HYDRAULICS & PNEUMATICS (MCT-313L)

Semester Project Report

Automatic Glueing Station

Submitted by:

Name: **Hurraira Adrees**	Registration No: **2021-MC-01**
Name: **Muhammad Saad Yaseen**	Registration No: **2021-MC-37**
Name: **Muhammad Mujahid Iqbal**	Registration No: **2021-MC-38**
Name: **Muhammad Rafay**	Registration No: **2021-MC-39**
Name: **Abiam Asif Khalid**	Registration No: **2021-MC-40**

Submitted to:

Dr. Ali Raza

Department of Mechatronics & Control Engineering

University of Engineering & Technology, Lahore.

January-2024

Table of Contents

INTRODUCTION:

The development of high-performance adhesives tailored to specific applications has led to an increasing prevalence of **Glueing** procedures in industry. The graphic demonstrates the process of applying glue to a ready-made joint. The workpiece assembly is turned and raised out of the workpiece carrier for this purpose. A pneumatic cylinder delivers the adhesive nozzle to the workpiece assembly. Pneumatic cylinders are typically also used to stop the workpiece carriers. A feature that allows the rotary unit to fine-tune its rotational speed is required.

OBJECTIVES:

The main objective of the projects is:

- To implement a logic developed on Festo FluidSim and then use the hardware to implement the circuit.
- To source the components required to make a proper hardware by visiting different markets.
- To make sure the budget doesn't go beyond the limit given by the instructor.
- To use the principles of electro pneumatics to make an automated glueing system.
- To make a replica of industrial application that is further used for industrial applications.

HARDWARE COMPONENTS:

There are multiple components used in the manufacturing process of glueing mechanism and their description is given below:

PNEUMATICS:

1. PNEUMATIC ACTUATORS:

A pneumatic actuator is a device that converts energy typically in the form of compressed air into mechanical motion. Within the industry, pneumatic actuators are recognized by several different names including pneumatic cylinders, air cylinders, and air actuators; all of which are one and the same. Consisting of a piston, cylinder, and valves or ports, a pneumatic actuator can convert energy into linear or rotary mechanical motions[1].

Figure 1: Pneumatic Actuator

2. DIRECTIONAL CONTROL VALVES:

A 5/2-way double solenoid valve, commonly known as a 5-port, 2-position double solenoid directional control valve, has one input, two output, and two exhaust ports. There is no spring return function on the double-solenoid valve. The position is attained by activating the coils in this sort of valve. When voltage is delivered to a solenoid coil, the double solenoid valve is reversed and remains in this switching state until an opposing signal is applied[2].

Figure 2: 5/2-Way Double Solenoid Valve

3. FLOW CONTROL VALVES:

The one-way flow control valve consists of a combination of a flow control valve and a non-return valve. The non-return valve blocks the flow of air in one direction, whereby the air flows via the flow control valve. The throttle cross section is adjustable by means of a knurled. screw. The setting can be fixed by means of a knurled nut[3].

Figure 3: One-Way Flow Control Valve

4. PNEUMATIC PIPES:

To get the compressed air to the tools, you can use a pneumatic hose. A pneumatic hose is a type of industrial hose. The basic function of a pneumatic hose is to transport pressurized air[4].

Figure 4: Pneumatic Pipe(4mm)

5. MANIFOLD:

Pneumatic manifolds provide a convenient junction point for the distribution of fluids or gases and are used to provide pneumatic power to two or more locations to supply multiple tools. Air manifolds come in various port options and different material types for low and high-pressure applications[5].

Figure 5: Manifold

6. WOODEN FRAME ASSEMBLY:

Wooden Pieces are made by accurate required dimensions with the help of screws and brackets and is converted into wooden frames on which all DCVs, actuators and wires are mounted. Cardboard, ply and soft woods are used for cylinders fittings, and they all are placed on base wood.

Figure 6: Wooden Base Frame

ELECTRICAL:

1. RELAYS (24V):

Relay is an electromagnetic device which is used to isolate two circuits electrically and connect them magnetically. They are very useful devices and allow one circuit to switch another one while they are completely separate. They are often used to interface an electronic circuit (working at a low voltage) to an electrical circuit which works at very high voltage[6].

