German University in Cairo

Mechatronics Lab (MCTR704)

Metal Separation

Project No. [22]

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# Project Description

- The project involves the manufacturing and assembly of a metal separator using 3 pneumatic cylinders.
- The metallic parts along with the non-metallic parts will be placed in a 100x100mm box present in the structure.
- The structure consists of a wooden seated frame structure that has all the components fitted on.
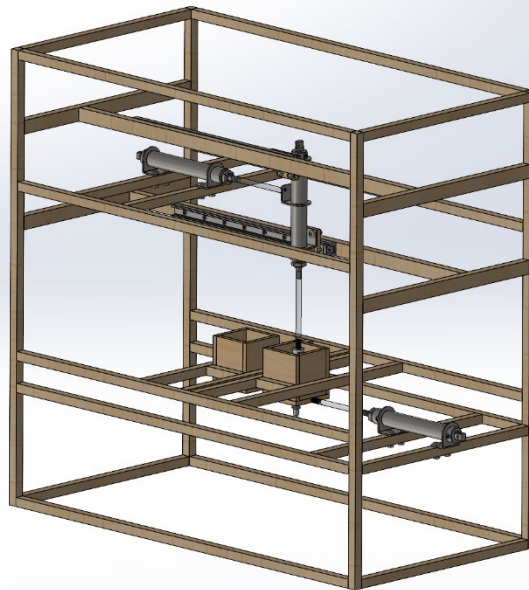

Figure 1: Metal Separator Frame Structure

- The frame consists of 2 boxes, a separation box containing metals and nonmetals and a collection box to collect the metals.
- The collecting cylinder (Cylinder A) is fitted with an electromagnet at its end to collect the metals.
- The transfer cylinder (Cylinder B) moves Cylinder A back and forth between the separation box and collecting box.
- The discharge cylinder (Cylinder C) gets rid of remaining nonmetals.
- The operation starts when start button is pressed and the fitted metal sensor detects the presence of metals in the separation box.
- Cylinder A extends above the separation box activating the electromagnet to collect the metals and retracts back.
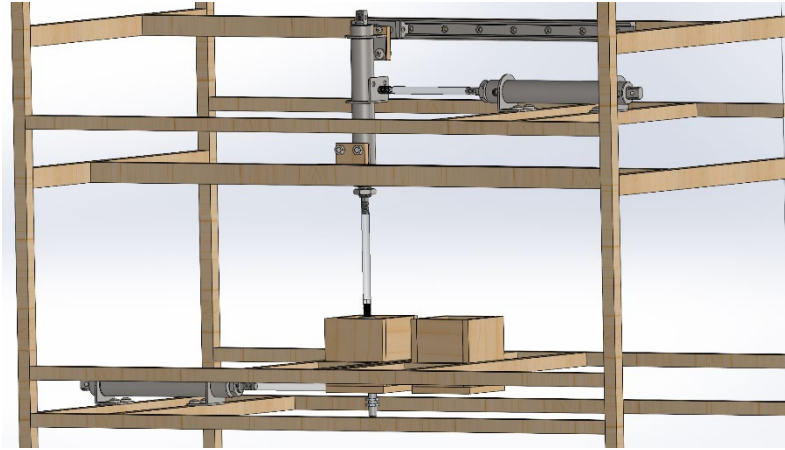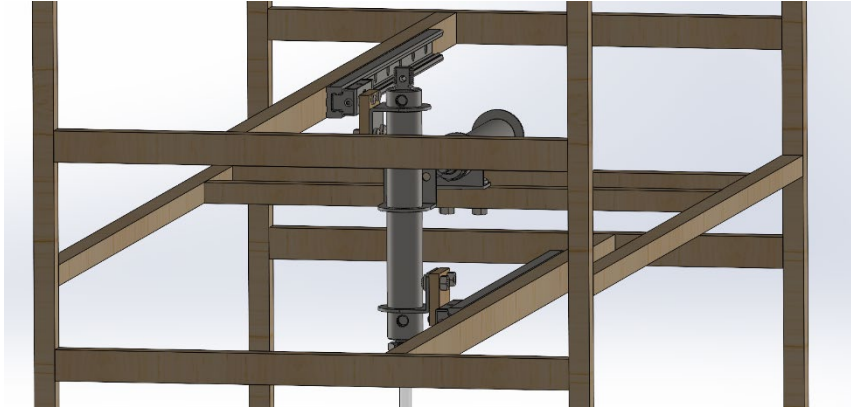
Figure 2: Cylinder A Extending Above the Separation Box

- Upon collecting metal Cylinder B retracts moving Cylinder A towards the collection box.
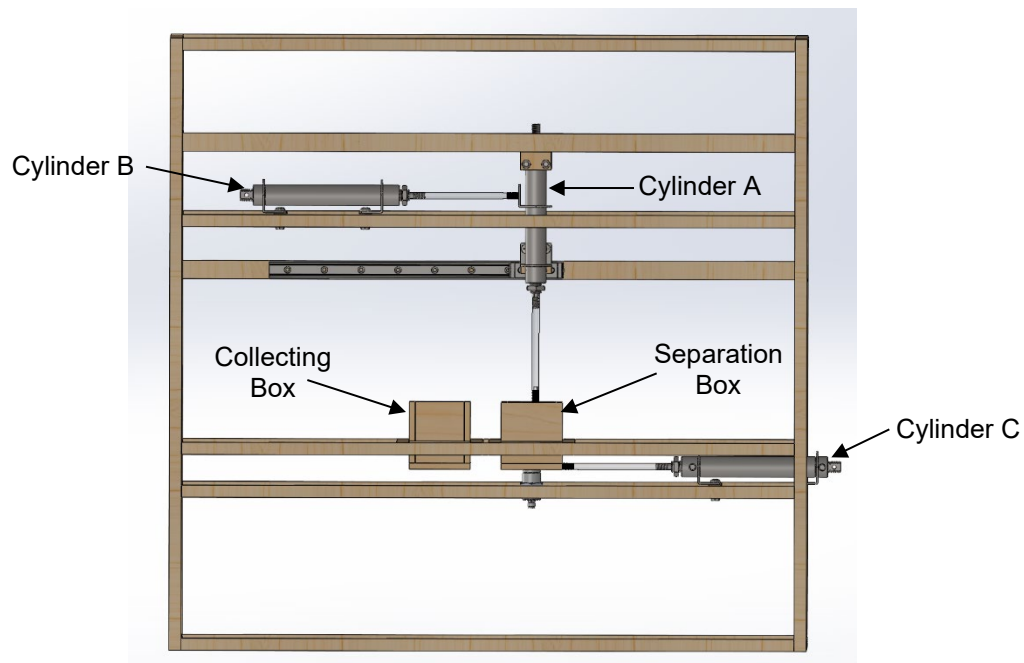

Figure 3: Side View Showing Different Components

- Cylinder A is fitted along slider rails to allow ease of sliding from one position to another.

