sum of the parts meaning that we as viewers of a composition, get greater pleasure from the whole composition than by examining the individual elements used to create the composition. To achieve Gestalt, or unity, we can utilize the concepts of repetition, proximity and continuation.

Proximity

Proximity can create unity or tension depending on how much emphasis is given to each element and how close the elements are placed to one another. A sphere near the top edge of a cube creates tension through the sense that the sphere could drop, whereas another cube placed squarely on top of the cube creates a sense of unity or stability.



Proportion

Proportion is the relationship of elements in comparison with each other, or with aspects of a single element or object. Proportion can create a sense of unity or of unease. If we view a house with a door much out of scale with the rest of the house, we have a sense that something is not right. The same goes for a man with arms too long for his body. Proportion can also govern the amount of an element we use to create balance, such as how many organic shapes we might use in conjunction with how many geometric shapes. Proportion works well with balance and with unity.

Contrast

Contrast is used to create emphasis through the use of contrasting elements. Elements with strong contrast stand in opposition to one another: light against dark, large against small, round against square, smooth against rough, etc. In color, this might mean warm colors against cool colors, or light colors against dark ones.

There will often be many kinds of contrast within one design. Too little contrast will cause a design to be uninteresting; too much contrast can cause it to be confusing.

Contrast is a part of our everyday world. From the shape of a building against the sky, a boat against an ever-changing backdrop of sea and sky, or a statue in a garden, the mix of man-made and natural contrasts is all around us.

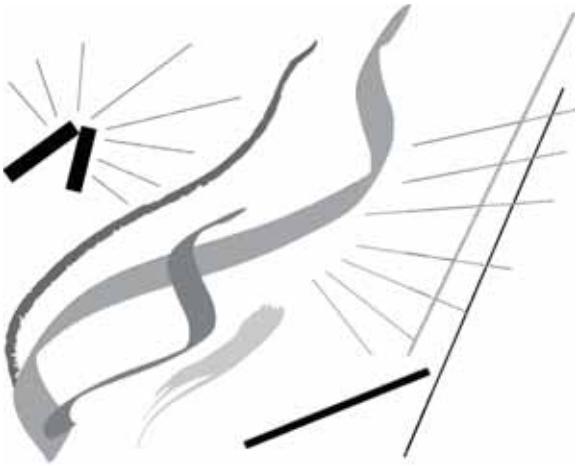
Examples of contrasts used in design might be:

- Large to small
- Light to dark
- Curved to straight
- Old to new
- Geometric to organic
- Smooth to rough
- Warm to cool
- Many to few
- Deep to shallow

Types of contrast

Line Contrast

The use of different types of lines can create a strong contrast. Thick, bold lines have a bold effect, but when contrasted with delicate lines, the entire atmosphere of a design can change. The bold lines may appear closer and the smaller, more delicate lines appearing further away. An emotional context can be established for strength versus weakness, leader versus follower, etc.



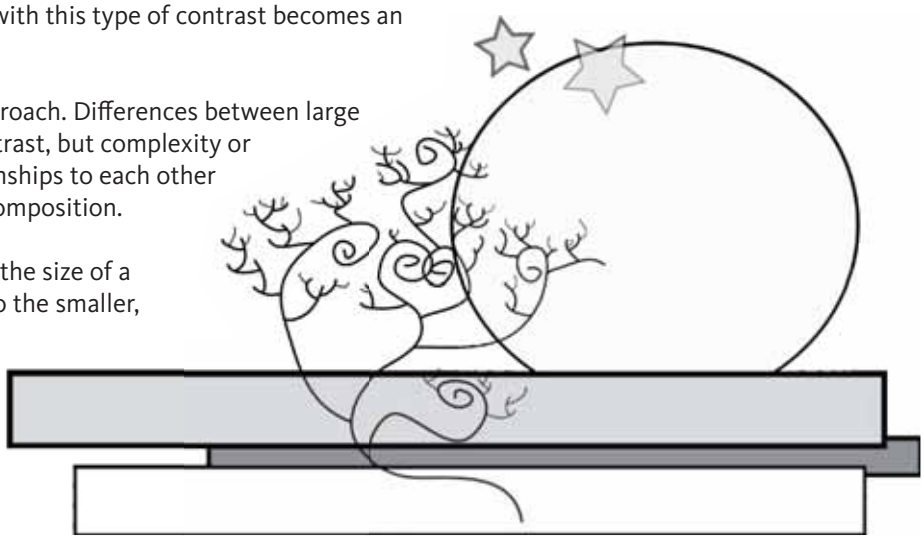
Line contrast can also create pattern and texture. Think of the hard flowing line that might make up the horns of a goat (pattern), and the short softer lines that can represent the fur of the goat (texture).

Shape and Form Contrast

Similar shapes of different sizes offer many opportunities for contrast. A larger shape may seem to advance visually, or it might appear more stationery because of its stronger visual weight. A smaller shape, because of its lesser visual weight, may seem to have the freedom to move around at will. Working with this type of contrast becomes an exercise in space and balance.

Completely different shapes offer another approach. Differences between large and small shapes can provide one form of contrast, but complexity or simplicity of different shapes and their relationships to each other plays a large part in the overall contrast of a composition.

A small, but complex organic shape can offset the size of a larger, simpler one. The eye will be attracted to the smaller, organic shape because of its complexity.
Angled or sharp edges can be very dramatic when tempered with curved or softer shapes. This type of contrast adds visual interest to a design.



Color Contrast

Color allows for very bold, or very subtle contrast, and an infinite number of steps in between. Colors can be contrasted with warm against cool, light against dark, bright against muted, etc.

Value Contrast

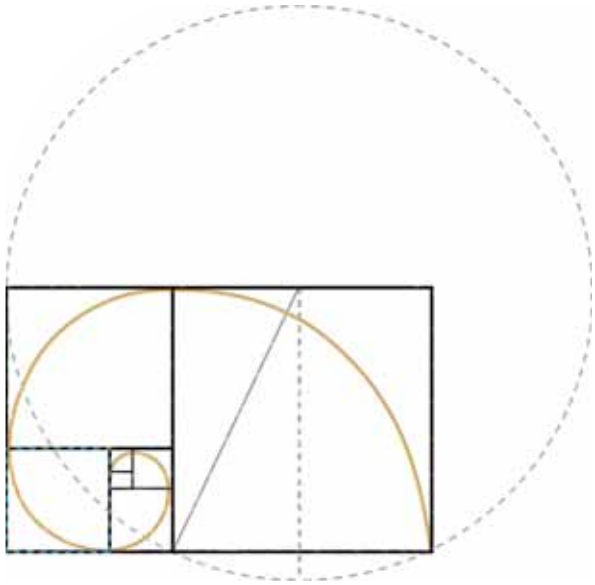
The effects of dark and light offer an infinite number of dramatic possibilities. They can set mood, create emphasis, establish a pattern, as well as give a sense of excitement, dimension, space, or environment.

Composition

Focal Point

An area of interest is called a focal point. As an artist, you can create and manipulate this area of interest. A focal point can also be thought of as a visual starting point within an image or space.

When designing a composition and placing a focal point, the artist is creating areas of emphasis within the picture area. The Golden Section is one method that artists throughout history have used to create these divisions of space in a harmonious manner. The “golden section” is a system of proportion, devised by the Ancient Greeks, based on mathematical relationships found in nature. This system of proportion relies on the use of a ratio, which defines the relation of one part to another. This is also used to create a relationship to the whole composition through a mathematical formula. The “golden section” is also known as the “golden ratio”.



Contrasts of value, shape and color are all simple and effective ways to engage the viewer. These differences and contrasts attract attention and can be used to make images more engaging.

The area of greatest contrast may also be the area of greatest interest in a design. This area of interest is called a focal point. The artist is both the creator and manipulator of this area of interest.

There are many ways to create this area of visual interest but one of the simplest is through value contrast. To review, value contrast refers to the relationship between areas of light and dark. Areas of similar value within an image are can be described as low-value contrast and areas with more extreme, pronounced value contrast can be referred to as having high-value contrast.

To create a focal point using shape:

- Use complex shape(s).
- Direct the viewer using compositional or perspective lines.
- Isolate the area of interest.
- Interrupt a pattern.

To create a focal point using value:

- Place highest value contrast in area of emphasis.
- Create a focal point in a high key design with dark values.
- Create a focal point in a low key design with light values.
- Create emphasis with size difference.

To create a focal point using color:

- Place an intense, saturated color in a design of muted colors to create emphasis.
- Place muted colors in a saturated design to create an area of interest.
- Introduce another color in a monochromatic scheme to create a focal point.

Color Theory

Controlling color can be difficult. But, it can be one of the most effective ways to control or affect a composition. The best approach with color is to think about a color scheme before applying color to shape or form. Joseph Ittens, the famous color theorist, said, "He who first draws lines and then adds color will never succeed in producing a clear, intense color effect." Color is an essential part of any composition and needs to be determined in the early stages of any work to be the most effective.

Color is tricky, in that it is constantly changing and is always being influenced by the colors surrounding it. It is almost impossible to see a color by itself without it interacting with its surroundings. In virtual space and on a 2D plane, color can behave quite differently than in the real world. In the real world, distant objects in the background appear to blend together and appear less saturated due to atmosphere. This can be replicated in virtual space, as well as on a 2D surface if you understand how to manipulate color.

The Color Wheel

Many people find choosing colors that work together an intimidating and confusing process. The following are some of the basic principles about how the color wheel works and schemes for using color. The following guidelines will help you learn how to use a very limited palette, yet give the impression of using many colors. The basic color wheel is made of twelve colors:

- Yellow
- Yellow-green
- Green
- Blue-green
- Blue
- Blue-violet
- Violet
- Red-violet
- Red
- Red-orange
- Orange
- Yellow-orange

All colors can be changed by changing the tint or shade. Tint is changed by adding white, and shade is changed by adding black. The following colors examples will include not only hue (the color) but the hue with tint (white) and the hue with shade (black).

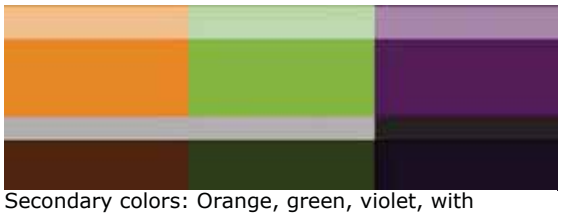
Primary Colors

Primary colors are used to create all other colors. When Primary colors are used together in a design, there is a strong color contrast because of their lack of similarity. Each color has a separate, independent identity.

Primary colors: Red, yellow, blue, with desaturation, tints and shades

Secondary Colors

Secondary colors are the product of mixing two primary colors together. They are positioned midway between the primary colors from which they are mixed. Secondary colors, when used together, have less color contrast than primary colors. For example, green and violet are secondary colors which both contain the primary color blue. The influence of the color blue creates a commonality between them. A softer color contrast is the result.



Secondary colors: Orange, green, violet, with desaturation, tints and shades

Tertiary Colors

Tertiary colors are made by mixing a primary with a secondary color. They are positioned between the primary and secondary colors from which they are mixed.

Tertiary colors: Yellow-orange, red-orange, red-violet, blue-violet, blue-green, yellow-green, with desaturation, tints and shades

Temperature

The color wheel can be divided into areas of color temperature, known as warm and cool.

Cool Colors

Cool colors are any colors that contain or are related by the color blue. Colors such as green, blue and violet are dominant cool colors. Cool colors are calming and appear to recede into space when placed next to warm colors.

Cool colors from the color wheel

Warm Colors

Warm colors are any colors that contain or are related by orange. Yellow, orange and red are dominant warm colors. Warm colors are aggressive. When used with cool colors, they appear to move forward into the foreground.

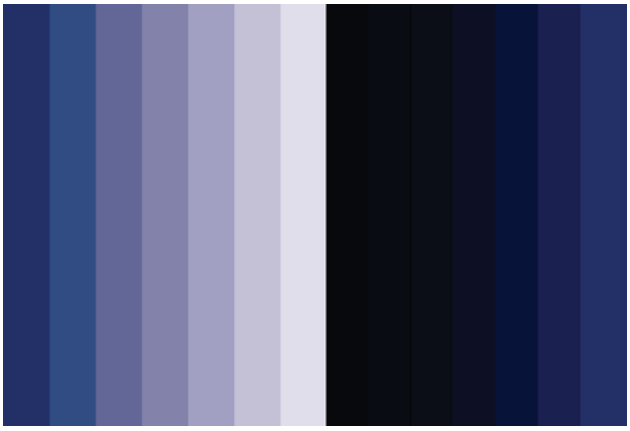
Warm colors from the color wheel

Working with Color as a Beginner

Many artists who are just beginning to work with color find choosing colors that function well together an intimidating process. The biggest mistake artists make in the beginning is trying to use too broad of a color palette. Learning to work with a limited palette in an effective way can actually give the impression of using many colors. Let's look at a few of the basic color schemes and consider some of the basic ways to begin using color.

Monochromatic

Monochromatic is the simplest of the color schemes. It uses only a single hue along with tints, shades, and tones. Adding a neutral and varying the values of that single color can help create interest and add contrast. A monochromatic color scheme explores the tints and shades of a single color. You will notice that the pure hue is brighter and more vivid than the hue mixed with either white or black. The color in its fully-saturated state attracts the eye more powerfully than the tints and shades around it. The tints and shades are not as intense in hue saturation and become desaturated. Adding white, black, or any other color to a pure color will desaturate it.



Monochromatic color scheme, blue with black and white added

Analogous

An analogous color scheme uses two or more hues lying next to each other on the color wheel. This is an elegant scheme to use and often seen in nature. An analogous color scheme is harmonious because the colors used share common color characteristics.

For example, red-orange, orange, and yellow-orange are all mixed from varying amounts of red and yellow. Analogous color schemes can be very effective and like monochromatic, in a 3D environment or on a flat 2D picture plane, can create color consistency.

Analogous color scheme with example of value changes

Complementary

A simple complementary scheme begins with two colors that are opposite of one another on the color wheel. These colors intensify each other's appearance, so the end result tends to be stimulating, and can even give the visual illusion of vibration

Toning down the saturation of complementary hues (with tint/shade/saturation) and raising or lowering their value beyond the level of maximum saturation lessens the visual contrast between them.

Complementary color scheme

Triadic

This is a broader range of contrasts that draws on three colors equidistant from each other on a color wheel. (This happens if you draw an equilateral triangle within the color wheel). An example would be the three primary hues. If you turn the triangle a bit, you would have red-orange, yellow-green, and blue-violet. When any two colors from a triadic color scheme are mixed together, they will create interesting semi-neutrals.

Triadic color scheme

These colors are called semi-neutrals because they are not true neutrals. A true neutral, or mute, is the product of a color mixed with its complement.

Split Complementary

A split complementary is any one hue plus the two hues located on either side of its complement. This can be a broad color scheme and easy to use in a number of interesting ways.

Split complementary color scheme

Hue, Value, and Intensity

Every color has three properties: hue, value and intensity.

Hue

Hue is the quality we identify by a color name such as “red” or “purple.” It corresponds to the distinctive wave-length of a color. To change the hue of a color, we must mix another color with it. If a little green is mixed with blue, the resulting change from blue to greenish blue is a change in hue.

Change of hue

Value

Value is how light or dark a color appears. Referring to the relation of a color to white or black, value indicates where on the value range of pure dark to pure light a hue resides. Think of it this way: a light blue sky has a high value; a dark night sky has a low value. A change in value is higher or lower in value than the normal spectrum of the hue.

To change the value of a color, we need to mix it with something lighter or darker. By mixing black or white with a color, we change the value without changing the hue. This is how you desaturate a color.

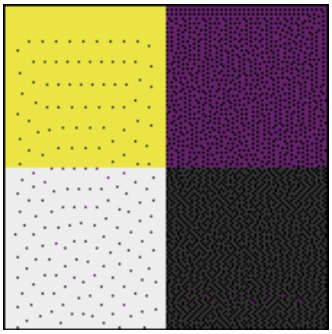
Intensity

Intensity refers to how bright or dull a color appears. It is also called saturation or chromaticity.

Basically, intensity is how much of the hue is identifiable. Grays are achromatic, meaning no hue or color is identifiable. Therefore, grays are low in intensity. A primary red, on the other hand, would be completely saturated and therefore extremely intense and high in chromaticity. Hues reach their full intensity at different values. Yellow would reach its full intensity higher on a scale of grays than red or blue.

Color wheel with value and intensity

Different colors have different values. For example, if you compare the value of yellow to the value of violet, yellow is much lighter in value than violet.



Color and value comparison

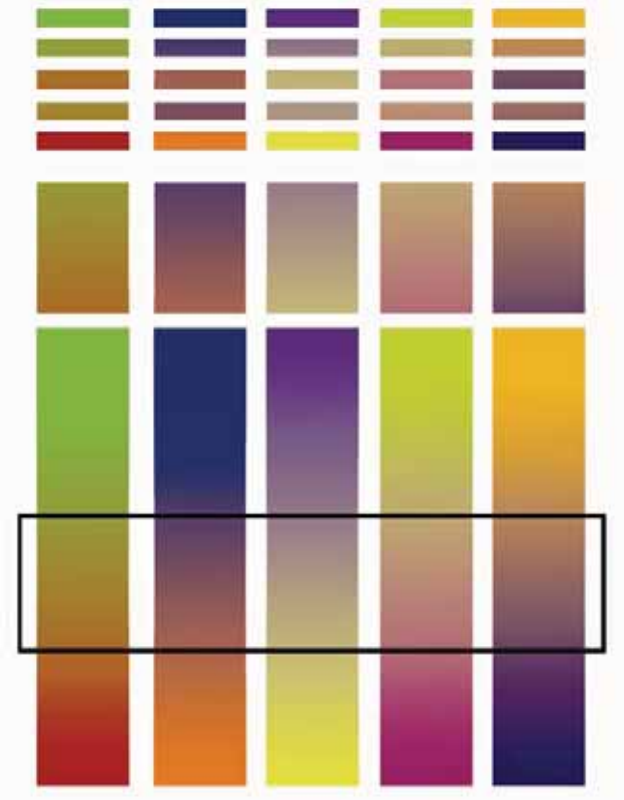
One way to imagine the value of a color is to imagine it as a black and white photograph.

Color wheel with corresponding gray scale swatches for value

Neutrals

Neutrals are hues that have had their complements added to them. Adding a color's complement to desaturate it is referred to as muting the color. This creates a neutral hue. Mixing any two highly contrasting colors is an easy way to make the colors harmonize. The two hues mixed begin to share the same influences in the process.

This process is one to stay in if you want your work to appear harmonious. It is also one way to ensure a pleasing color scheme. When you can work primarily in the neutral range, you can use the more saturated and contrasting colors to create your focal points or relief to the predominate color range.



Palette of neutral colors that have had their complements mixed

Color and Storytelling

Color theory may not be magic, but it does bring us to the hidden emotional power of color.

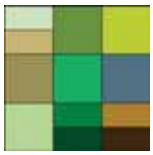
When it's a drab day and you watch a movie that takes place in a sunny resort, you may feel as if you've been in the sunshine. What we see affects our feelings, but how? If you put your hand on a picture of warm colors, then on a picture of cool colors, you can't tell the difference. But somehow your eyes tell you that one is warm and the other cool. That's because color has "associative power." Warm colors like yellow and orange and red are associated with the sun and fire and embers. Cool colors like green and blue and violet remind us more of leaves and pools and nighttime. There are exceptions – some fire is blue, and the petals of a rose may be just as cool as the leaves – but we still feel as if red is warmer and blue is cooler, even if it's not literally true.

Artists use this. Storytellers use it. They choose colors based on how the colors "feel." They may use bright colors to make a block look like a piece of candy, or a poisonous frog. They may color a track to appear like vines or limbs or blood vessels or trails of light. They may color a tense conversation scene with a palette like an erupting volcano. They may color a love scene, even if it takes place indoors during the winter, with a palette like a spring garden. This is how we use color creatively – not by choosing literal colors, but by choosing colors that express feeling. Or to put it another way: we don't paint with acrylics or oils or RGB coordinates, but with fire and ice and blood and earth.

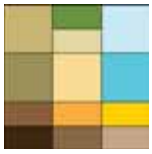
Now, put your imagination to work. How would this scene look if it were colored like an ice-cream parlor?

A blast furnace?

A jungle?



A farm?

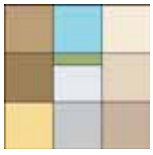


A dungeon?

A junkyard?

A fiesta?

A desert?



What "season" should it feel like? Autumn colors may give a story a somber tone, whereas summer colors may feel more cheerful. If you think this scene should feel a certain way, come up with your own ideas for color associations. It will help you to make creative choices for your palette, and add emotion to the scene.

As you learn to model, texture and animate in 3D, think about how the elements and principles of design, color theory and composition apply to your scene.

- Are your objects interesting shapes?
- Are the scale and proportion working?
- Are there areas where your eyes can rest?
- Are there focal points to draw the viewer to?
- Are you using color to tell your story?

Working in 3D allows you to view your objects in orthographic and perspective views. You are able to create objects and render them from different camera angles. Design, color and composition are important factors and a larger challenge to control in a 3D space. As you start to lay out your project, think about what the story is you want to tell and how you can apply the theories you have learned to create a clear message for the final viewer of your project.

Workbook

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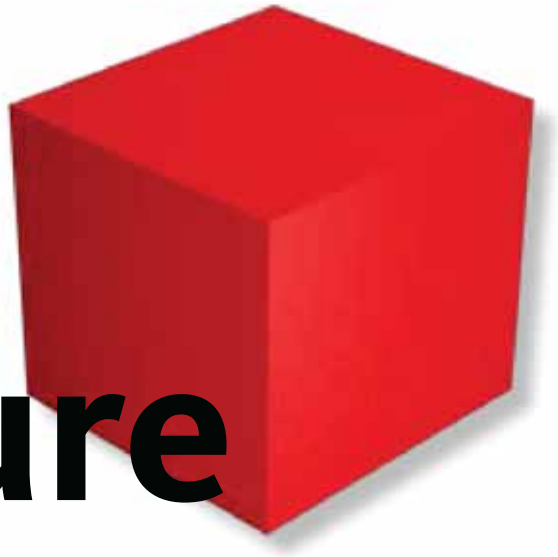

Texture

Workbook

Texture

2010

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Texture Principles

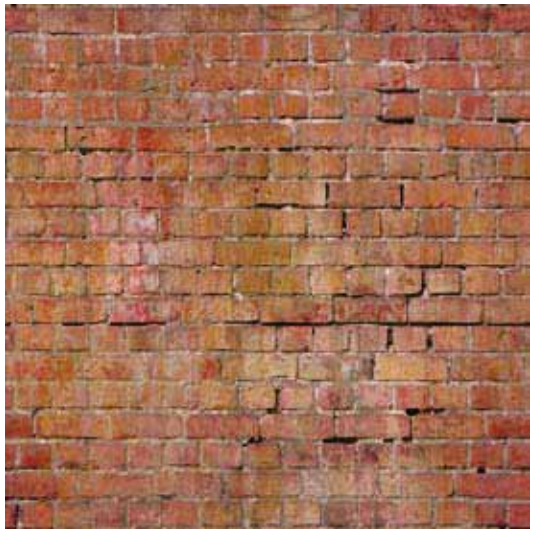
In this lesson, you learn the process of creating a texture from photographic references, and how they apply to video games and film. The texture tells the story of the untextured grey model. Textures add life to the entire environment, and give way to new ideas. Many art styles are combined when creating professional textures. Hand painted textures are created with a stylus much like a painter's brush. A great deal of time is required to get high quality results. Devising a system of texture creation can speed up production time. The process is easy to understand, but it may take some practice to get the textures just right.

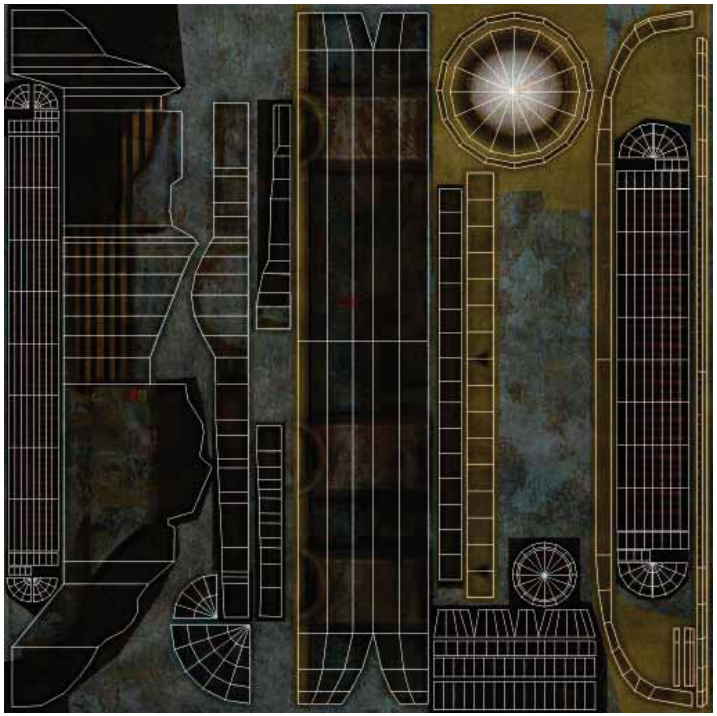
Tileable and Custom

A texture map is a 32 bit RGB color file created in Adobe Photoshop or another 2D painting program. Textures are used in video games, film, TV, and advertising. Most 3D models have a texture on them, like a colored skin that shows color, specular, and fine details. Procedural textures require a mathematical algorithm to be generated. These are used mainly in film and TV production.

A tileable texture is a 2D image that is applied to a polygonal object or BSP level geometry. You create the textures from a digital photograph or a hand painted image. Tileable textures are designed to have seams in a specific area, or no seams at all. Having no seams enables a texture to be repeated over a large area. Custom textures are unique to a specific model or area. A custom texture has unique UV space and a fixed resolution. It is possible to reuse portions of a custom texture to save space and time. One way to reuse a portion of texture is to mirror from the right side of an object to the left side.

Pictured are a tiled brick texture and a custom metal prop texture.



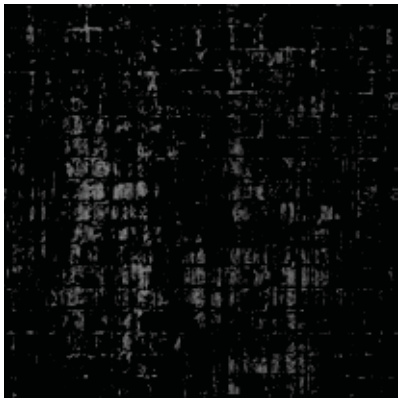
Tileable brick texture

Custom prop texture

Texture Principles

The images display a brick texture mapped on primitive objects. The brick texture is tiled once, and can be made to tile in all directions. This is a Phong shader, and it has a diffuse, specular, and normal map.

Diffuse Map

Specular Map



Cosine Map

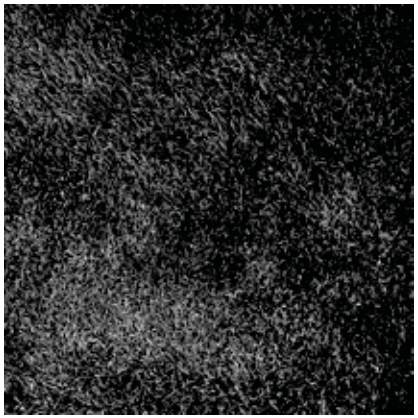
Normal Map

Texture Principles

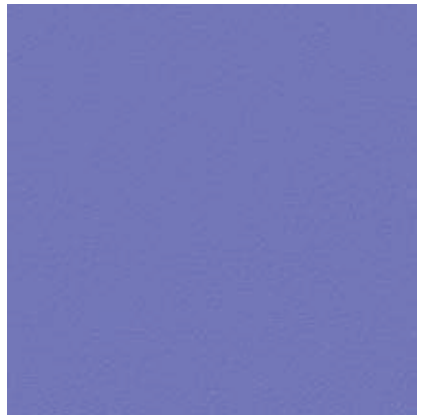
Pictured is an organic grass texture. This is a Phong shader and it has a diffuse, specular, and normal map.

Diffuse Map

Specular Map



Cosine Map

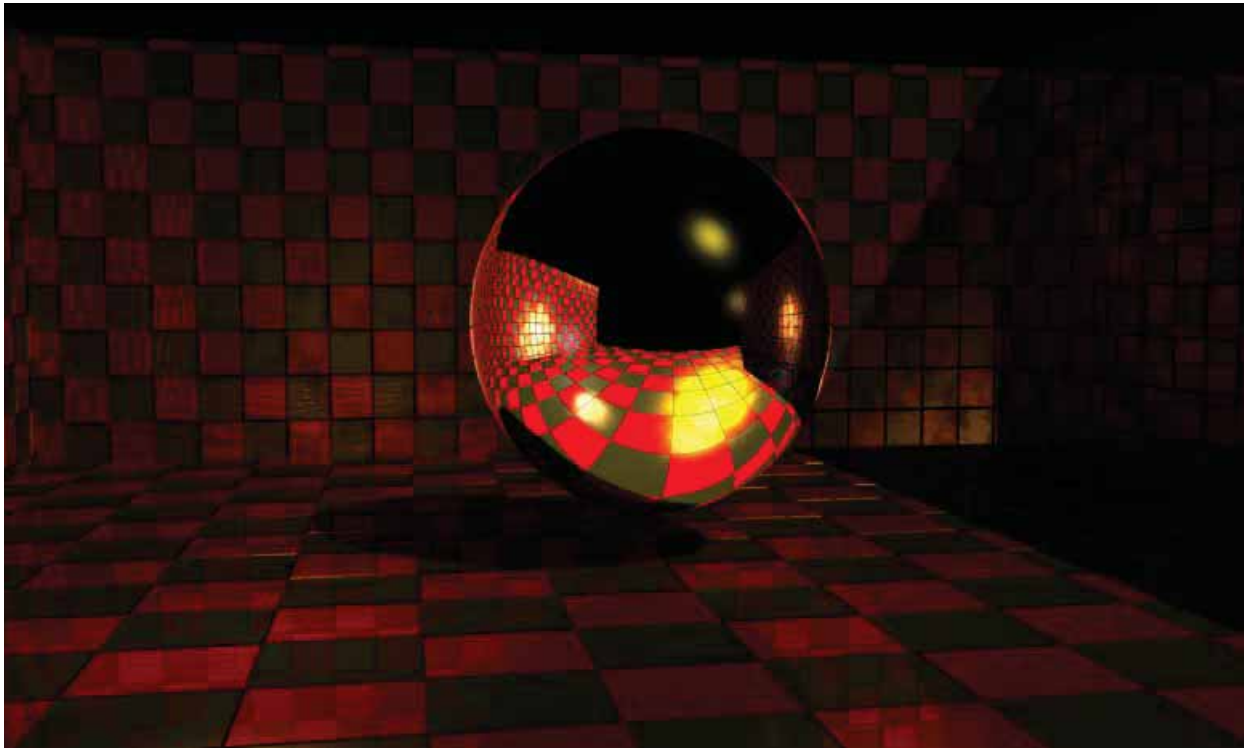


Normal Map

Texture Principles

You create procedural textures using a nod- based system in the material editor of the 3D software package or game engine. These textures are mathematically based, and can be infinitely tiled.

The image is a chrome shader on a sphere, in an environment with checkers on the walls and floor. Notice the yellow lights in the scene are reflected on the chrome ball. There is a directional light facing downward to the lower left, and two point lights.



Texture Principles

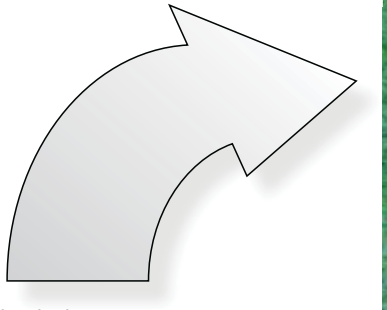
The process for creating a tiled texture that may be used vertically and horizontally is done in Photoshop. Once you have a good photograph, use the offset filter to display the seams in the middle of the texture. The goal is to paint out the hard edges. Using the Clone tool, the seams are hand painted so they are not visible. The same process is done for concrete and wood textures. It is more difficult to paint out the seams in organic textures, and may take time to perfect. Brick can be made seamless by using single or groups of bricks to cover the seams.

The images are of a grass texture, the offset texture, and the texture with seams painted out.

Original grass texture

Grass texture using offset filter

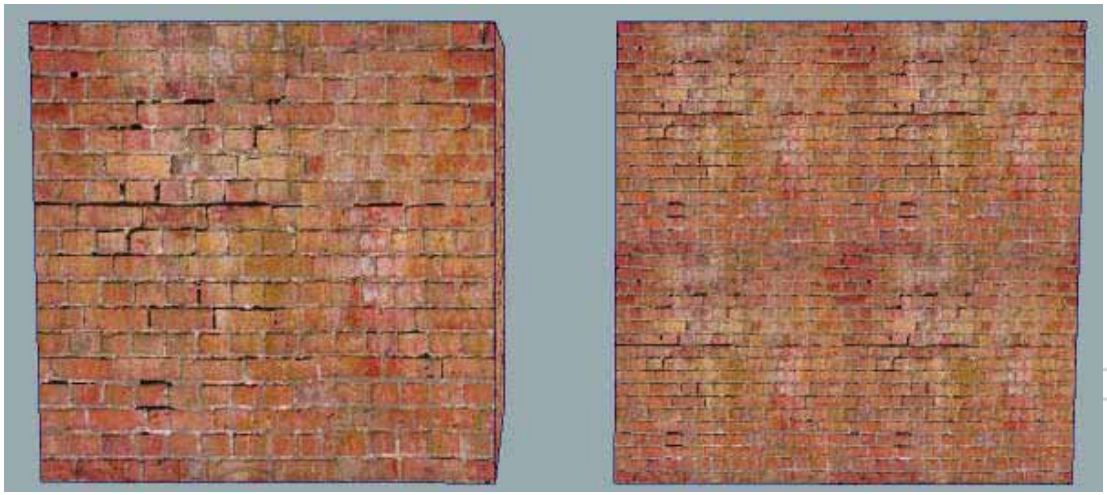
Grass texture with painted seams



Pictured is the seamless grass texture tiled twice in both directions.

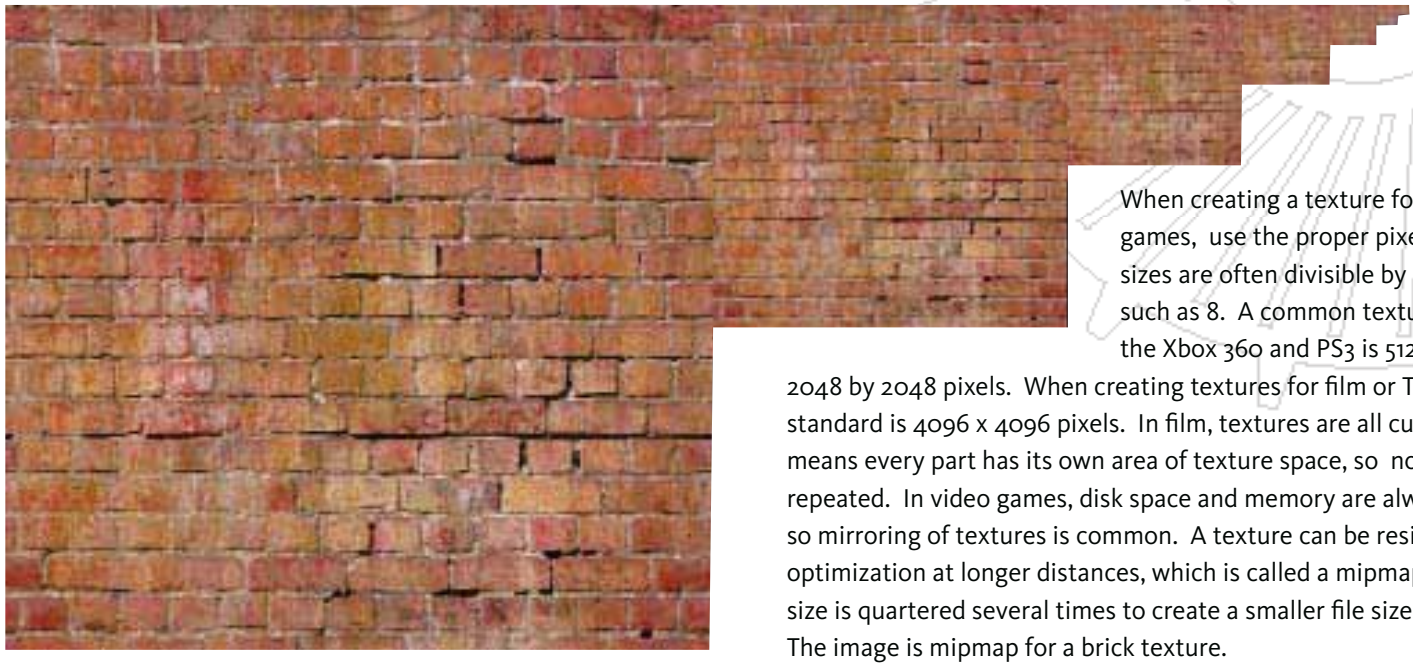
Texture Principles

The images are the brick texture on a cube, one is tiled once, and the other is tiled twice.



UV's tiled once

UV's tiled twice



When creating a texture for film or video games, use the proper pixel size. Texture sizes are often divisible by an even number such as 8. A common texture size for the Xbox 360 and PS3 is 512 by 512, up to 2048 by 2048 pixels. When creating textures for film or TV, the current standard is 4096 x 4096 pixels. In film, textures are all custom. This means every part has its own area of texture space, so nothing looks repeated. In video games, disk space and memory are always a concern, so mirroring of textures is common. A texture can be resized for game optimization at longer distances, which is called a mipmap. The texture size is quartered several times to create a smaller file size.
The image is mipmap for a brick texture.

Texture Principles

You create a mipmap using a plug-in for Adobe Photoshop, with the Nvidia Normal Maps and DDS filter. The Nvidia Normal Map and DDS filter create normal maps, and may also export specific settings to the DDS format. The DDS format is a compression tool for exporting smaller versions of the same texture. Creating a mipmap is usually done on the programming side, and is automatically swapped when the player gets farther away from an object. The physical resolution or polygon count is optimized in video games called a Level of Detail model. A LOD model is created at half the resolution for viewing at long distances. In film, there is no need for this since it is all rendered out for non real time viewing.

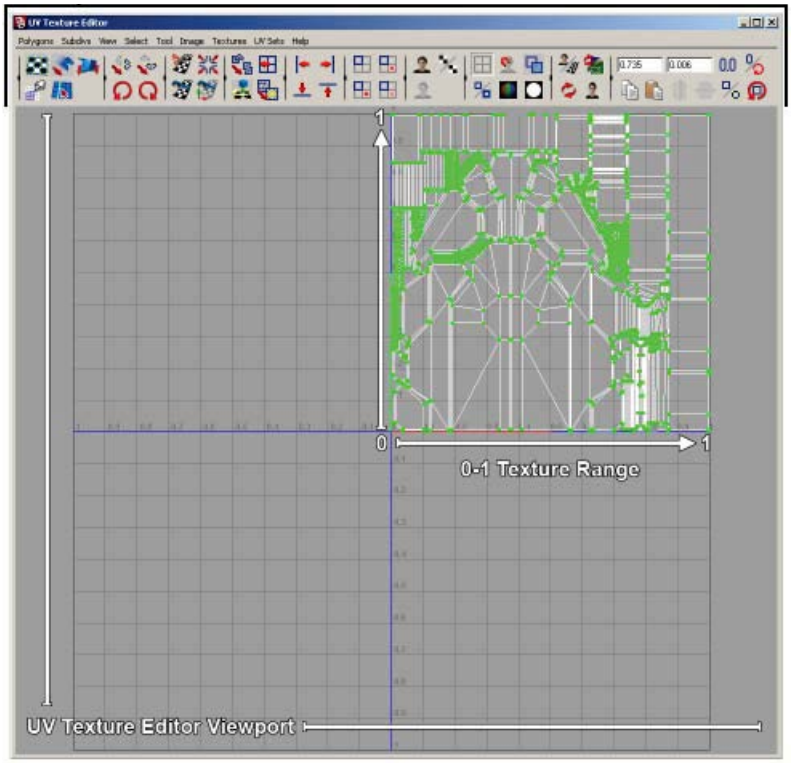
The image is mipmap for a prop texture.

Texture Principles

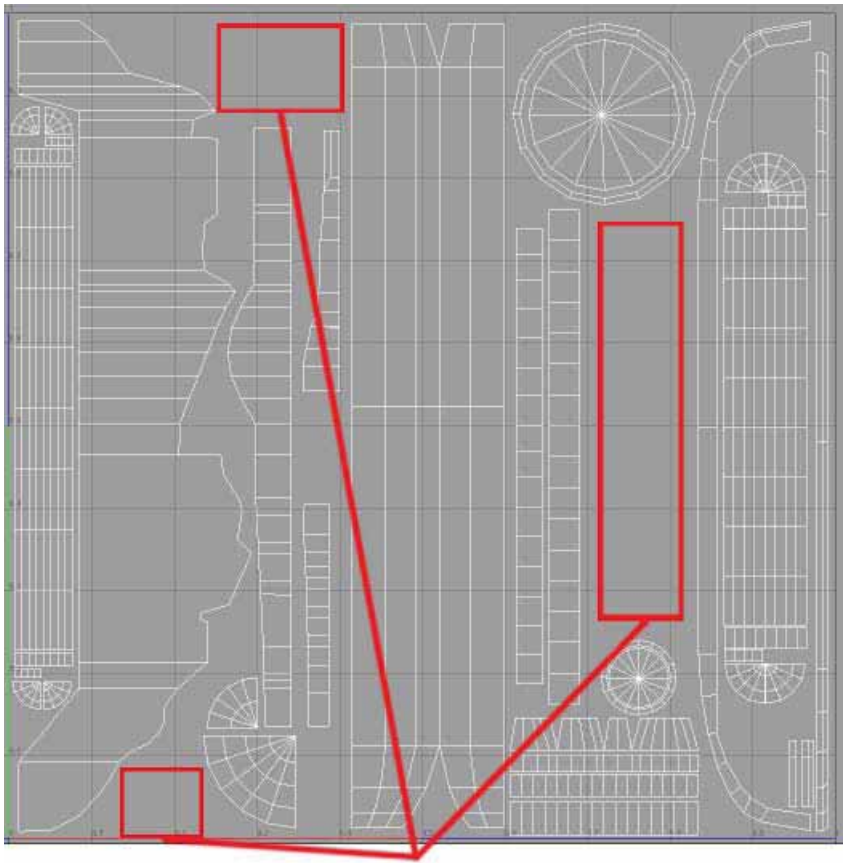
UV Placement

A model has a set of UVs on each polygon edge, similar to a vertex for texturing. A tileable texture usually starts on the 0 to 1 Texture Range, and can be scaled to the desired resolution based on the geometry size. It is okay to go outside of the 0 to 1 UV space when creating a tileable texture in a 3D package. In a human head model, the geometry is laid out so that there is no UVs overlapping. In some cases, there may be overlapped UVs when the geometry is mirrored or reused.

The image is the Autodesk Maya UV Texture Editor and 0 to 1 texture range.



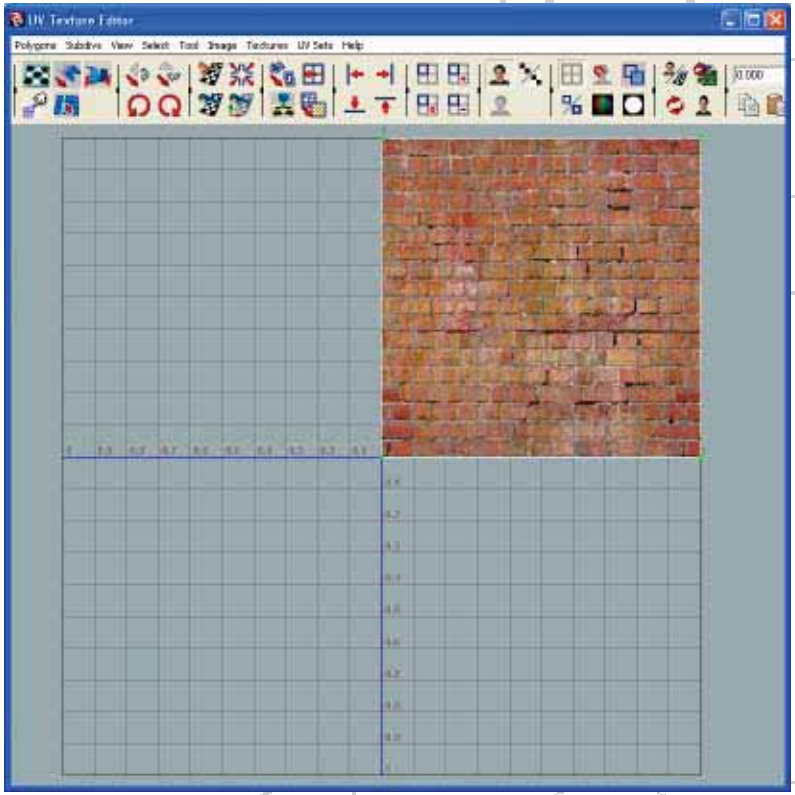
Pictured is a prop with correct UV placement, although there is some wasted UV space. Use stickers and detail variations to fill empty space.



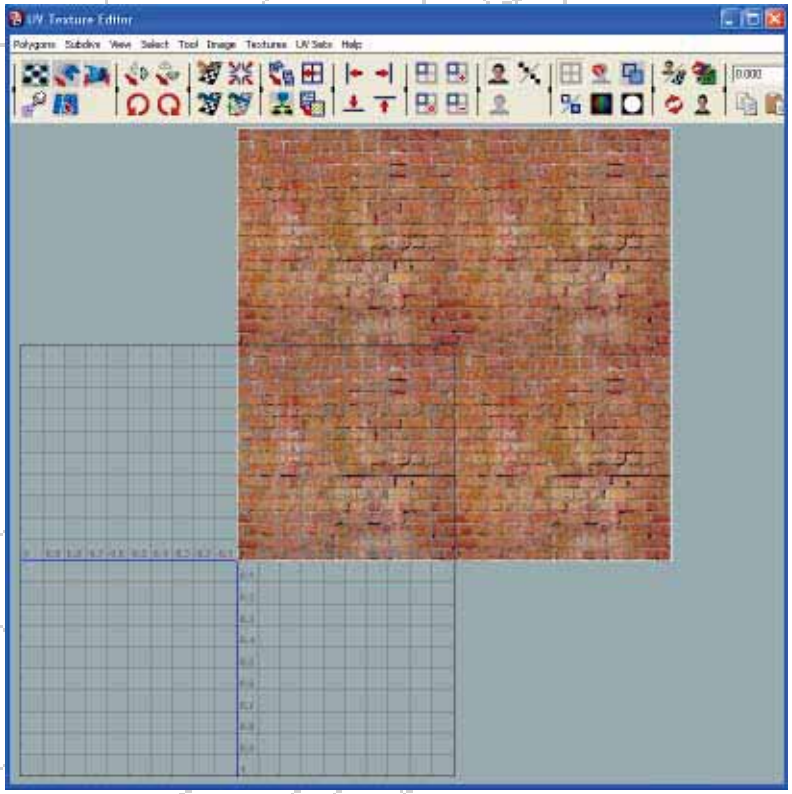
Try and fill the empty space with extra details and variations

Texture Principles

The image displays a UV Layout with UVs in the 0 to 1 space.



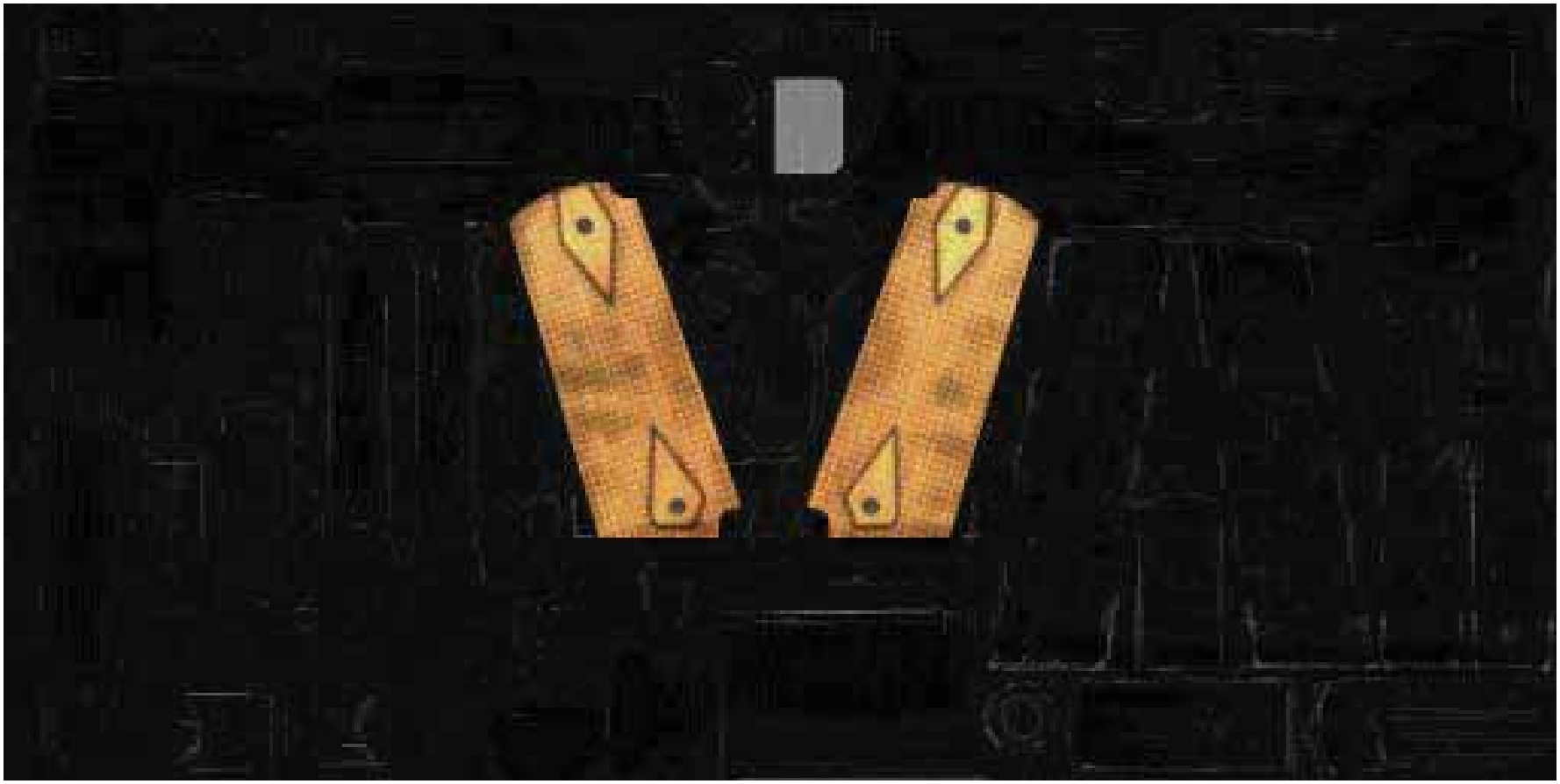
The image displays the UV layout with tiled UVs twice.



Texture Principles

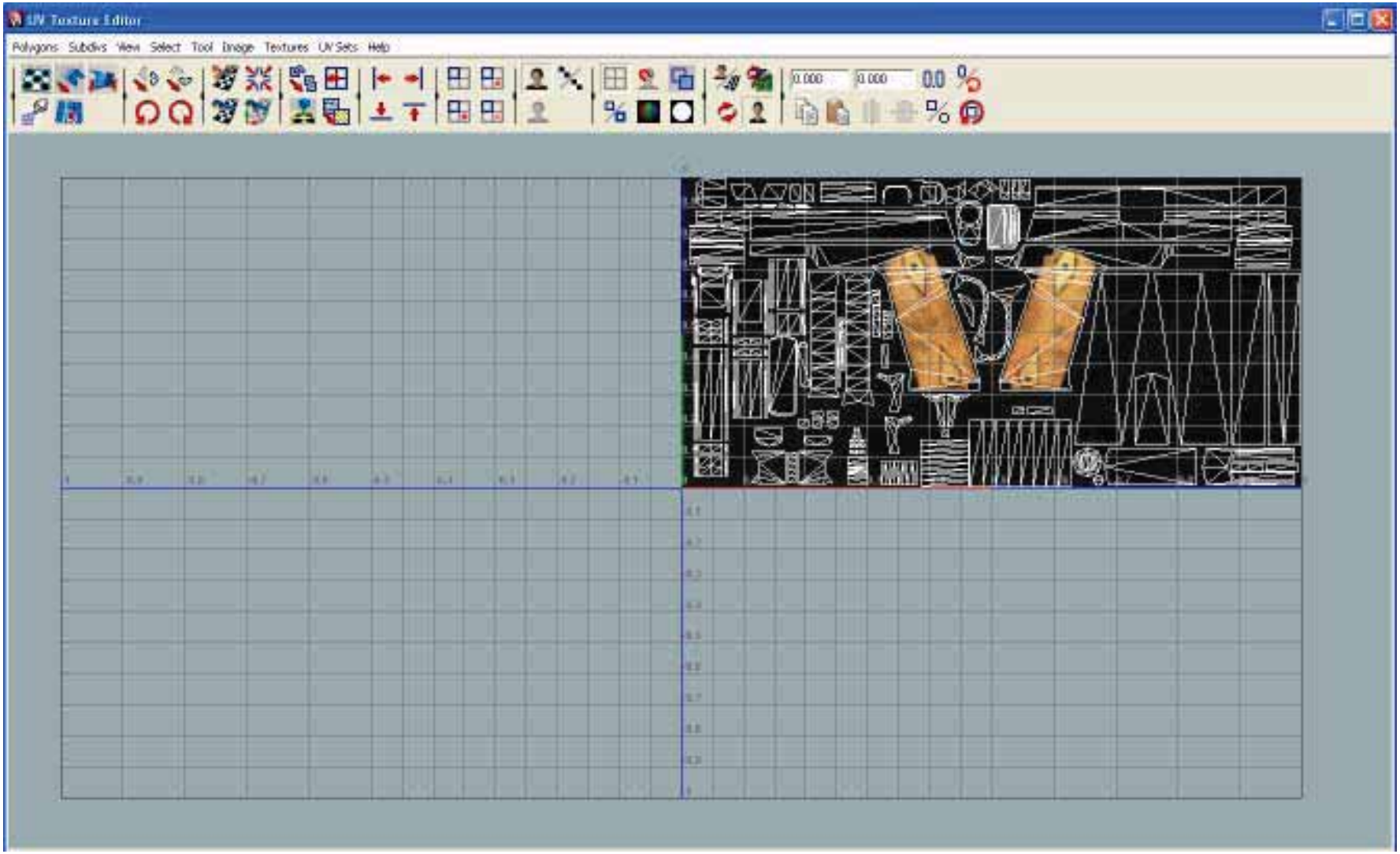
A square texture occupies the 0 to 1 UV space, such as 512 by 512. A rectangular-shaped texture, such as 1024 x 512, also occupies the 0 to 1 space. However, it must be scaled left to right to fit. When the texture is applied, it will show up in the Texture Editor and on the model as looking correct. This is a good way to save space using the 2:1 ration textures. When creating UV layouts, think about ideal placement for optimal resolution and reuse. It might seem extreme, but the tighter the UVs, the higher the quality of the textures.

The texture displayed fits in the 0 to 1 space and is 1024 x 2048 pixels.



Texture Principles

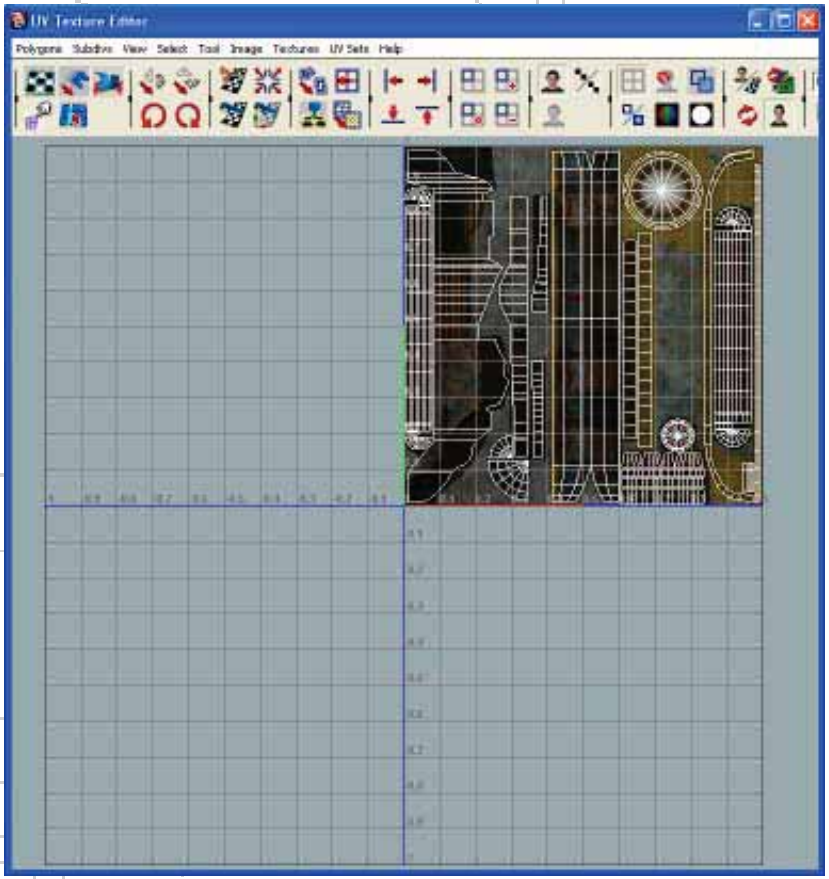
This image is the UV layout of the handgun.



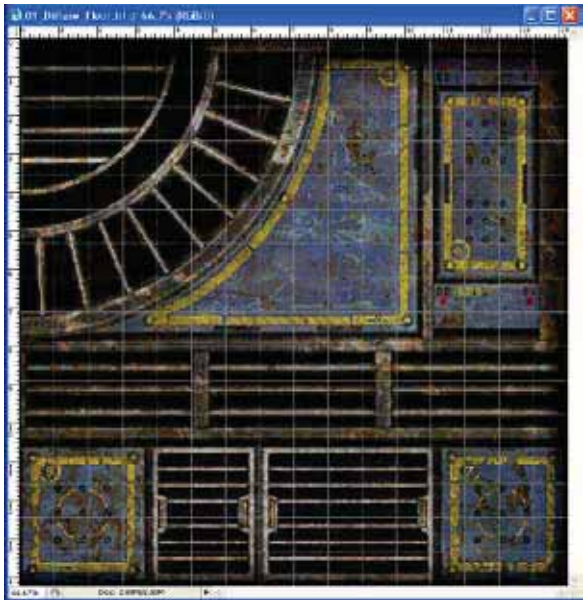
Texture Principles

The texture displayed fits in the 0 to 1 space and is 1024 x 1024 pixels.

This image is the UV layout of the prop.



Texture Principles



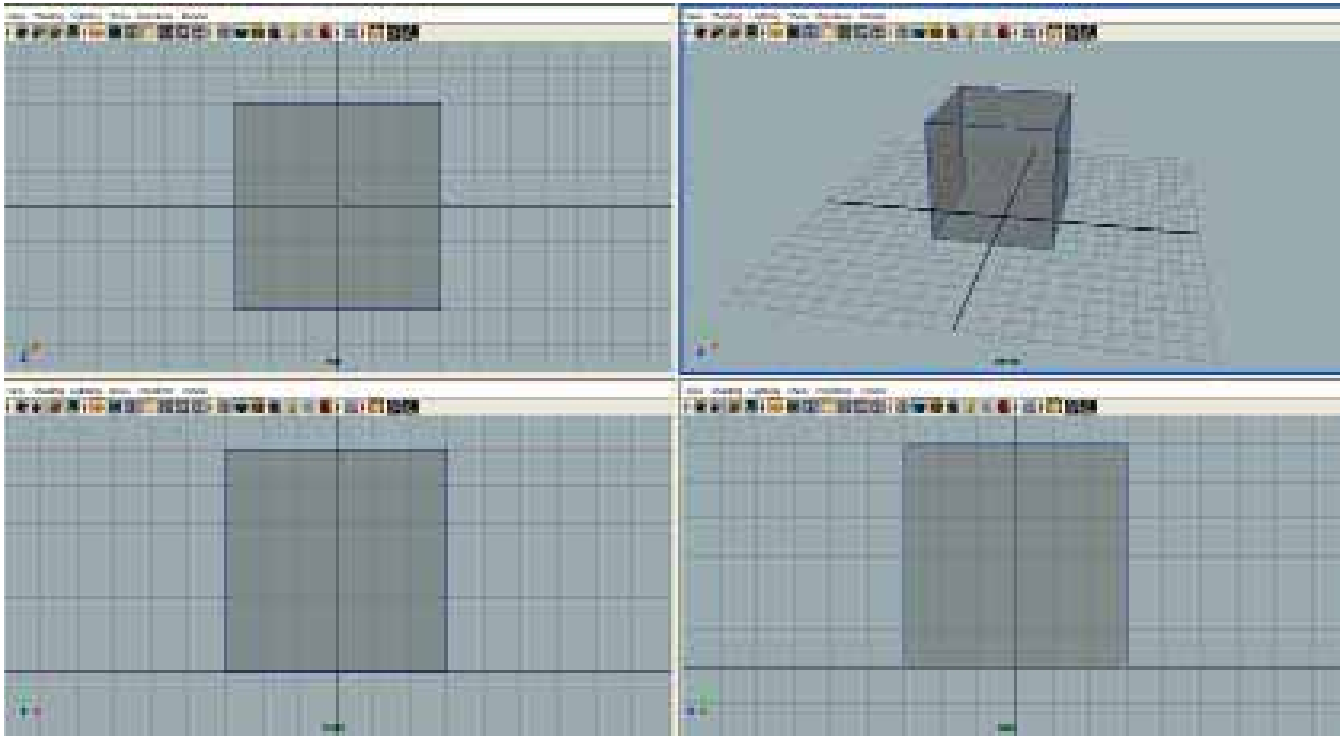
The Grid

The grid refers to the coordinate system that a game engine, Photoshop, and 3D software use to align geometry and textures. The game engine is based on powers of 2. The grid is used in every 3D software package, but may have different settings. It is applicable in creating assets for film and TV. Setting up proper grid units in the 3D software and Photoshop enables you to take full advantage of reusing textures. The artist creates trim pieces that can be taken from a tileable texture and reused throughout the level. Texture sets that are the same style may be built on the grid, and will line up with the game engine or 3D geometry.

The image is a photo of a grid setup in Adobe Photoshop with a grid overlay and rulers.

In older generation video games, the textures were made to lie precisely on the grid. Today, video games have enough storage to have custom texture maps on many surfaces. When creating environment artwork, use the 3D grid. The grid enables modular pieces to be snapped to one another. Many video games also take advantage of the 3D package unit setup, which usually matches the video game engine units. You adjust the grid for the scale and dimensions of the object being created. It is important to build the geometry clean, so there are few intersecting pieces of geometry.

Pictured here is a cube snapped to the grid in Autodesk® Maya® software.



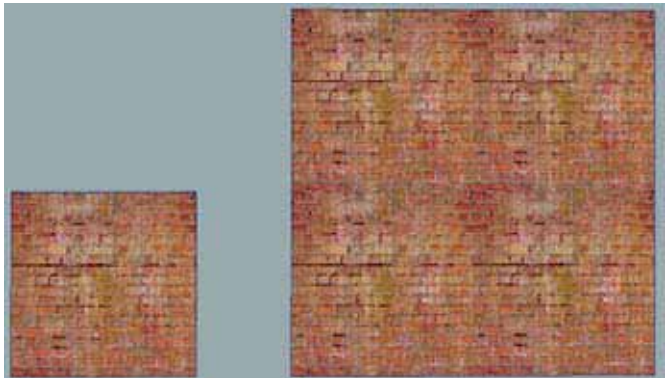
Texture Principles

Texel Density

Texel density is the pixel resolution on the relative size of the object. The pixel resolution keeps a relative balance between the textures in a scene. It is best to keep a close relationship of resolution on the environment and characters. You make adjustments if visual flaws are apparent. Some game engines automatically use a predefined texel density, such as 4 pixels per inch. The game engine automatically repeats the texture to fit the size of the level geometry. In film, the resolution is set manually by the artist in the UV editor. There are resolution standards for games and films that export directly from a 3D package.

Texel density is the amount of pixels used per inch of geometry. A 512 by 512 pixel texture covers 7 1/2 feet of space, or 90 inches. A 1024 by 1024 pixel texture covers 15 feet of space, or 180 inches. The desired texel density of 5.6 pixels per inch is calculated this way for most surfaces. When creating smaller table top sized props, use a higher texel density of 8.5 pixels per inch. This means that a 512 by 512 should cover 5 feet, or 60 inches. A vehicle or portion using a 512 by 512 texture equates to 10 feet or 120 inches, with a texel density of 4.2 pixels per inch. The wheels use the 90 inch formula of 5.6 pixels per inch.

The image is a 7 1/2 foot and 15 foot wall using a 512 by 512 texture.



Brick wall that is 7 1/2 feet tall using a 512 x 512 texture

Brick wall that is 15 feet tall using a 512 x 512 texture

In Maya, enter 90 in the Projection Height and Width. It displays the amount of UV space to use. Autodesk® 3ds Max® and XSI also have settings that enable a fixed texture resolution. If your object only takes up one quarter of the 0 to 1 space when a 90 inch projection is used, then the model will only require a 256 by 256 texture. This ratio of size to pixels may be changed when more resolution is needed. There is no exact texel resolution for film or games. It is usually set by a technical director and may vary.

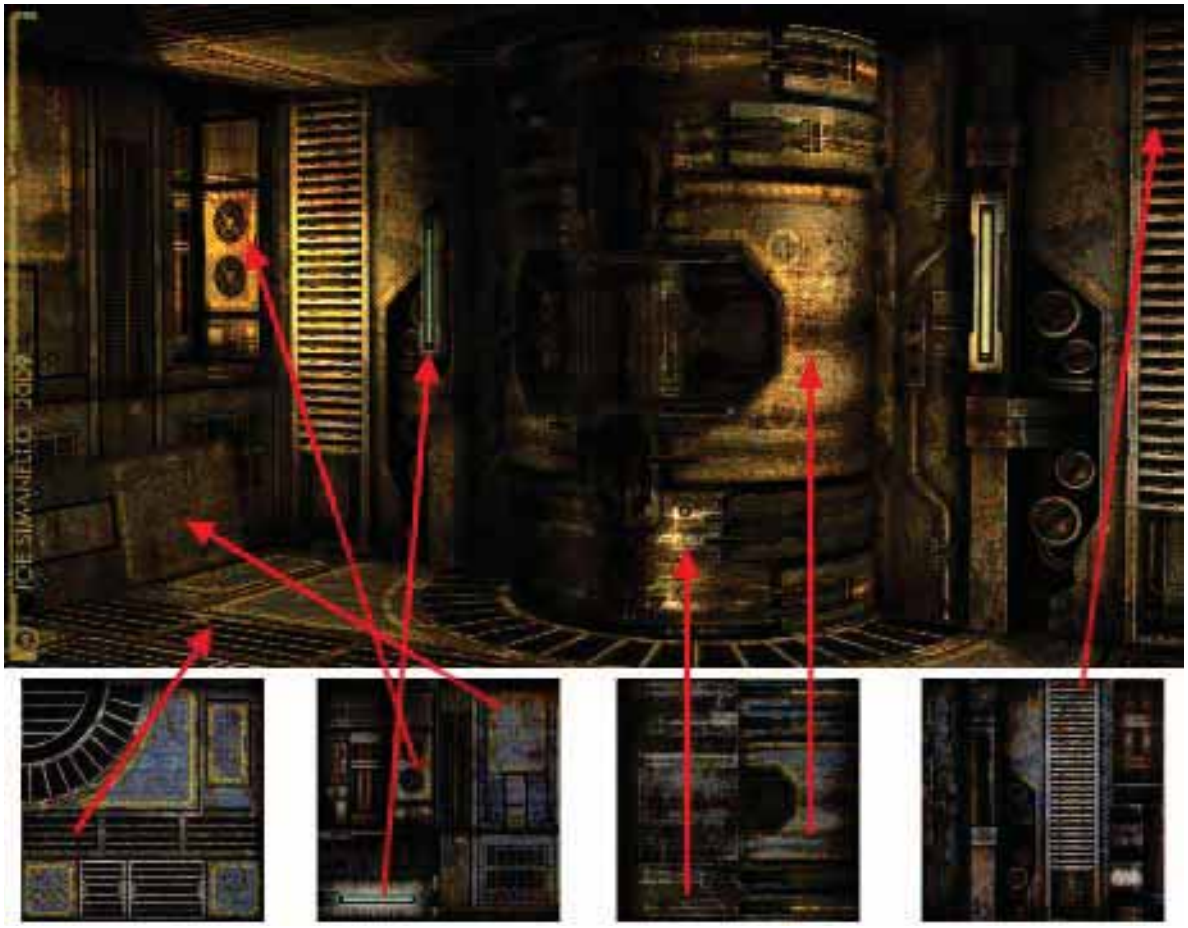
The image is an 8 foot prop using a 1024 by 1024 texture.

Texture Construction

Common Usages

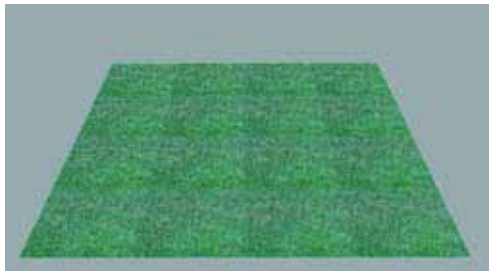
There are many hard surface and organic types of textures with multiple uses. When creating a texture for film or games, never assume that it has one purpose. An artist applies a wall texture on the floor or ceiling. It is good to create textures for use on multiple types of architecture. You use hard surfaces such as concrete, metal, and wood on almost every type of surface.

In the image, the textures point to their location on the model.



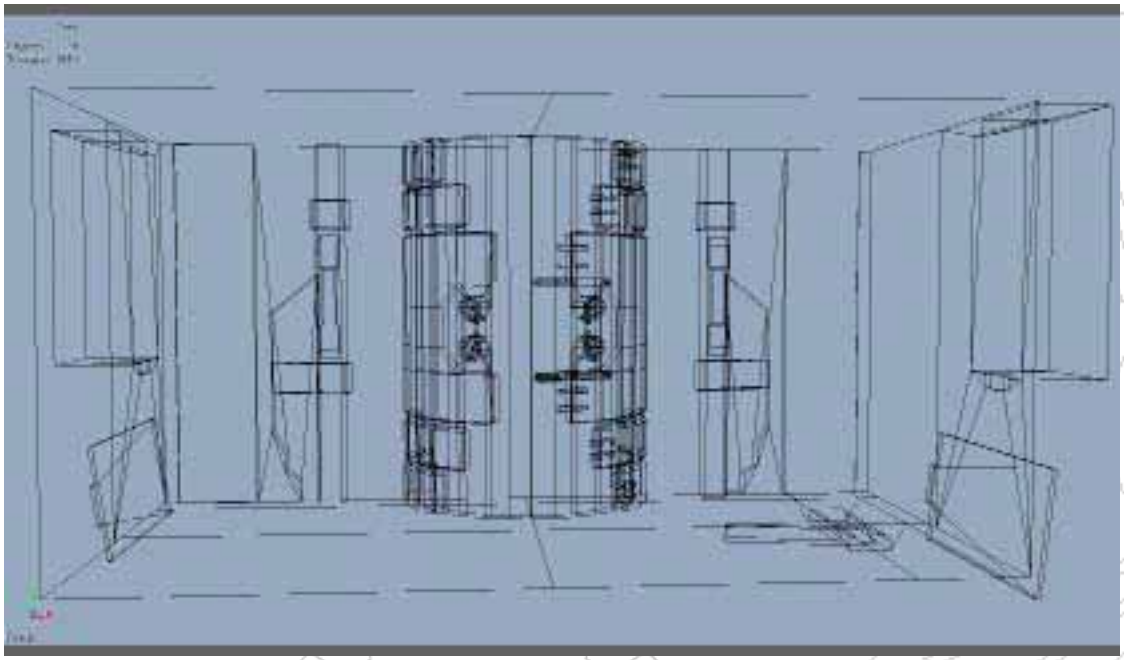
Do not build surfaces such as grass and dirt on the grid unless they have incorporated trim pieces. Organic textures are commonly used on ground surfaces. Architectural pieces such as floors, walls, ceilings, and trim are similarly made. These pieces are grouped in texture sets. Create doors, windows, and detail pieces to accent the environment.

The image is a tiled grass texture applied to a polygon plane.

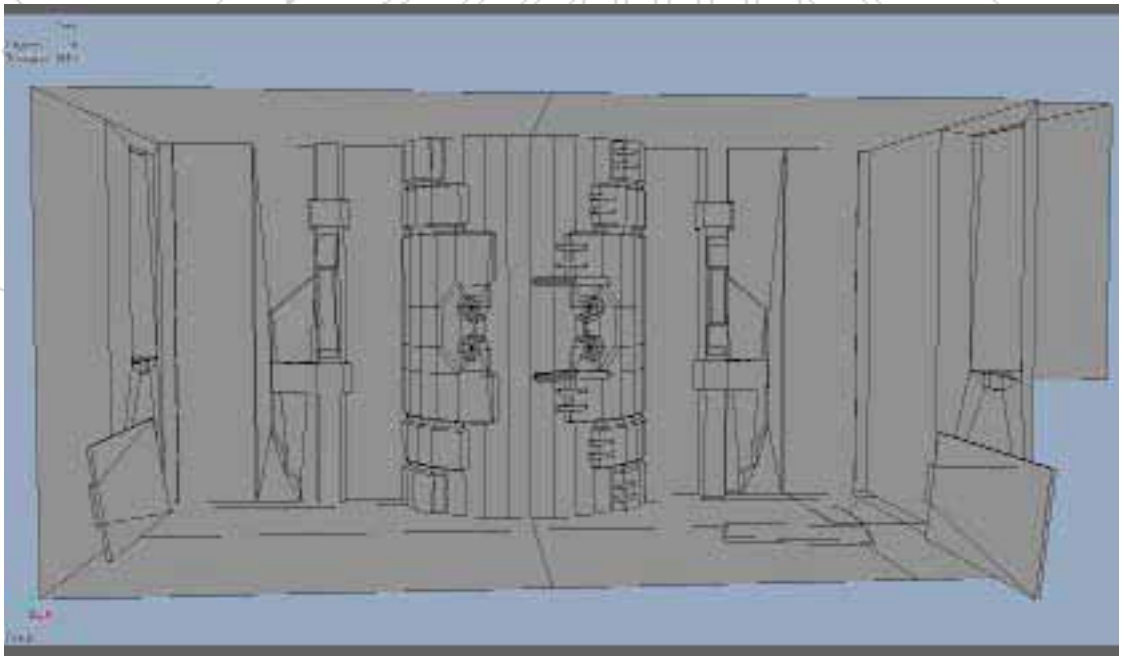


The polygons are best to texture if the geometry is flush, without overlapping areas. Without lights, the wireframe and shaded views display the geometry lines and hard edges. If the model is built in quads, the video game converts it to triangles. This is done to optimize performance of the render engine. When rendering for film, keep the geometry in quads.

Texture Construction

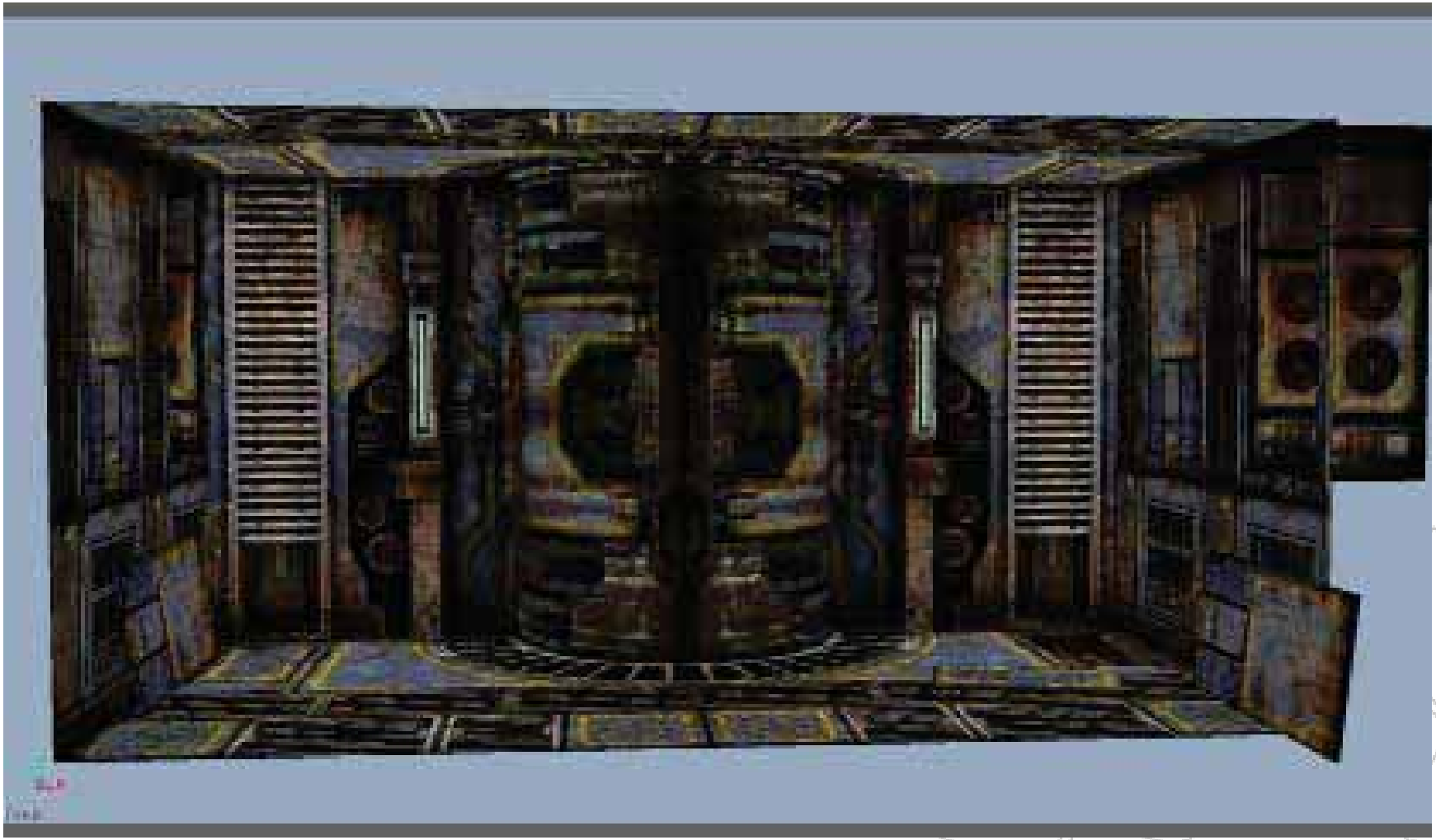


Pictured are the Bio Chamber scene in wireframe and shaded wireframe.



Texture Construction

The image is the Bio Chamber scene with textures applied.

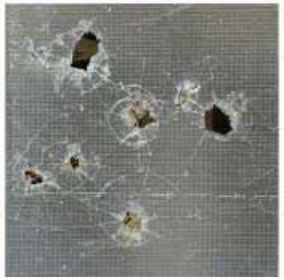


Texture Construction

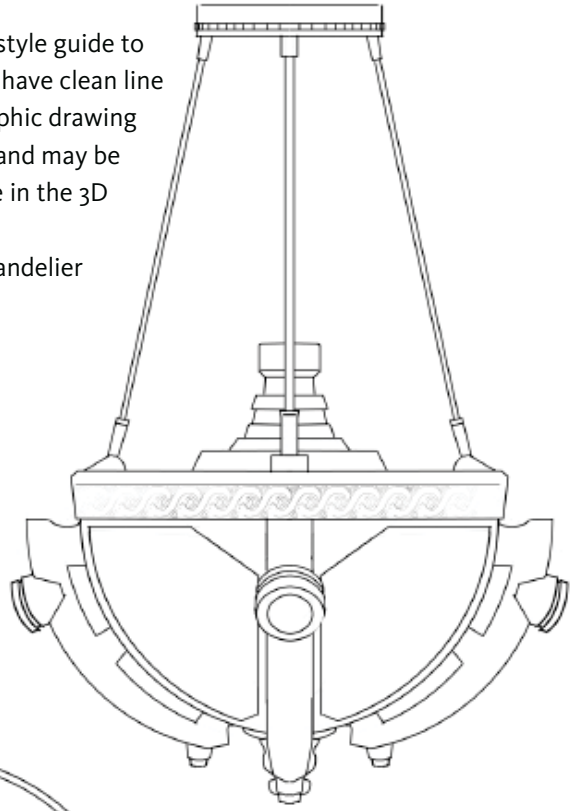
Reference Images

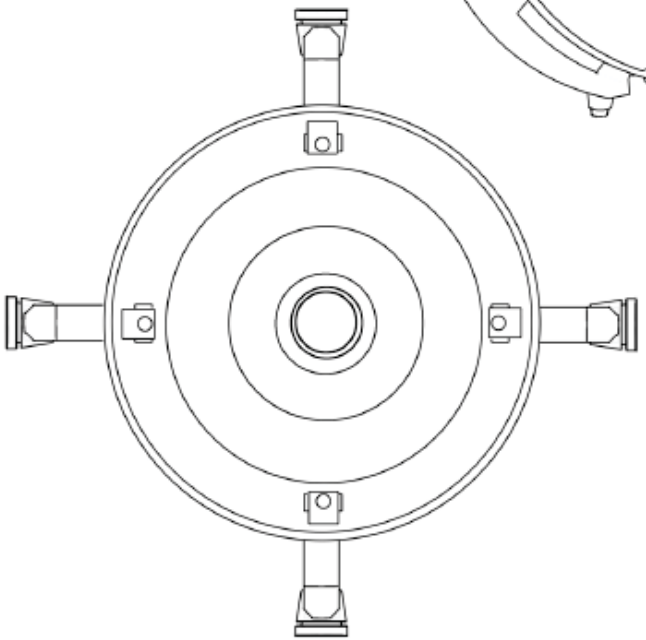
You use reference images as visual guides to create the details of the texture. It is difficult to create details from memory. When designing a texture, use photographs or references. Apply the reference photos directly on the texture and blend into the surrounding elements. Using realistic textures creates a good sense of urban reality. Many films and video games are themed to an urban style.

The images are references of a cargo container, concrete cracks, broken glass, and rust.



Concept art is often used as a style guide to create 3D models. It is best to have clean line art to work from. An orthographic drawing is made by the concept artist, and may be modeled from as a visual guide in the 3D viewports.
The image is a drawing of a chandelier prop.

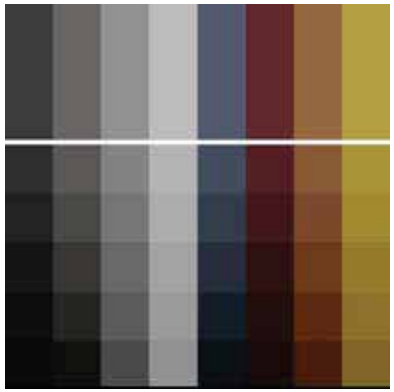




Texture Construction

It is a good idea to use a color scheme when building a texture set. Try different color schemes before settling on a specific one. Complimentary colors often work well. Use low saturation pantone colors to create a color scheme. Sometimes, one color needs the slightest adjustment, either in the hue or saturation, to make it perfect. Using a color scheme ensures that textures maintain visual consistency. The colors of a palletized color scheme were placed in vertical strips, and gradients of grey were overlaid horizontally to create different hues.

Pictured is the color scheme used for the Bio Chamber.

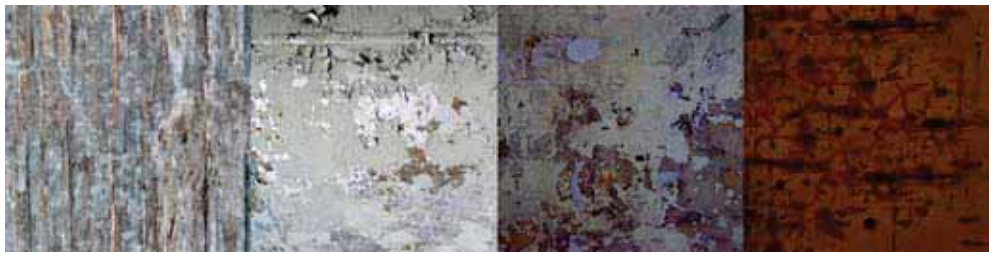


The image is an example of a palletized color scheme.

Base Textures and Detail Templates

It may take a production artist several hours to create a single texture. To save time, create a base set of Photoshop layers to use for a texture set. You use these layers as a starting point, and then add the details needed to build the final texture. This system enables the textures to have a uniform look.

A metal base texture is built by taking a series of metal photographs, and setting them to Overlay Layer Style. Set the Opacity 20%. Use five to ten images to create a metal base texture. Below is an image of four side by side examples of textures used for the metal base. The same process is used for concrete, organic, and custom layout textures. Similar textures are used on organic textures, not necessarily metal photos. You use this process to create a consistent look in film and games.
The following image is four metal base texture examples

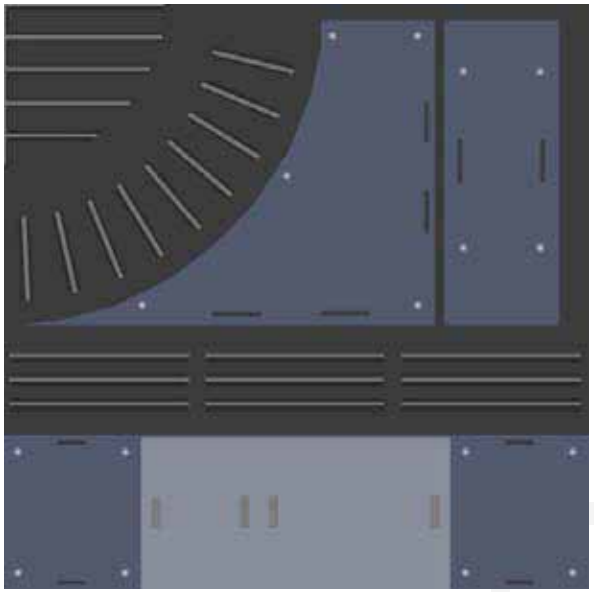


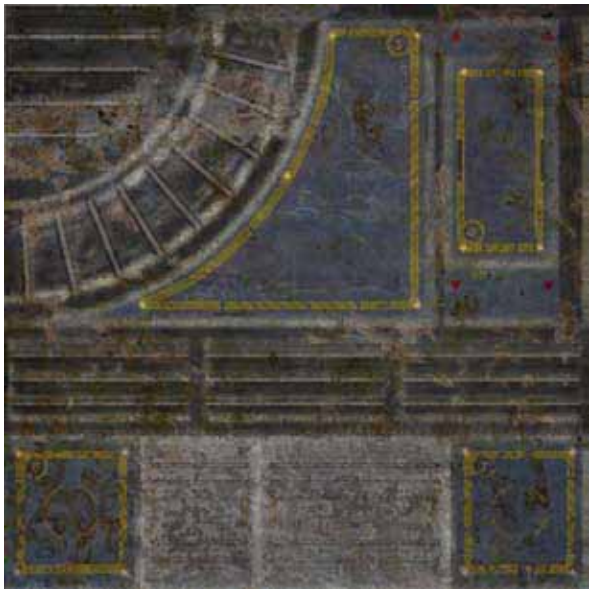
Texture Construction

Positioned under the metal base layers are localized Color Areas. This is an easy way to block in the color, and change it any time. You use the Marquee Selection tools to select areas, using the UV map as a guide. You employ the Paint Bucket tool to fill in areas with color.

The black, gray, and blue colors display areas where this process has been applied. Once the base texture is built up to a good point, it is easy to place the base metal layers into a folder and reuse to other files.

The images display the color base map and the color with metal overlays.

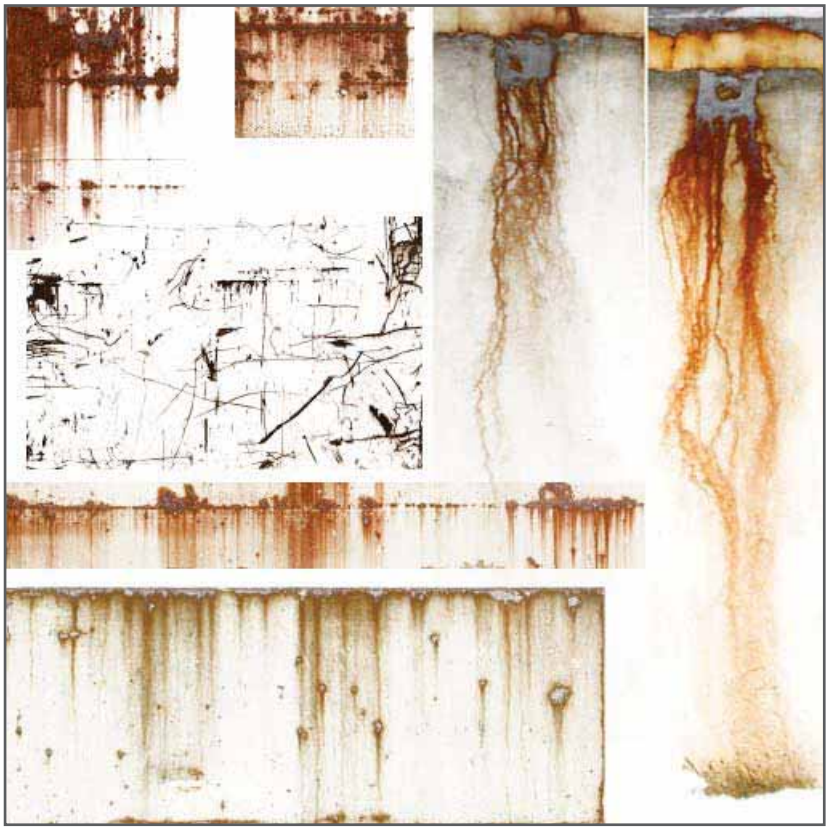




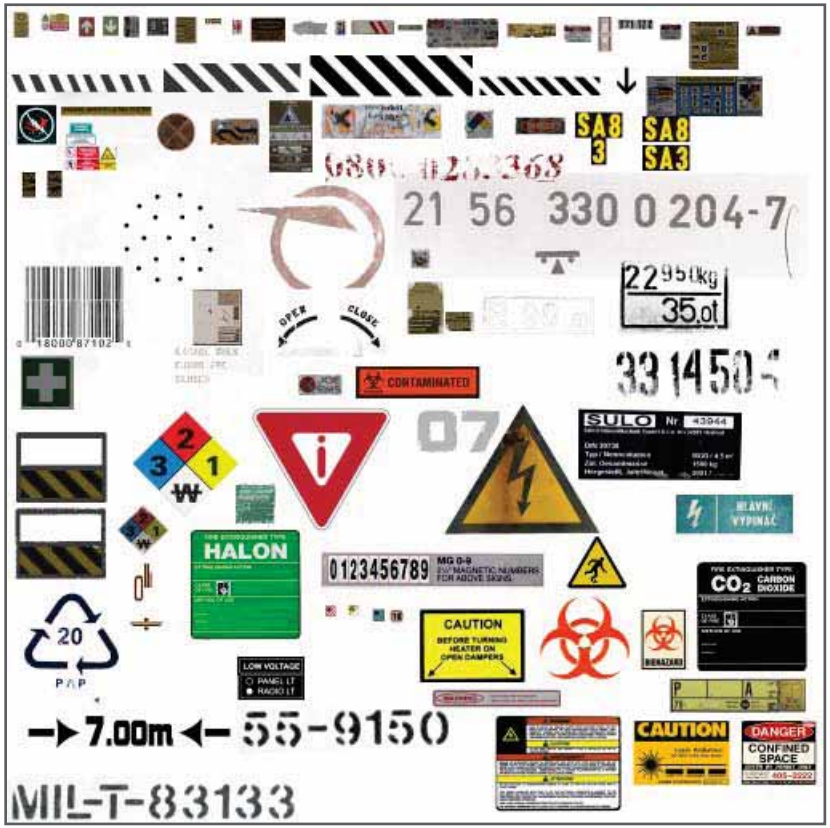
Pictured below is a common layer tab in Photoshop.

Texture Construction

Detail templates are similar to metal base layers because they are a collection of details that may be reused on many textures. For example, a rust dripping texture may take several minutes to find and extract using the Color Selection tool. You copy and paste it to the new layers, and tweak it to the desired parameters. Multiply this task by 20, and it may take several hours. The trick is to save your handpicked, cleaned up details to a new file or separate folder. When a rust texture is needed, go to the folder, pull out a layer, and flip it or erase a bit to make it look different. Create detail templates for bolts, cracks, stickers, and color variations. The image is a detail layer set of rust that may be used for overlays.



The image is a collection of stickers and logos used to detail the textures.

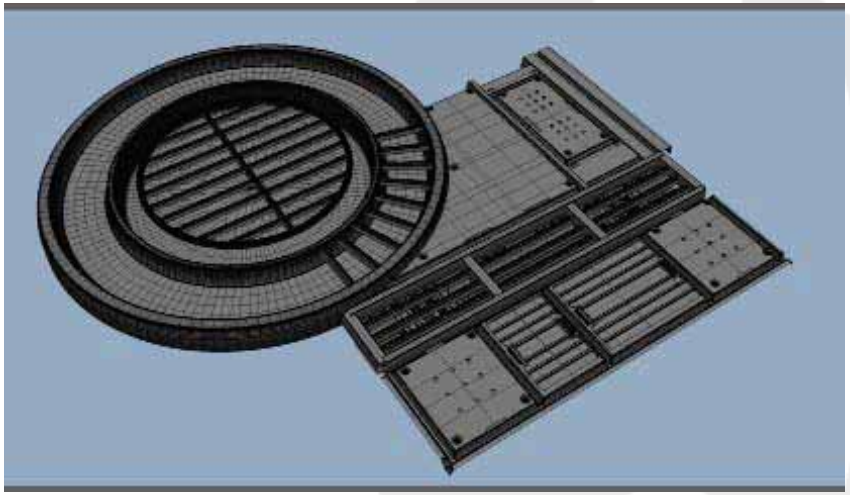


Texture Construction

High Resolution Models

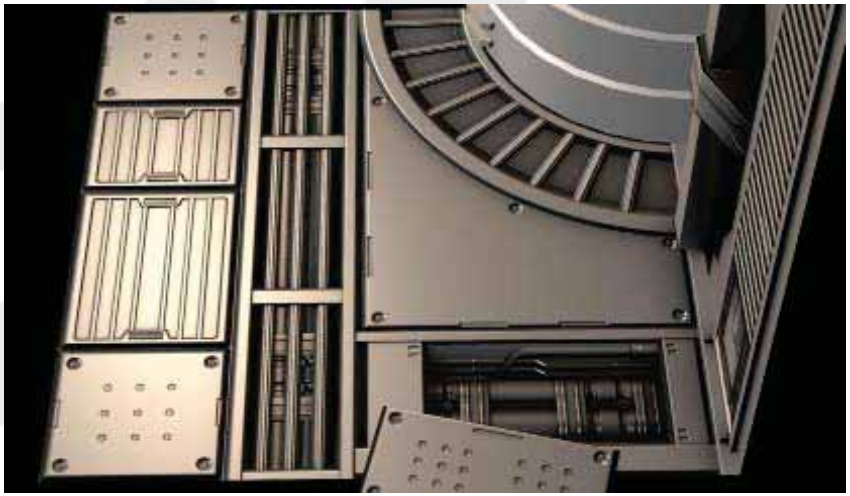
You use primitive and complex models to design a tileable or custom texture. Details do not always have to be created in 2D. You may use high resolution 3D models to design all the texture. High resolution models add great realism and depth to the texture. A 3D model enables you to bake a normal map and a matching ambient occlusion map.

The image below is a picture of a high resolution model used to create the Bio Chamber textures.



The process for constructing a normal map begins by creating a high resolution model and a low resolution model. The high resolution model is created by using polygons and a collection of detail pieces. Establishing a library of detail pieces makes it easier to design complex models. Once the high resolution model is finished, it is baked down to the low resolution model. The low resolution model may be a primitive plane or fitted to the high resolution model. Creating textures that have detail baked in will save on the polygon count and improve performance.

The image is the normal map rendered on the low resolution geometry.



Texture Maps

Pictured are renders of the Hydrant Prop created in Maya.

Textures add more realism to an environment and characters. There are many 2D painting programs that can be used to create textures, such as Adobe Photoshop and Corel Painter. Many artists use photographs and add hand-painted details to create textures. Every artist paints a different way, with a certain style or look. Sometimes you adapt to a predefined art style, so that the textures look similar. The textures in this lesson are from different models, but were all painted by the same artist. The first textures shown are from a science fiction-themed scene. The textures depicted later in this lesson are from an ammo case prop and a fantasy prop. These scenes and props were rendered using mental ray Standalone in 3D software such as Maya, 3ds Max, or Softimage (formerly Softimage|XSI) .

The image displays a render of the Bio Chamber created in XSI

Texture Maps

The images are renders of the Ammo Case created in Maya.

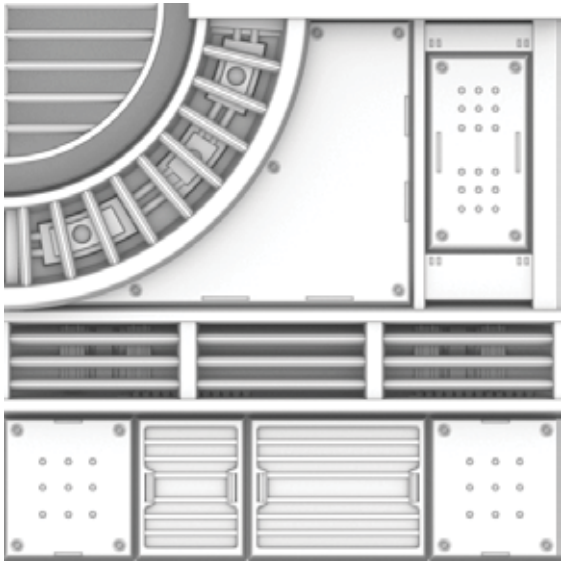
Texture Maps

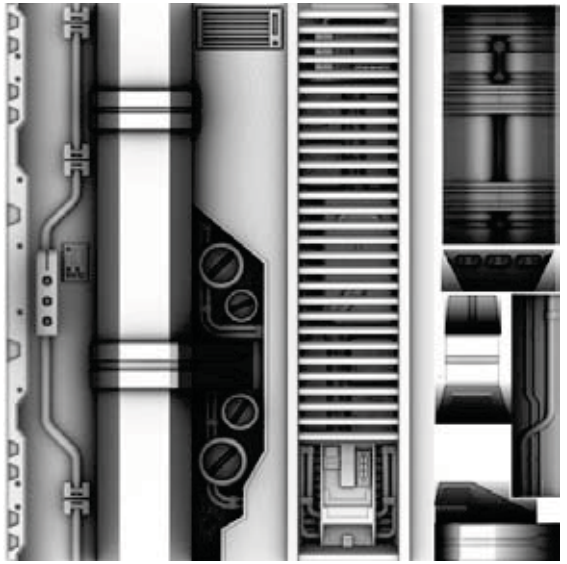
Standard Texture Maps

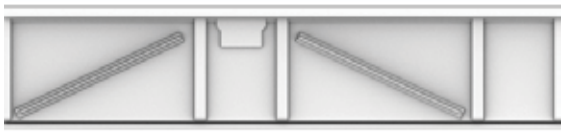
AO Maps

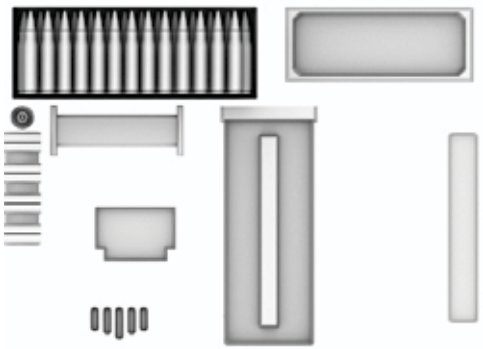
Ambient Occlusion is a shading model that adds realistic shadows to a 3D model or scene. AO maps add shadows to cracks and the underside of objects. AO maps have a soft look, and are used as an overlay on the diffuse texture. This is accomplished by setting the AO map Layer Style to Multiply in Photoshop. This is a simple way to fake global illumination, which is a method to calculate realistic lighting. It saves rendering time because the shadows are overlaid onto the diffuse texture. AO maps are created from a high resolution model and can take a long time to calculate.

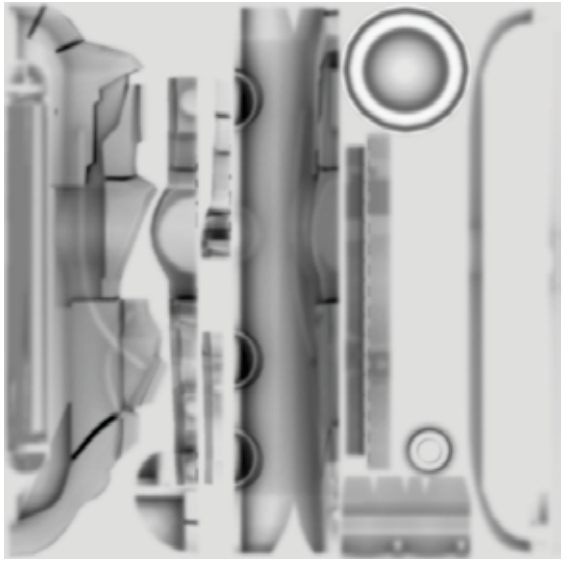
The images below are ambient occlusion maps.









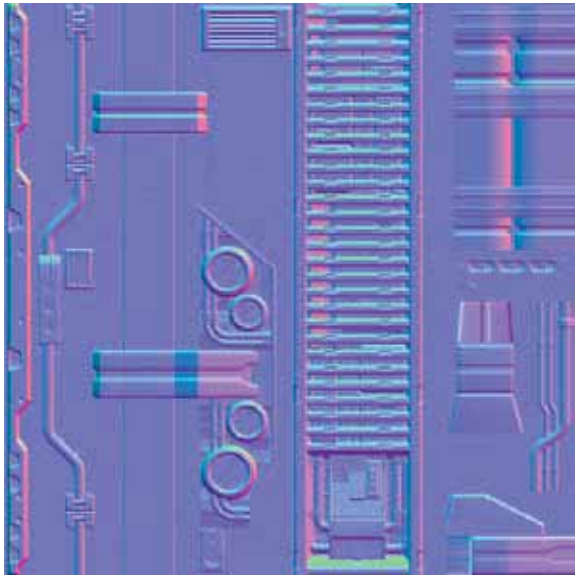


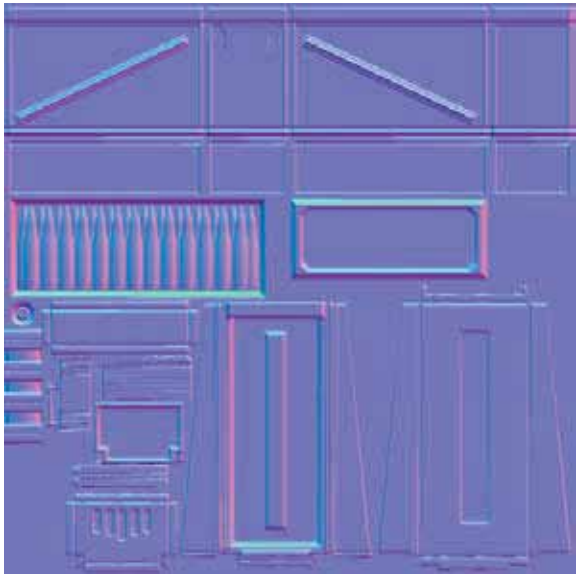
Texture Maps

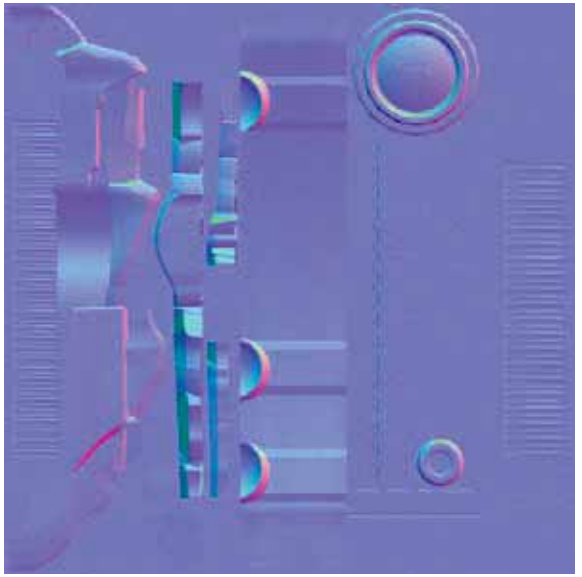
Normal Maps

A normal map is an RGB colored texture that acts as a 3D bump map. A normal map uses X, Y, Z coordinates to add detail to the surface normal of the polygon face. The normal map adds fine detail on a relatively flat surface. The normal map is seen when a light hits the polygon, shading the concave areas with shadows and the edges with highlights. A normal map bumps in any direction, but tends to degrade the effect when viewed at less than a 45 degree angle. You create normal maps in Photoshop using a grayscale image. You use the Nvidia map filter to convert a grayscale image into a RGB normal map. The common colors of a normal map are shades of blue, pink, purple, orange, and green.

Pictured are normal maps used on a floor and props.





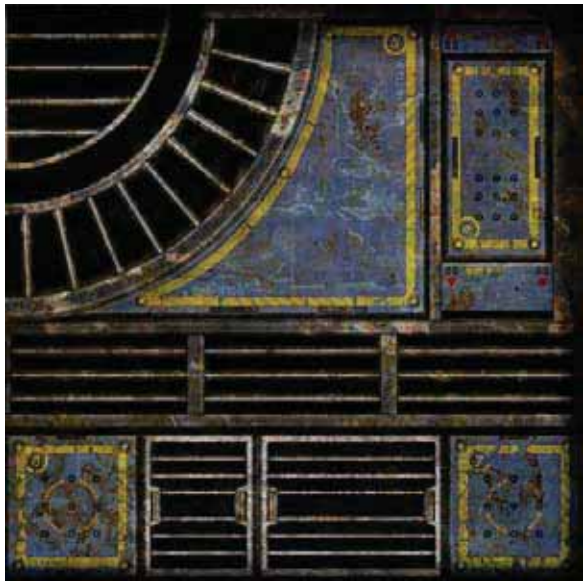


Texture Maps

Diffuse Maps

The diffuse map is an RGB color texture. This texture holds the majority of the detail and color information seen on the 3D model. In production settings, the normal map and ambient occlusion maps are created before the diffuse map. The textures should have details that line up on top of one another. It is common to go back to the normal and AO maps to add details while creating the diffuse map. When viewing a diffuse texture in a video game engine, it sometimes over saturates colors, blows out the color white, and darkens black colors. Lower the saturation, and never use pure white or black.

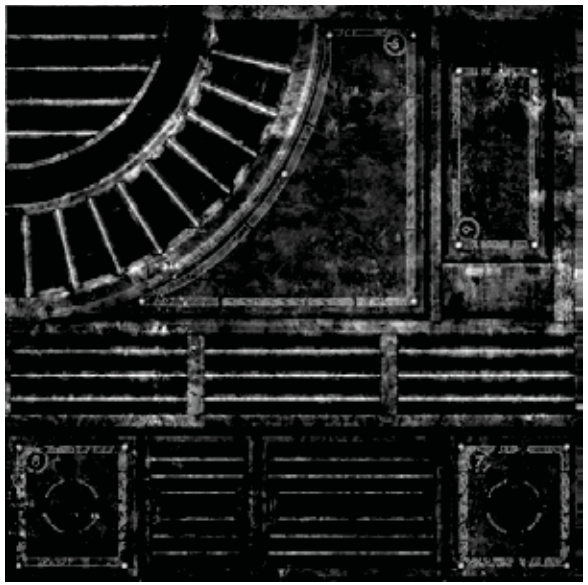
The images are diffuse color maps.

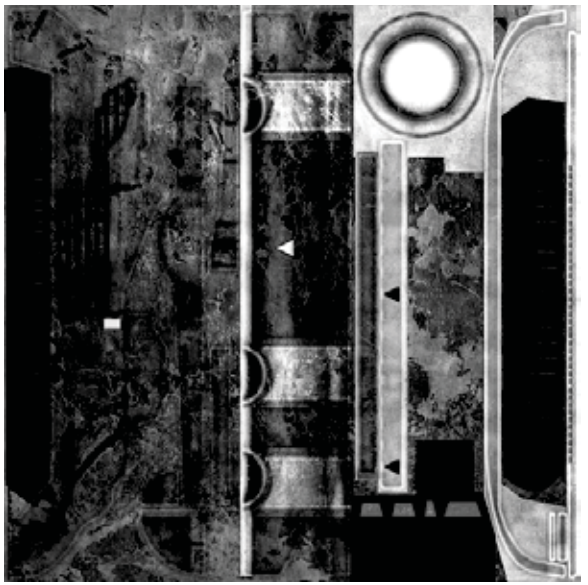


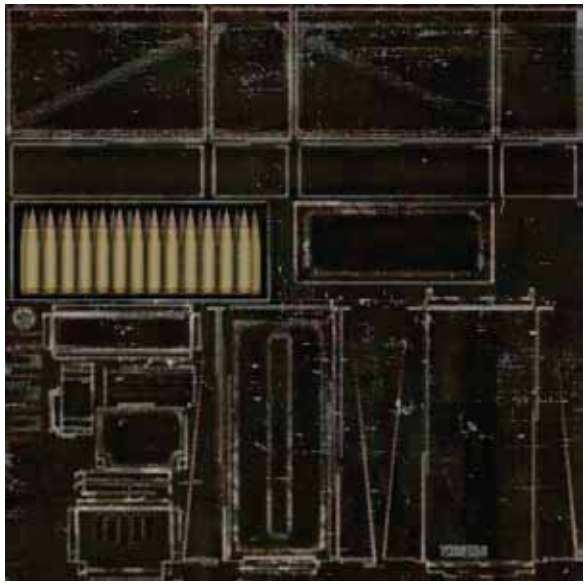
Texture Maps

Specular Maps

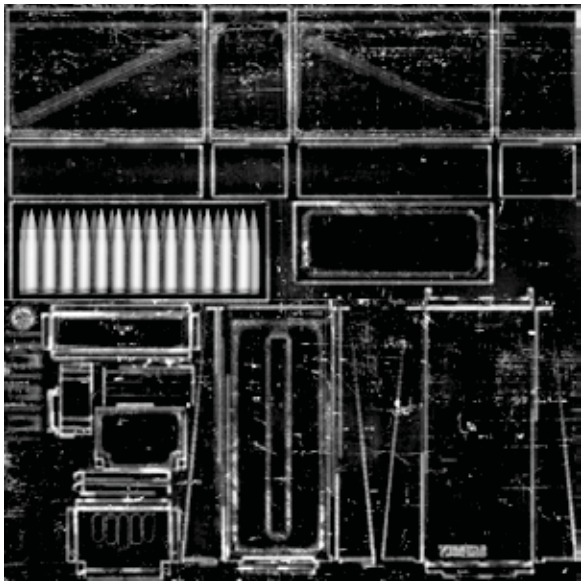
Specular textures come in two styles: grayscale maps and color maps. A grayscale specular map accents areas of the texture that are shiny and matte. White and gray areas are shinier when hit by a light. The black and dark gray areas do not reflect much light, and have a low specular value. You use color specular maps to add color when viewed at a glancing angle. To create a chrome material, add some of the same color to the specular map. The specular map adds refined detail in a texture. The final specular map is sharpened or blurred to get a worn or soft feel.
The images below are specular maps.







Color Specular Map



Grayscale Specular Map

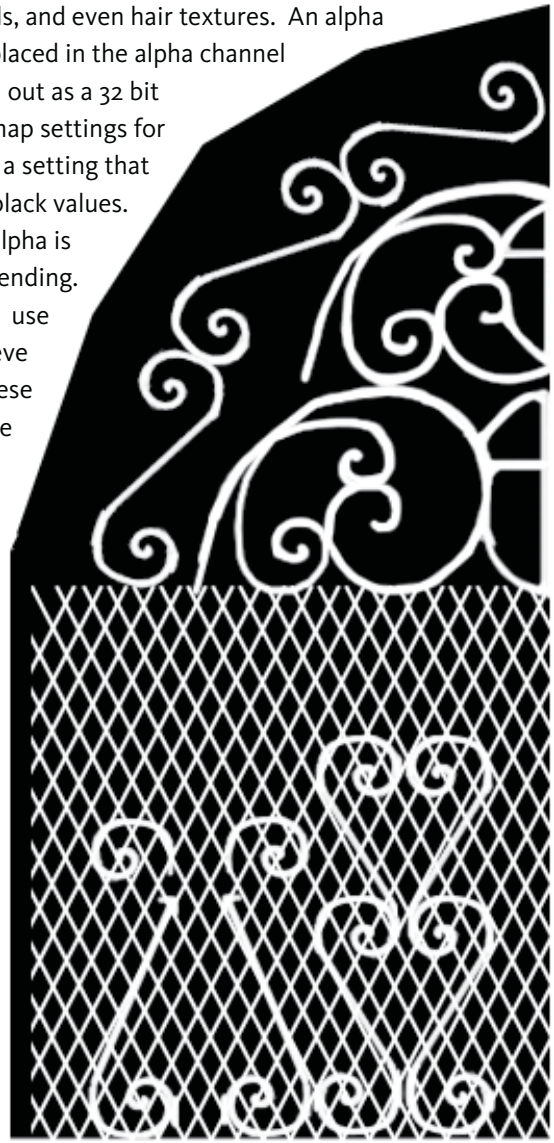
Texture Maps

Special Texture Maps

Alpha Maps

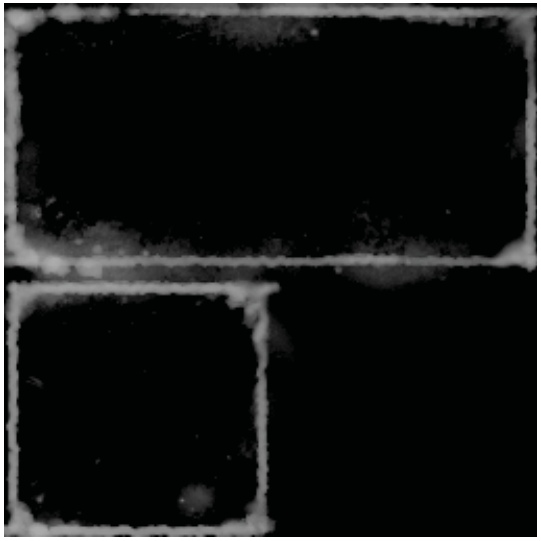
You use alpha maps for glass, decals, and even hair textures. An alpha map is a grayscale texture usually placed in the alpha channel in Photoshop. The texture is saved out as a 32 bit Targa file. There are special alpha map settings for use in a game engine. Alpha test is a setting that uses almost completely white and black values. This is less expensive because the alpha is transparent and opaque, with no blending. Alpha channels applied to windows use the full grayscale spectrum to achieve the desired transparency value. These settings are slightly more expensive in video games, when there are transparent objects rendering in front of another. In pre-render, this is not as much of a performance concern.

The images are an alpha map used with alpha test, and another used for glass.



Alpha Test

Glass Diffuse



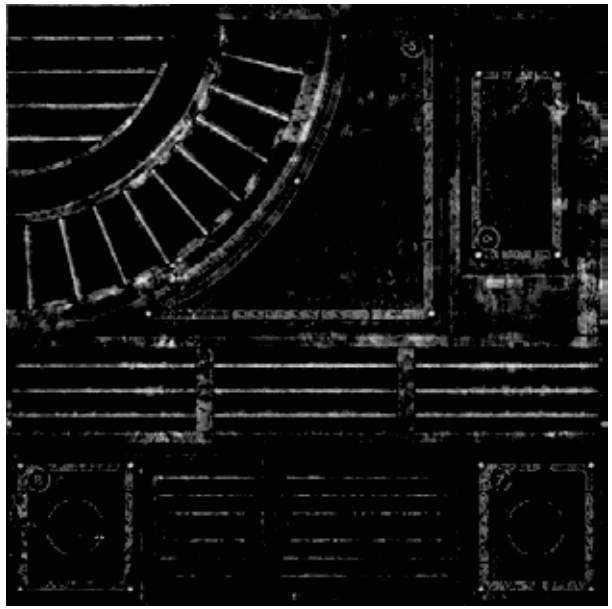
Glass Alpha

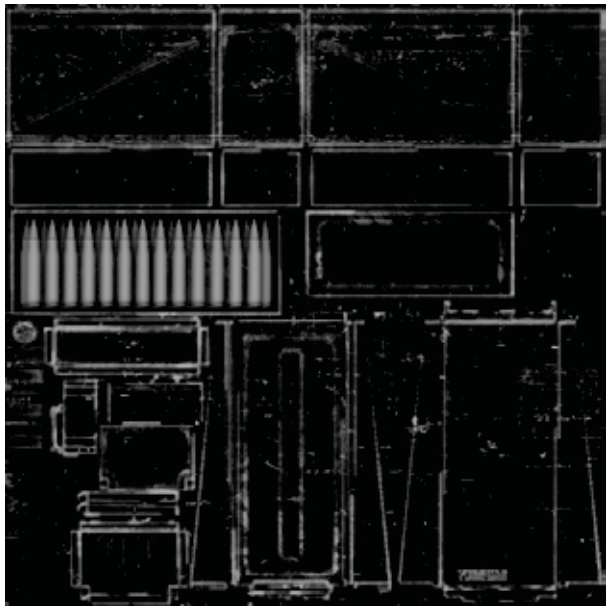
Texture Maps

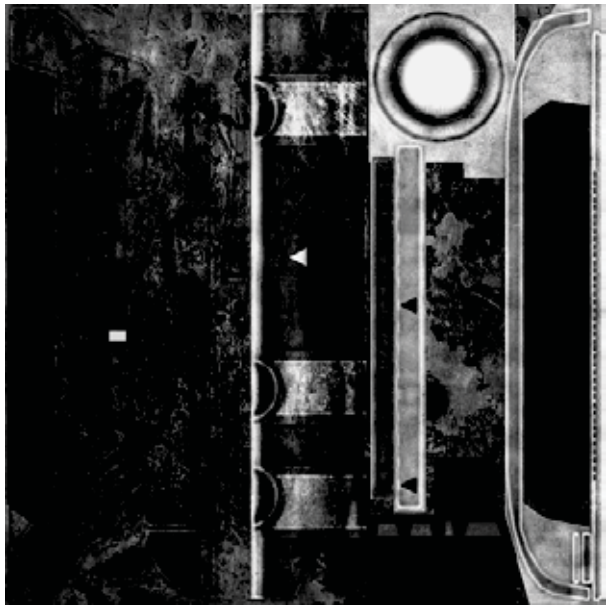
Cosine Maps

Cosine maps define the glossiness of a surface. A cosine map is a grayscale map, and may be used in combination with a color specular map. In some game engines, the glossiness level uses a reflection cube map. White areas in the cosine map pick up the reflection of the world through the cube map. When trying to get a highly reflective surface, the diffuse texture must be a darker color. Cosine maps look similar to a grayscale specular map.

The images are examples of cosine maps.





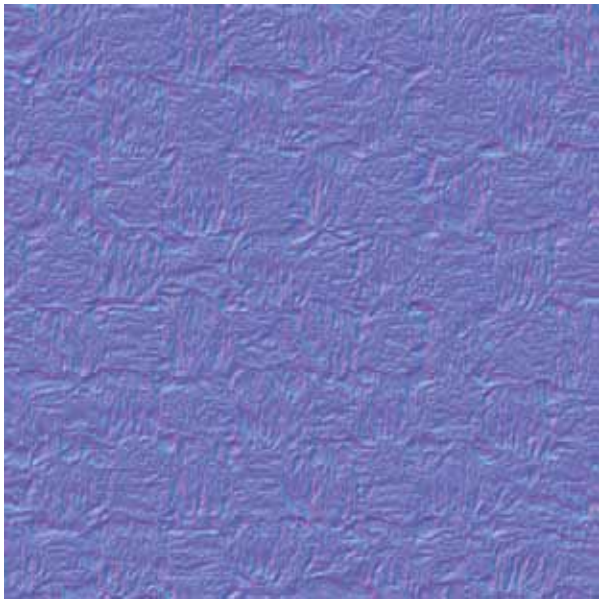


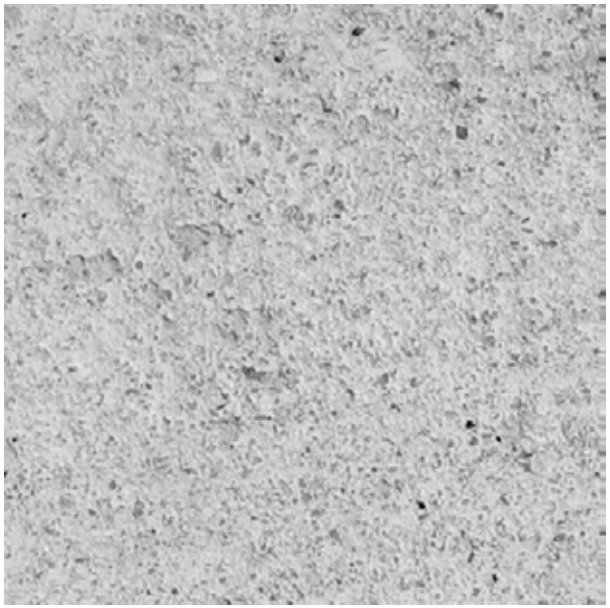
Texture Maps

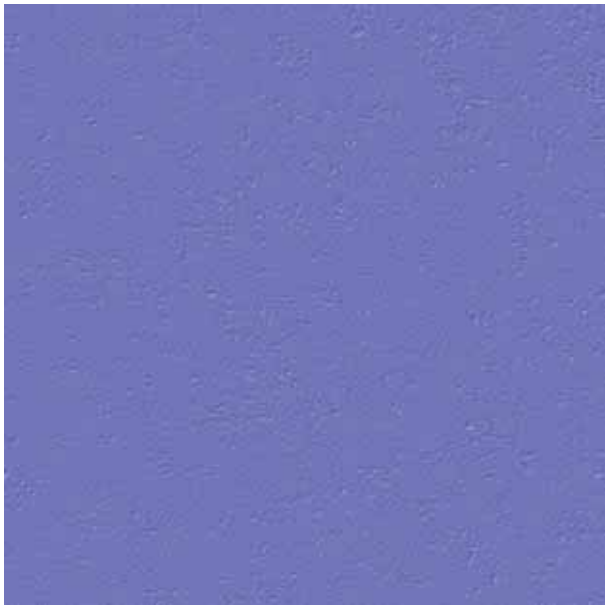
Secondary Texture Maps

Detail Normal Maps

Detail normal maps create macro details surfaces such as fabric, or large subtle variations in stone. You create a second set of UVs for adjusting the scaling and detail. Detail normal maps are usually small, about 128 by 128 pixels or less. A dual layer shader is needed with two normal map channels. The detail normal map is created from a grayscale map, using the Crazy Bump or the Nvidia normal map filter. These images are detail normal maps in grayscale and normal map.





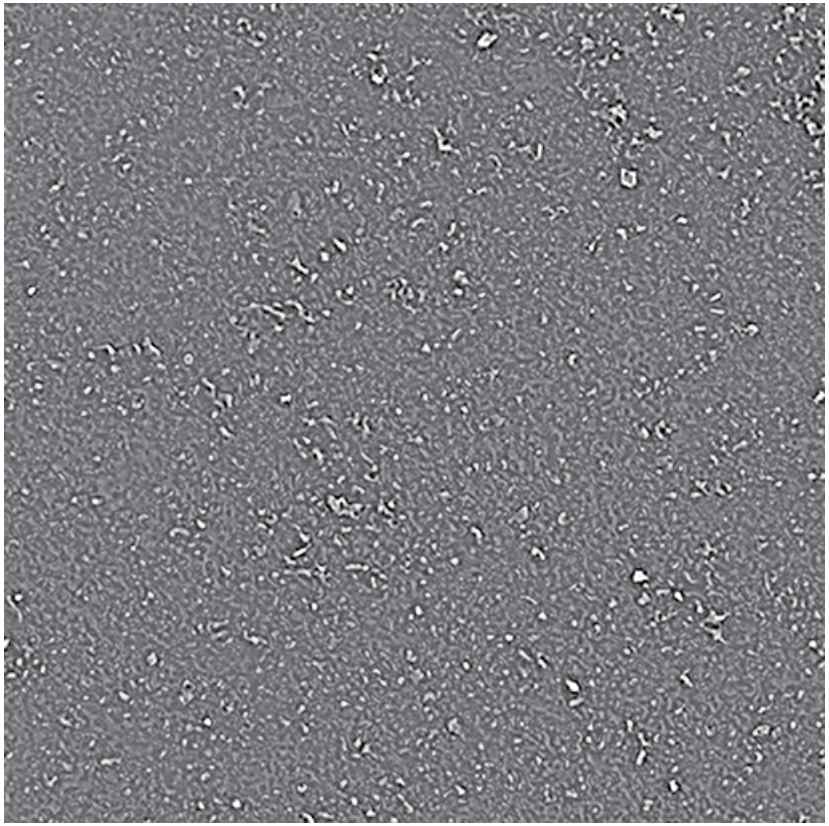


Texture Maps

Parallax Maps

Parallax maps are a form of visual displacement map. This map makes the environments surface look like it has more depth. Parallax textures are grayscale textures and are similar to normal maps in that they add depth in all directions. The more extreme the view angle, the more depth is created. Organic textures are ideal for parallax maps because they have a nonuniform layout. Custom normal mapped textures are sometimes problematic if they have very detailed edges and corners. Some 3D packages such as Softimage create a depth map, which may be used as a parallax map. There are also file converters that create a displacement or parallax map from a normal map.

The images are parallax maps for fabric and stone.



Texture Maps

BRDF Maps

The bidirectional reflectance distribution function is a four dimensional equation that defines how light is reflected on a 3D object. In video games, a 128 by 128 pixel color texture that simulates a light source is used to create lighting effects. A BRDF map is created on a solid black background, using gradients and hand painted details. Depending on the placement of the painted details, it controls the reflection properties on the model. One effect is rim lighting, which is a highlight around the edge of the model.

Diffuse BRDF

Specular BRDF

Anisotropic is a directionally dependent property that prevents the light from moving with the model when it is rotated. An anisotropic surface changes in appearance as it is rotated around its center. Cloth and velvet are examples of anisotropic materials. There are two types of BRDF maps: a diffuse and specular map. The diffuse map defines the lighting from the polygon normal of the light source. The specular map defines the lighting from polygon normal facing the camera or player. The images display diffuse and specular BRDF maps.

Glass Diffuse BRDF

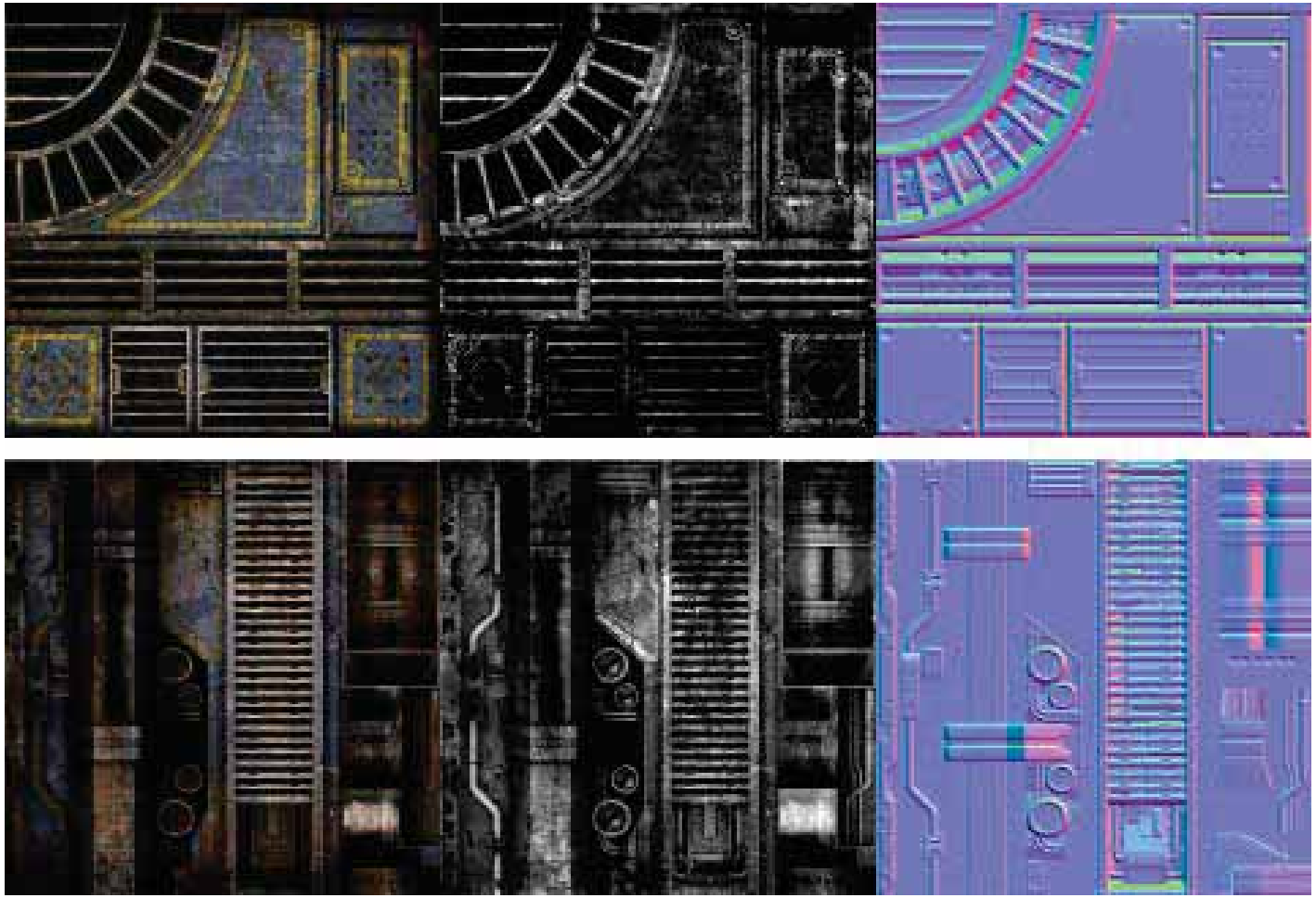
Glass Specular BRDF

Texture Maps

Final Textures

Most traditional game engines render a diffuse, normal, and specular map. The advanced game engines such as Unreal 3, Cry Engine 2, and Hammer support the maps covered above and many more. 3D software rendering supports many of these, but may have to be created and applied in different ways.

Below are final texture maps created at 1024 by 1024 pixel resolution. From left to right, they are diffuse, specular, and normal map.



Texture Realistic Wear & Polish

The application of realistic wear and tear, dirt, and grime is an art form in itself. Objects that interact with humans and the environment develop a wear pattern. The patterns may be oils from hands or machinery parts, and scratches from rubbing on another surface. When you study objects that receive heavy traffic such as furniture, you notice the corners are worn down to bare wood, and the large surfaces have scratches and dents. When objects are exposed to environmental elements such as sunlight and moisture, it causes paint to peel and cracks to form. Visit a large body of water and look at metal and wooden objects, noticing the water stains and rust formation. The bottom section of an object shows signs of decay and may turn white when minerals such as salt are deposited on the surface. Concrete shows a great deal of history, with cracks and the pot holes on street asphalt. A video game environment does not look like a clean hospital ward, but has skillfully placed areas of dirt and grime. Observe the real world process of weathering to create a convincing replica texture. Use the techniques outlined in this section, and your props and environments will look more realistic.

Pictured is a wooden table that has been outside for an extended period of time.

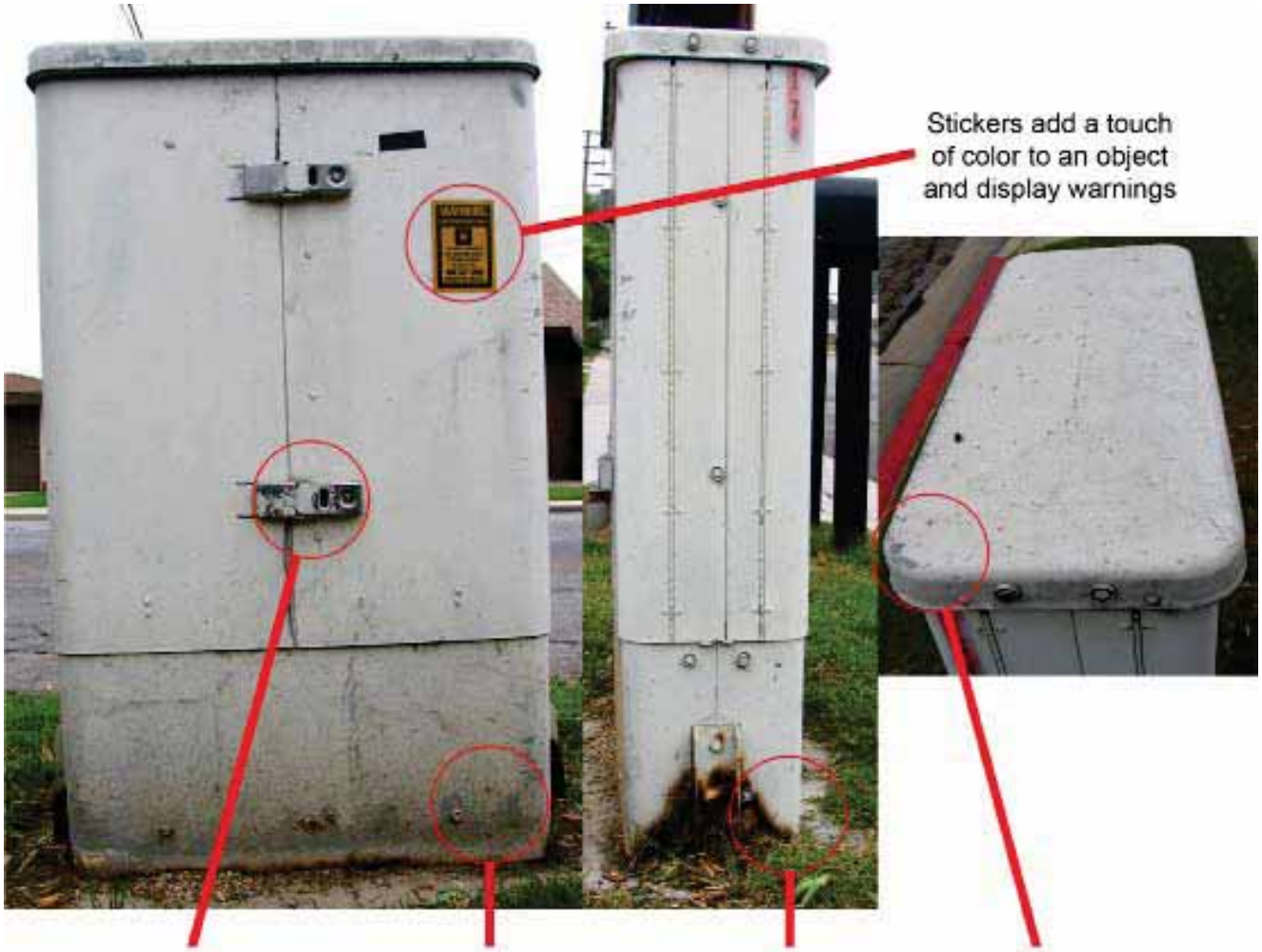
The image is the hood of a truck that has been in a hot climate near the ocean.

Texture Realistic Wear & Polish

Localized Wear

Localized wear and tear happens to specific areas of an object over time. Mother Nature is the most powerful source of structure decay. Water, wind, and sunlight on the coastline effect the surrounding environment causing constant erosion. The metal on a power box is a good source to study for signs of breakdown. On the handle area where there is frequent access with tools, the paint is stripped, exposing the bare metal. Aluminum does not rust very easily because it forms a layer of aluminum oxide, which protects the underlying metal. The sun causes paint to peel and fade over time, causing it to expand and contract. Be aware of the type of material an object is sitting on, such as dirt, concrete, or grass. Areas that have grass contain moisture in the topsoil, which disintegrates the metal over relatively short periods of time. Dirt often accumulates and sticks to the paint on lower sections of objects. The underside of lips and overhangs rust, causing streaks to form.

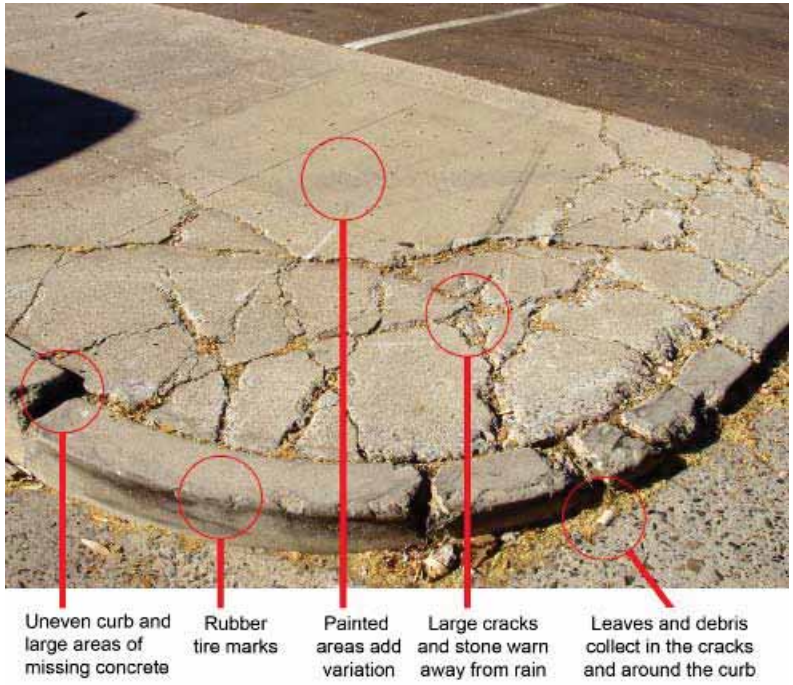
Pictured here is a diagram of a power box near the ocean.



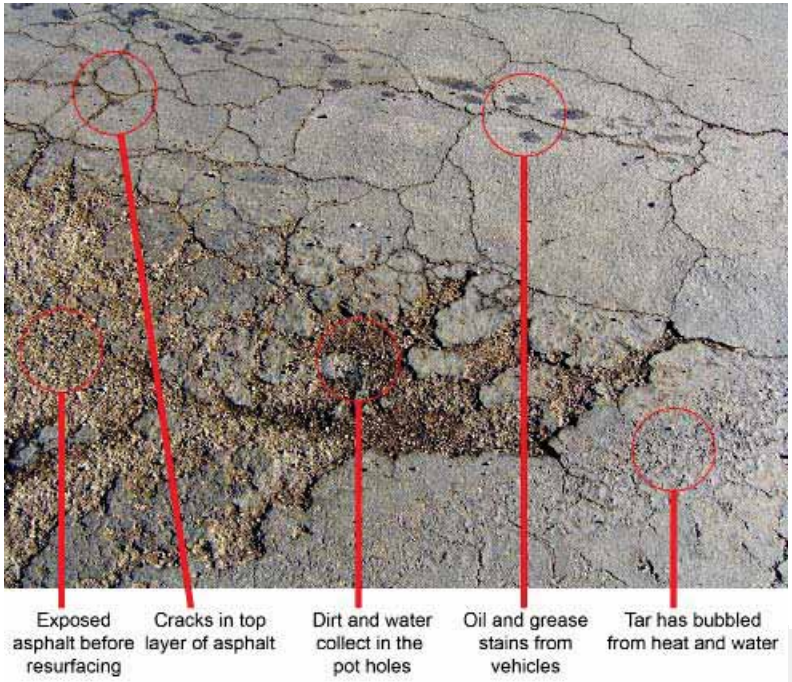
Texture Realistic Wear & Polish

Water and the movement of the underlying ground cause cracks on a stone or concrete surface. Damage occurs when vehicles drive over the surface, and heavy objects drop on them. Water and dirt erode the surface and create deep cracks and holes. When creating a texture, find good top down reference of these details. You create variation by cutting out crack details and overlaying them on top of a similar surface. Dirt layers may be overlaid onto a clean version of concrete or asphalt. The key is to use sharp details from photos and subtle dirt layers fine tuned to the desired result. The diagrams show areas of detail that may be replicated in a real texture.

The photograph below displays distress on a concrete sidewalk.



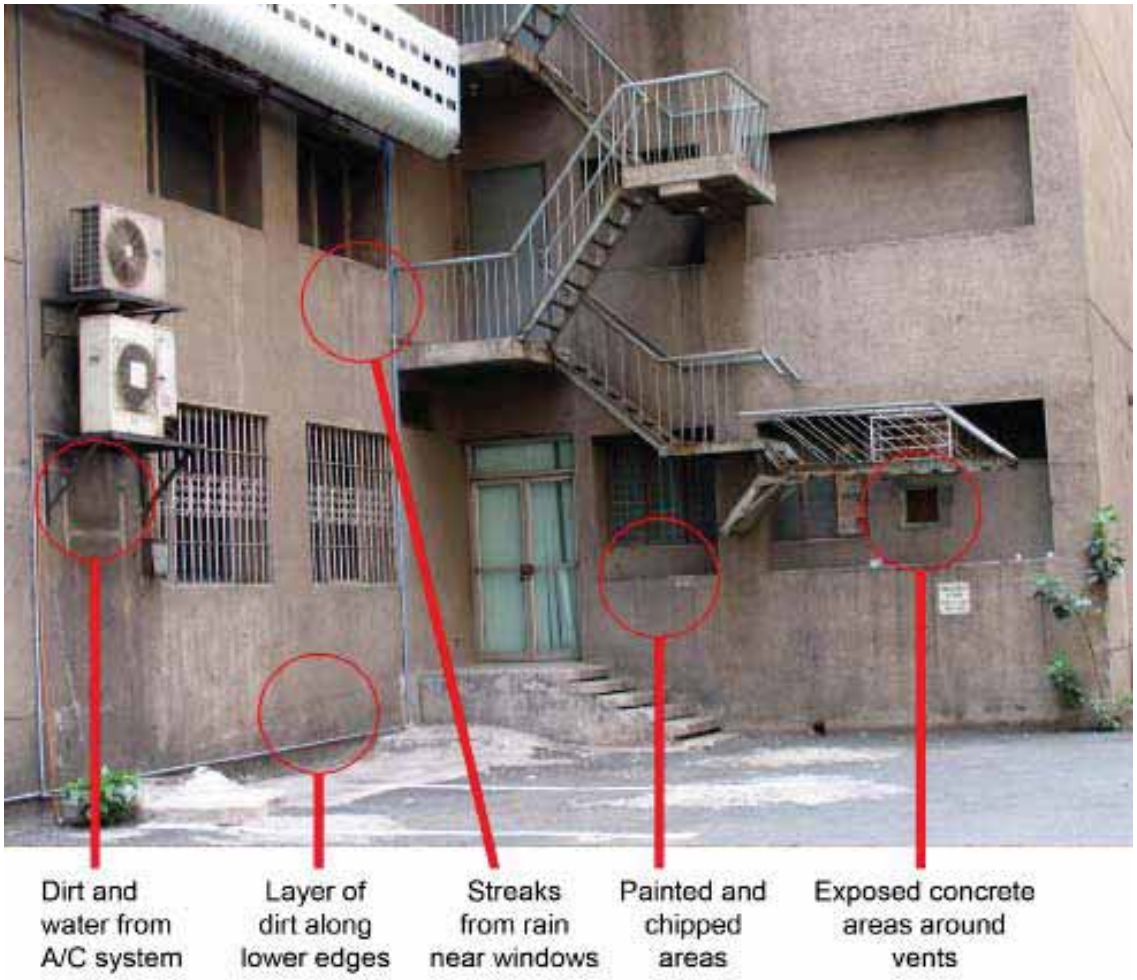
The image is a photograph of distress on an asphalt lot.



Texture Realistic Wear & Polish

Dirt and grime effects are applied in layers over the base textures. The dirt may be applied as streaks under windows and awnings. You apply grime as a treatment for a more uniform looking texture. Game engines support a second and third UV channel, and multiply the dirt layers over the base texture. Use a multilayer shader in a 3D package for use in a film. Large surfaces tend to look very tiled, even without a seam showing. Using a grim texture breaks up the repeating pattern and adds realism. Dirt gathers in the corners and along the bottom edges of the buildings, windows, and door trim. Details that are inset, such as vents, may be caulked with materials such as sealer or concrete. Polygon geometry pipes running along a building have a grime strip texture behind them to add depth. The buildings in the diagrams have not been cleaned for a long time, and have collected dirt in the corners. When it rains, the dirt runs down along a building's natural cracks or connection points.

The image displays areas where dirt collects and is washed away during rainy days.



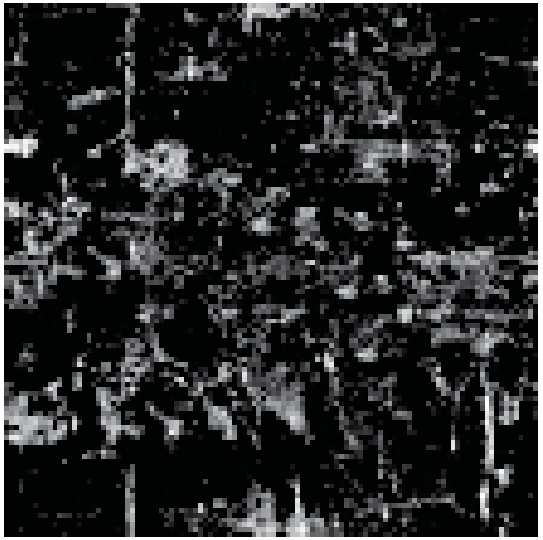
Texture Realistic Wear & Polish

Surface Overlays

A solid library of textures enables you to build a convincing texture. There some textures essential to creating the effects described in this section. The black and white grime overlay is great for a full surface effect. In Photoshop, set this layer style to overlay, or multiply and adjust the layer's opacity. The concrete wall photograph is a real world example of the desired effect. Another way to create this effect is to use a dark grime texture, and place a black and white overlay texture in the alpha channel.

Black and white grime overlay

Concrete wall photograph

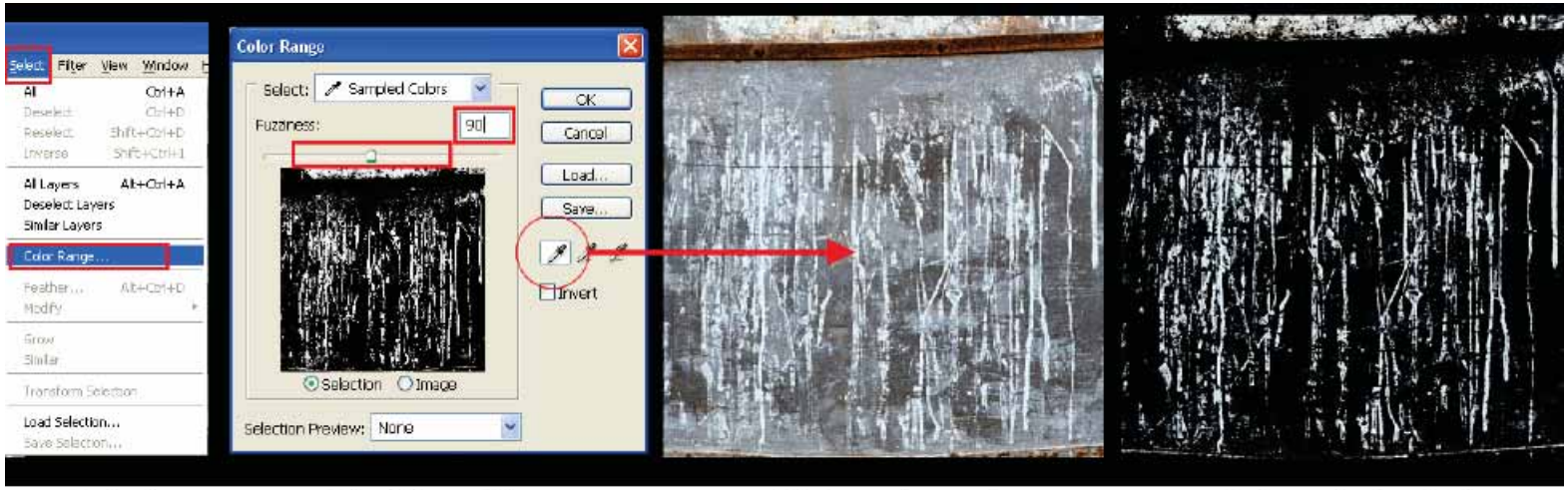


Alpha black and white grime

Dark grime texture

Texture Realistic Wear & Polish

Selecting a color range makes it easy to choose localized areas for overlays. Apply rust and colored streaks directly onto a texture, or use as an alpha texture sheet. Take a photograph with streaks on it, use the Color Selection tool in Photoshop to select out that color, and paste it into a new layer. The new grime layer may be set to overlay or multiply. Make adjustments to the hue and saturation to tint the color. Place this new grime layer on areas that need localized wear and tear.



Select Color Range | Select the white using the color picker | Photograph used for color selection | Color selection that is overlayed, and colored

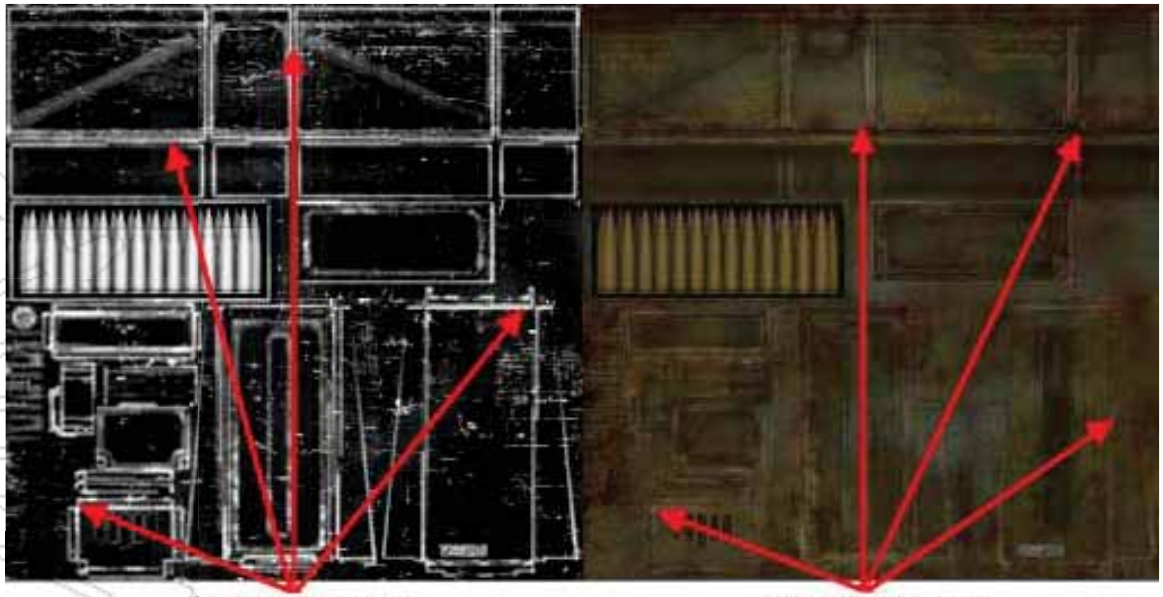
Texture Realistic Wear & Polish

Rust is a common detail that is separated by using the color selection method. Take textures while looking at buildings and finding areas of heavy run off.

Pictured is a layer selection of rust.

Edges may look worn down on the corners of the model's textures to simulate every day use. You use the Paint Brush tool and a light color to paint in the wear and tear. Use the specular map for the majority of this high contrast detail. When the light catches the edges of the surface, they create a nice highlight. The inset areas of an object usually collect dirt as illustrated in the diffuse texture. Dirt is trapped in the tread of a tire or along the trim of an automobile. Study real world objects with heavy outdoor use, and reproduce the localized areas on a texture.

The images displayed are the edges on a specular map and dirt on a diffuse map.



Edges are painted lighter in the specular map

Dirt and scratches are painted in the corners

Texture Realistic Wear & Polish

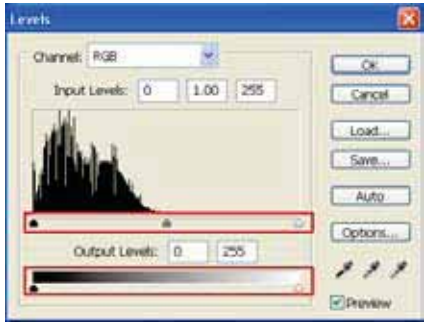
Color Correction

Texture polish refers to the time it takes an artist to refine a texture to match others. This can be a series of shader setting used by everyone working on a project. It takes time to become accustomed to using the Wacom tablet to draw in details. Painting by hand brings the external artist back into the more painterly and sculptural areas of art. The final texture looks like a piece of art, with clear form and resolution.

Color correction is done at the end of creating a texture or multiple textures. Adjust them all to within a value and color range, so they look similar. There are ways to adjust a texture when it is completed. You create a brightness contrast layer, or a levels adjustment layer. These filters are accessed in the Image and Adjustments list. Using the Levels windows makes it easy to adjust the minimum and maximum light values. The keyboard shortcut for adjusting the Levels is CTRL + L.

The images are an over saturated texture of the ammo case, and a color corrected one.

Pictured is the Levels tab. Levels are adjusting by using the sliders to clamp the color values.

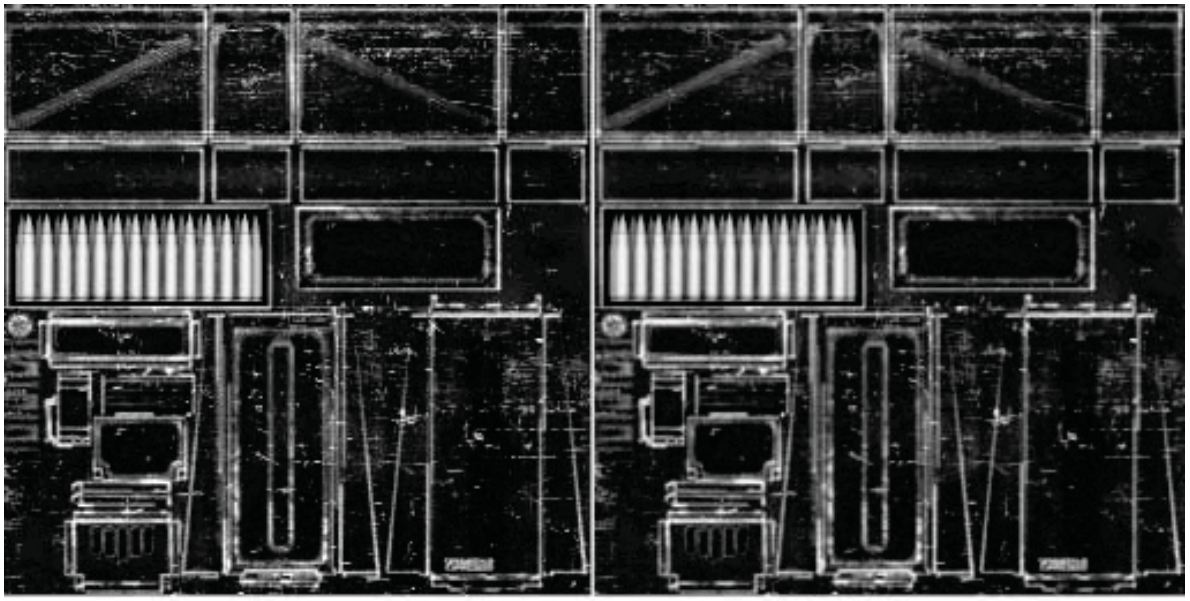


Texture Realistic Wear & Polish

When the texture is finished, sharpen it for a grittier look. It adds bang for your buck when the texture is rendered. Use the Photoshop Sharpen filter or un-sharp mask to sharpen the texture. If the specular map is too sharp, the texture appears to flicker on the screen. To adjust the specular map use a Gaussian blur. Set the blur of a few pixels to offset it, so that the texture looks smooth.

The images display a diffuse texture that has been sharpened, and a specular texture that has been blurred.

Normal Texture | Sharpened Texture



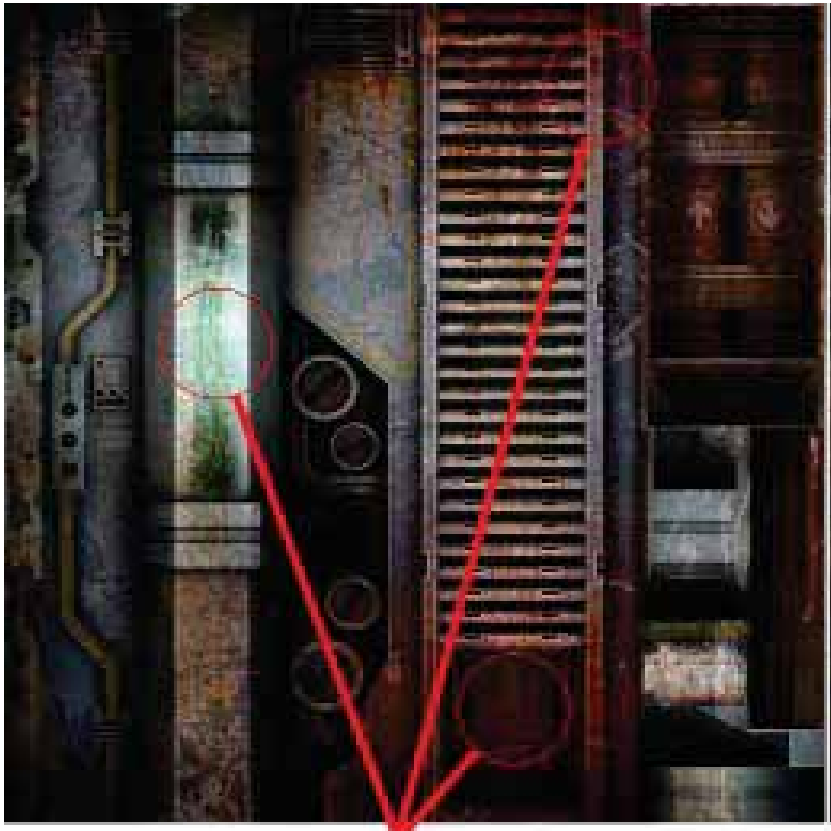
Normal Texture | Blurred Texture

Texture Realistic Wear & Polish

Rendering

When a texture has a light source directly over it, a bright area is created and shadows are cast. A secondary shadow map that includes lighting and color information is added as a multiply layer during rendering. The process bakes the lighting and shadows into the texture. This saves processing power and enables the computer to run faster. A light map is similar to a secondary ambient occlusion pass, multiplied over the diffuse layer when rendered in game or for film.

The images are textures that have lights and shadows baked into them.



Blue and Red Lights baked on the wall from a light source

Texture with no lights baked, only shadows

Texture Realistic Wear & Polish

Rendering for video games and films is a different process. Video games attempt to get all of the artwork rendered in real time, which means it has to render it on the fly. In film and TV, it is rendered out to a video file that is replayed. This is called pre-visualization. Mental Ray is a rendering engine used for film that takes texture sizes up to 4096 by 4096 pixels. This is the standard for film quality resolution.

A video game engine may only handle 100 megabytes of texture memory at once, and may require lower quality textures, such as 1024 by 1024 pixels. 3D software packages such as Maya, Softimage, and 3ds Max render images in mental ray. Rendering a final shot and setting up the lighting may take hours. A specialized artist may only work on rendering and lighting for a project.

Pictured are renders of the Bio Chamber in mental ray.

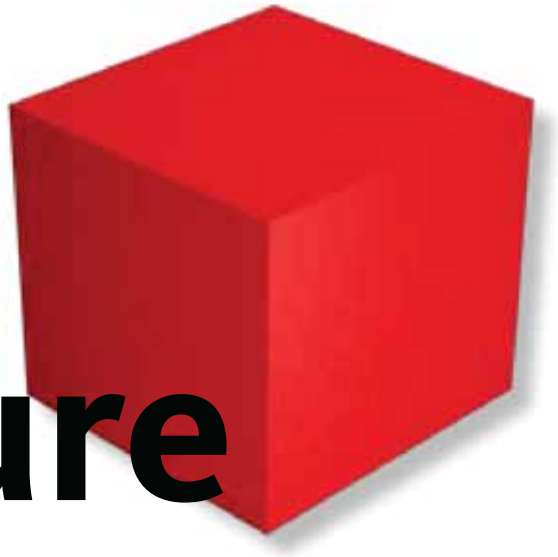
Workbook

SkillsUSA™ CHAMPIONSHIPS

2010

3D Visualization & Animation Competition

This Workbook provided through a generous grant from Autodesk®



Texture

SkillsUSA
2010 Contest Projects

Advertising Design

Advertising Design
In accordance with current Advertising Design industry technical standards, the contest will be composed of three parts.

The first section will be a general knowledge test for Advertising Design. Definitions, terms, file types, processes and procedures relevant to Advertising Design will be the basis for these questions.

In the second section the student will be required to re-create a given advertisement on the computer, using contestant supplied software. The industry standard software packages that are acceptable are as follows: QuarkXpress, PageMaker, InDesign, PhotoShop, Illustrator and Freehand. CorelDraw is an acceptable substitute, but should only be used if the aforementioned programs are not available.

The technical committee cannot guarantee technical support for CorelDraw, nor guarantee its compatibility with the contest. Students are to supply their own copies of the software to be used. Special attention should be paid to QuarkXpress, as some versions require a “dongle” that must accompany the software. Students and advisors should be sure that their machines would operate while not connected to their school network. Quark also has a version that requires a network license administrator. You will not have Internet access available in the competition area. Please be prepared for potential problems.

The third section of the competition is the creative section. The students will be presented with a design challenge, which they will have to complete in the time allotted. They must follow and complete the 3 steps to the creative process: thumbnails, roughs and the comprehensive stage. This year, the final comprehensive step is to be created on the computer; however, students must complete the other steps by hand. In the event of unforeseen changes or technical problems, the students may be responsible for creating the comprehensive by hand ... be prepared for any eventuality.

Contestants will be required to create an Adobe Acrobat PDF file of both their Creative and Mechanical portions of the contest. Acrobat is an industry standard program, and many page layout programs support the exporting of files in this format. Please consult www.adobe.com for specific information regarding Acrobat and Acrobat files, or contact the contest chairman with questions.

Materials list:
The materials that the contestants will be required to have are based upon the needs of the computer mechanical and creative portions of the competition. With the state of air travel as it is, there has been some questions as the type and size of the equipment specified in the SkillsUSA manual. This list will serve as a guideline for the actual materials required this year. There will be no need for x-acto blades or unusually long t-squares or rulers.

Computer Mechanical:
In addition to the computer requirements listed above, students MUST bring a USB removable memory “jump-drive” to save their work to. These are very inexpensive and should cost no more than $10.

Here is a link to the type of drive required: http://en.wikipedia.org/wiki/USB_flash_drive

The contestant MUST be able to leave the drive with the technical committee at the conclusion of the contest. The drive does not need to be any larger than 1 GB in size, as the contestant will only be copying two PDF’s onto it for judging. Students may also wish to bring blank CD’s or Zip Disks for storage. Again, it is best to prepare for any potential problems. Students will also require a ruler to transfer measurements from a supplied example. A proportional wheel or knowledge of how to mathematically determining the enlargement or reduction of an item is a must.

Creative:
As mentioned above, students will be creating thumbnails and roughs BY HAND. Therefore, it is critical that the student bring the proper art supplies with them, as they will not be supplied by the committee. There will also be NO sharing of supplies during the competition. THE ONLY ALLOWABLE

AND USABLE CLIP ART WILL BE PROVIDED BY THE COMMITTEE. For the creation of other artwork to be used, students must rely on themselves and their talent. As such, students should bring:

- An assortment of graphite pencils
- Either colored pencils or markers or both
- Fine point black markers (i.e. Sharpie)
- Paper that is appropriate to the medium in which the student will be working, (i.e. marker paper or visualizer pad)
- Triangle, compass or french curve as needed by student for drawing purposes
- A ruler that is at least 12”
- Small t-square for drawing appropriately sized thumbnail or rough boxes
- Pencil Sharpener
- Tape for securing paper to table if the student will be using a t-square
- Erasers
- A small extension cord
- A power strip
- A scanner is suggested and permitted but not required
- A digital camera is permitted but not required
- A digitizing tablet, (ie. Wacom tablet) is permitted but not required
- Above all, the student MUST bring with them whatever they feel they need to visually express the creative ideas in their heads.

Tips:

MECHANICAL:
Students will re-create with exacting precision and existing ad. This means that the must be able to properly read a ruler and transfer the measurements to their computer layout program. Technical proficiency and time management skills are paramount for this section of th competition. The placement of an item on the computer mechanical is either correct OR incorrect. There is no room for error in size, placement, or spelling. Be precise.

CREATIVE CONTEST:
Contestants must be familiar with the creative process. That means starting with thumbnails, moving to roughs then creating a final comprehensive. Proportion as extremely important. They must be able to determine the correct proportional thumbnail size from a given final product dimension. In addition, their thumbnails must be clear and communicative, as well as use color, and value properly. For the comprehensive students are judged on the strength of their ideas as well as the technical proficiency of their execution. Proper use of typography, color theory and the elements and principles of design are a must. Above all, be creative and appropriate to the subject matter.

For more information:
If you have any further questions please contact Lee Troxell at leetroxell2@gmail.com as soon as possible.

AD

ADVERTISING DESIGN

SKILLSUSA CHAMPIONSHIPS

JUNE 24, 2010

SkillsUSA®

CREATIVE SKILLS

SKILLSUSA CHAMPIONSHIPS

JUNE 24, 2010

SkillsUSA

Competition Area: Creative Skills

Time: 4.5 hours
Subject: Logo Design and Magazine Advertisement
Client: Renew-Able
Possible Points 600 (see attached judging sheet for point breakdown)

Background: You are an advertising designer and your client is **Renew-Able**. A unique company, **Renew-Able** is a company that pays people to recycle. They pay cash for items like old electronic devices, computers, appliances, paper products, etc. If you have used it, they can recycle it. **Renew-Able** wants to help people do the right thing AND help the environment.

Assignment: Your job will be as follows: Conceive, design, and execute a logo for **Renew-Able**. First, create a logo for the company within the allotted time. The required text for the logo is "**Renew-Able**". The logo design may be in full color and must not be a strictly typographic solution (it must incorporate some form of a graphic or illustration). Your logo design for this part can be any shape or size, but for the purposes of this competition, your thumbnails should fit in at least a 3" square. Your logo thumbnails should be NO LARGER than 4". Please remember, this DOES NOT mean that your logo should be square. If you choose to do a rectangular or oval-shaped logo, you should adjust the size of your logo thumbnails accordingly. Above all, PACE YOURSELF. Do not spend too much time on your thumbnails. The logo should represent the idea of a company that is being environmentally responsible and should be presented in a professional, but fun and energetic way. It should communicate instantly what they do. To this end, we are asking you to be as creative as possible in the time allotted. You will notice that we DID NOT supply you with a slogan or tag-line. **You are expected to come up with one**. This is the creative portion of the competition. BE CREATIVE. Show us your absolute best ideas.

Second, you will create a full color Magazine Advertisement. The Ad should announce Renew-Able as a new company, providing this new, unique service. Include these things in your design:

- Must include an eye catching, attention grabbing & clever headline
- Must include body copy. NOTE: We are not supplying this. You MUST WRITE something descriptive and tantalizing. This is a NEW service. People will not know what Renew-Able is. You must tell them. Just a few lines of type will not be acceptable. You must SELL this service. Be creative. (and check your spelling)
- Must incorporate the logo
- Must include the tag line or slogan copy you have come up with.
- Must include a visual

You may choose to incorporate some of the images provided, or you may choose to create graphic images to accompany the logo and required copy. Before you begin work on the composition on your computer, you must complete thumbnails for this portion of the competition. You may, of course, use your computer to view the images. You will create text for the Ad, as well as the information that would generally appear on such an Ad (i.e. address, phone number, web address, etc.).You should allow yourself at least 1/4" margin for the live area of your Ad. SAVE the Ad as your Contestant Number. Type set your Contestant Number in the upper right corner of the table card in 20 pt. Helvetica. Feel free to use the imagery provided or create your own. The graphic elements provided are a starting point, and it is assumed that you will make some changes to images provided. We know what we have given you. Show us how creative you can be with it.

Your Ad design must:

- Incorporate the logo you have created, as well as the elements requested above
- Include some sort of slogan or tag-line
- Anything that makes your design REAL or BELIEVABLE. (web address, etc.)

Keep an eye on the time. **PACE YOURSELF!** The key to all of this is to finish in the time allotted.

Color: Full-color

Size: See instructions above for logo guidelines. Ad size is 7.625" x 9.375"
Required copy: See instructions above

Procedure:
1. **Read directions**, look over all materials & evaluation sheet.
2. Sketch 10 thumbnails **EACH** of the logo and Ad **in proportion** and in color. Logo FIRST. A SECOND.
3. Develop your designs for the logo and Ad in proportion and in color from your thumbnails on the computer.
4. Create a PDF of the final version of your logo BY ITSELF. It should fit within a 5" x 5" box, (but it doesn't have to be square.) Save it as your contestant number + the word "logo" If created in Photoshop, keep the resolution 250 dpi. Type set your Contestant Number in the upper right corner of the logo in 10 pt. Helvetica or equivalent. Save as a PDF
5. Create 1 full-size, final of the Ad on the computer which has your logo incorporated into it.
6. Proof on the screen! Create a PDF
7. Copy to jump drive, place all your elements back in the envelope and raise your hand to turn in your work.

Provided: Evaluation Sheet, Reference artwork & copy

Contestant Number:_____

Creative Skills
Judging Sheet

JUDGING

		Range	Actual	Max per Section
Thumbnails:	**Logo**			**20**
	10 **Different** Thumbnails	1 to 5		
	Creative strength of ideas	1 to 15		
Thumbnails:	**Advertisement**			**20**
	10 Different Thumbnails	1 to 5		
	Creative strength of ideas	1 to 15		
Final Piece				**60**
	Designs Developed from Thumbnails	1 to 5		
	Strength of Idea, Communicative Strength	1 to 15		
	Strength of Color Model (Design and Type)	1 to 10		
	Creative Use of Illustrations/Photos	1 to 10		
	Overall Creativity	1 to 20		**100 Points** **(x 6 for final score)**

Judge:_____

Computer Mechanical

SKILLSUSA CHAMPIONSHIPS

JUNE 24, 2010

SkillsUSA

Competition Area: Computer Generated Mechanical

Time: 2.5 hours

Subject: Ad

Client: FOIL

Assignment: Assemble the ad shown using the elements provided

Size: 7.375" x 9.75"

Colors: Full color

Assessed Points 100 x 3 (see attached judging sheet for point breakdown)

Procedure: CAREFULLY view the Ad and all the elements provided to re-create the Ad.

With your Desktop Layout program and using the Ad provided a guide, SAVE the ad as your Contestant Number. Type set your Contestant Number in the upper right corner of the ad in 20 pt. Helvetica. Type in ALL of the text. Use your spell check utility to make sure your text is accurate. Using your RULER transfer the measurements from your sample ad to your computer generated mechanical for placement of elements such as rule lines, border, type and image placement. You will import the images from the "SKILLS CONTEST" folder on your hard drive. Assign colors as indicated. Pay close attention to the instructions, DO NOT PANIC...you can do this in the time allotted. PACE YOURSELF using your evaluation sheet as a guide...be aware of how the points are assigned. SAVE OFTEN!

Materials Provided: Copy of finished Ad for reference, actual size
Images
Judging sheet

INSTRUCTION SHEET
Actual size ad on next page.

A .25 pt. rule box surrounds the ad. The rule is Black.

Create this type element using breeze1.eps as a starting point. Size, color and kern as shown.

Create these 3 separate airwave forms using Airwave.tif as a starting point. They are White, with an opacity setting of 20%. Size and place as shown.

Place this background image, windmill2.jpg. Size, crop and position as shown.

This text is Times New Roman 10 pt. type on 19 pt. leading, color is black, justified, no hyphenation. Set kerning and tracking as shown. Bold or italicize type as indicated.

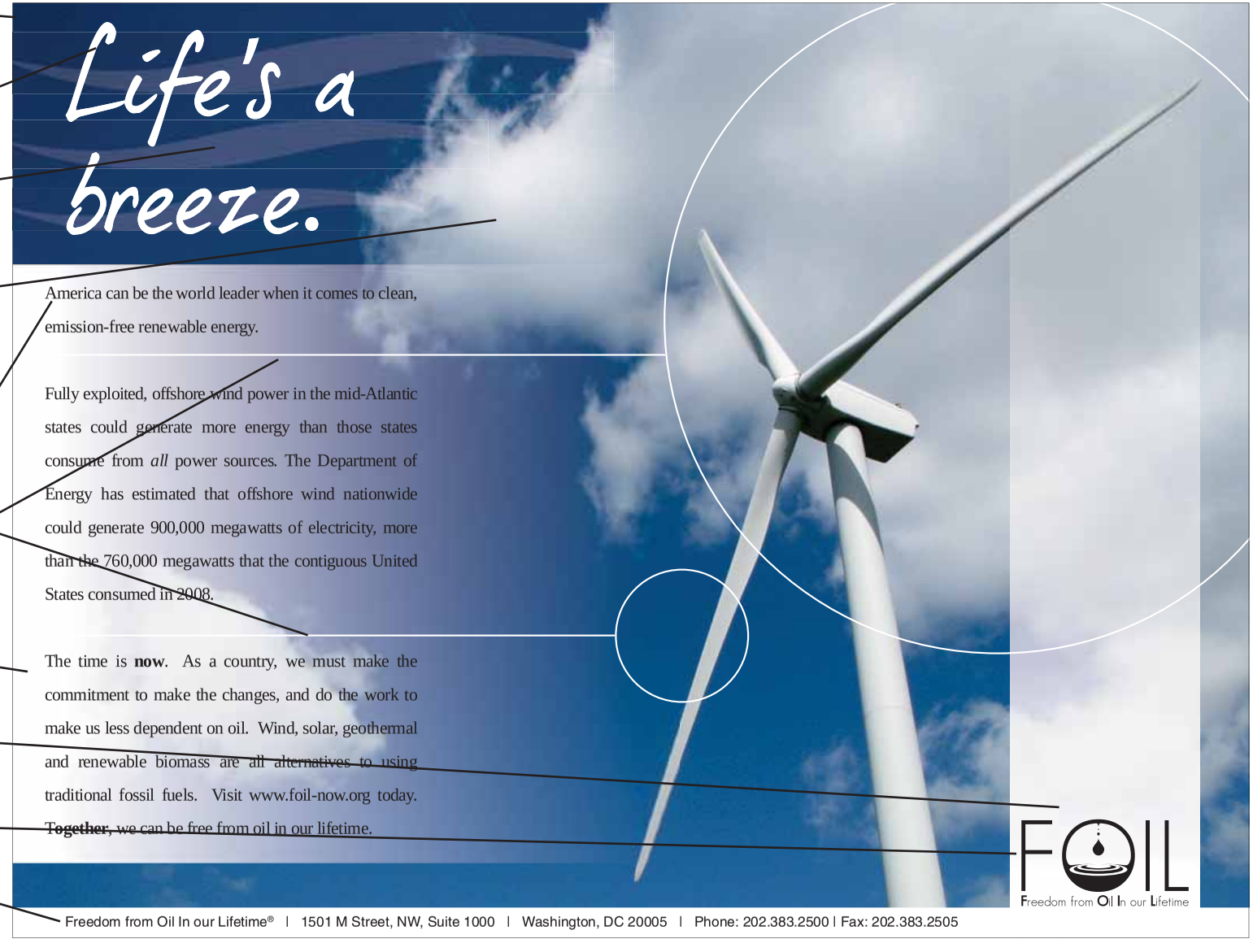
These 1 pt. rule lines are White and touch the circles as shown. They run from the left of the ad. Size and place as indicated. The circles are also 1 pt. Size and place them as shown.

This gradient is behind the body copy. It is made with the gradient.png file. Size and place as indicated.

The gradient behind the FOIL logo is also created with gradient.png. Size and place that too.

Place logo. Size and position as shown.

These words are Helvetica 8 pt. type on 9.6 pt. leading. Kern as shown.



Life's a breeze.

America can be the world leader when it comes to clean, emission-free renewable energy.

Fully exploited, offshore wind power in the mid-Atlantic states could generate more energy than those states consume from *all* power sources. The Department of Energy has estimated that offshore wind nationwide could generate 900,000 megawatts of electricity, more than the 760,000 megawatts that the contiguous United States consumed in 2008.

The time is **now**. As a country, we must make the commitment to make the changes, and do the work to make us less dependent on oil. Wind, solar, geothermal and renewable biomass are all alternatives to using traditional fossil fuels. Visit www.foil-now.org today. T**ogether**, we can be free from oil in our lifetime.

FOIL

Freedom from Oil In our Lifetime

Freedom from Oil In our Lifetime® | 1501 M Street, NW, Suite 1000 | Washington, DC 20005 | Phone: 202.383.2500 | Fax: 202.383.2505

Contestant Number:_____

Computer Generated Mechanical
Judging Sheet

JUDGING

	Range	Actual	Max per Section
1. Followed Instructions			
1. CORRECT SIZE & PLACEMENT OF ELEMENTS			
"Life's a breeze" Graphic	0-20		65
3 Air Waves	0-20		
Rule Lines and Circles	0-15		
Background element	0-5		
Logo	0-5		
2. CORRECT USE OF TYPOGRAPHY			
Body Copy	0-5		15
Bold & Italics	0-5		
Info at the bottom	0-5		
3. GRADIENTS			
Behind Body Copy	0-5		10
Behind FOIL logo	0-5		
4. SPELLING			
Spelling errors	0-10		10
TOTAL	100 pts. max		
			(x 3 for final score)

Judge:_____

SkillsUSA
2010 Contest Projects

Architectural Drafting

Click the “Print this Section” button above to automatically print the specifications for this contest. Make sure your printer is turned on before pressing the button.

SkillsUSA

Architectural Drafting
June 24, 2010

You have just been contacted by a hopeful new client, Mr. Lyle Pig, who has asked you to produce a set of schematic drawings for his new custom home. Mr. Pig's vision is to construct his home using bales of straw, which is an unconventional construction type in his town of Dark Woods. Before he spends his hard-earned money to have you develop a full set of construction documents, Mr. Pig needs to take his schematic drawings to a meeting with the local Codes Department to see if they will consider issuing a building permit using this method of construction.

In his research, Mr. Pig has learned that straw bales were a fairly common building material in the United States between 1895 and 1940. Straw Bale construction is coming back in favor and he is very interested in this earth-friendly and energy efficient method of construction. Straw bale construction, when done properly, can be very fire-resistant, as well as very resistant to winds that could blow his house down. Straw bales also have excellent insulating properties.

There are two main construction methods using straw bales, non-load-bearing (also called post-and-beam) or load-bearing. Non-load-bearing construction uses a structural framework and uses the straw bales as in-fill. The load-bearing method uses the bearing capacity of the stacked bales to support roof loads. Mr. Pig would like to employ the non-load-bearing method so he can have the structural framework support a second story and because he has learned that this method is typically more easily accepted by local building code officials in other communities.

Mr. Pig intends to use 2-string straw bales which measure 18" wide by 16" high by 36" long. He has provided a preliminary floor plan for you to use. While the house will use the non-load bearing method of construction, for this set of plans, the Code Official, Mr. B. B. Wolf, is only interested in seeing what the "weird straw bale house" will look like. After Mr. Wolf has seen the plans and has approved the construction method, you will employ the help of a structural engineer who will show the load-bearing posts and beams on her drawings, therefore, you do not need to worry about showing the structural members in the wall at this time.

The home will have a 4" concrete slab on grade first floor and a framed second floor. Do not draft the second floor, only provide the drawings as listed below. The foundation will be 8" cast-in-place concrete with 8" x 24" concrete footings. The frost line for this project is 36". The exterior of the bales will be coated with a cement-mixture stucco. The interior of the bales will be plastered. As straw bales need to be able to breathe in order to allow any moisture to evaporate, no moisture barrier will be installed.

Please provide complete drawings as noted below, including dimensions and all appropriate annotations. Refer to the following information for specific requirements and materials required in addition to the information contained here.

When working on projects like this, you know you can procrastinate. You work best when you create interim deadlines for yourself. Knowing this, you have told yourself you will have your hand sketch completed by lunch time. As such, please turn in your hand sketch at noon, when we break for lunch.

The second deadline is at 4:00 p.m. All remaining drawings and associated information are due at this time.

Your task is to provide the following documents for Mr. Pig's use:

-Hand sketch of exterior wall section cut "M" where indicated on the floor plan sketch
-Dimensioned First Floor Plan created from Sketch A
-Openings Schedule(s)
-Three exterior elevations
-Interior elevation as indicated on the floor plan sketch and labeled "ELEV"

General Information - Computer Generated Items

-Use good CAD production techniques.
-You are allowed only one plotted sheet.
-Dimensioning, general text, and notes shall have a plotted height of 1/8".
-Other text (i.e. titles, room names) may be a height of your choice, but must be legible and appropriately sized using architectural conventions.
-Include a title and scale for each drawing on the sheet. Include a North arrow where appropriate.
-The size of your finished, plotted sheet will be 24" x 36". Construct a border of a plotted size of 34" x 22". Place a 1" x 1" square (plotted size) in the bottom, right-hand corner of your sheet. Place your contestant number in this square.
-The scale of all required drawings will vary. Utilize wise sheet layout.
-Provide full and complete drawings. Do not compromise quality and completeness on required drawings in order to provide drawings that are not required.
-Read all sheets to get all required information to produce all required drawings.

First Floor Plan – Computer-Generated Drawing

1. First Floor per attached Sketch A.
2. First floor plan is to be plotted at a scale of ¼" = 1'-0".
3. The north, west and east walls are framed with 2-string straw bales. Straw bales are not to be cut as much as possible in the exterior wall construction.
4. The south wall, where it is not framed with straw bales, will be 2 x 4 wood-stud framed, see attached Sketch A.
5. Exterior faces of all walls shall be cement-mixture stucco with wire lath with a finished thickness of ¾".
6. Interior faces of all exterior walls shall be plastered with a finished thickness of 1/2".
7. All interior walls are framed with 2 x 4's, sheathed with ½" gypsum board on each side.
8. The first bale will sit on continuous 2 x 4 plates located at the exterior and interior edges of the bale.
9. The dimension from the top of concrete first floor to the truss bearing is 8'-1-1/2".
10. The ceiling joist shall be 2 x 6. The subfloor for the second floor shall be ½" plywood.
11. The roof will be framed with a scissor truss made up of 2 x 6's installed at 24" on center. The roof pitch shall be 10:12.
12. The roof shall be standing seam metal panels installed over roofing paper on ½" plywood.
13. The overhangs shall be 16" deep.
14. Provide batt insulation at the roof trusses.

15. Show casework, appliances and plumbing fixtures. Do not show furniture.
16. Provide necessary interior and exterior dimensions for construction.
17. Dimension all exterior windows and doors to their centers.
    a. All first floor windows to be 36" wide with the exception of the three windows located on the south wall. Those windows shall be 24" wide.
    b. All window sills to be at 33-1/2" above finished floor. All windows shall be 48" tall.
    c. The rough opening for all exterior doors is 36" for single doors and 6'-0" for pairs of doors.
    d. Interior swinging doors are 2'-6", except for closet doors that are 2'-0" wide. Sliding doors have a total opening width of 6'-0". The pocket door is 30" wide.
18. Indicate door and window sizes for each door and window in an opening schedule(s). Make sure each door and window is scheduled with a unique door number and window letter.
    a. Include the openings schedule on the same drawing sheet as the floor plan.
19. Do not include electrical information.

Exterior Elevations - Computer-Generated Drawings

Provide three exterior elevations; the South, North and West elevations.

The elevations must be plotted on the same sheet as the other required CAD (or manually drafted) elements.

-Draft the South elevation at a scale of ¼" = 1'-0".
-Draft the North and West elevations at a scale of 1/8" = 1'-0".
-Provide proper annotation and dimensioning.

Interior Elevation - Computer-Generated Drawing

Draft an interior elevation as indicated on the attached floor plan sketch.

-Scale of elevation to be ½" = 1'-0".
-Show casework cabinets and all appliances as required at the kitchen.
-Show all other elements that would be visible in the elevation.
-Dimension and notate appropriately, including material designations as required.

Wall Section – Hand Sketch

Using the basic list of construction items provided below, the information previously stated in this document about the exterior wall construction types, and all notes included throughout this packet as applicable, develop a hand sketch of an exterior wall section including footing, foundation, first floor construction, second floor construction and roof framing. Wall section to be cut as indicated on floor plan sketch.

-Hand draw the sketch at 1/2" = 1'-0" on the provided paper. Put your contestant number in a 1" x 1" square at the bottom right corner of the hand sketch sheet.

-Provide all necessary components, as well as notes, dimensions, and material hatching on your sketch. Include the entire wall from the footing/foundation, wall framing, up to, and including, the roof rafters and eaves. Break lines may be used to allow the sketch to fit on the sheet.

Include, at a minimum, the following on your hand sketch:

1. Concrete footing and foundation
2. Grade (especially as related to first floor)
3. First floor construction
4. Exterior wall construction, including finishes
5. Ceiling joist(s)
6. Roof trusses with insulation
7. Eave and soffit with appropriate depth overhang
8. Metal roofing system
9. Appropriate dimensions
10. Quality lettering

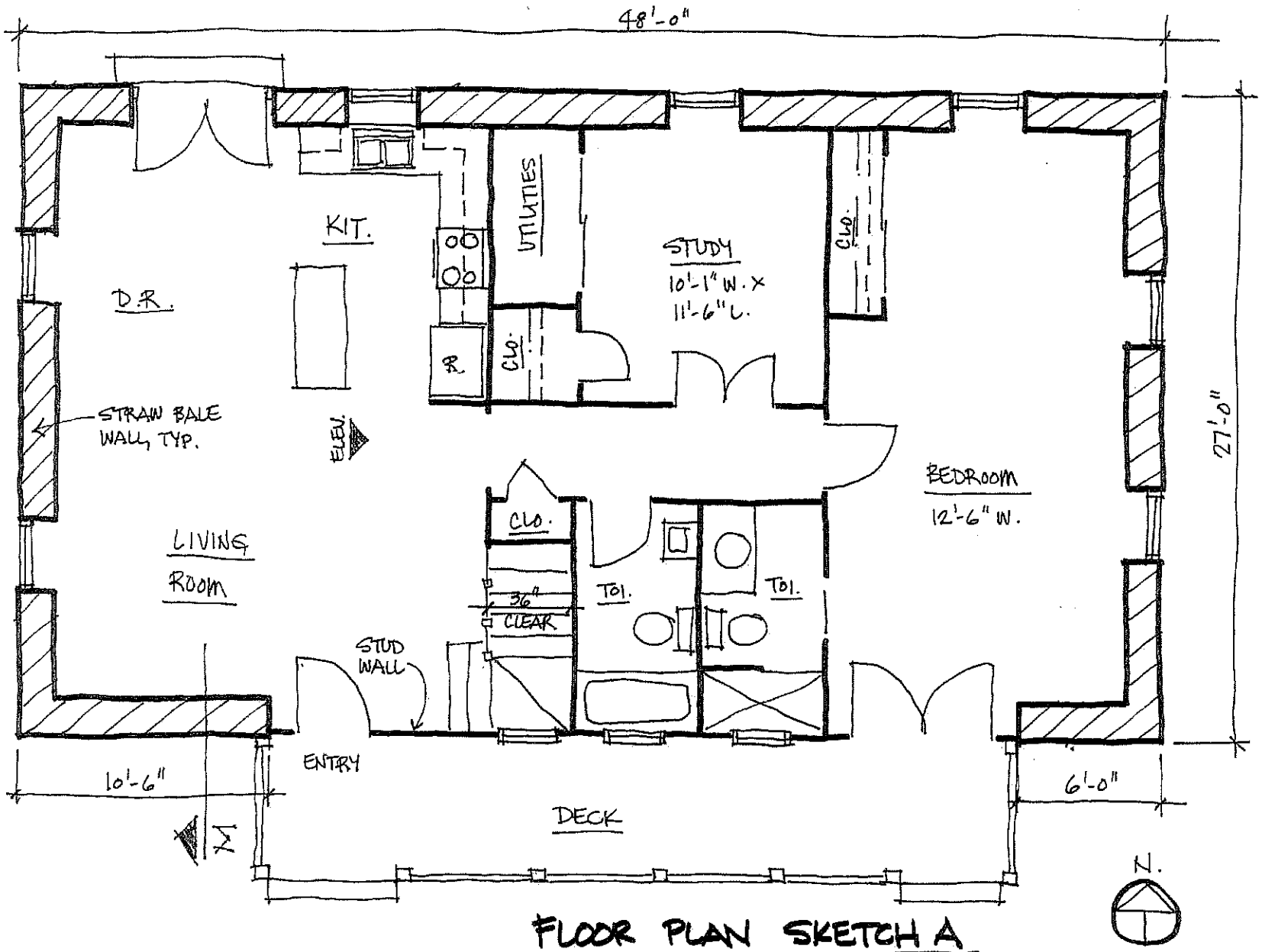
**NOTE: Considering all notes and dimensions as listed in this document, how many "courses" of straw bales are required at the exterior walls? Print the answer on the hand sketch sheet in the following format:

"The number of courses of straw bales required is _____."

Turn in the hand sketch (with the required straw bale information) at the lunch break.

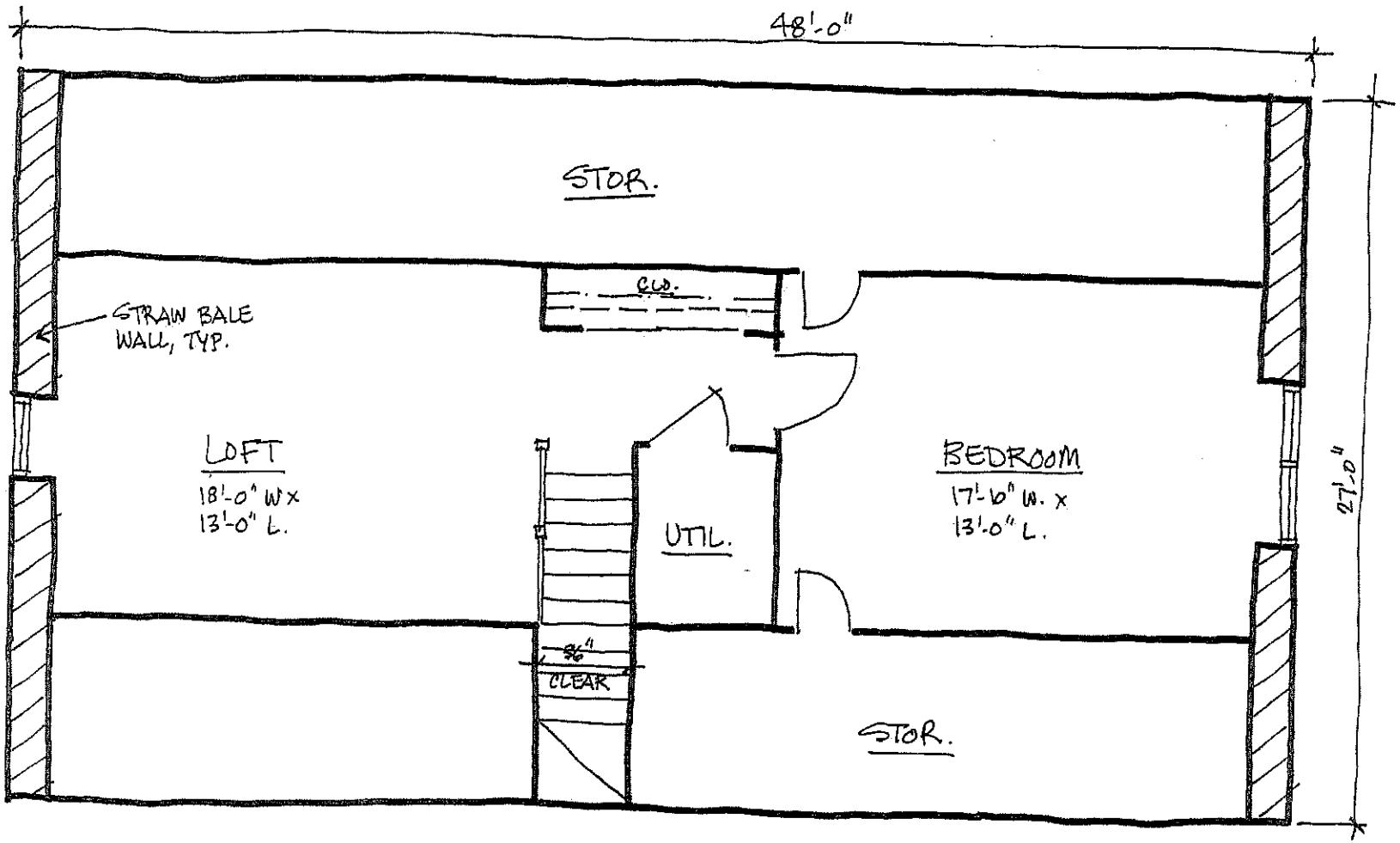
Remember to put your contestant number in the 1" square box on all of your sheets as directed. This shall be the only identifying factor on any of your sheets. Do not put your name on any of your sheets.

Please name all of your electronic files with your contestant number, i.e. 123.dwg, 123.dwf, 123.plt, etc.



FLOOR PLAN SKETCH A

N.T.S.



SECOND FLOOR PLAN

N.T.S.

N.

SkillsUSA
2010 Contest Projects

Audio (Radio) Production

Click the “Print this Section” button above to automatically print the specifications for this contest. Make sure your printer is turned on before pressing the button.

SkillsUSA
Champions at Work

2010 Audio/Radio Production Prompt

MISSION:

Your assignment is to produce a :60 second sound rich news story about the World Cup viewing parties taking place at The Living Room in Kansas City's Power & Light District. Your client wants to do a news story about the viewing parties featuring today's game (U.S. Men's National Team vs. Algeria).

Content: Our client has requested that the following information must be represented within your production:

1. Information and sound from inside The Living Room.
2. Use this morning's game as the basis for your story but don't forget to mention that the viewing parties continue throughout the World Cup.
3. Clearly communicate that the viewing parties are family events. Even though alcohol may be served during the event that shouldn't be mentioned.
4. Make sure you have interviews from people participating in the viewing party.
5. You are allowed to leave immediate The Living Room area to record your voiceover but you shouldn't return to the contest room earlier than 11:00 a.m.

Target Audience:

Sports fans (especially soccer fans) of all ages. You want to mention that the viewing parties are open to families and fans of all ages. The viewing parties are being coordinated by the Kansas City Wizards, the local Major League Soccer (MLS) team.

Here's some specific information from Chad Reynolds with the Kansas City Wizards:

So here's a bit of a briefer on the P&L and how it's been for the watch parties:

There's a big courtyard in the middle called "The Living Room" with a giant big-screen where there should be anywhere from several hundred to a couple thousand soccer fans (tough to predict a crowd with it being a Wednesday morning). There will also be people in some of the surrounding restaurants/bars. The largest concentration of fans (and the rowdiest) will be in a bar/grill called "Johnny's Tavern" near the back of the area. That's where the "American Outlaws" U.S. soccer supporter's club has their organized party in conjunction with the big party. That's where the singing/chanting type crowd will be.

It's really been a great turnout for this event for us. We've had folks there of all ages and levels of soccer fandom. And as the tournament has gone on we're seeing bigger and

bigger numbers. Hopefully we see big-time numbers on Wednesday for what is in reality the most important U.S. soccer match in years (arguably since 2002 and the quarterfinals).

There should be plenty for the contestants to record. And plenty of people to interview. Good stuff.

Guidelines:

1. Safety (please be aware that there will be a large and possibly rowdy crowd and that alcohol may be served in the area --- no contestants are allowed to drink during the contest even if you're 21 or older).
2. All audio will be done in the field, including your voiceover.
3. You should try to include the following audio elements: natural sound, narration and interviews, during at least one portion of the project. You must record your narration and interviews in the field.
4. You must use the following lockout to end your news package: "Reporting from the Power & Light District in Downtown Kansas City, I'm *your name(s) here*, SkillsUSA News." If both partners voices are heard as reporters within the news package then both names should be mentioned but if only one partner's voice is heard then only one name should be mentioned. The lockout counts in the 60 second time limit.

SkillsUSA
2010 Contest Projects

Automated Manufacturing Technology

Click the “Print this Section” button above to automatically print the specifications for this contest. Make sure your printer is turned on before pressing the button.

2010 SKILLS USA CHAMPIONSHIP

AUTOMATED MANUFACTURING TECHNOLOGY COMPETITION

TEAM GUIDE

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AutoDesk, Inc.
CNC Software, Inc.
Depco, LLC.
River Valley Technical Center
MSC
Rolla Technical Institute
SolidWorks
Learning Labs
Holmquist Educational Resources
LS Starrett

AMT Competition Technical Committee

The following individuals contributed their time and energy to the Technical Committee.

Richard McManus
Aztech Educational Resources

Rick Knisely
Aztech Educational Resources

Jeff Stone
intelitek

Terry Graham
Depco, Inc.

Brenda Quinn
intelitek

Rod Murphy
Depco, Inc.

Richard Walker
National Tooling & Machining Assoc.

Mike Ogilvy
VP Sales and Marketing
intelitek

Dan Larochelle
intelitek

Dustin Spieth
CNC Software

Dan Newbey
CNC Software

Robert Clarke
intelitek

Judges

The following individuals contributed their time and energy as Judges for the competition.

Terry Graham
Depco, LLC.

Rod Murphy
Depco, LLC.

Rick Knisely
Aztech Educational Resources

Dan Newby
CNC Software

Stephanie Holmquist
Holmquist Educational Consultants, Inc

Dan Hanson
Honeywell

Terry Johnson
R.T. Johnson Co., Inc.

Matt Selter
Honeywell

Jess Mooney
Honeywell

Dustin Spieth
CNC Software

Sheldon Richardson
Sales Manager
Learning Labs

Ben Richarson
Sales Manager
Learning Labs

National Educational Technical Committee

The following individuals contributed their time and energy to the National Educational Technical Committee.

Don Block, Chairperson
Rolla Technical Institute
Rolla, MO 65401

Samuel Dolson
Manteca High School
Manteca, CA 95336

Rick Huddleston
Tulsa Technology Center
Tulsa, OK 74147-7200

Jeffrey Fisher
South Central Technical College
New Ulm, MN 56073

George Skena
Old Dominion University
NASA Langley Research Center
NorthStar Research Institute

Awards

The following companies have supplied awards:

Intelitek, Inc

AutoDesk, Inc.

CNC Software Inc.

Newell Rubbermaid

Solid Works

1: Contest Overview

1.1: Cutting-edge Technology

Current advances in manufacturing technologies such as CAD, CAM, and CNC, have allowed the United States to remain competitive within the global market. To compete in this evolving field, companies worldwide must remain at the forefront of both current and emerging technologies in design and manufacturing. With today's complex design and manufacturing challenges, no individual is equipped with all the answers, so it is imperative for manufacturers to combine the resources and abilities of a team to resolve problems.

1.2: Your Team

Success in Automated Manufacturing is often found using a team approach. In the interest of emulating industry, this competition will be structured in this manner. For optimum team efficiency, we suggest your team be comprised of a specialist in each of the following fields:

- Computer Aided Design (CAD)
- Computer Aided Manufacturing (CAM)
- Computer Numeric Control (CNC)

1.3: Cost Reduction

Rapid Prototyping and Concurrent Engineering are two of the most efficient methods used by industry to reduce the time and cost of bringing a new product from concept to market. Rapid Prototyping is simply the development of a prototype as quickly as possible. Concurrent Engineering is the pairing of the designer with the manufacturer to simultaneously work on the design of the product throughout the development of the product in its entirety.

1.1: Statement of the Problem

1.1.1: The Client's Needs

D&J Industries, Incorporated (hereafter referred to as The Client) is dissatisfied with its old supplier. They used manual machines causing the part signatures to have an unacceptable variance, their quotations were inaccurate, and their lead-time was unacceptable.

It is critically important that The Client locate a firm able to rapid prototype and meet engineering changes at any point of the prototyping process. The Client wishes to find the best shop to have the Rotary Stamp assembly prototyped and manufactured.

As an Automated Manufacturing Technology team, known as Pro Design, Incorporated, your company will be competing for this lucrative contract against several other firms.

1.1.2: Your Assignment

Pro Design has been presented with a sample part drawing that The Client wishes to have mass produced. Your team will need to prototype the Rotary Stamp assembly, incorporate any changes that the client might make, then manufacture the final assembly.

Pro Design's Team Leader is responsible for communication between your company and D&J Industries, Incorporated.

1.2: Instructions

1.2.1: Rapid Prototype

The Client is a manufacturing plant that needs a new product designed and created. Currently, the only information they can supply is a rough concept and drawing for a Rotary Stamp assembly. This assembly is made up of five pieces, and the prototype material (Ren board-440) will be provided by the client. Your team's job is to machine this assembly prototype.

The Client requires that each stage of the CAD/CAM/CNC process be well documented, including a properly dimensioned CAD print for each of the components. All drawings should meet proper guidelines for engineering drawings.

After your prototype has been cut and has passed your internal quality control, you will submit it to The Client's Quality Assurance Group. The Client has specified accuracy, finish, and the turn-around-time it takes to complete the process.

1.2.2: Concurrent Engineering

The Client will review the prototype and may require one or more changes. The Client requires quick updates to product design throughout the development process. Significant issues in this stage are The Client's specified dimensional accuracy, finish, and efficiency in part programming.

1.3: Guidelines

1.3.1: Requirements

The Client's Engineering Project Manager has provided an outline of materials to begin your planning and manufacturing process. Your success on this project is based upon the following criteria:

1. Provide complete documentation of your design.
2. Provide complete documentation of process plan, tooling and setup.
3. Provide Quality Assurance on all parts.
4. Use the technology in preparation of documentation, setups, design, and machining properly.
5. Package completed project with accompanying documentation in an orderly, professional presentation.
6. Use team work in project management effectively.
7. Take safety precautions in the manufacturing process.
8. Use time, materials, and resources effectively.

1.4: QA and Design Restrictions

1.4.1: Tolerances

The prototype parts are considered perfect if their measurements are within the following tolerances:

1. Hole Locations = + OR - .005"
2. Hole Diameter = + OR - .003" on finished holes
3. Slot Dimension = + OR - .005"
4. Hole Depths = + OR - .010"
5. Slot and Shoulder Locations = + OR - .010"

1.5: Team Guidelines

1.5.1: Production Guidelines

Your team should follow these guidelines:

1. Primary responsibilities and duties are organized.
2. A team leader is identified to interact with Technical Committee representatives.
3. Your team decides upon appropriate break times with the exception of the mandatory lunch break.
4. Breaks are to be taken within assigned individual work areas.
5. Team members must notify a Technical Committee representative before taking a bathroom break. Only one team member is allowed to leave the contest area at a time.
6. You must create a separate file of your CAD drawing on your CAD computer and transport it to your CAM computer via floppy disk or USB memory stick.

1.5.2: Equipment Malfunctions

IN THE CASE OF A MACHINE FAILURE: The team leader will communicate the problem to a representative of the Technical Committee. The representative will then notify the Project Manager.
If it is determined that it is in fact a machine problem, the running time clock may be stopped for that team. In the case of a stopped time clock, all work will stop for the entire team until the problem is resolved.

IN THE CASE OF SOFTWARE PROBLEMS: The choice of CAD and CAM software is the responsibility of the team. All software must be original copies. If your team develops a problem with your software, the Technical Committee will work in whatever way it can to resolve the problem but the clock will not be stopped.

2: Official Competition

2.1: History

This competition is officially sanctioned by SkillsUSA and has run continuously since 1994. This competition is unique due to its three-member team concept and the intensive use of hardware and software. The 2005 Kansas City competition was the largest Skills Automated Manufacturing Technology Competition.

2.1: Purpose

2.1.1: Goals of the Competition

To evaluate each contestant's preparation for employment in automated manufacturing and the team approach to problem solving in the work environment. To recognize outstanding students for excellence and professionalism in the field of automated manufacturing technology.

2.2: Clothing Requirement

2.2.1: Correct Attire

- official khaki work shirt
- official khaki work pants
- black or brown leather work shoes
- safety glasses with side shields or goggles (prescription glasses must be covered with goggles unless they are equipped with side shields)

To purchase official work clothing, contact Midwest Trophy Manufacturing Co., Inc. by calling 1-800-324-5996 or order online at: http://www.mwtrophy.com/.

2.3: Eligibility

2.3.1: Qualifications

This competition is open to active SkillsUSA members enrolled in programs with precision machining, automated manufacturing, or CAD/CAM or CNC as their occupational objective.

2.4: Scope of Contest

2.4.1: Teams and Documentation

1. Teams MUST be composed of three members. Teams will demonstrate their ability to perform, utilize skills and knowledge necessary to complete the project as presented to them by the Technical Committee.

2. Your team is presented with a dimensioned drawing(s) of a part(s) to prototype. When you finish machining the prototype part(s) you will present it to The Client (judges). At this time you will be presented with a new drawing(s); either a change order or an additional part(s) request.

3. Each team will be issued a notebook. This three-ring view binder will include all of the necessary information and forms to complete the project. These forms will not be highly specific but will coach the teams. All binders, forms and drawings must be turned in to the judges at the end of the competition.

2.4.2: Required Competencies

Successful competitors possess the following skills:

A. Mathematics and Measurement
   1. Measure to the nearest .001 inch
   2. Calculate CNC speed and feeds
   3. Calculate stock utilization and setup
   4. Calculate tolerances
   5. Estimate costs and material usage and write an evaluation

B. Designing, Sketching, Planning
   1. Translate information from drawing to CAD
   2. Create CAD file for manufacturing
   3. Manufacturing documentation
   4. Process plan
   5. Plot CAD file
   6. Export CAD file
   7. Process Engineering Change Orders (ECOs)

C. Create Toolpath (CAM file), CNC Code
   1. Create Process/Job Plan
   2. Read-in CAD export file
   3. Create toolpath
   4. Verify toolpath
   5. Create CNC code
   6. Send CNC code to machine tool
   7. Process ECO

D. Perform CNC Machining Functions
   1. Verify CNC file
   2. Verify toolpath
   3. Setup part blank on mill
   4. Set all offsets and tooling
   5. Adjust speeds and feeds as needed
   6. In-process Quality Assurance
   7. Perform tool changes
   8. Perform multiple machining operations in one setup
   9. Verify (TQM) process and part
   10. Process

E. Inspect Part TQM Process
   1. Verify part to standards
   2. Verify part to ECO standards
   3. Document process

F. Safety
   1. Follow proper safety procedures in a general industrial workplace environment.
   2. Follow proper safety procedures in running and programming a CNC Machine tool.

G. Quotation
   1. Take a written evaluation that measures ability to solve various solutions to the process that is involved to quoting a job in a rapid prototyping environment.

2.5: Group Organizational Goal

2.5.1: Team Dynamics

The competition should run much like you would expect from industry; with group members interacting at will. The CAD operator will construct the part geometry, the CAM operator will generate the toolpaths, and the CNC operator will do the setup and machine the part.

The contest is designed to promote creativity in organization of production responsibility. Teams should divide duties among all team members. No one individual should dominate by taking responsibility for more than one project specialty. When a team member has spare time, they will help their teammates. All Team members are responsible for double-checking each other's work and quality control.

2.6: General Information

2.6.1: Necessities

The following items are required to compete in this contest;

1. Intelitek's Super proLIGHT 1000 series CNC milling machines and tooling will be provided.
2. Teams must provide two computers, one of which must accept a full size PCI card.
3. Each team will have licensed versions of CAD/CAM software.
4. Each team will provide a 6" dial or digital Vernier caliper. Dial indicator (i.e. Starrett Last Word Dial Test Indicator, must have 3/8" or ½" holding shank), a calculator, a set of 1" parallels, 6" or 12" steel rule and a soft face hammer.
5. Teams must consist of 3 members.
6. The Prototype and the finished part will be machined in a prototype material.
7. Each team can provide 3/8 or ½ edge finder.
8. Each team can provide a set of parallels.
9. Each team can provide appropriate sized end mills.
10. Each team must provide a machinist handbook.

2.7: Goals

2.7.1: Team Objectives

1. To have every team complete the competition.
2. To have each team member demonstrate reading and writing skills.
3. To have each team member use their critical thinking and problem solving abilities in the contest.
4. To have each team member illustrate responsibility, teamwork, self-management skills, and professionalism.

2.8: Notebook

2.8.1: Supplied Documentation

Each team is issued this notebook and information packet. This 3-ring view binder will allow the team to display a plot or print of their operation. Required documentation is also included.

2.9: Required Materials

2.9.1: Workstation Components

Teams require the following materials to complete the competition. The Technical Committee provides many of these materials, but the teams must also bring certain items.

AMT Technical Committee provides:

intelitek's Super proLIGHT 1000 CNC Machining Center with:

- Machinist vise
- Hold-downs and clamps
- Tool holders

Part(s) design.
Competition notebook.
Pencils.
Blank diskettes.
Prototype Material for machining.
Information and furnishings for judges and technical committee.

2.9.2: Team Provided Components

Teams provide:

Two computers:

- One computer loaded with CAD software for CAD program.
- One computer loaded with software for CAM program. This computer MUST have an open full-sized PCI slot and Windows 2000 or higher operating system.

Licensed versions of the above CAD and CAM software must be available at start of the orientation/practice session on Tuesday for loading onto the technical committee's computer(s).
One six inch dial or digital vernier caliper.
One dial indicator (example: L.S. Starrett Last Word dial test indicator) Dial indicator MUST have 3/8" or ½" holding shank to fit into tool holder supplied by Technical Committee.
One calculator.
One pair of ¾" or 1" parallels.
One soft-face hammer
One 6" or 12" steel rule.
Each team can provide 3/8 or ½ edge finder.
Each team must provide a machinist handbook.
Each team can provide appropriate size end mills.

Note: ONLY the above listed items will be allowed in the contest area during the competition.

2.10: Division of Duties

2.10.1: Department Contributions

Process Documentation Notebook	*Possible Division of Duties*
CAD Department Stage 1, Rapid Prototype Original print CAD dimensioned views necessary to detail part completely Stage 2, Finish Part Production Change order CAD dimensioned print (views necessary to detail part completely) and pictorial view	**CAD Engineer** All CAD system import and export Creating part geometry Exporting necessary geometry to CAM system Dimensioning parts Plots Receive change order Communication of changes to team Update all CAD files All drawings should meet guidelines for engineering drawings
CAM Department Stage 1, Rapid Prototype Process documentation to include selection of tools, machining order, etc. Generate NC code Stage 2, Finish Part Production Develop new process plan Program new toolpath Generate NC code	**CAM Engineer** All CAM system input and output Importing CAD geometry Creating tool paths Process sequencing Tool selection Creating NC code
CNC Department Stage 1, Rapid Prototype Fixturing description Tool description Tool setup Fixture and set-up Stage 2, Finish Part Production Finish ECO part production	**CNC Engineer** All CNC setup and operation CNC control software input Fixturing stock, tool offsets
Quality Control Department Stage 1, Rapid Prototype Part inspection sheet, all team members sign-off All members check positions, tolerances, etc. Stage 2, Finish Part Production Part inspection sheet, all members sign All members double-check work, clean-up	**Quality Control** All Members

2.11: Suggested Organizational Flow

2.11.1: RECEIVE THE PART DRAWING

A. CAD operator confers with the CAM operator and draws only what is necessary for the CAM operator to program a toolpath. Once that drawing is ready, the drawing is transferred to the CAM operator.

B. CAM operator, after consulting with the CAD operator, consults with the CNC operator and fills out the Job Sequence Plan, defining machining order, tool paths, tool definitions and sequencing.

C. CNC operator squares up the vise and the CNC operator confers with the CAM operator on tool definition and sequencing. The CNC operator sets and mounts selected tools in holders and sets tool length offsets in the CNC control software. The CNC operator then sketches the fixture.

2.11.2: CAD OPERATOR TRANSFERS FILE TO CAM

A. CAD operator copies the CAM transfer file to diskette to be transferred to the CAM operator, then begins work on documenting the part with all necessary views.

B. CAM operator transfers in the CAD file and double checks against the supplied drawing. The CAM operator begins programming tool paths and, if necessary, documents any changes to the Job Process Plan.

C. CNC operator helps either the CAD or CAM operator, staying aware of CAM toolpath sequencing and tool changes. CNC operator could also study part for most efficient tool paths.

2.11.3: TRANSFER OF NC-CODE TO CNC MACHINE

A. CAD operator continues to document part and prints the dimensioned CAD drawing.

B. CAM operator transfers NC-Code to the CNC operator.

C. CNC operator loads the program, runs a simulation, sets the touch off point, and then runs the program.

2.11.4: PROTOTYPE COMPLETE, QUALITY CONTROL

A. Each team member inspects the part and fills out inspection sheet. If errors are found, they are documented and the part is submitted.

2.11.5: RECEIVE CHANGE ORDER

A. CAD operator revises CAD drawing and produces new-dimensioned drawings for plotting assurance.

B. CAM operator and the CNC operator review the change order and develop a new Job Process Plan, as deemed necessary.

C. CNC operator loads the program, runs a simulation, sets the touch-off point, and then runs the program.

2.11.6: MANUFACTURE FINISHED PART

A. CAD operator completes all part documentation and hard copies.

B. CAM operator assembles part documentation booklet and assists CAD and CNC operators.

C. CNC operator manufactures and inspects part.

2.11.7: QUALITY CONTROL AND FINAL HAND-IN

A. CAD, CAM, and CNC operators complete part inspection, documentation, and work area cleanup.

3: Safety

3.1: Importance of Safety

To maintain an effective and competitive company, it is in the best interest of both employer and employee to maintain a safe work environment. When a company's history of incidents resulting in injury is minimal, the company increases its likelihood of reduced insurance rates and workman compensation fees.

Safety considerations are taken into account during judging to further replicate a professional industrial environment.

3.2: Safety Violations

If a team or a team member violates a safety rule, or operates their work cell in an unsafe manner, the following penalties will be enforced:

1st Violation:
Team will be issued a written warning.

2nd Violation
Team will have 50 points deducted from their total score.

3rd Violation
Team will be disqualified.

3.3: Avoiding Safety Hazards

Some safety issues:

1. Team members must keep their work area reasonably clean. Clean work places promote efficient and safe working conditions.
2. Team members must keep their teammates and other teams aware of possible dangerous situations, such as flying chips, noise, possible tool breakage, etc.
3. Safety guards must be in place and properly interlocked during machining and when the spindle is turning.
4. Team members must wear safety glasses when they are in the proximity of the machine during setup as well as during machining.
5. Spindle must NOT be in motion during a tool change.
6. Tampering with or dismantling of any part of the supporting equipment (ie: computers, printers, ect.) is a direct safety violation, and can be grounds for immediate disqualification.

4: Additional Forms

4.1: Document Submission

The following documentation must be prepared by teams for judging. These sheets are included on the following pages of this team information packet:

- Notebook Judging Form
- Process Plan
- Fixturing Description
- Quality Assurance
- Mathematics Problem
- Concurrent Engineering Process Plan

4.2: Judge Prepared Documentation

Judges will prepare the following documentation for each team:

- CAD Evaluation
- Surface Finish/ Dimensional Accuracy
- Hand-In Time Run
- Concurrent Engineering CAD Evaluation
- Concurrent Engineering Surface Finish/ Dimensional Accuracy
- Area Clean-Up
- Safety Violations (if applicable)

SKILLS USA
AUTOMATED MANUFACTURING TECHNOLOGY
NOTEBOOK JUDGING FORM 2010

	MAXIMUM POINTS	CHECK	POINTS AWARDED
CAD Rapid Prototype			
1. Dimensioned Print of Prototype, Hardcopy (top and front views)	170		
2. Prototype Contest Drawing	25		
CAD Subtotal	195		
CAM Rapid Prototype			
1. Process Plan Form	100		
CAM Subtotal	100		
CNC Rapid Prototype			
1. Fixturing Description Form	80		
2. Quality Assurance Form	50		
3. Surface Finish/Dimensional Accuracy	150		
4. Hand-In-Time	100		
CNC Subtotal	380		
Concurrent Engineering			
1. Engineering Change Order Drawing	25		
2. Process Plan Form	30		
3. CAD Drawing (top, front, side & pictorial), Hard Copy	70		
4. Surface Finish/Dimensional Accuracy	100		
5. Area Clean-up	50		
Concurrent Engineering Subtotal	275		
Math Problem	50		
Safety (deductions)			
GRAND TOTAL	1000 pts		

AUTOMATED MANUFACTURING TECHNOLOGY

Base Block

PROCESS PLAN

TEAM NUMBER _____ CUSTOMER _____

COMPLETED BY _____

DATE _____ PART DUE DATE _____

PART NAME _____

PART NUMBER _____ CNC MACHINE _____

BLANK SIZE _____ MATERIAL _____

Operation #	Operation Description	Tool #	Tool Description	Spindle Speed	Feed Rate	Plunge Rate

NOTES _____

Possible Pts. 100 Total _____

Team # _____

AUTOMATED MANUFACTURING TECHNOLOGY

Base Block

FIXTURING DESCRIPTION

TEAM NUMBER _____ CUSTOMER _____

DRAWN BY _____

DATE _____ PART DUE DATE _____

PART NAME _____

PART NUMBER _____

SKETCH FIXTURE WITH TOOL TOUCH-OFF INDICATED

Possible Pts. 80 Total _____

Team # _____

AUTOMATED MANUFACTURING TECHNOLOGY

Base Block

QUALITY ASSURANCE FORM

TEAM NUMBER _____ CUSTOMER _____

COMPLETED BY _____

DATE _____ PART DUE DATE _____

PART NAME _____

PART NUMBER _____ CNC MACHINE _____

BLANK SIZE _____ MATERIAL _____

Object #	Object Description	Defined Tolerance	Met Tolerance		Amount Off	Finish Errors	
			Yes	No		Yes	No

Identify errors on picture

NOTES _____

_____

_____
Signature

_____
Signature

_____
Signature

Possible Pts. 50

Total _____
Team# _____

AUTOMATED MANUFACTURING TECHNOLOGY
CONCURRENT ENGINEERING
PROCESS PLAN

TEAM NUMBER _____ CUSTOMER _____

COMPLETED BY _____

DATE _____ PART DUE DATE _____

PART NAME _____

PART NUMBER _____ CNC MACHINE _____

BLANK SIZE _____ MATERIAL _____

Operation #	Operation Description	Tool #	Tool Description	Spindle Speed	Feed Rate	Plunge Rate

Possible Pts. 30 Total _____

Team # _____

Automated Manufacturing Technology

Math Problem

2010

Competition for contracts with companies like D&J Industries is very strong. Your R&D department at Pro Design, Incorporated, has asked your team to provide a prototype production run of a Rotary Stamp assembly as designed by D&J Industries, the client. A rapid response is essential to capture new business for your employer, Pro Design. The client requires that you provide a total of 16 prototypes of the rotary stamp assembly. These will be distributed evenly to 4 different testing labs for final inspection and testing. The client needs to verify the quality and production capability of rotary stamp manufacturers, before going into a mass production contract.

The rotary stamp assembly has 5 pieces that require assembly. The assembly consists of a base block that is 5-1/4" x 2" x 3/4", a rotating crank approximately 1.9" x 1.9" x 1.0", a stamp made of two parts, each 1-1/4" x 1-1/4" x 3/4" (approx) and a lever (connecting the crank and the stamp) 3-1/2" x 3/4" x 1/4". The complete prototype will be made of Ren Board-440. The Ren Board is supplied in standard sheets measuring 48" x 48" x 2" each costing $230 per sheet. It takes 60 minutes to make one set of the 5 pieces. Each set has a material cost of $5.35. The machine overhead rate is assumed to cost $100.00 per hour. It therefore costs $5.35 plus $100 to make each set. It takes $42.00 to assemble, package, and ship each set of the 5 pieces. Please answer the following questions. When answering DO NOT allow for waste material from the saw blade used to cut the parts to size. Each question is worth 5 points. TOTAL 50 Points.

NOTE: This math problem is similar too but does not resemble the exact dimensions of your prototype parts, made in the AMT competition.

1. How many total pieces are required to complete the order for the client?
2. How many total prototype sets is Pro Design, required to manufacture?
3. How many square inches of Ren Board are in a 2" thick standard sheet?
4. How many square inches of Ren Board are required to manufacture 1 set of parts for a complete rotary stamp assembly?
5. What is the machine operation cost for 2-1/2 hours of machining time?
6. What is the total cost of one complete rotary stamp assembly, manufactured, assembled and delivered?
7. How many square inches of Ren Board are required to make one base block and rotating crank?
8. How many prototypes will be sent to each testing lab?
9. From the supplied prototype drawings, calculate both the length of travel of the stamp and the total distance travelled through one complete rotation of the crank?
10. How many machine hours will be required to manufacture all 16 prototypes?

SkillsUSA
2010 Contest Projects

Automotive Refinishing Technology

Click the “Print this Section” button above to automatically print the specifications for this contest. Make sure your printer is turned on before pressing the button.

Automotive Refinishing Technology

The Automotive Refinishing Technology competition requires contestants to demonstrate their skills in the following areas:

Color Tinting
The contestants are provided pre-painted panels. They are asked to identify paint color groups and then identify the adjustment of the face and flip/flop of individual panels as well as the suggested toner.

Paint Identification &Vehicle Masking
The contestants will identify the paint code off of an assigned vehicle and use the code as requested. They will also be asked to mask a vehicle in preparation for painting.

Spot Refinishing
The contestants are provided a panel to spot refinish. They are provided the paint product information and technical sheets.

Featheredge, Prime and Block
The contestants are provided a panel to featheredge, prime and block. They are provided the paint product information and technical sheets.

Written Estimate
The contestants will complete a written estimate of damage. The students will be provided the materials necessary to complete a hand-written estimate.

Interview
The contestants will be engaged in an oral assessment and their typed resume will be reviewed.

ASE Test
The contestants will complete a 100 question written test based on ASE standards.

Automotive Refinishing Technology
This year, Delmar, a part of Cengage Learning is making their online ASE Test Preparation tools available to all instructors and competitors immediately. This means that some competitors may be able to use the tool in advance of their district and state competitions.

Instructors should only share the material with competitors.

Access will be terminated when the National Competition begins.
Please use the contact information below to get the necessary link
jonathan.sweeney@cengage.com | www.delmarlearning.com

ASE Damage Analysis and Estimating Certification (B6)

Objective: To identify and recognize those estimators who possess knowledge of the skills necessary to properly analyze and estimate automotive collision damage.

Scope of Program: The ASE Damage Analysis and Estimating (B6) Test complements the other tests in the Collision Repair Test series that identify and recognize collision repair technicians and refinishers. This test is specially constructed and intended for those professionals who may not actually repair vehicles, but have the special knowledge needed to assess collision damage, estimate repair costs, and work with vehicle owners.

Test Development: The questions that appear on the this test are written and approved by a cross-section of industry experts that includes collision repair shop estimators, collision repair technicians, independent appraisers, and representatives of automobile manufacturers, information providers, industry trainers and insurance companies. This procedure ensures that the tests are fair to all estimators without bias towards any specific manufacturer, insurer, or estimating system.

ASE Collision Repair and Refinishing

Objective: To identify and recognize those collision repair technicians and refinishers who possess knowledge of the skills necessary to properly analyze and repair automotive collision damage and correct paint finish damage.

Scope of Program: The ASE Collision Repair and Refinish Test Series includes one test for paint refinishers and three other tests for repair technicians: Painting and Refinishing (B2), Non-Structural Analysis and Damage Repair (B3), Structural Analysis and Damage Repair (B4), and Mechanical and Electrical Components (B5).

Test Development: The collision repair and refinishing tests are written and approved by a cross-section of industry experts that includes collision repair technicians, refinishers, and representatives of vehicle manufacturers, information providers, paint manufacturers, parts and equipment manufacturers, industry trainers, and insurance companies. This procedure ensures that the tests are fair to all without bias towards any specific manufacturer, insurer, or refinishing system.

For additional information and go to the AYES website at www.ayes.org/elearning

DUPONT Refinish

DuPont™ ChromaBase® Basecoat

Description

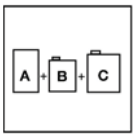
ChromaBase® is an easy-to-use, fast-drying basecoat with good fill. It provides high-quality and high-productivity. ChromaBase® is available in both mix and factory package, for spot, panel and overall repairs. Select from a wide choice of solid, metallic and pearl colors, and a multitude of special-effect colors.

General Information

Components
ChromaBase® - Basecolor "K"
Basemaker® 7160S™ - Low Temp
Basemaker® 7175S™ - Mid Temp
Basemaker® 7185S™ - High Temp
Basemaker® 7195S™ - Very High Temp
ChromaPremier® 12305S™ Activator (optional)
ChromaBase® 7775S™ Activator-Reducer (optional)

	60° F	70° F	80° F	90° F
Spot Repair	Basemaker® 7160S™	Basemaker® 7175S™	Basemaker® 7175S™	Basemaker® 7185S™
Panel Repair	Basemaker® 7160S™	Basemaker® 7175S™	Basemaker® 7185S™	Basemaker® 7185S™
Overall Repair	Basemaker® 7175S™	Basemaker® 7185S™	Basemaker® 7185S™	Basemaker® 7195S™

Tips for Success
- For temperatures above 90°F, use Basemaker® 7195S™ for increased flow and leveling.



Mix Ratio/Viscosity
Mix Ratio (1:1)
Mix 1 part ChromaBase® to 1 part Basemaker®. ChromaBase® Basecoat should be activated with ChromaPremier® 12305S™ Activator for optimum performance and for lifetime warranty. Mix basecoat with Basemaker® at normal 1:1 ratio. Stir thoroughly, then activate: Add 1 ounce of ChromaPremier® 12305S™ Activator to a ready-to-spray quart of ChromaBase®, or add ½ ounce of ChromaPremier® 12305S™ to a ready-to-spray pint of basecoat.

RTS Color	ChromaPremier® 12305S™ Activator or ChromaBase® "4 to 1" 7775S™ Activator-Reducer
1 quart	1 ounce (32 grams)
1 pint	½ ounce (16 grams)
½ pint	¼ ounce (8 grams)

Viscosity
15 - 17 seconds in a Zahn #2 (DuPont M-222) cup.

Tips for Success
- *Use mixing stick for accurate measurements.*
- *Use activated basecoat within 2 hours for optimum performance.*
- *Do not use activated basecoat after the 8-hour pot life.*
- *Activate only what you intend to spray.*

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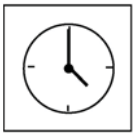
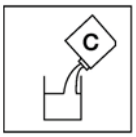
DuPont™ ChromaBase® Basecoat



Pot Life
Indefinite (unactivated).
8 hours (activated).



Additives

Accelerator:	Not recommended.
Fish Eye Eliminator:	Not recommended.
Flex Additive:	Not required; See Tips for Success.
Retarder:	Not recommended.

Tips for Success

- *If fish eyes occur, allow the basecoat to dry thoroughly, then apply dry coats of base color to bridge the affected area.*
- *The use of ChromaPremier® 12305S™ Activator in ChromaBase® (1 ounce of ChromaPremier® 12305S™ per RTS quart of basecoat) is required over flexible substrates. No other flex additive is necessary.*
- *Do not add Accelerator to activated basecoat. It will not speed cure and could damage film properties.*

Tinting
Up to 5% with MasterTint® mixing colors that are 6.0 VOC or below.

Clearcoats
ChromaPremier® 72200S™, 72500S™ and 72600S™ Clearcoats
ChromaClear® G2-4500S™, G2-4700S™ and HC-7776S™, 7779S™Clearcoats
DuPont™ 1780S™ ISO-Free Clearcoat

Flatteners
Flattening agents are not recommended to flatten ChromaBase®. Small amounts of DuPont™ 4530S™ Flop Control Agent may be used to adjust color for flake orientation in metallic and pearl colors.

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DuPont™ ChromaBase® Basecoat

Application

Substrates

DuPont™ 222S™ Mid-Coat Adhesion Promoter
Plas-Stick® 2340S™ Flexible Adhesion Sealer
DuPont™ 2510S™/2540S™/2570S™/2580CR™ DTM Epoxy Primer
ChromaPremier® 32430S™ 2K Premier Primer (alone or with Plas-Stick® 2350S™ Flexible Additive)
DuPont™ 4004S™ 2K UltraProductive Primer-Filler (alone or with Plas-Stick® 4150S™ Flex-Additive)
ChromaPremier® 42410S™/42440S™/42470S™ Sealer (alone or with Plas-Stick® 2350S™ Flexible Additive)
DuPont™ 4904S™ 2K UltraProductive Primer-Filler (alone or with Plas-Stick® 4950S™ Flex-Additive)
DuPont™ 4910S™/4940S™/4970S™ 2K UltraProductive Primer-Sealer (alone or with Plas-Stick® 4950S™ Flex-Additive)
DuPont™ ChromaSurfacer® 7704S™ 2K Urethane Primer-Filler (alone or with Plas-Stick® 2350S™ Flexible Additive)
DuPont™ ChromaSeal® 7710S™/7740S™/7770S™ 2K Urethane ValueShate® Sealer (alone or with Plas-Stick® 2350S™ Flexible Additive)
DuPont™ A-3130S™ UVA Primer-Surfacer
Properly sanded OEM finishes

Tips for Success

For information on ValueShade®, see the Specialty Procedures section of the DuPont™ ChromaSystem™ Technical Manual.

Surface Preparation

Prepare all surfaces to be repainted using the recommended undercoat systems, following recommended procedures. Finish sand with P400 DA grit paper or finer (dry or wet).

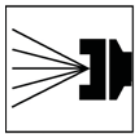
Gun Setups*

Conventional

	Siphon Feed:	1.4 mm - 1.6 mm (.055” - .063”)
	Gravity Feed:	1.4 mm - 1.5 mm (.055” - .059”)

HVLP

	Siphon Feed:	1.4 mm - 1.6 mm (.055” - .063”)
	Gravity Feed:	1.4 mm - 1.6 mm (.055” - .063”)



Air Pressure*

	Spot/Panel	Overall
Conventional		
Siphon Feed:	30 - 40 psi @ the gun.	45 psi @ the gun.
Gravity Feed:	25 - 35 psi @ the gun.	35 - 45 psi @ the gun.
HVLP		
	6 - 8 psi @ the gun cap.	7 – 9 psi @ the gun.

*The listed setups cover the usual range for various application equipment. For information on specific manufacturers’ equipment, see the Equipment Information section of the DuPont™ ChromaSytem™ Technical Manual.

Application

Apply 2 - 3 medium coats until hiding and color match are achieved.

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DuPont™ ChromaBase® Basecoat

Flash/Dry Times

Air Dry

Flash between Coats	5 - 10 minutes.
Flash before Clearcoat:	15 - 30 minutes.
Flash before Tape:	30 minutes.
Flash before Two-Toning:	30 minutes.
Maximum Allowable Dry before Clearcoating:	24 hours.
Force Dry	Not recommended.

Blending

Apply 1 coat of DuPont™ 222S™ Mid-Coat Adhesion Promoter over the entire repair area. Apply the first coat of color beyond the primed area. Apply the second coat just beyond the first coat. Apply subsequent coats just beyond the previous coats, staying within the area covered by DuPont™ 222S™. Follow recommended flash times, then apply clearcoat over the entire panel.

Tips for Success

- *Tapering out each consecutive coat to melt the new color into the old color.*
- *For alternate blending techniques, refer to the Specialty Basecoat Blending Procedures in the Specialty Procedures section.*
- *Use DuPont™ ChromaSystem™ 69301S™ Basecoat Blender for difficult to blend colors, optimal flake control, improved edge wetting and improved melt-in.*
- *Refer to DuPont™ ChromaSystem™ 69301S™ Basecoat Blender Technical Data Sheet in the Specialty Procedures section of the DuPont™ ChromaSystem™ Technical Manual.*

Recoatability/Re-repair

ChromaBase® Basecoat may be recoated with itself within 24 hours.

Sanding

ChromaBase® Basecoat dries to a smooth matte finish and should not be sanded. Nib sanding of small areas to remove dirt must be followed by the application of more color before clearcoating.

Cleanup

Clean spray equipment immediately after use with DuPont Lacquer Thinner.

Physical Properties

VOC: 6.3 lbs/gal ready-to-spray (maximum).
Recommended Dry Film Thickness: 0.5 - 2.0 mils.

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Refinish

DuPont™ ChromaBase® Basecoat

VOC Regulated Areas

These directions refer to the use of products which may be restricted or require special mixing instructions in VOC regulated areas. Follow mixing and usage recommendations in the VOC Compliant Products Chart for your area.

Safety and Handling

For industrial use only by professional, trained painters. Not for sale to or use by the general public. Before using, read and follow all label and MSDS precautions. If mixed with other components, mixture will have hazards of all components.

Ready to use paint materials containing isocyanates can cause irritation of the respiratory organs and hypersensitive reactions. Asthma sufferers, those with allergies and anyone with a history of respiratory complaints must not be asked to work with products containing isocyanates.

Do not sand, flame cut, braze or weld dry coating without a NIOSH approved air purifying respirator with particulate filters or appropriate ventilation, and gloves.

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Repintado Automotriz DuPont

Base color DuPont™ ChromaBase®

Descripción

ChromaBase® es una base color fácil de usar de secado rápido, con un buen relleno. Proporciona una alta calidad y productividad. Está disponible en paquetes para mezcla y en colores preparados de fábrica, para reparaciones de pequeñas imperfecciones, paneles y en repintados en general. Existe una amplia gama de colores sólidos, metálicos y perlados y de colores de efectos especiales.

Información general

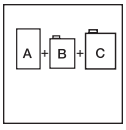
Componentes

Base color "K" ChromaBase®
Catalizador Reductor no Penetrante Basemaker® 7155S™
Catalizador Reductor de Temperatura Baja Basemaker® 7160S™
Catalizador Reductor de Temperatura Media Basemaker® 7175S™
Catalizador Reductor de Temperatura Alta Basemaker® 7185S™
Catalizador Reductor de Temperatura Muy Alta Basemaker® 7195S™
Catalizador ChromaPremier® 12305S™ (opcional)

	16 °C	21 °C	27 °C	32 °C
Reparación de pequeñas imperfecciones	7160S™	7175S™	7175S™	7185S™
Paneles	7160S™	7175S™	7185S™	7185S™
Generales	7175S™	7185S™	7185S™	7195S™

Recomendaciones para una aplicación exitosa

■ *Para sustratos sensibles utilice* Basemaker® *7155S™ que es menos agresivo.*
■ *Para temperaturas arriba de 32° C utilice* Basemaker® *7195S™ para una mejor apariencia y nivelación.*



Relación de mezcla/viscosidad

Relación de mezcla 1:1

Mezcle una parte de ChromaBase® con una parte de Basemaker®. La Base color ChromaBase® se debe catalizar con el Catalizador ChromaPremier® 12305S™ para un rendimiento óptimo y para garantizar el tiempo de vida útil. Mezcle la base color con Basemaker® en una relación normal de 1:1. Mezcle vigorosamente, luego catalícela: agregue 1 onza de Catalizador ChromaPremier® 12305S™ a un litro listo para aplicar de ChromaBase®, o agregue fi onza de ChromaPremier® 12305S™ a un medio litro listo para aplicar de base color.

Color LPA	***Catalizador* ChromaPremier® *12305S™***
1 litro	1 onza (32 gramos)
1/2 litro	fi onza (16 gramos)
⁄ de litro	⁄ onza (8 gramos)

Viscosidad

15 - 17 segundos en una copa Zahn # 2 (DuPont M-222).

Recomendaciones para una aplicación exitosa

■ *Utilice una pala graduada para medidas exactas.*
■ *Utilice la base color catalizada dentro de 2 horas para un óptimo desempeño.*
■ *No utilice base color catalizada después de 8 horas de vida útil de la mezcla.*
■ *Catalice solo lo que usted pretenda aplicar.*

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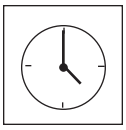
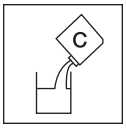
Base color DuPont™ ChromaBase®



Tiempo de vida útil

Indefinido (no catalizado).
8 horas (catalizado).



Aditivos

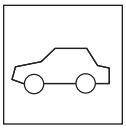
Acelerador: No se recomienda.
Eliminador de ojo de pescado: No se recomienda.
Aditivo flexibilizante: No se requiere. Ver recomendaciones para una aplicación exitosa.
Retardador: No se recomienda.

Recomendaciones para una aplicación exitosa

■ *Si se produce un ojo de pescado, permita que la base color se seque por completo, luego aplique manos resecas de base color para igualar el área afectada.*
■ *Sobre sustratos flexibles, se requiere el uso del catalizador ChromaPremier® 12305S™ en ChromaBase® (1 onza de* ChromaPremier® *12305S™ por litro LPA de base color), no es necesario ningún otro aditivo.*
■ *No agregue un acelerador a la base color catalizada. No se cura con rapidez y podría dañar las propiedades de la película.*

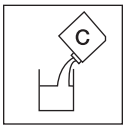
Entintado

Hasta 5% con colores de mezcla MasterTint® con VOC 0.72 o menor.



Primarios

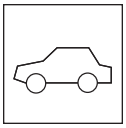
Primarios ChromaPremier® 72200S™, 72400S™ y 72500S™
Primarios ChromaClear® 4500S™, 4700S™, G2-4500S™, G2-4700S™, 7500S™, 7600S™, y V-7500S™
Transparente DuPont 1780S™ libre de Isocianatos



Mateantes

Los mateantes no se recomiendan para matear las Bases color ChromaBase®. Se pueden usar pequeñas cantidades del agente de control de flops DuPont 4530S™ para ajustar la orientación de las hojuelas en colores metálicos o perlados.

Application



Substratos

Primario Acrílico de Superficie Fill 'N Sand® 131S™
Acelerador de Adherencia entre Capas DuPont 222S™
Primario Rellenador Base Agua DuPont 275S™
Primario Rellenador DuPont URO® 1120S™/1140S™
Primario Rellenador DuPont URO® 1120S™/1140S™ con Aditivo Flexibilizante Plas-Stick® 2350S™
Primario Rellenador de Poliuretano DuPont 1141S™/1144S™/1147S™
Primario Rellenador de Poliuretano DuPont 1141S™/1144S™/1147S™ con Aditivo Flexibilizante Plas-Stick® 2350S™
Sellador Acrílico Velvaseal® 1986™
Primario Sellador Base Agua WPS Velvaseal®
Sellador Adhesivo Flexiblizante Plas-Stick® 2340S™
Low VOC Prime 'N Seal® 2710S™/2740S™/2770S™
Primario Rellenador Ultraproductivo DuPont 4001S™/4004S™/4007S™
Primario Rellenador Ultraproductivo DuPont 4001S™/4004S™/4007S™ con Aditivo Flexibilizante Plas-Stick® 4150S™
Primario Multiuso ChromaFil® 4140S™
Primario Rellenador Ultraproductivo DuPont 4904S™
Primario Rellenador Ultraproductivo DuPont 4904S™ con Aditivo Flexibilizante Plas-Stick® 4950S™
Primario Sellador Ultraproductivo DuPont 4910S™/4940S™/4970S™
Primario Sellador Ultraproductivo DuPont 4910S™/4940S™/4970S™ con Aditivo Flexibilizante Plas-Stick® 4950S™
Sellador ChromaPremier® 42410S™/42440S™/42470S™
Sellador ChromaPremier® 42410S™/42440S™/42470S™ con Aditivo Flexibilizante Plas-Stick® 2350S™

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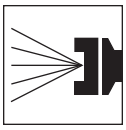
Base color DuPont™ ChromaBase®

Recomendaciones para una aplicación exitosa
Para información sobre ValueShade®, vea la sección Procedimientos especiales.

Preparación de la superficie
Prepare todas las superficies que se van a repintar usando los sistemas de primarios y procedimientos recomendados. Aplique un lijado final usando una lija orbital DA de grano P400 o más finas (en seco o en húmedo).

Configuración de la pistola*

Convencional	
Por sifón:	1.4 mm - 1.6 mm (.055” - .063”)
Por gravedad:	1.4 mm - 1.5 mm (.055” - .059”)
HVLP	
Por sifón:	1.4 mm - 1.6 mm (.055” - .063”)
Por gravedad:	1.4 mm - 1.6 mm (.055” - .063”)



Presión de aire*

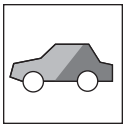
Convencional	*pequeñas imperf. /panel*	*General*
Por sifón:	30 - 40 psi en la pistola	45 psi en la pistola
Por gravedad:	25 - 35 psi en la pistola	35 - 45 psi en la pistola
HVLP	6 - 8 psi en la boquilla de la pistola	7 - 9 psi en la boquilla de la pistola.

*Los ajustes listados cubren el rango usual del equipo de aplicación. Para información sobre equipos de fabricantes específicos, ver la sección de Apéndices titulada "Información sobre el equipo."

Aplicación
Aplique 2 a 3 manos medianas hasta que logre el cubriente y la igualación del color.

Tiempos de secado y oreo

Secado al aire	
Oreo entre manos:	*5 - 10 minutos*
Oreo antes de la transparente:	*15 - 30 minutos*
Oreo antes del franjeo:	*30 minutos*
Oreo antes de dos tonos:	30 minutos
Tiempo máximo permisible de secado	
Antes de aplicar la transparente:	24 horas
Secado forzado:	*no se recomienda*



Esfumado
Aplique una mano de Promotor de Adherencia DuPont 222S™ sobre la reparación completa. Aplique la primera capa de color más allá del área con primario. Aplique la segunda mano justo al pasar la primara mano, aplique las subsecuentes manos más adelante de las previas, permaneciendo dentro del área cubierta por DuPont 222S™. Siga los tiempos de oreo que se recomiendan, luego aplique la transparente sobre el panel completo.

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Base color DuPont™ ChromaBase®

Recomendaciones para una aplicación exitosa

■ Diluya cada mano consecutiva permite que se funda el nuevo color con el anterior.

■ Para técnicas alternas de esfumado refiérase a los procedimientos de esfumado de bases color especiales en la sección de procedimientos especiales.

■ Utilice el Blender de Bases color DuPont ChromaSystem 69301S™ para colores difíciles de esfumar, para un control optimo de hojuelas, asi como una mejor humectación de bordes y esfumado.

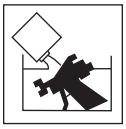
■ Refiérase a la hoja de datos técnicos del Blender de Bases color DuPont ChromaSystem 69301S™ en la sección de procedimientos especiales.

Reparaciones

ChromaBase® se puede recubrir de nuevo dentro de 24 horas.

Lijado

El color base ChromaBase® produce un acabado mate suave el cual no debe lijarse. En caso de un lijado ligero en áreas pequeñas para quitar suciedades se debe aplicar más color antes de la transparente.



Limpieza

Lave el equipo de aplicación tan pronto como sea posible con Thinner Acrílico DuPont.

Propiedades físicas

VOC:	0.76 kg/litro listo para aplicar (máximo)
Rendimiento teórico:	36 m2/litro (plata) y 41 m2/litro (blanco) listo para aplicar a 1 milésima
Sólidos en peso:	13.2% (plata) y 20.1% (blanco) listo para aplicar usando 7160S
Sólidos en volumen:	8.7% (plata) y 10.4% (blanco) listo para aplicar usando 7160S
Espesor recomendado de la película seca:	0.5 -2.0 milésimas
Punto de inflamación:	ver MSDS

Áreas con VOC regulados

Estas instrucciones se refieren al uso de productos que pueden estar restringidos o requieren instrucciones especiales de mezcla en áreas con VOC regulados. Siga las recomendaciones de preparación y manejo indicadas en la carta para productos que cumplen con los VOC en su área.

Seguridad y manejo

UTILICE UN RESPIRADOR DE PRESIÓN POSITIVA (NIOSH TC - 19C), PROTECCIÓN PARA LOS OJOS, GUANTES Y ROPA PROTECTORA MIENTRAS MEZCLA EL CATALIZADOR CON LA PINTURA, DURANTE LA APLICACIÓN Y HASTA QUE TODOS LOS VAPORES Y BRISAS SE HAYAN EXTRAÍDO. SIGA TODAS LAS INSTRUCCIONES DE USO DEL FABRICANTE DEL RESPIRADOR. LAS PERSONAS CON HISTORIA DE PROBLEMAS PULMONARES O RESPIRATORIOS O DE REACCIÓN ANTERIOR AL ISOCIANATO NO DEBEN USAR O EXPONERSE AL VAPOR O A LA MEZCLA ATOMIZADA. NO PERMITA EL PASO A NADIE SIN LA PROTECCIÓN ADECUADA EN EL ÁREA DE PINTADO.

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DUPONT Refinish

ChromaClear® G2-4700S™ Clearcoat (*Hyper Cure*™ - Air Dry and Express Bake)

Description

ChromaClear® G2-4700S™ is an express bake clear with improved appearance and application latitude. This 4.2 VOC three-component clearcoat can be used for spot and multi-panel repairs of OEM base/clear finishes.

This product eliminates the typical 30 minutes x 140° F baking cycle normally required to process clearcoat. It air dries in 1.5 hours at 70° F, and can be express baked (10 min. x 120° F) for even faster delivery. That is, 10 min. (total cycle time, including temp. ramp up) x 120° F booth temp. setting, not substrate temp. (a) The energy savings alone makes this clearcoat more profitable to use.

General Information

Components

ChromaClear® G2-4700S™ Clearcoat
ChromaClear® G2-4507S™ Low Temp Activator (65-75° F)
ChromaClear® G2-4508S™ Medium Temp. Activator (75-85° F)
ChromaClear® G2-4509S™ High Temp Activator (>85° F)
DuPont™ ChromaSystem™ 19301S™ Blender

Reducers for 4.2 lbs./gal. VOC:
ChromaPremier® 12365S™ Fast Reducer
ChromaPremier® 12375S™ Medium Reducer
ChromaPremier® 12385S™ Slow Reducer
ChromaPremier® 12395S™ Very Slow Reducer

	@ 4.2 lbs./gal. VOC			
Application Temp.	70° F	80° F	90° F	100° F
ChromaPremier® Reducer	12365S™	12375S™	12385S™	12395S™

Tips for Success

- *For optimum performance it is important to choose the correct ChromaPremier® Reducer for the temperature range (see above), and the activator that meets your dry time and appearance requirements.*
- *Allow the sealer to flash for 20 minutes before applying basecoat.*

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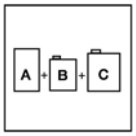
ChromaClear® G2-4700S™ Clearcoat
(*Hyper Cure*™ - Air Dry and Express Bake)



Mix Ratio/Viscosity

Combine the components either by volume or weight, then mix thoroughly.

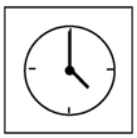
For 4.2 lbs./gal. VOC	Volume	Weight (cumulative qt.)
ChromaClear® G2-4700S™ Clear	3	543.0 grams
ChromaClear®G2-450XS™	1	743.5 grams
(7, 8 or 9) Activator[b]		
ChromaPremier® 12375S™ Medium Reducer	1	905.2 grams

Viscosity

15 - 17 seconds in a Zahn #2 (DuPont M-222) cup.

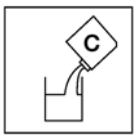
Tips for Success

- *Use mixing stick for accurate measurements.*



Pot Life

1-2 hours at 70° F (depending on activator used).



Additives

Application Enhancer: DuPont 19379S™ Application Enhancer; use 1 to 2 ounces per ready-to-spray quart. DuPont 19379S™ Enhancer is intended for use in hot weather (>95°F) to improve handling and appearance. DuPont 19379S™ Enhancer is not recommended for use in cooler temperatures.

Accelerator: Not required.

Fish Eye Eliminator: DuPont 659S™ Additive ([silicone free] use 0.5-1.5 oz per ready-to-spray quart), or DuPont 459S™ Anti-Cratering Additive (use 0.25 to 0.5 oz per ready-to-spray quart).

Flex Additive: Only needed if optimum performance is required.
Add 2 oz. Plas-Stick® 2350S™ Flexible Additive per ready-to-spray quart of activated clearcoat or use Plas-Stick® 2350S™ as described below.

@ 4.2 lbs./gal. VOC	Volume	Weight (cumulative qt)
ChromaClear® G2-4700S™ Clear	9	509.1 grams
ChromaClear® G2-4507S™ Activator	3	697.1 grams
Plas-Stick® 2350S™ Flex Additive	1	848.7 grams
ChromaPremier® 12375S™ Reducer	3	905.5 grams

Basecoats

ChromaBase® Basecoat
ChromaPremier® Basecoat

Application

Substrates

ChromaBase® Basecoat
ChromaPremier® Basecoat
DuPont 222S™ Mid-Coat Adhesion Promoter for blend areas

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ChromaClear® G2-4700S™ Clearcoat
(*Hyper Cure*™ - Air Dry and Express Bake)

Surface Preparation

For application over a properly prepared basecoat repair:

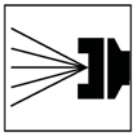
- Mask the entire vehicle to protect from overspray.
- Allow basecoat to dry 15 - 30 minutes prior to clearcoat application.
- Extend basecoat dry time to 30 minutes when applying several base color coats, tri-coat colors, or in cooler shop conditions.

Gun Setups* 4.2 VOC

Conventional

Gravity Feed	1.3 mm - 1.6 mm (.051" - .063") (c)
Siphon Feed	1.4 mm - 1.8 mm (.055" - .070")
HVLP	1.3 mm - 1.4 mm (.051" - .055")

(c) 1.5 - 1.6 mm DeVilbiss and 1.4 SATA



Air Pressure* 4.2 VOC

Conventional	35 - 45 psi @ the gun
HVLP	8 - 10 psi @ the gun cap

*The listed setups cover the usual range for various application equipment. For information on specific manufacturers' equipment, see the Appendix section titled "Equipment Information."

Application

Apply 2 full coats.

Flash/Dry Times

Do not use IR heat. It may cause the clearcoat to solvent pop.

Air Dry For optimum appearance, follow temperature guidelines for using activators and reducers.

	G2-4507S™	G2-4508S™	G2-4509S™
Flash between Coats:	7 - 10 minutes	7 - 10 minutes	7 - 10 minutes
Dust Free:	15 - 20 minutes	15 - 20 minutes	15 - 20 minutes
Time to Handle (Assemble):	1.5 - 2 hours	2 – 3 hours	2.5 - 4 hours
Time to Polish:	1.5 - 2 hours (d)	2 – 3 hours	2.5 - 4 hours
Time to Stripe:	1.5 - 2 hours	2 – 3 hours	2.5 - 4 hours
Time to Deliver:	1.5 - 2 hours	2 – 3 hours	2.5 - 4 hours
Time to Decal:	24 hours	24 hours	24 hours

(d) Although the clearcoat may fingerprint slightly at 1.5 hours, it will polish very well.

Use the lower end of the time range for warmer temperatures and the higher end for cooler temperatures.

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ChromaClear® G2-4700S™ Clearcoat
(*Hyper Cure*™ - Air Dry and Express Bake)

Flash/Dry Times (Con't)

Express Dry

Flash between coats:	7 - 10 minutes
Flash before Force Dry:	none
Cycle Time:	10 min (total cycle time) X 120° F - (booth temp., not substrate temp.)(a)
Dust Free:	out of express dry
Time to Handle (Assemble):	30 - 60 minutes
Time to Polish:	30 - 60 minutes
Time to Stripe:	2 hours
Time to Deliver:	90 minutes
Time to Decal:	24 hours

Examples for optimum bake cycles (e):

Application Temp (ambient)	Bake Cycle (min)	Approx. Final Part Temp
70° F	10 min x 120° F	110° F
80° F	10 min x 120° F	115° F
90° F	10 min x 120° F	120° F

(e) If ChromaClear® G2-4700S™ is baked at higher temperatures than described above, dieback may occur.

Blending

- Panel repair is the approved procedure for clearcoat warranty repairs. This allows the refinisher to attain the recommended film builds.

Recoatability/Re-repair

ChromaClear® G2-4700S™ Clearcoat may be recoated 1 h @ 90° F or 2h @ 70° F air dry. If the clear is force dried, wait 1 hour. If recoating after 24 hours, scuff sand with 1200 - 1500 grit. Also, use activated basecoat (ChromaBase® or ChromaPremier®).

Polishing

Optimum Times

Air Dry:	1.5 - 2.5 hours
Express Dry:	45 - 60 min. after cool down

Sanding, Compounding, Polishing

The optimum technique for removing dirt is as follows:

1. Sanding:

- Sand with 1500 grit wet or finer or use a foam interface pad with P1500 DA or finer.

2. Compounding:

- Apply a ribbon of rubbing compound to the area that was sanded or contains sandscratches.
- Maintain air polisher or variable speed buffer at 1400 - 1800 rpm. Remove excess finishing compound with a clean soft cloth prior to applying finishing polish.
- Use a wool pad and an effective rubbing compound.
- (If reduction in hardness is desired, add 1 -2 oz Plas-Stick® 2350S™ Flexible Additive or 1 - 2 oz DuPont 19379S™ Application Enhancer per ready-to-spray quart to moderate hardness.

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3. Polishing:

- Apply a ribbon of polishing material to the area to be polished.
- Maintain a variable speed buffer or an orbital polisher at 1400 - 1800 rpm.
- Use a foam pad and an effective polishing compound. Keep the polisher/buffer moving at all times. Overlap each pass approximately 50%. As finishing polish begins to dry, stop polishing. Wipe off excess finishing polish with a clean soft cloth.
- Hand buff with a clean soft cloth as a finishing touch.

Tips for Success

- *Always use clean water to wet sand and add a few drops of soap to help clear the paper.*
- *Always use a foam interface pad when DA sanding.*
- *Use clean cloths and pads to insure that the clear does not get scratched with dirt particles form old or re-used cloths or pads.*
- *Do not wax for the first 120 days after painting.*

Cleanup

Clean spray equipment immediately with DuPont Lacquer Thinner.

Physical Properties	@ 4.2 lbs./gals. VOC RTS
Theoretical Coverage:	655 sq. ft. per ready-to-spray gallon at 1 mil
Weight Solids:	47.6% ready-to-spray
Volume Solids:	40.86% ready-to-spray
Recommended Dry Film Thickness:	2.0 - 2.4 mils in 2 coats
Flash Point:	See MSDS

VOC Regulated Areas

These directions refer to the use of products which may be restricted or require special mixing instructions in VOC regulated areas. Follow mixing and usage recommendations in the VOC Compliant Products Chart for your area.

Safety and Handling

For industrial use only by professional, trained painters. Not for sale to or use by the general public. Before using, read and follow all label and MSDS precautions. If mixed with other components, mixture will have hazards of all components.

Ready to use paint materials containing isocyanates can cause irritation of the respiratory organs and hypersensitive reactions. Asthma sufferers, those with allergies and anyone with a history of respiratory complaints must not be asked to work with products containing isocyanates.

Do not sand, flame cut, braze or weld dry coating without a NIOSH approved air purifying respirator with particulate filters or appropriate ventilation, and gloves.

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H-19365
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Repintado Automotriz DuPont

DuPont™ ChromaClear® G2-4700S™ (Secado al aire y horneado exprés - *Hyper Cure* ™)

Descripción

ChromaClear® G2-4700S™ representa la segunda generación de ChromaClear® 4700S™. ChromaClear® G2-4700S™ no es sólo la transparente de horneado express y secado al aire más rápido del mundo, también revoluciona el ahorro de energía y la productividad. Además, la versión de la segunda generación (G2) proporciona una apariencia y rango de aplicación mejorados dependiendo del catalizador elegido (catalizadores ChromaClear® G2-4507S™, G2-4508S™ o G2-4509S™). Esta transparente de tres componentes 4.2 VOC puede usarse en la reparación de pequeñas imperfecciones, multi-paneles y de acabados originales de bases color de transparente.
Este producto elimina el típico ciclo de horneado de 30 minutos x 60 °C que se requiere por lo general para procesar la transparente. Se seca al aire en 1.5 horas a 21°C y puede hornearse de manera express (10 min. X 49 °C) para una entrega aún más rápida. Esto es, 10 min. (tiempo total del ciclo, incluyendo una elevación de temperatura) x 49 °C del ajuste de la temperatura de la cabina, no de la temperatura del substrato. (a) El solo ahorro de energía hace que esta transparente sea más rentable de usar que cualquier otra, incluyendo las transparentes genéricas.

ChromaClear® G2-4700S™ se debe usar con catalizadores nuevos (catalizadores ChromaClear® G2-4507S™, G2-4508S™ y G2-4509S™). Además, requiere también reductores ChromaPremier® y una relación de mezcla de 3:1:1 por volumen. Este producto puede aplicarse sobre las base color DuPont ChromaSystem™ y sustituye a la transparente ChromaClear® 4700S™ y a los catalizadores ChromaClear® 4505S™ y 4507S™.

Información general

Componentes
Transparente ChromaClear® G2-4700S™
Catalizador de Temperatura Bajas (18-24 °C) ChromaClear® G2-4507S™
Catalizador de Temperatura Media (24-29 °C) ChromaClear® G2-4508S™
Catalizador de Temperatura Altas (>29 °C) ChromaClear® G2-4509S™
Blender DuPont ChromaSystem 19301S™

Reductores para 0.5 kg / litro VOC:
Reductor Rápido ChromaPremier® 12365S™
Reductor Medio ChromaPremier® 12375S™
Reductor Lento ChromaPremier® 12385S™
Reductor Muy Lento ChromaPremier® 12395S™

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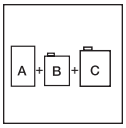
	Para 0.5 kg / litro VOC:			
Temp de aplicación.	**70° F**	**80° F**	**90° F**	**100° F**
Reductor ChromaPremier®	12365S™	12375S™	12385S™	12395S™

Recomendaciones para una aplicación exitosa
Que el funcionamiento óptimo es importante elegir el reductor correcto ChromaPremier® para el rango de temperatura (ver arriba), y el catalizador que cumpla con sus requerimientos de apariencia y tiempo de secado. Además, permite que el sellador se oree durante 20 min. antes de aplicar la base color.



Relación de mezcla/viscosidad
Combine los componentes ya sea por volumen o peso, y mezcle completamente.

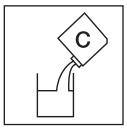
Para 0.5 kg / litro VOC	**Volumen**	**Peso***
Transparente ChromaClear® G2-4700S™	3	543.0 gramos
Catalizador ChromaClear® G2-450XS™ (X = 7, 8 ó 9)*	1	743.5 gramos
Reductor Medio ChromaPremier® 12375S™	1	905.2 gramos

* no use catalizadores ChromaClear® 4505S™ ó 4507S™.

Con Reductor Rápido ChromaPremier® 12365S™, el total es de 909 gramos
Con Reductor Lento ChromaPremier® 12385S™, el total es de 904 gramos
Con Reductor Muy Lento ChromaPremier® 12395S™, el total es de 915 gramos
* cuarto de galón (0.946 litros) acumulativo

Viscosidad
15-17 segundos en copa Zahn #2 (DuPont M-222).

Recomendaciones para una aplicación exitosa
Utilice una pala graduada, para lograr medidas exactas .



Aditivos

Mejorador de apariencia: Intensificador de aplicación DuPont 19379S™; utilice 1a 2 onzas por cuarto listo para aplicar. Intensificador de aplicación DuPont 19379S™ se piensa para el uso en tiempo caliente (> 95°F) de mejorar la dirección y el aspecto. No es recommende para el uso en temperaturas más frescas.

Acelerador: No se requiere.

Eliminador de ojo de pescado: Aditivo DuPont 459S™ ([libre de silicón] usar 0.5 - 1.5 oz por cuarto listo para aplicar), o aditivo antigrietas DuPont 459S™ (usar 0.25 a 0.5 oz por cuarto listo para aplicar).

Aditivo flexibilizante: Sólo es necesario si se requiere un desempeño óptimo.

Agregar 2 oz. de Plas-Stick® 2350S™ por cuarto listo para aplicar de transparente catalizada o utilizar Plas-Stick® 2350S™ como se describe abajo.

Por 0.5 kg / litro de VOC	**Volumen**	**Peso***
Transparente ChromaClear® G2-4700S™	9	509.1 gramos
Catalizador ChromaClear® G2-4507S™	3	597.1 gramos
Aditivo Flexibilizante Plas-Stick® 2350S™	1	848.7 gramos
Reductor ChromaPremier® 12375S™	3	905.5 gramos

* cuarto de galón (0.946 litros) acumulativo

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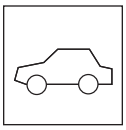
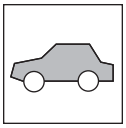


Base color
Base color ChromaBase®
Base color ChromaPremier®

Aplicación



Substratos
Base color ChromaBase®
Base color ChromaPremier®
Promotor de Adherencia entre Capas DuPont 222S™ para áreas de esfumado.

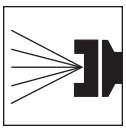
Preparación de superficie
Para su aplicación sobre una reparación de base color preparada de manera apropiada:

- Cubra todo el vehículo para protegerlo contra el briseado.
- Permita que la base color seque de 15 - 30 minutos antes de la aplicación de la transparente.
- Aumente el tiempo de secado de la base color a 30 minutos cuando aplique varias manos de base color, colores tricapas, o en condiciones de taller frías.

Configuración de la pistola* 0.5 VOC

Convencional	
Alimentación por gravedad	1.3 mm - 1.6 mm (.051" - .063") (c)
Alimentación por Sifón	1.4 mm - 1.8 mm (.055" - .070")
HVLP	1.3 mm - 1.4 mm (.051" - .055")

(c) 1.5 - 1. 6 mm DeVilbiss y 1.4 SATA



Presión de aire* 0.5 VOC

Convencional	35 - 45 psi en la pistola
HVLP	8 - 10 psi en la boquilla de la pistola

*Los ajustes listados cubren el rango usual para varios equipos de aplicación. Para información sobre equipo específico del fabricante, vea en el Apéndice la sección titulada "Información sobre el equipo".

Aplicación
Aplicar 2 manos completas.

Tiempos de secado y oreo
No use calor IR. Puede causar que la transparente se hierva
Para una óptima apariencia, siga las pautas de la temperatura para usar los catalizadores *y los reductores.*

Secado al aire	*G2-4507S™*	*G2-4508S™*	*G2-4509S™*
Oreo entre manos:	*7 - 10* minutos	*7 - 10* minutos	*7 - 10* minutos
Libre de polvo:	*15 - 20* minutos	*15 - 20* minutos	*15 - 20* minutos
Al manejo (ensamble):	*1.5 - 2* horas	*2 - 3* horas	*2.5 - 4* horas
Al pulir:	*1.5 - 2* horas *(d)*	*2 - 3* horas	*2.5 - 4* horas
Al franjear:	*1.5 - 2 h*horas	*2 - 3* horas	*2.5 - 4* horas
Al entregar:	*1.5 - 2* horas	*2 - 3* horas	*2.5 - 4* horas
Para calcomanías:	*24 hours*	*24* horas	*24* horas

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(d) Aunque pueden presentarse ligeras huellas en la trasparente después de 1.5 horas, éstas pueden pulirse muy bien.

Secado express

Oreo entre manos:	7 -10 minutos
Oreo antes del secado forzado:	ninguno
Tiempo de horneo:	10 minutos X 120° (temperatura de la cabina, no temp. del substrato) (a)
Al polvo:	fuera del secado forzado
Al manejo (ensamble):	30 - 60 minutos
Al pulir:	30 - 60 minutos
Al franjear:	2 hora
Al entregar:	90 minutos
Para calcomanías:	24 horas

(a) Cuidado cuando los competidores ofrecen (10 min. X 49°C), por lo general, se refieren al tiempo de la temperatura del substrato. De hecho, esto significa en un ciclo de 20 - 25 minutos en una temperatura de la cabina de 60° - 66 °C (lo que representa más tiempo y costos de energía comparado con G2-4700S™).

Ejemplos para ciclos óptimos de horneado (e):

Temp. de aplicación (ambiente)	Ciclo de horneado	Temp. de la parte final aprox.
21 °C	10 min. x 49 °C	43 °C
27 °C	10 min. x 49 °C	46 °C
32 °C	10 min. x 49 °C	49 °C

(e) Si ChromaClear® G2-4700S™ se hornea a temperaturas más altas de las descritas arriba, se puede rechupar el acabado.

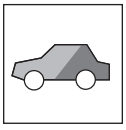
Esfumado

La reparación de paneles es un procedimiento aprobado para reparaciones de garantía de transparentes. Esto permite al responsable del repintado lograr la formación de película que se recomienda. Si elige esfumar, use el Blender DuPont ChromaSystem 19301S™. Ya que este contiene más sólidos, es crucial en este caso mantener la presión del aire (20 - 25 psi) en comparación con un blender como DuPont 7601S™ donde la presión de aire se reduce por lo general (10 - 15psi) durante la aplicación.

- Diluya gradualmente y aplique con cuidado la segunda mano de transparente fuera de los límites de la primera.
- Después de la mano final de transparente, enseguida hay que reducirla mezclando 1 parte del Blender DuPont ChromaSystem 19301S™ con una parte de la transparente restante y diluir gradualmente la mezcla restante.
- Después de que la mano final de transparente se haya esfumada con la mezcla de DuPont ChromaSystem 19301S™ y la transparente, reduzca más la mezcla y use la misma pistola para terminar de fundir las orillas.

Recomendaciones para una aplicación exitosa

Para el esfumado de paneles muy grandes, asegúrese de que se aplica DuPont 222S™ mas allá del área de la transparente.



Reparaciones

La Transparente Ultraproductiva ChromaClear® G2-4700S™ puede recubrirse de 1 h a 32 °C o en un secado al aire por 2h a 21 °C. Si se recubre después de 24 horas, lije con una fibra de grano 1200 - 1500. Use también una base color catalizada (ChromaBase® o ChromaPremier®).

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DuPont™ ChromaClear® G2-4700S™ (Secado al aire y horneado exprés - *Hyper Cure* ™)

Pulido

Tiempos óptimos

Secado al aire:	1.5 - 2.5 horas
Secado express:	1.5 - 2 horas

Lijado, pulido, abrillantado

La técnica óptima para remover la suciedad es como sigue:

1. Lijado

- Utilice un grano de 1500 en húmedo o más fino, o bien utilice una Orbital DA P1500 ó más fino.

2. Pulido

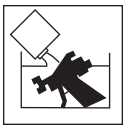
- Aplique una cantidad pequeña de pulimento al área que se lijó o que esté rayada.
- Mantenga un pulidor neumático o una velocidad variable entre 1400 - 1800 rpm. Remueva el exceso de pulimento con un trapo limpio y suave antes de aplicar el abrillantador.
- Utilice una almohadilla de lana y un pulimento eficaz (por ejemplo, 3M Perfect-it II).
- (Menos favorable: una una borla de espuma y pulimento 3M Extra Cut Perfect-it III; no removerá los rayones del lijado tan fácilmente.
- (Si se desea una reducción en la dureza, agregue 1 - 2 onzas de Aditivo Flexibilizante Plas-Stick® 2350S™ o 1 - 2 onzas de Mejorador de Apariencia DuPont 19379S™ por litro listo para aplicar para moderar la dureza.

3. Abrillantado

- Aplique una cantidad pequeña de material para abrillantar un área de 0.2 a 0.3 m2.
- Mantenga el pulidor a una velocidad variable entre 1200 - 1800 rpm.
- Utilice una borla de espuma y abrillantador efectivo.
- Mantenga el pulidor en movimiento todo el tiempo. Traslape cada paso aproximadamente un 50%. Conforme el pulido comience a secarse, deje de pulir. Limpie el exceso con un paño suave y limpio. Pula a mano con un trapo limpio y suave para un acabado final.

Recomendaciones para una aplicación exitosa

- *Siempre utilice agua limpia para mojar la lija y agregue unas gotas de jabón para ayudar a limpiar el papel.*
- *Siempre utilice una borla de espuma cuando lije DA.*
- *No utilice pulimentos de uso medio o pesado. Utilice trapos y borlas para asegurar que la transparente no se raye con partículas de suciedad de trapos o borlas usadas.*
- *No encere durante los primeros 120 días después de haber pintado*



Limpieza

Lave el equipo de aplicación tan pronto como sea posible con Thinner Acrílico DuPont.

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DuPont™ ChromaClear® G2-4700S™ (Secado al aire y horneado exprés - *Hyper Cure* ™)

Propiedades físicas	a 0.5 kg / litro VOC
Rendimiento teórico:	16 m2/litro a 1 millar listo para aplicar
Peso de sólidos:	47.6% listo para aplicar
Volumen de sólidos:	40.86% listo para aplicar
Espesor recomendado de la película seca:	2.0 - 2.4 millares en dos manos
Punto de flash:	vea MSDS

Áreas con VOC regulados

Estas instrucciones se refieren al uso de productos que pueden estar restringidos o requieren instrucciones especiales de mezcla en áreas con VOC regulados. Siga las recomendaciones de preparación y manejo indicadas en la carta para productos que cumplen con los VOC en su área.

Seguridad y manejo

ANTES DE USAR CUALQUIER PRODUCTO DE REPINTADO DUPONT, ASEGÚRESE DE HABER LEÍDO TODAS LAS INSTRUCCIONES Y ADVERTENCIAS DE SEGURIDAD. USE UN RESPIRADOR DE PRESIÓN POSITIVA (NIOSH TC - 19C), PROTECCIÓN PARA LOS OJOS, GUANTES Y ROPA PROTECTORA MIENTRAS MEZCLA EL CATALIZADOR CON LA PINTURA, DURANTE LA APLICACIÓN Y HASTA QUE TODOS LOS VAPORES Y BRISAS SE HAYAN EXTRAÍDO. SIGA TODAS LAS INSTRUCCIONES DE USO DEL FABRICANTE DEL RESPIRADOR. LAS PERSONAS CON HISTORIA DE PROBLEMAS PULMONARES O RESPIRATORIOS O DE REACCIÓN ANTERIOR AL ISOCIANATO NO DEBEN USAR O EXPONERSE AL VAPOR O A LA MEZCLA ATOMIZADA. NO PERMITA EL PASO A NADIE SIN LA PROTECCIÓN ADECUADA EN EL ÁREA DE PINTADO. ESTE PRODUCTO ESTÁ HECHO PARA USO INDUSTRIAL Y PARA SER APLICADO SÓLO POR PINTORES PROFESIONALES CAPACITADOS.

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Martin Senour® *Complete* Color Surfacer System

TP520, TP521, TP522, TP523, TP524, TP525, TP526

PRODUCT AT-A-GLANCE

SUITABLE SUBSTRATES

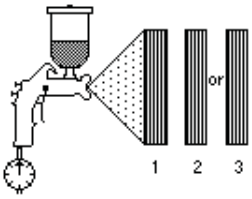
- Treated Steel
- Galvanized Steel
- Treated Aluminum
- OEM Enamels
- Refinish Enamels
- Fiberglass
- Body Filler
- Trio/Prime Etching Primers
- Martin Senour® Wash Primers

MIXING

4 *Complete* Color Surfacer + 1 5112 or TS1-TS4 + 1 TH527

APPLICATION

- Apply 2 –3 medium/wet coats at a gun distance of 5” to 7”
- Allow each coat to flash 5 to 10 minutes
- 6-9 psi HVLP/ 25-45 psi Conventional



RECOAT

- Martin Senour® *Complete* Color Sealer
- 2K Basecoat Transparent / Adhesion Promoter 5180
- Tec/SYSTEM® Basecoat and Single-stage Urethane.
- Tec/SEAL® Acrylic Urethane Sealers
- Maximum recoat time after sanding: 7 days. After 7 days, solvent clean and scuff with gray nylon pad.

NOTES

- Excessive number of coats will extend drying times.
- When topcoating directly over *Complete* Color Surfacer, sand with P600 sandpaper.
- On Soluble substrates, use *Complete* Color Surfacer on complete panels or for overall refinishing only.

PERSONAL PROTECTION

- For use by trained professionals only.
- Read label, directions, and MSDS before use.
- Use appropriate Personal Protective Equipment while mixing and spraying.

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Cleveland, OH 44115

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MA4778
09/26/06

Martin Senour® *Complete* Color Surfacer System

TP520, TP521, TP522, TP523, TP524, TP525, TP526

PRODUCT DESCRIPTION:

Martin Senour® *Complete* Color Surfacer is a premium quality 2K-urethane primer-surfacer that utilizes state of the art technology to provide the ultimate in performance, versatility, and productivity. The TP520 system offers seven FPC colors that can be used by themselves or in combination with each other to provide an unlimited color pallet. *Complete* Color Surfacer provides the best in gloss holdout, resistance to film shrinkage, easy sanding, and does not require the addition of a flex additive for plastic parts repair/refinishing. TP520 *Complete* Color Surfacer can be sanded in as little as 10 minutes with Infra Red cure, or 45 minutes at 70°F. *Complete* Color Surfacer can be converted to *Complete* Color Sealer, a wet-on-wet sealer or barrier coat. Please refer to the TP520 *Complete* Color Sealer Product Data Sheet (MA4942) to learn more. From underhood topcoats, direct to OEM E-coat, Direct To Metal recommendations, plastic repair process, to typical collision repair scenarios, the TP520 system is the most versatile product on the market.

SURFACE PREPARATION:

Substrates: Properly treated Steel, Galvanized Steel, Aluminum, or Fiberglass

1. Clean the surface with 6386 Water Based Surface Cleaner, followed by 6384 - Tec/CLEAN™ Surface Cleaner – Fast and wipe dry with clean, dry cloths.
2. Apply two coats of TE502 LCF Wash Primer or 2 medium-wet coats of Trio/Prime™ LCF Etching Filler TE500.
3. An etch primer is ***NOT*** required for small sand throughs or areas of bare metal that are 5” x 5” or smaller.

Pre-painted Substrates:

1. Clean the surface with 6386 Water Based Surface Cleaner, followed by 6384 - Tec/CLEAN™ Surface Cleaner – Fast and wipe dry with clean, dry cloths.
2. Sand repair area and featheredge using P80, P180, P280, and finish with P320 grit treated sandpaper on a random orbital sander. Use Tec/CLEAN™ Surfacer Cleaner 6384 to remove sanding residue before recoating.

DRYING SCHEDULE:

Air Dry:	2-3 Hours at 70º F. with Tec/SOLVENT® Reducers.
Air Dry:	45 Minutes with 5112 Reducer
Force Dry:	20-30 Minutes at 140º F.
Short Wave IR:	5 minutes full power at 18”-20” distance using 5112 reducer with 2 to 3 coats applied using a wet-on-wet, limited flash application technique. 10 minutes flash power, 10 minutes full power at 36” distance with TS2-TS4 reducers

REGULATORY DATA*

	As Packaged		As Applied	
	G/L	**Lbs/Gal**	**G/L**	**Lbs/Gal**
VOC Total	736	736	467	3.89
VOC Less Exempt	6.14	6.14	467	3.89
	Lbs/Gal Solids	**Lbs/Lbs Solids**	**Lbs/Gal Solids**	**Lbs/Lbs Solids**
HAPs	18.39	1.50	3.48	0.20
	Wt.%	**Vol.%**	**Wt.%**	**Vol.%**
Volatiles	76.8	84.8	33.1	54.2
Water	0.00	0.00	0.00	0.00
Exempt Compounds	0.00	0.00	0.00	0.00
	G/L	**Lbs/Gal**	**G/L**	**Lbs/Gal**
Density	958	8.00	1412	11.79

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09/26/06

Martin Senour® *Complete*
SPEED Sistema de Acabador de Color
TP520, TP521, TP522, TP523, TP524, TP525, TP526
PARA AREAS DE BAJO VOC

SUSTRATOS APROPIADOS

- Acero Tratado
- Acero Galvanizado
- Aluminio Tratado
- Esmaltes OEM
- Esmaltes para Reacabados
- Fibra de Vidrio
- Rellenador de Poliéster
- Fondo Rellenador de Rayas Trio/Prime
- Fondo Rellenador de Limpieza Martin Senour®

MEZCLADO

*****NUEVA PROPORCION DE MEZCLADO*****
(2:2:1 = Lotes AR15 de C08 y más nuevo)
(2:1:1 = Lotes AR15 de B08 y más viejos)

2 Partes
Acabador de color *Complete*

\+

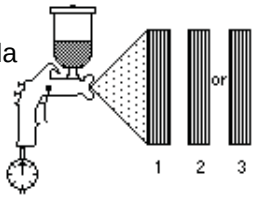
2 Partes
Reductor Acelerado AR15

\+

1 Parte
Endurecedor 5198

NOTA: Vida útil cuando listo para aplicar es 15 – 20 minutos. Limpiar la pistola de rociar inmediatamente después de del uso.

APLICACION



- Aplicar 2 –3 manos medianas/húmedas a una distancia de pistola
- de 13-18 cm (5-7 pulgadas).
- Tiempo de orea no es necesario – no exceder 2 minutos.
- 6-9 psi HVLP/25-45 psi convencional.
- Espesor de la película seca después de lijar = 2,0 – 2,5 mils.
- Las mejores pistolas de rociar recomendadas = 1,3 – 1,4 mm HVLP alimentación por gravedad.

REPINTADO

- Sellador de color TP527 Martin Senour® *Complete*
- Capas finales Vortex Waterborne
- Aplicación monocapa Tec/SYSTEM®.
- Máximo tiempo de repintado después de lijar: 7 días. Después de 7 días, limpiar con solvente y raspar con un cojín gris de nilón.

NOTAS

- Una cantidad excesiva de capas extenderán los tiempos de secado.
- Cuando se aplica la capa final directamente sobre el acabador de color *Complete*, se debe usar papel de lija P600 para el lijado final.
- Sobre los sustratos solubles, usar el acabador de color *Complete* sobre los paneles completos o para el reacabado general solamente.

PROTECCION PERSONAL

- Uso solamente por profesionales entrenados.
- Lea las etiquetas, instrucciones y la Hoja de Datos de Seguridad de Material antes de usar.
- Se debe usar los equipos de Protección Personal apropiados durante el mezclado y la aplicación del producto.

PRODUCTO A LA VISTA

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Martin Senour® *Complete*
SPEED Sistema de Acabador de Color
TP520, TP521, TP522, TP523, TP524, TP525, TP526
PARA AREAS DE BAJO VOC

DESCRIPCION DEL PRODUCTO:

El acabador de color Martin Senour® *Complete* es un fondo rellenador-acabador de uretano-2K de alta calidad que utiliza la tecnología más avanzada para ofrecer lo último en rendimiento, versatilidad y productividad. El sistema TP520 ofrece siete colores FPC que pueden ser utilizados solos o en combinación uno con el otro para ofrecer una paleta de colores ilimitada. El acabador de color *Complete* ofrece lo mejor en la retención de brillo, resistencia al encogimiento de la película, es fácil de lijar y no requiere la adición del aditivo flexible para las piezas plásticas de reparación/reacabado. Con el uso de un sólo producto nuevo, el reductor acelerado AR15, se puede lijar el acabador de color *Complete* en tan sólo 15 minutos secado al aire. El acabador de color *Complete* se puede convertir al Sellador de color *Complete*, un sellador húmedo sobre húmedo o una capa de barrera. Por favor referir a la hoja de datos del producto del sellador de color TP520 *Complete* (MA4942), o la hoja de datos del producto del acabador de color TP520 *Complete* (MA4778) para aprender más. El sistema TP520 es el producto más versátil en el mercado para las capas finales del interior del capó, directamente a la capa-E del OEM, recomendaciones directo al metal, proceso de reparación plástico, hasta la reparación de colisión típicos.

PREPARACION DE LA SUPERFICIE:

Sustratos Desnudos: Acero, Acero Galvanizado, Aluminio, o Fibra de Vidrio

1. Limpiar la superficie con el limpiador de superficie apropiado y secar con repasadores limpios y secos.
   **Nota:* Verificar las regulaciones locales relativas a la utilización de disolventes de limpieza.
2. Aplicar 2 manos del fondo rellenador de rayas TE504 LCF.

*NOTA: **No** se requiere usar un fondo rellenador de rayas para las áreas de metal desnudos lijados o de metal desnudo de tamaño 13 x 13 cm **(**5 x 5 pulgadas) o más pequeño.

Sustratos Previamente Pintados

1. Limpiar la superficie con el limpiador de superficie apropiado y secar con repasadores limpios y secos.
2. Lijar el área de reparación a un acabado uniforme usando P80, P180, P280, y terminar con papel de lija tratado de P320 granos sobre una lijadora orbital auxiliar. Usar el limpiador de superficie apropiado para quitar los residuos de lijado antes de repintar.
   * *Nota:* Verificar las regulaciones locales relativas a la utilización de disolventes de limpieza.

TIEMPOS DE SECADO:

Secado al aire:	15 – 20 minutos a 21°C (70º F) con el reductor AR15.
Secado Forzado:	10 minutos a 60°C (140º F) temperatura de superficie.
Infrarrojo corta onda:	10 minutos plena fuerza a 91 cm (36 pulgadas) distancia.
Nota:	Altas espesores de la película y las temperaturas bajas pueden aumentar los tiempos de secado.

DATOS REGULATORIOS*

	Empacado		Aplicado	
	G/L	**Lbs/galón**	**G/L**	**Lbs/galón**
VOC Total	736	6.14	157	1.31
VOC Menos Exentos	736	6.14	243	2.03
	Lbs/galón sólidos	**Lbs/Lbs sólidos**	**Lbs/galón sólidos**	**Lbs/Lbs sólidos**
HAPs	18.39	1.50	1.77	0.13
	Peso%	**Volumen%**	**Peso%**	**Volumen%**
Volátiles	76.8	84.8	38.9	53.4
Agua	0.00	0.00	0.00	0.00
Compuestos Exentos	0.00	0.00	26.2	35.2
	G/L	**Lbs/galón**	**G/L**	**Lbs/galón**
Densidad	958	8.00	1244	10.39

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SkillsUSA®
CHAMPIONSHIPS

CONTEST SCORING CRITERIA

Contest Automotive Refinishing Technology Chair Alan Craighead

Skill Description	Maximum Points
1. Color Tint	175
2. Spot Refinish	175
3. Featheredge & Prime	175
4. Masking & Paint Identification	175
5. Estimate	100
6. Interview	100
7. ASE Written Test	100
8.	
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Résumé submitted? No ○ (5% penalty)	

Tie Breakers
1. SkillsUSA Professional Development Program Test 2. Color Tint 3. Spot Refinish

SkillsUSA
2010 Contest Projects

Automotive Service Technology
(High School)

Click the "Print this Section" button above to automatically print the specifications for this contest. Make sure your printer is turned on before pressing the button.

Automotive Service Technology
This year, Delmar, a part of Cengage Learning is making their online ASE Test Preparation tools available to all instructors and competitors immediately. This means that some competitors may be able to use the tool in advance of their district and state competitions.

Instructors should only share the material with competitors.

Access will be terminated when the National Competition begins.
Please use the contact information below to get the necessary link
jonathan.sweeney@cengage.com | www.delmarlearning.com

2010 AST HIGH SCHOOL CONTEST STATIONS

TASK	ON-VEHICLE WORKSTATIONS	SPECIAL TOOLS, COMPONENTS, & VEHICLES PROVIDED
S1 Vehicle HVAC System Diagnosis and Testing Honda	Students will be judged on their ability to read and use electronic schematics and service information, correctly use test equipment, and use diagnostic strategies to identify root cause. Car is bugged. Students will be asked to explain the logic behind the troubleshooting procedure.	N/A
S2 Vehicle Engine Performance Diagnosis & Testing Toyota	Students will be required to use a repair order to identify customer complaint. They will also be required to diagnose and repair faults related to the engine control and emissions system. This includes drivability, MIL-ON DTC, and Engine Control Module related issues. Students will be expected to read schematics/wiring diagrams, locate information using factory service information, correctly connect and use test equipment, and use diagnostic strategies to identify root cause. Car is bugged. Parts replacement may be required.	Toyota Scantool – Techstream
S3 Vehicle Body Electrical Diagnosis and Testing Ford	Diagnose electrical circuits on car related to battery, starting, charging, lighting, and accessories. Students will be expected to read schematics, locate information in service information, correctly connect and use test equipment, and use diagnostic strategies to identify root cause. Car is bugged. Use of repair order.	N/A
BENCH WORKSTATIONS		

S4 Environment, Health and Safety	Students demonstrate their knowledge of automotive work related safety equipment, environmental issues, procedures and familiarity with MSDS and PPE.	Prior SP/2 training in Mechanical Safety and Pollution Prevention to be completed. www.sp2.org
S5 Job Interview	Students demonstrate they can clearly and completely fill out a job application, communicate clearly and effectively and have appropriate professional behaviors during the job interview. Printed copy of resume required.	Prior training in PDP Level I & II to be completed. **Contestant must bring printed copy of Resume to the Contestant Orientation Meeting.**
S6 Electrical Circuit Diagnosis, Testing, and Wiring Repair.	Students will measure resistance, voltage, amperage with a shunt, and voltage drop measurements on a bench circuit board. Students will demonstrate proper circuit diagnosis to locate faults placed in various electrical circuits.	N/A
S7 Electronic Service Information	Students locate specifications and other service information using electronic service information resources.	Mitchell 1- ShopKey Electronic Service Information.
S8 Steering and suspension	Component identification and wheel alignment theory diagnosis. Identify vehicle suspension and steering components, wheel alignment tools & adjustment components. Answer questions on wheel alignment theory & diagnosis of related conditions. Exhibit the ability to properly use reference materials and work orders.	N/A
S9 Brake Service & Diagnosis	Students will be judged on their ability to inspect, service, and determine necessary action related to disc and drum brake systems. Tasks may include part identification, inspection, measurements, disassemble and assemble.	N/A
S10 Manual Drive Train Service and Diagnosis	Students will be asked to identify components and power flow of a manual transmission, as well as answer questions on transmission theory. Students will also be required to diagnose a transmission condition.	N/A

S11 Automatic Transmission Service	Students will demonstrate understanding of basic automatic transmission service, mechanical adjustments, parts identification, normal measurements and inspection. Removal and replacement of components may be required.	N/A
S12 Engine Mechanical Service	Contestants will demonstrate their knowledge of the internal combustion gasoline engine. As well as use precession measurement instruments and the Factory Repair Manual to inspect various engine components. Contestants will be required to identify various engine components and answer engine mechanical questions.	N/A
S13 Written Test ASE	Given by ASE, this 100 question written test will test the student's technical knowledge of automobile diagnosis and repair in the vehicle system specialty areas of: • Engine Repair • Automatic Transmission/Transaxle • Manual Drive Train and Axles • Suspension and Steering • Brakes • Electrical/Electronic Systems • Heating and Air Conditioning • Engine Performance	Test booklet answer sheet, pencil.

SkillsUSA
2010 Contest Projects

Automotive Service Technology
(College/Postsecondary)

Click the "Print this Section" button above to automatically print the specifications for this contest. Make sure your printer is turned on before pressing the button.

2010 AST COLLEGE CONTEST STATIONS

TASK	ON-VEHICLE WORKSTATIONS	TOOLS PROVIDED
P1 Vehicle HVAC System Diagnosis and Testing Chrysler	Perform diagnosis and repair of a problem related to the HVAC/Climate Control system on a CAN bus vehicle. Students will be expected to read schematics, locate information in service information, correctly connect and use test equipment, and use diagnostic strategies to identify root cause. Car is bugged Parts replacement. Use of repair order.	A/C Pressure gauges. Chrysler Star Mobile or wiTECH software.
P2 Vehicle Engine Performance Diagnosis and Testing GM	Students diagnose and repair faults related to the power train control module, drivability and emissions, using service information and diagnostic equipment. Students will be expected to read schematics, locate information in service information, correctly connect and use test equipment, and use diagnostic strategies to identify root cause. Car is bugged. Use of repair order.	G.M. Tech 2 Scan Tool.
P3 Vehicle Wheel Alignment Hunter	Students will demonstrate their understanding of wheel alignment angles, setup and use of alignment measuring equipment, and diagnosis of customer concerns. Use of repair order.	Hunter WA series alignment machine with 11.0 software. Hunter Hawkeye sensors.
BENCH WORKSTATIONS		
P4 Environment, Health and Safety	Automotive work related safety and environmental procedures and issues, including MSDS and PPE.	Prior SP/2 training in Mechanical Safety and Pollution Prevention to be completed. www.sp2.org

P5 Customer Service	Act in an appropriate and professional manner. Bench test electrical components to diagnose a no-start condition. Clearly and effectively communicate with the customer information on the diagnosis and repair of their vehicle. Printed copy of resume required.	**Must bring printed copy of Resume to the Contestant Orientation Meeting.**
P6 Electrical Circuit Testing	Students will measure resistance, voltage, amperage with a shunt, and voltage drop measurements on a bench circuit board. Students will demonstrate proper circuit diagnosis to locate faults placed in various electrical circuits.	N/A
P7 Electrical Service Information	Students locate specifications and other service information using electronic service information resources.	Chilton Pro
P8 Electrical Diagnosis	Electrical diagnosis through scope pattern interpretation. Basic Labscope operation.	Snap-On (Modis) For additional training information go to: http://www.snapon.com/Modis/flash/Modis_Test_Driv$asp
P9 Brake Service and Diagnosis	Inspection, diagnosis, testing and repair of an ABS disc brake system.	Snap-On (Vantage Pro) For additional information go to: http://www1.snapon.com/TrainingSolutions/Courses/VantagePRO.nws

P10 Manual Drive Train Service and Diagnosis	Service, testing and diagnosis of rear drive vehicle differential assembly. Students may perform procedures including pinion depth measurement and shim determination, ring gear backlash adjustment and preloading of ring gear bearing and checking of gear contact patterns.	N/A
P11 Automatic Transmission Service and Diagnosis	Service, testing and diagnosis of automatic transmission drive train components. Students will demonstrate understanding of basic transmission service, diagnosis of solenoids and sensor, mechanical adjustments, parts identification, normal measurements and inspection. Perform bench diagnosis of transmission. Identify faulty components/circuits.	N/A
P12 Engine Mechanical Service, diagnosis, and Precision Measurement	Students will perform precision measurements and diagnostics on an overhead cam engine to diagnose and determine proper corrective action. This may include checking: timing, valve lash, camshaft or crankshaft endplay, Timing chain or belt stretch and basic engine measurements.	N/A
P13 Written Test ASE	Given by ASE, this 100 question written test will test the student's technical knowledge of automobile diagnosis and repair in the vehicle system specialty areas of: • Engine Repair • Automatic Transmission/transaxle • Manual Drive Train and Axles • Suspension and Steering • Brakes • Electrical/Electronic Systems • Heating and Air Conditioning • Engine Performance	Test Booklet answer sheet, pencil.

SkillsUSA
2010 Contest Projects

Aviation Maintenance Technology

Click the “Print this Section” button above to automatically print the specifications for this contest. Make sure your printer is turned on before pressing the button.

2010 Aviation Maintenance Technology Contest

General Section (Secondary)

Precision Measuring
Contestants were required to measure the provided set of machined components. Contestants use the drawings to identify a set of different types of measurements for each of the machined components. Contestants use the provided precision measuring tools to make a variety of different types of measurements. These measurements including but not limited to inside dimensions, outside dimensions, depth and tolerance.

Hardware ID
Contestants were required to identify various pieces of aviation hardware. Contestants are provided with a set of aviation hardware, measuring tools and reference material. Contestants use the reference material and measuring tools to identify specific pieces of aviation hardware by part number.

Electrical
Contestant are required to compare circuit board wiring with the electrical diagram, make corrections as required, check continuity, measure and record circuit electrical values, and calculate electrical values using Ohms Law.

Tube Bending and Flare
Contestants were required to fabricate a fluid line to specific specifications. The contestant will make bends, install fittings, and fabricate flares. The flares will be fabricated to a specific size.

TCDS/AD's
Contestants were required to answer questions pertaining to Type Certificate Data Sheets or Airworthiness Directives. The answers will be obtained by using microfiche/microfiche reader OR computer software.

Aircraft Parts Identification
Contestants were required to identify aircraft and instrument panel components using the appropriate diagrams.

Safety
Contestants were required to answer a series of multiple-choice questions pertaining to safety in the aviation maintenance field.

FAR's
Contestants were required to answer questions pertaining to Federal Aviation Regulations (FAR's) by indicating the correct number for the specific Code of Federal Regulations (CFR's).

Weight and Balance
Contestants were required to solve different problems relating to aircraft weight and balance. Problems include computing various weights, moment, center of gravity (CG), forward and aft CG and shifting CG.

Safety Wire
Contestants were required to complete a combination of any of the following. Safety wire turnbuckles using various methods, safety wire different types of bolts and/or install cotter pins.

Forms, Records and Log Entries
Contestants were required to make a various logbook entries and complete 337 Form.

Flexible Hose Fabrication
Contestants were required to fabricate flexible hose to specific standards. The contestant will fabricate the hose, including installation of end fittings, made to proper length.

2010 Aviation Maintenance Technology Contest

Airframe/Powerplant Section (Postsecondary)

Composite
Contestants will be required to answer questions on proper procedures and repair techniques for composite material and to determine the delaminated area of composite material.

Visible Dye Penetrant Inspection
Contestants will be required to perform a visible dye penetrant inspection. The necessary references and materials are supplied.

Sheet Metal
Contestants will be required to fabricate a sheet metal project by cutting, bending and/or installing fasteners. All tools and materials required for the project are provided. Contestant will be scored on proper dimensions, rivet spacing and rivet installation.

Aircraft Tires and Wheel Maintenance and Inspection
Contestants will be required to disassemble, clean, inspect and reassemble an aircraft wheel and tire according to maintenance and servicing instructions found in the aircraft Maintenance Manual. The necessary tools references and materials have been supplied.

Aileron Rigging
This task will require the contestant to remove and replace a flight control cable and rig flight control using the aircraft and manufacturer's maintenance manual. The necessary tools, references, and materials have been supplied.

Electrical Troubleshooting
Contestants are required to troubleshoot circuit board wiring, make corrections as required, check continuity, measure and record circuit electrical values, and calculate electrical values using Ohms Law.

Fluid Line Fabrication
Contestants will be required to fabricate a fluid line to specific specifications. The contestant will make bends, install fittings, and fabricate flares. The flares will be fabricated to a specific size.

Cable Fabrication and Tensioning
Contestants will be required to fabricate a cable with a Nicopress thimble splice on each end and tension the cable according to the appropriate rigging chart. All the necessary tools references and materials have been supplied.

Propeller
Contestant were required to measure the blade angles, blade track, inspect propeller and/or read and determine conformity of propeller specification using references provided. All the necessary tools, references and materials have been supplied.

Magneto
Contestants were required to remove and install the contact points, cam, inspect and internally time a magneto. All the necessary tools, references and materials have been supplied.

Safety
Contestants were required to answer a series of multiple-choice questions pertaining to safety in the aviation maintenance field.

Turbine Parts Identification
Contestants were required to identify by part number and complete nomenclature of Pratt and Whitney JT8D turbine engine parts. All the necessary tools, references and materials have been supplied.

SkillsUSA
2010 Contest Projects

Basic Health Care Skills

Click the “Print this Section” button above to automatically print the specifications for this contest. Make sure your printer is turned on before pressing the button.

Basic Health Care Skills 2010

SkillsUSA Champions at Work

Station Check-Off List

Contestant# _____

Please have judges place a sticker on each completed station!

Thank you & good luck!

Station #1 Written Test	Station #2
Station #3	Station #4
Station #5	Station #6
Station #7	Station #8
Station #9	Station #10
Station #11	Station #12

Facilitator Check Off Sheet

Skills USA
June 24, 2010

Station Number

Contestant Number	1 Written Test	2	3	4	5	6	7	8	9	10	11	12	
1													
2													
3													
4													
5													
6													
7													
8													
9													
10													
11													
12													
13													
14													
15													
16													
17													
18													

Facilitator Supplies

Sticker with numbers- 1 for each station 1/contestant- (at each contest area)
pencil
clip board
chairs 1/contestant + 1 for facilitator
table
Written test 1/contestant--- can set 2/table at 2 tables to take (2 tables & 4 chairs)
1 pencil/ test taker

Basic Health Care Skills 2010

SkillsUSA Champions at Work

SUBJECT: CPR/FBAO Contestant#_____

Scenario: You are out with some friends at Mazzios Pizza Parlor on a Saturday night. As you walk up to the counter to get a refill of Dr. Pepper you notice a middle age man grab his chest, then he falls face down to the floor. His family rushes to his side and calls for help. Being trained in CPR demonstrate what you would do. (except just tell us when you are breathing, instead of actually doing it).

Criteria	Points Possible	Score
"With a middle aged man collapsed on the floor, what do you do?" 1. Gently shake and ask if client is alright? 2. Find someone to call for help if no response 3. Get help and gently turn client over face up. 4. Open airway 5. Look, listen, and feel. (Should not be giving breaths yet)	25	
1. 1st make sure chin is lifted and nose is plugged 2. 2nd give 2 slow breaths- **"What are you watching for?"** 3. 3rd check for pulse (there is still no pulse) 4. Now should start with the 30 compressions to every 2 breaths (Making sure they are using correct hand placement 5. Should continue four cycles then recheck the pulse now he has a pulse. (30 X 2)	25	
1. "Victim is now breathing with a pulse." 2. Put into recovery position and should continue to assess the pulse every two minutes until help has arrived.	10	
1. Performed techniques safely & effectively	15	
	Total Score =	

(75 points possible)

Notes:

Basic Health Care Skills 2010

SUBJECT: CPR/FBAO Contestant#_____

Scenario:

You are out with some friends at Mazzios Pizza Parlor on a Saturday night. As you walk up to the counter to get a refill of Dr. Pepper you notice a middle age man grab his chest, then he falls face down to the floor. His family rushes to his side and calls for help.

Being trained in CPR demonstrate what you would do, except just tell us when you are breathing, instead of actually doing it.

Basic Health Care Skills 2010

SkillsUSA Champions at Work

SUBJECT: Ethical & Legal Issues Contestant#_____

Criteria	Points Possible	Score
1. What is the difference between negligence and abuse? Answer: Negligence-failure to give care that is normally expected of a person in a particular position resulting in injury to another. Abuse- Care that results in physical harm, pain or mental anguish.	10	
2. Mr. Jones wants to leave the hospital because he is not happy with his care. He will be asked to sign what? Answer: AMA form. Against Medical Advise	10	
3. Mrs. Smith's nurse was rude and disrespectful, violating the patient's what? Answer: The Patient's Bill of Rights.	10	
4. Name two examples of torts that can lead to legal action. Answer: Malpractice, negligence, assault and battery, defamation, invasion of privacy, false imprisonment, abuse	10	
5. Mrs. White is hospitalized for back pain again, and her nurse, Miss Peabody, falsely tells her neighbor, who happens to be Mrs. White's boss, that she abuses her narcotics. This in turn caused Mrs. White to lose her job. What would this be called? Answer: Defamation/ slander.	10	
	Total Score =	

Notes: (50 points possible)

Basic Health Care Skills 2010

SkillsUSA Champions at Work

Subject: Anatomy & Physiology Contestant #_____

Circle the one best answer.

1. Which of these is not part of the small intestines?

A. Jejunum
B. Ileum
C. Cecum
D. Duodenum

2. Bile is responsible for the

A. final digestion of fats.
B. emulsification of fats.
C. chemical breakdown of fats.
D. chemical breakdown of cholesterol.

3. The liver is an

A. enzyme.
B. endocrine organ.
C. endocrine gland.
D. exocrine gland.

4. Obstruction of the_____will lead to jaundice.

A. hepatic duct
B. pancreatic duct
C. cystic duct
D. none of the above

5. The largest gland in the body is the?

A. pituitary
B. liver
C. thyroid
D. thymus

6. Which one of these is a simple sugar?

A. maltose
B. sucrose
C. lactose
D. glucose

7. Fats are broken down into

A. amino acids.
B. simple sugars.
C. fatty acids.
D. disaccharides.

8. Most digestion of carbohydrates takes place in the

A. stomach.
B. mouth.
C. small intestines.
D. large intestines.

9. Cane sugar is the same as

A. maltose.
B. lactose.
C. sucrose.
D. glucose.

10. What is the middle portion of the small intestine called?

A. Jejunum
B. Ileum
C. Duodenum
D. Cecum

From the anatomical model write in the corresponding number of the following parts of the digestive system.

_____ parotid gland

_____sublingual gland

_____pharynx

_____esophagus

_____stomach

_____liver

_____gallbladder

_____ileum

_____ascending colon

_____transverse colon

_____splenic flexure of colon

_____descending colon

_____sigmoid colon

_____anal canal

Score= _____
(each question worth 3 points)

Basic Health Care Skills 2010

SkillsUSA Champions at Work

SUBJECT: Academic Topic Blood Flow Through the Heart
Contestant#_____
Answers:

1. Name the structures of the heart: a-j (10 parts)
   (20 pts.) See Chart

2. Blood flows away from the heart through the?
   (5 Pts) arteries

3. Blood flows to the heart through the

   (5 pts.) veins

4. The valve between the right atrium and the right ventricle is called the tricuspid valve. (5pts.)
5. The right ventricle receives blood from the right atrium and pumps the blood into the pulmonary artery.
   (5 pts.)

6.The left atrium receives oxygenated blood from the lungs. (5pts.)

7. The septum is a muscular wall that supports the heart into a right side and a left side. (10 pts.)

8. The pericardium is a double layered sac that covers the outside of the heart. (10 pts.)
9. Blood from the lower part of the body flows to the heart through the inferior vena cava. (5 pts.)
10. The mitral valve is located between the left atrium and the left ventricle. (5 pts)

Basic Health Care Skills 2010

SkillsUSA Champions at Work

SUBJECT: Culture Diversity & Communication Contestant#____

Criteria	Points Possible	Score
1. Does contestant make eye contact?	20	
2. Does contestant introduce themselves?	20	
3. Does contestant explain procedure prior to implementing?	20	
4. Does contestant lock wheel chair wheels before transfer?	20	
5. Does contestant use proper technique during transfer?	20	
	Total Score =	

Notes:

Basic Health Care Skills 2010

SkillsUSA Champions at Work

Subject: Cultural Diversity & Communication Scenario

Please review the following CONFIDENTIAL patient information.

Client Name: Maxim Sterner
Age: 41
Sex: Male
Primary Contact: Sister- Ingrid Henning
Advanced Directives: N/A
Primary Diagnosis: DM, CVA with right-sided weakness, legally blind

Background:

Mr. Sterner came to facility with right-sided weakness. Mr. Sterner has a history of CVA due to being a noncompliant diabetic. Mr. Sterner has consult with OT, PT, ST. Ambulates x 1 assist. Mr. Sterner is here on business and speaks very little English.

Current Assigned Task:

Please assist Mr. Sterner in transfer from the recliner to wheelchair.

SkillsUSA
Medical Center

Kardex

Diagnosis: DM, CVA with right-sided weakness, legally blind. Allergies: PCN Advanced Directive: N/A	In case of Emergency Notify Name: Ingrid Henning Relation: Sister HP#: cell # (555) 876-5309
Activities: Ambulate with assist X 1. Diet: Mechanical Soft VS: q4h I&O: q shift Daily weights: daily	Marital Status: Widower Occupation: Drug Representative Religion: Christian Ethnicity: German

Procedures:

LAB: CBC, Bun, creatinine, HbA1c, PT & INR	X-ray: MRI	Other: Barium swallow study
Dentures: No Partials: No	Glasses: yes Contact lens: No	Hearing Aid: No Prosthesis: No

Stamp Plate
Patient Identification

Sterner, Maxim, A. 6540097
Dr. Tompkins 345667560000076
Admit: 6-24-10
DOB: 01-09-69

M

Room #	Patient	Physician
205	Sterner, Maxim, A.	Tompkins

Basic Health Care Skills- 2010
Prepared Presentation Contestant #_____

	4	8	12	16	Row Total
Organization	Audience cannot understand presentation because there is no sequence of information	Information follows a logical sequence, but is < 5 or > 7 minutes in length	Contestant presents information in logical, timely sequence which audience can follow	Contestant presents information in interesting, logical, and timely (5-7 minute) sequence which audience can follow	
Subject Knowledge	Contestant did not prepare a topic that falls under the scope of basic health care skills	Contestant is uncomfortable with information; able to answer only rudimentary questions	Contestant is at ease with expected answers to all questions, but fails to elaborate	Contestant demonstrates full knowledge (more than required) by answering all questions with explanations and elaboration.	
Graphics	Display does not follow rules of contest (30"X30"X30") Tri-fold poster is acceptable (2008 = 4' X 6')	Display is correct size, but contains trade names	Display is correct size with no trade names, but visuals were not prepared by the student	Display is correct size, trade names are absent, and contestant prepared own visuals	
Mechanics	Four (4) or more spelling and/or grammatical errors	Three (3) or more spelling and/or grammatical errors	No more than two (2) spelling and/or grammatical errors	No misspelling or grammatical errors	
Eye Contact	Contestant reads all of the report with no eye contact	Contestant occasionally uses eye contact, but still reads most of the report	Contestant maintains eye contact most of the time but frequently returns to notes	Contestant maintains eye contact with audience, seldom returning to the notes	
Elocution (Speaking style)	Contestant mumbles, incorrectly pronounces terms, and speaks too quietly for audience to hear	Contestant's voice is low, incorrectly pronounces terms. Audience has difficulty hearing presentation	Contestant's voice is clear. Pronounces most words correctly. Presentation can be heard by most	Contestant uses clear voice and correct, precise pronunciation of terms. Audience has no problem hearing presentation	
				Total Points	+4 =

Notes:

Basic Health Care Skills 2010

SkillsUSA Champions at Work

SUBJECT: Academic Topic : The Heart Contestant#_____

1. Name the structures of the heart:

a.	f.
b.	g.
c.	h.
d.	i.
e.	j.

2. Blood flows away from the heart through the _____.

3. Blood flows to the heart through the_____.

4. The valve between the right atrium and the right ventricle is called the;

_____

5. The_____receives blood from the right atrium and pumps the blood into the pulmonary artery.

6. The _____ receives oxygenated blood from the lungs.

7. The_____ is a muscular wall that separates the heart into a right side and a left side.

8. The_____ is a double layered sac that covers the outside of the heart.

9. Blood from the lower part of the body flows to the heart through the;

_____.

10. The _____ is located between the left atrium and the left ventricle.

Basic Health Care Skills 2010

SkillsUSA Champions at Work

SUBJECT: Safety Practices Contestant#_____

Scenario: You are observing a colleague transfer a patient with right sided weakness who is in contact precautions. Name five (5) things your colleague did or did not do that jeopardized the safety of the colleague and or patient.

Criteria	Points Possible	Score
1. Putting the isolation equipment on in wrong order.	10	
2. Misuse of the gait belt, hand positioning.	10	
3. Transferring towards the weaker side of the patient, to the right.	10	
4. Scratching nose while still in isolation equipment.	10	
5. Taking off isolation equipment in wrong order.	10	
Could also get credit for saying: • Not having the patient grab on to the chair and ease down.		

Possible 50 points

Basic Health Care Skills
2010

SUBJECT: Safety Practices Contestant#_____

Scenario: You are observing a colleague transfer a patient with right sided weakness who is in contact precautions.

List five (5) things your colleague did or did not do that that jeopardized the safety of the colleague and or patient.

1. _____
   _____
2. _____
   _____
3. _____
   _____
4. _____
   _____
5. _____
   _____

Basic Health Care Skills 2010

SkillsUSA Champions at Work

SUBJECT: Jeopardy

Contestant#	Game Score	Placement Score
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		
11		
12		
13		
14		
15		
16		
17		

Scoring:

1st place = 50 points
2nd place = 48
3rd place = 46
4th place = 44
5th place = 42
6th place = 40
7th place = 38
8th place = 36
9th place = 34
10th place = 32
11th place = 30
12th place = 28
13th place = 26
14th place = 24
15th place = 22
16th place =20

Basic Health Care Skills 2010

SkillsUSA Champions at Work®

SUBJECT: Jeopardy Contestant # ___

Score for each question.

Contestant picks category & amount.
Open question.
Read question twice.
15 seconds to answer (timed)
Reveal answer.
12 questions allowed.
(Tie breaker is question amounts in order)

1. _____
2. _____
3. _____
4. _____
5. _____
6. _____
7. _____
8. _____
9. _____
10. _____
11. _____
12. _____

SkillsUSA

JEOPARDY

2010

Convert This	Where's The Muscle	Abbreviate	Planes	Jobs	Tools
100	100	100	100	100	100
200	200	200	200	200	200
300	300	300	300	300	300
400	400	400	400	400	400
500	500	500	500	500	500

Convert This
100

1 oz. = this many cubic centimeters.

A: What is **30 cc's?**

Convert This
200

1 teaspoon = this many milliliters.

A: What is 5 mls.?

Convert This
300

1 kilogram = this many pounds.

A: What is 2.2 lbs?

Convert This
400

1 inch = this many centimeters.

A: What is 2.54 cm's?

Convert This
500

7:15 p.m. is this on the 24-hour clock or in military time.

A: What is 1915 hours?

Where's the Muscle
100

Pectoralis major is located here.

A: Where is the chest?

Where's the Muscle
200

Trapezius is located here.

A: Where is the shoulder/upper back/neck?

Where's the Muscle
300

The soleus is located here.

A: Where is the lower leg?

Where's the Muscle
400

The masseter is located here.

A: Where is the cheek/jaw/face?

Where's the Muscle
500

The bicep femoris is located here.

A: Where is the upper leg?

Abbreviate
100

TPR

A: What is temperature, pulse, respiration?

Abbreviate
200

WNL

A: What is within normal limits?

Abbreviate
300

PC

A: What is after meals?

Abbreviate
400

OS

A: What is by mouth ?

Abbreviate
500

AD

A: What the right ear?

Planes
100

Caudal is close to this body area.

A: Where is towards the tail or sacrum?

Distal end or inferior position?

Planes
200

Cranial means close to this body part.

A: Where is the head?

Planes
300

Coronal divides the body by _____ and _____.

A: What is front and back?

Ventral and dorsal, or

Anterior and posterior

Planes
400

Transverse divides the body by _____ and _____.

A: What is top and bottom?

Superior and inferior

Cranial and caudal

Planes
500

Sagital divides the body by _____ and _____.

A: What is side to side?

Right and left

Medial and lateral

Jobs
100

This person has a doctorate degree to prevent, diagnose, and treat diseases and injuries in animals.

A: Who is a veterinarian?

Jobs
200

This person has a doctorate degree to dispense drugs prescribed by doctors, dentists, and other health care professionals.

A: Who is a pharmacist?

Jobs
300

This is the highest level of emergency medical technicians.

A: Who are paramedics?

Jobs
400

They install, test, service, and repair the equipment nsed to diagnose, treat, and monitor patients.

A: Who are biomedical equipment techn icians?

Jobs
500

This person is also referred to as an extracorporeal circulation technologist.

A: Who is a perfusionist?

Tools
100

Measures body temperature.

What is a thermometer?

Tools
200

Placed around the patient's waist during transfers and ambulation.

A: What is a gait belt ?

Tools
300

Cuff and gauge used to measure blood pressure.

A: What is a sph ygmomanometer?

Tools
400

Used to measure blood sugar levels.

A: What is a glucometer?

Tools
500

High-efficiency particulate air mask that requires fit testing, and used for special airborne precaution room isolations.

A: What are N95 or P100 masks?

Basic Health Care Skills 2010

SkillsUSA Champions at Work

Job Application

Date:_____ Contestant#_____
(For Office Use Only)

Position Desired:_____

Education: Highest Level Attained_____

Major Area of Study_____

Attendance Record: Check One Excellent___Good___Fair____Poor_____

Are you a U.S. Citizen?_____

Salary Desired:_____

Are you willing to work weekends or holidays?_____

Full time _____or Part-time_____

Are you willing to submit to a drug screen today?_____

Emergency Contact: Name_____Relationship_____

Phone Number_____

2 References who are not relatives: Name and phone number

1)_____

2)_____

Past Work Experience: Starting with most recent or current job.

Job Title_____Length of Employment_____

Beginning Salary $_____Ending Salary$_____

May we contact previous employer?_____

Job Title_____Length of Employment_____

Beginning Salary $_____Ending Salary$_____

May we contact previous employer?_____

Skills (Applicable to Position Desired)

_____

_____

_____

Three (3) qualities you possess that make you an outstanding health care worker:

1)_____

2)_____

3)_____

Do you have any licenses or certifications related to this job?

#_____ Expiration Date:_____ Where Obtained:_____

#_____ Expiration Date:_____ Where Obtained:_____

Contest Question: Since you are wearing a scrub uniform today, how would you describe the appropriate attire for a real job interview?

_____

_____

_____

Thank you

for your interest
and hard work
with the
Skills USA
Organization!

SkillsUSA - Basic Health Care Skills
Job Application/Interview Station

2010 - Job Interview Questions Contestant #_____

1. Why do you want to work in this field (other than, "I want to take care of people.")?

2. Tell me something you feel you need to improve on (learning needs, bad habits, temptations, etc.)?

3. What do you think it means to have a good work ethic?

4. Give an example of a time you put in extra effort at work.

5. When faced with a situation you feel is unethical, what action would you take to correct this situation?

6. What do you plan to contribute to the field?

7. What questions do you have about this facility? (Note to Judges: questions should include information about the institution or company, hours of employment, not just salary.)

Basic Health Care Skills 2010

SkillsUSA Champions at Work

Job Application/Interview

Scoring Sheet Contestant#_____

	Points Possible	Actual
Resume		
1. Typed/Easy to Read/Appropriate Font	5	_____
2. Name/Address	5	_____
3. Education Background	5	_____
4. Career Objective & Work Experience	5	_____
5. Correct Spelling	5	_____
Job Application		
1. Handwriting Legible/Neat/Black or Blue Ink	5	_____
2. Grammatically Correct	5	_____
3. Followed All Directions	5	_____
4. Application Complete	5	_____
5. Answered last "contest question" correctly	5	_____
Interview		
1. Introduces self at start/Thanks interviewer at end	20	_____
2. Appearance/ Posture/Eye Contact/Mannerisms	20	_____
3. Listens closely to questions/Speaks clearly	20	_____
4. Appropriateness of answers	20	_____
5. Overall Impression with Answers	20	_____
	Overall Total	_____

Basic Health Care Skills 2010

SkillsUSA Champions at Work

SUBJECT: Patient Safety Contestant#_____

Mr. Jones is the client. He is a 75 year old with DM who is hospitalized with a stroke. He is having trouble swallowing and has an order for honey thickened liquids. He also was ordered a diabetic diet. He has just be served lunch. Go into the room and identify 10 safety hazards and write a corrective action for each.
You have ten (10) minutes.

Go into room & identify ten (10) hazards & a corrective action for each.

Do Not Physically Correct The Hazard!

HAZARD + CORRECTIVE ACTION

1. _____

_____

2. _____

_____

3. _____

_____

4. _____

_____

5.

6.

7.

8.

9.

10.

SUBJECT: Patient Safety

Contestant# ANSWER KEY

Mr. Jones is the client. He is a 75 year old DM who has had a stroke and is in the hospital. He is having trouble swallowing so he is on a thicken liquids. He also was ordered a diabetic diet. He has just be served lunch. Go into the room and identify 10 safety hazards and write a corrective action for each.

Go into room & identify fifteen (10) hazards & a corrective action for each.
Do Not Physically Correct The Hazard!

HAZARD (5 points for hazard)	+	CORRECTIVE ACTION (10 points for fix)
1. Unthickend Liquids	+	Remove and provide thickend
2. Medicine bottle on table	+	Put in medicine cabinet
3. Urine on the floor	+	Clean up properly
4. No socks on his feet	+	Place socks on the patient
5. Cleaning supplies out	+	remove
6. Regular sugar packets on tray	+	Give a substitute
7. BM on side rail	+	Clean
8. Razor in the trash can	+	Remove
9. HOB not elevated 45 degrees	+	Raise HOB
10. Heat pad on pt. and set on high	+	Remove from room

Reference pages 402-406 & 945-947

Basic Health Care Skills 2010

SkillsUSA Champions at Work

SUBJECT: Emergency Care Contestant#_____

Scenario: While in your kitchen you hear a commotion outside. You run out to find a small girl that has been mulled by a dog. She has several small lacerations on the arms and legs. She is lying limp on the ground. You are not sure if she is breathing. What should you do?

Criteria	Points Possible	Score
1. Secure the scene	5	
2. Checks for breathing	5	
3. Call 911 and decides on CPR or not	15	
4. Cleans and Assesses wounds	15	
5. Apply pressure to wound on arm until ambulance arrives	15	
Correct Triaging	10	
Written Test Score	10	
	Total Score =	

(75 points possible)

Basic Health Care Skills
2010

SUBJECT: Emergency Care

Scenario: While in your kitchen you hear a commotion outside. You run out to find a small girl that has been mulled by a dog. She has several small lacerations on the arms and legs. She is lying limp on the ground. You are not sure if she is breathing.

What should you do?

Basic Health Care Skills 2010

SkillsUSA Champions at Work

Emergency Care Quiz Contestant #_____

Select the one best answer.

1. Which is not a sign of shock?

   a. Skin cool to the touch
   b. Low BP
   c. Generalized weakness
   d. Slow deep breaths

2. Which is a type of wound that involves tearing of tissue by way of excessive force?

   a. Abrasion
   b. Laceration
   c. Puncture
   d. Incision

3. _____ is the first priority in caring for open wounds?

   a. Apply bandage
   b. Control bleeding
   c. Apply tourniquet
   d. Elevate head of bed

4. The main pressure point in the leg is the?

   a. Brachial artery
   b. Tibial artery
   c. Femoral artery
   d. Ulnar artery

5. What is the first step to be taken when poison has been ingested?

   a. Save the label
   b. Elevate feet
   c. Induce vomiting
   d. Call poison control

6. Which is not a sign of Hypoglycemia
    a. hunger
    b. laughing and smiling
    c. anxiety
    d. mental confusion

7. A myocardial infarction is also known as?

    a. trauma
    b. seizure
    c. heart attack
    d. stroke

8. A burn on just the surface of the skin is classified as a _____ degree burn?

    a. first
    b. second
    c. third
    d. fourth

9. In an emergency situation which would be the priority in order of care?

    a. profusely bleeding wound
    b. deceased male
    c. heart attack
    d. bloody nose

10. A person collapse in front of you, you would?:

    a. check ABCs
    b. slap them
    c. begin crying hysterically
    d. call the wife

SkillsUSA
2010 Contest Projects

Building Maintenance

Click the “Print this Section” button above to automatically print the specifications for this contest. Make sure your printer is turned on before pressing the button.

CONTEST #1
LIQUID
MEASUREMENT

CONTESTANT NUMBER

ITEMS EVALUATED	PTS. POSS.
1. Read Material Safety Data Sheets, Special Precautions and First Aid Instructions.	0-10
2. USE PERSONAL SAFETY EQUIPMENT.	0-40
3. READ DIRECTIONS	0-20
4. OBTAIN AND USE CORRECT MEASURING DEVICES / CONTAINERS.	0-30
5. MEASUREMENT AND MIXING OF SOLUTION #1	0-40
6. MEASUREMENT AND MIXING OF SOLUTION #2	0-40
7. CLEANING OF TESTING AREA.	0-20

GRAND TOTAL POINTS
(200 POSSIBLE)

CLOTHING PENALTY (-0TO5%)

GRAND TOTAL
(200 POSSIBLE)

CONTESTANT REMARKS ARE ON THE BACK

)NTESTANT #	REMARKS

#2 STRIPPING AND FINISHING FLOORS

ITEMS EVALUATED	PTS. POSS.	CONTESTANT #							
Set up appropriate sign.	0-10								
Select properly coded mop for applying stripper. (blue head)	0-10								
Select and mix proper solution from given products.	0-10								
Put stripper boots on.	0-10								
Observe sequence of task.	0-10								
A. Mop floor with stripper	0-10								
B. Explain to judge that you would normally allow the stripper to set for 10-15 min.	0-10								
C. Pick the correct pad (black). Install the pad on the machine and scrub the floor in 2 directions.	0-10								
D. Pick up solution with wet/dry vac.	0-10								
E. Mop on clear hot rinse with red handled - red mop.	0-10								
F. Pick up hot water rinse with wet/dry vac.	0-10								
G. Apply cold water rinse with vinegar with red mop - white handle.	0-10								
H. Pick up excess water with wringed out mop	0-10								
I. Check mop code (red/white handle)	0-10								
J. Set up blower for drying floor.	0-10								
K. Mopping technique	0-10								
Select proper product from several choices to apply finish	0-10								
Select proper mop and bucket (blue handle)	0-10								
Apply finish observe proper technique	0-20								
TOTAL POINTS	200								
CLOTHING PENALTY	(max 5%)								
GRAND TOTAL POINTS	200								
CONTESTANT #									

)NTESTANT #	REMARKS

#3 BONNET SCRUBBING AND EXTRACTING CARPETS

CONTESTANT#

ITEMS EVALUATED		PTS. POSS.
A.	SET UP APPROPRIATE SIGNS.	0-10
B.	SELECT SPOT REMOVER	0-5
C.	SPRAY ON SPOT	0-5
D.	BLOT THE STAIN WITH A RAG AND STATE THAT YOU DO NOT RUB THE STAIN BECAUSE IT WILL SPREAD.	0-20
E.	SELECT TRAFFIC LANE CLEANER	0-20
F.	SPRAY TRAFFIC LANES	0-20
G.	SELECT FOAM CARPET SHAMPOO FOR BONNET	0-20
H.	MIX SOLUTION AND SOAK BONNET	0-20
I.	WRING OUT BONNET AND PLACE ON FLOOR	0-20
J.	PLACE MACHINE OVER BONNET AND SCRUB CARPET IN A BACK AND FORTH MOTION.	0-20
K.	SELECT SOLUTION FOR CARPET EXTRACTION AND MIX ONE GALLON IN MACHINE.	0-20
L.	EXTRACT FLOOR, RATE SPEED AND PROCESS	0-20

SUB TOTAL POINTS (200 POSS.)

CLOTHING PENALTY (-0 TO 5%)

GRAND TOTAL PTS. (200 POSS.)

CONTESTANT REMARKS ARE ON THE BACK

CONTESTANT #	REMARKS

OFFICE CLEANING

	Contest #4	CONTESTANT # :
		Points Possible
A.	**Safety Equipment**	
	Rubber Gloves	5
	Safety Glasses	5
B.	**Wall / Blinds - Dust**	
	Let down blind	0-10
	Choose correct tool	0-10
	Clean blind	0-10
	Dust picture and chair	0-10
	Dust window frame	0-10
C.	**Clean Computer and Desk**	
	Select proper cleansers	0-10
	Wash monitor glass	0-10
	Dust desk & rest of computer	0-10
D.	**Wash Wall**	
	Choose general purpose cleaner	0-10
	Use rag and cleaner to wash wall	0-10
E.	**Wash Window**	
	Select proper cleaner	0-10
	Select proper tools	0-10
	Wash window properly	0-10
F.	**Dust Mop Floor**	
	Select proper equipment	0-10
	Dust mop floor	0-10
	Pick up debris	0-10
G.	**Sweep Carpet**	
	Police area for obstructions	0-10
	Select proper equipment	0-10
	Sweep carpet	0-10
	SUB-TOTAL POINTS	**200 POSS.**
	CLOTHING PENALTY 5%	
	GRAND TOTAL POINTS	**200 POSS.**
	CONTESTANT #	

INTESTANT #	REMARKS

	CONTEST #5 - RESTROOM MAINTENANCE									
	CONTESTANT #									
		Points Possible:								
	Skill Evaluated:									
1	Dust off lights, vents, fixtures, wall, floor, and empty waste can	0-20								
2	Flush toilet, add proper cleaner to soak	0-20								
3	Spray/soak all surfaces with disinfectant cleaner (sink, counters, urinal)	0-20								
4	Clean Mirrors, walls/windows with glass cleaner	0-20								
5	Clean toilet interior surfaces with toilet bowl cleaner under rim, bowl, down to waste exit pipe, leave seat up.	0-20								
6	With clean cloth clean toilet exterior, under seat, top of bowl, top of seat, back of bowl, outside of bowl.	0-20								
7	With clean cloth, clean all handles of sink, toilet, urinal, doors, etc., with disinfectant	0-20								
8	Clean floor and wall baseboard from back of the room toward door/exit with disinfectant and rinse.	0-20								
9	Fill dispensers	0-20								
10	Spot clean waste can and replace waste can liner. Clean and return tools to storage area.	0-20								
	Subtotal Points	200								
	Clothing Penalty (5% of score)									
	TOTAL POINTS EARNED	200								
	CONTESTANT #									

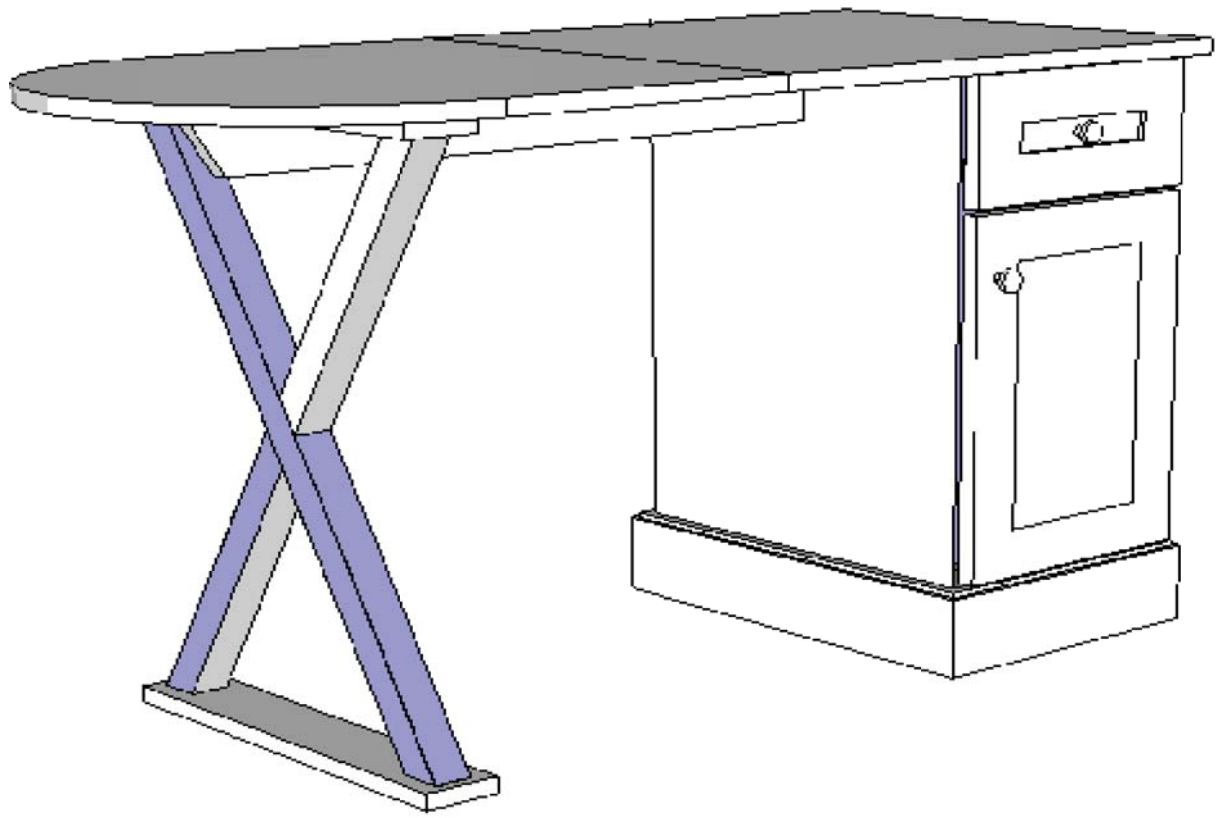
CONTESTANT #	REMARKS

SkillsUSA
2010 Contest Projects

Cabinetmaking

Click the “Print this Section” button above to automatically print the specifications for this contest. Make sure your printer is turned on before pressing the button.

AWI ARCHITECTURAL WOODWORK INSTITUTE



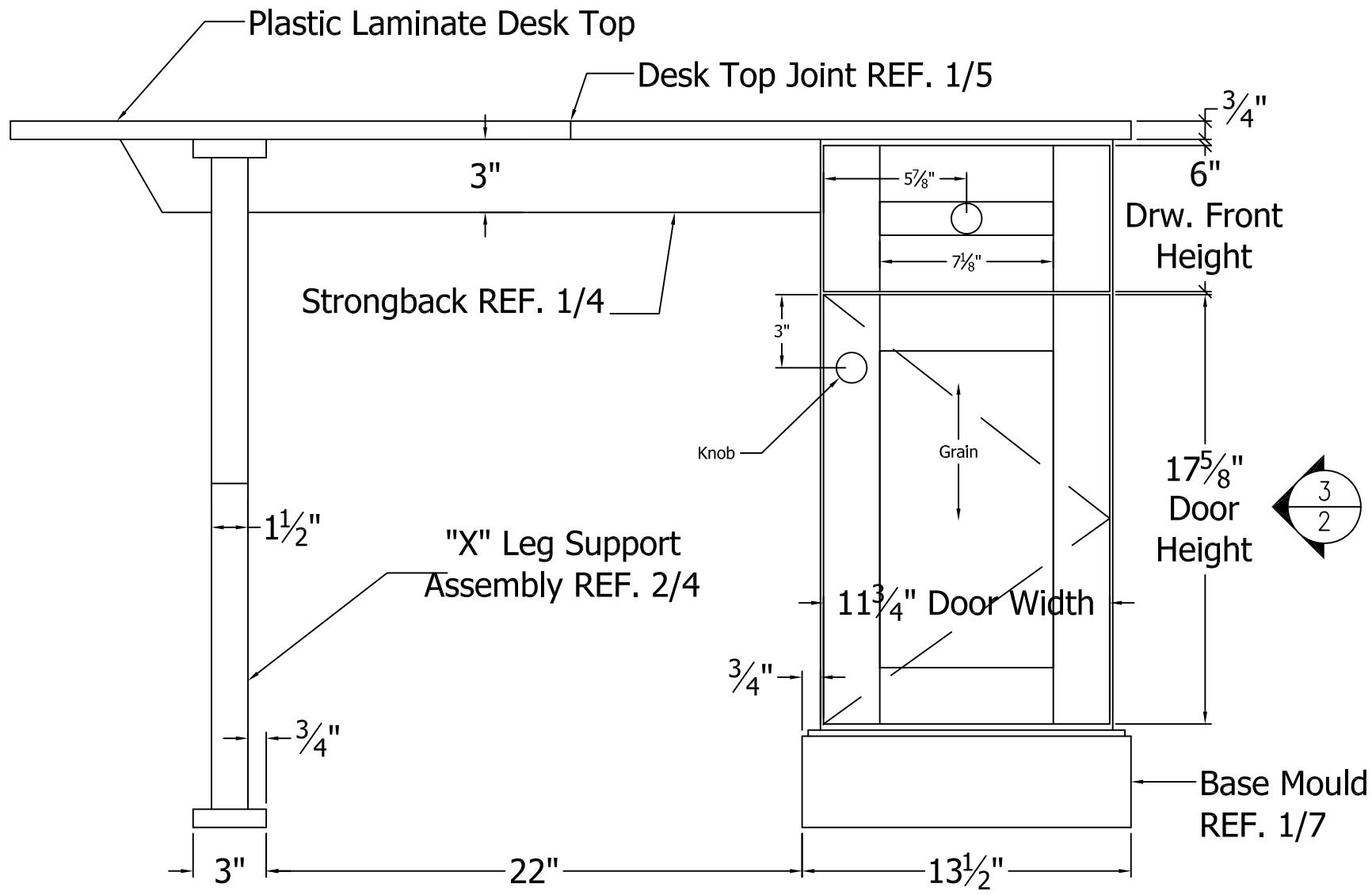
CONTRIBUTING AWI MANUFACTURING MEMBER COMPANIES
- ALLEN MILLWORK CO. - WICHITA, KS
- FREMONT INTERIORS, INC. - CARMEL, IN
- OHIO VALLEY DOOR CO. - NEW ALBANY, IN
- SALINA PLANING MILL, INC. - SALINA, KS
- LOUISVILLE LUMBER & MILLWORK - LOUISVILLE, KY
- ROWLAND WOODWORKING, INC. - HIGH POINT, NC
- TECHNIQUE MANUFACTURING, INC - HUTCHINSON, KS
- CHISHOLM ARCHITECTURAL MILLWORK, INDIANAPOLIS, IN
- GILLPATRICK WOODWORKS, KANSAS CITY, MO

THE FOLLOWING COMPANIES HAVE GENEROUSLY PROVIDED MATERIALS AND MACHINERY FOR THIS CONTEST
- BLUM - KANSAS CITY, KS
- COLUMBIA FOREST PRODUCTS
- LOWES
- LIBERTY HARDWOODS, INC. - KANSAS CITY, MO
- KOETTER WOODWORKING, INC. - BORDEN, IN
- FLEXIBLE MATERIALS - JEFFERSONVILLE, IN
- THE COURTER COMPANY - INDIANAPOLIS, IN
- WILSONART DECORATIVE LAMINATES
- AMERICAN PACKAGING CORP.
- DEWALT POWER TOOLS
- PORTER-CABLE POWER TOOLS
- IRWIN INDUSTRIAL TOOLS
- SAWSTOP TABLE SAWS
- DISTRIBUTORS SERVICES, INC.
- HOOD DISTRIBUTION, McEWEN GROUP
- OVERLAND TOOL, INC. - KANSAS

2010 SkillsUSA

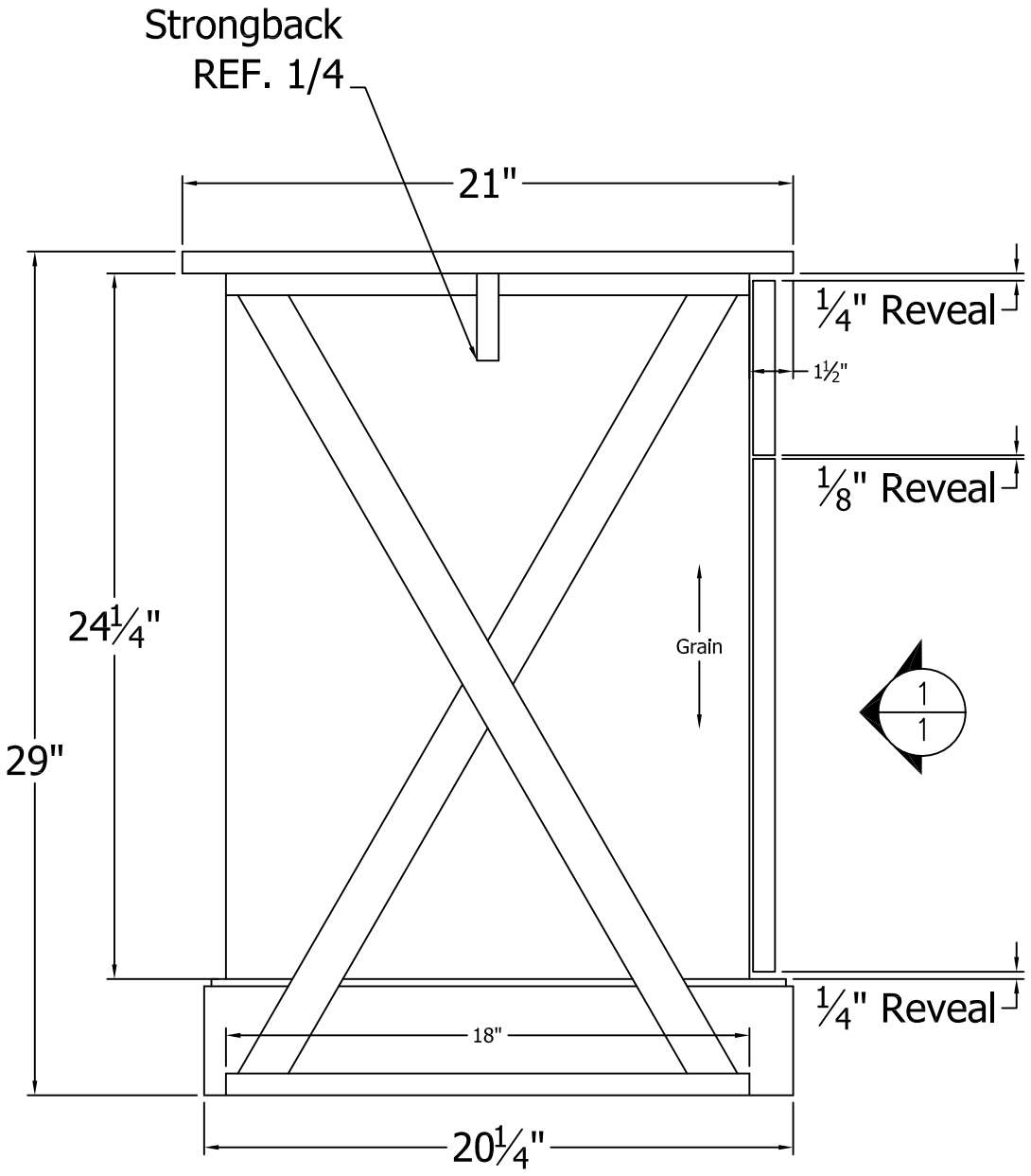
NATIONAL CONTEST

DATE: JUNE 24, 2010	SHEET NO:
DRAWN BY: RKG	SCALE: NA
TITLE: KNOCK-DOWN LAPTOP DESK	



FRONT ELEVATION — 1

Scale: NA



LEFT SIDE ELEVATION — 2

Scale: NA

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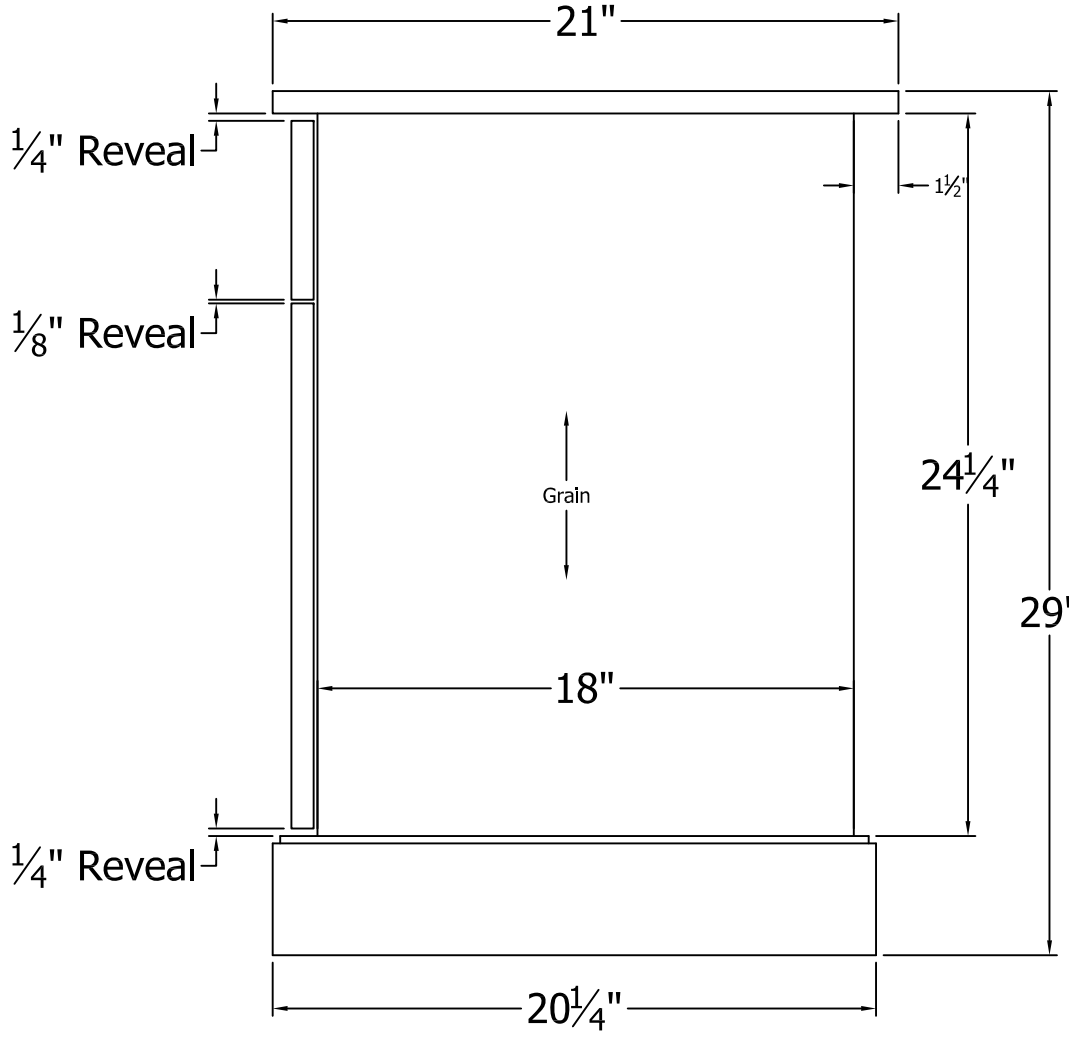
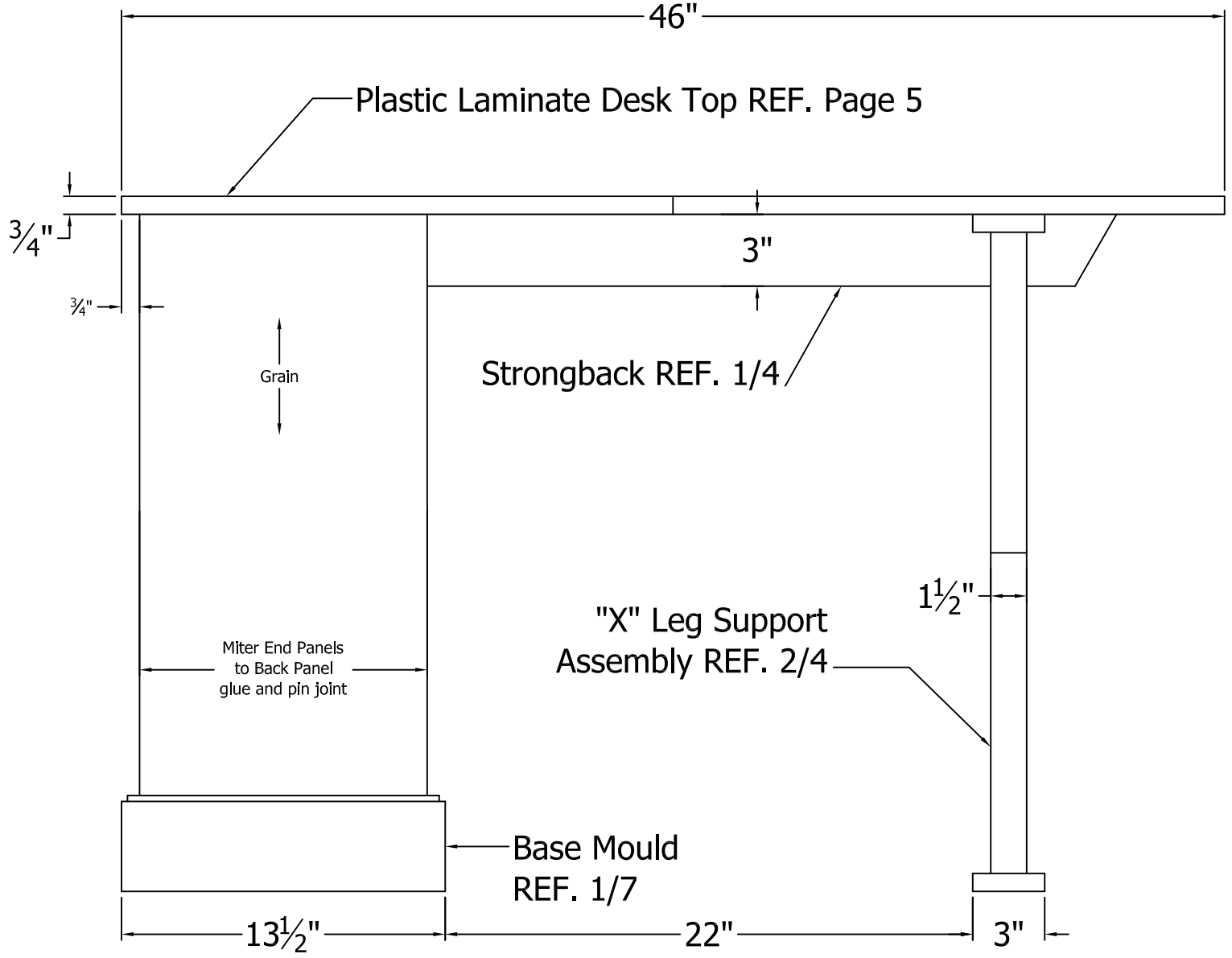
2010 SkillsUSA

NATIONAL CONTEST

DATE: JUNE 24, 2010	SHEET NO: 1
DRAWN BY: RKG	SCALE: NA
TITLE: FRONT & SIDE ELEVATIONS	



RIGHT SIDE ELEVATION 3
Scale: NA



BACK ELEVATION 4
Scale: NA

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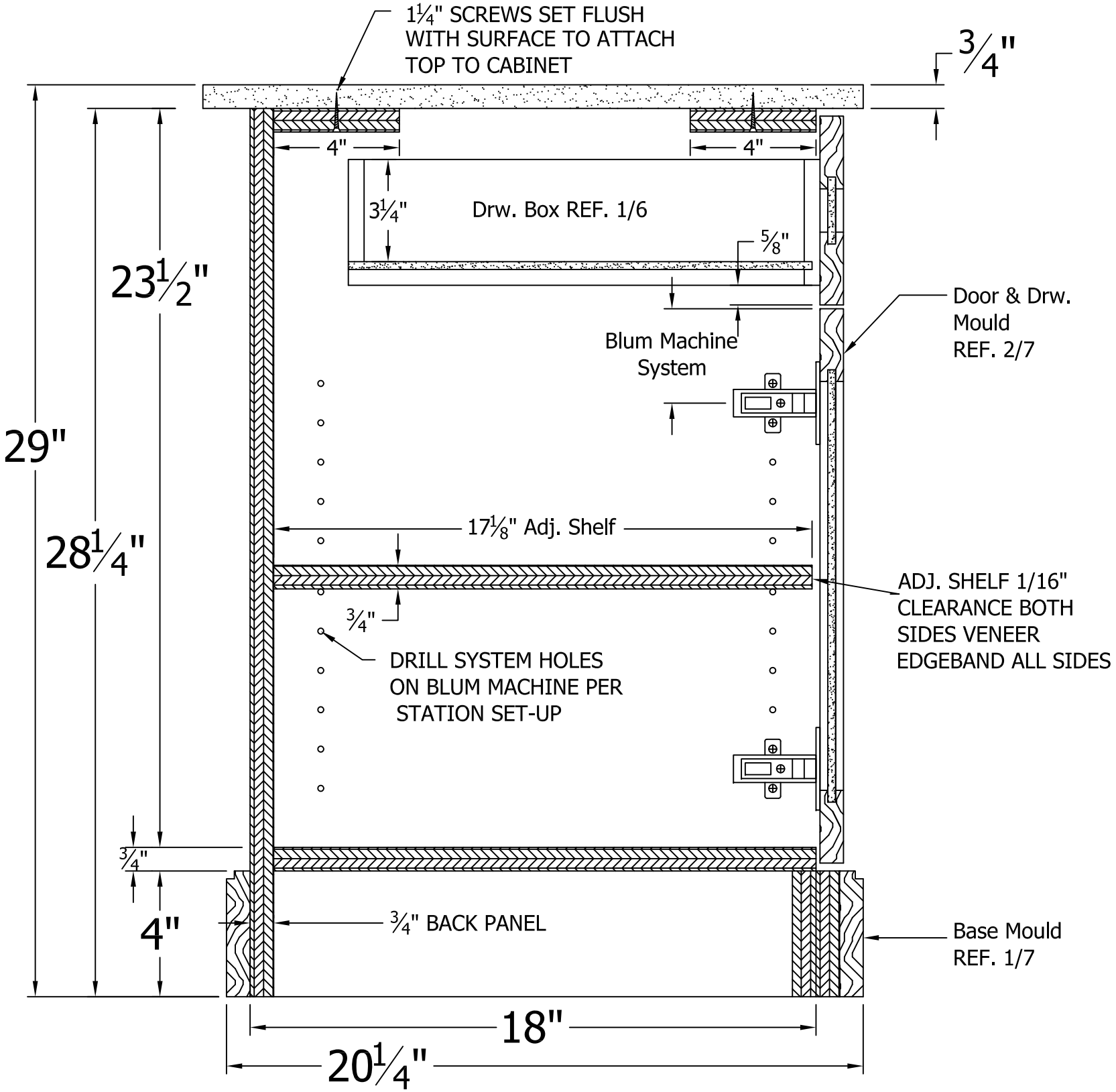
NATIONAL CONTEST

DATE: JUNE 24, 2010	SHEET NO: 2
DRAWN BY: RKG	SCALE: NA
TITLE: RIGHT SIDE & BACK ELEVATIONS	

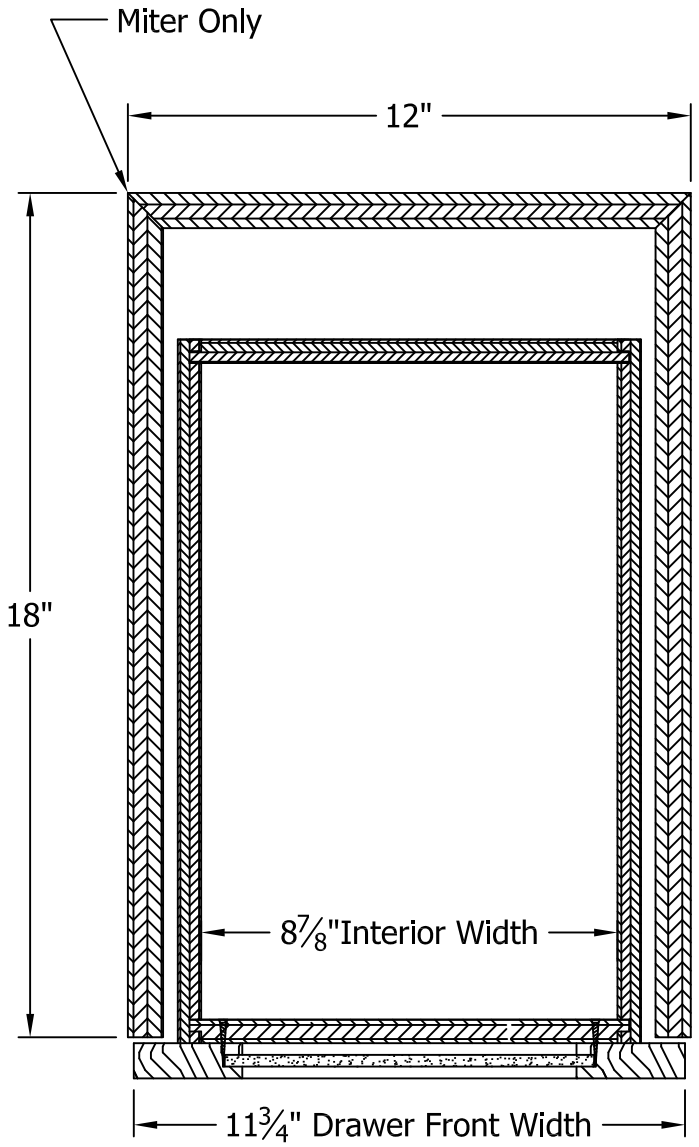


VERTICAL SECTIONS 5

3"=1'–0"

GENERAL NOTES:

1.) Pocket screw floor and rails to side and back panels.
2.) Veneer on all exposed edges of cabinet.



HORIZONTAL SECTION 6

3"=1'–0"

GENERAL NOTES:

1.) Attach drawer front to box with 2 - 1" wood screws.

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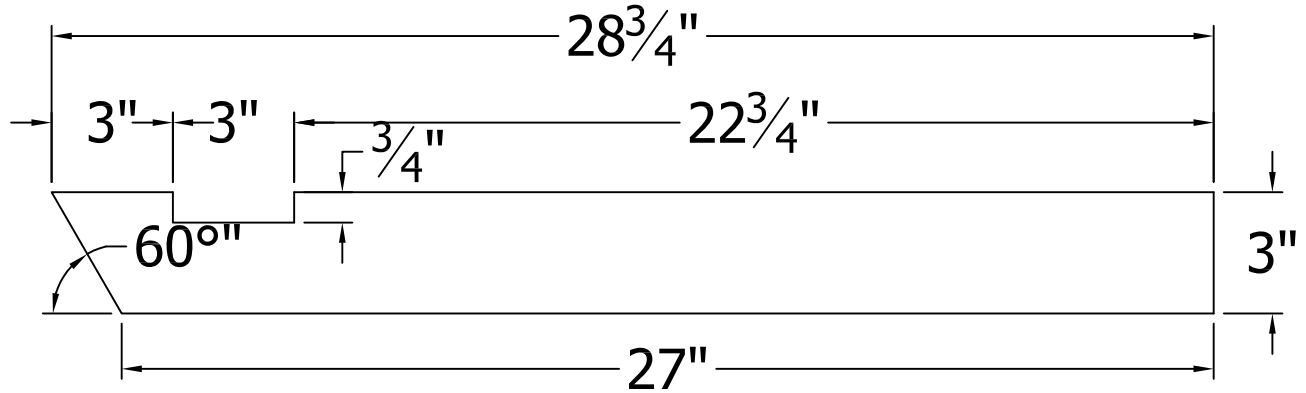
NATIONAL CONTEST

DATE: JUNE 24, 2010	SHEET NO: 3
DRAWN BY: RKG	SCALE: 3"=1'-0"
TITLE: VERTICAL & HORIZONTAL SECTIONS	

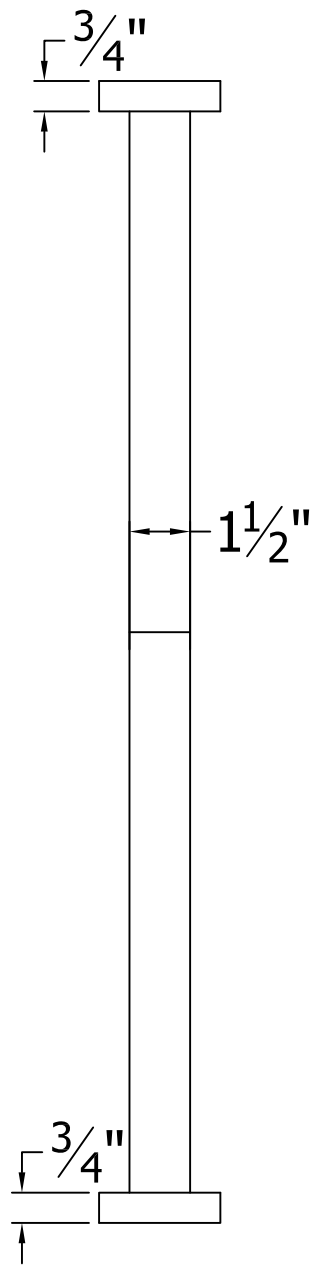


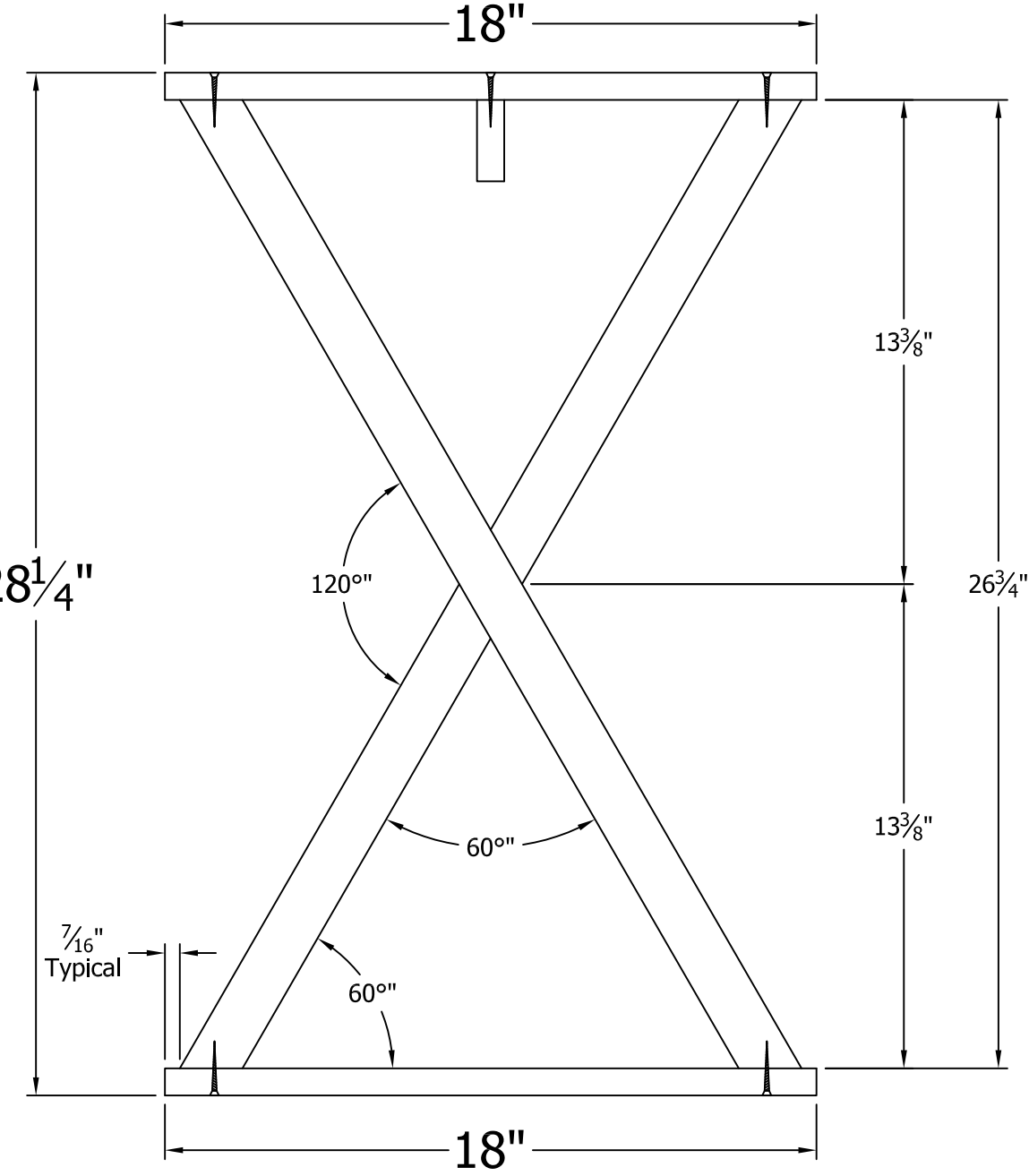
STRONGBACK DETAIL 1

Scale: NA

GENERAL NOTES:

1.) Machine interlocking half lap joint on "X" legs.
2.) Use router fixture to machine joint.
3.) Stongback connects to cabinet and "X" support top plate with 1½" screws.
4.) Use router fixture for NOTCH in strongback.





"X" LEG SUPPORT DETAIL 2

Scale: NA

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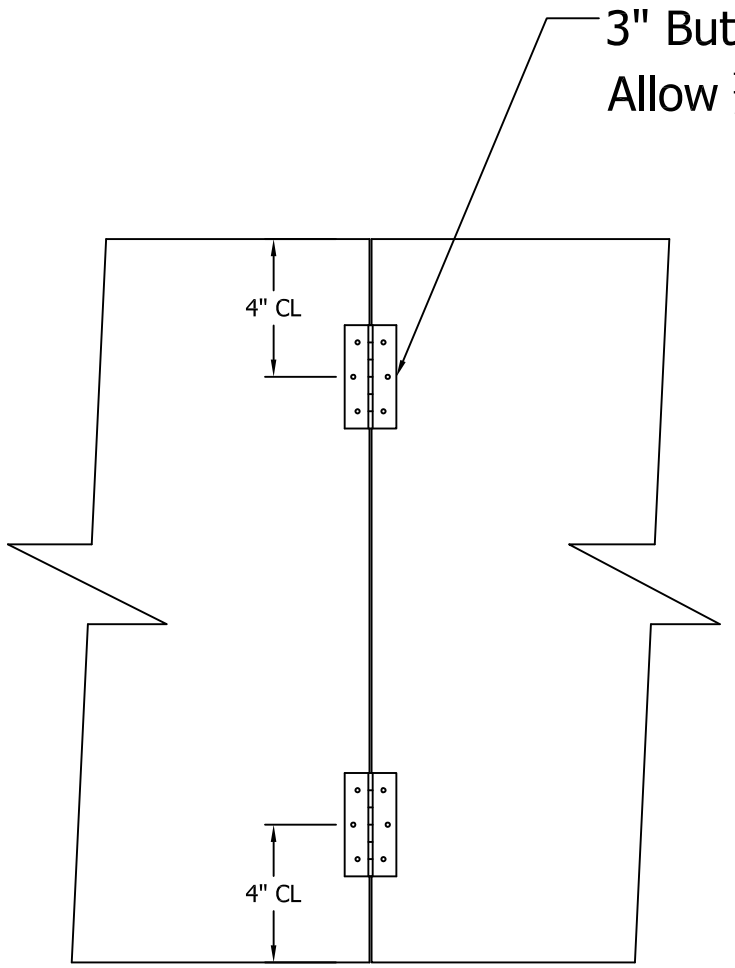
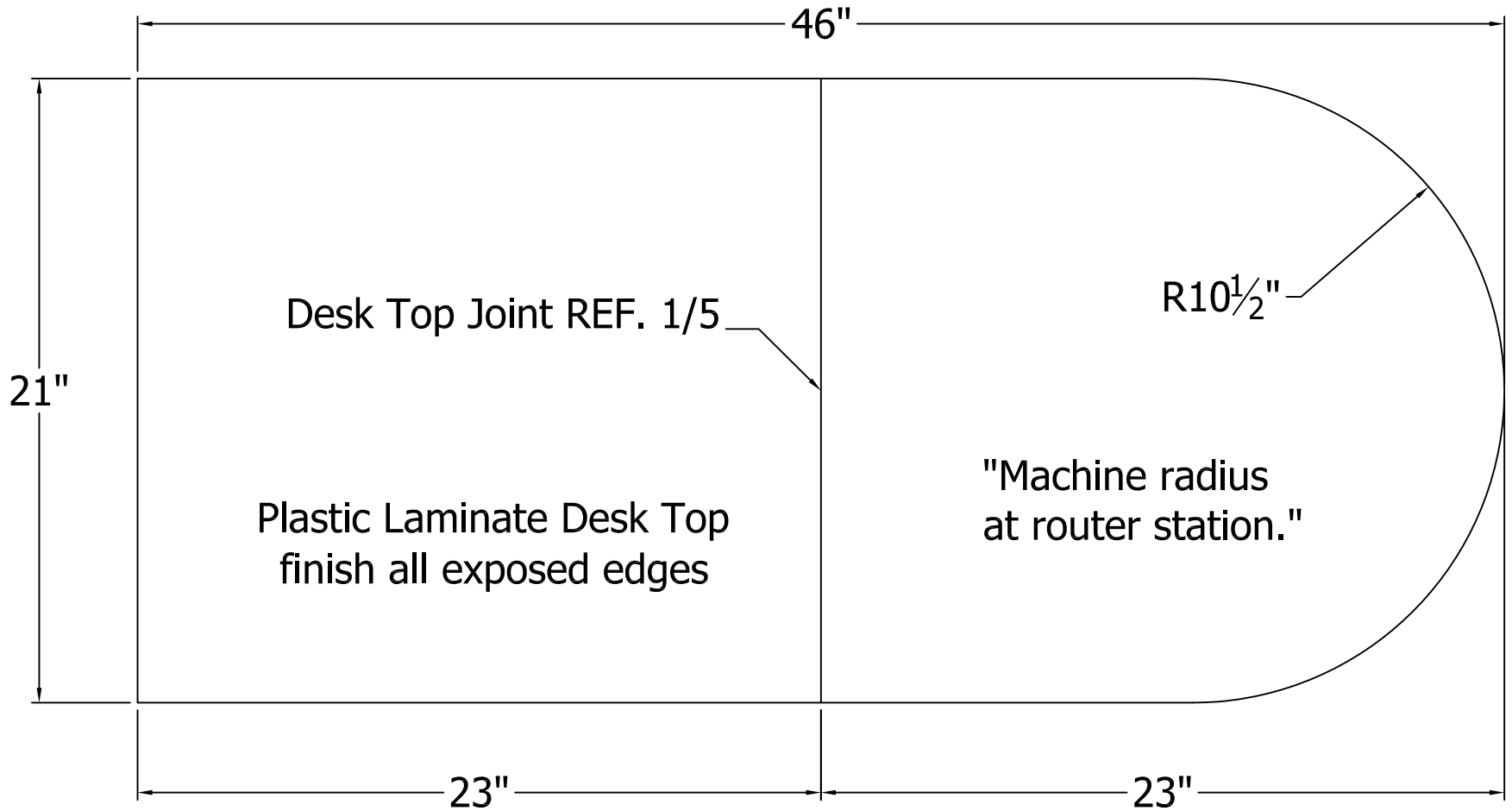
2010 SkillsUSA	
NATIONAL CONTEST	
DATE: JUNE 24, 2010	SHEET NO: 4
DRAWN BY: RKG	SCALE: 3"=1'-0"
TITLE: SIDE & BACK MACHINING	

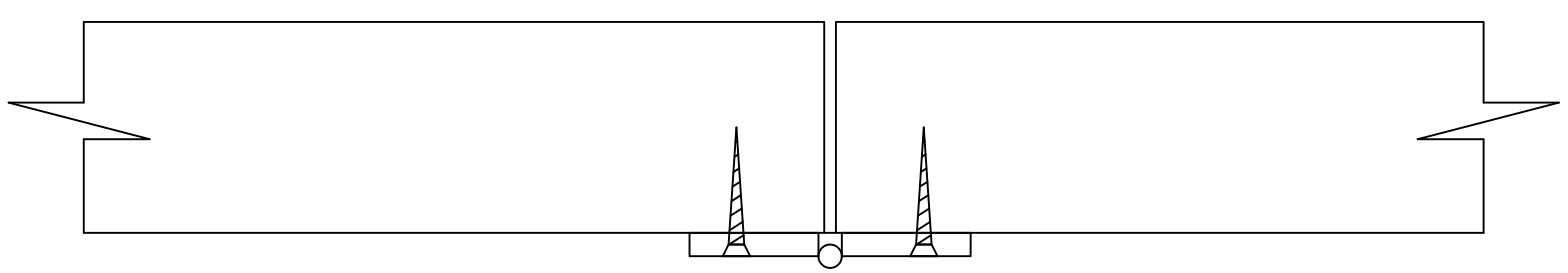


HINGE LOCATIONS 1
Scale: NA



NOTE: Dimensions are "core measurements"

COUNTER TOP PLAN VIEW 1
Scale: NA



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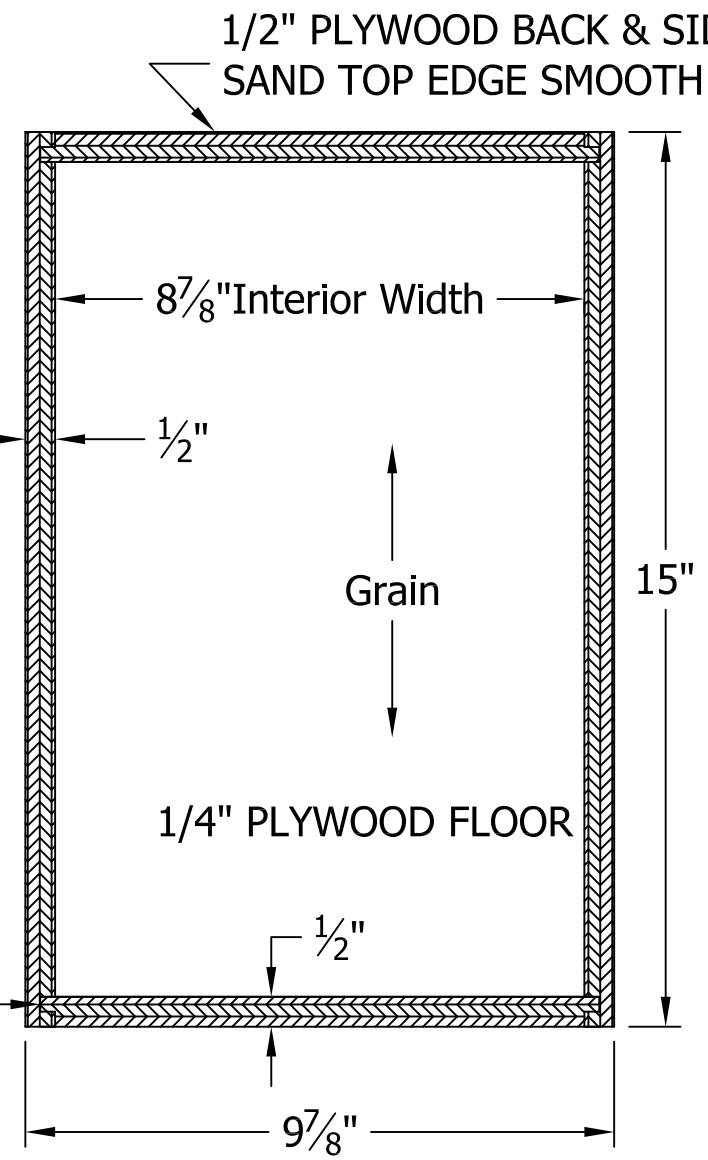
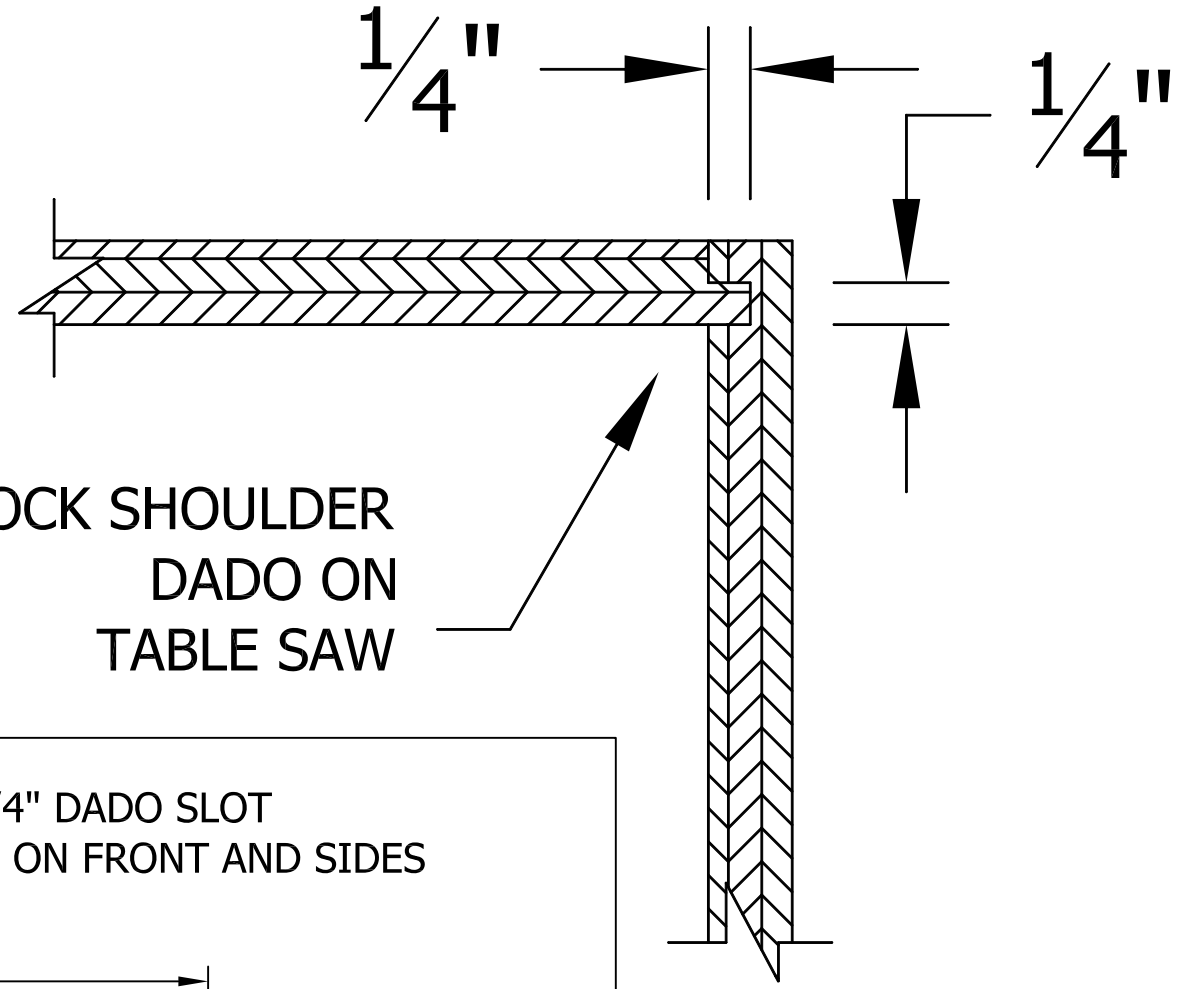
NATIONAL CONTEST

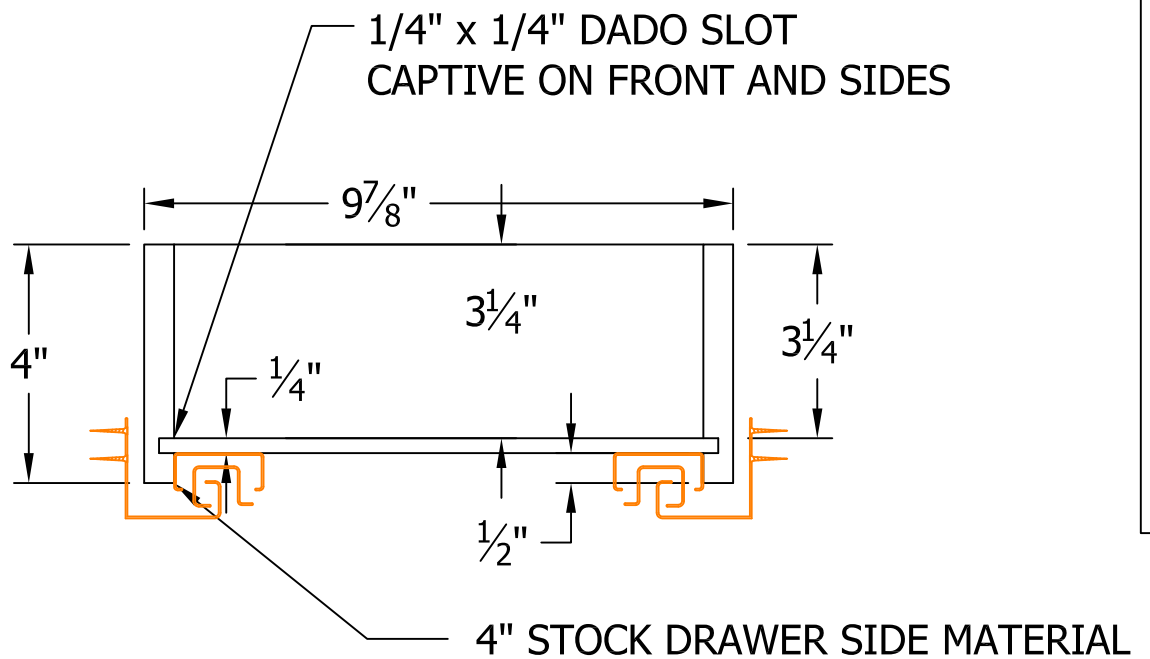
DATE: JUNE 24, 2010	SHEET NO: 5
DRAWN BY: RKG	SCALE: 3"=1'-0"
TITLE: COUNTER TOP DETAILS	

GENERAL NOTES:

1.) Blum Guide #562H3810B
2.) Drill rear positioning hole @ hinge station







DRAWER BOX DETAIL

1

3"=1'-0"

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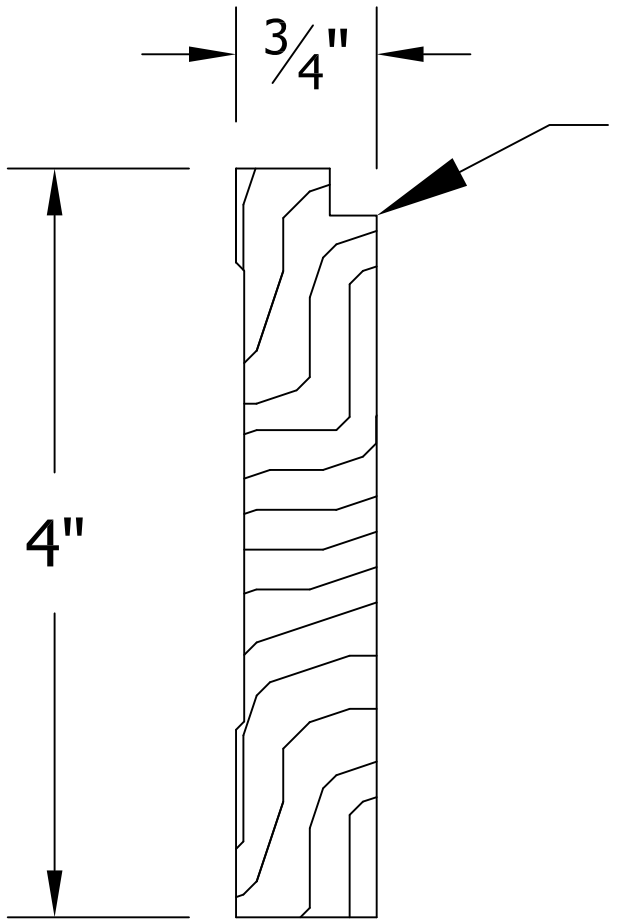
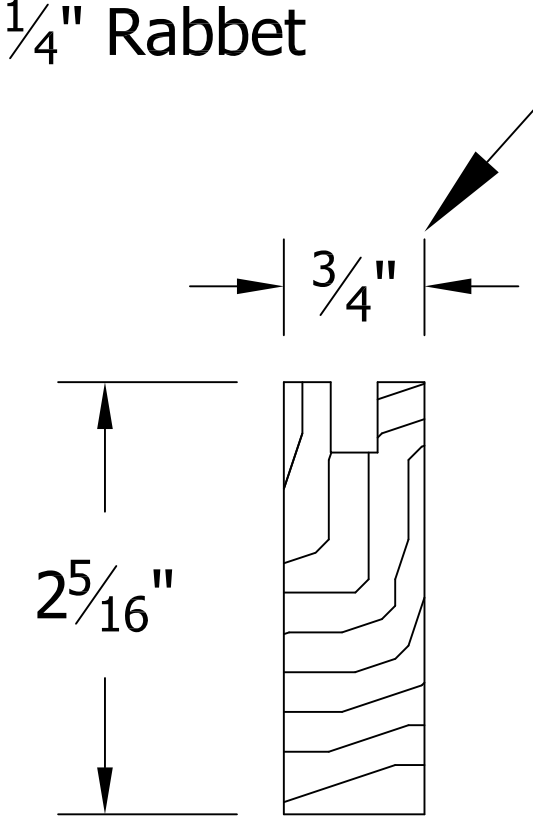
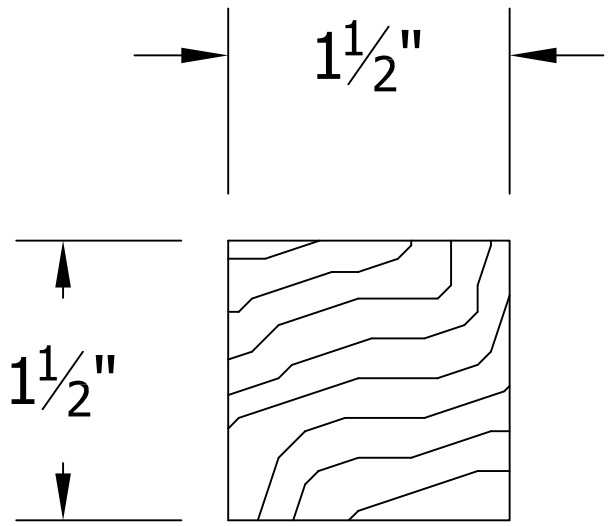
2010 SkillsUSA

NATIONAL CONTEST

DATE: JUNE 24, 2010	SHEET NO: 6
DRAWN BY: RKG	SCALE: 3"=1'-0"
TITLE: DRAWER BOX DETAILS	



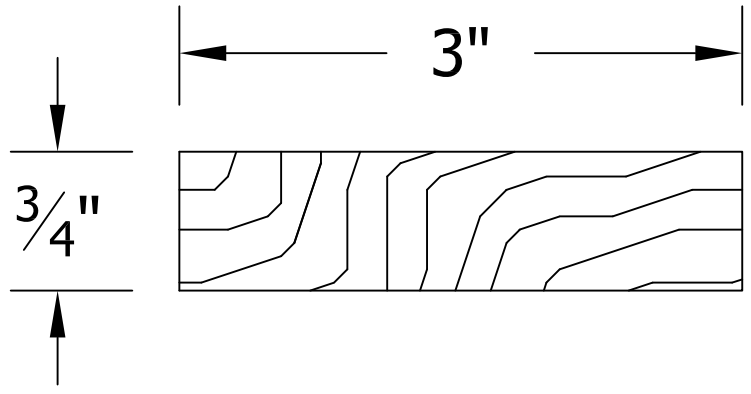




1 BASE BOARD
FULL SIZE

2 DOOR & DRW FRONT FRAME STOCK
FULL SIZE

3 "X" LEG STOCK LUMBER
FULL SIZE



4 "X" LEG TOP & BOTTOM PLATES & STRONGBACK
FULL SIZE

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2010 SkillsUSA

NATIONAL CONTEST

DATE: JUNE 24, 2010	SHEET NO: 7
DRAWN BY: RKG	SCALE: 6"=1'-0"
TITLE: DOOR AND TRIM DETAIL	

MATERIAL LIST (DIMS MAY VARY)

1 PC	3/4" RED OAK PLYWOOD	3/4" X 24" X 59"
1 PC	3/4" RED OAK PLYWOOD	3/4" X 24" X 37"
1 PC	1/4" RED OAK PLYWOOD	1/4" X 24" X 18"
1 PC	1/2" MAPLE DRAWER SIDE	1/2" X 4" X 72"
1 PC	RED OAK LUMBER	3/4" X 3 1/4" X 84"
1 PC	RED OAK BASE BOARD	3/4" X 4" X 84"
2 PCS	RED OAK DOOR FRAME STOCK	3/4" X 2 5/16" X 48"
2 PCS	RED OAK LUMBER	1 1/2" X 1 1/2" X 36"
1 PC	PARTICLE BOARD	3/4" X 24" X 48"
1 PC	PLASTIC LAMINATE	24" X 48"
2 PCS	PLASTIC LAMINATE	1" X 96"
1 PC	OAK VENEER EDGE BAND	.018 X 7/8 X 180" (15 LF.)
1 PAIR	15" DRAWER GUIDEs	BLUM #562H3810B (15" GUIDE)
1 PAIR	BLUM FRONT FIXING CLIPS	BLUM #T51.1700.04 RIGHT & LEFT
2 EA	BLUM "INSERTA" SELF CLOSE HINGES	BLUM #73T5590B
2 EA	BLUM "EXPANDO" HINGE PLATES	BLUM #174H7100E
12 EA	WOOD SCREWS	#8 X 1 1/2"
8 EA	WOOD SCREWS	#8 X 1 1/4"
2 EA	DRAWER MOUNT SCREWS	1"
18 EA	POCKET HOLE SCREWS	1 1/4"
	BRADS	1 1/4"
2 EA	3" BUTT HINGES / C-TOP JOINT	
	BUMPER PADS	
2 EA	DECORATIVE KNOBS W/SCREWS	

CUTTING LIST

Dimension Tolerance - 1/32"

PART	MATERIAL	QTY	THICK	WIDTH	LENGTH
END PANELS	RED OAK PLY				
BACK PANEL	RED OAK PLY				
FLOOR	RED OAK PLY				
ADJUSTABLE SHELF	RED OAK PLY				
RAILS	RED OAK PLY				
BASE RAILS	RED OAK PLY				
DRW FRONT RAILS	RED OAK SOLIDS				
DRW FRONT STILES	RED OAK SOLIDS				
DRW FRONT PANEL	RED OAK PLY				
DOOR RAILS	RED OAK SOLIDS				
DOOR STILES	RED OAK SOLIDS				
DOOR PANEL	RED OAK PLY				
DRW. BOX SIDE	MAPLE DRW. SIDE				
DRW. BOX FRONT	MAPLE DRW. SIDE				
DRW. BOX BACK	MAPLE DRW. SIDE				
DRW. BOX FLOOR	RED OAK PLY				

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2010 SkillsUSA

NATIONAL CONTEST

DATE: JUNE 24, 2010	SHEET NO: 8
DRAWN BY: RKG	SCALE: NA
TITLE: MATERIAL LIST & CUT LIST	

CUTTING LIST

Dimension Tolerance - 1/32"

CONTESTANT # _____

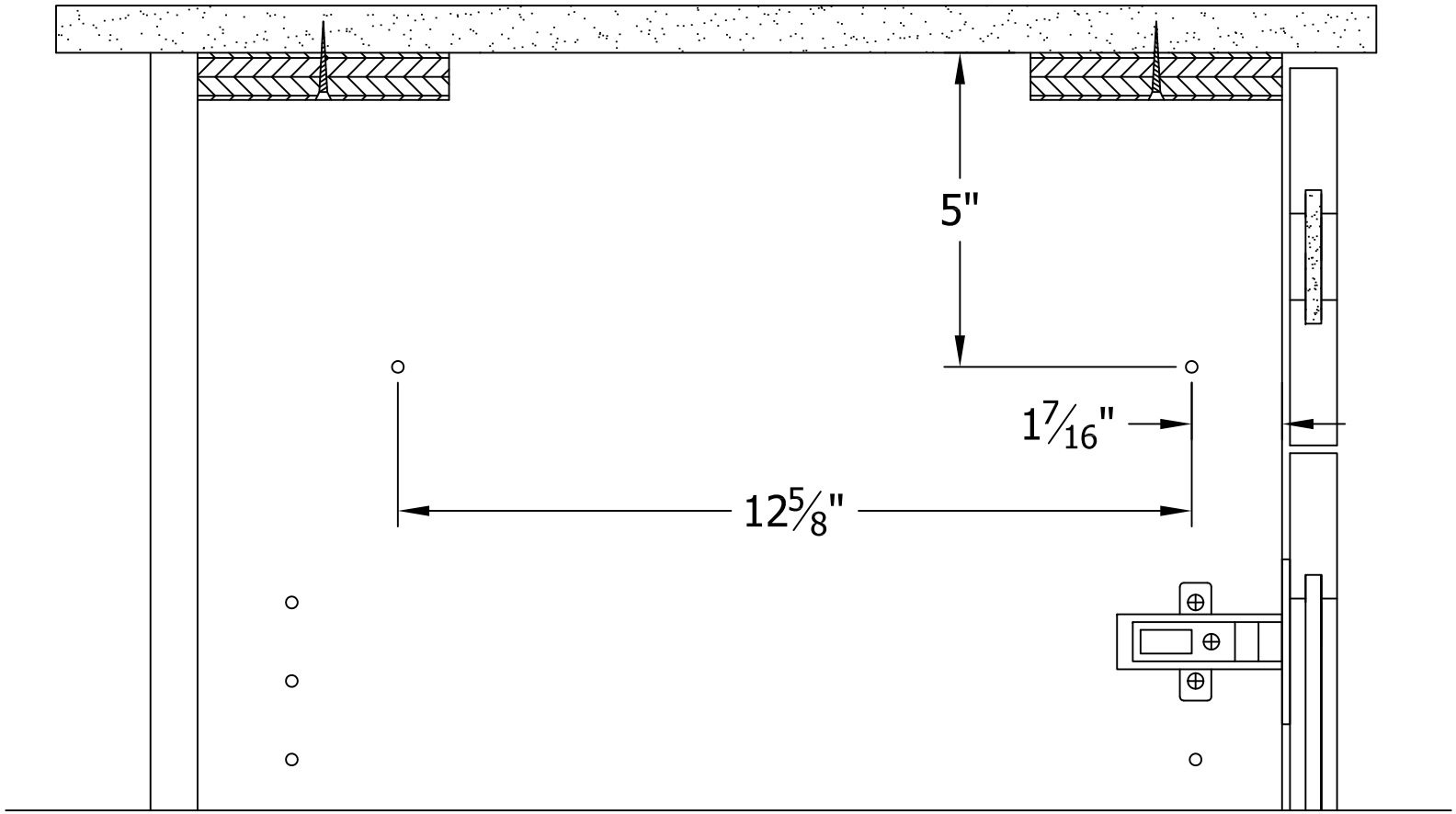
PART	MATERIAL	QTY	THICK	WIDTH	LENGTH
END PANELS	RED OAK PLY				
BACK PANEL	RED OAK PLY				
FLOOR	RED OAK PLY				
ADJUSTABLE SHELF	RED OAK PLY				
RAILS	RED OAK PLY				
BASE RAILS	RED OAK PLY				
DRW FRONT RAILS	RED OAK SOLIDS				
DRW FRONT STILES	RED OAK SOLIDS				
DRW FRONT PANEL	RED OAK PLY				
DOOR RAILS	RED OAK SOLIDS				
DOOR STILES	RED OAK SOLIDS				
DOOR PANEL	RED OAK PLY				
DRW. BOX SIDE	MAPLE DRW. SIDE				
DRW. BOX FRONT	MAPLE DRW. SIDE				
DRW. BOX BACK	MAPLE DRW. SIDE				
DRW. BOX FLOOR	RED OAK PLY				

AWI ARCHITECTURAL WOODWORK INSTITUTE

2010 SkillsUSA

NATIONAL CONTEST

DATE: JUNE 24, 2010	SHEET NO: 9
DRAWN BY: RKG	SCALE: NA
TITLE: CUT LIST - TURN IN	



RIGHT END PANEL DETAIL

NA

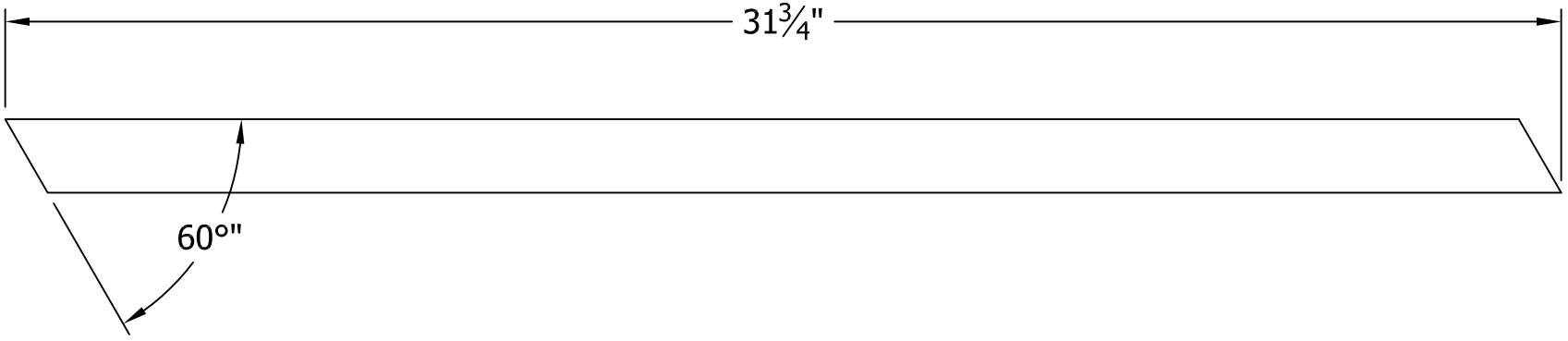
GENERAL NOTES:

1.) Locate front hole for drawer guide - bottom row, 4th hole back.

2010 SkillsUSA

NATIONAL CONTEST

DATE: JUNE 24, 2010	SUPPLEMENT
DRAWN BY: RKG	SCALE: NA
TITLE: DRAWER GUIDE LOCATION	



X LEG DETAIL

NA

2010 SkillsUSA

NATIONAL CONTEST

DATE: JUNE 24, 2010	SUPPLEMENT
DRAWN BY: RKG	SCALE: NA
TITLE: X LEG DETAIL	

SkillsUSA
2010 Contest Projects

Carpentry

Click the “Print this Section” button above to automatically print the specifications for this contest. Make sure your printer is turned on before pressing the button.