Figure 7: 24V Relay

2. TRANSISTOR(TIP 122):

A transistor is a semiconductor device used to amplify or switch electrical signals and power. It is composed of semiconductor material, usually with at least three terminals for connection to an electronic circuit[7].

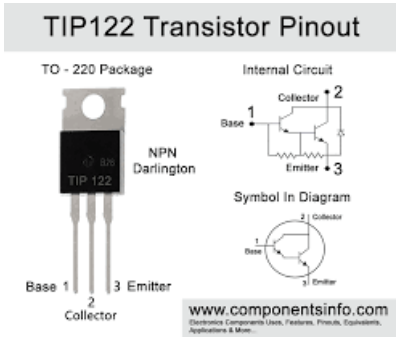

Figure 8: TIP 122

3. RESISTORS (2.2K):

A resistor is an electronic component that is designed to resist the flow of electric current. Resistors are used in a wide variety of electronic circuits to control the flow of current, to divide voltages, to limit current, and to provide a known resistance for calibrating and testing purposes[8].

Figure 9: 2.2K Resistor

4. SERVO MOTOR:

Micro Servo Motor SG90 is a tiny and lightweight server motor with high output power. Servo can rotate approximately 180 degrees (90 in each direction) or 360 degrees and works like the standard kinds but smaller. You can use any servo code, hardware, to control these servos[9].

Figure 10: SG90 Servo Motor

5. REED SWITCHES:

A magnetic reed switch operates by magnetic field. Like any other type of electrical switch, a magnetic reed switch is used to control the flow of electricity. If the contact of a magnetic reed switch is open, electricity cannot flow. If the magnetic reed switch is closed, electricity can flow[10].

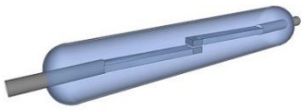

Figure 11: Magnetic Reed Switch

6. ARDUINO NANO:

The Arduino Nano is an open-source breadboard-friendly microcontroller board based on the Microchip ATmega328P microcontroller (MCU) and developed by Arduino.cc and initially released in 2008. It offers the same connectivity and specs of the Arduino Uno board in a smaller form factor. The Arduino Nano is equipped with 30 male I/O headers, which can be programmed using the Arduino Software integrated development environment (IDE)[11].

Figure 12: Arduino Nano

7. TIMER RELAY:

It is a 6-30V 1-Channel Delay time Relay Module with Onboard Adjustable Timing Cycle Switches with Digital LED display It is mostly used in Home Automation Delay Timer Control Switch Module Timer Controller. The Module operates at an operating voltage range of 6-30V, also it supports a micro-USB 5.0V power supply[12].

Figure 13: Timer Delay Relay

8. BUCK CONVERTOR:

A buck converter or step-down converter is a DC-to-DC converter which decreases voltage, while increasing current, from its input to its output. It is a class of switched-mode power supply[13].

Figure 14: Buck Convertor

9. CONNECTORS:

Terminal Block Connector is a type of electrical connector, frequently used to connect wires to the PCB. The connector has a screw in each pin to fasten the wire securely[14].

Figure 15: Green Terminal Block

SIMULATION:

The Analysis of Glueing System is created in FluidSim and Proteus 8 and these are given below:

PNEUMATICS:

The circuit diagram is made on Festo FluidSim and the actuators along with electropneumatic diagram is shown as:

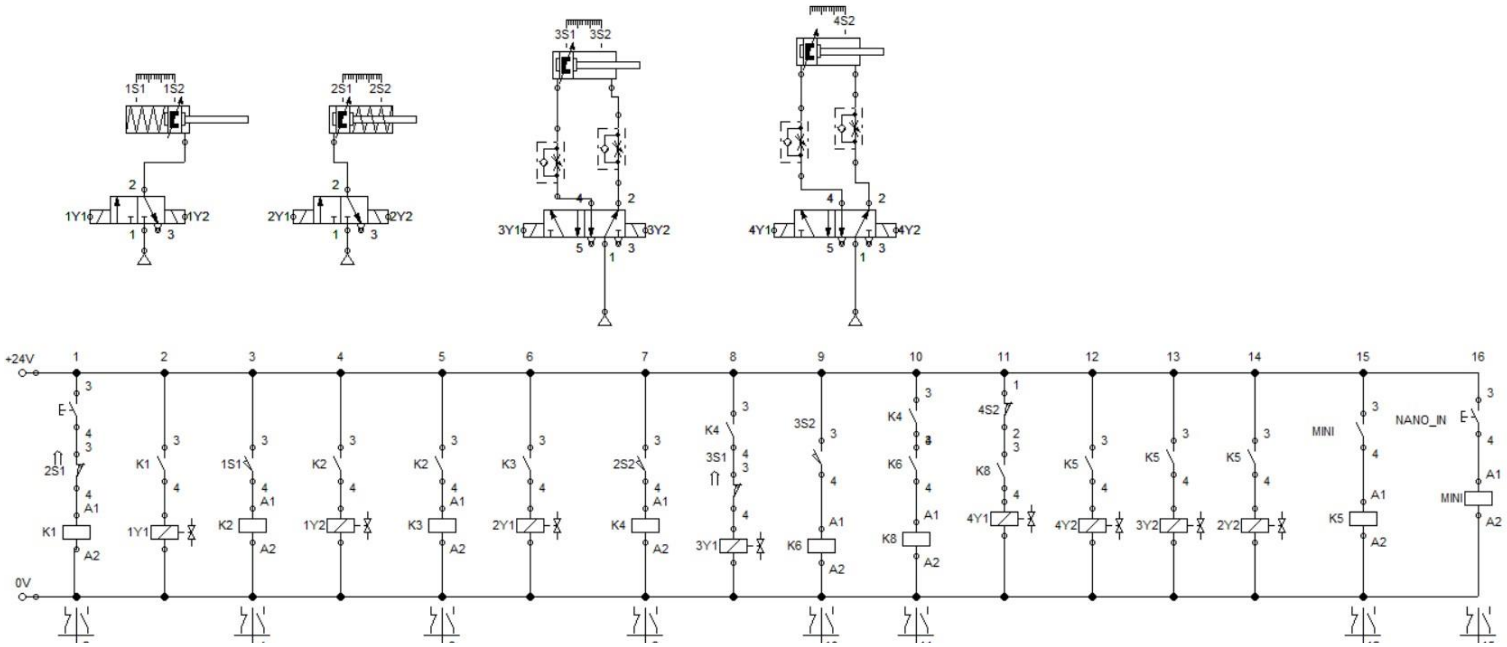

Figure 16: FluidSim Circuit

The Displacement-Step Diagram and sequence of this circuit is:

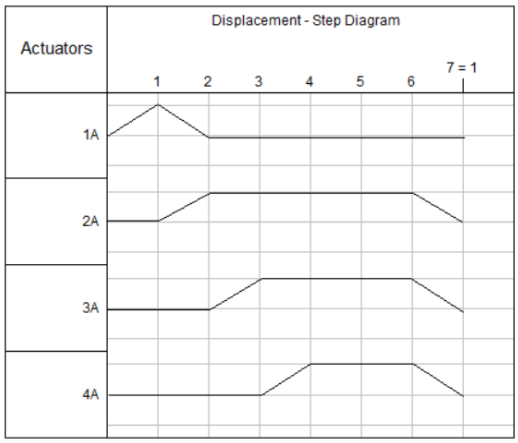

Figure 17: Displacement Step Diagram

Sequence:

1A- 1A+ 2A+ 3A+ 4A+ 1R 3A- 4A- 2A-

ELECTRICAL:

The electrical control logic is made on Proteus, and it is given below:

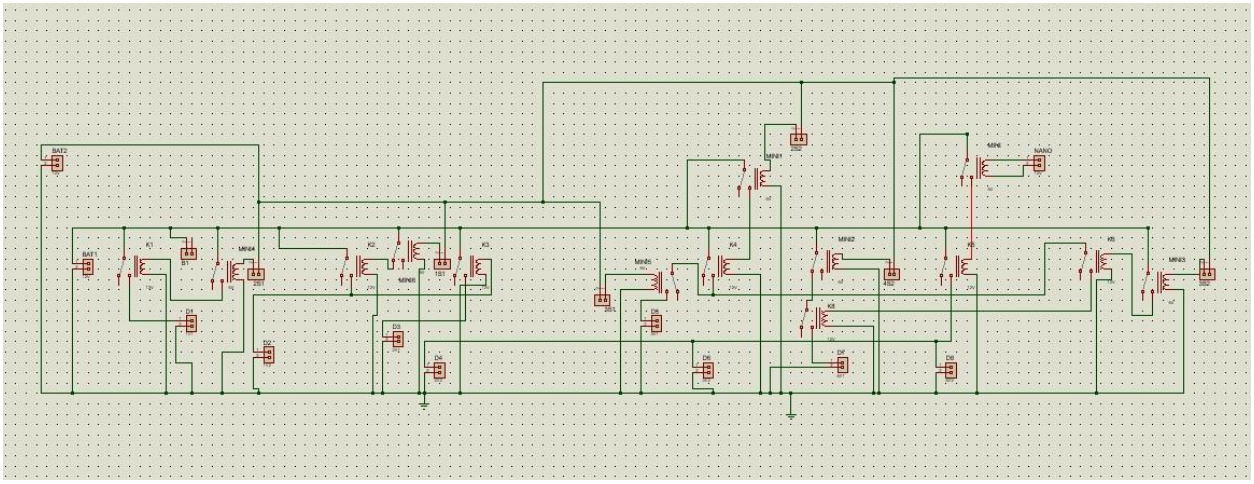

Figure 18: Proteus Simulation

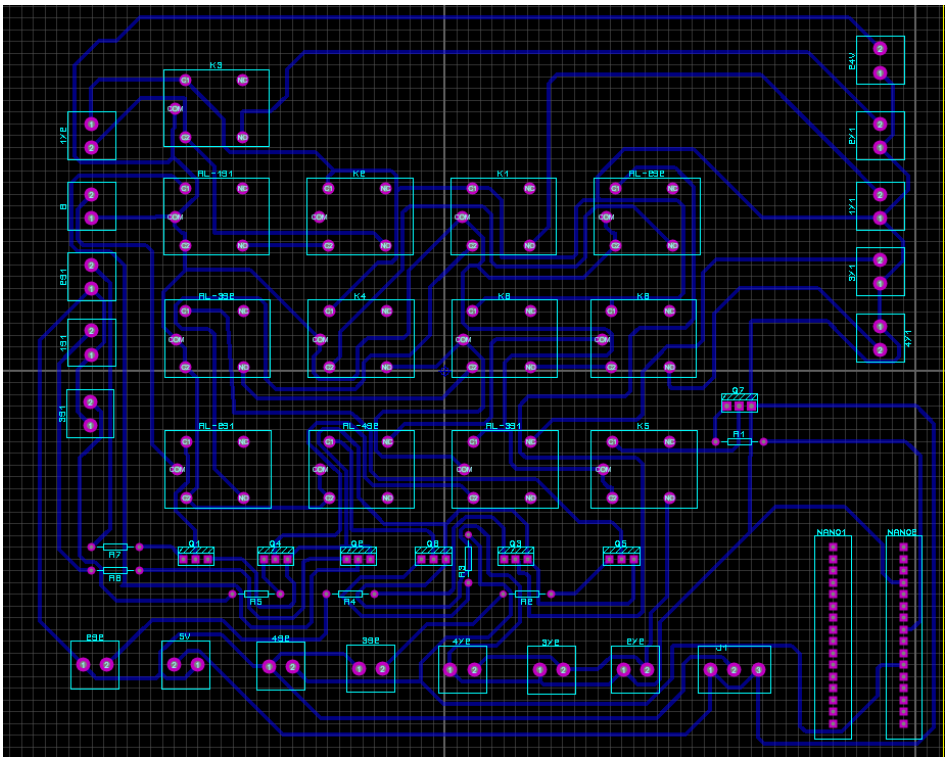

Figure 19: PCB Layout

WORKING PRINCIPLE:

The glueing station follows the sequence as mentioned, the initiation of the sequence is begun by pressing the push button B1, after which using the relays and sensors to detect the current position of all actuators the cylinder 1A retracts. After retraction the 1A and 2A cylinders are actuated to stop the work pieces. 1A holds the new workpiece on the conveyor while 2A positions the first work piece to be lifted by cylinder 3A. Then cylinder 3A lifts the workpiece from the holder and using the timer relay and Arduino the Servo motor (SG-90) rotates the workpiece for 360 degrees. After which the stopper cylinder 2A and Lifter cylinder 3A retracts along with stopping of Servo-Motor to allow the workpiece to move forward. The cycle is ready to be initiated by using the Push button B1.