Figure 4: Slider Rails

- Upon reaching the collection box, Cylinder A extends again deactivating the electromagnet to drop the metals in the collection box and then retracts.
- Upon collecting the metals, Cylinder B extends returning Cylinder A above the separation box.
- This sequence is continuous and is repeated continuously as long as the metal sensor fitted in the separation box detects metal inside the box.
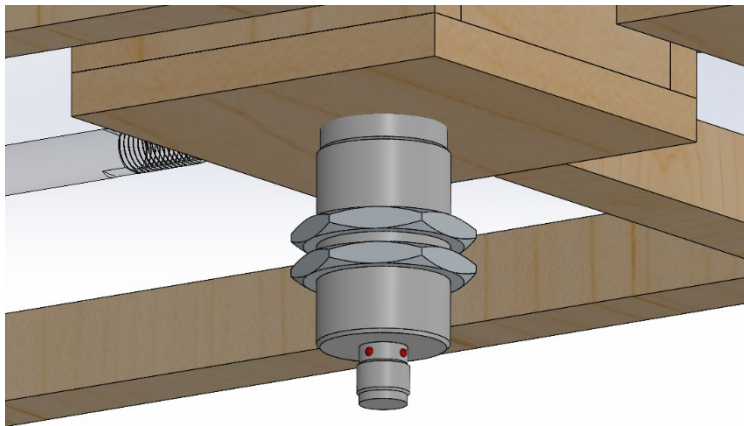
Figure 5: Metal Sensor

- When the above sequence ends and the metal sensor doesn't detect the presence of any metal, Cylinder C retracts opening a sliding door to discharge of the nonmetals and then extends again to close the sliding door.
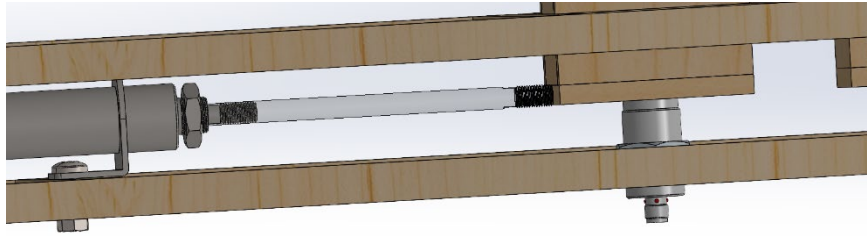
Figure 6: Sliding Door

- The user can now introduce a new patch of materials to be separated.