MATERIALS LIST:

WOOD FRAMING MATERIALS	
QTY	**DESCRIPTION**
25	2" x 4" x 8' FRAMING
1	2" x 6" x 6' RIDGE BOARD
7	2" x 4" x 8' RAFTERS
3	4'-0" x 4'-0" x 3/8" SIDING (GROOVED 4" O.C. UNTREATED WD. SIDING)
1	3 1/4" x 2'-0" x 1/2" PLYWOOD
2	1" x 6" x 10' P.T. FASCIA
2	1" x 3 7/8" x 10' WINDOW JAMB
1	1" x 4" x 10' P.T. WINDOW TRIM
1	2" x 12" x 4' STAIR STRINGER
1	2" x 4" x 3' P.T. WINDOW TRIM (15-DEG. BEVEL)
1	1" x 2 3/4" x 3' P.T. WINDOW SILL (15-DEG. BEVEL)
1	1" x 6" x 3'-8" P.T. FASCIA (27-DEG. BEVEL)
1	10' GALVANIZED Z FLASHING

STEEL FRAMED WALL	
QTY	**DESCRIPTION**
4	6'-1 3/16" WALL STUDS & KING STUDS
2	5'-5 13/16" JACK STUDS
2	1'-7 3/4" LOWER CRIPPLE STUDS
1	7 5/8" UPPER CRIPPLE STUD
2	1'-8" HEAD AND SILL TRACK
2	3'-10 3/4" TOP AND BOTTOM TRACK
1	1'-11 1/4" BOTTOM OF HEADER TRACK
2	1'-9 1/4" HEADER MEMBERS
2	6 1/2" HEADER END SUPPORT

PROJECT NOTES:

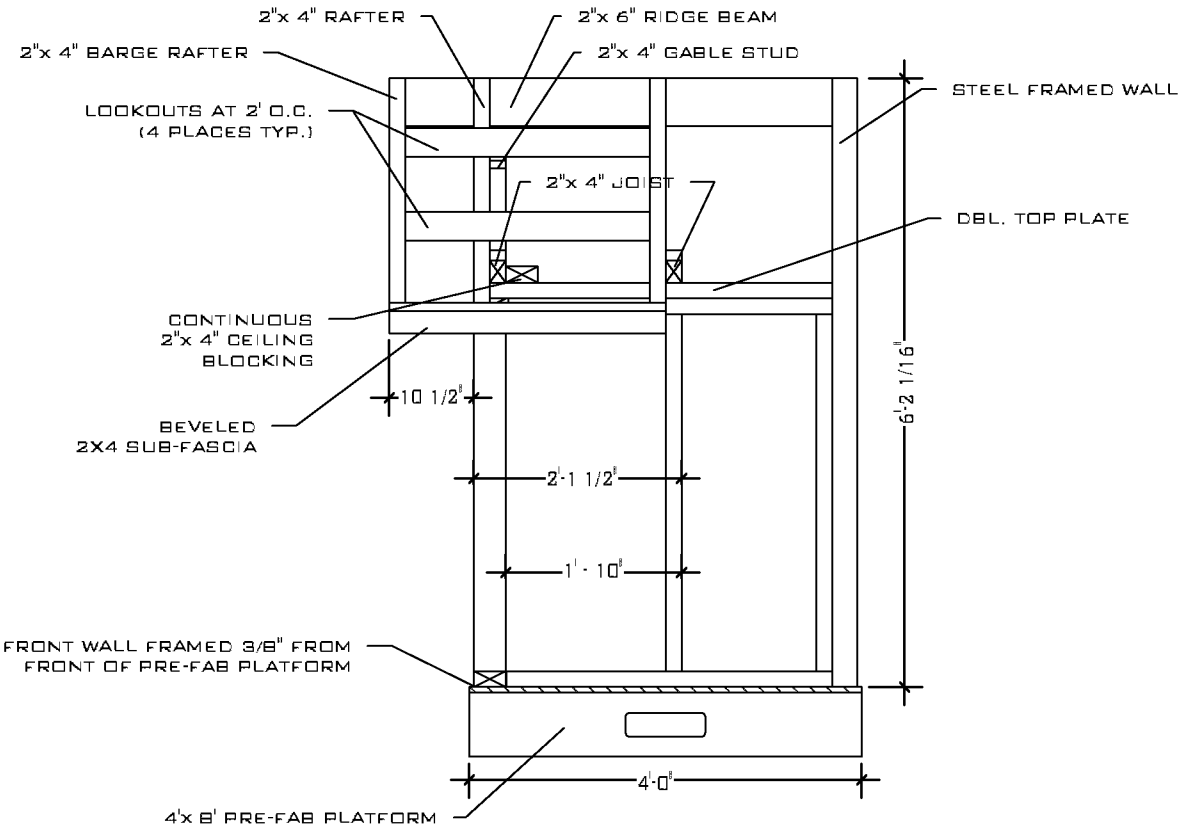
PLATES:

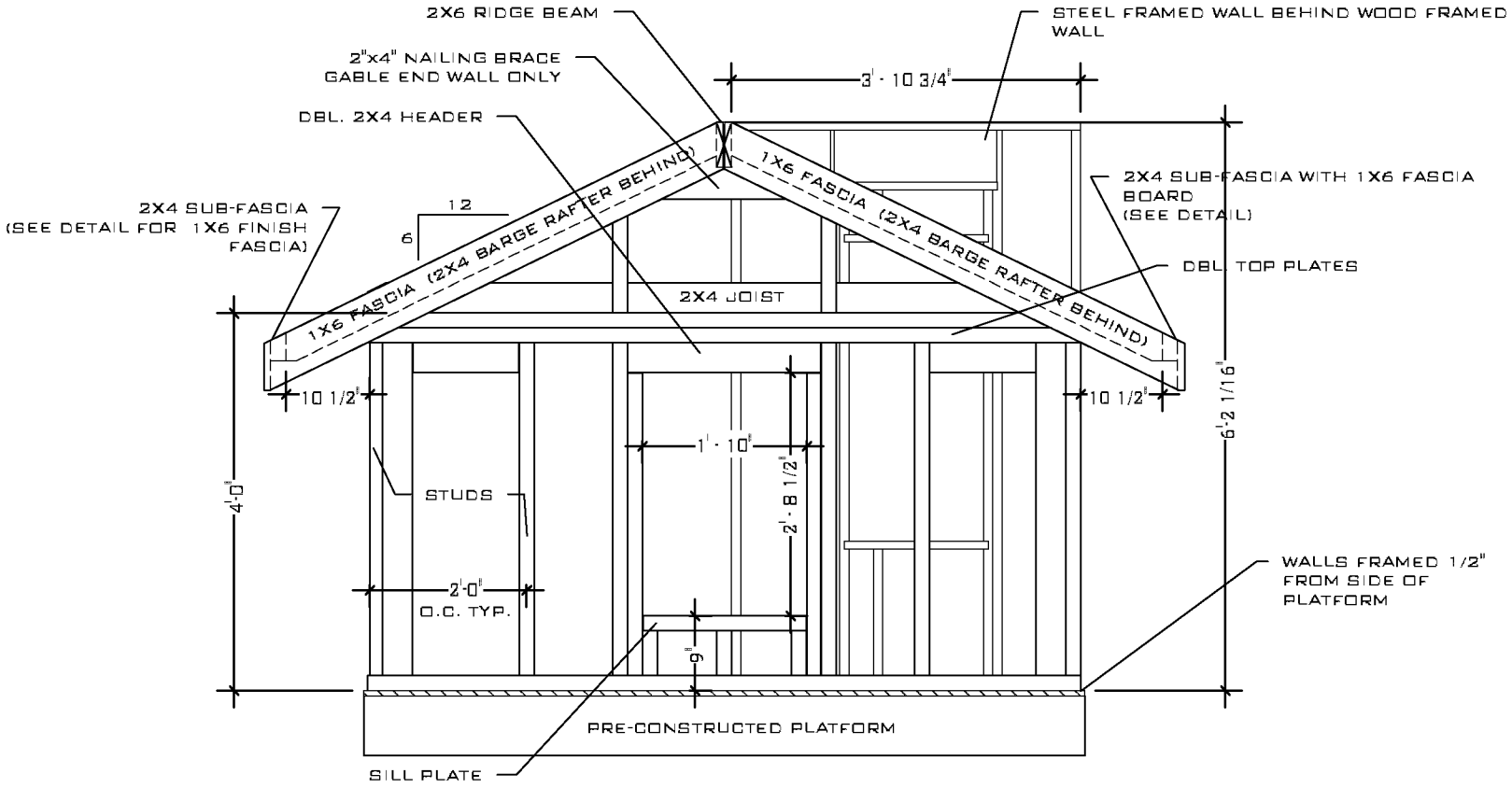
2 1/2" #8 PILOT POINT SCREWS TO BE USED ON WOOD & STEEL PLATES, AND WOOD-TO-STEEL CONNECTIONS

BOTTOM PLATES TO BE SCREWED ON TO BASE OF PLATFORM

HEADER:

USE 1/2" PLYWOOD SPACER IN WINDOW HEADER


2"x 4" RAFTER
2"x 6" RIDGE BEAM
2"x 4" BARGE RAFTER
2"x 4" GABLE STUD
LOOKOUTS AT 2' O.C.
(4 PLACES TYP.)
STEEL FRAMED WALL
2"x 4" JOIST
DBL. TOP PLATE
CONTINUOUS
2"x 4" CEILING
BLOCKING
10 1/2"
BEVELED
2X4 SUB-FASCIA
2'-1 1/2"
1' - 10"
6'-2 1/16"
FRONT WALL FRAMED 3/8" FROM
FRONT OF PRE-FAB PLATFORM
4'-0"
4'x 8' PRE-FAB PLATFORM

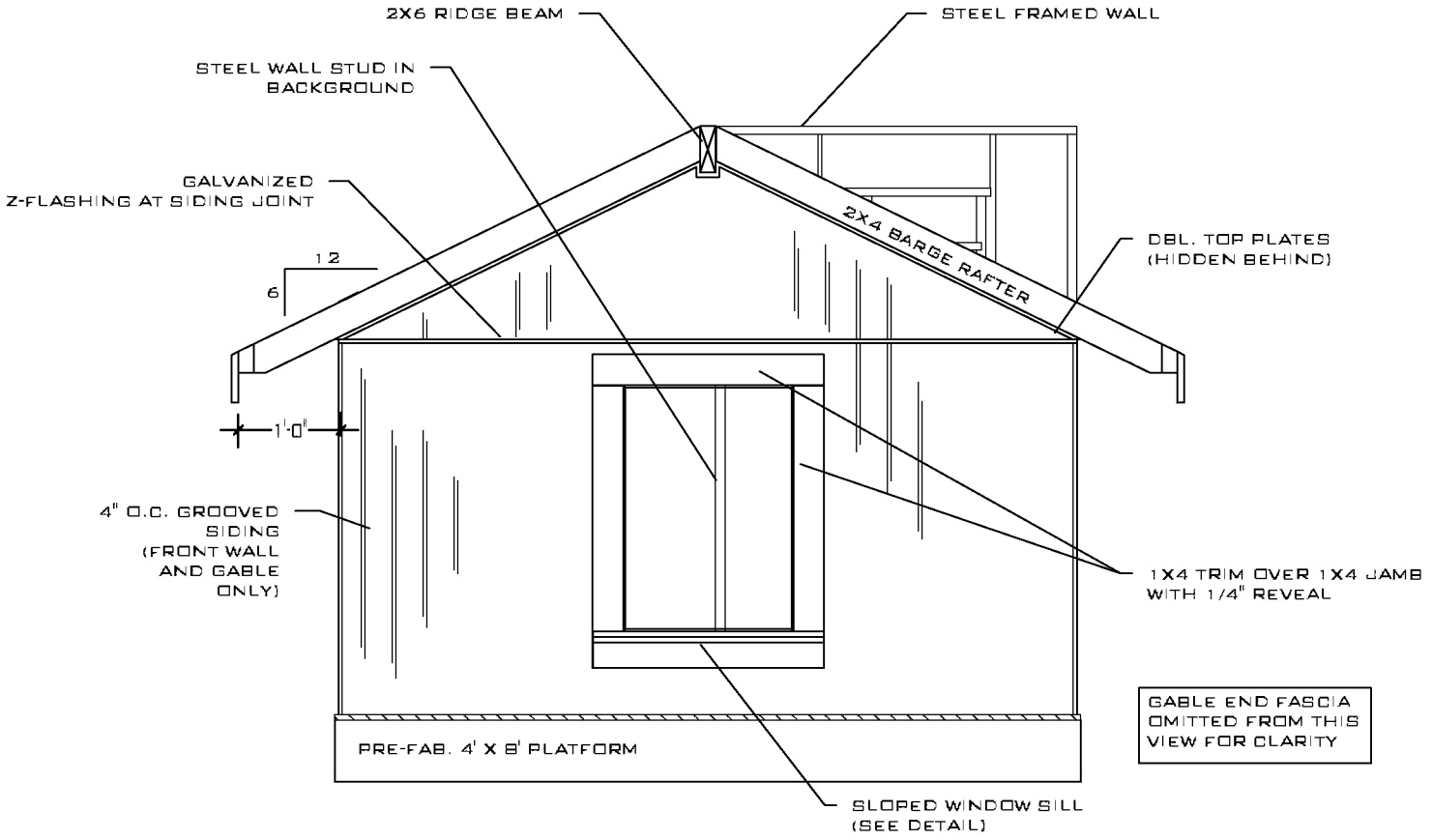


FRONT ELEVATION WITH STEEL WALL

SCALE: 1/2"=1'-0"

46TH ANNUAL

REVISIO



4" O/C GROOVED SIDING FRONT ELEVATION

SCALE: 1/2"=1'-0"

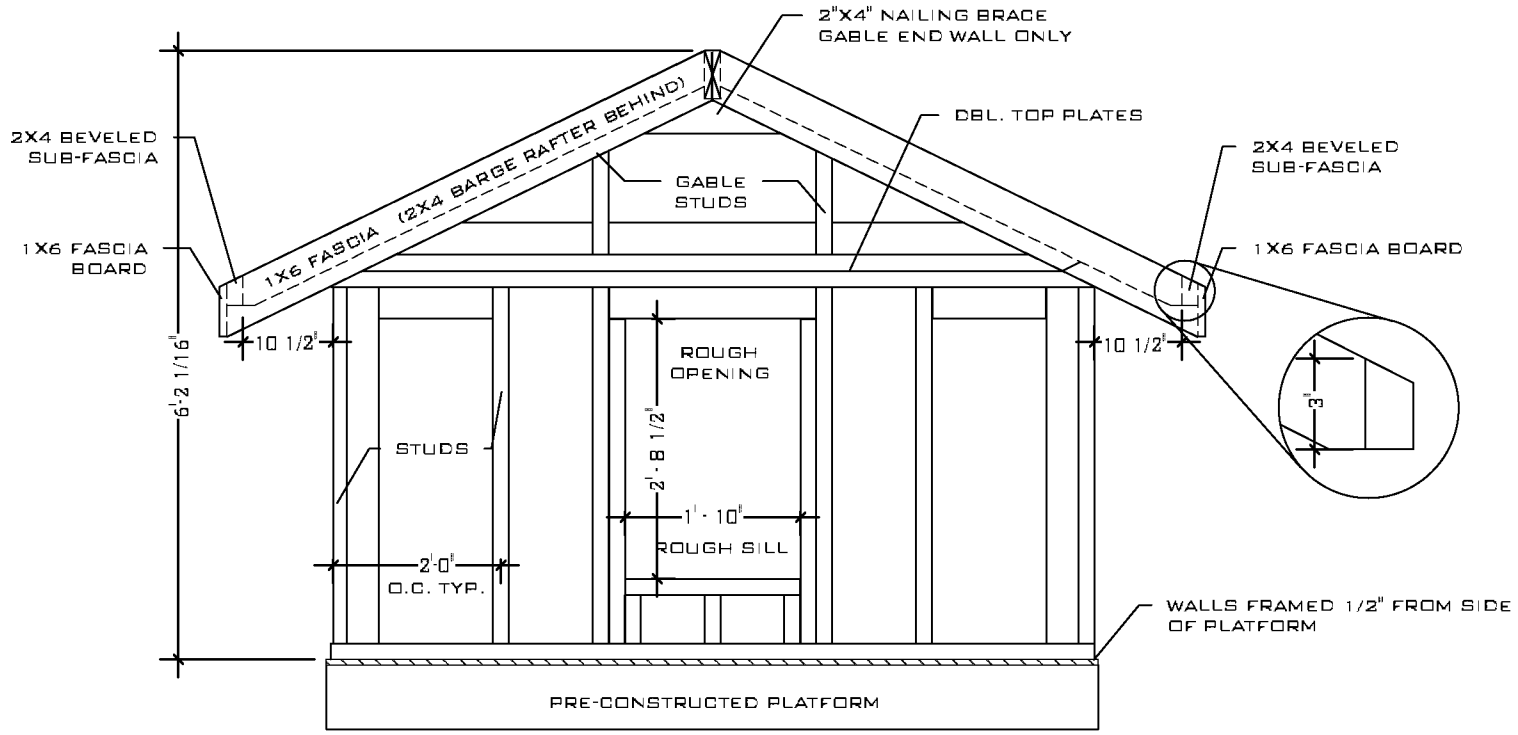
DATE

SCALE

DRAWI

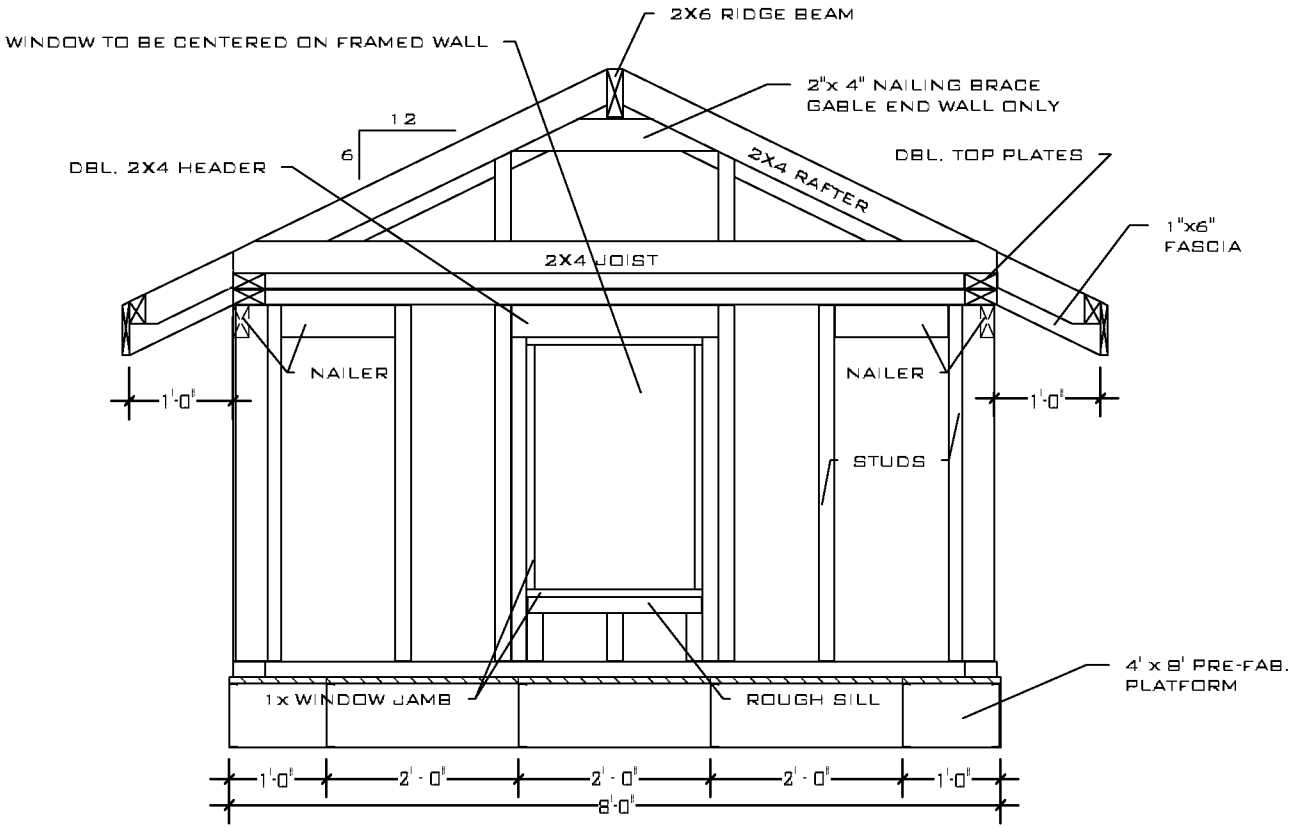
SHEET

OF



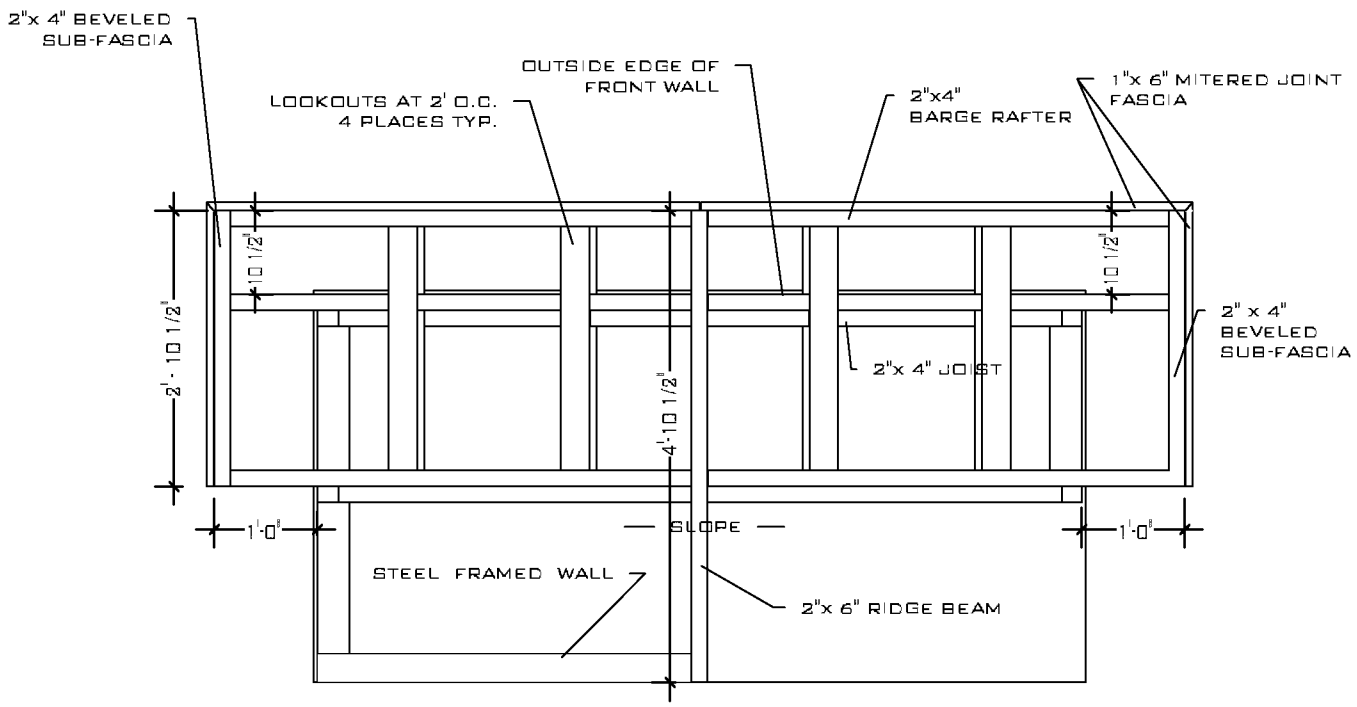
FRONT ELEVATION W/O STEEL FRAMING

SCALE: 1/2"=1'-0"



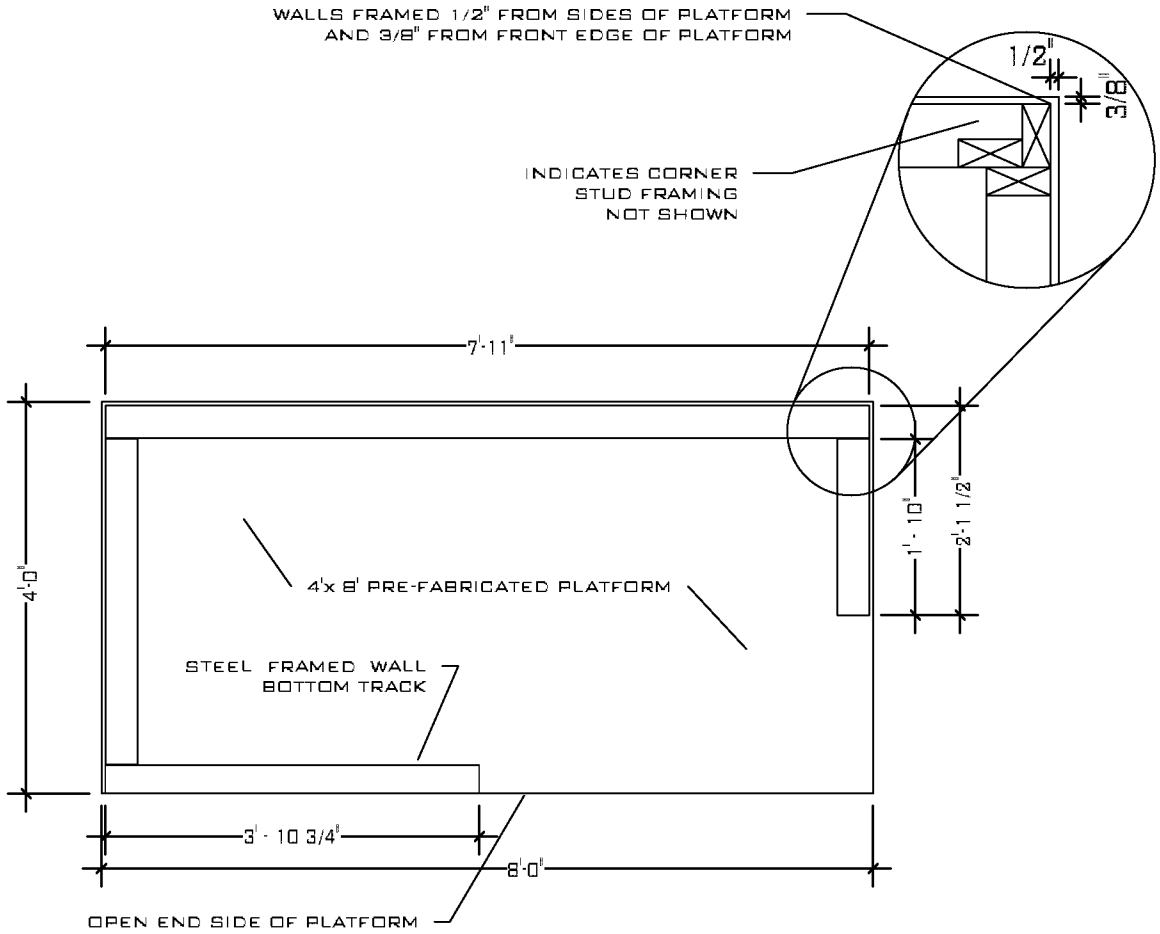
REAR ELEVATION W/O STEEL FRAMING

SCALE: 1/2"=1'-0"



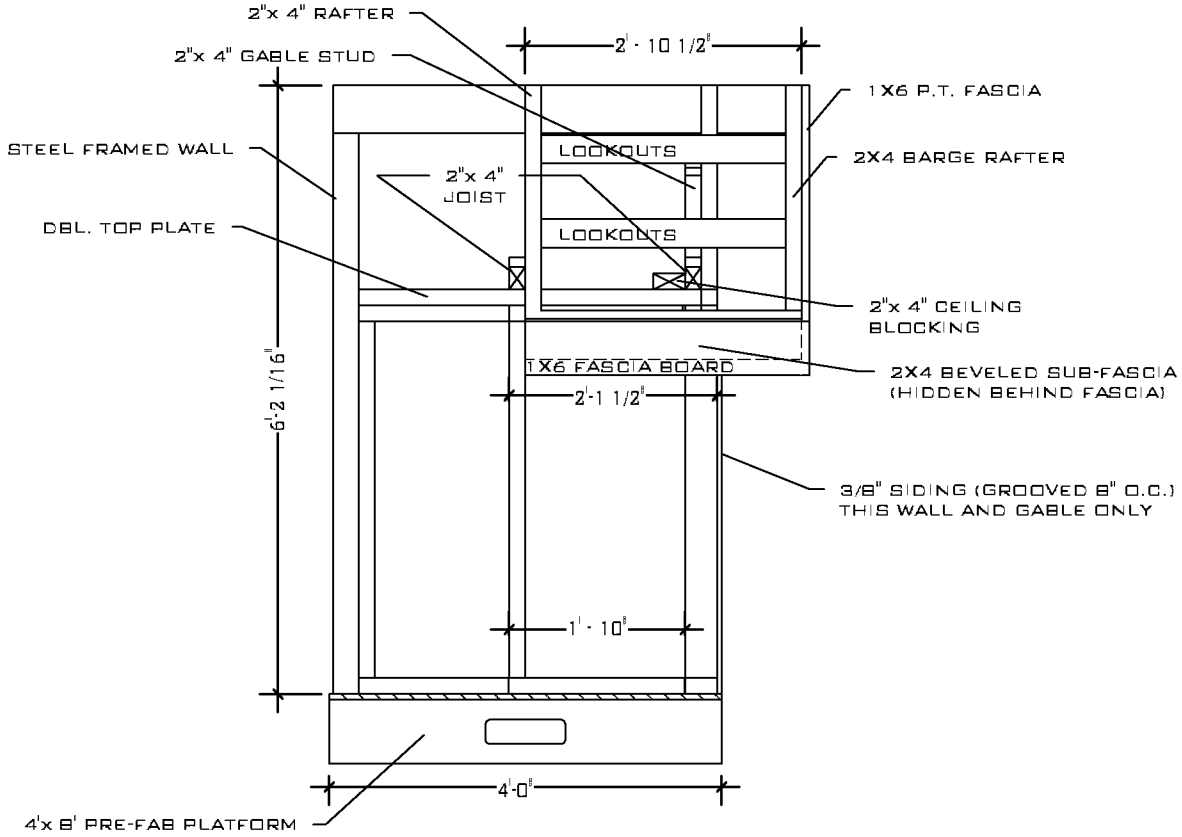
ROOF FRAMING DETAILS

SCALE: 1/2"=1'-0"



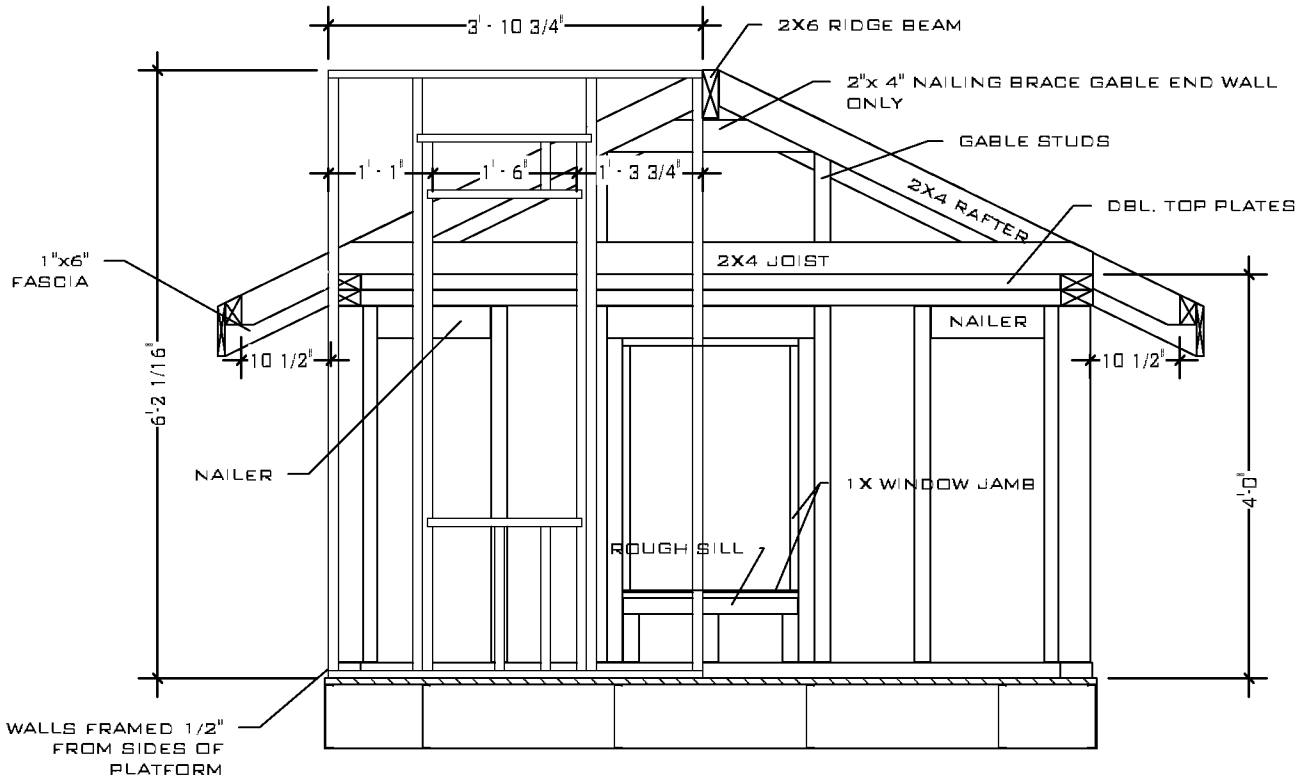
FLOOR PLAN

SCALE: 1/2"=1'-0"



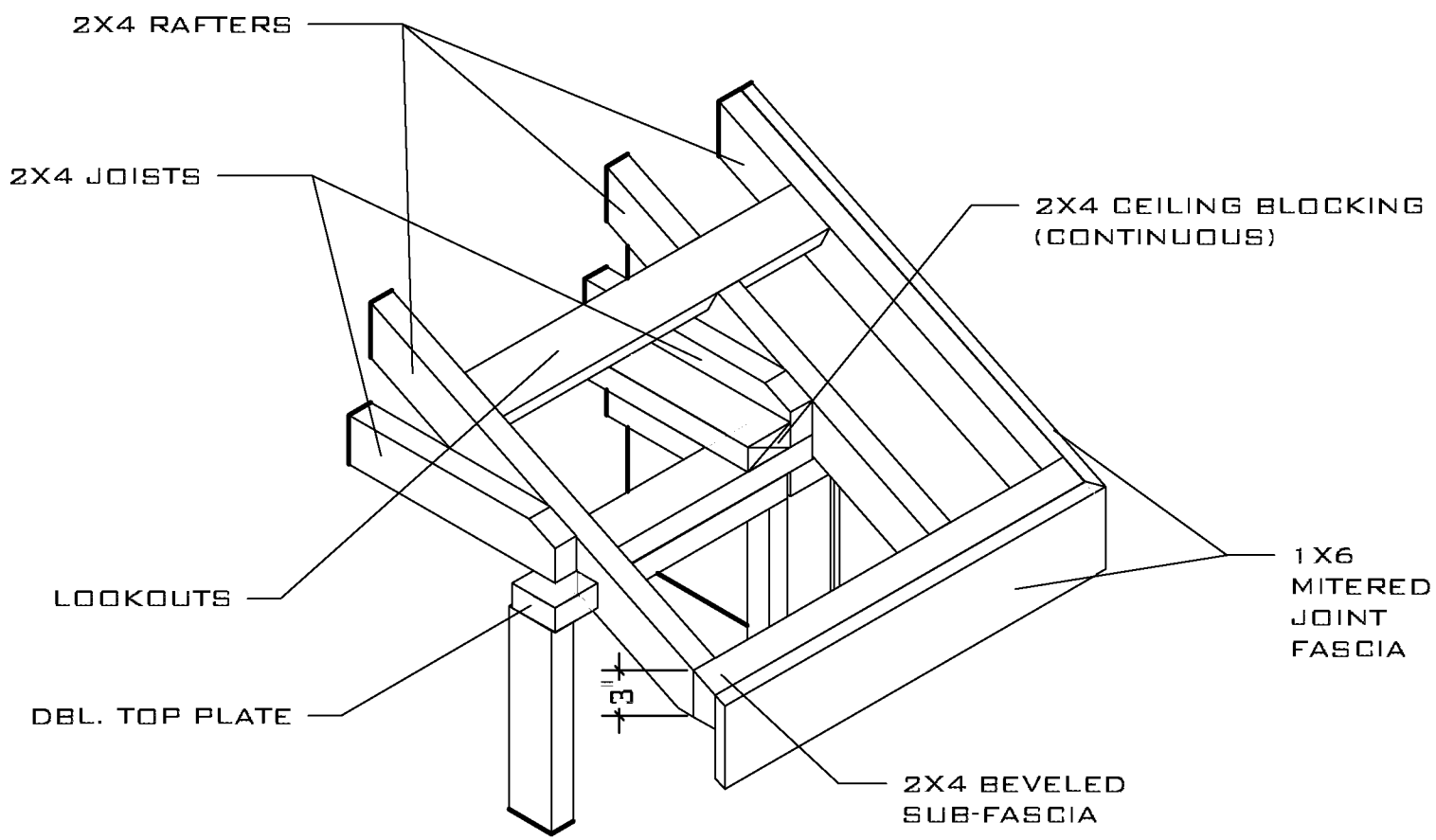
LEFT FRAMING

SCALE: 1/2"=1'-0"



REAR ELEVATION WITH STEEL WALL

SCALE: 1/2"=1'-0"



SUB-FASCIA / FASCIA DETAIL

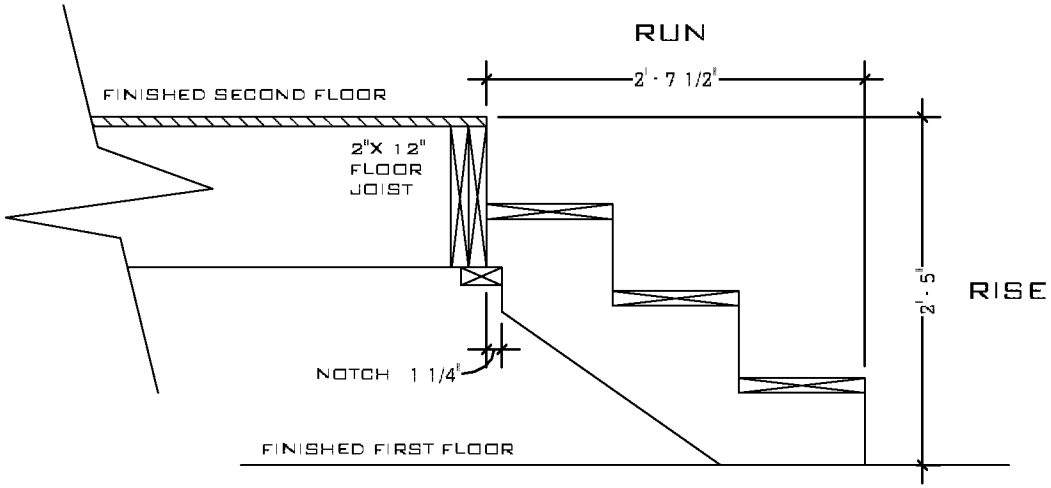
PROVIDE 2" x 12" x 4'-0"

TOTAL RISE = 29" (TREAD THICKNESS 5/4")

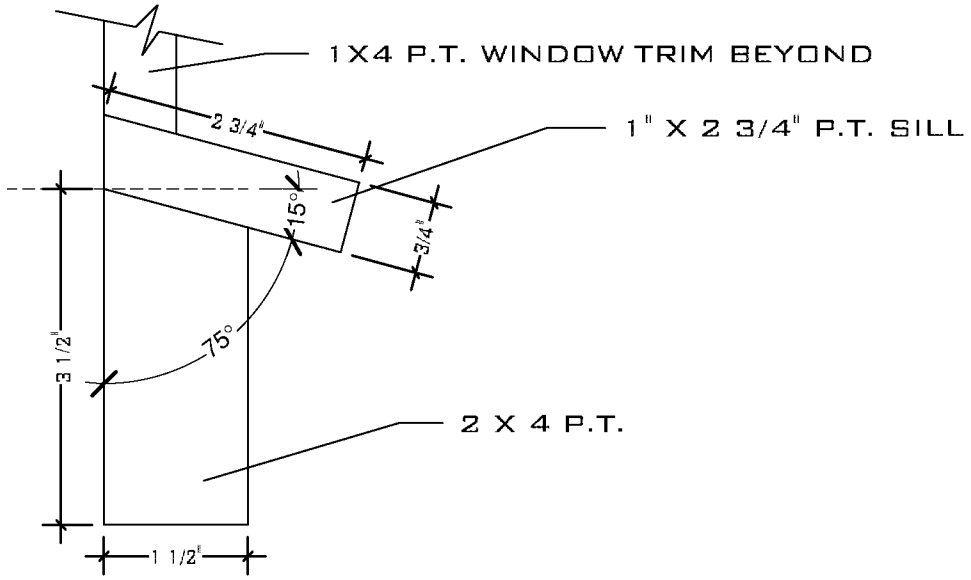
TOTAL RUN = 31 1/2" (OPEN RISER)

FINISH FLOORING = 3/4"

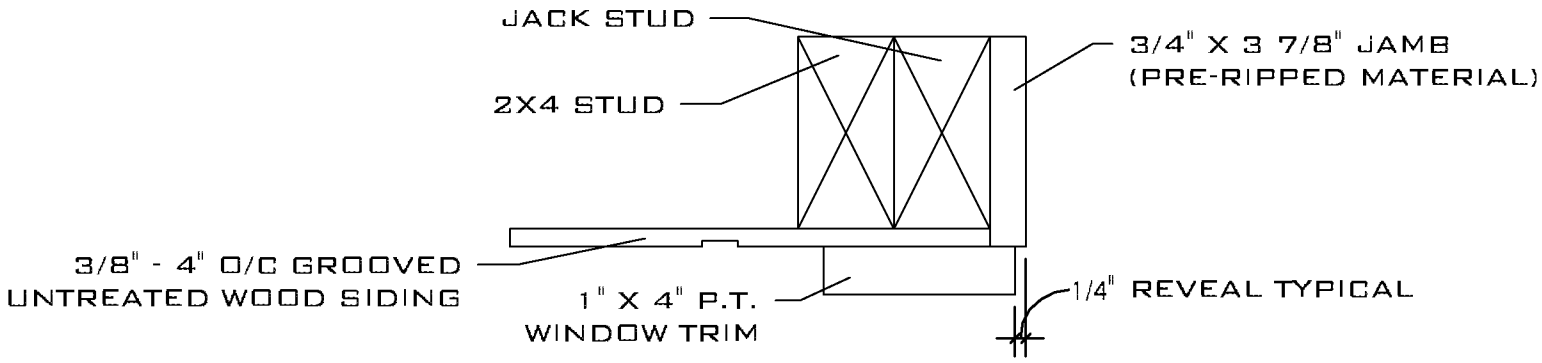
2"x 12" FLOOR JOIST (ACTUAL WIDTH = 11 3/4")



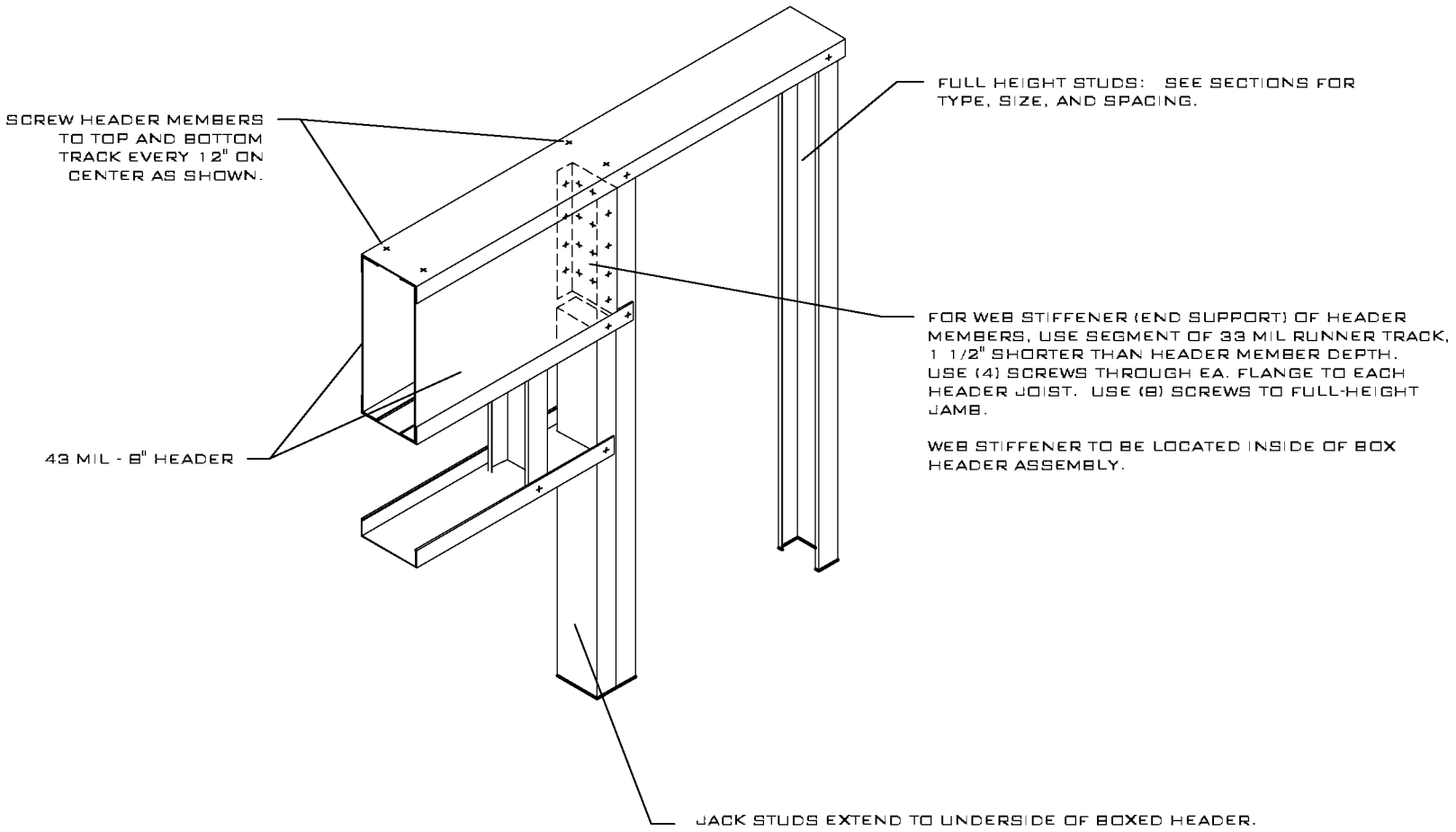
STAIR STRINGER DETAILS



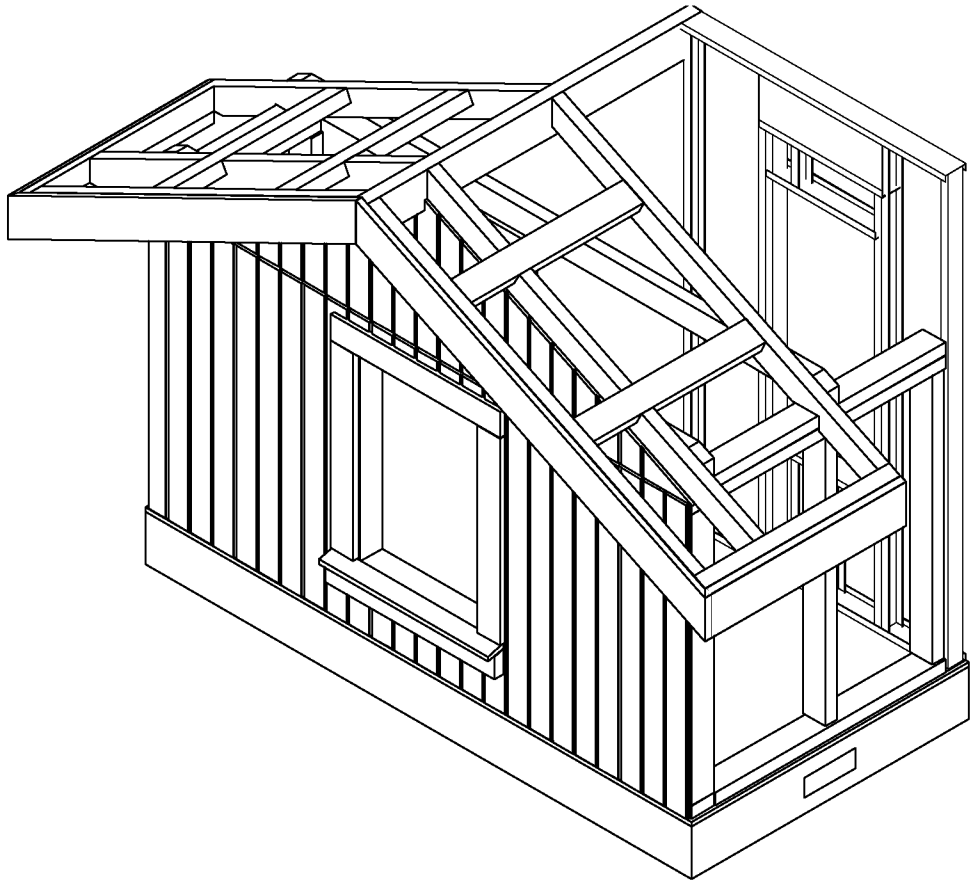
SLOPED EXTERIOR WINDOW SILL AND TRIM DETAIL



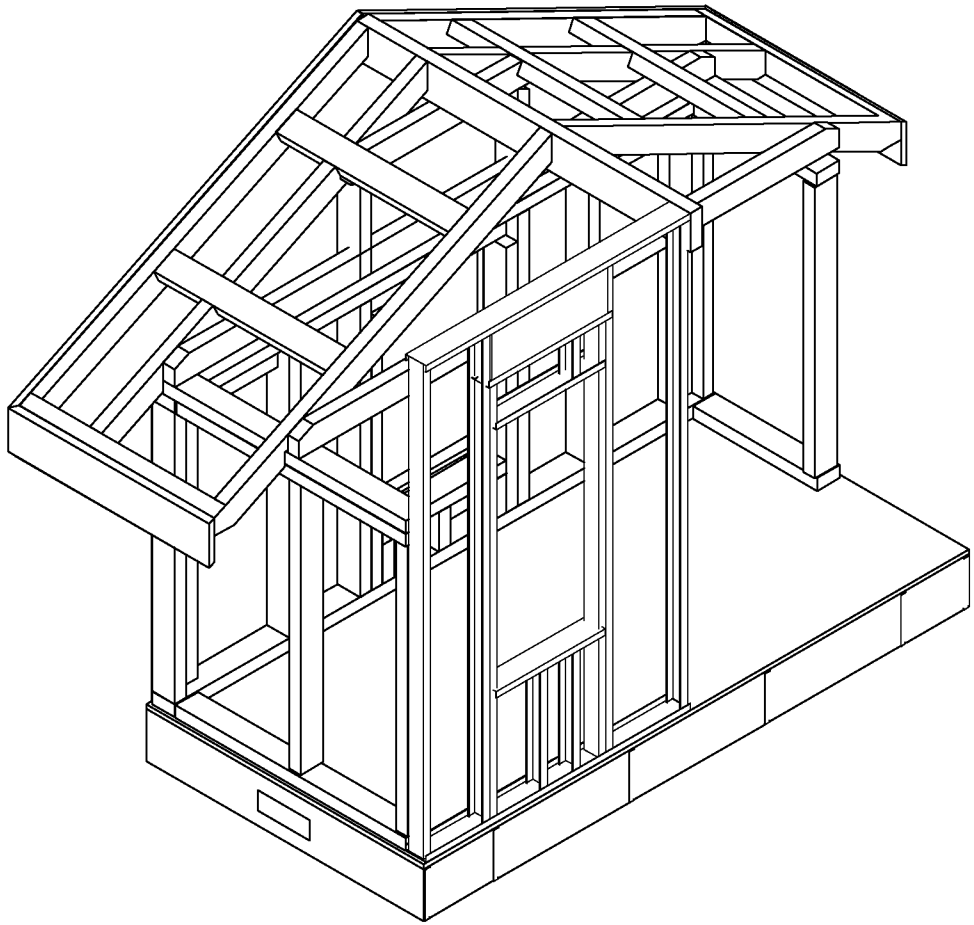
WINDOW JAMB / TRIM REVEAL DETAIL



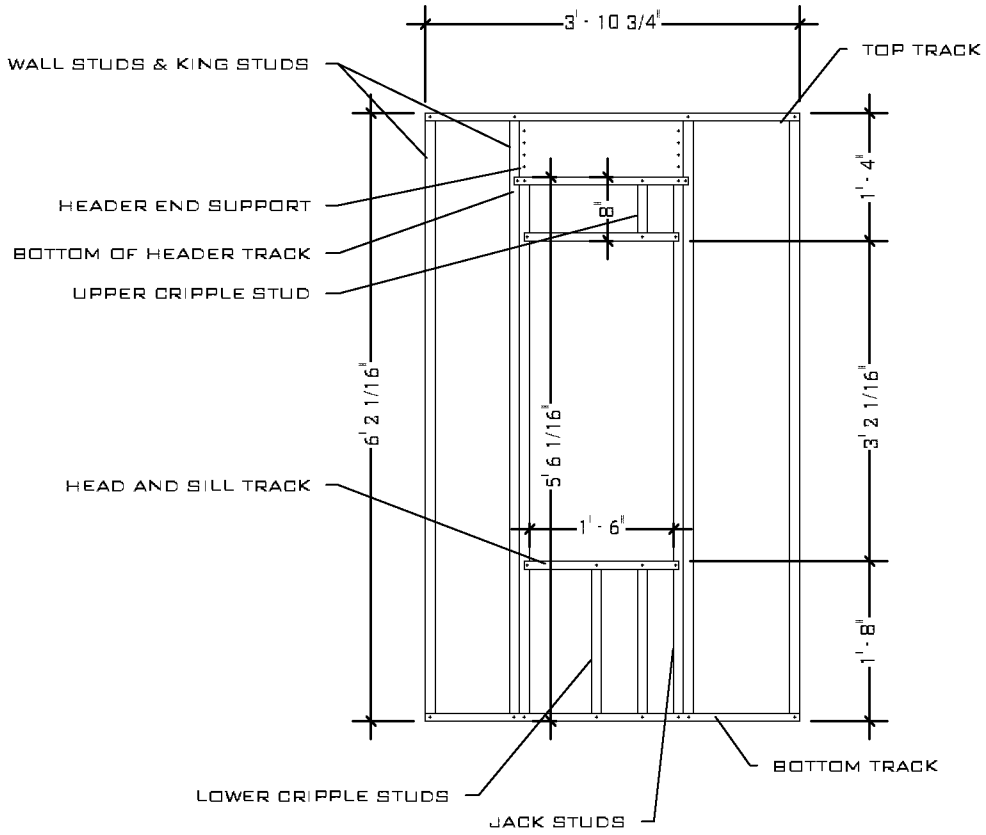
TYPICAL STEEL FRAMING HEADER AND JAMB



3D VIEW - FRONT RIGHT

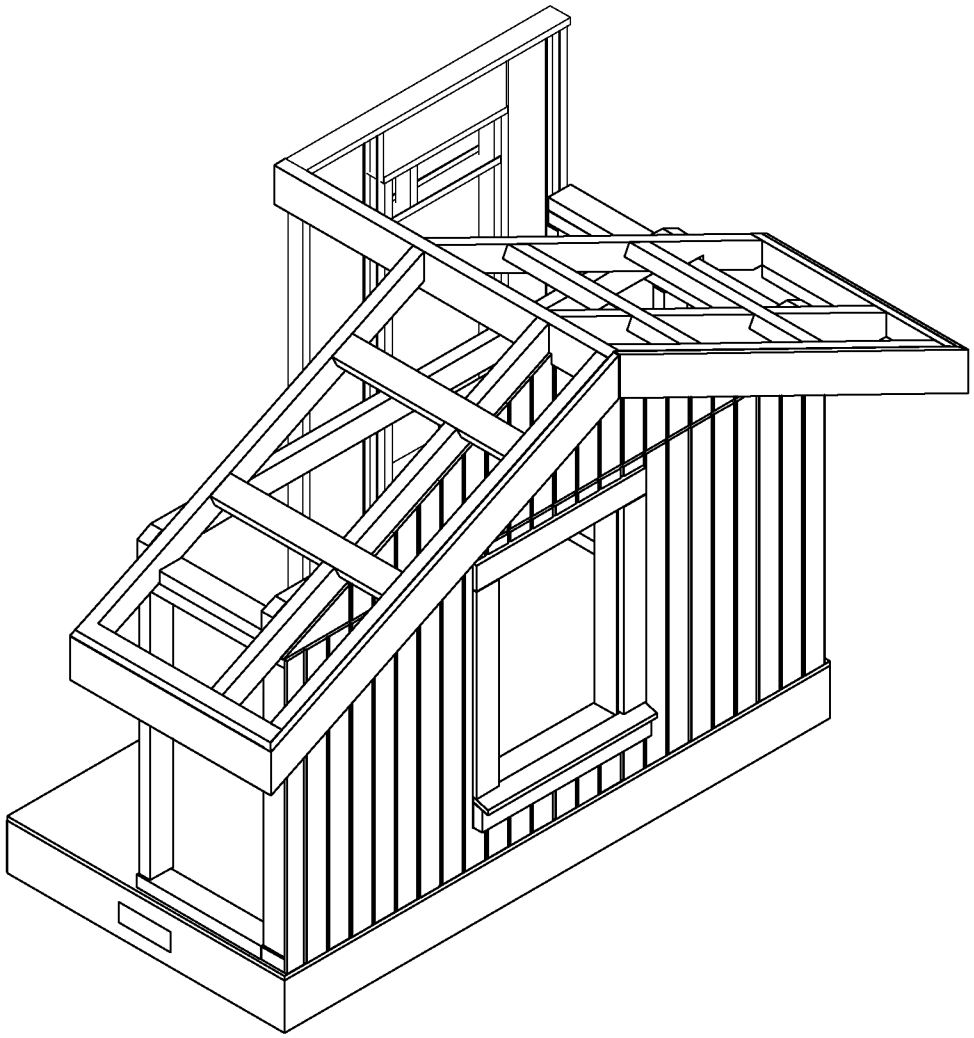


3D VIEW - BACK RIGHT

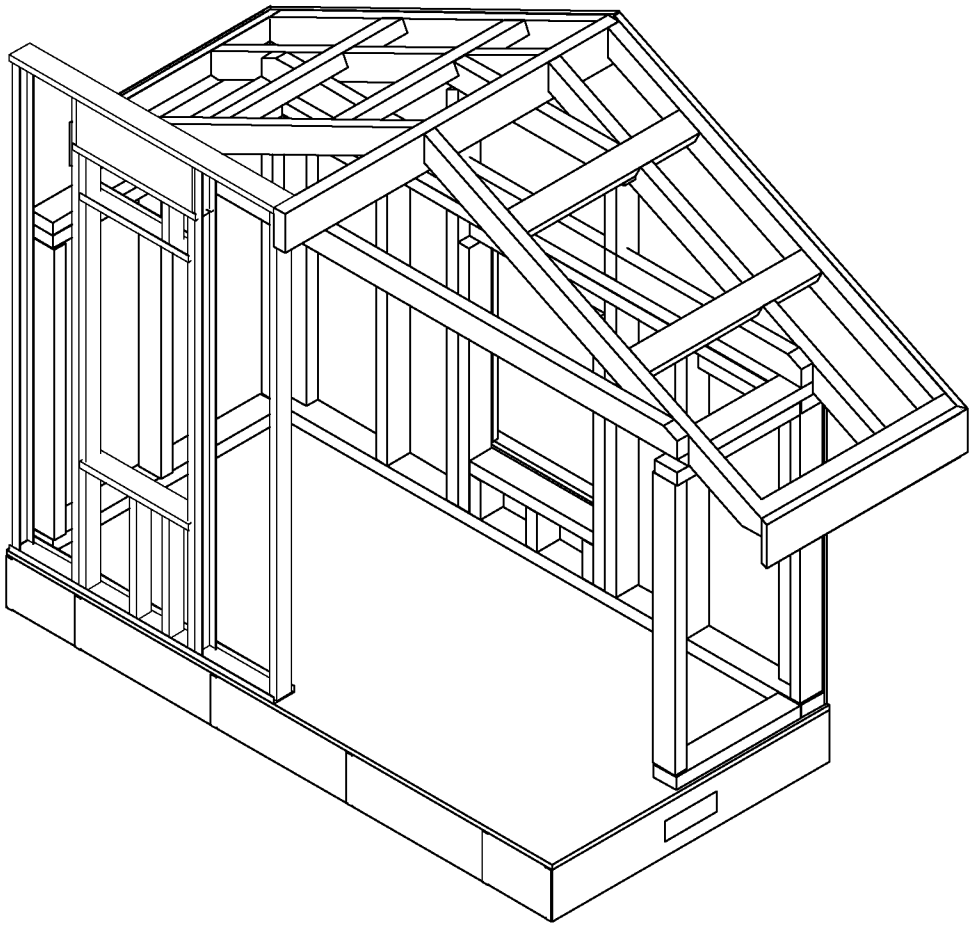


STEEL WALL FRAMING DETAILS

SCALE: 1/2"=1'-0"



3D VIEW - FRONT LEFT



3D VIEW - BACK LEFT

SkillsUSA
2010 Contest Projects

Chapter Business Procedure

Click the “Print this Section” button above to automatically print the specifications for this contest. Make sure your printer is turned on before pressing the button.

SkillsUSA Chapter Business Procedures
Business Agenda
Preliminary Round

Required Order of Business:

Call to order

Reading and approval of the minutes

Reports of Officers, boards and standing committees

Special Committee Reports

Special Orders

Unfinished Business and general orders

New Business

- Move that the chapter work with other Career and Technical Student Organizations in hosting an Employer Appreciation Banquet in the spring.

Adjournment

SkillsUSA Chapter Business Procedures
Preliminary Round
Minutes

The regular monthly meeting of the local SkillsUSA Chapter was held on Wednesday, May 12, 2010, at 9:30am in the local chapter room, the President being in the chair and the secretary being present. The minutes of the previous meeting were read and approved as corrected.

The Treasurer reported an ending balance of $2348.67. The report was received and placed on file.

On behalf of the professional development committee, _____ moved that we invite a guest speaker to come speak at the opening meeting in August. _____ moved to amend the motion by striking the words "a guest speaker" and inserting the words, "Mr. Bob Romax, Chamber President." Amendment adopted. Motion Adopted.

There was no unfinished business.

_____ moved that the club send the officers to national convention. _____ moved that the motion be referred to the Ways and Means Standing Committee to investigate costs, as well as suggesting ideas for raising funds to send them, and report back at the next meeting. Motion to refer adopted.

_____ moved that the chapter hold a summer retreat for officers. Motion adopted.

The Vice President introduced the program, which was a talk by Ms. Jones, the HR manager at First National Bank.

The Chapter Advisor announced that registration deadline for Nationals was Friday, May 14.

The meeting was adjourned at 8:30am with the closing ceremonies.

_____, Secretary

SkillsUSA Chapter Business Procedures
Preliminary Round
Treasurer's Report 06/23/10

Beginning Balance 05/12/10		$2,348.67
Receipts		
Fruit Sales	$305.00	
Dues	13.00	
Total Receipts	381.00	
Funds Available		2,739.67
Expenses		
Frazier Family Farms	124.00	
Total Expenses	124.00	
Ending Balance 06/25/09		$2,615.67

SkillsUSA Chapter Business Procedures
Business Agenda
Final Round

Required Order of Business:

Call to order

Reading and approval of the minutes

Reports of Officers, boards and standing committees

Special Committee Reports

Special Orders

Unfinished Business and general orders

New Business

- Move that the chapter raise funds for homeless shelters in the greater Kansas City area.

Adjournment

SkillsUSA Chapter Business Procedures
Final Round
Treasurer's Report 06/24/10

Beginning Balance 05/21/10		$2,035.01
Receipts		
Garage Sales	$563.00	
Dues	25.00	
Total Receipts	588.00	
Funds Available		2,623.01
Expenses		
City Permit	15.00	
School Supply Warehouse	11.23	
Total Expenses	26.23	
Ending Balance 06/24/09		$2,649.10

SkillsUSA Chapter Business Procedures
Final Round
Minutes

The regular monthly meeting of the local SkillsUSA Chapter was held on Thursday, May 20, 2010, at 2:00pm in the local chapter room, the President being in the chair and the secretary being present. The minutes of the previous meeting were read and approved as corrected.

The Treasurer reported a fund ending balance of $2,305.01.

The report of the fundraising committee was received and placed on file.

Under new business, _____ moved that the club buy a SkillsUSA emblem for the chapter meeting room. _____ moved to postpone the motion to our June meeting. Motion adopted.

_____ moved that the chapter work with other CTSO student organizations in recognizing outstanding CTE students. _____ moved to lay the motion on the table. Motion adopted.

The Vice President introduced the program, which was a talk by Mr. Dooley, the Auto Parts Store Manager.

During announcements, _____ announced his(her) intention to move to rescind the motion made at the April meeting to host a school-wide back-to-school open house in September at the next meeting.

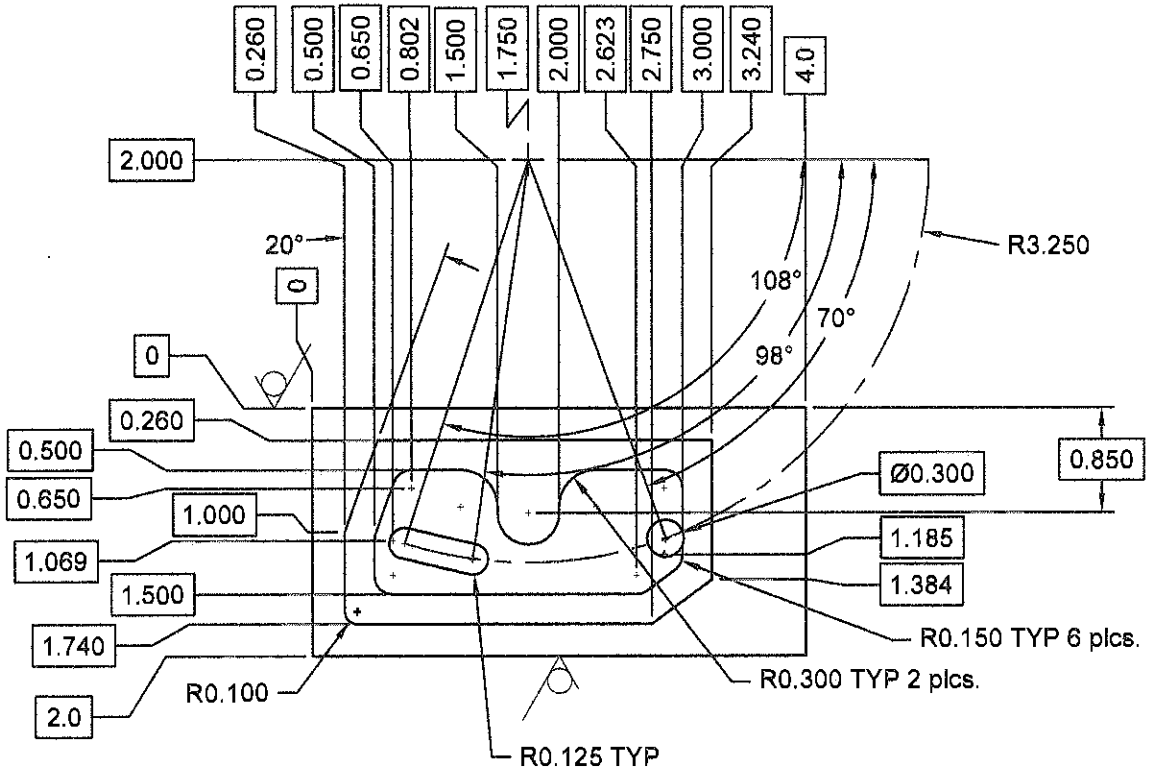
The meeting was adjourned at 2:30pm with the closing ceremonies.

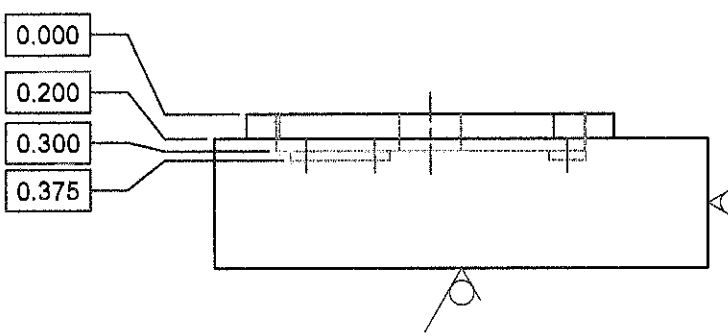
_____, Secretary

SkillsUSA
2010 Contest Projects

CNC Milling

Click the “Print this Section” button above to automatically print the specifications for this contest. Make sure your printer is turned on before pressing the button.





Notes:
Tool #1 - $\frac{3}{8}$ - 2 flute end mill S2037 F 5.2
Tool #2 - $\frac{1}{2}$ - 2 flute end mill S 2292 F 4.5
Tool #3 - $\frac{1}{4}$ - 4 flute ball mill S2292 F2.3
Maximum Spindle Speed - 3500 RPM
Maximum Feed Rate - 80 IPM

63

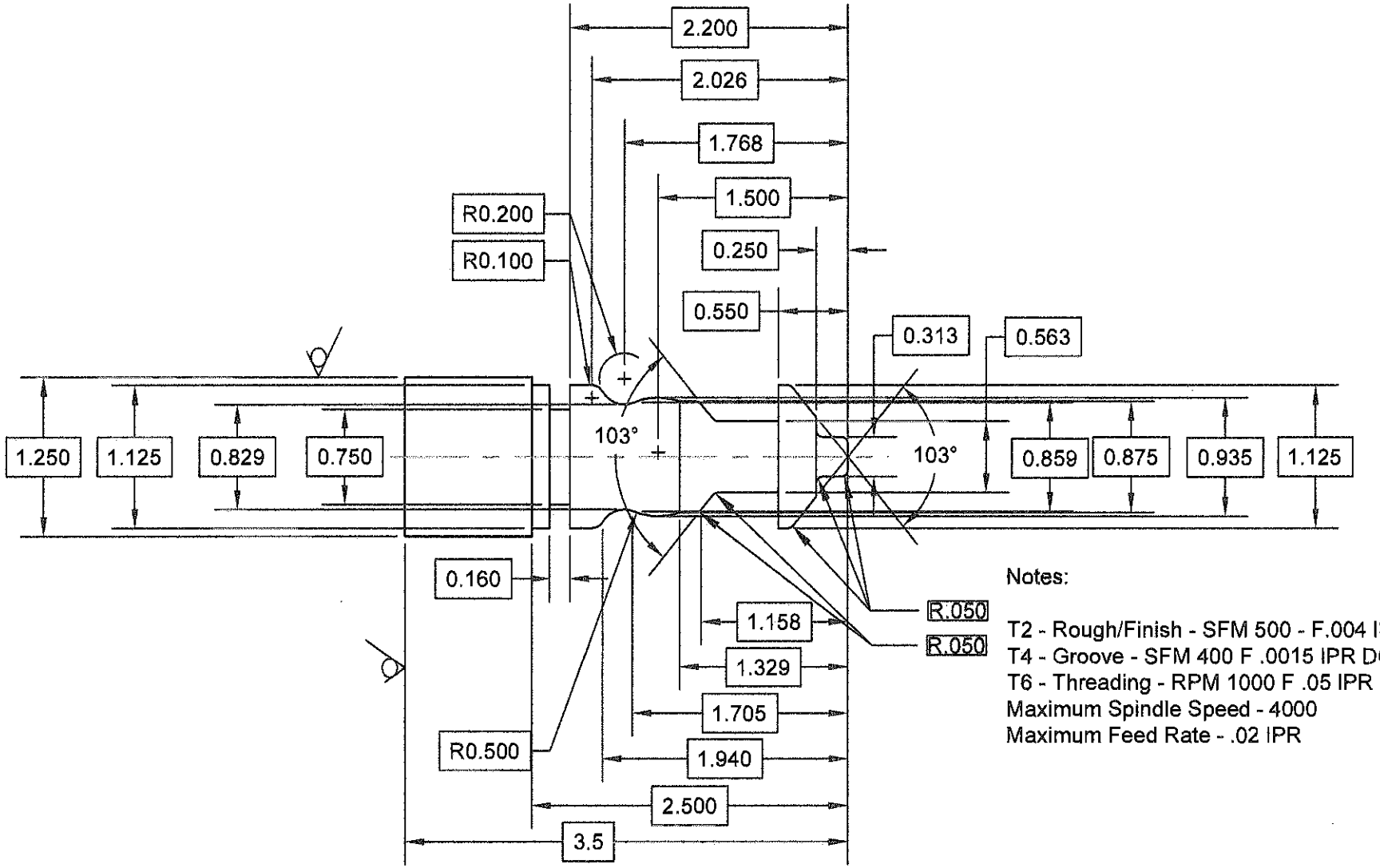
+0.02 −0.02
−0.00 −0.01

Scale	Gen. Tol.		
NTS	±0.004 Angles: ±0.5°	SkillsUSA	CNC Mill
Date: 6-20-10	Material : 6061 Aluminum2"x4"x1.25"		
	Description: *Mill Project 1*	Project: CNC Mill Test 1	
		Test ID#: 032525.75.02	

SkillsUSA
2010 Contest Projects

CNC Turning

Click the “Print this Section” button above to automatically print the specifications for this contest. Make sure your printer is turned on before pressing the button.



Notes:

T2 - Rough/Finish - SFM 500 - F.004 IPR - DOC .04
T4 - Groove - SFM 400 F .0015 IPR DOC .03
T6 - Threading - RPM 1000 F .05 IPR DOC .033
Maximum Spindle Speed - 4000
Maximum Feed Rate - .02 IPR

63

+0.02 −0.00

−0.02 −0.01

Scale	Gen. Tol.		
NTS	±0.004 Angles: ±0.5°	SkillsUSA	CNC Lathe
Date: 6-20-10	Material : 6061 Aluminum Ø1-1/4"x3½"		
	Description: *Lathe Project 1*	Project: CNC Lathe Test 1	
		Test ID#: 032525.75.01	

SkillsUSA
2010 Contest Projects

Collision Repair

Click the “Print this Section” button above to automatically print the specifications for this contest. Make sure your printer is turned on before pressing the button.

Collision Repair Technology
Scope of the contest

Contestants will demonstrate their ability to perform jobs and skills based on the task list outlined by the National Institute for Automotive Service Excellence (ASE) Collision Repair/Refinishing Study Guide, and the National Automotive Technicians Education Foundation (NATEF) Collision Repair and Refinishing Standards. The competition includes a series of workstations to assess skills in the following areas: metal straightening, welding, plastic repair, and structural analysis. There will be a written test on estimating, structural analysis, and an ASE exam. The competitors will also participate in an interview. The overall appearance of the finished product, speed and proper safety practices will be judged.

Collision Repair Technology

This contest includes a series of workstations to assess the skills in the following areas.

Metal Repair
Proper use of tools, metal straightening and shrinking techniques, use of plastic filler material, and evaluation of overall appearance

Welding
GMA (MIG) welding light gauge steel in overhead and vertical positions

Structural Analysis and Frame
Suspension and steering identification and function, use specification sheet to install gauge measuring system. Diagram and analyze structural misalignment using mechanical and computerized measuring system.

Plastic Repair
Surface preparation, featheredging, block sanding, plastic identification, and general knowledge test.

Written Test
The contestants will have 3 written tests
ASE test which consists of 50 questions that will cover the three skill areas of the areas that are identified in the NATEF Collision Repair/Refinishing Program Standards and the ASE Official Study Guide – Collision Repair/Refinish which are: Non-Structural Analysis and Damage Repair, Structural Analysis and Damage Repair, Mechanical and Electrical Components. Estimating test is a written test using an industry estimating manual, manually entering data on an estimate sheet, and making calculations. Structural test will include identifying suspension and steering components and functions.

Job Application and Interview
Fill out job application; participate in a scheduled job interview, and résumé assessment.

SkillsUSA CHAMPIONSHIPS

CONTEST SCORING CRITERIA

Collision Repair Technology — Contest

Darrell Andrews — Chair

Skill Description	Maximum Points
1. Metal Repair	175
2. Welding	175
3. Structural Analysis	175
4. Plastic Repair	175
5. Estimating	100
6. Interview	100
7. ASE Exam	100
8.	
9.	
10.	
11.	
12.	
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16.	
17.	
18.	
19.	
20.	
21.	
22.	
23.	
24	
Résumé submitted? Yes O No O (5% penalty)	

Tie Breakers
1. SkillsUSA Professional Development Program Test 2. Estimating 3. Structural Analysis

Collision Repair Technology
This year, Delmar, a part of Cengage Learning is making their online ASE Test Preparation tools available to all instructors and competitors immediately. This means that some competitors may be able to use the tool in advance of their district and state competitions.

Instructors should only share the materials with competitors.

Access will be terminated when the National Competition begins.
Please use the contact information below to get the necessary link
jonathan.sweeney@cengage.com | www.delmarlearning.com

ASE Damage Analysis and Estimating Certification (B6)

Objective: To identify and recognize those estimators who possess knowledge of the skills necessary to properly analyze and estimate automotive collision damage.

Scope of Program: The ASE Damage Analysis and Estimating (B6) Test complements the other tests in the Collision Repair Test series that identify and recognize collision repair technicians and refinishers. This test is specially constructed and intended for those professionals who may not actually repair vehicles, but have the special knowledge needed to assess collision damage, estimate repair costs, and work with vehicle owners.

Test Development: The questions that appear on the this test are written and approved by a cross-section of industry experts that includes collision repair shop estimators, collision repair technicians, independent appraisers, and representatives of automobile manufacturers, information providers, industry trainers and insurance companies. This procedure ensures that the tests are fair to all estimators without bias towards any specific manufacturer, insurer, or estimating system.

ASE Collision Repair and Refinishing

Objective: To identify and recognize those collision repair technicians and refinishers who possess knowledge of the skills necessary to properly analyze and repair automotive collision damage and correct paint finish damage.

Scope of Program: The ASE Collision Repair and Refinish Test Series includes one test for paint refinishers and three other tests for repair technicians: Painting and Refinishing (B2), Non-Structural Analysis and Damage Repair (B3), Structural Analysis and Damage Repair (B4), and Mechanical and Electrical Components (B5).

Test Development: The collision repair and refinishing tests are written and approved by a cross-section of industry experts that includes collision repair technicians, refinishers, and representatives of vehicle manufacturers, information providers, paint manufacturers, parts and equipment manufacturers, industry trainers, and insurance companies. This procedure ensures that the tests are fair to all without bias towards any specific manufacturer, insurer, or refinishing system.

For additional information and go to the AYES website at www.ayes.org/elearning

SkillsUSA
2010 Contest Projects

Commercial Baking

Click the “Print this Section” button above to automatically print the specifications for this contest. Make sure your printer is turned on before pressing the button.

SkillsUSA
Commercial Baking Contest
June 22-24 2010

Contestant's Orientation

Contents

Welcome Letter

Schedule

General Regulations for the Contest

About the Written Test

About the Performance Test

Judging Criteria and Photos

Tip sheet

Sample score sheet

Message to the Contestants:

Congratulations on your participation in this national competition and reaching this milestone in your baking career.

The 2009 SkillsUSA Championships represent the culmination of more than 10,000 contests held at local, district and state levels across the country. The nation's top 3,900 vocational-technical students are competing in more than 68 occupational contests this week.

For Commercial Baking in 2009 we hosted **63** students - **23** in the college division and **40** in the high school division. Like you, they are the local, regional or state baking contest champions. This provides you the rare privilege of testing your skill and knowledge with the best baking students in the United States. The real competition is with yourself - relax and do your best work. We know you are ready for the challenge.

The competition consists of two tests. The written test will evaluate your baking knowledge. Points are awarded based on the percentage of correct answers. The performance test will evaluate your baking skills. We will use eight judges, nearly all of whom are Certified Master Bakers (CMBs). There is more information about both tests in this package.

The Commercial Baking Competition is made possible by the generous donation of time, equipment, supplies and awards from more than 30 baking industry and educational sponsors - including Retail Bakers of America. The RBA, founded in 1918, represents 1,000 member companies who bring consumers quality bakery foods from bakery departments, independent bakeries, and foodservice facilities. In addition, RBA members include baking instructors, students, and suppliers of ingredients, equipment, and services

The Judges, members of the Education Committee and members of the Technical Committee have spent most of their lives in the baking industry. Our goal is to help you be successful and make this competition a positive experience so that you continue on as a successful baker. Regardless of what happens this week, you will leave Kansas City a changed person. You will be richer in experience and friendships. And, you will be better prepared for a bright future in retail baking.

Good luck to each of you.

Overview of the Written Test

The written test will be given at the mandatory pre-contest meeting and consist of 100 multiple-choice questions. **Students will have 60 minutes to complete the test.**

The written test is the same test used for RBA's Certified Journey Baker (CJB) certification. If you pass this test, you will have completed the written test portion for certification. The passing score is 70%.

Overview of the Performance Test

Purpose
To evaluate each contestant's preparation for employment and to recognize outstanding students for excellence and professionalism in the commercial baking.

Scope of the Contest

1. The contest will be geared toward the commercial (retail) baking business rather than commercial restaurant business.

2. Contestants will be given a written test covering basic baking science and scheduled during a contestant meeting held before the practical contest.

3. The performance phase of this contest will be the actual preparation of goods and presentation of finished products ready for sale to customers.

4. Contestants will be given a predetermined selection of all necessary food items. Due to limited supplies, spoiled or burnt supplies will not be replaced.

5. No cell phones, computers, Blackberries or similar electronic devices will be allowed

6. Contestants will prepare a total of seven products: six baked goods made from scratch and/or from fresh or frozen dough, and one iced and decorated cake. The products will be selected by the Commercial Baking Technical Committee from the following categories.

   One product each from the following categories: (total of 7)
   - Yeast Breads and Rolls
   - Quick Breads—(No Yeast)
   - Sweet Dough Products
   - Cookies
   - Basic Cake Decorating
   - Puff Pastry (Laminated Dough) or Pate a Choux Products
   - Pie and Pie Crust Pastry

Clothing Requirement
Contestants must wear the official SkillsUSA Championships clothing or work uniform specified for their particular contests during competition or be subject to a maximum penalty of 5 points (assessed by SkillsUSA). The commercial baking judges will also credit points for proper dress

Dress: White chef's shirt or coat, white work pants or checkered chef's pants (black and white only) of the proper size (pants should not drag on floor), white SkillsUSA apron, white chef's hat (paper or cloth), and/or hairnet. A white chef's scarf is optional. No identification of contestant, school or state is allowed on official clothing. If you have a marked coat or shirt, please cover the marking.

The Commercial Baking contest will allow any reasonable hair covering excluding baseball caps. Chef hats are not mandatory but are recommended. Hairnets may be worn with hats to contain all loose hair.

Contestants with long hair that poses a possible safety or sanitary hazard must wear hair containment devices or hairnets. Contestants may be disqualified for lack of safe clothing or attire and not allowed to participate. The orientation meeting would be the time to clarify any questionable attire or hair restraints.

Work shoes: white or black work shoes (closed leather upper, non-skid sole). No canvas, vinyl, plastic or leather athletic-type shoes, sandals or open-toed shoes are permitted in any SkillsUSA Championships event without penalty. The shoe must come up the heel. Contestants may be disqualified where improper footwear constitutes a health or safety hazard.

Equipment and Materials

1. Supplied by the technical committee:
   a. All necessary equipment including mixers, sheet pans, all baking pans, speed racks, pastry cloths
   b. All food items
   c. All necessary information and furnishings for judges and technical committee

2. Supplied by the contestant:
   a. One pallet knife
   b. One hand whip
   c. One large kitchen spoon
   d. Three pastry bags tips and scissors
   e. One bowl scraper
   f. One dough knife
   g. One serrated knife
   h. One pastry wheel
   I. One bench brush
   j. One grease brush
   k. One pastry brush
   1. One rolling pin
   m. Three side towels
   n. One cleaning towel
   o. One set of nested mixing bowls (1, 2 and 3 qt.)

p. Ruler
q. Thermometer
r. Timer
s. Oven mitts or pan handlers
t. No other food items allowed (i.e. sprinkles, decorates, etc.)
u. A small (battery powered or spring) scale, 2 to 5 # capacity
v. Marker (Sharpie) to mark all items (ballpoint pen does not work)

Procedures

Judges will rate each contestant independently and will not compare rating sheets.

The baking contest ends at 3:30 pm. This means ovens will be shut down. Products must be displayed by 3:45 pm - no product will be accepted on the table after 3:45 pm.

A 30 Minute lunch break is required by SkillsUSA

Judges may speak to students or ask questions about their work or product. They will not help nor give advice or instructions.

General Skills

Students work will be observed throughout the day for the “General Skills” portion of the test. The “General Skills” evaluation sheet lists specific, observable performances for safety, sanitation and production efficiency. Judges will closely observe student's Production Efficiency and Use of Equipment/tools. In the area of efficiency they will pay close attention to waste. Are students correctly measuring ingredients to produce the right sized batch? Regardless of batch size, are students using all the dough as instructed? In the area of Equipment/tools Judges will pay close attention the proper and safe use of hand tools and mixers.

Judge's Scoring Criteria

General Skills
Rating Scale:

Oral Professional Development Assessment
- The work area is organized
- Has a plan of work for the day
- Understands the products and is knowledgeable about how each must be prepared

Proper Uniform
- Uniform (shirts, pants, skirts, shoes, hat, towel etc) are clean and fit properly, pants not dragging on floor
- Wears head gear or other covering properly

Safety
- Keeps work area well-organized and free of hazards
- Follows safety requirements for operating equipment
- Works with a regard for safety of self and others
- Uses appropriate tools and equipment for baking function or product (mixer, hand tools etc.)

Sanitation
- Hands clean
- Washes hands correctly and at appropriate times during baking process
- Inspects tools and equipment before using – correctly cleans items
- Uses a clean side towel and replaces as needed during the day
- Avoids contaminating food
- Keeps floor area clean in work area

Production Efficiency
- Accurately measures ingredients
- Uses most or all raw ingredients – little or no wasted ingredients
- Uses most or all mixed ingredients - little or no wasted raw dough
- Properly bakes and finishes product –maximum sellable product is produced

Properly marks all products produced
- Student number is on all product made
- All pans that leave the work area marked with student number

<u>Evaluating Products</u>

There are five basic criteria used to judge products: external and internal appearance, taste, following directions and correct size. The product scoring sheets list the objective criteria associated with each. Judges are asked to pay close attention to proper proofing, proper bake, uniform/consistent shape and size, and specified finish weight (all are included in the five criteria) as they evaluate student's product.

Scratch Products

The "taste" criteria will be applied to the scratch bakery items only. This includes the bread, quick bread, cookies, and pie formulas. Some additional factors for these products are:

Breads: There should be consistent size and weight with slightly rounded ends. The exterior crust should have a uniform thickness and overall golden brown color. There should be no sharp or irregular corners and unusual shapes or streaks. Sidewalls should be firm, and crust neither thick or thin.

Cookies:

Should have excellent top crevices and evidence of proper mixing, even color and uniform shape and size.

Muffins:

Muffins should have good volume, nice top crevices and tops that are not blown out. They should have even rounded sides and a nice crown. The inside should have good even cell structure with no tunnels.

Frozen Dough Products: Sweet Dough and Puff Pastry
For the frozen dough items (sweet dough and puff pastry) we've eliminated the score for taste. We will be judging the products external appearance, the proper bake, the proper proof, creativity with the products made and if the basic instructions were followed. Other factors that will be considered are poor shapes, excessive flour dusting, unprepared fillings, over or under-baked and proofing the sweet dough properly. Even bake should be evident at the sides, center and where toppings meet the dough. The product should have an even gently rolling crown without indentations. The basic desired shape consists of symmetrical swirls to the center on uniform circular base. Good dispersion of cinnamon sugar, a light feel and even bake. For the coffee ring, Crust should have uniform thickness and be baked evenly. Excessive toppings may inhibit crust development.

Secondary Performance Test **Category: Puff Pastry**

Judge's Scoring Criteria for Puff Pastry

Use dough provided to prepare:
Minimum 6 cream horns and fill with whip topping
The test will involve making 3 different shapes with the dough provided

External Appearance

- Factors: Volume, form or shape, size, symmetry, structure, color, crust, thickness, character or feel, and even bake. For certain products, you may also consider: Weight, size, flakiness, over spring, structure, toppings, fillings, and glazes.

Internal Appearance

- Factors: Volume, symmetry, structure, color, grain, texture and even bake.

Salability

- Factors: Product quality, consistency, and presentation as a desirable consumer good.

Secondary Performance Test **Category: White Pan Bread**

Bread in Pan

Bread proofed in oven

Baked Bread

Finished loaf

Judge's Scoring Criteria for Bread

External Appearance

- Factors: Volume, form or shape, size, symmetry, structure, color, crust, thickness, character or feel, and even bake.

Internal Appearance

- Factors: Volume, break or shred, slice, symmetry, structure, color, grain or density, tunneling or holes, texture or feel.

Proper proof, size and weight

- Factors: Product quality, consistency, and correct size

Judge's Scoring Criteria for Sweet Dough

The dough is provided. Divide the dough in thirds to create three different products: Filled coffee cake ring, cinnamon sweet buns and sweet rolls – any shape.

External Appearance

- Factors: Volume, form or shape, size, symmetry, structure, color and even bake.

Internal Appearance

- Factors: Volume, break or shred, grain or density, tunneling or holes and texture

Proper proof and creativity

- Factors: presentation as a desirable consumer good.

Judge's Scoring Criteria for Cake Decorating

Icing Factors

- Symmetry – cake centered on board, final shape of cake, sides perpendicular to top, square and level cake
- Opacity (no window or crumbs)
- Enough/too much icing
- Evenness of slice
- Evenness of filling.

Design Factors:

- Borders – even and symmetrical
- Use of color
- Does design fit the cake (room for lettering, flower too big or small)
- Balance
- Use of flowers

Technique Factors:

- Borders – level of difficulty
- Correct hand pressure to make desired shapes
- Types of flowers – level of difficulty
- Lettering
- Execution of design
- Follow the directions on the cake order

2009 Commercial Baking Competition
Tip Sheet

BEFORE YOU BEGIN…

READ all your formulas through. Points are deducted for not following directions

ORGANIZE your workstation. Keep your table neat and safe

ORGANIZE your time, you will need the entire time allowed to complete this competition

PLAN and this has several steps

- Don't assume or necessarily work in the same order as the formulas presented in the workbook
- For each product, estimate the time needed to scale, mix, rest, bake, cook and finish
- Put it all together – what will you work on, in what order, at what time

Pay attention at Orientation – get a sense of where everything is located. Ask questions…that's the time to get your questions answered

ONCE YOU START….

MARK your product, sheet pans etc. everything that leaves your table, with your ID number

WRITE a note - use your timers - do whatever it takes to avoid these common mistakes –
Leaving products in the oven too long
Letting products over proof
Forgetting to display products

Watch your oven temperatures…make sure you are baking at the right temp

Check and double check your ingredients……Is it sugar **OR** is it salt?

CAKES are easier to decorate when they are frozen

Always CHECK and start mixers at what level? - #1

Make sure you **mark** your product to make sure no one takes your product. Do not take anyone else's product.

Daily Production Sheet

Product	**Quantity**	**Notes**	
Bread			
- Pan loaves			
- Baguettes			
Nut bread			
Muffins			
Coffee Ring			
Cinnamon sweet rolls			
Sweet Rolls			
Cookies			
- Sugar Cookies			
- Butter Tea Cookies			
Cream Horns			
Fruit-filled pastries			
Éclairs			
Pie			
- Pineapple			
- Pecan			

Sample Score Sheet

Candidate #:	Judge:

Product: **(1) Bread**

Rating Scale: From 20 (Excellent) to 1 (Poor)

External Appearance	

- Factors: Volume, form or shape, symmetry, structure

Proper bake	

- Factors: correct crust color and even bake, bottom color correct

Internal Appearance	

- Factors: Volume, break or shred, slice, symmetry, structure, color,

Proper proof	

- Factors: grain or density, tunneling or holes, texture or feel, size

Taste	

- Factors: Aroma, flavor, mouth feel, after-taste, character, palatable, texture, favorable, moist or dry, and freshness.

Proper size and weight	

- Factors: proper length and weight with-in 2 oz over and no underweight

total	

Bakery Formulas

For the

SkillsUSA
Commercial Baking Contest

Secondary Division

For Distribution
2010

The Test

Contestants will prepare a total of seven products selected by the Commercial Baking Technical Committee from the following categories

Standard	The 2010 Test
Yeast Breads and Rolls	1. White Pan Bread
Quick Breads—(No Yeast)	2. Pumpkin bread
Sweet Dough Products	3. Sweet Dough Variations
Cookies	4. Sugar Cookies
Basic Cake Decorating	5. Decorate Cake
Puff Pastry (Laminated Dough)	6. Puff Pastry Variations
Pie and Pie Crust Pastry	7. Pineapple Pie

1. White Pan Bread

Source*: RBA*

Raw material	LB	OZ	Bakers %	Instructions
Yeast		2	2.5	Mix with 6 oz of water, set aside
Water	3	4	64	Variable
Bread Flour	5		100	
Salt		1.8	2.25	
Sugar, granulated		4	5	
Milk powder		4	5.0	
Shortening, all purpose		2.5	3	
TOTAL	**9**	**2.5**		

1. Dough temperature: Between 75 and 80 degrees. (Watch your temperatures). Allow dough to rise, dough should double in size.

2. Cut into proper size pieces, round the piece of dough up and let rest. DO NOT USE PROOF BOX –Keep dough at room temperature, covered.

3. Make Up:
   - 2 pan loaves, scale 12 oz to achieve finished weight of 10-11 oz.
   - 2 three-braided loaves – scale to 18 oz – finished weight 16 oz
   - With remaining dough prepare one baking sheet of single knot rolls.

4. Proof to proper size.

5. Wrap excess dough and leave on your rolling rack.

6. Bake: 400 degrees.

Display: One standard loaf, one braided loaf, and three knot rolls.

2. Pumpkin Bread

Source: Baking Fundamentals, Noble Masi

Raw Material	LB	OZ	Baker's %	Instructions
Pumpkin, canned		14	100	Combine the pumpkin with the sugar, eggs, baking soda, salt and spices
eggs		6	43	
Sugar	1	2	128	
Baking soda		1/8	1	
salt		1/4	2	
Ground cloves		1/8	1	
Ground cinnamon		1/8	1	
Bread flour		14	100	Just blend together, avoid over mixing.
Baking powder		1/4	2	
Vegetable oil		6	43	
raisins		8	57	Add water and raisin. Blend together
water		6	43	
Total	**4**	**9**		

Procedure

Combine first 7 ingredients and mix with paddle for approx. 5 minutes

Gradually add oil, flour and baking powder

Add water and raisins

Pour into loaf pans provided to make proper size loaf

Bake at 375 degrees

3. Sweet Dough

The dough is provided: 2 lb 8 oz. (40 oz).

Prepare the following:

- 2 Filled Coffee Cake Ring use 10oz dough for each one
- Cinnamon Sweet Rolls (use all remaining dough; focus on uniformity of shape and weight). Bake in straight sided aluminum pans.

1. Proof finished products.

2. Bake: 375 degrees

3. Finish with premade icing provided.

*see attached page for different Danish designs

4. Sugar Cookies

Source*: RBA*

Raw Ingredients	LB	OZ	Baker's %	Instructions
Sugar		8	50	Cream ingredients to soft mix
Salt		0.16	.8	
Butter		6	37.5	
Eggs, whole		4	25	Add eggs in two stages and cream in.
Milk, liquid		2	12.5	Add milk and vanilla and stir slightly
Vanilla		0.25	.25	
Cake Flour	1		100	Sift flour and baking powder together, add and fold lightly.
Baking Powder		0.6	3	
TOTAL	**2**	**5**		

1. Roll dough to approximately ¼-inch thickness on canvas lightly dusted with flour.
2. Use parchment-lined baking sheets.
3. Cut out at least 2 dozen cookies, assorted shapes (round, heart, crescent, diamond).
4. Wash with milk and sprinkle with granulated sugar.
5. Bake in 375 degrees F oven. *DO NOT OVERBAK*E.
6. Display 6 cookies.
7. (Wrap left over dough and leave on your rack.) **LEAVE REMAINING COOKIES ON PAN FOR DISPLAY/JUDGING.**

5. Cake Decorating

Source*: RBA*

Each student is provided two 8" round cake and white icing.

This is your cake order.

Test Problem

Customer Name: Ms. Sarah Jones **Phone:** 800-638-0924

Day Wanted: Thursday

Date Wanted: 6/24/10

Time Wanted: 4:00PM

Size: 8" rounds, split and filled with red jelly filling. Fillings are provided.

Icing: Use icing provided

Colors: Yellow roses, green leaves

Flower Type: Spray of roses- 3 to 5

Inscription: Happy Birthday Vickie

Special instructions:

1. Scale no more than 2 lbs of whip topping. Use whipped topping for icing the cake.
2. Prepare colors and bags. Use butter cream icing provided for roses.
3. Pipe white border of your choosing.
4. Do not comb sides.

6. Puff Pastry

Have dough come to room temperature

Use the dough provided to prepare the following products:

Make four (4) fruit-filled pastries, 4 cream horns, and 4 of a shape of your choosing to yield 12 total. (Not to exceed 4 oz. each). Add fruit filling after baking and finish pastries with icing that is provided. Fill cream horns with whip topping.

Rest for 30 minutes before baking.

. Bake: 400F degrees.

Display one piece of each shape/variety.

7. Pineapple Pie

Source*:* *Baking Fundamentals* © *2007,* modified 2008 by Noble Masi, CMB

Dough

Raw Material	LB	OZ	Baker's %	Instruction
Pastry Flour	1		100	Prepare by hand.
Shortening, all purpose		10	60	Rub shortening and flour until dough forms small pieces
Salt		0.30	1.87	Dissolve ingredients in water. Add to the above and fold over lightly until the liquid is absorbed.
Water (cold)		7	40	
TOTAL	**2**	**1 1/2**		

Filling

Canned pineapples- drained		12		place pineapple, sugar and 2 oz. water in sauce pan, and bring to a boil
Sugar		6		
Water		4		
Corn starch		1		Use 2 oz water to make slurry
				add slurry to boiling pineapple (let liquid return to a boil)
				let cool before placing in pie shell
TOTAL	**1**	**7**		

1. Rest dough for half hour minimum.

2. Prepare enough for one double crust pie and one unbaked 8-inch pie shell. Use the 8" pie pans, *not the straight sided pans*. Scale 5 to 7 oz for each top and bottom. You should have a little dough left over.

3. Fill one pie and top the pie with a pie crust (double crust or lattice top)

4. Sprinkle with sugar.

5. Bake pie at 400 F until golden brown.

6. Do not bake the second, unfilled pie shell. However, finish and flute the edges for display.

Bakery Formulas

For the

SkillsUSA
Commercial Baking Contest

Postsecondary Division

For Distribution
2010

The Test

Contestants will prepare a total of seven products selected by the Commercial Baking Technical Committee from the following categories.

Standard	The 2010 Test
Yeast Breads and Rolls	1. Basic French Bread
Quick bread—(No Yeast)	2. Blueberry Muffins
Sweet Dough Product	3. Sweet Dough Variations
Cookies	4. Butter Tea Cookie
Basic Cake Decorating	5. Decorate Quarter Cake
Pate a Choux Products	6. Éclair Pastry
Pie and Pie Crust Pastry	7. Pecan Pie

1. Basic French Bread Dough

Source: RBA formula database, (858 -Power) 2000.

Raw Ingredients	LB	OZ	Baker's %	Instructions
Bread Flour (high gluten)	3	8	100	Use straight dough method.
Salt		1.25	2	
Yeast, compressed		2.0	4	
Water	2	4	64	variable
TOTAL	**5**	**15.25**		

1. Dough temperature should be 75 to 80 degrees.
2. Bulk ferment on the bench, depending of dough temperature and room conditions. Allow dough to double in size.
3. Cut dough into appropriate size pieces and let rest.
4. Make six traditional baguettes with a finished weight of 11 oz each. Judges will accept 2 oz overweight on the finished bread. Underweight will be penalized points.
5. Length should be 16"-18"
6. With left over dough make creative loaf.
7. Proof
8. Slash bread with 7 diagonal (seven) cuts
9. Bake: 425 degrees.

2. Blueberry Muffins (Quick bread)

Source: Commercial Baking Contest 1996, revised 2001 based on Professional Baking, Gisslen.

Raw Ingredients	LB	OZ	Baker's %	½ Batch Reformation	Instructions
Sugar, granulated		12	30		Cream ingredients
Shortening, all purpose		12	30		
Salt		0.5	1		
Vanilla		0.5	1		
Eggs whole, beaten		8	20		Add eggs and cream.
Pastry Flour	2	8	100		Sift together dry ingredients. This may be done ahead of time and set aside before adding liquid.
Baking Powder		2.5	6		
Milk, liquid	2		80		Add flour and milk to the creamed ingredient in stage
TOTAL	**6**	**11**			
Blueberries		10	25		Fold into batter and bake immediately.

Procedure

1. Assure pans are ready before mixing. You may either use pan liners or grease them.
2. Once the wet and dry ingredients are mixed you must pan up one dozen and bake immediately.
3. Blueberries should be well drained or, if frozen, kept frozen until batter is ready for the addition of the berries. Berries should be added quickly and immediately panned out.
4. Fill tins 1/2 to 2/3 full.
5. Bake at 400-degree F.

3. Sweet Dough

Commercial Baking Contest 1995, revised 2000.

The dough is provided: 2 lb 8 oz. (40 oz).
Use about a 1/3 of the dough for each product listed below:

- Filled Coffee Cake Ring –13 oz- Total weight
- Cinnamon Sweet buns – 13 oz-Total weight
- Sweet Rolls – any shape – 13 oz-Total weight

Underweight will be penalized points.

Use all dough. Focus on uniform shape and weight.

1. Proof product to the right size
2. Bake: 375 degrees.
3. Finish with icing provided
4. Do not use red fillings on the pastry cloths

4. Butter Tea Cookie

Source: Commercial Baking Contest 1992, revised 1998, revised 2001 based on Professional Baking, Gisslen.

Raw Ingredients	LB	OZ	Baker's %	Instructions
Butter		11	33	Creaming method.
Shortening, all purpose		11	33	
Sugar, granulated		11	33	
Sugar, 6X (powdered)		6	18	
Eggs, whole		8.25	25	Cream light and fluffy.
Vanilla		.3	1	
Cake Flour	2	1	100	Sift then blend in flour.

Procedure

1. Bag cookies using plain tube or star tube.
2. Make cookies small - about size of quarter, make one sheet pan.
3. Cookies are to be plain and not decorated.
4. Bag onto parchment lined pan. Make only one sheet of cookies. **Left over dough must be wrapped and placed on rack.**
5. Bake at 375F.

5. Cake Decorating

Source: Commercial Baking Contest, revised 1998.

The Bakery Cake Order Form

Customer Name: Ms. Sarah Jones **Phone:** 800-638-0924

Day Wanted: Wednesday

Date Wanted: 6/23/10

Time Wanted: 4:00PM

Size: quarter sheet

Icing: Use icing provided

Colors: white icing, red roses, green leaves

Flower Type: spray of roses – 3 to 5

Inscription: Happy Birthday Tina

Special instructions:

1. Scale no more than 2 lbs of icing provided.
2. Use butter cream for flowers and writing.
3. Piped border of your choosing.
4. Do not comb sides.

6. Éclair Cream Puff

Sources: Commercial Baking Contest RBA

Raw Ingredients	LB	OZ	Bakers %	Instructions
Water	2		133	Combine the liquid, shortening, salt sugar in a heavy saucepan or kettle. Bring the mixture to a full, rolling boil
Shortening, all purpose	1		67	
Salt		0.75	3	
Sugar, granulated		0.75	3	
Bread Flour	1	8	100	Remove from heat and add the flour all at once. Stir quickly. Return to moderate heat, stir vigorously until the dough forms a ball and pulls away from the sides of the pan. Cook thoroughly. Transfer the dough to the bowl of a mixer. With the paddle attachment, mix at low speed until the dough has cooled slightly. It should be about 140 degrees F (60 degrees C), which is still very warm, but not too hot to touch.
Eggs, whole/fresh	1	8	100	At medium speed, beat in the eggs a little at a time. Wait until they are completely absorbed before adding more. Mix until blended. The paste is ready to use.
TOTAL	**6**	**1.5**		

Procedure:

1. Line sheet pans with silicone paper.
2. Pipe out éclairs 4-5” long, cream puffs approximately 3” round.
3. Bake at 400 F degrees for about 30 minutes. Do not under bake. Remove them from the oven and let cool slowly in a warm place.
4. When cool, fill with cream filling (based on available materials) using a pastry bag with a star tube. Dust with confectioners’ sugar.

7. Pecan Pie

Source: RBA database, Mark Atwood/Atwood's Bakery

Pie Filling

Raw Ingredients	LB	OZ	Instructions
Sugar, granulated		8	Blend together until smooth.
Flour, Bread		1/2	
Salt		1/8	
Butter		2	
Corn syrup		15	Then add and mix until smooth, but not over mixed.
Eggs		8	
Vanilla		1/4	Be sure to scrape bowl well.
Pecans		4	Stir pecans into mix and pour into crust.

1. Bake at **325 for 45-55 minutes**, until top starts to crack and center is **no longer liquid**.

Pie Dough

Raw Material	LB	OZ	Baker's %	Instruction
Pastry Flour	1	4	100	Prepare by hand.
Shortening, all purpose		12	60	Rub shortening and flour until dough forms small pieces
Salt		0.4	2	Dissolve ingredients in water. Add to the above and fold over lightly until the liquid is absorbed.
Water (cold)		7	35	
TOTAL	**2**	**7.4**		

1. With remaining dough, make one unbaked pie shell for display.

2. Use 9" standard pie pan for the baked pie and for the **unbaked shell**.

2010 Commercial Baking Competition
Judge's Score Sheet

Candidate #:	Judge:

Product: **(1) Bread**

Rating Scale: From 20 (Excellent) to 1 (Poor)

External Appearance	

- Factors: Volume, form or shape, symmetry, structure

Proper bake	

- Factors: correct crust color and even bake, bottom color correct

Internal Appearance	

- Factors: Volume, break or shred, slice, symmetry, structure, color,

Proper proof	

- Factors: grain or density, tunneling or holes, texture or feel, size

Taste	

- Factors: Aroma, flavor, mouth feel, after-taste, character, palatable, texture, favorable, moist or dry, and freshness.

Proper size and weight	

- Factors: proper length and weight with-in 2 oz over and no underweight

TOTAL	

2010 Commercial Baking Competition
Judge's Score Sheet

Candidate #:	Judge:

Product: **(2) Quick Bread/ Muffins**

Rating Scale: From 20 (Excellent) to 1 (Poor)

External Appearance	

- Factors: Volume, form or shape, size, symmetry, structure

Proper bake	

- Factors: baked to proper color, even bake, not doughy inside

Internal Appearance	

- Factors: Volume, can be sliced, not crumbly, grain or density, tunneling or holes, proper texture

Taste	

- Factors: Aroma, flavor, mouth feel, after-taste, character, palatable, favorable, moist or dry, and freshness.

Correct size	

- Factors: size consistency, right amount of batter for the pan

Followed instructions	

- Right size pan, mixed properly, right ingredients, made according to directions

TOTAL	

2010 Commercial Baking Competition
Judge's Score Sheet

Candidate #:	Judge:

Product: **(3) Sweet Dough**

Rating Scale: From 20 (Excellent) to 1 (Poor)

External Appearance	

- Factors: Volume, form or shape, size, symmetry, structure, toppings, fillings, and glazes. Rolls made properly

Proper bake	

- Factors: baked to proper color, even bake

Proper proof	

- Factors: raised to proper size

Internal Appearance	

- Factors: Volume, slice, symmetry, structure, color, grain or density, tunneling or holes, texture, not doughy

Creativity	

- Good use of fillings, good eye appeal

Followed instructions	

- Right size pan, right amount product, made according to directions

TOTAL	

2010 Commercial Baking Competition
Judge's Score Sheet

Candidate #:	Judge:

Product:/S **(4) Cookies**

Rating Scale: From 20 (Excellent) to 1 (Poor)

External Appearance	

- Cookie has good eye appeal

Proper bake	

- Baked to proper color, even bake, not doughy inside

Internal Appearance	

- Volume, color, grain or density, tunneling or holes, texture or feel, and even bake.

Taste	

- Aroma, flavor, mouth feel, after-taste, character, palatable, texture, favorable, moist or dry, and freshness.

Followed instructions	

- Mixed properly, right ingredients, made according to directions

Uniformity	

- All cookies made to the same size and shape

TOTAL	

2010 Commercial Baking Competition
Judge's Score Sheet

Candidate #:	Judge:

Product:/S **(6) Puff Pastry**

Rating Scale: From 20 (Excellent) to 1 (Poor)

External Appearance	

- Factors: Volume, form or shape, size, symmetry, structure

Proper bake	

- Factors: baked to proper color, even bake, not doughy

Internal Appearance	

- Factors: Volume, proper flakiness, symmetry, and even bake. Not doughy inside

Followed instructions	

- Three different products made, finished according to directions, filled after baking

Dough handled properly	

- Maintained the layers in the dough, rolled to right thickness

Dough utilization	

- Used all or most of dough, very little scrap

TOTAL	

2010 Commercial Baking Competition
Judge's Score Sheet

Candidate #:	Judge:

Product: **(6) Pastry - Éclair**

Rating Scale: From 20 (Excellent) to 1 (Poor)

External Appearance	

- Volume, proper shape, same size

Proper bake	

- Baked to proper color, even bake

Cooked and mixed properly	

- Paste made properly cooked correctly, mixed correctly

Internal Appearance	

- Volume, proper cavity formed, not doughy

Followed instructions	

- Right size product, mixed properly, right ingredients, made according to directions

Finished properly	

- Cream puff filled with whip topping, éclair filled with Bavarian cream, correct topping

TOTAL	

2010 Commercial Baking Competition
Judge's Score Sheet

Candidate #:	Judge:

Product:/S **(7) Pie**

Rating Scale: From 20 (Excellent) to 1 (Poor)

External Appearance	

- Factors: form or shape, size, symmetry, structure, crust thickness flaky crust

Proper bake	

- Factors: baked to proper color, even bake, baked on bottom

Internal Appearance	

- Factors: filling cooked properly
- Crust proper thickness

Taste	

- Factors: Aroma, flavor, mouth feel, after-taste, palatable, texture, favorable, moist or dry, and freshness.

Pie shell	

- Factors: good general appearance, proper crust thickness, nice finished top edge

Followed instructions	

- Right size pan, mixed properly, right ingredients, made according to directions

TOTAL	

2010 Commercial Baking Competition
Judge's Score Sheet

Candidate #:	Judge:

Product: Cake Decorating

Rating Scale: From 20 (Excellent) to 1 (Poor)

Icing	

- Symmetry – cake centered on board, cake correct shape, sides perpendicular to top, square and level cake
- Opacity (no window or crumbs)
- Not enough or too much icing

Borders	

- Even borders
- Proper size for cake

Design	

- Use of color
- Does design fit the cake (room for lettering, flower too big or small)
- Balance
- Use of flowers

Flowers	

- Right size for cake, made properly leaves added properly

Writing	

- Lettering
- Execution of design
- Does it convey proper message and fit cake

Followed instructions	

- made according to directions, followed the cake order

TOTAL	

2010 Commercial Baking Competition
Judge's Score Sheet

Candidate #:	Judge:

Product: (8) General Skills

Rating Scale: From 10 (Excellent) to 1 (Poor)

Oral Professional Development Assessment.	

- The work area is organized
- Has a plan of work for the day
- Understands the products and is knowledgeable about how each must be prepared

Proper Uniform	

- Uniform (shirts, pants, skirts, shoes, hat, towel etc) are clean and fit properly, pants not dragging on floor
- Wears appropriate head gear or other covering

Safety.	

- Keeps work area well-organized and free of hazards
- Follows safety requirements for operating equipment
- Works with a regard for safety of self and others
- Uses appropriate tools and equipment for baking function or product (mixer, hand tools etc)

Sanitation.	

- Hands clean
- Washes hands correctly and at appropriate times during baking process
- Inspects tools and equipment before using – correctly cleans items
- Uses a clean side towel and replaces as needed during the day
- Avoids contaminating food
- Keeps floor area clean in work area

Production Efficiency.	

- Accurately measures ingredients
- Uses most or all raw ingredients – little or no wasted ingredients
- Uses most or all mixed ingredients - little or no wasted raw dough
- Properly bakes and finishes product –maximum salable product is produced

Properly marks all product	

- Student number on all items made
- All pans that leave work area marked with student number

TOTAL	

SkillsUSA
2010 Contest Projects

Computer Maintenance Technology

Click the “Print this Section” button above to automatically print the specifications for this contest. Make sure your printer is turned on before pressing the button.

Computer Maintenance Technology

Computer Maintenance Tech contestants must bring two forms of identification to Kansas City. This ID is required for you to take the CompTIA A+ Certification exams, which are a key part of the contest. The recommended ID is a driver's license and anything else, such as a student ID, credit/debit card, social security card, etc. If you don't have a driver's license, a photo ID and one other ID must be provided. Passports and military IDs are valid, too. Candidates who do not provide ID will not be admitted to the test and will received no score for this portion of the contest. Exceptions cannot be granted.

Some time in June you may receive an e-mail message indicating you have been scheduled to take the A+ Certification exams at a Pearson VUE test center. Don't worry about the time or place for this exam registration, we will give you a schedule for taking the exam at the pre-contest orientation. All contestants will take the exams, even if previously A+ certified. There is no cost for taking the exams.

2010 CMT Contest Summary

The 2010 CMT contest was designed to measure the following.

- Ability to move the location of the "My Documents" folder for a user, including restore a relocated "My Documents" folder back to the default location.
- Familiarity with the use of secondary display screens. This includes consideration of what might happen if a PC that had been setup for a secondary video output was suddenly left with just a single/primary display screen.
- Knowledge of all means available for programs to be launched automatically, without user consent, in a Windows computer.
- Familiarity with the use of the TCP/IP "hosts" file.
- Other basic Ethernet and TCP/IP client configurations including selection of correct Ethernet media type, and TCP/IP addressing basics.
- Ability to setup a simple shared read-only network folder. Ability to modify a simple shared folder to allow for read-write-delete access.

Wireless Networking

- The ability to configure a standard, encrypted 802.11 wireless network
- Use standard method to protect a wireless network beyond encryption
- Configure a SOHO router for home use
- Use basic firewall protections for a standard home router

Windows Startup Issues

- The ability to recover a system that is missing key boot files without reformatting or reinstalling.
- An understanding of the system files typically located at C:\, and what they do.
- The ability to attack and stop basic malware activity.
- Properly utilize commands such as FIXBOOT.

Other Skills

- The ability to make major system configuration changes while ensuring that customer data remains *absolutely* safe.
- The ability to install new hard drives.
- The ability to halt system files from launching malware in a command-line environment.
- The ability to use common commands (not search tools) to locate files.
- Identify various parts and pieces commonly found in computers and peripherals.
- Use a multimeter to measure continuity, DC voltages, and simple current.
- Understand a simple application of Ohm's Law.

Contestant # _____

Windows XP Laptop Part 2, Boot

Note: The BIOS is not part of the problem or the solution.

If you are prompted to approve the installation of any driver for new hardware, click STOP or NO! *Do not install the driver.*

(you don't need it, plus it takes far too much time…you'll be sorry!)

This system normally launches with its only useful account, the *Administrator* account, and that account has no password. ***Note: It's old, but this computer is plenty fast enough for this exercise. You don't have time to reinstall Windows. You may use your own boot device, a flash drive or live CD.***

◆**Make the system boot normally/properly.** All necessary tools have been provided. The Windows disk has not been tampered with, all the files are original. You may use your own software tools, e.g. CD, flash drive, etc.

Briefly, what was the boot problem? (you are not scored on this optional explanation)

_____

_____

◆Once you get the system to boot properly, it is supposed to have about **5 GB** of free space. Resolve this storage space issue without deleting applications or important user data files. **Permanently fix any malware issues** you may encounter. Use Windows configuration defaults where appropriate.

Briefly, describe the problems you fixed: (you are not scored on this optional explanation)

_____

_____

◆Be sure to verify that these problems are resolved, and stay resolved.

◆Finally, set the system file view options to their default hidden/protected status.

SkillsUSA Computer Maintainence Technology - Contestant Number_____

Username: student (administrator privelages)
Password: total

Station 1 - The Wonders of Windows

Feel free to do these questions in any order.

1) The Windows Registry is stored as files on your hard drive. Write down the location of the files, the names of the files and their size.

2) Is Data Execution Prevention (DEP) enabled on this system?

Is User Access Control (UAC) enabled on this system?

Many people confuse DEP with UAC. Explain what each of these features do.

3) Inspect the currently running services on the system. Give you opinion as to which of the running services should be shut down (maximum of 5).

4) Your computer is running as a server for a very common Internet application. What is the application name. and what port is it using?

5) These machines are configured for DHCP. If they cannot find a DHCP server, what IP address will they use?

6) Change the file association for ZIP files to use the installed 7zip application. When done, raise your hand to show the proctor.

7) Write down the location of the swap file on this system and its size.

8) Reconfigure Internet Explorer to use a proxy server at 192.168.5.200 only for FTP. When done, raise your hand to show the proctor.

9) What is the native resolution of the monitor for this laptop?

10) Does this system have hibernation enabled?

Laptop 1 Windows XP Contestant # _____

Configure the laptop to the customer's criteria and resolve the problems or issues they are having. the tasks may be completed in any order, place a check mark by the completed tasks...

The Issue: the system was infected by a Trojan horse *SHeur2.BKB*. The system *was cleaned* but the file it infected was deleted (%system%\system32\userinit.exe). Since then, the computer acts as it is logging in, then instantly returns to the login screen. Now the computer will not boot, it says a file is missing.

- *A windows XP SP2 disk is provided for your use.*
- ***DO NOT** try to reinstall the OS.*
- **Login**: Administrator **Password**: password
- **Login**: Skills **Password**: Skills

POINTS	✓	Posssible			Use this login to complete the task
			Problem to resolve:		
		25	•	Will not boot	Administrator
		25	•	Will not allow you to login	~~Administrator~~
		25	•	Comes up in safe mode	~~Administrator~~
			Customer Configuration:		~~Skills~~
		20	•	Change the primary partition (system) from FAT32 to NTFS	
		10	•	Create a 2GB partition o Volume name SWAP o File System: NTFS	
		10		o Change the pagefile to use the SWAP partition only o Let system manage size	
			Create a share:		~~Skills~~
		10		o Create a folder in the root of the system drive named SUSA o Share and give full control only to the *Administrator Group*, all others must be removed	
		5		o Allow only 10 users	
			Set to Windows 2000 environment:		~~Skills~~
		10		o Classic: Menu, Theme and Folders	
		10	•	Adjust Visual Effects: for best performance	
		150			

SkillsUSA
2010 Contest Projects

Computer Programming

Click the “Print this Section” button above to automatically print the specifications for this contest. Make sure your printer is turned on before pressing the button.

NATIONAL CONTEST PROGRAM #1
FURNITURE SALES PROGRAM

A furniture and appliance dealership has asked you to create a sales screen to allow the salespeople to figure a customer order.

Buttons will include: At the bottom
- Calculate
- Clear (allows for another entry, reset to another amount)
- Exit

All screens will be clearly labeled with contestant number, program number and title.
All boxes will be clearly labeled.
Screen will have company name, complete address and phone. Allow salespeople to select from 5 pieces of furniture or appliance (of your choice), the selection will be made from a list on your screen, list will include furniture or appliance price.
Examples:
Stoves, refrigerators, dishwashers, chairs, sofas, etc.
Screen will have the following.

Input
- List of 5 items with their product number and price on the screen
- Product number 1 – 5
- Number of the items ordered
- Months to pay

Output
- Product ordered name and amount
- Number of items ordered
- Months to pay
- Monthly payment
- Total amount of items

Calculated screen will show their choice of the above items; calculated total price and monthly payment. Remember that part of the judging is based on the proficiency of your code.

When you have completed this program put your number and time on the sheet for the first program, the judge will take you in turn for execution for the correct output. When approved, print out your code instructions and screen. Clearly mark with your assigned contestant number and had in to judges table. Go on to next program.

NATIONAL CONTEST PROGRAM #2

COMPUTE NEW YEARLY SALARY

You are to write a program to display the salaries projected for next year.

Input data: Employee Number 1 – 5
Employee rating for the year 1 – 3
Employee current salary
Number of years with the company

Output data:
Employee name retrieved from store in the program
Employee number
Employee rating
Number of years with the company
Current salary
New salary
Amount of increase

Employee rating 1 = 5%
2 = 7%
3 = 9%
Employee's with 10 years and more receive and additional 3%.
Employee's with 15 years and more receive and additional 5%.

When you have completed this program sign the sheet and wait for the judges to execute for the correct output. When approved print out your code and instructions. Clearly mark with your assigned contestant number and hand in to judge. Wait until the judges have graded both of your programs and you are free to leave.

SkillsUSA
2010 Contest Projects

Cosmetology

Click the “Print this Section” button above to automatically print the specifications for this contest. Make sure your printer is turned on before pressing the button.

Competitions - SkillsUSA

Cosmetology SkillsUSA National Championships 2010

SkillsUSA Championship offers students of career and technical and education the opportunity to demonstrate their leadership and hands-on occupational skills and receive recognition for their achievement. Winners advance from local competitions to district and /or state championships and finally to the national Skills USA Championship in Kansas City at the end of June each year.

Nationals Schedule

SkillsUSA 2010

Wednesday, June 23th

12:00 pm	Committee Meeting
1:00 pm	Registration for contestants, hand in résumés(We went to electronic submission of resumes this year)
1:15 pm	Welcome, introduction of conference team, sponsors and judges, WorldSkills update
1:30 pm	Orientation and review of contest rules
2:30 pm	Written Test - Secondary Oral Test - Post Secondary Fill out sketch sheets for long hair color
3:00 pm	Written Test - Post Secondary

	Oral Test -Secondary
4:00 pm	On-site visit

Thursday, June 24th

8:30 am	Registration (Kit check)
9:00 am	Orientation/Introduction
9:15 am	Long Hair Overview
9:30a am	Long Hair (1 hour)
10:30 am	Judge Long Hair Design
11:00 am	Women's Cut and Design Overview
11:15 am	Women's Cut and Design (45 minutes)
12:00 pm	Judge Women's Cut and Design
	LUNCH
1:00 pm	Women's 90-degree Cut and Design Overview - Secondary Men's Cut and Design Overview - Postsecondary

1:15 pm	Women's 90-Degree Cut and Design (45 minutes) - Secondary Men's Cut and Design Overview - Postsecondary
2:00 pm	Judge Women's 90-Degree Cut and Design - Secondary Judge Men's Cut and Design Overview - Postsecondary
2:30 pm	Women's 90-Degree Cut and Design Overview - Postsecondary Men's Cut and Design - Secondary
2:45 pm	Women's 90-Degree Cut and Design (45 minutes) - Postsecondary Men's Cut and Design (45 minutes) - Secondary
3:30 pm	Judge Women's 90-Degree Cut and Design - Postsecondary Judge Men's Cut and Design - Secondary
4:00 pm	Grand finale parade
4:15 pm	Final introduction of judges, committee members and sponsors

Contest Instructions

Mannequins

The technical committee will supply mannequins and holders for all areas of this contest. The long hair mannequin will be sent before the competition as soon as your state director forwards the student's name to SkillsUSA. The long hair mannequin should be pre-colored prior to the competition and brought to Kansas City.

If this changes in any given year, contestants will be told in advance to bring their own mannequins and holders.

Orientation Meeting:

Orientation meeting is conducted the day before the contest. Please submit your résumé in a simple manila file folder.(If not posted online prior to the event) The contest rules are reviewed as well as clothing requirements. Contestants will be escorted to contest site once the written test and oral communications test have been administered. Once contestants are familiar with the site and receive final instructions they will receive their gifts from the sponsors of the contest and will be free to leave for the day.

SkillsUSA Test: Used as a tie-breaker only. Subject matter-SkillsUSA Championships.

Parade Finale

Once the contest has been completed, contestants will be asked to provide some information to the commentator on a sheet of paper. Please type using 14-point typeface and print out the following information before arriving to SkillsUSA. Below is a sample:

Name:

School:

Advisor:

City/State: "Chicago, IL" (sample)

State slogan: "The Land of Lincoln" (sample)

Contestant will be asked to select from their completed mannequins and present them to the audience and judges during the parade finale.

Announcement of Winners

1st, 2nd and 3rd place winners for Secondary and Post Secondary winners will not be announced until the Awards Ceremony. Sponsor prizes for these winners will be shipped to their home addresses compliments from the Technical Committee.

Uniform Layer (90-Degree) Haircut Procedure

Contestants must be able to duplicate a uniform layer (90-degree) haircut and design selected by the National Tech Committee. Contestant will style the hair with blow dryer and fingers only. Steps must be followed in the exact order.

Please also refer to the April 15th SkillsUSA Standards Update

a. Time allotted - 45 minutes

b. 200 possible points - cut and blow dry will be scored

c. Tools assembled and station prepared

d. Create a four-section parting

e. Establish the design length around the back perimeter

f. Establish the design length around the front perimeter

g. Establish the interior guide at the top of the head (apex, crown)

h. Continue cutting guideline to front hairline

i. Continue cutting guideline from crown to nape

j. Use vertical partings to blend top guide to design line

k. Maintain a constant 90-degree elevation throughout the procedure

l. Follow a traveling guide to maintain uniformly layered lengths

m. Perform a cross check of procedure for accuracy

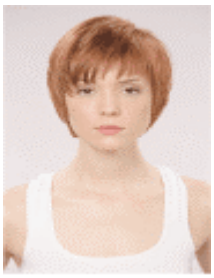
n. Check perimeter guideline and finish as necessary

o. Finished cut is uniformly blended

p. Blow hair dry to frame face

q. Clean and organize station

All of the following images below will be selected for the Cuts and Style contest at Nationals



Pivot Point Long Hair Mannequin that will be used at Nationals:

1. Ladies': Educational mannequin: Elizabeth - MMLSCDML-XL

OTHER MANNEQUINS USED AT NATIONALS:

2. Ladies': Burmax

3. Men's: Clic

SkillsUSA
2010 Contest Projects

Crime Scene Investigation

Click the “Print this Section” button above to automatically print the specifications for this contest. Make sure your printer is turned on before pressing the button.

SkillsUSA Crime Scene Investigation Competition

2010 Crime Scene Investigations judging sheet

Page 2

Judges name: _____ **Team number:** _____

		Item	Yes 25 points	No 0 points
8.	Evidence properly packaged			
		Hair	☐	☐
		Blood	☐	☐
		Cell phone	☐	☐
		Hotel key card	☐	☐
		Shell casing	☐	☐
		Shell casing	☐	☐
		Photo Scan Disk	☐	☐
9.	Hotel key card processed for latent prints		☐	☐
10.	Recovered latent fingerprint.		☐	☐
11.	Latent fingerprint usable		☐	☐
12.	Vehicle diagram		☐	☐
13.	Evidence log properly filled out		☐	☐
14.	Photograph log completed		☐	☐
15.	Photographs usable & depicts the scene (overall, medium, close-up)		☐	☐

16. Report contents– Who☐, What☐, Where☐, Why☐, How☐ 10 points each Total _____

Page 2 Total _____

Page 1 Total _____

TOTAL _____

SkillsUSA Crime Scene Investigation Competition

2010 Crime Scene Investigations judging sheet

Page 1

Judges name: _____ **Team number:** _____

1. Ask for Search Warrant — 75 points _____

2. Exterior of vehicle photographed prior to vehicle search? — 25 points _____

3. Systematic search of vehicle? — 25 points _____

4. Did they wear gloves? — 25 points _____

5. Did they change gloves for each item? **Hair** ☐ **Blood** ☐ (25 points for each) Points _____

6. Photograph each item before collection.

Item	**Yes 25 points**	**No 0 points.**
Blood	☐	☐
Hair	☐	☐
Cell phone	☐	☐
Shell casing	☐	☐
Shell casing	☐	☐
Hotel key card	☐	☐

7. Item collected from vehicle.

Item		
Blood	☐	☐
Hair	☐	☐
Cell phone	☐	☐
Shell casing	☐	☐
Shell casing	☐	☐
Hotel key card	☐	☐

Page 1 Total _____

SkillsUSA
2010 Contest Projects

Criminal Justice

Click the “Print this Section” button above to automatically print the specifications for this contest. Make sure your printer is turned on before pressing the button.

QUESTIONS ON CONSTITUTIONAL LAW
SCORE SHEET

1. A law enforcement officer must advised a subject of their Miranda warnings at what time.

   a. Anytime a suspect is arrested
   b. Anytime a suspect is questioned about a crime
   c. Anytime a custodial interrogation is conducted
   d. All of the above.

2. A law enforcement officer has made an "arrest" when the subject in question

   a. Has been advised of their Miranda rights.
   b. When the person in question is placed in handcuffs
   c. When the person's freedom of movement has been significantly restricted.
   d. None of the above

3. The right of an individual to not be compelled to testify against himself is guaranteed by what amendment to the Constitution of the United States

   a. 1st
   b. 4th
   c. 5th
   d. 14th

4. In order for a police officer to stop or detain a person, officer must have what degree of knowledge that the person stopped is involved in criminal activity

   a. Probable Cause
   b. Proof beyond a reasonable doubt
   c. Reasonable suspicion
   d. Clear and Convincing

5. When a police officer makes a valid arrest, the officer may search the person of the arrestee due to

   a. Search incident to arrest
   b. Inventory search
   c. Protective pat down
   d. All of the above

6. The issuance of a search warrant for a person's residence shall be based on

   a. Reasonable suspicion
   b. Probable cause
   c. Articulable suspicion
   d. Personal belief

7. If a law enforcement officer has a valid search warrant for a person's residence authorizing that officer to search for illegal firearms, that officer may search

   a. Anywhere he desires within that residence
   b. Only where the search warrant specifically orders the officer to search
   c. Any room or container found inside the residence
   d. Any room or container where the illegal firearms may reasonably be found

8. Once a valid search warrant is issued and executed, the executing officers may continue to search until

   a. All areas listed on the warrant are search
   b. Until the object or objects under the warrant have been located
   c. The officers present leave the search site
   d. All of the above

9. In a situation where all of the objects of a search have not been located, the executing officers

   a. May continue the search as long as necessary to find the objects of the search
   b. May not spend more than 42 hours to complete the search
   c. May search on as long as is reasonable under the circumstances
   d. none of the above

10. Before officers are allowed to begin a valid search as authorized by a search warrant

   a. A certified copy of the search warrant must be present at the scene of the search
   b. The original search warrant must be present at the search scene
   c. A non certified copy of the search warrant must be present at the scene
   d. The search warrant need not be present at the scene

11. When conducting a search incident to an arrest, a law enforcement officer may search

   a. The body of the arrestee
   b. The room in which the subject was actually arrested
   c. The passenger compartment of a vehicle in which the subject was arrested or was in just prior to the arrest
   d. All of the above

12. A law enforcement officer may search a person for weapons for the officer's safety

    a. Anytime the officer makes personal contact with the subject of an investigation
    b. Anytime a person is stopped for a traffic violation
    c. Only if the officer can articulate specific reasons he feels this particular person is armed
    d. Anytime a person is in a high crime area and is wearing baggy clothing where a weapon can easily be hidden

13. A law enforcement officer may stop a vehicle for an investigative stop if

    a. Known gang members are in the car
    b. It is very late at night or early in the morning
    c. One of the occupants is a known felon
    d. None of the above

14. A law enforcement officer may stop a person if the officer has reasonable suspicion that this person is involved in

    a. A crime just that occurred
    b. A crime that is occurring
    c. A crime that is about to occur
    d. All of the above

15. The right of the people to be secure in their persons, houses, papers and effects against unreasonable searches and seizures is guaranteed which U.S. Constitutional amendment

    a. 1st
    b. 4th
    c. 5th
    d. 14th

16. In all criminal prosecutions, the right of the accused to have the assistance of counsel for his defense is guaranteed by which U.S. Constitutional amendment

a. 1st
b. 4th
c. 6th
d. 14th

17. The Supreme Court has stressed that searches conducted without prior approval by a judge or magistrate are unreasonable under the 4th amendment subject to the following exceptions

a. Exigency McDonald vs U.S. 1948
b. Consent U.S. vs Matlock 1974
c. Vehicle exceptions U.S. vs Ross 1988
d. All of the above

18. The particularity portion of the 4th amendment requires that a search warrant contain

a. Names of particular people who can verify that certain evidence should be found at the search site
b. A description that enables the officer with a search warrant, with reasonable effort, to ascertain and identify the place intended
c. The particular numerical address of the place to be searched
d. All of the above

19. A search warrant may become invalid before it is executed if

a. Not served within the statutory limit
b. Probable cause no longer exist
c. An unreasonable delay exist
d. All of the above

20. The exclusionary rule is
    a. A rule which excludes certain law enforcement officers from obtaining search warrants
    b. A remedy for unconstitutional police conduct
    c. The rule which prohibits the same search warrant from being executed twice
    d. All of the above

21. Probable cause in an arrest situation is
    a. Fact based
    b. means probably
    c. is less that evidence that would convict
    d. All of the above

22. Reasonable suspicion is
    a. Fact based
    b. That which a reasonable person would believe
    c. Less than probable cause
    d. All of the above

23. A police officer may seize crack cocaine found in a subject's pocket if
    a. The officer was patting down the subject specifically for drugs and immediately recognized the feel of this object to be crack cocaine
    b. The officer was patting down the subject for weapons and immediately recognized the feel of this object to be crack cocaine
    c. After moving the object in his fingers the officer could identify the object as crack cocaine
    d. All of the above

24. The Fifth Amendment provides that the subject of an investigation may not be compelled to

    a. Give a verbal or written statement concerning the allegations
    b. Provide investigators with samples of his hair or handwriting
    c. Provide investigators with his fingerprints
    d. All of the above

25. The Fifth Amendment provides that a person can not be compelled to

    a. Participate in a live line up
    b. Provide a photograph to be used in a photo display
    c. Speak the words used by the suspect during the commission of a crime
    d. None of the above

SkillsUSA 2010 NATIONAL CRIMINAL JUSTICE CONTEST
KANSAS CITY, MISSOURI

SCORE SHEET

COMMUNICATIONS EXERCISE
(50 Total Points Possible)

Contestant _____

Judge _____ Total Points _____

****

TRAFFIC STOP
(0 to 50 Points Possible)

1. Did contestant advise of traffic stop? (0 to 15 points)
   a) Location of stop
   b) Vehicle information-license plate

2. Did contestant request a records check on violator? (0 to 10 points)
   a) Run name, DOB, etc.

3. Did contestant advise they had a subject in custody? (0 to 5 points)

4. Did contestant request a transport unit to transport subject? (0 to 5 points)

5. Did contestant advise they were clearing the scene? (0 to 5 points)

6. Did contestant communicate clearly and effectively? (0 to 10 points)

SkillsUSA 2010 NATIONAL LAW ENFORCEMENT CONTEST
KANSAS CITY, MISSOURI

SCORE SHEET

REPORTING WRITING EXERCISE
(200 Total Points Possible)
(30 minute time limit)

Contestant _____

Judge _____ Total Points _____

****

TRAFFIC STOP

1. Did contestant write in a clear and concise manner? (0 to 20 points)

2. Did contestant use proper grammar and spelling? (0 to20 points)

3. Did contestant state the reasonable suspicion for the traffic stop? (0 to 50 points)

4. Did contestant properly identify the violator? (0 to 20 points)

5. Did contestant show probable cause for the arrest? (0 to 20 points)
   a) Was arrest made after probable cause was established? (Active arrest warrant)

6. Did contestant find contraband? (0 to 40 points)
   a) Search incident to arrest or other legal search?

7. Did contestant conduct a legal search of the vehicle? (0 to 30 points)

JUDGES SCORING COMMENTS

SkillsUSA 2010 CRIMINAL JUSTICE CONTEST
KANSAS CITY, MISSOURI

SCORE SHEET
PRE-EMPLOYMENT EXERCISE
(150 Points Possible)

Contestant _____

Judge _____ Total Points _____

****

1) **Contestants Presentation**
   a) Did the contestant pay attention to your questions?
   b) Did the contestant sit erect and look at the interviewer?
   c) Did the contestant shake your hand and introduce themselves?

2) **Communications Skills**
   a) Did the contestant generally speak clearly and effectively?
   b) Did the contestant use appropriate grammar?
   c) Did the contestant answer the questions precisely?

JUDGES SCORING COMMENTS

SkillsUSA 2010 CRIMINAL JUSTICE CONTEST
PRE-EMPLOYMENT INTERVIEW QUESTIONS

1) Why do you want to be a police officer?

2) What is your long-range goal in law enforcement?

3) What personal traits do you have that will make you a good police officer?

4) What computer skills do you possess?

5) Law enforcement officers are sometimes held at a higher standard than others are in the general public. What, if any, higher standards do you believe a law enforcement officer should possess?

6) Are you more comfortable expressing yourself verbally or in written form?

7) Discuss the most successful event that you have been involved in.

8) What do you feel are your outstanding qualities?

9) Who has been the most influential person or role model in your life? Explain why and how that person has been important to you.

10) What do you think makes a good police officer?

SkillsUSA 2010 CRIMINAL JUSTICE CONTEST
KANSAS CITY, MISSOURI

SCORE SHEET

OBSERVATION EXERCISE
(150 Points Possible)
(10 Minute Time Limit)

CONTESTANT #_____

1. What was the race of the suspect? (20 points)

2. What was the sex of the suspect? (20 points)

3. Was there a weapon displayed? (20 points)

4. Did the suspect say anything, if so what? (15 points)

5. What color was the suspects hair? (10 points)

6. What type of footwear was the suspect wearing? (15 points)

7. What color was the suspects shirt? (15 points)

8. What color was the supects pants? (20 points)

9. Did the suspect have any facial hair? (15 points)

SkillsUSA 2010 CRIMINAL JUSTICE CONTEST
KANSAS CITY, MISSOURI

QUESTIONAIRE SHEET

OBSERVATION EXERCISE

1. What was the race of the suspect?

2. What was the sex of the suspect?

3. Was there a weapon displayed?

4. Did the suspect say anything, if so what?

5. What color was the suspects hair?

6. What type of footwear was the suspect wearing?

7. What color was the suspects shirt?

8. What color was the supects pants?

9. Did the suspect have any facial hair?

SkillsUSA 2010 CRIMINAL JUSTICE CONTEST
KANSAS CITY, MISSOURI

SCORE SHEET

BASIC SKILLS EXERCISE

FINGERPRINT SUBJECT

(*50* Points Possible)

Contestant _____

Judge _____ Total Points _____

****

1) Did the contestant use acceptable method of fingerprinting the subject?

2) Did the contestant produce a complete and usable set of fingerprints?

JUDGES SCORING COMMENTS

Score Criteria Detail By Contest

Contest:

Skilled and Technical Sciences Contests

Contest: Criminal Justice

Division: Secondary

Chairperson: Wes Clark

Hotel or Email: wclarkon@olatheschools.com Phone: 913-915-7050

Contest #: 123

Code: CJ

Limit: 1

Judges: **0**

Score Type	Seq.	Skill Description	Max Points
Standard	1	Written Exam	100
	2	Traffic Stop	350
	~~3~~	~~Finger Printing~~ Finger Printing	~~50~~ 50
	4	Communications Exercise	~~50~~ 50
	5	Pre-Employment Interview	150
	6	Report Writing Exercise	150
	~~7~~	~~Check the Welfare~~ handcuffing	~~150~~ 150
	Total Standard Points (7 skills)		**1000**
Penalty	201	Clothing	-50
	202	Resume Penalty	-50
	Total Penalty Points (2 skills)		**-100**
Tie Breaker	401	SkillsUSA Knowledge Test	1
	402	Written Exam	1
	Total Tie Breaker Points (2 skills)		**2**

OK

SkillsUSA
2010 Contest Projects

Culinary Arts
(High School)

Click the "Print this Section" button above to automatically print the specifications for this contest. Make sure your printer is turned on before pressing the button.

SkillsUSA

National Culinary Arts Contest

High School

June 24, 2010

Kansas City, Missouri

SkillsUSA
High School Culinary Arts Contest
June 24, 2010

MENU

Salad with Emulsified Dressing

Chicken Vegetable Soup

Pan Fried Chicken Cutlet with Lemon Butter Sauce
Rice Pilaf
Sautéed Green beans and Julienne Carrots

Deep Poached Salmon – Warm Herb Vinaigrette
Parsley Potatoes
Stewed Zucchini

High School Judging Categories

A. Sanitation & Mise en Place

1. There will be four floor judges that will judge
    i. Sanitation procedures
    ii. Basic organization/ cleanliness/ attitude
    iii. Safety

B. Skills Components:

1. Vegetable Cuts – may include any of the following:
    i. Mince, Chop, Bruniose, Julienne, Batonnet, Dice(all sizes), Concassee,
2. Meat Fabrication – Including but not limited to:
    i. Chicken, Fish Fillet
3. Chicken Broth or Stock
4. Emulsion Dressing
5. Soup– may include any of the following:
    i. Cream, Puree, Clear
6. Main entrees - 2 different cooking techniques from the following:
    i. Saute, Roast, Braise, Stew, Poach (shallow or deep), Panfry,
7. Sauces – 2 different types from the following:
    i. Cream, Pan Sauce, Au Jus, Gravy, Butter Sauce, Warm Vinaigrette, reduction.
8. Vegetable Cookery – may include any of the following:
    ii. Boiling, Steaming, Glazing, Saute, Roasting, Pan Frying
9. Starch Cookery – may include any of the following:
    iii. Pilaf, Roasted, Pureed, Pan fry, Boiled, Steamed, legumes

C. Written Test

The NOCTI test gives the student an opportunity to demonstrate their knowledge of culinary principles including but not limited to : Culinary Math, Sanitation, Safety, Techniques and priciples of cooking.

Skills USA National Culinary Arts Competition Scoring Breakdown

High school and Post Secondary

Total Possible Points: 1000

Category	Value
Written Test (NOCI)	100
Sanitation	200
Mise en Place	100
Knife Skills/ Meat Fabrication	100
Technical Skills/ Taste	500
Total	1000

Tie Breaker: In the event of a tie, the competitor with the highest overall technical skills/ tasting score will be determined to be the winner. If there is still a tie, the competitor with the highest score on the written test will be determined to be the winner.

Deductions:

Poor/ no clean-up and reset of station and over all contest area…….....10-50 points

From Skills USA – Uniform infraction……..10-50 points

No Resume'…….50 points

GENERAL INSTRUCTIONS/ TIPS

- During Orientation for the Contest, a member of the Technical Committee will review the contest packet with you.

- Before the Contest, carefully study the contest packet:
  - ✓ **Review** the list of available spices, herbs and ingredients in contest packet.
  - ✓ **Write** a Food List and a Preparation and Cooking Schedule designed to be ready during the specific service times identified in your packet.

- Please use only as much of each ingredient as is necessary. Return unused portions to the supply tables.

- Contact a judge to look at your garbage before removing anything from your station

- You may work on any component of your menu at any time. ie: You can begin working on your stock and/or soup during your knife cut time.

- You will present one (1) tasting plate to the Tasting Judges and one (1) presentation plate for the public to see

- Raise your hand and ask for assistance if there is anything that you do not understand. – There will be a period just before the start of the first session when all questions will be answered for all contestants to hear. Once the competition starts, any questions about technique or definitions, etc will not be answered – Questions about where to find ingredients and the like will be answered.

- Remember two things – This is about LEARNING and it should be FUN. If at any time you feel overwhelmed and feel that you can not continue, speak to a judge or member of the Technical committee. We are here for you!

Competition Schedule

8:00 am Contestants Meet in competition area

8:10 Every contestant has from 8:10 until 8:25 to set their station. No one will be allowed to their station after 8:25 until there scheduled start time

8:25 Open question and answer with Technical Committee Chair – ALL questions will be answered – everyone will be able to hear the questions and the answers. If a contestant is late and misses this session, the questions will not be repeated or re-answered.

8:45 Competition starts – Competitors will start in groups of 8, staggered in 15 minute intervals – The chart below shows each competitors schedule

JUDGING SCHEDULE

Contestant #	**1-8**	**9-16**	**17-24**	**25-32**	**33-40**	**41-48**
Judging Time						
Start	8:45	9:00	9:15	9:30	9:45	10:00
Meat Fabrication	9:15	9:30	9:45	10:00	10:15	10:30
Knife Cuts	10:15	10:30	10:45	11:00	11:15	11:30
Salad	10:45	11:00	11:15	11:30	11:45	12:00
Lunch	11:15	11:30	11:45	12:00	12:15	12:30
Soup	12:30	12:45	1:00	1:15	1:30	1:45
Entrée #1	1:00	1:15	1:30	1:45	2:00	2:15
Entrée #2	1:30	1:45	2:00	2:15	2:30	2:45
Clean up	2:00	2:15	2:30	2:45	3:00	3:15

Contest Time Line

- Please be aware of the time frame for presentation of all items.
- The window for presenting is 5 minutes long. For example, contestants 1-10 have between 10:00 AM and 10:05 AM to present their knife cuts without penalty.
- Any items presented between 5-10 minutes late will result in a 25 % point loss for that item.
- Any items presented between 10-15 minutes late will result in a 75 % point loss for that item.
- Any items presented 15 minutes late will not be scored.
- Chicken Fabrication and knife cuts will be judged at your station
- On all other courses, the contestant will present one plate to the judges and one plate will go on the presentation table for the public.

ALL FOOD PREPARATION AND PRESENTATION MUST BE COMPLETED BY 3:15pm

3:45pm Judges Critique (approx. 45 minutes) Room to be announced

SKILLS COMPONENT(SECONDARY):
Chicken Fabrication

Each contestant will have 1 chicken to fabricate. They should execute the following:

1. Two breasts – The breast should be skin off and boneless, except for the first bone of the wing which should be attached. The tender should be intact and attached to the breast.

Note: Flattening of the breast for pan-frying is recommended but optional and does not have to be done during the fabrication portion of the contest.

2. Two leg/thigh portions – the leg and thigh should be boneless and skinless
3. Leg meat, trim and bones are to be used for stock and soup.

SKILLS COMPONENT(SECONDARY):
VEGETABLE CUTS

Prepare the following vegetable cuts and/or tasks and present for judging. These items will be used in other menu items:

1. **Minced Shallot –** Chop one shallot fine
2. **Chopped Parsley –** ¼ Bunch
3. **Tomato Concassee –**1 tomato
4. **Minced** ½ onion
   ½ head garlic
5. **Medium Dice (¾ ” x ¾” x ¾” cube)** Use vegetables based on your menu.
6. **Julienne (1/8x1/8 x1 ½ to 2inches)** Carrots -3 oz finished

RECIPES

Chicken Vegetable Soup
Skill component: Stock
Yield: 1 to 1-1/2 Qts
Ingredients:

Chicken bones, leg meat and trim from your fabricated chicken	
Water	40 oz.
Mixed diced vegetables from required cuts	10 oz.
Sachet	1
Seasoning	TT

1. Add cold water to chicken bones and meat. Bring to a boil – reduce to a simmer.
2. Simmer 30 minutes skimming fat and scum.
3. Add sachet.
4. Simmer until desired flavor is reached
5. In a separate 2-3 qt sauce or stock pot, sweat vegetables in a small amount of vegetable oil. Add the vegetables in increments according to cooking time.
6. Strain 2/3 of broth, reserving meat, on top of cooked vegetables. Save the rest of the broth to use in other menu items
7. Clean up all of the cooked chicken meat and cut or shred it as it should be added to the soup as a garnish.

SALAD WITH EMULSION DRESSING
Contestants choice
Skill Component: Emulsion
Yield: 2 servings
Instructions:

- Each contestant will have a selection of greens for this salad.
- Prepare emulsion dressing of choice using ingredients available – pasteurized egg yolk, and /or mustard will be available.
- Prepare appropriate garnish (croutons, nuts, etc.). .
- Immediately prior to the designated plating time for the salad course, assemble and plate your salad. Deliver one plate to tasting judges and one plate to presentation area.

PAN FRIED CHICKEN BREAST WITH LEMON BUTTER SAUCE
Skill Component: Pna-fry with pan sauce
Yield: 2 Servings

Chicken breasts from morning session	2 ea
Salt	as needed
Pepper	as needed
Flour	as needed
Eggs, beaten	as needed
Breadcrumbs	as needed
Clarified butter or oil	1 oz
Shallot chopped	2 t.
White wine	¼ C
Demi-glace	¼ C
Lemon juice	1 T.

1. Season chicken and standard bread.
2. Pan-fry to correct color and doneness in the butter or oil – remove and keep hot. Assess fat and residue left in pan and make the necessary adjustments.
3. Quickly sauté shallot in hot pan
4. Deglaze pan with wine and reduce almost dry
5. Add demi-glace and reduce until medium nappe
6. Add lemon juice and reduce to desired consistency. Season to taste
7. Serve chicken with sauce on the side or underneath.

Instructions:

- Use chicken breasts fabricated during Morning Session
- Execute pan-fry cooking method
- Prepare pan sauce
- Plate two (2) plates of entrée with appropriate starch and vegetable accompaniment

STARCH ACCOMPANIMENTS FOR PAN-FRIED ENTRÉE
Skill Component: Pilaf
Yield: 2 servings
Ingredients:

Rice	½ C
Onions, fine dice,	2 T
Oil	½ oz
Chicken stock	1 C

Seasonings, herbs – your selection from contest supplies

Follow standard pilaf method

VEGETABLE ACCOMPANIMENTS FOR PAN-FRIED ENTRÉE
Skill Component: Green Vegetable Cookery
Yield: 2 servings
Ingredients:

Green beans	6-8 oz.	Cut as desired
Seasonings – your selection from contest supplies		as desired
Fresh herbs – your selection from contest supplies		as desired

Instructions:

- Using proper cooking technique for vegetables, prepare a sufficient amount for two (2) portions.

For creative variation, you may utilize additional herbs and seasonings from the contest supplies at your discretion

Skill Component: Glazed Vegetables
Yield: 2 portions

Julienne Carrots	From knife cuts
Butter	½ oz
Sugar or honey	1 T
Stock	1 oz.
Salt	to taste
Pepper	to taste

1. Place carrots in pan with butter, sugar, and stock
2. Cover with a parchment paper and bring to a simmer
3. Simmer until vegetables are tender and they are glazed
4. Adjust seasoning

DEEP POACHED SALMON
Skill Component: Deep Poach
Yield: 2 Servings

Court Bouillon	40 oz.
Salmon Filet	12-16 oz

1. Prepare a court bouillon, simmer it for approximately 30 minutes and strain into a medium sauce pot.
2. Cut the salmon into 2 even portions and place them into the court bouillon at the correct temperature until 145 d.
3. Remove, blot excess moisture and serve immediately with a warm herb vinaigrette and the following accompaniments.

NOTE: The vinaigrette can be made with a choice of ingredients available at the common table. The vinaigrette must be a temporary emulsion, otherwise specific flavors and herbs are at the discretion of the student.

PARSLIED POTATOES

Skill Component: Simmer
Yield: 2 Servings

Potatoes, russet or other variety	8-10 oz.
Water	as needed
Salt	as needed
Butter	1-2 oz
Parsley, chiffonade	1 T.
Salt	to taste
Pepper	to taste

1. Cut and/or shape potatoes as desired
2. Place the potatoes in a small sauce pot and cover with cold water with the salt.

3. Bring to a simmer and continue to cook until tender.
4. Drain the potatoes well and then, coat them gently with the butter, parsley, salt and pepper.
5. Serve immediately.

STEWED ZUCCHINI

Skill Component: Stew
Yield: 2 Servings

Clarified butter or oil	1 oz.
Garlic crushed	1 clove
Onions, sliced or diced	1-2 oz
Zucchini, cut as desired	6-8 oz.
Tomato concasee	from knife cuts
Chicken stock	1-2 oz.
Aromatics - Seasonings and/or Herbs	as desired
Salt	to taste
Pepper	to taste

1. In a medium sauté pan, sauté onions and garlic until lightly caramelized and tender.
2. Add zucchini and sauté until lightly colored. Add stock and simmer until squash is tender.
3. Add tomato concasee and cook for approximately one minute or until all vegetables are tender.
4. Adjust seasoning as necessary

For creative variation, you may utilize additional herbs and seasonings from the contest supplies at your discretion

SkillsUSA
2010 Contest Projects

Culinary Arts
(College/Postsecondary)

SkillsUSA

National Culinary Arts Contest

Post Secondary June 23, 2010 Kansas City, Missouri

The Post Secondary Culinary Arts Competition will be in a Market Basket format.

1. **Competitors will receive a market basket with various proteins, vegetables, fruits, and starches the day before the competition**
2. **They will also have a community storeroom that they can use as much or as little product from as they would like.**
3. **The competitors will write a menu that includes a salad chosen by the technical committee, and a soup, and two entrees of their own choosing.**
4. **They must use at least a small amount of each item in their market basket in their menu. They can use as much or as little as they want.**
5. **They can supplement those ingredients with items from the community storeroom.**

Post Secondary School Judging Categories

B. Sanitation & Mise en Place

1. There will be four floor judges that will judge
    i. Sanitation procedures
    ii. Basic organization/ cleanliness/ attitude
    iii. Safety

C. Skills Components:

1. Vegetable Cuts – Minimum of 5 cuts including but not limited to:
    i. Mince, Chop, Brunoise, Julienne, Batonnet, Dice(all sizes), Concassee',
    ii. These cuts should be used in your production
2. Meat Fabrication – Including but not limited to:
    i. Any proteins in the market basket
3. Emulsion Dressing
4. Soup– Including but not limited to:
    i. Cream, Puree, Clear
5. Main entrees - 2 different cooking techniques from the following:
    i. Sauté, Roast, Braise, Stew, Poach (shallow or deep), Panfry,
7. Sauces – 2 different types including but not limited to:
    i. Cream, Pan Sauce, Au Jus, Gravy, Butter Sauce, reduction.
8. Vegetable Cookery – Including but not limited to:
    ii. Boiling, Steaming, Glazing, Sauté, Roasting, Pan Frying
9. Starch Cookery – Including but not limited to:
    iii. Pilaf, Roasted, Pureed, Pan fry, Boiled, Steamed, legumes
10. Creativity and Degree of difficulty

C. Written Test

The NOCTI test gives the student an opportunity to demonstrate their knowledge of culinary principles including but not limited to: Culinary Math, Sanitation, Safety, Techniques and principles of cooking.

Skills USA National Culinary Arts Competition Scoring Breakdown

High school and Post Secondary

Total Possible Points: 1000

Category	Value
Written Test (NOCI)	100
Sanitation	200
Mise en Place	100
Knife Skills/ Meat Fabrication	100
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Total	1000

Tie Breaker: In the event of a tie, the competitor with the highest overall technical skills/ tasting score will be determined to be the winner. If there is still a tie, the competitor with the highest score on the written test will be determined to be the winner.

Deductions:

Poor/ no clean-up and reset of station and over all contest area…….....10-50 points

From Skills USA – Uniform infraction……..10-50 points

No Resume'…….50 points

GENERAL INSTRUCTIONS/ TIPS

- During Orientation for the Contest, a member of the Technical Committee will review the contest packet with you and give out the Market basket assignment.

- Before the Contest, carefully study the contest packet:
  - ✓ **Review** the list of available spices, herbs and ingredients in contest packet.
  - ✓ **Menu –** Write a menu based on the market basket
  - ✓ **Write** a Food List and a Preparation and Cooking Schedule designed to be ready during the specific service times identified in your packet.

- Please use only as much of each ingredient as is necessary. Return unused portions to the supply tables.

- Contact a judge to look at your garbage before removing anything from your station

- You may work on any component of your menu at any time. ie: You can begin working on your stock and/or soup during your knife cut time.

- You will present one (1) tasting plate to the Tasting Judges and one (1) presentation plate for the public to see

- Raise your hand and ask for assistance if there is anything that you do not understand. – There will be a period just before the start of the first session when all questions will be answered for all contestants to hear. Once the competition starts, any questions about technique or definitions, etc will not be answered – Questions about where to find ingredients and the like will be answered.

- Remember two things – This is about LEARNING and it should be FUN. If at any time you feel overwhelmed and feel that you can not continue, speak to a judge or member of the Technical committee. We are here for you!

Competition Schedule

8:00 am Contestants Meet in competition area

8:10 Every contestant has from 8:10 until 8:25 to set their station. No one will be allowed to their station after 8:25 until there scheduled start time

8:25 Open question and answer with Technical Committee Chair – ALL questions will be answered – everyone will be able to hear the questions and the answers. If a contestant is late and misses this session, the questions will not be repeated or re-answered.

8:45 Competition starts – Competitors will start in groups of 8, staggered in 15 minute intervals – The chart below shows each competitors schedule

JUDGING SCHEDULE

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Knife Cuts	10:15	10:30	10:45	11:00	11:15	11:30
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Lunch	11:15	11:30	11:45	12:00	12:15	12:30
Soup	12:30	12:45	1:00	1:15	1:30	1:45
Entrée #1	1:00	1:15	1:30	1:45	2:00	2:15
Entrée #2	1:30	1:45	2:00	2:15	2:30	2:45
Clean up	2:00	2:15	2:30	2:45	3:00	3:15

Contest Timeline:

- Please be aware of the time frame for presentation of all items.
- The window for presenting is 5 minutes long. For example, contestants 1-10 have between 10:00 AM and 10:05 AM to present their knife cuts without penalty.
- Any items presented between 5-10 minutes late will result in a 25 % point loss for that item.
- Any items presented between 10-15 minutes late will result in a 75 % point loss for that item.
- Any items presented 15 minutes late will not be scored.
- Meat Fabrication and knife cuts will be judged at your station.
- On all other courses, the contestant will present one plate to the judges and one plate will go on the presentation table for the public.

ALL FOOD PREPARATION AND PRESENTATION MUST BE COMPLETED BY 3:15pm

3:45pm Judges Critique (approx. 45 minutes) Room to be announced

SKILLS COMPONENT:
Meat Fabrication

Each contestant will have Proteins in their market basket that need to be fabricated. They should be done in the best possible manner appropriate for their menu and use.

SKILLS COMPONENT:
VEGETABLE CUTS

Prepare a minimum of 5 different cuts that will be used in your menu - they can include, but are not limited to:

Mince, Chop, Brunoise, Julienne, Batonnet, Dice(all sizes), Concassee',

General Criteria for Market Basket

Skills USA Culinary-Post Secondary Competition

Salad (recipe may be provided)
Choice of Permanent or Temporary Emulsion (to be determined)
Garnish to Display two distinct knife cuts

Soup (recipe may be provided)
Choice of Cream, Puree or Consomme (to be determined)
Garnish to Display two distinct knife cuts

Entrée 1	
Protein:	Seared, Sauteed or Roasted
Vegetable:	Boiled or Blanched
Starch:	Steamed or Roasted
Sauce:	Reduction or Emulsion, variation of Mother Sauce

Entrée 2:	
Protein;	Braised or Poached
Vegetable:	At Least Two Vegetables displaying distinct knife cut
Starch:	Simmered Grain
Sauce:	Fortified Reduction of Braising Liquid

SKILLS COMPONENT:
SALAD

Prepare a salad chosen by the technical committee – the recipe will be supplied by the committee and posted to the Skills USA website in May

SKILLS COMPONENT:
Entrée, Sauce, Starch, Vegetable

Prepare two entrees of choice each using a different cooking method. Vegetables and starches should also demonstrate different cooking methods. A minimum of 4 different cooking methods must be used in the two entrees

RECIPES

The final Community Storeroom and salad recipe will be posted by the end of May

Skills USA Culinary-Post Secondary Competition 2010

Mystery Basket 1

1 whole flounder, 2 lb ea.
2 ea. chicken leg quarters
1 oz. salt pork

½ lb. haricot vert
1 lb. Yellow squash
½ lb. Pearl onions
1 lb. Belgium endive
½ lb. Rutabaga
1 lb. Russet potatoes
3 oz. Quinoa
3 ea. Plum tomatoes
1 cup green split peas

Mystery Basket 2

1 lb. salmon filet
1 each, 3 lb. chicken
2 slices bacon

½ lb. Snow peas
1 lb. Eggplant (asian)
½ lb. Oyster mushrooms
½ lb. Arugala
1 lb. Celery root
1 lb. Red (b) potatoes
3 oz. cous cous
3 ea. Plum tomatoes
1 cup Green lentils

Mystery Basket 3

1 whole flounder, 2 lb. ea.
1 lb. pork tenderloin

½ lb. Asparagus
½ lb. Sugar snap peas
½ lb. Shitake mushrooms
1 head Romaine lettuce
½ lb Parsnips
1 lb. Yukon gold potatoes
2 oz. Wheat berries
3 ea. Plum tomatoes
1 cup red lentils

Store Table Sample Available Throughout Exam

Dry Goods	**Produce**	**Dairy**
• AP Flour • Sugar • Flour • Corn Meal • Cous cous • lentils • French Bread • Corn Starch • Honey • Brown rice • Vegetable Oil • Extra Virgin Olive Oil • Soy Sauce • Tabasco • Orzo pasta • Anchovy filets • Dijon Mustard • Grain Mustard • Walnuts • Tomato Puree • Tomato Paste • Almonds • Capers • Calamata Olives • Sun Dried Tomatoes • White Wine Vinegar • Red Wine Vinegar • Sherry Vinegar • Asst. Dry Spices	• Apples • peaches • Lemons • Shallots • Garlic • Onions • Carrots • Celery • Leeks • White Mushrooms • Red Peppers • Green Leaf Lettuce • Parsley • Scallions • Radicchio	• Butter • Cream • Milk • Eggs • Cheddar Cheese • Swiss Cheese • Parmesan Cheese • Blue Cheese

Stocks	**Non-Food**	**Herbs**
• Beef Stock • Fish Stock • Chicken Stock • Demi Glace Wines • White Wine • Red Wine • Port • Vermouth • Madeira	• Butcher's Twine • Tooth Picks • 2 oz Portion Cups • Skewers	• Oregano • Thyme • Basil • Cilantro • Sage • Rosemary

SkillsUSA
2010 Contest Projects

Diesel Equipment Technology

Click the "Print this Section" button above to automatically print the specifications for this contest. Make sure your printer is turned on before pressing the button.

Diesel Equipment Technology
This year, Delmar, a part of Cengage Learning is making their online ASE Test Preparation tools available to all instructors and competitors immediately. This means that some competitors may be able to use the tool in advance of their district and state competitions.

Instructors should only share with materials competitors.

Access will be terminated when the National Competition begins.
Please use the contact information below to get the necessary link
jonathan.sweeney@cengage.com | www.delmarlearning.com

DET #5

2010 Job Interview Station - Orientation

SkillsUSA.

Interview Orientation – Someone must say this before each round begins.

"The interview station is based on a scenario where you are applying for an apprentice technician job at a John Deere construction dealership.

You will have two tasks.

The first is to fill out an application. You will be judged on the clarity of your application.

Proctors will be present to answer any questions you may have about the application itself.

The second task is to go through a mock interview.

In this, you will be judged on your self presentation and on the depth and maturity of your answers.

Two interviews will be conducted at a time, the remaining contestants will fill out their application.

Do not worry if you haven't completed your application when you are called for your interview.

You will have 20 minutes total in this rotation to complete the application.

Are there any questions?"

Send four contestants to application tables.

Send two contestants to the interview areas.

VET #6

2010 Job Interview Station - Written Test

SkillsUSA

APPLICATION FOR EMPLOYMENT

(An Equal Opportunity Employer)

DATE

PLEASE PRINT AND COMPLETE ALL SECTIONS (USE BALLPOINT PEN)

PERSONAL INFORMATION				
NAME LAST	FIRST	MIDDLE	CONTESTANT NUMBER	
PRESENT ADDRESS NUMBER & STREET	CITY		STATE	ZIP CODE
E-MAIL ADDRESS	CELLULAR TELEPHONE NUMBER ( ) -		HOME TELEPHONE NUMBER ( ) -	

HAVE YOU EVER USED ANOTHER NAME? ☐ YES ☐ NO

IF YES, PLEASE PROVIDE OTHER NAMES USED

HAVE YOU EVER PLED GUILTY OR "NO CONTEST" TO, OR BEEN CONVICTED OF, A MISDEMEANOR OR FELONY? ☐ YES ☐ NO

IF YES, PLEASE GIVE DATE AND DETAILS

(Answering yes to this question does not constitute an automatic bar to employment. Factors such as age and time of the offense, seriousness and nature of the violation, and rehabilitation will be taken into account. Do not include minor traffic citations and arrests or convictions which have been sealed or expunged in answering this question.)

EMPLOYMENT DESIRED		
POSITION DESIRED	DATE YOU CAN START	SALARY DESIRED

EDUCATION			
SCHOOL LEVEL	NAME & LOCATION (CITY, STATE) OF SCHOOL	GRADUATE?	SUBJECTS STUDIED/MAJOR
HIGH SCHOOL			
COLLEGE			
TRADE, BUSINESS CORRESPONDENCE SCHOOL			

SUBJECTS OF SPECIAL STUDY OR RESEARCH WORK

SPECIAL TRAINING

SPECIAL SKILLS

2010 Job Interview Station - Written Test

SkillsUSA

EMPLOYMENT HISTORY	List your most recent employment first. Resumes will not be accepted in place of a completed application form. Respond completely to all information in this section.
1	NAME & ADDRESS OF PRESENT OR MOST RECENT EMPLOYER
	STARTING DATE / LEAVING DATE
	JOB TITLE
	NAME & TITLE OF SUPERVISOR
	DESCRIPTION OF WORK
	REASON FOR LEAVING

GENERAL EMPLOYMENT INFORMATION

HAVE YOU EVER BEEN TERMINATED OR ASKED TO RESIGN FROM ANY JOB? ☐ YES ☐ NO

IF YES, PLEASE EXPLAIN THE CIRCUMSTANCES

ARE THERE ANY GAPS IN YOUR EMPLOYMENT HISTORY? ☐ YES ☐ NO

IF YES, PLEASE EXPLAIN

IF YES, PLEASE EXPLAIN

ARE YOU LEGALLY AUTHORIZED TO WORK IN THE U.S.? ☐ YES ☐ NO (PROOF SUFFICIENT TO SATISFY U.S. IMMIGRATION LAWS IS A REQUIREMENT OF EMPLOYMENT)

IF HIRED, CAN YOU FURNISH PROOF THAT YOU ARE OVER 16 YEARS OF AGE? ☐ YES ☐ NO

ARE YOU CAPABLE OF SATISFACTORILY PERFORMING THE ESSENTIAL JOB DUTIES REQUIRED OF THE POSITION FOR WHICH YOU ARE APPLYING? ☐ YES ☐ NO

REFERENCES

Include only individuals familiar with your work ability. DO NOT include relatives.

NAME	RELATIONSHIP	YEARS KNOWN
1.		
2.		

SIGNATURE OF APPLICANT / DATE

DET #8

Verbal Presentation Test

2010 Job Interview Station - Interview Questions

SkillsUSA

Contestant Number:_____

1. Tell me about yourself.

2. What made you decide to pursue the diesel industry for your career?

3. What have been some of your major accomplishments at school or work?

4. What are you looking for in a company?

5. If you could create the perfect job, what would it involve?

6. Tell me about a time when you had difficulty maintaining composure at school or work. How did you handle the situation?

7. What motivates you to succeed in a job?

8. Tell me about an area (work skill or personality trait) where you could use improvement.

9. What separates you from the other students here?

10. What questions do you have for me?

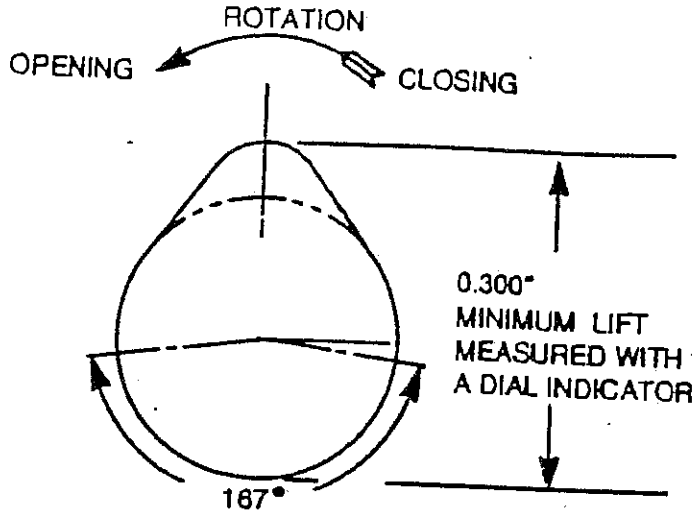
Contestant #_____

2010
Skills USA – VICA
Championships

Station #1
Precision Measurements

Contestant Score_____

INTAKE CAM CONTOURS



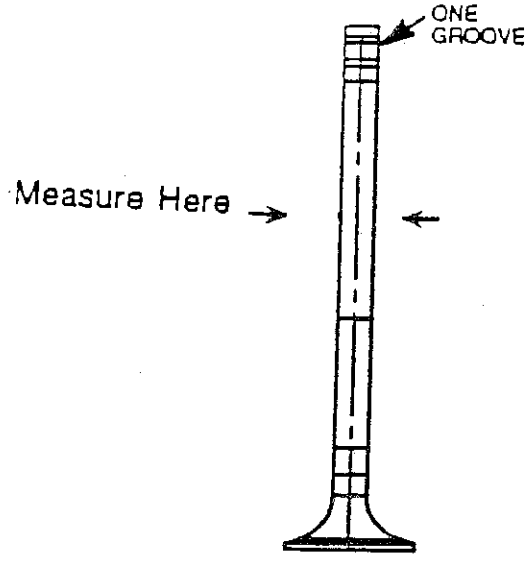
CONTOUR OF INLET CAMS

1. Set up base mount dial indicator and measure the lift on the intake lobe. Is it within specifications?

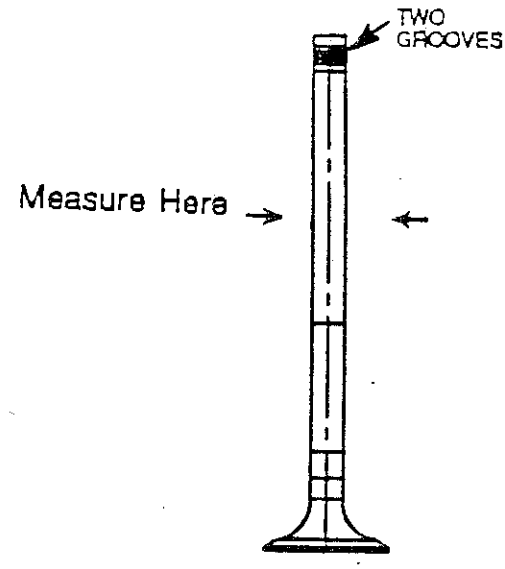
No _____

Yes _____

INLET AND EXHAUST VALVE



INLET VALVE



EXHAUST VALVE

2. Using the valve spring compressor, disassemble and remove the inlet valve. Measure and record the stem diameter in metric and install valve.

   Answer _____

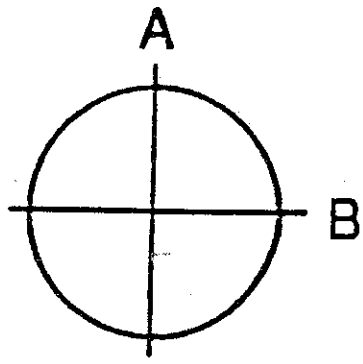
3. Using the valve spring compressor, disassemble and remove the exhaust valve. Measure and record the stem diameter in U.S. standard install valve.

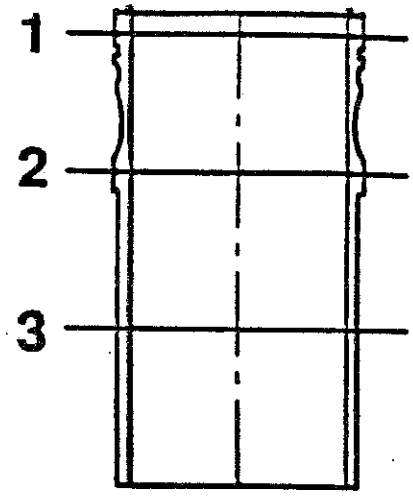
   Answer _____

4. (For Judge) was it disassembled and assembled correctly?

   Yes _____ No _____

CYLINDER SLEEVE (LINER) MEASUREMENTS



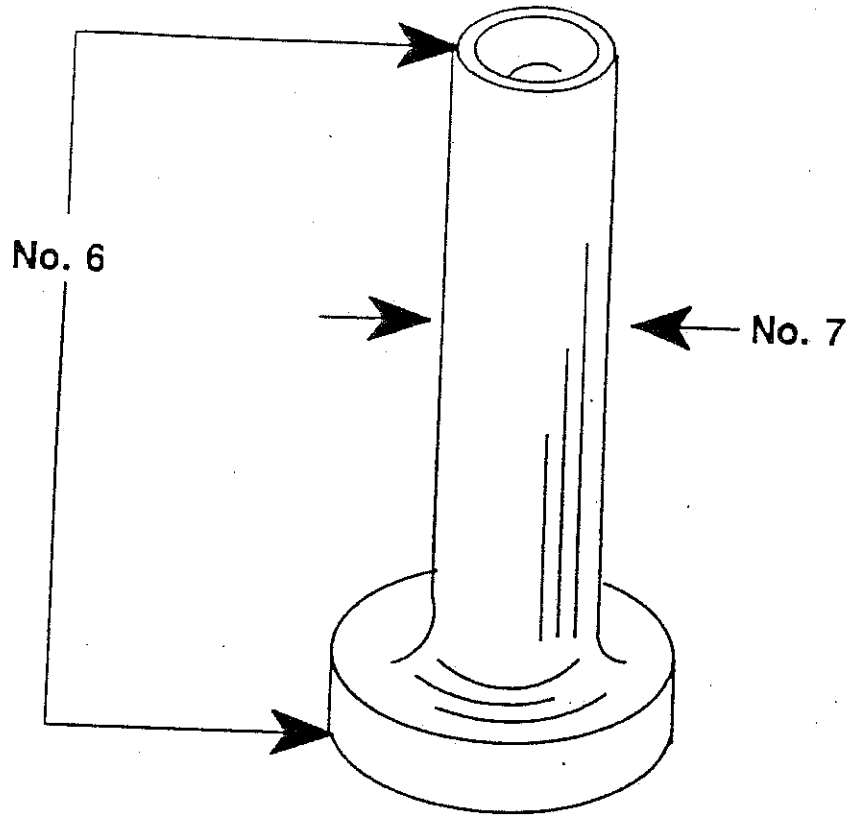


5. Using the dial bore gauge, measure at the 3 positions shown in the liner, then rotate bore gauge 90° and measure at those locations again.

Is the liner tape or out-of-round more than .003?

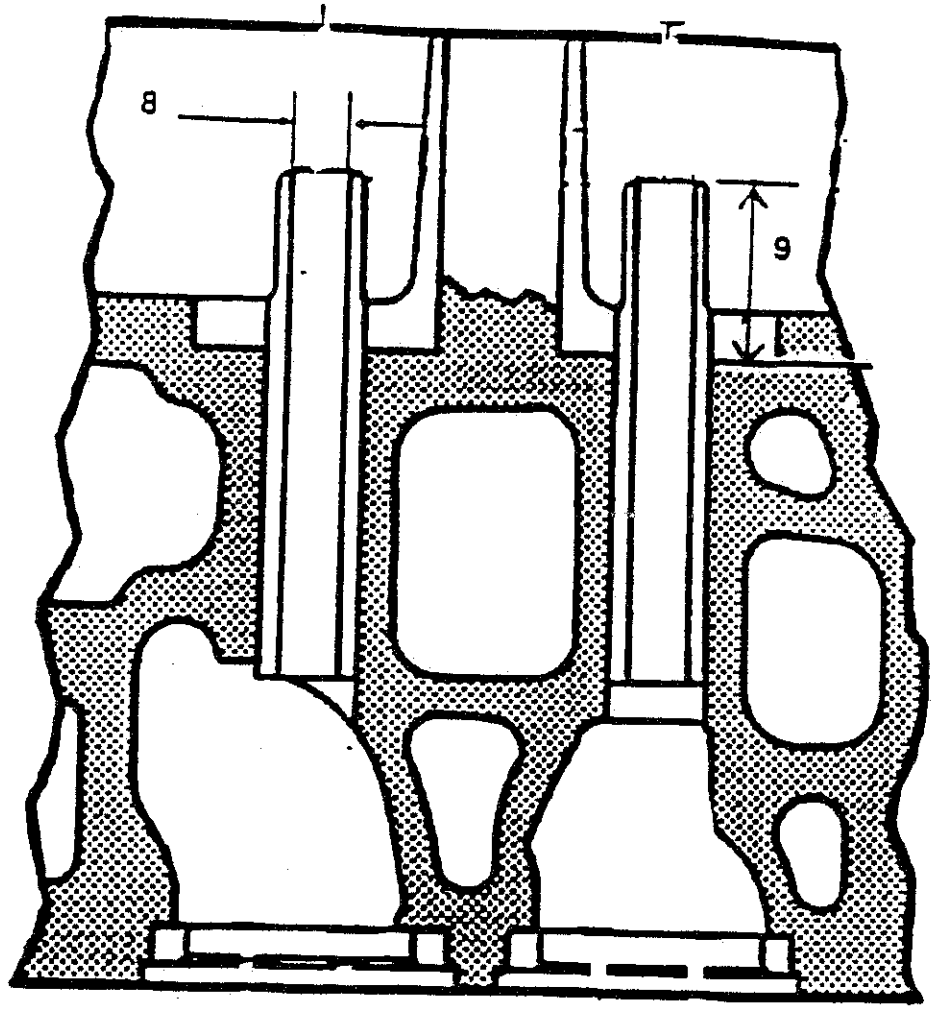
Yes _____ No _____

LIFTER



6. Using the dial caliper, measure and record the length in U.S. Standard. _____

7. Using the metric micrometer, measure and record the shank dimension in metric. _____



8. Using an inside telescoping gauge and a micrometer, record the valve guide diameter in U.S. standard. _____

9. Using a depth micrometer, measure and record valve guide extension in U.S. standard. _____

10. What is the clearance between the valve stem (question # 3), and valve guide that was measured in question # 8.

in U.S. standard. _____

Station # 2 Live Engines

THIS IS A LIVE ENGINE STATION. You will be performing maintenance task and inspections as well as accessing fault codes with the computer.
Complete the task in the order given below under Contestant Task.
The equipment in this station is in the shop for repairs due to an **Engine overheat condition.** Be careful to insure the job is complete.

Contestant Task:
1. Ensure the engine is ready to start
2. Start the engine; check that engine is running properly.
3. Use the Laptop computer to document and verify active fault codes
4. Locate troubleshooting tree for any active codes
5. Locate circuit on wiring diagram of active fault component.
6. Describe the failure mode of the component
7. Clear any inactive fault codes and verify proper operation of the component
8. Inspect the drive belt that is on the bench for reuse, (good or bad)
9. Check the SCA concentration level of the sample coolant on the bench. Record you findings_____.
10. Using the refractometer check the concentration level of the Diesel Exhaust Fluid (DEF) sample on the bench. Record your findings_____.
11. Answer Task 1, 2, & 3 questions concerning Truck Dash Operator Interface with Aftertreatment lights.

Score Sheet 2010
Live Diesel Engine Diagnostic - Test Station 2
Total Number of Possible Points = 100

Contestant # _____ Time _____

Points Possible	Required Steps to Get Points	Points Awarded
2	General walk around before starting engine	
2	Checked oil level	
2	Checked coolant level	
8	Student located belt missing or off pulley	
8	Student installed belt properly	
4	Student connected Laptop to correctly	
4	Navigated laptop to fault codes	
4	Recorded active fault (coolant sensor)	
4	Proper use of Multimeter and settings	
4	Used test leads where required	
4	Located circuit on wiring diagram	
6	Followed troubleshooting tree	
4	Contestant described failure mode properly	
4	Cleared inactive fault codes	
4	Navigated laptop to proper screen to record coolant temp	
4	Contestant provide correct inspection on belt	
2	Coolant SCA test performed properly	
2	Coolant SCA test results recorded are correct	
2	DEF concentration test performed properly	
2	DEF test results recorded are correct	
8	DPF Task one	
8	DPF Task two	
8	DPF Task three	

100 Total Possible Points

Total Points Scored _____

SkillsUSA
VICA

2010 DIESEL SKILLS
JUDGES INSTRUCTIONS
Station # 3

1) THIS IS A BASIC ELECTRICAL TEST CONSISTING OF MARKER LIGHTS, TURN SIGNAL, BRAKE LIGHT AND STARTER SYSTEMS.

2) THE SCHEMATIC LOCATED ON EACH TEST BOARD IS FOR THE LIGHT SYSTEM ONLY (STOP, TAIL, TURN AND MARKER LIGHTS). THE SCHEMATIC DOES NOT INCLUDE THE STARTER SYSTEM.

3) YOU WILL NEED TO DEMONSTRATE YOUR ABILITY TO USE THE "DVOM" WHILE DIAGNOSING THE PROBLEMS LISTED.

4) YOU ARE NOT REQUIRED TO REPAIR ANY PROBLEM YOU HAVE DIAGNOSED.

5) THERE IS A JUMPER WIRE PROVIDED FOR YOU TO USE, YOU DO NOT NEED TO USE IT TO DIAGNOSE THE PROBLEMS ON THE BOARD. PLEASE USE CAUTION IF YOU USE A JUMPER WIRE. THE JUDGE MAY STOP YOU IF YOU WILL CAUSE A SHORT CIRCUIT AND POINTS MAY BE DUDUCTED FROM YOUR SCORE IF YOU CAUSE A SHORT.

6) YOU HAVE 35 MINUTES TO COMPLETE THIS TEST. SOMEONE WILL GIVE YOU A 5-MINUTE WARNING NEAR THE END OF THE SESSION.

7) NO TALKING DURING OR AFTER THE TEST. AFTER YOU ARE FINISHED, GIVE YOUR CLIPBOARD WITH THE TEST TO THE JUDGE AND RETURN TO YOU CHAIR.

8) FOLLOW ALL SAFTEY PRECAUTIONS AT ALL TIMES.

Kansas City 2010
Heavy Equipment Technician
Station #4

Contestant #:

Note: All contestants must have bump hats and safety glasses.

TOTAL

GAS WELD—(34 POINTS POSSIBLE)

	POINTS
Procedure to open tanks	3
Correctly adjust gauges	3
Light torch and adjust flame	4
Proper handling of torch:	
A) Connection of heat	3
B) Feeding of filter rod	3
Quality of braze and weld	8
Procedure of shutting down tanks and gauges	4
Coiling of hoses and putting equipment back in place	3
Ability to work safely	3

SCORE

SHOP TOOLS---(33 POINTS POSSIBLE)

Attention to instructions & ability to follow orders	10
Ability to complete task	10
Ability to work safety	3
Assemble to standard	10

Improper assembly of components - 1 point each
Improper assembly of (bolts, washers, nuts) – 1 point each

SCORE

ARC WELD—(33 POINTS POSSIBLE)

	POINTS
Ability to turn on and set proper heat range for size of welding rod and work	5
Proper use of protection equipment (welding helmet, gloves, long sleeves, shielding others from ray of arc)	5
Ability to use and protect equipment properly:	
A) Ground - disconnect/connect	4
B) Strike and hold arc	2
C) Angle of welding rod	2
D) Speed and direction of rod travel	2
Quality of welds	5
Shutdown equipment and put away tools	3
Ability to work safely	5

SCORE

VET - #5

Chassis Station

This station will cover measuring driveline component slopes, working angle of two joints, and identifying chassis and brake components.

To successfully complete this task, students will need to have an understanding of decimals, basic mathematics, and the ability to follow instructions. Students will also need to understand the setup and usage of the digital protractor and calculate the working drive line angle.

Students will also know the components and component locations as well as complete a 28 question written test.

DET #5

2010 Skills USA

Diesel Equipment Technology Contest

Station Chassis

Welcome to Station #5, the Chassis Station. This station will cover measuring driveline component slopes, working angle of two joints, and identifying chassis components. You will have a total of 30-35 minutes to complete your tasks. Half will start with the written test and half will begin with the hands on portion. You will change positions halfway through the allotted time. You may ask questions about your tasks at each workstation. Any special tools will be provided at each work station. After you complete your task, please return to your seat. **Please write legibly**. If we can not read an answer it will be marked incorrect. (Each question is worth 2 points

1. Axle alignment on a tandem rear leaf spring suspension is adjusted by
   a. Changing the length of the torque rods
   b. installing wedge type spacers
   c. rotating the eccentric bolts on the front axle
   d. both a and c

2. Suspension system torque arms are used to
   a. Mount the leveling valve
   b. Equalize load between the axles
   c. Reduce wheel hop
   d. Control axle torque

3. The _____ uses universal joints.
   a. steering column
   b. pitman arm
   c. tie-rod assembly
   d. steering wheel

4. The _____uses ball joints.
   a. Steering wheel
   b. Steering gear
   c. Tie-rod end
   d. Steering knuckle

5. _____ is defined as the forward or rearward tilt of the kingpin centerline when viewed from the side of the vehicle.
   a. Kingpin inclination
   b. Camber
   c. Caster
   d. Toe

6. _____is defined as the inward or outward tilt of the top of the tires when viewed from the front of the vehicle.
    a. Ackerman geometry
    b. Caster
    c. Camber
    d. Toe

7. _____can be corrected using shims.
    a. Kingpin inclination
    b. Toe
    c. Caster
    d. Camber

8. The _____connects the Pitman arm to the steering arm.
    a. Tie-rod assembly
    b. Drag link
    c. Cross shaft
    d. Steering column

9. Symptoms of a vehicle that is out-of-alignment include:
    a. Wandering
    b. Tire wear
    c. Hard steering
    d. All of the above

10. The _____ of a clutch is a driven member.
    a. Cross shaft
    b. Clutch disc
    c. Intermediate plate
    d. Pressure plate

11. All of the following are parts of the clutch cover except:
    a. Release lever
    b. Pressure spring
    c. Pressure plate
    d. Adapter ring

12. The _____is splined to the input shaft of the transmission.
    a. Release bearing
    b. Pressure plate
    c. Clutch disk
    d. Flywheel

13. In an air brake system the _____functions as a lever.
    a. Rotor
    b. Brake chamber
    c. Caliper
    d. Slack adjuster

14. In an air brake system the _____ sets the system cut-in and cut-out pressures.
    a. Wet tank
    b. Supply tank
    c. Governor
    d. Air dryer

15. A _____is required on all air brake system air tanks.
    a. Unloader valve
    b. Safety valve
    c. Drain cock
    d. Pressure protection valve

16. When the parking brake is released air leaks from the exhaust port of the brake relay valve. The most likely cause is a _____.
    a. faulty quick release valve.
    b. leaking park brake chamber diaphragm.
    c. Back feed from the air dryer.
    d. Air governor valve set too high

17. Driver complains his truck steering is tight and will not return to straight ahead after a turn. A possible cause could be _____ .
    a. Slipping power steering belt.
    b. Incorrect camber setting
    c. Seized king pin bushings
    d. Sticking relief valve in power steering pump

18. Truck pulls to the right under braking. Technician A states the brakes may not be adjusted evenly. Technician B states that a pinched air line could be the cause. Who is correct?
    a. Technician A only.
    b. Technician B only.
    c. Both A & B
    d. Neither A or B.

19. While servicing a truck with air brake the technician finds oil in the primary air tank. The most likely cause would be _____ .
    a. Restriction in the air dryer
    b. Failing air compressor
    c. Incorrect oil viscosity
    d. Defective pressure protection valve

20. During a routing inspection a technician finds a leaking wheel seal. The most likely cause of failure could be _____.
    a. Wheel having too much lateral run out.
    b. Incorrect axle inclination
    c. Loose wheel bearing
    d. Slack adjuster set beyond limit.

21. Technician found excess wear on one wheel while inspecting air brakes. Possible causes could be _____ .
    a. Seized brake camshaft bushing
    b. QR-1 valve.
    c. Sticking foot valve
    d. Low air supply in primary air tank.
22. Driver notices a vibration in the drive train while decelerating. One possible cause could be _____ .
    a. Incorrect suspension ride height adjustment
    b. Incorrect clutch adjustment
    c. Worn clutch brake
    d. Missing pinion snubber
23. The clutch brake will not stop the input shaft from turning making engagement in low and reverse difficult. The cause could be all except _____ .
    a. Warped clutch disc
    b. Seized pilot bearing
    c. Leaking range valve
    d. Worn clutch brake facing
24. Steer axle tire wear on the inside tread tapering out is most likely caused by _____ .
    a. Too much caster
    b. Too little caster
    c. Wheels toed out
    d. Wheels toed in
25. Low air pressure warning light/buzzer on vehicles with air brakes should activate below _____.
    a. 120 psi
    b. 90 psi
    c. 60 psi
    d. 30 psi
26. On vehicles with air brakes a loss of air pressure below _____ will activate the parking brake.
    a. 120 psi
    b. 90 psi
    c. 60 psi
    d. 30 psi
27. The purpose of the QR-1 valve is _____ .
    a. Prevent loss of air in primary tank if compressor fails
    b. Set parking brake when system falls below 90 psi
    c. Speed brake release times
    d. Allow driver to apply air to trailer brakes
28. A truck with air suspension the sits too high when pulled out from the trailer. The most likely cause would be _____ .
    a. Leaking air bag
    b. Too high pressure in primary air tank
    c. Improperly adjusted air leveling valve
    d. Sticking unloader valve

#5

Diesel Equipment Technology Contest

Chassis Station

Contest Time 30 – 35 minutes - 100 Points

Contestant # _____ Total Score _____

Welcome to Station #5, the Chassis Station. This station will cover measuring driveline component slopes, working angle of two joints, and identifying chassis components. You will have a total of 30–35 minutes to complete your tasks. Half will start with the written test and half will begin with the hands on portion. You will change positions half way through the allotted time. You may ask questions about your tasks at each work station. Any special tools will be provided at each workstation. After you complete your task, please return to your seat. **Please write legibly.** If we cannot read an answer it will be marked incorrect.

Driveshaft Exercise: Measure driveline components at the designated/marked locations.

A. Slope/Angle of the Front Driveshaft (+/- .5°) _____ (5 points)
B. Slope/Angle of the Transmission (+/-.5°) _____ (5 points)
C. Slope/Angle of the Front Drive Axle (+/-.5°) _____ (5 points)
D. Working angle of A & C (+/- 1°) _____ (5 points)
E. Working angle of A & B (+/- 1°) _____ (5 points)
F. Identify Drag Link tag # _____ (2 points)
G. Identify Tie Rod tag # _____ (2 points)
H. Identify Front Spring Shackle tag # _____ (2 points)
I. Identify Pitman Arm tag # _____ (2 points)
J. Identify Primary Air Reservoir tag # _____ (2 points)
K. Identify Governor tag # _____ (2 points)

SkillsUSA

2010 - Transmission

Contestant #: _____ **Score:** _____

Station #: 6 **Judge:** _____

_____ **1)** Using the Service Manual provided at this station, completely assemble the RTLO-16718 Shift Bar Housing.

(Circle the correct answer on questions 2 thru 6)

_____ **2)** In the following nomenclature, what does the '9' represent?

'RTLO-20913A'

A. Design Level – Improved Seal System
B. Ratio Set
C. Number of Forward Speeds
D. Nominal Torque Capacity

_____ **3)** What is the correct torque value for the shift yoke lockscrews?

A. 20-25 lb/ft
B. 8-12 lb/ft
C. 35-45 lb/ft
D. 18-22 lb/ft

_____ **4)** The filter/regulator assembly regulates the air pressure to:

A. 38-43 PSI
B. 58-63 PSI
C. 48-53 PSI
D. 68-73 PSI

_____ **5)** Once the shift bar housing has installed on the main case, the capscrews should be torqued to the following value:

A. 25-35 lb/ft
B. 35-45 lb/ft
C. 45-55 lb/ft
D. 55-65 lb/ft

_____ **6)** Referring to the power flow section for a 13-speed transmission, how many gearsets are being used while in 3rd gear? (Note: One gearset equals three mating gears)

A. None – Straight through the box
B. 2
C. 3
D. 4

SkillsUSA 2010
Diesel Equipment Technology Competition
Drive Axle – Station #7

SCORE

Component Identification and Axle Operation

1. Using the inter-axle differential [IAD] assembly from a Meritor forward drive axle, identify each component of the inter-axle differential. Write your answers below:

   Item A _____.
   Item B _____.
   Item C _____.
   Item D _____.
   Item E _____.

2. Using the inter-axle differential [IAD] assembly from a Meritor forward drive axle trace the power flow through the assembly. Conditions are; normal driving conditions, IAD unlocked. Start with first component receiving torque and finish with last component delivering torque. Write your answers below:

   1st component _____.
   2nd component _____.
   3rd component _____.
   4th component _____.

3. Using the inter-axle differential [IAD] assembly from a Meritor forward drive axle, which two [2] components are delivering torque equally?
   - _____.
   - _____.

4. Using the inter-axle differential [IAD] assembly from a Meritor forward drive axle, answer the following questions.
   - Which one component drives the rear drive axle ?
     _____
   - Which one component drives the forward drive axle ?
     _____

5. Using the main differential assembly from a Meritor drive axle, identify each component of the main differential. Write in your answers below.

   Item F _____.
   Item G _____.
   Item H _____.
   Item I _____.

Contestant # ____ **Drive axle #_____** **Score_____**

SkillsUSA 2010
Diesel Equipment Technology Competition
Drive Axle – Station #7

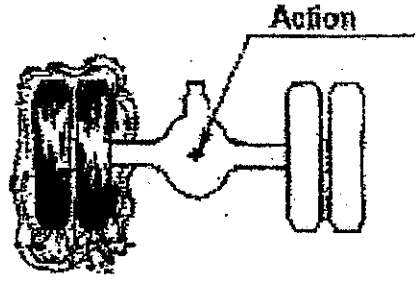
6. Using the Illustrations on the following page, identify whether or not differential ***action*** is taking place in each of the three [3] differentials. Complete the blanks with one of the following two choices. **NOTE: The spinning wheels are spinning at the same speed.**

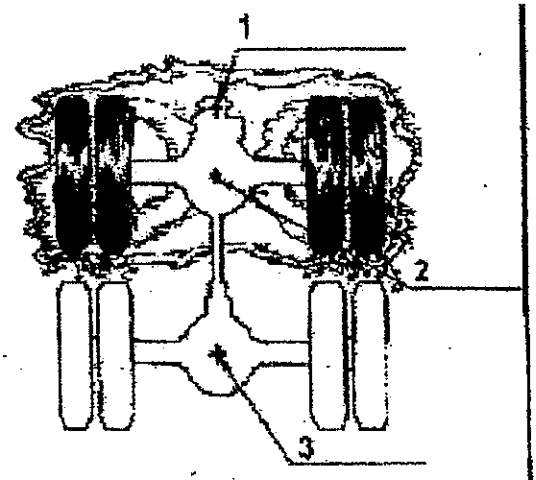
    - Action
    - No action

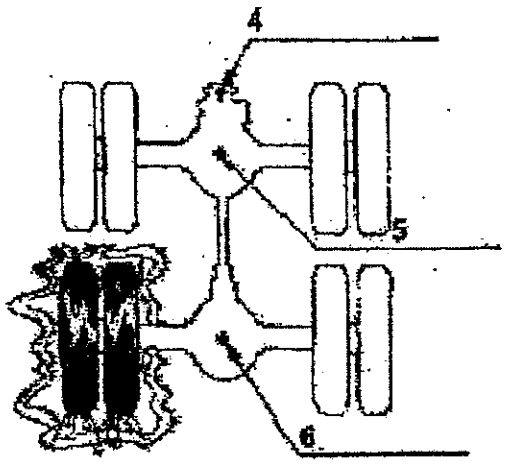
SkillsUSA Competition

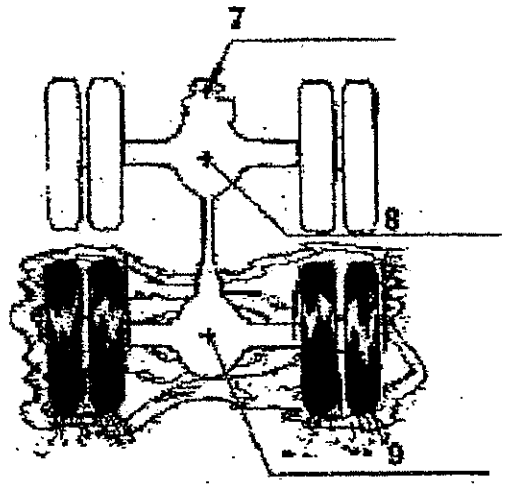
Drive Axle Station # 7

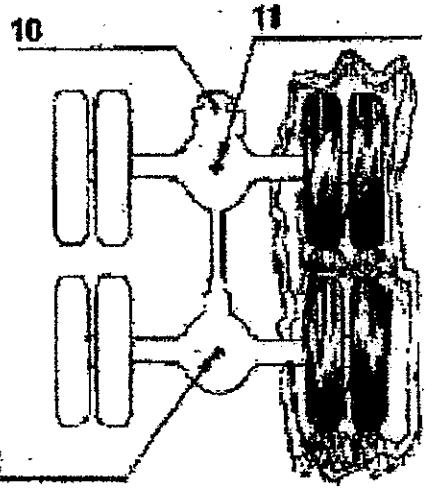
Example

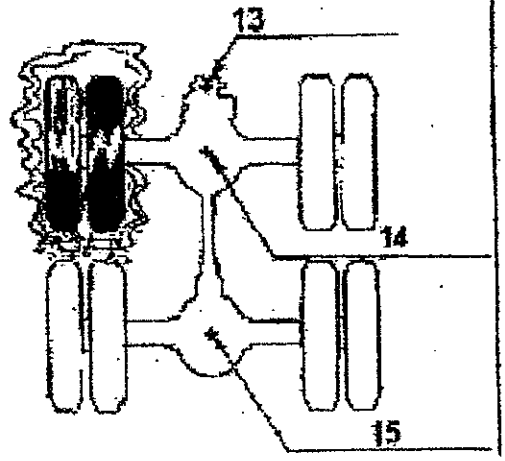












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SkillsUSA 2010
Diesel Equipment Technology Competition
Drive Axle – Station #7

7. Locking in the driver controlled differential lock [DCDL], will eliminate differential action on which of the following components? Circle letter of the one correct answer:

   a. The main differential of the selected drive axle.
   b. The inter-axle differential.
   c. Both A and B.
   d. All of the above.

8. Locking in the inter-axle differential, will eliminate differential action on which of the following components? Circle letter of the one correct answer:

   a. The main differential of the forward drive axle.
   b. The main differential of the rear drive axle.
   c. The inter-axle differential.
   d. All of the above.

9. Correctly assemble the main differential assembly, including all thrust washers. Only install 2 bolts finger tight.

10. Correctly assemble the inter-axle differential assembly.

Contestant # ____ **Drive axle #**_____ **Score**_____

SkillsUSA 2010
Diesel Equipment Technology Competition
Drive Axle – Station #7
Axle Identification and Inspection

1. What is the gear ratio of this drive axle?

   _____

2. Measure the input shaft end play.

   Measured end play is:

   _____

   Specification end play is:

   _____

   Is the end play within specification? Yes _____ No _____

3. Measure the ring gear run out.

   Measured run out is:

   _____

   Specification for ring gear run out is:

   _____

   Is the run out within specifications? Yes _____ No _____

Contestant # ____ **Drive axle #_____** **Score_____**

SkillsUSA 2010
Diesel Equipment Technology Competition
Drive Axle – Station #7

4. Measure the ring gear backlash.

   Measured backlash is:

   _____

   Specification for backlash is:

   _____

   Is the backlash within specifications?

   _____

5. If the backlash were out of specifications how would you correct it?

   _____
   _____
   _____
   _____

6. Is this carrier equipped with an oil pump?

   Yes _____ No _____

7. Is this carrier equipped with a driver controlled differential lock?

   Yes _____ No _____

Contestant # ____ **Drive axle #_____** **Score_____**

DET #9

Skills USA
2010 National Skills Competition

Number_____

Directions: Circle the correct response for each item.

1. What occurs in a hydraulic system if fluid flow is restricted?

    a. Fluid flow rate and pressure decrease
    b. Fluid flow rate decreases and pressure increases
    c. Fluid flow rate and pressure increase
    d. Fluid flow rate increases and fluid pressure decreases
    e. None of the above

2. Which hydraulic component is designed to use fluid flow and pressure to produce mechanical motion and thus do work?

    a. Pump
    b. Line
    c. Cylinder
    d. Tank
    e. a and d

3. Hydraulics can best be defined as:

    a. The use of liquid under controlled pressure to do work
    b. Generating electricity with waterpower
    c. Using mechanical advantage to lift large loads
    d. A way of compressing gas to turn it into liquid
    e. None of the above

4. Which of the following functions are performed by the tank in a typical hydraulic system?

    a. Allows air to separate from the oil
    b. Allows contaminant to settle out of oil
    c. Cools hydraulic fluid
    d. All of the above

5. A charge pump supplies flow to the outlet of a larger pump to prevent cavitation.

    a. True
    b. False

6. A closed loop system that uses a hydraulic pump and motor to transfer power is called:

    a. Reciprocating drive
    b. Rotary drive
    c. High drive
    d. Hydrostatic drive
    e. None of the above

7. Pump displacement is calculated by measuring which of the following?

    a. The volume of fluid pumped in one minute
    b. The average pressure during one revolution of the pump
    c. The volume of the fluid pumped during one revolution of the pump
    d. None of the above

8. An orifice in an oil passage causes:

    a. A lower oil pressure on the downstream side of the orifice when there is no oil flow
    b. A lower oil pressure on the downstream side of the orifice when there is oil flow
    c. A lower oil pressure on the downstream side of the orifice at all times
    d. None of the above

9. In a variable displacement piston pump, when the swashplate angle is increased, _____ is increased.

    a. Displacement
    b. RPM
    c. Pressure
    d. a and c
    e. None of the above

10. In a hydraulic system, valves control:

    a. Pressure
    b. Direction of flow
    c. Quantity of flow
    d. a and b
    e. a, b, and c

11. What hydraulic component applies a force to a fluid and causes it to flow?

    a. Actuator
    b. Pump
    c. Conductor
    d. Cylinder
    e. a and d

12. Pressure is defined as:

    a. Force of a fluid per unit area
    b. Excessive flow in the system
    c. The lifting capacity of a system
    d. The fluid volume of a system
    e. None of the above

13. To increase the flow rate of a fixed displacement pump, which of the following must be done?

    a. Increase the pressure relief valve settings
    b. Increase the drive speed or RPM of the pump
    c. a and b
    d. None of the above

14. How much pressure is necessary within a hydraulic system to support a 1000 pound load if the area of the piston supporting the load is 5 square inches?
    a. 0.05 pounds per square inch
    b. 20 pounds per square inch
    c. 200 pounds per square inch
    d. 2000 pounds per square inch
    e. None of the above

15. The upstream pressure of a main system relief valve is regulated by:

    a. The upstream pressure only
    b. The downstream pressure only
    c. The spring force only
    d. Both a and c

16. The path of oil flow in a gear type pump is:

    a. Through the center between the gears
    b. Around the outside between the gears and the housing
    c. Around the ends of the gears by the shafts
    d. Both a and c

17. The outlet pressure of a pressure reducing valve is regulated by:

    a. The spring force only
    b. The inlet pressure only
    c. The outlet pressure only
    d. Both a and c

18. The difference in pressure in a differential pressure valve is determined by:

a. The upstream pressure only
b. The downstream pressure only
c. Both the upstream and the downstream pressure
d. The spring force and the valve spool size

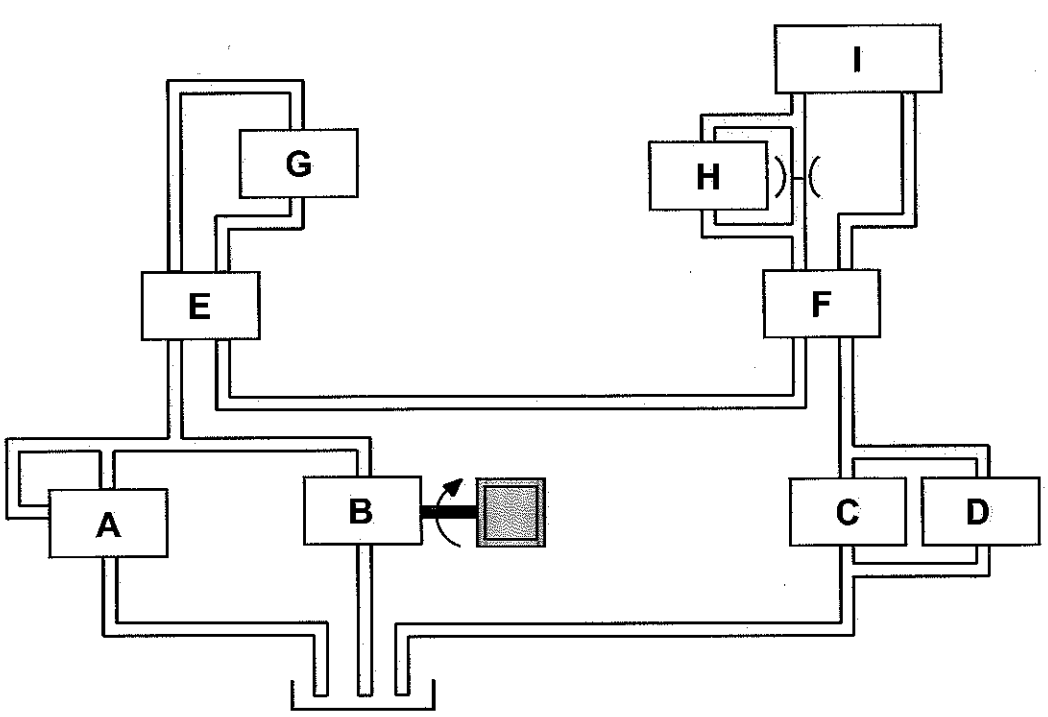
19. Accumulators are used in hydraulic systems to:

a. Permit the use of smaller pumps
b. Provide emergency steering and brakes
c. Maintain constant pressure
d. All of the above

20. What two factors affect the amount of fluid pressure required to lift a load?

a. Input force and the area on which the input force is applied
b. Input force and the resulting fluid pressure
c. Resisting force of the load and the area on which fluid exerts pressure to support the load
d. Maximum fluid pressure and the area on which that pressure is exerted

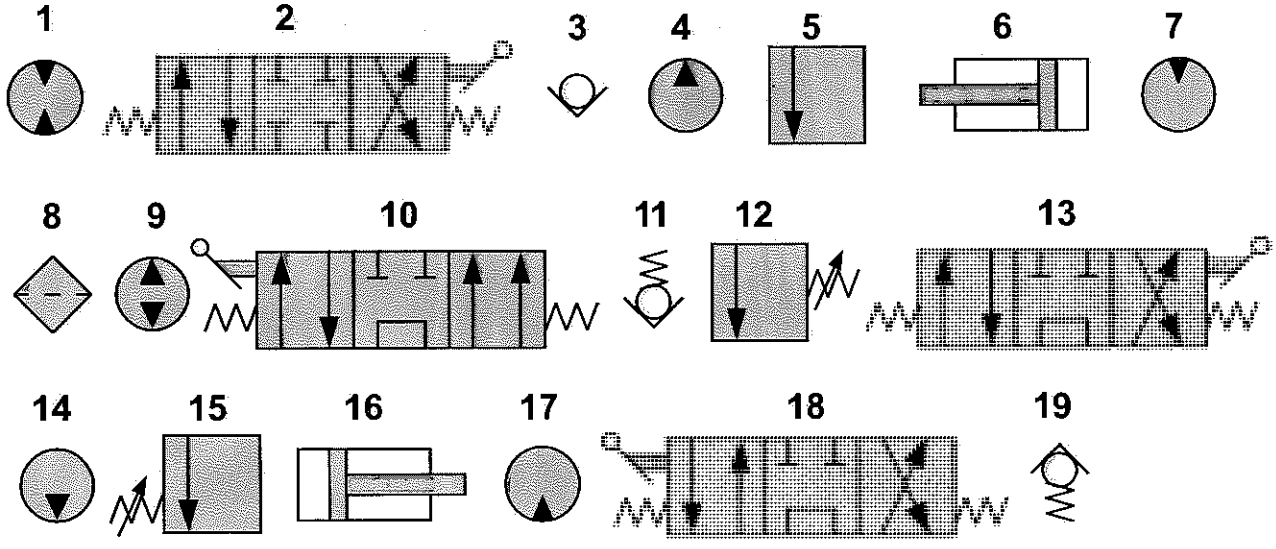
HYDRAULIC TEST



A ____
B ____
C ____
D ____
E ____
F ____
G ____
H ____
I ____

This is an open center, series circuit. The system is protected with an adjustable main relief valve. The mono-directional pump supplies the bi-directional track motor valve first and the cylinder valve second before returning to the tank through the filter with a bypass valve. The two-way cylinder is to retract rapidly with unrestricted inlet flow and extend slowly. Place the number for the proper ISO symbol beside the appropriate letter for the location in the column on the right. Symbols may be used more than once.

ISO SYMBOLS



Skills USA
2010 National Competition

Number _____

Component Identification: On the machine, match the tag number attached to the component using the list below. Write the tag number next to the component name. There are more tags on the machine than components listed below.

Using the schematic, write the part number for each of the hydraulic components listed. For this exercise, your machine is a 289C with XPS High Flow.

Tag Number	Schematic Part Number	Component
_____	_____	Lift Cylinder
_____	_____	Travel Motor
_____	_____	Implement Control Valve
_____	_____	Pilot Accumulator
_____	_____	Tilt Cylinder (two (2) possible correct answers)
_____	_____	Implement Pump
_____	_____	Hydraulic Oil Reservoir
_____	_____	Hydraulic Oil Filter
_____	XXX	Lift Arm Brace
_____	_____	Hydraulic Oil Cooler
_____	_____	Auxiliary Hydraulic Quick Couplers (two (2) possible correct answers)
_____	_____	Travel Propel Pump
_____	_____	Hydraulic Cooling Fan

DET #10

Instructions to Contestants

"Please put your number atop the sheet. This PM Inspection Station has 2 parts. You will be starting on Part (1 or 2).

"Make each check; if OK put a checkmark in the OK box. If not OK, briefly describe what is wrong in the Not OK box including position, if applicable. Some checks require you to record a number."

"Do not go inside the cab; there is no need to start the engine. ."

"Keep in mind, there may or may not being anything wrong with the vehicle you are inspecting."

"All the tools and equipment needed are here. Return them to this spot when you are finished using them. Gloves are provided to avoid getting dirty. All items can be inspected without going under the vehicle."

"You will have 15 minutes to complete each part of this station. I will give you a 2-minute warning for each part. When time is called, immediately move to the next part. If you complete before the allotted time, please have a seat and remain quiet until time is called. If you finish both parts before time is called, please have a seat over there and fill out the survey."

"Do you have any questions?" Remember to be safe.

"When they say Start, you may begin. "

PM INPECTION STATION Number _____

2010 Contestant Worksheet

Part 1

Front Axle Brakes		**Answers**
Record size and type of brake chamber on the steering axle.		Size: Type:
Engine Compartment Inspection	**OK**	**Not OK**
Check all starter cable connections in engine compartment		
Inspect radiator and mounting		
Inspect fan assembly and shroud		
Check for loose wiring		
Inspect coolant hoses and clamps		
Check entire intake system		
Check exhaust and turbo		
Check all belts for condition and alignment		
Check all belt driven components		
Identify EGR valve to judge; inspect EGR components		

Part 2

Behind the cab	**OK**	**Not OK**
Visually inspect the trailer air hoses and light cord for condition and mounting		
Check the battery box mounting, and battery hold-downs		
Check battery box cable condition and mounting		
Check quarter fender mounting		
Visually inspect 5th wheel and mounting		
Visually inspect rear springs, shocks, and air bags		
Check mud flaps and mounting		
Inspect axle breathers		
Inspect brake hoses and mounting		

PM INSPECTION STATION 2010 JUDGES SCORING SHEET

Contestant Number _____ Judge Name _____

Total Score _____

(1) Record Contestant Number, (2) Double check your math, (3) Put total score in space ABOVE, and (4) Sign your name in space provided.

Scoring (Part 1)	Each item below is worth 10 points	Score
Front chambers are Type 20 Long Stroke	5 points each	
Turbo inlet clamp missing		
Alternator ground wire loose		
Belt alignment bad		
EGR location and mounting bolt missing	5 points each	
	Subtotal	
xxxxxxxxxxxxxxxxxxxxxxxxx	xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx	xxxxxxxx
Scoring (Part 2)	**Each item below is worth 10 points**	**Score**
Battery hold down missing		
Missing nut from top of air bag		
5th Wheel slide hose loose		
5th Wheel safety bolt missing		
Axle breather missing A3		
	Subtotal	

SkillsUSA 2010 – Failure Analysis Station #11

You are at the Failure Analysis Station. You will find a total of **three groups** of questions. One of the three groups is **"Parts"** and you are required to identify the cause of the failure on each part. The second group is **"Oil Analysis"** questions that are related to various failure modes. The third group is **"General Knowledge"** questions.

Parts - Group One

- Use supplied parts to answer the following multiple choice questions.
- Inspect each part and determine the type or cause of the failure.
- Circle the answer that best describes the type or cause or the failure.

1. Item "1" is Coolant Test Equipment.-
Which of the tools displayed is the best tool for on sight testing of coolant.

A. Four floating ball tester.
B. Coolant test strips.
C. Refractometer.
D. Float type bulb tester.
E. None of the above

---

2. Item "2" is Tooth Fracture of Idler Gear.

A. Serviceable part. No defect. Return to service.
B. Foreign material damage.
C. Overloading of gear teeth.
D. Oil starvation due to lack of lubricating oil.

---

3. Item "3" is Cam Gear and Mounting Plate.

A. Serviceable part. No defect. Return to service.
B. Damaged thrust surface on gear, requiring replacement.
C. Damaged thrust surface on mounting plate, requiring replacement.
D. Both B & C.

---

4. Item "4" is Ripper Spool Valves.

A. Serviceable part. No defect. Return to service.
B. Contaminated hydraulic system
C. Material defect
D. Lack of lube oil

SkillsUSA 2010 – Failure Analysis Station #11

Parts - Group One - Continued

- Use supplied parts to answer the following multiple choice questions.
- Inspect each part and determine the type or cause of the failure.
- Circle the answer that best describes the type or cause or the failure.

5. Item "5" is a Connecting Rod and Piston Assembly

A. Serviceable part. No defect. Return to service.
B. Defective Connecting Rod.
C. Defective Piston.
D. Both B & C.

---

6. Item "6" is a Turbo Charger Oil Feed Line

A. Serviceable part. No defect. Return to service.
B. Defective fitting.
C. Cracked flare / seat.
D. Crushed braided line.

---

7. Item "7" Coolant Concentration Test
Record ethylene glycol freeze protection level of samples A & B

A. _____

B. _____

---

8. Item "8" is a Piston

A. Serviceable part. No defect. Return to service.
B. Impact damage to piston skirt
C. Piston pin bushing damage.
D. Dropped valve damage on piston dome.

Parts - Group One - Continued

- Use supplied parts to answer the following multiple choice questions.
- Inspect each part and determine the type or cause of the failure.
- Circle the answer that best describes the type or cause or the failure.

9. Item "3" is a Thermostat & Seal.

A. Serviceable part. No defect. Return to service.
B. Damaged thermostat seal. Do not reuse.
C. Worn thermostat housing. OK to reuse.
D. Both "B" and "C"

10.Item "10" is Push Tubes (Push Rods)

A. Serviceable part. No defect. Return to service.
B. Bent push tube. Do not reuse.
C. Damaged ball end. Do not reuse.
D. Damaged cup end. Do not reuse.

11.Item "11" is a Water Pump

A. Serviceable part. No defect. Return to service.
B. Excessive wear to bearing. Do not reuse.
C. Cracked housing. Do not reuse.
D. Defective seal / impeller. Do not reuse.

12.Item "12" is Bent Connecting Rod

A. Engine overspeed
B. Piston pin seizure.
C. Hydrostatic lock.
D. Manufacturing defect

OIL ANALYSIS QUESTIONS

- Circle the answer that best describes the type or cause or the failure.

13. Technician A says that in oil analysis excessive cylinder/valve train wear will show up as high iron levels. Technician B says that excessive piston/ring wear on older engines can show up as high aluminum/chromium levels. Who is correct?

A. Technician A only
B Technician B only
C. Both are correct
D. Neither is correct

---

14. The best method for obtaining an oil sample is?

A. Drain plug method
B. Oil gallery (pressure valve) method
C. Siphon (vacuum) method
D. None of the above

---

15. The four major solid contaminants found in used engine oil is soot, silicon (dirt), fuel, and coolant?

A. True
B. False

---

16. Technician "A" says that a high silicon reading can be caused by dirt entering the engine and contaminating the oil due to a faulty air intake system. Technician "B" says that a high silicon reading can be caused by using too much sealant during engine assembling. Who is correct?

A. Technician A only
B. Technician B only
C. Both are correct
D. Neither is correct

SkillsUSA 2010 – Failure Analysis Station #11

GENERAL KNOWLEDGE QUESTIONS

- Circle the answer that best answers the general knowledge questions.

17. If an engine has a sudden loss of oil and the operator does not shut off the engine and continues to operate it what will be the first major component to fail?

A. Piston / Liner
B. Flywheel
C. Crankshaft / bearings
D. Oil pump

18. If an engine has a sudden loss of coolant and the operator does not shut off the engine and continues to operate it what will be the first major component to fail?

A. Piston / Liner
B. Camshaft / Rollers
C. Water Pump
D. Unit Injector

19. A quart can of engine oil has a marking on the lid of SAE 10w30. Technician "A" says the SAE stands for *"Society Automotive Engineers"* and this oil is a 10 weight viscosity cold and 30 weight viscosity hot. Technician "B" says the SAE stands for *"Special Additive Enabled"* and the 10w30 stands for the types of additives used. Who is right?

A. Technician A only
B. Technician B only
C. Both Technicians A & B
D. Neither Technician A or B

20. Technician "A" says that orange colored diesel fuel should be used in US07 emission and newer on-highway engines. Technician "B" says that blue/green colored diesel fuel should be used in US07 emission and newer on-highway engines. Who is correct?

A. Technician A only
B. Technician B only
C. Both Technicians A & B
D. Neither Technician A or B

JOHN DEERE SkillsUSA

Written Total Score:

SkillsUSA Diesel Equipment Technology Competition 2010

Braking Systems
Station 12

Written Test **Contestant #_____**

Part 1: Identify the following brake related components on the hydraulic schematic. Mark the corresponding component number next to the name of the component. Each question is worth 2.5 points.

Component	Schematic Number
1. Brake Valve	
2. Brake Accumulator	
3. Brake Pressure Transducer	
4. Axle Circulation Pump	
5. Hydraulic Reservoir	
6. Main Hydraulic Pump	
7. Axle Oil Cooler	
8. Park Brake Solenoid	
9. Park Brake Pressure Switch	
10. Hydraulic Breather Filter	

Written Test

Part 2: Identify the best answer(s) to the questions below.

1. What types of brakes are used in heavy equipment:
    a. Drum
    b. Caliper Dry Disk
    c. Wet Disk
    d. All of the above

2. Select the appropriate definition for Drum Brakes:
    a. Friction resulting from the brake pad clamping down on the disk
    b. Friction resulting from the brake pad pressing out on the outer drum
    c. Friction resulting from the brake pad clamping down on the disk and parts are splashed with oil to dissipate heat

3. Select the appropriate definition for Caliper Dry Disk Brakes:
    a. Friction resulting from the brake pad clamping down on the disk
    b. Friction resulting from the brake pad pressing out on the outer drum
    c. Friction resulting from the brake pad clamping down on the disk and parts are splashed with oil to dissipate heat

4. Select the appropriate definition for Wet Disk Brakes:
    a. Friction resulting from the brake pad clamping down on the disk
    b. Friction resulting from the brake pad pressing out on the outer drum
    c. Friction resulting from the brake pad clamping down on the disk and parts are splashed with oil to dissipate heat

5. The Main Hydraulic Pump shown in the schematic is best described as:
    a. Fixed Displacement
    b. Variable Displacement
    c. Radial Piston
    d. Broken

6. The Axle Circulation Pump shown in the schematic is best described as:
    a. Variable Displacement
    b. Radial Piston
    c. Fixed Displacement
    d. Electric over hydraulic

7. The valve shown in the schematic that routes oil to the Park Brake is best described as:
    a. Pilot operated-spool type
    b. Electric operated solenoid valve
    c. Open centered
    d. Closed centered

8. The Brake Valve in the schematic is best described as a:
    a. Three position spool
    b. Five position spool
    c. Two position spool
    d. One way check valve

9. Item number 3 in the schematic is best described as a:

   a. Filter
   b. Cooler
   c. Pump
   d. None of the above

10. The Park Brake is best described as:

   a. Spring released-hydraulically applied
   b. Spring applied-hydraulically released
   c. Spring applied-air released
   d. Cable applied and released

2010 Brake Station - Orientation

SkillsUSA

Brake Station Orientation – Say this before each round begins.

"The braking station competition focuses on testing your knowledge of hydraulic braking systems used in off-road equipment. There will be two tasks in this station.

The first task is a written test consisting of a component identification task on a schematic along with ten multiple choice questions.

The second task is a hands-on skills verification where you will be asked to identify components of the braking system on the 4 wheel-drive-loader as well as perform an external brake disk inspection and wear measurement.

You will have access to the John Deere Service Advisor program to assist with component locations. You are welcome to use it if you would like, but you do not need it to effectively complete this activity.

Two hands-on tests will be conducted at a time, the remaining contestants will work on their written tests.

You will have 20 minutes total in this rotation to complete the written test.
You will have 10 minutes to complete the hands-on test.

Are there any questions?"

Send four contestants to written test tables.

Send two contestants to the hands-on area by the 4WD Loader.

JOHN DEERE

SkillsUSA®

SkillsUSA Diesel Equipment Technology Competition--2009

Braking Systems

Station 12

Hands-On Test—10 Minutes **Contestant #_____**

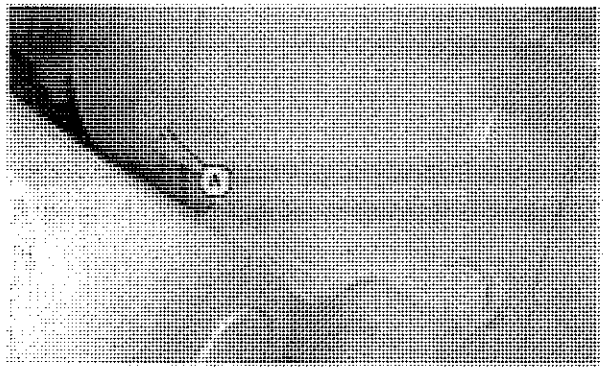
Part 1: Identify the following brake-related components on the machine using the tags provided.—30 points possible—3 points per item.

Component	Tag ID
1. Brake Valve	
2. Brake Accumulators	
3. Main Hydraulic Pump	
4. Brake Pressure Transducer	
5. Hydraulic Reservoir	
6. Park Brake	
7. Axle Oil Dipstick	
8. Park Brake Solenoid	
9. Park Brake Pressure Switch	
10. Brake Pedal	

Hands-On Test

Part 2: Using the tools and measurement equipment provided, perform a Brake Disk Inspection and Measurement.—20 points possible

Brake Disk Inspection (External)

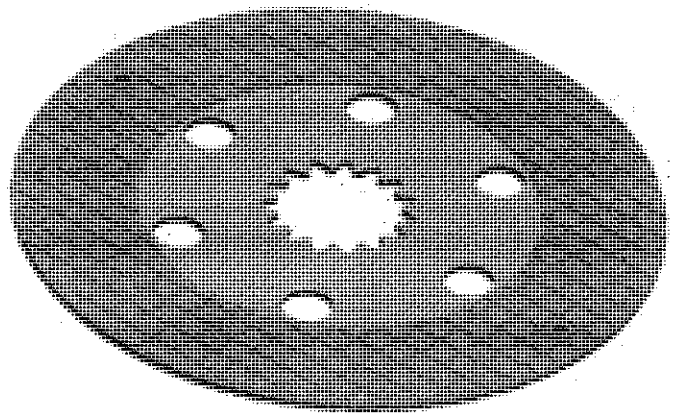


T6523BZ-UN: Brake Inspection Port Plug

LEGEND:

A - Brake Inspection Port Plug
Brake disks can be inspected for wear through the external inspection ports (A).

1. Remove brake inspection port plug (A).

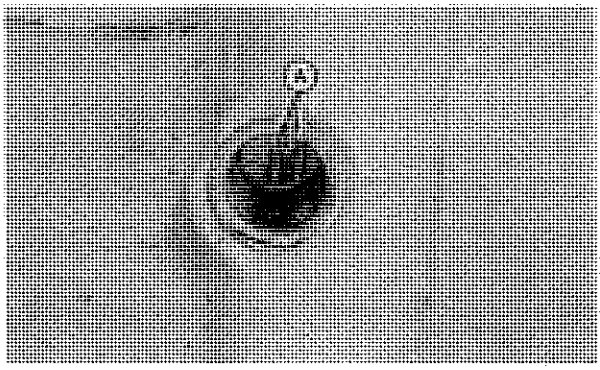


2.

YZ7359-UN: Brake Friction Plate

Replace the disk if oil grooves are no longer visible.

Item	Measurement	Specification
Brake Disk	Thickness (New)	7.57 mm (0.298 in.)
	Groove Depth (Minimum)	0.99 mm (0.039 in.)

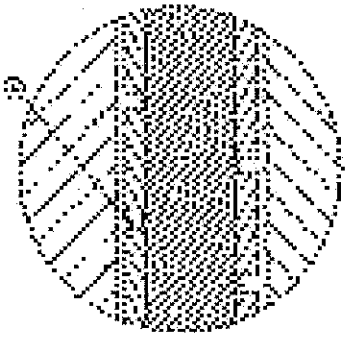
3. 

T6138AZ-UN: Brake Linings

LEGEND:

A - Brake Linings

Inspect the brake linings (A) on brake disk.

4. 

T8137AC-UN: Oil Grooves

LEGEND:

A - Brake Disk Oil Grooves

Remove axle housing and replace brake disc if oil grooves (A) on facing material are no longer visible.

SkillsUSA
2010 Contest Projects

Electronics Technology

Click the “Print this Section” button above to automatically print the specifications for this contest. Make sure your printer is turned on before pressing the button.

Electronics Technology

No oscilloscopes, multimeters or calculators will be provided by the technical committee.

TECHNICAL MANUAL

Electronics Technology

SkillsUSA
Champions at Work®

Contestant Handout

2010

Nida Corporation
300 John Rodes Blvd.
Melbourne, Florida 32904

Technical Manual

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THEORY OF OPERATION

General Description – Switched-mode power supplies have the advantage over linear power supplies of requiring less power input for the amount of power output. Linear power supplies require an "overhead" voltage, meaning the power supply itself requires 1 to 3 volts of input more than the required regulated output just to maintain regulation. Should a high demand be placed on a linear supply and the demand pull the output voltage below the required voltage plus the overhead voltage, regulation is lost.

Switched-mode power supplies can be found in almost every electronic device with circuit demands greater than 2 amperes. Switched-mode supplies are more complicated, and therefore, more expensive to manufacture; but they have proven to be more reliable than their linear counterparts in high-current applications. Switched-mode power supplies operate at much higher frequencies than 60 Hz, which reduces the size of required filtering capacitors.

The switched-mode power supply used in the competition uses Pulse Width Modulation (PWM) to provide output voltage regulation. The PWM switching power supply resides on the Skills07-1 and Skills07-2 circuit cards. The power supply output is adjustable between 1.5 and 10 VDC.

The Skills07-3 circuit card is used to provide a load with varying current demands but operates only within a narrow span of DC voltage. The load placed on the power supply is constantly changing, and varies between 50 mA and 150 mA.

The following circuit descriptions are presented in both a simplified block diagram, or systems version, and a detailed schematic signal flow version down to the component level. It is recommended that you read and understand both presentations.

Block Diagram Circuit Descriptions – Each circuit card (PWM Switching Power Supply I, PWM Switching power Supply II, and Load) will be described as it relates to the circuits.

PWM Switching Power Supply I. The PWM Switching Power Supply I circuit card (Skills07-1) consists of the B1, B2, B3, and B4 blocks. See Figure 1 on the next page.

The PWM Switching Power Supply I circuit card provides several functions to the switching power supply. Each is totally separate from the others but all are required for the proper operation of the circuit. Following is an explanation of each of the sections:

Block B1 is the rectifier block. The AC input is converted to unregulated filtered DC voltage. The single output, a DC voltage between 15 and 19 volts, can be verified at test point TP1. This voltage is also present at the circuit card output plug, J1, on pin 1.

Block B2 contains an oscillator and buffer circuit. The block is powered by regulated 10 VDC from block B3, the amplitude control circuitry. The output of the circuit, a 10 volt square wave with an 80% duty cycle, is measured at TP8. When the circuit is properly set up, this waveform has a frequency of 100 kHz.

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PWM Switching Power Supply I, continued

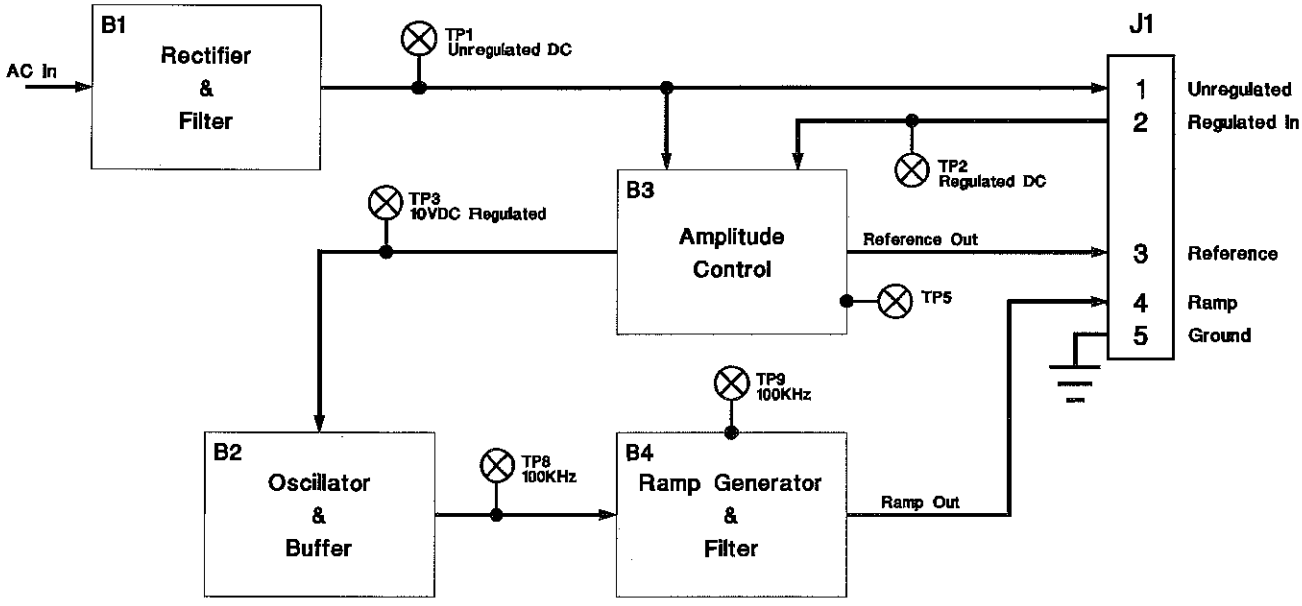

Figure 1. PWM Switching Power Supply I Block Diagram

Block B3, labeled Amplitude Control, contains an operational amplifier circuit configured as a differential amplifier. A sample of the regulated output voltage from the power supply enters the circuit card at J1 pin 2. This voltage is compared to a known internally-regulated DC voltage. The output of the differential amplifier, the correction signal for the switching power supply, labeled "Reference", is present at J1 pin 3. This output, a varying DC voltage of about 10 VDC, can be verified at TP5. A fixed 10 VDC output at TP3 powers block B2.

Block B4 contains a ramp generator circuit. The input to the circuit is the 100 kHz waveform output from block B2. This square wave input is converted to a ramp signal matching the duty cycle of the incoming waveform. This ramp signal can be viewed at TP9. A DC offset voltage of about 10 volts is added to the ramp signal, and the resulting composite signal, "Ramp", exits the circuit card at J1 pin 4.

PWM Switching Power Supply II. The PWM Switching Power Supply II circuit card (Skills07-2) consists of five blocks, B5 through B9. See Figure 2 on the next page.

The PWM switching power supply II circuit completes the switching power supply and has several functions. The five blocks making up the PWM switching power supply II circuit are B5 (PWM modulator & switch), B6 (current limiter), B7 (output filter), B8 (onboard load), and B9 (over-voltage protection). Following is an explanation of each block:

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PWM Switching Power Supply II, continued

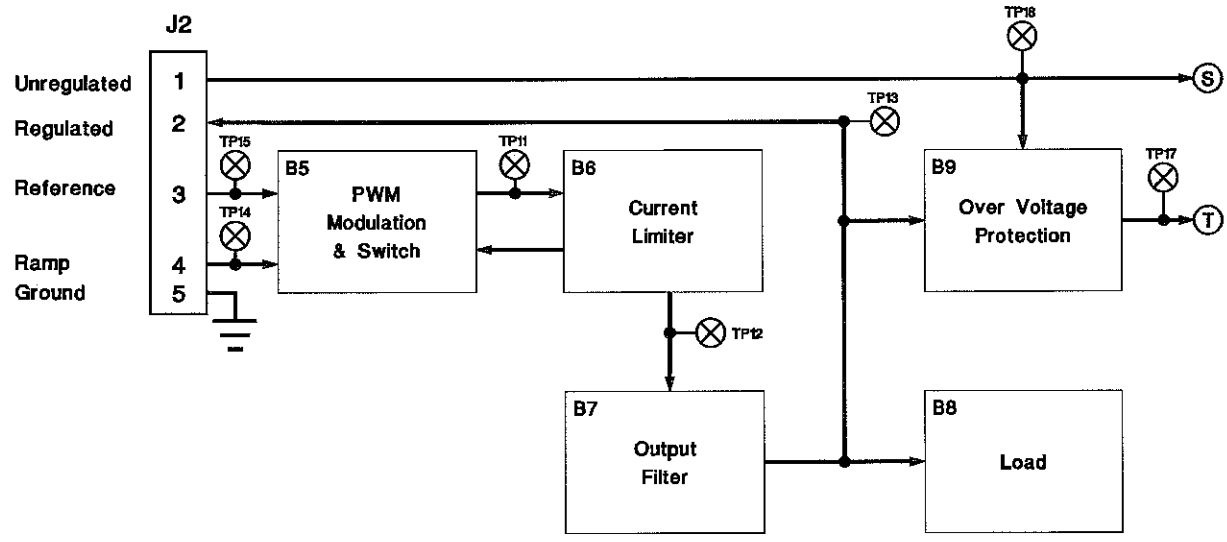

Figure 2. PWM Switching Power Supply II Block Diagram

Block B5 provides the pulse width modulation and switching. Regulation is provided by comparing the Reference and Ramp signals from the PWM switching power supply I circuit card.

TP14 allows the view of the composite Ramp signal and TP15 is used to verify the Reference signal. TP11 is the block 5 output, a 100 kHz square wave with slight rounding of the waveform at the top. The pulse width (duty cycle) will vary with the load. The pulse width will increase under higher current demand conditions.

Block B6, the current limiter, has a passive role in normal operation. Should the output loads fail in a way as to increase the current demand, the circuit activates and shuts down the power supply by disabling the switching signal in block B5. When the high current demand is removed, the current limiter again assumes the passive role as the power supply resumes normal operation.

TP12 is used to monitor the current limiter output. In normal use, the waveform at TP12 should be identical to the waveform at TP11, the block B5 output.

Block B7 is the output filter circuit. The input to the circuit is the switching square wave from block B6 common to TP12. The output of block B7 is the output for the switching power supply and can be measured at TP13. This output is applied to the over-voltage protection circuit and the loads; it also provides feedback for comparison in block B3 on the PWM Switching Power Supply I circuit card via J1 pin 4.

Block B8 has a voltage output indicator LED and a switched load.

Block B9 is an over-voltage protection circuit for the external load. Should the output of the switching power supply exceed a preset limit, the circuit trips, and the voltage to the external load is removed from the output terminal T. The output voltage can be measured at TP17.

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Load. The Load circuit card (Skills07-3) consists of four blocks: B10, B11, B12, and B13. See Figure 3.

The purpose of the Load circuit card is to provide an external varying load for the PWM switching power supply.

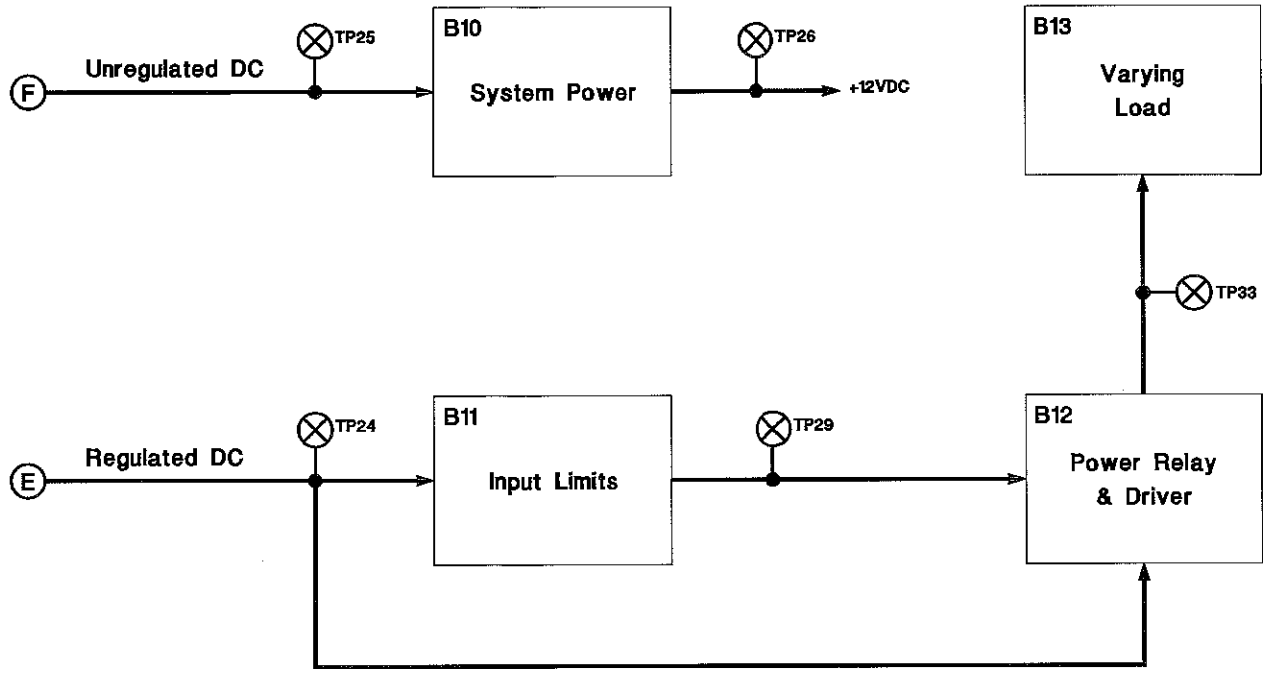

Figure 3. Load Block Diagram

Block B10 contains the system power supply. The protection and relay circuitry require a fixed operating voltage higher than the regulated output of the PWM switching power supply. Block B10 has a small low-current, single IC, linear power supply with a fixed +12 VDC output to power blocks B11 and B12.

The voltage source for block B10 is the unregulated DC voltage output from block B1, measured at TP25. The output for block B10 can be checked at TP26.

Block B11, Input Limits, monitors the regulated 8.5 VDC input voltage from block B9 on the PWM Switching Power Supply II circuit card. The input voltage can be verified at TP24. Should the regulated input voltage be above or below set limits, the circuitry will pull a normally-HIGH output at TP29 LOW, disabling the power relay and driver circuit in block B12.

Block B12 has the power relay and driver circuitry. A HIGH input at TP29 allows the circuitry to switch the PWM power supply regulated input to block B13, the Varying Load block. A LOW input at TP29 causes the circuitry to shut down, removing the power to block B13.

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Load, continued

Block B13 contains the varying load for the PWM switching power supply. Eighteen LEDs, arranged in 3 groups of 6 LEDs each, are turned on and off at different speeds. This causes the load to vary constantly. When regulated voltage is present at TP33, the circuit should be operating with the LEDs flashing at different rates.

Schematic Diagram Circuit Descriptions – Schematic diagrams provide the greatest detail for circuit analysis and troubleshooting; they also give component values and identification numbers. The parts location pictorial and test point list for each circuit card are located after the Operational Check. The schematic diagrams are at the end of this document.

PWM Switching Power Supply I (Skills07-1)

The PWM Switching Power Supply I circuit card makes up one-half the overall pulse width modulated (PWM) switching power supply. There are four different blocks on the circuit card. Each block on the circuit operates independently but all are required for the proper operation of the power supply.

Two separate 60 Hz AC voltages 180° out of phase enter the circuit card in block B1 at pins B, C, G, and H. Pins C and G are grounded and provide ground return for the B and H inputs. Diodes D1 and D2 make up a full-wave bridge, converting the AC inputs to DC voltage. When S1 is in the ON position, the DC voltage is applied to C1, a 1,000 µF electrolytic capacitor, which filters out most of the AC ripple from the DC voltage.

The DC voltage at this point is unregulated, and can be verified at test point TP1. The voltage will measure between 15 and 19 VDC. The AC ripple at the top of the DC voltage can be as high as 1 Vpp, or about 1/3rd volt RMS. DS1 is a power indicator.

The unregulated DC is applied to blocks B3 and B4 on the PWM Switching Power Supply I circuit card; it also powers other blocks on the PWM Switching Power Supply II and Load circuit cards via plug J1 terminal 1.

An oscillator in block B2 made up of U1E and U1F develops a square wave digital signal with a tapered trailing edge. The waveform can be viewed at TP7, will be 10 Vpp, and will vary in frequency between 80 kHz and approximately 150 kHz with the adjustment of R11, the Frequency control. The oscilloscope probe may load the circuit in the x1 setting; it is best to use the x10 setting on the oscilloscope probe.

During normal operation, R11 is set to produce a 100 kHz waveform. 100 kHz translates to a waveform of 10 µs duration, and it can be verified by setting the oscilloscope Time/Div control to the 1 µs position. The waveform should extend completely across the oscilloscope display when the frequency is set properly.

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PWM Switching Power Supply I (Skills07-1), continued

The output of the U1E / U1F oscillator is buffered in two stages: first by U1A, and then by U1B, U1C, and U1D in parallel. The resultant waveform is an almost perfect square wave with an 80% duty cycle. The waveform can be viewed at TP8. See Figure 4 for a sample. The sample in Figure 4 can be duplicated by setting the oscilloscope Time/Div control to 2 µs.

Because the supply voltage can affect the output of an RC oscillator circuit, block B2 receives a regulated 10 VDC supply voltage from block B3. Components C5, R10, R11, and D5 make up the RC timing circuit.

Block B3 contains U2, an operational amplifier set up in the differential mode that is used to compare the regulated output of the PWM switching power supply to a known voltage source. A difference output signal, termed "Reference", is developed at the output of U2 at pin 6. This signal is used as a correction signal for the power supply. The Reference signal, which can be viewed at TP5, departs the circuit card at J1 terminal 3.

The PWM Switching Power Supply sample output voltage enters the circuit card at J1 terminal 2 and can be measured at TP2. The voltage enters U2 at pin 2, the negative input to the op-amp, through R3. The configuration of R3 and R6, the feedback resistor, sets the gain of the op-amp at 10.

The fixed input to U2 is derived from the unregulated DC voltage at TP1. A voltage divider and regulator circuit consisting of R2, R4, and D3, a zener diode, drops and maintains the voltage at TP3 to 10 VDC. R4, a 5 kΩ variable resistor, sets the fixed voltage level to pin 3, the positive input to U2. The fixed 10 VDC at TP3 is applied to block B2 as the oscillator and buffer power source.

U2 compares the voltages at pins 2 and 3, the negative and positive inputs, and develops the difference signal as the Reference output signal. In normal working conditions when properly set, the Reference signal at TP5 is 10.5 to 11.5 VDC with a minor ripple at the top. The ripple is caused by the unregulated DC ripple and voltage correction changes made by U2.

The inputs to U2 can be verified at TP4, common to the positive input, and TP6, which is common to the negative input. When operating correctly, these voltages should be equal and just slightly higher than the regulated output of 8.5 VDC at 8.6 to 9 VDC.

Variations in the measured voltages at TP4 and TP6 are due to component tolerances, but they should measure with the multimeter to be equal in voltage. The voltage at TP4 is fixed, and the sample voltage at TP6 is adjusted at a 100 kHz rate by the power supply circuitry to be equal to the reference voltage at TP4.

Block B4 contains a simple ramp circuit consisting of an RC timing circuit, R8 and C3. R8, a 1 kΩ resistor, and C3, a 0.01 µF capacitor, make up a 10 µs (100 kHz) timing circuit. As the 80% duty-cycle square wave input from block B2 goes HIGH, C3 begins charging through R8.

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PWM Switching Power Supply I (Skills07-1), continued

The charging of C3 through R8 causes the output signal at TP9 to form a voltage ramp during the HIGH portion of the square wave input. Since the input waveform does not have a 100% duty cycle, the ramp never reaches the full potential of the square wave; it cuts off when the square wave goes LOW at the 80% charged mark.

C3 has charged to 7 to 8 volts the instant the incoming square wave goes LOW. This forward biases D4, causing a quick discharge of C3 through D4, and a sharp drop LOW in the ramp waveform. C3 discharges down to the point where D4 is no longer forward biased, about 0.7 VDC. When the incoming square wave goes HIGH, the process starts over again and continues at the rate of 100 kHz. Figure 4 compares the original square wave at TP8 to the ramp signal at TP9.

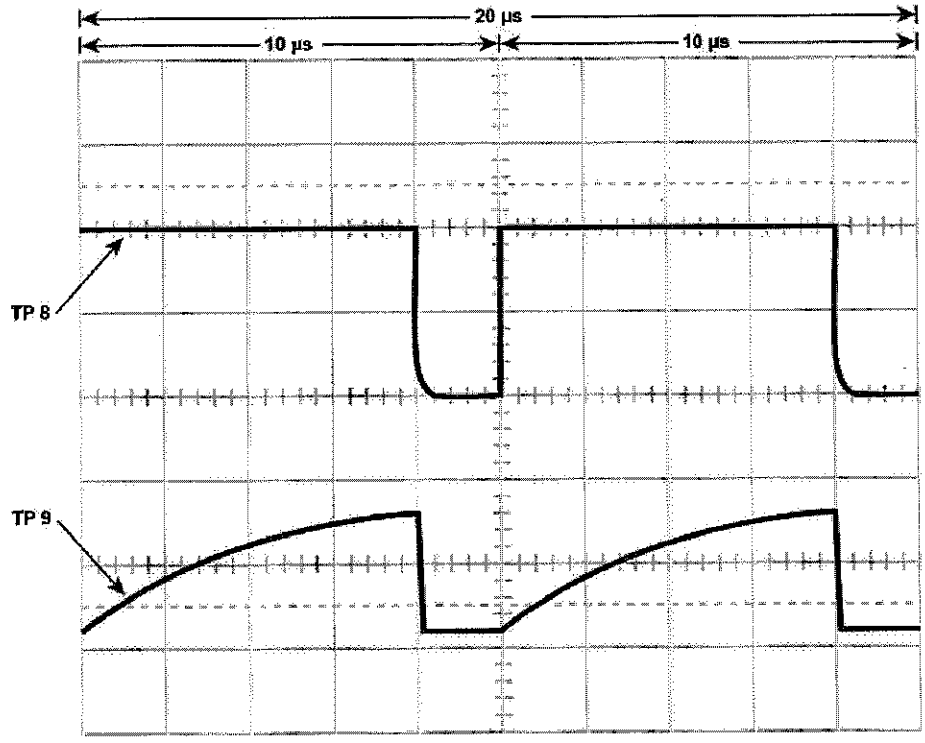

Figure 4

The unregulated DC voltage is used through R7 to provide a DC offset voltage to the ramp waveform signal. R9 and C4 comprise a low pass filter to remove high frequency noise. The resulting composite signal is the Ramp signal. The Ramp signal exits the circuit card at J1 terminal 4. See Figure 5 for a view of the Ramp signal.

J1 has three outgoing voltages or signals: the unregulated DC voltage at terminal 1, the Reference signal at terminal 3, and the Ramp signal at terminal 4. There is one incoming voltage on J1 terminal 2: the feedback DC voltage from the output filter circuit in block B7 on the PWM Switching Power Supply II circuit card. Terminal 5 of plug J1 is ground.

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PWM Switching Power Supply II (Skills07-2)

The Reference signal from J2 terminal 3 and the 100 kHz Ramp signal from J2 terminal 2 are applied to U3A in block B5. The Reference signal, a changing DC voltage, can be viewed at TP15. The Ramp signal is available at TP14. U3A is one-half an LM393, a voltage comparator, and is powered from the unregulated DC voltage at J2 terminal 5.

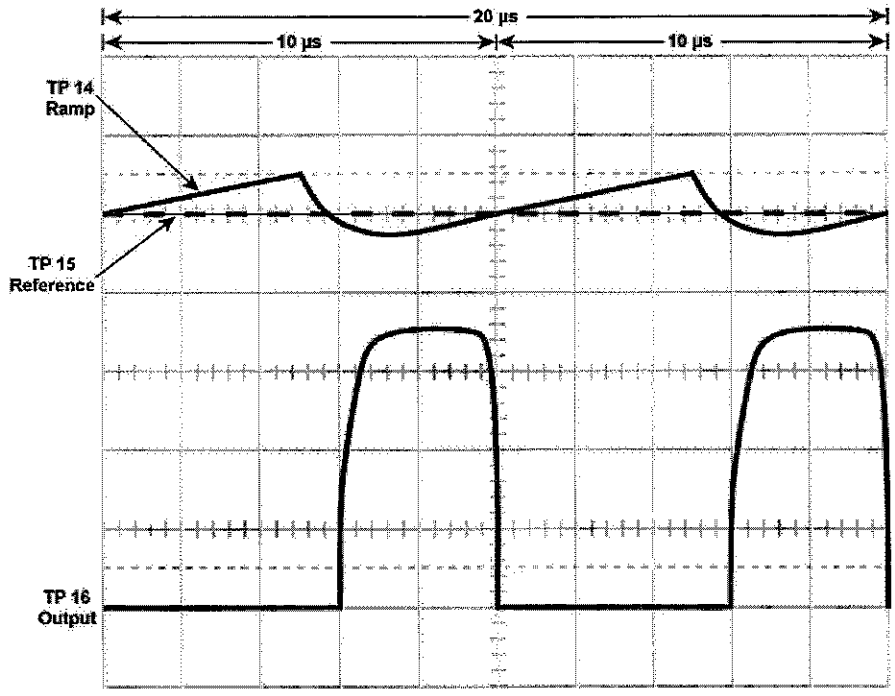

Figure 5

See Figure 5, the timing chart for U3A. U3A compares the voltage levels of the Reference signal at the positive input, pin 3, and the Ramp signal at the negative input, pin 2. As long as the Ramp signal is equal to or greater than the Reference signal, the output of U3A at TP16 remains LOW. However, when the Ramp signal is less than the Reference signal, the output of U3A goes HIGH.

The Ramp signal is very static and does not change. The Reference signal, a DC voltage, is developed from U2, the op-amp in block B3. The reference signal changes with the overall power supply output voltage in a reciprocal fashion.

If the power supply output voltage decreases, the reference voltage increases. If the power supply output voltage increases, the reference voltage decreases. The Ramp and Reference signal levels are constantly compared by U3A.

If the output current should rise, causing the output voltage to reduce, the Reference signal is increased, causing more of the Ramp signal to be below the Reference line. This increases the duty cycle of the output waveform, causing the output signal to be HIGH for more time during the 10 µs cycle.

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PWM Switching Power Supply II (Skills07-2), continued

Likewise, should the output current demand drop, causing the voltage to increase, the Reference signal reduces, and less of the Ramp signal is below the Reference level. This reduces the duty cycle of the output at TP16. R17 provides negative feedback to prevent the comparator from going into oscillations caused by stray capacitance.

The correction of the output voltage occurs at the ramp frequency of 100 kHz, or once every 10 µs. Small correctional changes in the Reference level and the output waveform duty cycle can be noted as the load conditions change.

The output at TP16 is applied to the base of Q2. Q1 and Q2 are arranged in a Darlington Pair. A Darlington Pair consists of two transistors in tandem arranged so the current amplified by the first transistor (Q2) is further amplified by the second transistor (Q1). The Darlington Pair configuration offers higher current switching than a single device.

The output of the Q1/Q2 pair is the emitter of Q1, where a series of positive pulses at 100 kHz can be found. The waveform, viewed at TP11, follows the timing of the waveform at TP16.

The pulse width (duty cycle) of the waveform at TP11 will vary based on the current demand, longer during high current demands, and shorter when less output current is required. The waveform will have a tapered trailing edge under low current demand conditions. The peak voltage will be at the unregulated DC voltage level.

The output of Q1 flows through R12, a 1.5Ω, 3W resistor. TP11 is common to one side of R12; TP12 is common to the other. All the output current from the power supply flows through R12.

The power supply output current can be calculated by measuring the voltage drop across R12, and then dividing the voltage drop by 1.5Ω, the R12 value. The calculated answer will be the output current, usually 50 to 150 mA in normal operation.

Across R12 is Q3, the current limiting transistor. The base of Q3, at the TP11 side of R12, will be more positive than TP12, common to the emitter due to the voltage drop of R12. The voltage drop, and the voltages at Q3's base and emitter junction, will increase or decrease with the current demanded by the load.

Should the voltage drop across R12 increase to 0.6 VDC, the load is pulling too much current. At this point Q3 becomes forward biased and conducts. When Q3 conducts, the collector is pulled down to the emitter voltage, which forward biases D7. This also pulls the output of U3A LOW, disabling the switching power supply until the high load is removed, reducing the R12 voltage drop and preventing Q3 from conducting.

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PWM Switching Power Supply II (Skills07-2), continued

The large circular device dominating the PWM Switching Power Supply II circuit card is inductor L1. L1 and C7 make up a low-pass filter arrangement, which filters the 100 kHz output from Q1 into steady DC voltage. The frequency of the switching power supply, 100 kHz, allows the relative small size for C7. The DC voltage at TP13, the power supply output, is 8.5 VDC for this application but is adjustable between 1.5 and 10 VDC using R4 in block B3.

Block B8 contains a visual indicator for power supply output, DS2. R14 provides current limiting for DS2, holding the current flow through DS2 down to about 15 mA. R15, switched on by S2, adds a load to the power supply if no external load is applied; or it can be used to provide additional load with an external load. DS3 illuminates when S2 is closed and R15 is added as a load.

An over-voltage protection circuit is in block B9. Should the output voltage exceed set limits, the circuit activates, removing the switching power supply output from the external load. The power supply output voltage leaves the circuit card at terminal T and can be measured at TP17.

The over-voltage protection circuit is powered by the unregulated DC voltage source at TP18. Operating like U3A in block B5, another voltage comparator, U4B in block B9 compares a known voltage to a sample voltage to determine if the sample voltage is above the set limit.

The known voltage is also derived from the unregulated DV voltage, through R19, but fixed to 5.1 VDC by D9, a zener diode. R23 taps the fixed 5.1 VDC, allowing a user-variable voltage input at pin 6, the negative input. The negative input to U4B, the reference voltage for the voltage comparator, can be measured at TP20 and adjusted by R23. The voltage will be 1 to 2 VDC with an 8.5 VDC output.

The regulated power supply output from TP13 in block B7 is the source for the positive input to U4B. The regulated voltage is reduced by the R20/R26 voltage divider to provide the sample voltage input. This input can be verified at TP19. The voltage at TP19 must be less than the voltage at TP20 for the circuit to operate normally.

The output of U4B, at pin 7, remains at less than 0.25 VDC. Should the sample voltage at the positive input exceed the reference voltage at the negative input, U4B activates and the output at pin 7 will increase to over 1 VDC. This voltage can be viewed at TP21.

When the U4B output voltage at TP21 increases, it forward biases the base-emitter junction of Q4. This pulls the collector LOW, energizing relay K1. When the relay is energized, the regulated output voltage at the normally-closed relay contact removes the voltage to the external load and TP17. LED DS4 provides a visual indication of the over-voltage condition. Diode D8 is placed across K1 to eliminate inductive kickback when the relay power is removed.

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Load (Skills07-3)

The Load circuit card provides a constantly-changing load for the PWM Switching Power Supply.

Block B10 is an onboard linear power supply using a 78L12 single IC regulator, IC1. R27 provides isolation and minor circuit protection from the power source, the unregulated DC output from block B1. C11 and C12 eliminate noise at the input and output of IC1. The output, +12 VDC, can be verified at TP26. The regulator supplies power to blocks B11 and B12.

Block B11 contains two voltage comparators, U5A and U5B. Both comparators monitor the input regulated voltage from the PWM Switching Power Supply. U5A monitors the incoming voltage for a too low condition. U5B monitors the incoming voltage for a too high condition. Should the incoming voltage be too high or too low, one of the comparators will activate, disconnecting the voltage to the load circuitry in block B13.

A single output measured at TP29 in block B12 can be used to determine the condition of the incoming DC voltage. TP29 will be HIGH, at +12 VDC, and LOW at about 1.5 VDC when either U5A or U5B have determined the incoming DC voltage is out of tolerance and switches ON to protect the Load circuitry.

Both U5A and U5B are in the single IC labeled U5. Each voltage comparator operates independently but has almost identical circuitry. You will note the only difference between U5A and U5B is the reversal of the input voltage sample and the reference voltage inputs at the negative and positive inputs.

U5A has the input voltage sample at the positive input, pin 3, and the reference voltage derived from the +12 VDC power supply in block B10 at the negative input, pin 2. R40 sets the lower limit reference voltage. When properly set up, pin 1, the output of U5A, will be normally HIGH, about +12 VDC but will go LOW, to less than 1 VDC, when the comparator activates because the sample voltage at the positive input drops lower than the reference voltage at the negative input.

U5B has just the opposite inputs: the input voltage sample at the negative input, pin 6, and the reference voltage at the positive input, pin 5. R40 sets the upper limit reference voltage. When properly set up, the output at pin 7 will be HIGH normally, but go LOW when the comparator activates because the sample voltage at the negative input rises above the reference voltage at the positive input.

The outputs of the U5A and U5B comparators have output indicators, DS5 and DS6, to indicate an input voltage that is out of tolerance. A LOW at either comparator output will illuminate the associated diode.

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Load (Skills07-3), continued

The comparator outputs are connected to the cathodes of switching diodes D11 and D12. Diodes D11 and D12 are not conducting in normal conditions with both the cathodes and the anodes HIGH at +12 VDC. When either comparator output goes LOW, the cathode voltage of the associated diode drops to 0.5 VDC and the diode becomes forward biased, causing the output at TP29 to drop LOW to about 0.5 VDC.

TP29 is the input to block B12 containing the power relay and driver. TP29 is common to the negative input of another voltage comparator, U6A, at pin 2. The positive input, pin 3, is fixed at about 6 VDC, half the +12 VDC supply voltage from block B10. In this configuration, U6A has a LOW (1 - 1.5 VDC) output at pin 1 under normal conditions. The output condition of U6A can be confirmed at TP31.

The U6A output rises HIGH should either of the U5 comparators activate, pulling pin 2 of U6A LOW. A HIGH output at U6A pin 1 reverse biases DS7, extinguishing the Relay On LED, but also reverse biases the base-emitter junction of Q5.

Q5 is a PNP transistor, the driver for relay K2. In normal operation, Q5 has proper bias and keeps K2 energized. When the U6A output goes HIGH, Q5 is reverse biased and current stops flowing in the relay K2 coil. The load in block B13 is then removed from the circuit through the action of K2. The collector of Q5 can be measured at TP32. A HIGH condition (+12 VDC) at TP32 indicates Q5 is reverse biased.

The load for the PWM Switching Power Supply is a group of 18 LEDs, DS8 through DS26. The LEDs are configured in three different sized concentric circles of 6 LEDs. Each circle is also made up of different colored LEDs.

The smallest circle, configured of red LEDs, switches on and off at the fastest rate. The next circle, made up of yellow LEDs, is larger and switches at a slower rate. The largest circle, of green LEDs, flashes at the slowest rate. All the LEDs are configured so that only half of each circle (3 LEDs) is illuminated at one time.

The flash rate and LED selection is done by U7, a 14-stage ripple counter IC with an onboard clock. The clock speed is controlled by an RC circuit consisting of R35, R42, R45, and C15. R35 is a variable resistor, allowing frequency adjustments. The clock frequency is 100 Hz.

Two test points are provided in the clock timing circuit, TP37 and TP38. TP38 provides a clean square wave of 100 Hz at 8.5 VDC with a 55% duty cycle.

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Load (Skills07-3), continued

The waveform at TP37 will also be 100 Hz, but the waveform will reflect the charge and discharge action the square wave has on C15. Placing the oscilloscope on TP37 without setting the oscilloscope probe to x10 mode will excessively load the circuit and shut down the oscillator. With the oscilloscope probe at x10, the probe might still load the circuit enough to change the frequency slightly.

A ripple counter is a series of flip-flops strung together with the input of each stage connected to the output of the preceding stage. Each stage toggles on the negative transition, and the output frequency of each stage is one-half the input frequency.

So, the initial clock frequency of 100 Hz is divided to 50 Hz by stage 1, 25 Hz by stage 2, 12.5 Hz by stage 3, etc. The outputs used to illuminate the LEDs are the 5th, 6th, and 7th stages with frequencies of about 3 Hz ($100Hz/2^5$), 1.5 Hz ($100Hz/2^6$), and 0.75 Hz ($100Hz/2^7$). This translates to waveform times of 320 ms (red), 640 ms (yellow), and 1.28 s (green) for one full cycle, or 160 ms (red), 320 ms (yellow), and 640 ms (green) for the ON time for the LEDs.

The switching waveforms for the LED outputs can be viewed at TP34, TP35, and TP36. The LEDs are configured so 3 LEDS are illuminated when each output is HIGH and then the other 3 are illuminated when the output is LOW.

OPERATIONAL CHECK

1. System Setup

Refer to the circuit card illustrations following these instructions for the locations of test points, LEDs, and variable resistors.

a. Verify that the circuit cards Skills07-1 (PWM Switching Power Supply I), Skills07-2 (PWM Switching Power Supply II), and Skills07-3 (Load) are installed on the Nida 130E Test Console in positions PC1, PC2, and PC3, respectively.

b. Verify the short 5-pin jumper cable between J1 and J2. Do not twist the cable; the wires should not cross over each other.

c. Set all variable resistors in the PWM Switching Power Supply and Load to the middle position.

d. Set S1 and S2 on the Skills07-1 and Skills07-2 circuit cards to the ON (UP) position.

e. Press the AC Power switch on the PC1 position. Verify that the PC1 AC LED is illuminated.

f. Verify the DS1 LED in Block 1 and the Output LED in Block 8 are illuminated. Ignore any other illuminated LEDs at this time.

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OPERATIONAL CHECK, continued

2. Circuit Set-up

a. Using the multimeter, adjust R40, the Lower Limit control, for 8.25 VDC at TP27.

b. Using the multimeter, adjust R30, the Upper Limit control, for 8.75 VDC at TP28.

c. Using the oscilloscope, adjust R11, the Frequency control, for a 100 kHz (10 µs) waveform at TP8.

d. Using the multimeter, adjust R4, the Output control, for 9.25 VDC at TP13.

e. Set R23, the Level control, fully counterclockwise. Then, slowly adjust R23 in a clockwise direction just until DS4, the Over (voltage) LED in Block 9, illuminates.

f. Readjust R4, the Output control, for 8.5 VDC at TP13. The Varying Load LEDs should be flashing.

g. Using the oscilloscope, adjust R35, the Clock control, for 100 Hz (10 ms) square wave at TP38. The PWM Switching Power Supply and Loads circuitry should be functioning normally. Complete the Operational Check by Performing the Limit Verification check.

3. Limit Verification Check (Low, High, and Over)

a. Using the multimeter, monitor the voltage at TP13.

b. Slowly adjust R4 counterclockwise until the Low LED illuminates. Voltage at TP13 should be approximately 8.25 VDC and the Varying Load LEDs should not be flashing.

c. Slowly adjust R4 clockwise until the High LED illuminates. Voltage at TP13 should be greater than 8.75 VDC and the Varying Load LEDs should again, not be flashing.

d. Slowly continue to adjust R4 clockwise until the Over LED illuminates. Voltage at TP13 should be greater than 9.00 VDC and voltage to the Load circuit is removed and the Low LED illuminates.

e. Readjust R4, the Output control, for 8.5 VDC at TP13. The Varying Load LEDs should be flashing.

End of Operational Check.

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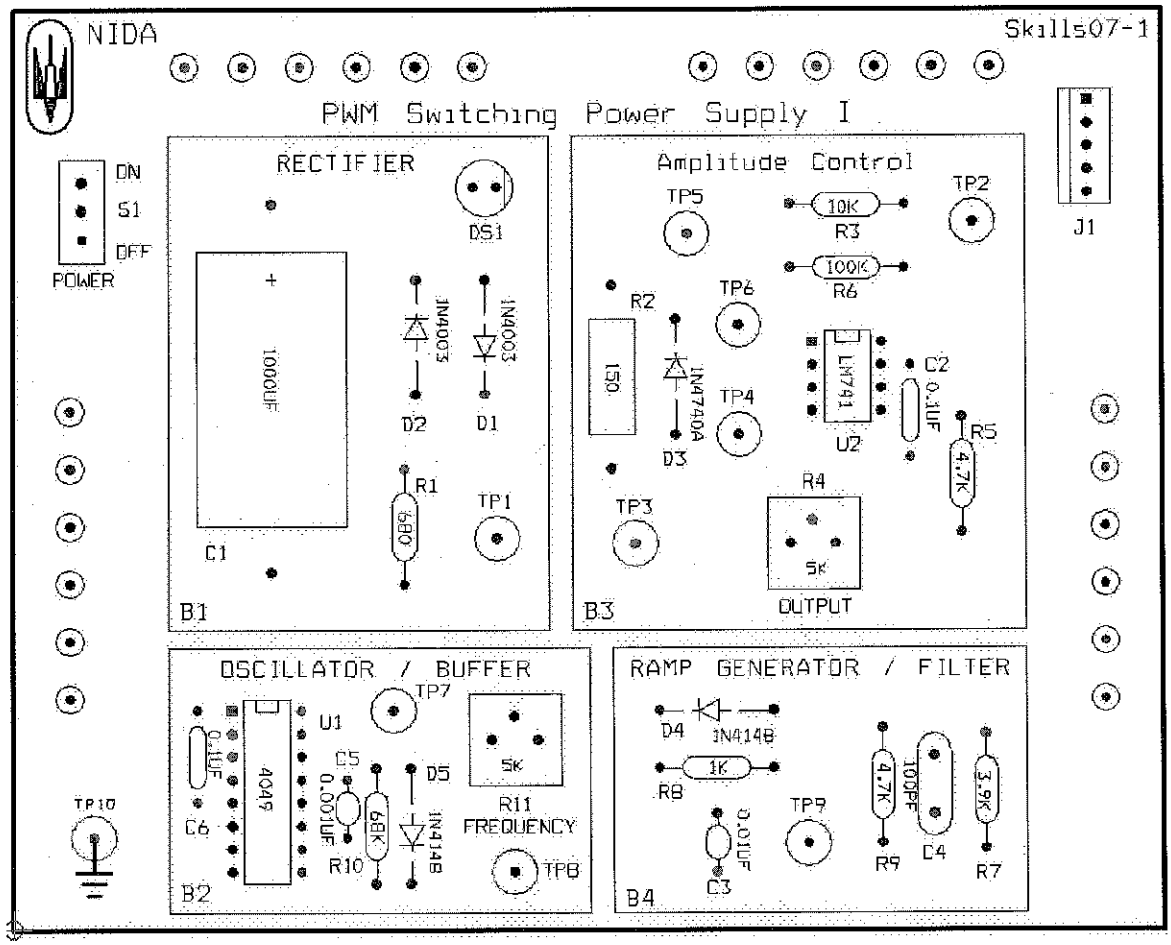
CIRCUIT CARD PICTORIALS & TEST POINT LIST



PWM Switching Power Supply I

Test Point	Description	Normal Condition
TP1	DC Unregulated	15 – 19 VDC
TP2	DC Regulated	8.5 VDC
TP3	Fixed +10 VDC	10 VDC
TP4	Reference Input (+)	8.6 – 9 VDC
TP5	Reference	10.5 – 11.5 VDC
TP6	Sample Input (-)	Equal to TP4
TP7	Oscillator	100 kHz
TP8	Buffer Output	100 kHz Square Wave
TP9	Ramp Output	100 kHz Ramp Wave
TP10	Ground	Ground

PWM Switching Power Supply I Test Point List

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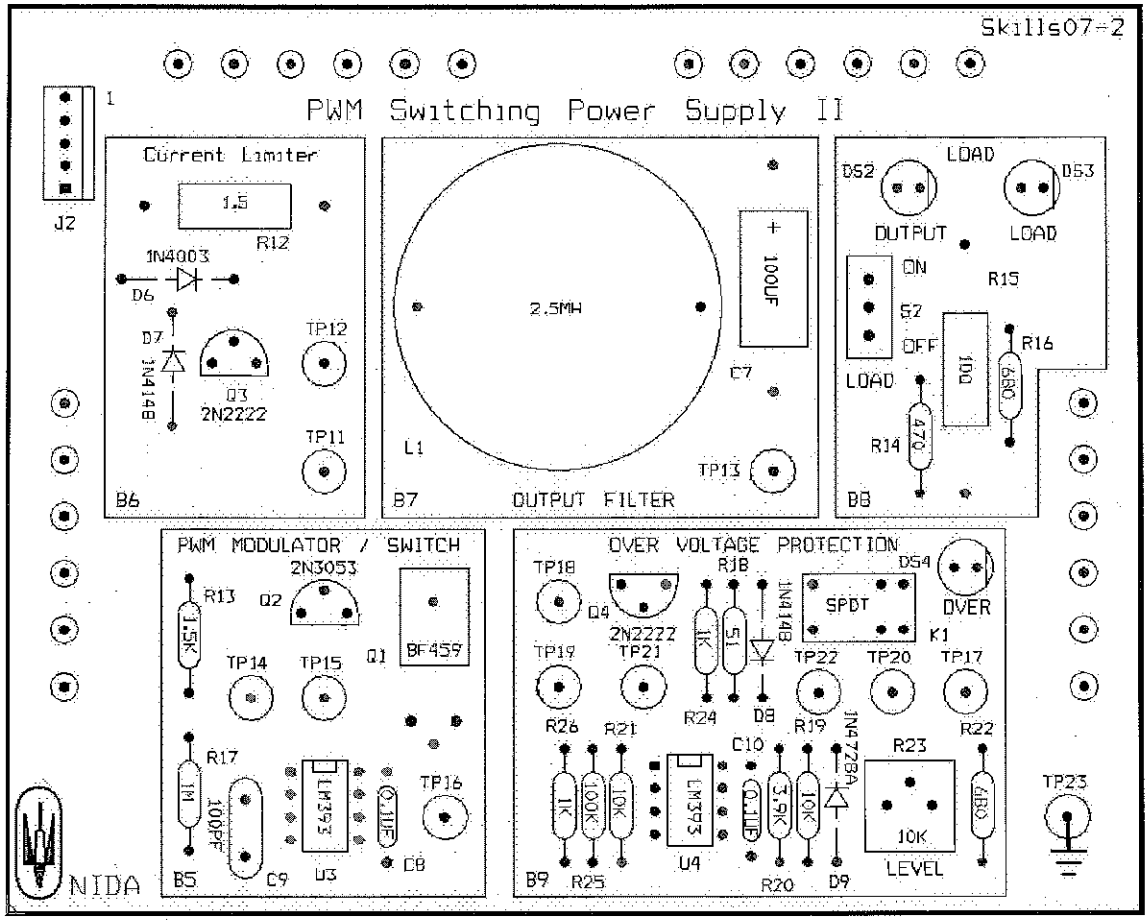
CIRCUIT CARD PICTORIALS & TEST POINT LIST, continued



PWM Switching Power Supply II Logic Circuit Card

Test Point	Description	Normal Condition
TP11	Switch Output	100 kHz Switch Output
TP12	Limiter Output	100 kHz Switch Output
TP13	Filter Output	8.5 VDC
TP14	Ramp Input (-)	100 kHz Ramp Signal
TP15	Reference Input (+)	10.5 – 11.5 VDC
TP16	Comparator Output	100 kHz Switch Signal
TP17	Over-Voltage Output	8.5 VDC
TP18	Unregulated DC	15 – 19 VDC
TP19	Regulated Input (+)	1.5 – 2 VDC
TP20	Reference Input (-)	Higher than TP19
TP21	Comparator Output	Less than 0.25 VDC
TP22	Relay Drive	14 – 19 VDC
TP23	Ground	Ground

PWM Switching Power Supply II Test Point List

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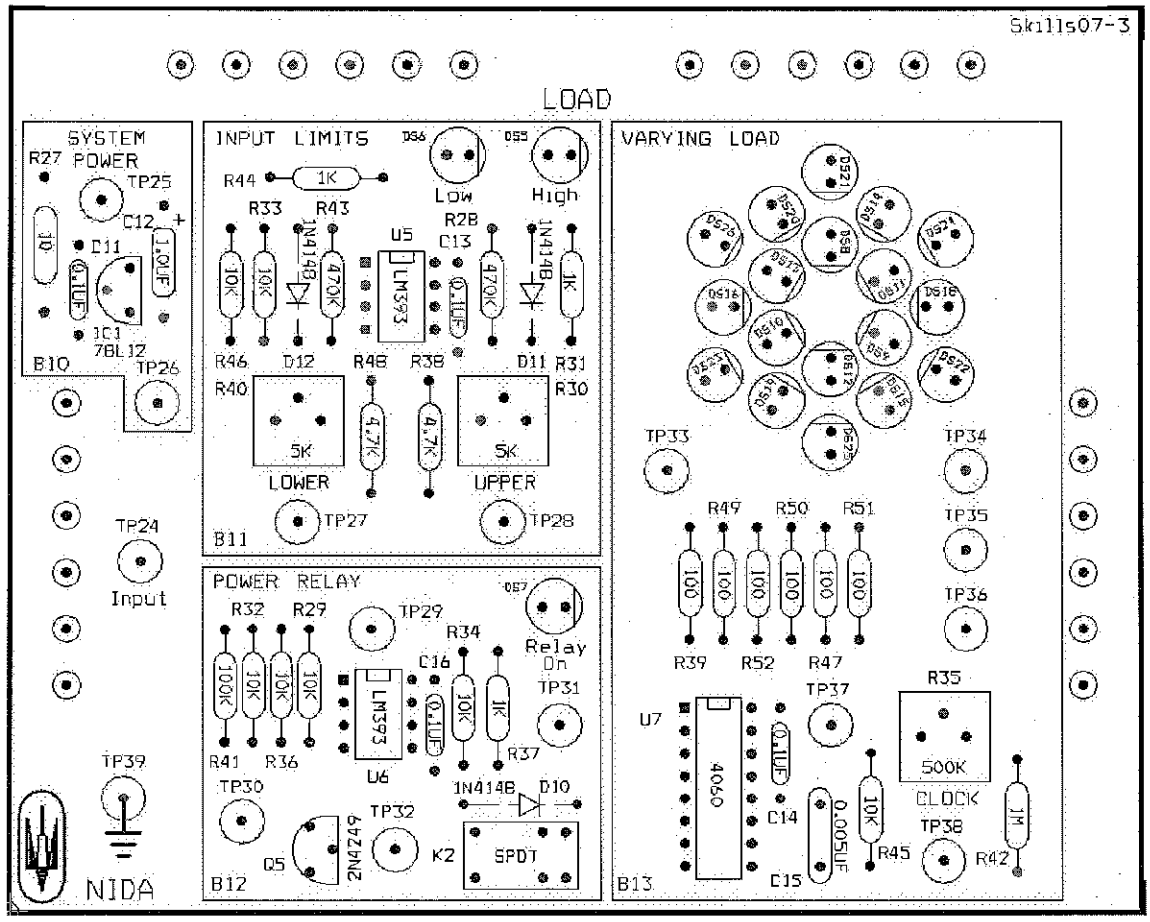
CIRCUIT CARD PICTORIALS & TEST POINT LIST, continued



Load Circuit Card

Test Point	Description	Normal Condition		Test Point	Description	Normal Condition
TP24	DC Input	8.5 VDC		TP32	Emitter of Q5	0.6 VDC Over TP31
TP25	Unregulated DC	15 – 19 VDC		TP33	Load Input	8.5 VDC
TP26	System Power Output	12 VDC		TP34	U7 Q5 Output	3 Hz Square Wave
TP27	Lower Limit Input (-)	8.25 VDC		TP35	U7 Q6 Output	1.5 Hz Square Wave
TP28	Upper Limit Input (+)	8.75 VDC		TP36	U7 Q7 Output	0.75 Hz Square Wave
TP29	Comparator Output	12 VDC		TP37	100 Hz Clock Source	100 Hz Spiked ± Ramp
TP30	Comparator Input (+)	6 VDC		TP38	100 Hz Clock Output	100 Hz Square Wave
TP31	Base of Q5	1 – 1.5 VDC		TP39	Ground	Ground

Load Circuit Card Test Point List

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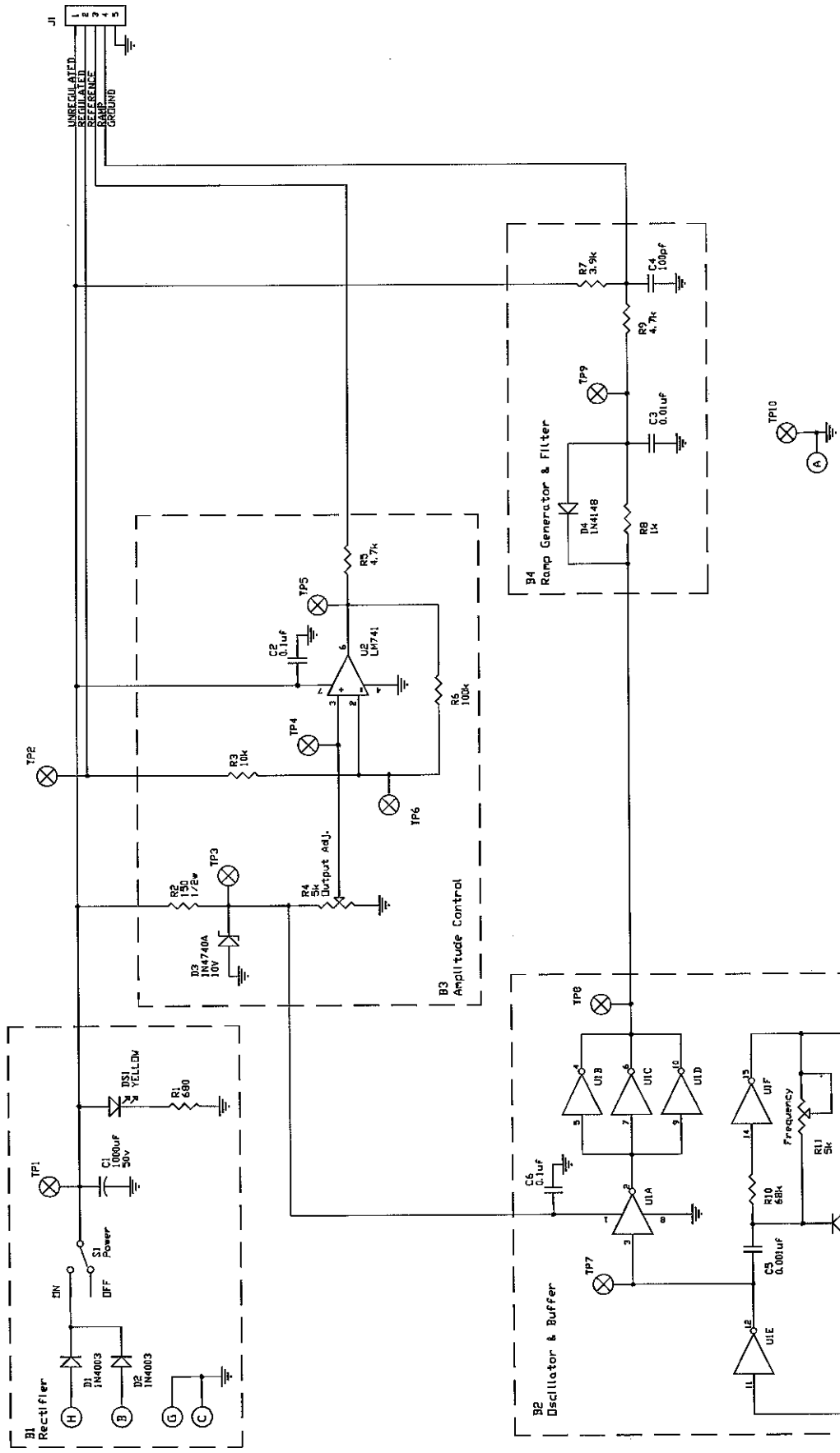

Skills07-1

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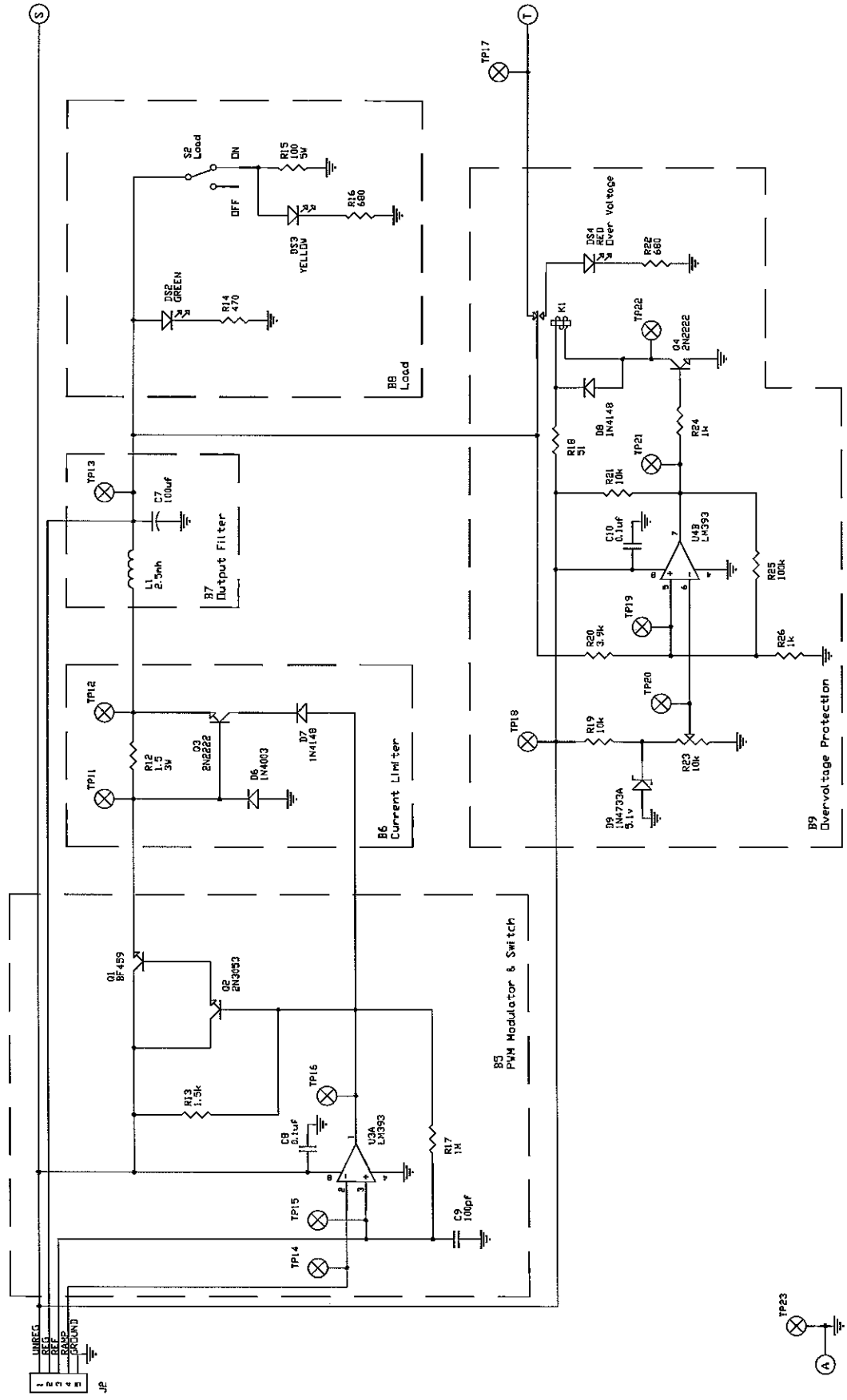

Skills07-2

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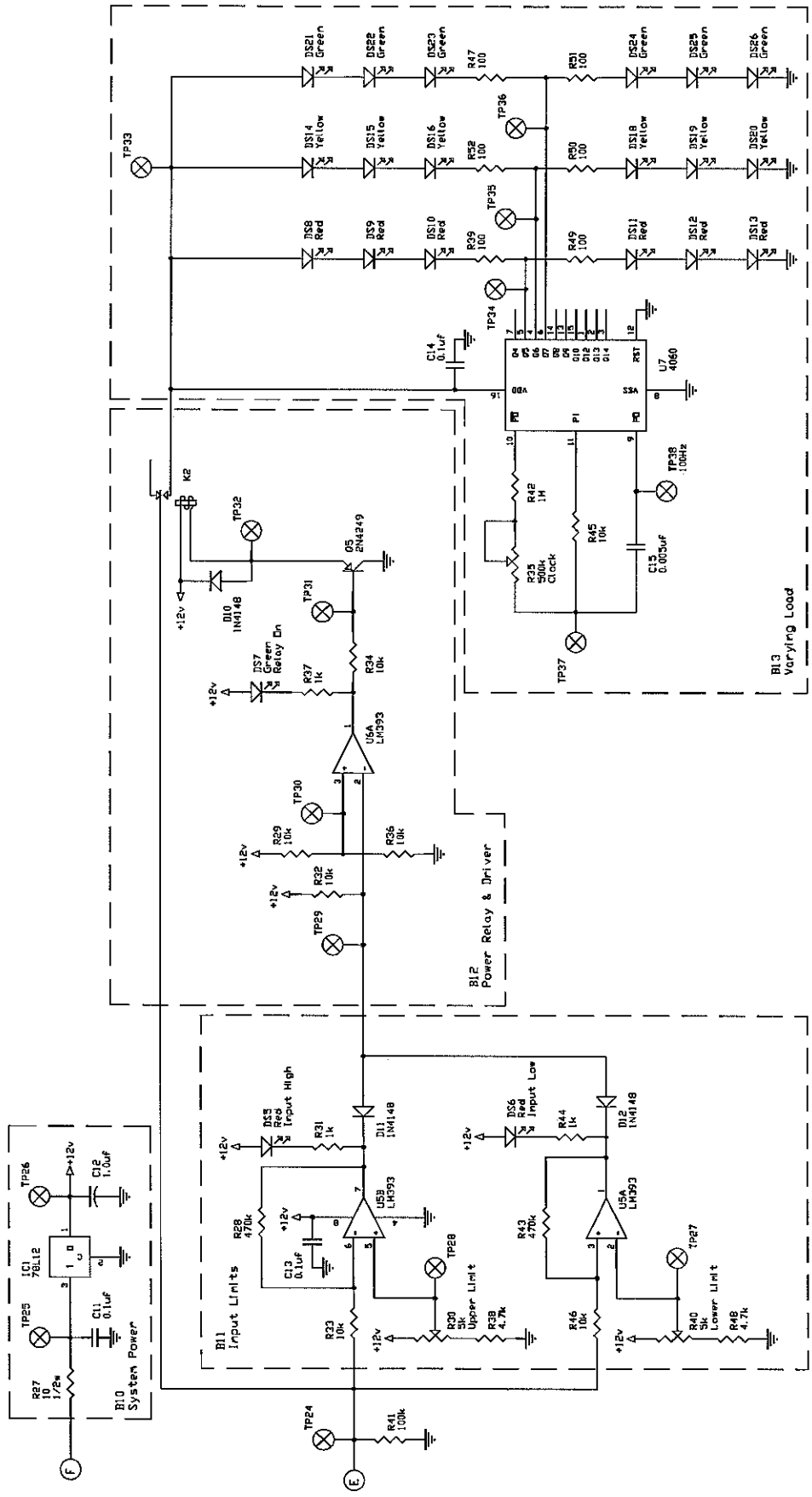

Skills07-3

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BREADBOARDING PROJECT

Electronics Technology

SkillsUSA

Champions at Work®

Contestant Handout

2010

Nida Corporation
300 S. John Rodes Boulevard
Melbourne, Florida 32904

BREADBOARDING PROJECT

Instructions

The total time allowed for this competition is 120 minutes. You will be scored on your ability to:

1. Read and follow instructions.
2. Interpret a circuit design drawing.
3. Identify and correct design flaws.
4. Construct a variable DC power supply and a random number generator.

Judges are **NOT** permitted to answer questions during the competition. Should you encounter a technical problem, assistance may be requested by pressing the "H" key on the console. All technical problems will be corrected by the Judge and no demerits will be assessed.

Judges **WILL** assess a 2 point demerit for each violation of the following. Demerit points will be used as a discriminating factor in breaking ties.

1. Unwarranted requests for assistance (2 points)
2. Identifying good equipment as faulty (2 points)
3. Failure to follow instructions (2 points)
4. Safety violations (2 points)
   - ✓ Wearing jewelry
   - ✓ Not wearing safety glasses
   - ✓ Improper use of soldering iron

Materials Required

Breadboarding Project Contestant Handout
Reference Manual (Data Sheets)
Part 1 Breadboarding Pre-packaged Design Kit
PC130X (single) Design Board
VICA03-1 Power Supply Circuit Board
Oscilloscope
Multimeter
Nida Screwdriver
Nida Model 130E Test Console
Miscellaneous Tools as Required

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Procedure

1. **Log-in.** Observe the display on the Nida Model 130E Test Console and ensure that it looks like the example shown in Figure 1. Verify that your contestant number replaces the **[--- xx ---]** shown in the example.

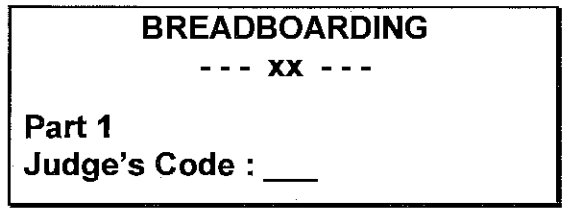

Figure 1

2. You will be required to breadboard two circuits, the first consisting of a Bar Graph Voltmeter. You will be scored on your ability to follow instructions, interpret schematic drawings, and produce a breadboard circuitry layout that meets the criteria of neatness, design, and operation. If any circuit fails your checks and you determine that a component displays symptoms of a factory defect, press the "**H**" key on the console and a Judge will respond. The Judge will assess the situation and determine the appropriate solution.

3. You will start with Part 1 and breadboard the Bar Graph Voltmeter circuit. When you are ready to begin, turn the page to "Worksheet 1" and carefully follow all instructions. Use the information provided in the Reference Manual (Data Sheets) as needed.

Begin when ready!

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WORK SHEET #1

Part 1

1. **Verification.** Using the Parts List provided below, verify the Bar Graph Voltmeter parts kit (green dot) is complete and all components are visibly serviceable. If you identify any discrepancy, press the "H" key on the console and a Judge will respond.

PARTS LIST

DESIGN COMPONENTS		
PART NO.	DESCRIPTION	QUANTITY
05930024	IC, LM3914	1
51020004	LED, RED RECTANGULAR	10
11223030	RES, 1.2k 1/4w	1
13923030	RES, 3.9k 1/4w	1
12026882	RES, 2k VAR	1
15026882	RES, 5k VAR	1
41030003	SLIDE SW, SPDT	1
81131001	Wire	2 ft

2. **Design.** Using the PC130-X (single) Design Board, pre-packaged design kit, the Reference Manual (Data Sheets), and the circuit shown in Figure 3, construct the Bar Graph Voltmeter circuit.

3. **System Setup.** Perform the System Setup.

4. **Operational Check.** Perform the Operational Check to verify functionality.

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SYSTEM SETUP

1. Bar Graph Voltmeter (PC130X)
   a. Install the PC130X circuit card containing your Bar Graph Voltmeter in the PC2 position of the Nida Model 130E Test Console.
   b. Set resistors R1 and R2 on the Bar Graph Voltmeter to the mid (halfway) position.
   c. Set slide switch S1 on the Bar Graph Voltmeter to the 5 Volt position.

2. Power Supply Circuit (VICA03-1)
   a. Install the VICA03-1 Power Supply circuit card in the PC1 position of the Nida Model 130E Test Console.
   b. Set S1 on the VICA03-1 Power Supply circuit card to the Off (down) position.
   c. Set R4 and R7 on the VICA03-1 Power Supply circuit card to the mid (halfway) position.

3. Nida Model 130E Test Console
   a. Set the test console Positive Power Supply to +5 VDC.
   b. Press the DC Power switch on the PC2 position of the test console and verify that the LED illuminates.
   c. Press the AC Power switch on the PC1 position of the test console and verify that the LED illuminates.

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OPERATIONAL CHECK

1. Power Supply Circuit (VICA03-1)
   a. Using a multimeter, adjust R4 on the VICA03-1 Power Supply circuit card for +12 VDC at TP2.
   b. Using a multimeter, adjust R7 on the VICA03-1 Power Supply circuit card for +5 VDC at TP3.
   c. Move S1 on the VICA03-1 Power Supply circuit card to the On (up) position.

2. Bar Graph Voltmeter (PC130X)
   a. Adjust R2 on the Bar Graph Voltmeter so that LED's 1 through 5 are illuminated.
   b. Move S1 on the on the Bar Graph Voltmeter to the 12 Volt position.
   c. Adjust R1 on the Bar Graph Voltmeter so that LED's 1 through 5 are illuminated. DO NOT change the calibration of R1 and R2 after the initial adjustments.
   d. End of Operational Check.

Press the "**H**" key and then the "**ENTER**" key on the console
to request your first verification check.
*****

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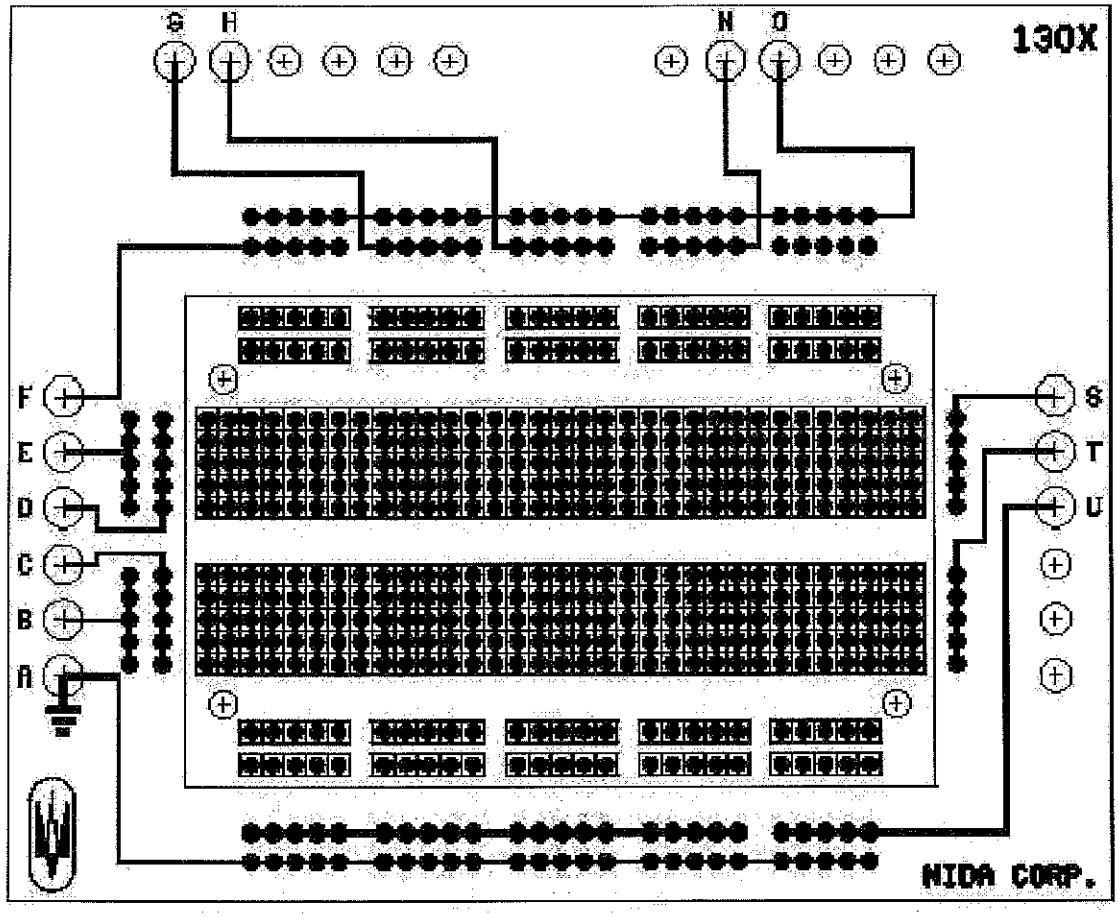
130X BREADBOARD DIAGRAM



PIN	TYPE
A	GROUND
B	AC
C	AC
D	INPUT
E	INPUT
F	INPUT
G	AC
H	AC
N	-DC
O	+DC
S	OUTPUT
T	OUTPUT
U	OUTPUT

Figure 2

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BAR GRAPH VOLTMETER

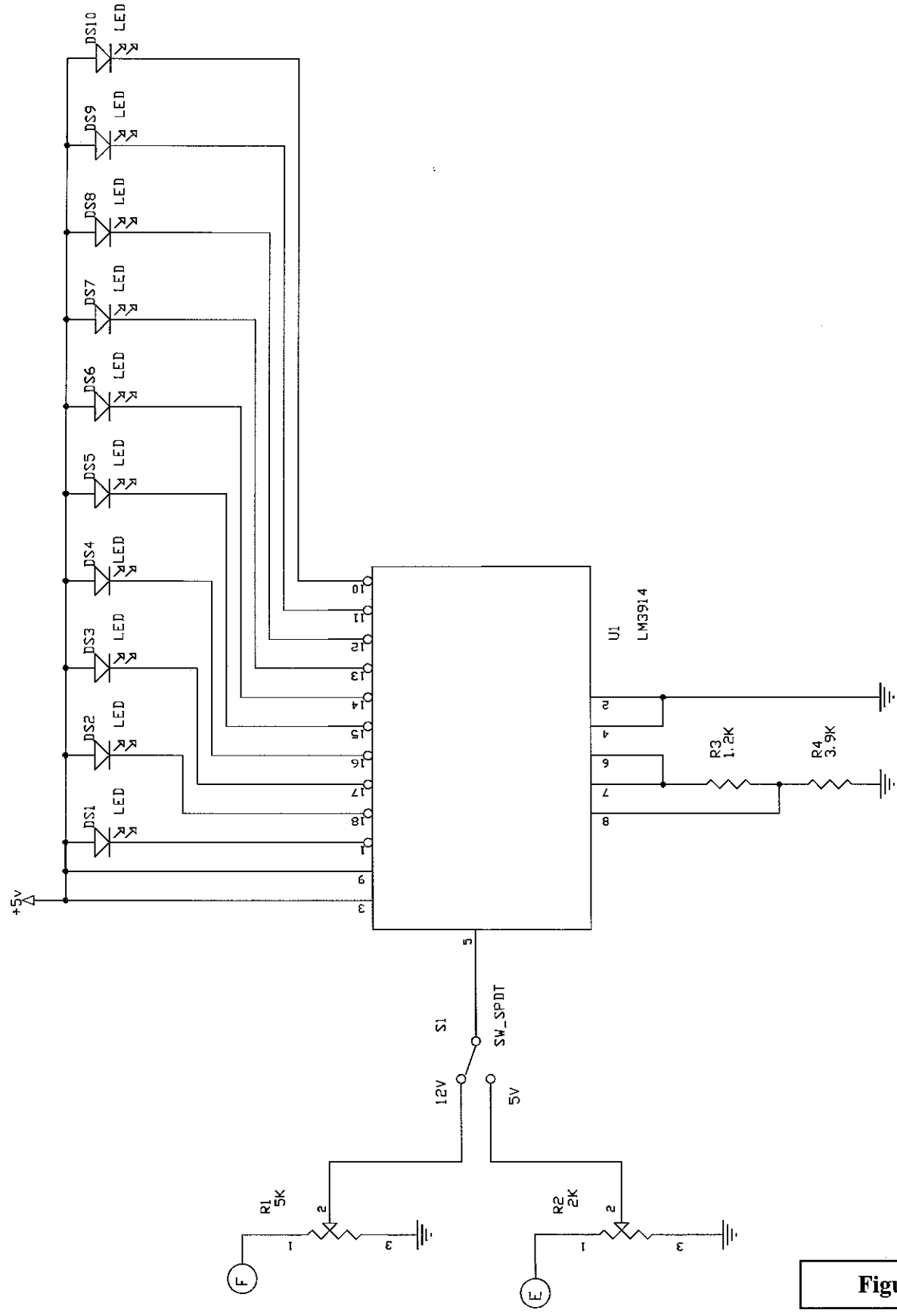

Figure 3

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BREADBOARDING PROJECT

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WORKSHEET #2

WORK SHEET #2

Part 2

1. **Verification.** Using the Parts List provided below, verify the Dual Voltage Power Supply parts kit (red dot) is complete and all components are visibly serviceable. If you identify any discrepancy, press the "**H**" key on the console and a Judge will respond.

PARTS LIST

DESIGN COMPONENTS		
PART NO.	**DESCRIPTION**	**QUANTITY**
21084400	CAP, 1000uf 50V	1
21041250	CAP, 0.1uf 25V (104)	4
21053350	CAP, 1uf 35V (105)	2
00520013	DIODE, 1N4003	2
05930029	IC, LM350T	2
11004319	RES, 10 3w	1
11213030	RES, 120 1/4w	2
12213030	RES, 220 1/4w	1
13313030	RES, 330 1/4w	1
11026882	RES, 1k VAR	2
41030003	SLIDE SW, SPDT	2
81131001	Wire	3 ft

2. **Design.** Using the PC130-XX (double) Design Board, pre-packaged design kit, the circuit shown in Figure 3, and the Reference Manual (Data Sheets), construct the Dual Voltage Power Supply. NOTE: The dual voltage power supply has two DC voltage outputs and is an exact duplicate of the VICA 03-1 power supply circuit card. IC1 and IC2 are almost-identical DC voltage regulator circuits powered by the full-wave rectifier and filter circuit made of D1, D2, R1, and C1. During construction, configure R4 and R7 to produce the lowest output voltage with R4/R7 at the fully counterclockwise (CCW) position, and the most output voltage when R4/R7 is fully clockwise (CW).

3. **System Setup.** Perform the System Setup.

4. **Operational Check.** Perform the Operational Check to verify functionality.

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SYSTEM SETUP

1. Duel Voltage Power Supply (PC130XX)

   a. Install the PC130XX circuit card containing your Duel Voltage Power Supply in the PC1 position of the Nida Model 130E Test Console.

   b. Set resistors R4 and R7 on the Dual Voltage Power Supply to the minimum position.

   c. Set slide switches S1 and S2 on the Dual Voltage Power Supply to the OFF position.

2. Bar Graph Voltmeter Circuit (PC130X)

   a. Install the PC130X circuit card containing your Bar Graph Voltmeter in the PC2 position of the Nida Model 130E Test Console.

   b. Set resistors R1 and R2 on the Bar Graph Voltmeter to the mid (halfway) position.

   c. Set slide switch S1 on the Bar Graph Voltmeter to the 5 Volt position.

3. Nida Model 130E Test Console

   a. Set the test console Positive Power Supply to +5 VDC.

   b. Press the DC Power switch on the PC2 position of the test console and verify that the LED illuminates.

   c. Press the AC Power switch on the PC1 position of the test console and verify that the LED illuminates.

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OPERATIONAL CHECK

1. Dual Voltage Power Supply Circuit (PC130XX)
   a. Move S1 and S2 on the PC130XX Power Supply circuit card to the On position.
   b. Using a multimeter, adjust R4 on the PC130XX Power Supply circuit card for +12 VDC at pin "S".
   c. Using a multimeter, adjust R7 on the PC130XX Power Supply circuit card for +5 VDC at pin "T".

2. Bar Graph Voltmeter (PC130X)
   a. Adjust R2 on the Bar Graph Voltmeter so that LEDs 1 through 5 are illuminated.
   b. Move S1 on the on the Bar Graph Voltmeter to the 12 Volt position.
   c. Adjust R1 on the Bar Graph Voltmeter so that LEDs 1 through 5 are illuminated. DO NOT change the calibration of R1 and R2 after the initial adjustments.
   d. End of Operational Check.

Press the "**H**" key and then the "**ENTER**" key on the console
to request your first verification check.
*****

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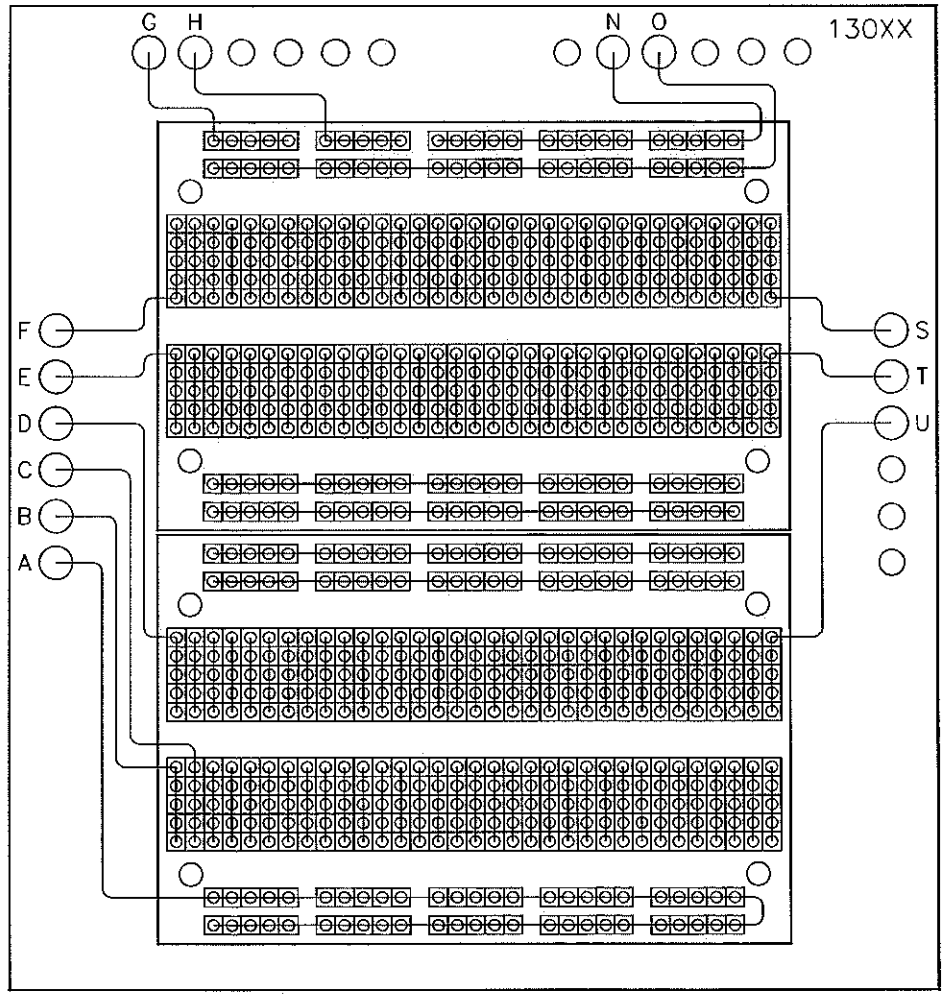
130XX BREADBOARD DIAGRAM



PIN
A = GROUND
B = AC
C = AC
D = INPUT
E = INPUT
F = INPUT
G = AC
H = AC
N = NEGATIVE DC
O = POSITIVE DC
S = OUTPUT
T = OUTPUT
U = OUTPUT

Figure 2

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DUAL VOLTAGE POWER SUPPLY

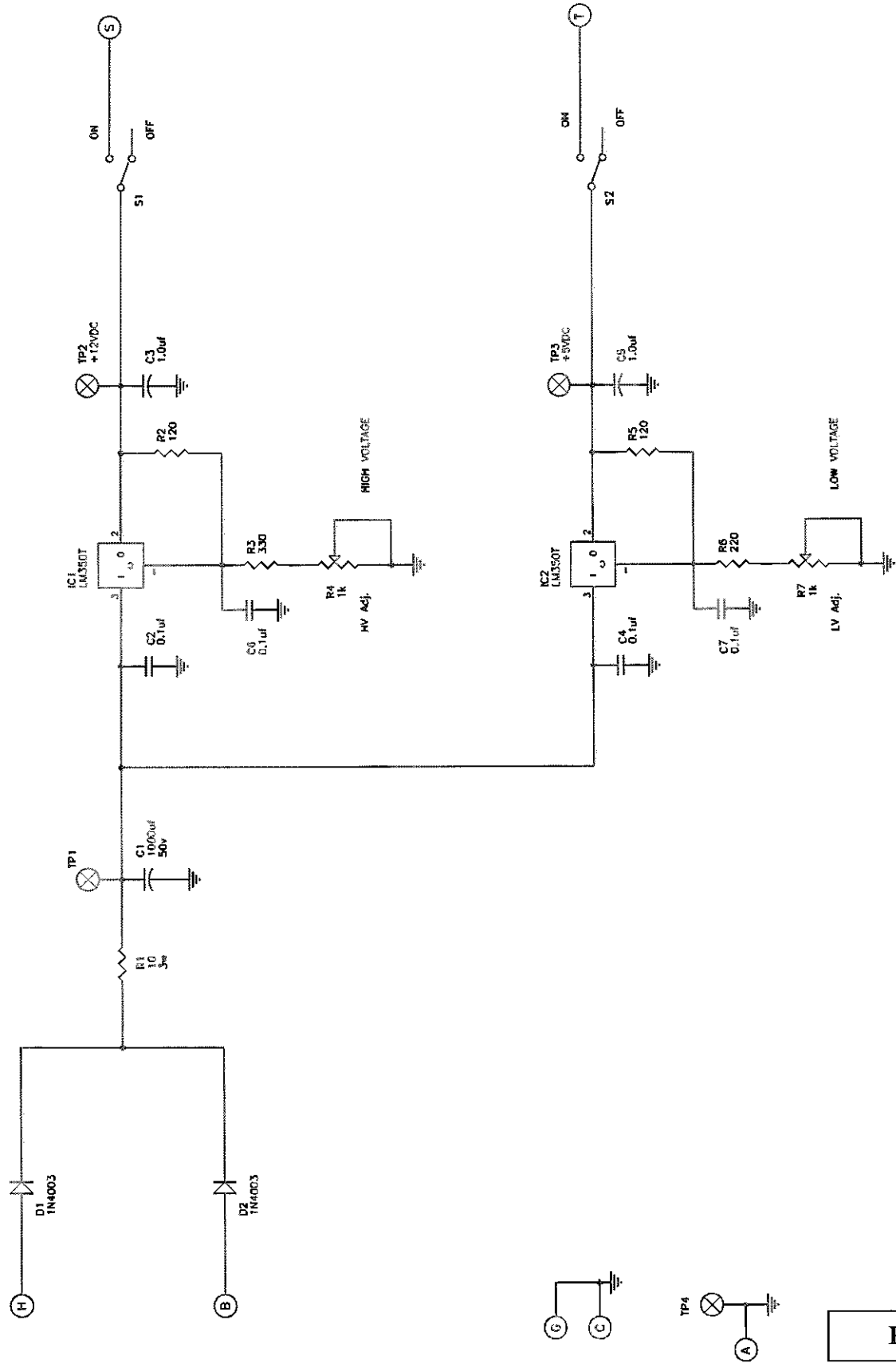

Figure 3

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CUSTOMER SERVICE EXAMINATION

Electronics Technology

SkillsUSA
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Contestant Handout

2010

Nida Corporation
300 S. John Rodes Boulevard
Melbourne, Florida 32904

CUSTOMER SERVICE EXAMINATION

Instructions

The total time allowed is 45 minutes. You will be scored on your ability to:

1. Read and follow instructions.
2. Answer questions correctly.

Judges are **NOT** permitted to answer questions during the competition. Should you encounter a technical problem, you may request assistance by pressing the **"H"** key and then the **"ENTER"** key on the test console. All technical problems will be corrected by the Judge and no demerits will be assessed.

Judges **WILL** assess a 2-point demerit for each violation of the following. Demerit points will be used as a discriminating factor in breaking ties.

1. Unwarranted requests for assistance (2 points)
2. Identifying good equipment as faulty (2 points)
3. Failure to follow instructions (2 points)
4. Safety violations (2 points)

Materials Required

Customer Service Examination - Contestant Handout
Paper Test Question Booklet
Answer Sheet (last page of this manual)
Nida Model 130E Test Console
Pencil

Quick Reference Listing

[S] Enter "S" to skip question

[R] Enter "R" & question number to go to a specific question (example – R26).

[Y] Enter "Y" to answer a yes question.

[N] Enter "N" to answer a no question.

[EXIT] Enter "EXIT" to end the test.

[A, B, C, D] Enter these letters to identify correct answer.

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Procedure

1. Observe the display on the Nida Model 130E Test Console and ensure that it looks like the example shown in Figure 1. Verify that your contestant number replaces the **[-- xx --]** shown in the example.

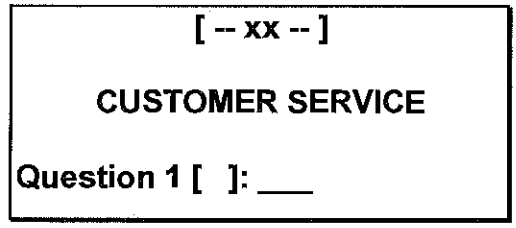

Figure 1

2. Read the question carefully and select the best answer from the choices. A correct answer is awarded 2 points. An incorrect answer will result in the loss of 1 point. Questions skipped (never answered) are awarded zero points.

3. If you wish to answer the question, enter the **"A, B, C, or D"** key on the Nida Model 130E Test Console keypad and press ENTER. Your response will be recorded, and the display will sequence to the next question number.

4. If you choose to skip a question, enter the letter **"S"** on the Nida Model 130E Test Console keypad and press ENTER. No response is recorded (never answered), and the display will sequence to the next question number.

5. When all 100 questions have been displayed in sequence, you will be asked if you are finished. Enter **"Y"** to end the test. Enter **"N"** to begin the review mode. You will jump to the beginning of the test. If you wish to go to a specific question number, enter **"R"** followed by the question number. For example, R26 will take you to question number 26.

6. Entering the word "EXIT" at any time during the test will end the test.

7. Questions **MUST** be answered using the Nida Model 130E Test Console keypad in order to receive credit. However, the scratchpad answer sheet has been provided as a reference. The scratchpad answer sheet will be destroyed at the conclusion of the test and will have no bearing on final test results. Begin when ready.

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CONTESTANT SCRATCHPAD ANSWER SHEET

Total Points - 200

CONTESTANT #: _____

1. A B C D	26. A B C D	51. A B C D	76. A B C D
2. A B C D	27. A B C D	52. A B C D	77. A B C D
3. A B C D	28. A B C D	53. A B C D	78. A B C D
4. A B C D	29. A B C D	54. A B C D	79. A B C D
5. A B C D	30. A B C D	55. A B C D	80. A B C D
6. A B C D	31. A B C D	56. A B C D	81. A B C D
7. A B C D	32. A B C D	57. A B C D	82. A B C D
8. A B C D	33. A B C D	58. A B C D	83. A B C D
9. A B C D	34. A B C D	59. A B C D	84. A B C D
10. A B C D	35. A B C D	60. A B C D	85. A B C D
11. A B C D	36. A B C D	61. A B C D	86. A B C D
12. A B C D	37. A B C D	62. A B C D	87. A B C D
13. A B C D	38. A B C D	63. A B C D	88. A B C D
14. A B C D	39. A B C D	64. A B C D	89. A B C D
15. A B C D	40. A B C D	65. A B C D	90. A B C D
16. A B C D	41. A B C D	66. A B C D	91. A B C D
17. A B C D	42. A B C D	67. A B C D	92. A B C D
18. A B C D	43. A B C D	68. A B C D	93. A B C D
19. A B C D	44. A B C D	69. A B C D	94. A B C D
20. A B C D	45. A B C D	70. A B C D	95. A B C D
21. A B C D	46. A B C D	71. A B C D	96. A B C D
22. A B C D	47. A B C D	72. A B C D	97. A B C D
23. A B C D	48. A B C D	73. A B C D	98. A B C D
24. A B C D	49. A B C D	74. A B C D	99. A B C D
25. A B C D	50. A B C D	75. A B C D	100. A B C D

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SAMPLE PROJECT

Part 1

Electronics Technology

SkillsUSA

Champions at Work®

Contestant Handout

2010

Nida Corporation
300 John Rodes Blvd.
Melbourne, Florida 32904

SAMPLE PROJECT

Introduction

This project is worth a maximum of 100 points but does not count as part of the competition. The total time allowed is 60 minutes. You will be scored on your ability to:

1. Read and follow instructions.
2. Answer questions correctly.

Judges are **NOT** permitted to answer questions during the competition. Should you encounter a technical problem, you may request assistance by pressing the **"H"** key and then the **"ENTER"** key on the test console. All technical problems will be corrected by the Judge and no demerits will be assessed.

Judges **WILL** assess a 2-point demerit for each violation of the following. Demerit points will be used as a discriminating factor in breaking ties.

1. Unwarranted requests for assistance (2 points)
2. Identifying good equipment as faulty (2 points)
3. Failure to follow instructions (2 points)
4. Safety violations (2 points)
   - ✓ Wearing jewelry
   - ✓ Not wearing safety glasses
   - ✓ Improper use of soldering iron

Materials Required

Sample Project Contestant Handout Part 1
Nida 130E Test Console

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Procedure

Welcome to SkillsUSA. You have just begun a sample project that should help you understand both procedures and interactions required during the real competition. Read all instructions carefully and do not skip any steps. Let's begin the Sample Project!

Observe the display on the Nida 130E Test Console and ensure that it looks like the example shown in Figure 1. Verify that your contestant number replaces the **[--- xx ---]** shown in the example.

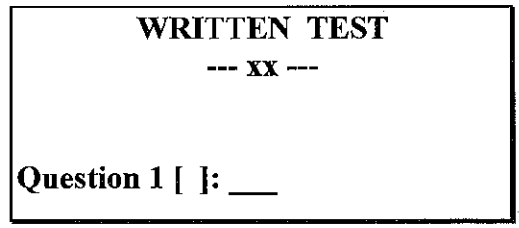

Figure 1

During the Written Test and the Customer Service Exam, the codes listed below are the only acceptable entries. Also, if you should identify a discrepancy, press the **"H"** key and then the **"ENTER"** key on the test console, and a Judge will respond. The Judge will assess the situation and determine the appropriate solution.

[S]	Enter "S" to skip question.
[R]	Enter "R" & question number to go to a specific question (example - R26).
[Y]	Enter "Y" to answer a yes question.
[N]	Enter "N" to answer a no question.
[EXIT]	Enter "EXIT" to end the test.
[TIME]	Enter "TIME" to see how much time has elapsed.
[1, 2, 3, 4]	Enter these numbers to identify correct answer.
[A, B, C, D]	Enter these letters to identify correct answer.

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1. How many legs does a normal dog have?

   A. 10

   B. 22

   C. 4

   D. 35

2. **READ!!!** Which of the following creatures can fly? **DO NOT** answer this question. Notice that the display indicates question number 2 and that it corresponds to the question you are currently on. **SKIP** this question and we will recall it later. Type "**S**" and press ENTER.

   1. Dog
   2. Frog
   3. Horse
   4. Eagle

3. What is the sum of 150 and 25?

   1. 25
   2. 125
   3. 175
   4. 200

4. **READ!!!** Using the resistor color codes, what value does green represent? Answer (B) to this question ***even though it is not the correct answer.***

   A. 1

   B. 3

   C. 4

   D. 5

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5. **READ!!!** Which of the following answers is an equivalent of 10^3?
   HINT: Select answer (2) to this question.

   1. 3E8
   2. $2^3 \times 5^3$
   3. 0.25 x 4000
   4. 900 + 300 - (200)

At this point, you have completed all five questions and your display should look like the example in Figure 2. The Sample Project told you to skip one question and answer another question incorrectly. In order to recall, review, and modify your answers, you need to respond to the question on the display by answering **"N"**.

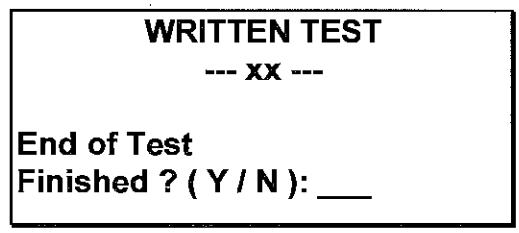

Figure 2

When you've answered **No** to the previous question, your display should look like the example in Figure 3. You have returned to Question 1 and your answer to Question 1 is shown in brackets [C].

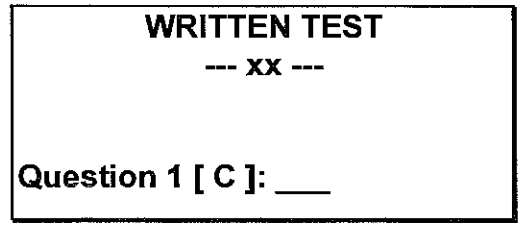

Figure 3

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You have a choice to change the answer by entering a new response or skipping to the next question by entering "**S**". In either case, you will automatically sequence to the next question. Enter "**S**" and observe that your display has changed to Question 2. See Figure 4.

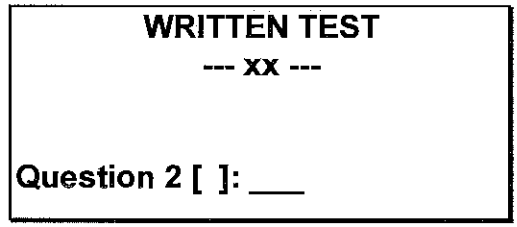

Figure 4

The brackets should be empty for Question 2 unless you did not follow the instructions. This is the question that you were told to skip. Refer to Question 2 in the booklet and enter the correct answer (4) to continue. Your display should sequence to Question 3. Type **R4** to recall Question 4 so that you can correct the answer entered incorrectly earlier. Your display should look like Figure 5.

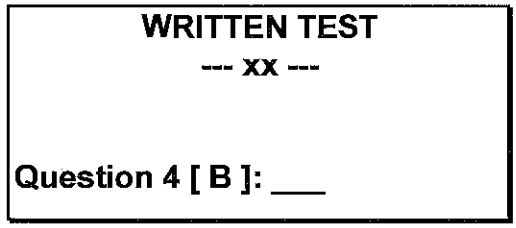

Figure 5

READ!!! Notice that the brackets contain the letter B. The correct answer to this question is D. Type the correct answer and press ENTER. The display sequences to Question 5; since we have finished our review, type "**EXIT**" and press ENTER to conclude the test. The display shown in Figure 6 should appear.

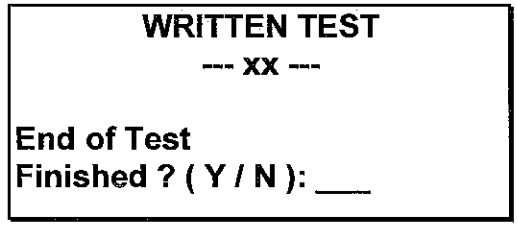

Figure 6

READ!!! We are finished with the test and the correct response to this question should be "**Y**". Notice that you are required to confirm your answer. The second confirmation is required so that you do not accidentally exit the test prematurely. You will **NOT** be permitted to restart or continue the test once you have exited. This concludes the Written Test example.

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CONTESTANT SCRATCHPAD ANSWER SHEET - WRITTEN TEST

Total Points - 100

CONTESTANT #:

1. A B C D		
2. 1 2 3 4		
3. 1 2 3 4		
4. A B C D		
5. 1 2 3 4		

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SAMPLE PROJECT

Part 2

Electronics Technology

SkillsUSA

Champions at Work®

Contestant Handout

2010

Nida Corporation
300 John Rodes Blvd.
Melbourne, Florida 32904

SAMPLE PROJECT

Introduction

This project is worth a maximum of 100 points but does not count as part of the competition. The total time allowed is 60 minutes. You will be scored on your ability to:

1. Read and follow instructions.
2. Answer questions correctly.
3. Perform an Operational Check.

Judges are **NOT** permitted to answer questions during the competition. Should you encounter a technical problem, you may request assistance by pressing the **"H"** key and then the **"ENTER"** key on the test console. All technical problems will be corrected by the Judge and no demerits will be assessed.

Judges **WILL** assess a 2-point demerit for each violation of the following. Demerit points will be used as a discriminating factor in breaking ties.

1. Unwarranted requests for assistance (2 points)
2. Identifying good equipment as faulty (2 points)
3. Failure to follow instructions (2 points)
4. Safety violations (2 points)
   - ✓ Wearing jewelry
   - ✓ Not wearing safety glasses
   - ✓ Improper use of soldering iron

Materials Required

Sample Project Contestant Handout Part 2
Skills07-1 PWM Switching Power Supply I Circuit Card
Skills07-2 PWM Switching Power Supply II Circuit Card
Skills07-3 Load Circuit Card
Oscilloscope
Multimeter
Nida Screwdriver
Nida 130E Test Console
Miscellaneous Tools as Required

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Procedure

Welcome to SkillsUSA. You have just begun a sample project that should help you understand both procedures and interactions required during the real competition. Read all instructions carefully and do not skip any steps. Let's begin Sample Project 2!

1. **READ!!!** Observe the display on the Nida 130E Test Console and ensure that it looks like the example shown in Figure 1. Verify that your contestant number replaces the [--- xx ---] shown in the example. The troubleshooting section is slightly different from the written test in that you are not allowed to recall or change a previously entered answer. You will, however, still be allowed to skip questions. Notice the word "Proceed" on the display. During the troubleshooting event, no malfunction (problem) is set until you answer "Y" to this question.

   At this point, perform the Operational Check on pages 13-14 in the Technical Manual and verify the operation of the PWM Switching Power Supply. When you have completed the Operational Check, return to Step 2, and finish the remaining parts of this Sample Troubleshooting Project.

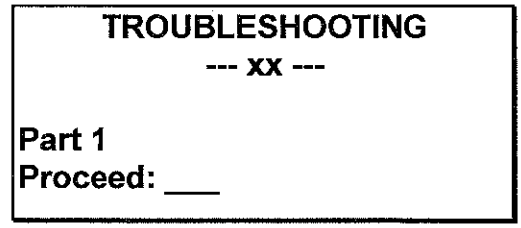

Figure 1

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Procedure, continued

2. If you are satisfied that the PWM Switching Power Supply and Loads are functioning correctly, Enter **"Y"** at the **Proceed:** prompt. Observe the display on the Nida 130E Test Console and ensure that it looks like the example shown in Figure 2.

   Notice that the display is requesting your input regarding the current status of the PWM Power Supply circuitry. The question you must answer is, "Does the circuit Pass or Fail an Operational Check"?

   Observe that the Varying Load LEDs are NOT flashing and the voltage measured at TP15 is zero. Based on this basic information, you can answer the **Pass / Fail: ___** question by entering an **"F"** for fail, at the prompt.

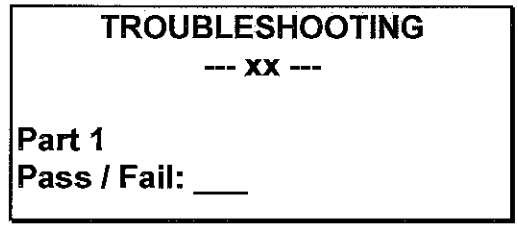

Figure 2

3. Now that you have identified that the circuit has Failed the Ops Check, you need to identify in which Block the fault has occurred. Use the schematics provided in the Technical Manual for this purpose. Monitor the voltage at TP5 (should be 12 volts) and the voltage at TP15 (is zero). Your readings indicate that no RAMP voltage exists between TP5 and TP15. The Block most likely to be the source of the failure is Block 3. Based on this basic information, you can answer the **Block #: ____** question by entering **"3"** at the prompt.

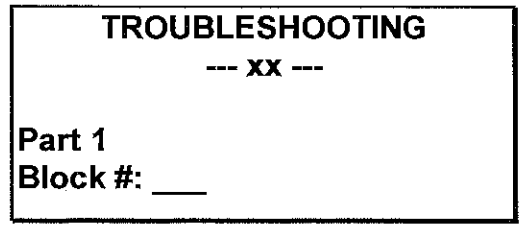

Figure 3

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Procedure, continued

4. Now that you have identified that the circuit failed and Block 3 is the most likely source of the problem, you need to enter a Reference # from the Malfunction Description table. Using the table provided and the basic information we have observed/measured, look at reference number 7. This malfunction says that R5 is open on Skills07-1. R5 is the only component between TP5 and TP15 and is located in Block 3. This is the most likely cause of the malfunction. You can answer the **Reference #: ____** question by entering **"7"** at the prompt.

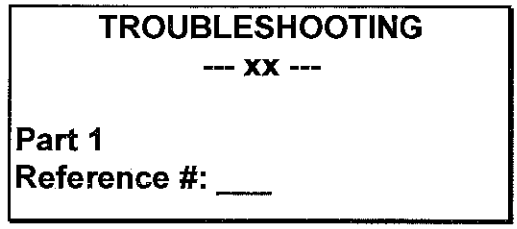

Figure 4

**** END OF SAMPLE PROJECT ****

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MALFUNCTION DESCRIPTION

Locate the **CIRCUIT CARD #** and associated **MALFUNCTION** that best describes the operation of your circuit. Enter the corresponding **REFERENCE #** on the Nida Test Console keypad. Malfunction descriptions may be used once, more than once, or not at all.

CIRCUIT CARD #	MALFUNCTION	REFERENCE #
Skills07-1	U2	1
Skills07-1	D3 open	2
Skills07-1	R10 open	3
Skills07-1	R8 shorted	4
Skills07-1	R9 open	5
Skills07-1	R8 open	6
Skills07-1	R5 Open	7
Skills07-2	C9 shorted	8
Skills07-2	U3A	9
Skills07-2	D9 shorted	10
Skills07-2	Q1 C-E short	11
Skills07-2	D9 open	12
Skills07-2	L1 open	13
Skills07-2	Q4 C-E short	14
Skills07-2	Q1 or Q2 B-E open	15
Skills07-3	R48 open	16
Skills07-3	U7	17
Skills07-3	C15 shorted	18
Skills07-3	K2 open	19
Skills07-3	IC1	20
Skills07-3	U6A	21
Skills07-3	D12 open	22

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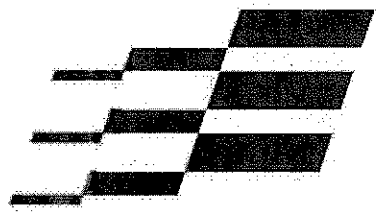
SOLDERING PROJECT

Electronics Technology



SkillsUSA

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Engineering Change Notice

2010

Nida Corporation
300 S. John Rodes Boulevard
Melbourne, Florida 32904

ENGINEERING CHANGE NOTICE

Instructions

During the design process, U3 pin numbers 2 and 3 were inadvertently crossed. This condition affects the performance of the Dice Circuit. Perform the procedure below.

Procedure

1. Locate the small length of 20 gauge wire.
2. Orient the Roll the Dice printed circuit card as shown in Figure 1.
3. Cut the copper LAN connected to U3 pins 2 and 3 where indicated.

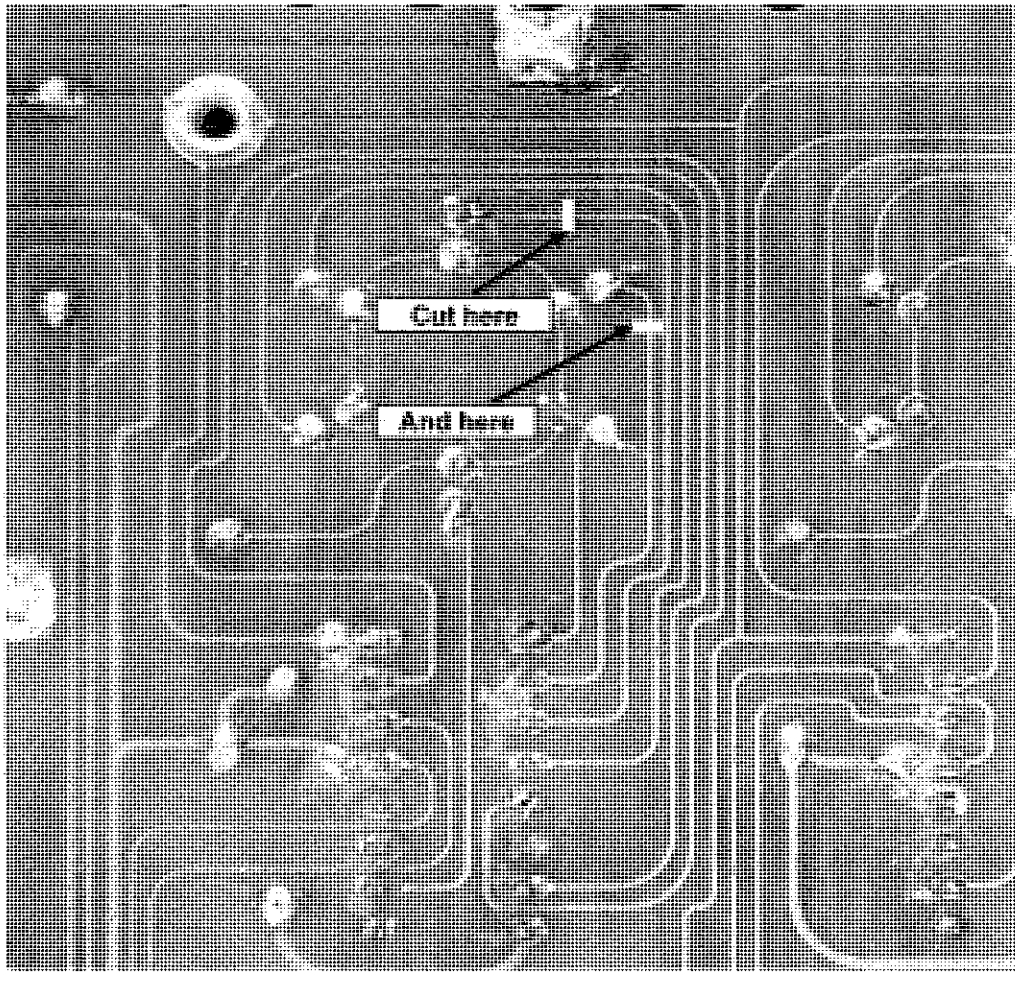

Figure 1

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Procedure, continued

4. Install and solder jumper wires as indicated in Figure 2.

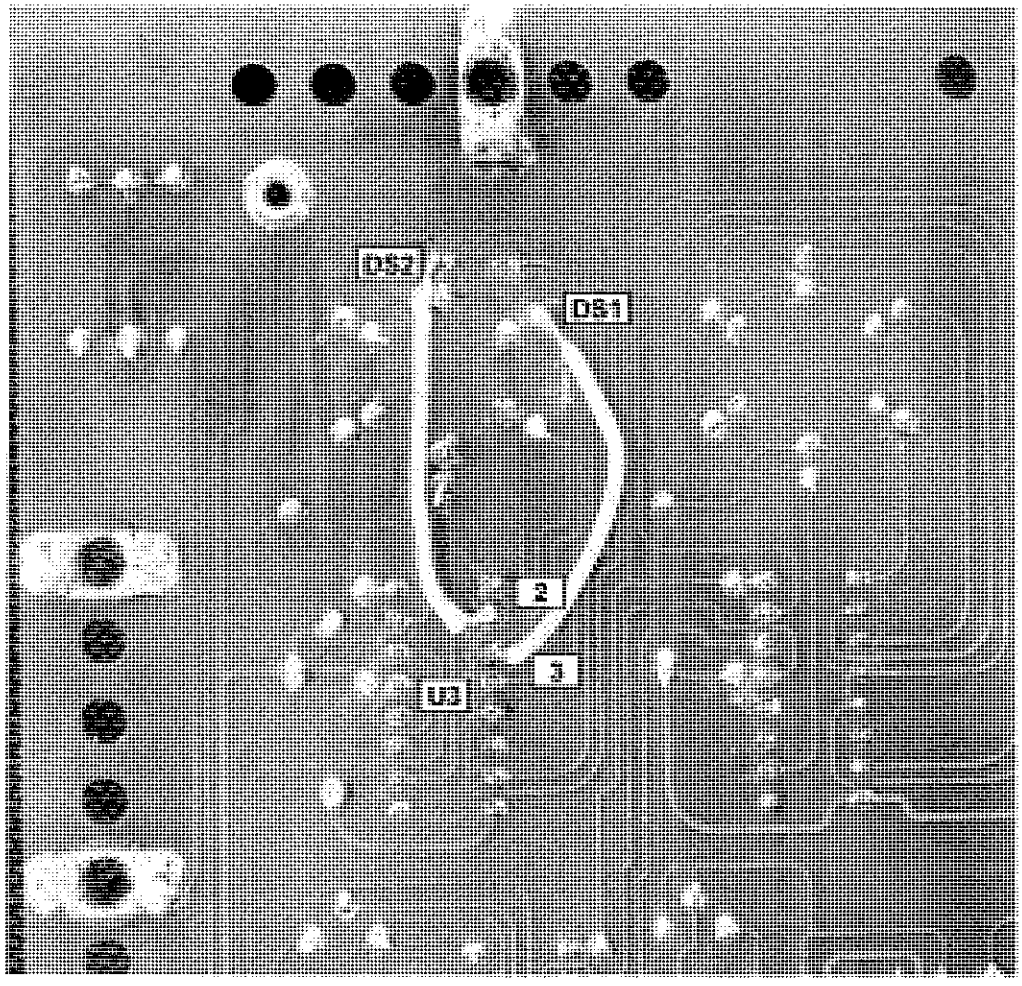

Figure 2

5. Perform the OPERATION CHECK on page 7 of the Soldering Contestant Handout.

6. Perform any necessary troubleshooting and repairs to make the circuit board operational.

7. When you are satisfied that your work is ready for inspection, press the "**H**" key and then the "**ENTER**" key on the keypad to request your final verification check.

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SOLDERING PROJECT

Electronics Technology

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Contestant Handout

2010

Nida Corporation
300 S. John Rodes Boulevard
Melbourne, Florida 32904

SOLDERING PROJECT

Instructions

The total time allowed is 90 minutes. You will be scored on your ability to:

1. Read and follow instructions.
2. Interpret a component layout diagram.
3. Prepare components for soldering.
4. Solder and de-solder components to a printed circuit board.

Judges are NOT permitted to answer questions during the competition. Should you encounter a technical problem, you may request assistance by pressing the "**H**" key and then the "**ENTER**" key on the Nida Model 130E Test Console. All technical problems will be corrected by the Judge and no demerits will be assessed.

Judges **WILL** assess a 2 point demerit for each violation of the following. Demerit points will be used as a discriminating factor in breaking ties.

1. Unwarranted requests for assistance (2 points)
2. Identifying good equipment as faulty (2 points)
3. Failure to follow instructions (2 points)
4. Safety violations (2 points)
   - ✓ Wearing jewelry
   - ✓ Not wearing safety glasses
   - ✓ Improper use of soldering iron

Materials Required

Soldering Project Contestant Handout
Reference Manual (Data Sheets)
Blank Roll the Dice Circuit Board
Soldering Project Pre-Packaged Parts Kit
Nida Screwdriver
Multimeter
Oscilloscope
Solder Equipment
Miscellaneous Tools as Required

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Procedure

1. **Log On.** Observe the display on the Nida Model 130E Test Console. Ensure that it looks like the example shown in Figure 1. Verify that your contestant number replaces the **[--- xx ---]** shown in the example.

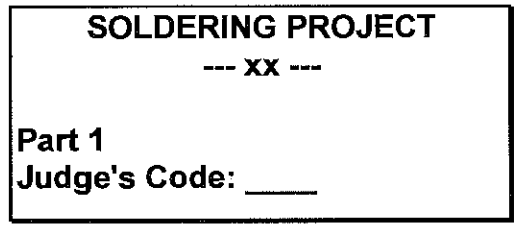

Figure 1

2. **Verification.** Locate the pre-packaged parts kit (blue dot) provided for this project. Verify that it is complete and visibly serviceable using the "**Soldering Parts List**" information provided in the "Reference Section" of this handout. If you determine that a component is missing or you have a surplus of components, press the "**H**" key and then the "**ENTER**" key, and a Judge will respond.

3. This project tests your ability to solder. The circuitry on the Nida Solder Project circuit board is a game that simulates the rolling of two dice. Upon completing the soldering portion of this project, you must demonstrate proper operation to one of the judges. **Read the Project Overview portion of the Reference Section before performing the final test.**

4. The separate Reference Manual and the Reference Section on the following pages are your only guides while you are constructing the soldering project. You will be scored on your ability to read and follow instructions, interpret a schematic and component layout diagram, prepare components for soldering, solder components to a printed circuit board, and de-solder components.

>>> Proceed to the "Reference Section" and Continue <<<

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REFERENCE SECTION

PROJECT OVERVIEW

The soldering project is a pair of identical one-of-six random number generator circuits disguised as a Roll the Dice game. Your task is to construct the circuit from commonly used electronic components while following the Soldering Procedure and schematic diagrams provided. The operation of the circuit will be judged functional when all components have been properly soldered and the circuit functions in accordance with the Operational Check. The schematic is at the end of this manual.

As mentioned, the two circuits are identical and share no common parts except for portions of integrated circuit U1, a hex buffer IC. Each circuit uses three of the six inverting buffers contained in U1. Two of the inverting buffers and a Junction Field Effect Transistor (JFET) make up the oscillator circuit for each random generator circuit, and the third inverting buffer is used in the decade counter circuit of U2 or U3.

Other than power and ground, U2 and U3 require just two inputs to operate: a clock input at pin 14, and an active low enabling input at pin 13. When enabled, the counter in U2/U3 advances at the leading edge of each clock input pulse, causing the IC to advance the count by one from Q0 to Q5, illuminating the single corresponding LED for each output. Since just six of the ten counting positions are used, the counter resets to zero whenever the counter enables position seven (Q6), with the high output state at pin 5 coupled to pin 15, the IC Reset input.

Each random generator circuit operates at a fast speed whenever the Roll button S1 or S2 is depressed. The circuit can be powered using the +12 volt power supply internal to the Nida 130E trainer, or externally by a 9-volt battery.

>>> Begin Part 1 when ready <<<

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SOLDERING PROCEDURE

Part 1

a. Locate the Roll the Dice circuit board.

b. Solder the six flanges and two turrets at the back of the circuit board as shown in Figure 2.

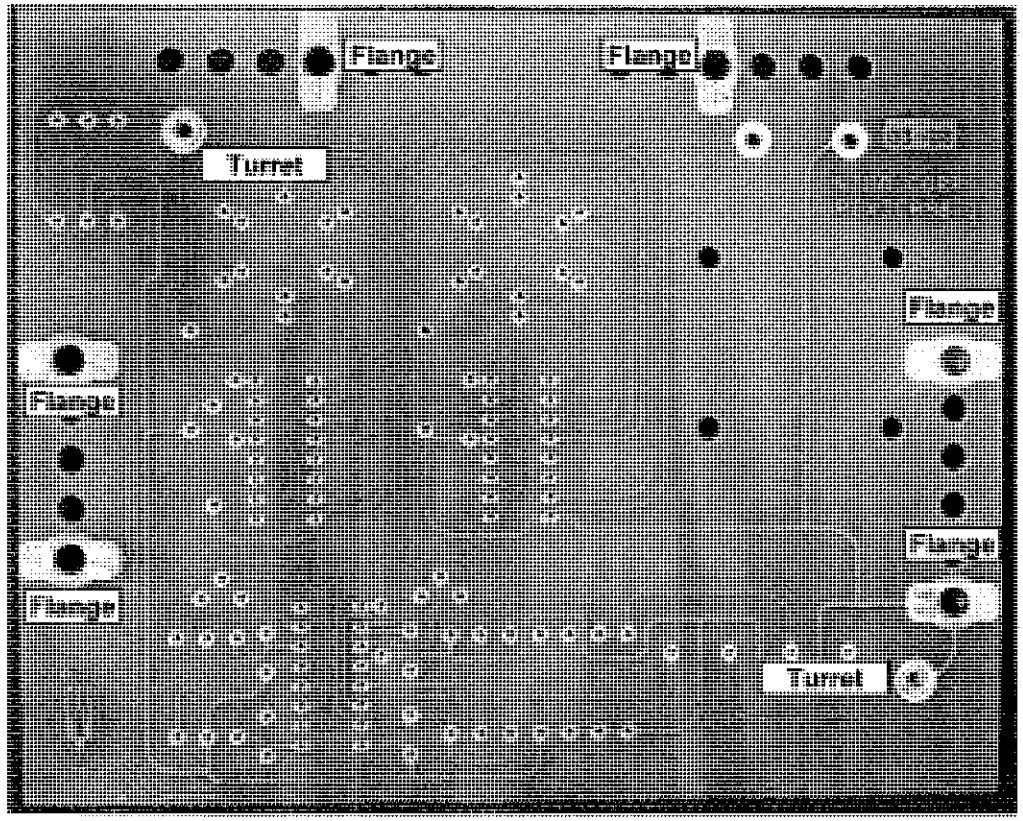

Figure 2

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SOLDERING PROCEDURE

Part 1, continued

c. Install and solder the ½" precut jumper, the nine resistors, and the three diodes as shown in Figure 3. Observe polarity on the diodes and install the resistors so the color codes can be read from top to bottom when installed on the circuit board.

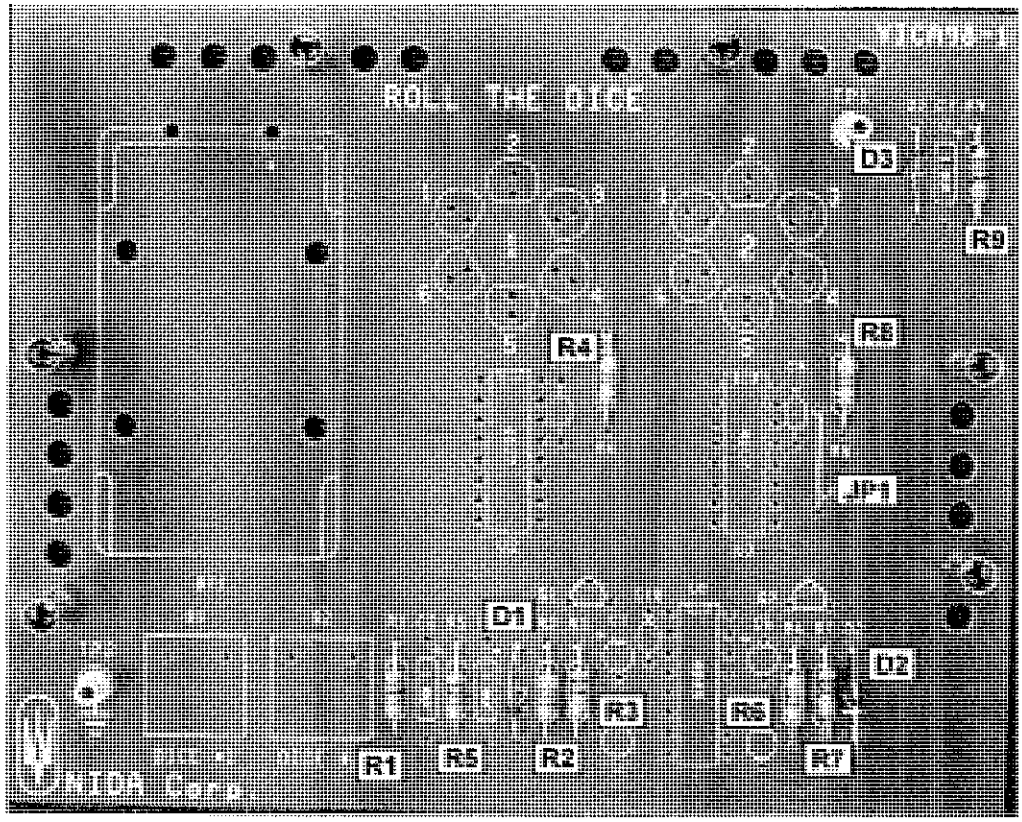

Figure 3

d. When you are satisfied with the solder connections and are ready for inspection, press the "**H**" key and then the "**ENTER**" key on the keypad to request your first verification check.

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SOLDERING PROCEDURE

Part 2

a. Locate the necessary components from the parts kit, and solder the ten capacitors and the twelve LEDs to the printed circuit board. Capacitors should be installed with the label in a position so the value can be seen from the top of the circuit board if mounted horizontally or the left side of the circuit board if mounted vertically. Make sure to observe polarity as needed and trim the component leads to the proper length. Use Figure 4 for reference.

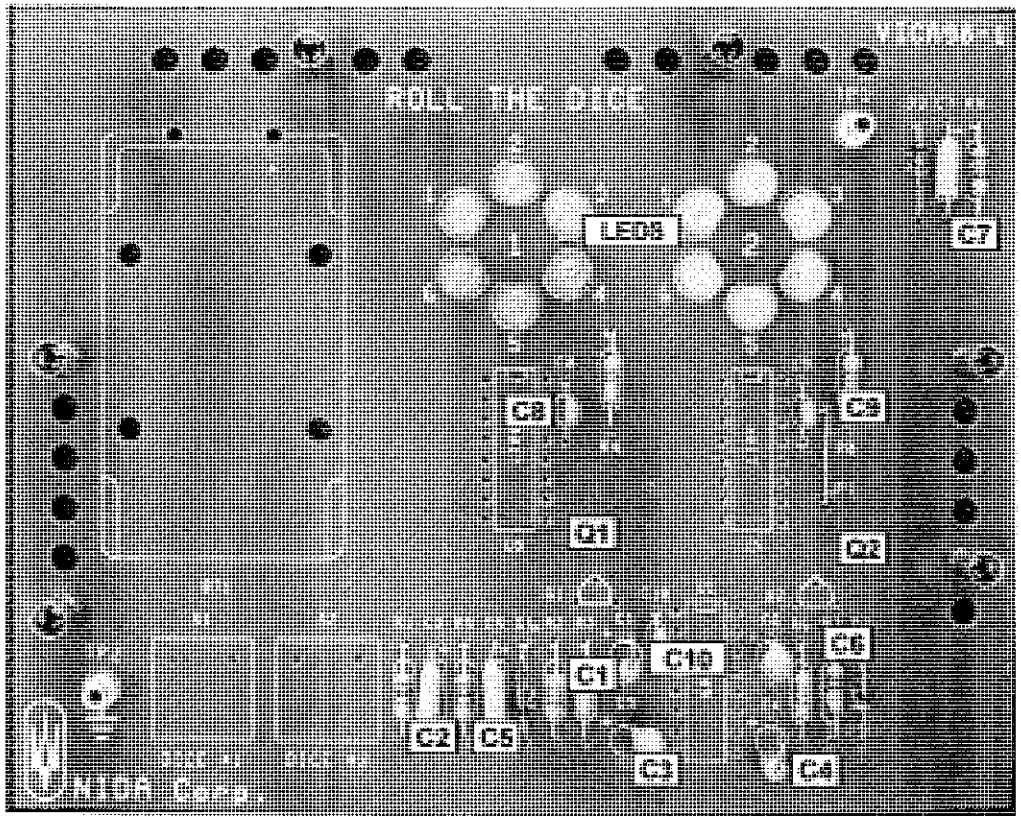

Figure 4

b. Locate and solder Q1 and Q2 to the printed circuit board. Q1 and Q2 should be approximately ¼ inch above the circuit board when completed. Make sure to observe polarity as needed and trim the component leads to the proper length.

c. When you are satisfied that your soldering thus far is ready for inspection, press the "**H**" key and then the "**ENTER**" key on the keypad to request your second verification check.

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SOLDERING PROCEDURE

Part 3

a. Solder to the circuit board the integrated circuit sockets for U1, U2, and U3. When completed, install the ICs. Observe proper pin alignment when soldering and installing.

b. Install and solder switches S1 and S2. Make sure each switch is in alignment and flush with the circuit board after soldering.

c. Solder the 9-volt battery holder to the circuit board. Cut the excess leads from the back of the printed circuit board after installation.

d. Test your soldering circuit board according to the OPERATION CHECK procedure below.

e. Perform any necessary troubleshooting and repairs to make the circuit board operational.

f. When you are satisfied that your work is ready for inspection, press the "**H**" key and then the "**ENTER**" key on the keypad to request your third verification check.

OPERATIONAL CHECK

1. Carefully install the Roll the Dice board on the test console in the PC2 location.

2. Set the 130E test console DC power supply to +12 VDC.

3. Press the DC Power switch on the PC2 position. Verify the DC LED at the PC2 position is illuminated.

4. Test the circuit by depressing S1 and S2 and observing the LED outputs. Each press of a roll input button will cause the corresponding LED display to "spin" and then stop at a single LED.

Part 4

One of the judges will advise you of the Part 4 instructions when this point in the assembly is reached.

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SOLDERING PARTS LIST

PART ID	DESCRIPTION	QUANTITY
VICA98-1	NIDA ROLL THE DICE CIRCUIT BOARD	1
51010005	HOLDER, 9 VOLT BATTERY	1
21053350	CAPACITOR, TANTALUM, 1 MFD 35V (105K)	5
21063160	CAPACITOR, 10 MFD 16V (106)	2
21042500	CAPACITOR, 0.1 MFD 50V (104)	3
51020006	LED, GREEN SHORT, ROUND	6
51020007	LED, YELLOW SHORT, ROUND	6
00510073	SILICONE DIODE, 1N914	2
00550029	ZENER DIODE, 1N960B 9.1V	1
81150031	JUMPER, 0.500 X 0.250	1
04100004	J-FET, 2N5640	2
11053030	RESISTOR, CARBON FILM, 1M 1/4W	2
14723030	RESISTOR, CARBON FILM, 4.7K 1/4W	2
11043030	RESISTOR, CARBON FILM, 100K 1/4W	2
14713030	RESISTOR, CARBON FILM, 470Ω 1/4W	2
15103030	RESISTOR, CARBON FILM, 51Ω 1/4W	1
41020030	PUSH BUTTON SWITCH, SPST MOMENTARY	2
05040047	4049 INVERTING HEX IC	1
05040143	4017 DECADE COUNTER IC	2
61000013	IC SOCKET, 16-PIN	3

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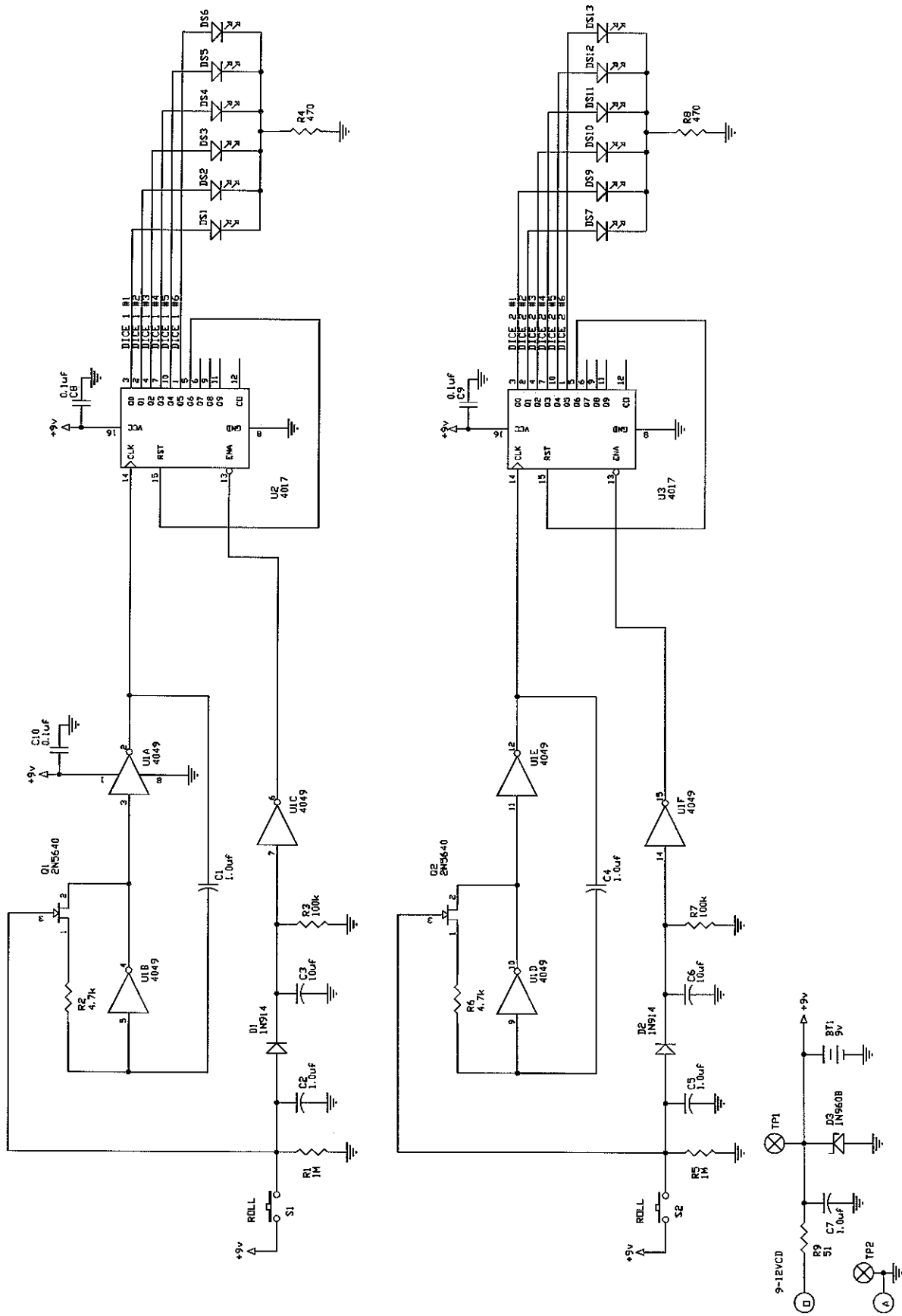

Roll the Dice Schematic

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REFERENCE MANUAL

Electronics Technology

SkillsUSA

Champions at Work®

Data Sheets

2010

REFERENCE MANUAL

DATA SHEETS

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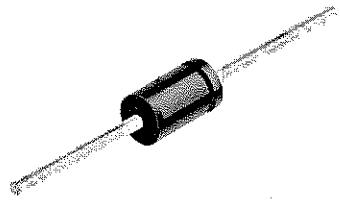
FAIRCHILD
SEMICONDUCTOR™

1N4001 - 1N4007

Features

- Low forward voltage drop.
- High surge current capability.



DO-41
COLOR BAND DENOTES CATHODE

1.0 Ampere General Purpose Rectifiers

Absolute Maximum Ratings*

T_A = 25°C unless otherwise noted

Symbol	Parameter	Value	Units
$I_{F(AV)}$	Average Rectified Current .375 " lead length @ T_A = 75°C	1.0	A
I_{FSM}	Non-repetitive Peak Forward Surge Current 8.3 ms single half-sine-wave Superimposed on rated load (JEDEC method)	30	A
P_D	Total Device Dissipation Derate above 25°C	2.5 20	W mW/°C
$R_{\theta JA}$	Thermal Resistance, Junction to Ambient	50	°C/W
T_{stg}	Storage Temperature Range	-55 to +175	°C
T_J	Operating Junction Temperature	-55 to +150	°C

*These ratings are limiting values above which the serviceability of any semiconductor device may be impaired.

Electrical Characteristics

T_A = 25°C unless otherwise noted

Symbol	Parameter	Device							Units
		4001	4002	4003	400	400	4006	4007	
V_{RRM}	Peak Repetitive Reverse Voltage	50	100	200	400	600	800	1000	V
V_{RMS}	Maximum RMS Voltage	35	70	140	280	420	560	700	V
V_R	DC Reverse Voltage (Rated V_R)	50	100	200	400	600	800	1000	V
I_{RM}	Maximum Instantaneous Reverse Current @ rated V_R T_A = 25°C T_A = 100°C	5.0 500							µA µA
V_{FM}	Maximum Instantaneous Forward Voltage @ 1.0 A	1.1							V
I_{rr}	Maximum Full Load Reverse Current, Full Cycle T_A = 75°C	30							µA
C	Typical Junction Capacitance V_R = 4.0 V, f = 1.0 MHz	15							pF

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High-speed diodes 1N4148; 1N4448

FEATURES

- Hermetically sealed leaded glass SOD27 (DO-35) package
- High switching speed: max. 4 ns
- General application
- Continuous reverse voltage: max. 100 V
- Repetitive peak reverse voltage: max. 100 V
- Repetitive peak forward current: max. 450 mA.

The diodes are type branded.

Fig.1 Simplified outline (SOD27; DO-35) and symbol.

APPLICATIONS

- High-speed switching.

DESCRIPTION

The 1N4148 and 1N4448 are high-speed switching diodes fabricated in planar technology, and encapsulated in hermetically sealed leaded glass SOD27 (DO-35) packages.

MARKING

TYPE NUMBER	MARKING CODE
1N4148	1N4148PH or 4148PH
1N4448	1N4448

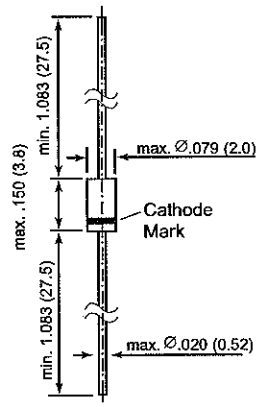
ORDERING INFORMATION

TYPE NUMBER	PACKAGE		
	NAME	DESCRIPTION	VERSION
1N4148	–	hermetically sealed glass package; axial leaded; 2 leads	SOD27
1N4448			

1N914

SMALL SIGNAL DIODE

DO-35



Dimensions in inches and (millimeters)

FEATURES

- Silicon Epitaxial Planar Diode
- For general purpose and switching.

MECHANICAL DATA

Case: DO-35 Glass Case
Weight: approx. 0.13 g

MAXIMUM RATINGS AND ELECTRICAL CHARACTERISTICS

Ratings at 25°C ambient temperature unless otherwise specified.

	SYMBOL	*VALUE*	*UNIT*
Peak Reverse Voltage	V_{RM}	100	V
Maximum Average Rectified Current	I_o	75	mA
Maximum Power Dissipation at T_{amb} = 25 °C	P_{tot}	500	mW
Maximum Junction Temperature	T_j	200	°C
Maximum Forward Voltage Drop at I_F = 10 mA	V_F	1.0	V
Maximum Reverse Current at V_R = 20 V V_R = 75 V	I_R	25 5.0	nA µA
Max. Reverse Recovery Time at I_F = I_R = 10 mA, V_R = 6 V, R_L = 100 Ω, to I_{rr} = 1 mA	t_{rr}	4.0	ns
Maximum Capacitance at V_R=0, f=1.0 MHz	C_{tot}	4.0	pF

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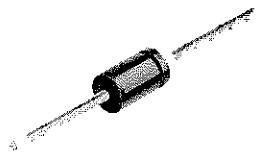
January 2005

1N4728A - 1N4764A

Zeners



DO-41 Glass case
COLOR BAND DENOTES CATHODE

Absolute Maximum Ratings * T_a = 25°C unless otherwise noted

Symbol	Parameter	Value	Units
P_D	Power Dissipation @ TL ≤ 50°C, Lead Length = 3/8"	1.0	W
	Derate above 50°C	6.67	mW/°C
T_J, T_{STG}	Operating and Storage Temperature Range	-65 to +200	°C

* These ratings are limiting values above which the serviceability of the diode may be impaired.

Electrical Characteristics T_a = 25°C unless otherwise noted

Device	V_Z (V) @ I_Z (Note 1)			Test Current I_Z (mA)	Max. Zener Impedance			Leakage Current	
	Min.	Typ.	Max.		Z_Z @ I_Z (Ω)	Z_{ZK} @ I_{ZK} (Ω)	I_{ZK} (mA)	I_R (μA)	V_R (V)
1N4728A	3.315	3.3	3.465	76	10	400	1	100	1
1N4729A	3.42	3.6	3.78	69	10	400	1	100	1
1N4730A	3.705	3.9	4.095	64	9	400	1	50	1
1N4731A	4.085	4.3	4.515	58	9	400	1	10	1
1N4732A	4.465	4.7	4.935	53	8	500	1	10	1
1N4733A	4.845	5.1	5.355	49	7	550	1	10	1
1N4734A	5.32	5.6	5.88	45	5	600	1	10	2
1N4735A	5.89	6.2	6.51	41	2	700	1	10	3
1N4736A	6.46	6.8	7.14	37	3.5	700	1	10	4
1N4737A	7.125	7.5	7.875	34	4	700	0.5	10	5
1N4738A	7.79	8.2	8.61	31	4.5	700	0.5	10	6
1N4739A	8.645	9.1	9.555	28	5	700	0.5	10	7
1N4740A	9.5	10	10.5	25	7	700	0.25	10	7.6
1N4741A	10.45	11	11.55	23	8	700	0.25	5	8.4
1N4742A	11.4	12	12.6	21	9	700	0.25	5	9.1
1N4743A	12.35	13	13.65	19	10	700	0.25	5	9.9
1N4744A	14.25	15	15.75	17	14	700	0.25	5	11.4
1N4745A	15.2	16	16.8	15.5	16	700	0.25	5	12.2
1N4746A	17.1	18	18.9	14	20	750	0.25	5	13.7
1N4747A	19	20	21	12.5	22	750	0.25	5	15.2

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SEMICONDUCTOR®

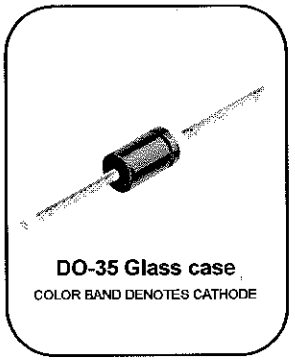
Zeners
1N957B - 1N991B

Absolute Maximum Ratings * T_A = 25°C unless otherwise noted

Symbol	Parameter	Value	Units
P_D	Power Dissipation @ TL ≤ 75°C, Lead Length = 3/8"	500	mW
	Derate above 75°C	4.0	mW/°C
T_J, T_{STG}	Operating and Storage Temperature Range	-65 to +200	°C

* These ratings are limiting values above which the serviceability of the diode may be impaired.

Tolerance = 5%



DO-35 Glass case
COLOR BAND DENOTES CATHODE

Electrical Characteristics T_A=25°C unless otherwise noted

Device	V_Z (Volts) (Note 1)				Z_Z (Ω) (Note 2)			I_R @ V_R		I_{ZM} (mA) (Note 3)
	Min.	Typ.	Max.	@ I_Z (mA)	Z_Z @ I_Z	Z_{ZK} @ I_{ZK} Ω	Z_{ZK} @ I_{ZK} mA	μA	Volts	
1N957B	6.46	6.8	7.14	18.5	4.5	700	1.0	150	5.2	47
1N958B	7.125	7.5	7.875	16.5	5.5	700	0.5	75	5.7	42
1N959B	7.79	8.2	8.61	15	6.5	700	0.5	50	6.2	38
1N960B	8.645	9.1	9.555	14	7.5	700	0.5	25	6.9	35
1N961B	9.5	10	10.5	12.5	8.5	700	0.25	10	7.6	32
1N962B	10.45	11	11.55	11.5	9.5	700	0.25	5	8.4	28
1N963B	11.4	12	12.6	10.5	11.5	700	0.25	5	9.1	26
1N964B	12.35	13	13.65	9.5	13	700	0.25	5	9.9	24
1N965B	14.25	15	15.75	8.5	16	700	0.25	5	11.4	21
1N966B	15.2	16	16.8	7.8	17	700	0.25	5	12.2	19
1N967B	17.1	18	18.9	7.0	21	750	0.25	5	13.7	17
1N968B	19	20	21	6.2	25	750	0.25	5	15.2	15
1N969B	20.9	22	23.1	5.6	29	750	0.25	5	16.7	14
1N970B	22.8	24	25.2	5.2	33	750	0.25	5	18.2	13
1N971B	25.652	27	28.35	4.6	41	750	0.25	5	20.6	11
1N972B	8.5	30	31.5	4.2	49	1000	0.25	5	22.8	10
1N973B	31.35	33	34.65	3.8	58	1000	0.25	5	25.1	9.2
1N974B	34.2	36	37.8	3.4	70	1000	0.25	5	27.4	8.5
1N975B	37.05	39	40.95	3.2	80	1000	0.25	5	29.7	7.8
1N976B	40.85	43	45.15	3.0	93	1500	0.25	5	32.7	7.0
1N977B	44.65	47	49.35	2.7	105	1500	0.25	5	35.8	6.4
1N978B	48.45	51	53.55	2.5	125	1500	0.25	5	38.8	5.9
1N979B	53.2	56	58.8	2.2	150	2000	0.25	5	42.6	5.4
1N980B	58.9	62	65.1	2.0	185	2000	0.25	5	47.1	4.9
1N981B	64.6	68	71.4	1.8	230	2000	0.25	5	51.7	4.5

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FAIRCHILD SEMICONDUCTOR™

October 1987
Revised January 2004

CD4017BC • CD4022BC
Decade Counter/Divider with 10 Decoded Outputs • Divide-by-8 Counter/Divider with 8 Decoded Outputs

General Description

The CD4017BC is a 5-stage divide-by-10 Johnson counter with 10 decoded outputs and a carry out bit.

The CD4022BC is a 4-stage divide-by-8 Johnson counter with 8 decoded outputs and a carry-out bit.

These counters are cleared to their zero count by a logical "1" on their reset line. These counters are advanced on the positive edge of the clock signal when the clock enable signal is in the logical "0" state.

The configuration of the CD4017BC and CD4022BC permits medium speed operation and assures a hazard free counting sequence. The 10/8 decoded outputs are normally in the logical "0" state and go to the logical "1" state only at their respective time slot. Each decoded output remains high for 1 full clock cycle. The carry-out signal completes a full cycle for every 10/8 clock input cycles and is used as a ripple carry signal to any succeeding stages.

Features

- Wide supply voltage range: 3.0V to 15V
- High noise immunity: 0.45 V_{DD} (typ.)
- Low power Fan out of 2 driving 74L
  TTL compatibility: or 1 driving 74LS
- Medium speed operation: 5.0 MHz (typ.)
  with 10V V_{DD}
- Low power: 10 µW (typ.)
- Fully static operation

Applications

- Automotive
- Instrumentation
- Medical electronics
- Alarm systems
- Industrial electronics
- Remote metering

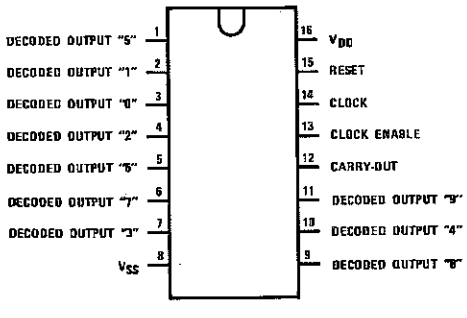
Ordering Code:

Order Number	Package Number	Package Description
CD4017BCM	M16A	16-Lead Small Outline Integrated Circuit (SOIC), JEDEC MS-012, 0.150" Narrow
CD4017BCN	N16E	16-Lead Plastic Dual-In-Line Package (PDIP), JEDEC MS-001, 0.300" Wide
CD4022BCM	M16A	16-Lead Small Outline Integrated Circuit (SOIC), JEDEC MS-012, 0.150" Narrow
CD4022BCN	N16E	16-Lead Plastic Dual-In-Line Package (PDIP), JEDEC MS-001, 0.300" Wide

Devices also available in Tape and Reel. Specify by appending the suffix letter "X" to the ordering code.

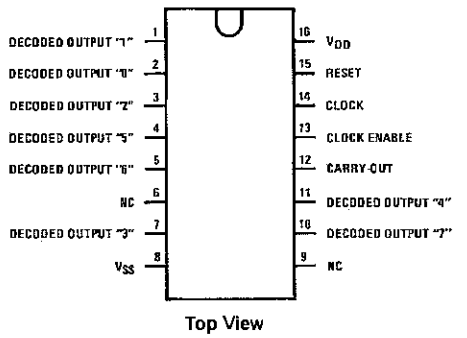
Connection Diagrams

CD4017B



Top View

CD4022B



Top View

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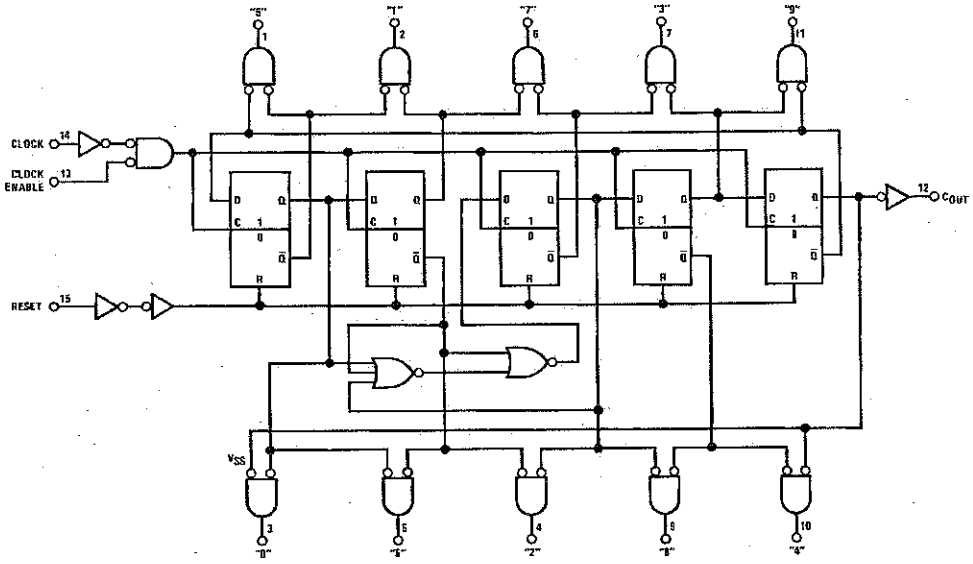
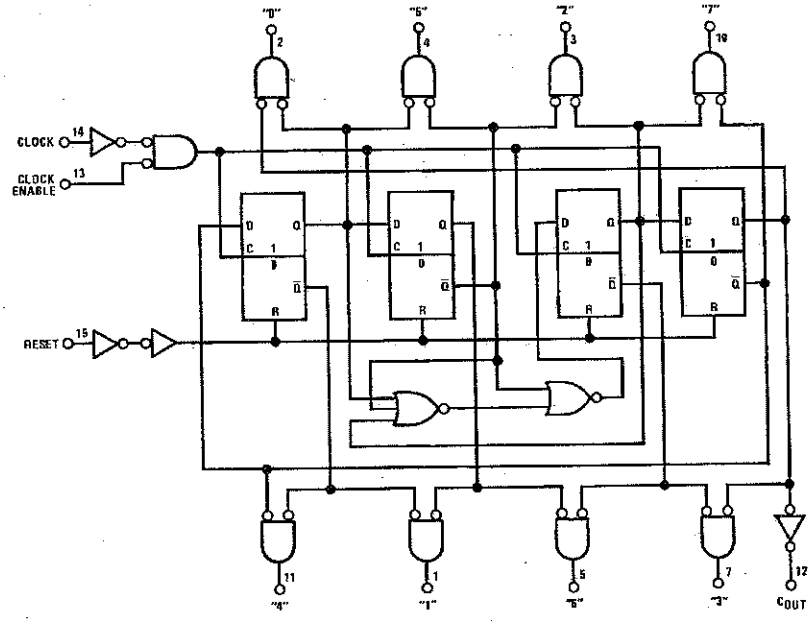
Logic Diagrams

CD4017B



Terminal No. 8 = GND
Terminal No. 16 = V_{DD}

CD4022B



Terminal No. 16 = V_{DD}
Terminal No. 8 = GND

Absolute Maximum Ratings (Note 1)

(Note 2)

DC Supply Voltage (V_{DD})	−0.5 V_{DC} to +18 V_{DC}
Input Voltage (V_{IN})	−0.5 V_{DC} to V_{DD} +0.5 V_{DC}
Storage Temperature (T_S)	−65°C to +150°C
Power Dissipation (P_D)	
Dual-In-Line	700 mW
Small Outline	500 mW
Lead Temperature (T_L)	
(Soldering, 10 seconds)	260°C

Recommended Operating Conditions (Note 2)

DC Supply Voltage (V_{DD})	+3 V_{DC} to +15 V_{DC}
Input Voltage (V_{IN})	0 to V_{DD} V_{DC}
Operating Temperature Range (T_A)	−55°C to +125°C

Note 1: "Absolute Maximum Ratings" are those values beyond which the safety of the device cannot be guaranteed, they are not meant to imply that the devices should be operated at these limits. The table of "Recommended Operating Conditions" and "Electrical Characteristics" provides conditions for actual device operation.

Note 2: V_{SS} = 0V unless otherwise specified.

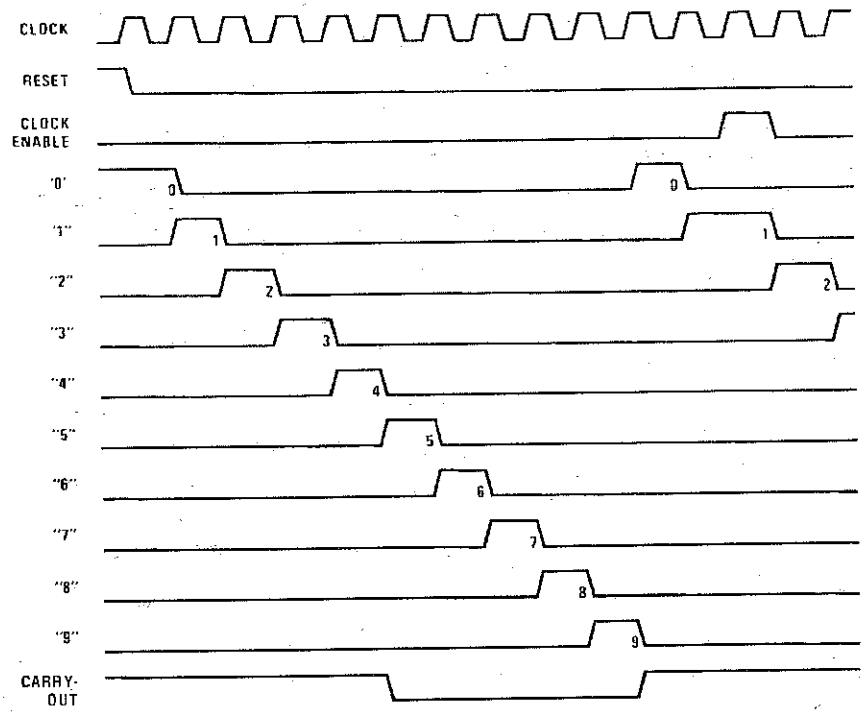
DC Electrical Characteristics (Note 2)

Symbol	Parameter	Conditions	−55°C		+25°			+125°C		Units
			Min	Max	Min	Typ	Max	Min	Max	
I_{DD}	Quiescent Device	V_{DD} = 5V		5		0.3	5		150	
	Current	V_{DD} = 10V		10		0.5	10		300	µA
		V_{DD} = 15V		20		1.0	20		600	
V_{OL}	LOW Level	$\|I_O\|$ < 1.0 µA								
	Output Voltage	V_{DD} = 5V		0.05		0	0.05		0.05	
		V_{DD} = 10V		0.05		0	0.05		0.05	V
		V_{DD} = 15V		0.05		0	0.05		0.05	
V_{OH}	HIGH Level	$\|I_O\|$ < 1.0 µA								
	Output Voltage	V_{DD} = 5V	4.95		4.95	5		4.95		
		V_{DD} = 10V	9.95		9.95	10		9.95		V
		V_{DD} = 15V	14.95		14.95	15		14.95		
V_{IL}	LOW Level	$\|I_O\|$ < 1.0 µA								
	Input Voltage	V_{DD} = 5V, V_O = 0.5V or 4.5V		1.5			1.5		1.5	
		V_{DD} = 10V, V_O = 1.0V or 9.0V		3.0			3.0		3.0	V
		V_{DD} = 15V, V_O = 1.5V or 13.5V		4.0			4.0		4.0	
V_{IH}	HIGH Level	$\|I_O\|$ < 1.0 µA								
	Input Voltage	V_{DD} = 5V, V_O = 0.5V or 4.5V	3.5		3.5			3.5		
		V_{DD} = 10V, V_O = 1.0V or 9.0V	7.0		7.0			7.0		V
		V_{DD} = 15V, V_O = 1.5V or 13.5V	11.0		11.0			11.0		
I_{OL}	LOW Level Output	V_{DD} = 5V, V_O = 0.4V	0.64		0.51	0.88		0.36		
	Current (Note 3)	V_{DD} = 10V, V_O = 0.5V	1.6		1.3	2.25		0.9		mA
		V_{DD} = 15V, V_O = 1.5V	4.2		3.4	8.8		2.4		
I_{OH}	HIGH Level Output	V_{DD} = 5V, V_O = 4.6V	−0.25		−0.2	−0.36		−0.14		
	Current (Note 3)	V_{DD} = 10V, V_O = 9.5V	−0.62		−0.5	−0.9		−0.35		mA
		V_{DD} = 15V, V_O = 13.5V	−1.8		−1.5	−3.5		−1.1		
I_{IN}	Input Current	V_{DD} = 15V, V_{IN} = 0V		−0.1		-10^{-5}	−0.1		−1.0	µA
		V_{DD} = 15V, V_{IN} = 15V		0.1		10^{-5}	0.1		1.0	

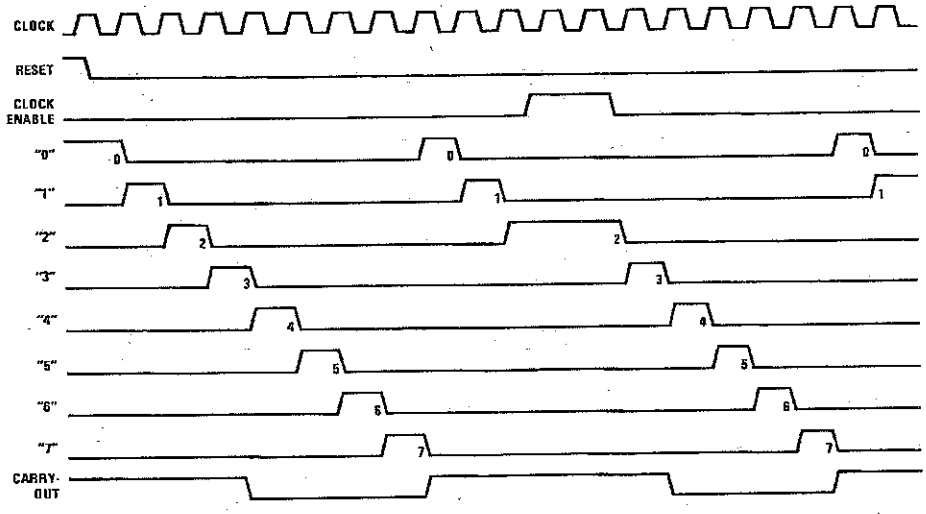
Note 3: I_{OL} and I_{OH} are tested one output at a time.

Timing Diagrams

CD4017B



CD4022B



MC14049B, MC14050B

Hex Buffer

The MC14049B Hex Inverter/Buffer and MC14050B Noninverting Hex Buffer are constructed with MOS P−Channel and N−Channel enhancement mode devices in a single monolithic structure. These complementary MOS devices find primary use where low power dissipation and/or high noise immunity is desired. These devices provide logic level conversion using only one supply voltage, V_{DD}.

The input−signal high level (V_{IH}) can exceed the V_{DD} supply voltage for logic level conversions. Two TTL/DTL loads can be driven when the devices are used as a CMOS−to−TTL/DTL converter (V_{DD} = 5.0 V, $V_{OL} \leq$ 0.4 V, $I_{OL} \geq$ 3.2 mA).

Note that pins 13 and 16 are not connected internally on these devices; consequently connections to these terminals will not affect circuit operation.

Features

- High Source and Sink Currents
- High−to−Low Level Converter
- Supply Voltage Range = 3.0 V to 18 V
- V_{IN} can exceed V_{DD}
- Meets JEDEC B Specifications
- Improved ESD Protection On All Inputs
- Pb−Free Packages are Available*

MAXIMUM RATINGS (Voltages Referenced to V_{SS})

Symbol	Parameter	Value	Unit
V_{DD}	DC Supply Voltage Range	−0.5 to +18.0	V
V_{in}	Input Voltage Range (DC or Transient)	−0.5 to +18.0	V
V_{out}	Output Voltage Range (DC or Transient)	−0.5 to V_{DD} + 0.5	V
I_{in}	Input Current (DC or Transient) per Pin	±10	mA
I_{out}	Output Current (DC or Transient) per Pin	±45	mA
P_D	Power Dissipation, per Package (Note 1) (Plastic) (SOIC)	 825 740	mW
T_A	Ambient Temperature Range	−55 to +125	°C
T_{stg}	Storage Temperature Range	−65 to +150	°C
T_L	Lead Temperature (8−Second Soldering)	260	°C

1. Temperature Derating: See Figure 3.

This device contains protection circuitry to protect the inputs against damage due to high static voltages or electric fields referenced to the V_{SS} pin only. Extra precautions must be taken to avoid applications of any voltage higher than the maximum rated voltages to this high−impedance circuit. For proper operation, the ranges $V_{SS} \leq V_{in} \leq$ 18 V and $V_{SS} \leq V_{out} \leq V_{DD}$ are recommended.

Unused inputs must always be tied to an appropriate logic voltage level (e.g., either V_{SS} or V_{DD}). Unused outputs must be left open.

*For additional information on our Pb−Free strategy and soldering details, please download the ON Semiconductor Soldering and Mounting Techniques Reference Manual, SOLDERRM/D.

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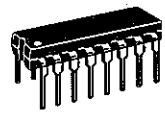
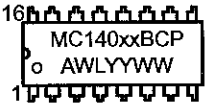
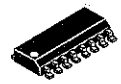
MARKING DIAGRAMS

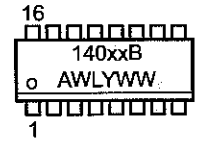


PDIP−16
P SUFFIX
CASE 648

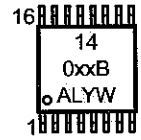


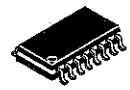


SOIC−16
D SUFFIX
CASE 751B

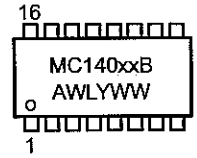


TSSOP−16
DT SUFFIX
CASE 948F





SOEIAJ−16
F SUFFIX
CASE 966



xx	= Specific Device Code
A	= Assembly Location
WL, L	= Wafer Lot
YY, Y	= Year
WW, W	= Work Week

ORDERING INFORMATION

See detailed ordering and shipping information in the package dimensions section on page 2 of this data sheet.

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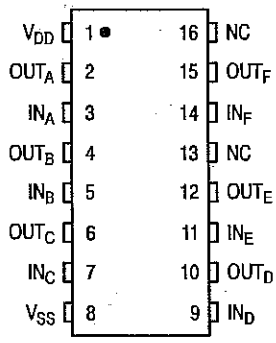
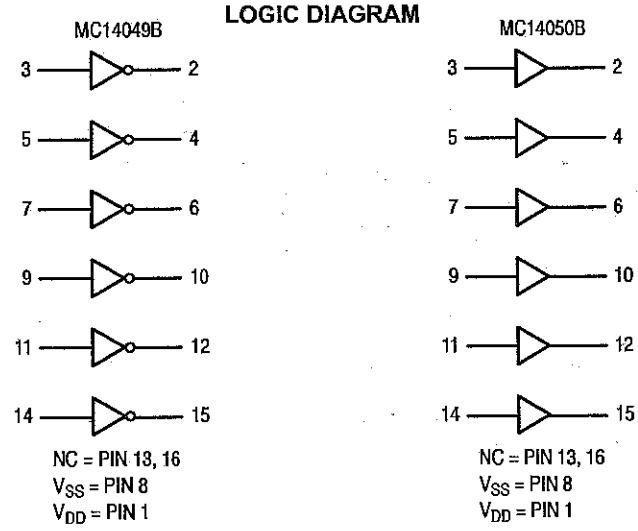
PIN ASSIGNMENT



LOGIC DIAGRAM



ORDERING INFORMATION

Device	Package	Shipping†
MC14049BCP	PDIP−16	500 Units / Rail
MC14049BCPG	PDIP−16 (Pb−Free)	500 Units / Rail
MC14049BD	SOIC−16	48 Units / Rail
MC14049BDG	SOIC−16 (Pb−Free)	48 Units / Rail
MC14049BDR2	SOIC−16	2500 Units / Tape & Reel
MC14049BDR2G	SOIC−16 (Pb−Free)	2500 Units / Tape & Reel
MC14049BFEL	SOEIAJ−16	2000 Units / Tape & Reel
MC14050BCP	PDIP−16	500 Units / Rail
MC14050BCPG	PDIP−16 (Pb−Free)	500 Units / Rail
MC14050BD	SOIC−16	48 Units / Rail
MC14050BDR2	SOIC−16	2500 Units / Tape & Reel
MC14050BDR2G	SOIC−16 (Pb−Free)	2500 Units / Tape & Reel
MC14050BDT	TSSOP−16*	96 Units / Rail
MC14050BDTR2	TSSOP−16*	2500 Units / Tape & Reel
MC14050BFEL	SOEIAJ−16	2000 Units / Tape & Reel
MC14050BFELG	SOEIAJ−16 (Pb−Free)	2000 Units / Tape & Reel

†For information on tape and reel specifications, including part orientation and tape sizes, please refer to our Tape and Reel Packaging Specifications Brochure, BRD8011/D.
*This package is inherently Pb−Free.

FAIRCHILD
SEMICONDUCTOR™

October 1987
Revised January 1999

CD4020BC • CD4040BC • CD4060BC
14-Stage Ripple Carry Binary Counters • 12-Stage Ripple Carry Binary Counters • 14-Stage Ripple Carry Binary Counters

General Description

The CD4020BC, CD4060BC are 14-stage ripple carry binary counters, and the CD4040BC is a 12-stage ripple carry binary counter. The counters are advanced one count on the negative transition of each clock pulse. The counters are reset to the zero state by a logical "1" at the reset input independent of clock.

Features

- Wide supply voltage range: 1.0V to 15V
- High noise immunity: 0.45 V_{DD} (typ.)
- Low power TTL compatibility: Fan out of 2 driving 74L or 1 driving 74LS
- Medium speed operation: 8 MHz typ. at V_{DD} = 10V
- Schmitt trigger clock input

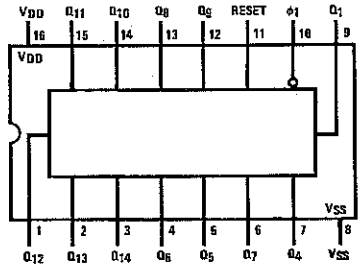
Ordering Code:

Order Number	Package Number	Package Description
CD4020BCM	M16A	16-Lead Small Outline Integrated Circuit (SOIC), JEDEC MS-012, 0.150" Narrow
CD4020BCN	N16E	16-Lead Plastic Dual-In-Line Package (PDIP), JEDEC MS-001, 0.300" Wide
CD4040BCM	M16A	16-Lead Small Outline Integrated Circuit (SOIC), JEDEC MS-012, 0.150" Narrow
CD4040BCSJ	M16D	16-Lead Small Outline Package (SOP), EIAJ TYPE II, 5.3mm Wide
CD4040BCN	N16E	16-Lead Plastic Dual-In-Line Package (PDIP), JEDEC MS-001, 0.300" Wide
CD4060BCM	M16A	16-Lead Small Outline Integrated Circuit (SOIC), JEDEC MS-012, 0.150" Narrow
CD4060BCN	N16E	16-Lead Plastic Dual-In-Line Package (PDIP), JEDEC MS-001, 0.300" Wide

Devices also available in Tape and Reel. Specify by appending the suffix letter "X" to the ordering code.

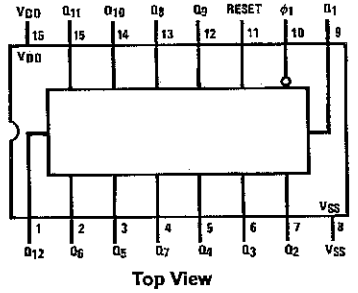
Connection Diagrams

Pin Assignments for DIP and SOIC
CD4020BC



Top View

Pin Assignments for DIP, SOIC and SOP
CD4040BC



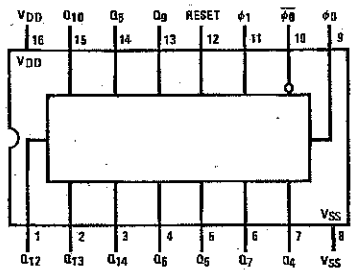
Top View

© 1999 Fairchild Semiconductor Corporation

Connection Diagrams (Continued)

Pin Assignments for DIP and SOIC

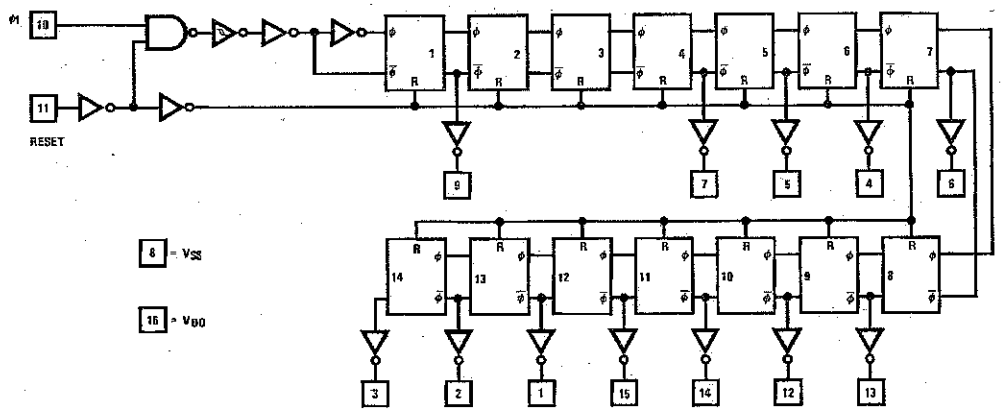
CD4060BC



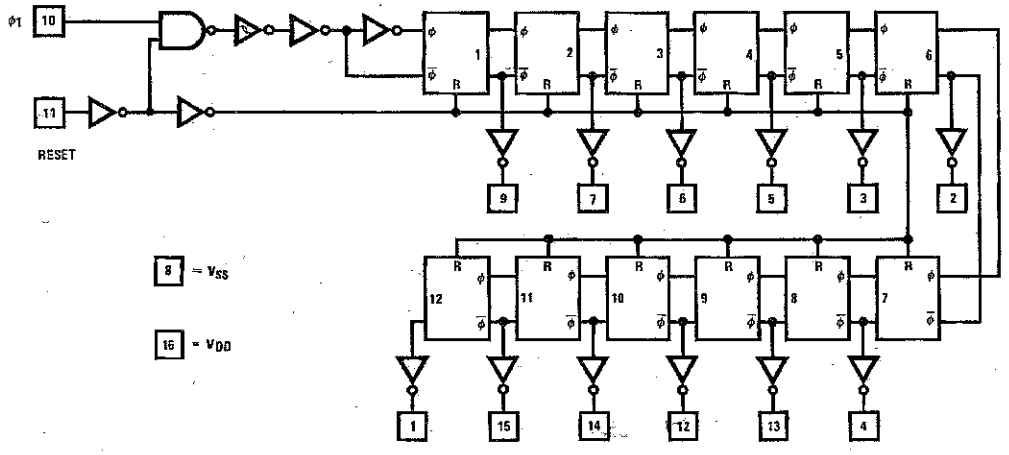
Top View

Schematic Diagrams

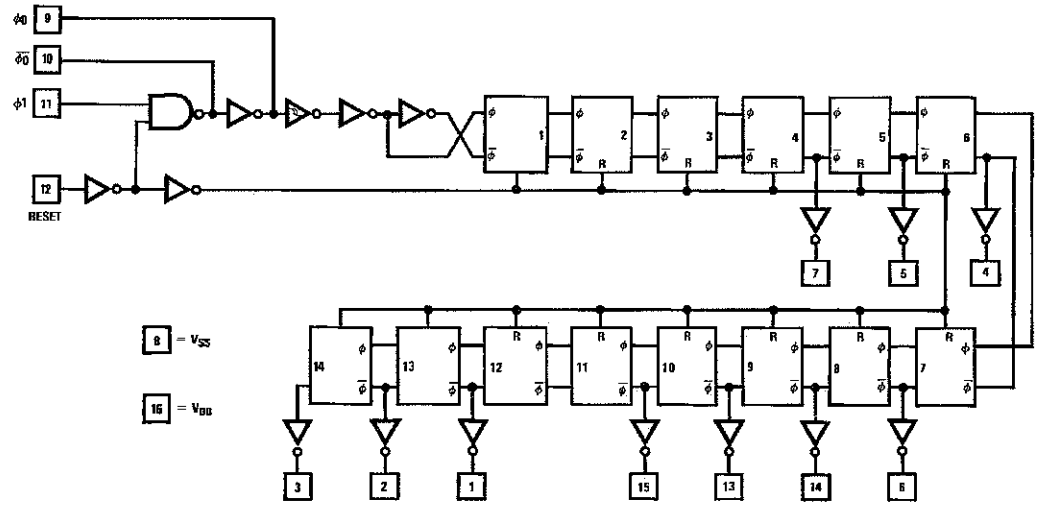
CD4020BC



CD4040BC

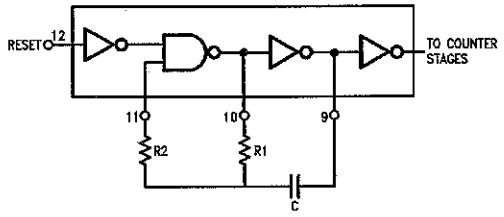


CD4060BC

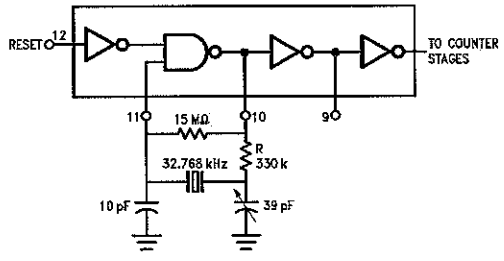


CD4060B Typical Oscillator Connections

RC Oscillator



Crystal Oscillator



National Semiconductor

August 2002

LM193/LM293/LM393/LM2903
Low Power Low Offset Voltage Dual Comparators

General Description

The LM193 series consists of two independent precision voltage comparators with an offset voltage specification as low as 2.0 mV max for two comparators which were designed specifically to operate from a single power supply over a wide range of voltages. Operation from split power supplies is also possible and the low power supply current drain is independent of the magnitude of the power supply voltage. These comparators also have a unique characteristic in that the input common-mode voltage range includes ground, even though operated from a single power supply voltage.

Application areas include limit comparators, simple analog to digital converters; pulse, squarewave and time delay generators; wide range VCO; MOS clock timers; multivibrators and high voltage digital logic gates. The LM193 series was designed to directly interface with TTL and CMOS. When operated from both plus and minus power supplies, the LM193 series will directly interface with MOS logic where their low power drain is a distinct advantage over standard comparators.

The LM393 and LM2903 parts are available in National's innovative thin micro SMD package with 8 (12 mil) large bumps.

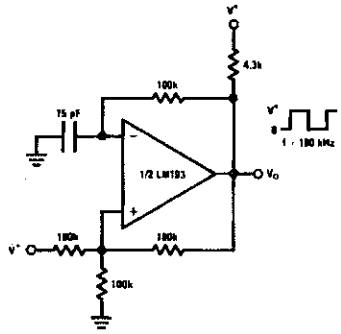
Advantages

- High precision comparators
- Reduced V_{OS} drift over temperature
- Eliminates need for dual supplies
- Allows sensing near ground
- Compatible with all forms of logic
- Power drain suitable for battery operation

Features

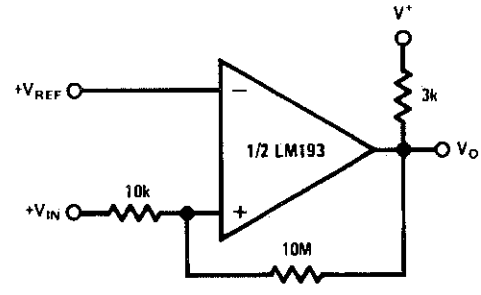
- Wide supply
  - — Voltage range: 2.0V to 36V
  - — Single or dual supplies: ±1.0V to ±18V
- Very low supply current drain (0.4 mA) — independent of supply voltage
- Low input biasing current: 25 nA
- Low input offset current: ±5 nA
- Maximum offset voltage: ±3 mV
- Input common-mode voltage range includes ground
- Differential input voltage range equal to the power supply voltage
- Low output saturation voltage,: 250 mV at 4 mA
- Output voltage compatible with TTL, DTL, ECL, MOS and CMOS logic systems
- Available in the 8-Bump (12 mil) micro SMD package
- See AN-1112 for micro SMD considerations

Squarewave Oscillator



00570938

Non-Inverting Comparator with Hysteresis



00570909

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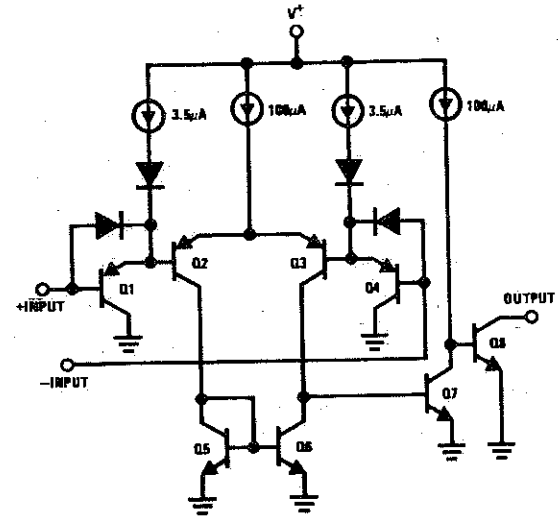
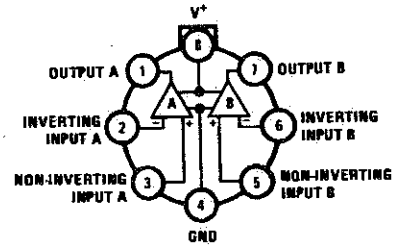
Schematic and Connection Diagrams



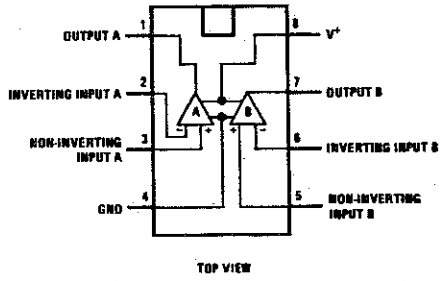
00570902

Metal Can Package



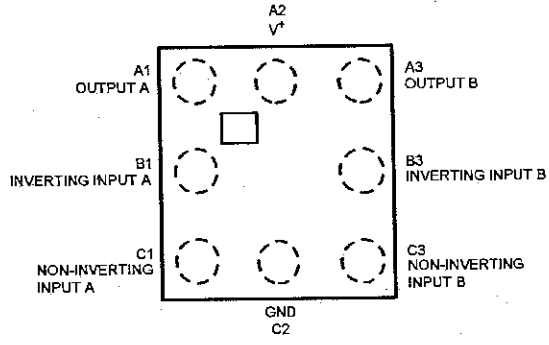
00570903

Dual-In-Line/SOIC Package



00570901

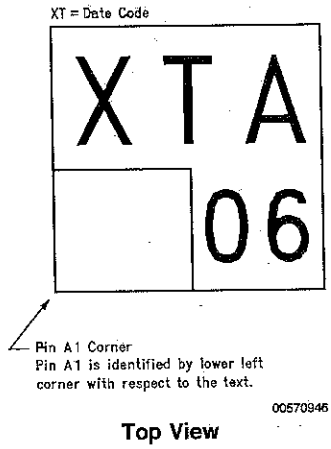
micro SMD



00570945

Top View

micro SMD Marking



00570946

Top View

National Semiconductor

February 2003

LM3914
Dot/Bar Display Driver

General Description

The LM3914 is a monolithic integrated circuit that senses analog voltage levels and drives 10 LEDs, providing a linear analog display. A single pin changes the display from a moving dot to a bar graph. Current drive to the LEDs is regulated and programmable, eliminating the need for resistors. This feature is one that allows operation of the whole system from less than 3V.

The circuit contains its own adjustable reference and accurate 10-step voltage divider. The low-bias-current input buffer accepts signals down to ground, or V^-, yet needs no protection against inputs of 35V above or below ground. The buffer drives 10 individual comparators referenced to the precision divider. Indication non-linearity can thus be held typically to ½%, even over a wide temperature range.

Versatility was designed into the LM3914 so that controller, visual alarm, and expanded scale functions are easily added on to the display system. The circuit can drive LEDs of many colors, or low-current incandescent lamps. Many LM3914s can be "chained" to form displays of 20 to over 100 segments. Both ends of the voltage divider are externally available so that 2 drivers can be made into a zero-center meter.

The LM3914 is very easy to apply as an analog meter circuit. A 1.2V full-scale meter requires only 1 resistor and a single 3V to 15V supply in addition to the 10 display LEDs. If the 1 resistor is a pot, it becomes the LED brightness control. The simplified block diagram illustrates this extremely simple external circuitry.

When in the dot mode, there is a small amount of overlap or "fade" (about 1 mV) between segments. This assures that at no time will all LEDs be "OFF", and thus any ambiguous display is avoided. Various novel displays are possible.

Much of the display flexibility derives from the fact that all outputs are individual, DC regulated currents. Various effects can be achieved by modulating these currents. The individual outputs can drive a transistor as well as a LED at the same time, so controller functions including "staging" control can be performed. The LM3914 can also act as a programmer, or sequencer.

The LM3914 is rated for operation from 0°C to +70°C. The LM3914N-1 is available in an 18-lead molded (N) package.

The following typical application illustrates adjusting of the reference to a desired value, and proper grounding for accurate operation, and avoiding oscillations.

Features

- Drives LEDs, LCDs or vacuum fluorescents
- Bar or dot display mode externally selectable by user
- Expandable to displays of 100 steps
- Internal voltage reference from 1.2V to 12V
- Operates with single supply of less than 3V
- Inputs operate down to ground
- Output current programmable from 2 mA to 30 mA
- No multiplex switching or interaction between outputs
- Input withstands ±35V without damage or false outputs
- LED driver outputs are current regulated, open-collectors
- Outputs can interface with TTL or CMOS logic
- The internal 10-step divider is floating and can be referenced to a wide range of voltages

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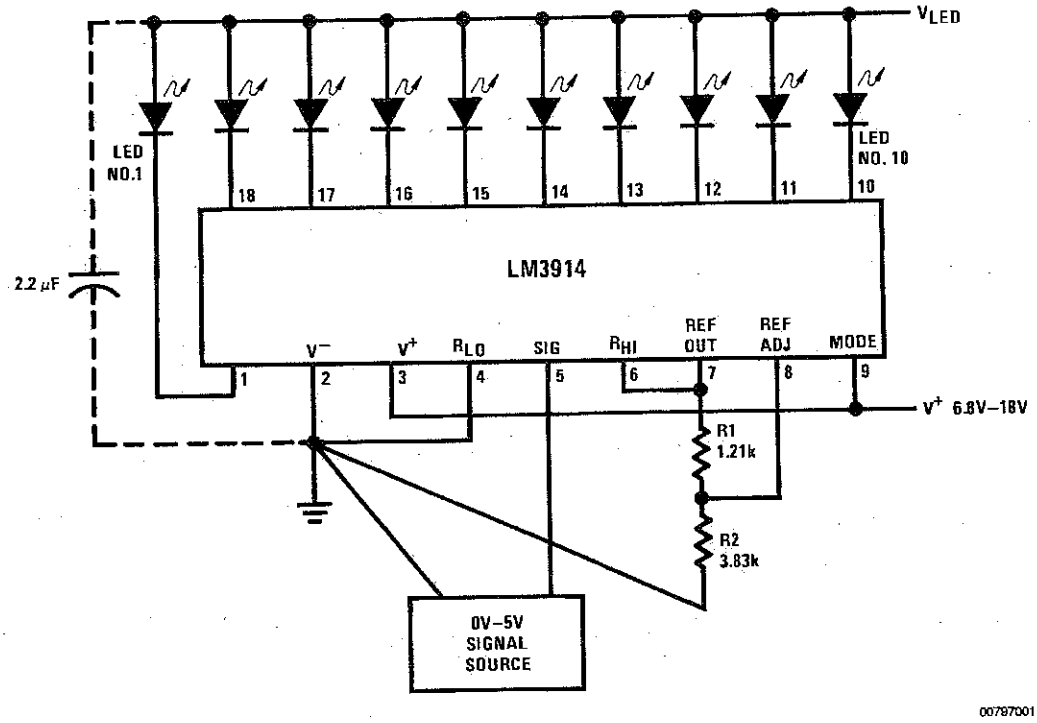
Typical Applications

0V to 5V Bar Graph Meter



$$\text{Ref Out V} = 1.25\left(1 + \frac{R2}{R1}\right)$$

$$I_{LED} \cong \frac{12.5}{R1}$$

Note: Grounding method is typical of *all* uses. The 2.2µF tantalum or 10 µF aluminum electrolytic capacitor is needed if leads to the LED supply are 6" or longer.

Absolute Maximum Ratings (Note 1)

If Military/Aerospace specified devices are required, please contact the National Semiconductor Sales Office/ Distributors for availability and specifications.

Power Dissipation (Note 6)	
Molded DIP (N)	1365 mW
Supply Voltage	25V
Voltage on Output Drivers	25V
Input Signal Overvoltage (Note 4)	±35V
Divider Voltage	−100 mV to V^+
Reference Load Current	10 mA
Storage Temperature Range	−55°C to +150°C
Soldering Information	
Dual-In-Line Package	
Soldering (10 seconds)	260°C
Plastic Chip Carrier Package	
Vapor Phase (60 seconds)	215°C
Infrared (15 seconds)	220°C

See AN-450 "Surface Mounting Methods and Their Effect on Product Reliability" for other methods of soldering surface mount devices.

Electrical Characteristics (Notes 2, 4)

Parameter	Conditions (Note 2)		Min	Typ	Max	Units
COMPARATOR						
Offset Voltage, Buffer and First Comparator	$0V \le V_{RLO} = V_{RHI} \le 12V$, $I_{LED} = 1$ mA			3	10	mV
Offset Voltage, Buffer and Any Other Comparator	$0V \le V_{RLO} = V_{RHI} \le 12V$, $I_{LED} = 1$ mA			3	15	mV
Gain ($\Delta I_{LED}/\Delta V_{IN}$)	$I_{L(REF)} = 2$ mA, $I_{LED} = 10$ mA		3	8		mA/mV
Input Bias Current (at Pin 5)	$0V \le V_{IN} \le V^+ - 1.5V$			25	100	nA
Input Signal Overvoltage	No Change in Display		−35		35	V
VOLTAGE-DIVIDER						
Divider Resistance	Total, Pin 6 to 4		8	12	17	kΩ
Accuracy	(Note 3)			0.5	2	%
VOLTAGE REFERENCE						
Output Voltage	$0.1\text{ mA} \le I_{L(REF)} \le 4$ mA, $V^+ = V_{LED} = 5V$		1.2	1.28	1.34	V
Line Regulation	$3V \le V^+ \le 18V$			0.01	0.03	%/V
Load Regulation	$0.1\text{ mA} \le I_{L(REF)} \le 4$ mA, $V^+ = V_{LED} = 5V$			0.4	2	%
Output Voltage Change with Temperature	$0°C \le T_A \le +70°C$, $I_{L(REF)} = 1$ mA, $V^+ = 5V$			1		%
Adjust Pin Current				75	120	µA
OUTPUT DRIVERS						
LED Current	$V^+ = V_{LED} = 5V$, $I_{L(REF)} = 1$ mA		7	10	13	mA
LED Current Difference (Between Largest and Smallest LED Currents)	$V_{LED} = 5V$	$I_{LED} = 2$ mA		0.12	0.4	mA
		$I_{LED} = 20$ mA		1.2	3	
LED Current Regulation	$2V \le V_{LED} \le 17V$	$I_{LED} = 2$ mA		0.1	0.25	mA
		$I_{LED} = 20$ mA		1	3	
Dropout Voltage	$I_{LED(ON)} = 20$ mA, $V_{LED} = 5V$, $\Delta I_{LED} = 2$ mA				1.5	V
Saturation Voltage	$I_{LED} = 2.0$ mA, $I_{L(REF)} = 0.4$ mA			0.15	0.4	V
Output Leakage, Each Collector	(Bar Mode) (Note 5)			0.1	10	µA
Output Leakage	(Dot Mode) (Note 5)	Pins 10–18		0.1	10	µA
		Pin 1	60	150	450	µA
SUPPLY CURRENT						
Standby Supply Current (All Outputs Off)	$V^+ = 5V$, $I_{L(REF)} = 0.2$ mA			2.4	4.2	mA
	$V^+ = 20V$, $I_{L(REF)} = 1.0$ mA			6.1	9.2	mA

WP103HDT BRIGHT RED

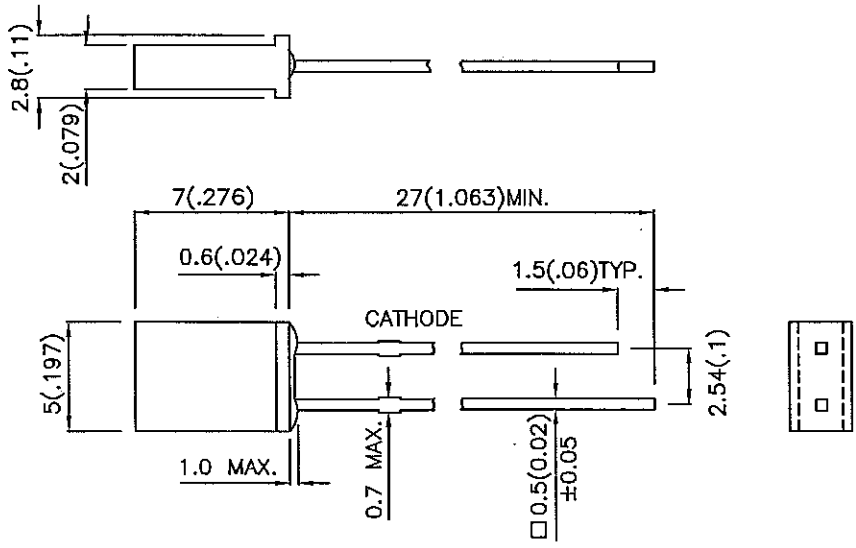
Features

- LOW POWER CONSUMPTION.
- RELIABLE AND RUGGED.
- EXCELLENT UNIFORMITY OF LIGHT OUTPUT.
- SUITABLE FOR LEVEL INDICATOR.
- LONG LIFE - SOLID STATE RELIABILITY.
- RoHS COMPLIANT.

Description

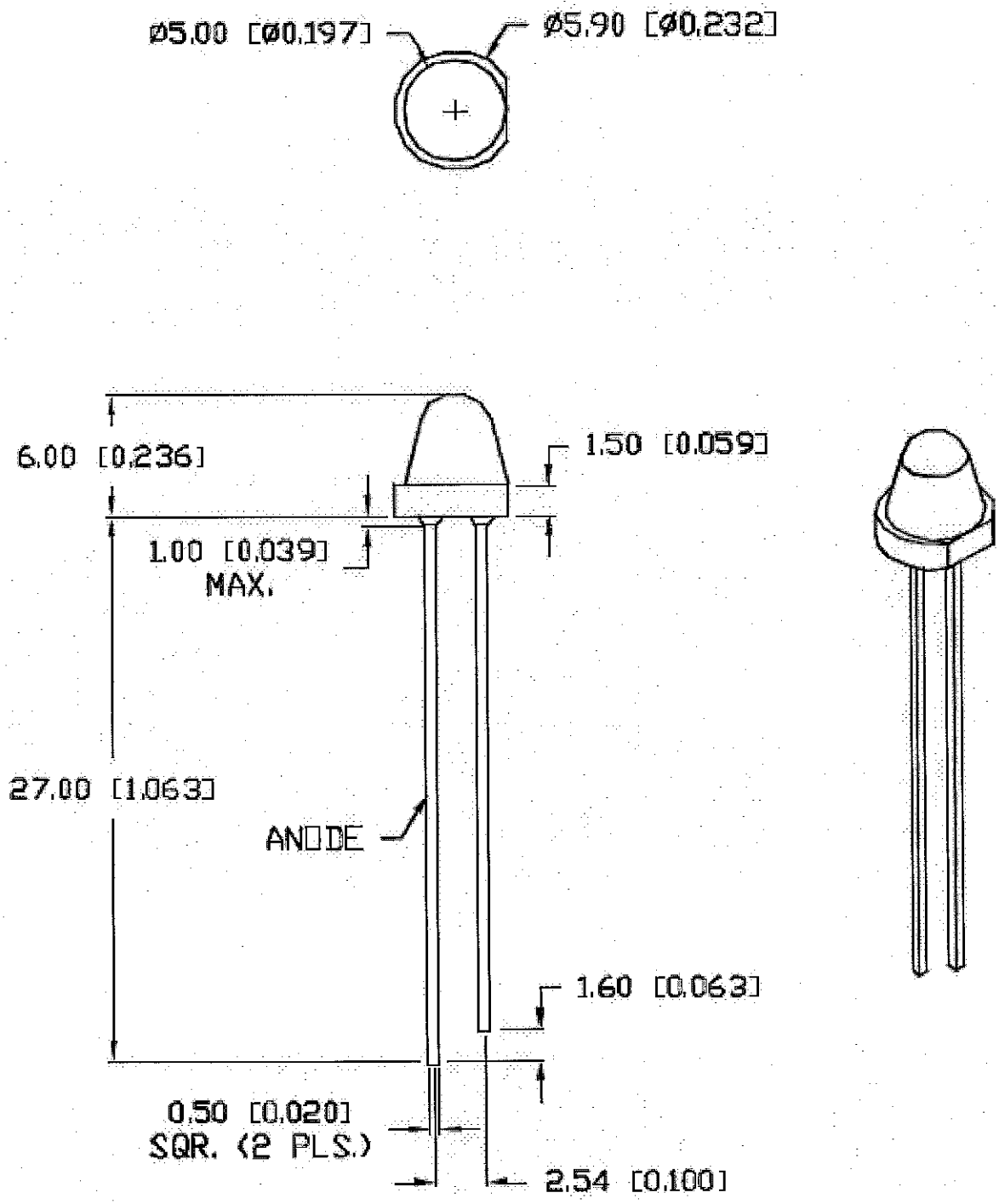
The Bright Red source color devices are made with Gallium Phosphide Red Light Emitting Diode.

Package Dimensions



Notes:
1. All dimensions are in millimeters (inches).
2. Tolerance is ±0.25(0.01") unless otherwise noted.
3. Lead spacing is measured where the leads emerge from the package.
4. Specifications are subject to change without notice.

LEDs


Ø5.00 [Ø0.197]
Ø5.90 [Ø0.232]
6.00 [0.236]
1.50 [0.059]
1.00 [0.039]
MAX.
27.00 [1.063]
ANODE
1.60 [0.063]
0.50 [0.020]
SQR. (2 PLS.)
2.54 [0.100]

National Semiconductor

August 2000

LM741
Operational Amplifier

General Description

The LM741 series are general purpose operational amplifiers which feature improved performance over industry standards like the LM709. They are direct, plug-in replacements for the 709C, LM201, MC1439 and 748 in most applications.

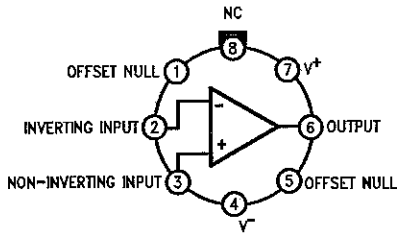
The amplifiers offer many features which make their application nearly foolproof: overload protection on the input and output, no latch-up when the common mode range is exceeded, as well as freedom from oscillations.

The LM741C is identical to the LM741/LM741A except that the LM741C has their performance guaranteed over a 0°C to +70°C temperature range, instead of −55°C to +125°C.

Features

Connection Diagrams

Metal Can Package

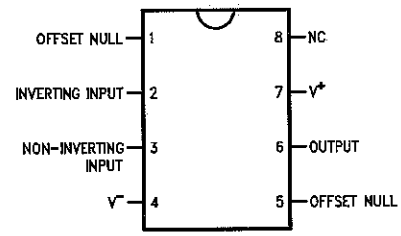


00934102

Note 1: LM741H is available per JM38510/10101

Order Number LM741H, LM741H/883 (Note 1), **LM741AH/883 or LM741CH**
See NS Package Number H08C

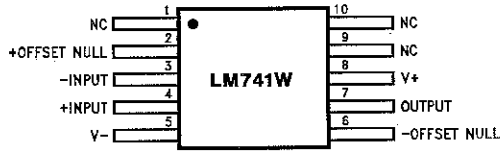
Dual-In-Line or S.O. Package



00934103

Order Number LM741J, LM741J/883, LM741CN
See NS Package Number J08A, M08A or N08E

Ceramic Flatpak

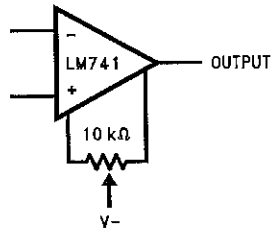


00934106

Order Number LM741W/883
See NS Package Number W10A

Typical Application

Offset Nulling Circuit



00934107

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Electrical Characteristics (Note 5) (Continued)

Note 3: For operation at elevated tamperatures, these devices must be derated based on thermal resistance, and T_j max. (listed under "Absolute Maximum Ratings"). $T_j = T_A + (\theta_{jA} P_D)$.

Thermal Resistance	Cerdip (J)	DIP (N)	HO8 (H)	SO-8 (M)
θ_{jA} (Junction to Ambient)	100°C/W	100°C/W	170°C/W	195°C/W
θ_{jC} (Junction to Case)	N/A	N/A	25°C/W	N/A

Note 4: For supply voltages less than ±15V, the absolute maximum input voltage is equal to the supply voltage.

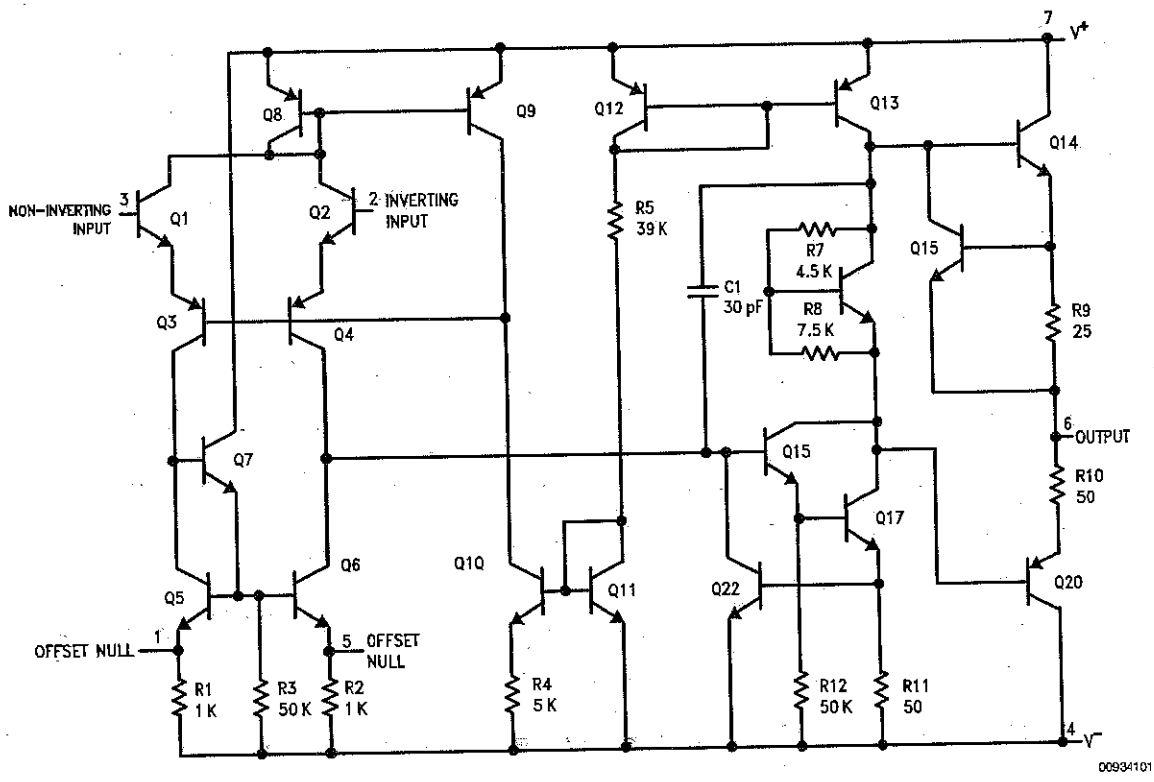
Note 5: Unless otherwise specified, these specifications apply for V_S = ±15V, −55°C ≤ T_A ≤ +125°C (LM741/LM741A). For the LM741C/LM741E, these specifications are limited to 0°C ≤ T_A ≤ +70°C.

Note 6: Calculated value from: BW (MHz) = 0.35/Rise Time(μs).

Note 7: For military specifications see RETS741X for LM741 and RETS741AX for LM741A.

Note 8: Human body model, 1.5 kΩ in series with 100 pF.

Schematic Diagram



NPN high-voltage transistors BF458; BF459

FEATURES

- Low current (max. 100 mA)
- High voltage (max. 300 V).

APPLICATIONS

- Intended for video output stages in black-and-white and in colour television receivers.

DESCRIPTION

NPN transistors in a TO-126; SOT32 plastic package.

PINNING

PIN	DESCRIPTION
1	emitter
2	collector, connected to mounting base
3	base

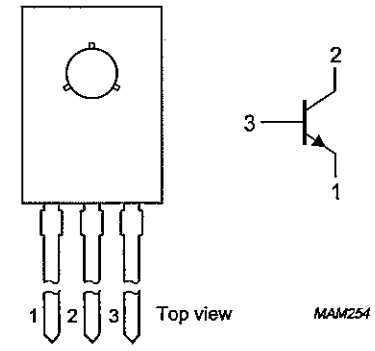


Fig.1 Simplified outline (TO-126; SOT32) and symbol.

LIMITING VALUES

In accordance with the Absolute Maximum Rating System (IEC 134).

SYMBOL	PARAMETER	CONDITIONS	MIN.	MAX.	UNIT
V_{CBO}	collector-base voltage	open emitter			
	BF458		–	250	V
	BF459		–	300	V
V_{CEO}	collector-emitter voltage	open base			
	BF458		–	250	V
	BF459		–	300	V
V_{EBO}	emitter-base voltage	open collector	–	5	V
I_C	collector current (DC)		–	100	mA
I_{CM}	peak collector current		–	300	mA
I_{BM}	peak base current		–	100	mA
P_{tot}	total power dissipation	$T_{mb} \leq 90$ °C	–	6	W
T_{stg}	storage temperature		–65	+150	°C
T_j	junction temperature		–	150	°C
T_{amb}	operating ambient temperature		–65	+150	°C

SGS-THOMSON MICROELECTRONICS

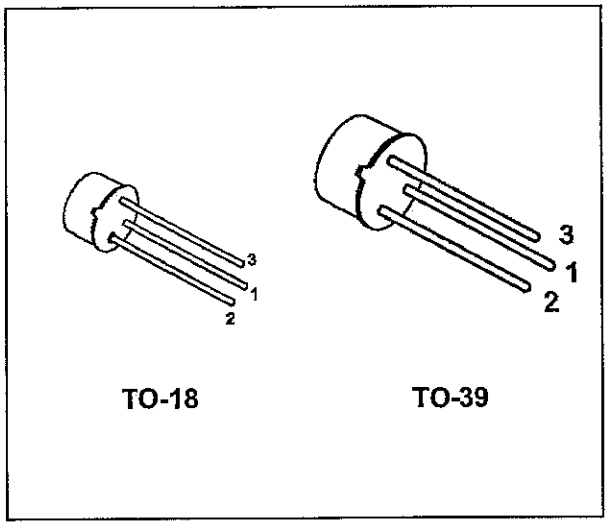
2N2219A 2N2222A

HIGH SPEED SWITCHES

DESCRIPTION

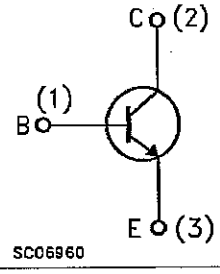
The 2N2219A and 2N2222A are silicon planar epitaxial NPN transistors in Jedec TO-39 (for 2N2219A) and in Jedec TO-18 (for 2N2222A) metal case. They are designed for high speed switching application at collector current up to 500mA, and feature useful current gain over a wide range of collector current, low leakage currents and low saturation voltage.

