German University in Cairo

Mechatronics Lab (MCTR704)

Size-Based Sorting Machine

Project No. [1]

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Project Description

The aim of the project is to sort two different sizes of objects by height using actuators and sensors. As shown in figure (a, b) and according to the numbering of figure (c): The objects will be supplied from the magazine (8) to the cylinder (1) where the cylinder will extend and feed the object to the position where height measuring will take place; In front of the wall, above the end effector (5). After the height is measured using the sensor, cylinder (3) will place the suitable chamber of end effector (6) under the hole made in the table. Then cylinder (2) (which is normally extended) will take action by retracting its end effector (5) exposing the whole and making the object fall in the chamber chosen by cylinder (3) where the objects will fall in end effector's (6) proper chamber. End effector (6) is a box with 2 chambers; one for the short objects and the other for the tall ones. The objects will keep on stacking above each other in the box as the process continues.

The signal of whether it's a short or tall object will come from 2 vertically collinear sensors: if only the lower sensor is sensing the object, its labeled as short; if both the sensors are sensing the object, its labeled as tall and actions are taken accordingly whether its short or tall as explained above.

Solid works Design: 3D Schematic Diagram

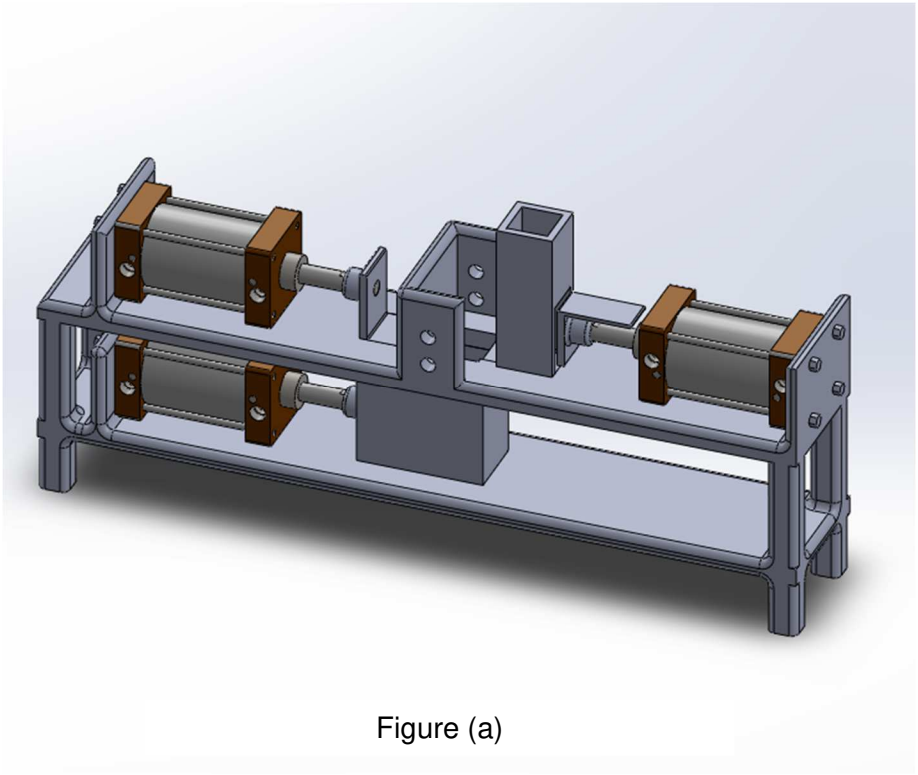


Figure (a)