Solid works Design: 3D Schematic Diagram

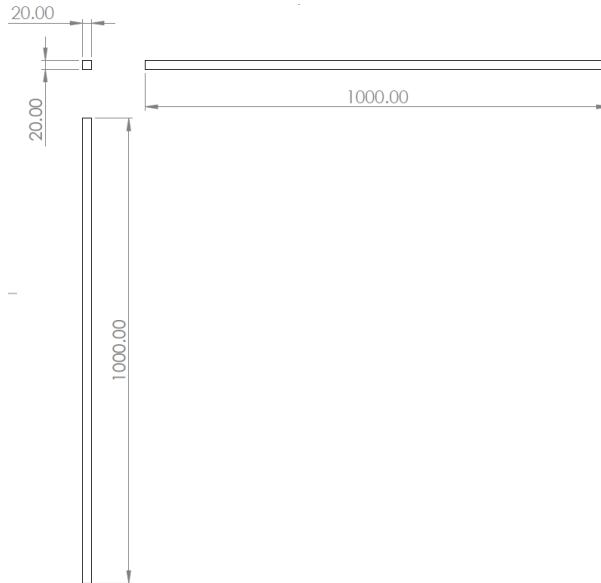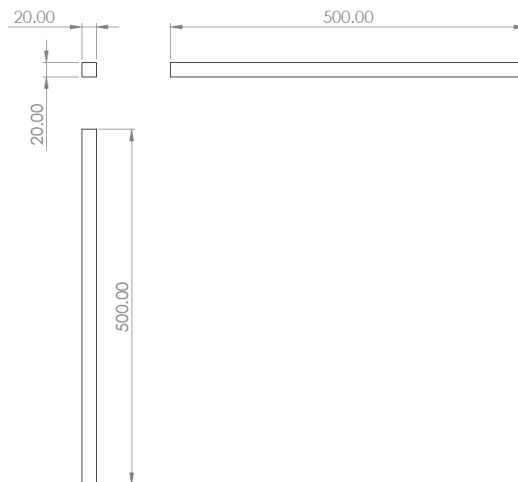| Item Number	Part Number	Quantity
1	20 x 20 x 1000mm Wooden Square Dowel Rod	14
2	20 x 20 x 500mm Wooden Square Dowel Rod	8
3	Cylinder Holder Rod	4
4	Double Acting Pneumatic Cylinder	3
5	Mounting Bracket	7
6	M8 x 30 Screw	8
7	M8 Nut	12
8	Box Side Plate	6
9	20 x 20 x 100mm Wooden Square Dowel Rod	4
10	Box Front & Back Plate	4
11	30 x 20 x 1000mm Wooden Square Dowel Rod	2
12	Side Rail	2
13	30 x 20 x 400mm Wooden Square Dowel Rod	4
14	Electromagnet	1
15	M8 x 20 Screw	4
16	Sliding Door	1
17	Metal Sensor	1
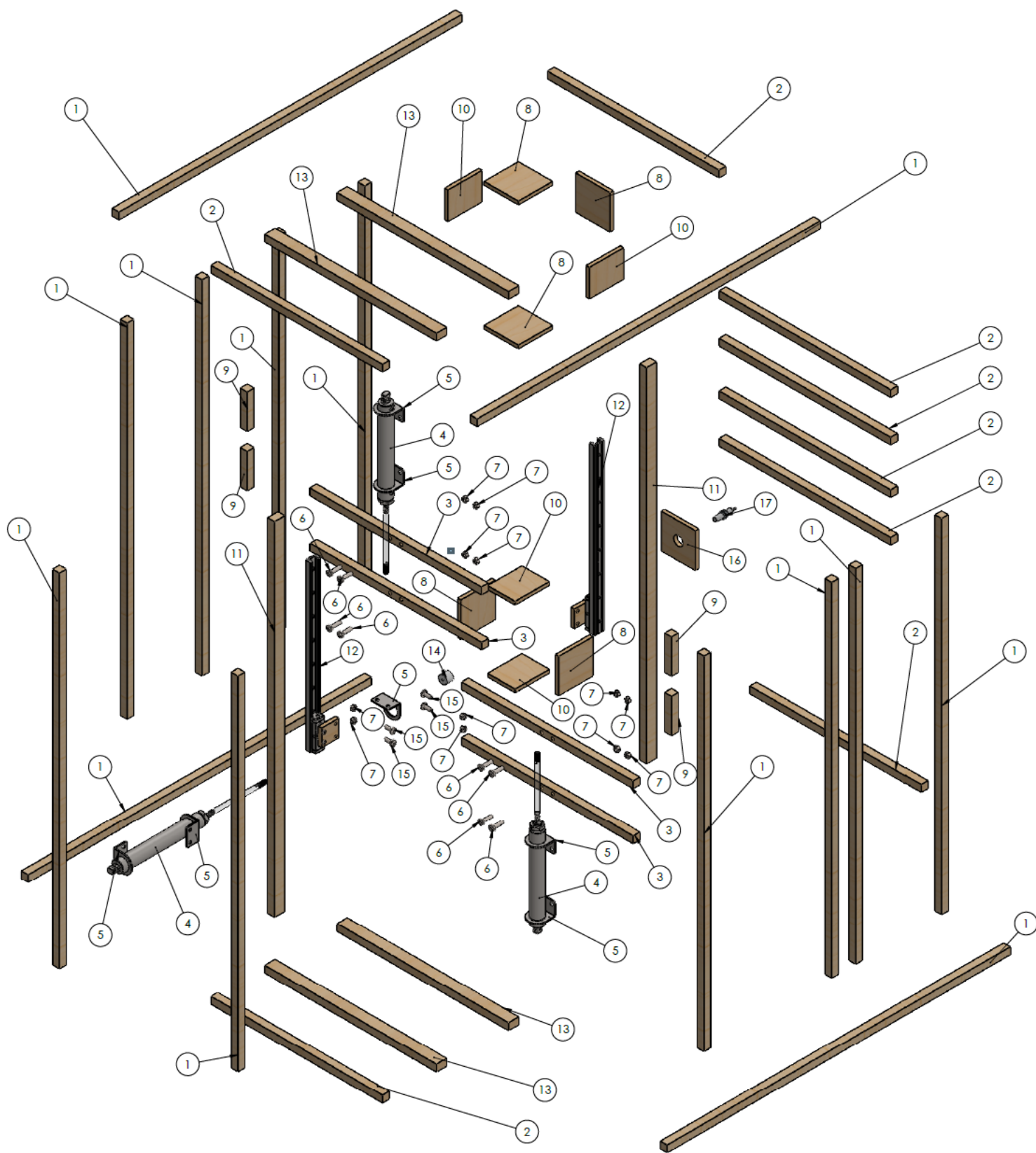
Figure 7: Exploded View

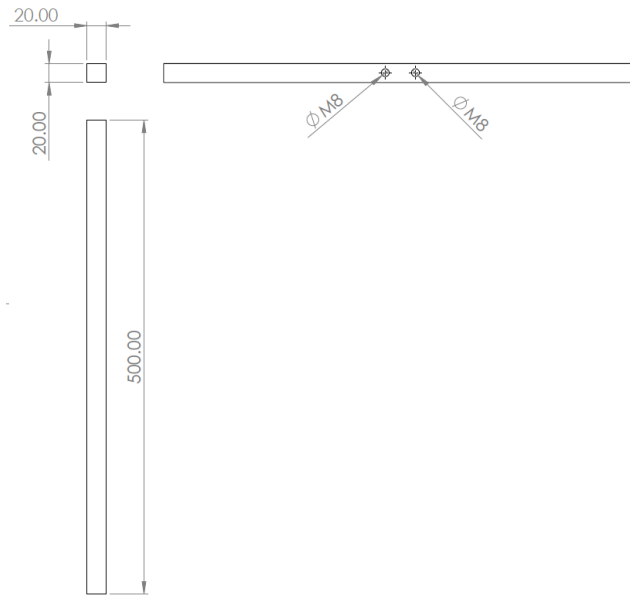# Mechanical Components 2D Projections with Dimensions