2N2219A approved to CECC 50002-100, 2N2222A approved to CECC 50002-101 available on request.



TO-18 TO-39

INTERNAL SCHEMATIC DIAGRAM



ABSOLUTE MAXIMUM RATINGS

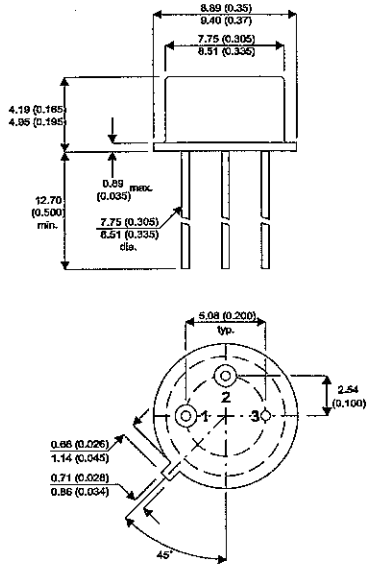
Symbol	Parameter	Value	Unit
V_{CBO}	Collector-Base Voltage (I_E = 0)	75	V
V_{CEO}	Collector-Emitter Voltage (I_B = 0)	40	V
V_{EBO}	Emitter-Base Voltage (I_C = 0)	6	V
I_C	Collector Current	0.8	A
P_{tot}	Total Dissipation at $T_{amb} \leq 25$ °C for **2N2219A** for **2N2222A** at $T_{case} \leq 25$ °C for **2N2219A** for **2N2222A**	 0.8 0.5 3 1.8	 W W W W
T_{stg}	Storage Temperature	-65 to 200	°C
T_j	Max. Operating Junction Temperature	175	°C

SEME LAB

2N3053

MECHANICAL DATA
Dimensions in mm (inches)

MEDIUM POWER SILICON NPN PLANAR TRANSISTOR



TO39 PACKAGE

Underside View

Pin 1 = Emitter Pin 2 = Base Pin 3 = Collector

FEATURES

- V_{CEO} = 40V
- I_C = 0.7A
- P_{tot} = 5W

ABSOLUTE MAXIMUM RATINGS (T_{case} = 25°C unless otherwise stated)

V_{CBO}	Collector – Base Voltage	60V
V_{CEO}	Collector – Emitter Voltage	40V
V_{CER}	Collector – Emitter Sustaining Voltage	50V
V_{CEX}	Collector - Emiiter Voltage	60V
V_{EBO}	Emitter-Base Voltage	5V
I_C	Collector Current	0.7A
P_{TOT}	Power Dissipation T_{amb} = 25°C	1W
	T_{case} = 25°C	5W
T_j	Junction Temperature	200°C
T_{stg}	Storage Temperature	–65 to 200°C
$R_{th(jc)}$	Thermal Resistance Junction to Case	35°C / W
$R_{th(ja)}$	Thermal Resistance Junction to Ambient	175°C / W

Data Sheet

Central™
Semiconductor Corp.
145 Adams Avenue, Hauppauge, NY 11788 USA
Tel: (631) 435-1110 • Fax: (631) 435-1824

Manufacturers of World Class Discrete Semiconductors

2N4248
2N4249
2N4250
2N4250A

SILICON PNP TRANSISTOR

JEDEC TO-106 CASE

DESCRIPTION

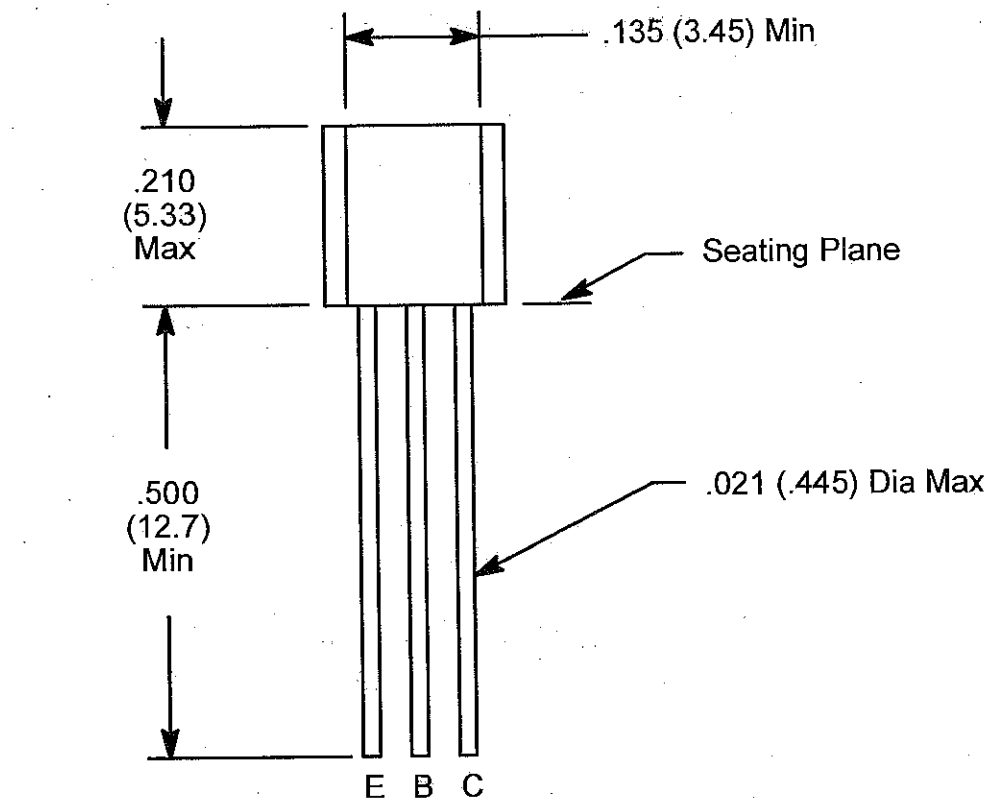
The CENTRAL SEMICONDUCTOR 2N4248 Series Types are Silicon PNP Transistors designed for low level - low noise amplifier applications.

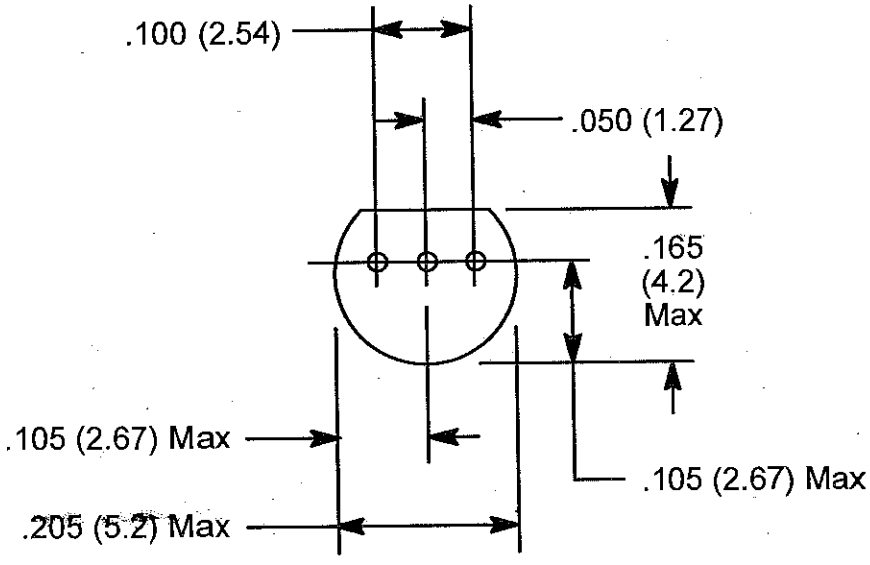
MAXIMUM RATINGS (T_A=25°C)

	SYMBOL	2N4248 2N4250	2N4249 2N4250A	UNIT
Collector-Base Voltage	V_{CBO}	40	60	V
Collector-Emitter Voltage	V_{CES}	40	60	V
Collector-Emitter Voltage	V_{CEO}	40	60	V
Emitter-Base Voltage	V_{EBO}	5.0	5.0	V
Power Dissipation	P_D	200	200	mW
Operating and Storage Junction Temperature	T_J, T_{stg}	-55 TO +150		°C

ELECTRICAL CHARACTERISTICS (T_A=25°C)

SYMBOL		2N4248 MIN	2N4248 MAX	2N4249 MIN	2N4249 MAX	2N4250 MIN	2N4250 MAX	2N4250A MIN	2N4250A MAX	UNIT
I_{CBO}	V_{CB}=40V (2N4250A V_{CB}=50V)		10		10		10		10	nA
I_{EBO}	V_{EB}=3.0V		20		20		20		20	nA
BV_{CBO}	I_C=10μA	40		60		40		60		V
BV_{CES}	I_C=10μA	40		60		40		60		V
BV_{CEO}	I_C=5.0mA	40		60		40		60		V
BV_{EBO}	I_E=10μA	5.0		5.0		5.0		5.0		V
$V_{CE(s)}$	I_C=10mA, I_B=0.5mA		0.25		0.25		0.25		0.25	V
$V_{BE(s)}$	I_C=10mA, I_B=0.5mA		0.9		0.9		0.9		0.9	V
h_{FE}	V_{CE}=5.0V, I_C=100μA	50		100	300	250	700	250	700	
h_{FE}	V_{CE}=5.0V, I_C=1.0mA	50		100		250		---		
h_{FE}	V_{CE}=5.0V, I_C=10mA	50		100		250		---		
f_T	V_{CE}=5.0V, I_C=0.5mA, f=20MHz	40		40		50		---		MHz
C_{ob}	V_{CB}=5.0V, f=1.0MHz		6.0		6.0		6.0		6.0	pF
C_{ib}	V_{EB}=0.5V, f=1.0MHz		16		16		16		---	pF
NF	Wide Band, V_{CE}=5.0V, I_C=20μA, Rs=100KΩ PBW=15.7kHz, f=10Hz TO 10kHz		---		3.0		2.0		2.0	dB
NF	Narrow Band, V_{CE}=5.0V, I_C=20μA, Rs=10KΩ PBW=150Hz, f=1.0kHz		---		3.0		2.0		2.0	dB


.135 (3.45) Min
.210
(5.33)
Max
Seating Plane
.500
(12.7)
Min
.021 (.445) Dia Max
E B C


.100 (2.54)
.050 (1.27)
.165
(4.2)
Max
.105 (2.67) Max
.205 (5.2) Max
.105 (2.67) Max

n-channel JFETs *designed for . . .*

Siliconix

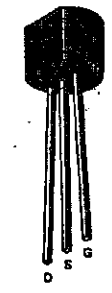
Performance Curves NC
See Section 5

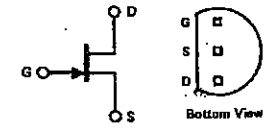
- **Analog Switches**
- **Commutators**
- **Choppers**

BENEFITS

- Low Cost
- Industry Standard Package
- Automatic Insertion Package
- Fast Switching
  $t_{rise} < 5$ ns (2N5638)
- Low Insertion Loss
  $R_{DS(on)} < 30\ \Omega$ (2N5638)
- Short Sample and Hold Aperture Time
  $C_{rss} < 4$ pF

TO-92
See Section 7





*ABSOLUTE MAXIMUM RATINGS (25°C)

Drain-Source Breakdown Voltage	30 V
Drain-Gate Breakdown Voltage	30 V
Source-Gate Breakdown Voltage	30 V
Forward Gate Current	10 mA
Total Device Dissipation at T_{LEAD} = 25°C	625 mW
Derate above 25°C	5.68 mW/°C
Operating Junction Temperature Range	-65 to +135°C
Storage Temperature Range	-65 to +150°C
Lead Temperature (1/16" from case for 10 seconds)	300°C

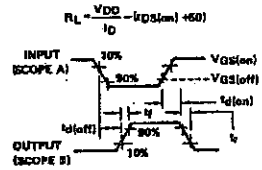
*ELECTRICAL CHARACTERISTICS (25°C unless otherwise noted)

		Characteristic		2N5638		2N5639		2N5640		Unit	Test Conditions	
				Min	Max	Min	Max	Min	Max			
1	STATIC	BV_{GSS}	Gate-Source Breakdown Voltage	-30		-30		-30		V	$I_G = -10\ \mu A$, $V_{DS} = 0$	
2		I_{GSS}	Gate Reverse Current		-1.0		-1.0		-1.0	nA	$V_{GS} = -15$ V, $V_{DS} = 0$	
3					-1.0		-1.0		-1.0	μA		T_A = +100°C
4		$I_{D(off)}$	Drain Cutoff Current		1.0		1.0		1.0	nA	$V_{DS} = 15$ V, $V_{GS} = -12$ V (2N5638)	
5					1.0		1.0		1.0	μA	$V_{GS} = -8$ V (2N5639), $V_{GS} = -6$ V (2N5640)	T_A = +100°C
6		I_{DSS}	Saturation Drain Current	50		25		5.0		mA	$V_{DS} = 20$ V, $V_{GS} = 0$ (Note 1)	
7		$V_{DS(on)}$	Drain-Source ON Voltage		0.5		0.5		0.5	V	$V_{GS} = 0$, $I_D = 12$ mA (2N5638), $I_D = 6$ mA (2N5639), $I_D = 3$ mA (2N5640)	
8		$r_{DS(on)}$	Static Drain-Source ON Resistance		30		60		100	Ω	$I_D = 1$ mA, $V_{GS} = 0$	
9		$r_{ds(on)}$	Drain-Source ON Resistance		30		60		100	Ω	$V_{GS} = 0$, $I_D = 0$	f = 1 kHz
10	DYN	C_{iss}	Common-Source Input Capacitance		10		10		10	pF	$V_{GS} = -12$ V, $V_{DS} = 0$	f = 1 MHz
11		C_{rss}	Common-Source Reverse Transfer Capacitance		4.0		4.0		4.0	pF		
12	SW	$t_{d(on)}$	Turn-On Delay Time		4.0		6.0		8.0	nsec	$V_{DD} = 10$ V, $V_{GS(on)} = 0$, $V_{GS(off)} = -10$ V	$I_{D(on)} = 12$ mA (2N5638), $R_L = 800\ \Omega$ (2N5638)
13		t_r	Rise Time		5.0		8.0		10	nsec		$I_{D(on)} = 6$ mA (2N5639), $R_L = 1.6$k Ω (2N5639)
14		$t_{d(off)}$	Turn-OFF Delay Time		5.0		10		15	nsec		$I_{D(on)} = 3$ mA (2N5640), $R_L = 3.2$k Ω (2N5640)
15		t_f	Fall Time		10		20		30	nsec		

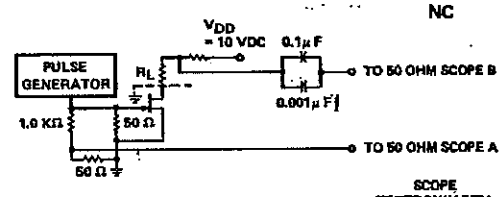
* JEDEC registered data

NOTE:

1 Pulse test PW ≤ 300 μsec, duty cycle ≤ 3.0%



NC



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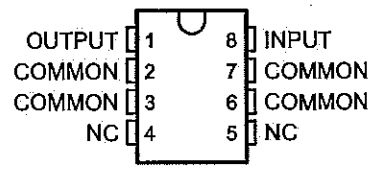
SLVS010P – JANUARY 1976 – REVISED JUNE 2002

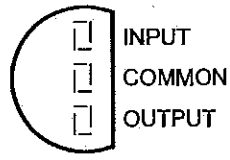
- **3-Terminal Regulators**
- **Output Current up to 100 mA**
- **No External Components**
- **Internal Thermal-Overload Protection**
- **Internal Short-Circuit Current Limiting**
- **Direct Replacements for Fairchild μA78L00 Series**

D PACKAGE
(TOP VIEW)



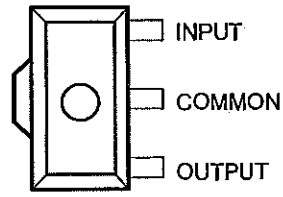
NC – No internal connection

LP PACKAGE
(TOP VIEW)



TO–226AA

PK PACKAGE
(TOP VIEW)



The center lead is in electrical contact with the tab.

description

This series of fixed-voltage integrated-circuit voltage regulators is designed for a wide range of applications. These applications include on-card regulation for elimination of noise and distribution problems associated with single-point regulation. In addition, they can be used with power-pass elements to make high-current voltage regulators. One of these regulators can deliver up to 100 mA of output current. The internal limiting and thermal-shutdown features of these regulators essentially make them immune to overload. When used as a replacement for a zener diode-resistor combination, an effective improvement in output impedance can be obtained, together with lower bias current.

The μA78L00C and μA78L00AC series are characterized for operation over the virtual junction temperature range of 0°C to 125°C. The μA78L05AI is characterized for operation over the virtual junction temperature range of –40°C to 125°C.

Please be aware that an important notice concerning availability, standard warranty, and use in critical applications of Texas Instruments semiconductor products and disclaimers thereto appears at the end of this data sheet.

PRODUCTION DATA information is current as of publication date. Products conform to specifications per the terms of Texas Instruments standard warranty. Production processing does not necessarily include testing of all parameters.

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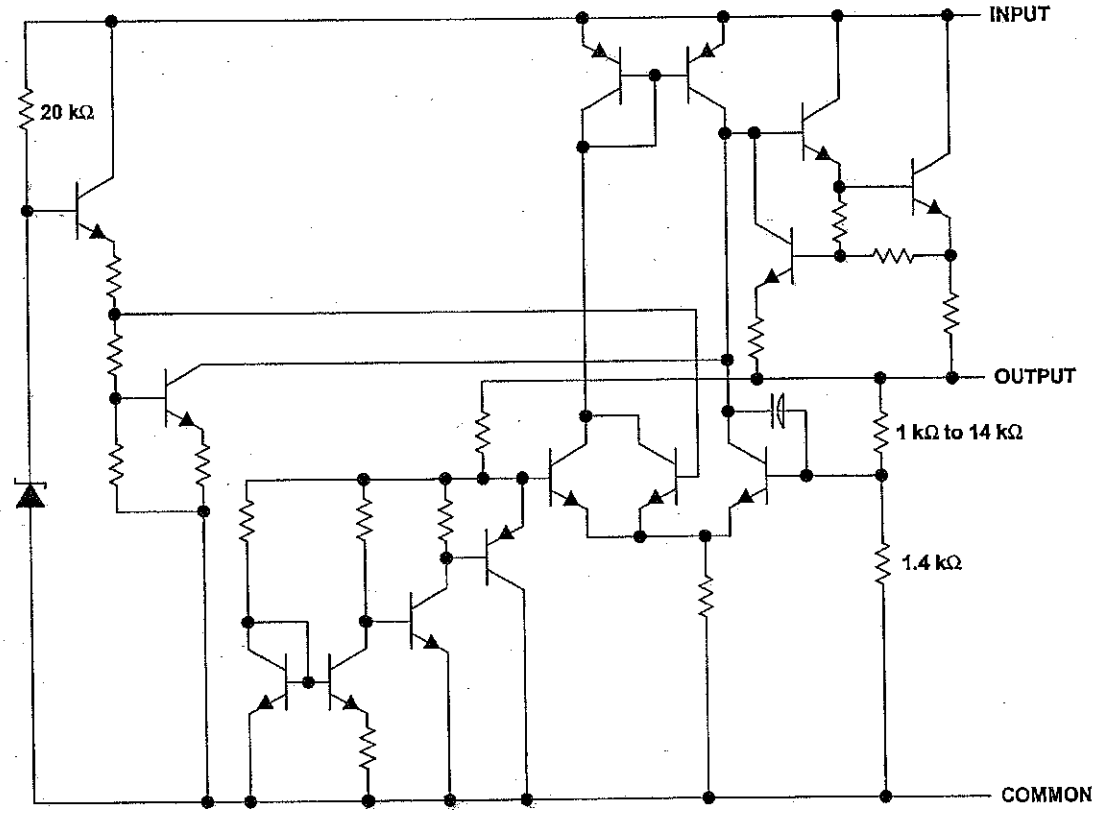
AVAILABLE OPTIONS

T_J	$V_{O(NOM)}$ (V)	PACKAGE					
		SMALL OUTLINE (D)		PLASTIC CYLINDRICAL (LP)		SOT-89 (PK)	
		OUTPUT VOLTAGE TOLERANCE					
		5%	10%	5%	10%	5%	10%
0°C to 125°C	2.6	μA78L02ACD	–	μA78L02ACLP	–	–	–
	5	μA78L05ACD	μA78L05CD	μA78L05ACLP	μA78L05CLP	μA78L05ACPK	μA78L05CPK
	6.2	–	–	μA78L06ACLP	–	μA78L06ACPK	–
	8	μA78L08ACD	μA78L08CD	μA78L08ACLP	–	μA78L08ACPK	μA78L08CPK
	9	μA78L09ACD	–	μA78L09ACLP	μA78L09CLP	μA78L09ACPK	–
	10	μA78L10ACD	–	μA78L10ACLP	–	μA78L10ACPK	–
	12	μA78L12ACD	–	μA78L12ACLP	–	μA78L12ACPK	–
	15	μA78L15ACD	–	μA78L15ACLP	–	μA78L15ACPK	–
–40°C to 125°C	5	–	–	μA78L05AILP	–	–	–

D and LP packages are available taped and reeled. Add the suffix R to the device type (e.g., μA78L05ACDR). The PK package is only available taped and reeled (do not add the suffix R to the device type).

schematic



NOTE A: Resistor values shown are nominal.

absolute maximum ratings over virtual junction temperature range (unless otherwise noted)†

Input voltage, V_I: μA78L02AC, μA78L05C–μA78L09C, μA78L10AC ..... 30 V
μA78L12C, μA78L12AC, μA78L15C, μA78L15AC ..... 35 V
Package thermal impedance, θ_{JA} (see Notes 1 and 2): D package ..... 97°C/W
LP package ..... 156°C/W
PK package ..... 52°C/W
Virtual junction temperature, T_J ..... 150°C
Lead temperature 1,6 mm (1/16 inch) from case for 10 seconds ..... 260°C
Storage temperature range, T_{stg} ..... –65°C to 150°C

† Stresses beyond those listed under "absolute maximum ratings" may cause permanent damage to the device. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those indicated under "recommended operating conditions" is not implied. Exposure to absolute-maximum-rated conditions for extended periods may affect device reliability.

NOTES: 1. Maximum power dissipation is a function of $T_J(max)$, θ_{JA}, and T_A. The maximum allowable power dissipation at any allowable ambient temperature is $P_D = (T_J(max) - T_A)/\theta_{JA}$. Operating at the absolute maximum T_J of 150°C can affect reliability. Due to variations in individual device electrical characteristics and thermal resistance, the built-in thermal-overload protection may be activated at power levels slightly above or below the rated dissipation.
2. The package thermal impedance is calculated in accordance with JESD 51-7.

recommended operating conditions

			MIN	MAX	UNIT
V_I	Input voltage	μA78L02AC	4.75	20	V
		μA78L05C, μA78L05AC	7	20	
		μA78L06C, μA78L06AC	8.5	20	
		μA78L08C, μA78L08AC	10.5	23	
		μA78L09C, μA78L09AC	11.5	24	
		μA78L10AC	12.5	25	
		μA78L12C, μA78L12AC	14.5	27	
		μA78L15C, μA78L15AC	17.5	30	
I_O	Output current			100	mA
T_J	Operating virtual junction temperature range	μA78LxxC and μA78LxxAC series	0	125	°C
		μA78L05AI	–40	125	

LM350

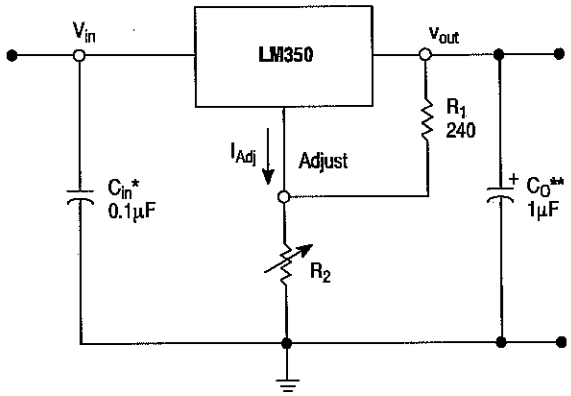
3.0 A, Adjustable Output, Positive Voltage Regulator

The LM350 is an adjustable three−terminal positive voltage regulator capable of supplying in excess of 3.0 A over an output voltage range of 1.2 V to 33 V. This voltage regulator is exceptionally easy to use and requires only two external resistors to set the output voltage. Further, it employs internal current limiting, thermal shutdown and safe area compensation, making it essentially blow−out proof.

The LM350 serves a wide variety of applications including local, on card regulation. This device also makes an especially simple adjustable switching regulator, a programmable output regulator, or by connecting a fixed resistor between the adjustment and output, the LM350 can be used as a precision current regulator.

Features

- Guaranteed 3.0 A Output Current
- Output Adjustable between 1.2 V and 33 V
- Load Regulation Typically 0.1%
- Line Regulation Typically 0.005%/V
- Internal Thermal Overload Protection
- Internal Short Circuit Current Limiting Constant with Temperature
- Output Transistor Safe Area Compensation
- Floating Operation for High Voltage Applications
- Standard 3−lead Transistor Package
- Eliminates Stocking Many Fixed Voltages
- Pb−Free Packages are Available*



* = C_{in} is required if regulator is located an appreciable distance from power supply filter.
** = C_O is not needed for stability, however, it does improve transient response.

$$V_{out} = 1.25\ V\left(1 \le \frac{R_2}{R_1}\right) \le I_{Adj} R_2$$

Since I_{Adj} is controlled to less than 100 μA, the error associated with this term is negligible in most applications.

Figure 1. Simplified Application

*For additional information on our Pb−Free strategy and soldering details, please download the ON Semiconductor Soldering and Mounting Techniques Reference Manual, SOLDERRM/D.

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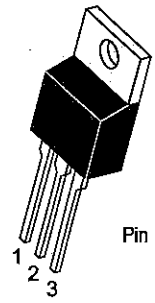
THREE−TERMINAL ADJUSTABLE POSITIVE VOLTAGE REGULATOR

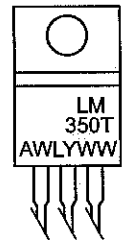


TO−220
T SUFFIX
PLASTIC PACKAGE
CASE 221A

Pin 1. Adjust
2. V_{out}
3. V_{in}

Heatsink surface is connected to Pin 2.

MARKING DIAGRAM



A = Assembly Location
WL = Wafer Lot
Y = Year
WW = Work Week

ORDERING INFORMATION

See detailed ordering and shipping information in the package dimensions section on page 3 of this data sheet.

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MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Input–Output Voltage Differential	V_I–V_O	35	Vdc
Power Dissipation	P_D	Internally Limited	W
Operating Junction Temperature Range	T_J	−40 to +125	°C
Storage Temperature Range	T_{stg}	−65 to +150	°C
Soldering Lead Temperature (10 seconds)	T_{solder}	300	°C

Maximum ratings are those values beyond which device damage can occur. Maximum ratings applied to the device are individual stress limit values (not normal operating conditions) and are not valid simultaneously. If these limits are exceeded, device functional operation is not implied, damage may occur and reliability may be affected.

ELECTRICAL CHARACTERISTICS (V_I–V_O = 5.0 V; I_L = 1.5 A; T_J = T_{low} to T_{high}; P_{max} [Note 1], unless otherwise noted.)

Characteristics	Figure	Symbol	Min	Typ	Max	Unit
Line Regulation (Note 2) T_A = 25°C, 3.0 V ≤ V_I–V_O ≤ 35 V	1	Reg_{line}	–	0.0005	0.03	%/V
Load Regulation (Note 2) T_A = 25°C, 10 mA ≤ I_I ≤ 3.0 A V_O ≤ 5.0 V V_O ≥ 5.0 V	2	Reg_{load}	 – –	 5.0 0.1	 25 0.5	 mV % V_O
Thermal Regulation, Pulse = 20 ms, (T_A = +25°C)		Reg_{therm}	–	0.002	–	% V_O/W
Adjustment Pin Current	3	I_{Adj}	–	50	100	μA
Adjustment Pin Current Change 3.0 V ≤ V_I–V_O ≤ 35 V 10 mA ≤ I_L ≤ 3.0 A, P_D ≤ P_{max}	1,2	ΔI_{Adj}	–	0.2	5.0	μA
Reference Voltage 3.0 V ≤ V_I–V_O ≤ 35 V 10 mA ≤ I_O ≤ 3.0 A, P_D ≤ P_{max}	3	V_{ref}	1.20	1.25	1.30	V
Line Regulation (Note 2) 3.0 V ≤ V_I–V_O ≤ 35 V	1	Reg_{line}	–	0.02	0.07	%/V
Load Regulation (Note 2) 10 mA ≤ I_L ≤ 3.0 A V_O ≤ 5.0 V V_O ≥ 5.0 V	2	Reg_{load}	 – –	 20 0.3	 70 1.5	 mV % V_O
Temperature Stability (T_{low} ≤ T_J ≤ T_{high})	3	T_S	–	1.0	–	% V_O
Minimum Load Current to Maintain Regulation (V_I–V_O = 35 V)	3	I_{Lmin}	–	3.5	10	mA
Maximum Output Current V_I–V_O ≤ 10 V, P_D ≤ P_{max} V_I–V_O = 30 V, P_D ≤ P_{max}, T_A = 25°C	3	I_{max}	 3.0 0.25	 4.5 1.0	 – –	A
RMS Noise, % of V_O T_A = 25°C, 10 Hz ≤ f ≤ 10 kHz		N	–	0.003	–	% V_O
Ripple Rejection, V_O = 10 V, f = 120 Hz (Note 3) Without C_{Adj} C_{Adj} = 10 μF	4	RR	 – 66	 65 80	 – –	dB
Long Term Stability, T_J = T_{high} (Note 4) T_A = 25°C for Endpoint Measurements	3	S	–	0.3	1.0	%/1.0 k Hrs.
Thermal Resistance, Junction–to–Case Peak (Note 5) Average (Note 6)		$R_{\theta JC}$	 – –	 2.3 –	 – 1.5	°C/W

1. T_{low} to T_{high} = 0° to +125°C; P_{max} = 25 W for LM350T; T_{low} to T_{high} = −40° to +125°C; P_{max} = 25 W for LM350BT
2. Load and line regulation are specified at constant junction temperature. Changes in V_O due to heating effects must be taken into account separately. Pulse testing with low duty cycle is used.
3. C_{Adj}, when used, is connected between the adjustment pin and ground.
4. Since Long–Term Stability cannot be measured on each device before shipment, this specification is an engineering estimate of average stability from lot to lot.
5. Thermal Resistance evaluated measuring the hottest temperature on the die using an infrared scanner. This method of evaluation yields very accurate thermal resistance values which are conservative when compared to the other measurement techniques.
6. The average die temperature is used to derive the value of thermal resistance junction to case (average).

SkillsUSA
2010 Contest Projects

Firefighting

Click the “Print this Section” button above to automatically print the specifications for this contest. Make sure your printer is turned on before pressing the button.

SkillsUSA

Fire Fighting 2010

Orientation Packet

Fire Fighting

Purpose
To evaluate each contestant's preparation for employment and to recognize outstanding students for excellence and professionalism in the field of fire fighting.

Clothing Requirements
Official SkillsUSA light blue work shirt and navy pants and black leather work shoes. To purchase official work clothes, contact Midwest Trophy Manufacturing Co. Inc. by calling 1-800-324-5996 or you can order online at www.mtmrecognition.com/skillsusa

Eligibility
Open to active SkillsUSA members enrolled in technical and career technology programs with Protective Services/Firefighting as part of the curriculum and occupational objective.

Equipment and Materials
1. Provided by the Technical Committee
    a. All ladders, hose, hand tools, ropes, training tower/facility.
    b. All necessary information and materials for the judges.

2. Supplied by the Contestant
    a. Full Personal Protective Equipment: to include Helmet w/face-shield and chin strap, Bunker Coat and Pant w/liners, Standard Fire Boots (w/ steel toe/shank/shin guard), Nomex Hood, Fire Gloves, and Sneakers.
    b. Pen and/or Pencil for written test.

Scope of the Contest
1. Each individual student represents one state association. Contestants will demonstrate their ability to perform skills selected from the CPAT and Firefighter I Skill Station Menu NFPA 1001-2002 Edition.

2. The skills selected will consist of the following: for two events the Competitor will compete in full NFPA approved turnout gear including coat, pants, helmet (with skull cap), firefighting gloves, leather or rubber (steel toe/shank/shin guard) boots and nomex hood. All department/school names must be removed/covered prior to the competition.

    a. Donning of Structural PPE
    b. Ropes and Knots (without gloves)

3. For the following CPAT portion, the contestants will wear long pants and sneakers (not black leather work shoes). These are required for the CPAT remaining eight events of the competition.
    a. Stairmaster Event

b. Hose Drag Event
c. Equipment Carry Event
d. Ladder Raise Event
e. Forcible Entry Event
f. Search Event
g. Rescue Event
h. Breach and Pull Event

SkillsUSA
Firefighting Contest
Sponsor Listing

Conrad Fire Equipment, Inc.
887 N. Jan-Mar Court
Olathe, KS 66061
(Fire Helmets)

Mr. Paul Schultz

Channel Lock, Inc.
1306 South Main Street
Meadville, PA 16335
(Rescue Tool & T Shirts)

Mr. Mark Yoder

Newell Rubbermaid Irwin
9829 Northcross Center Court
Huntersville, NC 28078
(Misc Tools)

Ms. R. Michelle Efird

Union Shop Apparel
7400 E. 12th Street
Kansas City, MO 64126
(Flashlights)

Mr. Robert Palmer

SkillsUSA

Fire Fighting 2010

Scoring Packet

SkillsUSA CHAMPIONSHIPS

CONTEST SCORING CRITERIA

Contest - Fire Fighting

Chair – Michele Newby

Skill Description	Maximum Points
1.Donning Structural PPE Ensemble	25
2.Ropes and Knots	50
3.Stairmaster Event	85
4.Hose Drag Event	85
5.Equipment Carry Event	85
6.Ladder Raise Event	85
7.Forcible Entry Event	85
8.Search Event	85
9.Rescue Event	85
10.Breach and Pull Event	85
11.CPAT Time	70
12.	
13.	
14.	
15.	
16.	
17.	
18.	
19.	
20.	
21.	
22.Oral Professional Assessment	25
23.Written Test	150
24	
Résumé submitted? No O (5% penalty)	

Tie Breakers
1. SkillsUSA Professional Development Program Test
2.
3.

Contestant Number_____

SkillsUSA Fire Fighting Skills Competition

Donning Structural PPE Ensemble station worth 25 points (60 sec)

Ropes and Knots station worth 50 points (30 sec each knot)

All stations of the CPAT are worth 85 points each with the CPAT time worth 70 points.

1. There will be a 1 point deduction for any and every warning given.

2. There will be a 2 point deduction for any and every safety infraction occurrence.

3. A 50 lb. vest will be worn through all CPAT events. (Post Secondary will be required to wear an additional 25 lbs. for the Stairmaster event).

4. Any incomplete event except for the Stairmaster event will be an automatic 85 point deduction for that particular event.

5. Proctor instructions will be read from the official course booklet supplied by the CPAT program with the addition of the modifications made for this particular course.

6. The format listed below will be for scoring only.

1. **Donning Structural PPE Ensemble**

Safety infractions: 2 point deduction for each infraction

1. Head __ __ __ __ __
2. Collar __ __ __ __ __
3. Chin Strap __ __ __ __ __
4. Bunker Gear __ __ __ __ __

5 point deduction for over the 60 second time limit __

Donning PPE Score _____ (25 point max)

2. **Ropes and Knots (PPE – No Gloves)**

1. Perform a figure eight (8) within 30 second time limit. Pass or Fail (25 points)

5 point deduction for over the 30 sec time limit __

2. Perform one of the following within 30 second time limit: Pass or Fail (25 points)
   a. Hoisting of an axe
   b. Hoisting of a pike pole

5 point deduction for over the 30 sec time limit __

Ropes and Knots Score_____(50 point max)

Events 3-10 Modified CPAT

3. Stairmaster Event:

There will be a 20 second period at a rate of 50 steps per minute followed by a 3 minute period at a rate of 60 steps per minute for a total of 3:20 on the Stairmaster. Secondary will only wear 50 lb vest and Post Secondary will wear the vest with additional 25 lbs.

Warnings: 1 point deduction for each infraction

1. Grasping the handrail __ __ __ __ __
2. Stepping off of the Stairmaster __ __ __ __ __

Safety infractions: 2 point deduction for each infraction

1. Slipping from the Stairmaster __ __ __ __ __
2. Removal of any PPE __ __ __ __ __

The following points will also be deducted from the Stairmaster event if the full time is not completed:

Time on the Stairmaster	
0-29 seconds	-20 __
30-59 seconds	-15 __
60-89 seconds	-10 __
90-119 seconds	-7 __
120-149 seconds	-5 __
150-179 seconds	-3 __

Subtract all warnings/safety and/or time deductions from the total possible points (85) for a final score on the Stairmaster event.

Stairmaster Score _____ (85 max)

4. **Hose Drag Event:**

Warnings: 1 point deduction for each infraction

1. Stepping outside marked boundaries __ __ __

Safety infractions: 2 point deduction for each infraction

1. Slipping and falling __ __ __
2. Removal of any PPE __ __ __

Hose Drag Score _____

5. **Equipment Carry Event:**

Warnings: 1 point deduction for each infraction

1. Stepping outside marked boundaries __ __ __

Safety infractions: 2 point deduction for each infraction

1. Dropping either or both saws __ __ __
2. Slipping and falling __ __ __

Equipment Carry Score _____

6. **Ladder Raise Event:**

Warnings: 1 point deduction for each infraction

1. Missing a rung __ __ __

Safety infractions: 2 point deduction for each infraction

1. Losing control of or dropping the ladder __ __ __
2. Removal of any PPE __ __ __

Ladder Raise Score _____

7. **Forcible Entry Event:**

Warnings: 1 point deduction for each infraction

1. Stepping outside the marked boundaries __ __ __

Safety infractions: 2 point deduction for each infraction

1. Losing control of the sledge hammer __ __ __
2. Removal of any PPE __ __ __

Forcible Entry Score _____

8. **Search Event:**

Warnings: 1 point deduction for each infraction

1. Disorientation/exiting from the entrance __ __ __

Safety infractions: 2 point deduction for each infraction

1. Slipping and falling __ __ __
2. Removal of any PPE __ __ __

Search Event Score _____

9. **Rescue Event:**

Secondary will only drag the dummy down one way and Post Secondary will drag the dummy down and back.

Warnings: 1 point deduction for each infraction

1. Grasping the barrel __ __ __

Safety infractions: 2 point deduction for each infraction

1. Slipping and falling __ __ __

Rescue Event Score _____

10. **Breach and Pull Event:**

Secondary will only complete 2 sets and Post Secondary will complete 4 Sets.

Warnings: 1 point deduction for each infraction

1. Stepping outside of marked boundaries __ __ __

Safety infractions: 2 point deduction for each infraction

1. Dropping the pike pole __ __ __
2. Slipping and falling __ __ __

Breach and Pull Event Score _____

Total Score From All 10 Events _____

SKILLS USA CPAT TIMES

00.00 – 10:20	70 PTS
10:21 – 10:40	65 PTS
10:41 – 11:00	60 PTS
11:01 - 11:20	55 PTS
11:21 - 11:40	50 PTS
11:41 - 12:00	45 PTS
12:01 - 13:00	40 PTS
13:01 – 14:00	35 PTS
14:01 - 15:00	30 PTS
15:01 +	25 PTS

Candidate Number_____

FIRE FIGHTING ORAL PROFESSIONAL ASSESSMENT

1. Candidate walks in and greets the interviewer.
   Candidate should smile
   Give firm but polite handshake
   Look the interviewer in the eye

   1 pt Poor
   3 pts Good
   5 pts Excellent

2. Please take a few minutes to tell me about yourself.
   Candidate should attempt to grab your interest within first 30 seconds.
   Opening should not be more than 1-1 ½ minutes.

   1 pt Poor
   3 pts Good
   5 pts Excellent

3. Tell me why you want to be a fire fighter.
   This is a great opportunity for the candidate to show his/her enthusiasm and excitement for the position.
   Candidate should personalize his/her response. (Use personal experience.)

   1 pt Poor
   3 pts Good
   5 pts Excellent

4. Tell me what you think are the most important character traits a fire fighter should possess and why.
   Should include honesty, teamwork, morals, ethics, service to community reliability, etc.

   1 pt Poor
   3 pts Good
   5 pts Excellent

5. We have no more questions for you. However, you may take a couple minutes to ask any questions or to add anything you would like me to consider.
   The candidate should take this opportunity to close the deal! He/she should show excitement, enthusiasm and attempt to convince you to hire them.

   1 pt Poor
   3 pts Good
   5 pts Excellent

Total _____ (25 pts max)

SkillsUSA

Fire Fighting 2010

Written Exam

Exam #1

Name_____

MULTIPLE CHOICE. Choose the one alternative that best completes the statement or answers the question.

1) The self-contained breathing apparatus (SCBA): 1) _____
A) protects the wearer's ears from airborne particles.
B) protects the head from impact.
C) provides an audible means by which a lost, trapped, or incapacitated firefighter can be located.
D) protects the face and lungs from toxic smoke and products of combustion.

2) Which of the following is MOST important to the secondary search? 2) _____
A) Threats B) Speed C) Thoroughness D) Exposures

3) Which of the following is NOT a condition under which an emergency move may be necessary? 3) _____
A) There is fire in the distance.
B) It is impossible to protect the accident scene.
C) Explosives are involved.
D) The victim is in cardiac arrest and must be moved so rescuers can administer CPR.

4) Which of the following conditions make a building susceptible to collapse? 4) _____
A) Age of the building B) Atmospheric conditions
C) Height of the building D) Wooden floors and ceilings

5) Which of the following is NOT a life-safety reason for fireground ventilation? 5) _____
A) It expedites search and rescue operations.
B) It reduces damage caused by water.
C) It provides an escape path for the steam when water is vaporized.
D) It reduces interior temperature.

6) Which of the following statements about executing a primary search is MOST accurate? 6) _____
A) Start the search in the middle of each room.
B) Start the search as far away from the fire as possible.
C) Start the search as close to the fire as possible.
D) Do not search closets, shower stalls, or bathrooms.

7) When searching a hallway with only one team, which of the following actions should members of a search team take? 7) _____
A) Wait for a second search team to arrive.
B) Split up and take both sides of the hallway.
C) Search down one side of the hallway and back up the other side.
D) Alternate both sides of the hallway to search the entire hallway in one pass.

8) Which of the following is the most common building material used in North America and is the main component of a variety of structural assemblies? 8) _____
A) Reinforced concrete B) Wood
C) Masonry D) Cast iron

9) Which of the following classifications of fires involve combustible metals such as aluminum, magnesium, potassium, sodium, titanium, and zirconium? 9) _____

A) Class A fires B) Class B fires C) Class C fires D) Class D fires

10) Cross members that provide the foothold for climbing are: 10) _____

A) rungs. B) pawls. C) stops. D) rails.

11) Unprotected lightweight steel and wooden trusses will fail after _____ minutes of exposure to fire. 11) _____

A) 1 to 5 B) 5 to 10 C) 15 to 20 D) 10 to 15

12) If backdraft conditions are apparent, attempt entry: 12) _____

A) before beginning ventilation. B) immediately.
C) only after ventilation is complete. D) after ventilation has started.

13) Which of the following is the primary oxidizing agent in most fires? 13) _____

A) Carbon monoxide B) Methane
C) Oxygen D) Carbon dioxide

14) If fire is encountered during a search, close the door, report the condition, and: 14) _____

A) wait for all team members to arrive. B) begin fire suppression activities.
C) exit the area immediately. D) be guided by your supervisor's orders.

15) Which of the following is NOT an element of the fire tetrahedron? 15) _____

A) Oxygen B) Self-sustained chemical reaction
C) Fuel D) Fire inhibitor

16) The critical temperature at which steel trusses can fail from exposure to heat alone without any flames is: 16) _____

A) 500°F (260°C). B) 750°F (399°C). C) 1,000°F (538°C). D) 1,250°F (677°C).

17) During the _____ search, be sure to check the known or likely locations of victims as quickly as conditions allow. 17) _____

A) primary B) tertiary
C) secondary D) rapid intervention

18) Which of the following steps should be done immediately after a firefighter realizes he or she is in imminent life-threatening danger? 18) _____

A) Transmit Mayday! according to local protocol.
B) Describe location as clearly as possible.
C) Communicate air supply status to Command.
D) Stay in contact with Command and keep them informed of the situation.

19) Which of the following classifications of fires involve flammable and combustible liquids and gases such as gasoline, oil, lacquer, paint, mineral spirits, and alcohol? 19) _____

A) Class A fires B) Class B fires C) Class C fires D) Class K fires

20) If heated, _____ may crack and shatter when it is struck by a cold fire stream. 20) _____

A) gypsum B) steel
C) reinforced concrete D) glass

21) In thermal layering, the hottest gases tend to be: 21) _____
A) in the lower layers.
B) in the top layer.
C) in the neutral plane.
D) in both the top and lower layers.

22) Which of the following modes of combustion occurs when solid fuels undergo oxidation at the surface of the fuel? 22) _____
A) Nonflaming or smoldering combustion
B) Standard combustion
C) Flaming combustion
D) Linear combustion

23) Which of the following is an indicator of building collapse? 23) _____
A) Height of the building
B) Structural members falling from building
C) Unusual creaks and cracking noises
D) Flames breaking through roof covering

24) Which of the following is the first step to breaching an interior wall? 24) _____
A) Create an opening large enough to pass through.
B) Feel it for heat.
C) Remove sections on both sides of a stud as well as the stud itself.
D) Do not remove any studs, as that may compromise the integrity of the structure.

25) Which of the following is a rapid but thorough search that is performed either before or during fire suppression operations? 25) _____
A) Primary search
B) Rapid intervention
C) Secondary search
D) Tertiary search

26) Which of the following methods of controlling and extinguishing a fire uses water for the extinguishment of smoldering fires? 26) _____
A) Chemical flame inhibition
B) Temperature reduction
C) Fuel removal
D) Oxygen exclusion

27) Which of the following standards requires turnout coats to be made of an outer shell, moisture barrier, and thermal barrier? 27) _____
A) NFPA® 1500 B) NFPA® 2101 C) NFPA® 1971 D) NFPA® 1982

28) Which of the following is NOT an option if you cannot find your way out of a burning building through a door or window? 28) _____
A) Breach an interior wall, then try to find a door or window.
B) Break through an exterior wall.
C) Breach an interior wall.
D) Find a closet and break through the floor.

29) An increase in ventilation in a fire that is in the decay stage can result in a deflagration called a: 29) _____
A) backdraft. B) flashover. C) flameover. D) rollover.

30) Which of the following contributes to the spread and intensity of a fire? 30) _____
A) Roof coverings
B) Roof supports
C) Location of exits
D) Location of hydrants

31) Which of the following is a characteristic of utility rope? 31) _____
A) Must conform to NFPA® 1983
B) Must be block creel construction.
C) Used to hoist equipment and secure unstable objects
D) Used to support rescuers during training

32) Which of the following is the temperature to which the surface of a substance must be heated for ignition and self-sustained combustion to occur? 32) _____
A) Self-starting ignition
B) Piloted ignition
C) Autoignition
D) Pre-combustion ignition

33) Which of the following fire classifications has the recommended method of extinguishment as first turning off or disconnecting the electrical power and then using the appropriate extinguisher? 33) _____
A) Class A fires B) Class B fires C) Class C fires D) Class D fires

34) Which of the following classifications of fires involve ordinary combustible materials such as wood, cloth, paper, rubber, grass, and many plastics? 34) _____
A) Class A fires B) Class B fires C) Class C fires D) Class D fires

35) Firefighters who wear prescription safety eyeglasses should select frames and lenses that meet _____ for severe exposure to impact and heat. 35) _____
A) NFPA® 1982 B) NFPA® 2101 C) ANSI Z101.2 D) ANSI Z87.1

36) Which of the following extinguishers are intended for use on small Class A fires only and are equipped with either a single- or double-acting pump? 36) _____
A) Pump-type water extinguishers
B) Aqueous film forming foam extinguishers
C) Stored-pressure dry chemical extinguishers
D) Wet chemical stored-pressure extinguishers

37) Which of the following refers to the transition when conditions in the compartment change very rapidly from partial to full involvement of the compartment? 37) _____
A) Rollover B) Backdraft C) Isolated flames D) Flashover

38) For flaming combustion to occur, fuels must be in the: 38) _____
A) chemical state. B) liquid state. C) gaseous state. D) solid state.

39) The rope or cable used for hoisting and lowering the fly sections of an extension ladder is the: 39) _____
A) pulley. B) guide. C) halyard. D) butt spur.

40) When searching multistory buildings, which of the following actions should be taken once critical areas have been searched? 40) _____
A) The intervening floors should be checked.
B) The all-clear should be sounded.
C) The fire floor should be checked.
D) The topmost floor should be checked.

41) Firefighters should consider that elongating _____ can actually push out load-bearing walls and cause a collapse. 41) _____
A) steel B) gypsum C) wood D) cast iron

42) Which of the following extinguishers are for use on Class A-B-C fires and/or Class B-C fires and are among the most common portable fire extinguishers in use today? 42) _____
A) Clean agent extinguishers
B) Aqueous film forming foam extinguishers
C) Carbon dioxide extinguishers
D) Dry chemical extinguishers

43) Which of the following products of combustion is frequently identified as the cause of death for civilian fire fatalities and acts as a chemical asphyxiant by binding with hemoglobin in the blood? 43) _____
A) Hydrogen cyanide
B) Methane
C) Carbon monoxide
D) Carbon dioxide

44) Which of the following fire classifications involve flammable and combustible liquids, gases, and greases such as alcohol, gasoline, lubricating oils, and liquefied petroleum gas (LPG)? 44) _____
A) Class A fires
B) Class B fires
C) Class D fires
D) Class K fires

45) Which of the following is energy possessed by a moving object? 45) _____
A) Thermal energy
B) Forward energy
C) Kinetic energy
D) Potential energy

46) Applying large amounts of heat to solid fuels such as wood causes: 46) _____
A) pyrolysis.
B) deflagration.
C) vaporization.
D) autoignition.

47) Which of the following fire classifications can easily be extinguished with water, water-based agents such as foam, or dry chemicals? 47) _____
A) Class A fires
B) Class B fires
C) Class D fires
D) Class K fires

48) Which of the following refers to the temperature at which a liquid gives off sufficient vapors to ignite, but not sustain, combustion? 48) _____
A) Volatility rating
B) Fire point
C) Flash point
D) Autoignition point

49) Which of the following is conducted after the fire is under control and the greatest hazards have been controlled? 49) _____
A) Primary search
B) Tertiary search
C) Secondary search
D) Rapid intervention search

50) Which of the following methods of controlling and extinguishing a fire depends on reducing the temperature of a fuel to a point where it does not produce sufficient vapor to burn? 50) _____
A) Chemical flame inhibition
B) Oxygen exclusion
C) Fuel removal
D) Temperature reduction

51) Which of the following extinguishers have an air-aspirating nozzle that aerates the foam solution, producing a better-quality foam than a standard extinguisher nozzle? 51) _____
A) Dry chemical extinguishers
B) Carbon dioxide extinguishers
C) Clean agent extinguishers
D) Aqueous film forming foam extinguishers

52) Which of the following is NOT an indicator of building collapse? 52) _____
A) Amount of smoke coming from the building
B) Walls that appear to be leaning
C) Structural members separating from roof
D) Structural members that appear to be distorted

53) The lowest and widest section of an extension ladder is the: 53) _____
A) bed section.
B) protection plate.
C) fly section.
D) truss block.

54) Curved metal devices installed near the top end of roof ladders to secure the ladder to the highest point on a peaked roof of a building are: 54) _____
A) pulleys.
B) protection plates.
C) pawls.
D) hooks.

55) Which of the following fire classifications involve ordinary combustibles such as textiles, paper, plastics, rubber, and wood? 55) _____
A) Class A fires B) Class B fires C) Class D fires D) Class K fires

56) A *chimney effect* occurs: 56) _____
A) when a ventilation opening is made in the lower portion of a building.
B) when a ventilation opening is made in the upper portion of a building.
C) when a vertical ventilation opening is made.
D) when a ventilation opening is made in the chimney of a structure.

57) All of the following are warning signs of an unsafe roof condition EXCEPT: 57) _____
A) hard asphalt.
B) "spongy" roof.
C) fire coming from the roof.
D) smoke coming from the roof.

58) In order to burn, liquids must be: 58) _____
A) contained. B) pyrolysized. C) vaporized. D) flowing.

59) Which of the following fire classifications involve combustible cooking oils? 59) _____
A) Class A fires B) Class B fires C) Class D fires D) Class K fires

60) Which of the following is the primary consideration in whether solids are easy or difficult to ignite? 60) _____
A) Orientation to the source of heat
B) Proximity to the source of heat
C) Source of ignition
D) Surface-to-mass ratio

61) Which of the following products of combustion is a product of complete combustion of organic materials and also acts as a respiratory stimulant? 61) _____
A) Hydrogen cyanide
B) Carbon monoxide
C) Carbon dioxide
D) Methane

62) Which of the following refers to the transfer of heat within a body or to another body by direct contact? 62) _____
A) Absorption B) Radiation C) Convection D) Conduction

63) Which of the following actions should firefighters take when dealing with truss-containing buildings exposed to fire conditions for longer than 5 minutes? 63) _____

A) Attack the fire from the roof.
B) Do not enter the building to attack the fire.
C) Enter and proceed to extinguish the flames.
D) Do not treat the situation any differently than other types of buildings.

64) Which of the following is one of the two primary objectives of a building search? 64) _____

A) Extinguishing fire
B) Locating victims
C) Determining the fire load
D) Determining the structure's floor plan

65) Fuel in a combustion reaction is known as the: 65) _____

A) primary agent.
B) reducing agent.
C) increasing agent.
D) combustion agent.

66) Which of the following fire classifications would use the following agents for extinguishment: Carbon Dioxide, Dry Chemical, and Class B Foam? 66) _____

A) Class A fires
B) Class B-C fires
C) Special Hazard Class B fires
D) Special Hazard Class K fires

67) Which of the following causes the most fire deaths? 67) _____

A) Exhaustion
B) Structural collapse
C) Heat
D) Toxic smoke

68) Which of the following refers to the transfer of heat energy from a fluid (liquid or gas) to a solid surface? 68) _____

A) Convection B) Radiation C) Conduction D) Absorption

69) The main structural member of a ladder supporting the rungs or rung blocks is the: 69) _____

A) tip. B) butt. C) truss block. D) beam.

70) If you are unable to exit the structure, do not have a functioning radio, and cannot reach the wall, position your flashlight to shine: 70) _____

A) toward the window.
B) toward the north wall.
C) toward the ceiling.
D) toward the door.

71) Which of the following classifications of fires involve oils and greases normally found in commercial kitchens and food preparation facilities using deep fryers? 71) _____

A) Class A fires B) Class B fires C) Class C fires D) Class K fires

72) Which of the following fire stream classifications discharges more than 350 gpm (1 400 L/min) and is fed by 2 1/2- or 3-inch (65 mm or 77 mm) hoselines? 72) _____

A) Low-volume stream
B) High-volume stream
C) Handline stream
D) Master stream

73) Intercom/ear protection systems provide a dual benefit because of their ability to reduce the amount of noise the ear is exposed to and: 73) _____

A) eliminate the need for radio communication.
B) allow the crew to communicate or monitor the radio.
C) minimize the noise of radio traffic.
D) mask distracting sounds.

74) Which of the following methods of controlling and extinguishing a fire effectively extinguishes any fire? 74) _____

A) Chemical flame inhibition
B) Temperature reduction
C) Fuel removal
D) Oxygen exclusion

75) When operating within a burning building, search and rescue personnel should work in teams of at least_____ or more. 75) _____

A) 2 B) 5 C) 4 D) 3

SkillsUSA
2010 Contest Projects

First Aid/CPR

Click the “Print this Section” button above to automatically print the specifications for this contest. Make sure your printer is turned on before pressing the button.

First AID/CPR

Contestants are required to provide a copy of approved certificates in CPR(Adult/AED, Child and Infant) and First Aid. From any of the following organizations, The American Red Cross, American Heart Association, American Health and Safety Institute or the National Safety Council

SKILLS USA CHALLENGES **CONTESTANT NUMBER_____**

SCENARIO 1: **Adult CPR/AED**

You are standing in line at the license bureau when the person in front of you groans and slumps to the floor. There is an AED available.

Check for scene safety	_____	10
Check for consciousness (tap and shout)	_____	10
Check for breathing **Judge States (no breathing)**		
Head tilt, chin lift	_____	10
Look, listen and feel for 5-10 seconds	_____	10
Give two slow breaths	_____	10

Judge States Victim Unresponsive

Check for severe bleeding		
Scan entire body	_____	10
Call for EMS	_____	10
While providing care:		
Use of gloves	_____	6

Judge States AED is available:

Turn on AED, Place pads on victim	_____	23
Analyze Victim	_____	23
Make sure all are clear of victim	_____	23
Deliver Shock when prompted	_____	23
Begin CPR		

Judge States: Not a shock able rhythm

Begin CPR		
Start with 30 compressions (no breaths)	_____	20
Do five uninterrupted cycles of 30 to 2	_____	20
Recheck pulse and breathing after two minutes	_____	20

Judge States: Victim has a pulse and is breathing

Maintain open airway and continue to monitor	_____	12

Total Points Awarded: _____ (240)

Judges Name:
Comments

SKILLS USA CHALLENGES **CONTESTANT NUMBER_____**

SCENARIO 2: **Child CPR**

You are picking up your brother from a birthday party when you see a crowd around a child in the hall. What do you do next?

Check for scene safety	_____	12
Check for consciousness	_____	12
(Tap and shout)		
Check for breathing	_____	12
(Head tilt, chin lift)		
(Look, listen and feel for 5-10 seconds)	_____	12
Check for severe bleeding		
(Look over entire body for signs of bleeding)	_____	12
Call for Emergency Medical Assistance		
(Send bystander to call for assistance immediately)	_____	12
While providing care:		
Use of gloves	_____	12
Reassuring victim/bystanders	_____	12

Judge States: Child has no pulse and is not breathing

Start CPR (30 compressions and 2 breaths)	___	60
Continue giving CPR to child for 2 minutes		
30 compressions and 2 breaths		
Stop and check for responsiveness 5-10 seconds	____	11
Child is responsive		

Judge States: Victim is breathing and has a pulse.

Monitor victim until help arrives		
Maintain open air way	_____	11
Check for breathing	_____	11
Check for pulse	_____	11

Total Points Awarded: _____ (200)

Judges Name:
Comments:

SKILLS USA CHALLENGES **CONTESTANT NUMBER_____**

SCENARIO 3: **Infant CPR**

You are walking in to a shopping center when you see and hear a mother yelling for help leaning over a baby stroller. What do you do next?

Check for scene safety	_____	12
Check for consciousness		
(Tap and shout)	_____	12
Check for breathing		
(Head tilt, chin left)	_____	12
(Check for breathing and pulse for 5-10 seconds)	_____	12
Check for pulse		
Check for severe bleeding		
(Look over entire body for signs of bleeding)	_____	12
Call for Emergency Medical Assistance		
(Send bystander to call for assistance immediately)	_____	12
While providing care:		
Use of gloves	_____	10
Reassuring victim/bystanders	_____	8

Judge States: Baby has no pulse and is not breathing.

During check phase:		
Give two slow breaths	_____	12
Start CPR		
Head tilt, chin lift	_____	12
30 compressions 2 breaths	_____	28
Continue for 2 minutes	_____	28

Judge States: Infant is responsive

Monitor until help arrives		
Maintain open air way	_____	10
Check for breathing	_____	10
Check for pulse	_____	10

Total Points Awarded: _____ (200)

Judges Name:
Comments:

SKILLS USA CHALLENGES **CONTESTANT NUMBER_____**

SCENARIO 4: **Medical Emergency**

You are eating at a restaurant when someone at the next table starts to cough and places his hands on his throat? What do you do next?

Check scene for safety	_____	10
Ask victim if he can cough or speak victim nods no get into position		
Give Abdominal thrusts (show position)	_____	10
.		
Judge States: Victim faints (2 minutes)		
Check for Breathing Tell someone to call 911	_____	10
Head tilt chin lift	_____	10
Look, listen and feel for 5-10 sec.	_____	10
Give 2 breaths **Judge States breaths do not go in**		
Re tilt head give 2 breaths **Judge States breaths do Not go in**.	_____	10
Begin Unconscious choking (2 minutes)		
Give 30 compressions check airway before giving breaths.	_____	15
Give 2 breaths. **Judge States Airway still blocked**	_____	10
Continue cycle of compressions and checking airway	_____	15
Judge States Airway is open No pulse or Breathing (1 minute)		
Give 2 breaths and continue CPR	_____	10
30 compressions and 2 breaths	_____	15
Judge states: Victim is breathing and has a pulse: (1 minute)		
Continue to monitor victim and maintain air way	_____	15

Total Points Awarded: _____ (120)

Judges Name:

Comments:

SKILLS USA CHALLENGES **CONTESTANT NUMBER_____**

SCENARIO 5: **First Aid**

You and a friend are riding bikes on a bike trail when you come across a rider who has fallen. First Aid kit is Available

Check for scene safety ask if you can help	_____	8

Victim states he/she slid on some gravel and fell off.
There is a large abrasion on their right arm by the elbow victim is holding arm.

Put on gloves	_____	8
Have someone call EMS	_____	8

Victim States my arm hurts to move it:

Clean of wound area with cleaning pad	_____	8
Check to see if arm is bruised or discolored	_____	8

Judge states Victim has bruising on right elbow

Ask the patient to support their arm while applying ointment And large band aid to area (**simulated)**	_____	15
Check the injured area for discoloration and pain **(Support above and below the site of injury.**)	_____	15
Place a sling from a triangular bandage on The injured arm and secure	_____	15
Tie 1 triangular bandages securely across the Chest and secure	_____	15
Recheck for feeling, warmth, and color on fingers	_____	15
Continue to monitor victim until help arrives.	_____	5

Total Points Awarded: _____ (120)

Judges Name:
Comments

SkillsUSA
2010 Contest Projects

Heating, Ventilation Air Conditioning and Refrigeration

Click the "Print this Section" button above to automatically print the specifications for this contest. Make sure your printer is turned on before pressing the button.

2010 SkillsUSA Championships
HVACR Contest

June 24, 2010 Kansas City, Missouri

THE HARRIS PRODUCTS GROUP

Contestant Procedure Sheet

Event #1: Brazing

Sponsor: Harris Products Group

Time Allowed: 60 minutes

This exercise involves your ability to accomplish the following in the allotted time period:

1. Read and follow a piping diagram
2. Select, measure, cut, and assemble material
3. Use tools and torch
4. Join piping with silver braze alloy and phos-copper braze alloy into a leak-tight assembly

Notes:

1. Use all tools necessary
2. Follow drawing accurately
3. Work safely

2010 SkillsUSA Championships
HVACR Contest

June 24, 2010 Kansas City, Missouri

Judging Criteria

Event #1 – Brazing

Sponsor: Harris Products Group

A. **Wear safety glasses –** 10 points maximum

10 points if glasses continually worn.
5 points if contestant needs to be reminded
0 points if glasses not worn

B. **Layout tube cuts** - 10 points maximum

10 points if contestant makes 7 to 9 cuts.
5 points if contestant makes 10 to 11 cuts.
0 points if contestant makes more than 11 cuts.

C. **Clean prior to brazing** – 15 points maximum

15 points if contestant uses tube brush or sand cloth to clean fitting I.D. and tube O.D., and uses deburring tool on tube ends.
10 points if contestant cleans fitting I.D. and tube O.D. (no-deburring).
0 points if there is no part cleaning or cleans only one part, or only deburrs.

D. **Flux required connections** – 10 points maximum

10 points if contestant fluxes *only* connections where Safety Silv 45 is called out, (reference alloy B call out on drawing).
5 points if contestant fluxes any connections where Dynaflow is called out, (reference alloy A callout on drawing).
0 points if no flux is used on any connections where Safety Silv 45 is called out.

E. **Correct braze alloy selection** – 10 points maximum

10 points if contestant uses correct alloys as shown on drawing.
5 points if contestant uses Safety Silv 45 where Dynaflow is called out on the drawing.
0 points if contestant uses Dynaflow on any steel to copper connection, (where Safety Silv 45 is called out).

F. **Braze equipment use; start up** – 10 points maximum

<u>Opening tank valves</u>

5 points if contestant stands to side of regulators when opening cylinder valves.
0 points if contestant stands in front of regulators when opening cylinder valves.

<u>Adjusting delivery pressure and lighting torches</u>

5 points if contestant uses proper delivery pressure settings as listed on the tip chart at the braze station.
(Air/acetylene 13 – 15 PSI, and oxy-acetylene 2 -4 PSI for #2 tip, 3 -5 PSI for #3 tip).

0 points if contestant sets acetylene delivery pressure other than above.

2010 SkillsUSA Championships
HVACR Contest

June 24, 2010 Kansas City, Missouri

G. **Brazing technique and joint appearance** – 10 points maximum

5 points if contestant removes Schrader valve pin.
5 points if over all braze appearance is acceptable; (unacceptable items would include run down, balls, lumps, charred flux residue).
0 points if contestant makes any brazes not specified on drawing; (example would be butt brazing two tubes).

H. **Assembly Layout/Size** – 15 point maximum

15 points if finished assembly fits within template tolerances.
0 points if assembly is outside size limits.

I. **Leak Test** – 20 point maximum

20 points if assembly is leak free.
5 points if contestant repairs leak and it passes second test.
0 points if it leaks after repair, (or if no repair is attempted).

J. **Braze equipment use; shut down** – 10 points maximum

Closing valves and bleeding lines.

10 points if contestant: (1)closes cylinder valve(s),(2) opens torch valves, (one at a time), to bleed pressure from line(s),(3) "backs off" (closes by turning counter-clockwise) regulator(s) adjustment screw,
5 points if contestant only closes cylinder valve(s), and closes torch adjustment valves, but leaves pressure in the system, (evidenced by gauge pressure reading).
3 points if contestant only closes torch adjustment valves.

K. **Clean up braze area** – 5 points maximum

5 points if contestant straightens up braze table, (things to look for include putting lid on flux jar, not leaving drawing or instructions on table, not leaving unused rod, cleaning pad, torches, strewn about table).
0 points if no effort made to clean up after brazing.

Notes:

1

2010 SkillsUSA Championships
HVACR Contest

June 24, 2010 Kansas City, Missouri

THE HARRIS PRODUCTS GROUP

Contestant Score Sheet

Event #1 - Brazing **Sponsor: Harris Products Group**

Stop Time _____ Contestant # _____

Start Time _____

Total _____ Judge's Initial's _____

		Score	Points
A.	Wear safety glasses	_____	(0 to10)
B.	Layout & tube cuts	_____	(0 to 10)
C.	Pre-braze cleaning	_____	(0 to 15)
D.	Flux required connections	_____	(0 to 10)
E.	Braze alloy selection	_____	(0 to 10)
F.	Braze equipment use - start	_____	(0 to 10)
G.	Braze technique and joint appearance	_____	(0 to 10)
H.	Assembly layout & size	_____	(0 to 15)
I.	Leak test	_____	(0 to 20)
J.	Braze equipment use – shut down	_____	(0 to 10)
K.	Clean braze area	_____	(0 to 5)
		_____	
		_____	
		_____	
	Total	_____	(125 max)

Note: Maximum Score is 125. No fractional points to be given.
*** If contestant performs an unsafe practice, STOP the action and correct the contestant. Deduct up to 5 points depending upon the severity of the issue.**

2010 SkillsUSA Championships
HVACR Contest

June 24, 2010 Kansas City, Missouri

EMERSON Climate Technologies

SkillsUSA

Contestant Procedure Sheet

Event #2: Troubleshooting Procedure **Sponsor: Emerson Climate Technologies**

Time Allowed: 30 Minutes

Description of Job:

Perform or follow proper system troubleshooting procedures to identify cause of inadequate cooling.

Problem Statement:

The complaint is poor or no cooling. System runs continuously.

Notes:

1. Follow all normal safety procedures.
2. Use proper tools and/or instruments.
3. Return tools and instruments to proper place when finished.
4. Normal conditions: 115 psig HP, 21 psig LP, 12.1 amps, 10°F SH, 10°F SC.

Judges Notes:

1. Have student read Problem Statement prior to starting.
2. Clarify any questions or concerns.
3. Problem Statement must not leave judging area.

2010 SkillsUSA Championships
HVACR Contest

June 24, 2010 Kansas City, Missouri

EMERSON Climate Technologies

SkillsUSA

Judges Instruction Sheet

Event #2: Troubleshooting Procedure **Sponsor: Emerson Climate Technologies**

DO NOT CHAT WITH CONTESTANTS OR TALK TO ANY SPECTATOR (could be instructor or parent). Call for Technical Committee Member to answer spectator questions.

Total Your Own Score Sheet Print your name on Score Sheet

Grading Instructions:

1. Safety:

a. Contestants must wear safety glasses. If not, DEDUCT 10 POINTS, then remind contestant.

2. Performance:

a. When contestant has proper size wrench available but uses adjustable wrenches, **DEDUCT POINTS.**

b. Low side gauge to suction service valve. Leave attached.

c. High side gauge to receiver service valve. Leave attached.

d. To pump down system, close receiver service valve. If suction service valve is closed causing pressure to pull down quickly, **DEDUCT POINTS.**

e. Contestant does not necessarily have to troubleshoot in the same sequence as the score sheet.

f. Did contestant verify problem by pump down?

g. If contestant identifies the problem correctly, without completing ALL of the performance functions listed, (A through M on the score sheet), ask him/her if there are any other system checks they would want to do to verify the problem. If “Yes”, ask them to proceed. If “No”, then they are finished.

h. When contestant indicates He/She is finished, Escort them back to the waiting area.

i. Deduct points for any performance checks that were not done by the contestant

j. Normal conditions: 115 psig HP, 21 psig LP, 12.1 amps, 10°F SH, 10°F SC.

2

2010 SkillsUSA Championships
HVACR Contest

June 24, 2010 Kansas City, Missouri

EMERSON Climate Technologies

Contestant Score Sheet

Event #2: Troubleshooting Procedure **Sponsor: Emerson Climate Technologies**

Start Time _____ Contestant # _____

Stop Time _____

Total _____ Judge's Initial's _____

		Score	Points
Safety			
A.	Wear safety glasses		(0 to10)
Performance			
A.	Select proper tools and use correctly		(0 to 10)
B.	Check ambient temperature		(0 to 5)
C.	Check low side pressure		(0 to 5)
D.	Check suction line temperature		(0 to 5)
E.	Calculate compressor superheat		(0 to 5)
F.	Check high side pressure		(0 to 5)
G.	Check liquid line temperature		(0 to 5)
H.	Calculate sub-cooling		(0 to 5)
I.	Calculate compression ratio		(0 to 5)
J.	Check voltage at compressor		(0 to 5)
K.	Check amperage at compressor		(0 to 5)
L.	Verify using pump down procedure*		(0 to 5)
M.	Correctly identify fault		(0 to 50)
		Total	Max 125

*Contestant has four options in bypassing low pressure cutout to pump down the system:

1. Turn off power and put both low pressure wires under one terminal.
2. Turn off power and place jumper wires across terminals.
3. Readjust low pressure control to cut out at 0 PSIG.
4. Insert screw driver into toggle switch on control.

Maximum score is 125. No fractional points to be given.

2

3

2010 SkillsUSA Championships
HVACR Contest

June 24, 2010 Kansas City, Missouri

Carrier
Turn to the Experts

Contestant Procedure Sheet

(use this sheet as your worksheet)

Event #3: Airflow and Superheat Measurements **Sponsor: Carrier Corporation**

Time Allowed: 25 Minutes

There are **two** problems to solve in this event.

1. The first is to measure the **Airflow** in the system and determine if it is **adequate** for this particular system.

2. The second problem is to measure the **Suction Gas Superheat and Subcooling** in the system and determine if it is correct or not.

To determine the airflow, you may choose either method listed below. The Judge will decide which system you will be assigned to, and provide you with the appropriate instruments to make your determinations.

A. **Velocity Pressure Method** using a Pitot Tube, Magnehelic Gauge, and a tape measure.
B. **Temperature Rise Method** using the system's resistance heaters along with a Voltmeter, Clamp-on Ammeter, and an Electronic Thermometer.

After measuring the actual airflow, determine if you believe it is correct or not for this system. Next, measure the Suction Gas Superheat in the same operating system and determine if you believe it is correct or not. Once again the judge will provide the necessary instruments for you to make your determination.
If you wish, you may use the data sheet provided for various formulae and equations which may be helpful in performing your calculations. There are also calculators for your use if you need one.

1. **Explain your procedures and answers to the judge.**

2. **Explain what complaint a customer might have if the airflow was too high or too low.**

3. **What should the airflow, superheat and subcooling be on this particular system?**

2010 SkillsUSA Championships
HVACR Contest

June 24, 2010 Kansas City, Missouri

Carrier
Turn to the Experts

SkillsUSA

Problem Statement

Event #3: Airflow, Superheat and Subcooling Measurements

Sponsor: Carrier Corporation

Time Allowed: 25 Minutes

This exercise involves measuring the airflow of a typical indoor fan section of a residential type air – conditioning system and then measuring the "suction gas superheat" of the same air conditioning system. Choosing from the instruments provided, you are to measure the total airflow of the air conditioning system, the suction gas superheat as well as the liquid Subcooling, and then answer the related questions on the attached procedure sheet.

Procedure: See next page.

Notes:
1. Follow all normal safety procedures.
2. Use tools and/or instruments properly.
3. Perform tasks in proper sequence.
4. Explain your procedure and findings to your judge.
5. Return tools, instruments, etc. to their proper place when finished.

Judges Notes:

1. Have contestant read this "Problem Statement" and procedure sheet prior to starting. These sheets are not to leave the contest area.

2. The "Procedure Sheet" is for the contestant to use as a worksheet. Place contestant number in upper right and affix behind judges completed score sheet.

3. Clarify any questions after contestant reads instructions and before the judge starts the timing for the event.

3

2010 SkillsUSA Championships
HVACR Contest

June 24, 2010 Kansas City, Missouri

Carrier
Turn to the Experts

Contestant Score Sheet

Event #3: Airflow using **Temperature Rise,** and measure **Superheat and Subcooling.**

Sponsor: Carrier Corporation

25 minute max

Stop Time _____ Contestant # _____

Start Time _____

Total _____ Judge's Initial's _____

Safety		**Score**	**Points**
A.	Wear safety glasses	_____	(0 to 5)
B.	Worked safely while taking electrical readings	_____	(0 to 5)

Procedure for Measuring Airflow

A.	Turned on electric heat and allowed time to warm up	_____	(0 to 5)
B.	Chose proper probes for temperature difference and read TD correctly (_____ degrees TD)	_____	(0 to 10)
C.	Measured volts and amps correctly * (_____ Volts, _____ Amps)	_____	(0 to 10)
D.	Chose proper formula to calculate CFM	_____	(0 to 15)
E.	Calculated CFM correctly (_____)	_____	(0 to 15)
F.	Explained consequences of too much / too little airflow	_____	(0 to 15)
G.	What should airflow be? (_____) Is this airflow acceptable for a 2-ton system?	_____	(0 to 10)

Procedure for Measuring Suction Superheat and Subcooling

A.	Uses and reads gauge manifold correctly?	_____	(0 to 10)
B.	Uses and reads electronic thermometer correctly?	_____	(0 to 5)
C.	Calculates the subcooling and superheat properly and correctly?	_____	(0 to 10)
	(Safety Deduction) *	_____	(0 to -10)
	Total	_____	(125 max)

NOTES:

1. Maximum score is 125. No fractional points are to be given.
2. Inform contestants that voltage and amperage are to be taken from the disconnect box. If they ask for the motor amperage you may tell them it is ____ amps.

*** Judges may assist with setting the thermostat at the contestant's request– watch contestants closely when they are measuring voltage and amperage. Be prepared to intervene quickly if they appear to be unsafe. (0 to 10 point deduction)**

3

3

2010 SkillsUSA Championships
HVACR Contest

June 24, 2010 Kansas City, Missouri

Carrier
Turn to the Experts

Contestant Score Sheet

Event #3: Airflow using **Velocity Pressure,** and measure **Superheat and Subcooling**

Sponsor: Carrier Corporation

25 minute max

Stop Time _____ Contestant # _____

Start Time _____

Total _____ Judge's Initial's _____

Safety		**Score**	**Points**
A.	Wear safety glasses	_____	(0 to 5)
B.	Worked safely while taking electrical readings	_____	(0 to 5)
Procedure for Measuring Airflow			
A.	Divided duct for traverse reading	_____	(0 to 10)
B.	Hooked up tubes to meter correctly	_____	(0 to 10)
C.	Properly positioned Pitot tube and read	_____	(0 to 10)
D.	Converted pressures to FPM and averaged properly	_____	(0 to 10)
E.	Calculated square footage area of duct properly	_____	(0 to 10)
F.	Calculated CFM correctly (_____)	_____	(0 to 10)
G.	What should airflow be? ± 10% Is this airflow acceptable for a 2-ton system?	_____	(0 to 15)
H.	Explained consequences of too much / too little airflow	_____	(0 to 15)
Procedure for Measuring Suction Superheat			
A.	Uses and reads gauge manifold correctly?	_____	(0 to 10)
B.	Uses and reads electronic thermometer correctly?	_____	(0 to 5)
C.	Calculates the superheat and subcooling properly and correctly?	_____	(0 to 10))
	(Safety Deduction) *	_____	(0 to -10)
	Total	_____	(125 max)

NOTES:

1. Maximum score is 125. No fractional points are to be given.
2. Judge should volunteer to hold Pitot tube for contestant, BUT contestant MUST instruct judge about where to hold and how to position Pitot tube for each reading.

***Caution: Judges should watch contestants carefully; be prepared to intervene if safety is not being observed! (0 to 10 point deduction)**

3

2010 SkillsUSA Championships
HVACR Contest

June 24, 2010 Kansas City, Missouri

Contestant Procedure Sheet

Event #4 – Electrical Troubleshooting - Wiring **Sponsor: Lennox Industries**

Time Allowed: 5 minutes

This exercise involves the ability to read a wiring diagram found on a Residential Air Conditioner.

Read the 2 part question. Using the wiring diagram provided, you are to determine the meaning of the diagram line styles. Tell the Judge the letter for the correct sequence of the operation for Question 1 and the letter of the correct answer for Question 2.

PROBLEM:

What do the heavy dashed lines mean?

Q1

A Factory Installed Field Wiring High Voltage Connections

B Field Installed Factory Wiring Low Voltage Connections.

C Field Installed Low Voltage Connections

Q2

What are components S4, S87, & C12?

A Compressor, Contactor & Outdoor Fan

B Low Pressure Switch, High Pressure Switch & Dual Run Capacitor

C Start Capacitor, Low Pressure Switch, High Pressure Switch

4

2010 SkillsUSA Championships
HVACR Contest

June 24, 2010 Kansas City, Missouri

Contestant Procedure Sheet

Event #4 – Electrical Troubleshooting, A/C **Sponsor: Lennox Industries**

Time Allowed: 15 minutes

This exercise involves the diagnosis of a typical problem found on a residential heating and air conditioning system.

Read the "customer complaint" below. Using tools and/or instruments provided, you are to determine the cause of the system problem. Explain to the judge what the problem is, your method of troubleshooting and what the corrective action would be.

CUSTOMER COMPLAINT OR PROBLEM

The problem consists of a home getting too cold. The new system installed yesterday.

The dispatcher for your heating and cooling company instructed the customer to turn the thermostat mode to 'off' and the blower switch to 'on' until you could arrive to troubleshoot.

Notes:

1. Follow all normal safety procedures
2. Use proper tools and/or instruments
3. Perform task in proper sequence
4. Explain your diagnosis to the judge
5. Return all tools, instruments, etc. to proper place when finished

Judge's Notes

1. Have contestant read CUSTOMER COMPLAINT OR PROBLEM statement
2. Clarify questions before beginning
3. CUSTOMER COMPLAINT OR PROBLEM statement must not leave immediate contest area

4

4

2010 SkillsUSA Championships
HVACR Contest

June 24, 2010 Kansas City, Missouri

Judges Guidelines

The problem consists of a new Air Conditioning system installed yesterday and will not turn off. The office advised the homeowner to turn the thermostat system switch to 'off', and the blower to 'on' position. The problem is miswired control voltage in the outdoor unit: R and Y are reversed.

Before contestant arrival:

1) Set thermostat in mode OFF position, with fan set to ON position
2) Furnace and condensing unit access doors are removed,
3) Furnace safety switch is in closed position,
4) Manifold gauge set is attached.

		Score	Points
Safety			
A.	Wear safety glasses	_____	(0 or 10)
B.	a) Used tools safely	_____	(0 or 5)
	b) Practiced safe work procedures	_____	(0 or 5)
Performance			
A.	**Used tools and instruments properly**		(0 to 20)
	b) Used screw/nut drivers, pliers, etc, properly?	_____	(0 to 5)
	a) Set meter correctly when measuring volts or ohms?	_____	(0 to 15)
B.	**Troubleshooting**		
	Followed proper troubleshooting procedures? Contestants are expected to:		(0 to 60)
	1) Read the Problem Statement		
	2) Turn the thermostat to "call" for cooling		
	3) Observe System Components Operation		(0 to 10)

4

2010 SkillsUSA Championships
HVACR Contest

June 24, 2010 Kansas City, Missouri

4) Utilize required testing equipment in logical pattern

i) Check for cooling call from thermostat.

(1) Measurement from Y to C at furnace terminal strip

ii) Check for line voltage at contactor

iii) Check for 24v at outdoor unit Y and C connection points

iv) Look at attached pressure manifold set?

v) Trace fault to control wiring reversed at R and Y in outdoor unit _____ (0 to 15)

Correctly identified fault?

vi) "Control wiring miswired" - Award 15 points

vii) "R and Y Low voltage connections reversed in outdoor unit miswired" - Award 25 points _____ (0, 15 or 25)

5) Explained findings to judge properly?

i) "Control wiring must be corrected to allow normal control and operation." - Award 15 points _____ (0 to 15)

C. Solved wiring diagram circuit correctly? (0 to 20)

Q1. What do the heavy dashed lines mean? A B C _____ (0 or 10)

Q2. What are components S4, S87, & C12? A B C _____ (0, 5 or 10)

Note: Maximum score is 125. No fractional points to be given. **Total** _____ (125 max)

4

2010 SkillsUSA Championships
HVACR Contest

June 24, 2010 Kansas City, Missouri

Judging Guidelines

Event #4 – Electrical Troubleshooting - Wiring **Sponsor: Lennox Industries**

Time Allowed: 5 minutes

This exercise involves the ability to read a wiring diagram found on a Residential Air Conditioner.

Read the 2 part question. Using the wiring diagram provided, you are to determine the meaning of the diagram line styles. Tell the Judge the letter for the correct sequence of the operation for Question 1 and the letter of the correct answer for Question 2.

PROBLEM:

What do the heavy dashed lines mean?

Q1

A	Factory Installed Field Wiring High Voltage Connections	0 points
B	Field Installed Factory Wiring Low Voltage Connections.	0 points
C	Field Installed Low Voltage Connections	10 points

Q2

What components are S4 S87 & C12?

A	Compressor, Contactor & Outdoor Fan	0 points
B	Low Pressure Switch, High Pressure Switch & Duel Run Capacitor	10 points
C	Start Capacitor, Low Pressure Switch, High Pressure Switch	5 points

JUDGES COPY

4

2010 SkillsUSA Championships
HVACR Contest

June 24, 2010 Kansas City, Missouri

Contestant Score Sheet

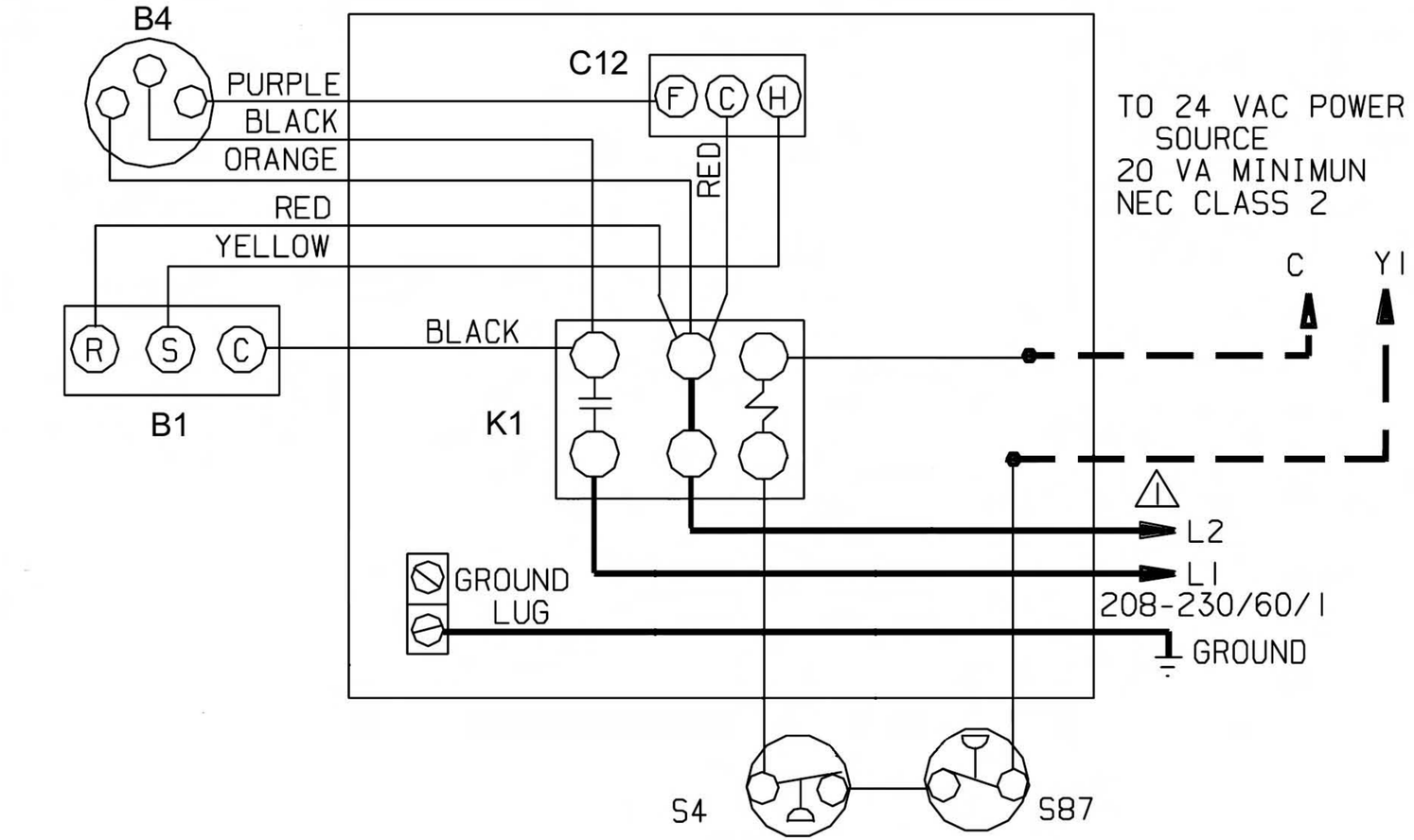
Event #4: Electrical Troubleshooting, A/C **Sponsor: Lennox Industries**

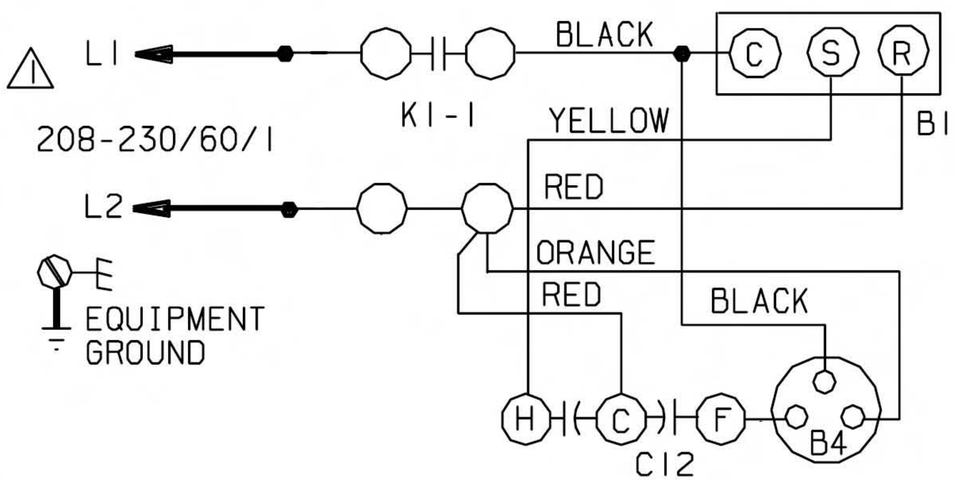
	Troubleshooting 15 minute max	**Wiring Diagram** 5 minute max	
Stop Time			Contestant #
Start Time			
Sub-Total			Judge's Initial's
Total		Troubleshooting + Wiring Diagram	

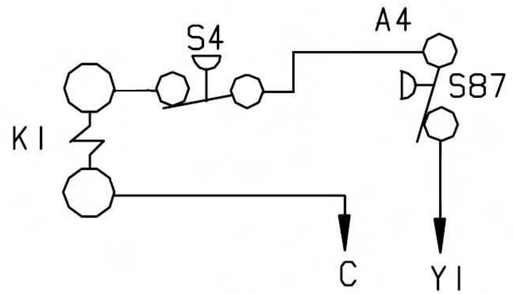
			Score	**Points**
Safety				
A.	Wear safety glasses			(0 or 10)
B.	a) Used tools safely			(0 or 5)
	b) Practiced safe work procedures			(0 or 5)
Performance				
A.	Used tools and instruments properly			(0 to 20)
B.	Troubleshooting			
	a) Followed proper troubleshooting procedures?			(0 to 25)
	b) Correctly identified fault?			(0 to 25)
	c) Explained findings to judge properly?			(0 to 15)
C.	Solved wiring diagram circuit correctly?			
	Q1. What components are shown in the diagram?	A B C		(0 or 10)
	Q2. How is the outdoor fan motor energized?	A B C		(0, 5 or 10)
		Total		(125 max)

Note: Maximum score is 125. No fractional points to be given.

DESCRIPTION	
KEY	COMPONENT
B1	COMPRESSOR
B4	MOTOR-OUTDOOR FAN
C12	CAPACITOR-DUAL
K1,-1	CONTACTOR-COMPRESSOR
S4	SWITCH-HIGH PRESSURE
S87	SWITCH-LOW PRESS,COMP 1







⚠ FOR USE WITH COPPER CONDUCTORS ONLY. REFER TO UNIT RATING PLATE FOR MINIMUM CIRCUIT AMPACITY AND MAXIMUM OVERCURRENT PROTECTION SIZE.

WARNING-
ELECTRIC SHOCK HAZARD, CAN CAUSE INJURY OR DEATH. UNIT MUST BE GROUNDED IN ACCORDANCE WITH NATIONAL AND LOCAL CODES.

LINE VOLTAGE FIELD INSTALLED

CLASS II VOLTAGE FIELD INSTALLED

NOTE - A COMPLETE UNIT WIRING DIAGRAM IS LOCATED INSIDE THE UNIT CONTROL BOX COVER.

5

2010 SkillsUSA Championships
HVACR Contest

June 24, 2010 Kansas City, Missouri

HUSSMANN

Contestant Procedure Sheet

Event: #5 – Refrigeration System Troubleshooting (Electrical) **Sponsor: Hussmann**

Time Allowed: 15 Minutes

DESCRIPTION OF THIS JOB

This exercise involves diagnosis of a problem in a self-contained refrigeration display case commonly found in supermarkets and convenience stores.

The following tools and equipment are provided:

- · Screwdrivers
- · Needle-nosed pliers
- · Digital volt-ohmmeter (VOM)
- · Electrical diagram

JOB DESCRIPTION:

Locate an electrical fault in a commercial refrigeration unit.

PROBLEM STATEMENT:

You're about to deliver this new unit to your customer. A quick check reveals that the compressor does not operate.

Use the digital volt-ohm meter (VOM) and the electrical diagram to trace the voltage path.

Be able to:

1. *Use the schematic diagram to trace circuits on the equipment.*
2. *Point out the fault on the cooler.*
3. *Point out the fault on the electrical diagram and explain why it would cause the symptom.*
4. *Explain the thought-process that led you to the fault.*
5. *Explain how to remove the "bug" that's been placed in this unit.*

- Follow all normal safety procedures.
- Treat the judge like a customer: explain the problem thoroughly and clearly.
- When finished, return the unit to the condition it was in when you began.

Note to Judge:

1. Have contestant read the "Problem Statement" shown above.
2. Ask the contestant to respond to all of the five (5) items listed above.
3. This document and the electrical diagram must not leave the contest area.

5

2010 SkillsUSA Championships
HVACR Contest

June 24, 2010 Kansas City, Missouri

HUSSMANN

Contestant Score Sheet

Event: #5 – Refrigeration System Troubleshooting (Electrical) **Sponsor: Hussmann**

Troubleshooting
15 minute max

Stop Time _____ Contestant # _____

Start Time _____

Total _____ Judge's Initial's _____

		Score	Points
1. Safety			
A.	Wears safety glasses *(0 to 10 points)*		**(0 to10)**
B.	Uses tools safely *(0 to 10 points)*		**(0 to10)**
2. Performance			
A.	**Combines the use of voltmeter and electrical diagram to trace the path.**		**(0 to 20)**
	Traces current path on diagram. (0 to 10 points)		
	Relates current path on diagram to the equipment. (0 to 10 points)		
B.	**Points out the fault on the cooler.**		**(0 to 20)**
	Points to fault on the cooler. (0 to 20 points)		
C.	**Points out the fault on the electrical diagram.** *(0 to 20 points)*		**(0 to 20)**
D.	**Provides an accurate and reasonable "diagnostic thought process".**		**(0 to 20)**
	Checked for voltage at compressor. (5 points)		
	Looked at wiring diagram to identify wires and terminals involved. (5 points)		
	Traced compressor "hot" and "neutral" to terminals strips and clock. (5 points)		
	Recognized that the current path is not complete across clock circuit link. (5 points)		
E.	**Demonstrates a thorough understanding of the unit fault.**		**(0 to 25)**
	Explains how to remove the fault from this unit. (15 points)		
	Explains how this fault could occur in the field. (10 points)		

Note: Maximum score = 125. No fractional points given. **TOTAL** _____ **(125 max)**

This "bug" addresses the skills shown below.

HVAC 7.0 — Diagnose and repair common problems in refrigeration systems according to applicable requirements identified by the Refrigeration Service Engineers Society

7.1 Diagnose electrical problems in self-contained refrigerated merchandisers
7.1.1 Use a schematic diagram to trace circuits in equipment

5

6

2010 SkillsUSA Championships
HVACR Contest

June 24, 2010 Kansas City, Missouri

Contestant Score Sheet

Event #7 – ICE Written Test

Sponsor: American Heating Air Conditioning Institute (AHRI)

Contestant	Score
1	
2	
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4	
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29	
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Contestant	Score
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502	
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530	

6

7

2010 SkillsUSA Championships
HVACR Contest

June 24, 2010 Kansas City, Missouri

Problem Statement

Event #7: Refrigerant Procedures **Sponsor: JKL Technical Sales**

Time allowed: 45 minutes

While waiting for Event #8, contestants should carefully read this "Problem Statement" and organize their thoughts as to what actions they will be asked to perform. When called into this event, contestants will be given another copy of this sheet for reference during the contest. Contestants should clarify any questions with the event judge before starting this event.

Scenario: The service manager has informed you that this system has a leak. You'll need to: find the leak; recover the remaining refrigerant; evacuate, recharge the system and ready the system for normal operation.

Notes:

1. Follow all normal safety procedures.
2. Use proper tools and/or instruments.
3. Perform tasks in proper sequence.
4. Explain your process to the judge as you proceed.
5. Return tools and instruments to proper place when finished.

This exercise involves using the following tools and equipment:

- Package air conditioning unit
- Recovery unit and cylinder
- Vacuum pump
- Manifold set
- Electronic vacuum gauge
- Electronic scale
- Electronic leak detector

Contestant is to:

1. Check system for refrigerant leaks using electronic leak detector.
2. Properly hook-up the Recovery Unit and Cylinder to the Package AC system and recover some refrigerant.
3. Properly hook-up Vacuum Pump & Vacuum Gauge, evacuate the system to industry standard, and check for vacuum leaks.
4. Properly hook-up refrigerant cylinder and recharge the system.
5. Identify 3 types of unknown refrigerant.
6. Answer some questions the judge has for you regarding the processes you have just completed.

DO NOT REMOVE THIS SHEET FROM THIS CHAIR!!!

7

7

2010 SkillsUSA Championships
HVACR Contest

June 24, 2010 Kansas City, Missouri

Problem Statement

Event #7: Refrigerant Procedures **Sponsor: JKL Technical Sales**

Time allowed: 45 minutes

Read this entire "Problem Statement" page and clarify any questions you have with your judge before starting this event.

Notes:

1. Follow all normal safety procedures.
2. Use proper tools and/or instruments
3. Perform tasks in proper sequence.
4. Explain your process to the judge as you proceed.
5. Return tools and instruments to proper place when finished.

This exercise involves using the following tools and equipment:

- Package air conditioning unit
- Recovery unit and cylinder
- Vacuum pump
- Manifold set
- Electronic vacuum gauge
- Electronic scale
- Electronic leak detector

Contestant is to:

1. Check system for refrigerant leaks using electronic leak detector.
2. Properly hook-up the Recovery Unit and Cylinder to the Package AC system and recover some refrigerant.
3. Properly hook-up Vacuum Pump & Vacuum Gauge evacuate the system to industry standard also check for vacuum leaks.
4. Properly hook-up refrigerant cylinder and recharge the system.
5. Identify 3 types of unknown refrigerant.
6. Answer some questions the judge has for you regarding the processes you have just completed.

Return this sheet to Judge when you finish this event!

7

7

2010 SkillsUSA Championships
HVACR Contest

June 24, 2010 Kansas City, Missouri

Judges Scoring Instructions
Confidential

Event #7: Refrigerant Procedures **Sponsor: JKL Technical Sales**

A Wear safety Glasses (0 – 2)

a) *If contestant has and wears safety glasses, award (2) points.*

b) *If the contestant must be told to put on safety glasses, award (1) point.*

c) *If the contestant does not have safety glasses award (0) points.*

B Identify what type of Refrigerant is in this system (0 – 3)

(Look at the name plate)

C Connect gauges set properly to system (0 – 8)

a) *Identify the high and low access fittings on the unit =4 points*

b) *Connect high and low side hoses to the appropriate fittings = 2 points*

c) *Purge air from hoses = 2 points*

D Check system for refrigerant leak (0 – 10)

(Judge is to connect the red hose from leak tube to vapor valve of tank. Contestant is to use an electronic leak detector and find the approximate source of the leak.)

a) *Contestant should check if system has some charge = 2 points*

b) *What would be done if no charge? = 2 points*

c) *Contestant should be familiar with the basic operation of an electronic leak detector = 2 points*

d) *Contestant should know and demonstrate the process for finding the leak with leak detector = 4 points*

Note –Contestant does not need to find the exact leak to get all points!

7

2010 SkillsUSA Championships
HVACR Contest

June 24, 2010 Kansas City, Missouri

E Connect recovery unit to system and tank (0 – 8)

a) *Contestant to explain the 3 methods of recovering refrigerant*
   1) *Vapor = 1 point*
   2) *Liquid = 1 point*
   3) *Push pull = 1 point*

b) *Contestant to connect recovery machine to system and tank = 2 points*

c) *Filter must be used = 1 point*

d) *Place tank on scale. Recovery should be stopped at what weight? = 2 points*
   1) *80 % of tanks maximum capacity*

F Proper use of pressure vessel (0 – 2)

Contestant safely releases pressure from hoses and insures the valve are closed before doing so = 2 point

G Determine Pressure Rating on tank (0 – 2)

Each contestant must determine the pressure rating on the tank by looking at the DOT – 4BA rating = 2 points

H Check the Certification Date (0 – 2)

Each contestant must determine the retest date of the cylinder by finding it on the safety collar of the tank = 2 points

I Check refrigerant in tank to prevent cross contamination (0 – 6)

Contestant must determine the type of refrigerant in the tank by explaining the use of P/T verification = 6 points total

a) *Checking the Temperature (2) points*

b) *Checking the Pressure (2) points*

c) *Using a P/T Chart (2) points*

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J Perform recovery through a complete pull down (0 – 5)

(Judge is to discharge a small amount of refrigerant into hoses by opening and closing C&D valves)

a) Contestant to run a recovery on the system; they must pull the system down to below 4 inches of vacuum = 3 points

b) *If they do not open valve on tank or manifold = 2 points*

K EPA required recovery pull down level for this system (0 – 5)

This system contains 52 oz of refrigerant (less than 5 pounds); therefore a recovery to 4 psig is required = 5 points

L Correctly connect vacuum pump and vacuum gauge (0 – 5)

a) Contestant is to connect vacuum pump and vacuum gauges to system as agreed to in judges meeting and pull a vacuum = 3 points

b) Manifold should be reading 0 PSI or below prior to connecting to vacuum pump = 2 points

M The purpose of pulling a vacuum on the system? (0 – 5)

A vacuum is pulled to remove <u>air</u> and <u>moisture</u> from the system piping and components.

c) If contestant states <u>only</u> air <u>or</u> moisture, award 2 points

d) If contestant states <u>both</u> air <u>and</u> moisture, award 5 points

.

N The purpose of the electronic vacuum gauge? What is the term of measurement they report? (0 – 6)

An electronic vacuum gauge allows technicians to:

a) Accurately measure a deep vacuum = 2 points

b) Ensure is tight and dry = 2 points

c) Term of measurement used in a vacuum gauge is a micron = 2 points

O Check vacuum pump for performance (0 – 3)

Use a vacuum micron gauge directly on the vacuum pump. A good pump should be able to pull below 100 microns = 3 points

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P Complete evacuation of the system (0 – 10)

Pull vacuum to approx. 1000 – 500 microns = 10 points

1) *If contestant shuts machine off above 29 inches of vacuum – award zero (0) points*
2) *If contestant reads only the manifold to determine vacuum state (but must be below 29 inches of vacuum) – award six (6) points*
3) *If contestant stops evacuation before reaching 1000 microns – award six (6).*

Q Check system for vacuum leaks (0 – 5)

(Have contestants explain what they are doing)

a) *Perform "standing vacuum check". Vacuum must hold for at reasonable amount of time and within reasonable amount of rise in microns to be acceptable for a dry, non-leaking system = 5 points*

R Use the charging device, set up to properly recharge (0 – 9)

a) *Connect yellow hose of manifold to refrigerant tank and place tank on charging scale = 3 points*
b) *"Zero" the scale or write down cylinder weight = 3 points*
c) *Charging should be vapor unless contestant asks for "liquid charging restrictor" = 3 points*

S What is the proper refrigerant charge for this unit (0 – 3)

Refrigerant Charge – award three (3) points

T Procedure for checking quality of refrigerant / oil in a system (0 – 4)

a) *Acid test can be run on the system oil = 2 points*
b) *Moisture sight glass can be used for moisture = 2 points*

U How can refrigerant be cleaned in a working system (0 – 4)

A filter dryer can be used to remove contaminates and dry the refrigerant)

a) *Filter only = 2 points*
b) *Dryer only = 2 points*

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V **<u>If Nameplate information is not available</u>**, how is the proper charge determined? (0 – 6)

(Based on the type of metering device, either fixed orifice or expansion valve, charge using either superheat or Subcooling)

a) Fixed restriction: SuperHeat = 3 points

b) TXV: SubCool = 3 points

W Replace all tools and Caps to their original locations((0 – 4)

(Contestant must put back all tools and caps)

If completed;

a) Tools – award 2 points

b) Caps – award 2 points

At this point the judge should subtotal the score for a maximum of 117 points and pass the scoring sheet to the refrigerant identification judge.

X Identify the type of refrigerant in tanks (0 – 8)

(Contestant will take a pressure temperature reading on three tanks of refrigerant and determine the type of refrigerant in the tank)

a) If contestant does not know how to determine refrigerant by pressure temp method, -- award 4 points

b) If contestant knows process but does not get readings correct. (At least 2 of the three refrigerants must be correctly identified to get all points for this section.)-- award 4 points

TOTAL SCORE (125 max)

7

2010 SkillsUSA Championships
HVACR Contest

June 24, 2010 Kansas City, Missouri

Contestant Score Sheet

Event #7: Refrigerant Procedures **Sponsor: JKL Technical Sales**

45 minute max

Stop Time	
Start Time	
Total	

Contestant # _____

Judge's Initial's _____

		Score	Points
A.	Safety Glasses		(0 – 2)
B.	**Identify correct refrigerant type for this system?**		(0 – 3)
C.	Connect gauges properly to system		(0 – 8)
D.	Check system for refrigerant leak		(0 - 10)
E.	Connect recovery unit to system and tank		(0 – 8)
F.	Proper Use of Pressure Vessel		(0 – 2)
G.	**Tank Pressure Rating?**		(0 – 2)
H.	**Tank Certification Date?**		(0 – 2)
I.	**Type of Refrigerant in Tank?**		(0 – 6)
J.	Perform recovery through a complete pull down		(0 – 5)
K.	**EPA required level unit must be pulled down to?**		(0 – 5)
L.	Correctly connect vacuum pump and vacuum gauge		(0 – 5)
M.	**Purpose of pulling a vacuum on the system?**		(0 – 5)
N.	**Purpose of an electronic vacuum gauge?**		(0 – 6)
O.	Check vacuum pump for performance		(0 – 3)
P.	Complete evacuation of the system		(0 – 10)
Q.	Check system for vacuum leaks		(0 – 5)
R.	Use the charging device, set up to properly recharge		(0 – 9)
S.	**Proper refrigerant & charge for this unit?**		(0 – 3)
T.	**Procedure for checking refrigerant/oil in a system?**		(0 – 4)
U.	**Procedure for cleaned refrigerant in a working system?**		(0 – 4
V.	**Nameplate is not available, how is charge determined?**		(0 – 6)
W.	Replace all tools to their original locations		(0 – 4)
	Subtotal		**(117 max)**
X.	Identify the type of refrigerant in tanks		(0 – 8)
	Total		**(125 max)**

NOTE: Maximum score – **125 Points**

7

8

2010 SkillsUSA Championships
HVACR Contest

June 24, 2010 Kansas City, Missouri

Contestant Procedure Sheet

Event #8 Electrical Troubleshooting, Gas Heating **Sponsor: Carrier Corp.**

Contestant: Read this entire "Procedure Sheet" page and clarify any questions you have with your judge before starting this event.

Time Allowed: 15 Minutes

DESCRIPTION OF THIS JOB

- This exercise involves diagnosing an inoperable gas furnace.

SITUATION:

- It is 4:30pm on Thursday afternoon in January. Your company has just installed a gas furnace for Mrs. Homeowner. The installers could not get the furnace to operate and have left the jobsite. Your employer has dispatched you with instruction to 'get the furnace running before you go home tonight.'

TASK:

- Determine why the heat is not operating.
- Before taking corrective actions check with judge
- Explain determination process and conclusions to the judge

JUDGE'S NOTES:

- Have Contestant read "Problem Statement" prior to starting.
- Clarify questions before beginning.
- "Problem Statement" must not leave immediate contest area.

8

2010 Skills USA Championships

HVACR Contest

June 24, 2010, Kansas City, Missouri

Judging Guidelines/Procedures

Event #8: Electrical Troubleshooting, Heating **Sponsor: Carrier Corporation**

Overview

Problem

The problem consists of an 80% AFUE gas furnace that has a blown low voltage fuse in it's control circuit. Also, there are several wires disconnected since "brother-in-law" has attempted to repair the unit (see Contestant Procedure Sheet).

Before contestant arrives at the station, the judge will insure the low voltage wiring is disconnected from the control board, the wire harness is disconnected from the control board, the ignition wire is removed from the igniter, the thermostat is set to "off", and the furnace doors are resting against the unit .

Expected Contestant Diagnostic Logic

Contestants are expected to

A. Read the Problem Statement

B. Correct visible wiring problems using the furnace's wiring diagram.

- Disconnect Power
- Connect low voltage wiring to control board
- Connect igniter wiring
- Connect wiring harness to controls.
- Reapply power

C. Turn the thermostat to "call" heat

D. Observe Unit Operation

- Unit will not display any low voltage and will not attempt any ignition sequence
- The burner will not fire

E. Utilize a VOM meter and/or amber light observation to determine:

- No 24 volts in furnace control system.

F. Contestant explains findings to judge and how the problem should be corrected.

G. Judge dismisses contestant (replacing the flame sensor is not required)

2010 Skills USA Championships

HVACR Contest

June 24, 2010, Kansas City, Missouri

Judging

Upon Contestant Arrival Judge:

- Records Contestant Number
- Allows contestant ample time to review Problem Statement
- Answers questions contestant may have unless answer will provide contestant unfair advantage
- Once contestant is ready the judge will record start time
- After the contestant offers final explanation judge will record stop time

Safety

A. Wear safety glasses – Five (5) points
   - Safety glasses must be in place before starting contest. Contestant is permitted to have glasses removed while reading Problem Statement.
   - Points are awarded in an “all or nothing” basis

B. Use tools and work safely – Fifteen (15) points
   - Tools and test instruments must be used in accordance to their intended purpose. Any other use is not permitted (i.e. using a screwdriver for prying).
   - Point guideline
     - Points are awarded for observing all safety procedures
     - Ten points are deducted for connecting wiring or otherwise working on electrical (unless making voltage check) with unit powered
     - Five points are deducted for using tools and instruments for purposes other than intended (ie using a screwdriver for prying).

Performance

A. Use tools properly? – Five (5) points
   - The only hand tools necessary for this station is a screwdriver to change the low voltage wires.
   - Points are awarded in an “all or nothing” format

B. Use instruments properly? – Five (5) points
   - Use of VOM to measure phasing of unit and/or checking microamperes

C. Did contestant:
   - Reconnect low voltage wiring? – Five (5) points
     - Points awarded on an “all or nothing” basis
   - Reconnect igniter wiring? – Five (5) points
     - Points awarded on an “all or nothing” basis

- Reconnect wiring harness? – Five (5) points
    - Points awarded on an “all or nothing” basis
- Correctly diagnose “blown” fuse? – Twenty (20) points
    - Points awarded based on diagnostics
        - Zero (0) points for incorrect diagnostics
        - Ten (10) points for stating that a problem exists in addition to the blown low- voltage fuse.
        - Twenty (20) points for stating that the fuse appears to be the only problem.

D. Did contestant follow proper/logical procedure? – Thirty (30) points

- This section is subjective, however the following are guidelines the judge should use
    - Did contestant use a systematic approach in searching for the problem? – Five (5) points
    - Did contestant reconnect wiring and attempt to fire the unit before making diagnosis? – Five (5) points
    - Did contestant’s actions appear to be consistent with expected diagnostic procedures? – Twenty (20) points

E. Explain findings to judge properly? – Thirty (30) points

- At the conclusion of the station the judge will ask the contestant, “How did you come to your conclusions?” and “Tell me about your diagnostic approach.”
- This section is subjective, however the following are guidelines the judge should use
    - Did contestant explain diagnostics in a manner constant with the problems?
        - General comments about unit and correcting wiring issues – Ten (10) points max
        - How determination was made with regard to defective control fuse – Twenty (20) points max
            - Note: at least 50% point loss if contestant indicates that a problem exists in addition to the “blown” fuse. (i.e. failed control PCB) or appears to be guessing.

8

2010 SkillsUSA Championships
HVACR Contest

June 24, 2010 Kansas City, Missouri

Contestant Score Sheet

Event #8: Electrical Troubleshooting, Heating **Sponsor: Carrier Corporation**

Troubleshooting
15 minute max

Stop Time _____ Contestant # _____

Start Time _____

Total _____ Judge's Initial's _____

	Score	Points
1. Safety		
A. Wear safety glasses	_____	(0 or 5)
B. Used tools safely and worked safely	_____	(0 to 15)
2. Performance		
A. Use tools properly?	_____	(0 or 5)
B. Use instruments properly?	_____	(0 to 5)
C. Did contestant:		
1. Check low voltage wiring for power?	_____	(0 or 10)
2. Use the correct tools?	_____	(0 or 10)
3. Use the troubleshooting charts?	_____	(0 or 10)
4. Use a logical diagnostic procedure?	_____	(0, 10, or 20)
5. Correctly identify the fault?	_____	(0 to 30)
D. Explain findings to judge properly?	_____	(0 to 15)
Total	_____	(125 max)

Note: No fractional points to be given.

8

HVAC/R NET Chairman's Report
2010 SkillsUSA Championships
(Heating, Ventilation, Air Conditioning, and Refrigeration)

By: Richard D. Dorssom C.M.S., National Education Team Chairman
HVAC/R Instructor
Hillyard Technical Center
3434 Faraon Street
St. Joseph, Missouri 64506
816-671-4170
rick.dorssom@sjsd.k12.mo.us

The 2010 National SkillsUSA HVAC/R Championships were held on June 24, 2010 at Bartle Hall in downtown Kansas City, Missouri. This year the contest had eight (8) different stations. Station number seven (6) was a written test. The test was taken on Tuesday June 22, 2010. Warren Lupson, Director of Education at ARHI, and Pat Murphy, Technical Development Director, at NATE, were the proctors of the test. The test was ARI-ICE Light Commercial.

On Thursday, June 24, 2010, our contest had 53 combined Secondary and Post Secondary contestants. Judges looked for safety consciousness, troubleshooting skills, general knowledge, and the contestant's quickness in determining or fixing the related problem.

Station 1 Brazing. The contestants were given 60 minutes to interpret, cut, fabricate, and braze a piping project from a blueprint. This year's piping project consisted of 3/8" hard drawn copper and steel, copper 90's, 45's couplings, tees and a brass sweat type Schrader fitting. Contestants had to cut and ream sections of pipe to length using tubing cutters, sand and properly clean joints, assemble the apparatus and then correctly flux, solder, and braze the sections of pipe according to the directions on the drawing. Contestants used *Harris* oxyacetylene torch sets, and also they had available a *Harris* air acetylene torch. . *Harris* provided the alloys, torch outfits, and materials used this year. Contestants used *Dynaflow 6%* silver brazing alloy, *Safety Sil 45%* Silver brazing alloy. Once the projects were completed each one was pressurized with nitrogen and dunked in a bucket of water to check for leaks. The contestants were alloted 1 hour in this contest area. The contest chair was Robert Henson of *Harris*.

Station 2 Mechanical Service Procedures. Contestants were given a complaint sheet that stated: "The complaint is poor or no cooling. System runs continuously. Normal conditions: 115psig HP, 21 psig LPO, 12.1 amp, 10 F SH, 10 F SC." The problem was the valves were broken and the compressor operated ineffieciently.The contestants were allotted 30 minutes in this contest area. The contest chair was Steve Brown of *Emerson Climate Controls.*

Station 3 Airflow and Superheat Measurement. The contestants were given 25 minutes in the two-part contest. First the contestants had to determine the amount of airflow in CFM existing in a rectangular plenum for a split system *Carrier* R-410A unit. Contestants were allowed two different methods of airflow calculation. They could use either the temperature rise for electric heat or the velocity method using a magnehelic gauge in conjunction with a duct traverse. Once the amount of airflow was determined, contestants then had to find out what the superheat was for the R-410A piece of equipment. *Carrier* furnished 4 Performance (mid-level) 2-ton 13SEER R-410a units. The contestants were allotted 25 minutes in this contest area. The contest chair was Les Karcher of *Carrier.*

Station 4 Residential AC Electrical Troubleshooting. Contestants had to use the proper instruments and procedures, diagnose, analyze and describe the nature of an electrical control failure on a residential air conditioning system. The contestants were given a complaint sheet that stated: "The problem consists of a new air conditioning unit not cooling the home. The dispatcher for your heating and cooling company instructed the customer to turn the thermostat blower switch to "on" until you could arrive to troubleshoot". The contestants were given 15 minutes in this contest area. This contest also had a 5 minute schematic reading and interpretation process. The contest chair were David King and of *Lennox Industries.*

Station 5 Refrigeration System Troubleshooting. The equipment used was 3 self contained refrigeration display cases. The complaint was: You're about to deliver a new unit to your customer. A quick check reveals that the compressor does not operate. Use the digital VOM and the electrical diagram to trace the voltage path. The contestants were given 15 minutes in this contest area. The contest chair was Thomas L. Brown of *Hussmann.*

Station 6 Written Test

Station 7 Refrigerant Recovery. Contestants were given the following: A *York* package air conditioning system an *Appion* recovery machine with tank, a set of manifold gauges, a digital scale, an electronic leak detector, a vacuum pump, and a digital micron gauge. The contestants had to properly hook the recovery unit to the air conditioning system and recover the refrigerant. Then the contestant had hook up the vacuum pump and micron gauge and evacuate the system to industry standards. The next step was to properly connect a refrigerant cylinder to the system and recharge it by weight using the digital scales. Afterward the system was checked for leaks by using an electronic leak detector. This contest consisted of two parts. Once the contestant completed the previous steps, they moved on to a refrigerant identification station. Here contestants had to identify three unknown refrigerants. Three unmarked containers held different refrigerants. Each cylinder had a digital thermometer attached to it to display its temperature, and each cylinder had a pressure gauge displaying its pressure. Using a temperature/pressure chart, contestants had to identify each of the three refrigerants. The contestants were to identify if the recovery tanks within a legal test date and the size of tank used. The contestants

were given 45 minutes to complete the contest area. The contest chair was Rick LeBeau of *JKL Tech Sales Inc.*

Station 8 Residential Furnace Electrical Troubleshooting. The contestants were assigned to a *Carrier* 80% gas furnace. Using the proper instruments and procedures, determine and explain the nature of a heating failure in a gas furnace. The complaint sheet stated: " It is 4:30 on Thursday afternoon in January. Your company has just installed a gas furnace for Mrs. Homeowner. The installaters could not get the furnace to operate and have left the jobsite. Your employer has dispatched you with instructions to "get the furnace running before you go home tonight". The contest chair was *Paul Jackey* of *Carrier*.

I would like to recognize the people that help in our area to make this contest operate so smoothly.
The Members of the National Technical Committee: Bob Mikell (Carrier), Lynn Bosse (Lennox), Co-Chairs; Warren Lupson (ARHI), Mike Eckstein (RSES), Les Karcher (Carrier), Pat Murphy (NATE), Rick Lebeau (JKL Tech sales), David King and Bill Roberts (Lennox) Robert Henson (Harris) .
The Educational Team:
Todd Huxford.
All of the set up teams and judges from the following companies or organizations: J.W. Harris, Carrier, Emerson climate control, Hussmann, CFM, Washington Alloy, Comfort Products, York, RSES (local and national), Lennox, Mingledorff Inc.,ARHI, Parker/Sporlan Valves, HVAC Excellence, Mueller Co., CFM Distributors.

I would like to thank the instructors for helping their students to become champions, our students are our future. After watching this years contest like every other year I know that our future will be in good hands.

Some random thoughts for Instructors and future contestants, Learn schematics, digital VOM's (have faith in what you read). Use good troubleshooting methods. Test all of the switches in the control circuit. Use the LED light to help find the problem. ECM motors are not turned on by a contactor. Gas Furnaces (other than standing pilot), CFM Calculations (Anemometers are expensive tools, Magnehelics are less expensive).Duct area vs Duct measurement. Effects of too much or too little airflow. Be able to convert velocity first from all readings before you do an average. Remember that technology is ever changing in this field, and we as Instructors and Technicians must keep current.

Until Next year, Be Safe, and God Bless.

SkillsUSA
2010 Contest Projects

Industrial Motor Control

Click the “Print this Section” button above to automatically print the specifications for this contest. Make sure your printer is turned on before pressing the button.

Skills Process/Mixing Equipment Control Problem (2010)

Skill's has hired your company to wire a control circuit for Process/Mixing Equipment.

The equipment consists of a tank for mixing three liquids (liquids "A", "B" and "C" will be controlled by solenoid valves). A mixer paddle to mix the three liquids. A drain solenoid valve and pump to empty the tank.

Conditions:

1. A stop/start station will control power to the process.
2. The tank is empty with the low level float switch closed and the high level float switch open (this is one switch with two contacts and will operate together).

Customer Requirements: (Work description)

The operator must have control to stop and start the operation with a green indicator light signaling when the process has power. The operator must be able to monitor the process: a red indicator light when the mixing motor is ON and a green indicating light when the drain valve is open and the drain pump is ON.

Sequence of Operation:

The operator will engage the start button on the stop/start station. At this point the operation is automatic.

a. Liquid "A", "B" and "C" will start to flow
b. Liquid "A" and "B" will stop flowing after a predetermined time period
c. The Mixer will come on after Liquids "A" and "B" stop flowing
d. Liquid "C" will continue to flow until the tank is filled – the mixer will turn off when the tank is full
e. A full tank will open the drain valve and start the drain pump
f. The tank will continue to empty its contents until the low level switch is activated – the drain valve will close and the drain pump will stop and the cycle will start over.

Material List (2010)

Qty.	Description
1	Large Enclosure - 24" X 18"
1	Push Buttons Oiltight 1NC (red)
1	Push Buttons Oiltight 1NO (push to test – green)
1	Pilot light Oiltight (green)
1	Pilot light Oiltight (red)
1	Limit Switch CH E50SA 1NO/1NC
1	Motor Starter Open (CH C306GN3)
1	Motor Starter Enclosed (CHECN0511AAA)
1	Motor Starter Aux Blocks C-H C320KGT15 Top-2NO/2NC
2	Relay - 4PDT - D2PR4A
2	Relay Sockets - 4PDT - DP2PA4
1	Timing Relay/w/socket CH TRNP240AC
20′	EMT ½"
2	EMT ½" Box connectors
7′	MC cable – 14-4 /w/ ground
2	MC Cable box connectors – ½" straight
1	MC Cable box connectors – ½" 90 degree
3	MC Cable 1-hole straps
1′	Metal Flex ½"
2	Metal Flex ½" Box connector straight
5′	Liquid Tight ½"
10	Liquid Tight ½", Box connector straight
2	Liquid Tight ½", Box connector 90 degree
5	½" HW, 1-hole strap
6	Oct. Box, 4" x 1 1/2"
6	Lamp holders
6	Lamps
15′	14 awg THHN – Black
25′	14 awg THHN – White
20′	14 awg THHN – Red
15′	14 awg THHN – Green
1	Power cord with cord grip
25	#10 x ¾" Sheet metal screw
2	# 8 x 1 1/2" Sheet metal screw
1	Ground Bar 10 or greater holes
Misc.	Wire nuts, tape, marker book, tie-wraps, ground screws/clips
1	Terminal strip – 10 blocks (din rail mounted – replaceable blocks)

SPECIFICATIONS: Skill's 2010 – Process/Mixing Equipment

1. The work area consists of a 4' x 8' sheet of plywood. All AFF measurements will be from the bottom of the plywood.

2. All work will be done using the 2008 NEC.

3. Installation must utilize minimum materials while still meeting all requirements.

4. All box and device mounting dimensions will be to the center of the box or device unless otherwise specified.

5. Power will be supplied by cord set attached to the large enclosure.

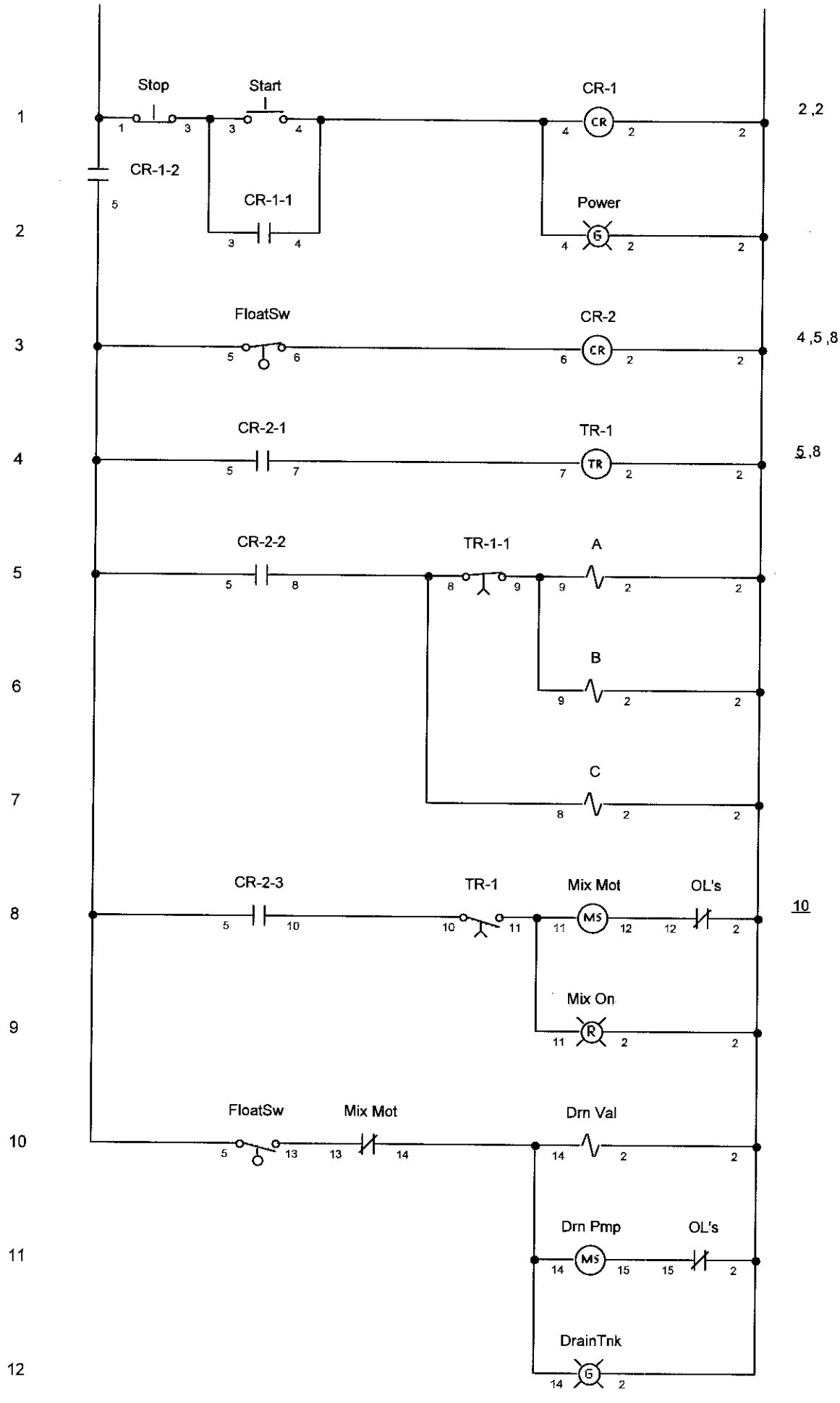
6. Porcelain light fixtures and lamps will be used to simulate all motors and solenoids The lamp indicating the "Mixer" is mounted 27" AFF and 12" from the left edge of board. The lamp indicating the "Drain Pump" is mounted 18" AFF and 12" from the left edge of board. A lamp mounted 42" AFF and 24" from right edge of the board to the right side of the box will simulated the solenoid for liquid "A". A lamp mounted 27" AFF and 24" from the right edge of the board to the right side of the box will simulate the solenoid for liquid "B". A lamp mounted 18" AFF and 24" from the right edge of the board to the right side of the box will simulate the solenoid for liquid "C". (Use liquid-tight flexible non-metallic conduit for the above.) A lamp mounted 60" AFF and 6" from the right edge of the board will simulate the solenoid for the drain valve. (EMT will be used for this solenoid.)

7. The Float Switch is a limit switch. The Float Switch will be mounted 3' AFF to the bottom of the switch and 6" from right edge board to the right side of the limit switch. Use MC cable for the limit switch. The switch will be mounted so the long side is parallel to the floor.

8. The "Mixer" starter will be mounted in the control enclosure. The "Drain Pump" starter will be mounted 3' AFF to the bottom. (Use flexible metal conduit between the large enclosure and the starter.)

   The motors in Item 8 (simulated by porcelain light fixtures) will be wired with black wire for the current carrying conductor and white wire for the neutral. The neutral will not be broken (i.e. it will feed through the starter).

9. The job is not complete until the Job Work Sheet is filed out.


1
Stop
Start
CR-1
2 ,2
1
3
3
4
4
CR
2
2
CR-1-2
5
CR-1-1
Power
2
3
4
4
G
2
2
FloatSw
CR-2
3
4 ,5 ,8
5
6
6
CR
2
2
CR-2-1
TR-1
4
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7
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CR-2-2
TR-1-1
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9
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B
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C
7
8
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2
CR-2-3
TR-1
Mix Mot
OL's
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MS
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12
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Mix On
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11
R
2
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FloatSw
Mix Mot
Drn Val
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5
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13
14
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2
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Drn Pmp
OL's
11
14
MS
15
15
2
DrainTnk
12
14
G
2

Work Sheet **Contestant Number** _____

Page No._____ **Date:**_____

Customer Name: 2010 Industrial Motor Control Competition **Work Station**_____
Address: Bartle Hall
Kansas City, Missouri 64105
Phone: None

Work Description:_____
_____
_____

Quantity	Item Description	Unit Cost	Total Cost	
	Total Additional Materials from Attached Pages			
	Total Materials			

Arrived on Job Site:	Departed Job Site:

Labor to Be Billed	Name	Hours (Regular)	Hours (Overtime)

I hereby acknowledge satisfactory completion of work as described.

Work approved by:_____ **Date:**_____

Continuation Sheet

Page ___ of ___ **Job Number_____**

Quantity	Item Description	Unit Cost	Total Cost	
	Total This Page			

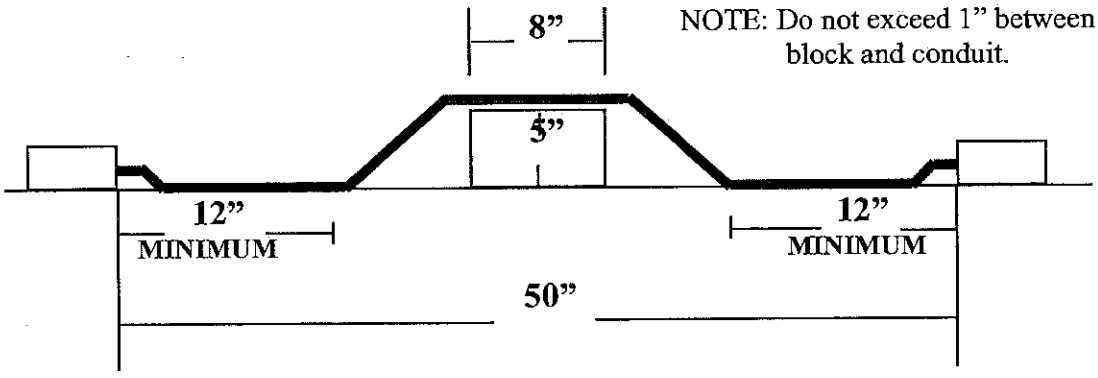
Continuation Sheet

Page ___ of ___ **Job Number_____**

Quantity	Item Description	Unit Cost	Total Cost	
	Total This Page			

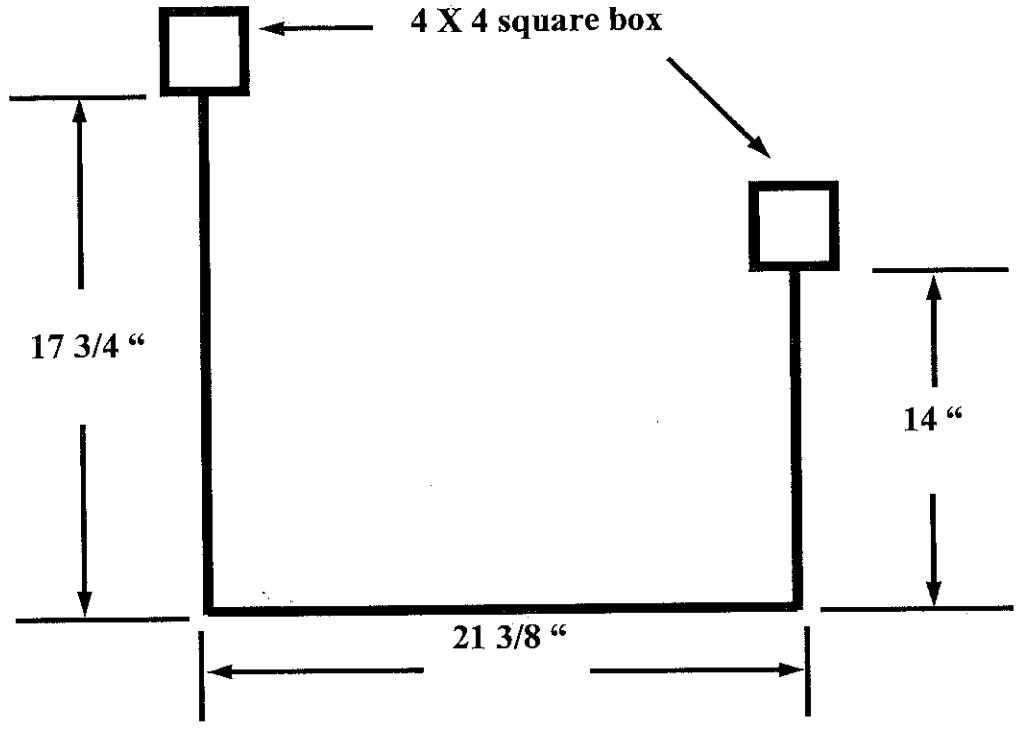
CONDUIT ASSIGNMENT

1. **Make each conduit bend from the measurements shown.**
2. **Offsets are required at all boxes.**
3. **Label your conduit and place at the edge of your work station.**
4. **You may use a 4" square box to get the box measurements.**
5. **All measurements - within 1/8"**



CONDUIT ASSIGNMENT

1. **Make each conduit bend from the measurements shown.**
2. **Offsets are required at all boxes.**
3. **Label your conduit and place at the edge of your work station.**
4. **You may use a 4" square box to get the box measurements.**
5. **All measurements - within 1/8"**



Skills USA 2010 Motor Control Test

Student # _____

For the first 12 questions, draw the appropriate electrical symbol that represents each term.

1 _____ Normally closed push button

2 _____ Normally open push button

3 _____ Normally open pressure switch

4 _____ Normally closed flow switch

5 _____ Normally open float switch

6 _____ Normally closed limit switch

7 _____ Normally open held closed limit switch

8 _____ Normally open temperature switch

9 _____ Normally open to close: delay on energize

10 _____ Normally closed to open: delay on energize

11 _____ **Normally open to open: delay on de-energize**

12 _____ **Normally closed to close: delay on de-energize**

For the remaining questions, write the letter representing the correct answer on the line following the question number.

13 _____ **Conductors sizes are expressed in American Wire Gage (AWG) or _____.**

a. inches
b. circular mils
c. square inches
d. AWG

14 _____ **The *NEC* requires that electrical work be _____**

a. installed in a neat and workmanlike manner
b. installed under the supervision of a qualified person
c. completed before being inspected
d. all of these

15 _____ **Determine the allowable ampacity of six current carrying No. 8 THW copper conductors installed in EMT with an ambient temperature of 30°C**

a. 40A
b. 45A
c. 50A
d. 55A

16 _____ **The auxiliary contact used to maintain a circuit to the coil of a relay when the start button is released is known as the**

a. holding contact
b. maintaining contact
c. sealing contact
d. all of these

17 _____ **Conductor ampacity must be de-rated when more than ___ current-carrying conductors are grouped together in a raceway or cable**

a. two
b. three
c. four
d. six

18 _____ **The rating of a branch circuit shall be determined by the rating of the _____ .**

a. ampacity of the largest device connected to the circuit
b. average of the ampacity of all devices
c. branch-circuit over-current devices
d. ampacity of the branch-circuit conductors according to Table 310.16

19 _____ **Resistance values for conductors to be used when calculating voltage drop are given in ___**

a. Table 310.15
b. Table 310.16
c. Table 400.5
d. Table 8 of Chapter 9

20 _____ **A *continuous load* is one that is expected to operate ___**

a. for three hours or more
b. daily
c. at peak connected load
d. none of these

21 _____ **Illumination shall be provided for all working spaces about service equipment, switchboards, panel-boards, and motor control centers**

a. Over 600V
b. Using automatic means of control
c. Rated 1,200A or more
d. Located indoors

22 _____ **The *NEC is* _____ .**

a. Intended to be a design manual
b. meant to be used as an instruction guide for untrained persons
c. for the practical safeguarding of persons and property from hazards arising from the use of electricity
d. published by the Bureau of Standards

23 _____ **Which of the following is not a standard size fuses of inverse time circuit breaker?**

a. 45A
b. 70A
c. 75A
d. 80A

24 _____ **For general motor applications, the motor branch-circuit short-circuit protection device shall be sized based on the _____ values**

a. motor name plate
b. NEMA standard
c. *NEC* Table
d. factory manual

25 _____ **The motor _____ currents listed in Table 430.247 through 430.250 shall be used to determine the ampacities of motor circuit conductors and short-circuit and ground-fault protection devices.**

a. nameplate
b. full-load
c. power factor
d. service factor

26 _____ **The current in ampears a conductor can carry continuously, where the temperature will not be raised in excess of the conductor's insulation temperature rating is called its _____ .**

a. short-circuit rating
b. ground-fault rating
c. ampacity
d. all of these

27 _____ **Motors shall be located so that adequate _____ is provided and so that maintenance, such as lubrication of bearings and replacement of brushes, can be readily accomplished.**

a. space
b. ventilation
c. protection
d. all of these

28 _____ **For stationary motors of 2 HP or less and 300V or less on a ac circuits, the controller is permitted to be an ac-rated general-use snap switch where the motor full-load current rating is not more than ___ percent of the rating of the switch**

a. 80
b. 50
c. 75
d. 125

29 _____ **In determining the highest rated motor for the purposes of 430.24, the highest rated motor shall be based on the rated full-load current as selected _____ .**

a. from the motor nameplate
b. from Tables 430.247 through 430.250
c. from taking the horsepower times 746 watts
d. using the largest horsepower motor

30 _____ **Branch-circuit conductors supplying a single continuous-duty motor shall have an ampacity not less than _____ rating**

a. 125 percent of the motor's nameplate current
b. 125 percent of the motor's full-load current as determined by 430.6(A)(1)
c. 125 percent of the motor's locked-rotor current
d. 80 percent of the motor's full -load current

31 _____ **The total opposition to current flow in an ac circuit is expressed in ohms is called**

a. resistance
b. reluctance
c. conductance
d. impedance

32 _____ **Feeder tap conductors supplying motor circuits, with an ampacity at least one-third that of the feeder, shall not exceed _____ in length.**

a. 10 ft
b. 15 ft
c. 20 ft
d. 25 ft

33 _____ **Overload devices are intended to protect motors, motor control apparatus, and motor branch-circuit conductors against _____ .**

a. excessive heating due to motor loads
b. excessive heating due to failure to start
c. short circuits and ground faults
d. a and b

34 _____ **Motors with a nameplate service factor (SF) rating of 1.15 or more must have the overload protection device sized at no more than ___ percent of the motor nameplate current rating**

a. 100
b. 115
c. 125
d. 135

35 _____ **If a dual-element fuse is used for overload protection, what size fuse is required for a 30 hp, 460V, three phase synchronous motor, with a temperature rise of 38°C ?**

a. 20 A
b. 30 A
c. 25 A
d. 40 A

36 _____ **Unless overload protection is provided by other approved means, the minimum number of overload units required for a three-phase ac motor is _____ .**

a. one
b. two
c. three
d. any of these

37 _____ **The maximum rating or setting of an inverse time breaker used as the motor branch-circuit short-circuit and ground-fault protective device for a single-phase motor is _____ percent of the full-load current given in Table 430.52**

a. 125
b. 175
c. 250
d. 300

38 _____ ***NEC* 310.3 requires that conductors 8 AWG and larger must be ___ when installed in a raceway**

a. grounded
b. bonded
c. stranded
d. none of these

39 _____ **The internal diameter of a 1" trade size EMT is _____ .**

a. 1" b. .824"
c. .96" d. 1.049"

40 _____ **Only wiring methods recognized as _____ are included in the *NEC* code.**

a. expensive b. efficient
c. suitable d. all of these

41 _____ **_____ is a term indicating that there is an intentional delay in the tripping action of the circuit breaker, which decreases as the magnitude of the current increases**

a. Adverse time b. Inverse time
c. Time delay d. Timed unit

42 _____ **The branch-circuit conductors supplying a motor that draws 40 amperes must have an ampacity not less than:**

a. 40 A b. 50 A
c. 60 A d. 70 A

43 _____ **If no other information is given, a motor that draws 100 amperes must be protected by an overload device rated at not more than:**

a. 115 A b. 125
c. 140 d. 150

44 _____ **The conductors between the final over-current device protecting the circuit and the (outlets) are known as ____ conductors.**

a. feeder b. branch-circuit
c. home run d. none of these

45 _____ **The conductors of a feeder supplying two (2) continuous duty motors, one 7 1/2 hp, 240 volts dc, and one rated 10 hp 240 volts dc shall have a current rating not less then:**

a. 56 A b. 74 A
c. 77 A d. 84 A

46 _____ **An electric heater is rated 10 kW @ 277 volts. What is the kW output of this heater if it is connected to a 240 volt source?**

a. 5 KW
b. 7.5 KW
c. 8.7 KW
d. 10 KW

47 _____ **In a 3-wire, 3-phase ac system feeding a motor, with one conductor grounded, where must fuses for motor overload protection be inserted in the circuit?**

a. A fuse must be inserted in each ungrounded conductor and also in the grounded conductor
b. No fuses are required for motor overload protection
c. A fuse must be inserted only in each ungrounded conductor
d. None of these are correct

48 _____ **A power factor correction capacitor connected on the load side of the overload device of a motor reduces the line current by 20%. If the full-load current of the motor is 100 amperes, the setting of an overload device in the circuit is based on a current of:**

a. 80 A
b. 100 A
c. 125 A
d. 135 A

49 _____ **A feeder supplying fixed load(s) shall have a protective device with a rating or setting _____ branch-circuit short-circuit and ground-fault protective device for any motor in the group, plus the sum of the full-load currents of the motors of the group**

a. not greater than the largest rating or setting of the
b. 125 percent of the largest rating of the
c. equal to the largest rating of any
d. none of these

50 _____ **A pneumatic timer operates on the principle of**

a. the decay of a magnetic field in a coil
b. an RC time constant
c. air entering a bellows through an orifice
d. a crystal oscillator

SkillsUSA™
CHAMPIONSHIPS

2010

Industrial Motor Control

Math Test

Secondary _____

Postsecondary _____

Contestant Number _____

PERFORM THE FOLLOWING OPERATIONS

1. $618 + 59 + 274 + 446 =$ _____ **2.** $742 - 366 =$ _____ **3.** $640 \times 58 =$ _____

4. A new type of light fixture will be installed in a machine shop. The new fixtures must be installed for every 121 ft^2 of floor space. If the machine shop has 3388 ft^2, determine the number of light fixtures required _____

SOLVE AND REDUCE TO LOWEST TERMS

5. $17\frac{5}{6} + 4\frac{2}{3} =$ _____ **6.** $17\frac{3}{4} - 6\frac{7}{8} =$ _____ **7.** $4\frac{4}{5} \times 3\frac{1}{3} =$ _____

8. An electrician can bend and install lengths of conduit at a rate of 8¼ per hour. Calculate the length of time it takes the electrician to install 75 lengths of conduit. _____

PERFORM THE FOLLOWING OPERATIONS

9. A maintenance technician measures 8.361′ of wire between the disconnect panel and the control panel, 1.8′ from the top to the bottom of the control panel, 5.73′ from the panel to the 3ϕ motor box, and 0.477′ in the 3ϕ motor box. How many feet of wire are required to run the 3ϕ motor? _____

10. 29.24 gal. – 22.464 gal. = _____ **11.** 0.75 g × 1.6 g × 0.437 g = _____

12. $\frac{120E}{7.5R} =$ _____

SIGNED NUMBERS

13. $6 - (-4.9) =$ _____ **14.** $-18.5 - (-11.2) =$ _____

SOLVE THE FOLLOWING

15. $(6 \times 10^4) \times (5 \times 10^2) =$ _____ **16.** $(12 \times 10^{-3}) \times (4 \times 10^{-8}) =$ _____

ORDER OF OPERATIONS

17. $\frac{21}{7} - 6(20 - 8 \times 2) =$ _____ **18.** $\left(\sqrt{25} + 3\right) - \left(3^3 + \frac{16}{4}\right) =$ _____

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SOLVE FOR THE UNKNOWN

19. $26 - 2a = 8 + a$ $a =$ _____

20. $3x - 17 = 28 - x$ $x =$ _____

21. $\frac{15Y}{3} - 8 = 27$ $Y =$ _____

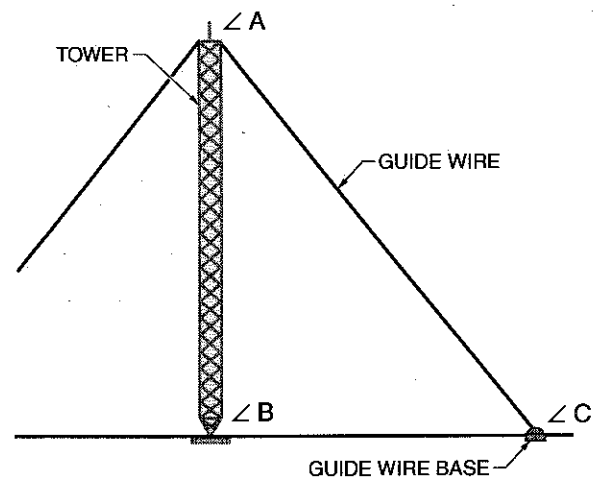
22. In an electrical circuit where $E = I \times R$, the circuit has two (2) loads in series. Load #1 causes a voltage drop of 32 V, and Load #2 causes a voltage drop of 64 V. The total resistance of the circuit is 48 Ω. What is the current in the circuit? _____

USE THE RIGHT TRIANGLE LAWS FOR THE FOLLOWING PROBLEMS

23. If angle A (∠ A) = 53°, then ∠ C = _____.

24. If line BC = 25′ and line AC = 26′, then line AB = _____.

25. If ∠ A = 45° and line AC = 26′, then ∠ C = _____, and line BC = _____.



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SkillsUSA
2010 Contest Projects

Marine Service Technology

Click the “Print this Section” button above to automatically print the specifications for this contest. Make sure your printer is turned on before pressing the button.

Instructions for Skills USA Marine Technologies Test

Description of Test

1. Create a Boat Pre-Delivery Inspection Form

You must create a list of the items, in order of importance, that should be checked before the boat is delivered to the customer. Pre-Delivery forms are used by many dealers to assure that the boat is "customer ready" and all safety features have been checked before the actual delivery takes place.

2. Create a Trailer Pre-Delivery Inspection Form

You must create a list of the items, in order of importance, that should be checked before the boat trailer is delivered to the customer. Pre-Delivery forms are used by many dealers to assure that the trailer is "customer ready" and all safety systems have been checked before the actual delivery takes place.

Pre-Delivery Inspection
Judges Scoring Sheet

Workstation # _____ Contestant #_____

Boat

1. Used boat as example to determine specific items to be checked _____ (25)
2. Included “critical” items like blower operation / fuel leaks _____ (25)
3. Categorize areas if inspection (boat electrical, engine, drive, etc..) _____ (25)
4. Completeness of list _____ (25)

Total _____ (100)

Trailer

1. Used trailer as example to determine specific items to be checked _____ (25)
2. Included “critical” items like tire pressure / brake function / lights _____ (25)
3. Included proper boat to trailer fit / bunk adjustment _____ (25)
4. Completeness of list _____ (25)

Total _____ (100)

Overall Evaluation

1. Used systematic / organized process to determine overall needs _____ (25)

Total Score _____ (225)

Boat PDI List

Work Station # _____ **Contestant #_____**

- ☐ 1 _____
- ☐ 2 _____
- ☐ 3 _____
- ☐ 4 _____
- ☐ 5 _____
- ☐ 6 _____
- ☐ 7 _____
- ☐ 8 _____
- ☐ 9 _____
- ☐ 10 _____
- ☐ 11 _____
- ☐ 12 _____
- ☐ 13 _____
- ☐ 14 _____
- ☐ 15 _____
- ☐ 16 _____
- ☐ 17 _____
- ☐ 18 _____
- ☐ 19 _____
- ☐ 20 _____
- ☐ 21 _____
- ☐ 22 _____
- ☐ 23 _____
- ☐ 24 _____
- ☐ 25 _____

Trailer PDI List

Work Station # _____ **Contestant #_____**

- ☐ 1 _____
- ☐ 2 _____
- ☐ 3 _____
- ☐ 4 _____
- ☐ 5 _____
- ☐ 6 _____
- ☐ 7 _____
- ☐ 8 _____
- ☐ 9 _____
- ☐ 10 _____
- ☐ 11 _____
- ☐ 12 _____
- ☐ 13 _____
- ☐ 14 _____
- ☐ 15 _____
- ☐ 16 _____
- ☐ 17 _____
- ☐ 18 _____
- ☐ 19 _____
- ☐ 20 _____
- ☐ 21 _____
- ☐ 22 _____
- ☐ 23 _____
- ☐ 24 _____
- ☐ 25 _____

Instructions for Skills USA Marine Technologies Test

Description of Test

1. Test Condenser Charge Coil
2. Battery Charge Coil
3. Pulser Coil

You must use the service materials and tools provided to properly measure and record the test information on the Suzuki Outboard electrical ignition components.

You must complete the appropriate section of the worksheet provided as you do the job making notations of the components condition as you proceed.

Skills USA Test Evaluation Form

Work Station #_____ **Technician #_____**

Condenser Charge Coil Tests (14 points each)

1. Setup multi-meter properly for test. _____(14)
2. Examine coil condition-cuts or damage to coil or insulation. _____(14)
3. Performed resistance test and recorded results. _____(14)
4. Used correct specification for determination of results. _____(14)
5. Performed short to ground test properly. _____(14)
6. Reached correct test results _____(14)

Condenser Charge Coil Total _____**(84)**

Battery Charge Coil Tests (14 points each)

1. Setup multi-meter properly for test. _____(14)
2. Examine coil condition-cuts or damage to coil or insulation. _____(14)
3. Performed resistance test and recorded results. _____(14)
4. Used correct specification for determination of results. _____(14)
5. Performed short to ground test properly. _____(14)
6. Reached correct test results. _____(14)

Condenser Charge Coil Total _____**(84)**

Pulser Coil Tests (13 points each)

1. Setup multi-meter properly for test. _____(13)
2. Performed pulser coil resistance tests as shown in materials _____(13)
3. Reached the proper conclusion on pulser coil condition _____(13)

Rectifier Test Total _____**(39)**

General (9 points each)

1. Completed technician worksheet. _____(9)
2. Properly used instructions, tools and followed procedures _____(9)

General Total _____**(18)**

(225 points possible) Grand Total _____

Skills USA Technician Worksheet

W/S#_____ Technician #_____

Condenser Charge Coil Test: (check boxes as completed)

- ☐ Setup multi-meter for proper scale to test
- ☐ Examine coil condition–cuts or damage to coil or insulation _____ OK / bad
- ☐ Perform resistance test on the condenser charge coil. _____ ohms
- ☐ Resistance reading is within specification _____ OK / bad
- ☐ Check for electrical short to bracket ground _____ OK / bad
- ☐ Condenser charge coil should be replaced _____ Yes / No

Battery Charge Coil Test: (check boxes as completed)

- ☐ Setup multi-meter for proper scale to test
- ☐ Examine coil condition–cuts or damage to coil or insulation _____ OK / bad
- ☐ Perform resistance test on the battery charge coil. _____ ohms
- ☐ Resistance reading is within specification _____ OK / bad
- ☐ Check for electrical short to bracket ground _____ OK / bad
- ☐ Battery charge coil should be replaced _____ Yes / No

Pulser Coil Test: (check boxes as completed)

- ☐ Setup multi-meter for proper scale to test
- ☐ Perform pulser coil resistance test.
- ☐ All resistance readings with specification _____ OK / bad
- ☐ Pulser coil should be replaced _____ Yes / No

Electrical Test Station Information

Suzuki DT40 Stator test specifications

Condensor Charge coil	**(Green - Black)**	
	Ω at 20° C	**200 ~ 300**
Battery Charge coil	**(Yellow - Red)**	
	Ω at 20° C	**.2 ~ .5**
Pulser coil	**(Red/White to ground)**	
	Ω at 20° C	**160 ~ 230**

SUZUKI MARINE

Electrical Test Station Information

Suzuki DT200 Stator test specifications

Condensor Charge coil	**(Green - Black/Red)**	
	Ω at 20° C	**200 ~ 300**
Battery Charge coil	**(Yellow - Red)**	
	Ω at 20° C	**.3 ~ .6**
Pulser coil	**(Red/Black - Black)**	
	Ω at 20° C	**160 ~ 230**

2010 Skills USA Championships
Marine Service Technology Contest

Workstation
PTT Electrical Troubleshooting
Judge's Scoresheet

Contestant # _____ Start Time: _____
Judge's Initials: _____ Stop Time: _____
Total Time: _____

Scoring Directions- *Unless otherwise specified,* the performance of each skill should be "0, 5, 10 or 30" using the following criteria.

"0" indicates that the contestant **could not** perform this skill.
A "5, 10 or 30" indicates that the contestant **could** perform this skill.

I. PERFORMANCE:

1. Check red pan switch wire voltage (12V)	____ (0,10)
2. Check red remote switch wire voltage (12V)	____ (0,10)
3. 0 volts – check fuse next	____ (0,10)
4. Switch bypass – PTT goes up	____ (0,10)
5. Switch bypass – PTT goes down	____ (0,10)
6. If jump works, switch is bad	____ (0,10)
7. Switch up mode – 12V on blue wire	____ (0,10)
8. Switch down mode – 12V on green wire	____ (0,10)
9. Relay ground lead – no resistance	____ (0,10)
10. Jump blue lead – motor turns over	____ (0,10)
11. If motor turns over – motor good, bad relay	____ (0,10)
12. If motor doesn't turn over – bad motor, good relay	____ (0,10)
13. Problem #1 – open in blue wire from remote switch	____ (0,30)
14. Problem #2 – green wire to down relay open	____ (0,30)
15. Problem #3 – ground wire (black) to relays open	____ (0,30)

16. **JOB SKILLS:**

Used tools safely and properly.	_____ (0,10)
Cleaned and organized the work area.	_____ (0,5)

POSSIBLE SCORE: ***225 pts.*** **TOTAL** _____

2010 Skills USA Championships

Marine Service Technology Contest

Contestant Worksheet

Contestant # _____

In this task, you will be working on the Power Trim &Tilt (PTT) electrical system. You have two tasks in this lab. First, do the electrical checks listed in your worksheet on this system while it is working normally. This will give you some familiarity with normal readings.

Second, you will "bug" the system. Your job will be to use the troubleshooting list to find the problem. You may use the materials on your table for reference.

Normal Operation
The unit should operate normally at this point. Try both switches and make sure they both make the trim motor operate forward and backward. If you have operational problems, tell the judge now.

Using your materials, check each of the following components and write down your results.

1. Pan switch - check for voltage on the red wire going to the switch. What do you find?

_____

2. Remote switch - check its red wire for voltage. What do you find?

_____

3. If there was 0 volts on the red wire, where would you look next?

_____

4. Switch bypass - take a jumper and go between the red wire and sky-blue wire at each switch. What happens?

_____

5. Now make the same test between the red wire and the light-green wire. What happens?

_____

6. Looking at the results of steps 4 and 5, if the switch wouldn't activate the motor, but the jump did, what does that tell you about the switch?

---

7. Click either switch into the "up" mode. What voltage reading do you get on the sky-blue wire at the "up" relay?

---

8. Perform the same test, but this time click either switch into "down" mode. What voltage reading do you get on the light-green wire at the "down" relay?

---

9. Relay ground lead - check the black ground wires to each relay for continuity to ground. What resistance reading should you get?

---

10. Disconnect the Blue motor lead on the relay and touch it to the positive post on the relay. Does the motor turn over?

---

11. If the motor turns over, what does that tell you?

---

12. If the motor didn't turn over, what would that tell you?

PT&T Electrical System Problems
"Bugged" System

The following tasks involve PT&T problems. You will be given a customer's description of the problem. Find the problem. Use your reference materials to troubleshoot the system.

Do not try to fix the problems you find. Fill in the steps you take to find each problem. If a component is bad, write down your findings. If you find that a section of wire is bad, write down the location, such as "break in the wire between the switch and relay."
After completing each problem, move the problem switch to the up position.

Problem #1 – Move SW1 to the down position
Customer Jones complains that when under way, he can't get the motor to go up when he hits the trim up switch. Write down the steps you take to find the p
roblem.

_____

_____

_____

Problem #2 – Move SW2 to the down position
Customer Smith complains that no matter what he does, the motor won't come down once he has trimmed it up. He ends up having to use the manual release valve to lower it. Write down your troubleshooting steps.

_____

_____

_____

Problem #3 – Move SW3 to the down position
Customer Brown states that the system won't work at all. He can't get any up or down movement. Write down your troubleshooting steps.

_____

_____

_____

When finished, return the paperwork and equipment to its original position.

Instructions for Skills USA Marine Technologies Test

Description of Test

1. Tappet clearance measurement.

You must use the service materials and tools provided to properly measure and record all tappet clearances on this DF40 Four Stroke Suzuki outboard cylinder head. You must complete the appropriate section of the worksheet provided as you do the job. You will be awarded points for each step you perform and completion of the worksheet.

2. Tappet clearance adjustment.

You must determine from your worksheet which tappets require adjustment. Using the service materials and tools provided, perform a tappet clearance adjustment on all tappets not within specification for this DF40 Four-Stroke Suzuki outboard cylinder head. You must complete the appropriate section of the worksheet provided as you do the job. You will be awarded points for each step you perform and completion of the worksheet.

Skills USA Test Evaluation Form

Work Station #____ Technician #_____

Tappet Clearance Inspection (14 points each)

1. Read the instructions carefully. Choose proper thickness gauge. _____(14)
2. Positioned camshaft nose 180^0 to tappet shim before inspection. _____(14)
3. Checked all valve tappet clearances. _____(14)
4. Measured exact clearances if not using GO-NO-GO gauges. _____(14)
5. Recorded clearances on worksheet. . _____(14)
6. Determined correct number of tappets with incorrect clearance _____(14)

Tappet clearance inspection Total _____**(84)**

Tappet clearance adjustment (15 points each)

1. Positioned cam nose 180^0 to shim of incorrect clearance tappets _____(15)
2. Properly removed shims using Suzuki tappet depressor & retainer _____(15)
3. Determined and recorded correct replacement shims _____(15)
4. Properly installed replacement shims _____(15)
5. Properly removed tappet retainer tool _____(15)
6. Use thickness gauge to recheck tappet clearance _____(15)

Tappet clearance Adjustment Total _____**(90)**

General (51 points total)

1. Properly used instructions, tools and followed procedures. _____(13)
2. Completed technician worksheet. _____(13)
3. Technician's work habits – cleanliness – organization. _____(13)
4. Technician's overall attitude – enthusiasm. _____(12)

General Total _____**(51)**

(225 points possible) Grand Total _____

TAPPET SHIM SELECTION CHART

Shim I.D. No. / Present shim size (mm) / Tappet clearance (mm)	218	220	222	224	226	228	230	232	234	236	238	240	242	244	246	248	250	252	254	256	258	260	262	264	266	268	270	272	274	276	278	280	282	284	286	288	290	292	294	296	298	300
	2.18	2.20	2.22	2.24	2.26	2.28	2.30	2.32	2.34	2.36	2.38	2.40	2.42	2.44	2.46	2.48	2.50	2.52	2.54	2.56	2.58	2.60	2.62	2.64	2.66	2.68	2.70	2.72	2.74	2.76	2.78	2.80	2.82	2.84	2.86	2.88	2.90	2.92	2.94	2.96	2.98	3.00
0.00 – 0.04										218	220	222	224	226	228	230	232	234	236	238	240	242	244	246	248	250	252	254	256	258	260	262	264	266	268	270	272	274	276	278	280	282
0.05 – 0.09								218	220	222	224	226	228	230	232	234	236	238	240	242	244	246	248	250	252	254	256	258	260	262	264	266	268	270	272	274	276	278	280	282	284	286
0.10 – 0.14					218	220	222	224	226	228	230	232	234	236	238	240	242	244	246	248	250	252	254	256	258	260	262	264	266	268	270	272	274	276	278	280	282	284	286	288	290	292
0.15 – 0.17			218	220	222	224	226	228	230	232	234	236	238	240	242	244	246	248	250	252	254	256	258	260	262	264	266	268	270	272	274	276	278	280	282	284	286	288	290	292	294	296
0.18 – 0.24	SPECIFIED CLEARANCE / NO ADJUSTMENT REQUIRED																																									
0.25 – 0.29	224	226	228	230	232	234	236	238	240	242	244	246	248	250	252	254	256	258	260	262	264	266	268	270	272	274	276	278	280	282	284	286	288	290	292	294	296	298	300			
0.30 – 0.34	230	232	234	236	238	240	242	244	246	248	250	252	254	256	258	260	262	264	266	268	270	272	274	276	278	280	282	284	286	288	290	292	294	296	298	300						
0.35 – 0.39	234	236	238	240	242	244	246	248	250	252	254	256	258	260	262	264	266	268	270	272	274	276	278	280	282	284	286	288	290	292	294	296	298	300								
0.40 – 0.44	240	242	244	246	248	250	252	254	256	258	260	262	264	266	268	270	272	274	276	278	280	282	284	286	288	290	292	294	296	298	300											
0.45 – 0.49	244	246	248	250	252	254	256	258	260	262	264	266	268	270	272	274	276	278	280	282	284	286	288	290	292	294	296	298	300													
0.50 – 0.54	250	252	254	256	258	260	262	264	266	268	270	272	274	276	278	280	282	284	286	288	290	292	294	296	298	300																
0.55 – 0.59	254	256	258	260	262	264	266	268	270	272	274	276	278	280	282	284	286	288	290	292	294	296	298	300																		
0.60 – 0.64	260	262	264	266	268	270	272	274	276	278	280	282	284	286	288	290	292	294	296	298	300																					
0.65 – 0.69	264	266	268	270	272	274	276	278	280	282	284	286	288	290	292	294	296	298	300																							
0.70 – 0.74	270	272	274	276	278	280	282	284	286	288	290	292	294	296	298	300																										
0.75 – 0.79	274	276	278	280	282	284	286	288	290	292	294	296	298	300																												
0.80 – 0.84	280	282	284	286	288	290	292	294	296	298	300																															
0.85 – 0.89	284	286	288	290	292	294	296	298	300																																	
0.90 – 0.94	290	292	294	296	298	300																																			
0.95 – 0.99	294	296	298	300																																						

1. Measure tappet clearance “Engine cold”.
2. Measure present shim size.
3. Match clearance in vertical column with present shim size in horizontal column

[EXAMPLE]
Tappet clearance is — 0.35 mm
Present shim size — 2.40 mm
Shim size to be used — 2.56 mm

Skills USA Technician Worksheet

W/S#_____ Technician #_____

Tappet clearance inspection: (check boxes as completed)

- ☐ Setup GO / NO-GO gauge
- ☐ Position #1 cylinder exhaust camshaft nose 90^0 to tappet shim
- ☐ Check #1 cylinder exhaust valve tappet clearance
- ☐ Measure exact clearance if not within GO / NO-GO specification
- ☐ Record clearance on worksheet
- ☐ Continue clearance inspection of #1cylinder intake valve tappets and exhaust / intake valve tappets for cylinders #2 and #3

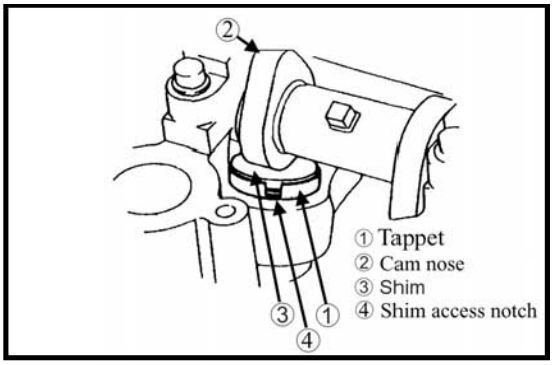
Number of tappets requiring clearance adjustment? None____ # (1~12)_____

Tappet clearance adjustment: (check boxes as completed)

- ☐ Position camshaft nose 90^0 to shim of tappet with incorrect clearance
- ☐ Use Suzuki tappet depressor and retainer to remove tappet shim
- ☐ Determine shim required for proper tappet clearance from shim selection chart and record selection on worksheet
- ☐ Install selected shim into tappet
- ☐ Remove tappet retainer and tappet depressor
- ☐ Use GO / NO-GO gauge to check tappet clearance after installing selected shim
- ☐ Repeat procedure for any tappet you determined to have incorrect clearance
- ☐ Return workstation to as found condition

TAPPET CLEARANCE ADJUSTMENT PROCEDURE SHEET

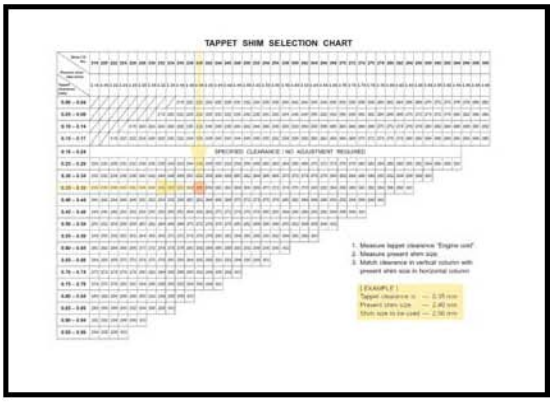
1 Use 23mm open end wrench to turn cam-shaft until cam nose on tappet requiring shim adjustment is at 180° from the tappet shim.



2 Remove the shim from the tappet which you determined had incorrect tappet clearance.

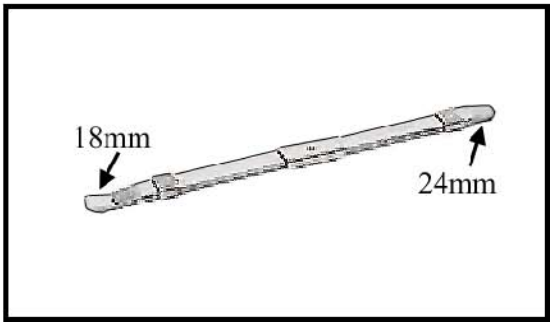
NOTE:
Follow the procedure in the tappet depressor instruction sheet.

1 Using the measured tappet clearance from your worksheet and the thickness of the tappet shim you removed, determine the correct shim for proper clearance from the shim selection chart.



2 Select the correct clearance shim from the shim box, install the shim into the tappet and remove the tapper retainer tool.

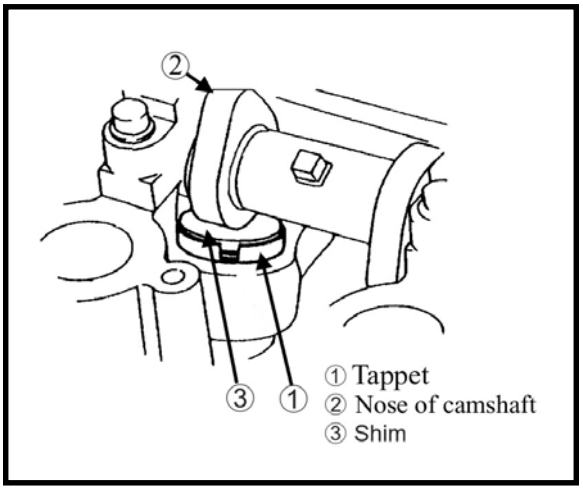
3 Measure clearance after installing the selected clearance shim using the GO / NO-GO gauge. Change worksheet to “OK” if clearance measurement is within specification.



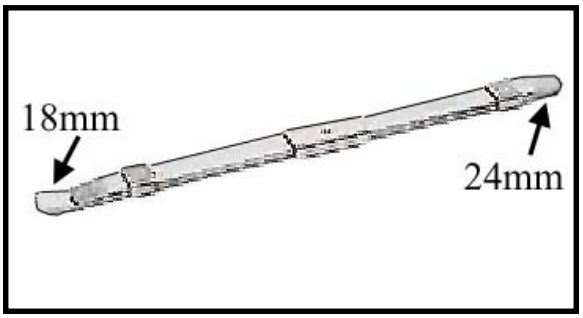
4 Repeat tappet clearance adjustment procedure for all tappets which you determined had incorrect clearance.

TAPPET CLEARANCE MEASUREMENT PROCEDURE SHEET

Tappet clearance (cold engine)
IN. : 0.18 – 0.24 mm (0.007 – 0.009 in.)
EX. : 0.18 – 0.24 mm (0.007 – 0.009 in.)

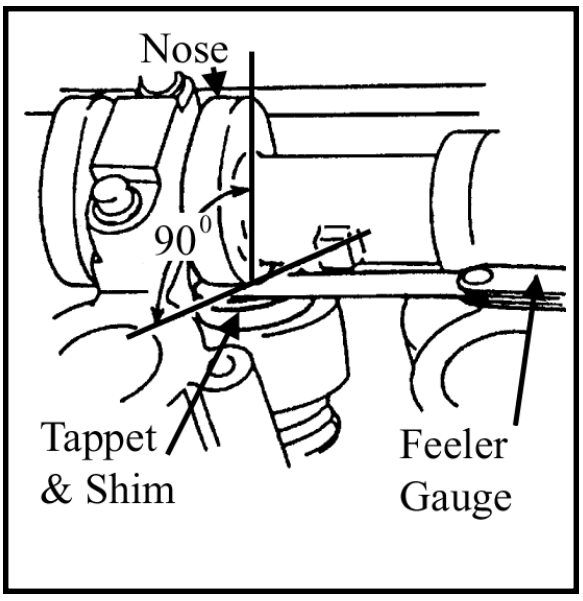


1. Use 23mm open end wrench to turn camshaft until cam nose on the cylinder to be checked is at 90° from the tappet shim.



2. Use Go / No-Go gauge to measure tappet clearance by inserting gauge between base circle of cam and tappet shim.

   If 18mm end is loose and 24mm end is tight or will not fit, mark worksheet as OK for that tappet's clearance.

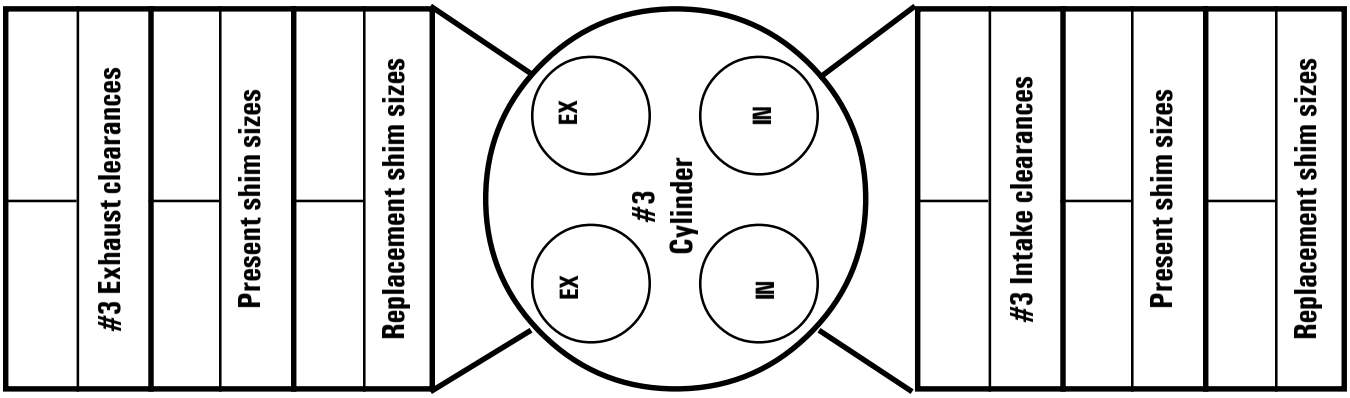


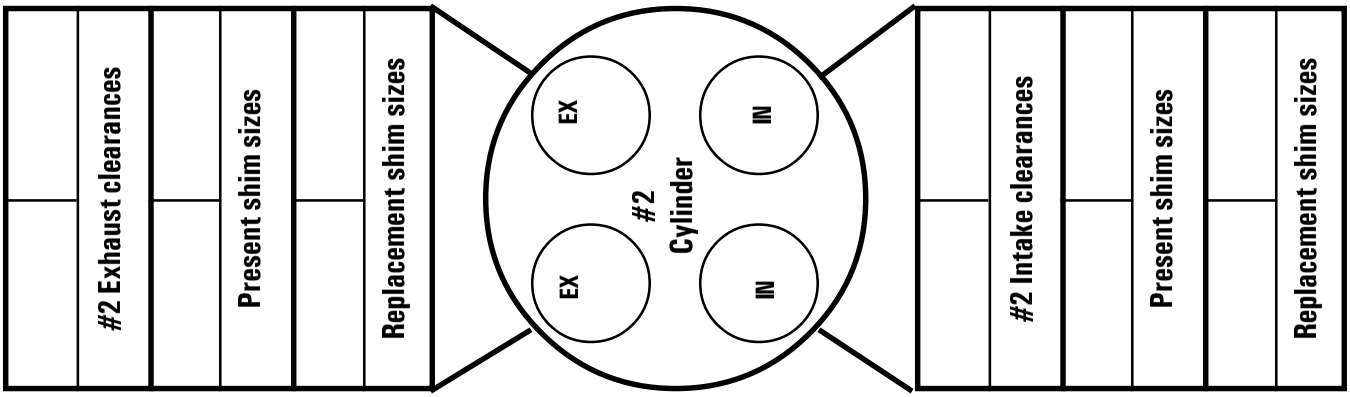
3. Use feeler gauge to determine exact tappet clearance for any tappet which does not meet the Go / No-Go specification.

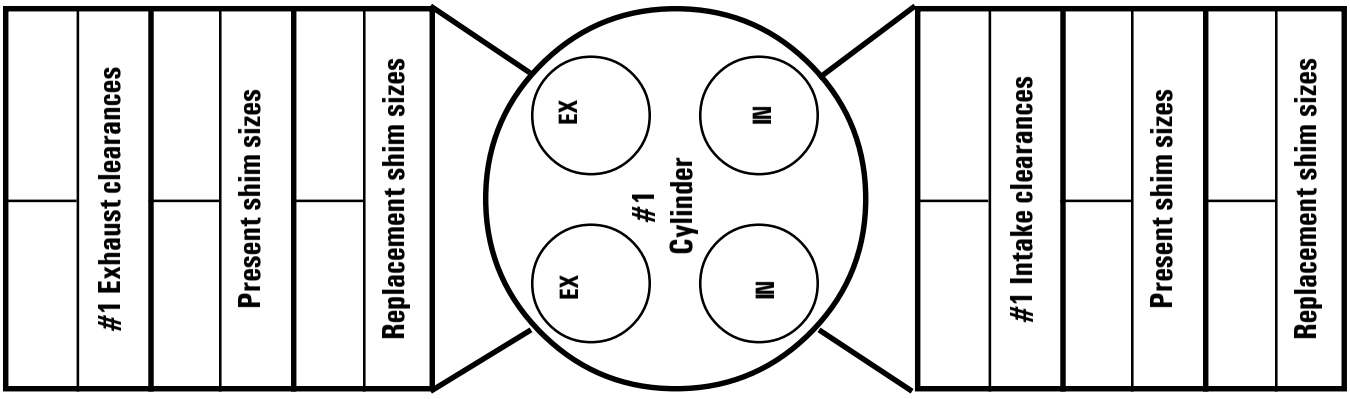
   Mark exact clearance on worksheet.

SKILLS USA Technician Worksheet

W/S#_____ Technician #_____







TAPPET DEPRESSOR INSTRUCTION SHEET

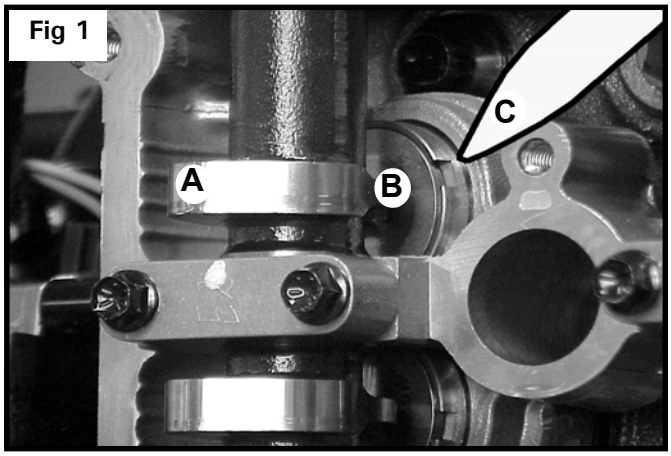
VALVE SHIM REPLACEMENT PROCEDURE:

1. Rotate the camshaft until the cam nose "A" faces 180-degrees away from the tappet shim "B" (Fig 1).

2. Rotate the tappet body until the shim access notch "C" faces towards center of cylinder head (Fig 1).

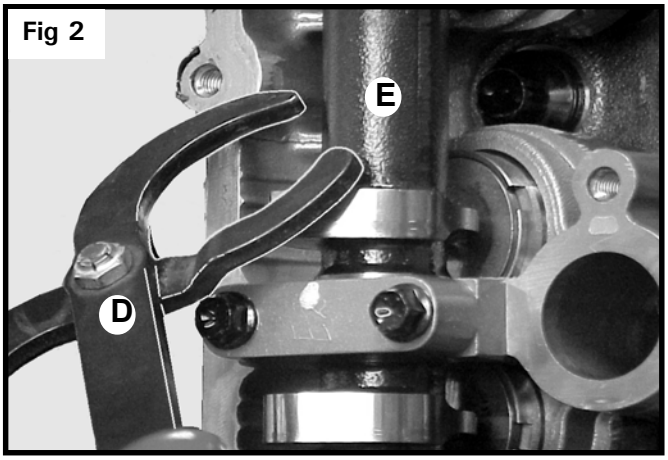
   The notch in the tappet provides access to the shim edge to lift and remove.

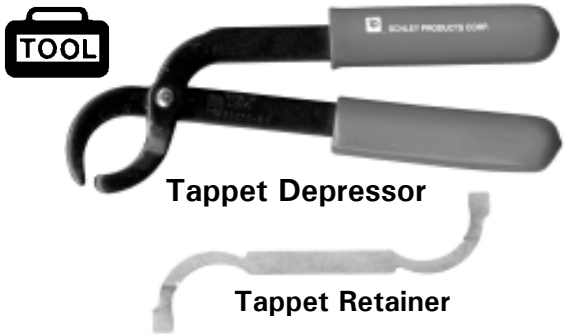
Fig 1



3. Place depressor tool "D" over camshaft "E" with the single curve jaw of the tool towards outside of cylinder head (Fig 2).

Fig 2





4. Squeeze the depressor tool handles together (slightly depresses the tappet), then rotate the depressor tool towards the center of the cylinder head to completely depress the tappet. (Fig 3 & 4).

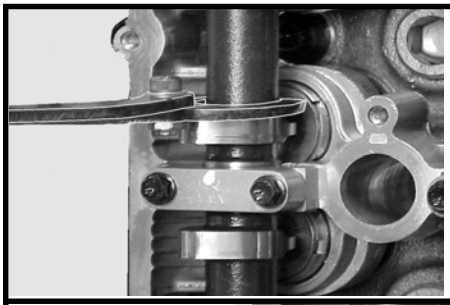


Fig 3

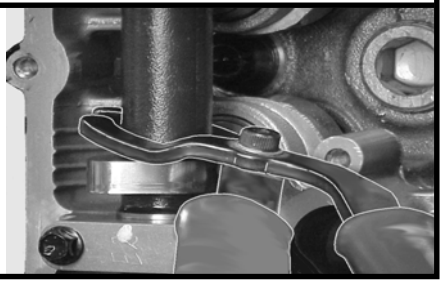


Fig 4

NOTE

The tappet must be fully depressed (below flush with cylinder head tappet bore) before inserting the tappet retainer tool.

5. Place the tappet retainer tool "F" between outer rim of tappet and camshaft holder to hold tappet in the depressed position (Fig 5).

   Once the retainer is in place, remove the depressor tool.

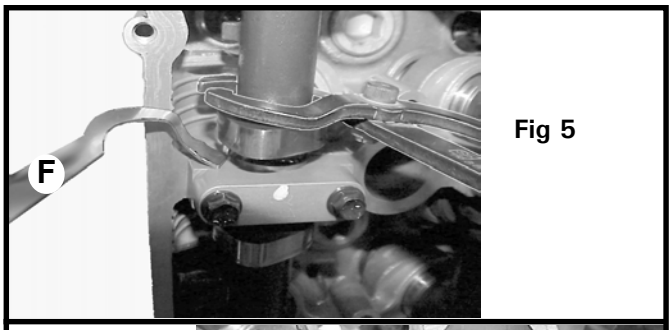


Fig 5

NOTE

When placing the retainer tool on the edge of the tappet, make sure the tool is not touching the shim (Fig 6, camshaft removed for better view). This would prevent removal of the shim "G".

Each end of the retainer tool is shaped differently to fit the upper and lower tappets of each cylinder.

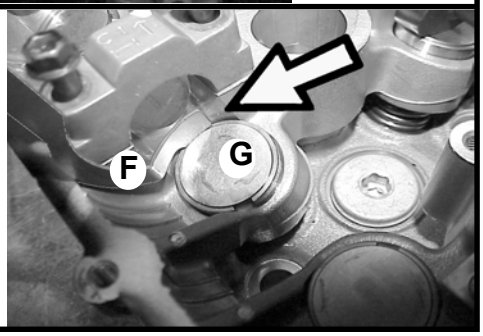


Fig 6

6. Use a forceps / small screwdriver / magnet to pick out the shim. Read the size number "H" or measure the shim's thickness with a micrometer or caliper to determine the size (Fig 7).

   Use the shim selection table to chose a replacement shim which will provide the proper tappet clearance.

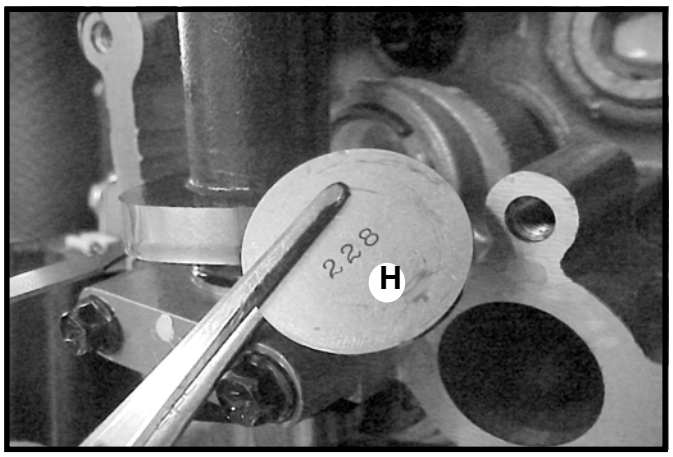


Fig 7

NOTE

Install the replacement shim with the size mark towards the tappet. This prevents the camshaft lobe from wearing the number off the shim.

Apply clean engine oil to the shim so it will adhere to the tappet during installation.

7. After installing the replacement shim, use the depressor tool to depress the tappet and remove the retainer tool.

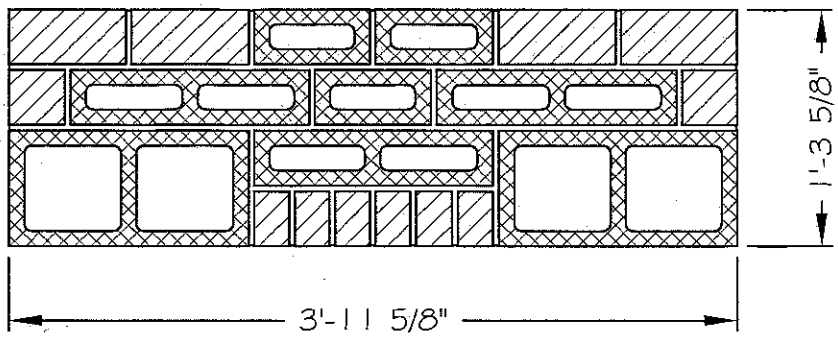
   DO NOT REMOVE THE RETAINER TOOL WITHOUT FIRST DEPRESSING THE TAPPET.

   Rotate the engine at least one full revolution and measure again to verify correct tappet clearance (repeat procedure if necessary to acheive proper clearance). Repeat this procedure for all tappets which require shim replacement to adjust clearance.

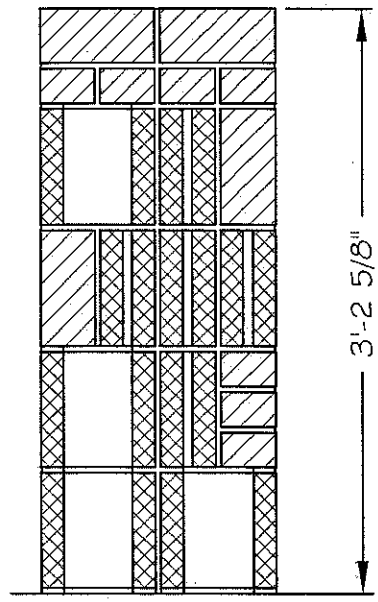
SkillsUSA
2010 Contest Projects

Masonry

Click the “Print this Section” button above to automatically print the specifications for this contest. Make sure your printer is turned on before pressing the button.



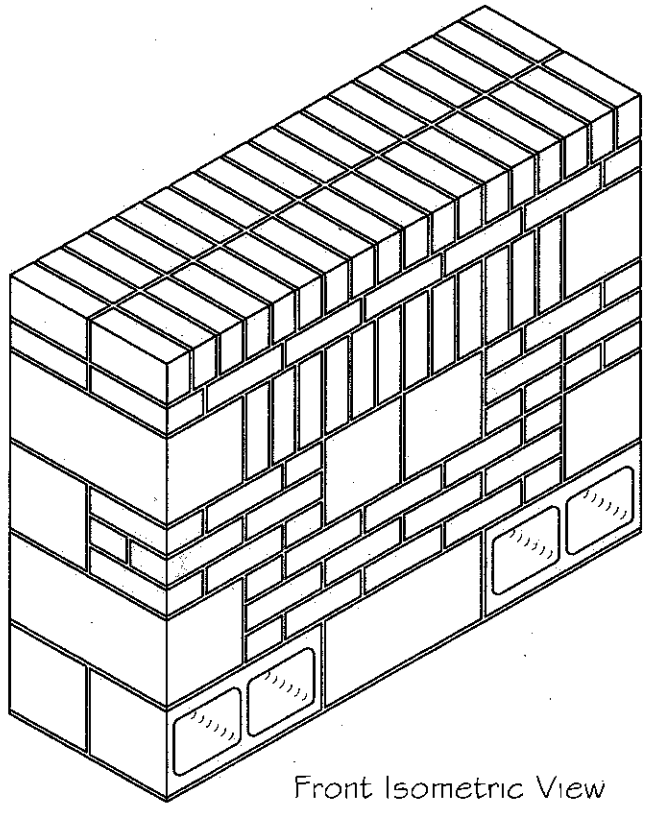
Plan



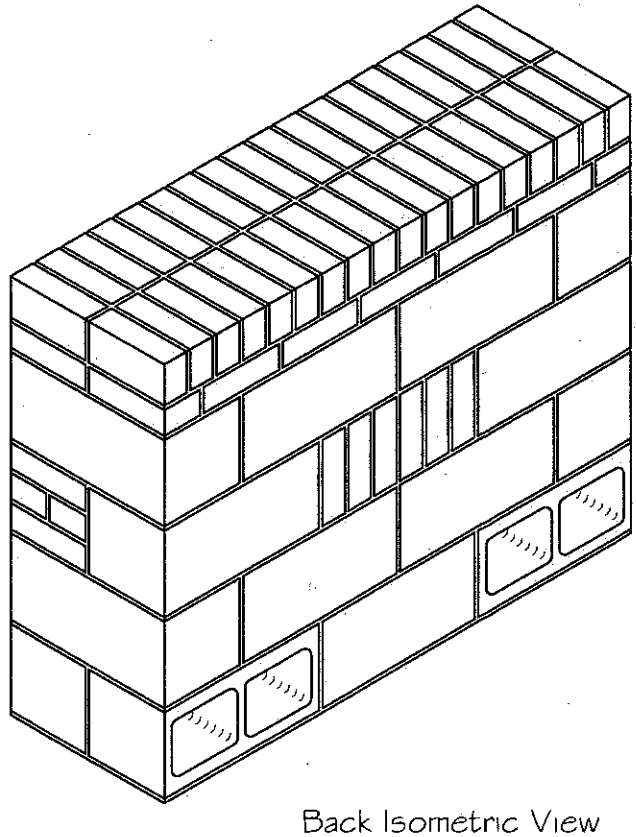
Section

Materials:

16 - 8" CMU
7 - 4" CMU
3 - 4" CMU Halfs
101 - Modular Brick
4 - Uncored Modular Brick



Front Isometric View



Back Isometric View

SILLS MASONRY CHAMPIONSHIPS

MASONRY COMPETITION
JUNE 24, 2010

SkillsUSA
2010 Contest Projects

Mechatronics
(High School)

Click the “Print this Section” button above to automatically print the specifications for this contest. Make sure your printer is turned on before pressing the button.

Contestant Numbers _____, _____

SkillsUSAMechatronics Competition

Construction Phase 1 Secondary
Time Limit: 180 Minutes (3 hrs)

Read all documentation prior to starting!

You are tasked with designing a circuit to extend and retract a double-acting cylinder based on FluidSIM software and the MecLab. Each step must be judged before you proceed to the next step.

***SAVE ALL FILES IN THE SKILLSUSA FOLDER ***

Plans and schematics (electrical and pneumatic) must be shown to the judge PRIOR to physical construction (They will NOT be graded at this time)

1. Judge's Initials: _____
   Pressing one switch will cause the cylinder to fully extend; pressing a second switch will cause the cylinder to fully retract.
   a. It is not required to continually depress either switch.
   b. Demonstrate this ability in simulation

2. Judge's Initials: _____
   Same exercise using the MecLab hardware.
   a. Using the software and MecLab, duplicate this process with hardware
   b. Use flow controls in the meter out configuration to control the speed of each motion to 1 second to extend and 2 seconds to retract.

3. Judge's Initials: _____
   Redesign the existing circuit from step 2 to eliminate the pushbutton switch that causes the cylinder to retract. (Automatic Return)

4. Judge's Initials: _____
   Redesign the existing circuit from step 3 to provide reciprocating (back and forth motion). That is to say, the cylinder continually extends and retracts as long as the pushbutton is actuated.
   a. When the pushbutton is released, the cylinder will finish its motions and end in the retracted position.

After completing steps 1 through 4, your judge will provide you a partial schematic for the next task, 5, which will be timed.

This schematic will be provided to your team if you have not completed tasks 1-4 in two hours. You will lose all documentation, professional practice and time bonus points (200 out of 400 possible points)

Contestant Numbers _____, _____

5. Using the circuit from step 4, your next task is to install a counter to count the number of cycles your machine completes.
    a. The counters need to be pre-set to a specific value. In our case we will use 10 cycles. They will decrement until they reach 0.
    b. When they reach 0, they will emit an electrical signal which will stop the oscillating circuit.

Your tasks are:

1. Design and draw the electrical schematic for the machine using FluidSIM. Use ISO or JIC symbology only. Where will you save it?
2. Design and draw the pneumatic circuit diagram for the machine. Use the appropriate symbology and label all components and ports.
3. Build the machine to control the cylinder according to the above task descriptions. WARNING: Collisions between components will result in heavy penalties.
4. All wiring must be done through cable ducts; tubing must be neatly tie-wrapped and fastened to the base-plate.

Description	**Evaluation**	**Max. evaluation**
Documentation		**100**
Electrical Drawing (Ladder – JIC, Waterfall - ISO)	40	
Pneumatic Drawing	40	
Valves and Sensors correctly labelled	20	

Description	**Evaluation**	**Max. evaluation**
Function		**200**
Use of proper cylinders and valves		**20**
Flow control adjusted properly		**20**
Physical valves labeled		**10**
Physical sensors labeled		**10**
Counter is preset to 10 cycles		**5**
Counter emits signal when reaches 0. Cylinder stops		**90**
All cylinders, , valves and switches labeled		**5**
Pushbutton switch resets counter (IV)		**10**
Does cylinder go to home position when cycle finishes		**10**

Contestant Numbers _____, _____

Counter function is reset by pushbutton		**20**

Description	**Evaluation**	**Max. evaluation**
Professional practice		**90**
comments) All components securely mounted in correct position Professional appearance (cable ducts, tie downs) Correct tubing: (pressure in blue to extend cylinder, pressure in black to retract) Collisions or Pinch Points: -5 each.	 30 30 30	

Description	**Evaluation**	**Max. eval.**
Time evaluation		
Time points are only possible when all points for function and minimum 85 points for professional practice are achieved!		
act. time	___. ___min.	Max time: 60 min.
Points for time = (max. time – act.time)x max.points /(max.time – min.time) = (120.0 - .....) x 10 points / (120.0 - .....)	**___.__ points**	**Max 10 points**
NO TIME BONUS AVAILABLE TO STUDENTS WHO USE PROVIDED DRAWINGS		

Total evaluation:

Description	**evaluation**	**Max. eval.**
Points for documentation	**____**	**100**
Points for Function	**____**	**200**
Points for professional practice	**____**	**90**
Points for time evaluation	**____**	**10**
Total points	**____**	**400**

SkillsUSA
2010 Contest Projects

Mechatronics
(College/Postsecondary)

Task #1: Assembly, commissioning and programming of Pick and Place station – sort out workpieces

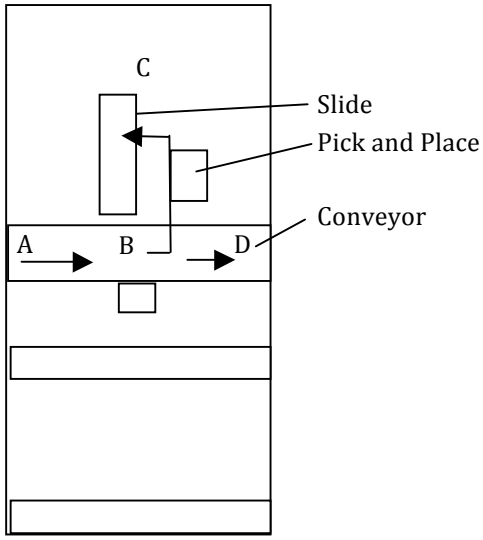
Points	400
t_{min}	fastest team
t_{max}	150 min

Situation

You have the task to assemble, commission and program the Pick and Place station.

The task is fulfilled when the station is completely assembled and commissioned according to the professional practice agreement'. The system has to fulfill the specifications according to the evaluation sheet.

System layout proposal:



Pick and Place station

Task Description

Different workpieces (red, black) are manually put on the conveyor at (A)

Red workpieces are gripped with the Pick and Place module from position (B) and sorted to the slide (C).

Black workpieces are transported to the conveyor end (D), where they are passed to the next station.

PLC program:

Initial situation:

No workpieces are on the station
Conveyor is switched off

When the start button is pressed the sequence starts:

- Green “Start LED” on
- (put one workpiece manually onto the conveyor (position A)
- Green “Start LED” off
- Transport workpiece to pick and place position (B)
- Switch light Q1 on

Red workpiece:

- Grip workpiece with pick and place module
- Put workpiece on slide.
- Return to initial situation

Black workpiece:

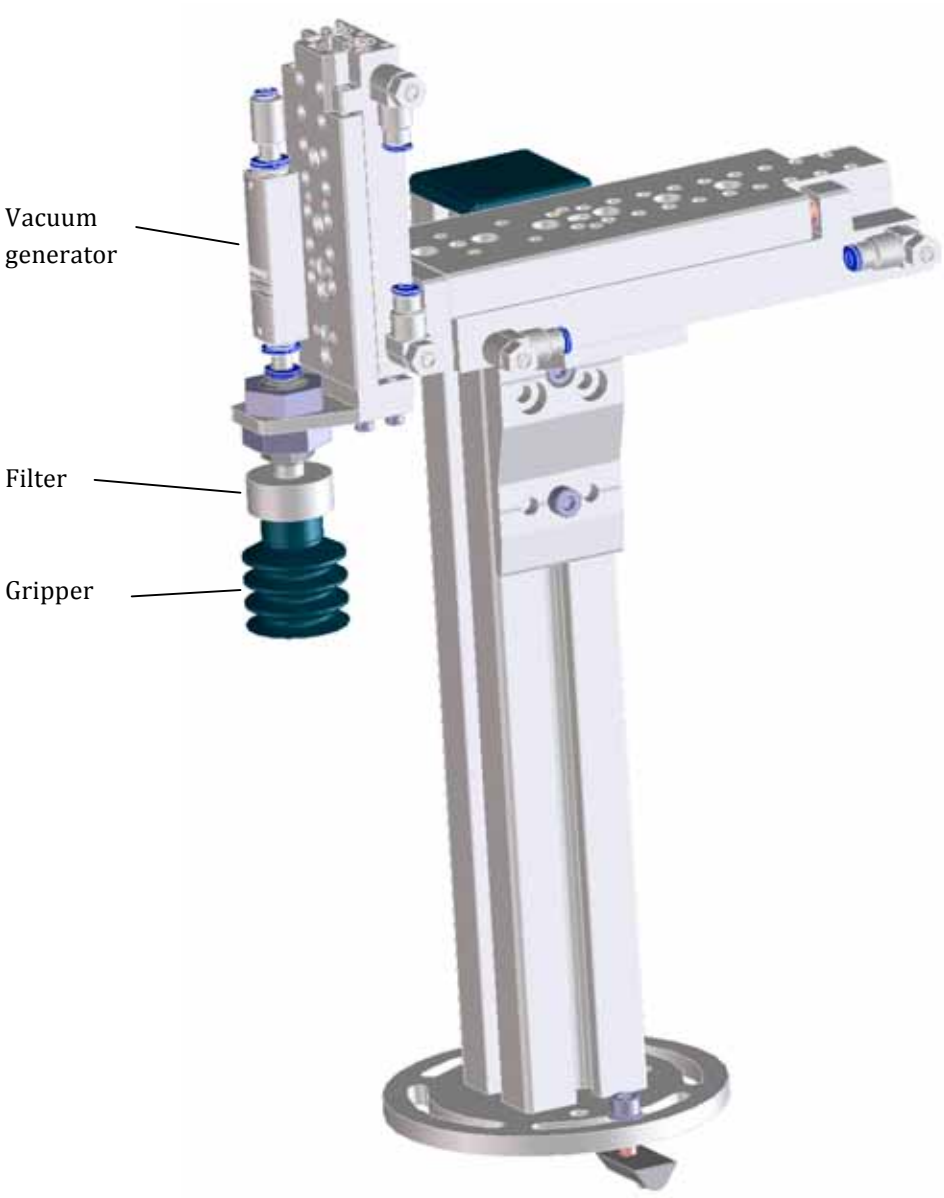
- Move workpiece to the conveyor end (D) so that it goes off the end of the conveyor.
- Switch light Q1 off, switch conveyor off

Sequence repeats for each new workpiece without pressing the start button.

NOTE: It is OK for you to examine the posters to determine spacing and proper wiring and tubing.

Assembly hints:

Pick and place module:

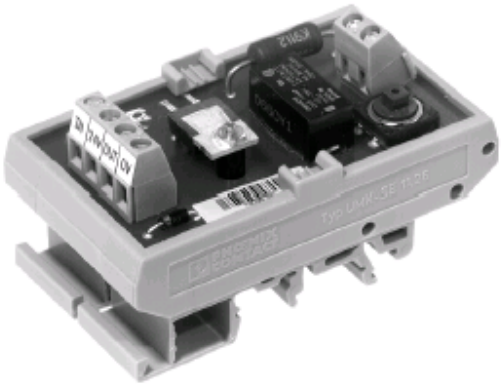


Wiring hints:

Current limiter:

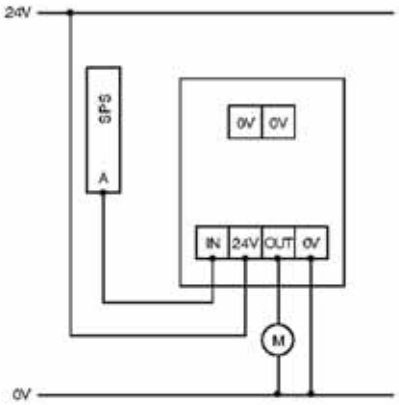
Use the current limiter to control the motor of the conveyor.

- Connect your plc output “Ox.x” (I/O-terminal) to “IN” (current limiter).
- Connect the motor to “OUT” (current limiter) and “0VDC” (I/O-terminal)
- Connect “24VDC” (I/O-terminal) with “24V” (current limiter).
- Connect “0VDC” (I/O-terminal) with “0V” (current limiter).



Design	A relay and an electronic current limiter have been integrated on a circuit board. The circuit board can be fitted via the attachments on the reverse side. Electrical connection is effected via screw terminals.
Function	The device limits the surge current to a maximum of 2A the moment it is switched on. Otherwise, the module operates in the same way as a relay.
Note	This module must only be used to operate consuming devices with a maximum static current requirement of 1A. The current limiting effect must not be used for the continuous current limiting of a consuming device.

NOTE: SPS = PLC



Description	Evaluation	Max. evaluation
Function to check with SimuBox **IDENTIFY SENSOR AND FUNCTION BELOW**	**achieved points**	**Max points 160**
O0		10
O1		10
O2		10
O3		10
O4		10
O5		10
O6		10
O7		10
I0		10
I1		10
I2		10
I3		10
I4		10
I5		10
I6		10
I7		10
Total		

Description	Evaluation	Max. evaluation
Function to check with plc program	**achieved points**	**Max points 100**
Preparation: Connect PLC to the I/O-terminal of the station, prepare and start the PLC		
(remove all workpieces from the station)		
Press start button		
Silver workpiece:*		
Conveyor is switched off		5
Green “Start LED” on		5
put one workpiece manually onto the conveyor (position A)		
Green “Start LED” off		5
Transport workpiece to pick and place position (B)		10

Turn on lamp Q1		
Grip silver workpiece with pick and place module		10
Put silver workpiece on slide		10
Red or Black workpiece:		
Conveyor is switched off		5
Green "Start LED" on		5
put one workpiece manually onto the conveyor (position A)		
Green "Start LED" off		5
Transport workpiece to pick and place position (B)		10
Turn on lamp Q1		
Move workpiece to the conveyor end (D)		10
Workpiece successfully passed to next station		10
Switch light Q1 off		10
Total		

Description	**Evaluation**	**Max. evaluation**
Professional practice		**100**
(comments) All components securely mounted in correct position Professional appearance (cable guides, tie downs) Correct tubing: (blue to extend cylinders, black to retract) Collisions or Pinch Points: -5 each.	 20 50 30	

Description	**Evaluation**	**Max. eval.**
Time evaluation		**40**
Time points are only possible when all points for function (with SimuBox and with PLC) and minimum 4 points for professional practice are achieved!		
act. Time	___. ___min.	Max time: 150 min.
Points for time = (max. time – act.time)x max.points /(max.time – min.time) = (150.0 - .....) x 10 points / (150.0 - .....)	**___.___ points**	**Max 40 points**

Total evaluation:

Description	**evaluation**	**Max. eval.**

Points for Function with I/O box	**_____**	**160**
Points for Function to check with PLC board	**_____**	**100**
Points for professional practice	**_____**	**100**
Points for time evaluation	**_____**	**40**
Total points	**_____**	**400**

Task #2: Assembly, commissioning and programming of Pick and Place station – transfer workpieces

Points	500
t_{min}	fastest team
t_{max}	150 min

Situation

Your task is to assemble, commission and program the Pick and Place station.

The task is fulfilled when the station is completely assembled and commissioned according to the "professional practice agreement'. The system has to fulfil the specifications according to the evaluation sheet.

Task Description

Inserts are buffered on the Slide (C). The pick and place station delivers workpieces from the slide off the end of the conveyor.

If workpiece is red, insert is placed onto workpiece. (This is not a collision!)

If workpiece is black, no insert is placed and workpiece proceeds off the conveyor end.

PLC program:

Initial situation:
A number (3-5) of inserts are on the slide.

NOTE: It is OK for you to examine the posters to determine spacing and proper wiring and tubing.

Evaluation sheet Project :
Assembly, commissioning and programming of Pick and Place station – insert workpieces

Max time: 150 min.

Team:

Description	**Evaluation**	**Max. evaluation**
Function to check with SimuBox **IDENTIFY SENSOR AND FUNCTION BELOW**	**achieved points**	**Max points** **80**
O0		5
O1		5
O2		5
O3		5
O4		5
O5		5
O6		5
O7		5
I0		5
I1		5
I2		5
I3		5
I4		5
I5		5
I6		5
I7		5
Total		

Description	Evaluation	Max. evaluation
Function to check with plc program **RED**	**achieved points**	**Max points** **150**
Preparation: Connect plc to the I/O-terminal of the station, prepare and start the plc		
put inserts (3-5) on the slide		
Reset PLC using RESET switch		
Press Start button		
Place workpiece at "A"		
Lamp Q1 turns on		10
Conveyor starts		15
Separator extends		15
Part is transported to transfer point		10
Insert is extracted from slide		20
Insert is placed securely on workpiece NOTE: This is NOT a collision!		10
Lamp Q2 turns on		15
Separator retracts		15
Assembled unit is transported to next station		10
Lamps Q1 and Q2 turn off		15
Conveyor stops		15
Ready for next workpiece		
total		

Description	Evaluation	Max. evaluation
Function to check with plc program **BLACK**	**achieved points**	**Max points** **150**
Preparation: Connect plc to the I/O-terminal of the station, prepare and start the plc		
put inserts (3-5) on the slide		
Reset PLC using RESET switch		
Press Start button		
Place workpiece at "A"		
Lamp Q1 turns on		15
Conveyor starts		15
Separator extends		15
Part is transported to transfer point		15
Lamp Q2 turns on		15
Separator retracts		15
Workpiece is transported to next station		15
Lamps Q1 and Q2 turn off		15
Conveyor stops		15
Ready for next workpiece		15
total		

Description	Evaluation	Max. evaluation
Professional practice		**70**
comments) All components securely mounted in correct position Professional appearance (cable guides, tie downs) Correct tubing: (blue to extend cylinders, black to retract) Collisions or Pinch Points: -5 each.	 20 20 30	

description	Evaluation	Max. eval.
Time evaluation		
Time points are only possible when all points for function (with SimuBox and with plc) and minimum 4 points for professional practice are achieved!		
act. time	____. ____min.	Max time: 150 min.
Points for time = (max. time – act.time)x max.points /(max.time – min.time) = (150.0 - .....) x 10 points / (150.0 - .....)	**___.___ points**	**Max 50 points**

Total evaluation:

Description	evaluation	Max. eval.
Points for Function with I/O box	**_____**	**80**
Points for Function to check with plc board	**_____**	**300**
Points for professional practice	**_____**	**70**
Points for time evaluation	**_____**	**50**
Total points	**_____**	**500**

Expert evaluation team (names, signs)**:**

SkillsUSA
2010 Contest Projects

Medical Assisting

Click the “Print this Section” button above to automatically print the specifications for this contest. Make sure your printer is turned on before pressing the button.

SKILLSUSA NLSC
MEDICAL ASSISTING

INTERVIEW/ORAL ASSESSMENT

TIME LIMIT: 20 MINUTES (TOTAL)
Break down – 10 minutes – Application
10 minutes - Interview

CONTESTANT INFORMATION: You have just completed school and are looking for a position in a Family Practice office. Complete the application and wait to be called in for an interview. (You will note that some of the information has been completed for you to maintain the integrity of the competition, **please use only your contestant number, and Missouri for any state references** you fill are needed).

When you are called for the interview, please take your application with you. Your time for the interview will start when you are called. Your time for the application starts now.

SKILLSUSA NLSC
MEDICAL ASSISTING

Insurance Coding

TIME LIMIT: 30 MINUTES

CONTESTANT INFORMATION: Read the scenario below and complete a CMS-1500. You have 30 minutes to complete this task. Read the information below and tell the judge when you are ready to start.

Mr. Smith, returns to the office today stating that he has "severe pain in the bottom of my stomach" as he points to his lower right pelvic area. You ask follow-up questions and then note your findings; "*RLQ pain at 6 on pain scale with urination x this a.m.*". After a detailed history and physical exam by the physician; he orders an IVP (intravenous pyelograph) with KUB (done at hospital next door), and a UA, non-automated with microscopy (which you completed in the office lab). Utilizing moderate complexity medical decision making the physician reviewed the X-rays and labs and rendered a dx of Nephrolithiasis. The pt is given an rx for an analgesic, told to drink plenty of water, and strain all urine. He is to go to ER if pain worsens. Charges today are: OV - $75.00, U/A - $10.00. Patient will be billed for 20% coinsurance after MCR has paid.

Demographics: John Smith, 44 Rest Haven Rd, Yourtown, MO, 33333. Phone: 555-555-1212 Birth date: 12/13/34 Married, no children
Employment: Retired
Insurance: Medicare Policy Number: (copy of card attached)
Other Insurance: None Signature on file: yes
Emergency Contact: Wife; Jane Smith -555-555-1212

MEDICARE HEALTH INSURANCE

NAME OF BENEFICIARY
JOHN SMITH

MEDICARE CLAIM NUMBER SEX
123-45-6789A **Male**

IS ENTITLED TO EFFECTIVE DATE
Hospital (Part A) **July 1, 2000**
Medical (Part B) **July 1, 2000**

CMS Center, Chicago, IL 55555

Please complete CMS-1500 for this patient using the information above.

SKILLSUSA NLSC
MEDICAL ASSISTING

Infection Control

TIME LIMIT: 10 MINUTES

CONTESTANT INFORMATION: There has been a spill in your work area. Read the criteria below and tell the judge when you are ready to start.

1. Define PPE to the judge.
2. Put on PPE appropriate for the situation.
3. Select the solution/s and supplies you would use and explain to the judge why you made the choices that you did.
4. Remove your PPE correctly and discard.

SKILLSUSA NLSC
MEDICAL ASSISTING

VITAL SIGNS/CHARTING

TIME LIMIT: 15 MINUTES

CONTESTANT INFORMATION: Please triage pt (assess reason for pt's visit, get v/s) and chart to the progress note. Your physician's office only requires P, R, & BP, as V/S.

Please let the judge know when you are ready to begin. You will have 15 minutes.

SKILLSUSA NLSC
MEDICAL ASSISTING

CPR

TIME LIMIT: 10 MINUTES

CONTESTANT INFORMATION: Utilizing the dummy before you, please Act Accordingly! The Judge will tell you when there is pulse or breath; until such time, continue CPR.

Scenario: you walked out of the office at the end of your shift and found a person lying on the ground. There are people in the parking lot.

Please let the judge know when you are ready to begin. You will have 10 minutes.

SKILLSUSA NLSC
MEDICAL ASSISTING

ANATOMY/HUMAN DISEASE IDENTIFICATION

TIME LIMIT: 15 MINUTES

CONTESTANT INFORMATION: Please pronounce the listed disease process for the Judge. Please speak slowly and distinctly so that the judge can hear your pronunciation. Now write down and pronounce for the judge the organ affected by the disease.

Points will be awarded for correct pronunciation of organ, correct pronunciation of disease, and for spelling.

Please tell the judge when you are ready to start. You have 15 minutes.

SKILLSUSA NLSC

MEDICAL ASSISTING

PATIENT EDUCATION/ROOM SET-UP

TIME LIMIT: 15 MINUTES

CONTESTANT INFORMATION: Multi-tasking is the Medical Assistants most admirable trait. Keep this in mind as you move through this station. Your patient is already in the exam room.

Since today is your first day at your new job, the office manager asked that you prepare to complete an ECG in room 1. She tells you that 16-year-old Alexis presented today with chest pain. She is anxious because her father died of a heart attack last month at age 41 and she fears she will have heart disease as well. Please explain the procedure to the patient as you prepare for the ECG. Alexis is exceptionally scared and nervous, so be thorough and calming!

Your judge, acting as the office manage, has additional information for you (please let the judge know when you are here). Ask any questions of the judge and then let the judge know when you are ready to start. Your time will start when you are ready. You will have 15 minutes.

SKILLSUSA NLSC
MEDICAL ASSISTING

SURGICAL - SECONDARY

TIME LIMIT: 15 MINUTES

CONTESTANT INFORMATION: Following correct technique is an important part of Medical Assisting and good patient care. This can make a difference between healing and infection.

Scenario; Sally Doe has a 2cm superficial laceration she received while playing soccer with her brother. The physician has ordered steri-strips. Please clean the wound and apply steri-strips utilizing correct technique follow with aftercare instructions.

You have 15 minutes to complete this task. Please let the judge know when you are ready.

SKILLSUSA NLSC
MEDICAL ASSISTING

SURGICAL – POST SECONDARY

TIME LIMIT: 15 MINUTES

CONTESTANT INFORMATION:

The next patient scheduled is for a biopsy. The office policy is to set the room and any equipment up **before** bringing the patient back. The physician likes his tray neat, orderly and with betadine on the tray. Please use the materials provided to complete this task.

Please take a moment to look over the supplies available to you. Ask any pertinent questions of the judge and then let the judge know when you are ready to begin. You will have 15 minutes.

SKILLSUSA NLSC
MEDICAL ASSISTING

LAB - SECONDARY

TIME LIMIT: 5 MINUTES

CONTESTANT INFORMATION: Complete U/A dip and record results

Scenario: Dr. James Smith asks you to do a STAT U/A on his urine. He states he left a specimen in the lab.

Record the results on the laboratory report form and give to Dr (judge) when you are finished.

Ask any pertinent questions of the judge. When you are ready let the judge know and begin. You have 5 minutes to complete this task.

SKILLSUSA NLSC
MEDICAL ASSISTING

VENIPUNCTURE – POST SECONDARY

TIME LIMIT: 10 MINUTES

CONTESTANT INFORMATION: Please read the following chart note, complete the physician's order, and document. Judge has additional information to share with you, please ask before you begin task.

PROGRESS NOTE

Pt: Sally Doe Allergies: NKDA

06/24/2010 – 10:05 a.m. – 98.6ºF, 98, 16, 148/92 – here for follow-up on meds.
Meds: Coumadin, Atenolol and Lipitor ----------BSky,RMA

order: draw and send to lab - Chem. panel, CBC & PT
RTOx1wk for results - D.Deitsch, MD

Physician Information
KC Family Practice
David Deitsch, MD
555 Nowhere Street
Kansas City, MO 50000-1234
Phone: 555-555-0000

Patient Information:
Sally Doe
DOB: 06/25/34
123 Any St
Kansas City, MO 5000
Phone: 555-000-1234

Ask any pertinent questions of the judge and then let the judge know when you are ready to begin. You have 10 minutes.

SKILLSUSA NLSC
MEDICAL ASSISTING

MEDICATION ADMINISTRATION – POST SECONDARY

TIME LIMIT: 15 MINUTES

CONTESTANT INFORMATION: Please read the following chart note, complete the physician's order and document.

PROGRESS NOTE

Pt: Jane Smith Allergies: NKDA

06/24/2010 – 1:00 p.m. – 100.2ºF, 98, 18, 148/92 – CC: achy, productive cough, green, low grade fever x 3 days, Tylenol without relief----------BSky,RMA

order: give 500mg Ancef IM- V.Reynolds, MD

Physician Information	**Patient Information:**
KC Family Practice Vickie Reynolds, MD 555 Nowhere Street Kansas City, MO 50000-1234 Phone: 555-555-0000	Jane Smith DOB: 06/25/34 123 Any St Kansas City, MO 5000 Phone: 555-000-1234

Ask any pertinent questions of the judge and then let the judge know when you are ready to begin. You have 15 minutes.

SKILLSUSA NLSC
MEDICAL ASSISTING

MEDICATION ADMINISTRATION – SECONDARY

TIME LIMIT: 15 MINUTES

CONTESTANT INFORMATION: Please read the following chart note; complete the physician's order, calculating dosage, and document. Show judge your math prior to administering med.

PROGRESS NOTE

Pt: Jane Smith Allergies: NKDA

06/24/2010 – 1:00 p.m. – 97.8ºF, 98, 18, 148/84 – CC: nausea x 2 days since chemo began----------BSky,RMA

order: Promethazine50mg PO now - V.Reynolds, MD

Physician Information	**Patient Information:**
KC Family Practice Vickie Reynolds, MD 555 Nowhere Street Kansas City, MO 50000-1234 Phone: 555-555-0000	Jane Smith DOB: 06/25/34 123 Any St Kansas City, MO 5000 Phone: 555-000-1234

Ask any pertinent questions of the judge and then let the judge know when you are ready to begin. You have 15 minutes.

CONTEST SCORING CRITERIA

Contest **Medical Assisting** Chair; **Diana Kendrick**

Skill Description	Maximum Points
1. Insurance Coding	50
2. Infection Control	45
3. Vital Signs	170
4. CPR	60
5. A&P	45
6. Patient Prep/Patient Education	130
7. Surgical	100
8. Lab	100
9. Medication	100
10.Oral Professional Assessment/Interview	100
11.Written Test	100
Résumé submitted? No O (5% penalty)	

Tie Breakers
1. SkillsUSA Professional Development Program Test 2. Written Test 3.

SkillsUSA
2010 Contest Projects

Medical Teminology

Click the “Print this Section” button above to automatically print the specifications for this contest. Make sure your printer is turned on before pressing the button.

Medical Terminology Fill in the Blank Contestant Number _____

1.

The medical term meaning the surgical removal of a joint is _____ (ARTHR/O means joint).

2.

The fluid secreted by the specialized membranes that line body cavities is called _____.

3.

The term _____ describes the time and events before birth.

4.

The study of the formation, structure, and function of cells is known as _____.

false

5.

Each _____ is a functional unit of heredity.

6.

A specialist in the study of genes is known as a/an _____.

7.

Blood within a joint space is known as _____.

8.

The partial displacement of a bone from its joint is known as _____.

9.

An abnormal increase in the outward curvature of the thoracic spine as viewed from the side is known as _____.

10.

Muscle _____ can be caused by the disuse of a muscle over a long period of time.

11.

The condition known as _____ is the degeneration of muscle tissue.

12.

The age-related reduction in skeletal muscle mass in the elderly is known as _____.

13.

A/An _____ is administered to prevent new blood clots from forming.

14.

Cooley's anemia, also known as _____, is a diverse group of genetic blood diseases.

15.

A/An _____ is the surgical removal of an aneurysm.

16.

A/An _____ is a large white blood cell that can eat and destroy substances such as cell debris, dust, pollen, and pathogens.

17.

A complex series of proteins that, when activated, puncture an antigen's cell membrane are known as _____.

18.

Medications that are administered to block and control allergic reactions are known as _____.

19.

A pulse _____ measures the oxygen saturation level in the blood.

20.

A sleep apnea study is also known as _____.

21.

The direct visual examination of the larynx is known as _____.

22.

A/An _____ is the surgical removal of hemorrhoids.

23.

A/An _____ is a surgical procedure performed to create an artificial opening between an organ and the body surface.

24.

A/An _____ is the surgical removal of all or part of the liver.

25.

The surgical fixation of the bladder to the abdominal wall is known as _____.

26.

A/An _____ is usually performed to correct urinary stress incontinence.

27.

A/An _____ is administered to increase urine secretion.

28.

Multiple _____ is a progressive autoimmune disorder characterized by scattered patches of demyelination of nerve fibers of the brain and spinal cord.

29.

The term _____ describes an inflammation of the root of a spinal nerve.

30.

A/An _____ is a tumor of the spinal cord.

31.

In the condition known as _____ degeneration, central vision is lost.

32.

The medical term for color blindness is _____.

33.

The _____ membrane is also known as the eardrum.

34.

A/An _____ is a swelling of clotted blood trapped in the tissues that is usually caused by an injury.

35.

The medical term for itching is _____.

36.

An abnormally high concentration of calcium circulating in the blood is known as _____.

37.

The _____ are mineral substances, such as sodium and potassium, that are normally found in the blood.

38.

Primary _____ is also known as Conn's syndrome.

39.

A/An _____ is the male sterilization procedure.

40.

The term _____ means the removal of a body part or the destruction of its function.

41.

Bacterial _____ is a sexually transmitted bacterial infection of the vagina that may cause complications during pregnancy and an increased risk of HIV infection.

42.

The term _____ means blood in the urine.

43.

The presence of pus in the urine is known as _____.

44.

The term _____ describes the position of a patient when lying in a recumbent position.

45.

The surgicl repair of the conjunctiva is known as _____.

46.

A/An _____ is the surgical creation of an opening between the colon and the body surface.

47.

Plastic surgery performed to reshape the nose is known as _____.

48.

Sexually transmitted diseases are also known as _____ diseases.

49.

The incomplete development of an organ or tissue is known as _____.

50.

The inability to resist the impulse to set fires is known as _____.

SkillsUSA
2010 Contest Projects

Mobile Robotics Technology

Click the “Print this Section” button above to automatically print the specifications for this contest. Make sure your printer is turned on before pressing the button.

2010 SKILLS USA CHAMPIONSHIP

MOBILE ROBOTICS COMPETITION
Secondary

TEAM GUIDE

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Acknowledgments

The success of the competition is the result of the motivated contestants and their instructors, the determined efforts of the National and State Technical Committees, and the generosity of companies donating equipment. The following companies have contributed resources and support.

intelitek Inc.
AZTECH Educational Resources
Caterpillar
Holmquist Educational
Solidworks
IFI

Mobile Robotics Technical Committee

The following individuals contributed their time and energy to the Technical Committee.

Secondary Competition

Dan Larochelle
intelitek
444 East Industrial Park Drive
Manchester, NH 03109-5317

Rick Knisely
AZTECH Educational Resources
17611 North Foothills Dr
Sun City, AZ 85373

Paul Copioli
IFI
1519 Interstate 30 West
Greenville, TX 75402

Stephanie Holmquist
Holmquist Educational Consultants
2926 Forest Hammock Dr.
Plant City, FL 33566

Judges

The following individuals contributed their time and energy as Judges for the competition.

National Educational Technical Committee

The following individuals contributed their time and energy to the National Educational Technical Committee.

Dr. Jeanea Lambeth Engineering Teacher
Camelback High School, Phoenix, AZ

Martin Bencic, Engineering Teacher
Sunrise Mountain High School, Peoria, AZ

Awards

The following companies have supplied awards:

intelitek

Solidworks

1: Contest Overview

Cutting-edge Technology

Many believe that in the future, robotics will encompass every part of life. Even today, robots do the jobs that people find dull, dirty or dangerous. To compete in this evolving field, companies will be looking for individuals who are fluent in mechanical design, electrical systems and robot programming. Additionally, working well in a team with diverse skills is important to success in the robotics industry. With today's complex design and engineering challenges, no individual is equipped with all the answers to any robotics problem.

Your Team

Success in a Mobile Robotics Competition is often found using a team approach. In the interest of emulating industry, this competition will be structured in this manner. For optimum team efficiency, we suggest your team be comprised of a specialist in each of the following fields:

- Mechanical Design
- Mobile Robotics Programming

1.1: Statement of the Problem

1.1.1: The Client's Needs

The Springfield Nuclear Power Plant (hereafter referred to as the client) is looking to improve on its nuclear waste disposal process. Normally, the client has to send highly trained workers into dangerous locations to move nuclear waste by hand to local containment facilities and to flatbed trucks to be disposed of off-site. This job is highly dangerous and could expose the employees to high doses of radiation. Additionally, in order to maintain a safe working environment, the waste is disposed of very slowly. Overall, this process is very costly and dangerous.

1.1.2: Your Assignment

As a Mobile Robotics development team, known as MD Robotics, your task is to create a mobile robot that can handle the nuclear waste and safely dispose of it in a timely fashion. This robot must be able to respond to operator commands on the fly, as well as autonomously collect and dispose of the nuclear waste.

The client's waste disposal facility is divided into two sections. One section is the collection facility where the waste is brought from the reactors and is treated to be safe to handle. The other section is the waste disbursement facility where the waste is processed and made ready for transport. Between these two sections, there is a thick, shielded wall designed to stop radiation from penetrating into the disbursement facility .A large portion of the door opens to allow workers to move the waste from section to section. However, the door is on an automatic timer that will close after sixty seconds to ensure that radiation does not leak out. Additionally, the collection facility's shielding does not allow a person to see in from the outside. This means that the robot will have to attempt to move waste to the disbursement facility completely autonomously.

1.2: Instructions

1.2.1: Initial Design

The Client is a nuclear power plant that needs a new robotic waste disposal system. Currently, the Client is able to give you a layout of the plant along with some general robot operating guidelines. The robot must autonomously deliver ten pieces of waste to the disbursement facility. Once at the disbursement facility, the robot will need to load the waste either into flatbed trucks or into local waste storage containers. Your team's job is to create a robot that can do these tasks.

The Client requires that each stage of the design fabrication, and programming process be well documented. This includes a bill of materials, assembly instructions, a code flowchart and a printed, final program for the robot.

After your prototype has been designed, programmed and assembled, you will test the robot in a simulation of the Client's facility.

1.2.2: Concurrent Engineering

The Client will review the prototype and may require one or more changes. Be prepared to handle waste that may be a different shape and size and handle the waste in different ways. Having a robot that can handle diverse challenges will make your design more appealing to the Client.

1.3: Guidelines

1.3.1: Requirements

The Client's Engineering Project Manager has provided an outline of materials to begin your planning and manufacturing process. Your success on this project is based upon the following criteria:

1. Teams must be composed of two members.
2. Teams are given a task that they will solve using a mobile robotic system provided buy the technical committee.
3. During the orientation session, each team will have 10 minutes to present their Engineering Notebook to the judges.
4. Teams can only use an Engineering Notebook during the contest as a reference tool in the construction and programming of their robot.
5. The Engineering Notebook is a tool for students to document their designs prior to the competition. It can include pictures, printed out sections of code, detailed assembly instructions etc. All pages must be bound and numbered.
6. The Robot can only be constructed by the materials supplied by the technical committee.
7. Once a team has performed the required task or set of tasks, a design change may be introduced.
8. Contestants are required to adhere to industry safety standards using the hardware and software provided.

9. All team members are responsible for double-checking each other's work and quality control.
10. All engineering notebooks, forms, documentation and programs must be turned in to the judges at the end of the competition.
11. All team members and advisors are required to attend a debriefing session after the competition has concluded.

1.4: Kit of Parts

1.4.1: Kit of Parts Overview

Your robot may only be made of components listed on the Skills USA kit of parts. A full list is available in Appendix A

1.5: Team Guidelines

1.5.1: Challenge Rules

These are the official rules and guidelines for the Mobile Robotics Competition. All teams will be expected to adhere to these rules.

1.5.1.1: Definitions:

- Autonomous Period: A 60 second period in which robots operate only based on pre-programmed instructions and sensor inputs. Team members are not allowed to interact with the robot during this period.
- Driver Control Period: A sixty second period in which robots are operated by team members through a wireless transmitter.
- Autonomous Side: The right side of the field where robots begin the match.
- Operator Side: The left side of the field where all objects are scored.
- Green Ball: A four and one-half inch diameter, green foam ball.
- Short Goal: A bin approximately 18" long, 11" wide and 10" tall where green balls may be scored. The front opening of the goal is 9.25" wide and is 4" off of the ground.
- Tall Goal: An 18" tall goal located near the middle of the field where green balls may be scored.
- Scoring Zone: The volume defined by the inner edge of the field, or the outer edge of the short or tall goal and from the playing surface upwards infinitely.
- Penalty Starting Location: A tile where a robot will be placed if it is on the autonomous side of the field after autonomous, or if it would be contacted by the wall as it is replaced after autonomous. The zone is defined as the outside of an 18" by 18" taped box.

1.5.1.2: Field Setup

- The field is 12' by 12', enclosed by an 11.5" tall field border. The field is seperated into two zones by an 11.25" tall wall.
- The surface of the field is grey, foam tiles.
- There are 20 green balls on the field. See Appendix B for the green ball layout.

- Two Short Goals begin the match two tiles up and two tiles in from each of the short edges of the field border on the operator side of the field.
- Two tall goals begin the match attached to the wall near the center of the field.
- The center section of the wall is removable. The match begins with this section of the wall removed. It will be replaced onto the field after the autonomous period to create a solid wall that robots will not be allowed to cross.

1.5.1.3: Scoring

- Points will be given out as follows:
    - Each green ball in the operator zone at the end of the match is worth one point.
    - Each green ball completely within a Small Goal at the end of a match is worth two points.
    - Each green ball in a tall goal at the end of a match is worth four points.
- A ball is considered scored if every part of the ball is within the scoring zone it would be scored in.
- Each ball may only be in one scoring zone at a time. When scores are tallied, a ball will always be in the scoring zone that is worth the most points.

1.5.1.4: Match Sequence

- 0-60 Seconds: Autonomous Period.
- 60 Seconds: The center section of the wall will be replaced. If a robot is still on the autonomous side of the field, or if it would be contacted by the wall as it is being replaced, the robot will be placed in the Penalty Starting Location.
- 60-120 Seconds: Operator Period.

1.5.1.5: Game Play Rules

- Each match will be two-minutes long and will consist of only one robot.
- Balls that leave the field during a match will not be returned to the field.
- During a match, robots may be remotely controlled only by the drivers and by software running on the control system. If any team member touches his or her team's robot anytime during a match, the robot will be disabled and the team disqualified from that match.
- Scores will be calculated once all robots and field elements come to rest.
- Robots must start the match touching the long edge of the field opposite the wall on the autonomous side of the field.
- Robots will begin the operator period in the operator zone in whatever orientation and position they end autonomous unless they have been placed in the penalty starting zone.
- Once the autonomous period is complete, the center section of the wall will be replaced. If a robot is on the autonomous side of the field or is touched by the wall as it is being replaced, that robot will begin the operator portion of the match in the penalty starting zone and will receive a ten (10) point dedcution from their score. The robot must start the operator period touching the wall adjoining the penalty starting zone. Any balls within the robot will be removed from the field before the beginning of the operator period.

1.5.1.6: Robot Rules

- Robots must be no larger than 18" in every dimension at the start of a match. They may expand to any size once the match has begun.
- Robots may only be constructed from the same type and quantity of parts found in the Skills USA Vex Robot Kit, and only after the challenge has been released to teams.
- No robot may have mechanisms that could potentially damage the playing field or field elements, or pose a safety hazard to teams or spectators.
- All parts of the robot must remain attached to the robot for the duration of the match. Any infraction of this rule may result in an immediate disqualification. Minor pieces that unintentionally become detached from the robot, or are the result of improper design/construction will not cause a disqualification
- Teams may not modify any part of the control system or any motor or servo.
- Robots are allowed only the following non-Vex components:
    - Any material strictly used as a color filter for a Vex Light Sensor.
    - Any parts which are identical to legal Vex parts.
    - Any non-functional decorations that do not affect robot performance.
    - Commercial threadlocker may be used only to help secure fasteners.

1.5.2: Field Malfunctions

IN THE CASE OF A FIELD FAILURE: The team leader will communicate the problem to a representative of the Technical Committee. The representative will then notify the Project Manager. If it is determined that it is in fact a field problem, the match will be replayed. In the case of a replayed match, the previous score will not be counted and the team's rematch score will count, regardless of whether the team scores more or less points.

IN THE CASE OF PROGRAMMING PROBLEMS: A robot's program is the responsibility of the team. All software must be original copies. If your team develops a problem with your software or robot program, the Technical Committee will work in whatever way it can to resolve the problem but no matches will be replayed due to problems with the robot's program.

2: Official Competition

2.1: Purpose

2.1.1: Goals of the Competition

To evaluate each contestant's preparation for employment in fields related to mobile robotics and the team approach to problem solving in the work environment. To recognize outstanding students for excellence and professionalism in the field of mobile robotics.

2.2: Clothing Requirement

2.2.1: Correct Attire

For men: Official SkillsUSA white polo shirt with black dress slacks, black socks and black leather shoes.

For women: Official SkillsUSA white polo shirt with black dress slacks or skirt, black socks or black or skin-tone seamless hose, and black leather shoes.

All: Safety glasses with side shields or goggles. (Prescription glasses can be used only if they are equipped with side shields. If not, they must be covered with goggles.)

These regulations refer to clothing items that are pictured and described at: www.skillsusastore.org. If you have questions about clothing or other logo items, call 800-401-1560 or 703-956-3723. Note: Contestants must wear their official contest clothing to the contest orientation meeting.

2.3: Eligibility

2.3.1: Qualifications

Open to a team of two active SkillsUSA members enrolled in programs in a career and technical education engineering program or program that integrates robotics, engineering or pre-engineering techniques as an integral component of the instructional program.

2.4: Scope of Contest

The contest will test the ability to perform, exhibit and compile skills and knowledge from the following list of competencies determined by the SkillsUSA Mobile Robotic technical committee. Committee membership includes intelitek Inc., IFI and AZTECH Educational Resources.

Knowledge Performance

The contest will include a written exam assessing general knowledge of robotics operations and programming. Written portions may also exist during the skills portion of the contest.

Skill Performance

The contest will include activities that simulate situations encountered by robotic programmers and support professionals.

Contest Guidelines

1. Teams must be composed of two members.

2. Teams are given a task that they will solve using a mobile robotic system provided by the technical committee.

3. During the orientation session each team will have 10 minutes to present their Engineering Notebook to the judges.

4. Teams can only use an Engineering Notebook during the contest as a reference tool in the construction and programming of their robot

5. The Engineering Notebook is a tool for students to document their designs prior to the competition. It can include pictures, printed out sections of code, detailed assembly instructions etc. All pages must be bound and numbered.

6. Robot(s) can only be constructed by the materials supplied by the technical committee.

7. Once a team has preformed the required task or set of tasks, a design change may be introduced.

8. Contestants are required to adhere to industry safety standards using the hardware

2.4.1: Teams and Documentation

1. Teams MUST be composed of two members. Teams will demonstrate their ability to perform, utilize skills and knowledge necessary to complete the project as presented to them by the Technical Committee.

2. Your team is presented with a game challenge with which to design and prototype a robot. You will then be asked to assemble this robot at the event. When you finish the robot, you will participate in a number of matches. Your scores will be tallied and points will be awarded.. After your two matches, the game will be changed in some way, requiring you to modify some part of your robot.

2.4.2: Required Competencies

As defined by the technical committee.

2.5: Group Organizational Goal

2.5.1: Team Dynamics

The competition should run much like you would expect from industry; with group members interacting at will. The mechanical expert will lead in the robot construction while the programmer will lead the robot programming.

The contest is designed to promote creativity in organization of production responsibility. Teams should divide duties among all team members. No one individual should dominate by taking responsibility for more than one project specialty. When a team member has spare time, they will help their teammates. All Team members are responsible for double-checking each other's work and quality control.

2.5.2: Team Objectives

1. To have every team complete the competition.
2. To have each team member demonstrate reading and writing skills.
3. To have each team member use their critical thinking and problem solving abilities in the contest.
4. To have each team member illustrate responsibility, teamwork, self-management skills, and professionalism.

2.6: Engineering Notebook

2.6.1: Oral Presentation

Each team will have ten minutes to present their Engineering Notebook to the judges. Teams may bring additional support materials such as PowerPoint Presentations, posters etc. . A projector and screen will be available to all teams.

2.6.2: Parts of the Engineering Notebook

Note: All of the following items will be submitted for judging prior to the assembly portion of the event.

Completed Notebook (50 Points Available):

The Engineering Notebook will be judged on format, organization, and presentation.

Bill of Materials (50 Points Available):

Each team will be required to list all of the materials used on their robot, both in type and quantity.

Assembly Instructions (50 Points Available):

Teams are encouraged to create detailed assembly instructions for their robot prior to arriving at the competition.

Illustrations of Design Process (50 Points Available):

Teams are encouraged to include pictures and sketches of their design process in their Engineering Notebook.

Program Flow Chart (50 Points Available):

Teams are encouraged to include a flow-chart of their robots program in their Engineering Notebook. This chart does not require actual portions of code, but should be a general overview of how the program flows.

Printed Program for Robot (50 Points Available):

Teams should print their code and include it in the engineering notebook. This program should follow the team's flow-chart. This does not need to be the final robot program; however teams are encouraged to make their program as complete as possible ahead of time to maximize their score.

2.7: Required Materials

2.7.1: Workstation Components

Teams require the following materials to complete the competition. The Technical Committee provides many of these materials, but the teams must also bring certain items.

The Technical Committee provides:

1. Workspace for teams to cut materials, including a few small vises.
2. The competition game field and game materials.
3. A projector and screen for team presentations.
4. SkillsUSA Kit of Parts
5. A printer.

2.7.2: Team Provided Components

Teams will provide the following:

1. Safety glasses for each team member.
2. Rotary tool with appropriate attachments.
3. Allen wrench set.
4. Straight cutting tin snips.
5. A Vex Programming Cable.
6. A laptop with licensed Vex programming software.
7. A power strip.
8. (3) 7.2v Vex Robot Batteries
9. (3) 9.6v Vex Transmitter Batteries
10. (3) Vex Battery Chargers
11. A tape measure.

Note: ONLY the above listed items will be allowed in the contest area during the competition.

3: Safety

3.1: Importance of Safety

To maintain an effective and competitive company, it is in the best interest of both employer and employee to maintain a safe work environment. When a company's history of incidents resulting in injury is minimal, the company increases its likelihood of reduced insurance rates and workman compensation fees.

Safety considerations are taken into account during judging to further replicate a professional industrial environment.

3.2: Safety Violations

If a team or a team member violates a safety rule, or operates their robot in an unsafe manner, the following penalties will be enforced:

1st Violation:
Team will be issued a written warning.

2nd Violation
Team will have 50 points deducted from their total score.

3rd Violation
Team will be disqualified.

3.3: Avoiding Safety Hazards

Some safety issues:

1. Team members must keep their work area reasonably clean. Clean work places promote efficient and safe working conditions.
2. Team members must keep their teammates and other teams aware of possible dangerous situations, such as pinch points, sharp edges and the enabling of robots.
3. Team members must wear safety glasses when they on the playing field and while they are in their work area.
4. Tampering with or dismantling of any part of the supporting equipment (ie: computers, printers, ect.) is a direct safety violation, and can be grounds for immediate disqualification.

4: Additional Forms

4.1: Document Submission

The following documentation must be prepared by teams for judging.

- Engineering Notebook
- Math Problem

SKILLS USA
Mobile Robotics
JUDGING FORM 2010

	MAXIMUM POINTS	CHECK	POINTS AWARDED
Presentation			
1. Oral Presentation	50		
2. Presentation Support Materials	50		
Presentation Subtotal	**100**		
Engineering Notebook			
1. Completed Notebook	50		
2. Bill of Materials	50		
3. Assembly Instructions	50		
4. Illustrations of Design Process	50		
5. Program Flow Chart	50		
6. Printed Program for Robot	50		
Engineering Notebook Subtotal	**300**		
Robotic Task Performance			
1. Round one and two Score	300		
Robotic Task Performance Subtotal	**300**		
Concurrent Engineering			
1. Round three and four Score	150		
2. Area Clean-Up	50		
Concurrent Engineering Subtotal	**200**		
Math Problem	**100**		
Safety (deductions)			
GRAND TOTAL	**1000 pts**		

Appendix A – SkillsUSA Vex Robotics Kit Bill of Materials

Item	Quantity
3-Wire Motor	5
3-Wire Servo	1
PIC Microcontroller V0.5	1
Line Tracking Sensor	3
Quadrature Encoder	2
Ultrasonic Sensor	1
Potentiometer	2
Clutch	6
5" Wheel	4
4" Wheel	4
2.75" Wheel	4
Intake Roller	4
Double Bogie wheel assemblies	4
Single Bogie wheel assemblies	2
Tank tread drive/idler wheels	4
Tread Links	170
10-tooth sprockets	2
15-tooth sprockets	4
24-tooth sprockets	4
40-tooth sprockets	2
48-tooth sprockets	2
Chain Links (48")	326
Differential frame	1
12-tooth pinion gear	2
12-tooth gears	8
19-tooth rack gear	12
Worm wheel	4
24-tooth bevel gear	7
36-tooth gears	8
60-tooth gears	10
84-tooth gears	4
Worm gears	4
Bearing Flat	46
Bearing Pop Rivet	100
Pillow Block	6
Lock Bar	4
Shaft Collar	37

12" Shaft	4
2" Shaft	8
3" Shaft	10
4" Shaft	3
11mm Shaft	11
Chassis Bumper (15-hole)	2
Chassis Bumper (25-hole)	2
Chassis Rail (16-hole)	4
Chassis Rail (25-hole)	4
C-Channel, 1x2x1x15 hole	4
C-Channel, 1x2x1x25 hole	3
C-Channel, 1x5x1x25 hole	2
Segmented Angle, 25-hole	2
Slotted Angle, 30-hole	2
Slotted Angle, 30-hole, REVERSE	2
Bar, 25-hole	10
Plate, 5 x 15 hole	3
Plate, 5 x 25 hole	2
Plate, 5 x 5 hole	2
Angle Gussets	4
Pivot Gussets	4
Plus Gussets	4
1" Standoffs	12
1/2" Standoffs	14
2" Standoffs	8
3" Standoffs	8
Screw, 6-32 x 1/2" Long	18
Screw, 6-32 x 1/4" Long	34
Screw, 8-32 x 1/2" Long	38
Screw, 8-32 x 1/4" Long	120
Screw, 8-32 x 3/4" Long	16
Screw, 8-32 x 3/8" Long	51
Screw, 8-32 x 1" for Bogie wheels	12
Nut, 8-32 Keps	181
Nut, 8-32 Nylock	28
Spacer (8mm)	21
Spacer (4.6mm)	31
Plastic Washer	10

Steel Washer	30
4" Zip Tie	100
7.2v Robot Battery + Charger	1
9.6v Transmitter Battery + Charger	1
VEX Battery Holder (7.2V - AA 6x)	1
Cable, VEX "Y"	2
Cable, 3-Wire Extension, 6"	2
Cable, 3-Wire Extension, 12"	3
Cable, 3-Wire Extension, 24"	1

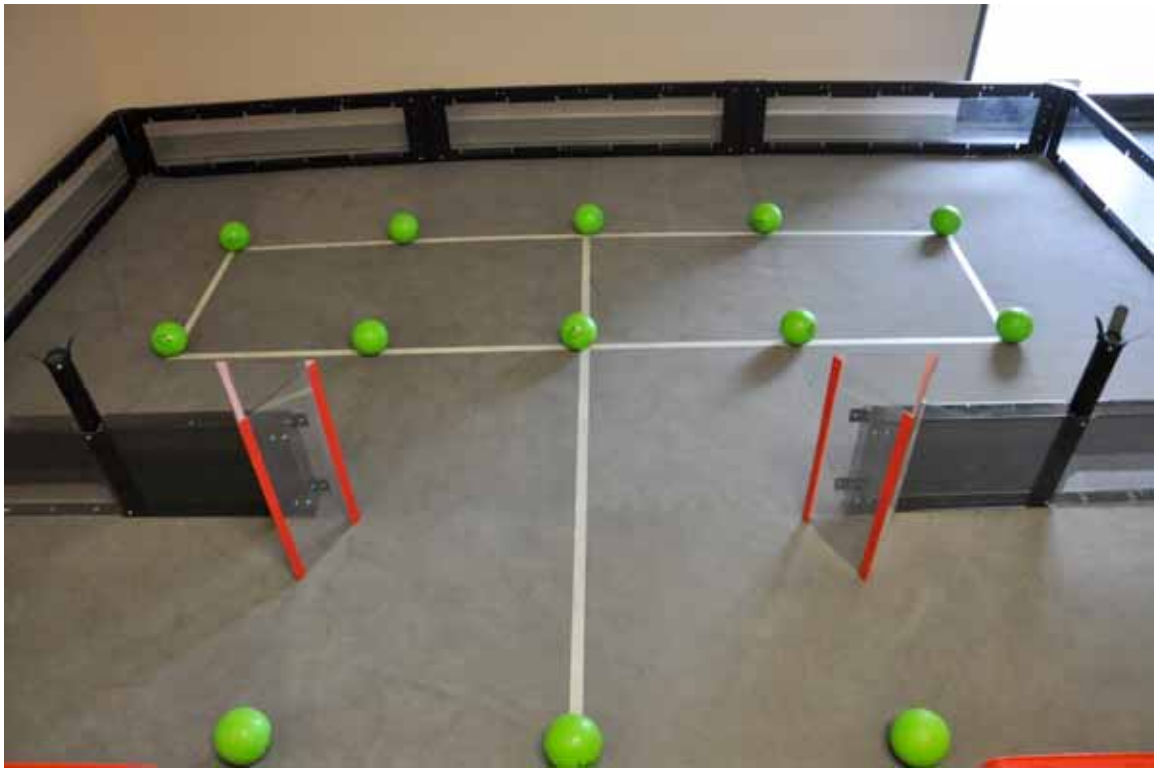
Cable, 3-Wire Extension, 36"	1
Tool, Allen Wrench Large (3/32")	1
Tool, Allen Wrench Small (5/64")	1
Tool, Nut Starter	1
Tool, VEX Open-Ended Wrench	1
Bumper Switch	2
Limit Switch	2
75 MHz Transmitter and Receiver	1
Jumpers	5

Appendix B – Field Information

Field Pictures

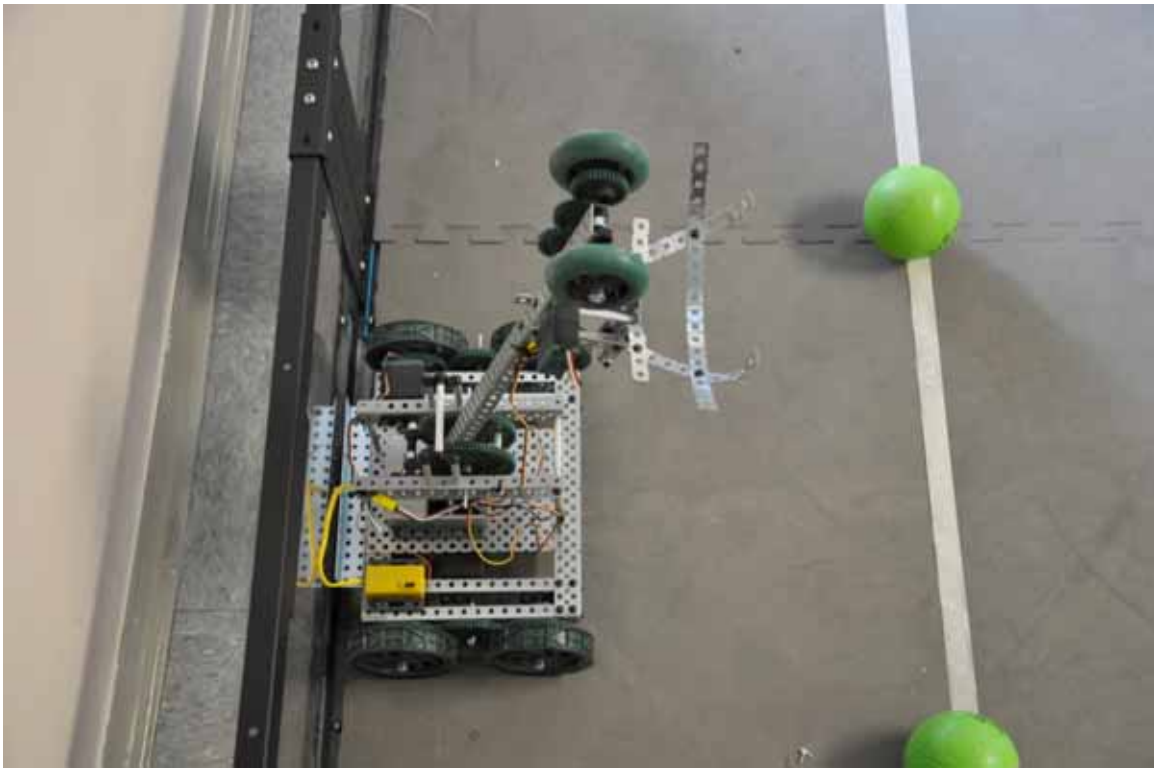
Full Field View – Gate open

Full Field View – Gate Closed

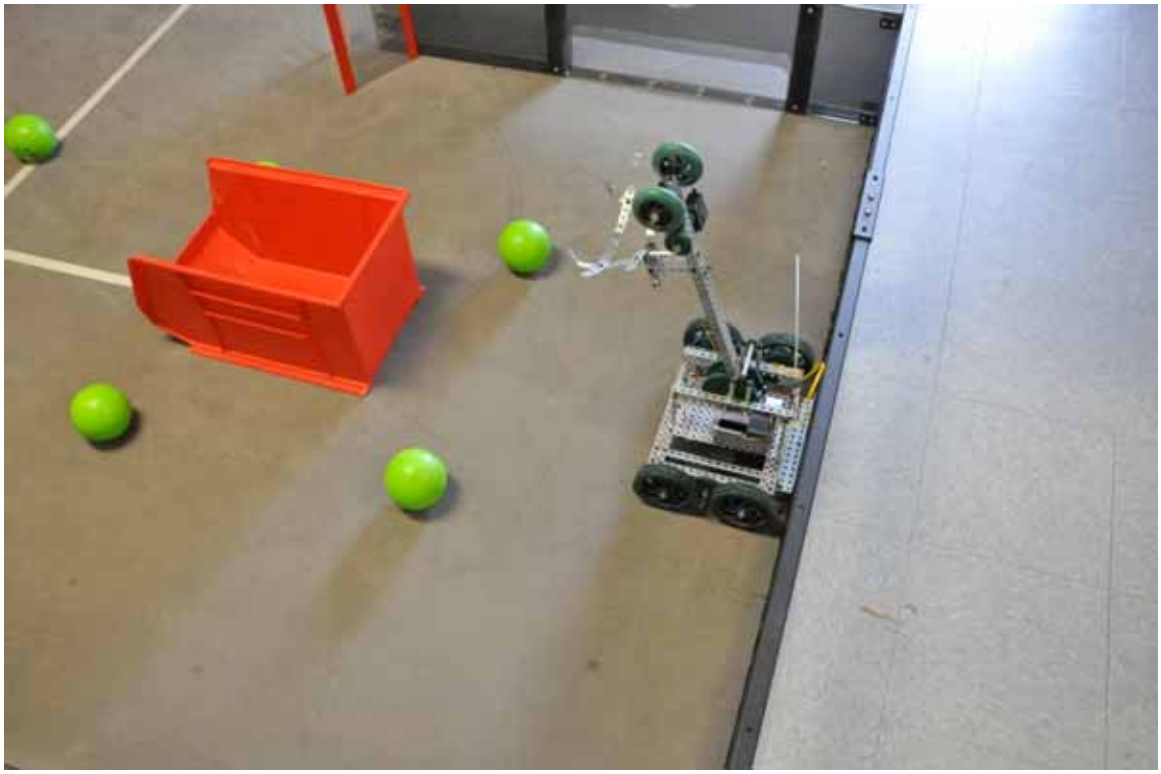


Autonomous Side

Operator Side

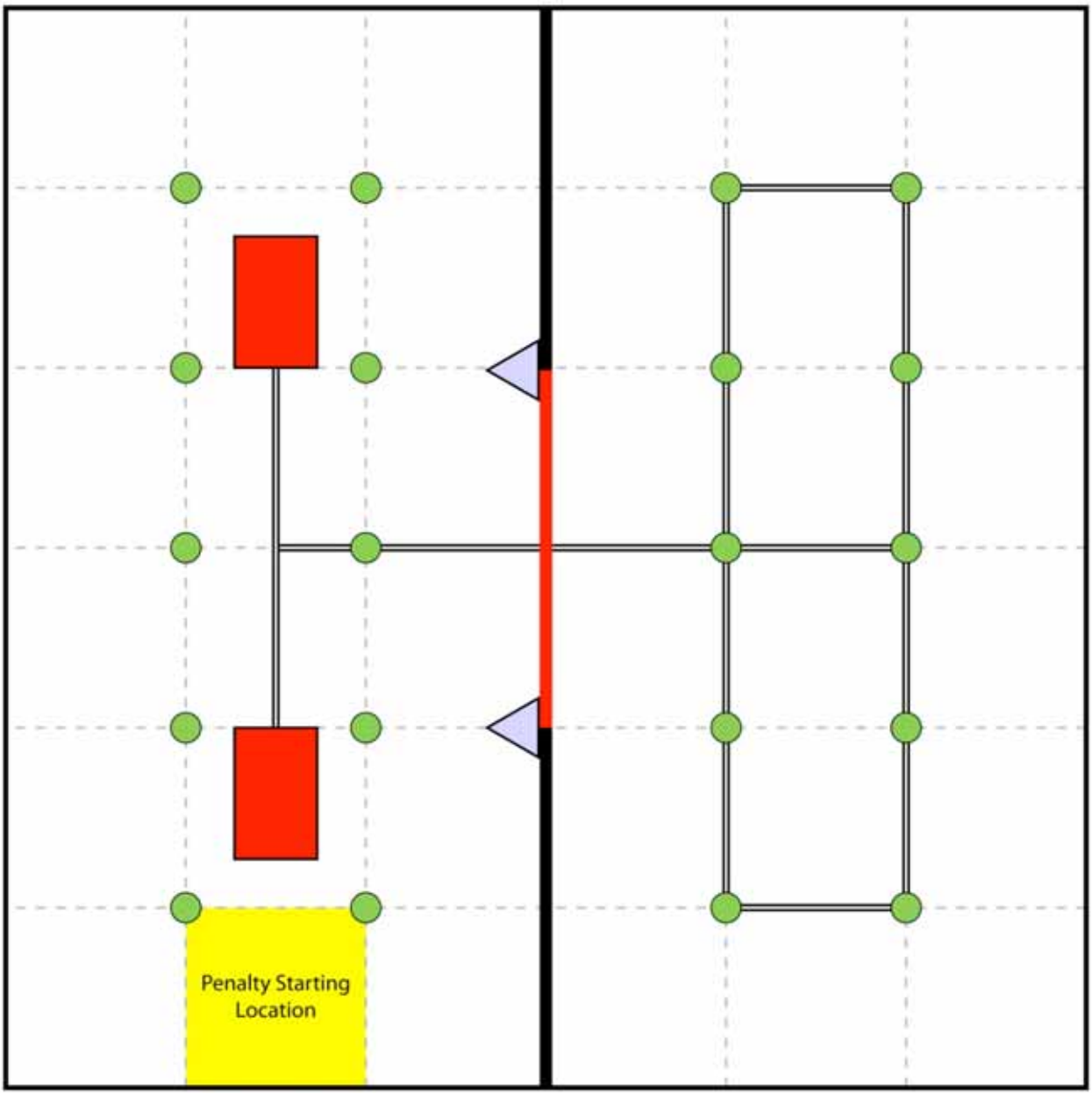


Robot in the correct starting position

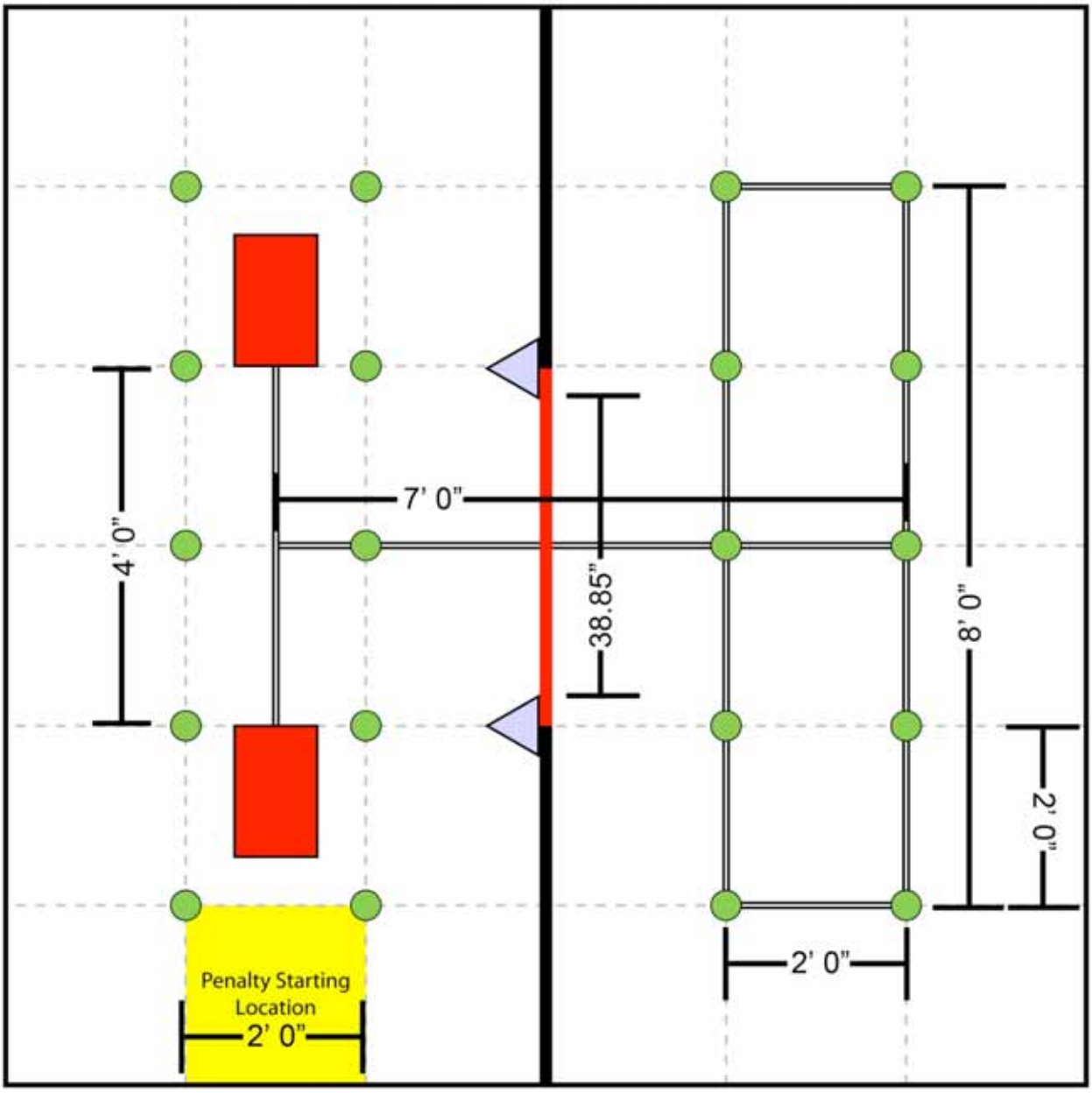


Robot in correct penalty starting location

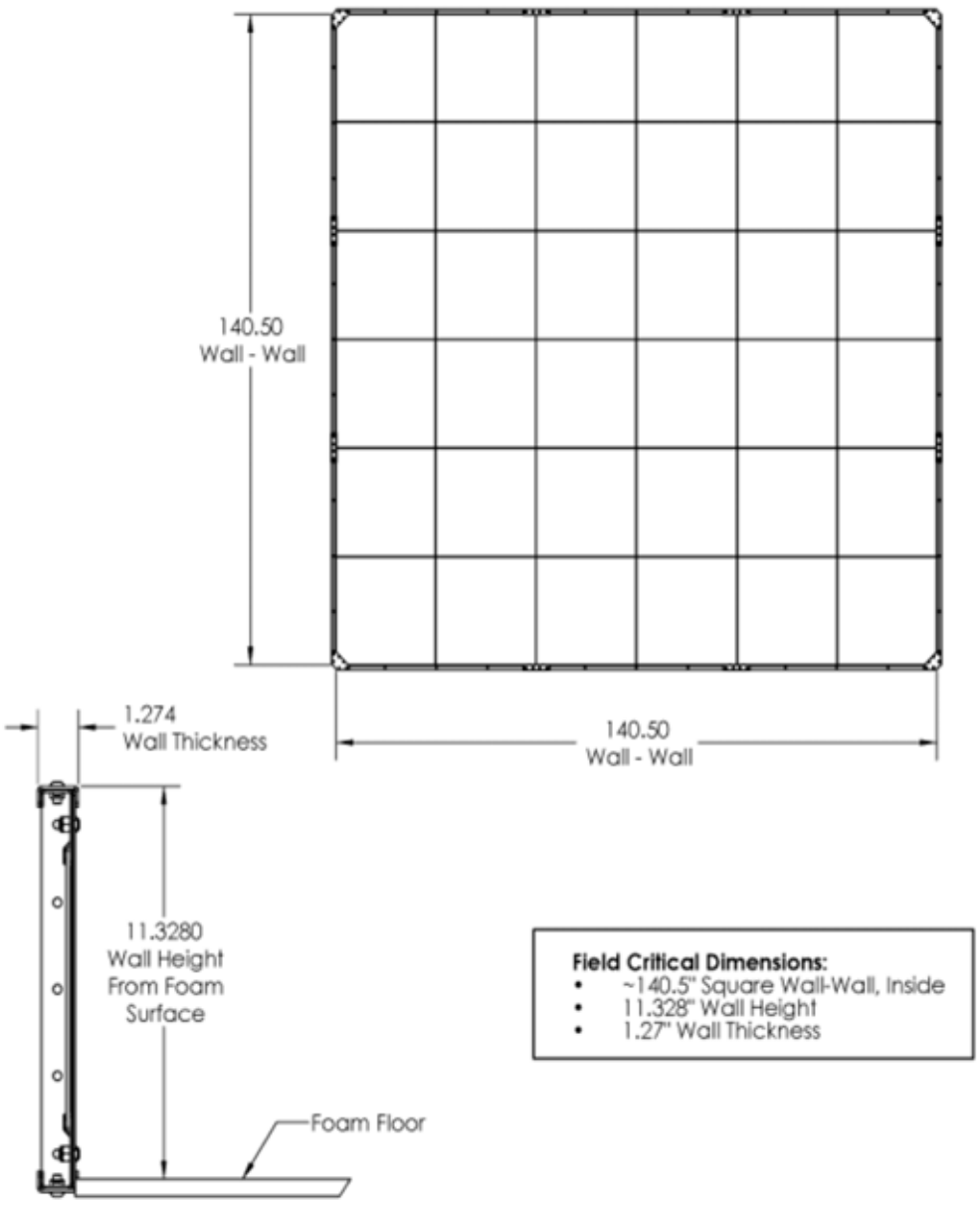
Field Diagrams



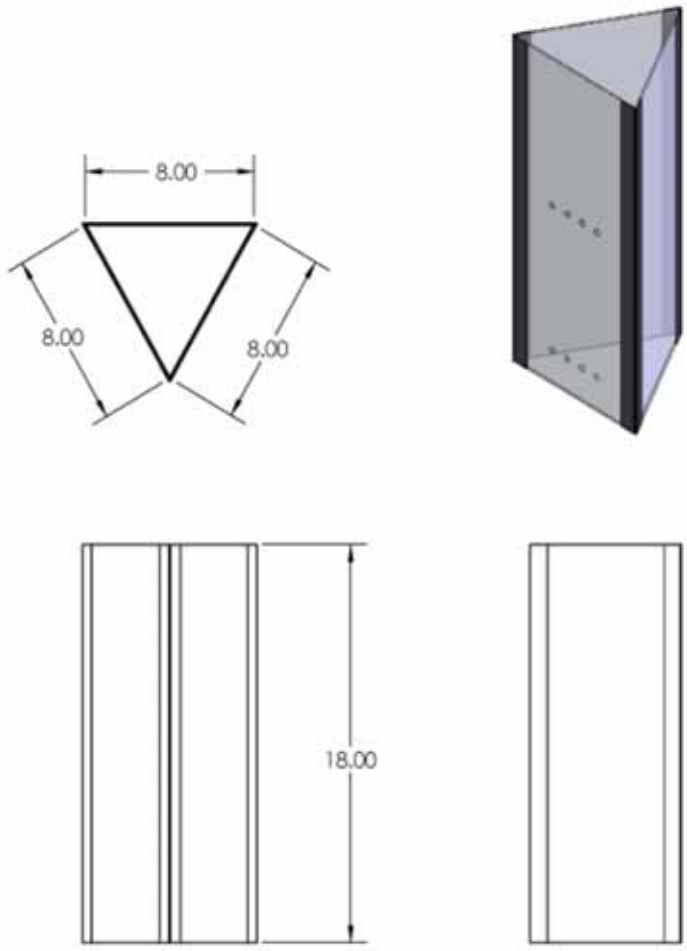
Full field diagram



Full field diagram with dimensions



Playing surface and field border



Large goal

Game Pieces

Green ball

Green balls are approximately four inches in diameter and are made of polyurethane foam, similar to a “Nerf” ball. A green ball weighs approximately 0.125 lbs. To purchase this item, please go to http://www.vexrobotics.com/products/competition-products/275-1399.html.

Small Goal

The small goal is a red bin available from Uline (part number S-12421R). The goal is approximately 18” long, 11” wide and 10” tall. The front opening of the goal is 9.25” wide and is 4” off of the ground. To purchase this item, please go to http://www.uline.com/Product/Detail/S-12421R/Plastic-Bins/18-x-11-x-10-Red-Plastic-Stackable-Bins.

SkillsUSA
2010 Contest Projects

Motorcycle Service Technology

Click the "Print this Section" button above to automatically print the specifications for this contest. Make sure your printer is turned on before pressing the button.

2010 SkillsUSA Championships

Motorcycle Service Technology Contest

Precision Measuring
VRSC Valve Lash Adjustment (250 pts.)
VRSC Clutch Inspection (100 pts.)

Sponsored by Harley-Davidson University

Objective Information Sheet

Time Limit 2 Hours

OBJECTIVE:

Given the tools, various engine components and workstation reference materials, participants will need to correctly measure valve lash, measure shims, adjust the valve lash where needed, and assemble with all four valves to be within specification. Participants will need to correctly read a Metric Micrometer and be familiar with feeler gauge usage for measuring valve lash.

Participants will perform a complete disassembly and inspection of all components of the VRSC Clutch prior to assembly. Condition of the clutch plates, springs and steel disks and their associated measurements will all be observed against Harley-Davidson specifications.

SPECIFIC SKILLS:

The contestant will:

1. Properly select and use precision measuring, hand tools, and equipment.
2. Locate specifications of components in the resource materials.
3. Correctly disassemble VRSC cylinder head valve train components.
4. Measure and adjust the valve lash on a VRSC cylinder head.
5. Correctly assemble VRSC cylinder head valve train components.
6. Correctly disassemble a VRSC Clutch.
7. Inspect and measure clutch plates.
8. Measure the free length of the clutch springs.
9. Correctly assemble a VRSC Clutch.
10. Calculate measurements and determine component condition.
11. Use tools and equipment properly and safely.
12. Clean and organize the work area for the next student.

Set-Up and inventory list (16 stations):

1. The VRSC® Valve Lash & Clutch workstation tools consist of:
    a. Bench VRSC Cylinder head and VRSC Clutch Assembly on pig mats
    b. “VRSC Cylinder Head Valve Lash Student Reference Guide”
    c. VRSC Valve Lash Worksheets (2)
    d. “VRSC Clutch Student Reference Guide”
    e. VRSC Clutch Worksheets (2)
    f. Calculator
    g. VRSC Intake & Exhaust Feeler gauges (HD-47181)
    h. Blue Point Angled Feeler Gauge (FB300A)
    i. Blue Point Flat Feeler Gauge (FB-340)
    j. 0-25mm Metric Micrometer
    k. 3/8” Ratchet
    l. 3/8” 6” extension
    m. 10mm 3/8” drive socket (Qty 2-one for ratchet & one for Torque Wrench)
    n. Extension Magnet (PT5B)
    o. 3/8” 40-200 in. lb. Torque Wrench Snap-on (QD2R200)
    p. Clutch Hub Alignment Tool (HD-45654)
    q. 0-150mm Dial Caliper (EDP 65910)
2. VRSC Valve Shim container and the two flat stones are placed at a central location for all participants to access.
3. The reference material, tools, spare parts should be organized on the table.
4. Extra parts and miscellaneous equipment should be out of sight of the contestant.
5. The judge needs to inspect the setting of the measuring equipment. The judge must insure all measuring equipment is zeroed.
6. The judge must be an active observer watching closely everything the participant is doing to accurately score the participant.

VRSC Valve Lash Adjustment (250 pts)

Contestant # _____ Station # _____

PLACE INITIAL EXHAUST CAM SHIMS HERE

No.____ No.____

PLACE INITIAL INTAKE CAM SHIMS HERE

No.____ No.____

1. Prior to checking the initial valve lash the camshafts must be orientated to what positions_____?

   Record all your initial valve lash measurements on the worksheet provided following the steps outlined in the VRSC Valve Lash Student Reference Guide.

2. Using the "Valve Lash Student Reference Guide" briefly explain the purpose of the numbers and arrows that are associated with the camshaft journal caps. _____
   _____

3. Record the torque specification for the cam journal caps. Specification: _____

4. When having a shim-under-bucket design; to increase the valve lash clearance a technician needs a smaller or larger shim? _____

5. With a shim under bucket design; to decrease the valve lash clearance a technician must find a smaller or larger shim? _____

   REMEMBER: Harley-Davidson VRSC valve shims come in .025mm increments. Knowing the initial valve lash will make choosing the correct shim easier. Even when using the math correctly, remember that the corrected valve lash must pass the feeler gauge test. A final shim change may still be necessary.

6. After new shims are chosen, correctly assemble the cams in the cylinder heads, check the new valve lash and record all measurements below. When complete, present the cylinder head to the judge.

Valve # Front 1-4 Rear 5-8	Valve Type	**Upper Limit**	**Lower Limit**	**Initial Lash** Measurement **10 pts max**	**Initial Shim** Measurement **10 pts max**	**New Shim** Chosen **10 pts max** **IF NEEDED**	**New Lash Measurement** Corrected Lash-if needed **10pts. max**
1 or 7	Exhaust	**.345mm**	**.295mm**				
2 or 8	Exhaust	**.345mm**	**.295mm**				
3 or 5	Intake	**.245mm**	**.195mm**				
4 or 6	Intake	**.245mm**	**.195mm**				

Upon VRSC valve lash completion/cylinder head assembly you are ready to complete the Clutch disassembly, measurement and assembly.

VRSC Clutch Inspection (100pts)

1. Disassemble the clutch removing clutch spring pressure gradually (each fastener a few turns at a time) and then record all your clutch component inspection measurements and the Harley-Davidson specifications on the worksheet provided-filling it out completely. Follow the steps outlined in the VRSC Clutch Student Reference Guide.

Areas of Inspection	**VRSC CLUTCH MEASUREMENTS / SPECIFICATIONS**								
Clutch Spring Free Length									
Factory Spec.:	**____mm**		**SAME FOR ALL**		**CLUTCH SPRINGS**				
Clutch Friction discs									
Factory Spec min.	**____mm**	**SAME**	**FOR**	**ALL**	**FRICTION**	**DISCS**			
Steel Plate Warpage									
Factory Spec max	**____mm**	**SAME**	**FOR**	**ALL**	**STEEL**	**PLATES**			

2. The damper spring is installed onto the damper spring seat with the concave side UP / DOWN?
   Circle One
3. There are two unique Friction Plates. How are these installed in relationship to the other friction plates?
   _____
   _____
4. In which direction should the steel plates be installed_____?
5. Per your answer above; why are the steel plates installed this way?
   _____
   _____
6. Describe where the larger inside diameter steel plate is installed within the clutch assembly?
   _____
   _____

This completes the Harley-Davidson Precision Measuring Workstation.

Stop: Leave your worksheets and pencil with the judge.

Contestant #_____ Station #_____

Judges Name_____

2010 SkillsUSA Championships

Motorcycle Service Technology Contest

Harley-Davidson XR 1200
Digital Technician II Diagnostics

Sponsored by Harley-Davidson University

Objective Information Sheet

Time Limit 30 Minutes

OBJECTIVE:

Given the tools, motorcycle, and Instruction Sheet, participants will correctly test and record vehicle data on a 2009 or 2010 Harley-Davidson XR 1200 motorcycle.

SPECIFIC SKILLS:

The contestant will:

1. Follow the instructions outlined in the supplied test booklet to correctly test and record the requested vehicle data using the Digital Technician II diagnostic computer.
2. Use a digital multimeter to properly measure voltage for the requested data.
3. Evaluate multimeter test results to determine component state or condition.
4. Perform a complete stator check.
5. Use the tools and equipment properly and safely.
6. Clean and organize the work area.

Instructions to Judge

Set-Up:

1. The workstation materials and instructions, and tools should be organized on the table.
2. The judge should monitor the participant's progress to ensure safe use of the equipment.
3. Verify the DVOM is functioning properly and that the motorcycle battery is fully charged.
4. The participant should turn "off" the DVOM, unhook the leads-properly preparing them for the participant that is to follow. Including Fuel Pump Fuse installed, side cover closed and Stator plug connected.
5. The judge must set-up station completely for the next participant.

Inventory per Workstation (four workstations):

Qty.	Description	Part Number	Furnished by
1	Station Instructions booklet		H-D
1	Battery Tender (Global Battery Charger)	94654-98	H-D
1	Set of: Test Leads, Gray Pin probes and alligator clips		H-D
1	Extension Cord for battery tender (if needed)		H-D
1	Fluke 789 Multimeter DVOM		H-D
1	Digital Technician II computer and power cord		H-D
1	Techlink II	HD-48650-1	H-D
1	USB Cord (Techlink II to USB Computer Port)		H-D

Contestant Worksheet

Contestant # _____

Using the test booklet and the Digital Technician II computer, record the following data below.

1) VIN _____ 2) Vehicle Mileage _____

3) Active and / or Historic Fault Code Numbers. _____

4) **Idle Air Control Steps** _____ 5) **Jiffy Stand Value** _____

6) **Battery Voltage** _____ 7) **Engine Temperature** _____

8) **Intake Air Temperature Degrees** _____ 9) **Manifold Absolute Pressure In. Hg.** _____

10) **Throttle Position Degrees at Closed Throttle** _____

11) **Throttle Position Degrees at Wide Open Throttle** _____

12) **Clutch Switch Input w/clutch lever out** _____

13) **Clutch Switch Input w/clutch lever compressed to handlebar** _____

14) Battery Voltage (from B+ post) _____

15) Remove the fuel pump fuse by using sidecover diagram-what is the amp rating?_____

16) Active Diagnostics: Perform System Relay Test-what do you hear? _____

17) Active Diagnostics: Perform System Relay Test (fuse installed)-what do you hear? _____

18) What is the voltage reading at one of the O2 sensor connectors? (pick one, front or rear) _____

19) What is the voltage reading at the ignition coil connector (following the instructions)? _____

STATOR: (Specifications from the supplied Electrical Diagnostics Manual)

20) When touching the meter leads together and pressing the REL button; the OHMS reading is now?_____

21) The XL Stator OHMS/resistance specification between the pins? _____ Your reading? _____

22) The XL Stator OHMS/resistance specification; pin to chassis ground? ____Your readings? 1st pin _____ 2nd pin _____

STOP: Leave this worksheet and pencil with the judge. **Organize** your work area to prepare for the next contestant.

_____

Harley-Davidson **XR1200R**
Engine Diagnostics

- **WELCOME! READ THESE INSTRUCTIONS CAREFULLY**

- IF THERE IS A COMPUTER GLITCH, NOTIFY JUDGE AND HE OR SHE WILL CORRECT IT AND, IF NECESSARY, ADD APPROPRIATE TIME AT THE END OF YOUR SESSION

- THESE COMPUTER SCREENS ARE TOUCH-SENSITIVE AND THE SUPPLIED ‘TOUCH-PEN’ IS BEST FOR SELECTING ICONS RATHER THAN THE MOUSE PAD AND BUTTONS.

Turn Run switch to **“RUN”**

Turn ignition on to establish communication

From the Digital Technician home screen, select the upper left-hand icon. (Vehicle Select)

Pausing the cursor arrow over any button icon will cause a brief description of that button to pop-up.

Carefully type in the Vehicle Identification number (VIN).

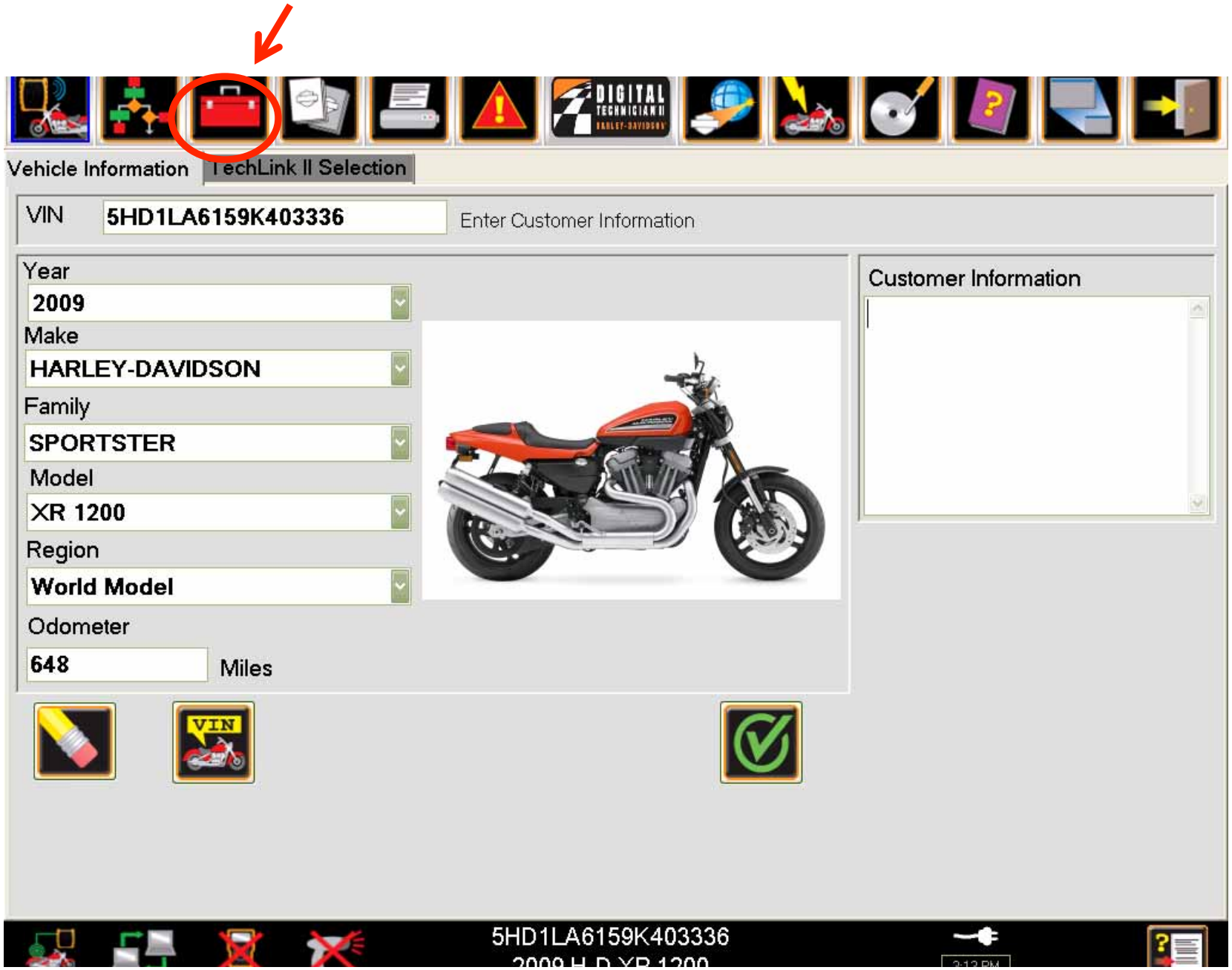
The VIN is located on the right-side of the frame behind the headlamp

NOTE: All ‘Os’ in the VIN are **numbers**, not letters

Click the ODOMETER box and enter the Mileage

Next, click on the circled check box.

Click the circled TOOLBOX icon



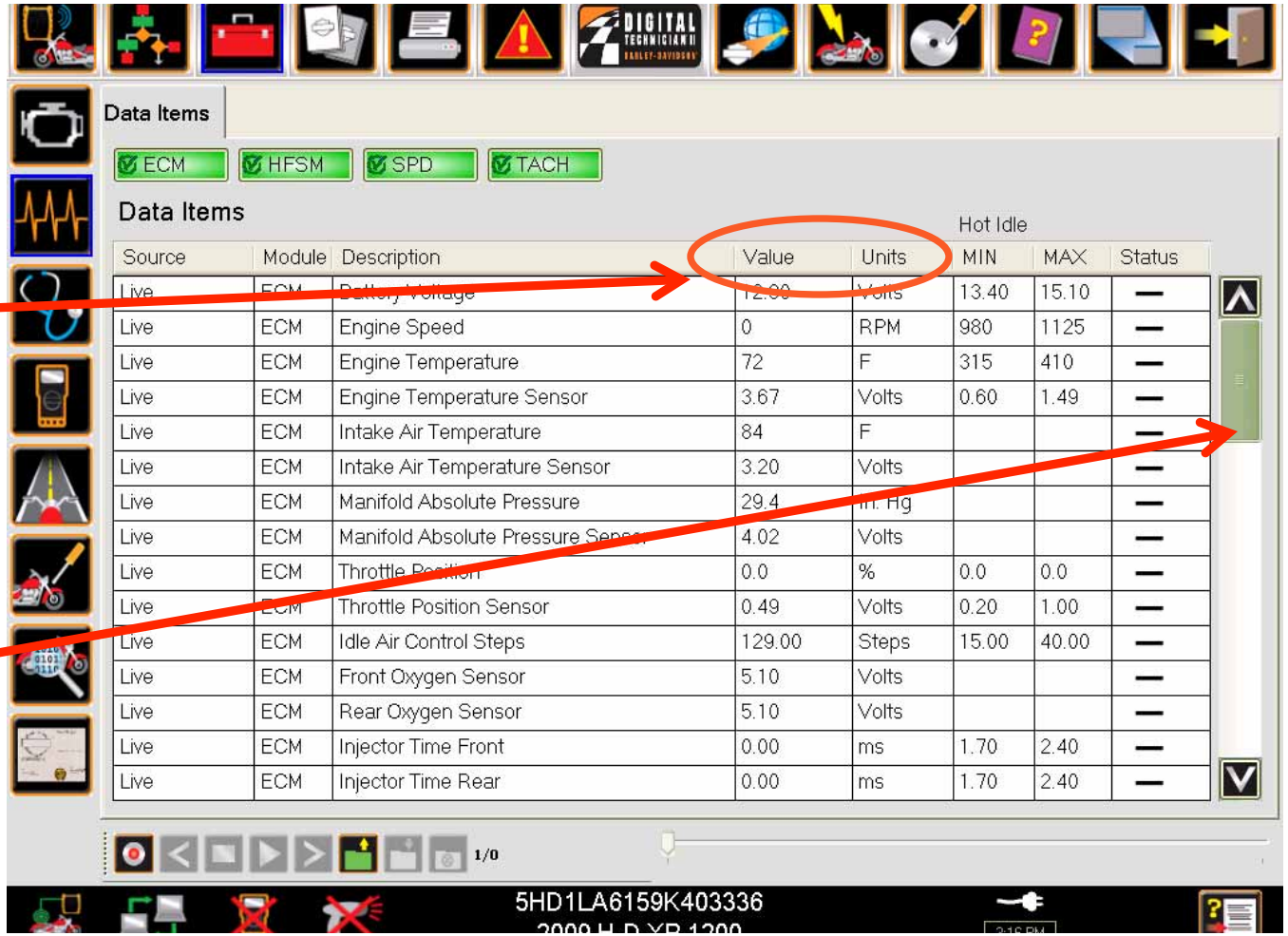
This screen lists any current or historic fault codes for the vehicle.

Record these fault codes, if any exist, on your work sheet. Or write NA if there are none.

Next, click on the DATA ITEMS icon.

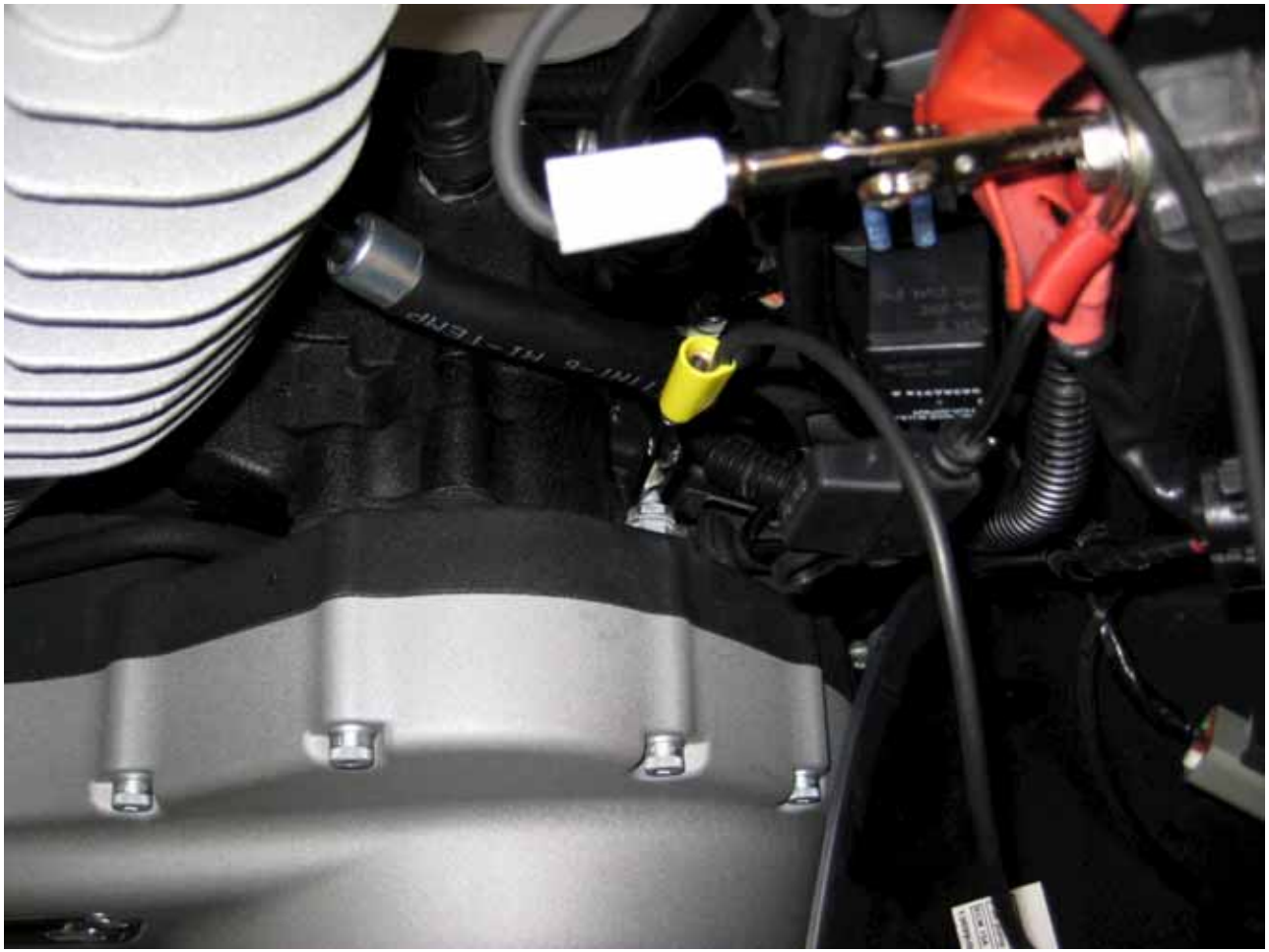
Record on your test sheet from the VALUE and UNITS column, the requested items for questions 4-13.

Additional Data Items can be viewed by using the scroll bar on the right side of the data screen.



Next, attach the multimeter leads to the meter *properly* and the positive lead to the battery + post and the ground or common lead to ground as shown.

Turn the meter dial to the appropriate selection and record the battery voltage on the worksheet.



Pull top of left side cover down. Cover is hinged at the bottom.

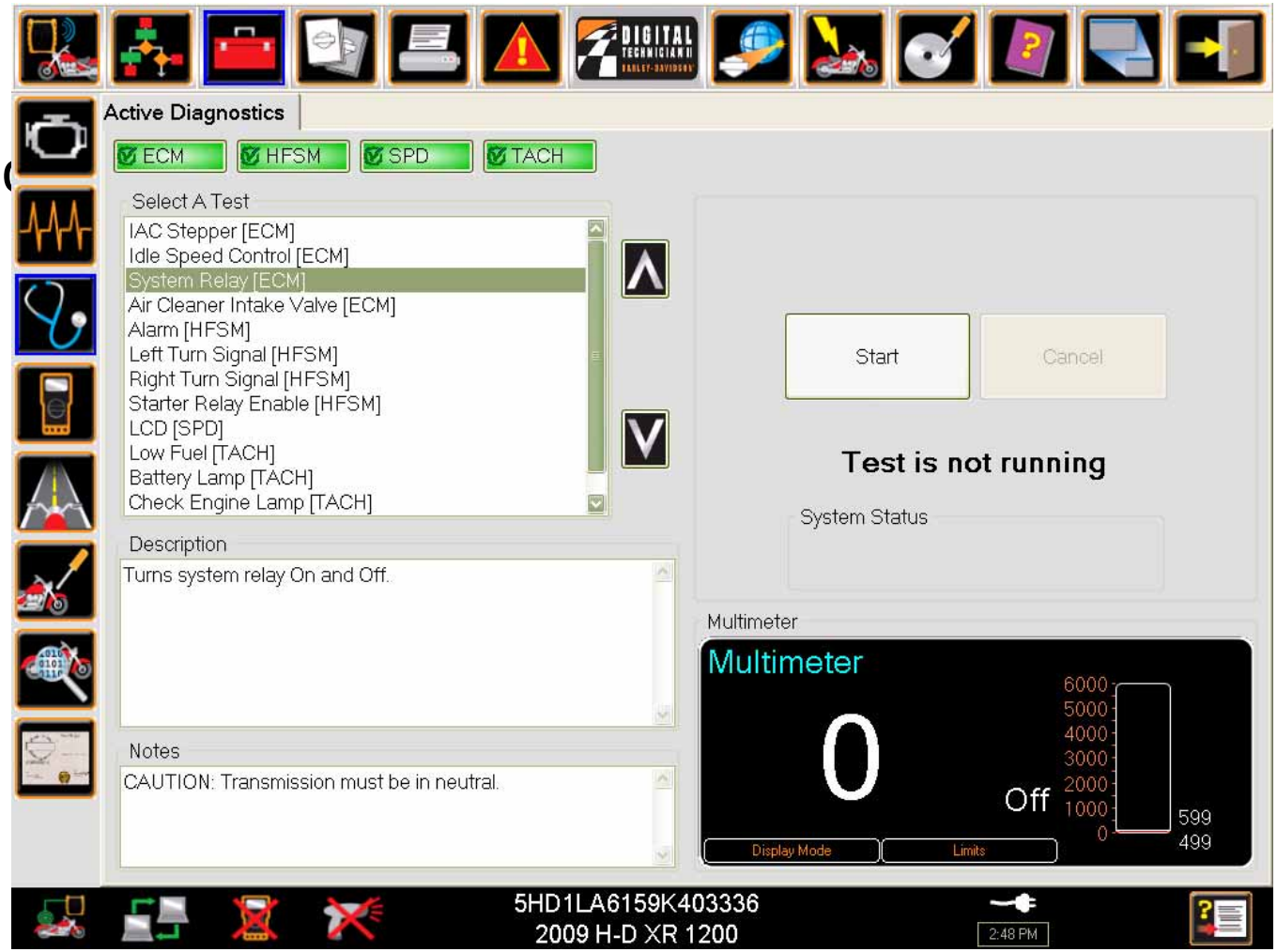
Observe the fuse block diagram decal on the inside of the left side cover.

Pull the fuel pump fuse to disable the fuel pump

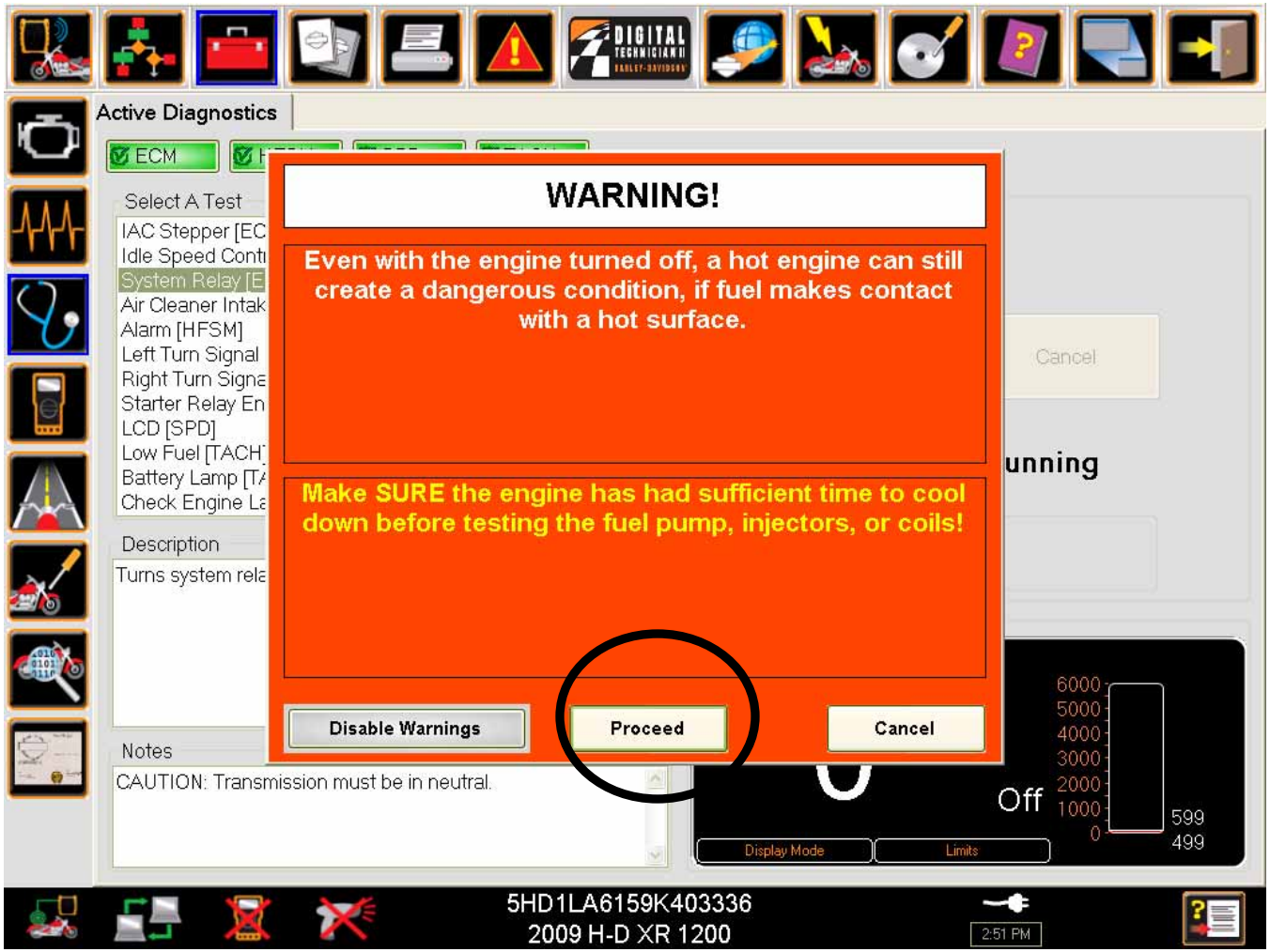
Click the circled ACTIVE DIAGNOSTICS icon

Source	Module	Description	Value	Units	MIN	MAX
Live	ECM	Front Oxygen Sensor	5.10	Volts		
Live	ECM	Jiffy Stand	Up			
Live	ECM	Battery Voltage	13.00	Volts	13.40	15.1
Live	ECM	Engine Speed	0	RPM	980	1125
Live	ECM	Engine Temperature	72	F	315	410
Live	ECM	Engine Temperature Sensor	3.67	Volts	0.60	1.49
Live	ECM	Intake Air Temperature	84	F		
Live	ECM	Intake Air Temperature Sensor	3.20	Volts		
Live	ECM	Manifold Absolute Pressure	29.4	In. Hg		
Live	ECM	Manifold Absolute Pressure Sensor	4.02	Volts		
Live	ECM	Throttle Position	0.0	%	0.0	0.0
Live	ECM	Throttle Position Sensor	0.49	Volts	0.20	1.00
Live	ECM	Idle Air Control Steps	129.00	Steps	15.00	40.0
Live	ECM	Rear Oxygen Sensor	5.10	Volts		
Live	ECM	Injector Time Front	0.00	ms	1.70	2.40

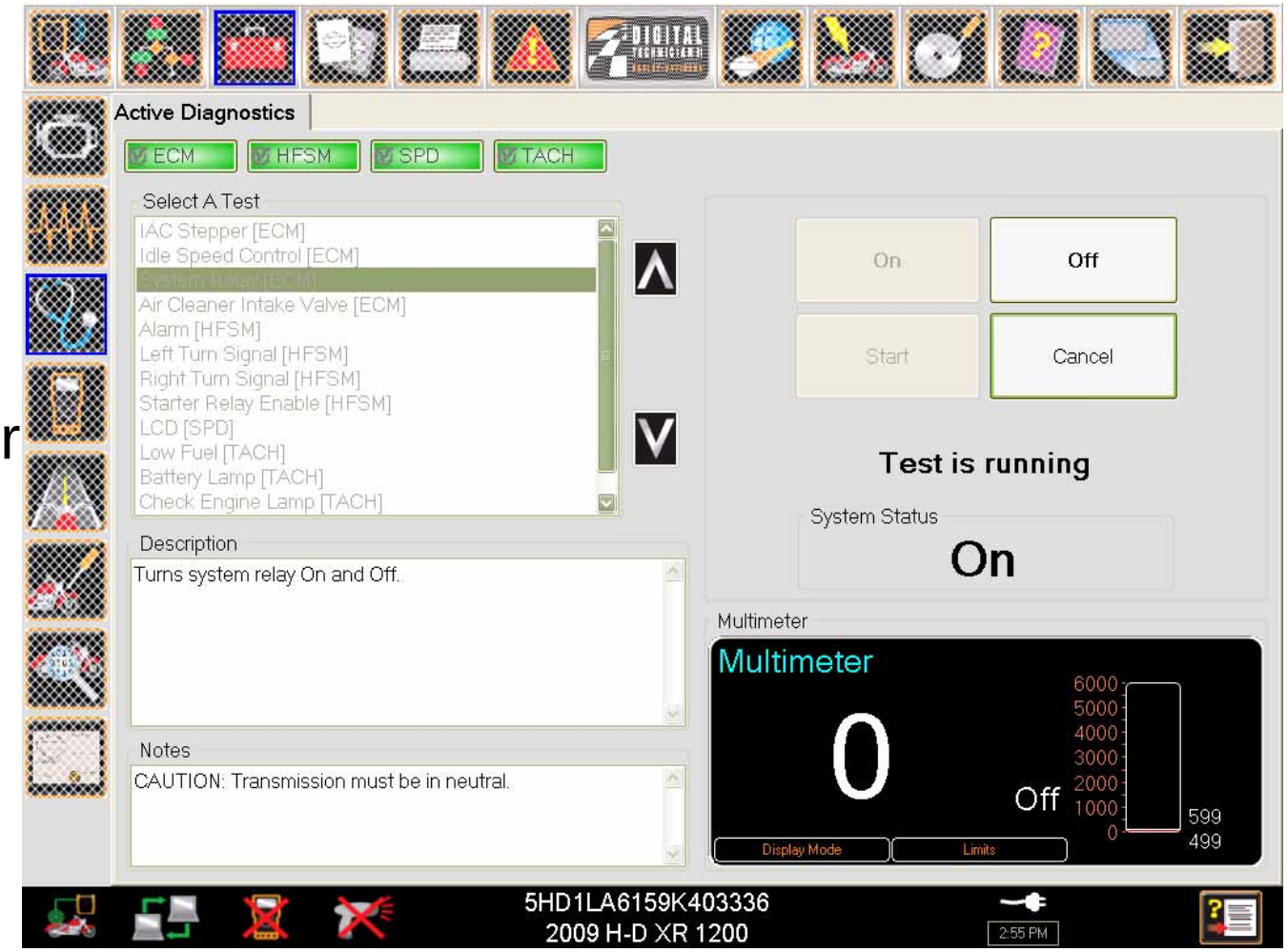
- Screen should l
  similar



- Click Proceed



- What can you hear?
- Cancel test after 5 seconds



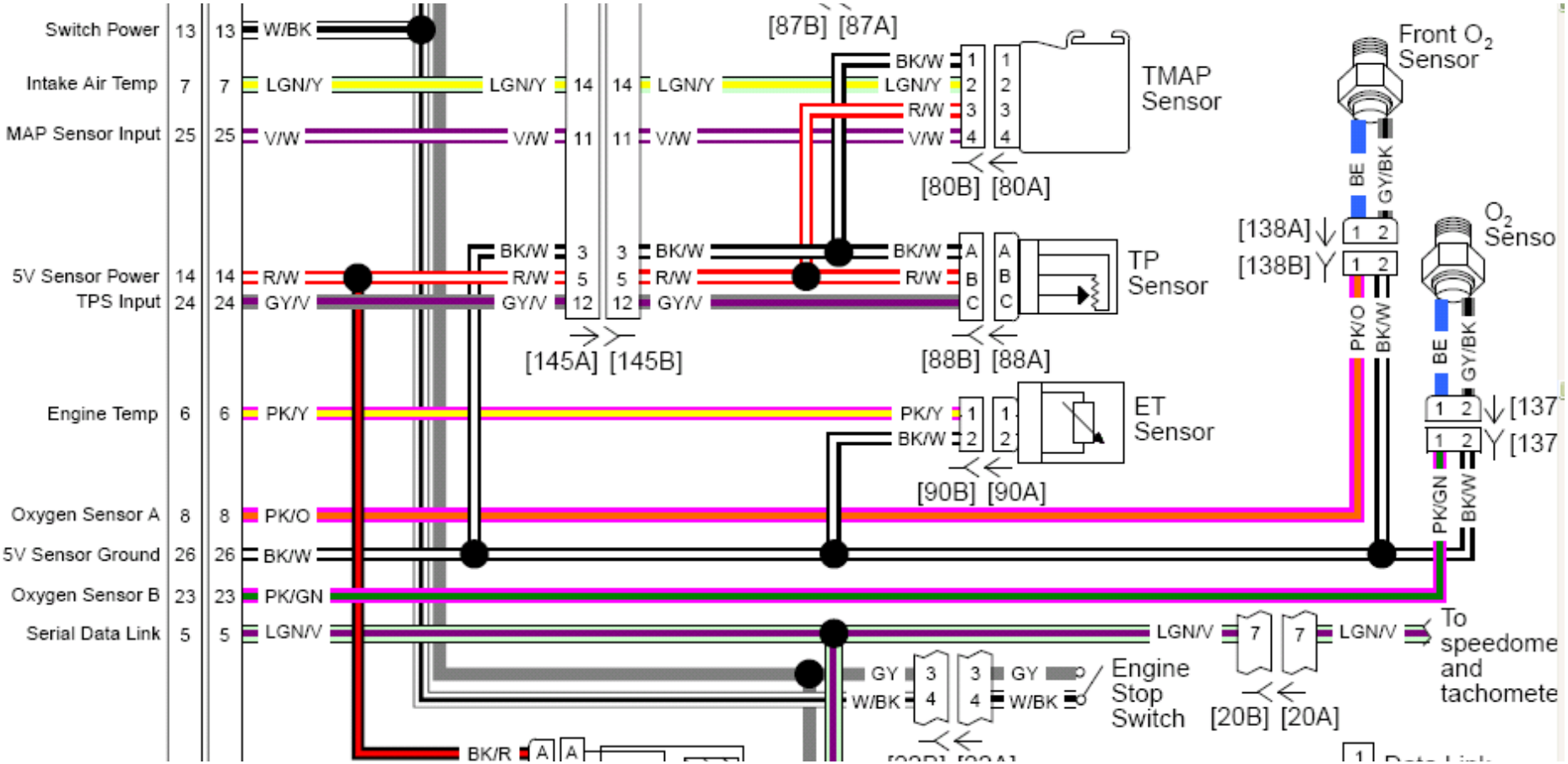
Replace fuel pump fuse and close the side cover.

Perform the Active Diagnostics test again for 5 seconds and then cancel.

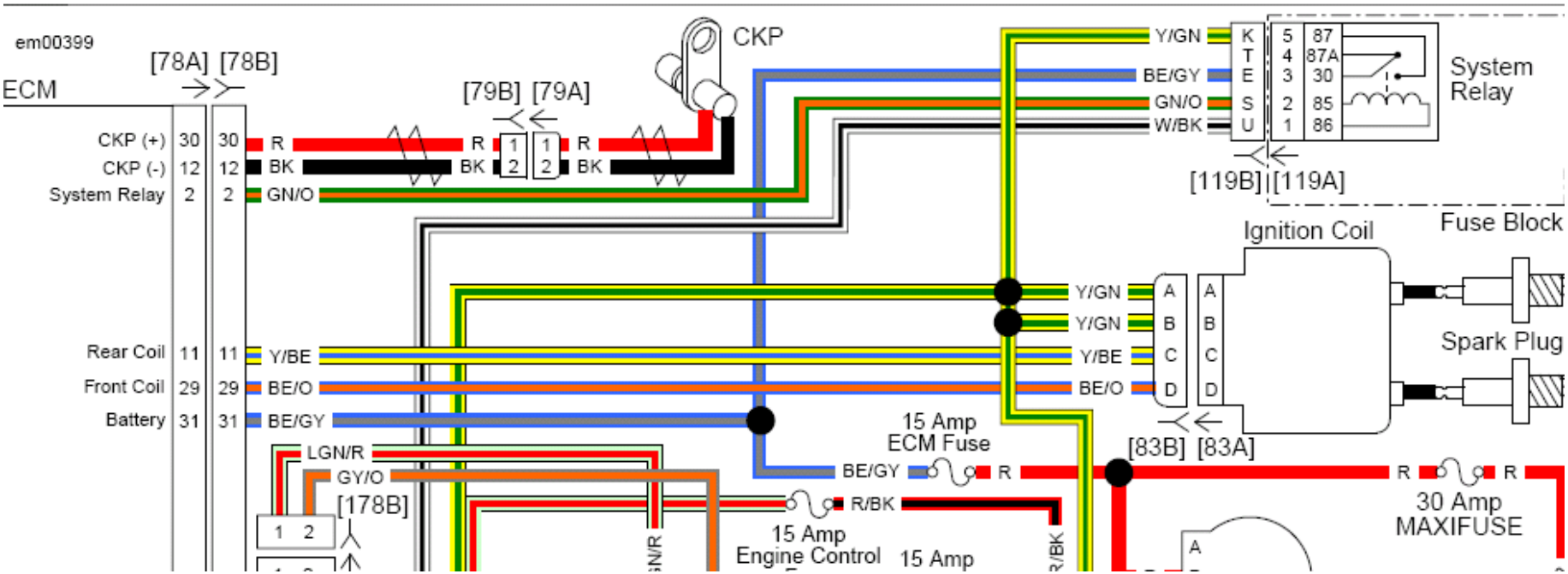
What do you hear?

CAREFULLY disconnect one of the two O2 sensor connectors. Each exhaust header pipe has an O2 sensor close to the cylinder head

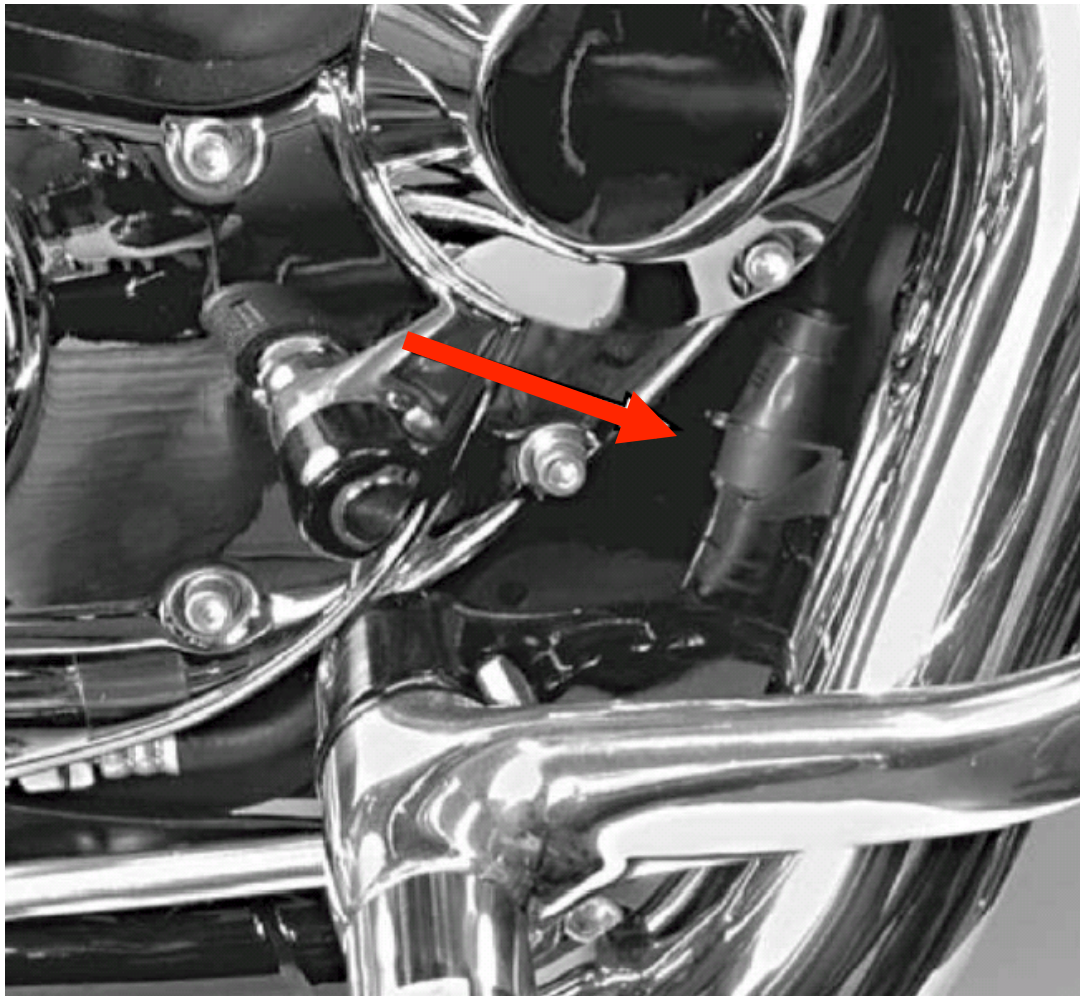
Using the wiring diagram, determine which wire to probe using the gray pin probe and the multimeter and with ignition key “on” record the Voltage at the connector.



- Find ignition coil above front cylinder/left side and turn Run switch to “**OFF**”
- CAREFULLY disconnect the ignition coil connector
- Using the wiring diagram and with the multimeter, determine the wire or wires to probe and record the voltage at the ignition coil connector when cycling the run switch to “**RUN”**.



- Turn ignition switch off
- Disconnect the stator plug
- Turn meter to OHMS



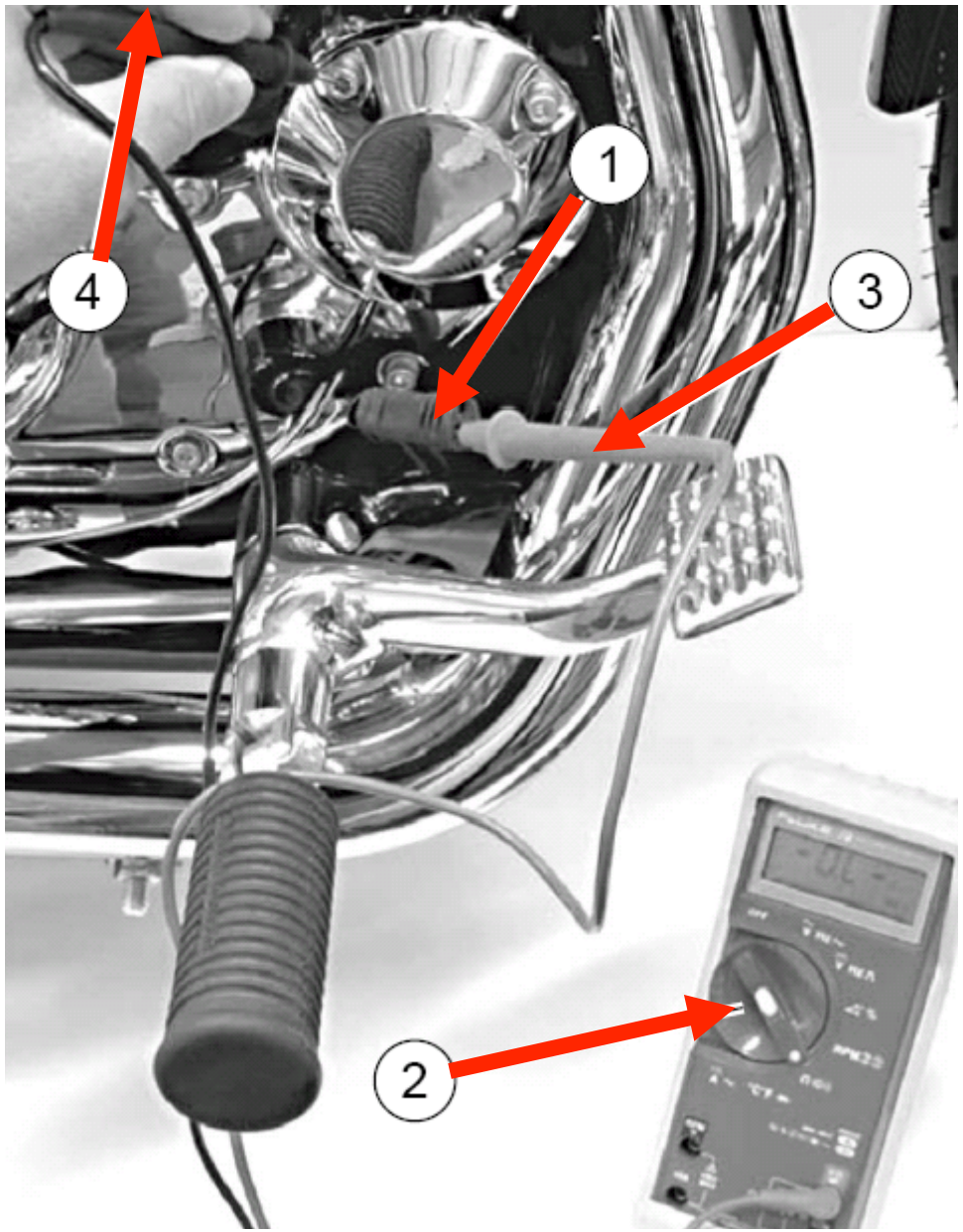
NOTE: Follow the two wires coming out of the lower right side of the engine. These are from the stator.

STATOR CHECK

- Zero the meter leads by touching them together while pressing the **“REL”** button on the meter.
- NOTE: Did you observe the meter lead resistance go to zero?

- 1. Check and record OHMS/ resistance between both pins

- 2. Check and record OHMS/ resistance to ground
- NOTE: Remember the ground location for checking battery voltage?



1. Alternator stator connector [46B]
2. DVOM set to ohms scale
3. Positive meter lead to each stator connector socket
4. Negative meter lead to ground

CONGRATULATIONS !!!

- You have completed the XR 1200 DT II and electrical diagnostic station.

- Please hand your worksheet to the judge and organize your work area for the next contestant.

SkillsUSA

Print Name: _____

Contestant Number: _____

Test questions for PHD 176.09 - Introduction to the XR1200

Highlight the letter of the correct answer for each question.

1. The XR wheel and tire sizes are:

a. front – 120 by 18" radial rear – 180 by 17" radial
b. front – 100 by 17" radial rear – 190 by 16" radial
c. front – 110 by 19" radial rear – 200 by 17" radial
d. front – 100 by 21" radial rear – 150 by 19" radial

2. The XR uses offset fork brackets (triple trees). The _____ .

a. steering angle is steeper (closer to 0^0) than the fork angle.
b. fork angle is steeper (closer to 0^0) than the steering angle.
c. steering angle and the fork angle are the same only the trail is changed.

3. The XR use hollow axles on both the front and rear.

a. true
b. false

4. The tire pressure for both the front and rear tires on the XR are _____ than those on the other XL models.

a. Higher
b. Lower
c. the same

5. The front brake discs on the XR are installed _____ .

a. with the part number facing inwards
b. the slots facing in opposite directions
c. using the "left" and "right" stampings
d. in any direction

6. When replacing the front brake pads, the spring clip is installed _____ .

a. with the arrow facing in the direction of wheel rotation
b. with the arrow facing up or towards the bleeder screw
c. with the arrow facing inwards towards the brake pads
d. can be installed in any direction

7. The XR uses a _____ .

a. cartridge style fork on the left and a conventional valve fork on the right
b. cartridge style fork on the right and a conventional valve fork on the left
c. cartridge style fork on both sides
d. conventional valve fork on both sides

8. The first step in the procedure for servicing the air cleaner is to:

a. Remove the outer cosmetic fuel tank cover
b. Remove the fuel pump fuse and crank the engine
c. Remove the main fuse and crank the engine
d. Remove the breather hoses

9. To remove the cosmetic fuel tank cover you remove the screws _____ .

a. at the 1,5,7 and 11 O'clock positions around the filler cap
b. at the 12,3,6, and 9 O'clock positions around the filler cap
c. all screws must be removed

10. In addition to removing the screws around the fuel filler cap, you must

_____ to remove the cosmetic fuel tank cover.

a. remove the two push pins at the rear under the seat
b. remove the two screws at the rear from under the tank
c. pry out on the cover at the rear to free the two latch tabs
d. lift up in the rear to break the grip of the two sided tape

11. The air cleaner housing is bolted to the _____ .

a. Frame
b. engine
c. fuel tank
d. floats free of all chassis components

12. The air filter element on the XR can be washed and reused.

a. true
b. false

13. When reinstalling the air cleaner assembly after servicing the filter, you

_____ first.

a. attach it to the fuel tank
b. install the rubber induction module grommet into the air box housing
c. connect the two breather lines from the cylinder heads
d. install the fuel tank first

14. When checking the compression of the cylinders, the XR will produce _____ readings on the pressure gauge than the XL 1200 engine.

a. higher
b. lower
c. the same

15. To remove the riders seat you _____ .

a. push in on the two tabs at the rear of the seat and lift the back up
b. push in on the two tabs at the front of the seat and lift the front up
c. remove the passenger seat and remove the two bolts attaching the riders seat
d. use the ignition key on the side

16. When replacing the rear brake pads it is necessary to remove the brake caliper from the mounting bracket.

a. true
b. false

17. The swingarm bearings used on the XR are the same as those used on the Softail® models.

a. true
b. false

18. The XR uses an adjustable idler wheel to control belt tension.

a. true
b. false

19. The rear axle alignment measurement is taken from the_____ .

a. ends of the adjuster bolts to the swingarm
b. center of the rear axle to the center of the pivot shaft
c. center of the rear axle to the rear of the slot in the side of the swingarm
d. axle is not adjustable

20. Belt deflection can be measures by using the marks _____ .

a. on the lower belt guard
b. on the rear of the gearcase cover
c. on the side of the swingarm
d. there are no gauge marks you must use a ruler

21. To remove the rear wheel you must remove the rear caliper from the caliper mounting bracket.

a. true
b. false

22. The primary sprocket is retained to the crankshaft _____ .

a. by a nut
b. by a bolt
c. by a spring loaded retaining clip
d. by a press fit

23. The clutch shell uses a _____ bearing.

a. plain
b. ball
c. roller

24. The XR uses the same clutch plates (steel and friction) as the XL.

a. true
b. false

25. The only gear in the XR's transmission that is not shared with the XL is _____.

a. fifth gear mainshaft
b. first gear mainshaft
c. fifth gear countershaft
d. first gear countershaft

26. The output shaft bearing on the XR is a double roller bearing design because of the _____ .

a. increased torque loads from the engine
b. wider rear tire
c. new swing arm mounting method
d. idler wheel used on the rear drive belt

27. The XR and XL models use the same sparkplug.

a. true
b. false

28. The oil cooler only cools the oil being delivered to the cylinder heads.

a. true
b. false

29. When the oil temperature reaches 1900 F or 880 C all of the oil being delivered to the engine will pass through the oil cooler.

a. true
b. false

30. The oil for precision cooling system passes through passages in both the cylinder heads and cylinders.

a. true
b. false

31. The oil flowing through the precision cooling passages in the cylinder heads returns to the _____ .

a. gearcase cover through external lines
b. flywheel compartment through internal passages
c. oil tank through external lines
d. oil cooler through external lines

32. The metal patches on the head gasket seal the _____ .

a. pressurized lubrication passage
b. pressurized cooling passage
c. lubricating oil return passage
d. compression release valve passage

33. The oil pressure readings on a XR at operating temperature when running 2500 rpm are _____ than an XL model.

a. higher
b. lower

c. the same

34. The crankcase camshaft bearings are _____ .

a. needle bearings
b. ball bearings
c. bronze bushings
d. parent metal

2010 SKILLS USA WHEEL BEARING REMOVAL AND INSTALLATION

At this station you will first read the procedure and answer 8 questions and then remove and replace the two wheel bearings on your supplied wheel. One bearing is a conventional wheel bearing and the other is an ABS (Anti-lock Brake System) sensor wheel bearing.

There are 150 total points possible for successful completion of the 8 questions, comprehension of the service manual sheets and the removing and installing both wheel bearings on the wheel.

IMPORTANT: Before removing and replacing the two wheel bearings, read the procedure in the supplied Harley-Davidson service manual sheets and answer the 8 questions before performing the procedure. This will help you, the contestant earn the highest possible score.

Each correct answer (multiple choice questions) is awarded 4 points (32 points total)

The non-ABS wheel bearing procedure is worth up to 53 points

The ABS wheel bearing is worth up to 65 points

Points will be deducted for damaged or improper use of tools, damaging the wheel or tools, for incorrect procedures or leaving a messy work station at completion

Enter answers (A,B,C or D) on answer sheet

Make sure your name and contestant number is entered on your answer sheet.

ou have 30 minutes to complete this station.

Wheel Bearing Procedure Questions

1. What color is the outside facing surface of a conventional non-ABS wheel bearing?

    A. Light orange

    B. Greenish tan

    C. Red

    D. Black

2. What color is the outside surface of an ABS wheel bearing?

    A. Light orange

    B. Greenish tan

    C. Red

    D. Black

3. The collets used to remove the wheel bearings from the hub are different for conventional vs. ABS bearings. Which part number is used for an ABS bearing?

    A. HD-44060-10

    B. HD-44060-11

    C. HD-44060-12

4. Where is the thin bearing spacer washer installed on ABS equipped wheels?

    A. Underneath the non-ABS bearing against the counter bore in hub

    B. Outside (on top) of the non-ABS bearing

    C. Underneath the ABS bearing against the counter bore in hub

    D. Outside (on top) of the ABS bearing

5. The primary side of a wheel is the brake caliper side. (With single caliper wheels) When installing a new set of bearings, which side of the wheel should you install the first bearing? Primary side or non-primary side?

    A. Primary side

    B. Non-primary side

6. For a front wheel, what is a visual cue to determine the primary side?

    A. Valve stem side of wheel

    B. Primary side has a ‘P’ stamped on the hub

    C. Primary side has ‘PRIMARY’ stamped on the hub

    D. Side opposite valve stem

7. The ABS Encoder wheel bearing is installed on the…

    A. Primary side

    B. Non-primary side

8. The non-ABS standard bearing should be installed with the…

    A. Lettered side out

    B. Lettered side in

    C. The side stamped ‘OUT’ facing out

    D. The side stamped ‘THIS SIDE OUT’ facing out

2010 SKILLS USA WHEEL BEARING REMOVAL AND INSTALLATION

ANSWER SHEET

Name _____ **Contestant Number** _____

Total Score _____ **Judges Initials** _____

1. _____

2. _____

3. _____

4. _____

5. _____

6. _____

7. _____

8. _____

DO NOT WRITE BELOW THIS LINE (For judges only)

Correct Answers Sub Total (32 points possible) _____

Non ABS Bearing Procedure (53 points possible) _____

ABS Bearing Procedure (65 points possible) _____

TOTAL POINTS _____ **(also enter at top of sheet)**

JUDGES KEY ANSWER SHEET

2010 SKILLS USA WHEEL BEARING REMOVAL AND INSTALLATION

ANSWER SHEET

Score (150 points possible _____

1. _____
2. _____
3. _____
4. _____
5. _____
6. _____
7. _____
8. _____

4 Points each for these 8 correct answers

(32 points possible)

9. **Successful removal and installation of the non ABS Bearing using the appropriate Harley-Davidson special tools. (53 points possible)**

10. **Successful removal and installation of the ABS Bearing using the appropriate Harley-Davidson special tools. (65 points possible)**

Deduct these points for the following errors

Bearing installed backward (20 points for each bearing)

Non-primary bearing installed first (20 points)

Damaged tool(s) (30 points)

Improper tool used (ex: wrong collet -20 points)

Leaving a messy work station (10 points)

2010 Skills USA Championships

Motorcycle Service Technology Contest

Harley-Davidson Twin Camshaft and Oil Pump Assembly Station (200 pts.)

Sponsored by Harley-Davidson University

Objective Information Sheet

Time Limit 30 minutes

OBJECTIVE:

Given the tools, various engine components and workstation reference materials, participants will need to correctly measure and assemble the camshafts and oil pump assembly of a Twincam 96 engine.

Specific Skills:

Participants will perform the following:

1. Correctly measure the alignment of front cam to lower sprocket
2. Choose the appropriate shim to align the cam sprockets
3. Assemble the two camshafts in proper timing using the special tool
4. Assemble the oil pump properly
5. Install the appropriate O-Rings in their respective locations
6. Demonstrate the proper use torque wrenches
7. Clean and organize the work area for the next student

Tools provided:

1. Crankshaft rotational tool
2. 6” steel rule
3. Feeler gauge
4. T27, ½” 9/16” and a 3/16” Allen 3/8ths drive sockets
5. 3/8” drive ratchet
6. inch pound torque wrench and a foot lb. torque wrench
7. Camshaft assembly tool
8. Cam sprocket shims

Important: This document includes supplemental information to the attached service literature that is essential to your success at this station.

The tasks you must perform at this station are to properly install an oil pump, camshafts, cam support plate, hydraulic tensioners and cam timing chain in a Twin Cam 96B engine. You will be graded on following proper service and safety procedures. This includes wearing safety glasses.

It is highly advisable that you familiarize yourself with the provided literature before attempting this station. You are allowed to highlight this literature as you see fit.

All ¼" fasteners will be torqued to a *final* torque of 90 in/lb. This includes the oil pump. We are using the low end of the torque specification to preserve training aids.

The fasteners for the oil pump, the rear cam shaft and the crank sprocket all have specific instructions on initial and final torque procedures. You will be asked questions regarding those procedures.

Assembly lubricant and Loctite will not be used due to time constraints. However, it is essential that you understand that when assembling an engine that will be run, it is critical that assembly lubricant and Loctite be used wherever the service literature instructs you to do so.

The rear of the engine is attached to the engine stand. Therefore, the rear camshaft will be installed closest to the engine stand.

Page 3-57, Step # 17 instructs you on how to install the oil pump. Failure to follow the steps as listed will not only result in lost points, but lost time as well.

The hydraulic tensioners must be assembled as shown in figure 3-129 on page 3-91. When torquing the fasteners that hold the inner tensioner to the cam support plate, you may ask your judge for assistance in holding the cam support plate.

Page 3-58, Step #1 omits a very important component. Prior to installing the cam support plate, (2) o-rings and a filter screen must be installed. Using figure 3-76 as a reference, first install the metal filter screen into hole #3 and then install an o-ring into hole #1 and hole #3.

Very specific instructions are given regarding how the engine should be oriented on the engine stand in order to align the rear cam sprocket (large) and crankshaft sprocket (small). It is acceptable to either have the cam compartment facing completely upward or a slight angle upward. If you need physical assistance with this, please ask your judge, and he or she will assist you with re-orienting the engine on the stand.
Be certain to demonstrate to your judge that you followed Step "d" on page 3-59.

When performing the procedure to tighten the (4) oil pump screws, it is acceptable to ask your judge for physical assistance if you are finding the procedure clumsy.

2010 Skills USA Harley-Davidson Camshaft Installation Station

Participant # _____

Judge_____

Items below to be filled out by the participant:

1) What is done to the motor while initially “snugging” the (4) oil pump fastener screws?

2) Initial oil pump torque specification (not including initial “snug”): _____

3) Final oil pump fastener torque specification:_____

4) Order of tightening oil pump fasteners: #_____ #_____ #_____ #_____

5) Initial *rear* camshaft fastener torque:_____

6) Final *rear* camshaft fastener torque:_____

7) Initial *crankshaft* sprocket fastener Torque:_____

8) Final *crankshaft* fastener torque:_____

2010 Skills USA Harley-Davidson Camshaft Installation Station

Judge grading sheet and answer key

Participant # _____

Judge _____

CIRCLE ZERO IN FIRST COLUMN IF INCORRECT/ERROR

CIRCLE VALUE IN SECOND COLUMN IF CORRECT

0	20	Properly phased camshafts when installing into cam support plate (dots faced each other)
0	15	Installed proper spacer onto front camshaft
0	25	Properly installed circlip onto front camshaft (Sharp Side out - MUST be seated all the way and MUST have worn safety glasses)
0	20	Properly assembled and installed hydraulic tensioners
0	10	Properly installed oil pump o-ring into crankcase
0	10	Properly installed oil pump body into crankcase
0	20	Properly installed oil pump internal components
0	20	Properly snugged oil pump fasteners while rotating engine (it is acceptable if they snugged all 4 while rotating engine)
0	25	Properly selected spacer for rear cam shaft and installed chain and sprocket assemblies. Demonstrated that they pushed the crank and cam components into case prior to taking sprocket measurements.
0	20	Properly torqued all components
0	15	Answered all questions correctly

SkillsUSA
2010 Motorcycle Service Technology Contest

Written Test

Motorcycle Technology Theory

Sponsored by

SkillsUSA
2010 Motorcycle Service Technology Contest
Motorcycle Technology Theory

Objective: This written test allows the participant to demonstrate knowledge of Motorcycle Technology Theory.

Directions: Select the best answer(s) for each question, and then fill in the appropriate letter's box on the answer sheet provided.

1. Using the following information, calculate cylinder volume in cubic centimeters.

   Bore = 72.5 mm
   Stroke = 60.3 mm

   A. 248,394 cc
   B. 497.868 cc
   C. 248.934 cc
   D. 34.336 cc

2. Pre-ignition is:

   A. spontaneous ignition after normal ignition
   B. auto-ignition before normal ignition
   C. compression
   D. auto-ignition after normal ignition

3. The intake valve opens in which quadrant?

   A. BTDC
   B. ATDC
   C. BBDC
   D. ABDC

4. The exhaust valve opens in which quadrant?

   A. BTDC
   B. ATDC
   C. BBDC
   D. ABDC

5. Valve overlap occurs at the:

    A. end of the combustion stroke and the beginning of the exhaust stroke
    B. end of the compression stroke and the beginning of the combustion stroke
    C. end of the exhaust stroke and the beginning of the intake stroke
    D. end of the intake stroke and the beginning of the compression stroke

6. Intake valve area is commonly _____ that of the exhaust valve.

    A. greater than
    B. the same as
    C. less than
    D. hotter than

7. The job of the camshaft is to:

    A. drive the crankshaft
    B. dampen valve spring oscillations
    C. run the oil pump
    D. control when, how fast, how far, how long the valve is opened

8. Which of these components changes reciprocation motion into rotary motion?

    A. rocker arm
    B. camshaft
    C. crankshaft
    D. piston

9. The intake port of a piston –port two-stroke engine typically:

    A. opens at BTDC and closes at ATDC
    B. opens at BTDC and closes at ABDC
    C. opens at BBDC and closes at ABDC
    D. opens at BBDC and closes at ATDC

10. A two-stroke engine with a leaking wet (clutch) side seal will exhibit which symptom?

    A. run lean
    B. smoke excessively
    C. none of the above
    D. all of the above

11. Changing a 32:1 pre-mix ration to 50:1 will:

A. put more oil in the fuel/oil mixture
B. put less oil in the fuel/oil mixture
C. lubricate the engine better
D. have no effect

12. Overdrive is a gear that is numerically:

A. less than 1:1
B. more than 1:1
C. 1:1
D. none of the above

13. If the transmission output sprocket has 14 teeth, and the rear wheel sprocket has 44 teeth, what would the final drive ratio be?

A. 3.143:1
B. 2.333:1
C. .318:1
D. 40.000:1

14. Clutch drag is:

A. the clutch does not transfer 100% of the engine's powerflow
B. clutch friction plates contaminated with oil
C. the clutch will not fully disengage
D. a clutch with worn out clutch springs

15. The largest driven gear found in a 5-speed indirect drive transmission will be:

A. C5
B. C1
C. M5
D. M1

16. The four purposes of motor oil are:

A. clean, cool, seal, quiet
B. clean, cool, seal, lubricate
C. clean, cool, seal, motivate
D. clean, cool, seal, calcify

17. The _____ is a lubricating system that stores oil in a remote tank.

A. wet sump
B. centrifugal
C. splash
D. dry sump

18. a 20W-50 multi-viscosity motor oil is one which:

A. is both 20 weight and 50 weight oil combined
B. thickens less when cold than a 20 weight and thins less when hot that a 50 weight
C. is a 20 weight mixed with 30 weight
D. thins less when cold than a 20 weight and thickens less when hot than a 50 weight

19. The component found in the oil filter that allows oil to flow if the filter becomes clogged is the:

A. oil pressure relief valve
B. bypass valve
C. reed valve
D. oil pump

20. The bearing which is the best for radial loads, but not at all good for axial loads is the:

A. thrust bearing
B. tapered roller bearing
C. ball bearing
D. roller bearing

21. Which one of these is one of the four purposes of bearings?

A. support radial and/or axial loads
B. lubricate
C. impressibility
D. permeability

22. In a liquid cooling system, the thermostat:

A. allows for quicker engine warm up time
B determines the cooling system's operating pressure
C. is a heat exchanger
D. sends electrical data to the instrument panel

23. In a liquid cooling system, the _____ determines the cooling system's operating pressure.

    A. thermostat
    B. water pump
    C. radiator
    D. radiator cap

24. Octane is the fuel's ability to:

    A. increase mechanical efficiency
    B. resist chemical breakdown
    C. resist detonation
    D. increase stroke efficiency

25. The main purpose of oxygenated fuels is to:

    A. improve fuel mileage of the engine
    B. reduce CO2 emissions
    C. reduce CO emissions
    D. reduce HC emissions

26. Air density:

    A. refers to the amount of oxygen in a given space
    B. decreases as altitude decreases
    C. affects the pressure differences
    D. increases and altitude increases

27. An air/fuel ratio of 12:1 has:

    A. 12 parts air (by volume) to 1 part fuel
    B. 1 part air (by volume) to 12 parts fuel
    C. 12 parts air (by weight) to 1 part fuel
    D. 12 parts fuel (by weight) to 1 part air

28. The force that results from an electrical pressure difference is called:

    A. watts
    B. ohms
    C. amps
    D. EMF

29. Which of the following formulas is correct?

    A. Volts = Amps X Ohms
    B. Volts X Ohms = Amps
    C Ohms ÷ Amps = Volts
    D. Amps ÷ Volts = Watts

30. The two major types of charging systems are:

    A. rising field, collapsing field
    B. excited field, normally open
    C. permanent magnet, full wave
    D. permanent magnet, electromagnet

31. The three strengths of charging systems are:

    A. half-wave, full-wave, permanent magnet
    B. half-wave, full-wave, sine-wave
    C. half-wave, full-wave, 3-phase
    D. permanent magnet, electromagnet, rising field

32. The ignition coil's _____ windings has more wire turns than it's _____ winding.

    A. solenoid; starter
    B. field; stator
    C. secondary; primary
    D. primary; secondary

33. An ignition coil operates on the principle of:

    A. polarity
    B. grounding
    C. residual magnetism
    D. mutual induction

SkillsUSA
2010 Motorcycle Service Technology Contest

Written Test Answer Sheet

Motorcycle Technology Theory

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MMI
MOTORCYCLE MECHANICS INSTITUTE
A DIVISION OF UNIVERSAL TECHNICAL INSTITUTE

SkillsUSA
2010 Motorcycle Service Technology Contest
Written Test
Motorcycle Technology Theory

CONTESTANT # _____

1. _____
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31. _____
32. _____
33. _____

SkillsUSA
2010 Motorcycle Service Technology Contest

Written Test

Harley-Davidson 2010 FXD Electrical Diagnostic Manual

Sponsored by

MMI
MOTORCYCLE MECHANICS INSTITUTE
A Division of Clinton Technical Institute

SkillsUSA
2010 Motorcycle Service Technology Contest
Written Test
Electrical Diagnostic Manual

Objective: This written test allows the participant to demonstrate knowledge of motorcycle service manuals and the ability to locate specific information contained in the manual provided.

Directions: Reference the provided 2010 Harley-Davidson FXD Electrical Diagnostic Manual (PN 99496-10) for all test questions and answers. Select the best answer for each question, and then fill in the appropriate letter's box on the answer sheet provided.

Read page I, "HOW TO USE YOUR SERVICE MANUAL"

1. The acronym DTC stands for_____.

A. Darn Tootin' Cool
B. Diagnostic Transportation Code
C. Diagnostic Temperature Code
D. Diagnostic Trouble Code
E. None of the above

2. The EFI system operates in _____ or _____ loop modes allowing the system to adjust for all possible operating conditions.

A. open, shorted
B. closed, grounded
C. open, closed
D. shorted, grounded
E. none of the above

3. The DTC with the highest Priority Order (1) is _____.

A. B1006
B. P1001
C. U1016
D. P0605
E. none of the above

4. A DTC P0505 Loss of Idle Speed Control could be set if the idle speed fluctuates _____ RPM from the preset idle speed for a period longer than 5 seconds with the IAC motor at zero or maximum.

A. +/- 100
B. +/- 200
C. +100
D. +2000
E. none of the above

5. When testing a Spark Plug Cable that is 7.4" long, a resistance (ohms) reading of _____ would indicate that the Spark Plug Cable is good.

A. 1.9K
B. 190.5
C. 1812K
D. 4750
E. 14.9K

6. The ET (Engine Temperature) sensor is a/an _____ device, which means that at a specific temperature it has a specific resistance across its terminals. As this resistance varies, so does the voltage.

A. potentiometer
B. Hall-effect
C. accelerometer
D. thermistor
E. pulse-width

7. When performing a Battery Voltage Test, a voltage reading of _____ would indicate that the battery has 75% state of charge.

A. 9.6
B. 12.0
C. 12.3
D. 12.6
E. 13.0

8. Typical starter motor current draw while on the motorcycle will range _____.

A. 160-200A
B. 180-220A
C. 160-200V
D. 180-220V
E. all are within range

9. The alternator consists of two main components:
• The _____ which mounts to the primary side of the crankshaft.
• The _____ which is attached to the crankcase half.

choose two (2) answers in the correct order

A. regulator
B. stator
C. rotor
D. generator
E. rectifier

10. Reference Figure 3-16 Charging System Circuit.
The 2010 FXD has a _____ charging system.

A. single phase
B. full wave
C. three phase
D. none of the above
E. all of the above

11. Loss of power on terminal _____, can cause the speedometer to be nonfunctional and the speedometer needle to freeze.

A. 1
B. 3
C. 5
D. 7
E. 9

12. Reference Figure 4-11 on pg 4-12.
The wire color at connector 21, pin 4 is _____.

A. TN (tan)
B. W (white)
C. BN (brown)
D. V (violet)
E. BK (black)

13. The Crank Position (CKP) sensor generates _____
as the teeth on the crankshaft pass by the sensor.

A. DC voltage
B. AC voltage
C. DC amps
D. AC resistance
E. ohms

14. Normal engine idle speed is _____ RPM.

A. 750-850
B. 850-950
C. 950-1050
D. 1050-1150
E. 1200

15. The possible causes for the oil pressure lamp to stay on are _____.

A. indicator malfunction
B. oil pressure switch malfunction
C. mechanical issue
D. short to ground in oil pressure circuit
E. all of the above
F. none of the above

16. Which of the following statements is correct when describing how a thermistor device functions?

A. At high temperatures, the resistance of the sensor is very low, which effectively lowers the signal voltage
B. At high temperatures, the resistance of the sensor is very high, which effectively lowers the signal voltage
C. At low temperatures, the resistance is very high, allowing the voltage to lower
D. At low temperatures, the resistance is very low, allowing the voltage to rise

17. All diagnostics described in the 2010 Harley-Davidson FXD Electrical Diagnostic Manual require the use of the Digital Technician II.

A. true
B. false

18. Locate Figure 6-4 Sensor Circuit for reference.
The BK/W (black/white) wire is a 5V sensor ground for _____ sensors.

A. 2
B. 4
C. 6
D. 8
E. 10

19. Special tool HD-41404-B is described as _____.

A. DEUTSCH CONNECTOR SERVICE KIT
B. HARNESS CONNECTOR TEST KIT
C. BREAKOUT BOX
D. ELECTRICAL CRIMPER TOOL
E. FLAT BLADE L-HOOK

20. Any vehicle sensor can cause the engine to shut down if the sensor fails.

A. true
B. False

SkillsUSA
2010 Motorcycle Service Technology Contest

Written Test Answer Sheet

Harley-Davidson 2010 FXD
Electrical Diagnostic Manual

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SkillsUSA
2010 Motorcycle Service Technology Contest
Written Test

Harley-Davidson 2010 FXD Electrical Diagnostic Manual

CONTESTANT # _____

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16. _____
17. _____
18. _____
19. _____
20. _____

2010 Harley-Davidson Dyna Models
Electrical Diagnostic Manual

99496-10

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IMPORTANT NOTICE

Harley-Davidson motorcycles conform to all applicable U.S.A. Federal Motor Vehicle Safety Standards and U.S.A. Environmental Protection Agency regulations effective on the date of manufacture.

To maintain the safety, dependability, and emission and noise control performance, it is essential that the procedures, specifications and service instructions in this manual are followed.

Any substitution, alteration or adjustment of emission system and noise control components outside of factory specifications may be prohibited by law.

Harley-Davidson Motor Company

2010 Harley-Davidson Dyna Models Electrical Diagnostic Manual

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99496-10

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VISIT THE HARLEY-DAVIDSON WEB SITE
http://www.harley-davidson.com

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Please comment on the completeness, accuracy, organization, usability, and readability of this manual.

Please list the page, item, and part number(s) of any errors you find in this manual.

Please tell us how we can improve this manual.

Occupation:

Name: **Dealership:**

Street: **Department:**

City: **State:** **Zip:**

Cut Here

Cut Here

2010 Harley-Davidson Dyna Models Electrical Diagnostic Manual (99496-10)

Please clip out and mail to:
Service Communications Department
Harley-Davidson Motor Company
P.O. Box 653
Milwaukee, WI USA 53201

NOTES

ABOUT THIS MANUAL

GENERAL

This electrical diagnostic service manual has been prepared with two purposes in mind. First, it will acquaint the user with the construction of the Harley-Davidson product and assist in the performance of repair. Secondly, it will introduce to the professional Harley-Davidson Technician the latest field-tested and factory-approved diagnostic methods. We sincerely believe that this manual will make your association with Harley-Davidson products more pleasant and profitable.

HOW TO USE YOUR SERVICE MANUAL

Refer to the table below for the content layout of this manual.

NO.	CHAPTER
1	General Information
2	Initial Diagnostics and Serial Data
3	Starting and Charging
4	Instruments
5	Accessories, Horn, Lights, and Security
6	Engine Management
A	Appendix A Connector Repair
B	Appendix B Wiring
C	Appendix C Conversions
D	Appendix D Glossary

Use the TABLE OF CONTENTS (which follows this FOREWORD) and the INDEX (at the back of this manual) to quickly locate subjects. Sections and topics in this manual are sequentially numbered for easy navigation.

For example, a cross-reference shown as **2.1 SPECIFICATIONS** refers to chapter 2 CHASSIS, heading 2.1 SPECIFICATIONS.

For quick and easy reference, all pages contain a section number followed by a page number. For example, **page 3-5** refers to page 5 in section 3.

A number of acronyms and abbreviations are used in this document. See the D.1 GLOSSARY for a list of acronyms, abbreviations and definitions.

PREPARATION FOR SERVICE

⚠WARNING

Stop the engine when refueling or servicing the fuel system. Do not smoke or allow open flame or sparks near gasoline. Gasoline is extremely flammable and highly explosive, which could result in death or serious injury. (00002a)

Good preparation is very important for efficient service work. A clean work area at the start of each job will allow you to perform the repair as easily and quickly as possible, and will reduce the incidence of misplaced tools and parts. A motorcycle that is excessively dirty should be cleaned before work starts. Cleaning will occasionally uncover sources of trouble. Tools, instruments and any parts needed for the job should be gathered before work is started. Interrupting a job to locate tools or parts is a distraction and causes needless delay.

NOTES

- *To avoid unnecessary disassembly, carefully read all relative service information before repair work is started.*
- *In figure legends, the number which follows the name of a part indicates the quantity necessary for one complete assembly.*
- *When servicing a vehicle equipped with the Harley-Davidson Smart Security System (H-DSSS), you must first disarm the security system. Either keep the fob in close proximity to the vehicle, or use Digital Technician II to disable the security system while the vehicle is being serviced and re-enable the system after service is completed.*

SERVICE BULLETINS

In addition to the information presented in this Service Manual, Harley-Davidson Motor Company will periodically issue Service Bulletins to Harley-Davidson dealers. Service Bulletins cover interim engineering changes and supplementary information. Consult the Service Bulletins to keep your product knowledge current and complete.

USE GENUINE REPLACEMENT PARTS

⚠WARNING

Do not use aftermarket parts and custom made front forks which can adversely affect performance and handling. Removing or altering factory installed parts can adversely affect performance and could result in death or serious injury. (00001a)

To ensure satisfactory and lasting repairs, carefully follow the Service Manual instructions and use only genuine Harley-Davidson replacement parts. Behind the emblem bearing the words GENUINE HARLEY-DAVIDSON stand more than 100 years of design, research, manufacturing, testing and inspecting experience. This is your assurance that the parts you are using will fit right, operate properly and last longer.

WARNINGS AND CAUTIONS

Statements in this service manual preceded by the following words are of special significance.

⚠WARNING

WARNING indicates a potentially hazardous situation which, if not avoided, could result in death or serious injury. (00119a)

⚠CAUTION

CAUTION indicates a potentially hazardous situation which, if not avoided, may result in minor or moderate injury. (00139a)

CAUTION

CAUTION used without the safety alert symbol indicates a potentially hazardous situation which, if not avoided, may result in property damage. (00140a)

NOTE

Refers to important information, and is placed in italic type. It is recommended that you take special notice of these items.

Proper service and repair is important for the safe, reliable operation of all mechanical products. The service procedures recommended and described in this service manual are effective methods for performing service operations.

⚠WARNING

Always wear proper eye protection when using hammers, arbor or hydraulic presses, gear pullers, spring compressors, slide hammers and similar tools. Flying parts could result in death or serious injury. (00496b)

Some of these service operations require the use of tools specially designed for the purpose. These special tools should be used when and as recommended. It is important to note that some warnings against the use of specific service methods, which could damage the motorcycle or render it unsafe, are stated in this service manual. However, please remember that these warnings are not all-inclusive. Inadequate safety precautions could result in death or serious injury.

Since Harley-Davidson could not possibly know, evaluate or advise the service trade of all possible ways in which service might be performed, or of the possible hazardous consequences of each method, we have not undertaken any such broad evaluation. Accordingly, anyone who uses a service procedure or tool which is not recommended by Harley-Davidson must first thoroughly satisfy himself that neither his nor the operator's safety will be jeopardized as a result. Failure to do so could result in death or serious injury.

PRODUCT REFERENCES

⚠WARNING

Read and follow warnings and directions on all products. Failure to follow warnings and directions can result in death or serious injury. (00470b)

When reference is made in this manual to a specific brand name product, tool or instrument, an equivalent product, tool or instrument may be substituted.

Kent-Moore Products

All tools mentioned in this manual with an "HD", "J" or "B" preface must be ordered through SPX Kent-Moore. For ordering information or product returns, warranty or otherwise, visit www.spx.com.

Loctite Sealing and Threadlocking Products

Some procedures in this manual call for the use of Loctite products. If you have any questions regarding Loctite product usage or retailer/wholesaler locations, please contact Loctite Corp. at www.loctite.com.

PRODUCT REGISTERED MARKS

Alcantara S.p.A., Allen, Amp Multilock, Bluetooth, Brembo, Delphi, Deutsch, Dunlop, Dynojet, Fluke, G.E. Versilube, Gunk, Hydroseal, Hylomar, Kevlar, Lexan, Loctite, Lubriplate, Keps, K&N, Magnaflux, Marson Thread-Setter Tool Kit, MAXI fuse, Molex, Michelin, MPZ, Mulitilock, NGK, Novus, Packard, Pirelli, Permatex, Philips, PJ1, Pozidriv, Robinair, S100, Sems, Snap-on, Teflon, Threadlocker, Torca, Torco, TORX, Tufoil, Tyco, Ultratorch, Velcro, X-Acto, and XM Satellite Radio are among the trademarks of their respective owners.

H-D MICHIGAN, INC. TRADEMARK INFORMATION

Harley, Harley-Davidson, H-D, Bar & Shield, Cross Bones, Digital Tech, Digital Technician, Digital Technician II, Dyna, Electra Glide, Evolution, Fat Bob, Fat Boy, Glaze, Gloss, H-D, H-Dnet.com, HD, Harley, Harley-Davidson, Heritage Softail, Low Rider, Night Rod, Nightster, Night Train, Profile, Revolution, Road Glide, Road King, Road Tech, Rocker, Softail, Sportster, Street Glide, Street Rod, Sun Ray, Sunwash, Tech Link, Twin Cam 88, Twin Cam 88B, Twin Cam 96, Twin Cam 96B, Twin Cam 103, Twin Cam 103B, Twin Cam 110, Twin Cam 110B, Tour-Pak, Screamin' Eagle, Softail, Super Glide, SYN3, Ultra Classic, V-Rod, VRSC and Harley-Davidson Genuine Motor Parts and Genuine Motor Accessories are among the trademarks of H-D Michigan, Inc.

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All photographs, illustrations and procedures may not necessarily depict the most current model or component, but are based on the latest production information available at the time of publication.

Since product improvement is our continual goal, Harley-Davidson reserves the right to change specifications, equipment or designs at any time without notice and without incurring obligation.

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DIGITAL TECHNICIAN® II HARLEY-DAVIDSON®

NOTES

SPECIFICATIONS AND COMPONENT LOCATIONS 1.1

SPECIFICATIONS

Table 1-1. Fuel System Specifications

FUEL SYSTEM	TYPE
Intake	Side draft
Recommended fuel	91 Octane

Table 1-2. Idle Speed Specifications

ADJUSTMENT	RPM
Normal idle speed	950-1050 Nominal, non-adjustable

Table 1-3. Battery Specifications

BATTERY	SPECIFICATIONS
Size	12V/19 AH/270CCA
Type	Sealed, AGM

Table 1-4. Spark Plug Specifications

SPARK PLUG	SPECIFICATIONS	
Gap	0.038-0.043 in.	0.97-1.09 mm
Torque with anti-seize applied to threads	12-18 ft-lbs	16.3-24.4 Nm
Type	Harley-Davidson No. 6R12	

Table 1-5. Spark Plug Cables

SPECIFICATION	FRONT	REAR
Length in.	21.9-22.4	7.25-7.50
Length mm	555.8-568.5	184.2-190.5
Resistance-ohms	4750-14920	1812-4375

Table 1-6. Ignition Coil Specifications

WINDING	RESISTANCE
Ignition coil primary resistance at room temperature	0.5-0.7 Ohm
Ignition coil secondary resistance at room temperature	5500-7500 Ohms

Table 1-7. Starter Specifications

STARTER	SPECIFICATIONS
Cranking current	200A
Free speed	3000 RPM (min)
Free current	90A
Stall torque	8.0 ft-lbs (10.8 Nm)

Table 1-8. Fuel Pump Pressure Specifications

RANGE	VALUE
Normal	55-62 psi (380-425 kPA)

Table 1-9. Relay Specifications

RELAY	PART NO.
Start	31586-07
System	31586-07

Table 1-10. Alternator Specifications

MEASUREMENT	VALUE
AC voltage output	16-23 VAC per 1000 RPM
Stator coil resistance	0.1-0.2 Ohm

Table 1-11. Regulator Specifications

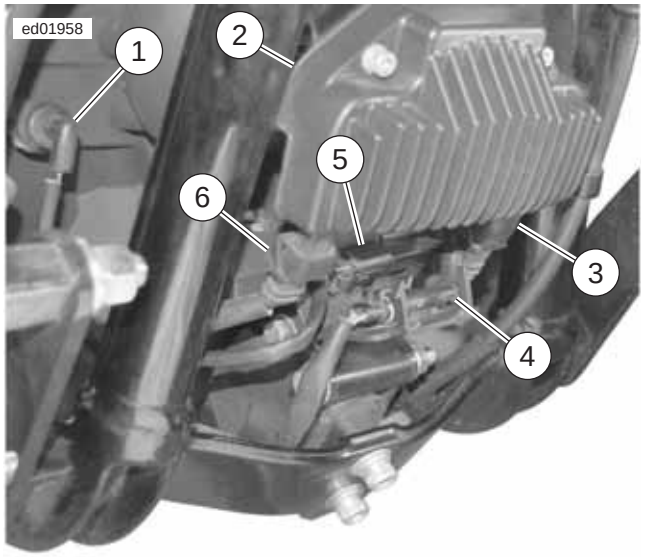
MEASUREMENT	VALUE
Amperes @ 3600 RPM	35-50A
Voltage @ 3600 RPM	14.3-14.7V @ 75 °F (24 °C)

Table 1-12. Fuse Specifications

ITEM	RATING (AMPERES)
Instruments fuse	15
ACCY fuse	15
Battery fuse	15
ECM fuse	15
Fuel pump fuse	15
Ignition fuse	15
Lights fuse	15
Main fuse	40
Customer ACCY	15
Engine control fuse	15

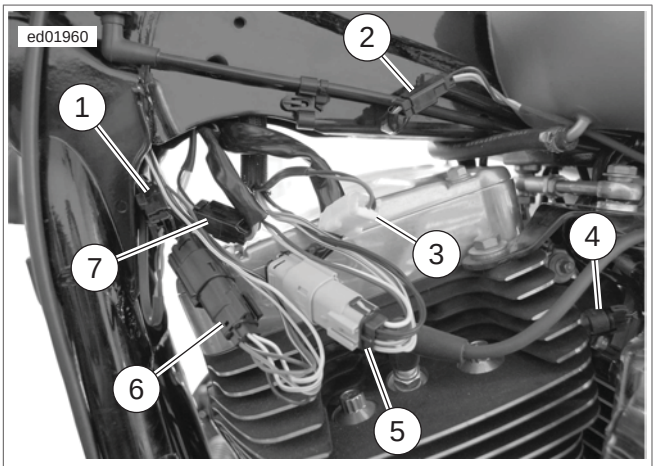
COMPONENT LOCATIONS

Some components and connectors are not easily located on the motorcycle. The following graphics show locations for these components and connectors. The graphics are generally ordered from front to back around the motorcycle.



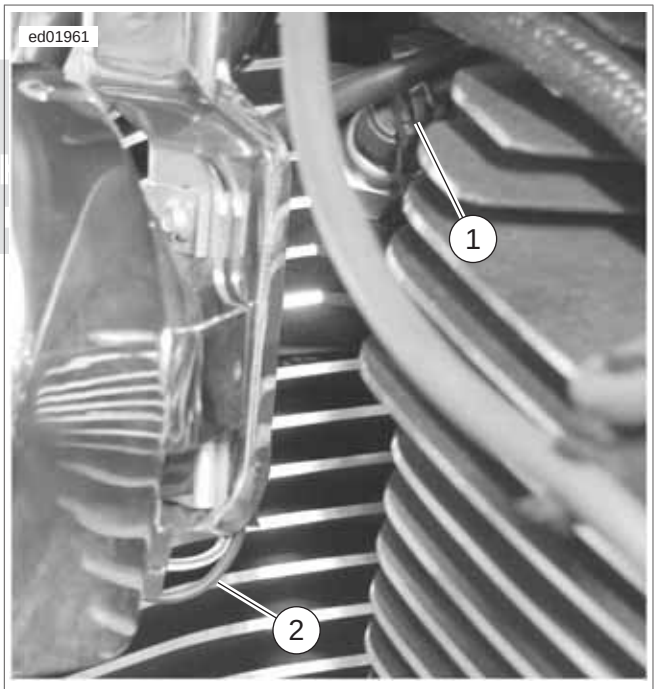
1. **Oil pressure switch [120]**
2. **Voltage regulator**
3. **Voltage regulator to stator [47]**
4. **Front O2 sensor (Domestic Only) [138]**
5. **CKP sensor [79]**
6. **Voltage regulator [77]**

Figure 1-1. Lower Front



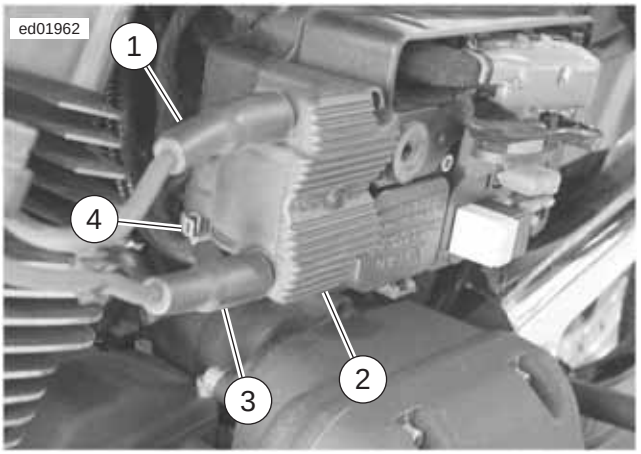
1. **Front turn signals (right) [31R]**
2. **Fuel gauge [117]**
3. **Front turn signals (left) [31L]**
4. **ET sensor [90]**
5. **Left hand controls and horn [24]**
6. **Right hand controls [22]**
7. **Headlamp [38]**

Figure 1-2. Under Fuel Tank Left Side



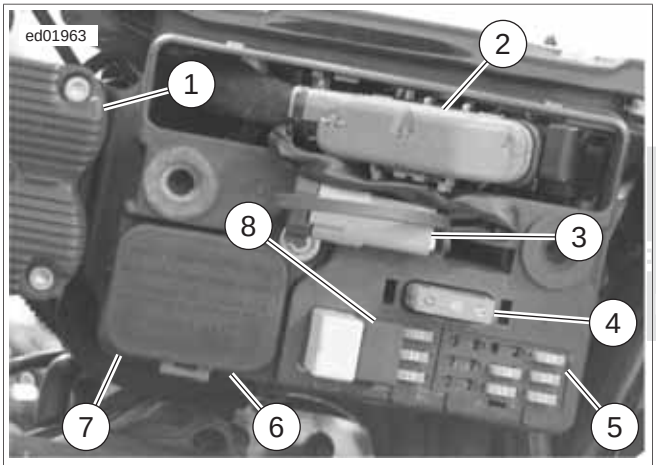
1. **ET sensor [90]**
2. **Horn [122]**

Figure 1-3. Horn: Except FXCWC



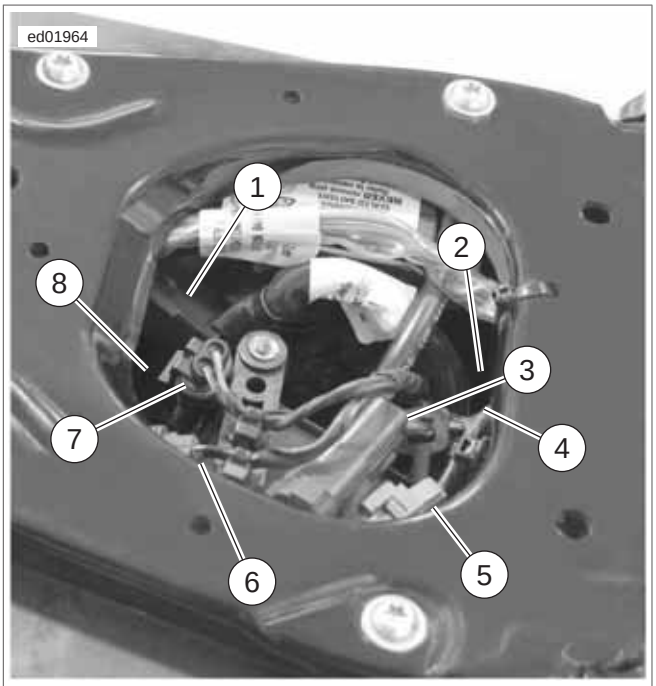
1. Rear spark plug wire
2. Coil
3. Front spark plug wire
4. Ignition coil [83]

Figure 1-4. Ignition Coil



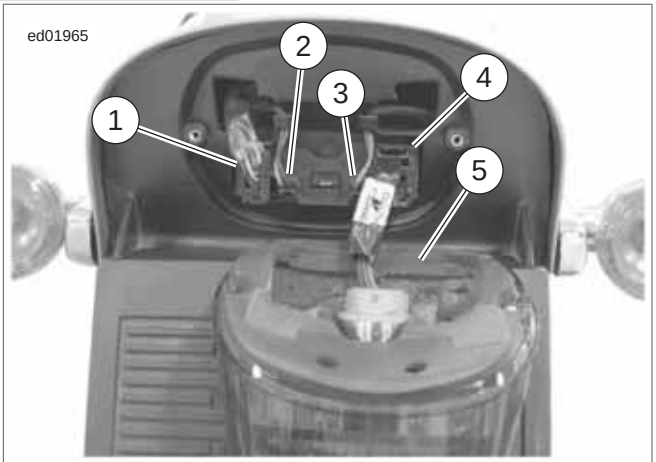
1. Ignition coil
2. ECM [78]
3. DLC [91]
4. Main fuse [5]
5. Fuse block [64]
6. TSM/TSSM/HFSM
7. HFSM antenna harness [208]
8. Fuse/relay block [62]

Figure 1-5. Under Left Side Cover



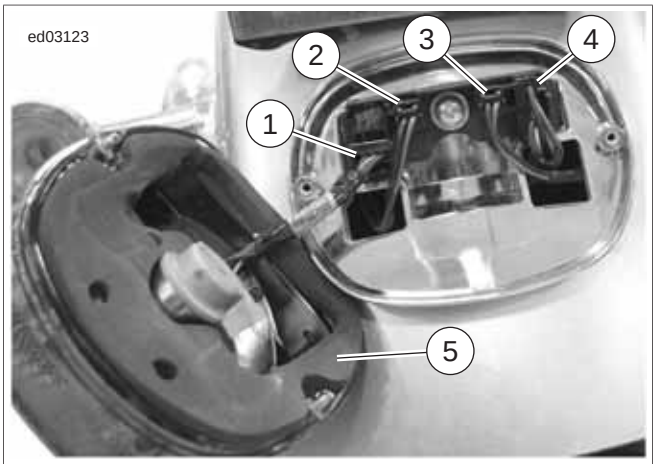
1. Tail lamp harness to main harness [7]
2. Grounds [GND1] & [GND2]
3. Accessory [4]
4. Security siren [142]
5. B+ [160]
6. IAT sensor [89]
7. Rear O2 sensor [137]
8. JSS (HDI only) [133]

Figure 1-6. Under Seat



1. Tail lamp power in [94]
2. Right rear turn signal [18]
3. Left rear turn signal [19]
4. Tail lamp [93]
5. Tail lamp

Figure 1-7. Tail Lamp: FXDF



1. Tail lamp [93]
2. Left rear turn signal [19]
3. Right rear turn signal [18]
4. Tail lamp power in [94]
5. Tail lamp

Figure 1-8. Tail Lamp: Except FXDF

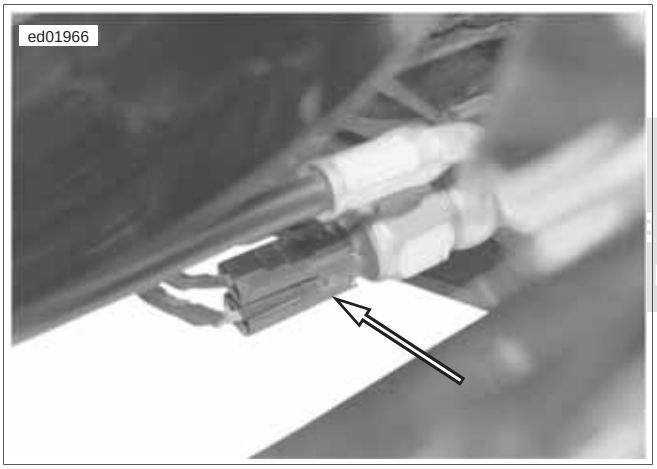
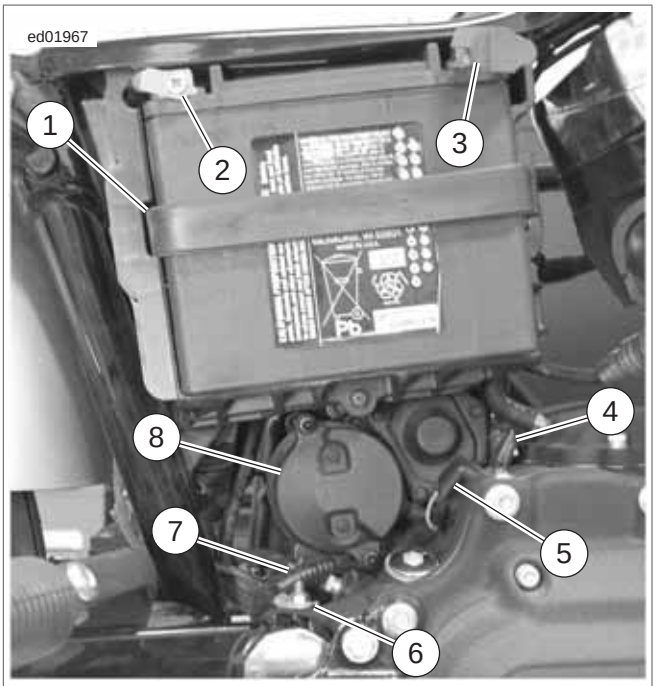
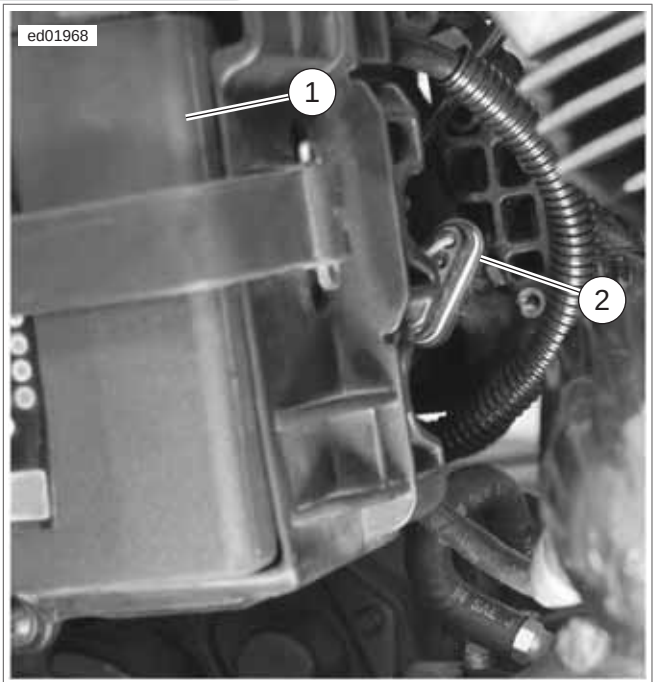


Figure 1-9. Rear Stop Lamp Switch [121]



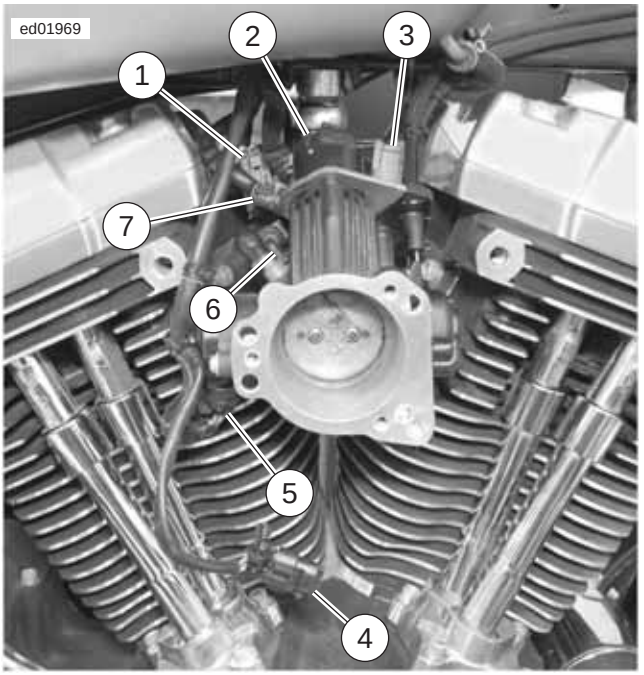
1. Battery
2. Battery negative
3. Battery positive
4. Starter solenoid [128]
5. Neutral switch [131]
6. Battery ground cable
7. VSS [65]
8. Starter

Figure 1-10. Under Right Side Cover



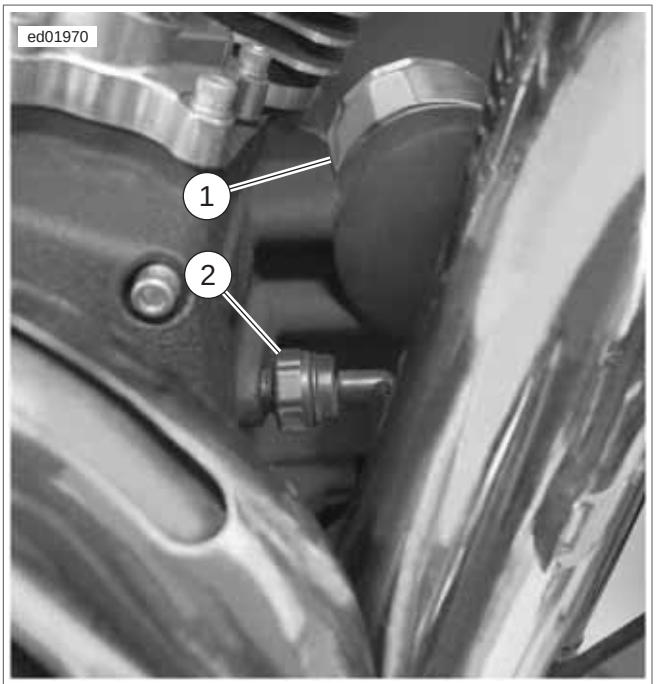
1. Battery
2. Active exhaust (HDI) [179]

Figure 1-11. Active Exhaust



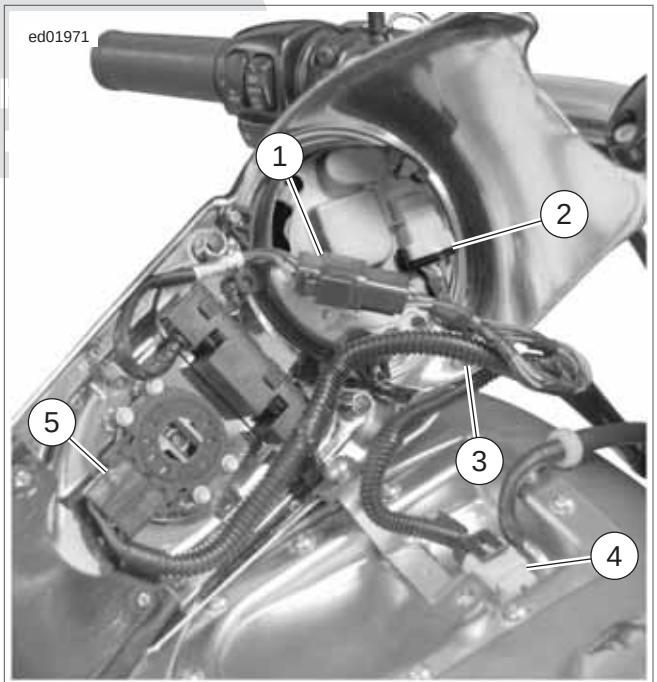
1. Rear fuel injector [85]
2. IAC [87]
3. Front fuel injector [84]
4. Active intake solenoid (HDI) [178]
5. TPS [88]
6. IAT sensor [89]
7. MAP sensor [80]

Figure 1-12. Between Cylinders Right Side



1. Oil filter
2. Oil pressure switch [120]

Figure 1-13. Oil Pressure Switch



1. Indicator lamps [21]
2. Speedometer [39]
3. Trip odometer reset switch
4. Fuel pump and sender [141]
5. Ignition switch [31]

Figure 1-14. Under Console (Typical)

HOW TO USE DIAGNOSTIC TOOLS

PART NUMBER	TOOL NAME
HD-26792	SPARK TESTER
HD-34730-2D	FUEL INJECTOR TEST LIGHT
HD-39978	DIGITAL MULTIMETER (FLUKE 78)
HD-41199-3	IAC TEST LIGHT
HD-41404-B	HARNESS CONNECTOR TEST KIT
HD-42682	BREAKOUT BOX
HD-43876	BREAKOUT BOX
HD-44687	IGNITION COIL CIRCUIT TEST ADAPTER
HD-46601	BREAKOUT BOX ADAPTERS
HD-48053	ADVANCED BATTERY CONDUCTANCE AND ELECTRICAL SYSTEM ANALYZER
HD-48650	DIGITAL TECHNICIAN II

HD-26792 Spark Tester

See Figure 1-15. The SPARK TESTER (Part No. HD-26792) is used to verify adequate spark at the spark plug. Attach the tester to the coil top plug and to ground, while cranking the engine a spark should jump across the gap on the tester leads.

NOTE

Engine will not spark with both spark plugs removed. When checking for spark, use SPARK TESTER (Part No. HD-26792) with both plugs installed.

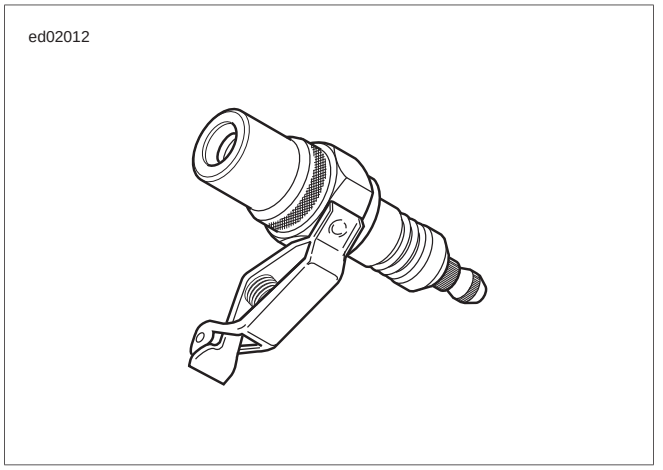


Figure 1-15. Spark Tester

HD-34730-2D Fuel Injector Test Light

The FUEL INJECTOR TEST LIGHT (Part No. HD-34730-2D) and IGNITION COIL CIRCUIT TEST ADAPTER (Part No. HD-44687) are used to test the fuel injector drivers as well as the ignition coil drivers in the ECM.

1. Connect the BREAKOUT BOX (Part No. HD-43876).
2. Disconnect the fuel injector connectors.
3. See Figure 1-16 for typical setup. Connect one side of the fuel injector test light to power and the other to the terminal on the ECM for the circuit you are testing.
4. Crank the engine.
5. If the test light flashes, the circuit is working properly.

1. HD-34730-2D Fuel Injector Test Light
2. HD-44687 Ignition Coil Circuit Test Adapter
3. HD-43876 Breakout Box

Figure 1-16. Fuel Injector Test Light

HD-39978 Digital Multimeter (Fluke 78)

The DIGITAL MULTIMETER (FLUKE 78) (Part No. HD-39978) is used for various tests throughout this manual.

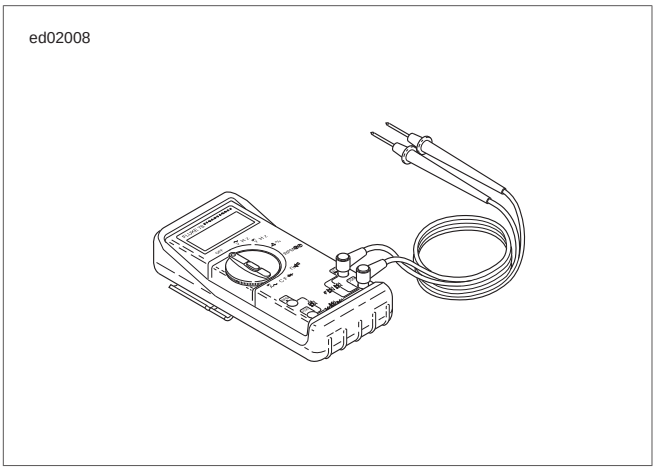


Figure 1-17. Digital Multimeter (Fluke 78) (Part No. HD-39978)

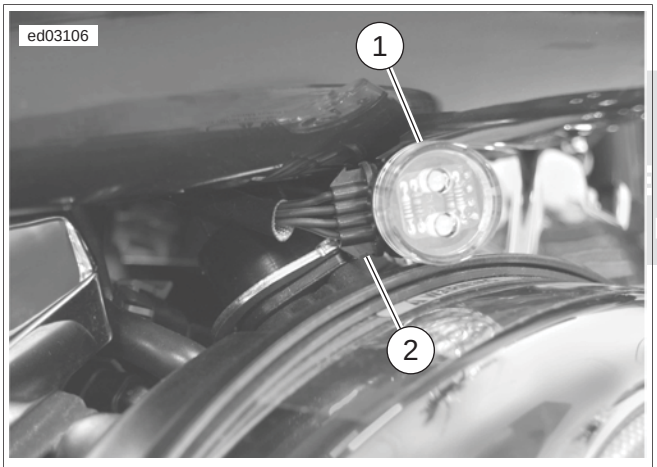
HD-41199-3 IAC Test Light

The IAC TEST LIGHT (Part No. HD-41199-3) is used to identify that the electrical circuit from the ECM to the IAC is operating correctly.

1. Disconnect IAC [87B] and connect test light.
2. See Figure 1-18.
3. Turn IGN ON for 2 seconds, then turn IGN OFF for 10 seconds. Test light behavior may follow two patterns. The color of the lights ins not relevant to IAC operation.
   a. **Normal behavior:** At IGN ON, test lights will alternately flash and then remain on to confirm ECM signals. At IGN OFF lights alternately flash and go out after 10 second reset procedure.
   b. **Problem indicated:** One or more lights fail to illuminate during IGN ON/IGN OFF cycle.

   NOTE

   There is a remote possibility that one of the circuits is shorted to voltage which would have been indicated by a steady light. Disconnect ECM and turn ignition ON. probe terminals to check for this condition.
4. Disconnect test light and connect IAC [87B].



1. **HD-41199-3 IAC Test Light**
2. **IAC [87]**

Figure 1-18. HD-41199-3 IAC Test Light

HD-41404-B Harness Connector Test Kit

The HARNESS CONNECTOR TEST KIT (Part No. HD-41404-B) contains pin and socket terminals, and stackable banana jack patch cords used to test circuits. The pin and socket terminals are used to connect to various connectors used on the vehicle. See the tool instruction sheet for specific terminal usage.

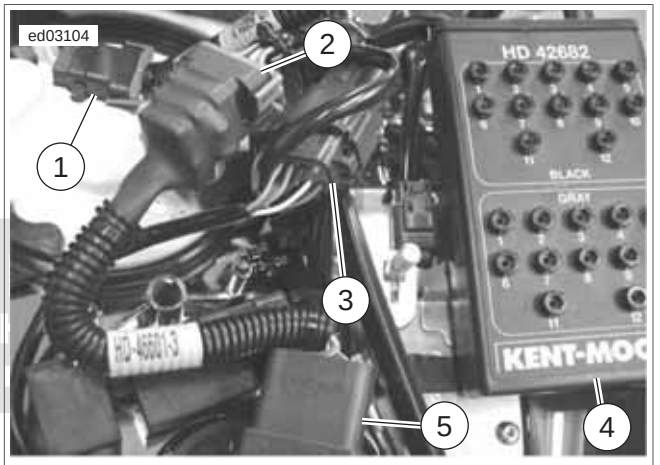
NOTE

To prevent terminal damage while using the probe tips, insert the probe tip straight into the cavity and keep it stable during the test. Do not wiggle or move the probe tip once it has been inserted into the terminal. Do not use more than one probe per terminal or cavity at any one time.

HD-42682 Breakout Box

The BREAKOUT BOX (Part No. HD-42682) and BREAKOUT BOX ADAPTERS (Part No. HD-46601) connect to the speedometer [39]. Used in conjunction with a multimeter, it allows circuit diagnosis of wiring harness and connections without having to probe with sharp objects. Install breakout box in series using the black connectors as follows:

1. Access the speedometer [39]. See the service manual.
2. See Figure 1-19. Press latch and disconnect [39B].
3. Connect BREAKOUT BOX ADAPTERS (Part No. HD-46601) to [39A] and [39B].
4. Attach black connectors from BREAKOUT BOX (Part No. HD-42682) to BREAKOUT BOX ADAPTERS (Part No. HD-46601). All tests will be performed using the black side of the breakout box.
5. When testing is completed remove the breakout box and jumper harness, restore connections.



1. **Speedometer [39]**
2. **Breakout box adapter HD-46601 to speedometer [39]**
3. **Breakout box adapter to harness connector**
4. **Breakout box HD-42682**
5. **Breakout box harness connector**

Figure 1-19. Breakout Box Connection

HD-42682 Breakout Box (TSM/TSSM/HFSM)

The BREAKOUT BOX (Part No. HD-42682) splices into the main harness. Used in conjunction with a multimeter, it allows circuit diagnosis of wiring harness and connections without having to probe with sharp objects. Install breakout box in series as follows:

NOTE

For HFSM: Disarm security system, then remove main fuse while the system remains disarmed.

1. Access TSM/TSSM/HFSM. See the service manual.
2. Disconnect [208B] and [30B] from TSM/TSSM/HFSM:
   a. **For HFSM:** Press latches and disconnect [208B].
   b. Press latches and disconnect [30B].

3. See Figure 1-20. Connect BREAKOUT BOX (Part No. HD-42682) to connectors.
4. **For HFSM:** Mate antenna [208B] to HFSM.
5. When testing is completed remove the breakout box and restore connections.

NOTE

Vehicle will not start with TSM/TSSM/HFSM disconnected or incorrectly mounted.

Figure 1-20. Breakout Box: TSM/HFSM

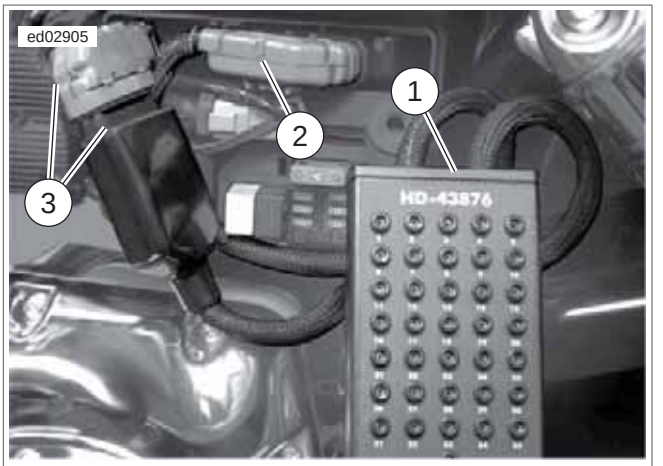
HD-43876 Breakout Box (ECM)

The BREAKOUT BOX (Part No. HD-43876) splices into the main harness. Used in conjunction with a multimeter, it allows circuit diagnosis of wiring harness and connections without having to probe with sharp objects. Install breakout box in series as follows:

NOTE

See wiring diagrams for ECM terminal functions. ECM is located under passenger seat.

1. Access the ECM. See the service manual.
2. Press latch and disconnect [78B].
3. See Figure 1-21. Connect BREAKOUT BOX (Part No. HD-43876) to connectors.
4. When testing is completed, remove the breakout box and restore connections.



1. **Breakout Box**
2. **ECM connection**
3. **Wiring harness connection**

Figure 1-21. Installed Breakout Box

HD-44687 Ignition Coil Circuit Test Adapter

The IGNITION COIL CIRCUIT TEST ADAPTER (Part No. HD-44687) and FUEL INJECTOR TEST LIGHT (Part No. HD-34730-2D) are used to test the fuel injector drivers as well as the ignition coil drivers in the ECM.

1. Connect the BREAKOUT BOX (Part No. HD-43876).
2. Disconnect the fuel injector connectors.
3. See Figure 1-16 for typical setup. Connect one side of the fuel injector test light to power and the other to the terminal on the ECM for the circuit you are testing.
4. Crank the engine.
5. If the test light flashes, the circuit is working properly.

HD-48053 Advanced Battery Conductance and Electrical System Analyzer

Follow the instructions in the ADVANCED BATTERY CONDUCTANCE AND ELECTRICAL SYSTEM ANALYZER (Part No. HD-48053) instruction manual to perform a battery test. The test results include a decision on the battery condition and the measured state of charge.

Figure 1-22. HD-48053 Advanced Battery Conductance and Electrical System Analyzer Kit

HD-48650 Digital Technician II

DIGITAL TECHNICIAN II (Part No. HD-48650) is a computer based diagnostic device used to communicate/diagnose and program systems/modules.

Diagnostics in this manual are developed under the assumption that DTII is not available.

DIGITAL TECHNICIAN® II HARLEY-DAVIDSON®

DIAGNOSTICS AND TROUBLESHOOTING 1.3

VOLTAGE DROP

Voltage Drop Test

The voltage drop test:

- Helps locate poor connections or components with excessive voltage drops.
- Measures the difference in potential or the actual voltage dropped between the source and destination.
- Checks the integrity of the wiring, switches, fuses, connectors, and contacts between the source and destination.

A voltage drop test measures the difference in voltage between two points in a circuit. The amount of voltage dropped over any part of a circuit is directly related to the amount of resistance in that part of the circuit.

Components such as wires, switches, and connectors are designed to have very little resistance and therefore very little voltage drop. A voltage drop greater than 1.0V across these components indicates a high resistance and possible fault.

The benefits of doing it this way are:

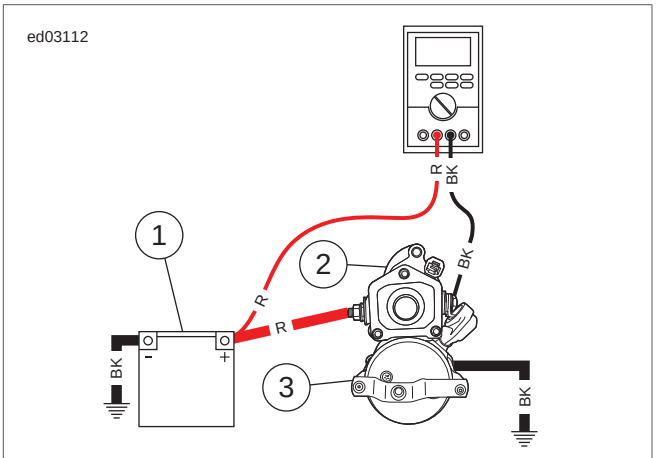
- Readings are not as sensitive to real battery voltage.
- Readings show the actual voltage dropped not just the presence of voltage.
- The system is tested as it is actually being used.
- Testing is more accurate and displays hard-to-find poor connections.
- Starting circuits, lighting circuits or ignition circuits can be tested with this approach. (Start from the most positive and go to the most negative destination or component).

When testing a typical power circuit, place the red meter lead on the positive battery post. Place the black meter lead at the positive side of the connector in question. Move the black meter lead through the circuit until the high voltage drop is found.

When testing a typical ground circuit, place the black meter lead on the negative battery post. Place the red meter lead at the negative side of the connector in question. Move the red meter lead through the circuit until the high voltage drop is found.

The following steps demonstrate a typical starter circuit voltage drop test:

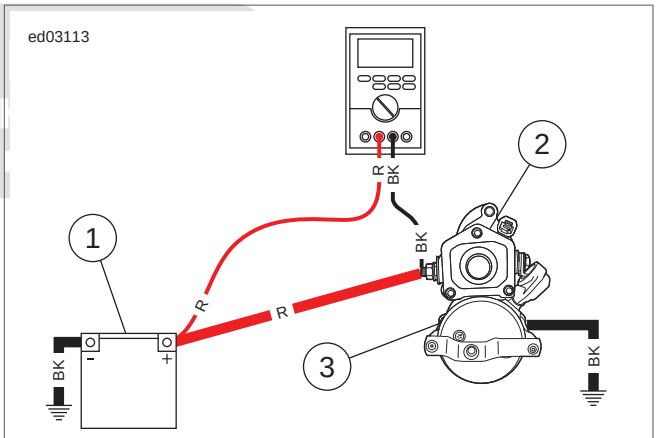
1. Disconnect the fuel pump connector [86] to prevent the engine from starting.
2. See Figure 1-23. Connect the red meter lead to the positive battery post. Connect the black meter lead to the starter side post of the starter solenoid and observe the meter reading. Crank the starter and observe the meter reading. The difference in the voltage is the voltage drop.



1. **Battery**
2. **Starter solenoid**
3. **Starter motor**

Figure 1-23. To Starter Solenoid Starter Terminal

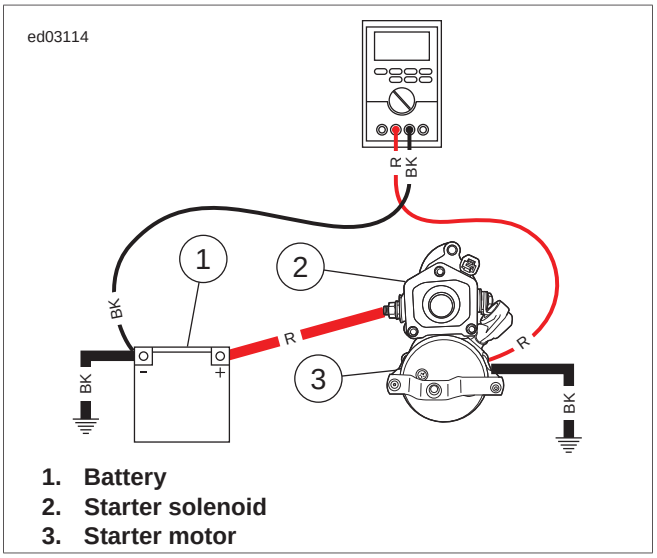
3. See Figure 1-24. Move the black meter lead to the battery side post on the starter solenoid. Crank the starter.



1. **Battery**
2. **Starter solenoid**
3. **Starter motor**

Figure 1-24. To Starter Solenoid Battery Terminal

4. See Figure 1-25. Finally move the black meter lead to the negative battery post and the red meter lead to the starter case. Crank the starter.



1. **Battery**
2. **Starter solenoid**
3. **Starter motor**

Figure 1-25. Starter Ground Circuit

WIGGLE TEST

PART NUMBER	TOOL NAME
HD-39978	DIGITAL MULTIMETER (FLUKE 78)
HD-43876	BREAKOUT BOX
HD-48650	DIGITAL TECHNICIAN II

The wiggle test checks for the presence of intermittents in a wiring harness. The DIGITAL TECHNICIAN II (Part No. HD-48650) can be used to perform the wiggle test.

1. See Figure 1-26. Connect DIGITAL MULTIMETER (FLUKE 78) (Part No. HD-39978) to wiring harness between the suspect connections. When diagnosing ECM connections, use BREAKOUT BOX (Part No. HD-43876) to simplify the procedure. See 1.2 DIAGNOSTIC TOOLS.
2. Set the multimeter to read voltage changes.
3. Start the motorcycle engine and run at idle.
4. Shake or wiggle the harness to detect intermittents. If intermittents are present, radical voltage changes register on the multimeter.

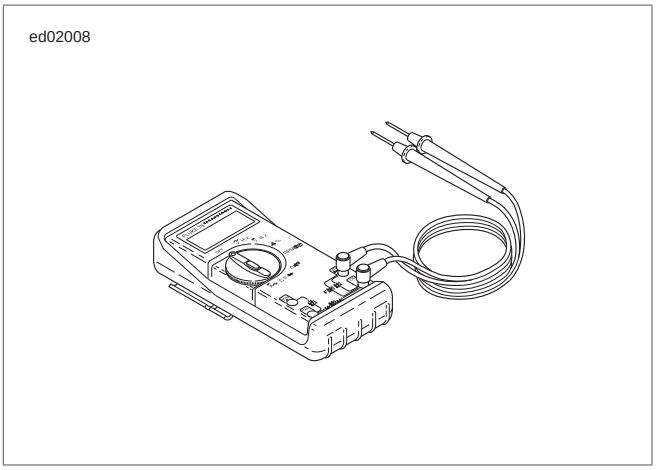
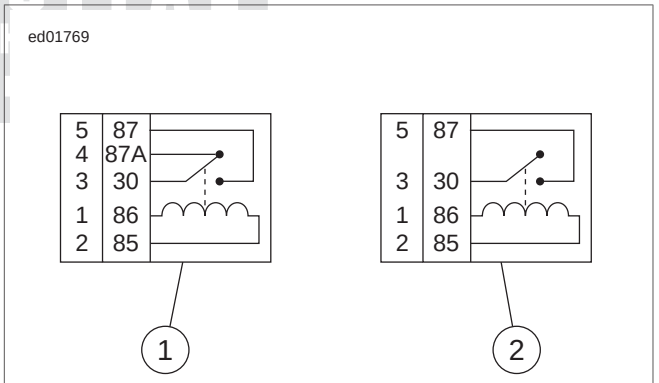


Figure 1-26. Digital Multimeter (Fluke 78) (Part No. HD-39978)

RELAY DIAGNOSTICS

Relay Variation

See Figure 1-27. Relays normally have four or five terminals. The circuitry inside the relays are very similar with the exception of the normally closed contact being eliminated in the four terminal relay. Some relays have five terminals at the base, even though internally 4 or 87A are not connected. See this topic whenever a relay terminal is referenced in this manual to make sure the proper terminal is being accessed.



1. **Standard 5 terminal relay**
2. **Standard 4 terminal relay**

Figure 1-27. Standard Relays

Relay Test

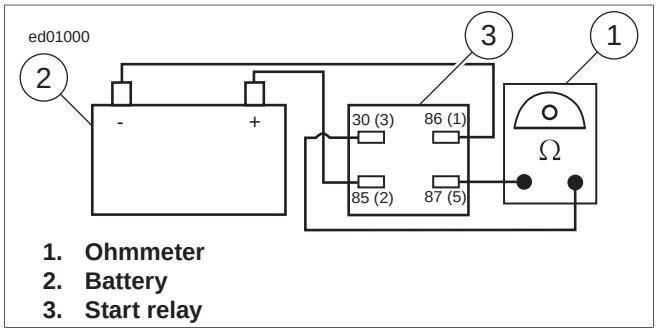
A relay can be tested using the motorcycle's 12V battery and a multimeter.

1. Unplug the relay from relay block.
2. See Figure 1-28 and Figure 1-29 to energize the relay. Connect relay terminal 85 to the negative battery terminal and relay terminal 86 to the positive battery terminal.

NOTE

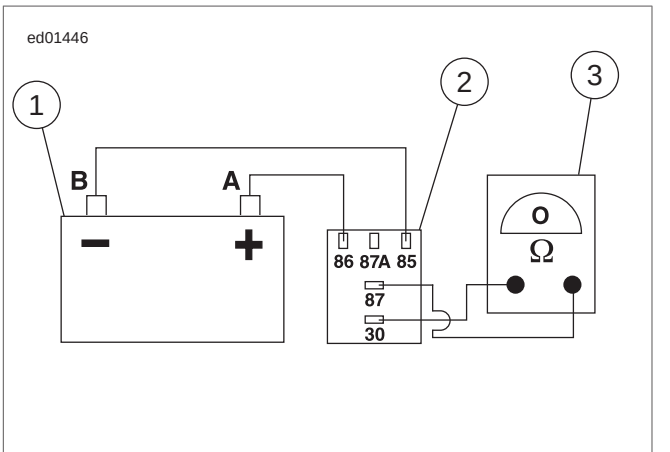
Some relays contain internal diodes. If the applied voltage is not the correct polarity, the diode could be damaged.

3. Test for continuity between terminals 30 and 87.
   a. A good relay shows continuity (continuity tester lamp on or a zero Ohm reading on the ohmmeter).
   b. A malfunctioning relay will not show continuity and must be replaced.



1. **Ohmmeter**
2. **Battery**
3. **Start relay**

Figure 1-28. Four Terminal Relay Test



1. **Battery**
2. **Start relay**
3. **Ohmmeter**

Figure 1-29. Five Terminal Relay Test

JOB/TIME CODES VALUES

PART NUMBER	TOOL NAME
HD-48650	DIGITAL TECHNICIAN II

Dealership technicians filing warranty claims should use the job/time code values printed in bold text at the end of the appropriate repair. When using DIGITAL TECHNICIAN II (Part No. HD-48650), dealership technicians filling out warranty claims should use the job/time code given by the computer.

DIGITAL TECHNICIAN II HARLEY-DAVIDSON

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DIGITAL TECHNICIAN® II
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NOTES

INITIAL DIAGNOSTICS 2.1

DESCRIPTION AND OPERATION

Use initial diagnostics as a starting point to efficiently troubleshoot concerns. A basic understanding of electronics and a general knowledge of the motorcycle are necessary to effectively use this manual.

Before diagnosing a concern, perform a general functional test of the motorcycle to verify the concern and to make sure there is nothing else that could cause problems with accurately diagnosing the motorcycle. Use the procedures in this chapter for initial diagnostics.

NOTE

When working through a diagnostic procedure follow the steps in the order instructed. Never jump to a test in another procedure. All "Go to test" statements refer to a test in that procedure.

RETRIEVING TROUBLE CODES

PART NUMBER	TOOL NAME
HD-48650	DIGITAL TECHNICIAN II

There are two levels of diagnostics.

- The most sophisticated mode uses a computer-based diagnostic package called DIGITAL TECHNICIAN II (Part No. HD-48650).
- The second mode requires using the odometer self-diagnostics. Speedometer, tachometer, TSM/TSSM/HFSM, ECM, and ABS (if equipped) codes can be accessed and cleared.

ODOMETER SELF-DIAGNOSTICS

Diagnostic Mode

1. To enter diagnostic mode press and hold the trip odometer reset switch while turning the IGN ON.
2. Release the trip odometer reset switch. "diag" should appear on the odometer display.
3. Press and release the trip odometer reset switch. "PSSPtb" will appear on the odometer display.
4. PSSPtb indicates the different modules that could display codes if equipped.
   - P - ECM codes
   - S - TSM/TSSM/HFSM codes
   - SP - Speedometer codes
   - t - Tachometer codes
   - b - ABS codes
5. Quickly press and release the trip odometer reset switch to cycle through the letters. The letters will flash as they are selected.
6. Once the corresponding letter is flashing to the desired module press and hold the trip odometer reset switch.
7. If no DTCs are present the odometer will display "none".
8. If any DTCs are stored in the module either current or historic the odometer will display the DTC. Quickly pressing and releasing the trip odometer reset switch will cycle through the stored DTCs.
9. If odometer displays "no rsp" then the motorcycle may not be equipped with the module. If the motorcycle is equipped with the selected module then go to other modules and look for applicable communication codes.
10. When all the DTCs have been cycled the odometer will display "end".
11. To clear all the DTCs in that module press and hold the trip odometer reset switch. If DTCs are not to be cleared quickly press and release the trip odometer reset switch. The part number of the module will be displayed.
12. Press and release the trip odometer reset switch again to continue to the next module.
13. Turn the IGN OFF to exit diagnostic mode.

DIAGNOSTICS

Diagnostic Tips

- For a quick check of instrument function, a "WOW" test can be performed by entering odometer self-diagnostics. Background lighting should illuminate, gauge needles should sweep their full range of motion, and indicator lamps controlled by the serial data circuit (battery, security, and check engine) should illuminate.
- If the instrument fails "WOW" test, check for battery, ground and ignition voltage to the instrument. If any feature in the speedometer or tachometer is non-functional, see 4.1 INSTRUMENTS.

Table 2-1. Diagnostic Trouble Codes (DTCs) and Fault Conditions

DTC	PRIORITY ORDER	FAULT CONDITION	SOLUTION
B0563	72	Battery voltage high	3.6 DTC B0563, P0562, P0563
B1004	76	Fuel sender low	4.2 DTC B1004, B1005
B1005	77	Fuel sender open/high	4.2 DTC B1004, B1005

Table 2-1. Diagnostic Trouble Codes (DTCs) and Fault Conditions

DTC	PRIORITY ORDER	FAULT CONDITION	SOLUTION
B1006	78	Accessory line overvoltage	3.7 DTC B1006, B1007
B1007	79	Ignition line overvoltage	3.7 DTC B1006, B1007
B1008	80	Trip odometer rest switch closed	4.3 DTC B1008
B1121	63	Left turn output fault	5.8 DTC B1121, B1122, B1123, B1124, B1125, B1126
B1122	64	Right turn output fault	5.8 DTC B1121, B1122, B1123, B1124, B1125, B1126
B1123	65	Left turn signal short-to-ground	5.8 DTC B1121, B1122, B1123, B1124, B1125, B1126
B1124	66	Right turn signal short-to-ground	5.8 DTC B1121, B1122, B1123, B1124, B1125, B1126
B1125	67	Left turn signal short-to-voltage	5.8 DTC B1121, B1122, B1123, B1124, B1125, B1126
B1126	68	Right turn signal short-to-voltage	5.8 DTC B1121, B1122, B1123, B1124, B1125, B1126
B1131	73	Alarm output low	5.15 DTC B1131, B1132
B1132	74	Alarm output high	5.15 DTC B1131, B1132
B1134	62	Start relay output high	5.16 DTC B1134
B1135	18	Accelerometer fault	5.9 DTC B1135, B1136, B1141, B1142
B1136	19	Accelerometer tip-over self-test fault	5.9 DTC B1135, B1136, B1141, B1142
B1141	75	Ignition switch open/low	5.9 DTC B1135, B1136, B1141, B1142
B1142	17	Internal fault	5.9 DTC B1135, B1136, B1141, B1142
B1143	69	Security antenna short-to-ground	5.17 DTC B1143, B1144, B1145
B1144	70	Security antenna short-to-battery	5.17 DTC B1143, B1144, B1145
B1145	71	Security antenna open	5.17 DTC B1143, B1144, B1145
B1154	20	Clutch swith short-to-ground	5.18 DTC B1154, B1155
B1155	21	Neutral switch short-to-ground	5.18 DTC B1154, B1155
P0107	36	MAP sensor open/low	6.4 DTC P0107, P0108
P0108	37	MAP sensor high	6.4 DTC P0107, P0108
P0112	40	IAT sensor voltage low	6.5 DTC P0112, P0113
P0113	41	IAT sensor open/high	6.5 DTC P0112, P0113
P0117	38	ET sensor voltage low	6.6 DTC P0117, P0118
P0118	39	ET sensor open/high	6.6 DTC P0117, P0118
P0122	22	TP sensor open/low	6.7 DTC P0122, P0123
P0123	23	TP sensor high	6.7 DTC P0122, P0123
P0131	56	Front O2 sensor low (lean)	6.8 DTC P0131, P0132, P0134, P0151, P0152, P0154
P0132	58	Front O2 sensor high (rich)	6.8 DTC P0131, P0132, P0134, P0151, P0152, P0154
P0134	60	Front O2 sensor open/not responding	6.8 DTC P0131, P0132, P0134, P0151, P0152, P0154
P0151	57	Rear O2 sensor low (lean)	6.8 DTC P0131, P0132, P0134, P0151, P0152, P0154
P0152	59	Rear O2 sensor high (rich)	6.8 DTC P0131, P0132, P0134, P0151, P0152, P0154
P0154	61	Rear O2 sensor open/not responding	6.8 DTC P0131, P0132, P0134, P0151, P0152, P0154
P0261	32	Front injector open/low	6.9 DTC P0261, P0262, P0263, P0264

Table 2-1. Diagnostic Trouble Codes (DTCs) and Fault Conditions

DTC	PRIORITY ORDER	FAULT CONDITION	SOLUTION
P0262	34	Front injector high	6.9 DTC P0261, P0262, P0263, P0264
P0263	33	Rear injector open/low	6.9 DTC P0261, P0262, P0263, P0264
P0264	35	Rear injector high	6.9 DTC P0261, P0262, P0263, P0264
P0373	16	CKP sensor intermittent	6.10 DTC P0373, P0374
P0374	15	CKP sensor synch error	6.10 DTC P0373, P0374
P0501	44	VSS low	6.11 DTC P0501, P0502
P0502	45	VSS high	6.11 DTC P0501, P0502
P0505	50	Loss of idle speed control	6.12 DTC P0505
P0562	42	Battery voltage low	3.6 DTC B0563, P0562, P0563
P0563	43	Battery voltage high	3.6 DTC B0563, P0562, P0563
P0603	2	ECM EEPROM error	6.13 DTC P0603, P0605
P0605	1	ECM flash error	6.13 DTC P0603, P0605
P0661	54	Intake solenoid low/open	6.14 DTC P0661, P0662
P0662	55	Intake solenoid high/shorted	6.14 DTC P0661, P0662
P1001	11	System relay coil open/low	6.16 DTC P1001, P1002, P1003, P1004
P1002	10	System relay coil high/shorted	6.16 DTC P1001, P1002, P1003, P1004
P1003	9	System relay contacts open	6.16 DTC P1001, P1002, P1003, P1004
P1004	12	System relay contacts closed	6.16 DTC P1001, P1002, P1003, P1004
P1009	13	Incorrect password	6.15 DTC P1009, P1010
P1010	14	Missing password	6.15 DTC P1009, P1010
P1351	26	Front ignition coil open/low	6.17 DTC P1351, P1352, P1354, P1355
P1352	28	Front ignition coil high/shorted	6.17 DTC P1351, P1352, P1354, P1355
P1353	49	Front cylinder no combustion detected	6.18 DTC P1353, P1356, P1357, P1358
P1354	27	Rear ignition coil open/low	6.17 DTC P1351, P1352, P1354, P1355
P1355	29	Rear ignition coil high/shorted	6.17 DTC P1351, P1352, P1354, P1355
P1356	48	Rear cylinder no combustion detected	6.18 DTC P1353, P1356, P1357, P1358
P1357	30	Front ignition coil intermittent secondary detected	6.18 DTC P1353, P1356, P1357, P1358
P1358	31	Rear ignition coil intermittent secondary detected	6.18 DTC P1353, P1356, P1357, P1358
P1475	51	Exhaust position actuator error	6.19 DTC P1475, P1477, P1478
P1477	52	Exhaust actuator low/open	6.19 DTC P1475, P1477, P1478
P1478	53	Exhaust actuator high/shorted	6.19 DTC P1475, P1477, P1478
P1501	24	JSS low	6.20 DTC P1501, P1502
P1502	25	JSS high	6.20 DTC P1501, P1502
P1653	46	Tachometer low	6.21 DTC P1653, P1654
P1654	47	Tachometer high	6.21 DTC P1653, P1654
U1016	6	Loss of ECM serial data	2.3 DTC U1016, U1064, U1097, U1255
U1064	5	Loss of TSM/TSSM/HFSM serial data	2.3 DTC U1016, U1064, U1097, U1255
U1097	7	Loss of speedometer serial data	2.3 DTC U1016, U1064, U1097, U1255

Table 2-1. Diagnostic Trouble Codes (DTCs) and Fault Conditions

DTC	PRIORITY ORDER	FAULT CONDITION	SOLUTION
U1255	8	Missing response at module	2.3 DTC U1016, U1064, U1097, U1255
U1300	3	Serial data low	2.4 DTC U1300, U1301 OR BUS ER
U1301	4	Serial data open/high	2.4 DTC U1300, U1301 OR BUS ER

CODE TYPES

PART NUMBER	TOOL NAME
HD-48650	DIGITAL TECHNICIAN II

There are two types of DTCs: current and historic. If a DTC is stored, it can be read using either a computer-based diagnostic package called DIGITAL TECHNICIAN II (Part No. HD-48650) or odometer self-diagnostics.

NOTES

- *Odometer self-diagnostics will display both current and historic DTCs. To differentiate between current and historic DTCs, a computer-based diagnostic package called DIGITAL TECHNICIAN II (Part No. HD-48650) must be employed.*
- *Current DTCs reside in the memory of the ECM, TSM/TSSM/ HFSM, speedometer, or tachometer until the DTC is resolved.*
- *A historic DTC can be cleared by use of the odometer self-diagnostics or after a total of 50 ignition cycles (start and run cycle) have elapsed. After the 50 ignition cycle retention period, the DTC is automatically erased from memory providing that no subsequent faults of the same type are detected in that period.*

Current

Current DTCs are those which presently disrupt motorcycle operation and are set during the current ignition cycle. See the appropriate diagnostic procedures for solutions.

Historic

If a particular problem happens to resolve itself, the active status problem is dropped and it becomes a historic DTC rather than a current DTC. DTCs will also lose their current status when the ignition is turned off. If the problem still exists when the ignition is turned on the code will show as current.

Historic DTCs are stored for 50 ignition cycles after any DTC was last set as current to assist in the diagnosis of intermittent faults. On the 50th cycle, the DTC will clear itself. The security lamp will only indicate the existence of historic DTCs for two ignition cycles.

It is important to note that historic DTCs will exist whenever the system indicates the existence of a current fault. See 2.1 INITIAL DIAGNOSTICS, Multiple Trouble Codes if multiple DTCs are found.

Diagnostic procedures are designed for use with current DTCs. As a result, they frequently suggest part replacement. When diagnosing a historic DTC, the procedures can be helpful but should not lead to part replacement without verification that the part is faulty.

MULTIPLE TROUBLE CODES

While it is possible for more than one fault to occur and set more than one trouble code, there are several conditions which may result in **one** fault setting **multiple** trouble codes:.

Serial data codes (DTC U1300, U1301, U1016, U1064, U1097, and U1255) may be accompanied by other codes. **Always** correct the serial data codes before resolving the other codes.