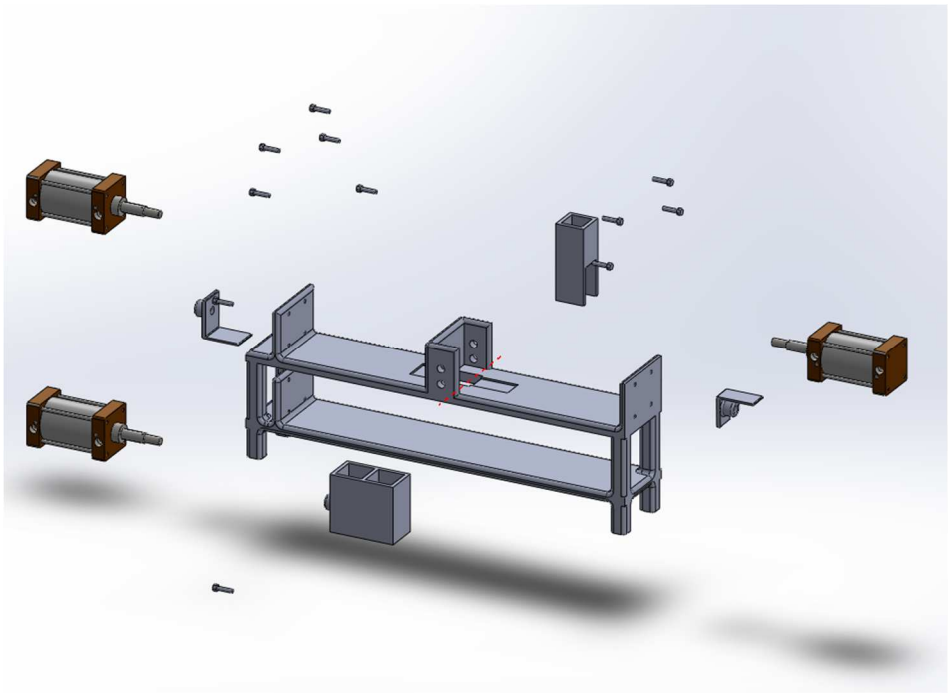


Figure (b)

Part number	Name
1	Single acting cylinder for feeding
2	First double acting cylinder for opening the hole that the objects will fall from
3	Second double acting cylinder that adjusts the right chamber of box (6) according to the object's height
4	End effector of feeding cylinder
5	End effector of cylinder (2) acting as a gate for the hole
6	End effector of cylinder (3) where the objects will get sorted
7	Table where the whole system is mounted
8	Magazine used as a storage to feed the system with objects that will be sorted
0	screws

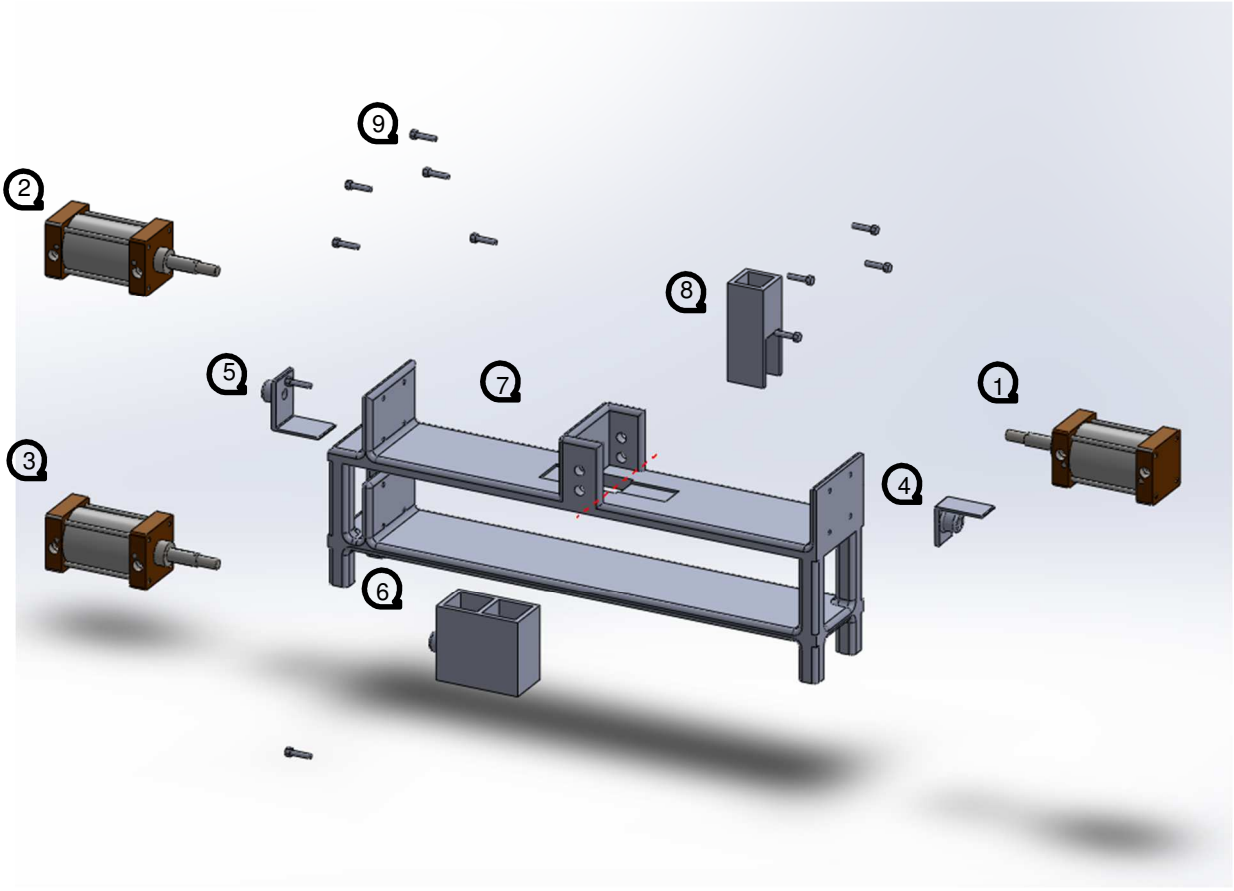
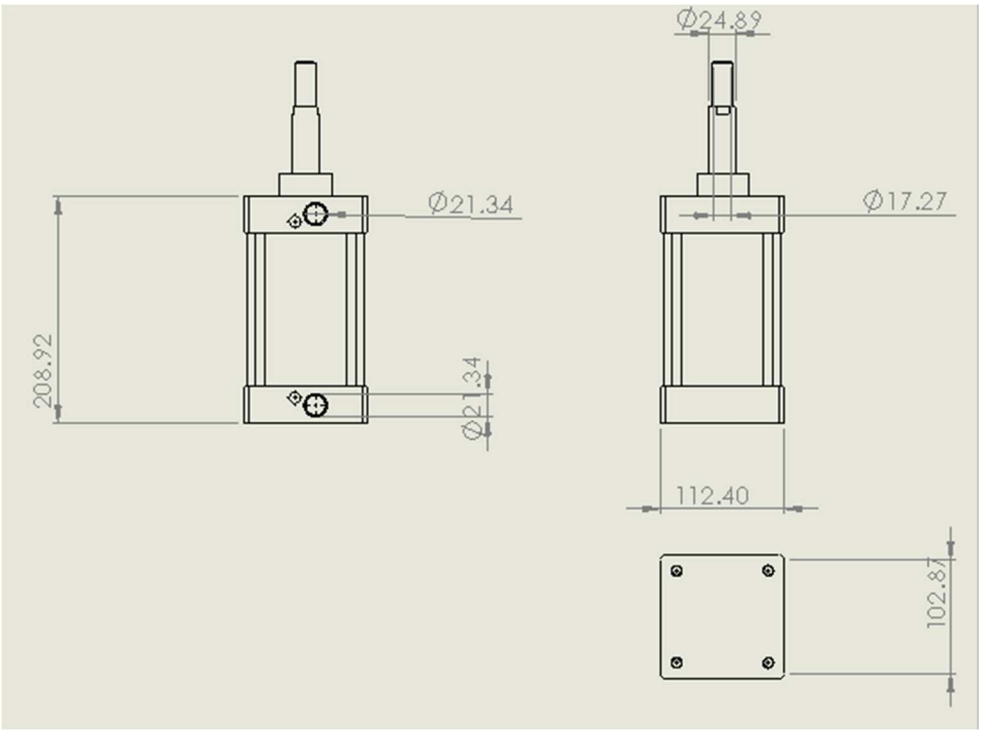


