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

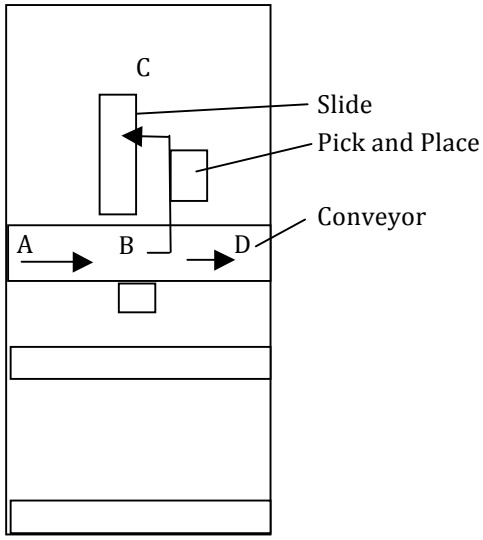
Points	400
t_{min}	fastest team
t_{max}	150 min

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:

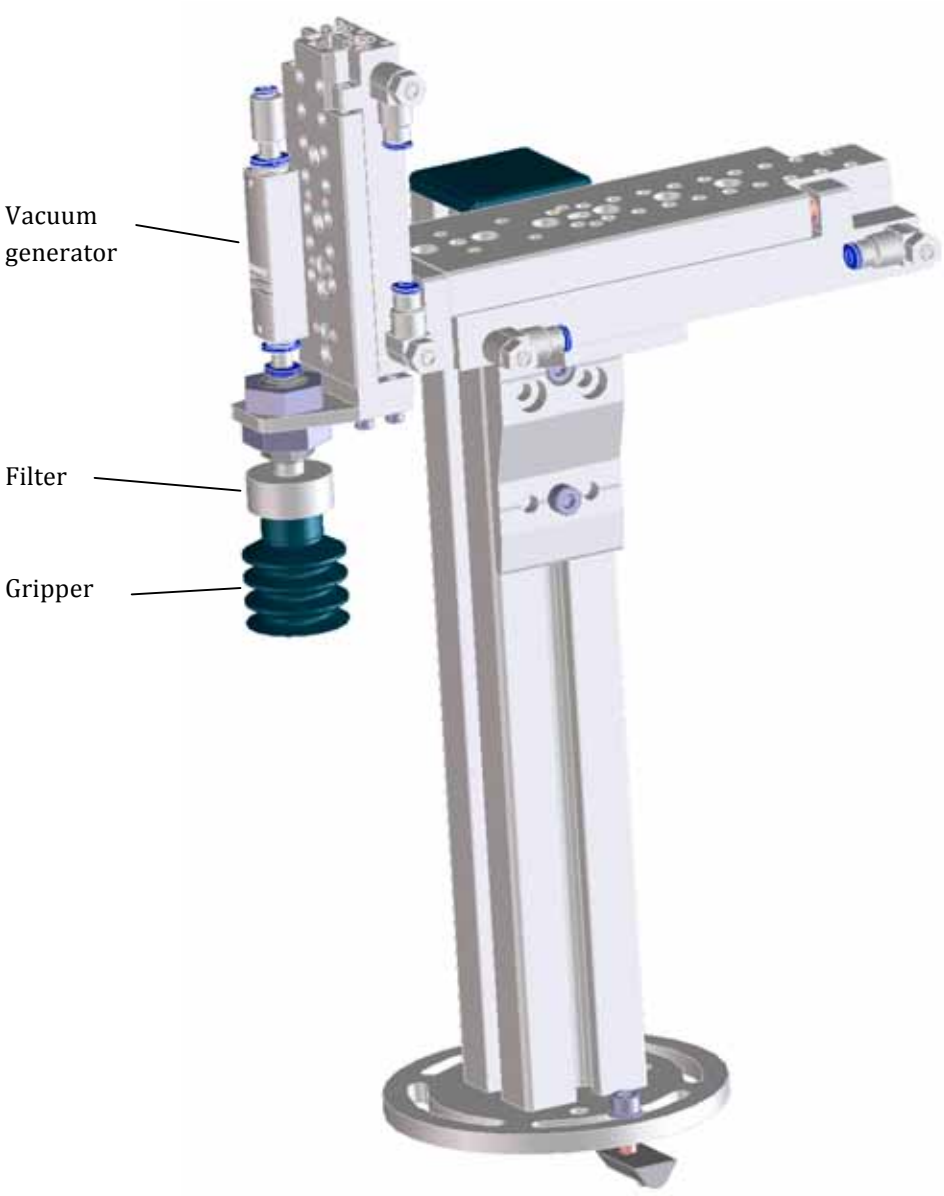
- Move workpiece to the conveyor end (D) so that it goes off the end of the conveyor.
- Switch light Q1 off, switch conveyor off

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:

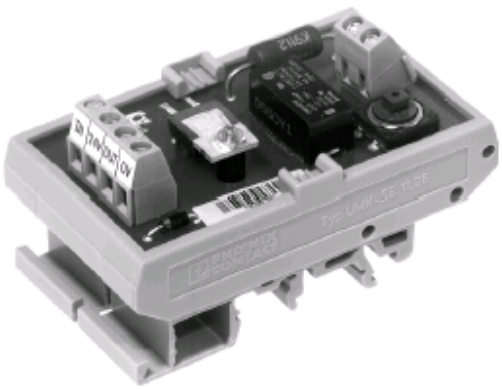


Wiring hints:

Current limiter:

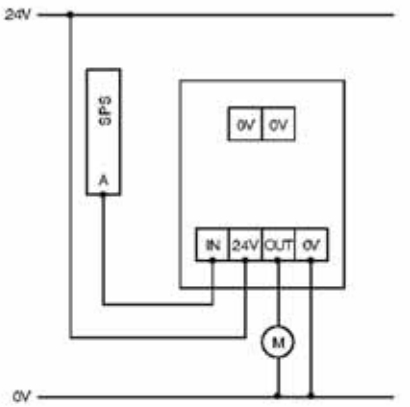
Use the current limiter to control the motor of the conveyor.

- 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)**:**