In the event multiple DTCs are present, DTCs are assigned priority order numbers to determine the order in which they should be diagnosed. The lowest priority number DTC should be diagnosed first and then continue with the next lowest DTC. DTCs should be cleared after each repair to verify they are still current. Refer to Table 2-1.

CLEARING DTCS

DTCs should be cleared after any diagnostic or repair procedure is performed. The odometer is capable of displaying and clearing ECM, TSM/TSSM/HFSM, speedometer, tachometer, and ABS DTCs. Once the DTCs are cleared perform a road test to verify DTCs do not return. It is important to perform a road test and not simply start the motorcycle since some DTCs may require vehicle speed or other inputs in order to validate repair.

SECURITY LAMP

The security lamp functions in the same manner as the check engine lamp, except that it is controlled by the TSSM/HFSM. The security lamp will be turned on when codes are present in the TSSM/HFSM. When B1004 or B1005 codes are present in the TSSM/HFSM, the low fuel lamp on the speedometer will also be illuminated.

CHECK ENGINE LAMP

To diagnose ECM system problems, start by observing the behavior of the check engine lamp.

NOTES

- *"IGN ON" means that the ignition switch is turned to IGN and the engine stop switch is set to RUN (although the engine is **not** running).*
- *When the IGN is turned ON, the check engine lamp will illuminate for approximately four seconds and then turn off.*
- *If the check engine lamp is not illuminated at IGN ON or if it fails to turn off after the initial four-second period, then see 6.23 NO ECM POWER.*

1. See Figure 2-1. After the check engine lamp turns off following the first four second illumination period, one of three events may occur.
   a. The lamp remains off. This indicates there are no current fault conditions or stored DTCs currently detected by the ECM.
   b. The lamp stays off for only four seconds and then comes back on for an eight second period. This indicates a DTC is stored, but no current DTC exists.
   c. If the lamp remains on beyond the eight-second period, a current DTC exists.
2. See 2.1 INITIAL DIAGNOSTICS, Code Types for a complete description of DTC formats.

NOTE

Some DTCs can only be fully diagnosed during actuation. For example, a problem with the ignition coil will be considered a current fault even after the problem is corrected, since the ECM will not know of its resolution until after the coil is exercised by the vehicle start sequence. In this manner, there may sometimes be a false indication of the current DTC.

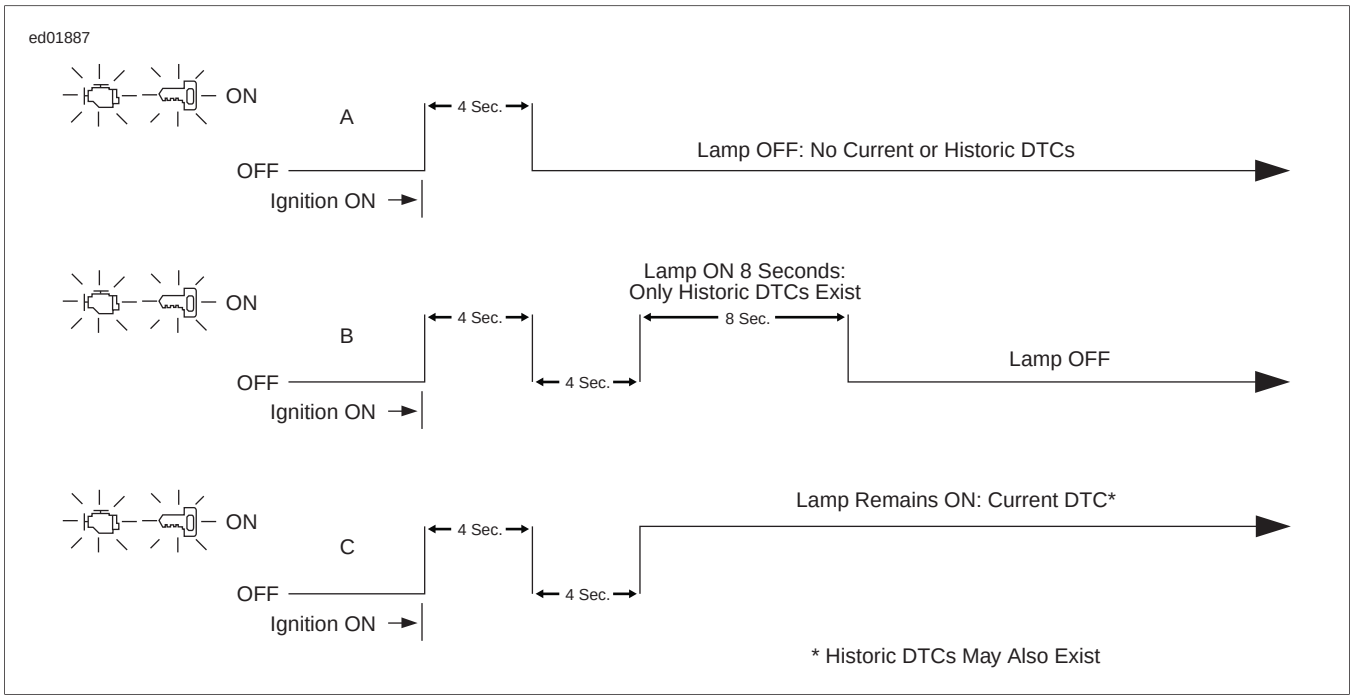


Figure 2-1. Check Engine Lamp and Security Lamp Operation

SYMPTOMS

If no DTCs are present but there is a symptom or concern indicating a malfunction, address and repair the symptom if it is not a normal characteristic of the system. Refer to Table 2-2 for a list of symptoms.

Table 2-2. Symptom Table

SYMPTOM	DIAGNOSTIC PROCEDURE
Battery runs down during use	3.5 CHARGING SYSTEM
Bus Er displayed	2.2 SERIAL DATA COMMUNICATION
Charging system inoperative	3.5 CHARGING SYSTEM
Check engine lamp inoperative	6.23 NO ECM POWER
Engine cranks, but will not start	6.22 ENGINE CRANKS, BUT WILL NOT START
Headlamp inoperative	5.3 LIGHTS
High beam indicator inoperative	4.5 INDICATOR LAMPS
Horn always on	5.2 HORN
Horn inoperative	5.2 HORN
Low battery after extended IGN OFF	3.5 CHARGING SYSTEM
Low fuel lamp always on	4.5 INDICATOR LAMPS

Table 2-2. Symptom Table

SYMPTOM	DIAGNOSTIC PROCEDURE
Low fuel lamp inoperative	4.5 INDICATOR LAMPS
Low or no charging	3.5 CHARGING SYSTEM
Neutral lamp always on	4.5 INDICATOR LAMPS
Neutral lamp inoperative	4.5 INDICATOR LAMPS
No ECM power	6.23 NO ECM POWER
Misfire at idle or under load	6.26 MISFIRE AT IDLE OR UNDER LOAD
Oil pressure lamp always on	4.5 INDICATOR LAMPS
Oil pressure lamp inoperative	4.5 INDICATOR LAMPS
Overcharging	3.5 CHARGING SYSTEM
P&A battery power inoperative	5.1 ACCESSORIES
Running lamps inoperative	5.3 LIGHTS
Security lamp inoperative	5.10 SECURITY SYSTEM
Speedometer inoperative	4.1 INSTRUMENTS
Starter does not spin	3.2 STARTING SYSTEM
Starter inoperative	3.2 STARTING SYSTEM
Starter solenoid clicks	3.2 STARTING SYSTEM
Starter spins, but does not engage	3.2 STARTING SYSTEM
Starter stalls or spins too slowly	3.2 STARTING SYSTEM
Starts, then stalls	6.24 STARTS, THEN STALLS
Stop lamp inoperative	5.3 LIGHTS
Tachometer inoperative	4.1 INSTRUMENTS
Tail lamp inoperative	5.3 LIGHTS
Turn signal indicator inoperative	4.5 INDICATOR LAMPS
Turn signal inoperative	5.3 LIGHTS

DIGITAL TECHNICIAN II HARLEY-DAVIDSON

Connector Information

For additional information about the connectors in the following diagram(s) and diagnostic procedure(s), including the color of the harness test kit terminal probes, see B.1 CONNECTORS.

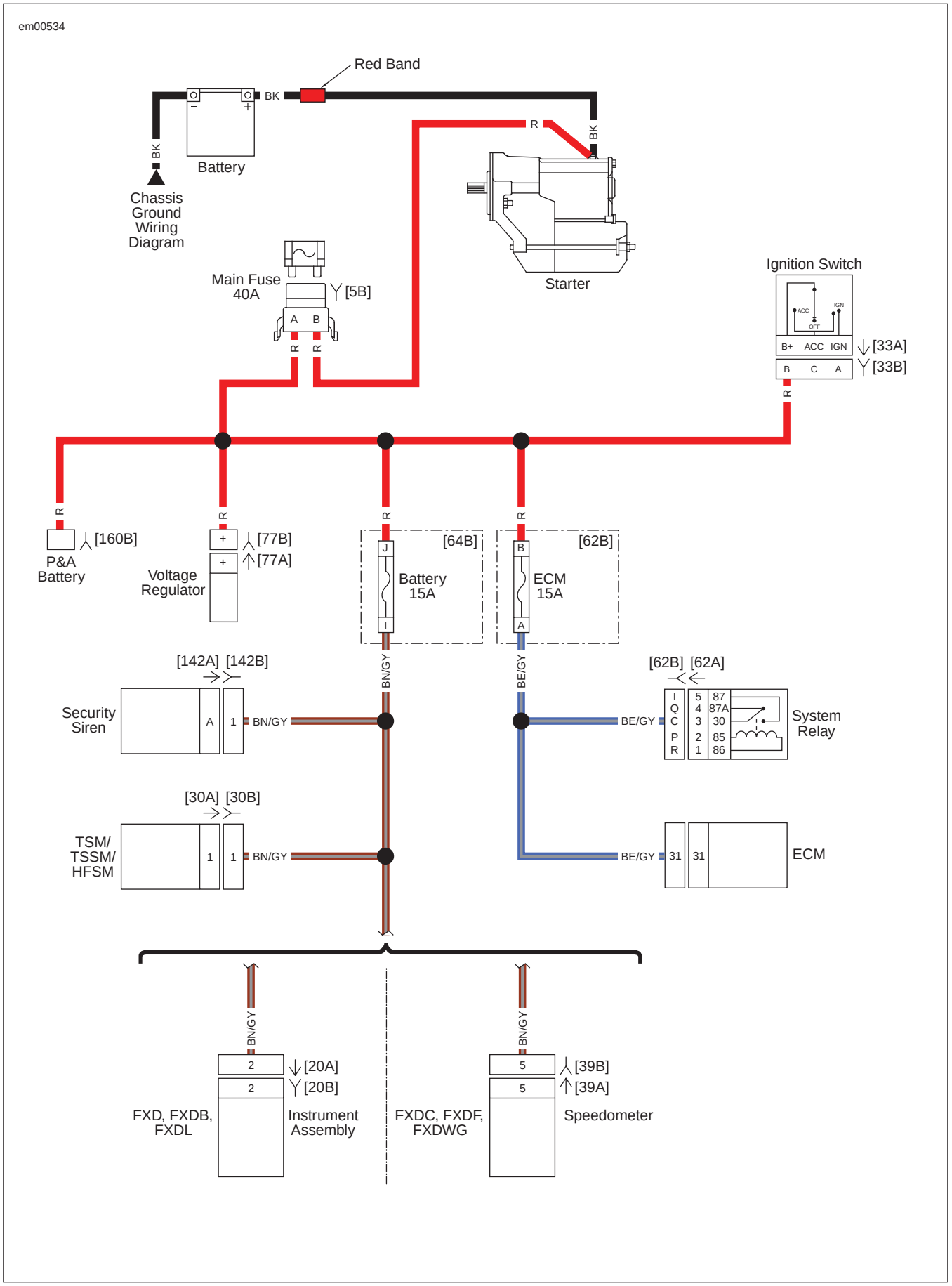


Figure 2-2. Battery Power

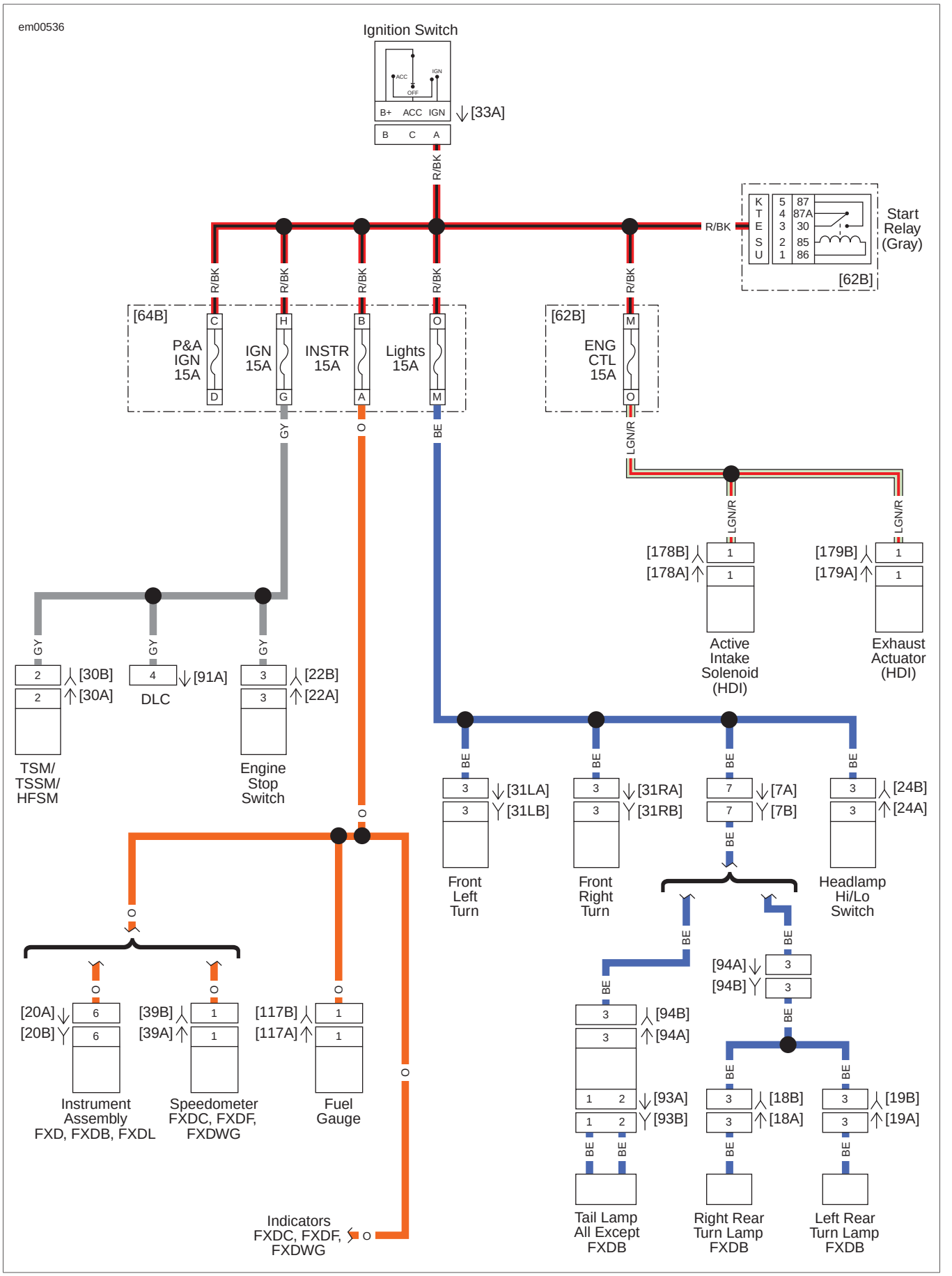


Figure 2-3. Ignition Power

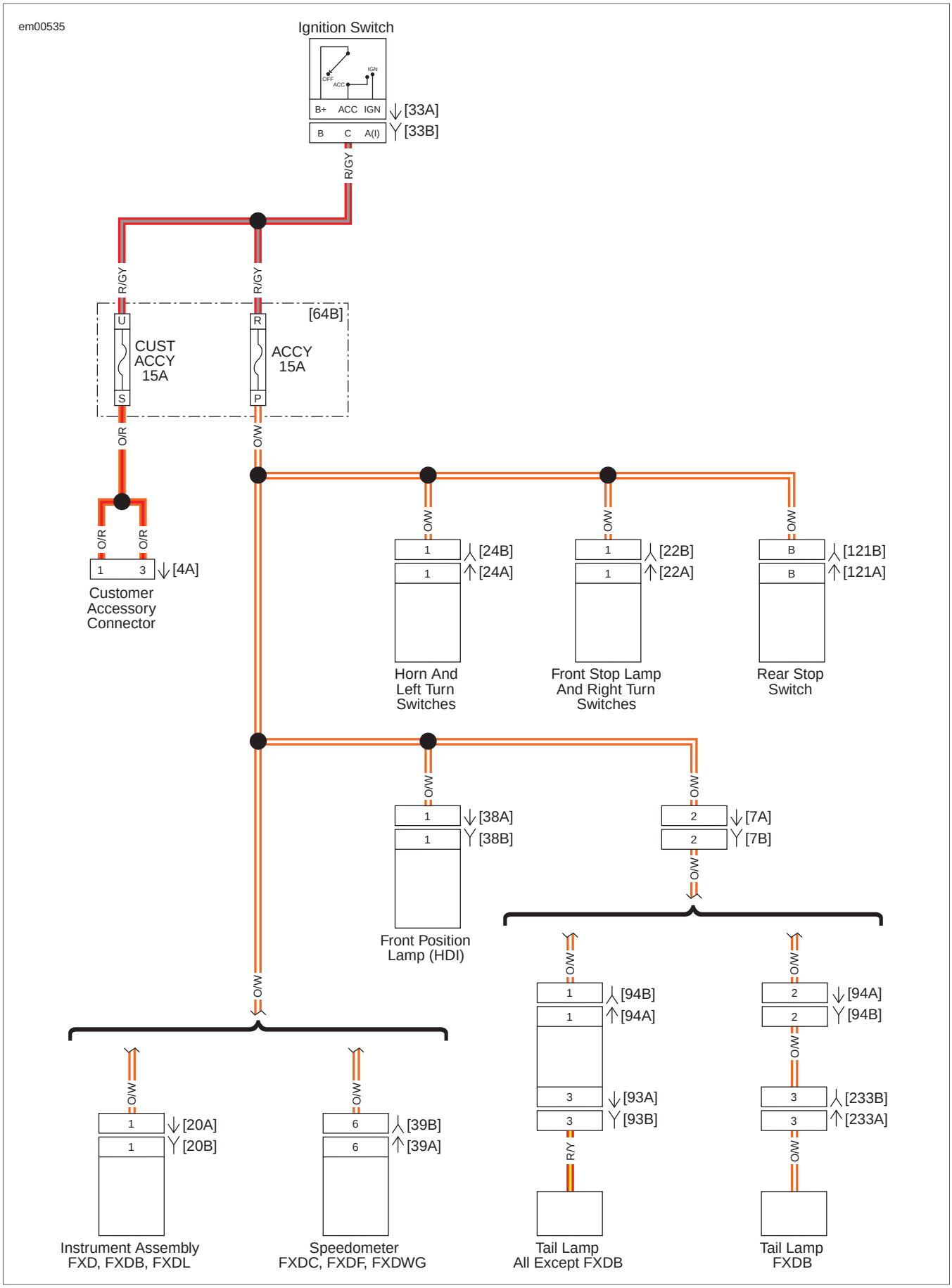


Figure 2-4. Accessory Power

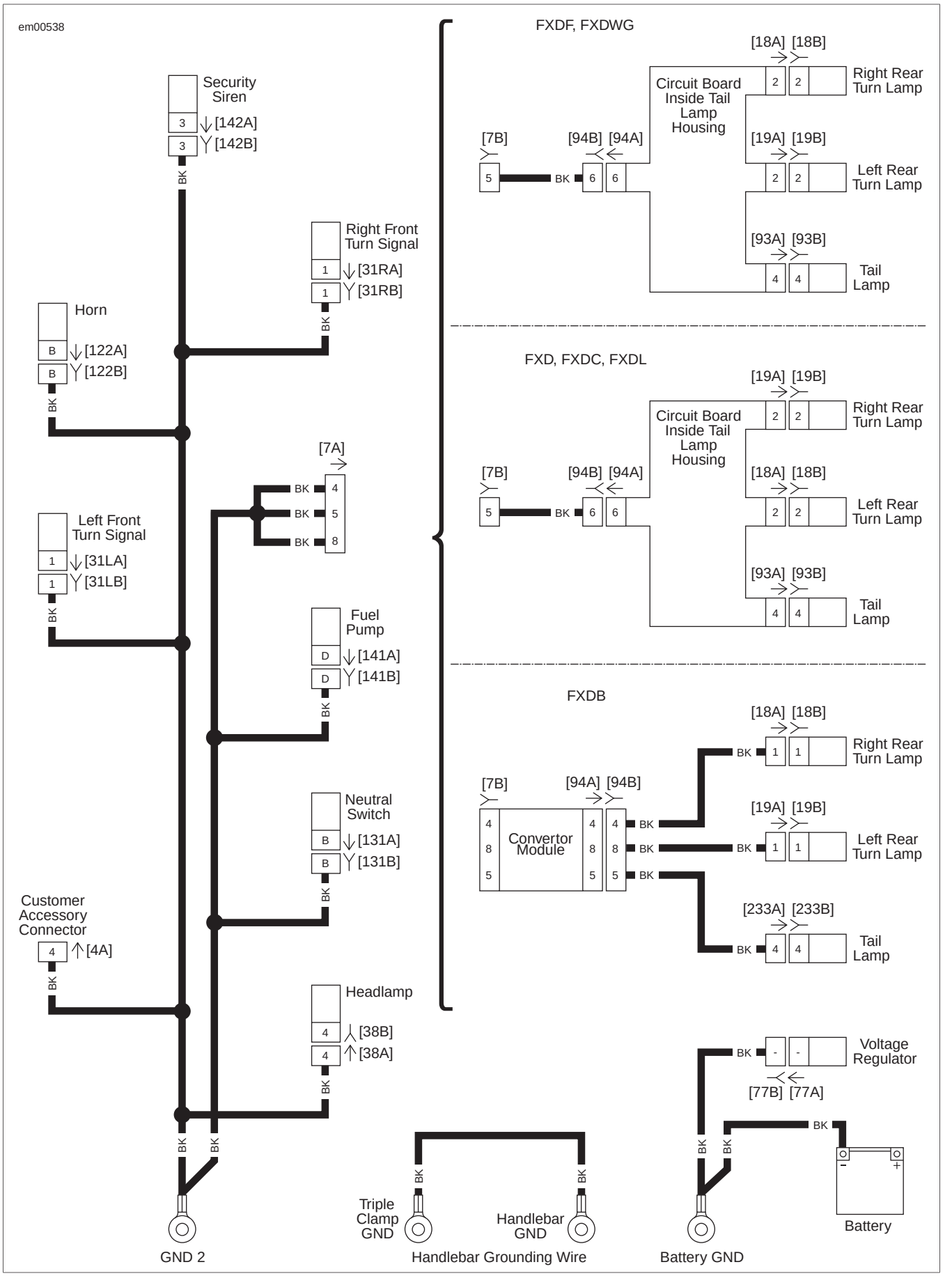


Figure 2-5. Chassis Grounds

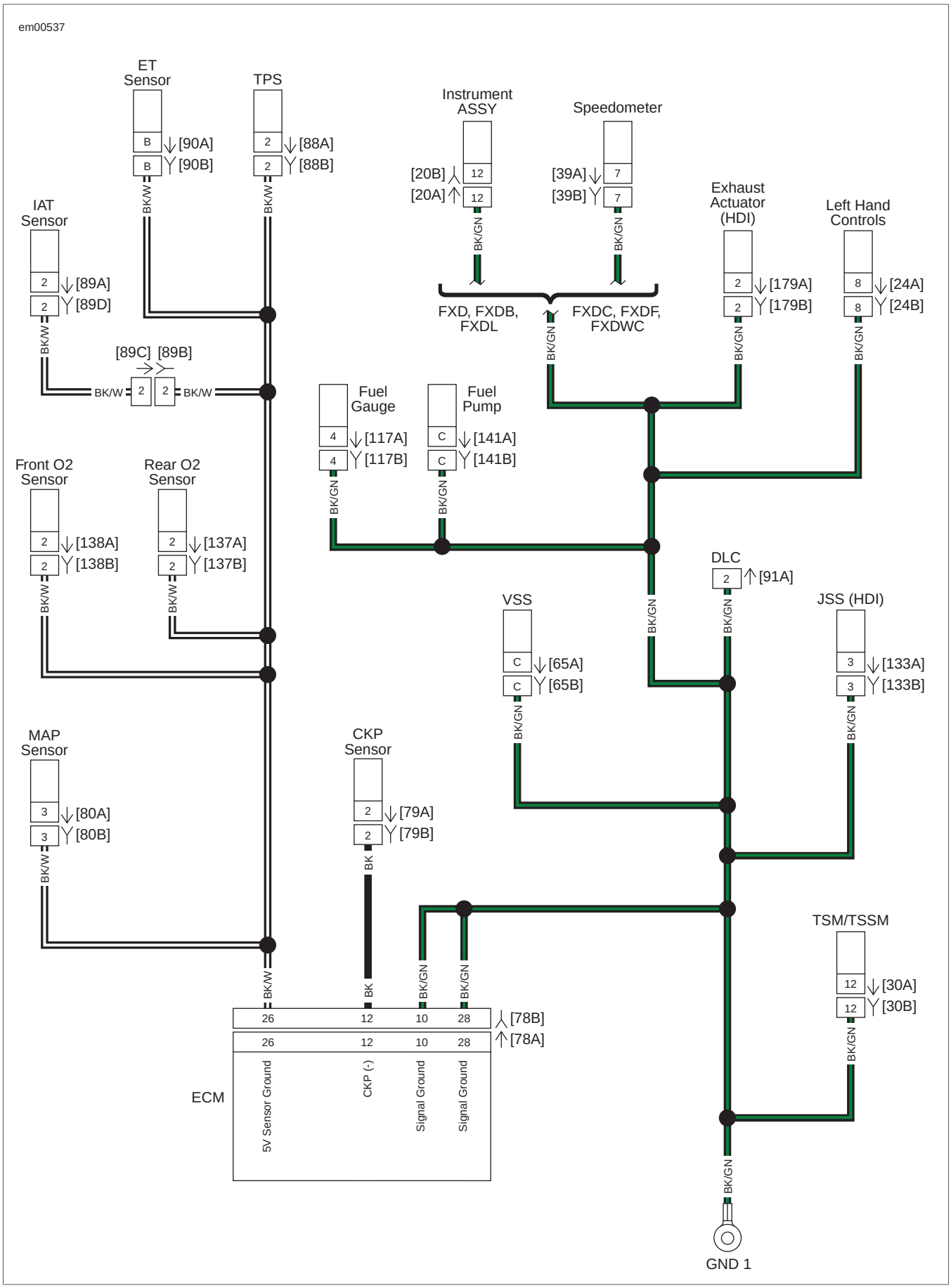


Figure 2-6. Sensor Grounds

INITIAL DIAGNOSTICS

1. Verifying Current DTC Test

1. Check for DTCs. See 2.1 INITIAL DIAGNOSTICS, Odometer Self-Diagnostics.
2. Are any DTCs present?
   a. **Yes.** Go to DTC diagnostics. Refer to Table 2-1.
   b. **No.** Go to Test 2.

2. Battery Power Test

1. Verify battery is charged. See 3.1 BATTERY TESTING.
2. Does vehicle have battery power?
   a. **Yes.** Go to Test 4.
   b. **No.** Go to Test 3.

3. Ignition Power Test

1. With the engine stop switch in the off position, turn IGN ON.
2. Does the headlamp and instruments illuminate?
   a. **Yes.** Go to Test 4.
   b. **No.** Go to appropriate system. Refer to Table 2-2.

4. Engine Stop Switch Circuit Test

1. Turn the engine stop switch to the RUN position.
2. Does the check engine lamp illuminate for a few seconds, then turn off?
   a. **Yes.** Go to Test 5.
   b. **No.** See 6.23 NO ECM POWER.

5. Security System Test

1. Turn the IGN OFF-ON.
2. Observe the security lamp.
3. Does the security lamp illuminate for a few seconds and then turn off?
   a. **Yes.** Go to Test 6.
   b. **No.** See 5.10 SECURITY SYSTEM.

6. Starter System Test

1. Press the start button.
2. Does the starter spin and crank the engine?
   a. **Yes.** Go to Test 7.
   b. **No.** See 3.2 STARTING SYSTEM.

7. Engine Running Test

1. Start the engine.
2. Does the engine start and run correctly?
   a. **Yes.** Go to Test 8.
   b. **No.** See 6.1 EFI SYSTEM.

8. Verification Test

1. Operate the systems of the vehicle to verify the concern.
2. Was the concern duplicated?
   a. **Yes.** Go to appropriate diagnostic. Refer to Table 2-2.
   b. **No.** Concern is intermittent. See 1.3 DIAGNOSTICS AND TROUBLESHOOTING, Wiggle Test.

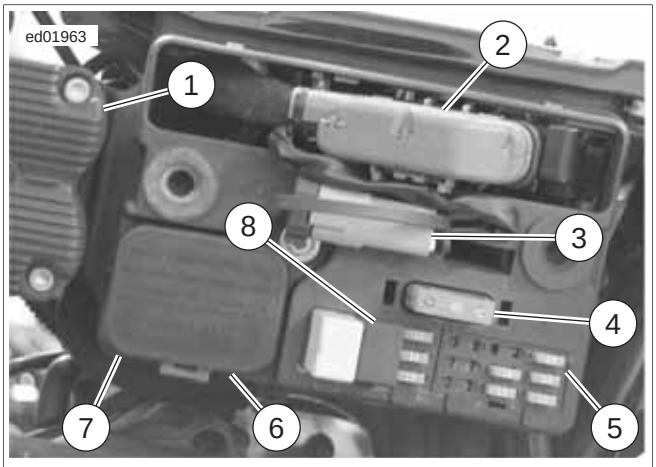
DIGITAL TECHNICIAN HARLEY-DAVIDSON

SERIAL DATA COMMUNICATION 2.2

DESCRIPTION AND OPERATION

PART NUMBER	TOOL NAME
HD-48650	DIGITAL TECHNICIAN II

Serial data communication circuits are used by modules and diagnostic tools to share information.



1. **Ignition coil**
2. **ECM [78]**
3. **DLC [91]**
4. **Main fuse [5]**
5. **Fuse block [64]**
6. **TSM/TSSM/HFSM**
7. **HFSM antenna harness [208]**
8. **Fuse/relay block [62]**

Figure 2-7. Under Left Side Cover

The speedometer, ECM, TSM/TSSM/HFSM and tachometer (if equipped) all communicate on the serial data line. The serial data line is a (LGN/V) wire that runs to all the modules and is used to transfer data from one module to the other. This line also runs to the DLC [91] and is used to communicate with the modules using DIGITAL TECHNICIAN II (Part No. HD-48650).

COMPONENTS

PART NUMBER	TOOL NAME
HD-48650	DIGITAL TECHNICIAN II

Electronic Control Module (ECM)

See Figure 2-7. The ECM is located under the left side cover. The ECM monitors the sensors from the engine and fuel system in order to manage the fuel and spark delivery to the motorcycle which enhances performance and driveability.

Speedometer and Tachometer

The speedometer and tachometer contain part of the indicator and warning lamps for the motorcycle. They use the serial data line to receive information from the other modules to know which lamps to illuminate at any given time.

TSM/TSSM/HFSM

See Figure 2-7. The TSM/TSSM/HFSM is located under the left side cover. It monitors the turn signal switches and controls the turn signals. The clutch and neutral switches are also inputs to the TSM/TSSM/HFSM. It uses these inputs to determine when it is safe to allow the motorcycle to start. It allows starter engagement and sends the information to the ECM over the serial data line letting the ECM know to activate the fuel injectors. The TSSM/HFSM also controls the security functions on the motorcycle if equipped with the factory security system.

Data Link Connector (DLC)

See Figure 2-7. The DLC is located under the left side cover. The DLC is used to connect the DIGITAL TECHNICIAN II (Part No. HD-48650) to the motorcycle.

COMMUNICATION DTCS AND "BUS ER"

There are several DTCs that may set due to and issue with the serial data line. Different DTCs are set by different modules. If a module loses communication it is not able to generate a DTC. Therefore the other modules will set DTCs for that module indicating they are not able to communicate with it.

Diagnostic Tips

Modules must have power and be grounded in order to communicate. Therefore, when checking any communication DTC be sure to check the power and ground connections on the suspected module. In some cases "Bus Er" will show on the odometer.

DTC U1016, U1064, U1097, U1255 2.3

DESCRIPTION AND OPERATION

The serial data circuit provides a means for the ECM, speedometer, tachometer, and TSM/TSSM/HFSM to communicate their current status. When all operating parameters on the serial data link are within specifications, a state of health message is sent between the components.

- DTC U1016 indicates that the ECM is not capable of sending this state of health message. It also indicates that there was communication on the data bus since power up, but communication was lost or interrupted during that key cycle.
- DTC U1064 indicates that the TSM/TSSM/HSFM is not capable of sending this state of health message. It also indicates that there was communication on the data bus since power up, but was lost or interrupted during that key cycle.
- DTC U1097 indicates the speedometer is not capable of sending its state of health message.
- DTC U1255 indicates that no messages were present during power up of the current key cycle.

NOTE

It is important to always start from 2.1 INITIAL DIAGNOSTICS before proceeding with this test.

Table 2-3. Code Description

DTC	SYMPTOM
U1016	Loss of all ECM serial data (state of health)
U1064	Loss of TSM/TSSM/HFSM serial data (state of health)
U1097	Loss of speedometer serial data (state of health)
U1255	Serial data error/missing message

Diagnostic Tips

The TSM/TSSM/HFSM controls the turn signals and supplies voltage for the turn signals to operate. A short on the turn signal circuits can cause the battery fuse to open. If no short to ground is found in the battery fuse circuit check the turn signal circuits between the TSM/TSSM/HFSM and the turn signals for a short to ground.

Connector Information

For additional information about the connectors in the following diagram(s) and diagnostic procedure(s), including the color of the harness test kit terminal probes, see B.1 CONNECTORS.

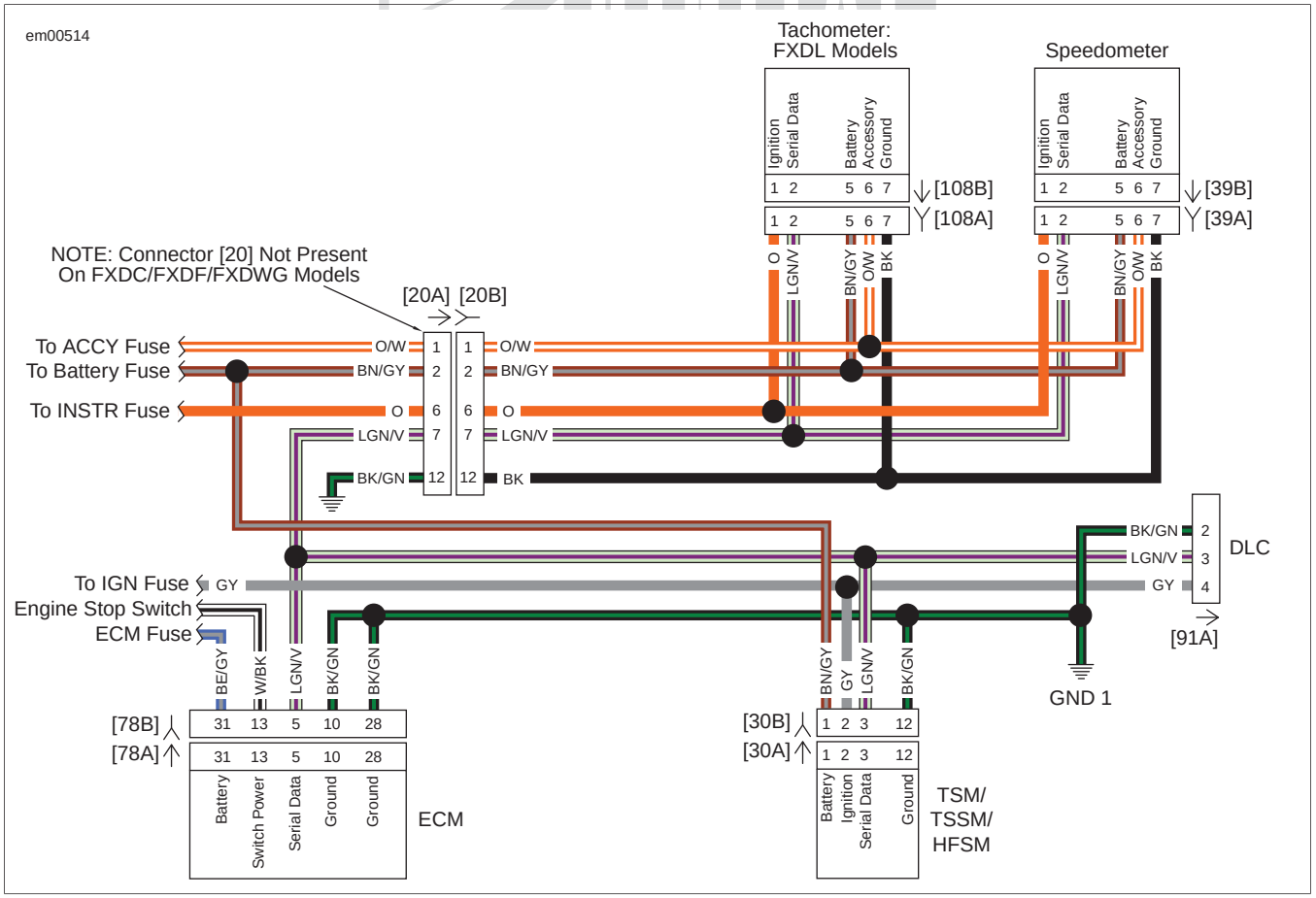


Figure 2-8. Serial Data Circuit

DTC U1016

PART NUMBER	TOOL NAME
HD-41404-B	HARNESS CONNECTOR TEST KIT
HD-42682	BREAKOUT BOX
HD-43876	BREAKOUT BOX
HD-46601	BREAKOUT BOX ADAPTERS

Table 2-4. DTC U1016 Diagnostic Faults

POSSIBLE CAUSES
Open ground
Open switched power
ECM malfunction
Open serial data circuit

1. Open Ground Test

1. Connect BREAKOUT BOX (Part No. HD-43876) between wire harness [78B] and ECM [78A]. See 1.2 DIAGNOSTIC TOOLS.
2. Using HARNESS CONNECTOR TEST KIT (Part No. HD-41404-B) and a multimeter, test for continuity from breakout box terminals 10 and 28 to ground.
3. Is continuity present?
   a. **Yes.** Go to Test 2.
   b. **No.** Repair open in ground circuit.

2. Switched Power Circuit Open Test

1. With IGN ON and engine stop switch in the RUN position, test for voltage at breakout box terminal 13.
2. Is battery voltage present?
   a. **Yes.** The TSM/TSSM/HFSM is reporting the DTC. Go to Test 3.
   b. **Yes.** The speedometer is reporting the DTC. Go to Test 4.
   c. **Yes.** The tachometer is reporting the DTC. Go to Test 5.
   d. **No.** Repair open in (W/BK) wire.

3. TSM/TSSM/HFSM Serial Data Circuit Continuity Test

1. With the IGN OFF, install BREAKOUT BOX (Part No. HD-42682) at the TSM/TSSM/HFSM. See 1.2 DIAGNOSTIC TOOLS.
2. Using HARNESS CONNECTOR TEST KIT (Part No. HD-41404-B) and a multimeter, test for continuity between TSM/TSSM/HFSM breakout box terminal 3 and ECM breakout box terminal 5.
3. Is continuity present?
   a. **Yes.** Replace ECM. See the service manual.
   b. **No.** Repair open on (LGN/V) wire.

4. Speedometer Serial Data Circuit Continuity Test

1. Connect harness BREAKOUT BOX ADAPTERS (Part No. HD-46601) to [39A] and [39B]. Attach connectors from BREAKOUT BOX (Part No. HD-42682) to harness adapters, leaving [39A] disconnected. See 1.2 DIAGNOSTIC TOOLS.
2. Test for continuity between speedometer breakout box terminal 2 and ECM breakout box terminal 5.
3. Is continuity present?
   a. **Yes.** Replace ECM. See the service manual.
   b. **No.** Repair open on (LGN/V) wire.

5. Tachometer Serial Data Circuit Continuity Test

1. Connect harness BREAKOUT BOX ADAPTERS (Part No. HD-46601) to [108A] and [108B]. Attach connectors from BREAKOUT BOX (Part No. HD-42682) to harness adapters, leaving [108A] disconnected. See 1.2 DIAGNOSTIC TOOLS.
2. Test for continuity between tachometer breakout box terminal 2 and ECM breakout box terminal 5.
3. Is continuity present?
   a. **Yes.** Replace ECM. See the service manual.
   b. **No.** Repair open on (LGN/V) wire.

DTC U1064, U1255

PART NUMBER	TOOL NAME
HD-41404-B	HARNESS CONNECTOR TEST KIT
HD-42682	BREAKOUT BOX
HD-43876	BREAKOUT BOX
HD-46601	BREAKOUT BOX ADAPTERS

Table 2-5. DTC U1064, U1255 Diagnostic Faults

POSSIBLE CAUSES
Open battery fuse
Open battery circuit
Open ground circuit
Open serial data circuit
TSM/TSSM/HFSM malfunction
Short to ground in power circuit

1. Fuse Test

1. Inspect battery fuse.
2. Is battery fuse good?
   a. **Yes.** Go to Test 2.
   b. **No.** Go to Test 6.

2. Loss of Battery Power Test

1. Connect BREAKOUT BOX (Part No. HD-42682) between wire harness [30B] and TSM/TSSM/HFSM [30A] and connect BREAKOUT BOX (Part No. HD-42682) and BREAKOUT BOX ADAPTERS (Part No. HD-46601) to the speedometer [39]. See 1.2 DIAGNOSTIC TOOLS.
2. With IGN ON and engine stop switch in the RUN position, use HARNESS CONNECTOR TEST KIT (Part No. HD-41404-B) and a multimeter to test for voltage at TSM/TSSM/HFSM breakout box terminal 1.
3. Is battery voltage present?
   a. **Yes.** Go to Test 3.
   b. **No.** Repair open in (BN/GY) wire.

3. Loss of Ignition Power Test

1. Test for voltage at terminal 2 of the TSM/TSSM/HFSM breakout box.
2. Is battery voltage present?
   a. **Yes.** Go to Test 4.
   b. **No.** Repair open in (GY) wire.

4. Loss of Ground Test

1. Turn IGN OFF.
2. Test for continuity to ground from TSM/TSSM/HFSM breakout box terminal 12.
3. Is continuity present?
   a. **Yes.** The speedometer is reporting the DTC. Go to Test 5.
   b. **Yes.** The ECM is reporting the DTC. Go to Test 7.
   c. **Yes.** The tachometer is reporting the DTC. Go to Test 8.
   d. **No.** Repair open in ground circuit.

5. Speedometer Serial Data Circuit Continuity Test

1. Test for continuity between speedometer breakout box terminal 2 and TSM/TSSM/HFSM breakout box terminal 3.
2. Is continuity present?
   a. **Yes.** Replace the TSM/TSSM/HFSM. See the service manual.
   b. **No.** Repair open on (LGN/V) wire.

6. Power Circuit Short to Ground Test

1. Disconnect the siren (if equipped).
2. Connect BREAKOUT BOX (Part No. HD-42682) between wire harness [30B] and TSM/TSSM/HFSM [30A] and connect BREAKOUT BOX (Part No. HD-42682) and BREAKOUT BOX ADAPTERS (Part No. HD-46601) to the speedometer [39]. See 1.2 DIAGNOSTIC TOOLS.
3. Using HARNESS CONNECTOR TEST KIT (Part No. HD-41404-B) and a multimeter, test for continuity between speedometer breakout box terminal 5 to ground.
4. Is continuity present?
   a. **Yes.** Repair short to ground in (BN/GY) wire and replace battery fuse.
   b. **No.** See diagnostic tips. Replace battery fuse and test for intermittent short to ground. See 1.3 DIAGNOSTICS AND TROUBLESHOOTING, Wiggle Test.

7. ECM Serial Data Circuit Continuity Test

1. Connect BREAKOUT BOX (Part No. HD-43876) between wire harness [78B] and ECM [78A]. See 1.2 DIAGNOSTIC TOOLS.
2. Test for continuity between TSM/TSSM/HFSM breakout box terminal 3 and ECM breakout box terminal 5.
3. Is continuity present?
   a. **Yes.** Replace TSM/TSSM/HFSM. See the service manual.
   b. **No.** Repair open on (LGN/V) wire.

8. Tachometer Serial Data Circuit Continuity Test

1. Test for continuity between tachometer breakout box terminal 2 and TSM/TSSM/HFSM breakout box terminal 3.
2. Is continuity present?
   a. **Yes.** Replace the TSM/TSSM/HFSM. See the service manual.
   b. **No.** Repair open on (LGN/V) wire.

DTC U1097, U1255

PART NUMBER	TOOL NAME
HD-41404-B	HARNESS CONNECTOR TEST KIT
HD-42682	BREAKOUT BOX
HD-43876	BREAKOUT BOX
HD-46601	BREAKOUT BOX ADAPTERS

Table 2-6. DTC U1097, U1255 Diagnostic Faults

POSSIBLE CAUSES
Open battery fuse
Open ignition circuit
Open ground circuit
Speedometer malfunction
Open serial data circuit
Short to ground in power circuit

1. Fuse Test

1. Inspect battery fuse.

2. Is battery fuse good?
   a. **Yes.** Go to Test 2.
   b. **No.** Go to Test 5.

2. Loss of Power Test

1. Connect BREAKOUT BOX (Part No. HD-42682) between wire harness [30B] and TSM/TSSM/HFSM [30A] and connect BREAKOUT BOX (Part No. HD-42682) and BREAKOUT BOX ADAPTERS (Part No. HD-46601) to the speedometer [39]. See 1.2 DIAGNOSTIC TOOLS.
2. With IGN ON and engine stop switch in the RUN position, use HARNESS CONNECTOR TEST KIT (Part No. HD-41404-B) and a multimeter to test for voltage at speedometer breakout box terminal 5.
3. Is battery voltage present?
   a. **Yes.** Go to Test 3.
   b. **No.** Repair open in (BN/GY) wire.

3. Loss of Ground Test

1. Turn IGN OFF.
2. Test for continuity to ground from speedometer breakout box terminal 7.
3. Is continuity present?
   a. **Yes.** The TSM/TSSM/HFSM is reporting the DTC. Go to Test 4.
   b. **Yes.** The ECM is reporting the DTC. Go to Test 6.
   c. **No.** Repair open in ground circuit.

4. Speedometer Serial Data Circuit Continuity Test

1. Test for continuity between speedometer breakout box terminal 2 and TSM/TSSM/HFSM breakout box terminal 3.
2. Is continuity present?
   a. **Yes.** Replace the speedometer. See the service manual.
   b. **No.** Repair open on (LGN/V) wire.

5. Power Circuit Short to Ground Test

1. Connect BREAKOUT BOX (Part No. HD-42682), using BREAKOUT BOX ADAPTERS (Part No. HD-46601) between wire harness [39B] and speedometer [39A]. See 1.2 DIAGNOSTIC TOOLS.
2. Using HARNESS CONNECTOR TEST KIT (Part No. HD-41404-B) and a multimeter, test for short to ground breakout box terminal 5.
3. Is a short to ground present?
   a. **Yes.** Repair short to ground in (BN/GY) wire and replace battery fuse.
   b. **No.** Replace battery fuse and test for intermittent short to ground. See 1.3 DIAGNOSTICS AND TROUBLESHOOTING, Wiggle Test.

6. ECM Serial Data Circuit Continuity Test

1. Connect BREAKOUT BOX (Part No. HD-43876) between wire harness [78B] and ECM [78A]. See 1.2 DIAGNOSTIC TOOLS.
2. Using HARNESS CONNECTOR TEST KIT (Part No. HD-41404-B) and a multimeter test for continuity between speedometer breakout box terminal 2 and ECM breakout box terminal 5.
3. Is continuity present?
   a. **Yes.** Replace speedometer. See the service manual.
   b. **No.** Repair open on (LGN/V) wire.

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DTC U1300, U1301 OR BUS ER 2.4

DESCRIPTION AND OPERATION

The typical serial data voltage range is 0V (inactive) to 7V (active). Due to the high speed voltage fluctuations of the signal, voltages will be much lower on a multimeter. In analog mode, a multimeter reading serial data will show continuous voltage when active, typically 0.6-0.8V. The range for acceptable operations is 0-7.0V.

Table 2-7. Code Description

DTC	DESCRIPTION
U1300	Serial data open/low
U1301	Serial data high

Diagnostic Tips

- If serial data is shorted, these DTCs will automatically cause the check engine lamp to illuminate. The odometer will read "BUS Er" in this condition.
- DTCs P1009 and P1010 may accompany DTCs U1300 and U1301.

Connector Information

For additional information about the connectors in the following diagram(s) and diagnostic procedure(s), including the color of the harness test kit terminal probes, see B.1 CONNECTORS.

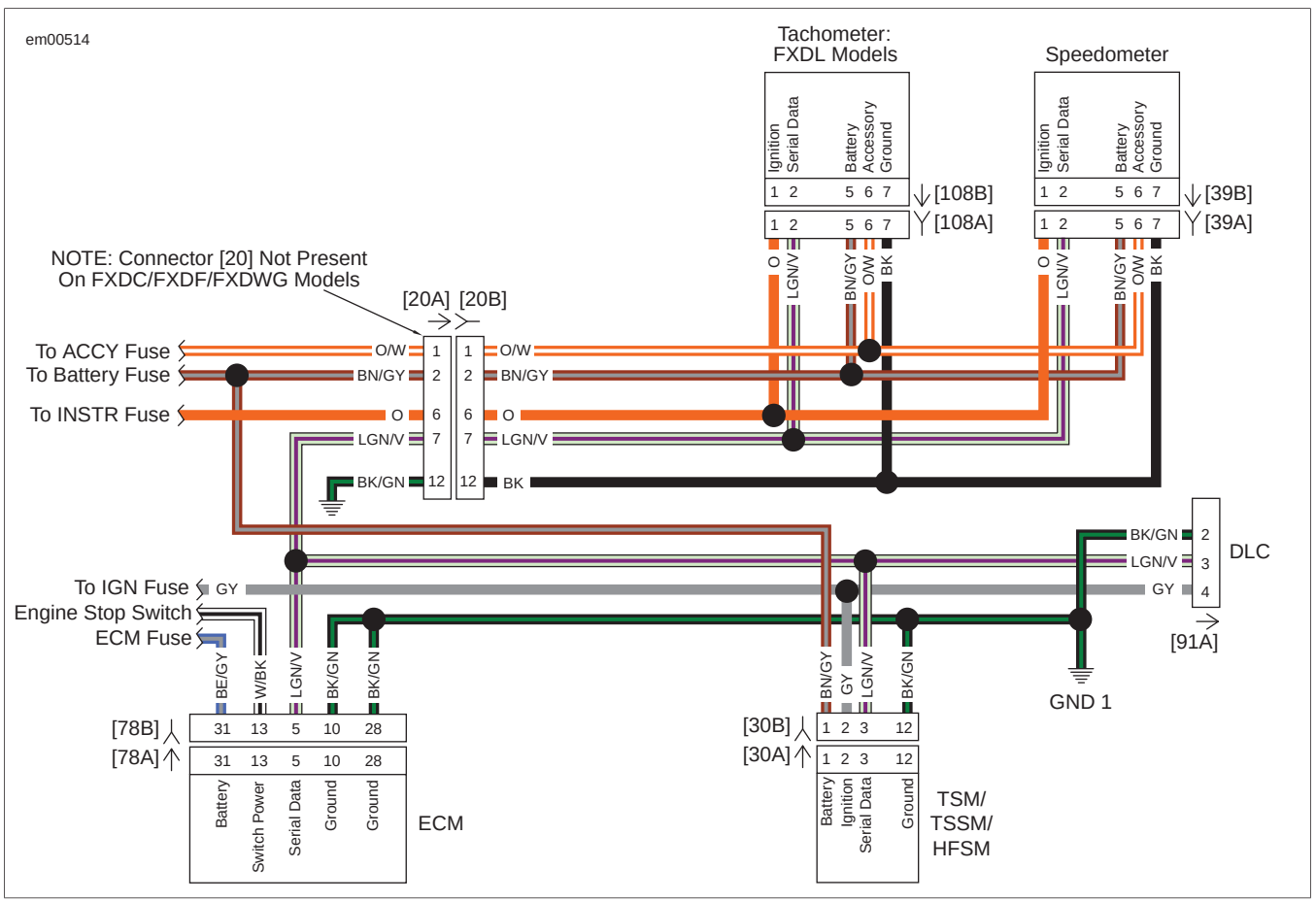

Figure 2-9. Serial Data Circuit

DTC U1300

PART NUMBER	TOOL NAME
HD-41404-B	HARNESS CONNECTOR TEST KIT
HD-42682	BREAKOUT BOX
HD-46601	BREAKOUT BOX ADAPTERS

Table 2-8. DTC U1300 Diagnostic Faults

POSSIBLE CAUSES
ECM malfunction
TSM/TSSM/HFSM malfunction
Tachometer malfunction
Short to ground in serial data wire
Speedometer malfunction
Open in Serial data circuit

1. Serial Data Short to Ground Test

1. Turn IGN ON.
2. Does BUS Er appear on odometer display?
   a. **Yes.** Go to Test 2.
   b. **No.** Go to Test 7.

2. ECM Test

1. Turn IGN OFF.
2. Disconnect the ECM [78B].
3. Turn IGN ON.
4. Does BUS Er appear on odometer display?
   a. **Yes.** Go to Test 3.
   b. **No.** Replace ECM. See the service manual.

3. TSM/TSSM/HFSM Test

1. Turn IGN OFF.
2. Disconnect the TSM/TSSM/HFSM [30A].
3. Turn IGN ON.
4. Does BUS Er appear on odometer display?
   a. **Yes.** Go to Test 4.
   b. **No.** Replace TSM/TSSM/HFSM. See the service manual.

4. Tachometer Test (If Vehicle is not Equipped with Tachometer, Go to Test 5.)

1. Turn IGN OFF.
2. Disconnect tachometer [108].
3. Turn IGN ON.
4. Does BUS Er appear on odometer display?
   a. **Yes.** Go to Test 5.
   b. **No.** Replace tachometer. See the service manual.

5. Serial Data Short to Ground Test

1. Turn IGN OFF.
2. Disconnect speedometer [39].
3. Using HARNESS CONNECTOR TEST KIT (Part No. HD-41404-B), test for continuity from DLC [91A] terminal 3 to ground.
4. Is continuity present?
   a. **Yes.** Repair short to ground in (LGN/V) wire.
   b. **No.** Go to Test 6.

6. Serial Data Circuit Open Test

1. Connect BREAKOUT BOX (Part No. HD-42682) and BREAKOUT BOX ADAPTERS (Part No. HD-46601) to the wiring harness [39B], leaving the speedometer disconnected. See 1.2 DIAGNOSTIC TOOLS.
2. Test for continuity from terminal 2 of breakout box to DLC [91A] terminal 3.
3. Is continuity present?
   a. **Yes.** Replace speedometer. See the service manual.
   b. **No.** Repair open in (LGN/V) wire.

7. Intermittent Test

1. Turn IGN OFF.
2. Disconnect the ECM [78B], speedometer [39B], TSM/TSSM/HFSM [30B], and tachometer [108B] (if equipped).
3. Test for continuity between DLC [91A] terminal 3 and ground while performing a wiggle test. See 1.3 DIAGNOSTICS AND TROUBLESHOOTING, Wiggle Test.
4. Is continuity present?
   a. **Yes.** Repair short to ground in (LGN/V) wire.
   b. **No.** Verify that current DTC U1300 is set.

DTC U1301

PART NUMBER	TOOL NAME
HD-41404-B	HARNESS CONNECTOR TEST KIT
HD-42682	BREAKOUT BOX
HD-46601	BREAKOUT BOX ADAPTERS

Table 2-9. DTC U1301 Diagnostic Faults

POSSIBLE CAUSES
ECM malfunction
TSM/TSSM/HFSM malfunction
Tachometer malfunction
Short to voltage in serial data circuit
Speedometer malfunction

1. Serial Data Short to Voltage Test

1. Turn IGN ON.

2. Does BUS Er appear on odometer display?
   a. **Yes.** Go to Test 2.
   b. **No.** Go to Test 7.

2. ECM Test

1. Turn IGN OFF.
2. Disconnect the ECM [78B].
3. Turn IGN ON.
4. Does BUS Er appear on odometer display?
   a. **Yes.** Go to Test 3.
   b. **No.** Replace ECM. See the service manual.

3. TSM/TSSM/HFSM Test

1. Turn IGN OFF.
2. Disconnect the TSM/TSSM/HFSM [30B].
3. Turn IGN ON.
4. Does BUS Er appear on odometer display?
   a. **Yes.** Go to Test 4.
   b. **No.** Replace TSM/TSSM/HFSM. See the service manual.

4. Tachometer Test (If Vehicle is not Equipped with Tachometer, Go to Test 5.)

1. Turn IGN OFF.
2. Disconnect the tachometer [108B].
3. Turn IGN ON.
4. Does BUS Er appear on odometer display?
   a. **Yes.** Go to Test 5.
   b. **No.** Replace tachometer. See the service manual.

5. Serial Data Short to Voltage Test

1. Turn the IGN OFF.
2. Disconnect the speedometer [39B].
3. Turn IGN ON.
4. Using the HARNESS CONNECTOR TEST KIT (Part No. HD-41404-B), test for voltage from DLC [91A] terminal 3 to ground.
5. Is battery voltage present?
   a. **Yes.** Repair short to voltage in (LGN/V) wire.
   b. **No.** Go to Test 6.

6. Serial Data Circuit Open Test

1. Turn IGN OFF.
2. Connect BREAKOUT BOX (Part No. HD-42682) and BREAKOUT BOX ADAPTERS (Part No. HD-46601) to the wiring harness [39B], leaving the speedometer disconnected. See 1.2 DIAGNOSTIC TOOLS.
3. Test for continuity from breakout box terminal 2 to DLC [91A] terminal 3.
4. Is continuity present?
   a. **Yes.** Replace speedometer. See the service manual.
   b. **No.** Repair open in (LGN/V) wire.

7. Intermittent Test

1. Turn IGN OFF.
2. Disconnect the ECM [78B], speedometer [39B], TSM/TSSM/HFSM [30B], and tachometer [108B] (if equipped).
3. Turn IGN ON.
4. Test for voltage between DLC [91A] terminal 3 and ground while performing a wiggle test. See 1.3 DIAGNOSTICS AND TROUBLESHOOTING, Wiggle Test.
5. Is voltage present?
   a. **Yes.** Repair short to voltage in (LGN/V) wire.
   b. **No.** Verify that current DTC U1301 is set.

DIGITAL TECHNICIAN II HARLEY-DAVIDSON

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NOTES

BATTERY TESTING 3.1

GENERAL

Three different procedures may be performed to provide a good indication of battery condition: a voltage test, a conductance test or a load test.

A battery may be tested, whether fully charged or not, using a conductance test. In order to perform a load test, however, the battery must be fully charged.

VOLTMETER TEST

The voltmeter test provides a general indication of battery state of charge or condition. Check the voltage of the battery to verify that it is in a 100% fully charged condition. Refer to Table 3-1.

If the open circuit (disconnected) voltage reading is below 12.6V, charge the battery and then recheck the voltage after the battery has set for one to two hours. If the voltage reading is 12.7V or above, perform a load test. See 3.1 BATTERY TESTING, Load Test.

Table 3-1. Voltmeter Test For Battery Charge Conditions

VOLTAGE	STATE OF CHARGE
12.7	100%
12.6	75%
12.3	50%
12.0	25%
11.8	0%

CONDUCTANCE TEST

PART NUMBER	TOOL NAME
HD-48053	ADVANCED BATTERY CONDUCTANCE AND ELECTRICAL SYSTEM ANALYZER

Test the battery using the ADVANCED BATTERY CONDUCTANCE AND ELECTRICAL SYSTEM ANALYZER (Part No. HD-48053). Perform a battery test as follows:

1. Connect the analyzer leads to the vehicle battery terminal, not to the bolt or wire terminal.

NOTE

Connecting the analyzer to the bolt or wire terminal may not give an accurate reading of battery condition.

2. Follow the instructions in the analyzer instruction manual to perform a battery test.

The test results will include a decision on the battery condition and the measured state of charge.

See Figure 3-1. The analyzer printer will provide a printout including the possible test results:

NOTE

A REPLACE BATTERY test result may also mean a poor connection between the battery cables and the vehicle. After disconnecting the battery cables from the battery, retest the battery using the out-of-vehicle test before replacing.

- GOOD BATTERY - Return the battery to service.
- GOOD-RECHARGE - Fully charge the battery and return to service.
- CHARGE & RETEST - Fully charge the battery and then check the voltage after the battery has set for one to two hours, and retest. If battery fails retest, replace battery.
- REPLACE BATTERY - Replace the battery.
- BAD CELL-REPLACE - Replace the battery.
- BATTERY NOISE - Remove surface charge from battery and retest.

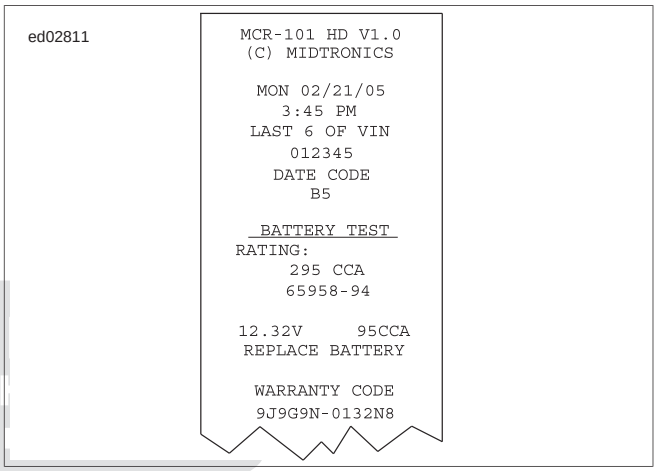


Figure 3-1. Battery Test Results Printout

LOAD TEST

WARNING

Disconnect negative (-) battery cable first. If positive (+) cable should contact ground with negative (-) cable connected, the resulting sparks can cause a battery explosion, which could result in death or serious injury. (00049a)

1. With vehicle battery on a bench, charge the battery.

NOTE

Always fully charge the battery before testing or test readings will be incorrect. Load testing a discharged battery can also result in permanent battery damage.

WARNING

Turn battery load tester OFF before connecting tester cables to battery terminals. Connecting tester cables with load tester ON can cause a spark and battery explosion, which could result in death or serious injury. (00252a)

2. See Figure 3-2. Connect tester leads to battery posts and place induction pickup over negative (black) cable.

NOTE

To avoid load tester and/or battery damage, do not leave the load tester switch turned ON for more than 20 seconds.

3. Refer to Table 3-2. Load battery at 50% of CCA rating using the load tester. Voltage reading after 15 seconds should be 9.6V or more at 70 °F (21 °C).

WARNING

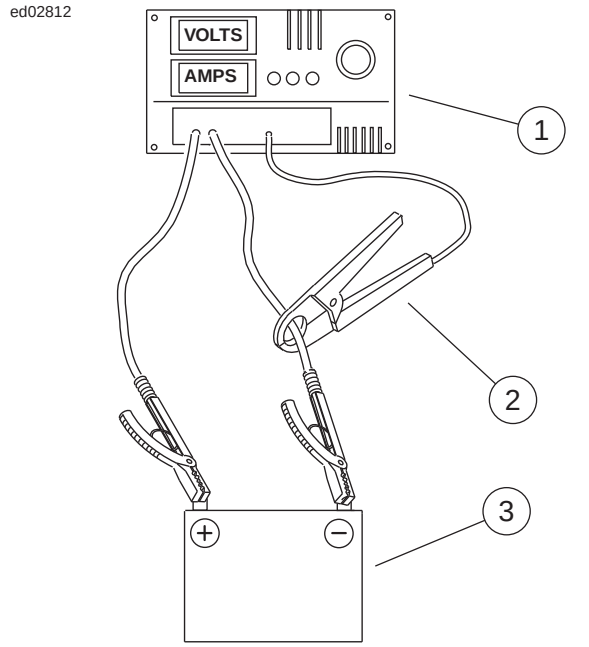
Turn battery load tester OFF before disconnecting tester cables to battery terminals. Disconnecting tester cables with load tester ON can cause a spark and battery explosion, which could result in death or serious injury. (00253a)

WARNING

Connect positive (+) battery cable first. If positive (+) cable should contact ground with negative (-) cable connected, the resulting sparks can cause a battery explosion, which could result in death or serious injury. (00068a)

CAUTION

Do not over-tighten bolts on battery terminals. Use recommended torque values. Over-tightening battery terminal bolts could result in damage to battery terminals. (00216a)



1. **Load tester**
2. **Induction pickup**
3. **Battery**

Figure 3-2. Load Test Battery

Table 3-2. Battery Load Test

COLD CRANKING AMPERAGE (CCA)	100%	50%
Dyna models	270	135

STARTING SYSTEM 3.2

DESCRIPTION AND OPERATION

With IGN ON, battery voltage is supplied to the start relay and ignition fuse. The ignition fuse supplies battery voltage to the engine stop switch and TSM/TSSM/HFSM.

With engine stop switch to RUN, battery voltage is supplied to the start switch and the ECM. The TSM/TSSM/HFSM monitors the clutch switch, neutral switch, and the state of the security system. If the security system is not armed and either the clutch lever is pulled in or the motorcycle is in neutral, the TSM/TSSM/HFSM provides ground to the start relay coil.

When the start switch is pressed, power flows to the coil side of the start relay. The TSM/TSSM/HFSM supplies the ground to the start relay, energizing the start relay. This allows battery voltage from the ignition switch to flow through the start relay to the starter solenoid. This energizes the solenoid and full battery power is sent to the starter.

COMPONENTS

Starter

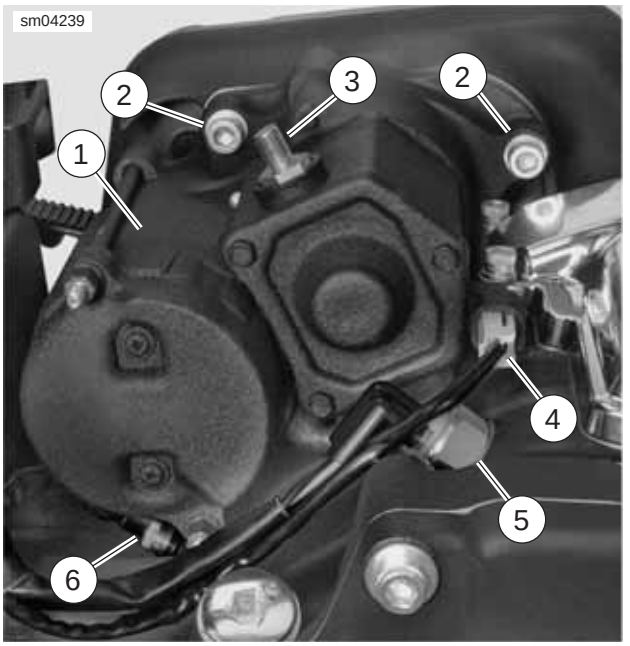
The starter receives power from the battery through the starter solenoid and is grounded through the starter case. When the starter solenoid is energized, two actions happen:

- The plunger pulls inward which allows current to flow to the starter motor.
- The pinion gear engages with the ring gear on the clutch shell.

With the starter motor turning, the rotation is transferred to the following:

- The starter armature gear transfers rotation to the idler gear.
- The idler gear transfers rotation to the starter clutch.
- The starter clutch transfers rotation through a spline gear to the starter drive shaft which also drives the pinion gear.
- The pinion gear transfers its rotation to the ring gear on the clutch shell.
- The primary chain drives the alternator rotor sprocket on the end of the crankshaft.

The starter clutch is equipped with one way clutch so when the engine starts, it allows the clutch shell and sprocket to spin freely without causing any damage to the starter motor. After the engine starts and the start switch is released, the plunger returns to its normal position, disengaging the pinion gear from the clutch shell and sprocket.



1. **Starter**
2. **Starter mounting fasteners**
3. **Positive battery cable post**
4. **Solenoid wire**
5. **Neutral switch**
6. **Vehicle speed sensor**

Figure 3-3. Starter

Starter Solenoid

See Figure 3-3. The starter solenoid provides power to the starter. The solenoid is a means of controlling a high amperage device with a low amperage switch. The low amperage switch in this circuit is the start relay. When the start relay is activated it sends voltage to the starter solenoid making a magnetic field that pulls a larger circuit closed, allowing voltage to the starter.

Engine Stop Switch (Right Hand Controls)

The engine stop switch is located on the right hand controls. With the engine stop switch in the RUN position, battery voltage is supplied to the start switch and the ECM.

Start Switch (Right Hand Controls)

The start switch is a push button switch located in the right hand controls. When the start switch is pressed, power flows to the coil side of the start relay.

Start Relay

The fuse block located under the left side cover contains the start relay. With the IGN ON, battery voltage is supplied to the start relay and ignition fuse. The ignition fuse supplies battery voltage to the engine stop switch and TSM/TSSM/HFSM. With the engine stop switch in the RUN position, battery voltage is supplied to the start switch and the ECM. When the start switch is pressed, power flows to the coil side of the start relay. The TSM/TSSM/HFSM supplies the ground to the start relay,

DIGITAL TECHNICIAN II HARLEY-DAVIDSON

energizing the start relay. This allows battery voltage from the ignition switch to flow through the start relay to the starter solenoid.

Ignition Switch

The ignition switch turns the electrical power to the vehicle on and/or off. The ignition switch has three positions. In the OFF position, the ignition switch turns off all power to the vehicle except for the components powered directly by the battery. When the ignition switch is in the ACC position it allows power to flow through the ACCY fuse and supplies power to only certain parts of the vehicle such as the lights. In the ON or IGN position the ignition switch supplies power for all the systems on the vehicle.

Battery

⚠WARNING

Batteries contain sulfuric acid, which could cause severe burns to eyes and skin. Wear a protective face shield, rubberized gloves and protective clothing when working with batteries. KEEP BATTERIES AWAY FROM CHILDREN. (00063a)

⚠WARNING

Never remove warning label attached to top of battery. Failure to read and understand all precautions contained in warning, could result in death or serious injury. (00064a)

⚠WARNING

Explosive hydrogen gas, which escapes during charging, could cause death or serious injury. Charge battery in a well-ventilated area. Keep open flames, electrical sparks and smoking materials away from battery at all times. KEEP BATTERIES AWAY FROM CHILDREN. (00065a)

⚠WARNING

If battery becomes hot, gassing or spewing of electrolyte can occur, which could cause death or serious injury. Unplug or turn OFF the charger until battery cools. (00412b)

⚠WARNING

Batteries, battery posts, terminals and related accessories contain lead and lead compounds, and other chemicals known to the State of California to cause cancer, and birth defects or other reproductive harm. Wash hands after handling. (00019e)

CAUTION

If battery releases an excessive amount of gas during charging, decrease the charging rate. Overheating can result in plate distortion, internal shorting, drying out or damage. (00413b)

The AGM batteries are permanently sealed, maintenance-free, valve-regulated, lead/calcium and sulfuric acid batteries.

The battery is recharged by the alternator and kept from overcharging by the regulator during use.

Battery condition can be determined by a voltage test, a conductance test, or a load test. See 3.1 BATTERY TESTING.

A battery may be tested, whether fully charged or not, using the conductance test. However, the battery must be fully charged to perform a load test.

Job/Time Code Values

Dealership Technicians filing warranty claims should use the job/time code values printed in (bold text) beside the appropriate repair.

Connector Information

For additional information about the connectors in the following diagram(s) and diagnostic procedure(s), including the color of the harness test kit terminal probes, see B.1 CONNECTORS.

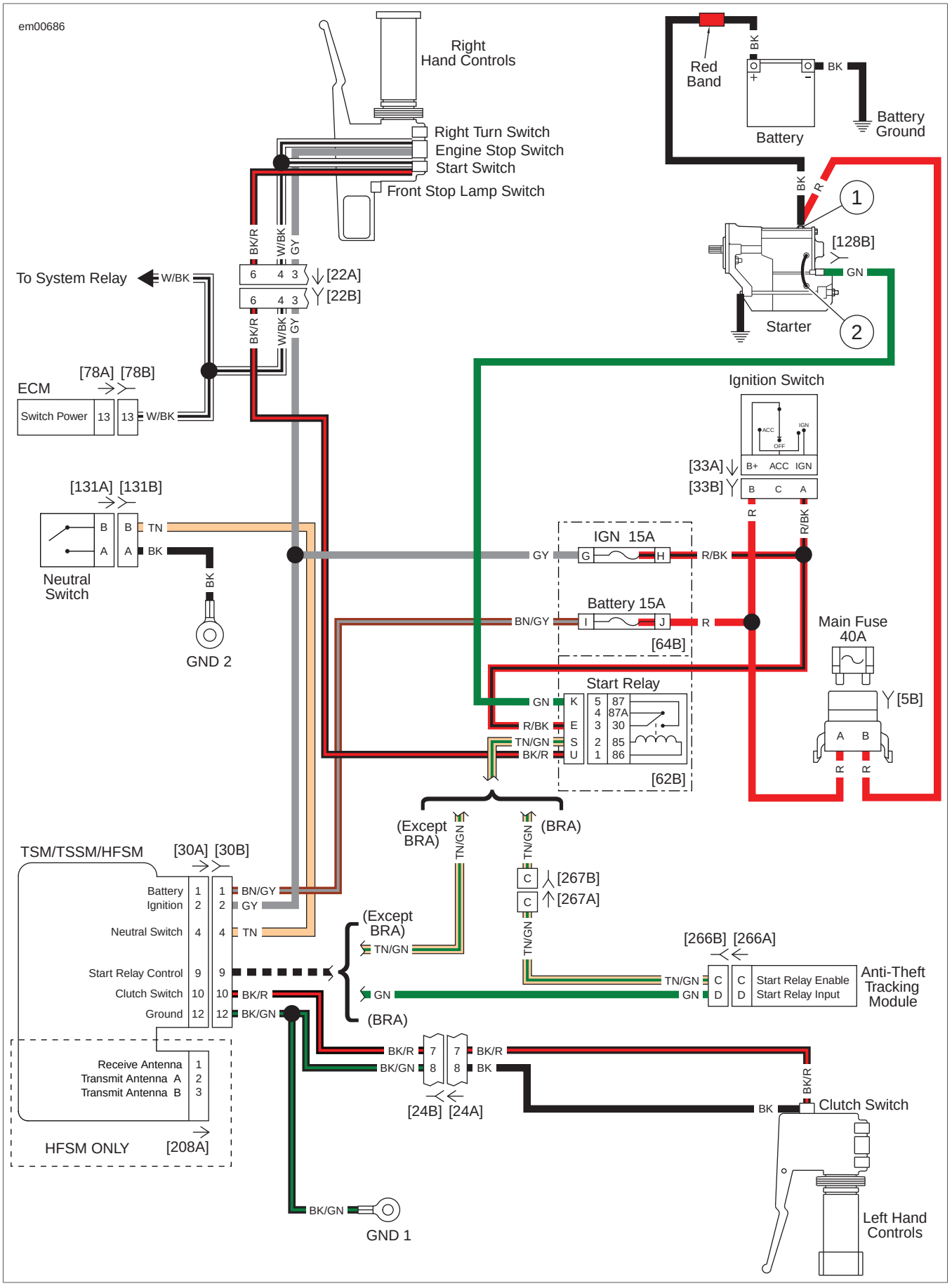


Figure 3-4. Starting Circuit

STARTER TROUBLESHOOTING

The troubleshooting tables contain detailed procedures to solve and correct problems. Follow 3.2 STARTING SYSTEM to diagnose starting system problems. The 1.3 DIAGNOSTICS AND TROUBLESHOOTING, Voltage Drop procedure will help you to locate poor connections or components with excessive voltage drops.

Table 3-3. Starter Does Not Run or Runs at Very Low Speeds

SOURCE OF PROBLEM	POSSIBLE CAUSE	SOLUTION
Battery	Voltage drop due to discharged battery.	Charge battery.
	Short-circuit or open between electrodes.	Replace battery.
	Poor contact condition of battery terminal(s).	Clean and retighten.
Wiring	Poor or no connection at either end of the battery positive or negative cable.	Repair or replace cable(s).
	Cracked or corroded battery cable ends.	Clean, tighten or replace cable(s) as needed.
	Open wire(s) or poor connection at handlebar switch or start relay, especially relay ground wire (grounds through TSM/TSSM/HFSM).	Tighten connections or repair or replace wire(s).
Start switch, clutch switch, engine stop switch or neutral switch	Poor switch contacts or open switch.	Replace switch.
Start relay	Open coil winding.	Replace relay.
	Poor or no continuity at relay points.	Replace relay.
	TSM/TSSM/HFSM has disabled start relay.	Disarm security system inspect for neutral or clutch circuit issue.
Starter solenoid	Poor contact condition caused by burned contacts.	Replace solenoid assembly.
	Windings open or short-circuited.	Replace solenoid assembly.
Starter motor	Brushes worn below specification.	Replace brush holder and brush springs.
	Commutator burnt.	Re-face commutator or replace armature and bearing.
	Commutator high mica.	Correct by undercutting or replace armature and bearing.
	Field winding grounded.	Replace field coil and armature and bearing.
	Armature winding grounded or short-circuited.	Replace armature and bearing.
	Free running current draw out of range.	Rebuild starter.
	Insufficient brush spring tension.	Replace brush springs.
Starter clutch	Starter clutch failure.	Replace starter clutch.

Table 3-4. Starter Spins But Does Not Engage

SOURCE OF PROBLEM	POSSIBLE CAUSE	SOLUTION
Battery	Voltage drop due to discharged battery.	Charge battery.
	Short-circuit or open between electrodes.	Replace battery.
	Poor contact condition of battery terminal(s).	Clean and retighten.
Starter motor	Pinion gear teeth worn out.	Replace clutch sub-assembly

Table 3-4. Starter Spins But Does Not Engage

SOURCE OF PROBLEM	POSSIBLE CAUSE	SOLUTION
Gear teeth on clutch shell and sprocket.	Excessively worn teeth.	Replace clutch shell and sprocket.
Starter clutch	Starter clutch failure.	Replace clutch sub-assembly

Table 3-5. Starter Does Not Stop Running

SOURCE OF PROBLEM	POSSIBLE CAUSE	SOLUTION
Start switch or start relay	Unopened contacts.	Replace start switch or start relay.
	Poor return caused by sticky switch or relay contacts.	Replace start switch or start relay.
Starter solenoid	Coil shorted.	Replace starter solenoid.
	Contact plate melted and stuck.	Replace starter solenoid.

STARTER TESTING

PART NUMBER	TOOL NAME
HD-41404-B	HARNESS CONNECTOR TEST KIT

Table 3-6. Starter Testing Diagnostic Faults

POSSIBLE CAUSES
Short to voltage at starter solenoid
Start switch malfunction
Short to voltage on start relay supply circuit
Start relay malfunction

1. Starting System Operational Test

1. With IGN ON, transmission in neutral, and the engine stop switch in the RUN position, press the start switch.
2. Does the starter spin?
   a. **Yes, starter spins but does not engage.** See 3.2 STARTING SYSTEM, Starter Spins But Does Not Engage.
   b. **Yes, starter stalls or spins too slowly.** See 3.2 STARTING SYSTEM, Starter Stalls or Spins Too Slowly.
   c. **Yes, starter runs on.** Go to Test 3.
   d. **No.** Go to Test 2.

2. Audible Noise Test

1. While listening for audible clicking noises from the start relay and starter solenoid, press the start switch.
2. Is there a click?
   a. **Yes, starter solenoid clicks.** See 3.2 STARTING SYSTEM, Starter Solenoid Clicks.
   b. **Yes, relay clicks.** See 3.2 STARTING SYSTEM, Start Relay Clicks.
   c. **No.** See 3.2 STARTING SYSTEM, Nothing Clicks.

3. Starter Solenoid Test

1. Disconnect [128].
2. Does starter stop?
   a. **Yes.** Go to Test 4.
   b. **No.** Replace starter solenoid. **(5845)**

4. Start Switch Circuit Test

1. Turn IGN OFF, remove start relay.
2. Turn IGN ON. Using HARNESS CONNECTOR TEST KIT (Part No. HD-41404-B) test for voltage at [62B] socket terminal U (BK/R) wire.
3. Is battery voltage present?
   a. **Yes.** Go to Test 5.
   b. **No.** Go to Test 7.

5. Start Switch Circuit Short to Voltage Test

1. Turn IGN OFF, disconnect [22].
2. Turn IGN ON, test for voltage at [22B] terminal 6.
3. Is voltage present?
   a. **Yes.** Repair short to voltage between [22B] terminal 6 and [62B] socket terminal U (BK/R) wire. **(5041)**
   b. **No.** Go to Test 6.

6. Start Switch Test

1. Test for continuity between [22A] terminal 4 (W/BK) wire and terminal 6 (BK/R) wire.
2. Is continuity present?
   a. **Yes.** Replace start switch. See the service manual. **(5818)**
   b. **No.** Repair short to voltage on [22A] terminal 6 (BK/R) wire. **(5041)**

7. Start Relay Test

1. Perform relay test. See 1.3 DIAGNOSTICS AND TROUBLESHOOTING, Relay Diagnostics.
2. Is the start relay good?
   a. **Yes.** Perform wiggle test to locate short to voltage between [62B] socket terminals K (GN) wire or E (R/BK) wire. See 1.3 DIAGNOSTICS AND TROUBLESHOOTING, Wiggle Test. **(5041)**
   b. **No.** Replace start relay. **(5832)**

NOTHING CLICKS

PART NUMBER	TOOL NAME
HD-41404-B	HARNESS CONNECTOR TEST KIT
HD-42682	BREAKOUT BOX

Table 3-7. Nothing Clicks Diagnostic Faults

POSSIBLE CAUSES
Low battery
Open fuse
Open ignition switch feed circuit
Start switch malfunction
Start relay malfunction
TSM/TSSM/HFSM malfunction
Ignition switch malfunction
Open ignition circuit
Open start switch circuit
Neutral switch malfunction
Open neutral circuit
Clutch switch malfunction
Open clutch switch circuit
Engine stop switch malfunction
Open ignition circuit
Open security circuit

NOTE

Verify that vehicle is in neutral and that the key fob is present and in working order (if security equipped) and that the engine stop switch is in RUN position.

1. Battery Test

1. Verify battery condition. See 3.1 BATTERY TESTING.
2. Is battery condition good?
   a. **Yes.** Go to Test 2.
   b. **No.** Charge or replace battery as needed, attempt to start engine, if nothing clicks continues. Go to Test 2.

2. Fuse Test

1. Verify that all fuses, including main fuse are good.
2. Are all fuses good?
   a. **Yes.** Go to Test 3.
   b. **No.** Replace fuse and repair circuit accordingly. If problem is still present, then continue with tests. Go to Test 3.

3. Ignition Circuit Test

1. With IGN ON, verify that ignition circuit is working properly.
2. Do lights illuminate?
   a. **Yes.** Go to Test 6.
   b. **No.** Go to Test 4.

4. Ignition Switch Supply Voltage Test

1. With IGN OFF, disconnect ignition switch [33].
2. Using HARNESS CONNECTOR TEST KIT (Part No. HD-41404-B) and multimeter, test for battery voltage at ignition switch [33B] terminal B (R) wire.
3. Is battery voltage present?
   a. **Yes.** Go to Test 5.
   b. **No.** Repair open between ignition switch [33B] terminal B and main fuse [5B] terminal A (R) wire. **(5041)**

5. Ignition Switch Test

1. With IGN ON, test for continuity between ignition switch [33A] terminals B+ and IGN.
2. Is continuity present?
   a. **Yes.** Repair open in (R/BK) wire from [33B] terminal A. **(5041)**
   b. **No.** Replace ignition switch. See the service manual. **(7287)**

6. Start Switch Circuit Voltage Test

1. With IGN OFF, remove start relay.
2. Turn IGN ON.
3. While pressing the start switch, using HARNESS CONNECTOR TEST KIT (Part No. HD-41404-B) and a multimeter, test for battery voltage at [62B] socket terminal U (BK/R) wire.
4. Is battery voltage present?
   a. **Yes.** Go to Test 9.
   b. **No.** Go to Test 7.

7. Start Switch Test

1. Turn IGN OFF and disconnect [22].

2. With the start switch pressed, test for continuity between [22A] terminals 6 (BK/R) wire and 4 (W/B) wire.
3. Is continuity present?
   a. **Yes.** Go to Test 8.
   b. **No.** Replace the start switch. See the service manual. **(5818)**

8. Start Switch Circuit Continuity Test

1. Test for continuity between [22B] terminal 6 and [62B] socket terminal U (BK/R) wire.
2. Is continuity present?
   a. **Yes.** Go to Test 15.
   b. **No.** Repair open between [22B] terminal 6 and [62B] socket terminal U (BK/R) wire. **(5041)**

9. Start Relay Control Circuit Test

1. Test for continuity between [62B] socket terminal S (TN/GN) wire and ground.
2. Is continuity present?
   a. **Yes.** Replace start relay. See the service manual. If problem is still present, go to 3.2 STARTING SYSTEM, Start Relay Clicks. **(5832)**
   b. **No.** Go to Test 10.

10. Start Relay Control Circuit Open Test

1. Connect BREAKOUT BOX (Part No. HD-42682) between wire harness [30B] and TSM/TSSM/HFSM [30A]. See 1.2 DIAGNOSTIC TOOLS.
2. Test for continuity between [62B] socket terminal S and breakout box terminal 9 (TN/GN) wire.
3. Is continuity present?
   a. **Yes.** Go to Test 11.
   b. **No.** Repair open between [62B] socket terminal S and TSM/TSSM/HFSM [30B] terminal 9 (TN/GN) wire. **(5041)**

11. TSM/TSSM/HFSM Ground Test

1. Test for continuity between breakout box terminal 12 (BK) wire and ground.
2. Is continuity present?
   a. **Yes.** Go to Test 12.
   b. **No.** Repair open between TSM/TSSM/HFSM [30B] terminal 12 and GND 1 (BK/GN) wire. **(5041)**

12. Continuity at Neutral Switch Test

1. Verify that transmission is in neutral.
2. Measure for resistance between breakout box terminal 4 (TN) wire and ground.
3. Is resistance less than 10 Ohms?
   a. **Yes.** Go to Test 14.
   b. **No.** Go to Test 13.

13. Neutral Switch Ground Circuit Test

1. Test for continuity between neutral switch [131] (BK) wire and ground.
2. Is continuity present?
   a. **Yes.** Replace neutral switch. See the service manual. **(5157)**
   b. **No.** Repair open between neutral switch [131] and GND 2 (BK) wire. **(5041)**

14. Start Relay Coil Control Circuit Short to Voltage Test

1. Turn IGN ON.
2. Test for battery voltage on breakout box terminal 9.
3. Is battery voltage present?
   a. **Yes.** Repair short to voltage between TSM/TSSM/HFSM [30B] terminal 9 and [62B] socket terminal S on (TN/GN) wire. **(5041)**
   b. **No.** Replace TSM/TSSM/HFSM. See the service manual. **(5838)**

15. Engine Stop Switch Voltage Test

1. Test for voltage between [22B] terminal 3 and ground.
2. Is battery voltage present?
   a. **Yes.** Replace engine stop switch. See the service manual.
   b. **No.** Repair open between ignition fuse and [22B] (GY) wire.

START RELAY CLICKS

PART NUMBER	TOOL NAME
HD-41404-B	HARNESS CONNECTOR TEST KIT

Table 3-8. Start Relay Clicks Diagnostic Faults

POSSIBLE CAUSES
Low battery
Starter solenoid malfunction
Open starter solenoid control circuit
Open start solenoid ground circuit

1. Battery Test

1. Verify battery condition. See 3.1 BATTERY TESTING.
2. Is battery condition good?
   a. **Yes.** Go to Test 2.
   b. **No.** Charge or replace battery as needed, attempt to start engine, if start relay continues to click and starter does not engage. Go to Test 2.

2. Starter Solenoid Control Coil Voltage Test

1. With IGN OFF, disconnect [128].
2. Turn IGN ON.

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3. Using HARNESS CONNECTOR TEST KIT (Part No. HD-41404-B) and a multimeter, test for battery voltage on [128B] terminal 1 (GN) wire.
4. Is battery voltage present when start switch is pressed?
   a. **Yes.** Replace starter solenoid. See the service manual. **(5845)**
   b. **No.** Go to Test 3.

3. Starter Solenoid Control Coil Continuity Test

1. Turn IGN OFF and remove start relay.
2. Test for continuity between [128B] terminal 1 and [62B] socket terminal K (GN) wire.
3. Is continuity present?
   a. **Yes.** See 1.3 DIAGNOSTICS AND TROUBLESHOOTING, Relay Diagnostics. If relay tests good, then continue tests. Go to Test 4.
   b. **No.** Repair open between [128B] terminal 1 and [62B] socket terminal K (GN) wire. **(5041)**

4. Start Solenoid Wiring Inspection Test

1. Inspect for corrosion or damage to the wiring from [128A] to starter solenoid.
2. Are there any problems?
   a. **Yes.** Repair damage or replace starter solenoid. See the service manual. If problem is still present, then continue with test. Go to Test 5. **(5845)**
   b. **No.** Go to Test 5.

5. Starter Solenoid Test

1. With IGN ON, press the start switch.
2. Does starter solenoid click?
   a. **Yes.** Go to 3.2 STARTING SYSTEM, Starter Solenoid Clicks.
   b. **No.** Repair open in [62B] socket terminal E (R/BK) wire.

STARTER SOLENOID CLICKS

Table 3-9. Starter Solenoid Clicks Diagnostic Faults

POSSIBLE CAUSES
Low battery
Starter malfunction
Starter solenoid malfunction
Open battery cable
Open starter cable
Mechanical binding

1. Battery Test

1. Verify battery condition. See 3.1 BATTERY TESTING.
2. Is battery condition good?
   a. **Yes.** Go to Test 2.
   b. **No.** Charge or replace battery as needed, attempt to start engine, if starter solenoid continues to click and starter does not engage. Go to Test 2.

2. Starter Voltage Test

1. With IGN ON, test for battery voltage at starter solenoid terminal 2 (BK) wire.
2. Is battery voltage present when start switch is pressed?
   a. **Yes.** Go to Test 3.
   b. **No.** Go to Test 4.

3. Starter Ground Test

1. Remove starter attaching bolts.
2. Clean bolts and starter base, install starter bolts. See the service manual.
3. Does engine crank?
   a. **Yes.** Engine cranks at normal speed.
   b. **Yes.** Engine cranks, but at a slower speed. See 3.3 TESTING STARTER ON MOTORCYCLE, Starter Current Draw Test.
   c. **No.** Replace starter. See the service manual. **(5817)**

4. Starter Stud Voltage Drop Test

1. Perform voltage drop tests from battery (+) to starter stud on starter (BK) wire. See 1.3 DIAGNOSTICS AND TROUBLESHOOTING, Voltage Drop.
2. Is voltage drop greater than 1.0V?
   a. **Yes.** Go to Test 5.
   b. **No.** Go to Test 7.

5. Starter Solenoid Voltage Drop Starter Side Test

1. Perform voltage drop test from battery (+) terminal to starter solenoid terminal 2 (BK) wire.
2. Is voltage drop greater than 1.0V?
   a. **Yes.** Go to Test 6.
   b. **No.** Replace starter solenoid. **(5845)**

6. Starter Solenoid Battery Side Voltage Drop Test

1. Perform voltage drop test from battery (+) terminal to starter solenoid terminal 1 (BK) wire.
2. Is voltage drop greater than 1.0V?
   a. **Yes.** Repair or replace (BK) wire from starter solenoid terminal 1 to battery (+) terminal. **(5041)**
   b. **No.** Replace starter solenoid. See the service manual. **(5845)**

7. Starter Ground Circuit Voltage Drop Test

1. Perform voltage drop test from battery (-) terminal to GND 2.
2. Is voltage drop greater than 1.0V?
   a. **Yes.** Repair or replace (BK) wire from battery (-) terminal. **(5041)**
   b. **No.** Go to Test 8.

8. Starter Draw Test

1. Perform Starter Current Draw Test on motorcycle. See 3.3 TESTING STARTER ON MOTORCYCLE, Starter Current Draw Test.
2. Perform Starter Motor Free Running Current Draw Test (on bench). See 3.4 TESTING STARTER ON BENCH, Free Running Current Draw Test.
3. Are test results within range?
   a. **Yes.** Go to Test 9.
   b. **No.** Replace starter. See the service manual. **(5817)**

9. Mechanical Binding Test

1. Remove spark plugs and place transmission in 5th gear.
2. Raise vehicle.
3. Rotate rear wheel.
4. Check for engine binding in the primary and/or crankshaft or starter clutch.
5. Is engine binding?
   a. **Yes.** Repair as needed. See the service manual. (Use appropriate code).
   b. **No.** Replace starter solenoid. See the service manual. **(5845)**

STARTER SPINS BUT DOES NOT ENGAGE

Table 3-10. Starter Spins But Does Not Engage Diagnostic Faults

POSSIBLE CAUSES
Clutch sub-assembly
Clutch shell and sprocket
Idler gear

1. Pinion Gear and Clutch Shell Test

1. Remove primary cover.
2. Inspect for damage to starter pinion gear and clutch shell and sprocket.
3. Is damage present?
   a. **Yes.** Replace the clutch sub-assembly or clutch shell and sprocket. See the service manual. **(5825)**
   b. **No.** Replace the clutch sub-assembly and idler gear. See the service manual. **(5837)**

STARTER STALLS OR SPINS TOO SLOWLY

Table 3-11. Starter Stalls or Spins Too Slowly Diagnostic Faults

POSSIBLE CAUSES
Low battery
Starter malfunction
Starter solenoid malfunction
Poor connections at starter ground
Open battery cable
Open starter cable

1. Battery Test

1. Verify battery condition. See 3.1 BATTERY TESTING.
2. Is battery condition good?
   a. **Yes.** Go to Test 2.
   b. **No.** Charge or replace battery as needed. If symptom is still present, then continue with tests. Go to Test 2.

2. Starter Stud Voltage Drop Test

1. Perform voltage drop test from battery (+) terminal to starter stud on starter (BK) wire. See 1.3 DIAGNOSTICS AND TROUBLESHOOTING, Voltage Drop.
2. Is voltage drop greater than 1.0V?
   a. **Yes.** Go to Test 5.
   b. **No.** Go to Test 3.

3. Starter Ground Circuit Voltage Drop Test

1. Perform voltage drop test between battery (-) terminal and starter attaching bolts.
2. Is voltage drop greater than 1.0V?
   a. **Yes.** Clean ground connections. **(5041)**
   b. **No.** Go to Test 4.

4. Starter Draw Test

1. Perform Starter Current Draw Test on motorcycle. See 3.3 TESTING STARTER ON MOTORCYCLE, Starter Current Draw Test.
2. Perform Starter Motor Free Running Current Draw Test (on bench). See 3.4 TESTING STARTER ON BENCH, Free Running Current Draw Test.
3. Are test results within range?
   a. **Yes.** With the spark plugs removed and the transmission in 5th gear, rotate rear wheel. Check for engine, primary and/or crankshaft bind. (Use appropriate code)
   b. **No.** Replace starter. See the service manual. **(5817)**

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5. Starter Solenoid Voltage Drop Starter Side Test

1. Perform voltage drop test between battery (+) terminal to starter solenoid terminal 2.
2. Is voltage drop greater than 1.0V?
   a. **Yes.** Go to Test 6.
   b. **No.** Repair connection or (BK) wire between starter solenoid and starter. **(5041)**

6. Starter Solenoid Battery Side Voltage Drop Test

1. Perform voltage drop test between battery (+) terminal and starter solenoid terminal 1 (R) wire.
2. Is voltage drop greater than 1.0V?
   a. **Yes.** Repair or replace connection between battery (+) terminal and starter solenoid terminal 1 (R) wire. **(5041)**
   b. **No.** Repair or replace starter solenoid. See the service manual. **(5845)**

DIGITAL TECHNICIAN® II HARLEY-DAVIDSON®

TESTING STARTER ON MOTORCYCLE 3.3

STARTER CURRENT DRAW TEST

PART NUMBER	TOOL NAME
HD-41404-B	HARNESS CONNECTOR TEST KIT

NOTES

- *Engine temperature should be stable and at room temperature.*
- *Battery should be fully charged.*

Check starter current draw with an induction ammeter before disconnecting battery. Proceed as follows:

1. Verify that transmission is in neutral and engine stop switch is in OFF position.
2. Remove start relay.
3. Using HARNESS CONNECTOR TEST KIT (Part No. HD-41404-B), connect patch cord to [62B] socket terminals K and E.
4. Clamp induction ammeter over positive starter cable to starter solenoid.

NOTE

In next step with engine stop switch in OFF position and purple male probes connected to the [62B] terminals K and E in place of the start relay, starter will turn but engine will not start. This configuration also prevents diagnostic trouble codes from being set.

5. With IGN ON, read the ammeter. Disregard initial high current reading which is normal when engine is first turned over.
   a. Typical starter current draw will range between 160-200A.
   b. If starter current draw exceeds 250A, then the problem may be in the starter or starter drive. See 3.4 TESTING STARTER ON BENCH, Free Running Current Draw Test.

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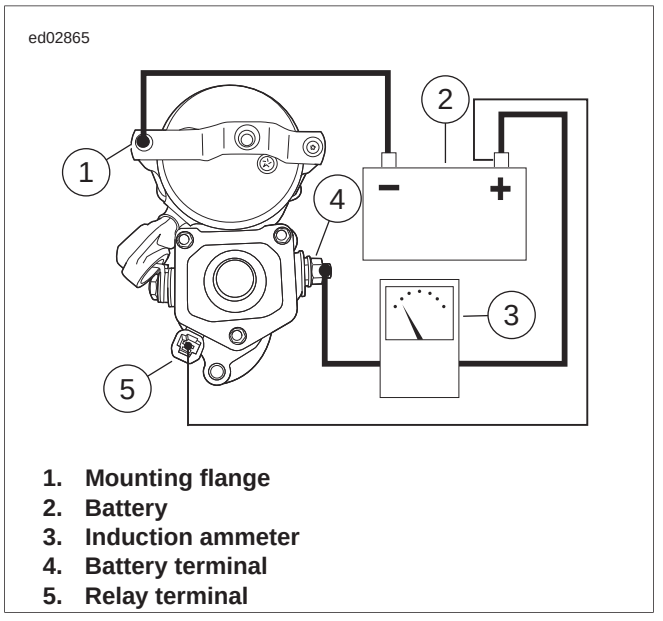
TESTING STARTER ON BENCH 3.4

FREE RUNNING CURRENT DRAW TEST

1. Place starter in vise, using a clean shop towel to prevent scratches or other damage.
2. See Figure 3-5. Attach one heavy jumper cable (6 gauge minimum).
   a. Connect one end to the starter mounting flange.
   b. Connect the other end to the battery (-) terminal of a fully charged battery.
3. Connect a second heavy jumper cable (6 gauge minimum).
   a. Connect one end to the battery (+) terminal of the battery.
   b. Connect the other end to the battery terminal on the starter. Place an induction ammeter over cable.
4. Connect a smaller jumper cable (14 gauge minimum).
   a. Connect one end to the positive (+) terminal of the battery.
   b. Connect the other end to the solenoid relay terminal.
5. Check ammeter reading.
   a. Ammeter should show 90A max.
   b. If reading is higher, repair or replace starter motor. See the service manual.
   c. If starter current draw on vehicle was over 120A and this test was within specification, there may be a problem with engine or primary drive.



1. **Mounting flange**
2. **Battery**
3. **Induction ammeter**
4. **Battery terminal**
5. **Relay terminal**

Figure 3-5. Free Running Current Draw Test

STARTER SOLENOID

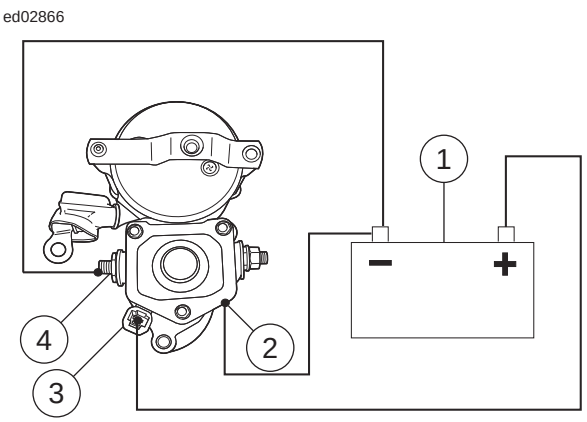
Do not disassemble solenoid. Before testing, disconnect field wire from motor terminal as shown in Figure 3-6.

Each test should be performed for only 3-5 seconds to prevent damage to solenoid.

The solenoid Pull-in, Hold-in, and Return tests must be performed together in one continuous operation. Conduct all three tests one after the other in the sequence given without interruption.

SOLENOID PULL-IN TEST

1. See Figure 3-6. Using a 12 volt battery, connect three separate test leads as follows:
   a. Solenoid housing to negative battery post.
   b. Solenoid motor terminal to negative battery post.
   c. Solenoid relay terminal to positive battery post.
2. Observe starter shaft.
   a. If starter shaft extends strongly, solenoid is working properly.
   b. If starter shaft does not extend strongly, replace the solenoid.

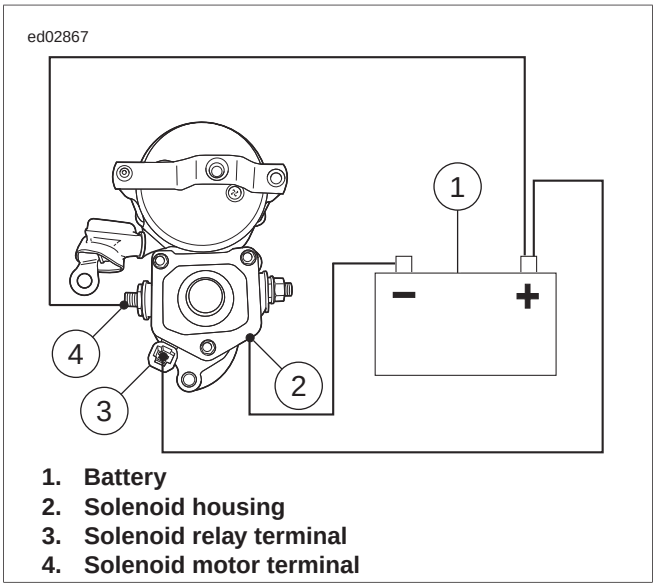


1. **Battery**
2. **Solenoid housing**
3. **Solenoid relay terminal**
4. **Solenoid motor terminal**

Figure 3-6. Pull-In Test

SOLENOID HOLD-IN TEST

1. See Figure 3-7. With test leads still connected in the manner specified in the previous 3.4 TESTING STARTER ON BENCH, Solenoid Pull-In Test, disconnect solenoid motor terminal/battery negative test lead at negative battery post only; reconnect loose end of this test lead to positive battery post instead.
2. Observe starter shaft.
   a. If starter shaft remains extended, solenoid is working properly.
   b. If starter shaft retracts, replace the solenoid.

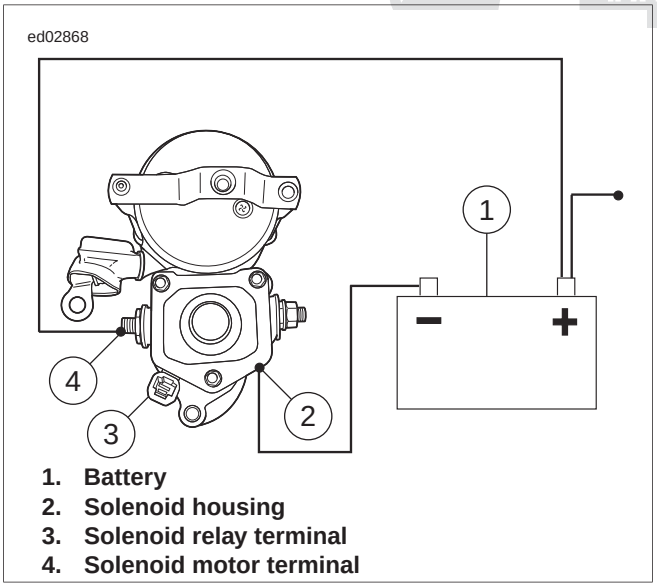


1. **Battery**
2. **Solenoid housing**
3. **Solenoid relay terminal**
4. **Solenoid motor terminal**

Figure 3-7. Hold-In Test

SOLENOID RETURN TEST

1. See Figure 3-8. With test leads still connected in the manner specified at the end of 3.4 TESTING STARTER ON BENCH, Solenoid Hold-In Test, disconnect solenoid relay terminal/positive battery post test lead at either end.
2. Observe starter pinion.
   a. If starter shaft retracts, solenoid is working properly.
   b. If starter shaft does not retract, replace the solenoid.



1. **Battery**
2. **Solenoid housing**
3. **Solenoid relay terminal**
4. **Solenoid motor terminal**

Figure 3-8. Return Test

ARMATURE TEST

Armature

1. Remove armature and brush holder from field coil. See the service manual.
2. Place armature in lathe or truing stand and check runout of commutator. Commutators with more than 0.015 in. (0.38 mm) of runout should be replaced or machined on a lathe. Commutators should be replaced when diameter is less than 1.141 in. (29.98 mm).
3. Check depth of mica on commutator. If undercut is less than 0.008 in. (0.20 mm), use an undercutting machine to undercut the mica to 1/32 in. (0.79 mm) deep. The slots should then be cleaned to remove any dirt or copper dust.

NOTES

- *See Figure 3-9. If an undercutting machine is not available, undercutting can be done satisfactorily using a thin hacksaw blade. After undercutting, lightly sand the armature with crocus cloth to remove any burrs.*
- *Do not use sandpaper or emery cloth on commutator. The abrasive grit may remain on commutator segments and could cause excessive brush wear.*

4. See Figure 3-10. Check for a SHORTED ARMATURE.
   a. Place armature on growler.
   b. Hold a thin steel strip (hacksaw blade), against the armature core and slowly turn armature.
   c. A shorted armature will cause the steel strip to vibrate and be attracted to the core. Replace the armature if shorted.
5. See Figure 3-11. Check for a GROUNDED ARMATURE with an ohmmeter or continuity tester.
   a. Touch one probe to any commutator segment.
   b. Touch the other probe to the armature core.
   c. There should be no continuity (infinite ohms). If there is continuity, the armature is grounded. Replace a grounded armature.
6. See Figure 3-12. Check for an OPEN ARMATURE with an ohmmeter or continuity tester.
   a. Check for continuity between all commutator segments.
   b. There should be continuity (0 ohms) at all test points. If there is no continuity at any test point, then the armature is open. Replace an open armature.

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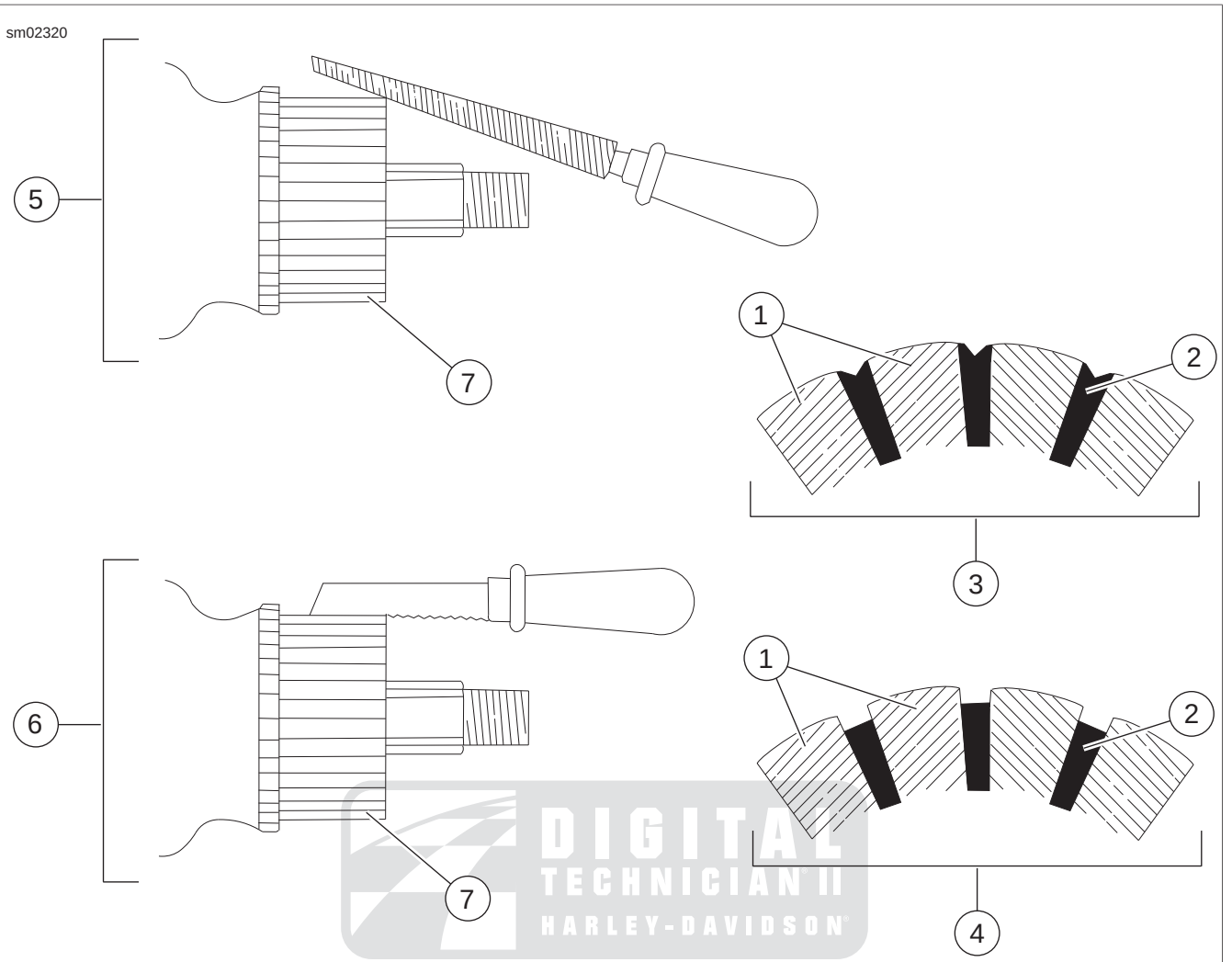

1. **Segments**
2. **Mica**
3. **Incorrect (Mica must not be left with a thin edge next to segments)**
4. **Correct (Mica must be cut away clean between segments)**
5. **Starting groove in mica with 3 cornered file**
6. **Undercutting mica with piece of hacksaw blade**
7. **Commutator**

Figure 3-9. Undercutting Mica Separators

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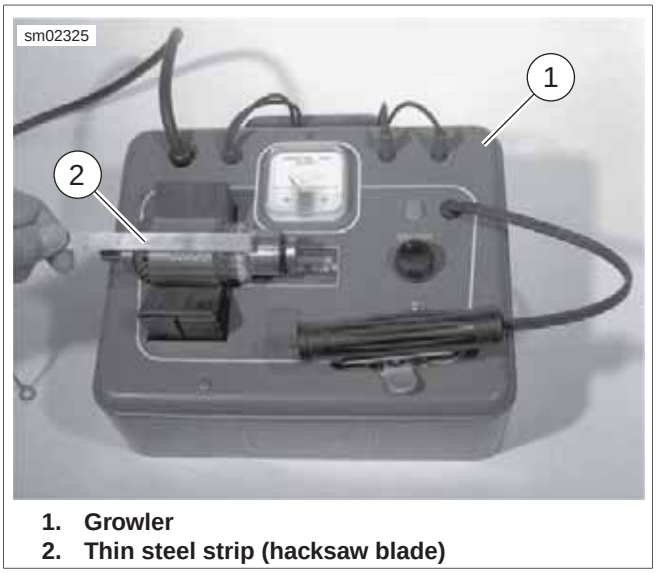

1. **Growler**
2. **Thin steel strip (hacksaw blade)**

Figure 3-10. Shorted Armature Test Using Growler

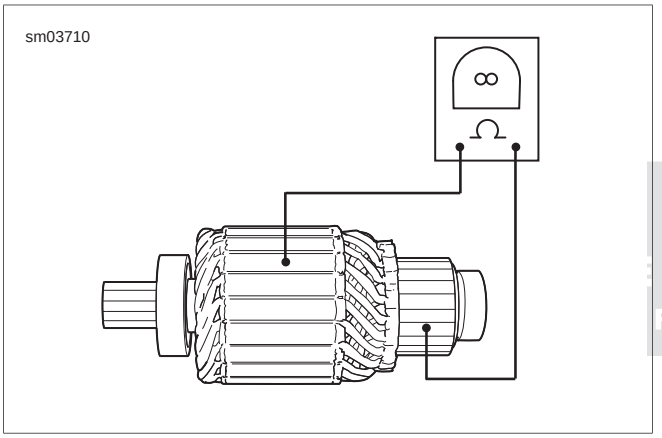

Figure 3-11. Grounded Armature Test

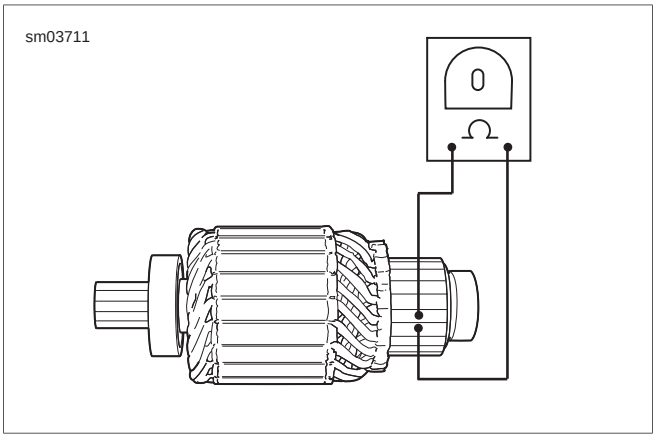

Figure 3-12. Armature Open Test

Brushes and Brush Holder

1. Remove armature and brush holder from field coil. See the service manual.
2. Measure the brush length. If any one of four brushes is less than 0.433 in. (11 mm), replace the field coil and brush holder assembly. No further testing is necessary.
3. See Figure 3-13. Check for a GROUNDED FIELD COIL WINDING with an ohmmeter or continuity tester.
   a. Touch one probe to the field coil housing (frame).
   b. Touch the other probe to each of two brushes attached to the field coil winding.
   c. There should be no continuity (infinite ohms). If there is continuity at either brush, then the field coil winding is grounded. Replace the field coil/brush holder assembly if grounded.
4. See Figure 3-14. Check for an OPEN FIELD COIL WINDING with an ohmmeter or continuity tester.
   a. Touch one probe to the field wire.
   b. Touch the other probe to each of the two brushes attached to the field coil winding(s).
   c. There should be continuity (0 ohms). If there is no continuity at either brush, then the field coil winding(s) are open. Replace the field coil/brush holder assembly if open.
5. See Figure 3-15. Test the BRUSH HOLDER INSULATION with an ohmmeter or continuity tester.
   a. Touch one probe to the holder plate.
   b. Touch the other probe to each of the positive (insulated) brush holders.
   c. There should be no continuity (infinite ohms). If there is continuity at either brush holder, replace the field coil/brush holder assembly.
   d. Touch one probe to the non-insulated brush holders and the other probe to the holder plate. If any resistance is measured, replace the field coil/brush holder assembly.

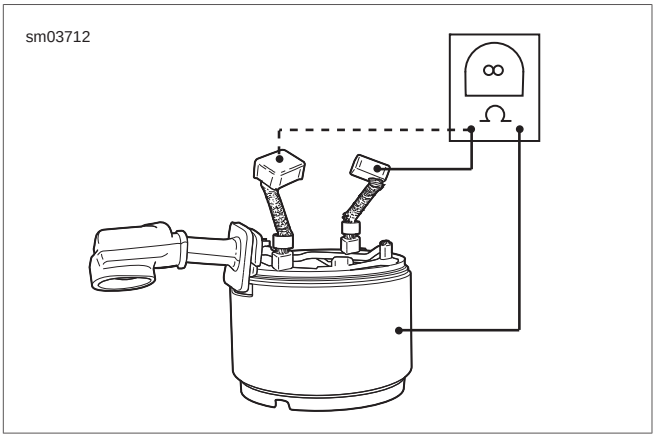

Figure 3-13. Grounded Field Test

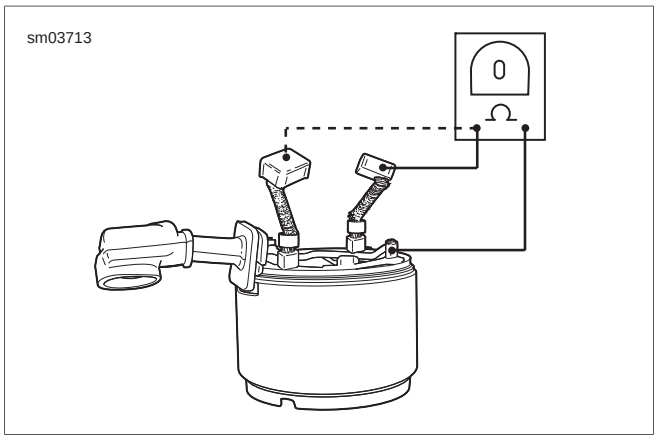

Figure 3-14. Open Field Test

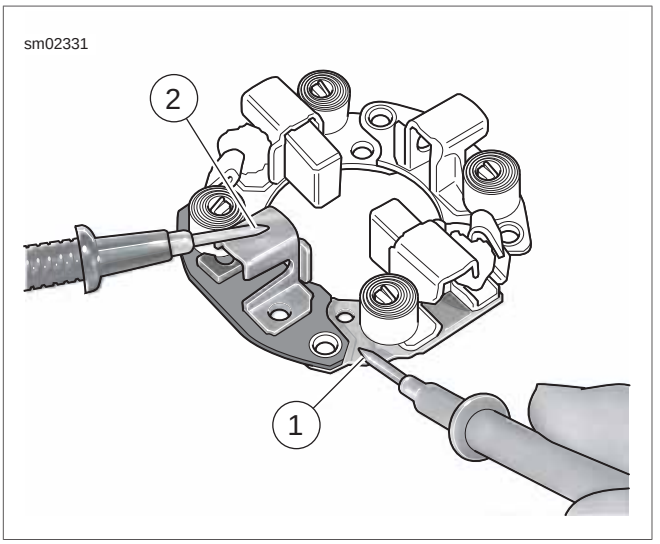

Figure 3-15. Brush Holder Insulation Test

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CHARGING SYSTEM 3.5

DESCRIPTION AND OPERATION

The charging system is the source of electric current that supplies power to run the ignition, lights, accessories, and charge the battery. AC voltage is generated by an alternator assembly driven by the crankshaft. A rotor supplied with a magnetic field spins around a stator with a full field winding. A rectifier (located in the regulator) converts the voltage from AC to DC. A regulator ensures that the output voltage is properly matched to the battery voltage as engine speed varies. Even though the alternator provides additional voltage at all engine speeds, it is not recommended to idle the vehicle for long periods of time.

Alternator

The alternator consists of two main components:

- The rotor which mounts to the primary side of the crankshaft.
- The stator which is attached to the crankcase half.

Voltage Regulator

See Figure 3-16. The voltage regulator is a series regulator. The circuit combines the functions of rectifying and regulating.

TROUBLESHOOTING

When the charging system fails to charge or does not charge at a satisfactory rate, make the following recommended checks.

Battery

Test for a weak or dead battery. See 3.1 BATTERY TESTING for battery testing procedures. Battery must be fully charged in order to perform a load test, or starting or charging tests.

Wiring

The stator connections must be clean and tight.

Check for corroded or loose connections in the charging system circuit.

Voltage Regulator Inspection

The voltage regulator must have clean, tight connections for proper operation. Insure both AC and DC connectors are fully inserted and locked with the regulator latch.

Job/Time Code Values

Dealership Technicians filing warranty claims should use the job/time code values printed in **bold text** next to the appropriate repair.

Connector Information

For additional information about the connectors in the following diagram(s) and diagnostic procedure(s), including the color of the harness test kit terminal probes, see B.1 CONNECTORS.

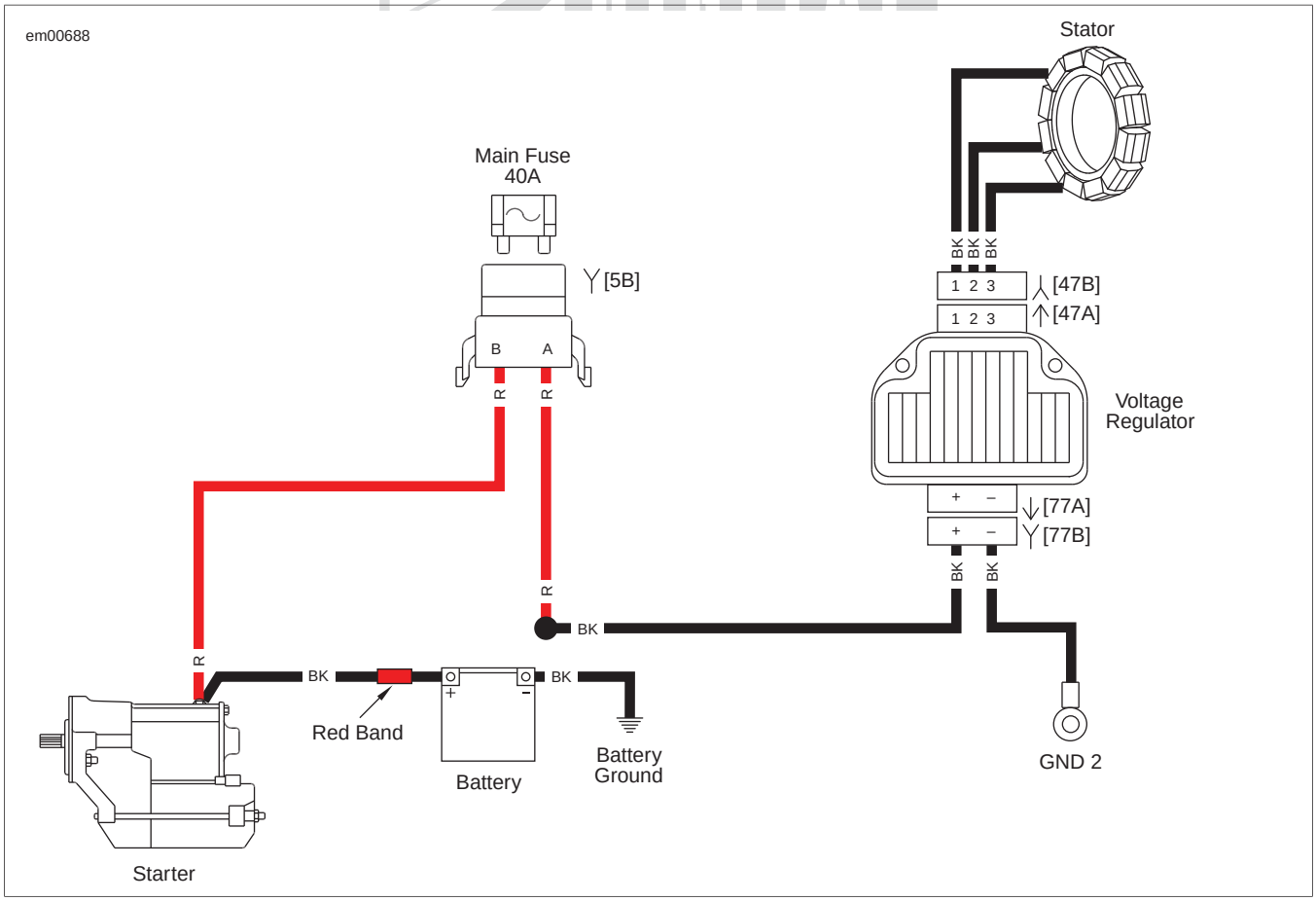

Figure 3-16. Charging System Circuit

LOW OR NO CHARGING

Table 3-12. Low or No Charging Diagnostic Faults

POSSIBLE CAUSES
Low battery
Stator malfunction
Rotor malfunction
Voltage regulator malfunction
Open voltage regulator circuit

1. Battery Test

1. Verify battery condition. See 3.1 BATTERY TESTING.
2. Is battery condition good?
   a. **Yes.** Go to Test 2.
   b. **No.** Charge or replace battery as needed. Verify repair.

NOTE

A discharged battery may show a reading under 13V even though the charging system is working properly.

2. Off Idle Voltage Test

1. With the vehicle is neutral, start engine and run at 3000 RPM.
2. Test battery voltage.
3. Is voltage above 13V?
   a. **Yes.** Charging system working properly.
   b. **No.** Go to Test 3.

3. AC Output Test

1. Perform an AC output test. See 3.5 CHARGING SYSTEM, Battery Charging Tests.
2. Did the output test pass?
   a. **Yes.** Go to Test 6.
   b. **No.** Go to Test 4.

4. Stator Test

1. Perform a stator test. See 3.5 CHARGING SYSTEM, Battery Charging Tests.
2. Is the stator good?
   a. **Yes.** Go to Test 5.
   b. **No.** Replace stator. See the service manual. **(5309)**

5. Rotor Inspection Test

1. Inspect the rotor for damage.
2. Remove center bolt and inspect for signs of the center hole becoming oval. See the service manual.
3. Verify that stator bolts have not backed out and contacted the rotor.
4. Is rotor in good condition?
   a. **Yes.** Go to Test 6.
   b. **No.** Replace rotor. See the service manual. **(5319)**

6. Voltage Regulator Ground Circuit Test

NOTE

The voltage regulator ground must have a clean, tight connection for proper grounding.

1. With IGN OFF, disconnect voltage regulator [77].
2. Test for continuity between voltage regulator [77B] terminal - and ground.
3. Is continuity present?
   a. **Yes.** Replace voltage regulator. See the service manual. **(5316)**
   b. **No.** Repair or replace wire between voltage regulator [77B] terminal - and GND 2 (BK) wire. **(5041)**

OVERCHARGING

Table 3-13. Overcharging Diagnostic Faults

POSSIBLE CAUSES
Voltage regulator malfunction
Open voltage regulator circuit

1. Battery Voltage Test

1. With the vehicle in neutral, start engine and run at 3000 RPM, test battery voltage.
2. Is voltage above 15.5V?
   a. **Yes.** Go to Test 2.
   b. **No.** Charging system working properly.

2. Voltage Regulator Ground Circuit Test

NOTE

The voltage regulator ground must have a clean, tight connection for proper grounding.

1. With IGN OFF, disconnect voltage regulator [77].
2. Test for continuity between voltage regulator [77B] terminal - and ground.
3. Is continuity present?
   a. **Yes.** Replace voltage regulator. See the service manual. **(5316)**
   b. **No.** Repair or replace wire between voltage regulator [77B] terminal - and GND 2 (BK) wire. **(5041)**

LOW BATTERY AFTER EXTENDED IGN OFF

Table 3-14. Low Battery After Extended IGN OFF Diagnostic Faults

POSSIBLE CAUSES
Battery
Accessories improperly wired to stay on at all times
Excessive draw from electrical component with IGN OFF
Battery self-discharge and/or component draw because motorcycle was not operated for a long period

1. Battery Test

1. Verify battery condition. See 3.1 BATTERY TESTING.
2. Is battery condition good?
   a. **Yes.** Go to Test 2.
   b. **No.** Charge or replace battery as needed. Verify repair.

2. Amp Draw Test

1. Perform a milliampere draw test. See 3.5 CHARGING SYSTEM, Battery Charging Tests.
2. Did the test exceed maximum draw?
   a. **Yes.** Repair excessive draw, and run test again. **(5308)**
   b. **No.** System is working properly.

BATTERY RUNS DOWN DURING USE

Table 3-15. Battery Runs Down During Use Diagnostic Faults

POSSIBLE CAUSES
Low battery
Excessive accessory draw
Accessories on when idling or low RPM riding for extended period

1. Total Current Draw Test

1. Perform a Total Current Draw and Output Test. See 3.5 CHARGING SYSTEM, Battery Charging Tests.
2. Does charging system exceed current draw by 3.5A?
   a. **Yes.** Go to Test 2.
   b. **No.** System accessory power requirements exceed charging system capability.

2. Battery Test

1. Verify battery condition. See 3.1 BATTERY TESTING.
2. Is battery condition good?
   a. **Yes.** System is working properly.
   b. **No.** Charge or replace battery as needed.

BATTERY CHARGING TESTS

PART NUMBER	TOOL NAME
HD-41404-B	HARNESS CONNECTOR TEST KIT

Milliampere Draw Test

NOTE

Be sure accessories are not wired so they stay on at all times. This condition could drain battery completely if vehicle is parked for a long time. Test for this by connecting ammeter between negative battery terminal and battery.

1. If vehicle is equipped with HFSM, enable service mode before performing test.
2. Disconnect the security siren (if equipped).
3. Remove main fuse.

NOTE

With IGN OFF, an initial current draw of up to 200 mA will occur directly after connecting meter. This should drop to the values shown in table in less than one minute.

4. See Figure 3-17. Using HARNESS CONNECTOR TEST KIT (Part No. HD-41404-B), connect ammeter to main fuse socket terminals. With this arrangement, you will also pick up any regulator drain.
5. With IGN OFF and all lights and accessories off, observe current reading.
   a. Refer to Table 3-16. Add voltage regulator draw to appropriate value for TSM/TSSM/HFSM and ECM. If observed ammeter reading is less than listed in table, draw is within limits.
   b. A higher reading indicates excessive current draw. Any accessories must be considered and checked for excessive drain.

Table 3-16. Milliampere Draw Test

ITEM	MAXIMUM DRAW IN MILLI-AMPERES
Speedometer	1.0
Tachometer (if equipped)	1.0
Regulator	1.0
TSM (non security models)	1.0
TSSM (disarmed)	3.0
TSSM (armed)	3.0
TSSM/HFSM-Storage mode (armed or disarmed)	1.0
HFSM	1.0
ECM	1.0
Security siren (optional)	20.0*
* Siren will draw for 2-24 hours from time motorcycle battery is connected and 0.05 mA once siren battery is charged. Disconnect siren during milliampere draw test.	

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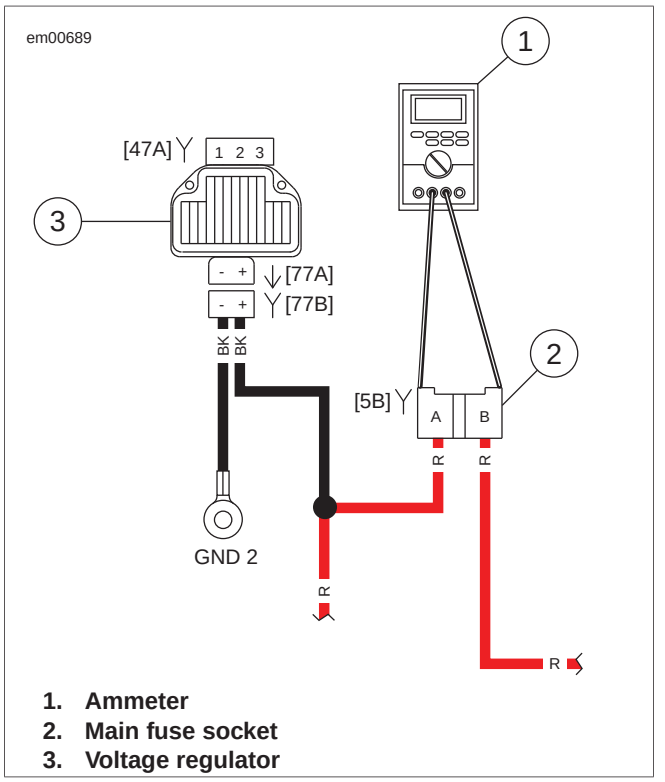


1. **Ammeter**
2. **Main fuse socket**
3. **Voltage regulator**

Figure 3-17. Milliampere Draw Test (Ignition Turned to OFF)

Total Current Draw and Output Test

If battery runs down during use, the current draw of the motorcycle components and accessories may exceed output of the charging system.

NOTE

If a load tester is unavailable, an ammeter with current probe may be used.

WARNING

Turn battery load tester OFF before connecting tester cables to battery terminals. Connecting tester cables with load tester ON can cause a spark and battery explosion, which could result in death or serious injury. (00252a)

1. See Figure 3-18. Connect load tester.
   a. Connect negative and positive leads to battery terminals.
   b. Place load tester induction pickup over battery negative cable.
2. With IGN OFF, disconnect voltage regulator [77].
3. Start engine.
4. Turn all continuously running lights and accessories turned ON (headlamp on high beam).
5. Run engine at 3000 RPM, and make note of the current draw.
6. Turn engine OFF.
7. With IGN OFF, connect voltage regulator [77].
8. Remove the induction pickup from the battery negative cable.
9. Place induction pickup over positive regulator cable.
10. Start engine and run at 3000 RPM.

NOTE

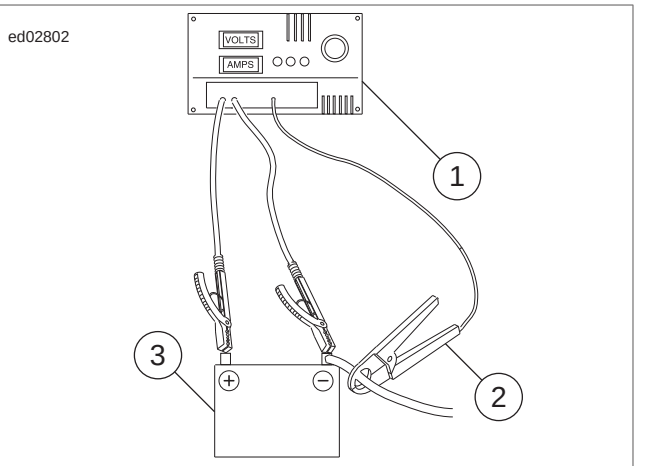
Do not leave any load switch turned on for more than 20 seconds or overheating and tester damage are possible.

11. Increase the load as required to obtain a constant 13.0V.
12. Current output should be 30-50A. Make note of current output.

NOTE

Rider's habits may require output test at lower RPM.

13. Compare both of these readings.
    a. The current output should exceed current draw by 3.5A minimum.
    b. If output does not meet specifications, there may be too many accessories for the charging system to handle.



1. **Load tester**
2. **Induction pickup**
3. **Battery**

Figure 3-18. Check Current Draw (Ignition Switch On)

Stator Test

1. Turn IGN OFF.
2. See Figure 3-19. Connect an ohmmeter.
   a. Disconnect voltage regulator connector from alternator stator wiring.
   b. Insert one ohmmeter lead into a stator connector socket.
   c. Attach the other lead to a suitable ground.
3. Test for continuity.
   a. A good stator will show no continuity (open circuit) between all stator sockets and ground.
   b. Any other reading indicates a grounded stator which must be replaced.

4. See Figure 3-20. Remove ground lead. Measure resistance across stator [47B] terminals 1-2, 2-3 and 3-1.
   a. Resistance across all the stator terminals should be 0.1-0.3 Ohm.
   b. If the resistance is higher, the stator is damaged and must be replaced.
   c. If resistance is lower, the stator may have a turn-to-turn short and should be replaced.

NOTE

When measuring resistance (Ohms), compensate for test lead resistance before performing the measurement. Select the Ohms position and touch the test leads together. Refer to the multimeter user's manual to either zero the display or manually subtract the test lead resistance from the measured circuit's value.

Figure 3-19. Test for Grounded Stator (Typical)

Figure 3-20. Check for Stator Resistance (Typical)

AC Output Test

1. See Figure 3-21. Test AC output.
   a. Disconnect voltage regulator [47] from alternator stator wiring.
   b. Test for VAC across stator [47B] terminals 1 to 2.
   c. Run the engine at 2000 RPM. The VAC output should be 32-46 VAC (approximately 16-22 per 1000 RPM).
   d. Repeat test using terminals 2 to 3 and 1 to 3.
2. Compare test results to specifications.
   a. If the output is below specifications, charging problem could be a faulty rotor or stator.
   b. If output is within specifications, charging problem might be faulty voltage regulator. Replace as required. See the service manual.
3. Check the output again as previously described under Current and Voltage Output Test.

Figure 3-21. Check Stator AC Voltage Output (Typical)

DTC B0563, P0562, P0563 3.6

DESCRIPTION AND OPERATION

Battery voltage is monitored by several modules. If the battery voltage fails to meet normal operating parameters, a DTC is set.

DTC B0563

Battery voltage is monitored by the TSM/TSSM/HFSM on terminal 1. DTC B0563 is displayed when the TSM/TSSM/HFSM exceeds 16.0V for more than 5.0 ±0.5 seconds.

DTC P0562 and P0563

Battery voltage is monitored by the ECM on terminal 13.

- DTC P0562 is displayed when battery voltage is less than 12.2V at idle and voltage does not increase when engine speed is greater than 2000 RPM.
- DTC P0563 is displayed when battery voltage is greater than 15.0V for more than 4 seconds.

Table 3-17. Code Description

DTC	DESCRIPTION
B0563	Voltage high
P0562	Voltage low
P0563	Voltage high

DIAGNOSTICS

Diagnostic Tips

Any of the following conditions could cause these DTCs to set:

- The vehicle is placed on a battery charger, on fast charge, for a long period of time.
- The charging system is malfunctioning
- There is excessive battery draw and/or extended idling in heavy traffic.
- A faulty system ground is present.

Low voltage generally indicates a loose wire, corroded connections, battery and/or a charging system problem.

Connector Information

For additional information about the connectors in the following diagram(s) and diagnostic procedure(s), including the color of the harness test kit terminal probes, see B.1 CONNECTORS.

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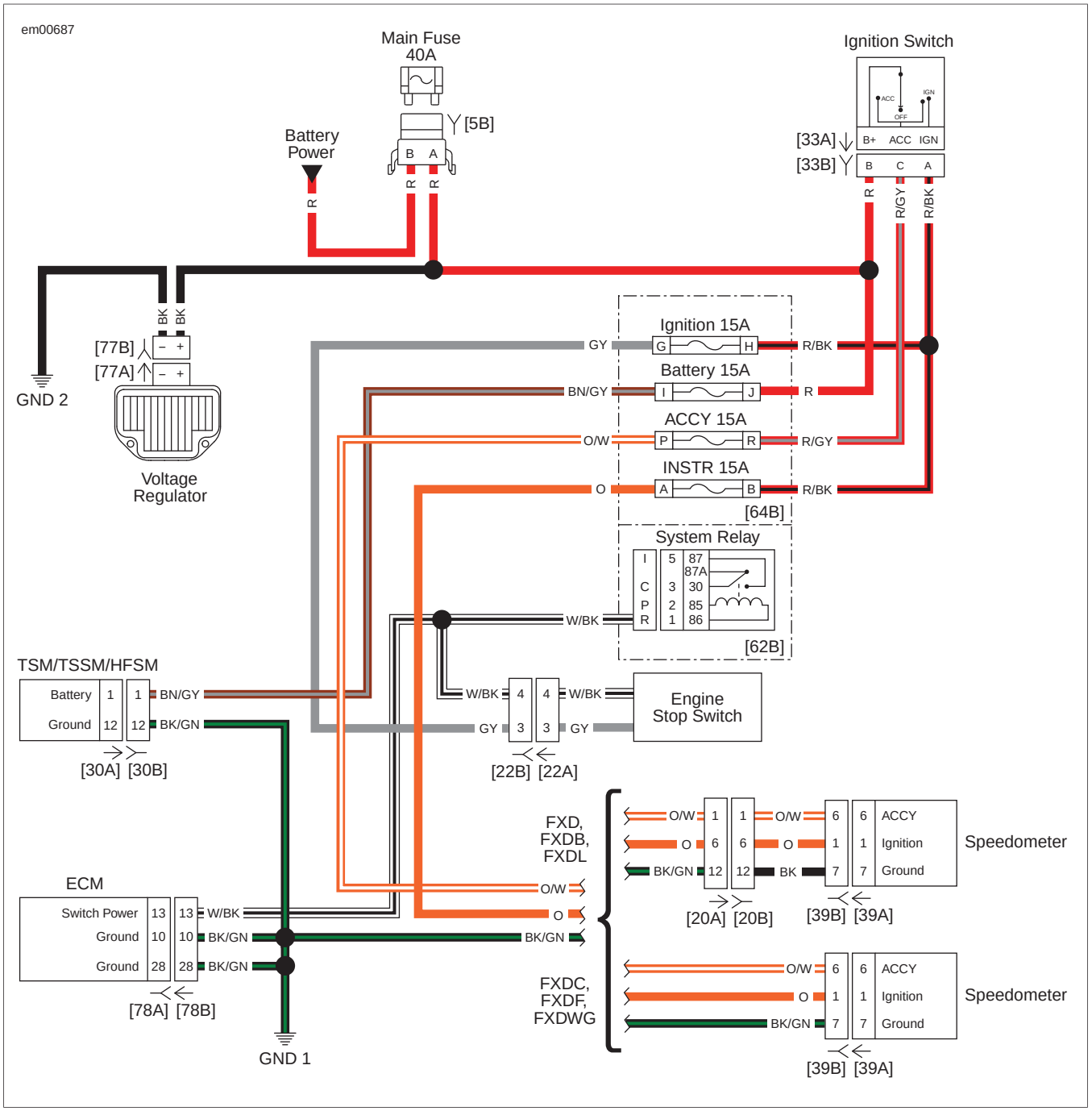

Figure 3-22. High and Low Voltage Sensors

DTC P0562

PART NUMBER	TOOL NAME
HD-41404-B	HARNESS CONNECTOR TEST KIT
HD-43876	BREAKOUT BOX

Table 3-18. DTC P0562 Diagnostic Faults

POSSIBLE CAUSES
Low battery
Ignition switch malfunction
Engine stop switch malfunction
ECM malfunction
Open ECM ground circuit
Open ECM switched power circuit
Open ignition circuit

1. Battery Test

1. Verify battery condition. See 3.1 BATTERY TESTING.
2. Is battery condition good?
   a. **Yes.** Go to Test 2.
   b. **No.** Charge or replace battery as needed. Verify repair.

2. Charging System Test

1. Perform charging system test. See 3.5 CHARGING SYSTEM, Low or No Charging.
2. Is charging system working properly?
   a. **Yes.** Go to Test 3.
   b. **No.** Repair charging system. Go to Test 15.

3. ECM Switched Voltage Test

1. With IGN OFF, connect BREAKOUT BOX (Part No. HD-43876) between wire harness [78A] and ECM [78B]. See 1.2 DIAGNOSTIC TOOLS.
2. With the engine stop switch in the RUN position and the transmission in neutral, turn the IGN ON.
3. Test for voltage on breakout box between terminals 13 and 28.
4. Is battery voltage present?
   a. **Yes.** System is working properly. Go to Test 15.
   b. **No.** Go to Test 4.

4. ECM Switched Voltage Drop Test

1. Perform a voltage drop test between battery (+) terminal and breakout box terminal 13. See 1.3 DIAGNOSTICS AND TROUBLESHOOTING, Voltage Drop.
2. Is voltage drop greater than 0.5V?
   a. **Yes.** Go to Test 6.
   b. **No.** Go to Test 5.

5. ECM Ground Circuit Voltage Drop Test

1. Test for voltage drop test between breakout box terminals 10 and 28 and battery (-) terminal.
2. Is voltage drop greater than 0.5V?
   a. **Yes.** Repair wiring between ECM [78B] terminals 10 and 28 and battery negative.
   b. **No.** Problem may be intermittent. Locate and repair bad connection. Perform 1.3 DIAGNOSTICS AND TROUBLESHOOTING, Wiggle Test. If no problem is found, then continue with tests. Go to Test 15.

6. ECM Switched Power Circuit Resistance Test

1. With IGN OFF, remove system relay.
2. Using HARNESS CONNECTOR TEST KIT (Part No. HD-41404-B) and a multimeter, measure resistance between breakout box terminal 13 and [62B] socket terminal R (W/BK) wire.
3. Is resistance greater than 1 Ohm?
   a. **Yes.** Repair (W/BK) wire between ECM [78B] terminal 13 and [62B] socket terminal R.
   b. **No.** Go to Test 7.

7. Switched Power Circuit Resistance Test

1. Disconnect [22].
2. Measure resistance between [22B] terminal 4 and [62B] socket terminal R (W/BK) wire.
3. Is resistance greater than 1 Ohm?
   a. **Yes.** Repair (W/BK) wire between [22B] terminal 4 and [62B] socket terminal 2.
   b. **No.** Go to Test 8.

8. Ignition Circuit Resistance Test

1. Measure resistance between ignition fuse [62B] socket terminal G and [22B] terminal 3 (GY) wire.
2. Is resistance greater than 1 Ohm?
   a. **Yes.** Repair (GY) wire between [64B] socket terminal G and [22B] terminal 3.
   b. **No.** Go to Test 9.

9. Engine Stop Switch Test

1. Measure resistance between [22A] terminals 4 (GY) wire and 3 (W/BK) wire.
2. Is resistance greater than 1 Ohm?
   a. **Yes.** Replace the engine stop switch assembly. See the service manual.
   b. **No.** Go to Test 10.

10. Ignition Circuit Voltage Drop Test

1. With IGN ON, perform a voltage drop test between battery (+) terminal and [64B] socket terminal H. See 1.3 DIAGNOSTICS AND TROUBLESHOOTING, Voltage Drop.

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2. Is voltage drop greater than 0.5V?
   a. **Yes.** Go to Test 11.
   b. **No.** Go to Test 13.

11. Ignition Circuit Resistance Test

1. With IGN OFF, disconnect ignition switch [33].
2. Measure resistance between ignition switch [33B] terminal A (R/BK) wire and [64B] socket terminal H.
3. Is resistance greater than 1 Ohm?
   a. **Yes.** Repair wire between ignition switch [33B] terminal A (R/BK) wire and [64B] socket terminal H.
   b. **No.** Go to Test 12.

12. Ignition Switch Battery Circuit Voltage Drop Test

1. Perform a voltage drop test between battery (+) terminal and ignition switch [33B] terminal B (R) wire.
2. Is voltage drop greater than 0.5V?
   a. **Yes.** Go to Test 13.
   b. **No.** Replace ignition switch. See the service manual.

13. Battery Voltage to Main Fuse Voltage Drop Test

1. With IGN OFF, remove main fuse.
2. Perform a voltage drop test between battery (+) terminal and main fuse [5B] terminal B (R) wire.
3. Is voltage drop greater than 0.5V?
   a. **Yes.** Repair wire between battery (+) terminal and main fuse [5B] terminal A (R) wire.
   b. **No.** Go to Test 14.

14. Main Fuse to Ignition Switch Resistance Test

1. Measure resistance between main fuse [5B] terminal A and ignition switch [33B] terminal B (R) wire.
2. Is resistance greater than 1 Ohm?
   a. **Yes.** Inspect main fuse for corrosion. If main fuse is good, repair wire between main fuse [5B] terminal A and ignition switch [33B] terminal B (R) wire.
   b. **No.** Go to Test 15.

15. Repair Validation Test

1. Clear DTCs using odometer self-diagnostics. See 2.1 INITIAL DIAGNOSTICS, Odometer Self-Diagnostics.
2. Start vehicle.
3. Run at 3000 RPM for 5 seconds.
4. Does code set?
   a. **Yes.** Replace ECM. See the service manual.
   b. **No.** System working properly.

DTC B0563, P0563

Table 3-19. DTC B0563, P0563 Diagnostic Faults

POSSIBLE CAUSES
Charging system malfunction
TSM/TSSM/HFSM malfunction
ECM malfunction

1. Charging System Test

1. Perform charging system tests. See 3.5 CHARGING SYSTEM.
2. Is charging system good?
   a. **Yes.** Go to Test 2.
   b. **No.** Repair charging system. Go to Test 2.

2. Repair Validation Test

1. Clear DTCs using odometer self-diagnostics. See 2.1 INITIAL DIAGNOSTICS, Odometer Self-Diagnostics.
2. Start vehicle.
3. Run at 3000 RPM for 5 seconds.
4. Does code set?
   a. **Yes.DTC B0563.** Replace TSM/TSSM/HFSM. See the service manual.
   b. **Yes.DTC P0563.** Replace ECM. See the service manual.
   c. **No.** System working properly.

DIGITAL TECHNICIAN II HARLEY-DAVIDSON

DTC B1006, B1007 3.7

DTC B1006, B1007

Description and Operation

Battery voltage is constantly monitored by the speedometer. If the battery voltage fails to meet normal operating parameters, a DTC is set.

DTC B1006 and B1007

The speedometer monitors terminal 1 for ignition power, and terminal 6 for accessory power.

- DTC B1006 is displayed when accessory line voltage is greater than 16.0V for longer than 5 seconds.
- DTC B1007 is displayed when ignition line voltage is greater than 16.0V for longer than 5 seconds.

NOTE

ECM, ECU, and/or TSM/TSSM/HFSM may also set a battery voltage DTC.

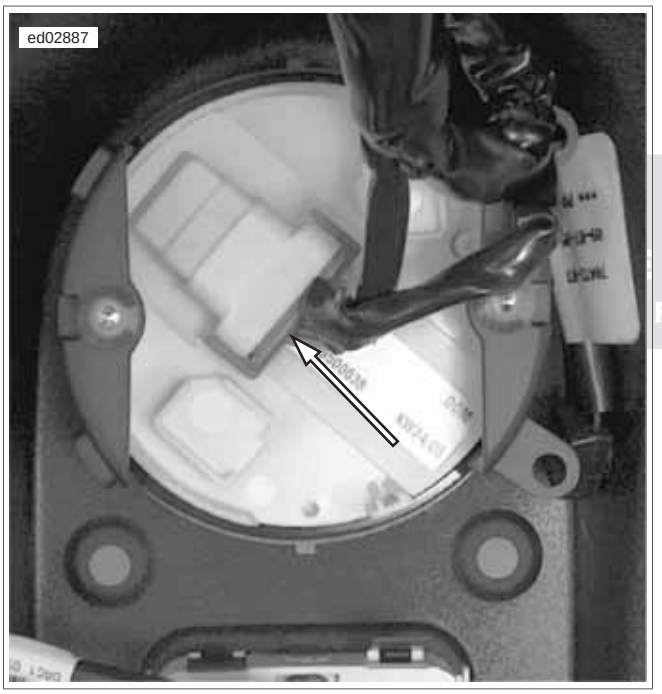

Figure 3-23. Speedometer Connector [39]

Table 3-20. Code Description

DTC	DESCRIPTION
B1006	Accessory line overvoltage
B1007	Ignition line overvoltage

Diagnostic Tips

This DTC may set when the vehicle is placed on a battery charger, on fast charge, for a long period of time.

DTCS B1006 AND B1007

Table 3-21. DTCs B1006 and B1007 Diagnostic Faults

POSSIBLE CAUSES
Charging system malfunction
Speedometer malfunction

1. Charging System Test

1. Perform charging system tests. See 3.5 CHARGING SYSTEM.
2. Is charging system good?
   a. **Yes.** Go to Test 2.
   b. **No.** Repair charging system.

2. Repair Validation Test

1. Clear DTCs using odometer self-diagnostics. See 2.1 INITIAL DIAGNOSTICS, Odometer Self-Diagnostics.
2. Start vehicle.
3. Run at 3000 RPM for 5 seconds.
4. Does code reset?
   a. **Yes.** Replace speedometer. See the service manual.
   b. **No.** System working properly.

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NOTES

INSTRUMENTS 4.1

DESCRIPTION AND OPERATION

See Figure 4-1 and Figure 4-2. The speedometer contains several indicators. These indicators include the check engine, security, low battery, and low fuel lamps. The sixth gear and cruise control indicators my also be shown depending on the model of vehicle.

Trip Odometer Reset Switch Operation

Pressing the trip odometer reset switch provides the following capabilities:

- Change the odometer display between mileage, trip and fuel range values (press and immediately release).
- Reset the trip odometer (press and hold 2-3 seconds).
- Gain access to self-diagnostic mode and clear diagnostic codes. See 2.1 INITIAL DIAGNOSTICS, Odometer Self-Diagnostics.

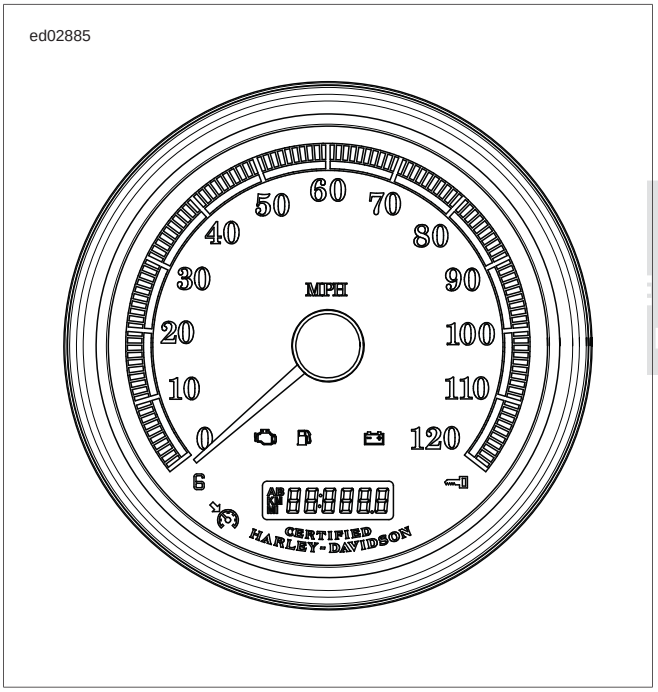

Figure 4-1. Speedometer: FXDC, FXDF

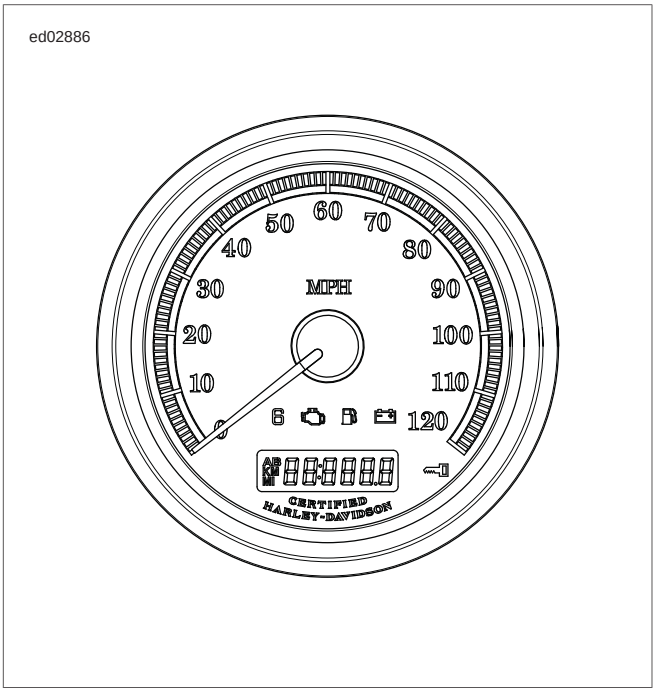

Figure 4-2. Speedometer: FXD, FXDB, FXDL

The odometer mileage is permanently stored and will not be lost when electrical power is turned off or disconnected. The trip odometer reset switch allows switching between the odometer, trip odometer and fuel range displays.

To zero the trip odometer, have the odometer display visible, press and keep the trip odometer reset switch depressed. The trip odometer mileage will be displayed for 2-3 seconds and then the trip mileage will return to zero miles.

The odometer can display six numbers to indicate a maximum of 999999 miles (999999 kilometers). The trip odometer can display six numbers with a tenth of a mile accuracy for a maximum of 999999.9 miles (999999.9 kilometers).

SPEEDOMETER THEORY OF OPERATION

The speed sensor is mounted at the back of the transmission case. The sensor circuitry is a Hall-Effect sensor that is triggered by the gear teeth of 5th gear on the transmission mainshaft.

The output from the sensor is a series of pulses that are interpreted by ECM circuitry, converted into serial data then sent to the speedometer. The speedometer converts the data to control the position of the speedometer needle. It also provides input to the TSM/TSSM/HFSM for turn signal cancellation.

TACHOMETER THEORY OF OPERATION

The tachometer receives serial data from the ECM. The ECM converts the signal from the CKP to serial data and sends it to the tachometer. The tachometer interprets the serial data and converts it into tachometer needle movement.

INSTRUMENT DIAGNOSTICS

The speedometer and tachometer monitor direct inputs from sensors and switches, along with receiving information from the ECM over the serial data line. They set codes when the parameters for the inputs are out of range. These codes begin with a B prefix to separate them from other types of codes.

Table 4-1. Code Description

CODE	DESCRIPTION
B1004	Fuel level sensor low
B1005	Fuel level sensor high/open
B1006	Accessory line overvoltage
B1007	Ignition line overvoltage
B1008	Trip switch closed

Some sensors and switches send direct inputs to the instruments and do not have DTCs associated with them. Therefore, symptoms may occur indicating a fault without any DTCs present.

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DTC B1004, B1005 4.2

DESCRIPTION AND OPERATION

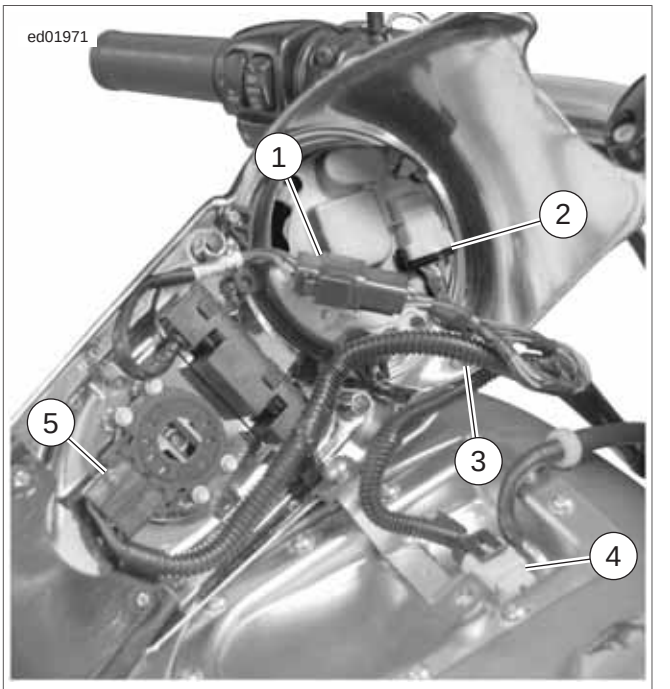
The fuel level is monitored by the speedometer [39] at terminal 9 (Y/W) wire.

- If the voltage on terminal 9 exceeds the lower limit for greater than or equal to 15 seconds a DTC B1004 will be set and the low fuel warning lamp will illuminate.
- If the voltage on terminal 9 exceeds the upper limit (or is open) for greater than or equal to 15 seconds a DTC B1005 will set and the low fuel warning lamp will illuminate.

Table 4-2. Code Description

DTC	DESCRIPTION
B1004	Fuel level sensor or wiring shorted low
B1005	Fuel level sensor or wiring high/open

Voltage is supplied to the fuel pump and sender from the fuel pump fuse through the (O/GY) wire. Voltage is also supplied to the fuel level sender on the (Y/W) wire from the fuel gauge. As the fuel level changes the resistance of the sender changes. The fuel gauge and the low fuel lamp are controlled through the (Y/W) wire based off the change in the resistance of the fuel level sender.



1. **Indicator lamps [21]**
2. **Speedometer [39]**
3. **Trip odometer reset switch**
4. **Fuel pump and sender [141]**
5. **Ignition switch [31]**

Figure 4-3. Under Console (Typical)

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Connector Information

For additional information about the connectors in the following diagram(s) and diagnostic procedure(s), including the color of the harness test kit terminal probes, see B.1 CONNECTORS.

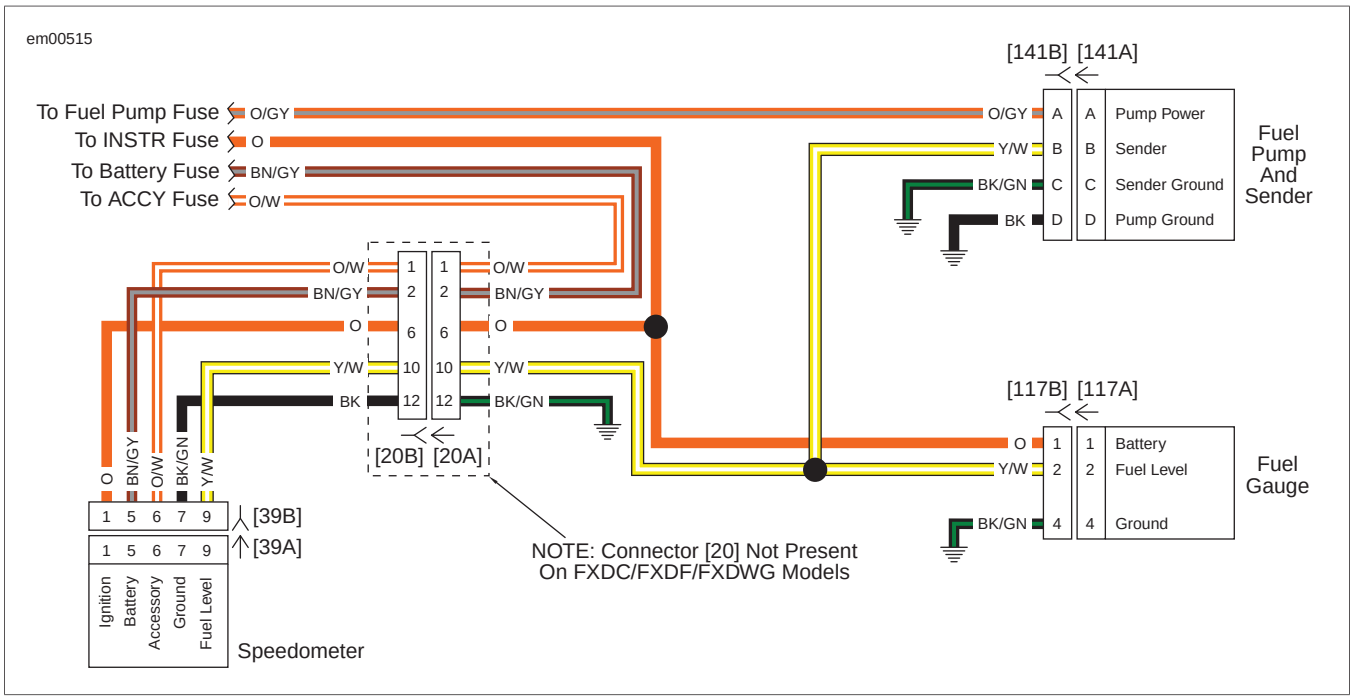

Figure 4-4. Fuel Sensor Circuit

DTC B1004

PART NUMBER	TOOL NAME
HD-41404-B	HARNESS CONNECTOR TEST KIT
HD-42682	BREAKOUT BOX
HD-46601	BREAKOUT BOX ADAPTERS

Table 4-3. DTC B1004 Diagnostic Faults

POSSIBLE CAUSES
Instrument malfunction
Short to ground in fuel level sensor circuit
Fuel pump and sender assembly malfunction
Open fuel level sender circuit
Short to ground in accessory power circuit
Ignition switch malfunction
Open ignition accessory circuit

1. Fuel Level Sender Voltage Test

1. Disconnect the speedometer [39].
2. Connect BREAKOUT BOX ADAPTERS (Part No. HD-46601) to [39]. Attach connectors from BREAKOUT BOX (Part No. HD-42682) to harness adapters leaving [39A] disconnected.
3. Turn IGN ON.
4. Measure voltage between terminal 9 and ground of breakout box.
5. Is voltage greater than 5.0V?
   a. **Yes.** Replace the speedometer. See the service manual.
   b. **No.** Go to Test 2.

2. Fuel Pump and Sender Test

1. Disconnect the fuel pump and sender assembly.
2. Measure voltage between breakout box terminal 9 and ground.
3. Is voltage greater than 5.0V?
   a. **Yes.** Replace the fuel pump and sender assembly. See the service manual.
   b. **No.** Go to Test 3.

3. Fuel Gauge Voltage Test

1. Disconnect the fuel gauge.
2. Using the HARNESS CONNECTOR TEST KIT (Part No. HD-41404-B) and a multimeter, test for voltage between fuel gauge [117B] terminal 1 and ground.
3. Is battery voltage present?
   a. **Yes.** Go to Test 4.
   b. **No.** Repair open in (O) wire between fuel gauge terminal 1 and instrument fuse.

4. Fuel Level Sender Circuit Test

1. Test for continuity between [117B] terminal 2 and breakout box terminal 9.

2. Is continuity present?
   a. **Yes.** Go to Test 5.
   b. **No.** Repair open in (Y/W) wire between fuel gauge and speedometer.

5. Fuel Level Sender Circuit Test

1. Test for continuity between [117B] terminals 2 and ground.
2. Is continuity present?
   a. **Yes.** Repair short to ground in (Y/W) wire.
   b. **No.** Replace the fuel gauge. See the service manual.

DTC B1005

PART NUMBER	TOOL NAME
HD-41404-B	HARNESS CONNECTOR TEST KIT
HD-42682	BREAKOUT BOX
HD-46601	BREAKOUT BOX ADAPTERS

Table 4-4. DTC B1005 Diagnostic Faults

POSSIBLE CAUSES
Open ground circuit
Short to voltage in fuel level sensor circuit
Fuel gauge malfunction
Instrument malfunction
Fuel pump and sender malfunction
Open fuel level sensor circuit

1. Fuel Level Sender Voltage Test

1. Disconnect the speedometer [39].
2. Connect BREAKOUT BOX ADAPTERS (Part No. HD-46601) to [39]. Attach connectors from BREAKOUT BOX (Part No. HD-42682) to harness adapters leaving [39A] disconnected.
3. Turn IGN ON.
4. Measure voltage between breakout box terminal 9 and ground.
5. Is voltage greater than 7.0V?
   a. **Yes.** Go to Test 2.
   b. **No.** Replace the speedometer. See the service manual.

2. Fuel Pump and Sender Test

1. Disconnect the fuel gauge [117].
2. Measure voltage between breakout box terminal 9 and ground.
3. Is voltage greater than 7.0V?
   a. **Yes.** Go to Test 3.
   b. **No.** Go to Test 4.

3. Fuel Level Sender Circuit Test

1. Disconnect fuel level sender [141].
2. Measure voltage between breakout box terminal 9 and ground.
3. Is voltage greater than 7.0V?
   a. **Yes.** Repair short to voltage on (Y/W) wire.
   b. **No.** Replace the fuel pump and sender assembly. See the service manual.

4. Fuel Level Sender Circuit Test

1. Using the HARNESS CONNECTOR TEST KIT (Part No. HD-41404-B) and a multimeter, test for continuity between [117B] terminal 2 and breakout box terminal 9.
2. Is continuity present?
   a. **Yes.** Go to Test 5.
   b. **No.** Repair open in (Y/W) wire between fuel gauge and speedometer.

5. Fuel Gauge Ground Circuit Test

1. Test for continuity between [117B] terminal 4 and ground.
2. Is continuity present?
   a. **Yes.** Go to Test 6.
   b. **No.** Repair open between [117] terminal 4 (BK/GN) wire and ground.

6. Fuel Sender Resistance Test

1. Disconnect fuel level sender [141].
2. Measure resistance between [141A] terminal B and ground.
3. Is resistance greater than 350 Ohms?
   a. **Yes.** Replace the fuel level sender. See the service manual.
   b. **No.** Replace the fuel gauge. See the service manual.

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DTC B1008 4.3

DESCRIPTION AND OPERATION

Trip Odometer Reset Switch Closed

Code B1008 will be set if trip odometer reset switch terminals are closed for more than 2 minutes.

Table 4-5. Code Description

DTC	DESCRIPTION
B1008	Trip odometer reset switch closed

DTC B1008

Table 4-6. DTC B1008 Diagnostic Faults

POSSIBLE CAUSES
Trip odometer reset switch boot malfunction
Instrument malfunction
Trip odometer reset switch malfunction

1. Rubber Boot Test

1. Remove the speedometer.
2. Remove rubber boot.
3. With the speedometer connected, clear DTCs using odometer self-diagnostics. See 2.1 INITIAL DIAGNOSTICS, Odometer Self-Diagnostics.
4. Did DTC B1008 set? This code may take up to 2 minutes to set.
   a. **Yes.** Go to Test 2.
   b. **No.** Replace boot. See the service manual.

2. Trip Odometer Reset Switch Test

1. Disconnect [39]. Using terminal remover HD-45928, remove terminal 11 from [39B]. Reconnect [39].
2. Turn IGN ON and observe the check engine lamp.
3. Is the DTC current? See 2.1 INITIAL DIAGNOSTICS, Check Engine Lamp.
   a. **Yes.** Replace speedometer. See the service manual.
   b. **No.** Replace the trip odometer reset switch. See the service manual.

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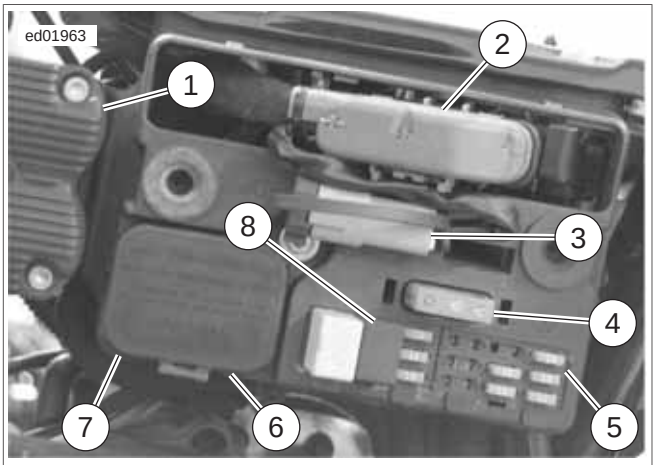
NO INSTRUMENT POWER 4.4

DESCRIPTION AND OPERATION

See Figure 4-5. The speedometer and tachometer (if equipped) receive battery power at terminal 5 and ignition power at terminal 1. This is supplied through the battery fuse and the instrument fuse located in fuse block [64]. Accessory power is supplied through the ACCY fuse at terminal 6. The speedometer and tachometer (if equipped) go through an initialization sequence every time power is removed and re-applied to terminal 1. The visible part of this sequence is the illumination of check engine lamp, security lamp, backlighting, odometer and fuel level. With IGN ON, the check engine lamp and security lamp will illuminate for 4 seconds and then (if parameters are normal) go out.

Loss of power on any of the inputs will change the instruments behavior. Refer to Table 4-7.



1. **Ignition coil**
2. **ECM [78]**
3. **DLC [91]**
4. **Main fuse [5]**
5. **Fuse block [64]**
6. **TSM/TSSM/HFSM**
7. **HFSM antenna harness [208]**
8. **Fuse/relay block [62]**

Figure 4-5. Under Left Side Cover

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Connector Information

For additional information about the connectors in the following diagram(s) and diagnostic procedure(s), including the color of the harness test kit terminal probes, see B.1 CONNECTORS.

Table 4-7. Function Chart - Loss of Input

TERMINAL 5 (BATTERY)	TERMINAL 1 (IGN)	TERMINAL 6 (ACC)	TERMINAL 7 (GND)
Speedometer is non-functional	Will not "WOW"	Will not "WOW"	Instrument completely non-functional
	Needles freeze	Speedometer non-functional in ACC position.	Other features non-functional or erratic
	Check engine lamp, low fuel, and battery lamp are non-functional. Diagnostics absent.	Diagnostics absent	Diagnostics absent

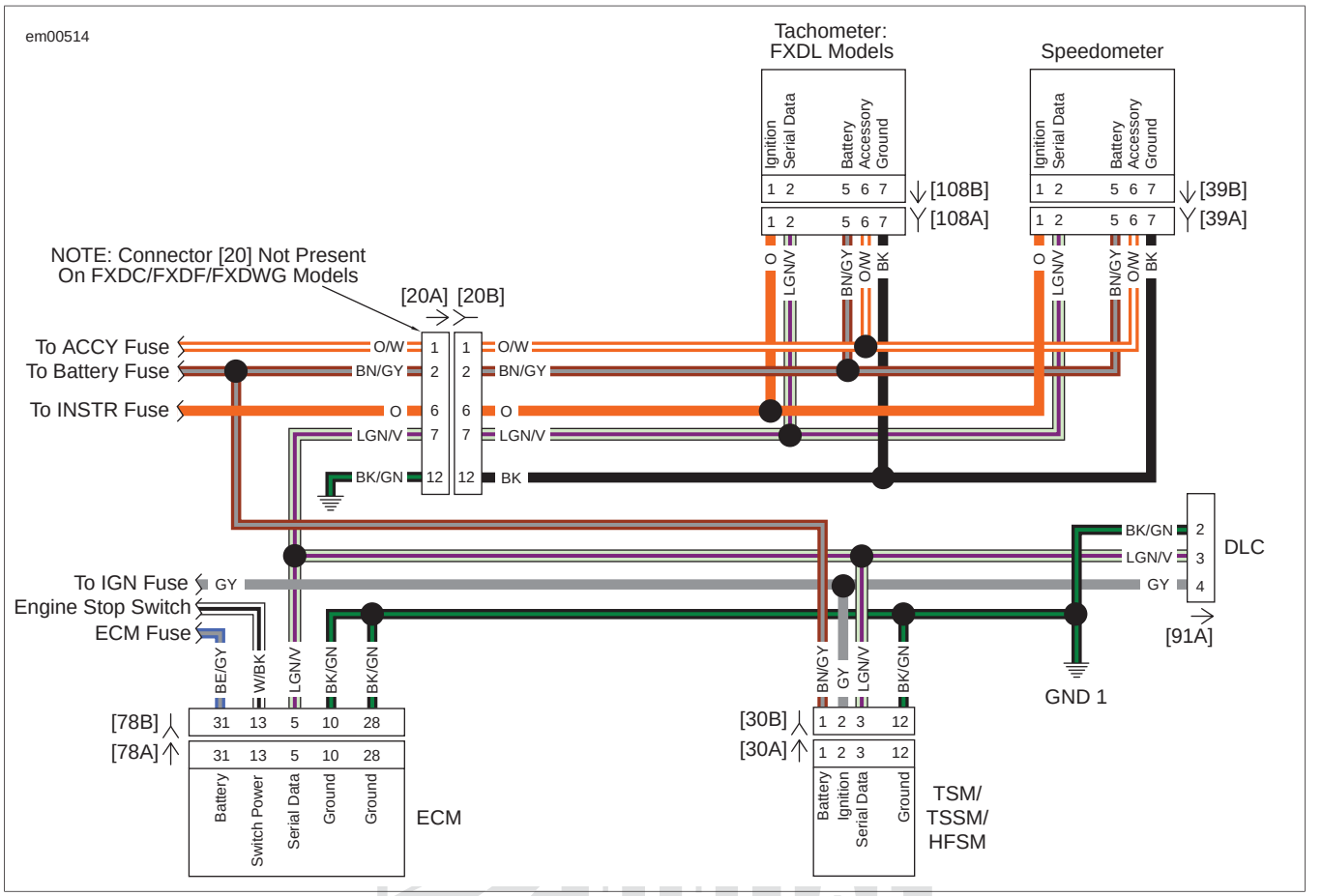


Figure 4-6. Instruments Power Circuit Diagram

SPEEDOMETER INOPERATIVE

PART NUMBER	TOOL NAME
HD-41404-B	HARNESS CONNECTOR TEST KIT
HD-42682	BREAKOUT BOX
HD-46601	BREAKOUT BOX ADAPTERS

Table 4-8. Speedometer Inoperative Diagnostic Faults

POSSIBLE CAUSES
Instrument malfunction
Open accessory circuit
Open battery circuit
Open ignition circuit
Short to ground in cooling fan circuit
Ignition switch malfunction
Short to ground in ignition circuit
Open ground circuit
Short in accessory circuit

1. Battery and Ignition Function Test

1. Turn IGN ON.
2. Does the speedometer have full function?
   a. **Yes.** Go to Test 2.
   b. **No.** Check engine lamp, battery lamp, and security lamp are inoperative but backlighting is functional. Go to Test 8.
   c. **No.** Speedometer does not operate at all. Go to Test 4.

2. Accessory Function Test

1. Turn IGN to ACC.
2. Does the instrument have full ACC function?
   a. **Yes.** Concern is intermittent, perform a wiggle test to test for intermittent. See 1.3 DIAGNOSTICS AND TROUBLESHOOTING, Wiggle Test.
   b. **No.** Go to Test 3.

3. Accessory Fuse Test

1. With IGN OFF, connect BREAKOUT BOX ADAPTERS (Part No. HD-46601) to [39]. Attach connectors from BREAKOUT BOX (Part No. HD-42682) to harness adapters leaving [39A] disconnected. See 1.2 DIAGNOSTIC TOOLS.
2. Turn IGN ON.

3. Using the HARNESS CONNECTOR TEST KIT (Part No. HD-41404-B) and a multimeter, test for voltage at breakout box terminal 6.
4. Is battery voltage present?
   a. **Yes.** Replace the speedometer. See the service manual. **(7311)**
   b. **No.** Repair open in (O/W) wire. **(5043)**

4. Battery Fuse Test

1. Inspect the battery fuse.
2. Is the fuse good?
   a. **Yes.** Go to Test 5.
   b. **No.** Go to Test 7.

5. Battery Circuit to Battery Fuse Test

1. Test for voltage at [64B] socket terminal J.
2. Is battery voltage present?
   a. **Yes.** Go to Test 6.
   b. **No.** Repair open between battery fuse and main fuse (R) wire. **(5041)**

6. Battery Circuit to Speedometer Test

1. With IGN OFF, connect BREAKOUT BOX ADAPTERS (Part No. HD-46601) to [39]. Attach connectors from BREAKOUT BOX (Part No. HD-42682) to harness adapters leaving [39A] disconnected. See 1.2 DIAGNOSTIC TOOLS.
2. Install battery fuse in fuse block.
3. Test for voltage at breakout box terminal 5.
4. Is battery voltage present?
   a. **Yes.** Go to Test 13.
   b. **No.** Repair open between [39B] terminal 5 and [64B] socket terminal I (BN/GY) wire. **(5041)**

7. Battery Circuit Short to Ground Test

1. With IGN OFF, connect BREAKOUT BOX ADAPTERS (Part No. HD-46601) to [39]. Attach connectors from BREAKOUT BOX (Part No. HD-42682) to harness adapters leaving [39A] disconnected. See 1.2 DIAGNOSTIC TOOLS.
2. Test for continuity between breakout box terminal 5 and ground.
3. Is continuity present?
   a. **Yes.** Repair short to ground in (BN/GY) wire. **(5041)**
   b. **No.** Concern is intermittent, perform a wiggle test to test for intermittent. See 1.3 DIAGNOSTICS AND TROUBLESHOOTING, Wiggle Test. Replace the battery fuse.

8. Ignition Circuit Test

1. Turn IGN OFF for at least 15 seconds.
2. Turn IGN ON.
3. Does the fuel pump run and then shut off?
   a. **Yes.** Go to Test 9.
   b. **No.** Go to Test 10.

9. Instrument Power Circuit Test

1. With IGN OFF, disconnect [39].
2. Connect BREAKOUT BOX ADAPTERS (Part No. HD-46601) to [39]. Attach connectors from BREAKOUT BOX (Part No. HD-42682) to harness adapters leaving [39A] disconnected. See 1.2 DIAGNOSTIC TOOLS.
3. With IGN ON, test for voltage between breakout box terminal 1 and ground.
4. Is battery voltage present?
   a. **Yes.** Replace speedometer. See the service manual. **(7311)**
   b. **No.** Repair open in (O) ignition wire. **(5041)**

10. Ignition Fuse Test

1. Inspect the ignition fuse.
2. Is the fuse good?
   a. **Yes.** Go to Test 11.
   b. **No.** Go to Test 12.

11. Ignition Power to Ignition Fuse Test

1. With IGN ON, test for battery voltage between [64B] socket terminal B and ground.
2. Is battery voltage present?
   a. **Yes.** Repair open in (O) wire. **(5041)**
   b. **No.** Inspect wiring from ignition fuse to ignition switch for an open or damaged condition. If the wiring is good replace the ignition switch. See the service manual.

12. Ignition Power Short to Ground Test

1. Test for continuity between [64B] socket terminal A and ground.
2. Is continuity present?
   a. **Yes.** Repair short to ground in (O) wire. Replace ignition fuse. **(5041)**
   b. **No.** Replace the ignition fuse and verify operation.

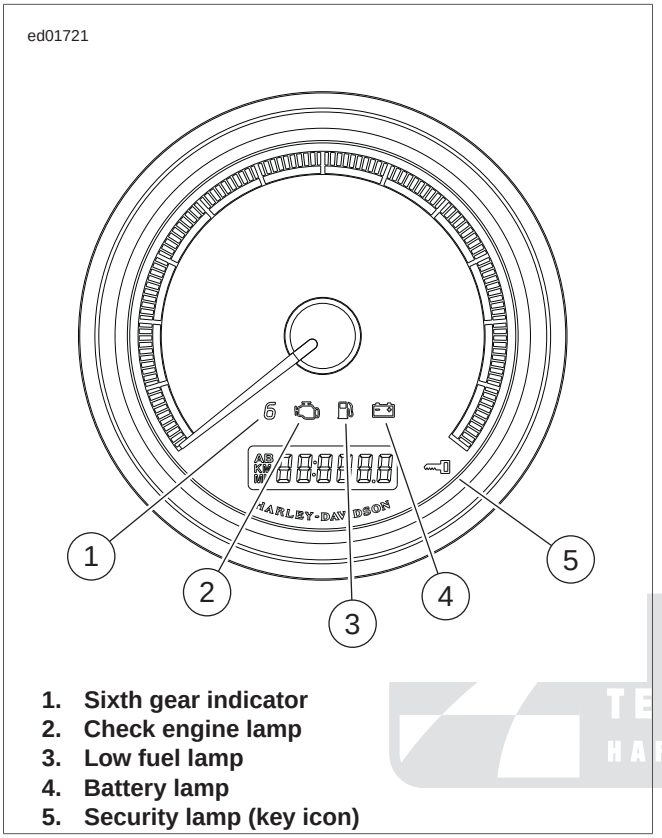
13. Ground Circuit Test

1. Using the HARNESS CONNECTOR TEST KIT (Part No. HD-41404-B) and a multimeter, test for continuity between breakout box terminal 7 and ground.
2. Is continuity present?
   a. **Yes.** Replace the speedometer. See the service manual. **(7311)**
   b. **No.** Repair open in (BK) wire. **(5041)**

INDICATOR LAMPS 4.5

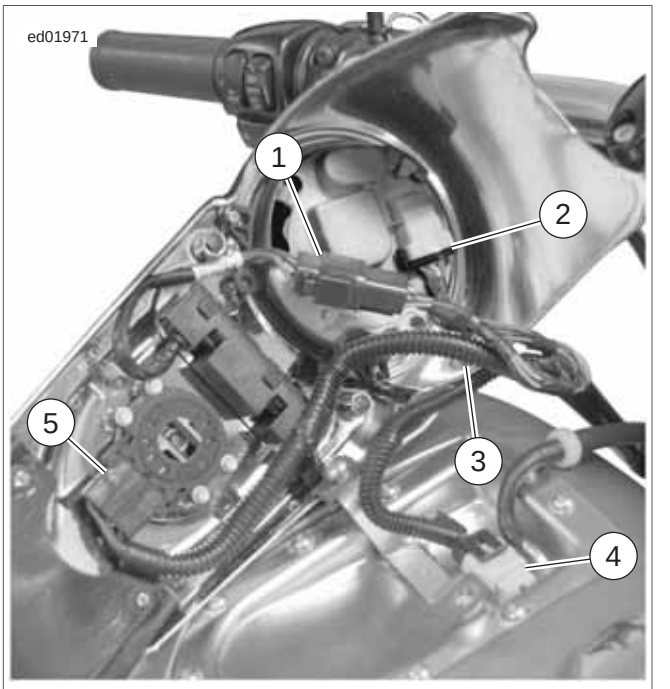
DESCRIPTION AND OPERATION

See Figure 4-7. The battery, check engine, security, and low fuel indicators are located in the speedometer. The other indicators are located separately from the speedometer.



1. **Sixth gear indicator**
2. **Check engine lamp**
3. **Low fuel lamp**
4. **Battery lamp**
5. **Security lamp (key icon)**

Figure 4-7. Indicator Lamps (Typical)



1. **Indicator lamps [21]**
2. **Speedometer [39]**
3. **Trip odometer reset switch**
4. **Fuel pump and sender [141]**
5. **Ignition switch [31]**

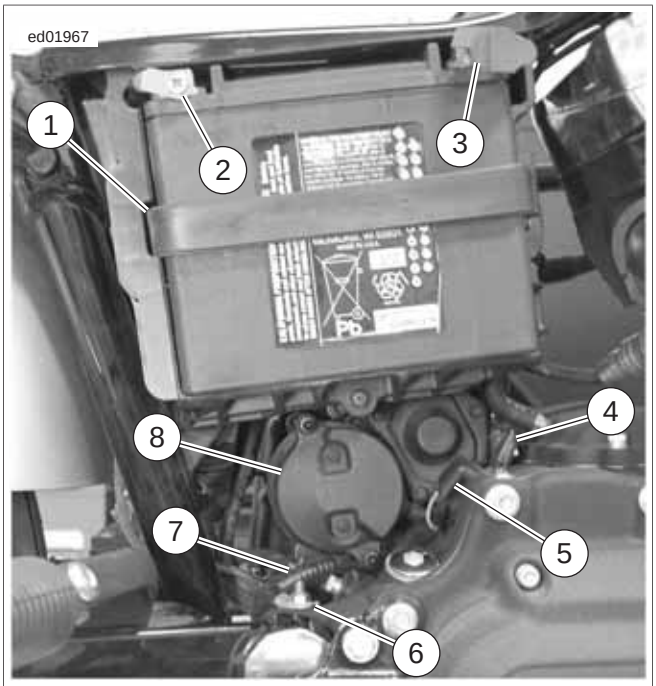
Figure 4-8. Under Console (Typical)

Table 4-9. Indicator Lamp Wiring

INDICATOR LAMP	CONNECTION
Check engine	Serial data
Security	Serial data
Battery	Serial data
Oil pressure	Ground through switch
Neutral	Ground through switch
High beam	12V when active
Right/left turn	12V when active
Low fuel	1.0 gal (3.8 L)

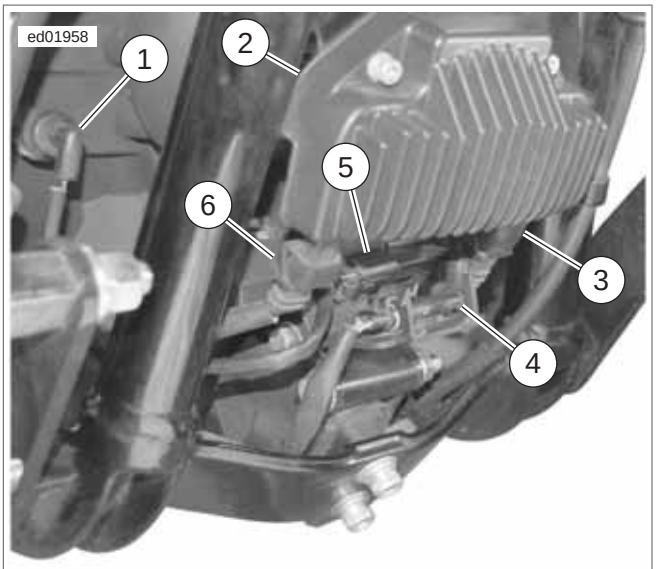
Low Fuel Indicator

See Figure 4-8. The low fuel indicator is controlled at terminal 9 (Y/W) of the speedometer. The fuel gauge sends voltage on the (Y/W) wire to the low fuel lamp and fuel level sender. When the fuel drops below 1.0 gal (3.8 L), the resistance in the fuel level sender reaches a point that causes enough of a change in the voltage on the (Y/W) wire it signals the speedometer to activate the low fuel lamp.



1. **Battery**
2. **Battery negative**
3. **Battery positive**
4. **Starter solenoid [128]**
5. **Neutral switch [131]**
6. **Battery ground cable**
7. **VSS [65]**
8. **Starter**

Figure 4-9. Under Right Side Cover



1. **Oil pressure switch [120]**
2. **Voltage regulator**
3. **Voltage regulator to stator [47]**
4. **Front O2 sensor (Domestic Only) [138]**
5. **CKP sensor [79]**
6. **Voltage regulator [77]**

Figure 4-10. Lower Front

Neutral Indicator

See Figure 4-9. The neutral indicator is controlled through the (TN) wire connected to the TSM/TSSM/HFSM and the neutral switch. When the transmission is in neutral, the neutral switch closes and illuminates the neutral indicator.

Oil Pressure Indicator

See Figure 4-10. The oil pressure indicator is connected to the oil pressure switch. The switch closes when oil pressure is low and illuminates the oil pressure indicator. This is why the oil pressure indicator is illuminated with the IGN ON and the engine OFF.

Turn Signal Indicators

The turn signal indicators are controlled by the TSM/TSSM/HFSM. When the TSM/TSSM/HFSM receives an input from the left or right turn signal switch it flashes the correct turn signals including the turn signal indicators. When the left turn signal switch is pressed voltage is supplied on the (V) wire to the left turn signals including the turn signal indicator. When the right turn signal switch is pressed, voltage is supplied on the (BN) wire to the right turn signals including the indicator.

High Beam

This circuit is powered when the headlamp switch is placed in the high beam position. In the high position, voltage is supplied to the (W) wire and the high beam headlamps. This wire also supplies power to the high beam indicator, causing it to illuminate.

Connector Information

For additional information about the connectors in the following diagram(s) and diagnostic procedure(s), including the color of the harness test kit terminal probes, see B.1 CONNECTORS.

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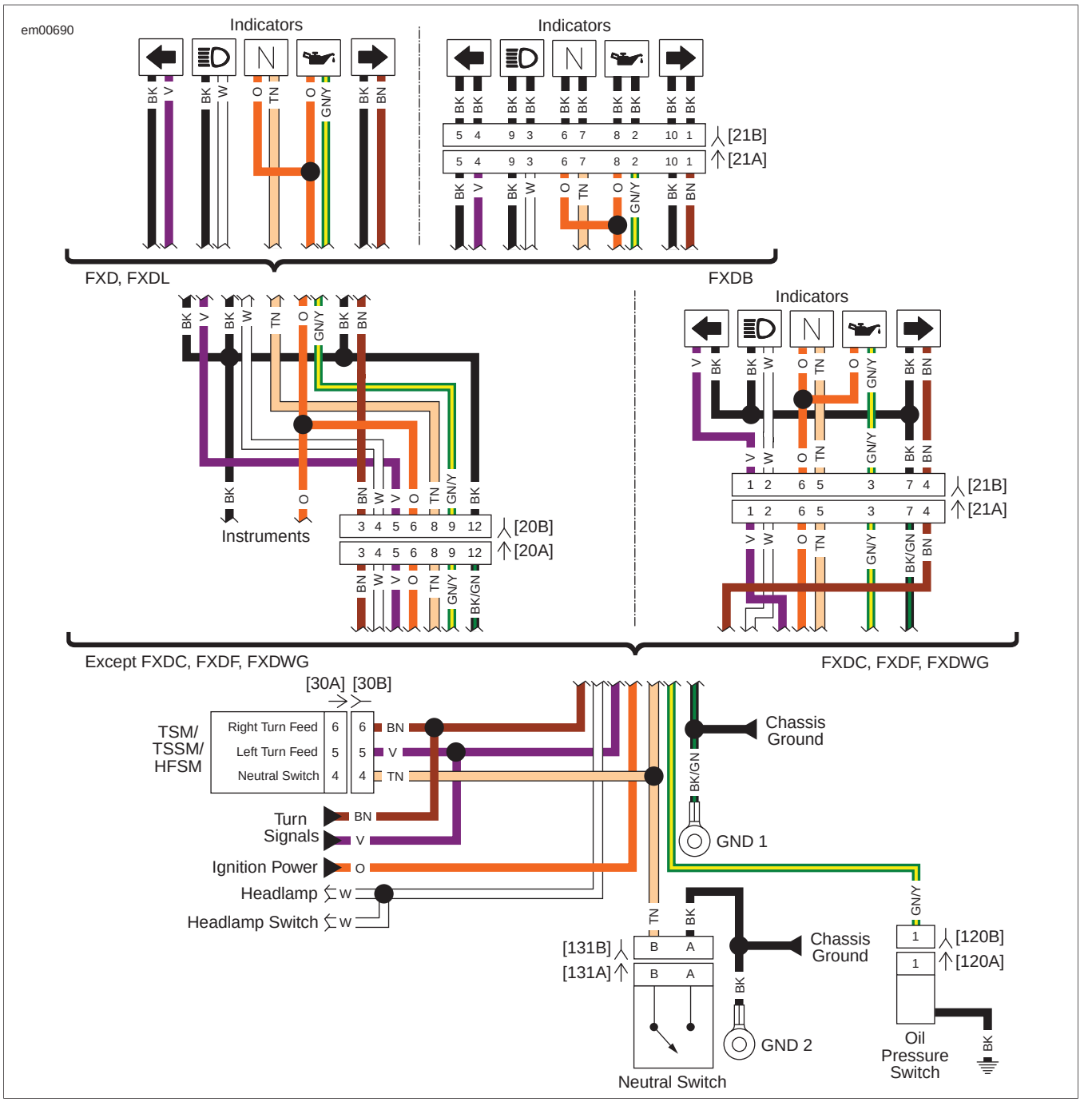

Figure 4-11. Indicator Lamps

OIL PRESSURE LAMP ALWAYS ON

PART NUMBER	TOOL NAME
HD-41404-B	HARNESS CONNECTOR TEST KIT

Table 4-10. Oil Pressure Lamp Always On Diagnostic Faults

POSSIBLE CAUSES
Short to ground in oil pressure circuit
Indicator malfunction
Mechanical issue
Oil pressure switch malfunction

1. Oil Pressure Lamp Function Test

1. Turn IGN ON with the engine OFF.
2. Does the oil pressure lamp illuminate?
   a. **Yes.** Go to Test 2.
   b. **No.** See 4.5 INDICATOR LAMPS, Oil Pressure Lamp Inoperative.

2. Engine Running Test

1. Start the engine.
2. Does the oil pressure lamp turn OFF and stay off?
   a. **Yes.** Oil pressure lamp is operating properly. Test for intermittent. See 1.3 DIAGNOSTICS AND TROUBLESHOOTING, Wiggle Test.
   b. **No.** Go to Test 3.

3. Oil Pressure Sensor Test

1. Disconnect the oil pressure sensor [120].
2. Does the oil pressure lamp turn OFF?
   a. **Yes.** Go to Test 5.
   b. **No.** Go to Test 4.

4. Oil Pressure Circuit Test

1. With IGN OFF, disconnect [20] (FXD, FXDL) or [21] (FXDC, FXDF, FXDB).
2. Using the HARNESS CONNECTOR TEST KIT (Part No. HD-41404-B) and a multimeter, test for continuity on the (GN/Y) wire between [20A] (FXD, FXDL) or [21A] (FXDC, FXDF, FXDWG, FXDB) and ground.
3. Is continuity present?
   a. **Yes.** Repair short to ground on (GN/Y) wire. **(5041)**
   b. **No.** Repair or replace the indicator harness. See the service manual. (Except FXDB) **(5191)**
   c. **No.** Go to Test 6. (FXDB).

5. Mechanical Test

1. Inspect the engine for any issues that may affect oil pressure.
2. Was the problem found?
   a. **Yes.** Repair as needed.
   b. **No.** Replace the oil pressure switch. See the service manual. **(5161)**

6. Indicator Harness Test: FXDB

1. Disconnect indicator lamp harness [21].
2. Using the HARNESS CONNECTOR TEST KIT (Part No. HD-41404-B) and a multimeter, test for continuity between [21A] terminal 2 and ground.
3. Is continuity present?
   a. **Yes.** Repair short to ground between [21] and [20] (GN/Y) wire.
   b. **No.** Repair or replace indicator lamp harness. See the service manual. **(5191)**

OIL PRESSURE LAMP INOPERATIVE

PART NUMBER	TOOL NAME
HD-41404-B	HARNESS CONNECTOR TEST KIT

Table 4-11. Oil Pressure Lamp Inoperative Diagnostic Faults

POSSIBLE CAUSES
Oil pressure switch malfunction
Open oil pressure circuit
Indicator malfunction

1. Oil Pressure Lamp Function Test

1. Turn IGN ON with the engine OFF.
2. Does the oil pressure lamp illuminate?
   a. **Yes.** Test for intermittent. See 1.3 DIAGNOSTICS AND TROUBLESHOOTING, Wiggle Test.
   b. **No.** Go to Test 2.

2. Oil Pressure Switch Test

1. Disconnect the oil pressure sensor [120].
2. Using the HARNESS CONNECTOR TEST KIT (Part No. HD-41404-B), connect [120B] terminal 1 to ground.
3. Does the oil pressure lamp turn ON?
   a. **Yes.** Replace oil pressure switch. See the service manual. **(5161)**
   b. **No.** Go to Test 3.

3. Oil Pressure Circuit Test

1. With IGN OFF, disconnect [20] (FXD, FXDL) or [21] (FXDC, FXDF, FXDWG, FXDB).
2. Test for continuity on (GN/Y) wire between [20A] (FXD, FXDL) or [21A] (FXDC, FXDF, FXDWG, FXDB) and [120B] terminal 1.

3. Is continuity present?
   a. **Yes.** Repair or replace the indicator harness. See the service manual. **(5191)**
   b. **No.** Repair open between indicators and [120] (GN/Y) wire. **(5041)**

NEUTRAL LAMP ALWAYS ON

PART NUMBER	TOOL NAME
HD-41404-B	HARNESS CONNECTOR TEST KIT

Table 4-12. Neutral Lamp Always On Diagnostic Faults

POSSIBLE CAUSES
Neutral switch malfunction
Short to ground in neutral circuit
Indicator malfunction
TSM/TSSM/HFSM malfunction

1. Neutral Lamp Function Test

1. With the vehicle in neutral, turn IGN ON with the engine OFF.
2. Does the neutral lamp illuminate?
   a. **Yes.** Go to Test 2.
   b. **No.** See 4.5 INDICATOR LAMPS, Neutral Lamp Inoperative.

2. Transmission Operation Test

1. Shift the transmission out of neutral.
2. Does the neutral lamp turn OFF and stay off?
   a. **Yes.** Neutral lamp is operating properly. Test for intermittent. See 1.3 DIAGNOSTICS AND TROUBLESHOOTING, Wiggle Test.
   b. **No.** Go to Test 3.

3. Neutral Switch Test

1. Disconnect the neutral switch [131].
2. Does the neutral lamp turn OFF?
   a. **Yes.** Replace the neutral switch. See the service manual. **(5157)**
   b. **No.** Go to Test 4.

4. TSM/TSSM/HFSM Test

1. Disconnect the TSM/TSSM/HFSM [30].
2. Does the neutral lamp turn OFF?
   a. **Yes.** Replace the TSM/TSSM/HFSM. See the service manual. **(6845)**
   b. **No.** Go to Test 5.

5. Neutral Switch Circuit Test

1. Disconnect [20] (FXD, FXDL) or [21] (FXDC, FXDF, FXDWG, FXDB).
2. Using the HARNESS CONNECTOR TEST KIT (Part No. HD-41404-B) and a multimeter, test for continuity on the (TN) wire between [20A] (FXD, FXDL) or [21A] (FXDC, FXDF, FXDWG, FXDB) and ground.
3. Is continuity present?
   a. **Yes.** Repair short to ground in (TN) wire. **(5041)**
   b. **No.** Repair or replace the indicator harness. See the service manual. **(5191)**

NEUTRAL LAMP INOPERATIVE

PART NUMBER	TOOL NAME
HD-41404-B	HARNESS CONNECTOR TEST KIT

Table 4-13. Neutral Lamp Inoperative Diagnostic Faults

POSSIBLE CAUSES
Neutral switch malfunction
Open ground circuit
Open neutral switch circuit
Indicator malfunction

1. Neutral Lamp Function Test

1. With the vehicle in neutral, turn IGN ON with the engine OFF.
2. Does the neutral lamp illuminate?
   a. **Yes.** Test for intermittent. See 1.3 DIAGNOSTICS AND TROUBLESHOOTING, Wiggle Test.
   b. **No.** Go to Test 2.

2. Neutral Switch Test

1. Disconnect the neutral switch [131].
2. Using the HARNESS CONNECTOR TEST KIT (Part No. HD-41404-B), jump the (TN) wire to ground.
3. Does the neutral lamp turn ON?
   a. **Yes.** Replace the neutral switch. See the service manual. **(5157)**
   b. **No.** Go to Test 3.

3. Neutral Switch Power Circuit Open Test

1. With IGN OFF, disconnect [20] (FXD, FXDL) or [21] (FXDC, FXDF, FXDWG, FXDB).
2. Using the HARNESS CONNECTOR TEST KIT (Part No. HD-41404-B) and a multimeter, test for continuity on the (TN) wire between [20A] (FXD, FXDL) or [21A] (FXDC, FXDF, FXDWG, FXDB) and [131B].
3. Is continuity present?
   a. **Yes.** Repair or replace the indicator harness. See the service manual. **(5191)**
   b. **No.** Repair open in (TN) wire between indicators and neutral switch. **(5041)**

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HIGH BEAM INDICATOR LAMP INOPERATIVE

PART NUMBER	TOOL NAME
HD-41404-B	HARNESS CONNECTOR TEST KIT

Table 4-14. High Beam Indicator Lamp Inoperative Diagnostic Faults

POSSIBLE CAUSES
Indicator malfunction
Open High beam indicator circuit

1. High Beam Indicator Function Test

1. With IGN ON, operate the headlamp switch.
2. Do the high and low beam headlamps function correctly?
   a. **Yes.** Go to Test 2.
   b. **No.** See 5.3 LIGHTS.

2. High Beam Indicator Circuit Test

1. With IGN OFF, disconnect [20] (FXD, FXDL) or [21] (FXDC, FXDF, FXDWG, FXDB).
2. With the headlamp switch in the high position and using HARNESS CONNECTOR TEST KIT (Part No. HD-41404-B) and a multimeter, test for voltage on (W) wire at [20A] (FXD, FXDL) or [21A] (FXDC, FXDF, FXDWG, FXDB).
3. Is voltage present?
   a. **Yes.** Repair or replace the indicator harness. See the service manual. **(5191)**
   b. **No.** Repair open in (W) wire between headlamp switch and indicators. **(5041)**

TURN SIGNAL INDICATOR INOPERATIVE

PART NUMBER	TOOL NAME
HD-41404-B	HARNESS CONNECTOR TEST KIT

Table 4-15. Turn Signal Indicator Inoperative Diagnostic Faults

POSSIBLE CAUSES
Indicator malfunction
Open turn signal circuit

1. Turn Signal Function Test

1. With ignition ON, operate the turn signals.
2. Do the turn signals operate?
   a. **Yes.** Go to Test 2.
   b. **No.** See 5.3 LIGHTS.

2. Turn Signal Indicator Circuit Test

1. With IGN OFF, disconnect [20] (FXD, FXDL) or [21] (FXDC, FXDF, FXDWG, FXDB).
2. With the turn signals activated and using the HARNESS CONNECTOR TEST KIT (Part No. HD-41404-B) and a multimeter, test for voltage on (BN) (right) or (V) (left) wires at [20A] (FXD, FXDL) or [21A] (FXDC, FXDF, FXDWG, FXDB).
3. Is voltage cycling on and off?
   a. **Yes.** Repair or replace the indicator harness. See the service manual. **(5191)**
   b. **No.** Repair open between indicators and TSM/TSSM/HFSM (BN) wire (right) or (V) wire (left). **(5041)**

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NOTES

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NOTES

ACCESSORIES 5.1

DESCRIPTION AND OPERATION

The P&A battery circuit is connected to battery power after the 40 Amp main fuse. This circuit can be used to supply power to additional systems on the motorcycle.

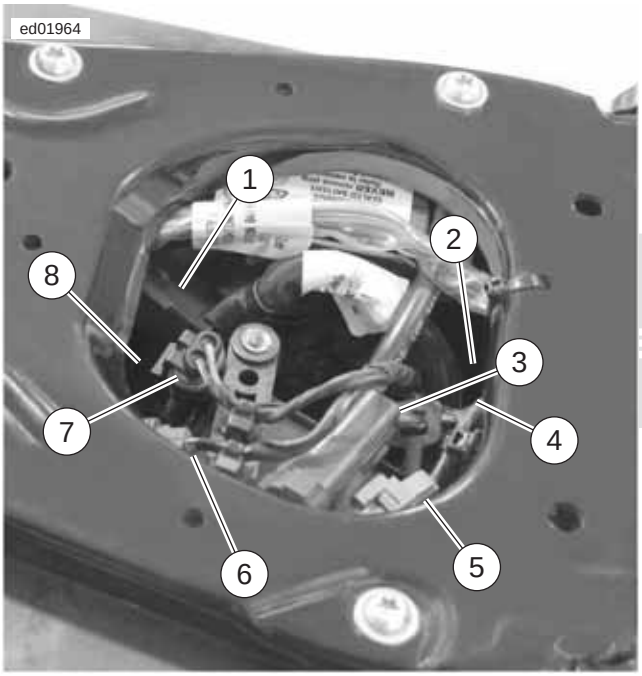
COMPONENTS

P&A Connector

See Figure 5-1. The P&A [160] is located under the seat with a cover plugged into it to keep it from being accidentally grounded.

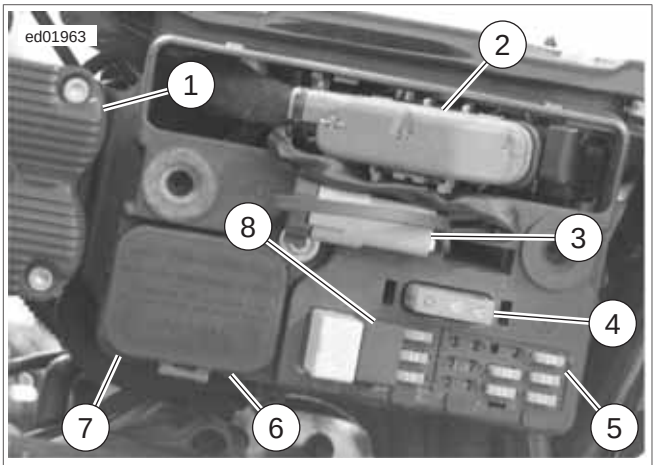
P&A Fuse

See Figure 5-2. The P&A IGN fuse is located in the fuse block under the left side cover. This is a 15A fuse that has voltage to it only when the ignition switch is turned ON.



1. **Tail lamp harness to main harness [7]**
2. **Grounds [GND1] & [GND2]**
3. **Accessory [4]**
4. **Security siren [142]**
5. **B+ [160]**
6. **IAT sensor [89]**
7. **Rear O2 sensor [137]**
8. **JSS (HDI only) [133]**

Figure 5-1. Under Seat



1. **Ignition coil**
2. **ECM [78]**
3. **DLC [91]**
4. **Main fuse [5]**
5. **Fuse block [64]**
6. **TSM/TSSM/HFSM**
7. **HFSM antenna harness [208]**
8. **Fuse/relay block [62]**

Figure 5-2. Under Left Side Cover

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HORN 5.2

DESCRIPTION AND OPERATION

The horn is powered through the horn switch from the ACCY fuse. The horn is grounded through GND 2. When the horn switch is pressed, battery voltage is applied to [122] terminal A, causing the horn to sound.

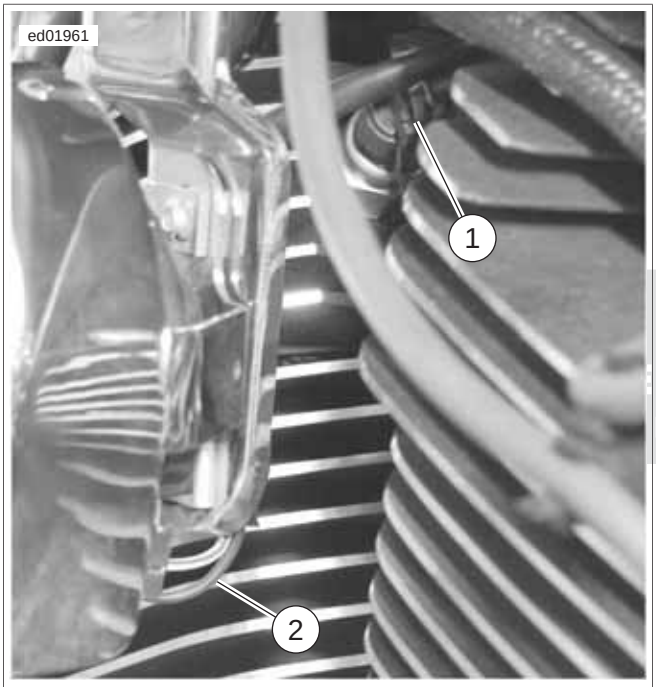
COMPONENTS

Horn Switch

The horn switch is a push button switch on the left handlebar controls.

Horn

See Figure 5-3. The horn is located on the left side of the vehicle between the cylinders.



1. **ET sensor [90]**
2. **Horn [122]**

Figure 5-3. Horn: Except FXCWC

SYMPTOMS

The horn circuit does not set DTCs when there is a malfunction. Instead, one of the symptoms shown in Table 5-1 exists to indicate a concern with the system.

Table 5-1. Horn Symptom Table

SYMPTOM	COMMON CAUSE
Horn Always On	Short to voltage or a stuck switch
Horn Inoperative	Open circuit, faulty horn or horn switch

Diagnostic Tips

If the fuse is open, check the circuit between the horn switch and the horn for a short to ground. This would cause the fuse to open only when the horn switch is pressed. A short between the brake lamp switches and the tail/stop lamp causes this fuse to open when the brakes are applied.

The (O/W) wire from the fuse supplies battery voltage to several components. A short anywhere in the (O/W) wire causes the fuse to open immediately.

Connector Information

For additional information about the connectors in the following diagram(s) and diagnostic procedure(s), including the color of the harness test kit terminal probes, see B.1 CONNECTORS.

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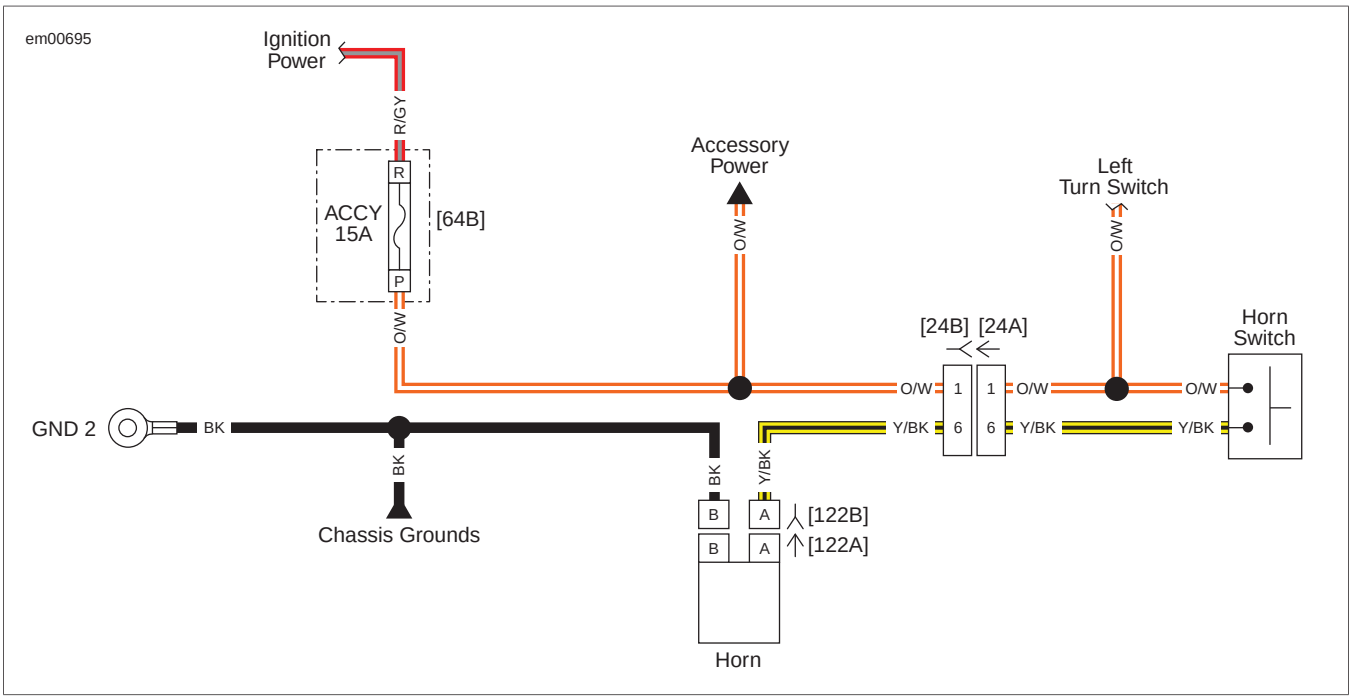


Figure 5-4. Horn

HORN ALWAYS ON

Table 5-2. Horn Always On Diagnostic Faults

POSSIBLE CAUSES
Short to voltage in horn power circuit
Horn switch malfunction

1. Horn Switch Test

1. Disconnect [24].
2. Does the horn turn off?
   a. **Yes.** Replace the horn switch. See the service manual. **(5171)**
   b. **No.** Repair short to voltage in the (Y/BK) wire between horn and left hand controls. **(5041)**

HORN INOPERATIVE

PART NUMBER	TOOL NAME
HD-41404-B	HARNESS CONNECTOR TEST KIT

Table 5-3. Horn Inoperative Diagnostic Faults

POSSIBLE CAUSES
Open accessory circuit
Shorted accessory circuit
Horn malfunction
Open ground circuit
Horn switch malfunction
Open horn power circuit

1. Accessory Circuit Open or Shorted Test

1. With the IGN ON, activate the front and rear brakes.
2. Does the tail/stop lamp illuminate?
   a. **Yes.** Go to Test 2.
   b. **No.** Inspect the fuse. If fuse is good locate and repair open in (O/W) wire. If fuse is open repair short to ground in circuits that may affect the fuse. Refer to Diagnostic Tips. **(5043)**

2. Horn Test

1. Disconnect the horn [122].
2. Using HARNESS CONNECTOR TEST KIT (Part No. HD-41404-B), test for voltage at [122B] between terminals A and B.
3. Press the horn switch.
4. Is battery voltage present?
   a. **Yes.** Replace the horn. See the service manual. **(5765)**
   b. **No.** Go to Test 3.

3. Ground Circuit Open Test

1. Test for continuity between [122B] terminal B and ground.
2. Is continuity present?
   a. **Yes.** Go to Test 4.
   b. **No.** Repair open in the ground circuit. **(5041)**

4. Horn Switch Malfunction Test

1. Connect the horn [122].

2. Disconnect [24].
3. With IGN ON, using the HARNESS CONNECTOR TEST KIT (Part No. HD-41404-B) jumper [24B] terminals 1 and 6.
4. Does the horn sound?
   a. **Yes.** Replace the horn switch. See the service manual. **(5171)**
   b. **No.** Go to Test 5.

5. Horn Power Circuit Open Test

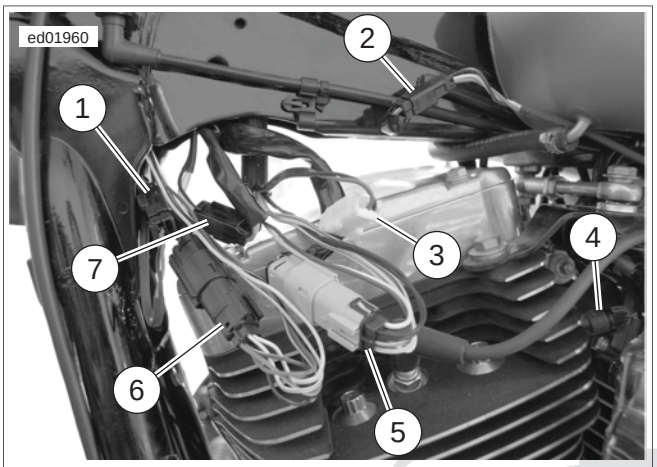
1. Test for voltage from [24B] terminal 1 (O/W) to ground.
2. Is battery voltage present?
   a. **Yes.** Repair open in (Y/BK) wire between [24B] and horn. **(5041)**
   b. **No.** Repair open (O/W) wire between [24B] and fuse block. **(5043)**

DIGITAL TECHNICIAN II HARLEY-DAVIDSON

LIGHTS 5.3

DESCRIPTION AND OPERATION

See Figure 5-5. The lighting system includes the headlamps, turn signals, running lamps, license plate lamps, tail, and brake lamps. The lights are powered by the accessory fuse and lights fuse. The accessory fuse circuit supplies power for the front running lamps, the turn signal switches, the license plate lamps, the tail lamp, the stop lamp switches, and the front position lamp (HDI only). The accessory circuit receives power when the ignition switch is in the IGN or the ACC position.



1. **Front turn signals (right) [31R]**
2. **Fuel gauge [117]**
3. **Front turn signals (left) [31L]**
4. **ET sensor [90]**
5. **Left hand controls and horn [24]**
6. **Right hand controls [22]**
7. **Headlamp [38]**

Figure 5-5. Under Fuel Tank Left Side

COMPONENTS

TSM

The TSM has three major functions:

- Controls the turn signals
- Serves as the BAS
- Monitors the clutch and neutral switches to prevent starter engagement

See Figure 5-6. The TSM is located under the left side cover. It receives battery power through terminal 1 and ignition power through terminal 2. The ground for the TSM is through terminal 12. The TSM communicates with the other modules on the vehicle through the serial data line from terminal 3.

The turn signal switches are inputs to the TSM. When the TSM receives voltage from either of the turn signal switches it supplies voltage to the corresponding turn signal lamps and the correct turn signal indicator.

The TSM also monitors the position of the clutch and neutral switches to determine if it is safe to start the vehicle. The BAS is internal to the TSM and allows the TSM to determine if the vehicle is tipped over. If a tip over event occurs, the TSM sends a signal to the ECM to turn off the engine.

Headlamp Switch

The headlamp switch is located on the left handlebar controls. This switch is used to select either the high beam or the low beam headlamps.

BAS Operation

See Figure 5-6. The TSM/TSSM/HFSM uses an internal BAS to monitor vehicle position. Under normal driving conditions the TSM/TSSM/HFSM uses the BAS along with speed input provided from the ECM to know when to automatically cancel the turn signals after a turn.

The TSM/TSSM/HFSM will disable turn signal lamps and starter activation and will send a message to the ECM to shut down the ignition and the fuel pump if the vehicle is tipped over. The odometer will display "tIP" when a tip-over condition is present.

BAS Restart

To restart the vehicle after shutdown has occurred:

1. Return the vehicle to an upright position.
2. Cycle the IGN OFF-ON before restarting the vehicle.

Low Beam Headlamp

The low beam headlamp receives power on the (Y) wire from the headlamp HI/LO switch. The low beam headlamp is only illuminated when the switch is in the low beam position.

High Beam Headlamp

The high beam headlamp receives power on the (W) wire from the headlamp HI/LO switch. When the switch is in the high position the low beam headlamp turns off and the high beam headlamp illuminates along with the high beam indicator.

Left Turn Signal Switch

The left turn signal switch is located on the left handlebar controls. The switch supplies an input to the TSM/TSSM/HFSM at terminal 8 on the (W/V) wire.

Right Turn Signal Switch

The right turn signal switch is located on the right handlebar controls. The switch supplies an input to the TSM/TSSM/HFSM at terminal 7 on the (W/BN) wire.

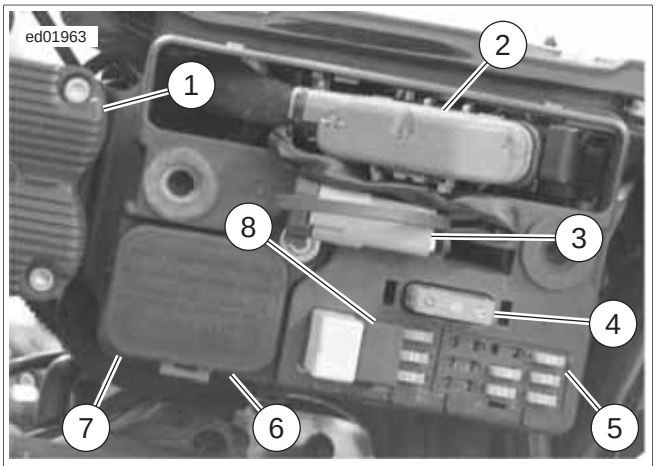
Turn Signals

The front turn signals are located below the handlebars. The rear turn signals are located at the sides of the rear fender. The TSM/TSSM/HFSM controls the turn signals. When the turn signal switch is pressed, voltage is sent to the TSM/TSSM/HFSM. The TSM/TSSM/HFSM then drives the turn signals for the appropriate side.

Tail/Stop Lamp

See Figure 5-6. The tail/stop lamp illuminates with the ignition switch in the ON or ACC position. When either the front or rear stop lamp switches are applied, the second filament in the bulb illuminates to light the brake lamp. The tail lamp portion of the

lamp is powered by the accessory fuse through the (O/W) wire. The stop lamp portion of the lamp receives power through the (R/Y) wire when either one of the stop lamp switches are applied.



1. **Ignition coil**
2. **ECM [78]**
3. **DLC [91]**
4. **Main fuse [5]**
5. **Fuse block [64]**
6. **TSM/TSSM/HFSM**
7. **HFSM antenna harness [208]**
8. **Fuse/relay block [62]**

Figure 5-6. Under Left Side Cover

License Plate Lamp

The accessory fuse supplies power to the license plate lamp on the (O/W) wire. The license plate lamp illuminates when the ignition is in the ON or ACCY position.

Stop Lamp Switches

The front and rear stop lamp switches control the stop lamp portion of the tail/stop lamp. The front stop lamp switch is a mechanical switch. When the front stop lamp lever is applied, the lever presses a mechanical switch, and closes the contacts on the switch. The rear stop lamp switch is a pressure switch. When the rear stop lamp switch is applied, it generates pressure in the brake fluid. This pressure in the fluid causes the contacts for the rear stop lamp switch to close.

The ACCY fuse supplies power to the stop lamp switches through the (O/W) wire. When the front stop lamp switch closes (front brake lever pulled in), power flows through the switch to the tail/stop lamp through the (R/Y) wire. When the rear stop lamp switch is applied (rear brake pedal pressed), power flows through the switch to the tail/stop lamp.

SYMPTOMS

The lighting circuit may not set DTCs when there is a malfunction. Instead symptoms will appear. Symptoms and the corresponding diagnostics are described in Table 5-4.

Table 5-4. Lighting Symptoms

SYMPTOM	START WITH DIAGNOSTIC PROCEDURE
Both turn signals on one side inoperative, no DTCs	5.4 TURN SIGNALS, Both Turn Signal Lamps on One Side Inoperative, No DTCs
Headlamps inoperative	5.5 HEADLAMPS, Headlamp Inoperative
Running lamps inoperative	5.7 MARKER LAMPS, Running Lamps Inoperative
One turn signal lamp inoperative, no DTCs	5.4 TURN SIGNALS, One Turn Signal Lamp Inoperative, No DTCs
Position lamp inoperative: HDI Only	5.7 MARKER LAMPS, Position Lamp Inoperative: HDI Only
Stop lamps inoperative	5.6 STOP LAMPS, Stop Lamp Inoperative
Turn signals flash at double normal rate	5.4 TURN SIGNALS, Flash at Double Normal Rate
Turn signals will not cancel on turn completion	5.4 TURN SIGNALS, Will Not Cancel Upon Turn Completion

TURN SIGNALS 5.4

TURN SIGNAL FUNCTION

Operation

The basic turn signal operation functions the same way whether you have a TSM, a TSSM, or a HFSM. The accessory fuse supplies power to the left and right turn signal switches. When the turn signal switch is pressed the switch closes and power flows to terminal 8 (left) or terminal 7 (right) of the TSM/TSSM/HFSM. This signals the TSM/TSSM/HFSM to supply voltage and control the flash rate to the turn signals and the turn signal indicator. The turn signals receive power from terminals 5 (left) and 6 (right). If the turn signal switches are pressed at the same time and held down the TSM/TSSM/HFSM initiates the four-way flashers.

Manual Cancellation

If you want to stop the turn signals from flashing, briefly press the turn signal switch a second time.

If you are signalling to turn in one direction and you press the switch for the opposite turn signal, the first signal is cancelled and the opposite side begins flashing.

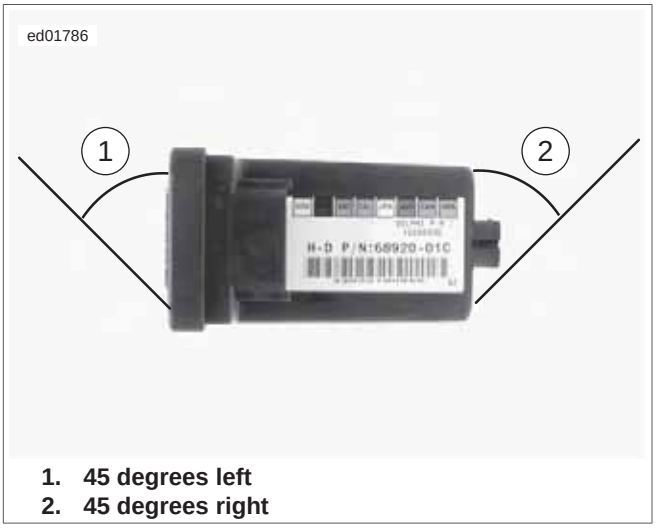
Automatic Cancellation

Press the left or right turn switch to activate automatic turn signal cancellation. There is no need to hold the turn switch in when approaching the turn. The TSM/TSSM/HFSM will not cancel the signal before the turn is actually completed.

- When the directional switch is released, the system starts a 20 count. As long as the vehicle is traveling above 7 mph (11 km/h), the directional will always cancel after 20 flashes if the system does not recognize any other input.
- If the vehicle speed drops to 7 mph (11 km/h) or less, including stopped, the directionals will continue to flash. Counting will resume when vehicle speed reaches 8 mph (12.9 km/h) and will automatically cancel when the count total equals 20 as stated above.
- See Figure 5-7. The turn signals will cancel within two seconds upon turn completion. A sensor inside the TSM/TSSM/HFSM cancels the signal after the vehicle has been returned to an upright position.

NOTE

The bank angle cancellation function has an automatic calibration feature. Ride the vehicle for 0.25 mile (0.4 km) at steady speeds (upright) to calibrate the system. Performance of bank angle function may not be optimal until this calibration is performed. This self-calibration is performed automatically every time the vehicle is started and ridden.



1. 45 degrees left
2. 45 degrees right

Figure 5-7. Tilting TSM/TSSM/HFSM

Four-Way Flashing

Use the following method to activate the four-way flashers:

1. With the ignition switch ON and the security system disarmed (models with security only), press the left and right turn signal switches at the same time.
2. Turn the ignition switch OFF and arm the security system if present and desired. The four-way flashers will continue for two hours.
3. To cancel four-way flashing, disarm the security system if necessary, turn the ignition switch ON and press the left and right turn signal switches at the same time.

This system allows a stranded vehicle to be left in the four-way flashing mode and secured until help is found.

If the security system is disarmed while the four-way flashers are active, the lights will flash as follows:

1. TSSM/HFSM stops four-way flashing mode. Vehicle sits for 1 second with turn signals off.
2. TSSM/HFSM performs disarming confirmation (1 flash).
3. Vehicle sits for 1 second with turn signals off.
4. Vehicle restarts four-way flashing mode.

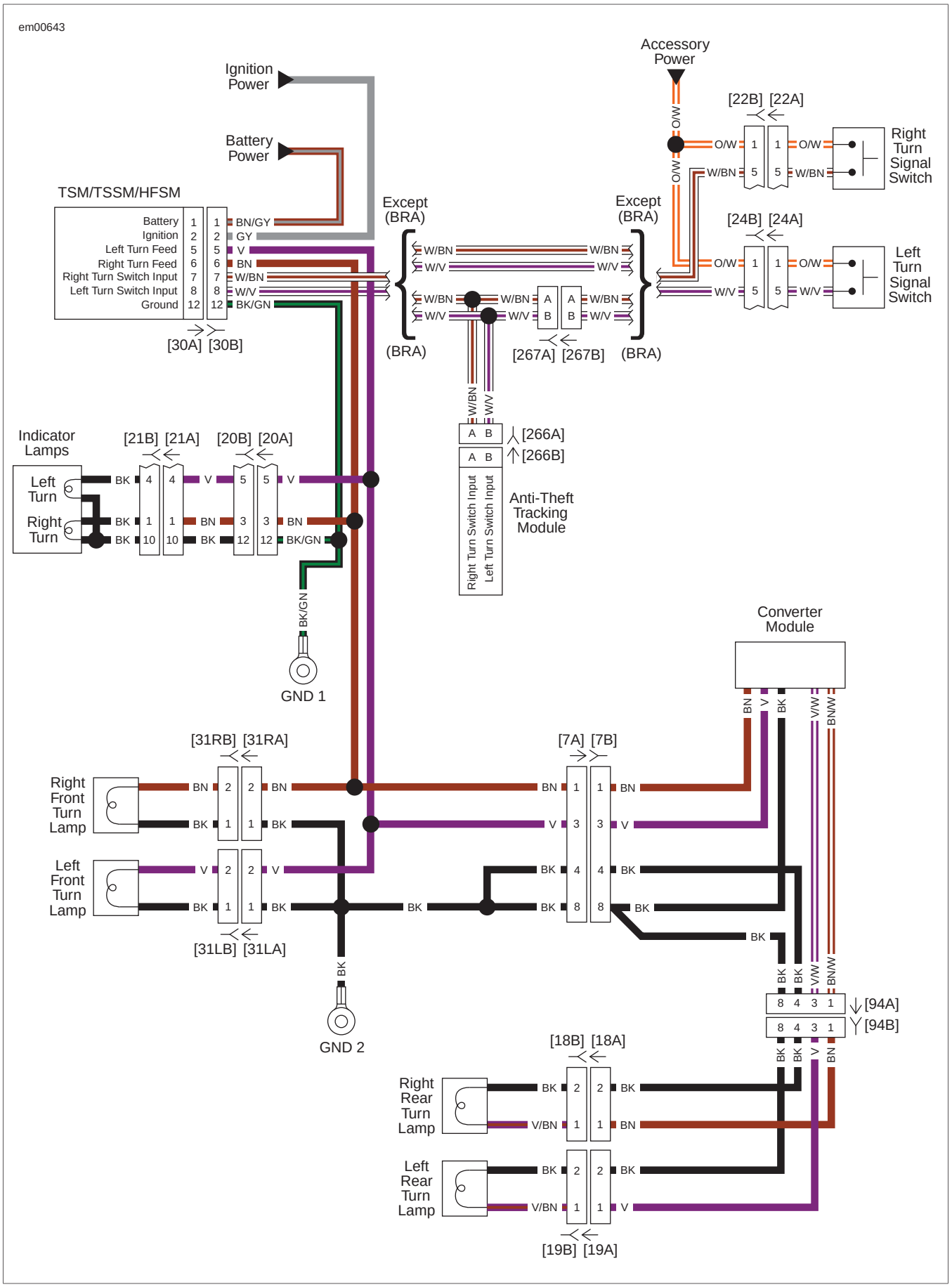


Figure 5-8. Turn Signal Circuit (FXDB)

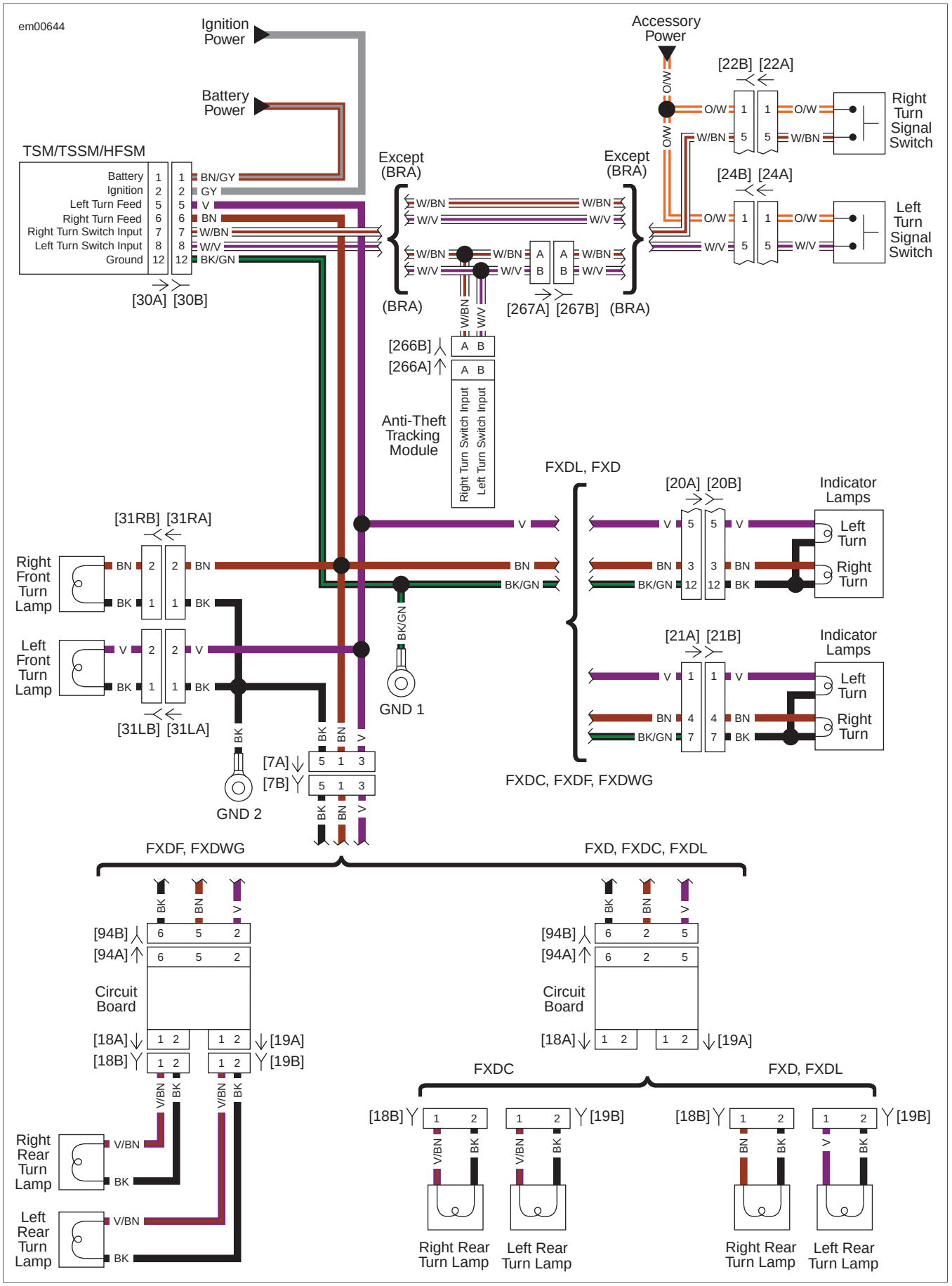


Figure 5-9. Turn Signal Circuit (Except FXDB)

WILL NOT CANCEL UPON TURN COMPLETION

Table 5-5. Will Not Cancel Upon Turn Completion No DTCs Diagnostic Faults

POSSIBLE CAUSES
Improper configuration
TSM/TSSM/HFSM malfunction

1. TSM/TSSM/HFSM Mounting Test

1. Verify TSM/TSSM/HFSM is mounted correctly.
2. Is TSM/TSSM/HFSM mounted properly?
   a. **Yes.** Go to Test 2.
   b. **No.** Mount correctly.

2. Correct Configuration Test

1. Check if TSM/TSSM/HFSM is configured correctly. See 5.13 SERVICE AND EMERGENCY FUNCTIONS AND CONFIGURATIONS.
2. Proper configuration?
   a. **Yes.** Go to Test 3.
   b. **No.** Select proper vehicle configuration.

3. 4-Way Cancellation Test

1. Gain access to the vehicle's TSM/TSSM/HFSM.
2. See Figure 5-7. Position TSM/TSSM/HFSM in the same orientation it is mounted on the vehicle.
3. With IGN ON, turn on 4-way flashers by depressing both left and right turn signal switches at the same time.
4. Turn IGN OFF. The 4-way flashers should continue to flash.
5. Tilt the module greater than 45 degrees to the left.
6. Repeat steps 2-4 then tilt the module greater than 45 degrees to the right.
7. Do 4-way flashers cancel in both directions?
   a. **Yes.** Go to Test 4.
   b. **No.** Replace TSM/TSSM/HFSM. See the service manual. **(6773)**

4. Turn Signals Cancel Test

1. Operate vehicle at a speed greater than 7 mph (11.2 km/h) in a straight line.
2. Activate either turn signal.
3. Turn signals should cancel after 20 flashes.
4. Do turn signals cancel?
   a. **Yes.** System operating properly.
   b. **No.** Go to Test 5.

5. Speedometer Test

1. Does speedometer register vehicle speed?
   a. **Yes.** Replace TSM/TSSM/HFSM. See the service manual. **(6773)**
   b. **No.** See 2.1 INITIAL DIAGNOSTICS.

FLASH AT DOUBLE NORMAL RATE

Table 5-6. Flash at Double Normal Rate, All Bulbs Work No DTCs Diagnostic Faults

POSSIBLE CAUSES
Incorrect lamps
TSM/TSSM/HFSM malfunction
Lamp malfunction

NOTE

Before troubleshooting this issue you should verify that the lamp loads have been learned by:

- *Disconnect the negative battery cable for 1 minute. Reconnect negative battery cable.*
- *Turn IGN OFF-ON.*
- *Activate left turn lamps for 4 or more flashes.*
- *Activate right turn lamps for 4 or more flashes.*

1. Lamp Verification Test

1. Determine correct part number for all installed turn signal bulbs.
2. Verify correct parts are installed on vehicle.
3. Are the correct parts installed?
   a. **Yes.** Go to Test 2.
   b. **No.** Replace with correct bulbs. See the service manual. **(6820)**

2. Bulb Corrosion Test

1. Check for corrosion on bulbs and/or sockets.
2. Is corrosion present?
   a. **Yes.** Go to Test 5.
   b. **No.** Go to Test 3.

3. Lamp Connection Terminal Corrosion Test

1. Check for corrosion on all lamp connection terminals.
2. Is corrosion present?
   a. **Yes.** Go to Test 4.
   b. **No.** Replace TSM/TSSM/HFSM. See the service manual. **(6791)**

4. Verification Test

1. Clean corrosion from wires and terminals.

2. Do lamps flash at normal rate?
   a. **Yes.** System OK. **(6822)**
   b. **No.** Replace TSM/TSSM/HFSM. See the service manual. **(6791)**

5. Lamp Operation Test

1. Remove corrosion with a wire brush.
2. Install ELECTRICAL CONTACT LUBRICANT (Part No. 99861-02) in bulb sockets.
3. Do lamps flash at normal rate?
   a. **Yes.** System OK. **(6822)**
   b. **No.** Go to Test 6.

6. Lamp Assembly Test

1. Clean or replace bulb.
2. Do lamps flash at normal rate?
   a. **Yes.** System OK. **(6822)**
   b. **No.** Replace lamp assembly. See the service manual. **(6823)**

BOTH TURN SIGNAL LAMPS ON ONE SIDE INOPERATIVE, NO DTCS

PART NUMBER	TOOL NAME
HD-41404-B	HARNESS CONNECTOR TEST KIT
HD-42682	BREAKOUT BOX

Table 5-7. Both Turn Signal Lamps on One Side Inoperative, No DTCs Diagnostic Faults

POSSIBLE CAUSES
Open on turn signal inputs
Open accessory circuit
Left turn signal switch malfunction
Right turn signal switch malfunction
TSM/TSSM/HFSM malfunction

1. Left or Right Turn Signal Malfunction Test

1. With IGN ON, operate the left and right turn signals.
2. Are the right turn signals inoperative?
   a. **Yes.** Go to Test 2.
   b. **No.** Go to Test 5.

2. Right Turn Signal Circuit Test

1. With IGN OFF, connect BREAKOUT BOX (Part No. HD-42682) between wire harness connector [30B] and TSM/TSSM/HFSM [30A]. See 1.2 DIAGNOSTIC TOOLS.
2. Turn IGN ON.
3. While pressing the right turn signal switch, using HARNESS CONNECTOR TEST KIT (Part No. HD-41404-B) and a multimeter, test for voltage on breakout box (gray) terminal 7.
4. Is battery voltage present when switch is pressed?
   a. **Yes.** Replace the TSM/TSSM/HFSM. See the service manual.
   b. **No.** Go to Test 3.

3. Right Turn Signal Switch Test

1. Disconnect [22].
2. Test for voltage between [22B] terminal 1 and ground.
3. Is battery voltage present?
   a. **Yes.** Go to Test 4.
   b. **No.** Repair open in (O/W) wire. **(5043)**

4. Right Turn Signal Circuit Continuity Test

1. Turn IGN OFF.
2. Test for continuity between [22B] terminal 5 and breakout box (gray) terminal 7.
3. Is continuity present?
   a. **Yes.** Replace the right turn signal switch. See the service manual. **(6811)**
   b. **No.** Repair open in (W/BN) wire. **(5041)**

5. Left Turn Signal Circuit Test

1. With IGN OFF, connect BREAKOUT BOX (Part No. HD-42682) between wire harness connector [30B] and TSM/TSSM/HFSM [30A]. See 1.2 DIAGNOSTIC TOOLS.
2. Turn IGN ON.
3. While pressing the left turn signal switch, using HARNESS CONNECTOR TEST KIT (Part No. HD-41404-B) and a multimeter, test for voltage on breakout box (gray) terminal 8.
4. Is battery voltage present when switch is pressed?
   a. **Yes.** Replace the TSM/TSSM/HFSM. See the service manual. **(6791)**
   b. **No.** Go to Test 6.

6. Left Turn Signal Switch Test

1. Disconnect [24].
2. Test for voltage between [24B] terminal 1 and ground.
3. Is battery voltage present?
   a. **Yes.** Go to Test 7.
   b. **No.** Repair open in (O/W) wire. **(5043)**

7. Left Turn Signal Circuit Continuity Test

1. Turn IGN OFF.
2. Test for continuity between [24B] terminal 5 and breakout box (gray) terminal 8.
3. Is continuity present?
   a. **Yes.** Replace the right turn signal switch. See the service manual. **(6811)**
   b. **No.** Repair open in (W/V) wire. **(5041)**

ONE TURN SIGNAL LAMP INOPERATIVE, NO DTCS

PART NUMBER	TOOL NAME
HD-34730-2D	FUEL INJECTOR TEST LIGHT
HD-41404-B	HARNESS CONNECTOR TEST KIT

Table 5-8. One Turn Signal Lamp Inoperative, No DTCs Diagnostic Faults

POSSIBLE CAUSES
Open turn signal circuit
Open turn signal ground circuit
Inoperative turn signal
TSM/TSSM/HFSM malfunction

1. Inoperative Signal Location Test

1. With IGN ON, operate the left and right turn signals.
2. Do all the turn signals operate on both sides?
   a. **Yes.** System operating properly.
   b. **No.** Right front turn signal inoperative. Go to Test 2.
   c. **No.** Left front turn signal inoperative. Go to Test 5.
   d. **No.** Right rear turn signal inoperative. Go to Test 8.
   e. **No.** Left rear turn signal inoperative. Go to Test 11.

2. Right Front Turn Signal Bulb Test

1. Remove the right front turn signal bulb.
2. Inspect the bulb.
3. Is the bulb good?
   a. **Yes.** Go to Test 3.
   b. **No.** Replace the bulb. See the service manual. **(6820)**

3. Right Front Turn Signal Circuit Test

1. Disconnect [31R].
2. Using HARNESS CONNECTOR TEST KIT (Part No. HD-41404-B), connect the FUEL INJECTOR TEST LIGHT (Part No. HD-34730-2D) to [31RA] between terminals 1 and 2.
3. Press the right turn signal switch.
4. Does the test light flash?
   a. **Yes.** Replace the right front turn signal. See the service manual. **(6823)**
   b. **No.** Go to Test 4.

4. Right Front Turn Signal Ground Circuit Test

1. Test for voltage between [31RA] terminal 2 and ground.
2. Does the test light flash?
   a. **Yes.** Repair open in (BK) wire between [31RA] terminal 1 and ground. **(5041)**
   b. **No.** Repair open in (BN) wire between [31RA] terminal 2 and TSM/TSSM/HFSM. **(5041)**

5. Left Front Turn Signal Bulb Test

1. Remove the left front turn signal bulb.
2. Inspect the bulb.
3. Is the bulb good?
   a. **Yes.** Go to Test 6.
   b. **No.** Replace the bulb. See the service manual. **(6820)**

6. Left Front Turn Signal Circuit Test

1. Disconnect [31].
2. Using HARNESS CONNECTOR TEST KIT (Part No. HD-41404-B), connect a test light to [31LA] between terminals 1 and 2.
3. Press the left turn signal switch.
4. Does the test light flash?
   a. **Yes.** Replace the left front turn signal. See the service manual. **(6823)**
   b. **No.** Go to Test 7.

7. Left Front Turn Signal Ground Circuit Test

1. Test for voltage between [31LA] terminal 2 and ground.
2. Does the test light flash?
   a. **Yes.** Repair open in (BK) wire between [31LA] terminal 1 and ground. **(5041)**
   b. **No.** Repair open in (V) wire between [31LA] terminal 1 and TSM/TSSM/HFSM. **(5041)**

8. Right Rear Turn Signal Bulb Test

1. Remove the right rear turn signal bulb.
2. Inspect the bulb.
3. Is the bulb good?
   a. **Yes.** Go to Test 9.
   b. **No.** Replace the bulb. See the service manual. **(6820)**

9. Right Rear Turn Signal Circuit Test

1. Disconnect [18].
2. Using HARNESS CONNECTOR TEST KIT (Part No. HD-41404-B), connect a test light to [18A] between terminals 1 and 2.
3. Press the right turn signal switch.
4. Does the test light flash?
   a. **Yes.** Replace the right rear turn signal. See the service manual. **(6823)**
   b. **No.** Go to Test 10.

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10. Right Rear Turn Signal Ground Circuit Test

1. Disconnect [94].
2. Connect a test light between [94A] terminals 1 and 4 (FXDB) or [94B] terminals 2 and 6 (except FXDB).
3. Does the test light flash?
   a. **Yes.** Repair open in (BK) or (BN) wire between [94] and [18] (FXDB). **(5041)**
   b. **Yes.** Replace circuit board (Except FXDB). See the service manual. **(5215)**
   c. **No.** Go to Test 14.

11. Left Rear Turn Signal Bulb Test

1. Remove the left rear turn signal bulb.
2. Inspect the bulb.
3. Is the bulb good?
   a. **Yes.** Go to Test 12.
   b. **No.** Replace the bulb. See the service manual. **(6820)**

12. Left Rear Turn Signal Circuit Test

1. Disconnect [19].
2. Using HARNESS CONNECTOR TEST KIT (Part No. HD-41404-B), connect a test light to [19A] between terminals 1 and 2.
3. Press the left turn signal switch.
4. Does the test light flash?
   a. **Yes.** Replace the left rear turn signal. See the service manual. **(6823)**
   b. **No.** Go to Test 13.

13. Left Rear Turn Signal Ground Circuit Test

1. Disconnect [94].
2. Connect a test light between [94A] terminals 3 and 8 (FXDB) or [94B] terminals 5 and 6 (Except FXDB).
3. Does the test light flash?
   a. **Yes.** Repair open in (BK) or (V) wire between [94A] and [19]. **(5041)**
   b. **Yes.** Replace circuit board (Except FXDB). See the service manual. **(5215)**
   c. **No.** Go to Test 16.

14. Right Turn Signal Wiring Test

1. Disconnect [7].
2. Connect a test light between [7A] terminals 1 and 4 (FXDB) or 1 and 5 (Except FXDB).
3. Does the test light flash?
   a. **Yes.** Replace the converter module (FXDB). See the service manual. **(6809)**
   b. **Yes.** Repair open in (BN) wire between [7] and [94] (except FXDB). **(5041)**
   c. **No.** Go to Test 15.

15. Right Turn Signal Ground Test

1. Connect a test light between [7A] terminals 1 and ground.
2. Does the test light flash?
   a. **Yes.** Repair open in (BK) wire between [7A] and the turn signal switch. **(5041)**
   b. **No.** Repair open in (BN) wire between [7A] and the turn signal switch. **(5041)**

16. Left Turn Signal Wiring Test

1. Disconnect [7].
2. Connect a test light between [7A] terminals 3 and 4 (FXDB) or 3 and 5 (Except FXDB).
3. Does the test light flash?
   a. **Yes.** Replace the converter module (FXDB). See the service manual. **(6809)**
   b. **Yes.** Repair open in (V) wire between [7] and [94] (except FXDB). **(5041)**
   c. **No.** Go to Test 17.

17. Left Turn Signal Ground Test

1. Connect a test light between [7A] terminals 3 and ground.
2. Does the test light flash?
   a. **Yes.** Repair open in (BK) wire between [7A] and the turn signal switch. **(5041)**
   b. **No.** Repair open in (V) wire between [7A] and the turn signal switch. **(5041)**

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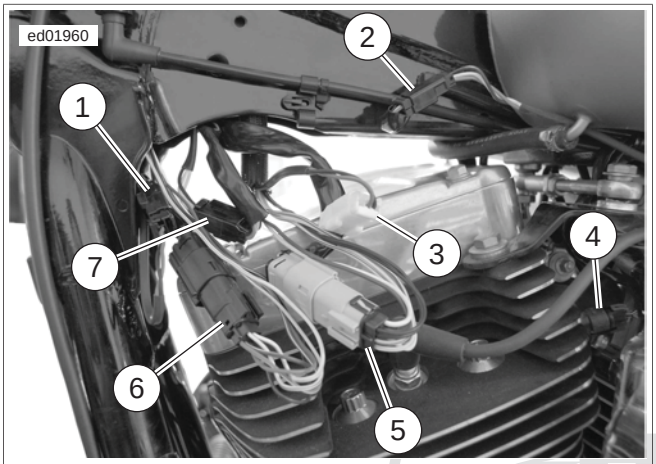
HEADLAMPS 5.5

DESCRIPTION AND OPERATION

When the ignition is turned ON the headlamp switch receives power through the lights fuse.

- In the low position, the headlamp switch directs voltage through the (Y) wire to illuminate the low beam headlamp.
- In the high position, voltage is directed through the (W) wire to the high beam headlamp and the high beam indicator.



1. **Front turn signals (right) [31R]**
2. **Fuel gauge [117]**
3. **Front turn signals (left) [31L]**
4. **ET sensor [90]**
5. **Left hand controls and horn [24]**
6. **Right hand controls [22]**
7. **Headlamp [38]**

Figure 5-10. Under Fuel Tank Left Side

Diagnostic Tips

If the lights fuse is open, test for short to ground on (BE) wire from the fuse to the headlamp switch. Also, check for a short to ground on the (W) wire from the headlamp switch. If this circuit is grounded, it will open the fuse when the headlamp switch is in the high position.

Connector Information

For additional information about the connectors in the following diagram(s) and diagnostic procedure(s), including the color of the harness test kit terminal probes, see B.1 CONNECTORS.

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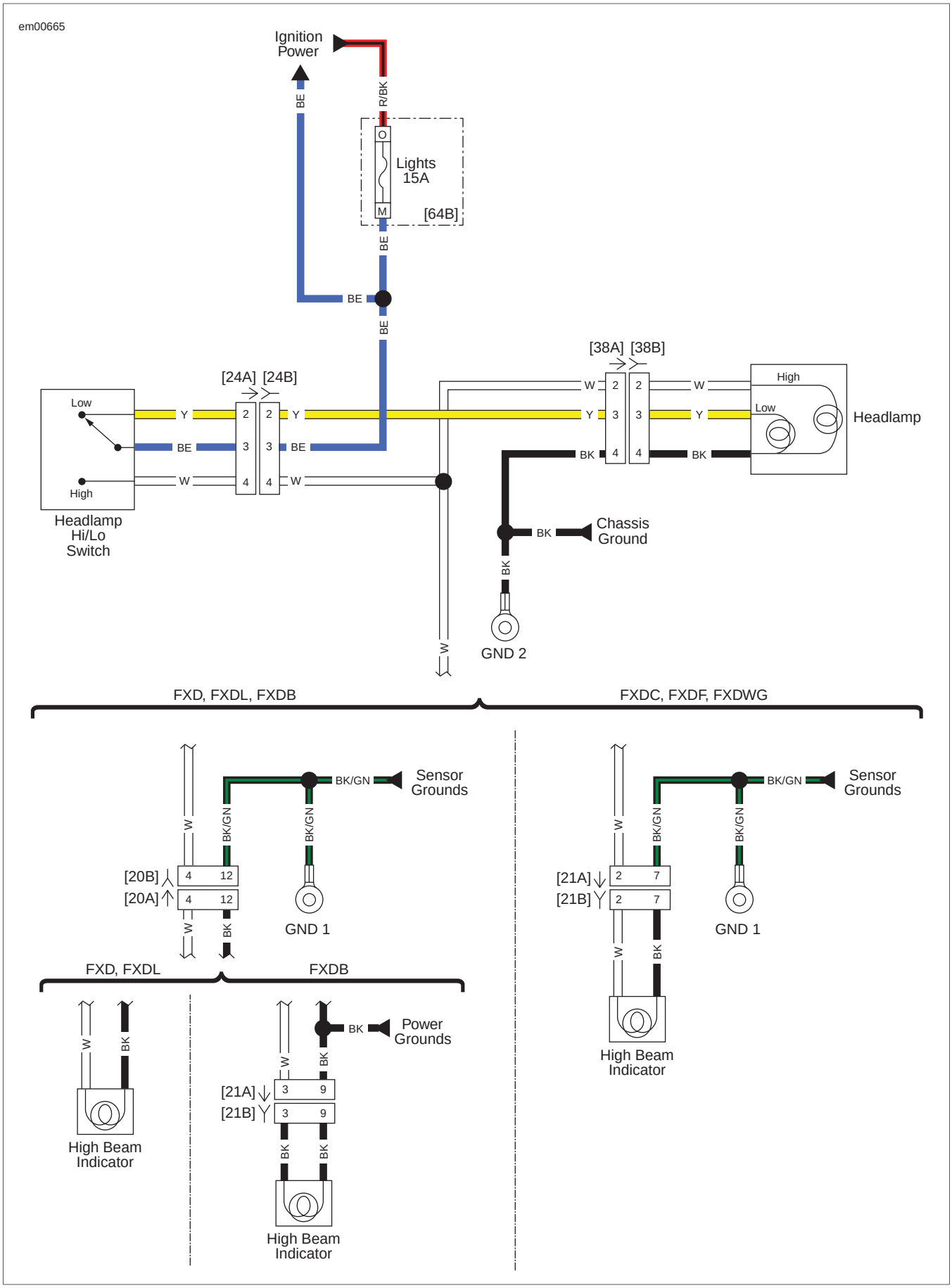


Figure 5-11. Headlamp and Running Lamps

HEADLAMP INOPERATIVE

PART NUMBER	TOOL NAME
HD-41404-B	HARNESS CONNECTOR TEST KIT

Table 5-9. Headlamp Inoperative No DTCs Diagnostic Faults

POSSIBLE CAUSES
Open fuse
Open power to switch circuit
Headlamp Hi/Lo switch malfunction
Open ground circuit
Open high beam power circuit
Open low beam power circuit
Headlamp malfunction

1. Operational Test

1. Turn IGN ON.
2. Move the headlamp switch to the high and low positions.
3. Do the headlamps work in both positions?
   a. **Yes.** Concern is intermittent perform wiggle test. See 1.3 DIAGNOSTICS AND TROUBLESHOOTING, Wiggle Test.
   b. **No.** High beam headlamp inoperative. Go to Test 2.
   c. **No.** Low beam headlamp inoperative. Go to Test 5.
   d. **No.** Both headlamps inoperative. Go to Test 7.

2. High Beam Indicator Test

1. With the headlamp Hi/Lo switch in the high position, observe the high beam indicator lamp.
2. Does the high beam indicator illuminate?
   a. **Yes.** Go to Test 4.
   b. **No.** Go to Test 3.

3. Headlamp Hi/Lo Switch Test

1. With IGN OFF, disconnect [24].
2. Using a HARNESS CONNECTOR TEST KIT (Part No. HD-41404-B), jumper [24B] terminals 3 and 4 together.
3. Turn IGN ON.
4. Does the high beam headlamp operate?
   a. **Yes.** Replace the left switch assembly. See the service manual. **(5171)**
   b. **No.** Repair open in (W) wire between [24B] and indicator. **(5041)**

4. High Beam Headlamp Test

1. Disconnect the headlamp.
2. With the IGN ON, and the headlamp Hi/Lo switch in the high position using HARNESS CONNECTOR TEST KIT (Part No. HD-41404-B) and a multimeter, test for voltage between [38A] terminals 2 and 4.
3. Is battery voltage present?
   a. **Yes.** Replace the headlamp. See the service manual. **(5185)**
   b. **No.** Repair open in (W) wire to headlamp. **(5041)**

5. Headlamp Hi/Lo Switch Test

1. With the IGN OFF, disconnect [24].
2. Using a HARNESS CONNECTOR TEST KIT (Part No. HD-41404-B), jumper [24B] terminals 2 and 3 together.
3. Turn IGN ON.
4. Does the low beam headlamp operate?
   a. **Yes.** Replace the left switch assembly. See the service manual. **(5171)**
   b. **No.** Go to Test 6.

6. Low Beam Headlamp Test

1. Connect [24].
2. Disconnect the headlamp.
3. With the headlamp Hi/Lo switch in the low position using HARNESS CONNECTOR TEST KIT (Part No. HD-41404-B) and a multimeter, test for voltage between terminals 3 and 4 of [38A].
4. Is battery voltage present?
   a. **Yes.** Replace the headlamp. See the service manual. **(5185)**
   b. **No.** Repair open in (Y) wire to headlamp. **(5041)**

7. High Beam Indicator Test

1. With the headlamp Hi/Lo switch in the high position, observe the high beam indicator lamp.
2. Does the high beam indicator illuminate?
   a. **Yes.** Go to Test 8.
   b. **No.** Go to Test 9.

8. Headlamp Test

1. Disconnect the headlamp.
2. With the IGN ON, and the headlamp Hi/Lo switch in the high position test for voltage between [38A] terminals 2 and 4.
3. Is battery voltage present?
   a. **Yes.** Replace the headlamp. See the service manual. **(5185)**
   b. **No.** Repair open in (BK) wire between headlamp and ground. **(5041)**

9. Ignition Power Circuit Test

1. With IGN ON, observe the tail lamp.

2. Is the tail lamp illuminated?
   a. **Yes.** Go to Test 10.
   b. **No.** Go to Test 11.

10. Headlamp Hi/Lo Switch Test

1. With the IGN OFF, disconnect [24].
2. Using a HARNESS CONNECTOR TEST KIT (Part No. HD-41404-B), jumper [24B] terminals 2 and 3 together.
3. Turn IGN ON.
4. Does the low beam headlamp operate?
   a. **Yes.** Replace the left switch assembly. See the service manual. **(5171)**
   b. **No.** Repair open in (BE) wire to [24B]. **(5039)**

11. Lights Fuse Test

1. Inspect the lights fuse.
2. Is the fuse good?
   a. **Yes.** Go to Test 12.
   b. **No.** Go to Test 13.

12. Power Circuit Test

1. Test for voltage on [61B] socket terminal G of the lights fuse.
2. Is battery voltage present?
   a. **Yes.** Repair open in (BE) wire between fuse block and headlamp Hi/Lo switch. **(5039)**
   b. **No.** Repair open in (R/BK) wire. **(5041)**

13. Power Circuit Short to Ground Test

1. With IGN OFF, remove the lights fuse.
2. Disconnect [24].
3. Measure resistance between [24B] terminal 3 and ground.
4. Is resistance less than 10 Ohms?
   a. **Yes.** Go to Test 14.
   b. **No.** Go to Test 17.

14. Tail Lamp Test

1. Disconnect [94] or [7].
2. Measure resistance between [24B] terminal 3 and ground.
3. Is resistance less than 10 Ohms?
   a. **Yes.** Go to Test 15.
   b. **No.** Go to Test 16.

15. Front Turn Signal Test

1. Disconnect [31].
2. Measure resistance between [24B] terminal 3 and ground.
3. Is resistance less than 10 Ohms?
   a. **Yes.** Repair short to ground in (BE) wire between [24B] and fuse block. **(5039)**
   b. **No.** Repair short to ground in front turn signal. **(5041)**

16. Rear Turn Signal Test

1. Connect [94] or [7].
2. Disconnect [93] (single tail lamp) or [18] and [19] dual tail lamp.
3. Measure resistance between [93A] terminal 1 and ground (single tail lamp) or [18A] and [19A] terminal 3 (dual tail lamp).
4. Is resistance less than 10 Ohms?
   a. **Yes.** Replace the circuit board (single stop lamp). See the service manual. **(5215)**
   b. **Yes.** Replace the converter module (dual tail lamps DOM). **(6809)**
   c. **Yes.** Repair short to ground in (O/W) wire between [7B] and tail lamps (dual tail lamps HDI). **(5039)**
   d. **No.** Replace tail/stop lamp assembly. See the service manual. **(5215)**

17. Low Beam Circuit Short to Ground Test

1. Measure resistance between [24B] terminal 2 and ground.
2. Is resistance less than 10 Ohms?
   a. **Yes.** Repair short to ground in (Y) low beam circuit. **(5041)**
   b. **No.** Go to Test 18.

18. High Beam Circuit Short to Ground Test

1. Measure resistance between [24B] terminal 4 and ground.
2. Is resistance less than 10 Ohms?
   a. **Yes.** Go to Test 19.
   b. **No.** Intermittent short perform wiggle test. See 1.3 DIAGNOSTICS AND TROUBLESHOOTING, Wiggle Test. Replace lights fuse and verify repair.

19. Indicator Short to Ground Test

1. Disconnect the [20].
2. Using HARNESS CONNECTOR TEST KIT (Part No. HD-41404-B) and a multimeter, measure resistance between [24B] terminal 4 and ground.
3. Is resistance less than 10 Ohms?
   a. **Yes.** Repair short to ground in (W) high beam circuit. **(5041)**
   b. **No.** Repair or replace the indicator harness. See the service manual. **(5191)**

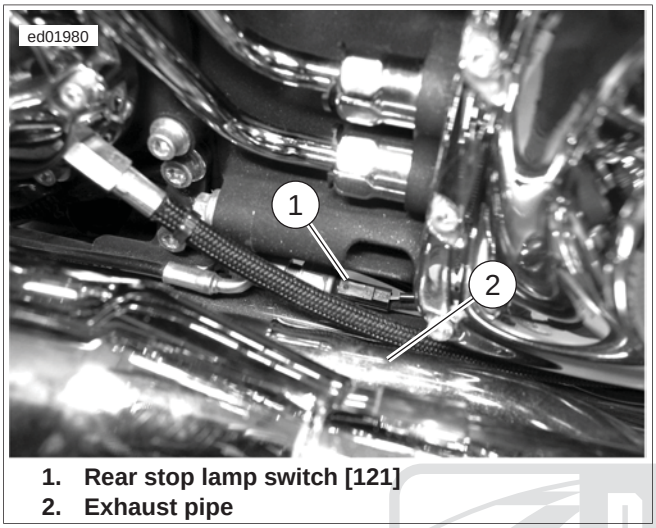
DIGITAL TECHNICIAN HARLEY-DAVIDSON

STOP LAMPS 5.6

DESCRIPTION AND OPERATION

The front stop lamp switch is a mechanical switch located under the fluid reservoir on the right handlebar. See Figure 5-12. The rear stop lamp switch is a pressure switch located under the left side cover.

The stop lamp switches receive power through the accessories fuse. When the front or rear stop lamp switch is applied, voltage travels through the switch to the tail/stop lamp.



1. **Rear stop lamp switch [121]**
2. **Exhaust pipe**

Figure 5-12. Rear Stop Lamp Switch [121]

Diagnostic Tips

When testing for a short to ground due to an open fuse, check the (R/Y) wire between the brake switches and the stop lamp. A short to ground on these wires causes the fuse to open only when the brake switches are closed. A short to ground in the (Y/BK) wire between the horn switch and the horn causes this fuse to open when the horn switch is pressed and needs to be checked for a short to ground as well.

Connector Information

For additional information about the connectors in the following diagram(s) and diagnostic procedure(s), including the color of the harness test kit terminal probes, see B.1 CONNECTORS.

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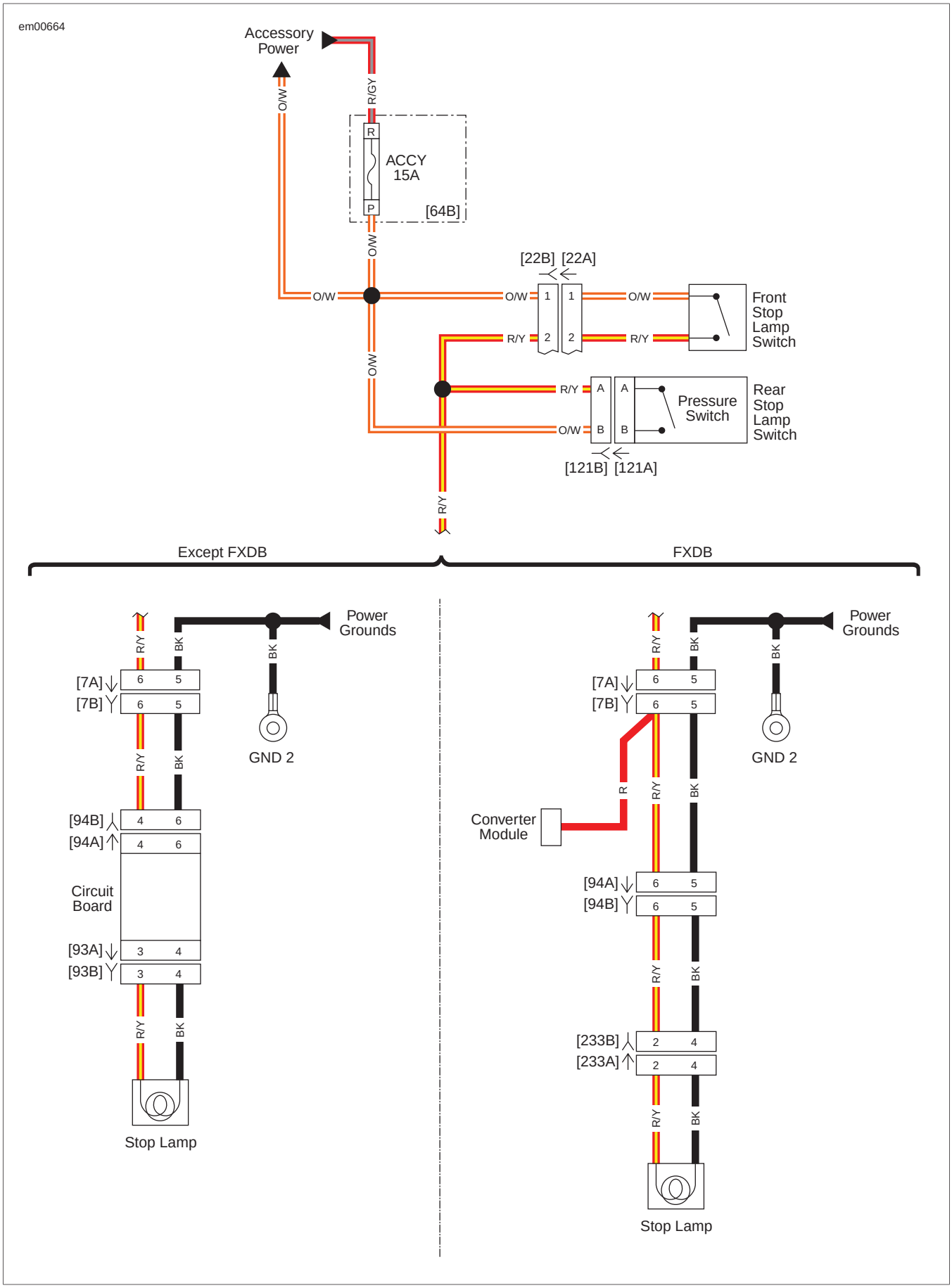

Figure 5-13. Tail/Stop and Turn Signal Lamps

STOP LAMP INOPERATIVE

PART NUMBER	TOOL NAME
HD-41404-B	HARNESS CONNECTOR TEST KIT

Table 5-10. Stop Lamp Inoperative Diagnostic Faults

POSSIBLE CAUSES
Open fuse
Short in stop lamp circuit
Open power to switch circuit
Open ground circuit
Open stop lamp circuit
Stop lamp malfunction
Rear stop lamp switch malfunction
Front stop lamp switch malfunction

1. Accessory Circuit Test

1. Turn IGN to ACC.
2. Do the instruments illuminate?
   a. **Yes.** Go to Test 8.
   b. **No.** Go to Test 2.

2. Accessories Fuse Test

1. Inspect the ACCY fuse.
2. Is the fuse good?
   a. **Yes.** Go to Test 3.
   b. **No.** Go to Test 5.

3. Accessory Circuit from Ignition Switch Test

1. With IGN in ACC, using HARNESS CONNECTOR TEST KIT (Part No. HD-41404-B) and a multimeter, test for voltage between [64B] socket terminal P and ground.
2. Is battery voltage present?
   a. **Yes.** Repair open in (O/W) wire from ACCY fuse. **(5043)**
   b. **No.** Go to Test 4.

4. Ignition Switch Test

1. Inspect for open or damaged wires between the ignition switch and the accessory fuse.
2. Was any damage to the wiring found?
   a. **Yes.** Repair open between [64B] socket terminal R and ignition switch. **(5041)**
   b. **No.** Replace the ignition switch. See the service manual. **(7287)**

5. Accessory Circuit Resistance Test

1. With the accessories fuse removed, using HARNESS CONNECTOR TEST KIT (Part No. HD-41404-B) and a multimeter, measure resistance between [64B] socket terminal P and ground.
2. Is resistance less than 10 Ohms?
   a. **Yes.** Go to Test 6.
   b. **No.** See diagnostic tips. Replace accessories fuse and verify repair.

6. Speedometer Test

1. Disconnect the speedometer [39].
2. Measure resistance between [64B] socket terminal P and ground.
3. Is resistance less than 10 Ohms?
   a. **Yes.** Without tachometer. Repair short to ground in accessory circuit (O/W) wire. **(5043)**
   b. **Yes.** With tachometer. Go to Test 7.
   c. **No.** Replace the speedometer. See the service manual. **(6765)**

7. Tachometer Test

1. Disconnect the tachometer [108].
2. Measure resistance between [64B] socket terminal P and ground.
3. Is resistance less than 10 Ohms?
   a. **Yes.** Repair short to ground in accessory circuit (O/W) wire. **(5043)**
   b. **No.** Replace the tachometer. See the service manual. **(6772)**

8. Stop Lamp Switch Test

1. Apply the front stop lamp switch while observing the stop lamp.
2. Apply the rear stop lamp switch while observing the stop lamp.
3. Does the stop lamp illuminate?
   a. **Yes.** Stop lamp illuminates only with front stop lamp switch applied. Go to Test 11.
   b. **Yes.** Stop lamp illuminates only with rear stop lamp switch applied. Go to Test 13.
   c. **No.** Go to Test 9.

9. Tail Stop Lamp Test

1. Disconnect [94] (single stop lamp) or [7] (dual stop lamps).
2. With one of the stop lamp switches applied test for voltage between [94B] (single stop lamp) or [7A] (dual stop lamps) terminals 4 and 6.
3. Is battery voltage present?
   a. **Yes.** Single stop lamp. Go to Test 15.
   b. **Yes.** Dual stop lamps. Go to Test 17.
   c. **No.** Go to Test 10.

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10. Stop Lamp Ground Test

1. With one of the stop lamp switches applied test for voltage between [94B] (single stop lamp) or [7B] (dual stop lamps) terminal 4 and ground.
2. Is battery voltage present?
   a. **Yes.** Repair open in the (BK) ground wire between stop lamp and GND 1. **(5041)**
   b. **No.** Repair open in (R/Y) wire between stop lamp switches and stop lamp. **(5041)**

11. Rear Stop Lamp Switch Test

1. Disconnect [121].
2. Jumper [121B] terminals A and B together.
3. Turn IGN ON.
4. Does the brake lamp illuminate?
   a. **Yes.** Replace the rear stop lamp switch. See the service manual. **(5141)**
   b. **No.** Go to Test 14.

12. Rear Stop Lamp Switch ACCY Circuit Test

1. Test for voltage between [121B] terminal B and ground.
2. Is battery voltage present?
   a. **Yes.** Repair open in (R/Y) wire between rear stop lamp switch and stop lamp. **(5041)**
   b. **No.** Repair open in (O/W) wire. **(5043)**

13. Front Stop Lamp Switch Test

1. With IGN OFF, disconnect [22].
2. Using HARNESS CONNECTOR TEST KIT (Part No. HD-41404-B) jumper [22B] terminals 1 and 2 together.
3. Turn IGN ON.
4. Does the brake lamp illuminate?
   a. **Yes.** Replace front stop lamp switch. See the service manual. **(5176)**
   b. **No.** Go to Test 14.

14. Front Stop Lamp Switch ACCY Circuit Test

1. Test for voltage between [22B] terminal 1 and ground.
2. Is battery voltage present?
   a. **Yes.** Repair open in (R/Y) wire between front stop lamp switch and stop lamp. **(5041)**
   b. **No.** Repair open in (O/W) wire. **(5043)**

15. Stop Lamp Bulb Test

1. Inspect the stop lamp bulb.
2. Is the bulb good?
   a. **Yes.** Go to Test 16.
   b. **No.** Replace the stop lamp bulb. See the service manual. **(5197)**

16. Circuit Board Test

1. Connect [94].
2. Disconnect [93].
3. With one of the stop lamp switches applied test for voltage at [93A] between terminals 3 and 4.
4. Is battery voltage present?
   a. **Yes.** Replace the tail lamp socket assembly. See the service manual. **(5215)**
   b. **No.** Replace the circuit board. See the service manual. **(5215)**

17. Stop Lamp Verification Test

1. Connect [7].
2. Apply either stop lamp switch while observing the stop lamps.
3. Are both stop lamps inoperative?
   a. **Yes.** Replace the tail lamp converter module. **(6809)**
   b. **No.** Go to Test 18.

18. Stop Lamp Circuit Test

NOTE

Depending on the model the stop lamps may be LEDs or conventional bulbs. If conventional bulbs are present inspect the bulbs and replace as needed.

1. Disconnect inoperative stop lamp [18] right or [19] left.
2. With the stop lamp switch applied test for voltage at [18] right or [19] left between terminals 1 and 2 (DOM) or terminals 1 and 4 (except DOM).
3. Is voltage present?
   a. **Yes.** Replace turn signal. See the service manual. **(6823)**
   b. **No.** (FXDB). Replace the tail lamp converter module. See the service manual. **(6809)**
   c. **No.** (Except DOM). Go to Test 19.

19. Stop Lamp Circuit Ground Test

1. With the stop lamp switch applied test for voltage at [18] right or [19] left between terminal 4 and ground.
2. Is voltage present?
   a. **Yes.** Repair open in (BK) wire between [7] and [18] right or [19] left. **(5041)**
   b. **No.** Repair open in (R/Y) wire between [7] and [18] right or [19] left. **(5041)**

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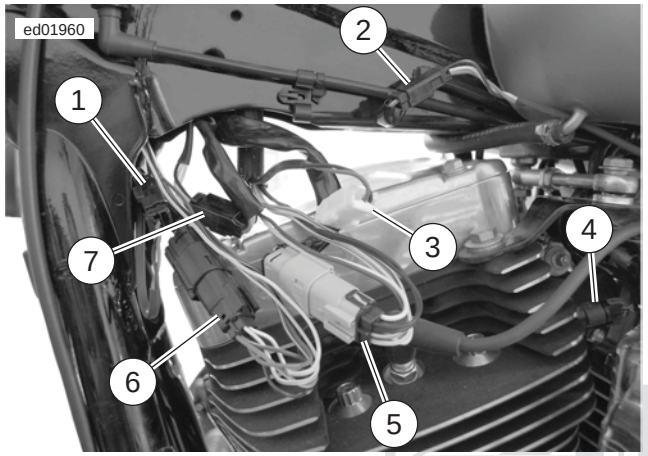
MARKER LAMPS 5.7

DESCRIPTION AND OPERATION

See Figure 5-14. The headlamp connector is located under the left side of the fuel tank.

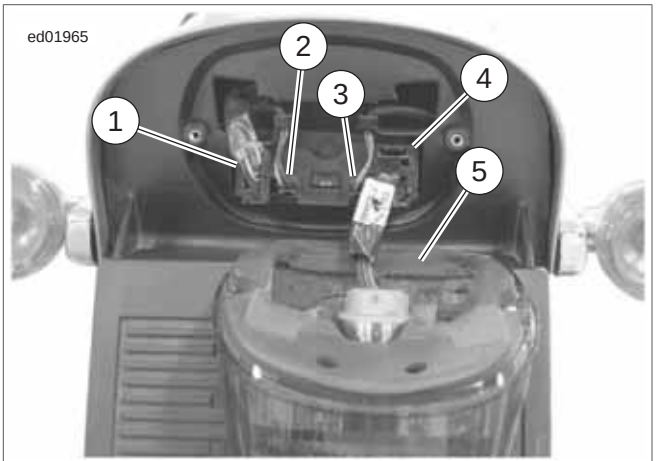
See Figure 5-15. The rear tail/stop lamp and license plate lamp connectors are located behind the tail lamp in the circuit board.

The running lamps consist of the front position lamp (HDI), located in the headlamp housing, the license plate lamp, and the tail lamp. The running lamps are powered through the accessory fuse when the ignition switch is in the ON or ACCY position.



1. **Front turn signals (right) [31R]**
2. **Fuel gauge [117]**
3. **Front turn signals (left) [31L]**
4. **ET sensor [90]**
5. **Left hand controls and horn [24]**
6. **Right hand controls [22]**
7. **Headlamp [38]**

Figure 5-14. Under Fuel Tank Left Side



1. **Tail lamp power in [94]**
2. **Right rear turn signal [18]**
3. **Left rear turn signal [19]**
4. **Tail lamp [93]**
5. **Tail lamp**

Figure 5-15. Tail Lamp: FXDF

Connector Information

For additional information about the connectors in the following diagram(s) and diagnostic procedure(s), including the color of the harness test kit terminal probes, see B.1 CONNECTORS.

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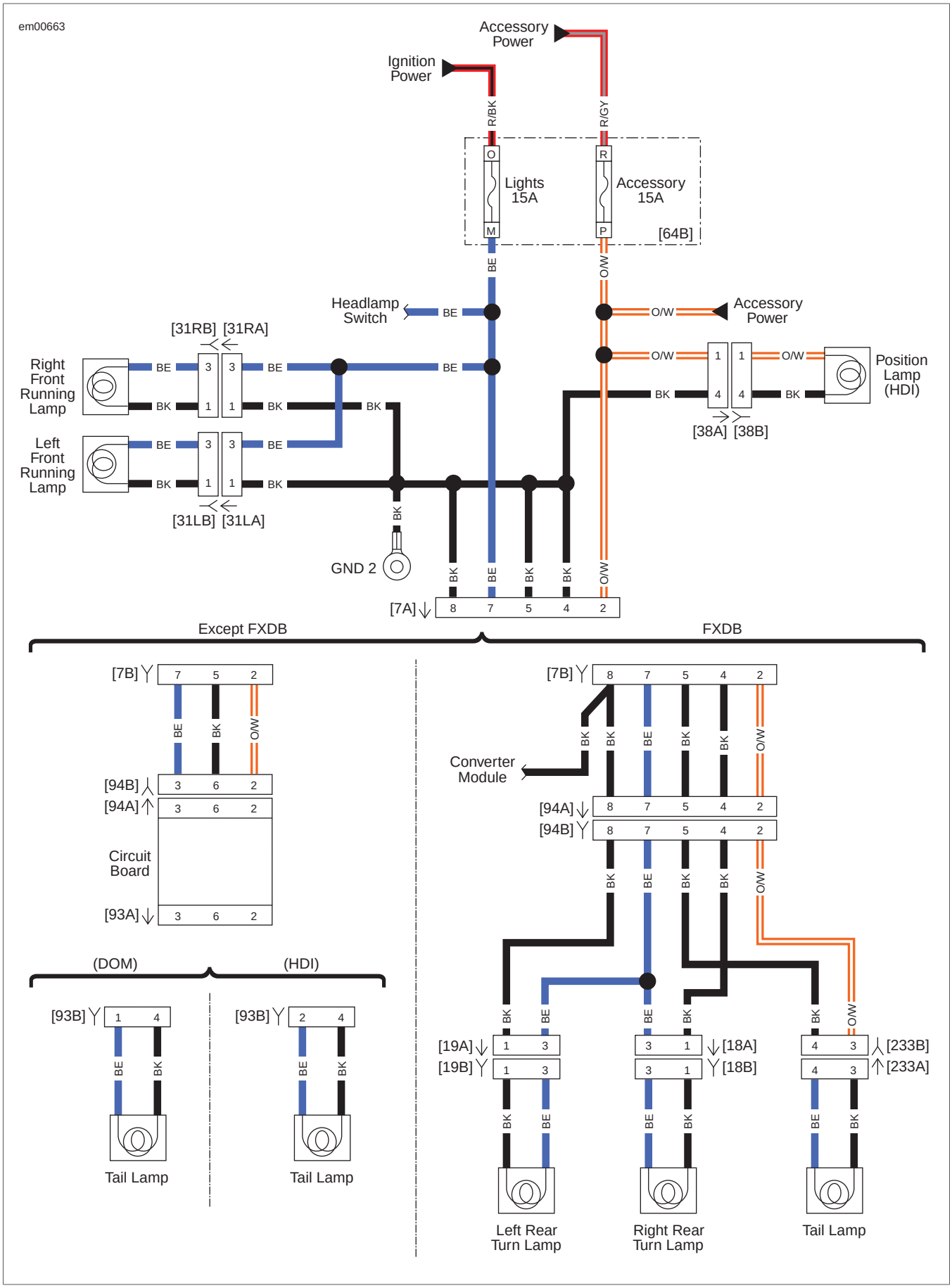


Figure 5-16. Running Lamps

POSITION LAMP INOPERATIVE: HDI ONLY

PART NUMBER	TOOL NAME
HD-41404-B	HARNESS CONNECTOR TEST KIT

Table 5-11. Position Lamp Inoperative (HDI) Diagnostic Faults

POSSIBLE CAUSES
Open accessory circuit
Lamp malfunction
Open ground

1. Accessory Circuit Test

1. Turn the IGN to ACC.
2. Apply either the front or rear stop lamp switch.
3. Does the stop lamp illuminate?
   a. **Yes.** Go to Test 2.
   b. **No.** See 5.6 STOP LAMPS, Stop Lamp Inoperative.

2. Position Lamp Test

1. Disconnect [38].
2. With the IGN ON, using HARNESS CONNECTOR TEST KIT (Part No. HD-41404-B) and a multimeter, test for voltage between [38A] terminals 1 and 4.
3. Is battery voltage present?
   a. **Yes.** Replace position lamp. See the service manual. **(5143)**
   b. **No.** Go to Test 3.

3. Ground Circuit Test

1. Test for voltage between [38] terminal 1 and ground.
2. Is battery voltage present?
   a. **Yes.** Repair open in (BK) ground wire. **(5041)**
   b. **No.** Repair open in (O/W) wire. **(5043)**

RUNNING LAMPS INOPERATIVE

PART NUMBER	TOOL NAME
HD-41404-B	HARNESS CONNECTOR TEST KIT

Table 5-12. Running Lamps Inoperative Diagnostic Faults

POSSIBLE CAUSES
Open lights circuit
Lamp malfunction
Open ground

1. Lights Circuit Test

1. Turn the IGN ON.
2. Does the headlamp illuminate?
   a. **Yes.** Go to Test 2.
   b. **No.** See 5.5 HEADLAMPS, Headlamp Inoperative.

2. Stop Lamp Test

1. Apply either stop lamp switch.
2. Does the stop lamp illuminate?
   a. **Yes.** Go to Test 3.
   b. **No.** See 5.6 STOP LAMPS, Stop Lamp Inoperative.

3. Tail Lamp Inspection Test

1. Inspect the tail lamp.
2. Is the bulb good?
   a. **Yes.** Go to Test 4.
   b. **No.** Replace the bulb. **(5197)**

4. Running Lamps Circuit Test

1. Disconnect [94].
2. With the IGN ON, using HARNESS CONNECTOR TEST KIT (Part No. HD-41404-B) and a multimeter, test for voltage between [94A] terminals 2 and 5 (FXDB) or 3 and 6 (Except FXDB).
3. Is battery voltage present?
   a. **Yes.** Go to Test 5. (Except FXDB)
   b. **Yes.** Go to Test 6. (FXDB only)
   c. **No.** Repair open in (BE) or (O/W) wire [94A] terminal 2 (FXDB) or 3 (Except FXDB). **(5039)**

5. Tail Lamp Test: Except FXDB

1. Connect [94].
2. Disconnect [93].
3. Connect a test light between [93] terminals 1 and 4 (DOM) or 2 and 4 (HDI).
4. With the running lamps on does the test light illuminate?
   a. **Yes.** Repair or replace the tail lamp assembly. See the service manual.
   b. **No.** Replace the circuit board. See the service manual.

6. Tail Lamp Test: FXDB

1. Connect [94].
2. Disconnect [233].
3. Connect a test light between [233] terminals 3 and 4.
4. With the running lamps on does the test light illuminate?
   a. **Yes.** Repair or replace the tail lamp assembly. See the service manual. **(5215)**
   b. **No.** Repair open in (O/W) or (BK) wire between [94] and [233]. **(5043)**

DIGITAL TECHNICIAN II HARLEY-DAVIDSON

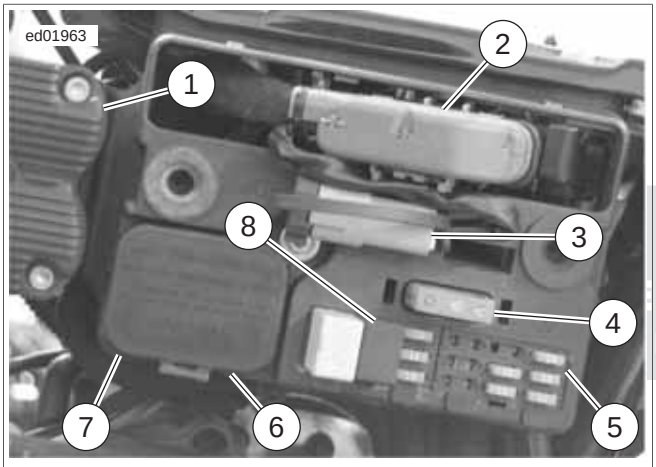
DTC B1121, B1122, B1123, B1124, B1125, B1126 5.8

GENERAL

See Figure 5-17. The TSM/TSSM/HFSM is located under the left side cover. It receives battery power through terminal 1 and ignition power through terminal 2. The ground for the TSM/TSSM/HFSM is through terminal 12. The TSM/TSSM/HFSM communicates with the other modules on the vehicle through the serial data circuit from terminal 3.

The turn signal switches are inputs to the TSM/TSSM/HFSM. When the TSM/TSSM/HFSM receives voltage from either of the turn signal switches it supplies voltage to the corresponding turn signal lamps and the correct turn signal indicator.

The TSM/TSSM/HFSM also monitors the position of the clutch and neutral switches to determine if it is safe to start the vehicle. The BAS is internal to the TSM/TSSM/HFSM and allows the TSM/TSSM/HFSM to determine if the vehicle is tipped over. If a tip over event occurs, the TSM/TSSM/HFSM shuts off the engine.



1. **Ignition coil**
2. **ECM [78]**
3. **DLC [91]**
4. **Main fuse [5]**
5. **Fuse block [64]**
6. **TSM/TSSM/HFSM**
7. **HFSM antenna harness [208]**
8. **Fuse/relay block [62]**

Figure 5-17. Under Left Side Cover

The TSM/TSSM/HFSM monitors the output circuits and sets DTCs if faults are detected.

Table 5-13. Turn Signal DTCs

DTC	DESCRIPTION
B1121	Left turn output fault
B1122	Right turn output fault
B1123	Left turn signal short-to-ground (HFSM only)
B1124	Right turn signal short-to-ground (HFSM only)
B1125	Left turn signal short-to-voltage (HFSM only)
B1126	Right turn signal short-to-voltage (HFSM only)

Connector Information

For additional information about the connectors in the following diagram(s) and diagnostic procedure(s), including the color of the harness test kit terminal probes, see B.1 CONNECTORS.

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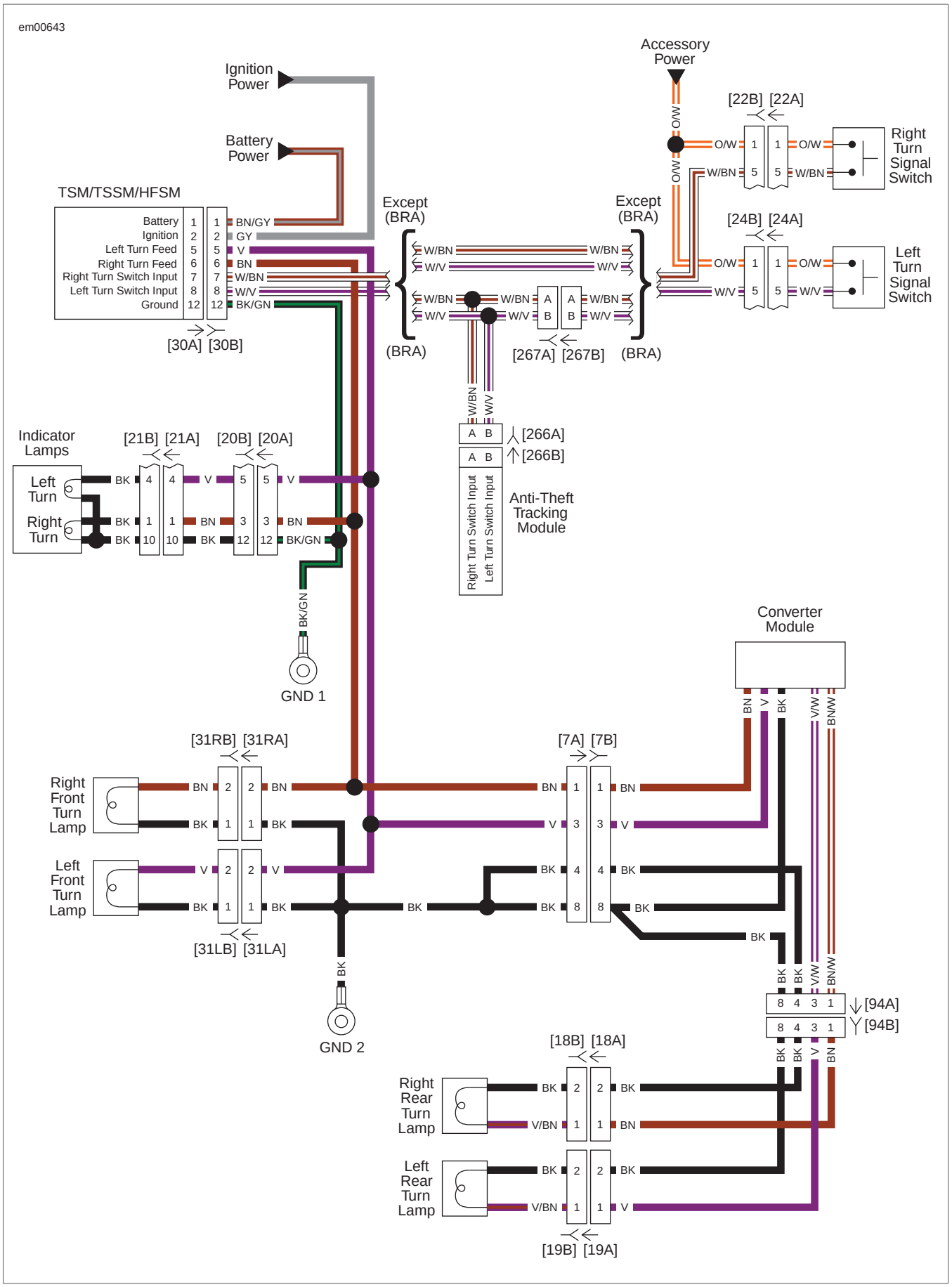

Figure 5-18. Turn Signal Circuit (FXDB)

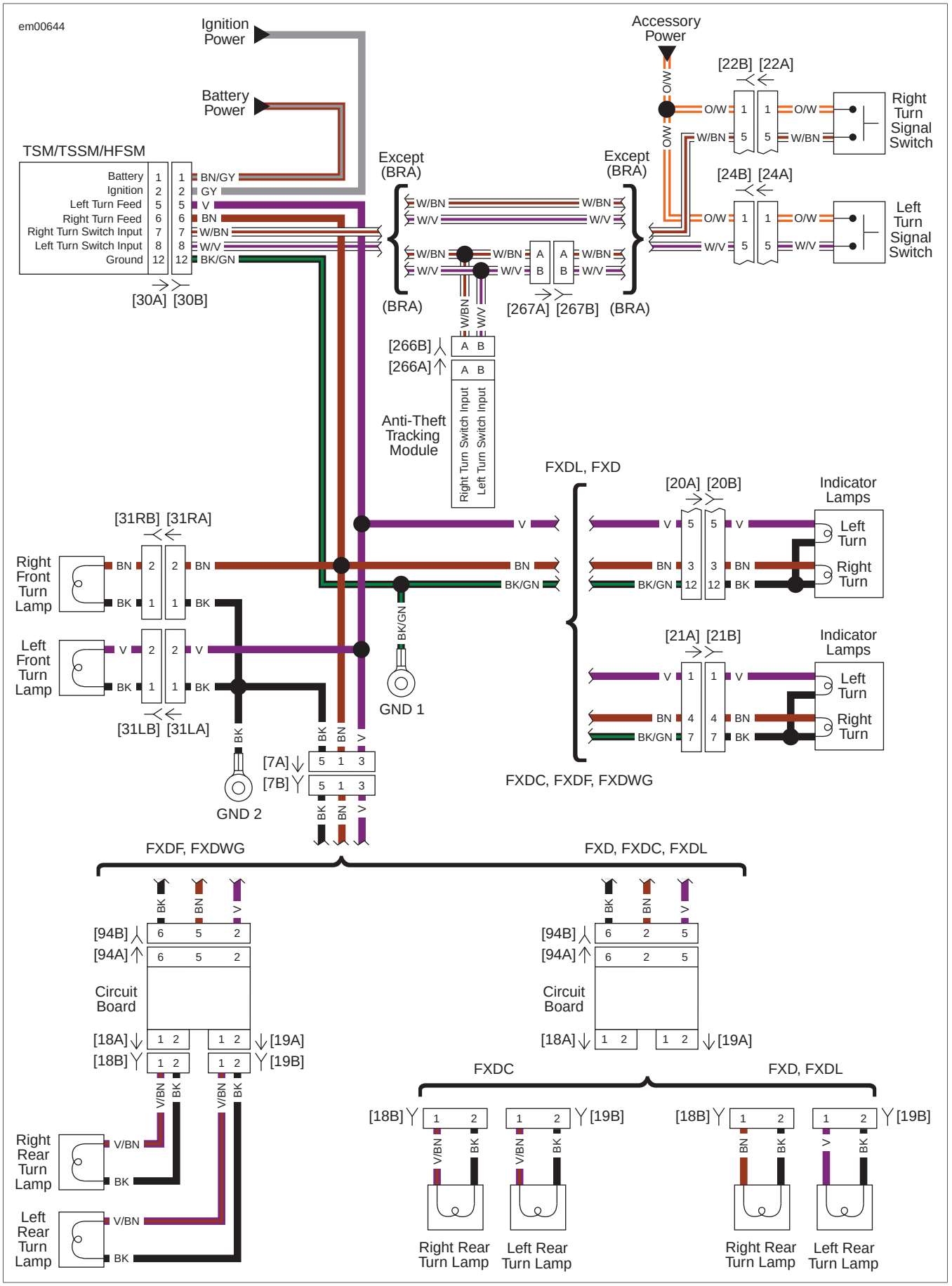

Figure 5-19. Turn Signal Circuit (Except FXDB)

DTC B1121: HFSM

PART NUMBER	TOOL NAME
HD-42682	BREAKOUT BOX

Table 5-14. DTC B1121 (HFSM) Diagnostic Faults

POSSIBLE CAUSES
Indicator lamp malfunction
HFSM malfunction
Open left turn signal circuit

1. Turn Signal Lamp Inspection Test

1. Remove and inspect left side turn signal bulbs.
2. Confirm the turn signal bulbs are the correct part numbers and the sockets are not corroded or damaged.
3. Were any issues found with the lamps?
   a. **Yes.** Repair as needed.
   b. **No.** Go to Test 2.

2. Turn Signal Circuit Open Test

1. With IGN OFF, disconnect HFSM [30].
2. Connect BREAKOUT BOX (Part No. HD-42682) to wire harness connector [30B] leaving HFSM [30A] disconnected. See 1.2 DIAGNOSTIC TOOLS.
3. Disconnect [31].
4. Test for continuity between breakout box terminal 5 and [31A] terminal 5.
5. Is continuity present?
   a. **Yes.** Replace the HFSM. See the service manual.
   b. **No.** Repair open in (V) wire.

DTC B1121: TSM/TSSM

PART NUMBER	TOOL NAME
HD-41404-B	HARNESS CONNECTOR TEST KIT
HD-42682	BREAKOUT BOX

Table 5-15. DTC B1121 (TSM/TSSM) Diagnostic Faults

POSSIBLE CAUSES
Indicator lamp assembly malfunction
Short to voltage on left turn signal circuit
TSM/TSSM malfunction
Short to ground on left turn signal circuit
Open left turn signal circuit

1. Operational Test

1. Turn IGN ON.
2. Are the turn signal lamps on continuously?
   a. **Yes.** Go to Test 2.
   b. **No.** Go to Test 4.

2. Indicator Short to Voltage Test

1. Turn IGN OFF.
2. Disconnect [20].
3. Turn IGN ON.
4. Are the turn signal lamps on continuously?
   a. **Yes.** Go to Test 3.
   b. **No.** Replace indicator lamp assembly. See the service manual.

3. TSM/TSSM Short to Voltage Test

1. Turn IGN OFF.
2. Connect BREAKOUT BOX (Part No. HD-42682) to wire harness connector [30B], leaving the TSM/TSSM [30A] disconnected. See 1.2 DIAGNOSTIC TOOLS.
3. With IGN ON, using HARNESS CONNECTOR TEST KIT (Part No. HD-41404-B) and a multimeter, test for voltage between breakout box terminal 5 and ground.
4. Is voltage present?
   a. **Yes.** Repair short to voltage on the (V) wire.
   b. **No.** Replace the TSM/TSSM. See the service manual.

4. Indicator Shorted Test

1. With IGN OFF, disconnect [20].
2. Turn IGN ON.
3. Operate the left turn signals.
4. Do the turn signals flash?
   a. **Yes.** Replace indicator lamp assembly. See the service manual.
   b. **No.** Go to Test 5.

5. Shorted Turn Signal Circuit Test

1. Turn IGN OFF.
2. Connect BREAKOUT BOX (Part No. HD-42682) to wire harness connector [30B] leaving TSM/TSSM [30A] disconnected. See 1.2 DIAGNOSTIC TOOLS.
3. Test for continuity between breakout box terminal 5 and ground.
4. Is continuity present?
   a. **Yes.** Repair short to ground in (V) wire from terminal 5.
   b. **No.** Go to Test 6.

6. Turn Signal Circuit Open Test

1. Disconnect [31].
2. Test for continuity between breakout box terminal 5 and [31A] terminal 5.

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3. Is continuity present?
   a. **Yes.** Replace the TSM/TSSM. See the service manual.
   b. **No.** Repair open in (V) wire.

DTC B1122: HFSM

PART NUMBER	TOOL NAME
HD-42682	BREAKOUT BOX

Table 5-16. DTC B1122 (HFSM) Diagnostic Faults

POSSIBLE CAUSES
Indicator lamp assembly malfunction
HFSM malfunction
Open right turn signal circuit

1. Turn Signal Lamp Inspection Test

1. Remove and inspect the right side turn signal bulbs.
2. Confirm the turn signal bulbs are the correct part numbers and the sockets are not corroded or damaged.
3. Were any issues found with the lamps?
   a. **Yes.** Repair as needed.
   b. **No.** Go to Test 2.

2. Turn Signal Circuit Open Test

1. Turn IGN OFF.
2. Connect BREAKOUT BOX (Part No. HD-42682) to wire harness connector [30B], leaving HFSM [30A] disconnected. See 1.2 DIAGNOSTIC TOOLS.
3. Disconnect [31].
4. Test for continuity between breakout box terminal 6 and [31A] terminal 2.
5. Is continuity present?
   a. **Yes.** Replace the HFSM. See the service manual.
   b. **No.** Repair open in (BN) wire.

DTC B1122: TSM/TSSM

PART NUMBER	TOOL NAME
HD-41404-B	HARNESS CONNECTOR TEST KIT
HD-42682	BREAKOUT BOX

Table 5-17. DTC B1122 (TSM/TSSM) Diagnostic Faults

POSSIBLE CAUSES
Indicator lamp assembly malfunction
Short to voltage on right turn signal circuit
TSM/TSSM malfunction
Short to ground on right turn signal circuit
Open right turn signal circuit

1. Operational Test

1. Turn IGN ON.
2. Are the turn signal lamps on continuously?
   a. **Yes.** Go to Test 2.
   b. **No.** Go to Test 4.

2. Indicator Short to Voltage Test

1. Turn IGN OFF.
2. Disconnect [20].
3. Turn IGN ON.
4. Are the turn signal lamps on continuously?
   a. **Yes.** Go to Test 3.
   b. **No.** Replace indicator lamp assembly. See the service manual.

3. TSM/TSSM/HFSM Short to Voltage Test

1. Turn IGN OFF.
2. Connect BREAKOUT BOX (Part No. HD-42682) to wire harness [30B], leaving TSM/TSSM [30A] disconnected. See 1.2 DIAGNOSTIC TOOLS.
3. With IGN ON, using HARNESS CONNECTOR TEST KIT (Part No. HD-41404-B) and a multimeter, test for voltage between breakout box terminal 6 and ground.
4. Is voltage present?
   a. **Yes.** Repair short to voltage on the (BN) wire.
   b. **No.** Replace the TSM/TSSM. See the service manual.

4. Indicator Shorted Test

1. With IGN OFF, disconnect [20].
2. Turn IGN ON.
3. Operate the left turn signals.
4. Do the turn signals flash?
   a. **Yes.** Replace indicator lamp assembly. See the service manual.
   b. **No.** Go to Test 5.

5. Turn Signal Circuit Shorted Test

1. Turn IGN OFF.
2. Connect BREAKOUT BOX (Part No. HD-42682) to wire harness [30B] leaving TSM/TSSM [30A] disconnected. See 1.2 DIAGNOSTIC TOOLS.
3. Test for continuity between breakout box terminal 6 and ground.
4. Is continuity present?
   a. **Yes.** Repair short to ground in (BN) wire.
   b. **No.** Go to Test 6.

6. Turn Signal Circuit Open Test

1. Disconnect [31].

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2. Test for continuity between breakout box terminal 6 and [31A] terminal 2.
3. Is continuity present?
   a. **Yes.** Replace the TSM/TSSM. See the service manual.
   b. **No.** Repair open in (BN) wire.

DTC B1123

PART NUMBER	TOOL NAME
HD-41404-B	HARNESS CONNECTOR TEST KIT
HD-42682	BREAKOUT BOX

Table 5-18. DTC B1123 Diagnostic Faults

POSSIBLE CAUSES
Indicator lamp assembly malfunction
HFSM malfunction
Short to ground on left turn signal circuit

1. Turn Signal Lamp Inspection Test

1. Remove and inspect left side turn signal bulbs.
2. Confirm the turn signal bulbs are the correct part numbers and the sockets are not corroded or damaged.
3. Were any issues found with the lamps?
   a. **Yes.** Repair as needed.
   b. **No.** Go to Test 2.

2. Turn Signal Circuit Short to Ground Test

1. Turn IGN OFF.
2. Connect BREAKOUT BOX (Part No. HD-42682) to wire harness [30B], leaving the HFSM [30A] disconnected. See 1.2 DIAGNOSTIC TOOLS.
3. Disconnect speedometer [20].
4. Using HARNESS CONNECTOR TEST KIT (Part No. HD-41404-B) and a multimeter, test for continuity between breakout box terminals 5 and 12.
5. Is continuity present?
   a. **Yes.** Repair short to ground in left turn signal circuit (V) wire.
   b. **No.** Go to Test 3.

3. Indicator Test

1. Install turn signal bulbs.
2. Remove breakout box and connect HFSM [30].
3. With [20] disconnected, operate the left turn signals.
4. Do the turn signals function and flash correctly?
   a. **Yes.** Replace the indicator lamp assembly. See the service manual.
   b. **No.** Replace the HFSM. See the service manual.

DTC B1124

PART NUMBER	TOOL NAME
HD-41404-B	HARNESS CONNECTOR TEST KIT
HD-42682	BREAKOUT BOX

Table 5-19. DTC B1124 Diagnostic Faults

POSSIBLE CAUSES
Indicator lamp assembly malfunction
HFSM malfunction
Short to ground on right turn signal circuit

1. Turn Signal Lamp Inspection Test

1. Remove and inspect right side turn signal lamps.
2. Confirm the turn signal bulbs are the correct part numbers and the sockets are not corroded or damaged.
3. Were any issues found with the lamps?
   a. **Yes.** Repair as needed.
   b. **No.** Go to Test 2.

2. Turn Signal Circuit Short to Ground Test

1. Turn IGN OFF.
2. Connect BREAKOUT BOX (Part No. HD-42682) to wire harness [30B], leaving HFSM [30A] disconnected. See 1.2 DIAGNOSTIC TOOLS.
3. Disconnect speedometer [20].
4. Using HARNESS CONNECTOR TEST KIT (Part No. HD-41404-B) and a multimeter, test for continuity between breakout box terminals 6 and 12.
5. Is continuity present?
   a. **Yes.** Repair short to ground in right turn signal circuit (BN) wire.
   b. **No.** Go to Test 3.

3. Indicator Test

1. Install turn signal bulbs.
2. Remove breakout box and connect HFSM [30].
3. With speedometer [20] disconnected, operate the right turn signals.
4. Do the turn signals function and flash correctly?
   a. **Yes.** Replace the indicator lamp assembly. See the service manual.
   b. **No.** Replace the HFSM. See the service manual.

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DTC B1125

PART NUMBER	TOOL NAME
HD-41404-B	HARNESS CONNECTOR TEST KIT
HD-42682	BREAKOUT BOX

Table 5-20. DTC B1125 Diagnostic Faults

POSSIBLE CAUSES
Indicator lamp assembly malfunction
HFSM malfunction
Short to voltage on left turn signal circuit

1. Turn Signal Circuit Short to Ground Test

1. Connect BREAKOUT BOX (Part No. HD-42682) to wire harness [30B], leaving the TSM/TSSM [30A] disconnected. See 1.2 DIAGNOSTIC TOOLS.
2. With IGN ON, using HARNESS CONNECTOR TEST KIT (Part No. HD-41404-B) and a multimeter, test for voltage between breakout box terminals 5 and 12.
3. Is voltage present?
   a. **Yes.** Go to Test 2.
   b. **No.** Replace HFSM. See the service manual.

2. Indicator Test

1. With IGN OFF, disconnect [20].
2. Turn IGN ON.
3. Test for voltage between breakout box terminals 5 and 12.
4. Is voltage present?
   a. **Yes.** Repair short to voltage in left turn signal circuit (V) wire.
   b. **No.** Replace the indicator lamp assembly. See the service manual.

DTC B1126

PART NUMBER	TOOL NAME
HD-41404-B	HARNESS CONNECTOR TEST KIT
HD-42682	BREAKOUT BOX

Table 5-21. DTC B1126 Diagnostic Faults

POSSIBLE CAUSES
Indicator lamp assembly malfunction
HFSM malfunction
Short to voltage on right turn signal circuit

1. Turn Signal Circuit Short to Ground Test

1. Connect BREAKOUT BOX (Part No. HD-42682) to wire harness [30B], leaving TSM/TSSM [30A] disconnected. See 1.2 DIAGNOSTIC TOOLS.
2. With IGN ON, using HARNESS CONNECTOR TEST KIT (Part No. HD-41404-B) and multimeter, test for voltage between breakout box terminals 6 and 12.
3. Is voltage present?
   a. **Yes.** Go to Test 2.
   b. **No.** Replace HFSM. See the service manual.

2. Indicator Test

1. With IGN OFF, disconnect [20].
2. Turn IGN ON.
3. Test for voltage between breakout box terminals 6 and 12.
4. Is voltage present?
   a. **Yes.** Repair short to voltage in right turn signal circuit (V) wire.
   b. **No.** Replace the indicator lamp assembly. See the service manual.

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DTC B1135, B1136, B1141, B1142 5.9

DIAGNOSTICS

DTC B1135 Accelerometer Fault

DTC B1135 indicates a failure which requires replacement of the TSM/TSSM/HFSM.

NOTE

When DTC B1135 is set, the tip-over engine shutdown, HFSM tamper alarm, and bank angle sensors are disabled. The security lamp will also illuminate when this code is set.

DTC B1136 Accelerometer Tip-Over Self-Test Fault

DTC B1136 indicates a failure which requires replacement of the HFSM.

DTC B1141

DTC B1141 indicates the TSM/TSSM/HFSM is recognizing an open or low condition on the ignition circuit.

DTC B1142 Internal Fault

DTC B1142 indicates a failure which requires replacement of the HFSM.

DTC B1141

PART NUMBER	TOOL NAME
HD-41404-B	HARNESS CONNECTOR TEST KIT
HD-42682	BREAKOUT BOX

Table 5-22. DTC B1141 Diagnostic Faults

POSSIBLE CAUSES
TSM/TSSM/HFSM malfunction
Open ignition circuit

1. Ignition Circuit Open Test

1. With IGN OFF, connect TSM/TSSM/HFSM BREAKOUT BOX (Part No. HD-42682) to wire harness [30B], leaving TSM/TSSM/HFSM [30A] disconnected. See 1.2 DIAGNOSTIC TOOLS.
2. With the IGN ON, using HARNESS CONNECTOR TEST KIT (Part No. HD-41404-B) and a multimeter, test for voltage between breakout box terminal 2 and ground.
3. Is voltage present?
   a. **Yes.** Replace the TSM/TSSM/HFSM. See the service manual.
   b. **No.** Repair open in (GY) ignition wire.

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SECURITY SYSTEM 5.10

SECURITY LAMP

The security lamp (key icon) in the speedometer face provides feedback to the rider confirming armed or disarmed status. Refer to Table 5-23.

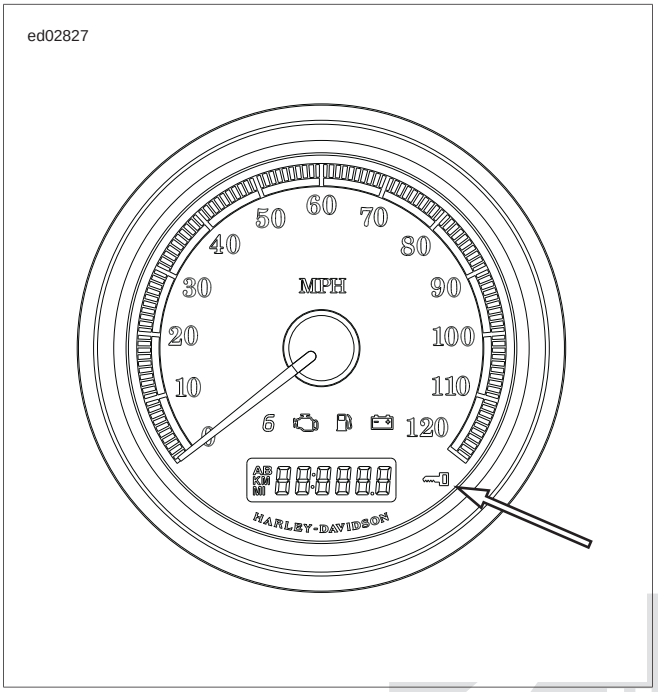

Figure 5-20. Security Lamp (key icon): Dyna Models

Table 5-23. Security Lamp Status

LAMP	MODE
Does not flash.	No security system (TSM only), security system not armed.
Flashes every second.	2 minute (HFSM) or ten minute (TSSM) timeout after failed PIN entry attempt or a battery reconnect has occurred while armed.
Flashes every 2.5 seconds.	Security system armed.
Flashes 4 times a second.	PIN entry mode.
Stays on solid with IGN OFF.	Arming is starting up. You have 5 seconds (HFSM) or 30 seconds (TSSM) before system is armed.
Stays on solid with IGN ON.	If solid for more than 4 seconds after IGN ON, a current DTC is present.

SECURITY IMMOBILIZATION

The TSSM/HFSM provides security and immobilization functions not found on the TSM. The TSSM/HFSM will disable the starter and ignition system. Additional functions include the ability to alternately flash the left and right turn signals and sound a siren (if equipped) if a theft attempt is detected.

NOTE

The siren must be in the chirp mode for the siren to chirp on arming or disarming. See 5.12 SIREN, Siren Chirp Mode Confirmation: HFSM Only.

Conditions that activate the security system when system is armed include:

- **Detecting tampering of the ignition circuit:** Turn signals flash three times, optional siren chirps once and then turns off. If the tampering continues, a second warning will activate after four seconds. Continued tampering will cause the alarm to activate for 30 seconds and then turn off. The two warnings/alarm cycle is repeated for each tampering incident.
- **Detecting vehicle movement:** Turn signals flash three times, optional siren chirps once and then turns off. If the vehicle is not returned to its original position, a second warning will activate after four seconds. If the vehicle is not returned to its original position, the alarm activates for 30 seconds then turns off. The two warnings/alarm cycle may repeat a maximum of 10 times with a 10 second pause between cycles.
- **Detecting that a battery or ground disconnect has occurred while armed:** The optional siren activates its self-alarm mode. Turn signals will not flash.

NOTE

Always disarm the TSSM/HFSM before removing or disconnecting the battery to prevent the siren (if installed) from activating. If the TSSM is in auto-arming mode, you must disarm the system and disconnect the battery or remove the battery fuse before the 30 second arming period expires.

TSSM/HFSM FEATURES

PART NUMBER	TOOL NAME
HD-48650	DIGITAL TECHNICIAN II

The following information applies only to vehicles equipped with the TSSM/HFSM.

- **Security lamp:** See Figure 5-20. The security lamp (key icon) tells the rider if the system is armed or disarmed.
- **Personal code disarming:** If the fob is not available, the TSSM/HFSM allows the rider to disable the security alarm and immobilization functions with a five-digit personal code.
- **Arming confirmation:** When the TSSM/HFSM is armed, the system provides visual feedback (confirmation) to the rider by flashing the turn signals and an audible "chirp" if equipped with the optional smart siren and chirp mode is enabled.
- **Remote arming/disarming (TSSM only):** See 5.11 KEY FOB. Owners may enable and disable security alarm and immobilization functions with a personally carried transmitter. This transmitter is referred to as a **key fob**. Remote

arming/disarming is a function of the TSSM (Japan/Korea) only.

- **Auto-arming (TSSM only):** Automatically enables the security alarm and immobilization functions within 30 seconds after the ignition switch is switched OFF.
- **Disarming confirmation:** When the TSSM/HFSM is disarmed, the system provides an audible "chirp" (confirmation) if equipped with the optional smart siren and chirp mode is enabled.
- **Transport mode:** It is possible to arm the security system without enabling the motion detector for one ignition cycle. This allows the vehicle to be moved in an immobilized state.
- **Starter/ignition disable:** When armed the starter and ignition system are disabled.
- **Security system alarm:** See 5.12 SIREN. The system will alternately flash the left and right turn signals and sound an optional Smart Siren if a vehicle security condition is detected while the system is armed.
- **Dealer service mode (HFSM only):** This mode allows the dealer to disable security system via DIGITAL TECHNICIAN II (Part No. HD-48650). Dealer service mode is exited when module detects an assigned fob in range.

Security System Options: TSSM

The following options are only available on the TSSM unit: alarm sensitivity, auto-arming feature, and storage mode.

Default settings for the TSSM include:

- Solo vehicle configuration.
- Medium motion sensitivity on alarm sensitivity.
- All vehicles are shipped with auto-arming disabled.
- Storage mode set to 10 days.

WARNINGS

A warning consists of three alternate flashes of the turn signals and chirp from the optional smart siren. Warnings are issued from an armed TSSM/HFSM in the following order:

1. **First Warning:** A warning is issued whenever a person without a fob present or with the system armed attempts to move the vehicle or turns the ignition switch to **IGN.**
2. **Second Warning:** If the motion continues or the ignition switch is not turned back to **OFF**, a second warning is issued within four seconds of the first.
3. **Alarm:** If the motion continues or the ignition switch is not turned to **OFF** past the second warning, the smart security system will go into full alarm.

ARMING: HFSM

The H-DSSS automatically arms within five seconds when the vehicle is parked and the ignition switch is turned to **OFF** and motion is not detected.

On arming, the turn signals flash twice and the smart siren will "chirp" twice if chirp function is activated. While armed, the security lamp (key icon) will flash once every 2.5 seconds. Refer to Table 5-23.

ARMING: TSSM

There are two methods to arm the security system:

- Using the key fob.
- Using auto-arming.

NOTE

The vehicle cannot be armed with the IGN ON.

Auto-Arming Function: TSSM

Auto-arming causes the system to automatically arm itself (no key fob needed) within 30 seconds after the ignition switch is turned OFF. During this period, the security lamp stays illuminated to indicate auto-arming is starting up.

The vehicle may be moved during these 30 seconds without triggering the alarm. However, any motion after that period will trigger the security alarm. Upon expiration of the auto-arming period, the turn signals flash twice, the security lamp begins to flash and the siren (if equipped) chirps twice.

The TSSM allows remote arming via the key fob at any time. However, if the system is remotely disarmed (with the key fob) but the ignition switch is not turned ON within 30 seconds, the system will re-arm itself when auto-arming is enabled.

Japan and Korea vehicles have auto-arming disabled by default. However, the feature may be enabled if the customer desires.

When auto-arming is disabled, the key fob must be used to arm the security system. To set the auto-arming function, refer to Table 5-24.

Table 5-24. Selecting TSSM Auto-Arming Function

NO.	ACTION	WAIT FOR CONFIRMATION	NOTES
1	Set engine stop switch to **OFF**		Verify the security lamp is not flashing (vehicle is disarmed)
2	Turn IGN **ON**-OFF-**ON**-OFF-**ON**		
3	Press **left** turn switch **2 times** and release	Two flashes turn signals and indicators (See 5.13 SERVICE AND EMERGENCY FUNCTIONS AND CONFIGURATIONS, Power Disruption and Configuring: TSSM regarding battery disconnects.)	Two flashes - Japan/Korea configuration TSSM

Table 5-24. Selecting TSSM Auto-Arming Function

NO.	ACTION	WAIT FOR CONFIRMATION	NOTES
4	Press and hold **key fob** button until confirmation is received	One flash turn signals and indicators	
5	Press and hold **key fob** button until confirmation is received	Two flashes turn signals and indicators	
6	Press **left** turn switch **1 time** and release	Turn signals and indicators flash to indicate option selected	One flash - auto-arming disabled Two flashes - auto-arming enabled
7	Press and release **left** turn switch to advance through options	Turn signals and indicators flash to indicate option selected	
8	Turn IGN OFF		

DISARMING: HFSM

There are two ways to disarm the H-DSSS:

- Automatic Disarming.
- Using the PIN.

Automatic Disarming

Always have the fob present when riding, loading, fueling, moving, parking or servicing the vehicle. Carry the fob in a convenient pocket. The H-DSSS disarms automatically when the ignition switch is turned to ON.

On disarming, the smart siren will chirp once (if chirp function is activated) and the security lamp (key icon) will turn ON solid for four seconds then go out. Refer to Table 5-23.

Disarming with a PIN

See 5.13 SERVICE AND EMERGENCY FUNCTIONS AND CONFIGURATIONS to enter an initial PIN to enable the system.

If you make an error while disarming the HFSM using the PIN, the alarm will activate for 30 seconds after the last digit is entered. After a failed attempt, the security lamp will flash once every second for 2 minutes (HFSM) or ten minutes (TSSM). **During this time, the vehicle will not accept any attempt to enter a PIN.** Refer to Table 5-23.

DISARMING: TSSM

There are two ways to disarm the system:

- Using the key fob. This method works in all situations **except** before turning ignition switch ON when TSSM storage mode is activated.
- Using a PIN.

If you make an error while disarming the TSSM using a PIN, the alarm will activate for 30 seconds after the last digit is entered. After a failed attempt, the security lamp will flash once every second for 10 minutes. **During this time, the vehicle will not accept any attempt to enter a PIN.** Refer to Table 5-25.

Table 5-25. Disarming TSSM with the PIN (Example: 3-1-3-1-3)

NO.	ACTION	WAIT FOR CONFIRMATION	NOTES
1	Set engine stop switch to **OFF**		
2	Turn IGN to **ACC**		
3	Hold **both** turn switches in until confirmation	Security lamp flashes at fast rate	System is ready for PIN entry
4	Enter first digit of code (3) by pressing **left** turn switch **3 times**		
5	Press **right** turn switch **1 time**		Serves as "enter" key for first digit
6	Enter second digit of code (1) by pressing **left** turn switch **1 time**		
7	Press **right** turn switch **1 time**		Serves as "enter" key for second digit
8	Enter third digit of code (3) by pressing **left** turn switch **3 times**		
9	Press **right** turn switch **1 time**		Serves as "enter" key for third digit
10	Enter fourth digit of code (1) by pressing **left** turn switch **1 time**		Serves as "enter" key for fourth digit
11	Press **right** turn switch **1 time**		

Table 5-25. Disarming TSSM with the PIN (Example: 3-1-3-1-3)

NO.	ACTION	WAIT FOR CONFIRMATION	NOTES
12	Enter fifth digit of code (3) by pressing **left** turn switch **3 times**		System is disarmed. You may use the vehicle or program another key fob
13	Press **right** turn switch **1 time**	Security lamps stop flashing	

ALARM

Activation

In the full alarm state, the turn signals flash alternately, and if equipped with the smart siren, the siren will sound.

After 30 seconds of alarm, if no further vehicle motion is detected, the alarm will stop.

NOTE

*Vehicle must be returned to original parked position with ignition switch turned to **OFF**.*

If vehicle motion continues, the alarm will start again continue for another 30 seconds.

The TSSM/HFSM will repeat the alarm cycles 10 times for a total of five minutes, with a 10-second pause between alarm cycles.

During warnings and alarms, the starter motor and the ignition remain disabled.

Deactivation

The alarm cycles can be discontinued at any time by moving an assigned fob to the vehicle. The presence of the fob will terminate the alarm.

ALARM SENSITIVITY: TSSM

Sensitivity

The TSSM has four sensitivity settings: extremely low, low, medium or high. The selection chosen controls the sensitivity of the security system regarding motion detection.

To set alarm sensitivity, refer to Table 5-26.

Table 5-26. TSSM Alarm Sensitivity

NO.	ACTION	WAIT FOR CONFIRMATION	NOTES
1	Set engine stop switch to **OFF**		Verify the security lamp is not flashing (vehicle is disarmed)
2	Turn IGN **ON**-OFF-**ON**-OFF-**ON**		
3	Press **left** turn switch **2 times** and release	Two flashes turn signals and indicators depending on vehicle configuration. (See 5.13 SERVICE AND EMERGENCY FUNCTIONS AND CONFIGURATIONS, Power Disruption and Configuring: TSSM regarding battery disconnects.)	Two flashes - Japan/Korea configuration TSSM
4	Press and hold **key fob** button until confirmation is received	One flash turn signals and indicators	
5	Press **left** turn switch **1 time** and release	Turn signals and indicators flash to indicate option selected	One flash - extremely low Two flashes - low sensitivity Three flashes - medium sensitivity Four flashes - high sensitivity
6	Press and release **left** turn switch to advance through options	Turn signals and indicators flash to indicate option selected	One flash - extremely low Two flashes - low sensitivity Three flashes - medium sensitivity Four flashes - high sensitivity
7	Turn IGN OFF		

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KEY FOB 5.11

HFSM FOB

See Figure 5-21. The HFSM's reception range for the hands-free fob signal depends on a specific receiver pattern. The typical range will be an arm's length.

NOTES

- *Environmental and geographic conditions may affect signal range.*
- *Always have the fob present whenever the vehicle is operated.*
- *Do not place fob in metal enclosure, and do not place it closer than 3.0 in. (80.0 mm) to cellular phones, the handsfree antenna, PDAs, displays and other electronic devices while operating the vehicle. That may prevent the fob from disarming the security system.*
- *Fob battery should be replaced every year. See the service manual.*

Figure 5-21. Hands-Free Fob

TSSM FOB

The TSSM reception range for the key fob signal depends on a specific receiver pattern.

NOTE

Environmental and geographic conditions may affect signal range.

Arming the System

1. Hold key fob horizontal at waist level.
2. Point key fob at the front of the vehicle.
3. Hold down the key fob button until the system responds with two turn signal flashes.

Disarming the System

1. Hold key fob horizontal at waist level.
2. Point key fob at the front of the vehicle.
3. Quickly press the key fob button twice. The system will respond with one turn signal flash.

NOTE

*Disarming function may require practice. The key fob button **must** be pressed twice within 1.5 seconds to send the disarm command. The action is very similar to double-clicking a computer mouse. Light quick taps work best; very hard or very slow taps are less likely to work.*

Troubleshooting

If the key fob button has been pressed numerous times while away from the vehicle, the fob may fall out of synchronization with the TSSM. If this happens, the TSSM might fail to recognize the key fob's commands.

To solve this problem, press and hold the key fob button for 10-15 seconds until the security system responds with two turn signal flashes. After confirmation, you may resume normal fob operation.

FOB ASSIGNMENT: HFSM

PART NUMBER	TOOL NAME
HD-48650	DIGITAL TECHNICIAN II

Use DIGITAL TECHNICIAN II (Part No. HD-48650) to assign both fobs to the H-DSSS. Follow the menu prompts in the DIGITAL TECHNICIAN II (Part No. HD-48650) display and scan the fob serial number with the bar code reader, or key-in the number from the keyboard. See a Harley-Davidson dealer.

NOTE

Each fob has a unique serial number. The label should be removed from the fob and attached to a blank NOTES page in the Owner's Manual for reference.

FOB ASSIGNMENT: TSSM

Refer to Table 5-27 to assign a key fob to a vehicle equipped with a TSSM.

The key fob on TSSM vehicles must be set so it will operate the alarm system on the vehicle. This assignment **must** be completed with no pauses between steps greater than 10 seconds. Turn the ignition OFF after all key fobs have been assigned. The programming mode will also exit after 60 seconds has elapsed without detecting any fob sign-up messages or turn signal switch activity.

Two key fobs may be assigned to the TSSM. The first successful attempt to program a fob will disable all previously assigned fobs. If a second fob is to be programmed, it must be done in the same programming sequence as the initial fob.

Table 5-27. Key FOB Assignment: TSSM

NO.	ACTION	WAIT FOR CONFIRMATION	NOTES
1	Set engine stop to **OFF**		Verify the security lamp is not flashing (vehicle is disarmed) This assignment procedure **must** be completed with no pauses between steps greater than 10 seconds
2	Turn ignition/headlamp switch **ON**-OFF-**ON**-OFF-**ON**		
3	Press **left** turn switch **2 times** and release	One to four flashes turn signals and indicators depending on vehicle configuration (See 5.13 SERVICE AND EMERGENCY FUNCTIONS AND CONFIGURATIONS, Power Disruption and Configuring: TSSM regarding battery disconnects.)	One flash - Worldwide TSM, no security Two flashes - Japan/Korea configuration TSSM
4	Press **right** turn switch **1 time** and release	One flash turn signals and indicators	
5	Press **left** turn switch **1 time** and release	Two flashes turn signals and indicators	
6	Press and hold **key fob** button until confirmation is received	Two flashes turn signals and indicators	This may take 10-25 seconds.
7	If you have two key fobs, press and hold button on second **key fob** until confirmation is received	Two flashes turn signals and indicators	Optional step
8	Turn ignition/headlamp switch OFF		

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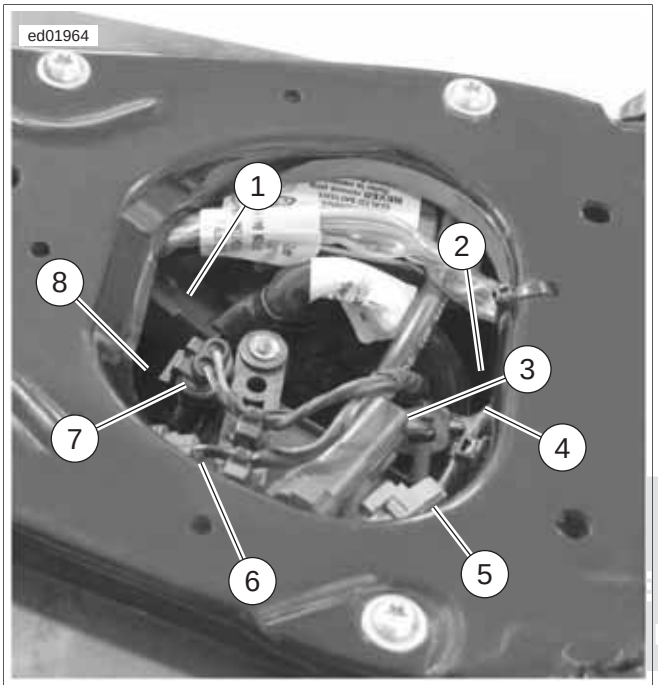
SIREN 5.12

DESCRIPTION AND OPERATION

See Figure 5-22. The Smart Siren is not a standard part of the security system but can be added to the system. The siren is attached at [142] off the TSSM/HFSM. Through this connector it shares the battery circuit, the ground circuit, and the alarm signal circuit with the TSSM/HFSM. The siren is used to add an audible warning to the visual warnings that are a standard function of the security system.



1. **Tail lamp harness to main harness [7]**
2. **Grounds [GND1] & [GND2]**
3. **Accessory [4]**
4. **Security siren [142]**
5. **B+ [160]**
6. **IAT sensor [89]**
7. **Rear O2 sensor [137]**
8. **JSS (HDI only) [133]**

Figure 5-22. Under Seat

SIREN CHIRP MODE CONFIRMATION: HFSM ONLY

Chirpless Mode

In the chirpless mode, the siren does not chirp on arming or disarming.

NOTE

Even when armed in the chirpless mode, the siren still chirps warnings on movement and will activate the alarm through the normal cycles.

Chirp Mode

On arming in the chirp mode, the siren responds with two chirps. When disarming, the siren responds with a single chirp.

Switching Modes

Cycling quickly through three armings and disarmings will switch the system from either the chirpless mode or the chirp mode to its opposite.

1. With the fob present, the IGN ON and the system disarmed, turn the IGN OFF.
2. When the security lamp turns off, immediately turn the IGN ON. If the turn signals flash twice before the IGN is turned ON, the system will drop out of the switching mode sequence and will have to be started over from the beginning.
3. Wait until the security lamp goes out, then immediately turn the IGN OFF.
4. When the security lamp turns off, immediately turn the IGN ON. If the turn signals flash twice before the IGN is turned ON, the system will drop out of the switching mode sequence and will have to be started over from the beginning.
5. Wait until the security lamp goes out, then immediately turn the IGN OFF.
6. When the security lamp turns off, immediately turn the IGN ON. If the turn signals flash twice before the IGN is turned ON, the system will drop out of the switching mode sequence and will have to be started over from the beginning.

SERVICE AND EMERGENCY FUNCTIONS AND CONFIGURATIONS 5.13

GENERAL

Setting up a vehicle's TSM/TSSM/HFSM depends on whether the vehicle has a TSM or the optional TSSM or HFSM security system installed.

ACTUATION: HFSM

Actuation consists of assigning two fobs to the system, and entering an initial PIN. The PIN can be changed by the rider at any time.

1. Configure HFSM vehicles by assigning **both** fobs to the vehicle.
2. Configure HFSM vehicles by entering a PIN picked by the owner. The personal code allows the owner to operate the system if the fob is lost or inoperable. Record the PIN in the owner's manual and instruct the customer to carry a copy (use the wallet card found in the owner's manual).

Once the system has been activated, it will always "arm" within 5 seconds of turning the ignition switch to **OFF** and no vehicle motion.

CONFIGURING A TSSM

NOTE

Do not forget to enter a PIN for TSSM vehicles. If a PIN is not assigned and both key fobs are lost or damaged while the vehicle is armed, the TSSM must be replaced.

Changes to TSSM settings are made by a series of programming operations involving the ignition key, left/right turn signal switches and key fob (security systems).

At certain steps in the programming sequence, the vehicle may provide confirmation of settings by flashing the turn signals, turn signal indicators and/or security lamp. In addition, when programming a PIN into a TSSM system, the odometer displays the PIN to the user and dynamically updates it as the code is entered or changed.

All programming operations are listed in table format. Follow the numbered steps to configure the system. If a confirmation response is listed, wait for the confirmation before continuing to the next step. Important information pertaining to certain actions will be found in the NOTES column.

SELECTING A PIN

The PIN consists of five digits. Each digit can be any number from 1-9. There can be no zeros (0) in the PIN. The PIN **must** be used to disarm the security system in case the fob becomes unavailable.

INITIAL PIN ENTRY: HFSM

To enter a PIN on a vehicle with no PIN previously installed during HFSM actuation, refer to Table 5-28.

DIGITAL TECHNICIAN II

Table 5-28. Entering an Initial PIN: HFSM

NO.	ACTION	WAIT FOR CONFIRMATION
1	Select a 5-digit (1 through 9) initial PIN and record in the owner's manual and on the wallet card.	
2	With an assigned fob present, set engine stop switch to **OFF.**	
3	Cycle **IGN ON-OFF-ON-OFF-ON**	
4	Press **left** turn signal button **2** times.	Turn signals will flash 3 times.
5	Press **right** turn signal button **1** time.	Five dashes will appear in the odometer window. The first dash will flash.
6	Enter first digit (a) of initial PIN by pressing **left** turn signal button **a** times.	
7	Press **right** turn signal button **1** time.	The digit (a) will replace the dash in the odometer. The second dash will flash.
8	Enter second digit (b) of initial PIN by pressing **left** turn signal button until desired digit is displayed in odometer.	
9	Press **right** turn signal button **1** time.	The digit (b) will replace the dash in the odometer. The third dash will flash.
10	Enter third digit (c) of initial PIN by pressing **left** turn signal button **c** times.	
11	Press **right** turn signal button **1** time.	The digit (c) will replace the dash in the odometer. The fourth dash will flash.
12	Enter fourth digit (d) of initial PIN by pressing **left** turn signal button **d** times.	

Table 5-28. Entering an Initial PIN: HFSM

NO.	ACTION	WAIT FOR CONFIRMATION
13	Press **right** turn signal button **1** time.	The digit (d) will replace the dash in the odometer. The fifth dash will flash.
14	Enter fifth digit (e) of initial PIN by pressing **left** turn signal button **e** times.	
15	Press **right** turn signal button **1** time.	The digit (e) will replace the dash in the odometer. The first digit will flash.
16	Turn **IGN OFF.**	

INITIAL PIN ENTRY: TSSM

NOTE

Do not forget to enter a PIN for TSSM vehicles. If a PIN is not assigned and the key fob is lost or damaged while the vehicle is armed, the TSSM must be replaced.

The TSSM PIN consists of five digits. Each digit can be any number from 1-9. There can be no zeros (0) in the PIN. The PIN **must** be used to disarm the security system in case the key fob becomes unavailable.

Refer to Table 5-29 to enter an initial PIN with no PIN previously installed. The procedure listed uses 3-1-3-1-3 as the desired PIN.

NOTE

For better security, do not use 3-1-3-1-3 as a PIN. It is shown as an example only.

Decide what five-digit PIN the owner would like to use. The code will be programmed using the turn signal switches and key fob. Keep a record of the PIN in a secure place such as your wallet or the Owner's Manual.

- When programming the PIN, the security lamp flashes to provide feedback when entering each digit. The odometer also displays the PIN and the change dynamically.
- The number of security lamp flashes corresponds to the number currently selected for a given digit. Therefore, the lamp may flash 1-9 times depending on the number entered. The five-digit PIN will change in the odometer window and the active digit will blink.
- Press the left turn switch one time to increment each digit.
- Quickly press the key fob button twice to advance to the next digit.

NOTE

The programming mode exits upon turning the ignition switch to OFF, or if no turn signal switch/key fob button activity occurs for 60 seconds. No data is saved for partial configuration attempts if entering a PIN for the first time. If a PIN has previously been entered, the user can change any digit or group of digits.

Table 5-29. Entering an Initial TSSM PIN (Example: 3-1-3-1-3) with No PIN Previously Entered

NO.	ACTION	WAIT FOR CONFIRMATION	NOTES
1	Set engine stop switch to **OFF**		Verify the security lamp is not flashing (vehicle is disarmed) This assignment procedure **must** be completed with no pauses between steps greater than 10 seconds
2	Turn IGN **ON**-OFF-**ON**-OFF-**ON**		
3	Press **left** turn switch **2** times and release	One to four flashes turn signals and indicators depending on vehicle configuration (See 5.13 SERVICE AND EMERGENCY FUNCTIONS AND CONFIGURATIONS, Power Disruption and Configuring: TSSM regarding battery disconnects)	One flash - Worldwide TSM, no security Two flashes - Japan/Korea configuration TSSM
4	Quickly press **key fob** button **2 times** and release	One flash turn signals and indicators Odometer displays current five-digit PIN (five dashes if no code entered), first digit flashes	Vehicle is in PIN entry mode ready to enter or modify first digit

Table 5-29. Entering an Initial TSSM PIN (Example: 3-1-3-1-3) with No PIN Previously Entered

NO.	ACTION	WAIT FOR CONFIRMATION	NOTES
5	Press **left** turn switch **1 time** and release	Security lamp flashes 1-9 times if code was previously entered	A lack of confirmation flashes indicates no digit entered
6	Press and release **left** turn switch to advance through the digits In this example, you will press and release three times	Blinking digit in odometer display increments, security lamp flashes to indicate each digit selected In this example, the blinking digit displayed is 3 and the security lamp will flash three times	You have selected 3 as a number for the first digit
7	Quickly press **key fob** button **2 times** and release	Two flashes turn signals and indicators second digit in odometer display blinks	You have confirmed 3 as a number for the first digit and have advanced to entering the second digit
8	Press **left** turn switch **1 time** and release	None	A lack of confirmation flashes indicates no digit entered
9	Press and release **left** turn switch to advance through the digits In this example, you will perform this step one time	Blinking digit in odometer display increments, security lamp flashes to indicate each digit selected In this example, the blinking digit displayed is 1 and the security lamp will flash one time	You have selected 1 as a number for the second digit
10	Quickly press **key fob** button **2** times and release	Three flashes turn signals and indicators third digit in odometer display blinks	You have confirmed 1 as a number for the second digit and have advanced to entering the third digit
11	Press **left** turn switch **1** time and release	None	A lack of confirmation flashes indicates no digit entered
12	Press and release **left** turn switch to advance through the digits In this example, you will repeat this step three times	Blinking digit in odometer display increments, security lamp flashes to indicate each digit selected In this example, the blinking digit displayed is 3 and the security lamp will flash three times	You have selected 3 as a number for the third digit
13	Quickly press **key fob** button **2 times** and release	Four flashes turn signals and indicators fourth digit in odometer display blinks	You have confirmed 3 as a number for the third digit and have advanced to entering the fourth digit
14	Press **left** turn switch **1** time and release	None	A lack of confirmation flashes indicates no digit entered
15	Press and release **left** turn switch to advance through the digits In this example, you will perform this step one time	Blinking digit in odometer display increments, security lamp flashes to indicate each digit selected In this example, the blinking digit displayed is 1 and the security lamp will flash one time	You have selected 1 as a number for the fourth digit
16	Quickly press **key fob** button **2 times** and release	Five flashes turn signals and indicators fifth digit in odometer display blinks	You have confirmed 1 as a number for the fourth digit and have advanced to entering the fifth digit
17	Press **left** turn switch **1 time** and release	None	A lack of confirmation flashes indicates no digit entered
18	Press and release **left** turn switch to advance through the digits In this example, you will repeat this step three times	Blinking digit in odometer display increments, security lamp flashes to indicate each digit selected In this example, the blinking digit displayed is 3 and the security lamp will flash three times	You have selected 3 as a number for the fifth digit
19	Quickly press **key fob** button **2 times** and release	One flash turn signals and indicators first digit in odometer display blinks	You have confirmed 3 as a number for the fifth digit and have gone back to the first digit

Table 5-29. Entering an Initial TSSM PIN (Example: 3-1-3-1-3) with No PIN Previously Entered

NO.	ACTION	WAIT FOR CONFIRMATION	NOTES
20	Turn IGN OFF		
21	Write down code in Owner's Manual		
22	Arm the security system and attempt to disarm using PIN entry. Refer to Table 5-25.		

CHANGING THE PIN

To change a PIN, refer to Table 5-30.

If a PIN was previously entered, the odometer will display the equivalent digit. Each additional press of the left turn switch will increment the digit.

Examples:

- To advance from 5 to 6, press and release the left turn switch 1 time.
- To advance from 8 to 2, press and release the left turn switch 3 times (9-1-2).

Table 5-30. Changing the PIN: HFSM

NO.	ACTION	WAIT FOR CONFIRMATION	NOTES
1	Select a 5-digit (1 through 9) personal code and record in the owner's manual and on the wallet card.		
2	With fobs present, cycle **IGN ON**-OFF-**ON**-OFF-**ON**		
3	Press **left** turn signal button **2** times.	Turn signals will flash 3 times.	
4	Press **right** turn signal button **1** time.	Current PIN will appear in odometer. The first digit will flash.	
5	Enter first digit (a) of new PIN by pressing **left** turn signal button until desired digit is displayed in odometer.		
6	Press **right** turn signal button **1** time.	The new digit will replace the current in the odometer. The second digit will flash.	
7	Enter second digit (b) of new PIN by pressing **left** turn signal button until the desired digit is displayed in the odometer.		
8	Press **right** turn signal button **1** time.	The new digit will replace the current in the odometer. The third digit will flash.	
9	Enter third digit (c) of new PIN by pressing **left** turn signal button until desired digit is displayed in the odometer.		
10	Press **right** turn signal button **1** time.	The new digit will replace the dash in the odometer. The fourth digit will flash.	
11	Enter fourth digit (d) of new PIN by pressing **left** turn signal button until desired digit is displayed in the odometer.		
12	Press **right** turn signal button **1** time.	The new digit will replace the current in the odometer. The fifth digit will flash.	

Table 5-30. Changing the PIN: HFSM

NO.	ACTION	WAIT FOR CONFIRMATION	NOTES
13	Enter fifth digit (e) of new PIN by pressing **left** turn signal button until desired digit is displayed in the odometer.		
14	Press **right** turn signal button **1** time.	The new digit will replace the current in the odometer. The first digit will flash.	
15	Turn the IGN OFF.		Turning the ignition switch to OFF stores the PIN.

TRANSPORT MODE

Transport mode is especially useful when working on the vehicle. If it is not used, the alarm will activate under many typical service activities.

To Enter Transport Mode: HFSM

It is possible to arm the security system without enabling the motion detector for one ignition cycle. This allows the vehicle to be picked up and moved in an armed state, however, any attempt to start the engine will trigger the alarm.

1. Turn the ignition switch to IGN.
2. Set the engine stop switch to the OFF position.
3. With an assigned fob within range, turn the ignition switch from OFF to ACC.
4. Simultaneously, press both the left and the right turn signal switches. This must be done within five seconds of turning the ignition switch to ACC.
5. After the turn signals flash once, turn the ignition switch to OFF and the module is armed.
6. The turn signals flash three times to confirm module arming in transfer mode for one ignition cycle.

To Exit Transport Mode: HFSM

Return the system to normal operation:

1. With the fob present, turn the ignition switch to IGN to disarm the HFSM.
2. To cancel the transport mode, set the engine stop switch to RUN.

To Enter Transport Mode: TSSM

It is possible to arm the security system without enabling the motion detector for one ignition cycle. This allows the vehicle to be picked up and moved in an armed state. In this mode, any attempt to bypass the ignition system will trigger the security system.

1. Turn the engine stop switch to the OFF position. Verify the security lamp is not flashing.
2. Turn IGN ON.
3. Press and hold key fob button until the turn signals and indicators flash three times.
4. Turn IGN OFF.
5. Press and hold key fob button until the turn signals and indicators flash three times.

To Exit Transport Mode: TSSM

To exit from transport mode and return the system to normal operation/functions, disarm the system using either the key fob or PIN.

SERVICE MODE

PART NUMBER	TOOL NAME
HD-48650	DIGITAL TECHNICIAN II

With a fob present, the HFSM can be configured for service by disabling the security system with DIGITAL TECHNICIAN II (Part No. HD-48650).

Once disabled, the vehicle can be operated without an assigned fob present. To maintain the Service Mode, the assigned fobs must be kept out of range. If the fob appears in range, the Service Mode will be exited.

FOUR-WAY FLASHING

To Arm the HFSM with the Hazard Warning Flashers ON

If it is necessary to leave a vehicle parked along side the road, the hazard warning four-way flashers can be turned ON with the smart security system armed.

1. Turn IGN ON.
2. Simultaneously press both left and right turn signal switches to turn the four-way flashers ON. The four-way flashers will continue for two hours.
3. Turn IGN OFF to arm the smart security system.

To Disarm the HFSM and Turn the Hazard Warning Flashers OFF

1. With a fob present, turn the ignition switch to IGN.
2. Simultaneously press the left and right turn signal switches.

STORAGE MODE: TSSM

The TSSM has a special mode for long term storage. This mode prevents the security system from draining the battery

after a period of days (10, 20, 60 or infinite) without any ignition switch activity.

- If the TSSM is set to infinite, the system will not go into storage mode.
- Vehicles will enter storage mode whether the security system is armed or disarmed.
- If set to 20 days or greater, the customer must use an approved trickle charger to keep the battery from discharging.

In storage mode, all alarm functions remain active but the receiver is shut down and will not respond to the key fob. The vehicle is immobilized because the starter motor and ECM are disabled. When the storage mode is entered, the security lamp stops flashing to conserve power.

To wake up the TSSM from storage mode, the ignition switch must be turned ON. This will trigger a warning/alarm if the system was previously armed. You must use the key fob or PIN to disarm the system and stop the alarm.

To set the storage mode preferences, refer to Table 5-31.

Table 5-31. Storage Mode Preferences: TSSM

NO.	ACTION	WAIT FOR CONFIRMATION	NOTES
1	Set engine stop switch to **OFF**		Verify the security lamp is not flashing (vehicle is disarmed)
2	Turn IGN **ON**-OFF-**ON**-OFF-**ON**		
3	Press **left** turn switch **2 times** and release	Two flashes turn signals and indicators depending on vehicle configuration (See 5.13 SERVICE AND EMERGENCY FUNCTIONS AND CONFIGURATIONS, Power Disruption and Configuring: TSSM regarding battery disconnects.)	Two flashes - Japan/Korea configuration TSSM
4	Press and hold **key fob** button until confirmation is received	One flash turn signals and indicators	
5	Release and then hold **key fob** button until confirmation is received	Two flashes turn signals and indicators	
6	Release and then hold **key fob** button until confirmation is received	Three flashes turn signals and indicators	
7	Press **left** turn switch **1 time** and release	Turn signals and indicators flash to indicate option selected	One flash - 10 days Two flashes - 20 days Three flashes - 60 days Four flashes - Infinite
8	Press **left** turn switch to advance through options	Turn signals and indicators flash to indicate option selected	One flash - 10 days Two flashes - 20 days Three flashes - 60 days Four flashes - Infinite
9	Turn IGN OFF.		

POWER DISRUPTION AND CONFIGURING: HFSM

PART NUMBER	TOOL NAME
HD-42682	BREAKOUT BOX

The HFSM will not enter PIN entry mode on the first attempt after battery voltage has been removed from terminal 1. This will occur after any of the following:

- Battery disconnect or power drain.
- Main fuse removal.
- Connecting BREAKOUT BOX (Part No. HD-42682) to HFSM connector.

Therefore, after all battery reconnects, the configuration sequence must be modified as follows:

1. Set engine stop switch to the OFF position, cycle ignition switch IGN to **ON**-OFF-**ON**-OFF-**ON** and press left turn signal switch twice.
2. Repeat steps listed above.
3. Continue with PIN entry sequence listed.

POWER DISRUPTION AND CONFIGURING: TSSM

PART NUMBER	TOOL NAME
HD-42682	BREAKOUT BOX

The TSM/TSSM will not enter configuration mode on the first attempt after battery voltage has been removed from terminal 1. This will occur after any of the following:

- Battery disconnect or power drain.
- Main fuse removal.
- Connecting BREAKOUT BOX (Part No. HD-42682) to TSSM connector.

Therefore, after all battery reconnects, the configuration sequence must be modified as follows.

1. Set engine stop switch to OFF, cycle ignition/headlamp switch **ON**-OFF-**ON**-OFF-**ON** and press left turn signal switch twice.
2. Repeat step listed above.
3. Continue with configuration sequence listed.

DIGITAL TECHNICIAN® II HARLEY-DAVIDSON®

FAILS TO DISARM 5.14

DESCRIPTION AND OPERATION

HFSM

If the HFSM does not respond, responds with limited range, or will not consistently disarm with fob within normal range, follow the diagnostic procedure.

TSSM

This section applies only to those vehicles equipped with the optional security system (TSSM).

NOTE

*Disarming function may require practice. The key fob button **must** be pressed twice within 1.5 seconds to send the disarm command. The action is very similar to double-clicking a computer mouse. Light quick taps work best; very hard or very slow taps are less likely to work.*

The key fob sends a RF signal to activate all remote TSSM functions. The left front turn signal switch wire serves as the vehicle's antenna. If the TSSM does not respond (no confirmation at arming/disarming system) or responds weakly (limited range, won't consistently arm/disarm or synchronize), follow the diagnostic procedure.

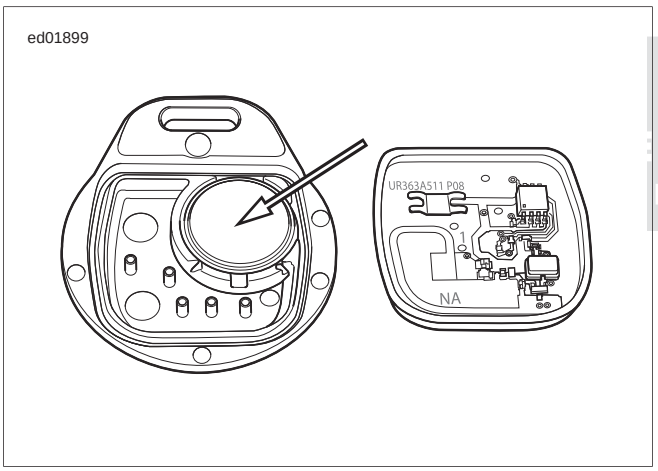


Figure 5-23. Key Fob Battery: TSSM

Diagnostic Tips

- Verify that cell phone is not within 3.0 in. (80.0 mm) of key fob.
- Interference from physical surroundings may affect RF transmission. Place fob next to vehicle or move vehicle to a new location and retest.
- See Figure 5-23. Verify that antenna is in OE location and that seat has not been replaced with a metal base seat.
- Check for damage to antenna wire.
- See Figure 5-24. Verify fob battery voltage is at least 2.9V.
- Fob serial number is located inside fob. Open fob by twisting a thin blade in the thumbnail slot between fob halves.

1. **Battery**
2. **Fob serial number**

Figure 5-24. Open Fob: HFSM

Connector Information

For additional information about the connectors in the following diagram(s) and diagnostic procedure(s), including the color of the harness test kit terminal probes, see B.1 CONNECTORS.

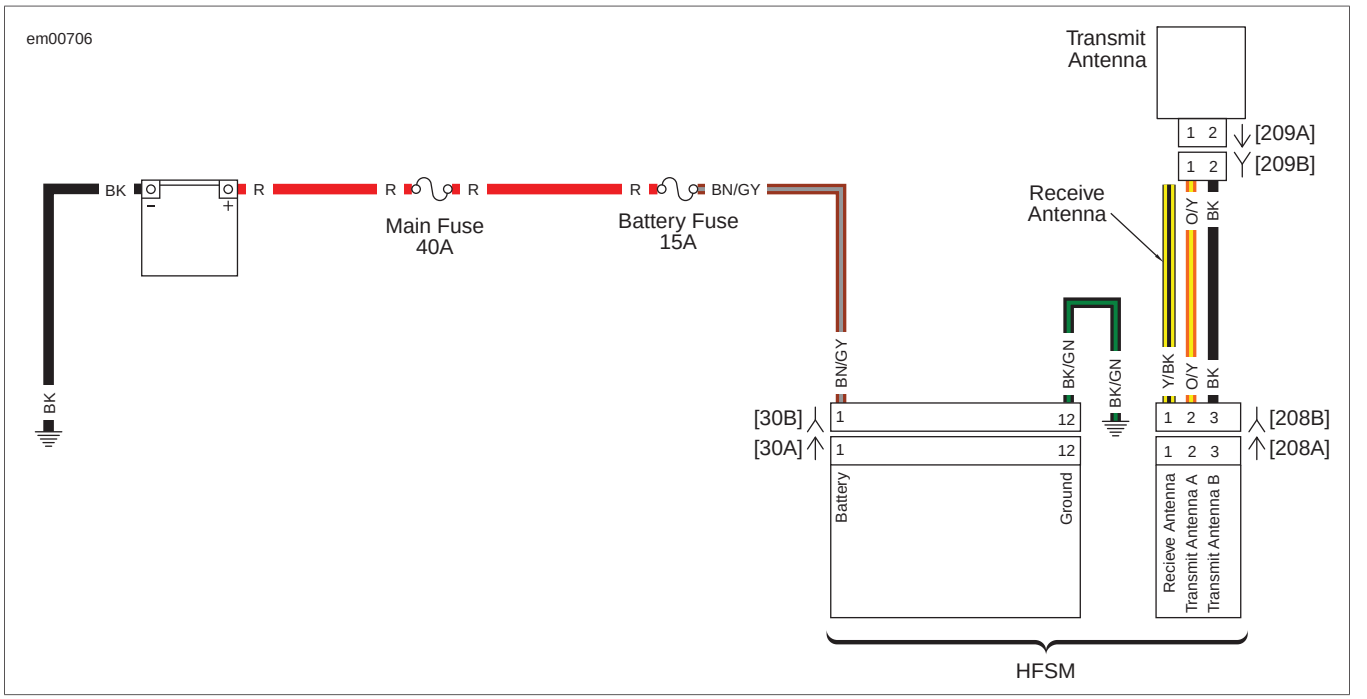


Figure 5-25. Antenna Circuit: HFSM

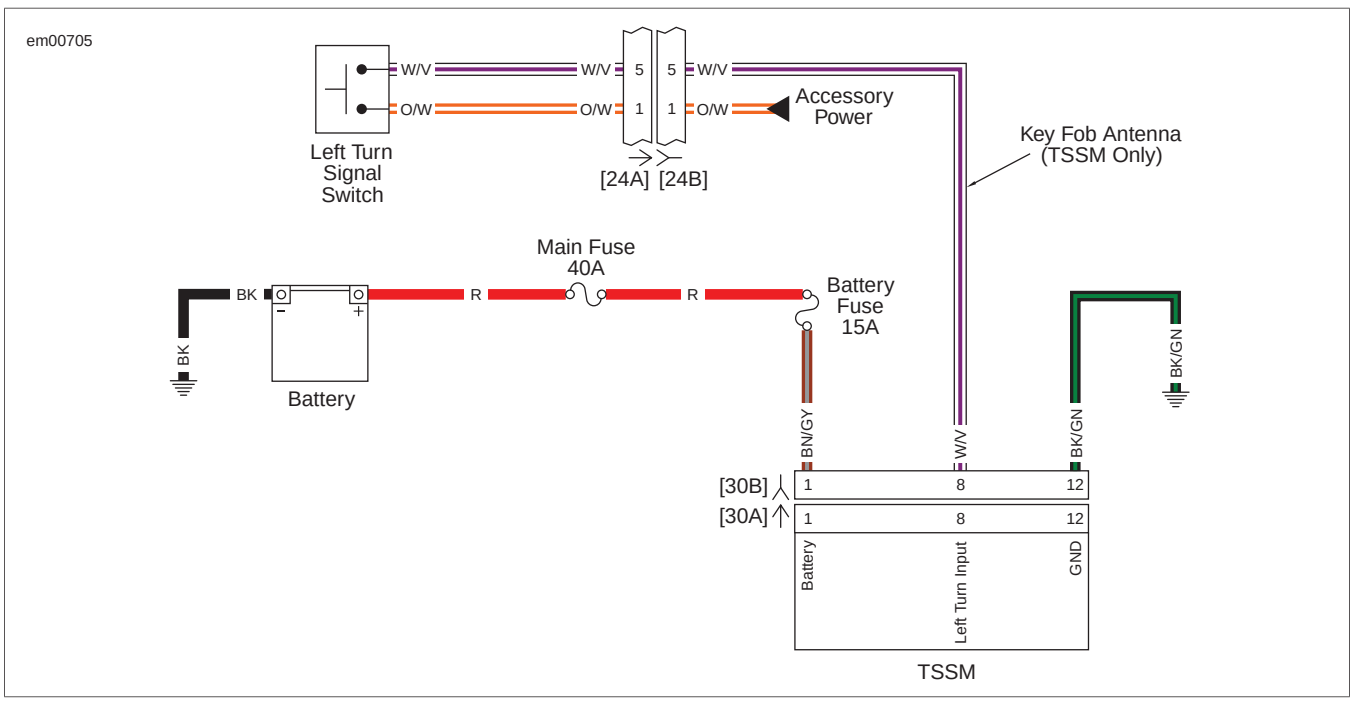


Figure 5-26. Antenna Circuit: TSSM

FAILS TO DISARM: HFSM

PART NUMBER	TOOL NAME
HD-41404-B	HARNESS CONNECTOR TEST KIT

Table 5-32. Fails to Disarm Diagnostic Faults: HFSM

POSSIBLE CAUSES
Open antenna circuit
Short to ground in antenna circuit
Antenna malfunction
Fob malfunction
HFSM malfunction

1. Fob Test

1. Test all assigned fobs.
2. Does any assigned fob work?
   a. **Yes.** Go to Test 5.
   b. **No.** Go to Test 2.

2. Antenna Circuit Short to Ground Test

1. Using HARNESS CONNECTOR TEST KIT (Part No. HD-41404-B) and a multimeter, test for continuity between [208B] terminal 1 and ground.
2. Is continuity present?
   a. **Yes.** Repair short to ground. **(5041)**
   b. **No.** Go to Test 3.

3. Antenna Circuit Open Test

1. Check for continuity between [208B] terminal 1 and end of (Y/BK) wire (pull back conduit to expose unterminated end of wire).
2. Is continuity present?
   a. **Yes.** Go to Test 4.
   b. **No.** Repair open on (Y/BK) wire. **(5041)**

4. Security System Antenna Test

1. Replace the security antenna with a known good security antenna. See the service manual.
2. Does the security system now disarm?
   a. **Yes.** Replace the security antenna. See the service manual. **(6878)**
   b. **No.** Replace HFSM. See the service manual. **(6757)**

5. Non-Functional Fob Test

1. Check battery on non-functional fob.
2. Is battery voltage greater than 2.9V?
   a. **Yes.** Replace fob. See the service manual. **(6756)**
   b. **No.** Replace battery. See the service manual. **(6755)**

FAILS TO DISARM: TSSM

Table 5-33. Fails to Disarm Diagnostic Faults: TSSM

POSSIBLE CAUSES
Fob malfunction
Fob battery discharged
TSSM malfunction

1. Key Fob Test

1. Verify the key fob is correct for the vehicle.
2. Is the key fob correct for the vehicle?
   a. **Yes.** Go to Test 2.
   b. **No.** Obtain correct fob or replace fob. See the service manual. Verify fob is synchronized to vehicle's TSSM.

2. Left Turn Signal Test

1. Operate the left turn signal.
2. Does left turn signal function?
   a. **Yes.** Go to Test 3.
   b. **No.** See 5.4 TURN SIGNALS.

3. Fob Battery Test

1. Replace fob battery and retest. See the service manual.
2. Does fob work?
   a. **Yes.** System OK. **(6755)**
   b. **No.** Go to Test 4.

4. TSSM Test

1. Attempt to assign new fob to TSSM and retest.
2. Does fob work?
   a. **Yes.** System OK. **(6756)**
   b. **No.** Replace TSSM. See the service manual. **(6757)**

DIGITAL TECHNICIAN HARLEY-DAVIDSON

DTC B1131, B1132 5.15

DESCRIPTION AND OPERATION

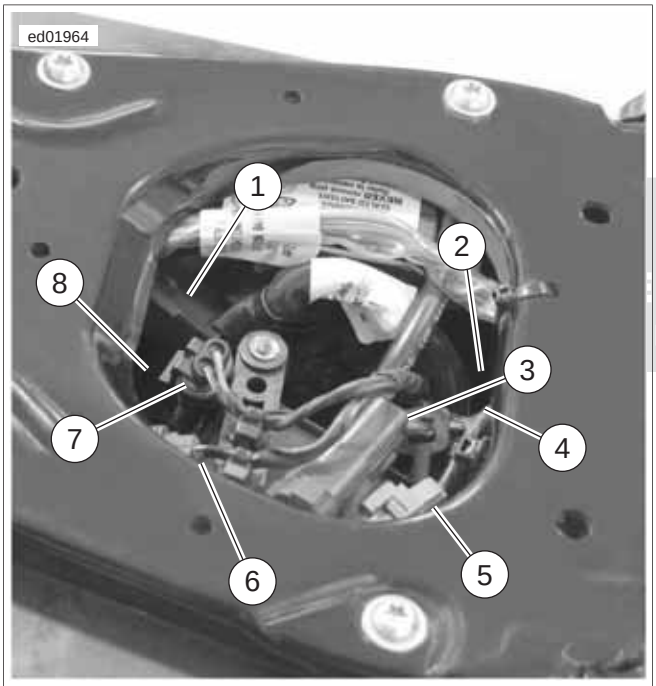
NOTE

This section applies only to those vehicles equipped with the optional security system.

See Figure 5-27. An alarm cycle is activated when the HFSM is connected, the siren has been armed by the HFSM and a security event occurs. See 5.10 SECURITY SYSTEM. Under normal armed operation, the siren input (terminal 2) is driven low by the HFSM to trigger the audible alarm. When the siren input is driven high by the HFSM the audible alarm stops.

Table 5-34. Siren Alarm Output DTCs

DTC	SYMPTOM
B1131	Alarm output low
B1132	Alarm output high



1. **Tail lamp harness to main harness [7]**
2. **Grounds [GND1] & [GND2]**
3. **Accessory [4]**
4. **Security siren [142]**
5. **B+ [160]**
6. **IAT sensor [89]**
7. **Rear O2 sensor [137]**
8. **JSS (HDI only) [133]**

Figure 5-27. Under Seat

Diagnostic Tips

- If the siren is armed and the internal siren battery is dead, shorted, disconnected, or has been charging for a period longer than 24 hours, the siren will respond with three chirps on arming instead of two.
- The internal siren battery may not charge if the vehicle's battery is less than 12.5V.
- If the siren does not chirp two or three times on a valid arming command from the HFSM, the chirp function has been disabled, the siren is either not connected, not working, or the siren wiring was opened or shorted while the siren was disarmed.
- If the siren enters the self-driven mode where it is powered from the siren internal 9V battery, the turn-signal lamps will not alternately flash. If the HFSM activates the siren, the turn-signal lamps will flash. If the siren has been armed and a security event occurs, and the siren is in self-driven mode, the siren will alarm for 20-30 seconds and then turn off for 5-10 seconds. This alarm cycle will be repeated ten times if the siren is in the self-driven mode.
- If the siren does not stop alarming after it has been armed, then either the HFSM output or siren input may be shorted to ground, or the siren vehicle battery connection is open or shorted to ground, or the siren vehicle ground connection is open, or a security event has occurred. See 5.10 SECURITY SYSTEM for a description of alarm functions.

Connector Information

For additional information about the connectors in the following diagram(s) and diagnostic procedure(s), including the color of the harness test kit terminal probes, see B.1 CONNECTORS.

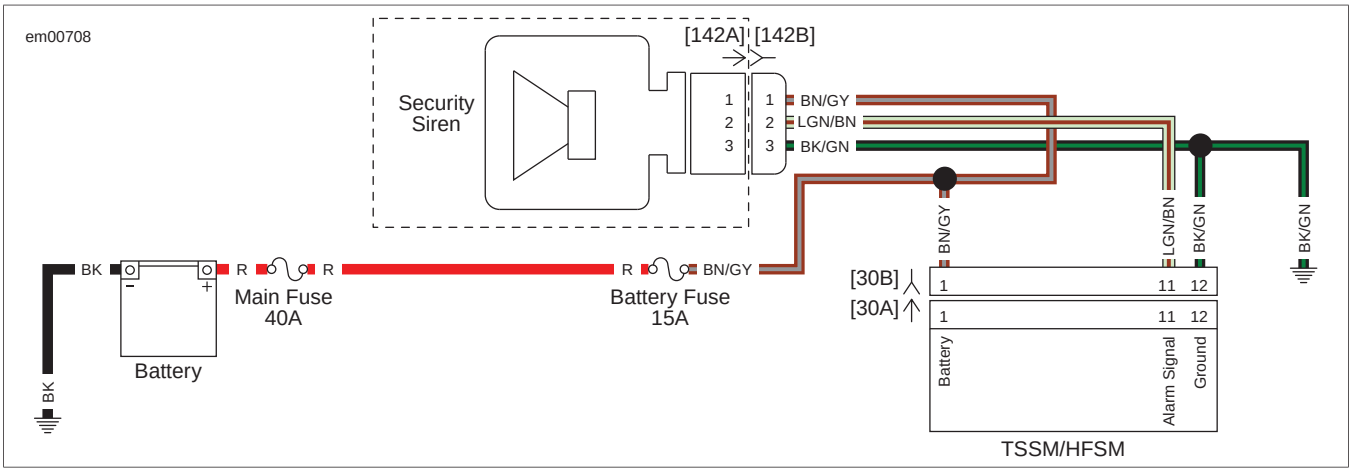


Figure 5-28. Smart Siren Circuit

DTC B1131

PART NUMBER	TOOL NAME
HD-41404-B	HARNESS CONNECTOR TEST KIT
HD-42682	BREAKOUT BOX

Table 5-35. DTC B1131 Diagnostic Faults

POSSIBLE CAUSES
Short to ground in alarm signal
Open ground circuit
Open power circuit
TSSM/HFSM malfunction
Open alarm signal
Siren malfunction

1. Siren Verification Test

1. Disarm the security system.
2. Inspect the vehicle for a security siren.
3. Is a security siren present?
   a. **Yes.** Go to Test 3.
   b. **No.** Go to Test 2.

2. Alarm Signal Short to Ground Test

1. With IGN OFF, connect BREAKOUT BOX (Part No. HD-42682) to wire harness [30B], leaving TSSM/HFSM [30A] disconnected. See 1.2 DIAGNOSTIC TOOLS.
2. Using HARNESS CONNECTOR TEST KIT (Part No. HD-41404-B) and a multimeter, test for continuity between breakout box terminals 11 and 12.
3. Is continuity present?
   a. **Yes.** Repair short to ground in (LGN/BN) wire between [142B] terminal B and [30B] terminal 11.
   b. **No.** Replace the TSSM/HFSM. See the service manual.

3. Battery Circuit Test

1. Remove the security siren.
2. With IGN ON, and the engine stop switch in the RUN position, using HARNESS CONNECTOR TEST KIT (Part No. HD-41404-B) and a multimeter, test for battery voltage at [142B] between terminals A and C.
3. Is battery voltage present?
   a. **Yes.** Go to Test 5.
   b. **No.** Go to Test 4.

4. Power Supply and Ground Test

1. Test for battery voltage between [142B] terminal A and ground.
2. Is battery voltage present?
   a. **Yes.** Repair open in (BK) ground wire between [142B] terminal C and ground.
   b. **No.** Repair open in (BN/GY) wire.

5. Alarm Signal Circuit Open Test

1. With IGN OFF, connect BREAKOUT BOX (Part No. HD-42682) to wire harness [30B], leaving TSSM/HFSM [30A] disconnected. See 1.2 DIAGNOSTIC TOOLS.
2. Using HARNESS CONNECTOR TEST KIT (Part No. HD-41404-B) and a multimeter, test for continuity between [142B] terminal B and breakout box terminal 11.
3. Is continuity present?
   a. **Yes.** Go to Test 6.
   b. **No.** Repair open in (LGN/BN) wire between [142B] and [30B].

6. Alarm Signal Short to Ground Test

1. Test for continuity between breakout box terminals 11 and 12.

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2. Is continuity present?
   a. **Yes.** Repair short to ground in (LGN/BN) wire.
   b. **No.** Go to Test 7.

7. Security Siren Resistance Test

1. Measure resistance at [142A] between terminals B and C.
2. Is the security siren resistance between 40,000-160,000 Ohms?
   a. **Yes.** Go to Test 8.
   b. **No.** Replace the security siren. See the service manual.

8. Security Siren Validation Test

1. Connect and operate the security siren on a known good vehicle.
2. Does the siren function properly with no DTCs set?
   a. **Yes.** Replace the TSSM/HFSM. See the service manual.
   b. **No.** Replace the security siren. See the service manual.

DTC B1132

PART NUMBER	TOOL NAME
HD-41404-B	HARNESS CONNECTOR TEST KIT
HD-42682	BREAKOUT BOX

Table 5-36. DTC B1132 Diagnostic Faults

POSSIBLE CAUSES
Short to ground in alarm signal
Open ground circuit
Open power circuit
TSM/TSSM/HFSM malfunction
Open alarm signal
Siren malfunction

1. Siren Verification Test

1. Disarm the security system.
2. Inspect the vehicle for a security siren.
3. Is a security siren present?
   a. **Yes.** Go to Test 3.
   b. **No.** Go to Test 2.

2. Alarm Signal Circuit Short to Voltage Test

1. With IGN OFF, connect BREAKOUT BOX (Part No. HD-42682) to wire harness [30B], leaving [30A] disconnected. See 1.2 DIAGNOSTIC TOOLS.
2. With IGN ON, using HARNESS CONNECTOR TEST KIT (Part No. HD-41404-B) and a multimeter, test for voltage between breakout box terminal 11 and ground.
3. Is battery voltage present?
   a. **Yes.** Repair short to voltage in (LGN/BN) wire.
   b. **No.** Replace the TSSM/HFSM. See the service manual.

3. Alarm Signal Short to Voltage Test

1. Disconnect the security siren.
2. With IGN OFF, connect BREAKOUT BOX (Part No. HD-42682) to wire harness [30B], leaving TSSM/HFSM [30A] disconnected. See 1.2 DIAGNOSTIC TOOLS.
3. With IGN ON, test for voltage between breakout box terminal 11 and ground.
4. Is battery voltage present?
   a. **Yes.** Repair short to voltage on LGN/BN wire.
   b. **No.** Replace the TSSM/HFSM. See the service manual.

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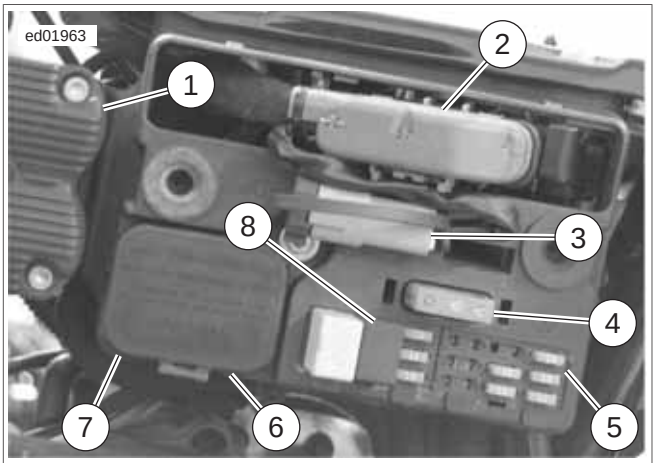
DTC B1134 5.16

DESCRIPTION AND OPERATION

See Figure 5-29. With the TSSM/HFSM (if equipped) disarmed, IGN ON, engine stop switch in the RUN position, and the transmission in neutral or clutch lever pulled in, the start relay is grounded. Battery voltage is applied to the start relay coil which is grounded through the TSM/TSSM/HFSM. DTC B1134 is set when that ground is not established through the TSM/TSSM/HFSM.

Connector Information

For additional information about the connectors in the following diagram(s) and diagnostic procedure(s), including the color of the harness test kit terminal probes, see B.1 CONNECTORS.



1. **Ignition coil**
2. **ECM [78]**
3. **DLC [91]**
4. **Main fuse [5]**
5. **Fuse block [64]**
6. **TSM/TSSM/HFSM**
7. **HFSM antenna harness [208]**
8. **Fuse/relay block [62]**

Figure 5-29. Under Left Side Cover

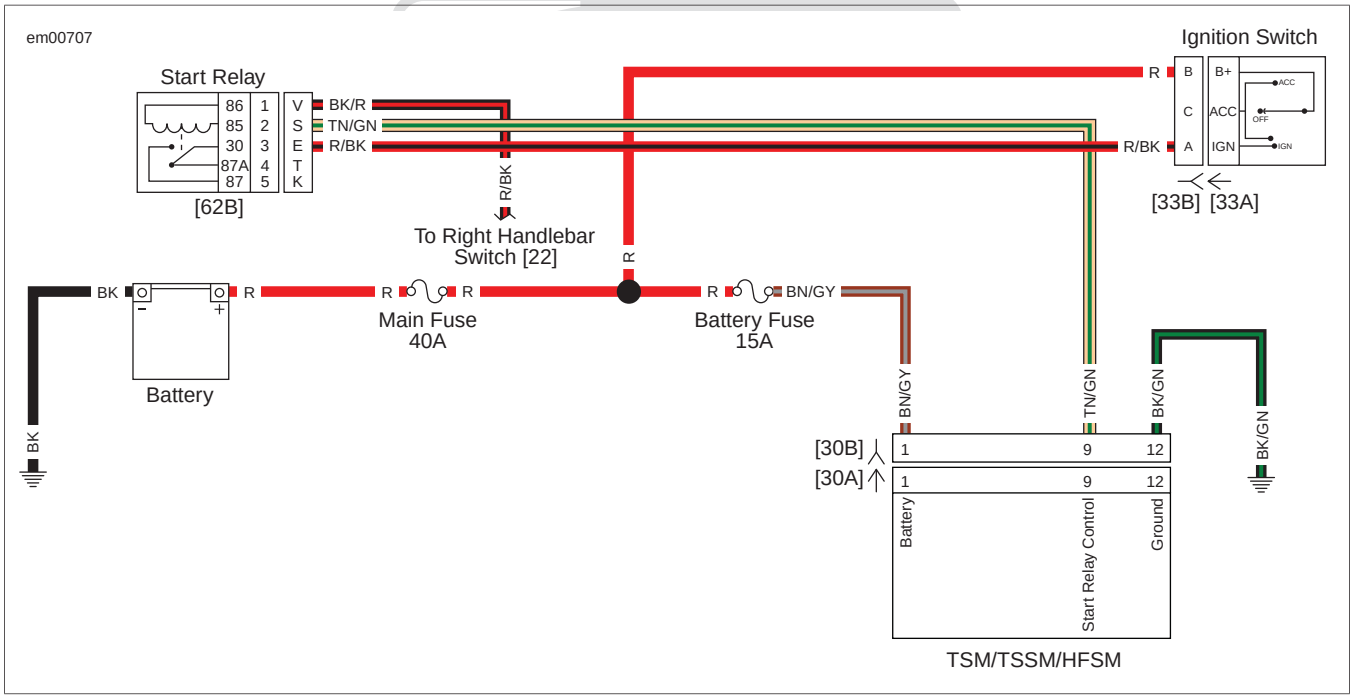


Figure 5-30. Starter TSM/TSSM/HFSM Circuit

DTC B1134

PART NUMBER	TOOL NAME
HD-41404-B	HARNESS CONNECTOR TEST KIT
HD-42682	BREAKOUT BOX

Table 5-37. DTC B1134 Diagnostic Faults

POSSIBLE CAUSES
TSM/TSSM/HFSM malfunction
Start relay malfunction
Short to voltage in start relay control circuit

1. Relay Control Circuit Short to Voltage Test

1. With IGN OFF, connect BREAKOUT BOX (Part No. HD-42682) between wire harness [30B] and TSM/TSSM/HFSM [30A]. See 1.2 DIAGNOSTIC TOOLS.
2. Remove start relay.
3. With IGN ON, using HARNESS CONNECTOR TEST KIT (Part No. HD-41404-B) and a multimeter, test for voltage on breakout box (Gray) terminal 9.
4. Is battery voltage present?
   a. **Yes.** Repair short to voltage on (TN/GN) wire.
   b. **No.** Go to Test 2.

2. Start Relay Test

1. Test start relay. See 1.3 DIAGNOSTICS AND TROUBLESHOOTING, Relay Diagnostics.
2. Does relay pass test?
   a. **Yes.** Replace TSM/TSSM/HFSM. See the service manual.
   b. **No.** Replace start relay. See the service manual.

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DTC B1143, B1144, B1145 5.17

DESCRIPTION AND OPERATION

DTC B1143, B1144, or B1145 will set when a fault occurs to the security antenna circuit used to transmit to the fob. Refer to Table 5-38.

Table 5-38. Security Antenna DTCs

DTC	CONDITION
B1143	Security antenna short-to-ground
B1144	Security antenna short-to-voltage
B1145	Security antenna open

Connector Information

For additional information about the connectors in the following diagram(s) and diagnostic procedure(s), including the color of the harness test kit terminal probes, see B.1 CONNECTORS.

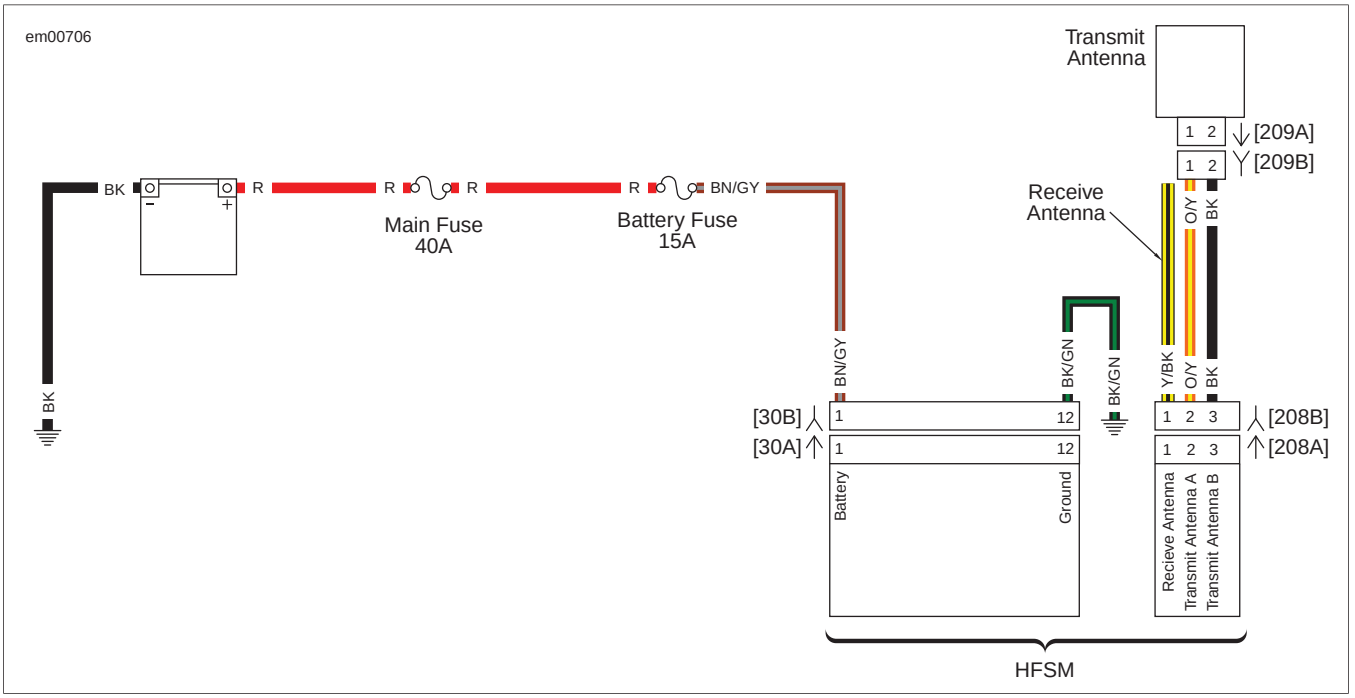

Figure 5-31. Antenna Circuit: HFSM

DTC B1143

PART NUMBER	TOOL NAME
HD-41404-B	HARNESS CONNECTOR TEST KIT

Table 5-39. DTC B1143 Diagnostic Faults

POSSIBLE CAUSES
Security antenna malfunction
HFSM malfunction
Open antenna circuit

1. Security Antenna Visual Test

1. Inspect the security antenna for damage.
2. Is damage to the security antenna present?
   a. **Yes.** Repair or replace security antenna as needed. See the service manual.
   b. **No.** Go to Test 2.

2. Security Antenna Short to Ground Test

1. Disconnect [208].
2. Using HARNESS CONNECTOR TEST KIT (Part No. HD-41404-B) and a multimeter, test for continuity between terminal 2 and ground.
3. Is continuity present?
   a. **Yes.** Repair short to ground in (O/Y) wire.
   b. **No.** Replace the HFSM. See the service manual.

DTC B1144

PART NUMBER	TOOL NAME
HD-41404-B	HARNESS CONNECTOR TEST KIT

Table 5-40. DTC B1144 Diagnostic Faults

POSSIBLE CAUSES
Security antenna malfunction
HFSM malfunction
Short to voltage in antenna circuit

1. Security Antenna Visual Test

1. Inspect the security antenna for damage.
2. Is damage to the security antenna present?
   a. **Yes.** Repair or replace security antenna as needed. See the service manual.
   b. **No.** Go to Test 2.

2. Security Antenna Short to Voltage Test

1. Disconnect [208].
2. With IGN ON, using HARNESS CONNECTOR TEST KIT (Part No. HD-41404-B) and a multimeter, test for voltage between terminal 2 and ground.
3. Is voltage present?
   a. **Yes.** Repair short to voltage in (O/Y) wire.
   b. **No.** Replace the HFSM. See the service manual.

DTC B1145

PART NUMBER	TOOL NAME
HD-41404-B	HARNESS CONNECTOR TEST KIT

Table 5-41. DTC B1145 Diagnostic Faults

POSSIBLE CAUSES
Security antenna malfunction
HFSM malfunction
Open antenna circuit

1. Security Antenna Resistance Test

1. Disconnect [209].
2. Using HARNESS CONNECTOR TEST KIT (Part No. HD-41404-B) and a multimeter, measure resistance at [209A] between terminals 1 and 2.
3. Is resistance greater than 5700 Ohms?
   a. **Yes.** Replace the security antenna. See the service manual.
   b. **No.** Go to Test 2.

2. Antenna B Circuit Open Test

1. Disconnect [208].
2. Test for continuity between [208B] terminal 3 and [209B] terminal 2.
3. Is continuity present?
   a. **Yes.** Go to Test 3.
   b. **No.** Repair open in (BK) wire.

3. Antenna A Circuit Open Test

1. Test for continuity between [208B] terminal 2 and [209B] terminal 1.
2. Is continuity present?
   a. **Yes.** Replace the HFSM. See the service manual.
   b. **No.** Repair open in (O/Y) wire.

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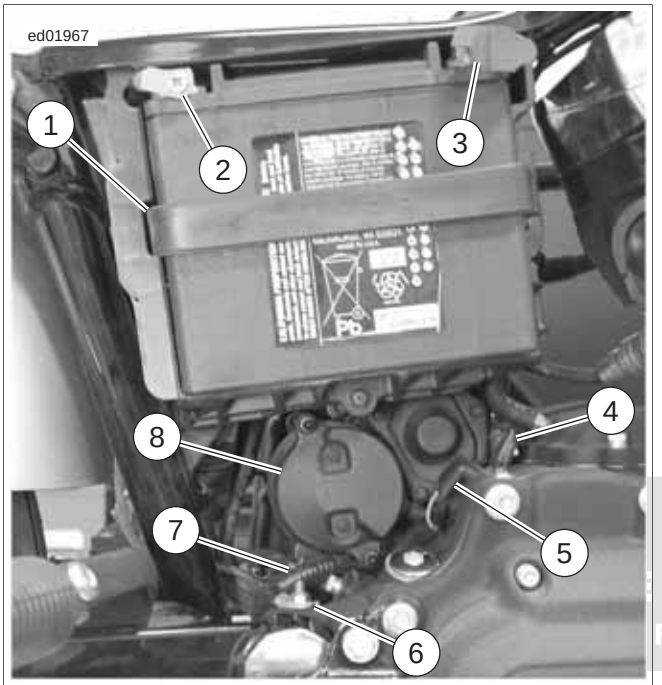
DTC B1154, B1155 5.18

DESCRIPTION AND OPERATION

The TSM/TSSM/HFSM monitors the clutch and neutral switch circuits to determine if it is safe to let the vehicle start. If the TSM/TSSM/HFSM does not see that the clutch switch is closed (lever pulled in) or the neutral switch is closed (transmission in neutral) it will not activate the start relay. The TSM/TSSM/HFSM controls the start relay by supplying the ground circuit to the coil of the start relay.



1. **Battery**
2. **Battery negative**
3. **Battery positive**
4. **Starter solenoid [128]**
5. **Neutral switch [131]**
6. **Battery ground cable**
7. **VSS [65]**
8. **Starter**

Figure 5-32. Under Right Side Cover

Diagnostic Tips

DTCs B1154 and B1155 will set when either the clutch switch circuit or neutral switch circuit is shorted to ground at speeds greater than 10 mph (16 km/h) for more than 60 seconds. Refer to Table 5-42.

Table 5-42. Clutch/Neutral Switch DTCs

DTC	SYMPTOM
B1154	Clutch switch short-to-ground
B1155	Neutral switch short-to-ground

Connector Information

For additional information about the connectors in the following diagram(s) and diagnostic procedure(s), including the color of the harness test kit terminal probes, see B.1 CONNECTORS.

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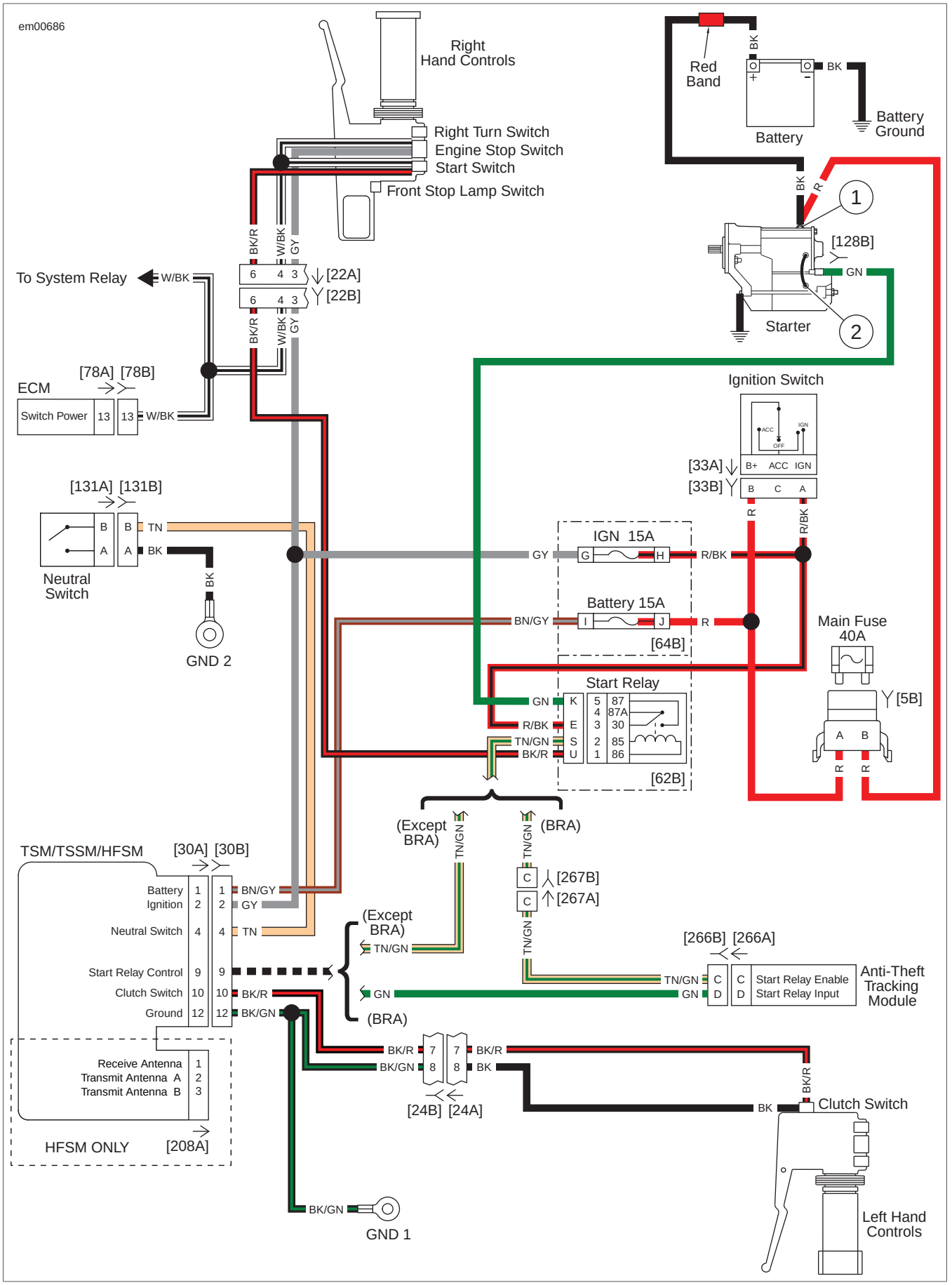

Figure 5-33. Starting Circuit

DTC B1154

PART NUMBER	TOOL NAME
HD-41404-B	HARNESS CONNECTOR TEST KIT
HD-42682	BREAKOUT BOX

Table 5-43. DTC B1154 Diagnostic Faults

POSSIBLE CAUSES
TSM/TSSM/HFSM malfunction
Switch malfunction
Short to ground in clutch switch circuit

NOTE

This DTC may occur if the vehicle is ridden with clutch disengaged (pulled in) at speeds greater than 10 mph (16 km/h) for more than 60 seconds (coasting down a long mountain road).

1. Clutch Circuit Short to Ground Test

1. With IGN OFF, connect BREAKOUT BOX (Part No. HD-42682) to wire harness [30B], leaving TSM/TSSM/HFSM [30A] disconnected. See 1.2 DIAGNOSTIC TOOLS.
2. Using HARNESS CONNECTOR TEST KIT (Part No. HD-41404-B) and a multimeter, test for continuity between breakout box (Gray) terminal 10 and terminal 12.
3. Is continuity present?
   a. **Yes.** Go to Test 2.
   b. **No.** Replace TSM/TSSM/HFSM. See the service manual.

2. Clutch Switch Circuit Test

1. Disconnect [24].
2. Test for continuity between breakout box (Gray) terminal 10 and terminal 12.
3. Is continuity present?
   a. **Yes.** Repair short to ground on (BK/R) wire in main wiring harness between [30B] and [24B].
   b. **No.** Go to Test 3.

3. Clutch Switch Test

1. Inspect left handlebar switch wiring for a short to ground.
2. Was a short to ground present?
   a. **Yes.** Repair short to ground in left handlebar switch wiring.
   b. **No.** Replace clutch switch. See the service manual.

DTC B1155

PART NUMBER	TOOL NAME
HD-41404-B	HARNESS CONNECTOR TEST KIT
HD-42682	BREAKOUT BOX

Table 5-44. DTC B1155 Diagnostic Faults

POSSIBLE CAUSES
TSM/TSSM/HFSM malfunction
Short to ground in neutral circuit
Neutral switch malfunction

NOTE

This DTC may occur if the vehicle is ridden in neutral at speeds greater than 10 mph (16 km/h) for more than 60 seconds (coasting down a long mountain road).

1. Neutral Circuit Short to Ground Test

1. Shift the transmission into 1st or 2nd gear.
2. With IGN OFF, connect BREAKOUT BOX (Part No. HD-42682) to wire harness [30B], leaving TSM/TSSM/HFSM [30A] disconnected. See 1.2 DIAGNOSTIC TOOLS.
3. Using HARNESS CONNECTOR TEST KIT (Part No. HD-41404-B) and a multimeter, measure resistance between breakout box (Gray) terminal 4 and terminal 12.
4. Is resistance less than 10 Ohms?
   a. **Yes.** Go to Test 2.
   b. **No.** Replace TSM/TSSM/HFSM. See the service manual.

2. Neutral Switch Short to Ground Test

1. Disconnect [131].
2. Measure resistance between breakout box (Gray) terminal 4 and terminal 12.
3. Is resistance less than 10 Ohms?
   a. **Yes.** Repair short to ground on (TN) wire.
   b. **No.** Replace neutral switch. See the service manual.

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NOTES

EFI SYSTEM 6.1

GENERAL

This chapter describes the operation of the Harley-Davidson EFI System. It is essential to have a working knowledge of the many components surrounding the engine to accurately troubleshoot and correct problems that may occur. 6.2 ELECTRONIC CONTROL MODULE and 6.3 SENSORS AND DRIVERS briefly explain the operation of the ECM and function of the various sensors and drivers. See 1.2 DIAGNOSTIC TOOLS for instructions on using the test equipment called out in the diagnostic test procedures in this chapter.

The EFI System provides microprocessor-based electronic engine management for the engine. The EFI system has the following features:

- Independently mapped spark and fuel control
- Compensated fuel delivery through engine temperature, intake air temperature, and manifold air pressure
- Engine load measurement via throttle position sensing
- Single point spark delivery
- Sequential port indirect (manifold) fuel injection
- Open/closed loop air/fuel control
- Automatic enrichment at start-up
- Engine speed and position determined by using a single CKP sensor
- Engine idle speed electronically managed with an IAC system

The EFI System performance is monitored by an ECM using sensors and switches to regulate engine operation. The ECM makes decisions for enabling ignition, starting, spark, and fuel delivery. Sensors include:

- Crank Position (CKP) sensor
- Throttle Position Sensor (TPS)
- Jiffy Stand Sensor (JSS) (HDI only)
- Turn Signal Module (TSM) or optional, factory-installed Turn Signal Security Module (TSSM Japan/Korea only) or Hands-Free Security Module (HFSM). This includes an integrated Bank Angle Sensor (BAS).
- Clutch switch
- Neutral switch
- Engine Temperature (ET) sensor
- Vehicle Speed Sensor (VSS)
- Oxygen (O2) Sensor
- Manifold Absolute Pressure (MAP)
- Intake Air Temperature (IAT) sensor

EFI Operation

The EFI system operates as an open or closed loop system, allowing it to adjust for all possible operating conditions. During open loop operation, the system uses programmed fuel and spark maps in the ECM providing easy cold starting and maximum power at Wide Open Throttle (WOT). The adaptive fuel value, learned during closed loop operation, is applied to open loop operation to adjust fuel and spark maps for optimal performance.

During closed loop operation, the O2 sensors provide input for an optimal air/fuel mixture resulting in reduced emissions, good fuel economy, and smooth power. O2 sensors must be at the normal operating temperature of the engine.

By using both open and closed loop systems, engine performance is continuously tuned to compensate for changing conditions and providing maximum performance. A simplified signal flow diagram for the EFI system is shown in Figure 6-1.

Symptom Diagnostics

Sections 6-4 through 6-21 contain diagnostic test procedures for DTCs listed in 2.1 INITIAL DIAGNOSTICS. For symptoms of engine malfunctions not specifically covered by DTCs, refer to tables 6-1 through 6-3 and sections 6-22 through 6-26.

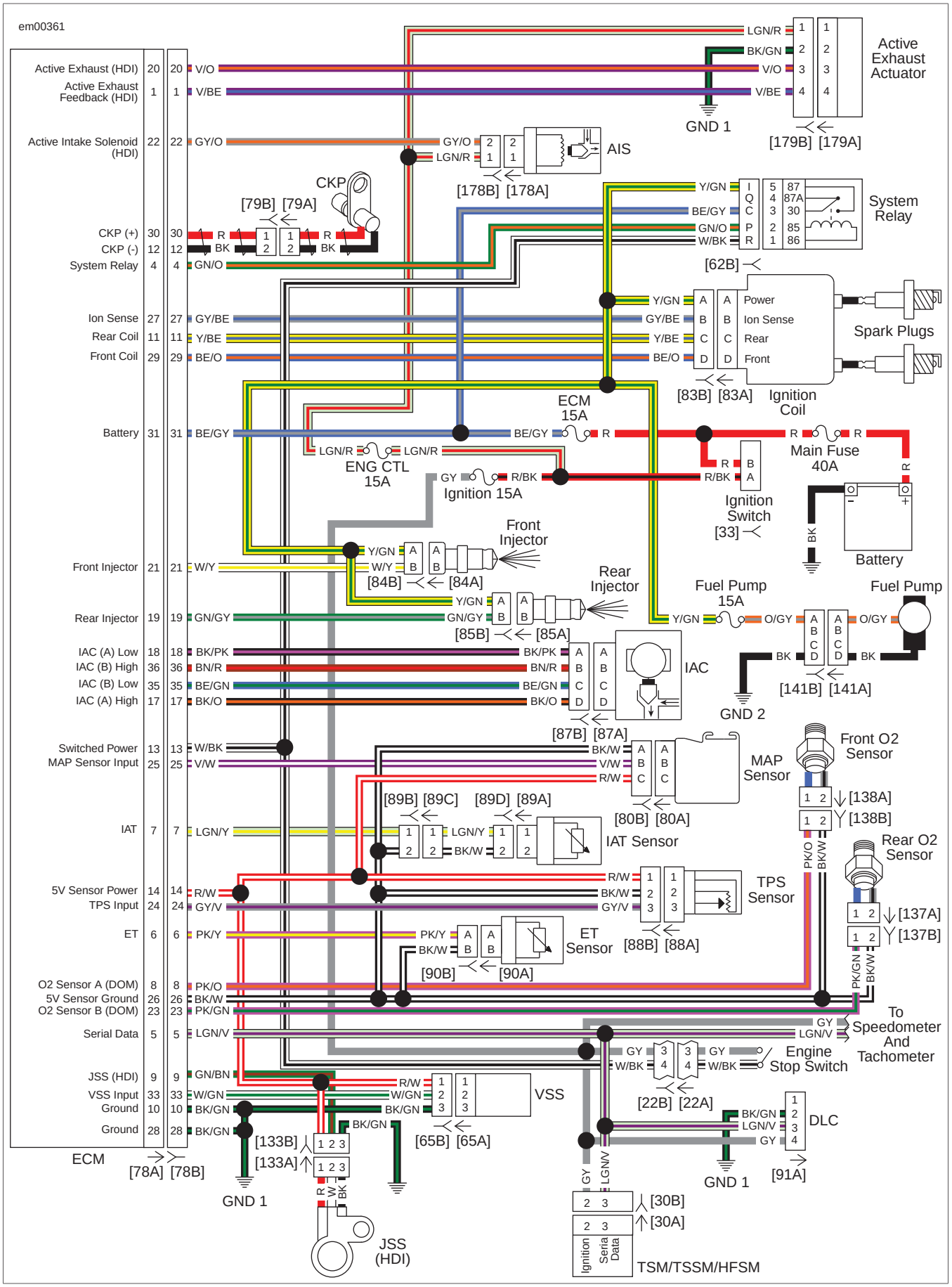
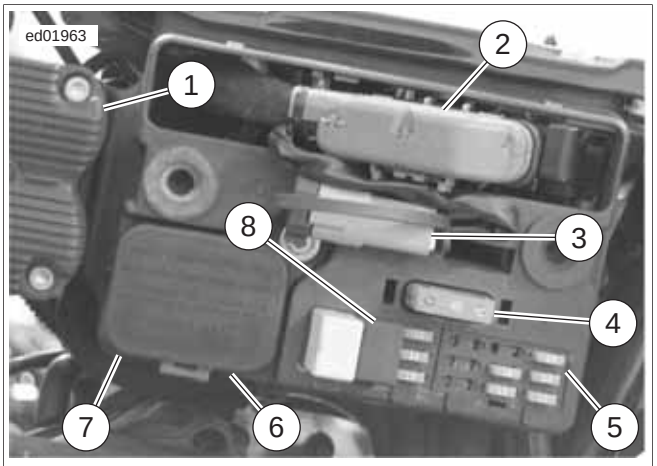


Figure 6-1. EFI Simplified Schematic

ELECTRONIC CONTROL MODULE 6.2

GENERAL

See Figure 6-2. The ECM receives and processes signals from the sensors and applies output signals to the drivers to crank, start, idle, and run the engine. This section describes the configuration of the ECM for this vehicle.



1. **Ignition coil**
2. **ECM [78]**
3. **DLC [91]**
4. **Main fuse [5]**
5. **Fuse block [64]**
6. **TSM/TSSM/HFSM**
7. **HFSM antenna harness [208]**
8. **Fuse/relay block [62]**

Figure 6-2. Under Left Side Cover

ECM

The ECM is mounted under the left side cover. It computes the spark advance for proper ignition timing and fuel control based on sensor inputs (from CKP, MAP, and TPS sensors) and controls the low-voltage circuits for the ignition coils and injectors.

The ECM contains all of the components used in the ignition system. The dwell time for the ignition coil is also calculated in the microprocessor and is dependent upon battery voltage. The programmed dwell is an added feature to give adequate spark at all speeds. (The ECM has added protection against transient voltages, continuous reverse voltage protection, and damage due to jump starts.) The ECM is fully enclosed to protect it from vibration, dust, water or oil. This unit is a non-repairable item. If it fails, it must be replaced. When the ECM is replaced, see the service manual.

32-2 Crankshaft

The crankshaft has 32 teeth evenly spaced around its circumference with two consecutive teeth missing (sync gap). In this configuration, the ECM determines engine position, engine phase, and engine speed from the CKP sensor input. Phase (TDC compression) is determined by the ECM during startup and, when necessary, while running. No engine ignition events can occur until the ECM determines the relationship of piston position to crankshaft position. The following paragraphs in this section describe synchronization and phasing by the ECM to provide smooth operation of the engine at all speeds.

Crank Position Signal Synchronization

In the 32-2 crank configuration, crankshaft position is determined by the ECM finding the two-tooth (sync gap) in the CKP sensor signal. This is usually accomplished the first time the sync gap is encountered. The ECM monitors the CKP signal status every engine revolution. If the ECM determines synchronization is lost, it immediately terminates ignition events and synchronizes on the next occurrence of the sync gap.

Engine Phase

Phasing is accomplished by the ECM identifying a widening in the CKP signal caused by the deceleration of the crankshaft, as a piston approaches TDC on its compression stroke. Since the rear cylinder approaches TDC earlier than the front cylinder, engine phase can be readily discriminated. Phasing is normally accomplished on the first TDC cycle after engine synchronization. Once phased, the ECM can begin normal ignition events. If the ECM experiences a system reset or loss of synchronization while the engine is running it also loses phase.

When phase is lost one of the following occurs:

- If an engine-not-running (Crank Mode) RPM is detected, the ECM executes the normal start-up phasing process.
- If Engine Run Mode is detected, the ECM executes a running re-phase sequence.

The front cylinder is fired every engine revolution. The ECM monitors the power stroke after the fire event to determine if sufficient acceleration occurred to indicate the ECM fired on the compression stroke. When two valid power strokes are detected, the ECM locks phase and resumes normal ignition events.

Engine Run Mode

Many functions of the EFI system require an engine run mode determination. Engine run is determined by the level of engine RPM. Generally, the engine is considered to be running when engine RPM exceeds a minimum of 750 RPM.

SENSORS AND DRIVERS 6.3

DESCRIPTION AND OPERATION

Sensors and drivers play an important part in the ECM's ability to provide the proper operational parameters for engine efficiency, emissions control, and fuel economy. When a failure occurs, a DTC is generated by, and stored in, the ECM. These codes help the technician diagnose engine trouble to the proper sensor or driver. See 2.1 INITIAL DIAGNOSTICS.

SENSORS

Not all sensor problems cause an engine shutdown, but sensor failure can seriously degrade overall engine performance. A notable exception is the CKP sensor, which if faulty, completely disables engine operation. The following are brief explanations of sensor types and their functions within the EFI system.

Crank Position (CKP) Sensor

The CKP sensor, located on the left front of the lower crankcase half, is a variable reluctance device that generates AC voltage as the teeth on the crankshaft pass by the sensor. The signal is routed to the ECM where it is used to determine crankshaft position, engine speed (RPM), and engine phase (TDC compression). Without the presence of the CKP signal, the ECM will not allow the ignition and fuel injection drivers to operate, and thus the engine will not run. The ECM uses crankshaft compression slow down events to determine engine phase. Therefore, the spark plugs must be installed when checking for spark.

Throttle Position Sensor (TPS)

The TPS is a variable resistor (potentiometer) having a linear resistance range, mounted on the throttle plate shaft. The output of the sensor is a voltage, dependent on the position of the throttle plate, and used by the ECM to determine ignition timing and fuel required at any given RPM and engine load.

Jiffy Stand Sensor (JSS): HDI Only

The JSS uses a Hall-effect device to monitor jiffy stand position. When the jiffy stand is fully retracted, the sensor picks up the presence of a metal tab mounted to the jiffy stand. When extended, the engine only starts and runs if the ECM receives a signal from the neutral switch indicating the transmission is in neutral, or a signal from the clutch switch indicating the clutch is engaged. Otherwise, the engine stalls as the clutch is released with the transmission in gear.

Bank Angle Sensor (BAS)

The BAS is within the TSM/TSSM/HFSM. The TSM/TSSM/HFSM will shut the engine down if the vehicle is tipped over. Once the sensor is tripped, the motorcycle must be righted, the ignition turned off and then on again before the engine can be restarted. This is communicated across the serial data circuit.

Clutch Switch

The TSM/TSSM/HFSM provides voltage to the clutch switch, which is open when the clutch is disengaged (released). With the clutch engaged (pulled in), the switch closes, allowing current flow to ground. The ECM will not allow the engine to start unless the transmission is in neutral or the clutch is engaged.

Neutral Switch

The indicators provide voltage to the neutral switch, which is open when the transmission is in gear. With the transmission in neutral, the switch is closed, allowing current flow to ground. The TSM/TSSM/HFSM will not allow the engine to start unless the transmission is in neutral or the clutch is engaged.

Engine Temperature (ET) Sensor

The ET sensor is a thermistor device, which means that at a specific temperature it has a specific resistance across its terminals. As this resistance varies, so does the voltage.

- At high temperatures, the resistance of the sensor is very low, which effectively lowers the signal voltage on ECM [78] terminal 6.
- At low temperatures, the resistance is very high, allowing the voltage to rise close to 5V. The ECM monitors this voltage to compensate for various operating conditions. The ECM also uses the sensor input as a reference for determining Idle Air Control (IAC) pintle position.

Manifold Absolute Pressure (MAP) Sensor

The MAP sensor is supplied 5V from the ECM and sends a signal back to ECM. This signal varies in accordance with engine vacuum, intake air temperature, and atmospheric barometric pressure. The MAP sensor monitors the intake manifold pressure (vacuum) and sends the information to the ECM. The ECM then adjusts the spark and fuel timing advance curves for optimum performance. The output of the sensor can also be used to determine if the engine is rotating when a fault with CKP sensor is present.

Intake Air Temperature (IAT) Sensor

The IAT sensor is a thermistor device. As such, it will have a specific resistance across its terminals at a specific temperature. As the temperature varies, the thermistor resistance varies, and so does the voltage on ECM [78] terminal 7.

- At high temperatures, the resistance of the sensor is very low, which effectively lowers the signal voltage on ECM [78] terminal 7.
- At low temperatures, the resistance is very high, allowing the voltage to rise close to 5V. The ECM monitors this voltage to compensate for various operating conditions.

Vehicle Speed Sensor (VSS)

The VSS is a Hall-effect device mounted close to the teeth of the 5th gear in the transmission. The output signal frequency varies with vehicle speed. The ECM processes the vehicle speed signal and transmits it via the serial data circuit to the speedometer to indicate vehicle speed.

O2 Sensor (Front and Rear)

The O2 sensor detects unburned oxygen in the engine exhaust. The output of the sensor is a voltage having a range of about 0-1.0V. The normal output is 0.5V which represents a balance between a lean (not enough fuel) and rich (too much fuel)

air/fuel mixture. An output less than 0.5V represents a lean mixture; greater than 0.5V represents a rich mixture. The change in output level signals the ECM to modify the air/fuel ratio.

It is important to note the O2 sensor does not operate efficiently until it is at vehicle operating temperature. Therefore, before any troubleshooting takes place, bring the sensor to operating temperature. Leaks in the exhaust system, leaky exhaust valves, misfires, or any engine problem allowing unburned oxygen into the exhaust stream could create a DTC indicating a bad sensor. Look for problems related to an improper air/fuel mixture before replacing the sensor.

DRIVERS

The ECM drivers are the output devices or system outputs of the EFI system. Drivers are provided ground by the ECM to pump, inject, and ignite the air/fuel mixture in the engine, and to activate relays.

Fuel Pump

The fuel pump, located inside the fuel tank, is provided battery voltage when the system relay is activated.

Ignition Coils and Spark Plugs

The ignition coils create the energy to fire the spark plugs and ignite the air/fuel mixture in the cylinders. Advancing or retarding the spark is controlled by the ECM to suit load and speed conditions of the engine.

See Figure 6-1. Each cylinder has its own ignition coil which is provided power by the system relay. Each coil is controlled independently by the ECM.

Fuel Injectors

The system relay provides battery power to the fuel injectors. The ECM provides the path to ground to trigger the injectors. The fuel injectors are pulse-width modulated solenoids for metering fuel into the intake tract. The pulse-width of the ground path to the injectors is varied by the ECM in response to inputs from the various sensors, thus varying the length of time the injector is open.

Idle Air Control (IAC)

The IAC motor is a stepper-motor used to regulate the amount of air entering the intake manifold during idle. The ECM controls engine idle speed by moving the IAC pintle to open or close a passage around the throttle plate. It does this by sending voltage pulses to the proper motor winding of the IAC. This causes the pintle to move in or out of the IAC a given distance for each pulse received.