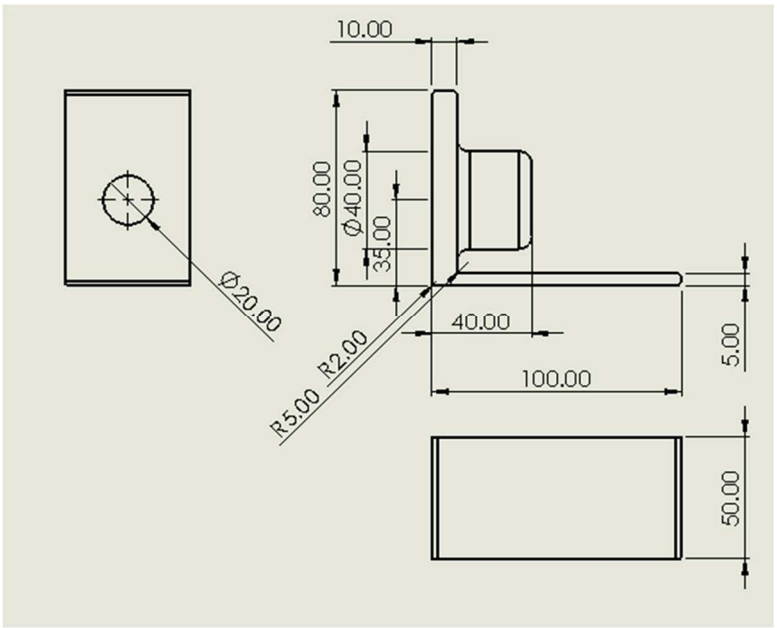
Figure (c)