Part No 1: 20 x 20 x 1000mm Wooden Square Dowel Rod

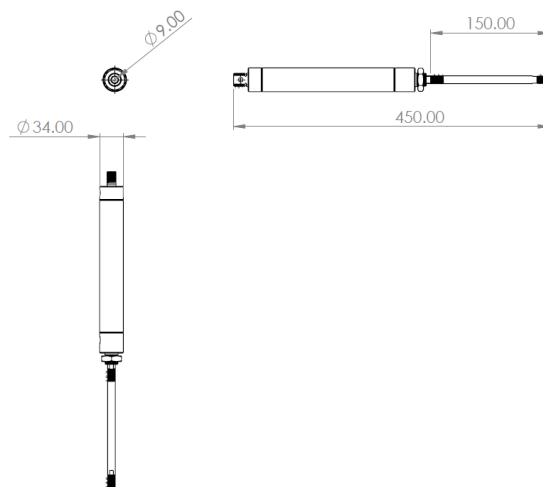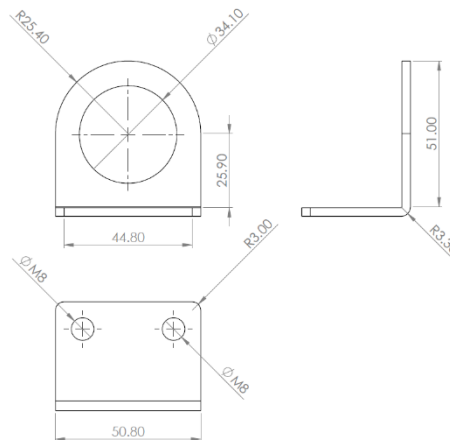**Part No 2:** 20 x 20 x 500mm Wooden Square Dowel Rod
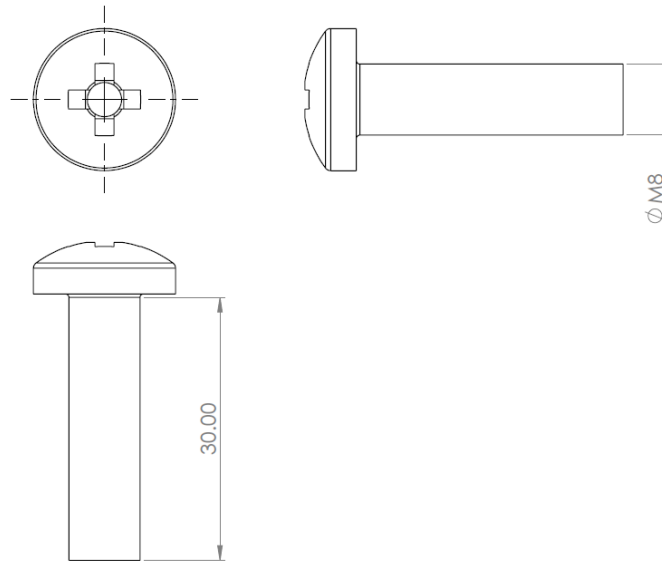
Part No 3: Cylinder Holder Rod

Part No 4: Double Acting Pneumatic Cylinder

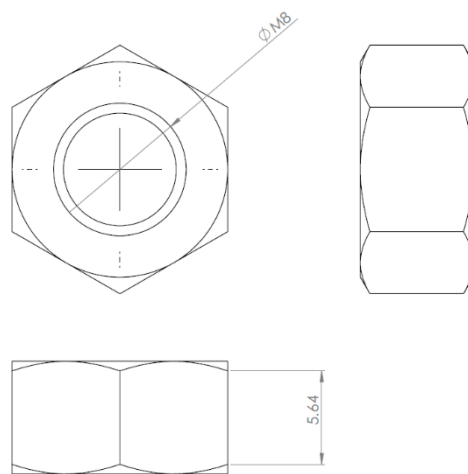**Part No 5:** Mounting Bracket

Part No 6: M8 x 30 Screw

30.00

∅ M8

Part No 7: M8 Nut

∅ M8

5.64

Part No 8: Box Side Plate

100.00

100.00

12.00
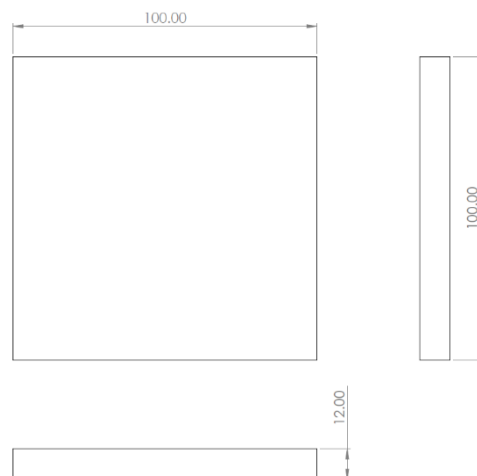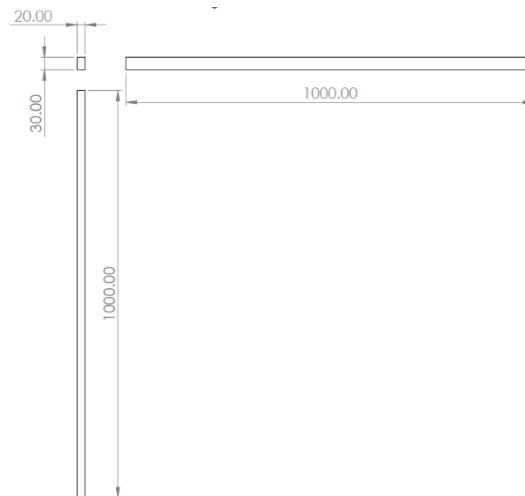
Part No 9: 20 x 20 x 100mm Wooden Square Dowel Rod
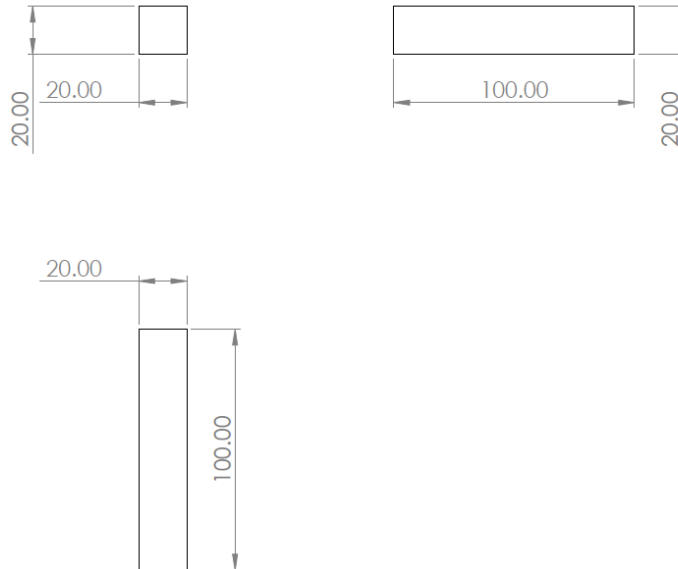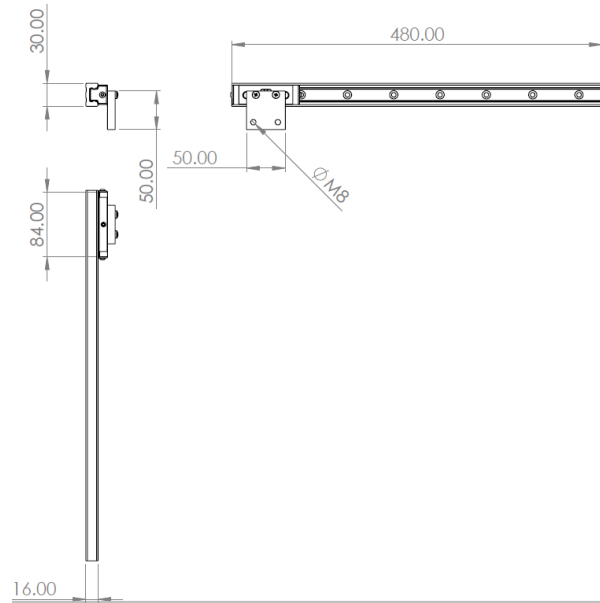