- To increase idle speed, the ECM retracts the pintle, allowing more air to flow through the throttle body.
- To decrease idle speed, the ECM extends the pintle, allowing less air to flow through the throttle body.

Start Relay

Pressing the start switch activates the start relay, sending battery voltage to the starter solenoid. The TSM/TSSM/HFSM controls the ground to the start relay, disabling it during security and tip over conditions.

Active Intake Solenoid (AIS): HDI Only

The AIS regulates the amount of air entering the air cleaner. The AIS opens when vehicle speed exceeds 45 mph (70 km/h) with 50% or greater throttle opening. Once open, active intake will close when vehicle speed falls below 40 mph (65 km/h).

Active Exhaust Actuator: HDI Only

The active exhaust system utilizes an actuator valve located in the rear exhaust pipe which is connected to a servo motor via a cable. The valve position automatically adjusts to enhance engine performance.

Table 6-1. Engine Starts Hard

CAUSE	SOLUTION
Engine temperature circuit	Repair the circuit. If DTC P0117 or P0118 is present, diagnose and correct DTCs.
Fuel or Ignition system fault	Perform misfire diagnostics.
Battery discharged	Charge and test the battery. Perform charging system diagnosis if problem continues.
Crank position sensor circuit	Repair the circuit. If DTC P0373 or P0374 is present, diagnose and correct DTC.
Manifold leak	Perform intake leak test. See the service manual.
Ignition coil circuit/spark plugs	Repair the circuit. If DTC P1351, P1352, P1354, or P1355 is present, diagnose and correct DTCs.
Leaky injectors	Check for mechanical failures of the fuel injectors. If DTC P0261, P0262, P0263, or P0264 is present, diagnose and correct them.
Valve sticking	Perform compression test. See the service manual.

Table 6-2. Engine Performance Problems

CAUSE	SOLUTION
Engine temperature circuit	Repair the circuit. If DTC P0117 or P0118 are present, diagnose and correct DTCs.
Crank position sensor circuit	Repair the circuit. If DTC P0373 and P0374 are present, diagnose and correct DTC.
Fuel or Ignition system fault	Perform misfire diagnostics.
Manifold Leak **Note:** If manifold leak is large enough, the IAC closes and DTC P0505 sets.	Perform intake leak test. See the service manual.
Clogged fuel injectors	Clean or replace fuel injectors. See the service manual.
Throttle plates not opening fully	Perform Throttle Cable Adjustment. See the service manual.
Fuel system contaminated	Drain and refill with fresh fuel.

Table 6-3. Engine Emits Black Exhaust or Fouls Plugs

CAUSE	SOLUTION
Engine temperature circuit	Repair the circuit. If DTC P0117 or P0118 are present, diagnose and correct DTCs.
Clogged air filter	Replace air filter.
Leaky injectors	Repair the circuit. If DTC P0261, P0262, P0263, or P0264 are present, diagnose and correct DTCs.
IAT sensor circuit	Repair the circuit. If DTC P0112 or P0113 are present, diagnose and correct DTCs.

DIAGNOSTIC TECHNICIAN II HARLEY-DAVIDSON®

DTC P0107, P0108 6.4

DESCRIPTION AND OPERATION

PART NUMBER	TOOL NAME
HD-23738	VACUUM PUMP

See Figure 6-3. The MAP sensor is supplied 5V from the ECM terminal 14 and sends a signal back to the ECM terminal 25. This signal varies in accordance with engine vacuum and atmospheric barometric pressure. Changes in barometric pressure are influenced by weather and altitude.

Table 6-4. Code Description

DTC	DESCRIPTION
P0107	MAP sensor open/low
P0108	MAP sensor high

Diagnostic Tips

These codes will set if the MAP sensor signal is out of range. Code P0108 can only be detected with the engine running.

NOTE

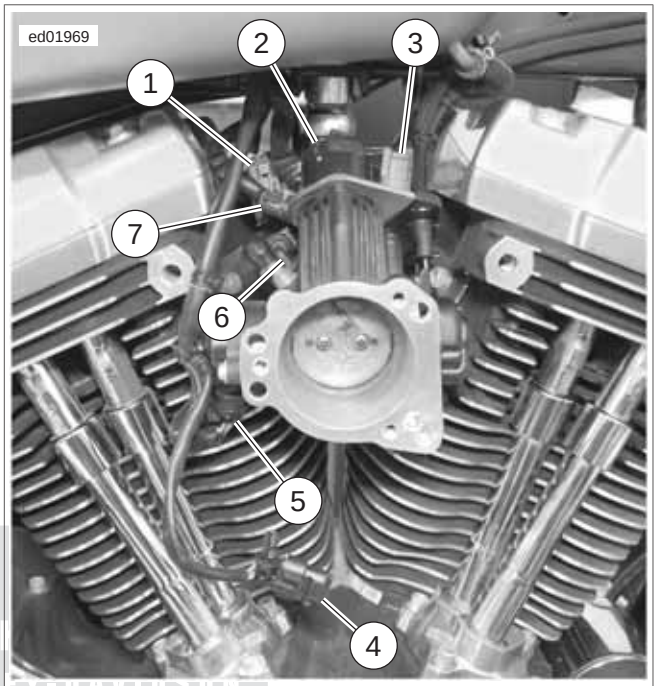
Do not over-pump vacuum pump during MAP sensor output check as sensor damage may result.

- MAP sensor output check. Using the VACUUM PUMP (Part No. HD-23738), apply a vacuum to the pressure port of the MAP sensor. The signal voltage should lower as the vacuum is applied.
- The MAP, JSS, TPS, and VSS are connected to the same 5V reference line. If the reference line shorts to ground or opens, multiple codes will be set (DTC P0107, P0108, P0122, P0123, P1501, P1502).
- A faulty sensor can negatively affect the signal voltage of the other sensors sharing the same 5V reference. If the wiring passes the following tests, disconnect one sensor at a time on the 5V reference and verify the DTC is still present. Additional DTC's will be set as each sensor is disconnected, clear DTC's after this test. Be sure to perform this test before replacing a component.
- MAP sensor codes may be set in cases of an intermittent TPS which has not yet set TPS codes.

See Figure 6-4 for common 5V sensor power and ground interconnections.

Connector Information

For additional information about the connectors in the following diagram(s) and diagnostic procedure(s), including the color of the harness test kit terminal probes, see B.1 CONNECTORS.



1. **Rear fuel injector [85]**
2. **IAC [87]**
3. **Front fuel injector [84]**
4. **Active intake solenoid (HDI) [178]**
5. **TPS [88]**
6. **IAT sensor [89]**
7. **MAP sensor [80]**

Figure 6-3. Between Cylinders Right Side

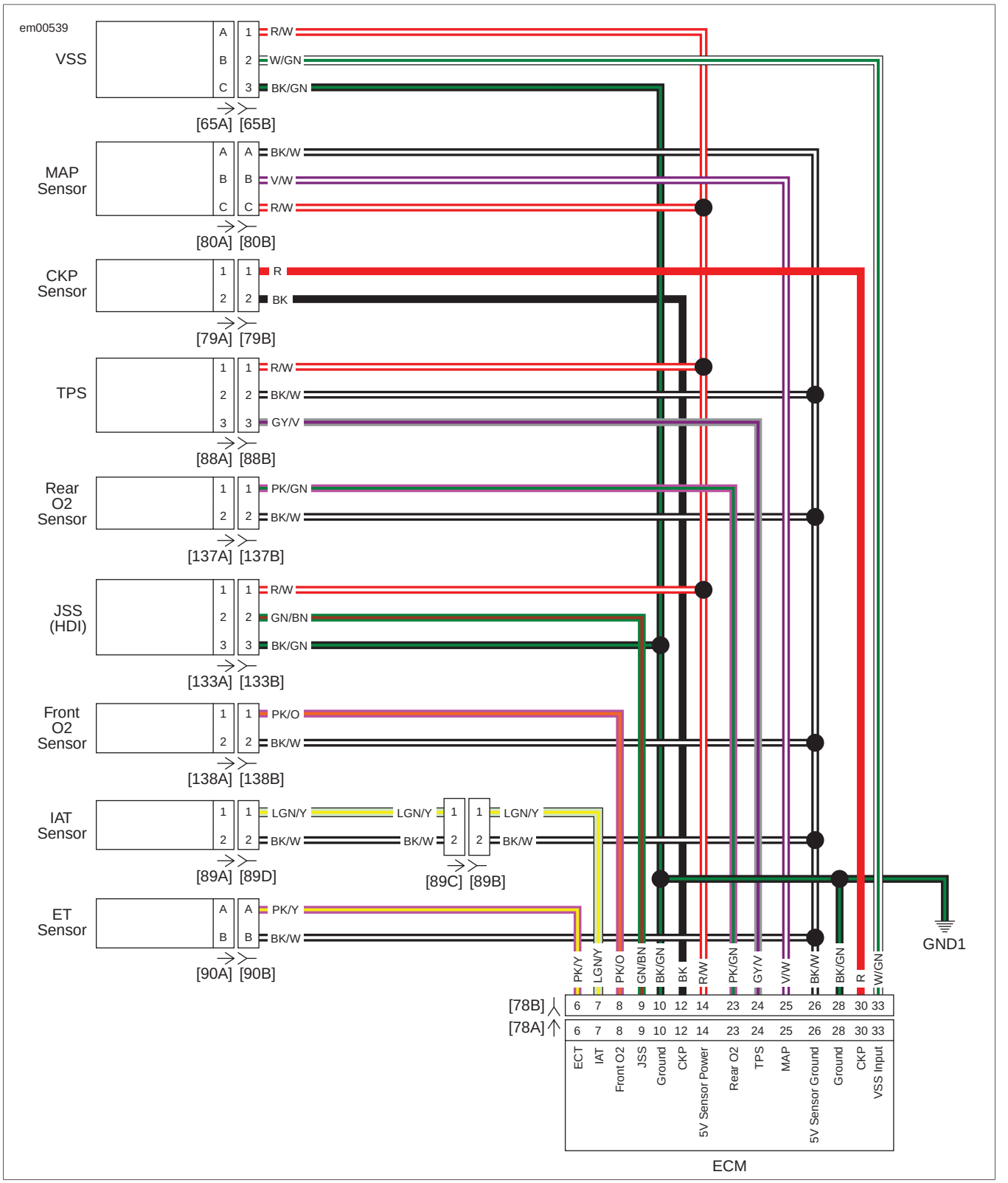


Figure 6-4. Sensor Circuit

DTC P0107

PART NUMBER	TOOL NAME
HD-41404-B	HARNESS CONNECTOR TEST KIT
HD-43876	BREAKOUT BOX

Table 6-5. DTC P0107 Diagnostic Faults

POSSIBLE CAUSES
MAP sensor malfunction
ECM malfunction
Open or shorted to ground signal wire
Open or shorted to ground 5V reference circuit

1. MAP Sensor Test

1. Disconnect the MAP sensor [80].
2. Using the HARNESS CONNECTOR TEST KIT (Part No. HD-41404-B), connect a test wire between [80B] terminals B and C.
3. Clear DTC P0107. See 2.1 INITIAL DIAGNOSTICS, Odometer Self-Diagnostics.
4. Turn IGN OFF and ON.
5. Does the DTC P0107 reset?
   a. **Yes.** Go to Test 2.
   b. **No.** Replace the MAP sensor. See the service manual.

2. MAP Sensor Signal Voltage Test

1. Remove the test wire
2. With IGN ON, test for voltage from [80B] terminal C to ground.
3. Is voltage approximately 5V?
   a. **Yes.** Go to Test 3.
   b. **No.** Go to Test 6.

3. MAP Sensor Signal Wire Continuity Test

1. Connect BREAKOUT BOX (Part No. HD-43876) to wire harness [78B], leaving ECM [78A] disconnected. See 1.2 DIAGNOSTIC TOOLS.
2. Test for continuity between [80B] terminal B and breakout box terminal 25.
3. Is continuity present?
   a. **Yes.** Go to Test 4.
   b. **No.** Repair open in (V/W) wire.

4. MAP Sensor Signal Wire Shorted to Ground Test

1. Test for continuity between breakout box terminal 25 and ground.
2. Is continuity present?
   a. **Yes.** Repair short to ground in (V/W) wire.
   b. **No.** Go to Test 5.

5. MAP Sensor Signal Wire Shorted to Sensor Ground Test

1. Turn IGN OFF.
2. Test for continuity between breakout box terminals 25 and 26.
3. Is continuity present?
   a. **Yes.** Repair short between (V/W) and (BK/W) wires.
   b. **No.** Replace the ECM. See the service manual.

6. MAP Sensor 5V Reference Wire Open Test

1. Connect BREAKOUT BOX (Part No. HD-43876) to wire harness [78B], leaving ECM [78A] disconnected. See 1.2 DIAGNOSTIC TOOLS.
2. Test for continuity between [80B] terminal C and breakout box terminal 14.
3. Is continuity present?
   a. **Yes.** Go to Test 7.
   b. **No.** Repair open in (R/W) wire.

7. MAP Sensor 5V Reference Shorted to Signal Ground Test

1. Test for continuity between breakout box terminals 14 and 26.
2. Is continuity present?
   a. **Yes.** Repair short between the (R/W) and (BK/W) wires.
   b. **No.** Replace the ECM. See the service manual.

DTC P0108

PART NUMBER	TOOL NAME
HD-43876	BREAKOUT BOX

Table 6-6. DTC P0108 Diagnostic Faults

POSSIBLE CAUSES
MAP sensor malfunction
ECM malfunction
Short to voltage

1. MAP Sensor Test

1. Disconnect the MAP sensor [80].
2. Clear DTC P0108. See 2.1 INITIAL DIAGNOSTICS, Odometer Self-Diagnostics.
3. Start engine.

4. Does the DTC P0108 reset?
   a. **Yes.** Go to Test 2.
   b. **No.** Go to Test 4.

2. MAP Sensor Signal Wire Short to 5V Test

1. Connect BREAKOUT BOX (Part No. HD-43876) to wire harness [78B]. See 1.2 DIAGNOSTIC TOOLS.
2. Test for continuity between breakout box terminals 14 and 25.
3. Is continuity present?
   a. **Yes.** Repair short between (R/W) and (V/W) wires.
   b. **No.** Go to Test 3.

3. MAP Sensor Signal Wire Short to Voltage Test

1. With IGN ON, test for voltage on breakout box terminal 25.
2. Is voltage present?
   a. **Yes.** Repair short to voltage in (V/W) wire.
   b. **No.** Go to Test 4.

4. MAP Sensor 5V Reference Shorted to Battery Voltage Test

1. With IGN ON, test for voltage between breakout box terminal 14 and ground.
2. Is voltage greater than 5.25V?
   a. **Yes.** Repair short to voltage in (R/W) wire.
   b. **No.** Go to Test 5.

5. MAP Sensor Ground Wire Open Test

1. Test for continuity between [80B] terminal A and breakout box terminal 26.
2. Is continuity present?
   a. **Yes.** Replace the MAP sensor. See the service manual.
   b. **No.** Repair open in (BK/W) wire.

DIGITAL TECHNICIAN® II HARLEY-DAVIDSON®

DTC P0112, P0113 6.5

DESCRIPTION

The ECM supplies and monitors a voltage signal on terminal 7 to one side of the IAT sensor. The other side of the IAT sensor is connected to a common sensor ground, which is also connected to the ECM terminal 26.

The IAT sensor is a thermistor device, meaning that at a specific temperature, it will have a specific resistance across its terminals. As this resistance varies, so does the voltage at terminal 7.

- At high temperatures, the resistance of the sensor is very low, which effectively lowers the signal voltage on terminal 7.
- At low temperatures, the resistance is very high, allowing the voltage to rise close to 5V.

The ECM monitors this voltage to compensate for various operating conditions.

Table 6-7. Code Description

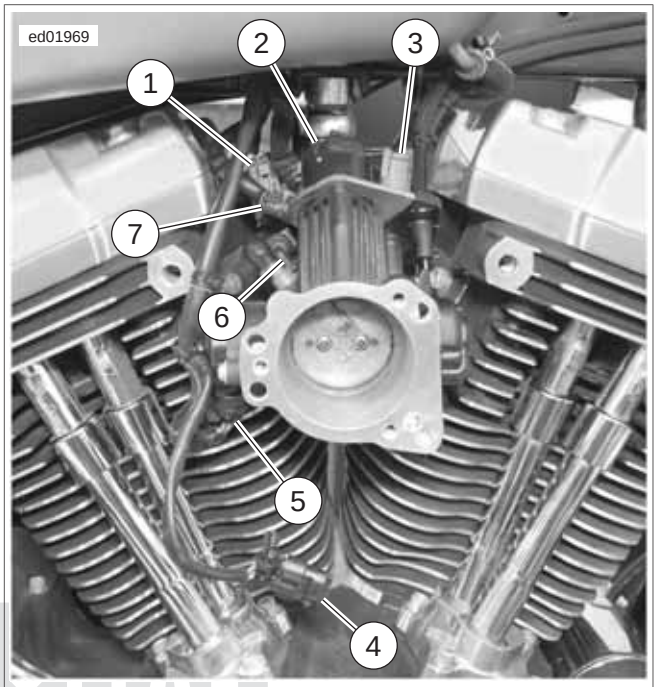
DTC	DESCRIPTION
P0112	IAT sensor voltage low
P0113	IAT sensor open/high

Diagnostic Tips

An intermittent may be caused by a poor connection, rubbed through wire insulation or an open wire inside the insulation.

Check the following conditions:

- **Poor connection:** Inspect ECM and harness connector [78] for backed out terminals, improper mating, inoperative locks, improperly formed or damaged terminals, poor terminal- to-wire connection and damaged harness.
- **Perform** 1.3 DIAGNOSTICS AND TROUBLESHOOTING, Wiggle Test **to locate intermittents:** If connections and harness check out OK, use a multimeter to check the IAT sensor voltage while moving related connectors and wiring harness. If the failure is induced, the IAT voltage will change.
- **Shifted sensor resistance value:** Compare the temperatures of the ET and IAT sensors with the engine at ambient temperature in order to evaluate the possibility of a shifted (out of calibration) sensor which may result in driveability problems. The sensor temperatures should be within 10 degrees of each other.



1. **Rear fuel injector [85]**
2. **IAC [87]**
3. **Front fuel injector [84]**
4. **Active intake solenoid (HDI) [178]**
5. **TPS [88]**
6. **IAT sensor [89]**
7. **MAP sensor [80]**

Figure 6-5. Between Cylinders Right Side

Connector Information

For additional information about the connectors in the following diagram(s) and diagnostic procedure(s), including the color of the harness test kit terminal probes, see B.1 CONNECTORS.

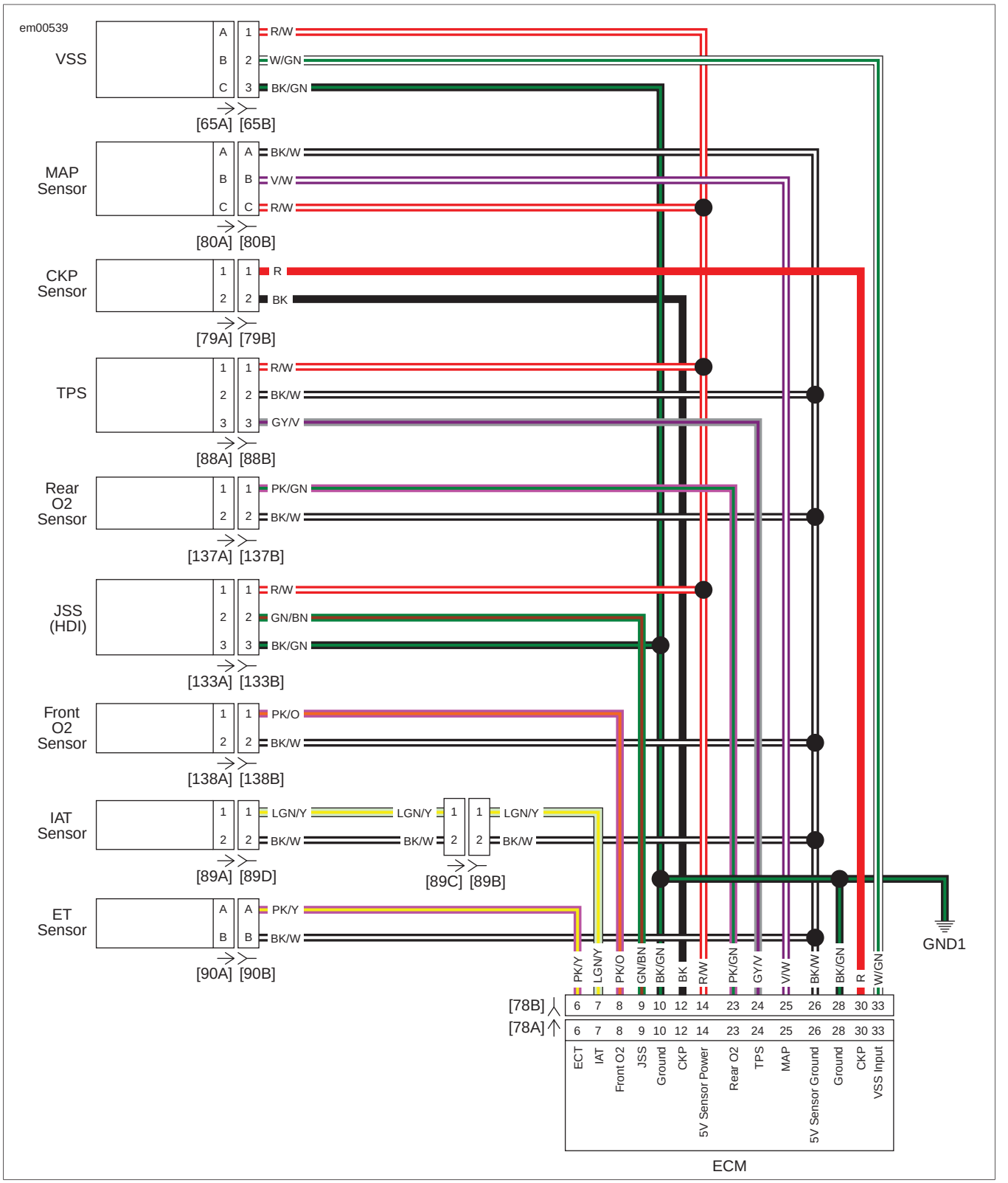


Figure 6-6. Sensor Circuit

DTC P0112

PART NUMBER	TOOL NAME
HD-41404-B	HARNESS CONNECTOR TEST KIT
HD-43876	BREAKOUT BOX

Table 6-8. DTC P0112 Diagnostic Faults

POSSIBLE CAUSES
IAT sensor malfunction
ECM malfunction
Short to ground in 5V reference circuit

1. IAT Sensor Test

1. Disconnect IAT sensor [89].
2. Using HARNESS CONNECTOR TEST KIT (Part No. HD-41404-B) and a multimeter, measure resistance between terminals 1 and 2 of [89A].
3. Is the resistance reading between 500-5K Ohms with the vehicle and sensor at ambient room temperature?
   a. **Yes.** Go to Test 2.
   b. **No.** Replace IAT sensor. See the service manual.

2. IAT Sensor Signal Wire Shorted to Ground Test

1. Measure resistance between [89B] terminal 1 (LGN/Y), and ground.
2. Is resistance reading less than 1 Ohm?
   a. **Yes.** Repair short to ground.
   b. **No.** Go to Test 3.

3. IAT Sensor Signal Voltage High Test

1. Connect BREAKOUT BOX (Part No. HD-43876) to wire harness [78B], leaving ECM [78A] disconnected. See 1.2 DIAGNOSTIC TOOLS.
2. Test continuity between breakout box terminals 7 and 10.
3. Is continuity present?
   a. **Yes.** Go to Test 4.
   b. **No.** Repair short to ground on (LGN/Y) wire.

4. IAT Sensor Signal Wire Shorted to Sensor Ground Test

1. Test continuity between to breakout box terminals 7 and 26.
2. Is continuity present?
   a. **Yes.** Repair short between terminals 1 and 2 of [89B] (LGN/Y and BK/W) wires.
   b. **No.** Replace ECM. See the service manual.

DTC P0113

PART NUMBER	TOOL NAME
HD-41404-B	HARNESS CONNECTOR TEST KIT
HD-43876	BREAKOUT BOX

Table 6-9. DTC P0113 Diagnostic Faults

POSSIBLE CAUSES
IAT sensor malfunction
ECM malfunction
Open or short to voltage in 5V reference circuit

1. IAT Sensor Test

1. Disconnect IAT sensor [89].
2. Using HARNESS CONNECTOR TEST KIT (Part No. HD-41404-B) and a multimeter, measure voltage between [89B] terminal 1 (LGN/Y), and ground.
3. Is the voltage reading greater than 6V?
   a. **Yes.** Repair short to voltage on (LGN/Y) wire.
   b. **No.** Voltage is less than 4V. Go to Test 2.

2. IAT Sensor Signal Wire Open Test

1. Turn IGN OFF.
2. Connect BREAKOUT BOX (Part No. HD-43876) to wiring harness [78B], leaving ECM [78A] disconnected. See 1.2 DIAGNOSTIC TOOLS.
3. Test for continuity between [89B] terminal 1 (LGN/Y) and breakout box terminal 7.
4. Is continuity present?
   a. **Yes.** Go to Test 3.
   b. **No.** Repair open circuit.

3. IAT Sensor Open Ground Wire Test

1. Test for continuity between breakout box terminal 26 and [89B] terminal 2 (BK/W).
2. Is continuity present?
   a. **Yes.** Go to Test 4.
   b. **No.** Repair open in (BK/W) wire.

4. IAT Sensor Signal Wire Shorted to Sensor Power Test

1. Test for continuity between breakout box terminals 7 and 14.
2. Is continuity present?
   a. **Yes.** Repair short between (LGN/Y) and (R/W) wires. Verify IAT sensor resistance value and if incorrect replace IAT sensor. See the service manual.
   b. **No.** Replace ECM. See the service manual.

DTC P0117, P0118 6.6

DESCRIPTION AND OPERATION

The ECM supplies and monitors a voltage signal terminal 6 to one side of the ET sensor. The other side of the ET sensor is connected to a common sensor ground, which is also connected to the ECM terminal 26.

The ET sensor is a thermistor device, which means that at a specific temperature it will have a specific resistance across its terminals. As this resistance varies, so does the voltage on terminal 6.

- At high temperatures, the resistance of the sensor is very low, which effectively lowers the signal voltage on terminal 6.
- At low temperatures, the resistance is very high, allowing the voltage to rise close to 5V.

The ECM monitors this voltage to compensate for various operating conditions. The ECM also uses the sensor input as a reference for determining IAC pintle position.

Table 6-10. Code Description

DTC	DESCRIPTION
P0117	ET sensor voltage low
P0118	ET sensor open/high

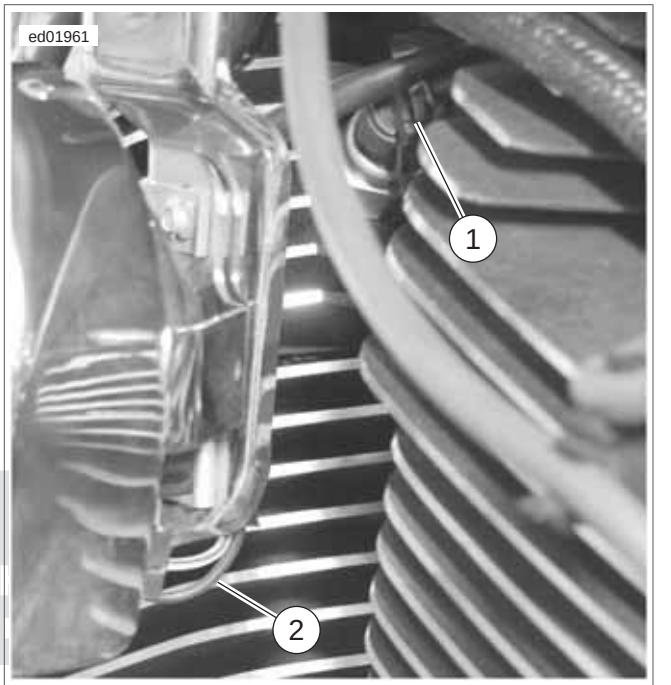
Diagnostic Tips

Once the engine is started, the temperature should rise steadily.

An intermittent may be caused by a poor connection, rubbed through wire insulation or an inoperative wire inside the insulation.

Check the following conditions:

- **Poor connection:** Inspect ECM harness connector [78] for backed out terminals, improper mating, inoperative locks, improperly formed or damaged terminals, poor terminal-to-wire connection and damaged harness.
- **Perform** 1.3 DIAGNOSTICS AND TROUBLESHOOTING, Wiggle Test **to locate intermittents:** If connections and harness check out OK, use a multimeter to check the engine temperature reading while moving related connectors and wiring harness. If the failure is induced, the engine temperature display will change.
- **Shifted sensor resistance value:** Compare the temperatures of the ET and IAT sensors with the engine at ambient temperature in order to evaluate the possibility of a shifted (out of calibration) sensor which may result in driveability problems. The sensor temperatures should be within 10 degrees of each other.



1. **ET sensor [90]**
2. **Horn [122]**

Figure 6-7. Horn: Except FXCWC

Connector Information

For additional information about the connectors in the following diagram(s) and diagnostic procedure(s), including the color of the harness test kit terminal probes, see B.1 CONNECTORS.

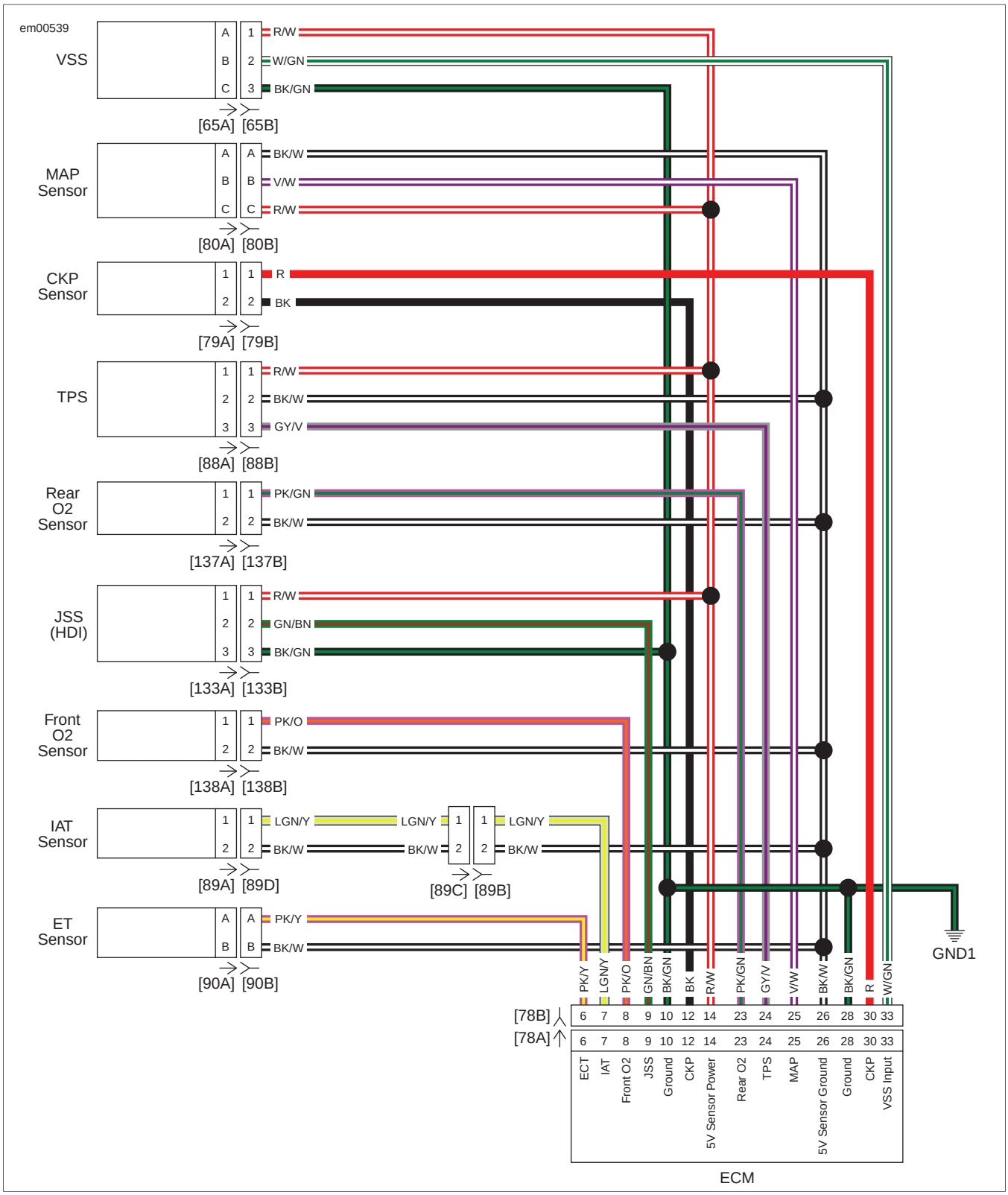


Figure 6-8. Sensor Circuit

DTC P0117

PART NUMBER	TOOL NAME
HD-41404-B	HARNESS CONNECTOR TEST KIT
HD-43876	BREAKOUT BOX

Table 6-11. DTC P0117 Diagnostic Faults

POSSIBLE CAUSES
ET sensor malfunction
ECM malfunction
Short to ground in 5V reference circuit

1. ET Sensor Test

1. Disconnect ET sensor [90].
2. Using HARNESS CONNECTOR TEST KIT (Part No. HD-41404-B) and a multimeter, measure the resistance between [90A] terminals A and B.
3. Is the resistance reading between 900-10K Ohms with the vehicle and sensor at ambient room temperature?
   a. **Yes.** Go to Test 2.
   b. **No.** Replace ET sensor. See the service manual.

2. ET Sensor Signal Wire Shorted to Ground Test

1. Measure resistance between ET sensor [90B] terminal A (PK/Y) and ground.
2. Is resistance reading less than 1 Ohm?
   a. **Yes.** Repair short to ground in (PK/Y) wire.
   b. **No.** Go to Test 3.

3. ET Sensor Signal Wire Shorted to Sensor Ground Test

1. Connect BREAKOUT BOX (Part No. HD-43876) to wire harness [78B], leaving ECM [78A] disconnected. See 1.2 DIAGNOSTIC TOOLS.
2. Test continuity between to breakout box terminals 6 and 26.
3. Is continuity present?
   a. **Yes.** Repair short between terminal A (PK/Y) and B (BK/W) of [90B] wires.
   b. **No.** Replace ECM. See the service manual.

DTC P0118

PART NUMBER	TOOL NAME
HD-41404-B	HARNESS CONNECTOR TEST KIT
HD-43876	BREAKOUT BOX

Table 6-12. DTC P0118 Diagnostic Faults

POSSIBLE CAUSES
ET sensor malfunction
ECM malfunction
Open or short to voltage in 5V reference circuit

1. ET Sensor Test

1. Disconnect ET sensor [90].
2. Using HARNESS CONNECTOR TEST KIT (Part No. HD-41404-B) and a multimeter, measure the voltage between to ET sensor [90B] terminal A (PK/Y) and ground.
3. Is the voltage reading greater than 6V?
   a. **Yes.** Repair short to voltage on (PK/Y) wire.
   b. **No.** Voltage is less than 4V. Go to Test 2.

2. ET Sensor Signal Wire Open Test

1. Turn IGN OFF.
2. Connect BREAKOUT BOX (Part No. HD-43876) to wiring harness [78B], leaving ECM [78A] disconnected. See 1.2 DIAGNOSTIC TOOLS.
3. Using HARNESS CONNECTOR TEST KIT (Part No. HD-41404-B) and a multimeter, test for continuity between ET sensor [90B] terminal A (PK/Y) and breakout box terminal 6.
4. Is continuity present?
   a. **Yes.** Go to Test 3.
   b. **No.** Repair open circuit.

3. ET Sensor Open Ground Wire Test

1. Test for continuity between ET sensor [90B] terminal B (BK/W) and breakout box terminal 26.
2. Is continuity present?
   a. **Yes.** Go to Test 4.
   b. **No.** Repair open in (BK/W) wire.

4. ET Sensor Signal Wire Shorted to Sensor Power Test

1. Test for continuity between breakout box terminals 6 and 14.
2. Is continuity present?
   a. **Yes.** Repair short between (PK/Y) and (R/W) wires. Verify ET sensor resistance value and if incorrect replace ET sensor. See the service manual.
   b. **No.** Replace ECM. See the service manual.

DTC P0122, P0123 6.7

DESCRIPTION AND OPERATION

The ECM supplies a 5V signal on terminal 14 to terminal B of the TPS. The TPS sends a signal back to the ECM on terminal 24. The returned signal varies in voltage according to throttle position.

- At idle (closed throttle), the signal is typically in the range of 0.2-0.8V.
- At wide open throttle, the signal is normally 4.0-4.9V.

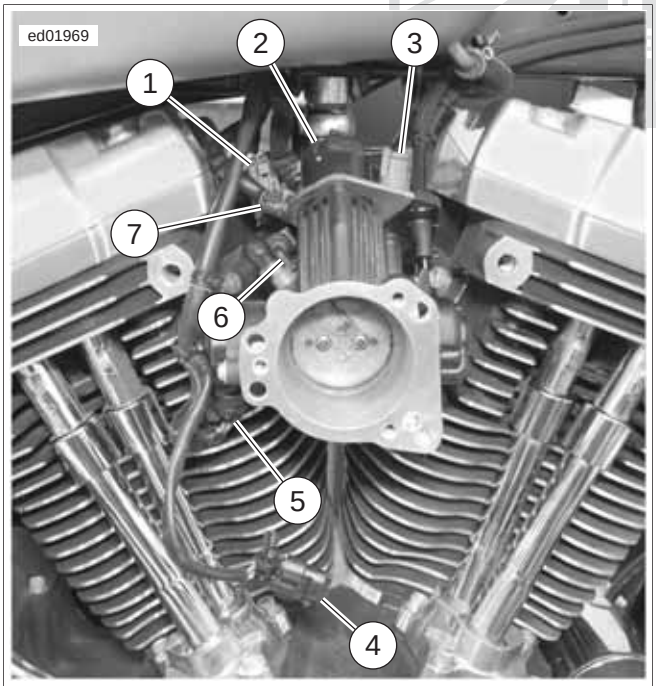
DTC P0122 or P0123 will set if the TPS voltage signal does not fall within the acceptable range.

Table 6-13. Code Description

DTC	DESCRIPTION
P0122	TPS open/low
P0123	TPS high

Diagnostic Tips

The multimeter reads throttle position in Volts. Voltage should increase at a steady rate as the throttle is moved from idle to wide open. A short to ground or open on the (GY/V) or (R/W) wires also will result in a DTC P0122. A short to ground or open on the (R/W) wire (+5V REF) sets multiple codes as described below.



1. **Rear fuel injector [85]**
2. **IAC [87]**
3. **Front fuel injector [84]**
4. **Active intake solenoid (HDI) [178]**
5. **TPS [88]**
6. **IAT sensor [89]**
7. **MAP sensor [80]**

Figure 6-9. Between Cylinders Right Side

A faulty sensor can negatively affect the signal voltage of the other sensors sharing the same 5V reference. If the wiring passes the following tests, disconnect one sensor at a time on the 5V reference and verify the DTC is still present. Additional DTC's will be set as each sensor is disconnected, clear DTC's after this test. Be sure to perform this test before replacing a component.

NOTE

The MAP, JSS (HDI), VSS, and TPS are connected to the same reference line (+5V REF). If the line goes to ground or open, multiple trouble codes will be set (DTCs P0107, P0108 and P0122, P0123, P1501, or P1502). Start with the DTC having the lowest ranking value.

Check for the following conditions:

- **Poor connection:** Inspect ECM harness connector [78B] for backed out terminals, improper mating, inoperative locks, improperly formed or damaged terminals, poor terminal-to-wire connection and damaged harness.
- **Perform** 1.3 DIAGNOSTICS AND TROUBLESHOOTING, Wiggle Test **to locate intermittents:** If connections and harness check out OK, monitor TPS voltage using a multimeter while moving related connectors and wiring harness. If the failure is induced, the TPS voltage will change.
- **TPS scaling:** Observe the TPS voltage display while opening the throttle with engine stopped and ignition switch ON. Display should vary from closed throttle TPS voltage (when throttle is closed) to greater than 4.0V (when throttle is held wide open). As the throttle is **slowly** moved, the voltage should change gradually without spikes or low voltages being observed.

Connector Information

For additional information about the connectors in the following diagram(s) and diagnostic procedure(s), including the color of the harness test kit terminal probes, see B.1 CONNECTORS.

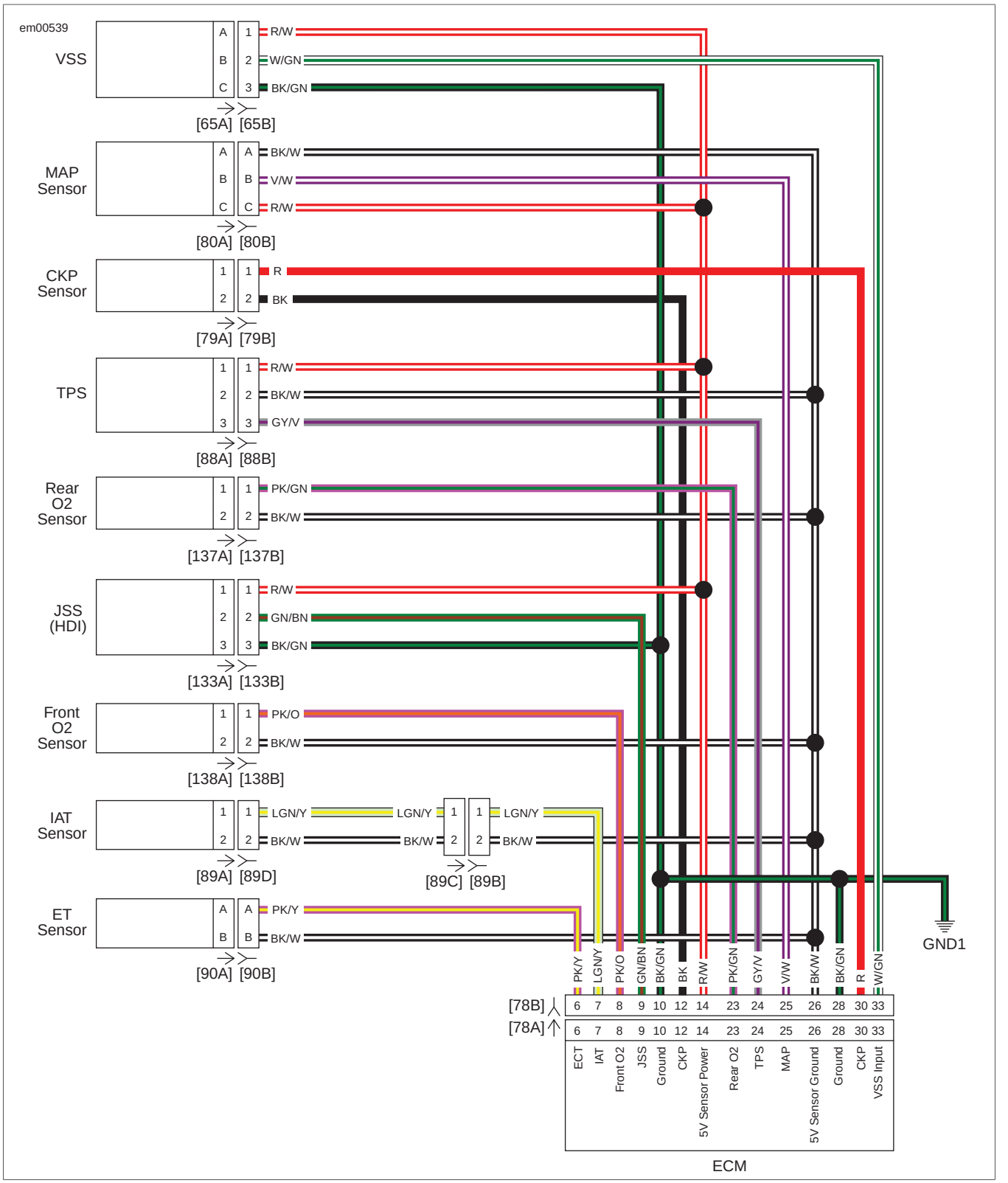


Figure 6-10. Sensor Circuit

DTC P0122

PART NUMBER	TOOL NAME
HD-41404-B	HARNESS CONNECTOR TEST KIT
HD-43876	BREAKOUT BOX

Table 6-14. DTC P0122 Diagnostic Faults

POSSIBLE CAUSES
TPS malfunction
ECM malfunction
Open or short to ground in 5V reference circuit
Short to ground in signal circuit

1. TPS Test

1. Disconnect the TPS [88].
2. Using the HARNESS CONNECTOR TEST KIT (Part No. HD-41404-B), connect a test wire across [88B] terminals 1 and 3.
3. Clear DTCs using speedometer self-diagnostics. See 2.1 INITIAL DIAGNOSTICS, Odometer Self-Diagnostics.
4. Turn IGN OFF and ON.
5. Does the DTC P0122 reset?
   a. **Yes.** Go to Test 2.
   b. **No.** Replace the TPS. See the service manual.

2. TPS Signal Voltage Test

1. Remove the test wire.
2. With IGN ON, test for voltage between [88B] terminal 1 and ground.
3. Is voltage approximately 5V?
   a. **Yes.** Go to Test 3.
   b. **No.** Go to Test 6.

3. TPS Signal Wire Continuity Test

1. Connect BREAKOUT BOX (Part No. HD-43876) to wire harness [78B], leaving ECM [78A] disconnected. See 1.2 DIAGNOSTIC TOOLS.
2. Test for continuity in (GY/V) wire between [88B] terminal 3 and breakout box terminal 24.
3. Is continuity present?
   a. **Yes.** Go to Test 4.
   b. **No.** Repair open in (GY/V) wire.

4. TPS Signal Wire Shorted to Ground Test

1. Test for continuity in (GY/V) wire between breakout box terminal 24 and ground.
2. Is continuity present?
   a. **Yes.** Repair short to ground in (GY/V) wire.
   b. **No.** Go to Test 5.

5. TPS Signal Wire Shorted to Sensor Ground Test

1. Test for continuity between breakout box terminals 24 and 26.
2. Is continuity present?
   a. **Yes.** Repair short between (GY/V) and (BK/W) wires.
   b. **No.** Replace the ECM. See the service manual.

6. TPS 5V Sensor Power Open Wire Test

1. Connect BREAKOUT BOX (Part No. HD-43876) to wire harness [78B], leaving ECM [78A] disconnected. See 1.2 DIAGNOSTIC TOOLS.
2. Test for continuity in (R/W) wire between [88B] terminal 1 and breakout box terminal 14.
3. Is continuity present?
   a. **Yes.** Replace the ECM. See the service manual.
   b. **No.** Repair open in (R/W) wire.

DTC P0123

PART NUMBER	TOOL NAME
HD-43876	BREAKOUT BOX

Table 6-15. DTC P0123 Diagnostic Faults

POSSIBLE CAUSES
TPS malfunction
ECM malfunction
Short to voltage in 5V reference circuit
Open sensor ground

1. TPS Test

1. Disconnect the TPS [88].
2. Clear DTCs using speedometer self-diagnostics. See 2.1 INITIAL DIAGNOSTICS, Odometer Self-Diagnostics.
3. Turn IGN OFF and ON.
4. Does the DTC P0123 reset?
   a. **Yes.** Go to Test 2.
   b. **No.** Go to Test 4.

2. TPS Signal Wire Short to 5V Test

1. Disconnect the ECM [78].
2. Test for continuity between [88B] terminals 1 and 3.
3. Is continuity present?
   a. **Yes.** Repair short between (R/W) and (GY/V) wires.
   b. **No.** Go to Test 3.

3. TPS Signal Wire Short to Voltage Test

1. With IGN ON, test for voltage on [88B] terminal 3.

2. Is voltage present?
   a. **Yes.** Repair short to voltage in (GY/V) wire.
   b. **No.** Replace the ECM. See the service manual.

4. TPS 5V Shorted to Battery Voltage Test

1. With IGN ON, test for voltage on [88B] terminal 1 and ground.
2. Is voltage greater than 5.25V?
   a. **Yes.** Repair short to voltage in (R/W) wire.
   b. **No.** Go to Test 5.

5. TPS Ground Wire Open Test

1. Connect BREAKOUT BOX (Part No. HD-43876) to wire harness [78B], leaving ECM [78A] disconnected. See 1.2 DIAGNOSTIC TOOLS.
2. Test for continuity between [88B] terminal 2 and breakout box terminal 26.
3. Is continuity present?
   a. **Yes.** Replace the TPS. See the service manual.
   b. **No.** Repair open in (BK/W) wire.

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DTC P0131, P0132, P0134, P0151, P0152, P0154 6.8

DESCRIPTION AND OPERATION

PART NUMBER	TOOL NAME
HD-48650	DIGITAL TECHNICIAN II

See Figure 6-11. The O2 sensor provides a signal to the ECM which indicates whether the engine is running rich or lean.

- A P0131 (front) or P0151 (rear) is set when the ECM detects an excessively lean condition for a specified length of time. DTCs may also set if O2 sensor fails.
- A P0132 (front) or P0152 (rear) is set when the ECM detects an excessively rich condition for a specified length of time. DTCs may also set if O2 sensor fails. This condition may also occur with oil contamination.
- A P0134 is set when the front O2 sensor circuit is open or sensor is too cold to respond. A P0154 is set when the rear O2 sensor circuit is open or sensor is too cold to respond. May also occur in cases of extreme oil contamination.

When the air/fuel mixture is ideal, approximately 14.6 parts air to 1 part fuel, the voltage will be approximately 0.45V.

Table 6-16. Code Description

DTC	DESCRIPTION
P0131	Front O2 sensor low or engine running lean
P0132	Engine running rich
P0134	Front O2 sensor open/not responding/high
P0151	Rear O2 sensor low or engine running lean
P0152	Engine running rich
P0154	Rear O2 sensor open/not responding/high

Figure 6-11. O2 Sensor

Diagnostic Tips

O2 sensor diagnostic codes may be seen during the vehicle break-in period. The O2 sensor DTCs will not illuminate the check engine lamp for current or historic codes and will only be indicated by DIGITAL TECHNICIAN II (Part No. HD-48650) or speedometer self-diagnostics. If the DTCs are reported during the break-in period, clear or ignore the codes until the break-in period is completed. All historic O2 sensor DTCs are to be ignored and cleared.

The multimeter displays the signal from the O2 sensor in Volts. This voltage will have an average value tending towards lean, rich or ideal value depending on operating temperature of the engine, engine speed and throttle position. An open/short to voltage or short to ground in the (PK/O) wire (front) and (PK/GN) wire (rear) will cause the engine to run rich (short to ground) or lean (short to voltage) until fault is detected. Once fault is detected, vehicle will run in open loop.

Check for the following conditions:

- **Poor connection:** Inspect the ECM [78], fuel injector [84, 85] and O2 sensor connectors for backed out terminals, improper mating, inoperative locks, improperly formed or damaged terminals, poor terminal-to-wire connection and damaged harnesses.
- **Dirty/stuck open injectors:** The vehicle may run lean (dirty/clogged injectors) or rich (stuck open injectors) if there are injector problems. This could also cause poor fuel economy and performance.
- **Loose O2 sensor:** If an O2 sensor is loose, engine performance may be affected. This could also show up as a slow changing O2 sensor voltage.
- **Loose/leaking exhaust:** This can cause a poor ground connection for the sensor or allow fresh air into the exhaust system. If fresh air enters exhaust system, the O2 sensor will read a lean condition, causing the system to go rich.
- **Engine misfire:** See 6.26 MISFIRE AT IDLE OR UNDER LOAD.
- **Leaking injectors:** This causes fuel imbalance and poor idle quality due to different air/fuel ratios in each cylinder. To check for leaky injectors, first remove the air box and air filter. See the service manual. Then, with the throttle wide open, turn IGN ON for 2 seconds and then OFF for 2 seconds five consecutive times. Replace the fuel injector if there is any evidence of raw fuel in the bores. See Fuel Injectors in the service manual.
- **Intake leaks:** See the service manual.
- **High oil usage:** (all O2 sensor codes).

Connector Information

For additional information about the connectors in the following diagram(s) and diagnostic procedure(s), including the color of the harness test kit terminal probes, see B.1 CONNECTORS.

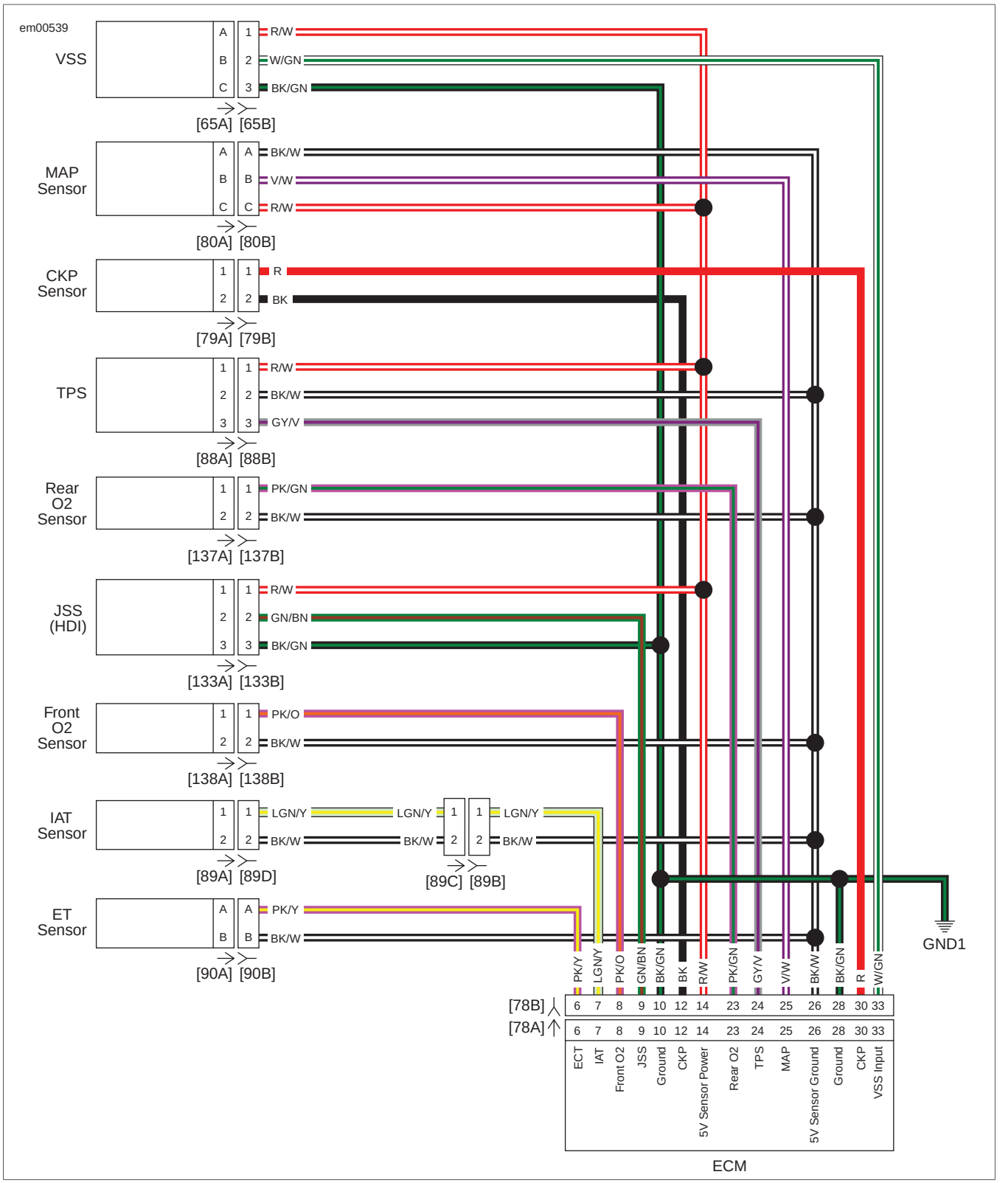

Figure 6-12. Sensor Circuit

DTC P0131

PART NUMBER	TOOL NAME
HD-43876	BREAKOUT BOX

Table 6-17. DTC P0131 Diagnostic Faults

POSSIBLE CAUSES
Front O2 sensor malfunction
ECM malfunction
Short to ground in signal circuit
Fuel system malfunction

1. Front O2 Sensor Test

1. Disconnect front O2 sensor [138].
2. Turn IGN ON.
3. Measure voltage between front O2 sensor [138B] terminal 1 (PK/O), to chassis ground.
4. Is voltage approximately 5V?
   a. **Yes.** Go to Test 4.
   b. **No.** Go to Test 2.

2. Front O2 Sensor Signal Wire Shorted to Sensor Ground Test

1. Turn IGN OFF.
2. Disconnect ECM [78].
3. Test for continuity between front O2 sensor [138B] terminals 1 (PK/O) and 2 (BK/W).
4. Is continuity present?
   a. **Yes.** Repair short between (PK/O) and (BK/W) wires.
   b. **No.** Go to Test 3.

3. Front O2 Sensor Signal Wire Shorted to Ground Test

1. Test for continuity between front O2 sensor [138B] terminal 1 (PK/O) and vehicle ground.
2. Is continuity present?
   a. **Yes.** Repair short between (PK/O) wire and ground.
   b. **No.** If ECM [78] connections are good, replace ECM. See the service manual.

4. Front O2 Sensor Operation Test

1. Connect BREAKOUT BOX (Part No. HD-43876) between wire harness [78B] and ECM [78A]. See 1.2 DIAGNOSTIC TOOLS.
2. Connect O2 sensor.
3. Place transmission in neutral, engine stop switch to RUN, and IGN ON. Start engine and allow to reach operating temperature.
4. With engine speed at a steady RPM, measure voltage between breakout box terminals 8 and 26.
5. Is voltage above 0.6V?
   a. **Yes.** Replace ECM. See the service manual.
   b. **No.** (0.0-0.6V). Perform fuel pressure test. See the service manual. Look for correct ECM calibration, low fuel pressure, air leaks, and dirty injectors. If no issues are found, replace O2 sensor.

DTC P0132

PART NUMBER	TOOL NAME
HD-43876	BREAKOUT BOX

Table 6-18. DTC P0132 Diagnostic Faults

POSSIBLE CAUSES
Front O2 sensor malfunction
ECM malfunction
Fuel system malfunction

1. Front O2 Sensor Operation Test

1. Turn IGN OFF.
2. Connect BREAKOUT BOX (Part No. HD-43876) between wire harness [78B] and ECM [78A]. See 1.2 DIAGNOSTIC TOOLS.
3. Start the engine and allow it to reach operating temperature.
4. With engine speed at a steady RPM, measure voltage between breakout box terminals 8 and 26.
5. Is voltage less than 0.4V?
   a. **Yes.** Replace the ECM. See the service manual.
   b. **No.** (0.4-1.0V) Perform fuel pressure test. See the service manual. Look for correct ECM calibration, high fuel pressure, stuck open or leaking injectors. If no issues are found, replace the O2 sensor.

DTC P0134

PART NUMBER	TOOL NAME
HD-41404-B	HARNESS CONNECTOR TEST KIT
HD-43876	BREAKOUT BOX

Table 6-19. DTC P0134 Diagnostic Faults

POSSIBLE CAUSES
Front O2 sensor malfunction
ECM malfunction
Open or short to voltage in signal circuit
Open sensor ground

1. Front O2 Sensor Signal Wire Short Circuit Voltage Test

1. Disconnect front O2 Sensor [138].
2. Turn IGN ON.

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3. Using HARNESS CONNECTOR TEST KIT (Part No. HD-41404-B) and a multimeter, measure voltage between front O2 sensor [138B] terminal 1 to ground.
4. Is voltage greater than 5.5V?
   a. **Yes.** Repair short to voltage on (PK/O) wire.
   b. **No.** (Greater than 4V.) Go to Test 2.
   c. **No.** (Less than 4V.) Go to Test 3.

2. Front O2 Sensor Open Sensor Ground Test

1. Turn IGN OFF.
2. Connect BREAKOUT BOX (Part No. HD-43876) to wire harness [78B], leaving ECM [78A] disconnected. See 1.2 DIAGNOSTIC TOOLS.
3. Test for continuity between front O2 sensor [138B] terminal 2 (BK/W), and breakout box terminal 26.
4. Is continuity present?
   a. **Yes.** Replace the front O2 sensor. See the service manual.
   b. **No.** Repair open on (BK/W) wire.

3. Front O2 Sensor Signal Wire Open Test

1. Test for continuity between front O2 sensor [138B] terminal 1 (PK/O) and breakout box terminal 8.
2. Is continuity present?
   a. **Yes.** Replace ECM. See the service manual.
   b. **No.** Repair open (PK/O) wire.

DTC P0151

PART NUMBER	TOOL NAME
HD-41404-B	HARNESS CONNECTOR TEST KIT
HD-43876	BREAKOUT BOX

Table 6-20. DTC P0151 Diagnostic Faults

POSSIBLE CAUSES
Rear O2 sensor malfunction
ECM malfunction
Short to ground in signal circuit
Fuel system malfunction

1. Rear O2 Sensor Test

1. Disconnect rear O2 sensor [137].
2. Turn IGN ON.
3. Using HARNESS CONNECTOR TEST KIT (Part No. HD-41404-B) and a multimeter, measure voltage between rear O2 sensor [137B] terminal 1 (PK/GN) to ground.
4. Is voltage approximately 5V?
   a. **Yes.** Go to Test 4.
   b. **No.** Go to Test 2.

2. Rear O2 Sensor Signal Wire Shorted to Sensor Ground Test

1. Turn IGN OFF.
2. Disconnect ECM [78].
3. Test for continuity between rear O2 sensor [137B] terminals 1 (PK/GN) and 2 (BK/W).
4. Is continuity present?
   a. **Yes.** Repair short between (PK/GN) and (BK/W) wires.
   b. **No.** Go to Test 3.

3. Rear O2 Sensor Signal Wire Shorted to Ground Test

1. Test for continuity between rear O2 sensor [137B] terminal 1 (PK/GN) and ground.
2. Is continuity present?
   a. **Yes.** Repair short between (PK/GN) wire and ground.
   b. **No.** If ECM [78] connections are good, replace ECM. See the service manual.

4. Rear O2 Sensor Operation Test

1. Connect BREAKOUT BOX (Part No. HD-43876) between wire harness [78B] and ECM [78A]. See 1.2 DIAGNOSTIC TOOLS.
2. Place transmission in neutral, engine stop switch to RUN, and IGN ON. Start engine and allow to reach operating temperature.
3. With engine speed at a steady RPM, measure voltage between ECM breakout box terminals 23 and 26.
4. Is voltage above 0.6V?
   a. **Yes.** Replace ECM. See the service manual.
   b. **No.** (0.0-0.4V). Perform fuel pressure test. See the service manual. Look for correct ECM calibration, low fuel pressure, air leaks, and dirty injectors. If no issues are found, replace O2 sensor.

DTC P0152

PART NUMBER	TOOL NAME
HD-43876	BREAKOUT BOX

Table 6-21. DTC P0152 Diagnostic Faults

POSSIBLE CAUSES
Rear O2 sensor malfunction
ECM malfunction
Fuel system malfunction

1. Rear O2 Sensor Operation Test

1. Turn IGN OFF.
2. Connect BREAKOUT BOX (Part No. HD-43876) between wire harness [78B] and ECM [78A]. See 1.2 DIAGNOSTIC TOOLS.

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3. Start the engine and allow it to reach operating temperature.
4. With engine speed at a steady RPM, measure voltage between breakout box terminals 23 and 26.
5. Is voltage less than 0.4V?
   a. **Yes.** Replace the ECM. See the service manual.
   b. **No.** (0.6-1.0V). Perform fuel pressure test. See the service manual. Look for correct ECM calibration, high fuel pressure, stuck open or leaking injectors. If no issues are found, replace the O2 sensor.

DTC P0154

PART NUMBER	TOOL NAME
HD-43876	HARNESS CONNECTOR TEST KIT

Table 6-22. DTC P0154 Diagnostic Faults

POSSIBLE CAUSES
Rear O2 sensor malfunction
ECM malfunction
Open or short voltage in signal circuit
Open sensor ground.

1. Rear O2 Sensor Signal Wire Short Circuit Voltage Test

1. Disconnect rear O2 Sensor [137].
2. Turn IGN ON.
3. Using HARNESS CONNECTOR TEST KIT (Part No. HD-43876) and a multimeter, measure voltage between rear O2 sensor [137B] terminal 1 to ground.
4. Is voltage greater than 5.5V?
   a. **Yes.** Repair short to voltage on (PK/GN) wire.
   b. **No.** (Greater than 4V.) Go to Test 2.
   c. **No.** (Less than 4V.) Go to Test 3.

2. Rear O2 Sensor Open Sensor Ground Test

1. Turn IGN OFF.
2. Connect BREAKOUT BOX (Part No. HD-43876) to wire harness [78B], leaving ECM [78A] disconnected. See 1.2 DIAGNOSTIC TOOLS.
3. Test for continuity between rear O2 sensor [137B] terminal 2 (BK/W) and breakout box terminal 26.
4. Is continuity present?
   a. **Yes.** Replace the rear O2 sensor. See the service manual.
   b. **No.** Repair open on (BK/W) wire.

3. Rear O2 Sensor Signal Wire Open Test

1. Test for continuity between rear O2 sensor [137B] terminal 1 (PK/GN) and breakout box terminal 23.
2. Is continuity present?
   a. **Yes.** Replace ECM. See the service manual.
   b. **No.** Repair open in (PK/GN) wire.

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DTC P0261, P0262, P0263, P0264 6.9

DESCRIPTION AND OPERATION

The fuel injectors are solenoids that allow pressurized fuel into the intake tract. The injectors are timed to the engine cycle and triggered sequentially. The power for the injectors comes from the system relay. The system relay also provides power for the fuel pump and the ignition coil. The ECM provides the path to ground to trigger the injectors.

NOTE

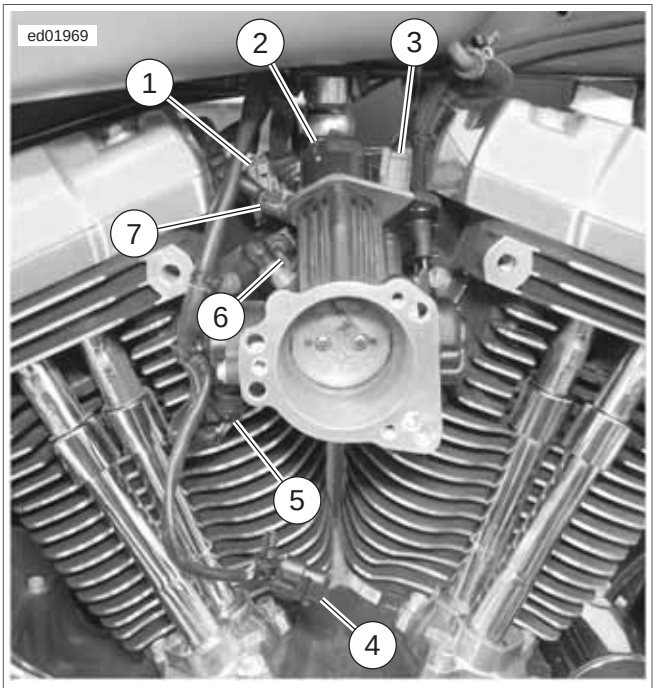
ECM fuse and system relay failures or wiring harness problems will cause 12V power to be lost to both injectors, ignition coils and fuel pump.

Table 6-23. Code Description

DTC	DESCRIPTION
P0261	Front injector open/low
P0262	Front injector high
P0263	Rear injector open/low
P0264	Rear injector high

Connector Information

For additional information about the connectors in the following diagram(s) and diagnostic procedure(s), including the color of the harness test kit terminal probes, see B.1 CONNECTORS.



1. **Rear fuel injector [85]**
2. **IAC [87]**
3. **Front fuel injector [84]**
4. **Active intake solenoid (HDI) [178]**
5. **TPS [88]**
6. **IAT sensor [89]**
7. **MAP sensor [80]**

Figure 6-13. Between Cylinders Right Side

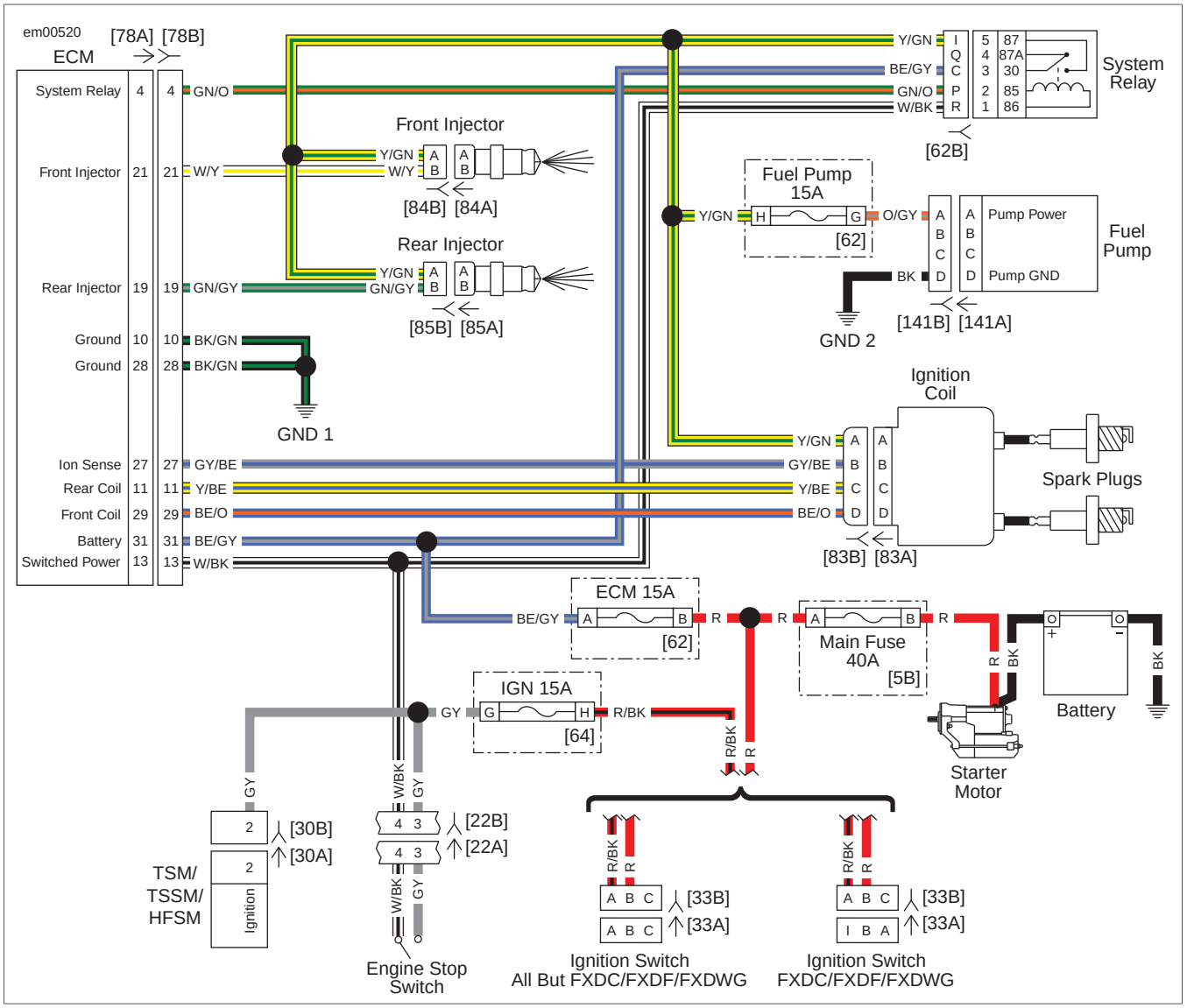


Figure 6-14. Ignition Circuit

DTC P0261

PART NUMBER	TOOL NAME
HD-34730-2D	FUEL INJECTOR TEST LIGHT
HD-43876	BREAKOUT BOX

Table 6-24. DTC P0261 Diagnostic Faults

POSSIBLE CAUSES
Front fuel injector malfunction
ECM malfunction
Open signal circuit
Open power circuit

1. Front Fuel Injector Test

1. Disconnect front fuel injector [84].
2. Connect FUEL INJECTOR TEST LIGHT (Part No. HD-34730-2D) to [84B].
3. Crank engine.
4. Does light flash when engine is cranking (or running)?
   a. **Yes.** Go to Test 5.
   b. **No, lamp does not illuminate.** Go to Test 2.
   c. **No, lamp is on steady.** Go to Test 6.

2. Front Fuel Injector Power Wire Open Circuit Test

1. Turn IGN OFF and engine stop switch to RUN.
2. Remove fuel injector test light.
3. Connect BREAKOUT BOX (Part No. HD-43876) to ECM harness [78B], leaving ECM [78A] disconnected. See 1.2 DIAGNOSTIC TOOLS.

4. Test for continuity between breakout box terminal 21 and fuel injector [84B] terminal B (W/Y).
5. Is continuity present?
   a. **Yes.** Go to Test 3.
   b. **No.** Repair open on (W/Y) wire.

3. Front Fuel Injector Power Wire Shorted to Ground Test

1. Test for continuity between breakout box terminal 21 and ground.
2. Is continuity present?
   a. **Yes.** Repair short in (W/Y) to ground.
   b. **No.** Go to Test 4.

4. Fuel Injector/System Relay Test

1. Remove system relay.
2. Test for continuity between system relay socket terminal I (Y/GN) wire and front injector [84B] terminal A (Y/GN).
3. Is continuity present?
   a. **Yes.** If connections are good, replace ECM. See the service manual.
   b. **No.** Repair open (Y/GN) wire.

5. Injector Resistance Test

1. Test resistance between terminal A and B of injector [84A].
2. Is resistance value between 10-20 Ohms?
   a. **Yes.** Replace ECM. See the service manual.
   b. **No.** Replace injector. See the service manual.

6. Driver Short to Ground Test

1. Connect BREAKOUT BOX (Part No. HD-43876) to wire harness [78B], leaving ECM [78A] disconnected. See 1.2 DIAGNOSTIC TOOLS.
2. Test for continuity between breakout box terminal 21 and ground.
3. Is continuity present?
   a. **Yes.** Repair short to ground on (W/Y) wire.
   b. **No.** Replace ECM. See the service manual.

DTC P0262

Table 6-25. DTC P0262 Diagnostic Faults

POSSIBLE CAUSES
Front fuel injector malfunction
ECM malfunction
Short to ground in signal circuit

1. Front Fuel Injector Control Wire Shorted to Voltage Test

1. Disconnect front injector [84].
2. Measure the voltage between front injector [84B] terminal B (W/Y) and ground.
3. Is voltage less than 1.0V?
   a. **Yes.** Go to Test 2.
   b. **No.** Repair short to voltage on (W/Y) wire.

2. Injector Resistance Test

1. Test resistance between terminal A and B of injector [84A].
2. Is resistance value between 10-20 Ohms?
   a. **Yes.** Replace ECM. See the service manual.
   b. **No.** Replace front injector. See the service manual.

DTC P0263

PART NUMBER	TOOL NAME
HD-34730-2D	FUEL INJECTOR TEST LIGHT
HD-43876	BREAKOUT BOX

Table 6-26. DTC P0263 Diagnostic Faults

POSSIBLE CAUSES
Rear fuel injector malfunction
ECM malfunction
Open signal circuit
Open power circuit

1. Rear Fuel Injector Test

1. Disconnect rear fuel injector [85].
2. Connect FUEL INJECTOR TEST LIGHT (Part No. HD-34730-2D) to [85B].
3. Crank engine.
4. Does lamp flash when engine is cranking (or running)?
   a. **Yes.** Go to Test 5.
   b. **No, lamp does not illuminate.** Go to Test 2.
   c. **No, lamp is on steady.** Go to Test 6.

2. Rear Fuel Injector Power Wire Open Circuit Test

1. Turn IGN OFF and engine stop switch to RUN.
2. Remove fuel injector test light.
3. Connect BREAKOUT BOX (Part No. HD-43876) to ECM harness [78B], leaving ECM [78A] disconnected. See 1.2 DIAGNOSTIC TOOLS.
4. Test for continuity between breakout box terminal 19 and fuel injector [85B] terminal B (GN/GY).
5. Is continuity present?
   a. **Yes.** Go to Test 3.
   b. **No.** Repair open on (GN/GY) wire.

3. Rear Fuel Injector Power Wire Shorted to Ground Test

1. Test for continuity between breakout box terminal 19 and ground.
2. Is continuity present?
   a. **Yes.** Repair short in (GN/GY) to ground.
   b. **No.** Go to Test 4.

4. Fuel Injector/System Relay Test

1. Remove system relay.
2. Test for continuity between system relay socket terminal I (Y/GN) wire and rear injector [85B] terminal A (Y/GN).
3. Is continuity present?
   a. **Yes.** If connections are good, replace ECM. See the service manual.
   b. **No.** Repair open (Y/GN) wire.

5. Injector Resistance Test

1. Test resistance between terminal A and B of injector [85A].
2. Is resistance value between 10-20 Ohms?
   a. **Yes.** Replace ECM. See the service manual.
   b. **No.** Replace front injector. See the service manual.

6. Driver Short to Ground Test

1. Connect BREAKOUT BOX (Part No. HD-43876) to wire harness [78B], leaving ECM [78A] disconnected. See 1.2 DIAGNOSTIC TOOLS.
2. Test for continuity between breakout box terminal 19 and ground.
3. Is continuity present?
   a. **Yes.** Repair short to ground on (GN/GY) wire.
   b. **No.** Replace ECM. See the service manual.

DTC P0264

Table 6-27. DTC P0264 Diagnostic Faults

POSSIBLE CAUSES
Rear fuel injector malfunction
ECM malfunction
Short to ground in signal circuit

1. Rear Fuel Injector Control Wire Shorted to Voltage Test

1. Disconnect rear injector [85].
2. Measure the voltage between rear injector [85B] terminal B (GN/GY) and ground.
3. Is voltage less than 1.0V?
   a. **Yes.** Go to Test 2.
   b. **No.** Repair short to voltage on (GN/GY) wire.

2. Injector Resistance Test

1. Test resistance between terminal A and B of injector [85A].
2. Is resistance value between 10-20 Ohms?
   a. **Yes.** Replace ECM. See the service manual.
   b. **No.** Replace rear injector. See the service manual.

DIGITAL TECHNICIAN HARLEY-DAVIDSON

DTC P0373, P0374 6.10

DESCRIPTION AND OPERATION

If the CKP sensor signal is weak or absent, DTCs P0373 or P0374 will be set. DTC P0373 is usually set when several attempts to crank the engine have failed.

NOTE

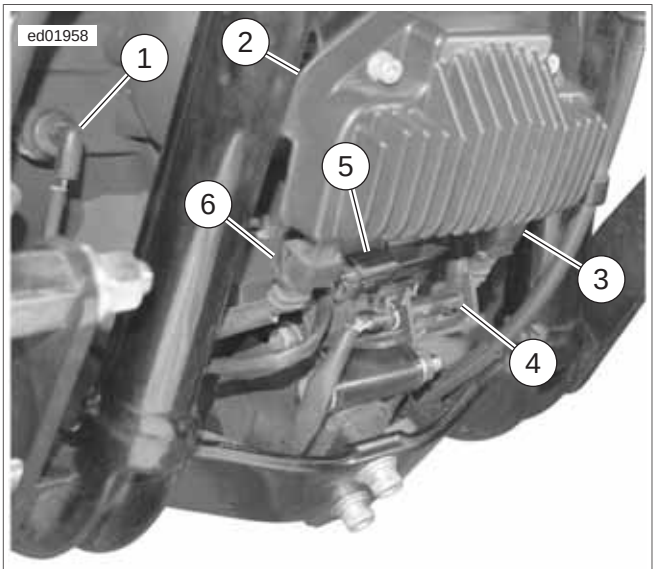
If signal is not detected or cannot synchronize (DTC P0374), engine will not start.

Table 6-28. Code Description

DTC	DESCRIPTION
P0373	CKP sensor intermittent
P0374	CKP sensor synch error

Diagnostic Tips

Engine must be cranked for more than five seconds without CKP signal to set P0374 code. Intermittent MAP or IAT wiring or sensor issues may cause these codes to set prior to setting MAP or IAT codes. Verify MAP or IAT wiring and sensor prior to replacing the ECM.



1. **Oil pressure switch [120]**
2. **Voltage regulator**
3. **Voltage regulator to stator [47]**
4. **Front O2 sensor (Domestic Only) [138]**
5. **CKP sensor [79]**
6. **Voltage regulator [77]**

Figure 6-15. Lower Front

DIGITAL TECHNICIAN HARLEY-DAVIDSON

Connector Information

For additional information about the connectors in the following diagram(s) and diagnostic procedure(s), including the color of the harness test kit terminal probes, see B.1 CONNECTORS.

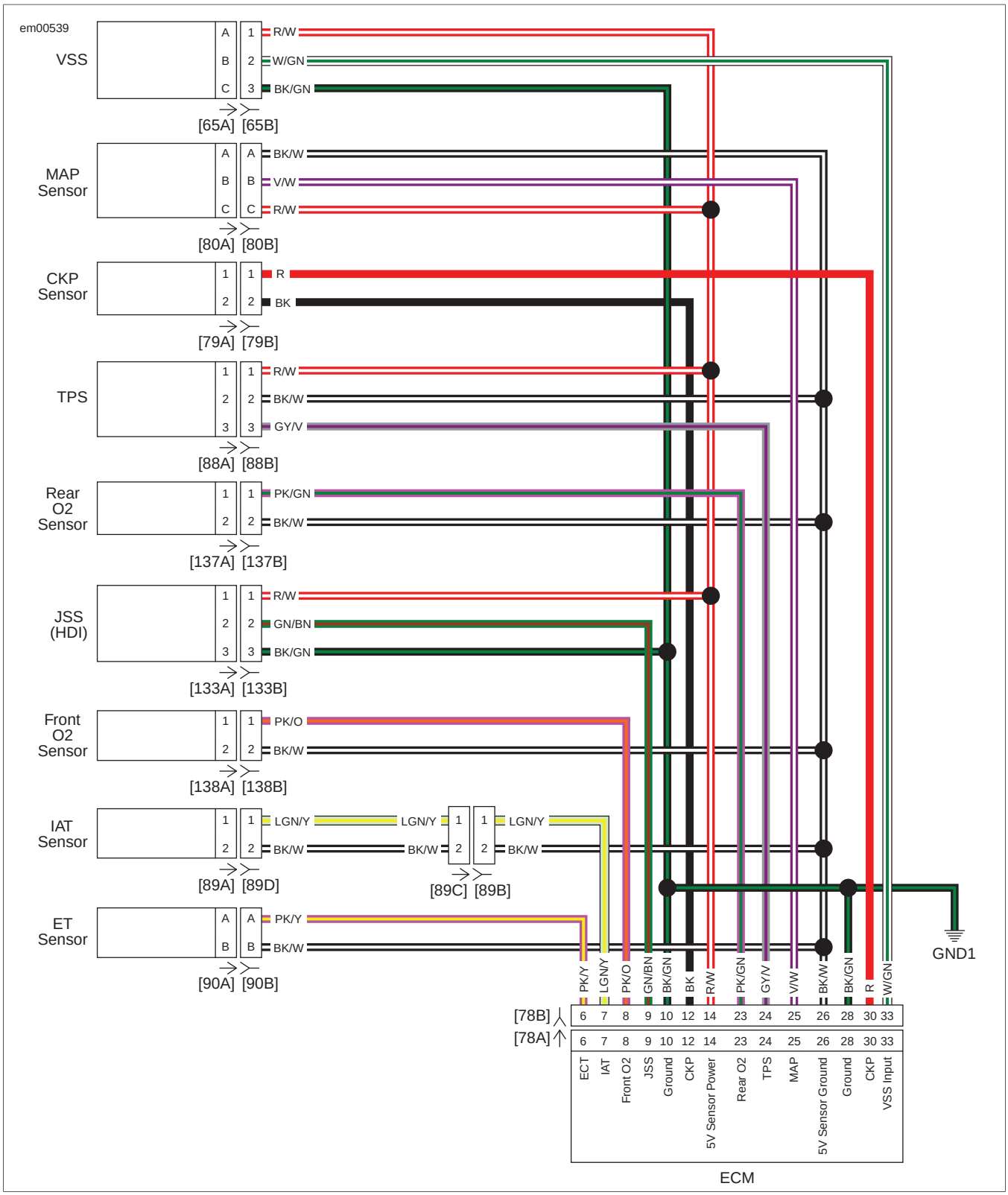


Figure 6-16. Sensor Circuit

DTC P0373

Table 6-29. DTC P0373 Diagnostic Faults

POSSIBLE CAUSES
CKP sensor malfunction
ECM malfunction
Open or short to ground in signal circuit

1. CKP Sensor Test

1. Clear the DTC. 2.1 INITIAL DIAGNOSTICS, Odometer Self-Diagnostics.
2. Start the vehicle.
3. Did DTC P0373 reset?
   a. **Yes.** Inspect and verify battery and starting system. See 3.2 STARTING SYSTEM.
   b. **No.** System functioning properly.

DTC P0374

PART NUMBER	TOOL NAME
HD-43876	BREAKOUT BOX

Table 6-30. DTC P0374 Diagnostic Faults

POSSIBLE CAUSES
CKP sensor malfunction
ECM malfunction
Open or short to ground in signal circuit
May be set if there are incorrect fluctuations from MAP that does not set MAP codes (examples - intermittent sensor or wiring issue)

1. CKP Sensor Connections Test

1. With IGN OFF, disconnect ECM [78].
2. Inspect the connection for corrosion or backed out terminals.
3. Are terminal problems present?
   a. **Yes.** Repair terminals as required.
   b. **No.** Go to Test 2.

2. CKP Sensor Signal Wire Continuity Test

1. Disconnect CKP sensor [79].
2. Connect BREAKOUT BOX (Part No. HD-43876) to wire harness [78B], leaving ECM [78A] disconnected. See 1.2 DIAGNOSTIC TOOLS.
3. Test for continuity between breakout box terminal 30 to CKP sensor [79B] terminal 1 (R).
4. Is resistance less than 1.0 Ohm?
   a. **Yes.** Go to Test 3.
   b. **No.** Repair open wire (R).

3. CKP Sensor Ground Wire Continuity Test

1. Test continuity from breakout box terminal 12 to CKP sensor [79B] terminal 2 (BK).
2. Is resistance less than 1.0 Ohm?
   a. **Yes.** Go to Test 4.
   b. **No.** Repair open on (BK) wire.

4. CKP Sensor Signal Wire Shorted to CKP Ground Wire Test

1. Test for continuity between breakout box terminals 30 and 12.
2. Is continuity present?
   a. **Yes.** Repair short between CKP [79B] terminals 1 (R) and 2 (BK).
   b. **No.** Go to Test 5.

5. CKP Sensor Low Shorted to Ground Test

1. Test for continuity between breakout box terminals 12 and 28.
2. Is continuity present?
   a. **Yes.** Repair short to sensor ground on (BK) wire.
   b. **No.** Go to Test 6.

6. CKP Sensor Output Test

1. Connect CKP sensor [79].
2. Test for AC voltage at breakout box terminals 30 and 12.
3. Place transmission in neutral, turn IGN ON, and engine stop switch to RUN.
4. Crank engine for 5 seconds while observing multimeter.
5. Is AC voltage present?
   a. **Yes.** Replace ECM. See the service manual.
   b. **No.** Go to Test 7.

7. CKP Sensor Signal Wire Shorted to Ground Test

1. Disconnect CKP sensor [79].
2. Test for continuity between breakout box terminals 30 and 28.
3. Is continuity present?
   a. **Yes.** Repair shorted (R) wire to ground.
   b. **No.** Replace the CKP sensor. See the service manual.

DIGITAL TECHNICIAN II HARLEY-DAVIDSON

DTC P0501, P0502 6.11

DESCRIPTION AND OPERATION

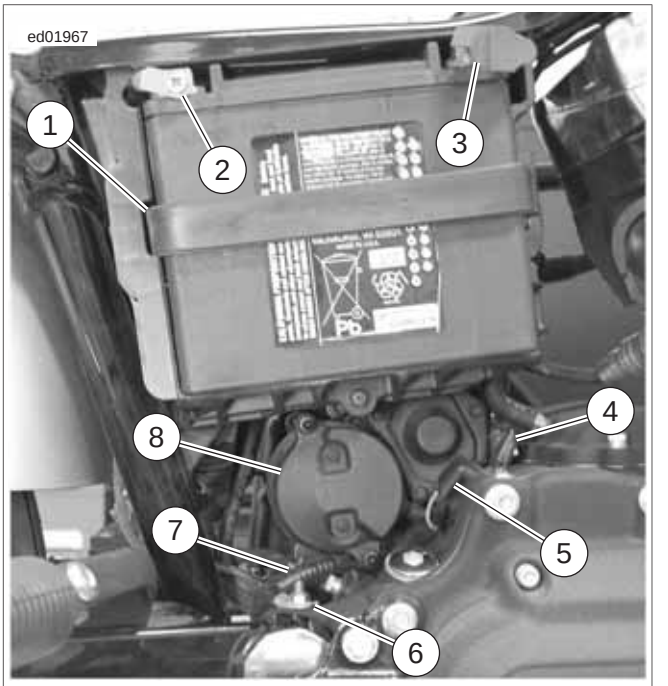
See Figure 6-17. The VSS is powered and monitored by the ECM. The ECM processes the vehicle speed signal and transmits this signal to the TSM/TSSM/HFSM, and speedometer through serial data.

NOTES

- *The ECM uses VSS input to calculate idle air control position. Therefore problems with the vehicle speed signal can lead to improper operation of the idle air control.*
- *The MAP, JSS, TPS, and VSS sensors are connected to the same reference line (+5V REF). If the reference line goes to ground or open, multiple codes will be set (DTC P0107, P0108, P0122, P0123, P0501, P0502, P1501, P1502). Start with the trouble code having the lowest ranking value.*
- *A faulty sensor can negatively affect the signal voltage of the other sensors sharing the same 5V reference. If the wiring passes the following tests, disconnect one sensor at a time on the 5V reference and verify the DTC is still present. Additional DTC's will be set as each sensor is disconnected, clear DTC's after this test. Be sure to perform this test before replacing a component.*

Table 6-31. Code Description

DTC	DESCRIPTION
P0501	VSS low
P0502	VSS high



1. **Battery**
2. **Battery negative**
3. **Battery positive**
4. **Starter solenoid [128]**
5. **Neutral switch [131]**
6. **Battery ground cable**
7. **VSS [65]**
8. **Starter**

Figure 6-17. Under Right Side Cover

Connector Information

For additional information about the connectors in the following diagram(s) and diagnostic procedure(s), including the color of the harness test kit terminal probes, see B.1 CONNECTORS.

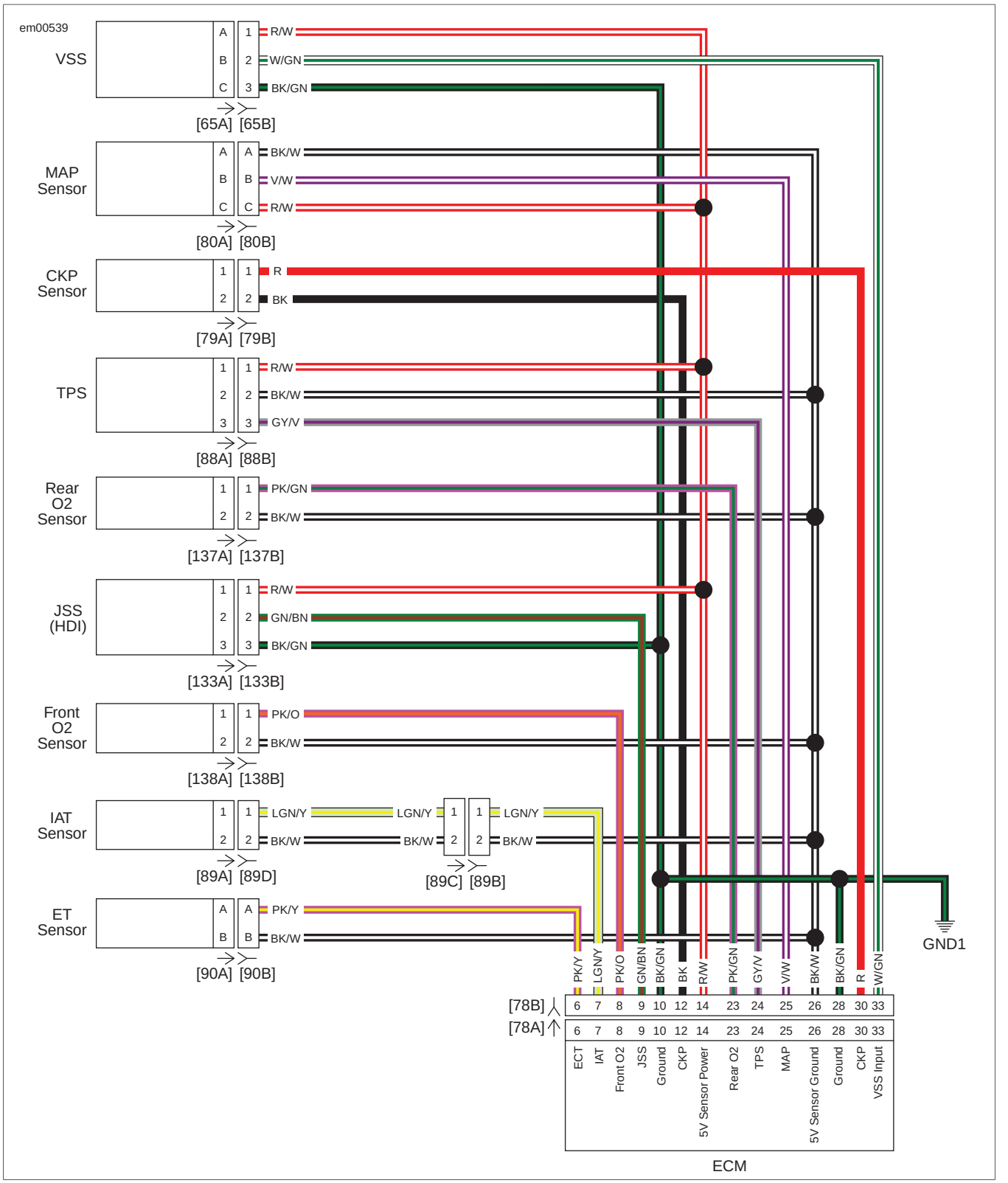


Figure 6-18. Sensor Circuit

DTC P0501

PART NUMBER	TOOL NAME
HD-41404-B	HARNESS CONNECTOR TEST KIT
HD-43876	BREAKOUT BOX

Table 6-32. DTC P0501 Diagnostic Faults

POSSIBLE CAUSES
VSS malfunction
ECM malfunction
Open or short to ground in signal circuit
Open or short to ground in 5V reference circuit

1. VSS Connections Test

1. With IGN OFF, disconnect VSS [65].
2. Inspect [65] for damaged terminals, backed out or bent terminals. Repair as necessary.
3. Place transmission in neutral, turn IGN ON, and engine stop switch to RUN.
4. Using HARNESS CONNECTOR TEST KIT (Part No. HD-41404-B) and a multimeter, measure voltage between VSS [65B] terminal A and ground.
5. Is voltage reading approximately 5.0V?
   a. **Yes.** Go to Test 3.
   b. **No.** Go to Test 2.

2. VSS Sensor Power Short to Ground Test

1. Turn IGN OFF.
2. Disconnect ECM.
3. Test continuity between [65B] terminal A and ground.
4. Is continuity present?
   a. **Yes.** Repair short to ground on (R/W) wire.
   b. **No.** Repair open on (R/W) wire.

3. VSS Signal Wire Short to Ground Test

1. Connect BREAKOUT BOX (Part No. HD-43876) to wire harness [78B, leaving ECM [78A] disconnected. See 1.2 DIAGNOSTIC TOOLS.
2. Test for continuity between breakout box terminals 33 and 28.
3. Is continuity present?
   a. **Yes.** Repair short to ground on (W/GN) wire.
   b. **No.** Go to Test 4.

4. VSS Signal Wire Open Test

1. Test for continuity between breakout box terminals 33 and [65B] terminal B.
2. Is continuity present?
   a. **Yes.** Go to Test 5.
   b. **No.** Repair open on (W/GN) wire.

5. VSS Dirty or Damaged Test

1. Remove VSS.
2. Check for debris on the sensor tip.
3. Is debris present?
   a. **Yes.** Clean debris from VSS and install.
   b. **No.** If VSS connections are good, replace VSS. See the service manual.

DTC P0502

PART NUMBER	TOOL NAME
HD-41404-B	HARNESS CONNECTOR TEST KIT
HD-43876	BREAKOUT BOX

Table 6-33. DTC P0502 Diagnostic Faults

POSSIBLE CAUSES
VSS malfunction
ECM malfunction
Short to voltage in signal circuit
Open ground
5V reference shorted to battery voltage

1. VSS Sensor Power Shorted to Voltage Test

1. With IGN OFF, disconnect VSS [65].
2. Inspect [65] for damaged, terminals backed out or bent terminals. Repair as necessary.
3. Place transmission in neutral, turn IGN ON, and engine stop switch to RUN.
4. Using HARNESS CONNECTOR TEST KIT (Part No. HD-41404-B) and a multimeter, measure voltage between VSS [65B] terminals A (BK/R) and C.
5. Is voltage greater than 6.0V?
   a. **Yes.** Repair short to voltage on (R/W) wire.
   b. **No.** Go to Test 2.

2. VSS Signal Wire Short to Voltage Test

1. Measure voltage between VSS [65B] terminal B (W/GN) and ground.
2. Is voltage above 6.0V?
   a. **Yes.** Repair short to voltage on (W/GN) wire.
   b. **No.** Go to Test 3.

3. VSS Signal Wire Shorted to Sensor Power Test

1. With IGN OFF, connect BREAKOUT BOX (Part No. HD-43876) to wire harness [78B], leaving ECM [78A] disconnected. See 1.2 DIAGNOSTIC TOOLS.
2. Test continuity between breakout box terminals 33 and 14.

DIGITAL TECHNICIAN HARLEY-DAVIDSON

3. Is continuity present?
   a. **Yes.** Repair short between (W/GN) and (R/W) wires.
   b. **No.** If ECM connections are good, replace ECM. See the service manual. Go to Test 4.

4. VSS Ground Wire Open Test

1. Test continuity between breakout box terminal 28 and VSS [65B] terminal C (BK/GN).
2. Is continuity present?
   a. **Yes.** Replace VSS. See the service manual.
   b. **No.** Repair open on (BK/GN) wire.

DIGITAL TECHNICIAN II HARLEY-DAVIDSON

DTC P0505 6.12

DESCRIPTION AND OPERATION

PART NUMBER	TOOL NAME
HD-48650	DIGITAL TECHNICIAN II

The ECM controls engine idle speed by moving the IAC to open or close a passage around the throttle plates. It does this by sending voltage pulses to the proper motor winding of the IAC. This causes the pintle to move in or out of the IAC a given distance for each pulse received.

- To increase idle speed, the ECM retracts the pintle, allowing more air to flow through the throttle body.
- To decrease idle speed, the ECM extends the pintle, allowing less air to flow through the throttle body.

The IAC position can be measured in steps. This can only be done by using DIGITAL TECHNICIAN II (Part No. HD-48650).

- A high number of steps represents a fully retracted pintle and open passage around throttle plate. This correlates with an increase in the amount of air flowing through the throttle body.
- Zero steps represents a fully extended pintle. A zero reading indicates an abnormal condition in which the pintle has been fully extended and has consequently closed the passage around throttle plate.

Each time the ignition is turned OFF, the ECM resets the IAC by sending enough pulses to extend the pintle and effectively close the throttle body. The fully extended value is the ECM reference point. A given number of steps are then calculated by the ECM for use in setting the proper idle speed and IAC position for the next start event.

NOTE

Idle speed is controlled by the ECM and cannot be adjusted.

Diagnostic Trouble Code P0505: Loss of Idle Speed Control

Loss of idle speed control will result if the idle RPM is ±200 from preset idle speed and IAC motor is at zero or maximum for greater than 5 seconds. This DTC may occur with others for a multiple code situation. Resolve the other codes first to correct.

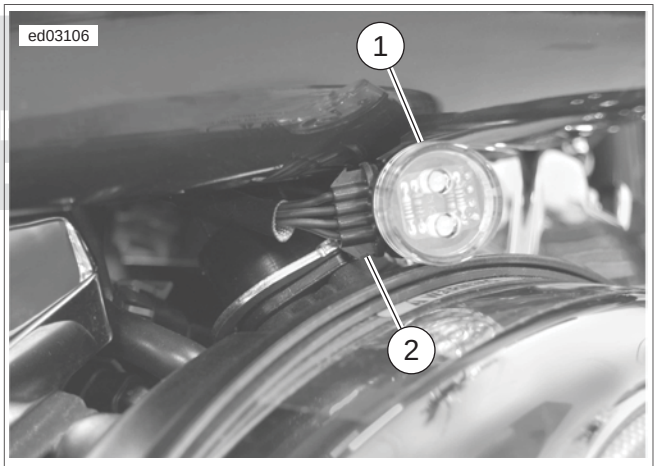
Table 6-34. Code Description

DTC	DESCRIPTION
P0505	Loss of idle speed control

Diagnostic Tips

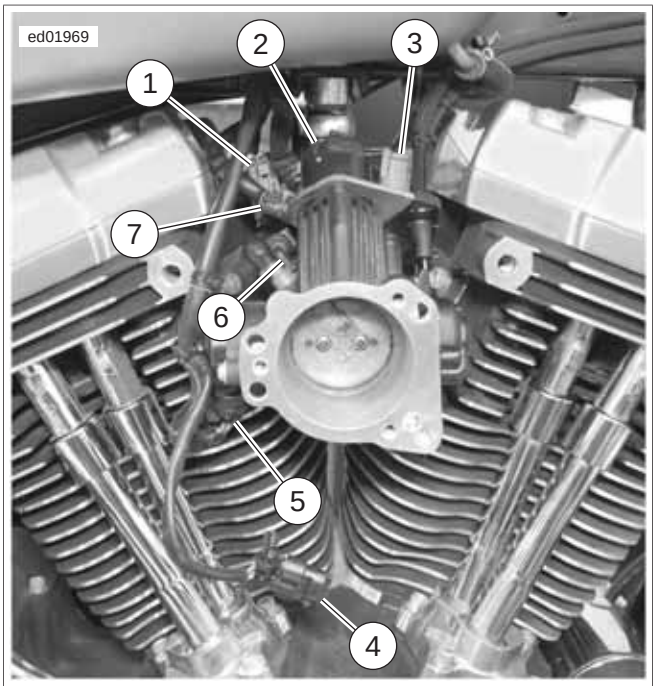
Engine idle speed can be adversely affected by the following:

- A loss of idle speed control does not necessarily imply the IAC actuator or wiring has failed. It can be caused by a number of conditions such as an intake air leak, improperly adjusted throttle stop or a misfiring cylinder.
- A non-O.E engine configuration can lead to idle instability and the generation of the P0505 code.
- Leaking injectors will cause fuel imbalance and poor idle quality due to different air/fuel ratios in each cylinder. To check for leaky injectors, first remove the air box and air filter. See the service manual. Then, with the throttle wide open, turn IGN ON for 2 seconds and then OFF for 2 seconds five consecutive times. Replace the fuel injector if there is any evidence of raw fuel in the bores. See the service manual.
- Intake leaks. See the service manual.
- Contaminated fuel.
- TPS reading of greater than 1% (possible throttle cable misadjustment) or battery voltage reading of less than 9V or a VSS greater than 0 will disable idle speed control.
- If there is a loss of battery power at ECM terminal 31, vehicle will start but IAC pintle will not reset at key OFF. Eventually pintle will be out of position causing performance problems.



1. **HD-41199-3 IAC Test Light**
2. **IAC [87]**

Figure 6-19. IAC Test Light (Part No. HD-41199-3)



1. **Rear fuel injector [85]**
2. **IAC [87]**
3. **Front fuel injector [84]**
4. **Active intake solenoid (HDI) [178]**
5. **TPS [88]**
6. **IAT sensor [89]**
7. **MAP sensor [80]**

Figure 6-20. Between Cylinders Right Side

Connector Information

For additional information about the connectors in the following diagram(s) and diagnostic procedure(s), including the color of the harness test kit terminal probes, see B.1 CONNECTORS.

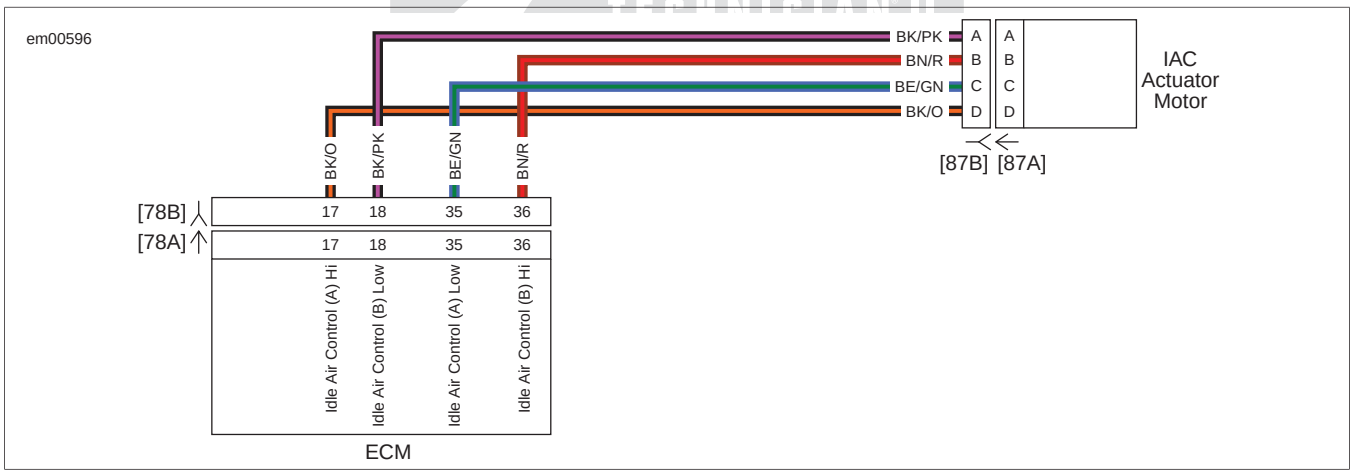


Figure 6-21. IAC Circuit

DTC P0505

PART NUMBER	TOOL NAME
HD-41199-3	IAC TEST LIGHT
HD-43876	BREAKOUT BOX

Table 6-35. DTC P0505 Diagnostic Faults

POSSIBLE CAUSES
IAC malfunction
ECM malfunction
Short to voltage in circuits
Short to ground in circuits
Open circuits
Vacuum/air leaks
Fuel system problems

1. IAC Operational Test

1. Remove air cleaner cover and element.
2. Turn IGN ON, then OFF, while watching the IAC pintle for movement.
3. Does the pintle move?
   a. **Yes.** IAC system okay. Check for improperly adjusted throttle stop, vacuum leaks, cylinder misfire, contaminated fuel, leaking injectors, and engine mechanical failure.
   b. **No.** Go to Test 2.

2. IAC Connector Test

1. Remove air cleaner base.
2. Disconnect IAC motor harness [87].
3. Connect IAC TEST LIGHT (Part No. HD-41199-3) to [87B].
4. Place IGN ON and engine stop switch to RUN.
5. While observing test light, turn IGN OFF.
6. Did both IAC test lights flash alternately?
   a. **Yes.** If connections are good, replace IAC motor. See the service manual.
   b. **No.** Go to Test 3.

Table 6-36. IAC, Wire Color, ECM

IAC [87B]	WIRE COLOR	ECM [78B]
A	BE/GN	35
B	BN/R	36
C	BK/PK	18
D	BK/O	17

3. IAC Circuits Open Test

1. Remove test light.
2. Connect BREAKOUT BOX (Part No. HD-43876) to wire harness [78B], leaving ECM [78A] disconnected. See 1.2 DIAGNOSTIC TOOLS.
3. Test for continuity on each IAC wire between breakout box and [87B]. Refer to Table 6-36.
4. Is continuity present on all circuits?
   a. **Yes.** Go to Test 4.
   b. **No.** Repair open in appropriate circuit.

4. IAC Circuits Shorted to Ground Test

1. Test for continuity on each IAC wire between breakout box and ground. Refer to Table 6-36.
2. Is continuity present on any circuits?
   a. **Yes.** Repair short to ground on appropriate circuit.
   b. **No.** Go to Test 5.

5. IAC Circuits Short to Voltage Test

1. Turn IGN ON.
2. Test for voltage between breakout box and ground on each IAC wire. Refer to Table 6-36.
3. Is voltage present on any circuit?
   a. **Yes.** Repair short to voltage in appropriate circuit.
   b. **No.** Inspect ECM connections. If connections are good, replace the ECM. See the service manual.

DIGITAL TECHNICIAN II HARLEY-DAVIDSON

DTC P0603, P0605 6.13

DESCRIPTION AND OPERATION

See Figure 6-22. The DTCs listed indicate a failure which requires replacement of the ECM. See the service manual for replacement information. Refer to Table 6-37.

NOTE

After replacing ECM, perform password learning procedure and clear DTCs using odometer self-diagnostics. See 2.1 INITIAL DIAGNOSTICS, Odometer Self-Diagnostics.

Table 6-37. Code Description

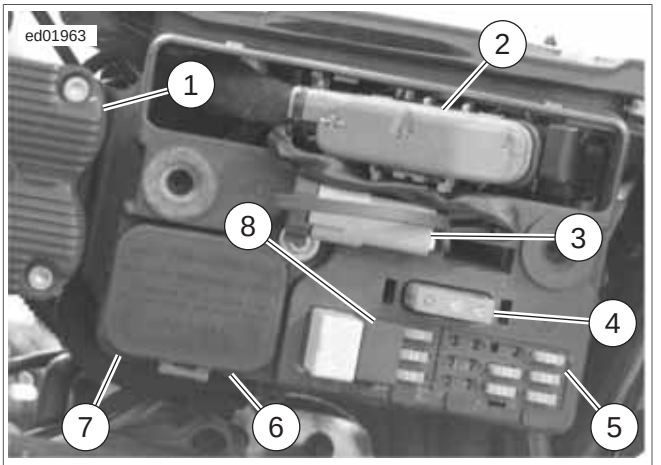
DTC	DESCRIPTION
P0603	ECM EEPROM error
P0605	ECM flash error

DTC P0603 Test

1. Clear DTCs using speedometer self-diagnostics. See 2.1 INITIAL DIAGNOSTICS, Odometer Self-Diagnostics.
2. Replace ECM if DTCs reappear. See the service manual.

DTC P0605 Test

1. Clear DTCs using speedometer self-diagnostics. See 2.1 INITIAL DIAGNOSTICS, Odometer Self-Diagnostics.
2. Attempt to program ECM using correct calibration.
3. Restart vehicle. If DTC reappears, replace ECM. See the service manual.



1. **Ignition coil**
2. **ECM [78]**
3. **DLC [91]**
4. **Main fuse [5]**
5. **Fuse block [64]**
6. **TSM/TSSM/HFSM**
7. **HFSM antenna harness [208]**
8. **Fuse/relay block [62]**

Figure 6-22. Under Left Side Cover

DIGITAL TECHNICIAN II HARLEY-DAVIDSON

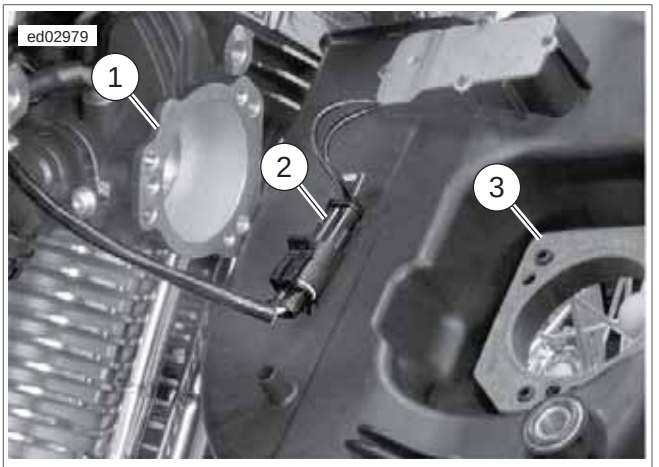
DTC P0661, P0662 6.14

DESCRIPTION AND OPERATION

The active intake solenoid (AIS) regulates the amount of air entering the air cleaner. The AIS opens when vehicle speed exceeds 45 mph (70 km/h) with 50% or greater throttle opening. Once open, active intake will close when vehicle speed falls below 40 mph (65 km/h). See Figure 6-24. The power for the AIS comes from the engine control fuse. The ECM provides the path to ground to trigger the AIS. AIS is included on HDI vehicles only.

Table 6-38. Code Description

DTC	DESCRIPTION
P0661	AIS open/low
P0662	AIS high/shorted



1. **Intake module**
2. **Intake solenoid connector [178]**
3. **Air cleaner backing plate**

Figure 6-23. Intake Solenoid Connector Location

NOTE

The AIS and active exhaust actuator share the same power source and function simultaneously.

Connector Information

For additional information about the connectors in the following diagram(s) and diagnostic procedure(s), including the color of the harness test kit terminal probes, see B.1 CONNECTORS.

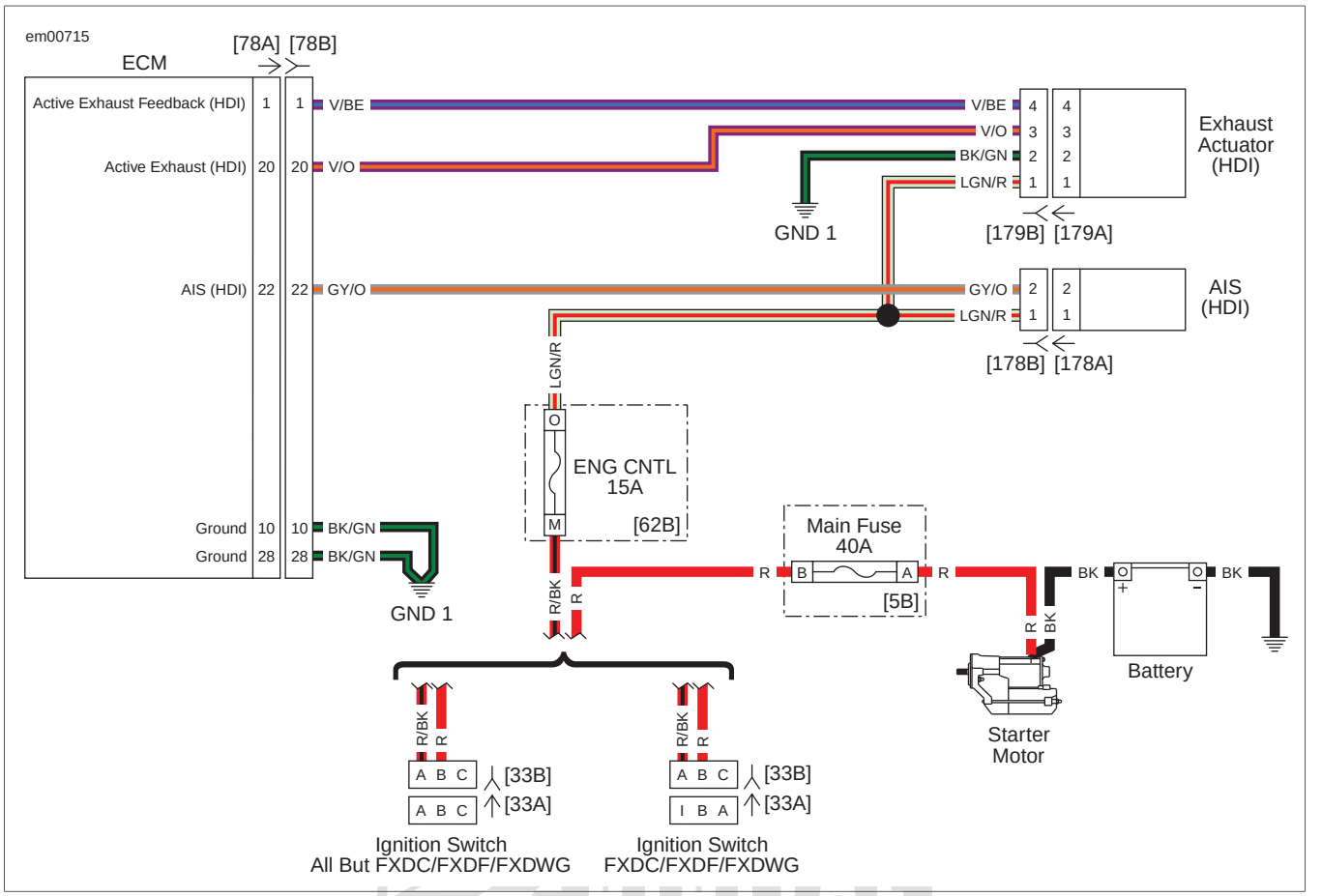


Figure 6-24. Active Exhaust Actuator and AIS Circuit

DTC P0661, P0662

PART NUMBER	TOOL NAME
HD-41404-B	HARNESS CONNECTOR TEST KIT
HD-43876	BREAKOUT BOX

Table 6-39. DTC P0661, P0662 Diagnostic Faults

POSSIBLE CAUSES
AIS malfunction
ECM malfunction
Shorted high to ground
Open low to ground

1. AIS Test

1. Connect BREAKOUT BOX (Part No. HD-43876) to [78B], leaving ECM [78A] disconnected.
2. Using HARNESS CONNECTOR TEST KIT (Part No. HD-41404-B), jump breakout box terminal 22 to terminal 10 or 28.
3. Turn IGN ON.
4. Does AIS activate immediately?
   a. **Yes.** AIS okay. Replace ECM. See service manual.
   b. **No.** Go to Test 2.

2. AIS Resistance Test

1. Turn IGN OFF and disconnect AIS [178].
2. Measure resistance between [178A] terminals 1 and 2.
3. Is resistance between 16 and 20 Ohms?
   a. **Yes.** Go to Test 3.
   b. **No.** Replace AIS. See service manual.

3. AIS Open Ground Wire Test

1. Test for continuity from breakout box terminal 22 to AIS [178B] terminal 2 (GY/O).
2. Is continuity present?
   a. **Yes.** Go to Test 4.
   b. **No.** Repair open wire (GY/O).

4. AIS Low Short to Ground Test

1. Test for continuity from breakout box terminal 22 to ground.

2. Is continuity present?
   a. **Yes.** Repair short to ground on (GY/O) wire.
   b. **No.** Go to Test 5.

5. AIS High Short to Ground Test

1. Remove engine control fuse.
2. Test for continuity between [62B] terminal O and ground.
3. Is continuity present?
   a. **Yes.** Repair short to ground on (LGN/Y) wire.
   b. **No.** Go to Test 6.

6. AIS Open Supply Wire Test

1. Test for continuity between engine control fuse [62B] terminal O and AIS [178B] terminal 1 (LGN/Y).
2. Is continuity present?
   a. **Yes.** Replace AIS. See the service manual.
   b. **No.** Repair open wire (LGN/Y).

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DTC P1009, P1010 6.15

GENERAL

Password Problem

The ECM and TSM/TSSM/HFSM exchange passwords during operation. An incorrect password or missing password will set a DTC. If any U-codes exist, troubleshoot the higher priority codes prior to performing the tests in this section.

NOTE

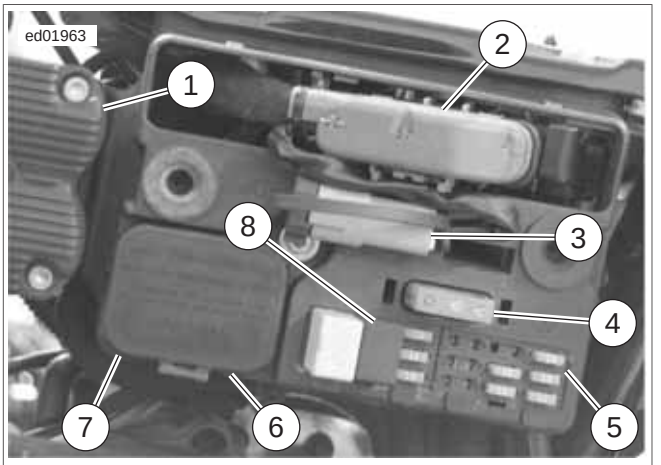
If the TSM/TSSM/HFSM is not connected to the wiring harness, the vehicle will not start.

Table 6-40. Code Description

DTC	DESCRIPTION
P1009	Incorrect password
P1010	Missing password

Connector Information

For additional information about the connectors in the following diagram(s) and diagnostic procedure(s), including the color of the harness test kit terminal probes, see B.1 CONNECTORS.



1. **Ignition coil**
2. **ECM [78]**
3. **DLC [91]**
4. **Main fuse [5]**
5. **Fuse block [64]**
6. **TSM/TSSM/HFSM**
7. **HFSM antenna harness [208]**
8. **Fuse/relay block [62]**

Figure 6-25. Under Left Side Cover

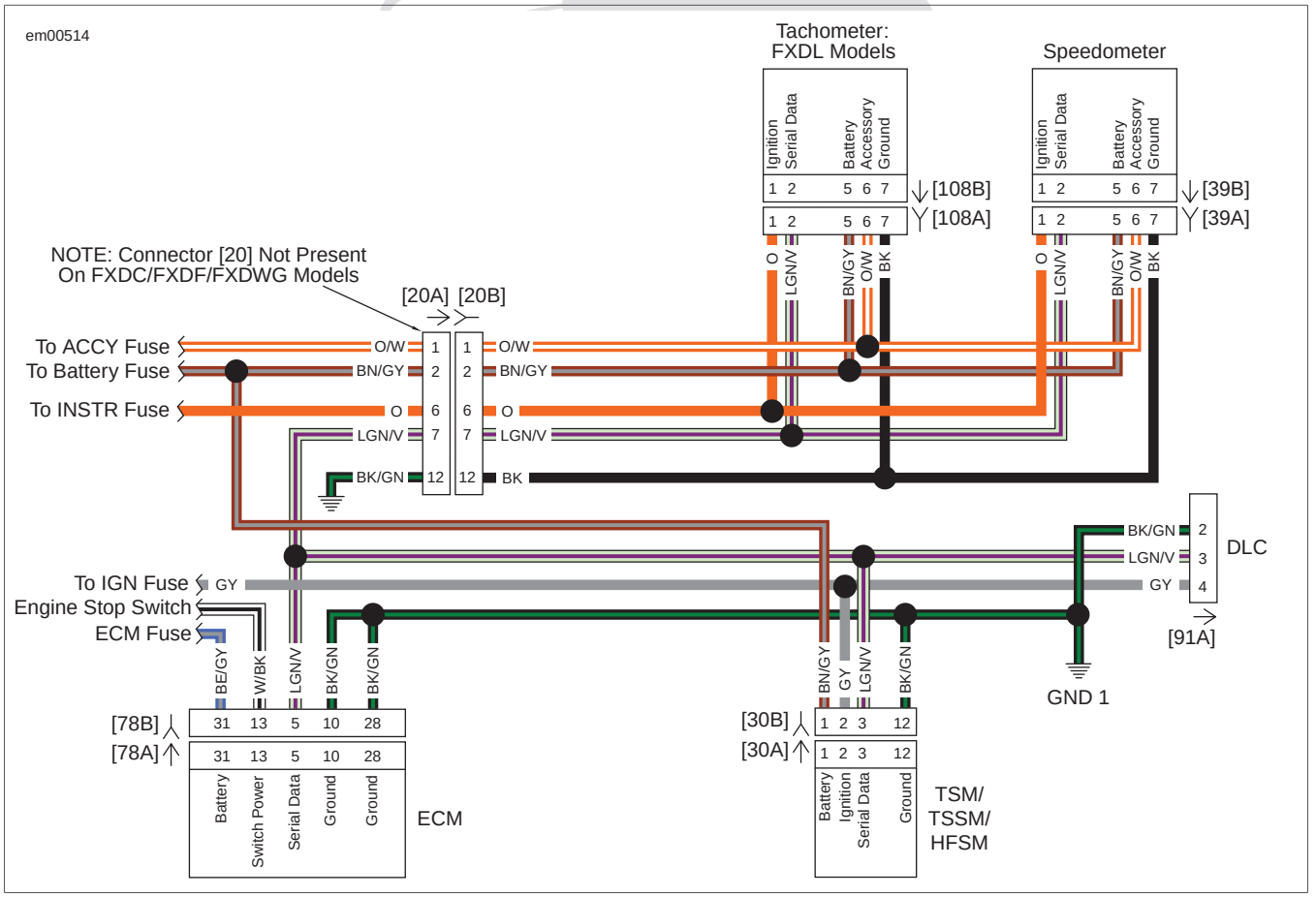


Figure 6-26. ECM and TSM/TSSM/HFSM Circuit

DTC P1009 OR P1010

Table 6-41. DTC P1009 and P1010 Diagnostic Faults

POSSIBLE CAUSES
ECM malfunction
TSM/TSSM/HFSM malfunction

1. Incorrect Password Test

1. Reprogram password. See the service manual.
2. Does DTC P1009 or P1010 set?
   a. **Yes.** Go to Test 2.
   b. **No.** System okay.

2. TSM/TSSM/HFSM Replacement Test

1. Replace TSM/TSSM/HFSM. See the service manual.
2. Program password. See the service manual.
3. Does DTC P1009 or P1010 set?
   a. **Yes.** Install original TSM/TSSM/HFSM and replace ECM. See the service manual.
   b. **No.** System okay.

DIGITAL TECHNICIAN® II HARLEY-DAVIDSON®

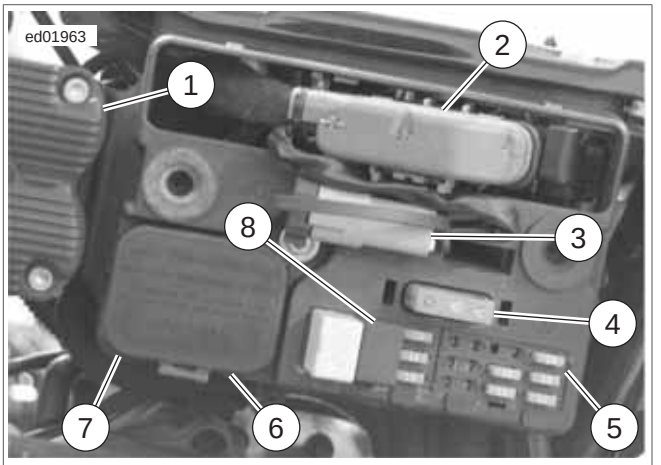
DTC P1001, P1002, P1003, P1004 6.16

DESCRIPTION AND OPERATION

See Figure 6-27. With IGN ON and the engine stop switch at RUN, the ECM will energize the system relay to complete the circuit to the fuel pump, ignition coils, and fuel injectors. They will remain powered as long as the engine is cranking or running, and the ECM is receiving ignition reference pulses from the CKP sensor. If there are no reference pulses, the ECM will de-energize the system relay within 2 seconds after ignition is ON or engine has stalled, or immediately after the ignition is shut OFF.

Table 6-42. Code Description

DTC	DESCRIPTION
P1001	System relay coil open/low
P1002	System relay coil high/shorted
P1003	System relay contacts open
P1004	System relay contacts closed



1. **Ignition coil**
2. **ECM [78]**
3. **DLC [91]**
4. **Main fuse [5]**
5. **Fuse block [64]**
6. **TSM/TSSM/HFSM**
7. **HFSM antenna harness [208]**
8. **Fuse/relay block [62]**

Figure 6-27. Under Left Side Cover

DIGITAL TECHNICIAN II HARLEY-DAVIDSON

Connector Information

For additional information about the connectors in the following diagram(s) and diagnostic procedure(s), including the color of the harness test kit terminal probes, see B.1 CONNECTORS.

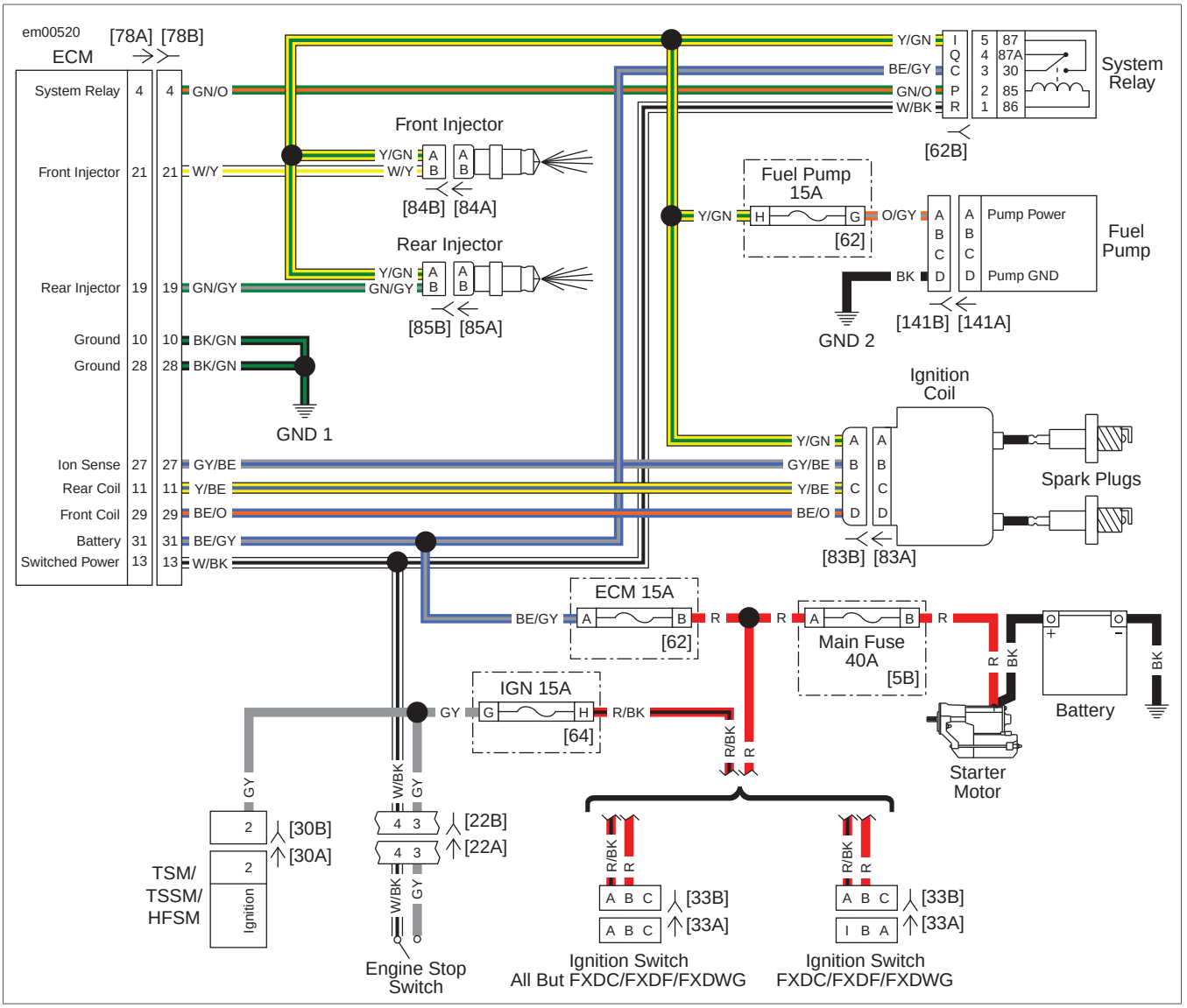


Figure 6-28. Ignition Circuit

DTC P1001

PART NUMBER	TOOL NAME
HD-43876	BREAKOUT BOX

Table 6-43. DTC P1001 Diagnostic Faults

POSSIBLE CAUSES
Relay malfunction
Open in coil supply circuit
Short to ground in coil control circuit
ECM malfunction
Open in coil control circuit

1. System Relay Test

1. Remove the system relay.
2. Test the system relay. See 1.3 DIAGNOSTICS AND TROUBLESHOOTING, Relay Diagnostics.
3. Is the system relay OK?
   a. **Yes.** Go to Test 2.
   b. **No.** Replace the system relay. See the service manual.

2. System Relay Coil Power Circuit Test

1. With IGN ON and the engine stop switch in RUN, test for voltage at [62B] socket terminal R.
2. Is battery voltage present?
   a. **Yes.** Go to Test 3.
   b. **No.** Repair open in (W/BK) wire.

3. System Relay Coil Control Short to Ground Test

1. With IGN OFF, disconnect the ECM [78].
2. Test for continuity from [62B] socket terminal P to ground.
3. Is continuity present?
   a. **Yes.** Repair short to ground in (GN/O) wire.
   b. **No.** Go to Test 4.

4. System Relay Coil Control Circuit Test

1. Connect BREAKOUT BOX (Part No. HD-43876) to wire harness [78B], leaving ECM [78A] disconnected. See 1.2 DIAGNOSTIC TOOLS.
2. Test for continuity between [62B] socket terminal P and breakout box terminal 4.
3. Is continuity present?
   a. **Yes.** Replace the ECM. See the service manual.
   b. **No.** Repair open in (GN/O) wire.

DTC P1002

Table 6-44. DTC P1002 Diagnostic Faults

POSSIBLE CAUSES
Relay malfunction
Short to voltage in coil control circuit
ECM malfunction

1. System Relay Test

1. Remove the system relay.
2. Test the system relay. See 1.3 DIAGNOSTICS AND TROUBLESHOOTING, Relay Diagnostics.
3. Is the system relay OK?
   a. **Yes.** Go to Test 2.
   b. **No.** Replace the system relay. See the service manual.

2. System Relay Coil Short to Voltage Test

1. Test for voltage between [62B] socket terminal P and ground.
2. Is voltage present?
   a. **Yes.** Repair short to voltage in (GN/O) wire.
   b. **No.** Replace the ECM. See the service manual.

DTC P1003

Table 6-45. DTC P1003 Diagnostic Faults

POSSIBLE CAUSES
Relay malfunction
ECM malfunction
Open in switch output circuit
Short to ground in the switch supply circuit
Open in switch supply circuit

1. System Relay Test

1. Remove the system relay.
2. Test the system relay. See 1.3 DIAGNOSTICS AND TROUBLESHOOTING, Relay Diagnostics.
3. Is the system relay OK?
   a. **Yes.** Go to Test 2.
   b. **No.** Replace the system relay. See the service manual.

2. System Relay Power Supply Test

1. Test for voltage between [62B] socket terminal C and ground.
2. Is battery voltage present?
   a. **Yes.** Go to Test 3.
   b. **No.** Go to Test 4.

3. System Relay Switch Side Circuit Test

1. Disconnect the rear injector [85].
2. Test for continuity between [62B] socket terminal I and [85B] terminal A.
3. Is continuity present?
   a. **Yes.** Replace the ECM. See the service manual.
   b. **No.** Repair open in (Y/GN) wire.

4. System Relay Power Supply Circuit Test

1. Test for continuity between [62B] socket terminal C and ground.
2. Is continuity present?
   a. **Yes.** Repair short to ground in (BE/GY) wire and replace ECM fuse.
   b. **No.** Repair open in power supply to system relay. This includes the (BE/GY) wire, ECM fuse, and the (R) wire between the ECM and 40A main fuse.

DIGITAL TECHNICIAN II HARLEY-DAVIDSON

DTC P1004

PART NUMBER	TOOL NAME
HD-43876	BREAKOUT BOX

Table 6-46. DTC P1004 Diagnostic Faults

POSSIBLE CAUSES
Relay malfunction
Short to voltage in the switch circuit
Short to ground in coil control circuit
Short to voltage rear coil control circuit
Short to voltage front coil control circuit

1. System Relay Test

1. Remove the system relay.
2. Test the system relay. See 1.3 DIAGNOSTICS AND TROUBLESHOOTING, Relay Diagnostics.
3. Is the system relay OK?
   a. **Yes.** Go to Test 2.
   b. **No.** Replace the system relay. See the service manual.

2. System Relay Switch Side Short to Voltage Test

1. Test for voltage on [62B] socket terminal I.
2. Is voltage present?
   a. **Yes.** Repair short to voltage in (Y/GN) wire.
   b. **No.** Go to Test 3.

3. System Relay Coil Short to Ground Test

1. Disconnect the ECM.
2. Test for continuity between [62B] socket terminal P and ground.
3. Is continuity present?
   a. **Yes.** Repair short to ground on (GN/O) wire.
   b. **No.** Go to Test 4.

4. Rear Coil Short to Voltage Test

1. Connect BREAKOUT BOX (Part No. HD-43876) to wire harness [78B], leaving ECM [78A] disconnected. See 1.2 DIAGNOSTIC TOOLS.
2. With IGN ON, test for voltage on breakout box terminal 11 to ground.
3. Is voltage present?
   a. **Yes.** Repair short to voltage on (Y/BE) wire.
   b. **No.** Go to Test 5.

5. Front Coil Short to Voltage Test

1. With IGN ON, test for voltage on breakout box terminal 29 to ground.
2. Is voltage present?
   a. **Yes.** Repair short to voltage on (BE/O) wire.
   b. **No.** Replace the ECM. See the service manual.

DIGITAL TECHNICIAN II HARLEY-DAVIDSON

DTC P1351, P1352, P1354, P1355 6.17

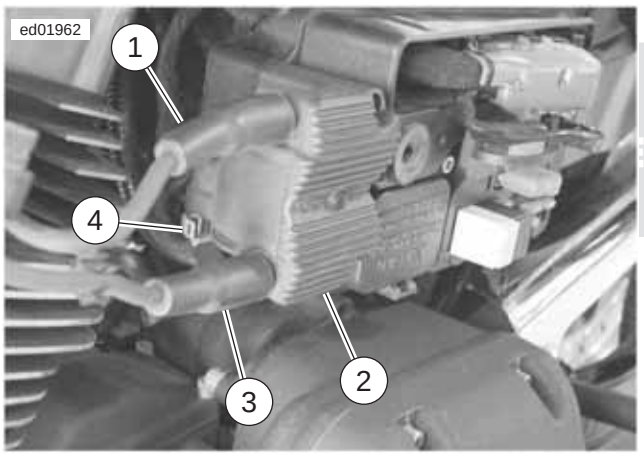
DESCRIPTION AND OPERATION

Ignition coil DTCs will set if the ignition coil primary voltage is out of range. This could occur if there is an open coil or loss of power to the coil. If front and rear DTCs are set simultaneously, it is likely a coil power failure or a coil failure.

The coil receives power from the system relay at the same time that the fuel pump and injectors are activated. The system relay is active for the first 2 seconds after the ignition switch is turned ON and then shuts off until RPM is detected from the CKP sensor, at which time system relay is reactivated. The ECM is responsible for turning on the system relay by providing the ground to activate the relay, which in turn powers the coil.

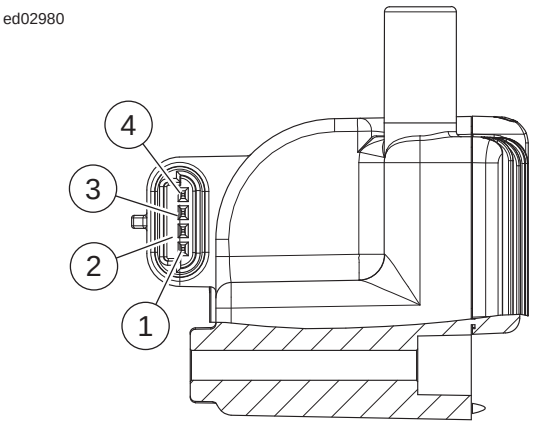
Table 6-47. Code Description

DTC	DESCRIPTION
P1351	Front ignition coil open/low
P1352	Front ignition coil high/shorted
P1354	Rear ignition coil open/low
P1355	Rear ignition coil high/shorted



1. **Rear spark plug wire**
2. **Coil**
3. **Front spark plug wire**
4. **Ignition coil [83]**

Figure 6-29. Ignition Coil



1. **Pin A: power**
2. **Pin B: ion sense**
3. **Pin C: rear coil**
4. **Pin D: front coil**

Figure 6-30. Ignition Coil

Connector Information

For additional information about the connectors in the following diagram(s) and diagnostic procedure(s), including the color of the harness test kit terminal probes, see B.1 CONNECTORS.

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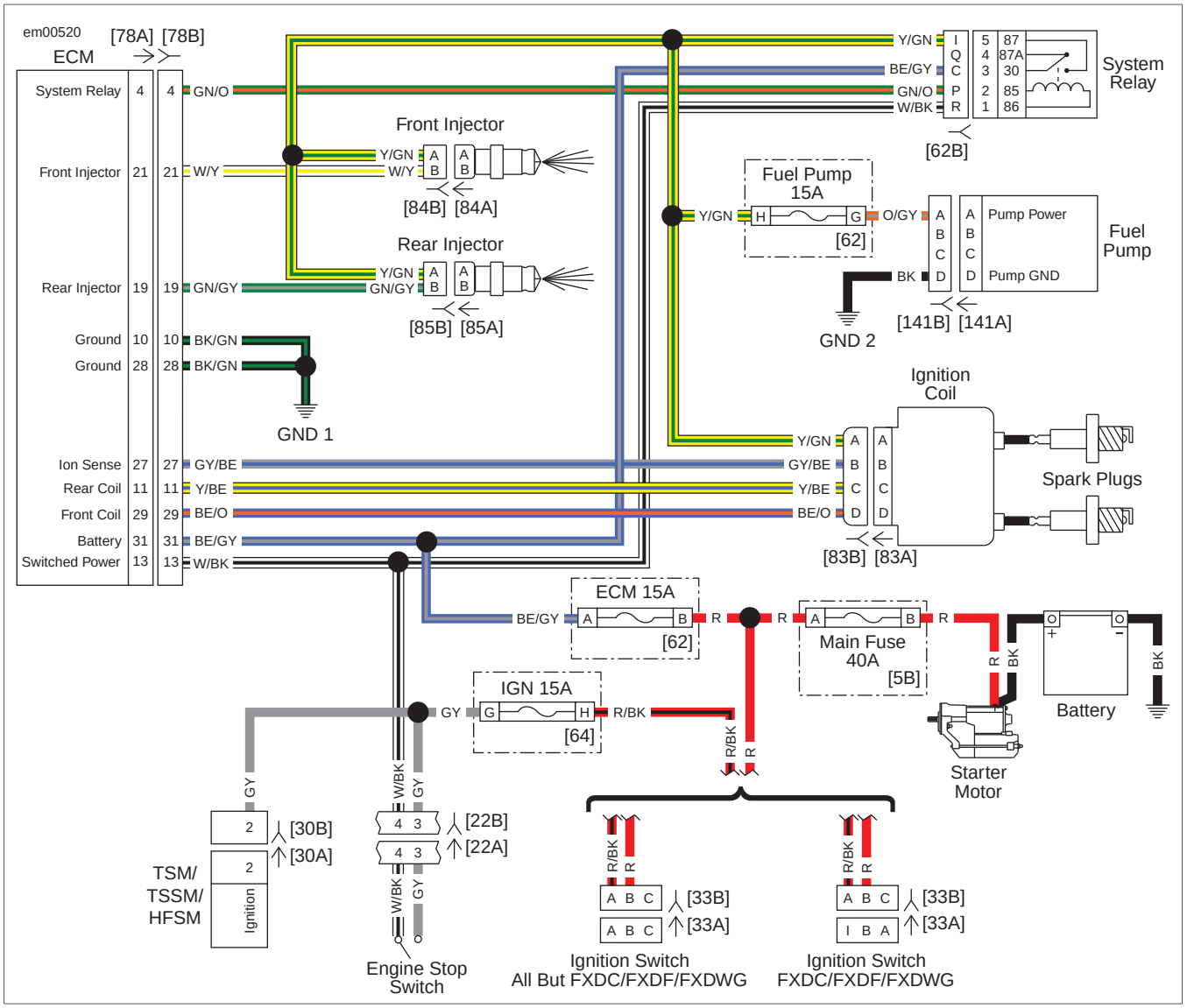


Figure 6-31. Ignition Circuit

DTC P1351

PART NUMBER	TOOL NAME
HD-34730-2D	FUEL INJECTOR TEST LIGHT
HD-41404-B	HARNESS CONNECTOR TEST KIT
HD-43876	BREAKOUT BOX

Table 6-48. DTC P1351 Diagnostic Faults

POSSIBLE CAUSES
Ignition coil malfunction
ECM malfunction
Open or short to ground in signal circuit
Open power circuit

1. Ignition Coil Test

1. Disconnect ignition coil [83]. Inspect for damaged or backed out terminals and corrosion. Repair as required.
2. See Figure 6-30. Use HARNESS CONNECTOR TEST KIT (Part No. HD-41404-B) to connect FUEL INJECTOR TEST LIGHT (Part No. HD-34730-2D) to [83B] terminals A and D.
3. Turn IGN ON and engine stop switch to RUN.
4. Does lamp flash when engine is cranked?
   a. **Yes.** Replace ignition coil. See the service manual.
   b. **No.** Go to Test 2.

2. Ignition Coil Input Voltage Test

1. Turn IGN ON. Voltage will only be present for 2 seconds after ignition is turned on.

2. Test for battery voltage at ignition coil [83B] terminal A to ground.
3. Is battery voltage present?
   a. **Yes.** Go to Test 3.
   b. **No.** Repair open (Y/GN) wire between [83B] and system relay [62B] terminal I.

3. Ignition Coil Control Wire Continuity Test

1. Turn IGN OFF and engine stop switch to RUN.
2. Connect BREAKOUT BOX (Part No. HD-43876) between wire harness [78B] and ECM [78A]. See 1.2 DIAGNOSTIC TOOLS.
3. Test for continuity between breakout box terminal 29 and ignition coil [83B] terminal D (BE/O).
4. Is continuity present?
   a. **Yes.** Go to Test 4.
   b. **No.** Repair open (BE/O) wire.

4. Ignition Coil Control Wire Shorted to Ground Test

1. Disconnect EDM [78A] from breakout box.
2. Test for continuity between breakout box terminals 29 and 28.
3. Is continuity present?
   a. **Yes.** Repair short to ground on (BE/O) wire.
   b. **No.** Replace ECM. See the service manual.

DTC P1352

PART NUMBER	TOOL NAME
HD-41404-B	HARNESS CONNECTOR TEST KIT

Table 6-49. DTC P1352 Diagnostic Faults

POSSIBLE CAUSES
Ignition coil malfunction
ECM malfunction
Short to voltage in signal circuit

1. Ignition Coil Shorted to Voltage Test

1. Disconnect ignition coil harness [83].
2. Turn IGN ON.
3. Using HARNESS CONNECTOR TEST KIT (Part No. HD-41404-B), measure voltage between terminal D of ignition coil [83B] and ground.
4. Is voltage more than 1.0V?
   a. **Yes.** Repair short to voltage on (BE/O) wire.
   b. **No.** Go to Test 2.

2. Ignition Coil Open Test

1. Test resistance between ignition coil [83A] terminals A and D.
2. Is resistance greater than 4.0 Ohms?
   a. **Yes.** If ECM connections are good, replace ECM. See the service manual.
   b. **No.** Replace ignition coil. See the service manual.

DTC P1354

PART NUMBER	TOOL NAME
HD-34730-2D	FUEL INJECTOR TEST LIGHT
HD-41404-B	HARNESS CONNECTOR TEST KIT
HD-43876	BREAKOUT BOX

Table 6-50. DTC P1354 Diagnostic Faults

POSSIBLE CAUSES
Ignition coil malfunction
ECM malfunction
Open or short to ground in signal circuit
Open power circuit

1. Ignition Coil Test

1. Disconnect ignition coil [83]. Inspect for damaged or backed out terminals and corrosion. Repair as required.
2. See Figure 6-30. Use HARNESS CONNECTOR TEST KIT (Part No. HD-41404-B) to connect FUEL INJECTOR TEST LIGHT (Part No. HD-34730-2D) [83B] terminals A and C.
3. Turn IGN ON and engine stop switch to RUN.
4. Does lamp flash when engine is cranked?
   a. **Yes.** Replace ignition coil. See the service manual.
   b. **No.** Go to Test 2.

2. Ignition Coil Input Voltage Test

1. Turn IGN ON. Voltage will only be present for 2 seconds after ignition is turned on.
2. Test for battery voltage at ignition coil [83B] terminal A to ground.
3. Is battery voltage present?
   a. **Yes.** Go to Test 3.
   b. **No.** Repair open (Y/GN) wire between [83B] and system relay [62B] terminal I.

3. Ignition Coil Control Wire Continuity Test

1. Turn IGN OFF and engine stop switch to RUN.
2. Connect BREAKOUT BOX (Part No. HD-43876) between wire harness [78B] and ECM [78A]. See 1.2 DIAGNOSTIC TOOLS.
3. Test for continuity between breakout box terminal 11 and ignition coil [83B] terminal C (Y/BE).
4. Is continuity present?
   a. **Yes.** Go to Test 4.
   b. **No.** Repair open (Y/BE) wire.

4. Ignition Coil Control Wire Shorted to Ground Test

1. Disconnect ECM [78A] from breakout box.
2. Test for continuity between breakout box terminals 11 and 28.
3. Is continuity present?
   a. **Yes.** Repair short to ground on (Y/BE) wire.
   b. **No.** Replace ECM. See the service manual.

DTC P1355

PART NUMBER	TOOL NAME
HD-41404-B	HARNESS CONNECTOR TEST KIT

Table 6-51. DTC P1355 Diagnostic Faults

POSSIBLE CAUSES
Ignition coil malfunction
ECM malfunction
Short to voltage in signal circuit

1. Ignition Coil Shorted to Voltage Test

1. Disconnect ignition coil harness [83].
2. Turn IGN ON.
3. Using HARNESS CONNECTOR TEST KIT (Part No. HD-41404-B), measure voltage between terminal C of ignition coil [83B] and ground.
4. Is voltage more than 1.0V?
   a. **Yes.** Repair short to voltage on (Y/BE) wire.
   b. **No.** Go to Test 2.

2. Ignition Coil Open Test

1. Measure resistance between ignition coil [83A] terminals A and C.
2. Is resistance greater than 4.0 Ohms?
   a. **Yes.** If ECM connections are good, replace ECM. See the service manual.
   b. **No.** Replace ignition coil. See the service manual.

DIGITAL TECHNICIAN II HARLEY-DAVIDSON

DTC P1353, P1356, P1357, P1358 6.18

DESCRIPTION AND OPERATION

See Figure 6-32. A feedback voltage signal in the secondary ignition circuit (terminal B) detects the presence of combustion each time a cylinder fires on ECM terminal 27. For diagnostic purposes, this signal is only analyzed at high speed and load conditions where it may be easily measured. Failure to detect combustion at high speed and load means one of following conditions is true:

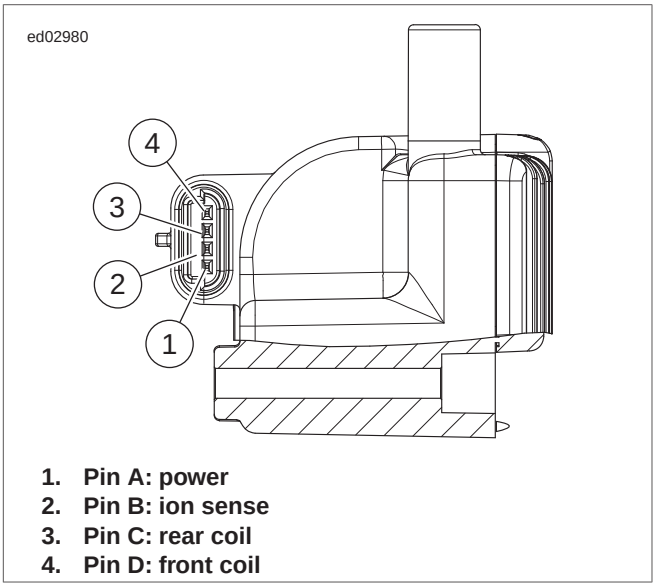
- Cylinder is truly misfiring.
- There is a lack of continuity in the ignition coil secondary circuit.

NOTE

Make sure vehicle is running properly before performing the tests in this section. Perform fuel pressure tests if required. See the service manual. If fuel pressure is not within the proper range, see 6.25 FUEL SYSTEM ELECTRICAL TEST.

Table 6-52. Code Description

DTC	DESCRIPTION
P1353	Front cylinder no combustion
P1356	Rear cylinder no combustion
P1357	Front cylinder combustion intermittent
P1358	Rear cylinder combustion intermittent



1. **Pin A: power**
2. **Pin B: ion sense**
3. **Pin C: rear coil**
4. **Pin D: front coil**

Figure 6-32. Ignition Coil

Connector Information

For additional information about the connectors in the following diagram(s) and diagnostic procedure(s), including the color of the harness test kit terminal probes, see B.1 CONNECTORS.

DIAGNOSTIC TECHNICIAN II HARLEY-DAVIDSON

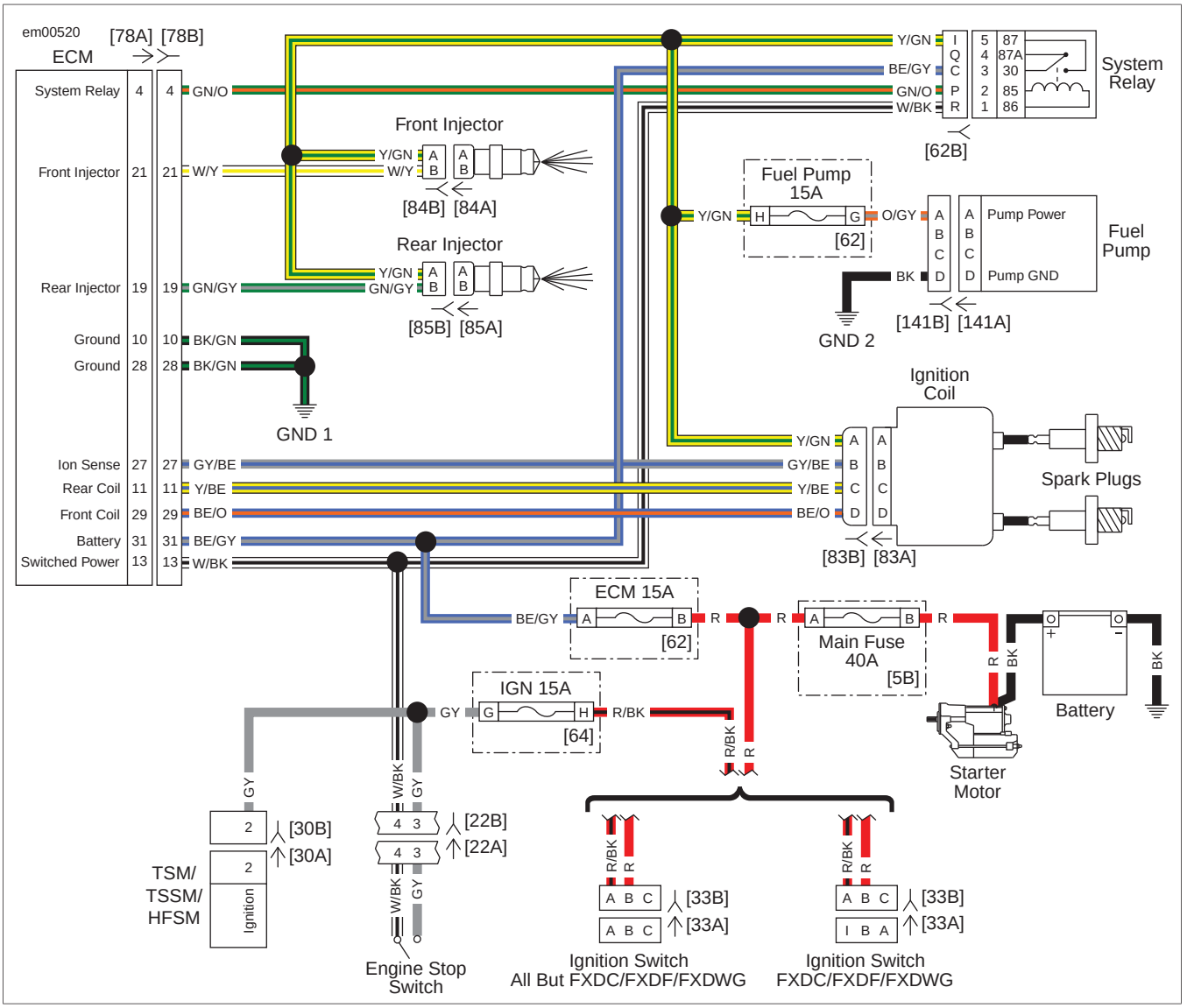


Figure 6-33. Ignition Circuit

DTC P1353 AND P1356

PART NUMBER	TOOL NAME
HD-41404-B	HARNESS CONNECTOR TEST KIT

Table 6-53. DTC P1353 and P1356 Diagnostic Faults

POSSIBLE CAUSES
Ignition coil malfunction
ECM malfunction
Fuel system problems
Open or short to voltage in signal circuit
Spark plug wire connections faulty

1. Absence of Fuel Test

1. Verify vehicle has fuel.
2. Has vehicle run out of fuel recently?
   a. **Yes.** Clear DTCs using speedometer self-diagnostics. See 2.1 INITIAL DIAGNOSTICS, Odometer Self-Diagnostics. Fill with fresh fuel and restart. If code returns, then continue with tests. Go to Test 2.
   b. **No.** Go to Test 2.

2. Ignition Coil Primary Resistance Test

1. Disconnect ignition coil [83].
2. Using HARNESS CONNECTOR TEST KIT (Part No. HD-41404-B) and a multimeter, measure resistance between ignition coil [83] terminals A and C, and then from terminals A and D.
3. Is resistance 0.3-0.5 Ohms?
   a. **Yes.** Go to Test 3.
   b. **No.** Replace the ignition coil. See the service manual.

3. Spark Plug Wire Test

1. Disconnect the spark plug wires.
2. Measure the resistance of the spark plug wires.
3. Is the front and rear spark plug wire resistance within the specified range? See Table 1-5.
   a. **Yes.** Go to Test 4.
   b. **No.** Replace the out of range spark plug wire. See the service manual.

4. Ignition Coil Secondary Resistance Test

1. Measure resistance between ignition coil [83A] terminal A to the front spark plug boot. Repeat measurement for the rear boot.
2. Is resistance 3500-4500 Ohms?
   a. **Yes.** Replace spark plug.
   b. **No.** Replace the ignition coil. See the service manual.

DTC P1357 AND P1358

PART NUMBER	TOOL NAME
HD-41404-B	HARNESS CONNECTOR TEST KIT
HD-43876	BREAKOUT BOX

Table 6-54. DTC P1357 and P1358 Diagnostic Faults

POSSIBLE CAUSES
Ignition coil malfunction
ECM malfunction
Fuel system problems
Open or short to voltage in signal circuit
Spark plug wire connections faulty

1. Ion Sense Continuity Test

1. Connect BREAKOUT BOX (Part No. HD-43876) to wire harness [78B], leaving ECM [78A] disconnected. See 1.2 DIAGNOSTIC TOOLS.
2. Using HARNESS CONNECTOR TEST KIT (Part No. HD-41404-B) and a multimeter, test for continuity between the ignition coil [83B] terminal B and breakout box terminal 27.
3. Is continuity present?
   a. **Yes.** Replace spark plug. See the service manual. If condition persists, then continue with tests. Go to Test 2.
   b. **No.** Repair open in (GY/BE) wire.

2. Ion Sense Resistance Test

1. Measure resistance between ignition coil [83A] terminals A and B.
2. Is resistance greater than 100K Ohms?
   a. **Yes.** Replace ECM. See the service manual.
   b. **No.** Go to Test 3.

3. Ion Sense Short to Voltage Test

1. Connect BREAKOUT BOX (Part No. HD-43876) between wire harness [78B] and ECM [78A]. See 1.2 DIAGNOSTIC TOOLS.
2. With IGN ON, use the HARNESS CONNECTOR TEST KIT (Part No. HD-41404-B) and a multimeter, test for voltage between ignition coil [83B] terminal B and breakout box terminals 10 or 28.
3. Is voltage present?
   a. **Yes.** Repair short to voltage on (GY/BE) wire.
   b. **No.** Replace ignition coil. See the service manual.

DTC P1475, P1477, P1478 6.19

DESCRIPTION AND OPERATION

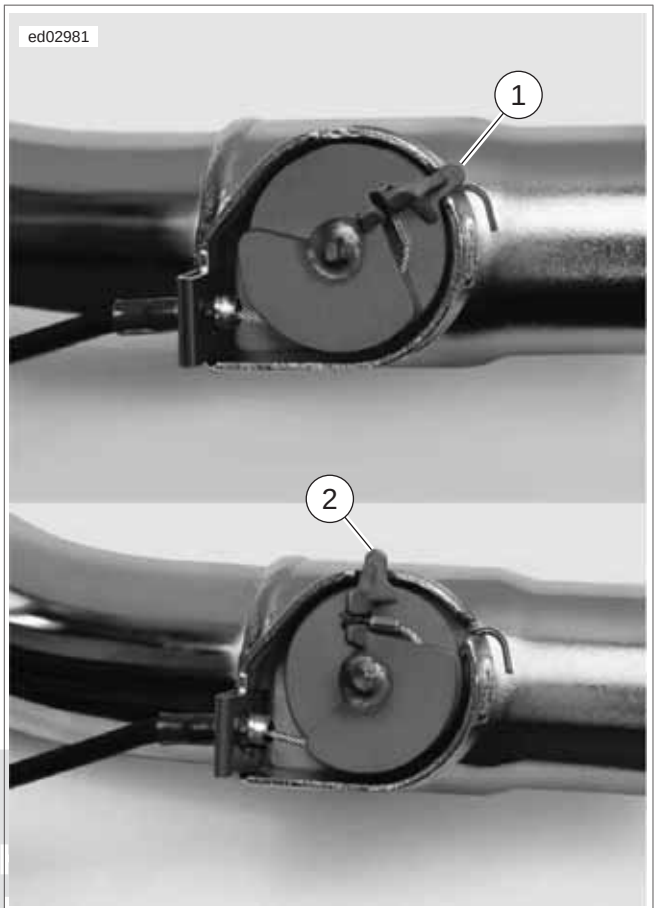
The active exhaust actuator system utilizes an actuator valve located in the rear exhaust pipe which is connected to a servo motor via a cable. The valve position automatically adjusts to enhance engine performance. Active exhaust actuator is included on HDI vehicles only.

Table 6-55. Code Description

DTC	DESCRIPTION
P1475	Exhaust actuator position failure
P1477	Exhaust actuator open/low
P1478	Exhaust actuator high

NOTE

The AIS and active exhaust actuator share the same power source and function simultaneously.



1. **Open position**
2. **Closed position**

Figure 6-34. Bellcrank

Connector Information

For additional information about the connectors in the following diagram(s) and diagnostic procedure(s), including the color of the harness test kit terminal probes, see B.1 CONNECTORS.

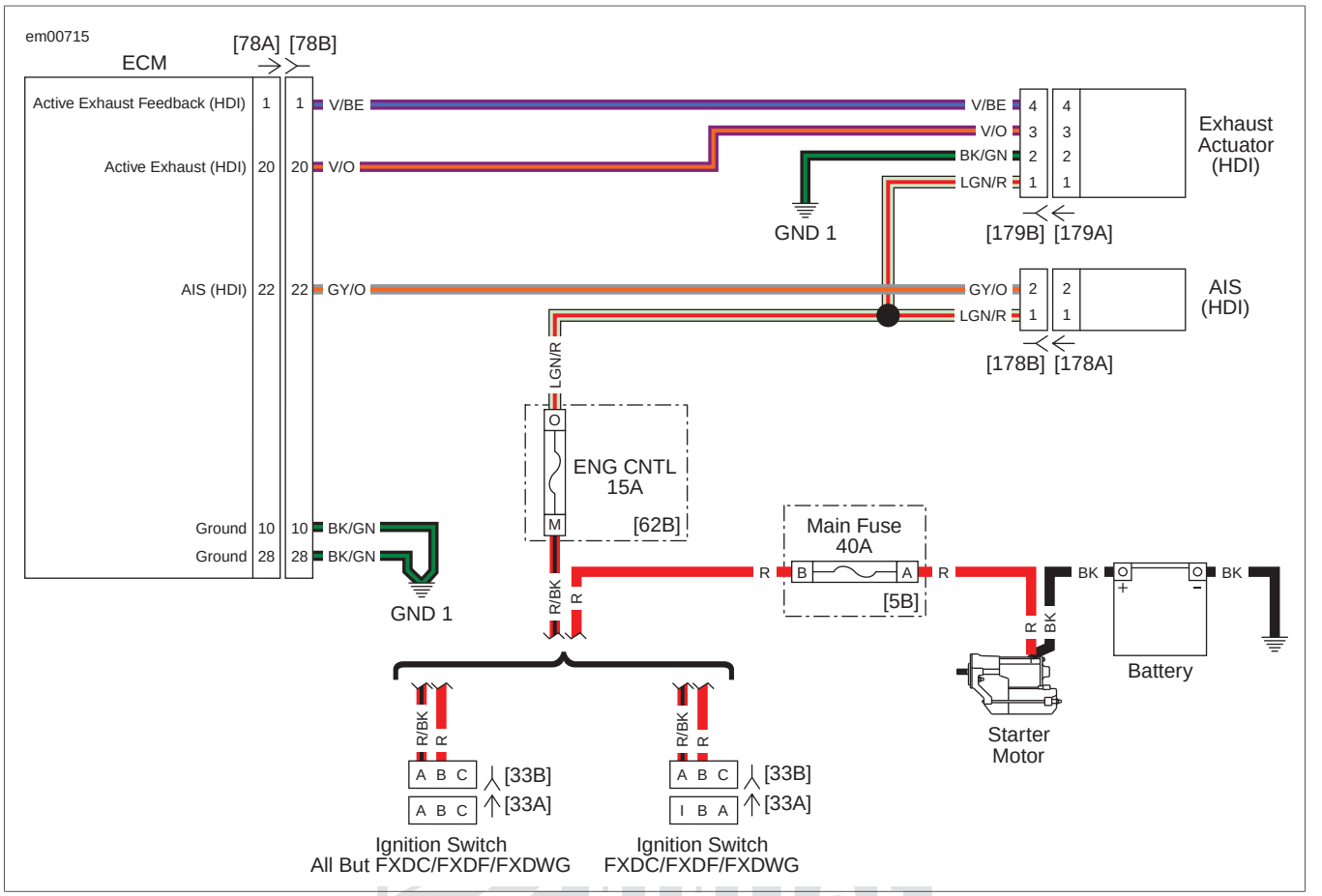


Figure 6-35. Active Exhaust Actuator and AIS Circuit

DTC P1475

PART NUMBER	TOOL NAME
HD-41404-B	HARNESS CONNECTOR TEST KIT
HD-43876	BREAKOUT BOX

Table 6-56. DTC P1475 Diagnostic Faults

POSSIBLE CAUSES
ECM malfunction
Cable and bellcrank malfunction
Open in ground circuit
Open in power circuit
Open in active exhaust feedback circuit
Exhaust actuator malfunction
Short to voltage in active exhaust feedback circuit
Short to ground in active exhaust feedback circuit

1. Exhaust Actuator Test

1. Connect BREAKOUT BOX (Part No. HD-43876) to [78B], leaving ECM [78A] disconnected.
2. Using HARNESS CONNECTOR TEST KIT (Part No. HD-41404-B), jump breakout box terminal 20 to terminal 10 or 28.
3. Turn IGN ON.
4. Does actuator activate immediately?
   a. **Yes.** Replace ECM. See service manual.
   b. **No.** Check engine control fuse. If fuse is okay, then continue with tests. Go to Test 2.

2. Exhaust Actuator Voltage Test

1. Disconnect exhaust actuator [179].
2. With IGN ON, measure the voltage between [179B] terminals 1 and 2.
3. Is battery voltage present?
   a. **Yes.** Check the cable and bellcrank assembly from exhaust actuator to exhaust valve for proper operation. See the service manual.
   b. **No.** Go to Test 3.

3. Exhaust Actuator Motor Ground Wire Continuity Test

1. Turn IGN OFF.

2. Test for continuity between [179B] terminal 2 and ground.
3. Is continuity present?
   a. **Yes.** Go to Test 4.
   b. **No.** Repair open on (BK/GN) wire.

4. Exhaust Actuator Motor Power Wire Continuity Test

1. With IGN OFF, test for continuity between [179B] terminal 1 and engine control fuse [62B] terminal O.
2. Is continuity present?
   a. **Yes.** Go to Test 5.
   b. **No.** Repair open on (LGN/R) wire.

5. Exhaust Actuator Feedback Voltage Test

1. Connect BREAKOUT BOX (Part No. HD-43876) between ECM [78A] and harness [78B].
2. Turn IGN ON.
3. Measure the voltage between breakout box terminals 1 and 10 or 28.
4. Is voltage 4.5-5.5V?
   a. **Yes.** Go to Test 6.
   b. **No.** Battery voltage. Go to Test 9.
   c. **No.** 0V. Go to Test 10.

6. Exhaust Actuator Feedback Continuity Test

1. Disconnect exhaust actuator [179].
2. Using HARNESS CONNECTOR TEST KIT (Part No. HD-41404-B) and multimeter, test for continuity between [179B] terminal 4 and breakout box terminal 1.
3. Is continuity present?
   a. **Yes.** Go to Test 7.
   b. **No.** Repair open wire (V/BE).

7. Exhaust Actuator Feedback Control Test

1. Connect the exhaust actuator [179].
2. Turn IGN ON and engine stop switch to RUN.
3. Measure the voltage between breakout box terminals 1 and 10 or 28.
4. Using HARNESS CONNECTOR TEST KIT (Part No. HD-41404-B), jump between breakout box terminals 20 and 28 several times.
5. Does the voltage change to less than 1 Volt and the exhaust actuator valve open each time?
   a. **Yes.** Go to Test 8.
   b. **No.** Replace exhaust actuator. See the service manual.

8. Exhaust Actuator Feedback Run Test

1. Clear codes and start the engine.
2. Run the engine in neutral between 1500-2500 RPM.
3. Does the exhaust valve open at 1600 RPM or less and close at 1800 or more?
   a. **Yes.** System okay.
   b. **No.** Check connectors for damaged, pushed out, or corroded pins. If no problems are found, replace ECM. See the service manual.

9. Exhaust Actuator Feedback Short to Voltage Test

1. Disconnect ECM from breakout box.
2. With IGN ON and engine not running, test for voltage between breakout box terminal 1 and ground.
3. Is voltage present?
   a. **Yes.** Repair short to voltage on (V/BE) wire.
   b. **No.** Replace ECM. See the service manual.

10. Exhaust Actuator Feedback Short to Ground Test

1. Disconnect ECM from breakout box.
2. Using HARNESS CONNECTOR TEST KIT (Part No. HD-41404-B) and multimeter, test for continuity between [179B] terminal 4 and ground.
3. Is continuity present?
   a. **Yes.** Repair short to ground on (V/BE) wire.
   b. **No.** Replace ECM. See the service manual.

DTC P1477

PART NUMBER	TOOL NAME
HD-41404-B	HARNESS CONNECTOR TEST KIT
HD-43876	BREAKOUT BOX

Table 6-57. DTC P1477 Diagnostic Faults

POSSIBLE CAUSES
Open in active exhaust circuit
ECM malfunction
Short to ground in active exhaust circuit
Exhaust actuator malfunction

1. Exhaust Actuator Motor Open Test

1. Connect BREAKOUT BOX (Part No. HD-43876) to harness [78B], leaving ECM [78A] disconnected.
2. Disconnect exhaust actuator [179].
3. Using HARNESS CONNECTOR TEST KIT (Part No. HD-41404-B), test for continuity between breakout box terminal 20 to [179B] terminal 3.
4. Is continuity present?
   a. **Yes.** Go to Test 2.
   b. **No.** Repair open (V/O) wire.

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2. Exhaust Actuator Motor Shorted to Ground Test

1. Connect ECM to breakout box.
2. Using HARNESS CONNECTOR TEST KIT (Part No. HD-41404-B), test for continuity between breakout box terminal 20 and ground.
3. Is continuity present?
   a. **Yes.** Go to Test 3.
   b. **No.** Replace ECM. See the service manual.

3. Exhaust Actuator Feedback Shorted to Ground Test

1. Disconnect exhaust actuator [179] and disconnect ECM from breakout box.
2. Test for continuity between breakout box terminal 20 and ground.
3. Is continuity present?
   a. **Yes.** Repair short to ground on (V/O) wire.
   b. **No.** Replace active exhaust actuator. See the service manual.

DTC P1478

PART NUMBER	TOOL NAME
HD-41404-B	HARNESS CONNECTOR TEST KIT
HD-43876	BREAKOUT BOX

Table 6-58. DTC P1478 Diagnostic Faults

POSSIBLE CAUSES
ECM malfunction
Short to voltage in active exhaust circuit
Exhaust actuator malfunction

1. Exhaust Actuator Motor High Test

1. Connect BREAKOUT BOX (Part No. HD-43876) to harness [78B], leaving ECM [78A] disconnected.
2. Turn IGN ON and engine stop switch to RUN.
3. Using HARNESS CONNECTOR TEST KIT (Part No. HD-41404-B), test for voltage between breakout box terminal 20 and ground.
4. Is voltage present?
   a. **Yes.** Go to Test 2.
   b. **No.** Replace ECM. See the service manual.

2. Exhaust Actuator Motor Shorted to Voltage Test

1. Disconnect exhaust actuator [179].
2. Using HARNESS CONNECTOR TEST KIT (Part No. HD-41404-B), test for voltage between breakout box terminal 20 and ground.
3. Is voltage present?
   a. **Yes.** Repair short to voltage on (V/O) wire.
   b. **No.** Replace active exhaust control actuator.

DIGITAL TECHNICIAN II HARLEY-DAVIDSON

DTC P1501, P1502 6.20

DESCRIPTION AND OPERATION

The JSS uses a Hall-effect sensor to monitor jiffy stand position. When the jiffy stand is fully retracted the sensor picks up the presence of the metal tab mounted to the jiffy stand. The metal tab is moved away from the sensor as the jiffy stand is extended. When the jiffy stand is extended the engine will only start and run if the TSM/TSSM/HFSM determines the transmission is in neutral. Otherwise the engine will start and stall. This is done by monitoring the neutral switch input to the TSM/TSSM/HFSM and communicating that input over the serial data circuit to the ECM.

See Figure 6-37. The JSS is powered and monitored by the ECM. The ECM terminal 14 supplies the 5V reference to the JSS connector [133] terminal 1. The JSS terminal 2 sends a signal back to the ECM terminal 9. This signal is used by the ECM to determine when the jiffy stand is retracted or extended. The JSS terminal 3 is grounded through the ECM terminal 28.

The JSS also has a Fail Enable Mode. This mode allows the engine to start and run if the system recognizes a problem with the JSS circuit. When a problem exists or if the transmission is put in gear with the jiffy stand extended the speedometer will display "SIdE Stand." DTC P1501 or P1502 will set if the JSS circuits are out of range.

Table 6-59. Code Description

DTC	DESCRIPTION
P1501	JSS low
P1502	JSS high

NOTE

The ECM supplies 5V reference voltage from [78] terminal 14 to the VSS, TPS, and MAP sensors in addition to the JSS. Problems on the 5V reference will cause other DTCs.

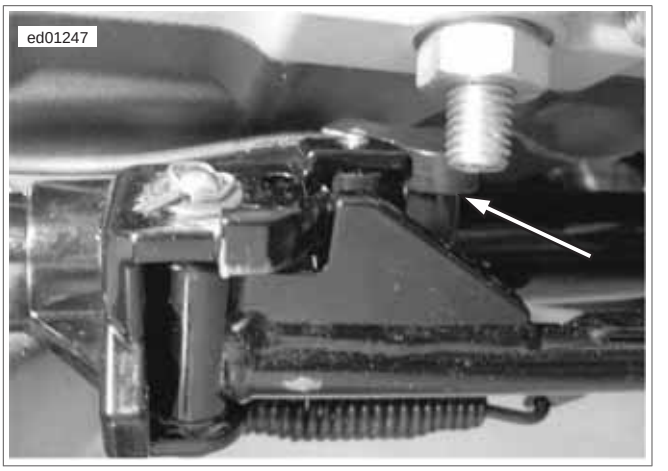

Figure 6-36. JSS (HDI)

Connector Information

For additional information about the connectors in the following diagram(s) and diagnostic procedure(s), including the color of the harness test kit terminal probes, see B.1 CONNECTORS.

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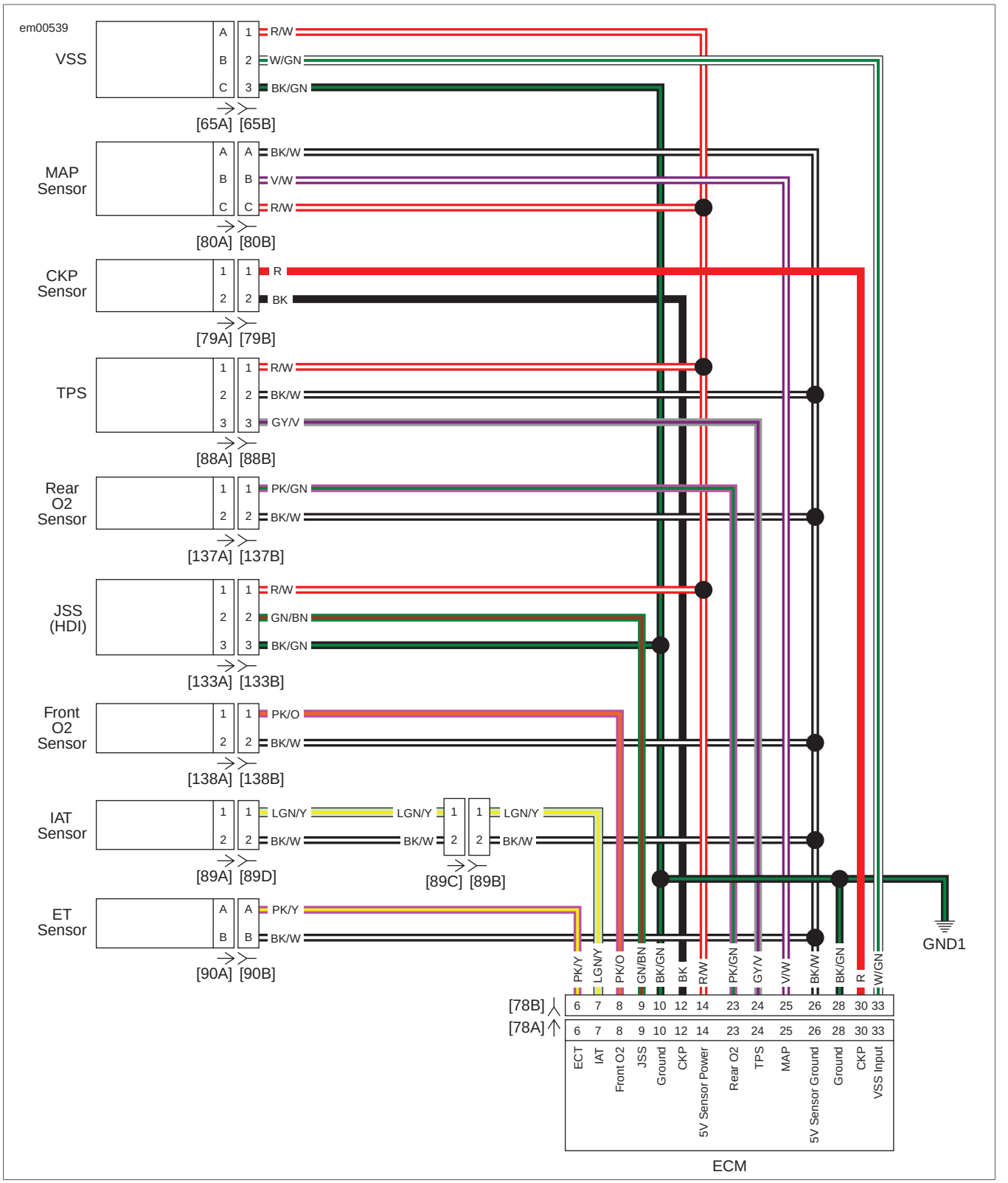

Figure 6-37. Sensor Circuit

DTC P1501

PART NUMBER	TOOL NAME
HD-41404-B	HARNESS CONNECTOR TEST KIT
HD-43876	BREAKOUT BOX

Table 6-60. DTC P1501 Diagnostic Faults

POSSIBLE CAUSES
JSS malfunction
ECM malfunction
Open or short to ground in 5V reference circuit
Open or short to ground in signal circuit

1. JSS 5V Reference Open Circuit Test

1. Disconnect the JSS [133].
2. Inspect the connection for corrosion or backed out terminals. Repair as required.
3. Connect BREAKOUT BOX (Part No. HD-43876) to wire harness [78B], leaving ECM [78A] disconnected. See 1.2 DIAGNOSTIC TOOLS.
4. Using the HARNESS CONNECTOR TEST KIT (Part No. HD-41404-B), test for continuity between breakout box terminal 14 and JSS [133B] terminal 1 (R/W).
5. Is continuity present?
   a. **Yes.** Go to Test 2.
   b. **No.** Repair open on (R/W) wire.

2. JSS 5V Reference Shorted to Ground Test

1. Test for continuity between JSS [133B] terminal 1 (R/W) to ground.
2. Is continuity present?
   a. **Yes.** Repair short to ground on (R/W) wire.
   b. **No.** Go to Test 3.

3. JSS Signal Wire Shorted to Ground Test

1. Test for continuity between breakout box terminal 9 and ground.
2. Is continuity present?
   a. **Yes.** Repair short to ground on (GN/BN) wire.
   b. **No.** Go to Test 4.

4. JSS Signal Wire Open Circuit Test

1. Test for continuity between breakout box terminal 9 and JSS [133B] terminal 2 (GN/BN).
2. Is continuity present?
   a. **Yes.** Replace JSS. See the service manual.
   b. **No.** Repair open on (GN/BN) wire.

DTC P1502

PART NUMBER	TOOL NAME
HD-41404-B	HARNESS CONNECTOR TEST KIT

Table 6-61. DTC P1502 Diagnostic Faults

POSSIBLE CAUSES
JSS malfunction
ECM malfunction
Short to voltage in signal circuit
Open ground
Short to voltage in 5V reference circuit

1. JSS Ground Wire Test

1. Disconnect the JSS [133].
2. Using the HARNESS CONNECTOR TEST KIT (Part No. HD-41404-B), test for continuity between terminal 3 of [133B] and ground.
3. Is continuity present?
   a. **Yes.** Go to Test 2.
   b. **No.** Repair open in (BK/GN) wire.

2. JSS 5V Reference Wire Short to Voltage Test

1. Test for voltage at [133B] terminal 1 (R/W) wire.
2. Is voltage greater than 6V?
   a. **Yes.** Repair short to battery voltage on (R/W).
   b. **No.** Go to Test 3.

3. JSS Signal Wire Short to Voltage Test

1. Test for voltage on [133B] terminal 2.
2. Is voltage greater than 5.5V?
   a. **Yes.** Repair short to battery voltage in (GN/BN) wire.
   b. **No.** Go to Test 4.

4. JSS 5V Reference and Signal Shorted Together Test

1. With IGN OFF, disconnect the ECM [78].
2. Test for continuity between terminals 1 and 2 of [133B].
3. Is continuity present?
   a. **Yes.** Repair short between (R/W) and (GN/BN) wires.
   b. **No.** Replace JSS. See the service manual.

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SIDE STAND DISPLAYED ON SPEEDOMETER

Table 6-62. Side Stand Displayed on Speedometer Diagnostic Faults

POSSIBLE CAUSES
Jiffy stand is down
Jiffy stand out of adjustment

1. Starts then Stalls Test

1. Check for DTCs and diagnose them first.
2. Does the engine start and stall?
   a. **Yes.** See 6.24 STARTS, THEN STALLS.
   b. **No.** Go to Test 2.

2. Neutral Test

1. Verify the transmission is in neutral.
2. Is the neutral indicator on?
   a. **Yes.** Go to Test 3.
   b. **No.** See 4.5 INDICATOR LAMPS.

3. JSS Clearance Test

1. Inspect the JSS and the jiffy stand for correct mounting and clearance to the jiffy stand tab.
2. Is the clearance less than 0.18 in (4.5mm)?
   a. **Yes.** Replace the JSS. See the service manual.
   b. **No.** Install the JSS and jiffy stand correctly. See the service manual.

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DTC P1653, P1654 6.21

DESCRIPTION AND OPERATION

DTCs P1653 and P1654 are associated with terminal 3 from the ECM. This terminal supports a tachometer output that is not used from the factory. If either of these codes appear when checking for DTCs, inspect for any aftermarket components or systems wired into terminal 3 of the ECM.

Table 6-63. Code Description

DTC	DESCRIPTION
P1653	Tachometer low
P1654	Tachometer high

An issue with the wiring or component using this terminal could cause the codes to set. If no wiring is present in this terminal, clear the codes and perform a road test. If the codes return, replace the ECM.

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ENGINE CRANKS, BUT WILL NOT START 6.22

DESCRIPTION AND OPERATION

If the starter will not crank the engine, the problem is not EFI related. Refer to 3.2 STARTING SYSTEM or 5.10 SECURITY SYSTEM.

There may be DTC's associated with this problem. check for DTC's and clear them before proceeding with this test.

NOTE

To set a CKP DTC, a start attempt must last at least 5 seconds.

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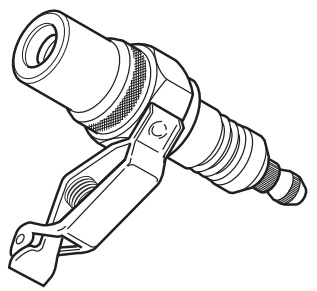

Figure 6-38. Spark Tester

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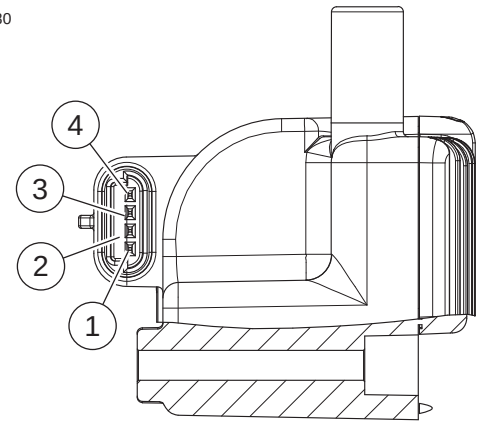

1. **Pin A: power**
2. **Pin B: ion sense**
3. **Pin C: rear coil**
4. **Pin D: front coil**

Figure 6-39. Ignition Coil

Connector Information

For additional information about the connectors in the following diagram(s) and diagnostic procedure(s), including the color of the harness test kit terminal probes, see B.1 CONNECTORS.

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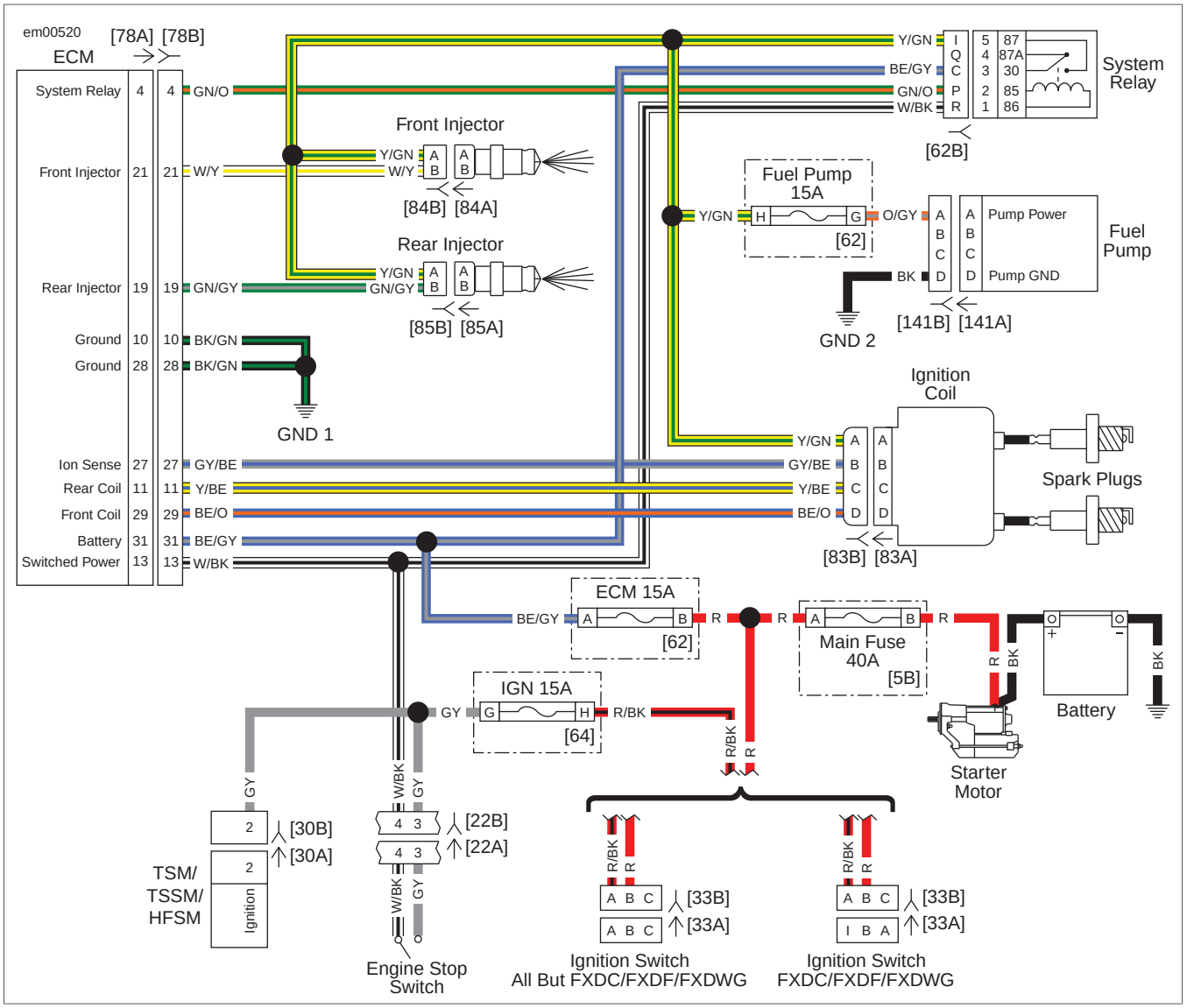

Figure 6-40. Ignition Circuit

ENGINE CRANKS BUT WILL NOT START

PART NUMBER	TOOL NAME
HD-26792	SPARK TESTER

Table 6-64. Engine Cranks But Will Not Start Diagnostic Faults

POSSIBLE CAUSES
ECM malfunction
Battery voltage too low
Ignition system malfunction
Fuel system malfunction
IAC malfunction
No or low compression

1. Preliminary Engine Tests

1. Make sure there is fresh fuel in tank, spark plug wires firmly connected to coil terminals, and battery connections in good condition.
2. Check for DTCs. See 2.1 INITIAL DIAGNOSTICS, Odometer Self-Diagnostics. If DTCs are present, go to the appropriate DTC procedure.
3. Verify battery condition. See 3.1 BATTERY TESTING.
4. Does battery pass tests?
   a. **Yes.** Go to Test 2.
   b. **No.** Charge or replace battery.

2. Check Engine Lamp Test

1. Turn IGN ON and engine stop switch to RUN.

2. Does check engine lamp illuminate for 4 seconds immediately after key ON?
   a. **Yes.** Go to Test 3.
   b. **No.** Go to 6.23 NO ECM POWER.

3. IAC Operation Test

1. Remove the air cleaner.
2. Turn IGN ON.
3. Does IAC function (pintle moving in and out of idle air passage)?
   a. **Yes.** Go to Test 4.
   b. **No.** Refer to 6.12 DTC P0505.

4. Spark Present Test

1. Check spark plug condition and replace if fouled.
2. Using SPARK TESTER (Part No. HD-26792), check spark at both plugs while cranking engine.
3. Is spark present?
   a. **Yes.** Perform compression test, check fuel system, and perform fuel pressure test. See the service manual.
   b. **No.** The spark plugs will not spark if there is low or no compression. If spark is not present, test compression before troubleshooting ignition circuit. Once good compression is confirmed, check condition of ignition coils, coil primary wiring, and spark plug boots. Refer to 6.17 DTC P1351, P1352, P1354, P1355 or 6.10 DTC P0373, P0374.

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NO ECM POWER 6.23

DESCRIPTION AND OPERATION

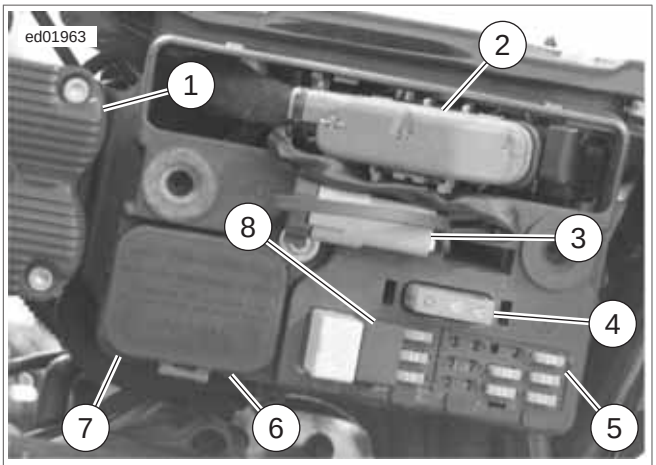
Constant power is supplied to the ECM through terminal 31. The ECM turns on when power is applied to terminal 13 of connector [78]. The ECM goes through an initialization sequence every time power is removed and re-applied to terminal 13. The only visible part of this sequence is the check engine lamp. Upon starting, the check engine lamp will illuminate for 4 seconds and then (if parameters are normal) go out.

If battery power is absent at ECM terminal 31:

- DTCs cannot be cleared. Tool will show them as cleared but will be present next time ignition key is cycled.
- ECM cannot be re-flashed.
- Vehicle will start but IAC pintle will not reset at key OFF. Eventually pintle will be out of position causing performance problems.

NOTE

The IGN ON sequence also activates the idle air control motor. If power from terminal 31 is disrupted (open fuse, etc.) always turn IGN OFF wait 10 seconds then turn IGN ON to reset the motor to the default position.



1. **Ignition coil**
2. **ECM [78]**
3. **DLC [91]**
4. **Main fuse [5]**
5. **Fuse block [64]**
6. **TSM/TSSM/HFSM**
7. **HFSM antenna harness [208]**
8. **Fuse/relay block [62]**

Figure 6-41. Under Left Side Cover

DIGITAL TECHNICIAN HARLEY-DAVIDSON

Connector Information

For additional information about the connectors in the following diagram(s) and diagnostic procedure(s), including the color of the harness test kit terminal probes, see B.1 CONNECTORS.

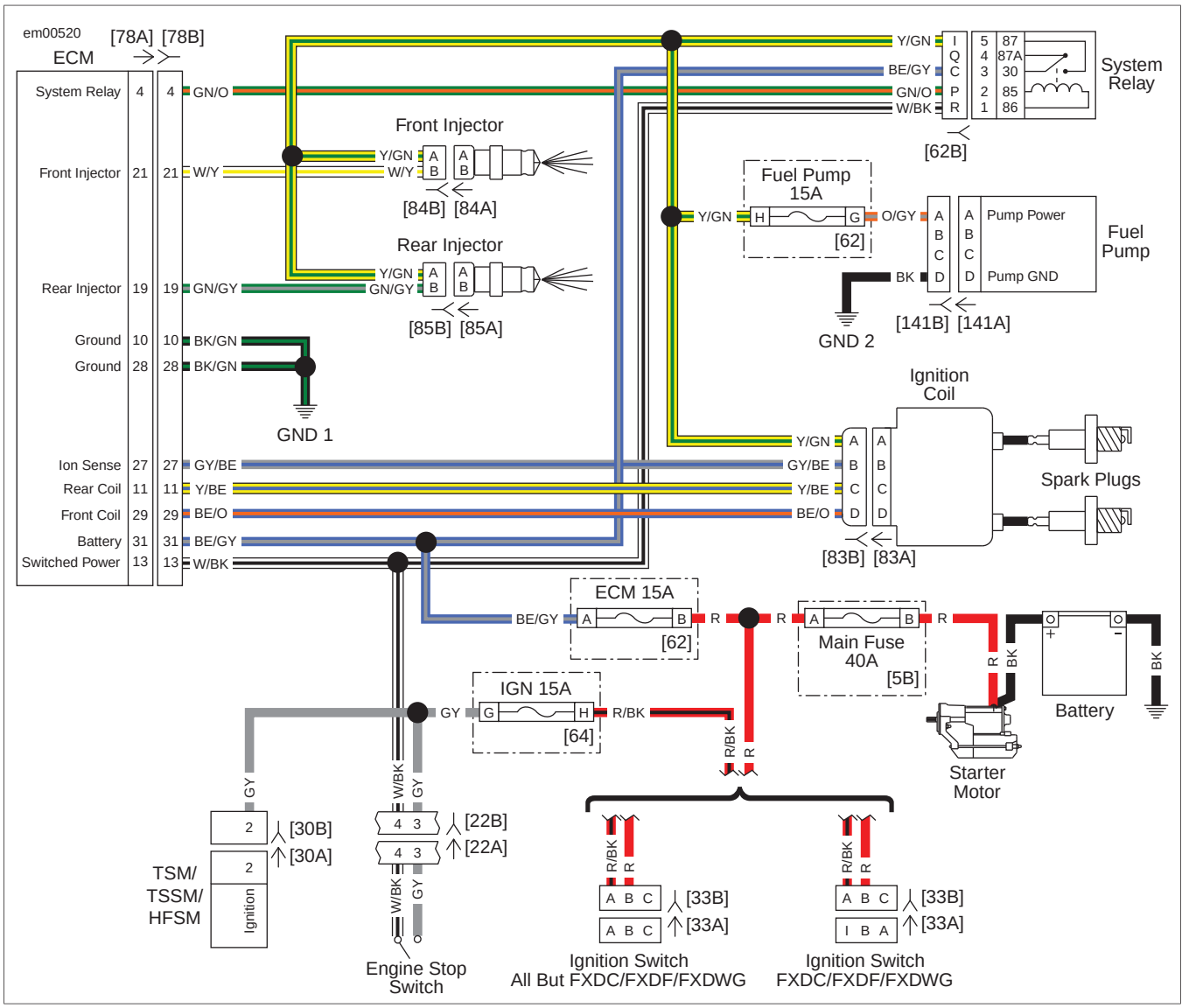


Figure 6-42. Ignition Circuit

NO ECM POWER

PART NUMBER	TOOL NAME
HD-41404-B	HARNESS CONNECTOR TEST KIT
HD-43876	BREAKOUT BOX

Table 6-65. No ECM Power Diagnostic Faults

POSSIBLE CAUSES
Short to ground in ECM power circuit
Open in ECM switched power circuit
Open ECM ground circuit
ECM malfunction
Engine stop switch malfunction

1. ECM Fuse Test

1. Check ECM fuse.
2. Is fuse good?
   a. **Yes.** Go to Test 2.
   b. **No.** Repair short to ground on (BE/GY) wire and replace fuse.

2. IGN Fuse Test

1. Check IGN fuse.
2. Is fuse good?
   a. **Yes.** Go to Test 3.
   b. **No.** Repair short to ground on (GY) or (W/BK) wire and replace IGN fuse.

3. ECM Connector Test

1. With IGN OFF, disconnect ECM [78].
2. Inspect the connection for corrosion or backed out terminals. Repair as required.

3. Connect ECM [78].
4. Turn IGN ON.
5. Does ECM have power?
   a. **Yes.** Problem solved.
   b. **No.** Go to Test 4.

4. ECM Battery Wire Test

1. Connect BREAKOUT BOX (Part No. HD-43876) between wire harness [78B] and ECM [78A]. See 1.2 DIAGNOSTIC TOOLS.
2. Using HARNESS CONNECTOR TEST KIT (Part No. HD-41404-B) and a multimeter, test for battery voltage between breakout box terminal 31 and ground.
3. Is battery voltage present?
   a. **Yes.** Go to Test 5.
   b. **No.** Repair open in (BE/GY) wire.

5. ECM Switched Voltage Test

1. Turn IGN ON and engine stop switch in RUN.
2. Measure voltage between breakout box terminal 13 and ground.
3. Is battery voltage present?
   a. **Yes.** Go to Test 6.
   b. **No.** Repair open (W/BK) wire. If wire is okay, then continue with tests. Go to Test 7.

6. ECM Ground Wires Test

1. Measure voltage between positive battery terminal and breakout box terminals 10 and 28.
2. Is battery voltage present?
   a. **Yes.** Replace ECM. See the service manual.
   b. **No.** Repair open in (BK/GN) wire.

7. Engine Stop Switch Battery Voltage Test

1. Disconnect [22].
2. Turn IGN ON.
3. Measure voltage on [22B] terminal 3 (GY) and ground.
4. Is battery voltage present?
   a. **Yes.** Go to Test 8.
   b. **No.** Repair open wire (GY).

8. Engine Stop Switch Test

1. Turn IGN OFF and engine stop switch in RUN.
2. Measure the resistance between [22A] terminals 3 and 4.
3. Is resistance less than 1.0 Ohm?
   a. **Yes.** Repair open in (W/BK) wire from terminal 4 of [22B] and ECM (78B).
   b. **No.** Repair or replace engine stop switch. See the service manual.

DIGITAL TECHNICIAN II HARLEY-DAVIDSON

STARTS, THEN STALLS 6.24

DESCRIPTION AND OPERATION

The starts, then stalls condition may be created by the fuel system, the idle air control system or an ECM failure. When this condition exists, refer to 2.4 DTC U1300, U1301 OR BUS ER.

There may be DTCs set causing this condition. Solve the problems with the DTCs before performing the tests in this section. The DTCs that may be involved with starts, then stalls are:

- Fuel injectors: DTCs P0261, P0262, P0263, and P0264
- Ignition coils: DTCs P1351, P1352, P1354, and P1355
- IAC actuator: DTC P0505
- Password problem: DTCs P1009 and P1010
- TPS: DTCs P0122 and P0123
- JSS: DTCs P1501, P1502, and P1503
- Neutral switch: DTC P1155
- All modes: DTCs P0603 and P0605

Diagnostic Tips

- The vehicle will stall on HDI models, if the jiffy stand is extended when the transmission is in gear and the clutch is released.
- If serial data is shorted, U1300 and U1301 will automatically set the check engine light.
- DTCs P1009 and P1010 may accompany DTCs U1300 and U1301.
- If this condition is fuel related, perform Fuel Pressure Test. See the service manual.
- If the fuel system passes the pressure test, perform the Fuel System Electrical Test. See 6.25 FUEL SYSTEM ELECTRICAL TEST.

Connector Information

For additional information about the connectors in the following diagram(s) and diagnostic procedure(s), including the color of the harness test kit terminal probes, see B.1 CONNECTORS.

STARTS, THEN STALLS

Table 6-66. Starts, Then Stalls Diagnostic Faults

POSSIBLE CAUSES
Fuel system malfunction
Idle air control system malfunction
Speedometer malfunction
Open serial data circuit
Neutral switch malfunction
TSM/TSSM/HFSM malfunction

1. Throttle Test

1. Will engine start with the throttle partially opened and then stall when closed?
   a. **Yes.** Check IAC for proper operation. If necessary, perform IAC test, DTC P0505.
   b. **No.** Go to Test 2.

2. Jiffy Stand Test

1. Turn IGN OFF.
2. Raise jiffy stand.
3. Turn IGN ON and engine stop switch to RUN.
4. Does speedometer display SidE StAnd?
   a. **Yes.** Inspect JSS for correct mounting and clearance to jiffy stand tab 0.18 in (4.5mm). If sensor is mounted correctly, replace sensor. See the service manual.
   b. **No.** Go to Test 3.

3. Neutral Switch Test

1. Verify neutral switch circuit operation.
2. Is neutral switch circuit operating normally?
   a. **Yes.** Replace TSM/TSSM/HFSM. See the service manual.
   b. **No.** Replace neutral switch. See the service manual.

4. Fuel System Test

1. Perform Fuel Pressure test. See the service manual.
2. Is fuel pressure normal?
   a. **Yes.** If fuel injectors are okay, replace ECM. See the service manual.
   b. **No.** Repair fuel pressure problem. See the service manual.

DIGITAL TECHNICIAN II HARLEY-DAVIDSON

FUEL SYSTEM ELECTRICAL TEST 6.25

DESCRIPTION AND OPERATION

With the IGN ON and the engine stop switch at RUN, the ECM will energize the system relay to complete the circuit to the in-tank fuel pump. It will remain on as long as the engine is cranking or running, and the ECM is receiving ignition reference pulses from the CKP sensor. If there are no reference pulses, the ECM will de-energize the system relay within 2 seconds after ignition is turned on or the engine has stalled, or immediately after the ignition is shut off.

The fuel pump delivers fuel to the injectors. The pressure regulator controls system pressure.

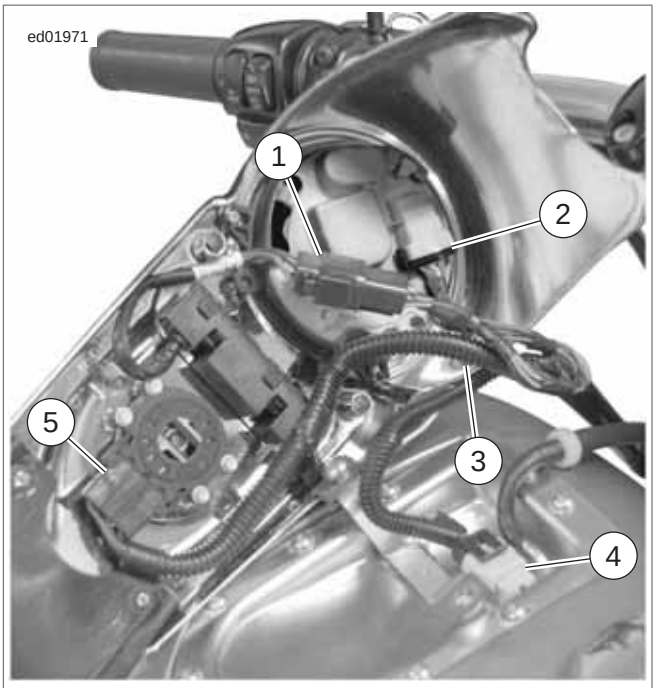
See Figure 6-43. When the engine is stopped, the pump can be turned on by applying battery voltage to terminal 1 and ground to terminal 4 of the fuel pump connector [141B].

Improper fuel system pressure may contribute to the following symptoms:

- Engine cranks, but will not run.
- Engine cuts out (may feel like ignition problems).
- Hesitation, loss of power and poor fuel economy.

NOTE

After turning ignition off, you must wait 10 seconds before turning the ignition back on to get the fuel pump to reprime. This time-out period is necessary for the fuel pump and IAC to reset.



1. **Indicator lamps [21]**
2. **Speedometer [39]**
3. **Trip odometer reset switch**
4. **Fuel pump and sender [141]**
5. **Ignition switch [31]**

Figure 6-43. Under Console (Typical)

Connector Information

For additional information about the connectors in the following diagram(s) and diagnostic procedure(s), including the color of the harness test kit terminal probes, see B.1 CONNECTORS.

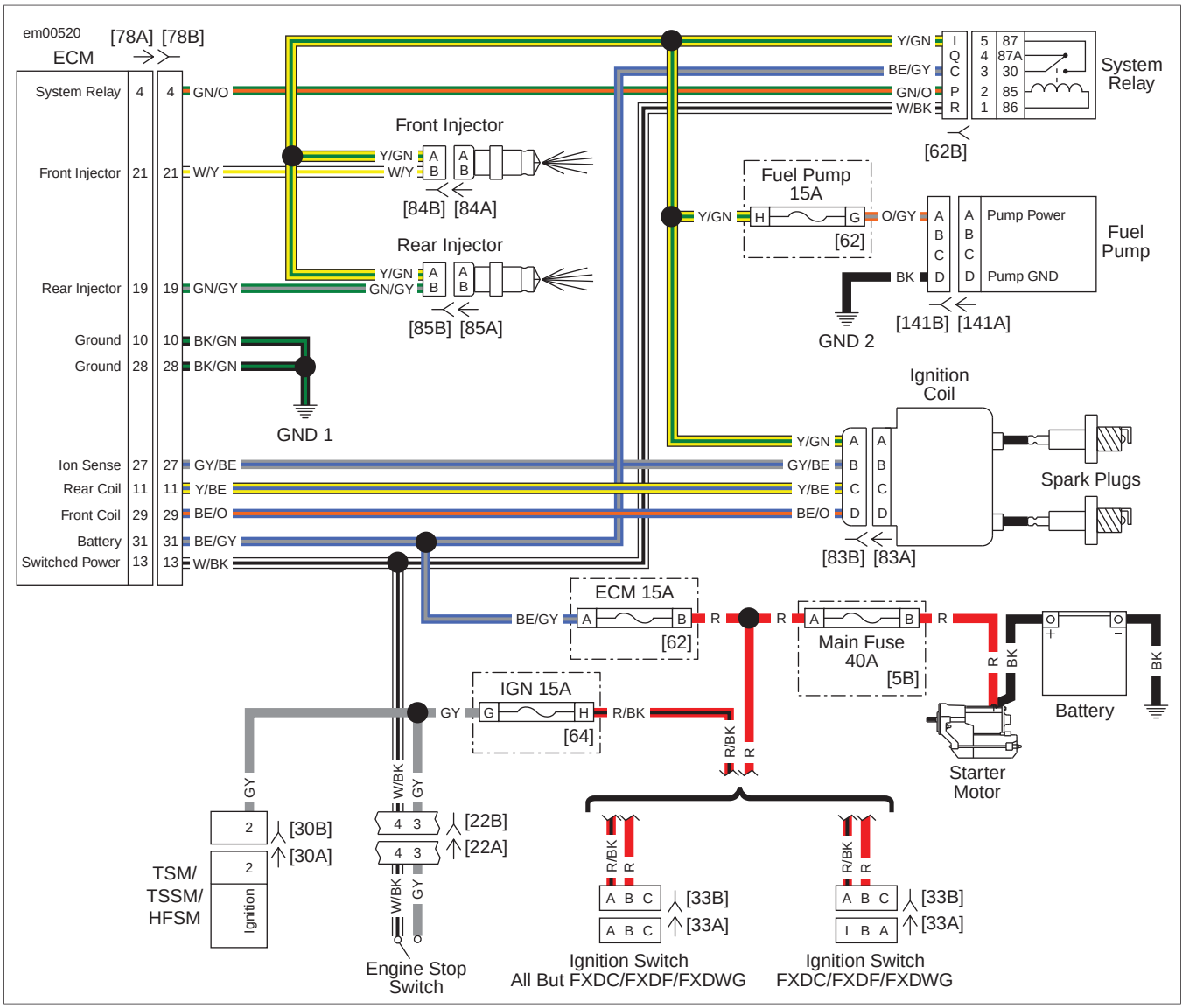


Figure 6-44. Ignition Circuit

FUEL SYSTEM ELECTRICAL TEST

PART NUMBER	TOOL NAME
HD-41404-B	HARNESS CONNECTOR TEST KIT

Table 6-67. Fuel System Electrical Test Diagnostic Faults

POSSIBLE CAUSES
Fuel pump malfunction
Fuel pump electrical system
ECM malfunction
Electrical system malfunction
System relay malfunction
Open ground circuit

1. ECM and Fuel Pump Fuse Test

1. Check ECM and fuel pump fuses.
2. Are fuses good?
   a. **Yes.** Go to Test 2.
   b. **No.** Go to 6.23 NO ECM POWER.

2. Fuel Pump Voltage Test

1. Disconnect fuel pump connector [141].
2. Using HARNESS CONNECTOR TEST KIT (Part No. HD-41404-B) and a multimeter, measure voltage between fuel pump [141B] terminals A and D during the first 2-3 seconds after IGN ON.
3. Is battery voltage present?
   a. **Yes.** Replace fuel pump. See service manual.
   b. **No.** Go to Test 3.

3. Fuel Pump Open Circuit Test

1. Turn IGN OFF.

2. Using HARNESS CONNECTOR TEST KIT (Part No. HD-41404-B) and a multimeter, test for continuity between [141A] terminal A and system relay [62B] terminal I.
3. Is continuity present?
   a. **Yes.** Repair open on (BK) wire to ground.
   b. **No.** Repair open (Y/GN) wire.

4. Fuel Pump Voltage Short to Ground Test

1. Disconnect fuel pump [141].
2. Using HARNESS CONNECTOR TEST KIT (Part No. HD-41404-B) and a multimeter, test for continuity between [141B] terminal A and ground.
3. Is continuity present?
   a. **Yes.** Repair short to ground (Y/GN) and replace fuel pump fuse.
   b. **No.** Test system relay. See 1.3 DIAGNOSTICS AND TROUBLESHOOTING, Relay Diagnostics.

DIGITAL TECHNICIAN® II HARLEY-DAVIDSON®

MISFIRE AT IDLE OR UNDER LOAD 6.26

DESCRIPTION AND OPERATION

Misfire conditions may be caused by:

- Battery condition and connections.
- Fuel system problems. Refer to tables in 2.1 INITIAL DIAGNOSTICS.
- Ignition system faults.

Diagnostic Tips

⚠WARNING

Wipe up spilled fuel and dispose of rags in a suitable manner. An open spark around gasoline could cause a fire or explosion, resulting in death or serious injury. (00518b)

When performing the steps in the diagnostic tests, a known good part can be used to verify whether a suspected part is faulty. The ignition coil does not require full installation to be functional. Verify faulty ignition coil by performing resistance test. See 6.17 DTC P1351, P1352, P1354, P1355.

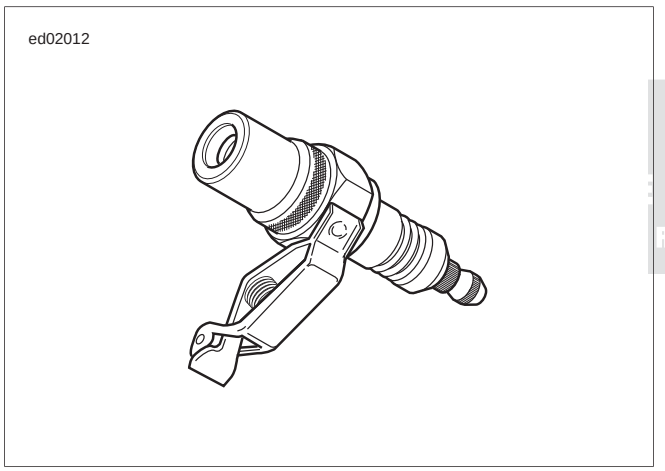


Figure 6-45. Spark Tester

IN-LINE SPARK TESTER

PART NUMBER	TOOL NAME
YA840	SNAP-ON IN-LINE SPARK TESTER

See Figure 6-46. The use of a SNAP-ON IN-LINE SPARK TESTER (Part No. YA840) or equivalent, can help determine whether a problem exists in the ignition or fuel systems. If the test light flashes without interruption on both cylinders during the misfire event, verify spark plug condition and gap, and inspect the fuel system for proper operation. If the test light does not flash, or the flash is interrupted during the misfire event, the problem is ignition related.

1. Turn IGN OFF.
2. Remove front spark plug wire and install SNAP-ON IN-LINE SPARK TESTER (Part No. YA840) between spark plug wire and spark plug.
3. Start engine and inspect tester light. The light will flash on each spark event if power is transmitted to the plug.
4. Install and repeat procedure on rear cylinder.

NOTE

A SNAP-ON IN-LINE SPARK TESTER (Part No. YA840) can also be used in conjunction with a load-able dynamometer to diagnose misfire under load.

Figure 6-46. Inline Spark Tester

Connector Information

For additional information about the connectors in the following diagram(s) and diagnostic procedure(s), including the color of the harness test kit terminal probes, see B.1 CONNECTORS.

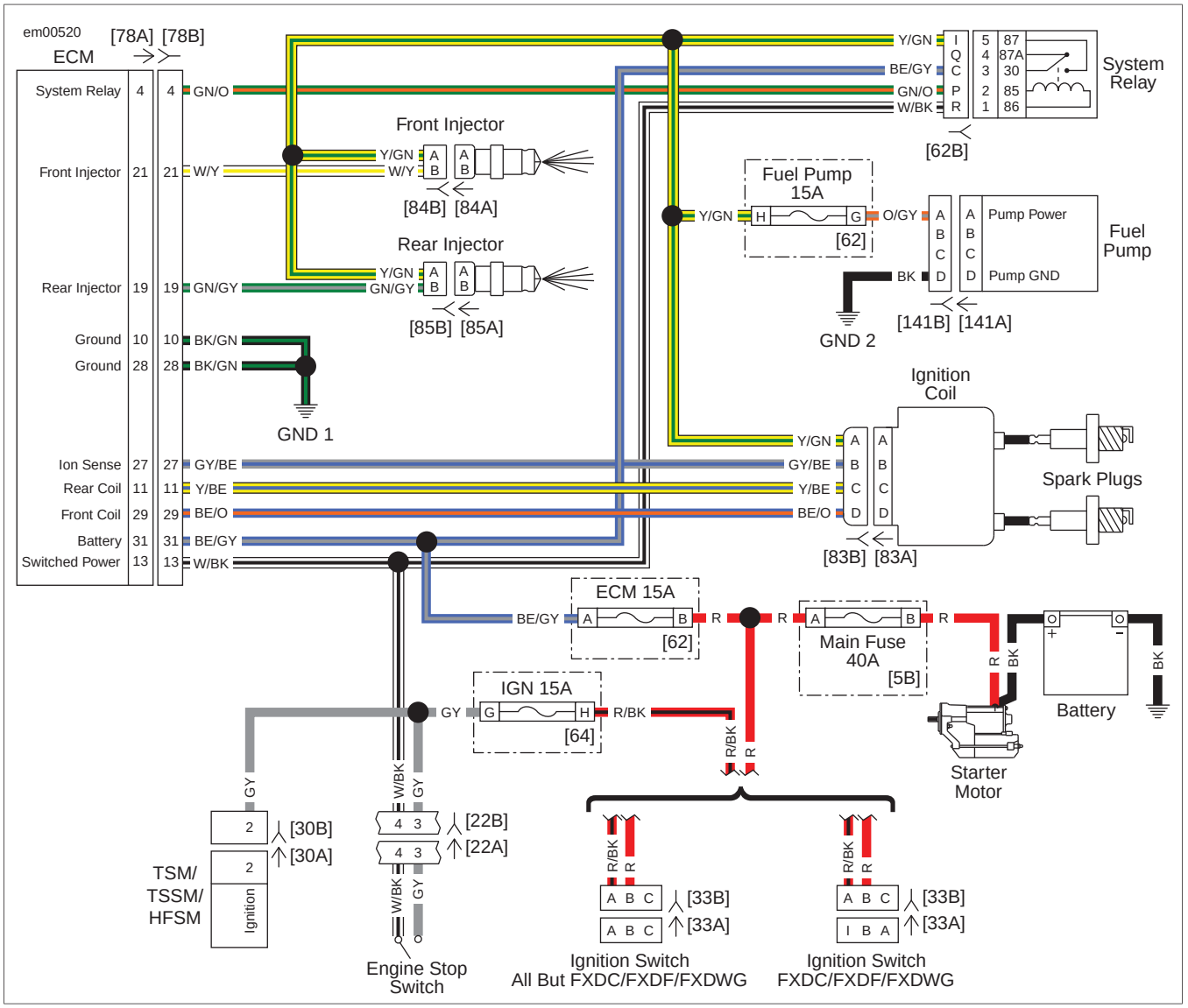


Figure 6-47. Ignition Circuit

MISFIRE AT IDLE OR UNDER LOAD

PART NUMBER	TOOL NAME
HD-26792	SPARK TESTER
HD-41404-B	HARNESS CONNECTOR TEST KIT
HD-43876	BREAKOUT BOX

Table 6-68. Misfire At Idle or Under Load Diagnostic Faults

POSSIBLE CAUSES
ECM malfunction
Ignition system malfunction
Fuel system malfunction
IAC malfunction
Electrical system malfunction

1. Power Ground Continuity Test

1. Connect BREAKOUT BOX (Part No. HD-43876) between wire harness [78B] and ECM [78A]. See 1.2 DIAGNOSTIC TOOLS.
2. Using HARNESS CONNECTOR TEST KIT (Part No. HD-41404-B) and a multimeter, check for continuity between breakout box terminals 10 and then 28, to ground.
3. Is continuity present?
   a. **Yes.** Go to Test 2.
   b. **No.** Repair poor ground on (BK/GN) wire.

2. Spark Test

1. Connect SPARK TESTER (Part No. HD-26792) between front spark plug cable and ground. See 1.2 DIAGNOSTIC TOOLS.
2. Crank engine for a few seconds.

3. Remove tester from front spark plug cable and connect rear spark plug cable and ground.
4. Did spark jump gap on both cables?
   a. **Yes.** Check for faulty, worn, or cracked spark plugs, plug fouling due to mechanical problems, or faulty connection at plug or coils. See the service manual and repair as required.
   b. **No.** Go to Test 3.

3. Spark Plug Wire Test

1. Disconnect the spark plug wires.
2. Measure the resistance of the spark plug wires.
3. Is the front and rear spark plug wire resistance within the specified range? See Table 1-5.
   a. **Yes.** Go to Test 4.
   b. **No.** Replace the out of range spark plug wire. See the service manual.

4. Carbon Tracking Inspection Test

1. Inspect top of ignition coils for carbon tracking.
2. Is carbon tracking present?
   a. **Yes.** Replace ignition coil. See the service manual.
   b. **No.** Switch ignition coil with known good unit and perform Test 2. If spark jumps gap, replace ignition coil. See the service manual. If not, then continue with tests. Go to Test 5.

5. Ignition Coil Primary Wire Continuity Test

1. Turn IGN OFF.
2. Remove system relay and disconnect [83].
3. Measure resistance between [62B] socket terminal I and [83B] terminal A. Wiggle connectors while measuring.
4. Is resistance continuously less than 0.5 Ohms?
   a. **Yes.** Go to Test 6.
   b. **No.** Repair intermittent on (Y/GN) wire.

6. Battery to System Relay Voltage Drop Test

1. Reconnect ignition coil and install system relay.
2. Turn IGN ON, start engine.
3. With engine running, measure voltage drop between battery (+) and system relay [62B] socket terminal I (underside of fuse/relay block). See 1.3 DIAGNOSTICS AND TROUBLESHOOTING, Voltage Drop.
4. Is voltage drop less than 1.0V?
   a. **Yes.** Problem is fuel related. Recheck symptoms.
   b. **No.** Go to Test 7.

7. Battery to System Relay Contact Voltage Drop Test

1. With engine running, measure voltage drop between battery (+) and system relay [62B] socket terminal C (underside of fuse/relay block).
2. Is voltage drop less than 1.0V?
   a. **Yes.** Replace system relay. See the service manual.
   b. **No.** Go to Test 8.

8. Battery to ECM Fuse Voltage Drop Test

1. With engine running, measure voltage drop between battery (+) and [64B] socket terminal A.
2. Is voltage drop less than 1.0V?
   a. **Yes.** Repair (BE/GY) wire or connections.
   b. **No.** Go to Test 9.

9. Battery to Fuse Block Voltage Drop Test

1. With engine running, measure voltage drop between battery (+) and [64B] socket terminal B.
2. Is voltage drop less than 1.0V?
   a. **Yes.** Repair ECM fuse connections or replace ECM fuse.
   b. **No.** Go to Test 10.

10. Battery to Main Fuse Block Voltage Drop Test

1. With engine running, measure voltage drop between battery (+) and main fuse [5B] terminal B.
2. Is voltage drop less than 1.0V?
   a. **Yes.** Repair (R) wire.
   b. **No.** Go to Test 11.

11. Battery to Main Fuse Block Voltage Drop Test

1. With engine running, measure voltage drop between battery (+) and main fuse [5B] terminal A.
2. Is voltage drop less than 1.0V?
   a. **Yes.** Repair main fuse connections or replace main fuse.
   b. **No.** Repair (R) wire between battery and main fuse [5B] terminal A.

DIGITAL TECHNICIAN II HARLEY-DAVIDSON

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DIGITAL TECHNICIAN® II
HARLEY-DAVIDSON®

NOTES

AMP MULTILOCK CONNECTORS A.1

AMP MULTILOCK CONNECTOR REPAIR

PART NUMBER	TOOL NAME
HD-41609	AMP MULTILOCK CRIMPER
SNAP-ON TT600-3	SNAP-ON PICK

General

AMP Multilock connectors are found between wire harnesses and component wiring and may be either floating or anchored to the frame with attachment clips.

See Figure A-1. Attachment clips (1) on the pin housings are fitted to T-studs on the motorcycle frame. The T-studs identify OE connector locations. To maintain serviceability, always return connectors to OE locations after service.

Obtain the necessary tools to repair the connector and terminals.

NOTE

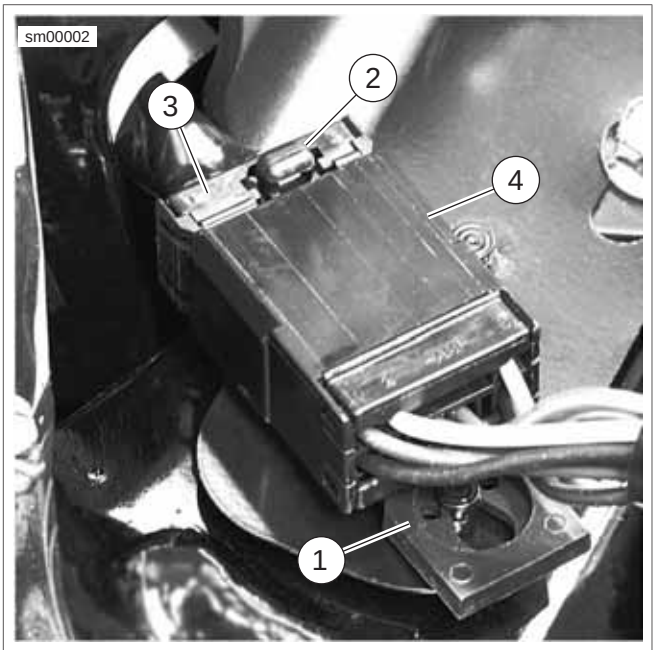
For terminal crimping use the AMP MULTILOCK CRIMPER (Part No. HD-41609).

Separating Pin and Socket Housings

1. If necessary, slide connector attachment clip T-stud to the large end of the opening.
2. See Figure A-1. Depress the release button (2) on the socket terminal side of the connector and pull the socket housing (3) out of the pin housing (4).

Mating Pin and Socket Housings

1. Hold the housings to match wire color to wire color.
2. Insert the socket housing into the pin housing until it snaps in place.
3. If OE location is a T-stud, fit large opening end of attachment clip over T-stud and slide connector to engage T-stud to small end of opening.



1. **Attachment clip**
2. **Release button**
3. **Socket housing**
4. **Pin housing**

Figure A-1. AMP Multilock Connector

Removing Terminals from Housing

1. See Figure A-2. Bend back the latch (1) to free one end of secondary lock (2) then repeat on the opposite end. Hinge the secondary lock outward.
2. Look in the terminal side of the connector (opposite the secondary lock) and note the cavity next to each terminal.
3. Insert a pick or pin into the terminal cavity until it stops.

NOTE

If socket/pin terminal tool is not available, a push pin/safety pin or a SNAP-ON PICK (Part No. SNAP-ON TT600-3) may be used.

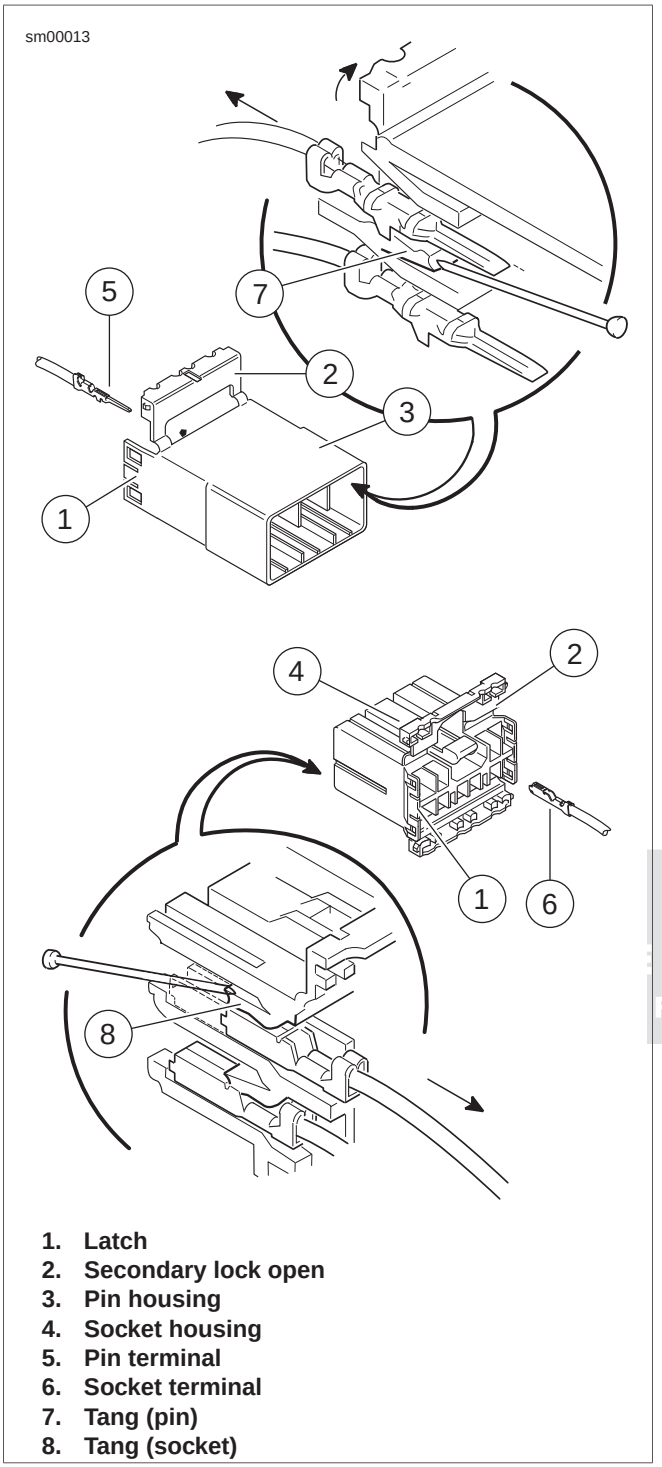
4. Press the tang in the housing to release the terminal.
   a. **Socket:** Lift the socket tang (8) up.
   b. **Pin:** Press the pin tang (7) down.

NOTE

A "click" is heard if the tang is released.

5. Gently tug on wire to pull wire and terminal from cavity.

DIGITAL TECHNICIAN II HARLEY-DAVIDSON



1. **Latch**
2. **Secondary lock open**
3. **Pin housing**
4. **Socket housing**
5. **Pin terminal**
6. **Socket terminal**
7. **Tang (pin)**
8. **Tang (socket)**

Figure A-2. AMP Multilock Connector: Socket and Pin Housings

Inserting Terminals into Housing

NOTE

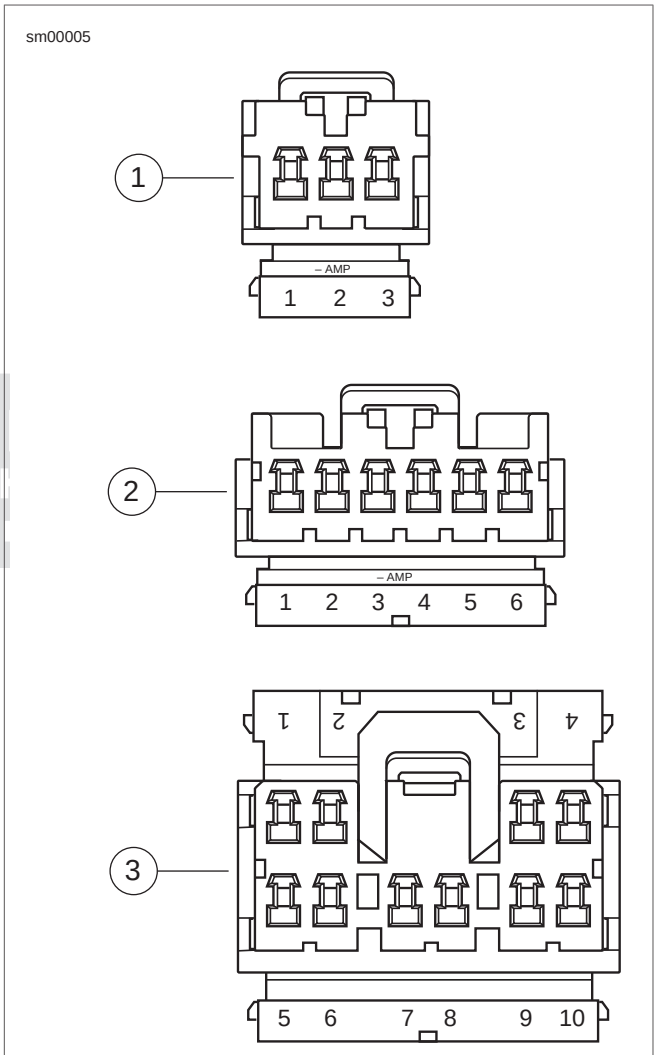
See Figure A-3. Cavity numbers are stamped into the secondary locks of both the socket and pin housings. Match the wire color to the cavity number found on the wiring diagram.

1. Hold the terminal so the catch faces the tang in the chamber. Insert the terminal into its numbered cavity until it snaps in place.

NOTES

- *Up and down can be determined by the position of the release button, the button is the top of the connector.*
- *On the pin side of the connector, tangs are positioned at the bottom of each cavity, so the slot in the pin terminal (on the side opposite the crimp tails) must face downward.*
- *On the socket side, tangs are at the top of each cavity, so the socket terminal slot (on the same side as the crimp tails) must face upward.*

2. Gently tug on wire end to verify that the terminal is locked in place.
3. Rotate the hinged secondary lock inward until tabs fully engage latches on both sides of connector.



1. **3-place housing**
2. **6-place housing**
3. **10-place housing**

Figure A-3. AMP Multilock Connector: Cavity Numbers on Secondary Locks (Socket Housings Shown)

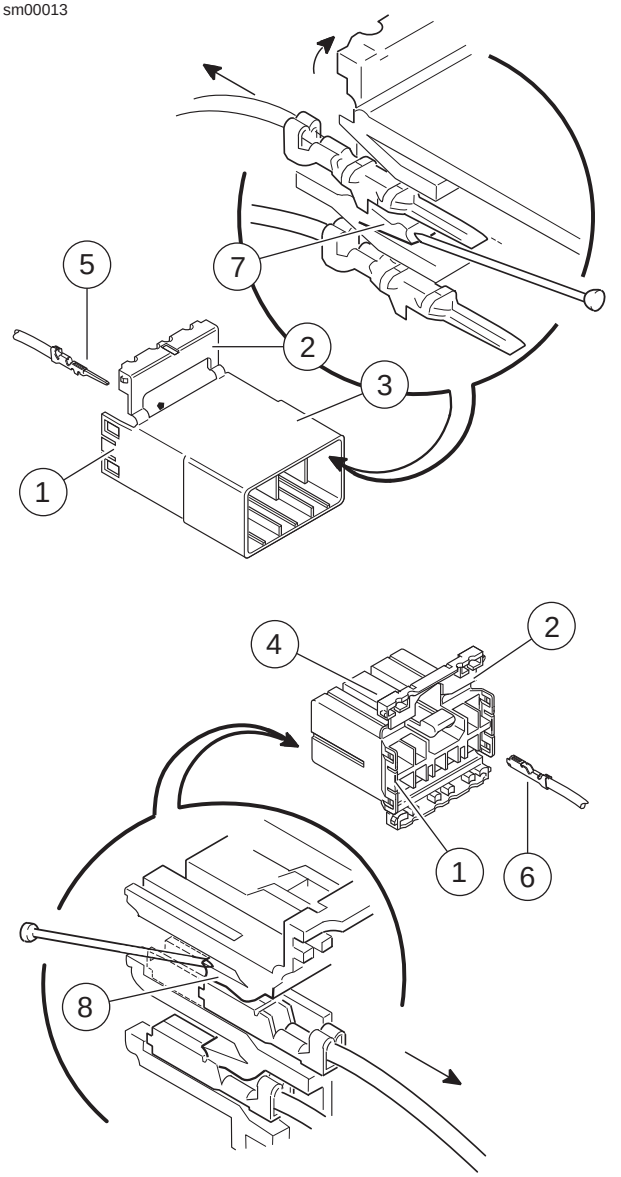
Preparing Wire Leads for Crimping

1. Strip 5/32 in. (4.0 mm) of insulation from the wire lead.

2. See Figure A-2 and Figure A-5. Select the pin/socket terminals from the parts catalog and identify the insulation crimp tails (1) and the wire crimp tails (2) and the groove for the crimp tool locking bar (3).
3. Identify the wire lead gauge and the corresponding crimper tool and nesting die. Refer to Table A-1.

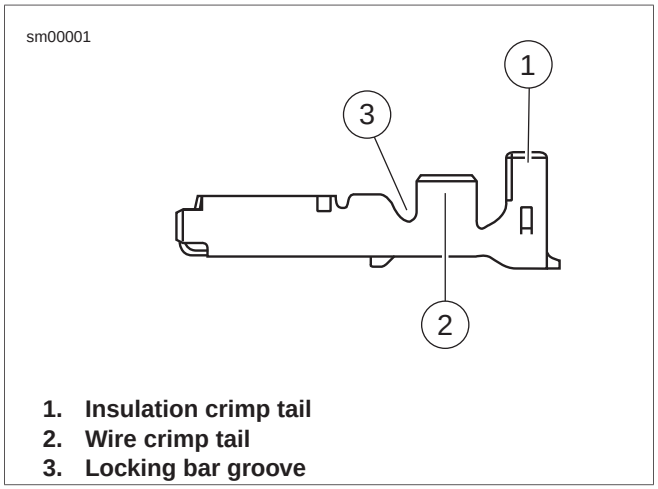
Table A-1. AMP Multilock Connector: Crimp Tool Wire Gauge/Nest

WIRE GAUGE	NEST
20	Front
16	Middle
18	Rear



1. **Latch**
2. **Secondary lock open**
3. **Pin housing**
4. **Socket housing**
5. **Pin terminal**
6. **Socket terminal**
7. **Tang (pin)**
8. **Tang (socket)**

Figure A-4. AMP Multilock Connector: Socket and Pin Housings



1. **Insulation crimp tail**
2. **Wire crimp tail**
3. **Locking bar groove**

Figure A-5. AMP Multilock Connector: Socket Terminal

Crimping Terminals to Leads

NOTE

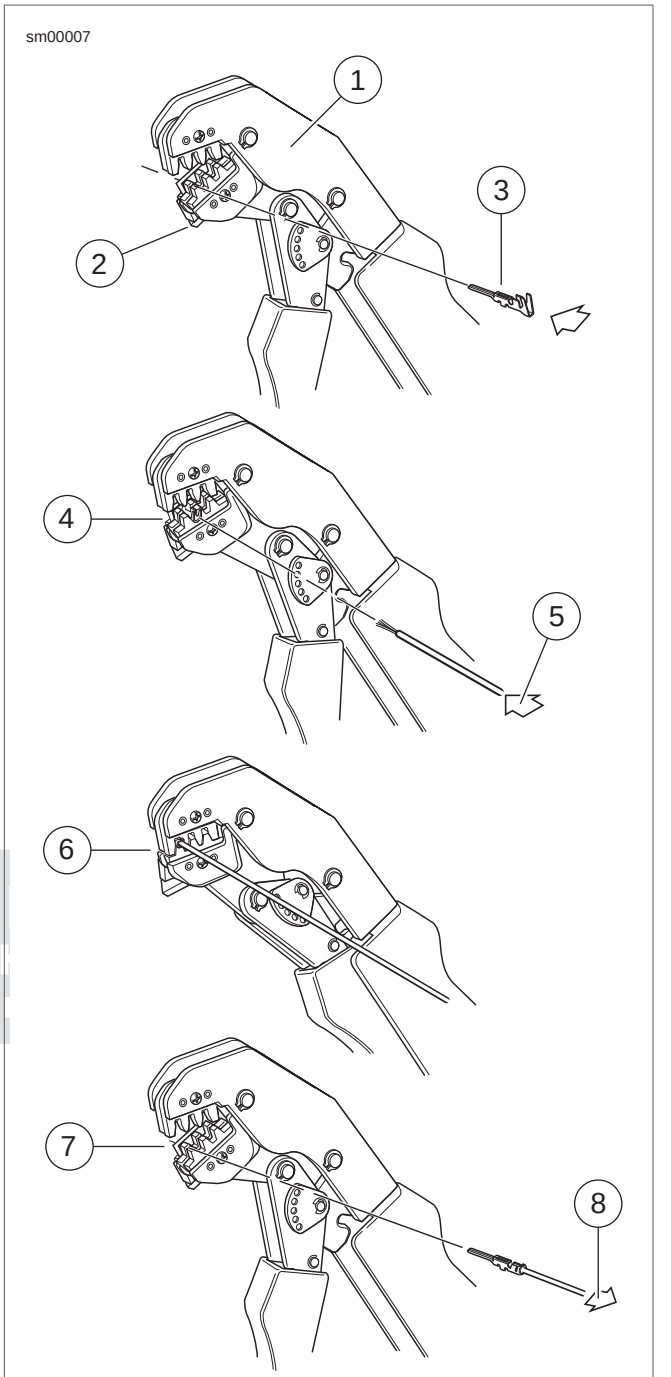
Crimping with an Amp Multilock tool is a one step operation. One squeeze crimps both the wire core and the insulation tails.

1. See Figure A-6. Squeeze the handles to cycle the AMP MULTILOCK CRIMPER (Part No. HD-41609) to the fully open position (1).
2. Raise locking bar by pushing up on bottom flange (2).

NOTE

See Figure A-2 and Figure A-5. Hold the terminal with the insulation crimp tail (1) facing up. The tool will hold the terminal by the locking bar groove (3) and crimp the wire crimp tail (2) around the bare wire of the stripped lead and the insulation crimp tail around the insulation.

3. See Figure A-6. With the insulation crimp tail facing upward, insert terminal (pin or socket) (3) through the locking bar, so that the closed side of the terminal rests on the nest of the crimp tool.
4. Release locking bar to lock position of contact (4). When correctly positioned, the locking bar fits snugly in the space at the front of the core crimp tails.
5. Insert stripped end of lead (5) until ends make contact with locking bar.
6. Verify that wire is positioned so that wire crimp tails squeeze bare wire strands, while insulation crimp tails fold over the wire lead insulation.
7. Squeeze handle of crimp tool until tightly closed. Tool automatically opens when the crimping sequence is complete.
8. Raise up locking bar (7) and remove crimped terminal.

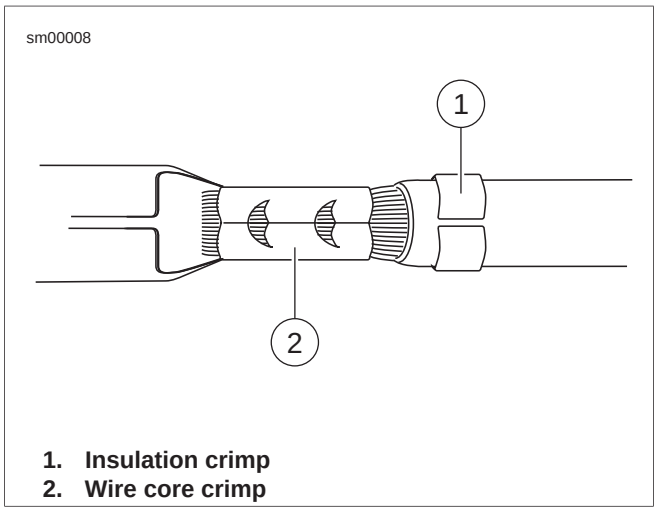


1. **Open position**
2. **Locking bar flange**
3. **Insert contact**
4. **Release locking bar**
5. **Insert lead**
6. **Squeeze**
7. **Raise locking bar**
8. **Remove crimped terminal**

Figure A-6. AMP Multilock Connector: Terminal Crimping Procedure

Inspecting Crimped Terminals

See Figure A-7. Inspect the wire core crimp (2) and insulation crimp (1). Distortion should be minimal.



1. **Insulation crimp**
2. **Wire core crimp**

Figure A-7. AMP Multilock Connector: Terminal Crimp

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DELPHI CONNECTORS A.2

DELPHI CONNECTOR REPAIR

General

Delphi connectors are embossed with the brand name, Delphi, on the housing latch.

Separating Pin and Socket Housings

See Figure A-8. Bend back the external latch(es) slightly and separate pin and socket halves of connector.

Mating Pin and Socket Housings

Push pin and socket halves of connector together until external latch(es) engage.

Removing Socket Terminals

NOTE

Although the parts of the different Delphi connectors vary in appearance, the instructions which follow will work for all.

1. See Figure A-9. If present, free one side of wire lock (1) from ear on wire end of socket housing, then release the other side. Release wires from channels in wire lock and remove from socket housing.
2. Use a fingernail to pry colored terminal lock (2) loose and then remove from mating end of socket housing.
3. Using a thin flat blade, like the unsharpened edge of a hobby knife, gently pry tang (3) outward away from terminal, and then tug on wire to back terminal out wire end of chamber. Do not pull on wire until tang is released or terminal will be difficult to remove.

Figure A-8. Delphi Connector: Socket Housing Latch

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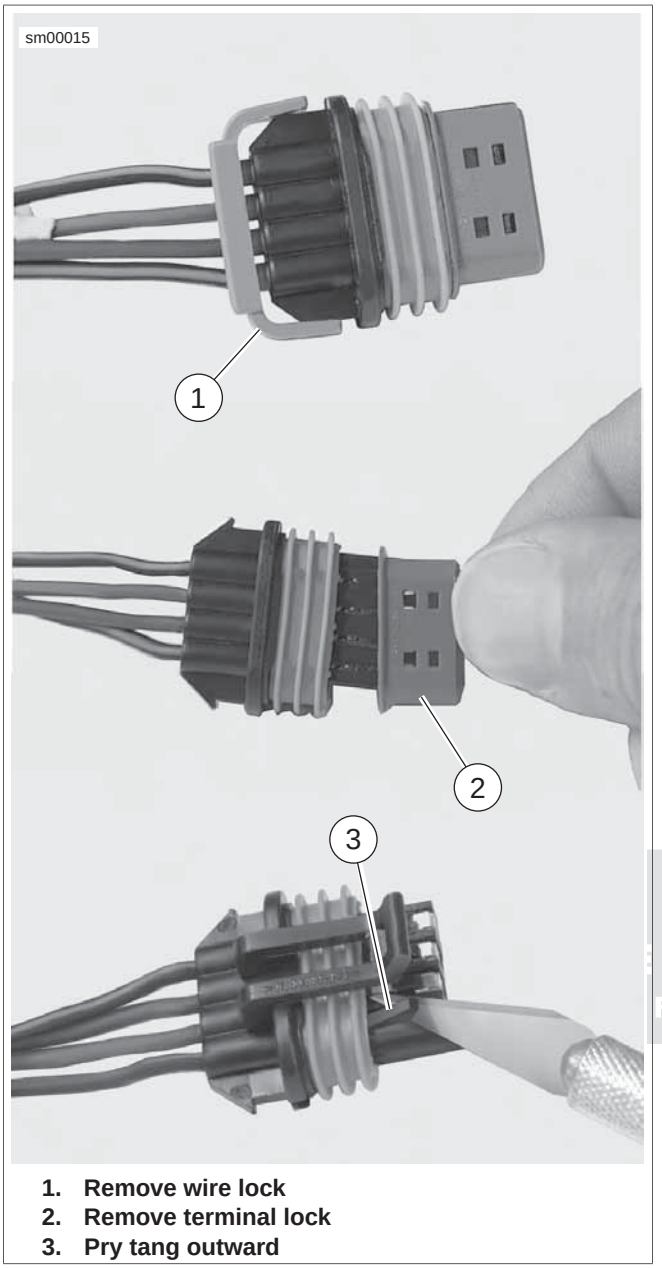
Installing Socket Terminals

NOTE

For wire location purposes, alpha or numeric characters are stamped into the wire end of each socket housing.

1. Gently push tang on socket housing inward toward chamber. With the open side of the terminal facing the tang, push terminal into chamber at wire end of socket housing.
2. Gently tug on wire to verify that terminal is locked and will not back out of chamber. If necessary, use fingernail to push tang into engagement with terminal.
3. Install colored terminal lock onto mating end of socket housing.
4. If present, seat wires in separate channels of wire lock and then push channels **inside** chambers at wire end of socket housing. Fully installed, slot on each side of wire lock engages ear on socket housing.



1. **Remove wire lock**
2. **Remove terminal lock**
3. **Pry tang outward**

Figure A-9. Delphi Connector: Removing Socket Terminals

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DEUTSCH 1-PLACE ELECTRICAL CONNECTORS A.3

DEUTSCH 1-PLACE CONNECTOR REPAIR

Separating Pin and Socket Housings

Depress external latch and separate the pin and socket housings of the Deutsch one place connector found on voltage regulators.

Mating Pin and Socket Housings

Orient the housings so the latch faces the catch and push the housings together until it clicks.

Removing Socket Terminals

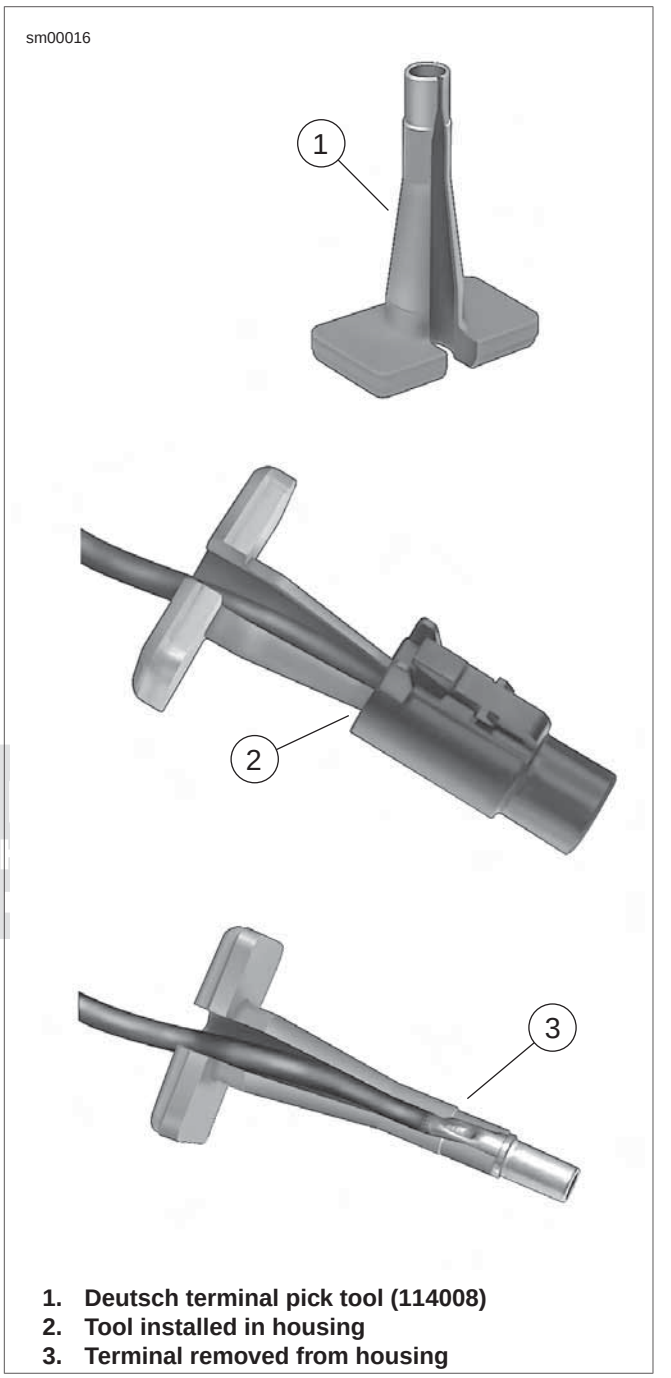
NOTE

Rough handling or careless storage can result in tool damage. Exercise care to avoid cracking or breaking the thin plastic construction.

1. Pull rear wire seal from back of housing and slide down voltage regulator cable to move out of the way.
2. See Figure A-10. Using terminal pick tool (Deutsch® 114008) (1), install tool onto voltage regulator cable so that the tapered end is in the wire end of the housing (2).
3. Push tool into wire end of housing until it bottoms. Gently tug on housing to pull from terminal (3).
4. Remove tool from voltage regulator cable.

Installing Socket Terminals

1. Insert terminal into wire end of housing until it "clicks" in place. Verify that terminal will not back out of housing. A slight tug on the voltage regulator cable will confirm that it is properly locked in place.
2. Fit rear wire seal into back of housing.



1. **Deutsch terminal pick tool (114008)**
2. **Tool installed in housing**
3. **Terminal removed from housing**

Figure A-10. Deutsch 1-Place Connector: Remove Socket/Pin Housing

DEUSCH ELECTRICAL CONNECTORS A.4

DEUTSCH CONNECTOR REPAIR

PART NUMBER	TOOL NAME
HD-41475	DEUTSCH CONNECTOR SERVICE KIT
HD-41475-100	FLAT BLADE L-HOOK

General

Deutsch connectors are colored coded for location purposes. Those connectors associated with **left** side accessories, such as the front and rear **left** turn signals, are **gray**. All other connectors, including those associated with right side accessories, are **black**.

NOTE

A DEUTSCH CONNECTOR SERVICE KIT (Part No. HD-41475) contains a selection of wire seals, internal seals, seal plugs, secondary locking wedges, attachment clips and socket/pin terminals. Also included is a compartmented storage box, carrying case and a FLAT BLADE L-HOOK (Part No. HD-41475-100) is used for the removal of all types of locking wedges.

Separating Pin and Socket Housings

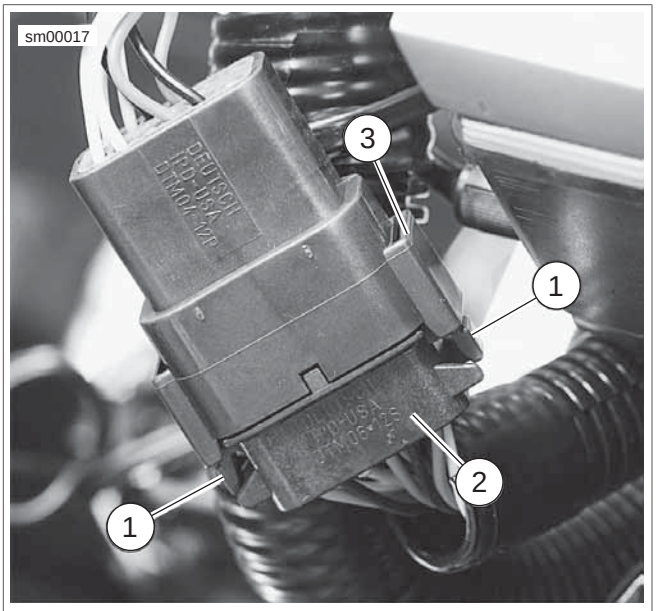
See Figure A-10. To separate the connector halves, depress the external latch(es) (1) on the socket housing (2) while rocking the pin (3) and socket housings.

NOTES

- *Generally, the socket housing is found on the accessory side, while the pin housing is plumbed to the wiring harness.*
- *Two-, three-, four- and six-place Deutsch connectors have one latch on the connector.*
- *Eight- and twelve-place connectors have a latch on each side. Simultaneously press both latches to separate the connector.*

Mating Pin and Socket Housings

1. Align the connectors to match the wire lead colors.
   a. **For One External Latch:** Two-, three-, four- and six-place Deutsch connectors have one external latch on the socket half of the connector. To fit the halves of the connector together, the latch on the socket side must be aligned with the latch cover on the pin side.
   b. **For Two External Latches:** (8-place and 12-place) Align the tabs on the socket housing with the grooves on the pin housing.
2. Insert socket housing into pin housing until it snaps or clicks into place.
   For Two External Latches: (8-place and 12-place) If latches do not click (latch), press on one side of the connector until that latch engages, then press on the opposite side to engage the other latch.
3. If necessary, fit the attachment clip to the pin housing.
4. Place large end of slot on attachment clip over T-stud on frame. Push assembly forward to engage small end of slot.



1. **External latch**
2. **Socket housing**
3. **Pin housing**

Figure A-11. Deutsch Connector

Removing Socket Terminals

1. See Figure A-12. Insert a small screwdriver between the socket housing and locking wedge in-line with the groove (in-line with the pin holes if the groove is absent). Turn the screwdriver 90 degrees to pop the wedge up and remove the secondary locking wedge.
2. See Figure A-15. Use a pick or small screwdriver to depress terminal latches inside socket housing and back out sockets through holes in rear wire seal.

NOTE

*If wire leads require **new** terminals, see the instructions for crimping terminals.*

Installing Socket Terminals

1. Match wire lead color to connector cavity.
2. See Figure A-14. Fit rear wire seal (1) into back of socket housing (2), if removed.
3. Grasp wire lead (3) approximately 1.0 in. (25.4 mm) behind the socket terminal. Gently push socket through hole in wire seal into its chambers until it "clicks" in place.
4. A tug on the wire will confirm that it is properly locked in place.

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NOTE

Seal plugs (6) are installed through the wire seals of unused chambers. If removed, seal plugs must be replaced to seal the connector.

5. Install internal seal (4) on lip of socket housing, if removed.
6. Insert tapered end of secondary locking wedge (5) into socket housing and press down until it snaps in place. The wedge fits into the center groove within the socket housing and holds the terminal latches tightly closed.

NOTES

- *See Figure A-13. While rectangular wedges do not require a special orientation, the conical secondary locking wedge of the 3-place connector must be installed with the arrow (1) pointing toward the external latch.*
- *If the secondary locking wedge does not slide into the installed position easily, verify that all terminals are fully installed in the socket housing. The lock indicates when terminals are not properly installed by not entering its fully installed position.*

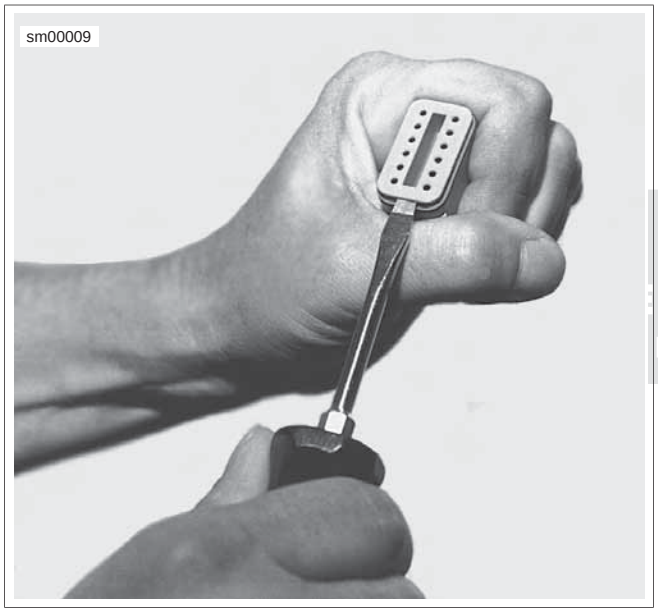
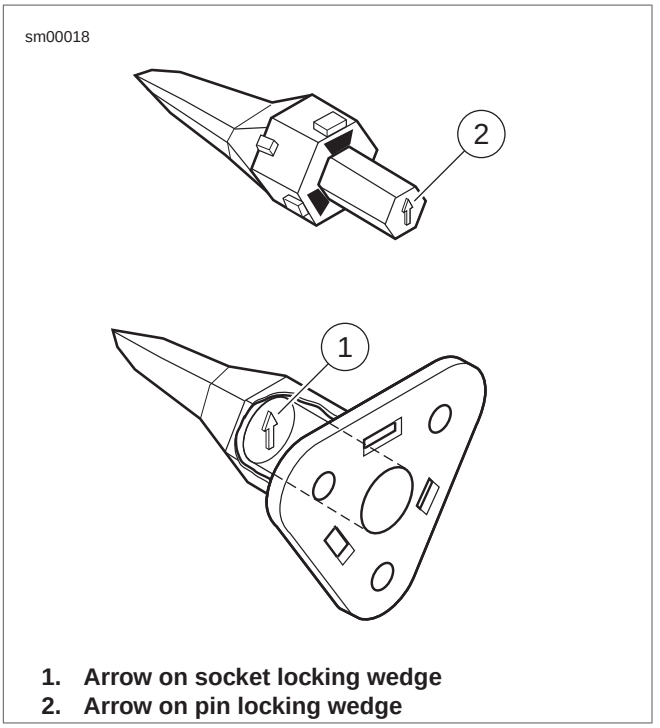


Figure A-12. Deutsch Connector: Remove Secondary Locking Wedge



1. Arrow on socket locking wedge
2. Arrow on pin locking wedge

Figure A-13. Deutsch Connector: 3-Place Locking Wedges

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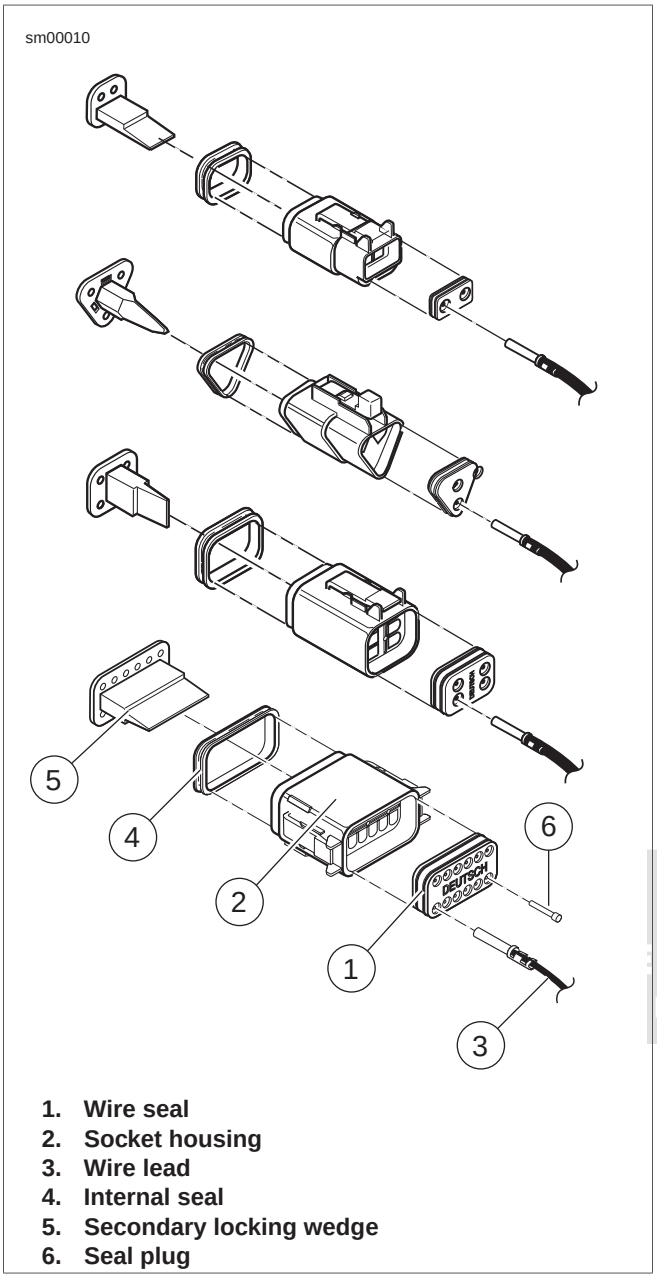


1. **Wire seal**
2. **Socket housing**
3. **Wire lead**
4. **Internal seal**
5. **Secondary locking wedge**
6. **Seal plug**

Figure A-14. Deutsch Connector: 2, 3, 4 and 12-Place Socket Housings

Removing Pin Terminals

1. Use the hooked end of a stiff piece of mechanics wire, a needle nose pliers or the FLAT BLADE L-HOOK (Part No. HD-41475-100) to remove the secondary locking wedge.
2. Gently depress terminal latches inside pin housing and back out pins through holes in wire seal.

NOTES

- *If wire leads require **new** terminals, see the instructions for crimping terminals.*
- *If it should become necessary to replace a pin or socket housing, please note that the 8-place and 12-place gray and black connectors are not interchangeable. Since location of the alignment tabs differ between the black and gray connectors, plugs or receptacles must be replaced by those of the same color.*
- *When replacing both socket and pin housings, then the black may be substituted for the gray, and vice versa. The socket and pin housings of all other connectors are interchangeable, that is, the black may be mated with the gray, since the alignment tabs are absent and the orientation of the external latch is the same.*

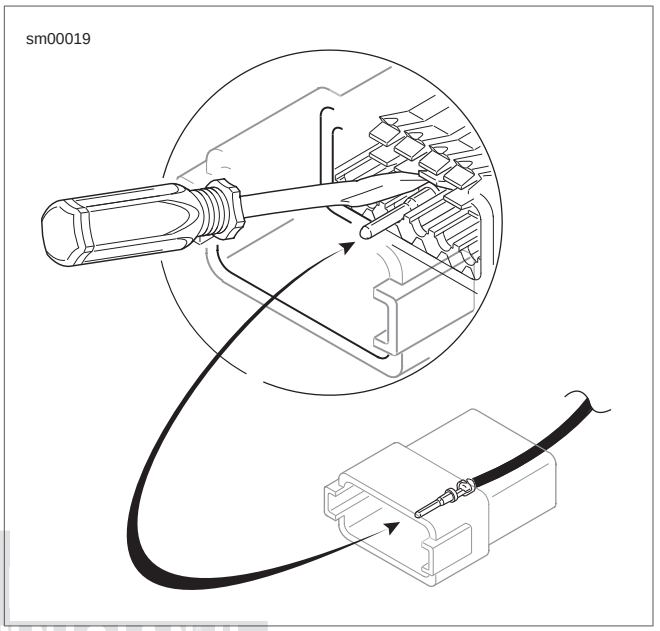


Figure A-15. Deutsch Connector: Depress Terminal Latch and Back Out Pin

Installing Pin Terminals

1. See Figure A-16. Fit wire seal (1) into back of pin housing (2).
2. Grasp wire lead approximately 1.0 in. (25.4 mm) behind the pin terminal (3). Gently push pin through holes in wire seal into its respective numbered chamber until it "clicks" in place.

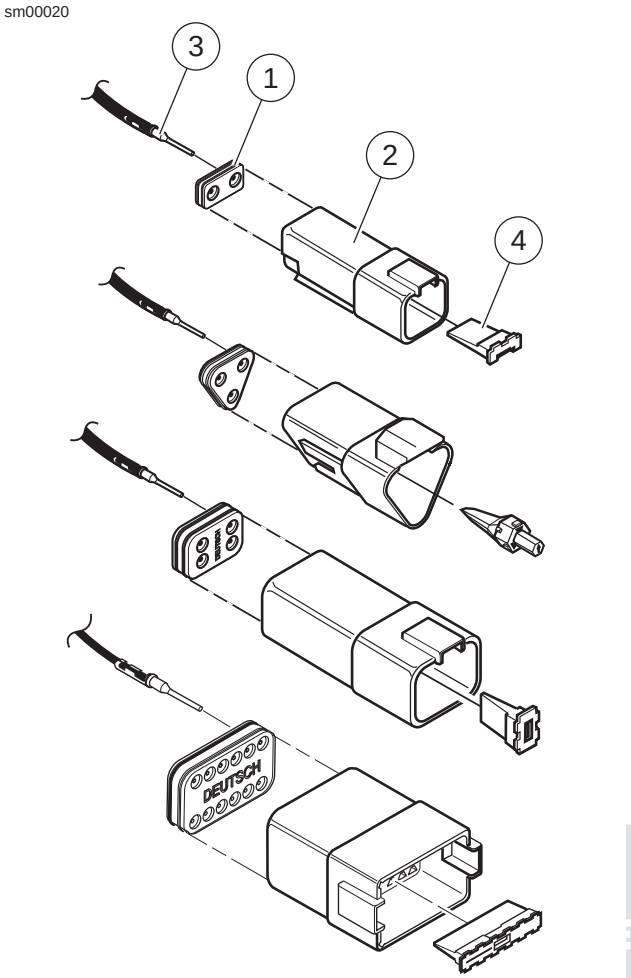
NOTE

A tug on the wire lead will confirm that a pin is locked in place.

3. Insert tapered end of secondary locking wedge (4) into pin housing and press down until it snaps in place.

NOTES

- *The wedge fits in the center groove of the pin housing and holds the terminal latches tightly closed.*
- *See Figure A-13. While rectangular wedges do not require a special orientation, the conical secondary locking wedge of the 3-place connector must be installed with the arrow (2) pointing toward the external latch.*
- *If the secondary locking wedge does not slide into the installed position easily, verify that all terminals are fully installed in the pin housing. The lock indicates when terminals are not properly installed by not entering its fully installed position.*



1. **Wire seal**
2. **Pin housing**
3. **Pin terminal**
4. **Locking wedge**

Figure A-16. Deutsch Connector: 2, 3, 4 and 12-Place Pin Housings

Crimping Terminals

Identify which of the types of Deutsch terminals are used with the connector and follow the corresponding crimping instructions. Refer to Table A-2.

Table A-2. Deutsch Connector: Terminal Crimping Instructions

TYPE	CRIMPING INSTRUCTIONS
Standard (with crimp tails)	A.5 DEUTSCH STANDARD TERMINALS
Mini Terminal (solid barrel)	A.7 DEUTSCH SOLID BARREL TERMINALS
Mini Terminal (with crimp tails)	A.6 DEUTSCH MINI-TERMINAL CRIMPS

DEUTSCH STANDARD TERMINALS A.5

DEUTSCH STANDARD TERMINAL CRIMPS

PART NUMBER	TOOL NAME
HD-39965-A	DEUTSCH TERMINAL CRIMP TOOL

Preparing Wire Leads for Crimping

1. Use a shop gauge to determine gauge of wire lead.
2. Strip lead removing 5/32 in. (4.0 mm) of insulation.

Crimping Terminal to Lead

1. See Figure A-17. Squeeze the handles of the DEUTSCH TERMINAL CRIMP TOOL (Part No. HD-39965-A) to open the jaws. Push the locking bar (1) up.
2. Insert (2) terminal (socket/pin) through hole of the locking bar, so that the rounded side of the contact barrel rests in the nest (concave split level area) with the crimp tails facing upward. To match the wire gauge to the crimp tool die, refer to Table A-3.
3. Release locking bar to lock terminal in die.

NOTE

If the crimp tails are slightly out of vertical alignment, the crimp tool automatically rotates the terminal so that the tails face straight upward. When positioned, the locking bar fits snugly in the space between the contact band and the core crimp tails.

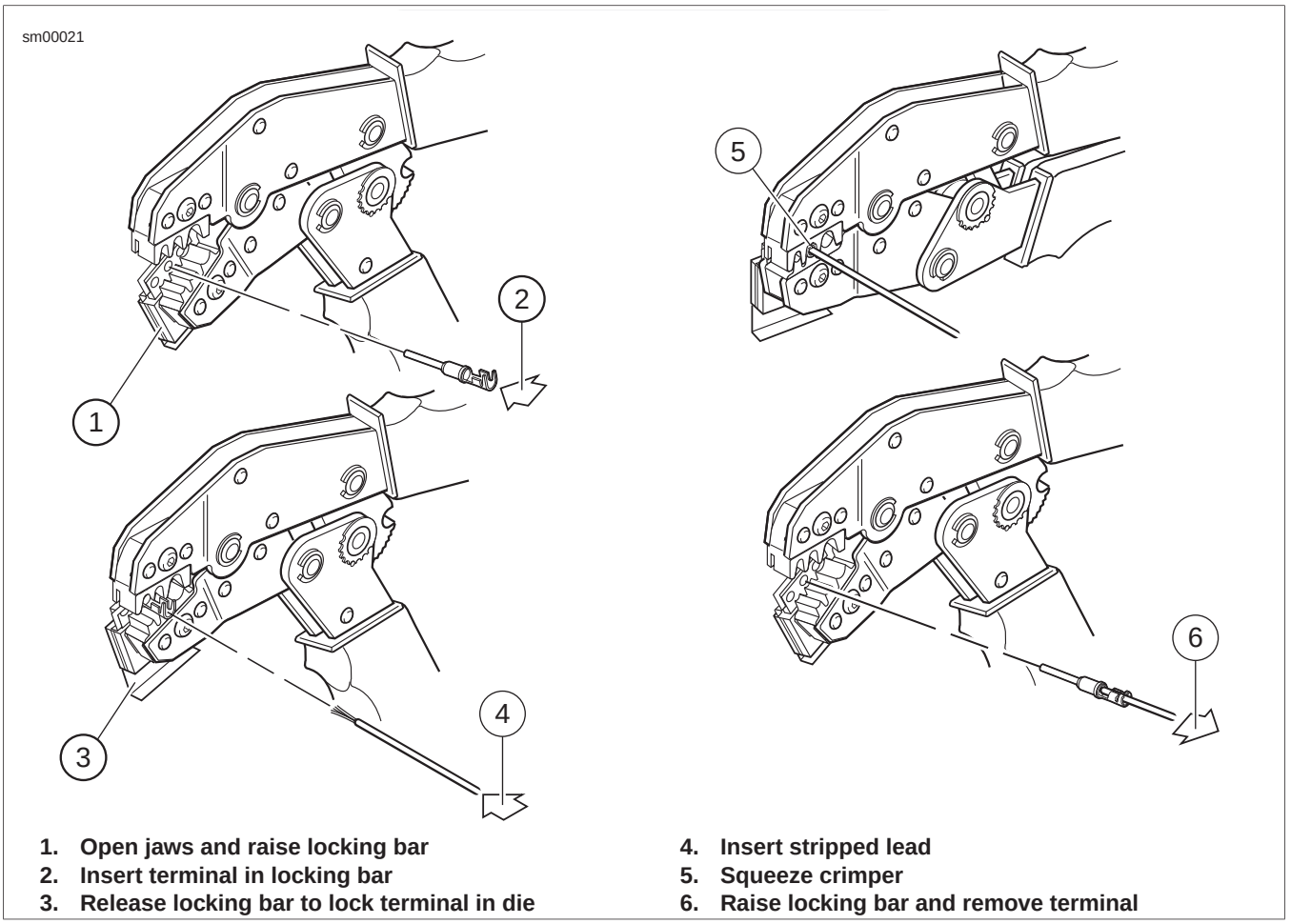
4. Insert stripped wire core between crimp tails until ends make contact with locking bar. Verify that wire is positioned so that short pair of crimp tails squeeze bare wire strands, while long pair folds over the insulation.
5. Squeeze handle of crimp tool until tightly closed. Tool automatically opens after the terminal is crimped.
6. Raise locking bar up and remove wire lead and terminal.

Inspecting Crimps

Inspect the wire core and insulation crimps. Distortion should be minimal.

Table A-3. Deutsch Standard Terminal Crimp: Wire Gauge To Die

WIRE GAUGE (AWG)	CRIMP TOOL DIE
20	Front
16-18	Middle



1. **Open jaws and raise locking bar**
2. **Insert terminal in locking bar**
3. **Release locking bar to lock terminal in die**
4. **Insert stripped lead**
5. **Squeeze crimper**
6. **Raise locking bar and remove terminal**

Figure A-17. Crimping a Deutsch Standard Terminal

DEUTSCH MINI-TERMINAL CRIMPS A.6

DEUTSCH MINI TERMINAL CRIMPS

PART NUMBER	TOOL NAME
HD-38125-7	PACKARD TERMINAL CRIMPER

Preparing Wire Leads for Crimping

Strip wire lead removing 5/32 in. (4.0 mm) of insulation.

Crimping a Mini Terminal to Wire Lead

1. See Figure A-18. Compress the handles of PACKARD TERMINAL CRIMPER (Part No. HD-38125-7) until the ratchet (2) automatically opens.

NOTE

Always perform core crimp before insulation crimp.

2. Position the core crimp on die E (1) of the crimper. Be sure the core crimp tails are facing the forming jaws.
3. Gently apply pressure to handles of tool until crimpers just secure the core crimp tails.
4. Insert stripped wire core stands between crimp tails. Position wire so that short pair of crimp tails squeeze bare wire strands, while long pair squeeze over the insulation.
5. Squeeze handle of crimper until tightly closed. Tool automatically opens when the crimping sequence is complete.

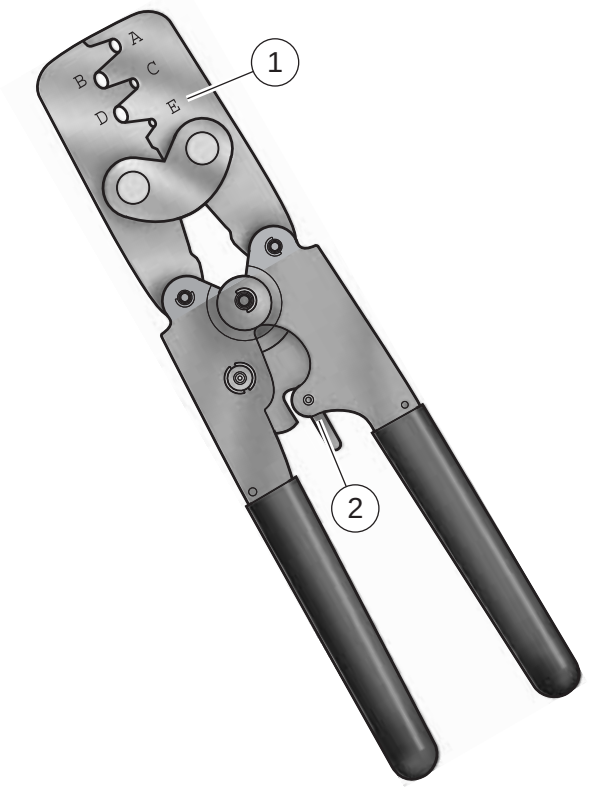
NOTE

If the crimper does not open, it can be opened by squeezing the ratchet trigger (2).

6. Position the insulation crimp on nest C of the crimper. Be sure the insulation crimp tails are facing the forming jaws.
7. Squeeze handle of crimp tool until tightly closed. Tool automatically opens when the crimping sequence is complete.

Inspecting Crimps

Inspect the core and insulation crimps. Distortion should be minimal.



1. E die
2. Crimper ratchet trigger

Figure A-18. Packard Terminal Crimper (HD-38125-7)

DEUTSCH SOLID BARREL TERMINALS A.7

DEUTSCH SOLID BARREL TERMINAL CRIMPS

PART NUMBER	TOOL NAME
HD-42879	ELECTRICAL CRIMPER TOOL

Preparing Wire Leads For Crimping

For size 20, 16 and 12 contacts, wire ranges 26-12 AWG.

Strip wire lead removing 1/4 in. (6.4 mm) of insulation.

Adjusting Crimper Tool

1. See Figure A-19. Squeeze the ELECTRICAL CRIMPER TOOL (Part No. HD-42879) handles to cycle the crimp tool to open.
2. Remove locking pin (1) from selector knob (2).
3. Raise selector knob and rotate until selected wire size stamped on wheel is aligned with "SEL. NO." arrow (3).
4. Loosen knurled locknut (4) and turn adjusting screw (5) clockwise (in) until it stops.

Crimping a Barrel Contact To Wire Lead

1. See Figure A-20. Turn tool over and drop contact barrel (1) into indentor cover (2) hole with the wire end out.
2. Turn adjusting screw counterclockwise (out) until contact is flush with bottom of depression in indentor cover. Tighten knurled locknut.
3. Slowly squeeze handles of crimp tool until contact is centered between the four indentor points (3).
4. Insert bare wire core strands of stripped wire lead (4) into contact barrel. Squeeze handle of crimp tool until tightly closed. Tool automatically opens when the crimping sequence is complete.
5. Remove wire lead with crimped contact from indentor.

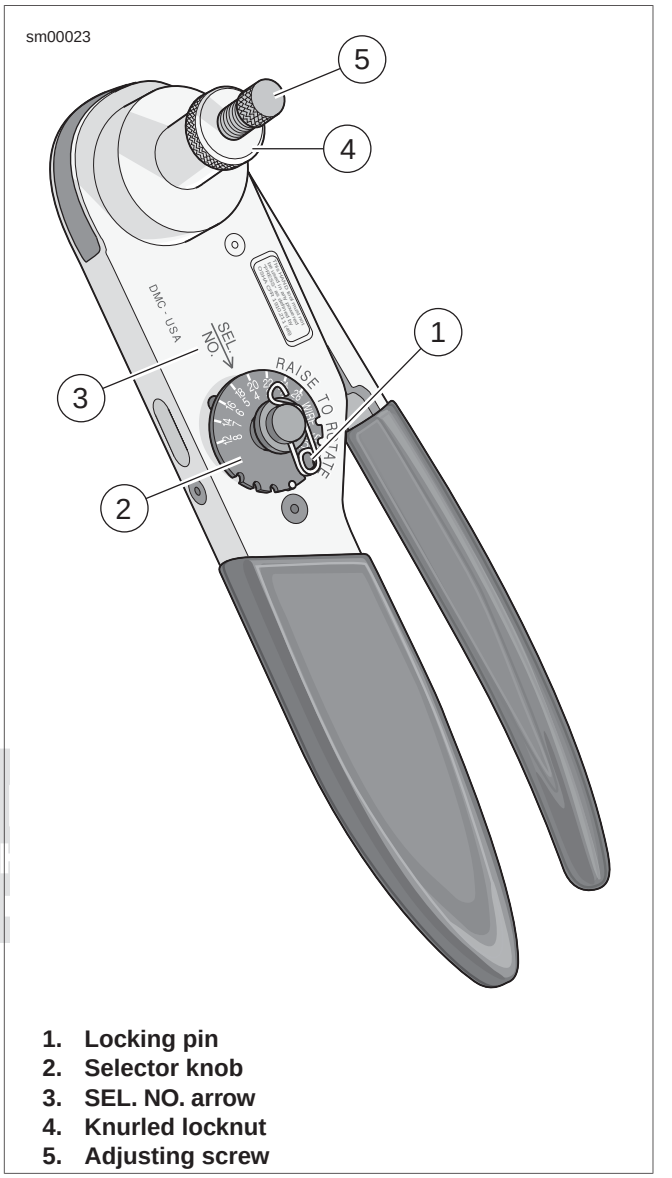
NOTE

Tool must be readjusted when changing contact size/type.

6. Install pin to lock selector knob.

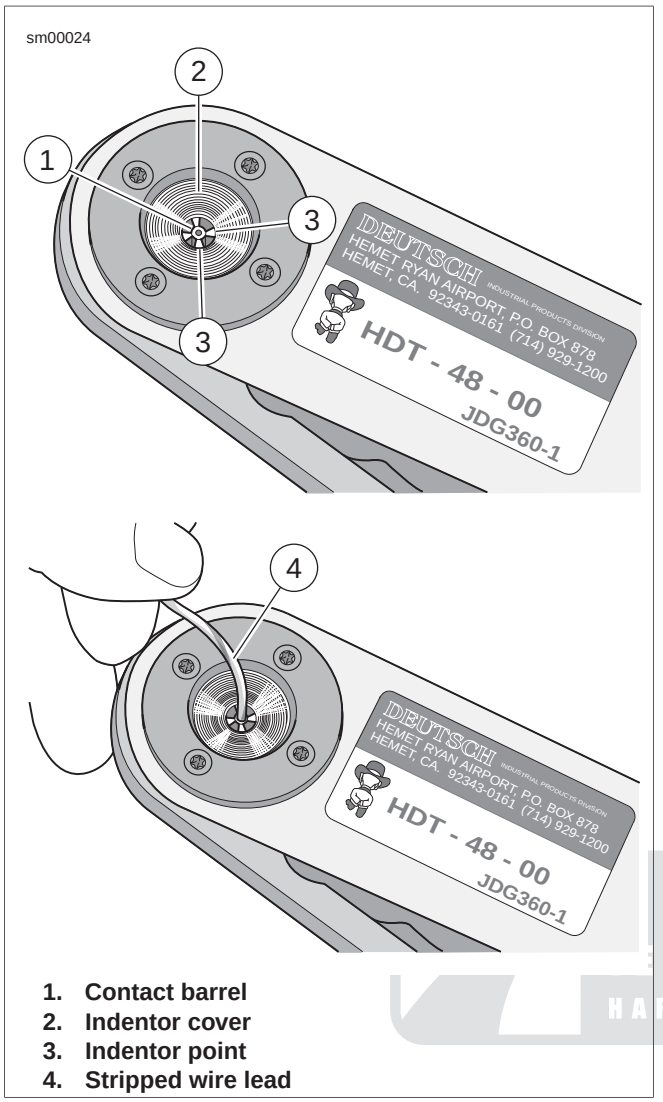
Inspecting Crimps

Inspect the crimp. All core wire strands are to be crimped in the barrel.



1. **Locking pin**
2. **Selector knob**
3. **SEL. NO. arrow**
4. **Knurled locknut**
5. **Adjusting screw**

Figure A-19. Electrical Crimper Tool (HD-42879)



1. **Contact barrel**
2. **Indentor cover**
3. **Indentor point**
4. **Stripped wire lead**

Figure A-20. Deutsch Solid Barrel

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RELAY AND FUSE BLOCKS A.8

FUSE BLOCK REPAIR

Removing Socket Terminals

1. See Figure A-21. To remove secondary locks, insert end of small flat blade screwdriver (1) under lip of locking wedge (2) and gently pry up secondary lock.

NOTE

For best results, start with locking wedge on outboard side of secondary lock.

2. Looking into chamber at top of fuse block, note the tang next to each socket terminal.
3. Using a thin flat blade, like that on a hobby knife, gently push tang away from terminal, and then tug on wire to back terminal out.

Installing Socket Terminals

1. Match the wire lead color to the fuse block terminal cavity.

NOTES

- *Refer to the main harness wiring diagram for wire lead color codes.*
- *See Figure A-22. The main fuse block terminal cavity is identified as alpha (1) and numeric (2) coordinates. Refer to the main harness wiring diagram for fuse block terminal cavity coordinates.*

2. With the open side of the socket terminal facing the tang, push lead into chamber at the wire end of the fuse block. A click is heard when the terminal is properly engaged.
3. Gently tug on the wire to verify that the terminal is locked in place and will not back out of the chamber.
4. Install the secondary locks. With the locking wedges positioned above the tangs in each chamber, slide flat side of secondary lock into slot (between rows), and push down until it bottoms.

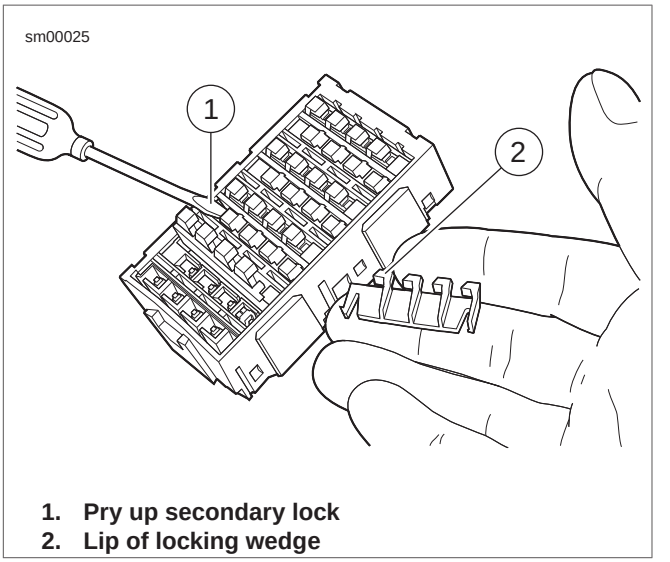
Crimping Terminals

Terminals are crimped twice; once over the wire core and a second time over the insulation/seal.

A correctly crimped terminal may require different crimping dies found on separate crimpers.

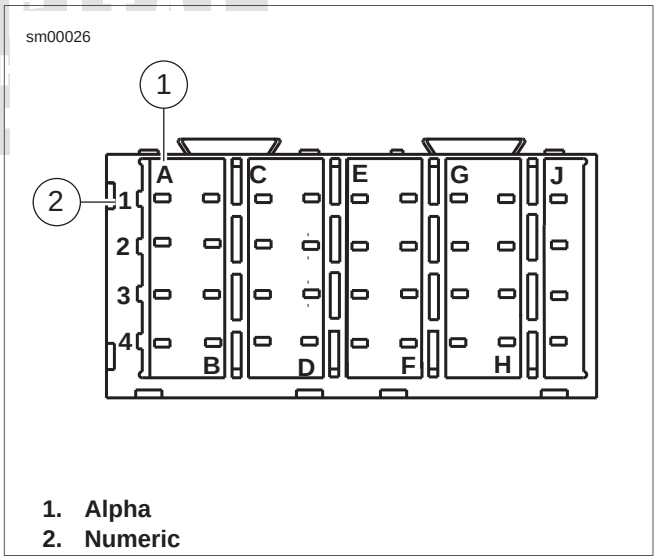
NOTE

The wiring diagram indicates when one socket terminal is be crimped to two wire leads.



1. Pry up secondary lock
2. Lip of locking wedge

Figure A-21. Fuse Block: Remove Secondary Locks



1. Alpha
2. Numeric

Figure A-22. Fuse Block: Coordinates (typical)

150 METRI-PACK CONNECTORS A.9

150 METRI-PACK CONNECTOR REPAIR

General

Metri-Pack connectors are embossed with the initials (P.E.D.).

There are two types of connectors in this series:

- Pull-to-Seat
- Push-to-Seat

Separating Pin and Socket Housings

Bend back the external latch slightly and separate the pin and socket halves of the connector.

Mating Pin and Socket Housings

Align the wire colors and push the pin and socket halves of the connector together.

Removing Socket Terminal

1. See Figure A-23 for pull-to-seat connector or Figure A-24 for push to seat connector. Remove wire lock (1) from wire end of socket housing on push-to-seat type connectors.

NOTE

For best results, free one side of wire lock first and then release the other side.

2. Find the locking tang in the mating end of the connector.

NOTE

The tangs are always positioned in the middle of the chamber and are on the same side as the external latch.

3. Gently insert a safety pin into the chamber about 1/8 in. (3.2 mm).
   a. **For pull-to-seat:** Stay between the terminal and the chamber wall and pivot the end of the pin toward the terminal body.
   b. **For push-to-seat:** There is a small opening for the pin.
4. When a click is heard, remove the pin and repeat the procedure.

NOTE

The click is the sound of the tang returning to the locked position as it slips from the point of the pin.

5. Pick at the tang until the clicking stops and the pin seems to slide in deeper than it had previously. This is an indication that the tang has been depressed.

NOTE

On those terminals that have been extracted on multiple occasions, the click may not be heard, but pivot the pin as if the click was heard at least 3 times.

6. Remove the pin.
   a. **For pull-to-seat:** Push on the lead to extract the terminal from the mating end of the connector.
   b. **For push-to-seat:** Pull on the lead to draw the terminal out the wire end.

Inserting Socket Terminal

NOTE

For wire location purposes, alpha characters are stamped into the socket housings.

1. See Figure A-23 for pull-to-seat connector or Figure A-24 for push to seat connector. Using a thin flat blade, like that on a hobby knife, carefully bend the tang outward away from the terminal body.
2. Gently pull or push on the lead to install the terminal back into the chamber. A click is heard when the terminal is properly seated.
3. Gently pull or push on the lead to verify that the terminal is locked in place.

   For push-to-seat: See Figure A-24. Seat wires in separate channels of wire lock and then push channels **inside** chambers at wire end of socket housing. Fully installed, slot on each side of wire lock engages ear on socket housing.

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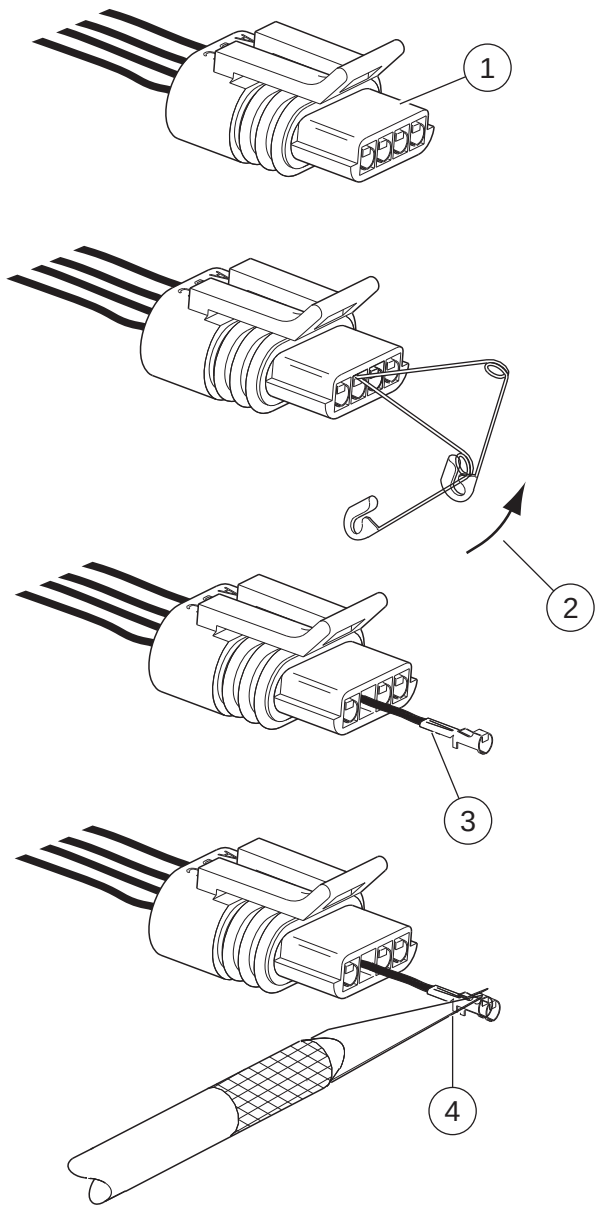
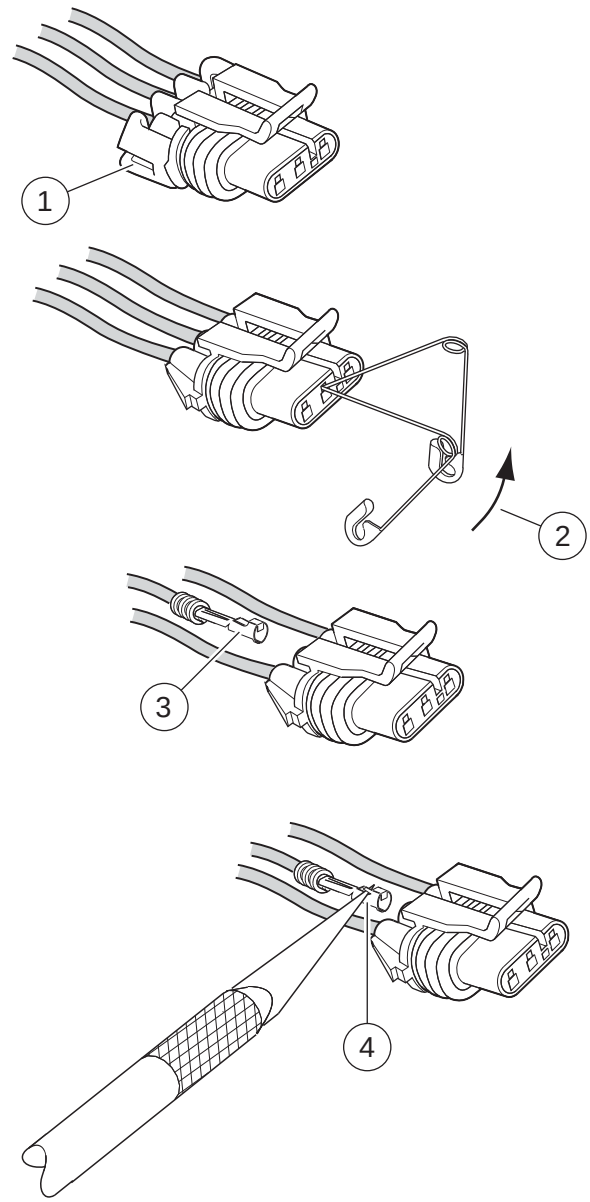
sm00027



1. Locate tang in chamber
2. Pivot pin to depress tang
3. Push to remove
4. Raise tang to install

Figure A-23. 150 Metri-Pack Connector: Pull-to-Seat

sm00028



1. Remove wire lock
2. Pivot pin to depress tang
3. Pull to remove
4. Raise tang to install

Figure A-24. 150 Metri-Pack Connector: Push-to-Seat

280 METRI-PACK CONNECTORS A.10

280 METRI-PACK CONNECTOR REPAIR

General

See Figure A-25. Called Packard connectors, Metri-Pack series connectors are embossed with the initials (P.E.D.)

Separating Pin and Socket Housings

Depress the wireform and use a rocking motion to detach the socket connector half.

Mating Pin and Socket Housings

Align the groove in the socket housing with the tab in the pin housing. Push the pin and socket halves of the connector together until the latch clicks.

Removing Socket Terminals

1. See Figure A-26. Pry rubber seal from wire end of connector and move seal down wires (1) toward conduit. Hold the connector so that the wireform is facing down.
2. Looking into the wire end of the connector, insert the point of a safety pin (2) between the top of the terminal and the inside chamber wall.
3. Push safety pin completely into chamber while watching terminal on mating end of connector. When terminal is observed moving forward slightly, tang is depressed. Remove safety pin.

NOTE

Repeat as necessary until the terminal can be pushed out of the connector.

4. Push on wire end of the lead to extract the terminal from the mating end of the connector.
5. If necessary, crimp new terminals on wires. See A.14 METRI-PACK TERMINALS, Metri-Pack Terminal Crimps.

Installing Socket Terminals

NOTE

Terminal cavities are lettered on the socket housing. To match the wire lead colors to the terminal cavity, refer to the wiring diagram.

1. See Figure A-26. Using a thin flat blade, like a hobby knife (4), carefully bend the tang outward away from the terminal body.
2. Gently pull on the wire lead (5) to draw the terminal back into the chamber. The tang faces opposite the wireform as it enters the chamber.

NOTE

A "click" is heard when the terminal is properly seated.

3. Push on lead to verify that terminal is locked in place.
4. Fit rubber wire seal back into wire end of connector.

Crimping Terminals

If necessary, crimp new terminals on the wire leads. Refer to A.14 METRI-PACK TERMINALS, Metri-Pack Terminal Crimps.

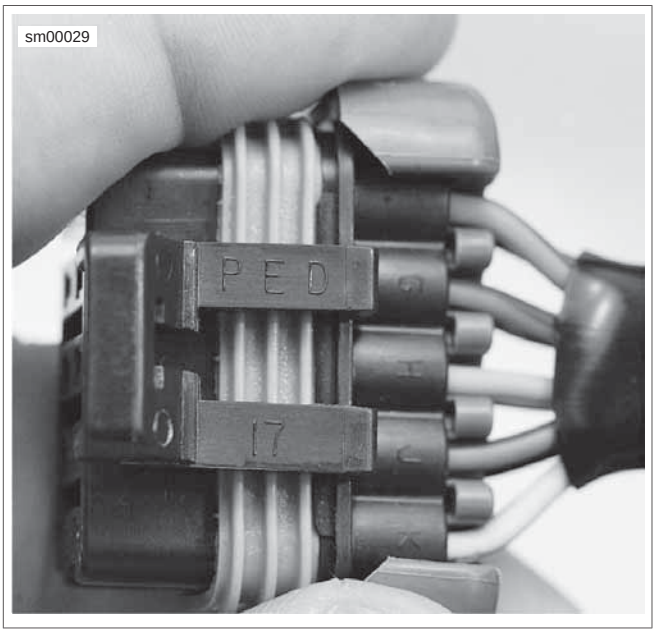


Figure A-25. 280 Metri-Pack Connector (P.E.D.)

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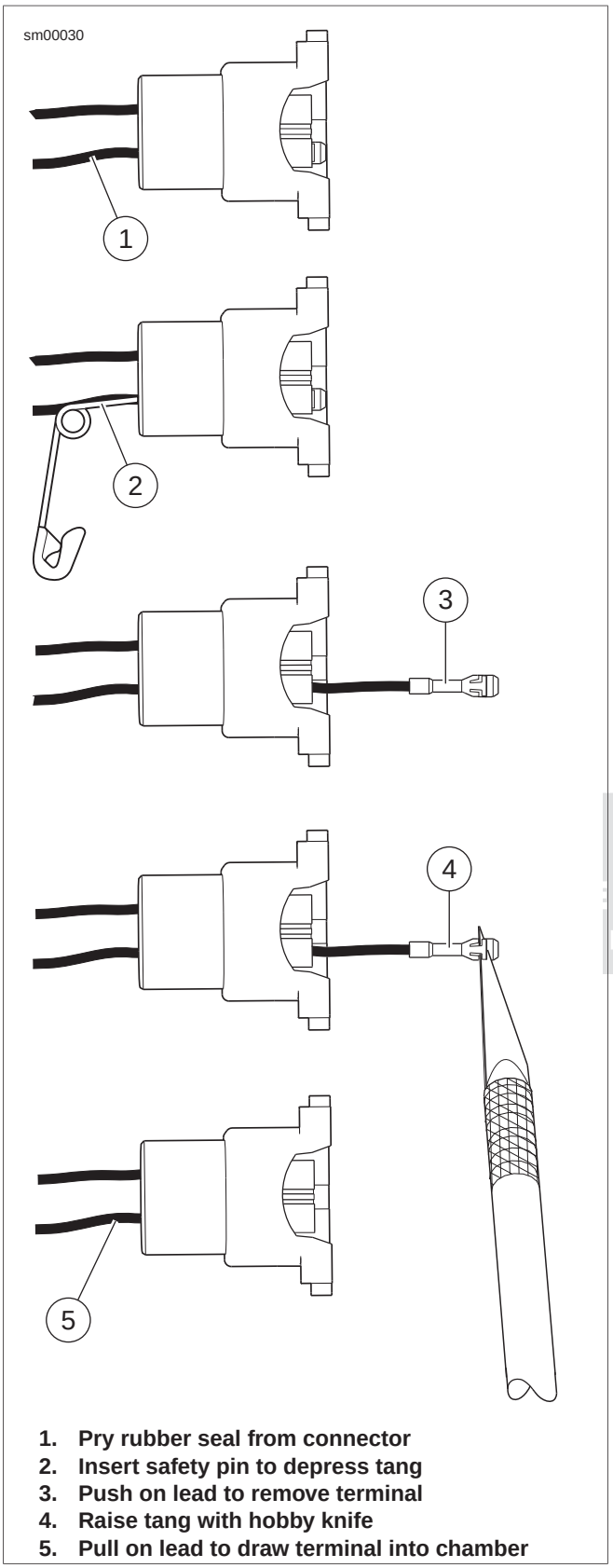

1. Pry rubber seal from connector
2. Insert safety pin to depress tang
3. Push on lead to remove terminal
4. Raise tang with hobby knife
5. Pull on lead to draw terminal into chamber

Figure A-26. 280 Metri-Pack Connector: Remove/Install Socket Terminal

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480 METRI-PACK CONNECTORS A.11

480 METRI-PACK CONNECTOR REPAIR

General

A 480 Metri-Pack (P.E.D.) connector is frequently used for the B+ (battery voltage) connector to power P&A accessories.

Referred to as Packard connectors, Metri-Pack connectors are embossed with the initials P.E.D.

See Figure A-27. An AFL housing (5) is used on many ignition/light switches. The secondary lock (4) must be opened before removing the terminal from the housing.

Separating Pin and Socket Housings

NOTE

Cut any cable strap anchoring the wire conduits of the pin (accessory connector housing) and the socket (B+) housing.

See Figure A-27. Using small flat blade screwdriver, press button (1) on pin housing (red wire) side of the connector and pull apart the pin and socket housings.

Mating Pin and Socket Housings

Orient the latch on the socket housing to the button catch on the pin housing and press the housings together.

Removing Socket Terminals

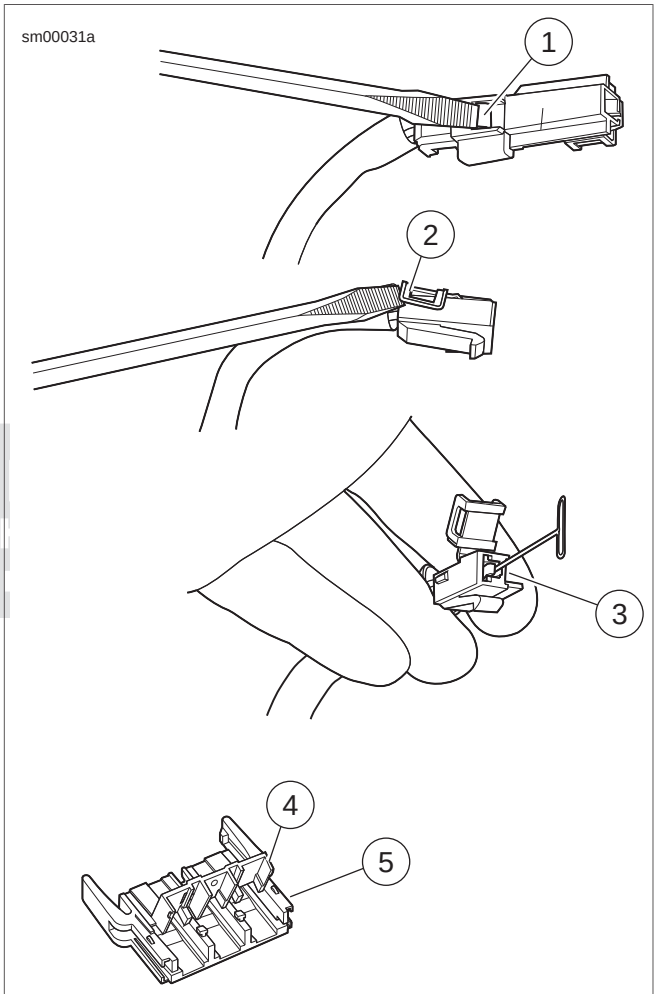
1. See Figure A-27. Bend back the latch (2) slightly and free one side of secondary lock, then repeat to release the opposite side. Rotate the secondary lock outward on hinge to access terminal in chamber of connector housing.
2. On the mating end of the connector, note the tang in the square shaped opening centered next to the terminal. Gently insert the point of a stick pin or large safety pin into the opening (3) between the tang and the chamber wall until it stops.
3. Pivot the end of the pin toward the terminal body to press the tang.
4. Remove the pin and then pull terminal out of the wire end of connector housing.
5. If necessary, crimp **new** terminals on wires. See A.14 METRI-PACK TERMINALS.

Installing Socket Terminals

1. Carefully bend the tang outward away from the terminal body.
2. With the tang on the same side as the square shaped opening in the mating end of the connector housing, feed terminal into wire end of connector housing until it "clicks" in place.
3. Verify that terminal will not back out of the chamber. A slight tug on the cable will confirm that it is locked.
4. Rotate the hinged secondary lock inward until latches fully engage tabs on both sides of connector housing.

NOTE

*If removed, install **new** anchored cable strap in O.E. location. Tighten cable strap to capture conduit of both accessory connector and B+ connector approximately 1.0 in. (25.4 mm) from housings.*



1. **Button on pin housing**
2. **Secondary lock latch**
3. **Opening between tang and chamber wall**
4. **Secondary Lock (shown open)**
5. **AFL housing**

Figure A-27. 480 Metri-Pack Connector: Remove Socket Terminal

630 METRI-PACK CONNECTORS A.12

630 METRI-PACK CONNECTOR REPAIR

PART NUMBER	TOOL NAME
SNAP-ON TT600-3	SNAP-ON PICK

General

Referred to as Packard connectors, Metri-Pack 630 series connectors are embossed with the initials P.E.D.

Separating Pin and Socket Housings

NOTE

If necessary, remove connector from barbed anchor or other retaining device.

Bend back the external latch slightly and separate pin and socket halves of the connector.

Mating Pin and Socket Housings

Orient the latch to the catch and push the pin and socket halves of the connector together until the latch "clicks".

NOTE

If removed, install connector on barbed anchor or other OE retaining device.

Removing Socket Terminal

1. Bend back the latch slightly and free one side of the secondary lock. Repeat the step to unlatch the other side.
2. Rotate the secondary lock outward on hinge to view the terminals in the chambers of the connector housing. The locking tang is on the side opposite the crimp tails and engages a rib in the chamber wall to lock the terminal in place.
3. Moving to the mating end of the connector, take note of the small opening on the chamber wall side of each terminal.
4. Insert SNAP-ON PICK (Part No. SNAP-ON TT600-3) into opening until it stops. Pivot the end of the pick toward the terminal to depress the locking tang.
5. Remove the pick and gently tug on the wire to pull the terminal from the wire end of the connector. Repeat steps if the terminal is still locked in place.
6. If necessary, crimp **new** terminals on wires. Refer to A.14 METRI-PACK TERMINALS.

Installing Socket Terminal

NOTE

Refer to the wiring diagrams to match wire lead colors to alpha characters molded into the secondary locks of each connector housing.

1. Using a thin flat blade, like that of a hobby knife, carefully bend the tang outward away from the terminal body.
2. With the tang facing the chamber wall, push the lead into the chamber at the wire end of the connector. A click is heard when the terminal is properly seated.
3. Gently tug on the wire end to verify that the terminal is locked in place and will not back out of the chamber.
4. Rotate the hinged secondary lock inward until tabs fully engage latches on both sides of connector.

DIGITAL TECHNICIAN HARLEY-DAVIDSON

800 METRI-PACK CONNECTORS A.13

DELPHI MAIN FUSE HOUSING REPAIR

General

A Delphi Main fuse connector completes the circuit through the main fuse.

Removing Main Fuse

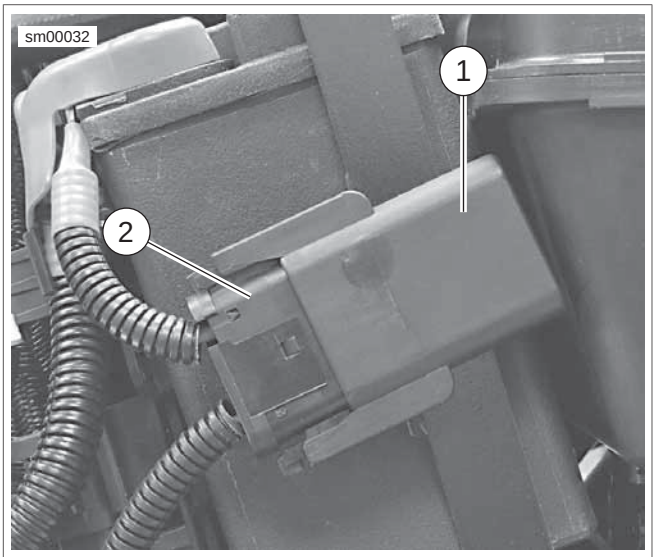
1. See Figure A-28. Depress latches on main fuse cover (1) and then slide cover off of connector (2).
2. Holding the connector (fuse holder), pull the main fuse out of the connector.

Installing Main Fuse

1. Insert the blade terminals of the main fuse into the sockets of the connector and press the main fuse into the connector.
2. Slide the cover over the fuse until the cover clicks into place.

NOTE

If removed from an OE attachment such as a grooved fuse block cover, engage cover and slide into place.



1. **Main fuse cover**
2. **Delphi main fuse housing**

Figure A-28. Delphi Connector Housing: Main Fuse

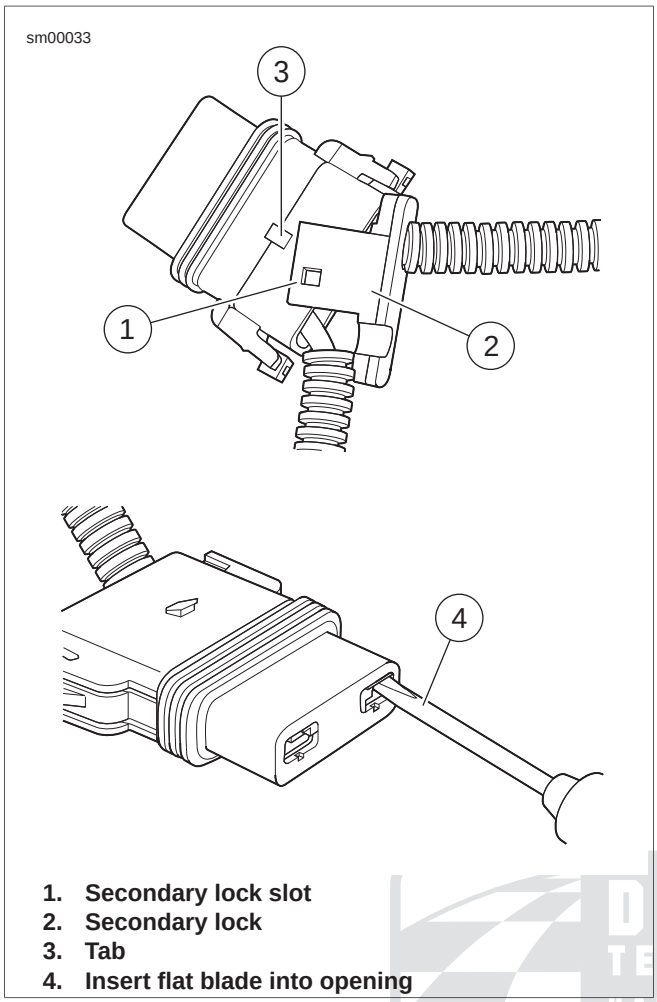
Removing Socket Terminals

1. See Figure A-29. Gently pull socket housing to disengage slots (1) on secondary lock (2) from tabs (3) on socket housing. Free secondary lock from cables and set aside.
2. Take note of the opening on one side of the socket terminal. Gently insert flat blade of pick (Snap-On TT600-5) or small screwdriver into opening (4) until it stops. Pivot the pick toward the terminal body and hold in position.
3. Tug on cable to pull socket from wire end of socket housing. A firm tug is necessary to overcome the resistance of the rubber seal.
4. Repeat to remove remaining socket terminal.

Installing Socket Terminals

1. See Figure A-30. Carefully bend tang outward away from the terminal body.
2. Feed socket into wire end of socket housing until it clicks in place. Verify that socket will not back out of chamber. A slight tug on the cable will confirm that it is locked.
3. Push rubber seal into wire end of socket housing.
4. Repeat to install remaining socket terminal.
5. Install secondary lock onto cables and then push onto wire end of socket housing until slots engage tabs on sides of socket housing.

DIGITAL TECHNICIAN II HARLEY-DAVIDSON



1. Secondary lock slot
2. Secondary lock
3. Tab
4. Insert flat blade into opening

Figure A-29. Delphi Main Fuse Housing: Remove Socket Terminals

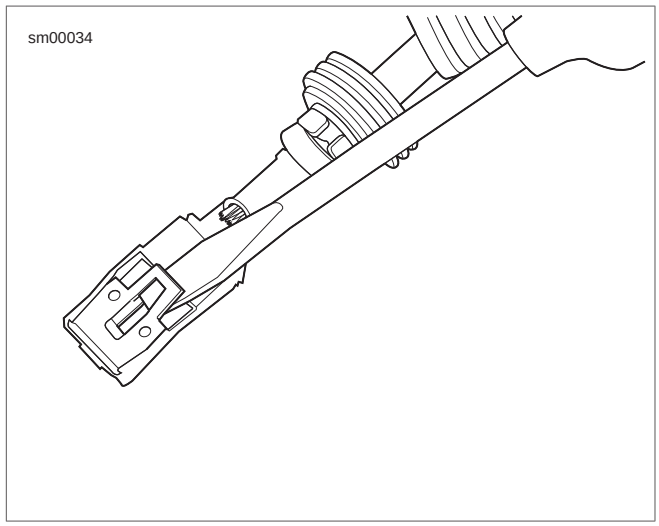


Figure A-30. Delphi Main Fuse Housing: Bend Tang

DIGITAL TECHNICIAN II HARLEY-DAVIDSON

METRI-PACK TERMINALS A.14

METRI-PACK TERMINAL CRIMPS

PART NUMBER	TOOL NAME
HD-38125-6	PACKARD TERMINAL CRIMP TOOL
HD-38125-7	PACKARD TERMINAL CRIMPER
HD-38125-8	PACKARD CRIMPING TOOL

Matching Terminal To Crimper

Metri-Pack connectors embossed with the initials P.E.D. require Packard crimp tools to crimp terminals to wire leads.

Terminals are crimped twice to a wire lead, once over the wire core and a second time over the insulation/seal.

See Figure A-31. A completed crimp may require two different crimping dies found on PACKARD TERMINAL CRIMP TOOL (Part No. HD-38125-6) and/or PACKARD TERMINAL CRIMPER (Part No. HD-38125-7). The terminal (pin or socket) and the wire lead gauge will determine the core crimp die and the insulator/seal die.

NOTE

The PACKARD CRIMPING TOOL (Part No. HD-38125-8) will also crimp sealed splice connectors in wire gauge sizes 18-20, 14-16 and 10-12.

Preparing Wire Lead

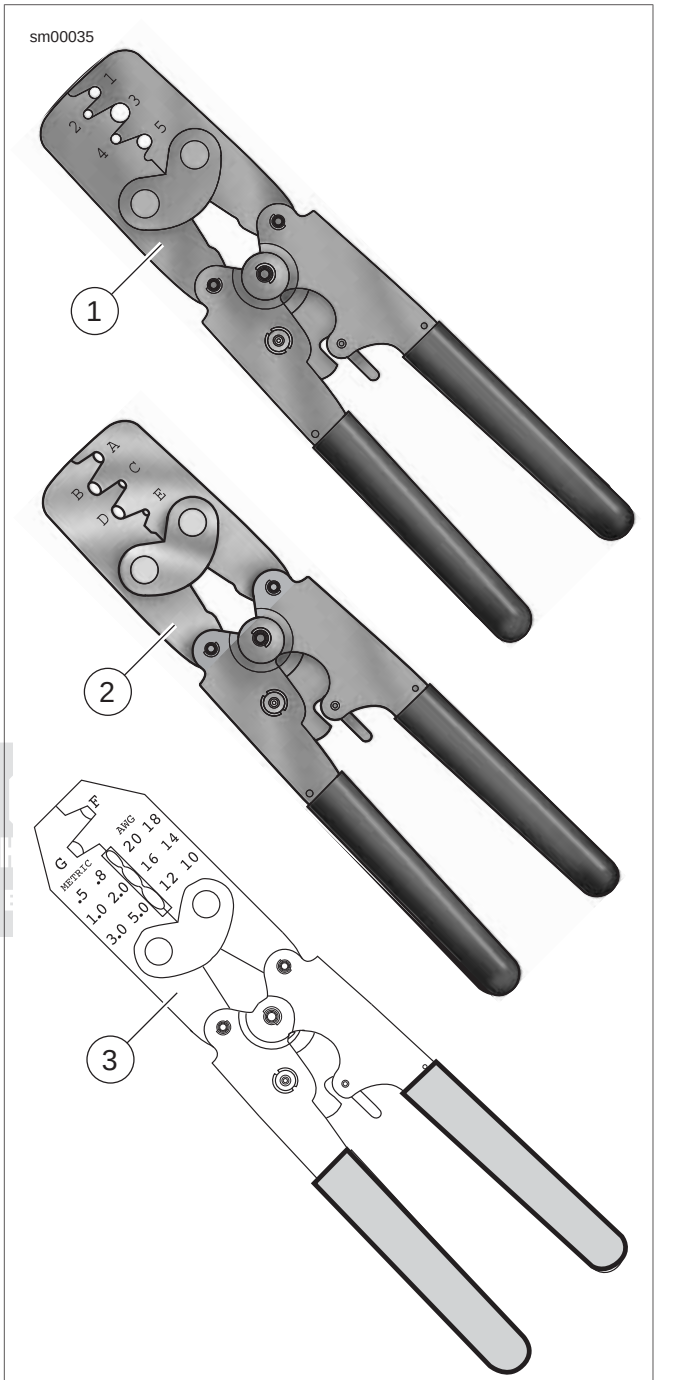
Use a wire striper to strip off the insulation and expose 5/32 in. (4.0 mm) of wire core.

Crimping Wire Core

NOTE

*Metri-Pack terminal crimps require two steps. Always perform **Crimping Wire Core** before **Crimping Insulation/Seal**.*

1. Squeeze and release handles until ratchet automatically opens.
2. Identify the corresponding sized nest for the core crimp.
3. Position the core crimp in the die. Be Sure the core crimp tails are facing the forming jaws.
4. Gently squeeze the handles until crimpers just secure the core crimp tails.
5. Insert stripped wire between crimp tails. Verify that wire is positioned so that short pair of crimp tails squeeze core wire strands, while long pair is positioned over the insulation or seal material.
6. Squeeze handles tightly closed. Release grip and the tool will automatically open.



1. **HD-38125-6 sealed terminals**
2. **HD-38125-7 non-sealed terminals**
3. **HD-38125-8 non-sealed terminals**

Figure A-31. Metri-Pack Terminal Crimp Tools

Crimping Insulation/Seal

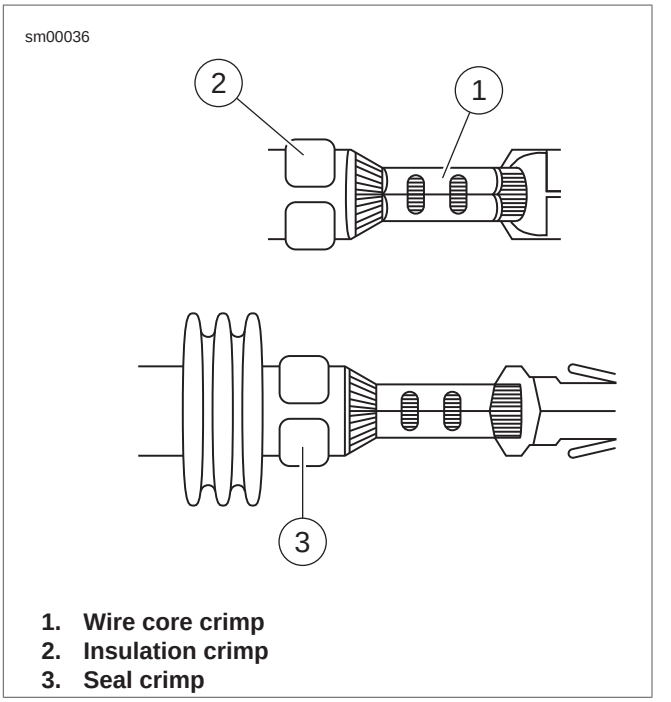
NOTE

*Always perform **Crimping Wire Core** before **Crimping Insulation/Seal**.*

1. See Figure A-32. Identify the correct die for the insulation/seal crimp (2).
2. Position the insulation/seal crimp in the nest. Be sure the insulation/seal crimp tails are facing the forming jaws.
3. Squeeze handle of crimp tool until tightly closed. Tool automatically opens when the crimp is complete.

Inspecting Crimps

1. See Figure A-32. Inspect the wire core crimp (1). The tails should be folded in on the wire core without any distortion or excess wire strands.
2. Inspect the insulation (2) or seal (3) crimp. The tails of the terminal should be wrapped around the insulation without distortion.



1. **Wire core crimp**
2. **Insulation crimp**
3. **Seal crimp**

Figure A-32. Metri-Pack Connector: Inspect Core and Insulation/Seal Crimps

DIGITAL TECHNICIAN II HARLEY-DAVIDSON

MOLEX CONNECTORS A.15

MOLEX CONNECTOR REPAIR

PART NUMBER	TOOL NAME
HD-48114	MOLEX ELECTRICAL CONNECTOR TERMINAL REMOVER

Separating Pin and Socket Housings

See Figure A-33. Depress the latch while pulling the pin and socket housings apart.

Mating Pin and Socket Housings

1. Orient the latch on the pin housing to the latch pocket on the socket housing so the rails on the outside of the pin housings lines up with the tunnels on the socket housing.
2. Press the housings together until the latch clicks.

Removing Terminals

1. Pull the secondary lock up, approximately 3/16 in. (4.8 mm), until it stops.
   a. **Socket Housing:** See Figure A-34. Use a small screwdriver in the pry slot. The slot next to the external latch provides a pivot point.
   b. **Pin Housing:** See Figure A-35. Use needle nose pliers to engage the D-holes in the center of the secondary lock.

NOTE

Do not remove the secondary lock from the connector housing.

2. See Figure A-36. Insert MOLEX ELECTRICAL CONNECTOR TERMINAL REMOVER (Part No. HD-48114) into the pin hole next to the terminal until the tool bottoms.
   a. **Socket Housing:** The pin holes are inside the terminal openings.
   b. **Pin Housing:** The pin holes are outside the pins.
3. Pressing the terminal remover to the bottom of the pin hole, gently pull on the wire to remove wire terminal from its cavity.

Installing Terminals

1. See Figure A-37. From the wiring diagram, match the wire color to its numbered terminal cavity.

NOTE

Cavity numbers (1) are stamped on the housing at the ends of the cavity rows. The cavity number can be determined by counting the cavities up or down along the row from each stamped number.

2. Orient the terminal so that the tang (2) opposite the open crimp engages the slot (3) in the cavity.
3. Push the terminal into the cavity.
4. Gently tug on wire to verify that the terminal is captured by the secondary lock.
5. With all terminals installed, push the secondary lock into the socket housing to lock the wire terminals into the housing.

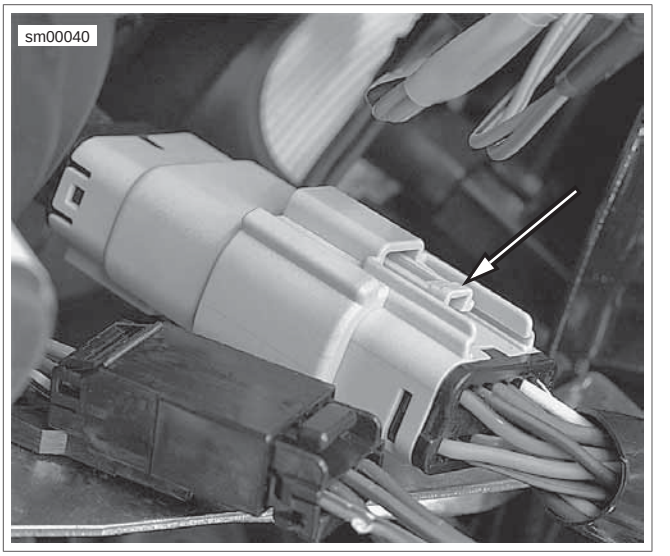


Figure A-33. Molex Connector: Latch

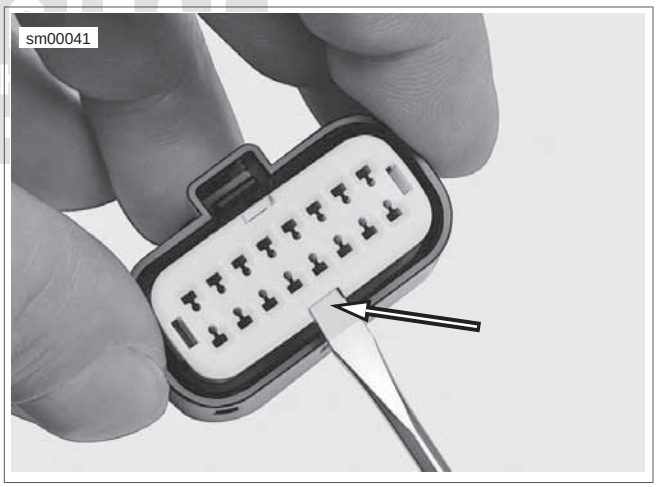


Figure A-34. Molex Connector: Secondary Lock Pry Slot (Socket Housing)

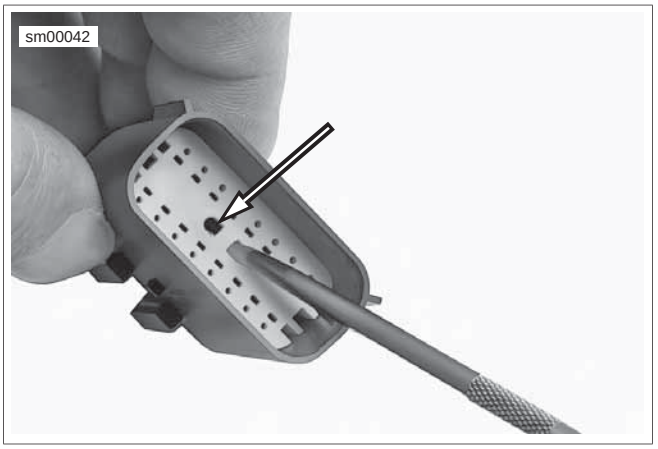


Figure A-35. Molex Connector: Secondary Lock D-Holes (Pin Housing)

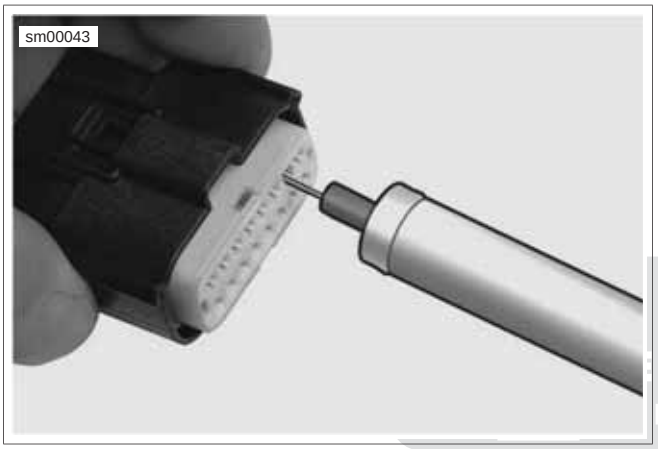
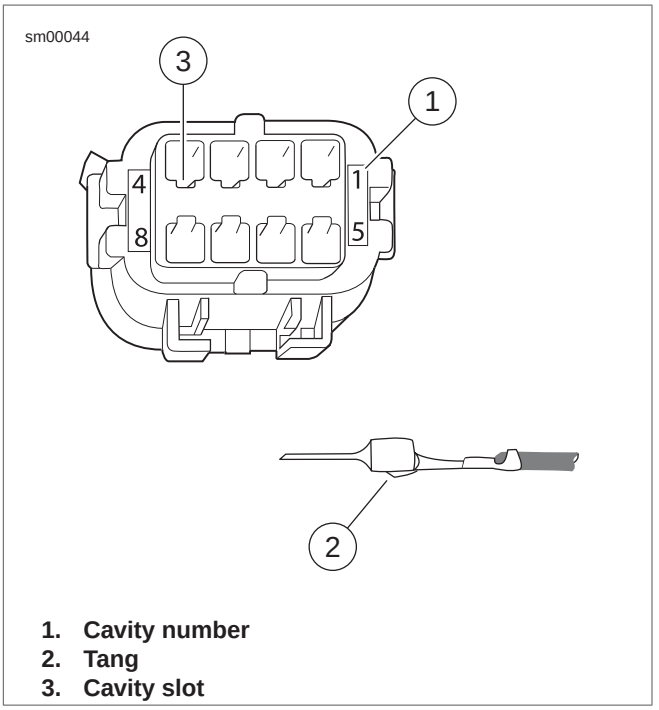


Figure A-36. Molex Connector: Terminal Remover (HD-48114)



1. **Cavity number**
2. **Tang**
3. **Cavity slot**

Figure A-37. Molex Connector: Pin Cavities and Wire Terminal

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PACKARD ECM CONNECTOR A.16

PACKARD 100W CONNECTOR REPAIR

General

A Packard 100W connector connects the electronic control module (ECM) to the main harness.

NOTE

For vehicles with 73-pin connectors, see A.17 PACKARD MICRO-64 CONNECTORS and A.14 METRI-PACK TERMINALS.

Separating Socket Housing From ECM

See Figure A-38. While pressing the connector into the ECM, press the thumb lever (1) against the connector until the latch (2) pops out of the catch (3) on the ECM.

Mating Socket Housing To ECM

Push the connector into the ECM until the latch is captured by the catch on the ECM.

Removing Socket Terminal

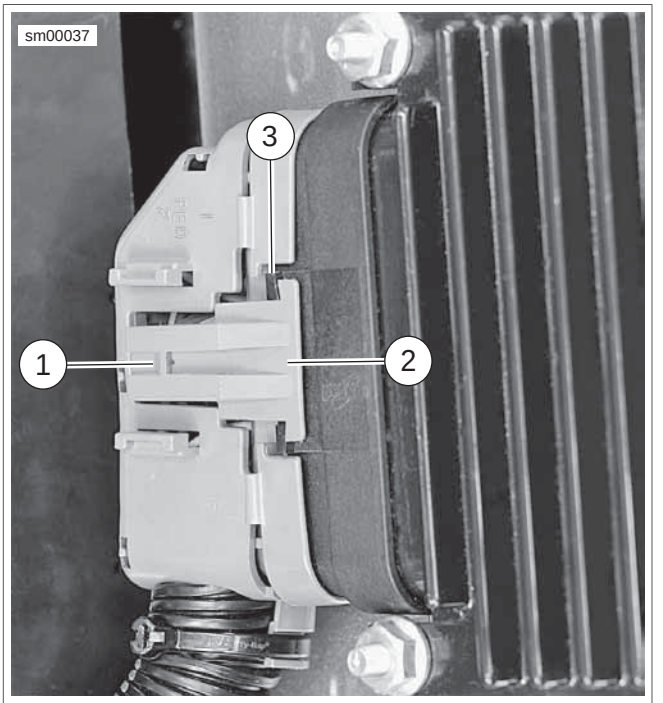
1. See Figure A-39. Gently press latch (1) on each side of the clear plastic secondary lock (2) and remove. For best results, release one side at a time.
2. Carefully cut cable strap (3) to free strain relief collar (4) from conduit (5).
3. See Figure A-40. Using a thin blade, gently pry at seam at back of socket housing to release three plastic pins (1) from slots in housing. Separate and spread halves of socket housing.
4. Push on wire lead to free terminal from chamber.

Installing Socket Terminal

1. From inside socket housing, gently pull on wire to draw terminal into chamber.
2. Exercising caution to avoid pinching wires, press halves of socket housing together until three plastic pins fully engage slots in housing.
3. Install **new** cable strap in groove of strain relief collar capturing cable conduit.
4. With the two ribs on the secondary lock on the same side as the external latch, install over terminals until latches lock in place.

Crimping Terminals

If necessary, crimp new terminals on wire leads. See A.14 METRI-PACK TERMINALS.



1. **Thumb lever**
2. **Latch**
3. **Catch (ECM)**

Figure A-38. Packard 100W to ECM (Typical)

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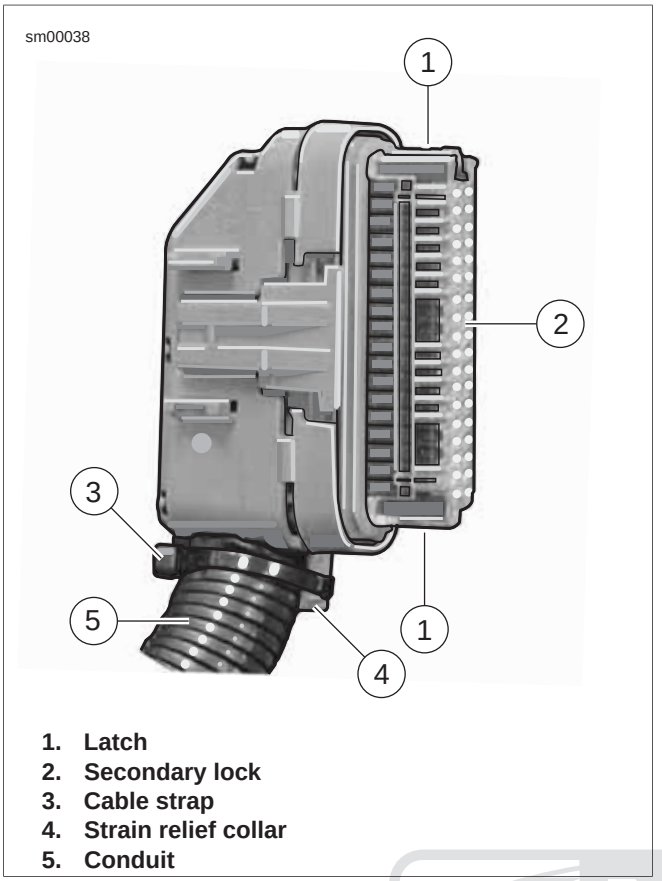
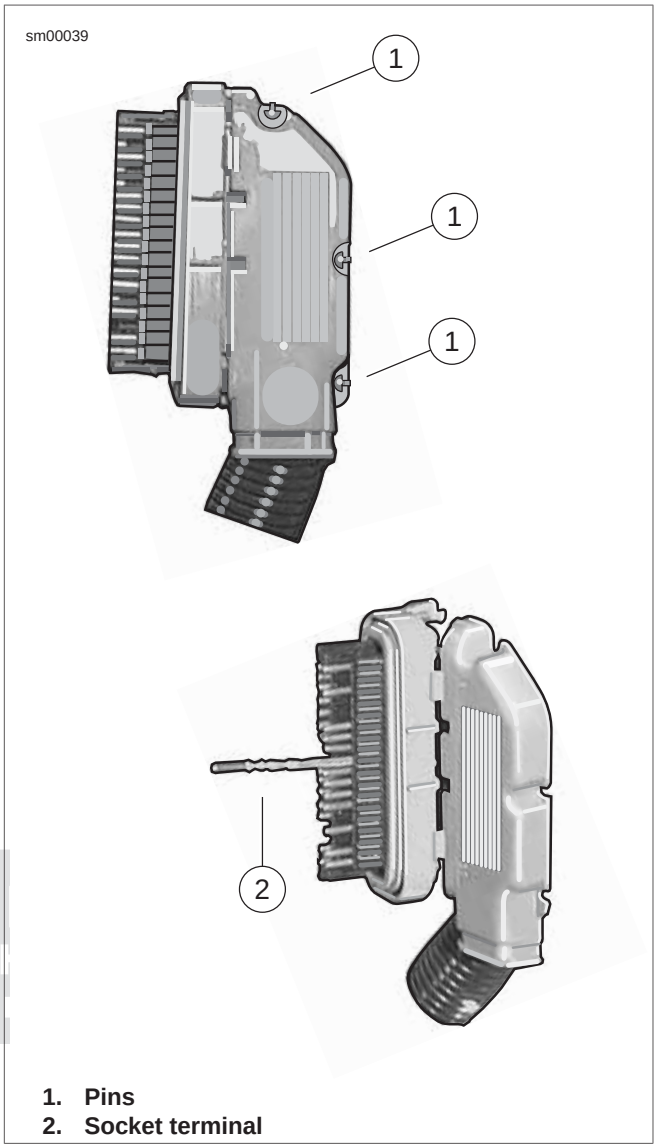


1. Latch
2. Secondary lock
3. Cable strap
4. Strain relief collar
5. Conduit

Figure A-39. Packard 100W Connector



1. Pins
2. Socket terminal

Figure A-40. Packard 100W Connector: Separate Halves of Socket Housing

PACKARD MICRO-64 CONNECTORS A.17

PACKARD MICRO-64 CONNECTOR REPAIR

PART NUMBER	TOOL NAME
HD-45928	PACKARD MICRO-64 TERMINAL REMOVER
HD-45929	PACKARD MICRO-64 TERMINAL CRIMPER

General

Packard Micro-64 connectors are frequently found on speedometers, tachometers and the ECM of Touring Models. For pin 73 of these ECMs, see A.9 150 METRI-PACK CONNECTORS.

Separating Pin and Socket Housings

Bend back the external latches slightly and separate the pin and socket housings.

Mating Pin and Socket Housings

Orient the wire lead colors and push the pin and socket housings of the connector together until the latches click.

Removing Terminal

1. See Figure A-43. Locate the head of the secondary lock (1) on one side of the connector housing.
2. Insert the blade of a small screwdriver between the center ear of the lock and the connector housing and gently pry out lock. When partially removed, pull lock from connector housing.
3. Locate pin hole (2) between terminals on mating end of connector.
4. See Figure A-44. Obtain the PACKARD MICRO-64 TERMINAL REMOVER (Part No. HD-45928).
5. See Figure A-42. Push the adjacent terminals all the way into the connector housing and then insert tool into hole until it bottoms.
6. Leaving the tool installed, gently tug on wires to pull either one or both terminals from wire end of connector. Remove tool.

Figure A-41. Packard Micro 64 Terminal Remover (HD-45928)

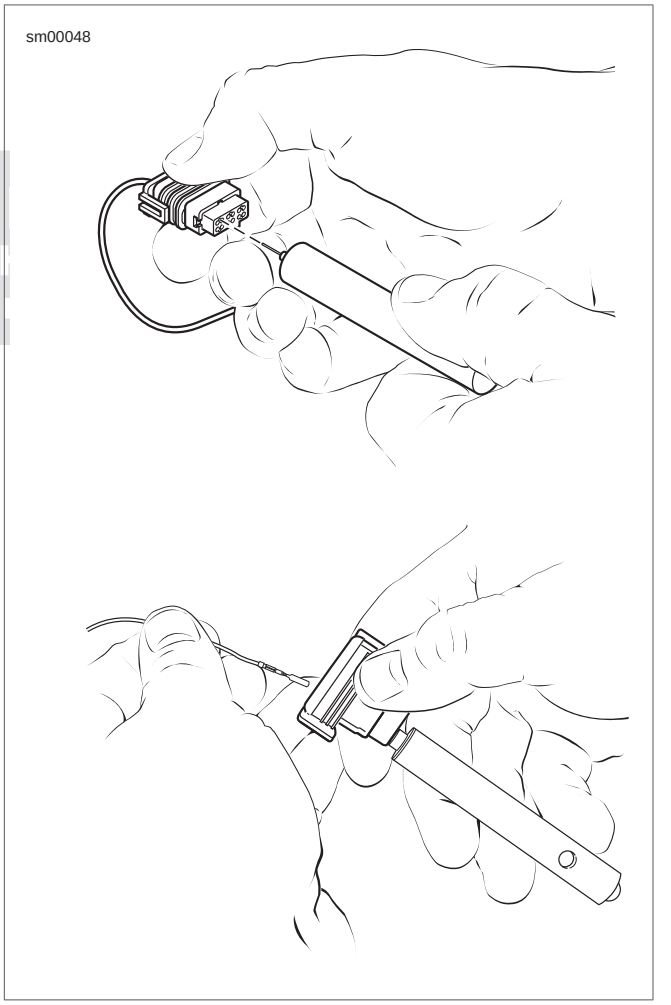


Figure A-42. Packard Micro 64 Connector: Insert Tool and Remove Terminal

Installing Terminal

1. Insert terminal into its respective numbered chamber on wire end of connector. No special orientation of the terminal is necessary.

NOTE

See Figure A-43. For wire location purposes, the corners of the socket housing are stamped (3) with the numbers 1, 6, 7 and 12, representing terminals 1-6 on one side, and 7-12 on the other.

2. Bottom the terminal in the chamber and then gently tug on the wire to verify that it is locked in place.

NOTE

Once the terminal is removed it may not lock in place when first installed. Until the lock engages, move the terminal back and forth slightly while wiggling the lead.

3. Since the terminal remover tool releases two terminals simultaneously, repeat step 2 on the adjacent terminal even if it was not pulled from the connector housing.

4. With the center ear on the head of the secondary lockpin facing the mating end of the connector, push secondary lock in until head is flush with the connector housing.

Preparing Wire Leads for Crimping

Strip lead removing 1/8 in. (3.0 mm) of insulation.

Crimping Terminals

1. Inspect **new** socket terminal for bent or deformed contact and crimp tails. Replace as necessary.

2. See Figure A-45. Squeeze the handles of the PACKARD MICRO-64 TERMINAL CRIMPER (Part No. HD-45929) to cycle the tool to the fully open position (1).

3. Raise locking bar and barrel holder by pushing up on bottom tab with index finger (2).

4. With the crimp tails facing upward, insert terminal through locking bar into front hole in barrel holder (20-22 gauge wire) (3).

5. Release locking bar to lock position of contact. When correctly positioned, the locking bar fits snugly in the space at the front of the core crimp tails and the closed side of the terminal rests on the outer nest of the crimp tool.

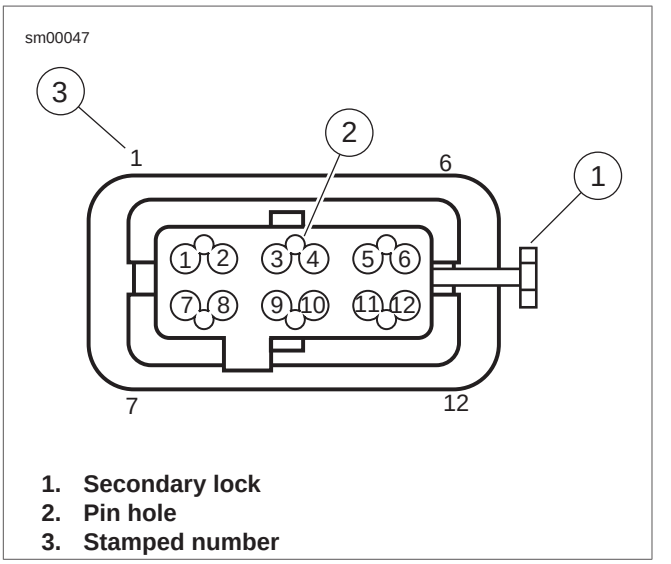
6. Insert wires between crimp tails until ends make contact with locking bar. Verify that wire is positioned so that wide pair of crimp tails squeeze bare wire strands, while the narrow pair folds over the insulation material.

7. Squeeze handle of crimp tool until tightly closed (4). Tool automatically opens when the crimping sequence is complete.

8. Raise locking bar and barrel holder to remove contact.

Inspecting Crimps

Inspect the quality of the core and insulation crimps. Distortion should be minimal.



1. Secondary lock
2. Pin hole
3. Stamped number

Figure A-43. Packard Micro 64 Connector: Housing

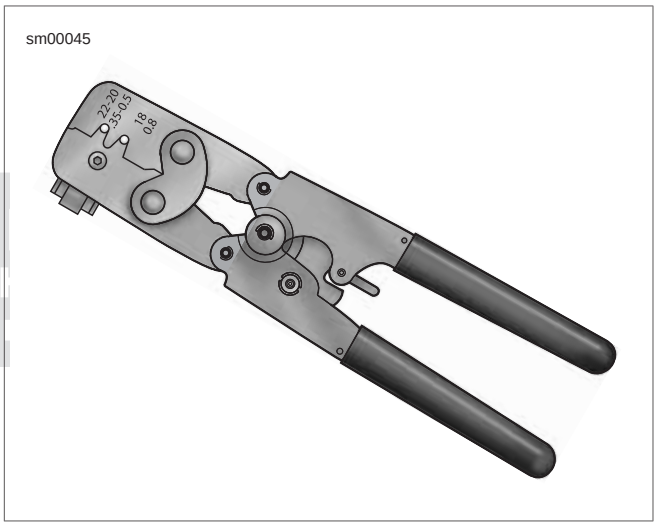
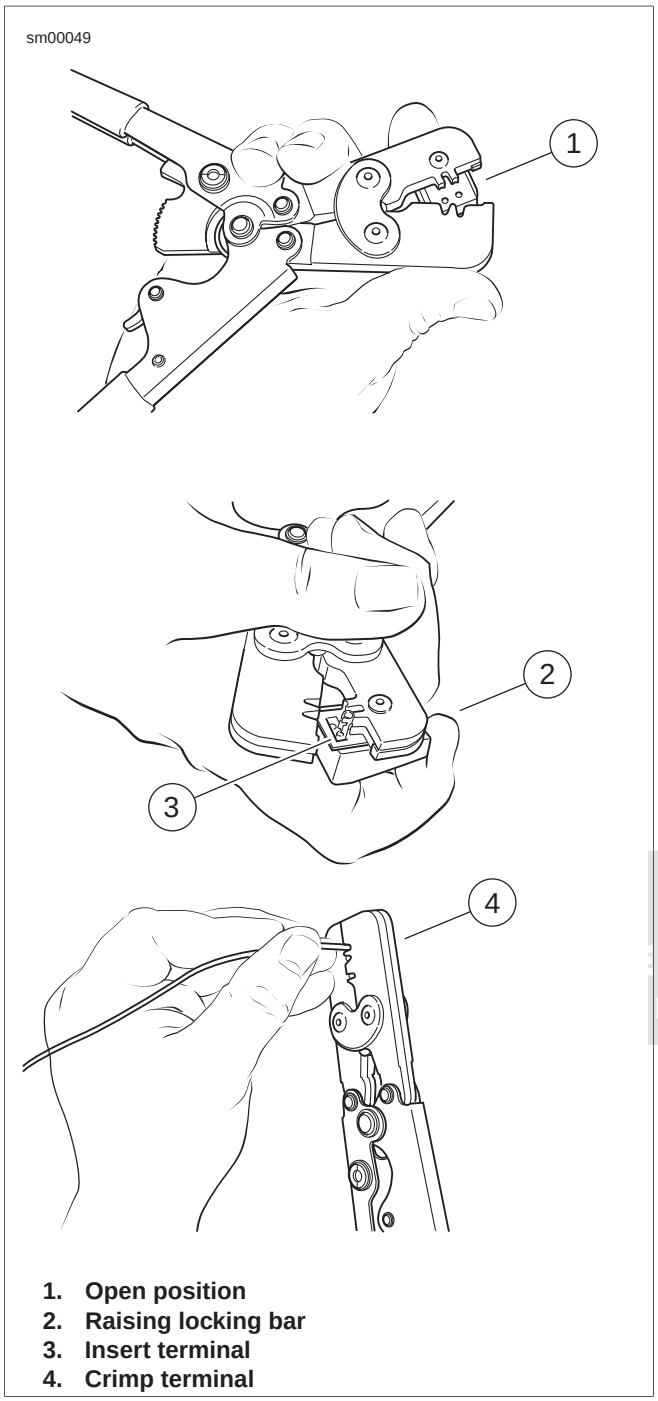


Figure A-44. Packard Micro 64 Terminal Crimper (HD-45929)



1. Open position
2. Raising locking bar
3. Insert terminal
4. Crimp terminal

Figure A-45. Packard Micro 64 Connector: Terminal in Crimper

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SEALED SPLICE CONNECTORS A.18

SEALED SPLICE CONNECTOR REPAIR

PART NUMBER	TOOL NAME
HD-25070	ROBINAIR HEAT GUN
HD-38125-8	PACKARD CRIMPING TOOL
HD-39969	ULTRA TORCH UT-100
HD-41183	HEAT SHIELD ATTACHMENT

General

Splice connectors and several OE ring terminal connectors use heat shrink covering to seal the connection.

Preparing Wire Leads

NOTE

If adjacent wires are to be spliced, stagger the splices so that the sealed splice connectors will not touch each other but are located at different positions along the length of the wires.

1. Using a shop gauge, identify the gauge of the wire.
2. Match the wire gauge to a sealed splice connector by color and part number. Refer to Table A-4.
3. Using a wire stripper, cut and strip a length of insulation off the wire ends. Refer to Table A-4 for the strip length.

Table A-4. Sealed Splice Connectors

WIRE GAUGE	COLOR	PART NO.	STRIP LENGTH
18-20 (0.5-0.8 mm)	Red	70585-93	3/8 in. (9.5 mm)
14-16 (1.0-2.0 mm)	Blue	70586-93	3/8 in. (9.5 mm)
10-12 (3.0-5.0 mm)	Yellow	70587-93	3/8 in. (9.5 mm)

NOTE

If any copper wire strands are cut off of the wire core, trim the end and strip the wire again in a larger gauge stripper.

Splicing Wire Leads

NOTE

See Figure A-47. The connector is crimped twice - one side and then the other.

1. See Figure A-46. Open the PACKARD CRIMPING TOOL (Part No. HD-38125-8) ratchet by squeezing the handles closed.
2. Match the connector color to the wire gauge crimp die in the jaws and insert one end of the sealed connector.
3. Gently squeeze the handles until the connector is held in the jaws.
4. See Figure A-47. Feed the stripped end of a wire into the connector until the wire stops inside the metal insert (1).
5. Squeeze the handles tightly closed to crimp the lead in the insert (2). The tool automatically opens when the crimping is complete.
6. Slide the connector to the other half of the metal insert. Insert the stripped wire lead (1) until it stops, and crimp the lead in the insert (2).

⚠WARNING

Be sure to follow manufacturer's instructions when using the UltraTorch UT-100 or any other radiant heating device. Failure to follow manufacturer's instructions can cause a fire, which could result in death or serious injury. (00335a)

- Avoid directing heat toward any fuel system component. Extreme heat can cause fuel ignition/explosion resulting in death or serious injury.
- Avoid directing heat toward any electrical system component other than the connectors on which heat shrink work is being performed.
- Always keep hands away from tool tip area and heat shrink attachment.

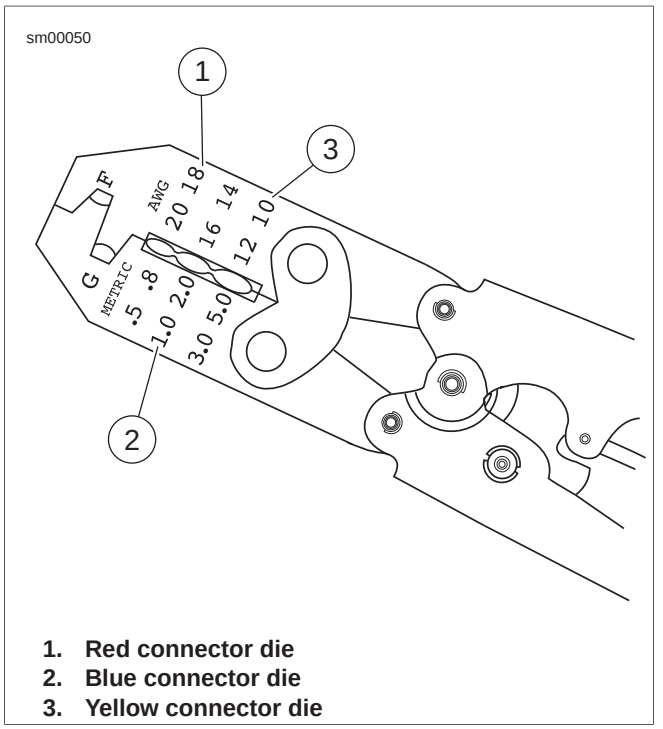
7. Use an ULTRA TORCH UT-100 (Part No. HD-39969), or a ROBINAIR HEAT GUN (Part No. HD-25070) with a HEAT SHIELD ATTACHMENT (Part No. HD-41183), to heat the connector from the center of the crimp (3) out to each end.

NOTE

It is acceptable for the splice to rest against the heat shrink tool attachment.

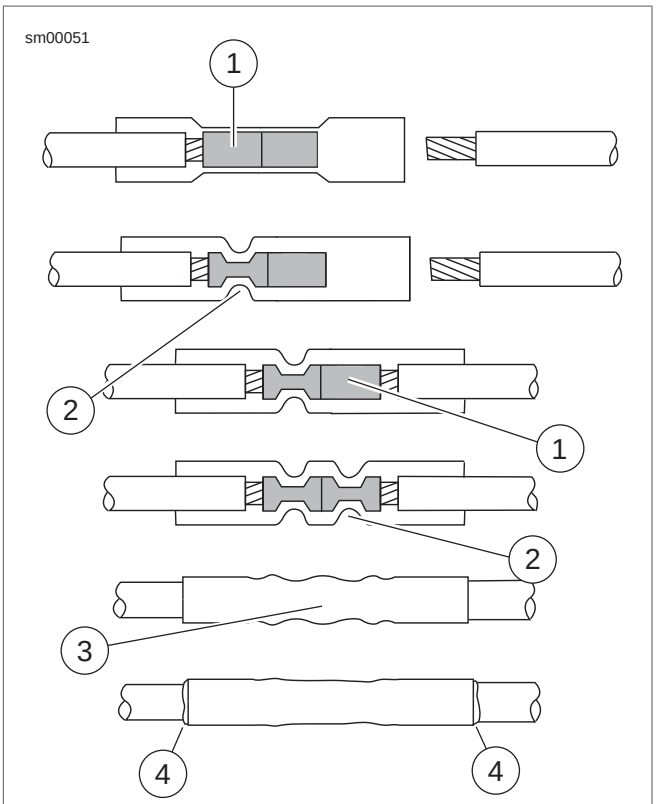
Inspecting Seals

See Figure A-47. Allow the splice to cool and inspect the seal. The insulation should appear smooth and cylindrical. Melted sealant will have extruded out the ends (4) of the insulation.



1. Red connector die
2. Blue connector die
3. Yellow connector die

Figure A-46. Packard Crimping Tool (HD-38125-8)



1. Wire lead in metal insert
2. Crimp metal insert
3. Center of crimp
4. Melted sealant

Figure A-47. Sealed Splice Connector

DIGITAL TECHNICIAN II HARLEY-DAVIDSON

TABLE OF CONTENTS

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B.1 CONNECTORS.....B-1
B.2 WIRING DIAGRAMS.....B-3

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NOTES

CONNECTORS B.1

CONNECTOR LOCATIONS

Function/Location

On the vehicle, a connector can be identified by its function and location. Refer to Table B-1.

Place and Color

The place (number of wire cavities of a connector housing) and color of the connector can also aid identification.

Connector Number

On wiring diagrams and in service/repair instructions, connectors are identified by a number in brackets.

Repair Instructions

The repair instructions in Appendix A are by connector type. Refer to Table B-1.

Table B-1. Dyna Connector Locations

NO.	DESCRIPTION	TYPE	TERMINAL PROBE COLOR	LOCATION
[4]	Accessory connector	4-place Deutsch (BK)	Black	Under seat
[5]	Main fuse	Spade terminals (BK)	Red	Under electrical caddie cover
[7]	Tail lamp harness to main harness	8-place Multilock (BK)	Gray	Under seat
[18]	Right rear turn signal	2-place Multilock (BK)	Gray	Inside tail lamp lens
[19]	Left rear turn signal	2-place Multilock (BK)	Gray	Inside tail lamp lens
[20]	Console gauges/indicator lamps (all except FXDC, FXDF, and FXDWG	12-place Deutsch (BK)	Black	Inside top frame tube
[21]	Indicator lamps	8-place Mini-Deutsch (BK) (FXDC, FXDF, FXDWG) 10-place Mini-Deutsch (BK) (FXDB)	Brown	Under fuel tank console
[22]	Right hand controls	6-place Molex (BK)	Gray	Inside top frame tube
[24]	Left hand controls	8-place Molex (GY)	Gray	Inside top frame tube
[30]	TSM/TSSM/HFSM	12-place Deutsch (GY)	Breakout Box	Under electrical caddie cover
[31 L]	Front turn signals (left)	3-place Multilock (W)	Gray	Inside top frame tube
[31 R]	Front turn signals (right)	3-place Multilock (BK)	Gray	Inside top frame tube
[33]	Ignition switch	3-place Delphi (BK)	Red	Inside top frame tube (FXD, FXDL) Under fuel tank console (FXDC, FXDF, FXDWG)
[38]	Headlamp	4-place Multilock (BK)	Gray	Inside top frame tube
[39]	Speedometer	12-place Packard (GY)	Breakout Box	Back of speedometer
[47]	Voltage regulator to stator	3-place Dekko (BK)		Back of voltage regulator
[62]	Fuse/Relay block (starter relay, system relay)	Spade terminals (BK)	Gray	Under electrical caddie cover
[64]	Fuse block	Spade terminals (BK)	Gray	Under electrical caddie cover
[65]	VSS	3-place Delphi (BK)	Gray	Rear of transmission case
[77]	Voltage regulator	2-place Dekko (BK)		Back of voltage regulator
[78]	ECM	36-place Packard (GY)	Breakout Box	Under electrical caddie cover
[79]	CKP Sensor	2-place Mini-Deutsch (BK)	Brown	Inside front electrical caddie
[80]	MAP sensor	3-place Delphi (GY)	Gray	Top of induction module
[83]	Ignition coil	4-place Delphi (GY)	Gray	Back of coil
[84]	Front fuel injector	2-place Delphi (GY)	Purple	Beneath fuel tank
[85]	Rear fuel injector	2-place Delphi (GY)	Purple	Beneath fuel tank

DIGITAL TECHNICIAN II HARLEY-DAVIDSON

Table B-1. Dyna Connector Locations

NO.	DESCRIPTION	TYPE	TERMINAL PROBE COLOR	LOCATION
[87]	IAC	4-place Delphi (BK)	Gray	Beneath fuel tank
[88]	TP sensor	3-place Delphi (BK)	Gray	Behind air cleaner backing plate
[89A]	IAT sensor	2-place Delphi (GY)	Gray	Behind air cleaner backing plate
[89B]	IAT sensor	2-place Deutsch (GY)	Brown	Under seat
[90]	ET sensor	2-place Delphi (BK)	Gray	Back of front cylinder, left side
[91]	DLC	4-place Deutsch (GY)	Black	Under electrical caddie cover
[93]	Tail lamp	4-place Multilock (BK)	Gray	Inside tail lamp lens
[94]	Tail lamp power in	6-place Multilock (BK)	Gray	Inside tail lamp lens
[108]	Tachometer	12-place Packard (GY)	Breakout Box	Back of tachometer
[117]	Fuel gauge	4-place Multilock (BK)	Gray	Under fuel tank
[120]	Oil pressure switch	Post terminal (BK)		Oil pressure switch, front of right crankcase
[121]	Rear stop lamp switch	Spade terminals (BK)	Red	Behind rear brake master cylinder
[122]	Horn	Spade terminals (BK)	Red	Between cylinders, left side
[128]	Starter solenoid	Spade terminal (W)	Red	Top of starter
[131]	Neutral switch	Post terminals (BK)		Top of transmission
[133]	JSS (HDI)	3-place Molex (BK)	Gray	Under seat
[137]	Rear O2 sensor (Domestic only)	2-place Amp (BK)	Gray	Under seat
[138]	Front O2 sensor (Domestic only)	2-place Amp (BK)	Gray	Inside front electrical caddie
[141]	Fuel pump and sender	4-place Delphi (BK)	Gray	Top of fuel tank
[142]	Security siren (optional)	3-place Delphi (BK)	Gray	Under seat
[154]	Trip odometer reset switch		Black	Back of speedometer (FXD) On console (FXDB, FXDL, FXDC, FXDF)
[160]	B+ connector	1-place Packard (GY)	Purple	Under seat
[178]	Active intake solenoid (HDI)	2-place Amp (BK)	Gray	Air cleaner backing plate
[179]	Active exhaust (HDI)	5-place Amp (BK)	Gray	Behind rear cylinder head
[208]	HFSM antenna harness	4-place Deutsch (GY)	Black	Under electrical caddie cover
[209]	HFSM antenna	2-place Molex (GY)	Gray	Under seat
[257]	Rear lighting	6-place Molex (BK)	Gray	Under seat
[266]	Anti-theft tracking module (BRA)	4-place Delphi (BK)	Gray	Under seat
[267]	Main harness	3-place Deutsch (BK)	Black	Under seat
[GND1] [GND2]	Harness grounds (3)	Ring terminals		Under electrical caddie

DIGITAL TECHNICIAN II HARLEY-DAVIDSON

WIRING DIAGRAMS B.2

WIRING DIAGRAM INFORMATION

Wire Color Codes

Wire traces on wiring diagrams are labeled with alpha codes. Refer to Table B-2.

For Solid Color Wires: See Figure B-1. The alpha code identifies wire color.

For Striped Wires: The code is written with a slash (/) between the solid color code and the stripe code. For example, a trace labeled GN/Y is a green wire with a yellow stripe.

Wiring Diagram Symbols

See Figure B-1. On wiring diagrams and in service/repair instructions, connectors are identified by a number in brackets. The letter inside the brackets identifies whether the housing is a socket or pin housing.

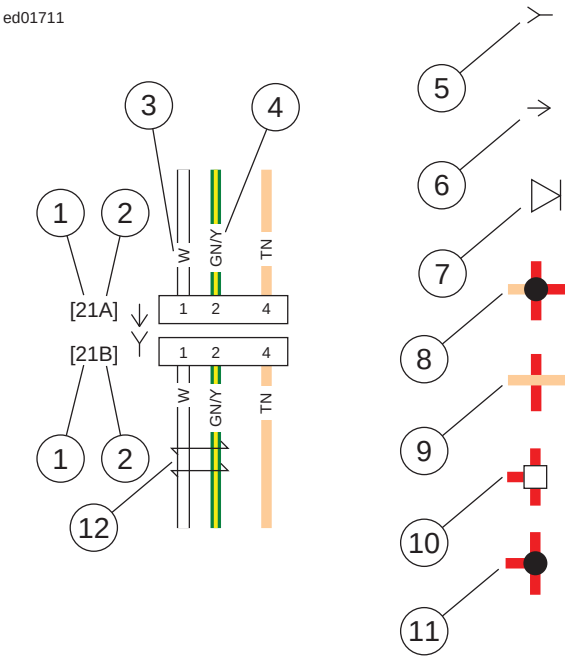
A=Pin: The letter A after a connector number and the pin symbol identifies a pin housing.

B=Socket: The letter B after a connector number and the socket symbol identifies a socket housing.

Other symbols found on the wiring diagrams include the symbol for a diode, a symbol for a wire-to-wire connection, a symbol verifying that no connection between two wire traces exists, symbols for actual and virtual splices, and a symbol identifying two wires that are twisted together.

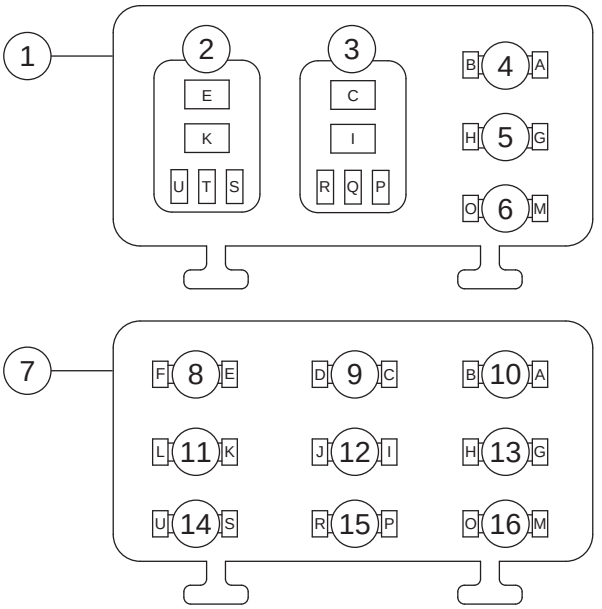
Actual splices are splices where two wires are connected together at a specific location along a wire. Virtual splices are splices shown connected anywhere along a wire, usually used in a wiring or schematic diagram for clarity.

Grounds are classified as either clean or dirty grounds. Clean grounds are normally used for sensors or modules. These grounds usually do not have electric motors or coils or anything that may cause electrical interference on the ground circuit. The dirty grounds are used for components that are not as sensitive to electrical interference.



1. **Connector number**
2. **Terminal code (A=pin, B=socket)**
3. **Solid wire color**
4. **Striped wire color**
5. **Socket symbol**
6. **Pin symbol**
7. **Diode**
8. **Connection**
9. **No connection**
10. **Actual splice**
11. **Virtual splice**
12. **Twisted pair**

Figure B-1. Connector/Wiring Diagram Symbols



1. **Fuse and relay block [62] (under left side cover)**
2. **Start relay**
3. **System relay**
4. **ECM**
5. **Fuel pump**
6. **Eng CTL**
7. **Fuse block [64] (under left side cover)**
8. **Spare**
9. **P&A IGN**
10. **Instruments**
11. **Spare**
12. **Battery**
13. **Ignition**
14. **Cust ACCY**
15. **Accessories**
16. **Lights**

Figure B-2. Fuse Block and Socket Terminals

Table B-2. Wire Color Codes

ALPHA CODE	WIRE COLOR
BE	Blue
BK	Black
BN	Brown
GN	Green
GY	Gray
LGN	Light Green
O	Orange
PK	Pink
R	Red
TN	Tan
V	Violet
W	White
Y	Yellow

DIGITAL TECHNICIAN II HARLEY-DAVIDSON

2010 DYNA WIRING DIAGRAMS

Refer to the table below for wiring diagram information.

Wiring Diagram List

DIAGRAM	LOCATION
Battery Power	Figure B-3
Accessory Power	Figure B-4
Ignition Power	Figure B-5
Sensor Grounds	Figure B-6
Chassis Grounds	Figure B-7
Sensor 5 Volt Reference Distribution	Figure B-8
Charging Circuit: 2010 Dyna	Figure B-9
Main Harness (1 of 2): 2010 Dyna (FXD, FXDB, and FXDL)	Figure B-10
Main Harness (1 of 2): 2010 Dyna (FXDC, FXDF, and FXDWG)	Figure B-11
Main Harness (2 of 2): 2010 Dyna	Figure B-12
Instruments and Indicators: 2010 Dyna	Figure B-13
Starting Circuit: 2010 Dyna	Figure B-14
Ignition Circuit: 2010 Dyna	Figure B-15
Lighting, Hand Controls, and Adapter Harnesses: 2010 Dyna	Figure B-16
Security Circuit: 2010 Dyna (FXD, FXDB, and FXDL)	Figure B-17
Security Circuit: 2010 Dyna (FXDC, FXDF, and FXDWG)	Figure B-18
Security Circuit, Anti-Theft Tracking Module (BRA): 2010 Dyna (FXD, FXDB, and FXDL)	Figure B-19
Security Circuit, Anti-Theft Tracking Module (BRA): 2010 Dyna (FXDC, FXDF, and FXDWG)	Figure B-20

DIGITAL TECHNICIAN II HARLEY-DAVIDSON

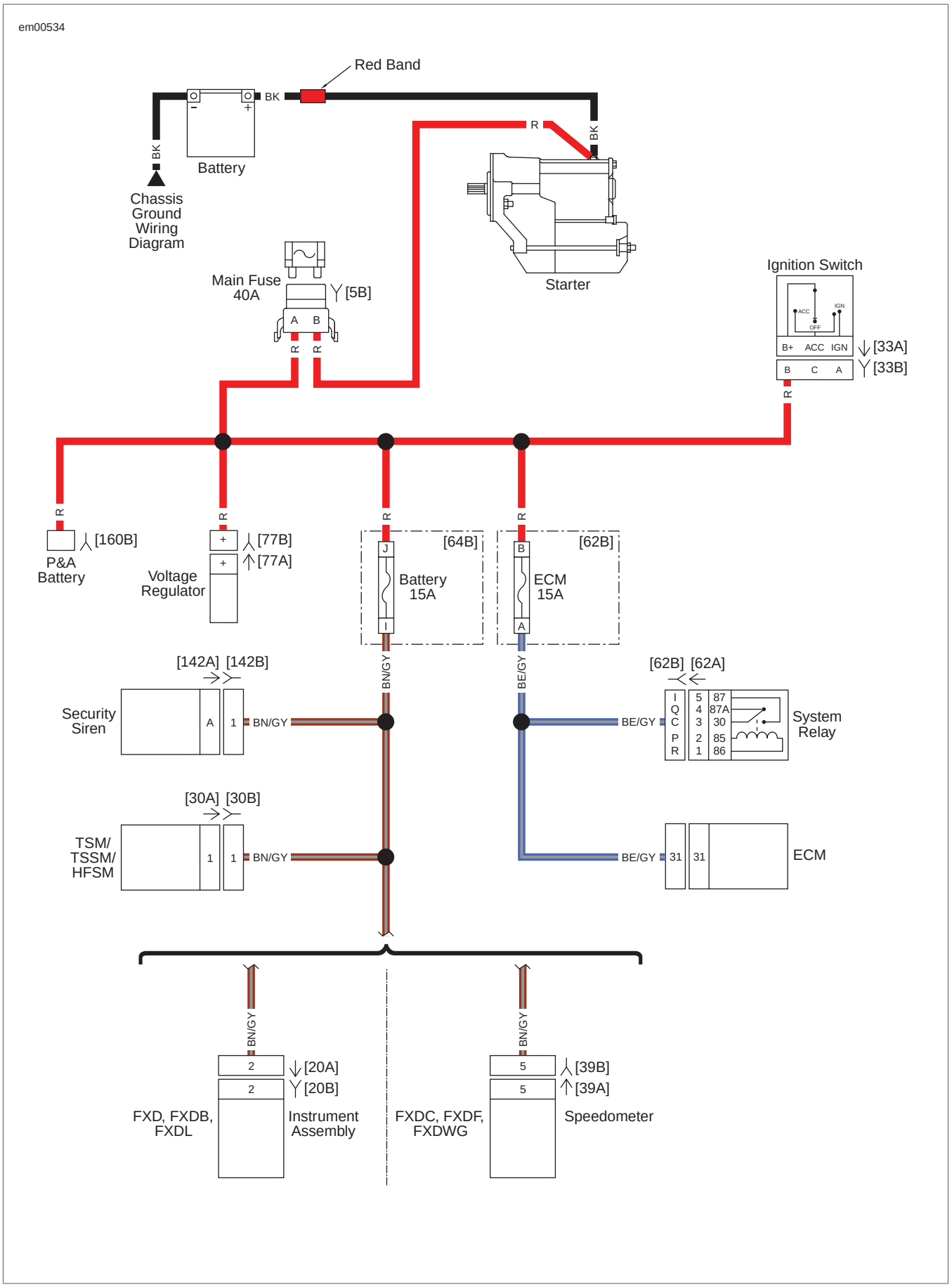


Figure B-3. Battery Power

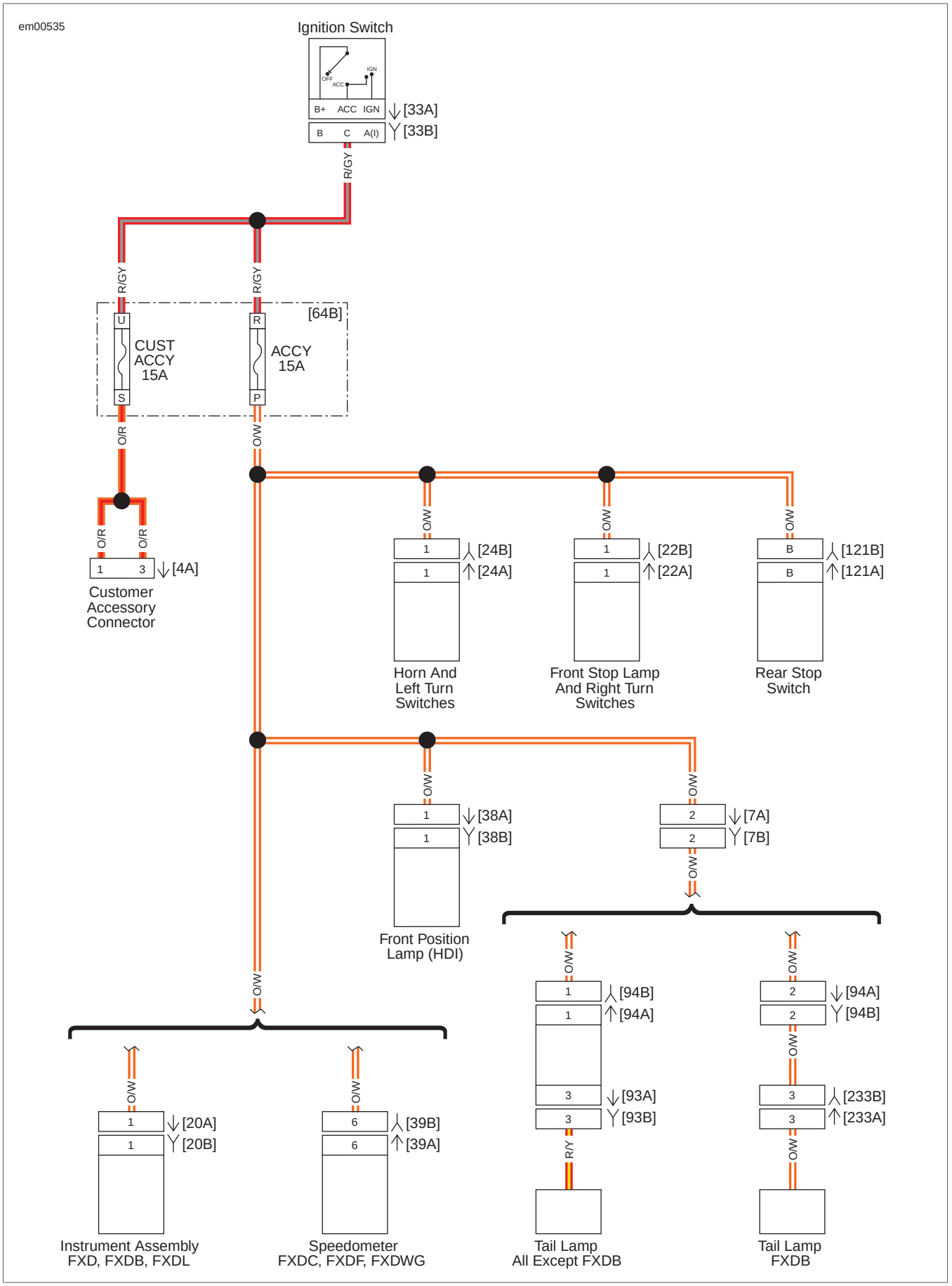


Figure B-4. Accessory Power

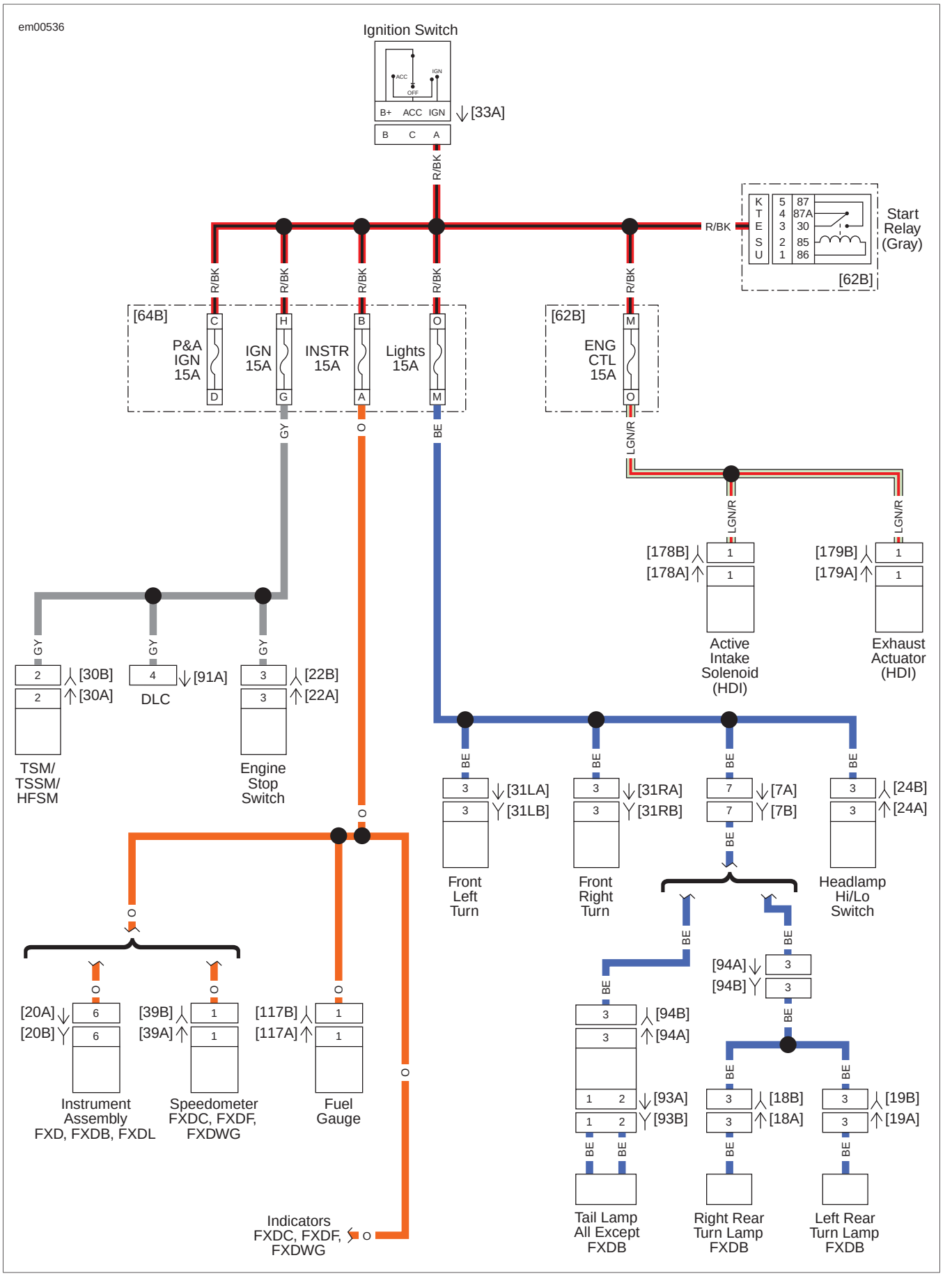


Figure B-5. Ignition Power

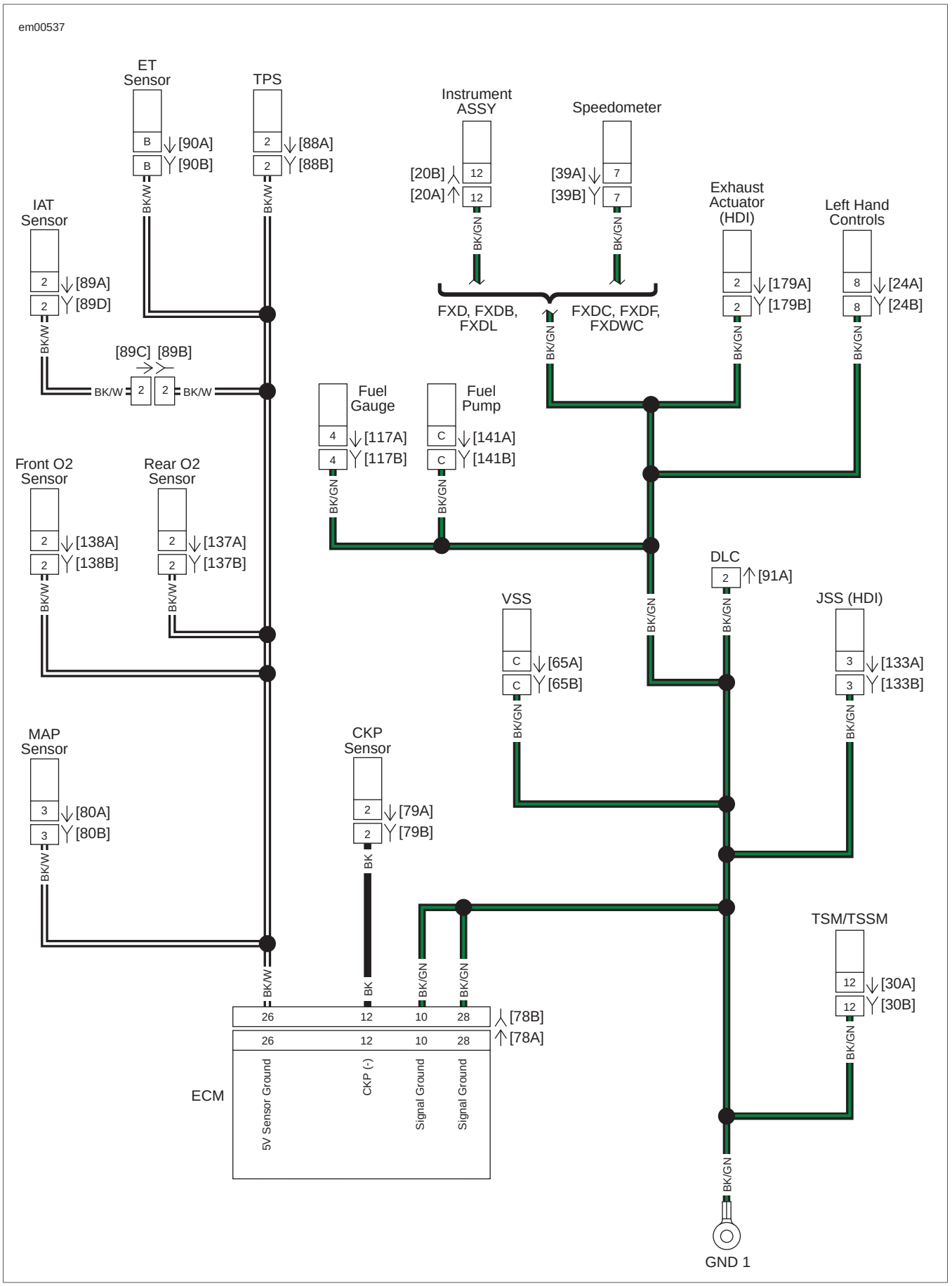


Figure B-6. Sensor Grounds

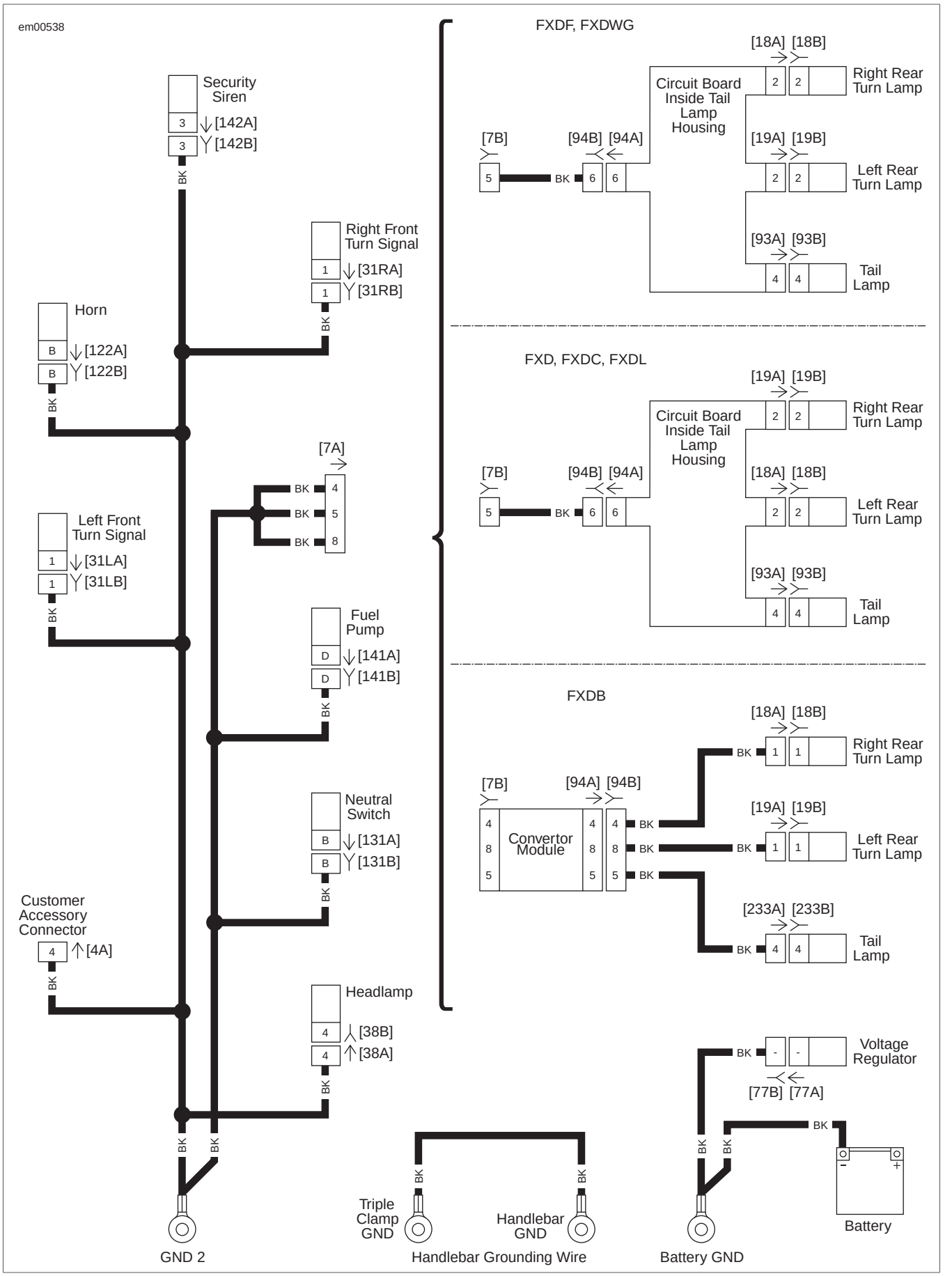


Figure B-7. Chassis Grounds

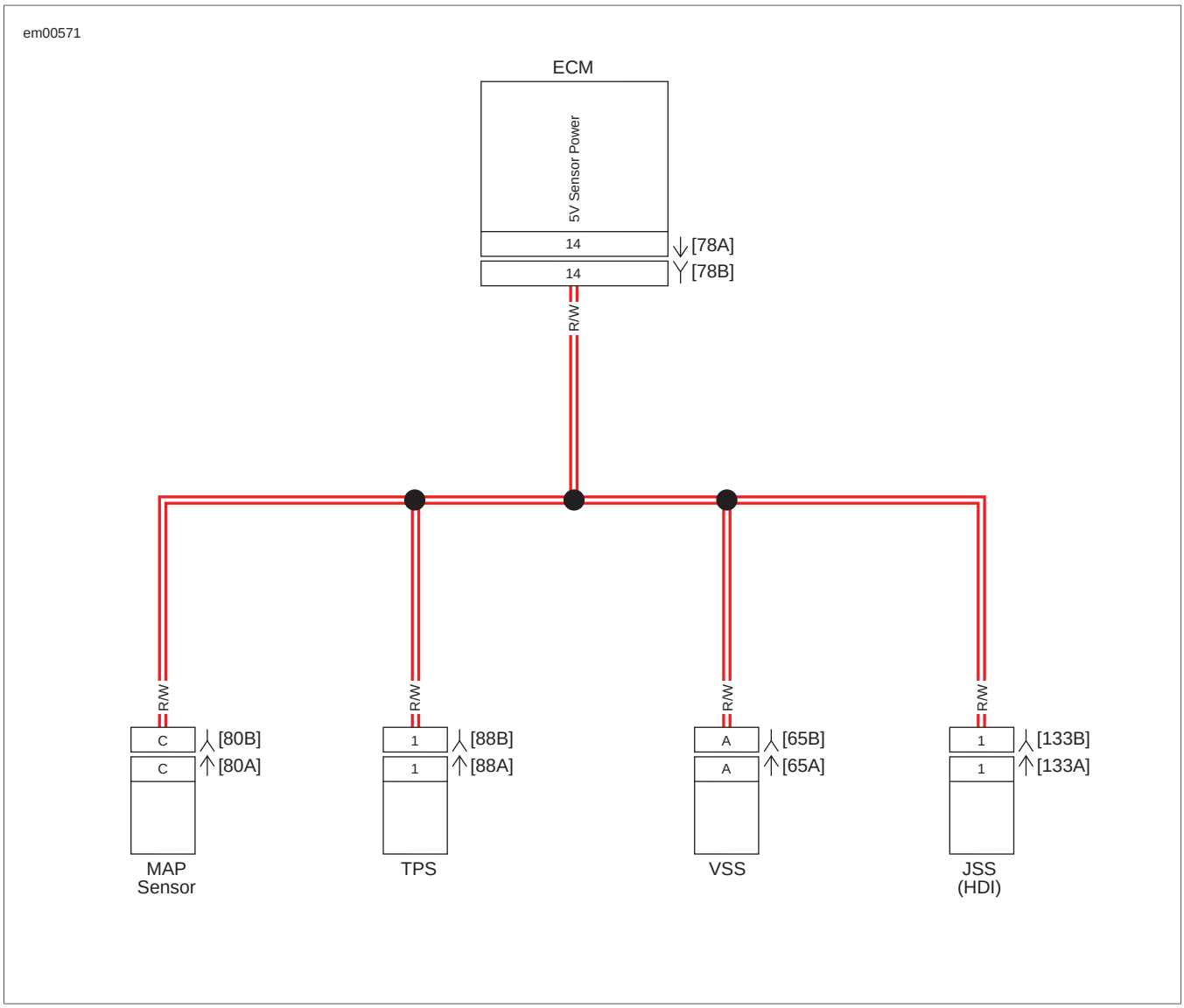


Figure B-8. Sensor 5 Volt Reference Distribution

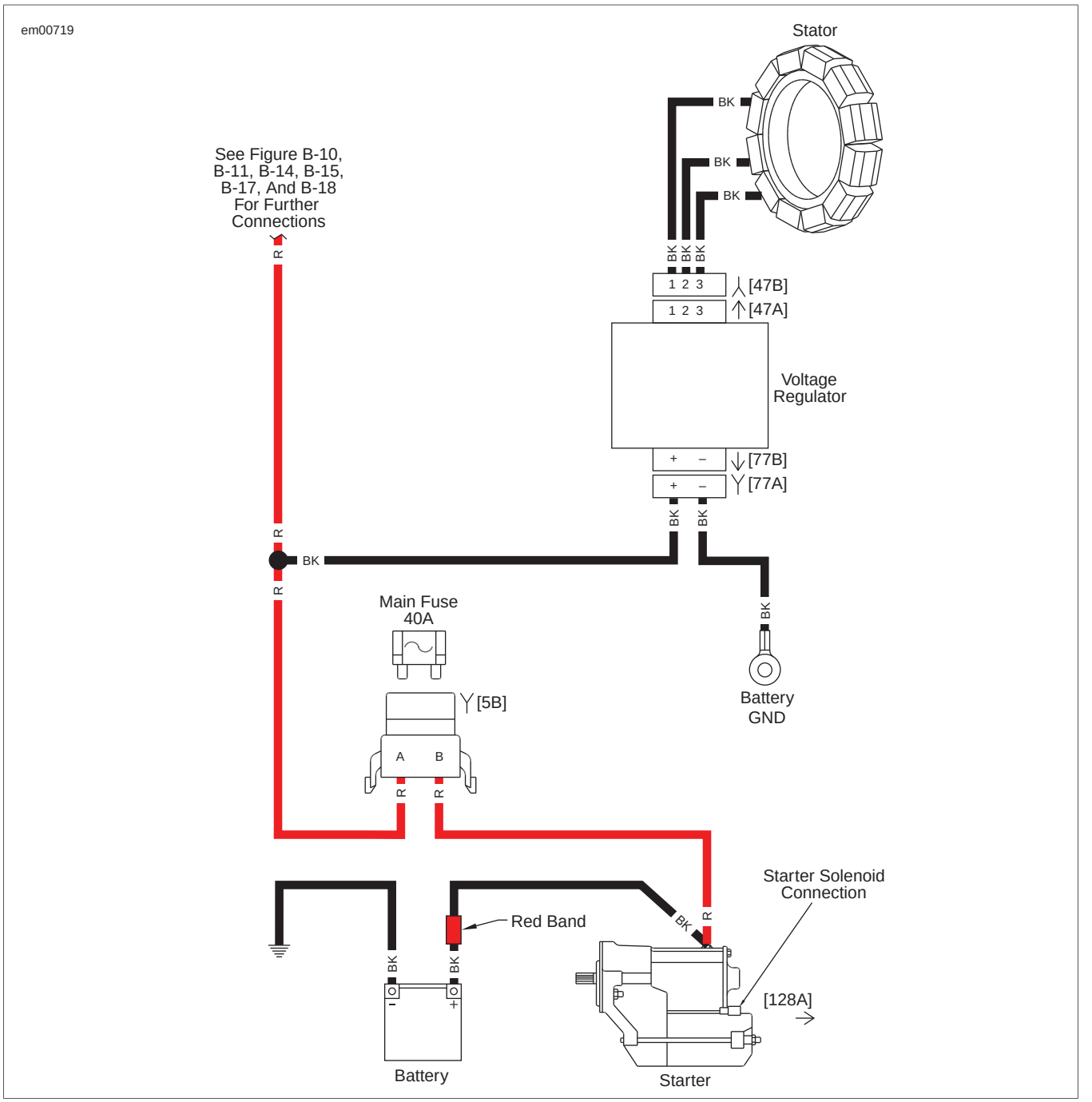


Figure B-9. Charging Circuit: 2010 Dyna

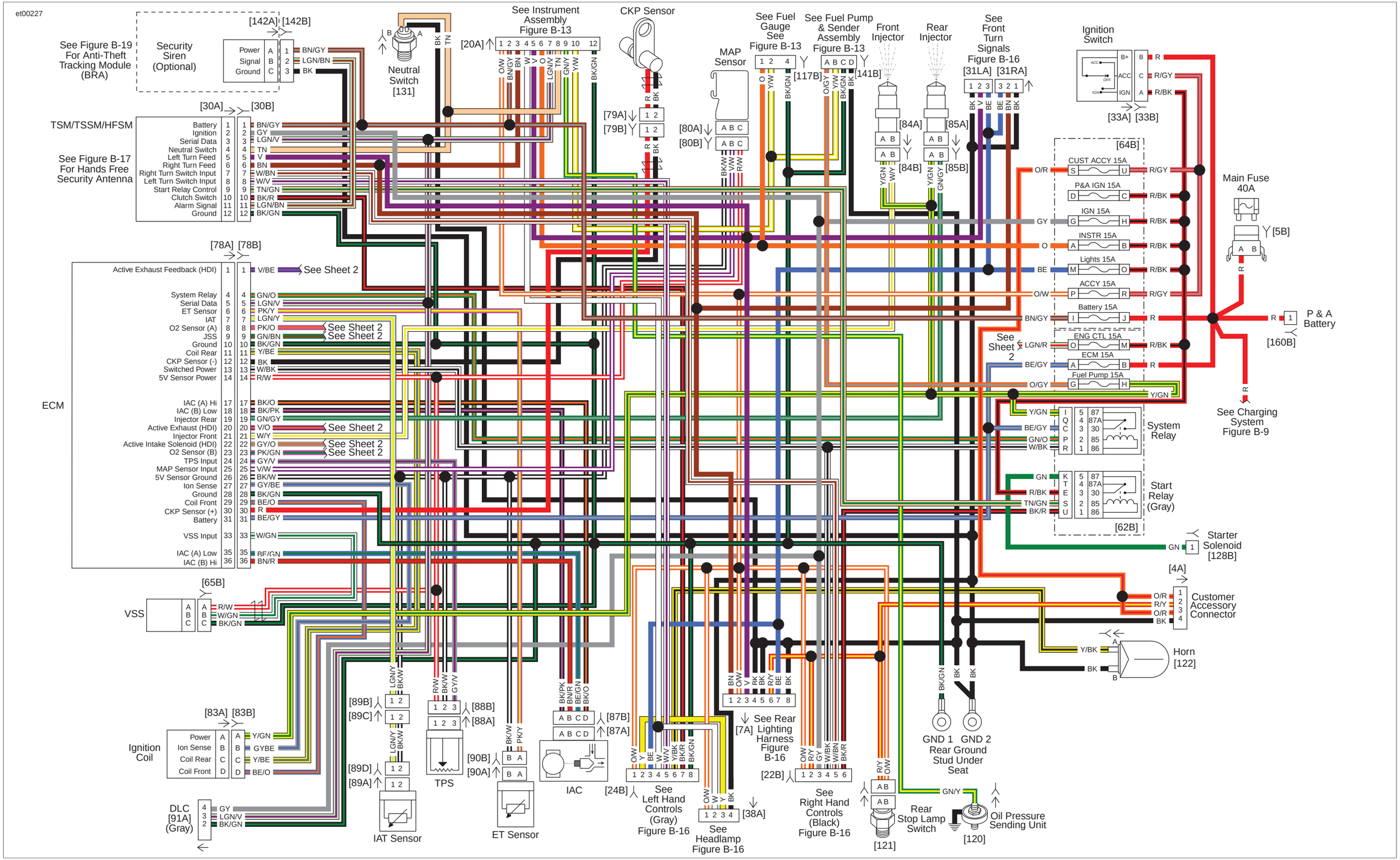


Figure B-10. Main Harness (1 of 2): 2010 Dyna (FXD, FXDB, and FXDL)

Figure B-10.
Main Harness (1 of 2): 2010 Dyna (FXD, FXDB, and FXDL)

Figure B-10.
Main Harness (1 of 2): 2010 Dyna (FXD, FXDB, and FXDL)

et00228

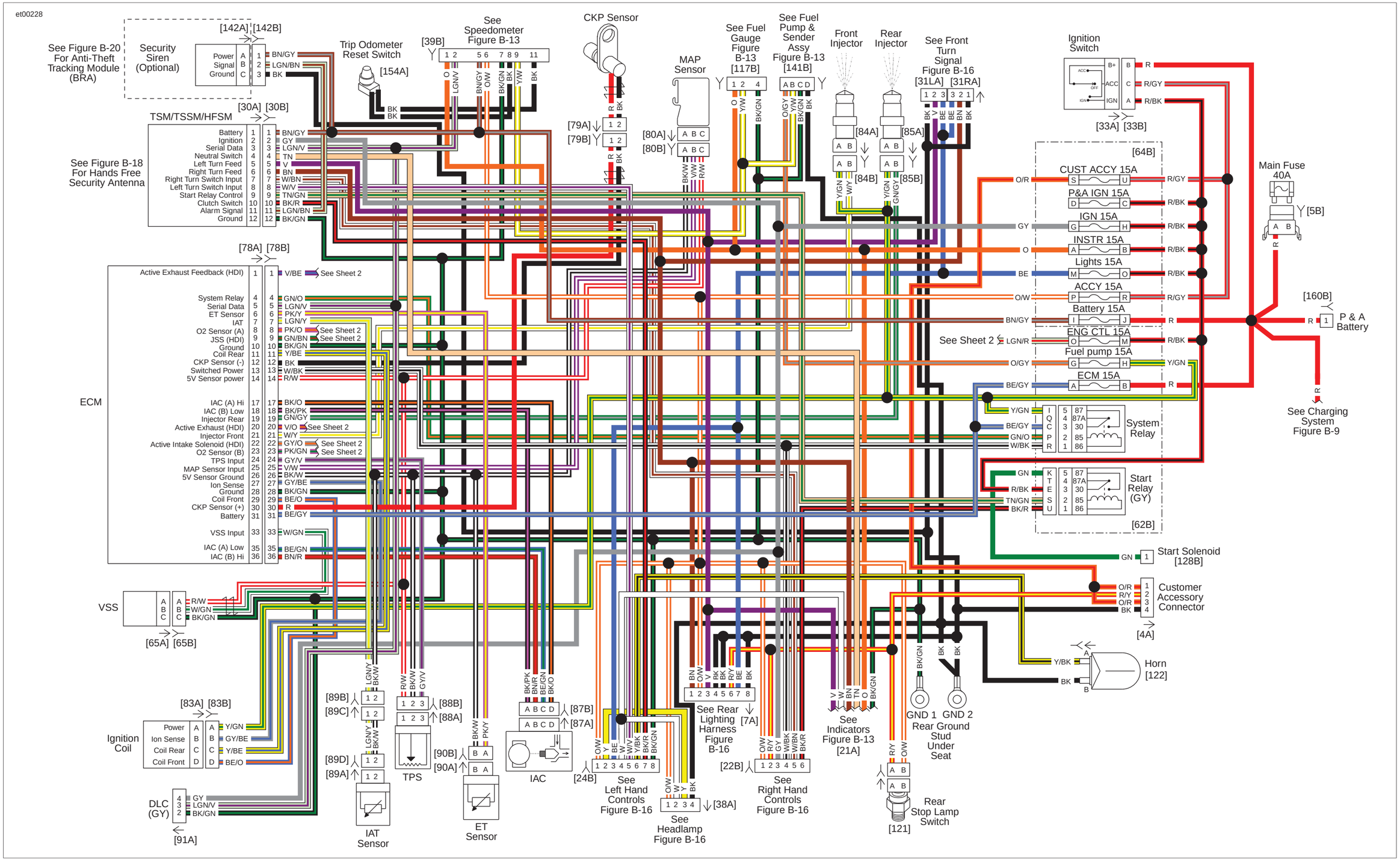


Figure B-11. Main Harness (1 of 2): 2010 Dyna (FXDC, FXDF, and FXDWG)

Figure B-11.
Main Harness (1 of 2): 2010 Dyna (FXDC, FXDF, and FXDWG)

Figure B-11.
Main Harness (1 of 2): 2010 Dyna (FXDC, FXDF, and FXDWG)

et00229

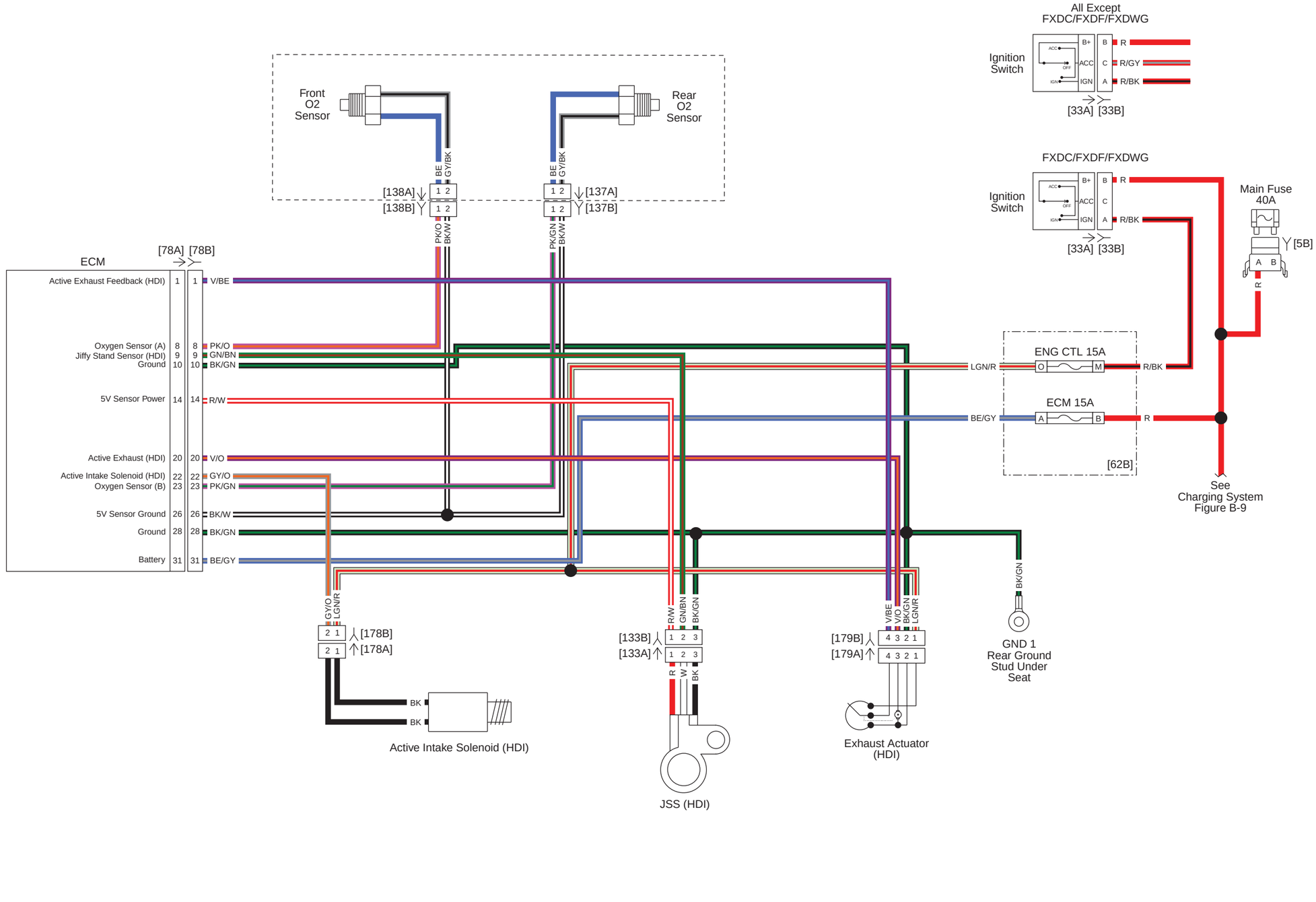
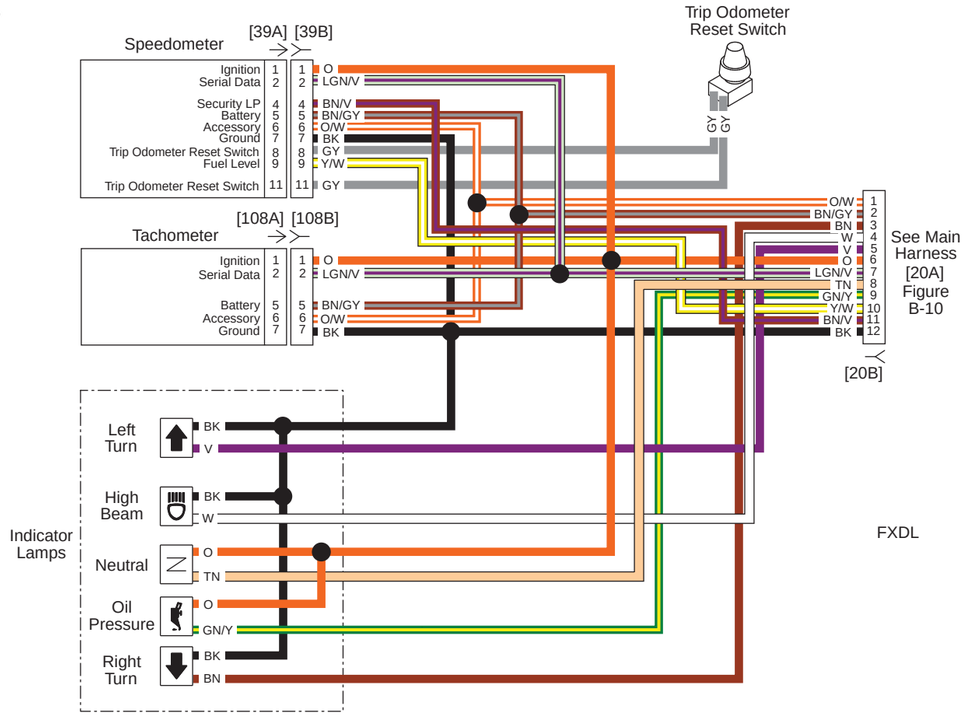


Figure B-12. Main Harness (2 of 2): 2010 Dyna

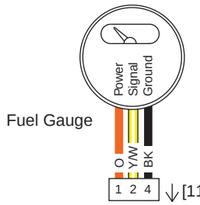
Figure B-12.
Main Harness (2 of 2): 2010 Dyna

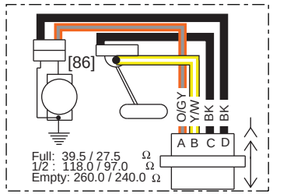
Figure B-12.
Main Harness (2 of 2): 2010 Dyna

et00230

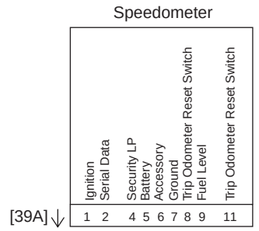


FXDL

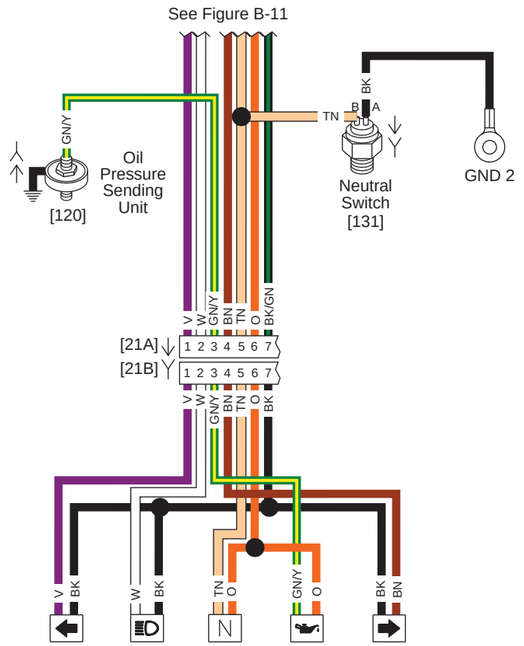




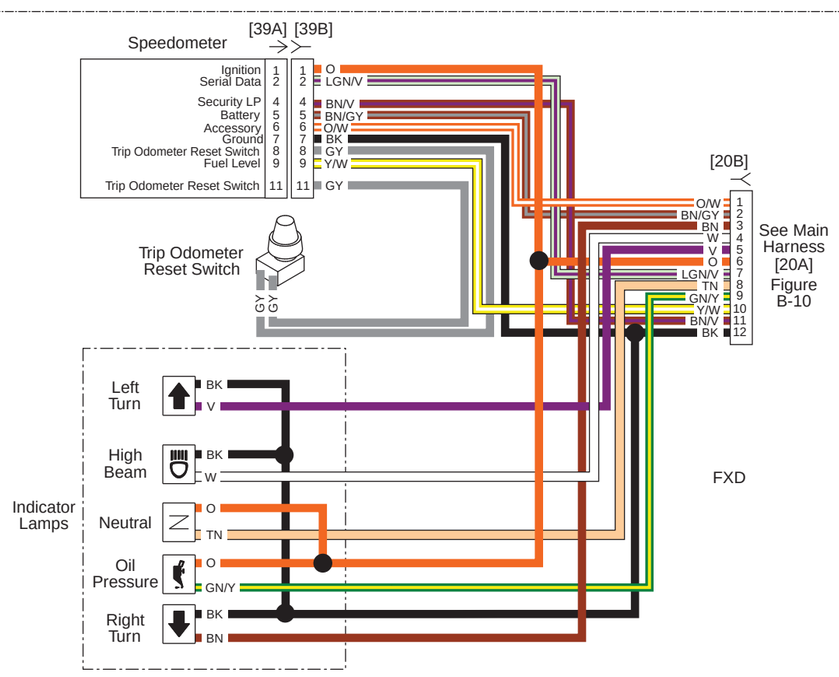
All Models



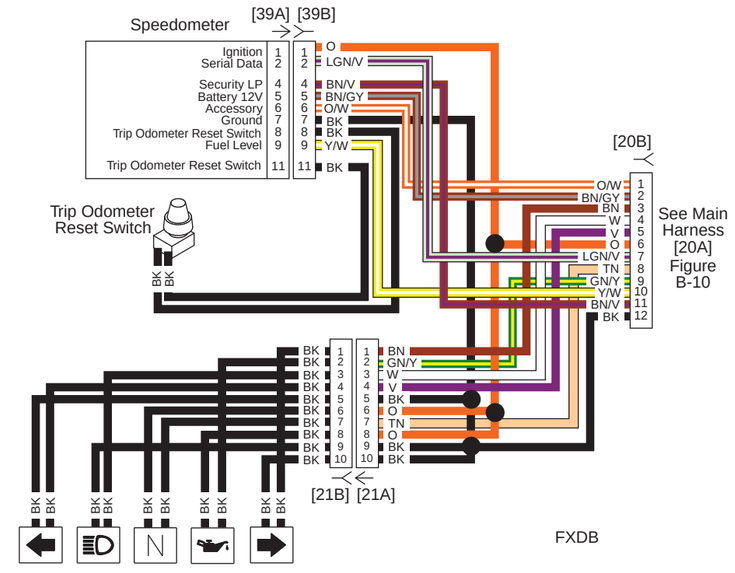
FXDC,FXDF,FXDWG



FXDC,FXDF,FXDWG



FXD



FXDB

Figure B-13. Instruments and Indicators: 2010 Dyna

Figure B-13.
Instruments and Indicators: 2010 Dyna

Figure B-13.
Instruments and Indicators: 2010 Dyna

et00232

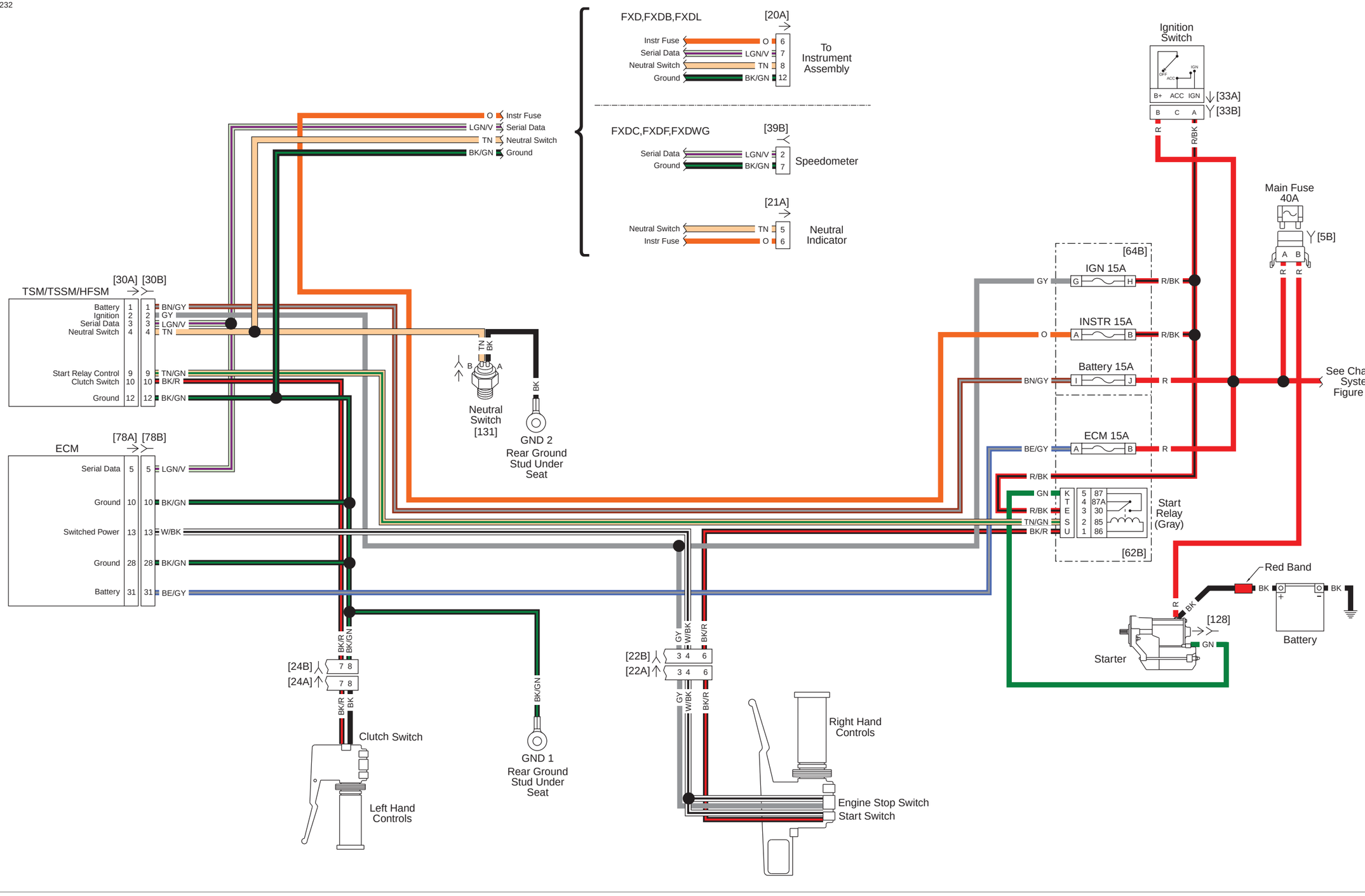


Figure B-14. Starting Circuit: 2010 Dyna

Figure B-14.
Starting Circuit: 2010 Dyna

Figure B-14.
Starting Circuit: 2010 Dyna

et00233

FXDC, FXDF, FXDWG

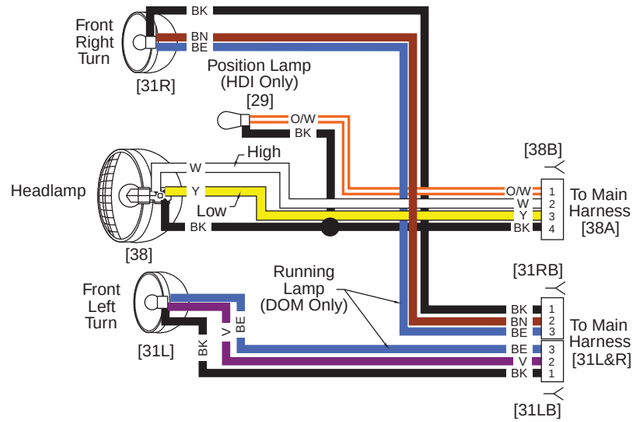
Figure B-15. Ignition Circuit: 2010 Dyna

Figure B-15.
Ignition Circuit: 2010 Dyna

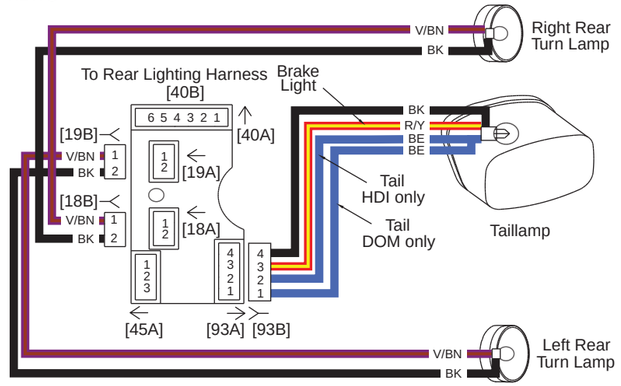
Figure B-15.
Ignition Circuit: 2010 Dyna

et00234

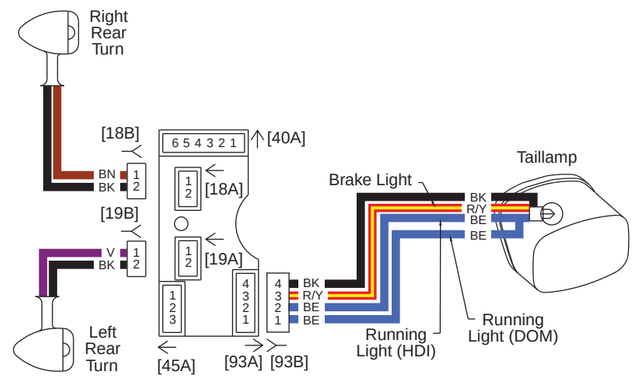
Front Lighting
All Models



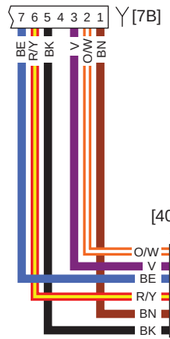
Rear Lighting
FXDF, FXDWG



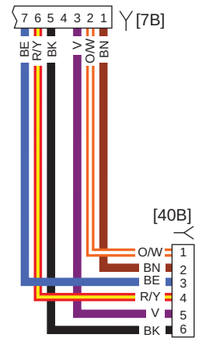
Rear Lighting
FXD, FXDL



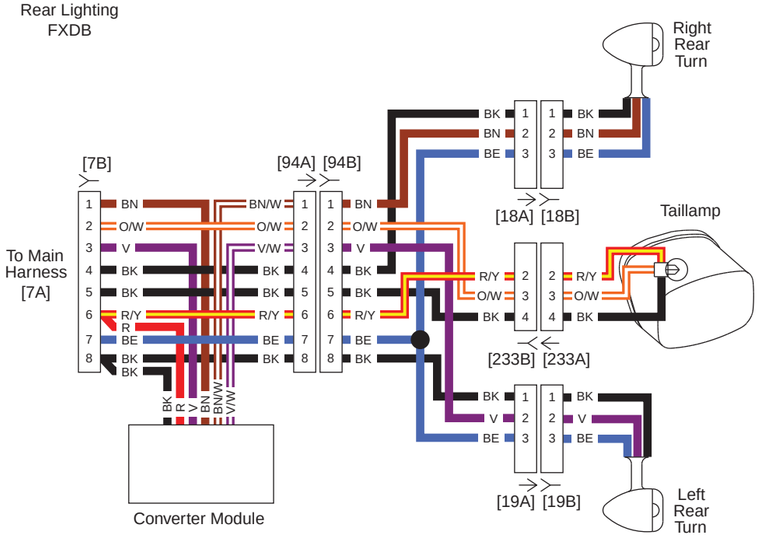
Rear Lighting Harness
FXDF,FXDWG



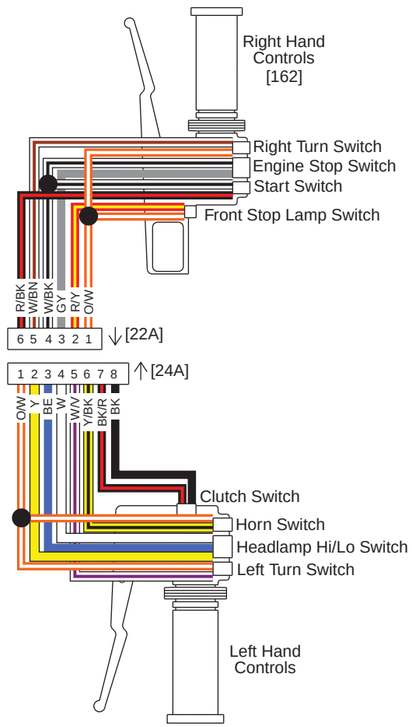
Rear Lighting Harness
FXD, FXDB, FXDC, FXDL



Rear Lighting
FXDB



Right And Left Hand Controls
All Models



Rear Lighting
FXDC

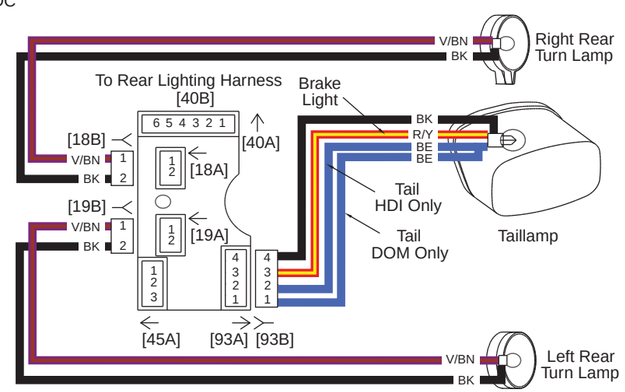


Figure B-16. Lighting, Hand Controls, and Adapter Harnesses: 2010 Dyna

Figure B-16.
Lighting, Hand Controls, and Adapter Harnesses: 2010 Dyna

Figure B-16.
Lighting, Hand Controls, and Adapter Harnesses: 2010 Dyna

et00235

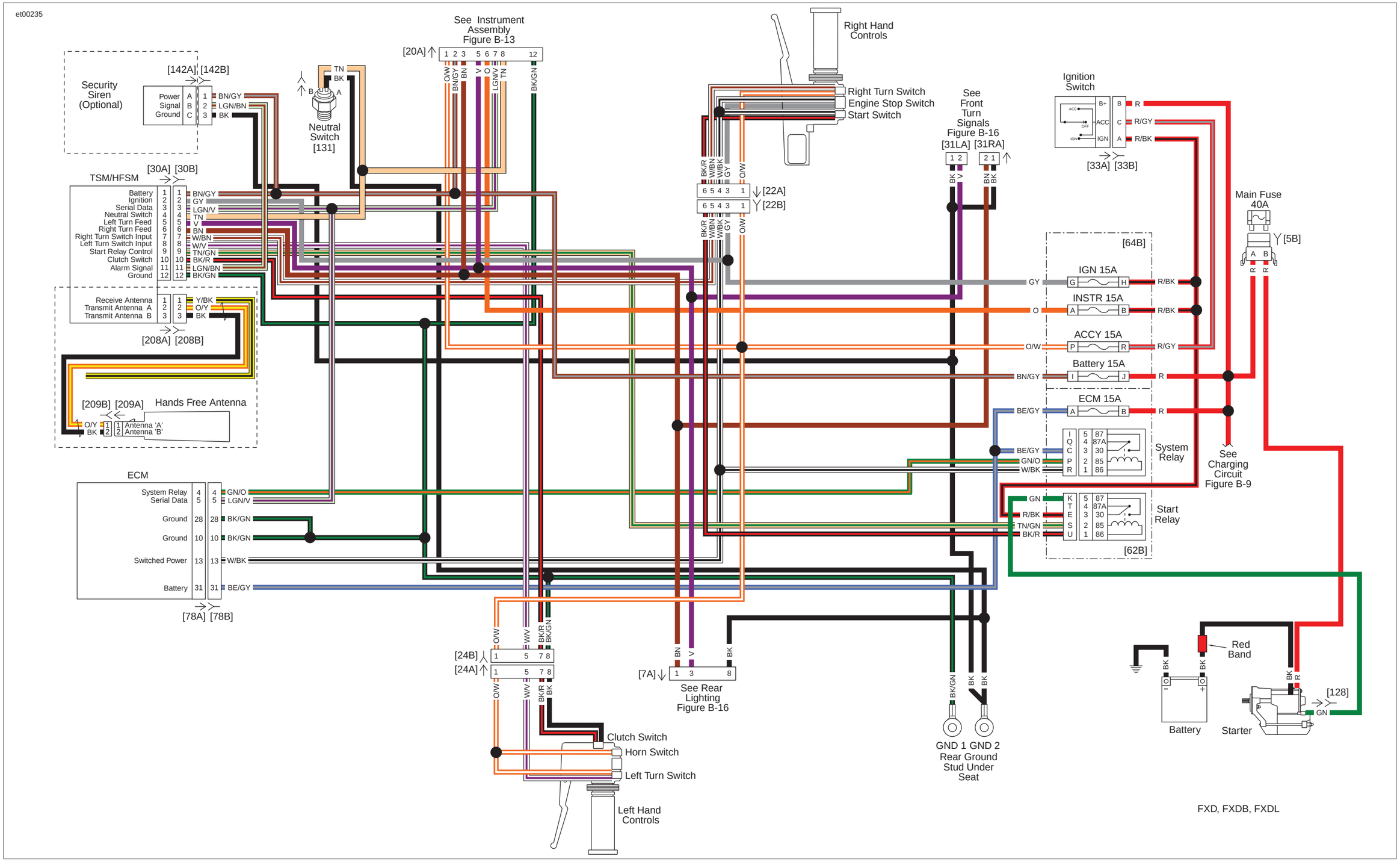


Figure B-17. Security Circuit: 2010 Dyna (FXD, FXDB, and FXDL)

Figure B-17.
Security Circuit: 2010 Dyna (FXD, FXDB, and FXDL)

Figure B-17.
Security Circuit: 2010 Dyna (FXD, FXDB, and FXDL)

et00236

Security Siren (Optional)
[142A] [142B]
Power A 1 BN/GY
Signal B 2 LGN/BN
Ground C 3 BK

Neutral Switch [131]
B C A
TN BK

See Speedometer Figure B-13
[39B] 1 2 5 6 7
O LGN/V BN/GY O/W BK/GN

N
BK O TN BN V
7 6 5 4 1 [21B]
7 6 5 4 1 [21A]
BK/GN O TN BN V

Right Hand Controls
Right Turn Switch
Engine Stop Switch
Start Switch
Front Stop Lamp Switch
BK/R W/BN W/BK GY R/Y O/W
6 5 4 3 2 1 [22A]
6 5 4 3 1 [22B]
BK/R W/BN W/BK GY O/W

See Front Turn Signals Figure B-16
[31LA] [31RA]
1 2 2 1
BK V BN BK

Ignition Switch
B+ B R
ACC C R/GY
IGN A R/BK
[33A] [33B]

Main Fuse 40A
[5B]
A B
R R

TSM/HFSM
[30A] [30B]
Battery 1 1 BN/GY
Ignition 2 2 GY
Serial Data 3 3 LGN/V
Neutral Switch 4 4 TN
Left Turn Feed 5 5 V
Right Turn Feed 6 6 BN
Right Turn Switch Input 7 7 W/BN
Left Turn Switch Input 8 8 W/V
Start Relay Control 9 9 TN/GN
Clutch Switch Control 10 10 BK/R
Alarm Signal 11 11 LGN/BN
Ground 12 12 BK/GN

Receive Antenna 1 1 Y/BK
Transmit Antenna A 2 2 O/Y
Transmit Antenna B 3 3 BK
[208A] [208B]

Hands Free Antenna
[209B] [209A]
O/Y 1 1
BK 2 2
Antenna 'A'
Antenna 'B'

[64B]
IGN 15A G H R/BK
INSTR 15A A B R/BK
ACCY 15A P R R/GY
Battery 15A I J R
ECM 15A A B R

System Relay
I 5 87
Q 4 87A
C 3 30
P 2 85
R 1 86
BE/GY GN/O W/BK

Start Relay (GRAY)
K 5 87
T 4 87A
E 3 30
S 2 85
U 1 86
GN R/BK TN/GN BK/R
[62B]

See Charging Circuit Figure B-9

ECM
System Relay 4 4 GN/O
Serial Data 5 5 LGN/V
Ground 28 28 BK/GN
Ground 10 10 BK/GN
Switched Power 13 13 W/BK
Battery 31 31 BE/GY
[78A] [78B]

[24B] 1 5 7 8
[24A] 1 2 3 4 5 6 7 8
O/W W/V BK/R BK/GN
O/W Y BE W W/V Y/BK BK/R BK

Clutch Switch
Horn Switch
Headlamp Hi/Lo Switch
Left Turn Switch
Left Hand Controls

[7A] 1 3 8
BN V BK
See Rear Lighting Figure B-16

BK/GN BK BK
GND 1 GND 2
Rear Ground Stud Under Seat

Red Band
BK BK
Battery
BK R
[128]
GN
Starter

FXDC, FXDF, FXDWG

Figure B-18. Security Circuit: 2010 Dyna (FXDC, FXDF, and FXDWG)

Figure B-18.
Security Circuit: 2010 Dyna (FXDC, FXDF, and FXDWG)

Figure B-18.
Security Circuit: 2010 Dyna (FXDC, FXDF, and FXDWG)

et00264

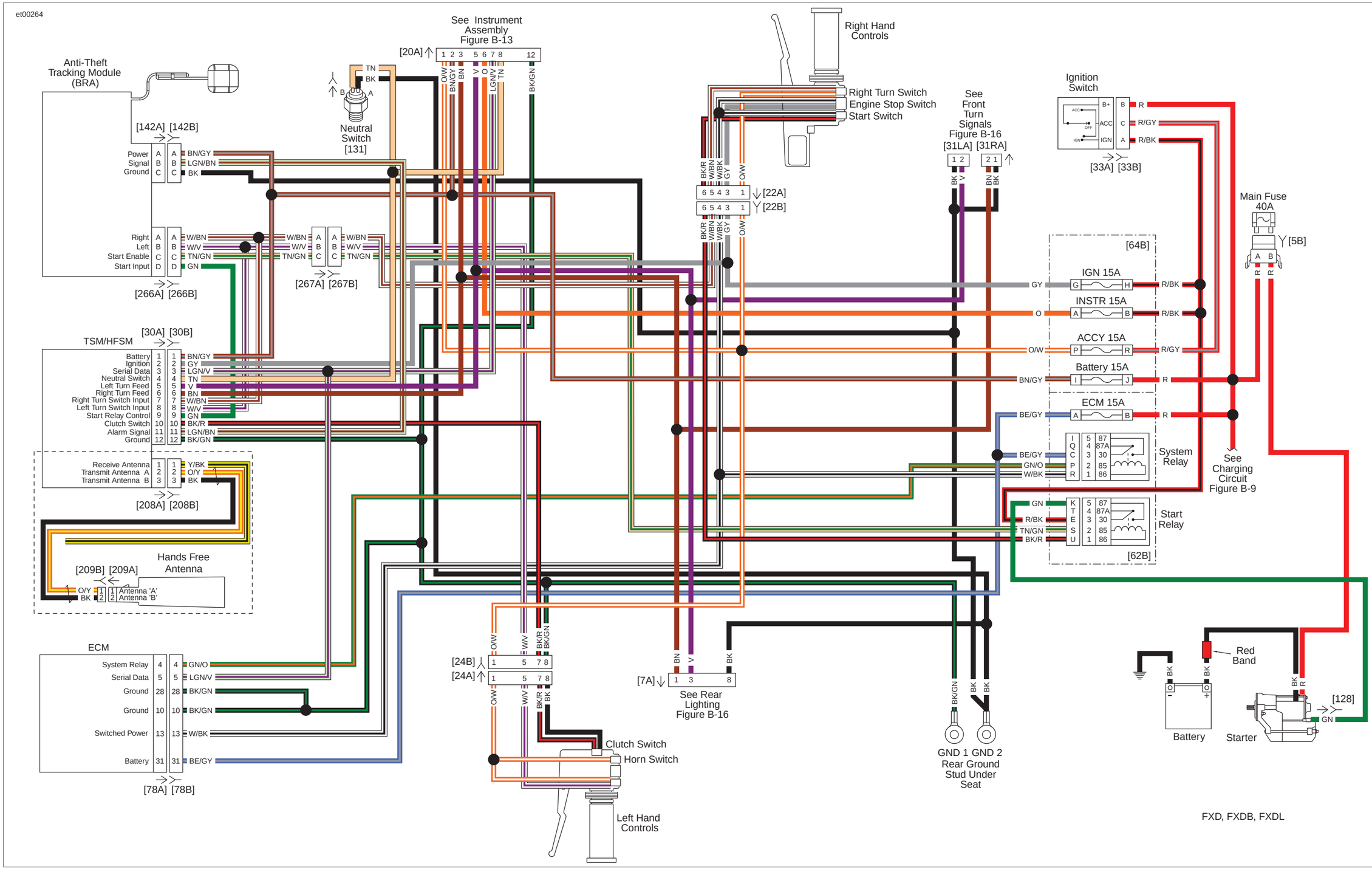


Figure B-19. Security Circuit, Anti-Theft Tracking Module (BRA): 2010 Dyna (FXD, FXDB, and FXDL)

Figure B-19.
Security Circuit, Anti-Theft Tracking Module (BRA): 2010 Dyna (FXD, FXDB, and FXDL)

Figure B-19.
Security Circuit, Anti-Theft Tracking Module (BRA): 2010 Dyna (FXD, FXDB, and FXDL)

et00265

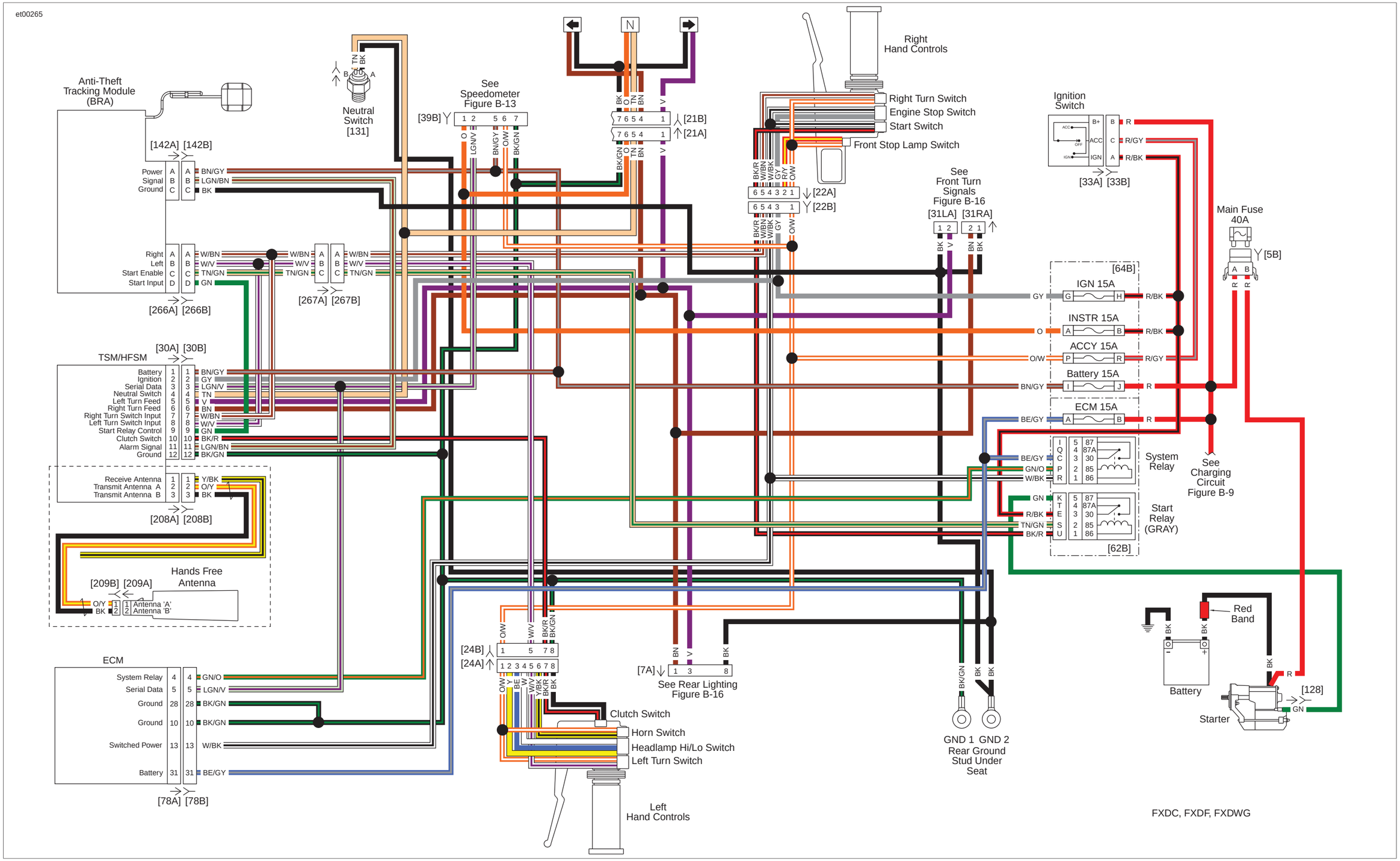


Figure B-20. Security Circuit, Anti-Theft Tracking Module (BRA): 2010 Dyna (FXDC, FXDF, and FXDWG)

Figure B-20.
Security Circuit, Anti-Theft Tracking Module (BRA): 2010 Dyna (FXDC, FXDF, and FXDWG)

Figure B-20.
Security Circuit, Anti-Theft Tracking Module (BRA): 2010 Dyna (FXDC, FXDF, and FXDWG)

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DIGITAL TECHNICIAN® II
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NOTES

METRIC CONVERSION C.1

CONVERSION TABLE

Table C-1. Metric Conversions

MILLIMETERS to INCHES (MM x 0.03937 = IN)								INCHES to MILLIMETERS (IN x 25.40 = MM)							
mm	in	mm	in	mm	in	mm	in	in	mm	in	mm	in	mm	in	mm
.1	.0039	25	.9842	58	2.283	91	3.582	.001	.025	.6	15.240	1-15/16	49.21	3-5/16	84.14
.2	.0078	26	1.024	59	2.323	92	3.622	.002	.051	5/8	15.875	2	50.80	3-3/8	85.72
.3	.0118	27	1.063	60	2.362	93	3.661	.003	.076	11/16	17.462	2-1/16	52.39	3.4	86.36
.4	.0157	28	1.102	61	2.401	94	3.701	.004	.102	.7	17.780	2.1	53.34	3-7/16	87.31
.5	.0197	29	1.142	62	2.441	95	3.740	.005	.127	3/4	19.050	2-1/8	53.97	3-1/2	88.90
.6	.0236	30	1.181	63	2.480	96	3.779	.006	.152	.8	20.320	2-3/16	55.56	3-9/16	90.49
.7	.0275	31	1.220	64	2.519	97	3.819	.007	.178	13/16	20.638	2.2	55.88	3.6	91.44
.8	.0315	32	1.260	65	2.559	98	3.858	.008	.203	7/8	22.225	2-1/4	57.15	3-5/8	92.07
.9	.0354	33	1.299	66	2.598	99	3.897	.009	.229	.9	22.860	2.3	58.42	3-11/16	93.66
1	.0394	34	1.338	67	2.638	100	3.937	.010	.254	15/16	23.812	2-5/16	58.74	3.7	93.98
2	.0787	35	1.378	68	2.677	101	3.976	1/64	.397	1	25.40	2-3/8	60.32	3-3/4	95.25
3	.1181	36	1.417	69	2.716	102	4.016	.020	.508	1-1/16	26.99	2.4	60.96	3.8	96.52
4	.1575	37	1.456	70	2.756	103	4.055	.030	.762	1.1	27.94	2-7/16	61.91	3-13/16	96.84
5	.1968	38	1.496	71	2.795	104	4.094	1/32	.794	1-1/8	28.57	2-1/2	63.50	3-7/8	98.42
6	.2362	39	1.535	72	2.834	105	4.134	.040	1.016	1-3/16	30.16	2-9/16	65.09	3.9	99.06
7	.2756	40	1.575	73	2.874	106	4.173	.050	1.270	1.2	30.48	2.6	66.04	3-15/16	100.01
8	.3149	41	1.614	74	2.913	107	4.212	.060	1.524	1-1/4	31.75	2-5/8	66.67	4	101.6
9	.3543	42	1.653	75	2.953	108	4.252	1/16	1.588	1.3	33.02	2-11/16	68.26	4-1/16	102.19
10	.3937	43	1.693	76	2.992	109	4.291	.070	1.778	1-5/16	33.34	2.7	68.58	4.1	104.14
11	.4331	44	1.732	77	3.031	110	4.331	.080	2.032	1-3/8	34.92	2-3/4	69.85	4-1/8	104.77
12	.4724	45	1.772	78	3.071	111	4.370	.090	2.286	1.4	35.56	2.8	71.12	4-3/16	106.36
13	.5118	46	1.811	79	3.110	112	4.409	.1	2.540	1-7/16	36.51	2-13/16	71.44	4.2	106.68
14	.5512	47	1.850	80	3.149	113	4.449	1/8	3.175	1-1/2	38.10	2-7/8	73.02	4-1/4	107.95
15	.5905	48	1.890	81	3.189	114	4.488	3/16	4.762	1-9/16	39.69	2.9	73.66	4.3	109.22
16	.6299	49	1.929	82	3.228	115	4.527	.2	5.080	1.6	40.64	2-15/16	74.61	4-5/16	109.54
17	.6693	50	1.968	83	3.268	116	4.567	1/4	6.350	1-5/8	41.27	3	76.20	4-3/8	111.12
18	.7086	51	2.008	84	3.307	117	4.606	.3	7.620	1-11/16	42.86	3-1/16	77.79	4.4	111.76
19	.7480	52	2.047	85	3.346	118	4.645	5/16	7.938	1.7	43.18	3.1	78.74	4-7/16	112.71
20	.7874	53	2.086	86	3.386	119	4.685	3/8	9.525	1-3/4	44.45	3-1/8	79.37	4-1/2	114.30
21	.8268	54	2.126	87	3.425	120	4.724	.4	10.160	1.8	45.72	3-3/16	80.96	4-9/16	115.89
22	.8661	55	2.165	88	3.464	121	4.764	7/16	11.112	1-13/16	46.04	3.2	81.28	4.6	116.84
23	.9055	56	2.205	89	3.504	122	4.803	1/2	12.700	1-7/8	47.62	3-1/4	82.55	4-5/8	117.47
24	.9449	57	2.244	90	3.543	123	4.842	9/16	14.288	1.9	48.26	3.3	83.82	4-11/16	119.06

FLUID CONVERSIONS C.2

UNITED STATES SYSTEM

Unless otherwise specified, all fluid volume measurements in this Service Manual are expressed in United States (U.S.) units-of-measure. See below:

- 1 pint (U.S.) = 16 fluid ounces (U.S.)
- 1 quart (U.S.) = 2 pints (U.S.) = 32 fl. oz. (U.S.)
- 1 gallon (U.S.) = 4 quarts (U.S.) = 128 fl. oz. (U.S.)