Mechanical Components 2D Projections with Dimensions

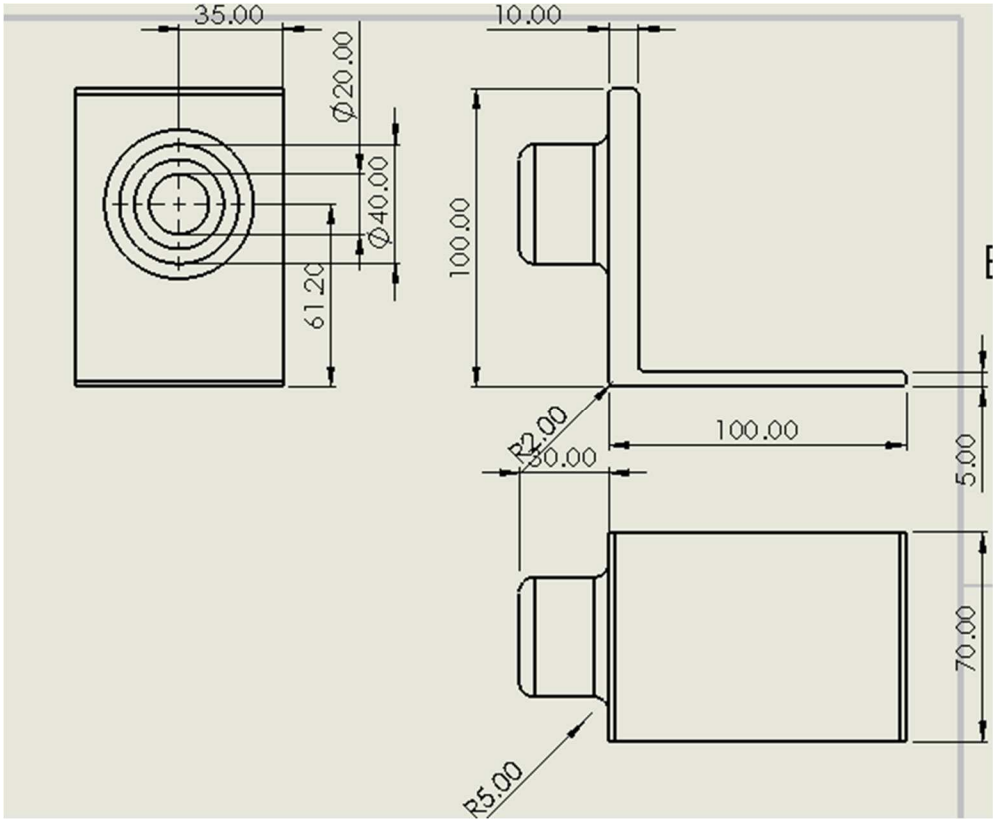
Cylinders parts (1,2,3)