FINAL HARDWARE:

The application is designed, and final hardware mechanism is formed which is shown as:

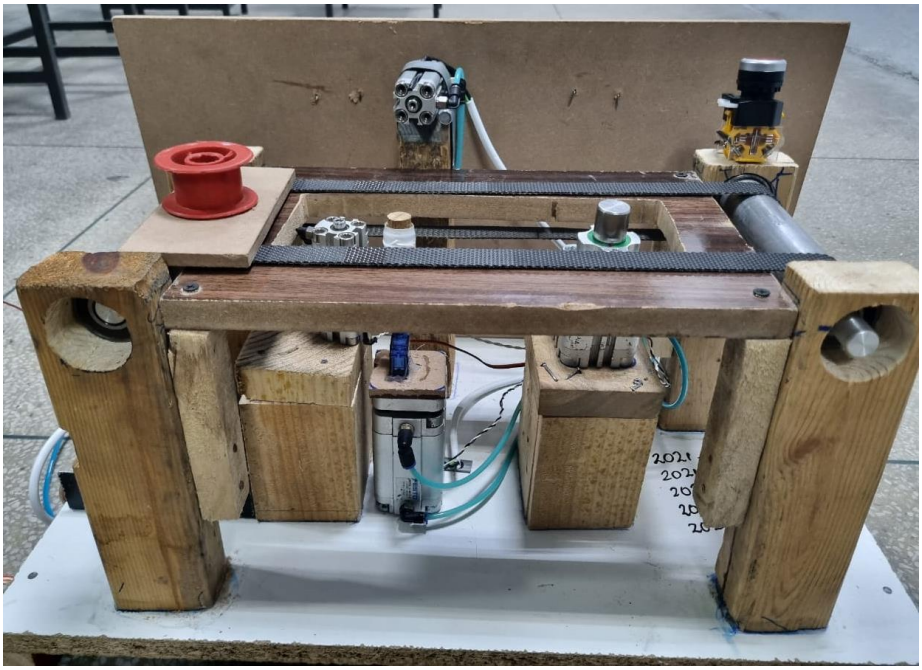

Figure 20: Final Hardware Unit for Glueing Station

APPLICATIONS:

The Glueing System is used in many industries, and it has the following applications:

- Pneumatic Glueing Unit are used in Footwear assembly for different shoe components.
- Pneumatic gluing stations play a crucial role in bonding various components of car interiors, such as panels, trims, and upholstery.
- Pneumatic gluing stations are used in the assembly of cabinets, drawers, and other wooden structures, providing a quick and efficient method for applying adhesive.
- Pneumatic gluing stations play a role in bookbinding processes, ensuring the proper bonding of pages and covers.

LIMITATIONS:

This Project has following limitations which caused problems in the manufacturing of Glueing System:

- The button has to be pressed till the workpiece reaches the 2nd stopper cylinder.
- It is currently used for holding the single workpiece.
- Managing all the actuators simultaneously is the difficult task.
- Checking what is the correct forward or backward relay of the solenoid and connecting the correct DCV with actuators is one of the limitations.

FUTURE ENHANCEMENTS:

The application can be improved and enhanced further in future:

- Manual Conveyor can be converted to automatic conveyor which drives multiple workpieces.
- Functionality of Continuous cycle can be added which is the ultimate goal of industry.
- Emergency stop, Reset and other factors could be added.
- Pneumatic Rotary can be used instead of servo-motor.
- PLC logic can be used to simplify the circuit and improve control
- Proximity sensors can be introduced to make control more robust.

BILL OF MATERIALS:

Since we were a group of five the total budget allocated was 12000 Pakistani Rupees, but since we were unable to find the pneumatic motor and had to replace it with a servo motor and timer relay, we got the final budget of 13000 Pakistani rupees.

BILL OF MATERIALS

Item to be created: Automatic Glueing Station

Serial No.	PART No.	THUMBNAIL IMAGE	PART NAME	DESCRIPTION	MATERIAL	WEIGHT	QUANTITY	COST PER UNIT	TOTAL COST	Vendor
1	PNEU-C-0001		Pneumatic Cylinders	Piston rod to transform Pneumatic Energy	Steel, Chrome	1.3Kg	4	250	1000	Gujrat Machinery Store, Sharif Garden, Machiney Market Street # 2 Slamatpura, Lahore, PK +92333- 8899699
2	DCV-S-0002		5/2-Way Double Solenoid Valve	Control the flow of air using electrical signal	Nickel-plated Brass	1.4Kg	4	275	1100	Gujrat Machinery Store, Sharif Garden, Machiney Market Street # 2 Slamatpura, Lahore, PK +92333- 8899699
3	FLO-C-2903		Flow Control Valves, Manifold	To Control the speed of air, Connecting pipes	PVC	0.2Kg	5	90	450	Ibrahim Pneumatic House, Shop No # 31, Ismail Centre, Oppo Qaiser Mukhtar Beside Noble Scale Brandreth Road Lahore, Pakistan
4	PIP-F-294		Pipes & Fittings	To mount on the frame and source of flow of air	PVC, Plastic	0.7Kg	20ft,8	8	800	Gujrat Machinery Store, Sharif Garden, Machiney Market Street # 2 Slamatpura, Lahore, PK +92333- 8899699
5	BEL-S-29505		Belt & Sprocket	Used for the conveyor system	Rubber, Steel	1Kg	2	950	1900	Brandreth Road, Lahore
6	24-R-2506		24 V Relay	Used for actuation with DCV & Sensors	Plastic	0.2Kg	13	50	650	https://digilog.pk/products/dc-24v-40a-5-terminals-male-power-connector-relay
7	REE-N-2407		Reed Switch	Used as magnetic sensors of cylinders	Glass	0.04Kg	6	40	240	https://digilog.pk/products/reed-switch-sensor-reed-sensor-magneto-magnet-magnetic-switch
8	TIP-B-875		TIP 122	Transistor as a Switch	Plastic	0.1Kg	7	25	175	https://epro.pk/product/transistor-npn-tip122-aluminio-unidad-in-pakistan/
9	RES-C-2407		2.2K Resistors	To restrict the flow of current	Metal	0.03Kg	7	1	7	https://digilog.pk/products/1-4-watt-quarter-0-25w-5-resistor-in-pakistan
10	2-P-21210		2-Pin Connector	Connector that connects all the wires of Cylinders and DCVs	Steel	0.3Kg	19	12	228	https://digilog.pk/products/2-pin-pcb-screw-terminal-block-connector
11	PCB-+-220011		PCB(6x6)	Printed Circuit Board on which Control Circuit is made	Copper, Plastic	0.05Kg	1	200	200	https://thaltoad.org/products/12x6-5-inch-copper-sheet-pcb-board-clad-plate-in-pakistan?_pos=3&_psq=copper+clad+board&_ss=e&_v=1.0
12	ARD-Mi-270012		Arduino Nano	To Give PWM Signal to Servo Motor	Plastic	0.13Kg	1	700	700	https://epro.pk/product/pre-soldered-arduino-nano-v3-0-with-cable-in-pakistan/
13	SER-Mi-29203		Servo Motor	Used as Rotary Actuator that is rotated 360°.	Plastic	0.1Kg	1	310	310	https://epro.pk/product/towerpro-sg90-sg-90-360-degree-servo-motor-in-pakistan/
14	TIM-R-2834		Timer Relay	To give specific Time Delay for the motor	Plastic	0.3Kg	1	500	500	https://epro.pk/product/12v-multifunction-1-channel-relay-on-off-timer-delay-switch/
15	Buck Converter-B-1515		Buck Convertor	For 5V supply	Metal, Plastic	0.3Kg	1	250	250	https://www.aliexpress.com/item/4000642838869.html
16	CAB-C-260016		Cable & Connecting Wires	For giving connection to the circuits	PVC	0.5Kg	12 Gaz	500	500	https://digilog.pk/products/20cm-pin-to-pin-jumper-wire-dupont-line-40-pin-arduino-make-to-make-jumper-wire-in-pakistan?_pos=1&_sid=11a6f2173cb&_ss=r
17	WOO-F-2400017		Wooden Frame	Conveyor and Base of Assembly Frame	Wood	—	1	3800	3800	Timer Market Azadi Chowk, Lahore
18	FAS-I-265018		Fasteners	Nuts, Bolts, Screws, Zip ties, Double Tape, EPI for joining	Steel, Plastic	0.4Kg	Dozens	350	350	Shah Kamal Road, Lahore
								Total Cost =	13160	

REFERENCES:

1. *What is a pneumatic actuator and how does it work?* 2024 [cited 2024 8-01-2024]; Available from: What is a pneumatic actuator and how does it work?
2. *5/2 Way Double Solenoid Valves*. 2024 [cited 2024 08-01-2024]; Available from: https://www.ammarindustrial.com/five-two-way-double-solenoid-valves/.
3. *The functions of one-way flow control valves*. 2024 [cited 2024 08-01-2024]; Available from: https://mastermac2000.com.au/functions-one-way-flow-control-valve/.
4. *Understanding the Basic Function of a Pneumatic Hose*. 2024 [cited 2024 08-01-2024]; Available from: https://hosewarehouse.com/blogs/news/understanding-the-basic-function-of-a-pneumatic-hose#:~:text=A%20pneumatic%20hose%20is%20a,is%20to%20transport%20pressurized%20air.
5. *Pneumatic Manifolds*. 2024 [cited 2024 08-01-2024]; Available from: https://www.pneumadyne.com/pneumatic-manifolds.html#:~:text=Pneumatic%20manifolds%20provide%20a%20convenient,locations%20to%20supply%20multiple%20tools.
6. *5 Pin Relay 24v Coil Jqc-3f(t73)*. 2024 [cited 2024 08-01-2024]; Available from: https://digilog.pk/products/5-pin-relay-24v-coil-jqc-3f-t73.
7. *TIP122 - Darlington NPN Transistor*. 2024 [cited 2024 08-01-2024]; Available from: https://components101.com/transistors/tip122-pinout-equivalent-datasheet.
8. *How Is A 2.2K Resistor Different from Other Resistors?* 2024 [cited 2024 08-01-2024]; Available from: https://www.raypcb.com/2-2k-resistor/.
9. *TowerPro Micro Servo Motor SG90*. 2024 [cited 2024 08-01-2024]; Available from: https://www.tertiaryrobotics.com/micro-servo-motor-sg90.html#:~:text=Micro%20Servo%20Motor%20SG90%20is,library%20to%20control%20these%20servos.
10. *What is a Reed Switch?* 2024 [cited 2024 08-01-2024]; Available from: https://www.reedswitchdevelopments.com/what-is-a-reed-switch/#:~:text=As%20the%20name%20implies%2C%20a,is%20closed%2C%20electricity%20can%20flow.
11. *Arduino Nano*. 2024 [cited 2024 08-01-2024]; Available from: https://en.wikipedia.org/wiki/Arduino_Nano#:~:text=The%20Arduino%20Nano%20is%20an,Arduino%20Nano.
12. *Switch Delay Time Relay Module Micro USB 5V LED Display Automation Cycle Delay Timer Control Board DC 6V 9V 12V 24V Controller*. 2024 [cited 2024 08-01-2024]; Available from: https://iduino.co.in/product/switch-delay-time-relay-module-micro-usb-5v/.
13. *Buck Convertor*. 2024 [cited 2024 08-01-2024]; Available from: https://en.wikipedia.org/wiki/Buck_converter.
14. *Pin GREEN Color KF301-2P 2 Pin Connector PCB Mount Straight Screw Terminal Block 2 Pin Cable Connector 5.08mm Pitch Socket PCB Screw Connectors 2 Way*. 2024 [cited 2024 08-01-2024]; Available from: https://udvabony.com/product/green-color-kf301-2p-2-pin-pcb-mount-straight/#:~:text=Description%3A%202Pin%20GREEN%20Color%20KF301,Mount%20Straight%20Screws%20Terminal%20Block&text=2%20Pin%205.08mm%20Pitch,to%20fasten%20the%20wire%20securely.