METRIC SYSTEM

Fluid volume measurements in this Service Manual include the metric system equivalents. In the metric system, 1 liter (L) = 1,000 milliliters (mL). Should you need to convert from U.S. units-of-measure to metric units-of-measure (or vice versa), refer to the following:

- fluid ounces (U.S.) x 29.574 = milliliters
- pints (U.S.) x 0.473 = liters
- quarts (U.S.) x 0.946 = liters
- gallons (U.S.) x 3.785 = liters
- milliliters x 0.0338 = fluid ounces (U.S.)
- liters x 2.114 = pints (U.S.)
- liters x 1.057 = quarts (U.S.)
- liters x 0.264 = gallons (U.S.)

BRITISH IMPERIAL SYSTEM

Fluid volume measurements in this Service Manual do not include the British Imperial (Imp.) system equivalents. The following conversions exist in the British Imperial system:

- 1 pint (Imp.) = 20 fluid ounces (Imp.)
- 1 quart (Imp.) = 2 pints (Imp.)
- 1 gallon (Imp.) = 4 quarts (Imp.)

Although the same unit-of-measure terminology as the U.S. system is used in the British Imperial (Imp.) system, the actual volume of each British Imperial unit-of-measure differs from its U.S. counterpart. The U.S. fluid ounce is larger than the British Imperial fluid ounce. However, the U.S. pint, quart, and gallon are smaller than the British Imperial pint, quart, and gallon, respectively. Should you need to convert from U.S. units to British Imperial units (or vice versa), refer to the following:

- fluid ounces (U.S.) x 1.042 = fluid ounces (Imp.)
- pints (U.S.) x 0.833 = pints (Imp.)
- quarts (U.S.) x 0.833 = quarts (Imp.)
- gallons (U.S.) x 0.833 = gallons (Imp.)
- fluid ounces (Imp.) x 0.960 = fluid ounces (U.S.)
- pints (Imp.) x 1.201 = pints (U.S.)
- quarts (Imp.) x 1.201 = quarts (U.S.)
- gallons (Imp.) x 1.201 = gallons (U.S.)

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TORQUE CONVERSIONS C.3

UNITED STATES SYSTEM

The U.S. units of torque, foot pounds and inch pounds, are used in this service manual. To convert units, use the following equations:

- foot pounds (ft-lbs) X 12.00000 = inch pounds (**in-lbs**).
- inch pounds (**in-lbs**) X 0.08333 = foot pounds (ft-lbs).

METRIC SYSTEM

All metric torque specifications are written in Newton-meters (Nm). To convert metric to United States units and United States to metric, use the following equations:

- Newton meters (Nm) X 0.737563 = foot pounds (ft-lbs).
- Newton meters (Nm) X 8.85085 = inch pounds (**in-lbs).**
- foot pounds (ft-lbs) X 1.35582 = Newton meters (Nm).
- inch pounds (**in-lbs**) X 0.112985 = Newton meters (Nm).

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DIGITAL TECHNICIAN® II
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GLOSSARY D.1

ACRONYMS AND ABBREVIATIONS

Table D-1. Acronyms and Abbreviations

ACRONYM OR ABBREVIATION	DESCRIPTION
A	Amperes
ABS	Anti-lock Braking System
Ah	Ampere-hour
AC	Alternating Current
ACC	Accessory position on ignition switch
ACR	Automatic compression release
AIS	Active Intake Solenoid
AGM	Absorbed Glass Mat (battery)
AWG	American Wire Gauge
B+	Battery voltage
bar	Bar
BAS	Bank angle sensor
BTDC	Before top dead center
°C	Celsius (Centigrade)
CA	California
CAL	Calibration
CAN	Controller area network
cc	Cubic Centimeters
cm	Centimeters
cm^3	Cubic centimeters
CCA	Cold Cranking Amps
CKP	Crankshaft position
cm	Centimeter
CCW	Counterclockwise
CW	Clockwise
DC	Direct current
DLC	Data link connector
DOM	Domestic
DTC	Diagnostic Trouble Code
DOT	Department of Transportation
DVOM	Digital Volt Ohm Meter
ECM	Electronic control module
ECT	Engine Coolant Temperature
ECU	electronic control unit
EEPROM	Electrically Erasable Programmable Read Only Memory
EFI	Electronic Fuel Injection
ET	Engine Temperature
EVAP	Evaporative Emissions Control System
°F	Fahrenheit
FPS	Fuel Pressure Sensor

DIGITAL TECHNICIAN® II HARLEY-DAVIDSON®

Table D-1. Acronyms and Abbreviations

ACRONYM OR ABBREVIATION	DESCRIPTION
ft	Foot
ft-lbs	Foot-Pounds
fl oz	Fluid Ounce
g	Gram
gal	Gallon
GAWR	Gross axle weight rating
GPS	Global Positioning System
GND	Ground (electrical)
GVWR	Gross vehicle weight rating
HCU	Hydraulic control unit
HDI	Harley-Davidson International
H-DSSS	Harley-Davidson Smart Security System
HFSM	Hands-Free Security Module
Hg	Mercury
H02S	Heated oxygen sensor
hp	Horsepower
hr	Hour
IAC	Idle Air Control
IAT	Intake Air Temperature
IC	Instrument Cluster
ID	Inside diameter
IGN	Ignition light/key switch position
in	Inch
in^3	Cubic inch
INJ PW	Injector pulse width
in-lbs	Inch-pounds
JSS	Jiffy stand sensor
kg	Kilogram
km	Kilometer
kPa	Kilopascal
km/h	Kilometers per hour
kW	Kilowatt
L	Liter
lb	Pounds
LCD	Liquid crystal display
LED	Light emitting diode
L	Liter
mA	Milliampere
MAP	Manifold absolute pressure
max	Maximum
mi	Mile
ml	Milliliter
min	Minimum

DIGITAL TECHNICIAN II HARLEY-DAVIDSON

Table D-1. Acronyms and Abbreviations

ACRONYM OR ABBREVIATION	DESCRIPTION
mL	Milliliter
mm	Millimeter
mph	Miles per hour
ms	millisecond
Nm	Newton-meter
NiMH	Nickel metal hydride
N/A	Not applicable
O2	Oxygen
OD	Outside Diameter
OEM	Original Equipment Manufacturer
oz	Ounce
P&A	Parts and Accessories
Part No.	Part Number
PIN	Personal identification number
psi	Pounds per square inch
PWM signal	Pulse Width Modulated signal
qt	Quart
RCM	Reverse control module
RES	Reserve mark on fuel supply valve
RPM	Revolutions per minute
s	seconds
SCFH	Cubic feet per hour at standard conditions
TCA	Throttle control actuator
TDC	Top dead center
TGS	Twist grip sensor
TMAP	Intake Air Temperature/Manifold Absolute Pressure
TPS	Throttle Position Sensor
TSM	Turn Signal Module
TSSM	Turn Signal/Security Module
V	Volt
VAC	Volts of alternating current
VDC	Volts of direct current
VIN	Vehicle identification number
VSS	Vehicle speed sensor
W	Watt
WSS	Wheel speed sensor

DIGITAL TECHNICIAN II HARLEY-DAVIDSON

NOTES

Tools Used in This Manual

PART NUMBER	TOOL NAME	NOTES
HD-23738	VACUUM PUMP	6.4 DTC P0107, P0108, Description and Operation
HD-25070	ROBINAIR HEAT GUN	A.18 SEALED SPLICE CONNECTORS, Sealed Splice Connector Repair
HD-26792	SPARK TESTER	1.2 DIAGNOSTIC TOOLS, How To Use Diagnostic Tools
HD-26792	SPARK TESTER	6.22 ENGINE CRANKS, BUT WILL NOT START, Engine Cranks but Will Not Start
HD-26792	SPARK TESTER	6.26 MISFIRE AT IDLE OR UNDER LOAD, Misfire At Idle or Under Load
HD-34730-2D	FUEL INJECTOR TEST LIGHT	1.2 DIAGNOSTIC TOOLS, How To Use Diagnostic Tools
HD-34730-2D	FUEL INJECTOR TEST LIGHT	1.2 DIAGNOSTIC TOOLS, How To Use Diagnostic Tools
HD-34730-2D	FUEL INJECTOR TEST LIGHT	5.4 TURN SIGNALS, One Turn Signal Lamp Inoperative, No DTCs
HD-34730-2D	FUEL INJECTOR TEST LIGHT	6.9 DTC P0261, P0262, P0263, P0264, DTC P0261
HD-34730-2D	FUEL INJECTOR TEST LIGHT	6.9 DTC P0261, P0262, P0263, P0264, DTC P0263
HD-34730-2D	FUEL INJECTOR TEST LIGHT	6.17 DTC P1351, P1352, P1354, P1355, DTC P1351
HD-34730-2D	FUEL INJECTOR TEST LIGHT	6.17 DTC P1351, P1352, P1354, P1355, DTC P1354
HD-38125-6	PACKARD TERMINAL CRIMP TOOL	A.14 METRI-PACK TERMINALS, Metri-Pack Terminal Crimps
HD-38125-7	PACKARD TERMINAL CRIMPER	A.6 DEUTSCH MINI-TERMINAL CRIMPS, Deutsch Mini Terminal Crimps
HD-38125-7	PACKARD TERMINAL CRIMPER	A.14 METRI-PACK TERMINALS, Metri-Pack Terminal Crimps
HD-38125-8	PACKARD CRIMPING TOOL	A.14 METRI-PACK TERMINALS, Metri-Pack Terminal Crimps
HD-38125-8	PACKARD CRIMPING TOOL	A.18 SEALED SPLICE CONNECTORS, Sealed Splice Connector Repair
HD-39965-A	DEUTSCH TERMINAL CRIMP TOOL	A.5 DEUTSCH STANDARD TERMINALS, Deutsch Standard Terminal Crimps
HD-39969	ULTRA TORCH UT-100	A.18 SEALED SPLICE CONNECTORS, Sealed Splice Connector Repair
HD-39978	DIGITAL MULTIMETER (FLUKE 78)	1.2 DIAGNOSTIC TOOLS, How To Use Diagnostic Tools
HD-39978	DIGITAL MULTIMETER (FLUKE 78)	1.3 DIAGNOSTICS AND TROUBLESHOOTING, Wiggle Test
HD-41183	HEAT SHIELD ATTACHMENT	A.18 SEALED SPLICE CONNECTORS, Sealed Splice Connector Repair
HD-41199-3	IAC TEST LIGHT	1.2 DIAGNOSTIC TOOLS, How To Use Diagnostic Tools
HD-41199-3	IAC TEST LIGHT	6.12 DTC P0505, DTC P0505
HD-41404-B	HARNESS CONNECTOR TEST KIT	1.2 DIAGNOSTIC TOOLS, How To Use Diagnostic Tools
HD-41404-B	HARNESS CONNECTOR TEST KIT	2.3 DTC U1016, U1064, U1097, U1255, DTC U1016
HD-41404-B	HARNESS CONNECTOR TEST KIT	2.3 DTC U1016, U1064, U1097, U1255, DTC U1016
HD-41404-B	HARNESS CONNECTOR TEST KIT	2.3 DTC U1016, U1064, U1097, U1255, DTC U1064, U1255
HD-41404-B	HARNESS CONNECTOR TEST KIT	2.3 DTC U1016, U1064, U1097, U1255, DTC U1064, U1255
HD-41404-B	HARNESS CONNECTOR TEST KIT	2.3 DTC U1016, U1064, U1097, U1255, DTC U1097, U1255
HD-41404-B	HARNESS CONNECTOR TEST KIT	2.3 DTC U1016, U1064, U1097, U1255, DTC U1097, U1255
HD-41404-B	HARNESS CONNECTOR TEST KIT	2.3 DTC U1016, U1064, U1097, U1255, DTC U1097, U1255
HD-41404-B	HARNESS CONNECTOR TEST KIT	2.4 DTC U1300, U1301 OR BUS ER, DTC U1301

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Tools Used in This Manual

PART NUMBER	TOOL NAME	NOTES
HD-41404-B	HARNESS CONNECTOR TEST KIT	3.2 STARTING SYSTEM, Starter Testing
HD-41404-B	HARNESS CONNECTOR TEST KIT	3.2 STARTING SYSTEM, Start Relay Clicks
HD-41404-B	HARNESS CONNECTOR TEST KIT	3.6 DTC B0563, P0562, P0563, DTC P0562
HD-41404-B	HARNESS CONNECTOR TEST KIT	4.2 DTC B1004, B1005, DTC B1004
HD-41404-B	HARNESS CONNECTOR TEST KIT	4.2 DTC B1004, B1005, DTC B1005
HD-41404-B	HARNESS CONNECTOR TEST KIT	4.4 NO INSTRUMENT POWER, Speedometer Inoperative
HD-41404-B	HARNESS CONNECTOR TEST KIT	4.4 NO INSTRUMENT POWER, Speedometer Inoperative
HD-41404-B	HARNESS CONNECTOR TEST KIT	5.4 TURN SIGNALS, Both Turn Signal Lamps on One Side Inoperative, No DTCs
HD-41404-B	HARNESS CONNECTOR TEST KIT	5.4 TURN SIGNALS, Both Turn Signal Lamps on One Side Inoperative, No DTCs
HD-41404-B	HARNESS CONNECTOR TEST KIT	5.4 TURN SIGNALS, One Turn Signal Lamp Inoperative, No DTCs
HD-41404-B	HARNESS CONNECTOR TEST KIT	5.8 DTC B1121, B1122, B1123, B1124, B1125, B1126, DTC B1121: TSM/TSSM
HD-41404-B	HARNESS CONNECTOR TEST KIT	5.8 DTC B1121, B1122, B1123, B1124, B1125, B1126, DTC B1122: TSM/TSSM
HD-41404-B	HARNESS CONNECTOR TEST KIT	5.8 DTC B1121, B1122, B1123, B1124, B1125, B1126, DTC B1123
HD-41404-B	HARNESS CONNECTOR TEST KIT	5.8 DTC B1121, B1122, B1123, B1124, B1125, B1126, DTC B1124
HD-41404-B	HARNESS CONNECTOR TEST KIT	5.8 DTC B1121, B1122, B1123, B1124, B1125, B1126, DTC B1125
HD-41404-B	HARNESS CONNECTOR TEST KIT	5.8 DTC B1121, B1122, B1123, B1124, B1125, B1126, DTC B1126
HD-41404-B	HARNESS CONNECTOR TEST KIT	5.9 DTC B1135, B1136, B1141, B1142, DTC B1141
HD-41404-B	HARNESS CONNECTOR TEST KIT	5.14 FAILS TO DISARM, Fails to Disarm: HFSM
HD-41404-B	HARNESS CONNECTOR TEST KIT	5.15 DTC B1131, B1132, DTC B1131
HD-41404-B	HARNESS CONNECTOR TEST KIT	5.15 DTC B1131, B1132, DTC B1131
HD-41404-B	HARNESS CONNECTOR TEST KIT	5.15 DTC B1131, B1132, DTC B1132
HD-41404-B	HARNESS CONNECTOR TEST KIT	5.16 DTC B1134, DTC B1134
HD-41404-B	HARNESS CONNECTOR TEST KIT	5.18 DTC B1154, B1155, DTC B1154
HD-41404-B	HARNESS CONNECTOR TEST KIT	5.18 DTC B1154, B1155, DTC B1155
HD-41404-B	HARNESS CONNECTOR TEST KIT	6.4 DTC P0107, P0108, DTC P0107
HD-41404-B	HARNESS CONNECTOR TEST KIT	6.5 DTC P0112, P0113, DTC P0112
HD-41404-B	HARNESS CONNECTOR TEST KIT	6.5 DTC P0112, P0113, DTC P0113
HD-41404-B	HARNESS CONNECTOR TEST KIT	6.6 DTC P0117, P0118, DTC P0117
HD-41404-B	HARNESS CONNECTOR TEST KIT	6.6 DTC P0117, P0118, DTC P0118
HD-41404-B	HARNESS CONNECTOR TEST KIT	6.6 DTC P0117, P0118, DTC P0118
HD-41404-B	HARNESS CONNECTOR TEST KIT	6.8 DTC P0131, P0132, P0134, P0151, P0152, P0154, DTC P0134
HD-41404-B	HARNESS CONNECTOR TEST KIT	6.8 DTC P0131, P0132, P0134, P0151, P0152, P0154, DTC P0151
HD-41404-B	HARNESS CONNECTOR TEST KIT	6.11 DTC P0501, P0502, DTC P0501

Tools Used in This Manual

PART NUMBER	TOOL NAME	NOTES
HD-41404-B	HARNESS CONNECTOR TEST KIT	6.11 DTC P0501, P0502, DTC P0502
HD-41404-B	HARNESS CONNECTOR TEST KIT	6.14 DTC P0661, P0662, DTC P0661, P0662
HD-41404-B	HARNESS CONNECTOR TEST KIT	6.17 DTC P1351, P1352, P1354, P1355, DTC P1351
HD-41404-B	HARNESS CONNECTOR TEST KIT	6.17 DTC P1351, P1352, P1354, P1355, DTC P1352
HD-41404-B	HARNESS CONNECTOR TEST KIT	6.17 DTC P1351, P1352, P1354, P1355, DTC P1355
HD-41404-B	HARNESS CONNECTOR TEST KIT	6.18 DTC P1353, P1356, P1357, P1358, DTC P1357 and P1358
HD-41404-B	HARNESS CONNECTOR TEST KIT	6.18 DTC P1353, P1356, P1357, P1358, DTC P1357 and P1358
HD-41404-B	HARNESS CONNECTOR TEST KIT	6.19 DTC P1475, P1477, P1478, DTC P1475
HD-41404-B	HARNESS CONNECTOR TEST KIT	6.19 DTC P1475, P1477, P1478, DTC P1475
HD-41404-B	HARNESS CONNECTOR TEST KIT	6.19 DTC P1475, P1477, P1478, DTC P1477
HD-41404-B	HARNESS CONNECTOR TEST KIT	6.19 DTC P1475, P1477, P1478, DTC P1478
HD-41404-B	HARNESS CONNECTOR TEST KIT	6.20 DTC P1501, P1502, DTC P1501
HD-41404-B	HARNESS CONNECTOR TEST KIT	6.23 NO ECM POWER, No ECM Power
HD-41404-B	HARNESS CONNECTOR TEST KIT	6.26 MISFIRE AT IDLE OR UNDER LOAD, Misfire At Idle or Under Load
HD-41475	DEUTSCH CONNECTOR SERVICE KIT	A.4 DEUSCH ELECTRICAL CONNECTORS, Deutsch Connector Repair
HD-41475-100	FLAT BLADE L-HOOK	A.4 DEUSCH ELECTRICAL CONNECTORS, Deutsch Connector Repair
HD-41609	AMP MULTILOCK CRIMPER	A.1 AMP MULTILOCK CONNECTORS, AMP Multilock Connector Repair
HD-41609	AMP MULTILOCK CRIMPER	A.1 AMP MULTILOCK CONNECTORS, AMP Multilock Connector Repair
HD-42682	BREAKOUT BOX	1.2 DIAGNOSTIC TOOLS, How To Use Diagnostic Tools
HD-42682	BREAKOUT BOX	1.2 DIAGNOSTIC TOOLS, How To Use Diagnostic Tools
HD-42682	BREAKOUT BOX	1.2 DIAGNOSTIC TOOLS, How To Use Diagnostic Tools
HD-42682	BREAKOUT BOX	2.3 DTC U1016, U1064, U1097, U1255, DTC U1016
HD-42682	BREAKOUT BOX	2.3 DTC U1016, U1064, U1097, U1255, DTC U1016
HD-42682	BREAKOUT BOX	2.3 DTC U1016, U1064, U1097, U1255, DTC U1016
HD-42682	BREAKOUT BOX	2.3 DTC U1016, U1064, U1097, U1255, DTC U1064, U1255
HD-42682	BREAKOUT BOX	2.3 DTC U1016, U1064, U1097, U1255, DTC U1097, U1255
HD-42682	BREAKOUT BOX	2.3 DTC U1016, U1064, U1097, U1255, DTC U1097, U1255
HD-42682	BREAKOUT BOX	2.4 DTC U1300, U1301 OR BUS ER, DTC U1300
HD-42682	BREAKOUT BOX	2.4 DTC U1300, U1301 OR BUS ER, DTC U1301
HD-42682	BREAKOUT BOX	3.2 STARTING SYSTEM, Nothing Clicks
HD-42682	BREAKOUT BOX	4.2 DTC B1004, B1005, DTC B1004
HD-42682	BREAKOUT BOX	4.2 DTC B1004, B1005, DTC B1005
HD-42682	BREAKOUT BOX	4.4 NO INSTRUMENT POWER, Speedometer Inoperative

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PART NUMBER	TOOL NAME	NOTES
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HD-42682	BREAKOUT BOX	4.4 NO INSTRUMENT POWER, Speedometer Inoperative
HD-42682	BREAKOUT BOX	4.4 NO INSTRUMENT POWER, Speedometer Inoperative
HD-42682	BREAKOUT BOX	5.4 TURN SIGNALS, Both Turn Signal Lamps on One Side Inoperative, No DTCs
HD-42682	BREAKOUT BOX	5.4 TURN SIGNALS, Both Turn Signal Lamps on One Side Inoperative, No DTCs
HD-42682	BREAKOUT BOX	5.8 DTC B1121, B1122, B1123, B1124, B1125, B1126, DTC B1121: HFSM
HD-42682	BREAKOUT BOX	5.8 DTC B1121, B1122, B1123, B1124, B1125, B1126, DTC B1121: TSM/TSSM
HD-42682	BREAKOUT BOX	5.8 DTC B1121, B1122, B1123, B1124, B1125, B1126, DTC B1122: TSM/TSSM
HD-42682	BREAKOUT BOX	5.8 DTC B1121, B1122, B1123, B1124, B1125, B1126, DTC B1124
HD-42682	BREAKOUT BOX	5.8 DTC B1121, B1122, B1123, B1124, B1125, B1126, DTC B1125
HD-42682	BREAKOUT BOX	5.8 DTC B1121, B1122, B1123, B1124, B1125, B1126, DTC B1126
HD-42682	BREAKOUT BOX	5.9 DTC B1135, B1136, B1141, B1142, DTC B1141
HD-42682	BREAKOUT BOX	5.13 SERVICE AND EMERGENCY FUNCTIONS AND CONFIGURATIONS, Power Disruption and Configuring: HFSM
HD-42682	BREAKOUT BOX	5.15 DTC B1131, B1132, DTC B1131
HD-42682	BREAKOUT BOX	5.15 DTC B1131, B1132, DTC B1131
HD-42682	BREAKOUT BOX	5.15 DTC B1131, B1132, DTC B1132
HD-42682	BREAKOUT BOX	5.15 DTC B1131, B1132, DTC B1132
HD-42682	BREAKOUT BOX	5.18 DTC B1154, B1155, DTC B1154
HD-42682	BREAKOUT BOX	5.18 DTC B1154, B1155, DTC B1155
HD-42879	ELECTRICAL CRIMPER TOOL	A.7 DEUTSCH SOLID BARREL TERMINALS, Deutsch Solid Barrel Terminal Crimps
HD-43876	BREAKOUT BOX	1.2 DIAGNOSTIC TOOLS, How To Use Diagnostic Tools
HD-43876	BREAKOUT BOX	1.2 DIAGNOSTIC TOOLS, How To Use Diagnostic Tools
HD-43876	BREAKOUT BOX	1.2 DIAGNOSTIC TOOLS, How To Use Diagnostic Tools
HD-43876	BREAKOUT BOX	1.3 DIAGNOSTICS AND TROUBLESHOOTING, Wiggle Test
HD-43876	BREAKOUT BOX	2.3 DTC U1016, U1064, U1097, U1255, DTC U1016
HD-43876	BREAKOUT BOX	2.3 DTC U1016, U1064, U1097, U1255, DTC U1064, U1255
HD-43876	BREAKOUT BOX	2.3 DTC U1016, U1064, U1097, U1255, DTC U1097, U1255
HD-43876	BREAKOUT BOX	3.6 DTC B0563, P0562, P0563, DTC P0562
HD-43876	BREAKOUT BOX	6.4 DTC P0107, P0108, DTC P0107
HD-43876	BREAKOUT BOX	6.5 DTC P0112, P0113, DTC P0112

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PART NUMBER	TOOL NAME	NOTES
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HD-43876	BREAKOUT BOX	6.6 DTC P0117, P0118, DTC P0117
HD-43876	BREAKOUT BOX	6.6 DTC P0117, P0118, DTC P0118
HD-43876	BREAKOUT BOX	6.7 DTC P0122, P0123, DTC P0122
HD-43876	BREAKOUT BOX	6.8 DTC P0131, P0132, P0134, P0151, P0152, P0154, DTC P0131
HD-43876	BREAKOUT BOX	6.8 DTC P0131, P0132, P0134, P0151, P0152, P0154, DTC P0134
HD-43876	BREAKOUT BOX	6.8 DTC P0131, P0132, P0134, P0151, P0152, P0154, DTC P0151
HD-43876	BREAKOUT BOX	6.9 DTC P0261, P0262, P0263, P0264, DTC P0261
HD-43876	BREAKOUT BOX	6.9 DTC P0261, P0262, P0263, P0264, DTC P0263
HD-43876	BREAKOUT BOX	6.11 DTC P0501, P0502, DTC P0501
HD-43876	BREAKOUT BOX	6.11 DTC P0501, P0502, DTC P0502
HD-43876	BREAKOUT BOX	6.12 DTC P0505, DTC P0505
HD-43876	BREAKOUT BOX	6.16 DTC P1001, P1002, P1003, P1004, DTC P1001
HD-43876	BREAKOUT BOX	6.17 DTC P1351, P1352, P1354, P1355, DTC P1351
HD-43876	BREAKOUT BOX	6.17 DTC P1351, P1352, P1354, P1355, DTC P1354
HD-43876	BREAKOUT BOX	6.18 DTC P1353, P1356, P1357, P1358, DTC P1357 and P1358
HD-43876	BREAKOUT BOX	6.18 DTC P1353, P1356, P1357, P1358, DTC P1357 and P1358
HD-43876	BREAKOUT BOX	6.19 DTC P1475, P1477, P1478, DTC P1475
HD-43876	BREAKOUT BOX	6.19 DTC P1475, P1477, P1478, DTC P1475
HD-43876	BREAKOUT BOX	6.19 DTC P1475, P1477, P1478, DTC P1477
HD-43876	BREAKOUT BOX	6.19 DTC P1475, P1477, P1478, DTC P1478
HD-43876	BREAKOUT BOX	6.20 DTC P1501, P1502, DTC P1501
HD-43876	BREAKOUT BOX	6.23 NO ECM POWER, No ECM Power
HD-43876	BREAKOUT BOX	6.26 MISFIRE AT IDLE OR UNDER LOAD, Misfire At Idle or Under Load
HD-44687	IGNITION COIL CIRCUIT TEST ADAPTER	1.2 DIAGNOSTIC TOOLS, How To Use Diagnostic Tools
HD-44687	IGNITION COIL CIRCUIT TEST ADAPTER	1.2 DIAGNOSTIC TOOLS, How To Use Diagnostic Tools
HD-45928	PACKARD MICRO-64 TERMINAL REMOVER	A.17 PACKARD MICRO-64 CONNECTORS, Packard Micro-64 Connector Repair
HD-45929	PACKARD MICRO-64 TERMINAL CRIMPER	A.17 PACKARD MICRO-64 CONNECTORS, Packard Micro-64 Connector Repair
HD-46601	BREAKOUT BOX ADAPTERS	1.2 DIAGNOSTIC TOOLS, How To Use Diagnostic Tools
HD-46601	BREAKOUT BOX ADAPTERS	1.2 DIAGNOSTIC TOOLS, How To Use Diagnostic Tools
HD-46601	BREAKOUT BOX ADAPTERS	2.3 DTC U1016, U1064, U1097, U1255, DTC U1016
HD-46601	BREAKOUT BOX ADAPTERS	2.3 DTC U1016, U1064, U1097, U1255, DTC U1016
HD-46601	BREAKOUT BOX ADAPTERS	2.3 DTC U1016, U1064, U1097, U1255, DTC U1064, U1255
HD-46601	BREAKOUT BOX ADAPTERS	2.3 DTC U1016, U1064, U1097, U1255, DTC U1064, U1255

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Tools Used in This Manual

PART NUMBER	TOOL NAME	NOTES
HD-46601	BREAKOUT BOX ADAPTERS	2.3 DTC U1016, U1064, U1097, U1255, DTC U1097, U1255
HD-46601	BREAKOUT BOX ADAPTERS	2.3 DTC U1016, U1064, U1097, U1255, DTC U1097, U1255
HD-46601	BREAKOUT BOX ADAPTERS	2.4 DTC U1300, U1301 OR BUS ER, DTC U1300
HD-46601	BREAKOUT BOX ADAPTERS	2.4 DTC U1300, U1301 OR BUS ER, DTC U1301
HD-46601	BREAKOUT BOX ADAPTERS	4.2 DTC B1004, B1005, DTC B1004
HD-46601	BREAKOUT BOX ADAPTERS	4.2 DTC B1004, B1005, DTC B1005
HD-46601	BREAKOUT BOX ADAPTERS	4.4 NO INSTRUMENT POWER, Speedometer Inoperative
HD-46601	BREAKOUT BOX ADAPTERS	4.4 NO INSTRUMENT POWER, Speedometer Inoperative
HD-46601	BREAKOUT BOX ADAPTERS	4.4 NO INSTRUMENT POWER, Speedometer Inoperative
HD-46601	BREAKOUT BOX ADAPTERS	4.4 NO INSTRUMENT POWER, Speedometer Inoperative
HD-48053	ADVANCED BATTERY CONDUCTANCE AND ELECTRICAL SYSTEM ANALYZER	1.2 DIAGNOSTIC TOOLS, How To Use Diagnostic Tools
HD-48053	ADVANCED BATTERY CONDUCTANCE AND ELECTRICAL SYSTEM ANALYZER	3.1 BATTERY TESTING, Conductance Test
HD-48114	MOLEX ELECTRICAL CONNECTOR TERMINAL REMOVER	A.15 MOLEX CONNECTORS, Molex Connector Repair
HD-48650	DIGITAL TECHNICIAN II	1.2 DIAGNOSTIC TOOLS, How To Use Diagnostic Tools
HD-48650	DIGITAL TECHNICIAN II	1.3 DIAGNOSTICS AND TROUBLESHOOTING, Job/Time Codes Values
HD-48650	DIGITAL TECHNICIAN II	5.10 SECURITY SYSTEM, TSSM/HFSM Features
HD-48650	DIGITAL TECHNICIAN II	6.8 DTC P0131, P0132, P0134, P0151, P0152, P0154, Description and Operation
HD-48650	DIGITAL TECHNICIAN II	6.12 DTC P0505, Description and Operation
SNAP-ON TT600-3	SNAP-ON PICK	A.1 AMP MULTILOCK CONNECTORS, AMP Multilock Connector Repair
SNAP-ON TT600-3	SNAP-ON PICK	A.12 630 METRI-PACK CONNECTORS, 630 Metri-Pack Connector Repair
YA840	SNAP-ON IN-LINE SPARK TESTER	6.26 MISFIRE AT IDLE OR UNDER LOAD, In-line Spark Tester

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FASTENER	TORQUE VALUE	NOTES
No torque values were found in this manual.		

DIGITAL TECHNICIAN® II HARLEY-DAVIDSON®

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SkillsUSA
2010 Contest Projects

Nail Care

Click the “Print this Section” button above to automatically print the specifications for this contest. Make sure your printer is turned on before pressing the button.

SPECIAL INSTRUCTIONS (INCLUDING GUIDELINES)

1. All contestants must bring a model for the competition.
2. Contestants are not permitted to touch their models before the competition begins or between segments.
3. Conversation between contestant & model is limited. The only conversation allowed is if the contestant needs to ask the model to reposition her hand or arm. Communication with observers, judges and other contestants is prohibited during the contest. If you have a question, raise your hand and a committee member will help you.
4. Time limits: 1 hour for pedicure, 1 hour for acrylic, 1 hour for tips and wrap, .5 hours for written examination and 1.5 hours for polish and flat nail art applications. All segments of work must be completed in the specified time during competition. (i.e., during the tip and wrap segment, no work may be completed or started on the sculptured, nail art or polish application.)
5. No eating, drinking, smoking or gum chewing is allowed during the competition. Lunch will be provided for contestant and model.
6. All contestants and models must be escorted to the bathroom by a Technical or Educational Committee member. Bathroom breaks will take place after judging segments.
7. Penalty points may be taken for the following:
   a) Any rule not followed with NO exceptions!
   b) Leaving competition area before completion of model (applies to both contestant and model) without proper escort.
   c) Unauthorized use of a product that is not allowed or that doesn't appear in the listing or use of any product that appears to have been altered.
8. Each Contestant must turn in a digital photo on a CD of the art they will be creating, a written description of their nail art and a resume. All three items must be turned in by 9:00 am on Thursday.

12:15-12:45 pm: Written Examination & Model Break

Test will consist of 50 multiple-choice questions covering aspects of nail care not physically evaluated during the contest. Those subjects include but not limited to sanitation and disinfection, pedicures and light-cured gels.

1:00-2:30 pm: Nail Art & Polish Application

1.5 hours Allotted for Lacquer & Nail Art Application

Two coats of Dark Red Crème Lacquer/Polish is to be applied to the model's right hand. The following will be evaluated:

- Neatness, coverage, evenness and cuticle involvement.

Nail art is to be applied to all 5 fingers of the model's left hand. A specific theme is to be carried through on all 5 fingers and in a written description. Contestant must have written and submitted a description of the theme they intend to create at contest check in. Themes should be typewritten, may be decorated and must be contained in the plastic sleeve. Diagrams of the art you intend to create can be used, however, are limited to the finished product and may not be step by step instructions. Once all judging is complete, props may be used to enhance art during the parade of models. All nail art must be created using polishes, lacquers and/or paint Only! The following will be evaluated:

- Creativity; theme, follow through of theme, artist expression, and color coordination.
- Level of Difficulty; complexity of design.
- Precision; neatness and clarity of lines.

2:45-3:15 pm: Judging of Wearable Nail Art & Polish

3:30 pm: Parade of Models

Once parade has concluded, make sure to finish cleaning up your contest area and turn in your evaluation of the contest.

4:00 pm: Contest Debriefing at Contest Site

Immediately Following Contest, we will have a debriefing in the contest area.

CONTEST INSTRUCTIONS / SCHEDULE

Wednesday, June 23, 2010

8:00 am –1:00 pm: Secondary Contestants w/ Models

8:00 – 8:30: Check in & set up for Pedicure (turn in CD, Resume and/or Art Theme)
8:30 – 8:45: Prejudging of Models
8:45 – 9:45: Perform Pedicure
9:45 – 10:15: Judging of Pedicures
10:15 – 1:00 Oral Presentations

1:00 pm –5:00 pm: Post-Secondary Contestants w/ Models

1:00 – 1:30: Check in & set up for Pedicure (turn in CD, Resume and/or Art Theme)
1:30 – 1:45: Prejudging of Models
1:45 – 2:45: Perform Pedicure
2:45 – 3:15: Judging of Pedicures
3:15 – 5:00 Oral Presentations

Pedicures

Contestants will set up for and perform a basic pedicure on one foot of their model. Procedures should include, but not limited to clipping & shaping toenails, pushing back cuticles, cleaning under toenails, refining skin and polishing. Based on industry standards, the following will be evaluated:

- Safe & sanitary procedures and handling of the foot
- End result: Toenail length & shape, polish application, skin quality & appearance and cuticle involvement

Oral Professional Development Assessment

Contestants will give a 3-4 minute presentation on the benefits of Natural Nail Care. You can direct your presentation to the judges as if they were a client who came to you for a consultation. Props may be used. The presentation should cover the following points:

- Recommended natural nail care services.
- Results the client should expect.
- The home care products the client would need to purchase and use to obtain these results.

Thursday, June 24, 2010

8:00-9:00 am: Contestant & Model Check In

If you haven't previously turned in your CD, Resume and/or Art Theme, you must at this time. Once checked in, you will be escorted to your seat and begin set up for the acrylic application ONLY. At this time the Committee will be conducting a kit check to make sure that you have all proper items. All cell phones must be turned off at this time.

8:30 am: Bathroom Break for Contestants ONLY

You may wash hands, fill water bottles, etc. at this time. There will be antibacterial soap at you station for your use. Prejudging of models will take place at this time.

9:00-10:00 am: Acrylic Nail Application

1 hour allotted – All five fingers of the model's right hand are to be sculpted with forms, no tips, using the two-tone/French-manicure technique. Based on salon quality nails, the following will be evaluated:

- Acrylic Application: product control, clarity/no bubbles, smile line, c-curve, arch, thinness and continuity.
- Finished Appearance: smoothness, shape & length consistent finger to finger and proportionate to hand, high-gloss shine and cuticle involvement.

10:00-10:15 am: Reset Station

Contestant will clean up from Acrylic Application and set up for Tip and Wrap Application.

10:15-11:15 am: Nail Tip & Wrap Application

1 hour allotted – All five fingers of the model's left hand are to have nail tips applied and blended and overlaid with a wrap system. Based on salon quality nails, the following will be evaluated:

- Tip Application: fit, alignment, and blending.
- Fabric Application: placement.
- Resin/Adhesive Application: product control, even coverage of fabric, and thinness.
- Finished Appearance: clarity, smoothness, shape & length consistent finger to finger and proportionate to hand, high-gloss shine and cuticle involvement.

11:30-12:00 pm: Judging of Acrylic and Tip & Wrap & Contestant Break

SAMPLE DONOR THANK YOU

(Date)

Dear Industry Sponsor,

My name is (Insert Name) and I attend (insert school name). I was fortunate to compete at SkillsUSA National Championships in the Nail Care contest.

I would like to thank you for your generous gifts and support. Your commitment to helping SkillsUSA is sincerely appreciated. Words could never tell you what your donations and support to the Nail competition has meant to me. Your company has truly enriched me through your kindness and generosity.

I look forward to using your products.

With sincere appreciation,

(Sign Your Name)

SAMPLE VOLUNTEER THANK YOU

(Date)

Dear SkillsUSA Volunteer,

My Name is (Insert Name) and I attend (Insert School Name). I was fortunate to compete at this year's SkillsUSA National Championships in the Nail Care contest.

Words could never tell you what your time and support has meant to me. It is people like you that make this contest possible. You are a great example of commitment to one's industry. Thank you for all you do for me and my fellow students. Your commitment to helping SkillsUSA is sincerely appreciated.

I look forward to a rewarding career in the beauty industry.

With sincere appreciation,

(Sign Your Name)

SkillsUSA Championships
Nail Care Contest Evaluation

What did you like about the Nail Care Contest?

What would you change about the Nail Care Contest?

Additional Comments.

OVERALL RATING OF CONTEST

❒ Excellent ❒ Very Good ❒ Good ❒ Fair ❒ Poor

SkillsUSA
2010 Contest Projects

Nurse Assisting

Click the “Print this Section” button above to automatically print the specifications for this contest. Make sure your printer is turned on before pressing the button.

NURSE ASSISTING
SKILLSUSA CHAMPIONSHIPS
2010

GENERAL BRIEFING FOR THE CONTESTANT

1. You will wash your hands at the sinks during one station. At other times, you may verbalize when you would use hand hygiene.

2. When privacy is needed for the procedures, please indicate this orally to the judges. There are no curtains available.

3. Your name badge should always show your contestant number.

4. You will be given appropriate time to look at the area, to familiarize yourself with surroundings, read instructions, etc. After reading the instruction sheet, you are to indicate to the judges when you are ready to begin the procedure. (3 minutes)

5. You will be evaluated on speed and accuracy once you begin the procedure. You may not be able to complete all the procedures in the time allotted. Work quickly but appropriately.

6. You may introduce yourselves when necessary by your contestant number only.

7. All equipment you use is to be returned to the place from which you found it.

8. Please no talking about the contest while you are in the waiting area. To do so may endanger your chances of winning.

9. Use of cell phones is strictly prohibited. Contestants found using their cell phone may be disqualified.

10. You should have no instructions from outside sources after the contest begins. You may be disqualified for communication with observers. (This includes advisors.)

11. If for any reason you need to leave the waiting area, you must check with the proctor for instructions.

12. You will be informed when 5 minutes are remaining at each station.

13. You must leave the contest area immediately after completing all stations and obtaining clearance from the proctor.

Contestant Number: _____

Intake and Output Record

Patient's Name:							**Date:**		
Time	**Oral**	**IV**	**Irrigation**	**Remarks**	**BM**	**Emesis**	**Urine**	**Irrigation**	**Remarks**
7:00 AM	240 cc				Lg. soft	280 cc	320 cc		
8:00 AM	460 cc								
9:00 AM									
10:00 AM									
11:00 AM									
12:00 PM									
1:00 PM									
2:00 PM									
TOTAL				**8 Hr Intake**	**TOTAL**	**280 cc**			**8 Hr Output**
3:00 PM							420 cc		
4:00 PM	220 cc								
5:00 PM									
6:00 PM	700 cc								
7:00 PM									
8:00 PM	180 cc						500 cc		
9:00 PM									
10:00 PM									
TOTAL	**1100 cc**			**8 Hr Intake**	**TOTAL**		**920 cc**		**8 Hr Output**
11:00 PM	120 cc								
12:00 AM									
1:00 AM									
2:00 AM									
3:00 AM									
4:00 AM									
5:00 AM							350 cc		
TOTAL	**120 cc**			**8 Hr Intake**	**TOTAL**		**1270 cc**		**8 Hr Output**
TOTALS				**24 Hr Intake**	**TOTALS**				**24 Hr Output**

(Please Print in Ink)

In considering your application for employment, the facility may conduct a detailed and thorough investigation which may include but is not limited to a criminal record check, interviews or inquiries of prior employers, coworkers, acquaintances, relatives or friends.

PERSONAL

LAST NAME	FIRST	MIDDLE	
PRESENT ADDRESS	CITY	STATE	ZIP CODE
PERMANENT ADDRESS	CITY	STATE	ZIP CODE

HOME TELEPHONE NO.

CONTACT TELEPHONE NO.

E-MAIL ADDRESS (optional)

BEST TIME TO CONTACT YOU:

DATE AVAILABLE FOR WORK:

ANY PREVIOUS NAME(S)? YES ☐ NO ☐ IF YES, IDENTIFY ALL OTHER NAMES INCLUDING MAIDEN NAME:

POSITION APPLIED FOR: SALARY DESIRED:

HOW DID YOU LEARN ABOUT THIS POSITION? (NEWSPAPER, INTERNET, FRIEND, IF OTHER – PLEASE LIST)

RELATIVES OR FRIENDS EMPLOYED IN THIS FACILITY? YES ☐ NO ☐

NAME: DEPT: RELATIONSHIP:

HAVE YOU EVER BEEN EMPLOYED BY THIS FACILITY?
YES ☐ NO ☐ WHEN?

ARE YOU 18 YRS OF AGE OR OLDER?
YES ☐ NO ☐

ARE YOU A U.S. CITIZEN OR AN ALIEN LEGALLY AUTHORIZED TO WORK IN THE UNITED STATES?
YES ☐ NO ☐

LONG RANGE OCCUPATIONAL GOALS:

CHECK ALL YOU WOULD CONSIDER WORKING:

- FULL TIME / REGULAR ☐
- FULL TIME / TEMPORARY ☐
- PART TIME / REGULAR ☐
- PART TIME / TEMPORARY ☐

WOULD YOU CONSIDER WORKING:

WEEKENDS & HOLIDAYS	YES ☐	NO ☐
ROTATING SHIFTS	YES ☐	NO ☐
ON CALL	YES ☐	NO ☐
ANY SHIFT	YES ☐	NO ☐

SHIFT AVAILABILITY (check all that apply):
DAYS ☐ EVENINGS ☐ NIGHTS ☐

HAVE YOU EVER BEEN CONVICTED OF, OR PLEAD GUILTY TO, A CRIME OTHER THAN **A MISDEMEANOR TRAFFIC VIOLATION?** YES ☐ NO ☐
IF YES, WHICH STATE(S), AND EXPLAIN: (You are not required to disclose any SEALED or EXPUNGED criminal records.)

HAVE YOU EVER BEEN INVOLVED IN THE SUBSTANTIATED ABUSE OR NEGLECT OF CHILDREN OR ADULTS UNDER THE LAWS OF THIS OR ANY OTHER STATE OF THE UNITED STATES? YES ☐ NO ☐ IF YES, WHICH STATE(S), AND EXPLAIN:

HAVE YOU BEEN SANCTIONED, CITED, REPORTED, OR EXCLUDED FROM PARTICIPATION IN MEDICARE, MEDICAID, OR ANY OTHER HEALTHCARE RELATED LAW OR REGULATION? YES ☐ NO ☐ IF YES, EXPLAIN:

If your answer is "yes" to any of the above, you will not be automatically disqualified from employment consideration, except as required by state or federal law.

EDUCATION / SKILLS

SCHOOL	NAME AND ADDRESS OF SCHOOL	COURSE OF STUDY	CHECK LAST YEAR COMPLETED	DID YOU GRADUATE?	LIST DIPLOMA OR DEGREE
HIGH			1 2 3 4	☐ YES ☐ NO	
COLLEGE			1 2 3 4	☐ YES ☐ NO	
COLLEGE			1 2 3 4	☐ YES ☐ NO	

OTHER Business College or Special Courses: (Include Special Military Training, Post Graduate and Nursing)

AREA(S) OF SPECIALIZATION OR MAJOR INTEREST:

LIST OFFICE SKILLS INCLUDING COMPUTER/SOFTWARE EXPERIENCE:

LIST HEALTH CARE, BUSINESS, OR INDUSTRIAL EQUIPMENT OPERATED:

WORD PROCESSING: (Approx. WPM)

PROFESSIONAL LICENSES

☐ CURRENTLY LICENSED ☐ ELIGIBLE FOR LICENSE
☐ CURRENTLY REGISTERED ☐ ELIGIBLE FOR REGISTRATION
TYPE: STATE:
NO: DATE:

LICENSE OR REGISTRATION **EVER** SUSPENDED, REVOKED OR ON PROBATION? ☐ YES ☐ NO IF YES, EXPLAIN:

PROFESSIONAL CERTIFICATIONS

☐ CURRENTLY CERTIFIED
☐ ELIGIBLE FOR CERTIFICATION
TYPE:
STATE: DATE:

☐ CURRENTLY LICENSED ☐ ELIGIBLE FOR LICENSE
☐ CURRENTLY REGISTERED ☐ ELIGIBLE FOR REGISTRATION
TYPE: STATE:
NO: DATE:

LICENSE OR REGISTRATION **EVER** SUSPENDED, REVOKED OR ON PROBATION? ☐ YES ☐ NO IF YES, EXPLAIN:

☐ CURRENTLY CERTIFIED
☐ ELIGIBLE FOR CERTIFICATION
TYPE:
STATE: DATE:

Briefly describe duties and skills acquired through military or volunteer service: (include dates)

PREVIOUS EXPERIENCE

PROVIDE INFORMATION REGARDING PREVIOUS EMPLOYMENT BEGINNING WITH MOST RECENT EMPLOYER.

FROM: (MO/YR)	TO: (MO/YR)	SUPERVISOR'S NAME:	SALARY: (Hr/ Mo/Yr)

JOB TITLE: _____

EMPLOYER NAME: _____ PHONE: _____

ADDRESS: _____

DUTIES: _____

REASON FOR LEAVING: _____

MAY WE CONTACT YOUR CURRENT EMPLOYER? YES ❑ NO ❑

FROM: (MO/YR)	TO: (MO/YR)	SUPERVISOR'S NAME:	SALARY: (Hr/ Mo/Yr)

JOB TITLE: _____

EMPLOYER NAME: _____ PHONE: _____

ADDRESS: _____

DUTIES: _____

REASON FOR LEAVING: _____

FROM: (MO/YR)	TO: (MO/YR)	SUPERVISOR'S NAME:	SALARY: (Hr/ Mo/Yr)

JOB TITLE: _____

EMPLOYER NAME: _____ PHONE: _____

ADDRESS: _____

DUTIES: _____

REASON FOR LEAVING: _____

FROM: (MO/YR)	TO: (MO/YR)	SUPERVISOR'S NAME:	SALARY: (Hr/ Mo/Yr)

JOB TITLE: _____

EMPLOYER NAME: _____ PHONE: _____

ADDRESS: _____

DUTIES: _____

REASON FOR LEAVING: _____

PLEASE IDENTIFY AND EXPLAIN ANY GAPS IN EMPLOYMENT LONGER THAN THREE (3) MONTHS:

LANGUAGE

LANGUAGE SKILLS - DO NOT COMPLETE UNLESS REQUESTED

LANGUAGE	DO YOU?	❑ SPEAK	❑ FAIR ❑ GOOD ❑ FLUENT	❑ READ	❑ FAIR ❑ GOOD ❑ FLUENT	❑ WRITE	❑ FAIR ❑ GOOD ❑ FLUENT
LANGUAGE	DO YOU?	❑ SPEAK	❑ FAIR ❑ GOOD ❑ FLUENT	❑ READ	❑ FAIR ❑ GOOD ❑ FLUENT	❑ WRITE	❑ FAIR ❑ GOOD ❑ FLUENT

REFERENCES

LIST AT LEAST THREE (3) PROFESSIONAL / WORK / SCHOOL REFERENCES WHO ARE NOT RELATIVES OR PERSONAL ACQUAINTANCES:

NAME AND RELATIONSHIP	TITLE	COMPANY NAME AND ADDRESS	TELEPHONE

SIGNATURE

CAREFULLY READ THIS SECTION PRIOR TO PROVIDING SIGNATURE BELOW

I hereby affirm that the information provided on this application (and accompanying resume, if any) is true and complete. I understand that any false or misleading representations or omissions made on the application or during the hiring process may disqualify me from further consideration for employment and may result in discharge even if discovered at a later date.

I understand that employment may be conditioned upon successfully passing a medical examination and that I may be required to satisfactorily complete a drug screening as a condition of employment.

I hereby authorize persons, schools, my current employer (if applicable) and previous employers and other organizations to provide this facility and its affiliates with any requested information regarding my application or suitability for employment, and I completely release all such persons or entities from any and all liability related to the providing or use of such information.

I understand that my employment is at-will which means that I may terminate the employment relationship at any time and for any reason with or without notice, and that the facility has the same right. I understand that no one has the authority to enter into any agreement contrary to the preceding sentence, except for a written agreement signed by an administrative representative of this facility and notarized.

Date _____ **Signature** _____

Courtesy Association Management Resources, Naperville, Ill © 2006

Nurse Assisting
SkillsUSA Championships
2010
Performance Checklist

Station I W/C to Bed, ROM
Contestant Number _____
Judge Initials _____

Total possible points - 175
Points earned _____

Performance Points	*Pts. Poss.*	*Pts. Earned*	*Remarks*
1. Assembles equipment	2		
2. Hand hygiene (may verbalize)	2		
3. Knocks on door, introduces self, identifies patient, and explains procedure	6		
4. Provides privacy	6		
5. Prepares wheelchair:			
a. positions correctly	2		
b. locks wheels	6		
c. removes footrests or puts them out of the way	2		
6. Locks bed to prevent movement	6		
7. Places gait belt snugly around pt waist	4		
8. Instructs pt to place hands on WC arms to assist with standing	2		
9. Grasps gait belt at back of pt	4		
10. Positions feet for broad base	2		
11. Gives signal	2		
12. Assists to standing position	2		
13. Turns pt to bed	2		
14. Positions pt in supine position	2		
15. Covers pt	2		
16. Raises bed to good working height	2		
17. Performs all ROMs as follows:			
a. Proceeds in organized manner	6		
b. Performs each movement a minimum of 3 times	4		

c. Provides support for body parts	4		
d. Does not expose patient during procedure	4		
e. Instructs patient to inform if pain/discomfort	4		
18. Exercises nearest shoulder:			
a. Supports arm properly	2		
b. Abducts and adducts arm	2		
c. Flexes and extends arm	2		
19. Exercises nearest elbow:			
a. Flexes and extends elbow	2		
20. Exercises nearest wrist:			
a. Flexes, extends, and hyperextends hand	2		
b. Deviates ulnarly and radially	2		
21. Exercises nearest fingers and thumb:			
a. Flexes and extends fingers	2		
b. Abducts and adducts fingers	2		
c. Performs oppostion by touching thumb to each finger tip	2		
22. Exercises nearest hip:			
a. Abducts and adducts leg	2		
b. Flexes and extends knee	2		
c. Rotates leg medially and laterally	2		
23. Exercises nearest ankle:			
a. Dorsiflexes and plantar flexes foot	2		
b. Inverts and everts foot	2		
24. Exercises nearest toes:			
a. Abducts and adducts toes	2		
b. Flexes and extends toes	2		
24. Positions patient in correct alignment	2		
25. Replaces bed covers	2		
26. Observes checkpoints before leaving:			
a. Lowers bed to lowest level	2		
b. Places call signal and supplies within reach	2		
c. Opens curtain	2		
d. Leaves area neat and clean	2		

27. Hand hygiene (or verbalizes)	4		
28. Reports any abnormal findings	2		
29. Organization of work:			
a. arrives at contest ready to begin skill problem	2		
b. reads problems/checks assumptions/questions	2		
c. obtains necessary equip to complete problem	2		
d. organizes equip/solves problem conveniently	2		
30. Attitude:			
a. toward patient	4		
b. toward supervisors (judges)	4		
c. toward task	4		
31. Communication skills:			
a. facial expressions	4		
b. ability to listen	4		
c. attempts to lower patient anxiety	4		
d. interprets/implements oral/written directions	4		
e. accuracy of oral/written terminology	2		
32. Safety measures:			
a. Utilizes safety precautions for patient & self	6		
33. Speed in completion of task:			
a. completed within alloted time	3		
Total points available	175		

NURSE ASSISTING
SKILLSUSA CHAMPIONSHIPS
2010

INSTRUCTION SHEER FOR CONTESTANT

STATION NUMBER II

ASSIGNMENT:	Perform CPR on the adult manikin for 2 minutes and reassess
TIME TO COMPLETE SKILL:	15 minutes You will be informed with 5 minutes remaining
EQUIPMENT:	All equipment you will need is in the station area. Please clean and replace equipment.
SITUATION:	The patient has been found unresponsive on the floor.

Contestant Number _____

Judge's Initials _____

PLEASE LEAVE THIS SHEET WITH THE JUDGE WHEN COMPLETED TASK AT THIS STATION.

Nurse Assisting
SkillsUSA Championships
2010

Performance Checklist

Station II Adult CPR
Contestant Number _____
Judge Initials _____

Total possible points - 75
Points earned _____

Performance Points	*Pts. Poss.*	*Pts. Earned*	*Remarks*
1. Places manikin on firm surface in supine position	5		
2. Checks consciousness	5		
3. Activates EMS system	5		
4. Opens airway, using head tip/chin lift method	5		
5. Looks, listens and feels for respirations for 5-10 seconds	5		
6. Gives 2 slow full breaths	5		
7. Checks for carotid pulse and other signs of circulation (5-10 sec.)	5		
8. Administers chest compressions as follows:			
a. Places heel of hand on lower half of sternum	5		
b. Gives compressions at a rate of 100 per minute	5		
d. Compresses chest 1 1/2 to 2 inches	5		
9. Gives two ventilations after every thirty compressions	5		
10. Repeats cycle of 30:2 for 2 minutes	5		
11. Checks pulse and breathing for 5-10 seconds	5		
12. Verbalizes what should be done if no pulse. Tell contestant that patient has a pulse and respirations.	5		
13. Positions patient in recovery position if breathing and circulation are present	5		
Total	75		

NURSE ASSISTING
SKILLSUSA NATIONALS
2010

INSTRUCTION SHEET FOR CONTESTANT

STATION NUMBER III

ASSIGNMENT:

1. Wash your hands
2. Apply gloves at appropriate times
3. Perform denture and mouth care

TIME TO COMPLETE SKILL: 20 minutes
You will be informed with 5 minutes remaining

EQUIPMENT: All equipment you will need is in the station area.
Please clean and replace equipment.

SITUATION: Mr. Jones is a 86 year old nursing home resident who had a left hip replacement. He needs denture and mouth care. Observe standard precautions.

Contestant Number _____

Judge's Initials _____

PLEASE LEAVE THIS SHEET WITH THE JUDGE WHEN COMPLETED TASK AT THIS STATION.

Nurse Assisting
SkillsUSA Championships
2010

Performance Checklist

Station III Handwashing, Glove Application and Denture/Oral Care — Total possible points - 160

Contestant Number _____ — Points earned _____

Judge Initials _____

Performance Points	*Pts. Poss.*	*Pts. Earned*	*Remarks*
1. Assembles equipment	4		
2. Turns faucet on with dry towel	2		
3. Regulates temperature of water	2		
4. Wets hands with fingertips pointed down	3		
5. Gets soapy lather	3		
6. Scrubs palms	3		
7. Scrubs tops of hands with opposite palm	3		
8. Interlaces fingers to wash between	3		
9. Cleans nails	3		
10. Rinses with fingerips pointed down	3		
11. Dries thoroughly	3		
12. Places towels in waste can	3		
13. Turns off faucet with dry towel	3		
14. Leaves area neat and clean	2		
15. Assembles equipment for denture care	4		
16. Hand hygiene (may verbalize)	6		
17. Knocks on door, introduces self, identifies patient & explains procedure	5		
18. Provides privacy	2		
19. Puts towel on pt's. chest	2		
20. Puts on gloves	5		
21. Obtains dentures from patient - assists as needed	2		
22. Places dentures in cup	2		

23. Lines sink with paper towels	2		
24. Uses cool water to clean dentures	2		
25. Brushes all surfaces	2		
26. Handles dentures carefully	2		
27. Rinses dentures in cool water	2		
28. Places clean dentures in cool water in denture cup	2		
29. Removes gloves without contaminating hands	4		
30. Returns dentures to patient	2		
31. Places towel on pt chest if not already there	2		
32. Applies clean gloves	5		
33. Assists pt with mouthwash/swabs	2		
34. Returns dentures to patient or places on bedside table	2		
35. Removes towel from pt chest	2		
36. Removes gloves (and preforms hand hygiene)	5		
37. Positions pt in correct alignment	2		
38. Observes checkpoints before leaving:			
a. Lowers bed to lowest level	2		
b. Places call signal and supplies within reach	5		
c. Opens curtain	2		
d. Leaves area neat and clean	2		
39. Hand hygiene (may verbalize)	5		
40. Reports any abnormal findings	3		
41. Organization of work:			
a. arrives at contest ready to begin skill problem	2		
b. reads problems/checks assumptions/questions	2		
c. obtains necessary equip to complete problem	2		
d. organizes equip/solves problem conveniently	2		
42. Attitude:			
a. toward patient	3		
b. toward supervisors (judges)	3		
c. toward task	3		
43. Communication skills:			

a. facial expressions	2		
b. ability to listen	2		
c. attempt to lower patient anxiety	2		
d. interprets/implements oral/written directions	2		
e. accuracy of oral/written terminology	2		
44. Safety measures:			
a. Utilizes safety precautions for patient & self	5		
45. Speed in completion of task:			
a. completed within alloted time	3		
Total	160		

NURSE ASSISTING
SKILLSUSA CHAMPIONSHIPS
2010

INSTRUCTION SHEER FOR CONTESTANT

STATION NUMBER IV

ASSIGNMENT:	Fill out a job application Participate in job interview Assessment of resume
TIME TO COMPLETE SKILL:	Job application will be completed while waiting 10 minutes for interview You will be informed with 5 minutes remaining
EQUIPMENT:	All equipment you will need is in the station area. Please clean and replace equipment.

Contestant Number _____

Judge's Initials _____

PLEASE LEAVE THIS SHEET WITH THE JUDGE WHEN COMPLETED TASK AT THIS STATION.

Nurse Assisting
SkillsUSA Championships
2010

Performance Checklist

Station IV Job Application, Interview, Resume
Contestant Number _____
Judge Initials _____

Total possible points - 120
Points earned _____

Performance Points	*Pts. Poss.*	*Pts. Earned*	*Remarks*
JOB APPLICATION			
1. Prints in blue/black ink unless writing requested	1		
2. Follows all directions provided on form	3		
3. Completes all the following information on form:			
a. Personal information	3		
b. Education	3		
c. Work experience	3		
d. References	3		
e. Signature in correct area	3		
4. Spells all words correctly	4		
5. Completes form neatly and thoroughly; places "none" or "NA" in places as necessary	3		
JOB INTERVIEW			
6. Dresses appropriately for interview	4		
7. Introduces self to employer and shakes hands firmly if indicated	4		
8. Refers to employer by name	3		
9. Sits correctly with good posture	4		
10. Listens closely to employer's questions and comments	4		
11. Speaks slowly and clearly without mumbling	4		
12. Smiles but avoids excessive laughter or giggling	4		
13. Maintains eye contact with employer	4		

14. Avoids mannerisms during interview	4		
15. Uses correct English and avoids slang terms	4		
16. Uses correct manners and acts politely	4		
17. Avoids smoking, chewing gum, eating candy, etc.	3		
18. Asks questions pertaining to job responsibility and avoids questioning fringe benefits, raises, etc.	4		
19. Thanks employer for the interview at the end	4		
20. Shakes hands firmly if indicated	4		
RESUME			
21. Uses good quality paper	3		
22. Types all information neatly and accurately	3		
23. Follows consistent format and spacing throughout resume	3		
24. Includes all of the following information:			
a. Personal identification: name, address, telephone	3		
b. Employment objective	3		
c. Educational background: name and address of school, special courses, or training	3		
d. Work or employment experience: name and address of employers, dates employed, job title, description of duties, in order from most recent backward	3		
e. Skills and specific knowledge	3		
f. Other activities; organizations, offices held, awards, volunteer work, hobbies, interests	3		
g. References: full name, title, and address or states "References will be furnished on request"	3		
25. Spells all words correctly	3		
26. Punctuates all information correctly	3		
Total	120		

NURSE ASSISTING
SKILLSUSA CHAMPIONSHIPS
2010

INSTRUCTION SHEER FOR CONTESTANT

STATION NUMBER V

ASSIGNMENT:	Measure patient vital signs, and calculate oral intake
TIME TO COMPLETE SKILL:	15 minutes You will be informed with 5 minutes remaining
EQUIPMENT:	All equipment you will need is in the station area. Please clean and replace equipment.
SITUATION:	Mrs. Delpha was admitted to your facility from her home yesterday. She needs to have her vital signs, and intake and output monitored for her first week. Please record her fluid intake for the meal she just completed. Remember, fluid is recorded in cc/ml.

Contestant Number _____

Judge's Initials _____

PLEASE LEAVE THIS SHEET WITH THE JUDGE WHEN COMPLETED TASK AT THIS STATION.

Nurse Assisting
SkillsUSA Championships
2010

Performance Checklist

Station V Measure vital signs and caluclate patient intake
Contestant Number _____
Judge Initials _____

Total possible points - 180
Points earned _____

Performance Points	*Pts. Poss.*	*Pts. Earned*	*Remarks*
1. Assembles equipment for intake and v/s	3		
2. Performs hand hygiene	6		
3. Knocks on door, introduces self, and identifies patient	3		
4. Provides privacy	2		
VITAL SIGNS			
5. Explains vital signs procedures and obtains patient permission	5		
6. Assures patient is comfortable	2		
7. Asks patient re eating, smoking, or drinking	2		
8. Uses protective sheath on thermometer	2		
9. Checks that thermometer indicates "ready" with correct mode	2		
10. Positions patient correctly with easy access to ear	2		
11. Pulls ear pinna up and back	2		
12. Presses scan or activator button	2		
13. Holds thermometer steady for time required	2		
14. Removes probe and correctly reads thermometer	8		
15. Removes and discards sheath correctly	2		
16. Places fingers correctly for counting pulse	2		
17. Counts pulse for at least 30 seconds	5		
18. Obtains correct count to +/- 2 beats per minute	5		
19 Notes rhythm and volume	2		

20. Leaves hand on pulse site	2		
21. Counts respirations for at least 30 seconds	8		
22. Keeps patient unaware of counting activity	2		
23. Obtains correct count to +/- 2 breaths per minute	8		
24. Notes rhythm and character	2		
25. Cleans stethoscope earpeices and bell/disk with alcohol	2		
26. Applies BP cuff correctly	2		
27. Places stethoscope in ears correctly	2		
28. Locates brachial artery and places bell correctly	2		
29. Inflates cuff	2		
30. Reads pressure to +/- 2 mm Hg	8		
31. Recognizes abnormal V/S measurements and reports immediately	3		
32. Records V/S appropriately and accurately	3		
33. Cleans stethoscope earpeices and bell/disk with alcohol	3		
Calculate Intake			
34. Calculates intake from tray	3		
35. Records intake in correct column and time in cc's	3		
36. Adds all columns correctly, total for shift worked	3		
37. Uses ink pen	2		
38. Recheck all work:			
a. If error made, corrects with one line drawn thru	1		
b. Places initials by the error line	1		
39. Turns I & O paper to judge	2		
40. Observes patient for comfort	2		
41. Observes checkpoints before leaving:			
a. Lowers bed to lowest level	2		
b. Places call signal and supplies within reach	5		
c. Opens curtain	2		
d. Leaves area neat and clean	2		
42. Hand hygiene (may verbalize)	6		
43. Reports any abnormal findings	3		

44. Organization of work:			
a. arrives at contest ready to begin skill problem	2		
b. reads problems/checks assumptions/questions	2		
c. obtains necessary equip to complete problem	2		
d. organizes equip/solves problem conveniently	2		
45. Attitude:			
a. toward patient	3		
b. toward supervisors (judges)	3		
c. toward task	3		
46. Communication skills:			
a. facial expressions	2		
b. ability to listen	2		
c. attempt to lower patient anxiety	2		
d. interprets/implements oral/written directions	2		
e. accuracy of oral/written terminology	2		
47. Safety measures:			
a. Utilizes safety precautions for patient & self	5		
48. Speed in completion of task:			
a. completed within alloted time	3		
Total	180		

NURSE ASSISTING
SKILLSUSA CHAMPIONSHIPS
2010

INSTRUCTION SHEER FOR CONTESTANT

STATION NUMBER VI

ASSIGNMENT:	Empty indwelling catheter bag using standard precautions Measure and record output Position on left side
TIME TO COMPLETE SKILL:	15 minutes You will be informed with 5 minutes remaining
EQUIPMENT:	All equipment you will need is in the station area and utility area. Please clean and replace equipment.
SITUATION:	Mr. Martell has an indwelling catheter. The bag needs to be emptied and his output recorded and totaled for your shift and totaled for the 24 hour shift. You are working the 7 AM to 3 PM shift. You also need to position him on his left side.

Contestant Number _____

Judge's Initials _____

PLEASE LEAVE THIS SHEET WITH THE JUDGE WHEN COMPLETED TASK AT THIS STATION.

Nurse Assisting
SkillsUSA Championships
2010

Performance Checklist

Station VI Empty indwelling catheter bag and record output; positioning — Total possible points - 180

Contestant Number _____ — Points earned _____

Judge Initials _____

Performance Points	*Pts. Poss.*	*Pts. Earned*	*Remarks*
1. Assembles equipment needed	4		
2. Verbalizes/performs hand hygiene	6		
3. Knocks on door, introduces self, identifies patient, and explains procedure	5		
4. Provides privacy	4		
5. Applies gloves	5		
6. Places measuring pitcher on paper towels on floor	2		
7. Notes amount of urine in graduated bag	2		
8. Puts drainage outlet in graduate	2		
9. Releases clamp	2		
10. Tilts bag as necessary to empty urine	2		
11. Wipes drainage outlet with antiseptic/disinfectant	5		
12. Clamps outlet and replaces in unit	2		
13. Accurately reads amount in graduate	6		
14. Disposes of urine appropriately	4		
15. Rinses the graduate and replaces it	3		
16. Removes gloves	5		
17. Hand hygiene (may verbalize)	6		
18. Makes sure patient data on I&O form	5		
19. Accurately records urinary output	5		
20. Accurately totals shift output	5		
Position on Left side			
21. Explains procedure to patient	5		
22. Moves shoulders and head to rt. side of bed	5		
23. Moves hips to rt. side of bed	5		

24. Moves legs to rt. side of bed	5		
25. Turns patient to lt. side, assuring that face never becomes obstructed by pillow or hits side rail	7		
26. Checks patient is not lying on left arm	5		
27. Places support under head and rt. arm, behind back, between knees	10		
28. Observes checkpoints before leaving:			
a. Lowers bed to lowest level	2		
b. Places call signal and supplies within reach	5		
c. Opens curtain	2		
d. Leaves area neat and clean	2		
29. Hand hygiene (may verbalize)	6		
30. Reports any abnormal findings	3		
31. Organization of work:			
a. arrives at contest ready to begin skill problem	2		
b. reads problems/checks assumptions/questions	2		
c. obtains necessary equip to complete problem	2		
d. organizes equip/solves problem conveniently	2		
32. Attitude:			
a. toward patient	3		
b. toward supervisors (judges)	3		
c. toward task	3		
33. Communication skills:			
a. facial expressions	2		
b. ability to listen	2		
c. attempt to lower patient anxiety	2		
d. interprets/implements oral/written directions	2		
e. accuracy of oral/written terminology	5		
34. Safety measures:			
a. Utilizes safety precautions for patient & self	5		
35. Speed in completion of task:			
a. completed within alloted time	3		
Total	180		

Nurse Assisting
SkillsUSA Championships
2010

Performance Checklist

Station VII Professional Appearance
Contestant Number _____
Judge Initials _____

Total possible points - 10
Points earned _____

Performance Points	*Pts. Poss.*	*Pts. Earned*	*Remarks*
1. Uniform is neat and clean	2		
2. Hair is orderly and pulled back from face	2		
3. Minimal amount of make-up/clean shaven	2		
4. Minimal amount of jewelry is worn	2		
5. Shoes are appropriate	2		
Total	10		

SkillsUSA
2010 Contest Projects

Photography

Click the “Print this Section” button above to automatically print the specifications for this contest. Make sure your printer is turned on before pressing the button.

Photography

Please be prepared to submit two photographs, a minimum size of 11x14, mounted & matted on 16 x 20 board, at the orientation meeting to be judged and displayed at the competition.

Field Assignment – Contact Sheet – Conceptual Overview

Field Assignment (Time to completion: 2 hours)
Demonstrate your ability to follow assignment guidelines with respect to Location, Theme, Time limit and Technical & artistic proficiency.

1. Do not shoot in RAW mode. Super-fine or high quality JPEG is sufficient.
2. Cameras MUST be set to **M**anual exposure. NO version of Auto exposure is acceptable (i.e. P, Av, Tv, Portrait, Landscape or Sports modes, etc...). Any use of auto exposure settings will result in immediate disqualification on this portion of the contest. Judges will check the EXIF data for proper camera settings.
2. Auto focus is acceptable.
3. All memory cards must be formatted. The "No Image" message must be shown to a judge prior to departing on the field assignment.
4. NO computers or memory storage devices allowed on the shoot.
5. NO communicating with other students/advisors while on shoot.
6. NO leaving designated shooting location outlined by the Contest Chair.
7. Be back in 60 minutes SHARP, points deducted if late.

Contact Sheet (Time to completion: _____)

1. Create a desktop folder named "FieldAssignment-##". (i.e. FieldAssignemtn-05).
2. DO NOT OPEN YOUR IMAGES USING Photoshop, Bridge or Lightrooom otherwise you may be disqualified. PC users use folder viewer using "Filmstrip" or Mac users use Preview to view your images. **NOT EDITING OF IMAGES!!!**
3. Choose 4 of your top images and place them into the "FieldAssignment" folder.
4. Create a 2x2 contact sheet. CS4 does not have "contact sheet", manually creating a contact sheet is acceptable.
5. **The contact sheet MUST be an 8x10 @ 300 dpi using 2 rows & 2 columns. (4 total)**
6. Make sure to place your contestant number somewhere in the upper middle section of the contact sheet using Photoshop's "text tool" before flattening and saving the contact sheet to the folder.
7. Flatten the Contact Sheet and **Save As "ContactSheet-##" (i.e. ContactSheet-05) as a JPEG (10 compression) inside the "FieldAssignment" folder on the desktop.**
8. Copy the "FieldAssignment-##" folder to a jump drive and bring to a printing station.

Conceptual Design (Time to completion: _____)
Let your imagination run wild as you create a conceptual (Fine Art) piece using the 4 images from your Field Assignment Contact Sheet. Manipulate, layer, and work the images together to produce something unique. Very few parameters are given and judging is based on creativeness, use of standard rules of art & design and mastery of Photoshop skills.

1. Create a desktop Folder named "Conceptual-##" (i.e. Conceptual-05).
2. ONLY the 4 chosen Field Assignment images may be used.
3. You MUST use a minimum of 3 images to get credit for this contest.
4. **The Conceptual piece MUST be an 8x10 @ 300dpi.**
5. Flatten the Conceptual piece and **Save As "Conceptual-##" (i.e. Conceptual-05) as a JPEG (10 compression) inside the "Conceptual" folder on the desktop.**
6. Save to a jump drive and bring to the Conceptual piece to the printing station.

FIELD ASSIGNMENT

Contestant #	**Technical** *(0-5 points)*	**Creativity** *(0-5 points)*	**On Theme** *(0-5 points)*	**TOTAL**
1				
2				
3				
4				
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512				

SkillsUSA

2010 Job Interview

Contestant #:_____

A. Education

1. Highest level of education? _____

a. What do you like the **least** about school / Why? _____

_____

b. What do you like the **most** about school / Why? _____

_____

2. If you could do it all over again knowing what you know now, what would you do differently?

_____

B. Work History

3. Do you have a job? _____

* If "NO", Why? _____
(**Note:** *If "NO", skip to Section C)*

* If "YES", What do you do (responsibilities)? _____

_____

4. Are you a reliable employee? _____ Why? _____

_____

5. Do you like your job & Why? _____

_____

C. Photography Background

6. Why do you want to become a photographer? _____

_____

7. What started your interest in Photography? _____

8. Steps taken to improve your skills? _____

_____

9. What is your dream job? _____

10. How do you plan to achieve this goal? _____

_____

11. What are your greatest photographic accomplishments? _____

_____

D. Judges Questions

a. Question #1:

Answer: _____

_____

b. Question #2:

Answer: _____

_____

Judges Evaluation

Resume (*0-20 points*):	_____
Section A (*0-10 points*):	_____
Section B (*0-10 points*):	_____
Section C (*0-20 points*):	_____
Section D (*0-20 points*):	_____
Overall (*0-20 points*):	_____
TOTAL	_____

SkillsUSA
2010 Contest Projects

Plumbing

Click the “Print this Section” button above to automatically print the specifications for this contest. Make sure your printer is turned on before pressing the button.

2010 SkillsUSA Championships

RESIDENTIAL PLUMBING

SkillsUSA
Champions at Work®

This information has been produced, compiled, and printed by the PHCC Educational Foundation with the guidance of the SkillsUSA Residential Plumbing Technical Committee.

CONTESTANT'S BOOK

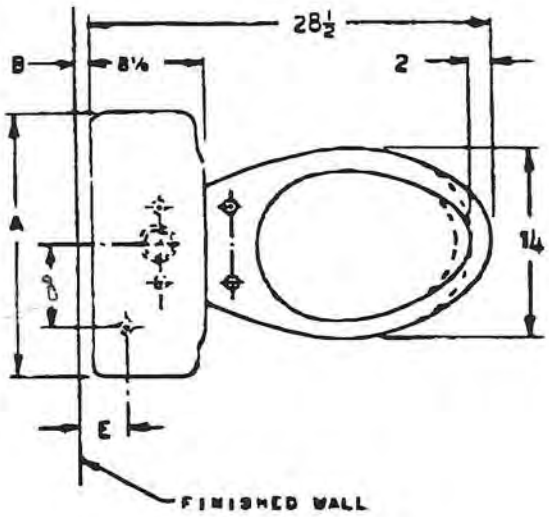
PHCC
PLUMBING-HEATING-COOLING CONTRACTORS ASSOCIATION

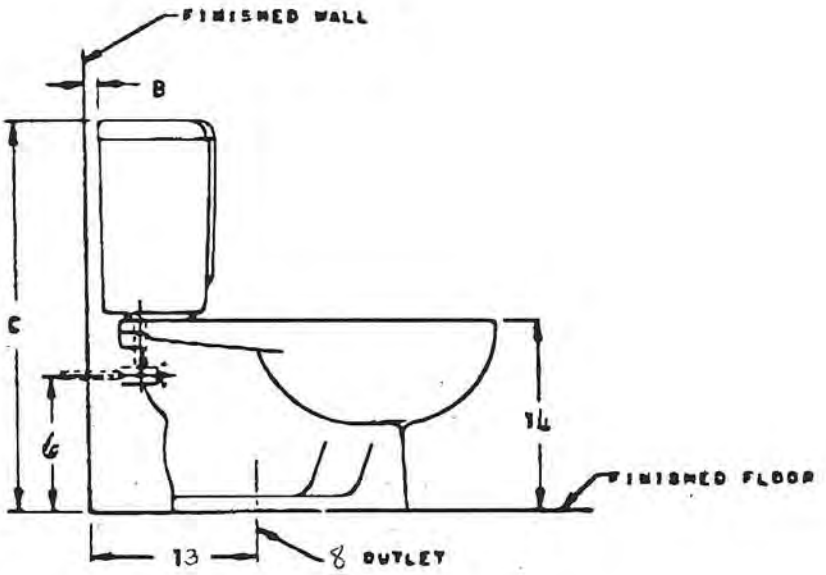
PHCC
EDUCATIONAL FOUNDATION

Contest Material Requirements
2010 Skills USA Competition

Qty	Description
	No-Hub Cast Iron Material
2	3" x 1-1/2" No-Hub Combo
1	3" x 2" No-Hub Combo
1	3" x No-Hub Combo
1	3" No-Hub Cleanout w/plug
1	3" No-Hub Sanitary Tee
1	3" No-Hub 90° Ell
1	3" No-Hub Floor Flange
1	2" No-Hub Sanitary Tee
1	2" No-Hub P-trap
15	3" No-Hub Bands
7	2" No-Hub Bands
2	1-1/2" No-Hub Bands
1	2" x 1-1/2" No-Hub Band
1	3" NH x PVC Transition Coupling
1	2" x 1-1/2" NH x PVC Transition Coupling
2	1-1/2" NH x PVC Transition Coupling
1	2" NH x PVC Transition Coupling
10 ft	3" Cast Iron Pipe
5 ft	2" Cast Iron Pipe
10 ft	1-1/2" Cast Iron Pipe
	PVC Material
1	3" x 2" PVC Sanitary Tee
2	1-1/2" PVC Sanitary Tee
1	1-1/2" PVC Fit Trap Adaptor
1	2" x 2" x 1-1/2" PVC Sanitary Tee
1	2" x 1-1/2" x 1-1/2" PVC Sanitary Tee
2	1-1/2" PVC 90° Ell
1	2" PVC No-Hub Floor Drain
1	1-1/2" PVC Test Cap
5 ft	3" PVC Pipe
5 ft	2" PVC Pipe
20 ft	1-1/2" PVC Pipe
	Copper Material
2	3/4" x 1/2" x 1/2" Copper Tee
12	1/2" Copper 90° Ell
1	3/4" x 3/4" x 1/2" Copper Tee
2	3/4" Copper 90° Ell
1	3/4" x 3/4" x FIP Copper Tee
2	1/2" Copper Caps
1	1/2" Copper Street 90° Ell
8	1/2" Copper 2-Hole Straps
8	3/4" Copper 2-Hole Straps
20 ft	1/2" Copper Tube Type M
10 ft	3/4" Copper Tube Type M

Qty	Description
	Miscellaneous Material
1	1lb Roll No-Lead Solder
1	Small Container ASTM B813 Flushable Flux w/Brush
1	Small Roll of Plumbers Cloth
1	Roll of Teflon Tape
1	Pint of Purple PVC Cleaner
1	Pint of PVC Cement
4	3" Clevis Hangers
4	Side Beam Hangers
9	3/8" Hex Nuts
9	3/8" Flat Washers
8 ft	3/8" All-Thread Rod
1	3" Riser Clamps
1	2" Riser Clamps
2	1-1/2" Riser Clamps
4	#12 x 1" Phillipshead Screws
6	#12 x 1-1/4" Pan-Head Screws
8	#12 x 1" Pan-Head Screws
	Fixtures & Accessories
1	1-1/2" PVC Tubular P-Trap
3	1/2" x 3/8" Sweat x Compression Chrome Angle Stops
2	3/8" Chrome Lavatory Risers
1	China Lavatory Sink
1	4" Center Set Faucet with Pop-Up
2	3/8" x 3/8" Compression x Compression Couplings
1	1-1/2" x 1-1/4" Slip Nut Washer
5	622-M08 - 1/2" x 8" Bullet Stub Out
2	522-16245 - Universal Slider bracket (19" span)
1	521-6415 - Stub out Brackets





CLOSET ROUGH-IN

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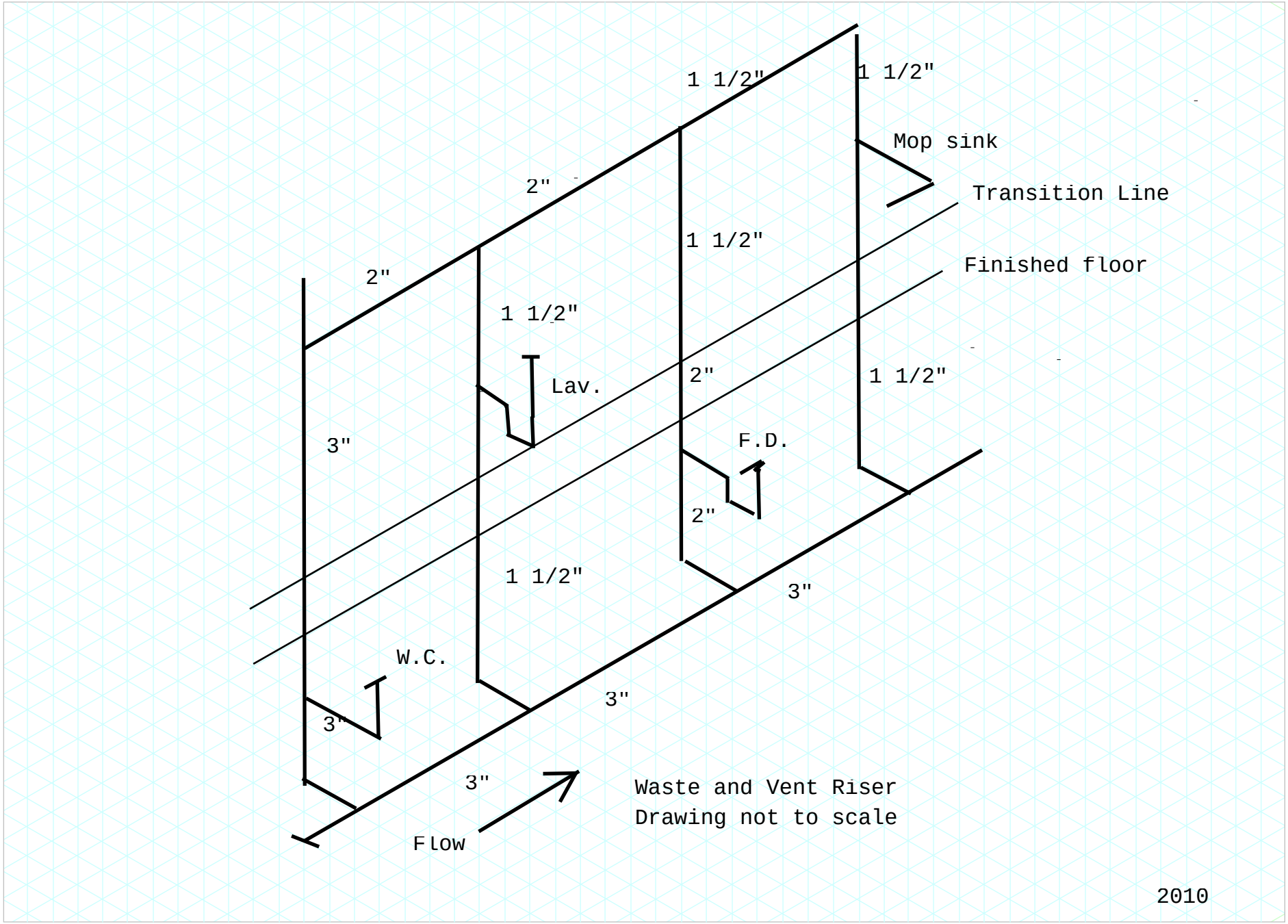

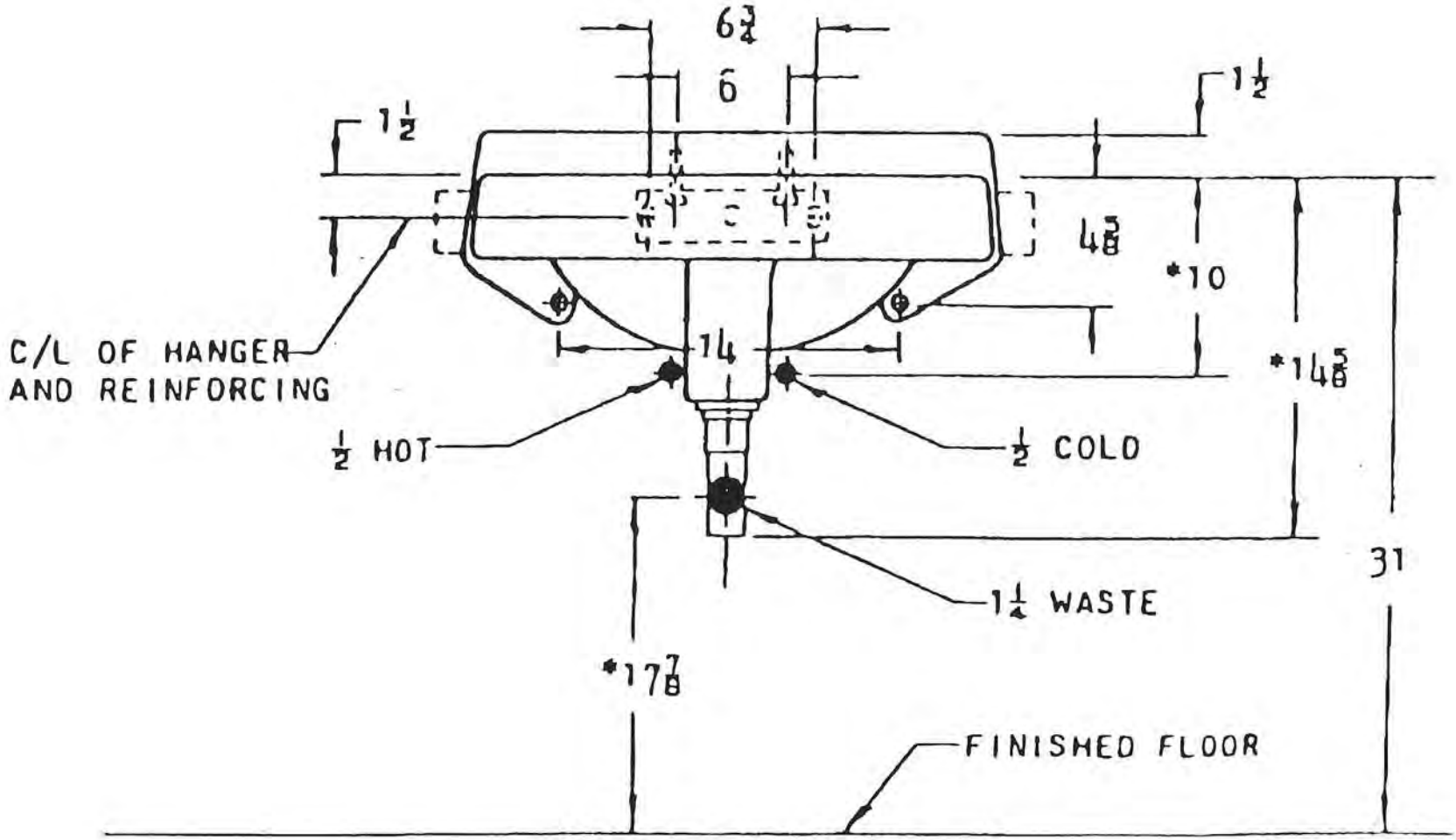

LAVATORY ROUGH-IN

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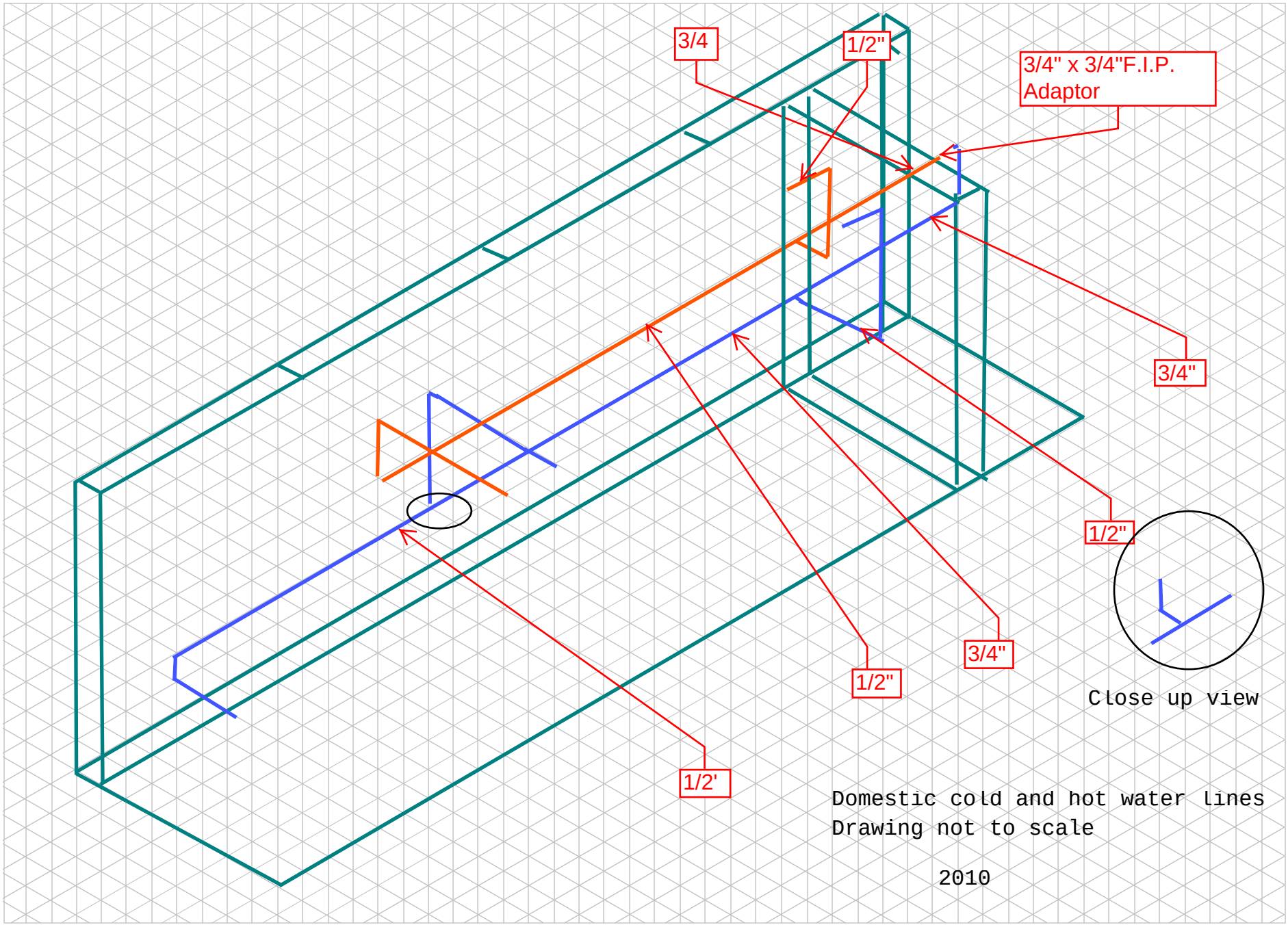
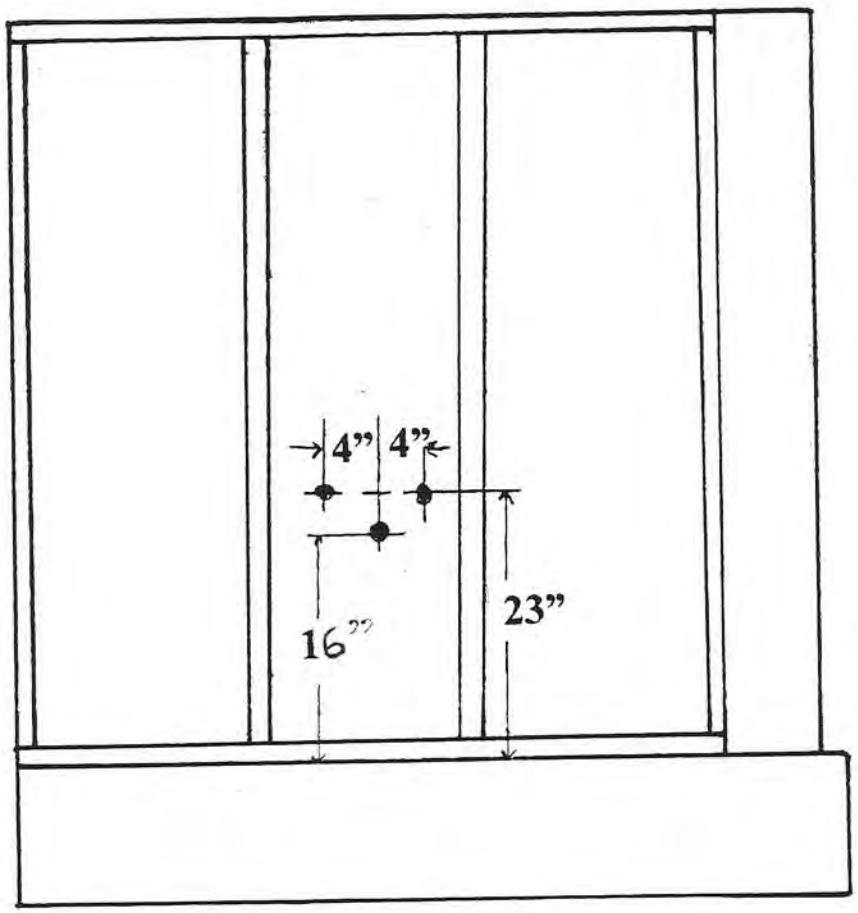


Domestic cold and hot water lines
Drawing not to scale

2010

UTILITY TRAY
ROUGH-IN



SkillsUSA
2010 Contest Projects

Power Equipment Technology

Click the “Print this Section” button above to automatically print the specifications for this contest. Make sure your printer is turned on before pressing the button.

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SkillsUSA Competition Test
Power Equipment Technology

EXAMINATION INSTRUCTIONS

Read these directions silently to yourself.

This examination has 100 questions; each followed by four possible answers. Some questions have drawings associated with them. Read each question and study any drawings; then select the BEST ANSWER. Mark your answers on the Answer Sheet as shown below. **Do not mark in the test booklet.**

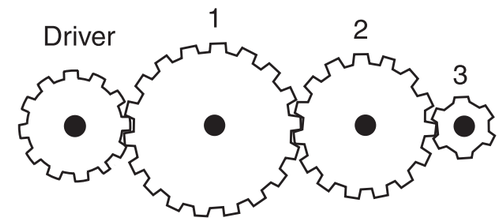
Please read the sample question below:

Please read <u>all</u> answers before selecting your response!

SAMPLE QUESTION:

Which gear will turn in the same direction as the driver gear?

A. 1
B. 2
C. 3
D. None of the above



Fill in the correct answer on the answer sheet.

Sample Question **Answer Sheet** A B C D

WHEN INSTRUCTED, PLEASE TURN THE PAGE AND BEGIN THE TEST.

I. Two Stroke Cycle Engine Questions

1. A two-stroke engine that “hunts” or has erratic idle is likely to have:
   A. An air leak.
   B. A defective ignition module.
   C. Restricted jets.
   D. Both A & B (140)

2. With a typical “lean” piston seizure of an engine, you will notice the majority of the score marks on:
   A. The intake side of the piston.
   B. The piston ring land area.
   C. The exhaust side of the piston.
   D. None of the above (117)

3. While analyzing a “Lean Seizure,” the basic cause of failure would be:
   A. Too much fuel.
   B. Not enough fuel.
   C. Not enough air.
   D. Improper fuel/oil ratio. (72)

4. To complete one power cycle, the crankshaft of a two-stroke engine must rotate:
   A. One revolution.
   B. Two revolutions.
   C. Four revolutions.
   D. None of the above (51)

5. Improper torque on two-stroke engine fasteners could cause:
   A. Air leaks.
   B. Poor operating characteristics.
   C. Thread damage.
   D. All of the above (33)

6. The piston stroke from B.D.C to T.D.C. achieves which of the following?
   A. Intake and transfer phase
   B. Exhaust and transfer phase
   C. Compression and exhaust phase
   D. Compression and intake phase (25)

7. What is the purpose of transfer ports in the cylinder?
   A. To get the fuel/air mixture from the crankcase to the combustion chamber.
   B. To get the fuel/air mixture from the cylinder to the crankcase.
   C. To get the fuel/air mixture from the carburetor to the crankcase.
   D. To get the fuel/air mixture from the crankcase to the carburetor. (24)

8. The two-stroke engine depends on:
   A. A higher percentage of air to fuel mixture than a comparable four-stroke engine.
   B. An oil reservoir to hold the lubricating oil.
   C. A sealed crankcase.
   D. Crankcase venting for all-position operation. (22)

SkillsUSA Competition Test
Power Equipment Technology

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9. Technician A says a properly designed two-stroke exhaust system can help draw in the fresh intake charge and prevent it from escaping out the exhaust port. Technician B says its ONLY function is to reduce noise. Who is correct?
   A. A only
   B. B only
   C. Both A & B
   D. Neither A nor B (18)

10. In an all position diaphragm carburetor, the metering diaphragm's main function is:
   A. To pump fuel into the engine.
   B. To keep air from entering the fuel mixture.
   C. To control fuel flow through the carburetor.
   D. All of the above (3)

11. Two-stroke engines commonly use a _____ design to take in the fuel-air mixture.
   A. Piston port
   B. Rotary valve
   C. Reed valve
   D. All of the above (1)

12. A spark plug's heat range refers to:
   A. The speed that the temprature rises.
   B. The temperature of the spark plug body.
   C. Its range of heat dissipation.
   D. The voltage required to fire the plug. (5)

13. Air cooled two-stroke engine oils:
   A. Are all are pretty much the same.
   B. Are not much different than automotive-type motor oils.
   C. Have different certifications depending on engine design and use.
   D. Should only be used if they are NMMA (BIA) certified. (6)

14. The air entering an engine provides:
   A. An atomized fuel mixture.
   B. A coolant for internal engine parts.
   C. For proper operation of the carburetor.
   D. All of the above. (7)

15. Which components are **NOT** part of a two-stroke engine's fuel system?
   A. A carburetor and fuel filter.
   B. A fuel tank vent and fuel line.
   C. A crankcase and fuel tank.
   D. An air filter cover and muffler. (8)

17. Excess carbon deposits are more likely to be found in engines that:
   A. Operate with changing engine RPM.
   B. Have a lean carburetor adjustment.
   C. Have additives in the gasoline.
   D. Run under constant load and speed. (142)

18. When the piston is moving downward, the pressure in the crankcase:
    A. Increases.
    B. Decreases.
    C. Reverses.
    D. Vents. (11)

19. What is the function of the piston rings in a two-stroke engine?
    A. To maintain compression.
    B. To transfer heat from the piston.
    C. To keep combustion gases from entering the crankcase.
    D. All of the above. (12)

20. The average four-stroke lawnmower engine runs at approximately 3000 RPM and produces 25 power strokes per second. How many power strokes per second does a high performance two-stroke chain saw engine produce at 12,000 RPM?
    A. 220
    B. 200
    C. 120
    D. 100 (15)

21. Using a torque wrench to tighten the flywheel nut helps prevent:
    A. Flywheel distortion.
    B. Flywheel key shearing.
    C. Crankshaft damage.
    D. All of the above. (96)

22. Carbon removal is important because it:
    A. Restores horsepower.
    B. Helps engines to run cooler.
    C. Reduces the risk of detonation.
    D. All of the above. (97)

23. Oiled foam elements should be cleaned by:
    A. Cleaning in solvent, drying and re-oiling.
    B. Cleaning in carburetor cleaner, drying and re-oiling.
    C. Cleaning in soapy water, drying and re-oiling.
    D. Tapping on a hard surface and re-oiling. (98)

24. When servicing a carburetor it is recommended to:
    A. Replace the fuel filter.
    B. Inspect the fuel line.
    C. Clean the fuel tank.
    D. All of the above. (99)

25. During disassembly, ball type main bearings should be routinely inspected by:
    A. Checking radial and axial free play.
    B. Turning the bearing and checking for roughness.
    C. Measuring the ball to race clearance.
    D. Both A and B. (100)

92. Negative battery cables are removed first:
    A. To help prevent open circuits.
    B. Only on side terminal batteries.
    C. To help prevent short circuits to ground.
    D. All of the above. (8)

93. While using an analog ohmmeter, the needle points to . This symbol represents:
    A. High resistance.
    B. Low resistance.
    C. The battery test position.
    D. Reversed polarity of the leads. (11)

94. A high resistance connection in a circuit causes:
    A. Increased battery voltage.
    B. Decreased battery voltage.
    C. Increased current flow.
    D. Decreased current flow. (12)

95. The open-circuit voltage test on a good alternator stator should result in:
    A. Voltage the same as battery voltage.
    B. Zero volts.
    C. One-half of battery charge.
    D. Higher than battery voltage. (21)

96. While attempting to start an engine the starter solenoid clicks repeatedly but will not turn the engine over. The first component to check is the:
    A. Key switch.
    B. Solenoid.
    C. Battery.
    D. Starter motor. (22)

97. The ignition coil contains two windings. The one with less turns is the:
    A. Secondary winding.
    B. Lamination.
    C. Stator.
    D. Primary winding. (23)

98. The ignition coil is a type of :
    A. Transistor.
    B. Transformer.
    C. Rheostat.
    D. Capacitor. (24)

99. A magneto ignition systems produces a spark when the:
    A. DC current flows from the primary to secondary windings.
    B. AC current flows from the secondary to primary windings.
    C. Primary circuit opens inducing current in the secondary windings.
    D. Points close. (28)

100. In a Capacitive Discharge Ignition System, what is charged by the exciter coil?
    A. Silicon Control Rectifier.
    B. Primary circuit.
    C. Secondary circuit.
    D. Capacitor. (29)

IV. Electrical Questions Continued

84. When the insulation of a hot-side wire wears off and the bare copper wire touches the steel frame of the tractor, which type of circuit fault is formed?
A. Open.
B. Closed.
C. Shorted.
D. Shared. (63)

85. When soldering an electrical wiring connection, use:
A. Acid core flux.
B. Rosin core flux.
C. Either A or B.
D. Neither A nor B. (61)

86. One of the first areas to inspect when troubleshooting a faulty charging system is the:
A. Regulator.
B. Diodes.
C. Battery and connections.
D. Alternator output with a digital multimeter. (41)

67. Ammeters are connected:
A. To unpowered circuits.
B. In series with loads.
C. In parallel with loads.
D. None of the above. (14)

88. An engine cranks over too slowly. A technician places a 12-volt probe light on the starter motor terminal and it lights. This indicates that:
A. The starter motor is defective.
B. The polarity is correct.
C. The starter is receiving enough amperage.
D. Voltage is getting to the starter motor. (5)

89. Standard diodes:
A. Act as an electrical stop in both directions.
B. Allow current flow in both directions.
C. Allow current flow in only one direction.
D. Have small miniature moving parts. (4)

90. Current needed to charge a battery is:
A. Alternating current.
B. Direct current.
C. Negative current.
D. None of the above. (1)

91. A material that prevents electrical current from transferring from one conductor to another is called:
A. Amperage.
B. Resistance.
C. An open circuit.
D. An insulator. (7)

II. Four Stroke Cycle Engine Questions

26. An engine that has failed by over speeding could MOST likely cause a:
A. Collapsed float.
B. Broken connecting rod.
C. Warped cylinder head.
D. None of the above. (150)

27. Technician A says ignition components may break down, causing poor performance as they heat up. Technician B says engine temperature will not affect ignition performance because combustion occurs more easily in a hot engine. Who is correct?
A. Technician A is correct.
B. Technician B is correct.
C. Technician B if engine is OHV.
D. Technician B if engine is liquid cooled. (141)

28. An excessively discolored crank-pin would be caused by:
A. Abrasive material in the oil.
B. A bent crankshaft.
C. An over speeding engine.
D. Insufficient lubrication. (125)

29. An engine is leaking oil around the governor shaft during operation. What is the first test that should be performed in trying to determine the cause of the leak?
A. Test for excessive exhaust back pressure that could be pressurizing the crankcase.
B. Test compression to determine if ring wear blow-by is pressurizing the crankcase.
C. Test crankcase vacuum with a manometer.
D. Test for high pressure at the governor shaft bearing. (116)

30. A crankcase breather valve:
A. Allows positive pressures to exit the crankcase.
B. Allows air to enter the engine only.
C. Cleans air entering the crankcase.
D. Allows air to enter and exit the crankcase. (114)

31. Variable ignition timing can:
A. Increase low speed performance.
B. Increase high speed performance.
C. Improve ease of starting.
D. Do all of the above. (107)

32. In a CDI ignition system, what is triggered creating a path to ground through the coil?
A. Capacitor
B. SCR
C. Exciter coil
D. Primary circuit (101)

33. At high altitudes re-jetting the carburetor may be necessary because:
A. Less fuel is available.
B. More oxygen is available.
C. Less oxygen is available.
D. The air temperature is cooler. (88)

34. Connecting rod to crankshaft clearance can be measured BEST using:
    A. A telescoping micrometer.
    B. Plastigage.
    C. Vernier caliper.
    D. Thickness gauge. (81)

35. Piston rings control oil consumption BEST when:
    A. They always remain flat against the cylinder wall.
    B. They flex slightly to use the edge of the piston ring.
    C. The ring end gaps are below .001”.
    D. The oil ring has become as wide as possible. (78)

36. A correctly honed cylinder wall will have a crosshatch pattern of:
    A. 0 to 10 degrees.
    B. 15 to 20 degrees.
    C. 30 to 45 degrees.
    D. 60 to 90 degrees. (69)

37. If the piston is at Top Dead Center, but **NOT** on the compression stroke, what position will the valves be in?
    A. Both valves will be open slightly.
    B. Both valves will be closed.
    C. The intake valve will be open slightly, with the exhaust valve closed.
    D. The exhaust valve will be open slightly, with the intake valve closed. (64)

38. Valve seats that are too narrow cause:
    A. Valve shearing.
    B. Valve overheating.
    C. Valve seat deposits.
    D. Excessive valve overlap. (61)

39. Using a torque wrench to tighten the flywheel retainer helps prevent:
    A. Flywheel damage.
    B. Flywheel key shearing.
    C. Crankshaft thread damage.
    D. All of the above. (53)

40. Horsepower is BEST defined as:
    A. A force acting on a radial distance from a point of rotation.
    B. Volumetric efficiency of an engine.
    C. A timed rate of doing work.
    D. Opposite of torque. (45)

41. To complete one operating cycle the crankshaft of a four-stroke engine must rotate:
    A. One-half revolution.
    B. One revolution.
    C. Two revolutions.
    D. Four revolutions. (42)

42. As temperature drops from 80 degrees F. to 30 degrees F., battery output:
    A. Decreases.
    B. Increases.
    C. Stays the same.
    D. Is not affected. (32)

75. Which of the following does not describe a brake system?
    A. Disc
    B. Band
    C. Drum
    D. Linear (26)

76. There are three types of V-belt; classic, narrow, and double.
    A. True
    B. False (29)

77. If a hydrostatic transaxle unit is noisy:
    A. The brake setting is too tight.
    B. Check the inlet oil filter.
    C. Check the oil level.
    D. All of the above. (105)

78. If a hydrostatic transaxle unit is low on power:
    A. Check the engine overloading.
    B. Check bypass valves.
    C. Check operating temperatures.
    D. All of the above. (106)

79. Excessive filter restriction in a pump suction line can cause:
    A. Air bubbles from leaky gaskets.
    B. Cavitation erosion.
    C. Pump noise.
    D. All of the above. (107)

80. Some transaxles are sealed airtight and should not have oil added to them.
    A. True
    B. False (102)

IV. Electrical Questions

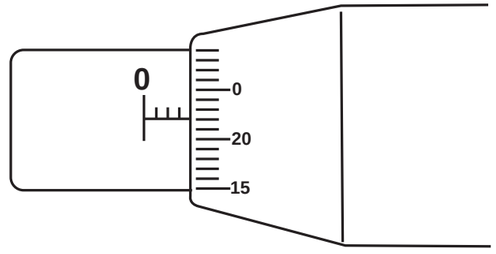
81. What code is marked on a safety switch that would indicate that there should be continuity between the terminals when the switch plunger is out?
    A. NA.
    B. NO.
    C. NC.
    D. NB. (76)

82. A 0.2-volt drop is observed across the starter solenoid contacts with the engine cranking. What should be done to the system?
    A. Nothing--it is acceptable.
    B. Install a larger battery.
    C. Replace the cable or component.
    D. None of the above. (68)

83. Electrical circuits may be protected against shorts by:
    A. Switches.
    B. Relays.
    C. Circuit breakers / fuses.
    D. All the above. (65)

43. Which of the following formulas describes Ohm's law?
    A. Volts = Amps X Ohms
    B. Amps = Volts X Ohms
    C. Ohms = Volts X Amps
    D. Volts = Amps – Ohms (30)

44. Read the following standard (non-metric) micrometer. What is the correct answer?
    A. .620 inches
    B. .097 inches
    C. .022 inches
    D. .977 inches (19)



45. Recommended torque for a cylinder head bolt is 384 inch pounds. What is the foot pound equivalent?
    A. 26 foot-pounds
    B. 32 foot-pounds
    C. 36 foot-pounds
    D. 42 foot pounds (13)

47. A four-stroke engine gets its name from:
    A. The number of cylinders it has.
    B. The number of valves used in the engine design.
    C. The number of piston movements during a combustion cycle.
    D. The number of engineers who designed the original engine. (1)

48. If a four-stroke engine misses under load the problem could be:
    A. A fouled spark plug.
    B. An improper spark plug gap.
    C. A weak valve spring.
    D. All of the above. (2)

49. Fuel tanks are vented to:
    A. Prevent an explosion.
    B. Increase engine speed.
    C. Prevent a vacuum.
    D. Increase the vacuum. (3)

50. An engine that runs rich and blows black smoke is MOST likely a symptom of:
    A. Low compression.
    B. Restricted air intake.
    C. Tight valves.
    D. Weak ignition system. (142)

66. If the drive system is engaged, the clutch is activated, and there is no output, which area would you inspect?
    A. Belt
    B. Input
    C. Final Drive
    D. All of the above (21)

67. What effect does reducing the outer diameter of the input pulley have on the input speed of the drive system?
    A. Reduces.
    B. Increases.
    C. Stays the same.
    D. None of the above. (20)

68. A declutching mechanism:
    A. Automatically returns to neutral when the clutch is applied.
    B. Is no longer used in lawn and garden vehicles.
    C. Is only used in gear drive transaxles.
    D. Stops the input rotation when clutch is applied. (18)

69. Belt guides have only one purpose, which is to keep the belt from falling off the pulleys.
    A. True
    B. False (17)

70. Transaxles contain:
    A. A differential.
    B. A transmission.
    C. A set of axles.
    D. All of the above. (3)

71. The purpose of a transmission is:
    A. To provide a neutral between forward and reverse.
    B. To provide low axle speeds for high torque operations.
    C. To transfer power from the engine to the differential.
    D. All of the above. (4)

72. A spring tensioned idler:
    A. Prevents the overloading of a drive unit's input shaft.
    B. Requires little or no adjustment.
    C. Is always better in application than a solid mounted tensioner.
    D. Both A and B. (6)

73. Vehicle opperator manuals dictate and caution should be taken when towing any vehicle with regard to the transmission.
    A. True
    B. False (11)

74. The most common cause of hydraulic system failure is _____:
    A. Contamination.
    B. High oil temperature.
    C. Leakage.
    D. Wrong fluid. (145)

51. Burned valves are MOST likely a result of:
    A. Excessive valve clearance.
    B. Insufficient valve clearance.
    C. Unleaded fuel.
    D. Rich air/fuel mixture. (127)

52. The specific gravity of the electrolyte in a discharged battery, compared to the specific gravity of electrolyte in a charged battery will be:
    A. Lower.
    B. Heavier.
    C. Higher.
    D. The same. (25)

53. According to Ohm's law, if the voltage is 110, and the resistance is 11 ohms, the current would be:
    A. 1 ampere.
    B. 10 amperes.
    C. 11 amperes.
    D. 100 amperes. (26)

54. The electromotive force that causes electrons to flow in a circuit is measured in:
    A. Amps.
    B. Ohms.
    C. Volts.
    D. Watts. (27)

55. In a magneto ignition system the breaker points open:
    A. As primary voltage starts to build.
    B. To start induction in the primary windings.
    C. As primary voltage peaks.
    D. To reduce cross firing. (108)

56. The type of current obtained from a storage battery is called:
    A. Alternating current.
    B. Alternating direct current.
    C. Direct current.
    D. Rectified current. (31)

57. The inside chamfer on a piston ring:
    A. Transfers heat to the cylinder wall.
    B. Improves the seal against the cylinder wall.
    C. Helps control oil consumption.
    D. Is designed to reduce reciprocating weight. (79)

58. Connecting rod to crankshaft clearance should be measured:
    A. If diagnosing an internal engine noise problem.
    B. When installing new lower end parts.
    C. During any reassembly.
    D. All the above. (80)

59. What is the MOST appropriate tool for measuring valve guide wear?
    A. Inside micrometer
    B. Small hole gauge
    C. Dial bore gauge
    D. Dial indicator (20)

60. Which tool should NOT be used to measure cylinder I.D.?
    A. Vernier caliper
    B. Cylinder bore gauge/dial indicator
    C. Inside micrometer
    D. Telescoping gauge (24)

III. Driveline & Hydraulics Questions

61 A lawn tractor has broken an axle. The most likely cause is:
    A. Defective axle from the manufacturer.
    B. Normal wear.
    C. Customer abuse through overload.
    D. None of the above. (139)

62. A lawn tractor had three belts replaced last year. The first belt turned over in the pulley sheaves. The others had to be overly tensioned to eliminate slippage and both failed in a short time. What was the most likely cause?
    A. The use of an incorrect type of belt dressing.
    B. Worn pulley sheaves.
    C. There is no problem; this is typical.
    D. None of the above. (136)

63. If no recommendations are given for lubrication change intervals on mechanical transaxles, the lubrication should be changed at:
    A. 6 months or 200 hours of operation.
    B. 8 months or 200 hours of operation.
    C. 10 months or 200 hours of operation.
    D. Only during internal mechanical service. (100)

64. The brake/clutch pedal on a gear-type transmission / transaxle is properly adjusted if:
    A. The input pulley slips on the v-belt and the brake is not binding.
    B. The drive belt slips when the drive pulley slips.
    C. The drive belt is fully disengaged and the brake is applied.
    D. The input shaft is held firmly and the wheels are free to turn. (95)

65. When attaching a wheel to an axle, you should:
    A. Pre-heat components prior to assembly.
    B. Apply loctite to shaft and assemble.
    C. Clean components and apply rust preventative and assemble.
    D. Paint parts and assemble. (32)

2010
Power Equipment Technology
Station # 2 – Parts Identification

SCENARIO - TANAKA

Please Read Carefully.

On the table, you have five parts for a Tanaka TBC255PF Grass Trimmer; each labeled A, B, C, D, or E.

DO NOT REMOVE THE PARTS FROM THE BAGS!

Locate the correct PART NUMBER for each part using the TBC255PF Illustrated Parts Manual.

Write the correct PART NUMBER on the score sheet next to the letter of the bagged part.

When you have completed the Tanaka parts lookup, move on to the next page and the Briggs & Stratton/ Simplicity parts lookup.

When you have completed all three of the manufacturer's parts lookup, raise your hand and the judge will come and collect your score sheet.

Do not write in the Illustrated Parts Manual.

2010
Power Equipment Technology
Station # 2 – Parts Identification

SCENARIO - SIMPLICITY

This section of Station #2 tests your ability to:

- Identify parts
- Locate replacement parts

A customer brought you this part from his Simplicity Regent Series tractor and said he thinks he has his machine's issue narrowed down to this very part. Using the Illustrated Parts List given to you, answer the questions on your score sheet.

When you have completed the Simplicity parts lookup, move on to the next page and the Kohler parts lookup.

2010
Power Equipment Technology
Station # 2 – Parts Identification

SCENARIO - KOHLER

This third section of Station #2 tests your ability to identify parts:

1. Use the engine identification decal above for reference when looking up the part. List the engine model and spec numbers on the score sheet.

2. Locate the reference number on the illustrated parts list.
3. Determine what the service part number is using the parts list.
4. Give a brief description illustrating your knowledge of the function of the individual part identified.

Each contestant must enter the required information on the Score Sheet.
Do not write on this page.

2010
Power Equipment Technology
Station # 3 - Service Writing

SCENARIO

Please Read Carefully.

This station will test your ability to perform customer service which might include both verbal and written skills. In your station you will find a Yard Machine Mower as well as a Miller Welder.

Your first task is to place your contestant number just below the Service Order number.

Scenario 1:

Customer Name: Eddie Van Halen
1985 Hager Road
Tucson, AZ 20060
Phone: 962-126-1955

The lawnmower was a gift and he has been complaining that it starts hard and when it does run it seems to hunt. Because the unit was a gift he seems to be uncomfortable in putting money into the unit.

Please fill out the service order to help the technician successfully repair the unit. You may ask questions; however, the judge can only answer yes or no questions.

Scenario 2:

The customer (played by a judge) has just purchased a Miller Welder and asks you about service support. Tell the customer about the service support you offer at your fictitious dealership.

Score
_____

SkillsUSA Champions at Work®

Contestant Number
_____

2010
Power Equipment Technology
Station # 4 – Starter Repair

SCORE SHEET

Briggs & Stratton Recoil Starter Assembly

(75 points)

This section of the competition tests your ability to:

- Effectively repair recoil assemblies

A customer brought you this recoil starter assembly from his brand new Briggs & Stratton Professional Series 8.75 Ft/lbs Torque Power Engine. The rope shows some signs of fraying. The customer saw this and wants it replaced before it breaks.

1. Roughly how many turns did it take to wind the spring adequately when installing the rope? _____

2. Roughly how many inches of the starter rope are in the recoil currently?
_____

3. What number designation rope size is this?
_____

4. Is this starter worth repairing or is it better to replace the whole assembly?
Repair _____ Replace _____

Score
_____

SkillsUSA Champions at Work®

Contestant Number
_____

2010
Power Equipment Technology
Station # 5 – Ignition Systems

SCORE SHEET
(95 points)

This station will test your knowledge of the ignition systems used on Kohler engines. You will be required to perform some basic tests and record the results. You will also need to write a brief description of the reason and function of some components to verify your understanding of the purpose for the part.

1. What is the function of a SAM? _____
   _____ _____ **(10 points)**
2. What does the acronym ASAM stand for?
   _____ _____ **(10 points)**
3. What does the acronym DSAM stand for?
   _____ _____ **(10 points)**

Test each module to see if they are functioning correctly and record your findings, by writing **Pass** or **Fail** after the question.

4. Module #1 _____ **(10 points)**
5. Module #2 _____ **(10 points)**
6. Module #3 _____ **(10 points)**
7. What code was used to test module #1? _____ **(10 points)**
8. What code was used to test Module #2? _____ **(10 points)**
9. What code was used to test Module #3? _____ **(10 points)**
10. Without seeing the engine, how would you determine if the SAM is from a single cylinder or twin cylinder engine? _____ **(5 points)**

Score
_____

Contestant Number
_____

2010
Power Equipment Technology
Station # 6 – Failure Analysis

SCORE SHEET

Briggs & Stratton 120412

(75 points)

This section of the competition tests your ability to identify what the cause of the failure is and how it may have occurred. The components provided are from a model 120412-0023-E1 and displays one example of the five major engine failures normally encountered by the air-cooled engine service technician. The major engine failures are dirt ingestion, insufficient lubrication, overheating, over speeding, and breakage.

Perform the following tasks:

Using measuring tools and your knowledge of major engine failures, examine the engine parts supplied and answer the following questions to the best of your ability.

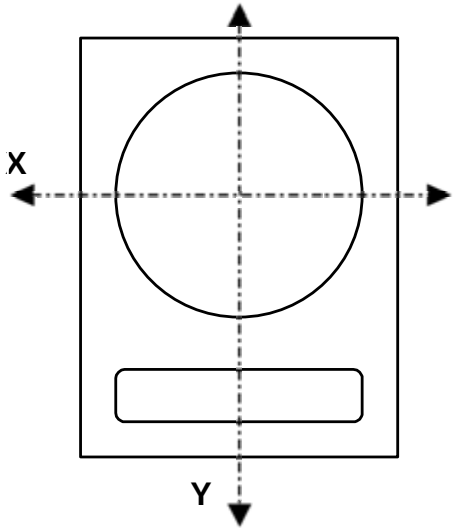
1. Measure the cylinder bore and record your findings;

Cylinder # _____

Top **X** _____
Y _____

Middle **X** _____
Y _____

Bottom **X** _____
Y _____



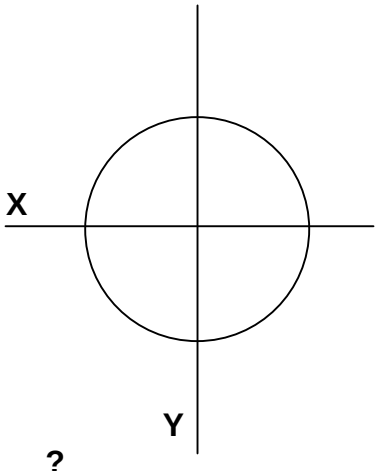
2. Measure the crankshaft and record your findings;

Crankshaft # _____

PTO Bearing **X _____**
Y _____

Crank Pin **X _____**
Y _____

Mag Bearing **X _____**
Y _____



3. What caused the engine to fail (pick one) _____?

A. Dirt Ingestion
B. Insufficient Lubrication
C. Overheating
D. Over speeding
E. Breakage

4. What action would you consider taking to help repair the engine for the customer? Pick the best option listed based on a shop labor rate of $45.00 per hour _____.

A. Sell the customer the following individual parts, new cylinder block, crankshaft, piston with rings and connecting rod, and crankcase cover?

B. Sell the customer a new piston with rings, connecting rod and crankcase cover and oversize the cylinder bore to the next good dimension?

C. Sell the customer a short block?

D. Sell the customer a new replacement engine?

Score
_____

SkillsUSA Champions at Work®

Contestant Number
_____

2010
Power Equipment Technology
Station # 7 – Internal

SCORE SHEET

Echo SRM-265 Power Head

Please Read Carefully.

In front of you is an SRM-265 Echo Power Head along with the necessary tools to perform the following tasks.

1. What is the spark plug gap? _____ 10 pts_____
2. What is the engine compression? _____ 20 pts_____
3. What is the air gap on the ignition module? _____ 20 pts_____
4. What type of ignition does this have? _____ 20 pts_____
5. What type of clutch is used? _____ 20 pts_____

Once you have finished these steps, ask the judge to check where you are and then reassemble the unit. Do not reassemble until the judge has looked at your work.

6. Correctly reassemble the power head 5 pts _____

Score
_____

SkillsUSA Champions at Work®

Contestant Number
_____

2010
Power Equipment Technology
Station # 8 – Measurement

SCORE SHEET

This station will test your knowledge of using basic measurement tools. Please read the questions carefully and answer based on your measurements. All tools needed are provided for you and you may write on this sheet. **Each question is worth 10 points.**

1. **Cylinder Head Gasket Kit: 15 041 07-S.** You have been contacted by your source of parts supply to check your stock of head gaskets. It's possible that the wrong head gasket was packaged in the kit. Measure the thickness of the head gasket on the outside edge and record your findings below to the nearest hundredth.
   - _____

2. **Oil Dipstick: 15 038 04-S** A customer has brought his engine into the shop for you to look at. He is complaining that when he installed the 15 038 04-S dipstick it reads low on oil, but with his old dipstick it reads full. Measure the width of the crosshatching on his new dipstick and record your measurement to the nearest tenth.
   - _____

3. **Crankshaft: 15 014 04-S** Measure the connecting rod journal and record your measurement below to the nearest thousandth.
   - _____

4. **Valve, Exhaust: 15 016 01-S** Measure the valve stem diameter near the middle and record your measurement to the nearest thousandth.
   - _____

5. **Camshaft Kit: 15 010 06-S** Measure the camshaft bearing surface outer diameter at the gear and lobe ends. Record your measurements to the nearest thousandth.

    - Gear End: _____
    - Lobe End: _____

6. **Piston Kit: 15 874 01-S** Using the feeler gauges, measure the top, middle, and oil control ring to groove side clearance. Record your measurements to the nearest ten-thousandth.

    - Top Compression Ring-To-Groove Side Clearance: _____
    - Middle Compression Ring-To-Groove Side Clearance: _____
    - Oil Control Ring-To-Groove Side Clearance: _____

7. **Spark Plug:** Measure the gap on the spark plug. The recommended plug gap is 0.040 in. (1.02 mm).

    - Is the plug gapped correctly? **YES or NO**

Score
_____

SkillsUSA Champions at Work®

Contestant Number
_____

2010
Power Equipment Technology
Station # 9 – Running Adjustments

SCORE SHEET

Briggs & Stratton Engine

(75 points)

This station will test your ability to troubleshoot and adjust engine speed.

In front of you is a Briggs & Stratton OHV Engine that needs the top no load RPM and idle RPM set properly. Consult the repair manual for RPM and adjustment information. A tachometer, manual and tool are supplied for you. Once you feel you have it set, call the judge over to verify your final RPM readings for idle and top no load speed.

	Judge's Score
1. What is the top no load RPM for this engine? _____	**(10 pts) _____**
2. What is the Idle RPM for this engine? _____	**(10 pts) _____**
3. Does this engine utilize a governed idle system? _____	**(5 pts) _____**
4. (Judges: Was correct Top no load RPM achieved?)	**(25 pts) _____**
5. (Judges: Was correct Idle RPM achieved?)	**(25 pts) _____**

2010
Power Equipment Technology
Station # 10 – Two Cycle Running

SCENARIO - TANAKA

Please Read Carefully.

This Tanaka TBC255PF grass trimmer was recently purchased at a freight salvage sale by your customer.

The original carburetor and spark plug were damaged.

The customer installed a new carburetor and a new spark plug.

Following the customer repair, the trimmer is difficult to start.

When it does start, it runs erratically.

1. **Safely troubleshoot the trimmer.**

2. **Identify and replace any missing parts and repair it to proper operating condition.**

3. **Ask the judge for any parts which need to be replaced, by part number, using the Illustrated Parts List.**

Do not write on or in the Illustrated Parts List.

SkillsUSA
Champions at Work®

STATION #10
TWO-CYCLE TROUBLESHOOTING
TOOLS PROVIDED

TBC225PF Illustrated Parts List
TBC225PF General Maintenance Sheet
Ignition Spark Tester
VOA Meter
Digital Tachometer
3mm T-Handle Allen Wrench
4mm T-Handle Allen Wrench
Needle-Nosed Pliers
Hemostat
Spark Plug Wrench
Phillips-Tip Screwdriver
Feeler Gauge
Air Gap Strips (Set of 4)

Score
_____

SkillsUSA Champions at Work®

Contestant Number
_____

2010
Power Equipment Technology
Station # 11 – Carburetor Service

SCORE SHEET

This Station will test your knowledge of a basic Walbro carburetor used on a single cylinder Kohler engine. You will be required to identify the correct color of the various parts listed below. You will use some colors more than once. Colors used are: Black, White, Blue, Green, Red, Orange, and Gold.

1.	Choke Valve (Plate)	_____	**(5 Points)**
2.	Idle Air Bleed	_____	**(5 Points)**
3.	Main Air Bleed	_____	**(5 Points)**
4.	Venturi	_____	**(5 Points)**
5.	Throttle Valve (Plate)	_____	**(5 Points)**
6.	Bowl Vent	_____	**(5 Points)**
7.	Fuel Inlet	_____	**(5 Points)**
8.	Shut-down Solenoid	_____	**(5 Points)**
9.	Float	_____	**(5 Points)**
10.	Main Jet	_____	**(5 Points)**
11.	Idle Orifice (Port)	_____	**(5 Points)**
12.	Progression Orifices (Ports)	_____	**(5 Points)**
13.	Idle Mixture Adjustment Screw	_____	**(5 Points)**
14.	Idle Speed Adjustment Screw	_____	**(5 Points)**

15.	Is the main jet on this carburetor adjustable?	**YES / NO (1 Point)**
16.	The shut-down solenoid closes off the fuel inlet to the bowl?	**YES / NO (1 Point)**
17.	Can you adjust the float on this carb?	**YES / NO (1 Point)**
18.	Is the idle adjustment screw limited in its amount of travel?	**YES / NO (1 Point)**
19.	The shut-down solenoid is electrically grounded through the carb?	**YES / NO (1 Point)**

2010
Power Equipment Technology
Station # 12 – Wildcard

SCENARIO – HYDRO-GEAR

Please Read Carefully.

Step 1

Using the exploded view of the ZT2800/ZT3100 Hydrostatic Transaxle provided, write the correct reference number next to the five part descriptions listed on the score sheet. Upon completion, turn in the score sheet to the judge.

Step 2

Remove and inspect the charge pump assembly and look for any signs of wear and/or damage to the Gerotor.

Show the judge that you have removed the Gerotor.

Reassemble the charge pump assembly, taking care to return it to the original orientation.

Do not write on the exploded view.

SkillsUSA
2010 Contest Projects

Practical Nursing

Click the “Print this Section” button above to automatically print the specifications for this contest. Make sure your printer is turned on before pressing the button.

SKILLSUSA NSLC PRACTICAL NURSING

INTERVIEW/ORAL ASSESSMENT

TIME LIMIT: 10 MINUTES (TOTAL)
Break down – 10 minutes - Interview

CONTESTANT INFORMATION: You have just completed school and are looking for a position at the local hospital. You have been called in for an interview.

Ask any pertinent questions of the judge. Your time for the interview will start now. Please look to your judge to let him/her know that you are ready.

SKILLSUSA NLSC
PRACTICAL NURSING

PHYSICAL ASSESMENT/VITAL SIGNS

TIME LIMIT: 20 MINUTES

CONTESTANT INFORMATION: Patient has just been admitted to the floor. The RN asked you to complete the physical assessment to begin the admission process. Chart to the progress note.

Ask any pertinent questions of the judge. Please let the judge know when you are ready to begin. You will have 20 minutes.

SKILLSUSA NLSC
PRACTICAL NURSING

CPR

TIME LIMIT: 10 MINUTES

CONTESTANT INFORMATION: Utilizing the dummy before you, please Act Accordingly! The Judge will tell you when there is pulse or breath; until such time, act as needed.

Scenario: You have just come off shift and driving into your garage you look over and see your 58-year-old neighbor lying in his front yard. His wife is standing near by. What would you do?

Please let the judge know when you are ready to begin. You will have 10 minutes.

SKILLSUSA NLSC
PRACTICAL NURSING

ANATOMY/HUMAN DISEASE IDENTIFICATION

TIME LIMIT: 10 MINUTES

CONTESTANT INFORMATION: Please pronounce the listed disease process for the Judge. Please speak slowly and distinctly so that the judge can hear your pronunciation. Now write down **and** pronounce for the judge the organ affected by the disease.

Points will be awarded for correct pronunciation of organ, correct pronunciation of disease, and for spelling.

Please tell the judge when you are ready to start. You have 10 minutes.

SKILLSUSA NLSC
PRACTICAL NURSING

PATIENT EDUCATION

TIME LIMIT: 15 MINUTES

CONTESTANT INFORMATION: Patient education is one of the most important aspects of all allied health and nursing professions. Correct patient education with patient understanding must be given in a short amount of time. Good communication skills, knowledge of task and observation and listening skills are required.

SCENARIO: Joe Smith, post allergic reaction, bee sting, is to be d/c'd to home today. You are to complete the final order and report to the RN that pt is ready for d/c.

Order: dispense epipen with instruction

to pt and family member

j.patton, m.d

Ask any pertinent questions of judge, then let the judge know when you are ready to begin**.**

SKILLSUSA NLSC
PRACTICAL NURSING

DRESSING CHANGE

TIME LIMIT: 15 MINUTES

CONTESTANT INFORMATION: Following correct technique is an important part of Nursing, as is good patient care. This can make a difference between healing and infection.

Scenario; Sally Doe has a 2cm superficial laceration she received while playing soccer with her brother. The physician has placed 2 sutures, please clean and apply sterile dressing. Please complete a sterile dressing change.

You have 15 minutes to complete this task. Ask any pertinent questions of the judge. Take a minute to look at your supplies. Please let the judge know when you are ready and then begin.

SKILLSUSA NLSC
PRACTICAL NURSING

MEDICATION ADMINISTRATION – POST SECONDARY

TIME LIMIT: 15 MINUTES

CONTESTANT INFORMATION: Medical math must be done correctly in order to give medication as ordered and prevent medication errors. Medication administration is one of an LPN's most important jobs. Incorrect math or med. administration can lead to serious consequences.

Please read the following chart note, complete the physician's order and document.

CHART NOTE

Pt: Jane Smith Allergies: NKDA
06/24/2010 – 7:30 a.m. – blood sugar per glucometer – 250mg/dl------S.Lee,LP

order: *regular and NPH insulin*

based on sliding scale

V. Reynolds, MD

Ask any pertinent questions of the judge and then let the judge know when you are ready to begin. You have 15 minutes.

SKILLSUSA NLSC

PRACTICAL NURSING

MEDICATION ADMINISTRATION – SECONDARY

TIME LIMIT: 15 MINUTES

CONTESTANT INFORMATION: Please read the following chart note; complete the physician's order, calculating dosage, and document. Show judge your math prior to administering med.

PROGRESS NOTE

Pt: Jane Smith Allergies: NKDA

06/24/2010 – 1:00 p.m. – 97.8ºF, 98, 18, 148/84 – CC: nausea x 2 days since chemo began----------BSky,RMA

order: Promethazine50mg PO now - V.Reynolds, MD

Ask any pertinent questions of the judge and then let the judge know when you are ready to begin. You have 15 minutes.

SKILLSUSA NSLC

PRACTICAL NURSING

SAFETY

TIME LIMIT: 10 MINUTES

CONTESTANT INFORMATION; For the Practical Nurse knowing physiology, terminology and abbreviations are crucial. We know that Safety must remain a top priority in all that we do for the patient. Generally good rehabilitation techniques help get the patient back to ADLs as soon as possible, which is what we want for the patients. Good communication, taking in pt. hx, and disease processes, helps us to help the pt understand physician's orders even when they do not want to follow them. Please read the scenario below and act accordingly

SCENARIO: Cranky Sam Brown, post R. ORIF is to be d/c'd tomorrow from NH. Mr. Brown has a mild case of dementia. Further, he does not like to walk in the halls, which he must do. Help him to understand as you fulfill the physician's order.

Order reads; ambulation with walker, length of hall x 2, b.i.d.

Ask any pertinent questions of the judge, and then let him/her know when you are ready. You have 10 minutes to complete this task.

SKILLSUSA NSLC
PRACTICAL NURSING

NUTRITION

TIME: 10 MINUTES

CONTESTANT INFORMATION: Good nutrition is a healthy concept many people take for granted. The elderly's diet is often times less than it should be for various reasons. As the practical nurse you should take the physiological reasons for poor diet into consideration when you deliver meals to your elderly patients. Culture in relation to diet is also to be considered and addressed with all patients. Please read and complete the scenario below.

SCENARIO: Mr Jesus Gonzelas will be d/c'd to home this afternoon. Discharge dx; Food poisoning, N&V, Diarrhea. Discharge orders include Bland diet x 3 days, progressing to regular diet as tolerated.

Please explain, thoroughly, physician's order to Mr. Gonzelas and his family member regarding bland and regular diet, and choices for this diet. Also, explain "as tolerated"

Ask any pertinent questions of the judge. Take ONE minute to gather your thoughts. Your time will start when you begin talking, or if after one minute when the judge asks you to begin.

CONTEST SCORING CRITERIA

Contest **PRACTICAL NURSING** Chair; **BRANDI CANNON/Diana Kendrick**

Skill Description	Maximum Points
Assessment/Vital Signs	100
CPR	100
A&P/Terminology	100
Patient Education	100
Dressing Change	100
Medication Administration	100
Safety	100
Nutrition	100
Oral Professional Assessment/Interview	100
Written Test	100
Résumé submitted? No O (5% penalty)	

Tie Breakers
1. SkillsUSA Professional Development Program Test 2. Written Test 3.

SkillsUSA
2010 Contest Projects

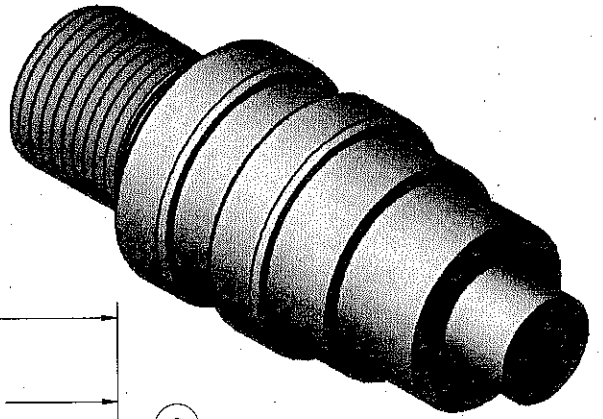
Precision Machining Technology

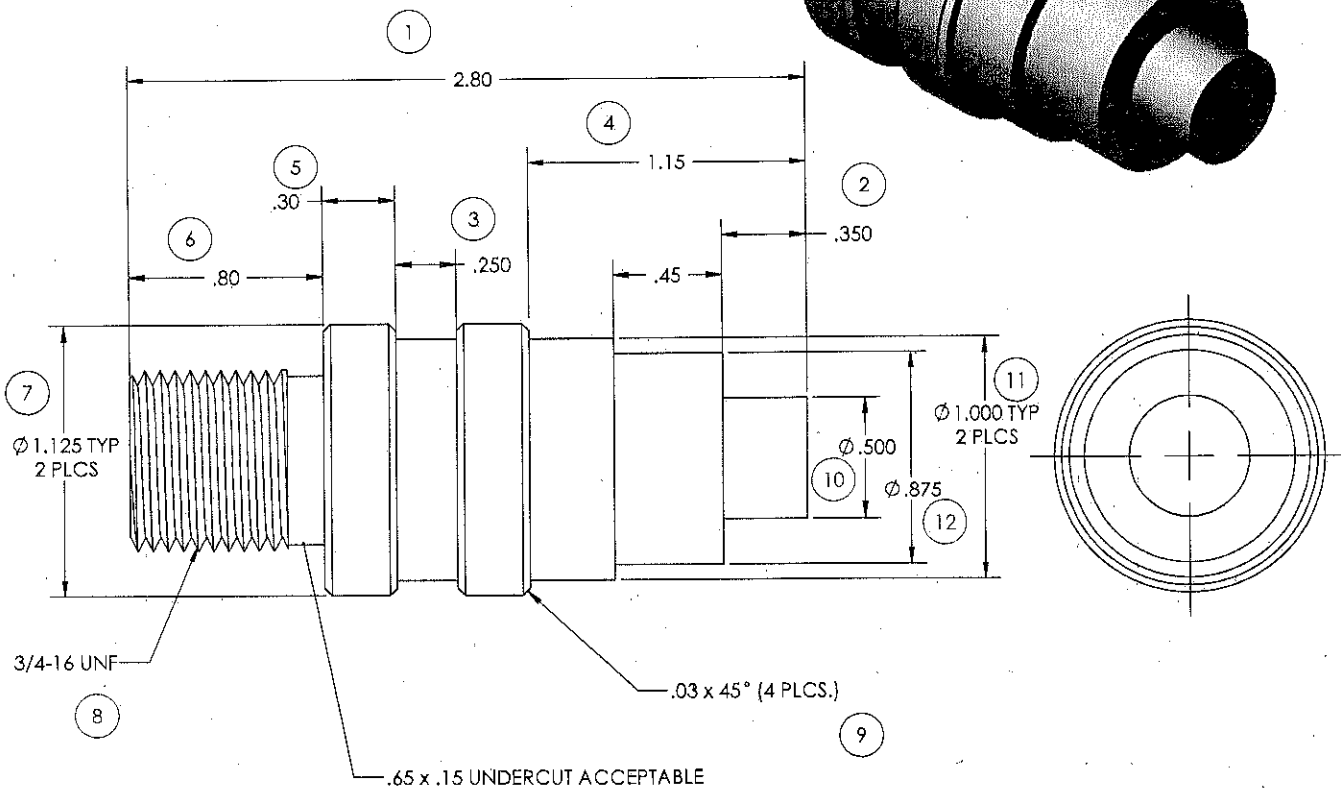
Click the “Print this Section” button above to automatically print the specifications for this contest. Make sure your printer is turned on before pressing the button.

Precision Machining

Immersive Engineering, Inc is now offering free training resources for SkillsUSA participants.The LearnHaasCNC.com Virtual Training Environment is being offered free to students and instructors preparing for the SkillsUSA Precision Machining Contests. This program provides a virtual training environment for CNC Machining that combines powerful “flight-simulator” technology with a flexible Internet-based learning content management system to deliver a truly innovative learning experience.

To access the Precision Machining Technology Virtual CNC and Machine and online training system, click the link below and complete the registration form to get started today preparing for this years contests www.learnhaascnc.com/learnhaascnc/skillsusa.cfm





TOTAL POINTS

CONTESTANT NUMBER

NUMBER	
1	10
2	15
3	10
4	10
5	10
6	10
7	15
8	15
9	10
10	15
11	15
12	15
TOTAL	150

NOTES:
1. MATERIAL : 6061 ALUMINUM
2. PART TO BE FREE OF BURRS
3. NO LAYOUT BLUING ALLOWED ON LATHES
4. MINIMAL TOOLMARKS ALLOWED ON O.D. SURFACES

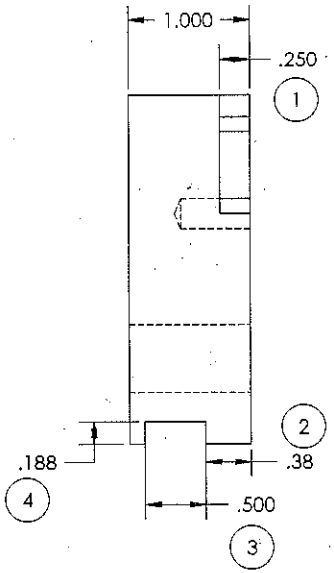
SCALE: 1:1

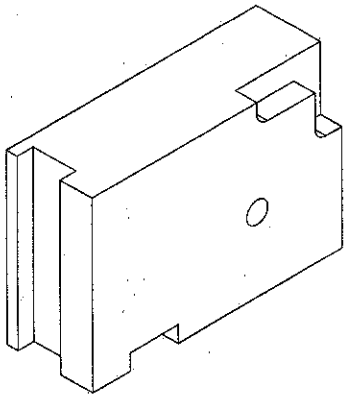
UNLESS OTHERWISE SPECIFIED TOLERANCES ARE:
.X = ±.03
.XX = ±.010
.XXX = ±.003

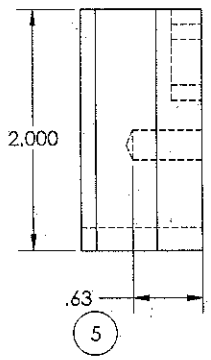
SKILLS USA 2010 MANUAL LATHE PROJECT

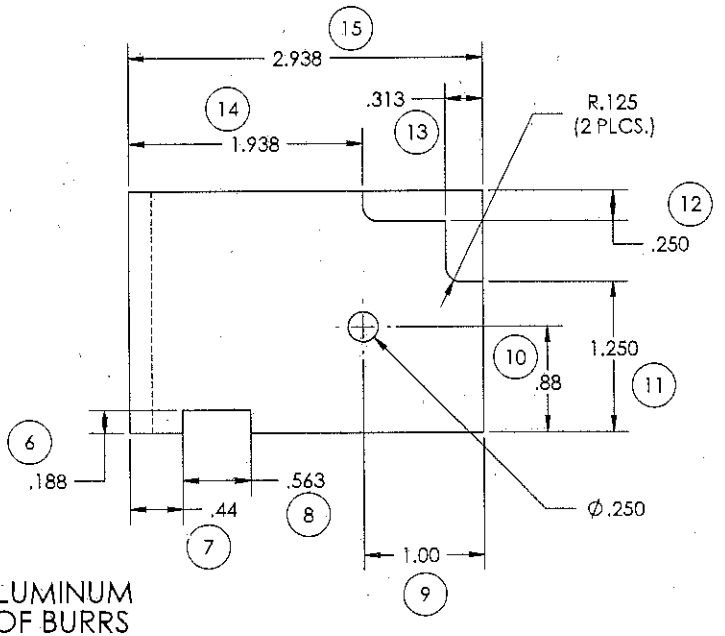
SIZE B | DRAWN BY XXX | DATE XXX | REV

UNLESS OTHERWISE SPECIFIED, ALL DIMENSIONS ARE IN INCHES









NOTES:
1. MATERIAL 6061 ALUMINUM
2. PART TO BE FREE OF BURRS
3. NO LAYOUT BLUEING ALLOWED ON MILLS

TOTAL POINTS

CONTESTANT NUMBER

Number	
1	10
2	10
3	10
4	10
5	10
6	10
7	10
8	10
9	10
10	10
11	10
12	10
13	10
14	10
15	10
SAFETY	
TOTAL	**150**

SCALE: 1:1

UNLESS OTHERWISE SPECIFIED TOLERANCES ARE:
.X = ±.03
.XX = ±.010
.XXX = ±.003

SKILLS USA 2010 MANUAL MILLING MACHINE PROJECT

SIZE	DRAWN BY	DATE	REV
B	XXX	XXX	

UNLESS OTHERWISE SPECIFIED: ALL DIMENSIONS ARE IN INCHES

2010
PRECISION MACHINING TECHNOLOGY COMPETITION

PROFESSIONAL DEVELOPMENT ORAL EXAMINATION

!!!JUDGES USE ONLY!!!

NOTE: 100 POINTS MAXIMUM

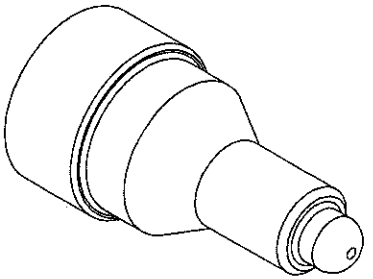
	Poor	Average	Excellent
1. Confidence	1	5	10
2. Knowledge of the subject/self	1	5	10
3. Articulate (Grammar)	1	5	10
4. Decision Making	1	5	10
5. Enthusiasm	1	5	10
6. Poise (manners)	1	5	10
7. Body Language & Eye Contact	1	5	10
8. Organization of thoughts	1	5	10
9. Overall Professionalism	1	5	10
10. Overall Communication	1	5	10

CONTESTANT # : _____

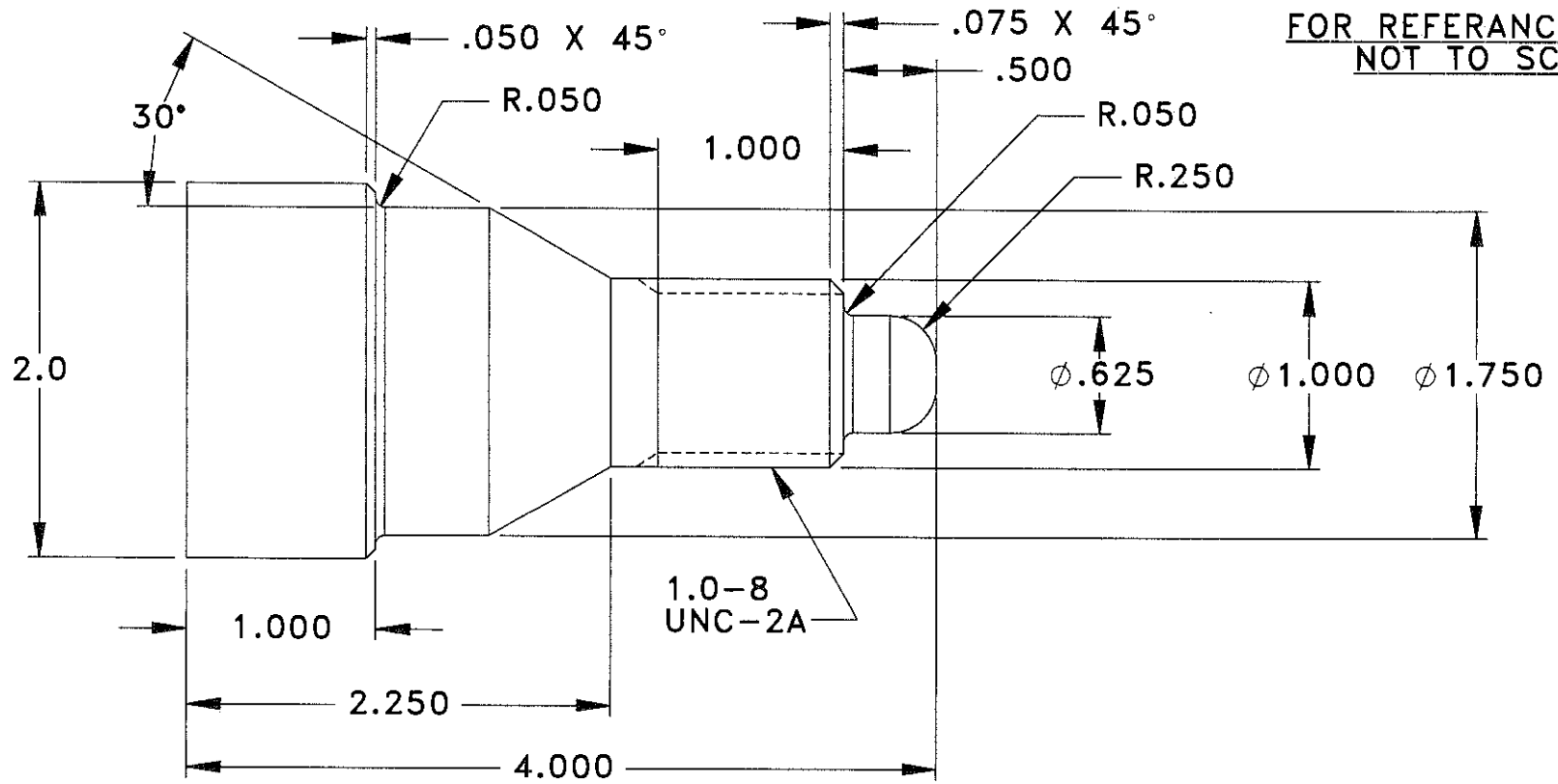
TOTAL SCORE: 100

JUDGE'S INITIALS: _____

NOTES:
Stock size ∅2.0" X 4.1"



FOR REFERANCE ONLY
NOT TO SCALE



DIMS IN INCHES BREAK EDGES 0.015
LATHE FINISH 63 uINCH MILL FINISH 125 uINCH
90° CSINK TAPPED HOLES 0.016R OVER MAJOR∅
TOLERANCES- UNLESS OTHERWISE SPECIFIED
X/X ±0.06 X.X ±0.06 X.XX ±0.02 X.XXX ±0.005
ANGLES ±1° X.XXX DIAMETERS ◎ 0.005 TIR
X.XXXDIA & SURFACES // & ⏊ 0.001 INCH/INCH

Skills USA

HAAS AUTOMATION, INC.

CNC Lathe Part

APPROVALS	DATE
DRAWN Daniel Scott	04-06-10
CHECKED CHECKER	XX-XX-XX
ENGINEER Daniel Scott	04-06-10

MATERIAL	FINISH	SIZE	SCALE	DWG	REV
6061 T6	NONE	A	1:1	Turning 2010	A

Haas Automation, Inc.

Skills USA
Precision Machining 2010

CNC Turning Part Score Sheet **Contestant Number** _____

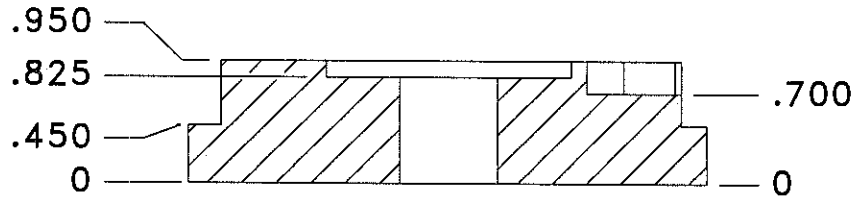
		Points Poss.	Points Earned
1.	Face front of part	5 pts	_____
2.	.250" Radius	5 pts	_____
3.	.625" Diameter	5 pts	_____
4.	.050" Radius (2)	10 pts	_____
5.	.075" x 45 degree chamfer	10 pts	_____
6.	1.000" Diameter	5 pts	_____
7.	1.0"- 8 x 1.0" Thread	20 pts	_____
8.	30 deg chamfer	20 pts	_____
9.	1.750" Diameter	5 pts	_____
9.	.050" x 45 degree chamfer	10 pts	_____
9.	.500" Z dim	5 pts	_____
9.	1.000" Z dim	5 pts	_____
9.	2.250" Z dim	5 pts	_____
9.	4.000" Z dim	5 pts	_____
10.	Spindle on	5 pts	_____
11.	Rotation correct	5 pts	_____
12.	Break sharp edges .015"	5 pts	_____
13.	Speeds, feeds and DOC	10 pts	_____
14.	Following instructions	5 pts	_____
15.	Tool Changes	5 pts	_____

Total Points Available: 150 points **Total Points Earned:** _____

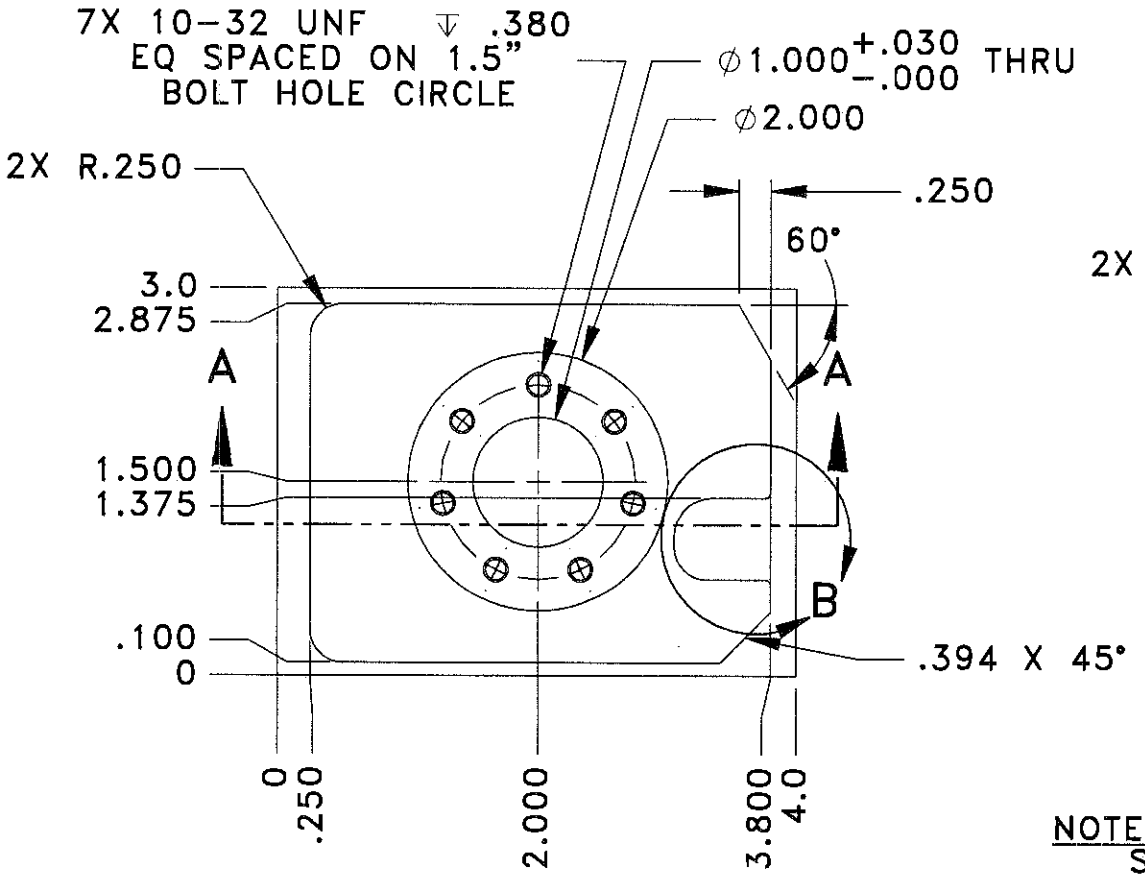
Scored by: _____

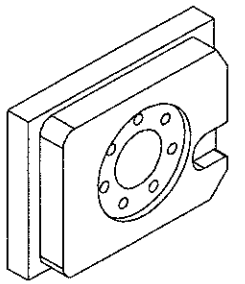
Run on lathe by: _____

Headquarters: 2800 Sturgis Road, Oxnard, California 93030
Telephone: 805-278-1800 • **Fax:** 805-278-2255 • **www.HaasCNC.com**



SECTION A–A





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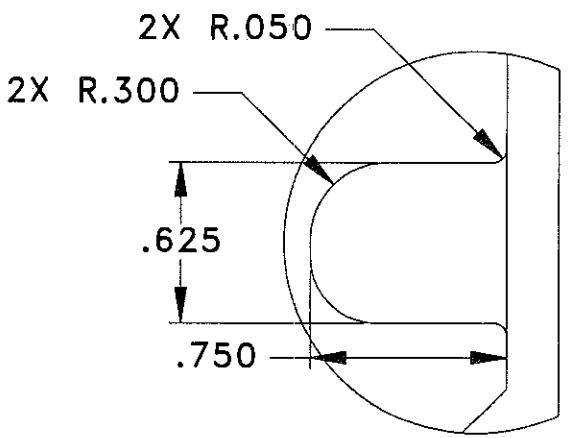
NOT TO SCALE



DETAIL B
SCALE 2 : 1.5

NOTES:
Stock size 4"x3"x1"

DIMS IN INCHES BREAK EDGES 0.015
LATHE FINISH 63 uINCH MILL FINISH 125 uINCH
90° CSINK TAPPED HOLES 0.016R OVER MAJOR⌀
TOLERANCES– UNLESS OTHERWISE SPECIFIED
X/X ±0.06 X.X ±0.06 X.XX ±0.02 X.XXX ±0.005
ANGLES ±1° X.XXX DIAMETERS ◎ 0.005 TIR
X.XXXDIA & SURFACES // & ⏥ 0.001 INCH/INCH

MATERIAL	FINISH
6061 T6	NONE

SKILLS USA

HAAS AUTOMATION, INC.

APPROVALS	DATE
DRAWN DANIEL SCOTT	04–12–10
CHECKED CHECKER	XX–XX–XX
ENGINEER DANIEL SCOTT	04–12–10

CNC MILL PART

SIZE	SCALE	DWG	REV
A	1:1.5	MILLING 2010	A

Haas Automation, Inc.

Skills USA
Precision Machining 2010
Milling

CNC Milling Part Score Sheet _____ Contestant Number _____

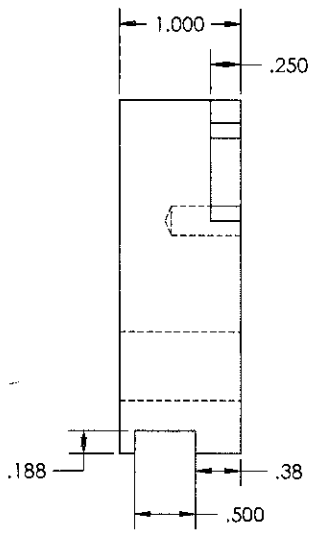
		Points Poss.	Points Earned
1.	Face mill top of part	5 pts	_____
2.	.500" deep perimeter cut	10 pts	_____
3.	.250" radius (2)	10 pts	_____
4.	.394" x 45-Degree chamfer	5 pts	_____
5.	.250" x 60-degree chamfer	5 pts	_____
6.	Drilled holes correct depth (7)	10 pts	_____
7.	Tapped holes correct depth (7)	10 pts	_____
9.	Tapped holes correct location (7)	10 pts	_____
9.	2.0" Dia. x .125" pocket	20 pts	_____
10.	Tool changes	5 pts	_____
11.	Spindle on	5 pts	_____
12.	Rotation correct	5 pts	_____
13.	Break sharp edges .015"	5 pts	_____
14.	Speeds and feeds	10 pts	_____
15.	"Detail B"	20 pts	_____
16.	1.000" Hole	5 pts	_____
17.	Following instructions	10 pts	_____

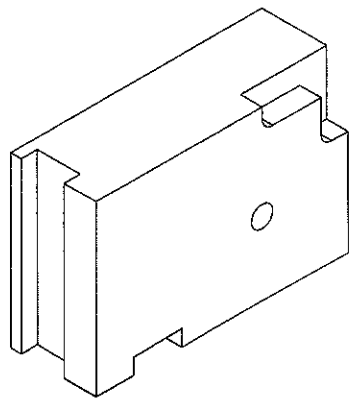
Total Points Available: 150 points **Total Points Earned:** _____

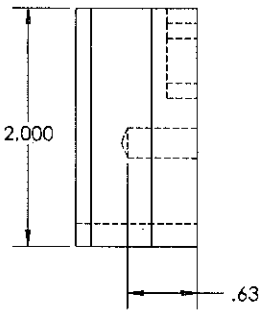
Scored by: _____

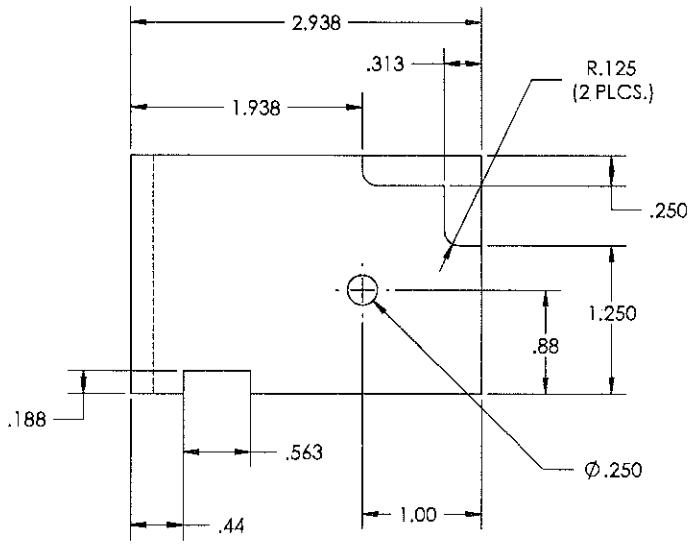
Run on Mill by: _____

Headquarters: 2800 Sturgis Road, Oxnard, California 93030
Telephone: 805-278-1800 • Fax: 805-278-2255 • www.HaasCNC.com









NOTES:

1. MATERIAL 6061 ALUMINUM
2. PART TO BE FREE OF BURRS
3. NO LAYOUT BLUEING ALLOWED ON MILLS

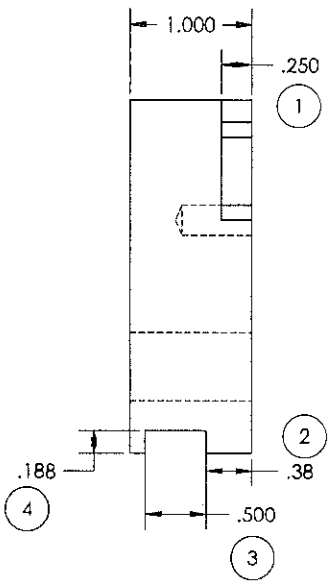
SCALE: 1:1

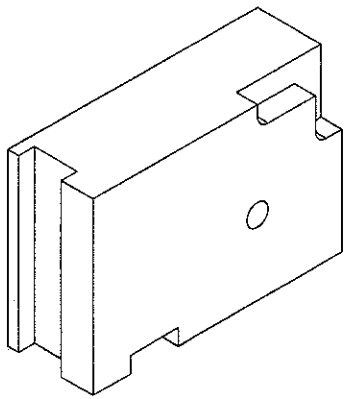
UNLESS OTHERWISE SPECIFIED TOLERANCES ARE:

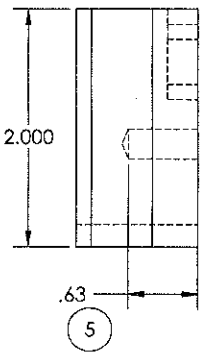
.X = ±.03
.XX = ±.010
.XXX = ±.003

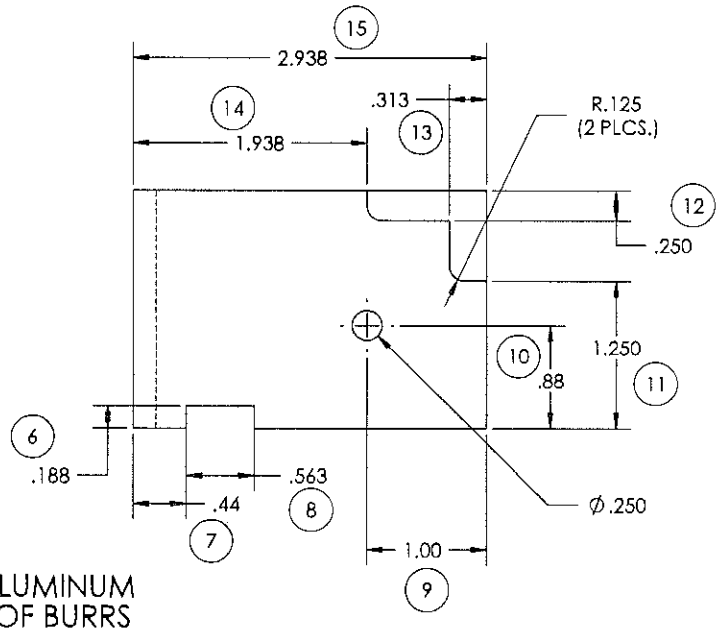
SKILLS USA 2010 MANUAL MILLING MACHINE PROJECT

SIZE	DRAWN BY	DATE	REV
B	XXX	XXX	









TOTAL POINTS

CONTESTANT NUMBER

Number			
1	10		
2	10		
3	10		
4	10		
5	10		
6	10		
7	10		
8	10		
9	10		
10	10		
11	10		
12	10		
13	10		
14	10		
15	10		
SAFETY			
TOTAL	**150**		

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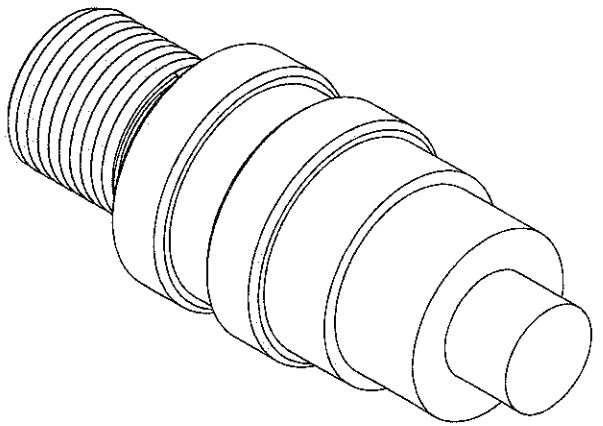
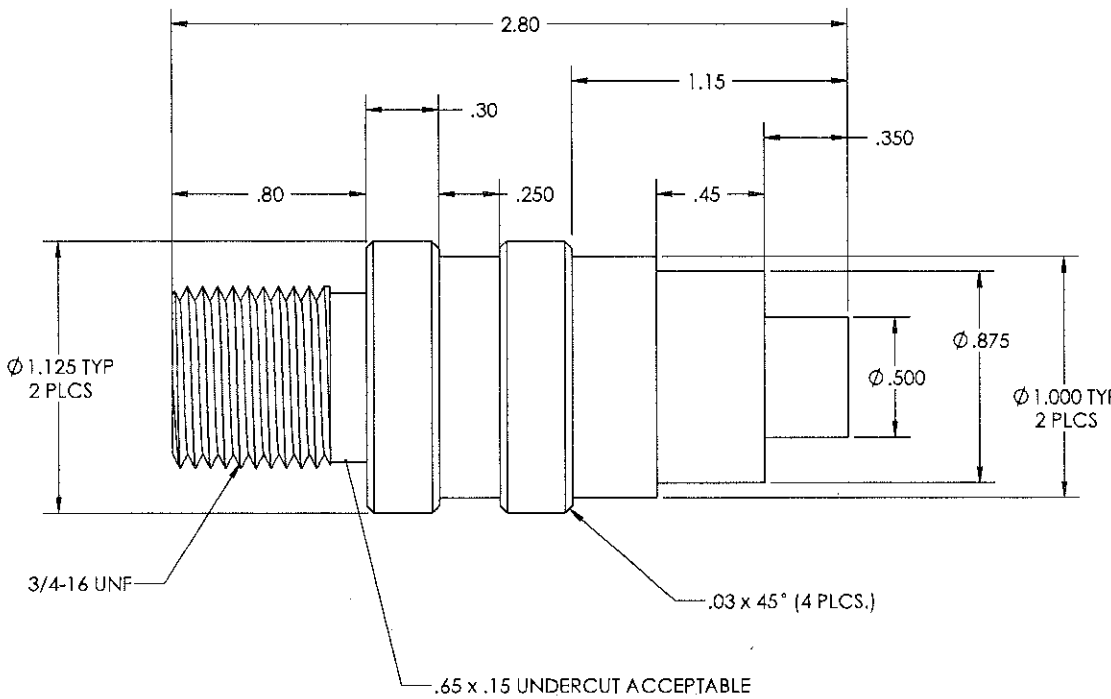
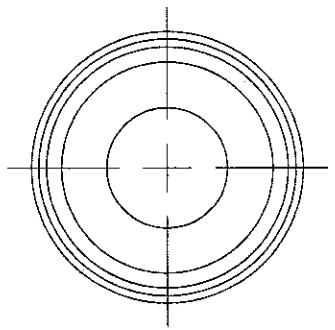
SKILLS USA 2010 MANUAL MILLING MACHINE PROJECT

SIZE: B | DRAWN BY: XXX | DATE: XXX | REV







NOTES:
1. MATERIAL : 6061 ALUMINUM
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3. NO LAYOUT BLUING ALLOWED ON LATHES
4. MINIMAL TOOLMARKS ALLOWED ON O.D. SURFACES

SCALE: 1:1

UNLESS OTHERWISE SPECIFIED TOLERANCES ARE:
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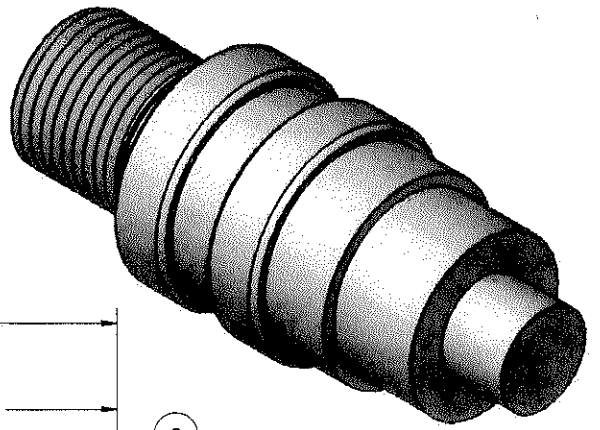
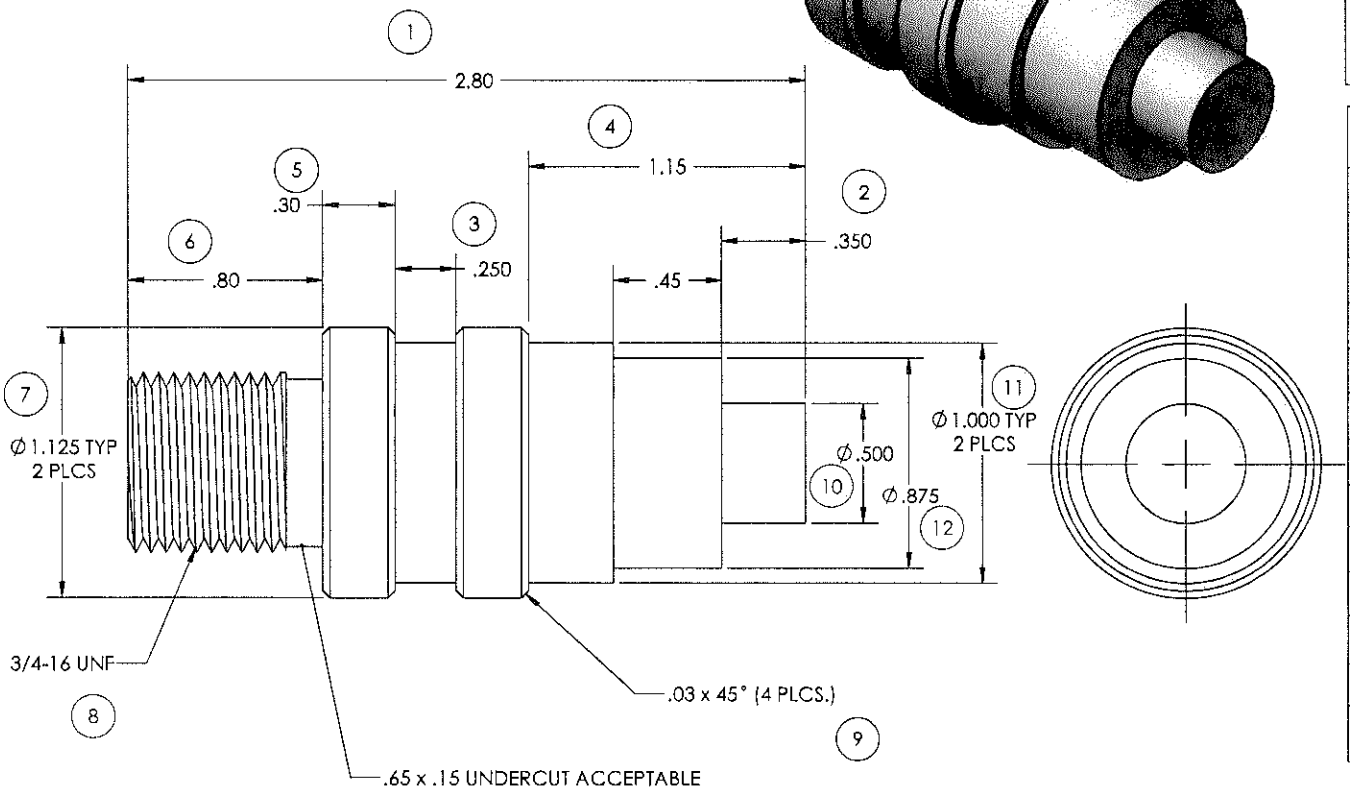
.XX = ±.010
.XXX = ±.003

SKILLS USA 2010 MANUAL LATHE PROJECT

SIZE B | DRAWN BY XXX | DATE XXX | REV





TOTAL POINTS

CONTESTANT NUMBER

NUMBER			✓
1	10		
2	15		
3	10		
4	10		
5	10		
6	10		
7	15		
8	15		
9	10		
10	15		
11	15		
12	15		
TOTAL	150		

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SKILLS USA 2010 MANUAL LATHE PROJECT

SIZE B | DRAWN BY XXX | DATE XXX | REV

SkillsUSA
2010 Contest Projects

Related Technical Math

Click the “Print this Section” button above to automatically print the specifications for this contest. Make sure your printer is turned on before pressing the button.

Answer Sheet **Student Number** Key

3M 2010 SkillsUSA Related Technical Math

Show all necessary work on the test sheets and record your answers on this sheet

1. 1175
2. 25%
3. 25°
4. 1/10 or .10
5. $227
6. 24
7. 34.5
8. 1/16 or .06
9. 58.83
10. −1
11. $96,030
12. 2988.29 pounds
13. 5TT or 15.71
14. 32
15. 95.07 units²
16. Mrnesu .3355
17. $188 million/mi
18. 141.30 million
19. 56 songs
20. 6/5
21. 1/3
22. 30
23. $\log_b x = 8$
24. 7.24 cm
25. 16
26. 6 days 14.70 hr
27. 0.74 or $\frac{N5}{3}$
28. 32
29. 1/4 or .25
30. 0
31. $12,629.71
32. 12
33. 67.5° and 112.5
34. 200 Type A; 260 Type B
35. $8
36. 5
37. 5
38. 61%
39. 4/3 or 1.33 units
40. 35 km
41. 5; 3; 1
42. $4215.12
43. 5°
44. 5 5/6 hr or 5.83 hr
45. 21/4 units² of 5.25 units²
46. 34 boys
47. 141.56 ft
48. 38.20 mm
49. 4.17%
50. 32°

1. **Lockheed Martin laid-off 47 workers at a certain plant, which was 4% of their work force. How many workers did they have previous to the lay-off?**

x = total workforce

$$\frac{x}{100\%} = \frac{47}{4\%}$$

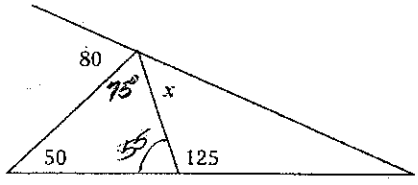
$$x = 1175$$

2. **A 1qt. bottle full of liquid is 10% alcohol, and a 3-qt. bottle full of liquid is 30% alcohol. If the two bottles are combined, what is the percentage of alcohol in the mixture?**

$$\frac{.10(1qt) + .3(3qt)}{1qt + 3qt} = \frac{.1qt + .9qt}{4qt}$$

$$= \frac{1}{4} = 25\%$$

3. **Find the value of angle x.**



$$80 + 75 + x = 180$$

$$x = 180 - 155$$

$$x = 25°$$

4. **Blood groups for a certain sample of people are shown in the table. If one person from the sample of people is randomly selected, what is the probability that he or she has type B blood?**

Blood Group	Frequency
O	110
A	64
B	20
AB	6

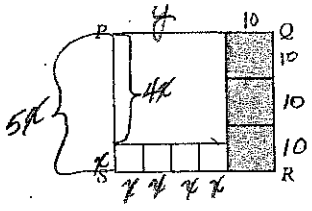
$\frac{20}{200} = \frac{1}{10}$ or .10

5. **For a fee, the American Scholarship Search Company helped 28,560 students locate various study grants and fellowships. They collected $13,623,120 in finder's fees from these students. The company advertised in their literature that they collected a finder's fee of only $250 per student. On average how much did they overcharge each student?**

$\frac{\$13,623,120}{28,560 \text{ students}} = \$477/\text{student}$

$\$477 - 250 = \$227$ overcharge student

6. **Rectangle PQRS is divided into eight squares. The length of each shaded square is 10. What is the length of the side of the largest square?**



$PS = 30$

$30 = 4x + x$

$30 = 5x$

$x = 6$

$y = 4x$

$= 4(6)$

$= 24$

$QR = 3(10)$

$QR = 30 = PS$

7. **Find the third quartile of the following data: 12, 15, 42, 37, 61, 14, 14, 9, 25, 32, 32, and 30.**

9, 12, 14 | 14, 15, 25, 30, 32, 32 | 37, 42, 61

$Q_2 = \frac{25+30}{2} = 27.5$

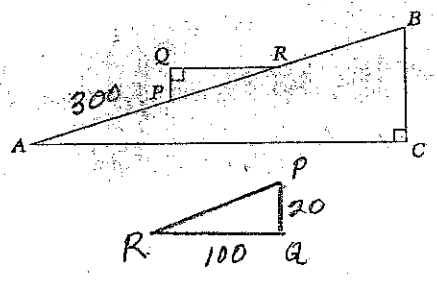
$Q_3 = \frac{32+37}{2} = \frac{69}{2} = 34.5$

8. **A certain medication is known to cure a specific illness for 75% of the people who have the illness. If two people with the illness are selected at random and take the medication, what is the probability that neither will be cured?**

$\left(1-\frac{3}{4}\right)\left(1-\frac{3}{4}\right) =$

$\left(\frac{1}{4}\right)\left(\frac{1}{4}\right) = \frac{1}{16}$ or .0625 .06

9. **As shown AB = 300, PQ = 20 and QR = 100. Line QR is parallel to line AC. Determine the length of BC, to the nearest tenth.**



$RP = \sqrt{(100)^2 + (20)^2}$

$RP = \sqrt{10{,}400}$

$\frac{BC}{20} = \frac{300}{\sqrt{10{,}400}}$

$BC = \frac{(300)(20)}{\sqrt{10{,}400}}$

$= 58.834$

$= 58.83$

10. **For all nonzero numbers x and y such that $x-y=xy$, find $\frac{1}{x}-\frac{1}{y}$**

$$\frac{1}{x}-\frac{1}{y}=$$

$$\frac{y}{xy}-\frac{x}{xy}=\frac{y-x}{xy}$$

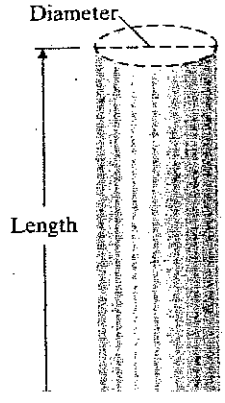
$$=\frac{-1(x-y)}{(x-y)}=-1$$

11. **Wells Fargo has decided to donate their old computers to the Mandan Public Schools. Each computer donated is worth \$120 in tax-deductible dollars. In addition, the computer company supplying the bank with new computers gives a 7% rebate to any customer donating used computers to schools. If sixty new computers are purchased at a list price of \$1850 each and sixty old computers are donated to the Mandan Public Schools, what is the net cost to the bank?**

$$(100\%-7\%)(60)\$1850-60(\$120)=$$

$$\$103,230-7200=\$96,030$$

12. **Many applied problems involve joint variation. For example, a cylindrical concrete column has a safe load of capacity that varies directly with the diameter raised to the fourth power and inversely with the square of its length. Where d = diameter and l = length, the equation would be of the form $y=\frac{kd^4}{l^2}$ Find y when $d=1.5$ feet, $l=12$ feet and $k=85{,}000$ pounds**

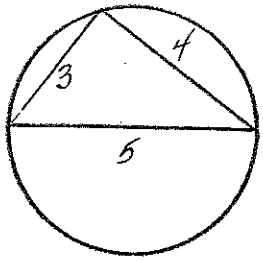


$$y=\frac{85{,}000(1.5)^4}{(12)^2}=\frac{85{,}000(5.0625)}{144}$$

$$=2988.28125$$

$$=2988.28 \text{ pounds}$$

13. **A circle is drawn around a triangle with side lengths of 3, 4, and 5. Find the circumference of the circle. Write answer in terms of pi.**



$r = \frac{5}{2} = 2.5$

$C = 2r\pi$

$C = 2(2.5)\pi$

$= 5\pi$ or 15.71

14. **McKenzie paid $480 to purchase a certain number of T-shirts for her softball team. Two shirts were slightly damaged, so the vendor gave her 2 extra shirts, effectively decreasing the cost per shirt by $1. How many shirts (including the 2 extra) did McKenzie receive?**

$x =$ number of T-shirts

$\frac{\$480}{x-2} - \frac{\$480}{x} = \$1$

$480x - 480(x-2) = x(x-2)$

$480x - 480x + 960 = x^2 - 2x$

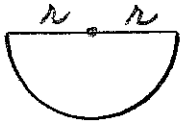
$0 = x^2 - 2x - 960$

$0 = (x-32)(x+30)$

$x = 32$

32

15. **The perimeter of the semicircle is 40. Find the area of the semicircle. Round the answer to the nearest thousandth.**



$C = \frac{2r\pi}{2}$

$C = r\pi$

$P = 2r + r\pi$

$40 = 2r + 3.142\pi$

$40 = 5.142r$

$r = 7.779$

$A = \frac{\pi r^2}{2}$

$= \frac{\pi(7.779)^2}{2}$

$= 95.07$

$= 95.07 \text{ units}^2$

16. **Minnesota Twins players Mauer and Morneau are going into the last day of the season almost tied for the batting title. Morneau has 200 hits in 600 at bats, Mauer Has 199 hits in 600 at bats. On the last day of the season Morneau goes 3 for 5 and Mauer goes 3 for 4. Who wins the batting title and what is their average (rouud to the nearest ten-thousadth)? Recall batting percentage is determined by dividing the hits by at bats to obtain the batting average in decimal form.**

Morneau $\frac{200+3}{600+5} = \frac{203}{605} = .33553$

Mauer $\frac{199+3}{600+4} = \frac{202}{604} = .33443$

Morneau .3355

17. **The London subway system has a staff of 16,000 and accommodates 2.5 million passeugers each day. A 1993 expansion of the system extended the system 16 kilometers and cost 2.85 billion British pounds. How many dollars per mile (to the nearest million) will this extension cost? (Use 1 kilometer = 0.62 miles and 1 U. S. dollar = 1.5258 British pounds.**

$$\frac{\frac{2.85\times10^9}{1}\left(\frac{\$1}{1.528\pounds}\right)}{\left(\frac{16\text{ km}}{1}\right)\left(\frac{.62\text{ mi}}{1\text{ km}}\right)} = \frac{\$1,865,183,246}{9.92\text{ mi}}$$

$$= \frac{\$188,022,504.6}{\text{mi}}$$

$$= \$188 \text{ million / mi}$$

18. **The orbit of Venus is an ellipse with the Sun as a focus. If we say that the center of the ellipse is at the origin, an approximate equation for the orbit is: $\frac{x^2}{5013}+\frac{y^2}{4970}=1$ where x and y are measured in million of miles. Find the greatest possible distance across the ellipse. Round your answer to the nearest million miles. The standard form of an ellipse is: $\frac{x^2}{a^2}+\frac{y^2}{b^2}=1$**

$\sqrt{a^2} = \sqrt{5013} = 70.803$

$\sqrt{b^2} = \sqrt{4970} = 70.498$

141.301

$a + b = 141$ million

$= 141.30$ million

19. **Cormac has a collection of 50 songs that are each 3 minutes long and 50 songs that are each 5 minutes long. What is the maximum number of songs from his collection that he can play in 3 hours without repeating a song?**

$\left(\frac{3\ hr}{1}\right)\left(\frac{60\ min}{1\ hr}\right) = 180\ min$

$50\ songs \times 3\ min = 150\ min$

$30\ min$

$\frac{30\ min}{5\ min} = 6\ songs$

$50\ songs + 6\ songs$

$56\ songs$

20. **If $\frac{a+b}{a}=6$ and $\frac{b+c}{c}=7$ find the ratio of a to c.**

$a\left(\frac{a+b}{a}\right) = 6(a$

$a+b = 6a$

$b = 5a$

$c\left(\frac{b+c}{c}\right) = 7(c)$

$b+c = 7c$

$b = 6c$

$5a = 6c$

$a = \frac{6c}{5}$

$\frac{a}{c} = \frac{6c}{5c}$

$\frac{a}{c} = \frac{6}{5}$

21. **Three pennies showing 2 heads and 1 tail are on a table. Two of the coins are selected at random and turned over. What is the probability that all three coins now show the same side?**

$P(3\ tails) = 0 + \frac{1}{3}$

$P(3\ tails) = \frac{1}{3}$

22. **The sum of three numbers is 98. The first number is $\frac{2}{3}$ of the second, and the second is $\frac{5}{8}$ of the third. What is the second number?**

x = the first y = the second z = the third

$x = \frac{2}{3}y \qquad y = \frac{5}{8}z$

$\frac{2}{3}y + y + z = 98$

$\frac{5y}{3} + z = 98$

$\left(\frac{5}{3}\right)\left(\frac{5}{8}z\right) + z = 98$

$\frac{25}{24}z + \frac{24}{24}z = 98$

$\frac{49}{24}z = 98$

$\left(\frac{24}{49}\right)\frac{49}{24}z = \left(\frac{24}{49}\right)98$

$z = 48$

$y = \frac{5}{8}\left(\frac{48}{1}\right)$

$y = 30$

30

23. **If $\log_b(xy) = 11$ and $\log_b\left(\frac{x}{y}\right) = 5$, what is $\log_b x$?**

$\log_b x + \log_b y = 11 \qquad \log_b x - \log_b y = 5$

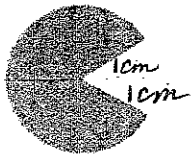
$\log_b x + \log_b y = 11$

$\log_b x - \log_b y = 5$

$2\log_b x = 16$

$\log_b x = 8$

24. **An old video game featured a hungry creature in the form of a sector of a circle with a radius 1 cm. The missing portion, the mouth, has a central angle of 60 degrees. What is the perimeter (in cm) of the creature?**



$P = 2r + \frac{\theta}{360}\,2\pi r$

$= 2(1\text{cm}) + \left(\frac{300}{360}\right)2(1)\pi$

$= 2\text{cm} + \frac{(5)2\pi}{6}$

$= 2\text{cm} + \frac{5\pi}{3}$

$= 2\text{cm} + 5.23598$

$= 7.24\text{cm}$

25. **Find $x+y+z$ given that $\frac{x}{3-x}=\frac{y}{5-y}=\frac{z}{16-z}=2$**

$$\frac{x}{3-x}+\frac{y}{5-y}+\frac{z}{16-z}=2$$

$$\frac{x+y+z}{3+5+8-(x+y+z)}=2$$

$$\frac{x+y+z}{24-(x+y+z)}=2$$

$$x+y+z=2(24-(x+y+z))$$

$$x+y+z=48-2x-2y-2z$$

$$3x+3y+3z=48$$

$$3(x+y+z)=48$$

$$x+y+z=16$$

26. **Kay Cobb and her brother Ruferthana went on a cruise from San Diego to Miami via the Panama Canal for a distance of 4380 miles. The ship Constellation travels at 24 knots per hour. How many days and hours of sailing would the ship Constellation need to cover the 4380 land miles? 1 knot = 1.15 miles.**

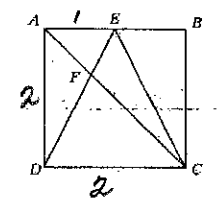
$$24\text{ knots}\left(\frac{1.15\text{ mi}}{1\text{ knot}}\right)=27.6\text{ mi/hr}$$

$$\left(\frac{4380\text{ mi}}{1}\right)\left(\frac{\text{hr}}{27.6\text{ mi}}\right)=158.695\text{ hr}$$

$$\frac{158.695\text{ hr}}{1}\left(\frac{1\text{ day}}{24\text{ hr}}\right)=6\text{ days }14.695\text{ hr}$$

$$=6\text{ days }14.70\text{ hr}$$

27. **ABCD is a square with an inscribed isosceles triangle EDC such that E is the midpoint of AB. Diagonal AC intersects DE at F. If the area of the square ABCD is 4, find the length of FE.**



$DE=\sqrt{(2)^2+(1)^2}$

$DE=\sqrt{5}$

$\triangle FAE \sim \triangle FCD$

$$\frac{AE}{DC}=\frac{FE}{FD}$$

$$\frac{1}{2}=\frac{EF}{DF}$$

$DF=2EF$

$ED=EF+DF=\sqrt{5}$

$EF+2EF=\sqrt{5}$

$3EF=\sqrt{5}$

$EF=\frac{\sqrt{5}}{3}$

$EF=.74$

$=.74$

28. **If n is greater than 0 and $\sqrt[2]{n^2+n^2+n^2+n^2}=64$, what is the value of n?**

$$\sqrt{4n^2} = 64$$

$$2n = 64$$

$$n = 32$$

29. **Find all real values of x such that $2x+\sqrt{x}-1=0$**

$$2x-1 = -\sqrt{x}$$

$$(2x-1)^2 = (-\sqrt{x})^2$$

$$4x^2-4x+1 = x$$

$$4x^2-5x+1 = 0$$

$$(4x-1)(x-1) = 0$$

$4x-1=0$ $\quad x=1$

$x=\frac{1}{4}$ or .25

Check

$$2\left(\tfrac{1}{4}\right)+\sqrt{\tfrac{1}{4}}-1 \stackrel{?}{=} 0$$

$$\tfrac{1}{2}+\tfrac{1}{2}-1 = 0$$

$$0 = 0$$

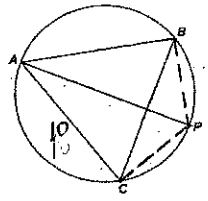
$x=1$

$2(1)+\sqrt{1}-1=0$

$2+1-1=0$

$2 \neq 0$

30. **Equilateral triangle ABC is inscribed in a circle. The angle bisector at A intersects the circle again at P. If the length of segment AC is 10, Find AP – (BP + CP)**



$PC = \frac{10\sqrt{3}}{3}$ $\quad BP = \frac{10\sqrt{3}}{3}$ $\quad AP = \frac{20\sqrt{3}}{3}$

$AP-(BP+CP)$

$AP^2 = \sqrt{(10)^2+\left(\frac{10\sqrt{3}}{3}\right)^2}$ $\quad AP = \sqrt{\frac{400}{3}}$ $\quad = \frac{20\sqrt{3}}{3} - \left(\frac{10\sqrt{3}}{3}+\frac{10\sqrt{3}}{3}\right)$

$AP^2 = \sqrt{100+\frac{100(3)}{9}}$ $\quad = \frac{20}{\sqrt{3}}$ $\quad = \frac{20\sqrt{3}}{3} - \frac{20\sqrt{3}}{3}$

$AP^2 = 100+\frac{100}{3}$ $\quad = \frac{20\sqrt{3}}{3}$ $\quad = 0$

$AP = \sqrt{\frac{300+100}{3}}$

31. **Suppose that the cost of a college education is increasing 8% per year. The equation $C(t) = P(1.08)^t$ forecasts the tuition cost in t years from now and is based on the present cost P in dollars. How much will a college now charging $5850 for tuition charge in 10 years?**

$$C(t) = P(1+.08)^{10}$$
$$= 5850(1.08)^{10}$$
$$= 5850(2.158924)$$
$$= \$12,629.71$$

32. **Compute the smallest value of n for which the mean and median of the set $\{13,21,26,28,41,n\}$ are equal.**

$$\text{mean} = \frac{129+n}{6}$$

$$\text{median} = \frac{26+28}{2} = \frac{47}{2}$$

$$13+21+26+28+41+n = 129+n$$

$$\frac{129+n}{6} = \frac{47}{2}$$

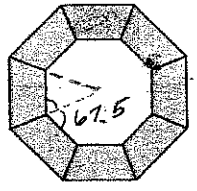
$$129+n = \left(\frac{47}{2}\right)6$$

$$129+n = 47(3)$$

$$129+n = 141$$

$$n = 12$$

33. **Eight identical tables shaped as isosceles trapezoids fit together without gaps to make a "round" table. Find the interior angle measures of the trapezoidal tabletops.**



$$\frac{360}{8} = 45^\circ$$

$$x + x + 45^\circ = 180^\circ$$
$$2x = 180^\circ - 45^\circ$$
$$2x = 135^\circ$$
$$x = 67.5$$

$$\frac{360^\circ - 2(67.5)}{2} = 112.5^\circ$$

67.5°; 112.5

34. **Electo Electronics makes two types of switching devices. Type A takes 4 minutes to make and requires \$3 worth of materials. Type B takes 5 minutes to make and requires \$5 worth of materials. When the production manager reviewed the latest batch, she found that it took 35 hours to make these switches with a materials cost of \$1900. How many switches of each type were produced for the latest batch?**

x = type A
y = type B

time $4x + 5y = 2100$

cost $3x + 5y = 1900$

$$\begin{array}{r} 4x+5y=2100 \\ -3x-5y=-1900 \\ \hline x=200 \end{array}$$

$3(200) + 5y = 1900$

$5y = 1900 - 600$

$5y = 1300$

$y = 260$

200 Type A

260 Type B

35. **A ticket fee was \$10 but reduced. The number of customers increased by 50%, but the gate receipts increased by only 20%. What was the new price of the ticket?**

x = new fee

N = original customers

$(100\% + 20\%)\$10\,N = (100\% + 50\%)x\,N$

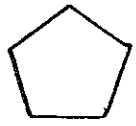
$1.2(10)N = 1.5xN$

$$\frac{1.2(10)N}{1.5N} = \frac{1.5xN}{1.5N}$$

$\$8 = x$

\$8

36. **If each side of a regular pentagon is x^2+17 and each side of a regular hexagon is x^2+2x, for what value or values of x will the perimeters of the figures be equal?**



$6(x^2+2x) = 5(x^2+17)$

$6x^2+12x = 5x^2+85$

$6x^2-5x^2+12x-85=0$

$x^2+12x-85=0$

$(x+17)(x-5)=0$

$x=5$

37. If $2^x = 15$ and $15^y = 32$, find the value of xy.

$2^x = 15$

$x \log 2 = \log 15$

$x = \dfrac{\log 15}{\log 2}$

$x = 3.9068$

$15^y = 32$

$y \log 15 = \log 32$

$y = \dfrac{\log 32}{\log 15}$

$y = 1.2797$

$xy = (3.9068)(1.2797)$

$= 4.9998$

$xy = 5$

38. Ella takes five mathematics tests, each scaled from 0 to 100, and obtains an average of 73%. After her teacher drops one of the test scores, Ella's new average is 76%. What was the score on the test the teacher dropped?

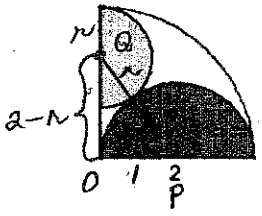
$5 \times 73 = 365$

$4 \times 76 = 304$

61

61%

39. The two semicircles in the figure are tangent to each other. The radius of the quadrant and the diameter of the larger semicircle are each 2. Find the diameter of the smaller circle.



$(2-r)^2 + (1)^2 = (r+1)^2$

$4 - 4r + r^2 + 1 = r^2 + 2r + 1$

$5 + r^2 - r^2 - 1 = 2r + 4r$

$4 = 6r$

$r = \dfrac{4}{6}$

$r = \dfrac{2}{3}$

Diameter $= 2r$

$= 2\left(\dfrac{2}{3}\right)$

$= \dfrac{4}{3}$ units

or $1.\overline{3}$ units

40. On Monday, Jack drove to work at an average speed of 70 km/h and arrived 1 minute late. On Tuesday, he left at the same time and took the same route. This time he drove at an average speed of 75 km/h and arrived 1 minute early. How long is his route to work?

$d = rt$

$\frac{d}{r} = t$

$\frac{d}{70} - \frac{d}{75} = \frac{1}{30}$

$75d - 70d = \frac{(70)(75)}{30}$

$1\,min + 1\,min = 2\,min$

$\left(\frac{1}{5}\right)5d = \frac{(70)(75)}{30}\left(\frac{1}{5}\right)$

$2\,min\left(\frac{1\,hr}{60\,min}\right) = \frac{1}{30}\,hr$

$d = 35\,km$

41. Every year 28 baseball writers cast votes for first, second, and third place for the Cy Young award the American League award for the best pitcher in the league. How many points were awarded for each first, second, and third place vote? The totals for the top three pitchers in 2009 were:

	1st	2nd	3rd	Total
Zack Grenki	**25**	**3**	**0**	**134**
Felix Hernandez	**2**	**23**	**1**	**80**
Justin Verlander	**1**	**0**	**9**	**14**

x = first y = second z = third

$x = 5 \quad y = 3 \quad z = 1$

$25x + 3y = 134$

$2x + 23y + z = 80$

$1x + 9z = 14$

$-9(2x + 23y + z) = 80$

$-18x - 207y - 9z = -720$

$x + 9z = 14$

$25(-17x - 207y) = (-706)25$

$17(25x + 3y) = (134)17$

$425x + 51y = 2278$

$-425x - 5175y = -17{,}650$

$-5124y = -15372$

$y = 3$

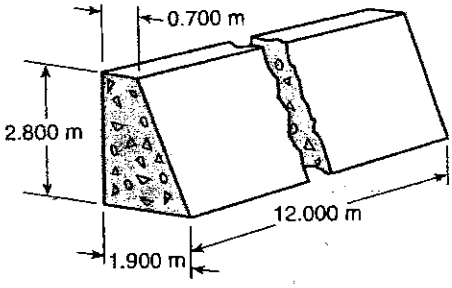
$25x + 3(3) = 134$

$25x = 125 \quad x = 5$

$5 + 9z = 14$

$z = 1$

42. A concrete retaining wall is shown. At a cost of $96.50 per cubic meter, what is the total cost of the concrete wall?



$V = \left(\frac{1}{2}(b_1 + b_2)h\right)l$

$= \left(.5\left(1.9 + .7\right)2.8\right)12$

$= .5\,(2.6)(2.8)(12)$

$= 43.68\,m^3$

$= 43.7\,m^3$

$43.68\,m^3\left(\frac{\$96.50}{m^3}\right) =$

$= \$4215.12$

43. **To convert Celsius temperatures to Fahrenheit temperatures quickly without a calculator, some people use this rule of thumb: Double the Celsius reading and add 30 degrees. The correct formula is $F = \frac{9}{5}C + 32$. What is the error when the rule of thumb is used at 35 degrees Celsius?**

Rule of Thumb

$2(35) + 30° =$

$70 + 30 = 100°$

Formula

$F = \left(\frac{9}{5}\right) 35° + 32$

$= 63° + 32°$

$= 95°$

$100° - 95° = 5°$

44. **Working alone, pump A can fill a pool in 8 hours, while pump B can fill it in 10 hours. The two pumps are turned on at the same time and run until the pool is 75% full. Pump A then stops working, but pump B continues until the pool is filled. How long does it take to fill the empty pool?**

Rate of pump A $= \frac{1}{8}$ hr

" " " B $= \frac{1}{10}$ hr

y = time to complete

$\frac{1}{10} y = \frac{1}{4}$

$y = \frac{10}{4}$

$= \frac{5}{2}$

x = time to fill 75%

$\left(\frac{1}{8}\right)x + \left(\frac{1}{10}\right)x = \frac{3}{4}$

$10x + 8x = \frac{3(8)(10)}{4}$

$18x = 60$

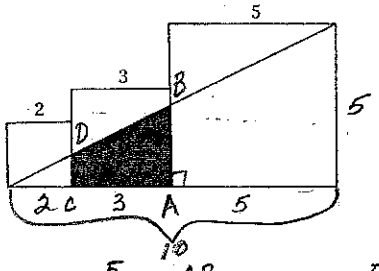
$x = \frac{60}{18} = \frac{10}{3}$ hr

Total $\frac{10}{3} + \frac{5}{2} = \frac{20}{6} + \frac{15}{6} = \frac{35}{6}$ hr

$5\frac{5}{6}$ hr

5.83 hr

45. **Three squares have the dimensions indicated. What is the area of the shaded quadrilateral?**



$\frac{5}{10} = \frac{AB}{5}$

$\frac{(5)(5)}{10} = AB$

$AB = \frac{25}{10}$

$AB = \frac{5}{2}$

$\frac{5}{10} = \frac{DC}{2}$

$\frac{5(2)}{10} = DC$

$\frac{10}{10} = DC$

$DC = 1$

$A = \frac{1}{2}(b_1 + b_2)h$

$= \frac{1}{2}\left(\frac{5}{2} + 1\right)3$

$= \frac{1}{2}\left(\frac{7}{2}\right)\left(\frac{3}{1}\right)$

$= \frac{21}{4}$ units^2 or 5.25 units

46. **The ratio of boys to girls in Mr. Shag's class is 3 to 2. The ratio of boys to girls in Mrs. Bag's class is 4 to 3. If there are 30 students in Mr. Shag's class and 28 students in Mrs. Bag's class, what is the total number of boys in the two classes?**

Mr Shag ratio $= \frac{3b}{2g}$ $\quad \frac{3}{5}(30) = 18$ boys

Mrs Bag ratio $= \frac{4b}{3g}$ $\quad \frac{4}{7}(28) = 16$ boys

$\underline{\qquad\qquad}$

34 boys

47. **The Buckingham Memorial Fountain in Chicago shoots water from a nozzle within the fountain. The height h, in feet, of the water above the ground t seconds after it leaves the nozzle is given by $h(t) = -16t^2 + 90t + 15, h \geq 15$. What is the maximum height of the water-spout? Round to the nearest tenth of a foot.**

$h(t) = -16t^2 + 90t + 15$

$\frac{dh}{dt} = -32t + 90$

$32t = 90$

$t = 2.8125$

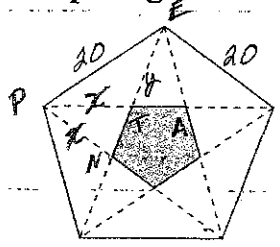
$h(2.8125) = -16(2.8125)^2 + 90(2.8125) + 15$

$= -126.5625 + 253.125 + 15$

$= 141.5625$

$= 141.56$ ft

48. **If the perimeter of a regular pentagon is 100 mm, what is the perimeter of the regular pentagon formed by connecting the diagonals?**



$\triangle ETA \sim \triangle EPN$

$\frac{PE}{PN} = \frac{ET}{TA}$

$\frac{x+y}{x} = \frac{x}{y}$

$y(x+y) = (x)(x)$

$xy + y^2 = x^2$

$x^2 - xy - y^2 = 0$

$x = \frac{y \pm \sqrt{y^2 - 4(-y^2)}}{2}$

$x = \frac{y \pm y^2\sqrt{5}}{2}$

$x = y\left(\frac{1+\sqrt{5}}{2}\right)$

$\frac{x+y}{y} = \frac{x}{y} + 1$

$= \frac{1+\sqrt{5}}{2} + 1$

$= \frac{3+\sqrt{5}}{2}$

$\frac{100}{P \text{ of small pent}} = \frac{3+\sqrt{5}}{2}$

$\frac{200}{3+\sqrt{5}} = P$

$P = 50(3-\sqrt{5})$

$= 38.20$ mm

49. **The populations of two cities were equal at the end of 2005. The population of Charboneau decreased by 2.9 percent in 2006, increased by 8.9 percent 2007, and increased by 6.9 percent in 2008. The population of Grassy Butte increased by r percent each of the three years. If the populations of the towns were equal at the end of 2008, determine the value of r correct to one decimal place. Given $A = P\left(1+\frac{r}{100}\right)^n$**

$$A(1-.029)(1+.089)(1+.069) = P\left(1+\frac{r}{100}\right)^3$$

$$1.1303809 = \left(1+\frac{r}{100}\right)^3$$

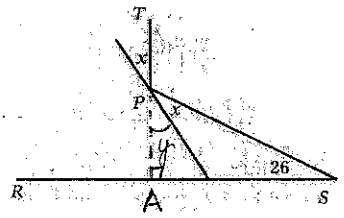
$$\sqrt[3]{1.1303809} = \sqrt[3]{1+\frac{r}{100}}$$

$$1.04169 = 1+\frac{r}{100}$$

$$.04169 = r \qquad 4.17\%$$

$$4.169 = r$$

50. **A beam of light shines from point S, reflects off a reflector at point P, and reaches point T so that line PT is perpendicular to line RS. Find the value of x.**



$\angle x = \angle y$

The angles of $\triangle APS = \angle SAP + \angle APS + \angle PSA$

$$180^\circ = 90^\circ + 2x + 26^\circ$$

$$180^\circ = 116^\circ + 2x$$

$$180^\circ - 116^\circ = 2x$$

$$64^\circ = 2x$$

$$x = 32^\circ$$

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Len Mrachek, 7301 Shannon Drive, Minneapolis, MN 55439

SkillsUSA
2010 Contest Projects

Residential Wiring

Click the “Print this Section” button above to automatically print the specifications for this contest. Make sure your printer is turned on before pressing the button.

Please see the attached "Contestant Information" Sheets.

Please make 100 copies of each page on 8 1/2" x 11" paper and collate and staple.

Please have copies available at 2:00 PM on Monday, June 21' 2010.

2010 SKILLS USA CHAMPIONSHIPS
RESIDENTIAL WIRING
CONTEST INFORMATION SHEET

MATERIALS – All is provided for contest. Wire is limited, it is important that you plan your installation per the specifications included, without waste; you'll have just enough to complete your project.

SPECIAL INSTRUCTIONS:

- ***DO NOT SCREW DEVICES TO BOXES.***
- ***DO NOT BACK STAB (BACK WIRE) DEVICES.***
- ***POINTS WILL BE DEDUCED IF BOXES AND/OR DEVICES ARE NOT LOCATED AS SPECIFIED.***
- ***DO NOT PLUG IN YOUR WORK STATION FOR ANY REASON.***
- ***USE ALL MATERIAL PER INDUSTRY STANDARDS, SUCH AS BOX SUPPORT DEVICES, GROUNDING FITTINGS, CONNECTORS etc..***

WHEN YOUR WORK IS COMPLETE:

- ✓ **RETURN ALL TOOLS PER YOUR TOOL LIST, ALONG WITH THE TOOL LIST, TO THE CHECKOUT TABLE LOCATED IN THE REAR OF THE CONTEST AREA. CONTESTANTS WILL BE RESPONSIBLE FOR RETURNING ALL THE TOOLS LISTED ON THE TOOL LIST.**
- ✓ **PLACE ALL UNUSED MATERIAL IN THE MATERIAL BOX AND PICK UP YOUR AREA.**
- ✓ **ONCE YOU HAVE CHECKED OUT OF THE CONTEST YOU CAN NOT RE-ENTER THE CONTEST AREA FOR ANY REASON.**

2010 SKILLS USA CHAMPIONSHIPS
RESIDENTIAL WIRING
CONTEST INFORMATION SHEET

Study the attached drawing and specifications. Note the different layout of the work stations (left and right sides). All boxes and devices have specified locations and heights, all wiring sizes and cable types are specified and must be installed as specified.

1. CHECK MATERIALS: Take inventory of all your stock, any missing items need to be collected before 10 am (Including TOOLS)
2. CHECK YOUR TOOLS: Account for all the tools listed on your tool list, if your missing any item notify the Chairperson immediately.
3. MEASUREMENTS- All measurements must be within 1/16" of the specified height.
4. CODE REQUIREMENTS- Must meet the 2008 National Electric Code.
5. CLOTHING CHECK- Must meet the SKILLS USA requirements.
6. SPECIAL NOTES:
    a. There will be no talking allowed once the contest has started.
    b. NO person(s) will be allowed in the CONTEST AREA at any time during the contest.
    c. ALL questions regarding the contest shall be directed to the CONTEST CHAIRPERSON(S).
    d. Any contestant who must leaves the work area for any reason shall notify the CONTEST CHAIRPERSON(S) prior to leaving the area.
    e. There will be **NO Cellular Telephone(s)** allowed in the CONTEST AREA at any time during the contest.

SAFETY – EACH CONTESTANT IS REQUIRED TO WORK IN A SAFE AND ORDERLY MANNER. ALL CONTESTANTS ARE REQUIRED TO WEAR HARDHATS, SAFETY GLASSES AND PROPER WORK SHOES AT ALL TIMES. ANY CONTESTANT NOT WEARING THE REQUIRED SAFETY EQUIPMENT MAY BE DISQUALIFIED AND REMOVED FROM THE CONTEST AREA.

TIME – Actual contest will begin at 8:00 am on Wednesday and Thursday and break for lunch at 11:30 am on Wednesday and 12:00 noon on Thursday. The contestants will have 60 minutes for lunch both Wednesday and Thursday. Contestants are not permitted to work on their project, but may review their paper work during lunch. The contest will continue at 1:00 pm on both Wednesday and Thursday and end at 3:00 pm on Wednesday and 5:00 pm on Thursday. No actual work will be permitted prior to 8:00 am. The contest chairman will start the contest.
Finishing before the allotted time will not be a factor in the contest scoring, however an incomplete project will.

Please see the attached "Contestant Material" List.

Please make 100 copies of each page on 8 1/2" x 11" paper and collate and staple.

Please make available at 2:00 PM on Monday, June 21' 2010.

2010
Skills USA Championship
Residential Wiring Contestant Material List

QUANTITY PER CONTESTANT				DESCRIPTION		
14 ft.				#14/2 w/ground MC Cable		
25 ft.				#14 THHN SOLID RED		
35 ft.				#14 THHN SOLID WHITE		
25 ft.				#14 THHN SOLID BLACK		
25 ft.				#14 THHN SOLID GREEN		
12 ft.				#14-3 Romex w / ground		
50 ft.				#14-2 Romex w / ground		
20 ft.				#12 THHN Solid Black		
10 ft.				#12 THHN Solid White		
15 ft.				#12 THHN Solid Green		
4				15 Amp, Single Pole Switch		
4				15 Amp 3 - way toggle switch		
1				120 volt 15amp GFCI Receptacle		
2				15amp 120volt Duplex Receptacle		
30				Red Wire Nuts		
15				Yellow Wire Nuts		
15				Green Grounding Wire Nuts		
4				3/8" MC Cable Connectors		
6				Low Voltage Staples		
14				Insulated Romex Staples		
3				3/8" 1-Hole MC Cable Straps		
11				Green Ground Screwa		
44				#10 x 1/2" Pan Head Wood Screw		

2010
SkillsUSA NLSC
Residential Wiring Contestant Material list

QUANTITY PER CONTESTANT				DESCRIPTION		
3				15 Amp Sq. D Breaker type HOM		
1				20 Amp Sq. D Breaker type HOM		
1				120/240 Volt, 125 Amp MLO 16 Ckt. Main Panel		
1				4" Round Non-Metallic Box with Bar Support		
4				1 Gang Switch Box Non-Metallic Nail-On Box		
1				4" Oct 1-1/2" Deep Metal Box w/ Romex Clamps		
1				Metal 1 Gang O.W. Box w/ Ears & RX Clamps		
3				4" Sq x 1 1/2" Deep Box w/ 1/2" & 3/4" K.O.'s		
3				4" Sq x 1 1/2" Deep Box w/Mounting Bracket		
1				1-Gang Retrofit Low Voltage Bracket		
1				1-Gang New Construction Low Voltage Bracket		
1				2 Gang Non-Metallic Nail-Up Box		
12				1/2" EMT Set Screw Connector		
3				1/2" Romex Connector		
2				4" Round Non-Metallic Nail-On Box		
4				1 Gang Device Ring		
2				Madison Strap		
1				2 Gang Device Ring		
10				1/2" EMT One Hole Straps		
30 ft.				1/2" EMT		
4				Keyless Lampholders		
2				Telephone Jack		
10 ft.				Cat- 5e Telephone Cable		
4				8" Ty-Wraps		

Please see the attached "Tool Check List'.

Please make 100 copies on 8 1/2" x 11" paper.

Please make available at 2:00 PM on Monday, June 21' 2010.

SKILLS USA 2010 TOOL LIST
Contestant #_____

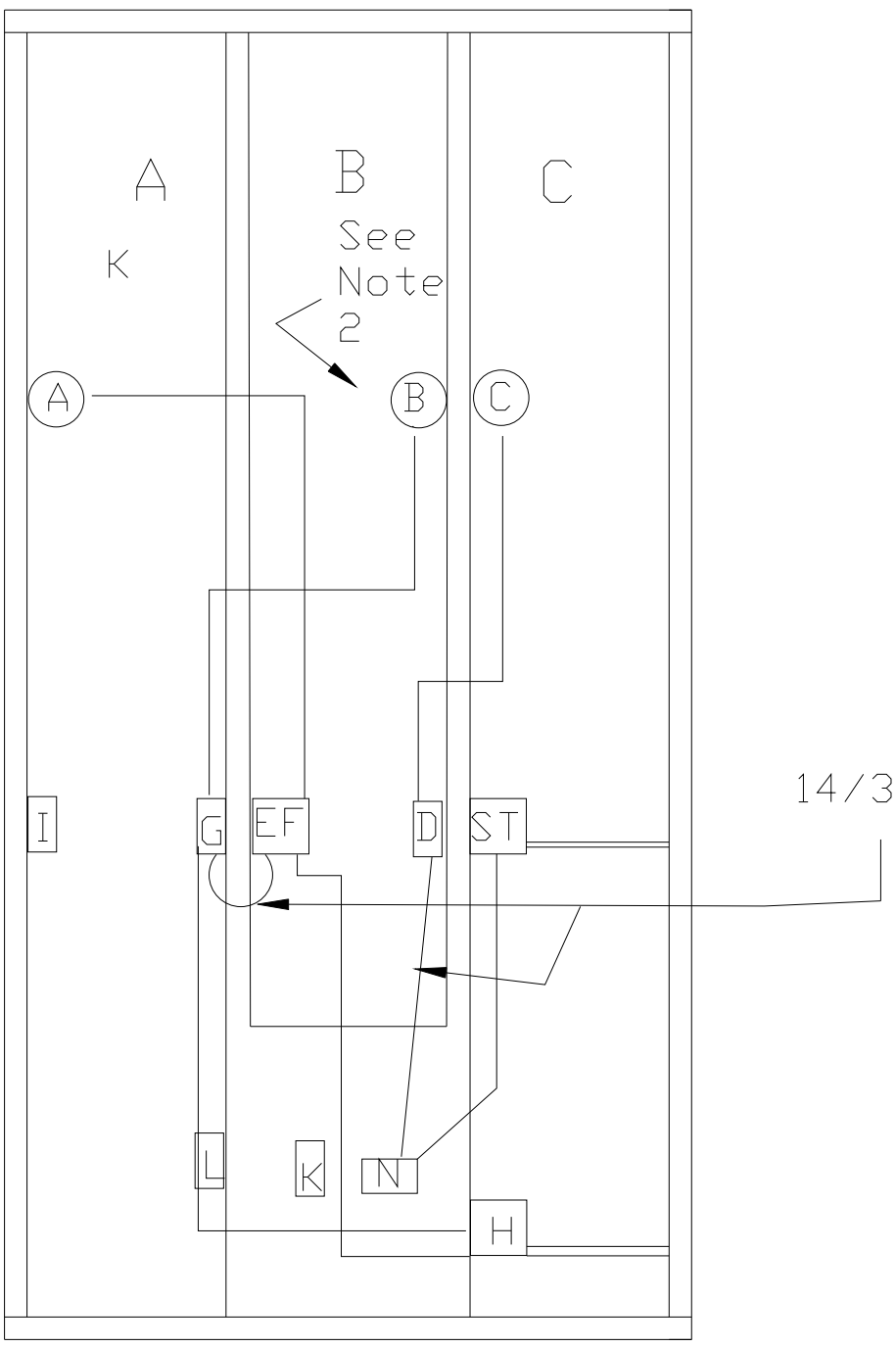
QUANITY	TOOL DESCRIPTION	RECEIVED	RETURNED	Check By
1	8" Diagonal cutters (angle head)			
1	9" Linesman Pliers			
1	16 oz. Claw Hammer			
1	8" Needle Nose Pliers			
1	10" Pump Pliers			
1	Torpedo Level			
1	603-3 Phillips screwdriver #1			
1	603-4B Phillips Screwdriver #2			
1	605-4 1/4" Screwdriver 4"			
1	605-6 1/4" Screwdriver 6"			
1	725 Keyhole Saw			
1	25' tape Measure			
1	11045 Wire Stripper/Cutter			
1	1550-11Electricians knife			
1	85191 Reaming Screwdriver			
1	650 Scratch Awl			
1	1412 Dual Cable Sripper/Cutter			
1	32476 Screw/Nut Driver			
1	70570 Hex Key Set			
1	Tool Pouch			
1	Tool Belt			
1	Cordless Drill			
1	Auger drill Bit			
1	1/2" EMT Bender			
1	Hack Saw			
1	Hammer Holder			
1	1/8" Cabinet Rd. shank screw driver # 608-3			

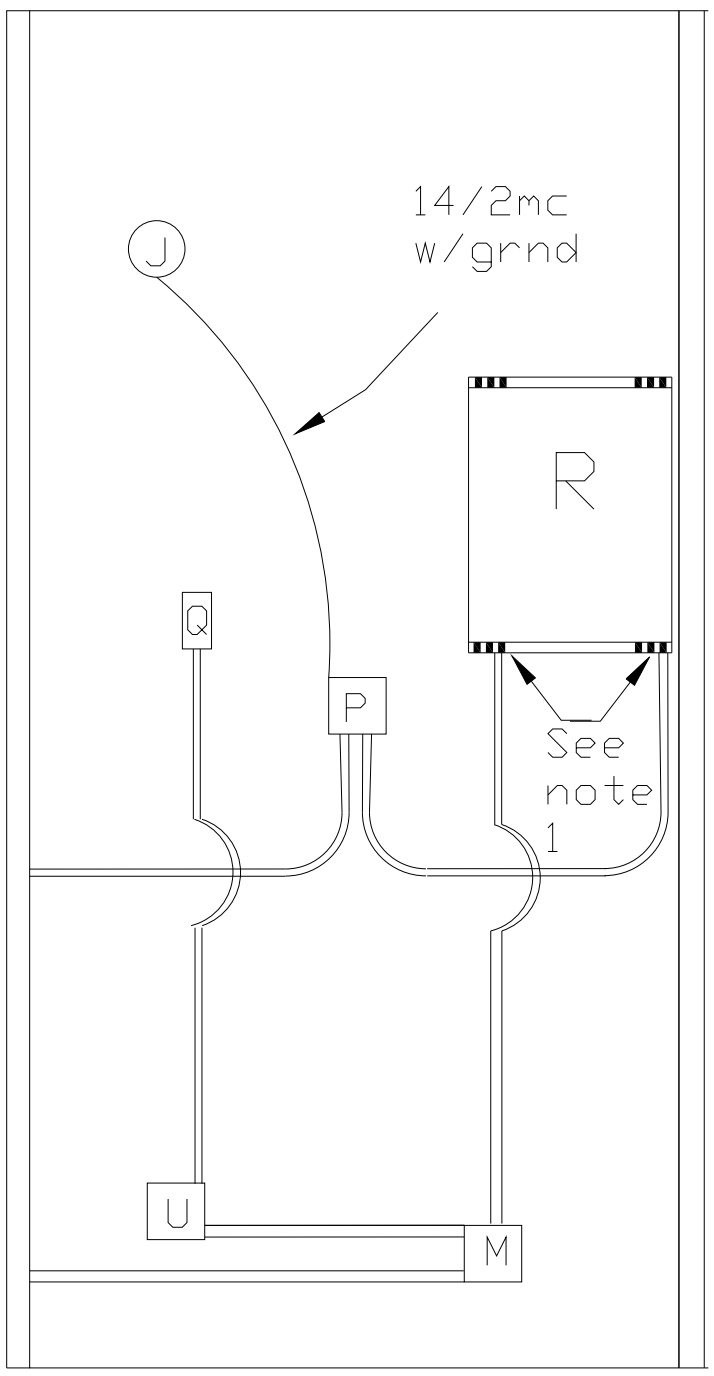
Please see the attached "Left Side Packet" and "Right Side Packet" of the drawings.

Please make me 50 copies on 11" x 17" paper of each packet, I need them collated and stapled and available for pick-up at 2:00 PM on Monday, June 21' 2010.

2010 SkillsUSA NLSC
National Competion
Residential Wiring
Drawing is NOT to Scale

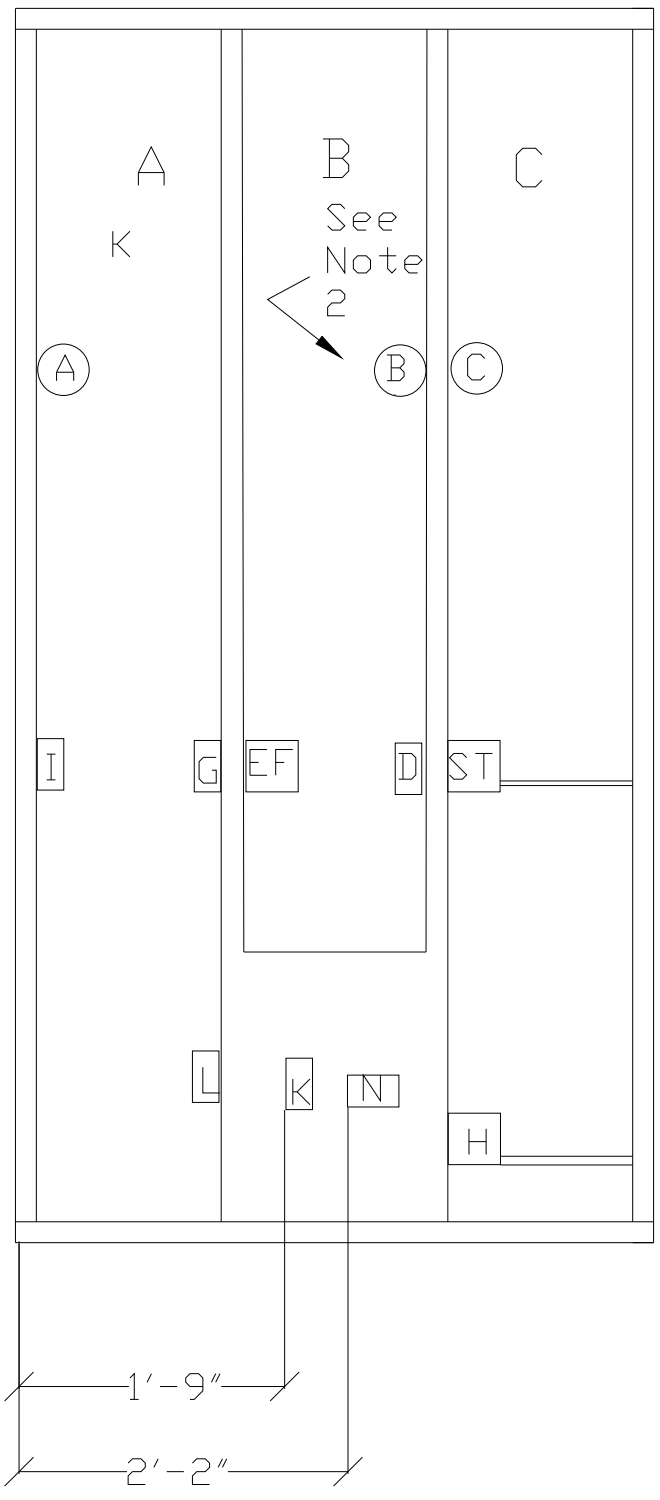
Right Side

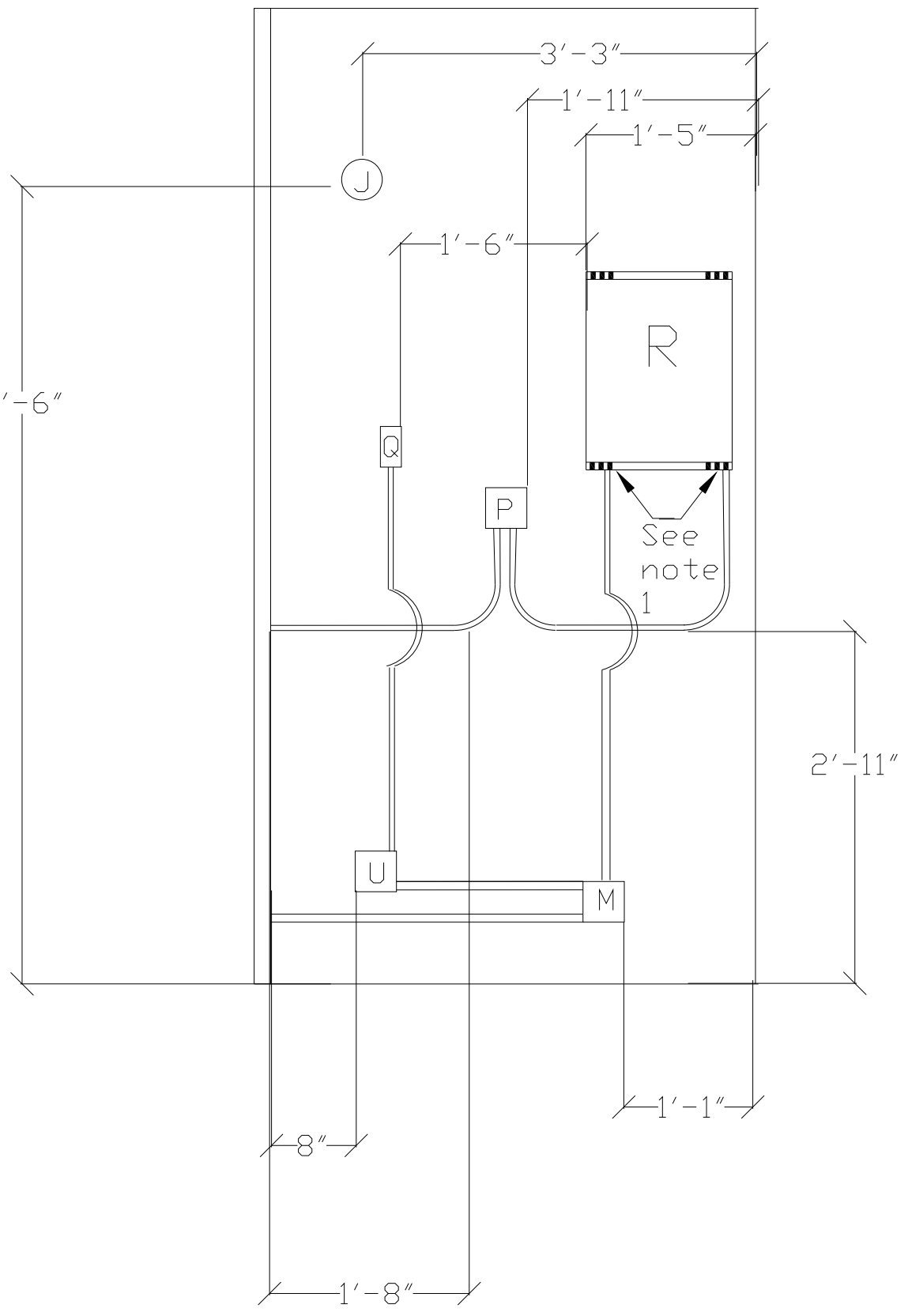




2010 SkillsUSA NLSC
National Competion
Residential Wiring
Drawing is NOT to Scale

Right Side





2010 SkillsUSA NLSC
National Competion
Residential Wiring
Drawing is NOT to Scale

NOTES

1. Last 1/2" K.O., 1/2 EMT w/#12
2. Center Of box in the Center between studs
3. Telephones to be Interconected with Blue Pair an primary.
4. Device "N" to be Left Half Switched from "T" and Right Half hot all the time.
5. GFCI "L" to Control Device "G", "F", and "C"
6. Wire between "D" and "N" should be 14/2 with ground MC
7. No shared Netural Wires.
8. All Metal Boxes shall be Grounded
9. Ciruit 1 shall be 20amp 120volt, all other circuits shall be 15amp 120volt.
10. Box offsets at all EMT Termiations.
11. All Saddles Shall be 3-Point Saddles.
12. "U" shall be Switch from "Q"
13. EMT Fittings not of Grounding Type

Cable List
RX- Nonmetalic sheated cable
UF- Underground Feeder and branch circuit cable
MC- Metal Clad Cable

Materials

LETTER	DESCRIPTION	BOX TYPE	HEIGHT	LOCATION	BOX MTG.	CIRCUIT
A	Keyless Receptacle	4" Round Plastic/Nail On	5'-7'' Center	Wall A	Nail On	4
B	Keyless Receptacle	4" Round Plastic/Nail On	6' Top	Wall C	Nail On	2
C	Keyless Receptacle	4" Round Plastic/Bar Hgrs	6' Top	Wall B	Nail On	3
D	Single Pole Switch	4" Sq.Box with 1-Gang Device Ring.	44" Top	Wall B	2 -#10 X 1/2" with Mounting Bracket	2
E	Single Pole Switch	Plastic 2-Gang New Work	46" Top	Wall B	Nail On	4
F	Three Way Switch	Plastic 2-Gang New Work	46" Top	Wall B	Nail On	3
G	Three Way Switch	Plastic 1-gang New Work	49'' Top	Wall A	Nail On	3
H	Junction Box	4" Square Metal Box	6" Top	Wall C	2 - #10 X 1/2"	N/A
I	Flush Mount Telephone Jack	1-Gang New Work Low Voltage Bracket	42" Bottom	Wall A	Nail On	N/A
J	Keyless Receptacle	4" Metal Octagon	5'-6" Top	Plywood	2 - #10 X 1/2"	2
K	Flush Mount Telephone Jack	1-Gang Retrofit Low Voltage Bracket	16" Bottom	Wall B	Cut-In	N/A
L	GFCI Receptacle	Plastic 1-gang New Work.	16" Bottom	Wall A	Nail On	3
M	Junction Box	4" Square Metal Box	6" Top	Plywood	2 - #10 X 1/2"	N/A
N	Duplex Receptacle	Metal 1-Gang Old Work Box	12"' Bottom	Wall B	Cut-In With Madison Straps	2
P	Three Way Switch	4" Sq.Box with 1-Gang Device Ring.	3'9" Bottom	Plywood	2 - #10 X 1/2"	2
Q	Single Pole Switch	4" Sq.Box with 1-Gang Device Ring.	4'-7" Top	Plywood	2 - #10 X 1/2"	1
R	Main Panel	Main Panel	4'-3" Bottom	Plywood	2 - #10 X 1/2"	N/A
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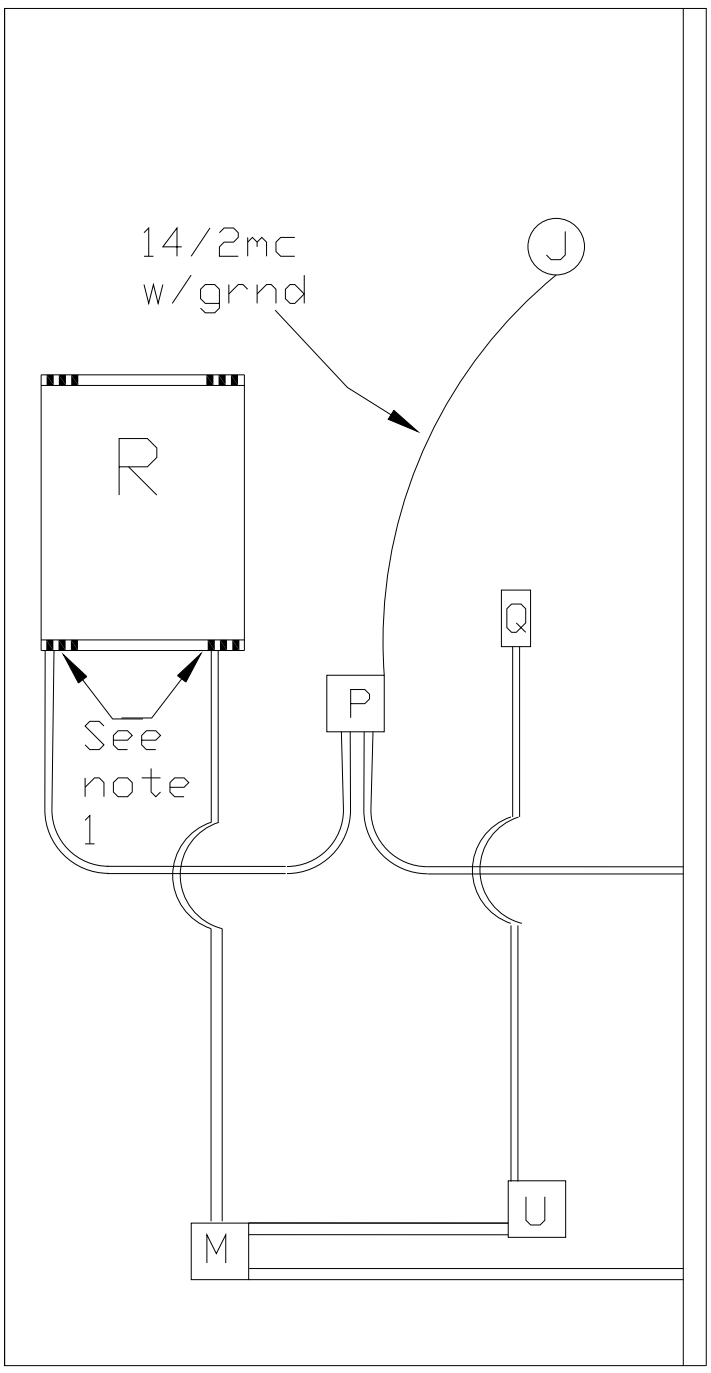
2010 SkillsUSA NLSC
National Competion
Residential Wiring
Drawing is NOT to Scale

Left Side

Plywood



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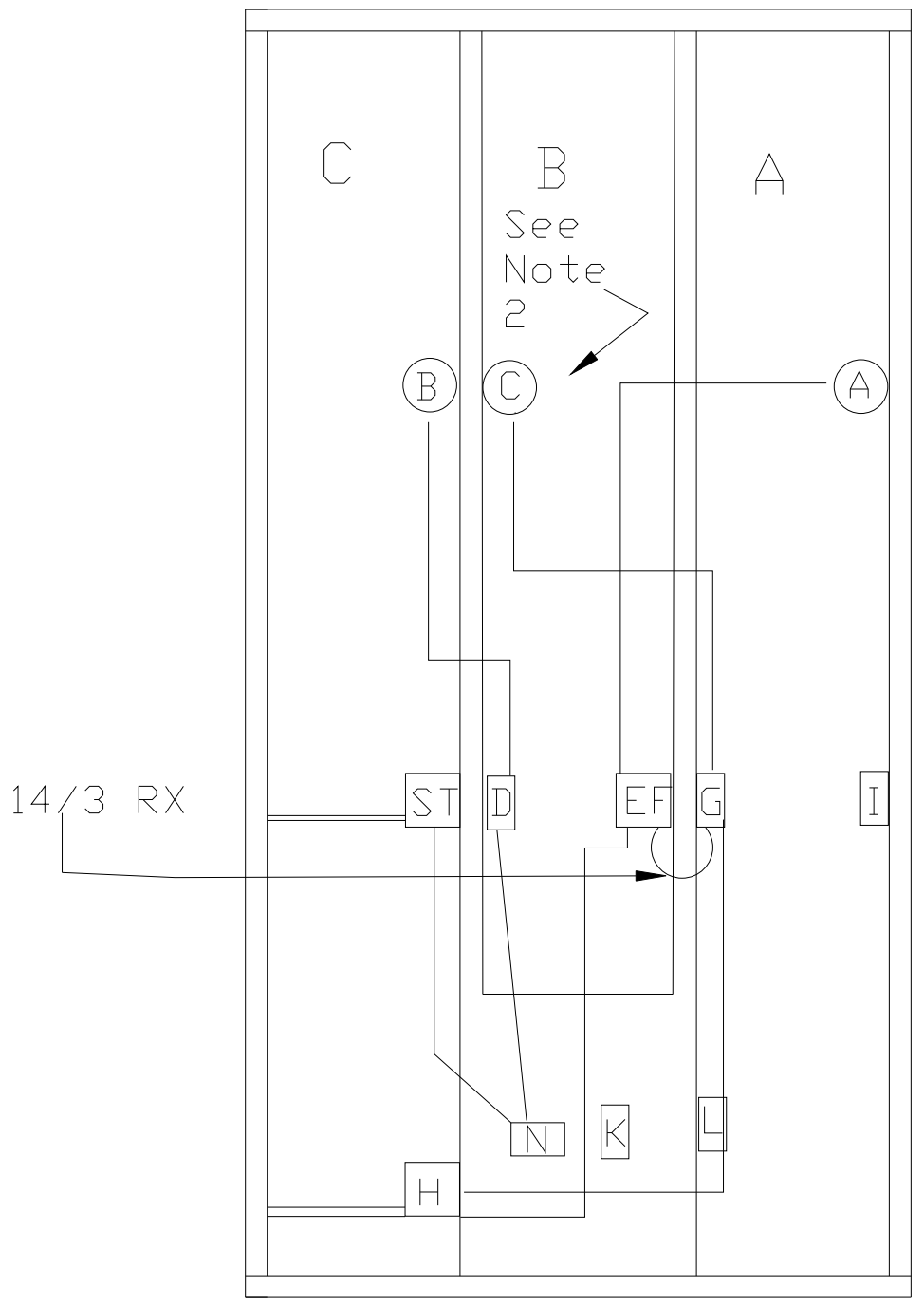

2010 SkillsUSA NLSC
National Competion
Residential Wiring
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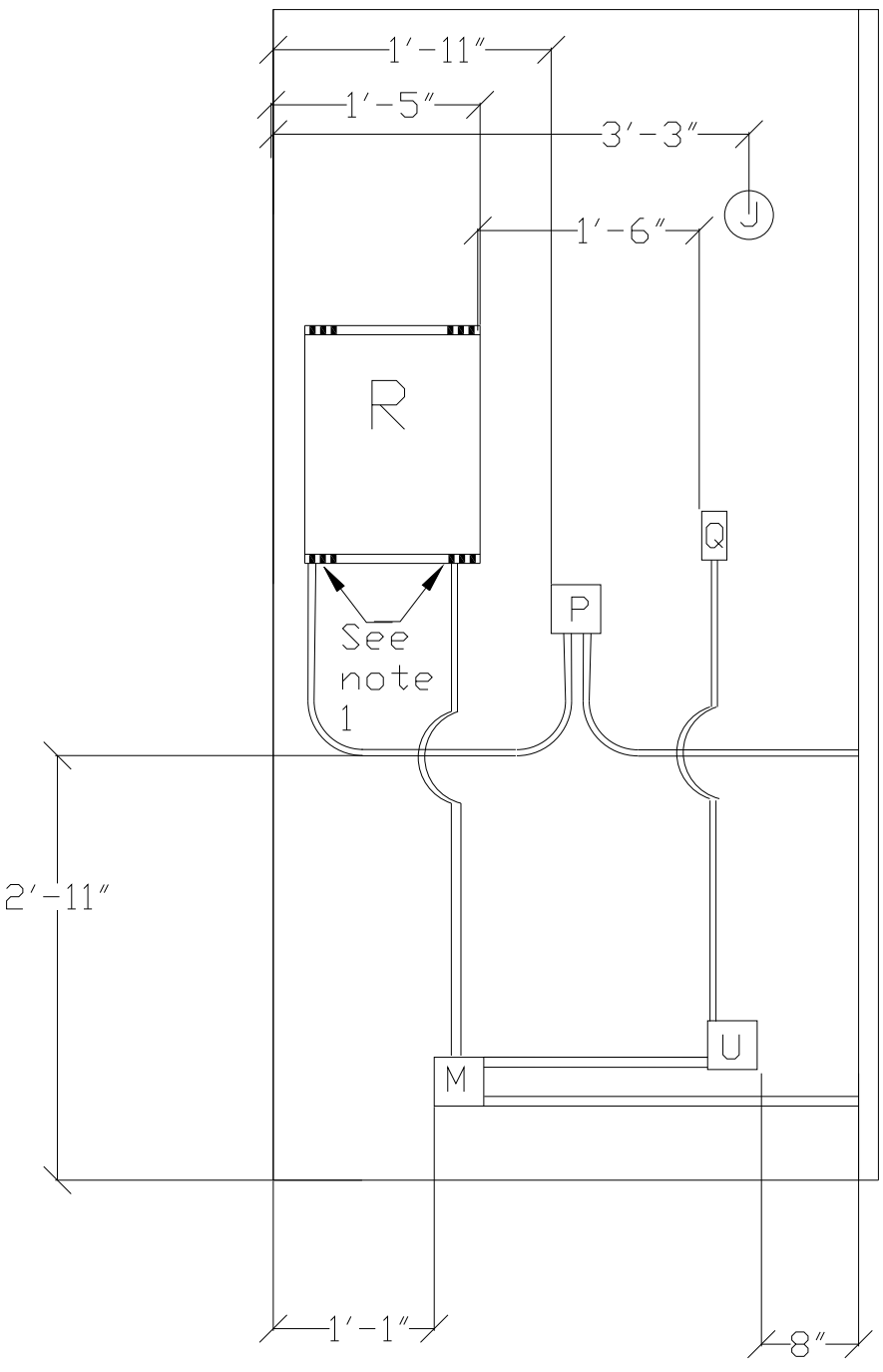
Left Side

Plywood



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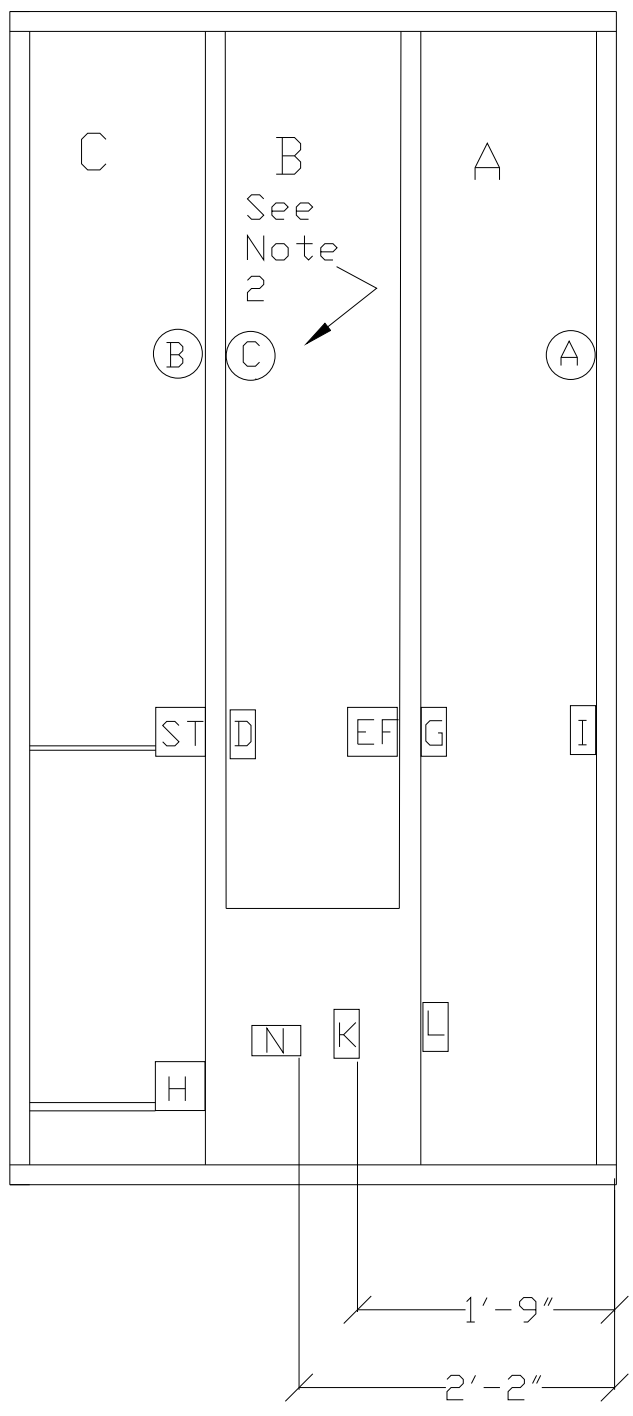

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SkillsUSA
2010 Contest Projects

Robotics and Automation Technology

Click the “Print this Section” button above to automatically print the specifications for this contest. Make sure your printer is turned on before pressing the button.

ROBOTICS AND AUTOMATION TECHNOLOGY

2010

SKILLS CHAMPIONSHIP

444 Industrial Park Drive
Manchester New Hampshire 03109
603-625-8600

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COMPETITION BRIEFING

1. Welcome to the Robotics and Automation Technology competition. You should already have your system setup and tested, if not you will be given time to do so. I will try to apprise you of the contest during this briefing. Please wait until the end of the briefing to ask questions.

2. While in the work area observe all safety precautions. Unsafe acts could disqualify you from participating in the contest. Wear safety glasses.

3. If you have questions during the competition, contact a competition official. The official will evaluate your question and determine if it is a question that all teams should hear. If the official deems that all should hear, the response will be given for all to hear. If the answer is in the documentation provided, the question would not be answered. It will be suggested that you do more research. If it is obvious that you should know the answer to the question you are asking, there will be no answer.

4. Restroom breaks. Contact an official and you will be escorted to the restroom. Only one person from a team at a time. Please try to hold these to a minimum.

5. Breaks. A team may take a break in their work area when both team members agree.

6. Do not communicate with anyone other than the other person on your team or a contest official. Communication with anyone other than the above mentioned, may be grounds for disqualification from the contest

7. Start the competition when told to do so.

8. You will be apprised of time remaining as the contest nears finish time.

9. There will be a debriefing after the contest is over. You will be told when and where.

10. Good Luck.

Introduction

This document describes the Skills State Championship Robotics and Automation Technology Competition.

Acknowledgments

Since the inception of this contest it has had wide spread support. Interested companies and individuals provide equipment and materials for this event. Industrial experts, volunteers from companies, education professionals and private business, all donate their valuable services in designing and conducting the competition.

The success of this competition is the motivation of the contestants and their instructors, the determined efforts of the National and State Technical Committees, and the generosity of those donating equipment and material.

Intelitek is proud to sponsor the Skills State Championships, Robotics and Automation Technology competition:

Intelitek
Eshed Robotics / Light Machines
444 East Industrial Park Drive
Manchester, NH 03109-5317

ROBOTICS AND AUTOMATION TECHNOLOGY COMPETITION

OVERVIEW:

Robotics and Automation encompass a large field of manufacturing technologies. The integration of these processes is making the United States competitive in today's world market. It is essential that the labor force be on the leading edge of current and emerging technologies to maintain industry leadership in the manufacturing processes. With today's complex manufacturing problems, no individual can be an expert in all areas, so it is imperative for manufacturers to mold the necessary skills into a team using the combined resources to resolve problems. Workers in the field of Robotics and Automation have found the team approach to be successful, as it is our hope to emulate industry whenever possible. Therefore, we will use the Team approach in this competition. We suggest a two-person team comprised of a specialist from the following fields: Robot Programmer and Electronic and Mechanical Integration specialist.

Installing a new, up-to-date system, in a prompt manner is highly beneficial to remain competitive in the industrial market. The ability to change an existing system to a more efficient operation saves time in bringing a new product to market and reduces production time, thus lowering job costs.

Statement of the Problem

Robotics and Automation Inc. have just hired you. You have been teamed up with another new hire and assigned to a project, which involves designing a new production line. Supervision has provided you with a description of the required process and a list of equipment and material available for use in the system you are to design and implement. This task has also been assigned to other newly hired people who are paired into teams. As you may surmise, doing an outstanding job on this assignment could establish your future with Robotics and Automation Inc. Your assigned team number will be you team name.

Quality and production cost is essential in remaining competitive in the manufacturing industry. Therefore, you can be certain that, completeness of your project, elapsed time for you to come on line, cycle time, insight into good implementation techniques and documentation will all be considered in your job performance and evaluation.

DIRECTIONS

Your assignment is to:

Implementation

Using the description of the process and the provided equipment and material you are to layout your production system and develop a robot program to fulfill the requirement of the task. Complete documentation of the project is required. Minimum documentation is to include a sketch of the layout and equipment placement, a flow chart of the program and a copy of the robot program.

Line updating

Requirements of the project have changed. You are required to update your program and layout to meet the new requirements. Documentation for the updated system must reflect the changes. Cycle time has become an issue, and must be brought to a minimum.

Guidelines

The project manager has provided the base outline of the materials within this document to begin your planning implementation. Your success on this project is based upon the following criteria:

1. Providing complete documentation of the project.
    a. Sketch of layout
    b. Flow chart
    c. Robot program
    d. Input and Output Assignment
    e. Terminal Strip Assignment
    f. Block Diagram

2. Using the proper technology for the preparation of the documentation
3. Packaging the documentation in an orderly and professional manner
4. Effective use of teamwork in managing the project
5. Safety in the manufacturing process
6. Efficient use of time, material and resources

Team Guidelines

1. Your team is organized for primary responsibilities and duties.
2. Breaks are to be taken within assigned individual work areas.
3. Team members must notify a Technical Committee member or a judge before taking a bathroom break. Only one member of a team is permitted to leave at a time and must be accompanied by contest official.
4. In case of a software or hardware problem:
   You will communicate any problem(s) to a judge so that the running time clock may be stopped for that team. In the case of a stopped time clock, all work will stop for the entire team until the problem(s) is resolved.
5. The software for your robot should be loaded on your computer or controlling device. Teach pendants are optional
6. You must save your final programs to a usb drive. This is part of your project documentation.
7. No more than 3.5 hours will be allowed to complete the contest. Stopped clock as referenced in item 5 above will be considered.

OFFICIAL COMPETITION

Purpose

To evaluate each school's preparation of students for employment in the emerging arena of robotics and automation and the team approach to the problem-solving work environment. To recognize outstanding performance in the use of new work styles and technology by students and schools.

Clothing Requirements

Skills State Championships

Acceptable work clothes, safety glasses with side shields or goggles. (Prescription glasses can be used only if they are equipped with side shields. If not, they must be covered with goggles. Refer to the SkillsUSA – Championships below.)

Official khaki work shirt and pants, black or brown leather shoes, and safety glasses with side shields or goggles. (Prescription glasses can be used only if they are equipped with side shields. If not, they must be covered with goggles.) Refer to General Regulations Item 24, Page 11 and Robotics and Automation Technology, Page 265 of SkillsUSA Championships Technical Standards 2005 – 2007

Eligibility

Open to active SkillsUSA members enrolled in programs with robotics, automation and/or manufacturing as the occupational objective.

Scope of Contest

Teams of two will demonstrate their ability to perform, exhibit, and compile skills and knowledge necessary from the following list competencies determined by the Robotics and Automation Skills New Hampshire Technical Committee Members.

The team will be provided with a written description of the task requirement and a list of the available equipment and material. The team will develop a system layout and robot program then demonstrate their product. Upon completion of this task they will be provided a requirement to refine their system design and again demonstrate it's functionality.

A. Perform analysis of task

1. Evaluate written task
2. Evaluate provided equipment and material
3. Evaluate system revision

B. Design, Sketch and Plan

1. Determine sequence of operation
2. Select equipment and material to meet functional need
3. Create Flow Chart
4. Create layout
5. Create Input and Output Assignment
6. Draw block Diagram
7. Process system revision

C. Implement Design

1. Develop robot program
2. Install equipment
3. Integrate equipment with system controller
4. Modify system to meet revision requirements

D. System Performance

1. Perform functional test for total system operation
2. Present system for evaluation
3. Perform functional test to meet revision requirements
4. Present revised system for evaluation

Group Organization and Goals

This is a group competition and all members may interact at will. It is our hope that the competition will run much like industry.

The robot programmer will program the robot and peripheral equipment.

The Electro-mechanical integrator will install the peripheral equipment and integrate it into the system

We expect that when a team member has spare time they will help the other team member.

It is our hope that one person will not dominate a team. We do not want one person doing all the work while the other team member just assists. Each team member must take an active role in this competition. We have taken this course to promote creativity in organization of production responsibility.

All members are responsible for double-checking each other's work and quality control.

General Information

1. This competition will be accomplished using your robot system. (**SkillsUSA - Championships** will use the SCORBOT ER4U and other supplied peripherals)
2. Other equipment and material is from local supply sources.
3. Teams will consist of two members.

Goals

1. To have every team complete the contest.
2. To have each member demonstrate reading and writing skills.
3. To have each team member use their critical thinking and problem solving abilities.
4. To have each team member illustrate responsibility, teamwork, and self-management skills.

Notebooks

Each team will be issued a notebook and information packet. This will be a bound binder that will allow the team to complete the documentation of their assigned task.

Required Materials

The team will require the following equipment and material to complete the competition. The Technical Committee provides most of the required equipment and materials, but the team must also bring certain items.

Robotics and Automation Technical Committee Provides:

Robot and Controller	Bad parts bin
Gravity Parts feeder	Storage area templates
12 V Power Supply	Task assignment
Conveyor	Documentation
Metal and Plastic Blocks	
Stack Lights	
Sensor Station: Proximity Sensor and Micro Switch	

Team Provides:

Multi-meter with test leads	Wire strippers (electronic)
Long nose pliers (electronic)	Small screwdriver set (common and Phillips)
Diagonal pliers (side cutters)	Power strip, 6 outlets, circuit breaker protected
Extension cords, minimum 25’	100’ hookup wire (20-24 AWG)
Tape, masking & electrical	Jumper leads for troubleshooting
2-#2 pencils (sharpened)	12” ruler
Safety glasses	Any other tools specific to your equipment

Points will be deducted for items listed and not provided by the team. (5 points per item)
Points may be deducted for tools brought that are not list. (5 points per item)

Suggested Division of duties

Task analysis	Both team members
System layout	Both team members
Robot program	Robot programmer
Equipment placement	Electro-mechanical integration tech
Electrical integration	Electro-mechanical integration tech
System layout sketch	Electro-mechanical integration tech
Other documentation	Either team member
Program flow chart	Robot programmer
Hard copy of program	Robot programmer
Notebook	Both team members

SAFETY

The safety aspects are judged in this contest because in the real industrial environment safety is an economic business factor. The welfare of employees is in the best interest of any employer and employee to maintain the effectiveness and competitiveness of the company. Also, the safer a company is in their working environment the more cost effective they become which enables the company to obtain better insurance. In addition, workman compensation fees are reduced if the accident history of a company is good.

If during this contest a team or team member violates a safety rule or operates their system in an unsafe condition the following rule will be in effect.

1st Violation:

Team will be issued a written notice

2nd Violation

Team will have 50 points deducted

3rd Violation

Team will be disqualified

Some safety issues

1. Team members must keep their work area reasonably clean. Clean work places allow efficient and safe working conditions

2. Team members must keep other team members and teams aware of possible dangerous situations, such as: flying debris from wire cutting and stripping and/or noise

3. The Emergency Stop Switch must be depressed when working on an active system other than when an active system is required to accomplish a required part of the task, such as teaching the robot positions.

4. Team members must wear safety glasses when they are in proximity of an operational system or performing tasks that require safety glasses, such as cutting and stripping wire.

5. Overall safety is not limited to the above rules. Unsafe acts or practices will not be tolerated.

Proper safety practices are vital in all stages of this competition. Points will be deducted and/or contestants disqualified for unsafe practices in the work area. Judges decisions on safety are final.

State Competition

Directions

Your team is to assess the following task, then determine the layout and positioning of the provided components and develop a robot program to achieve the desired results.

Task

Refer to the Stack Light Specifications for stack light usage.

There are several Parts (metal and plastic blocks) provided that will be loaded in the gravity parts feeder. A judge will load the parts in any order with the holes facing down.

1. The Robot must take a block from the parts feeder if a block is in the feeder, otherwise loop until a part is placed in the feeder.
2. Robot must use the hardware in workcell to determine if a part is:
    - Metal block with hole
    - Metal block without hole
    - Plastic block with hole
    - Plastic block without hole.
3. All blocks must be placed on the conveyor for visual inspection and then placed in the appropriate template

    - Parts without holes are to be placed in the Bad Parts Bin with the hole facing up, in the appropriate area, and counted.

    - If there is more then one part, the part must be stacked on top of the existing block, inside the bin area. (Place the metal block part on the template –metal parts bin, and the plastic block part on the template –plastic parts bin.) If there is more then 1 part, the second block must be stacked on top of the existing block, inside the bin area.

    - The parts without holes are to be separated and placed on assigned templates, inside the associated bins. (Place the small block part on the template –Small Part Bin, and the large block parts on template, large part bin.) If there is more then 1 part, the second block must be stacked on top of the existing block, inside the bin area.

    - The stack light must display the appropriate colors.

Workcell Component Placement

The items are to be positioned on the table at your discretion. The choice is yours. Place them for the best implementation of the solution to the task. Use the double-sided tape to hold items securely in place.

Equipment/material supplied

1. Parts Feeder with parts present switch
2. Robot and Controller
3. Test box with inductive proximity sensor and micro switch.
4. Conveyor with sensor
5. Bad parts bin template (paper)
6. Storage area template (paper)
7. Blocks, cubes:
    - 2 metal blocks with hole
    - 2 metal blocks without hole
    - 2 plastic blocks with hole
    - 2 plastic blocks without hole.
8. Hand outs

Initial Block Placement

Load the supplied blocks into the Parts Feeder with the holes down in an arbitrary order. You may be requested to load the blocks in any order.

Special Criteria

1. Power cord for power supply will not be provided until a judge verifies the work cell wiring is connected to the controller appropriately.
2. Refer to the stack light specifications for usage.
3. With power applied to the system, and the program is not running, turn on a stack light to indicate the status of the robot.

Required Documentation

1. Flow Chart of program
2. Sketch of system layout
3. Block Diagram of Electrical Wiring
4. Terminal Strip Assignment
5. Inputs and Output Assignment
6. Saved program

Documentation Evaluation

A system that another person cannot use, troubleshoot or understand how it is designed to function is of little value. Therefore, it is necessary to fully document your system design.

The following will be given maximum attention in evaluating your system design.

1. Does the system function to achieve the assigned task?
2. Is the program “Remarked” to make it easy to follow?
3. Does the system layout match the system layout sketch?
4. Does the Flow chart match the hard copy of the program?
5. Is the documentation complete and accurate?

System Performance Evaluation

After your team has made your layout, developed and tested your program, call a judge to evaluate the performance of your program. For the judge to evaluate your process, you will start your program from the beginning and let it run a complete cycle. You may be asked to run your process in a continuous mode.

In the event your program does not meet the task requirements on the first and subsequent attempts the following scoring criteria will be used:

You will receive a multiplier of 1.0 on your overall score if you meet all the performance criteria on the first attempt.
A multiplier of 0.95 if you meet all of the performance criteria on the second attempt.
A multiplier of 0.90 if you meet all of the performance criteria on the third attempt
0.85 on the forth attempt.
0.80 on the fifth attempt.
Each additional attempt will reduce the multiplier 0.05
It pays to be sure your process is correct the first time you request evaluation.

Other Items for Evaluation

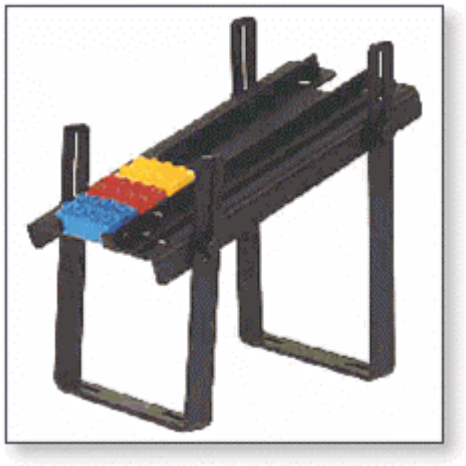
1. Were the parts accurately placed on the templates?
2. Was the system completed in a timely manner?
3. Is the program efficient?
4. Were safety rules adhered to?

Hardware connections

Hardware connections - Parts Feeder

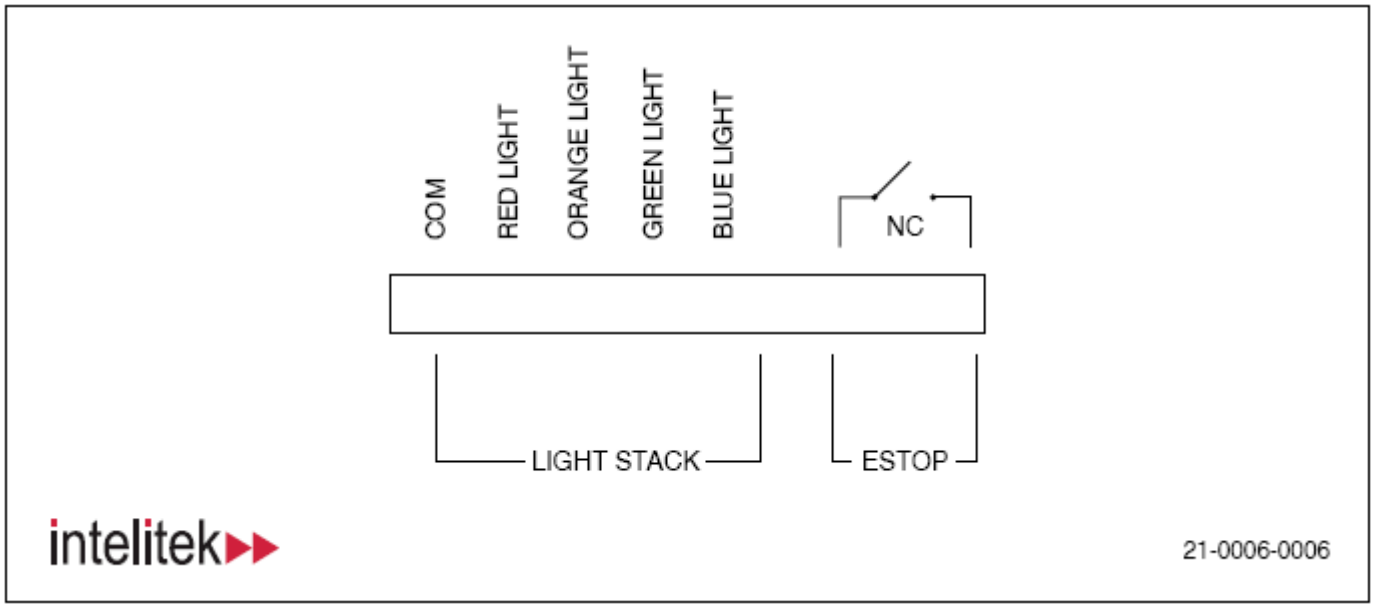
The parts feeder is a gravity feed assembly with a guide on each side and a parts present switch. A micro switch sensor detects the presence or absence of parts and communicates with the robot controller by means of I/O connections. One wire to input ground; one wire to the input terminal (1-8).

The feeder can be adjusted using a adjustable front leg support: (5.5"– 8.5") and an adjustable rear leg support: (8.5" – 12")



Hardware connections - Stack Light

DO NOT DISASSEMBLE THE STACK LIGHT UNIT



Stack Light requires 12 volts DC current.

Color	Usage
Red	ON when the robot motors have power and workspace is unsafe.
Yellow	ON when Testing parts, off at all other times
Green	ON (solid) when power for all motors is OFF and the work area is safe for technicians to work in. Program is not running.
Blue	ON when a "bad part" is identified and turned off after bad part is placed in Bad Template area.

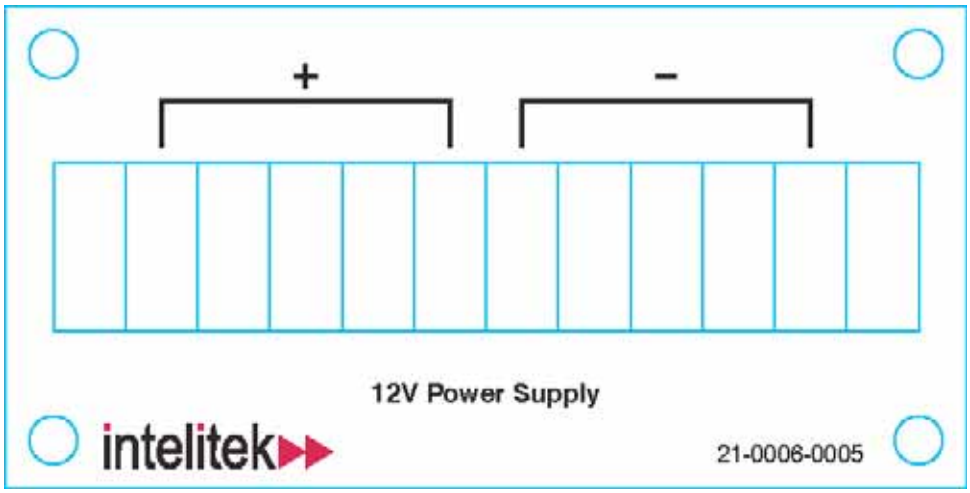
DO NOT DISASSEMBLE THE STACK LIGHT UNIT

If you have Questions, ASK a contest official.

Hardware connections - Power Supply (12 Volt DC)

+12 Volts DC current with common ground is used to power all devices in the work cell. The power supply is connected a terminal strip that can be located anywhere on the table.

DO NOT USE THE POWER SUPPLY ON THE CONTROLLER



Note: The above unit (12 V Power Supply) and the Controller each have their own power supplies.

Since there are multiple power supplies, one powering the device that produces a signal and the other apart of the device that accepts a signal they must have a common ground, a common reference between all power supplies.

Hardware connections - Sensor Box

Wiring

DO NOT OPEN SENSOR BOX

- The Sensor Box contains an Inductive Proximity Sensor and Micro-switch
- **All connections are made to the Terminal strip on the outside of the sensor box.**

Terminal Strip connections:

Inductive Proximity (Prox) Sensor:

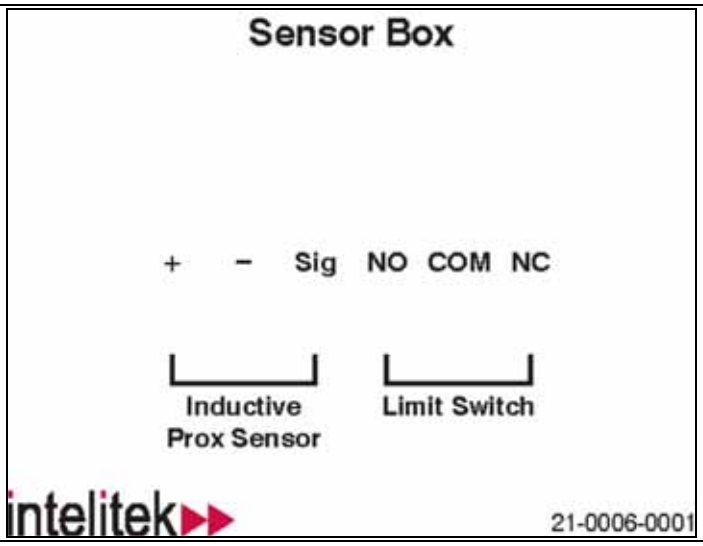
+	12 Volts DC (Power for the Inductive Proximity Sensor)
-	Ground (Common)
SIG	Output Signal (to controller input)

Limit Switch

NO	- Normally Open Contact
COM	- Common
NC	- Normally Closed Contact

DO NOT OPEN SENSOR BOX

If you have Questions, please ASK a contest official.



Hardware connections - Conveyor - Photo Sensor

13.1: Conveyor Sensor

Connect attached power supply to a 115 volt AC source.
Connect the remaining leads to an Input and Ground on the controller (Inputs).
The leads are polarity sensitive

Software - Conveyor Control - Sample SCORBASE Software program

In order for the conveyor to stop correctly, please use the following commands in your program.

```
Start Conveyor Axis 8 at Speed 5 in Plus Direction
Enable Input Interrupt 6
On Input Interrupt 6 On Call Subroutine STOP_CONVEYOR
Wait 100 (10ths of seconds)
.
.
Set Subroutine STOP_CONVEYOR
Stop Conveyor Axis 8
Return from Subroutine
```

Sample Program and Subroutines

In this example:

- **Positions 12 and 13 – Parts are above the conveyor.**
- **Positions 2 and 3 – Parts are on the conveyor.**
- **Photo Sensor is connected to input 6.**
- **Conveyor is connected to Axis 8.**

Program example:

```
Remark: **** Place part on Conveyor ****
Go to Position 12 Speed 5
Go to Position 2 Speed 5
Open Gripper
Go to Position 12 Speed 5
Start Conveyor Axis 8 at Speed 5 in Plus Direction
Enable Input Interrupt 6
On Input Interrupt 6 On Call Subroutine STOP_CONVEYOR
Wait 100 (10ths of seconds)
.
. The rest of the main program
.
.
Remark: ***Subroutine's start here***
Set Subroutine STOP_CONVEYOR
Stop Conveyor Axis 8
Go to Position 13 Speed 5 Position 13 – part is above the conveyor
Go Linear to Position 3 Speed 5 Position 3 – part is above the conveyor
Close Gripper
Go Linear to Position 13 Speed 5
Return from Subroutine
```

Notes: If using subroutines, they must be at the end of the program. Any remarks must be within the subroutines.

Required Documentation

ACCEPTABLE FLOW CHART SYMBOLS

Quite often, when employed by a Company or a Corporation, anything that you produce belongs to them. The corporation owns the patents and copyrights. Therefore, complete documentation is quite essential. You may think that keeping the knowledge to yourself is job security but at some time in your career you could be the recipient of an undocumented system. In this situation you will want all the documentation you can find. Document your work completely.

1. The Flow Chart symbols must be the symbols provided on the next page. Straight lines should be drawn with a straight edge. The program must start and stop with a Terminator symbol. Continuations without lines must use Connectors with identifying characters such as (A, b, 1 or 2 etc.). Use these symbols to develop your Flow Chart.

2. The symbols are representative of the required shapes. You may change the size to meet your needs.

3. Use a straight edge to draw the symbols.

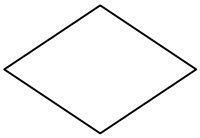
4. Be neat. If the judges can't read them they can't score them. Points lost.

5. Your Flow Chart and Robot Program must coincide. The Flow Chart/Robot Program scoring will be based on how well you designed your Flow Chart before you started developing your Robot Program.

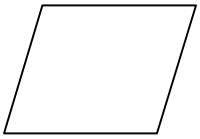
FLOW CHART SYMBOLS

Process

Alternate Process

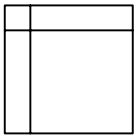


Decision



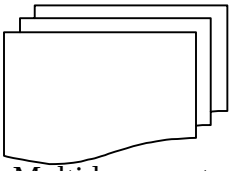
Data

Predefined Process



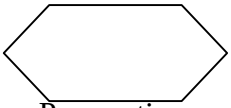
Internal Storage

Document

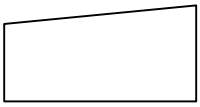


Multidocument

Terminator

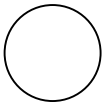


Preparation



Manual Input

Manual Operation



Connector Junction

Required Documentation - Safety Issues

Describe any safety issues that are of concern when running the robot program.

Required Documentation – PROGRAM FLOW CHART

Draw a flowchart of the Robot program. Use a straight edge. Be complete, neat and legible.

Total Points_____

See judges or instructor for additional copies.

Required Documentation – ROBOTIC WORKCELL LAYOUT

Draw a sketch of the hardware layout of your system. Use a straight edge. Be complete, neat and legible.

Total Points_____

Required Documentation – CONTROLLER INPUT ASSIGNMENTS

Document what is connected to each input on the controller interface. The judges must be able to read and understand what is connected to each input of the controller interface. ***(This must be completed before you receive a power cord for the DC power supply).***

1. _____
2. _____
3. _____
4. _____
5. _____
6. _____
7. _____
8. _____

Notes:

Required Documentation – CONTROLLER OUTPUT ASSIGNMENTS

Document what is connected to each output on the robot controller. The judges must be able to read and understand what is connected to each output of the controller interface. They should also be able to look at the device and see the wire color etc. ***(This must be completed before you receive a power cord for the DC power supply).***

Output #1	NO	_____
	COM	_____
	NC	_____
Output #2	NO	_____
	COM	_____
	NC	_____
Output #3	NO	_____
	COM	_____
	NC	_____
Output #4	NO	_____
	COM	_____
	NC	_____
Output #5	NO	_____
	COM	_____
	NC	_____
Output #6	NO	_____
	COM	_____
	NC	_____
Output #7	NO	_____
	COM	_____
	NC	_____
Output #8	NO	_____
	COM	_____
	NC	_____

Required Documentation – WORKCELL DEVICE CONNECTIONS

Describe what is connected to each device. The judges must be able to read and understand what is connected to each device.

Stack Light

COM _____

Red _____

Yellow _____

Green _____

Blue _____

Sensor Box - Inductive Prox Sensor

\+ _____

\- _____

Sig _____

Limit Switch

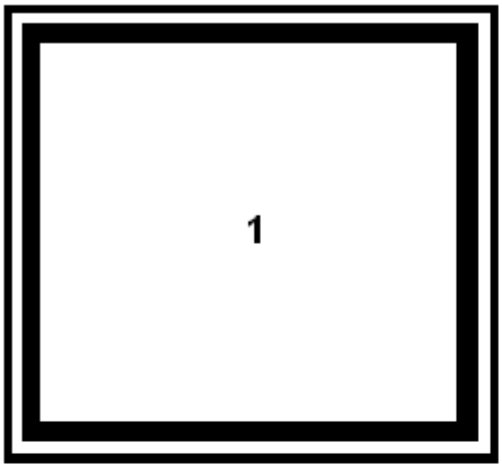
NO _____

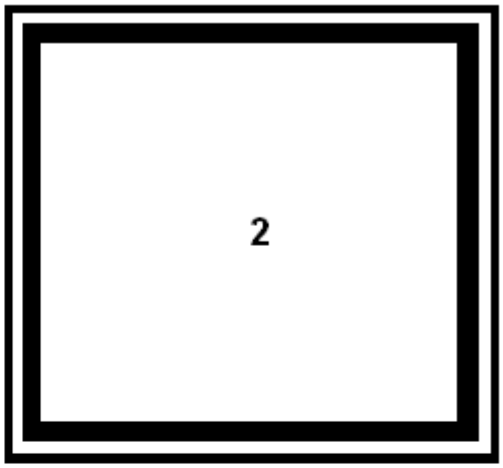
COM _____

NC _____

Attachment 1 – Metal Parts Storage
Attachment 2 – Plastic Parts Storage

Plastic Parts - Hole facing up

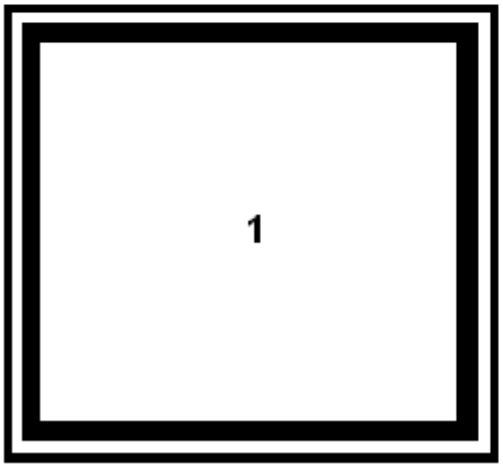


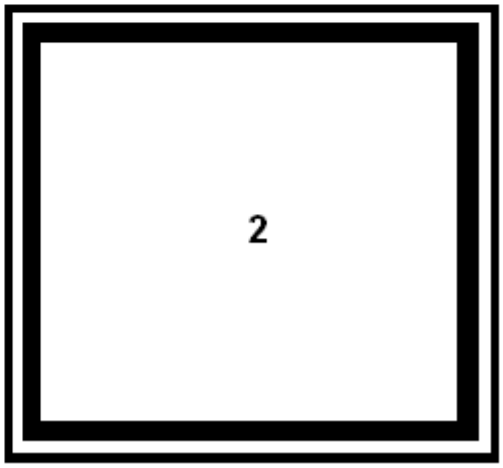


All Parts must fit inside each bin.

Intelitek - Skills USA Competition

Metal Parts - Hole facing up





All Parts must fit inside each bin.

Intelitek - Skills USA Competition

SkillsUSA
2010 Contest Projects

Screen Printing Technology

Click the “Print this Section” button above to automatically print the specifications for this contest. Make sure your printer is turned on before pressing the button.

SkillsUSA 2010
Screen Printing Technology Performance Test Plan

Bartle Hall
Level 3, Exhibit Hall
Kansas City, Missouri

June 20-25, 2010

General Information
For
Technical Committee Members
Judges
State SkillsUSA Directors
Screen Printing Instructors
And
Contestants

Dr. Jesse L. Hudson
Aero Travel
2604 N. Free King Highway
Pittsburg, KS 66762
j.hudson6@cox.net
417 496 6585
620 231 0155

SkillsUSA 2010
Screen Printing Technology

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SkillsUSA 2010
Screen Printing Technology
Organizational Structure

I. Performance Test Chair and Co-Chair Responsibilities
   A. Coordinates details of organization.
   B. Reviews floor plans for performance test.
   C. Coordinates acquisition of equipment and supplies.
   D. Identifies and appoints judges.
   E. Assigns local committee members a list of needed supplies to have on hand on the day of the performance test: staples, pencils, marking pens, paper, and other consumable items.
   F. Arrange for security of performance testing area the evening before the day of the competition.

II. Technical Committee Responsibilities
   A. Selects competencies to be tested.
   B. Develops rating sheets.
   C. Completes preliminary instructions (scenario) and information sheets.
   D. Determines number of judges needed.
   E. Obtains names and addresses of judges.
   F. Determines materials, supplies, tools, and equipment needs for the performance test and identifies probable sources.
   G. Prepares a complete set of instructions in the form of scenarios.
   H. Determines the layout for the performance test area.
   I. Sets a time schedule for contestants.

III. Education Committee Responsibilities
   A. Work with the technical committee to protect the validity of the performance test.
   B. Reviews performance test content for accuracy and relevancy.

IV. Judges Responsibilities
   Judges must attend an orientation session prior to the start of the performance test.
   Contestants should be allowed to become familiar with the competency testing station with regard to the instructions in the performance test scenario.

SkillsUSA 2010
Screen Printing Technology
Contacts:

Jesse L. Hudson
Aero Travel, 2604 N. Free King Highway, Pittsburg, KS 66762
j.hudson6@cox.net
417 496 6585
620 231 0155

SkillsUSA Screen Printing Technology competition corporate contacts and confidential testing materials are listed in the appendices.

SkillsUSA 2010
Screen Printing Technology
Judges and Timekeepers Directory

Chair
Jesse L. Hudson
Aero Travel
2604 N. Free King Highway
Pittsburg, KS 66762
j.hudson6@cox.net
417 496 6585
620 231 0155

Co-Chair
Susan Major
HIX Corporation
1201 E. 27th Terrace
Pittsburg, KS 66762
smajor@hixcorp.com
620 231 8568 Ext. 251
620 231 1598 FAX

Inspection and Tensioning Station Judge
Betty Bassett
Classic Designs Screen Printing
160 E. Jackson Street
Ridgeland, MS 39157
printwomen@aol.com
601 966 5166 Work and Cell

Inspection and Tensioning Station Timekeeper
Bryan Schaffner
Education Comm. Member
400 GW Lane
Waynesville, MO 65583
bschaffner@waynesville.k12.mo.us
573 774 6106 School **573 528 5002 Cell**

Exposure & Washout Station Judge
Chris Blancho
HIX Corporation
1201 E. 27th Terrace
Pittsburg, KS 66762
cblancho@hixcorp.com
620 231 8568 Ext. 263
620 249 6816 Home

Exposure & Washout Station Timekeeper
Sabra Whittenburg
Education Comm. Member
30 N. Sandy
Greenland, AR 72737
swhittenburg@greenland.k12.ar.us
479 521 2366 Ext. 229
479 643 3174 Home **479 601 2899 Cell**

Registration Station Judge
James Ortolani
HIX Corporation
1201 E. 27th Terrace
Pittsburg, KS 66762
jortolani@hixcorp.com
620 231 8568 Ext. 230 Work
620 719 0883 Cell

Registration Station Timekeeper
Regina Gossett
Education Comm. Member
3203 Oak Grove Road
Poplar Bluff, MO 63901
rgossett@pb.k12.mo.us
573 785 2248 School **Cell**
573 785 4168 FAX

Screen Coating Station Judge
This Station will be inactive in 2010

Screen Coating Station Timekeeper
This Station will be inactive in 2010

Block-Out Station Judge
This Station will be inactive in 2010

Block-Out Station Timekeeper
This Station will be inactive in 2010

Reclaiming Station Judge
This Station will be inactive in 2010

Reclaiming Station Timekeeper
This Station will be inactive in 2010

SkillsUSA 2010
Screen Printing Technology
Judges and Time Keepers Information

Shirt Printing Station Process Judge
Harold Johnston
NASMA, Exec. Director
9800 N. Wayne Avenue.
Kansas City, MO 64155
harold-johnston@att.net
816 506 1686 Cell
816 734 5382 FAX/Home

Shirt Printing Station Assistant
Howard Bunnell
NASMA
TBA
Kansas City, MO
hbunnell@kc.rr.com
TBA Cell
816 734 5607

Quality Control Problem Judge
David Granschow
Absolute Graphix
98 Blue Declair
Sparks, NV 89434
No e-mail address
775 770 0065 Cell

Quality Control Problem Timekeeper
Bryan Schaffner
Education Comm. Member
400 GW Lane
Waynesville, MO 65583
bschaffner@waynesville.k12.mo.us
573 774 6106 School **573 528 5002 Cell**

Secondary Competition on Wed. June 23, 2010, 8:00 AM to 4:45 PM.

Oral Professional Assessment Judge
Rick Hicks
NazDar Consulting Services
8501 Hedge Lane Terrace
Shawnee, KS 66227
Rhicks@nazdar.com
913 422 1888 Work Ext. 2363
913 205 0571 Cell

Test Scores Collector
Bryan Schaffner
Education Comm. Member
400 GW Lane
Waynesville, MO 65583
bschaffner@waynesville.k12.mo.us
573 774 6106 School **573 528 5002 Cell**

Post-Secondary Competition on Wed. June 23, 2010, 8:00 AM to 4:45 PM.

Oral Professional Assessment Judge
Bruce Ridge
NazDar Consulting Services
8501 Hedge Lane Terrace
Shawnee, KS 66227
Bridge@nazdar.com
913 422 1888 Work Ext. 2377

Test Scores Collector
Bryan Schaffner
Education Comm. Member
400 GW Lane
Waynesville, MO 65583
bschaffner@waynesville.k12.mo.us
573 774 6106 School **573 528 5002 Cell**

SkillsUSA 2010
Screen Printing Technology
Judges and Time Keepers Information

Technical Knowledge Test Administrator
Jesse L. Hudson
Aero Travel
2604 N. Free King Highway
Pittsburg, KS 66762
j.hudson6@cox.net
620 231 0155 Home
417 496 6585 Cell

Technical Knowledge Test Scorer
Rebecca S. Hudson
Scoring Auditor
2604 N. Free King Highway
Pittsburg, KS 66762
Aerotravelpts@aol.com
620 231 0155 Home
620 875 6014 Cell

Performance Test Scoring Auditor
Rebecca S. Hudson
Scoring Auditor
2604 N. Free King Highway
Pittsburg, KS 66762
Aerotravelpts@aol.com
620 231 0155 Home
620 875 6014 Cell

Test Scores Collector
Vivian McCormick
Director Emeritus Kansas SkillsUSA
P. O. Box 53, Five Mile Road
Baxter Springs, KS 66713
tvfarm@junct.com
918 541 9255 Home

Timekeeper in Reserve
Pat Hoover
Education Comm. Member
2931 N. 69th
Kansas City, KS 66109
phoover@kc.rr.com
913 334 0224 Home
913 709 6702 Cell

Timekeeper in Reserve
Martha R. Brooks
Education Comm. Member
22431 179th St.
Tonganoxie, KS 66086
marthabrooks@hughes.net
816 863 6697 Cell
913 724 1473 Home

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SkillsUSA 2010
Screen Printing Technology
Judges Information

1. Do not ask students their names or where they are from.
2. Information about performance test needs to be given to students at the orientation, which is usually given by the performance test chair or coordinator.
3. Be as consistent as possible and avoid being too generous or conservative when the testing first begins.
4. Judges should not see another judge's ratings. A scorekeeper should add up the total score for each competency being tested. Each contestant's score should be tallied after they complete their performance and the judge has rated their product.
5. If a problem should arise the judge should attempt to solve the problem with minimal disruption of the testing process. Avoid giving the appearance of being helpful to a contestant while attempting to solve a problem that would cost the contestant performance points.
6. Tools: If a contestant forgets tools, **judges** are not there to be the "helper". Bringing needed tools is the contestant and their school advisor's job. Do not stall the performance testing process because one contestant did not bring a needed tool.
7. Judges need to know the performance test rules. States are to follow the rules set forth in the SkillsUSA Technical Standards. If a state deviates from the SkillsUSA Technical Standards the contestants must be told, in advance of entering the competition, about the changes.
8. Judges are not permitted to answer cell phones or beepers during a timed performance test.
9. If a judge encounters a problem tell the performance test coordinator as soon as practicable.
10. Judges should wear a judge's badge.
11. Judges should try to put contestants at ease.
12. Judges should not laugh at a contestant's performance.
13. Judges should use appropriate language to contestants.
14. Judges should avoid coming in contact with a contestant's person. Hand shaking is permissible.
15. Judges must avoid telling contestants they are winning or losing.

16. Judges who observe cheating should report the cheating to the contest coordinator. Cheating cannot be permitted and the incident must be reported to the State SkillsUSA Director.
17. Judges are role models to contestants; therefore, every effort should be made to avoid visits with instructors or contestants who have an interest in the competition.
18. Judges are asked to complete a judge information sign-in log by listing their name, address, town, Zip, telephone number and company name. Please tell the contest coordinator if you know in advance that you will be able to judge in the succeeding year.
19. Judges are asked to submit their name and communication information. Personal data is to be used for such as thank you letters and certificates of appreciation. Please help by submitting your personal data to the contest coordinator.

Thank you in advance for your selfless service as a judge of the SkillsUSA Screen Printing Technology Competition.

SkillsUSA 2010
Screen Printing Technology
Contestant Information Sheet

A. Purpose
To rate a screen-printing contestant's preparation for employment and to recognize outstanding contestants for excellence and professionalism in the field of graphic imaging.

B. Clothing Requirements
Established by the SkillsUSA general contest requirements.
An apron or smock is optional.
Contestants should consider safety glasses with side shields, ear protection and latex gloves in some of the operational areas such as screen reclaiming.

C. Eligibility
Open to all active SkillsUSA members enrolled in technical education programs that teach graphic communications skills.

D. Tools
The technical committee will provide the tools needed at each competency testing station.
Contestants may use rulers, rags, optical devices, markers and other items that they feel will enhance their performance.

E. The SkillsUSA Screen Printing Technology Scorecard lists three items that will not be evaluated during the current competition.
These three items are as follows:
1. Screen Coating
2. Screen Blockout
3. Screen Reclaiming
Therefore, the points for each of these three evaluation items will be recorded on the Screen Printing Technology Scorecard for every Screen Printing Technology Contestant.
The Assignment and Rating Sheets for these three performance-testing areas are included in this Performance Test Plan. The sheets have been included in this plan because Graphics Communications Students and Instructors may wish to refer to these sheets at some **future** time when screen printing performance testing procedure are needed at a local, district, state or **National Competition**.

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SkillsUSA 2010
Screen Printing Technology
Scope of the Test

I. Contestants will demonstrate their abilities to perform the duties and tasks that pertain to the following list of items that may be evaluated. The precise number of duties and tasks required for a competent performance of a screen-printing process will be determined by the Screen Printing Technology Technical Committee with **the level of skill** left to the professional judgment of the Screen Printing Technology Judges.
   A. Screen Preparation (Inspection & Tensioning)
   B. Screen Coating
   C. Screen Exposure & Washout
   D. Screen Blockout
   E. Image Registration
   F. Image Printing
   G. Screen Reclaiming
   H. Quality Control Problem
   I. Written Knowledge Test
   J. Oral Professional Assessment

II. This list of items that may be evaluated is taken from the Screen Printing Technology Scorecard. As listed on the Screen Printing Technology Scorecard each of the ten evaluation items listed above have an attending number of possible points. Performance testing station checklists may generate points in more than one of the ten evaluation areas. (Example: Image Registration and Image Printing will test some of the same screen-printing skills. The testing of these identical skills will contribute points to a composite score on the Screen Printing Technology Scorecard.)
   A. Screen Preparation, Inspection & Tensioning
      Inspect screens entering production.
      Check screen tension with a tension meter and retension if needed
   B. Screen Coating
      Evaluation of this item at the state level is optional. It will be not be evaluated at the national level in 2010.
      Select and prepare emulsion scoop
      Fill emulsion scoop coater
      Coat screen with emulsion
      Evaluate screen for acceptable tolerances
      Place coated screen in a screen dryer

C. Screen Exposure and Washout
Select the **black** film positive from an art file
Inspect the film positive for dirt and marks
Obtain a screen coated with emulsion from screen dryer
Inspect and protect screen from excess light
Center **black** film positive on screen **6 1/4** inches from frame bottom
Secure the film positive to the screen
Place screen and film positive on an exposure unit
Expose screen
Remove film positive
Washout the unexposed emulsion on a screen to create an image stencil
Remove excess water
Dry screen

D. Screen Blockout
Evaluation of this item at the state level is optional. It will be not be evaluated at the national level in 2010.
Use blockout fillers and tape to cover areas on the screen where plastisol could be printed on the image in an area that would produce a shirt that could not sold to a customer.

F. Image Registration
Place screen on the press
Coarse register to image printed at this press station (Note do not remove the blockout tape from the registration marks)
Check shirt boards for proper adhesion
Select adhesive by type
Apply adhesive to shirt boards for proper adhesion
Inspect contact side of screens for excess ink
Test screen off contact
Print test image on a rag or other substrate to check for correct registration
Fine register to image printed at this press station
Print proof image on two shirts
Place shirts in dryer

G. Image Printing
Check shirt boards for proper adhesion
Select adhesive by type
Apply adhesive to shirt boards for proper adhesion
Inspect contact side of screens for excess ink
Inspect all screens for off contact
Check ink supply on each screen
Check registration of all screens
Squeegee selection and inspection for hardness and damage
Print image on shirts
Place shirts in dryer

H. Screen Reclaiming

Evaluation of this item at the state level is optional. It will be not be evaluated at the national level in 2010.

Remove excess ink
Remove block-out filler and tape
Apply emulsion remover
Blow out emulsion with high pressure hot water
Use scrub brush where needed
Use environmentally safe chemicals and procedures

I. Quality Control Problem

Study technical specifications contained in the Tech Pack
Study the quality assurance worksheet scenario and inspection steps
Inspect a quality assurance sample of five garments

J. Written Test

Answer a minimum of 25 multiple-choice screen-printing technology questions.
Complete the test in the allotted fifteen (15) minutes

K. Oral Professional Assessment

Communicate in a job interview setting, which requires technical knowledge, career objective, professional judgment, and courtesy.

III. When a contestant has completed an assigned job the contestant is to be seated in the chair provided at that testing station to stop the time. After the judge and timekeeper have completed rating the contestant's performance and procedure the contestant will be notified. The judge will gather the completed project and rating form and submit it to the scorekeeper for tabulation and posting on a **Screen Printing Technology Scorecard**.

Each contestant will work independently without assistance from judges, instructors, fellow contestants, or observers. Such assistance may result in the contestant being disqualified.

IV. Contestants should perform minor testing station maintenance: such as clean up, tool and materials placement. Testing station maintenance is an item that will be evaluated by all testing station judges.

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SkillsUSA 2010
Screen Printing Technology
Screen Preparation

Screen Inspection and Tensioning Assignment

Objective:
Inspect and test three retentionable screens with stencils that are reentering production from storage. This inspection is made to determine if company production standards are being met. Special attention is to be given to screen tension. Tension tolerances are specified in the performance test scenario written at the top of the screen preparation **(tensioning)** station checklist. **Note: Screen mesh tension shall not vary by more than a plus or minus 5 Newtons at center of screen.**

Caution: Do not continue to tighten screws that are crooked or jammed. A jammed screw on any frame corner will prevent completion of the tensioning process and result in zero (0) points for this portion of your Screen Printing Technology Performance Test.

Screen inspection and tension testing instructions:
1. Obtain Screen Preparation (Inspection and Tension) Checklist from the station timekeeper.
2. Read the scenario written on the checklist.
3. Move to inspection and tension testing station.
4. Inspect and test screen # 1. Place a check mark to indicate either accept or reject.
5. Record the screen tension **number** as either **accept** or **reject**.
6. Move to screen # 2.
7. Inspect and test screen # 2. Place a check mark to indicate either **accept** or **reject**.
8. Record the screen tension **number** as either **accept** or **reject**.
9. Move to screen # 3.
10. Inspect and test screen # 3. Place a check mark to indicate either **accept** or **reject**.
11. Record the screen tension number as either **accept** or **reject**.
12. Submit your inspection report to the judge.
13. Move to screen # 4.
14. Tension and test screen # 4.
15. Place the tensioning tools back in their proper place on the workstation bench.
16. Return to the Inspection and Tension Station starting position.

Judging:
A screen printer will use the screen preparation **(inspection and tension)** checklist, reproduced on the following page, to judge the contestant's performance.

Time:
A timekeeper will control the time each contestant is allotted for the completion of the screen inspection and tension testing procedure. A maximum of fifteen (15) minutes is allocated to the procedure.

Points:
Contestants earn four (4) points for each inspection check mark that is recorded on the correct blank as an **accepted** or **rejected** inspection for items one (1) through four (4). Inspection item five (5), for each of the three (3) screens, requires the **number** of **Newtons** read from a tension meter be recorded as either **accepted** or **rejected.** A maximum of sixty (60) points may be given to contestants for the screen inspections.
A maximum of forty (40) points may be given to contestants for the screen tensioning performance.

Screen Preparation (Inspect and Tension) Checklist

Contestant Identification: _____Time Used: _____.

Scenario: Inspect and test the tension on three (3) screens. The standard tension is 25 Newtons with a tolerance of + or - 5. Use the items listed on this checklist to inspect and determine if screens one (1), two (2) and three (3) meet production standards. **Do not retention screen that have stencils.**
Then tension the fabric (mesh) on screen number four (4) to 25 Newtons at the screen's center.

Instructions for Judge's Scoring

Process Evaluation Criteria: Evaluation of the process involves how accurately the contestant performed with each screen. Depending on the placement of check marks and tension measurements for each of three inspection screens, award points of zero or four for each correct check mark and zero to four for the tension readings. Judges shall deduct one (1) point for each one (1) Newton of difference from the tension reading listed on the judging KEY. Tensioning screen number four (4) will require the judge to award 0 to 4 points for each tensioning operation listed while the contestant is working. Four (4) points may be awarded to contestants on each of the 25 lines provided in the Judges Scoring Box.

Contestants Rating for Performance of the Inspection Process:

Screen 1 Inspection and Tensioning Reports	**Accept**	**Reject**
1. Screen frame is free of damage.	_____	_____
2. Screen is free of cuts, splits or punctures.	_____	_____
3. Stencil is free of holes that could leak ink.	_____	_____
4. Screen mesh is not clogged in the image area.	_____	_____
5. Screen tension readings. **(Record Newtons)**	_____	_____
Screen 2 Inspection and Tensioning Reports	**Accept**	**Reject**
1. Screen frame is free of damage.	_____	_____
2. Screen is free of cuts, splits or punctures.	_____	_____
3. Stencil is free of holes that could leak ink.	_____	_____
4. Screen mesh is not clogged in the image area.	_____	_____
5. Screen tension readings. (**Record Newtons**)	_____	_____
Screen 3 Inspection and Tensioning Reports	**Accept**	**Reject**
1. Screen frame is free of damage.	_____	_____
2. Screen is free of cuts, splits or punctures.	_____	_____
3. Stencil is free of holes that could leak ink.	_____	_____
4. Screen mesh is not clogged in the image area.	_____	_____
5. Screen tension readings. (**Record Newtons**)	_____	_____

Before proceeding with tensioning screen number four (4) submit your inspection report to the judge.

Screen 4 Tensioning

1. Inserted tension jacks at screen frame bottom. _____
2. Loosened bottom frame screws. _____
3. Used tension jacks to tighten screen fabric. _____
4. Softened bottom screen corners. _____
5. Tightened frame bottom screws. _____
6. Repeated steps 2, 3, 4, and 5 at top and sides. _____
7. Checked screen frame corners for square. _____
8. Removed tension meter from protective case. _____
9. Tensioned screen center to 25 Newtons. _____
10. Replaced tension meter in protective case. _____

Judge's Signature _____

Judges Scoring Box

60 Points Possible

_____
_____
_____
_____
_____
Sub Total _____

_____
_____
_____
_____
_____
Sub Total _____

_____
_____
_____
_____
_____
Sub Total _____

Inspection Total _____

40 Points Possible

_____
_____
_____
_____
_____
_____
_____
_____
_____
_____
Sub Total _____

Tensioning Total _____

Station Total

SkillsUSA 2010
Screen Printing Technology
Screen Coating

Screen Coating Assignment

The Screen Coating Station will not be part of the 2010 Screen Printing Technology Performance Test. All Contestants will automatically receive 50 points on the Screen Printing Technology Scorecard. This action is taken to afford more time for the testing of additional contestants.

Objective:
Inspect five (5) screens and identify screens that best meet the needs of your company that are set forth in the screen-printing technology performance test scenario. The coated screens that you identify must meet the needs of the printing operations required to produce a saleable lot of garments, plus meet the standards established by the screen-printing industry.

Screen coating station procedure instructions:
1. Inspect screens for correct mesh count.
2. Inspect screen mesh and reject screens that are damaged.
3. Test the screens for proper tension.
4. Inspect the unexposed emulsion for defects that would render it unusable for your company's printing operation.
5. Inspect the unexposed screens emulsion for acceptable thickness.
6. Avoid excess light exposure to each screen's unexposed photosensitive emulsion.
7. Place a check mark to indicate, acceptance or rejection, by each of the ten criterion points on the screen coating worksheet for each of the five (5) screens.
8. Return each screen to the screen dryer after your inspection.
9. Place the screens in the screen dryer in the same place in which you found them.
10. Submit your screen coating worksheet to the judge for scoring.

Judging:
A screen printer will use the screen coating station worksheet, reproduced on the following page, to judge the contestant's performance, procedure and product.

Time:
A timekeeper will record the time each contestant needed to complete the inspection and selection procedure of five screens. A maximum of fifteen (15) minutes is allocated to the inspection and selection procedure.

Points:
A maximum of one hundred (100) points may be given to the contestant for a standard screen coating performance.

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Screen Coating Inspection Worksheet

Contestant Identification: _____ Time Started: _____

Scenario: You have been given the task of inspecting five (5) screens and selecting screens that meet the needs of a screen-printing job for which a company has taken a contract. You have been instructed to use the ten (10) criterion points listed on this worksheet for each of five (5) screen to determine if any or all screens meet printing operational requirements to produce a saleable lot of garments and meet industry standards.

==========

This screen coating inspection worksheet has a rating scale for each of five (5) direct emulsion coated screens. The rating given to each of the ten (10) criterion points will be earned by checking either **accept** or **reject** blank provided. Your decision to accept or reject a coated screen criterion point will be based on the standards set by your company's customer. If a screen receives a rejection on any one of the ten criterion points, that screen will be considered as not useable and should be reclaimed. The company's screen preparation department has five (5) screens that have been coated and are believed to be ready for exposure and washout to produce stencils for use on the company's manual rotary press. Screens must have a mesh count between 148 and 195 and tensioned between 23 and 27 Newtons. There may or may not be screens that could be used to produce high quality stencils.

After you have evaluated a screen place it back into the screen dryer in the same position from which the screen was taken.

Evaluation Criteria: Depending on the degree of quality for each screen criterion point listed below award one or zero points.

Total Points Possible (50)

Screen 1 Inspection Points	**Accept**	**Reject**
1. Mesh count is between 148 and 195.	_____	_____
2. Screen mesh is not damaged.	_____	_____
3. Screen tension is between 23 and 27 Newtons.	_____	_____
4. Screen is coated with direct emulsion.	_____	_____
5. Emulsion coating is dry.	_____	_____
6. Emulsion thickness will not leave mesh marks.	_____	_____
7. Emulsion does not have pinholes.	_____	_____
8. Emulsion smooth and even on contact side	_____	_____
9. Emulsion smooth and even on squeegee side	_____	_____
10. Screen frame is not damaged or out of square.	_____	_____

Screen 2 Inspection Points	**Accept**	**Reject**
1. Mesh count is between 148 and 195.	_____	_____
2. Screen mesh is not damaged.	_____	_____
3. Screen tension is between 23 and 27 Newtons.	_____	_____
4. Screen is coated with direct emulsion.	_____	_____
5. Emulsion coating is dry.	_____	_____
6. Emulsion thickness will not leave mesh marks.	_____	_____
7. Emulsion does not have pinholes.	_____	_____
8. Emulsion smooth and even on contact side	_____	_____
9. Emulsion smooth and even on squeegee side	_____	_____
10. Screen frame is not damaged or out of square.	_____	_____

Worksheet continues on the back of this page.

Screen 3 Inspection Points	**Accept**	**Reject**
1. Mesh count is between 148 and 195.	_____	_____
2. Screen mesh is not damaged.	_____	_____
3. Screen tension is between 23 and 27 Newtons.	_____	_____
4. Screen is coated with direct emulsion.	_____	_____
5. Emulsion coating is dry.	_____	_____
6. Emulsion thickness will not leave mesh marks.	_____	_____
7. Emulsion does not have pinholes.	_____	_____
8. Emulsion smooth and even on contact side	_____	_____
9. Emulsion smooth and even on squeegee side	_____	_____
10. Screen frame is not damaged or out of square.	_____	_____

Screen 4 Inspection Points	**Accept**	**Reject**
1. Mesh count is between 148 and 195.	_____	_____
2. Screen mesh is not damaged.	_____	_____
3. Screen tension is between 23 and 27 Newtons.	_____	_____
4. Screen is coated with direct emulsion.	_____	_____
5. Emulsion coating is dry.	_____	_____
6. Emulsion thickness will not leave mesh marks.	_____	_____
7. Emulsion does not have pinholes.	_____	_____
8. Emulsion smooth and even on contact side	_____	_____
9. Emulsion smooth and even on squeegee side	_____	_____
10. Screen frame is not damaged or out of square.	_____	_____

Screen 5 Inspection Points	**Accept**	**Reject**
1. Mesh count is between 148 and 195.	_____	_____
2. Screen mesh is not damaged.	_____	_____
3. Screen tension is between 23 and 27 Newtons.	_____	_____
4. Screen is coated with direct emulsion.	_____	_____
5. Emulsion coating is dry.	_____	_____
6. Emulsion thickness will not leave mesh marks.	_____	_____
7. Emulsion does not have pinholes.	_____	_____
8. Emulsion smooth and even on contact side	_____	_____
9. Emulsion smooth and even on squeegee side	_____	_____
10. Screen frame is not damaged or out of square.	_____	_____

Contestant Identification: _____ Time Finished: _____

Judge's Score Tallied Below This Line

	Screen 1	Screen 2	Screen 3	Screen 4	Screen 5		
Contestant ID	Correct	Correct	Correct	Correct	Correct	Checks	Problem
Identification	Checks	Checks	Checks	Checks	Checks	Total	Score

SkillsUSA 2010
Screen Printing Technology
Screen Exposure and Washout

Screen Exposure and Washout Assignment

Objective: Create an image on a screen in accordance with the instructions given at the screen exposure and washout station.

Screen exposure and washout station instructions:
1. Select needed film positive from art file
2. Check film positive's unmarked properties, clean the film positive if needed
3. **Position the <u>black</u> film positive on an unexposed emulsion coated screen with the registration marks (crosshairs) at the top and bottom center of the film positive on the screen's centerline. The registration mark (+) at the bottom of the film positive shall be positioned 6 1/4 inches from the outside edge of the frame at the bottom of the screen.**
4. Secure the film positive to the screen
5. Place the screen and film positive on the exposure unit
6. Expose the screen for approximately 3 **1/2** minutes
7. Remove film positive and return it to the art file
8. Place the exposed screen in a washout booth
9. Wet both sides of the exposed screen with warm water
10. Allow the unexposed emulsion to soak for a few seconds
11. Spray the unexposed area of the image with a low-pressure sprayer.
12. Washout all of the unexposed emulsion from the stencil
13. Remove the excess water from the screen
14. Check for emulsion binder (scum) left on the screen's washout areas
15. Place screen in a screen dryer rack

Judging:
A screen printer will use the screen exposure and washout station checklist to judge the contestant's performance, procedure and product.

Time:
A timekeeper will record the time each contestant needed to complete the screen exposure and washout procedure. A maximum of fifteen (15) minutes is allocated for the screen exposure and washout procedure.

Points:
A maximum of one hundred (100) points may be given to the contestant for a screen-printing stencil procedure that meets industry standards.

Screen Exposure and Washout Station Checklist

Contestant Number: _____ Time: _____

Directions: This is a performance evaluation sheet to rate a contestant on a scale of 0 to 4 and 0 to 5 for various items in relation to an occupational competency (skill). This instrument can be used for process, product, safety and time standard evaluations.

Process Evaluation: Evaluation of this process involves exposing a screen-printing screen with an ultra-violet exposure unit and washout of unexposed emulsion to create a stencil.

	80 Points Possible				
Contestants Rating for Performance of the Process:	**Zero**	**One**	**Two**	**Three**	**Four**
1. Selected needed film positive from art file.	____	____	____	____	____
2. Inspected film positive for dirt or marks.	____	____	____	____	____
3. Cleaned film positive and exposure unit glass, if needed.	____	____	____	____	____
4. Took an unexposed screen from screen dryer.	____	____	____	____	____
5. Placed and aligned the film positive on the screen.	____	____	____	____	____
6. Taped the film positive to the screen.	____	____	____	____	____
7. Checked exposure unit for correct exposure time.	____	____	____	____	____
8. Placed screen and film positive on the exposure unit.	____	____	____	____	____
9. Placed bleeder cord on screen and closed exposure unit lid.	____	____	____	____	____
10. Checked exposure unit timer for correct preset time.	____	____	____	____	____
11. Turned on exposure unit and vacuum pump power.	____	____	____	____	____
12. Checked exposure unit for proper blanket vacuum.	____	____	____	____	____
13. Exposed the screen.	____	____	____	____	____
14. Turned off exposure unit to allow vacuum release.	____	____	____	____	____
15. Opened the exposure unit lid.	____	____	____	____	____
16. Transferred screen to washout booth and wet both sides.	____	____	____	____	____
17. Washed out the unexposed emulsion to create a stencil.	____	____	____	____	____
18. Blotted excess water from stencil and inspected for scum.	____	____	____	____	____
19. Placed screen in screen dryer rack.	____	____	____	____	____
20. Cleaned up the testing station.	____	____	____	____	____

Product Evaluation: Evaluation of the dried screen in accordance with the following points scale;

0 – reject, 1 -- very poor, 2 -- fair, 3 -- good, 4 -- very good, 5 – excellent

Contestants Product Points **(20 Possible)**.	**Zero**	**One**	**Two**	**Three**	**Four**	**Five**
1. Image was centered and not crooked.	____	____	____	____	____	____
2. Image could be registered.	____	____	____	____	____	____
3. Screen was properly exposed.	____	____	____	____	____	____
4. Screen was properly washed out and dried.	____	____	____	____	____	____

Total Points Earned _____

Judge's Signature _____

SkillsUSA 2010
Screen Printing Technology
Screen Block Out

Screen Block Out Assignment

The Screen Block Out Station will be not be part of the 2010 Screen Printing Technology Performance Test. All Contestants will automatically receive 50 points on the Screen Printing Technology Scorecard. This action is taken to afford more time for the testing of additional contestants.

Objective:
Block out portions of a test screen where direct emulsion did not coat the screen fabric, or where the cured emulsion has a flaw such as a pin hole, scratch, cut or other defect that would allow plastisol to be applied to incorrect areas on a substrate during the printing process.

Screen Block Out station instructions:
1. Remove the test screen from the screen dryer.
2. Compare the number on the test screen to Contestant I D number.
3. Inspect Block Out station table for cleanliness and objects that could damage the test screen.
4. Place the test screen on the blackout station table.
5. Use block out tape to tape off the sides of the screen where emulsion is missing.
6. Use black out tape to tape off the top and bottom of the screen where emulsion is missing.
7. Create corner dams to prevent ink leaks.
8. Inspect test screen stencil for flaws, scum and orientation.
9. Use block out tape to tape off flaws such as pinholes.
10. Present test screen to the Block Out Judge for final check and evaluation.

Judging:
A screen printer will use the screen block out station checklist, reproduced on the following page, to judge the contestant's performance, procedure and product.

Time:
A timekeeper will record the time each contestant needed to complete the screen block out procedure. A maximum of fifteen (15) minutes is allocated to the screen block out procedure.

Points:
A maximum of fifty (50) points may be given to the contestant for a screen block out that meets industry standards.

Screen Block Out Station Checklist

Contestant Number: _____ Time: _____

Directions: This is a performance evaluation sheet to rate a contestant on a scale of 0 to 4 and 0 to 5 for various items in relation to an occupational competency (skill). This instrument can be used for process, product, safety and time standard evaluations.

Process Evaluation: Evaluation of the process involved with blocking out portions of a test screen where direct emulsion does not coat the screen fabric.

40 Points Possible

Contestants Rating for Performance of the Process:	**Zero**	**One**	**Two**	**Three**	**Four**
1. Removed the test screen from the screen dryer.	____	____	____	____	____
2. Compared test screen number to Contestant I D number.	____	____	____	____	____
3. Inspected station table for cleanliness and foreign objects.	____	____	____	____	____
4. Placed the test screen on the block-out station table.	____	____	____	____	____
5. Used block-out tape to tape off the sides of the screen.	____	____	____	____	____
6. Used block-out tape to tape off top and bottom of screen.	____	____	____	____	____
7. Created corner dams to prevent ink leaks.	____	____	____	____	____
8. Inspected test screen stencil for flaws, scum and orientation.	____	____	____	____	____
9. Used block-out tape to tape off flaws such as pinholes.	____	____	____	____	____
10. Presented screen to judge for final check and evaluation.	____	____	____	____	____

Product Evaluation: Evaluation of the dried screen in accordance with the following points scale;
0 – reject, 1 -- very poor, 2 -- fair, 3 -- good, 4 -- very good, 5 – excellent

Contestants Product Points **(10 Possible).**	**Zero**	**One**	**Two**	**Three**	**Four**	**Five**
1. Tape around frame is smooth and will not leak.	____	____	____	____	____	____
2. Flaws such as pinholes taped over and will not leak.	____	____	____	____	____	____

Total Points Earned _____

Judge's Signature _____

Image Registration Assignment

Objective:
Place a screen on a screen press and register the stencil image to screen stencils that have been registered and used to print an image on a substrate.

Image registration station instructions:
1. Remove the test screen from the reclaim area.
2. Do not remove block-out tape from the registration marks.
3. Print an image using the screen with darkest ink on a substrate.
4. Spot cure the dark image that is to be the registration reference.
5. Register the screen to an image that is being printed on the press.
6. Ink the screen.
7. Test the newly registered image by printing the multicolor image on the substrate provided.
8. Remove the test image from the press and place it on the conveyer dryer belt.
9. Print two (2) T-shirts.
10. Remove the T-shirts from the press and place them on the conveyer dryer belt.
11. Remove the test screen and place it by the reclaim sign on the worktable.

Judging:
A screen printer will use the image registration station checklist, reproduced on the following page, to judge the contestant's performance, procedure and product.

Time:
A timekeeper will record the time each contestant needed to complete the image registration procedure. A maximum of fifteen (15) minutes is allocated to the image registration procedure.

Points:
A maximum of one hundred (100) points may be given to the contestant for an image registration that meets industry standards.

Image Registration Station Checklist

Contestant Number: _____ Time: _____

Directions: This is a performance evaluation sheet to rate a contestant on a scale of 0 to 4 and 0 to 5 for various items in relation to an occupational competency (skill). This instrument can be used for process, product, safety and time standard evaluations.

Process Evaluation: Evaluation of the process involved with registering a screen-printing screen on a rotary press.

	80 Points Possible				
Contestants Rating for Performance of the Process:	**Zero**	**One**	**Two**	**Three**	**Four**
1. Took screen from reclaim area and attached it to the press.	____	____	____	____	____
2. Checked the rotary press head for zeroed out position.	____	____	____	____	____
3. Cleaned ink from mesh to allow view of printed images.	____	____	____	____	____
4. Registered to an image being printed at this station.	____	____	____	____	____
5. Checked screen for off contact and level.	____	____	____	____	____
6. Checked all screens and screen frames for unwanted ink.	____	____	____	____	____
7. Applied ink to screen being registered.	____	____	____	____	____
8. Selected appropriate squeegee.	____	____	____	____	____
9. Applied proper adhesive and amount to the platen.	____	____	____	____	____
10. Spot cure dark image that is the registration reference.	____	____	____	____	____
11.Flooded the newly registered screen with ink.	____	____	____	____	____
12.Printed registered image to a test image on substrate.	____	____	____	____	____
13.Checked test image for ink smears, pin holes, etc.	____	____	____	____	____
14.Cured the image in the conveyor dryer.	____	____	____	____	____
15.Printed two T-shirts with the multicolor image.	____	____	____	____	____
16.Dried the T-shirts in a conveyor dryer.	____	____	____	____	____
17.Removed test screen and placed it in reclaim area.	____	____	____	____	____
18.Cleaned work area of spills and drips. (If needed)	____	____	____	____	____
19.Submitted test image and T-shirts to the judge.	____	____	____	____	____
20.Completed registration procedure in allotted time.	____	____	____	____	____

Product Evaluation: Evaluation of the registered image in accordance with the following points scale;
0 – reject, 1 -- very poor, 2 -- fair, 3 -- good, 4 -- very good, 5 – excellent

Contestants Product Points **(20 Possible)**.	**Zero**	**One**	**Two**	**Three**	**Four**	**Five**
1. Test image was in registration.	____	____	____	____	____	____
2. All parts of the image printed.	____	____	____	____	____	____
3. Image was not blurred.	____	____	____	____	____	____
4. Ink smears do not appear in the image.	____	____	____	____	____	____

Total Points Earned _____

Judge's Signature _____

Image specifications (Tech Pack Page 1)

COMMENTS:	SUPPORT FILES (eps/tiff):	TECHNIQUE:	SEASON/GROUP: SKILLSUSA	DATE: 3/20/09
	None Needed	3 color flat print	DIVISION: TEES NATIONALS	GR.DESIGNER: Chris Huitt

Image specifications (Tech Pack Page 2)

PRINT ORDER
1 PANTONE 541 2 PANTONE 485 3 BLACK

SkillsUSA 2010
Screen Printing Technology
Image Printing

Image Printing Assignment

Objective:
Print and dry at least five (5) shirts within seven (7) minutes that are of salable quality.

Image printing station instructions:
1. Check the ink level in each screen.
2. Check the press shirt boards for proper adhesion.
3. Operate the printing press to print a multicolor image on shirts.
4. Spot cure after each image color **where printing wet on wet is not desirable**.
5. Place the shirts on the belt of a conveyor dryer.
6. Stack the printed shirts and give them to the judge
7. Remove ink smears from press, screens, squeegees, tools and image printing station area.

Judging:
A screen printer will use the image printing station checklist, reproduced on the following page, to judge the contestant's performance, procedure and product. Contestants may earn extra points by printing more than five (5) shirts within seven (7) minutes.

Time:
A timekeeper will record the time each contestant needed to complete the image printing procedure. A maximum of fifteen (15) minutes is allocated to the total image printing station procedure. Time stops when the contestant is seated.

Points:
A maximum of two hundred (200) points may be given to the contestant for a high quality image printing performance.

Image Printing Station Checklist

Contestant Number: _____ Time: _____

Directions: This is a performance evaluation sheet to rate a contestant on a scale of 0 to 8 and 0 to 20 for various items in relation to an occupational competency (skill). This instrument can be used for process, product, safety and time standard evaluations.

Process Evaluation: Evaluation of the process involves assessing how well a contestant can print shirts as well as how fast the shirts were printed on a rotary press.

	120 Points Possible				
Contestants Rating for Performance of the Process:	**Zero**	**Two**	**Four**	**Six**	**Eight**
1. Checked the ink level in each screen.	____	____	____	____	____
2. Checked shirt board for proper fabric adhesion.	____	____	____	____	____
3. Chose and applied proper adhesive type and amount.	____	____	____	____	____
4. Inspected all screens for off contact and cleanliness.	____	____	____	____	____
5. **Spot cured when printing wet on wet**.	____	____	____	____	____
6. Printed three salable T-shirts, 1 thru 3.	____	____	____	____	____
7. Skillfully placed each shirt in dryer.	____	____	____	____	____
8. Printed T-shirts, salable 4 thru 6.	____	____	____	____	____
9. Skillfully placed each shirt in dryer.	____	____	____	____	____
10. Printed T-shirts, salable 7 or more.	____	____	____	____	____
11. Skillfully placed each of the shirts in dryer.	____	____	____	____	____
12. Stopped printing when seven (7) minutes had elapsed.	____	____	____	____	____
13. Collected the printed shirts from the dryer basket.	____	____	____	____	____
14. Stacked printed shirts with the image up for judging.	____	____	____	____	____
15. Completed printing procedure in allotted time safely.	____	____	____	____	____

Product Evaluation: Using the printing technical specifications found in the customer's technical packet
(Tech.-Pack) evaluate the printed garments in accordance with the following zero to twenty point scale.
Deduct five points for each error found on the garments!

0 – reject, 5 -- fair, 10 -- good, 15 -- very good, 20 – excellent

Contestants Product Points **(80 Possible)**	**Zero**	**Five**	**Ten**	**Fifteen**	**Twenty**
1. Images were printed at correct height.	_____	_____	_____	_____	_____
2. Images were printed on center.	_____	_____	_____	_____	_____
3. Images were not crooked.	_____	_____	_____	_____	_____
4. Ink smudges do not appear on shirts.	_____	_____	_____	_____	_____

Total Points Earned _____

Judge's Signature _____

Image Printing Station Design

	Skills 2010 Folder	5 Color Flat Plastisol	SkillsUSA Nationals	04/09/2010 Chris Hulitt

I BELIEVE.

In the American way of life.

In education. In fair play.
Satisfaction is achieved by good work.
In high moral and spiritual standards.

"SkillsUSA: Champions at Work."

46th Annual National Leadership and Skills Conference, Kansas City June 20-June 25, 2010

Print Order

1 GREY 431
2 YELLOW 123
3 BROWN 469
4 HIGHLIGHT WHITE
5 BLACK

Artwork shown not actual size.
Actual width = 10.85"

SkillsUSA 2010
Screen Printing Technology
Screen Reclaiming

Screen Reclaiming Assignment

The Screen Reclaiming Station will be not be part of the 2010 Screen Printing Technology Performance Test. All Contestants will automatically receive 100 points on the Screen Printing Technology Scorecard. This action is taken to afford more time for the testing of additional contestants.

Objective:
Reclaim a screen that has been used to print an image on a shirt in accordance with the instructions given at the screen reclaiming station.

Screen reclaiming station instructions:
1. Remove a used screen from a storage rack.
2. Place screen in a cleanup rack that compares to a press with side clamps
3. Remove ink
4. Remove block-out tape (If present)
5. Remove emulsion
6. Secure high-pressure sprayer
7. Place screen in a storage rack
8. Clean up the workstation

Judging:
A screen printer will use the screen reclaiming station checklist, reproduced on the following page, to judge the contestant's performance, procedure and product.

Time:
A timekeeper will record the time each contestant needed to complete the screen reclaiming procedure. A maximum of fifteen (15) minutes is allocated to the screen reclaiming procedure. Time stops when the contestant is seated.

Points:
A maximum of one hundred (100) points may be given to the contestant for a screen reclaiming procedure that meets industry standards.

Screen Reclaiming Station Checklist

This station will not be in operation during the 2010 Competition

Contestant Number: _____ Time: _____

Directions: This is a performance evaluation sheet to rate a contestant on a scale of 0 to 4 and 0 to 5 for various items in relation to an occupational competency (skill). This instrument can be used for process, product, safety and time standard evaluations.

Process Evaluation: Evaluation of the process involved with reclaiming a screen.

	Total Points Possible 80				
Contestants Rating for Performance of the Process:	**Zero**	**One**	**Two**	**Three**	**Four**
1. Donned apron and safety glasses.	____	____	____	____	____
2. Used ear protection and gloves.	____	____	____	____	____
3. Removed screen from storage rack.	____	____	____	____	____
4. Placed screen on clean up rack.	____	____	____	____	____
5. Removed excess ink.	____	____	____	____	____
6. Removed block out tape. (If Present)	____	____	____	____	____
7. Used towels and solvent to remove remaining ink.	____	____	____	____	____
8. Disposed of the dirty towel.	____	____	____	____	____
9. Placed screen in the washout booth.	____	____	____	____	____
10.Turned the washout booth backlight on.	____	____	____	____	____
11. Applied emulsion remover.	____	____	____	____	____
12. Allowed time for the stencil emulsion to soften.	____	____	____	____	____
13. Used high-pressure washer to remove emulsion.	____	____	____	____	____
14. Used brush to help loosen emulsion hard spots.	____	____	____	____	____
15. Blotted or vacuumed excess water from the screen.	____	____	____	____	____
16. Placed the reclaimed screen in the screen dryer.	____	____	____	____	____
17. Cleaned the washout booth.	____	____	____	____	____
18. Stowed the high-pressure washer hose and nozzle.	____	____	____	____	____
19. Used safe procedures.	____	____	____	____	____
20. Completed reclaiming procedure in allotted time.	____	____	____	____	____

Product Evaluation: Evaluation of the reclaimed screen in accordance with the following points scale;
0 – reject, 1 -- very poor, 2 -- fair, 3 -- good, 4 -- very good, 5 – excellent

Contestants Product Points **(20 Possible)**.	**Zero**	**One**	**Two**	**Three**	**Four**	**Five**
1. Screen is free of block out tape.	____	____	____	____	____	____
2. Screen is free of ink residue.	____	____	____	____	____	____
3. Screen is free of emulsion residue.	____	____	____	____	____	____
4. Frame is clean and dry.	____	____	____	____	____	____

Total Points Earned _____

Judge's Signature _____

SkillsUSA 2010
Screen Printing Technology
Quality Control Problem

Quality Control Problem Assignment

Objective:
Judge quality levels of five (5) garments that have been reject by a quality assurance auditor before the auditor negotiates a new price for your company's customer.

Quality control station instructions:
1. Study technical specifications contained in the Tech Pack.
2. Obtain the Q. C. problem worksheet from the Q. C. station timekeeper
3. Study the quality assurance worksheet scenario and inspection steps.
4. Move to garment quality assessment station inspection pedestal.
5. Select garment number one (1) and spread it out on the inspection pedestal.
6. Inspect both sides of the garment number one (1).
7. Rate the degree of defect garment one (1) on the quality control inspection worksheet.
8. Place garment one (1) in box marked for either none, minor or major rejects.
9. Inspect the remaining four (4) garments according to steps 5, 6, 7 and 8.
10. Return to the judge or timekeeper and submit your completed report that is recorded on the quality control problem worksheet.

Judging:
A screen printer will use the quality control problem worksheet, reproduced on the following two pages, to judge and score the contestant's performance.

Time:
A timekeeper will record the time each contestant needed to complete the quality control problem procedure. A maximum of fifteen (15) minutes is allocated to the quality control problem procedure. Time stops when the contestant is seated.

Points:
A maximum of one hundred (100) points may be given to the contestant for the quality assurance audit that meets industry standards.

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Quality Control Problem Worksheet

Contestant Identification: _____ Time Finished: _____

Scenario: As a quality control inspector for New Era Screen Printing Company you have been given the task of assessing the validity of a recent quality assurance audit performed by one of your company's customers. The quality assurance auditor rejected five (5) garments. You have been instructed to use the criterion lists printed on the back of this worksheet to determine if each rejected garment was accurately evaluated and record the degree of each defect.

==========

The quality assurance audit criterion lists printed on the back of this worksheet has a rating scale for each of the ten possible defects that might be observed on each of the five sample garments that are being inspected for the second time. Rate each of the defect criterion factors listed by placing a check mark in the blank that indicates you found either no defect (**NONE)**, minor defect **(MINOR)**, or a major defect **(MAJOR)**. Your evaluation of each of the five possible defects will be supported in part by the image specifications included in the technical packet (Tech-Pack) that lists quality standards set by your company's customer. As you evaluate each of the five (5) garments against the ten (10) possible defects it will be your responsible to determine if the garments should have been rejected on the basis of a garment being considered **not saleable**.

Minor defects may be acceptable if the garment is considered as **saleable**.
A minor defect example could be a small pinhole ink deposit.

Major defects will render a garment as **not saleable**.
A major defect example would be a large smear of ink, or image printed out of dimension tolerance.

Judge's Evaluation Criteria: Depending on where the contestant placed a check mark to indicate the degree of quality defect for each criterion factor listed below award one or zero points. Judging will be accomplished by comparing the contestants rating to the judge's rating key.

Contestant Identification: _____ Time Finished: _____

Judge's Score Tallied Below This Line

	Shirt 1	Shirt 2	Shirt 3	Shirt 4	Shirt 5	Correct		Q. C.
Contestant ID	Correct	Correct	Correct	Correct	Correct	Checks	Multiply	Problem
Identification	Checks	Checks	Checks	Checks	Checks	Total		Score
							X 2 =	

A quality control inspector report form is printed on the back of this page.

Quality Control Inspector Report Form

Garment 1-Type of Inspection Defect or Defects Found	None	Minor	Major
1. Image printed on correct vertical dimension.			
2. Image printed on center.			
3. Image crooked.			
4. Ink smudges on sample garment.			
5. Color density varies across the image.			
6. Ink printed in non-image area due to pinhole.			
7. Last color covers previous colors.			
8. Missed register between colors.			
9. Garment fabric damage.			
10.Colors match the customer's standard.			

Garment 2-Type of Inspection Defect or Defects Found	None	Minor	Major
1. Image printed on correct vertical dimension.			
2. Image printed on center.			
3. Image crooked.			
4. Ink smudges on sample garment.			
5. Color density varies across the image.			
6. Ink printed in non-image area due to pinhole.			
7. Last color covers previous colors.			
8. Missed register between colors.			
9 Garment fabric damage.			
10.Colors match the customer's standard.			

Garment 3-Type of Inspection Defect or Defects Found	None	Minor	Major
1. Image printed on correct vertical dimension.			
2. Image printed on center.			
3. Image crooked.			
4. Ink smudges on sample garment.			
5. Color density varies across the image.			
6. Ink printed in non-image area due to pinhole.			
7. Last color covers previous colors.			
8. Missed register between colors.			
9. Garment fabric damage.			
10.Colors match the customer's standard.			

Garment 4-Type of Inspection Defect or Defects Found	None	Minor	Major
1. Image printed on correct vertical dimension.			
2. Image printed on center.			
3. Image crooked.			
4. Ink smudges on sample garment.			
5. Color density varies across the image.			
6. Ink printed in non-image area due to pinhole.			
7. Last color covers previous colors.			
8. Missed register between colors.			
9. Garment fabric damage.			
10.Colors match the customer's standard.			

Garment 5-Type of Inspection Defect or Defects Found	None	Minor	Major
1. Image printed on correct vertical dimension.			
2. Image printed on center.			
3. Image crooked.			
4. Ink smudges on sample garment.			
5. Color density varies across the image.			
6. Ink printed in non-image area due to pinhole.			
7. Last color covers previous colors.			
8. Missed register between colors.			
9. Garment fabric damage.			
10.Colors match the customer's standard.			

SkillsUSA 2010
Screen Printing Technology
Written Test

Written Test Assignment

Objective:
Correctly answer twenty-five (25) multiple choice test questions. (Questions will relate to graphic imaging and screen-printing processes)

Technical knowledge test station instructions:
1. Read instructions on the test book
2. Use number 2 lead pencil to mark the correct response
3. Give the testing administrator notice when the test has been completed
4. Remain seated until dismissed by the test administrator

Judging:
A technical knowledge test administrator will administer and score the technical knowledge test. Scoring will be accomplished by comparing a contestant's responses to an answer key prepared by the screen-printing technical committee.

Time:
The technical knowledge test administrator will record the time each contestant uses to complete the technical knowledge test. A maximum of fifteen (15) minutes is allocated to the technical knowledge testing procedure.

Points:
A maximum of one hundred (100) points may be given to the contestant who scores 100 percent on the technical knowledge written test.

Skills USA

Screen Printing Technology

Technical Knowledge Examination

Directions:

1. You will have 15 minutes to complete this 25-question multiple-choice test.
2. Write your contestant number on the Scantron Answer Sheet.
3. Use a No. 2 lead pencil to mark your responses to the questions on the Scantron Answer Sheet.
4. Do not mark on this test booklet.
5. When you have completed answering the 25 test questions, place both the answer sheet and test booklet face down on the table and wait for instructions from the testing monitor.

SkillsUSA 2010
Screen Printing Technology
Oral Professional Assessment

Oral Professional Assessment Assignment

Objective:
Participate in an oral professional assessment in a role-playing job interview setting related to a screen-printing career choice.

Oral professional assessment station instructions:

1. Introduce yourself
2. Take the seat indicated by the interviewer
3. Answer questions
4. Ask questions that you deem appropriate

Judging:
A human resources interviewer with basic knowledge of the screen printing industry will use the oral professional assessment station checklist, reproduced on the following page, to judge the contestant's screen printing knowledge and preparation needed for employment in a screen printing occupation.

Time:
The human resources interviewer will record the time each contestant participated in a job interview. A maximum of fifteen (15) minutes is allocated to the oral professional assessment.

Points:
A maximum of one hundred (100) points may be given to the contestant for an oral professional assessment that meets Equal Employment Opportunity (EEO) standards.

Oral Professional Assessment Station Checklist

Contestant Number: _____ Time: _____

Directions: This oral professional assessment checklist is designed to rate a contestant's responses to questions on a scale of 0 to 20. Five question areas or problems should be posed that are related to the contestant's occupational goals in the field of graphic imaging. This instrument should be used to record indications of person's readiness for employment as a screen printer.

Process Evaluation: Evaluation of the process involves interviewing a person who has applied for a job with a company that produces products requiring screen-printing processes. Questions will be related to a performance test that might be given to the applicant by a company's production personnel.

Questions to be developed by the screen-printing technical committee prior to the day of the state level screen-printing performance test.

Questions related to the following areas:

1. Ability to handle assignments
2. Ability to answer questions asked in technical terms
3. Situation handled in a professional manner
4. Demonstration of critical thinking throughout the job interview scenario
5. Realistic self concept

The following page is a copy of the *Oral Professional Assessment Station Checklist* related to the five areas listed above with the attending rating scale for each question area. Note: The specific questions have been removed and will be revised annually by technical committee members.

Oral Professional Assessment Station Checklist

Contestant Number: _____ Start Time: _____ End Time: _____

1. Ability to handle work assignments. **Question Area Score: 0 to 20 Points _____**

2. Answered questions using technical terms. **Question Area Score: 0 to 20 Points _____**

3. Situation handled in a professional manner. **Question Area Score: 0 to 20 Points _____**

4. Used critical thinking during the interview. **Question Area Score: 0 to 20 Points _____**

5. Demonstrated a realistic self-concept. **Question Area Score: 0 to 20 Points _____**

Total Points Out of Possible 100 _____

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SkillsUSA 2010
Screen Printing Technology
Helpful Hints

Prior to Performance Test

1. Contact people to donate supplies for the performance test
   a. Shirts
   b. Ink
   c. Cleaning solvents
   d. Screen fabric
   e. Etc.

2. Contact suppliers to donate prizes for contestants (3 Secondary/3Post Secondary)
   a. First prize – Tools plus registration for the National Conference
   b. Second prize – Tools
   c. Third prize – Tools

3. Make sure that the contestants can complete their assignments at each testing station in the time allotted
   A. Screen Preparation (Tensioning)
   B. Screen Coating **(Inactive in 2010)**
   C. Screen Exposure and Washout
   D. Screen Blockout **(Inactive in 2010)**
   E. Image Registration
   F. Image Printing
   G. Screen Reclaiming **(Inactive in 2010)**
   H. Quality Control Problem
   I. Written Knowledge Test
   J. Oral Professional Assessment
4. Contact screen printers to judge contests
5. Contact people to keep time

During the Performance Test

1. Check Contestant Number against the Testing Schedule
2. Announcements
3. Special instructions
4. Dismiss with a Good Luck Wish

After the Performance Test

1. Report the results

SkillsUSA 2010
Screen Printing Technology
Meeting Agenda for Contestant Orientation at 2:00 P. M. on Tuesday, June 22, 2010.

Introductions
Roll call of contestants
Give contestants a number
Review the testing schedules with contestants numbers listed on the schedules
Review the areas to be tested (Pass out the Assignment and Checklist Booklets)

A. Screen Preparation (Inspection and Tensioning)
B. Screen Coating will not be evaluated in 2010 points will be posted on the scorecard!
C. Screen Exposure & Washout
D. Screen Blockout will not be evaluated in 2010 points will be posted on the scorecard!
E. Image Registration
F. Image Printing
G. Screen Reclaiming will not be evaluated in 2010 points will be posted on the scorecard!
H. Quality Control Problem
I. Written Knowledge Test
J. Oral Professional Assessment

Special instructions:

a. Performance test flow from station to station Setting in station chair controls time.
b. The judging team will not give instruction during the performance test on Wed. or Thur.
c. Pass out the equipment operation manuals
d. Screen Tensioning Demonstration
    1. James Ortolani, Demonstration
e. SkillsUSA Competition Rules and Regulations Revision
f. Optional Tools and Equipment. (Safety Glasses, Ear Protection, Apron, and Vinyl Gloves)
g. Questions and Answers

ADMINISTER THE WRITTEN KNOWLEDGE TEST
FIFTEEN (15) MINUTE TIME LIMIT

Dismiss

SkillsUSA 2010
Screen Printing Technology
Industry Awards and Prizes

Awards and prizes presented to the Screen Printing Technology performance test winners should be related to the skills being developed in the contestants technical education program. Awards and prizes may be in the form of scholarships, tools, books, manuals, or educational travel. Awards must be equal in value for both secondary and post secondary contestants. Awards and prizes are needed for the first, second, and third place winners.

Secondary

1st Place

Items: 1 Hooded Sweat Shirt, 2 T Shirts with Competition Design, 1 Lap Top Carrying Case with Leather Organizer .
Winner's School will receive a $750.00 Certificate for purchase of HIX Corporation Equipment .
Equipment must be purchased through Hearily .
The school will also receive a complete set of the HIX Corporation Screen Printing Curriculum .
Donors: Hix, Hearlihy, and Hanes Corporation .

2nd Place

Items: 1 Hooded Sweat Shirt, 2 T Shirts with Competition Design, 1 Lap Top Carrying Case with Leather Organizer .
Winner's School will receive a $500.00 Certificate for purchase of HIX Corporation Equipment .
Equipment must be purchased through Hearily .
The school will also receive a complete set of the HIX Corporation Screen Printing Curriculum .
Donors: Hix, Hearlihy, and Hanes Corporation .

3rd Place

Items: 1 Hooded Sweat Shirt, 2 T Shirts with Competition Design, 1 Lap Top Carrying Case with Leather Organizer .
Winner's School will receive a $250.00 Certificate for purchase of HIX Corporation Equipment .
Equipment must be purchased through Hearily .
The school will also receive a complete set of the HIX Corporation Screen Printing Curriculum .
Donors: Hix, Hearlihy, and Hanes Corporation .

Post Secondary

1st Place

Items: 1 Hooded Sweat Shirt, 2 T Shirts with Competition Design, 1 Lap Top Carrying Case with Leather Organizer .
Winner's School will receive a $750.00 Certificate for purchase of HIX Corporation Equipment .
Equipment must be purchased through Hearily .
The school will also receive a complete set of the HIX Corporation Screen Printing Curriculum .
Donors: Hix, Hearlihy, and Hanes Corporation .

2nd Place

Items: 1 Hooded Sweat Shirt, 2 T Shirts with Competition Design, 1 Lap Top Carrying Case with Leather Organizer .
Donors: Hix, Hearlihy, and Hanes Corporation .

3rd Place

Items: 1 Hooded Sweat Shirt, 2 T Shirts with Competition Design, 1 Lap Top Carrying Case with Leather Organizer .
Donors: Hix, Hearlihy, and Hanes Corporation .

Screen Printing Schedule for Wednesday June 23, 2010

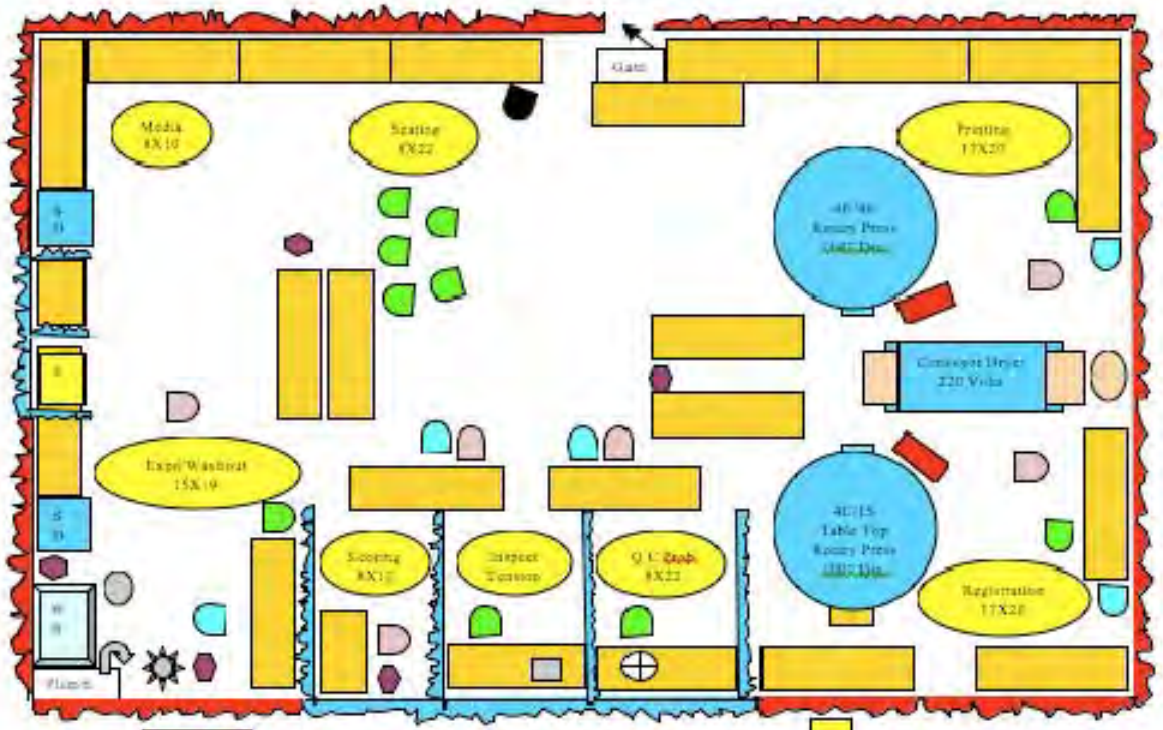
Time	Minutes	H. S. Oral Interview	P. S. Oral Interview	Q. C. . Problem	Inspection Tension	Exposure Washout	Image Registering	Image Printing
8:00	Test 15	HS 1						
8:15	Rotation 5							
8:20	Test 15	HS 2						
8:35	Rotation 5							
8:40	Test 15	HS 3						
8:55	Rotation 5							
9:00	Test 15	HS 4						
9:15	Rotation 5							
9:20	Test 15	HS 5						
9:35	Rotation 5							
9:40	Test 15	HS 6	PS 1	PS2	PS3	PS 4	PS5	PS6
9:55	Rotation 5							
10:00	Test 15	HS 7	PS 6	PS 1	PS2	PS3	PS 4	PS5
10:15	Rotation 5							
10:20	Test 15	HS 8	PS5	PS6	PS 1	PS2	PS3	PS 4
10:35	Rotation 5							
10:40	Test 15	HS 9	PS 4	PS5	PS6	PS 1	PS2	PS3
10:55	Rotation 5							
11:00	Test 15	HS 10	PS3	PS 4	PS5	PS6	PS 1	PS2
11:15	Rotation 5							
11:20	Test 15	HS 11	PS2	PS3	PS 4	PS5	PS6	PS 1
11:35	Rotation 5							
11:40	**Break 30**	**Lunch**	**Lunch**	**Lunch**	**Lunch**	**Lunch**	**Lunch**	**Lunch**
12:10	Test 15	HS 12			**SkillsUSA**	**University**	**Session 1**	**12:00**
12:25	Rotation 5							
12:30	Test 15	HS 13						
12:45	Rotation 5				**Instructors**	**Participants**	**Twelve**	
12:50	Test 15	HS 14						
1:05	Rotation 5				**Contestants**	**Participants**	**Zero**	
1:10	Test 15	HS 15						
1:25	Rotation 5							
1:30	Test 15	HS 16			**SkillsUSA**	**University**	**Session 2**	**1:30**
1:45	Rotation 5							
1:50	Test 15	HS 17						
2:05	Rotation 5				**Instructors**	**Participants**	**Twelve**	
2:10	Test 15	HS 18						
2:25	Rotation 5				**Contestants**	**Participants**	**Zero**	
2:30	Test 15	HS 19						
2:45	Rotation 5							
2:50	Test 15	HS 20						
3:05	Rotation 5							
3:10	Test 15	HS 21			**SkillsUSA**	**University**	**Session 3**	**3:00**
3:25	Rotation 5							
3:30	Test 15	HS 22			**Instructors**	**Participants**	**Twelve**	
3:45	Rotation 5							
3:50	Test 15	HS 23			**Contestants**	**Participants**	**Zero**	
4:05	Rotation 5							
4:10	Test 15	HS 24						
4:25	Rotation 5							
4:30	Test 15	HS25						
4:45	**Finish**							

Wednesday, June 23, 2010
Floor Plan
For
Screen Printing Technology
In
Battle Hall
34' X 59'
Legend:

Screen Printing Schedule for Thursday June 24, 2010

Time	Minutes	Inspection Tensioning	Exposure Washout	Q. C. . Problem	Image Registering	Image Printing
8:00	Test 15	1	2	3	4	5
8:15	Rotation 5					
8:20	Test 15	5	1	2	3	4
8:35	Rotation 5					
8:40	Test 15	4	5	1	2	3
8:55	Rotation 5					
9:00	Test 15	3	4	5	1	2
9:15	Rotation 5					
9:20	Test 15	2	3	4	5	1
9:35	Rotation 5					
9:40	Test 15	6	7	8	9	10
9:55	Rotation 5					
10:00	Test 15	10	6	7	8	9
10:15	Rotation 5					
10:20	Test 15	9	10	6	7	8
10:35	Rotation 5					
10:40	Test 15	8	9	10	6	7
10:55	Rotation 5					
11:00	Test 15	7	8	9	10	6
11:15	Rotation 5					
11:25	Test 15	11	12	13	14	15
11:40	Rotation 5					
11:45	Test 15	15	11	12	13	14
12:00	**Break 40**	**Lunch**	**Lunch**	**Lunch**	**Lunch**	**Lunch**
12:40	Test 15	14	15	11	12	13
12:55	Rotation 5					
1:00	Test 15	13	14	15	11	12
1:15	Rotation 5					
1:20	Test 15	12	13	14	15	11
1:35	Rotation 5					
1:40	Test 15	16	17	18	19	20
1:55	Rotation 5					
2:00	Test 15	20	16	17	18	19
2:15	Rotation 5					
2:20	Test 15	19	20	16	17	18
2:35	Rotation 5					
2:40	Test 15	18	19	20	16	17
2:55	Rotation 5					
3:00	Test 15	17	18	19	20	16
3:15	Rotation 5					
3:20	Test 15	21	22	23	24	25
3:35	Rotation 5					
3:40	Test 15	25	21	22	23	24
3:55	Rotation 5					
4:00	Test 15	24	25	21	22	23
4:15	Rotation 5					
4:20	Test 15	23	24	25	21	22
4:35	Rotation 5					
4:40	Test 15	22	23	24	25	21
4:55	**Finish**					

Thursday, June 24, 2010
Floor Plan
For
Screen Printing Technology
In
Bartle Hall
34' X 59'



Legend:

Master Time Keeper
Contestant's Chairs
Judge's Chairs
Timekeeper Chairs
Desks
Spot Heaters
Frame
Wet-Dry Vacuum
Washer
Hose with Nozzle
Garment Sample
Basket
Washout Booth
Screen Dryer
Trash Can
Art Tile
3-Foot High Drapes
8-Foot High Drapes

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Technical Committee Members

SkillsUSA 2010
Performance Test Inventories
Screen Printing Technology

A. Performance Test Inventories for 30 Contestants at the 2010 Competition:

1. Major Screen Printing Equipment
2. Tools
3. Materials

B. Major Screen Printing Equipment Inventory

1 - HIX NP 4-color / 1 Station Manual Rotary Screen Printer (WRAPPED FOR SHIPPING)
1 - HIX NP 6-color / 4 Station Manual Rotary Screen Printer (WRAPPED FOR SHIPPING)
1 - HIX E-2408 Electric Conveyor Dryer 220 Volt (INSTALL WHEELS WITH NO CRATE)
1 - HIX TT- 180 Table Top Fluorescent UV Screen Exposure Unit (BOXED)
1 - Washout Booth (BOXED)
2 - HIX SH - 1818 Automatic 18”X18” Spot Heater (BOXED FOR SHIPMENT BY TRUCK)
2 - HIX SD-2632 Screen Dryer 26”X32” 120 Volt (UNBOXED)
1 - HIX Model 750 Tension Meter (from 7 to 50 Newtons/cm)
1 - Reten Field Demo Kit
1 – Tension Jack Kit (16789)
30 - HIX 21”X23” Reten Manual Screen Frame that hold a polyester screen. (Screen will be either 140 or 154 mesh count) Each contestant will need one screen.
1 - Screen Coater
10 - HIX 21”X23” Screens with Stencils **(Stored at PSU Screen Print Lab)**
8 - HIX 21”X23” Screens with Stencils **(Stored at Hix Plant)**3
3- Inspection Screens with Stencils **(Supplied by PSU Screen Print Lab)**
3- Tensioning Screens with 154 Mesh Screen Fabric (Supplied by PSU Screen Print Lab)

C. Tools Inventory

24 - Eight foot tables (**Supplied by Bartle Hall**)
20 - Chairs (**Supplied by Bartle Hall**)
1- Stool for Quality Control Station (Optional)
7 - 20 Minute Timer
10 - Ink Knives
10- Squeegees
2 - ½” Masking Tape Dispenser
2 - Basket (Hanes Shirt Case)
1 - High Pressure Washer **(Supplied by Jess Hudson)**
1 - Garden Hose with Nozzle **(Supplied by Jess Hudson)**
1 - Wet Dry Vacuum **(Supplied by Jess Hudson)**
6 - Pair Safety Glasses
3 - Dozen Ear Plugs
3 - Box of Latex Gloves, Large Size
6 - Clip boards **(Supplied by Jess Hudson)**
6 - 12 Inch Metal Rulers **(Supplied by Jess Hudson)**
1 - T Square
1 - 24 or 36 Inch Ruler
1 - Pantone Color Matching Guides **(Supplied by PSU)**
1 - Assorted Hand Tools Kit
1 - 4 Wheel Dolly
1 - Exposure Booth Ceiling
1 - Assortment of Extension Cords

Materials Inventory

6 - Cases **Khaki** Hanes Tee Shirts (L or XL)
4 - Cases **White** Hanes Tee Shirts (L or XL)
30- 4C/1S Rotary Press Operation Manuals
30 - SH16 X16 Automatic Spot Heater Operation Manuals
30 - 2410 NP II Conveyor Dryer Operation Manuals
30 - TT- 180 Screen Exposure Unit Operation Manuals
30 - SD-2632 Screen Dryer 26"X32" 120 Volt Manuals
30 - Reten Frame Tensioning Assembly Instructions
30 - Reten Frame Demonstration CD/DVD's
30 - Reten Frame Tensioning Instruction Sheets for orientation **(Supplied by Jess Hudson)**
6 - Rolls of Block Out Tape
1 - Gallon Ulano Emulsion
1 - Gallon Emulsion Remover
1 - Gallon Screen Wash
1 - Gallon Mineral Spirits
1 - Emulsion Remover Spray Bottle
3 - Emulsion Screen Wash Spray Bottle
3 - Cans of **Heat Resistant** Shirt Board Adhesive
1 - Quart of Black Plastisol **(Supplied by National Mills and PSU)**
1 - Quart of White Plastisol **(Supplied by National Mills and PSU)**
1 - Quart of Blue Plastisol **(Supplied by National Mills and PSU)**
1 - Quart of Red Plastisol **(Supplied by National Mills and PSU)**
1 - Quart of Yellow Plastisol **(Supplied by National Mills and PSU)**
1 - Quart of Brown Plastisol **(Supplied by National Mills and PSU)**
1 - Art File **(Supplied by PSU)**
3 – Sets of 5 shirts with the registration design all with printing defects **(Supplied by PSU)**
1 - Production Specification Packet (Tech Pack) **(Supplied by PSU)**
12 - Rolls of Paper Towels
2 - Wet Task Towel Dispensers **(Supplied by OTC)**
4 - Rolls of Wet Task Towel **(Supplied by OTC)**
2 - Rolls of ½" Masking Tape
3 - ½" Cellophane Tape Dispenser
48 - Number 2 Lead Pencils
6 - Black Sharpie Permanent Marker
3 - Stapler and Staples
3 - Small Trash Receptacle **(4 - Trash Barrels Supplied by Rubber Maid at K. C.)**
50 - Contestant Orientation Manuals **(Supplied by OTC)**
30 - Written Test Booklets and 1 - Written Test Answer Key **(Supplied by Jess Hudson)**
30 - Written Test Scantron Sheets **(Supplied by PSU)**
30 - Oral Assessment Station Rating Sheets **(Supplied by OTC)**
30 - Printing Station Checklists **(Supplied by Jess Hudson)**
30 - Exposure Station Checklists **(Supplied by Jess Hudson)**
30 - Exposure Checklists **(Supplied by Jess Hudson)**
30 - Reclaiming Checklists **(Supplied by Jess Hudson)**
30 - Quality Control Problem Worksheets with Checklist **(Supplied by Jess Hudson)**
30 - Tensioning & Inspection Station Worksheets with Checklist **(Supplied by Jess Hudson)**
1 – Material Safety Data Sheets Manual

SCREEN PRINTING TECHNOLOGY
Chairman's Report
2010 SkillsUSA Championships

Dr. Jesse L. Hudson
2604 N. Free King Hwy
Pittsburg, Kansas 66762
417 496 6585 Cell
620-231-0155 Home
j.hudson6@cox.net

The 2010 National SkillsUSA Screen Printing Technology Championships were held on June 23 and June 24, 2010 at Bartle Hall in downtown Kansas City, Missouri.

A total of 20 secondary and 2 post-secondary Screen Printing contestants met for orientation on Tuesday, June 22. Instructors, Advisors, Technical Committee Members and Judges also attended the meeting. Contestants were given general and specific information for the 7 performance testing stations included in the 2010 contest. A 25 question multiple choice written knowledge examination was given at the end of the orientation session.

Station 1 – SCREEN PREPARATION – INSPECTION and TENSIONING

Each contestant was given 15 minutes to inspect 3 screens that were coming out of storage and being returned to production. They were required to test the tensions on the 3 retensionable screens and inspect the stencils to determine if they were acceptable for printing an order of garments for a customer. Each contestant was expected to tension a screen that had new screen mesh installed to 25 newtons with a tolerance of + or – 5 newtons at the screen stencil's center.
Contestants recorded the inspection results and tension readings on blank lines on the inspection and tensioning report as either *accept* or *reject.* Contestants were scored on the accuracy of the readings and the accuracy of the number of screens accepted or rejected. The tension meter and screens were provided by ***HIX Corporation***. ***Saati Print*** provided screen mesh. Betty Bassett of **Classic Designs Screen Printing** served as judge.

Station 2 – SCREEN EXPOSURE AND WASHOUT

Each contestant was given 15 minutes to expose and washout a screen image. Using information given in a written assignment, contestants were instructed to locate the correct film positive in an art file; place the art work on an emulsion-coated screen in the correct position; expose the screen; wash out the image; and place the screen in a screen dryer. Points were awarded for performance of the process and for the quality of the washed out stencil. Of the 22 total contestants most produced a stencil that could be registered at the registration station. The artwork and film positives for this station were prepared and provided by Chris Hewitt of ***Pittsburg State University Graphics Imaging Department***. The screen dryer, exposure unit, washout booth and screens were provided by ***HIX Corporation.*** Chris Blancho of ***HIX Corporation*** served as judge.

Station 3 – SCREEN REGISTRATION

Contestants were given 15 minutes to register a screen image to the image being printed on a 4 Color/1 Station Rotary Table Top Press. Each contestant inked the screen, printed test images as needed to produce a salable image, then printed and cured 2 t-shirts. All test images and t-shirts were cured (dried) in a conveyor dryer. Each contestant completed this testing station by removing the screen that was registered from the press and returning it to the reclaim area. A total of 22 contestants were able to register the image. During future competitions all contestants can expect to be issued a usable screen image at the screen registration station. The screen to be registered will have plastisol ink removed from the screen to be registered to the image being printed with the two screens that are still mounted on the rotary press. Contestants were and will continue to be judged on performance of the process and the quality of their finished product. ***HIX Corporation*** provided the 4 Color/1 Station Rotary Table Top Press and a Conveyor Dryer. James Ortolani of ***HIX Corporation*** served as the Post Secondary Judge and Chris Hewitt of ***Pittsburg State University Graphics Imaging Department*** served as Secondary Contestant Judge.

Station 4 – IMAGE PRINTING

Each contestant was given 15 minutes to complete the image printing station. The contestants were given 7 minutes to actually print and place t-shirts on the conveyor dryer. No contestant printed more than 6 shirts at this station; five contestants printed 6 shirts which is an increase of 1 shirt over 2009 record. Points for printing preparation included checking the ink level of each screen, checking the shirt board for adhesion, and inspecting all screens for off contact and cleanliness. The finished shirts were judged using the *Image Printing Station Checklist* and five-color image that was given to each contestant in the ***2010 Screen Printing Technology Performance Test Plan***. (See pages 33 and 34 of the attached plan.) Chris Hewitt of ***Pittsburg State University Graphics Imaging Department*** used *Adobe Illustrator* to prepare the image used at this performance test station. Harold Johnston, Executive Director of ***North American Specialty Printing Manufacturers Association (NASMA)*** served as judge for the image printing station. James Ortolani of ***HIX Corporation*** served as a time keeper for Secondary Contestant performances

Station 5 – QUALITY CONTROL

Each contestant was given 15 minutes to examine 5 printed t-shirts according to specifications set forth in a technical packet (Tech-Pack, pages 29 and 30 of the attached plan). Each garment was judged as to correct vertical dimension, printed on center and straight, no ink smudges, and pantone color matches. Each contestant determined from this inspection whether or not a quality insurance auditor had correctly inspected a *Lot* of 500 shirts. Their performance assignment was to determine the accuracy of the quality assurance audit by inspecting five garment that had been rejected as described in a scenario on the *Quality Control Problem Worksheet*. (See Page 39 of the attached plan.) This quality control problem required most of the 15 minutes allotted because the contestants were required to inspect both the front and back of each garment. Chris Hewitt of ***Pittsburg State University Graphics Imaging Department*** prepared the quality assurance test garments for this station. David Granschow, of ***Absolute Graphix*** located in Sparks, Nevada, prepared a performance test answer key and judged the quality control competition.

Station 6 – ORAL PROFESSIONAL ASSESSMENT

Each contestant participated in a role-play job interview. The interview was designed to determine the contestant's professionalism, critical thinking, screen-printing technology knowledge, and the contestant's realistic self-concept. Rebecca Hudson, Computer Science Instructor and former Human Resources Supervisor for a company in Waynesville, Missouri interviewed the Post Secondary Contestants, Rick Hicks, from ***NAZDAR Consulting Services*** interviewed the Secondary Contestants.

Station 7 – WRITTEN KNOWLEDGE TEST

Each contestant was given 15 minutes to complete a 25 question multiple-choice test related to graphic imaging and screen-printing processes. The questions used to compose the test have been subjected to a validation process by having screen-printing subject matter experts (SME) mark examination instruments that listed over 100 test items. Any question that a SME answered incorrectly was not included in the 25-question Knowledge Test. The test question pool was also administered to screen-printing students over a 3-year period. Questions answered correctly by all of the students were not used because those items did not differentiate between students who had screen-printing knowledge and those who did not. The test was scored and the results recorded by Rebecca Hudson, ***Aero Travel***. {**Note;** There were two persons named Rebecca Hudson who worked during the Screen Printing Technology Competition.}

MISCELLANEOUS SUPPLIES AND MATERIALS WERE PROVIDED BY THE FOLLOWING:

Aero Travel
Hanes Printables
HEARLIHY
HIX Corporation
National Mills
Ozarks Technical Community College
Pittsburg State University
Saati Print
Ulano

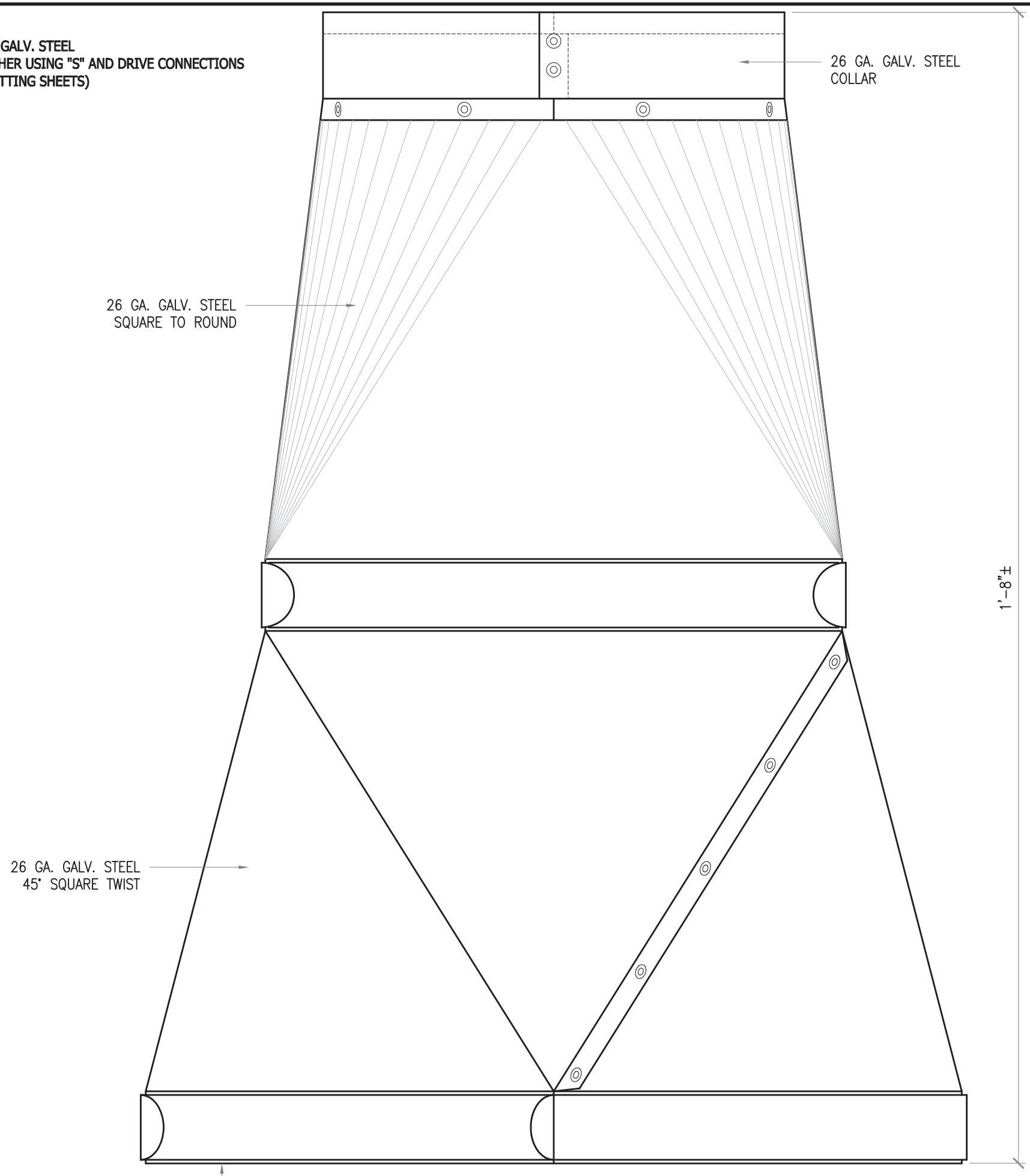
SkillsUSA
2010 Contest Projects

Sheet Metal

Click the “Print this Section” button above to automatically print the specifications for this contest. Make sure your printer is turned on before pressing the button.