End effector part 4



End effector part 5



End effector part 6

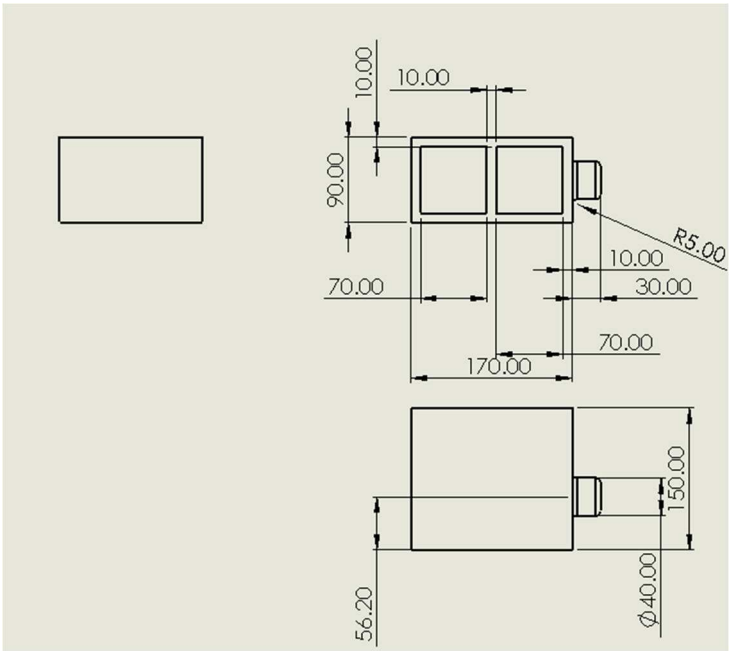
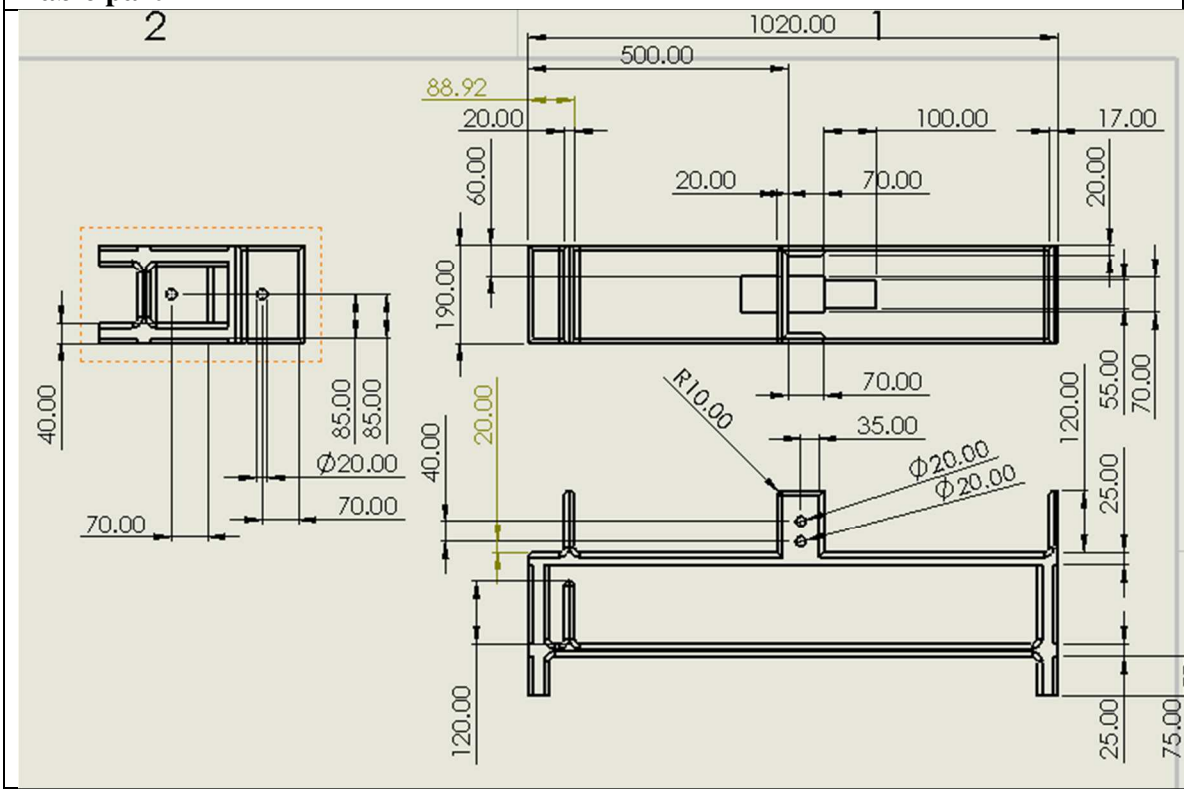
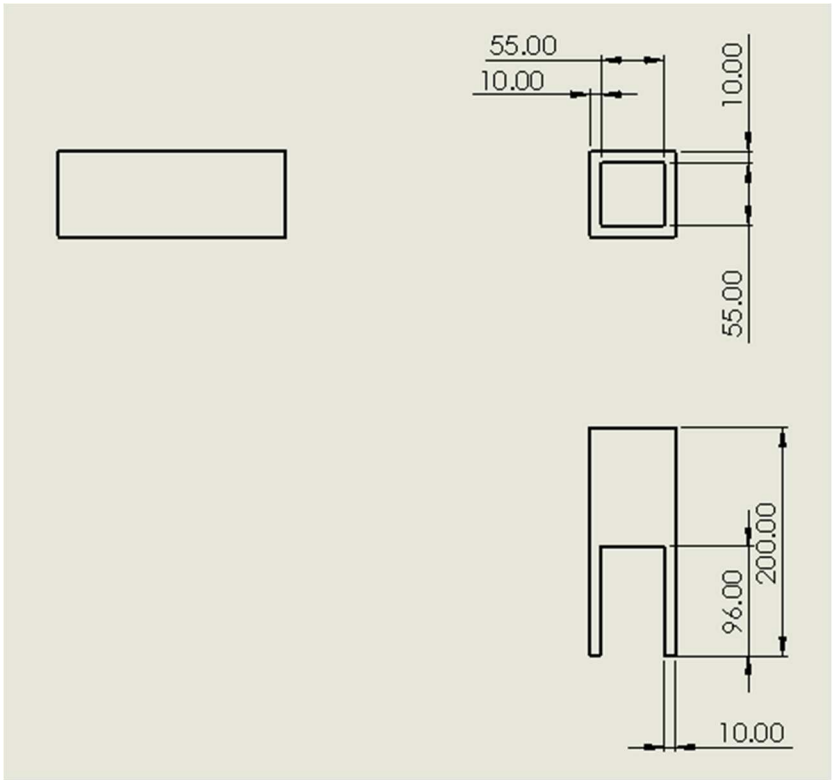