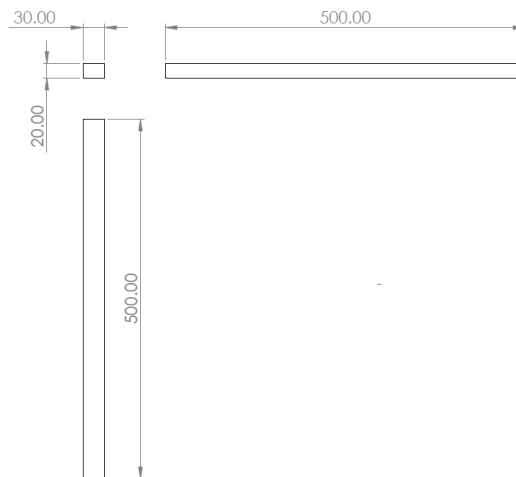**Part No 10:** Box Front & Back Plate
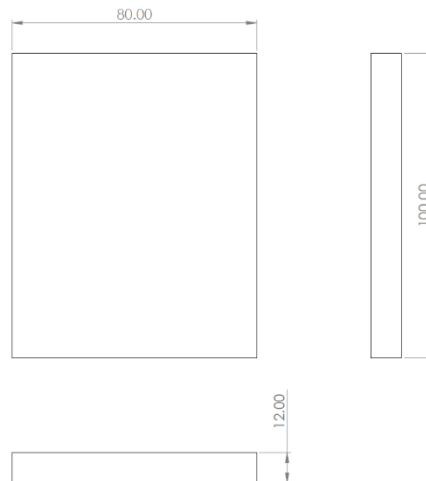
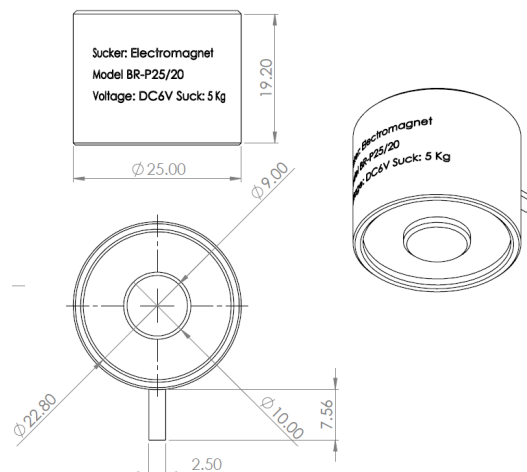**Part No 11:** 30 x 20 x 1000mm Wooden Square Dowel Rod

Part No 12: Side Rail

Part No 13: 30 x 20 x 500mm Wooden Square Dowel Rod

Part No 14: Electromagnet

Sucker: Electromagnet
Model BR-P25/20
Voltage: DC6V Suck: 5 Kg

Part No 15:   M8 x 20 Screw

⌀M8

20.00
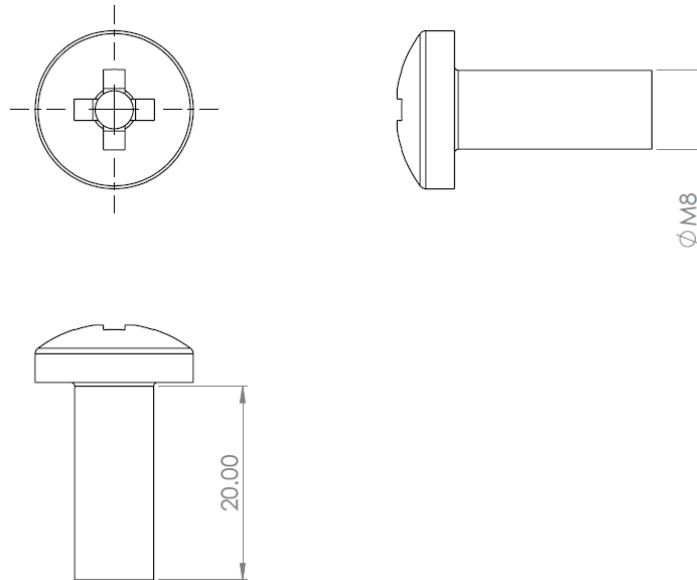
Part No 16:   Sliding Door

10.00

⌀30.00

100.00

100.00
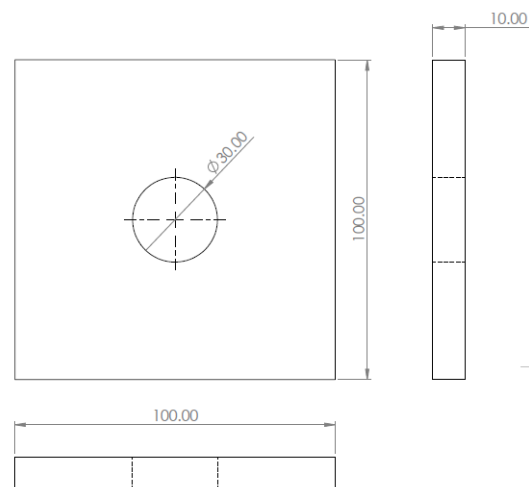
Part No 17:   Metal Sensor

⌀28.38

15.00

⌀28.38

⌀30.00

60.00
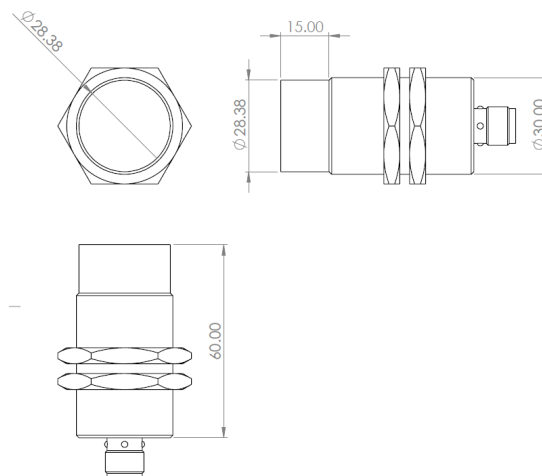
Project Components list and PDF Description