FABRICATION NOTES:

1. ALL FITTINGS FABRICATED FROM 26 GA. GALV. STEEL
2. ASSEMBLE COMPLETED FITTINGS TOGETHER USING "S" AND DRIVE CONNECTIONS (LOCATIONS NOTED ON INDIVIDUAL FITTING SHEETS)



COMPETITION PROJECT – ELEVATION VIEW

SkillsUSA
Champions at Work

SHEAR LIST

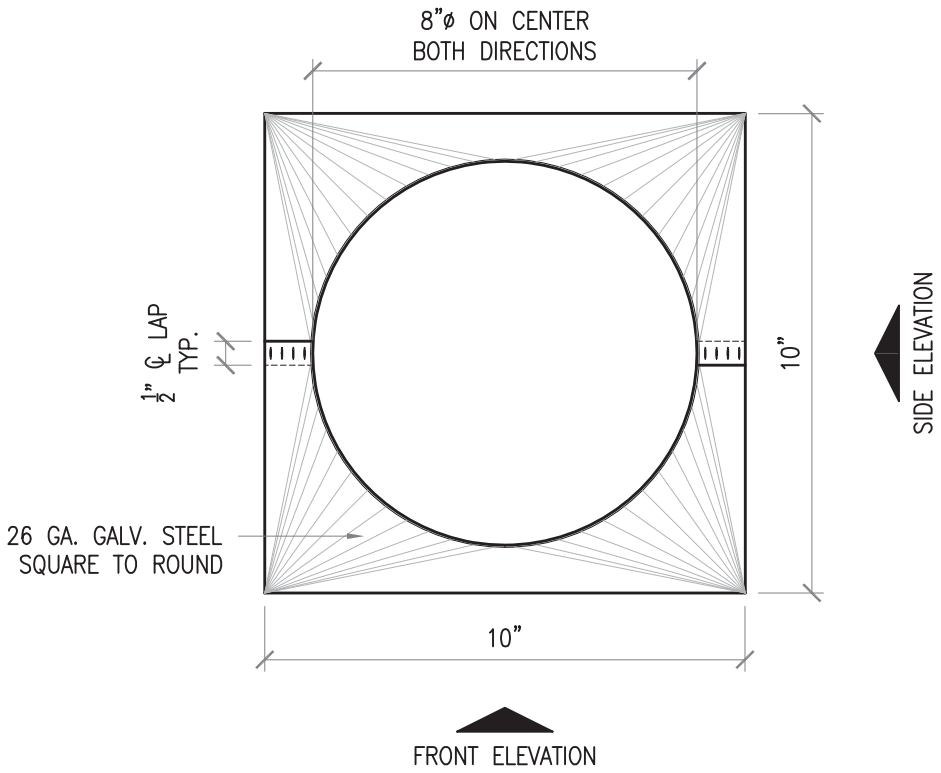
# OF PCS.	DIMENSIONS			MARK
		x		
		x		
		x		
		x		
		x		
		x		
		x		
		x		
		x		
		x		
		x		
		x		
		x		
		x		
		x		
		x		
		x		
		x		

PROJECT DESCRIPTION:

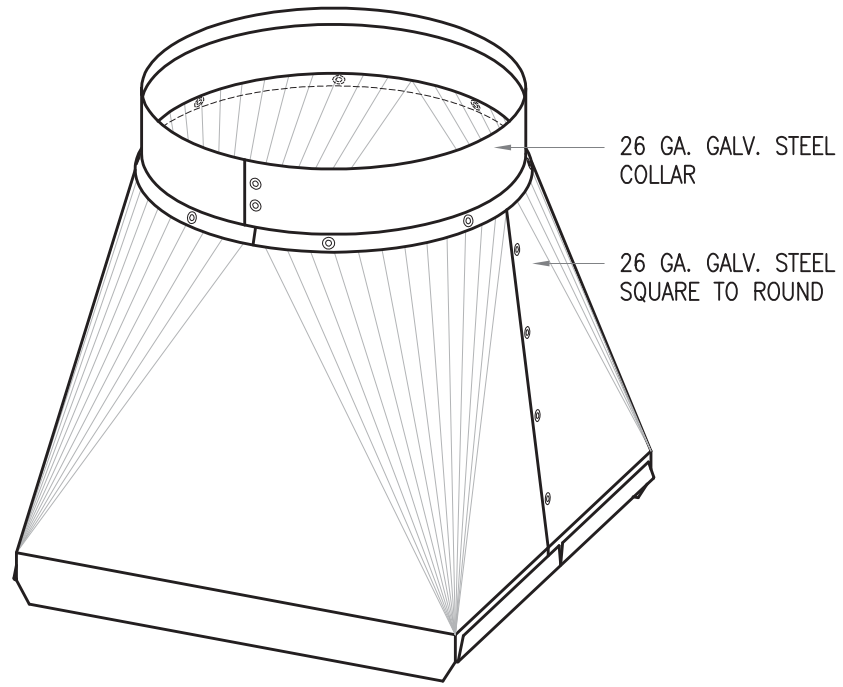
COMPETITION PROJECT

FABRICATION NOTES:

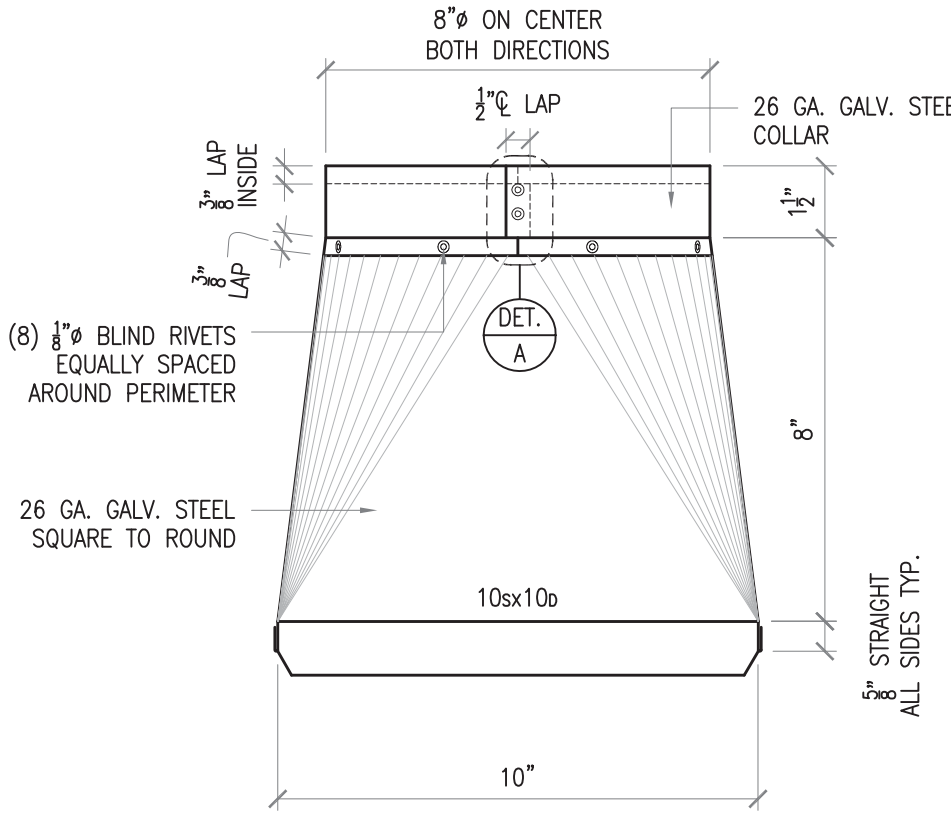
1. SQUARE TO ROUND AND COLLAR FABRICATED FROM 26 GA. GALV. STEEL



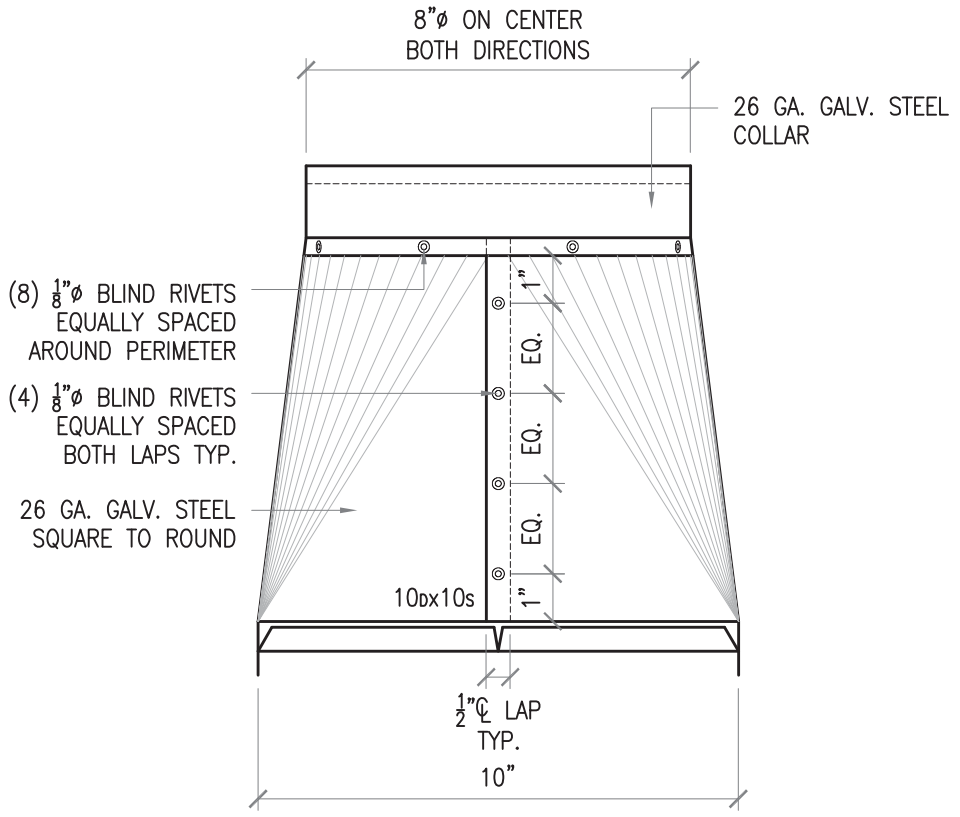
PLAN VIEW



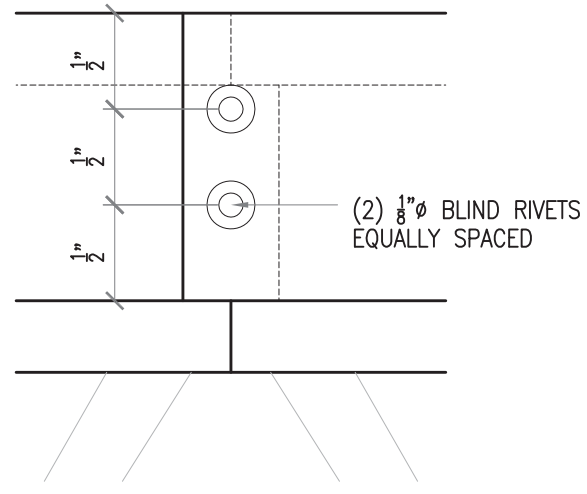
SQUARE TO ROUND – REFERENCE VIEW



FRONT ELEVATION



SIDE ELEVATION



DETAIL A

SkillsUSA
Champions at Work

SHEAR LIST

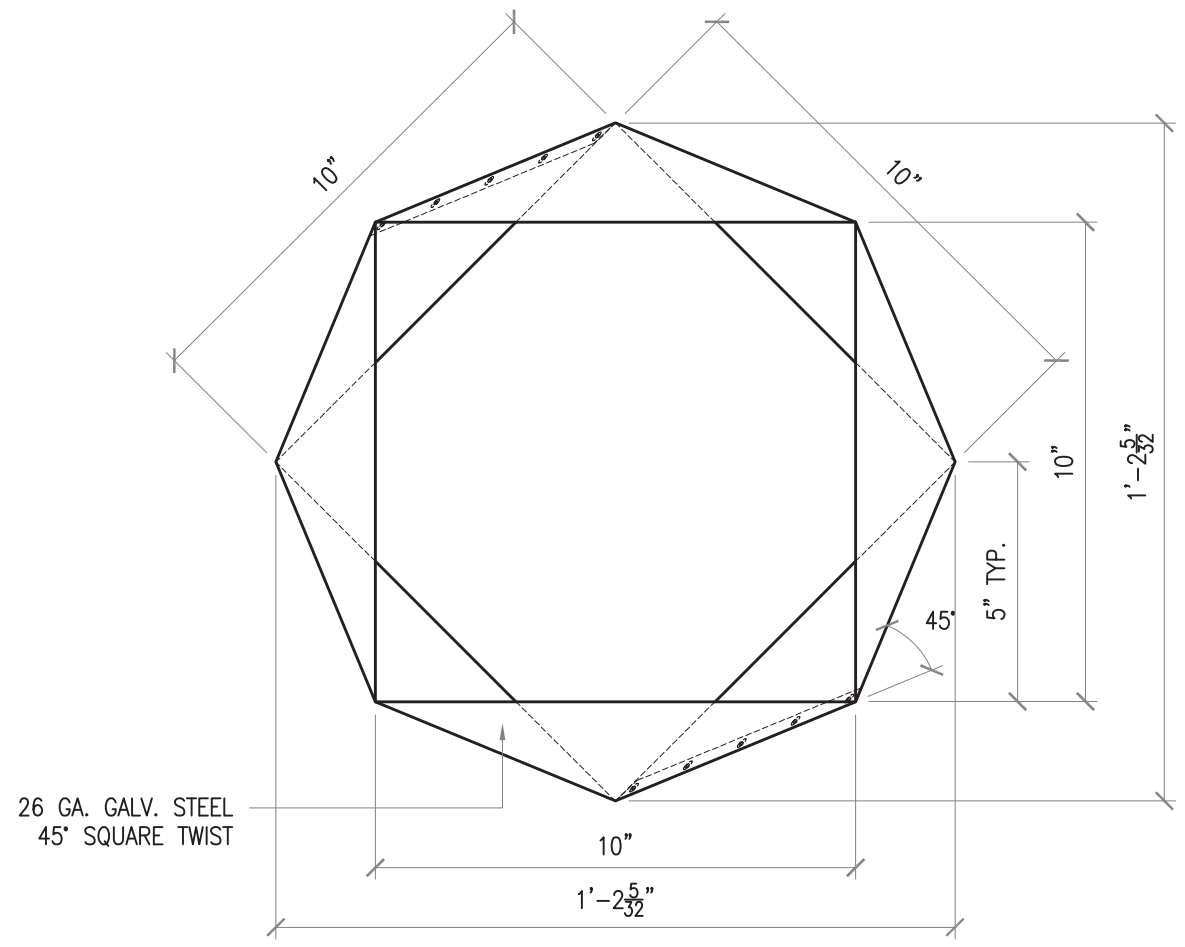
# OF PCS.	DIMENSIONS	MARK
	x	
	x	
	x	
	x	
	x	
	x	
	x	
	x	
	x	
	x	
	x	
	x	
	x	
	x	
	x	
	x	
	x	
	x	
	x	

PROJECT DESCRIPTION:

SQUARE TO ROUND

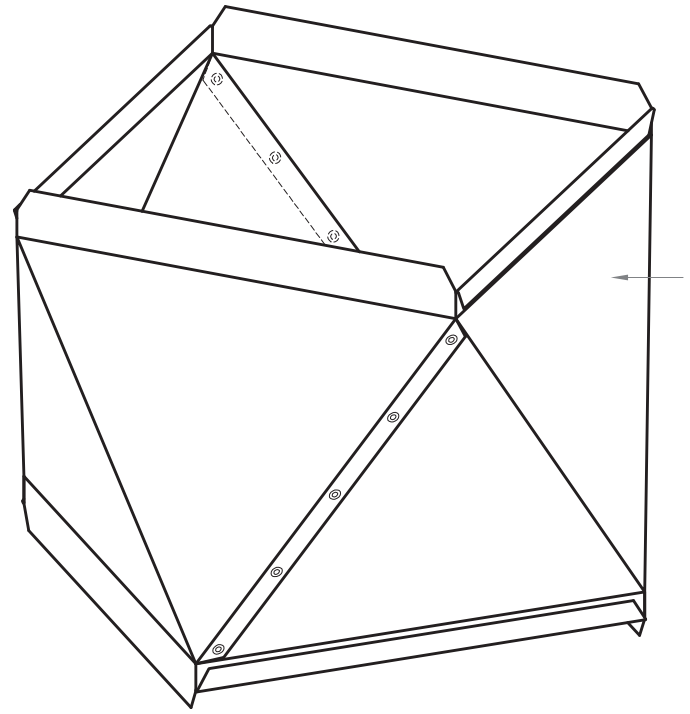
FABRICATION NOTES:

1. 45° SQUARE TWIST FABRICATED FROM 26 GA. GALV. STEEL



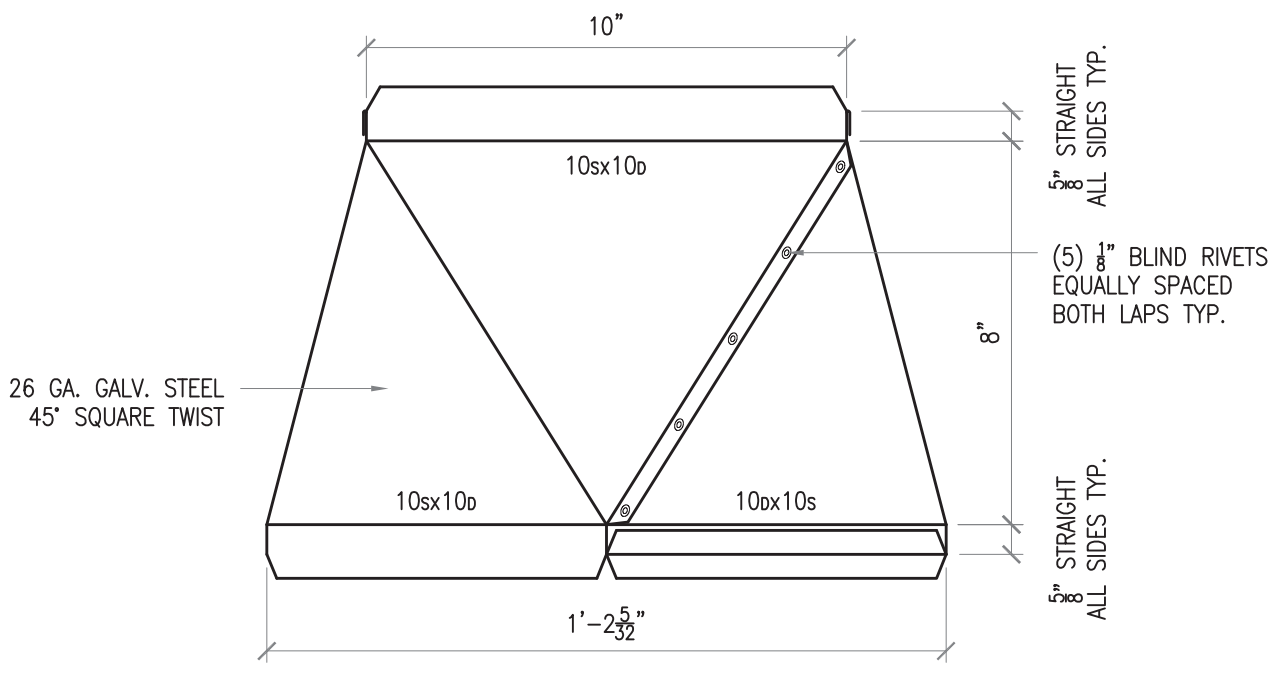
SIDE ELEVATION

FRONT ELEVATION

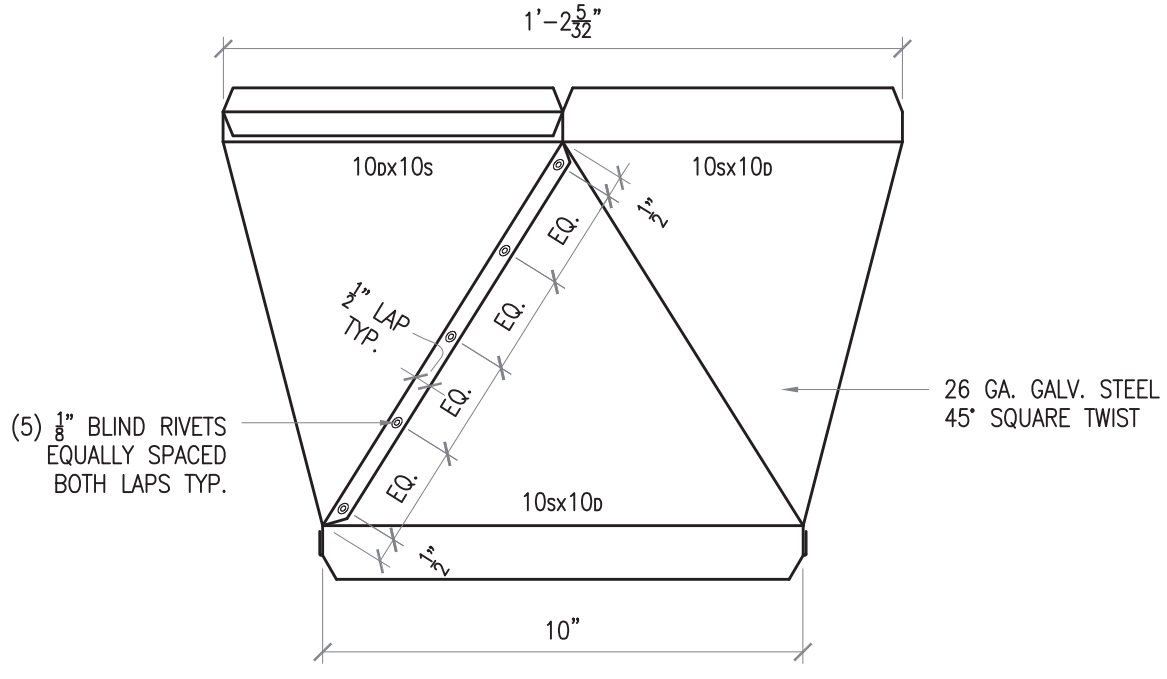


45° SQUARE TWIST – REFERENCE VIEW

PLAN VIEW



FRONT ELEVATION



SIDE ELEVATION

SkillsUSA
Champions at Work

SHEAR LIST

# OF PCS.	DIMENSIONS	MARK
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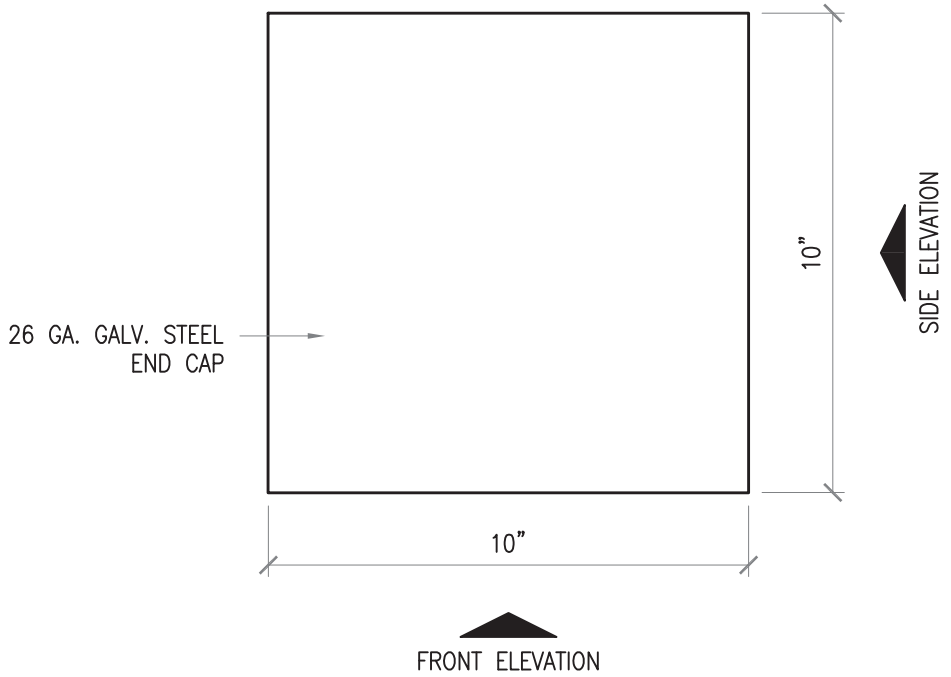
	x	
	x	
	x	
	x	
	x	
	x	
	x	
	x	
	x	
	x	
	x	
	x	
	x	
	x	
	x	
	x	
	x	
	x	
	x	

PROJECT DESCRIPTION:

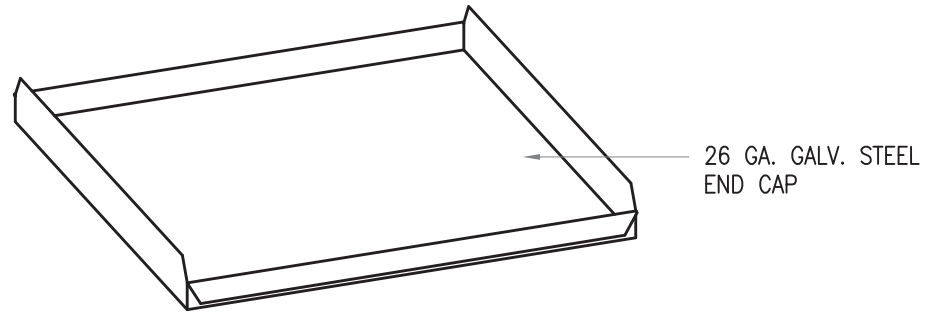
45° SQUARE TWIST

FABRICATION NOTES:

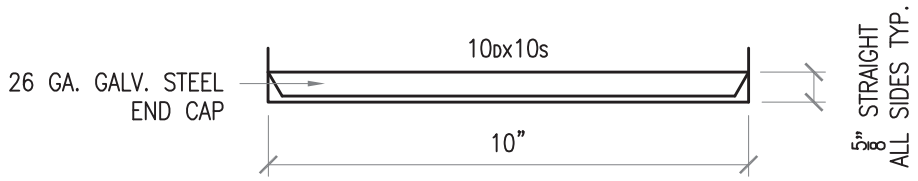
1. END CAP FABRICATED FROM 26 GA. GALV. STEEL



PLAN VIEW



END CAP – REFERENCE VIEW



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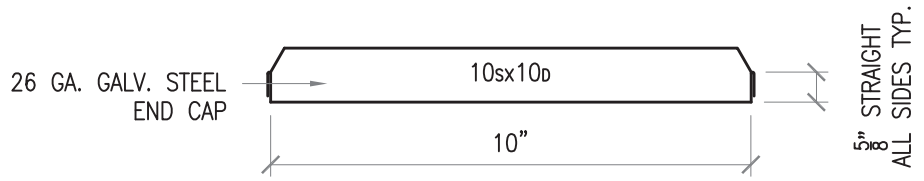

SIDE ELEVATION

SkillsUSA
Champions at Work

SHEAR LIST

# OF PCS.	DIMENSIONS			MARK
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		x		
		x		

PROJECT DESCRIPTION:

END CAP

SkillsUSA
2010 Contest Projects

TeamWorks

Click the “Print this Section” button above to automatically print the specifications for this contest. Make sure your printer is turned on before pressing the button.

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Founding Sponsors

Bosch Power Tools

Stanley Tools

Advisory Sponsors

Lowe's

NARI

State Farm

Program & Contributing Sponsors

3M

Bernzomatic

Bricklayer's Association

Copper Development Association

Ferguson

IEC

Mortar Net

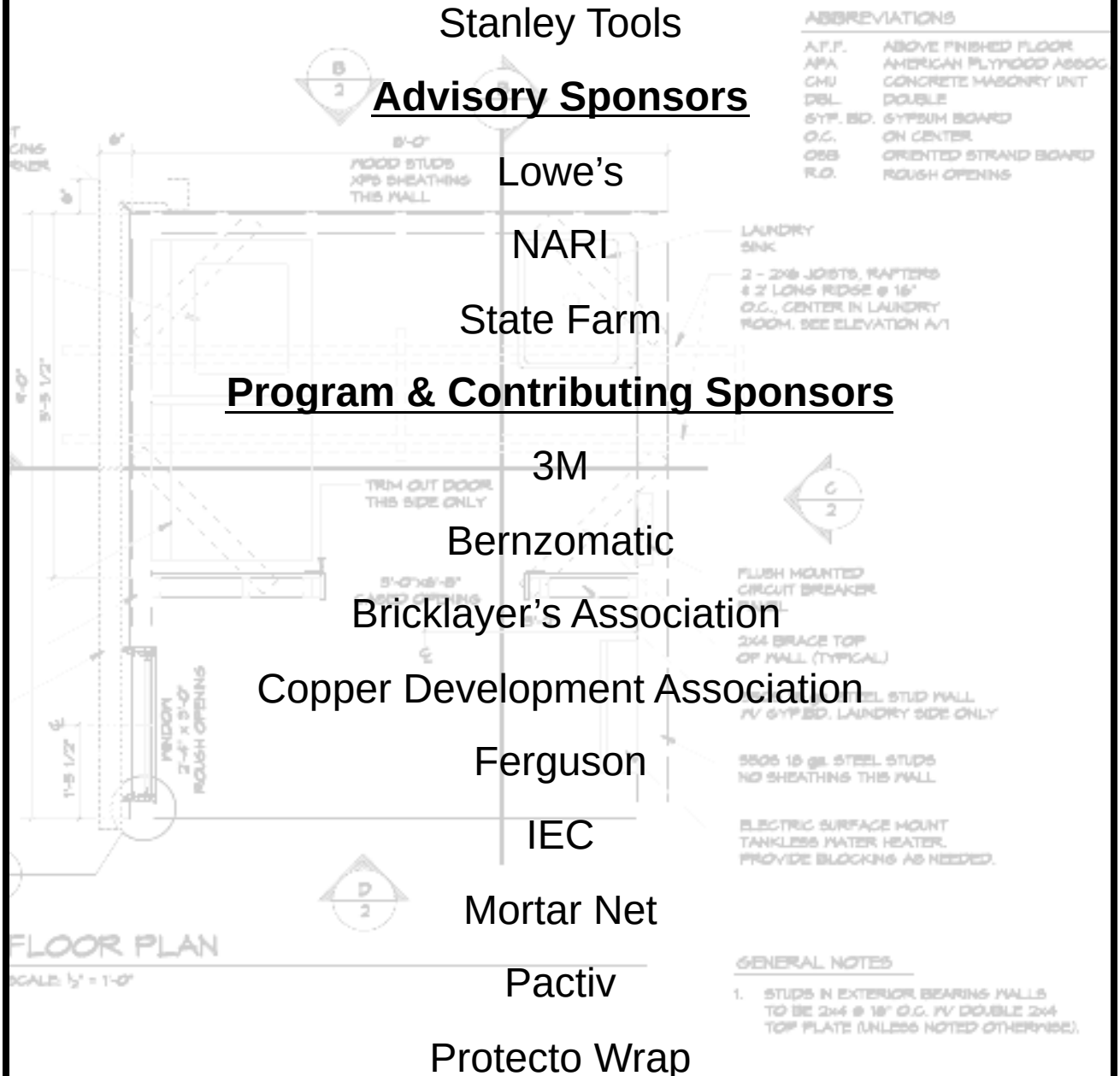
Pactiv

Protecto Wrap

Simpson Strong Tie

Spec Mix

Steel Framing Alliance



About TeamWork's

TeamWork's was introduced at the 2000 SkillsUSA Championships in Kansas City to promote and establish a model for "best in class" communication and coordination between trade disciplines; to support and develop skilled personnel capacity within the building trade disciplines; to encourage, recognize and celebrate the most talented young people who have elected a building trade career path; and, to strengthen the link between industry needs and building trade technology and management curriculum.

TeamWork's is a competition where teams of four, with training in carpentry, electrical, plumbing and masonry, compete in planning, scheduling and building a project over a two-day period, in a simulated real-world situation. This two-day competition places a special emphasis on individual trades with students working collaboratively to coordinate all phases of project execution.

The Technical Committee's Mission Statement is;

To provide a learning experience for all participates where they demonstrate relevant competencies that meet the changing needs of industry.

Rules & Regulations

Purpose
TeamWork's is a competition to evaluate team preparation for employment and to recognize outstanding students for excellence and professionalism in the fields of residential carpentry, masonry, plumbing, electrical and teamwork skills.

Refer to the General Regulations in the SkillsUSA Championships Technical Standards.

Clothing Requirement
Official SkillsUSA khaki work shirt and pants, black or brown leather work shoes, and safety glasses with side shields or goggles. Safety prescription glasses can be used only if they are equipped with approved side shields. If not, they must be covered with goggles. To purchase official work clothes, order online at: http://www.skillsusastore.org/skillsusa/welcome.asp or call 800-401-1560.

Eligibility
Open to a team of four SkillsUSA members enrolled in program(s) with building trades as the occupational objective. Two contestants from each team will be required to have an OSHA Certification prior to competition. Judges will check for OSHA certification during the team presentations. For every additional member with the OSHA Certification additional points will be awarded to the team. You can learn more about OSHA Certification at http://www.skillsusa.org/educators/careersafe.shtml

Safety Requirement
Both the instructor and the contestants certify, by their enter in this contest, that the contestants have received instructions and have satisfactorily passed an examination on the safe use of portable electric power tools (including cordless) and all hand tools. The contestants are responsible for inspecting the tools supplied and that they are in safe working condition. Further, they agree that SkillsUSA, Inc. the SkillsUSA Championships Technical Committees, volunteers and the national judges are released from all responsibility relating to personal injuries resulting from their use. Contestants will be removed from competition if proper training has not been provided and/or they are use the equipment in an unsafe manner.

Equipment and Materials
The Technical Committee will supply all equipment, materials and all necessary tools. Contestants who wish to use their own tool belt may do so after Technical Committee approval. If a contestant does not bring their own tool belt one will be provided by the Technical Committee. Any tools that contestants will be required to bring will be published in the April Update (published on www.skillsusa.org annually on April 15 and distributed to state association directors by SkillsUSA).

Rules & Regulations

Scope of Contest
Each team will be given the project drawing at the contest orientation meeting and given two hours to meet as a team, analyze the drawing and formulate a written action plan. Each team will prepare and conduct a 3 to 5-minute professional presentation to the judges on how their team plans to accomplish the project. Every team member will be required to have an active part in the presentation. The written action plan and the presentation will be judged.

Contestants will demonstrate their ability to perform jobs and skills selected from the following list of competencies considered essential by the SkillsUSA Championships Technical Committee. Committee members include: Robert Bosch Tools Corporation, Stanley Black & Decker, Train2Build, Construction Management Advisory Group, and State Farm Insurance Companies and Lowe's.

Contest Elements

I. Team Action Plan and Presentation

a. Analyze the project drawing
- Interpret and determine dimensions from multiview drawings
- Interpret specifications, abbreviations, symbols and drawing notes
- Interpret oral and written changes
- Prepare material "Take-Off" from blueprint

b. Write the action plan and give a presentation
- Be able to organize, prepare and present an action plan
- Use of data display instruments such as flow chart or cause and effect diagrams is recommended (reference Total Quality Curriculum)
- As a team, develop a presentation that is 3 to 5 minutes long portraying how your team will accomplish the building project including the team's safety plan
- Use of visuals is permitted. Each team will be provided with a flip chart, stand and markers for this component

II. Teamwork
- Demonstrate the ability to work as a team
- Demonstrate group problem solving techniques
- Demonstrate team proficiency in construction of a building project
- Other teamwork competencies as determined by the Technical Committee

III. Trade Skills

Carpentry

a. Materials, Estimating and Tools
   - Identify, receive and inspect materials
   - Store lumber and other materials properly
   - Use the correct amount of materials for the project in the correct manner
   - Correctly identify and use carpentry hand and power tools in a safe manner

b. Rough Framing
   - Frame and install sill plate, girders, floor joists and bridging
   - Use of dimensional and engineered wood products and steel products
   - Frame floor opening and install sub-floor
   - Frame and brace walls to include corners, openings, trimmers, cripples, partitions, plumbing partitions, fixture backing and sheathing
   - Frame stair stringer and other components
   - Calculate and use the rise and run of a common roof
   - Layout a common roof plan
   - Lay out, cut and install common rafters, ridge board, ceiling joists and collar ties
   - Install roof sheathing

c. Finish Carpentry
   - Install interior door unit plumb and square
   - Install interior trim to include miter cuts and or copped joints
   - Install siding and related trim pieces
   - Install windows to include weather resistant barrier and flashing

Masonry

a. Materials, Estimating and Tools
- Arrange masonry materials for efficient use
- Place mortar pans properly
- Keep areas neat and organized
- Estimate amount of brick, block, mortar mix and sand to be used
- Correctly identify and use masonry hand and power tools in a safe manner

b. Tooling and Polishing Joints
- Tool concave, rake weather, V-jointer, grapevine and struck joints
- Polish the joints
- Tuck-point a wall
- Brush and touch up a wall

c. Lay a Brick/Block Wall
- Lay out a wall in preparation for building a straight and/or corner wall
- Spread and furrow mortar correctly for brick units
- Construct a straight wall
- Construct an outside and inside corner lead
- Spread bed joints and throw on full head joints for block units
- Build a block corner to a specified height
- Properly install lintels and moisture drainage such as masonry flashing and wee holes
- Be prepared to install brick detailing

Plumbing

a. Materials, Estimating and Tools
   - Determine type and amount of materials needed
   - Store materials correctly around work area
   - Identify fittings from a isometric drawing of a plumbing system
   - Correctly identify and use plumbing hand and power tools in a safe manner

d. Rough In
   - Calculate the slope required for waste and vent lines
   - Rough in waste and vent lines for sinks, lavatories, bathtubs, showers and water closets
   - Install cleanout drains
   - Secure horizontal and vertical lines of pipe to wood, metal or masonry surfaces
   - Rough in water supply lines for sinks, lavatories, bathtubs, showers and water closets
   - Perform pressure tests on water supply system

e. Joining Pipes
   - Cut, ream and join copper tubing using the sweat method
   - Cut, ream and join copper tubing using the compression method
   - Cut, ream and join CPVC and other similar pipe
   - Cut, ream and join PVC pipe
   - Cut, ream and join ABS pipe
   - Cut, ream and join copper tubing by sweat, compression or other methods

Electrical

a. Materials, Estimating and Tools
   - Use and apply the current National Electrical Code
   - Plan work and lay out electrical installations
   - Select proper amount and size of materials
   - Correlating specifications, prints and job sites
   - Correctly identify and use electrical hand and power tools in a safe manner

b. Rough In
   - Choose size and install ganged, octagon and surface mount boxes to a specified height
   - Install and staple all electrical wire essentially free from hazard according to a blueprint
   - Make all necessary splices and junctions in boxes
   - Install distribution panel with main disconnect and breakers

c. Device and Fixture Installation
   - Install the following devices:
     - Single pole switch
     - Three-way switch
     - Four-way switch
     - Duplex grounded receptacle
     - Ground fault circuit interrupter
     - Light fixtures
   - Install wall plates

Other Competencies That May Be Considered

- Conduit in the electrical unit
- Troubleshooting the electrical circuits
- Installing plumbing fixtures
- Installing electric fixtures
- Repair or replace a P trap
- Brick/block composite wall
- Exterior or interior carpentry finish work
- Install shingles
- Install window(s)
- Install door(s)
- Install underlayment
- Install floor coverings

Team Presentation Judging Criteria
The presentation phase is designed to evaluate the team's awareness and understanding of "non-physical" and "non-technical" expectations. It is intended to reinforce the need for the participants to develop a broad range of physical and non-physical skills needed in order to achieve success. Scoring will be based on a team presentation made to the judges.

Trade Specific Judging Criteria
The construction phase of the TeamWork's competition will be evaluated using the criteria from score sheets located in the SkillsUSA Championships Technical Standards. For example, the carpentry portion of the competition will be judged using the same score sheet as the Carpentry Rules in the Technical Standards. The plumbing portion of the competition will be judged using the Residential Plumbing score sheet in the Technical Standards.

COMPETITION SCHEDULE

Tuesday, June 22rd

9:00am – 10:00am Orientation
Wagstaff Auditorium

11:00am – 1:00pm Team Presentations
Refer to Schedule Grid for Your Team's Location & Time
(Lunch will be served for students)

2:00pm – 3:00pm Site Visit – teams are allowed to visit their site and inspect their tools
Hale Arena

Wednesday, June 23rd

8:00am – 2:00pm Competition Build
Hale Arena

Thursday, June 24th

8:00am – 5:00pm Competition Build
Hale Arena

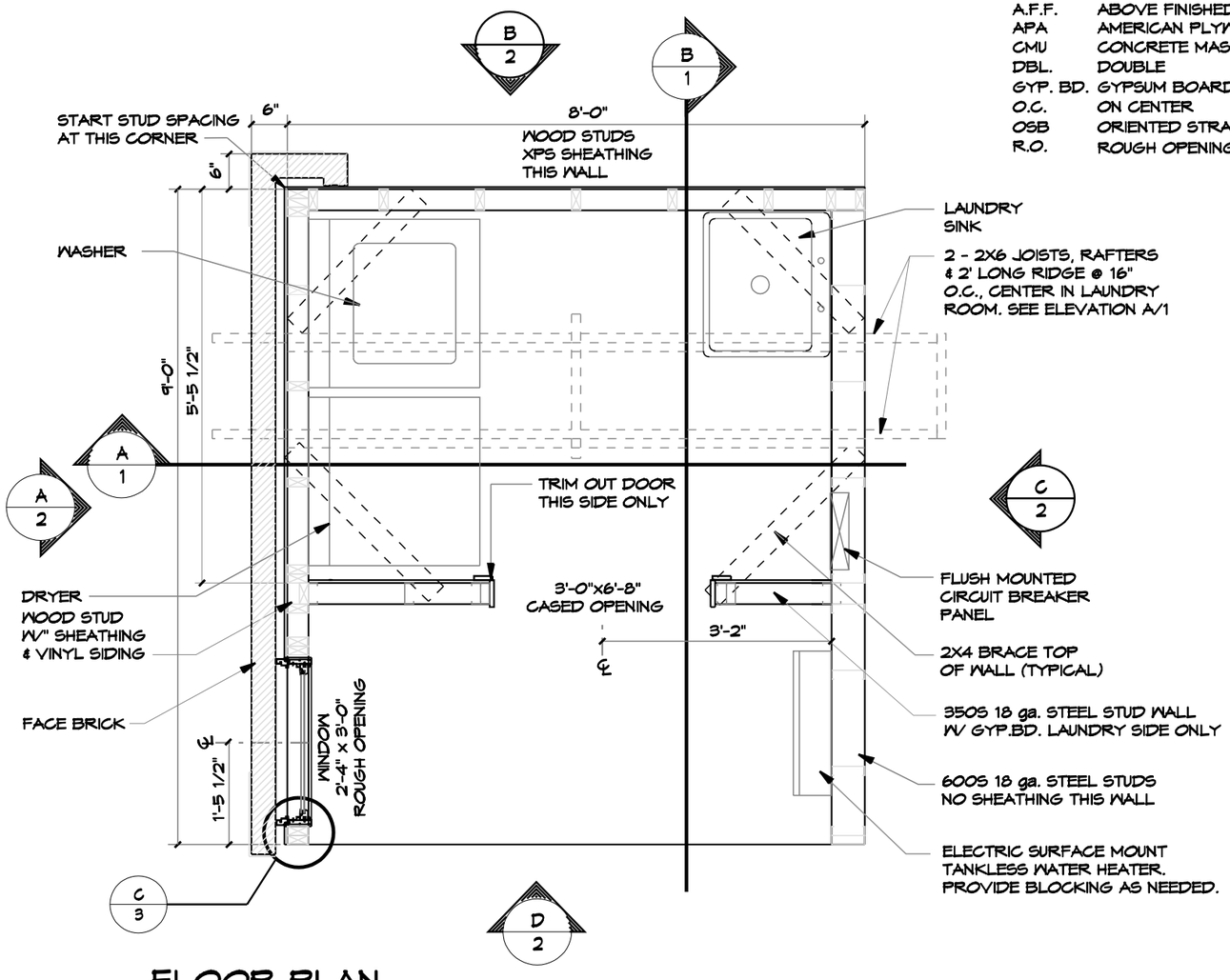
5:00pm – 5:15pm Site Visit – teams, instructors and family members are allowed to visit their site for an up-close look at the project and photos
Hale Arena

Friday, June 25th

7:45am – 8:00am Site Visit – teams, instructors and family members are allowed to visit their site for an up-close look at the project and photos
Hale Arena

8:00am – 10:00am Demolition – all teams must demolish their project, collect and return their tools. Only students are allowed on the site during demolition

10:30am – 12:00pm Debrief
Wagstaff Auditorium
(Lunch will be served for students and their instructors)



FLOOR PLAN

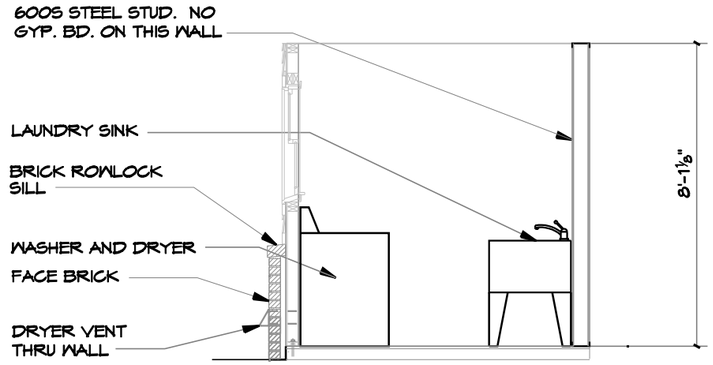
SCALE: ½" = 1'-0"

ABBREVIATIONS

A.F.F.	ABOVE FINISHED FLOOR
APA	AMERICAN PLYWOOD ASSOC.
CMU	CONCRETE MASONRY UNIT
DBL.	DOUBLE
GYP. BD.	GYPSUM BOARD
O.C.	ON CENTER
OSB	ORIENTED STRAND BOARD
R.O.	ROUGH OPENING

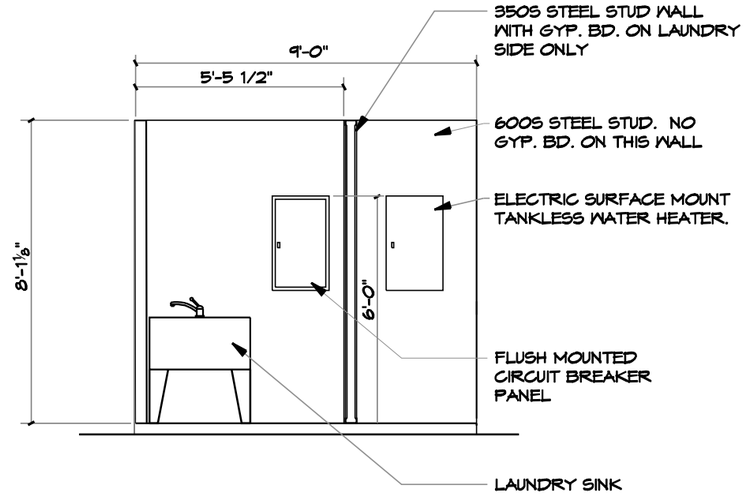
GENERAL NOTES

1. STUDS IN EXTERIOR BEARING WALLS TO BE 2x4 @ 16" O.C. W/ DOUBLE 2x4 TOP PLATE (UNLESS NOTED OTHERWISE).



A/1 BATHROOM ELEVATION

SCALE: ¼" = 1'-0"



B/1 BATHROOM ELEVATION

SCALE: ¼" = 1'-0"

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2010 NATIONAL TEAMWORKS COMPETITION

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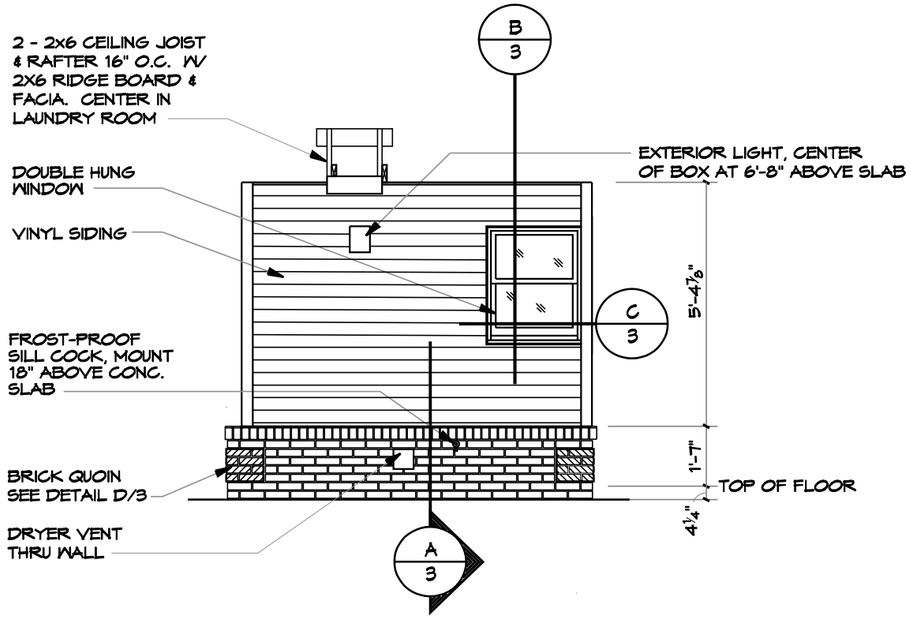
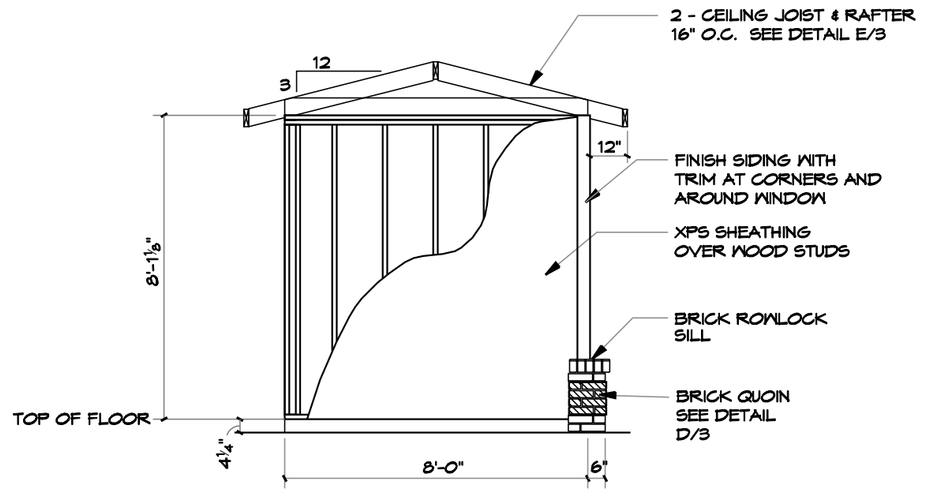


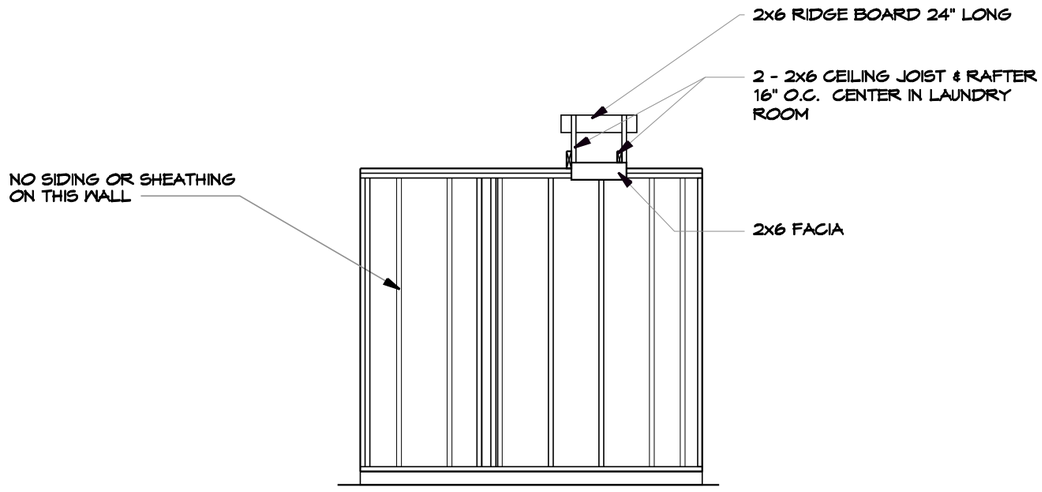
A/2 EXTERIOR ELEVATION

SCALE: ¼" = 1'-0"



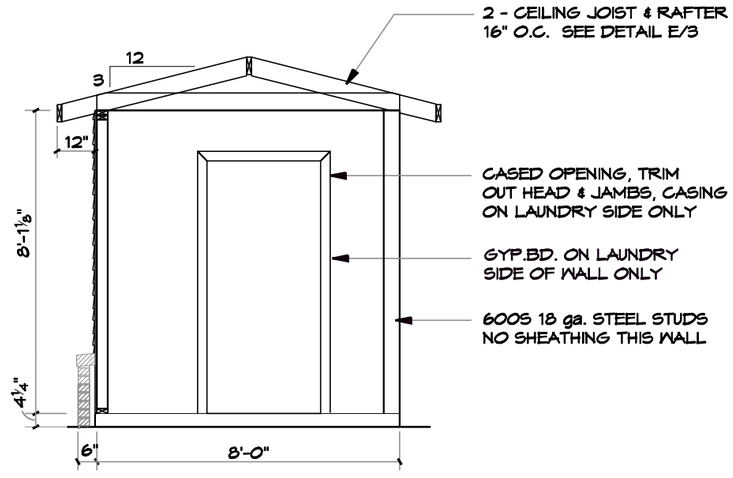
B/2 EXTERIOR ELEVATION

SCALE: ¼" = 1'-0"



C/2 EXTERIOR ELEVATION

SCALE: ¼" = 1'-0"



D/2 EXTERIOR ELEVATION

SCALE: ¼" = 1'-0"

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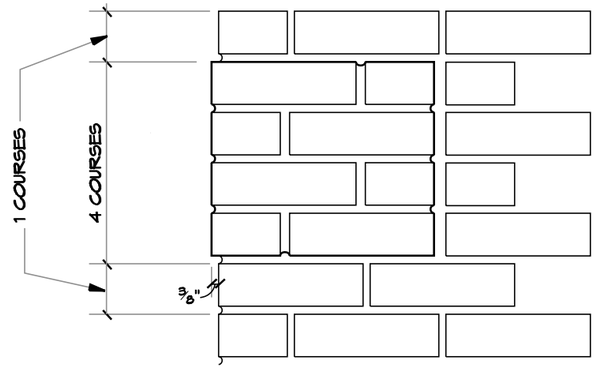
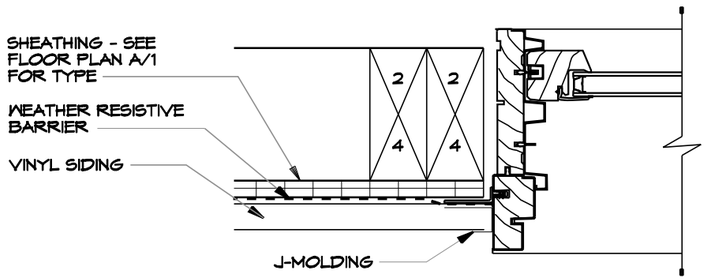


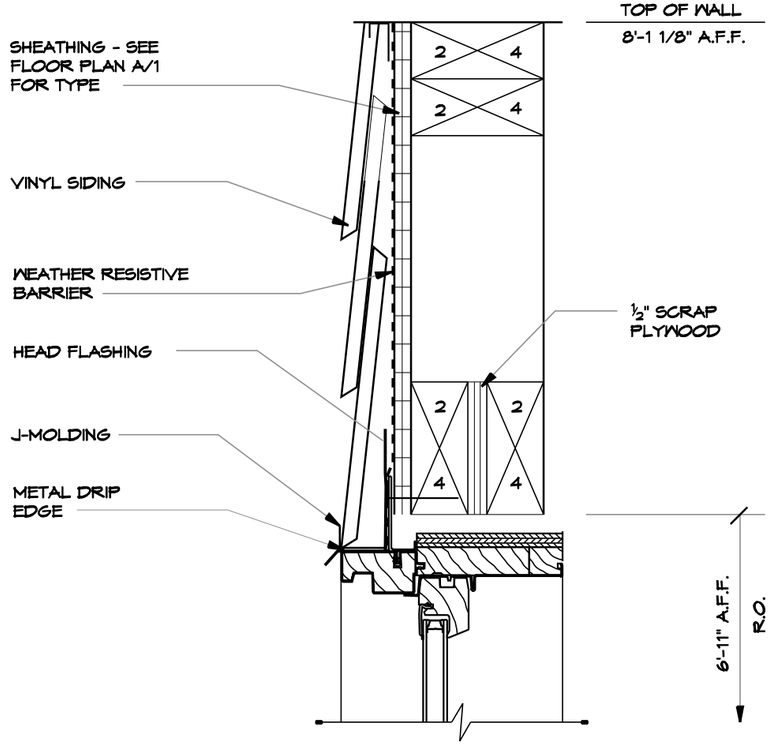
D/3 BRICK QUOINED CORNER DETAIL

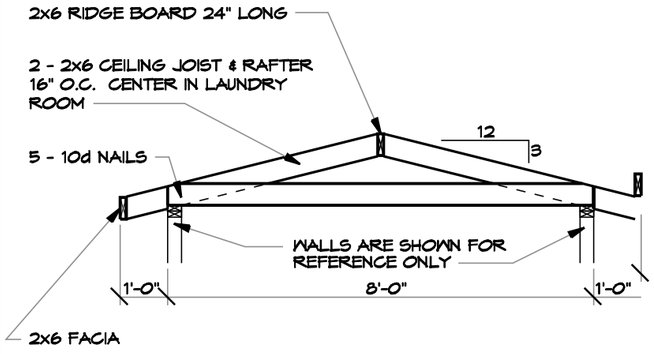
SCALE: 1½" = 1'-0"



C/3 WINDOW JAMB

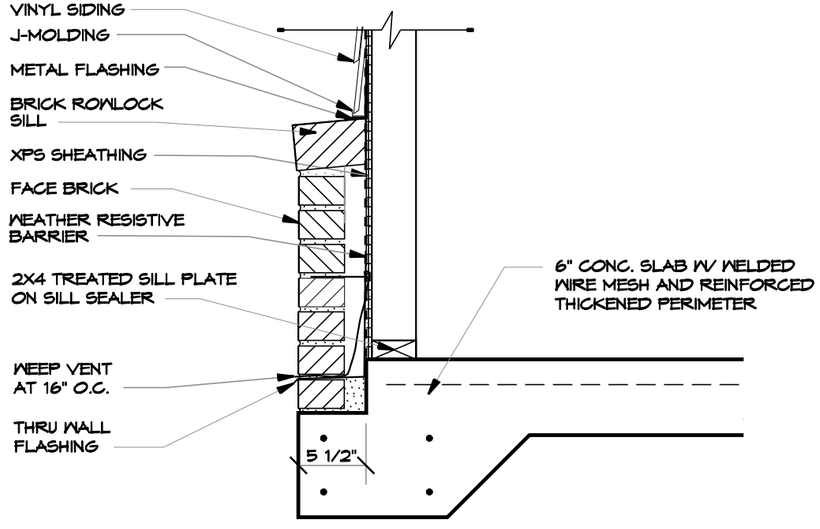
SCALE: 3" = 1'-0"





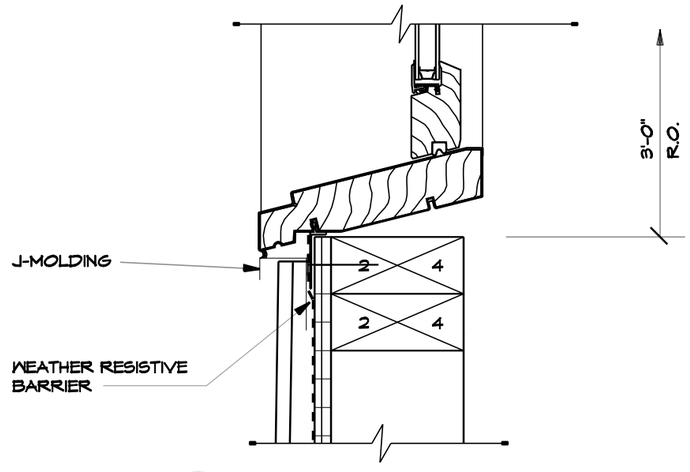
E/3 RAFTER DETAIL

NO SCALE



A/3 FOUNDATION / FLOOR SECTION

SCALE: 1" = 1'-0"



B/3 WINDOW SILL & HEAD DETAILS

SCALE: 3" = 1'-0"

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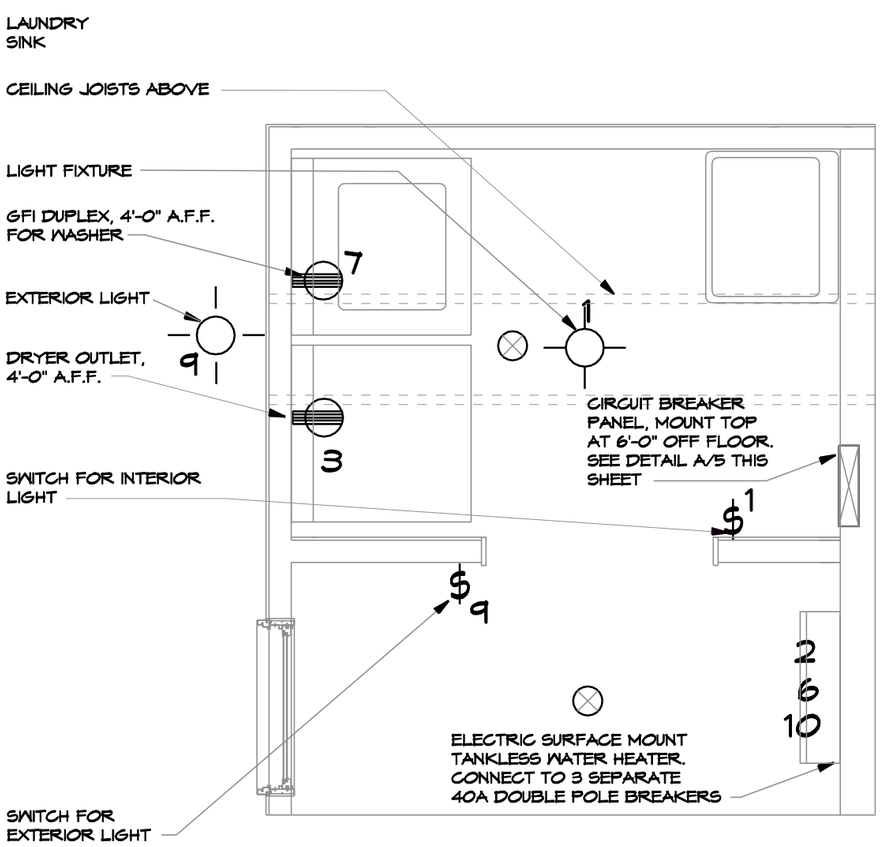


POWER FLOOR PLAN

SCALE: 1/2" = 1'-0"

ELECTRICAL LEGEND

GFI	GROUND FAULT INTERUPTER
A.F.F.	ABOVE FINISH FLOOR
3	GFI DUPLEX OUTLET & CIRCUIT NUMBER
$	SINGLE POLE SWITCH
M	APPLIANCE MOTOR

INTERIOR LIGHT	1	2	TANKLESS WATER HEATER
DRYER	3	4	TANKLESS WATER HEATER
DRYER	5	6	TANKLESS WATER HEATER
WASHER GFI	7	8	TANKLESS WATER HEATER
EXTERIOR LIGHT	9	10	TANKLESS WATER HEATER
NOT USED	11	12	TANKLESS WATER HEATER

A/5 BREAKER PANEL CIRCUITS

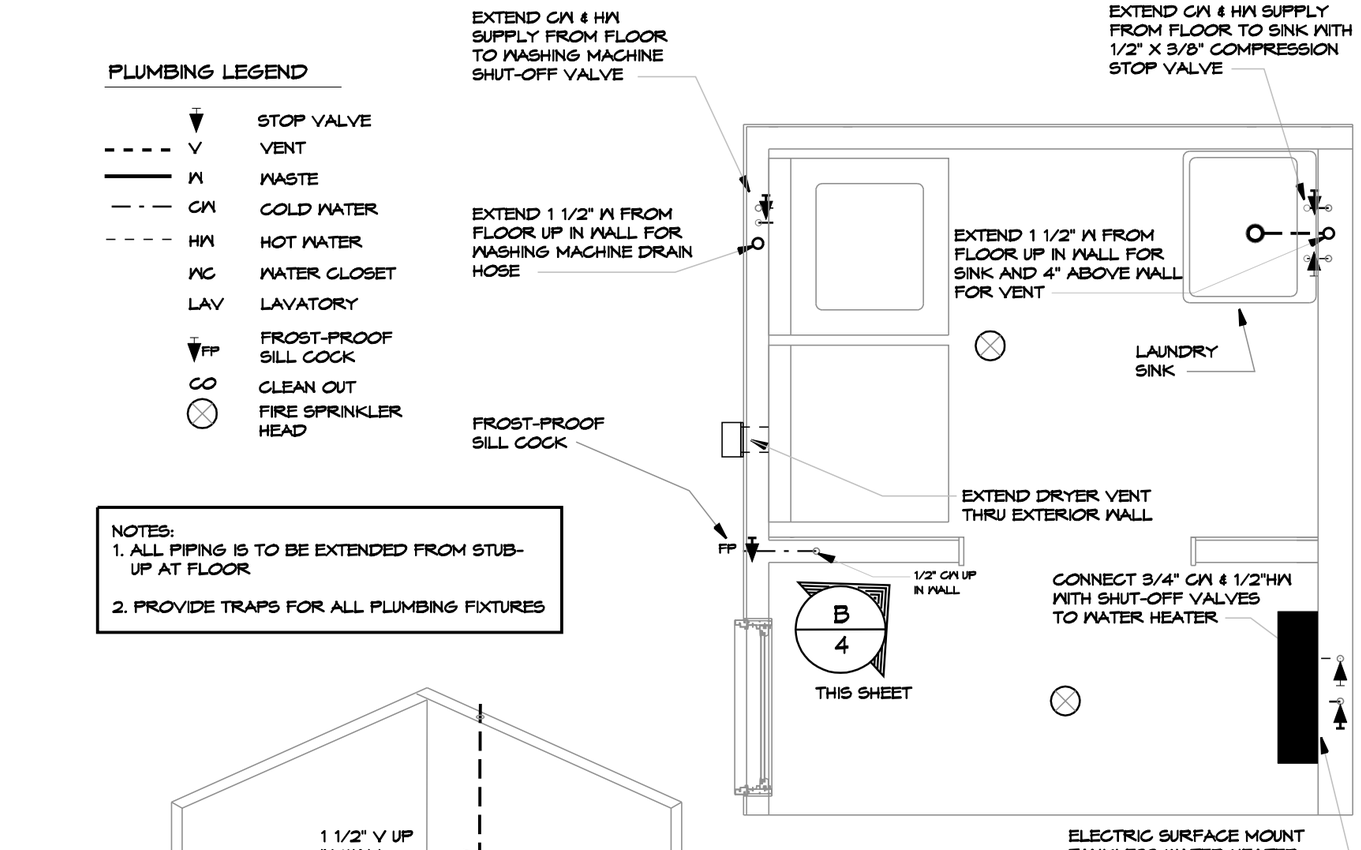
NO SCALE

ELECTRICAL

PLUMBING LEGEND

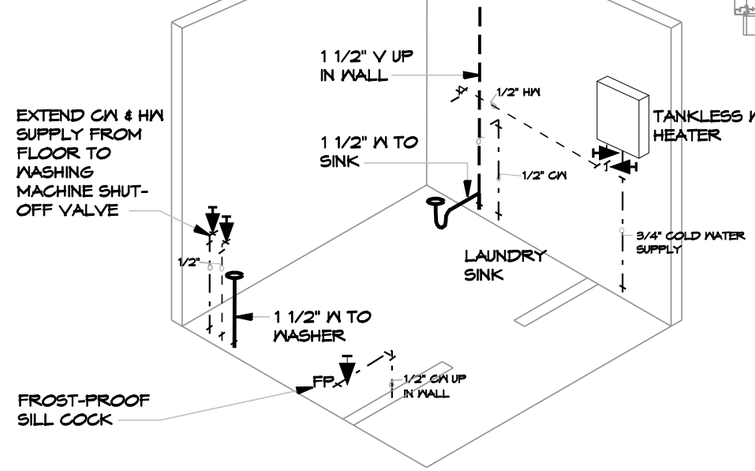
	STOP VALVE
V	VENT
W	WASTE
CW	COLD WATER
HW	HOT WATER
WC	WATER CLOSET
LAV	LAVATORY
FP	FROST-PROOF SILL COCK
CO	CLEAN OUT
	FIRE SPRINKLER HEAD

NOTES:
1. ALL PIPING IS TO BE EXTENDED FROM STUB-UP AT FLOOR
2. PROVIDE TRAPS FOR ALL PLUMBING FIXTURES



PLUMBING PLAN

SCALE: 1/2" = 1'-0"



B/4 PLUMBING STACK DIAGRAM

NO SCALE

PLUMBING

	2010 NATIONAL TEAMWORKS COMPETITION	REVISIONS: 6/03/2010 EK	DATE: 06/??/2010
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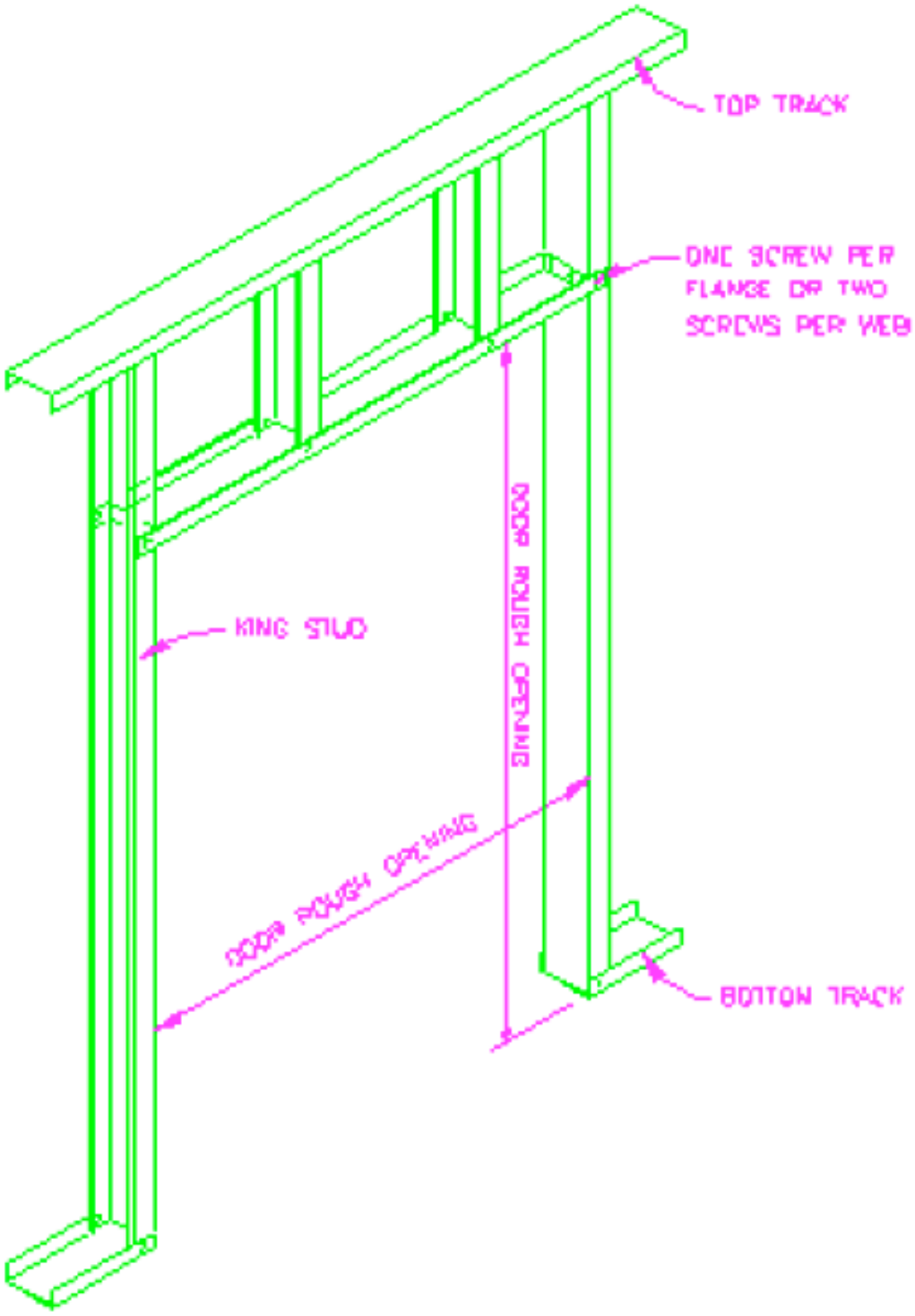
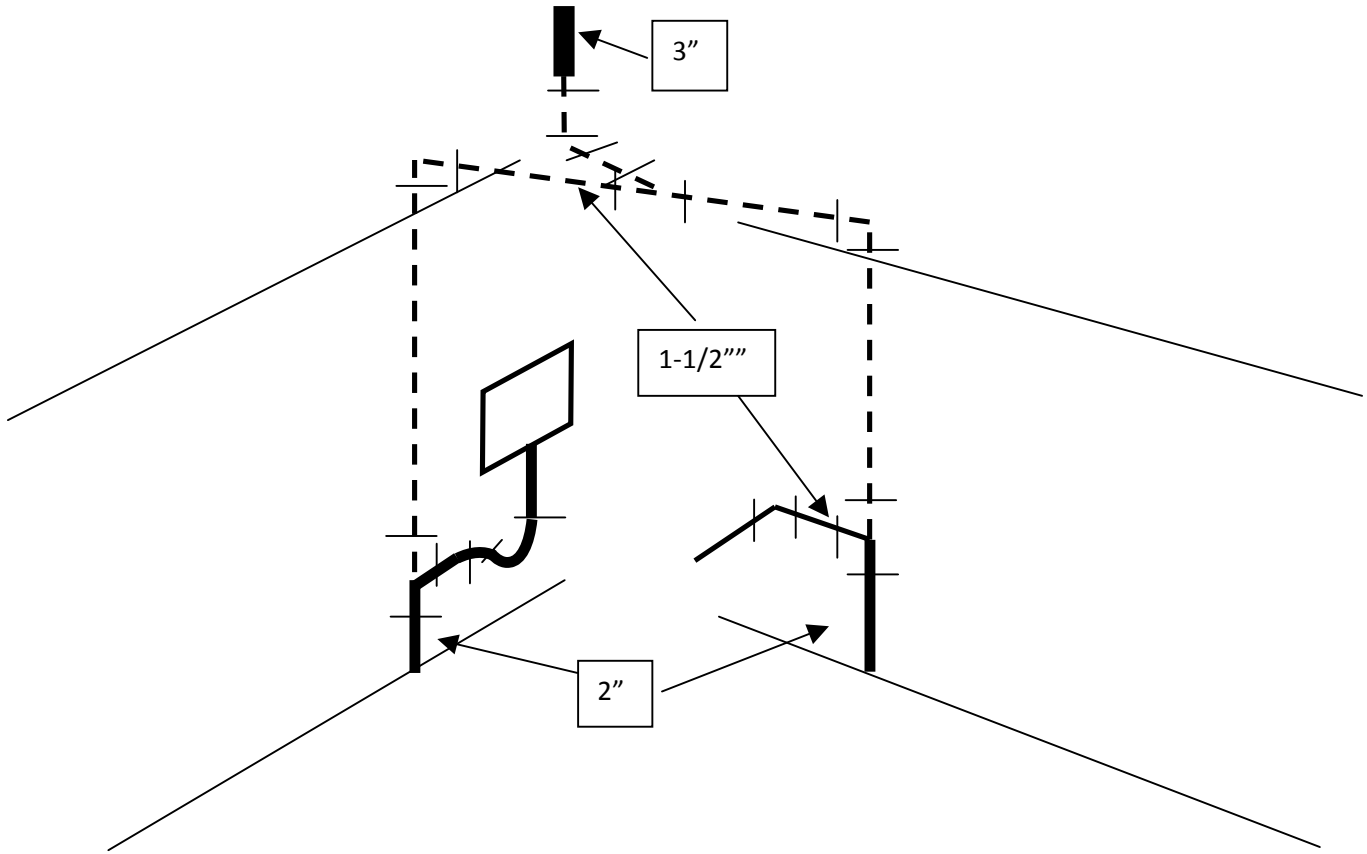
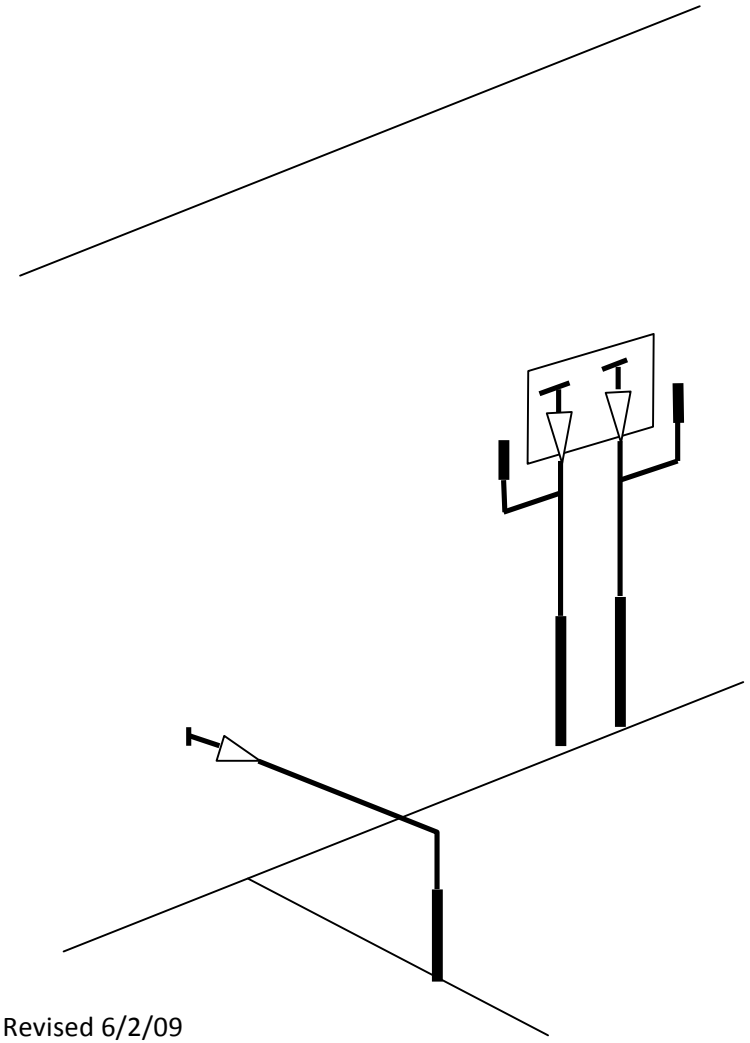
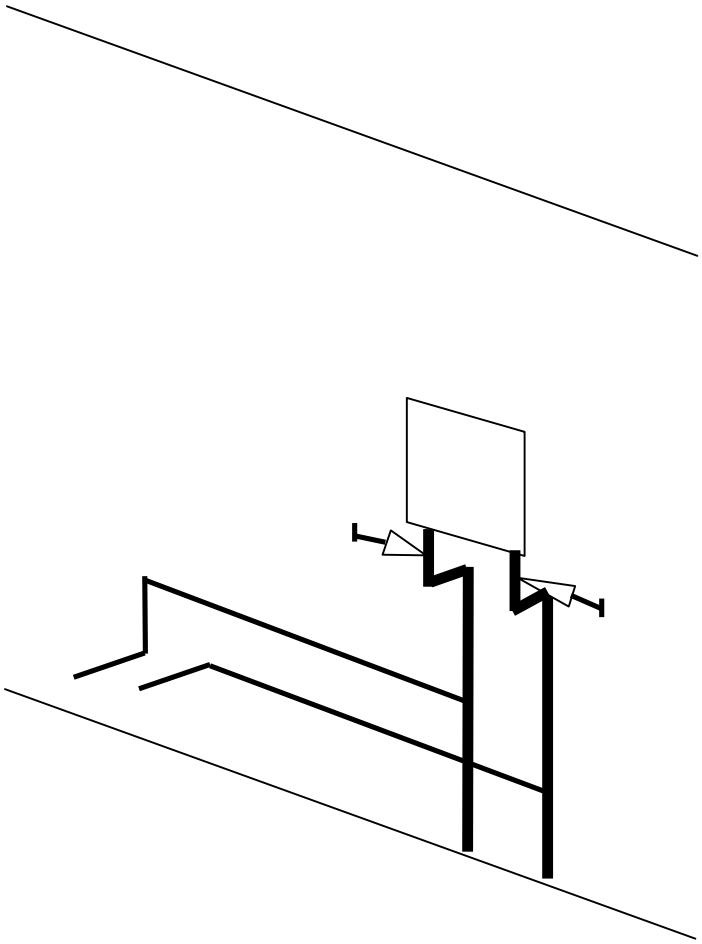

TOP TRACK
ONE SCREW PER FLANGE OR TWO SCREWS PER WEB
KING STUD
DOOR ROUGH OPENING
DOOR ROUGH OPENING
BOTTOM TRACK

PVC for TeamWork's 2009



Revised May 7, 2009

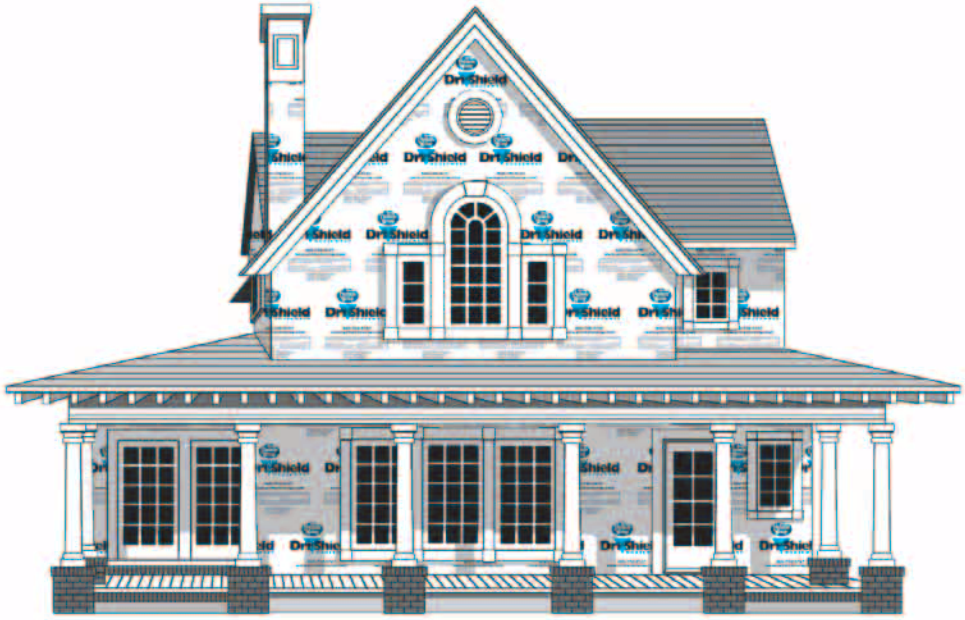




Premium Building Products
That Protect

Dri-Shield™ HOUSEWRAP

Another energy saving product from Protecto Wrap®



Dri-Shield™ Housewrap is a perforated polyolefin membrane that is installed beneath exterior siding to help reduce air and moisture infiltration. Dri-Shield™ Housewrap is not intended for use as a primary water barrier. Used in residential and commercial building, installing housewrap on an entire home or structure is generally the most common industry practice.

ADVANTAGES:

- Meets all building codes including SBCCI-ES 9737B, BOCAI-ES 21-56, and ICBO-ES ER-4449
- Dri-Shield™ Housewrap has achieved a permeance rating of 9 perms (average) and meets or exceeds all moisture/vapor transmission standards for building codes
- Helps stop mold and mildew by stopping moisture infiltration
- Perforated, high-quality, woven Polyolefin construction provides superior tear resistance
- Advanced perforated polyolefin membrane allows vapor to escape and prevent air infiltration and windblown rain from entering your home
- Protected with UV inhibitors and thermal degradation stabilizers to provide up to 365 day exposure
- Good contact clarity provides ease of stud recognition for precise fastener placement
- Works as a system application with all Protecto Wrap Products

PRODUCT WARRANTY:

Protecto Wrap Company warrants materials to be free of defects and will replace or, at our option, refund the purchase price of any materials proven to be defective. This limited warranty is in lieu of any other warranty or guarantee, expressed or implied, including warranties of merchantability or fitness for a particular purpose. In no event will Protecto Wrap Company be liable for incidental or consequential damages nor shall liability, if any, extend beyond the purchase price of the material. Protecto Wrap Company does not warrant the workmanship of the applicator.

Premium Building Products
That Protect

Dri-Shield™ HOUSEWRAP
www.protectowrap.com

INSTALLATION INSTRUCTIONS:

- Dri-Shield™ Housewrap should be installed on the exterior side of the exterior wall with the printed side facing outward.
- Place the roll 2-3 feet from the corner and fasten to studs with staples or roofing nails.
- Unroll the sheet horizontally around the building and fasten to studs and plates.
- Space the fasteners every 12″-18″ along the vertical studs using large-headed or plastic cap nails or minimum 1″ crown staples.
- Lap the sheet a minimum of 12 inches and tape it in both the vertical and horizontal dimensions.
- Seal all edges with an approved pressure sensitive tape.

FOR FINNED WINDOWS AND DOORS:

Cut the Dri-Shield™ even with the rough opening at the sill and header, trim back one inch at side jambs. Make relief cuts at the corners, fold back to expose exterior sheathing at the sides and top of the rough opening. Install window in accordance with manufactures instructions, flash with Protecto Wrap's BT25XL window and door sealing tape or Protecto Flex flexible flashing tape. After window is installed fold the Dri-Shield to cover the flashing and tape all seams.

For superior air infiltration resistance:

- Sill plates should be covered and taped or caulked.
- The wrap-around is completed with a 6 inch (152 mm) or greater overlap.
- All horizontal joints created by multiple layers must be positioned with the upper layer overlapping the lower layer by at least 2 inches (51 mm).
- Seal all edges, overlaps and punctures with a 2 inch minimum strip of BT25XL Window Sealing Tape, Housewrap seaming tape or equivalent product. **BT25XL Flashing Tapes have proven superior sealing and longevity over standard housewrap tapes.**

Protecto Wrap Dri-Shield™ Housewrap must be covered by approved siding product following the siding manufacturer's installation instructions and prevailing building codes within 12 months of installation for maximum product performance and warranty. Protecto Wrap Dri-Shield™ Housewrap is not intended to perform the function of an exterior siding product.

DIMENSIONS:

Weight:	27 lbs/1,500 sq. ft.
Thickness:	5 mils
Roll Sizes/Widths Available:	9', 10'
Roll Sizes/Lengths Available:	150'

WARNING:

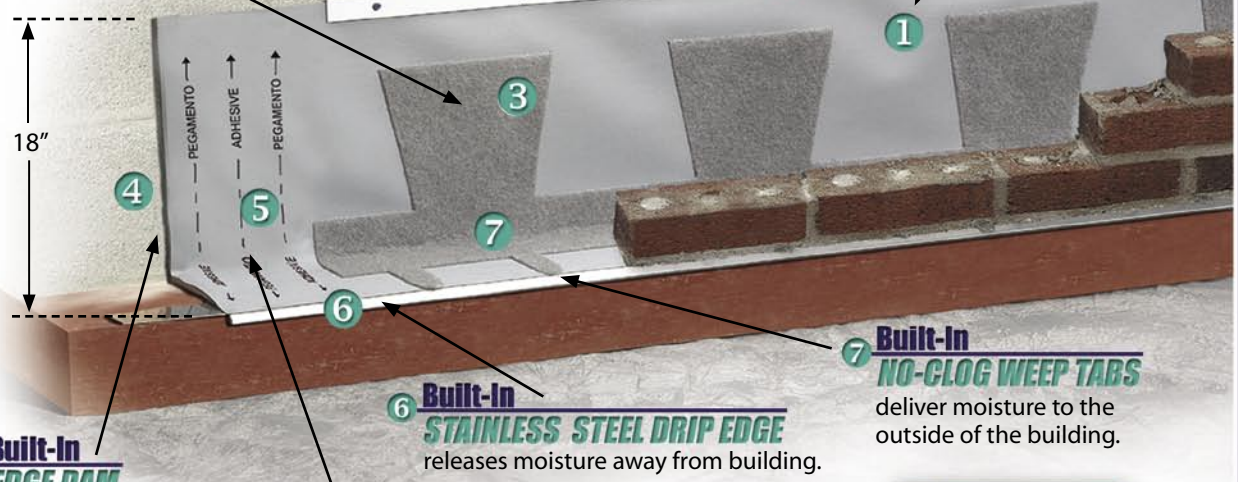
Protecto Wrap Dri-Shield™ Housewrap is slippery and should not be walked on. Dri-Shield™ Housewrap is not to be used directly with cedar siding. A cedar breather must be installed for correct air flow. Also, Protecto Wrap Company recommends code-approved kickbacks or scaffolds for exterior labor above the first floor.

PROTECTO WRAP COMPANY
1955 South Cherokee Denver, Colorado 80223 (303) 777-3001 Fax (303) 777-9273 (800) 759-9727
www.protectowrap.com

TOTALFLASH™

CAVITY-WALL DRAINAGE SYSTEM
by Mortar Net USA, Ltd.

Special Sizes for Restoration or Remediation Jobs, Too!



1 5-ft. Panels of PRE-CUT FLEXIBLE FLASHING*
All main components are factory-assembled onto easy-to-mount flashing panels.

2 Built-In TERMINATION BAR
with pre-drilled holes, allows quick, one-man installation.

3 Built-In NO-CLOG DRAINAGE MATTE
lets water pass, unobstructed, to Weep Tabs.

4 Built-In EDGE DAM
channels moisture down and out of building.

5 Clearly Specified LAP-JOINTS
enforce complete, secure coverage.

6 Built-In STAINLESS STEEL DRIP EDGE
releases moisture away from building.

7 Built-In NO-CLOG WEEP TABS
deliver moisture to the outside of the building.

*Our Standard Flashing Membrane is an 18-inch, 40-mil polymeric, reinforced, UV stable membrane, incorporating DuPont's Elvaloy® KEE polymer.

Screws & Adhesives Included
in each package of TOTALFlash™ panels.

IT'S 100 YEARS OF MOISTURE-CONTROL TECHNOLOGY THAT YOU CAN HOLD WITH ONE HAND.

Wondering how anyone could give you twice your usual protection (or more), with half your usual time & labor (or less)? Just see what our masonry experts have managed to build into each handy, 5-foot panel of premium flashing.

With TOTALFlash™ - Everyone Wins!

Flashing alone isn't enough to meet today's rigorous moisture-control demands. But until now, higher protection meant higher expenses for time & labor.

TOTAL*Flash*™ changed all that, delivering higher protection with lower costs. But the benefits don't end there:

BUILDERS see quicker completion while lowering the risk of future wall-damage or mold-growth.

MASONS no longer have to order an array of components, then hope everything arrives on time.

- They no longer have to struggle with "field-cutting" awkward flashing-rolls.
- Our new Pre-Formed Corners get them off to a quicker start.
- **TOTAL*Flash*™** high-speed installation lets them start laying brick much sooner.

ARCHITECTS get the coverage they specified. (Our clearly marked Lap Joints make it foolproof!)

OWNERS enjoys greater peace-of-mind and a longer building-life.

TENANTS breathe easier, knowing there's far less chance of moisture-related illness.

What will Mortar Net® USA LTD. think of next?

www.MortarNet.com
800-664-6638

TOTALFLASH™
CAVITY-WALL DRAINAGE SYSTEM
by Mortar Net USA, Ltd.

NOTHING to Cut

The job starts with corners, but you don't have to make them by hand any more. Our flawless, factory-built Corner Boots save you time & trouble.

And of course our new **TOTAL***Flash*™ means masons can quit being roofers, because each panel comes pre-cut to a handy, 5-foot length. (See inside.)

NOTHING Faster

TOTAL*Flash*™ can be installed by one worker, at speeds twice as fast as anything else they've used. Half the labor, half the time--it adds up to nice savings all around.

NOTHING Protects Better

For example, even when mortar or grout droppings pile up to the top of the flashing-panel, water will still escape through **TOTAL***Flash*™ layer of no-clog polyester mesh.

The Beauty of Green

Ideally, masonry buildings should last for centuries. Such longevity isn't just a benefit to the building's owner, it's a plus for our whole environment. Demolition wastes the resources that went into the old building, then spends new resources to build its replacement.

TOTAL*Flash*™ guards against the damage trapped moisture can cause to a building's exterior masonry walls, thus helping to prevent costly waste. It also works to suppress the air-quality hazards that can arise in damp wall cavities.

SECOND Chances

It happens that **TOTAL***Flash*™ was invented by Tom Sourlis, who restored the masonry of Chicago's famed Water Tower and many other historic landmarks.

Tom made sure to create **TOTAL***Flash*™ in sizes that could be easily installed in existing structures, without removing any additional courses of brick.

It can give older buildings a new lease on life, while helping to sustain our nation's resources.

*The use of **TOTAL***Flash*™ may help your project to qualify for LEED credits.*

SUSTAINABLE BUILDINGS INDUSTRY COUNCIL

ARCAT

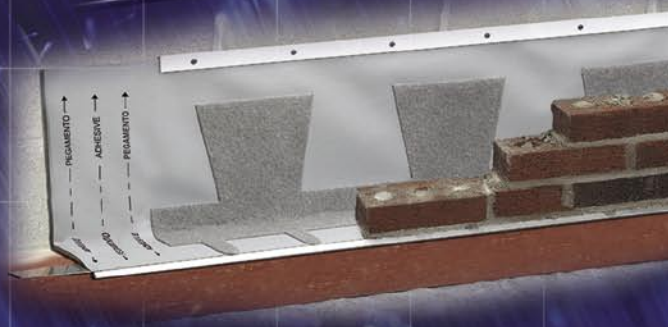
Mortar Net® USA LTD.

541 South Lake Street, Gary, IN 46403
800-664-6638
www.MortarNet.com

NEW TOTALFLASH™
CAVITY-WALL DRAINAGE SYSTEM
by Mortar Net USA, Ltd.

THE FIRST MASONRY FLASHING SYSTEM...

That Has It All!



Super Protection.
Super-Quick Installation.
Super Savings.

TOTAL Protection That Installs In A FLASH

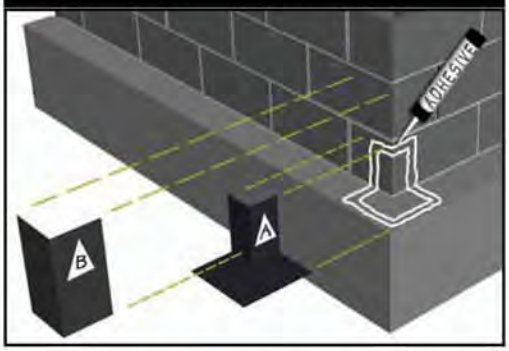
What will Mortar Net® think of next?

TOTALFLASH CAVITY-WALL DRAINAGE SYSTEM by MortarNet USA, Ltd.

(800) 664-6638

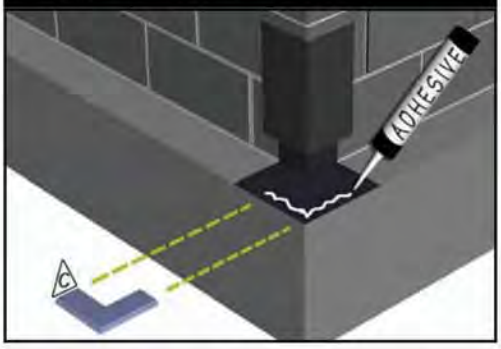
INSTALLATION GUIDE- Option A

1 STEP ONE



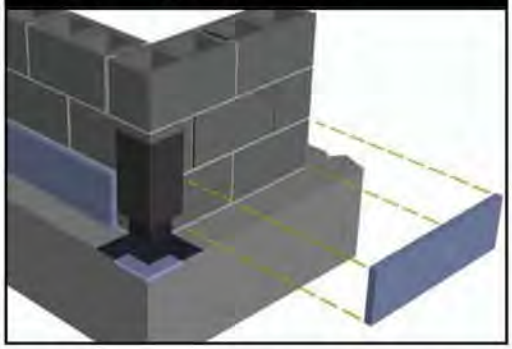
INSTALL PREFORMED CORNER A USING 2 BEADS OF ADHESIVE. APPLY PEEL & STICK LEGGING B OVER PRE FORMED CORNER BOOT.

2 STEP TWO



APPLY SEALANT / ADHESIVE TO PREFABRICATED STAINLESS STEEL CORNER C AND INSTALL OVER BOOT.

3 STEP THREE



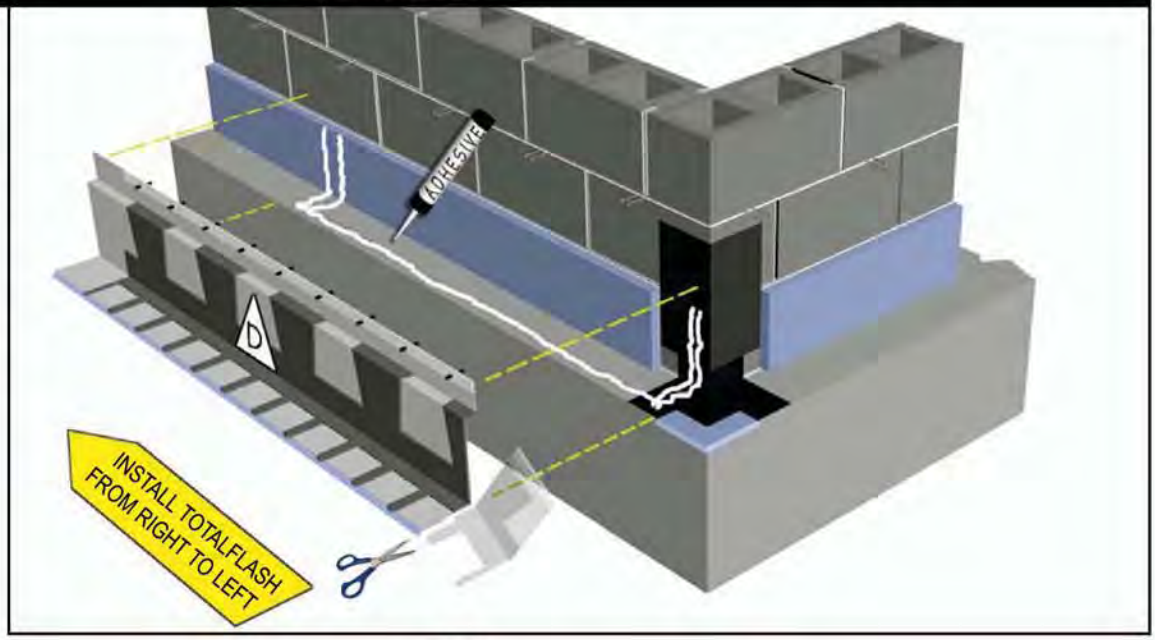
INSTALL 8" HIGH SECTIONS OF RIGID INSULATION BOARD AGAINST BACKUP WALL. HOLD INSULATION 6" FROM EACH CORNER.

4 STEP FOUR

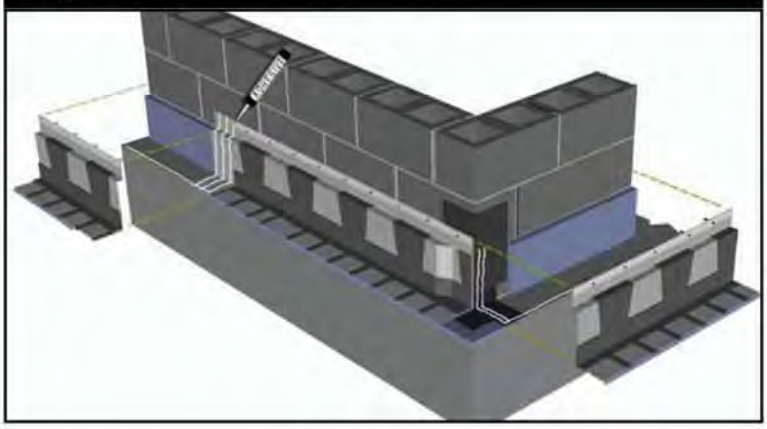
TRIM 6" LAP SECTION FROM RIGHT SIDE OF FIRST SECTION OF TOTALFLASH.

INSTALL TOTALFLASH D ADJACENT TO CORNER DRIP USING ADHESIVE.

INSTALL THE FIRST SECTION AT THE RIGHTMOST CORNER AND LAP SUBSEQUENT SECTIONS FROM RIGHT TO LEFT.

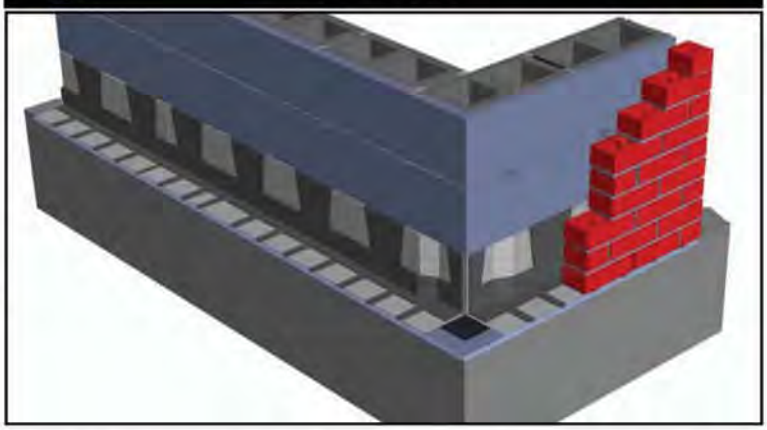


5 STEP FIVE



INSTALL REMAINING SECTIONS USING THE INTEGRATED LAP SYSTEM AND SEALANT, TRIM END SECTION FLUSH WITH CORNER DRIP. CAULK TOP OF TERMINATION BAR.

6 STEP SIX



INSTALL REMAINING RIGID BOARD INSULATION ABOVE TOTALFLASH.

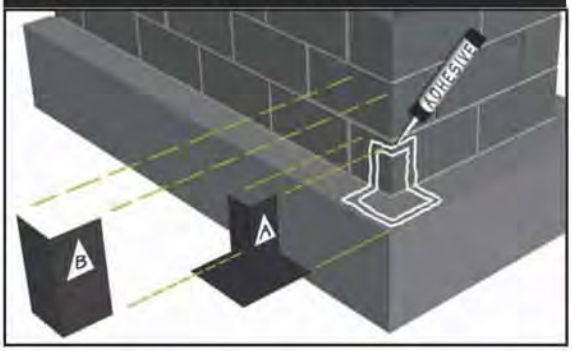
R2-12-14-07

TOTALFLASH
CAVITY-WALL DRAINAGE SYSTEM
by MortarNet USA, Ltd.

(800) 664-6638

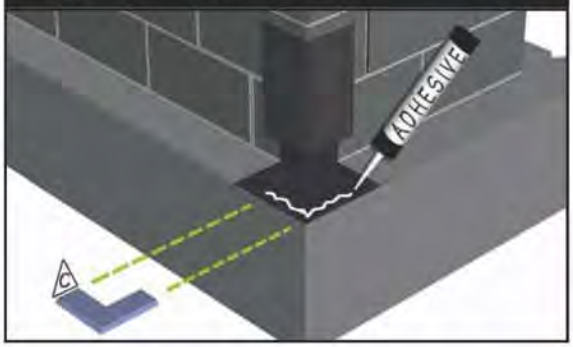
INSTALLATION GUIDE- Option B

1 STEP ONE



INSTALL PREFORMED CORNER A USING 2 BEADS OF ADHESIVE. APPLY PEEL & STICK LEGGING B OVER PRE FORMED CORNER BOOT.

2 STEP TWO



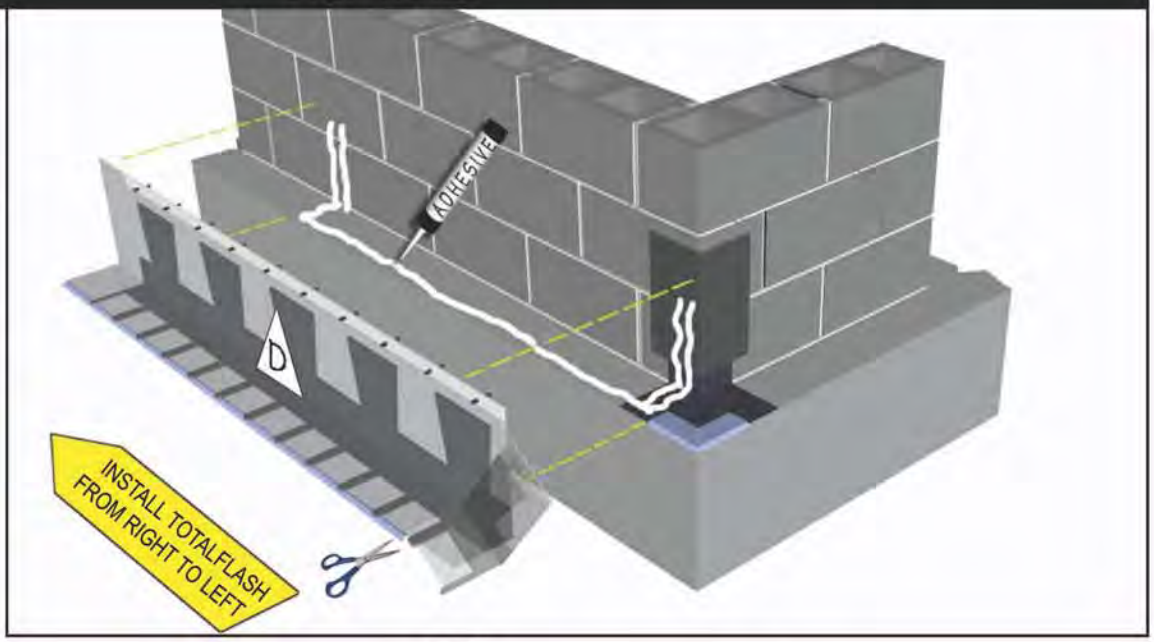
APPLY SEALANT / ADHESIVE TO PREFABRICATED STAINLESS STEEL CORNER C AND INSTALL OVER BOOT.

3 STEP THREE

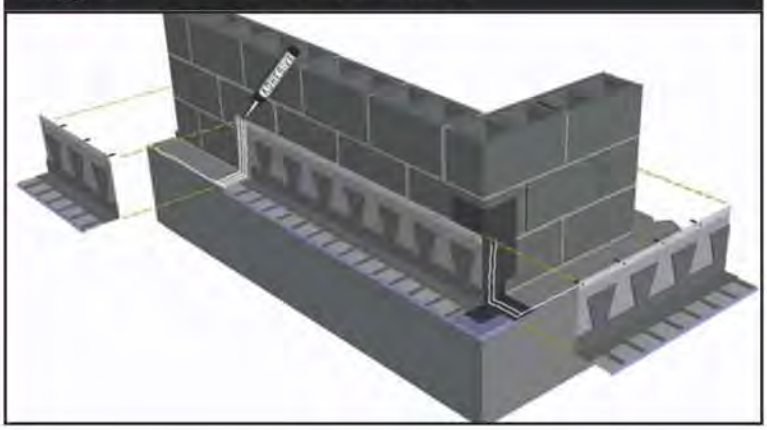
TRIM 6" LAP SECTION FROM RIGHT SIDE OF FIRST SECTION OF TOTALFLASH.

INSTALL TOTALFLASH D ADJACENT TO CORNER DRIP USING ADHESIVE.

INSTALL THE FIRST SECTION AT THE RIGHTMOST CORNER AND LAP SUBSEQUENT SECTIONS FROM RIGHT TO LEFT.

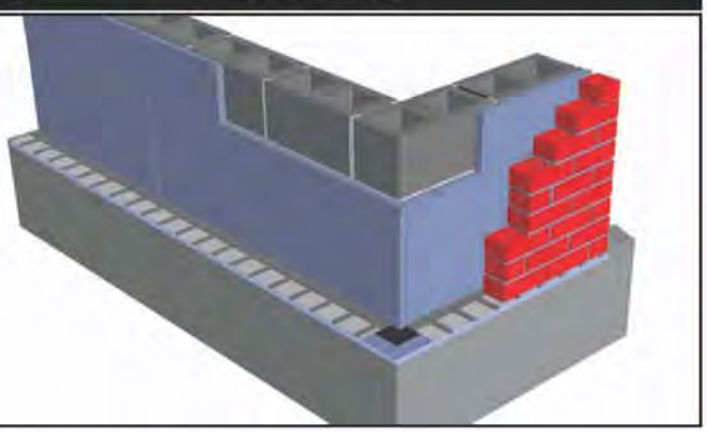


4 STEP FOUR



INSTALL REMAINING SECTIONS USING THE INTEGRATED LAP SYSTEM AND SEALANT, TRIM END SECTION FLUSH WITH CORNER DRIP. CAULK TOP OF TERMINATION BAR.

5 STEP FIVE



INSTALL RIGID BOARD INSULATION ABOVE TOTALFLASH.

R2-12-14-07

TOTALFLASH
CAVITY-WALL DRAINAGE SYSTEM
by MortarNet USA, Ltd.

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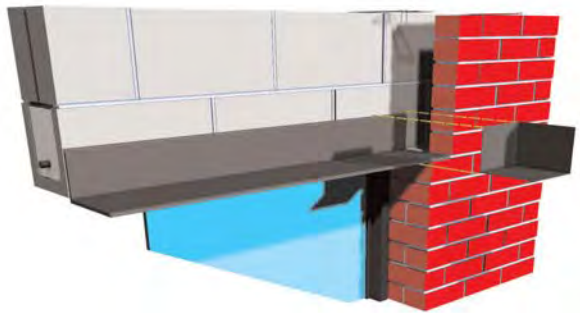
INSTALLATION GUIDE

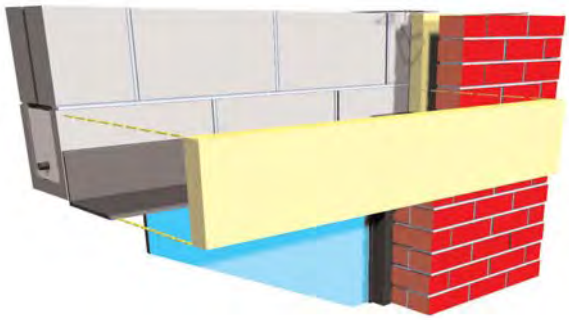
WINDOW HEAD FLASHING

1 STEP ONE



INSTALL SELF ADHERED PREFORMED END DAM ON BOTH ENDS OF OPENING, TRIM TO FIT.

2 STEP TWO

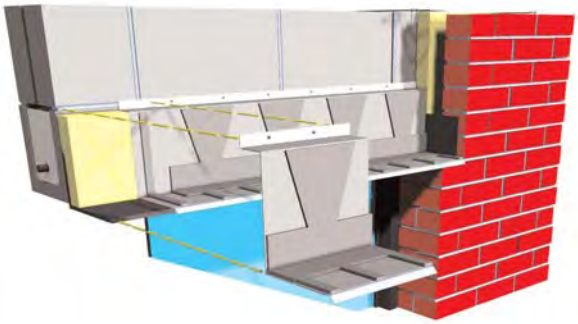


INSTALL 8 " HIGH SECTION OF RIGID INSULATION BOARD AGAINST THE BACKUP WALL AT LINTEL.

3 STEP THREE

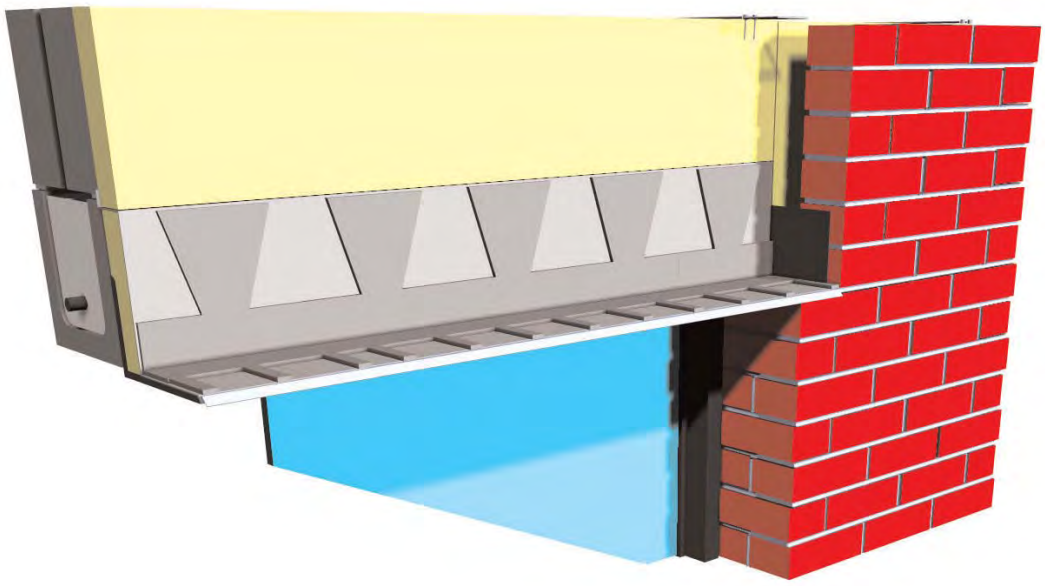
INSTALL FIRST SECTION OF TOTALFLASH ADJACENT TO END DAM USING ADHESIVE AND PRESSURE BAR SCREWS.

4 STEP FOUR



INSTALL REMAINING SECTIONS OF TOTALFLASH AS NEEDED USING THE INTEGRATED LAP SYSTEM, SEALANT AND SCREWS. CAULK TOP OF TERMINATION BAR.

5 STEP FIVE



INSTALL REMAINING RIGID BOARD INSULATION ABOVE TOTALFLASH.

TOTALFLASH
CAVITY-WALL DRAINAGE SYSTEM
by MortarNet USA, Ltd.

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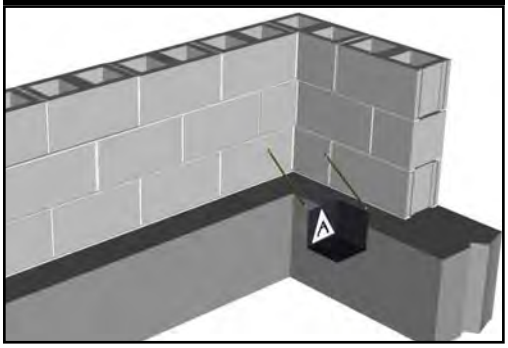
INSTALLATION GUIDE

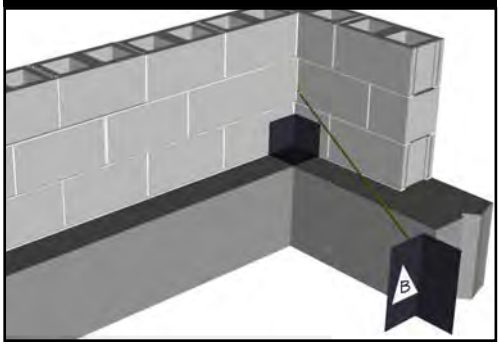
INSIDE CORNER

1 STEP ONE



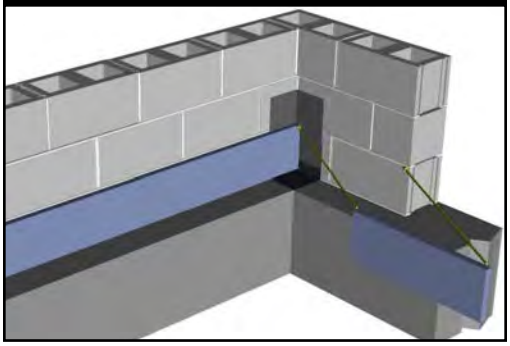
INSTALL PREFORMED CORNER Ⓐ USING 2BEADS OF ADHESIVE.

2 STEP TWO



APPLY PEEL & STICK LEGGING Ⓑ OVER PRE FORMED CORNER BOOT.

3 STEP THREE



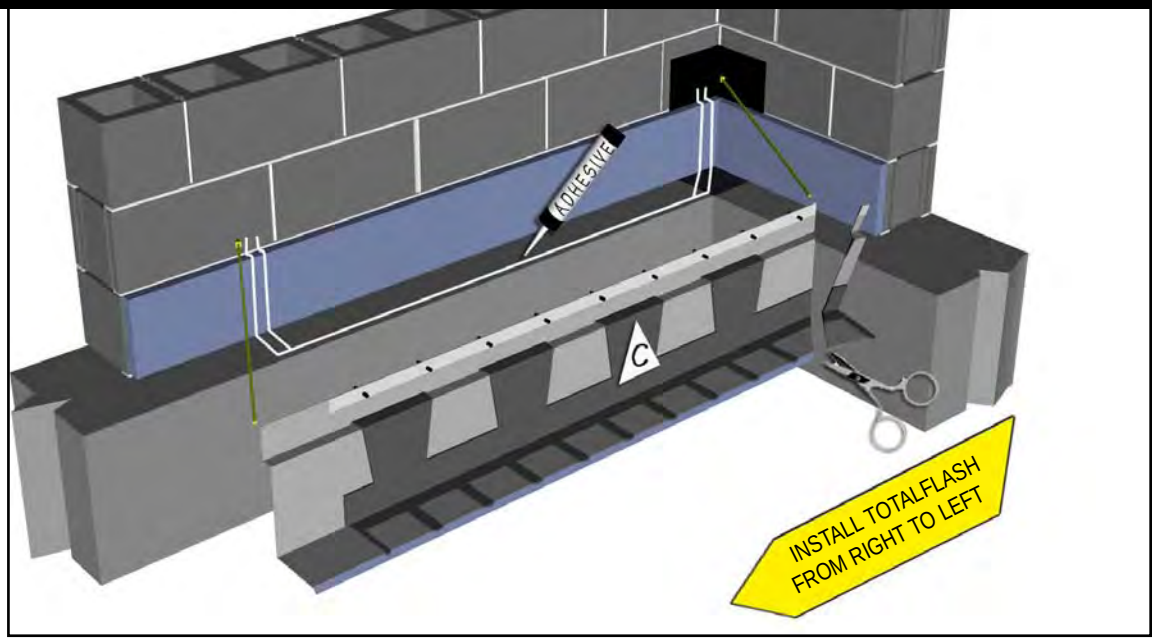
INSTALL 8" HIGH SECTIONS OF RIGID INSULATION BOARD AGAINST BACKUP WALL..

4 STEP FOUR

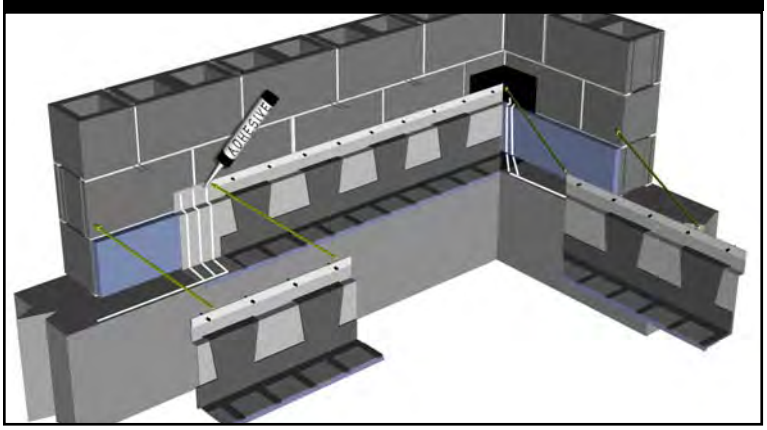
TRIM 6" LAP SECTION FROM RIGHT SIDE OF FIRST SECTION OF TOTAL FLASH AT A 45 DEGREE ANGLE.

INSTALL TOTALFLASH Ⓒ ADJACENT TO INSIDE CORNER USING ADHESIVE AND TERMINATION BAR SCREWS.

INSTALL THE FIRST SECTION AT THE RIGHTMOST CORNER AND LAP SUBSEQUENT SECTIONS FROM RIGHT TO LEFT.

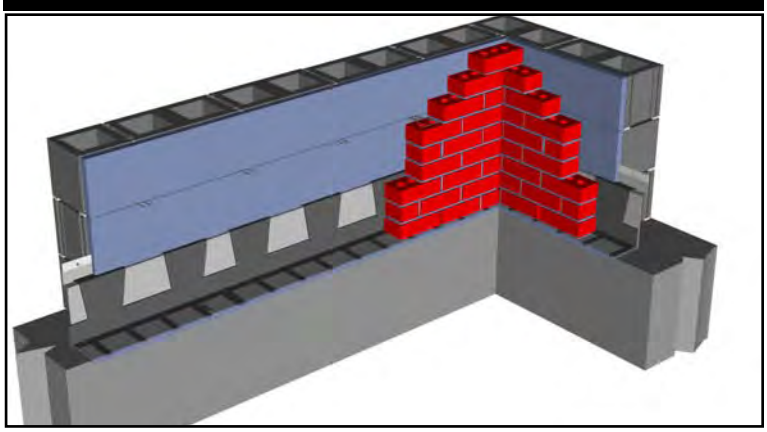


5 STEP FIVE



INSTALL REMAINING SECTIONS USING THE INTEGRATED LAP SYSTEM AND SEALANT, MITER END SECTION FLUSH WITH INSIDE CORNER. CAULK TOP OF TERMINATION BAR

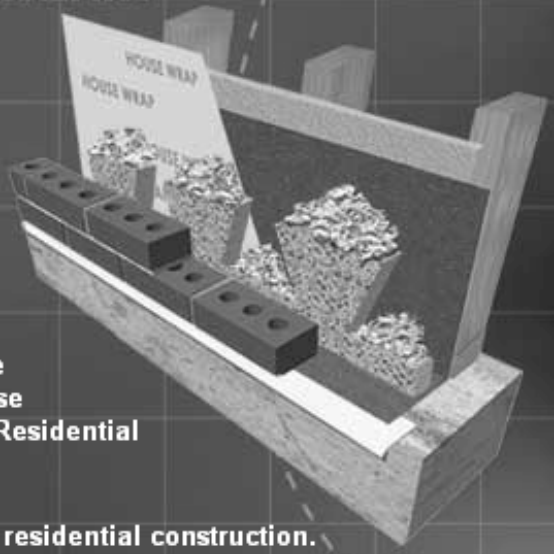
6 STEP SIX



INSTALL REMAINING RIGID BOARD INSULATION ABOVE TOTALFLASH

rev. 4-7-2008

HouseNet™ by Mortar Net®



The Residential HouseNet ™ Drainage System - Installation

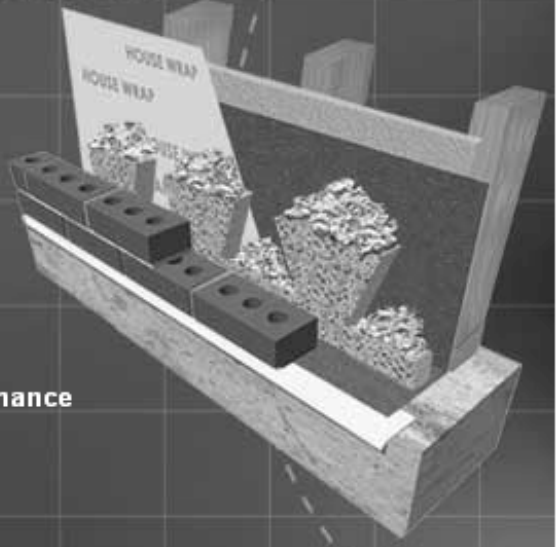
Residential HouseNet is easy to use. It requires no fasteners or adhesives, not special skill or tools. After the first one or two courses of bricks are laid, place a continuous row of Residential House Net in the cavity on the flashing against the back of the brick at the base of the wall. Flashing should extend to at least 6" above the top of the Residential HouseNet.

Mortar Net® USA, Ltd. recommends a minimum 1" cavity air space for residential construction. Mortar bridging can occur in cavities that are smaller. Should mortar bridging occur across the cavity space as the brick veneer wall is constructed, the mason should clean the mortar protrusions and bridges off the back of the bricks. Reasonable care must be taken to prevent excessive mortar droppings.

Cavity should be no more than ¼" wider than 1.0" and 2.0 thick material, and 0.4" thick material should touch both the outer and inner wall, insulation, or filler used to adjust the cavity size. Residential HouseNet is compressible to allow for variation in wall cavities.

Residential HouseNet must be used in conjunction with impermeable through wall flashings that are recommended by the flashing manufacturer for that use. Residential HouseNet used in combination with fast acting weep materials such as Mortar Net® Weep Vents create a system for proper water drainage and ventilation.

Residential HouseNet™ by Mortar Net®



The Residential HouseNet ™ Drainage System - Technical Data and Sizes

Residential HouseNet is made of recycled polyester with an anti-microbial additive to control mold growth. This material will not oxidize, rot, promote mold or fungus, or react with other common building materials such as mortar, cement, asphalt, modified bitumen, PVC, Copper, or galvanized metal, thereby ensuring long-term performance for all materials.

Residential HouseNet Sizes

Width	Height	Length	Package Qty
2.0"	7.75"	5'	80 lf
1.0"	7.75"	5'	80 lf
0.4"	7.75"	5'	80 lf

Mortar Net®
The Difference Is In *The Cut.*

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RESIDENTIAL HOUSENET™ CAVITY WALL SPECIFICATIONS 1/6

MASONRY ACCESSORIES 04090

This MANU-SPEC utilizes the Construction Specifications Institute (CSI) *Manual of Practice*, including *MasterFormat, SectionFormat, and PageFormat*. A MANU-SPEC is a manufacturer specific proprietary product specification using the proprietary method of specifying applicable to project specifications and master guide specifications. Optional text is indicated by brackets (); delete optional text in final copy of specification. Specifier Notes typically precede specification text; delete notes in final copy of specification. Trade/brand names with appropriate symbols typically are used in Specifier Notes; symbols are not used in specification text. Metric conversion, where used, is soft metric conversion.

This MANU-SPEC specifies a fabricated open mesh intended to catch and permanently suspend mortar droppings above weep holes, marketed under the Residential HouseNet™ brand name, as manufactured by Mortar Net USA, Ltd. (Patent Reissue #36676) When placed in the collar joint or cavity on top of the flashing at the base of a wall, the Mortar Net catches and permanently suspends mortar droppings in an irregular pattern above the weep hole vents. Due to its unique trapezoidal shape and strong plastic construction, mortar droppings cannot fall to the base of the flashing, so weep hole vents stay open. Because it prevents mortar droppings from forming a continuous dam, and due to its 90% open weave, moisture can pass quickly and easily to the weeps and air pressure differentials between the cavity and the exterior can equalize through the open weeps and Mortar Net itself. Revise MANU-SPEC section number and title below to suit project requirements, specification practices and section content. Refer to CSI MasterFormat for other section numbers and titles. Including 04050 Basic Masonry Materials & Methods; 04090 Masonry Accessories; 04200 Masonry Units; and 04800 Masonry Assemblies.

SECTION 04090
MASONRY ACCESSORIES
(MASONRY ASSEMBLIES)

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes: Mortar dropping collection device for masonry veneer walls.

Specifier Note: Revise paragraph below to suit project requirements. Add section numbers and title per CSI MasterFormat and specifier's practice.

B. Related Sections: Section(s) related to this section include:
   1. Unit Masonry: Division 4 Unit Masonry Assembly Section.
   2. Wall Flashing: Division 7 Flashing Section.
   3. Brick and Block Vents: Division 10 Vents Section.

Specifier Note: Retain paragraph below to suit project requirements. Coordinate with Part 2 Products herein and other Contract Documents.

C. Unit Prices: Products and Installation included in this section are specified by unit prices. Refer to Division 1 Unit Prices Section for unit prices amounts and requirements.
   1. Unit Price: Unit price is per lineal foot (304.8 mm).

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1.02 SYSTEM DESCRIPTION

A. System Description: Use Residential HouseNet™ as part of standard masonry veneer wall flashing/weep hole wall drainage systems. The Residential HouseNet™ keeps weep hole vents open and flashing free of mortar droppings and debris by catching and permanently suspending droppings above the level of the top of the weep hole vents, by preventing mortar from forming a continuous barrier against proper water flow to the weeps and by providing routes through the body of the product itself for water to flow to the flashing and weeps.

B. Performance Requirements: Provide (Section/Product Title) which has been manufactured, fabricated and installed to withstand loads from (specify code/standard reference,) and to maintain (specify performance criteria,) performance criteria stated (certified) by manufacturer without defects, damage or failure.

Specifier Note: Article below includes submittal of relevant data to be furnished by Contractor before, during or after construction. Coordinate this article with Architect's and Contractor's duties and responsibilities in Conditions of the Contract and Division 1 Submittal Procedures Section.

1.03 SUBMITTALS

A. General: Submit listed submittals in accordance with Conditions of the Contract and Division 1 Submittal Procedures Section.

B. Product Data: Submit product data, including manufacturer's SPEC-DATA product sheet, for specified products.

C. Samples: Submit selection and verification samples.

D. Quality Assurance Submittals: Submit the following:
   1. Certificates: Product certificates signed by manufacturer certifying materials comply with specified performance characteristics and criteria.
   2. Manufacturer's Instructions: Manufacturer's Installation Instructions.

E. Closeout Submittals: Submit the following:
   1. Warranty: Warranty documents specified herein.

Specifier Note: Article below should include prerequisites, standards, limitations and criteria which establish an overall level of quality for products and workmanship for this section. Coordinate below article with Division 1 Quality Assurance Section.

1.04 QUALITY ASSURANCE

A. Installer Qualifications: Installer experienced in performing work of this section who has specialized in installation of work similar to that required for this project.

Specifier Note: Paragraph below should list obligations for compliance with specific code requirements particular to this section. General statements to comply with a particular code are typically addressed in Conditions of the Contract and Division 1 Regulatory Requirements Section. Repetitive statements should be avoided.

B. Regulatory Requirements: (Specify applicable requirements of regulatory agencies.)

Specifier Note: Coordinate paragraph below with Division 1 Project Management and Coordination (Project Meetings) Section.

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1.04 QUALITY ASSURANCE (cont.)

C. Pre-installation Meeting: Conduct pre-installation meeting to verify project requirements, substrate conditions, manufacturer's installation instructions and manufacturer's warranty requirements. Comply with Division 1 Project Management and Coordination (Project Meetings) Section.

Specifier Note: Article below should include special and unique requirements. Coordinate article below with Division 1 Product Requirements Section.

1.05 DELIVERY, STORAGE AND HANDLING

A. General: Comply with Division 1 Product Requirements Sections.

B. Ordering: Comply with manufacturer's ordering instructions and lead time requirements to avoid construction delays.

C. Packing, Shipping, Handling and Unloading: (Specify applicable requirements.)

Specifier Note: Products of 1", 2", and .4" thick material are shipped 80 lineal feet (24,384 mm) per cardboard box, with sixteen 5' (1524 mm) sections per box. Product requires no special handling, is very lightweight, and boxes and loose materials are easily handled by 1 person. Secure loose and boxed material during strong winds.

D. Delivery: Deliver materials in manufacturer's original, unopened, undamaged containers with identification labels intact.

E. Storage and Protection: Store materials protected from exposure to harmful weather conditions and at temperature conditions recommended by manufacturer.
   1. Do not expose material to direct sunlight for more than 2 weeks. If material is protected from exposure to direct sunlight it may be stored indefinitely.

1.06 SEQUENCING

A. General: Install the Residendtial HouseNet™ product after flashing has been installed, the first 1 or 2 courses of brick have been laid, and weep holes have been created. Install product before third or higher courses of brick have been laid.

Specifier Note: Coordinate article below with Conditions of the Contract and with Division 1 Closeout Submittals (Warranty) Section.

1.07 WARRANTY

A. Project Warranty: Refer to Conditions of the Contract for project warranty provisions.

B. Manufacturer's Warranty: Submit, for Owner's acceptance, manufacturer's standard warranty document executed by authorized company official. Manufacturer's warranty is in addition to, and not a limitation of, other rights Owner may have under Contract Documents.

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1.07 WARRANTY (cont.)

Specifier Note: Coordinate paragraph below with manufacturer's warranty requirements. Mortar Net USA, Ltd. warrants its products to be of the quality and composition stated and free of manufacturer's defects. It will replace or refund the purchase price of any product proved defective. This limited warranty is the only warranty extended by Mortar Net USA, Ltd. In regard to its product, Mortar Net USA, Ltd.'s liability shall not exceed the purchase price of the material in question. Every construction project is unique; therefore, every use of Residential HouseNet™ *and Mortar Net Weep Vents must be evaluated and approved by a qualified professional such as an architect or engineer familiar with the project.*

1. Warranty Period: (Specify term,) years commencing on Date of Substantial Completion.

PART 2 PRODUCTS

Specifier Note: Retain article below for proprietary method specification. Add product attributes, performance characteristics, material standards and descriptions as applicable. Use of such phrases as "or equal" or "or approved equal" or similar phrases may cause ambiguity in specifications. Such phrases require verification (procedural, legal and regulatory) and assignment of responsibility for determining "or equal" products.

2.01 MASONRY VENEER WALL DRAINAGE SYSTEM

A. Manufacturer: Mortar Net USA, Ltd.

Specifier Note: Paragraph below is an addition to CSI SectionFormat and a supplement to MANU-SPEC. Retain or delete paragraph below per project requirements and specifier's practice.

1. Contact: 541 South Lake Street, Gary, IN 46403; Telephone: (800) 664-6638, (219) 939-3870; Fax: (219) 939-3877, E-mail: webmaster@mortarnet.com Website: www.mortarnet.com

Specifier Note: The Mortar Net is manufactured of nylon, high density polyethylene (HDPE) or polyester, fabricated in a 90% open mesh, 2", 1" or 0.4" (51, 25.4, 10.2 mm) thick. It has no negative reaction to PVC, polyethylene, polystyrenes, copper, lead, rubberized asphalt, or stainless steel and will not degrade or decompose over the life of the building. It will not absorb or trap moisture and water, and it will not support mold or fungus. The Mortar Net is patented, U.S. Patent Reissue #36676.

B. Proprietary Product(s)/System(s): The Residential HouseNet™ accessory.

1. Mortar Net MN 10-1: 7¾" (196.9 mm) high x 1" (25.4 mm) thick material.
2. Mortar Net MN 10-4: 7¾" (196.9 mm) high x 0.4" (10.2 mm) thick material.
3. Mortar Net MN 10-2: 7¾" (196.9 mm) high x 2" (51 mm) thick material.

Specifier Note: Edit article below to suit project requirements. If substitutions are permitted, edit text below. Add text to refer to Division 1 Project Requirements (Product Substitutions Procedures) Section.

2.02 SUBSTITUTIONS

A. Product Substitutions: No substitutions permitted.

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2.03 MATERIALS

Specifier Note: 1" (25.4 mm) material is high density polyethylene (HDPE), 0.4" (10.2 mm) thick material is nylon, and 2" (51 mm) thick material is recycled polyester. None of these materials will oxidize, rot, support mold or fungus, or react with common building materials, including mortar, cement asphalt, modified bitumen, PVC, copper, steel, or galvanized metal, and they are not edible by insects. The material retains its slope anti-rigidity and is undamaged by extended exposure to norml field temperatures, and is highly resistant to UV degradation.

A. Materials: Manufacturer's standard Residential HouseNet™ material for specified product.

1. All dimensions are nominal. Measurements are inclusive of the continuous bottom strip and the dovetail shape.
2. Four available sizes: 1" (25.4 mm) and 0.4" (10.2 mm) thicknesses by 10" (254 mm) height by 5' (1524 mm) long. 2" (51 mm) thick by 10" (254 mm) x 5' (1524 mm) long.
3. Continuous bottom strip on all sizes of material is 3" (76.2 mm) high, regardless of material thickness or overall material height.
4. 1" (25.4 mm) thick product is high density polyethylene (HDPE), 0.4" (6.4 mm) thick product is nylon, and 2" (51 mm) thick material is recycled polyester. Product is a 90% open weave mesh in a dovetail configuration connected by a continuous bottom strip.

2.04 SOURCE QUALITY

A. Source Quality: Obtain the Mortar Net materials from a single manufacturer.

PART 3 EXECUTION

Specifier Note: Article below is an addition to the CSI SectionFormat and a supplement to MANU-SPEC. Revise article below to suit project requirements and specifier's practice.

3.01 MANUFACTURER'S INSTRUCTIONS

A. Compliance: Comply with manufacturer's product data, including product technical bulletins, product catalog installation instructions and product carton instructions for installation.

3.02 EXAMINATION

A. Site Verification of Conditions: Verify substrate conditions, which have been previously installed under other sections are acceptable for product installation in accordance with manufacturer's instructions.
   1. Match product size to cavity size. Cavity should be no more than 1/4" (6.4 mm) wider than 1" (25.4 mm) thick material and 2" (51 mm) thick material, and 0.4" (10.2 mm) thick material should touch both the outer wythe and the inner wall. For cavities larger than 2" (51 mm), place rigid insulation of sufficient height to extend at least 6" (152 mm) above the top of the Residential HouseNet™ against the outside of the inner wythe and of appropriate thickness to reduce the cavity to the appropriate size.
   2. Inspect for and repair holes in flashing immediately prior to installing Residential HouseNet™.

541 South Lake Street • Gary, IN 46403
Tel: 800.664.6638 • Fax: 219.939-3877

3.03 PREPARATION

A. Preparation: Clean flashing and weep holes so they are free of mortar droppings and debris immediately prior to installing Mortar Net. If wicks are used (not recommended), prevent mortar from coating or covering wicks inside the cavity. Washing flashing with water or chemicals prior to installation is not necessary.

Specifier Note: Coordinate article below with manufacturer's recommended installation details and requirements.

Specifier Note: Manufacturer recommends placing 1 continuous row of Residential HouseNet™ in the collar joint or cavity on the flashing at the base of the wall, at each flashing level and over lintels. Position with the zigzag side up (see manufacturer's CAD details). The Mortar Net should fit snugly in cavity, so if cavity is greater than 2" (51 mm) wide, either use several thicknesses of The Mortar Net or use appropriately sized styrofoam board (or equivalent) not less than 16" (406 mm) high as a spacer to fill excess space. Place spacer against the outside of the interior wall so The Mortar Net is against the inside of the exterior wythe. If no spacer is used, flashing should extend not less than 6" (152 mm) above the top of The Mortar Net to avoid the possibility of mortar bridging between the exterior wythe and interior wall. Adhesives, fasteners, specials skills or tools are not required.

3.04 INSTALLATION

A. Mortar Net Installation:

1. For most walls, install 1 continuous row of The Mortar Net at base of wall and over all wall openings directly on flashing.
2. To prevent mortar bridging between the outer wythe and inner wall, install flashing extending from the bottom of The Mortar Net to at least 6" (152 mm) above the top of The Mortar Net.
3. Multiple thicknesses of Residential HouseNet™ may be installed to match cavity widths and if excessive droppings are expected. Inspection, preparation and installation procedure for multiple thicknesses is the same as for single thickness. When installing multiple thicknesses, align the dovetail sections with each other.
4. To match cavity width to product thickness without using multiple thicknesses of Residential HouseNet™, place rigid insulation of appropriate thickness against outside face of inner wall.
5. Lay the first 1 or 2 courses of brick at flashing level, then install Residential HouseNet™ continuously by placing it against the inside of the openings. No fasteners or adhesives are rquired, and mortar need not have set.
6. Residential HouseNet™ shall not come in contact with wall ties standard wall tile installations, but if it does, it may be cut or torn to accommodate wall ties, conduit, plumbing or other materials that bridge or intrude into cavity between inner and outer walls.
7. Compress Residential HouseNet™ horizontally so it can be forced into cavities slightly smaller than its nominal thickness without affecting Mortar Net or wall performance.
    a. When forcing Residential HouseNet™ into a cavity, be sure mortar has set sufficiently to resist outward pressure from product.

B. Related Products Installation: Refer to other sections for installation of related products as follows:
1. Masonry: Refer to Division 4 Unit Masonry Sections.

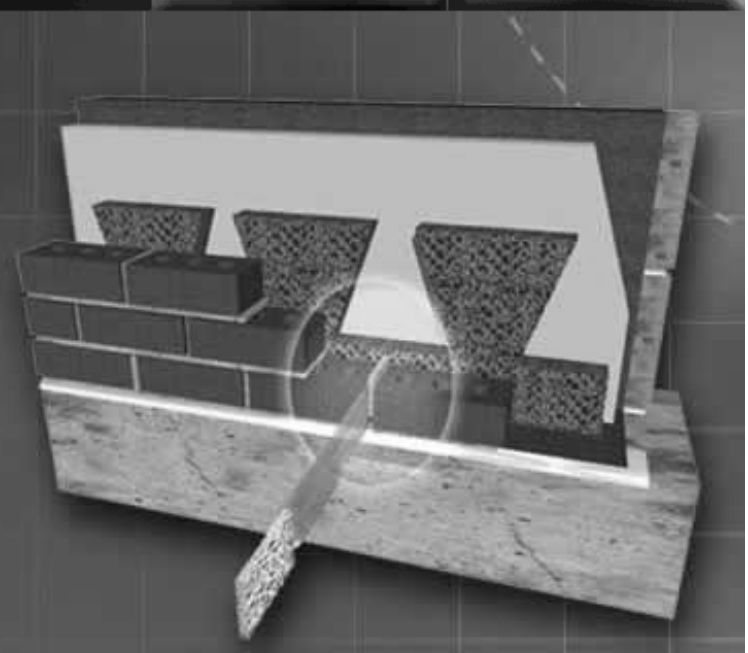
3.05 PROTECTION

1. Protection: Protect installed product from damage during construction.

END OF SECTION

Mortar Net®

WEEP VENT



Mortar Net Weep Vents - Technical Data

Mortar Net Weep Vents are made from recycled polyester with a 90% open mesh, and are bonded with a flame retardant adhesive to provide resiliency and strength, plus an anti-microbial additive to control mold growth.

Sizes

Width	Height	Thickness	Package Quantity
2.25"	3.5"	0.5"	125

Installation

Mortar Net Weep Vents are quick and easy to install. After the first course of brick simply place a Weep Vent in open head joint 24" O.C. No fasteners, adhesives or special tools are required. Mortar Net Weep Vents are slightly compressible to allow for variations

Available in these colors:

White Gray Almond Tan Red Brown

Installation Instructions For New Construction
Single Hung, Double Hung And Picture Windows.

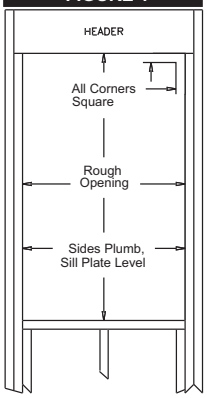
(The manufacturer's warranty is voided if these instructions are not followed.)

Window Opening

The rough opening must be plum, level and square and 1/2 inch larger than window size in width and height, not including the nailing fins (See fig. 1). Close and lock the sash to aid in keeping the window square during installation.

Apply a 3/8-inch continuous bead of silicone caulking to the interior surface of the nailing fin covering the holes in the fin, to seal the window's fin to the sheathing or house wrap. If the rough opening is larger than the window unit by more than 1/2 inch, also apply the caulk to the sheathing or house wrap making sure the bead is no more than 1/4 inch from the edge of the rough opening, so that it is covered by the nailing fin when the window is installed.

FIGURE 1



Setting Shims

The sill of the window must be supported in a straight and level position at a minimum of three points, at either end and in the middle. Windows wider than 30 inches should be supported at a maximum of every 12 inches. (See fig. 2)

Placing Shims

Place 1/4 inch shims on the sill plate of the window opening spaced as described above. Multiple twin or triple windows should have a shim under each mullion. (See fig. 2)

Setting Window

Set window on the shims and adjust side clearance to be equal on both sides. Tack one upper corner of the fin to keep window in place . Check sill with a level and adjust thickness of shims as required to level sill. Re-adjust side clearance if necessary. Shims must be cut to exact thickness to fit snug and not fall out but do not force shims into place, pushing the sill upward out of level. Shim both sides of window (see fig. 2) and adjust thickness of shims to make diagonal measurements equal with the window plumb and square.

If the above has been done correctly the width across the top, middle and bottom will measure the same. The wool pile clearance between the sash stile and jamb mainframe will be equal. The meeting rail and lock rail will align evenly at the top of the bottom sash with parallel sight lines. The sweep latches should lock smoothly.

FIG. 2, EXTERIOR VIEW

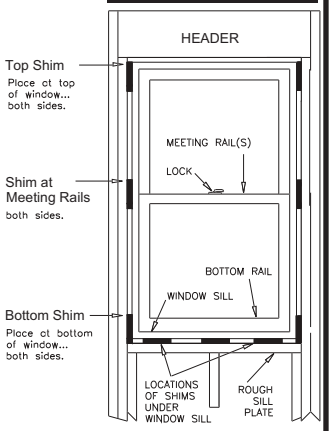
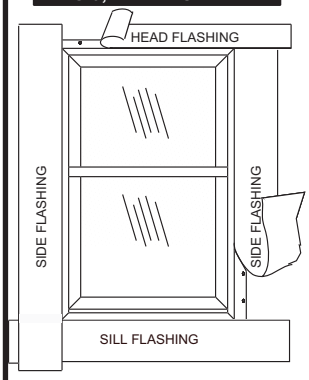


FIG.3, EXTERIOR VIEW



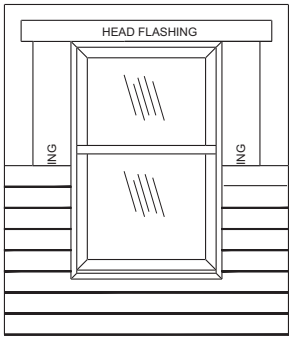
Nailing Windows Fins

Use stainless or galvanized steel roofing nails, long enough to penetrate studs a minimum of 1 inch.

Nail the entire perimeter of the nailing fin to the sheathing using every other slotted hole at minimum. Multiple windows twins & triples must be nailed directly under and 6" either side of each mullion. Make sure jambs are not bowed out.

Nail the fin snug but do not "sink" the nails similar to installing siding. Nailing should be just tight enough to hold window but not stop the movement of the "Frame-Work" underneath during expansion and contraction. Make sure the head and sill are NOT crowned up or down, or the jambs bowed in or out.

FIG.4, EXTERIOR VIEW



Flashing

Use self adhesive flexible flashing a minimum of 4" wide which has a self-adhering surface on one side, approved for use on vinyl, wood & other substances such as house wrap. This flashing material must meet a minimum water resistance of 24 hours in accordance with ASTM-D779.

(See fig. 3) Sill flashing is applied first up against the bottom of the window sill and over the fin extending beyond the sides of the window jamb fin and side flashing at least 2 inches. Apply jamb flashing next over the jamb-nailing fin, continuing over and beyond the sill flashing, 2 inches below. Apply head flashing similarly extending 2" past either side of the jamb flashing, to complete the window flashing detail.

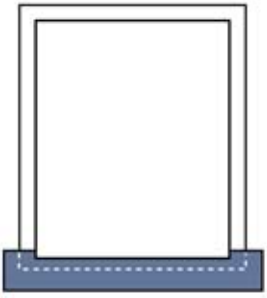
(See fig. 2) Install batt insulation between the window and rough opening. It is very important that these openings are not over stuffed and warp the frame. Do not NOT use expanding foam. Doing so will void warranties.

Cautions

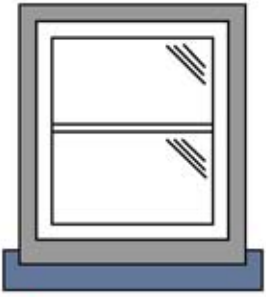
Remove or cut ventilation holes in plastic shipping wrap if windows are not installed immediately.
Do not lay windows flat or store in the sun. The heat will shrink the plastic wrapping and warp the frame.
Do not caulk or plug weep holes.
Do not drill into or through the sill of the window.
Protect the window during construction and plastering.
Do not lift window by top of frame, only by jambs.
Protect vinyl sill from traffic and damage.

Please call our hot line
1-(800) 234-4228
for any installation help
that you might need.

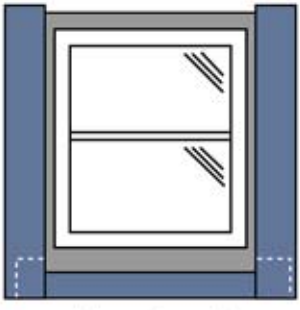
WINDOW APPLICATION



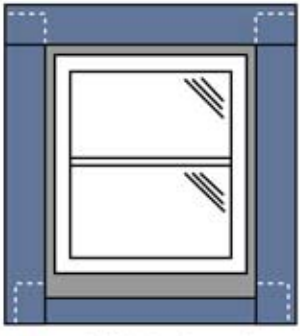
1. Apply a piece of BT25XL on top of the window sill prior to setting the window.



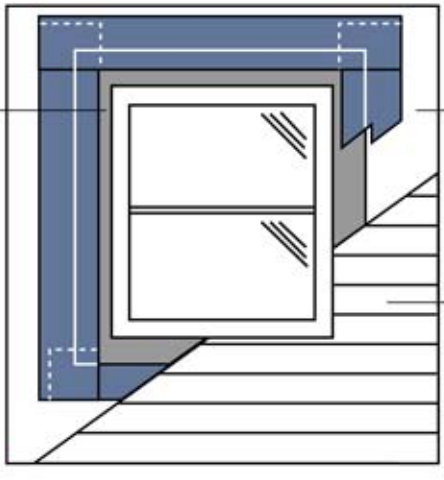
2. Set the window and mechanically fasten the fins to the building substrate.



3. Apply the vertical pieces of BT25XL on top of the window fin.



4. Apply the final top horizontal piece of BT25XL on the top of the window fin.



5.

BT-PRIMER and PROTECTO-TAK SPRAY ADHESIVE DATA SHEET

DESCRIPTION:

BT-Primer and Protecto-Tak Spray Adhesive are high tack primers for use under the BT-Series products over Dens-Glass Gold*, all OSB board, black sheathing board, metal, wood, dry concrete and dry masonry. When used over Dens-Glass Gold*, BT-Primer is moisture tolerant and is suitable for use on moist or damp Dens-Glass Gold*. BT-Primer is VOC compliant.

PROPERTIES:

	BT-Primer	Protecto-Tak Spray Adhesive
Adhesion to wood	Excellent	Excellent
Adhesion to steel	Excellent	Excellent
Adhesion to dry concrete	Excellent	Excellent
Adhesion to dry masonry	Excellent	Excellent
Adhesion to membrane	Excellent	Excellent
Coverage	150 sq. ft./gal.	2 oz: 4" x 100' roll
Shelf life (min.)	One Year	One Year
Tack free time (minutes)	10-20 minutes	10 sec to 15 min
Flash Point	24°F TCC	-42°F TCC

DIRECTIONS FOR USE:

PREPARATION:

BEFORE HANDLING read material safety data sheets for health information.

- The surface shall be cleaned so that all dirt, dust, loose concrete, or other contaminants that may adversely affect the adhesion of the membrane are removed.

BT-PRIMER APPLICATION:

- Apply primer to all surfaces by roller or brush.
- Primed surface shall be free of runs, puddles or excessive primer as this could cause blistering. Brush or roll out all primer puddles or drips immediately.
- Prime only as much area as can be covered in half a day's work. Re-prime areas not covered in half a day's work with a light coat of BT-Primer.
- Tack free time is approximately 10 to 20 minutes.

NOTE: Some bubbling in the primer may occur on the surface as it cures. This has no effect on the performance of the product and will smooth out as the membranes are applied.

PROTECTO-TAK SPRAY ADHESIVE APPLICATION:

- Shake can before using.
- Turn spray tip so arrow points to dot on rim.
- Hold can 6 – 8 inches from surface to be sprayed and apply to surface.
- After use, invert can, depress spray tip until spray is free of adhesive. Clean spray tips with turpentine.
- Clean oversprayed areas with a mix of 25% - 30% water added to isopropyl alcohol.

PACKAGING AND WEIGHTS:

BT-PRIMER

QUANTITY	PACKAGING	WEIGHT
1 U.S. Gallon	4 gallons/carton	38 lbs
5 U.S. Gallon pail	1 pail	46 lbs

PROTECTO-TAK SPRAY ADHESIVE

QUANTITY	PACKAGING	WEIGHT
16.5 oz can	12 cans/carton	19 lbs

**Dens-Glass is a registered trademark of Georgia-Pacific Corporation*

Premium Building Products That Protect

1955 South Cherokee St., Denver, Colorado 80223
(303) 777-3001 • Fax (303) 777-9273 • 1-800-759-9727
www.protectowrap.com

BT25XL 01 10/05

BT25XL Window and Door Sealing Tape

Forms a permanent waterproofing air/vapor seal around doors and windows that prevents air and moisture leaks.

- Stop moisture intrusion that causes black mold
- No special tools needed, peel and stick installation
- Meets or exceeds all building codes including ASTM 2112
- Meets or exceeds ICC Code Approval ESR1825
- The only flashing tape that passed hurricane level windblown rain test ASTM E331-90
- Adheres to vinyl, plywood, OSB, foam, metal, aluminum, and masonry
- Can be left exposed up to 120 days

Protecto Wrap's building tape **BT25XL** is a tough-faced superior self-adhering, air/vapor barrier and waterproofing membrane for vertical and horizontal above grade substrates. **BT25XL** seals window perimeters to building substrates to create an impenetrable barrier. This 20-mil polyethylene-backed aggressive rubberized adhesive membrane can be applied to vinyl, plywood, OSB, concrete, metal, aluminum, polyethylene, building wrap products, block and masonry surfaces to form an air/vapor moisture barrier system. **BT25XL is the only window sealing tape that can be installed and left exposed for 120 days without UV degradation.**

EASE OF INSTALLATION

Since BT25XL is a peel and stick self-adhering membrane, you simply center the tape over the area to be sealed and firmly **roll** the BT25XL against the surface. BT25XL also seals itself around nails, screws and staples.

ENERGY EFFICIENT

Not only will BT25XL waterproof around doors and windows, it stops air leakage, thus reducing heating and air conditioning costs to the homeowner.

Using this field tested product will prove that you are a builder who cares about providing the highest quality building materials to your customers.

Protecto Wrap's BT25XL is suitable for sealing the following applications:

- Window and door perimeters to the building substrate
- Joints in stucco insulation systems
- Sheet rock joints in roof assemblies
- Beneath metal cap flashings
- Full building coverage as an air/vapor barrier
- Sealing joints on gypsum sheathing in cavity wall construction
- Other areas where a water or air seal is required.

APPLICATION

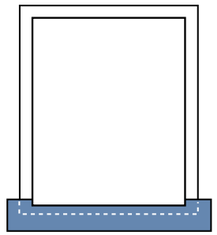
There should be no solvent-based caulks used in conjunction with Protecto Wrap BT25XL.

Surfaces should be clean, dry, free of dirt and other foreign matter. For best results, BT25XL should be applied at a temperature above 45°F (7°C). For applications from 20°F to 45°F (-6°C to 7°C), the material must be stored in a warm area prior to use and used with Protecto Wrap BT-Primer or Protecto-Tak Spray Adhesive. When used as an air/vapor barrier system, all lap and butt joints must overlap a minimum of 4". Masonry ties should be placed on top of the BT25XL and sealed with Protecto Wrap's JS160H Mastic. Cut a piece of BT25XL in a length that can be easily handled. Begin application by removing approximately 12 inches of the release paper and center the tape over the area being sealed. **Firmly roll** the BT25XL against the surface and continue pulling off the release paper while rolling the tape into place. Rolling the BT25XL is essential to gain 100% surface contact of the BT25XL adhesive to the substrate and will minimize trapping air beneath the tape. **Do not stretch BT25XL.** Lap building wrap material 4" on top of BT25XL and seal the building wrap to BT25XL.

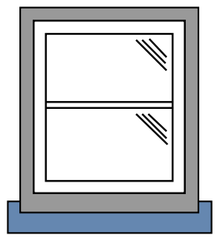
NOTE: When applying BT25XL to masonry, concrete, black sheathing board and OSB products or Dens-Glass Gold*, the surface must be primed with Protecto Wrap BT-Primer or Protecto-Tak Spray Adhesive.

**Dens-Glass is a registered trademark of Georgia-Pacific Corporation*

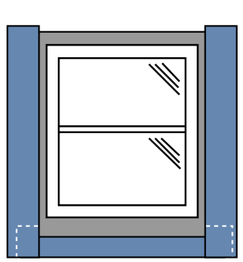
WINDOW APPLICATION



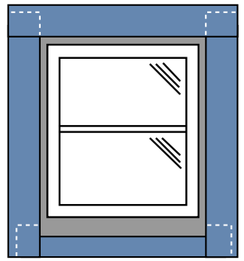
1. Apply a piece of BT25XL on top of the window sill prior to setting the window.



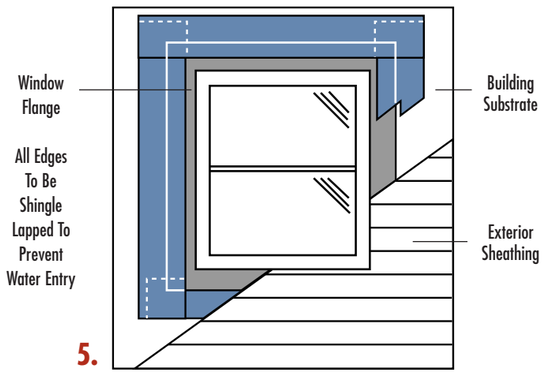
2. Set the window and mechanically fasten the fins to the building substrate.



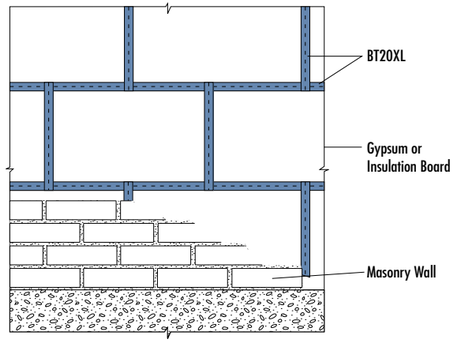
3. Apply the vertical pieces of BT25XL on top of the window fin.



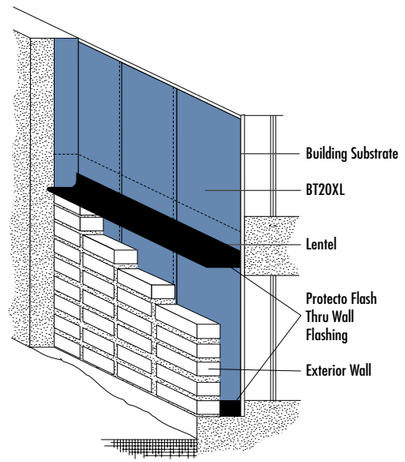
4. Apply the final top horizontal piece of BT25XL on the top of the window fin.



BT25XL as a Seam Sealing Tape



BT25XL for Cavity Wall Protection



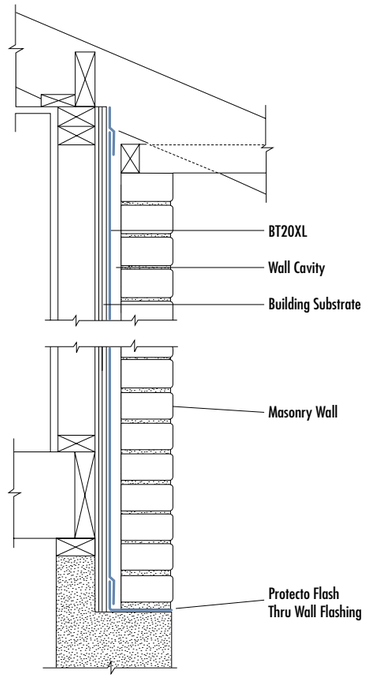
TESTING

BT25XL is the only flashing tape to pass hurricane level wind-driven rain testing. (ASTM E331-90, test method for water penetration of exterior windows.) Meets ASTM 2112. Meets or exceeds ICC Code Approval ESR1825.

PROPERTIES

		Test Method
Color:	White	
Thickness:	25+ mils	
Tensile Strength:	975 psi	ASTM D412
Elongation:	over 500% (rubberized adhesive only)	ASTM D412
Moisture Vapor Transmission Rate:	0.01 perms max.	ASTM E96
Max. Exposure Time:	120 Days	

BT25XL as a Thru-Wall Flashing



PRECAUTIONS

1. Rolling the BT25XL is essential to gain 100% surface contact of the BT25XL adhesive to the substrate and will minimize trapping air beneath the tape.
2. When Protecto Wrap's BT25XL is used as an air/vapor barrier, the dew point must be engineered to the exterior of the building.
3. Care should be taken not to leave the membrane exposed to direct sunlight for over 120 days.
4. Any caulking that contains solvents must not be used on or around the BT25XL membrane.
5. Do not stretch BT25XL. Stretching will adversely affect the adhesion of the product.
6. BT-Primer or Protecto-Tak Spray Adhesive must be used in applications with temperatures below 45°F (7°C).
7. BT-Primer or Protecto-Tak Spray Adhesive must be used on weathered surfaces, masonry, concrete and Dens-Glass Gold*, black sheathing board and OSB.
8. Some chemicals used in the production of OSB may adversely affect the adhesion of BT25XL. BT-Primer or Protecto-Tak Spray Adhesive will enhance the adhesion of BT25XL to OSB.
9. BT25XL must be stored in a location with temperatures above 50°F (10°C).
10. Protecto Wrap's EIFS Tape is recommended if stucco is to be applied directly to the air/vapor barrier.

Known for its outstanding performance qualities, vinyl siding is increasingly the material of choice for homeowners, remodeling contractors, architects, and builders. Compared to other siding products, vinyl is attractive, durable, easy to maintain, and cost-effective. Siding is available in a variety of textures, ranging from matte surfaces to deeply embossed wood grain surfaces, which simulate wood clapboard siding.

For best results, it is recommended that vinyl siding meet the requirements of the Vinyl Siding Institute Sponsored Certification Program. See www.vinyl-siding.org for a current list of certified products.

This manual sets forth the basic guidelines for vinyl siding installation. The instructions herein are based, in part, on ASTM Specification D4756, the standard method for installation of vinyl siding and soffit. Updated information has been added as necessary. Additionally, it is recommended that installers review applicable building codes for variations that may apply to specific products or geographic areas.

The method of applying vinyl siding and soffit is essentially the same for new construction and residing. However, where required, special instructions for new construction and residing are included, as well as recommendations for historic restoration. In all applications, care should be exercised to properly prepare the structure. See the Basic Installation Rules and additional details throughout this document for proper installation techniques.

This publication is not intended to provide specific advice, legal or otherwise, on particular products or processes. Readers should consult with their own legal and technical advisors, building material suppliers, and other appropriate sources (including but not limited to product or package labels, technical bulletins or sales literature) that contain information about known and reasonably foreseeable health and safety risks of their proprietary products and processes. As the manufacturer of the vinyl siding we do not assume any responsibility for the users' compliance with applicable laws and regulations, nor for any persons relying on the information contained in this guide.

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The manufacturer has provided these suggested instructions as installation guidelines. The manufacturer, however, neither installs the panels nor has any control over the installation. It is the responsibility of the contractor and/or the installer to ensure panels are installed in accordance with these instructions and any applicable building codes. The manufacturer assumes no liability for either improper installation or personal injury resulting from improper use or installation.

Fire Safety Information

Vinyl building materials require little maintenance for many years. Nevertheless, common sense dictates that builders and suppliers of vinyl products store, handle, and install vinyl materials in a manner that avoids damage to the product and/or the structure. Owners and installers should take a few simple steps to protect vinyl building materials from fire.

To Home and Building Owners:

Vinyl siding is made from organic materials and will melt or burn when exposed to a significant source of flame or heat. Building owners, occupants, and outside maintenance personnel should always take normal precautions to keep sources of fire, such as grills, and combustible materials, such as dry leaves, mulch and trash, away from vinyl siding.

To the Building Trades, Specifiers, Professionals, and to Do-It Yourself Installers:

When vinyl siding is exposed to significant heat or flame, the vinyl will soften, sag, melt, or burn, and may thereby expose materials underneath. Care must be exercised when selecting underlayment materials because many underlayment materials are made from organic materials that are combustible.

It is important to ascertain the fire properties of underlayment materials prior to installation. All building materials should be installed in accordance with local, state, and federal building code and fire regulations.

Storage and Transportation

When transporting vinyl siding and accessories to the job site, make certain to keep the cartons flat and supported along their entire length. At the job site, take the following precautions when storing panels:

- Store the cartons on a flat surface and support the entire length of the cartons.
- Keep the cartons dry.
- Store the cartons away from areas where falling objects or other construction activity may cause damage.
- Do not store the cartons in stacks more than 6 boxes high.
- Do not store the cartons in any locations where temperatures may exceed 130º F (e.g., on blacktop pavement or under tarps or plastic wraps without air circulation).

Residing over Asbestos Siding

Asbestos siding is a regulated material and the appropriate environmental agency should be contacted before residing over this product begins.

The manufacturer has provided these suggested instructions as installation guidelines. The manufacturer, however, neither installs the panels nor has any control over the installation. It is the responsibility of the contractor and/or the installer to ensure panels are installed in accordance with these instructions and any applicable building codes. The manufacturer assumes no liability for either improper installation or personal injury resulting from improper use or installation.

1. Installed panels must move freely from side to side.

2. Do not stretch horizontal siding panels upward when applying: instead, push upward on the bottom of the panel you are installing, until the locks fully engage. Nail in place. Panels should hang without strain after nailing. Stretching the panel upward pulls the natural radius out of the panel and increases the friction of the locks.

3. Always nail in the center of the slot. **WARNING: Do not nail at the end of a slot!** Doing so will cause the siding panel to be permanently damaged. If you must nail near the end of a slot to hit a stud, etc., extend the length of the slot with a nail slot punch tool.

4. Do not nail tightly. Allow a minimum of 1/32″ between the back of the nail head, screw or staple crown and the nailing strip. Nails or staples should be placed approximately 12″ to 16″ apart. Drive fasteners straight and level to prevent distortion and buckling of the panel. For fastening specs, see page 13.

5. Leave a minimum of 1/4″ clearance at all openings and stops to allow for normal expansion and contraction. When installing in temperatures below 40º F, increase minimum clearance to 3/8″.

6. Do not caulk the panels where they meet the receiver of inside corners, outside corners, or J-Channel Trim. Do not caulk the overlap joints.

7. Do not face-nail or staple through siding. Vinyl siding expands and contracts with outside temperature changes. Face-nailing can result in permanent ripples in the siding.

8. Panels should be overlapped approximately 1″. Fasten panels approximately 8″ or more from the overlap seam for best lap appearance.

9. Avoid the use of unstable or uneven underlayment. Keep in mind that siding can only be as straight and stable as what lies under it. See Section “Preparing the Walls” for more information.

10. When installing shutters, cable mounts, etc., make sure screw hole in the siding is 1/4″ larger than the attachment screw diameter. (Example: an 1/8″ screw requires a 3/8″ hole in the siding.) This will allow the panel to still expand and/or contract.

11. Never attach fixtures directly to panels. When attaching fixtures, first drill a hole in the siding 1/4″ larger than the diameter of the fasteners, allowing for expansion and contraction. Note: Fasteners for fixtures must penetrate the solid substrate.

The beauty of vinyl siding is maintained with little effort. Although vinyl siding will get dirty, like anything exposed to the atmosphere, a heavy rain will do wonders in cleaning it. Or, it's possible to wash it down with a garden hose. If neither rain nor hosing does a satisfactory job, follow these simple instructions:

1. Use an ordinary, long-handled car washing brush. This brush has soft bristles, and the handle fastens onto the end of the hose. It allows the siding to be washed just like a car. Avoid using stiff bristle brushes or abrasive cleaners, which may change the gloss of the cleaned area and cause the siding to look splotchy.

2. When washing down your entire house, start at the bottom and work up to the top in order to prevent streaking. Rinse Cleaning Solution with water before it dries. If your house has brick facing, cover the brick so that it is not affected by the runoff.

3. Follow the precautionary labeling instructions on the cleaning agent container. Protect shrubs from direct contact with cleaning agents.

4. To remove soot and grime found in industrial areas, wipe down the siding with a solution made up of the following:

1/3 cup powdered detergent [(e.g. Fab®, Tide®, or equivalent powder detergent)]*

2/3 cup powdered household cleaner [(e.g., Soilax®, Spic & Span®, or equivalent)]*

1 gallon water

5. If mold and mildew are a problem, add one quart of liquid laundry bleach to the cleaning solution mentioned above.

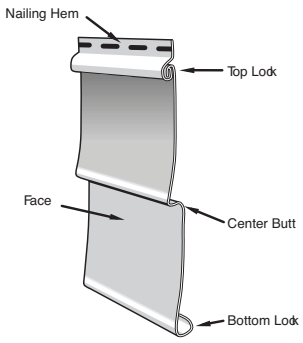
6. For stubborn stains, use the chart on the right. (page 6)

• Cleaning materials are listed in alphabetical order. The manufacturer does not endorse proprietary products or processes and makes no warranties for the products referenced herein. Reference to proprietary names is for illustrative purposes only and is not intended to imply that there are not equally effective alternatives.

STAIN	CLEANERS*
Bubble Gum	Fantastik®, Murphy's Oil Soap®, or solution of vinegar [30 percent] and water [70 percent]
Crayon	Lestoil®
DAP [Oil-based caulk]	Fantastik®
Felt-Tip Pen	Fantastik® or water-based cleaners
Grass	Fantastik®, Lysol®, Murphy's Oil Soap®, or Windex®
Lipstick	Fantastik®, or Murphy's Oil Soap®
Lithium Grease	Fantastik®, Lysol®, Murphy's Oil Soap®, or Windex®
Motor Oil	Fantastik®, Lysol®, Murphy's Oil Soap®, or Windex®
Paint	Brillo® Pad or Soft Scrub®
Pencil	Soft Scrub®
Rust	Fantastik®, Murphy's Oil Soap®, or Windex®
Tar	Soft Scrub®
Topsoil	Fantastik®, Lysol®, or Murphy's Oil Soap®

CAUTION: Do not use or mix sodium hypochlorite with other household chemicals or products containing ammonia. To do so will release hazardous gasses.

*Cleaning materials are listed in alphabetical order. The manufacturer does not endorse proprietary products or processes and makes no warranties for the products referenced herein. Reference to proprietary names is for illustrative purposes only and is not intended to imply that there are not equally effective alternatives.



Backerboard/Underlayment—a flat material used on the face of the house, between the studs and the siding, to provide a flat surface for the siding.

Bottom Lock—the bottom edge of a siding or a soffit panel, or accessory piece, opposite the nailing slots, which locks onto the preceding panel.

Channel—the area of the accessory trim or corner post where siding or soffit panel is inserted. Channel also refers to the trim itself, and are named for the letters of the alphabet they resemble (e.g., J-Channel, F-Channel, etc.).

Course—a row of panels, one panel wide, running the length of the house. Or, in the case of vertical siding, from top to bottom.

Drip Cap / Head Flashing—an accessory installed to channel water away from siding panels and sub-wall. Drip cap is often used on the tops of windows/doors and when transistioning from horizontal to vertical siding.

Face—refers to the side of a siding or soffit panel that is exposed once the panel has been installed.

Fascia Board— (sometimes referenced as a sub fascia) board attached to the ends of the rafters between the roofing material and the soffit overhang.

Fascia Cap—the covering installed on the fascia board.

Flashing—a thin, flat material, usually aluminum, positioned under or behind J-Channels, Corner Posts, Windows, etc., to keep draining water from penetrating the home.

Furring/Furring Strip—a wooden framing material, usually 1″ x 3″, used to provide an even nailing base. To "fur" a surface means to apply these strips.

H-Mold (Double Channel Lineal)—a siding accessory that joins the ends of vertical siding and soffit panels.

Housewrap—weather-resistant, breathable film used to cover wood underlayment prior to the installation of siding.

Lap—to overlap the ends of two siding panels or accessory pieces to join the panels/pieces and allow for expansion and contraction of the vinyl product.

Lug/Crimp—the raised "ears" or tabs on a siding panel, created by a snaplock punch, which can be used to lock a siding panel into undersill trim when the nailing hem has been removed.

Miter—to make a diagonal cut, beveled to a specific angle (usually 45º).

Nailing Hem (or Flange)—the section of siding or accessories where the nailing slots are located.

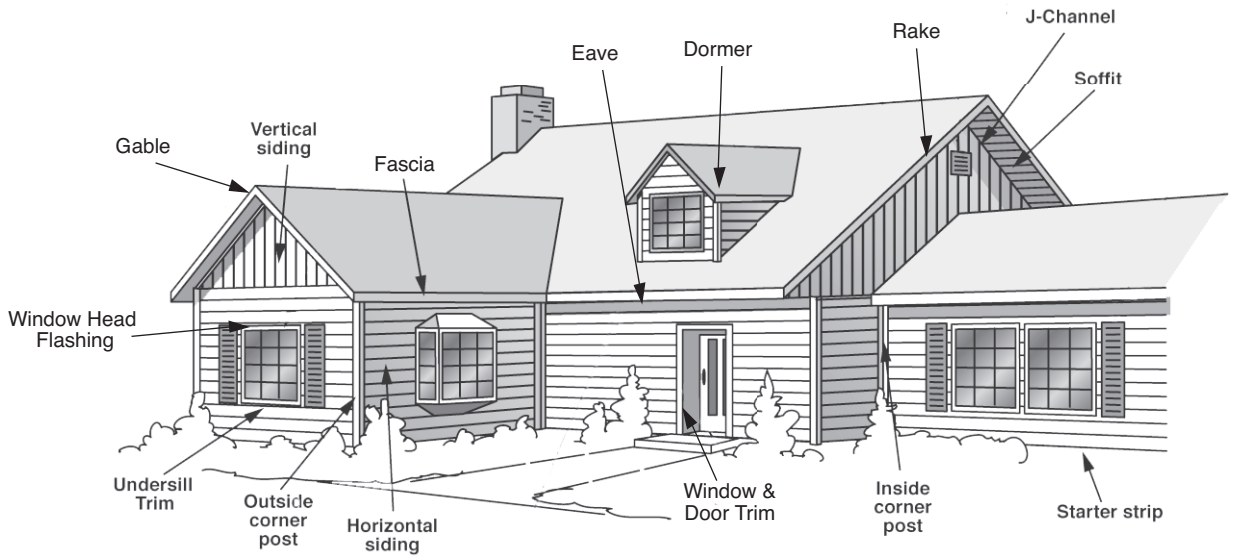
Plumb—a position or measurement that is truly and exactly vertical, 90º from a level surface.

Scoring—running a utility knife blade across a soffit or siding panel face without cutting all the way through the panel. This weakens the vinyl surface in a specific area and allows the panel to be bent and broken off cleanly.

Soffit—material used to enclose the horizontal underside of an eave, cornice or overhang.

Starter Strip—an accessory applied directly to the surface of the building and used to secure the first course of siding to the home.

Weep Holes—openings cut into the siding panel or accessories during the manufacturing process to allow for water runoff.



Outside and Inside Corner Post

Corner posts are used to provide a finished edge at an inside or outside corner. The siding from adjoining walls fits neatly into the inside or outside corner post channels.

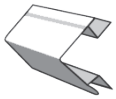
NOTE: We produce various sizes of J-Channels and Corner Posts. Remember to order accessories of the proper size to accommodate the siding panels.

Trim and Molding

A complete line of accessories is used to give every installation a professional, weather-resistant appearance. Common accessories include Corner Posts, Starter Strips, F-Channels, Undersill Trim, and J-Channels (left). Each of these accessories will be addressed in more detail throughout this manual.

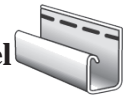
Inside Corner Post

Outside Corner Post



Undersill Trim

J-channel



Starter Strip

F-channel

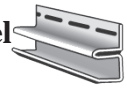


Fig. 1

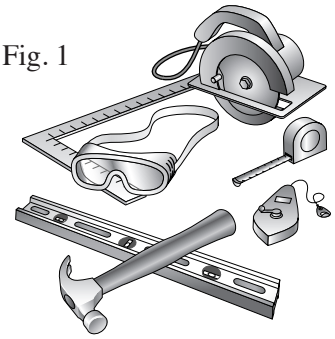


Fig. 2

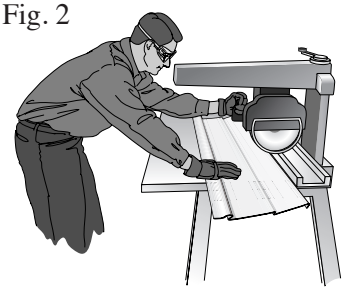
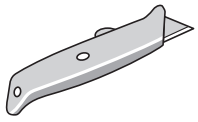


Fig. 3



Hand Tools
Common hand tools, such as a hammer, saw, square, chalkline, level, and tape measure are needed for proper installation (Fig. 1). Safety glasses are recommended for eye protection. Other basic tools include:

Power Saw
A bench or radial-arm power saw can speed the cutting of the siding. A finetooth blade (12 to 16 teeth per inch) should be used with the blade installed in the reverse direction. Some applicators prefer a hand-held power saw and a field-built cutting table. In extremely cold weather, move the saw through the material slowly to prevent chipping or cracking (Fig. 2).

Utility Knife
Vinyl is easy to cut, trim and score with a utility knife or scoring tool (Fig. 3).

NOTE: A saw blade set up in reverse direction should be used only for cutting vinyl. DO NOT attempt to use it on other materials such as wood, plywood, etc.

Tin Snips
Good quality tin snips and compound aviation-type snips will speed the cutting and shaping of the vinyl (Fig. 4).

Snaplock Punch
A snaplock punch is used to punch lugs in the cut edges of siding to be used for the top or finishing course at the top of a wall, or underneath a window (Fig. 5).

Nail Hole Punch
Occasionally, it may be necessary to elongate a nail slot. The hole is elongated to allow for expansion and contraction (Fig. 6).

Unlocking Tool (Zip-Lock Tool)
Remove or replace a siding panel with the unlocking tool. Insert the curved end of the tool under the end of the panel and hook onto the back lip of the buttlock. To disengage the lock, pull down and slide the tool along the length of the panel. Use the same procedure to relock a panel (Fig. 7).

Fig. 4

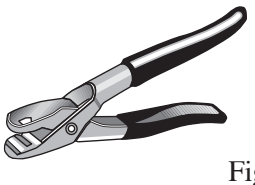


Fig. 5

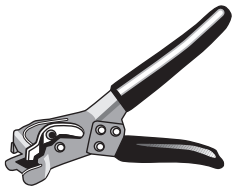


Fig. 6

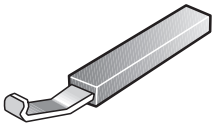
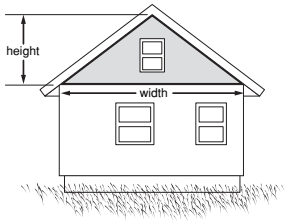
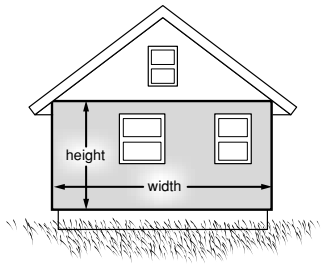


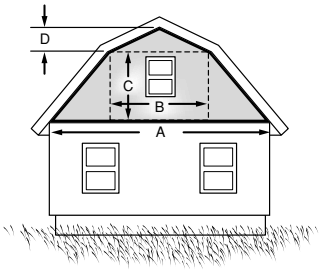
Fig. 7



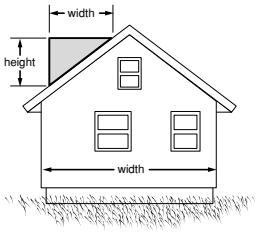
(1/2 height)____feet x width____feet=____square feet



Height____feet x width____feet=____square feet



1/2 (A + B) x C + 1/2 B x D = ___total area of gable
(square feet)



(1/2 height)____feet x width____feet =____total area of dormer
(square feet)

1. All houses can be broken down into shapes of rectangles, triangles or a combination of both.

2. The area to be sided can be determined by measuring the height and width of the house, including windows (below).

3. Total all of the measurements for the areas to be sided. Windows and doors are not usually deducted. Including them will provide an allowance factor for waste. If the windows and doors are extremely large (such as garage or sliding glass doors), some deductions can be made. Dormers and gables are prone to material waste due to cutting and fitting.

4. To estimate the amount of starter strip required, measure the linear feet around the entire base of the house. When measuring linear footage, add a factor of 10 percent to allow for waste.

Use the following worksheet to estimate the required materials:

Siding	**Walls**		____square feet
	Gable ends		____square feet
	Upper gambrel walls		____square feet
	Total wall surface area		____square feet
	Large areas not covered		____square feet **[A]**
	[garage doors/sliding doors]	x0.50=	
	Uncovered area		____square feet **[B]**
	Subtract B from A for		
	Total net surface area		____ square feet
Soffit			____square feet
Porch Ceiling			____square feet
Accessories	Starter Strip		____linear feet
	Utility trim		____linear feet
Receiving channel	J-Channel		____linear feet
	Flexible J-Channel		____linear feet
	F-trim		____linear feet
	3 1/2″ and 5″ Window & Door Surround		____linear feet
Outside corners	Outside corner post		____linear feet
	Fluted corner trim		____linear feet
Inside corners	Inside corner post		____linear feet
	J-Channel		____linear feet
Other	Soffit cove trim		____linear feet
	H-molding		____linear feet
	Light blocks		____linear feet
	Width of accessory recess opening:		
	[please circle one] 1/2″ 5/8″ 3/4″ 1 1/8″		
Nails	Pounds required		
	Length [1 1/2″minimum]		____pounds

Tools needed	___hammer	___tin snips	___chalkline
	___utility knife	___square	___hacksaw
	___nail hole punch	___tape measure	___level
	___power saw	___unlocking tool	
	___snaplock punch	___finetooth saw blade	

FASTENER CHOICES

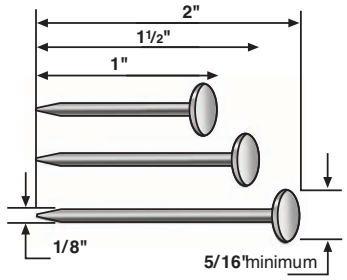
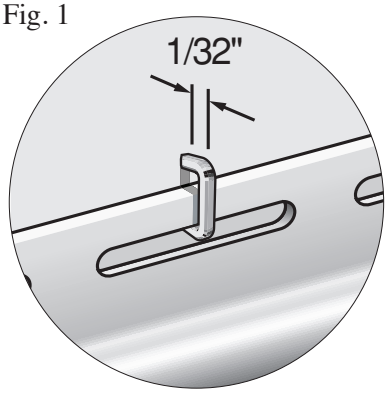


Fig. 1



Use aluminum, galvanized steel or other corrosion-resistant nails, staples or screws when installing vinyl siding. Aluminum trim pieces require aluminum or stainless steel fasteners.

Nails

Nail heads should be 5/16″ minimum in diameter. Shank should be 1/8″ in diameter.

Minimum nail lengths are as follows:

- 1 1/2″ for general use
- 2″ for residing
- 1″ to 1 1/2″ for trim

Screw Fasteners

Screw fasteners can be used if the screws do not restrict the normal expansion and contraction movement of the vinyl siding panel on the wall. Screws must be centered in the slot with a minimum 1/32″ space between the screw head and the vinyl.

Screws should be:

- Size #8, truss head or pan head.
- Corrosion-resistant, self-tapping sheet metal type.

Staples

If staples are being used instead of nails or screws, they must be:

- Not less than 16-gauge semi-flattened to an elliptical cross-section (Fig. 1).
- Wide enough in the crown to allow free movement of the siding.
- 1/32″ clearance between staple crown and nailing hem of the siding panel. Make sure to adjust staple gap to allow for 1/32″ clearance.

**** All fasteners must be long enough to penetrate into the framing 3/4 of an inch.***

Vinyl siding can expand and contract 1/2˝ or more over a 12´ 6˝ length with changes in temperature. Whether using a nail, screw or staple to fasten the siding, the following basic rules must be followed:

Step 1
Make sure the bottom lock of the panels are fully engaged along the entire length of the panel. WARNING: Push the panel up fully but do not stretch the panel by pulling it from the top.

Step 2
Do not drive the head of the fastener tightly against the siding nail hem. Leave a minimum of 1/32˝ (the thickness of a nickel) between the fastener head and the vinyl. Tight nailing, screwing, or stapling will cause the vinyl siding to buckle with changes in temperature (Fig.1). If the head or crown contacts the vinyl panel it may "pimple" or distort due to heat build-up.

Step 3
After locking the panel, fasten the panel in the center, work in, to both ends.This method helps keep panels running straight.

Step 4
Nail 8˝ or more away from the end of a panel that will be overlapped with another panel. This will help the overlap appearance.

Center the fasteners in the slots to permit expansion and contraction of the siding (Fig. 2).

Step 5
Drive fasteners straight and level to prevent distortion and buckling of the panel (Fig. 3).

Step 6
Space the fasteners a maximum of 16˝ apart for horizontal siding panels, 12˝ apart for vertical siding panels, and 8˝ to 10˝ apart for the accessories.

Step 7
Start fastening vertical siding and corner posts in the top of the upper-most slots to hold them in position. Place all other fasteners in the center of the slots (Fig. 4).

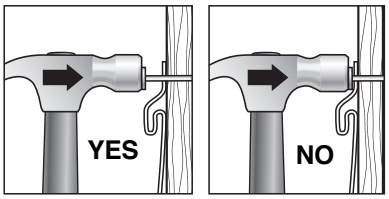


Fig. 1

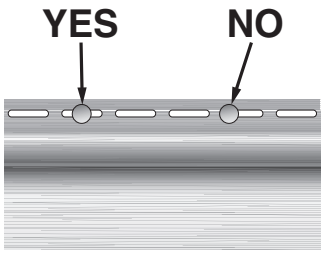


Fig. 2

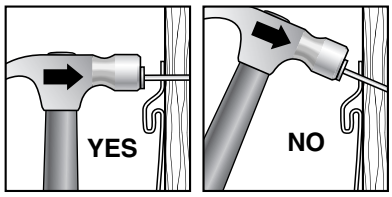


Fig. 3

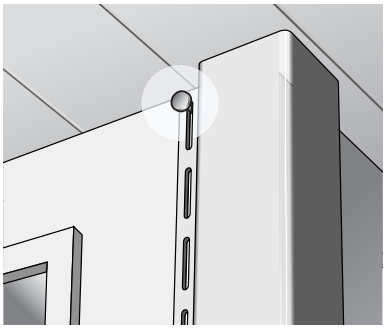


Fig. 4

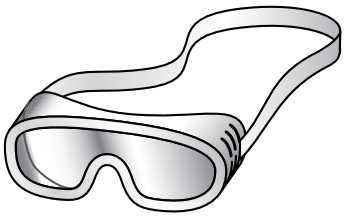


Fig. 1

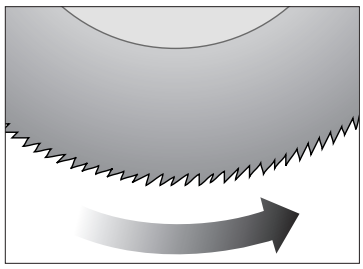


Fig. 2

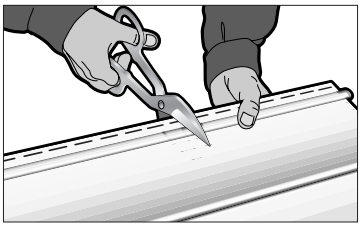


Fig. 3

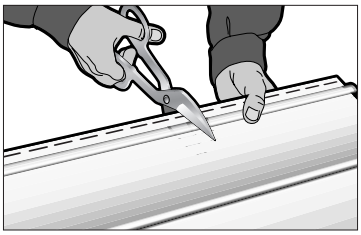


Fig. 4

When cutting vinyl siding, follow these guidelines:

Step 1

Safety goggles are always recommended for all cutting and nailing operations. As on any construction job, use proper safety equipment and follow safe construction practices (Fig. 1).

Step 2

With a circular saw, install the fine-toothed (plywood) blade backward on the saw for a smoother, cleaner cut. Cut slowly. Do not attempt to cut materials other than vinyl with a reversed direction saw blade (Fig. 2).

Step 3

With a utility knife or scoring tool, score the vinyl face up with medium pressure and snap it in half. It is not necessary to cut all the way through the vinyl (Fig. 3).

Step 4

With tin snips, avoid closing the blades completely at the end of a stroke for a neater, cleaner cut (Fig. 4).

Sheathing/Backerboard
Our vinyl siding should be applied over a sheathing that provides a smooth, flat, stable surface. Consult local building codes for sheathing requirements. Vinyl siding should never be applied directly to studs without sheathing. **We recommend that wood-based sheathings be protected utilizing moisture-resistant housewrap or building paper prior to the installation of the siding and accessories. Some building codes now require this protection.**

Flashing
Flashing, such as aluminum coil, roofing felt or house wrap, should be applied around windows, doors, other openings, inside and outside corners, and the intersection of walls and roofing to prevent water infiltration.

New Construction

Step 1
Make sure all studs are straight and true to avoid bulges or dips in the finished wall. Correct any bowed studs at this time.

Step 2
Make sure all sheathing is properly fastened to the framing according to building code requirements and/or the sheathing manufacturer's recommendations.

NOTE: Sheathing behind vinyl siding must be smooth, flat, stable and appropriate for use on the type of construction being erected. Increasing requirements in building codes, especially in the areas of fire and wind resistance, make the appropriate choice and fastening of wall sheathing an important area of consideration. Check local building codes for the allowable type and thickness of sheathing that can be utilized on the type of structure being sided.

Step 3
Make sure subwall assembly is weathertight before applying siding. Vinyl siding and vinyl siding accessories alone do not constitute a waterproof installation. The combination of proper subwall preparation and siding installation result in the desired protection of the structure.

Wall sheathing should be weather-resistant, or covered with a weather-resistant barrier such as fanfold insulation, housewrap, or building paper. **Independent VSI studies indicate that the combination of a weather resistant barrier plus a housewrap result in improved weather performance of the vinyl siding.** Some building code jurisdictions are currently requiring this protection.
A weather-resistant covering should be properly fastened according to the manufacturer's instructions, and be smooth and even. Flashing and caulking should be added as needed in areas such as windows, doors, and other openings to control moisture and to protect the subwall assembly.

WARNING: A smooth, flat, stable wall surface is necessary for the proper installation of vinyl siding. Waviness in the finished siding resulting from uneven or inadequate backerboard sheathing constitutes misapplication under the terms of the warranty.

TIP: Place the drywall in the house, on the floor of the room where it is going to be applied, prior to the installation of the siding when possible. This will help load the floor system and the floor band prior to applying siding. This can help reduce panel bulging in the floor band areas where compression and shrinkage typically occur.

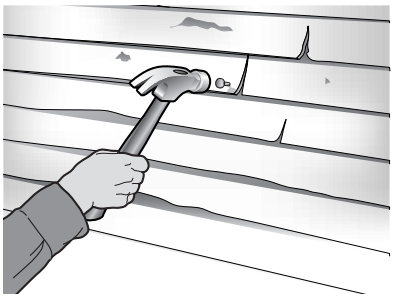


Fig. 1

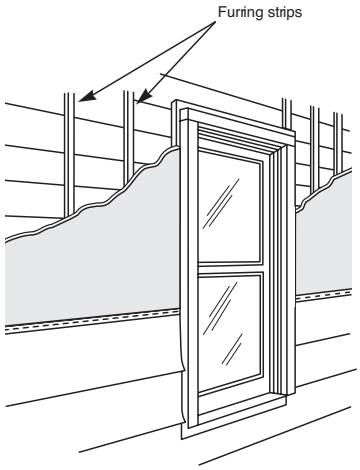


Fig. 2

Residing Existing Structures

Step 1

Nail down any loose boards on existing siding, and replace any rotten wood as needed. DO NOT INSTALL VINYL SIDING OVER ROTTEN WOOD. (See Fig. 1)

Step 2

Scrape off loose caulk and any other buildup that may interfere with the siding installation. Remove all items such as gutters, downspouts, and light fixtures as needed.

Step 3

Install suitable sheathing, as needed, to provide a smooth, flat, and stable surface for the installation of the vinyl siding. See information previously given in this segment for additional instructions on subwall protection and flashing.

Step 4

Install furring in areas needing straightening and leveling. Apply rigid sheathing to cover and level the furring strips. Do not apply vinyl siding directly to furring strips without sheathing, because the siding may conform around the furred areas causing an uneven appearance. (See Fig 2)

Step 5

Window and door casings may need additional attention or preparation. Depending on vinyl siding moldings being used, a window/door casing generally needs to extend out from the finished subwall sufficiently, to allow a J-Channel or similar molding to butt to it. In some situations, building out the casings, or using special purpose moldings such as Window and Door Surround may be necessary.

Over Masonry Sub-surface

A minimum 1″ x 3″ wood strips are installed with masonry nails over the masonry area to be sided (Fig. 1). For increased decay resistance, use pressure treated furring strips.

Step 1

For horizontal siding, strips should be installed vertically 16″ on center. They should be installed completely around doors, windows and other openings, at all corners, and at the top and bottom of the area to be sided.

Step 2

For vertical siding, furring is essentially the same as for horizontal siding. Strips should be nailed horizontally 12″ centers.

NOTE: Furring strips should be covered with insulated sheathing or the spaces between the furring strips should be filled in with insulated sheathing equal in thickness to the furring strips. This will provide an even wall surface for the siding and help avoid any waviness.

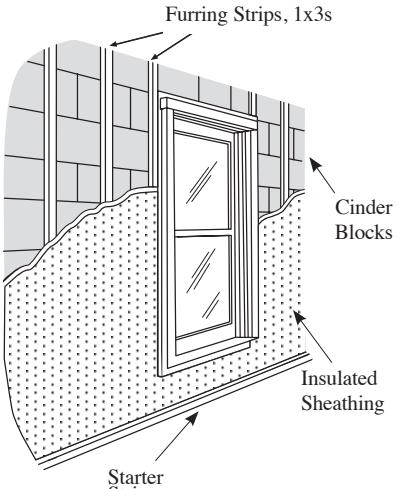


Fig. 1

STARTER STRIP

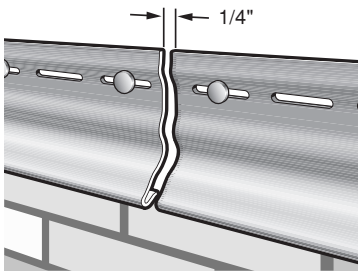


Fig. 1

Before the vinyl siding itself can be installed, a number of accessories must be installed first, including starter strips, corner posts, window flashing, trim and J-Channels.

Step 1
In order for the vinyl siding to be installed properly in a level fashion, the starter strip at the bottom of the wall must be level.

Step 2
The starting chalk line should be located so that it represents the top, not the bottom, of the starter strip.

Chalk lines are normally established from the lowest corner of the house. In situations where the ground at the corner of the house is not level, chalk lines must be measured from the soffit location to assure a uniform panel at the top of the walls.

Step 3
Attach a chalkline: go to the next corner and pull the line taut.

Step 4
Snap the chalkline and repeat the procedure around the entire house.

Step 5
Using the chalkline as a guide, install the top edge of the starter strip along the bottom of the chalkline, nailing at 10″ intervals. Allow space for accessories (corner posts, J-Channels, etc.)

Step 6
Keep the ends of starter strips at least 1/4″ apart to allow for expansion (Fig. 1).

Step 7
Nail in the center of the starter strip nailing slots.

Step 8
Starter strip fasteners should be driven just flush in the center of the slots to take out starter looseness, but should not be overdriven to where it indents the starter.

In most situations a typical starter strip is used to start the first course of siding. Special circumstances (panel application around decking, special roof lines and other unique applications) may require other techniques to secure the first panel locking leg. This can be accomplished in several manners (as illustrated in Figures 1 & 2).

Anytime a J-Channel is used as a starter strip it must have a 3/16″ diameter hole drilled no greater than 24″ on center to allow for water drainage.

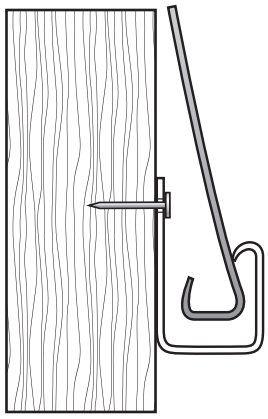


Fig. 1
Inside J-Channel

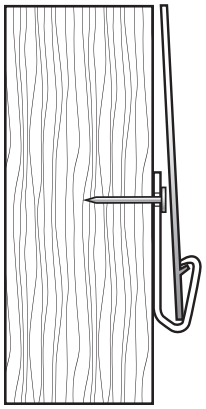


Fig. 2
Undersill with Snaplock

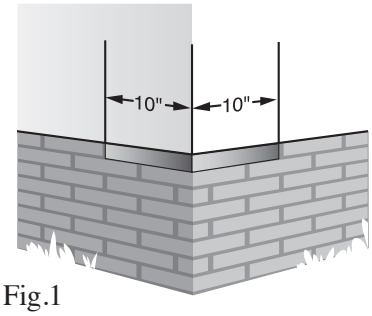


Fig.1

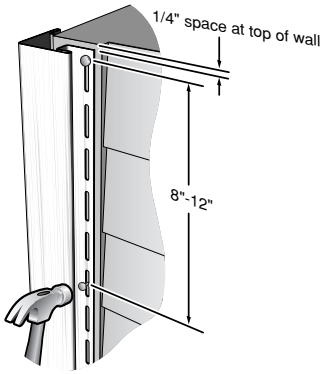


Fig. 2

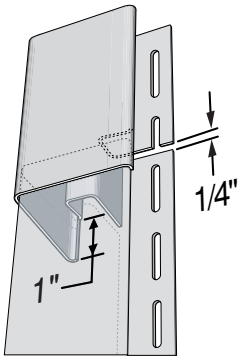


Fig.3

Step 1

A water-resistant material should be used to flash the inside and outside wall corners a minimum of 10″ on each side before installation of the corner posts. A housewrap would be an adequate flashing (Fig. 1).

Step 2

Place the corner post in position, allowing a 1/4″ gap between the top of the post and the eave or soffit (Fig. 2).

NOTE: If vinyl or aluminum soffit will be installed, either install prior to corner post installation or allow for soffit and accessory thickness when positioning the height of the corner.

Position a nail at the top of the upper slot on both sides of the corner post, leaving a 1/32″ gap between the nail heads and the corner post nailing hem. The corner post hangs from these nails. The balance of the nailing should be in the center of the slot, 8″ to 12″ apart, again leaving 1/32″ between the nail head and the corner post. This allows for the expansion and contraction to occur at the bottom. The corner post should extend 3/4″ below the starter strip. Make sure the posts are vertically straight and square.

Do not nail corner post tight.

Step 3

If more than one length of corner post is required, overlap the upper corner post over the lower corner post.

Splicing Outside Corner Post

Remove 1″ from the nail hem and receiving channel of the bottom end of the top piece. Position uncut top end of lower post under bottom edge of upper post allowing a 1/4″ gap at the nail for expansion and contraction. (Fig. 3).

Splicing Inside Corner Post

Cut 1″ off all but the outer face of the upper portion of the bottom corner post. (Fig 4) Lap 3/4″ of the upper post over the lower post, allowing 1/4″ for expansion.

This method will produce a visible joint between the two posts, but will allow water to flow over the joint, reducing the chance of water infiltration.

Capping a Corner Post

Step 1

Corner posts on homes with a second-story overhang need to be capped by making the cuts shown. Allow approximately 2″ extra length on the corner post. Trim away everything except the 2 faces. Fold the flaps created over each other as indicated (Fig. 5).

Step 2

Drill a 1/8″ hole in the center through both layers of vinyl, and install a pop rivet to hold them in place. Cut a notch in both layers to allow clearance for the corner (Fig. 5).

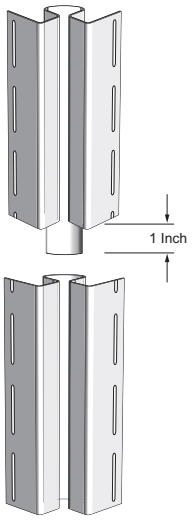


Fig. 4

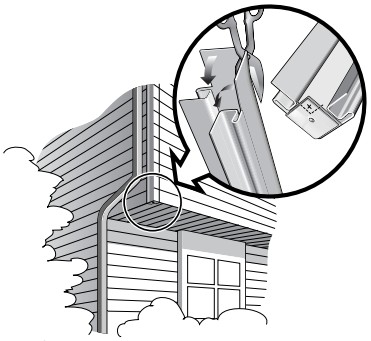


Fig. 5

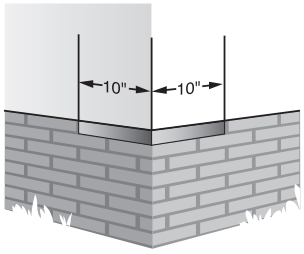


Fig.1

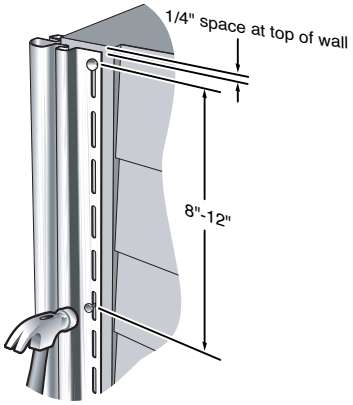


Fig. 2

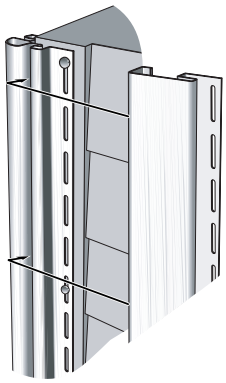


Fig. 3

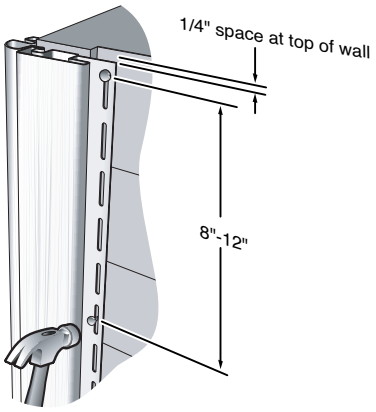


Fig. 4

Step 1

A water-resistant material should be used to flash the inside and outside wall corners a minimum of 10″ on each side before installation of the 3-piece corner system (Fig. 1).

Step 2

Place the Decorative Corner Starter on the outside wall corner, allowing a 1/4″ gap between the top of the post and the eave or soffit, and extending 3/4″ below the siding starter strip. Cut to length (Fig. 2).

Position a nail at the top of the upper full slot on both sides of the Decorative Corner Starter, leaving a 1/32″ gap between the nail heads and the corner post nailing hem. The Decorative Corner Starter hangs from these nails. The balance of the nailing should be in the center of the slot, 8″ to 12″ apart, again leaving 1/32″ between the nail head and the Decorative Corner Starter. This allows for proper expansion and contraction clearance. Make sure the Decorative Corner Starter is installed vertically straight and true.

Do not nail corner post tight.

Step 3

For typical installations, cut two 3-1/2″ or 5″ Window & Door Surround lineals to the same length as the Decorative Corner Starter. Snap the locking side of a Window & Door Surround into one side of the receiving lock section of the Decorative Corner Starter (Fig. 3). Repeat the procedure for installing the other Window and Door Surround.

Step 4

Make sure that all 3 parts are fully locked and line up evenly at the top and bottom. Fasten the Window & Door Surround lineals to the wall following the same nailing procedures outlined in Step 2 (Fig. 4).

Lineals

Step 1
Create a watertight seal:

Apply a 1/8″ bead of caulk around the perimeter of the window or door frame before installation.

Apply caulk around the corner of the nail fin and where the window or door meets the sheathing.

Measure the width of the top of the frame and cut a piece of starter strip 1/8″ less than the frame. (Fig.1)

Step 2
Butt the starter strip against the opening, center it and nail every 8″ to 12″ being sure to nail in the center of the nailing slots.

(Starter strips are available for both new construction and remodeling applications.)

Continue to measure and cut starter strips for the other sides of the frame. Be sure to cut starter strips 1/16″ less than each measurement. (Fig.2)

Step 3
Install the starters. For vertical starter strips, nail the first nail in the upper most edge of the first slot. All other nails should be centered in the slots every 8″ to 12″. (Fig.3)

Step 4
Measure and cut the lineals. For 3-1/2″ lineals add 7″ to your measurement in order to accommodate their widths at corners For 5″ lineals, add 10″.

Lineals should be installed in the following order: top, sides, bottom. (Fig. 4)

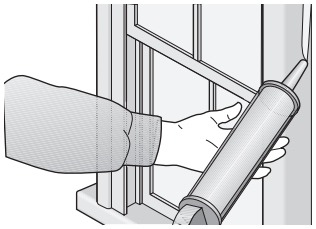


Fig.1

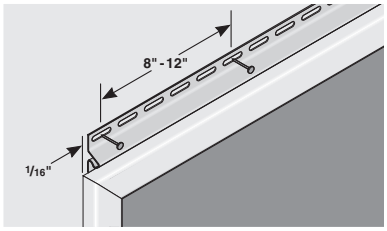
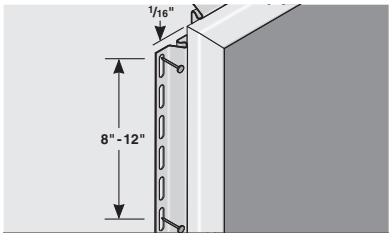


Fig. 2



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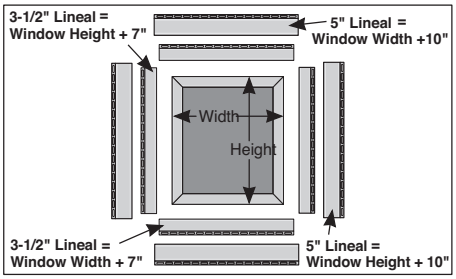


Fig. 4

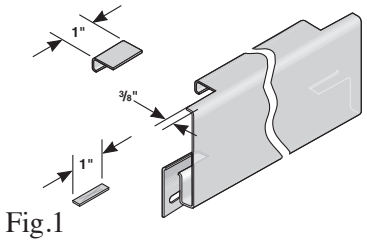


Fig.1

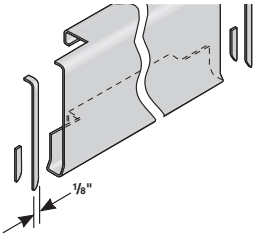


Fig.2

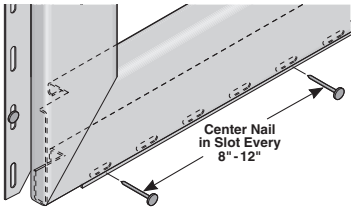


Fig. 3

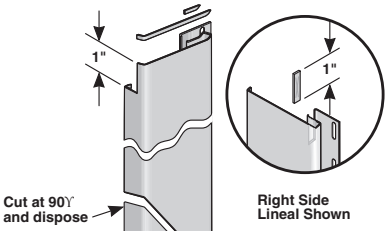


Fig. 4

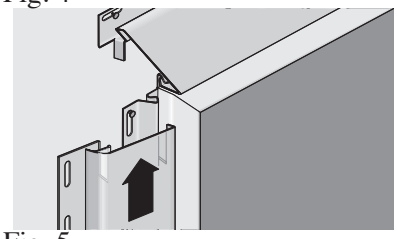


Fig. 5

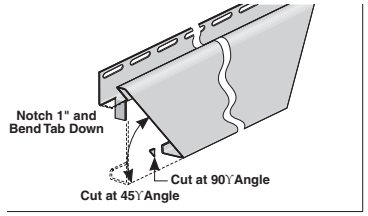


Fig.6

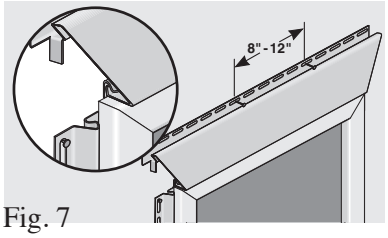


Fig. 7

To install the bottom lineal
Cut a notch on each side of the back of the lineal as shown. Cut a 1″ notch out of the nailing hem side. (Fig.1)

Make a 1/8″ curved sliver cut on the bottom front of the lineal. Push the locking leg of the lineal into the channel of the starter.

Nail the bottom lineal into place only after the side lineals are installed.

Work the bottom lineal into place by flexing the material to fit it together with the side lineals, lapping the side lineals over the bottom lineal.

Complete by nailing the bottom lineal every 8″ to 12″with nails centered in slots. (Fig.2 & Fig. 3)

To install side lineals
Cut a 1″ notch off the legs for the top of the lineal and a 45° miter cut for the bottom. Cut a 1″ notch out of the nailing hem side. Make curved sliver cuts on the top of the lineal. *NOTE: Right and left lineals should have opposite cuts. (*Fig. 4)

Push side lineals into the channel of the Starter about 2″ down from the header and slide the lineal into place.

Fit tabs of the header lineal down into the side lineals.

Nail top nail of the side vertical lineal into the top of the slot, then nail lineals into place every 8″ to 12″ with nails centered in slots. (Fig. 5)

To install the top lineal...
Miter each end of the lineal at a 45° angle. Notch the channel 1″ to form a flap and bend it down (do this on both ends) (Fig.6)

Push the locking leg of the lineal into the channel of the starter and center it above the frame. Nail every 8″ to 12″ with nails centered in slots of lineal. (Fig. 7)

Window Mantels

Standard Length Mantels

Locate the centerline of where the mantel will be installed. Measure to each side of the centerline as specified for each length mantel (see chart below).

Mantel Length	*Measurement*
36"	16-5/8"
40"	18-5/8"
44"	20-5/8"

Scribe a vertical line approximately 6″. These lines will correspond to the locking legs on the back of the mantels. Install 2 mounting clips to each line with the bottom of each clip at least 2″ above the bottom of the mantel, and the top of the other clip no higher than 4-3/4″ above the bottom of the mantel. (Fig.1)

Position the mantel over the clips and snap into place. (Fig.2)
NOTE: When applying clips over beveled siding, you will have to shim and/or bend the top of the clips to keep the clip throats the same distance from the wall.

To Install End Caps

(For non-standard window sizes.)
Cut the window mantel to the required length minus 3/8″. NOTE: The cut on a mantel with dentil blocks must be 1/8″ to the right (facing the mantel) of a full dentil block. Clean any shavings or grit from the cut end(s). Insert the end cap into the mantel and mark the mantel on the inside. Remove the end cap and spread adhesive on both the lip of the end cap and the end of the mantel where marked.

Insert the end cap into the mantel and clamp each side. Allow 10 minutes for drying and then install the mantel into place as described above. (Fig.3)

To Shorten a Mantel

Determine length and make two cuts to remove excess material from the center of the mantel. Be sure to cut through the center of the dentil blocks.

Turn the mantel sections face down. Drill a 3/16″ hole in the second indented hole marker 2-3/4″ from the cut edge of both mantel sections. Place mantel overlay face down under the cut and drilled mantel sections. The mantel overlay screw bosses will align with the 3/16″ drilled clearance holes. A paper pattern is included to locate screw location. Fasten together with #8x1/2″ self-tapping screws.

NOTE: Mantels must be installed directly over brick or stucco siding. If vinyl siding is to then be applied, panels will have to be cut to fit around the end caps. Mantels can also be installed in remodeling applications over vinyl siding.

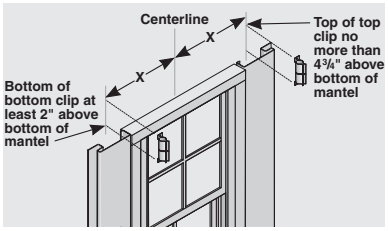
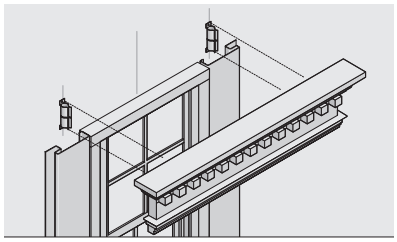


Fig.1



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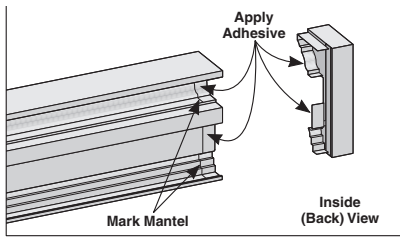

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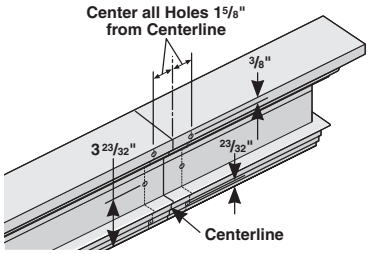

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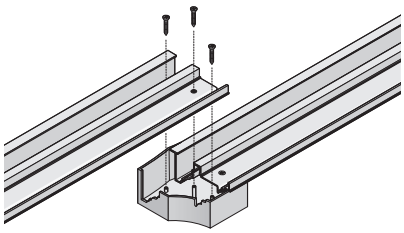

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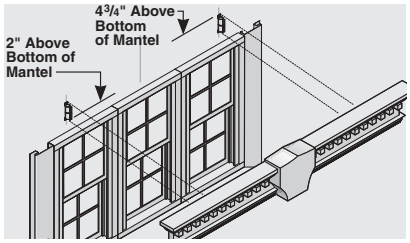

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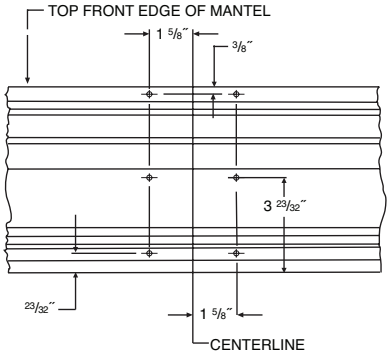


Fig. 4

To Install a Keystone
(to shorten or lengthen a mantle)

NOTE: Mantel keystones can be purely decorative, or can be used to modify mantels.

Determine the length of mantel necessary. Using this measurement, cut two equal pieces of the mantel (each will be one-half the length of the required total length). (Fig.1)

Clean the cut ends.

Drill three holes 3/16˝ in diameter into each mantel piece spacing holes 1-5/8˝ from the centerline (along the cut ends of the mantels). (Fig. 4)

If placing mantel keystone over dentil blocks, you may need to cut away a thin section on both sides of mantel to accommodate keystone over dentil blocks.

Place keystone face down on clean work area. Insert one mantel section into keystone and align drilled holes with molded screw bosses in keystone and fasten with three screws. Insert and fasten second mantel section with three screws. (Fig.2)

To set clip locations when mantel has modified or cut, measure from new mantel cut centerline to the locking legs. Install clips as described.

Install clips to wall. You must determine the distance to place clips from the center of modified mantel. (Fig.3)

To stabilize the mantel system, it is recommended that a piece of fitted plywood be screwed into the back of the mantel system behind the keystone.

Install mantel as described in Standard Mantel installation.

Long Length Mantel System

NOTE: If installing mantel over existing siding or masonry surfaces, use brick end caps. If installing new siding, the mantel system should be installed using siding end caps with integrated J-Channels before the siding is applied.

Determine the type of siding accessory to be used around opening. When using a standard J-Channel, cut the mantel to the width of the opening. (Fig.1)

When using a 3-1/2″ window and door casing lineal, determine the width of the opening and add 5″, then cut the mantel.

When using a 5″ corner lineal, determine the width of the opening and add 8″, then cut the mantel.

Clean the cut ends of the mantel. (Fig.2)

Insert the end cap into the mantel and mark the end cap with a pencil. Remove the end cap.

Spread a thin coat of styrene adhesive (included with caps) onto the end cap. ***CAUTION: Contact with styrene adhesive will cause painted surfaces to smear. (***Fig. 3)

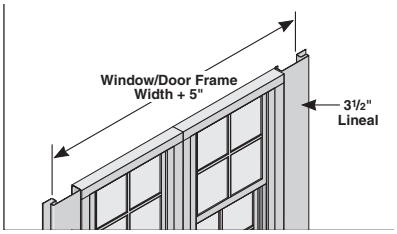
Install mantel end caps to both sides of the mantel. Allow adhesive to set 10 minutes using clamps to hold end caps in place.

Before installing the mantel, apply a 1/4″ caulking bead along the back edge of the window/door framing, and on the backside perimeter of the mantel and end caps.

Center the mantel with attached end caps over the frame and fasten through the pre-drilled holes, using screws/washers provided. (Fig.4)

Install cover strip onto the mantel. (Plain & dentil cover strips are available.) (Fig.5)

NOTE: When installing dentil cover strip, it may be necessary to trim cut from both ends to center the dentil blocks on the mantel.



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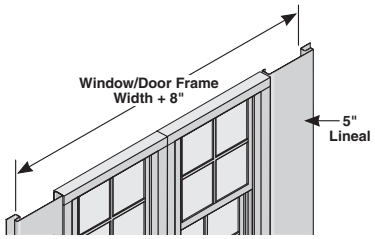

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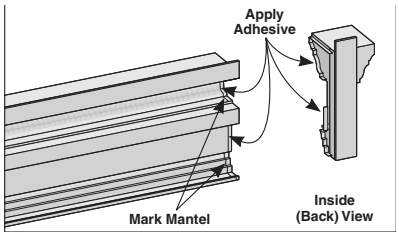

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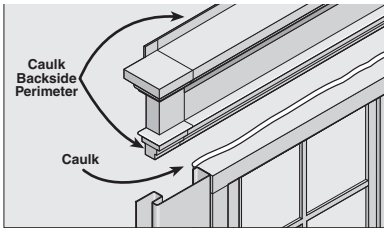

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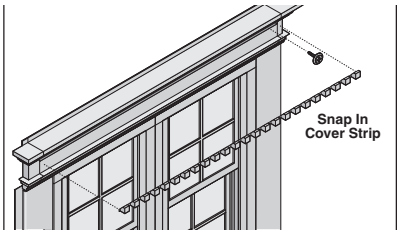

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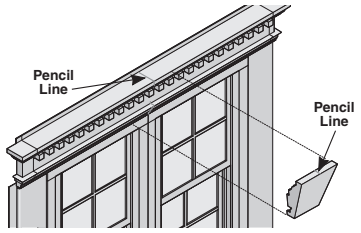

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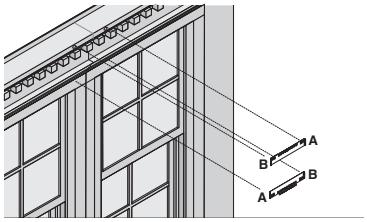

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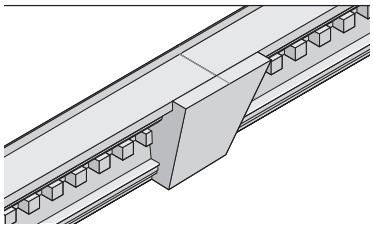


Fig. 3

Installing Long Length Mantel System Keystones

With the mantel already mounted to the wall, pencil a centerline on the top and bottom of both the mantel and keystone.

Using the drill jig provided with the keystone, place on the mantel's top edge and align slotted holes over the penciled centerline on the mantel.

Drill 1/4˝ holes through hole pattern of drill jig. Repeat second set of holes on bottom edge of mantel. (Fig.1)

Install the keystone clips making sure end "A" is inserted first, then snap in end "B".

Slide clip back 1/16˝ to ensure clamping legs are fully locked into place. (Fig.2)

Position the keystone using the centerline as the guide and snap it into place starting at one end of the top of the keystone. You may need to trim the sides of the keystone when using dentil cover strips. (Fig.3)
NOTE: When installing keystone over two-piece mantel, make sure mantel pieces are cut to equal lengths. Use the cut ends to form the centerline for clips and keystone. Caulk bottom ends then install.

Installing Over Brick or Existing Siding

To apply on brick or over other existing siding materials, cut mantel to desired length, allowing for brick end caps.

Clean cut ends, insert with adhesive and allow to dry as described in "Long Length Mantel System."

Score the groove on back of mantel 3-5 times with utility knife and snap off mantel's top flange.

Secure mantel to wall with anchors, screws and washers provided.

Install cover strip or dentil cover strip as described in "Long Length Mantel System."

For keystone installation, see Installing Long Length Mantel System Keystones. (Fig.1)

Siding Applications

Installing Accessories Over Top of Mantel

1. Use J-Channel for vertical siding or horizontal panel applications.
2. Use dual utility trim for a Dutch lap applications.
3. Use finish trim for regular panels. (Fig. 2)

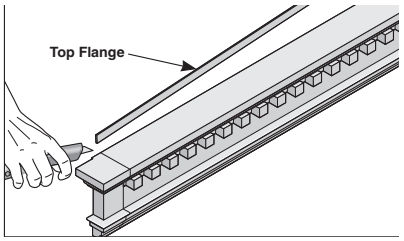
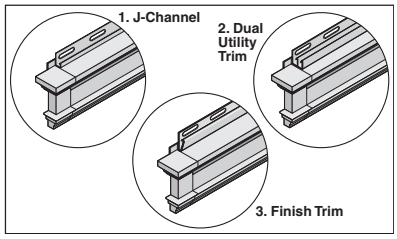


Fig.1



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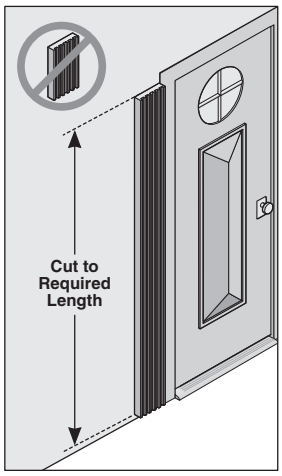

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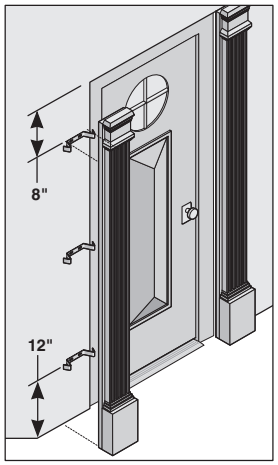

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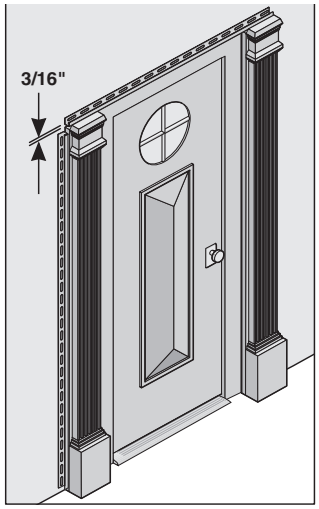


Fig. 3

Door Surrounds

Installation of Pilasters on Brick, Stucco or before vinyl siding.

Measure and cut pilasters to the required length. (Fig. 1)

To attach pilaster caps, use template enclosed in the carton. Mark and drill holes into back of pilasters (use 3/16″ drill bit). IMPORTANT: When installing during new construction before vinyl siding, use lower set of holes on the template. This will ensure that the caps will sit 3/4″ above the top of the pilasters. Attach caps to pilaster using 4 screws (enclosed).

To attach pilaster bases, use template enclosed in the carton. Mark and drill holes into back of pilasters (use 3/16″ drill bit).Attach caps to pilaster using 4 screws (enclosed). (Fig.1)

Attach mounting clips and pilasters (three sets for 96″ and four sets for 144″) by locating top clips 8″ from top and bottom clips 12″ from the ground. Space third set at mid-point for 96″ pilasters. Evenly space the other two sets for 144″ pilasters. If the clips are being applied to beveled wood or vinyl siding, bend the two tabs on the clips so that the clips are installed in a vertical position.

Locate clips 1/8″ from door trim. Attach the clips onto the substrate with two screws (enclosed).

Place pilasters over clips and snap into place. (Fig. 2)

Installation With Vinyl Siding

Follow Installation of Pilasters and then install J-Channels around the pilasters.

Make sure to allow a small gap (3/16″) between the top of the pilasters and the top J-Channel to allow the pilaster to expand.

Install vinyl siding, completing the wall before installing the top mantel. (Fig.3)

Installation of Mantel
Full Length-Mantel

Develop a chalk line that represents the bottom of the mantel. Mark the center of the mantel on the chalk line.

Mark 17-11/16″ from both sides of centerline. Draw an 8″ vertical line at both marks.

Attach two clips on both lines. Make sure that both clip throats fall in the area that is 3-1/8″ to 7-3/8″ from the chalk line. When applying on beveled siding you will have to shim and or bend the top of the clips to keep the clip throats the same distance from the wall. (Fig.1)

Place locking legs over the four clips and snap into place. *NOTE: In new construction applications using vinyl siding, the mantel will sit on top of the cap. In all other situations the mantel will sit on the pilaster behind the cap. (*Fig.2)

Modified Length-Mantel

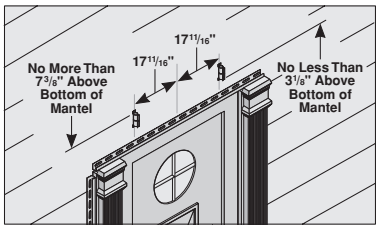
To lengthen a mantel, cut the ends off two mantels. The mantels should be equal in length and must span the required distance. (Fig. 3)

To shorten a mantel, cut out a center piece to make two equal size mantels totaling the required length.

Place the two cut mantels face down and locate hole for mantel overlay. From centerline (cut edge) of mantels measure over 2-3/4″, and from top of mantels measure down 4-1/8″. At these locations, drill one 3/16″ hole into each mantel piece. Place mantel overlay face down located under the two mantel sections. Make sure to tightly butt the two mantel parts and then fasten the two mantels to the overlay with two #8x1/2″ screws (provided). (Fig. 4)

To stabilize the system (especially longer lengths) it is recommended that you screw a 6″ by 7-3/4″ piece of plywood centered into the back of the two mantels. This will eliminate sagging.

To install clips and mount the mantel system, use the distance from the center of modified mantel system to one of the locking legs to determine the location of your clips. *NOTE: Seal gaps at top of mantel if Pediment / Urn system is not used. (*Fig. 5)



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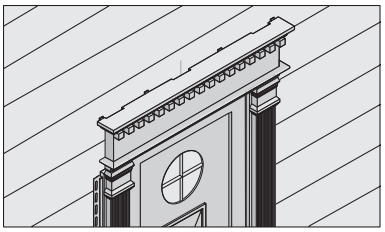
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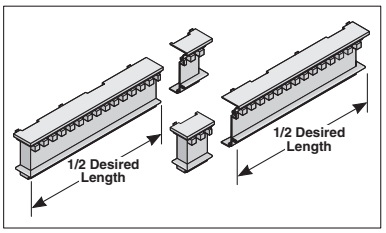

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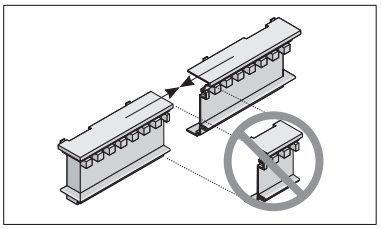
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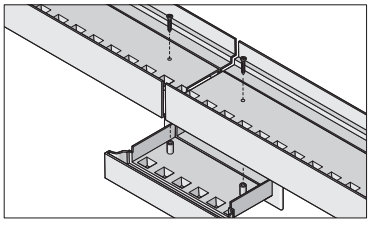
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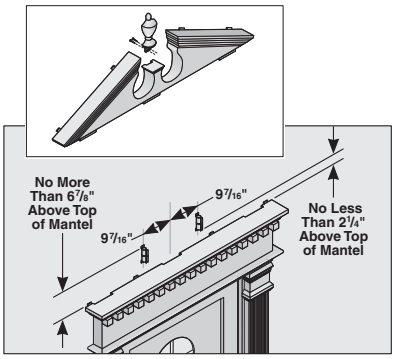

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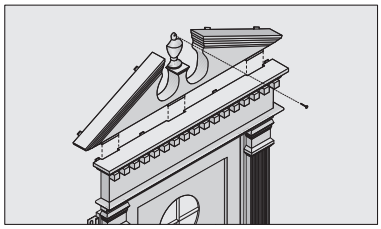

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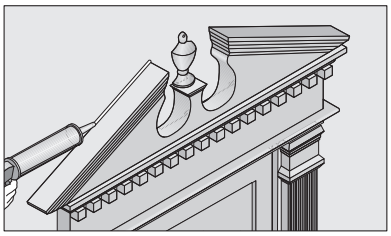


Fig. 3

Pediment and Urn Installation (Fits Standard Size Mantel Only)

Attach urn to pediment by sliding urn into place from back. Fasten with #8x1/2˝ self-tapping screws.

Measure 9-7/16˝ to each side of the mantelcenter line and scribe a vertical line approximately 8” long.

On each side of the lines, install two clips. Be sure the bottom of the bottom clip throats are located at least 2-1/4˝ above the top of the mantel and the top of the top clip throat is no higher than 6-7/8˝ above the top of the mantel. (Fig.1)

Position the pediment over the mantel by inserting the three male lugs on the bottom of the pediment into the matching slots in the top of the mantel.

Align the ribs over the clips and snap into place.

Secure the top of the urn to the wall by nailing through nail hole in urn. (Fig. 2)

With brick or stucco walls, caulk space between top of pediment and wall and other places where water seepage is possible. (Fig. 3)

Window Trim Capping

Measure the required dimensions to cover window trim. Also, determine the required lengths of trims.

Cut trim sheet to the measurements and form each sheet on a bending break. (Fig.1)

Trim sheet should be installed in the following order: bottom, sides, top.

Place the trim sheet on the window frame and mark it for cutting.

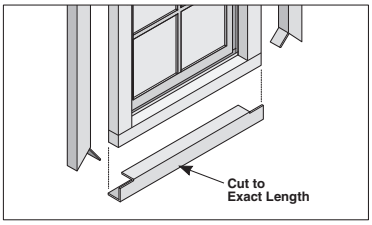
Create tabs into the trim sheet (both ends of bottom piece and tops of both side pieces) so that it covers the edge areas.

Miter the bottom of the side pieces and both ends of the top piece. (Fig. 2)

Nail into place using painted aluminum or stainless steel trim nails. Pre drill nail holes and do not nail tight. The top piece should be the last section to be nailed into place. (Fig. 3)

NOTE: Dissimilar Materials: Direct contact of aluminum products with certain dissimilar materials, or contact with water run-off from dissimilar materials, is likely to result in corrosion. Accordingly, care should be taken during installation to avoid such contact of aluminum with dissimilar materials including dissimilar metals (e.g. copper, zinc, steel, etc.), concrete, stucco, asbestos siding, pressure treated/pretreated lumber, masonry, roofing materials or roofing systems containing metallic granules or strips, or corrosive non-metallic materials.

A barrier must be used to separate trim from any pre-treated lumber. Optional barriers include: plastic, house wrap, roofing felt, foam, or a high quality primer or paint.



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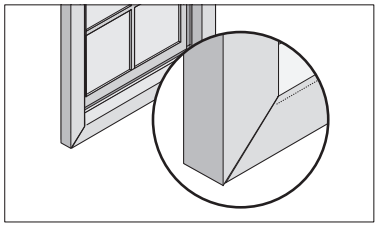

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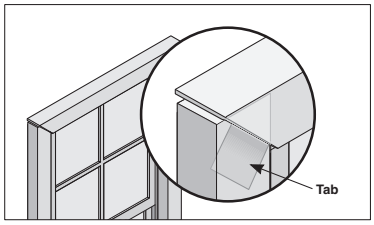

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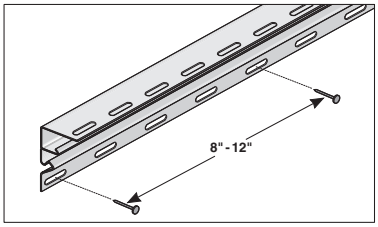

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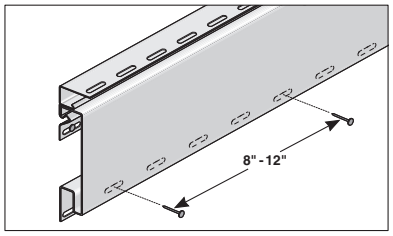


Fig. 2

Lineals

Choose either a 3.5˝ or 5˝ lineal, depending on the look you want to achieve.

At Eave or Gable, butt the small leg of the starter against, but not under the J-Channel that was installed to receive the soffit.

Nail the starter in place every 8˝ to 12˝ with nails centered in nailing slots. (Fig.1)

Push the locking leg of the lineal into the starter channel.

Nail the Lineal in place every 8˝ to 12˝ with nails centered in nailing slots.

Install utility trim into the lineal receiving channel, making sure to align nail slots with lineal nail slots.

Install last course of siding. (Fig. 2)

In some situations you may have to shim the utility trim or you can use a Double utility trim.

Band Board Installation

Option 1: Choose either a 3.5″ or 5″ lineal, depending on the look you want to achieve.

For easy installation (when possible), lock the lineal onto the last full course of siding.

Nail every 8″ to 12″ with nail centered in the nailing slots.

A drip cap must be installed along with a starter strip or J-Channel to recieve the 1st course of siding above the lineal. (Fig. 4, 5 & 6)

The drip cap should be formed so that it extends up the wall 4″ and extends over the face of the lineal by 3/4″. (Fig. 4)

Proceed with standard panel application by installing the siding into the lineal J-Channel.

*Option 2: (*Fig. 2) & (Fig. 3)

Determine the location of the band board in relation to the siding making certain it does not interfere with the butt of the siding panel.

Strike a chalk line and install utility trim along the line nailing every 8″ to 12″ with nails centered in the nailing slots.

Lock the band board into the utility trim and nail every 36″. (Fig. 2)

Once the band board is in place, install another piece of utility trim by aligning the nails slots of the finish trim with the band board lineal. You may have to shim the utility trim. Nail every 8″ to 12″.

To install siding panels, use a snap-lock tool to create tabs in each panel and install them into the utility trim. (Fig. 3)

Once the siding is in place, install a drip cap (field or factory formed) on top of the band board lineal to prevent water intrusion. (Fig. 4)

Finally, for horizontal siding applications,
install a universal starter strip over the drip cap nailing every 8″ to 12″ centered in slots. Make sure to attach starter strip 1/4″ above drip cap to allow siding to lock. (Fig. 5)

For vertical siding applications, install a J-Channel over the drip cap and proceed with standard panel application.

Drill 1/8″ holes in base of J-Channel every 24″ to allow for water to run off. (Fig. 6)

continued on next page

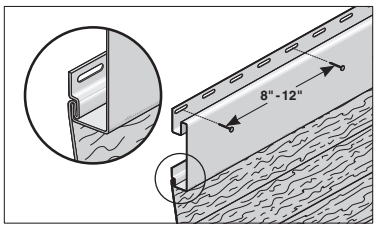


Fig.1

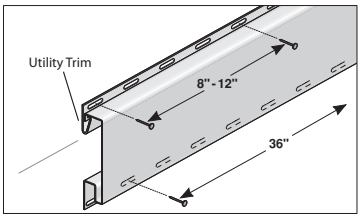
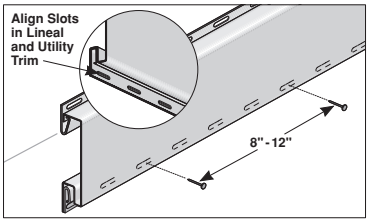
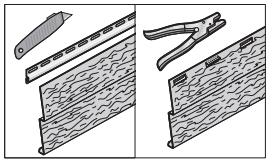


Fig. 2





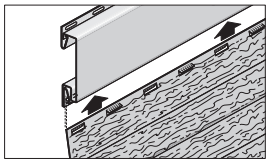


Fig. 3

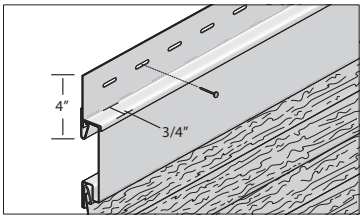
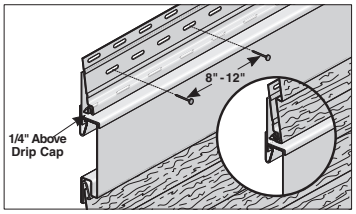


Fig. 4



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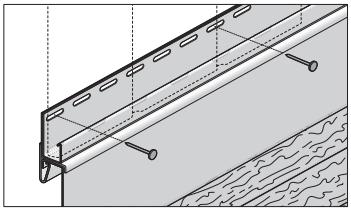


Fig. 6

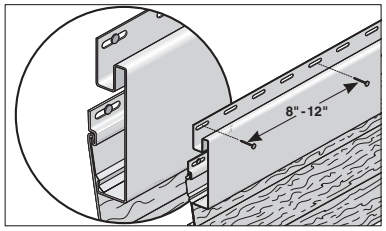


Fig.1

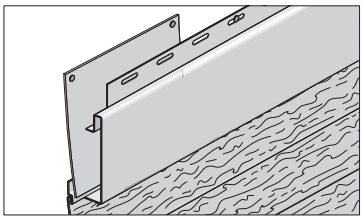


Fig. 2

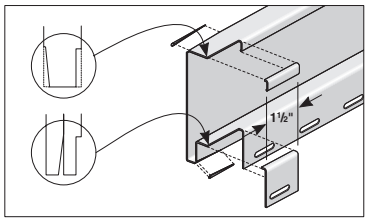


Fig. 3

Option 3:

Determine the band board location.

Install siding to that location and then install the band board. Nail every 8˝ to 12˝ with nails centered in slots.

Utilize field form aluminum to adjust the location of the lineal at the desired height.

Proceed with standard panel application for vertical or horizontal siding. (Fig.1)

Overlapping Lineals

Notch the back legs of the lineal to be overlapped by making a series of cuts as indicated in the diagram.

Cut a tapered notch into the radius at the top and bottom of the lineal on the end to be overlapped.

Slip the un-notched lineal 1˝ over the notched lineal, leaving 1/2˝ for expansion. (Fig. 3)

NOTE: For best appearance, be sure the overlaps are away from the direction that the house is most commonly viewed.

Dentil Molding

Vinyl Siding

Snap a chalk line 6-1/2″ down from the soffit panel location (chalkline.) (Fig.1)

Prepare the dentil molding either by cutting the soffit flange to create a tab, or by removing a portion of the upper soffit flange and slotting. Center of slots should be spaced 16″ apart. (Fig. 2)

Butt the dentil molding to the chalk line and nail into place every 16″.

If siding panels are to be terminated with finish trim to complete sidewall application, dentil mold should be slotted and nailed prior to final course of siding. Cover slots with utility trim. (Fig. 3)

Brick, Stucco or Masonry Installation

If a nailable, flat surface is not available, dentil mold can be applied as a decorative element by placing bottom edge of dentil mold into utility trim and nailing tabs to a 1″x6″ or 1″x8″ board. (Fig. 4)

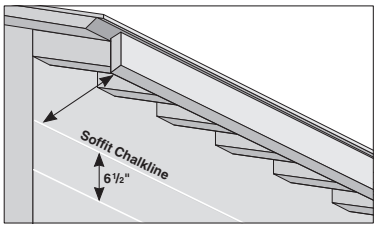


Fig.1

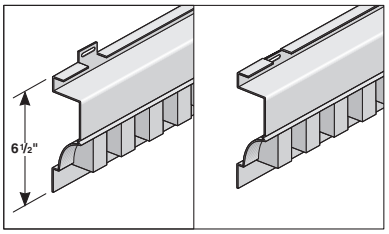


Fig. 2

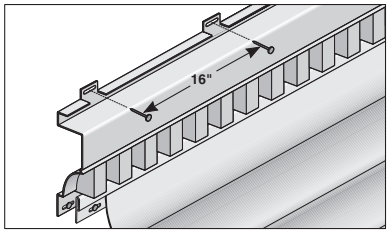
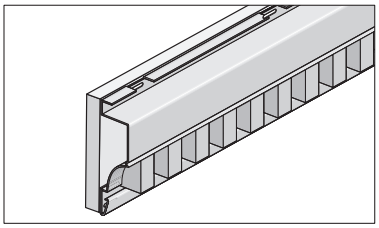


Fig. 3



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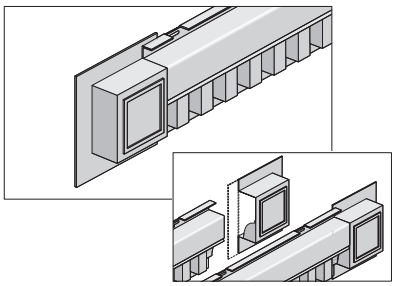
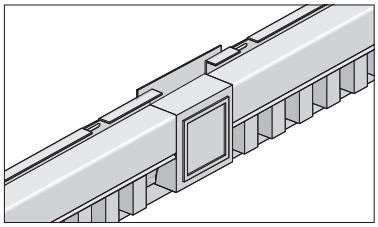


Fig.1



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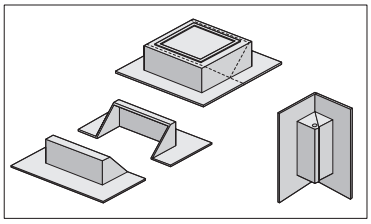


Fig. 3

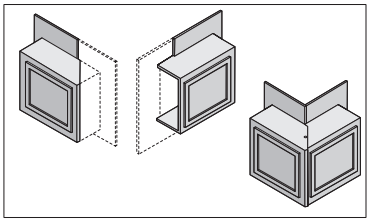


Fig. 4

Dentil Blocks

Dentil blocks finish dentil molding and can be installed at the ends, center, corners or the outside.

To install at ends, position the dentil-molding flange behind the soffit flange and trim as indicated in the illustration. (An option to installing at the end position is to scribe a line onto the dentil block, remove that portion and then position the dentil block at the end of the dentil molding.) (Fig.1)

To install at the center, position the end block at the center of the opening and then butt the dentil molding ends into the end of the block. (Fig. 2)

To install inside corners, cut and remove sections as shown in the illustration. Once removed, pop rivet the two pieces together and then fasten it to the wall. (Fig. 3)

To install outside corners, cut and remove sections as shown. Once removed, pop rivet the two pieces together and then fasten it to the wall. (Fig. 4)

Gable Vents

For Vinyl and Aluminum Siding

Using the inward edges of the vent base as a guide, mark the area to be cut in the exterior wall surface, then cut the hole.

Center the base of the vent over the opening and level the base.
Note the word "TOP" on the base when positioning it.

Nail the base onto the wall surface through the slotted nailing flange. A water diverter should be installed at the base. (Fig.1)

Siding can now be installed around the vent base. Be sure to leave a 1/4˝ clearance between the cut siding and the base to allow for expansion and contraction. (Fig. 2)

Snap the face into the base by pressing firmly.

Should it be necessary to remove the face, firmly pull the face from the base. (Fig. 3)

Gable vents can be installed without cutting a hole if you want it to be decorative only.

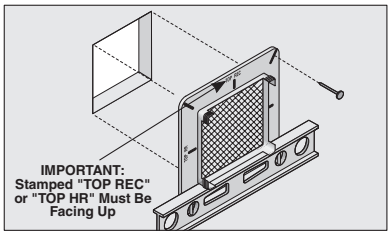


Fig.1

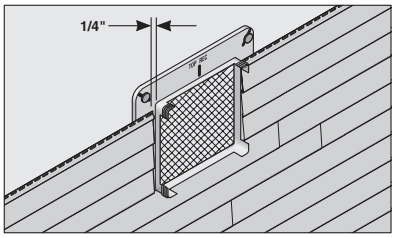


Fig. 2

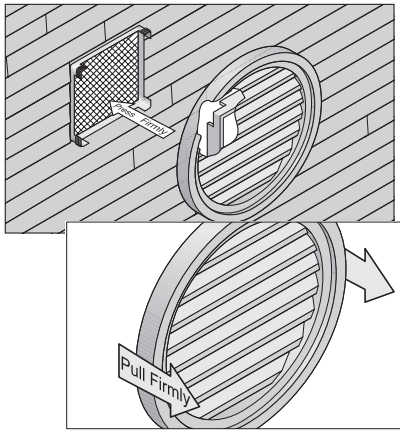


Fig. 3

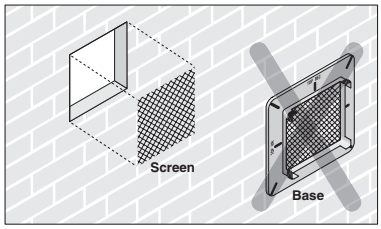


Fig.1

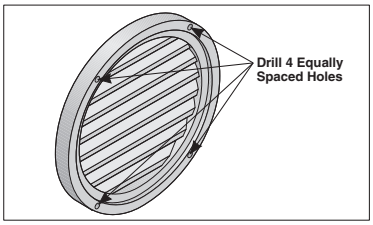


Fig. 2

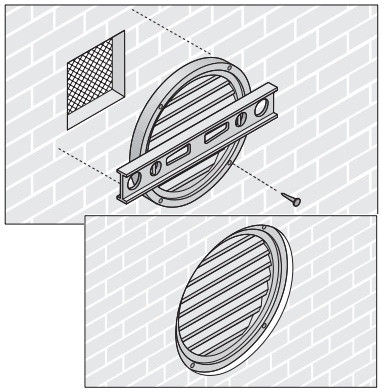


Fig. 3

For Installation onto Masonry Surfaces

Fasten the screen to the inside or outside of the wall opening. Discard the base. (Fig.1)

Drill four equally spaced holes around the outer front surface of the vent face. (Fig. 2)

Place the vent face over the exterior wall opening, level it and fasten it to the wall using masonry fasteners. (Fig. 3)

NOTE: On new homes, the vent face may be recessed into the brick.

Preparation

Determining proper ventilation

For best results, vents must provide 1.5 sq. inches of net free area per sq. ft. of attic floor area, including enclosed overhang. (Fig.1)

Placing proper ventilation

Ideally 50% of the required free ventilating area should be placed at the ridge and 25% in each opposing soffit. Soffit ventilation area may be slightly larger than ridge ventilation area. Do not have more ventilation area in ridge than in the soffit.

The slope/pitch must not be less than 3:12 or greater than 6:12. Wood cant strips should be used for slopes outside this range. (Fig. 2)

NOTE: Do not apply generic ridge vent part on roof hips.

Preparing an existing roof

Remove ridge cap shingles along the roof ridge.

Snap chalk lines on both sides of the ridgeline to the dimensions shown in the illustration at left, depending on your specific roof construction.

Cut out ventilation opening along the ridge at chalk lines with ventilation opening end 12˝ short of outside walls, chimneys, or roof protrusion.

Remove cutout portion of sheathing and shingles, leaving a clean open slot.

For new construction

Plywood can be set or cut back to the required dimension leaving a total opening of 1-1/2˝. Shingles should then be installed up to the edge of the sheathing. *NOTE: Never cut ventilation opening in overhang.*

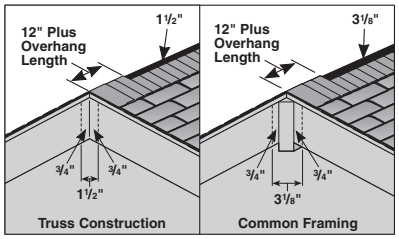


Fig.1

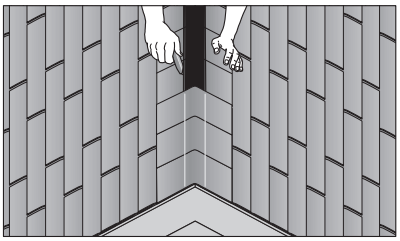


Fig. 2

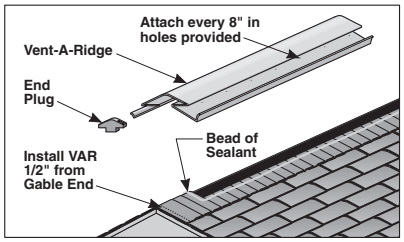


Fig.1

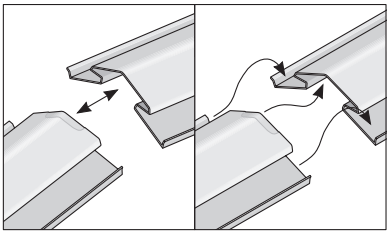


Fig. 2

Insert ends on an angle.

Insert baffles and top angle over or under as indicated by the arrows.

Slide together, closing notch.

NOTE: Aluminum or stainless steel nails or screws should be used to attach ridge every 8˝ (both sides). The fasteners should protrude at least 1/2˝ through sheathing. Sealant is required on the underside of all end plugs and both baffle legs.

Attaching the Vent

Starting with the male end, place the first vent on the ridge, making sure the center of the vent aligns with the center of the ridge slot. (For best appearance, place the vent 1/2˝ in from the end of the gable end.) A chalk line can be used to assist in the alignment.

Nail or screw one side of the vent to the roof every 8˝ through nail holes. Attach the other side of the vent, making sure the vent lies flat on the roof.

Align the next piece, slide and lock into place, then nail. Make sure the vent aligns with the center of the ridge. Install additional pieces in the same manner.

Cut the final section of the vent to the required length. Make sure to position and seal an end plug as desired for a starter piece. Nail into place.

NOTE: Ridge can be modified to be used in vertical and peak roof applications.

J-Channel at roof line

Step 1

Install the flashing before the J-Channel to prevent water infiltration along the intersection of a roof and wall.

Step 2

Keep the J-Channel at least 1/2″ from the roofline. Chalk a straight line up the roof flashing to guide J-Channel installation.

NOTE: Vinyl J-Channels should not be in direct contact with roofing shingles, since the shingles may transfer enough heat to the vinyl J-Channel to cause distortion. With dark shingles, or a south or west exposure, it is recommended to either use a metal J-Channel or raise the vinyl J-Channel approximately 2″ off the shingles and install, having first ensured that there is sufficient flashing behind the J-Channel to prevent water infiltration.

Step 3

Overlap the J-Channel (lapping the upper piece over the lower piece) if it is necessary to use more than one piece.

Step 4

Extend the J-Channel past the edge of the roof, channeling water into the gutter, in order to ensure proper runoff.

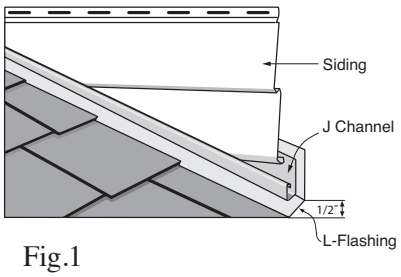


Fig.1

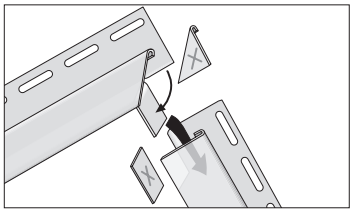


Fig. 2

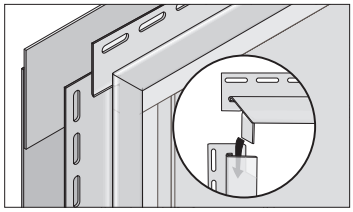


Fig. 3

J Channel

J-Channels are designed to receive the siding panels and must be installed around all windows, doors, other large openings and in the gables where built-in J-channels are not present. J-Channels can be installed over old wood casing or placed next to the casing leaving the old window casing exposed.

Water runoff can also be accomplised by making a series of notches and tabs in the J-Channel. (Fig. 2)

Install J-Channel in this order: Bottom, Sides then top.

Miter J-Channels at corners to prevent gaps and allow for proper water drainage. (Fig. 3)

Flex-J

Flexible J-Channels are designed for curved surfaces such as arched windows.

Begin nailing at one end of the arch one-half inch of the end of the channel. Nevver begin at the crown or middle of the arch.

Nail every six inches. (Fig. 4)

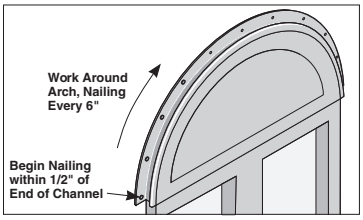


Fig. 4

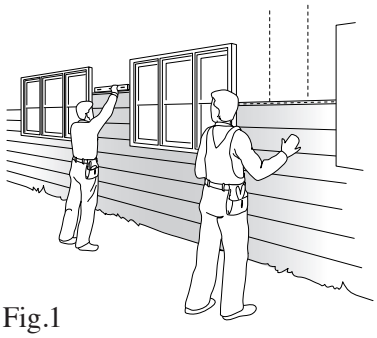


Fig.1

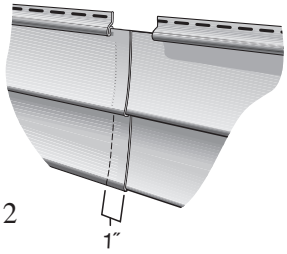


Fig. 2

Step 1
The first panel (or course) should be placed in the starter strip and securely locked along the entire length of the siding panel.

NOTE: Always overlap joints away from entrances and away from the point of greatest traffic. This will improve the overall appearance of the installation.

Step 2
Be sure to fasten the panels according to the instructions on page 14. Allowance should be made for expansion and contraction by leaving a 1/4″ gap between the siding and all corner posts and channels (increase to 3/8″ when installing in temperatures below 40ºF).

Step 3
Do not drive the head of the fastener tightly against the nail slot. Leave 1/32″ between the fastener head and the panel nailing strip.

Step 4
Do not stretch the panels up when fastening. Panel locks should be fully engaged; however, the panels should not be under vertical tension or compression when they are fastened.

Step 5
Since vinyl siding moves as the temperature changes, make certain that the vinyl panels can move freely in a side-to-side direction once fastened.

Step 6
Check every fifth or sixth course for horizontal alignment (Fig. 1). **[Check siding alignment with adjoining walls]**

Step 7
When panels overlap, make sure they overlap approximately 1″ (Fig. 2).

NOTE: Overlap with factory ends whenever possible. If you must use cut ends, duplicate the factory notches before installing. Avoid stair-step lapping.

Step 8
Stagger the siding end laps so that no two courses are aligned vertically, unless separated by three courses.

Beaded Horizontal Siding

Beaded panels are factory notched in three places (Fig. 1). For best results, overlap panels using factory notched ends only. **This panel should be overlapped 1˝ due to the unique design of the locking and lapping system.** Overlapping more than 1˝ will result in less than optimal laps and increase the chances of panel restriction (Fig. 2). For easiest panel installation, start locking the panel at one end and tap the lock into place toward the other end. This panel will not lock by pushing straight up as in standard panel installation.

TIP Always overlap joints away from entrances and away from the point of greatest traffic. This will improve the overall appearance of the installation.

Fitting Siding around Fixtures

For handling protrusions around the wall, refer to the figure (Fig. 3) for hand fabricating, or use manufacturers' accessories specifically designed for this purpose. In addition, the following tips are suggested:

- Always begin a new course of siding at the fixture to avoid excess lap joints.
- Cut a slot 1/4˝ bigger than the fixture. (Fig. 3)
- When cutting, match the shape and contour of the obstruction. (Fig. 4)

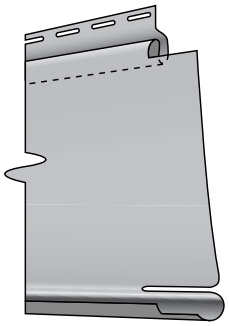


Fig. 1

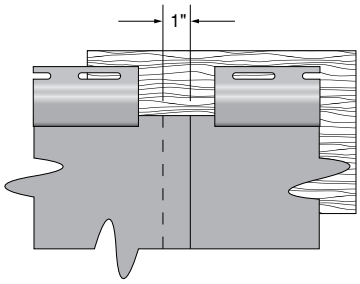


Fig.2

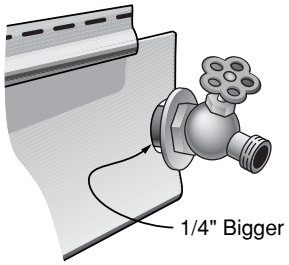


Fig. 3

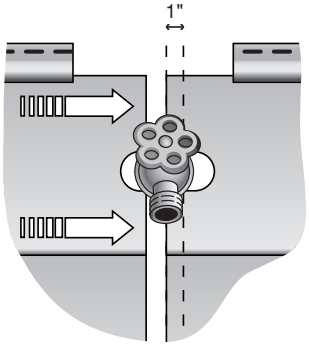


Fig. 4

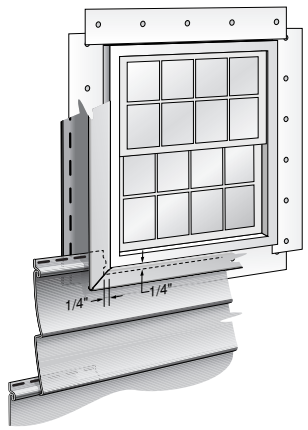
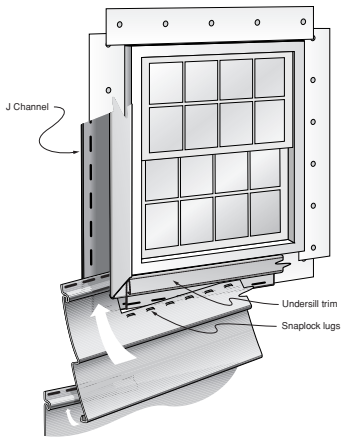


Fig. 1



Fitting under Windows

To mark the section to be cut, perform the following:

Step 1

Hold the panel under the window and mark the width of the window opening on the panel. Add 1/4″ to both sides to allow for expansion and contraction of the siding. These marks represent the vertical cuts (Fig. 1).

Step 2

Lock a small piece of scrap siding into the lower panel next to the window. This will be used as a template for the horizontal cuts. Mark it 1/4″ below the sill height (Fig. 1).

Step 3

Transfer the horizontal measurement to the panel, which will be installed under the window (Fig. 1).

Step 4

Cut the panel with tin snips and/or a utility knife.

The cut panel is now ready for installation under the window. Perform the following:

Step 5

Install undersill trim under the window, inside previously installed J-channel as a receiver for the cut siding. Undersill trim is used any time the nail hem has been removed from the siding. Furring may be needed to maintain the face of the panel at the desired angle.

Step 6

Use a snaplock punch to place lugs facing out in the cut edge of the panel every 6″-10″.

Step 7

Install the siding panel, making sure the lugs (from the snaplock punch) lock into the undersill trim (Fig. 2).

Finishing at the Top

Before the final course of siding is installed on the wall, any soffit accessories that will be used on the eaves must be installed.

Gable Ends

To install into gable ends, make a pattern that duplicates the slope of the gable (Fig. 1).

Step 1

Lock a short piece of siding into the gable starter course (i.e., the last course before the gable starts).

Step 2

Hold a second piece of siding against the J-Channel at the slope of the gable. Mark the slope with a pencil on the short piece of siding.

Step 3

Remove the short piece and cut along the pencil line as a pattern for the gable angle cuts. Repeat the procedure on the opposite side of the gable.

Step 4

It may be necessary to fasten the last panel at the gable peak with a trim nail. Use a 1 1/4″ to 1 1/2″ nail. **[This is the only time a nail should be placed in the face of the vinyl siding (Fig. 2).]**

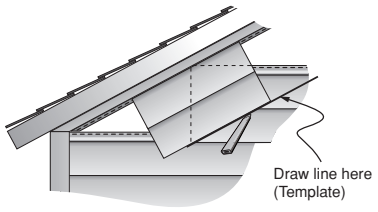


Fig.1

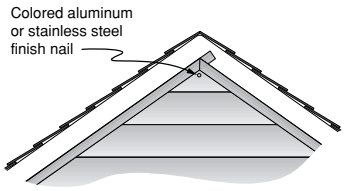


Fig. 2

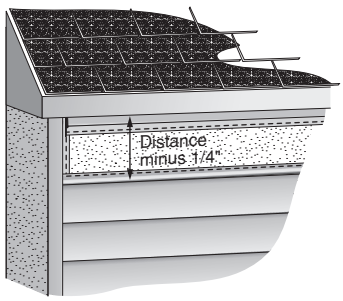


Fig.1

Eave Treatment

The last course of siding will generally need to be cut to fit the eave opening (Fig.1).

Step 1

Install undersill trim under the eave or overhang as a receiver for the cut siding. Undersill trim is used anytime the top or bottom lock has been removed from the siding. Furring may be needed to maintain face of the panel at the desired angle.

Step 2

Measure from the top of the undersill trim to the bottom of the upper lock on the previous course of panels. Subtract 1/4″. Mark this dimension on the panel to be cut, measuring from the bottom edge of the panel.

Step 3

Using a snaplock punch, punch the vinyl siding along the cut edge every 6″ to 10″, so the raised lug is on the outside face.

Step 4

Install the siding panel, making sure the lugs (from snaplock punch) lock into the undersill trim.

Starter Strip

You must use the required starter strip (with 1/2″ step). (Fig. 2)

Chalk lines are normally established from the lowest corner of the house. In situations where the ground at the corner of the house is not level, chalk lines must be measured from the soffit location to assure a uniform panel at the top of the walls.

The starting chalk line should be located so that it represents the top, not the bottom, of the starter strip (Fig.1)

Note: Make sure starter strip works with insulated siding.
Align the top of the starter strip with the chalk line.

Nail the starter strips 8″ on center and in the middle of each nail slot Do not drive nails tight. Always nail in the lowest row of the nail slots allowable. (Fig. 2)

Allow at least 1/4″ separation between pieces of starter strips for expansion and contraction. (Fig. 3)

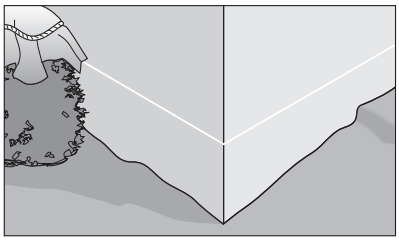


Fig.1

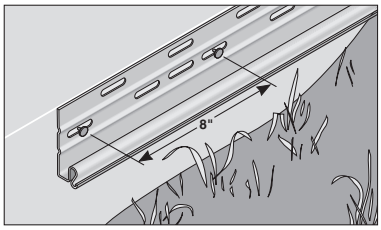


Fig. 2

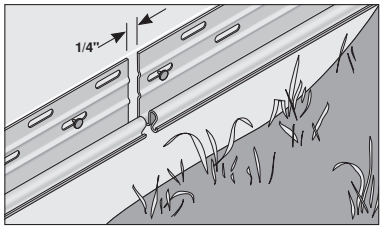


Fig. 3

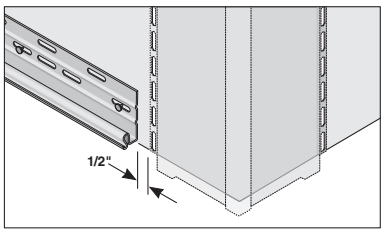


Fig.1

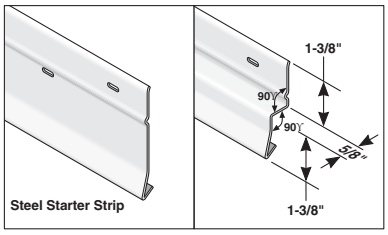


Fig.2

Starter Strip and Accessories

Cut the starter strip back from each corner so the corner post nailing hem may be installed without touching the starter strip. Leave a 1/2″ gap from all corner post nail hems.

Cut the corner post so that it hangs 3/4″ below the bottom of the starter strip. (Fig.1)

When installing panels above exposed overhang areas, the 3-1/2″ steel starter strip can be modified by bending the starter in two locations as shown. (Fig.2)

Corner Post Options

The preferred corner post is the foam-filled corner. This corner post has a1-1/4″ opening to receive the Insulated panel. (Fig.1)

NOTE: Nail all corner posts as described in Basic Accessory Installation, "Installing Corner Posts."

NOTE: For the best appearance do not start any course with factory ends. Remove the factory notch by cutting the first 2″ of the panel. This is important in high altitude, high heat applications.

If other corner posts are used, follow the steps below:

1. Attach 1/2″ thick shims under the nail hems of the corner.

2. 2″ of foam must be cut to allow the panel to be installed into the corner. (Fig. 2)

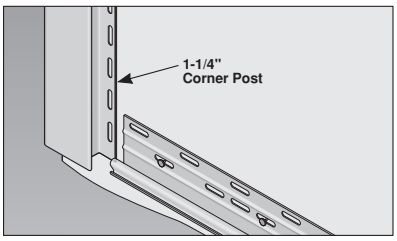


Fig.1

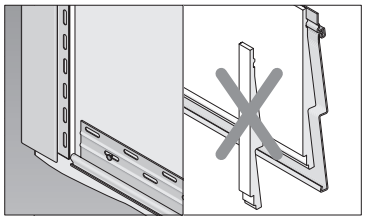


Fig. 2

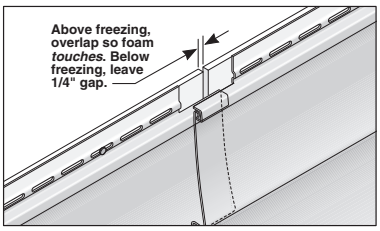


Fig.1

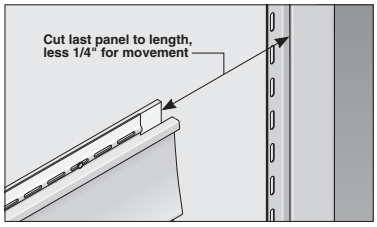


Fig.2

Panel Installation

When installing at overlaps, the vinyl of one panel should slide between the foam and the vinyl of the adjacent panel. With panel overlaps at temperatures above freezing, the Structure foam should touch. At applications below freezing, leave a 1/4″ gap at the foam area. (Fig.1)

When determining the length of the final panel of a course, measure from the edge of the foam on the installed panel to the corner, less 1/4″. Apply this measurement to the final panel, measuring the foam instead of the panel. This will insure foam to foam contact with the necessary amount of room for expansion of the siding. (Fig.2)

Installing Around Openings

The preferred J-Channels are 1-1/4″ or 2-1/2″. They should be installed as described in Basic Accessory Installation, "J-Channel, Flex-J, and Flashing."

Utilize a flexible water diverter at the bottom of all openings (see General Siding Installation). A flexible water diverter should be housewrap, plastic, or roofing felt. (Fig.2)

To measure for a window or other opening:

a. Set the panel below the opening.

b. Mark the J-Channel location, allowing for a 1/4″ gap on all sides of the opening for expansion and contraction. (Fig.3)

Cut the panel as marked using either a utility knife or tin snips. Cut back foam 2″ for 1-1/4″ or 3-1/2″ for 2-1/2″. (Fig.4)

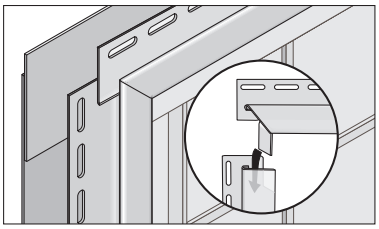


Fig.1

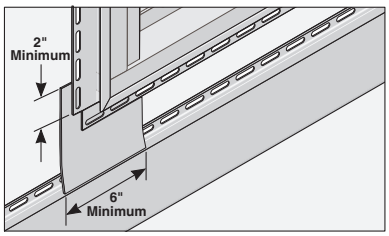


Fig.2

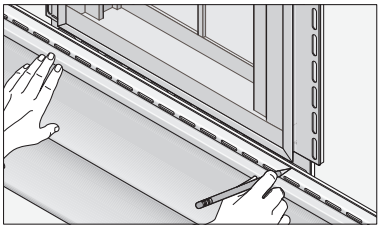


Fig.3

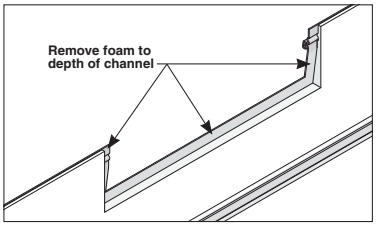


Fig.4

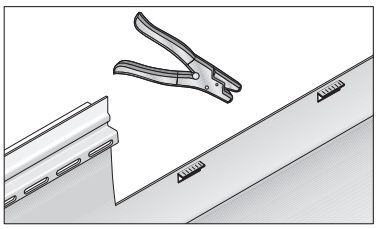


Fig.1

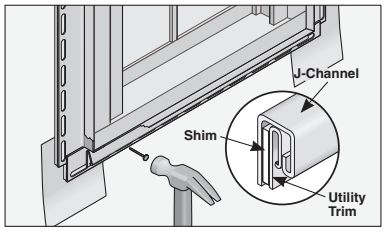


Fig.2

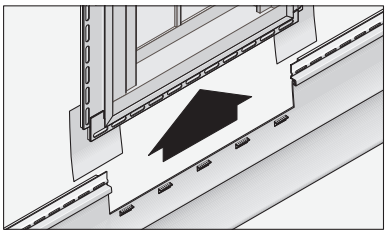


Fig.3

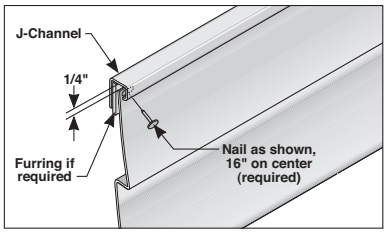


Fig. 4

Installing Around Openings continued

Use a snap-lock tool to create a tab every 16″ on the cut edge of the panel. These tabs should face out. (Fig.1)

Install a finish trim into the bottom J-Channel at the opening. A shim must be installed behind the finish trim. The foam that was cut from the panel can be used as the finish trim shim.
(Fig.2)

Snap the tabs of the cut edge of the panel into the finish trim under the windowsill. (Fig.3)

A shim must be installed. (Fig.4)

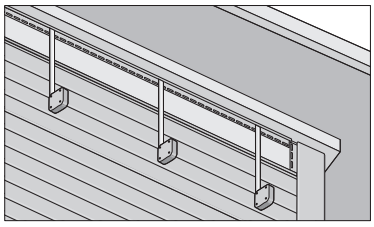
An optional method for this area is to nail slot the cut edge of panel every 16″ on center.

The face of the channel can be held to facilitate nailing. Nail in middle of every slot.

Final Course

Take the height measurement of the remaining open section in several locations.

Subtract 1/4″ from each location to allow for movement. (Fig.1)



Cut the panel to required measurement. (Fig.2)

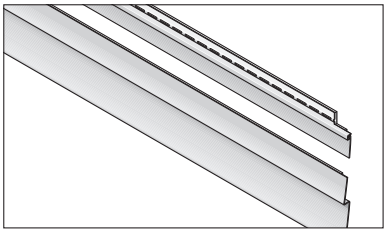


Fig.2

Cut back foam 2″ for 1-1/4″ J-Channels or 3-1/2″ for 2-1/2″ J-Channels (Fig.3)

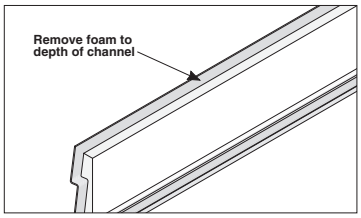
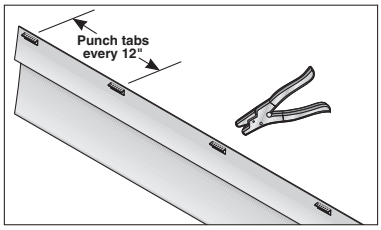
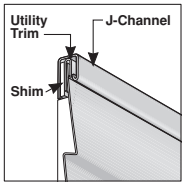


Fig.3





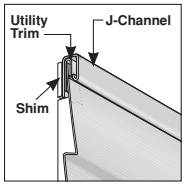
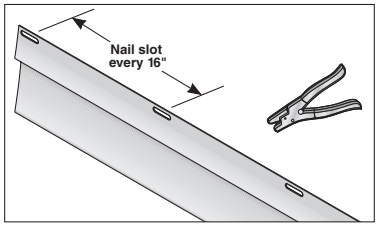
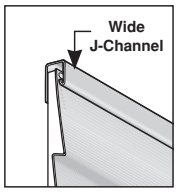
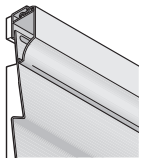


Fig.1

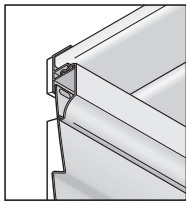




Wide Window Casing Trim



Snap-In Crown and Mount



Snap-In Crown and Mount with J-Channel

Fig.2

Snap Lock Options (Fig.1)

Use a snap-lock tool to create a tab every 12˝ on the cut edge of the panel. These tabs should face out. A utility trim must be used with this option.

Nail Slot Options (Fig.2)

A second option is to nail slot the top of the panel. A utility trim is not used with this option. *See fig. 2 for the use of the snap in crown system.*

NOTE: If Permatabs are used, nail slot the top of the panel every 16˝.

Transition from Horizontal to Vertical (Fig. 1)

Finish the last course of horizontal siding with the J-channel and finish trim. Install a drip cap and a J-channel. The top piece of J-channel must have minimum 3/16″ (4.8mm) diameter weep holes drilled no more than 24″ (610mm) apart to allow for water runoff.

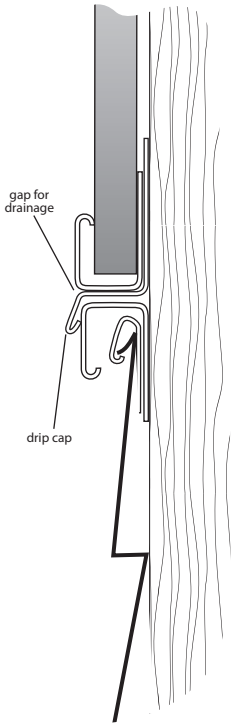


Fig.1

VERTICAL SIDING INSTALLATION

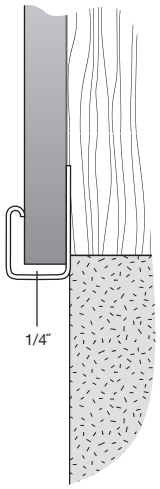


Fig.1

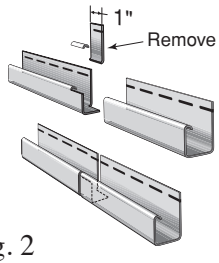


Fig. 2

When installing vertical siding, follow these steps:

Preparation

Step 1

Install a solid, nailable sheathing prior to applying vertical siding, if needed, to level the surface or provide sufficient material for proper fastener penetration. Use minimum 7/16″ plywood, OSB or equivalent.

Step 2

Snap a level chalkline around the base of the sidewalls. Typically, the chalkline is positioned so that the bottom of the J-Channel is 1/4″ below the lowest point on the wall that will be sided. (See the "Installing Accessories" section for tips on snapping a chalkline.) Install a J-Channel along the chalkline as a receiver for the vertical siding.

Installation

Step 1

Install vinyl outside corner posts, inside corner posts, and door/window trim, and/or J-Channel as needed. See previous sections for corner post installation techniques.

Step 2

Install top and bottom J-Channel: Apply J-Channel along the top and bottom of the walls to receive the siding panels (Fig. 1).

A Install the bottom J-Channel. Overlap J-Channels 3/4″. To do this, cut out a 1″ section of the nailing flange and face return (see Fig. 2).

B Install inverted J-Channel along the top of the wall, under the eave and the gable. Overlap J-Channels 3/4″ to allow for expansion.

NOTE: If you're going to install soffit, you may want to install the receiving channels for the soffit prior to this point.

If a wall requires more than one course of vertical siding, use two lengths of J-Channel, back-to-back and flashing, at the joint between the two courses (Fig. 1).

If a wider wall is being covered, then you can start with a full width vertical panel. In this case you can install that first piece by utilizing a starter strip on the cut nailing hem of a vertical panel. (Fig. 1)

If a smaller wall is being covered, you should try to create a balanced appearance.

- To create a balanced appearance (Fig. 2) divide the length of the wall by the exposure of the vertical panel to be used. For example, if the wall requires 20 full panels plus an adeditional 8" (203mm), then the first and last pieces installed would be cut to a new width of 4" (102mm). Make sure to allow for proper depth in the receiving channels of the accessories at both ends when measuring.
- To install the siding, if partial panels are required, mark the line to cut by measuring from the edge of the lock of the panel and cut the panel to the proper width. This will leave a panel with an intact nail hem and proper exposure.

The top J-Channel must have a minimum of 3/16" (4-8mm) diameter weep holes drilled no more than 24" (610mm) apart to allow for water runoff.

Step 1

Panel installation should begin at the end of a wall section at a corner post or J-Channel. An undersill trim piece should be installed and fastened inside the opening of the corner post or J-Channel to secure the edge of the first and last course of siding. Snaplock punch the cut edge every 6″ to 10″, and snap the edge into the secured undersill trim. Cut and install last course in similar fashion. (Fig. 3)

Step 2

TIP: A furring strip may be needed behind the undersill trim before fastening to shim it out and maintain the lines of the vertical panel.

Maintain a 1/4″ gap at each end of panels where they butt to trim pieces such as J-Channel. Failure to maintain this gap may result in permanent panel warpage. Maintain a 3/8″ gap if installing at temperatures 40º F or below.

Step 3

Fasten panels every 12″ through the middle of the nailing slots. Maintain 1/32″ minimum clearance between the fastener crown and nail hem of panel.

Special note for vertical panel installation: Vertical panels should be cut to allow clearance as specified. Panels should be positioned on wall allowing equal clearance top and bottom. One fastener should be placed at the top of a nail slot within the upper 12″ of the panel when installed. The panel will hang on this fastener and will expand in both directions rather than only upward. Balance of fastening should take place in the center of the nailing slots (Fig. 4).

Step 4

Undersill trim should be installed inside J-Channel, or built-in window receiver on the sides of windows and/ or doors to secure cut edge of vertical panels. Vertical panels should be snap-locked before insertion into the undersill trim (Fig. 3). A furring strip may be needed behind the undersill trim to maintain the lines of the vertical panel.

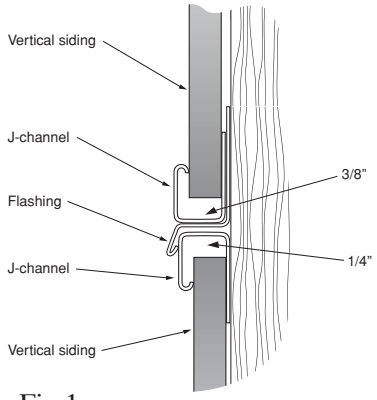


Fig.1

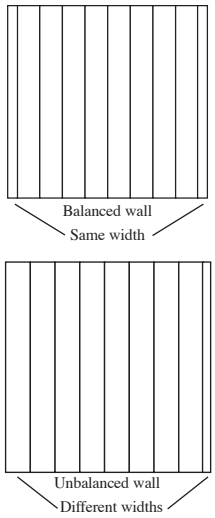


Fig. 2

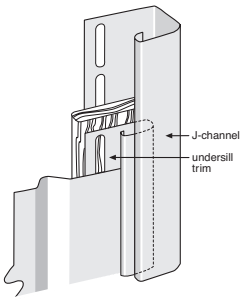


Fig. 3 Start and or finish

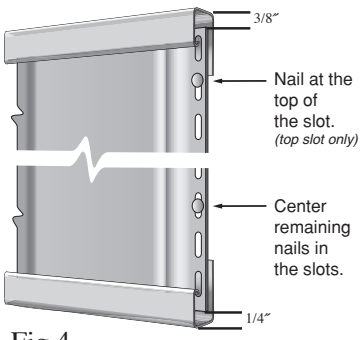


Fig.4

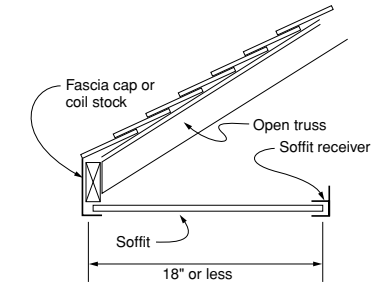


Fig.1

16″ or less

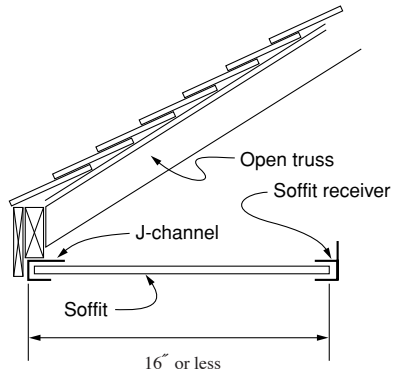


Fig. 2

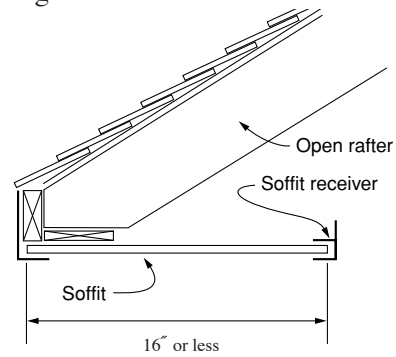


Fig. 3

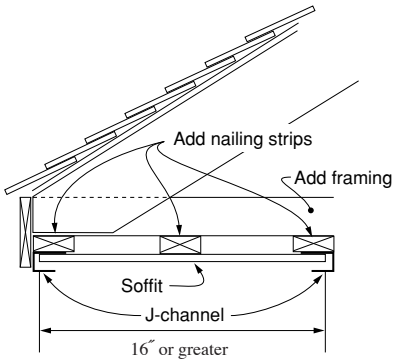


Fig. 4

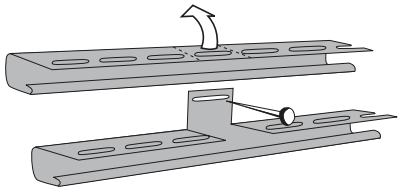


Fig. 5

Soffit is the name given to materials used to enclose the underside of eaves and porch ceilings. The installation of soffit will determine the positioning of the inside and outside corner posts.

Vinyl soffit is designed to be easily installed in residing or new construction. Soffit panels are similar to vertical siding. Soffits are available in aluminum or vinyl. Can be solid, fully perforated or lanced, or combination soffits. Also available in vinyl is a hidden vent system.

NOTE: Proper attic ventilation is important for any home. Consult a local building official for the appropriate requirements for a specific geographical area, and use vented soffit or other vented products as necessary.

Preparation

Inspect and plan the job in advance. For residing applications, nail down any loose panels, boards or shingles. Check surfaces for straightness and fur when necessary. Surfaces should be uniform and straight from various viewing angles.

The procedure used to install soffit depends on the construction of the eaves. There are two different types of eaves:

TYPE ONE

Open eaves with exposed rafters or trusses are typical of new construction. Open eave installation procedures are also used when removing damaged soffit during a residing project.

TYPE TWO

Enclosed eaves (eaves with a wood or plywood soffit already in place) are typical of residing projects.

Installation Over Open Eaves:

Step 1

Install receiving channels (F-Channel or J-Channel).

There are several ways to install receiving channels for soffit. You can use accessories such as J-Channel or F-Channel. The best approach is to select a method that works most effectively with the construction techniques used to create the eave.

Examine the illustrations at left and find one that most closely resembles the construction methods used for your particular project (Figs. 1-4). Another option is to cut tabs into J-Channel and to nail into those tabs.

Install the receiving channels following the details shown in the illustrations. Nail channels every 12″, positioning the nail in the center of the slot. Fasten channels, just snug to take out excessive play. Do not overdrive fasteners.

NOTE: If the eave span is over 16″, nailing strips must be installed (Fig. 4).

5-step procedure continued:

Step 2
Measure soffit panels 1/2" shorter than opening. Mark this dimension on a soffit panel and cut using a power saw with a reversed finetooth blade or snips.

Step 3
Insert one end of the panel into the channel on the wall, nail the other end to the wood fascia. (Fig. 1)

- Make certain the panel is perpendicular to the wall, and then nail. Depending on the installation method being used, nails will be hammered either into a nailing strip or fascia board.
- Do not nail soffit panels tightly.
- Continue the installation by locking and nailing the panels. Make certain the panels are fully locked along their entire length.

Step 4
To turn a corner, measure from the channel at the wall corner to the channel at the corner of the fascia board (Fig. 1). Subtract 1/4˝ for expansion. Cut and install H-Molding lineal or back-to-back J-Channel. If necessary, install nailing strips to provide backing for the lineal. Miter cut the corner soffit panels and install as described in Step 3.

Step 5
Install aluminum fascia as needed to finish installation. (see section on fascia installation)

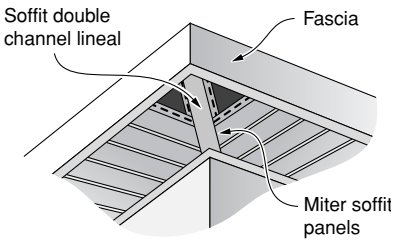


Fig. 1

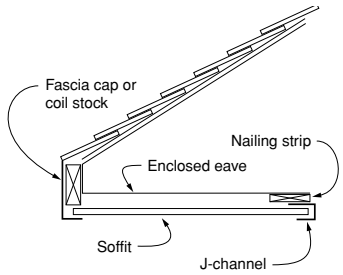


Fig.1

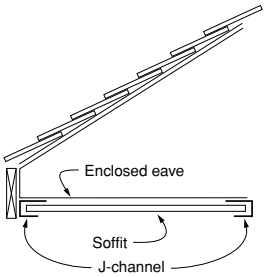


Fig. 2

Type 2

Installation Over Enclosed Eaves

The procedure used to install soffit over enclosed eaves is almost identical to that used for open eaves. A J-Channel or F-Channel can be used to recieve soffit panels. (Fig. 1& 2)

Determine the preferred method of installing soffit at the fascia board.

NOTE: If the existing soffit is rotted or damaged, remove it completely before installing vinyl soffit, then use the instructions for open eaves.

Step 1
Install soffit per instructions stated previously. Choose the soffit installation method that applies to your specific needs.

Step 2
Install metal drip edge, gutter trim, undersill trim, etc. along the top of the fascia board to receive and secure the top edge of the aluminum fascia.

Step 3
Measure from the lower side of the soffit panels to the top of the trim installed on the upper side of the fascia board. Deduct approximately 1/8″ from this dimension and cut fascia panel using snips, or score and break with a utility knife and straight edge.

Step 4
For the best appearance, we suggest that you do not face nail aluminum fascia. The recommended procedure is to slip the top edge of the fascia into the drip edge (or utility trim) and secure the fascia in place with trim nails installed through the bottom side (Fig.1). Nail no greater than 2´ on center.

Step 5
Outside corners: bend a 1″ flange at a 90-degree angle so it turns the corner. Then cut the overlapping fascia and position as shown (Fig. 2).

Inside corners: Use same technique as outside corners.

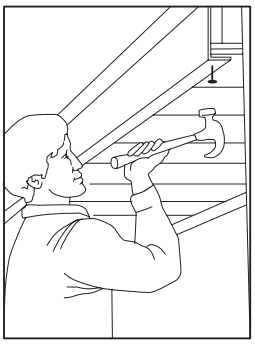


Fig. 1

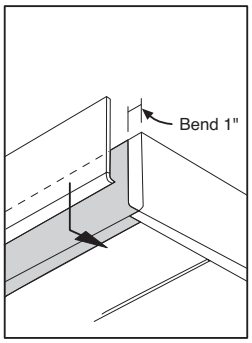


Fig. 2

NOTE: Nails or fasteners installed through the bottom of the aluminum fascia panel may penetrate the ends of the soffit panels in some installations. The following procedures are recommended if this situation occurs.

- ** Line up the aluminum fascia fasteners with the V-grooves in the soffit panels to avoid cupping the soffit panel faces.*
- ** If vinyl soffit panels are over 24″ in length, enlarge the fastener hole in the soffit panel 1/4´ larger than the fascia fastener diameter. This will allow the soffit panels to expand normally and avoid potential buckling.*
- ** When fastening aluminum trim, you can only use aluminum or stainless steel painted trim nails. You should always pre-drill (1/8") diameter hole in the aluminum and do not drive the nail tight.*

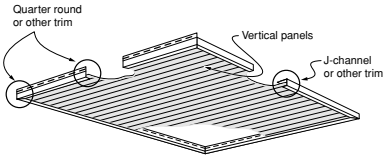


Fig.1

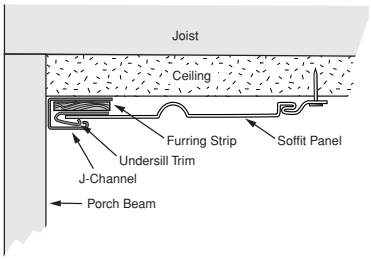


Fig. 2

Porch Ceilings

The procedures to install a porch ceiling are in many ways similar to those used to install soffit. These procedures vary slightly, depending on whether the installation is a new construction or a residing project.

INSTALLATION TIP: In hot climates or in attics with limited ventilation, it is advisable to install solid sheathing to the underside of the porch ceiling joists. This will protect vinyl soffit panels from excessive heat.

New Construction

Step 1
Begin by installing receiving F- or J-Channels on all four sides of the porch (Fig. 1). If F-Channels are being used, nail them to the existing walls or porch beams. If J-Channels are being used, a nailing base will have to be installed.

Step 2
When planning to use light blocks to attach external light fixtures, install them to adequate backing.

Step 3
Plan the layout of the ceiling panels to achieve an even balance or to align with adjacent work. If the ceiling joists run parallel to the direction of the soffit panels, additional 1″ x 3″ wood furring nailing strips will have to be installed. Install these nailing strips perpendicular to the ceiling joists, placing a strip every 12″.

Step 4
Install an undersill trim shimmed down by a furring strip into the J-Channel or F-Channel on the starting end (Fig. 2). Cut the hook side (opposite the nailing hem) off the panel and install snap locks every 6″ to 10″. Install the soffit panel locking the cut edge into the undersill trim and nailing the other side through the nailing slots. DO NOT NAIL TIGHTLY. Install remaining panels.

Step 5
For large areas where more than one panel length is needed, use a H or T mold or back-to-back J-Channel to separate the sections.

Step 6
To install last soffit panel, use same technique as outlined in step 4 and Figure 2, except that the nailing hem sidewall be trimmed and snap lock punched every 6″ to 10″. Install the final panel by locking the hook side of the panel on the previous panel and inserting the cut edge into the undersill trim for a secure fit.

Residing

Step 1
Check to be sure the existing ceiling can serve as a solid nailing base.

Step 2
If the existing ceiling is solid, remove all existing moldings and fixtures from the ceiling and begin by nailing inverted J-Channels along the perimeter of the ceiling area. Then follow Steps 2 through 6 in the instructions under “New Construction”. With a solid ceiling, however, additional nailing strips are not necessary. Use the existing ceiling as the nailing base for the panels.

If the existing ceiling is not solid, install nailing strips to provide a secure nailing base, then install the J-Channels. Additional nailing strips should be installed if the ceiling panels are to run parallel to the ceiling joists. Follow the instructions in Steps 2 through 6 for “New Construction”.

Vinyl Siding Panel

To repair or replace a siding panel, insert the zip-lock tool under the butt of the course above the damaged panel.

Pull downward and slide the tool along the length of the panel.

Remove the nails of the damaged panel.

Install the replacement panel making sure the lock is re-engaged. (Use the ziplock tool to re-engage the panel by forcing the bottom lock over the newly replaced panel.) (Fig.1)

When re-nailing, be sure panel can move freely in a horizontal direction to allow for expansion and contraction. (Fig. 2)

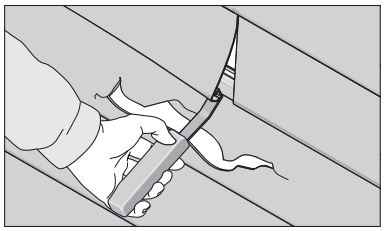


Fig. 1

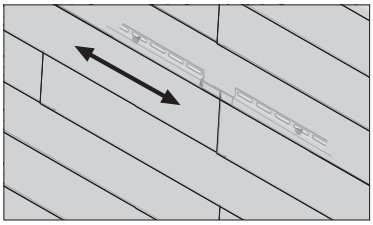


Fig. 2

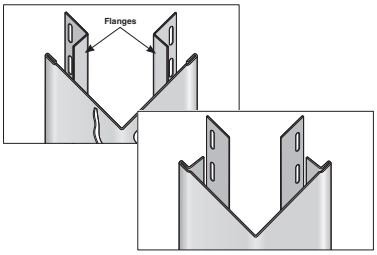
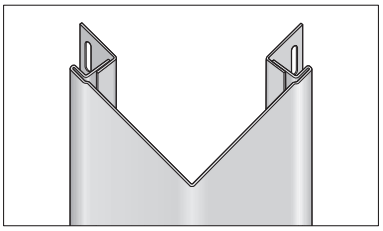


Fig. 1



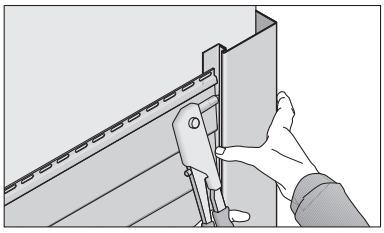


Fig. 3

Corner Posts

Using a utility knife cut away the nailing hem of the damaged corner. Be sure to leave the flange.

Trim the new corner post to fit (leaving the same flange). (Fig.1)

Position the new corner in place with flanges overlapping. (Fig. 2)

Attach the new corner posts to the existing flange with pop rivets. (Fig. 3)

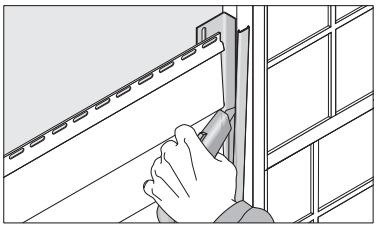
J-Channel

Cut away the face of the channel.

Cut the new J-Channel away from the nailing hem. (Fig.1)

Position the new J-Channel over the old. (Fig.2)

Pop rivet the new piece into place. (Fig.3)



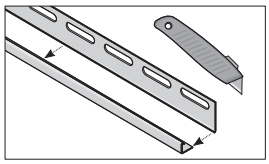


Fig. 1

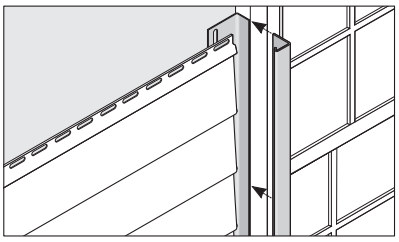


Fig. 2

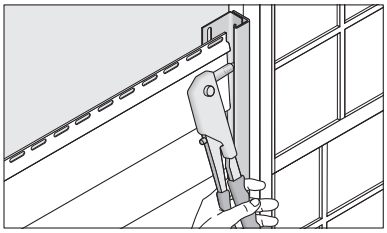


Fig. 3

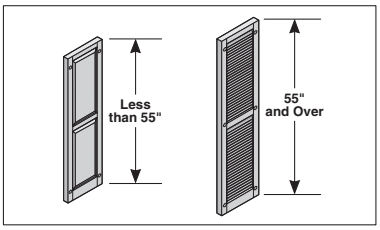


Fig. 1

Fig. 2

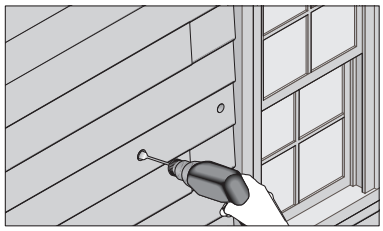


Fig. 3

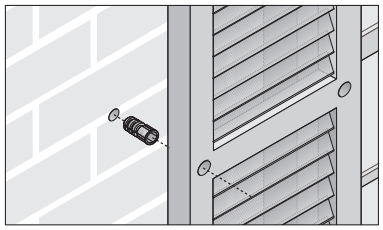


Fig. 4

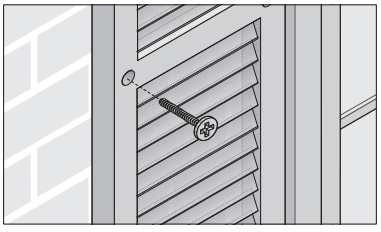


Fig. 5

Shutters

Two types of fasteners are included within the packaging of the shutter product; **metal screws** and **polymer shutterplugs.**

Use four fasteners for shutters less than 55″ in length. Position top screw/plug approximately 6″ down from the top of the shutter, and bottom screw/plug approximately 6″ up from the bottom of the shutter. (Fig.1)

Use six fasteners for shutters 55″ and longer in length. Attach the two additional screws at the midpoint along the length of the shutter. (Fig.2)

Following are the instructions when using the two types of fasteners:

Polymer Shutterplugs

Suggested for permanent, non-removable installations; works well on brick or block; solid-base construction material required; not for vinyl over foam insulation without sheathing.

Locate shutter beside window.

Drill a 1/4″ diameter hole in shutter and into solid base material a minimum of 2″ deep (into mortar joint locations for masonry).

Insert plug by tapping lightly with a hammer.
DO NOT FORCE SHUTTERPLUG SO TIGHTLY AS TO CAUSE DEPRESSION OF SHUTTER SURFACE.

Metal Screws

Can be used for all solid wall surfaces.

Wood Substrates

Locate shutter beside window

Drill 7/32″ diameter hole in shutter and in wood surface.

For vinyl siding applications, redrill a 3/4″ hole in the vinyl siding only to allow for expansion and contraction.

Screw shutter in place with 3″ long metal screws (included). DO NOT FORCE SCREW TIGHT ONTO SHUTTER SURFACE. (Fig.5)

Masonry Construction

Locate shutter beside window.

Drill 7/32″ hole into shutter making sure to position at mortar locations.

Drill hole in mortar joint of masonry as instructed by insert manufacturer. (Fig.4)

It is necessary to incorporate inserts (not supplied in shutter packaging) to provide holding power for the screw.

Place insert in hole with hammer.

Position shutter and screw in place with 3″ long screws. *DO NOT FORCE SCREW TIGHT ONTO SHUTTER SURFACE.* (Fig.5)

NOTE: Allow 1/4″ gap between shutter and window and all other stops to allow for expansion and contraction.

Optional hidden fasteners for standard shutters are available from your distributor.

The tough, long-lasting polypropylene construction of Cedar Discovery® Siding will bring years of beauty to a home without the maintenance required with natural cedar.

To avoid waste and make installation faster, please take a few minutes to read and understand these instructions.

Tools Required

- Hammer
- Pencil
- Snips
- Nail Slot Punch
- Circular Saw with 18-24 Tooth Carbide Tipped Blade (not reversed)
- Chalk Line
- Utility Knife
- Tape Measure
- Level
- Corrosion-Resistant Siding Nails or Screws

IMPORTANT

A SOLID NAILABLE SHEATHING, SUCH AS PLYWOOD OR OSB IS NECESSARY FOR A PROPER AND SECURE INSTALLATION.

PANELS MUST BE INSTALLED FROM RIGHT TO LEFT.

When nailing through slots, always nail in CENTER of slot. DO NOT NAIL TIGHT. Panels must be able to move to allow for expansion and contraction caused by temperature change.

All panels (full and partial) must have the following nailing sequence:

1. First, nail through center of Nail Slot at the right end of panel.
2. Nail through center of Nail Slot toward the left end of panel. Note, Do NOT nail through the far left nail slot.
3. Nail through center of the Nail Slot in the Left Side Flange.
4. Nail through Nail Hole (NOT Nail Slot) at the center of panel.
5. For maximum wind load nail through center of Nail Slots every 8″.

Panels should be acclimated to air temperature by placing them in the general work area at least one hour prior to installation. Air temperature should be checked when installing the first course of each new wall to determine the amount of panel overlap. As air temperature changes, it is NOT necessary to go back and adjust the spacing of previously installed panels.

Installation Tip for Cedar Discovery Triple 5: *For the best appearance, it is very important to be aware of panel temperature instead of air temperature. To accomplish this, the panels should be placed in a shaded area before being installed to acclimate to the ambient temperature. Another option is to measure the panel temperature with an Infrared Temperature device, In either case, install the panel to the appropriate temperature gauge mark.*

Special thought should be taken to eliminate short pieces.

Allow 1/4″ clearance for all stops, such as corner posts and J-Channels. When installing products in very cold temperatures (<40°F), allow 3/8″ clearance for expansion and contraction.

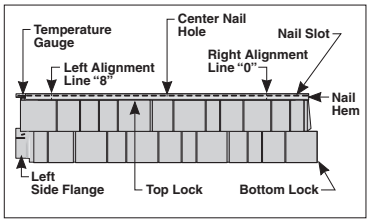
In order to finish the wall without a short course at the top, measure down from the soffit and adjust as needed.

This product is for exterior use only, and should be installed on flat, vertical walls to maintain an even appearance. It can be installed on mansard roofs with a slope of 45/12 or greater (15-degree angle or less). See Mansard Roof Installation instructions.

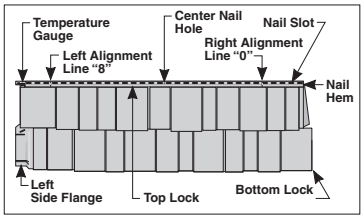
Maintenance

To clean, use mild soap with warm water to remove dirt, dust or surface stains that may collect from time to time.

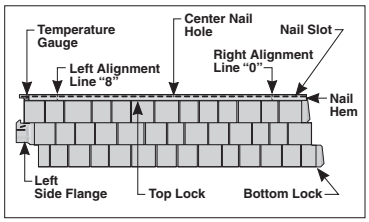
- Product should not be painted.



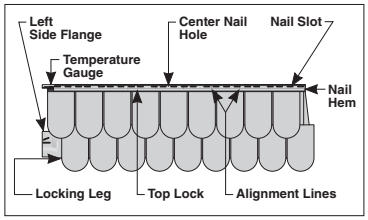
Cedar Discovery® Perfection Shingle Double 7"



Cedar Discovery® Hand-Split Shake



Cedar Discovery® Perfection Shingle Triple 5"



Cedar Discovery® Half-Round

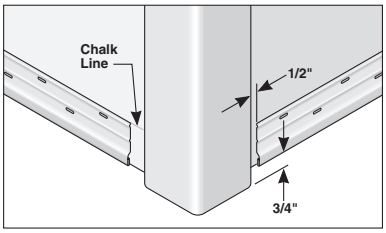


Fig. 1 (Cedar Discovery® Perfection Shingle Double 7 ")

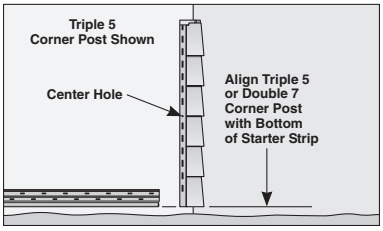


Fig. 2 (Cedar Discovery® Perfection Shingle Triple 5 ")

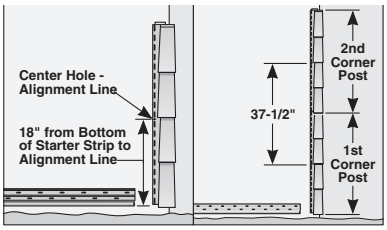


Fig. 3 (Cedar Discovery® Hand-Split Shake)

Starter Strip Installation

Snap a chalk line on all walls to align the top edge of the starter strip (or J-Channel). Make sure to use the special starter strip for Cedar Discovery®.

Installation of starter strip (or J-Channel) and panels should begin on the lowest wall.

Install starter strip (or J-Channel) along the chalk line, nailing in nail slots to allow for penetration into solid wood. Wood stripping may be required to accomplish this. Nail every 6-8″. DO NOT NAIL TIGHT.

To allow for movement, install starter strip (or J-Channel) 1/2″ from corner post. Let corner post hang 3/4” below the bottom of the starter strip (see Figure 1).

Install all accessories including J-Channel, corners, etc.

NOTE: Accessories must have 3/4″ receiver for all Cedar Discovery panels with the exeption of the hand-split shakes, which require 7/8″ pocket accessories.

Corner Post Installation

For all four Cedar Discovery panels, the Universal Corner Post can be used. In this case, hang the corner post 3/4″ below the starter strip or J-Channel. (see Figure 1).

For Cedar Discovery Perfection Shingle Triple 5″ and Double 7″, align bottom of corner post with bottom of starter strip or J-Channel (see Figure 2).

1. Nail through center hole.
2. Continue nailing corner post every 8″ through center of nail slot.

NOTE: Do Not Nail Tight.

Installing Cedar Discovery Hand-Split Shake Corner Post

1. Measure up 18″ from bottom of Starter Strip and mark wall (see Figure 3).
2. Position Alignment Line with mark, and nail through Center Hole.
3. Continue nailing Corner Post every 8″ through center of Nail Slots.

NOTE: Do Not Nail Tight.

4. To install additional Corner Post sections, measure and mark 37-1/2″ from previous post Alignment Line.
5. Position Alignment Line with mark, and nail.
6. Repeat Steps 4 and 5 as needed.

Installing Less Than Full Length Corner Post

Remainder of cut corner post can be used as starter corner post. Cut and remove section below last full cap.

1. For Triple 5″ and Double 7″, install modified corner aligning it with the bottom of starter.

2. Full length corner post can be installed as previously described.

3. For Hand-Split Shake Corners, the first alignment line should be adjusted to allow for the modified corner post by adding increments of 9-3/8” as needed.

Nailing Procedures

NOTE: Be sure panel is pulled up. Do not nail tight.

All panels (full and partial) must have the following nailing sequence: (see Figures 1-2).

1. First, nail through center of Nail Slot at the right end of panel. (See “N1”).

2. Nail through center of Nail Slot toward the left end of panel. (See “N2”).
NOTE: Do NOT nail through the far left nail slot.

3. Nail through center of the Nail Slot in the Left Side Flange. (See “N3”).

4. Nail through Nail Hole (NOT Nail Slot) at the center of panel. (See “N4”).

5. For maximum wind load nail through center of Nail Slots every 8″.

NOTE: For full panels, center hole is marked on nail hem (Fig. 2). For cut panels, measure to locate center point on nail hem.

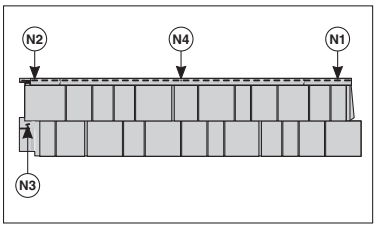


Fig. 1

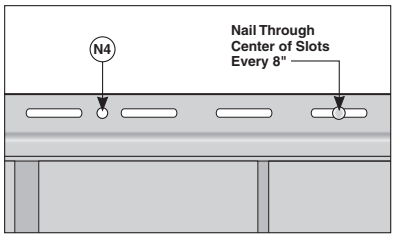


Fig. 2

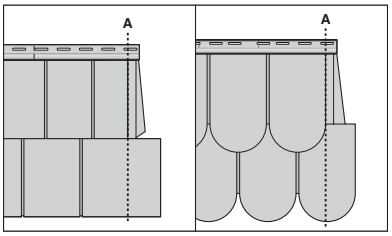


Fig. 1

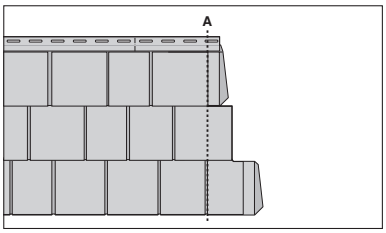


Fig. 2 (Cedar Discovery® Perfection Shingle Triple 5″)

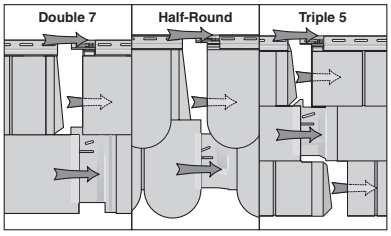


Fig. 3 Perfection Shingle 7″ & Hand Split Shake.

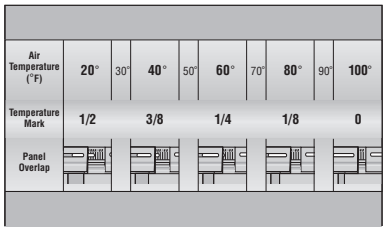


Fig. 4 Perfection Shingle 5″

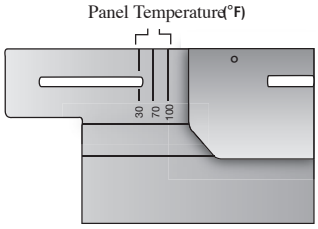


Fig. 5 Half Rounds

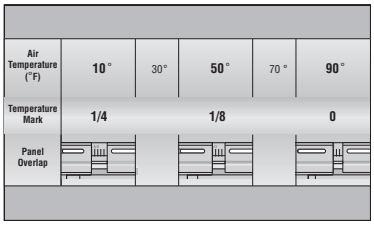


Fig. 6

First Course

NOTE: PANELS MUST BE INSTALLED FROM RIGHT TO LEFT.

a. Cut the first panel at "A" (see Figures 1-2).

NOTE: To provide for panel movement, allow 1/4″ gap at all corner posts, J-channels, or other stops.

b. Engage bottom lock firmly into Starter Strip. Nail according to "NAILING PROCEDURES."

c. Slide the next panel into position. For Perfection Shingle Double 7″, Hand-Split Shake and Half-Rounds, the top half of the panel, except the Nail Hem, slides under, and the bottom half slides over the previous panel. For Perfection Shingle Triple 5″, the top section of the panel (except the Nail Hem) and the bottom section of the panel slide under, and the middle section slides over the previous panel. On all products, the Nail Hem will be on top of the previous panel (see Figure 3).

For Perfection Shingle Double 7″ and Hand-Split Shake overlap amount, see (Figure 4). For Perfection Shingle Triple 5″ overlap, see (Figure 5). For Half-Rounds overlap, see (Figure 6).

NOTE: The amount of panel overlap is important and varies depending on air temperature. Check and monitor air temperature when starting to install the first course on each wall. See chart for amount of overlap (see Figures 4-6).

Installation Tip for Cedar Discovery® Triple 5: *For the best appearance, it is very important to be aware of panel temperature instead of air temperature. To accomplish this, the panels should be placed in a shaded area before being installed to acclimate to the ambient temperature. Another option is to measure the panel temperature with an Infrared Temperature device, In either case, install the panel to the appropriate temperature gauge mark.*

d. Nail according to "NAILING PROCEDURES."

e. Install additional full panels, repeating Steps b-d.

Last Panel on Each Course

For Perfection Shingle Double 7˝, Hand-Split Shake and Half-Rounds, measure the distance from the correct line on the temperature gauge into the corner post, less 1/4˝ (see "A" on Figure 1).

For *Triple 5˝*, measure the distance from the correct line on the temperature gauge to the edge of the corner post and ADD 1/4˝.

Cut off left end of panel (see "B" on Figure 1).

Engage lock into starter strip or continuous lock of previous course, pull up tight and nail according to *"NAILING PROCEDURES."*

Installation Tip: Panels will flex to allow installation. To minimize waste, cut pieces can be used as starter pieces on adjacent wall.

Using Alignment Lines

NOTE: Temperature gauge is used only for installation of the first course on each wall. Do NOT adjust temperature gauge on panels after 1st course is complete "except when adjusting panels for windows or last panel of each course".

Perfection Shingle Double 7˝, Triple 5˝ and Hand-Split Shake Panels – For 2nd and subsequent courses, align Left Side Flange with Left "8" or Right "0" Alignment Line of previous course, according to instructions.

Half-Rounds – For 2nd and subsequent courses, align Left Side Flange with nearest Alignment Line that allows proper fit and overlap of shingles. Be sure to cut panel to stagger vertical laps.

Second Course (and all even courses)

a. *Perfection Shingle Double 7˝ and Hand-Split Shake* – Measure the distance from the Left Alignment Line "8" of the panel below into the corner post or J-Channel, less 1/4˝ (see "A" on Figure 2).

b. *Perfection Shingle Triple 5˝* – Measure the distance from the Left Alignment Line "8" of the panel below into the corner post or J-Channel, PLUS 1/4" (see "A" on Figure 3). and subtract 1/4˝.

b. *Perfection Shingle Double 7˝*, and Hand-Split Shake – Measure from the Left Side Flange of panel and cut to this length (see "B" on Figure 2).

Perfection Shingle Triple 5˝ – Measure from the Left End of the Lowest Panel and cut to this length (see Figure 3).

Half-Rounds - Measure appropriate distance from the Left Side Flange of panel (allowing for staggered vertical laps) and cut (see Figure 4).

c. *Perfection Shingle Double 7˝* and Hand-Split Shake – Align Left Side Flange with Left Alignment Line "8" of the course below (see Figure 5).

Perfection Shingle Triple 5˝ – Align Lowest Panel Left Edge with Left Alignment Line "8" of the course below (see Figure 6).

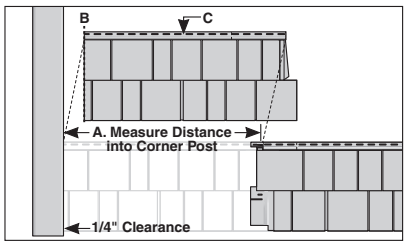


Fig. 1

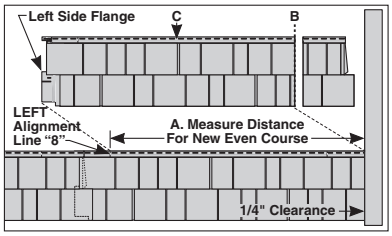


Fig. 2

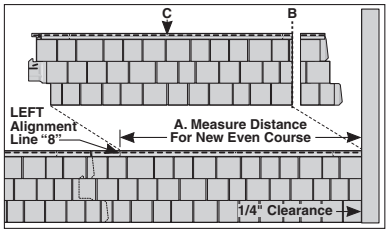


Fig. 3

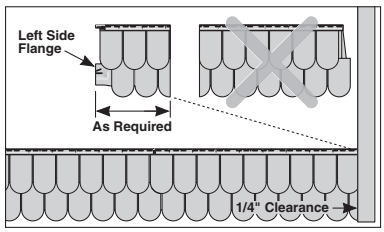


Fig. 4

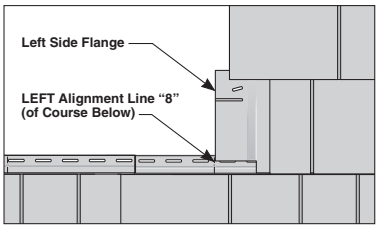


Fig. 5

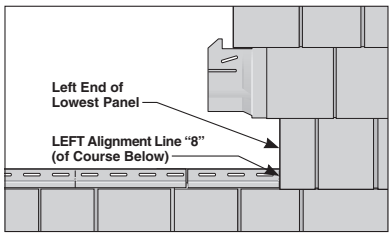


Fig. 6

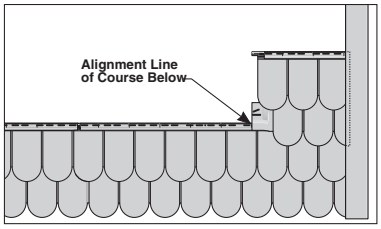


Fig.1

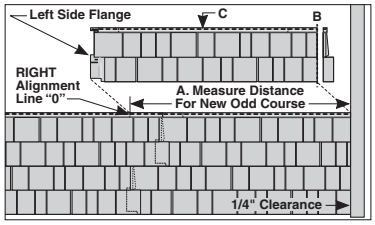


Fig.2

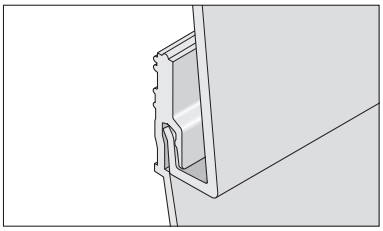


Fig.3

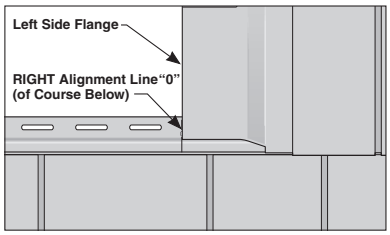


Fig.4

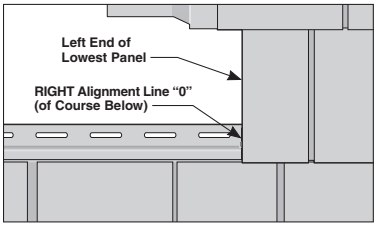


Fig.5

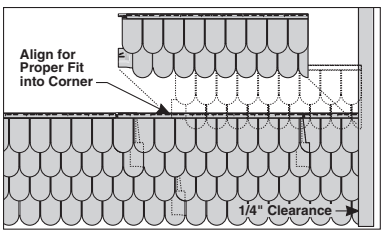


Fig.6

Half-Rounds

Align Left Side Flange with nearest Alignment Line of course below that allows for proper fit into corner post or J-Channel (see Figure 1).

d. Engage lock securely into continuous top lock of course below (Figure 3).

e. Pull up tight and nail according to *"NAILING PROCEDURES."*

f. Continue installing full panels in the course, following Steps c-e.

g. To finish course, refer to previous section titled *"Last Panel on Each Course"*.

Third Course (and all odd courses)

a. *Perfection Shingle Double 7˝, Triple 5˝ and Hand-Split Shake* – Measure the distance from the first RIGHT Alignment Line "0" of the course below into the corner post or J channel and subtract 1/4˝ (see "A" on Figure 2).

b. *Perfection Shingle Double 7" and Hand-Split Shake* – Measure from the Left Side Flange of panel and cut to this length (see "B" on Figure 2).

Perfection Shingle Triple 5˝ – Measure from the Left End of the Lowest Panel and cut to this length.

c. Engage lock securely into continuous top lock of course below.

d. *Perfection Shingle Double 7˝ and Hand-Split Shake* – Align Left Side Flange with RIGHT Alignment Line "0" of the course below (see Figure 4).

Perfection Shingle Triple 5˝ – Align Lowest Panel Left Edge with Right Alignment Line "0" of the course below (see Figure 5).

Half-Rounds – Align Left Side Flange with nearest Alignment Line of course below that allows for proper fit into corner post or J-Channel (see Figure 6).

e. Pull up tight and nail according to *"NAILING PROCEDURES."*

f. Continue installing full panels in the course, following Steps c-e above.

g. To finish course, refer to section titled *"Last Panel on Each Course"* on page 58.

Securing Panels Around Windows

Measure and cut panels around windows, allowing 1/4″ into all window channels for movement. (see Figure 1).

Make sure to install water diverters at the bottom corners of the window (refer to Basic Accessory Installation Section Installing J-Channel, Flex-J and Flashing).

Use a nail slot punch to create nail slots every 8″ on the cut edge of the panel.

Furr as needed.

Slide panel into window channel.

Pull up tight and nail according to

Installation Tip: A nail set can be used to ease installation.

Installing Final Course

NOTE: A crown molding, J-Channel or wide window casing can be used in eaves and gables to receive the final course (see Figure 2).

Measure the required width for last course less 1/4″ to allow for panel movement.

Cut panel height as required.

Punch nail slots every 8″.

Nail through center of slots.

NOTE: Furring may also be required.

Alternative Method:

Cut 2″ wide piece of utility trim. Nail into the eave J-Channel, making sure to locate them at the flat areas of the shakes. Using the snaplock punch, install a lug at each utility trim location.

Cedar Finish Trim
The Cedar Finish Trim can also be used to help provide a finished appearance and to help secure cedar products around windows and at the last course of siding. The Cedar Finish Trim has a wider opening that allows for the exta material thickness. Secure the panel with a finish trim nail.

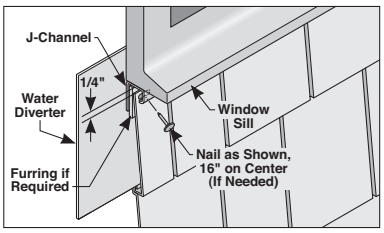
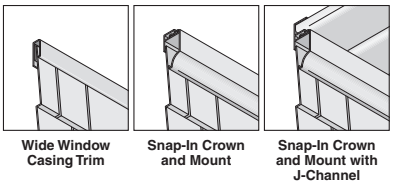


Fig. 1



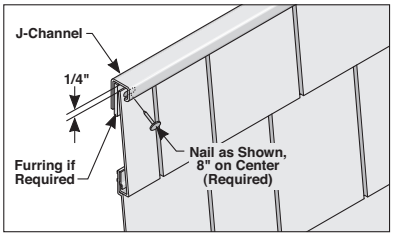


Fig. 2

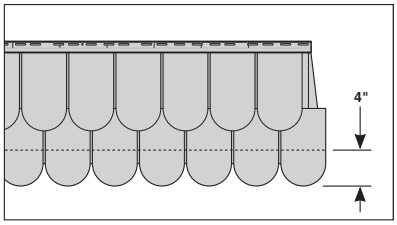


Fig. 1

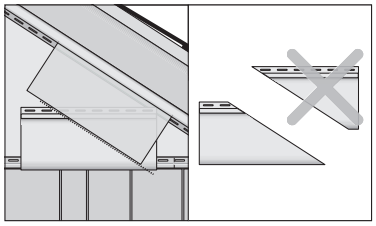


Fig. 2

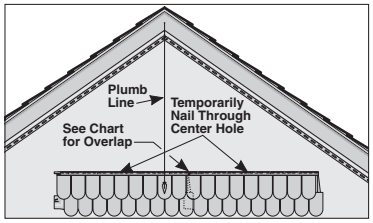


Fig. 3

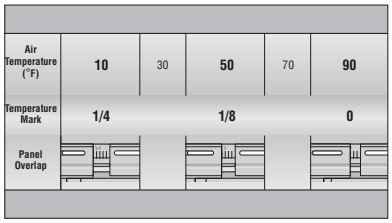


Fig. 4

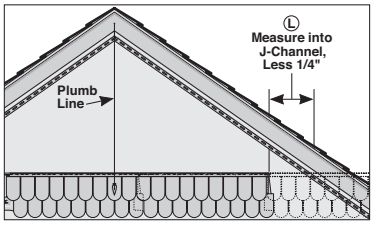


Fig. 5

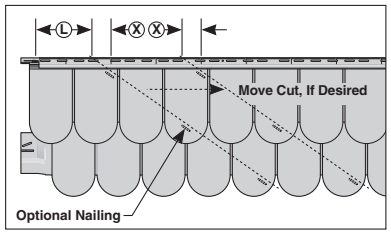


Fig. 6

Installing Cedar Discovery® Half-Rounds on Gable Ends

Cedar Discovery Half-Rounds can be locked directly onto other Cedar Discovery panels . If desired for transitions, panels can be installed using Starter Strip (CDSS) over Drip Cap, or into T-Channel or Lineals. When installing into any channel or lineal, cut 4″ from the bottom of the Half-Round (see Figure 1). Allow 1/4″ gap for panel movement.

NOTE: PANELS MUST BE INSTALLED FROM RIGHT TO LEFT. Do not nail tight. Allow 1/4″ into all channels, posts and stops. Make a template for gable angle by locking a short piece of siding into the gable starter course. Hold a second piece against the gable finish trim. Mark angle on first piece and cut (see Figure 2). Make templates as needed.

Centering Cedar Discovery Half-Rounds on Gable Ends

When installing Half-Rounds in gables, the last piece should be centered at the peak of the gable for proper appearance.

a. For symmetrical appearance at peak, position and lock full panel in the first course with Half-Rounds at center of the gable (see Figure 3). Temporarily fasten through center hole. Continue temporarily installing full panels toward right side of the gable (see chart, Figure 4, for overlap).

b. When less than full panel is needed, measure top of Nail Hem into gable end trim, less 1/4″ (see Figure 5). Use this dimension (L) to cut first piece for installation.

c. To locate the cut mark on 1st panel, measure from the appropriate temperature mark to the right and mark top of Nail Hem (see “L” on Figure 6).

d. Use template and cut at mark. If needed for secure installation, move the mark an equal distance (X on Figure 6) from any Alignment Line.

e. Remove temporarily nailed panels.

Installing First Course on Gable End

a. Use panel cut in step "d" in the previous section. If installing into Siding or Starter Strip, lock firmly, pull up tight and nail according to *"NAILING PROCEDURES."*

b. Slide the next panel into position. The top half of the panel, except the Nail Hem, slides under, and the bottom half slides over the previous panel. The Nail Hem will be on top of the previous panel (Figure 1). Nail slots can be placed at angle cut for additional nailing.

c. If this is your first course of Half-Rounds, refer to chart for over lap amount (Figure 2).

d. If this is not your first course of Half-Rounds, align Left Side Flange with nearest Alignment Line of course below that allows for proper fit into right end finish trim.

e. Engage bottom lock firmly into Siding or Starter Strip, pull up tight and nail according to *"NAILING PROCEDURES"*.

f. Install additional full panels, repeating Steps c-e.

Last Panel on Each Course

a. Make template for angle if needed.

b. Measure distance from correct line on temperature gauge into the gable end trim, less 1/4″ (see "L" on Figure 3).

c. Measure panel from right end of Nail Hem and cut at correct angle (see "L" on Figure 4).

d. Engage lock into starter strip or continuous lock of previous course, pull up tight and nail according to *"NAILING PROCEDURES."*

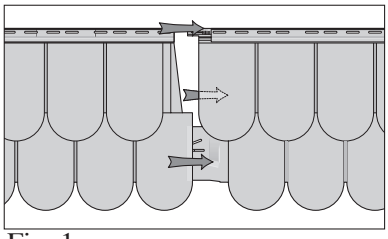


Fig. 1

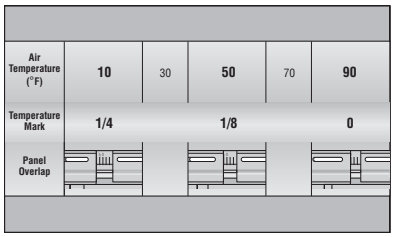


Fig. 2

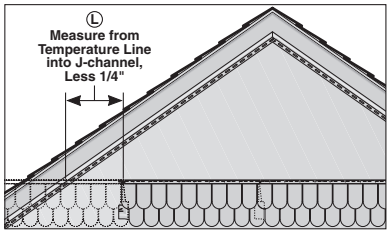


Fig. 3

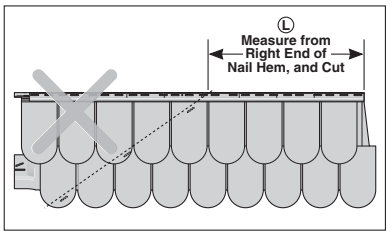


Fig. 4

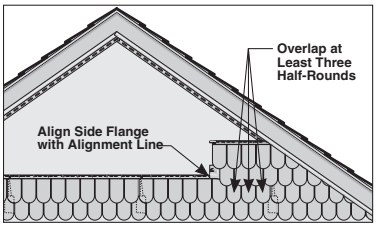


Fig. 1

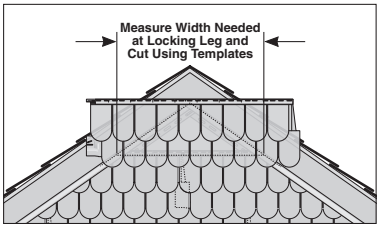


Fig. 2

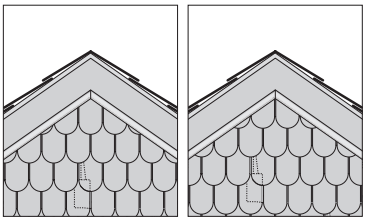


Fig. 3

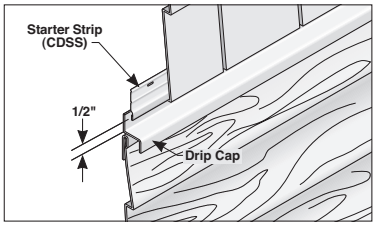


Fig. 4

Second and Subsequent Courses on Gable End

a. Make new template for angle if needed.

b. Measure from the Left Side Flange making sure to stagger the laps by at least 3 half-rounds (Figure 1).

c. Align Left Side Flange with nearest Alignment Line of course below (Figure 1).

d. Insert Bottom Lock into Top Lock of course below. Pull up tight and nail according to *"NAILING PROCEDURES."*

e. For second and subsequent panels, align Left Side Flange with nearest Alignment Line of course below that allows for proper fit. Insert Bottom Lock into Top Lock of course below. Pull up tight and nail according to *"NAILING PROCEDURES."*

Final Course on Gable end

Measure width needed at bottom lock (see Figure 2).

Carefully check alignment of Half Rounds to center full or partial rounds as needed and cut (see Figure 3).

Insert Bottom Lock of final course into Top Lock of course below, pull panel up tight, and nail at peak using a color matching trim nail.

Installing Above Horizontal Siding

Starter Strip "CDSS" with Drip Cap (see Figure 4).

Mansard Roof Installation Instructions

Cedar Discovery® can only be installed on mansard roofs with a slope of 45/12 or greater (15-degree angle or less). It must be attached with standard siding nails into a solid wood substrate.

The sheathing must be covered with either:

1 layer 30 lb. roofing felt with a 6″ minimum horizontal and vertical laps.

2 layer 15 lb. roofing felt (see Figure 1).

A field formed flashing must be installed at the bottom of the mansard. This can also be the cap for the soffit. The flashing should go up the roof a minimum of at least 4″. (see Figure 2).

The Cedar Discovery starter strip should be installed onto the flashing. Follow the standard installation guidelines. (see Figure 3).

Install any 3/4″ corner post system at all transitions. The bottom of these corner posts should be closed off by bending flaps as shown (see Figure 4).

Install all Cedar Discovery courses cutting the last course as required. Slot nail holes and nail into top of mansard following standard installation guidelines for last panel installation (see Figure 5).

Form a cap from trim sheet that will cover the top of the mansard and come down to cover the nails that are holding the last course of Cedar Discovery. It is recommended that this flashing be installed under the top roofing or behind the sidewall system (see Figure 6).

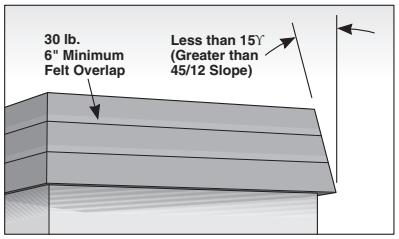


Fig. 1

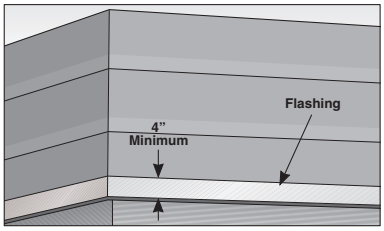


Fig. 2

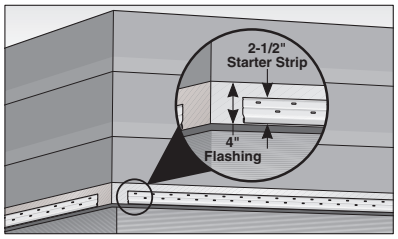


Fig. 3

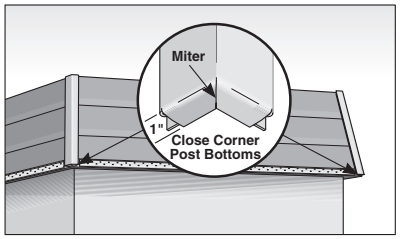


Fig. 4

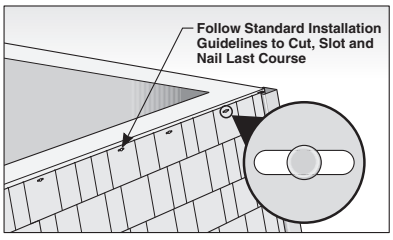


Fig. 5

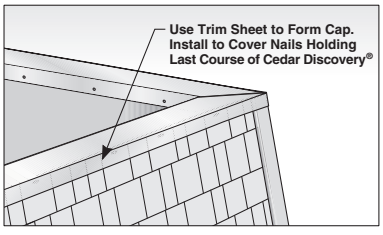


Fig. 6

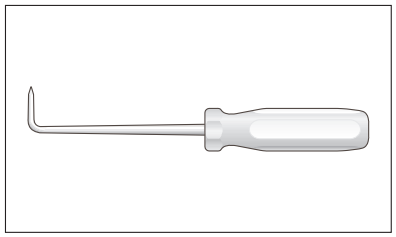


Fig. 1

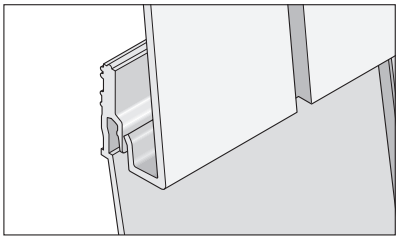


Fig. 2

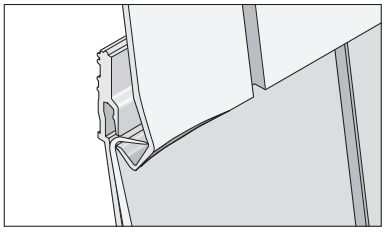


Fig. 3

Replacing A Damaged Panel

To repair or replace a damaged panel, unlock panel above the damaged panel in order to expose nail hem of damaged panel.

NOTE: This can be done by either pulling out at bottom lock with your hand, or using a Hook & Cotter Pin Puller Tool (NAPA Auto Parts No. 3470 or equivalent) (see Figure 2).

Remove nails from damaged panel, and unlock from previous course. (see Figure 3).

Install replacement panel by locking into course below, then nailing according to "NAILING PROCEDURES".

Using a Hook & Cotter Pin Puller Tool (NAPA Auto Parts No. 3470 or equivalent), start at the left end of the panel, and begin locking the panel above to the new installed panel (see Figure 1).

NOTE: For best results, engage 3˝-4˝ of lock at a time, continuing from left to right along the length of the panel.

When historic restoration projects arise, the manufacturer recommends the following:

Step 1
If a building is in a historic area, local Historic District or has been designated as a historic building, make sure that approval for the use of vinyl siding has been obtained from the local historic society or local Historic District Commission. This applies to building additions as well.

Step 2
Before a historic building is resided, it should be examined for moisture, insect infestation, structural defects, and other problems that may be present. These problems should be addressed and the building pronounced "sound" before residing with any material.

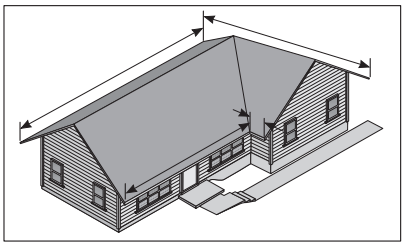
Step 3
Do not damage or remove the original siding. If at all possible, do not alter the original structure, so that the application of vinyl siding is reversible (i.e., the original siding would remain intact in the future, so that if desired, the vinyl siding could be removed). Exception: "In cases where a non-historic artificial siding has been applied to the building, the removal of such a siding before application of vinyl siding would, in most cases, be acceptable".

1Preservation Briefs, Number 8, U.S. Department of Interior, 1984.1

Step 4
Exercise every care to retain architectural details wherever possible. Do not remove, cover, or add details until the building owner's written approval has been obtained. Determine that the owner has consulted the local historic society for approval.

Step 5
Use siding that closely approximates the appearance of the original siding in color, size and style. In historic districts, the goal is to match the product as closely as possible and retain the original trim.

For further information, contact:
Historic Preservation at www2.cr.nps.gov



Planning, Measuring and Available Systems

Determine the lengths of gutters necessary. Minimize seams by selecting from various gutter lengths available.

Determine the number of accessories necessary.

Calculate the number of downspouts necessary. The number and placement of downspouts used determine the water carrying capabilities of a gutter. Use the following guide to calculate the proper amount of downspouts:

- a 2x3 downspout will carry an average rainfall amount of 600 sq. ft. of roof area
- a 3x4 downspout will carry an average rainfall amount of 1,200 sq. ft. of roof area

Sectional Gutters and Accessories Hangers

Determine which of these hanger systems will work best. All hangers should be attached with two 1-1/4˝ stainless steel screws or screw shank aluminum nails.

Snug Fit Hanger

This hanger is ideal for remodeling use where it is necessary for the back leg of the gutter to fit tightly under roof shingles. A chalk line should be struck along the fascia to act as a guide when installing these hangers. These hangers will allow the gutter to be installed level or with a slight slope. After all hangers are installed, the gutter is attached by engaging the front lip of the gutter into the front lip of the hanger and rotating the back leg of the gutter up against the fascia. The clip at the back of the hanger should be loosened so that it is free to slide under the lip on the back leg of the gutter. Once the clip is engaged in the back leg of the gutter, the nut and bolt should be tightened.

Combination Hanger

This hanger is ideal for both remodeling and new construction use. A chalk line should be struck along the fascia to act as a guide when installing these hangers. These hangers can be installed level or with a slight slope. Once the hangers are installed, the gutter is attached by engaging the front lip of the gutter into the front lip of the hanger and rotating the back leg of the gutter up against the fascia so that the two hooks on the back of the hanger lock into the lip on the back of the gutter.

Strap Hanger

Use in combination with roof or fascia apron* – This combination is ideal for new construction and re-roofing applications. In lieu of a drip edge, the roof apron should be installed continuously along the edge of the roof above the fascia and nailed every 16˝ with 1-1/4˝ aluminum nails through the top flange of the roof apron. The gutter is then attached by sliding the back leg of the gutter up under the roof apron so that the lip on the gutter locks into the hook portion of the roof apron. Once the gutter is locked up along the entire length of the roof apron, strap hangers can be installed by engaging the front of the strap hanger into the front lip of the gutter and rotating the other end of the hanger down into the roof surface. This type of installation is designed for level applications of gutter or an application which is parallel to the roof edge of fascia.

**NOTE: Roof apron is not applicable for slopes greater than 6:12. Hanger is to be installed on roof sheathing under shingles.*

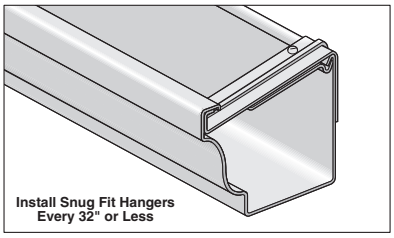


Fig. 1

	5"	6"
Hanger	OG91	N/A
Leaf Relief®	TP53ZIP	

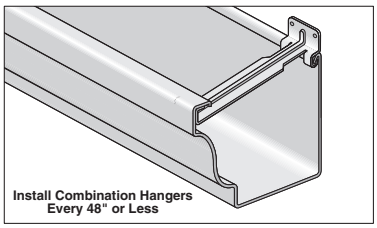


Fig. 2

	5"	6"
Hanger	OG101	OG1061
Leaf Relief®	TP53ZIP	N/A

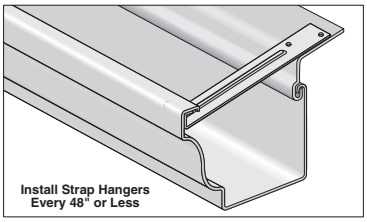


Fig. 3

	5"	6"
Hanger	OG111	OG1161
Leaf Relief®	See page 97	See page 97

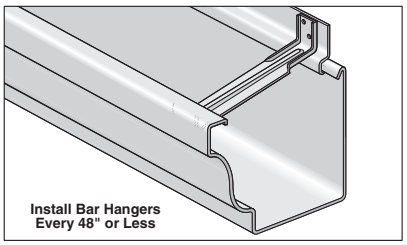


Fig. 1

	5"	6"
Hanger	OG12R1	OG12R61
Leaf Relief®	TP53ZIP	N/A

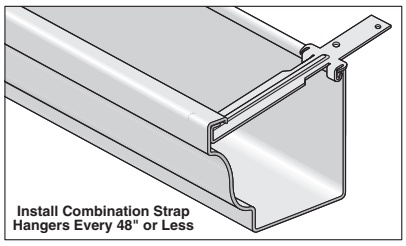


Fig. 2

	5"	6"
Hanger	OG141	N/A
Leaf Relief®	TP53ZIP	N/A

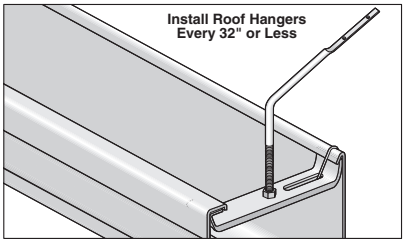


Fig. 3

	5"	6"
Hanger	OG131	OG1361
Leaf Relief®	N/A	N/A

Bar Hanger

When used with a fascia apron, this combination is ideal for remodeling applications. The fascia apron should be installed continuously along the top of the fascia and nailed every 16˝ into the fascia. The fascia apron can be installed level, parallel to the roof edge or to a desired slope. The gutter is then attached by sliding the back leg of the gutter up under the fascia apron. Once the gutter is locked into the fascia apron continuously, the bar hangers are installed by engaging the front of the bar hanger into the front lip of the gutter and rotating the back of the bar hanger down to rest on the fascia apron. Bar hangers should be fastened into a solid fascia board (minimum 3/4˝ thickness) through the fascia apron with two 1-1/4˝ stainless steel screws or screw shank aluminum nails. (Figure 1)

Combination Strap Hanger

This hanger is ideal for re-roofing or new construction applications. The hanger should be fastened into solid roof sheathing (minimum 1/2 thickness). The gutter is attached by engaging the front lip of the gutter into the front lip on the hanger and rotating the back leg of the gutter up so that the top lip engages into two hooks on the back of the hanger. The back leg is then locked in place by bending down the two tabs on either side of the hanger. This hanger will provide for a level installation, assuming that the edge of the roof and fascia are level. (Figure 2)

NOTE: Hanger is to be installed on roof heathing under shingles.

Roof Hanger

This hanger is ideal for new construction or remodeling work. It can be used in applications where there is no existing fascia board, a crown molding exists, or the fascia is attached to the rafter ends which are not parallel to the walls of the home. There is a flattened relief portion of the aluminum rod of the roof hanger that is designed to be bent to the pitch of the roof. After the rod has been bent to the pitch of the roof, the top flattened portion of the rod should be nailed into solid roof sheathing (minimum 1/2˝ thickness). Once the hangers are nailed into place, they can be adjusted up or down by loosening or tightening the two nuts on either side of the hanger bracket for a level or sloped installation. (Figure 3)

The gutter is attached by engaging the front lip of the gutter into the front of the hanger and rotating the back leg of the gutter up so that the top lip of the gutter engages on the back leg of the hanger bracket. The metal tab on the hanger is then bent up over the back leg of the gutter to lock the back leg of the gutter into place. (Figure 3)

NOTE: Hanger is to be installed on roof sheathing under shingles.

Preparing Gutters for Leaf Relief® Application

Installing NEW Gutters using Snap-In (Free Float) Gutter Hangers (OG13LR5) with Roof Apron or Fascia Apron

Prepare gutters with drop tubes, miters and endcaps as required.

Snap back of gutter into the hook portion of the apron.

Hook front of gutter hangers into front lip of gutter every 24˝ along length of gutter.

Position block of wood inside gutter at hanger locations. Using claw hammer, apply pressure to bottom of each hanger until hanger engages into existing roof apron or fascia apron. Remove wooden block.

If desired, begin installing TP5300 Leaf Relief® product. Refer to Leaf Relief® instructions for proper installation.

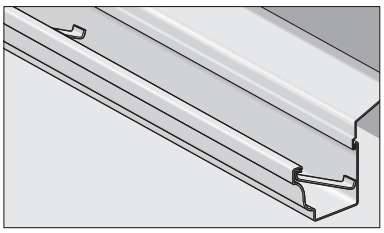


Fig. 1

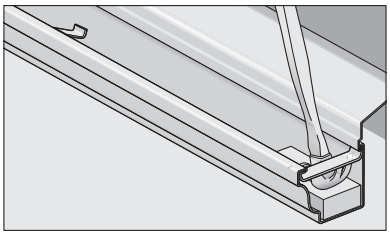


Fig. 2

	5"
Hanger	OG13LR5
Leaf Relief®	TP5300

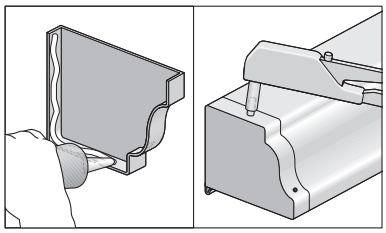


Fig. 1

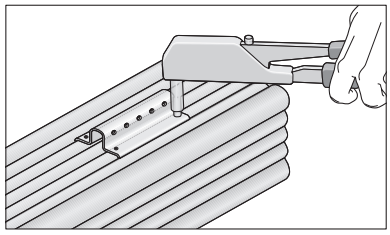


Fig. 2

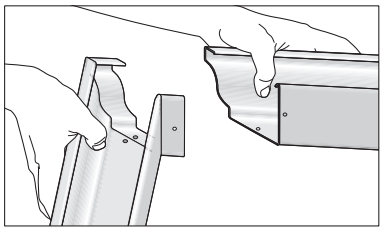


Fig. 3

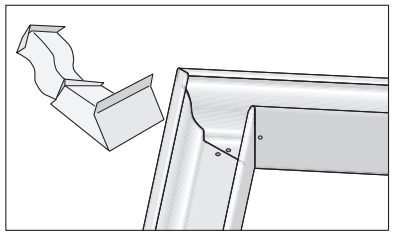


Fig. 4

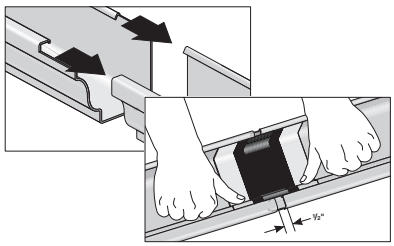


Fig. 5

Installing the Gutter

Using a hacksaw or a power saw, cut the gutter to the proper length.

Install end caps by first applying a bead of sealant to the ends of the gutter and then rivet the end caps into place with aluminum rivets. (Figure 1)

Using aluminum blind rivets, attach downspout clips to the back of the gutter downspouts approximately every eight feet. (Figure 2)

Cut a hole in the gutter to accommodate the eave tube (where the gutter attaches to the downspout). Be sure to allow sufficient clearance on all sides for the flange of the eave tube. (Figure 3)

Apply a bead of gutterseal and rivet the eave tube in place.

Assembling Miters

Occasionally, it will be necessary to miter gutter around an inside or outside corner. Determine the proper point on the gutter to be mitered and cut both left and right-hand gutter lengths at an approximate 45° angle for both inside and outside miters. Seal and rivet miter to one section of gutter and then position gutters onto hangers. Seal and attach miter to second gutter. (Figure 4)

NOTE: Most outside or inside corners are 90° angles.

The second option is to install both gutter sections onto the hangers. The strip miter can then be placed over the top of the mitered joint between the two pieces of gutter Using Gutterseal, seal and pop rivet the strip miter to the two pieces of gutter and then seal all rivet heads and joints on the interior of the gutter.

Installation of Expansion Joints

To join gutter sections together, modify one end by notching the top front bead and rear hook edge 2. Overlap sections 1-1/2˝ as shown. Apply sealant to all laps and rivet.

On long runs over 37´, or where there is no room for expansion, apply expansion joint. Notch gutter as shown and apply a sealant under both sides of the joint. Center the expansion joint over the 1-1/2˝ metal lap and rivet. (Figure 5)

Installing the Downspouts

Step 1

Attach an elbow to the eave tube, drill holes and rivet the elbow to the eave tube with aluminum rivets. (Figure 1)

Measure and square off the downspout cutting it with either a hack saw or power saw.

It may be necessary to use a second piece of downspout to connect the downspout with the eave tube. If so, rivet all three together, otherwise rivet the downspout directly to the eave tube.

Measure for the downspout clamp.

Step 2

Make a 3/4″ hole through the siding only using a boring bit. (Figure 2)

Step 3

Nail or screw the clamp through the center of the oversized hole. (Figure 3)

Step 4

Attach the downspout to the clamp and rivet. (Figure 4)

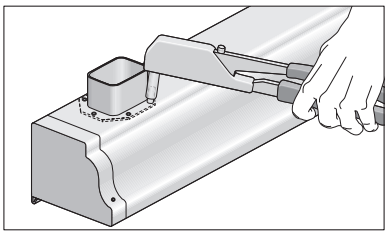


Fig. 1

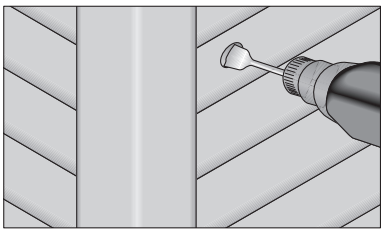


Fig. 2

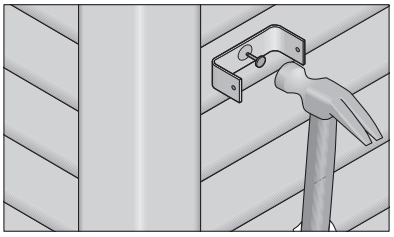


Fig. 3

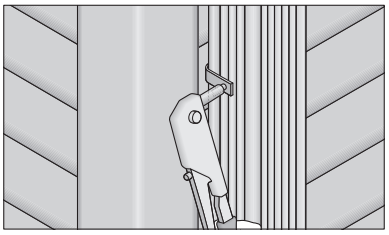
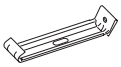
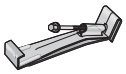


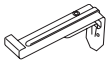
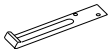
Fig. 4

Leaf Relief® Chart

Seamless Gutters

	Spike/ Ferrule	Hidden Hanger Systems	Zip Hanger Systems	No Hanger/ New Gutter
				
TP5300/ TP6300	✔	✔		
TP5100/ TP6100	✔	✔		
SN5200S SN6200S				✔
TP53ZIP TP63ZIP			✔	

Foldover Style Gutter

	Snap In (Free Float) (OG13LR5)	Combin -ation (OG101)	No Hanger	Snug Fit (OG91)	Bar 5" (OG12R1)	Bar 6" (OG12R61)	Strap 5" (OG111)	Combin -ation Strap 5" (OG141)	Roof Hanger 5" (OG131)	Roof Hanger 6" (OG1361)
										
TP5300/ TP6300	✔								■ ✔	■ ✔
TP5100/ TP6100	✔								■ ✔	■ ✔
SN5200S SN62005			✔							
TP53ZIP		✔		✔	✔			✔		
TP63ZIP						✔				
OG13LR5							★ ✔			

■ Field notch Leaf Relief® at rod.
★ Cut or remove existing hanger.

NOTE: See product guide for ordering code.

5″/6″ Leaf Relief® New Gutter Installation

Prepare the Gutter

Prepare the gutter for downspouts and end caps (including sealant) according to job requirements.

NOTE: Shingles shall extend past drip edge no more than 1/2″.

Install Leaf Relief® System

Option One (Preferred)

Use snap-lock punch (Malco SL5) or end-cap crimping tool (Malco SL2 – adjustment required) to create lugs every three feet on the back of the gutter (open lug toward fascia). (Figure 1)

Clip the Leaf Relief® into the front of the gutter and snap it over the lugs on the back. (Figure 2)

Clip subsequent Leaf Relief® sections with 1/2″ overlap. (Figure 3)

Lift the gutter and system into place against the fascia and align for proper drainage to outlet.

Fasten into the fascia every 24″ using #9x1-1/2″ gasketed screws. (Figure 4)

NOTE: Required to use a 6″ extension on drill for inserting screws.

Option Two
(when no drip edge is present)

Clip the Leaf Relief® system on the gutter (overlap sections 1/2″) and secure every two feet by screwing #9x1-1/2″ gasketed screws.

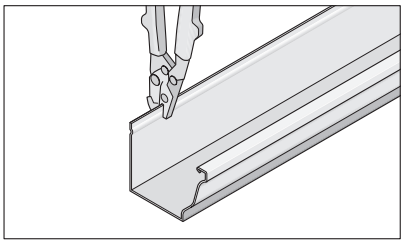


Fig. 1

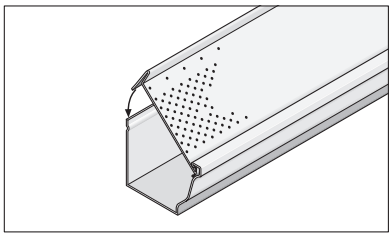


Fig. 2

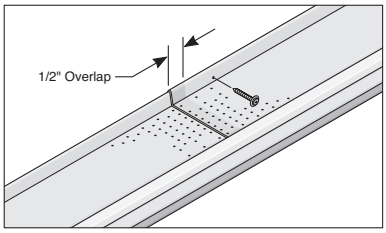


Fig. 3

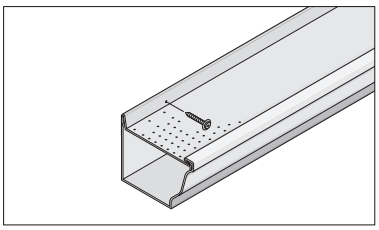


Fig. 4

GUTTERS, DOWNSPOUTS AND LEAF RELIEF

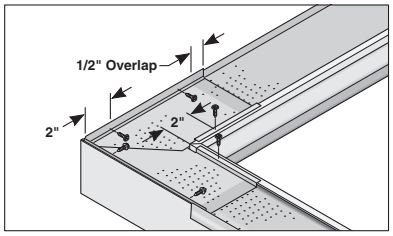


Fig. 1

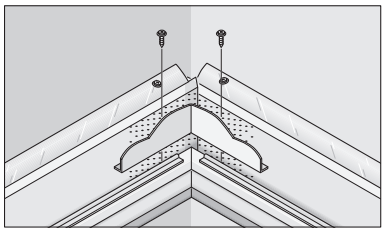


Fig. 2

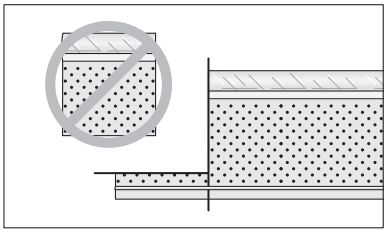


Fig. 3

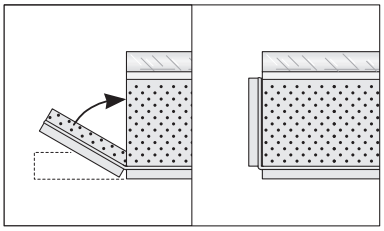


Fig. 4

Install Leaf Relief® Corners

At inside/outside corners, install Leaf Relief® sections towards the corner with a minimum 1/2″ overlap with adjacent Leaf Relief® sections.

Attach Leaf Relief® 5″ corners (IC5220/ OC5220) or 6″ corners (IC6220/OC6220) using 6 screws as shown in the drawing. (Figure 1)

NOTE: Prefabricated corners must be at the same level as the Leaf Relief® sections.

Important

Downspouts 3″ x 4″ or larger are recommended for proper function in a coniferous tree zone.

To prevent overflow, all inside corners and valleys must have a water diverter/deflector. Diverter/ deflector must be installed on the top surface of the Leaf Relief® (behind front lip). (Figure 2)

The flow from high-level gutters must be transferred within downspouts directly into lower-level gutters and sealed. An alternative to this would be to install water diverters.

In applications where the Leaf Relief® is level with the endcap.

At the end of the run, make a 4″ cut on the back of the Leaf Relief® up to the lip on the front. (Figure 3)

Cut parallel to the front about 1/2″ from the lip.

Make another cut in the opposite direction to the lip.

Turn and fold under the excess material. (Figure 4)

NOTE: If Leaf Relief® is lower than the endcap, stop the Leaf Relief® 1/16” short of the endcap.

Preparing Existing Foldover Gutters for Leaf Relief® Application

Replacing Strap Hangers or Bar Hangers on Existing Gutters

Hook front of snap-in (free float gutter hangers (OG13LR5) into front lip of gutter every 24˝ along length of gutter. (Figure 1)

NOTE: See product guide for ordering code.

Position block of wood inside gutter at hanger locations. Using claw hammer, apply pressure to bottom of each hanger until hanger engages into existing roof apron or fascia apron. Remove wooden block. (Figure 2)

For strap hangers use a metal cutting tool, such as a reciprocating saw, to cut old strap hangers at drip edge and remove from gutter system. (Figure 3)

For bar hangers remove nail or screw and remove bar hanger from gutter system.

Begin installing TP5300 Leaf Relief® product. Refer to Leaf Relief® instructions for proper installation.

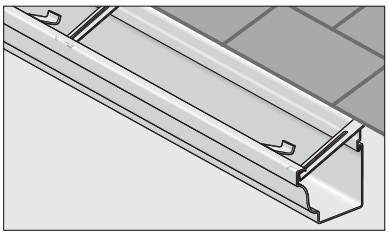


Fig. 1

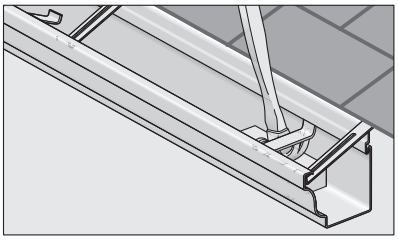


Fig. 2

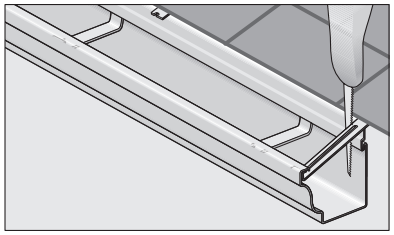


Fig. 3

GUTTERS, DOWNSPOUTS AND LEAF RELIEF

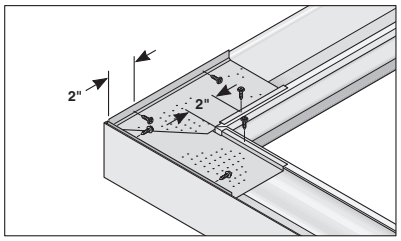


Fig. 1

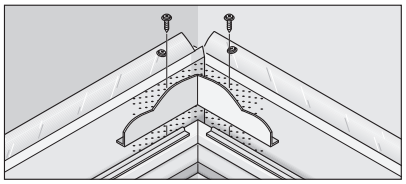


Fig. 2

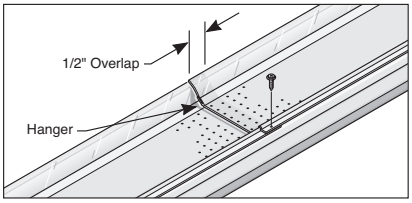


Fig. 3

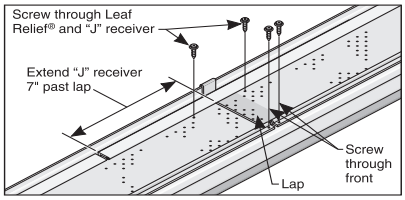
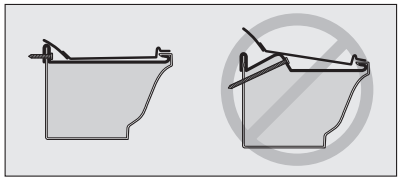


Fig. 4



For application using zip hangers, see Leaf Relief® Installation (Zip Hangers) *section.*

5″/6″ Leaf Relief® Retro-Fit Installation on Flat Hangers or Spike/Ferrule

Prepare the Gutter

Clean and flush existing gutters and downspouts thoroughly with water.

Install Leaf Relief® Corners

Attach Leaf Relief® 5″ corners (IC5220/ OC5220) or 6″ corners (IC6220/OC6220) using 6 screws as shown in the drawing. (Figure 1)

NOTE: Pre-fabricated corners must be at the same level as the Leaf Relief® sections.

Important

Downspouts 3″ x 4″ or larger are recommended for proper function in a coniferous tree zone.

To prevent overflow, all inside corners and valleys must have a water diverter/deflector (ASDIV). Diverter/deflector must be installed on the top surface of the Leaf Relief® (behind front lip). (Figure 2)

The flow from high-level gutters must be transferred within downspouts directly into lower-level gutters and sealed. An alternative to this would be to install water diverters.

Install Leaf Relief® System

NOTE: For TP5100P and TP6100P; slide "J" receiver onto the Leaf Relief® sections.

Place the Leaf Relief® sections on top of the gutter with the vinyl strip against the fascia or drip edge. For proper function, the Leaf Relief® surface (front-to-back) must be level or have a slight slope toward the fascia. Do not install Leaf Relief® over hangers that will result in a forward slope.

For best support, place Leaf Relief® so that the piece nearest the hanger is beneath the adjoining Leaf Relief® section (overlap 1/2″ with adjacent Leaf Relief® section – do not butt). Add or replace hangers as needed for proper support (maximum support spacing is 30″). (Figure 3)

Starting at one end, fasten front of Leaf Relief® to gutter every 24″ using #6-3/8″ screws. (Figure 4)

NOTE: For TP5100P and TP6100P; adjust the "J" receiver to fit the width of the gutter. Using same screws as noted above, attach every 2′ as shown.

Installing Leaf Relief® on Half-Round Gutters

Wrap-Around Fascia Hangers

Lay Leaf Relief® on gutter in front of hanger and mark location of bracket (see Figure 1).

Notch back of Leaf Relief® as shown in Figure 2.

Firmly press back of Leaf Relief® behind gutter, and pivot down to rest on front lip of gutter (see Figure 3).

Attach with screws through Leaf Relief® and front lip of gutter every 24″ (Figure 4).

Continue installing Leaf Relief® panels, overlapping 1/2″. As required, a screw can be inserted through overlapping panels to reduce sagging.

Spring Clip Bar Hangers

Lay Leaf Relief® on gutter in front of hanger and mark location of bracket (see Figure 5).

Cut and notch Leaf Relief® as shown in Figure 6.

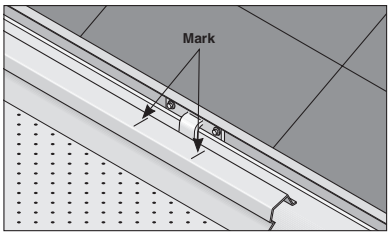


Fig. 1

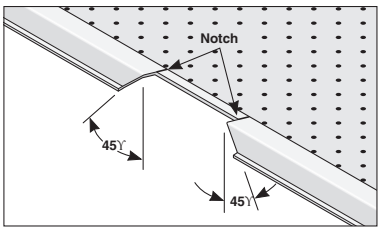


Fig. 2

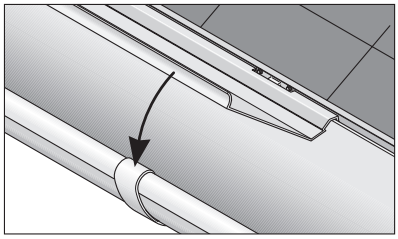


Fig. 3

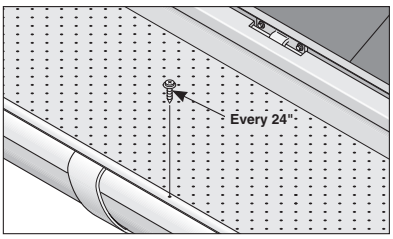


Fig. 4

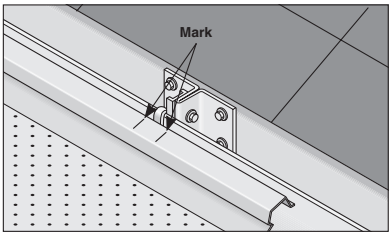


Fig. 5

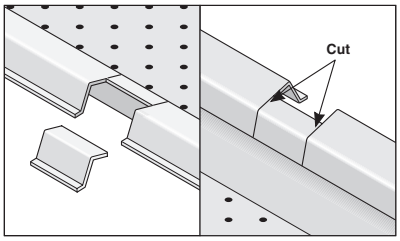


Fig. 6

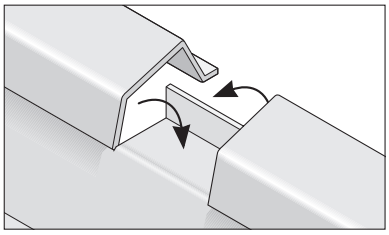
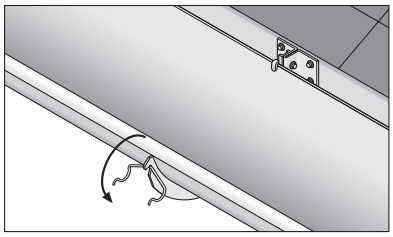


Fig. 1



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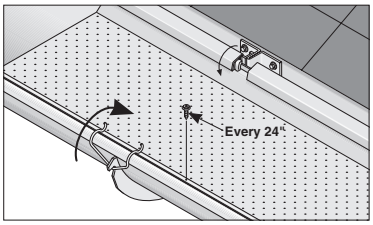

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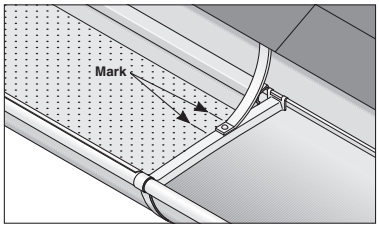


Fig. 4

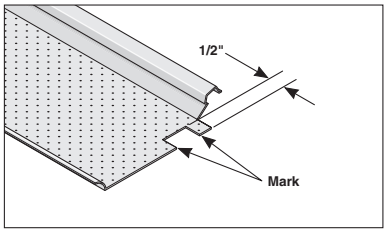


Fig. 5

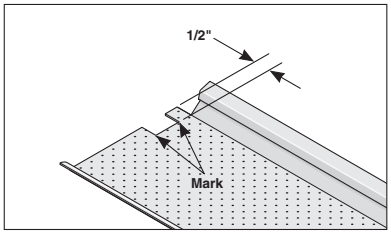


Fig. 6

Installing Leaf Relief® on Half-Round Gutters continued

Spring Clip Bar Hangers continued

Bend tab on Leaf Relief® as shown in Figure 1.

Release spring clip on front of gutter and bend up back tab holding gutter. (Figure 2).

Place Leaf Relief® on gutter, bend hanger back tab over the back of the Leaf Relief®. Fasten hanger spring clip over Leaf Relief® (Figure 3).

Continue installing Leaf Relief® panels, overlapping 1/2″, attaching with screws through Leaf Relief® and front lip of gutter every 24″. As required, a screw can be inserted through overlapping panels to reduce sagging.

Wrap-Around Strap Hangers (Existing Gutters)

Place first Leaf Relief® panel on gutter in front of hanger and mark location of strap (see Figure 4).

Cut and notch Leaf Relief® as shown in Figure 5 and lay in position on gutter.

Place next section of Leaf Relief® on gutter, mark location of strap, then cut and notch as shown in Figure 6.

Installing Leaf Relief® on Half-Round Gutters continued

Wrap-Around Strap Hangers (Existing Gutters) continued

Install on gutter in position so that it overlaps previous section by 1/2″.

Attach with screws through Leaf Relief® at every hanger overlap. Also, attach the Leaf Relief® every 24″ through the front lip of the gutter (Figure 1). As required, a screw can be inserted through overlapping panels to reduce sagging.

Wrap-Around Strap Hangers (New Gutter Installation)

Plan location of strap hangers and Leaf Relief® panels. Remember that Leaf Relief® must overlap 1/2″. Notch Leaf Relief® at each hanger as shown in Figure 2.

Install Leaf Relief®, overlapping panels by 1/2″. Screw through front edge of Leaf Relief® into front lip of gutter every 24″ (see Figure 3). As required, a screw can be inserted through overlapping panels to reduce sagging.

Attach hangers, over Leaf Relief®, to gutters (Figure 4).

Install gutters to structure per manufacturer's instructions.

Mitering Corners

For Outside Corners:

Use perforation pattern as a guide to create corners. Using tin snips, cut diagonally along the perforation to create a 45° angle, starting at the outside edge and cutting as shown. Notch and remove one inch of the front edge from the newly formed angle (Figure 5).

When mounted, the pieces will overlap one inch and form a 90° outside corner. Place one screw through the overlapping pieces (Figure 6).

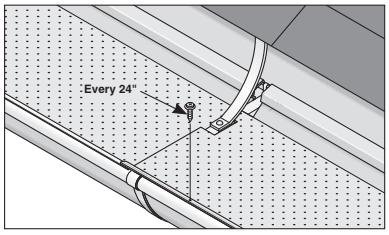


Fig. 1

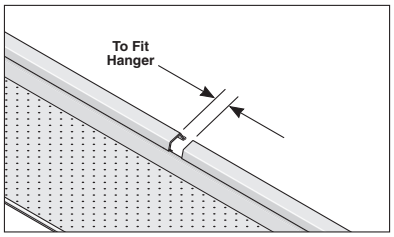


Fig. 2

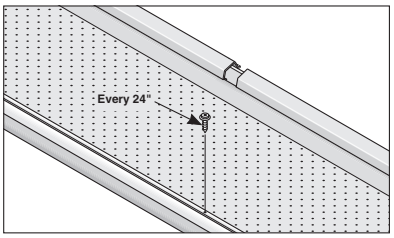


Fig. 3

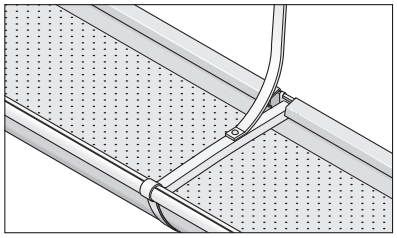


Fig. 4

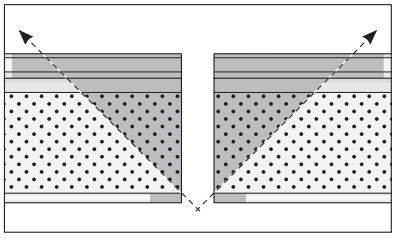
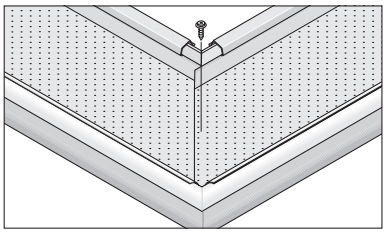


Fig. 5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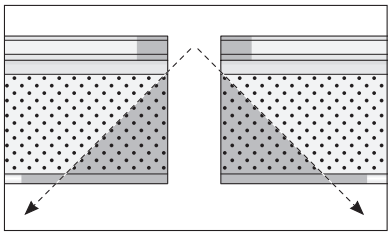


Fig. 1

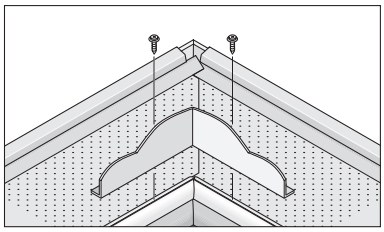


Fig. 2

Installing Leaf Relief® on Half-Round Gutters continued

Mitering Corners continued

For Inside Corners:
Use perforation pattern as a guide to create corners. Using tin snips, cut diagonally along the perforation to create a 45° angle, starting at the rear edge and cutting as shown. Notch and remove one inch of the front edge from the newly formed angle (Figure 1).

When mounted, the pieces will overlap one inch and form a 90° inside corner. Place one screw through the overlapping pieces (Figure 2).

NOTE: To prevent overflow, all inside corners and valleys must have a water diverter/deflector. Diverter/ deflector must be installed on the top surface of Leaf Relief®.

Leaf Relief® Installation (Zip Hangers)

Prepare the Gutter

Clean and flush existing gutters and downspouts thoroughly with water.

Important

Downspouts 3″ x 4″ or larger are recommended for proper function in a coniferous tree zone.

To prevent overflow, all inside corners and valleys must have a water diverter/deflector. Diverter/deflector must be installed on the top surface of the Leaf Relief® (behind front lip).

The flow from high-level gutters must be transferred within downspouts directly into lower-level gutters and sealed. An alternative to this would be to install water diverters.

Install Leaf Relief® System

Place the Leaf Relief® sections on top of the gutter with the vinyl strip against the fascia or drip edge. For proper function, the Leaf Relief® surfaces (front-to-back) must be level or have a slight slope toward the fascia. (Figure 1)

For best support, place Leaf Relief® so that the piece nearest the hanger is beneath the adjoining Leaf Relief® section (overlap 1/2″ with adjacent Leaf Relief® section – do not butt). Add or replace hangers as needed for proper support (maximum support spacing is 30″). (Figure 2)

Starting at one end, fasten front of Leaf Relief® to gutter every 24″ using #6-3/8″ screws (SQ6X038).

NOTE: To prevent overflow, all inside corners and valleys must have a water diverter/deflector. Diverter/deflector must be installed on the top surface of Leaf Relief®.

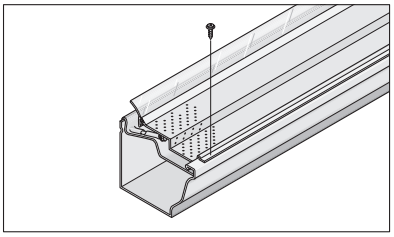


Fig. 1

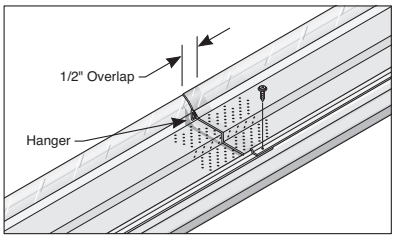


Fig. 2

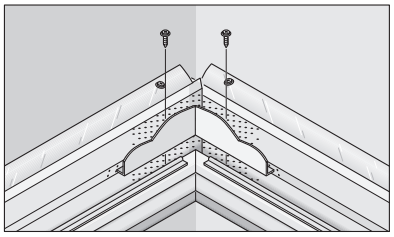


Fig. 3

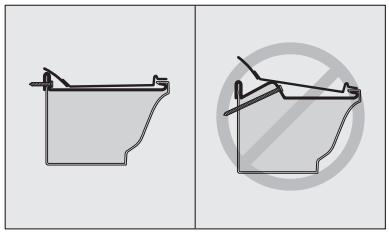


Fig. 1

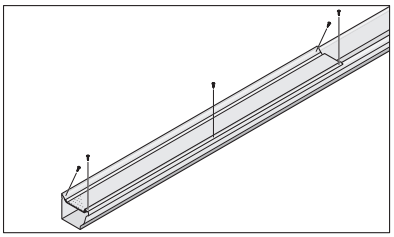


Fig. 2

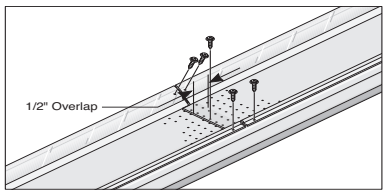


Fig. 3

Leaf Relief® EZ5340-DIY Installation

Prepare the Gutter

Clean and flush existing gutters and downspouts thoroughly with water.

Install Leaf Relief® System

For proper function, the Leaf Relief® surface (front to back) must be level or have a slight slope toward the fascia. (Figure 1)

NOTE: Call 1-800-962-6973 for assistance with hangers that cause a forward slope.

Mounting to Gutter

Using the existing spikes or hidden hangers for support, place Leaf Relief® section flat on the gutter (see sticker denoting "This Side Down").

Using screws provided, attach Leaf Relief® with three (3) screws on front and two (2) screws through the plastic strip on back as shown. (Figure 2)

Attach remaining pieces, making sure to overlap 1/2″ with adjacent Leaf Relief® sections. Place one screw through metal overlap. (Figure 3)

Leaf Relief® Installation (Mitered Corners)

Outside Corners

Use perforation pattern as a guide to create corners. Using tin snips, cut diagonally along the perforation to create a 45° angle, starting at the outside edge and cutting as shown, through the plastic strip. Notch and remove one inch of the front edge and plastic strip from the newly formed angle. When mounted, the pieces will overlap one inch and form a 90° outside corner. Place one screw through the overlapping pieces. Attach to back through plastic strip, with screws, two inches from the point of the corner.

TP53ZIP/TP63ZIP – Inside Corner

NOTE: Because TP product has profile, pre-fabricated corners can not be used.

Use the perforated pattern to cut a 45° angle at the ends of the Leaf Relief sections. Then cut away 1˝ from the front and back of one section as shown.

The sections will overlap by 1˝ and be attached with a #6x3/8˝ stainless steel screw.

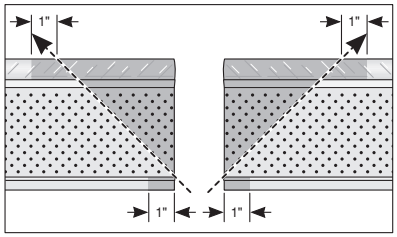


Fig. 1

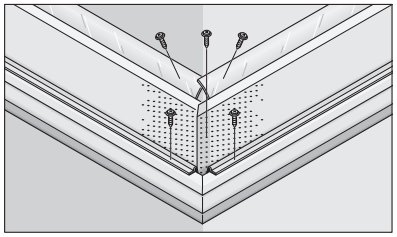


Fig. 2

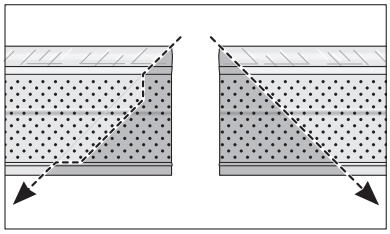


Fig. 3

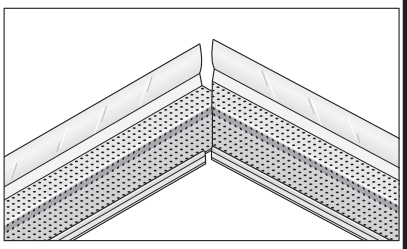


Fig. 4

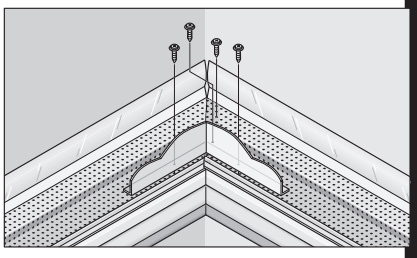


Fig. 5

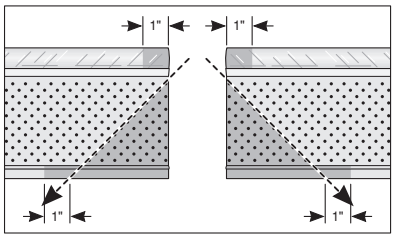


Fig. 1

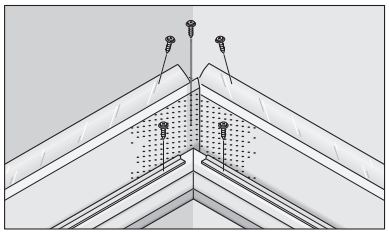


Fig. 2

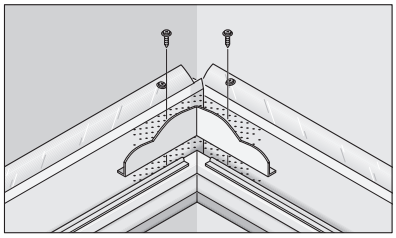


Fig. 3

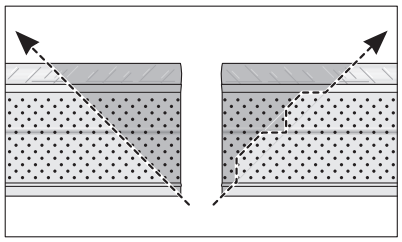


Fig. 4

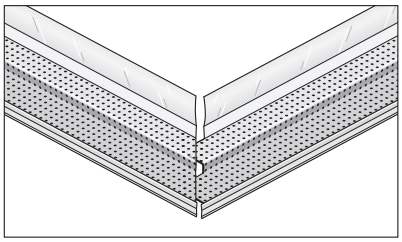


Fig. 5

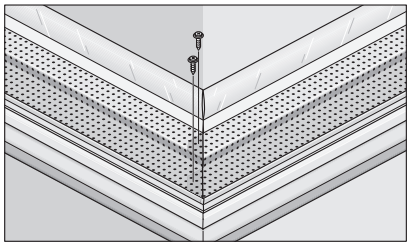


Fig. 6

Leaf Relief® Installation (Mitered Corners) continued

Inside Corners

Use perforation pattern as a guide to create corners. Using tin snips, cut diagonally along the perforation to create a 45° angle, starting at the rear edge (plastic strip) and cutting as shown, until complete. Notch and remove one inch of the front edge and plastic strip from the newly formed angle. When mounted, the pieces will overlap one inch and form a 90° inside corner. Place one screw through the overlapping pieces. Attach to back through plastic strip, with screws, two inches from the point of the corner.

Important

To prevent overflow, all inside corners and valleys must have a water diverter/deflector, sold separately. Diverter/deflector must be installed on the top surface of the Leaf Relief® (behind front lip).

TP53ZIP/TP63ZIP – Outside Corner

Use the perforated pattern to cut a 45° angle at the ends of the Leaf Relief sections. Then cut away 1” from the front, first step and back of one section as shown.

Overlap sections by 1″ and attach with a #6x3/8″ stainless steel screw.

NOTES

REDRING

For Questions contact :

BBT NORTH AMERICA
Bosch Group

Bosch Water Heating
340 Mad River Park
Waitsfield VT 05673
TOLL FREE
866-330-2729

www.boschhotwater.com

Handbook for

PowerStar

electric tankless water heaters

MODELS

AE115 **AE125**

SINGLE PHASE

IMPORTANT:This booklet should be given to the customer after installation and demonstration.

Important Safety Instructions

When using this electrical equipment, basic safety precautions should always be followed, including the following:

1. READ AND FOLLOW ALL INSTRUCTIONS.

2. This appliance must be grounded.
3. Disconnect this product from the electrical supply before cleaning, servicing or removing the cover.
4. To reduce the risk of injury, close supervision is necessary when the product is used near children or elderly persons.
5. Warning: Mount the unit onto a flat section of wall, well away from any potential splashes of water or spray and away from areas where direct moist or wet contact could occur.
6. Warning: Do not install the heater in a location where it may be subject to freezing.
7. Warning: Do not install a check valve or any other type of back flow preventer within ten feet of the cold water inlet.
8. The electrical installation must conform to current National Electrical Codes.
9. Warning: Do not switch the heater on if you suspect that it may be frozen. Wait until you are sure that it has completely thawed out.
10. The PowerStar is designed to heat potable cold water for domestic purposes. The **maximum** inlet water temperature it can handle is 86 degrees F. Contact Bosch Water Heating before specifying or installing the appliance in any other application.
11. Additional Canadian safety instructions:
    a) As per the Canadian Electrical Code, C22.1-02 Section 26-744, an auxiliary terminal block must be fitted to the unit before connecting to the electrical supply (Kit Part N° “AE Canada Kit”). (See Page 7).
    b) A green terminal (or a wire connector marked “G,” “GR,” “GROUND” or “GROUNDING”) is provided within the control. To reduce the risk of electrical shock, connect this terminal or connector to the grounding terminal of the electrical service of supply panel with a continuous copper wire in accordance with the Canadian Electrical Code, Part I.
    c) This product shall be protected by a Class A ground fault circuit interrupter.

Contents

Specifications	3
Installing the PowerStar	3
Starting up the PowerStar	8
How the PowerStar works	9
Using the PowerStar	10
Spare Parts	11
Maintenance	11
Troubleshooting	12
Warranty	15

SAVE THESE INSTRUCTIONS

Keep this guide in a safe place once your unit has been installed.
You may need to refer to it for general instructions or future maintenance.

Specifications

	AE115 Unit	AE125 Unit
Voltage supply	2 x 240V AC (Canada 240VAC)	3 x 240V AC (Canada 240VAC)
Amperage	2 x 40 A (Canada 80 A)	3 x 40 A (Canada 120 A)
Maximum output	17.25 kW	26.85kW
Temperature control range	95°F to 131°F	95°F to 131°F
Pressure range	15 psi to 150 psi	15 psi to 150 psi
Minimum flow rate	0.6 US gal / min	0.8 US gal / min
Maximum flow rate	See Graph 1, Page 8	See Graph 1, Page 8
Dimensions (excl. water couplers)	15½" H x 15¼" W x 4½" D	15½" H x 15¼" W x 4½" D
Weight (without water)	20 lbs	22 lbs

Note: The unit will work at lower supply voltages but the following changes will apply:

Maximum output	15kW at 220V	22.5kW at 220V
	13kW at 208V	20kW at 208V
Temperature control range	87°F to 116°F at 220V	87°F to 116°F at 220V
	82°F to 108°F at 208V	82°F to 108°F at 208V
Maximum flow rate	84% of maximum at 220V	84% of maximum at 220V
(refer to Graph 1, Page 8)	75% of maximum at 208V	75% of maximum at 208V

Installing the PowerStar

WARNING:

If water supply has a high mineral content, a water softening system is strongly recommended. Damage to the water heater resulting from scale or hard minerals will not be covered under warranty.

DISCLAIMER:

In the Commonwealth of Massachusetts a licensed plumber or electrician must perform the installation. (Approval number: P1-09-25).

Locating the Powerstar

WARNING:

Do not install the water heater in an area where there is a chance of freezing. Damage to the water heater as a result of freezing will not be covered under warranty.

- If being used in a public place, locate the heater out of easy reach to discourage vandalism.
- Mount the unit onto a flat section of wall, well away from any potential splashes of water or spray and away from areas where direct moist or wet contact could occur.

Should it be necessary to service the Powerstar, observe the following clearances. These are not required clearances, but would facilitate any service work.

Recommended minimum clearances for servicing			
Top	12"	Bottom	6"
Sides	0"	Front	12"

Mounting the Powerstar

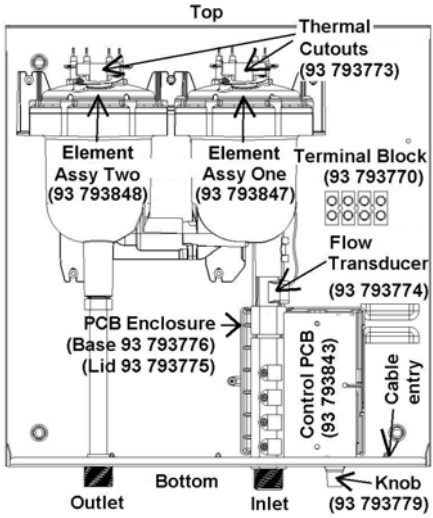
WARNING:

The heater must only be installed in the orientation shown in Diagram 1 i.e., mounted in a vertical position with the water fittings located at the bottom of the heater. ***Under no circumstances should the heater be mounted differently.***

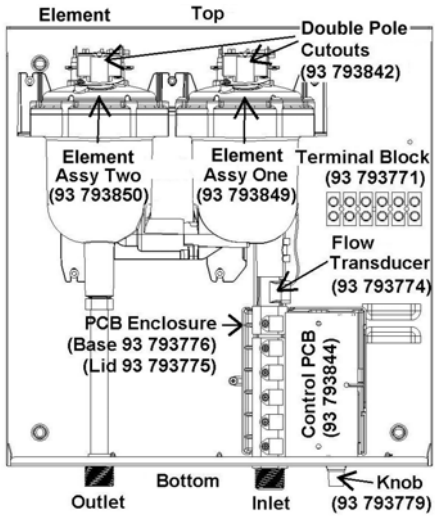
- Undo the retaining screws on the front cover and take the cover off the heater. Hold the back plate in position against the wall and mark the four mounting holes
- Drill the holes and secure the heater using the four wood screws supplied.

Diagram 1

AE115 Unit



AE125 Unit



Water Connections

WARNING:

Do not install a non-return check valve within 10 feet of the inlet.

WARNING:

Do not apply heat or solder to connections or pipe if they are already connected to the unit.

DISCLAIMER:

In the Commonwealth of Massachusetts a pressure relief valve shall be installed on the cold water side by a licensed plumber. (MGL 142 Section 19, Approval number P1-09-25)

- The heater must be connected directly to the main cold water supply and **not to pre-heated water**. (The inlet water temperature must not be greater than 86°F.)
- The heater must be installed with shutoff valves on both the inlet and outlet connections.
- It is recommended that you use ¾ inch or ½ inch copper or high-pressure flex connections.

- Do not use plastic piping within 3 feet on either side of heater.
- Use Teflon tape for sealing pipe threads. Do NOT use pipe dope.
- Remember to keep the hot water pipe runs as short as possible.
- After the heater has been plumbed, and before you wire it, flush it with water to remove any debris or loose particles. Heater must be full of water and air purged before power is turned on. Failure to do so may make the heater inoperable.
- The inlet and outlet connections are clearly marked on the heater. They each have a ¾ inch NPT connector.
- Check the pressure of the main water supply. To operate correctly, the heater needs the following running pressures:

Recommended water pressures			
Min water pressure	15 psi (1 Bar)	Max water pressure	150 psi (10 Bar)

Electrical connections

WARNING

The unit must be wired by a qualified electrician, in accordance with the current version of the National Electrical Code US) or Canadian Electric Code (Canada).

IMPORTANT

When the heater is not within sight of the electrical circuit breakers, a circuit breaker lockout or additional local means of disconnection for all non-grounded conductors must be provided that is within sight of the appliance. (Ref NEC 422.31.)

IMPORTANT

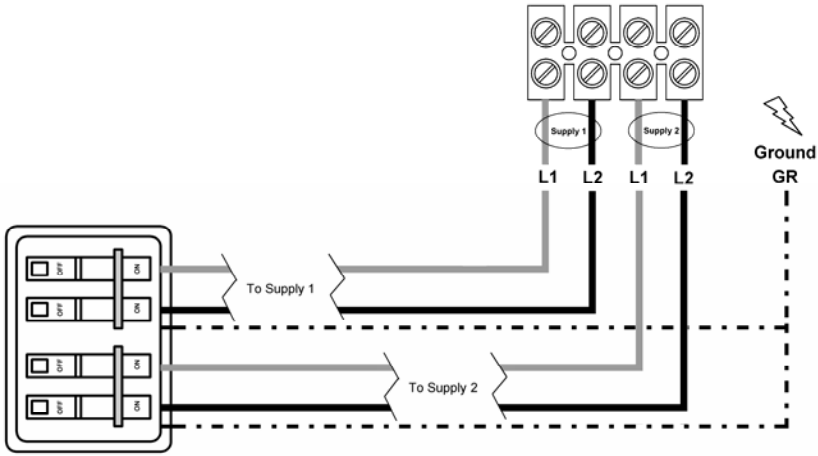
As per the Canadian Electrical Code, C22.1-02 Section 26-744, an auxiliary terminal block must be fitted to the heater before connecting to the electrical supply. This is available as a kit from Bosch Water Heating, Part Number "AE Canada Kit". (Contact 866-330-2729).

US wiring

- The minimum recommended wire size is 8 AWG. (The terminal block will accept cables up to 6 AWG size.)
- The cable entry is via the 1 ¼ inch cable entry hole on the bottom right hand edge of the back plate.
- Strip back the insulation on the power wires about ½ inch. Connect the live wires to the terminals marked "L1" and "L2." There are two pairs of live wires in the AE115 and three pairs of live wires in the AE125. (See Diagrams 2 or 3 on page 6).
- Any insulation on the ground wires should be stripped back about ¾ inch. The ground leads must be connected to the pillar terminal marked "GR". (See Diagrams 2 and 3, Page 6).
- Make sure the terminal block screws are tightened securely. Loose connections can cause wires to heat up.
- Make sure that the ground wires are wrapped around its terminal stud and into the saddle washer. The nut should be tightened securely.
- Attach the front cover and tighten the retaining screws.

Diagram 2

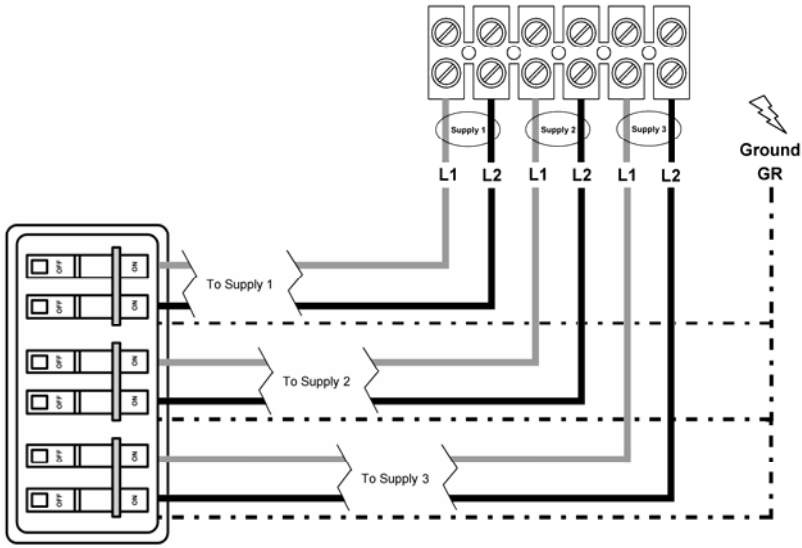
AE115 Terminal Block Connection



The AE115 requires two independent 240V AC circuits protected by two separate and independent double pole breakers (as shown) rated at 40 A each.

Diagram 3

AE125 Terminal Block Connection

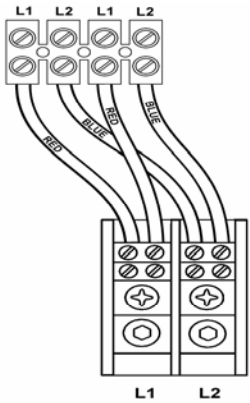


The AE125 requires three independent 240V AC circuits protected by three separate and independent double pole breakers (as shown) rated at 40 A each.

Canada wiring – auxiliary terminal block and connections

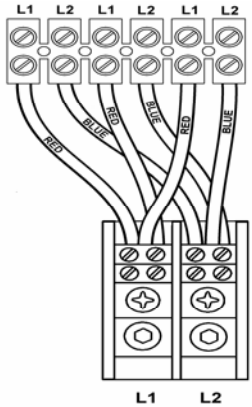
Fitting the auxiliary terminal block (see diagram below).

AE115



NOT FOR U.S.A.

AE125



- Connect the red wires from the left hand terminal of the new block to the L1 terminals in the unit. (There are two red wires required in the AE115 and three in the AE125).
- Connect the blue wires from the right hand terminal of the new block to the L2 terminals in the unit. (There are two blue wires required in the AE115 and three in the AE125).
- Push and click the auxiliary terminal block onto the louvered rail in the backplate.

Connecting the supply cable - Canada only - not for the USA.

- The AE115 requires an 80A 240V AC single phase supply protected by an 80A double pole circuit breaker.
- The AE125 requires a 120A 240V AC single phase supply protected by a 120A double pole circuit breaker.
- The power cable size and the installation must be in accordance with the Canadian Electrical Code, C22.1-02.
- The incoming hole diameter on auxiliary terminal block can accept up to 1/0 AWG size cables.
- The cable entry is via the 1 ¼ inch cable entry hole on the bottom right hand edge of the backplate.
- Strip back the insulation on the power wires about ½ inch. Connect the ungrounded conductors to the terminals “L1” and “L2” on the auxiliary terminal block.
- Any insulation on the ground wire should be stripped back about ¾ inch. The ground lead must be connected to the pillar terminal marked “GR.”
- Make sure the terminal block screws are tightened securely. Loose connections can cause wires to heat up.
- Make sure that the ground wire is wrapped around its terminal stud and into the saddle washer. The nut should be tightened securely.
- Attach the front cover and tighten the retaining screws.

Starting up the PowerStar

Checking for leaks and purging air

- Verify all circuit breakers supplying power to the water heater are turned off.
- Open all hot water taps supplied by the water heater and inspect all water connections for leaks.
- With all hot water taps still open, inspect each tap to ensure all air in the lines has been purged out.
- With the air purged and taps still flowing, turn on all circuit breakers supplying the water heater.
- Close all hot water taps and proceed to the next section.

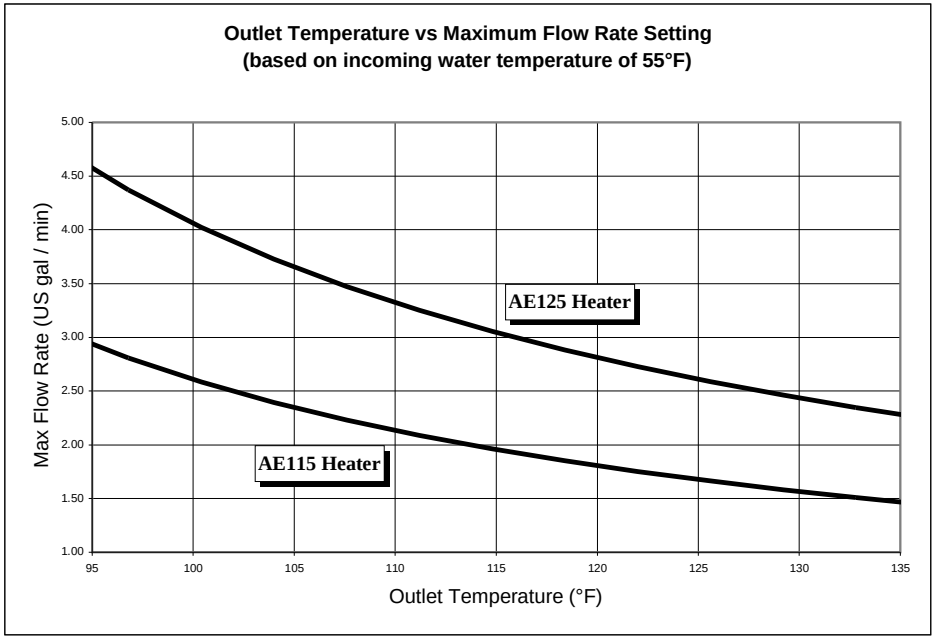
Adjusting the temperature dial

- The temperature adjustment is made using the dial on the bottom edge of the unit. The adjustment is between approximately 95°F and 135°F. Turning the dial clockwise increases the temperature setting as indicated by the marking on the unit.

Adjusting the flow

- Open fully both inlet and outlet shut-off valves at the heater, then :
- Turn on fully the highest flowing hot water faucet (e.g., bathtub) served by the water heater.
- Adjust the outlet shut-off valve until the water flow rate from the hot faucet corresponds to the value given in Graph 1 below.

Graph 1



For example:

- For the AE115 unit, using the outlet ball valve, ensure the flow rate does not exceed 2.3 gallons / minute.
- For the AE125 unit, using the outlet ball valve, ensure the flow rate does not exceed 3.5 gallons / minute.

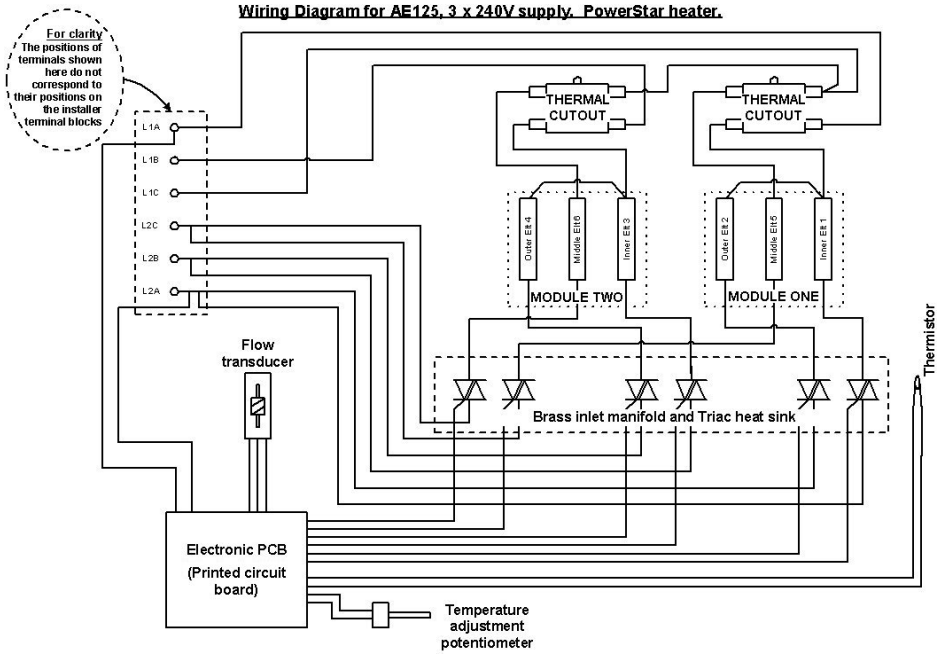
  Note: These figures are based on an inlet water temperature of 55°F and a supply voltage of 240 volts. If the inlet water temperature is lower than 55°F, or if the supply voltage is less than 240 volts, then the outlet temperature will be lower than what is shown in Graph 1. If a higher outlet water temperature is desired, then reduce the flow rate and/or supply the unit with 240 volts.

IMPORTANT
Before leaving the site, the installer should demonstrate the unit to the user and give them this guide.

How the PowerStar works

- The PowerStar heats water continuously as it flows through the heater modules.
- The electronic control PCB monitors the flow rate and the incoming water temperature and then switches on the required number of heater elements to reach the temperature set by the adjustment dial.
- As the flow rate or the incoming water temperature changes, the electronic control adjusts the number of heater modules used so that the outlet temperature is maintained.
- The outlet water temperature can change slightly as the flow rate changes due to the steps in power as different heater modules are switched on and off.
- The outlet water temperature can also vary if the maximum flow rate is exceeded (see Graph 1) or if the supply voltage changes.
- Each heater module is protected by an electro-mechanical thermal cut-out. If the temperature of any of the heater modules gets too high, then the cut-out will trip and cut the power to that heater module. If the cut-out trips, it must be reset while the circuit breakers are off. If you are not comfortable or qualified to perform this task, consult the original installer or a licensed electrician. This cut-out will only trip in exceptional circumstances.
- The AE115 unit is supplied from two independent voltage supplies and the AE125 unit from three independent voltage supplies. (In Canada the unit has just one voltage supply).
- Depending on the region of the country, the temperature of the water supply can vary between 40°F in winter to 70°F in summer, with an average of 55°F.

Diagram 4: Internal wiring schematic for single phase AE125 unit. (AE115 does not have Elt 5 & 6 fitted and uses two supplies). (In Canada an auxiliary terminal block is fitted during installation).



Using the PowerStar

WARNING

Do not use the unit if you think it may be frozen, as this could result in serious damage to the unit. Wait until you are sure that it has completely thawed out before you switch it on.

- Check that the power is switched on at the circuit breaker panel.
- Turn on the hot water faucet FULLY. The hot water temperature can be changed by adjusting the temperature dial on the bottom surface of the unit. (The dial adjusts the temperature typically between 95°F and 131°F. The factory sets the temperature dial at the lowest position.)
- There are internal safety thermal cut-outs which will trip if the unit overheats. If the cut-out trips, it must be reset while the circuit breakers are off. If you are not comfortable or qualified to perform this task, consult the original installer or a licensed electrician.
- If the unit has been used recently, run the water through for a few seconds to let the temperature cool down. You may initially get a short burst of very hot water that was in the plumbing lines from previous use.
- If a second outlet connected to the unit is also turned on, the hot water will be shared between the two.

Spare Parts

Part Number	Description (Refer to Diagram 1, Page 4)
93 793770	4 way term. block (for AE115)
93 793771	6 way term. block (for AE125)
93 793772	Front cover (white)
93 793773	Thermal cut-out (AE115)
93 793842	Double pole cut-out (AE125)
93 793774	Flow transducer
93 793775	PCB enclosure (lid)
93 793776	PCB enclosure (base)
93 793843	Control PCB (for AE115)
93 793844	Control PCB (for AE125)
93 793779	Adjustment knob
93 793845	O Ring set
93 793846	Fixing screws for heater flange
93 793784	¾" Inlet filter screen
93 793847	Heater element assembly 1 (AE115)
93 793848	Heater element assembly 2 (AE115)
93 793849	Heater element assembly 1 (AE125)
93 793850	Heater element assembly 2 (AE125)

For further information ask your local dealer.

FOR SERVICE AND INSTALLATION QUESTIONS CALL TOLL FREE:

866-330-2729 (Toll Free)

Fax: 802-496-6924

BBT NORTH AMERICA

Bosch Group

Bosch Water Heating
340 Mad River Park
Waitsfield, VT 05673
Phone 866-330-2729
Fax 802-496-6924

www.boschhotwater.com
techsupport@boschhotwater.com

Maintenance

Check inlet water filter screen once a year

- Shut off the installer supplied cold water isolation valve to the heater. If one is not installed, install before proceeding.
- Open nearest hot water tap to relieve pressure in the plumbing lines.
- Position a bucket under the cold water inlet connection of the heater to catch any water that may drain.
- Loosen cold water plumbing connection (bottom right of heater) to access filter screen (See Diagram 1, Page 4).
- Remove filter, clean with water and inspect for damage. If the filter is at all damaged, it should be replaced.

Troubleshooting

WARNING
Always switch off the electricity supply to the unit before you remove the cover.

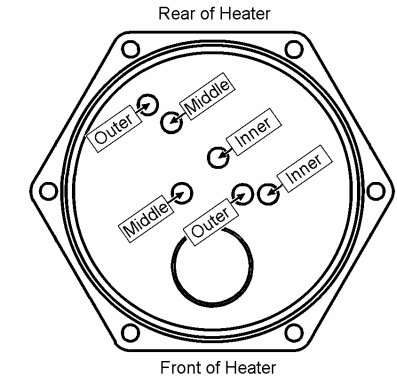
IMPORTANT:
If you are unable to perform the tasks listed below, or need additional assistance please contact your original installer/licensed electrician.

Cold water only – Neon light off	
Flow rate is too low	Verify the flow rate out of fixture is at or above the minimum activation rate required for the unit to activate. (Activation rates: AE115 = 0.6 GPM, AE125 = 0.8 GPM).
The water supply is connected to the outlet of the unit	Verify plumbing connections are correct (See Diagram 1, Page 4). Reconnect the water supply to the inlet of the unit (marked blue).
Plumbing crossover	To test for a plumbing crossover, turn off power supply to the heater. Close installer supplied cold water shut off valve (if none installed, install before proceeding). Open all hot water taps supplied by the heater. Wait 5 minutes and check all taps. Any water running is a sign of a plumbing crossover. Consult a local plumber or service person for help in correcting a plumbing crossover. To return the heater to service, reinstall cover, open the inlet water supply to the heater and open all hot water taps. Let all taps run until there is no air coming out of the fixtures. Shut off all hot water taps. Turn power supply on to the heater. Return heater to service. (This procedure will prevent the heating elements from burning out).
The flow transducer is not spinning	Turn off the power supply to the heater and remove the cover. Observe if the flow transducer "spins" when the water is turned on. Please note the flow transducer spins at a high speed and can appear to be stopped when actually spinning. It is recommended to observe the flow transducer without water flowing, then turn on a hot water tap while observing the flow transducer. If the flow transducer is not spinning, remove and flush flow transducer. See the technical support section of www.boschhotwater.com for more detailed instruction on removing the flow transducer.
One or more of the heating module thermal cut-outs has tripped	Turn off the power to the heater, remove the cover and locate thermal cutouts on the top of each heating module. Try resetting each cutout by pushing the reset button located in the center of the cutout. Determine and fix the cause of the overheating. Obstructions in the water path can restrict the flow of water through the heater causing it to overheat. Verify the heater's inlet filter screen and all outlets served by the heater are clear of debris. Ensure the heater is not being fed preheated water. This water heater is designed for a cold water supply only. If thermal cut out does not reset, check for continuity through each cutout (less than 0.5 Ohms). If any cutout reads more than 0.5 Ohms or open, then it may be defective and should be replaced.
No electricity at the heater or one of the supplies has failed	Have a licensed electrician verify proper wiring and adequate voltage on the terminal block inside the water heater. See the "Electrical connections" section on Page 5 of this manual.

<table>
<tr><th colspan="2">Water too cold – Neon light on</th></tr>
<tr><td>Temperature dial is turned too low</td><td>Turn the temperature dial located on the bottom of the water heater clockwise for hotter temperatures. Refer to Graph 1 for outlet temperature vs. flow rate variance.</td></tr>
<tr><td>Water flow is too high</td><td>Adjust water flow to stay within the water heater's specifications. See Graph 1 on Page 8 of this manual.</td></tr>
<tr><td>One or more of the heating module thermal cut-outs has tripped</td><td>Shut off the power to the unit, remove the cover and locate thermal cutouts on the top of each heating module. Try resetting each cutout by pushing the reset button located in the center of the cutout. Determine and fix the cause of the overheating. Obstructions in the water path can restrict the flow of water through the heater causing it to overheat. Verify the heater's inlet filter screen and all outlets served by the heater are clear of debris. Ensure the heater is not being fed preheated water. This water heater is designed for a cold water feed only. If thermal cut out does not reset, check for continuity through each cutout (Less than 0.5 Ohms). If any cutout reads more than 0.5 Ohms or open, then it may be defective and should be replaced.</td></tr>
<tr><td>The power supply voltage has dropped</td><td>This is likely an issue with the incoming power supply. Have a qualified electrician measure voltage on the water heater's terminal block while operating at maximum flow and maximum temperature setting. The AE115 / AE125 models are rated for 240V and will also operate at 220V or 208V with reduced output. The output will vary in accordance with the following ratios:
<table><tr><td>Volts</td><td>208</td><td>220</td><td>240</td></tr><tr><td>Output Ratio</td><td>0.75</td><td>0.84</td><td>1.0</td></tr></table></td></tr>
<tr><td>The inlet water temperature is too cold</td><td>Verify the heater is sized appropriately for it's geographic location. Turn temperature knob located on the bottom of the water all the way clockwise for maximum temperature setting. Ensure flow rates are within the heater's specifications. Refer to Graph 1 on Page 8 of the manual. Use of an isolation valve on the hot water outlet to control flow rate is recommended.</td></tr>
<tr><td>One of the power supplies is not on</td><td>Have a licensed electrician verify adequate voltage on the terminal block inside the water heater. Verify circuit breakers serving the heater are not tripped. See the "Electrical connections" section on Page 5 of this manual.</td></tr>
<tr><td>Premature element failure</td><td>Shut off power to the unit and remove cover. Use an ohmmeter to verify correct resistance on each element. If readings are different than listed specifications on Page 14, contact Technical Support (866) 330-2729 for further instruction.</td></tr>
</table>

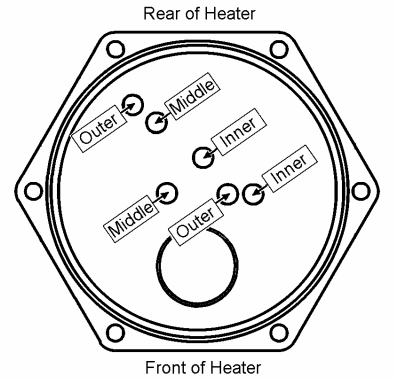
Using an Ohmmeter to check for Premature element failure

LEFT MODULE Top View



Meter probes	Ohm Reading
Outer to Outer	10.5 ± 0.5 Ohms
Middle to Middle	11.5 ± 0.5 Ohms
Inner to Inner	15.0 ± 1 Ohms

RIGHT MODULE Top View



Meter probes	Ohm Reading
Outer to Outer	10.5 ± 0.5 Ohms
Middle to Middle	11.5 ± 0.5 Ohms
Inner to Inner	21.0 ± 1 Ohms

Note: On AE115 model, there is no middle element.

Water flow too low	
There are restrictions in the plumbing	Obstructions in the water path can restrict the flow of water through the heater. Verify the heater's inlet filter screen, faucet aerators, showerheads and whole house filters are clear of debris. Verify proper flow on the outlet side of the heater with the hot water pipe disconnected. Maximum flow rates for each unit are as follows. AE115 = 2.3gpm, AE125 = 3.5gpm.
Water supply pressure too low	Verify incoming water supply is at least 30psi. For people on well systems, the recommended pressure range is 30-50psi.
Outlet shut-off valves are set too low	Adjust installer supplied outlet valve as described below: • Completely open both installer supplied inlet and outlet shut-off valves at the heater. (if none installed, install before proceeding) • Completely open hot water on the highest flowing hot water fixture served by the heater (i.e. bathtub). • Slowly close the outlet shut-off valve, slowing the water flow rate until the temperature at the hot water faucet corresponds to the values given on Graph 1 on Page 8 of the manual, or desired water temperature is reached.

Water Temperature Too Hot	
Temperature dial set too high	Turn the temperature knob located on the bottom of the water heater counterclockwise for cooler temperatures.
There are restrictions in the plumbing	Obstructions in the water path can restrict the flow of water through the heater causing overheating. Verify the heater's inlet filter screen, faucet aerators, showerheads and whole house filters are clear of debris. Verify proper flow on the outlet side of the heater with the hot water pipe disconnected. Opening hot water isolation valve fully may be necessary. Maximum flow rates for each unit are as follows. AE115 - 2.3gpm, AE125 - 3.5gpm.
Inlet water temperature is too warm	Verify the heater is being feed with cold water only. This water heater is not designed for preheated water or recirculation applications. Increase flow rate where ever possible. Replacing low flow showerheads and aerators with higher flowing (GPM) ones may be necessary.

Water Temperature Fluctuates	
Cold mix, heater deactivates	If inlet water temperature is over 70°F, water may be very hot out of the tap. This requires a lot of cold water to be added in order to get a usable hot water temperature. The addition of too much cold water will overpower hot water demand from the water heater. This slows the flow within the water heater, decreasing it below the activation point, which shuts off the heater. The end result is nothing but cold water coming out of the outlet. Increase the flow rate by cleaning or replacing fixtures and lower the setting on the temperature adjustment knob. See service bulletin TWH-E2-04 at www.boschhotwater.com for further troubleshooting on this symptom.
Fluctuating water pressure	If the water pressure in the home is erratic and the water flow is not consistent while a tap is opened, then the temperature of hot water will fluctuate. The minimum water pressure for the home should be 30psi or greater. For people on well systems the minimum pressure range is 30-50psi. The use of a pressure reducing/regulating valve is an effective way to maintain constant water pressure to the water heater. Watts brand 25AUB- ¾" or N35B-¾" pressure reducing/regulating valves or equivalent is suggested.
Changing flow rate	Major changes in flow rate can adversely affect the output water temperature of the heater. Increases from one major fixture running to multiple fixtures running at one time can cause the temperature to fluctuate. Stay within the heater's specifications. See Graph 1 on page 8.

PowerStar
LIMITED 10 YEAR WARRANTY

COVERAGE

BOSCH WATER HEATING (herein after BBT) guarantees this water heater to the original owner of the water heater at the original installation location against defects in material and workmanship for the periods specified below.

WARRANTY PERIOD

1. The Heating Modules – If the original heating module leaks or fails within ten (10) years from the date of original installation of the water heater because of a defect in material or workmanship, BBT will furnish to such an owner a replacement heater of the then-prevailing comparable model.

(Continued…)

(…Continued)

However, if the water heater is installed in other than a single family dwelling this heating modules warranty is limited to two (2) years from the date of original installation and operation.

Note : Damage caused by exposure to freezing conditions is not covered by the warranty.
Note : Damage caused by scale formation is not covered by the warranty.

2. Any Component Part Other Than the Heating Modules – If any other component part (other than the heating modules) proves to be defective in material or workmanship within one (1) year from the date of original installation of the water heater, BBT will furnish the owner with a replacement of the defective part(s).
3. Verification of Date of Original Installation – When owner cannot verify or document the original date of installation, the warranty period begins on the date of manufacture marked on the tag affixed to the water heater.

EXCLUSIONS

1. THIS LIMITED WARRANTY SHALL BE THE EXCLUSIVE WARRANTY MADE BY THE MANUFACTURER AND IS MADE IN LIEU OF ALL OTHER WARRANTIES, EXPRESSED OR IMPLIED (WHETHER WRITTEN OR ORAL), INCLUDING, BUT NOT LIMITED TO, WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE.
2. Manufacturer shall not be liable for incidental, consequential, special or contingent damages or expenses arising, directly or indirectly, from any defect in the water heater or the use of the water heater.
3. Manufacturer shall not be liable for any water damage arising, directly or indirectly, from any defect in the water heater component part(s) or from its use.
4. Manufacturer shall not be liable under this warranty if:
   a) The water heater or any of its component parts has been subject to misuse, alteration, neglect or accident, or;
   b) The water heater has not been installed in accordance with the applicable local plumbing and/or building code(s) and/or regulation(s), or;
   c) The water heater has not been installed in accordance with the printed manufacturer's instructions, or;
   d) The water heater is not continuously supplied with potable water.
5. The owner and not the manufacturer or his representative shall be liable for and shall pay for all field damages for labor or other expenses incurred in the removal and/or repair of the product or any expense incurred by the owner in order to repair the product.

SOME STATES DO NOT ALLOW THE EXCLUSION OR LIMITATION OF INCIDENTAL OR CONSEQUENTIAL DAMAGES, SO THE ABOVE LIMITATION OR EXCLUSION MAY NOT APPLY TO YOU. THIS WARRANTY GIVES YOU SPECIFIC LEGAL RIGHTS AND YOU MAY ALSO HAVE OTHERS.

IMPORTANT: OWNER SHALL KEEP THIS CERTIFICATE

NOTE: A water heater must be installed in such a manner that if it should leak, the resulting flow of water will not cause damage to the area in which it is installed.

The person who initially installed the unit is the best one to contact for help.
You can also call BBT toll free at 866-330-2729. Please have this guide, model number, serial number and date of installation with you when you call.

BBT NORTH AMERICA
Bosch Group

Bosch Water Heating
340 Mad River Park
Waitsfield VT 05673

TOLL FREE: 866-330-2729
Fax: 802-496-6924

www.boschhotwater.com

11.22.06

555-2028-10D

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Bosch Ne**xx**t®
500 Series Electric Dryer

Models / Modèle / Modelo:
WTMC3321US, WTMC3321CN, WTMC332SUS & WTMC332SCN

en Operating, Care and Installation Instructions
fr Seche-linge: Notice d'utilsation, de maintenance et d'installation
es Secador: Operacíon, cuidado y instrucciones para la instalación

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Congratulations on having selected a Bosch clothes dryer, the choice of those that demand exceptional drying performance and care from their clothes dryer.

This dryer complies with UL 2158/CAN/CSA–C22.2 No. 112–97 Clothes Dryers

A distinctive feature of your dryer is low energy consumption.

An easy operation philosophy, a variety of customized drying programs and a solid touch and feel make this appliance a user-friendly assistant in your household.

The Bosch dryer offers the following standard features:

- High efficiency precision drying system
- Large 6.4 cu.ft. (181 l) stainless steel drum with a capacity up to 17.6 lbs (8 kg)
- Large port hole (18"/457 mm), door lock with automatic drum stop function
- Exceptionally quiet operation
- Sensor controlled auto cycles
- Timed cycles 20, 40 and 60 minutes

Each dryer which leaves our factory has undergone a thorough performance test and is in full working condition. If you have any questions especially concerning installation of the dryer – our customer service team will be happy to assist you.

Further information and a selection of our products can be found on our web site:

www.boschappliances.com

Information

Please read and follow these operating and installation instructions and all other information enclosed with the dryer.

Definitions

⚠ WARNING ⚠

WARNING – This indicates that death or serious injuries may occur as a result of non-observance of this warning.

⚠ CAUTION ⚠

CAUTION– This indicates that injuries may occur as a result of non-observance of this warning.

CAUTION

CAUTION – This indicates that damage may occur as a result of non-observance of this warning.

i This symbol is used to draw the user's attention to important matters.

⚠ IMPORTANT SAFETY INSTRUCTIONS

⚠ WARNING ⚠

To reduce the risk of fire, electric shock, serious injury or death to persons and /or damage when using your dryer, follow basic precautions, including the following.

1. Read all instructions before using the dryer. Bosch dryers are provided with Operating, Care and Installation Instructions.
2. Do not dry articles that have been previously cleaned, washed, soaked, or spotted with gasoline, dry cleaning solvents, other flammable, or explosive substances as they give off vapors that could ignite or explode.
3. Do not allow children to play on or with the appliance. Close supervision of children is necessary when the appliance is used near children.
4. When children become old enough to operate the appliance, it is the legal responsibility of the parents or legal guardians to ensure that they are instructed in safe practices by qualified persons.
5. Before the appliance is removed from service or discarded, remove the door to the drying compartment.
6. Do not reach into the appliance if the drum is rotating.
7. Do not install or store this appliance where it will be exposed to the weather.
8. Do not tamper with the controls.
9. Do not repair or replace any part of the appliance or attempt any service unless specifically recommended in the user-maintenance instructions or in published user repair instructions that you understand and have the skills to carry out.
10. Do not use fabric softeners or products to eliminate static unless recommended by the fabric manufacturer.
11. Do not use heat to dry articles containing foam rubber (may be labeled latex foam) or similarly textured rubber-like materials. Foam rubber materials can ignite by spontaneous combustion.
12. Clean lint screen before or after each load.
13. Keep area around the exhaust opening and adjacent surrounding areas free from the accumulation of lint, dust and dirt. An obstructed port might reduce the airflow.
14. The interior of the machine and exhaust duct should be cleaned periodically by qualified service personnel.
15. Always be sure to unplug the dryer from the electrical supply before attempting any service. Disconnect the power cord by grasping the plug, not the cord.
16. Store all laundry chemicals and aids in a cool dry place according to the manufacturer's instructions in an area where children cannot reach them.
17. To reduce the risk of fire, clothes, cleaning rags, mop heads and the like which have traces of any flammable substance, such as vegetable oil, cooking oil, petroleum based oils or distillates, waxes, fats, etc., must not be placed in the dryer. These items may contain some flammable substance(s) even after washing, which may smoke or catch fire by itself.
18. Do not place items exposed to cooking oils in your dryer. Items contaminated with cooking oils may contribute to a chemical reaction that could cause a load to catch fire.
19. Do not sit on top of the dryer.
20. To reduce the risk of fire or electrical shock, DO NOT use an extension cord or an adapter to connect the dryer to the electrical power supply.
21. The dryer must only be used for its intended purpose.

22. Always check pockets and remove any objects. Cigarette lighters are particularly hazardous.
23. Replace worn out power cords and/or loose plugs.
24. Do not operate the dryer if any guards and/or panels have been removed.
25. Do not operate the dryer if any parts are missing or broken.
26. Do not bypass any safety devices.
27. Do not use a plastic or non-metal flexible duct with this dryer. Plastic or non-metal flexible duct are a potential fire hazard.
28. Do not operate this dryer until you are sure that the dryer has been installed according to the INSTALLATION INSTRUCTIONS and that installation and grounding are in compliance with all local regulations and/or other applicable regulations and requirements.
29. Failure to install, maintain and/or operate the dryer according to the manufac-
turer's instructions may result in injury and/or damage.
30. To avoid floor damage and mold growth, do not let spills or splashout cause standing water around or under the appliance.

Notes:

A The IMPORTANT SAFEGUARDS and WARNINGS presented in this manual do not cover all possible conditions that may occur.
Common sense, caution and care must be exercised when installing, maintaining or operating the dryer.

B Always contact your dealer, distributor, service agent or the manufacturer about any problems or conditions that you do not understand.

C Follow also the Safety Information in the INSTALLATION INSTRUCTIONS and the OPERATING INSTRUCTIONS.

GROUNDING INSTRUCTIONS

This appliance must be grounded. In the event of malfunction or breakdown, grounding will reduce the risk of electric shock by providing a path of least resistance for the electric current.

For U.S.A.

Your dryer comes without a power supply cord. The power cord must meet the following requirements:

– UL listed in the USA
– 208 – 240 volt rated (minimum)
– 30 amps
– Type SRDT or DRT (UL 2158)
– Five feet long (minimum)

For CANADA

This appliance is equipped with a cord having an equipment-grounding conductor and a grounding plug. The plug must be plugged into an appropriate outlet that is properly installed and grounded in accordance with all local codes and ordinances.

⚠ WARNING ⚠

Improper connection of the equipment grounding conductor can result in a risk of electric shock.
Check with a qualified electrician or service person if you are in doubt as to whether the dryer is properly grounded.
DO NOT modify the plug provided with the appliance.
If it will not fit the outlet, have a proper outlet installed by a qualified electrician.

KEEP THESE INSTRUCTIONS FOR FUTURE REFERENCE.

In case of change of ownership, manual should be conveyed with the dryer.

SAVE THESE INSTRUCTIONS

INSTALLATION INSTRUCTIONS

Introduction

Read these installation instructions completely and carefully. They will save you time and effort and help to ensure optimum dryer performance. Be sure to observe all listed warnings and cautions.
These installation instructions are intended for use by qualified installers. In addition to these instructions the dryer must be installed in accordance with all local codes or, in the absence of a local code:

– In the **U.S.A.**, in accordance with the National Electric Code, ANSI/NFPA70 – latest edition/State and Municipal codes and/or local codes.
– In **Canada**, in accordance with the Canadian Electric Code C22.1 – latest edition/Provincial and Municipal codes and/or local codes.

Information concerning waste disposal

Disposal of the packaging

⚠ WARNING ⚠

Keep children away from shipping carton and packaging components. Danger of suffocation from plastic foil and folding cartons.

All packaging materials are environmentally friendly and can be reused. Please dispose of packaging in an environmentally friendly manner.
Please ask your dealer or inquire at your local authority about the current means of disposal.

Disposal of the old appliance

⚠ WARNING ⚠

If appliance is no longer usable, pull out main plug, cut off power cord and discard with main plug.

To prevent children from locking themselves in the appliance, remove the door.
Old appliances are not worthless rubbish! Valuable raw materials can be reclaimed from environmentally friendly recycling.
Please ask your dealer or inquire at your local authority about the current means of disposal.

Before installing the dryer

Unpacking the appliance

⚠ CAUTION ⚠

The dryer is very heavy. Do not lift it by yourself. Do not lift the appliance by projecting components (e.g. door) – due to risk of breakage.

CAUTION

Remove the appliance packaging carefully to prevent damage to the surfaces.

Check the dryer for transportation damage. Do not connect a dryer which is visibly damaged. If in doubt, contact your dealer.

Supplied components

For U.S.A.

⚠ CAUTION ⚠

The dryer is supplied without a power cord. The power cord must be connected by qualified persons only.

CAUTION

After removing the packaging, immediately remove any objects from the drum.

The dryer is delivered as a complete unit. The operating instructions and supplied accessories can be found in the drum.

Installation location

⚠ WARNING ⚠

Do not install the dryer:

- outdoors
- in an environment with dripping water,
- near flammable materials,
- in rooms which are at risk of frost,
- in rooms which may contain gas or other fuels,
- in cupboards with lockable doors or in alcoves.

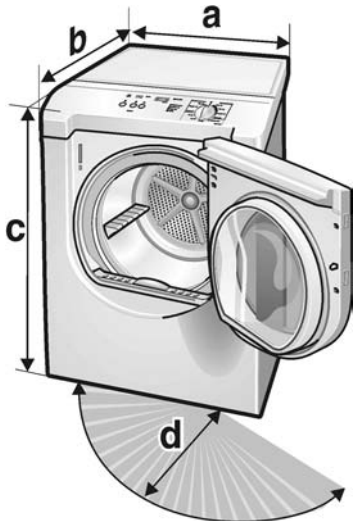
The installation room must be well ventilated, otherwise the dryer will operate below optimum performance.

Do not operate the dryer at temperatures above 104°F (40°C) and below 41°F (5°C). Low temperatures affect the automatic program sequence and may prolong the drying times.

The installation surface for the dryer must be clean, level and firm. Do not install the appliance on carpets! Compensate for uneven floors with the height-adjustable feet.

Install the dryer and level side to side and front to back. Use a bubble level. Never remove the height-adjustable feet!

The size of the installation area depends on the dimensions of the dryer. Ensure that there is adequate room for the swivel range of the door!



	Dimension	Weight
a	27.0” (686 mm)	125 lbs (56 kg)
b	31.8” (808 mm)	
c	37.2” (945 mm)	with packaging 143 lbs (64 kg)
d angle	19.7” (500 mm)/ 170 – 180˚	

If installing the dryer in a closet, observe the minimum distances according to the following table:

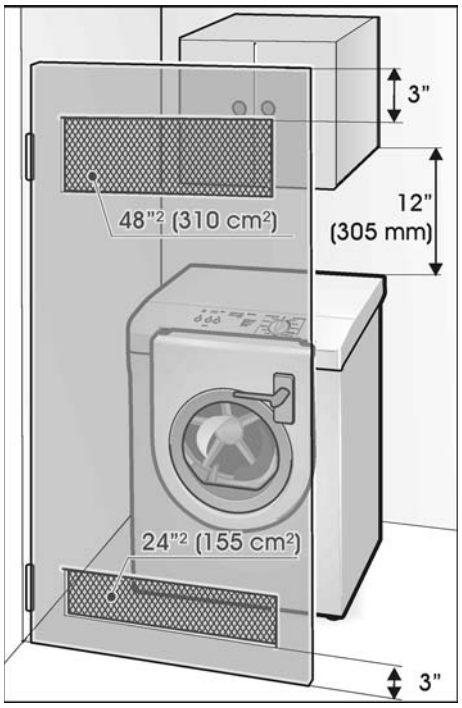
Minimum Installation Clearances

	Closet
Sides	0” (0 mm)
Top	12” (305 mm)
Rear*	0” (0 mm)

* as close to wall as venting will allow.

Important information concerning minimum distances:

- Depending on the location of the exhaust air connection, an additional minimum distance of 5½ inch (14 cm) must be provided on this side for pipes/brackets (see page 7).
- Distances above the indicated minimum dimensions reduce the risk of mold formation behind the appliance.
- Additional distances reduce noise transmission.
- Additional distances facilitate installation and service.
- If the dryer is installed in a small room, the doors of the room must be fitted with vents of a specified minimum size.



The dryer door is delivered with hinges on the right. If required, the door hinges can be switched to the left side.

If the door hinges are to be changed over, please contact your dealer or our customer service-team (see page 20)

Electrical connection

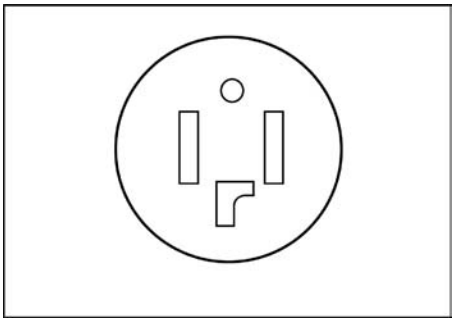
⚠ WARNING ⚠

Power cord must be connected by a qualified person only.
Connect to individual Branch Circuit.
Do not use an adapter.
Do not use an extension cord.
Do not remove ground prong.

For CANADA

Your dryer comes with a power supply cord, CSA listed in Canada.

The Bosch dryer requires a 4-wire receptacle.



When installing the receptacle for the dryer cord, ensure that the power supply cord is accessible when the dryer is in the installed position.

The power cord should only be replaced by a qualified person. Use a 4-wire power supply cord (see electrical connection U.S.A. below).

For U.S.A.

Your dryer comes without a power supply cord. The power cord must meet the following requirements:

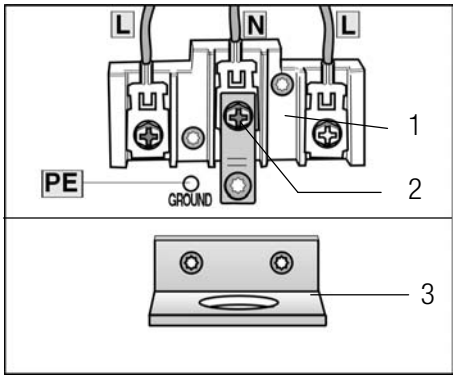
– UL listed in the USA
– 208 – 240 volt rated (minimum)
– 30 amps
– Type SRDT or DRT (UL 2158)
– Five feet long (minimum)

⚠ WARNING ⚠

Power cord must be connected by a licensed electrician only.
Use only a U.L. approved 30 amp power cord with strain relief clamp – note manufacturer's instructions.
Do not plug end of power cord into a live receptacle before connecting power cord to appliance terminals and closing junction/splitter box as described below.
Do not reuse old power cord.
Cord must have closed loop or upturned end wire terminating connectors.
Do not make a sharp bend or crimp wiring/conductor at connections.
Only a 4-conductor cord shall be used when the appliance is installed in a mobile home, in a recreational vehicle, in a new branch circuit installation or an area where the local codes do not permit grounding through the neutral.

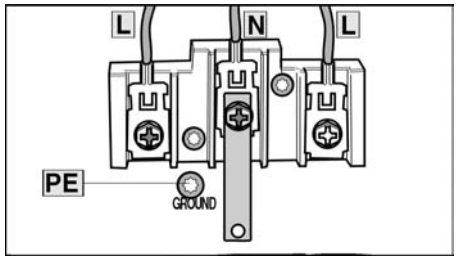
Connecting 4-wire power supply cord

1. Remove the screws from the cover of the terminal block located at the top rear of the appliance.

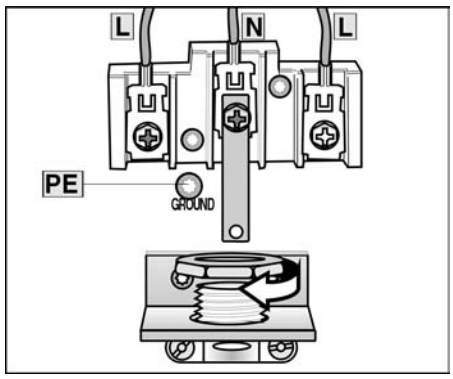


1 – terminal block
2 – grounding strap
3 – Angle bracket for strain relief clamp

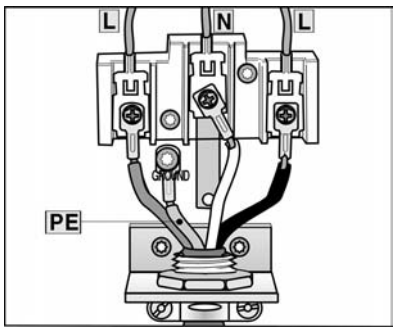
2. Loosen the bottom screw of the grounding strap. Place the screw to the GROUND location. Straighten the grounding strap and hang loosely.



3. Fix the strain relief clamp to the angle bracket. Tighten the nut.



4. Loosen the 2 screws labeled **L** and the screw labeled **N** in the terminal block. and the screw of the GROUND terminal.
5. Thread the 4 wire cable through the U.L. strain relief clamp.
6. Tighten the screws (2.5 Nm) of the U.L. strain relief clamp so that the power cord cannot be moved.
7. Attach the power cord ground conductor (green) to the GROUND terminal. Tighten the screw (2.5 Nm) so that the ground conductor is held securely in place.
8. Attach the 2 power cord outer conductors (red and black) to the 2 terminals labeled L and the remaining power cord conductor (white) to the terminal labeled N.
9. Tighten all 3 screws (3 Nm) so that the power conductors are held securely in place .



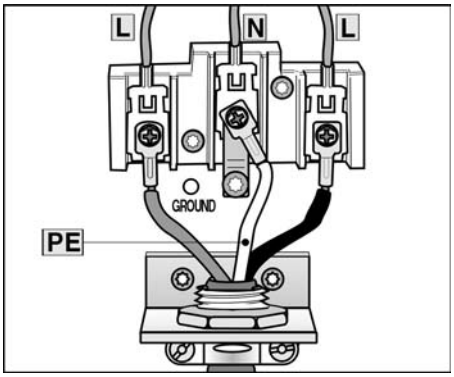
10. Check the U.L. strain relief clamp to make sure that it is tight and cannot be turned.
11. Replace the cover on the terminal block and fasten in place.

i Make sure that the U.L. strain relief clamp is outside the cover!

The appliance is now ready to be plugged into the 4-wire receptacle of the power rating.

Connecting 3-wire power supply cord

1. Remove the screws from the cover of the terminal block located at the top rear of the appliance.
2. Make sure that there is a grounding strap.
3. Fix the strain relief clamp to the angle bracket. Tighten the nut.
4. Loosen the 2 screws labeled **L** and the screw labeled **N** in the terminal block.
5. Thread the 3-wire cable through the U.L. strain relief clamp.
6. Tighten the screws (2.5 Nm) on the U.L. strain relief clamp so that the power cord cannot be moved.
7. Attach the 2 power cord outer conductors (red and black) to the 2 terminals labeled L and the remaining power cord conductor (white) to the terminal labeled N.
8. Tighten all 3 screws (3 Nm) so that the power conductors are held in place securely.



9. Check the U.L. strain relief clamp to make sure that it is tight and cannot be turned.
10. Replace the cover on the terminal block and fasten in place.

i Make sure that the U.L. strain relief clamp is outside the cover!

Additional grounding procedure

– Some local regulations may require a separate ground. In such cases, the required accessory ground wire, clamp and screw must be purchased separately.
– Never ground the dryer to plastic plumbing lines, gas lines or water pipes.

Grounding instruction

This appliance must be grounded. In the event of a malfunction or breakdown, grounding will reduce the risk of electric shock by providing a path of least resistance for the electric current.
For Canada the dryer comes with a cord which has an equipment grounding conductor and a grounding plug. The plug must be plugged into an appropriate outlet which has been properly installed and grounded in accordance with all local regulations and ordinances.

⚠ WARNING ⚠

Improper connection of the equipment grounding conductor may result in electric shock. Have the appliance checked by a qualified electrician or service technician if you are in doubt as to whether the dryer has been properly grounded.

Exhaust air connection

⚠ WARNING ⚠

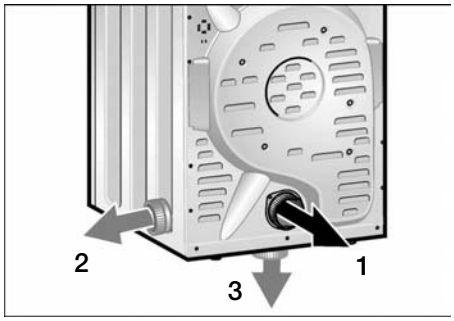
1. To reduce the risk of fire, this dryer MUST BE EXHAUSTED OUTDOORS.
2. To reduce the risk of fire, do not use the ductwork longer than recommended.
3. DO NOT use a plastic or non-metal duct with this dryer.
4. DO NOT use a duct smaller than 4 inches in diameter.
5. DO NOT use exhaust hoods with magnetic latches.
6. DO NOT exhaust the dryer into a chimney, furnace cold air duct, attic, crawl space, or any other ductwork used for venting.
7. DO NOT install a flexible duct in an enclosed wall, ceiling or floor.
8. DO NOT crush or kink the duct.
9. Do clean and inspect the exhaust system on a regular basis; at least once a year.
10. The exhaust duct must terminate in a manner to prevent back drafts or entry of birds or other wildlife.

The Bosch dryers are intended to be vented outdoors. To prevent build-up of moisture and accumulation of lint indoors, as well as to maintain maximum drying efficiency, it is recommended that the dryer is vented outdoors.

Exhaust air outlet on the dryer

The dryer is delivered with an exhaust air outlet on the rear of the appliance.
To take account of the spatial requirements and an existing exhaust air system, the following connection options are possible for the exhaust air outlet:

– on right side of the appliance,
– on the underside of the appliance.



1 – Exhaust air outlet on the rear of the appliance (standard)

2 – Exhaust air outlet on the side (optional)

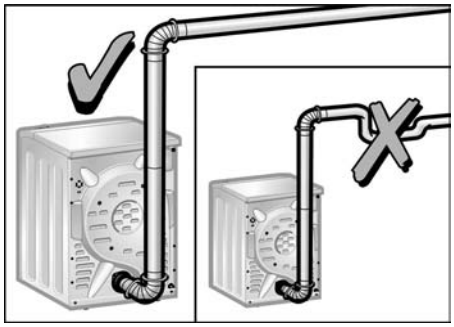
3 – Exhaust air outlet on the underside of the appliance (optional)

Special exhaust air connections must be obtained from your dealer or part supplier for either connection type (see page 8).

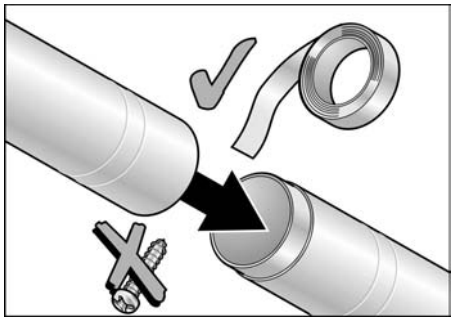
– Side exhaust kit
– Bottom exhaust kit

A qualified technician should change the exhaust air outlet to the optional connection location.

Ductwork



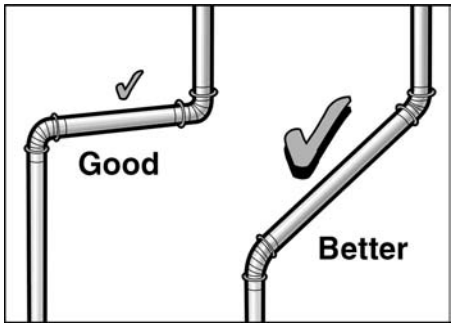
To ensure optimum performance, the ducting system of the dryer should be as short as possible with a minimum number of elbows. Your dryer will work best when the venting system has as few air flow restrictions as possible. Exhaust ducting which is longer than recommended may extend drying time, cause lint to accumulate and affect dryer performance and dryer life-time.
Four-inch (approx. 100 mm) diameter ducting should be used. Use either rigid metal or flexible metal ducting material.
DO NOT use plastic or non-metal duct with this dryer.
DO NOT assemble the ductwork with screws or fasteners that extend into the duct. They will serve as an accumulation point for lint.
Joints should be secured with aluminum tape.



All joints should be tight to avoid leaks. The male end of each duct section must point away from the dryer.
Whether connecting to an existing venting system or a new venting system, make sure that all ducting is clean and free of lint.
The maximum permitted length for both rigid and flexible metal duct is shown in the table below.

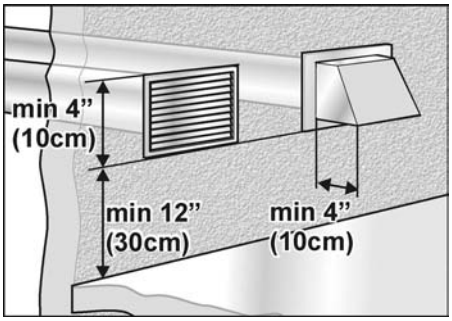
Number of 90˚ Turns or Elbows	Rigid Duct	Flexible Duct
0	66 ft. (2011 cm)	45 ft. (1372 cm)
1	56 ft. (1707 cm)	36 ft. (1097 cm)
2	48 ft. (1463 cm)	29 ft. (884 cm)
3	39 ft. (1189 cm)	22 ft. (671 cm)
4	30 ft. (914 cm)	16 ft. (488 cm)

Note:
Side and bottom exhaust installations have a 90˚ turn inside the dryer. To determine maximum exhaust length, add one 90˚ turn to the chart.
More than two 90° turns are not recommended. For best performance, separate all turns by at least 4 ft. of straight duct, including distance between last turn and exhaust hood.



Exhaust vent hood

The exhaust duct must end with an approved exhaust vent hood with swing out damper(s). DO NOT use an exhaust vent hood with magnetic latches.
To avoid exhaust restriction, the outlet must be a minimum of 12 inches (30 cm) above ground level or any other obstructing surface.



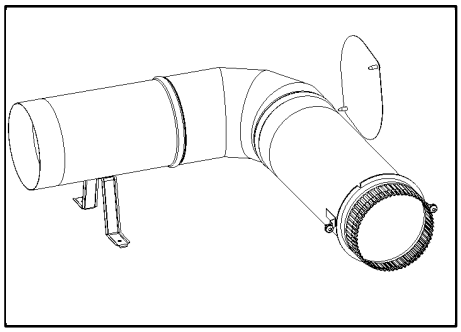
Required parts

The parts required for the exhaust air system (elbows, lines, exhaust air outlets) are not included in standard delivery of the dryer.

Accessories

The parts required for the exhaust air system can be obtained from customer service or your local dealer. Please follow the installation instructions supplied by the appropriate manufacturer!

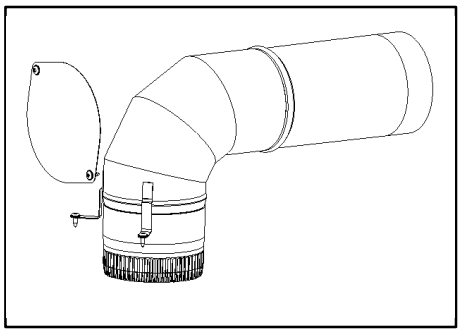
Side exhaust kit



part no. **WTZ 1265**
Note:
The maximum permitted number of 90˚ elbows (including this side exhaust kit) is four!

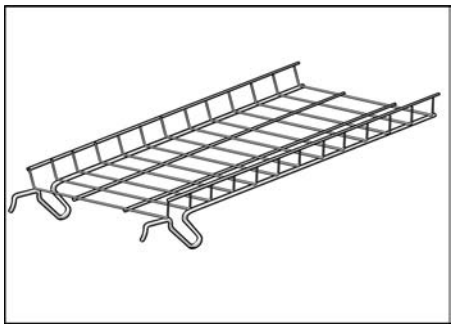
i Special tool for cutting the hole in prepared side panel is required. Contact local dealer!

Bottom exhaust kit



part no. **WTZ 1270**
Note:
The maximum permitted number of 90˚ elbows (including this side exhaust kit) is four!

Dryer rack



part no. **WTZ1290**
Use the dryer rack to dry washable woolen textiles (e.g. sweaters) and shoes.

Left hinge kit

part no. **WTZ1260** (White Dryers)
part no. **WTZ126S** (Silver Dryers)
The door catch can be reversed if necessary. The door is hinged on the right at the factory.

Pedestal Mounting Kit

part no. **WTZ 1295** (White Dryers)
part no. **WTZ 1295S** (Silver Dryers)
If mounting the dryer on the pedestal follow the instructions supplied with the pedestal.

Installation – step by step

1. Unpack the dryer.
2. Remove all objects from the drum.
3. Check the dryer for visible damage.
4. Position the dryer near the installation location.
5. If required, change the door hinges to the left (see page 5).
6. If required, have customer service install the exhaust air outlet on the dryer (see page 7).
7. Have the power supply cord fitted by an authorized technician (see page 5).
8. Install exhaust duct if necessary. Follow the installation instructions supplied by the appropriate manufacturer!

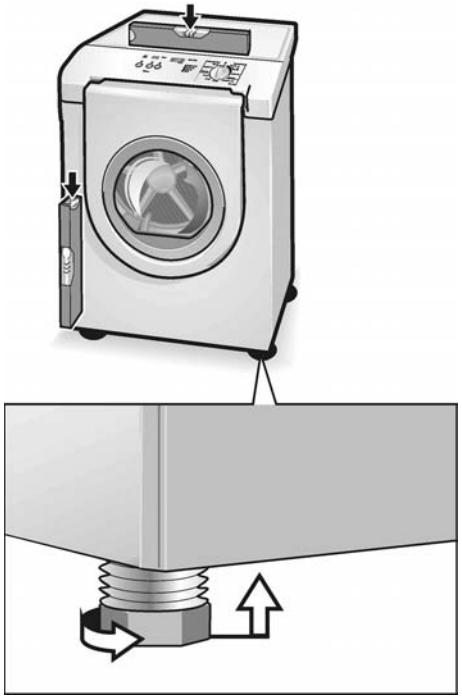
i If space is very restricted, it is recommended to fit the initial parts of the exhaust duct to the dryer before the dryer is moved to its final installation location.

9. Move the dryer to its final location and align.

CAUTION

Do not slide dryer across the floor if height-adjustable feet have been extended. Feet and/or dryer base may be damaged if dryer is slid across floor with height-adjustable feet extended.

10. Position and then level the dryer.



The dryer should be level with all four feet firmly on the ground. The dryer must not wobble. If the dryer is not level or if it does wobble, the feet must be adjusted. Adjust the height-adjustable feet until the dryer does not rock and is level, both front-to-back and side-to-side.

11. Connect the exhaust duct to the exhaust air outlet on the dryer.
12. Insert plug into the wall receptacle.

Check list before using the dryer

1. Check that steps 1–12 have been implemented properly.
2. Ensure that the dryer is connected to the power supply.
3. Read the operating instructions to understand how your dryer operates.
4. Conduct an appliance test:
   - ❑ Check that the drum is empty.
   - ❑ Close the dryer door.
   - ❑ Switch the dryer to ”Extra Dry” and then press the Start button.
   - ❑ After 3–5 minutes press the Stop button and open the door.
5. If the interior of the dryer feels warm, the dryer has been connected properly.
   Switch the dryer to ”OFF”.
6. If the dryer does not work, switch the dryer to ”OFF”.
   Look in the troubleshooting section (page 19) of the OPERATING INSTRUCTIONS and find the fault.

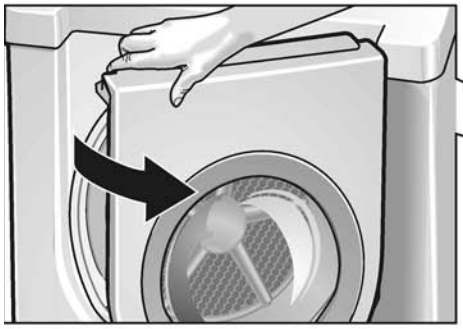
Preparing to transport the dryer – step by step

1. Rotate the program selector to ”OFF”.
2. Pull out the power supply plug.
3. Disconnect the exhaust duct from the exhaust air outlet on the dryer.
4. Place any accessories in the drum.
5. Close the door and secure with adhesive tape.
6. Screw the height-adjustable feet of the dryer into the housing to prevent them from being damaged during transportation.

OPERATING INSTRUCTIONS

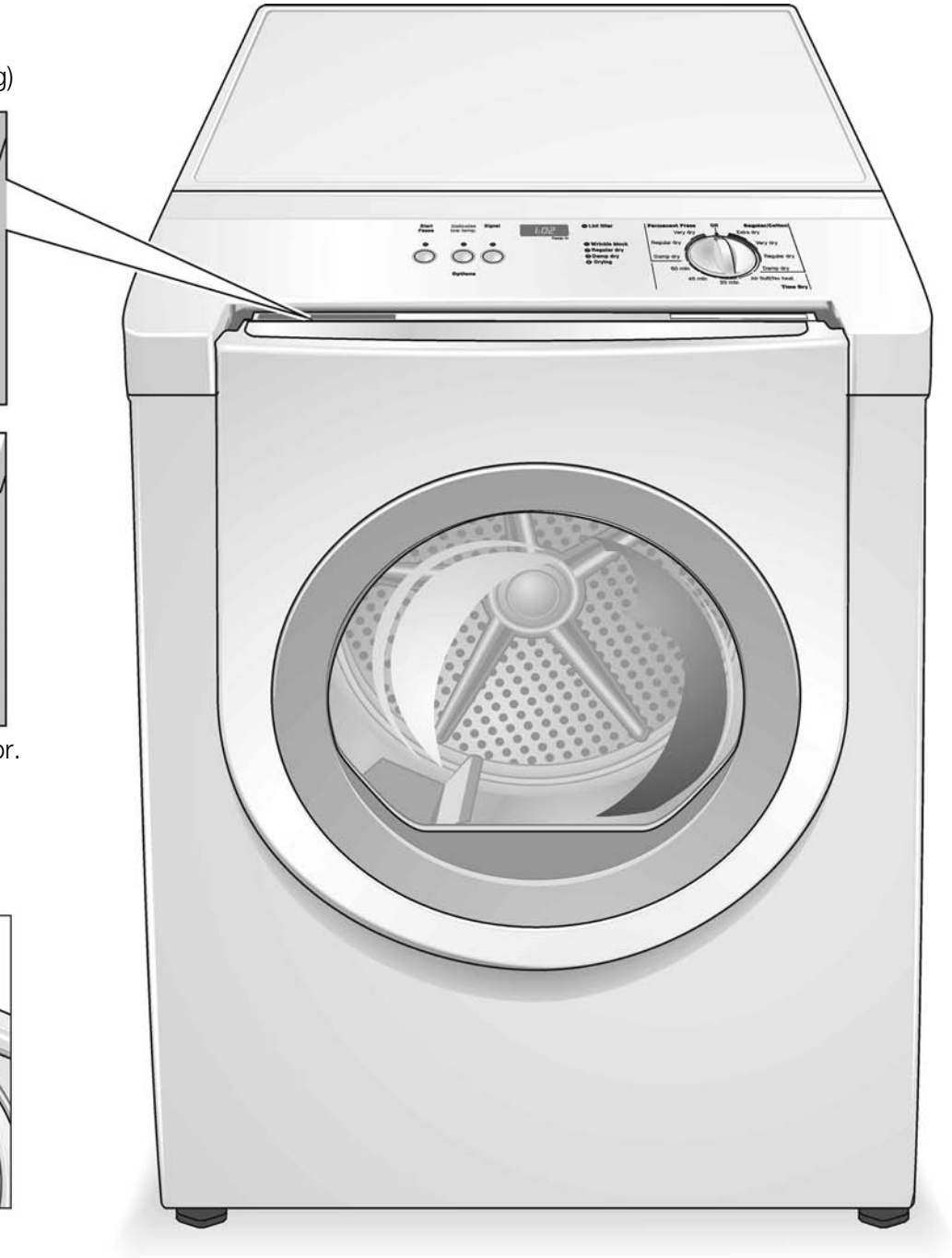
Your new dryer

Open the door .... (colored marking)



....and close the door.

Lint filter



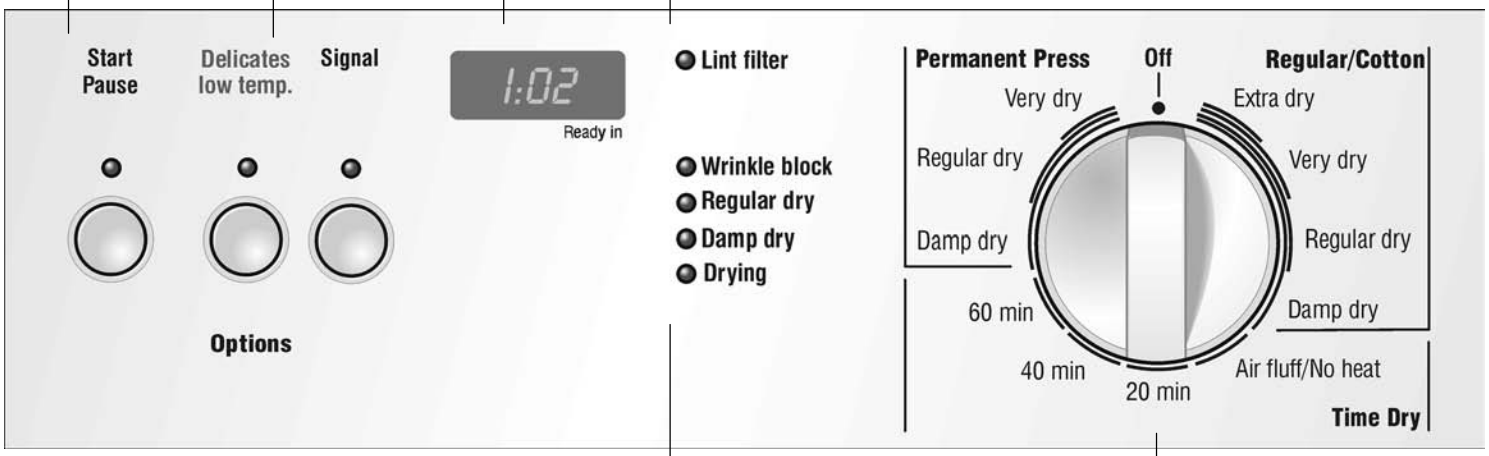
Panel

Start/Stop button
Starts, interrupts and ends the drying process.

Buttons for Options (in addition to the program if required). See page 14.
Delicates low temp.
Press for temperature-sensitive textiles (e.g. acrylic fibers). The temperature of the drying process is reduced, the drying time is extended correspondingly.
Signal
An acoustic signal indicates the end of the program.

Display
Indicates the estimated remaining time of programs.

Indicator light (LED)
Serves as a reminder to clean the lint filter



Program selector
Selects a program. See page 14.
Can be rotated in both directions.

To switch off the dryer, rotate the program selector to ”Off”.

Indicator lights (LED)
Indicate the current state of the drying process.

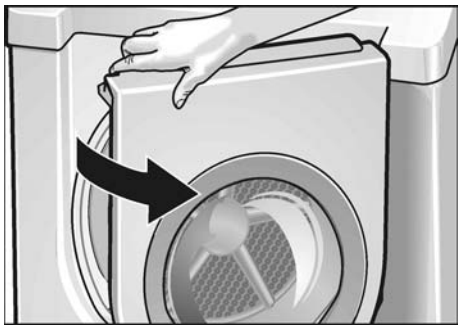
Summary of instructions

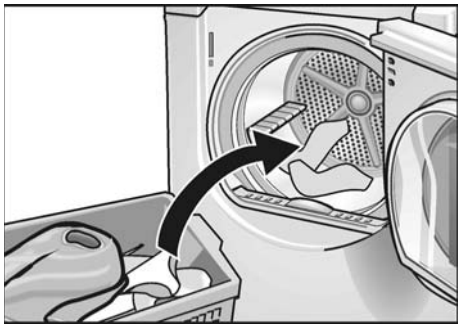
⚠ CAUTION ⚠

Before using your dryer read and follow all installation and operating instructions.

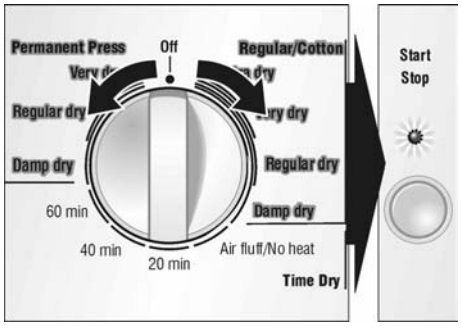
Preparing the dryer

i Check the lint filter. The filter should be cleaned before and after every drying process.

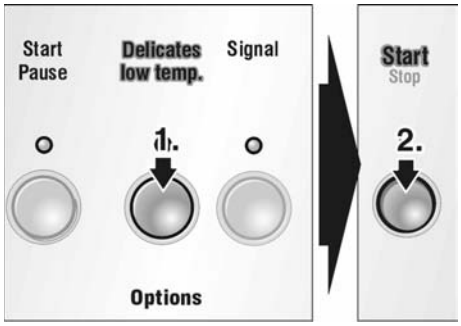




Selecting a program

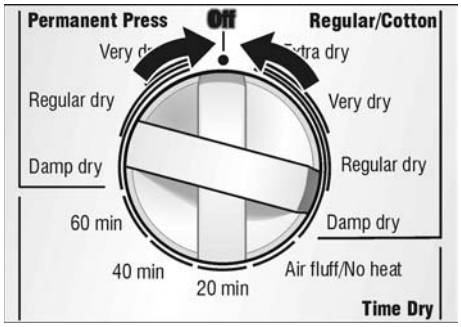


Choose an option...



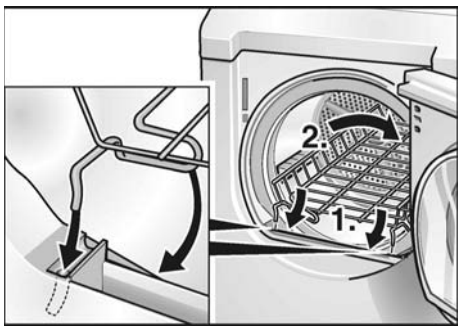
...and start the dryer.

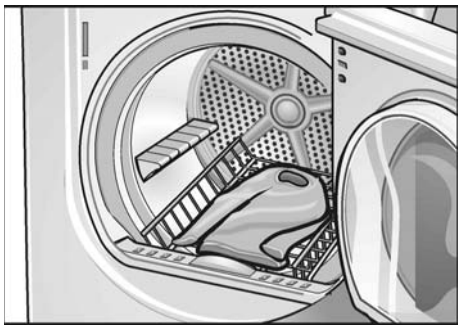
Switch off the dryer



Using the dryer rack

(Option, see page 8)





Safety information

⚠ WARNING ⚠

Always follow the IMPORTANT SAFETY INSTRUCTIONS (see page 23).

⚠ WARNING ⚠

TO AVOID EXPLOSION HAZARD!

Keep flammable materials and vapors, such as gasoline, away from the dryer.

Do not dry anything that has ever had anything flammable on it (even after washing).

Do not dry anything that has ever had any type of oil on it (including cooking oils).

Items containing foam, rubber or plastic must be dried on a clothes-line or by using an air fluff-cycle.

Do not allow items containing flammable materials, such as lighters, to remain in clothes while drying.

Failure to follow these instructions may result in explosion or fire.

To avoid risk of death or injury!

Use the dryer only in the house or the garage for drying normal amounts of laundry for the household.

Use only for drying textiles which were washed with water.

Before switching on the dryer

Install the dryer in accordance with the installation instructions (from page 4).
Do not use a dryer which is visibly damaged. If in doubt, contact your dealer.

Using the dryer

Do not leave children unsupervised near the dryer.
Keep pets away from the dryer. Before closing the door, check the contents of the drum.
Remove all objects from pockets. Lighters are particularly hazardous.
Risk of explosion!
Switch off the dryer at the end of the program.

Protecting the dryer

Do not climb on the dryer.
Do not lean or sit on the door.
Risk of dryer tipping over!
Do not store or use solvent detergent boosters or stain remover in the vicinity of the dryer.
The dryer could be damaged.
Do not lift the dryer by projecting components.
Risk of breakage!

Protection of the environment

Tips on saving energy

To save energy, money and time, Bosch recommends the following:

- **Drain the laundry thoroughly!**
  Before drying, spin the laundry thoroughly in the washing machine. Use the highest possible spin speed for the type of laundry! Higher spin speeds reduce the drying time and the energy consumption.
- **Use optimum load!**
  Use maximum recommended loads. However, do not exceed loads.
- **Clean filter!**
  Clean the filter before and after each drying process (see page 18).
- **Ventilate the room!**
  During the drying process provide an adequate supply of fresh air.
- **Do not dry unsuitable materials!**
  Do not dry rubberized or air-tight items.
- **Do clean and inspect the exhaust system on a regular basis!**
  Blockages may extend drying time.

Before using the dryer for the first time

Before you use the dryer for the first time:

1. Read these operating instructions carefully.
2. Check that the supply voltage corresponds with the voltage specifications on the rating plate of the dryer, see picture page 20
3. Remove all objects from the drum.
4. Check the dryer for visible damage. If damages found contact your dealer.
5. Wipe the inside of the drum with a damp cloth.
6. Conduct an appliance test, see page 9.
7. If the dryer does not work, switch the dryer to ”Off”.
   Look in the troubleshooting section (page 19) of the operating instructions and find the fault.

Temporary disconnection of the dryer

Operate your dryer only when you are at home. If you intend going on vacation or are not using your dryer for an extended period of time, you should:

1. Turn off the circuit breaker.
2. Pull out the power supply plug if possible.
3. Clean the lint filter.

Laundry

Identification of fabrics

Observe the treatment symbols on the textile labels. They provide valuable information as well as limitations about the drying process.
Do not dry the following textiles in the dryer:

- Air-tight textiles (e.g. rubberized)
- Delicate fabrics (silk, synthetic curtains)

i Dry woolen or wool-rich textiles with dryer rack only!

i Use the time program “Air fluff/No heat” to dry articles containing foam rubber or similarly textured rubber-like materials.

Drying tips

In principle, the following applies to all drying programs:

- To ensure a uniform drying result, sort the laundry according to fabric type and drying program.
- Fasten zippers, hooks and eyes. Fasten loose belts, apron strings, etc..
- Do not overdry easy-care laundry – risk of wrinkling! Leave laundry to dry in the air.
- Do not iron laundry immediately after drying. Place the laundry in a pile for a short while. Residual moisture will then be distributed uniformly.
- Knitted textiles (e.g. T-shirts, cotton jersey laundry) often shrink when dried for the first time. Do not use the ”Very dry/Extra dry” program.

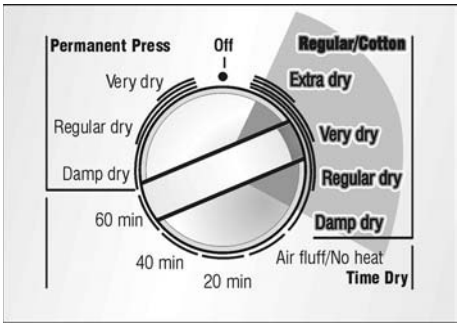
Program selection

For optimum drying results your dryer offers several program groups and additional options.
Select the required drying program from the program table according to the examples (see page 15).

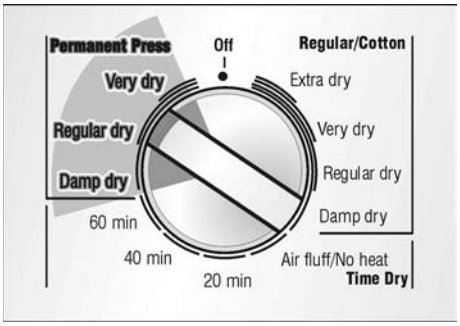
Automatic programs

There are automatic programs for different types of textiles.
(Regular/Cotton or Permanent Press).

Regular/Cotton

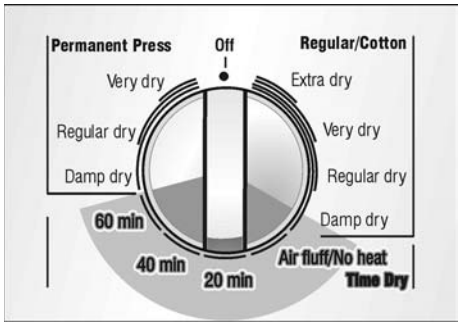


Permanent Press



The program sequence of automatic programs is controlled via sensors. The duration of the program depends on the measured degree of moisture in the laundry and on the selected degree of dryness (e.g. Damp dry or Extra dry).

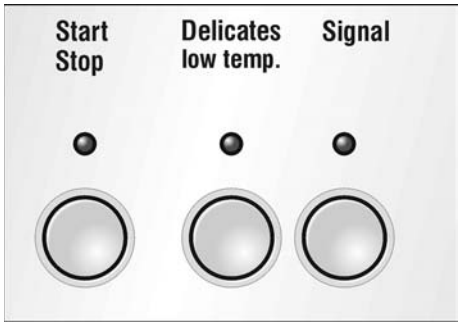
Time programs



Time programs run for a specific time (20, 40, 60 minutes).
In the "Air fluff/No heat" stage the dryer runs on ambient air without a heat supply for 20 minutes.

i Dry woolen or wool–rich textiles with dryer rack only!

Options



Delicates low temp.

Press the "Delicates low temp." button for temperature sensitive textiles. Observe the care information or symbols on the textiles. The temperature of the drying process is reduced, the drying time is extended.

Signal

Your dryer outputs different signals, if the "Signal" button is pressed.

Signal	Type
Start	Short tone
End	Sequence of short tones
Mal-operation	Sequence of long tones
Warning of malfunction	Sequence of long tones

i The signal "Warning of malfunction" is active in any case.

Indicator of program sequence

The dryer uses an electronic scanning system for all programs except the time programs . A moisture sensor continuously checks the moisture in the laundry. Drying ends automatically as soon as the selected degree of dryness has been reached.
The drum continues to rotate at specific intervals for one hour to prevent creasing.
The current degree of drying and the level reached during the program sequence is indicated via indicator lights (Drying, Damp dry, Regular dry, Wrinkle block).

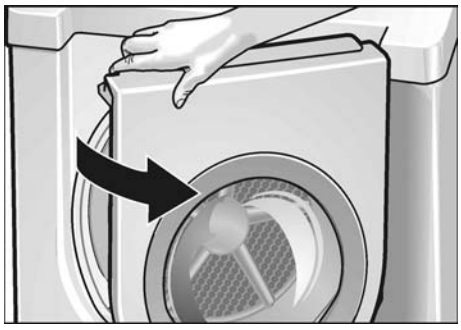
i If the indicator light "Wrinkle block" illuminates when the program selector is in Off–Position – turn off the circuit breaker and call for customer service!

Program selection table

Automatic programs		
For Cottons and coloreds made of cotton or linen. Press “Delicates low temp.” button for temperature-sensitive textiles.		**“Regular/Cottons”** Automatic program
Bed linen, table linen, towels	<u>For laundry,</u> which is to be ironed	Damp dry
Bed linen and table linen, towels, T-shirts, sports shirts, overalls		
T-shirts, sports shirts, dresses, trousers, overalls, underwear		
Terry towels, kitchen towels, hand towels, bed linen, underwear, cotton socks	which is not to be ironed	Regular dry
Terry towels, kitchen towels, hand towels, bed linen, underwear, cotton socks	which is not to be ironed, thick multi-ply	Very dry
Terry bathrobes and terry bed linen,	which is particularly thick or multi-ply	Extra dry
Easy-care (drip-dry) laundry made of synthetic and blended fabric, cotton e.g. polyester Press the “Delicates low temp.” button for very temperature-sensitive textiles.		**“Permanent Press”** Automatic program
	<u>For laundry,</u>	
Trousers, dresses, skirts, shirts, blouses, leggings, sports clothing with synthetic-rich fibers, lingerie	which is not to be ironed or only lightly ironed	Damp dry
Shirts, blouses, sports clothing	which is not to be ironed	Regular dry
Bed linen and table linen, track suits, comforters, blankets	which is not to be ironed, thick multi-ply	Very dry
Time programs		**“Time Dry”**
Pre-dried textiles with low moisture content, individual small items, e.g. bath towels, bathing suits, dish cloths. For the smallest loading condition from 0.22 lb – 0.44 lb (i. e. one small towel), for this a time dry program should be selected Press the “Delicates low temp.” button for temperature-sensitive textiles option.		
– Cottons and coloreds made of cotton or linen.		20, 40, 60 min
– Temperature-sensitive textiles.		20, 40, 60 min
Freshening or airing little worn items of clothing and drying of extreme sensitive textiles. For all textile types inclusive foam rubber (e.g. pillows, stuffed toys), plastic (e.g. shower curtains, table clothes), rubber (e.g. backed rugs), sheer nylon, polypropylene.		Air fluff

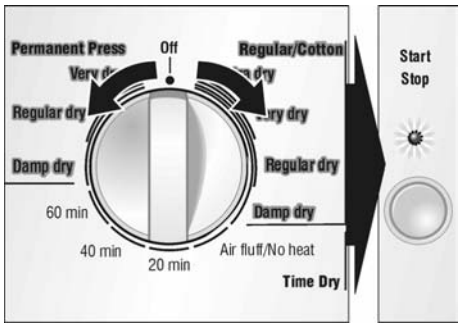
Operation

Using the dryer



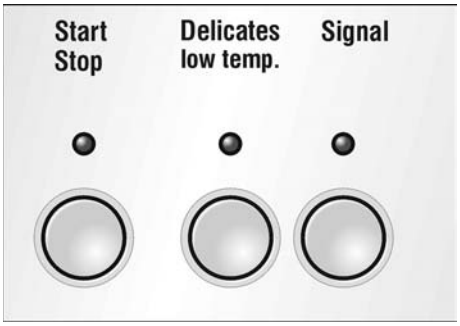
1. Open the door.

2. Check lint filter.
The filter should be cleaned after and before every drying process. Cleaning the filter reduces the drying time and saves energy.



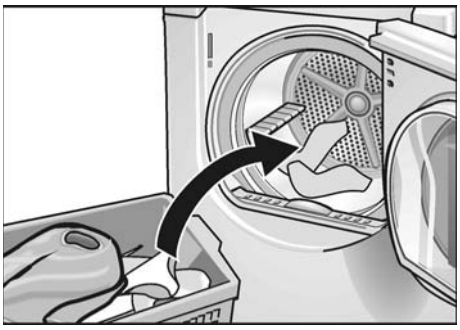
3. Rotate program selector to the desired program.
Select the program which corresponds to the laundry in the dryer from the program selection table (see page 15).
The dryer light turns on inside the drum.

i The “Start/Stop” indicator light starts flashing.



4. If required, select “Option” by pressing the button.
The ”Options” are explained on page 14.

i The estimated remaining time will be updated.



5. Place laundry in the empty drum. Put each piece of laundry into the machine separately.
For best results the laundry to be dried must be sorted according to type of laundry and desired degree of drying. For further information see page 13.

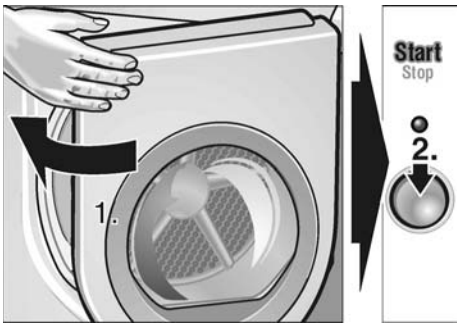
i Observe drying symbols of the laundry manufacturer. If drying woolen clothing and shoes, see the information on page 16.

Ensure that there is only laundry in the drum. Check that all items are completely in the drum.

6. Close the door.

The “Start/Stop” indicator light continues flashing.

i If the door has not been closed properly, the dryer will not start.



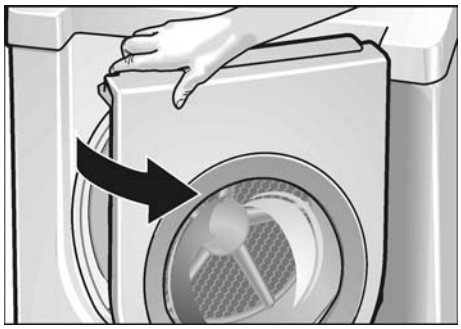
7. Press the “**Start**/Stop” button. The “Start/Stop” indicator light illuminates.

i The program starts with an acoustic signal (if set).

If a standard program has been selected, the indicator lights indicate the progress of the program sequence.

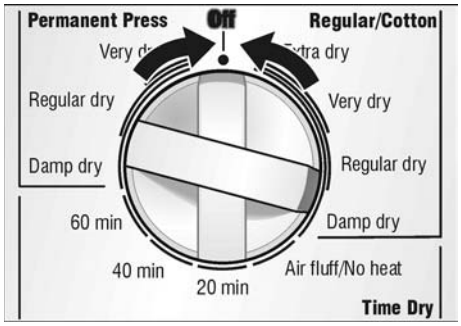
i At program end an acoustic signal is emitted (if set) and the LED “Wrinkle block” illuminates.

i When the drying process is complete (program or selected time program ended), the drum rotates at specific intervals for 1 hour.
This prevent the laundry from creasing. The laundry remains loose and fluffy until it is removed. The laundry should be removed before this time has elapsed.



8. Open the door.

9. Take the laundry out of the dryer.



10. Rotate the program selector to “Off”.
The dryer light goes out.

11. Clean the filter.
The filter should be cleaned after each drying process. Cleaning the filter reduces the drying time and saves energy.

12. Close the door.

Using the dryer rack

(Option, see page 8)

Use the dryer rack to dry washable woolen textiles (e.g. sweaters) and shoes. The dryer rack remains stationary while the drum rotates. Damp wool should not be moved, as it has a tendency to matt. Drying shoes without a rack could damage the drum.

⚠ CAUTION ⚠

Dry only one item of clothing or one pair of shoes – maximal dry load 2,2 lbs (1 kg)! The laundry must have been spun! Only dry prewashed shoes! The laundry must not touch the drum! It could jam and be damaged. After using the dryer rack, take it out of the dryer immediately.

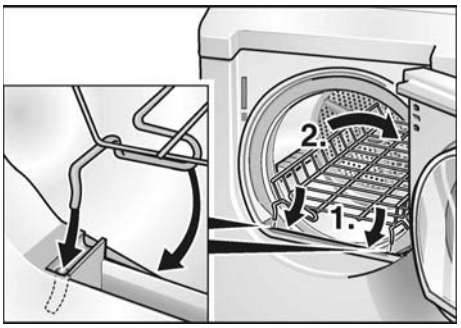
Inserting the dryer rack

1. Open the dryer door.

2. Check that the drum is empty.

3. Remove the lint filter.

4. Lift the dryer rack horizontally into the drum.

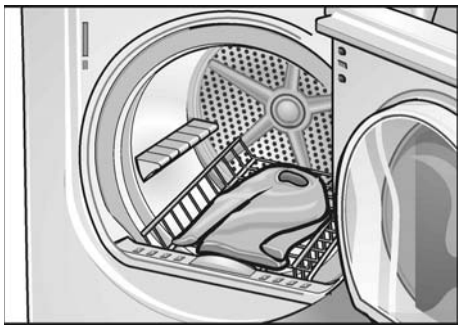


5. Place the dryer rack so that the catches are inserted at the front in the locating holes.

6. Insert the lint filter.
   The lint filter must be inserted flush with the drum edge!

Drying laundry items on the dryer rack

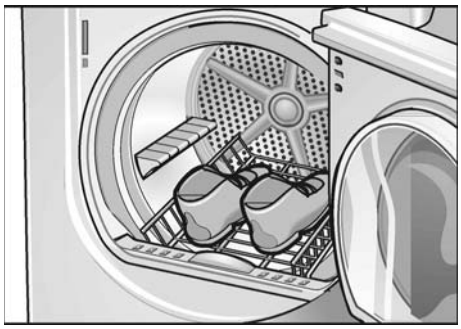
1. Fold laundry to fit the dryer rack.



2. Place laundry loosely on the basket. Do not crush! Laundry must not touch the drum! Do not allow items to hang over the dryer rack!
3. Close the door.
4. Follow directions for time program on next page.

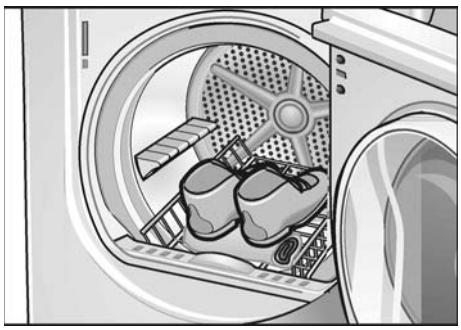
Drying shoes on the dryer rack:

1. Prepare shoes.
   - ❑ Clean shoes to prevent the drum from becoming soiled.
   - ❑ If preparing sports shoes, extend the tongue.
   - ❑ Loosen or remove shoe-laces.
   - ❑ Remove insoles and heel pads.



2. Place shoes on the rack.
   - ❑ Directly on the dryer rack

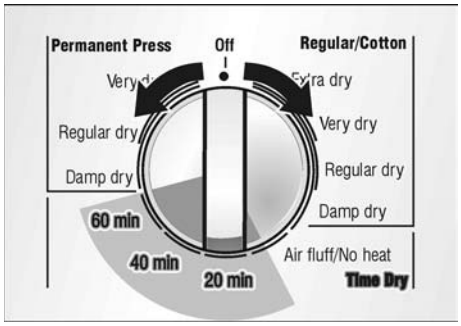
   or



   - ❑ Roll up a towel and place the heels of the shoes on the towel. This will ensure a more uniform drying result.

3. Close the door.

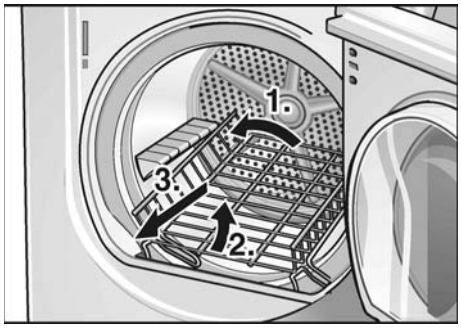
Choose a time program



1. Rotate program selector to “Time dry/.... min.”.
– Select the drying time from the following table according to the laundry type.

Laundry type	Required drying time
Thin woolen pullover (approx. 0,8lbs/350 g)	80 min. (e.g. 60 + 20 min)
Thick woolen pullover (approx. 1,9lbs/850 g)	90–120 min. (e.g. 60 + 40 min)
Skirt	60–90 min.
Trousers	60–90 min.
Small items (e.g. gloves)	30 min.
Shoes	30 min.

2. Press the “**Start**/Stop” button. The “Start/Stop” indicator light illuminates.
3. If the item of clothing still contains residual moisture after the indicated drying time:
   - ❑ Fold the item of clothing so that the damp parts are on the outside.
   - ❑ Restart the program and reduce the drying duration depending on the degree of residual moisture.
4. After drying, spread out the laundry at air for approx. 15 min. (shoes for approx. 30 min.).
5. Remove the lint filter.



6. Take the dryer rack out of the drum.

7. Re-insert the lint filter.

Cleaning and care

Cleaning the dryer

⚠ WARNING ⚠

TO AVOID RISK OF EXPLOSION!
Never use solvents or highly flammable liquids for cleaning.

CAUTION

Incorrect cleaning may damage the dryer. Do not spray with a water jet. Do not use scouring agents or all-purpose cleaners. Do not use steam cleaners.

Wipe the housing and fascia with a soft cloth and soapy water only.
Wipe the drum, door seal and inside of the door with a damp cloth only.

Cleaning the lint filter

A dirty filter extends the drying time and increases energy consumption.
The filter should be cleaned before and after each drying process.
If a warning signal and an E01 warning message are emitted during a drying program, clean the filter immediately and check the exhaust duct.

i The program interrupts automatically.

1. Switch off the dryer. Program selector to “Off”.

⚠ CAUTION ⚠

The inside of the door heats up during the drying process.

2. Open the door.

3. Remove the lint filter.

4. Remove lint by stroking your hand over the filter.

The filter should be lightly scrubbed twice a year with warm soapy water. The filter is cleaned when it no longer holds water. The filter must be dried thoroughly before being replaced.

5. Insert the filter.
6. Close the door.

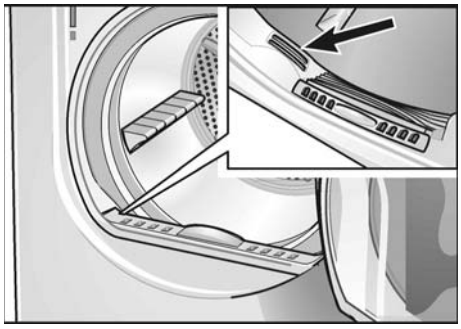
Cleaning the exhaust duct

Inspect and clean the exhaust ducting at least once a year to prevent clogging. A partially clogged exhaust can lengthen the drying time.

- ❑ Turn off the circuit breaker
- ❑ Pull out power supply plug
- ❑ Disconnect the duct from the dryer.
- ❑ Vacuum and reconnect the duct.

Cleaning the moisture sensor

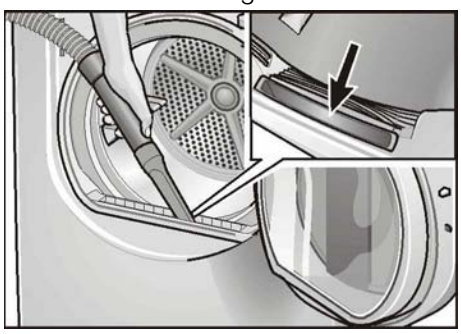
The moisture sensor has to be cleaned because a fine layer of transparent buildup is deposited on the sensors.



This deposit can easily be removed by wiping the sensors (the two bars next to the lint filter) with a cloth and a little white vinegar.
Use white vinegar only!
Clean the moisture sensor once a month.

Cleaning the bearing shield

Over time, fluff from the drying process collects in the bearing shield.

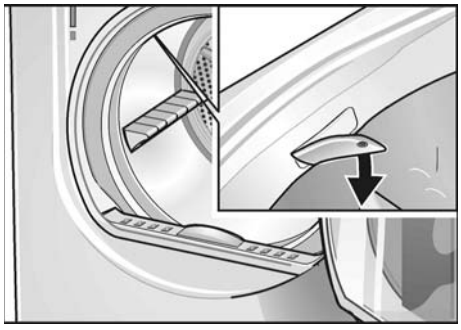


This fluff can be easily removed using your vacuum cleaner, at least once a month.

Change the light bulb

The dryer light turns on inside the drum when you open the door.
To change the light bulb:

- ❑ Set program selector to “Off”.
- ❑ Turn off the circuit breaker.
- ❑ Pull out power supply plug.
- ❑ Open the door and locate the light bulb on the upper left side of the seal.



- ❑ Loosen the screw of the cover and open the cover.
- ❑ Turn bulb counterclockwise. Replace the bulb with a new appliance bulb only (obtainable through parts department).
- ❑ Replace the cover and secure with the screw.
- ❑ Plug in dryer or reconnect power supply.

Troubleshooting

⚠ WARNING ⚠

TO AVOID RISK OF ELECTRICAL SHOCK!
Repairs or replacement of parts may be carried out by authorized technicians only.

Before calling the customer service, check whether you can rectify the fault yourself by means of the following table.

If a fault cannot be rectified or a repair is required:

1. Set program selector to "Off".
2. Turn off the circuit breaker.
3. Pull the main plug out of the socket.
4. Call customer service (see page 20).

Problem	Possible cause	Remedial action
Dryer does not start. "Start/Stop" indicator light does not illuminate.	Main plug not inserted at all or not inserted correctly.	Insert main plug correctly.
	A fuse of power supply has tripped.	Replace/switch on fuse.
	"Start/Stop" button not pressed.	Press "Start/Stop" button.
	No program selected.	Select program.
	Door not closed.	Close door.
	Ambient temperature below 41 °F/5 °C.	Increase room temperature.
Program has been interrupted. A warning signal is emitted and the display shows "E:01".	Lint filter dirty.	Clean filter as described on page 18. Switch off/switch on again.
	Exhaust air duct is blocked or too long.	Clean exhaust air duct. Reduce exhaust air duct to maximum length as described on page 7. Switch off/switch on again.
	Fault in program sequence or malfunction.	Switch off dryer, leave to cool down for 30 min, switch on again. Restart program.
	The room/cabinet is not adequately ventilated.	Provide an adequate supply of fresh air. Switch off/switch on again.
Degree of drying has not been reached or the drying time is too long. Display may indicate "E:03".	Moisture sensor dirty.	Clean moisture sensor as described on page 18. Switch off/switch on again.
	Exhaust air duct is blocked or too long.	Clean exhaust air extraction. Reduce exhaust air duct to maximum length as described on page 7. Switch off/switch on again.
	Lint filter dirty.	Clean filter as described on page 18. Switch off/switch on again.
	Laundry was too wet.	Spin laundry at higher speed in the washing machine. Switch off/switch on again.
	Unsuitable program selected.	Select program with aid of the program selection table (see page 15). Switch off/switch on again.
	Maximum drying time was exceeded.	Clean lint filter (see page 18). Check exhaust air extraction. Spin laundry at a higher speed in your washer.
	Motor limit temperature was exceeded.	Switch off dryer, leave to cool down for 30 min. Switch on again. Start program.
Drum light does not function.	No program selected.	Select program.
	Light bulb defective, light bulb burned out.	Change light bulb, see page 18.
	No power supply.	Guarantee power supply.
	Light bulb is loose.	Tighten light bulb. Remove and reinstall the cover as directed on page 24.
"Start/Stop" indicator light does not illuminate. "Wrinkle block" indicator lights. The display shows "000".	Fault in program sequence or malfunction.	Switch off dryer, leave to cool down for 30 min, switch on again. Restart program.
Lint filter LED is blinking after lint filter has been cleaned	Blinking of lint filter LED is not an indication of a problem. It is used only as a reminder.	No action required. Light will stop blinking.

SERVICE and REPAIR

⚠ CAUTION ⚠

CAUTION – Label all wires prior to disconnection when servicing controls. Wiring errors can cause improper and dangerous operation. verify proper operation after servicing.

The Bosch dryers require no special care other than the care and cleaning noted above.

i If you are having a problem with your dryer, before calling for service please refer to Table on page 19, following.

If service becomes necessary, contact your dealer or installer or an authorized service center. Do not attempt to repair the appliance yourself. Any work performed by unauthorized personnel may void the warranty.

If you are having a problem with your Bosch dryer and are not pleased with the service you have received:

- First, please contact your installer or the Bosch Authorized Service Contractor in your area and explain to them why you are not satisfied. This will usually correct the problem.
- If after working with your installer or service person the problem still has not been resolved to your satisfaction, please let us know by either writing to us at,

  BSH Home Appliances
  5551 McFadden Avenue
  Huntington Beach, CA 92649

or, calling us at

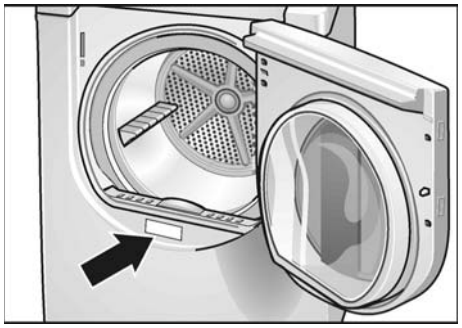
1-800-944-2904.

Please be sure to include, if writing, or have available, if calling, the following information:

- Model Number
- Serial Number
- Date of Original Purchase
- Date Problem Originated
- Explanation of Problem

Also, if writing, please be sure to include a daytime telephone number and a copy of the sales invoice.

You will find the model number and serial number information on the rating plate located on the inside of the front panel.



STATEMENT OF WARRANTIES BOSCH CLOTHES DRYERS

The warranties provided by BSH Home Appliances (''Bosch'') in this Statement of Warranties apply only to Bosch Clothes dryers sold to the first using purchaser by Bosch or its authorized dealers, retailers or service centers in the United States or Canada. The Warranties provided herein are not transferable.

LENGTH OF WARRANTY	SCOPE OF WARRANTY
1 Year Full Limited Warranty From Date of Installation*	Bosch will repair or replace, free of charge, any component part that is proven defective under conditions of normal home use, labor and shipping costs included. Warranty repair service must be performed by an authorized Bosch Service Center.
2 Year Limited Warranty From Date of Installation*	Bosch will provide replacement parts, free of charge, for any component part that is proven defective under conditions of normal home use, shipping costs included, labor charges excluded.
2 Year Limited Warranty on Electronics From Date of Installation*	Bosch will repair or replace, free of charge, any microprocessor or printed circuit board that is proven defective under conditions of normal home use from the date of original installation, labor charges excluded.
2 Year Limited Warranty on Motor From Date of Installation*	Bosch will repair or replace, free of charge, any motor or component part of the motor that is proven defective under conditions of normal home use from the date of original installation, labor charges excluded.
* Date of installation shall refer to the earlier of the date the clothes dryer is installed or ten business days after the delivery date.	

Exclusions

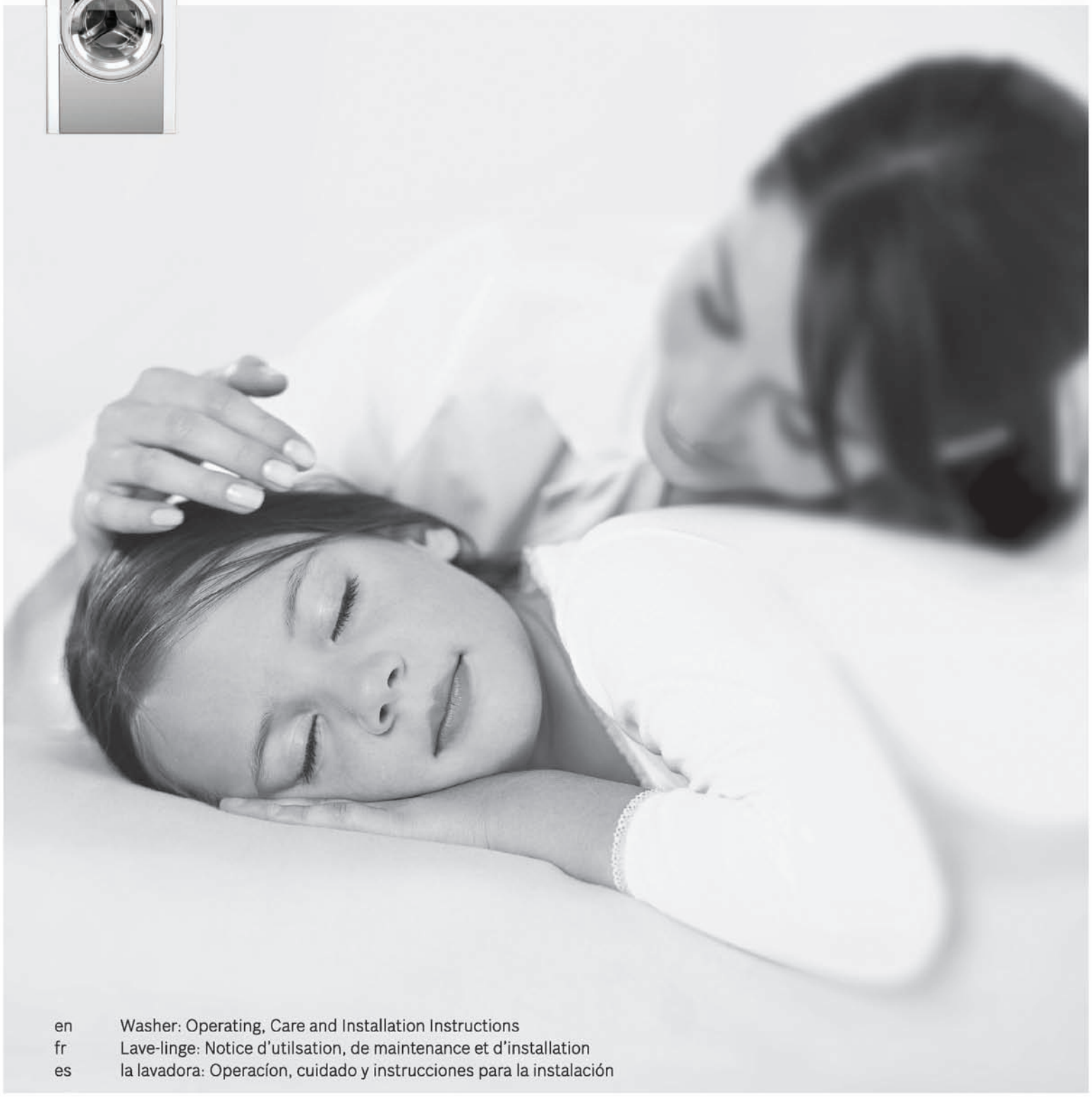
This warranty does not cover service calls or repairs to correct the installation of the clothes dryer, to provide instructions on the use of your clothes dryer, to replace house fuses or correct plumbing or the electric wiring in your home or to repair any clothes dryer that's use was in a manner other than what is normal and customary for home use. In addition, the warranties provided in this Statement exclude any defects or damage arising from accident, alteration, misuse, abuse, improper installation, unauthorized service work, external forces beyond Bosch's control, such as fire, flood, and other acts of God, or installation not in accordance with local electrical and plumbing codes. Labor charges incurred in the repair or replacement of any clothes dryer after a period of one year from date of installation shall not be covered by this warranty. Any and all replaced and/or repaired parts shall assume the identity of the original for purposes of the applicable warranty period. TO THE EXTENT PERMITTED BY LAW, THIS WARRANTY IS IN LIEU OF ALL OTHER EXPRESS AND IMPLIED WARRANTIES, INCLUDING THE IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE. BOSCH DOES NOT ASSUME ANY RESPONSIBILITY FOR INCIDENTAL OR CONSEQUENTIAL DAMAGES. TO OBTAIN WARRANTY SERVICE, CONTACT THE NEAREST BOSCH AUTHORIZED SERVICE CENTER OR CALL 1-800-944-2904, OR WRITE TO:

BSH HOME APPLIANCES CORP.,
5551 MCFADDEN AVENUE

Bosch Nexxt® 500 Plus Series Washer

Models / Modèle / Modelo:
WFMC5301UC, WFMC530SUC, WFMC530RUC

BOSCH
Invented for life



en Washer: Operating, Care and Installation Instructions
fr Lave-linge: Notice d'utilsation, de maintenance et d'installation
es la lavadora: Operacíon, cuidado y instrucciones para la instalación

Features and Benefits of Your New Washer

SENSOTRONIC® Technology

The Bosch **SENSO**TRONIC® technology optimizes the wash process at every stage of the cycle by sensing load size, water level and temperature needs for superior results. Digital sensors care for all fabrics including wool, mohair and silk. This machine virtually operates at the touch of a button.

Exclusive Hinge and Gasket System

A reinforced hinge and a new, revolutionary gasket design keep the door shut. They also seal in the heat, allowing your laundry to reach the optimum temperature, which eliminates even the toughest stains.

3–Part Detergent Dispenser

A 3–part dispenser automatically distributes the appropriate amounts of detergent, bleach and softener at exactly the right times. And, working together with our unique suds sensor, you can be sure your clothing is rinsed completely clean.

XXTRASANITARY™ Cycle

With this innovative cycle, a thermostat–controlled, intelligent sensor heats up the water to 170º F and maintains the temperature for exactly 3 minutes. After killing 99.9% of most common household bacteria, the water temperature is reduced to a gentler 150º F to prevent clothing breakdown. The clothes are thoroughly cleaned and sanitized with no damage to fibers.

KIDSCARE™ Cycle

The littlest people in the house usually account for the toughest stains. This cycle heats the wash water up to 150º F to remove even the most stubborn stains with ease.

Archie Paddles

As your wash gently tumbles, Archie paddles cascade water from high above, rinsing away suds and giving your laundry a complete, even clean. An inclined drum works with them to ensure not a single shirt goes unturned.

Stainless Steel Drum

The Ne**xx**t washer drum has hundreds of smooth double punched holes, which allow your garments to gently tumble completely snag–free.

Internal Water Heater

An Internal Heating Element heats the water to up to 170º F while a Digital Temperature Sensor continually monitors the water temperature. Bosch Nexxt® washers deliver the most efficient and accurate water heating method for each selected fabric type.

Quiet Performance

Bosch laundry appliances use brushless motors, suspended pump systems and special sound–deadening material to keep them exceptionally quiet while in operation. Which means they can be installed virtually anywhere in the home without causing a disturbance.

SYNCRO™ Technology

Manage your washer and dryer times with the **SYNCRO**™ Technology Operation Logic. The Ne**xx**t® Dryers coordinate with the spin speed of the washer, based upon the fabric setting and water temperature of your wash load. Therefore, your wash pile won't stack up as you wait for your dryer to finish its cycle.

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Congratulations!
The new washing machine you just purchased is a modern, high quality domestic appliance.
This modern washing machine cleans your laundry using the most sophisticated washing processes to obtain superior cleaning results.
Excellent engineering and reliability reduces operating costs significantly.
An easy operation philosophy, a variety of customized washing programs and a solid touch and feel makes this appliance a user-friendly assistant in your household.
It offers the following standard features:

- Low noise level for washing and spinning.
- High door with pull-lock (magnetic door lock).
- Door opening 16 inches (41 cm), quality sturdy hinge, opening angle –180°.
- Drum capacity 17.6 lbs (8 kg) for regular cotton.

Each washing machine which leaves our factory has undergone a thorough performance test and is in full working condition. The appliance may contain residual water due to the testing procedures. If you have any questions concerning installation of the washing machine, our customer service will be happy to advise you.
Further information and a selection of our products can be found on our Web site: www.boschappliances.com
Please read and follow these operating and installation instructions along with all other information enclosed with the washing machine.
These operating and installation instructions describe various models. Differences are indicated in the appropriate places.
The illustrations may show different details than your washer.

Definitions

⚠ WARNING ⚠

WARNING – This indicates that death or serious injuries may occur as a result of non-observance of this warning.

⚠ CAUTION

CAUTION– This indicates that injuries may occur as a result of non-observance of this warning.

ATTENTION

ATTENTION – This indicates that damage may occur as a result of non-observance of this warning.

i This symbol is used to draw the user's attention to important matters.

⚠ IMPORTANT SAFETY INSTRUCTIONS

⚠ WARNING ⚠

To reduce the risk of fire, electric shock, serious injury or death when using your washing machine, follow basic precautions, including the following:

1. BOSCH washers are provided with an Operating, Care and Installation Instructions Manual. Read and understand all instructions before using the washing machine.
2. Do not wash articles that have been previously cleaned, washed, soaked, or spotted with gasoline, dry cleaning solvents, other flammable or explosive substances as they give off vapors that could ignite or explode.
3. Do not add gasoline, dry cleaning solvents, or other flammable or explosive substances to the wash water. These substances give off vapors that could ignite or explode.
4. Under certain conditions hydrogen gas may be produced in a hot water system that has not been used for 2 weeks or more. HYDROGEN GAS IS EXPLOSIVE. If the hot water system has not been used for this length of time, turn on all hot water faucets and let the water flow out of each faucet for several minutes before using the washing machine. This will release any accumulated hydrogen gas. As the gas is flammable, do not smoke or use an open flame while carrying out this procedure.
5. Before the appliance is removed from service or discarded, remove the door and the power cord/plug.
6. Do not reach into the appliance if the wash drum is moving.
7. Do not install or store this appliance where it will be exposed to the weather.
8. Do not tamper with the controls.
9. Do not repair or replace any part of the appliance or attempt any service unless specifically recommended in the user maintenance instructions or in published user repair instructions that you understand and have the skills to carry out.
10. Always unplug the washing machine from the power supply before attempting any service. Disconnect the power cord by grasping the plug, not the cord.
11. To reduce the risk of fire, clothes, cleaning rags, mop heads and the like which have been soiled with any flammable substance, such as vegetable oil, cooking oil, petroleum based oils or distillates, waxes, fats, etc., must must be kept away from any source of ignition, including a clothes dryer. These items may contain flammable substances which, even after washing, may smoke or catch fire.
12. Do not machine wash fiberglass materials (such as curtains and window coverings that use fiberglass materials). Small particles may remain in the washing machine and stick to fabrics in subsequent wash loads causing skin irritation.

13. When children become old enough to operate the appliance, it is the legal responsibility of the parents or legal guardians to ensure that they are instructed in safe practices by qualified persons.
14. Do not allow children to play on or with the appliance. Close supervision of children is necessary when the appliance is used near children.
15. Keep pets away from the washing machine.
16. Do not insert/pull out the power plug with wet hands.
17. Do not touch the door if washing at high temperatures.
18. Use caution when draining hot water.
19. Do not climb onto the washing machine and/or lean on the open door.
20. Do not sit or stand on the top of the washing machine.
21. To reduce the risk of fire or electrical shock, DO NOT use an extension cord or an adapter to connect the washing machine to the power supply.
22. The washing machine must only be used for its intended purpose.
23. Always follow the fabric care instructions recommended by the clothing manufacturer.
24. Do not use the washing machine if it has a worn power cord or loose plug. If this is the case, contact an authorized service agent.
25. Make sure that all water connections to the washing machine have shut-off valve(s) that are readily accessible. Close the washing machine water shut-off valve(s) at the end of each wash day.
26. Check the fill hose connections on a regular basis to ensure that they are tight and not leaking.
27. Always read and follow the instructions of the manufacturer of the detergent(s), cleaning aid(s), fabric softener(s) and static eliminator(s) which you are using. Heed all warnings and precautions.
28. Store all laundry chemicals and aids in a cool dry place according to the manufacturers' instructions.
29. To reduce the risk of poisoning or chemical burns, keep all cleaning products out of the reach of children.
30. Do not operate the washing machine if any guards, panels and/or fasteners except transport fixing bolts have been removed.
31. Do not operate the washing machine if parts are missing or broken.
32. Do not bypass any safety devices.
33. To avoid floor damage and mold growth, do not let spills or splashes cause standing water around or under the appliance.
34. Do not operate this washing machine until you are sure that:
    a. the washing machine has been installed according to the INSTALLATION INSTRUCTIONS.
    b. all water, drain, power and grounding connections are in compliance with all local regulations and/or other applicable regulations and requirements.
35. Failure to install, maintain and/or operate the washing machine according to the manufacturer's instructions may result in injury and/or damage.
36. Removing any panel, including the round service panel in the front can expose sharp edges and points, electrical connections and hot surfaces.
37. To avoid damage to the door, do not push against the door when moving the unit. Precautions should be taken to avoid damage to the floor.
38. The water connections should be made and tested before electrical power is applied to the machine.

Notes:

A. The IMPORTANT SAFE-GUARDS and WARNINGS indicated in this manual do not cover all possible conditions which may occur. Common sense, caution and care must be exercised when installing, maintaining or operating the washing machine.

B. Always contact your dealer, distributor, service agent or the manufacturer about any problems or conditions that you do not understand.

GROUNDING INSTRUCTIONS

This appliance must be grounded. In the event of a malfunction or breakdown, grounding will reduce the risk of electric shock by providing a path of least resistance for the electric current. This appliance is equipped with a cord that has an equipment-grounding conductor and a grounding plug. The plug must be plugged into an appropriate outlet that is properly installed and grounded in accordance with all local codes and ordinances.

⚠ WARNING ⚠

Improper connection of the equipment grounding conductor can result in electric shock.
Connect to an individual branch circuit.
Check with a qualified electrician or serviceman if you are in doubt as to whether the washer is properly grounded.
DO NOT modify the plug provided with the appliance – if it will not fit the outlet have a proper outlet installed by a qualified electrician.

KEEP THESE INSTRUCTIONS FOR FUTURE REFERENCE.

In case of change of ownership, manual should be conveyed with the washer.

SAVE THESE INSTRUCTIONS

INSTALLATION INSTRUCTION

Introduction

⚠ CAUTION

TO AVOID RISK OF INJURY
The washing machine is heavy. Lift with caution.

Be sure to observe all listed warnings and cautions.

ATTENTION

Frozen hoses can tear/burst. Do not install the washing machine outdoors or in an area exposed to freezing conditions.

These installation instructions are intended for use by qualified installers. In addition to these instructions, if installing the washing machine:

– In the United States comply with the National Electric Code, ANSI/NFPA70 – latest edition/State and municipal and/or local regulations.
– In Canada comply with the Canadian Electric Code C22.1 – latest edition/Provincial and Municipal and/or local regulations.

If the washing machine is located in a room which will be exposed to temperatures below freezing, or if it is located in a cabin that is being shut down for the winter, any residual water in the pump or water inlet hose(s) **must** be drained.

Take care not to damage the washing machine. Do not hold on to protruding parts (e.g. door) when lifting.

In addition to the safety information listed here, the local water and electricity supplier may have special requirements.

If in doubt, have the appliance connected by an authorized technician.

Information concerning waste disposal

Disposing of the packaging

The shipping package has protected your new appliance on its way to your home. All packaging materials are non–polluting and recyclable. Please contribute to a better environment by disposing of packaging materials in an environmentally friendly manner.

Please ask your dealer or local authority about the best means of disposal.

⚠ WARNING ⚠

Keep children away from shipping carton and packaging components. Danger of suffocation from plastic foil and folding cartons.

Disposing of your old appliance

Old appliances are not worthless rubbish! Valuable raw materials can be reclaimed from environmentally friendly recycling.

⚠ WARNING ⚠

If appliance is no longer usable, pull out main plug, cut off power cord and discard.

To prevent children from locking themselves in the appliance, disable the door lock or remove the door.

Intended Use

Your washing machine is intended:

– For domestic use only.
– For washing machine washable fabrics in washing water.
– For operation using cold and hot (140 °F/60 °C) tap water and conventional additives that are suitable for use in residential washing machines.

Environmental Protection / Conservation Issues

Your washing machine uses water, energy and detergent efficiently, thereby protecting the environment and reducing your household costs.

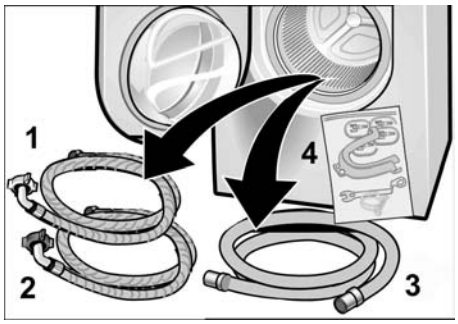
To use your washing machine in an efficient and non polluting manner:

– Avoid using too much detergent.
– Use detergent bearing HE symbol for high efficiency and front loading washers.
– Add detergent according to the degree of soiling, amount of laundry and water hardness, and follow the detergent manufacturer's instructions.

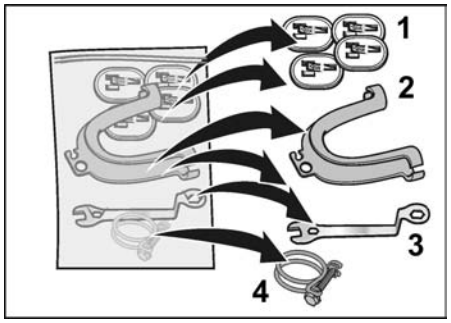
Factory-supplied Equipment

There is a packet of accessory parts supplied with your washer. Check that all the accessory parts supplied for your model are there. If any parts are missing contact your dealer immediately.

The drum contains:



1. Water supply hose for cold water (blue marking).
2. Water supply hose for hot water (red marking).
3. Water drain hose.
4. Accessory parts bag (see below)



The accessory parts bag contains:

1. Covers to be placed over the holes for the transport bolts (after removing them).
2. Elbow for attaching the drain hose, e.g. to a sink.
3. Wrench for leveling.
4. Clamp for drain hose.

Depending on the type of connection, the following may also be required:

– Y-connector (can be obtained from any hardware store) in case there is only a cold water connection available.

Any residual moisture inside the drum is due to the final testing which every washing machine undergoes before leaving the factory.

Connections located on the rear of the appliance:

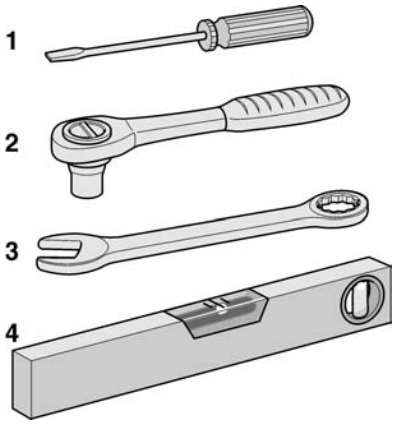
– Power cord with plug.

H = hot water connection
C = cold water connection

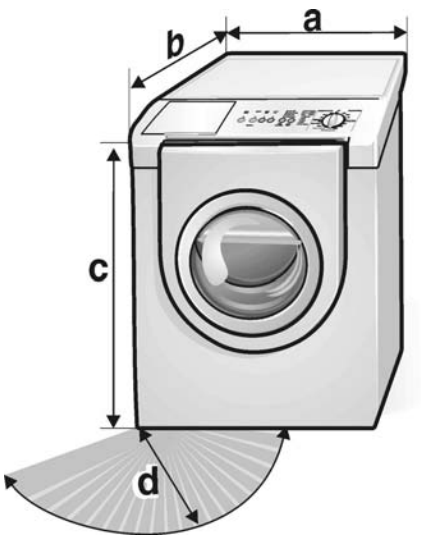
Useful tools

The following tools are helpful:

1. Flat head screwdriver.
2. Socket wrench (1/2" / 13mm).
3. Closed wrench (1/2" / 13 mm).
4. Bubble Level.



Dimensions



a = 27.0 inches (686 mm)
b = 30.7 inches (780 mm)
c = 37.0 inches (940 mm)
d = 16.0 inches (407 mm)
Door opening angle 180°
Approx. weight = 220 lbs (100 kg)

Installation area

⚠ WARNING ⚠

Never ground the washer to plastic plumbing lines, gas lines or hot water pipes.

This appliance must be installed on a solid floor and well leveled due to the higher spin speeds available. If installing the machine on a wood floor over a basement or on a second floor, the floor may need to be reinforced. Sound, vibration, and risk of "walking" will be affected depending on the structure and stability of the floor surface where it is installed.

If the washing machine is to be installed on a weak wood floor consider the following:

- ❑ Soft floor surfaces, such as carpets or surfaces with foam backing, are not suitable. If possible, place the washing machine in a corner of the room.
- ❑ Screw a water resistant wooden board (at least 3/4" thick) to the floor.
- ❑ Secure the feet of the washing machine with holding brackets. Order the holding brackets (set) from Bosch Customer Service (WMZ 2200).
- ❑ Units are not designed to be stacked.
- ❑ Units are not designed for under counter installation

Pedestal Mounting

If mounting the washer on the Bosch pedestal (accessory no.
WTZ1295 for solid white color
WTZ 1295P for duo tone silver
WTZ1295R, for duo tone red
Follow the instructions supplied with the pedestal.

i **Install pedestal prior to removing transport bolts.**

Closet

If installing the washer in a closet, observe the minimum distances according to the following table:

Minimum Installation Clearances

	Closet
Sides	1/4" (6 mm)
Top	12" (305 mm)
Rear	2.5" (64 mm)
Front	1/4" (6 mm)

Ventilation:
Top: 48 sq. in (310 sq. cm),
Bottom: 24 sq. in (155 sq. cm)

Checklist for Installation

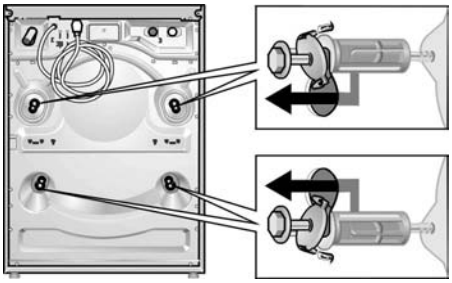
	Page
completely remove 4 shipping bolts	8
move the washer into place	8
connect the water supply line and drain pipe	8
connect the electrical power	10
slide the washer into its final location	11
level the washer as low as possible	11
before first use, run a cleaning cycle	15

Removing the transport bolts

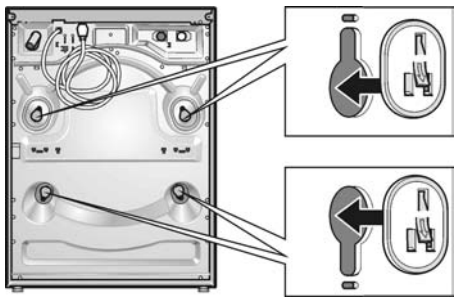
⚠ CAUTION

To avoid possible injury and damage to the appliance and adjacent surfaces, all 4 transport bolts must be removed before using the appliance for the first time and must be retained for any future transport (e.g. when moving).

- ❑ Loosen all four bolts before removing any of the bolts all the way from the unit.
- ❑ Remove the bottom two bolts prior to removing the top two bolts.
- ❑ Loosen the bolts using the closed end of the 1/2" wrench provided. Loosen them until they can be removed freely.
- ❑ The recessed bottom bolts may be more easily removed using a 1/2" (13 mm) socket wrench.



- ❑ Completely remove all 4 transport bolt assemblies (bolt, spring, washer and bushings) by reaching through the open washing machine door and pulling the drum slightly forward to loosen, then pull out from the back.
- ❑ If the bushings do not come out when removing the bolts, place the bolts back into the bushings and carefully try again. It is important to do this with the bolts, otherwise the bushings will not come out properly.
- ❑ To store the bolts for future use, do not remove the bolts from the plastic bushings.

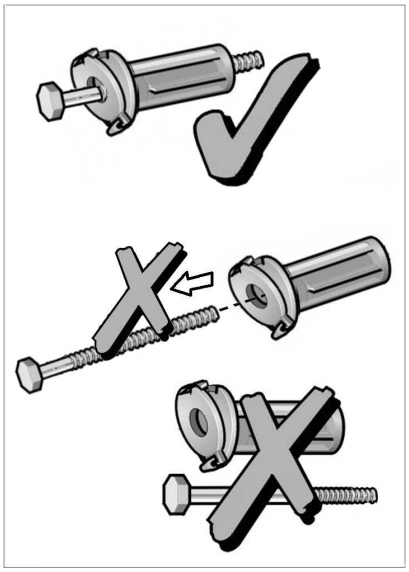


- ❑ Insert the covers until they snap in completely.

Storing the transport bolts

Always keep the transport bolts for future transportation of the appliance (such as when moving out).

- ❑ Store the transport bolts with the washer and bushing attached.



Water connection

Water supply

ATTENTION

The washing machine must only be operated with cold and hot (max. 140 °F / 60 °C) tap water. Do not connect the appliance to the mixer tap of an unpressurized hot-water boiler.

If in doubt, have the water connection installed by an authorized technician.

The water supply hoses must not be:

- Bent or flattened.
- Modified or cut (integrity can no longer be guaranteed).

Observe the water pressure in the supply network:

- The water pressure should be between 14.5 and 145 p.s.i. (1 and 10 bars) when the tap is turned on, at least 2.2 U. S. gallons (8 liters) of water should be discharged per minute.
- A pressure regulator valve must be installed if the maximum water pressure is exceeded.

ATTENTION

To prevent water damage, the hot and cold water valves should be accessible when the washing machine is in place and should always be turned off when the washing machine is not in use.

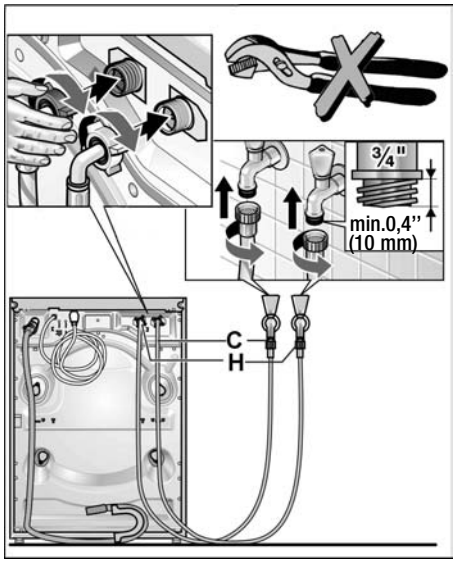
ATTENTION

If installing the washing machine in a new building or a building in which the plumbing system was recently installed or upgraded, flush the lines before installing the washing machine to remove any sand, dirt or residue.

Supply Line Connection

C Cold water connection and
H Hot water connection
(max. 140 °F / 60 °C)

- ❑ Plastic threads must only be tightened **by hand** when connecting the water supply hoses to the back of the unit. Do not remove the strainers from the water supply hoses.



- ❑ After connecting, turn on the water completely, and check that connection points are watertight.

⚠ CAUTION

The connection points are under full water pressure. Check seal with tap fully open.

Water drainage

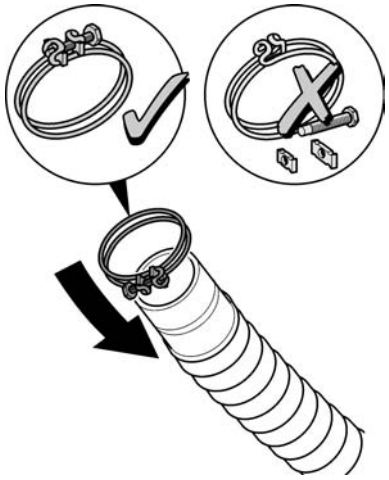
ATTENTION

Do not bend or pull the water drainage hose.

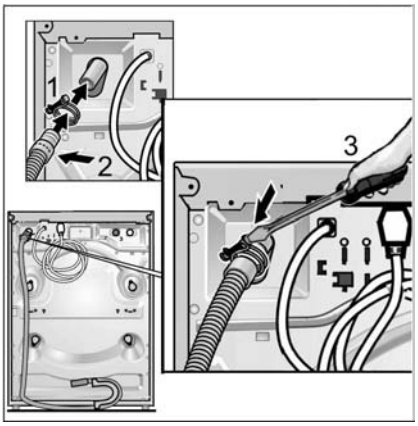
Height difference between the installation location of the washing machine and the drainage point: Maximum 8 feet / 244 cm, minimum 2 feet / 60 cm.

Connecting the water drainage hose

❑ **Do not remove the screw from the clamp assembly.** Loosen the screw only enough so that the clamp will slide freely onto the water drain hose.

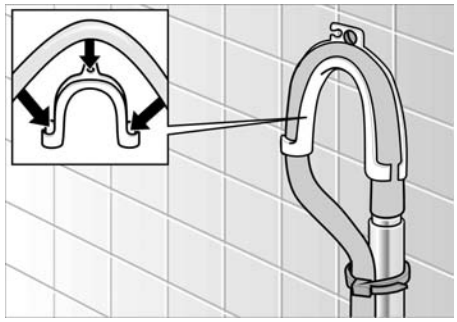


1. Place the hose clamp over the end of the drain hose before attaching the drain hose to the appliance.



2. Attach the drain hose to the drain hose connection on the back of the appliance; position the hose clamp approximately 3/8 inch (9 mm) from the end of the hose.
3. tighten the clamp with a screwdriver

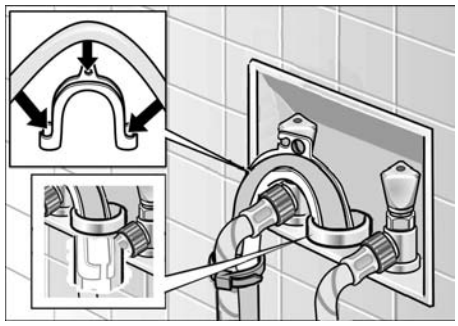
Standpipe Installation



❑ Use the elbow. Attach the elbow to the end of the hose and insert end of hose into standpipe.

❑ Use a strap or cable tie to hold hose in place.

In–Wall Installation

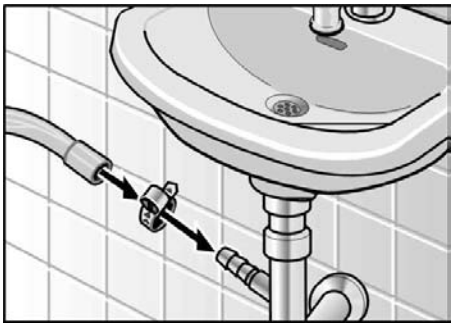


❑ Use the elbow. Attach the elbow to the end of the hose and insert the end of the hose into the wall drain.

❑ The hose and elbow should extend into the open drain pipe as far as the elbow allows when seated as shown in the above picture.

❑ Use a strap or cable tie to hold hose in place.

Drainage into a siphon

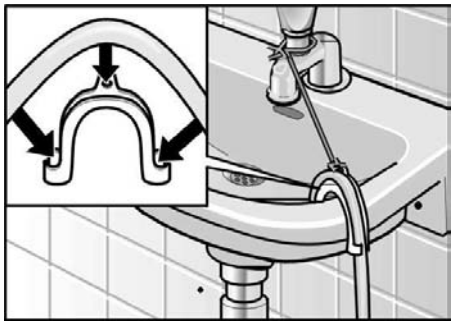


❑ Secure the connection point with a hose clip(not included in factory–supplied equipment).

Drainage into a sink

ATTENTION

Ensure that the plug is not in the drain hole.



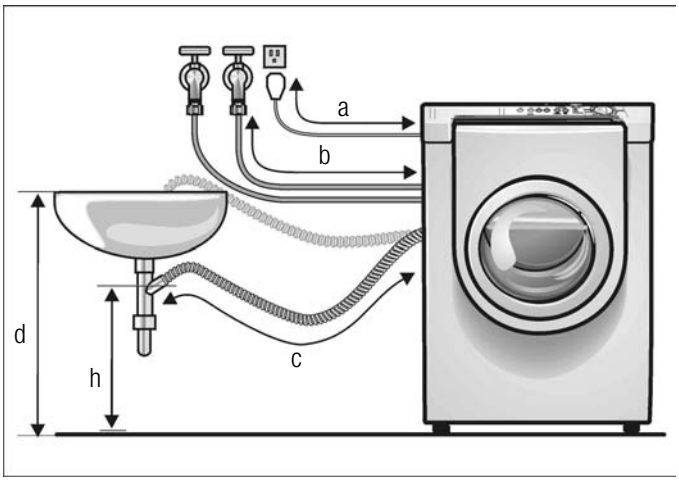
❑ Attach water drain hose securely to sink.

❑ Use a strap or cable tie to hold hose in place.

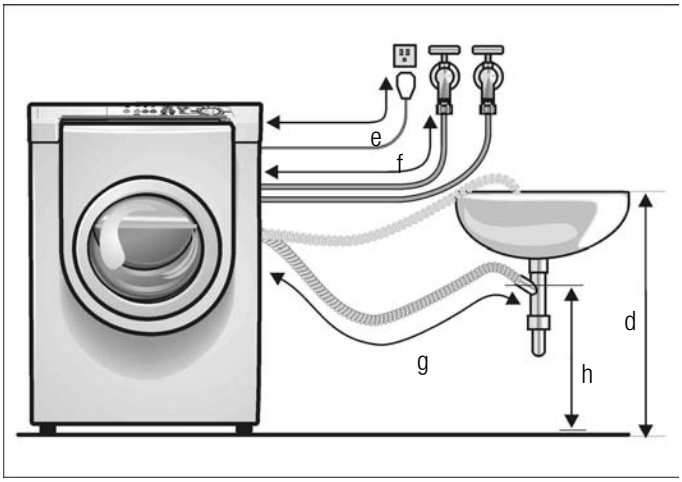
❑ When the water is being drained, check that the water flow out of the sink is adequate.

Hose and cable lengths

Left-hand connection



Right-hand connection



a = 55.0 in. / 140 cm (approx.)
b = 51.0 in. / 130 cm (approx.)
c = 33.5 in. / 85 cm (approx.)
d = 39.0 in. / 100 cm (max.)
e = 69.0 in. / 175 cm (approx.)
f = 34.6 in. / 88 cm (approx.)
g = 55.0 in. / 140 cm (approx.)
h = 24.0 in. / 60 cm (approx.)
h = minimum drain point height

Other hoses

Available from appliance dealers:
– Extended supply hose (approx. 96.1 in. /2.44 m).

Electrical connection

GROUNDING INSTRUCTIONS

This appliance must be grounded. In the event of a malfunction or breakdown, grounding will reduce the risk of electrical shock by providing a path of least resistance for the electric current.

This appliance features a cord with an equipment-grounding conductor and a grounding plug. The plug must be plugged into an appropriate outlet which has been properly installed and grounded in accordance with all local regulations and ordinances.

⚠ WARNING ⚠

Improper connection of the equipment grounding conductor may result in electric shock. Have the appliance checked by a qualified electrician or service technician if you are in doubt as to whether the washer has been properly grounded.

Do not modify the plug provided with the appliance – if it will not fit in the outlet, have a proper outlet installed by a qualified electrician.

⚠ WARNING ⚠

The washing machine must only be connected to an individual branch circuit via a socket which has been properly installed and grounded.

The household electrical voltage must correspond to the voltage specification on the washing machine (rating plate, see page 25).

Connection specifications as well as the required fuses are stipulated on the appliance rating plate.

Volts	Hertz	Amperes	Watts
110–120	60	15	1350 (max.)

Make sure that:
– the power plug fits into the socket.
– the wire size is sufficient.
– the grounding system is properly installed.

The power cord may be replaced by an electrician only.
Replacement power cords are available from Customer Service.

⚠ WARNING ⚠

To reduce the risk of fire or electrical shock, DO NOT use an extension cord or an adapter to connect the washing machine to the power supply.

If an ground fault circuit breaker is to be used, only use types marked with the following symbol: ⎓.
Only this symbol can guarantee compliance with all current regulations.

Do not insert/remove the power plug with wet or damp hands.

Touch the plug only when removing the plug from the socket.

Leveling Procedure

1. The appliance should now be in its final position, ready for leveling (moving the appliance after leveling can make it unlevel again.)

   Each foot of the appliance or pedestal must be placed firmly on the floor to prevent the washing machine from wobbling.

   Start with all four feet screwed in as far as possible, then back individual feet out as necessary to level the washer.

2. Use the bubble level to level the washer front to back and side to side (be sure the level fits between the edges of the washer, and is not elevated at mone end on a ridge on the surface of the washer.)

3. Adjust the leveling of the washer with the four height–adjustable feet. Level the washer as low as possible to heklp reduce vibration.

⚠ CAUTION

TO AVOID RISK OF INJURIES–Take care when using the wrench.

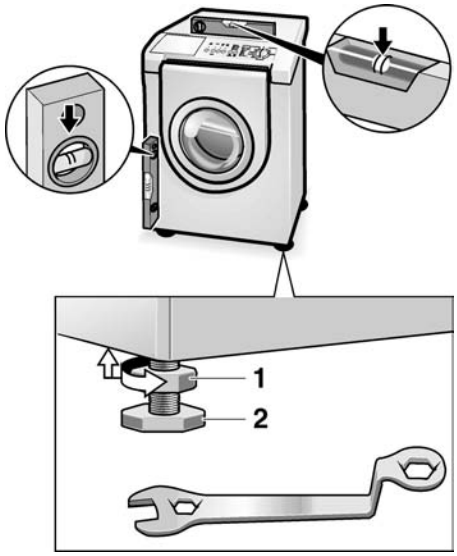
- ❑ Loosen the lock nut **1** (1 on the illustration) by turning it clockwise. Use the wrench provided (or a 5/8" – 16mm open end wrench). When you turn the lock nut, the foot (**2** on the illustration) it is locked against will turn with it. This will extend the height of the foot.
- ❑ Turning the foot out (clockwise) will raise the corner of the washer, turning the foot in (counter–clockwise) will lower the corner of the washer. When the corner of the washer is satisfactorily raised or lowered, lock the height–adjustable feet in place by turning the lock nut counter–clockwise until it locks tightly against the washer housing.

  i It may be necessary to hold the washer foot with a pair of pliers to keep it from turning while tightening the lock nut. It the foot does turn, it will change the height of the corner.

- ❑ After making preliminary adjustments, press down on each corner of the washer to make sure the unit does not wobble. If it does wobble, lower the foot on that corner until the foot touches the floor firmly.

4. Use a bubble level (24" or less in length) to check the leveling status of the appliance.

   - ❑ Lay the bubble level across the unit worktop to check the level from side to side and from front to back.
   - ❑ A center–located bubble indicates the unit is leveled. Otherwise, repeat the leveling procedure until the unit is leveled. Tip: if the bubble is closer to one end, it indicates the high side of the unit. To level the unit, either lower the higher side or raise the lower side.
   - ❑ After leveling the unit from side to side, then turn the level so that it lays on the worktop from front to back to also check the level in that direction.



5. Fine tune the leveling by placing a small load of laundry in the machine, starting it in spin cycle and then leveling the washer again.

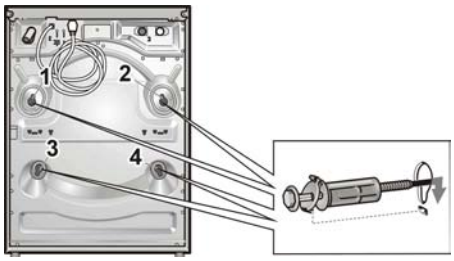
i If the test spin cycle is manually stopped before its completion, then the door may remain locked for 10 seconds.

Transport, such as when moving out

Before transporting the washing machine:

- Turn off the water.
- Disconnect the washing machine from the power outlet.
- Dismantle the supply and drainage hoses.
- Install the transport bolts.

Preparing and inserting the transport bolts

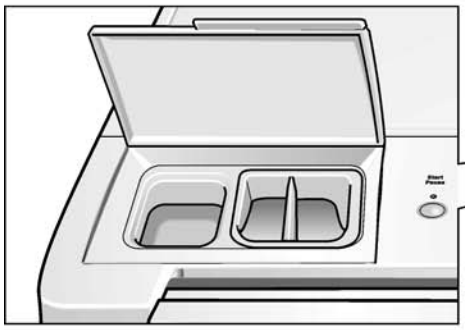


- ❑ Remove the covers.
- ❑ Prepare the transport bolts: Loosen the screw in the sleeve until the end of the screw is level with the end of the sleeve.
- ❑ Insert and tighten all transport bolts. Make sure that the tab on the transportation bolt is inserted in the slot on the washing machine back panel.

OPERATING INSTRUCTION

Your new washer

Filling laundry detergent and/or additives into dispensers



Open the door (colored marking) ...

...and close the door

⚠CAUTION The access panel located on the bottom right of the washer is for Service Access and is only to be opened by an Authorized or Qualified Service Technician.

Panel

Buttons for additional options
(in addition to the program if required)

ECO e: Reduces the amount of energy used for the washing program.

Rinse Plus: Additional rinsing cycle.

Heavy duty: Increased wash time for heavily soiled loads.

Additional options can be combined at any time.

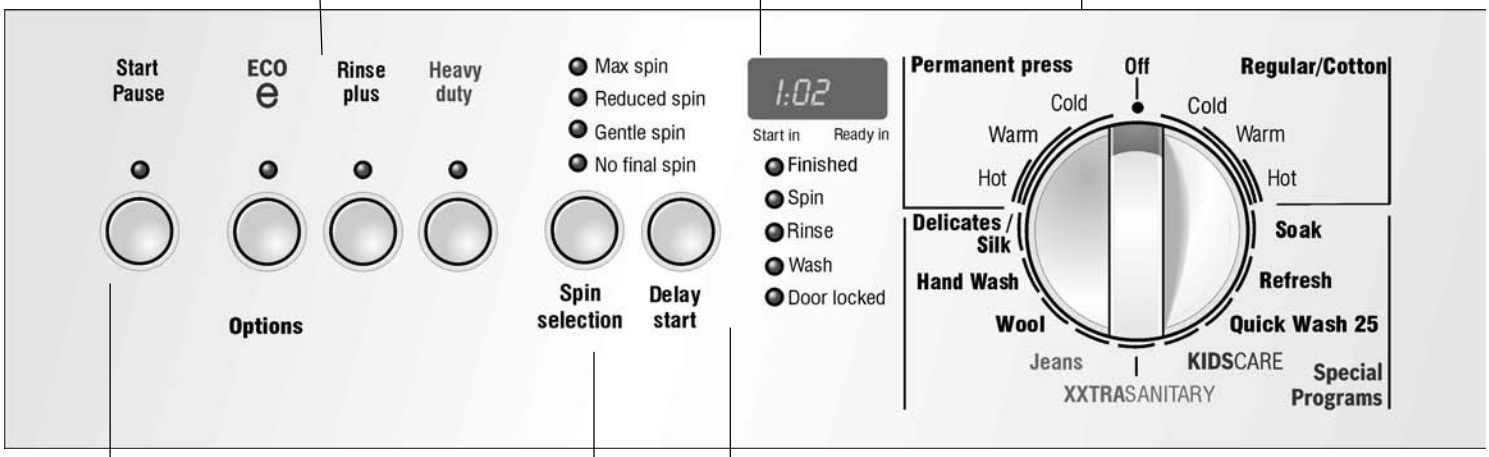
Additional option selected:
Indicator light is lit red.

Switch off additional option:
Press button again. Indicator light turns off.

Display
The **Ready in** time is displayed, if a program is selected.
The **Start** time is displayed, if this function is additionally selected.

Program selector
Switches the machine on and off and selects the program. Can be turned in both directions.

The program selector does not turn while the program is running – the program sequence is electronically controlled.



Start/Pause button
Starts or interrupts the washing cycle (program must first be selected).

Indicator light
Indicator light flashes red: Settings can be changed, the wash cycle can be started, door is locked for reasons of safety or program is in "Pause" mode.

Indicator light is lit red: Program is running and "Pause" can be activated.

The indicator light is off: Program is finished or no program selected.

Indicator lights
The **door locked** lights up if a program is selected and the **Start** button is pressed.
The **wash**, **rinse** and **spin** lights up if the respective program segment runs.
The **finished** lights up if the program has ended.

Indicator lights flash: Operation error!

Delay Start button
The **Start** time can be delayed by hours up to a maximum of 19 hours (if required).
The display shows the **Delay Start** time.

Spin Selection button
For changing the spin speed (if required). The indicator light of the selected spin speed is lit red.

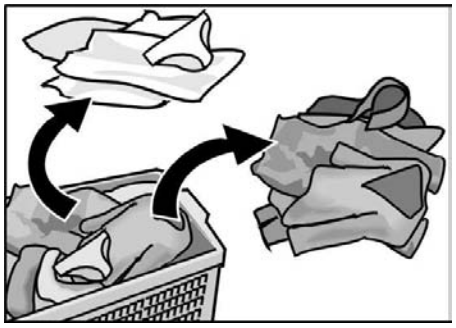
Summary of instructions

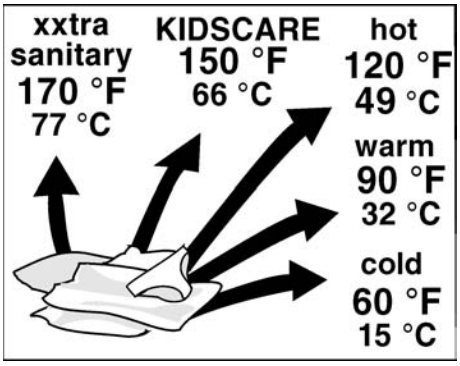
Before using

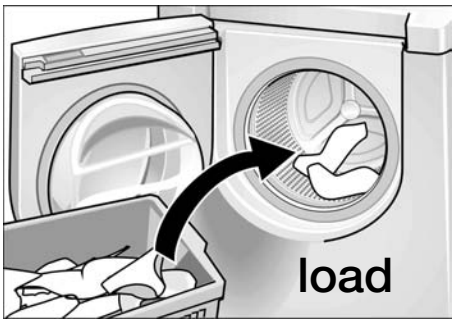
⚠ **Warning**

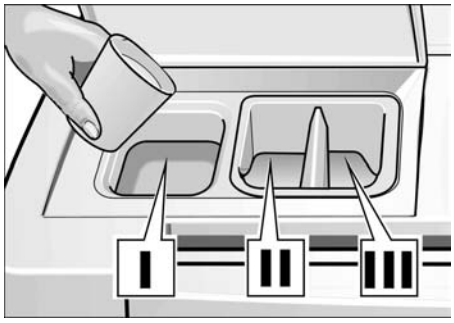
Before using your washing machine, read and follow all installation and operating instructions.

Preparing the laundry

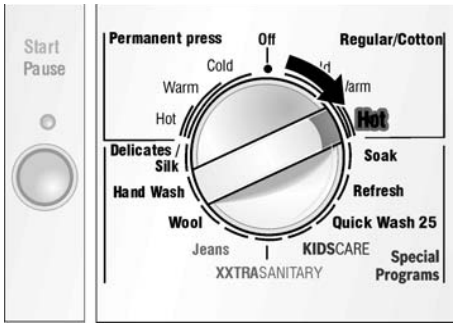






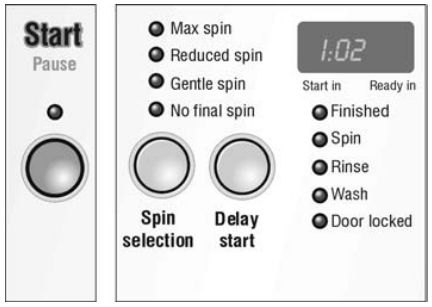


Select a cycle and start the machine

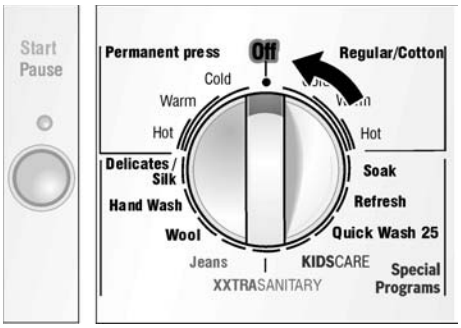


Select desired settings

press start



After washing



Before Using For the First Time

The washing machine must be installed and connected properly (refer to Page 6).

Before using your washing machine for the first time:

- ❑ Make sure that the supplied voltage is the same as the voltage shown on the rating plate.
- ❑ Check that the water valves for the washing machine have been connected correctly and are open.

Using For the First Time

First washing cycle (without laundry)

Your appliance was tested before leaving the factory. To ensure a fresh wash with your initial load of clothes, run the washer a complete cycle, without clothes, in advance.

- ❑ Do not load any laundry.
- ❑ Turn on the water tap.
- ❑ Open the flap of the detergent dispenser.
- ❑ Pour approx. 1 quart (1 liter) of water into the detergent chamber **I**; see Page 16.
- ❑ Pour 1–2 Tbsp. detergent into detergent chamber **I**.

i Do not use special detergents for delicates or wool (this will cause excessive sudsing).

- ❑ Close the flap of the detergent dispenser.
- ❑ Close the door.
- ❑ Set the program selector to **Regular/Cotton Hot.** The **Start/Pause** indicator light flashes red.
- ❑ Press the **Start/Pause** button. The program starts. The indicator light is on (red).

i The display shows the run time of program.

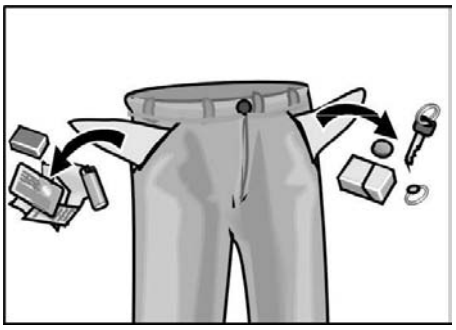
When the display shows "0:00":

- ❑ Open the door.
- ❑ Turn the program selector to **Off**.

Preparing the laundry

ATTENTION

Loose debris (coins, paper clips, nails and other hard objects) can damage items of clothing as well as parts of the washing machine (e.g. drum).



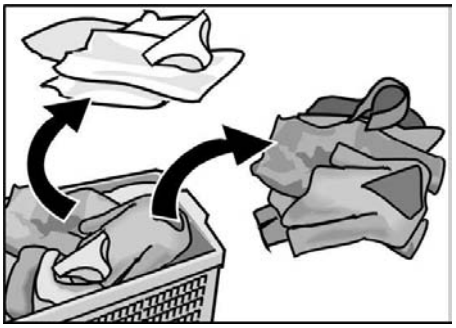
- ❑ Empty all pockets.
- ❑ Brush off lint and dirt.
- ❑ Close zippers, button up duvets and hooks.
- ❑ Remove curtain rings or tie them up in a net bag.
- ❑ Remove pins, buttons, buckles and other hard objects to avoid scratching the washer interior.
- ❑ Remove non-washable trim and ornaments.
- ❑ Turn synthetic knitwear inside-out to avoid pilling.
- ❑ Treat spots and stains.

To prevent loss or damage to laundry and the machine, the following items should be washed in a mesh laundry bag:

- ❑ Baby socks (small items)
- ❑ Hosiery
- ❑ Belts
- ❑ Underwired bras (directly washed in the washer, the wire may come loose during wasing and cause damage)

Sorting the laundry

According to color and degree of soiling



ATTENTION

Items of clothing may become discolored. Never wash new multi-colored items together with other items.

White items may become gray. Always wash white and colored items separately.

Degrees of soiling

Slight dirt

No recognizable dirt or staining. Laundry may have some body odor.

- – Light summer clothing.
- – T–shirts, shirts and blouses that have been worn for up to one day.
- – Bed linen and guest towels that have been used for one day.

Normal dirt

Visible dirt and/or some light recognizable staining.

- – T–shirts, shirts and blouses that are very sweaty or have been worn several times.
- – Dish towels, hand towels and bed linen that have been used for up to one week.
- – Sheer curtains (without smoke staining) that have not been washed for up to 6 months.

Intensive dirt

Dirt and/or staining recognizable.

- – Kitchen hand towels that have been used for up to one week.
- – Cloth napkins.
- – Bibs.
- – Children's outer clothing or sportswear with grass and soil stains.
- – Working clothes such as overalls or baker's and butcher's coats.

Typical stains

- – Body oils, cooking oils/grease, sauces, mineral oil, wax (containing fat/oil).
- – Tea, coffee, red wine, fruit, vegetables.
- – Blood, egg, milk, starch (containing protein/ carbohydrate).
- – Soot, soil, sand (pigments), red clay.

Removing stains

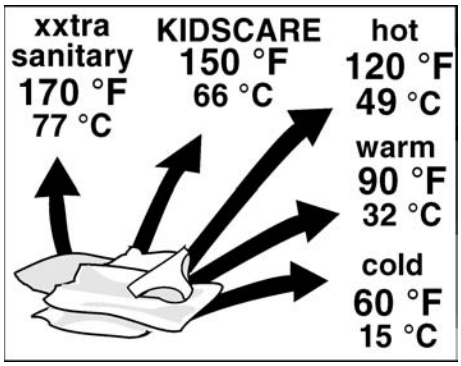
If possible, pretreat stains while they are still fresh.

First, dab soapy water onto the stain. Do not rub.

Subsequently, wash the items of clothing using the appropriate program.

Occasionally, several wash cycles may be required in order to remove persistent, dried on stains.

Sorting laundry according to care label specifications



Fabric Types

Machine Wash, Cottons
Machine Wash, Permanent Press
Machine Wash, Delicates
Hand Wash

Temperatures

Cold
Warm
Hot

Do not wash clothes in washing machine if the care label says “Do Not Wash” or the DO NOT WASH symbol is on the care label.

Loading the laundry

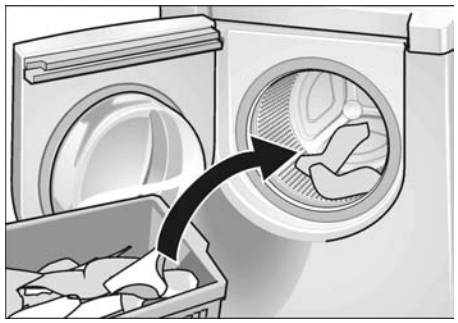
⚠ WARNING ⚠

TO AVOID EXPLOSION HAZARD!
Items of clothing that have been pretreated with solvent-based cleaning agents, e.g. stain remover and dry cleaning solvents, represent an explosion hazard once loaded into the washing machine. Therefore, these items must first be rinsed thoroughly by hand.

ATTENTION

Loose debris in the washing machine drum can damage the laundry. Before loading the laundry, check that there is no debris in the drum.

❑ Open the door.



❑ Unfold the sorted items of clothing and place them loosely into the drum. Mix up large and small items. Items of varying size will distribute better during the spin cycle.

i Do not exceed the maximum load. Overloading will cause poor wash results and increase wrinkling.

For best results it is recommended to load the drum depending on the fabric type, see special programs Page 17 for information on bulky items, e.g. comforters :

Full Load
Cotton and Linens

½ Load
Permanent Press, Synthetic Blends and Knitwear

⅓ Load
Wool, Delicates, Silk

i **Close the door.**
Do not trap any items of clothing between the door and rubber seal.
Door should be able to close easily, not by force.

Laundry Detergents and Additives

Dispensing the correct amount of detergent

⚠ WARNING ⚠

TO AVOID RISK OF POISONING!
Keep detergents and additives out of the reach of children.

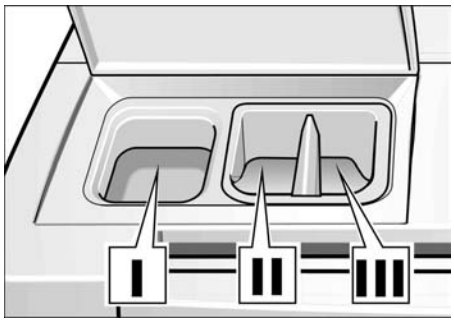
Measure out the detergent (powder or liquid) according to:

– The water hardness. This information can be obtained from your local water authority. Soft water requires less detergent.
– The amount of laundry.
– The degree of soiling. Information on soiling can be found on Page 15.
– The specifications of the detergent manufacturer. Measuring the correct amount of detergent relieves the strain on the environment and ensures optimum washing results.

Too little detergent:
The laundry is not cleaned properly and will eventually become gray and stiff. Grayish brown spots (fat globules) may appear on the laundry. The heater may calcify.

Too much detergent:
Not environmentally friendly, excessive suds reduce wash agitation producing poor washing and rinsing results or may prevent proper spinning.

Filling laundry detergent and/or additives



❑ Open the flap of the detergent dispenser.
❑ Add the detergent and/or additive.

Dispenser **I**:
Dispenser for detergent, stain remover.

i **We recommend HE detergents because they are particularly designed to deliver optimum performance from your front–loading washer. Not using HE detergent could cause problems such as oversudsing, extended cycle periods, or a decrease in wash performance.**

Dispenser **II**:
Cleaning additives, e.g. fabric softener, fabric conditioner. Do not fill over edge of max line!
Dispenser **III**:
Dispenser for liquid bleach (chlorine bleach, color safe bleach).
Do not overfill!

i Concentrated or thick fabric softener, conditioner and powder–bleach must be diluted with a little water before being poured into the dispenser (prevents overflow due to obstruction).

i Bleach may cause discoloration of the washer's colored surface. Therefore, it is important to keep the bleach away from the colored surface of your washer. If any bleach spills on the surface, use a moist paper towel to thoroughly clean it immediately.

i Close the flap of the detergent dispenser. **Please ensure the lid is entirely closed.**

Decolorizing

ATTENTION

Dyes may contain sulphur or chlorine. These substances may cause parts of the washing machine to corrode. Do not dye items of laundry in the washing machine.

Programs and Functions

Cycle time will vary depending on cycle selected, temperature and pressure of incoming water, water hardness, size of load, type of fabrics and distance of unit from the drain.

The maximum spin speeds of the programs are dependent upon the cycle. For adjusting the spin speed, see page 18.

Basic programs

Regular/Cotton Hot
Normally and/or heavily soiled colorfast fabrics. Sturdy, hard wearing items made of cotton or linen such as work clothes and underwear.

Regular/Cotton Warm
Lightly and/or normally soiled non-colorfast fabric. Sturdy, hard wearing items made of cotton or linen such as jeans, T-shirts and sweatshirts.

Regular/Cotton Cold
Lightly soiled non-colorfast fabric. Sturdy, hard wearing items made of cotton or linen (colors that may bleed or fade).

Permanent Press Hot
Items consisting of normally soiled colorfast cotton, permanent press, linen, synthetic or blended fabrics and outer garments. Clothes requiring a special tumble sequence and spin speed to minimize creasing.

Permanent Press Warm
Items consisting of lightly and/or normally soiled non-colorfast cotton, permanent press, linen, synthetic or blended fabrics and outer garments. Clothes requiring a special tumble sequence and spin speed to minimize creasing, such as blouses, shirts and overalls.

Permanent Press Cold
Items consisting of lightly and/or normally soiled non-colorfast cotton, permanent press, linen, synthetic or blended fabrics and outer garments. Clothes requiring a special tumble sequence and spin speed to minimize creasing.

Special programs

Delicates/Silk
Delicates/Silks settings are intended for use with delicate easy care items made of cotton, satin, synthetic or blended fabrics and curtains, dresses, skirts and blouses.
Bulky items, e.g. comforters, can be washed with this cycle because of gentle action and additional rinse (automatically added).
No spinning between rinse cycles.

Hand wash
Hand Wash settings are intended for very delicate, easy care items that usually require hand washing.
This cycle has been specifically designed to provide extremely gentle treatment of fabrics.
Silk or other items marked with the "Hand wash" symbol on the care label can be safely washed with this cycle.

Wool
Woolens (machine wash and hand wash).

Jeans
Specially designed for jeans and heavy denims, this progam reduces fading and wrinkling.

XXTRASANITARY
This program was specifically designed to eliminate most common houshold bacterium while providing gentle treatment of fabrics. At the beginning of the washing phase, hot water is introduced and then the internal heating element heats the water to 167ºF–174ºF for a minimum of three minutes. Clothes will be saturated in the hot water long enough to kill most common household bacterium, yet without causing additional wear and tear to the clothes.
Used for heavily soiled and/or stained colorfast fabrics that need to be sanitized, such as, towels, underware, socks, bed sheets, table clothes, etc.

KIDSCARE
For stained, heavily soiled, and hard–wearing fabrics, like children's jeans, sheets, t–shirts.

i Do not wash new multicolored laundry with other laundry together.

Quick Wash 25
For mixed load, e.g. cotton, linen, synthetic materials or blended fabrics, lightly soiled.

Refresh
Program for rinsing unsoiled textiles, e.g. swimwear, and for removing detergent residue from textiles. Ends with a spin cycle.
Spin cycle for spinning wet, hand washed laundry.
Water is drained before and during the spin cycle.

Soak
A cycle for pre-treatment of heavily stained items. The soak cycle lasts 2 hours and ends with a short spin cycle.

Maximum spin speeds of the programs
The indicator light “max spin speed” is lit red.

Revolutions per minute	Program
1100	Regular/Cotton
800	Permanent Press
600	Delicates/Silk
800	Wool
800	Jeans
1100	**XXTRA** SANITARY
1100	**KIDS**CARE
1000	Quick Wash 25
1100	Refresh

Reduced spin
The indicator light “reduced spin” is lit red only if you have selected a reduced spin speed for gentle treatment of your laundry.

Gentle spin speeds
The indicator light “Gentle spin speed” is lit red.

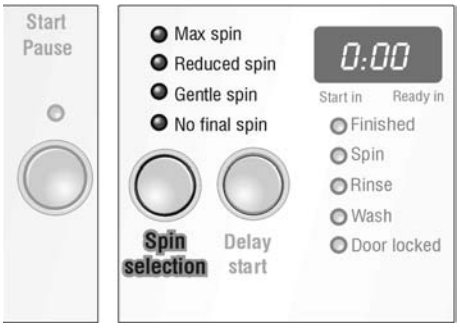
Revolutions per minute	Program
400	Hand Wash
400	Soak

No final spin
The indicator light “no final spin” is lit red.

All water is drained but no spinning occurs.

Modifiers

Spin Selection
Preset cycle setting of max. spin speed can be changed.



Press this button until the desired setting lights up.

Delay Start
Before starting a program you can modify by when the cycle should be started.

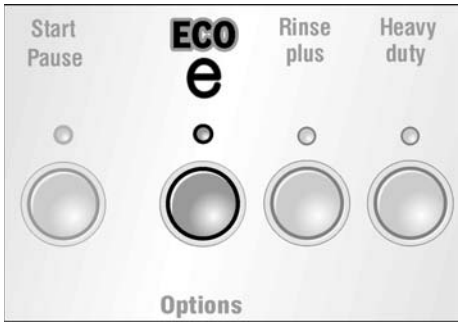
Press **Delay Start** button. The display shows the start time **0:00.**
The time can be delayed up to a maximum of 19 hours (with 1 hour increments) by pressing the **Delay Start** button repeatedly.
The **Start** time begins running immediately after pushing the **Start/Pause** button. This is indicated by the points between the digits flashing.

i Changes to the **Start** time are possible at any time, press the **Delay Start** button until the new time appears.

i If the program is changed or if the program is interrupted, the preselected **Start** time is also interrupted. The **Ready in** time of the program is displayed. The **Start** time must be reselected.

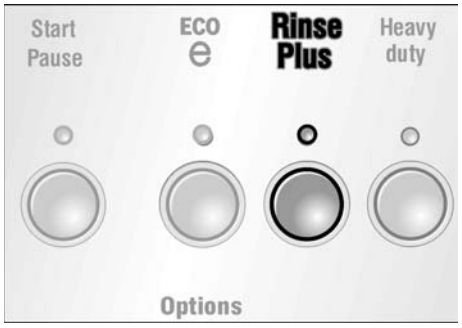
Option buttons

ECO e



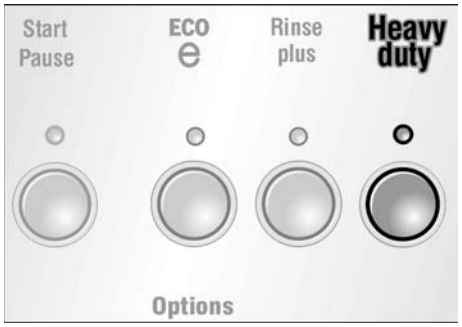
This option reduces the amount of energy used for the washing program by reducing the wash temperature and increasing the washing time. This option is not available for cold programs.

Rinse Plus



When this button is pressed, an additional rinsing cycle will be added to the selected cycle.
Washing cycle time is extended accordingly.

Heavy duty



The Heavy duty option is recommended for use **ONLY for heavily soiled clothes that require the removal of tough, ground–in protien–based stains**. It is **NOT** recommended to use the Heavy duty option with other cycles when laundering normal or lightly soiled clothes.

Washing time is extended.
Only cold water is introduced to the drum. The washing machine then heats the water to the selected wash temperature. By raising the temperature from cold up to the set temperature all components of the detergent are activated in stages for best stain removal and cleaning results.

Acoustic Signal

An acoustic signal indicates program statuses (e.g. start/end of program and operating faults.)
To activate the signal:

❑ Select a program.

❑ Press two of the Option Buttons(e.g. Bleach and Rinse Plus) until a long signal is emitted.

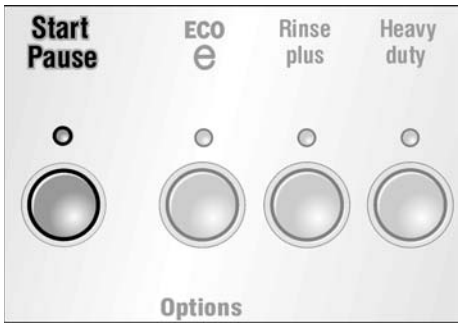
To deactivate the signal:

❑ Select a program.

❑ Press two of the Option Buttons and hold until a short signal is emitted.

i Do not activate/deactivate the acoustic signal during a cycle.

Indicator light above the "Start/Pause" button



The indicator light conveys the following information:

– Indicator light **flashing red:** Program can be started.
– Adding laundry is possible.
– Indicator light is lit **red**. Program is running.
– Adding laundry is not possible because the door is locked for safety reasons.

Laundry may be added after pressing the **Start/Pause** button.

Special features

Auto Load adjust
"Auto Load adjust" adjusts the water and energy consumption for each program and determines the amount of laundry and type of fabrics.
This process is built into your machine and occurs automatically.
This control reduces water and energy consumption when washing small loads.

Unbalanced load detection system
The automatic unbalanced load detection system spins the laundry several times to ensure even distribution.
If the wash load is unevenly distributed, it will not spin (for safety reasons) or the final spin speed is reduced.
In the wool program the appliance will attempt to start the spin cycle only twice in order to prevent shrinking.

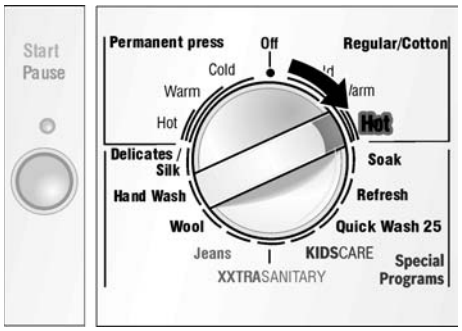
Displayed Time
Due to these and other characteristics of the controls the actual cycle time will vary.
When a program has been selected, the expected program duration is displayed.
The following will effect the displayed time:

– Load size
– Repeated spin attempts to evenly distributed load
– Additional rinse cycles if excessive foam occurs
– Water pressure is too low
– Selection of additional options, e.g. "Rinse plus"

i You may notice these effects (more or less time) changes the displayed time when they occur in the cycle. If no options are selected and these effects do not occur, the time indicated will count down until the end of the cycle.

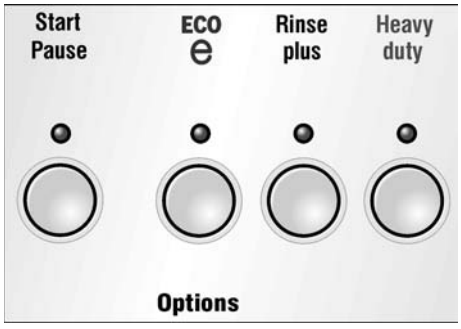
Washing

❑ Turn on the water taps.



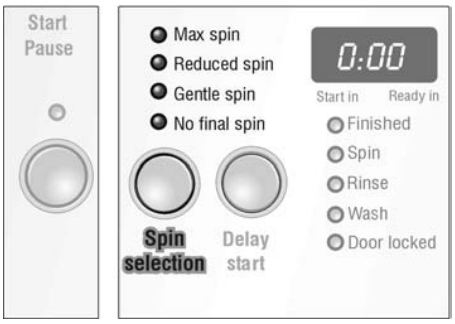
❑ Turn the program selector to the desired program.

❑ Load the washing machine and close the door.
The **Start/Pause** indicator light flashes (red).

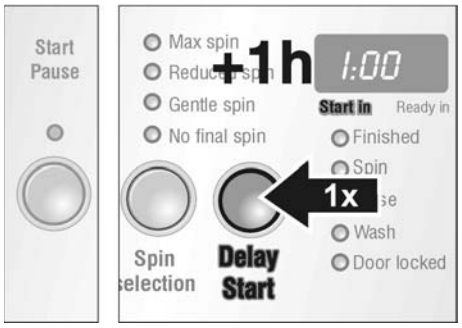


❑ If necessary, press the button(s) for additional option(s).
The indicator light of the selected button is lit (red).

i If an incorrect combination was inadvertently selected, the indicator light of the selected button is turned off.



❑ If necessary, change the spin speed with the **Spin selection** button until the the desired spin speed indicator light is lit.



❑ If necessary, change the **Start** time. Press the **Delay Start** button until the desired **Start** time is displayed.

❑ Press the **Start/Pause** button. The indicator light is lit (red). Display shows the run time of the selected program. The program starts.

i Each program step is indicated by the indicator lights under the display.

During Washing

i **Due to the highly engineered suspension of this appliance, it may experience a shudder or shake when progressing from lower to higher spin speeds. This behavior is normal due to shifting of the drum system and should not cause concern.**

Changing a program

❑ Turn the program selector to **Off**.

❑ Turn the program selector to a newly selected program. The **Start/Pause** indicator light flashes.

❑ If required, change the settings; see from Page 18.

❑ Press the **Start/Pause** button. The program starts.

The indicator light is lit.

Add a garment / Interrupting the program

You can put laundry in the drum after washing begins, take laundry out of the drum early or interrupt the program at any time.

i It is not recommended to add laundry after the washing phase is complete.

i You can add or reduce laundry as long as the **Start/Pause** indicator light flashes (red).

❑ Press the **Start/Pause** button. The **Start/Pause** indicator light flashes.

❑ Open the door.

❑ Place/remove the laundry.

❑ Close the door.

❑ Press the **Start/Pause** button. The program continues. The indicator light is lit (red).

i When the **Start/Pause** indicator light is lit (red), the program can be interrupted, however the door cannot be opened for safety reasons (water level, temperature or speed too high).

i If the spin speed is too high, the **Start/Pause** indicator light is lit (red). Laundry can be added in “Pause” mode when the drum is at a standstill.

Canceling an active program

If you would like to terminate a program and remove the laundry:

i If a program is interrupted at a high temperature, leave the laundry to cool down until the glass is cool to touch.

❑ Turn the program selector to **Off**.

❑ Turn the program selector to **Refresh.**

i Select the desired spin speed (but not **no final spin**).

❑ Press the **Start/Pause** button.

❑ Wait until this program ends.

❑ Open the door.

❑ Unload the laundry.

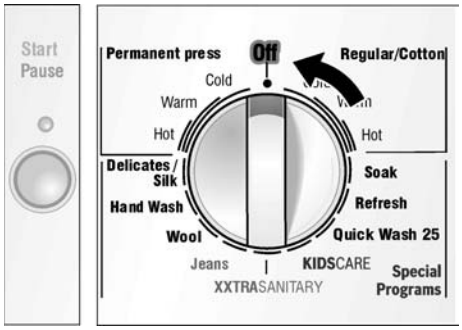
i If a program is interrupted at a high temperature, the door may remain locked until the appliance has cooled down.

i If the program is terminated by switching off the appliance, the door may remain locked.

After Washing

The **Start/Pause** indicator light goes out.
0:00 appears in the display.

❑ Open the door.



❑ Turn the program selector to **Off**.
❑ Close the taps.

❑ Remove the laundry.

i **After washing, leave the loading door ajar to allow the inside of the washing machine to dry.**

Cleaning and Care

Cleaning the washer

⚠ WARNING ⚠

TO AVOID RISK OF ELECTRIC SHOCK!
Always disconnect the appliance from the power outlet before cleaning.
Never clean the washing machine with a pressure washer.

⚠ WARNING ⚠

TO AVOID RISK OF EXPLOSION!
Never use flammable solvents to clean the appliance.

ATTENTION

Occasionally check for any foreign objects (e. g. coins, paper clips) between the drum and rubber seal **–To avoid risk of rust!**

Cleaning the appliance housing and control panel

As required:

❑ Use hot soapy water or a mild, non-abrasive cleaning agent.

❑ Rub dry with a soft towel.

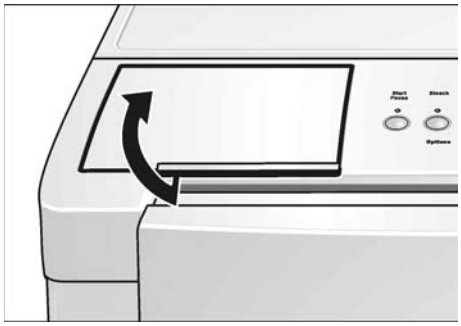
Cleaning the drum

If rust spots have formed due to left-over debris (e.g. coins, paper clips, nails):

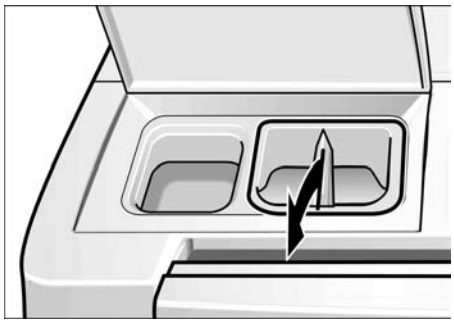
❑ Use a chlorine-free cleaning agent. Follow the manufacturer's instructions. Never use steel wool.

Cleaning the detergent dispenser

If residual detergents or additives have accumulated
or if softener/bleach are not fully rinsed out:

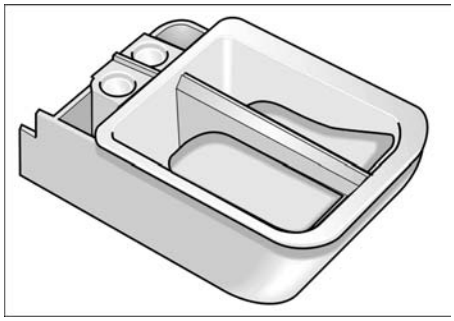


❑ Open the flap of the detergent dispenser.



❑ Pull out the softener/bleach compartment in a vertical direction and remove.

❑ Clean the detergent dispenser under running water. The detergent dispenser can be disassembled into two parts.



❑ Insert the detergent dispenser until it clicks into place.

Cleaning water inlet strainers

This is necessary if very little or no water flows into the washing machine.
First release the water pressure in the supply hoses:

❑ Turn off the water taps.

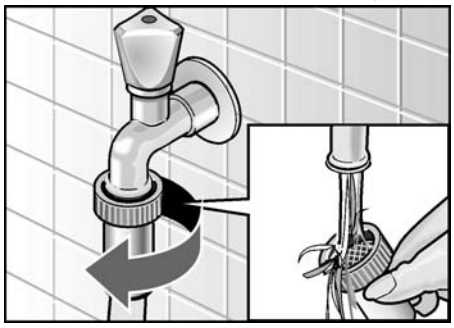
❑ Turn the program selector to any program.

❑ Press **Start/Pause** button and wait approximately ten seconds.

❑ Turn the program selector to **Off**.

Cleaning the strainer(s) on the water tap

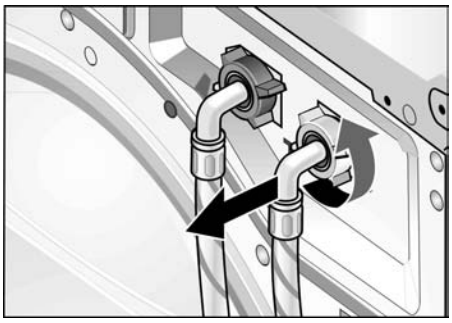
In both the hot and cold water tap:



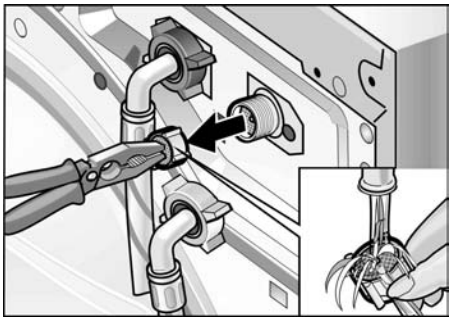
- ❑ Disconnect the hose from the water tap.
- ❑ Rinse the strainer under running water.
- ❑ Reconnect the hose.

Cleaning the strainers on the washing machine

On both the hot and cold water tap:



- ❑ Disconnect the hose from the back of the washing machine.



- ❑ Pull out the strainer and rinse under running water.
- ❑ Insert the strainer and reconnect the hose.
- ❑ Turn on the water taps and check that there are no leaks. If water is leaking, check that the strainer is properly attached.
- ❑ Turn off the water taps.

Cleaning Tips

It is recommended that a small amount of household bleach be run through the washer every 3 months.
With no laundry in the machine, run the machine as follows:

- ❑ Pour 1 cup of bleach in Detergent compartment of the dispenser
- ❑ Run a Regular/Cotton Hot program

Descaling the washing machine

ATTENTION

Descaling agents contain acids which may attack parts of the washing machine and discolor the laundry.

Provided that you use the correct type of detergent, it is not necessary to descale the washing machine.
If white spots, lime or mineral deposits appear on the interior of the washing machine drum you can use a descaling agent to remove them.
However, if the appliance has to be descaled, please follow the instructions provided by the descaling agent manufacturer.

Troubleshooting of Minor Faults

⚠ WARNING ⚠

TO AVOID RISK OF ELECTRIC SHOCK!
Repairs should only be carried out by an authorized technician.

If repairs are necessary, and you cannot eliminate the fault yourself with the aid of the following table:

- ❑ Turn the program selector to **Off**.
- ❑ Disconnect the washing machine from the power outlet.
- ❑ Turn off the water taps.
- ❑ Call Customer Service (refer to Page 25).

Fault	Possible cause	Action
The door cannot be opened.	Power failure.	An interrupted program will be resumed when power is restored. If the laundry is to be removed during a power failure, call Customer Service (refer to Page 25).
	Program is running and/or the door is locked for safety reasons.	Wait until the program ends; see Page 21.
	Plug is loose or not inserted.	Eliminate the cause.
	Program selector turned to **Off** before end of program.	Select a program.
Door cannot be opened, even though the appliance has been switched off and on again.	For safety reasons the door has been locked because the water level, temperature or speed is too high.	See "Add a garment/Interrupting the program", Page 20.
Control lights do not light up.	A fuse has blown.	Reset circuit breaker.
		Call Customer Service if this fault recurs.
	Power failure.	An interrupted program will be resumed when power is restored. If the laundry is to be removed during a power failure, call Customer Service (refer to Page 25).
Program does not start. **Start/Pause** indicator light flashes.	Start/Pause button not pressed.	Press the **Start/Pause** button.
Program does not start. Indicator light "**end**" is lit and display is flashing "**E:01**"	Door not closed properly.	Check whether laundry is trapped in door.
		Close the door (a click should be heard). Program continues.
Spin speed cannot be selected.	Spinning is already in progress; during spin cycle the speed cannot be changed.	Select speed before spinning.
Detergent residue in the detergent dispenser.	Detergent was damp or lumpy.	Clean and dry the detergent dispenser; see Page 21.
		Use the cap of the detergent bottle to measure liquid detergents.
Water does not enter the machine or detergent is not washed away. Indicator light "**spin**" is lit and display is flashing "**E:02**" or **"E:03**".	Water tap(s) not turned on.	Turn on water tap(s) and press **Start/Pause** button. Program continues.
	Supply hose kinked or pinched.	Eliminate the cause.
	Strainers in supply hose clogged.	Clean the water inlet strainers; see Page 21.
	Water pressure too low.	Eliminate the cause.
Water cannot be seen in drum.	This is not a fault. The water level is below the visible part of the drum.	
Indicator light "rinse" is lit and display is flashing "**E:04**" with no water remaining in tub.	Suds or pump is blocked.	Use less detergent for future wash loads. Detergents specifically designed for your High Efficiency washer produce fewer suds and will include the letters "HE" on the packaging. Clean the water drainage pipe and/or drain hose. Run any program to remove the excess suds.

Fault	Possible cause	Action
Water is flowing out from underneath the machine.	The thread of the supply hose is not tight.	Tighten the thread.
	Leak in the drain hose.	Replace the drain hose.
Suds coming out of the detergent dispenser.	Too much soap or non–HE soap used, pump could not remove suds.	Mix 1 tablespoon of fabric softener with 1 pt (½ litre) of water and pour into detergent dispenser **III**.
		Use less detergent for future wash loads. Detergents specifically designed for you High Efficientcy washer produce fewer suds and will include the letters “HE” on the packaging.
Repeated spinning.	This is not a fault. The imbalance compensation system is attempting to balance the load through repeated spins.	Always load the drum with large **and** small items together.
The laundry was not spun.	Large items of clothing have become entangled and could not be distributed evenly in the drum. For safety reasons the high–speed spin cycle was automatically suppressed.	Always load the drum with large **and** small items together.
Program duration extended.	This is not a fault. The suds detection feature has activated an additional rinsing cycle to reduce the amount of suds.	Add a more appropriate amount of detergent.
	This is not a fault. The imbalance compensation system is attempting to balance the load through repeated spins.	Always load the drum with large **and** small items together.
Unsatisfactory washing result.	The degree of soiling was higher than estimated.	Select suitable program or **Heavy duty** as an additional option.
	Not enough detergent.	Add detergent according to the manufacturer’s specifications.
Detergent residue on the laundry.	Some phosphate-free detergents contain water-insoluble residues that may appear as light spots on the laundry.	Brush off spots when laundry is dry.
Gray residue on the laundry.	Dirt accumulation from ointments, fats or oils.	Add the maximum amount of detergent and select the highest permissible temperature.
System shakes or shudders when passing from lower to higher speed spinning.	Drum system suspension can shift during speed up, this is not a failure.	Mix small and large laundry pieces in load to minimize this effect.

If the fault cannot be eliminated with the aid of the above table, switch the appliance off, wait 5 seconds, switch the appliance on again, select and start the program.
If the fault continues, call customer service; see Page 25.

Customer Service

The washing machine requires no special care other than the care and cleaning noted previously. If you are having a problem with your washing machine, please refer to page 23 before calling for service.

If service becomes necessary, contact your dealer or installer or an authorized service center. Do not attempt to repair the appliance yourself. Any work performed by unauthorized personnel may void the warranty.

If you are having a problem with your washing machine and are not pleased with the service you have received:

- ❑ First, please contact your installer or the Authorized Service Contractor in your area and explain to them why you are not satisfied. This will usually correct the problem.
- ❑ If after working with your installer or service technician the problem still has not been resolved to your satisfaction, please let us know either by writing to us at:

  BSH Home Appliances
  5551 Mc Fadden Ave.
  Huntington Beach, CA 92649

or calling us:
1–800–944–2904

If writing or calling, please provide the following information:

- Model Number
- Serial Number
- Date of Original Purchase
- Date Problem occurred
- Explanation of Problem

If writing, please also include a daytime telephone number and a copy of the sales invoice.

You will find the model number and serial number on the rating plate located on the housing and is visible with the door open.

STATEMENT OF LIMITED PRODUCT WARRANTY

What this Warranty covers & Who it Applies to:

The limited warranty provided BSH Home Appliances ("BOSCH") in this Statement of limited product Warranty applies only to the Bosch Nexxt washer ("Product") sold to you, the first using purchaser, provided that the Product was purchased: (1) for your normal, household (non–commercial) use, and has in fact at all times only been used for normal household purposes: (2) new at retail (not a display, "as is", or previously returned model), and not for resale, or commercial use: and (3) within the United States or Canada, and has at all times remained within the country of original purchase. The warranties stated herein apply only to the first purchaser of the Product and are not transferable.

i Please make sure to return your registration card: while not necessary to effectuate warranty coverage, it is the best way for Bosch to notify you in the unlikely event of a safety notice or product recall.

How Long the Warranty Lasts:

Bosch warrants that the Product is free from defects in materials and workmanship for a period of three hundred sixty–five (365) days from the date of purchase. The foregoing timeline begins to run upon the date of purchase, and shall not be stalled, tolled, extended, or suspended, for any reason whatsoever.

Repair/Replace as Your Exclusive Remedy: During this warranty period, Bosch or one of its authorized service providers will repair your Product without charge to you (subject to certain limitations stated herein) if your Product proves to have been manufactured with a defect in materials or workmanship. If reasonable attempts to repair the Product have been made without success, then Bosch will replace your Product (upgrade models may be available to you, in Bosch's sole discretion, for an additional charge). All removed parts and components shall become the property of Bosch at its sole option. all replaced and/or repaired parts shall assume the identity of the original part for purposes of this warranty and this warranty shall not be extended with respect to such parts. Bosch's sole liability and responsibility hereunder is to repair manufacturer–defective Product only, using a Bosch–authorized service provider during normal business hours.

For safety and property damage concerns, Bosch highly recommends that you do not attempt to repair the Product yourself, or use an un–authorized servicer; Bosch will have no responsibility or liability for repairs or work performed by a non–authorized servicer. If you choose to have someone other than an authorized service provider work on your Product, THIS WARRANTY WILL AUTOMATICALLY BECOME NULL AND VOID. Authorized service providers are those persons or companies that have been specially trained on Bosch products, and who possess, in Bosch's opinion, a superior reputation for customer service and technical ability (note that they are independent entities and are *not* agents, partners, affiliates or representatives of Bosch). Notwithstanding the foregoing, Bosch

will not incur any liability, or have responsibility, for the Product if it is located in a remote area (more than 100 miles from an authorized service provider) or is reasonably inaccessible, hazardous, threatening, or treacherous locale, surroundings, or environment; in any such event, if you request, Bosch would still pay for labor and parts and ship the parts to the nearest service provider, but you would still be fully liable and responsible for any travel time or other special charges by the service company, assuming they agree to make the service call.

Out of Warranty Product: Bosch is under no obligation, at law or otherwise, to provide you with any concessions, including repairs, pro–rates, or Product replacement, once this warranty has expired.

Warranty Exclusions: The warranty coverage described herein excludes all defects or damage that are not the direct fault of Bosch, including without limitation, one or more of the following: (1) use of the Product in anything other than its normal, customary and intended manner (including without limitation, any form of commercial use, use or storage of an indoor product outdoors, use of the Product in conjunction with air or water–going vessels); (2) any part's willful misconduct, negligence, misuse, abuse, accidents, neglect, improper operation, failure to maintain, improper or negligent installation, tampering, failure to follow operating instructions, mishandling, unauthorized service (including self–performed "fixing" or exploration of the appliance's internal workings); (3) adjustment, alteration or modification of any kind; (4) a failure to comply with any applicable state, local, city, or county electrical, plumbing and/or building codes, regulations, or laws, including failure to install the product in strict conformity with local fire and building codes and regulations; (5) ordinary wear and tear, spills of food, liquid, grease accumulations, or other substances that accumulate on, in, or around the product; and (6) any external, elemental and/or environmental forces and factors, including without limitation, rain, wind, sand, floods, fires, mud slides, freezing temperatures, excessive moisture or extended exposure to humidity, lightning, power surges, structural failures surrounding the appliance, and acts of God. In no event shall Bosch have any liability or responsibility whatsoever for damage to surrounding property, including cabinetry, floors, ceilings and other structures or objects around the Product. Also excluded from this warranty are scratches, nicks, minor dents, and cosmetic damages on external surfaces and exposed parts; Products on which the serial numbers have been altered, defaced, or removed; service visits to teach you how to use the Product, or visits where there is nothing wrong with the Product; correction of installation problems (you are solely responsible for any structure and setting for the Product, including all electrical, plumbing or other connecting facilities, for proper foundation/flooring, and for any alterations including without limitation cabinetry, walls, floors, shelving, etc.); and resetting of breakers or fuses. **TO THE EXTENT ALLOWED BY LAW, THIS WARRANTY SETS OUT YOUR EXCLUSIVE REMEDIES WITH RESPECT TO PRODUCT, WHETHER THE CLAIM ARISES IN CONTRACT OR TORT (INCLUDING STRICT LIABILITY, OR NEGLIGENCE OR OTHERWISE. THIS WARRANTY IS IN LIEU OF ALL OTHER WARRANTIES, WHETHER EXPRESS OR IMPLIED. ANY WARRANTY IMPLIED BY LAW, WHETHER FOR MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE, OR OTHERWISE, SHALL BE EFFECTIVE ONLY FOR THE PERIOD THAT THIS EXPRESS LIMITED WARRANTY IS EFFECTIVE. IN NO EVENT WILL THE MANUFACTURER BE LIABLE FOR CONSEQUENTIAL, SPECIAL, INCIDENTAL, INDIRECT, "BUSINESS LOSS", AND/OR PUNITIVE DAMAGES, LOSSES, OR EXPENSES, INCLUDING WITHOUT LIMITATION TIME AWAY FROM WORK, HOTELS AND/OR RESTAURANT MEALS, REMODELLING EXPENSES IN EXCESS OF DIRECT DAMAGES WHICH ARE DEFINITIVELY CAUSED EXCLUSIVELY BY BOSCH, OR OTHERWISE. SOME STATES DO NOT ALLOW THE EXCLUSION OR LIMITAITON OF INCIDENTAL OR CONSEQUENTIAL DAMAGES, AND SOME STATES DO NOT ALLOW LIMITATIONS ON HOW LONG AN IMPLIED WARRANTY LASTS, SO THE ABOVE LIMITAITONS MAY NOT APPLY TO YOU. THIS WARRANTY GIVES YOU SPECIFIC LEGAL RIGHTS AND YOU MAY ALSO HAVE OTHER RIGHTS WHICH VARY FROM STATE TO STATE.** No attempt to alter, modify or amend this warranty shall be effective unless authorized in writing by an officer of BSH.

How to Obtain Warranty Service: To obtain warranty service for your Product, you should contact the nearest Bosch authorized service center.

BSH Home Appliances –
5551 McFadden Avenue
Huntington Beach,
CA 92649
1–800–944–2904

STATEMENT OF WARRANTIES FOR BOSCH CLOTHES WASHERS

The warranties provided by BSH Home Appliances (''Bosch'') in this Statement of Warranties apply only to Bosch Clothes washers sold to the first using purchaser by Bosch or its authorized dealers, retailers or service centers in the United States or Canada. The Warranties provided herein are not transferable.

LENGTH OF WARRANTY	SCOPE OF WARRANTY
1 Year Full Limited Warranty From Date of Installation*	Bosch will repair or replace, free of charge, any component part that proves defective under conditions of normal home use, labor and shipping costs included. Warranty repair service must be performed by an authorized Bosch Service Center (excluded cosmetic parts).
2 Year Limited Warranty From Date of Installation*	Bosch will provide replacement parts, free of charge, for any component part that proves defective under conditions of normal home use, shipping costs included, labor charges excluded.
2 Year Limited Warranty on Electronics From Date of Installation*	Bosch will repair or replace, free of charge, any microprocessor or printed circuit board that proves defective under conditions of normal home use for two years from the date of original installation, labor charges excluded.
2 Year Limited Warranty on Motor From Date of Installation*	Bosch will repair or replace, free of charge, any motor or component part of the motor that proves defective under conditions of normal home use for two years from the date of original installation, labor charges excluded.
* Date of installation shall refer to the earlier date the clothes washer is installed or ten business days after the delivery date.	

Exclusions

This warranty does not cover service calls or repairs to correct the installation of the clothes washer, to provide instructions on the use of your clothes washer, to replace house fuses or correct plumbing or the electric wiring in your home or to repair any clothes washer that is used in a manner other than what is normal and customary for home use.

In addition, the warranties provided in this Statement exclude any defects or damage arising from accident, alteration, misuse, abuse, improper installation, unauthorized service work, external forces beyond Bosch's control, such as fire, flood, and other acts of God, or installation not in accordance with local electrical and plumbing codes.

Labor charges incurred in the repair or replacement of any clothes washer after a period of one year from date of installation shall not be covered by this warranty.

Any and all replaced and/or repaired parts shall assume the identity of the original for purposes of the applicable warranty period.

TO THE EXTENT PERMITTED BY LAW, THIS WARRANTY IS IN LIEU OF ALL OTHER EXPRESSED AND IMPLIED WARRANTIES, INCLUDING THE IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE. BOSCH DOES NOT ASSUME ANY RESPONSIBILITY FOR INCIDENTAL OR CONSEQUENTIAL DAMAGES.

TO OBTAIN WARRANTY SERVICE. CONTACT THE NEAREST BOSCH AUTHORIZED SERVICE CENTER OR CALL 1-800-944-2904 OR WRITE TO:
BSH HOME APPLIANCES
ATTN. SERVICE
5551 MC FADDEN AVE.
HUNTINGTON BEACH, CA 92649
BE SURE TO PROVIDE YOUR CLOTHES WASHER MODEL NUMBER, SERIAL NUMBER, PURCHASE DATE , THE SELLER'S NAME AND ADDRESS, DATE PROBLEM OCCURRED, EXPLANATION OF PROBLEM, DAYTIME TELEPHONE NUMBER WHERE YOU CAN BE REACHED AND A COPY OF THE SALES INVOICE.

Dispositifs et avantages de votre nouveau lava–linge

Technologie **SENSO**TRONIC®

La technologie Bosch **SENSO**TRONIC® optimise le processus de lavage à tous les stades du cycle, et ceci au moyen de sondes détectant la charge de linge, le niveau d'eau et la température, et donne d'excellents résultats. Les sondes numériques protègent tous les textiles, la laine, le mohair et la soie. Cette machine fonctionne de facto par simple effleurement d'un bouton.

Système exclusif de charnière & joint

Une charnière renforcée et un joint nouveau, révolutionnaire, maintiennent le hublot bien fermé. Ils retiennent aussi la chaleur prisonnière et permettent à votre linge d'atteindre une température optimale d'éliminer les salissures même les plus rebelles.

Bac à produit lessiviel à 3 compartiments

Un bac à produit lessiviel à 3 compartiments distribue automatiquement les quantités appropriées de détergent, de produit blanchissant et de produit adoucissant exactement aux bons moments. Ce bac interagit avec notre sonde détectrice de mousse, unique en son genre, pour assurer que votre linge soit rincé jusqu'à obtention d'une propreté parfaite.

Cycle **XXTRA**SANITARY™

Pendant ce cycle innovant, une sonde intelligente commandée par thermostat fait chauffer l'eau jusqu'à 170° F et maintient cette température pendant exactement 3 minutes, ce qui tue 99,9% des bactéries domestiques les plus courantes. Ensuite, la température est ramenée à 150° F pour ne pas abîmer le linge. Ce cycle le nettoie et l'assainit en profondeur sans endommager les fibres.

Cycle **KIDS**CARE™

Ce sont habituellement les plus jeunes occupants de la maison qui sont à l'origine des taches les plus tenaces. Ce cycle porte l'eau jusqu'à 150º F pour enlever facilement les tâches même les plus rebelles.

Pales de brassage

Tandis que votre linge est brassé en douceur, les aubes font tomber de l'eau en cascade depuis une hauteur importante, évacuant ainsi la mousse et conférant à l'ensemble du linge une propreté uniforme. Un tambour incliné interagit avec les pales pour assurer que pas une chemise n'échappe au malaxage.

Tambours en acier inoxydable

Le tambour du lave–linge Ne**xxt**™ présente des centaines de trous double perforation à bords arrondis permettant à vos vêtement d'être malaxés en douceur sans risque de s'accrocher.

Chauffe–eau interne

Une résistance chauffante interne porte l'eau à 170° F tandis qu'une sonde thermométrique numérique surveille en permanence la température. Les lave–linge Bosch Nexxt® offrent la méthode de chauffage la plus efficace et la plus précise, pour chaque type de textile sélectionné.

Fonctionnement silencieux

Les lave–linge Bosch font appel à des moteurs sans balais, à des systèmes de pompage suspendus et à des matériaux insonorisants pour qu'ils dégagent extrêmement peu de bruit pendant leur fonctionnement. Ceci signifie qu'il est possible de les installer de facto n'importe où dans la maison, sans qu'ils ne gênent personne.

Technologie **SYNCHRO**™

Gérez vos temps de fonctionnement du lave–linge et du sèche–linge avec le système d'exploitation technologique **SYN**CRO™. Les sèche–linge Ne**xxt**® coordonnent leur action avec la vitesse d'essorage du lave–linge, selon les textiles sur lesquels il a été réglé et selon la température de lavage. Grâce à cette technologie, plus d'accumulation de linge lavé en attente que le sèche–linge finisse son cycle.

Bosch Ne**xx**t™ Laundry Pedestals

Models / Modèles / Modelos: **WTZ1500, WTZ1500S**
WTZ1500P, WTZ1500C

BOSCH
Invented for life

en Operating, Care and Installation Instructions
fr Socle: Notice d'utilsation, de maintenance et d'installation
es Pedestal: Operacíon, cuidado y instrucciones para la instalación

Important Safety Information

Please read and follow these **Installation Instructions** along with all other information enclosed with the pedestal.

Definitions

⚠ WARNING

WARNING – This indicates that death or serious injuries may occur as a result of non-observance of this warning.

⚠ CAUTION

CAUTION– This indicates that minor or moderate injury may occur as a result of non-observance of this warning.

NOTICE

NOTICE – This indicates that damage may occur as a result of non-observance of this warning.

i This symbol is used to draw the user's attention to important matters.

Tools and Parts

Confirm receipt of the following parts and tools in the pedestal drawer:

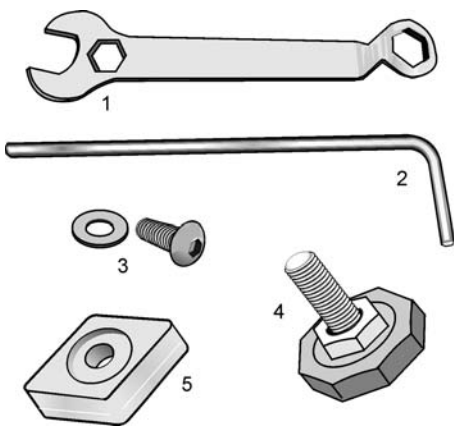


Figure 1

1. 17 mm open end wrench
2. 6 mm Allen (Hex) wrench
3. (4) Socket Head Cap Screws and (4) Flat Washers
4. (4) Height Adjustable Feet
5. (4) Spacers
6. Warranty Card (not pictured)

Before You Start

i **Important: If your appliance is already installed, it MUST be uninstalled before continuing.**

If you need to uninstall your appliance, refer to the **"Operating, Care and Installation Instructions"** provided with your appliance for tools and information required.

⚠ CAUTION

Excessive Weight Hazard

Use two or more people to move and uninstall the appliance. Failure to do so can result in injury.

⚠ CAUTION

Do not lift the appliance by the door or door opening.

Keep the door closed at all times during the pedestal installation.

Preparing Your Appliance

Existing Appliance – If you are installing the pedestal on an appliance that has already been in use, begin with the ***"Preparing Your Existing Appliance"*** section immediately below.

New Appliance –If you are installing the pedestal on a new washer or dryer, proceed to the ***"Preparing Your New Appliance"*** section on the page following.

Preparing Your Existing Appliance

1. Pull the appliance away from the wall so it can be positioned on its left side.

Step 2 below applies to washers. For dryers go directly to step 3.

NOTICE

Make sure the washer transportation bolts are reinstalled prior to pedestal installation to prevent potential damage to the washer drum.

i **Your washer was originally shipped with four transportation bolts installed to protect the drum during transit. The washer installation instructions required these bolts to be removed during the original setup. The transportation bolts must now be reinstalled prior to pedestal installation.**

2. To reinstall the transportation bolts:

   ❑ Locate the four transportation bolt assemblies originally shipped with your washer (see **Figure 2).**

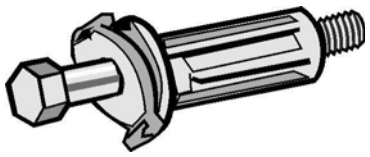


Figure 2

❑ **Remove the four transportation bolt hole covers** on the back of the washer. (1) Push the tab inward with your thumb while (2) sliding the cover in the direction of the two vertical slots in the plastic cover (see **Figure 3**).

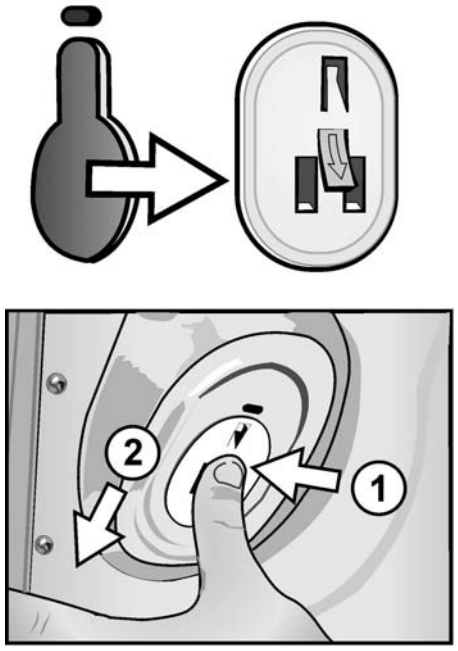


Figure 3

❑ **Insert the bolt assemblies.** Start with the lower left and install all four assemblies going counterclockwise. Align each one into the hole until the plastic bushing is all the way inside the back panel of the washer and the rectangular collar is oriented to fit the slot. This aligns the bolt assembly so the bolt will thread correctly into the drum. Slide the bolt assembly in the direction of the slotted area.

❑ When installing the first bolt assembly, it is necessary to push against the drum with the assembly to allow it to slide into place.

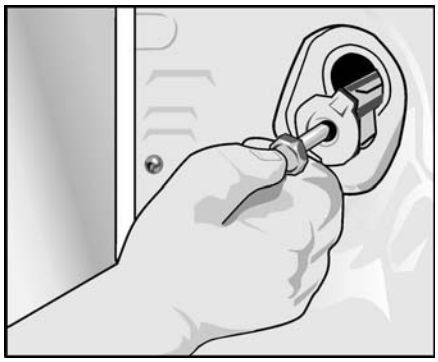


Figure 4

❑ Make sure the tab on the transportation bolt washer is inserted in the slot on the washing machine back panel.

i Do not thread any of the bolts until all four are in place, then tighten each one.

NOTICE

Damage to the drum may result if the plastic bushing is removed from the bolt prior to tightening.

3. Protect the floor and the side of the appliance by laying a sufficiently large piece of cardboard (such as the pedestal carton) or other suitable protective covering flat on the floor to the left of the unit.

   Support the appliance approximately 1 1/2" to 2" off the floor (see **Figure 5).**

   Helpful Hint: Rolled up towels can be used as support.

⚠ CAUTION

When lifting or lowering the appliance onto its side, avoid sliding it against the floor as this may result in injury or damage.

4. Lay the appliance on its **LEFT** side (see **Figure 6**).

   Note for Washers: Slight water spillage may be noticed due to laying washer on its side.

5. Go to the ***"Installing the Pedestal"*** section of this manual.

Preparing Your New Appliance

1. Position the original packaged appliance close to the final location. Using a utility knife, cut the two packaging straps.

NOTICE

If installing the pedestal to a new washer, **do not remove the washer transportation bolts** prior to installing the pedestal.

2. Remove the protective film, four corner supports, and two foam packaging pieces.
3. Protect the floor and the side of the appliance by laying a sufficiently large piece of cardboard (such as the pedestal carton) or other suitable protective covering flat on the floor to the left of the unit.

   Support the appliance approximately 1 1/2" to 2" off the floor.

   Helpful Hint: Place the two corner supports from your appliance packaging (see **Figure 5**).

   If corner supports are not available, items such as rolled up towels can be used.

Figure 5

4. Lay the appliance on its **LEFT** side (see **Figure 6**).

   Note for Washers: Slight water spillage may be noticed due to laying washer on its side.

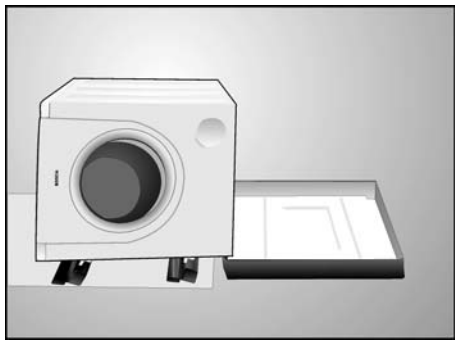


Figure 6

5. Remove the bottom of the packaging.
6. Go to ***"Installing the Pedestal"*** section of this manual.

Installing the Pedestal

⚠ CAUTION

Do not place fingers near the bottom of the pedestal while moving the drawer.

Doing so can result in a cut or pinch injury.

1. Remove the feet originally installed in the appliance (see **Figure 7**). DO NOT reinstall these feet into the pedestal. Retain the feet in case the appliance needs to be reinstalled later without the pedestal.

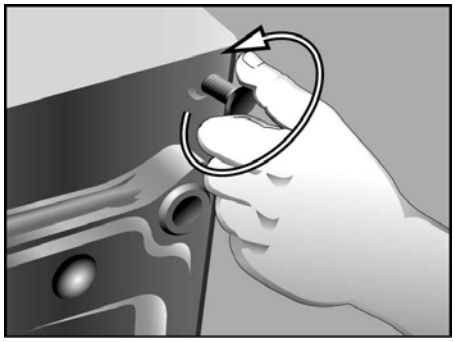


Figure 7

2. Protect the floor and the side of the pedestal by laying a sufficiently large piece of cardboard or other suitable protective covering flat on the floor under the pedestal.

   Remove the drawer from the pedestal by depressing the drawer release levers located in the drawer slide rails. Set the drawer aside.

   Helpful hint: It is recommended to have an assistant hold the pedestal housing during drawer removal.

   Push **up** on the drawer release lever on the **left side** and **down** on the drawer release lever on the **right side** while removing the drawer (see **Figure 8**).

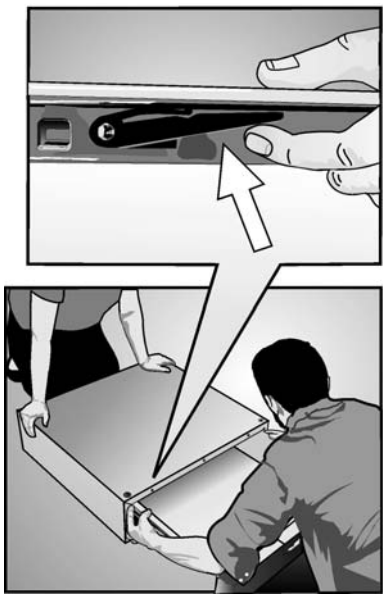


Figure 8

⚠ CAUTION

Excessive Weight Hazard

Use two or more people to install the pedestal. Failure to do so can result in injury.

3. Place the top of the pedestal against the appliance bottom.

   Ensure the pedestal drawer opening and appliance door face the same direction (see **Figure 9**).

   Helpful hint: Foam packaging may be used to help align the pedestal and the appliance.

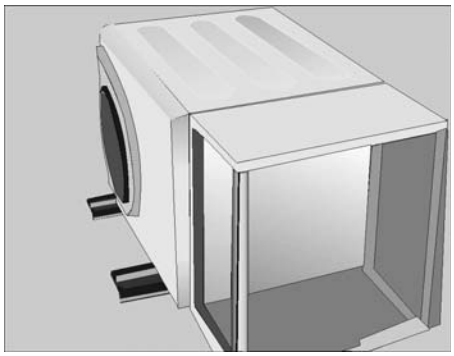


Figure 9

4. Using the 6 mm Allen (Hex) wrench, install the socket head cap screws and flat washers (see **Figure 10).**

   Insert the square spacer between the pedestal housing and the appliance housing. Holding the spacer in place, insert the bolt so it passes through the flat washer, pedestal housing, then the spacer, and into the protruding threaded bushing in the appliance base. Repeat for all four bolts.

   Make sure the webbed side of each spacer is down toward the base of the pedestal. The spacer should fit up against the appliance housing. Align the outer edges of the spacer with the appliance and pedestal housings. Loosely thread all four bolts with the washers and spacers in place before tightening any of the bolts completely.

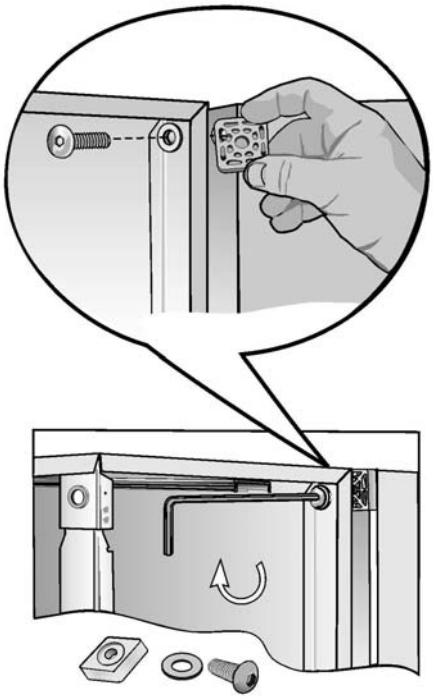


Figure 10

Use the wrench to **HAND TIGHTEN** all screws (see **Figure 10**).

Helpful hint: Do not tighten any screws completely until all are started into their threads.

After all screws are hand tight, use the wrench to tighten an additional 1/3 to 1/2 turn (see **Figure 11**).

Note: Tightening torque for the pedestal screws is a minimum of 10 ft-lb (14 N–m) to 13 ft–lb (18 N–m).

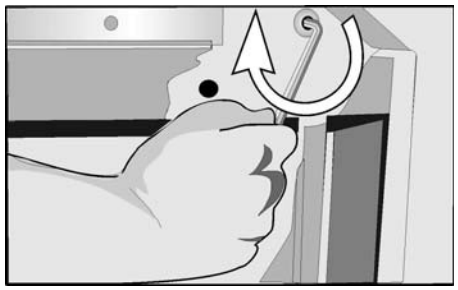


Figure 11

5. Install the four new feet that are included with the pedestal. Screw the feet into the threaded corner holes in the base of the pedestal.

NOTICE

Use only the feet supplied with the pedestal. Do not use the feet that originally came with the appliance.

Using the supplied 17 mm open end wrench, tighten only the two rear feet locknuts against the pedestal housing (see **Figure 12**).

The front two feet should be hand tightened only, so the appliance can be leveled later.

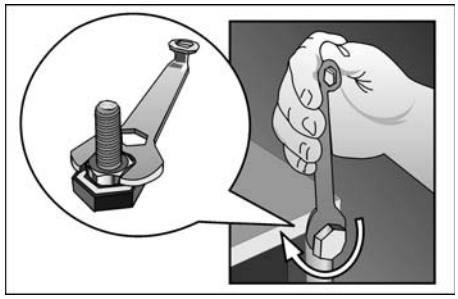


Figure 12

⚠ CAUTION

When lifting the appliance, be careful not to allow it to slide against the floor.

If the appliance slides, it may cause injury or damage.

6. Lift the appliance and pedestal assembly back to an upright position (use of an assistant is required) (see **Figure 13**).

⚠ CAUTION

Avoid holding the appliance by the pedestal when lifting it.

To avoid damaging the pedestal do not use a dolly to lift or move the appliance once the pedestal is installed.

Figure 13

Step 7 below applies to washers. For dryers go directly to step 8.

7. Remove the transport bolts.

⚠ CAUTION

To avoid possible injury and damage to the appliance and adjacent surfaces, all four transport bolts must be removed before using the appliance. Retain the bolts for use in any future transport (e.g. when moving).

- ❑ Loosen all four bolts before removing any of the bolts all the way from the unit.
- ❑ Remove the bottom two bolts prior to removing the top two bolts.

❑ Loosen the bolts using the closed end of the 17mm wrench provided. Loosen them until they can be removed freely.

❑ The recessed bottom bolts may be more easily removed using a 1/2" (13 mm) socket wrench.

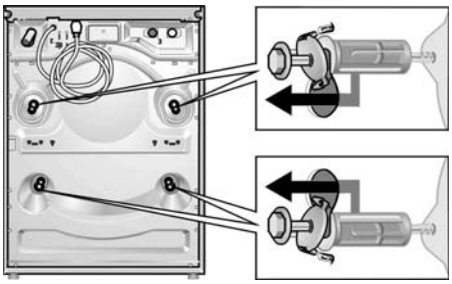


Figure 14

❑ Completely remove all 4 transport bolt assemblies (bolt, washer and bushings) by reaching through the open washing machine door and pulling the drum slightly forward to loosen, then pull them out from the back (see **Figure 14**).

❑ If the bushings do not come out when removing the bolts, place the bolts back into the bushings and carefully try again. It is important to do this with the bolts, otherwise the bushings will not come out properly.

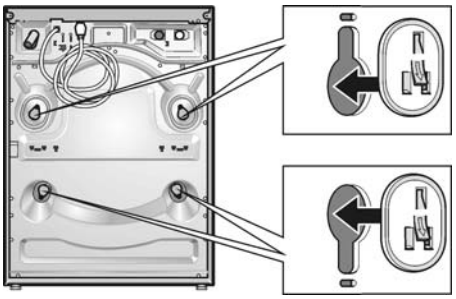


Figure 15

❑ Insert the covers until they snap in completely (see **Figure 15**).

Storing the transport bolts

Always keep the transport bolts for future transportation of the appliance (such as when moving out).

❑ Store the transport bolts with the washer and bushing attached.

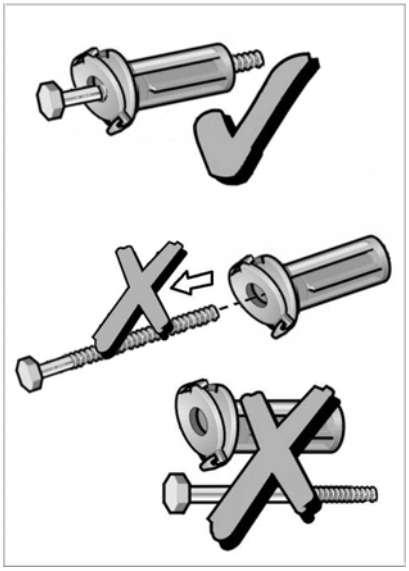


Figure 16

8. Follow the Installation Instructions that came with your appliance to finish installing or reinstalling your appliance (i.e., hoses, vents, etc.)

9. Slide the appliance to its final location.

Leveling Procedure

1. The appliance should now be in its final position, ready for leveling (moving the appliance after leveling can make it unlevel again.)

   Each foot of the appliance or pedestal must be placed firmly on the floor to prevent the appliance from wobbling.

   Start with all four feet screwed in as far as possible, then back individual feet out as necessary to level the appliance. Move the feet as little as possible to help reduce vibration.

2. Use a bubble level (24" or less in length) to check the leveling status of the appliance (be sure the level fits between the edges of the appliance, and is not elevated at one end on a ridge on the surface of the appliance.)

   ❑ Lay the bubble level across the unit worktop to check the level from side to side and from front to back.

   ❑ A center–located bubble indicates the unit is leveled. Otherwise, repeat the leveling procedure until the unit is leveled. Tip: if the bubble is closer to one end, it indicates the high side of the unit. To level the unit, either lower the higher side or raise the lower side.

   ❑ After leveling the unit from side to side, then turn the level so that it lays on the worktop from front to back to check if it is level in that direction.

⚠ CAUTION

To avoid risk of injuries –Take care when using the wrench.

❑ Loosen the lock nut (see **Figure 17, item 1**) by turning it clockwise. Use the wrench provided (or a 5/8" – 16mm open end wrench). When you turn the lock nut, the foot (see **Figure 17, item 2**) it is locked against will turn with it. This will extend the height of the foot.

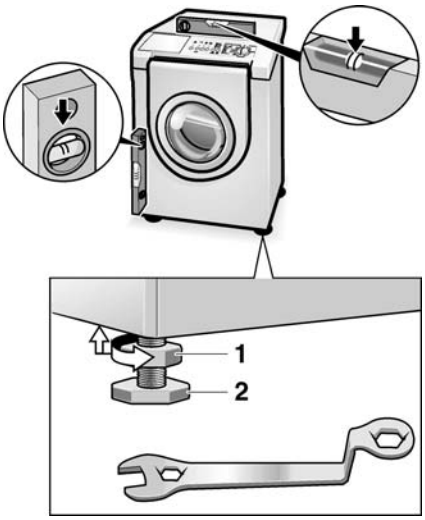


Figure 17

- ❑ Turning the foot out (clockwise) will raise the corner of the appliance, turning the foot in (counter–clockwise) will lower the corner of the appliance.

  When the corner of the appliance is satisfactorily raised or lowered, lock the height–adjustable feet in place by turning the lock nut counter–clockwise until it locks tightly against the pedestal housing.

  i It may be necessary to hold the appliance foot with a pair of pliers to keep it from turning while tightening the lock nut. It the foot does turn, it will change the height of the corner.

- ❑ After making preliminary adjustments, press down on each corner of the appliance to make sure the unit does not wobble. If it does wobble, lower the foot on that corner until the foot touches the floor firmly.

3. **For Washers:** Fine tune the leveling by placing a small load of laundry in the machine, starting it in spin cycle and then leveling the appliance again.

i If the test spin cycle is manually stopped before its completion, then the door may remain locked for 10 seconds.

Note: Correct adjustment of feet (equal weight distribution to all feet) is required to minimize vibration and movement of the appliance during operation.

4. Use the supplied 17mm open-end wrench to securely tighten both locknuts for the front feet against the pedestal. **All locknuts must be tightened firmly to prevent the height adjustable feet from moving during appliance use.**
5. Slide the ball bearing rails on the pedestal side to the front (see **Figure 18).**

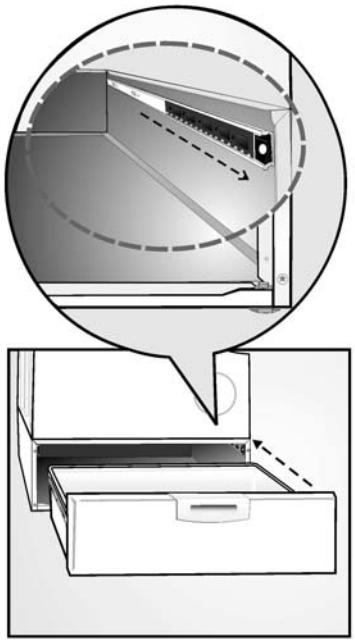


Figure 18

6. Replace the drawer by aligning it to the drawer slides. Ensure slides of pedestal and drawer are aligned correctly (see **Figure 19**).

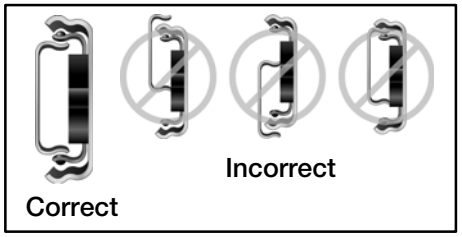


Figure 19

7. Close the drawer.

   Ensure drawer slides are correctly engaged by freely opening and closing the drawer.

⚠ CAUTION

Do not use the drawer as a step.

For problems with or service on your pedestal contact **BSH Home Appliances**. Contact information is available in the "**Customer Service**" section of the appliance manual.

WARRANTY

Full One-Year Warranty on Mechanical Parts

For one year from the date of purchase, when this pedestal is installed with the listed washer or dryer and operated according to the instructions provided in the washer or dryer **"Operating, Care and Installation Instructions"**, supplier will repair or replace any of its mechanical parts if defective in material or workmanship.

Warranty Restriction

If the Pedestal is subject to other than private family use and/or used with any other product than those listed in the **Installation Instructions**, the warranty is null and void.

Warranty Service

Warranty service is available by contacting the retailer where the Pedestal was purchased. If retailer is not available, please refer to the **"Operating, Care and Installation Instructions"** that came with the washer or dryer that is installed with the Pedestal and contact the service department listed there.

This warranty applies only while the Pedestal is in use in the United States or Canada*. This warranty gives you specific rights and you may also have other rights which vary from state to state or province to province.

*Warranty terms may vary in Canada.

In the space below, record the purchase date of your pedestal and model and serial number of the appliance on which the pedestal is installed.

Save these instructions and your sales receipt for future reference.

Purchase Date _____/_____/_____

Appliance Model Number _____

Appliance Serial Number _____

Oatey®
4700 W. 160th St.
Cleveland, Ohio 44135
Ph: (800) 321-9532
Fax: (800) 321-9535
www.oatey.com

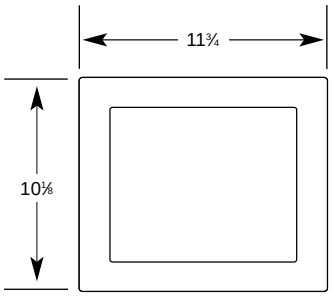
SUBMITTAL SPECIFICATION

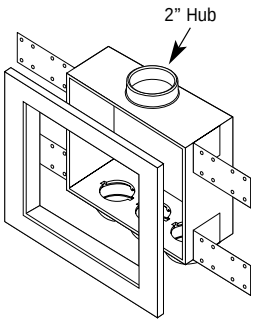
QUADTRŌ® Washing Machine Outlet Boxes

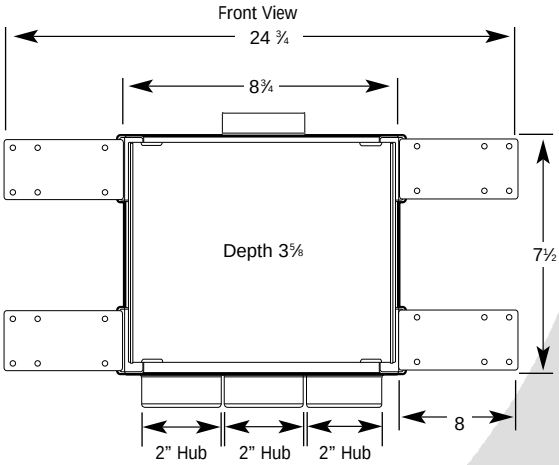
Engineering Specification: Oatey QUADTRŌ® washing machine outlet boxes can be used in commercial or residential applications which require supply valves and waste drain recessed into the wall. Available water hammer arrestor option provides water pressure shock arrestors required for installation on supply lines to quick closing valves.

Job Reference

Visit www.oatey.com for updates.







(All dimensions in inches)

- 2" drain opening fits PVC or ABS Sch. 40 DWV pipe
- All washing machine outlet boxes are shipped 12 per carton
- Box made of high impact polystyrene
- 4 support brackets included for mounting
- Easy to remove knockout
- Snap-on faceplate frame accommodates up to 1" drywall

✓	Part #	Description
	38530	1/4 Turn Brass Ball Valve – Copper Sweat – Standard Pack
	38531	1/4 Turn Brass Ball Valve – CPVC – Standard Pack
	38532	1/4 Turn Brass Ball Valve – ASTM F1807 PEX – Standard Pack
	38533	1/4 Turn Brass Ball Valve – ASTM F1960 PEX – Standard Pack
	38534	1/4 Turn Brass Ball Valve – ASTM F1974 PEX – Standard Pack
	38535	Single Lever Ball Valve – Copper Sweat – Standard Pack
	38536	Single Lever Ball Valve – CPVC – Standard Pack
	38537	Single Lever Ball Valve – ASTM F1807 PEX – Standard Pack
	38538	Single Lever Ball Valve – ASTM F1960 PEX – Standard Pack
	38539	Single Lever Ball Valve – ASTM F1974 PEX – Standard Pack
	38540	1/4 Turn Brass Hammer Ball Valve – Copper Sweat – Standard Pack
	38541	1/4 Turn Brass Hammer Ball Valve – CPVC – Standard Pack
	38542	1/4 Turn Brass Hammer Ball Valve – ASTM F1807 PEX – Standard Pack
	38543	1/4 Turn Brass Hammer Ball Valve – ASTM F1960 PEX – Standard Pack
	38544	1/4 Turn Brass Hammer Ball Valve – ASTM F1974 PEX – Standard Pack
	38545	Single Lever Hammer Ball Valve – Copper Sweat – Standard Pack
	38546	Single Lever Hammer Ball Valve – CPVC – Standard Pack
	38547	Single Lever Hammer Ball Valve – ASTM F1807 PEX – Standard Pack
	38548	Single Lever Hammer Ball Valve – ASTM F1960 PEX – Standard Pack
	38549	Single Lever Hammer Ball Valve – ASTM F1974 PEX – Standard Pack
	38550	Plain Box – No Valves – Standard Pack
	38551	1/4 Turn Brass Ball Valve – Compression – Standard Pack
	38552	Brass Boiler Drain Valve – Copper Sweat – Standard Pack
	38553	Brass Boiler Drain Valve with Screw Driver Stop – Copper Sweat – Standard Pack
	38554	North American Brass Boiler Drain Valve – Copper Sweat – Standard Pack
	38555	1/4 Turn Brass Ball Valve – F2080 PEX – Standard Pack
	38556	1/4 Turn Brass Ball Valve – 3/8" PEX – Standard Pack
	38557	1/4 Turn Brass Ball Valve – Standard Pack
	38560	1/4 Turn Brass Ball Valve – Copper Sweat – Contractor Pack
	38561	1/4 Turn Brass Ball Valve – CPVC – Contractor Pack
	38562	1/4 Turn Brass Ball Valve – ASTM F1807 PEX – Contractor Pack
	38563	1/4 Turn Brass Ball Valve – ASTM F1960 PEX – Contractor Pack
	38564	1/4 Turn Brass Ball Valve – ASTM F1974 PEX – Contractor Pack
	38566	1 /4 Turn Brass Hammer Ball Valve – F2080 PEX
	38567	Single Lever Hammer Ball Valve – F2080 PEX

US Patent #6,155,286 and Patents Pending

9420

Data is subject to manufacturing tolerances.

Valves meet ASME A112.18.1
Water Hammer Arrestors meet ASSE 1010

10/07

Part #	Description
38941	Plastic Faceplate for Quadtro Center and Offset WMOB
38768	Plastic Brackets, 4” Long, for Plastic Boxes
38648	Plastic Brackets, 12” Long, for Plastic Boxes
38576	Quadtro Test Cap
38577	Quadtro Hug/O-ring

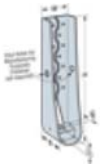
HDU Holdown

VALUE ENGINEERED

HDU Holdowns are pre-deflected during the manufacturing process, virtually eliminating deflection under load due to material stretch. They use Simpson Strong-Tie® Strong-Drive® screws (SDS) which install easily and provide reduced fastener slip. Using SDS screws results in a greater net section, when compared to bolts, as no material is removed.

The HDU series of holdowns are designed to replace previous versions of the product such as PHD's as well as bolted holdowns. The HDU2, 4 and 5 are direct replacements for the PHD2, 5 and 6, respectively.

For more information on holdown options, contact Simpson Strong-Tie.



Load Table
Gallery of images
Code Reports
Drawings
Catalog Page
Anchoring Solutions
Related Categories
Fliers
Help for downloads

Special Features:

- Pre-deflected body virtually eliminates deflection due to material stretch.
- Uses SDS screws which install easily, reduces fastener slip, and provides a greater net section area of the post compared to bolts.
- SDS screws are supplied with the holdowns to ensure proper fasteners are used.
- No stud bolts to countersink at openings.

Material: See table.

Finish: Galvanized.

Installation:

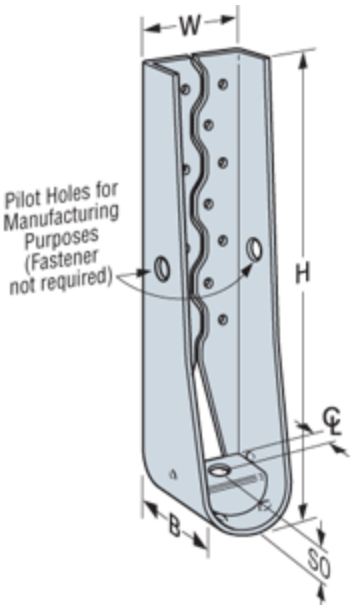
- Use all specified fasteners. See General Notes.
- For use in vertical and horizontal applications.
- No additional washer required.
- To tie multiple 2x members together, the Designer must determine the fasteners required to join the members to act as one unit without splitting the wood. See SDS Screw information.
- See SB and SSTB Anchor Bolts for anchorage options.
- SDS screws install best with a low speed high torque drill with a 3/8" hex head driver.
- Refer to Anchor Designer Software™ for ACI 318 for anchoring solutions.

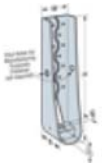
For holdowns, per ASTM test standards, anchor bolt nuts should be finger-tight plus 1/3 to 1/2 turn with a hand wrench, with consideration given to possible future wood shrinkage. Care should be taken to not over-torque the nut. Impact wrenches should not be used.

Gallery:

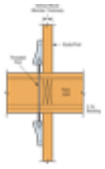
▲top

roll over images below to see larger image

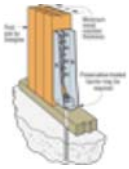




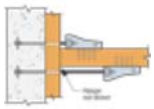
HDU
U.S. Patent
6,112,495



Typical HDU Tie Between Floors



Vertical HDU Installation



Horizontal HDU Offset Installation

(Plan View)
See footnote 7.

Load Table: See code report listings below

▲top

Model No.	Ga	Dimensions (in.)					Fasteners		Minimum Wood Member Thickness[4] (in.)	Allowable Tension Loads (I (160)[1]		
		W	H	B	℄	SO	Anchor Bolt Dia. (in.)	SDS Screws		DF/SP	SPF/HF	Def Allow
HDU2-SDS2.5	14	3	8 1⁄16	3¼	1 5⁄16	1⅜	⅝	6-SDS ¼"x2½"	3	3075	2215	
HDU4-SDS2.5	14	3	10 15⁄16	3¼	1 5⁄16	1⅜	⅝	10-SDS ¼"x2½"	3	4565	3285	
HDU5-SDS2.5	14	3	13 3⁄16	3¼	1 5⁄16	1⅜	⅝	14-SDS ¼"x2½"	3	5645	4065	
HDU8-SDS2.5	10	3	16⅝	3½	1⅜	1½	⅞	20-SDS ¼"x2½"	3	5980	4305	
									3½	6970	5020	
									4½	7870	5665	
HDU11-SDS2.5	10	3	22¼	3½	1⅜	1½	1	30-SDS ¼"x2½"	5½	9535	6865	
									7¼	11175	8045	
HDU14-SDS2.5	7	3	25 1⁄16	3½	1 9⁄16	1 9⁄16	1	36-SDS ¼"x2½"	7¼	14390[9]	10360	
									5½[8]	14925[8,9]	10745	

1. Allowable loads have been increased for wind or earthquake load durations with no further increase allowed; reduce where other load durations govern.
2. The Designer must specify anchor bolt type, length and embedment. See SB and SSTB Anchor Bolts. Refer to Anchor Designer Software™ for ACI 318 for anchoring solutions.
3. Structural composite lumber columns have sides that show either the wide face or the edges of the lumber strands/veneers. Values in the tables reflect installation into the wide face. See technical bulletin T-SCLCOLUMN for values on the narrow face (edge).
4. Post design by Specifier. Allowable load values are based on a minimum wood member thickness in the direction of the fastener penetration. Posts may consist of multiple 2x members provided they are designed to act as one unit independently of the holdown fasteners. Holdowns shall be installed centered along the width of the attached post.
5. Tension values are valid for holdowns flush or raised off of sill plate.
6. Deflection at Highest Allowable Tension Load includes fastener slip, holdown elongation, and anchor bolt elongation (L = 6"). Additional elongation of anchor bolts longer than 6" shall be added to holdown deflection.
7. Tabulated loads may be doubled when the HDU is installed on opposite sides of the wood member provided either the post is large enough to prevent opposing holdown screw inferference or the holdowns are offset to eliminate screw interferences.
8. Noted HDU14 allowable loads are based on a 5 1/2" wide post (6x6 min.).All other loads are based on 3 1/2" wide post minimum.
9. Requires heavy hex anchor nut to achieve tabulated loads (supplied with holdown).

Code Reports (PDFs):

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					LEGACY REPORTS		
	IAPMO ES ER	ICC-ES ESR	CITY OF LOS ANGELES	STATE OF FLORIDA	ICC-ES NER	ICC-ES ER	ICC-ES ES
HDU	See specific model numbers for code listings.						
HDU11-SDS2.5		ESR-2330 / ESR-2523 *	RR25720	FL10441			
HDU11-SDS2.5		ESR-2330 / ESR-2523 *	RR25720	FL10441			
HDU14-SDS2.5		ESR-2330 / ESR-2523 *	RR25720	FL10441			
HDU14-SDS2.5		ESR-2330 / ESR-2523 *	RR25720	FL10441			
HDU2-SDS2.5		ESR-2330 / ESR-2523 *	RR25720	FL10441			
HDU4-SDS2.5		ESR-2330 / ESR-2523 *	RR25720	FL10441			
HDU5-SDS2.5		ESR-2330 / ESR-2523 *	RR25720	FL10441			
HDU8-SDS2.5		ESR-2330 / ESR-2523 *	RR25720	FL10441			

* ESR-2523 is an Index of many of Simpson Strong-Tie Stamped and Welded Cold-formed Steel Products for Wood or Cold-formed Steel Construction

Drawings:

To download drawings, right-click or Ctrl-click on the link, then choose "Save Target As..."

DWG

Download the Simpson AutoCad Menu

Orthographic

HDU2 HDU2 front view HDU2 right view HDU2 top view HDU4
HDU4 front view HDU4 right view HDU5 HDU5 front view HDU5 right view HDU8
HDU8 front view HDU8 right view HDU11 HDU11 front view HDU11 right view
HDU11 top view

DXF

Orthographic

HDU2 HDU2 front view HDU2 right view HDU2 top view HDU4 HDU4 front view
HDU4 right view HDU5 HDU5 front view HDU5 right view HDU8 HDU8 front view
HDU8 right view HDU11 HDU11 front view HDU11 right view HDU11 top view

Catalog Pages (PDFs):

C-2009 (Wood Construction Connectors), page 37

Order free catalogs by mail

Anchoring Solutions:

Refer to Anchor Designer Software™ for ACI 318 for anchoring solutions.

Related Categories:

Holdowns - Concrete (Wood Construction)

Tension Ties (Wood Construction)

Technical Bulletins (PDFs):

Panelized Roof Systems Expiration extended to 1/31/09

Connectors Installed on SCL Columns

Fliers (PDFs):

The Effects of Wind

New Longer Titen HD®s Can Be Used With Simpson Holdowns

Holdowns for Alternate Braced Wall Panels

Need help with downloads?

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For Residential and Commercial Applications

Job Name _____ Contractor _____

Job Location _____ Approval _____

Engineer _____ Contractor's P.O. No. _____

Approval _____ Representative _____

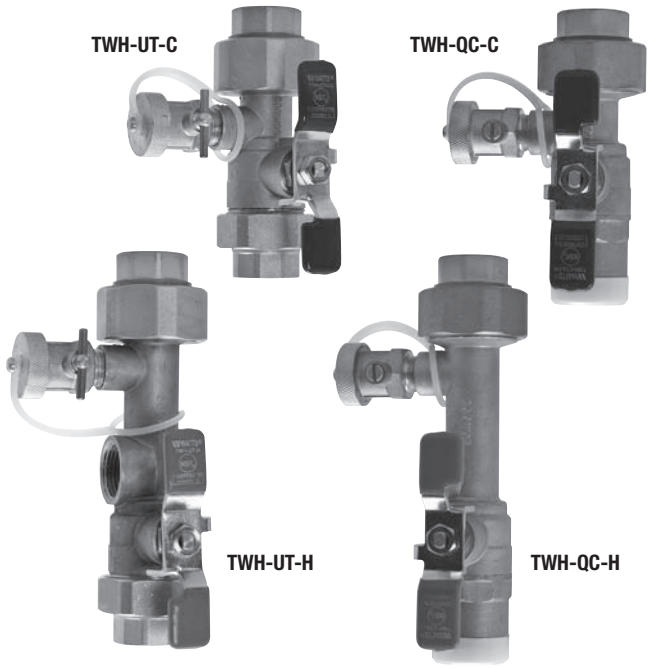
Series TWH
Tankless Water Heater Valves

Size: ¾" (20mm)

Series TWH tankless water heater valves are designed to simplify the installation, maintenance and operation of tankless water heaters.

Features

- ¾" FPT unions for connection to water heater (all models)
- ¾" FPT unions for connection to water lines (UT models)
- ¾" Quick-Connect end connections to water lines (QT models)
- ¾" FPT connection to water lines (FT models)
- ¾" FPT/sweat unions for connection to water lines (UTS models)
- Full-port, quarter-turn ball valve with color-coded tee handle and union
- Quarter-turn purge and drain valve with hose connection and tethered brass cap
- Optional ¾" pressure relief valve 150psi (10.3 bar)
- Optional integral spring check valve in cold water valves
- Hot and cold valves certified to NSF/ANSI 61
- Staggered connection points for ease of installation and access
- Valves are suitable for most tankless installations
- No additional adapters required
- 600 WOG rated



Specifications

A tankless water heater valve shall be installed where indicated on the plans. The valve shall facilitate isolation of the water heater from the water lines, water heater purging, draining and a provision for a pressure relief valve. The valve shall be a Watts Regulator Company Series TWH.

Materials

Body: Forged brass
Ball: Plated brass
Seats: Virgin PTFE

Models

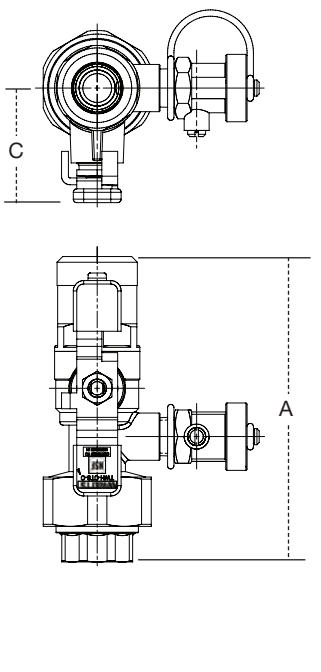
Model Nomenclature

		TWH	UTS	HCN	RV
TWH	tankless water heater	✓			
UT	union with female threaded tailpieces for connection to water lines		✓		
UTS	union with female threaded and sweat tailpieces for connection to water lines		✓		
QC	Quick Connect fittings to water lines		✓		
FT	Female pipe thread connection to water lines		✓		
H	hot water valve			✓	
C	cold water valve			✓	
CN	cold water valve without integral spring check			✓	
HC	hot and cold valve set			✓	
HCN	hot and cold valve set, no spring check			✓	
RV	150psi relief valve				✓

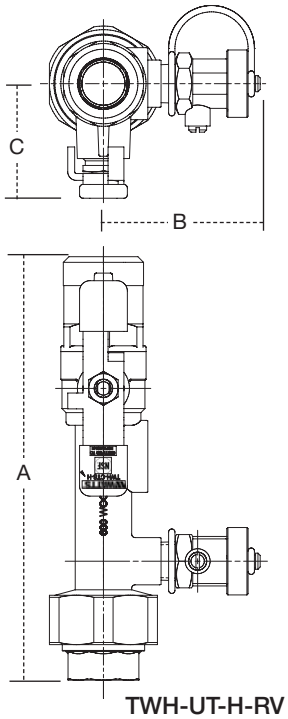
Watts product specifications in U.S. customary units and metric are approximate and are provided for reference only. For precise measurements, please contact Watts Technical Service. Watts reserves the right to change or modify product design, construction, specifications, or materials without prior notice and without incurring any obligation to make such changes and modifications on Watts products previously or subsequently sold.

WATTS®

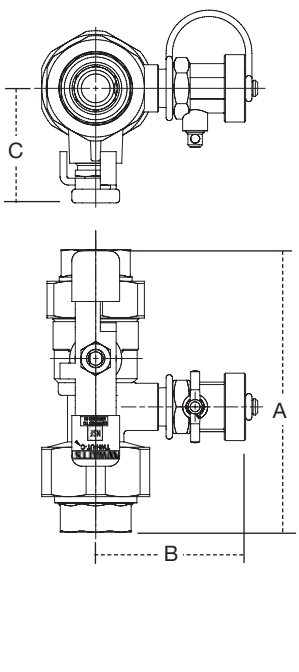
TWH-QC-C



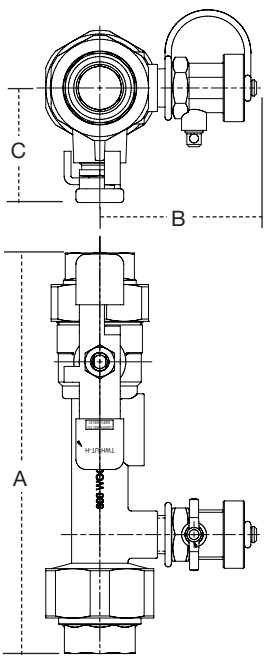
TWH-QC-H



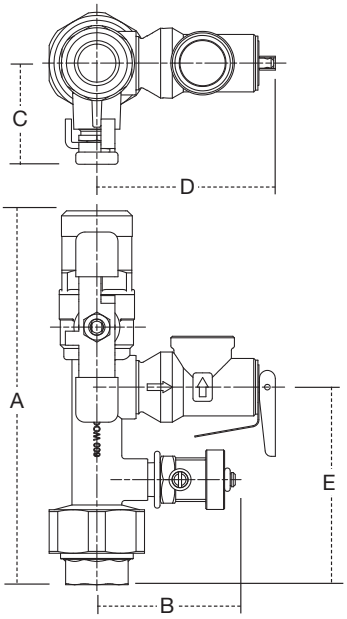
TWH-UT-C



TWH-UT-H



TWH-QC-H-RV



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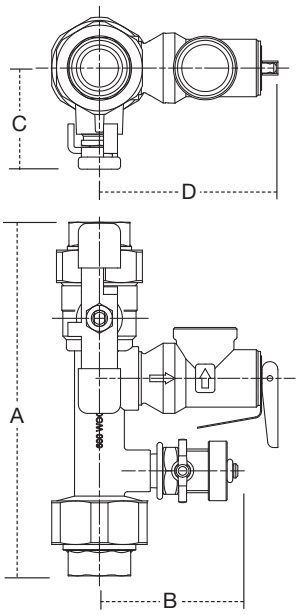
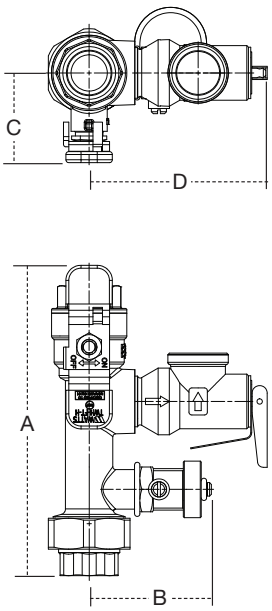
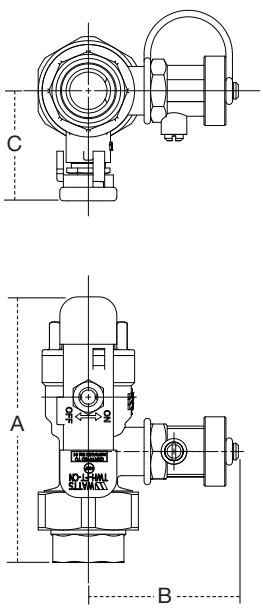


TWH-FT-H-RV



TWH-FT-CN



Dimensions — Weights

MODEL	CONNECTIONS	DIMENSIONS										WEIGHT	
		A		B		C		D		E			
		in.	*mm*	*in.*	*mm*	*in.*	*mm*	*in.*	*mm*	*in.*	*mm*	*lbs.*	*kgs.*
TWH-UT-C	Union x Union	4 15/16	125	2 13/16	71	2	51	–	–	–	–	2.2	1.0
TWH-UT-H	Union x Union	6 15/16	177	2 3/4	69	2	51	–	–	–	–	2.5	1.1
TWH-QC-C	Quick-connect x Union	5 5/16	135	2 13/16	71	2	51	–	–	–	–	2.0	.9
TWH-QC-H	Union x Quick-connect	7 3/8	187	2 3/4	69	2	51	–	–	–	–	2.4	1.1
TWH-UT-H-RV	Union x Union	6 15/16	177	2 3/4	69	2	51	3 1/2	89	3 7/8	99	2.5	1.1
TWH-QC-H-RV	Quick-connect x Union	7 3/8	187	2 3/4	69	2	51	3 1/2	89	3 7/8	99	2.4	1.1
TWH-FT-CN	Union x FPT	4 1/16	103	2 1/2	64	1 7/8	47	–	–	–	–	1.9	0.9
TWH-FT-H	Union x FPT	6	152	2 1/2	64	1 7/8	47	3 1/2	89	2 7/16	62	2.1	0.9

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A Watts Water Technologies Company

ISO 9001-2000 CERTIFIED

USA: 815 Chestnut St., No. Andover, MA 01845-6098; www.watts.com
Canada: 5435 North Service Rd., Burlington, ONT. L7L 5H7; www.wattscanada.ca

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Tankless Water Heater ¾" Service Valve Set

Installation Instructions

STOP!
Before connecting any components, be sure to read all of the tankless water heater manufacturer's installation instructions. Failure to follow instructions below can result in serious injury, death and/or property damage.

1. Identify all components and orientations before beginning installation

1. HOT WATER SERVICE VALVE (Fig.1) Identified by the red insulator handle.

2. COLD WATER SERVICE VALVE (Fig.2) Identified by the blue insulator handle.

3. PRESSURE RELIEF VALVE (Fig.3) Identified by a silver test lever.
Note: ANSI Z21.22 and local codes govern the installation of pressure relief valves.

2. Before attaching any components to the tankless water heater, attach PRESSURE RELIEF VALVE to HOT WATER ISOLATION VALVE (Figure 4)

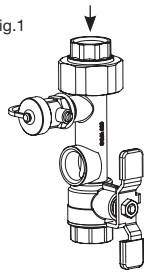
CAUTION: Do not over tighten relief valve. Do not tighten more than 2 turns past hand tight.

a. Apply thread sealant to the exposed threads of the pressure relief valve.

b. Thread the pressure relief valve into the ¾" port on the side of the hot water valve and hand tighten. Using a wrench, tighten the pressure relief valve until the discharge on the pressure relief valve is positioned downward on the isolation valve, as shown in Figure 4.

Attach this end to tankless water heater

Fig.1



Attach this end to tankless water heater

Fig.2

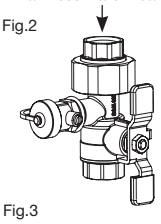


Fig.3

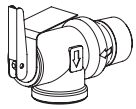
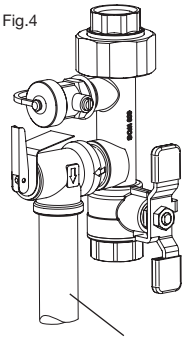


Fig.4



TWH-FT

3. Install COLD WATER SERVICE VALVE onto cold water inlet of tankless water heater

a. Locate the cold water threaded inlet on the tankless water heater and apply thread sealant to the threads.

b. Slightly loosen the union nut on the top of the cold water valve so that the union tailpiece rotates freely.

c. Holding the cold water valve beneath the cold water inlet, thread the union tailpiece onto the inlet and hand tighten. Using a wrench, tighten the union tailpiece. Next, position the cold water valve with the purge port pointing forward, towards the front of the water heater, and hand tighten the union nut.

d. Tighten the union nut with a wrench, making sure that the valve does not rotate out of position.

4. Install HOT WATER SERVICE VALVE onto hot water outlet of tankless water heater

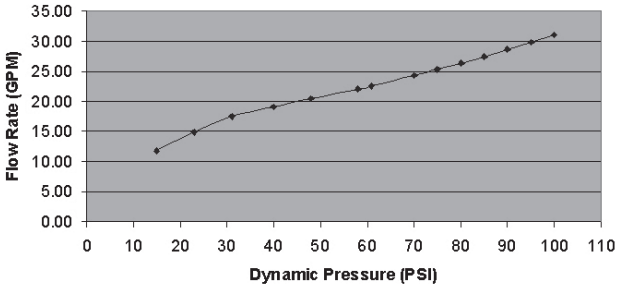
WARNING: There should not be a shutoff located between the tankless water heater and pressure relief valve. (See direction arrow in Fig. 5.)

a. Locate the hot water threaded outlet on the tankless water heater and apply thread sealant to the threads.

b. Slightly loosen the union nut on the top of the hot water valve so that the union tailpiece rotates freely.

c. Holding the hot water valve beneath the hot water outlet, thread the union tailpiece onto the outlet and hand tighten. Using a wrench, tighten the union tailpiece. Next, position the hot valve with the purge port and pressure relief valve pointing forward, towards the front of the water heater, and hand tighten the union nut. Tighten the union nut with a wrench, making sure that the valve does not rotate out of position.

Hot Service Valve Purge Port Flow Data



ATTENTION INSTALLER: After installation, please leave this Instruction Sheet for occupant's information.
IMPORTANT: Inquire with governing authorities for local installation requirements.

WARNING!
For valves with CPVC or PEX end connections do not exceed the tubing manufacturers pressure and temperature ratings. Refer to the tubing manufacturers product specifications for that information.

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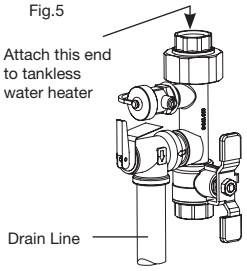
5. Connect water line and pressure relief drain line

a. Attach the HOT water supply line to the ¾" threaded connection on the HOT WATER VALVE using thread sealant on the threads of the water fitting.
b. Attach the COLD water supply line to the ¾" threaded connection on the COLD WATER VALVE using thread sealant on the threads of the water fitting.
c. Attach the drain line to the pressure relief valve and run line per local code requirements.

Fig.5



6. Start-up & Normal Operation

a. Before turning on the supply water to the heater, make sure that the main valve handles on both the hot & cold valves are closed (perpendicular to the main valve bodies). Also ensure that the purge port valve caps are tightened down and that the valves are in the closed position (slot perpendicular to the purge port valve body). NEVER RELY ON THE PURGE CAP TO STOP THE WATER FLOW.
b. For water heater start-up, refer to the water heater owners' manual.
c. During normal operation, the main water valves are open when the main valve handle is parallel with the main valve body and closed when the main valve handle is perpendicular to the main valve body.
d. For the purge port valves, the purge port valve is open when the slot is parallel with the purge port valve body and closed when the slot is perpendicular to the purge port valve.

7. Inspection and Maintenance

a. See tag attached to pressure relief valve for details.

WARNING: Hot water may be present in the system, use extreme caution when servicing tankless water heater. Hot water can cause personal injury, death and/or property damage.

8. Drain/Flush Operation

Note: The following are suggested instructions for the use of the service valves during draining and flushing of the tankless water heater. Please refer to the water heater owner's manual for specific instructions.

a. Disconnect the power supply to the water heater.
b. Close the main water valve handles on the cold water valve (blue handle) and the hot water valve (red handle) by rotating each until they are perpendicular with the respective valve body. This shuts off the incoming cold water to the water heater and isolates the water heater from the hot water piping within the rest of the home.
c. The purge valve on the cold water valve (blue) is used as the flushing inlet and the purge valve on the hot water valve (red) is used for the flushing outlet or drain. Ensure that the purge port is closed (perpendicular to the purge port valve body) before removing the purge port valve cap.
d. Slowly open the drain caps on each purge port valve. Ensure that the rubber washer stays in the cap.
e. Continue with the manufacturer's recommendations for attachment of the lines and for specific draining and flushing instructions. To open the purge port valves, the slots are rotated so that they are parallel to the purge port valve body.
f. When flushing is complete and before the lines are removed, ensure that the purge port valves are closed. Remove the lines and reinstall the purge port valve caps, ensuring that the rubber washer is in the cap, and tighten.

CALIFORNIA PROPOSITION 65 WARNING

WARNING: This product contains chemicals known to the State of California to cause cancer and birth defects or other reproductive harm. (California law requires this warning to be given to customers in the State of California.)

For more information: www.watts.com/prop65

8. Diagnostic & Testing

Note: Diagnostic and testing of the water heater can be performed using the purge port on the hot water valve. Diagnostic testing such as flow rate, firing rate and temperature testing can also be performed. Please refer to the water heater owner's manual for the manufacturer's specific testing instructions and specifications. All testing must be done in accordance with manufacturers' recommendations.

Purge port valve flow rate data is provided in the graph below. Refer to this data during diagnostic testing of the tankless water heater.

a. Close the main water valve handle on the hot water valve (red handle) by rotating until it is perpendicular with the valve body. Ensure that the hot valve purge port is closed (perpendicular to the purge port valve body) before removing the purge port cap.
b. Slowly open the hot valve purge port cap. Ensure that the rubber washer stays in the cap. Attach the drain line and confirm that line is run to a safe and acceptable area for discharge of hot water.
c. Continue with the manufacturer's recommendations for diagnostics and testing.
d. When testing is complete and before the drain line is removed, ensure that the hot valve purge port valve is closed (the tee handle should be perpendicular to the purge port valve body). Remove the drain line and reinstall the purge port valve cap, ensuring that the rubber washer is in the cap, and tighten.

Limited Warranty and Disclaimers

Limited Warranty: Watts Regulator Co. (the "Company") warrants each product to be free from defects in material and workmanship under normal usage for a period of one year from the date of original shipment. In the event of such defects within the warranty period, the Company will, at its option, replace or recondition the product without charge.

THE WARRANTY SET FORTH HEREIN IS GIVEN EXPRESSLY AND IS THE ONLY WARRANTY GIVEN BY THE COMPANY WITH RESPECT TO THE PRODUCT. THE COMPANY MAKES NO OTHER WARRANTIES, EXPRESS OR IMPLIED. THE COMPANY HEREBY SPECIFICALLY DISCLAIMS ALL OTHER WARRANTIES, EXPRESS OR IMPLIED, INCLUDING BUT NOT LIMITED TO THE IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE.

The remedy described in the first paragraph of this warranty shall constitute the sole and exclusive remedy for breach of warranty, and the Company shall not be responsible for any incidental, special or consequential damages, including without limitation, lost profits or the cost of repairing or replacing other property which is damaged if this product does not work properly, other costs resulting from labor charges, delays, vandalism, negligence, fouling caused by foreign material, damage from adverse water conditions, chemical, or any other circumstances over which the Company has no control. This warranty shall be invalidated by any abuse, misuse, misapplication, improper installation or improper maintenance or alteration of the product.

Some States do not allow limitations on how long an implied warranty lasts, and some States do not allow the exclusion or limitation of incidental or consequential damages. Therefore the above limitations may not apply to you. This Limited Warranty gives you specific legal rights, and you may have other rights that vary from State to State. You should consult applicable state laws to determine your rights. **SO FAR AS IS CONSISTENT WITH APPLICABLE STATE LAW, ANY IMPLIED WARRANTIES THAT MAY NOT BE DISCLAIMED, INCLUDING THE IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE, ARE LIMITED IN DURATION TO ONE YEAR FROM THE DATE OF ORIGINAL SHIPMENT.**

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Water Safety & Flow Control Products

USA: 815 Chestnut St., No. Andover, MA 01845-6098; www.watts.com
Canada: 5435 North Service Rd., Burlington, ONT. L7L 5H7; www.wattscanada.ca

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Safety Guidelines

In addition to the Safety Briefing please read the *Jobsite Safety Handbook* inserted in this binder's back pocket.

TeamWork's 2010 Tear Down Plan
Laundry Room Project

Phase One

- Remove and salvage
  - Remove Washer Box and Valves
  - Remove Laundry Sink
  - Re-Box Sink
  - Remove Frost Proof Sill Cock
  - Remove Tank Less Water Heater
  - Carry plumbing fixtures to designated location for ***Plumbing***

    SAVE all parts and place in bags provided by us

- Remove Light Fixtures and Re-Box
- Remove Breaker Panel with Breakers
- Carry items to designated location for ***Electrical***
- The brick will be taken apart and stacked neatly on pallets.
- Just around the window only remove trim and siding
  - Take all the siding and trim pieces to the location for
    - ***Siding Recycle***
- Carefully remove the window
  - Carry window to designated location for ***Window***

Phase Two

- Remove copper pipes and wire from walls and take to ***Copper Recycle*** area.
- Remove the PCV from the walls and take to ***PVC Recycle*** area.
- Remove the steel studs and track, take the studs and track apart, then to the ***Steel Recycle*** area.
- Remove the both wall with wood studs, take them to the ***Wood Wall*** area and stack for banding.
- Remove any pipe and connectors from the slab sections.
- Take the both slab sections to the ***Slab*** area and stack for banding.

Phase Three

- Teams that have completed previous tasks can remove the house wrap floor covering and discard in trash receptacle
- Sweep up all debris and place in trash bins
- Help other teams as needed
- Skid loader will then pick up the debris.
- Take tools to the tool area
- Wait quietly for further directions

.

Teams that have completed this segment should help the slow teams.

Demolition is complete, wait for instructions on where to go from here.

ajp

CHANGE ORDER FORM

Date: _____

Deletion:

Addition:

Comments:

Signature_____

In the upcoming days of the competition you will receive all the hand and power tools you will need to complete your project. You are responsible for those tools and should treat them with the same care you would afford borrowed from a good friend tools.

You should inventory the tools to ensure all the items on your Tool Checklist are there. If there are missing items, you must inform a Technical Committee member immediately.

Once you have all your tools it is your responsibility to charge all your batteries so the tools are ready to be used the next morning.

At the end of demolition, your tools will be checked as you return them. Failure to return a tool or returning a tool in a poor condition may impact your score.

If at any point during the competition you have a problem with a hand or power tool, please talk with a Technical Committee member so your problem can be addressed.

Remember, job site safety includes tool safety. Use your tools only for their intended use so you do not hurt yourself, others around you or damage the tool. Always use your eye protection and maintain a clean work area.

Best of luck in the competition

TeamWorks Technical Committee

ITMES TO BE RETURNED				
Quantity per Team	**Quantity Received**	**Quantity Returned**	**Item #**	**Description**
1			15-106	Coping Saw
1			16-300	**3pc Stanley Chisel Set**
				1/2" Chisel (16-308)
				3/4" Chisel (16-312)
				1" Chisel (16-316)
2			58-930	**3pc Cushion Grip Nail Set**
				1/32 Nail Set (58-911)
				2/32 Nail Set (58-912)
				3/32 Nail Set (58-913)
2			55-099	FatMax Xtreme FuBar
1			55-515	Wonder Bar Pry Bar
1			55-035	Nail Puller
1			16-328	FatMax Brick Set
1			16-334	FatMax Mason's Chisel
1			20-046	FatMax 15" Saw with Blade Armor
1			20-531	FatMax High Tension Hacksaw
1			20-556	FatMax Drywall Saw
1			42-345	24" FatMax Brassbound Level
1			42-350	48" FatMax Brassbound Level
1			43-649	48" FatMax Extreme Magnetic Box Beam Level
1			45-011	Premium Aluminum Rafter Square
2			43-512	Lighted Magnetic Torpedo Level
2			46-053	Premium Adjustable Quick Square
1			46-131	16" Combination Square
1			47-482	**2pc FatMax Xtreme Chalk Set**
				Chalk Reel (47-480)
				4oz Bottle Blue Chalk
4			10-815	FatMax Xtreme Retractable Utility Knife

ITMES TO BE RETURNED				
Quantity per Team	**Quantity Received**	**Quantity Returned**	**Item #**	**Description**
2			14-563	Straight Cut Aviation Snips
1			15-614	Bi-Metal Hacksaw Blades (10 per card)
2			51-167	FatMax Xtreme AntiVibe Framing Hammer
4			51-165	FatMax Xtreme AntiVibe Nailing Hammer
2			66-565	**6pc Vinyl Grip Screwdriver Set**
				1/4" x 1/4" Standard
				3/16" x 6" Cabinet
				3/16" x 3" Cabinet
				5/16" x 6" Standard
				1pt x 3" Phillips
				2pt x 4" Phillips
2			89-858	MaxSteel Diagonal Cutting Pliers
2			89-863	MaxSteel Lineman Pliers
2			89-870	MaxSteel Long Nose Pliers with Cutter
2			84-199	Wire Stripper
2			85-610	MaxGrip Locking Adjustable Wrench
2			84-816	MaxSteel C Clamp Locking Pliers
1			84-024	Bi-Material Groove Joint Pliers
1			37001	50 Gallon Mobile Tool Chest
1			60601	Set of Sawhorses
1				Masonry Utility Brush
4				Adjustable Line Stretchers
2				10” Narrow London Brick Trowel
1				Convex Jointer
1				Convex Sliderunner
1				Modular Spacing Rule
4				Wood Block Line Pair
1				18oz Brick Hammer
1				Mortar Stands

ITMES TO BE RETURNED				
Quantity per Team	**Quantity Received**	**Quantity Returned**	**Item #**	**Description**
1				Canvas Tool Bag

ITMES TO BE RETURNED				
Quantity per Team	**Quantity Received**	**Quantity Returned**	**Item #**	**Description**
1			3912	12” Compound Miter Saw
1			17618B	18V Brute Tough™ ½” Hammer Drill/Driver
1			25618B	18V Impactor ™ Impact Driver
1			CRS180B	18V Reciprocating Saw
1			36618B	18V Compact Tough™ Drill/Driver
1			PS30-2A	12V Max 3/8” Drill Driver
1			CS10	15A Circular Saw
1			1380SLIM	7.5A Small Angle Grinder
4			BAT618	18VFat-Pack Battery
1			BC630	18V Battery Charger
2			2610944955	Jobsite Carry Bag
1			DR01-1100	Rotozip Tool

ITEMS STUDENTS MAY KEEP				
Quantity per Team	**Quantity Received**	**Quantity Returned**	**Item #**	**Description**
1			CC2480	12 Pc Screwdriver Bit Set
1			HB25M	25 Pc Bi-Metal Hole Saw Kit
1			DSB5005	6 Pc Spade Bit Set w/Extension
1			PCM12	7/16” Mandrel for Hole Saws
1			HCBG21	5/8” Dia. X 12” Length Blue Granit™ Hammer Drill Bit
1			RDN9V-25B	Demolition For Wood/Nails Reciprocation Blade
1			CB724AB25	7 ¼” Circular Saw Blade
1			XB-DW10	Drywall X-Bit
1			XB-MPGP2	Multi Purpose X-Bit
1			TDSL681012	Slotted 6-8, 8-10, 10-12 2” Titanium Bit Set
1			TDP123203	Phillips #P1, #P2, #P3 Titanium Bit Set
1			CC90396	6 Pc Torx Bit Set
1			TI18	18 Pc Titanium Drill Bit Set
1			NKLT10	5/8” Nailkiller™ Auger Bit
4			33-890	25' FatMax Xtreme Tape

SkillsUSA
2010 Contest Projects

Technical Computer Applications

Click the “Print this Section” button above to automatically print the specifications for this contest. Make sure your printer is turned on before pressing the button.

Technical Computer Applications
If possible install the following software prior to Tuesday June 22, 2010.

On Tuesday you will be setting up your computer in the contest area, and are required to have the software installed before you can connect to the TCA network.

If you are renting a computer at the conference you will be able to install the software as part of your setup time. Please go to www.tcanationals.com/downloads

To download the files from the 2010 contest, click here.*

** This is a "ZIP" file. Mac users usually already have a copy of StuffitExpander installed on their computers. If not, see http://www.stuffit.com/mac-expander.html for a free download.*

PC users can download a free version of WinZip from this address: http://www.winzip.com/downwz.htm

SkillsUSA
2010 Contest Projects

Technical Drafting

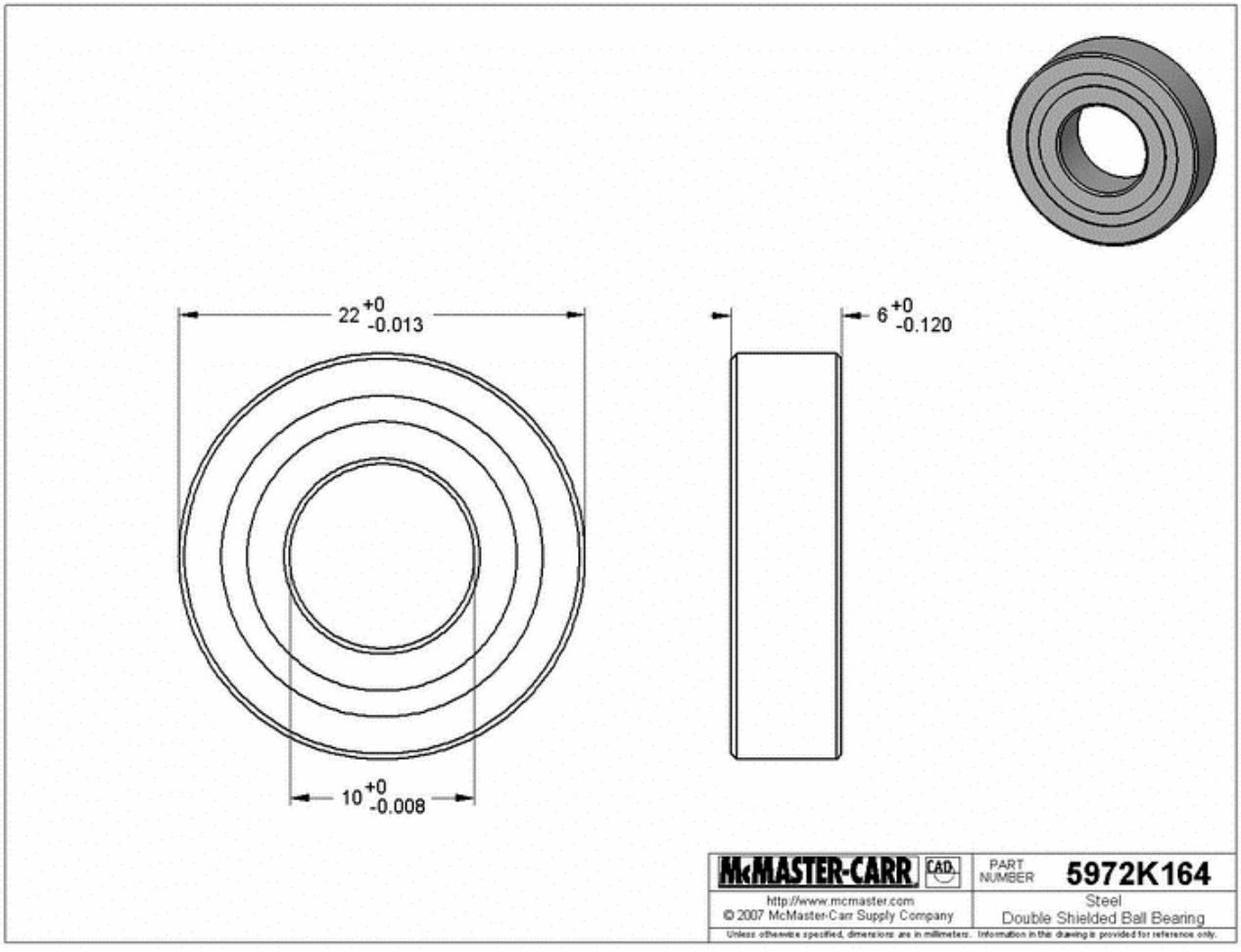
Click the “Print this Section” button above to automatically print the specifications for this contest. Make sure your printer is turned on before pressing the button.

UPDATE:

As is often the case in the design world, things may change before you even get done with the design. We have just received an update from the customer. They found a metric bearing with tighter tolerances that will fit into this design without too much modification or lost time, and want us to use it instead of the previously called out inch series bearing. The specs of this new bearing are shown in the view below.

Your task is to modify your design in order to use this new bearing. Since you haven't released control of any drawings that will be affected, you don't need to show any revisions on your drawings.

While you are making your changes, make sure that specifications called out in your instructions are still followed. For example, look at the definition of length of the lower bearing journal, etc. You need to maintain the existing positions of the outer faces of the bearings since those faces contact the Coupling Hub and the Lower Blade Holder, and those parts must remain where they were. Remember to watch your fits, tolerances and clearances as the bearing has changed size.



Orientation comments - general:

1. (Make sure the PA is proper for this area only.)
2. (Students meet in lobby and someone bring them up?? What time?? What time will we start talking to them? When can they start on the problem? What is the official stopping time? 4:30?)
3. Welcome and philosophy.
4. Roll call
5. State prizes will be distributed after the awards ceremony.
6. Debriefing will be on Friday at 11:00 am, but not in this room – see the program. Your drawings will be returned to you then as this is the point.
7. Rules:
    A. No electronics other than your computer. That means no cell phones, head phones, mp3 players, iPods, GPS, modems, radios, etc. – nothing wireless – this is monitored. We have had disqualifications in the past.
    B. If your equipment goes down, we will mark time on paper by your station, and you get the time back during make-up time between 4:30 & 5:00 pm
    C. Dress code
    D. Courtesy Corp for bathroom escorts
    E. Lunch will be at 11:30 am (30 minutes) and will be a provided sack lunch
    F. No one removes equipment until 5:00 pm.
    G. Return at 5:00 for teardown. Pack up the equipment, remove the paper from the tables, stack tables & chairs.

Orientation comments - problem:

8. Anyone here that was here last year?
9. You created the Title Block yesterday – make sure you use that.
10. File names are your contestant number- part number, not the other way around. This puts your stuff together on the server.
11. Here is the problem along with the associated references you need. (Do a quick walk-through. 14 pages? Everything readable?)
12. No complaints – this is what it is.
13. Pay attention to the details. "I didn't understand that." Isn't acceptable.
14. Save often – power could die any time.
15. Drawing M9456A01 Mounting Frame is due by 10:30.
16. Drawings M9456A04 Lower Blade Holder and M9456A05 Upper Blade Holder are due by 11:30.
17. Do not submit the other four drawings before 12:15.
18. Contest questions end at 1:00 pm – the customer is gone by then.
19. Drawings that you submit to the printers will be brought to you to initial. Only one initialed plot per drawing will be accepted – more than one per results in disqualification for that plot. Final plots will be delivered to the judges by the Courtesy Corp. Make sure you keep track of what you send – it is your responsibility. (Make sure we don't clear printer cache.)
20. Read through the entire problem first so you know what is expected and then decide how to best use your time. Remember the time deadlines for the first three drawings. Hint – only do the calculations necessary up front in order to get the first drawings done on time.
21. If you have a question about the problem, hold up a copy of it. If you have some other question, hold up a hand without the problem.
22. Questions about the problem will be answered by WT. (And maybe someone else if I can get someone up to speed on the problem.)
23. Don't break the rules – it's not worth it.
24. Hint – submit a required drawing anyway.
25. Have fun!

P.O. Box 3000
Leesburg, VA 20177-0300
Voice: (703) 777-8810
Fax: 703) 777-8999

Memo:

Date: June 23, 2010
To: Technical Drafting Contestants
From: Technical Drafting Committee
Re: Title Block Layout

Overview:
Create a title block such that it will fit on an 11" x 17" (B size) sheet of paper in a landscape orientation.

Text Information:
Unless otherwise specified, all text labels and notes are to be 0.104" tall. All text entered in the title block area for each specific drawing must be 0.146" tall, bold, and fit within the allotted space provided. Remember to always use a font that is readable & appropriate for mechanical drawings, such as Arial, Roman something, etc.

Instructions:

1. Create a 10" x 16" border so that it will fit evenly on the sheet. (The lower right hand corner will be referred to as the reference corner.)
2. Make a horizontal line 8" long and 1.5" up from the bottom border line, with one end of the line coincident with the right edge of the border line.
3. Draw a vertical line that is 1.5" long and 3" to the left of the reference corner, with one end of the line coincident with the bottom edge of the border line.
4. Create two more duplicate vertical lines such that they are spaced 6" & 8" respectively from the reference corner. *You should now have a rectangular shape that measures 1.5" tall and 8" wide and that is divided into 3 major vertical portions.*
5. In the reference corner, create a 3" long horizontal line spaced 0.375" up from the bottom border line, with one end of the line coincident with the right edge of the border line.
6. Create a duplicate parallel line 0.375" up from the before mentioned line, with one end of the line coincident with the right edge of the border line.
7. Equally divide the middle portion of the title block rectangle into 4 horizontal sections.
8. Equally divide the last portion of the title block rectangle into 2 horizontal sections.
9. The vertical portion that is closest to the reference corner will be called portion #1. Portion #2 is located immediately to the left of portion #1, and portion #3 is located to the left of portion #2. In portion #1, label the three boxes (starting with the top one) with DRAWING NAME:, CONTESTANT #:, and CONTESTANT INITIALS:.
10. **Also place your contestant number inside the lower left corner of the drawing border.**
11. In portion #2, label the four boxes (starting with the top one) with WEIGHT:, MATERIAL:, SCALE:, and DWG NO.:.
12. In the SCALE: box, further divide it by putting in a vertical line that is 1.32" to the left of its RH end. Label this new box as SHT NO.:.
13. In portion #3, label the two boxes as shown to the right. Tolerance notes are to be 0.06" tall, the SkillsUSA is to be 0.25" tall and bold, and the city and state are to be .125" tall. Everyone's drawings shall list "LEESBURG, VA", not your home town and state.

Additional Information:

- **Every document that is submitted for judging must have this title block format for points to be awarded.**

JUDGE
REFERENCE
ONLY

000

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCES ARE: FRACTIONS ±1/16 DECIMAL .XX ± .03 .XXX ± .004 ANGLES ± 1°	WEIGHT:		DRAWING NAME:
	MATERIAL:		
SkillsUSA Leesburg, VA	SCALE: 2:1	SHT NO: 1/1	CONTESTANT#: 000
	DWG NO:		CONTESTANT INITIALS: XYZ

P.O. Box 3000
Leesburg, VA 20177-0300
Voice: (703) 777-8810
Fax: (703) 777-8999

Memo:

Date: June 24, 2010
To: Technical Drafting Contestants
From: Technical Drafting Committee
Re: Seam Saw Assembly

Overview:

A major medical equipment manufacturer has requested that our company design a Seam Saw Assembly that will be used to cut open implantable electronic devices that have been LASER welded together. This company has provided pertinent details regarding the Mounting Frame (which will interface with an existing gearbox), the Housing, the Shaft, the Upper and Lower Blade Guards, and the Upper and Lower Blade Holders, as well as the necessary saw blade data and required hardware. This assembly requires that the Mounting Frame be attached to the gearbox using 1/4-20 hardware and a purchased High-Offset Slotted-Disc Shaft Coupler (Coupler Hub Assembly) to attach the gearbox shaft to the Seam Saw Shaft. The Coupler Hub Assembly will need to be altered to provide a relief such that the base of the upper hub half can be installed next to the inner race of the lower bearing. A drawing of the gearbox has been provided to aid in your design.

Drawing Requirements Summary:

For this event you are the assigned Designer and will be drawing/modeling and detailing the first five major items along with the assembly drawing. You have six drawings to submit as listed below.

M9456A00 - Seam Saw Assembly
M9456A01 - Mounting Frame
M9456A02 - Housing
M9456A03 - Shaft
M9456A04 - Lower Blade Guard
M9456A05 - Upper Blade Guard

The remaining manufactured items, M9456A06 - Lower Blade Holder and M9456A07 - Upper Blade Holder, will need to be designed but not detailed on a drawing.

The altered Coupler Hub Assembly will also need to be designed (simplified representation) and properly noted in the BOM, but not detailed on a drawing. Assign a part number of M9456A08 to the altered hub half.

The customer has specified how they want the Bill of Materials (BOM) shown on the assembly drawing. It shall be listed in ascending order (bottom-to-top) and shall be directly above the Title Block. Show “Make” items followed by “Purchased” items.

General Considerations:

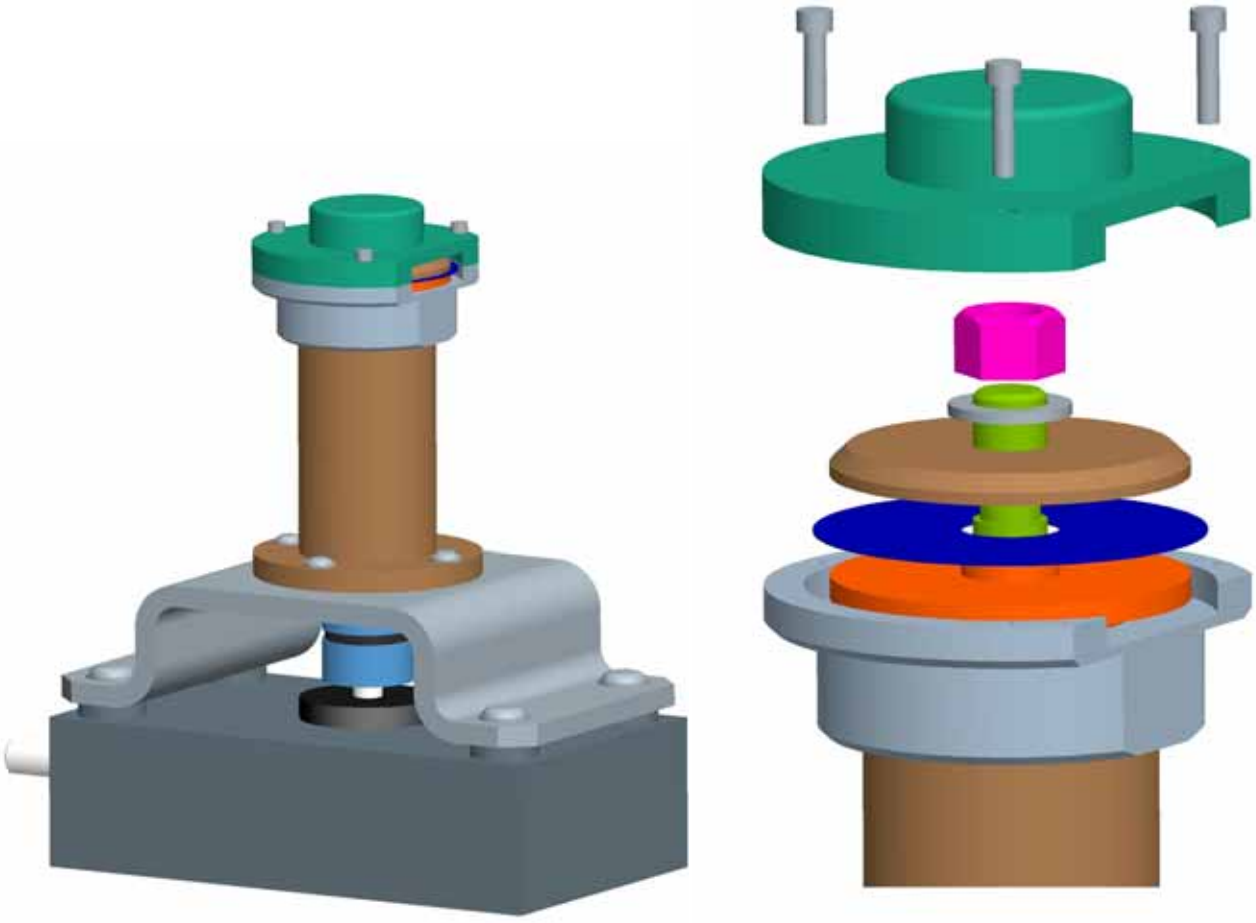
- All dimensions in this documentation are given in inches unless otherwise noted.
- Use nominal dimensions for all parts unless special fits are called for in this document.
- Dimensions are shown in this document as 3 place decimals for clarity.
- Use 2 place decimals when tolerancing non-critical features.
- Use ASME Y14.5M – 1994 symbols where necessary.

- A surface finish of 32 microinches shall be applied to all close tolerance diameter surfaces, which includes the bearing surfaces of the Housing and Shaft, the pilot surfaces of the Housing and the Mounting Frame, and the interface surfaces between the Housing and the Lower Blade Guard. All other surfaces shall have a finish of 63 microinches.
- Unless otherwise specified, all fabricated parts are to be made of Aluminum 6061 T6 and hard Black anodized .0010 thick per MIL-A-8625, TYPE III, Class 2.
- Show all threads as a simplified illustration – hardware excluded, see next bullet.
- Show all related assembly hardware as a simplified representation – exclude threads, lead-in chamfers, and socket head configurations. (Unless you find yourself with extra time at the very end, then go for it.)
- Clearance holes for all fasteners shall be the nominal fastener diameter plus 10%, and then round up to the nearest 1/64th inch standard fractional drill bit size.
- The box labeled "SHT NO.:" in the Title Block of each drawing is to be an indicator of the sheets for that drawing only, not the whole drawing set. So do not enter "3/6", etc.

PART: M9456A00 SEAM SAW ASSEMBLY:

This is the finished Seam Saw Assembly. It shows the proper orientation of the components and how they are to be assembled.

YOUR TASK: *Produce a drawing that shows how to properly put this assembly together, including the mounting hardware. If you have time at the end, show the gearbox as a reference. At a minimum you need to provide a full section view and an exploded isometric view along with the Item Detail Balloons that correspond to the BOM. Include a reference dimension that shows the overall height of the assembly, not counting the fasteners.*



PART: M9456A01 Mounting Frame (Formed or Weldment):

This Mounting Frame is the device that will allow the existing gearbox to be mated to the Housing assembly. It will support the Housing at the correct height and provide the proper alignment between the gearbox shaft and the Seam Saw Shaft. The Mounting Frame can be constructed as either formed sheet metal or as a multi-piece weldment – your choice. Both versions shall be made from 1/4 inch thick Aluminum 5052 H32 and shall be hard Black anodized .0010 thick per MIL-A-8625, TYPE III, Class 2 after all features and operations have been done. The overall length and width shall be such that there is .500 material past the centers of each of the mounting holes, not counting the corner chamfers. The overall height shall be 1.500 and the mounting tab lengths (inside to outside) shall be 1.350. See the Gearbox detail drawing for the mounting hole pattern. The corners are to be chamfered 45 degrees by .310. See the Housing detail to determine the tapped hole arrangement in this part, and match the threads to the selected hardware. Also use the Housing detail to determine the proper pilot hole diameter in order to have a .005 clearance when both parts are at their MMC. The pilot hole shall have a .160 deep counterbored feature and a through ID of 1.094. Use the pilot hole as the origin for dimensioning. Write a statement on your drawing (typed or legibly written) indicating the purpose of the counterbore, and if the feature could be omitted, then how and why. (~50 words or less)

The formed version shall have an inside bend radius of .280 and a K-factor of .47. This part will be LASER cut in the flat pattern shape. Provide a dimensioned flat pattern drawing view with geometry that is appropriate for sending directly to the LASER.

The welded version shall be a multi-piece weldment. You do not have to individually detail each member on a separate sheet – you may either show the dimensions of each piece in the weldment or show details of each on the same sheet. If you choose the welded version, you need to include a proper BOM and balloons. Use best design practices in determining weld joint design, bead type, and placement. Use weld symbols that are appropriate for your design.

Define the following geometric tolerances on the part as follows:
1) Specify a profile tolerance of .005 for the coplanar surfaces as Datum A (the bottoms of the mounting tabs).
2) Specify a parallel tolerance of .010 for the top surface, in the Free State, with respect to Datum A.

YOUR TASK*: Produce a drawing with the necessary views of this part in its final form (and flat pattern if elected) that include the correct features for the chosen version. Also include an isometric view.*

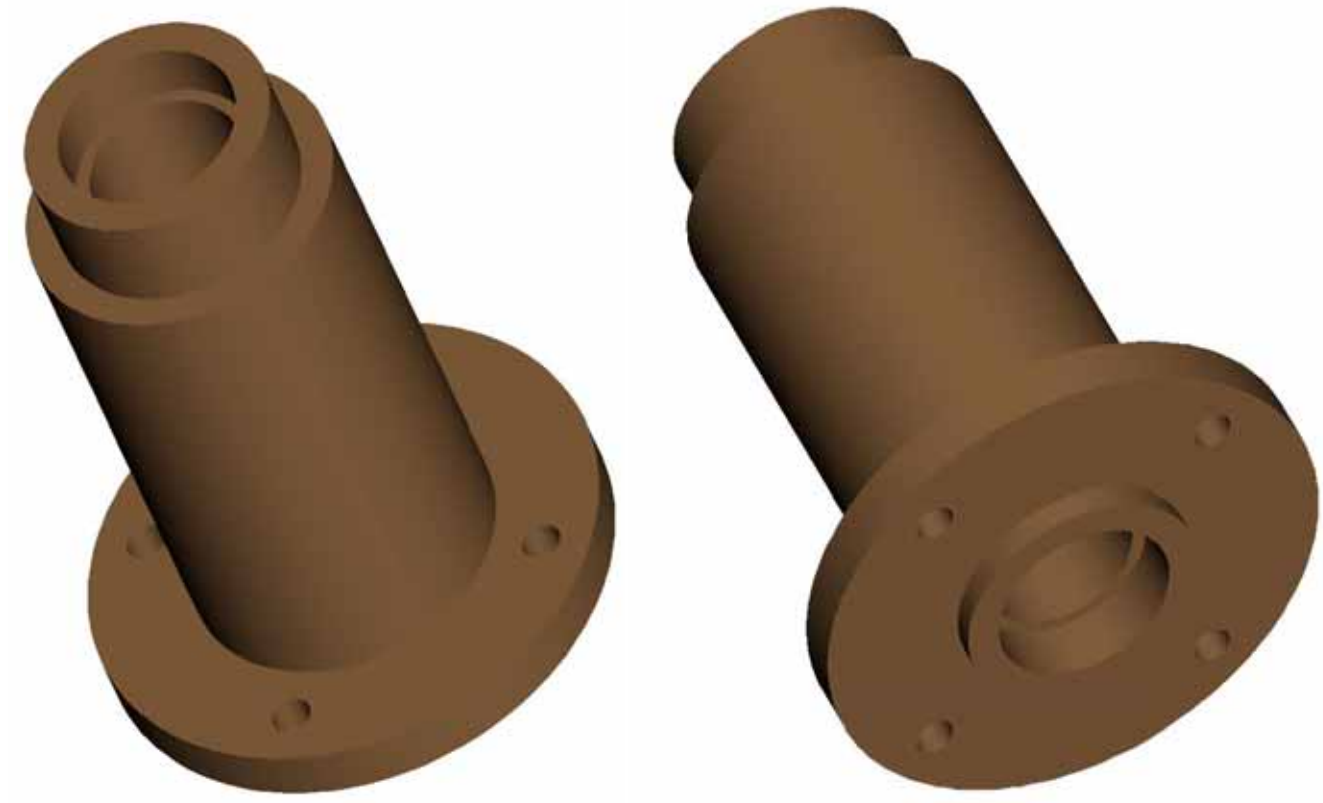
PART: M9456A02 Housing:

This is the main component of this engineering project. This component has two surfaces for ball bearings that have an LT1 fit and a "pilot" for interfacing with the Mounting Frame. Additionally, there is a cylindrical feature with an RC5 fit that holds the Lower Blade Guard, allowing it to rotate freely in the assembly.

Define the following geometric tolerances on the part as follows:
1) Identify Datum A as the bottom surface that mounts against the Mounting Frame.
2) Designate the ⌀.750 shaft hole as Datum B and apply a perpendicularity tolerance of .002, with a cylindrical tolerance zone shape, with respect to Datum A. Although this is a feature-of-size, do not use a material condition modifier.
3) Add a parallelism of .005, relative to Datum A, to the shoulder feature that the Lower Blade Guard sits on.
4) The ⌀1.180 ±.003 "pilot" feature needs a positional tolerance of .002 at MMC, with a cylindrical tolerance zone shape, with respect to Datum B at RFS.
5) The four mounting holes shall be specified with a positional tolerance of .010 at maximum material condition with respect to Datum A and Datum B. Remember, feature-of-size datum features need a material condition modifier.
6) Add a positional tolerance, with a cylindrical tolerance zone shape, of .0004 with respect to Datum B on the two bearing OD's.

The Housing is: 2.805 ±.002 between the bearing shoulders, has a major OD of 2.500 at the flange, the main body has an OD of 1.500, and the through hole for the Shaft (Datum B) is .750. Radially center (on the top face) the four mounting through holes on the flange. Counterbore the two ends to allow the bearings to be .004 below the surface at nominal and up to flush at MMC. The shoulder depth for the Lower Blade Guard is .495 ±.005 with a nominal diameter of 1.200. The height of the "pilot" shall be such as to leave .035 nominal clearance to the bottom of the pilot hole in the Mounting Frame. Break the outer edge of the "pilot." The thickness of the flange is .250. Show the overall height of the part as a reference dimension.

YOUR TASK: *Produce a drawing for this part that properly defines all the features. At a minimum include a full section front view, and an isometric view.*



PART: M9456A03 Shaft:

This component represents a threaded shaft onto which two ball bearings will be lightly pressed. The bearings have a measured ID of .378. Select a proper fit, and dimension the bearing journals accordingly per the nominal measured size of the bearings. The shaft will have provisions to locate the Lower and Upper Blade Holders along with a SST Washer and 3/8-24 SST Hex Nut. The threaded portion of the shaft shall be such as to prevent the Hex Nut from loosening when the shaft is turning in a clockwise direction as viewed from the top. The material for the shaft is 316L Stainless Steel and shall be passivated after machining.

Write a statement on your drawing (typed or legibly written) indicating the purpose of the passivation. (~25 words or less)

Define the following geometric tolerances on the part as follows:
1) Identify Datum A as the .500 OD.
2) Show a total runout of .001, relative to Datum A, on the 5/16 diameter on the coupler end.
3) Show a total runout of .0005, relative to Datum A, on the two bearing journals.

The Shaft has a major OD of .500. The distance and tolerances between the bearing shoulders are the same as the Housing. The threaded end of the shaft is 1.175 from tip to bearing shoulder with .590 of threaded area (including chamfers). The coupler end of the shaft is .636 long from tip to bearing shoulder and includes a 5/16 diameter with a .040 by .280 flat. Place a .010 maximum fillet between the bearing journals and related shoulder. Place a .100 wide relief between the threaded area and bearing journal, and make the diameter of it .020 less than the standard tap drill size for this thread. The length of the lower bearing journal shall be defined as a 3 place decimal. Determine that length such that the journal will never extend past the face of the bearing, and in that extreme condition, make the face of the journal and the end of the bearing flush with each other. Add chamfers where appropriate. Show the overall length of the shaft as a reference dimension.

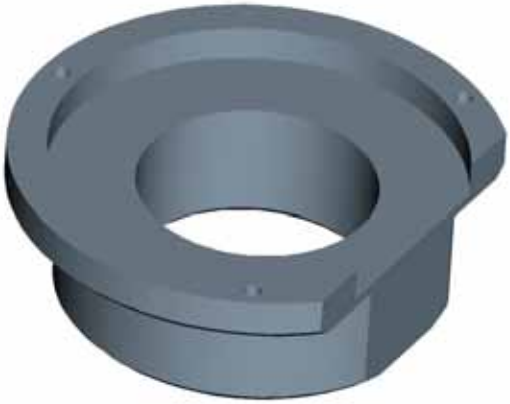
YOUR TASK: *Produce a fully dimensioned drawing for the Shaft as described. Use a minimum number of views to detail this component. Also include an isometric view.*

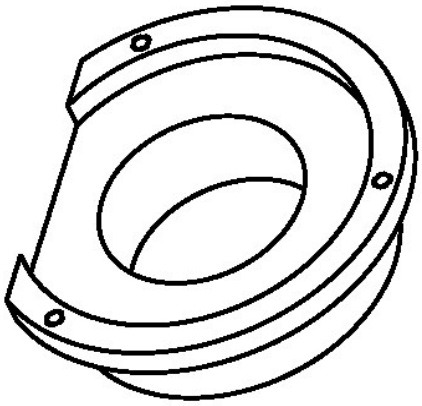
PART: M9456A04 Lower Blade Guard:

This item is the base component of the blade guard assembly and shall rotate freely (RC5 Fit) on the upper portion of the Housing. This Guard, when properly installed and assembled to the Upper Blade Guard, allows limited exposure to the rotating components when the Seam Saw is in operation. The two Blade Guards are held together by means of three #4-40 X 1/2" long SHCS.

The outer diameter is 2.500 (before flat feature) and the overall height is .800. The cavity for the Lower Blade Holder is .175 deep with a 1.050 radius, and the mounting flange is .250 thick. The minor OD is 1.960 before inclusion of the flat feature, which is created such that the blade is exposed by .100. There are three equally spaced tapped holes, radially centered on the top face of the flange, and centered relative to the flat side. Apply a 45 degree by .050 chamfer to the lower edge of the 2.500 diameter flange and to the lower inside and outside edges of the 1.960 feature, all before the flat feature is made.

YOUR TASK: *Produce a drawing of the Lower Blade Guard that includes a front sectional view and other appropriate views. Also include an isometric view.*



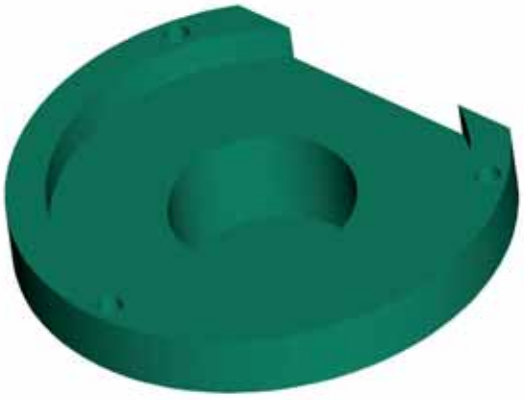


PART: M9456A05 Upper Blade Guard:

This item forms the top component of the blade guard assembly when assembled to the Lower Blade Guard and allows limited exposure to the rotating components when the Seam Saw is in operation.

Use the necessary features from the Lower Blade Guard to design this part including the following information: The overall height is .750, the flange thickness is .312, the recess for clearance of the Hex Nut is .940 in diameter by .660 deep as measured from the flange face, the outer diameter of the recessed feature is 1.250, and the cavity depth for clearance of the Upper Blade Holder is .180. There is a .060 radius on the outside edge of the 1.250 diameter.

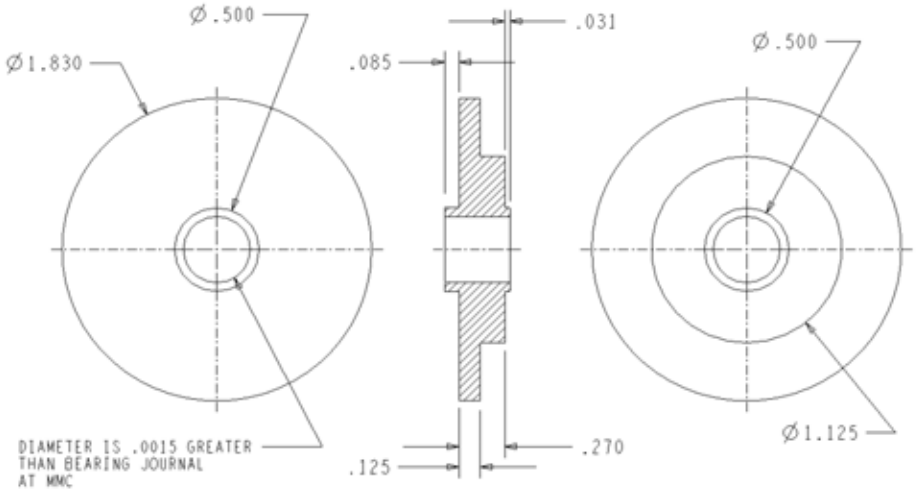
YOUR TASK: *Produce a drawing of the Lower Blade Guard that includes a front sectional view and other appropriate views. Also include an isometric view.*



PART: M9456A06 Lower Blade Holder:

This component, in combination with the Upper Blade Holder, provides support for the Thurston Jewelers Slotting Saw Blade and acts as a depth gauge to prevent the blade from penetrating the welded seam too deeply, which could cause unintentional damage to internal components of the medical device. For this contest you only need to show this simplified version – no detail drawing required.

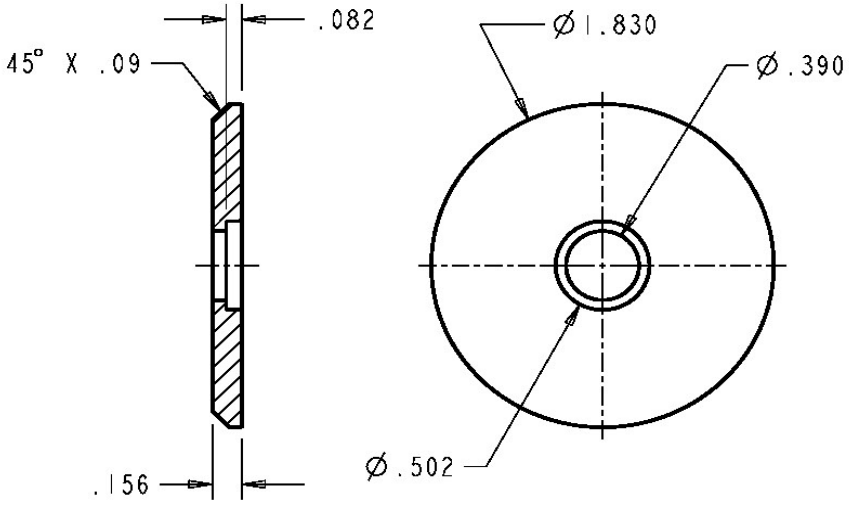
YOUR TASK: *Create this part per the provided dimensions and show this component in all related assembly views and in the BOM.*



PART: M9456A07 Upper Blade Holder:

This component, in combination with the Lower Blade Holder, provides support for the Thurston Jewelers Slotting Saw Blade. It has clearance for the location shoulder on the Lower Blade Holder as well as for the Shaft. It is held firmly in place by a Washer and Hex Nut. For this contest you only need to show this simplified version – no detail drawing required.

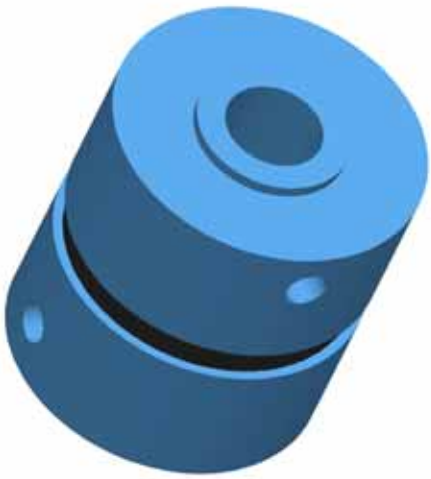
YOUR TASK: *Create this part per the provided dimensions and show this component in all related assembly views and in the BOM.*



PART: Coupler Hub Assembly - Alter:

This assembly is made up of purchased components from McMaster-Carr. The High-Offset Slotted-Disc Shaft Coupling is comprised of two coupling hubs and a coupling disc. For this application select the Set-Screw Coupling Hub and the correct Acetal Coupling Disc. Specify both the part number for the Coupling Hubs and the Coupling Disc in the BOM.

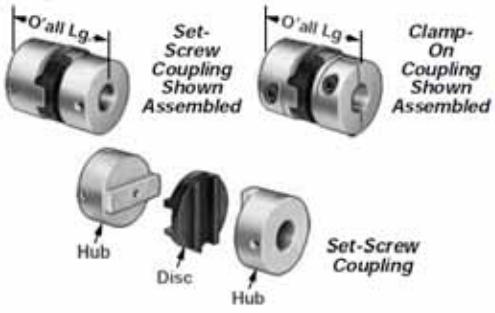
YOUR TASK: *Select the correct Coupling Hub from the available bore sizes that will fit the OD of both the Seam Saw assembly Shaft and Gearbox shaft, and fit within the available space. Alter one of the Coupling Hubs by adding a .040 step with a .490 OD to allow the hub to be installed against the inner race of the lower Ball Bearing. Properly indentify this hub, the other Hub, and the Coupling Disc in the BOM. No detail drawing required – show a simplified version of the altered Coupler Hub assembly (including the Coupling Disc) in all related assembly views and in the BOM.*



Flexible Shaft Couplings

For information about couplings and ANSI keyway dimensions, see page 1160.

High-Offset Slotted-Disc Shaft Couplings



Also known as Oldham couplings, these couplings have a slotted disc that allows hubs to slide independently to compensate for parallel misalignment. They allow zero backlash (no play) and never need lubrication. Maximum rpm is 4500. For a complete coupling, you need to order two hubs and one disc from the same line in the listing below (for example, 59985K1 hubs are designed to work with either 59985K61 or 59985K91 discs).

Set-screw couplings connect to shafts with two or four alloy steel set screws. ***Clamp-on couplings*** connect to shafts via integral shaft collars, which won't damage your shaft. Tighten the two alloy steel socket-head cap screws to secure.

Hubs—Made of lightweight, corrosion-resistant anodized aluminum, the hubs easily slide out of the disc for quick assembly and disassembly. **To Order:** Please specify bore size from those available below. *Note:* You can use two hubs with different bore sizes in one coupling as long as the hub ODs are the same.

Acetal Discs—Stand up to high twisting forces. Temp. range is –10° to +150° F.

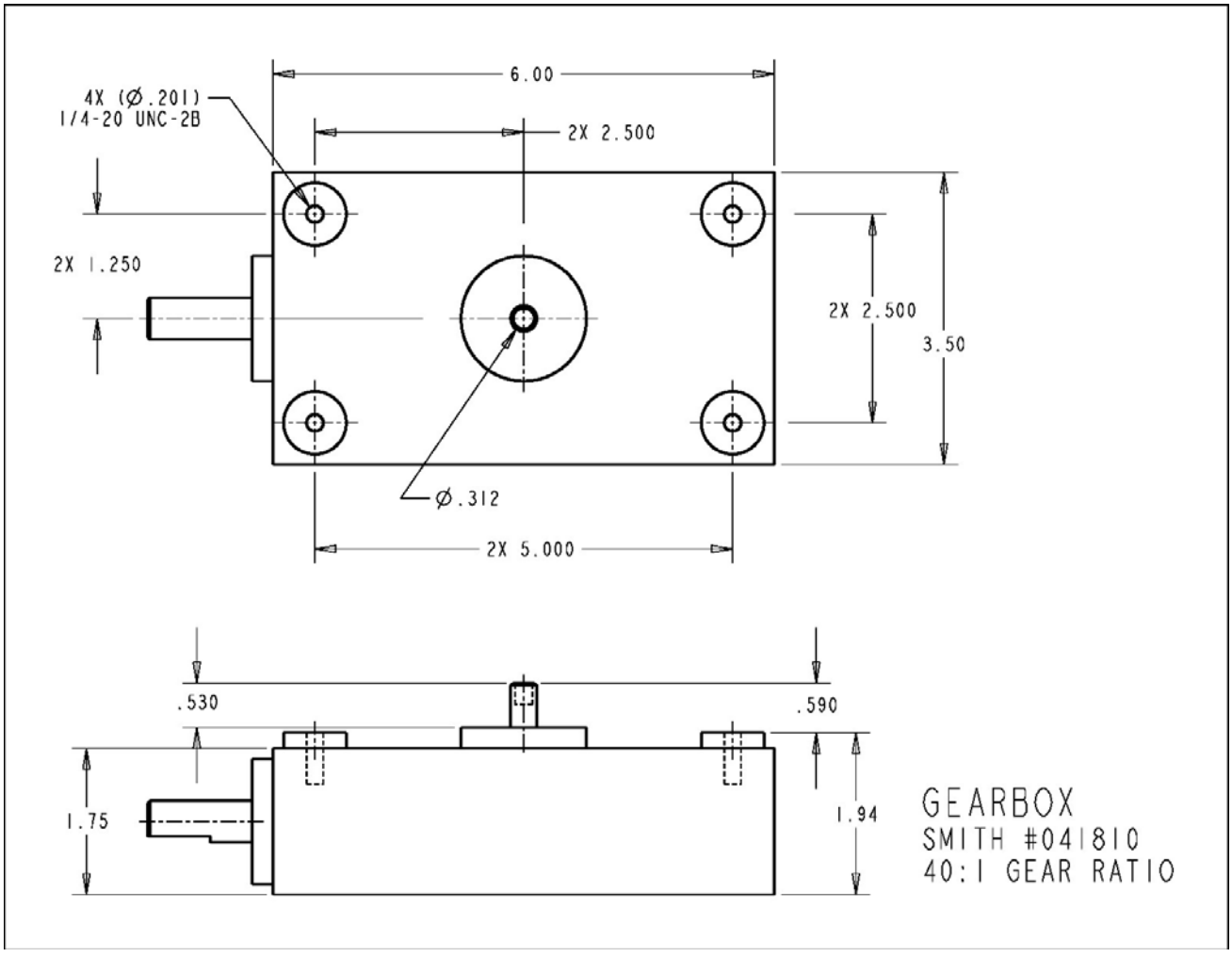
Nylon Discs—Have excellent vibration and shock absorption. Temp. range is –10° to +130° F.

COUPLING HUBS							COUPLING DISCS							
							Maximum Misalignment			Acetal Discs			Nylon Discs	
Available Bore Sizes	O'all Lg.	Hub OD	Bore Depth	Screw Size		Each	Parallel	Angular	Axial	Peak Torque, in.-lbs.		Each	Peak Torque, in.-lbs.	Each
Set-Screw Couplings														
1/8", 3/16", 1/4"	5/8"	1/2"	0.22"	M3	59985K1	$7.50	0.004"	0.5°	0.002"	34	59985K61	$1.81	25	59985K91 $2.42
3/16", 1/4", 5/16", 3/8"	7/8"	3/4"	0.30"	M3	59985K2	9.27	0.008"	0.5°	0.004"	93	59985K62	2.16	85	59985K92 3.35
1/4", 5/16", 3/8", 1/2"	1 1/8"	1"	0.39"	M4	59985K3	10.81	0.008"	0.5°	0.004"	168	59985K63	3.99	140	59985K93 4.85
5/16", 3/8", 1/2", 5/8"	1 7/8"	1 5/16"	0.59"	M4	59985K4	16.28	0.008"	0.5°	0.006"	350	59985K64	5.80	300	59985K94 7.13
3/8", 1/2", 5/8", 3/4"	2"	1 5/8"	0.71"	M5	59985K5	19.25	0.010"	0.5°	0.006"	480	59985K65	7.71	400	59985K95 10.55
Clamp-On Couplings														
3/16", 1/4", 5/16", 3/8"	1"	3/4"	0.38"	M2.5	9889T1	10.64	0.008"	0.5°	0.004"	93	59985K62	2.16	85	59985K92 3.35
1/4", 5/16", 3/8", 1/2"	1 1/4"	1"	0.467"	M3	9889T2	14.63	0.008"	0.5°	0.004"	168	59985K63	3.99	140	59985K93 4.85
5/16", 3/8", 1/2", 5/8"	1 7/8"	1 5/16"	0.59"	M3	9889T3	21.60	0.008"	0.5°	0.006"	350	59985K64	5.80	300	59985K94 7.13
3/8", 1/2", 5/8", 3/4"	2"	1 5/8"	0.71"	M4	9889T4	23.43	0.010"	0.5°	0.006"	480	59985K65	7.71	400	59985K95 10.55

GEARBOX:

This component is provided by the customer and it drives the Seam Saw assembly.

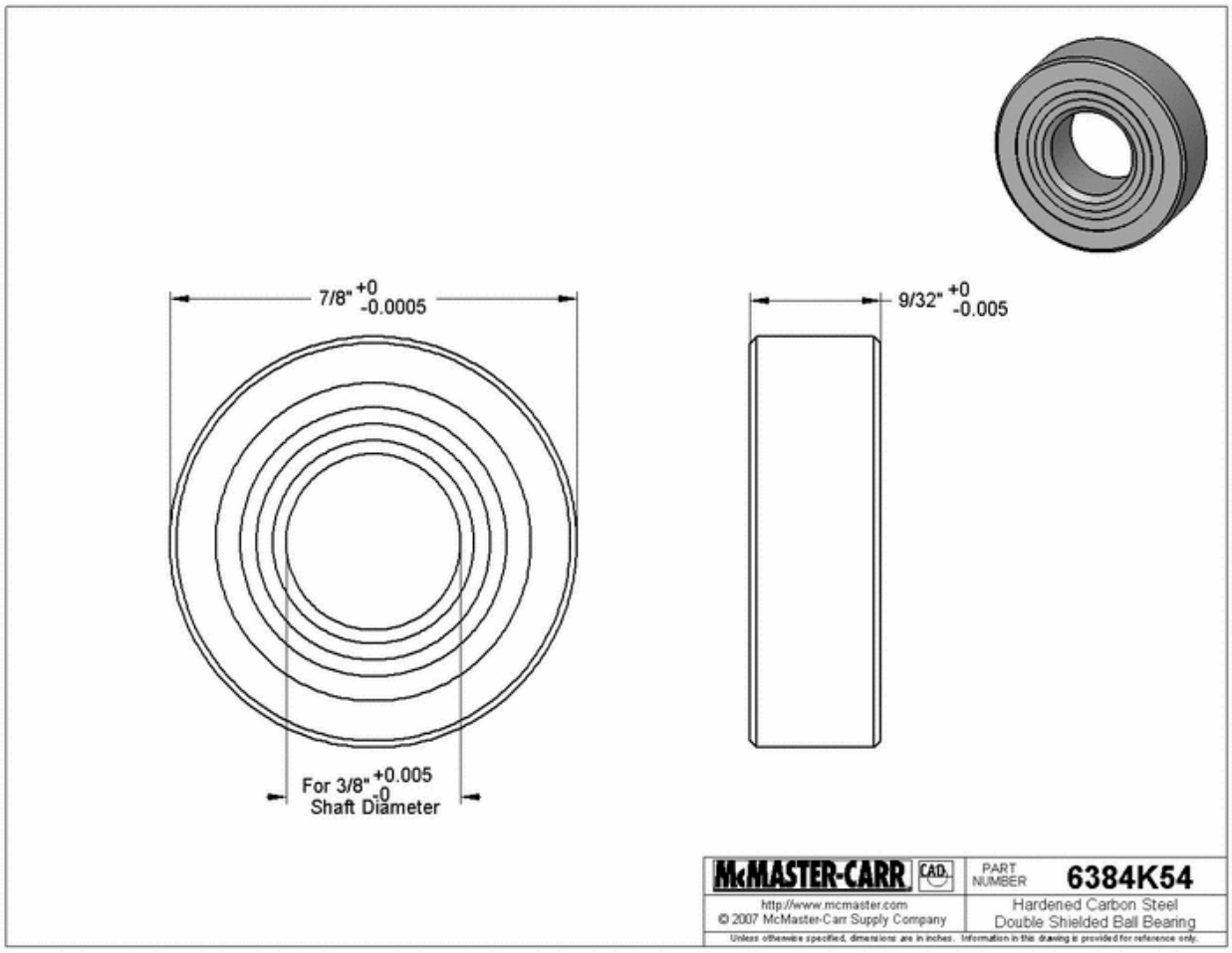
YOUR TASK: *Review the supplied Specification Control Drawing for the SMITH #041810 Gearbox and apply the necessary information to the Mounting Frame and the Coupler Hub selection.*

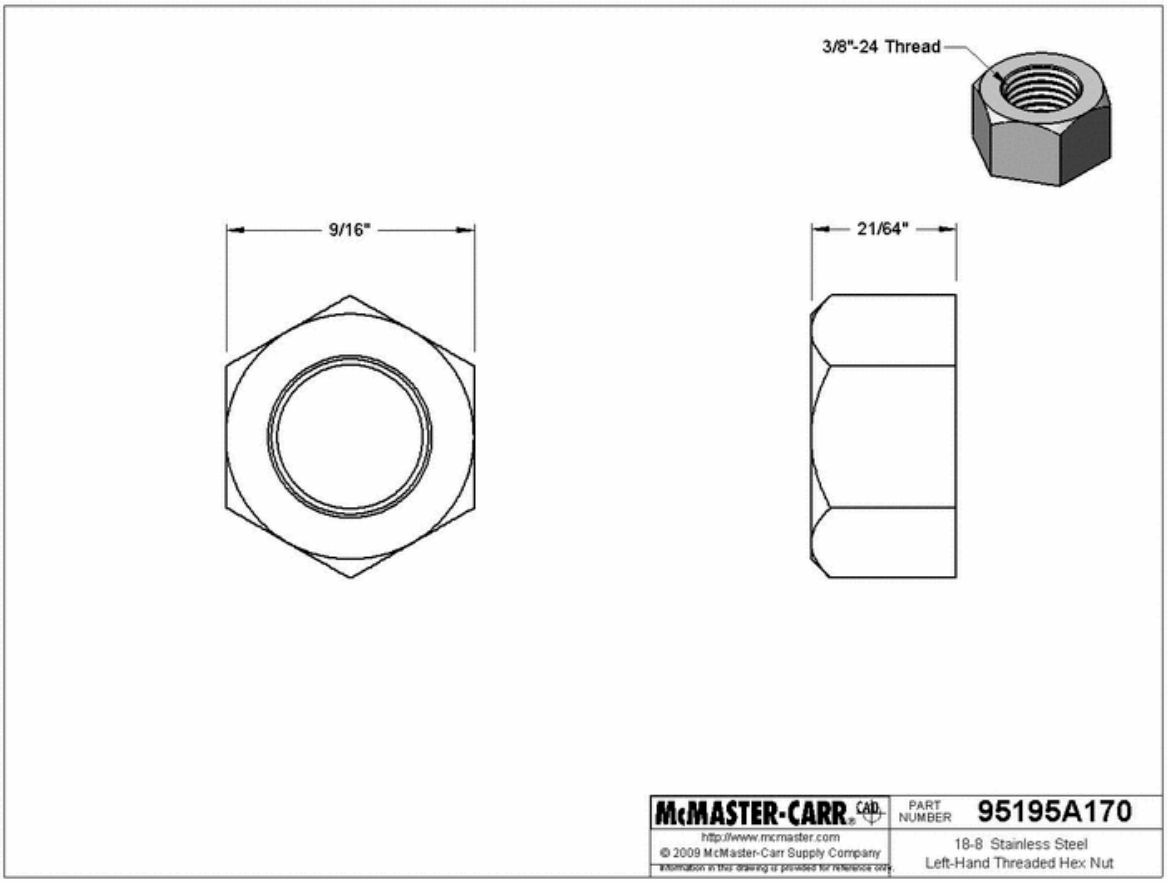


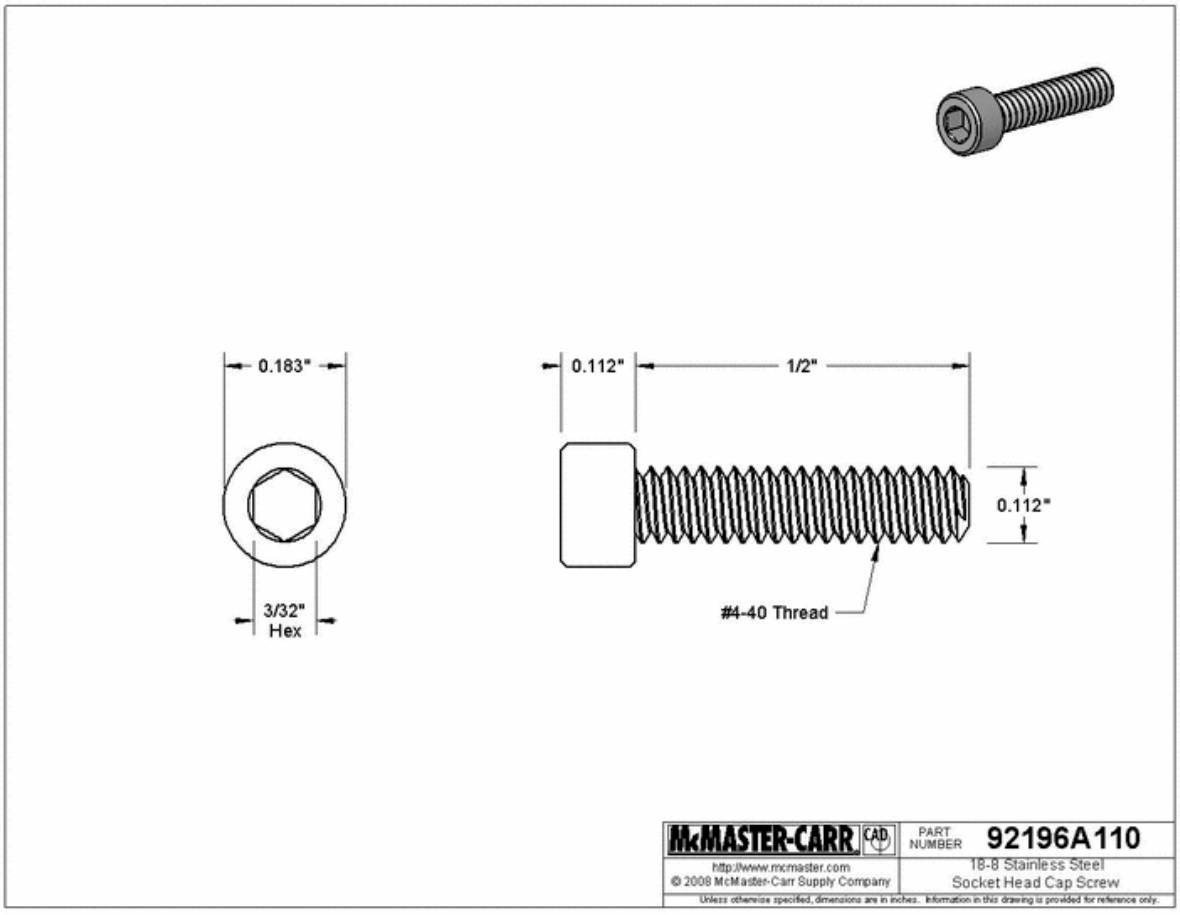
HARDWARE: Simplified Form:

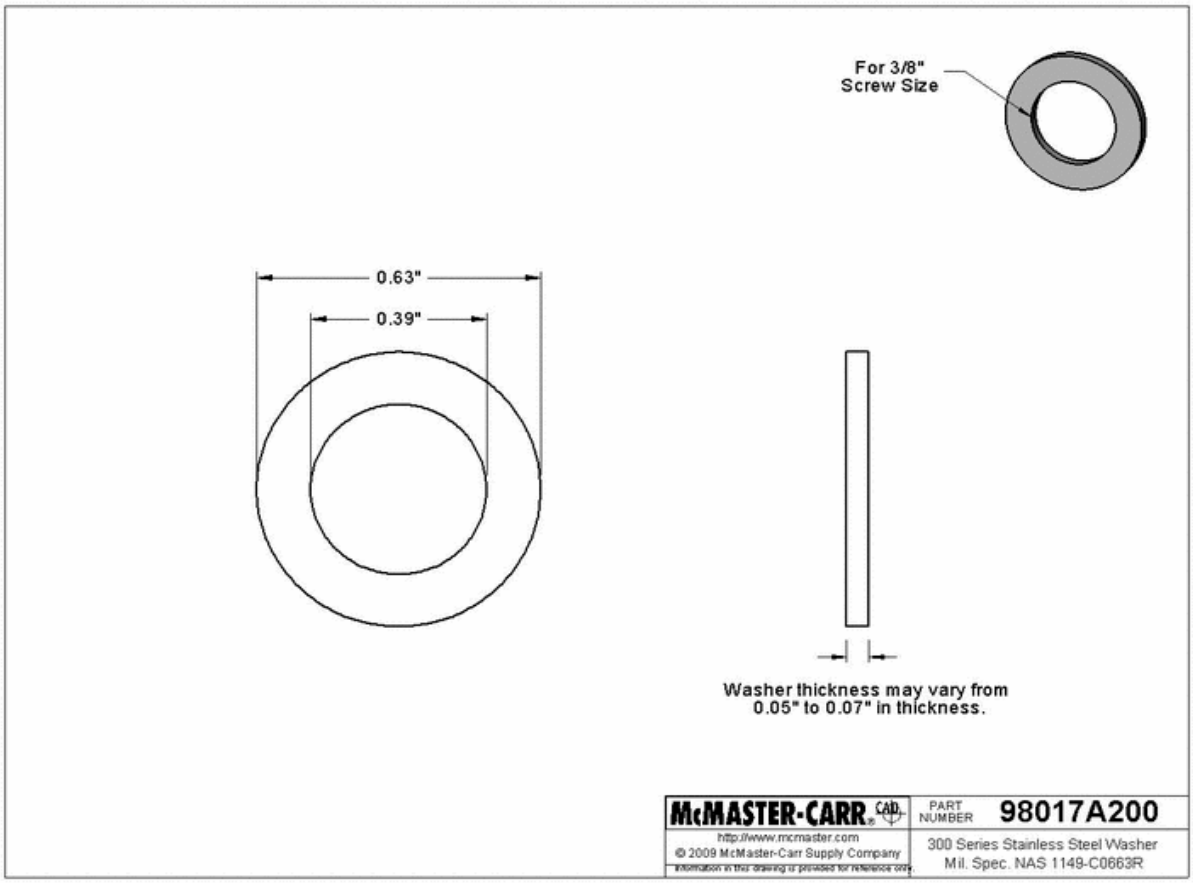
All assembly hardware is to be ordered from McMaster-Carr. See the provided Cut-Sheets for each item.

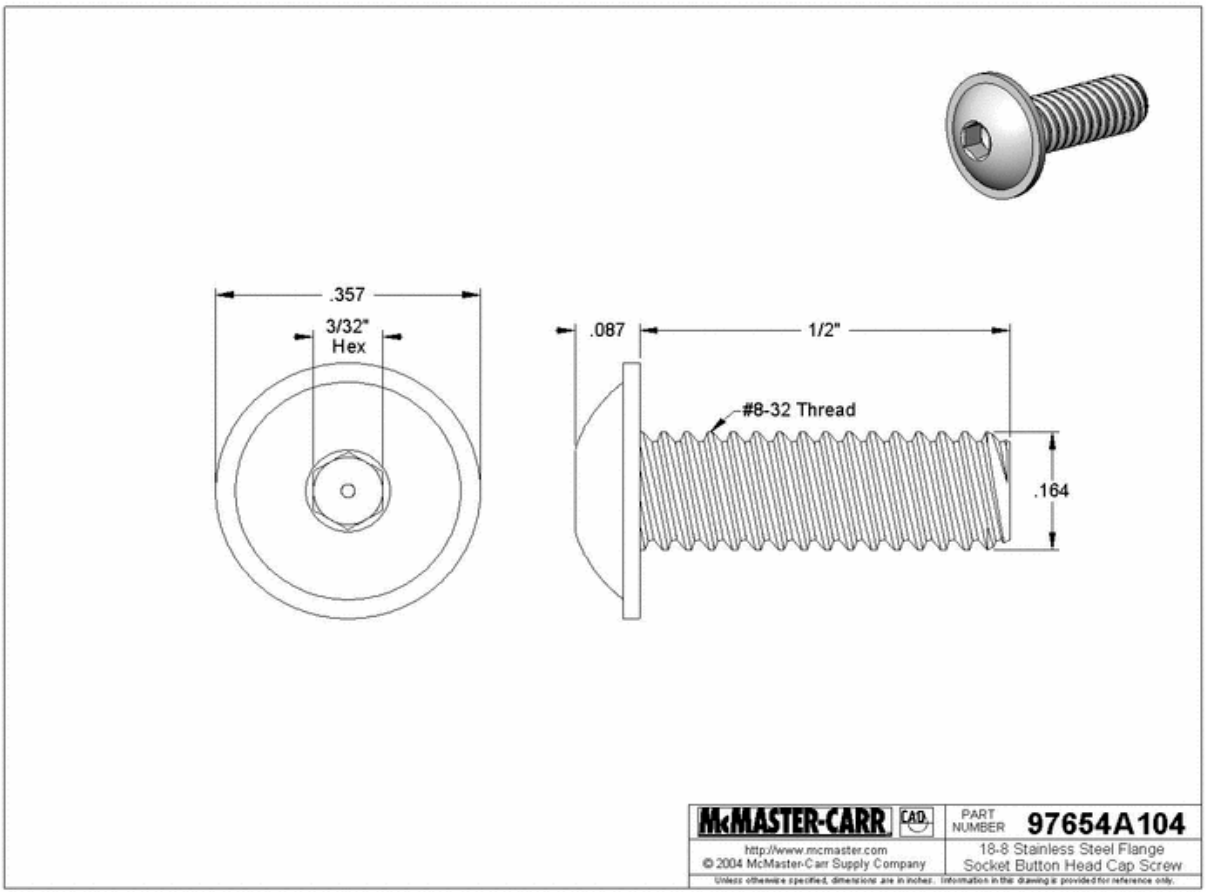
YOUR TASK: *Produce a simplified representation of all hardware to be used in the final assembly. Properly identify hardware in the BOM and on the assembly drawing.*

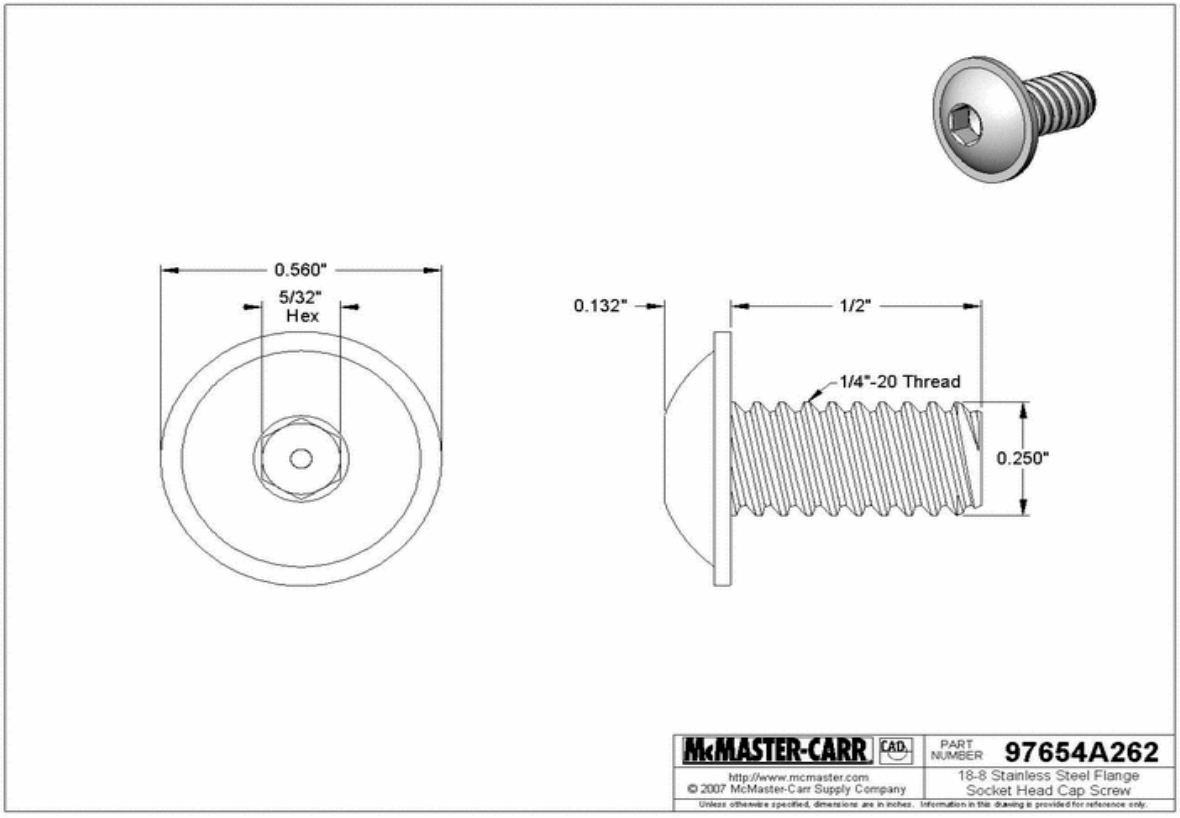



3/8"-24 Thread
9/16"
21/64"
McMASTER-CARR CAD
PART NUMBER 95195A170
http://www.mcmaster.com
© 2009 McMaster-Carr Supply Company
Information in this drawing is provided for reference only.
18-8 Stainless Steel
Left-Hand Threaded Hex Nut


0.183"
3/32"
Hex
0.112"
1/2"
0.112"
#4-40 Thread
McMASTER-CARR CAD
PART NUMBER 92196A110
http://www.mcmaster.com
© 2008 McMaster-Carr Supply Company
18-8 Stainless Steel
Socket Head Cap Screw
Unless otherwise specified, dimensions are in inches. Information in this drawing is provided for reference only.


For 3/8"
Screw Size
0.63"
0.39"
Washer thickness may vary from
0.05" to 0.07" in thickness.
McMASTER-CARR
CAD
http://www.mcmaster.com
© 2009 McMaster-Carr Supply Company
PART NUMBER 98017A200
300 Series Stainless Steel Washer
Mil. Spec. NAS 1149-C0663R


.357
3/32"
Hex
.087
1/2"
#8-32 Thread
.164
McMASTER-CARR
CAD
http://www.mcmaster.com
© 2004 McMaster-Carr Supply Company
PART NUMBER 97654A104
18-8 Stainless Steel Flange
Socket Button Head Cap Screw



Thurston Jewelers Slotting Saws

M-2 Grade High Speed Steel

Designed for slotting thin materials, requiring light, delicate cuts such as wire, thin tubing, or similar profiles.

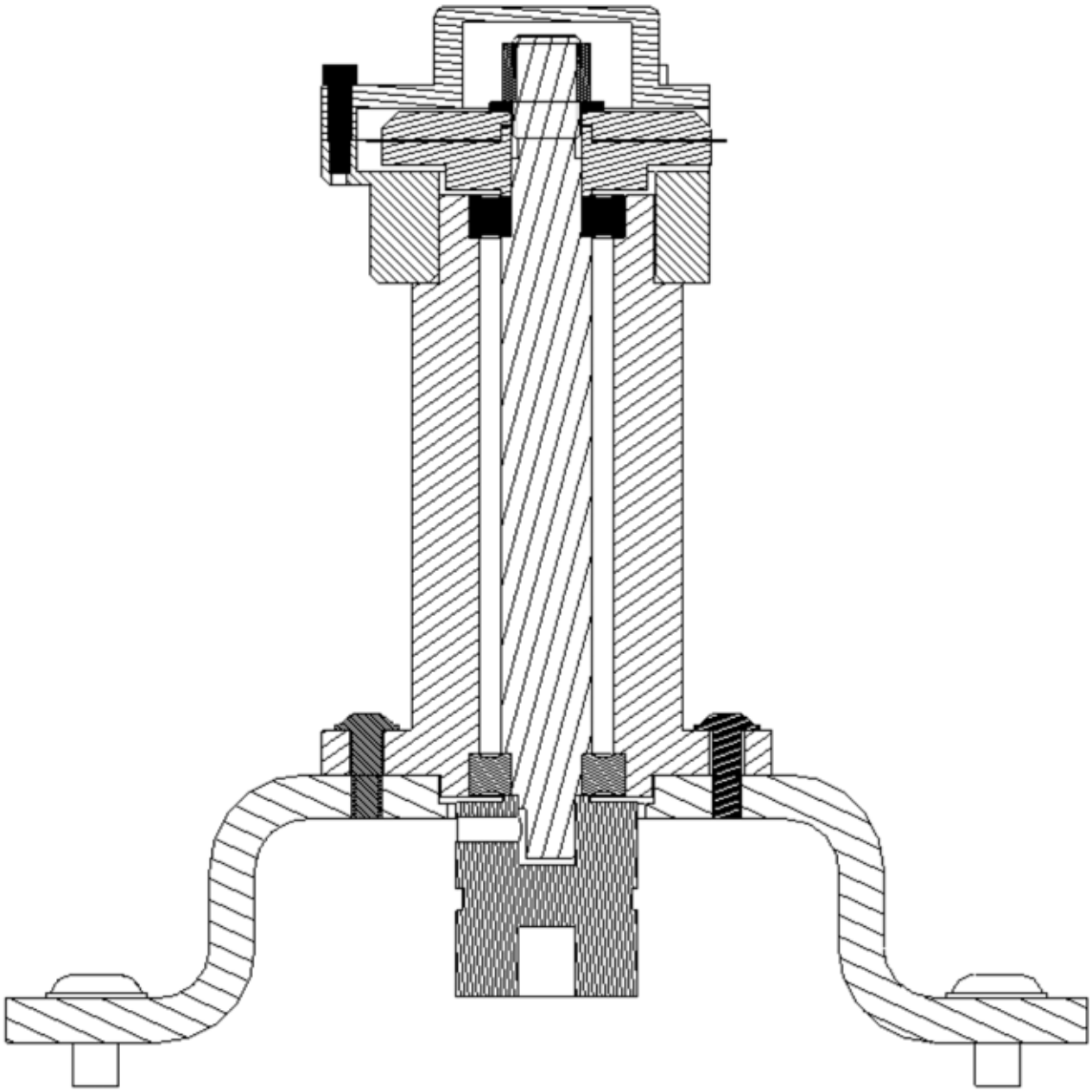
Ground tooth profile.

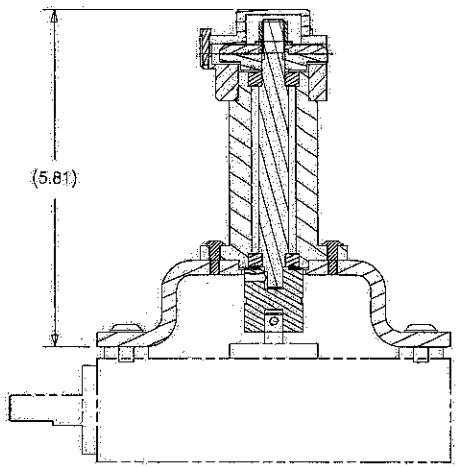
Concave ground sides insure proper side relief.

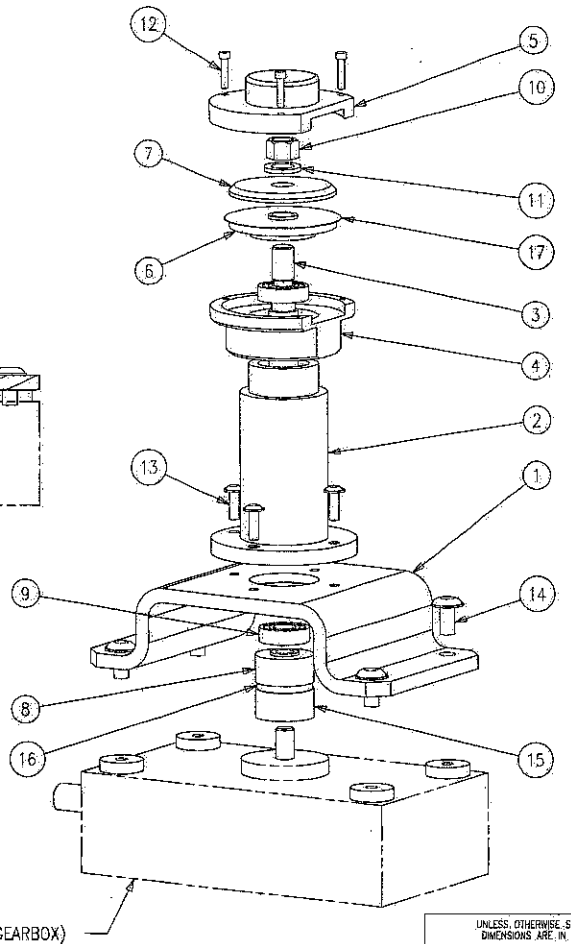
All blades individually straightened.

CATALOG NO.	DIAMETER	THICKNESS	SIZE OF HOLE	NO. TEE INCH
65CC	2	.012	3/8	30 TPI
65	2	.012	1/2	30 TPI

Full section view for reference







(SMITH #041810 GEARBOX)

JUDGES: If Gearbox is shown then a reference note, as shown, should be present.

JUDGE REFERENCE ONLY

000

ITEM NO.	QTY	PART NO.	DESCRIPTION
17	1	THURSTON #65	JEWELERS SAW BLADE
16	1	MCMASTER 59985K63	COUPLING DISC - ACETAL
15	1	MCMASTER 59985K3-5/16	COUPLING HUB
14	4	MCMASTER 97654A262	1/4-20 X 1/2 LG BHSCS
13	4	MCMASTER 97654A104	#8-32 X 1/2 LG BHSCS
12	3	MCMASTER 92196A110	#4-40 X 1/2 LG SHCS
11	1	MCMASTER 98017A200	WASHER - SST
10	1	MCMASTER 95195A170	3/8-24 LH HEX NUT
9	2	MCMASTER 5972K164	BALL BEARING, STEEL
8	1	M9456A08	COUPLING HUB - ALTER
7	1	M9456A07	UPPER BLADE HOLDER
6	1	M9456A06	LOWER BLADE HOLDER
5	1	M9456A05	UPPER BLADE GUARD
4	1	M9456A04	LOWER BLADE GUARD
3	1	M9456A03	SHAFT
2	1	M9456A02	HOUSING
1	1	M9456A01	MOUNTING FRAME

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES
TOLERANCES ARE: FRACTIONS ± 1/16, DECIMAL .XX ± .03, .XXX ± .004, ANGLE ± 1°

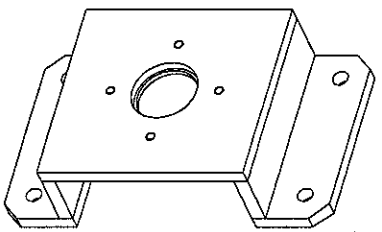
SkillsUSA
LEESBURG, VA

WEIGHT: 1.87 #
MATERIAL: NA
SCALE: 1:2
SHT NO.: 1/1
DWG NO.: M9456A00

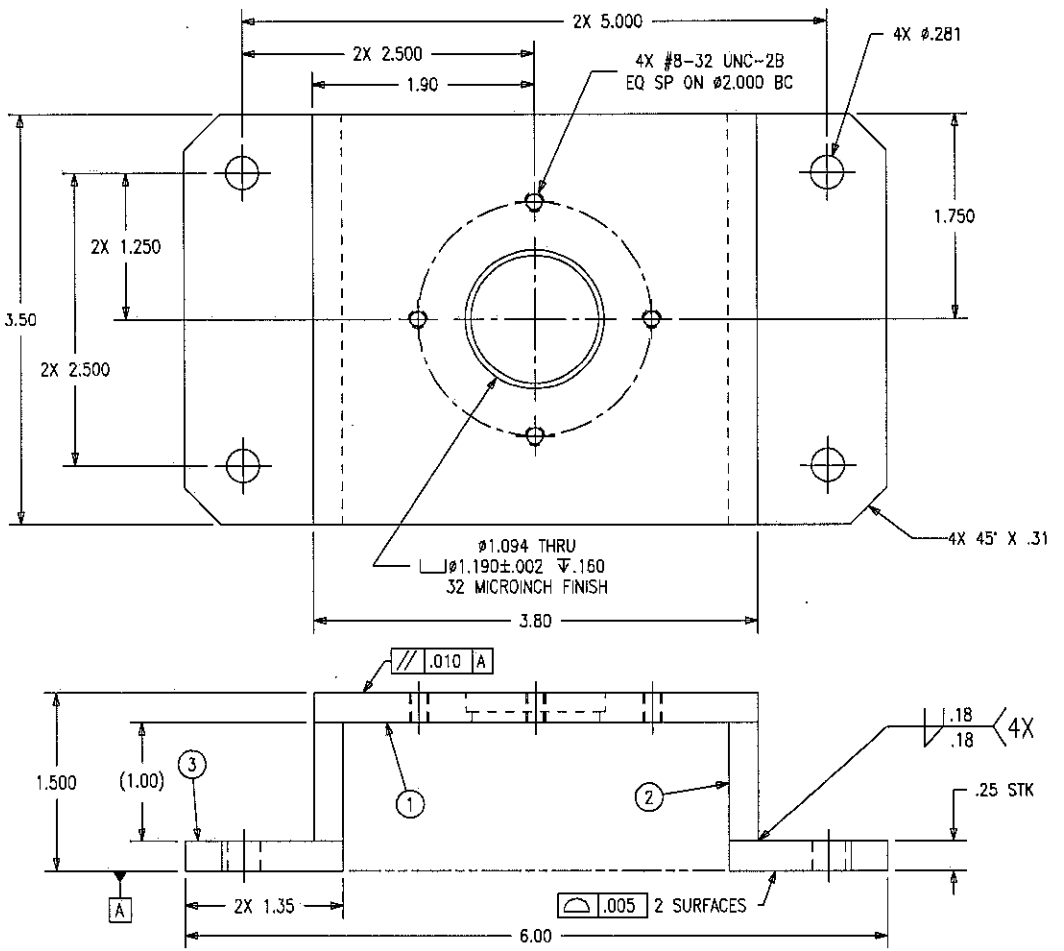
DRAWING NAME: SEAM SAW ASSEMBLY
CONTESTANT #: 000
CONTESTANT INITIALS: XYZ

NOTES: (UNLESS OTHERWISE SPECIFIED)
1. BREAK EDGES AND CORNERS
2. FINISH: 63 MICROINCHES OR BETTER
3. HARD BLACK ANODIZE .0010 THK PER MIL-A-8625, TYPE III, CLASS 2

Purpose of counterbore note.



SCALE 1:2



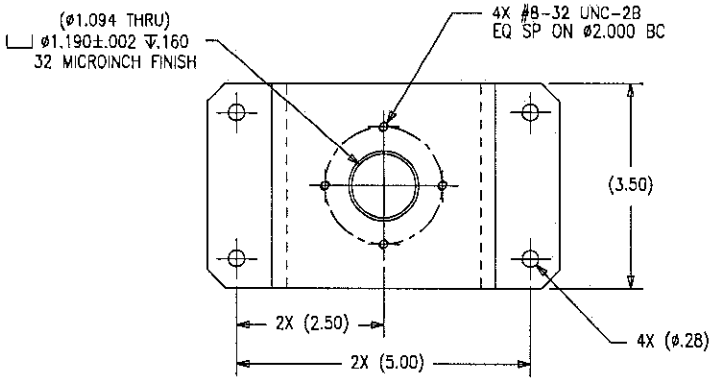
ITEM	QTY	DESCRIPTION
3	2	MOUNTING TAB
2	2	SIDE
1	1	TOP

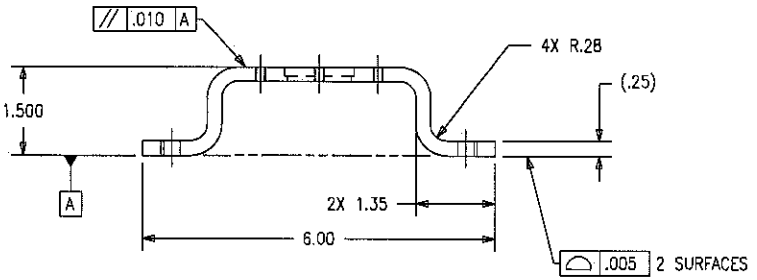
UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES. TOLERANCES ARE: FRACTIONS ± 1/16, DECIMAL .XX ± .03 .XXX ± .004, ANGLE ± 1°	WEIGHT: 0.69 #	DRAWING NAME: MOUNTING FRAME
	MATERIAL: ALUM 5052 H32	
SkillsUSA LEESBURG, VA	SCALE: 1:1 SHT NO.: 1/1	CONTESTANT #: 000
	DWG NO.: M9456A01	CONTESTANT INITIALS: XYZ

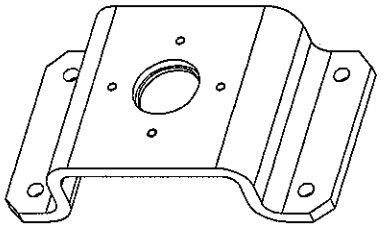
JUDGE REFERENCE ONLY

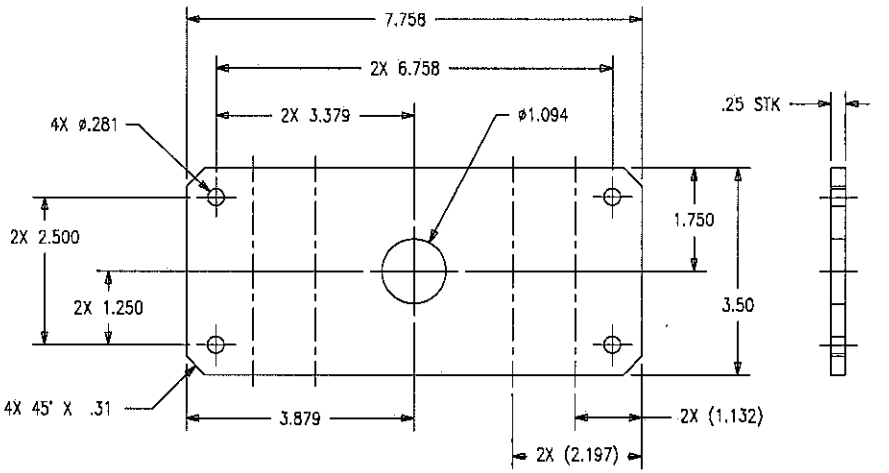
000

NOTES: (UNLESS OTHERWISE SPECIFIED)
1. BREAK EDGES AND CORNERS
2. FINISH: 63 MICROINCHES OR BETTER
3. BEND K-FACTOR: .47
4. HARD BLACK ANODIZE .0010 THK PER MIL-A-8625, TYPE III, CLASS 2









LASER CUT FLAT PATTERN

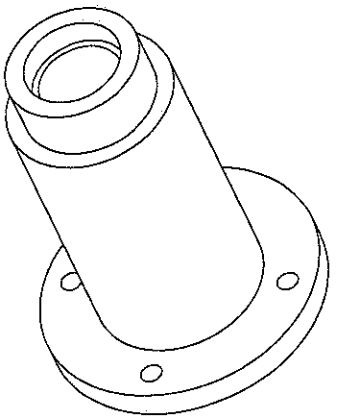
Purpose of counterbore note.

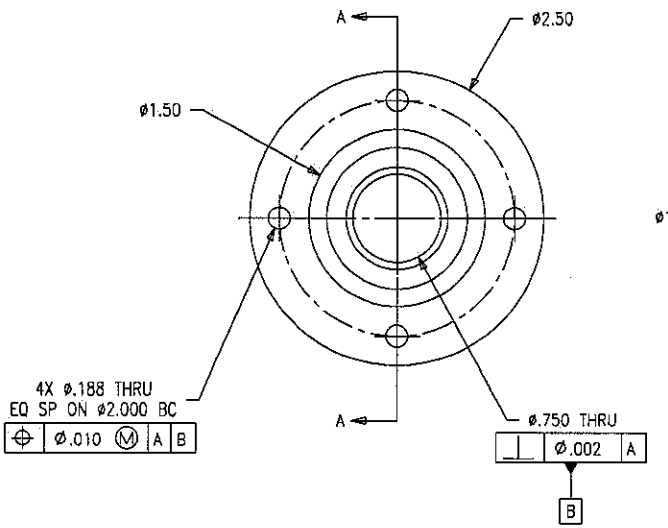
JUDGE REFERENCE ONLY

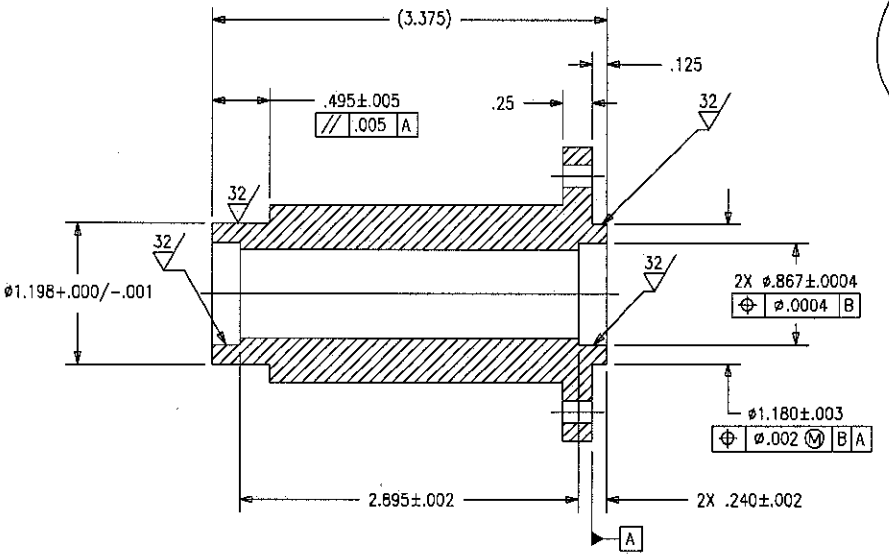
000

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES. TOLERANCES ARE: FRACTIONS ± 1/16, DECIMAL .XX ± .03, .XXX ± .004, ANGLE ± 1°	WEIGHT: 0.63 #		DRAWING NAME: MOUNTING FRAME
	MATERIAL: ALUM 5052 H32		
SkillsUSA LEESBURG, VA	SCALE: 1:2	SHT NO.: 1/1	CONTESTANT #: 000
	DWG NO.: M9456A01		CONTESTANT INITIALS: XYZ

NOTES: (UNLESS OTHERWISE SPECIFIED)
1. BREAK EDGES AND CORNERS
2. FINISH: 63 MICROINCHES OR BETTER
3. HARD BLACK ANODIZE .0010 THK PER MIL-A-8625, TYPE III, CLASS 2







SECTION A-A

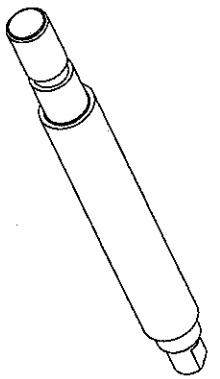
JUDGE REFERENCE ONLY

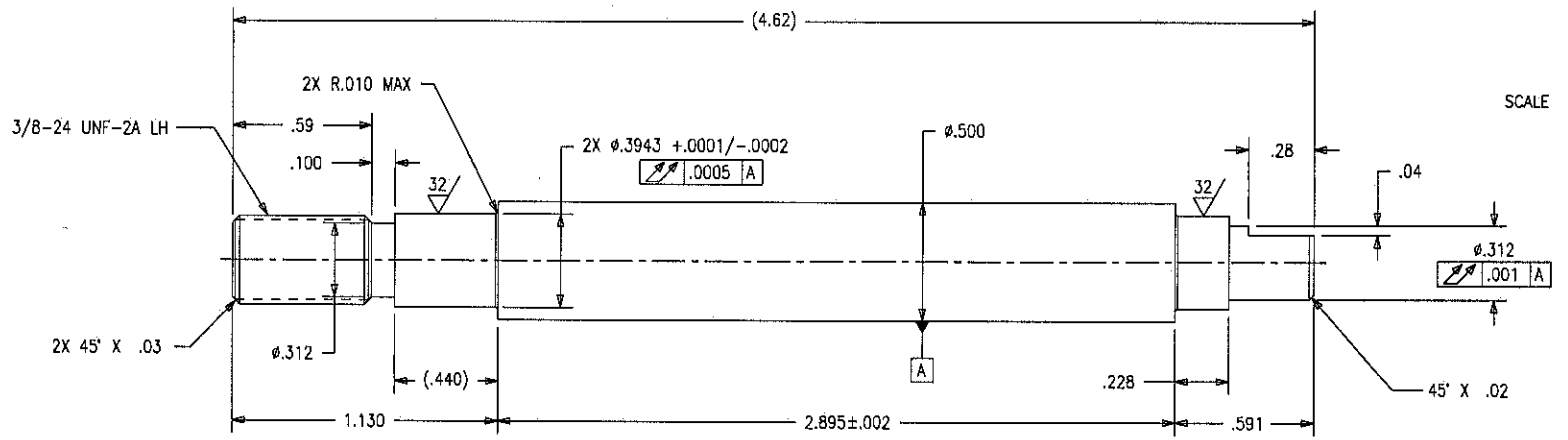
000

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES. TOLERANCES ARE: FRACTIONS ± 1/16, DECIMAL .XX ± .03, .XXX ± .004, ANGLE ± 1°	WEIGHT: 0.46 #		DRAWING NAME: HOUSING
	MATERIAL: ALUM 6061 T6		
SkillsUSA LEESBURG, VA	SCALE: 1:1	SHT NO.: 1/1	CONTESTANT #: 000
	DWG NO.: M9456A02		CONTESTANT INITIALS: XYZ

NOTES: (UNLESS OTHERWISE SPECIFIED)
1. BREAK EDGES AND CORNERS
2. FINISH: 63 MICROINCHES OR BETTER
3. PASSIVATE

Purpose of Passivation note.





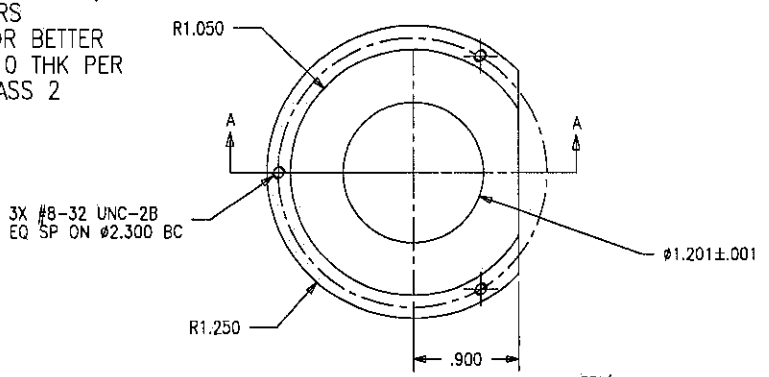
SCALE 1.000

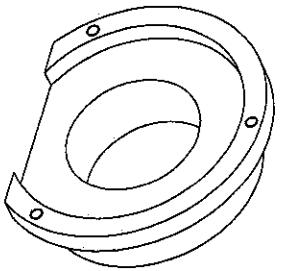
JUDGE REFERENCE ONLY

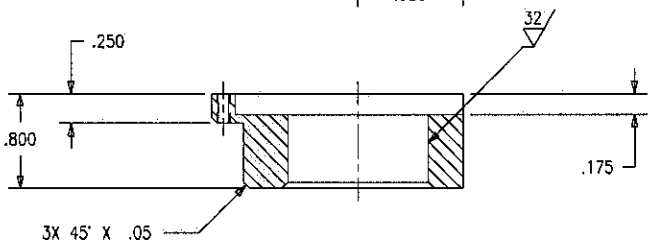
000

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES. TOLERANCES ARE: FRACTIONS ± 1/16, DECIMAL .XX ± .03, .XXX ± .004, ANGLE ± 1°	WEIGHT: 0.22 #		DRAWING NAME: SHAFT
	MATERIAL: 316 L SST		
SkillsUSA LEESBURG, VA	SCALE: 2:1	SHT NO.: 1/1	CONTESTANT #: 000
	DWG NO.: M9456A03		CONTESTANT INITIALS: XYZ

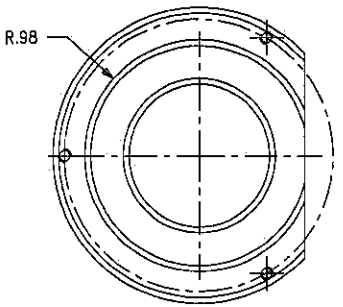
NOTES: (UNLESS OTHERWISE SPECIFIED)
1. BREAK EDGES AND CORNERS
2. FINISH: 63 MICROINCHES OR BETTER
3. HARD BLACK ANODIZE .0010 THK PER MIL-A-8625, TYPE III, CLASS 2







SECTION A-A



JUDGE REFERENCE ONLY

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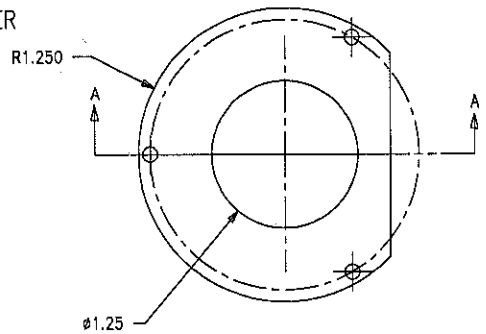
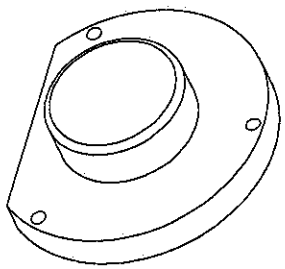
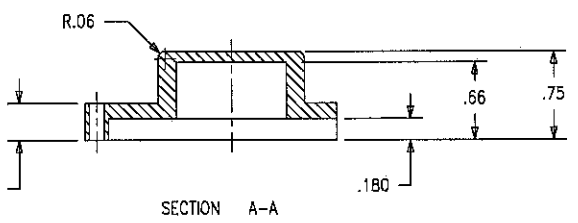
UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCES ARE: FRACTIONS ± 1/16 DECIMAL .XX ± .03 .XXX ± .004 ANGLE ± 1°	WEIGHT: 0.14 #		DRAWING NAME: LOWER BLADE GUARD
	MATERIAL: ALUM 6061 T6		
SkillsUSA LEESBURG, VA	SCALE: 1:1	SHT NO.: 1/1	CONTESTANT #: 000
	DWG NO.: M9456A04		CONTESTANT INITIALS: XYZ

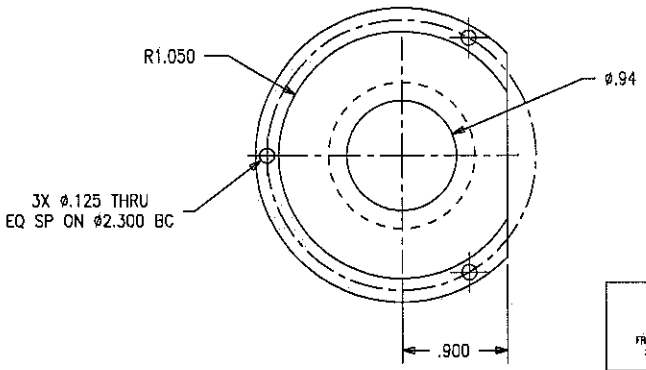
NOTES: (UNLESS OTHERWISE SPECIFIED)
1. BREAK EDGES AND CORNERS
2. FINISH: 63 MICROINCHES OR BETTER
3. HARD BLACK ANODIZE .0010 THK PER MIL-A-8625, TYPE III, CLASS 2







SECTION A-A



JUDGE REFERENCE ONLY

000

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCES ARE: FRACTIONS ± 1/16 DECIMAL .XX ± .03 .XXX ± .004 ANGLE ± 1°	WEIGHT: 0.10 #		DRAWING NAME: UPPER BLADE GUARD
	MATERIAL: ALUM 6061 T6		
SkillsUSA LEESBURG, VA	SCALE: 1:1	SHT NO.: 1/1	CONTESTANT #: 000
	DWG NO.: M9456A05		CONTESTANT INITIALS: XYZ

	Skills Area			Max Points
Seam Saw Assy M9456A00				
PN# M9456A00	Views	2	VW	12
PN# M9456A00	Dimensioning	1	DIM	10
PN# M9456A00	Weld Symbols/BOM		W/B	68
PN# M9456A00	GD&T		GDT	17
PN# M9456A00	Title Block Data		TB	18
PN# M9456A00	Neatness/Quality		NQ	20
Mounting Frame M9456A01				
PN# M9456A01	Views	4	VW	24
PN# M9456A01	Dimensioning	24	DIM	96
PN# M9456A01	Weld Symbols/BOM		W/B	34
PN# M9456A01	GD&T	2	GDT	12
PN# M9456A01	Title Block Data		TB	18
PN# M9456A01	Neatness/Quality		NQ	20
Housing M9456A02				
PN# M9456A02	Views	3	VW	18
PN# M9456A02	Dimensioning	13	DIM	52
PN# M9456A02	Weld Symbols/BOM	4	W/B	16
PN# M9456A02	GD&T	5	GDT	30
PN# M9456A02	Title Block Data		TB	18
PN# M9456A02	Neatness/Quality		NQ	20
Shaft M9456A03				
PN# M9456A03	Views	2	VW	12
PN# M9456A03	Dimensioning	16	DIM	64
PN# M9456A03	Weld Symbols/BOM	2	W/B	8
PN# M9456A03	GD&T	2	GDT	12
PN# M9456A03	Title Block Data		TB	18
PN# M9456A03	Neatness/Quality		NQ	20
Lower Blade Guard M9456A04				
PN# M9456A04	Views	4	VW	24
PN# M9456A04	Dimensioning	10	DIM	40
PN# M9456A04	Weld Symbols/BOM	1	W/B	4
PN# M9456A04	GD&T		GDT	5
PN# M9456A04	Title Block Data		TB	18
PN# M9456A04	Neatness/Quality		NQ	20
Upper Blade Guard M9456A05				
PN# M9456A05	Views	4	VW	24
PN# M9456A05	Dimensioning	10	DIM	40
PN# M9456A05	Weld Symbols/BOM		W/B	0
PN# M9456A05	GD&T	3	GDT	0
PN# M9456A05	Title Block Data		TB	18
PN# M9456A05	Neatness/Quality		NQ	20

Interview Scores		50
Written Test		100
	New total	1000

Clothing Penalty	-10
Resume Penalty	-10
Time	-10

SkillsUSA
2010 Contest Projects

Telecommunications Cabling

Click the “Print this Section” button above to automatically print the specifications for this contest. Make sure your printer is turned on before pressing the button.

Score Sheet

2010 Cable Termination: Twenty-five Pair on 110 Block

Contestant Number _____ **Judges Signature** _____

Directions:

1. You will have a total of 30 minutes to complete the Cable Termination exercise.
2. Determine the amount of cable remaining in the cable box. **Number of meters of cable =** _____
3. Terminate a 25 pair cable on Row two (2) of the110 block labeled 102. (Route the 25 pair cable from the top down and dress cable in from the right side.)
4. Run a Cat 6, 4 pair cable from Row two (2) beginning with Pair 5 on the 110 block labeled 101 to the wall outlet.
5. Use a C4 clip on 110 block 101 and a C5 clip on 110 block 102 to cross connect pair 1 of the 4 pair cable to pair 10 of the 25 pair cable.

Step	Possible Points	Description	Judges Comments	Score	Test Pass/Fail
1	10	Determining remaining cable in box			
2	20	Proper color code of twenty-five pair			
3	20	Proper termination of 110 block			
4	10	Dress cable			
5	10	Proper cross-connect routing			
6	10	Proper installation of C5 & C4 clips			
7	10	Proper amount of slack at work area			
8	10	Clean up			
	100		Point Subtotal		
			Multiplier x 2		
			Point Total		

Professionalism: Okay _____ Deduction _____ (Up to 5 points)
Safety: Okay _____ Deduction _____ (Up to 5 points)

Score Sheet

2010 Cable Installing

Contestant Number _____ **Judges Signature** _____

Directions:

1. You will have a total of 45 minutes to complete the Cable Installing exercise.
2. Secure the area.
3. Install two (2) Cat 6 cables from the work area to the equipment rack patch panel.
4. Terminate to T568B on positions 1 & 2 of patch panel 1.
5. Label per TIA-EIA 606 Labeling Standards identifying cable #1 and #2.

Step	Possible Points	Description	Criteria	Judges Comments	Score	Test Pass/Fail
1	5	Secure the work area.	5 pts or zero pts			
2	10	Setup pull boxes & label cables and boxes.	No label - 5			
3	10	Pull cables and dress across ladder rack.	2 pts for pulling cable. Bend radius 2 pts Pulling tension 2 pts Technique 2 pts Secure cables 2 pts			
4	10	Fish conduit & install pull string.	10 pts or zero pts			
5	15	Pull cables through conduit with pull string.	5 pts for string 10 pts for cables			
6	10	Terminate cables per T568-B standard at the patch panel and wall jack.	10 pts			
7	10	Install faceplate. (If this is not done the cable will not be tested resulting in the loss of all points in Step 10.)	Labels 2 pts each (2) Face plate 2 pts (1) Jack 2 pts each (2)			
8	5	Dress & secure cables.	Judges discretion			
9	10	Clean up work area.	Judges discretion			
10	15	Judge tests cable. Test Result:	Judges discretion			
	100			Point Subtotal		
				Multiplier x 2		
				Total Points		

Step 10 Test Results Ranking

1st	15 points
2nd	14 points
3rd	13 points
4th	12 points
5th	11 points
6th	10 points
7th	10 points
8th	10 points
9th	10 points
10th	10 points

Test Result: _____

Place: _____

Points Awarded _____

Professionalism: Okay _____ Deduction _____ (Up to 5 points)

Safety: Okay _____ Deduction _____ (Up to 5 points)

Score Sheet

2010 Cable Construction

Contestant Number _____ **Judges Signature** _____

Directions:

1. You will have 30 minutes to construct 3 cables.
2. Make a patch cable (**T568B**), a crossover cable, and a coax cable.
3. Each completed cable should be at least 3.5 feet long.
4. Label each cable with your contestant number and type cable.
   Patch – S Crossover – X Coax - C
5. When finished present your cables to the judge for testing.

Patch Cable	Points	End 1	End 2	Subtotal	
Cable is properly labeled	3 Total				
Insulation crimped	2 each end				
Pairs fully inserted	2 each end				
Nylon reinforcement cord trimmed	2 each end				Cable Total
Wire map passed T568B	15				

Crossover Cable	Points	End 1	End 2	Subtotal	
Cable is properly labeled	3 total				
Insulation crimped	2 each end				
Pairs fully inserted	2 each end				
Nylon reinforcement cord trimmed	2 each end				Cable Total
Wire map passed	15				

Terminate Coax with F Connectors		End 1	End 2	Subtotal	
Cable is properly labeled	3 total				
Insulation crimped	2 each end				
Conductor proper length	2 each end				
Outer shield trimmed properly	2 each end				Cable Total
Test cable (VOM)	15				

Penalties	Number of additional plugs used	Points
Deduct 10 points for each additional plug.		
Deduct 10 points for contestant not wearing eye protection.		
	Total Deduction	

Gross Cable Points (90 points max) _____

Subtract Penalty Points _____

Add 10 bonus points if all three cables work. _____

Net Cable Construction Points _____

Professionalism: Okay _____ Deduction _____ (Up to 5 points)
Safety: Okay _____ Deduction _____ (Up to 5 points)

Score Sheet

2010 Cable Troubleshooting

Contestant Number _____ **Judges Signature** _____

Directions:

1. You will have 30 minutes to complete cable troubleshooting.
2. Read the question and inspect the item at each station.
3. Put the answer to each station question on the answer sheet.
4. If an explanation is required, write it on the answer sheet.
5. If the station says Test the cable, mark pass or fail in the Test Pass/Fail column provided.

Station	Answer	Explanation	Judges Comments	Score	Test Pass/Fail
1					
2					
3					
4					
5					
6					
7					
8					
9					
10					
11					
12					
13					
14					
15					
16					
17					
18					
19					
20					
			Point Subtotal		
			Multiplier x 2		
			Total Score		

Professionalism: Okay _____ Deduction _____ (Up to 5 points)
Safety: Okay _____ Deduction _____ (Up to 5 points)

Score Sheet

2010 Technical Support

Contestant Number _____ **Judges Signature** _____

Directions:

In the Technical Support part of the contest, you will be judged on speaking skills, using a test headset, and solving a customer problem while experiencing simulated stress and distractions.

Scenario:

You've just moved to testing a fiber link that has been reported inoperative. The customer didn't give you much information just the room and ports that are having a problem. The CAD/CAE worker at the station is complaining they can't retrieve files from the network.

You are working with your coworker Jake who is in the telecommunications closest providing support on the remote end. When you pick up the headset to begin working with Jake you will be operating a half-duplex communications tool **and need to ask Jake if he is there**.

Time Limit: 10 Minutes

Step	Possible Points	Description	Judges Comments	Score
		Initial Contact		
1		Greeting		
2		Listening		
3	10	Problem Assessment		
4	10	Solution Approach		
5		Peer to Peer Communication		
	25		Subtotal	
		Customer Interaction		
6		Distraction Self Management		
7		Diagnostic Questions		
8		Abuse Self Management		
9		Isolating Problem		
10		Offering Solutions		
11		Integrity		
12		Knowledgeable		
13		Leadership		
14	5	Escalates		
15	10	Solves		
	50		Subtotal	
		Speaking Skills		
16		Volume		
17		Speed		
18		Tonal Quality		
19		Style		
20		Temper		
	25		Subtotal	
			Total	

Professionalism: Okay _____ Deduction _____ (Up to 5 points)

Safety: Okay _____ Deduction _____ (Up to 5 points)

Score Sheet

2010 Telecommunications Cabling – Professionalism

Contestant Number _____ **Judges Signature** _____

Item Evaluated	Possible Points	Score
Orientation (Attendance & Promptness)	**5**	
Competition Day Promptness	**5**	
Safety	**5**	
Attitude	**5**	
Tools and Equipment	**30**	
Total Score	**50**	

SkillsUSA
2010 Contest Projects

Television (Video) Production
(High School)

Click the "Print this Section" button above to automatically print the specifications for this contest. Make sure your printer is turned on before pressing the button.

SkillsUSA
Champions at Work

2010 Secondary Prompt
Television (Video) Production

Challenge:
Create a :60 second commercial for TV and/or the web to create awareness and excitement about the Kansas City Power & Light District.

Client:
The Kansas City Power and Light District

Content:
Your spot must include the following:

1. Location (downtown, multiple buildings, 8 blocks, etc)
2. Website
3. Not just middays (lunch), but night life social activities
4. We will give you a logo (.jpg) and a flyer of information

Target Audience:
30-55 yr. olds, (male and female).
Professionals
Educated
"High- tech" clientele (i.e. social networkers, web savvy)

Guidelines:
We do not have any special privileges for shooting, do not ask for them.

You can go only where the public can go.

You can only do what the public can do.

Do not damage floors with tripod legs. Please ensure that no metal spikes are protruding.

Teams who are causing disruptions or violating rules will be removed from the contest.

All audio must be acquired during production.

Time:
Be back at the room at 1:30pm for a one-hour block to record Voiceovers in a more comfortable and (hopefully) quiet environment.

SkillsUSA
2010 Contest Projects

Television (Video) Production
(College/Postsecondary)

SkillsUSA Champions at Work

2010 Post Secondary Prompt
Television (Video) Production

Challenge:
Create a :60 second commercial for TV and/or the web to increase the number of new shoppers, diners, and couples visiting Kansas City's famous Country Club Plaza.

Client:
The businesses of Kansas City Country Club Plaza

Content:
Your spot must include the following:

1. Location: West 47th and Broadway St., Kansas City, MO
2. Shopping and indoor/outdoor dining opportunities
3. Convenient and plentiful parking
4. Something for everyone
5. Safe, beautiful, and romantic
6. Website: www.countryclubplaza.com

Target Audience:
Diverse demographics, due to the diverse range of businesses represented.
Shoppers, diners, romantic encounters, fun for groups of friends.

Fast Facts:
-One of the oldest upscale shopping districts in the world (1923)
-Has been called the "Paris of the Midwest"
-Famous for its fountains and historical architecture (Spanish style)
-Nearly 200 shops, diners, attractions
-Live music outdoors throughout the year
-18 outdoor dining opportunities

Guidelines:
Do not shoot video inside any businesses. Shuts cams off and fold up tripods to go inside for food, drink, rest.
We do not have any special privileges for shooting, do not ask for them.
You can do/go only what/where the public can do/go..
Teams who are causing disruptions or violating rules will be removed from the contest.
All audio must be acquired during production.

Time:
Be back at the shuttle drop-off at 1:15pm to return to our room for a one-hour block of time to record Voice Overs in a more comfortable and (hopefully) quiet environment.

SkillsUSA
2010 Contest Projects

Welding

Click the “Print this Section” button above to automatically print the specifications for this contest. Make sure your printer is turned on before pressing the button.

Welding

The Contestants must make a one minute extemporaneous presentation to a panel of Judges. No notes allowed. The topic of the presentation is “How SkillsUSA has affected your life”

WELDING CONTEST 2010

CONTESTANT INSTRUCTIONS

Welcome to the 2010 Skills USA Championships. On Wednesday all College/Post Secondary contestants are to report to the contest area at 8:00 A.M. The contest starts at 8:30 AM prompt. On Thursday all High School contestants are to report to the contest area at 8:00 A.M. Secondary contestants will begin the contest at 8:30 AM prompt. Each contest day we will break at noon for a ½ hour lunch period. The contest will end at 4:00 PM each day. The contest floor is open to spectators both Wednesday and Thursday. **Contestants must wear the official VICA uniform. Failure to do so will result in a clothing penalty. Contestants may not have cell phones in the contest area.**

You will be divided into three groups. Each group will have Committee Escorts. One group will start at the OFC/Visual Inspection area, another will start in the SMAW/GTAW area, and the third will start in the FCAW/GMAW area. Every 2 hours' you will be rotated to a new station. Three judges will be at each station and will judge you as you go through their station. You are not allowed to ask the judges any questions related to the contest. Should you have any equipment problems notify a judge who will contact one of the equipment manufacturer's representatives.

In the OFC/Visual Inspection area half of you will go to the Visual Inspection area and half will go to the OFC area. When you are in the OFC area, layout and cut your project. The correct tip pressures will be set at each station. There is no need for you to make any adjustments. You will have one hour to complete the project. After one hour there will be a 15 minute break where you will be moved to the Visual Inspection area, and those that had been in the Visual Inspection area will be moved to the OFC area. At the SMAW area you have one hour to complete the project. After one hour you will have a 15 minute break where you will be required to switch the machine over to GTAW. You will then have one hour to complete the GTAW project. When you are finished with the GTAW project change the machine back to the SMAW process. At the FCAW/GMAW area you will complete two projects. You have one hour to complete the FCAW project. After one hour you will have a 15 minute break where you will be required to change over the machine and complete the second GMAW project. When you are finished with the GMAW project change the machine back to the FCAW process. The welding procedure will indicate in what positions the welds are to be made. Do not turn the project to weld flat. Welds made in the wrong position will receive no points. **You are not allowed to quench your projects until they have been completely welded. Quenching the project before you have completely welded it will result in a loss of points. Make sure the smoke extractors are directly over the arc so they can properly extract the fumes. If the fumes are not being captured you will stopped and told to reposition the vent duct.**

When you have finished the contest make sure you stop at the scoring table (the table with the sign on it) to receive some materials from us.

There will be a critique of the contest Friday morning at 8:30 A.M. Contestants are not required to be at the critique. The critique will be immediately followed by a Workshop sponsored by the American Welding Society. Please make every effort to attend. You should receive from Skills USA a comparison of your score to the maximum score for each scoring area. Any Safety violations will also be noted.

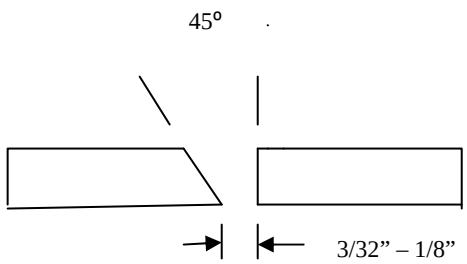
You will now take a job related quiz. Upon completion of the quiz you are to take the quiz, and the pencil if we have loaned it to you, to the table to my right if you are a High School student, and the table to my left if you are a College/Post secondary student. We will accept your resumes when you get in line. Each table is staffed by three ladies where you are to give your oral presentation. The presentation will be scored and will count in your final score.

Eugene G. Hornberger
Welding Contest Chairman

WELDING PROCEDURE SPECIFICATION

Company Name :	WELD SKILLS USA	By:	
Welding Procedure Specification No.	WPS-101	Revision No. :	0
Date :	June 9, 2009	Supporting PQR No.(s)	Prequalified
Welding Process(es	SMAW	Type(s) :	Manual

Weld Joint Design



BASE METALS		
Specification Type or Grade: A 36		
to Specification Type or Grade: A 36		
or		
Chem Analysis and Mech. Prop:		
To Chem Analysis and Mech. Prop:		
Thickness Range:		
Base Metal:	Groove: 1/8´to and including ¾”	Fillet: unlimited
Pipe Dia. Range :	Groove: 4” and over	Fillet: unlimited
Other:		

FILLER METALS	Root	Fill
Specification	A 5.1	A5.1
AWS Classification	E-6010	E-7018
Filler Metal F-No.	3	4
Weld Metal Analysis A-No.	NA	NA
Weld Metal Thickness Range:		
Groove	1/8” to 3/16”	1/8” to ¾”
Fillet	Unlimited	Unlimited
Electrode-Flux Classification	NA	NA
Flux Trade Name	NA	NA
Consumable Insert	NA	NA
Other	NA	NA

POSITIONS	POST WELD HEAT TREATMENT
Position(s) of Groove : Secondary-Horizontal	Temperature: No PWHT
Position(s) of Groove : College Post Secondary-Vertical	Time:
Position(s) of Fillet : NA	
Welding Progression: Vertical up	GAS
PREHEAT	Percent Composition
Preheat Temperature Min.: 60° F	Gas(es) Mixture Flow Rate
Interpass Temp. Max.: Not Controlled	Shielding NA
Preheat Maintenance : Ambient room temperature	Trailing NA
	Backing NA

ELECTRICAL CHARACTERISTICS
Current: DCEP Amperage Range : root 40 – 70, Fill 90-150 Voltage Range NA
Tungsten Electrode Size and Type : NA
Mode of Metal Transfer for GMAW : NA
Electrode Wire Feed Speed Range : NA

TECHNIQUE
String or Weave Bead: String and weave
Orfice or Gas Cup Size NA
Initial and interpass cleaning Chip slag and wire brush between passes
Methods of Back Gouging : NA
Oscillation : NA
Contact Tube To Work Distance: NA
Multiple or Single Pass per Side : Multiple
Multiple or Single Electrodes: Single
Travel Speed Range 4 – 8 ipm
Peening : None
Other : NA

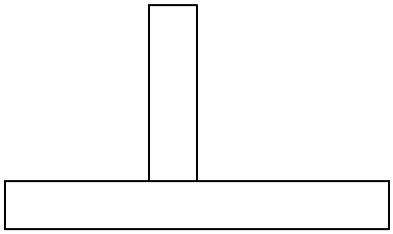
Welding Parameters

		Filler Metal		Current			
Weld layers	Process	Classification	Diameter	Polarity	Amperage	Voltage	Travel speed
Root	SMAW	E-6010	3/32”	DCEP	40 – 70	NA	4 – 8 ipm
Fill	SMAW	E-7018	1/8”	DCEP	90 – 150	NA	4 – 8 ipm

WELDING PROCEDURE SPECIFICATION

Company Name :	Skills USA	By:	
Welding Procedure Specification No.	WPS-102	Revision No. :	0
Date :	June 9, 2009	Supporting PQR No.(s)	Prequalified
Welding Process(es	FCAW	Type(s) :	Semiautomatic

Weld Joint Design



BASE METALS		
Specification Type or Grade: A-36		
to Specification Type or Grade: A-36		
Or		
Chem Analysis and Mech. Prop: NA		
To Chem Analysis and Mech. Prop:		
Thickness Range:		
Base Metal:	Groove: NA	Fillet: Unlimited
Pipe Dia. Range :	Groove: NA	Fillet: NA
Other:		

FILLER METALS		
Specification	A 5.20	
AWS Classification	E71T-1	
Filler Metal F-No.	NA	
Weld Metal Analysis A-No.	NA	
Weld Metal Thickness Range:		
Groove	NA	
Fillet	Unlimited	
Electrode-Flux Classification	NA	
Flux Trade Name	NA	
Consumable Insert	NA	
Other	NA	

POSITIONS	POST WELD HEAT TREATMENT			
Position(s) of Groove : NA	Temperature: No PWHT			
Position(s) of Fillet : All positions Base plate flat	Time:			
Welding Progression: Vertical up				
	GAS			
PREHEAT		Percent Composition		
Preheat Temperature Min.: 60°F		Gas(es)	Mixture	Flow Rate
Interpass Temp. Max.: Not controlled	Shielding	Ar CO_2	75% 25%	40 – 45 cfh
Preheat Maintenance : Ambient room temperature	Trailing	NA		
	Backing	NA		

ELECTRICAL CHARACTERISTICS
Current: DCEP Amperage Range : V & OH 150 - 200 , F & H 200 - 250, Voltage Range V&OH 24 - 26, F&H 26 - 28
Tungsten Electrode Size and Type : NA
Mode of Metal Transfer for GMAW : NA
Electrode Wire Feed Speed Range : 330 – 600 ipm

TECHNIQUE
String or Weave Bead: String or weave
Orfice or Gas Cup Size ½" minimum
Initial and interpass cleaning Chip slag and wire brush between passes
Methods of Back Gouging : NA
Oscillation : NA
Contact Tube To Work Distance ½"
Multiple or Single Pass per Side : Single
Multiple or Single Electrodes: Single
Travel Speed Range 6 – 8 ipm
Peening : None
Other : NA

Welding Parameters

		Filler Metal		Current			
Weld layers	Process	Classification	Diameter	Polarity	Amperage	Voltage	Travel speed
All V&OH	FCAW	E71T-1	.045"	DCEP	150-200	24-26	6 – 8 ipm
All F & H	FCAW	E71T-1	.045"	DCEP	200 – 250	26 – 28	6 – 8 ipm

WELDING PROCEDURE SPECIFICATION

Company Name :	SKILLS USA WELDING	By:	
Welding Procedure Specification No.	WPS-103	Revision No. :	0
Date :	June 9, 2009	Supporting PQR No.(s)	Prequalified
Welding Process(es	GTAW	Type(s) :	Manual

Weld Joint Design

BASE METALS		
Specification Type or Grade: 6061T-6		
to Specification Type or Grade: 6061T-6		
Or		
Chem Analysis and Mech. Prop: NA		
To Chem Analysis and Mech. Prop: NA		
Thickness Range:		
Base Metal:	Groove: NA	Fillet: unlimited
Pipe Dia. Range :	Groove: NA	Fillet: unlimited
Other:		

FILLER METALS		
Specification	A 5.10	
AWS Classification	ER 4043	
Filler Metal F-No.	NA	
Weld Metal Analysis A-No.	NA	
Weld Metal Thickness Range:		
Groove	NA	
Fillet	Unlimited	
Electrode-Flux Classification	NA	
Flux Trade Name	NA	
Consumable Insert	NA	
Other	NA	

POSITIONS	POST WELD HEAT TREATMENT			
Position(s) of Groove : NA	Temperature: No PWHT			
Position(s) of Fillet : All positions Base Plate Flat	Time:			
Welding Progression: Vertical up				
	GAS			
PREHEAT		Percent Composition		
Preheat Temperature Min.: 60° F		Gas(es)	Mixture	Flow Rate
Interpass Temp. Max.: Not controlled	Shielding	Ar	99.99%	10 – 15 cfh
Preheat Maintenance : Ambient room temperature	Trailing	NA		
	Backing	NA		

ELECTRICAL CHARACTERISTICS
Current: AC Amperage Range : 110 - 150 Voltage Range NA
Tungsten Electrode Size and Type : 3/32" EWP
Mode of Metal Transfer for GMAW : NA
Electrode Wire Feed Speed Range : NA

TECHNIQUE
String or Weave Bead: String
Orfice or Gas Cup Size 3/8" Minimum
Initial and interpass cleaning Wire brush with stainless steel wire brush or abrade with Scotch Brite© before welding. Wire brush with stainless
Steel wire brush between passes.
Methods of Back Gouging : None
Oscillation : NA
Contact Tube To Work Distance NA
Multiple or Single Pass per Side : Single
Multiple or Single Electrodes: Single
Travel Speed Range 4 – 8 ipm
Peening : NA
Other : NA

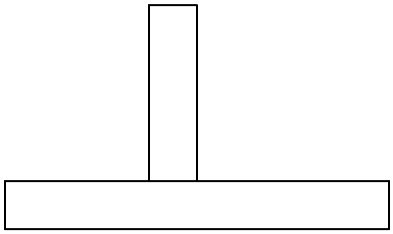
Welding Parameters

		Filler Metal		Current			
Weld layers	Process	Classification	Diameter	Polarity	Amperage	Voltage	Travel speed
All	GTAW	ER 4043	3/32	AC	110 – 150	NA	4 – 8 ipm

WELDING PROCEDURE SPECIFICATION

Company Name :	Skills USA	By:	
Welding Procedure Specification No.	WPS-104	Revision No. :	0
Date :	June 9, 2009	Supporting PQR No.(s)	Prequalified
Welding Process(es	GMAW	Type(s) :	Semiautomatic

Weld Joint Design



BASE METALS		
Specification Type or Grade: A-36		
to Specification Type or Grade: A-36		
Or		
Chem Analysis and Mech. Prop: NA		
To Chem Analysis and Mech. Prop:		
Thickness Range:		
Base Metal:	Groove: NA	Fillet: Unlimited
Pipe Dia. Range :	Groove: NA	Fillet: NA
Other:		

FILLER METALS		
Specification	A 5.18	
AWS Classification	ER70S-6	
Filler Metal F-No.	NA	
Weld Metal Analysis A-No.	NA	
Weld Metal Thickness Range:		
Groove	NA	
Fillet	Unlimited	
Electrode-Flux Classification	NA	
Flux Trade Name	NA	
Consumable Insert	NA	
Other	NA	

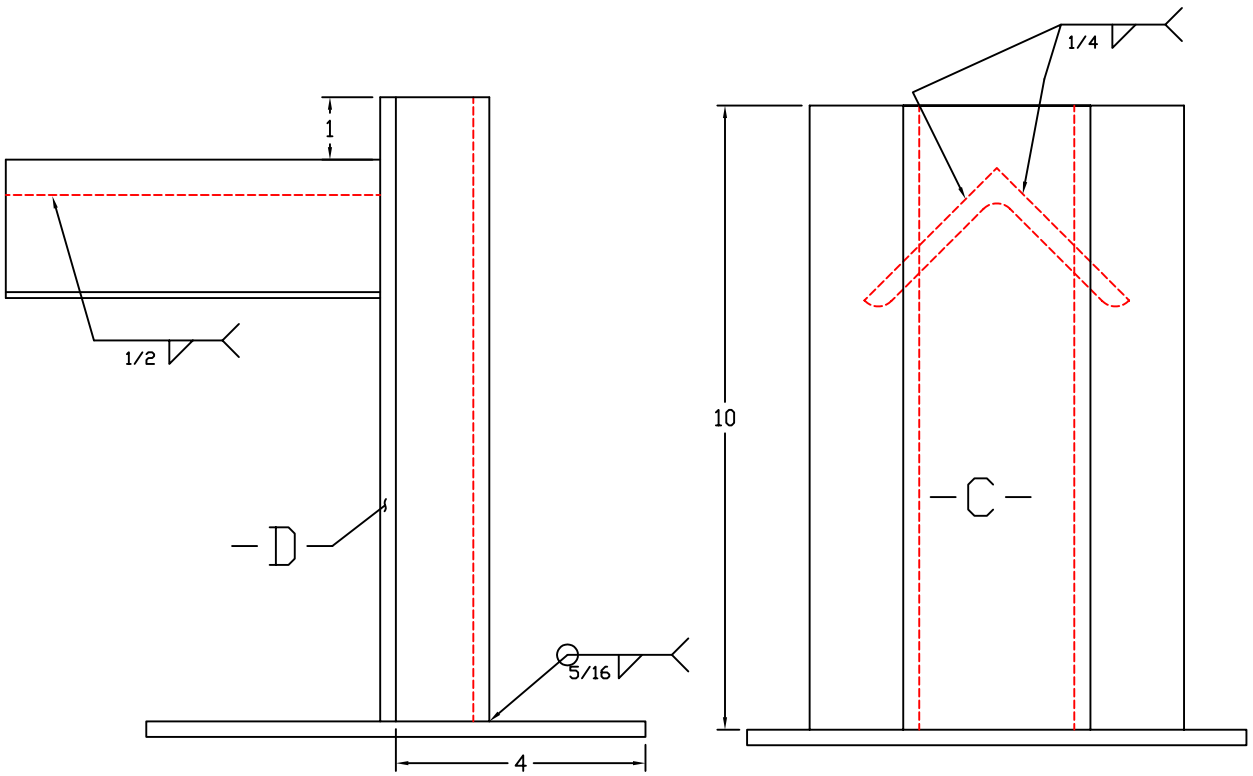
POSITIONS	POST WELD HEAT TREATMENT			
Position(s) of Groove : NA	Temperature: No PWHT			
Position(s) of Fillet : All positions Base Plate Flat	Time:			
Welding Progression: See Drawing				
	GAS			
PREHEAT		Percent Composition		
Preheat Temperature Min.: 60°F		Gas(es)	Mixture	Flow Rate
Interpass Temp. Max.: Not controlled	Shielding	Ar CO_2	75% 25%	40 – 45 cfh
Preheat Maintenance : Ambient room temperature	Trailing	NA		
	Backing	NA		

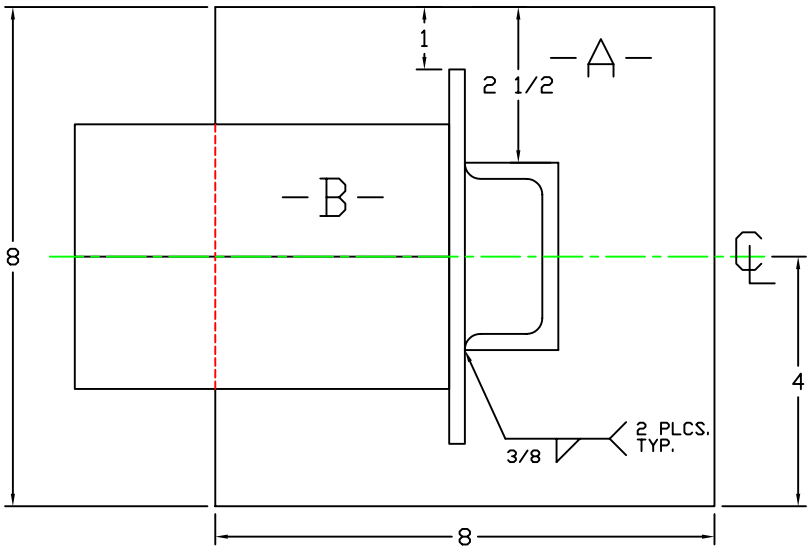
ELECTRICAL CHARACTERISTICS
Current: DCEP Amperage Range : 90 – 150 Voltage Range :17 - 19
Tungsten Electrode Size and Type : NA
Mode of Metal Transfer for GMAW : Short Circuiting
Electrode Wire Feed Speed Range : 330 – 600 ipm

TECHNIQUE
String or Weave Bead: String or weave
Orfice or Gas Cup Size ½" minimum
Initial and interpass cleaning: wire brush between passes
Methods of Back Gouging : NA
Oscillation : NA
Contact Tube To Work Distance ½"
Multiple or Single Pass per Side : Single
Multiple or Single Electrodes: Single
Travel Speed Range 6 – 8 ipm
Peening : None
Other : NA

Welding Parameters

		Filler Metal		Current			
Weld layers	Process	Classification	Diameter	Polarity	Amperage	Voltage	Travel speed
All	GMAW	ER70S-6	.035"	DCEP	90 – 150	17 – 19	6 – 8 ipm





NOTES

-ALL DIMENSIONS ARE INCHES UNLESS OTHERWISE SPECIFIED.
-ALL PROCESSES TO BE COMPLETED WITH THE MATERIALS PROVIDED

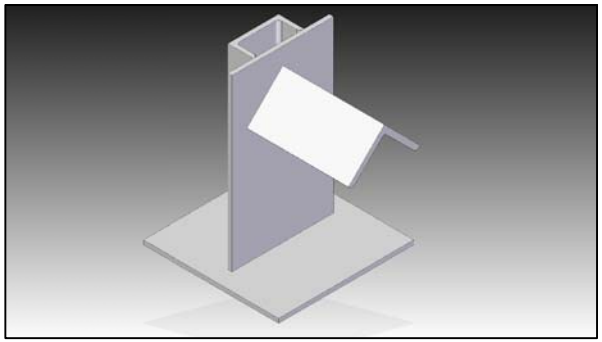
PROCEDURE

USE WPS# 102

ALL VERTICAL WELDS TO BE UPHILL

ALL WELDS TO BE COMPLETED WITH PLATE "A" FLAT ON TABLE

TACK COMPLETE ASSEMBLY BEFORE WELDING



ID	QTY	DESCRIPTION
D	1	1/4 X 6 X 10 CARBON STEEL
C	1	3 x 5.0# x 10 Channel
B	1	5/16 X 3 X 3 X 6 ANGLE
A	1	1/4 X 8 X 8 Carbon Steel

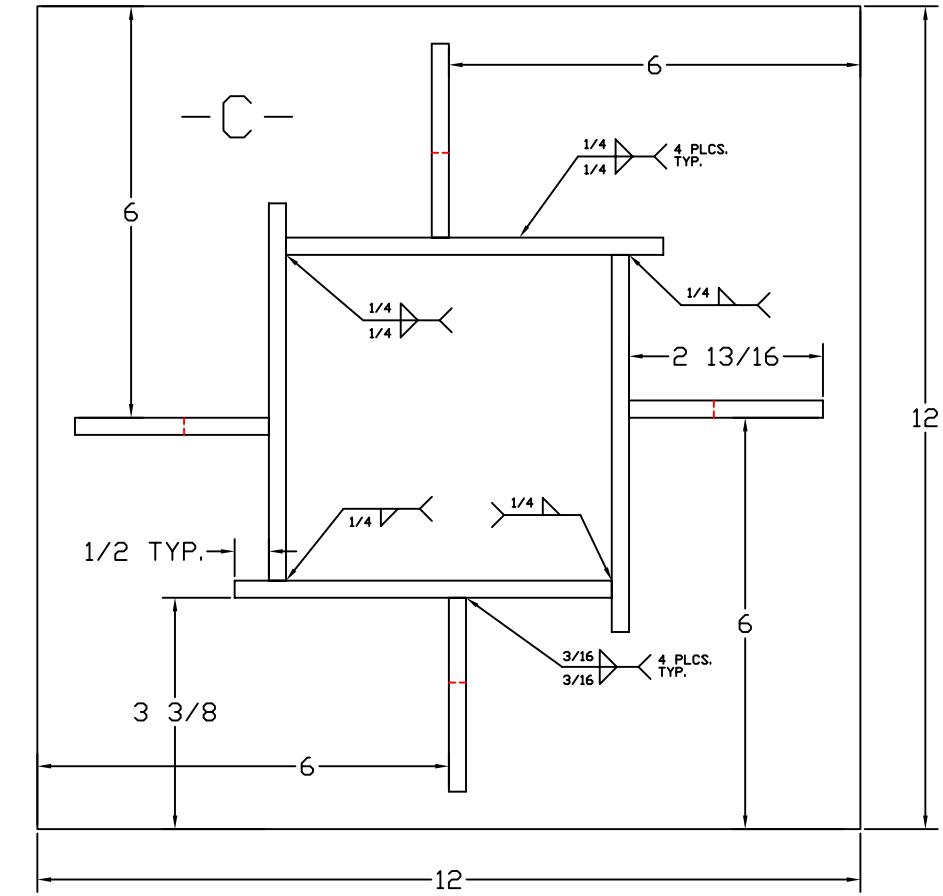
DWG TITLE

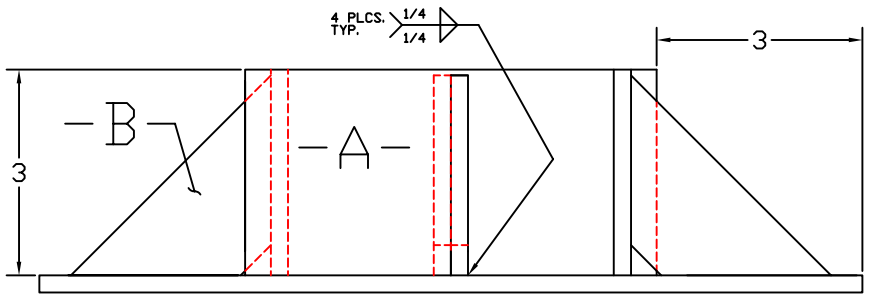
2010 SKILLSUSA

WELDING CHAMPIONSHIPS

SIZE	
A	FCAW-1
SCALE NONE	COLLEGE/POST SECONDARY

SkillsUSA





NOTES

-ALL DIMENTIONS ARE INCHES UNLESS OTHERWISE SPECIFIED.
-ALL PROCESSES TO BE COMPLETED WITH THE MATERIALS PROVIDED

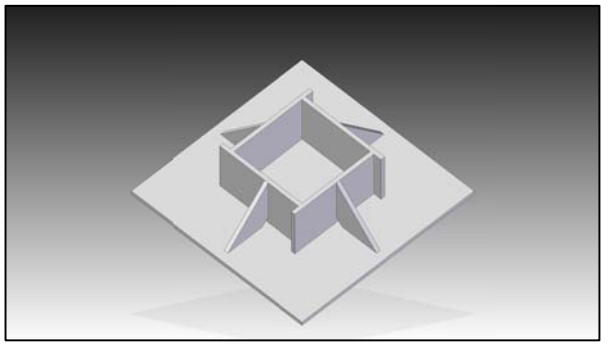
PROCEDURE

USE WPS# 104

VERTICAL WELDS TO BE UPHILL

ALL WELDS TO BE COMPLETED WITH PLATE "C" FLAT ON TABLE

TACK AND WELD IN ANY SEQUENCE



ID	QTY	DESCRIPTION
C	1	1/4 X 12 X 12 PLATE
B	4	1/4 X 1-3/4 X 4-1/8 BAR STOCK
A	4	1/4 X 3 X 5.5 Carbon Steel

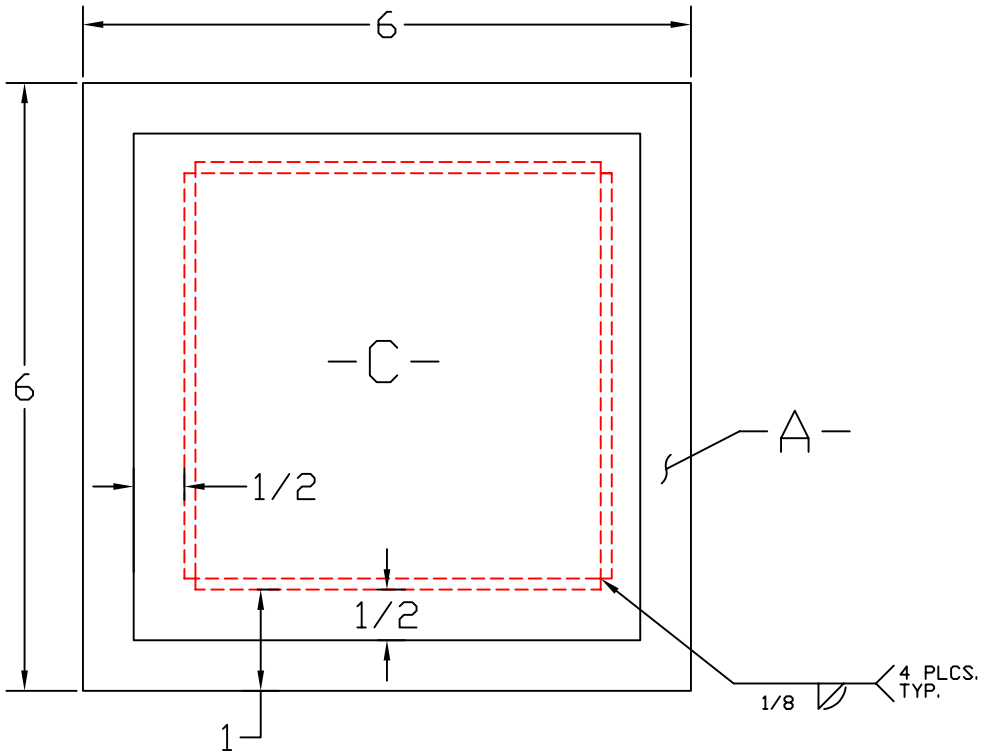
DWG TITLE

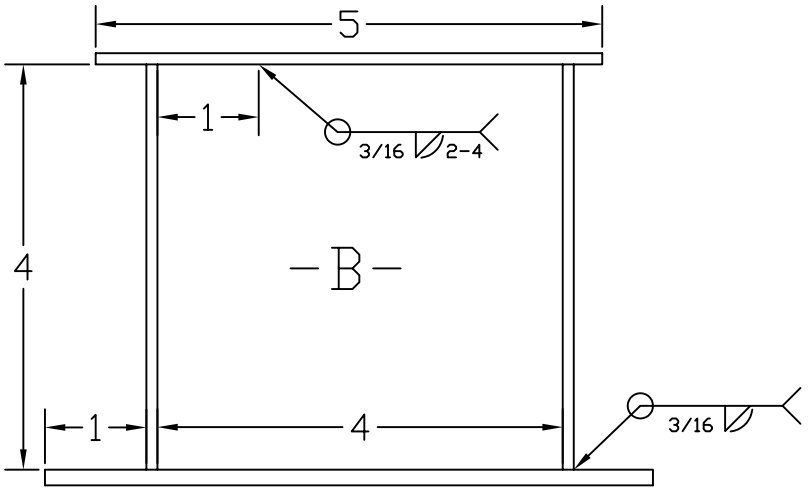
2010 SKILLSUSA

WELDING CHAMPIONSHIPS

SIZE	
A	GMAW-1
SCALE NONE	COLLEGE/POST SECONDARY

SkillsUSA





NOTES

-ALL DIMENSIONS ARE INCHES UNLESS OTHERWISE SPECIFIED.
-ALL PROCESSES TO BE COMPLETED WITH THE MATERIALS PROVIDED

PROCEDURE

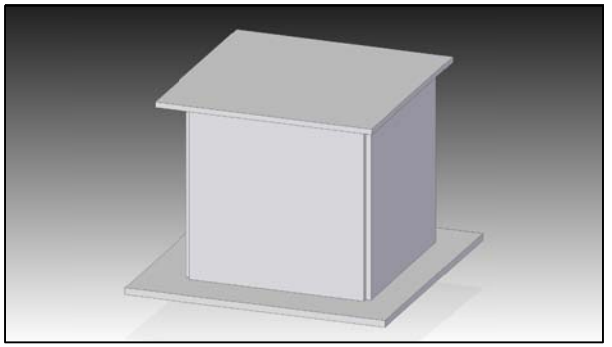
USE WPS# 103

ALL VERTICAL WELDS TO BE UPHILL

ALL WELDS TO BE COMPLETED WITH PLATE "A" FLAT ON TABLE

NO POST CLEANING

TACK COMPLETE ASSEMBLY BEFORE WELDING



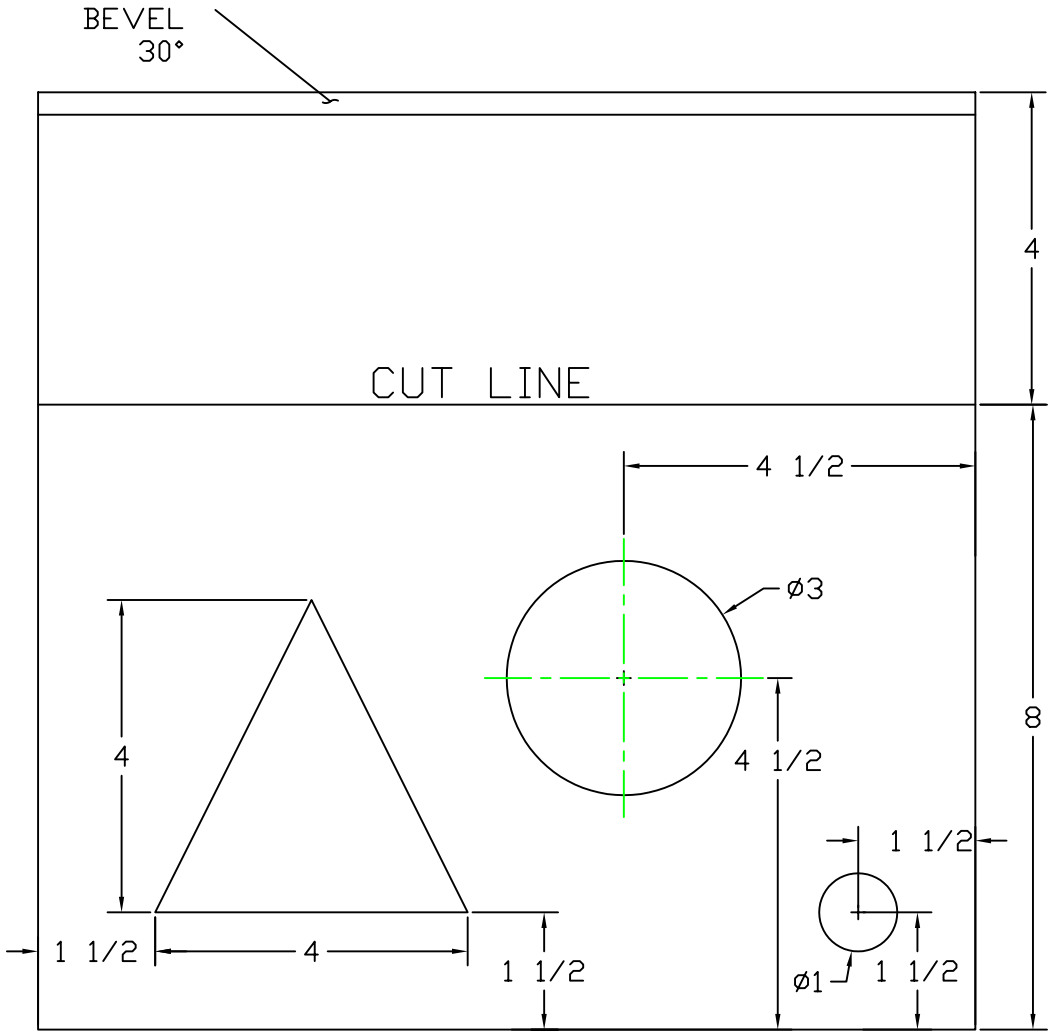
ID	QTY	DESCRIPTION
C	1	1/8 X 5X5 ALUMINUM
B	4	1/8 X 4X4 ALUMINUM
A	1	1/8" X 6X6 ALUMINUM

DWG TITLE

2010 SKILLSUSA

WELDING CHAMPIONSHIPS

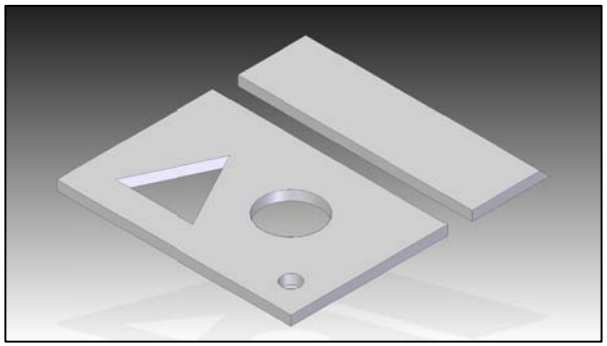
SIZE		
A	GTAW	SkillsUSA
SCALE NONE	COLLEGE/POST SECONDARY	



NOTES

-ALL DIMENSIONS ARE INCHES UNLESS OTHERWISE SPECIFIED.
-ALL PROCESSES TO BE COMPLETED WITH THE MATERIALS PROVIDED

PROCEDURE



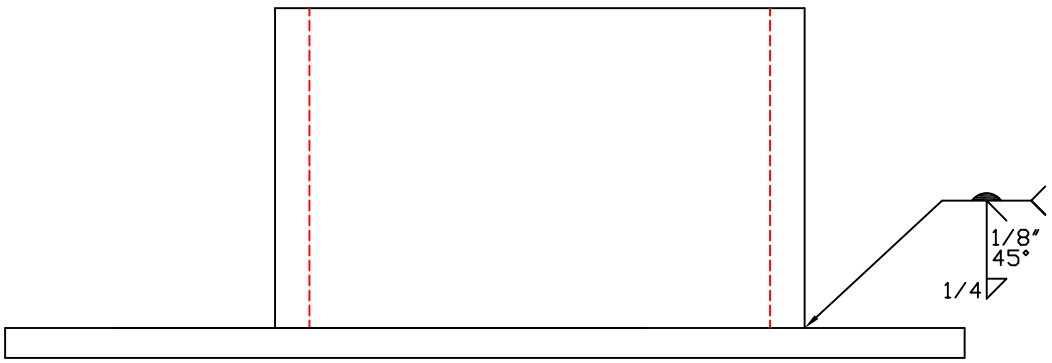
ID	QTY	DESCRIPTION
A	1	1/2 X 12 X 12 CARBON STEEL

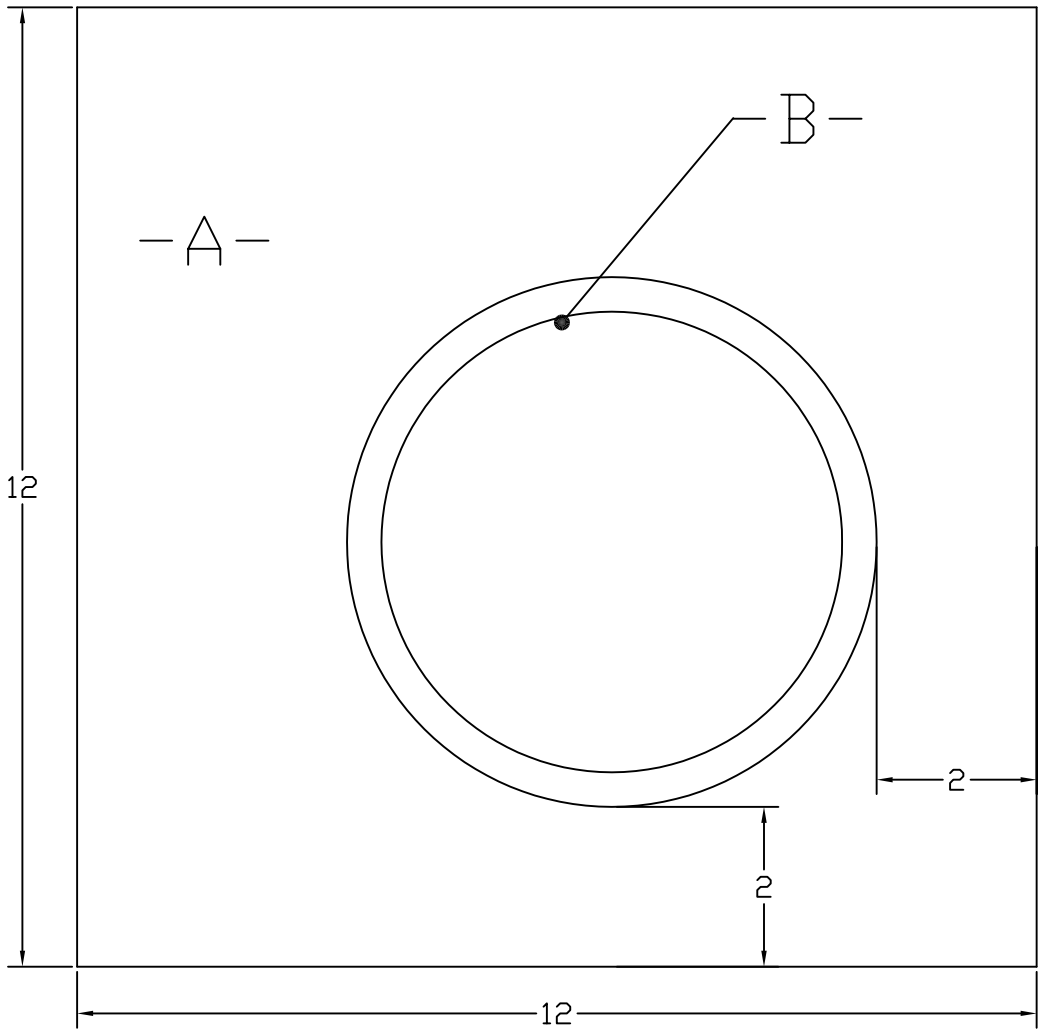
DWG TITLE

2010 SKILLSUSA

WELDING CHAMPIONSHIPS

SIZE		
A	OFC	SkillsUSA
SCALE NONE	COLLEGE / POST SECONDARY	





NOTES

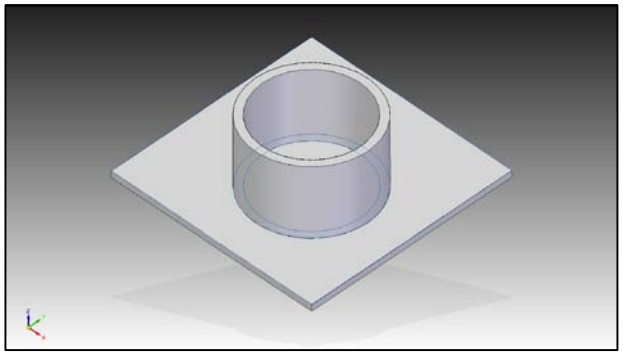
-ALL DIMENSIONS ARE INCHES UNLESS OTHERWISE SPECIFIED.
-ALL PROCESSES TO BE COMPLETED WITH THE MATERIALS PROVIDED

PROCEDURE

USE WPS# 101

TACK COMPLETE ASSEMBLY IN ANY POSITION BEFORE WELDING

WELD TO BE COMPLETED WITH BASE PLATE 'A' FIXED IN THE OVERHEAD POSITION WITH PIPE 'B' AXIS (VERTICAL) EXTENDING TO THE FLOOR.



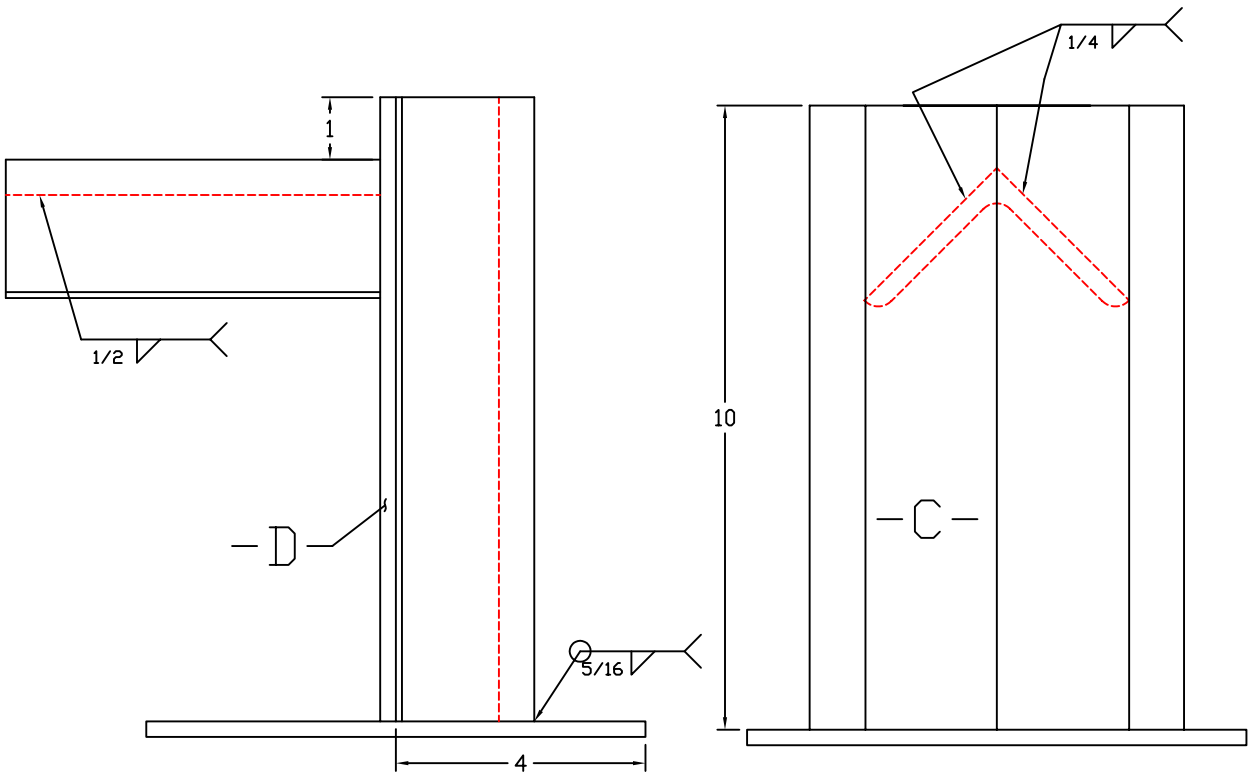
ID	QTY	DESCRIPTION
B	1	6" Sch. 40 Pipe 45° Bevel One Edge
A	1	1/2 X 12 X 12

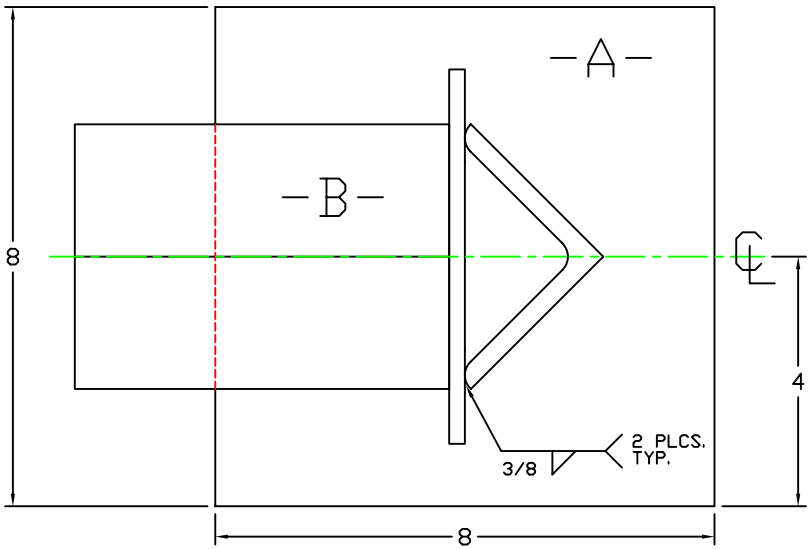
DWG TITLE

2010 SKILLSUSA

WELDING CHAMPIONSHIPS

SIZE		
A	SMAW	SkillsUSA
SCALE NONE	COLLEGE	





NOTES

-ALL DIMENSIONS ARE INCHES UNLESS OTHERWISE SPECIFIED.
-ALL PROCESSES TO BE COMPLETED WITH THE MATERIALS PROVIDED

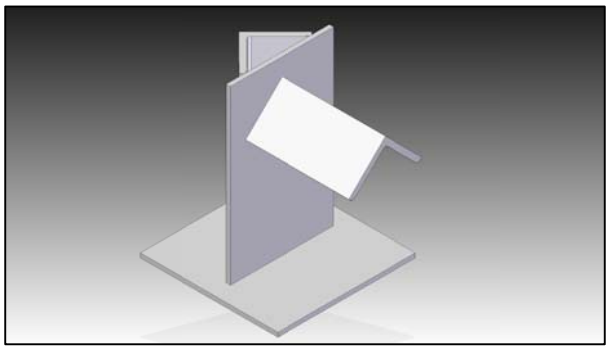
PROCEDURE

USE WPS# 102

ALL VERTICAL WELDS TO BE UPHILL

ALL WELDS TO BE COMPLETED WITH PLATE "A" FLAT ON TABLE

TACK COMPLETE ASSEMBLY BEFORE WELDING



ID	QTY	DESCRIPTION
D	1	1/4 X 6 X 10 CARBON STEEL
C	1	5/16 X 3 X 3 X 10 ANGLE
B	1	5/16 X 3 X 3 X 6 ANGLE
A	1	1/4 X 8 X 8 CARBON STEEL

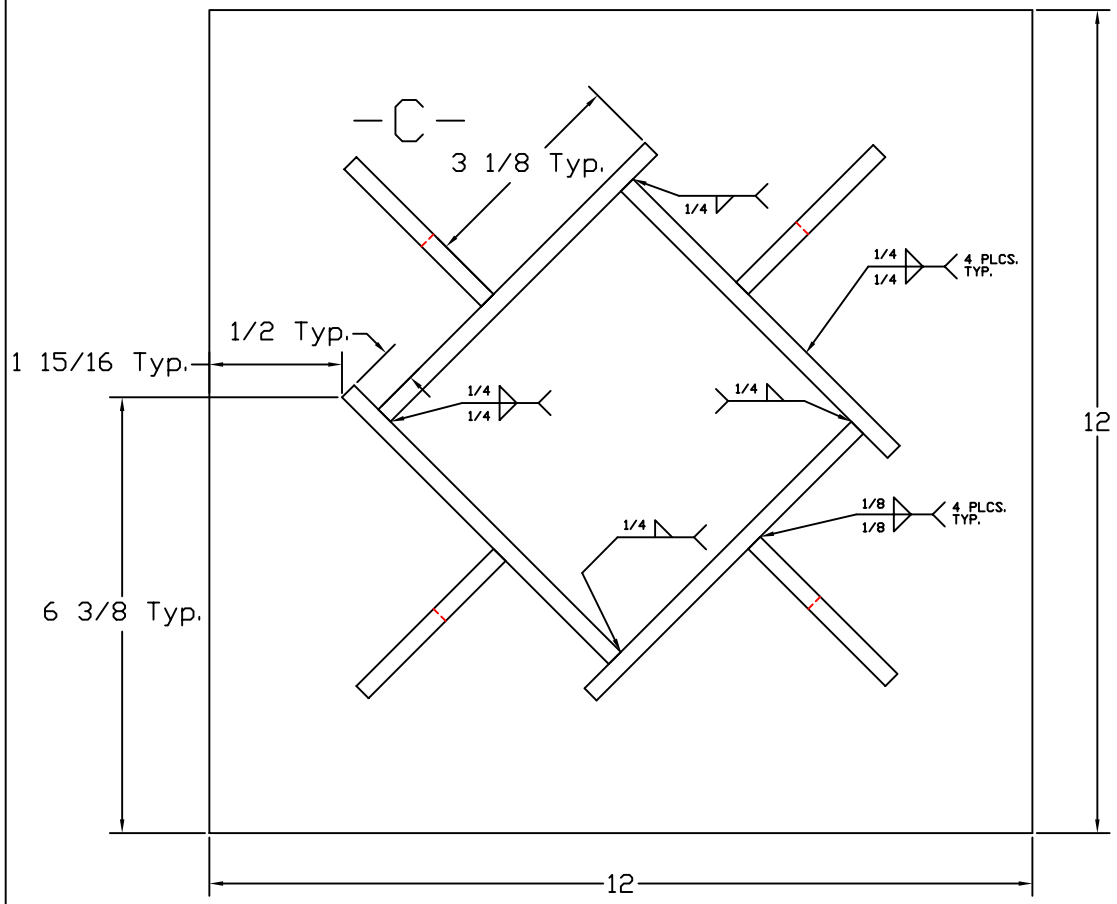
DWG TITLE

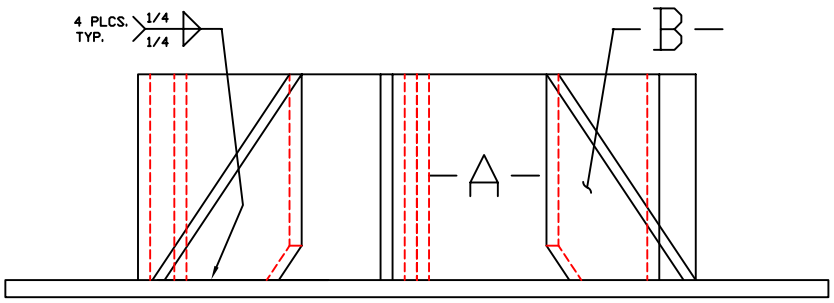
2010 SKILLSUSA

WELDING CHAMPIONSHIPS

SIZE	
A	FCAW-1
SCALE NONE	HIGH SCHOOL

SkillsUSA





NOTES

-ALL DIMENSIONS ARE INCHES UNLESS OTHERWISE SPECIFIED.
-ALL PROCESSES TO BE COMPLETED WITH THE MATERIALS PROVIDED

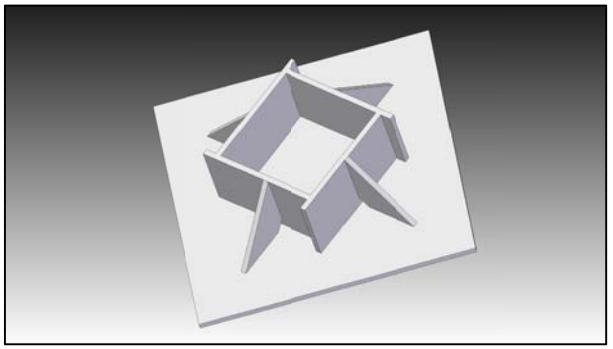
PROCEDURE

USE WPS# 104

VERTICAL WELDS TO BE DOWNHILL

ALL WELDS TO BE COMPLETED WITH PLATE "C" FLAT ON TABLE

TACK AND WELD IN ANY SEQUENCE



ID	QTY	DESCRIPTION
C	1	1/4 X 12 X 12 PLATE
B	4	1/4 X 1-3/4 X 4-1/8 BAR STOCK
A	4	1/4 X 3 X 5.5 Carbon Steel

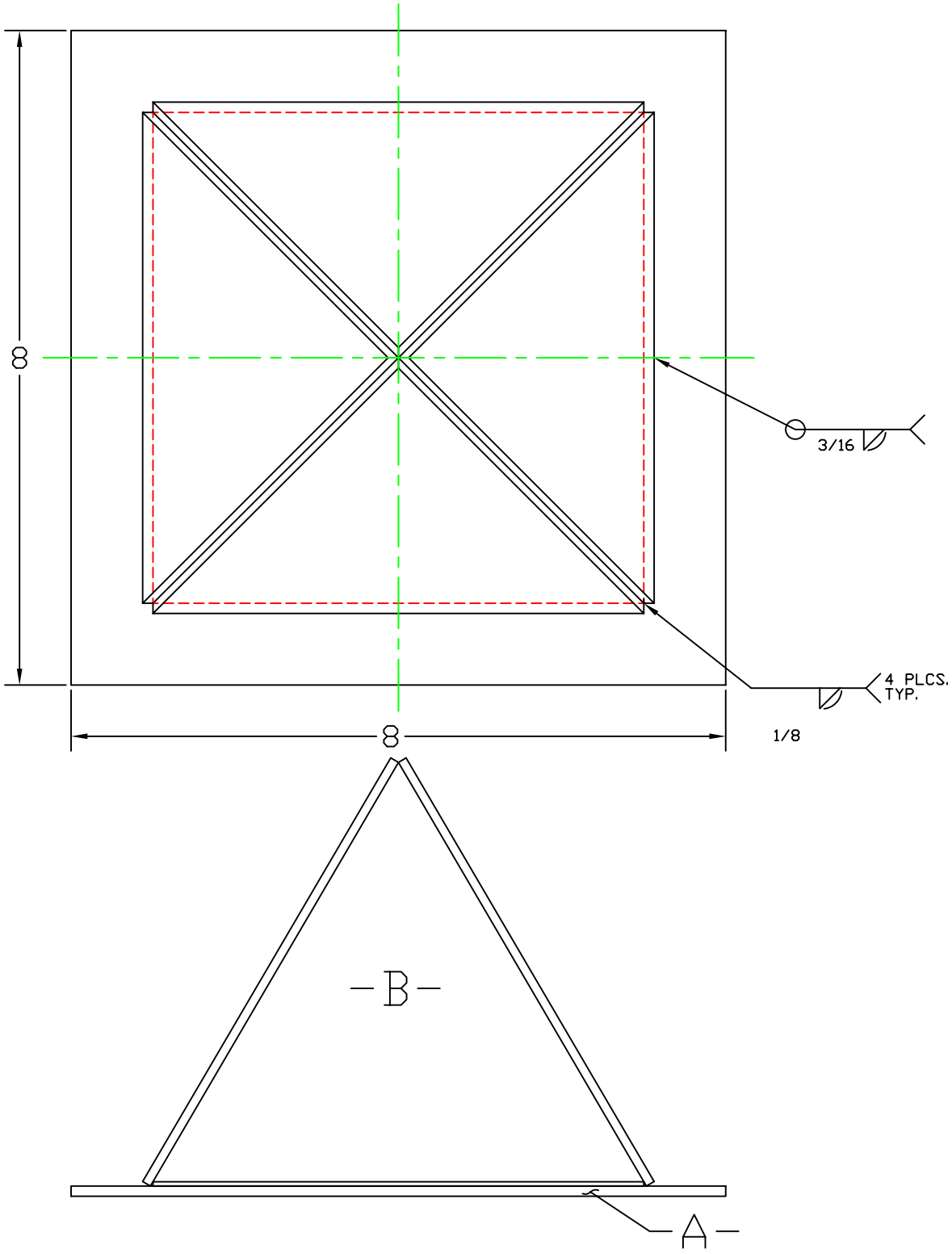
DWG TITLE

2010 SKILLSUSA

WELDING CHAMPIONSHIPS

SIZE	
A	GMAW-1
SCALE NONE	HIGH SCHOOL

SkillsUSA



NOTES

-ALL DIMENSIONS ARE INCHES UNLESS OTHERWISE SPECIFIED.
-ALL PROCESSES TO BE COMPLETED WITH THE MATERIALS PROVIDED

PROCEDURE

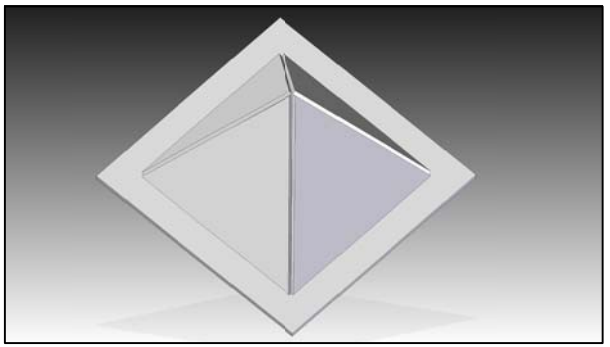
USE WPS# 103

ALL VERTICAL WELDS TO BE UPHILL

ALL WELDS TO BE COMPLETED WITH PLATE "A" FLAT ON TABLE

NO POST CLEANING

TACK COMPLETE ASSEMBLY BEFORE WELDING



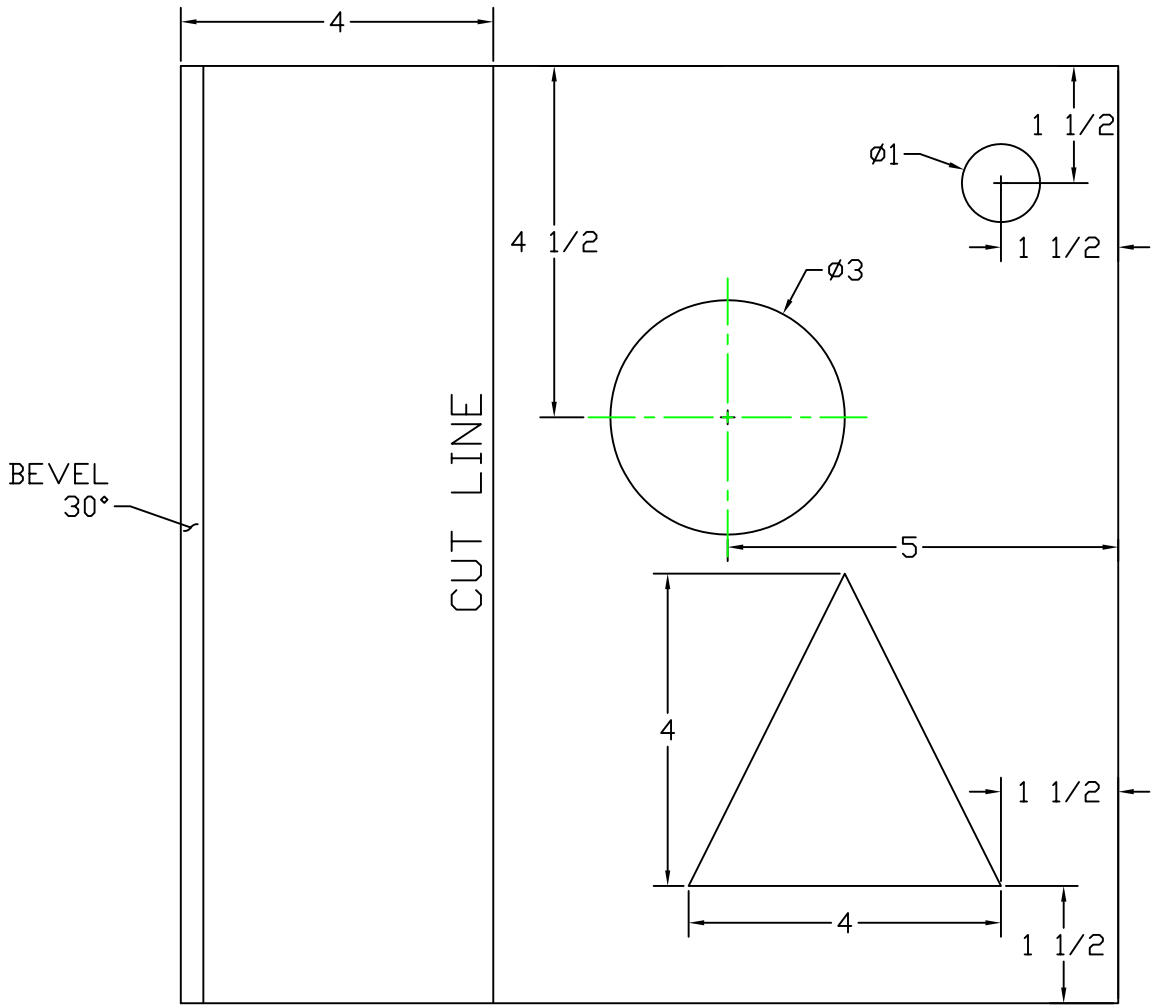
ID	QTY	DESCRIPTION
B	4	1/8 X 6X6X6 ALUMINUM
A	1	1/8" X 8 X 8 ALUMINUM

DWG TITLE

2010 SKILLSUSA

WELDING CHAMPIONSHIPS

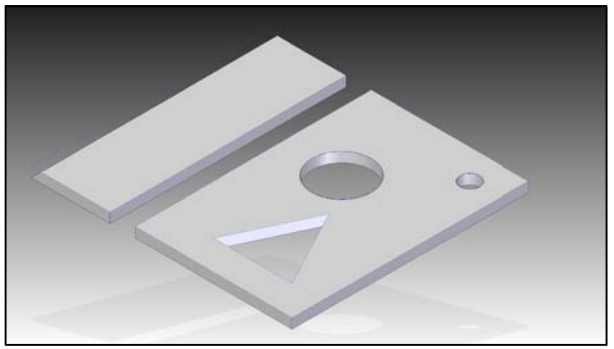
SIZE		
A	GTAW	SkillsUSA
SCALE NONE	HIGH SCHOOL	



NOTES

-ALL DIMENSIONS ARE INCHES UNLESS OTHERWISE SPECIFIED.
-ALL PROCESSES TO BE COMPLETED WITH THE MATERIALS PROVIDED

PROCEDURE



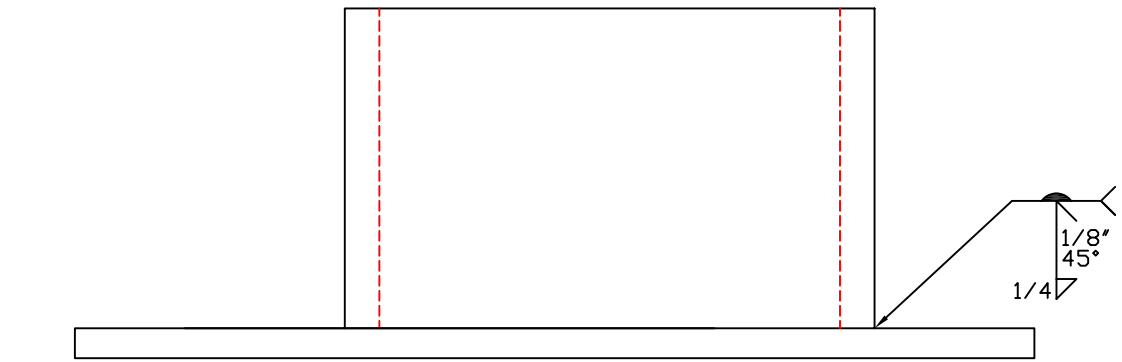
ID	QTY	DESCRIPTION
A	1	1/2 X 12 X 12 CARBON STEEL

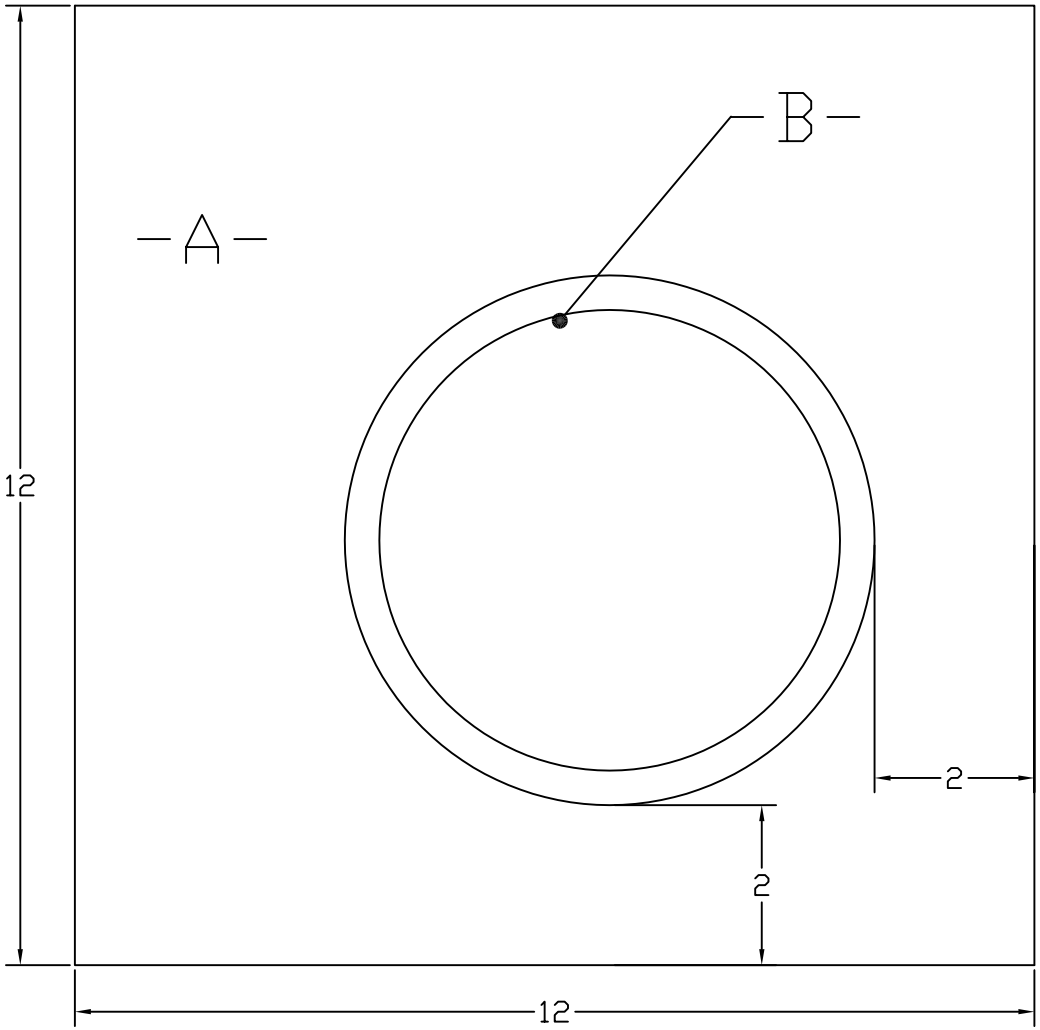
DWG TITLE

2010 SKILLSUSA

WELDING CHAMPIONSHIPS

SIZE		
A	OFC	SkillsUSA
SCALE NONE	HIGH SCHOOL	





NOTES

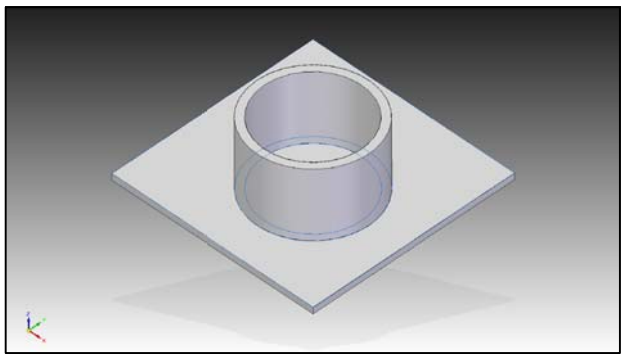
-ALL DIMENSIONS ARE INCHES UNLESS OTHERWISE SPECIFIED.
-ALL PROCESSES TO BE COMPLETED WITH THE MATERIALS PROVIDED

PROCEDURE

USE WPS# 101

TACK COMPLETE ASSEMBLY IN ANY POSITION BEFORE WELDING

WELD TO BE COMPLETED WITH BASE PLATE 'A' FIXED IN THE VERTICAL POSITION WITH PIPE 'B' AXIS EXTENDING HORIZONTALLY.



ID	QTY	DESCRIPTION
B	1	6" Sch. 40 Pipe 45° Bevel One Edge
A	1	1/2 X 12 X 12 Plate

DWG TITLE

2010 SKILLSUSA

WELDING CHAMPIONSHIPS

SIZE		
A	SMAW	SkillsUSA
SCALE NONE	HIGH SCHOOL	

SkillsUSA
2010 Contest Projects

Welding Fabrication

Click the “Print this Section” button above to automatically print the specifications for this contest. Make sure your printer is turned on before pressing the button.

National SkillsUSA Welding Fabrication Competition Update – 2010

Please review these instructions for the national competition in June. Now is the time to brainstorm, practice, and design your project to be built. Your team will have 6.5 hours to complete your project. Keep in mind your team & project will be judged throughout your 6.5 hours. Manage your time wisely. **Please note a CD of your design must be ready to turn in at orientation. (See items supplied by teams)**

Project Theme:

- Barbeque Grill

Material List Supplied by Committee

- **Quantity 4: 1/8" x 36" x 24" mild steel plate**
- **Quantity 2: 1/8" x 24" x 24" mild steel plate**
- **Quantity 4: Steel Hinges: 4.5" X 4.5"**
- **Quantity 2: Caster Wheels Stationary 4" X 4-1/2"**
- **Quantity 2: Caster Wheels Swivel 4" X 4-1/2"**
- **Quantity 3: 1/8" x 1" x 1" 10 ft length angle iron**
- **Quantity 1: 1/4" x 48" x 24" expanded steel mesh**

Welding Consumables Supplied by Committee:

- .045 Lincoln Electric SuperArc L-56 (AWS ER70S-6)
- .045 Lincoln Electric Ultracore 71A85 (AWS E71T-1/9)
- 3/32" Hobart ER70S-2 GTAW Filler Rods
- 3/32" Hobart E7018 SMAW Electrodes
- 1/8" Hobart E6010 SMAW Electrodes

Minimum Project Requirements:

- 5 SMAW Welds of 3" or greater (Two 3F vertical up welds required)
- 5 GMAW Welds of 3" or greater (Two 3F vertical up welds required)
- 5 GTAW Welds of 3" or greater (Two 3F vertical up welds required)
- 5 FCAW Welds of 3" or greater (Two 3F vertical up welds required)
- total of 25" of cut material using OFC process
- 75% of Total Weight of Material is required for project. **Bonus points awarded for least amount of unused material.**

Judging Categories:

- Safety
- Welding Skills
- Cutting Skills
- Teamwork
- Fabrication Accuracy
- Blueprint minimum requirements
  - Title block
  - Proper Critical Dimensions
  - No tolerances are acceptable
  - Proper Welding Symbols
  - Proper Finishing Symbols
  - Proper views needed to fabricate the project
- Written Test
- Verbal Project Description of design

Items Supplied by Teams: (These are in addition to what is listed in the

technical standards 2010)

- All Personal Protective Equipment
- **A CD containing all electronic file(s) must be turned in at orientation: a (.pdf) file and a (.dxf) file**
- **(4)Printed 11"x 17"Copies of Project Print(s) : 1 set for team, 2 sets for judges, 1 set for chairman**
- Teams may bring own hand tools but are not needed to complete the project
  - No templates may be used

Tools Supplied by Committee to each team:

- Welding Machines
  - Miller Electric Syncrowave 250 used for SMAW/GTAW
  - Lincoln Electric PowerMig 350MP for GMAW/FCAW
- Environmental Equipment
  - 1 Environmental Extraction Unit per team(Miller Electric or Lincoln Electric)
- Harris Calorific OFC Torches
- Materials from Bill of materials
- Metabo grinders
- Tape Measures
- All other shop tools needed to complete the project
  - Teams may use their own hand tools however no templates may be used

Other tools

- There will be a limited number of Mag Drills provided for drilling. If you choose to drill holes, you must provide your own drill bits. There will not be enough drills for each team to have one.
  - If a team's project calls for a hole to be drilled and the drill is unavailable, the holes may be cut using OFC with no penalty.

Other Information

- Include steel hinges and caster wheels on your prints. When fabricating, sometimes parts are not supplied with the correct dimensions. If the dimensions are different than your prints, "on the job" corrections will be made with no penalty.