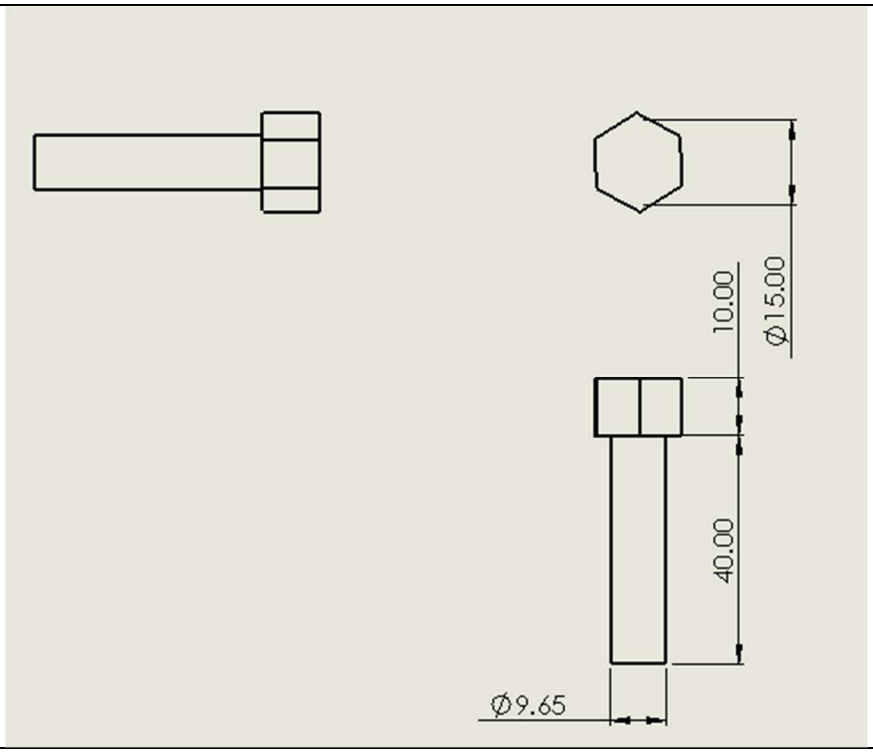
Table part 7



Magazine part 8



Screw part 9



Project Components list and PDF Description

Components	Quantity
16x100 Pneumatic Cylinder	3
24V Relay	8
Reed Switch	6
IR Sensor	2
5/2 way Solenoid Valve	3

Pneumatic Cylinder

The cylinders will be used to feed the pieces and direct them to their designated places, hence a low-pressure cylinder will be used.

Specifications

Bore size [mm]		8	10	12	16	20	25
Type		Pneumatic					
Action		Double acting, Double rod					
Fluid		Air					
Proof pressure		1.5 MPa					
Max. operating pressure		1.0 MPa					
Min. operating pressure	Rubber bumper	0.1 MPa	0.08 MPa		0.05 MPa		
	Air cushion	—	0.08 MPa		0.05 MPa		
Ambient and fluid temperature		Without auto switch: -20 °C to 80 °C (No freezing)					
		With auto switch: -10 °C to 60 °C (No freezing)					
Lubricant		Not required (Non-lube)					
Stroke length tolerance		$^{+1.0}_{0}$ mm				$^{+1.4}_{0}$ mm	
Piston speed		50 to 1500 mm/s					
Cushion		Rubber bumper					
		—	Air cushion				
Allowable kinetic energy	Rubber bumper	0.02 J	0.03 J	0.04 J	0.09 J	0.27 J	0.4 J
	Air cushion	—	0.17 J	0.19 J	0.4 J	0.66 J	0.97 J

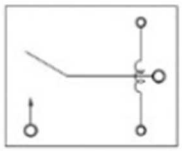
Standard Strokes

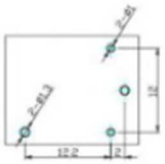
Bore size [mm]	Standard stroke [mm]*2*4	Max. stroke*3 [mm]
8*1	10, 25, 40, 50, 80, 100	100
10		
12	10, 25, 40, 50, 80, 100, 125, 160, 200	200
16		
20	10, 25, 40, 50, 80, 100, 125, 160, 200, 250, 300	500
25		

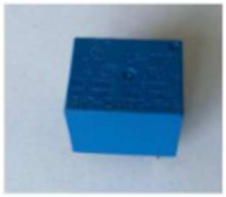
*1 Not available with air cushion.
*2 Other strokes are available on request.
*3 For exceeding the standard stroke range, it will be available as a special order (-X2018).
*4 The minimum stroke with air cushion is 25 mm.

Universal Relay 24 VDC 10 A 4 Pins

The relays will be used for each reed switch and sensor to be able to observe and control the position of the cylinders.