Name	Description	Quantity	Photo
20 x 20 Wood Square Dowel Rod	Square Wooden Rods of 1m length	21	
30 x 20 Wood Square Dowel Rod	Square Wooden Rods of 1m length	4	
Wooden Plate	1m x 1m Wooden Plate of Thickness 12mm	1	
M8 x 30 Screw	Screw of length 30mm and diameter 8mm	8	
M8 x 20 Screw	Screw of length 20mm and diameter 8mm	4	
M8 Nut	Nut for M8 Screw	12	
Sliding Rail	Sliding Rails Used for Drawers	2	
Mounting Bracket	Mounting Bracket Used to Secure Cylinders in Place of 30mm Diameter	7	
Electromagnet	Electromagnet of Pull Force 5kg	1	

Electrical Relay	Electrically Operated Switch	15	
Reed Switch	Magnetically Actuated Electrical Switch	6	
Metal Sensor	Inductive Metal Sensor for Metal Detection	1	
5/2 double actuated solenoid valve	5/2 double actuated solenoid valve	3	
Double Acting Pneumatic Cylinder	Pneumatic Cylinders of Controlled Extension & Retraction	3	
Hoses	Connection for Compressed Air	20	
Electric Wires	Different Color of Electric Wires		
Start Button	Green Button for Start	1	
Stop Button	Red Button for Stop	1	

Power Supply	Supply Converts 220 Vac to 24Vdc	1	
Voltage Regulator	Steps Down DC Voltage from 24V to 12V	1	

Pneumatic Circuit
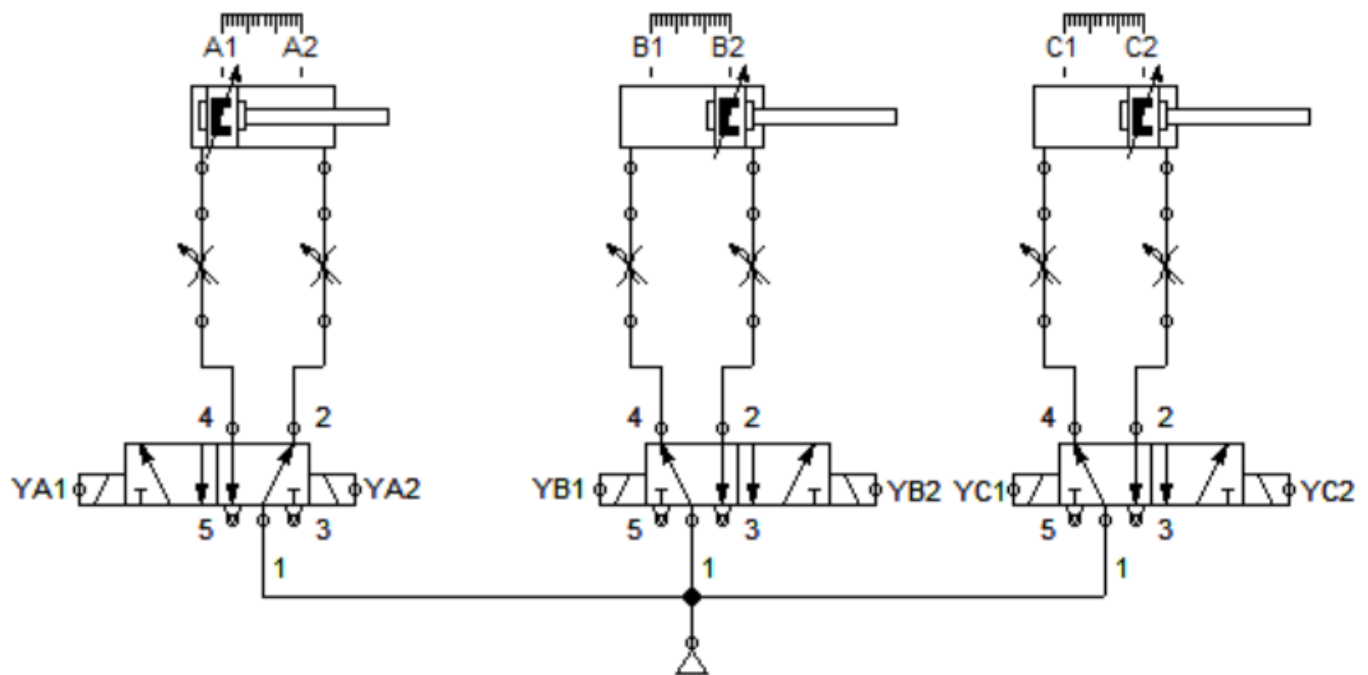
Figure 8: Pneumatic Circuit

Pneumatic Step Diagram and Description

Metal Sequence: A+ A- B- A+ A- B+
Nonmetal Sequence: C- C+

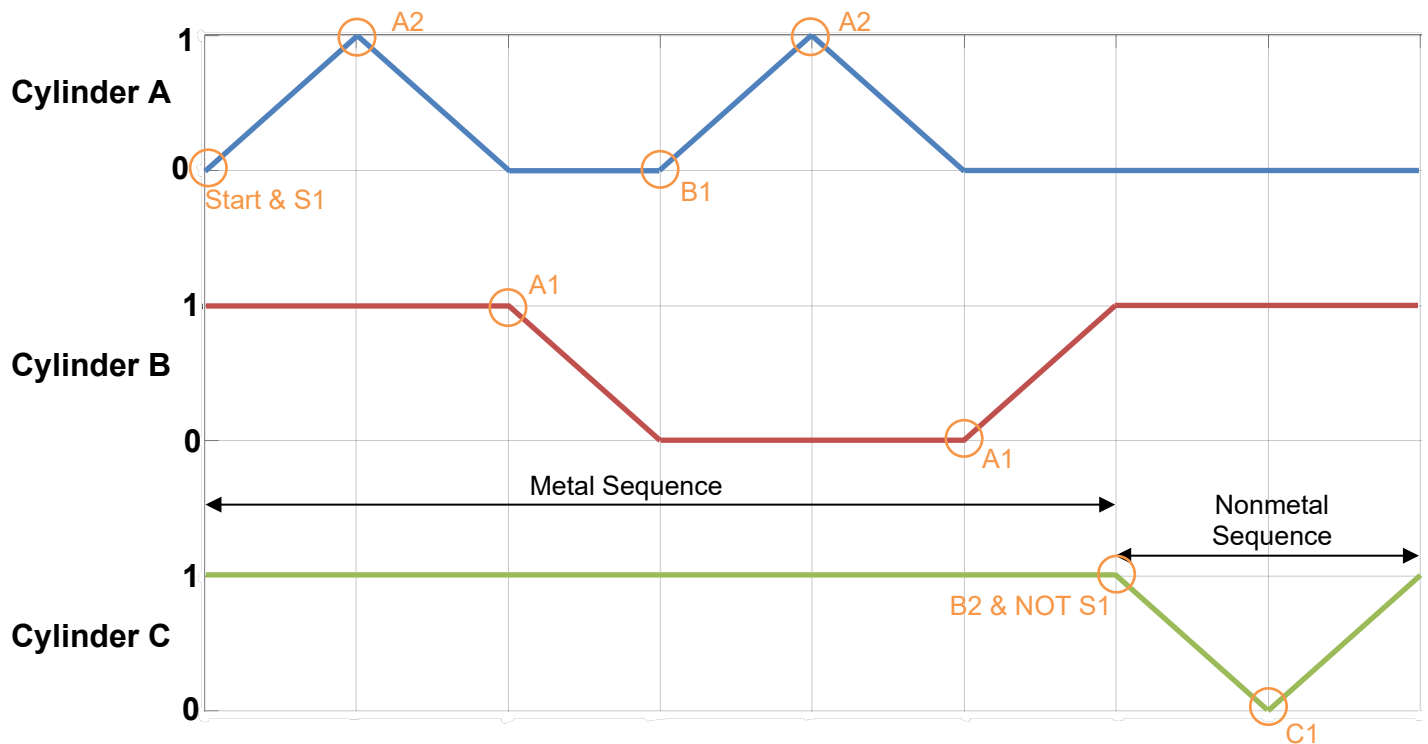- The metal sequence is the operation of collecting metals from separation box and dropping it in the collection box.
- The metal sequence is a continuous sequence as long as the metal sensor (S1) detects the presence of metal in the separation box.
- The metal sequence ends and nonmetal sequence begins when the metal sensor doesn't detect the presence of any metals in the separation box.
- The nonmetal sequence is the discharging of nonmetals to allow the user to introduce a new batch of materials.
- The nonmetal sequence is not continuous (one time sequence).
- After the completion of the nonmetal sequence the operation halts until the user presses start again.

Overall Sequence: A+ A- B- A+ A- B+ | C- C+
Continuous

Controller Simulation as for the Pneumatic Step Diagram
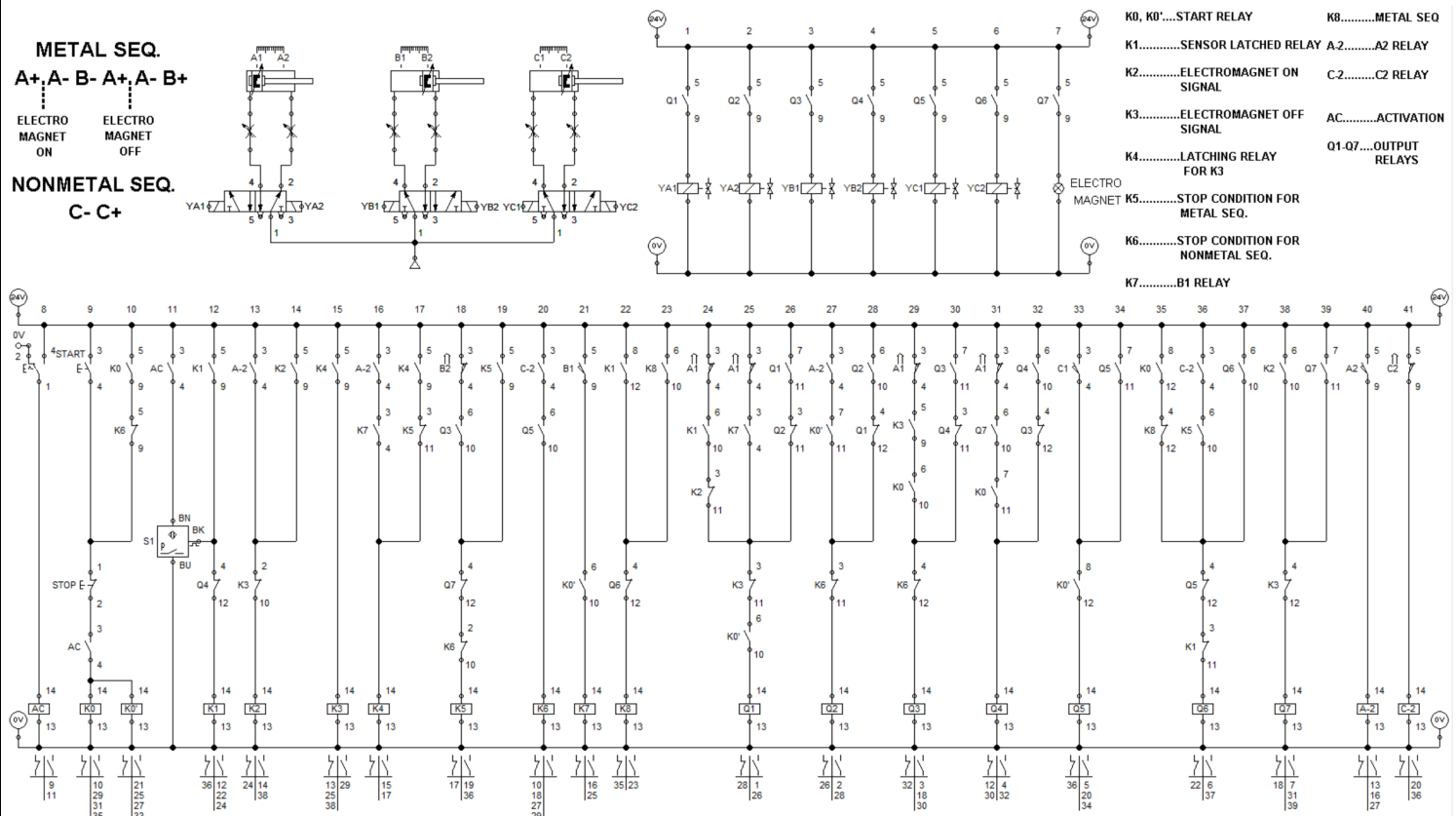
Figure 9: Controller Simulation Circuit

- The circuit simulation is done as built with each relay having only 4 contacts and reed switches have Normally Open contacts.
- The metal sequence is the separation sequence and it is a continuous sequence as long as the metal sensor (S1) detects metal in the separation box.
- Cylinder A extends (A+) to collect metal from the separation box and retracts again (A-)
- Cylinder B retracts (B-) pulling Cylinder A towards Metal Collecting Box
- Cylinder A extends (A+) to drop metal into the collection box and retracts again (A-)
- Cylinder B extends (B+) pushing Cylinder A towards the separation box to restart the process
- The above process repeats for as long as S1 has a signal
- When S1 doesn't detect any metal Cylinder C retracts (C-) opening the sliding door to discharge of the non-metals and extends again (C+) to close the door and allow the user to introduce another patch

Hardware Model (Electrical + Mechanical)
Including

Classic Control Implementation
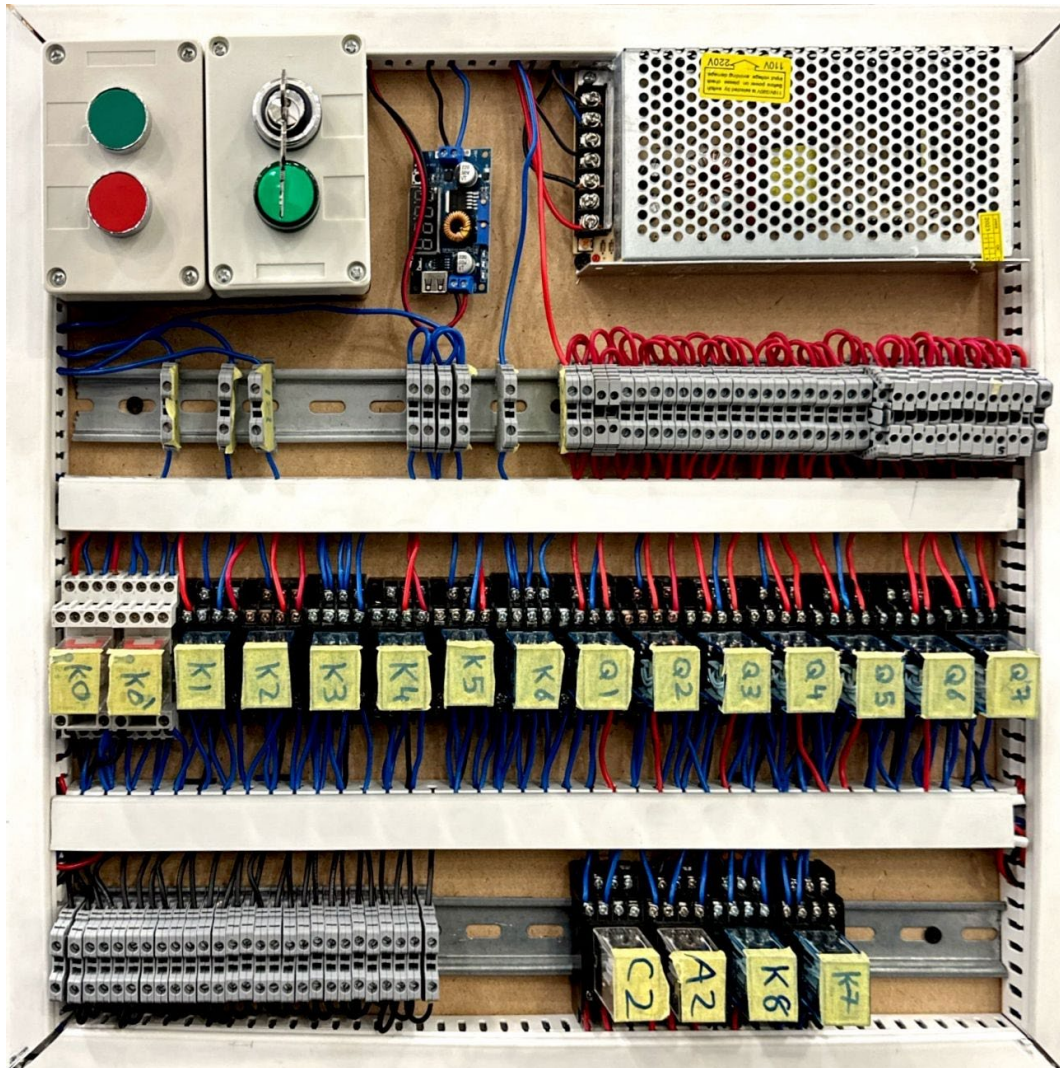
Figure 10: Control Circuit Assembly

The control circuit has dimensions of 50x50mm surrounded by ducts to hold the wires, omega bars to hold the relays, 24V 5A power supply and control box to hold the buttons and key switch. The circuit is built exactly like the simulation.

Project Hardware As Built

Figure 11: Hardware Assembly

Figure 12: Control Circuit Assembly

Figure 13: Project Assembly

QR Code
Including

Solidworks files, Testing Videos & Circuit Simulation

Figure 14: QR Code

A link including the full project documentation including Solidworks design, final hardware model, control circuit simulation, final control circuit, pneumatic cylinders testing and control circuit branch-by-branch testing.