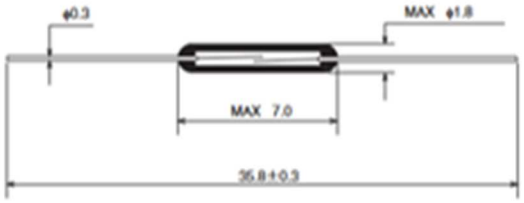


Pins	4
Outline Dimension	19 * 15.5 * 15 mm
Contact form	1a
Contact form (resistance)	10A 240 VAC / 125VAC / 28VDC
Coil voltage (DC)	24 V
Coil power (DC)	0.36 W
Close voltage	≤ 75% V
Release voltage	≥ 10% V
Strength between Contacts	1000 VAC/min
Strength Contacts and coils	1500 VAC/min
Contact resistance	≤ 50 mΩ
Insulation resistance	≥ 500 mΩ
Ambient temperature	-40 - 70 Celsius degree
Mechanical life	10.000.000 times/OPC
Electrical life	100.000 times/OPC
Mounting form	PCB
Weight	0.0078 KG
Application	Mete , Range hood
Operation temperature and humidity	- 40 ~ 70 degree Celsius ; 35% ~ 85% RH
Storage temperature and humidity	0 ~ 70 degree Celsius ; 35% ~ 80% RH
Dimension drawing with tolerance	Out dimension ≤ 1 mm, Tolerance: ± 0.2 mm; ≤ 1~5 mm, Tolerance: ± 0.3 mm
	Out dimension > 5 mm, Tolerance: ± 0.4 mm
Tolerance of mounting hole	± 0.1 mm

Reed Switch

The reed switch is needed to be able to know if the cylinders are completely extended or retracted.

■ EXTERNAL DIMENSIONS (Unit: mm)



■ APPLICATIONS

- Automotive electronic devices
- Control equipment
- Communication equipment
- Measurement equipment
- Household appliances

■ ELECTRICAL CHARACTERISTICS

Parameter	Rated value	Unit
Pull-in Value (PI)	10~40	AT
Drop-out Value (DO)	5min	AT
Contact resistance (CR)	200max	mΩ
Breakdown voltage	150min	VDC
Insulation resistance	10^9min	Ω
Electrostatic capacitance	0.4max	pF
Contact rating	1.0	VA
Maximum switching voltage	24 ($^{DC}_{AC}$)	V
Maximum switching current	0.1	A
Maximum carry current	0.3	A

IR Sensor

The IR sensors will be used to know whether the object is big or small.

Specifications

Parameter	typical	units
Number of thermojunctions	100	
Active area	0,5	mm²
Die size	2,2 x 2,2	mm²
Resistance of thermopile (Rth)	50±15	KΩ
Sensitivity	110±20	V/W [1]
Temp. Coeff. Of sensitivity	-0,52±0,08	%/K
Specific Detectivity	2,1 *10E8	cm.Hz½/W [1]
noise equivalent power	0,35	nW [1]
Noise voltage	37	nV/Hz½
Time constant	40±10	ms (63%)
Temperature range (sensor)	-20 - + 100	°C
Storage temperature	-40 - +100	°C
Filter (high pass)	5,5	µm
[1] at 500 K dc **Reference Thermistor (SMTIR9902 only)**		
Resistance	1,000 ±0,004	KΩ (@ 0 °C

5/2 Way Solenoid Valve

This valve controls the cylinders (extend or retract) when operated by the solenoid.

Technical data	
Orifice	DN 6.0
Body material	PA (Polyamide)
Seal material	NBR
Media	Lubricated and non-lubricated dry air; neutral gases (10 µm-filter)
Media temperature	-10 to +60 °C
Ambient temperature	-10 to +60 °C
Manual override	As a standard feature
Port connection	Flange for MP12 (please see illustration)
Pneumatic module	Type MP12 with G1/8, Push-in connection Ø 8 mm
Voltage	24 V DC
Voltage tolerance	±10%
Nominal power	2W, 1W
Duty cycle	Continuous operation (100%)
Electrical connection	Tag connector acc. to DIN EN 175301-803 (previously DIN 43650) Form C Type 2506
Protection class	IP 65 (with cable plug)
Weight	95g
Mounting	with 2 screws M3x30
Installation	Any, preferably solenoid system upright

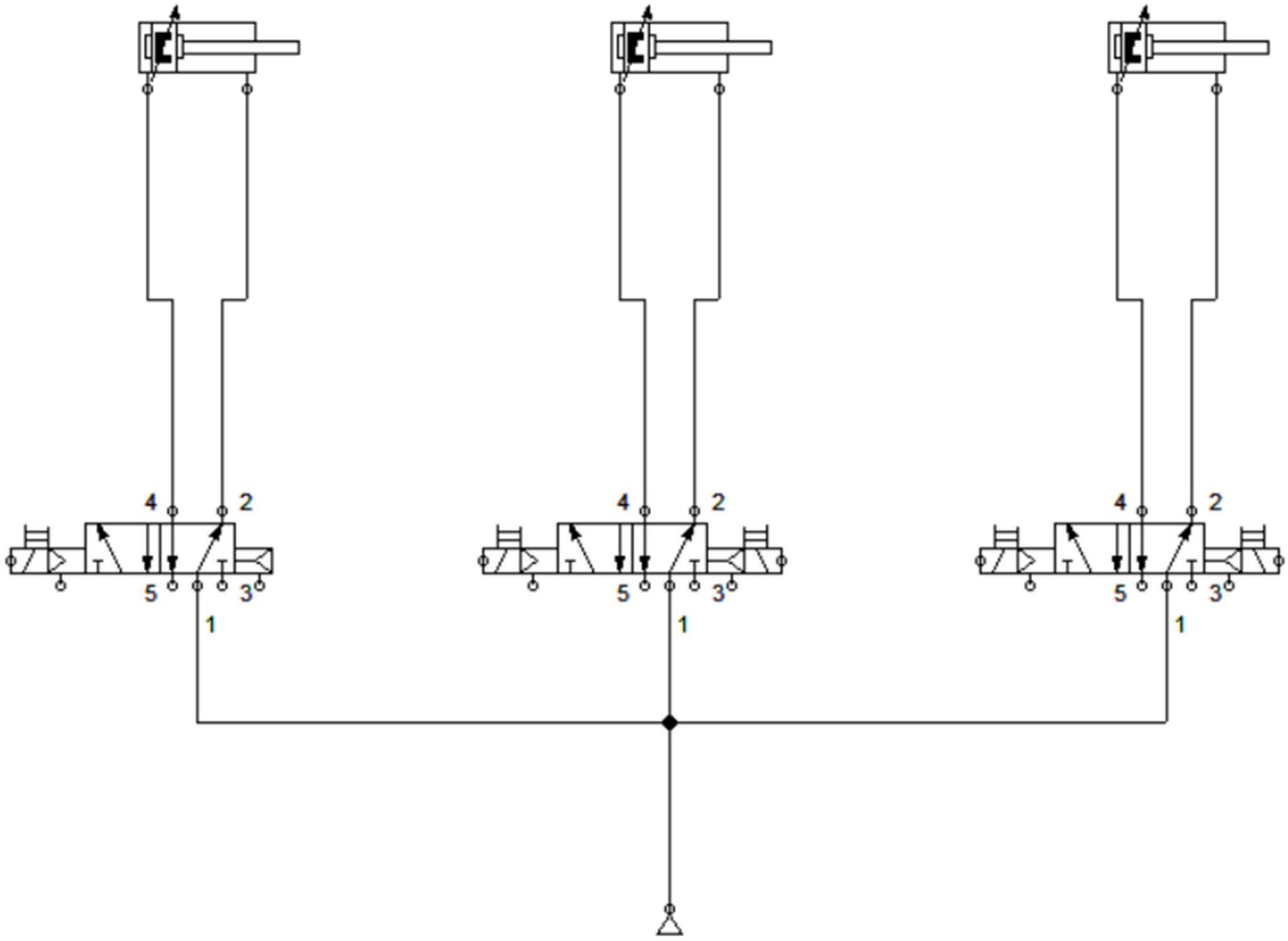
Module	Version	Feature	Item No.
Connection module	right	G 3/8	555 110
		NPT 3/8	555 113
	left	G 3/8	555 109
		NPT 3/8	555 111
Pneumatic basic module 2 valves	push-in connection Ø 8 mm	without check valve	156 617
		with integrated check valve with R-channel	156 635
		with integrated check valve with R and S-channel	156 632
	connection G 1/8	without check valve	156 630
		with integrated check valve with R-channel	156 636
		with integrated check valve with R and S-channel	156 633
	connection NPT 1/8	without check valve	156 631
		with integrated check valve with R-channel	156 637
		with integrated check valve with R and S-channel	156 634
Pneumatic basic module 4 valves	push-in connection Ø 8 mm	without check valve	156 666
		with integrated check valve with R-channel	156 662
		with integrated check valve with R and S-channel	156 659
	connection G 1/8	without check valve	156 667
		with integrated check valve with R-channel	156 663
		with integrated check valve with R and S-channel	156 660
	NPT 1/8	without check valve	156 668
		with integrated check valve with R-channel	156 664
		with integrated check valve with R and S-channel	156 661
Covering plate		for unused valve positions	553 785

5/2-way solenoid valve without cable plug

Circuit function	Orifice [mm]	QNn value air [l/min]	Pressure range [bar]	Power consumption [W]	Response times Opening [ms]	Response times Closing [ms][1]	Item no. 24 V DC
H 5/2-way valve 	6	700	1.0 - 10[1]	2	20	12	156 828
			1.0 - 10[1]	2	20	12	163 030[1]
			2.0 - 10	2	20	12	156 337
			2.0 - 10	2	20	12	156 842[1]
			2.0 - 8.0	1	20	17	156 827
			2.0 - 8.0	1	20	12	156 943[1]

[1] Version with auxiliary pilot air

Pneumatic Circuit



Pneumatic Step Diagram and Description

- **Draw the pneumatic step diagram based on your project's operation,as shown in the example below.**
- **Explain your provided pneumatic step diagram; the sequence andthe project's operation.**
- **Example for the pneumatic step diagram**

Controller Operating Panel/ Classic Control Implementation

As you already have the information for each component (power supply, solenoids, relays, I/O terminals…), you can configure the size of the panel you need for your project. Implement the classic control by using the fluidSim software

An example for a panel configuration is shown below: