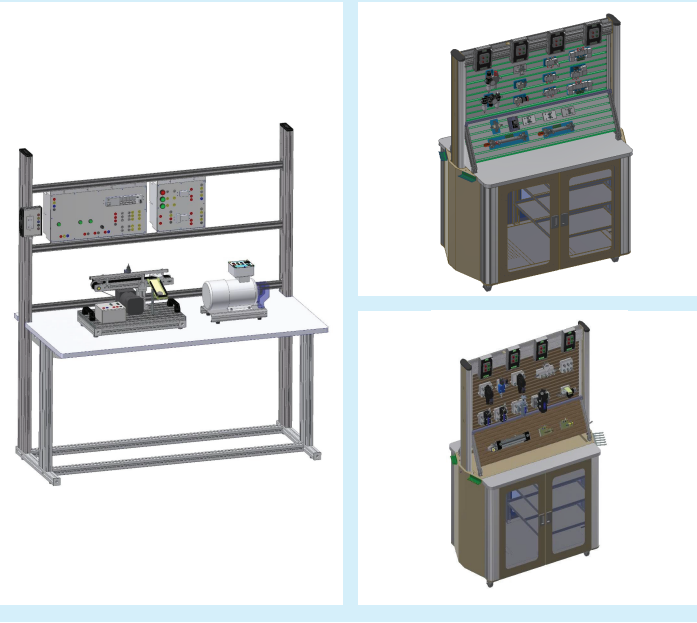
ETEK
TOTAL AUTOMATION SOLUTIONS

PNEUMATIC-HYDRAULIC TRAINING ROOM (LOT 1 A)

PRACTICE MANUAL



PNEUMATIC-HYDRAULIC TRAINING ROOM (LOT 1 A)

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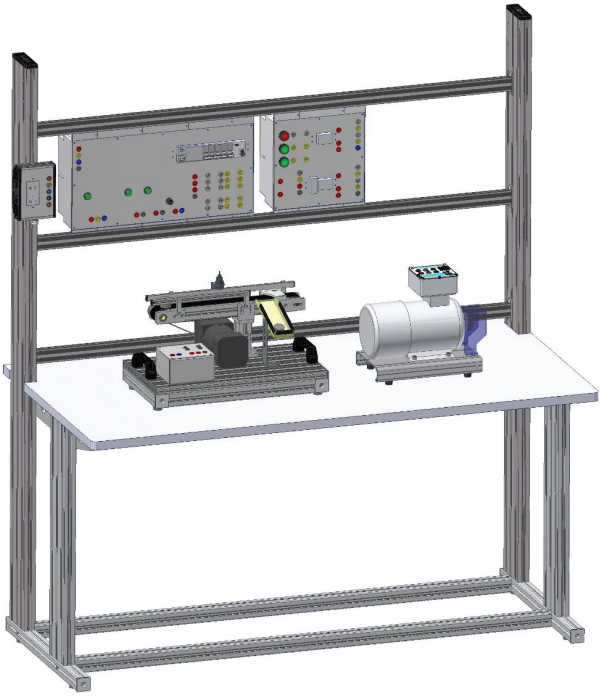
PRACTICE MANUAL

ELECTROMECHANICAL SEQUENCE CONTROL TRANING KIT

Code: *IE.C0100*

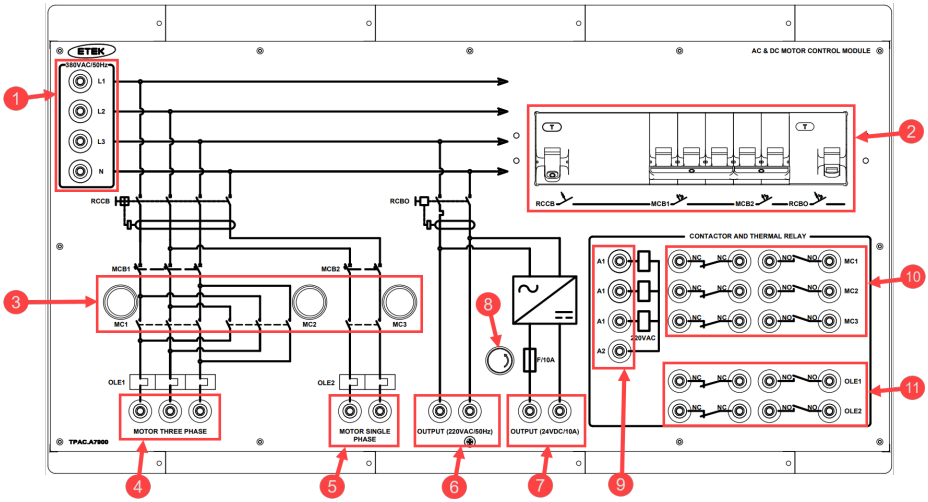


Manual

I. General Introduction of the Module

1. AC & DC Motor Control Module

User Interface



1.1. Technical Specifications

- Power supply: 3-phase 380VAC.
- RCBO: 1P+N / 10A / 30mA.
- RCCB: 4P / 25A / 30mA.
- MCB: 3P / 10A.
- CB: 2P / 10A.
- Contactor: 12A / 220VAC.
- Thermal relay: 1.0 ~ 1.6 A.
- Reversible output for three-phase motor: 380VAC/10A.
- Output for single-phase motor: 220VAC/10A.
- Single-phase output: 220VAC/10A.
- DC output: 24VDC/10A with overload protection by fuse.

1.2. User Manual

- Blocks on the module:

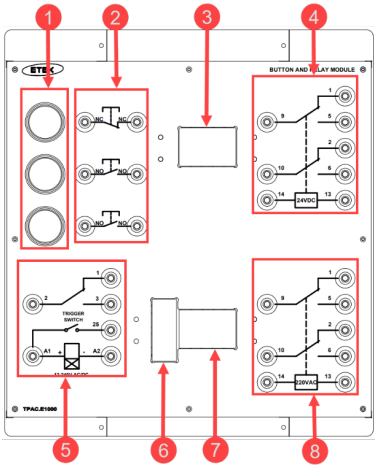
1. Three-phase power supply

2. Circuit breaker and protection devices
3. Status indicator lights for contactors
4. Output for three-phase motor
5. Output for single-phase motor
6. 220VAC single-phase power output
7. 24VDC DC power output
8. Fuse for 24VDC DC power output protection
9. Contactor coil block
10. Auxiliary contacts block of contactors
11. Auxiliary contacts block of thermal relays

- Instructions:
  + Step 1: Supply three-phase power to (1).
  + Step 2: Turn on the corresponding circuit breakers (2) and supply power to the contactor coils to provide power to the outputs (4-7) as per the diagram on the module surface. The status indicator lights (3) will light up when the corresponding contactors are closed.
  + Step 3: In case of an incident, the circuit breaker (3) or fuse (8) will automatically trip or the power can be manually turned off.

2. Button and Relay Module

User Interface



2.1. Technical Specifications

- Button:
  - + 01 red button: 1NC.
  - + 02 green buttons: 1NO.
- Electromagnetic Power Relay:
  - + 01 relay 220VAC: 2 NO-NC / 10A.
  - + 01 relay 24VDC: 2 NO-NC / 10A.
- Multifunction Time Relay:
  - + Operating voltage: 12-240V AC/DC.
  - + 1 NO-NC / 5A.
  - + 10 functions.

2.2. User Manual

- Blocks on the module:

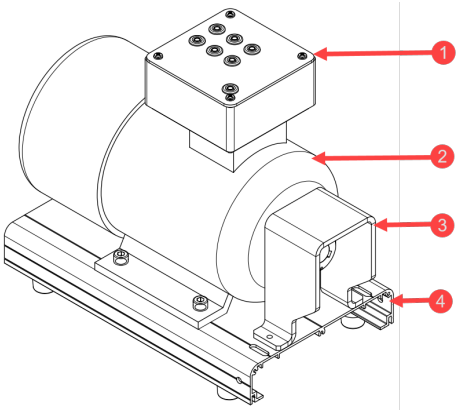
1. Button block
2. Button contact terminals
3. Electromagnetic power relay 24VDC
4. Electromagnetic power relay 24VDC connection terminals

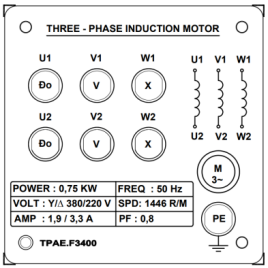
5. Multifunction timer relay
6. Multifunction relay connection terminals
7. Electromagnetic power relay 220VAC
8. Electromagnetic power relay 220VAC connection terminals

- Instructions:
  + Button block: Use the button contacts (2) to control or signal another device.
  + Electromagnetic power relay: Supply power to the relay coil terminals, and after the set time, the relay contacts will change state. Use the contacts to control or signal another device.
  + Multifunction timer relay: Supply power to the relay coil terminals, and after the set time, the relay contacts will change state. Use the contacts to control or signal another device.

3. Three Phase Induction Module

User Interface





3.1. Technical Specifications

- Three-phase squirrel-cage induction motor.
- Power: 0.75 kW.
- Voltage Δ/Y: 220/380VAC.
- Current: 3.3/1.9A.
- Rated speed: 1446 rpm.
- Power factor: 0.8.

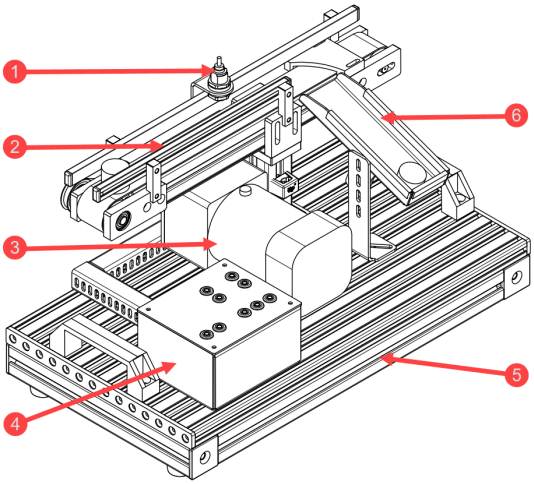
3.2. User Manual

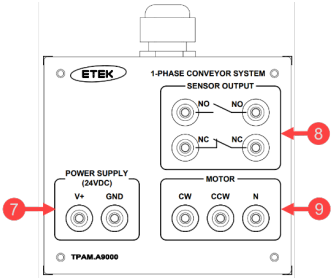
- Blocks on the module:
  1. Connection box
  2. Motor
  3. Motor shaft protective cover
  4. Aluminum base

- Instructions:
  + Step 1: Connect the motor in either Y or Δ configuration.
  + Step 2: Supply a three-phase power supply to the motor according to the connected configuration.

4. 1-Phase Conveyor System

User Interface





4.1. Technical Specifications

- Conveyor with reversible single-phase motor:
  - + Rated voltage: 220VAC
  - + Rated power: 60W
- Optical sensor for object detection:
  - + Power supply: 24VDC
  - + Output: 1NO-1NC

4.2. User Manual

- Blocks on the module:
  1. Object detection sensor
  2. Conveyor assembly
  3. Single-phase motor
  4. Connection box
  5. Base plate
  6. Trough assembly
  7. 24VDC power supply for sensor
  8. Sensor output
  9. Single-phase motor power input

- Instructions:
  + Supply 24VDC power to the sensor (7). When an object is detected, the sensor output (8) changes state. Use the sensor output contacts to control or signal another device.
  + Supply 220VAC single-phase power to (9). The single-phase motor rotates the conveyor. Supply power to the CW-N terminal to rotate the motor clockwise, and to the CCW-N terminal to rotate the motor counterclockwise.

II. Practice Exercises

1. Direct Start Circuit for Single-Phase Motor

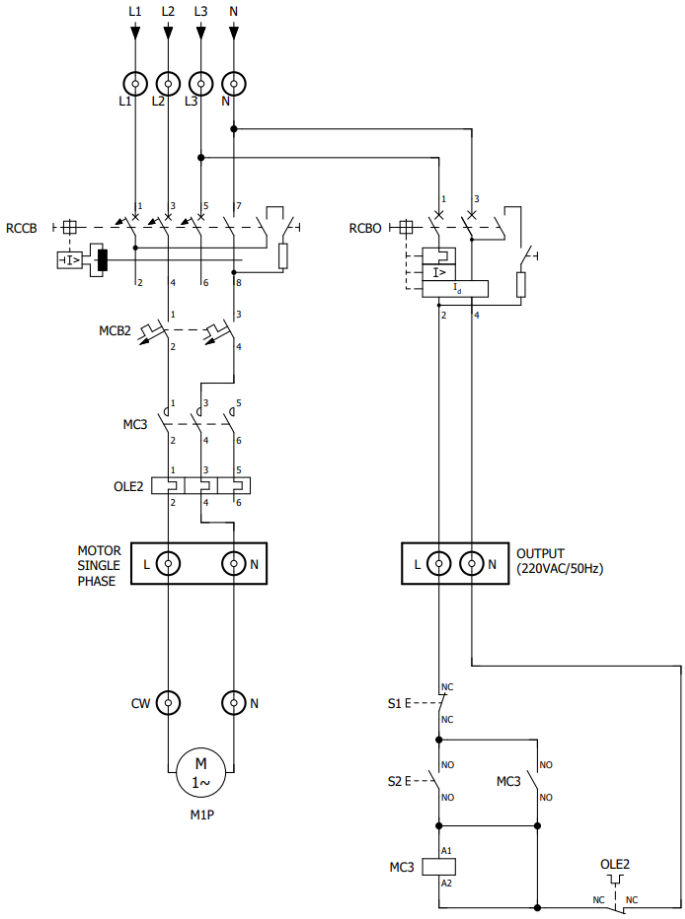
1.1. Objectives and Requirements

- Objectives:
  + Understand the diagram and working principle of the direct start circuit for a single-phase motor.
- Requirements:
  + Complete the connection of the direct start circuit for a single-phase motor.
  + Operation cycle: Press button S2 to start the motor, press button S1 to stop the motor.

1.2. List of Modules in the Exercise

No.	Module Name	Module Code	Unit	Quantity
1	AC & DC Motor Control Module	TPAC.A7900	Set	1
2	Button and Relay Module	TPAC.E1000	Set	1
3	1-Phase Conveyor System	TPAM.A9000	Set	1
4	Accessory Kit		Set	1

1.3. Connection Diagram



1.4. Practice Steps

Step 1: Prepare all necessary equipment and materials.

Step 2: Connect the modules according to the connection diagram.

Step 3: Perform a cold check, then turn on the RCCB, MCB2, and RCBO circuit breakers to supply power to the control and power circuits.

Step 4: Press button S2 to start the motor: Supply power to the coil of contactor MC3 → close the holding contacts of MC3 (NO, NO) → close the main contacts of MC3 in the power circuit → supply power to the motor.

Step 5: Press button S1 to stop the motor: Power to the coil of contactor MC3 is cut off → the holding contacts of MC3 (NO, NO) release → the main contacts of MC3 in the power circuit release → cut off power to the motor → the motor stops.

- If there is an overload, the thermal relay OLE2 will open the contacts OLE2 (NC, NC), cutting off power to the coil of contactor MC3 → releasing the main contacts of MC3 in the power circuit → cutting off power to the motor → the motor stops.

Step 6: Turn off the circuit breakers and end the exercise.

1.5. Test Result

No.	Situation	Result
1	Press button S2	Contactor MC3 close, MC3 status light turns on Single-phase motor runs
2	Press button S1	Contactor MC3 release, MC3 status light turns off Single-phase motor stops

2. Three-Phase Motor Reversal Circuit Practice

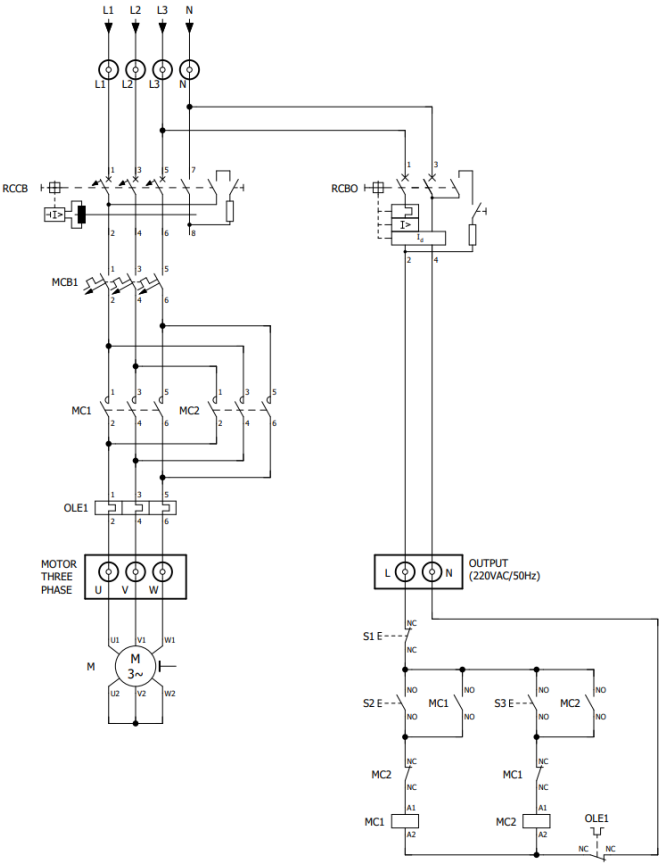
2.1. Objectives and Requirement

- Objectives:
  + Understand the diagram and working principle of the three-phase motor reversal circuit.
- Requirements:
  + Complete the connection of the three-phase motor reversal circuit.
  + Operation cycle: Press button S2 to run the motor forward, press button S3 to run the motor in reverse, press button S1 to stop the motor. When the motor is running forward, pressing button S3 has no effect, and vice versa, pressing button S2 has no effect when the motor is running in reverse.

2.2. List of Modules in the Exercise

No.	Module Name	Module Code	Unit	Quantity
1	AC & DC Motor Control Module	TPAC.A7900	Set	1
2	Button and Relay Module	TPAC.E1000	Set	1
3	Three Phase Induction Module	TPAE.F3400	Set	1
4	Accessory Kit		Set	1

2.3. Connection Diagram



2.4. Practice Steps

Step 1: Prepare all necessary modules and materials.

Step 2: Connect the modules according to the connection diagram.

Step 3: Perform a cold check, then turn on the RCCB, MCB1, and RCBO circuit breakers to supply power to the control and power circuits.

Step 4: Press button S2 to run the motor forward (motor is stopped): Supply power to the coil of contactor MC1 → close the holding contacts of MC1 (NO, NO) → close the main contacts of MC1 in the power circuit → supply power to run the motor forward, at the same time open the contacts MC1 (NC, NC) to prevent contactor MC2 from closing.

Step 5: Press button S3 to run the motor in reverse (motor is stopped): Supply power to the coil of contactor MC2 → close the holding contacts of MC2 (NO, NO) → close the main contacts of MC2 in the power circuit → supply power to run the motor in reverse, at the same time open the contacts MC2 (NC, NC) to prevent contactor MC1 from closing.

- **Note: Do not reverse the motor direction if it has not stopped.**

Step 6: Press button S1 to stop the motor: Cut off power to the coils of contactors MC1, MC2 → release the holding contacts of MC1, MC2 (NO, NO) → release the main contacts of MC1, MC2 in the power circuit → cut off power to the motor → motor stops.

- If there is an overload, the thermal relay OLE1 will open the contacts OLE1 (NC, NC), cutting off power to the coil of contactor MC1, MC2 → releasing the main contacts of MC3 in the power circuit → cutting off power to the motor → the motor stops.

Step 7: Turn off the circuit breakers and end the exercise

2.5. Test Results

No.	Situation	Result
1	Press button S2	Contactor MC1 closes, MC1 status light turns on Three-phase motor runs forward
2	Press button S3	Contactor MC2 closes, MC2 status light turns on Three-phase motor runs in reverse
3	Press button S1	Contactors MC1 and MC2 release, MC1 and MC2 status lights turn off Three-phase motor stops

3. Time-Limit Three-Phase Motor Circuit Practice

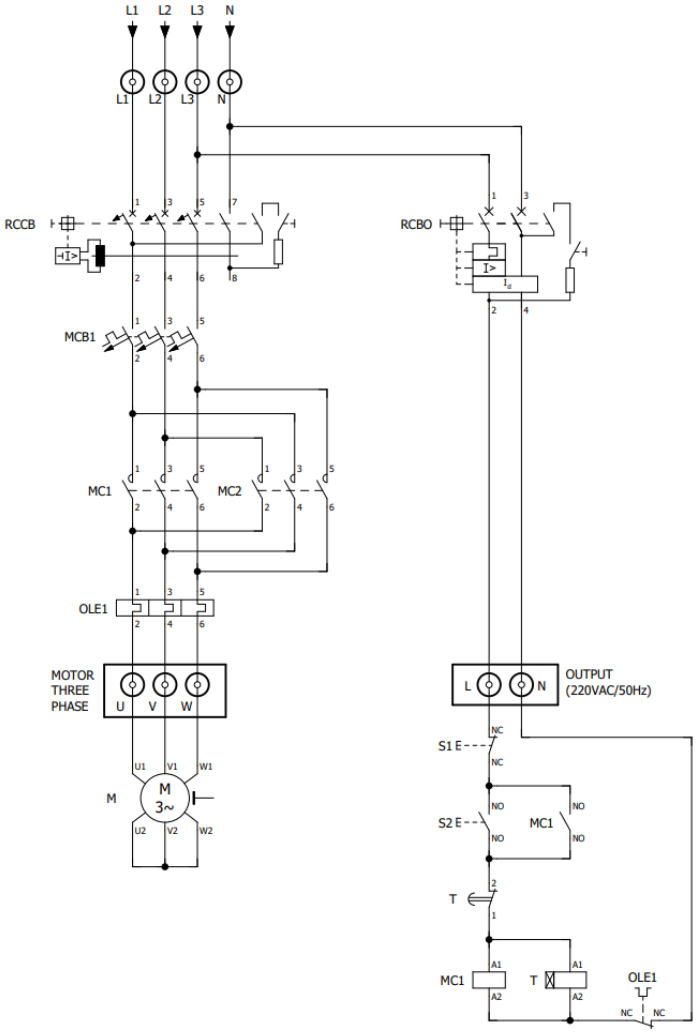
3.1. Objectives and Requirements

- Objectives:
  + Understand the diagram and working principle of the time-limited three-phase motor circuit.
- Requirements:
  + Complete the connection of the time-limited three-phase motor circuit.
  + Operation cycle: Press button S2 to run the motor, the motor stops after the set time or when button S1 is pressed.

3.2. List of Modules in the Exercise

No.	Module Name	Module Code	Unit	Quantity
1	AC & DC Motor Control Module	TPAC.A7900	Set	1
2	Button and Relay Module	TPAC.E1000	Set	1
3	Three Phase Induction Module	TPAE.F3400	Set	1
4	Accessory Kit		Set	1

3.3. Connection Diagram



3.4. Practice Steps

Step 1: Prepare all necessary modules and materials.

Step 2: Connect the modules according to the connection diagram.

Step 3: Perform a cold check, then turn on the RCCB, MCB1, and RCBO circuit breakers to supply power to the control and power circuits.

Step 4: Press button S2 to run the motor:

- Supply power to the coil of contactor MC1 → close the holding contacts of MC1 (NO, NO) → close the main contacts of MC1 in the power circuit → supply power to run the motor.
- After the set time at timer T, contacts T (1, 2) open, cutting off power to the coil of contactor MC1 and the timer coil T → release the holding contacts of MC1 (NO, NO) → release the main contacts of MC1 → cut off power to the motor → motor stops.

Step 5: Press button S1 to stop the motor: Cut off power to the coil of contactor MC1 → release the holding contacts of MC1 (NO, NO) → release the main contacts of MC1 in the power circuit → cut off power to the motor → motor stops.

- If there is an overload, the thermal relay OLE1 will open the contacts OLE1 (NC, NC), cutting off power to the coil of contactor MC1, MC2 → releasing the main contacts of MC1, MC2 in the power circuit → cutting off power to the motor → the motor stops.

Step 6: Turn off the circuit breakers and end the exercise.

3.5. Test Result

No.	Situation	Result
1	Press button S2	Contactor MC1 closes, MC1 status light turns on Three-phase motor runs
2	After preset time on timer T from pressing button S2	Contactor MC1 releases, MC1 status light turns off Three-phase motor stops
3	Press button S1	

4. Sequential Motor Control System Practice

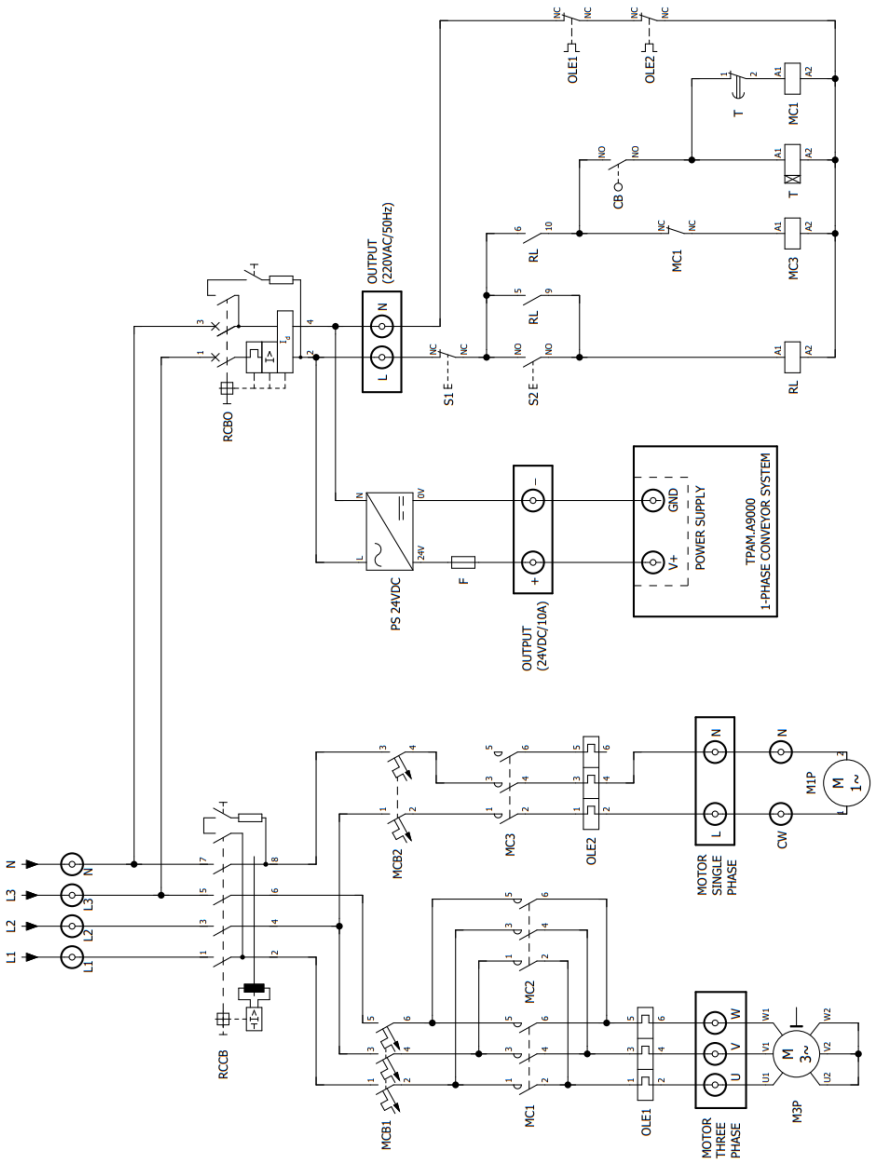
4.1. Objectives and Requirements

- Objectives:
  + Understand the diagram and working principle of the sequential motor control system.
- Requirements:
  + Complete the connection of the sequential motor control system.
  + Operation cycle: Press button S2 to run the single-phase conveyor motor. If the sensor detects an object, stop the conveyor motor and start the three-phase motor (simulating drilling). After the set time on timer T, stop the drilling motor and continue running the single-phase conveyor motor. This cycle repeats until button S1 is pressed to stop.

4.2. List of Modules in the Exercise

No.	Module Name	Module Code	Unit	Quantity
1	AC & DC Motor Control Module	TPAC.A7900	Set	1
2	Button and Relay Module	TPAC.E1000	Set	1
3	Three Phase Induction Module	TPAE.F3400	Set	1
4	1-Phase Conveyor System	TPAM.A9000	Set	1
5	Accessory Kit		Set	1

4.3. Connection Diagram



4.4. Practice Steps

Step 1: Prepare all necessary modules and materials.

Step 2: Connect the modules according to the connection diagram.

Step 3: Perform a cold check, then turn on the RCCB, MCB1, MCB2, and RCBO circuit breakers to supply power to the control and power circuits.

Step 4: Press button S2 to run the motor:

- Supply power to the coil of relay RL → close the holding contacts of RL (5, 9) → close the contacts RL (6, 10) to supply power to the control section.
- Supply power to the coil of contactor MC3 → close the main contacts of MC3 in the power circuit → the conveyor motor runs.
- When the sensor detects an object → contacts CB (NO, NO) close, supplying power to the coils of timer T and contactor MC1 → close the main contacts of MC1 in the power circuit → the drilling motor runs → contacts MC1 (NC, NC) open → cut off power to the coil of contactor MC3 → release the main contacts of MC3 → cut off power to the conveyor motor → the conveyor motor stops.
- After the set time on timer T → contacts T (1, 2) open, cutting off power to the coil of contactor MC1 → release the main contacts of MC1 → cut off power to the drilling motor → the drilling motor stops → contacts MC1 (NC, NC) close → supply power to the coil of contactor MC3 → close the main contacts of MC3 in the power circuit → the conveyor motor runs → sensor does not detect the object → cut off power to timer T → contacts T (1, 2) close as initially. The cycle continues sequentially.

Step 5: Press button S1 to stop the operation: Cut off power to the coil of relay RL → release the holding contacts of RL (5, 9) → release the contacts RL (6, 10) → cut off power to the coils of contactors MC1, MC3, and timer T → release the main contacts of MC1, MC3 → cut off power to the conveyor motor and drilling motor → both motors stop.

- If there is an overload, the thermal relays OLE1/OLE2 will open the contacts OLE1/OLE2 (NC, NC), cutting off power to the coils of relay RL, contactors MC1, MC3, and timer T → release the main contacts of MC1, MC3 in the power circuit → cut off power to the conveyor motor and drilling motor → both motors stop.

Step 6: Turn off the circuit breakers and end the exercise.

4.5. Test results

No.	Situation	Result
1	Press button S2	Contactor MC3 closes, MC3 status light turns on, Single-phase motor runs
2	Sensor detects an object	Contactor MC3 releases, MC3 status light turns off, Single-phase motor stops, Contactor MC1 closes, MC1 status light turns on, Three-phase motor runs
3	After preset time on timer T from object detection	Contactor MC3 closes, MC3 status light turns on, Single-phase motor runs, Contactor MC1 releases, MC1 status light turns off, Three-phase motor stops
4	Press button S1	Contactor MC3 releases, MC3 status light turns off, Single-phase motor stops, Contactor MC1 releases, MC1 status light turns off, Three-phase motor stops

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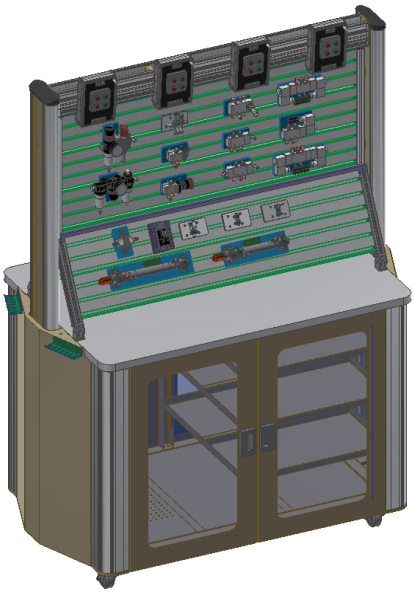
PRACTICE MANUAL

BASIC PNEUMATIC TRAINING KIT

Code: *HP.K0010*

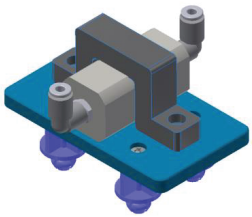


Manual

I. General Introduction to the Module

1. One-way valve

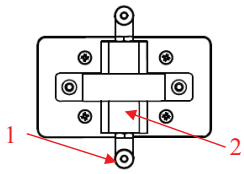
User Interface



1.1. Technical Specifications

- Working pressure range: 0.02 - 1MPa
- Number of ports: 1 port
- Positions: 1
- Quick connector: 4mm

1.2. User Manual

Module figure	Explanation	Symbol
	1. Quick connector 2. One-way valve	

Operating Procedure

Step 1: Supply air to port P, the air pressure will push the valve flap or ball valve to open, allowing the air to flow through.

1.3. Module Functions

The One-way valve allows air to flow from P to A, and prevents the air from flowing backward

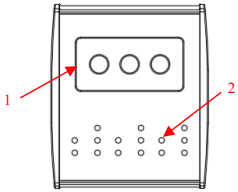
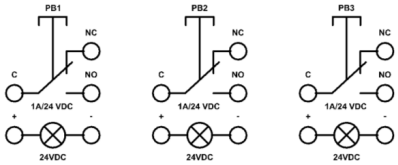
2. Set of 3 push buttons

User Interface

2.1. Technical Specifications

- Power Supply: 24VDC
- 03 input push-button
- Maximum current through contacts: 1A

2.2. User Manual

Module figure		*Symbol*
	1. Push-button 2. Connection to buttons (1) with M2-type Jack	

Non-latching push buttons: When the button is pressed, the NC contact opens while the NO contact closes, and stay in that state until the button is released and returns to the initial position.

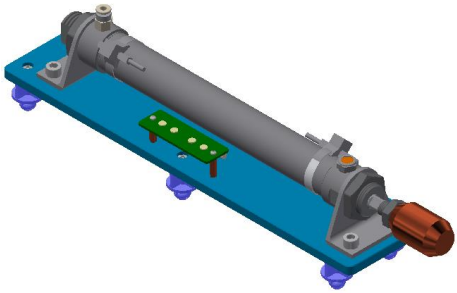
Indicator lights on the push-buttons: connect the + plug to the 24VDC terminal and the – plug to the 0VDC terminal of a DC power source for the lights to turn on

2.3. Module Function

Used to generate input signals for the system using push-buttons.

3. Single Acting Cylinder

User Interface

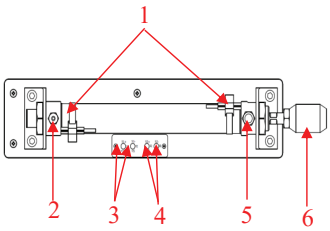


3.1. Technical Specifications

- Number of ports: 01 port
- Diameter: 25mm
- Stroke length: 100mm
- Working pressure range: 0.15 - 1 MPa
- Quick connector: 4mm
- Cylinder speed: 50 - 800 mm/s

3.2. User Manual

a) Cylinder Module

Module figure	Explanation	Symbol
	1. Cylinder body sensor 2. Cylinder Air Supply Port 3. Connection to Sensor (1) with M2-type Jack 4. Connection to Sensor (2) with M2-type Jack 5. Pneumatic Muffler 6. Camera	

b) Cylinder Body Sensor

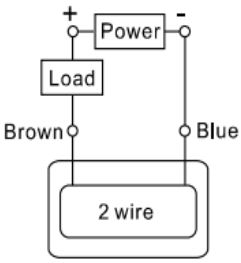
Device Illustration	Schematic Diagram
	

Figure 3: Schematic diagram of the Cylinder Body Sensor

Operating Procedure

Step 1: Supply air to port 1 causes the cylinder to extend to its full stroke, air is exhausted through port 2

Step 2: Supply 24VDC power to the Brown (+) wire of the cylinder sensor. When the cylinder reaches its stroke, current will flow through the positive terminal and through the Load (24VDC light turns on) and then return to the negative terminal.

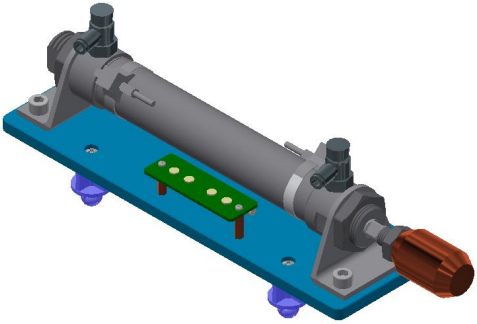
Step 3: When cut off the air supply to port 1 causes the cylinder to retract, current will flow through the positive terminal and through the Load (24VDC light turns on) and then return to the negative terminal.

3.3. Module Functions

Help the students understand the working principle and the structure of a Single Acting Cylinder

4. Double Acting Cylinder

User Interface

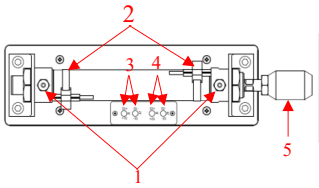
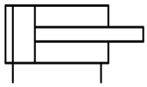


4.1. Technical Specifications

- Number of ports: 02 ports
- Diameter: 25mm
- Stroke length: 100mm
- Working pressure range: 0.15 - 1 MPa
- Cylinder speed: 50 - 800 mm/s
- Quick connector: 4mm

4.2. User Manual

a) Cylinder Module

Module figure	Explanation	Symbol
	1. Cylinder Air Supply Port 2. Cylinder Body Sensor 3. Connection to sensor 1 with M2-type Jack 4. Connection to sensor 2 with M2-type Jack 5. Camera	

b) Cylinder Body Sensor

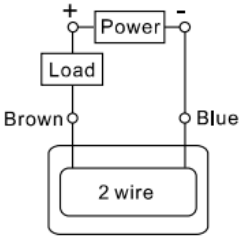
Device Illustration	Schematic Diagram
	

Figure 4: Schematic Diagram of the Cylinder Body Sensor

Operating Procedure

Step 1: Supply air to port 1 causes the cylinder to extend to its full stroke, air is exhausted through port 2

Step 2: Supply 24VDC power to the Brown (+) wire of the cylinder sensor. When the cylinder reaches its stroke, current will flow through the positive terminal and through the Load (24VDC light turns on) and then return to the negative terminal

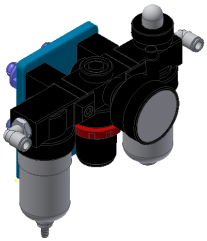
Step 3: Supply air to port 2 and cut off the air supply to port 1 causes the cylinder to retract, current will flow though the positive terminal and through the Load (24VDC light turns on) and then return to the negative terminal

4.3. Module Functions

Help the students understand the working principle and structure of a Double Acting Cylinder

5. Pneumatic Filter

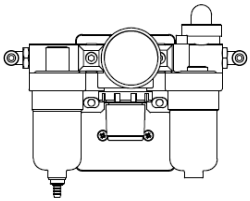
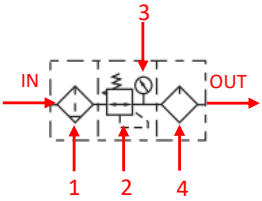
User Interface



5.1. Technical Specifications

- Working pressure range: 0.15 - 0.9 MPa
- Filtration level: 40µm (Particle size of dust or impurities that the filter can remove)
- Temperature range: 5-70 degrees Celsius

5.2. User Manual

Module figure	Explanation	Symbol
	1. Pneumatic Filter Valve 2. Pressure Regulator 3. Pressure gauge 4. Oil valve	

Operating Procedure

Step 1: Supply air (IN) to the Filter Valve (1) to filter out water vapor, particles and dust out of the compressed air

Step 2: The air flows through the Pressure Regulator to adjust and maintain the pressure at a stable level

Step 3: The cleaned air flows through the Air Lubricator and the oil mist is sprayed into the pressed air

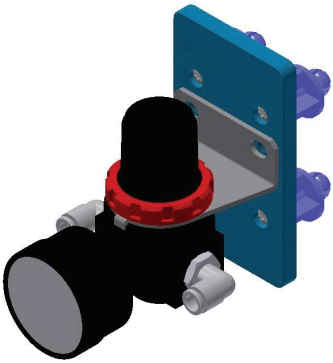
Step 4: The air flows out (OUT)

5.3. Module Functions

Filter out solid impurities such as dust, sand, and other small particles from the compressed air

6. Pressure Regulator

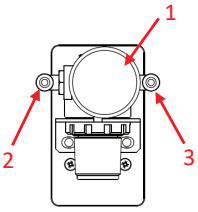
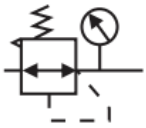
User Interface



6.1. Technical Specifications

- Number of ports: 02 ports (1 in, 1 out)
- In/out quick connector: phi 4mm
- Pressure adjustment range: 0.05 - 0.9 MPa
- Maximum pressure capacity: 1 MPa

6.2. User Manual

Module figure	Explanation	Symbol
	1. Pressure Regulator 2. Air Inlet 3. Air Outlet	

Operating Procedure

Step 1: Open the air inlet: Pull up the knob 1 and turn it clockwise to open and adjust the required amount of gas (showed on the pressure gauge), push the knob 1 down to lock it.

Step 2: Turn off: pull the knob 1 up and turn it counterclockwise until the pressure displayed on the gauge reaches 0. Then push the knob down.

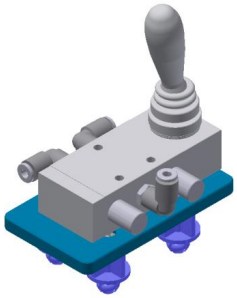
6.3. Module Functions

Purpose: To maintain the operating pressure of the system almost constant, regardless of the increase in pressure in the pipeline or the air consumption.

The pressure gauge helps the students observe the output pressure value.

7. 5/2 Hand Lever Valve

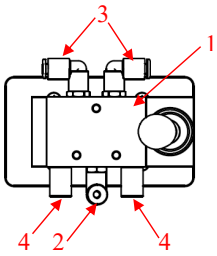
User Interface



7.1. Technical Specifications

- Number of ports: 05 ports
- Positions: 02
- Working pressure range: 0.1 - 1MPa
- Maximum pressure capacity: 1.5MPa
- Quick Connector: 4mm

7.2. User Manual

Module figure	Explanation	Symbol
	1. 5/2 Hand Lever Valve 2. Air Inlet 3. Air Outlet 4. Pneumatic Muffler	

Operating Procedure

Step 1: Supply air to port P. In the initial state, the air flows from port P to port A, the exhaust air flows from port B to port S, port R is locked

Step 2: Push the lever causes the 5/2 valve to switch state: the air flows from port P to B, exhaust air flows from port A to B, port S is locked

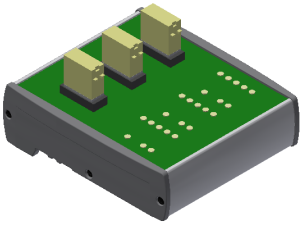
Step 3: Pull the lever to switch the 5/2 valve back to its initial state

7.3. Module Functions

Used to control the air flow to other devices or modules through lever action.

8. Set of 3 Relays

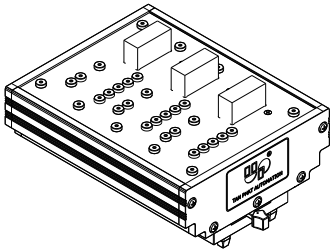
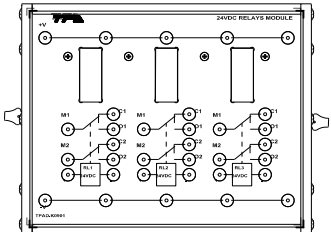
User Interface



8.1. Technical Specifications

- Coil voltage: 24VDC
- Include 03 relays, each have 2 pairs of contacts.
- Total load power: 90W
- Operate time: 15ms
- Contact release time: 10ms

8.2. User Manual

Module figure	Symbol
	

Operating Procedure

Step 1: Supply 24VDC power to the (+) plug and 0VDC to the (-) plug of each relay.

Step 2: When the relay is powered, the NC contacts open, while the NO contacts closes and remain in that state until the relay power is lost, then the contacts returns to their initial states.

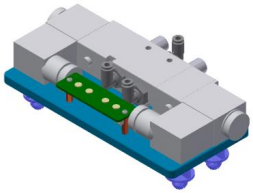
Step 3: Connect the +V plug to 24VDC terminal and the -V plug to 0VDC terminal of a DC power source. After that, the M2 Jacks can supply for other modules.

8.3. Module Functions

Used for wiring control signals for other actuator modules of the system.

9. 5/2 Double Solenoid Valve

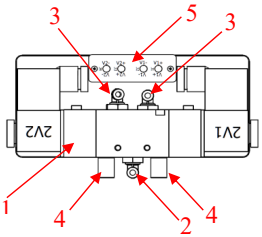
User Interface



9.1. Technical Specifications

- Number of ports: 05 ports
- Positions: 02
- Working pressure range: 0.15 - 0.8MPa
- Maximum pressure capacity: 1.5MPa
- Valve type: NC (Normally Closed)
- Quick connector: 4mm
- Coil voltage: 24VDC

9.2. User Manual

Module figure	Explanation	Symbol
	1. 5/2 Double Solenoid Valve 2. Air Inlet 3. Air Outlet 4. Pneumatic Muffler 5. Connection board: 4 M2-type Jacks	

Operating Procedure

Step 1: Supply power to the 2V1 coil of the valve, the valve will direct air flow from port P to A, exhaust air flow from port B to S, port R is locked

Step 2: Disconnect power of the 2V1 coil and supply power to the 2V2 coil to switch state: air flows from port P to B, exhaust air flows from port A to R, port S is locked

Step 3: Return the valve to unpowered state, the valve will direct air flow from port P to A, exhaust air flow from port B to S, port R is locked

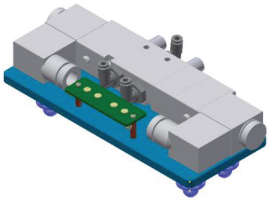
9.3. Module Functions

Used in automatic production lines or automated control systems, such as controlling cylinders, motors,…

Used for wiring control signals for other actuator modules of the system.

10. Middle-Closed 5/3 Solenoid Valve

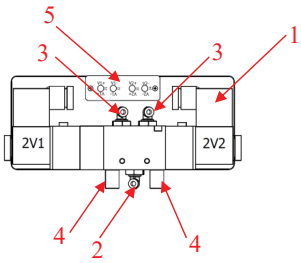
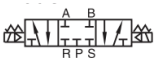
User Interface



10.1. Technical Specifications

- Number of ports: 05 ports
- Positions: 03
- Working pressure range: 0.15 - 0.8MPa
- Maximum pressure capacity: 1.5 MPa
- Valve type: NC (Normally Closed)
- Quick connector: 4mm
- Coil voltage: 110VAC

10.2. User Manual

Module figure	*Explanation*	*Symbol*
	1. Middle-Closed 5/3 Solenoid Valve 2. Air Inlet 3. Air Outlet 4. Pneumatic Muffler 5. Connection board: 4 M2-type Jacks	

Operating Procedure

Step 1: Supply power to the 2V1 coil of the valve, the valve direct air flow from port P to A, exhaust air from port B to S, port R is locked

Step 2: Disconnect power of the 2V1 coil and supply power to the 2V2 coil to switch state: air flows from port P to B, exhaust air flows from port A to R, port S is locked

Step 3: Return the valve to unpowered state, the valve will lock and prevent any air flow

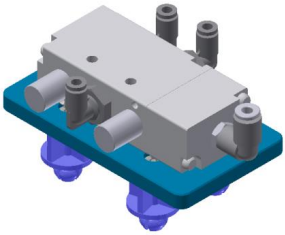
10.3. Module Functions

Used in automatic production lines or automated control systems, such as controlling cylinders, motors,…

Used for wiring control signals for other actuator modules of the system.

11. 5/2 Single-Acting Solenoid Valve

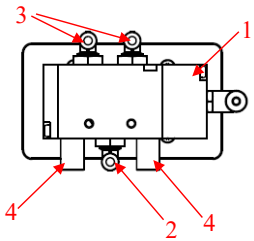
User Interface



11.1. Technical Specifications

- Number of ports: 05 ports
- Positions: 02
- Working pressure range: 0.15 - 0.8Mpa
- Maximum pressure capacity: 1.5MPa
- Reset method: spring
- Quick Connector: 4mm

11.2. User Manual

Module figure	Explanation	Symbol
	1. 5/2 Single-Acting Solenoid Valve 2. Air Inlet 3. Air Outlet 4. Pneumatic Muffler	

Operating Procedure

Step 1: Supply air to port P, in the initial state, air flows from port P to port A, exhaust air flows from port B to port S, port R is locked

Step 2: Supply air to the control port in the right to provide control signal

Step 3: When there is control signal, the valve switches state: air flows from Port P to B, exhaust air flows from port A to R, port S is locked

Step 4: Cut off the air supply to the control port The valve returns to its initial state thanks to the spring

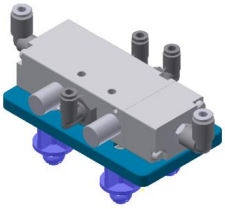
11.3. Module Functions

Used in automatic production lines or automated control systems, such as controlling cylinders, motors,…

Used to direct the air flow through the valve to supply the following modules.

12. 5/2 Double-Acting Solenoid Valve

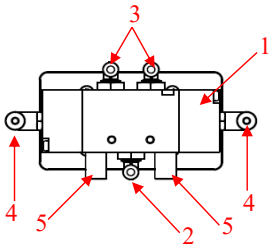
User Interface



12.1. Technical Specifications

- Number of ports: 05 ports
- Positions: 02
- Working pressure range: 0.15 - 0.8MPa
- Maximum pressure capacity: 1.5MPa
- Reset method: external impact
- Quick Connector: 4mm

12.2. User Manual

Module figure	Explanation	Symbol
	1. 5/2 Double-Acting Solenoid Valve 2. Air Inlet 3. Air Outlet 4. Control Port 5. Pneumatic Muffler	

Operating Procedure

Step 1: Supply air to P. In the initial state, the air flows from port P to port A, exhaust air flows from port B to port S, port R is locked

Step 2: Supply air to the control port on the right ⇦ to provide control signal

Step 3: When there is control signal, the valve switches state: air flows from port P to B, exhaust air flows from port A to R, port S is locked

Step 4: Supply air to the control port on the left ⇦ to provide control signal

Step 3: When there is control signal, the valve returns to its initial state

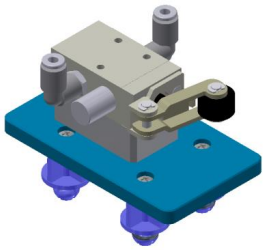
12.3. Module Functions

Used in automatic production lines or automated control systems, such as controlling cylinders, motors,…

Used to direct the air flow through the valve to supply the following modules.

13. 3/2 Valve with Roller Limit Switch

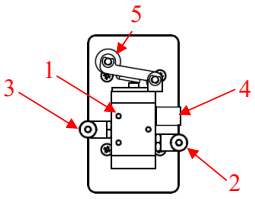
User Interface



13.1. Technical Specifications

- Number of ports: 03 ports
- Positions: 02
- Working pressure range: 0 - 1MPa
- Maximum pressure capacity: 1.5MPa
- Reset method: spring
- Quick Connector: 4mm

13.2. User Manual

Module figure	Explanation	Symbol
	1. 3/2 valve with roller limit switch 2. Đầu cấp khí 3. Đầu nối khí 4. Pneumatic Muffler 5. Limit switch wheel	

Operating Procedure

Step 1: Supply air to port P. In the initial state, the air flows from port P to port A, port R is locked

Step 2: When the metal wheel is actuated, the valve switches state: Air flows from port A to R, port P is locked

Step 3: When the actuation is released, the valve returns to its initial state

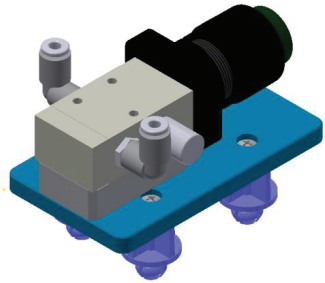
13.3. Module Functions

Used to direct the air flow to other devices and modules with the limit switch.

Help students understand the operating principle and the structure of a 3/2 Valve with limit switch

14. 3/2 Push button Valve

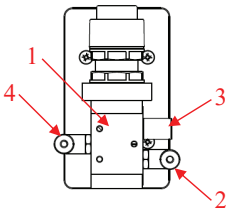
User Interface



14.1. Technical Specifications

- Number of ports: 03 ports
- Positions: 02
- Working pressure range: 0 - 1MPa
- Maximum pressure capacity: 1.5MPa
- Reset method: spring
- Quick Connector: 4mm

14.2. User Manual

Module figure	Explanation	Symbol
	1. 3/2 Pneumatic Valve 2. Air Inlet 3. Pneumatic Muffler 4. Air Outlet	

Operating Procedure

Step 1: Supply air to port P. In the initial state, the air flows from port P to port A, port R is locked

Step 2: When the button is pushed, the valve switches state: air flows from port A to R, port P is locked

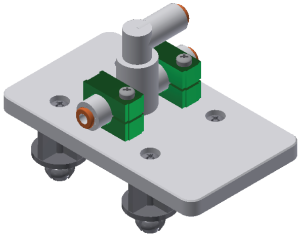
Step 3: If the button is released, the valve returns to its initial state

14.3. Module Functions

Used to direct the air flow to other devices and modules with a push-button.

15. OR Valve

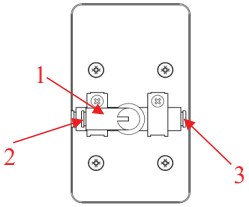
User Interface



15.1. Technical Specifications

- Working pressure range: 0.05 - 1MPa
- Maximum pressure capacity: 1.5MPa

15.2. User Manual

Module figure	*Explanation*	*Symbol*
	1. OR Valve 2. Air Inlet 3. Air Outlet	

Operating Procedure

Step 1: Supply air to port P -> the air is released at port A

Step 1: The air output at port A is used to supply for working devices (pneumatic cylinders, pneumatic valves,…)

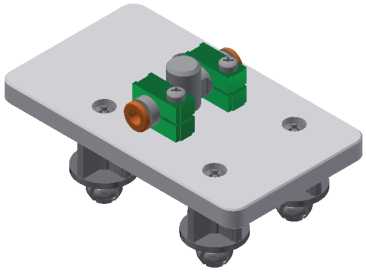
15.3. Module Functions

Used to supply air for another device or module from 1 of 2 input air sources.

Help students understand the operating principle and the structure of an OR valve.

16. Quick exhaust valve

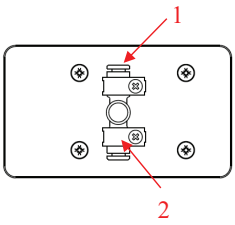
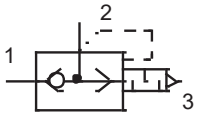
User Interface



16.1. Technical Specifications

- Working pressure range: 0.1 - 1MPa
- Maximum pressure capacity: 1.5MPa

16.2. User Manual

Module figure	*Explanation*	*Symbol*
	1.Quick exhaust valve 2. AND Valve	

Operating Procedure

Step 1: Supply air to port 1, the air is released at port 2, port 3 is locked

Step 2: If supply air to port 2 instead, the air is released at port 3, and port 1 is locked because of the One-way valve

Step 3: Air is released at port 3

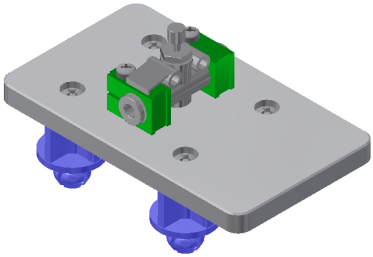
16.3. Module Functions

Used to quickly release air in the pipeline. The quick release valve is typically placed close to the actuators (cylinder,..)

Help students understand the operating principle and the structure of a Quick exhaust valve.

17. One-way Flow Control Valve

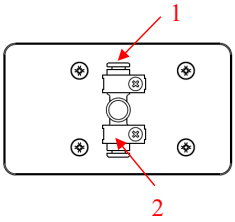
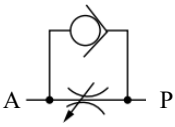
User Interface



17.1. Technical Specifications

- Working pressure range: 0.1 - 1MPa
- Maximum pressure capacity: 1.5MPa

17.2. User Manual

Module figure	*Explanation*	*Symbol*
	1. One-way Flow Control Valve 2. AND Valve	

Operating Procedure

Step 1: Supply air to port P, the air is released at port 2, port 3 is locked

Step 2: Turn the knob on the One-way Flow Control Valve

Step 3: Turn the knob counterclockwise to increase the airflow

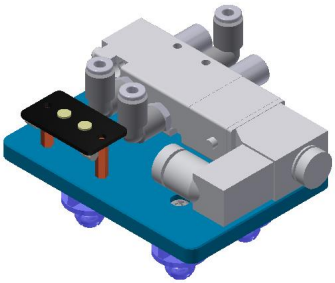
Step 4: Turn the knob clockwise to decrease the airflow

17.3. Module Functions

Used to control the cylinder speed in one direction

18. 5/2 Single Solenoid Valve

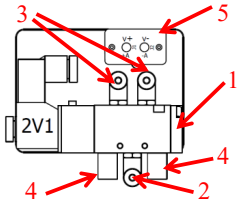
User Interface



18.1. Technical Specifications

- Number of ports: 05 ports
- Positions: 02
- Working pressure range: 0.15 - 0.8MPa
- Maximum pressure capacity: 1.5MPa
- Reset method: spring
- Quick Connector: 4mm
- Coil voltage 24VDC

18.2. User Manual

Module figure	*Explanation*	*Symbol*
	1. 5/2 Solenoid Valve 2. Air Inlet 3. Air Outlet 4. Pneumatic Muffler 5. Connection board: 2 M2-type Jacks	

Operating Procedure

Step 1: Supply air to port P. In the initial state, the air flows from port P to port A, the exhaust air flows from port B to port S, port R is locked

Step 2: Supply power to the 2V1 coil, the valve switches state: air flows from port P to B, the exhaust air flows from port A to R, port S is locked

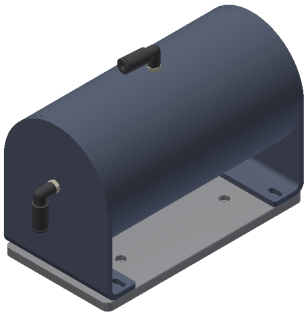
Step 3: Disconnect the power to the 2V1 coil, the valve returns to its initial state thanks to the spring

18.3. Module Functions

Used in automatic production lines or automated control systems, such as controlling cylinders, motors,…
Used to direct the air flow through the valve to supply the following modules.

19. Pressure Tank

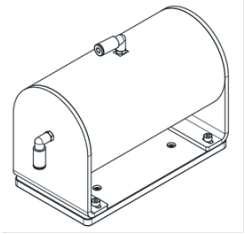
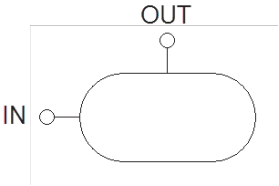
User Interface



19.1. Technical Specifications

- Number of ports: 01 port
- Capacity: 200ml
- Maximum pressure capacity: 1.5MPa

19.2. User Manual

Module figure	*Symbol*
	

Operating Procedure

Step 1: Supply air to the inlet on the side of the tank (IN port), the air can be taken from the outlet located on the tank to control other devices.

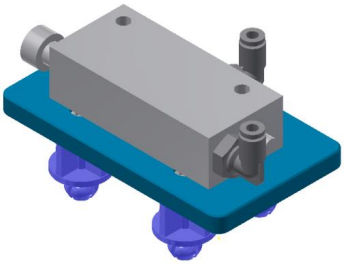
Step 2: The air pressure at the OUT port is always lower than the pressure at the IN port and equals to the pressure inside the tank. When the tank is full, the pressure is the same at both ports and inside the tank.

19.3. Module Functions

Help students understand the operating principle and the structure of a pressure tank.

20. Sequence Valve

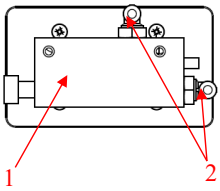
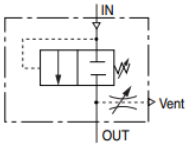
User Interface



20.1. Technical Specifications

- Working pressure range: 0.18-0.8MPa
- Uses phi 4 air tube for connecting of practice exercise

20.2. User Manual

Module figure	*Explanation*	*Symbol*
	1. Sequence Valve 2. Air ports	

Operating Procedure

Step 1: Supply air to the IN port, if the air pressure is below the set level, the valve remains closed.

Step 2: Gradually increase pressure to above the set level, the valve will open allowing air to flow through the OUT port

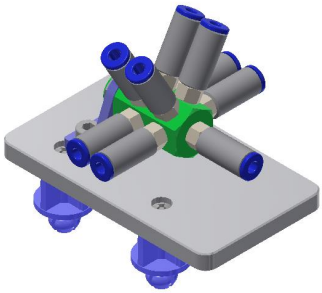
Step 3 : Cut off the air supply to close the valve, the remaining air is released through the Vent

20.3. Module Functions

Used to control the pneumatic circuit based on the principle of sequential pressure

21. Air Distributor

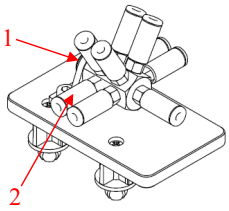
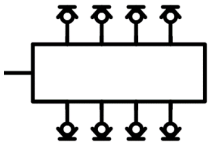
User Interface



21.1. Technical Specifications

- Number of ports: 09 ports
- Output Quick Connector: phi 4mm
- Input Quick Connector: phi 6mm

21.2. User Manual

Module figure	Explanation	Symbol
	1. Air Inlet 2. Air Outlets	

Operating Procedure

Step 1: Supply air to the Inlet (1) (phi 6mm tube) to provide air to multiple modules simultaneously

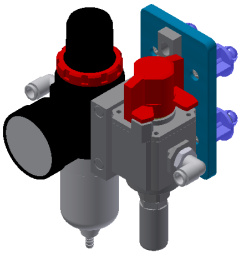
Step 2: Test the functions of provided modules (valves)

21.3. Module Functions

Used to receive air from the Filter Regulator (6mm tube) and provide air to multiple modules simultaneously.

22. Pneumatic Filter Regulator with 3/2 Valve

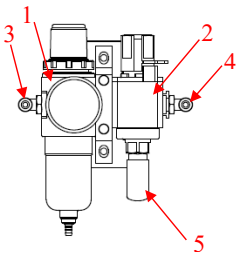
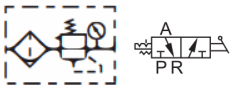
User Interface



22.1. Technical Specifications

- Number of ports: 09 ports
- Quick Connector: 6mm

22.2. User Manual

Module figure	Explanation	Symbol
	1. Filter Regulator 2. 3/2 Valve 3. Air Inlet 4. Air Outlet 5. Pneumatic Muffler	

Operating Procedure

Step 1: Supply air to the pneumatic filter

Step 2: After passing through the filter, the air flows through the 3/2 valve in its initial state

Step 3: In the initial state, exhaust air flows from port A to port R, port P is locked

Step 4: Turn the valve handle to switch state: air flows from port P to A, port R is locked

Step 5: Turn the handle back to switch the valve back to its initial state

22.3. Module Functions

Used to receive air from the Filter Regulator (6mm tube) and provide air to multiple modules simultaneously.
Lock and release the pneumatic circuit when not in use

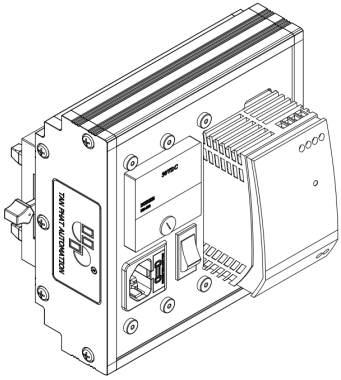
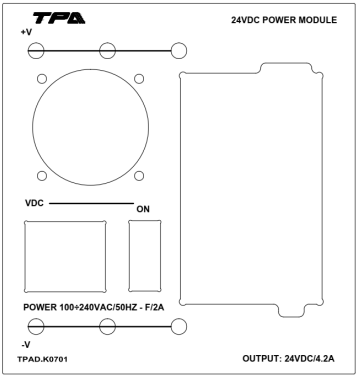
23. 24VDC Power Supply Module

User Interface

23.1. Technical Specifications

- Phoenix Contact components
- Input Voltage: 100 - 240 VAC
- Output Voltage: 24VDC/4.2A
- Power: 100 W
- Includes short-circuit protection and LED display

23.2. User Manual

Module figure	Symbol
	

Operating Procedure

Step 1: Connect the power cable into the 3-pin plug of the module to supply 220 VAC – 50Hz power

Step 2: Turn on the switch to supply 220VAC to the Phoenix Contact module

Step 3: Obtain 24VDC power from the +V plug, and 0VDC from the -V plug.

23.3. Module Functions

Used to supply 24VDC to other devices of the system.

II. Practice Exercises

1. Practicing with Switch Circuit

1.1. Objectives and Requirements

- Objectives:

  + Direct control on a Double Acting Cylinder.

- Requirements:

  + Complete wiring of a Switch Circuit

1.2. Operating Principle of the Exercise

Using a special device, the valve in the pipeline can be opened and closed. Open the valve by pushing the switch button and release to close it.

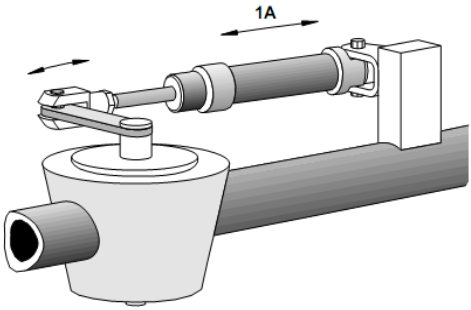
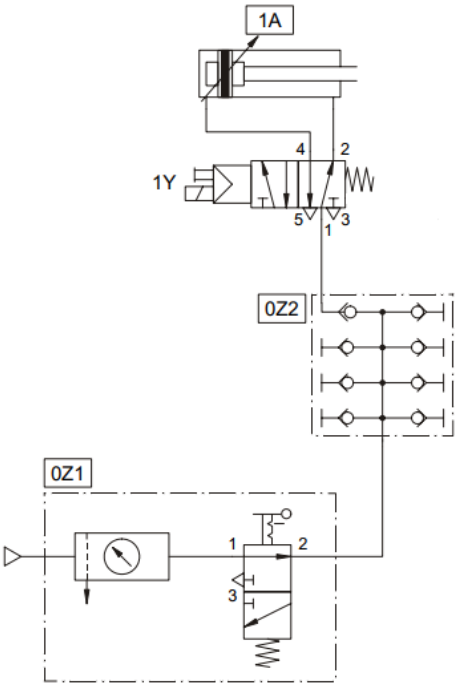
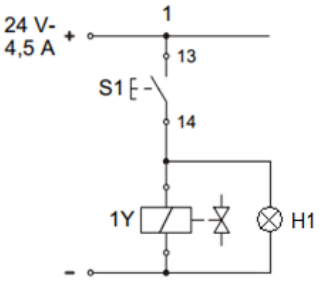


Figure 1: Exercise Illustration

1.3. Pneumatic Circuit Diagram



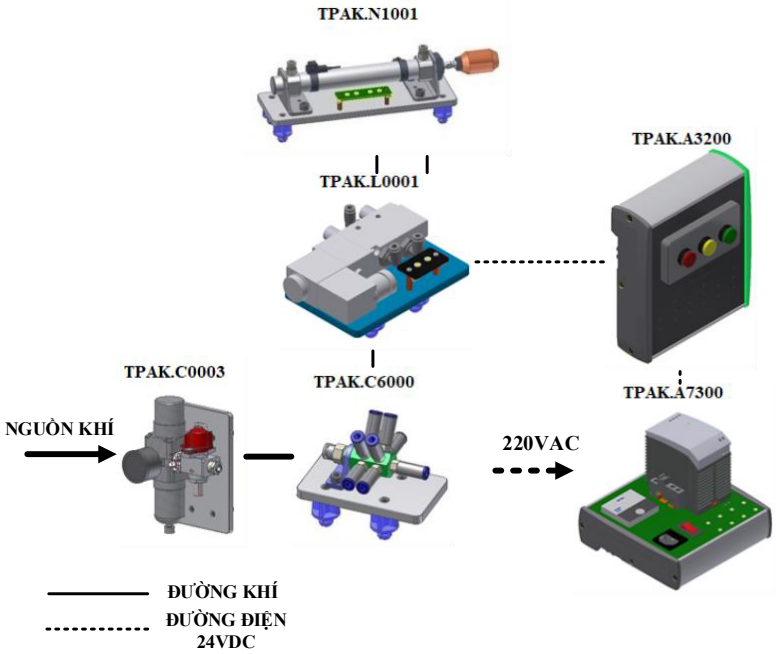
1.4. Electric Circuit Diagram



1.5. List of devices for the exercise

No.	Device	Device Name	Module Code	Qty
1		**Pneumatic Devices**		
1.1	0Z1	Pneumatic Filter Regulator with 3/2 Valve	TPAK.C0003	1
1.2	0Z2	Air Distributor	TPAK.C6000	1
1.3	1Y	5/2 Single Solenoid Valve	TPAK.L0001	1
1.4	1A	Double Acting Cylinder	TPAK.N1001	1
2		**Electric Devices**		
2.1		DC Power Supply Module	TPAK.A7300	1
2.2		Set of 3 Push buttons	TPAK.A3200	1
3		**Auxiliary Materials**		
3.1		Phi 4 Air tube	TU0425BU	2
3.2		Phi 6 Air tube	TU0604BU	1
3.3		Safety Plug Set		1

1.6. Connection Diagram



1.7. Operation Principle of the Electric-Pneumatic Circuit

When the button S1 is pushed, the electric circuit for the coil 1Y of the 5/2 Solenoid Valve is closed, the Solenoid Valve becomes active. The piston of the Double Acting Cylinder 1A will extend to the end of its stroke.

When the button S1 is released, the electric circuit for the coil 1Y is opened, the 5/2 Solenoid Valve returns to its initial state thanks to the spring. The piston then returns to its initial position.

2. Practicing with Capping Circuit.

2.1. Objectives and Requirements

- Objectives:

  + Direct control on a Double Acting Cylinder.

- Requirements:

  + Complete wiring of Capping Circuit.

2.2. Operating Principle of the Exercise

Use the device to press the installed lid on a plastic bucket. By pushing the switch button, the hemispherical pressing head moves down and the lid is pressed into place. When the button is released, the hemispherical pressing head returns to its initial position.

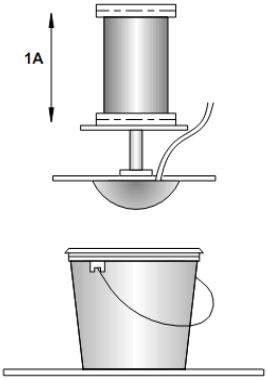
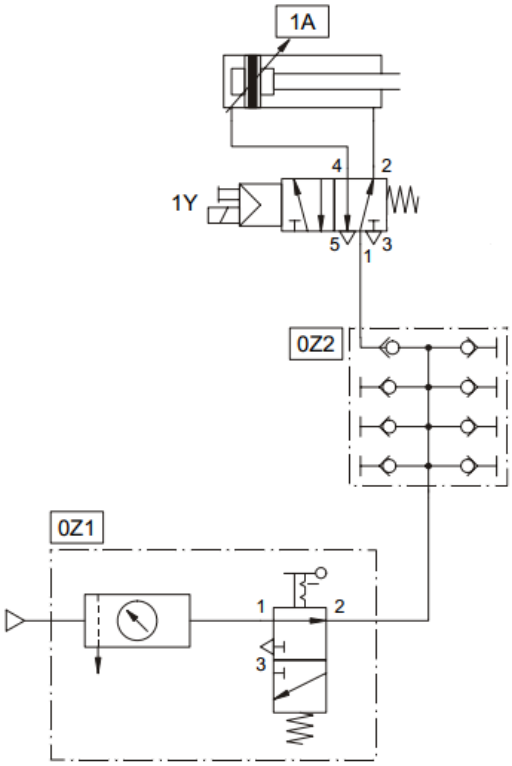
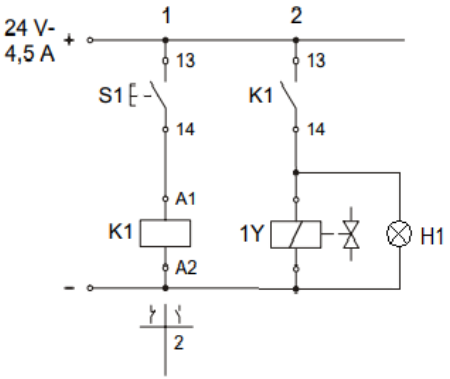


Figure 2: Exercise Illustration

2.3. Pneumatic Circuit Diagram



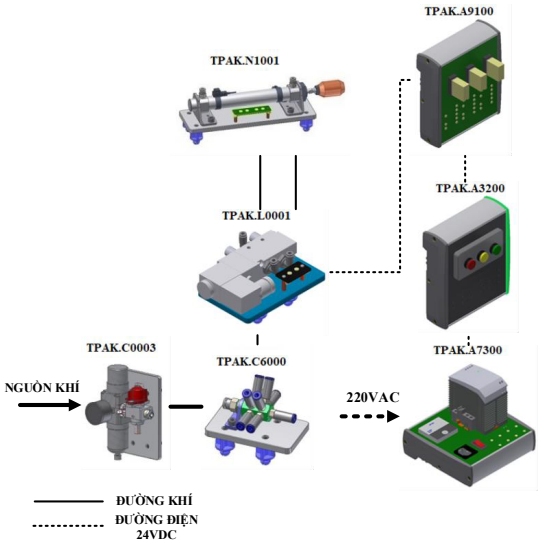
2.4. Electric Circuit Diagram



2.5. List of devices for the exercise

No.	Device	Device Name	Module Code	Qty
1		**Pneumatic Devices**		
1.1	0Z1	Filter Regulator with 3/2 Valve	TPAK.C0003	1
1.2	0Z2	Air Distributor	TPAK.C6000	1
1.3	1Y	5/2 Single-coil Solenoid Valve	TPAK.L0001	1
1.4	1A	Double Acting Cylinder	TPAK.N1001	1
2		**Electric Devices**		
2.1		DC Power Supply Module	TPAK.A7300	1
2.2		Set of 3 Push buttons	TPAK.A3200	1
2.3		Intermediate Relay Practice Module	TPAK.A9100	1
3		**Auxiliary Materials**		
3.1		Phi 4 Air tube	TU0425BU	2
3.2		Phi 6 Air tube	TU0604BU	1
3.3		Safety Plug Set		1

2.6. Connection Diagram



2.7. Operation Principle of the Electric-Pneumatic Circuit

When the button S1 is pushed, the electric circuit for the Relay K1 is closed and the contacts of K1 becomes active. The electric circuit for the coil 1Y is closed, the 5/2 Solenoid Valve becomes active. The piston of the Double Acting Cylinder extends to the end of its stroke.

When the button S1 is released, the electric circuit for the Relay K1 is opened, the contacts of K1 becomes inactive. The circuit for the coil 1Y is also opened, the 5/2 Solenoid Valve returns to its initial state thanks to the spring. The piston then returns to its initial position.

3. Practicing with Tilt Control Circuit.

3.1. Objectives and Requirements

- Objectives:
  + Direct control on a Single-acting/Double Acting Cylinder.
  + Direct activation using OR logic signal.
- Requirements:
  + Complete wiring of tilt control circuit.

3.2. Operating Principle of the Exercise

Use the tilt to pour out loose materials from a container. When the button is pushed, the door of the container opens, pouring out materials inside. Release the button for the door to close back.

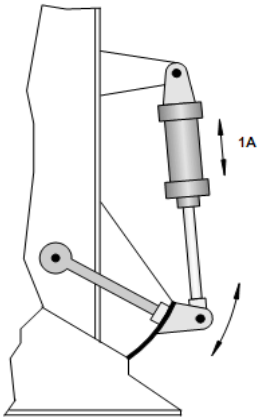
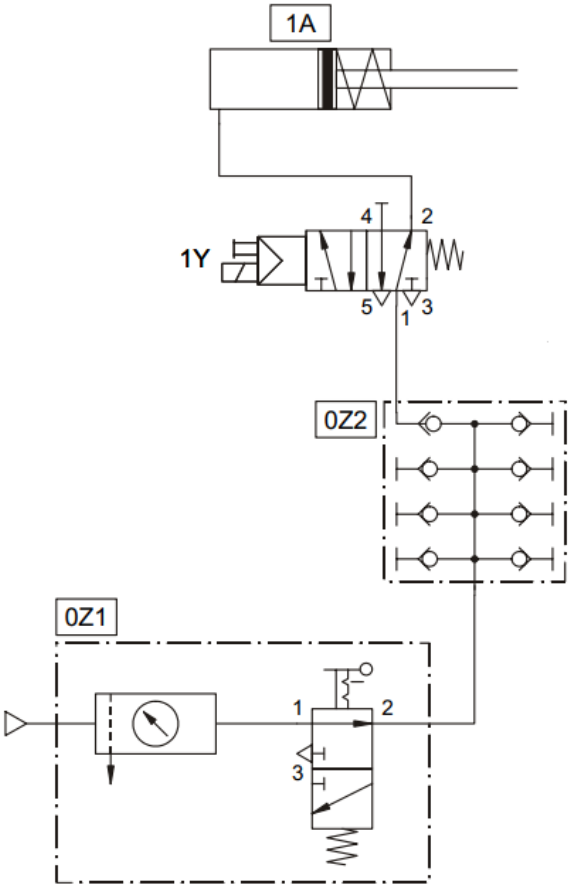


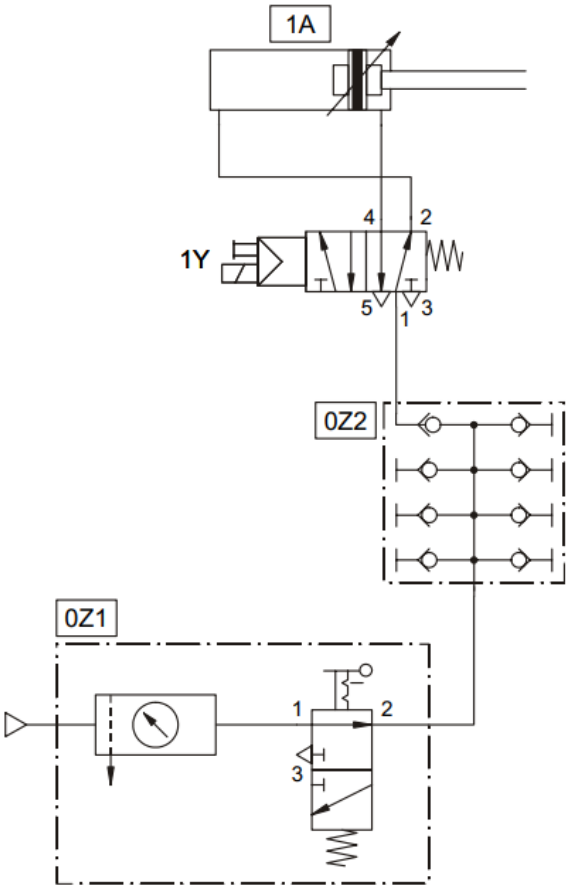
Figure 3: Exercise Illustration

3.3. Pneumatic Circuit Diagram

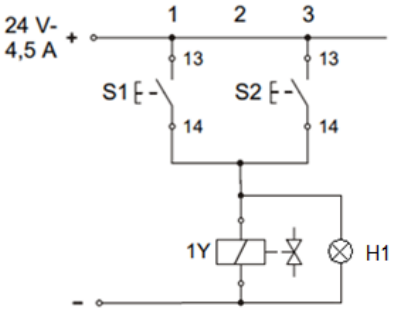
❖ Pneumatic Circuit Diagram with Single Acting Cylinder



❖ Pneumatic Circuit Diagram with Double Acting Cylinder



3.4. Electric Circuit Diagram

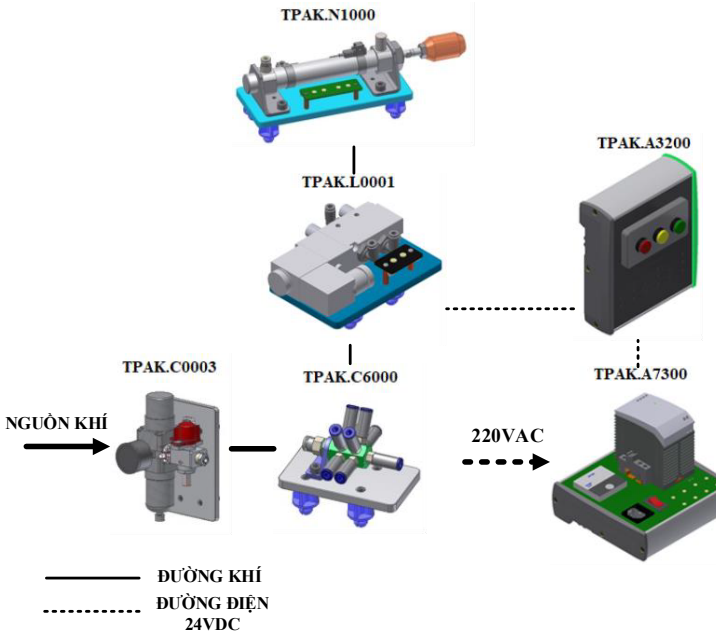


3.5. List of devices for the exercise

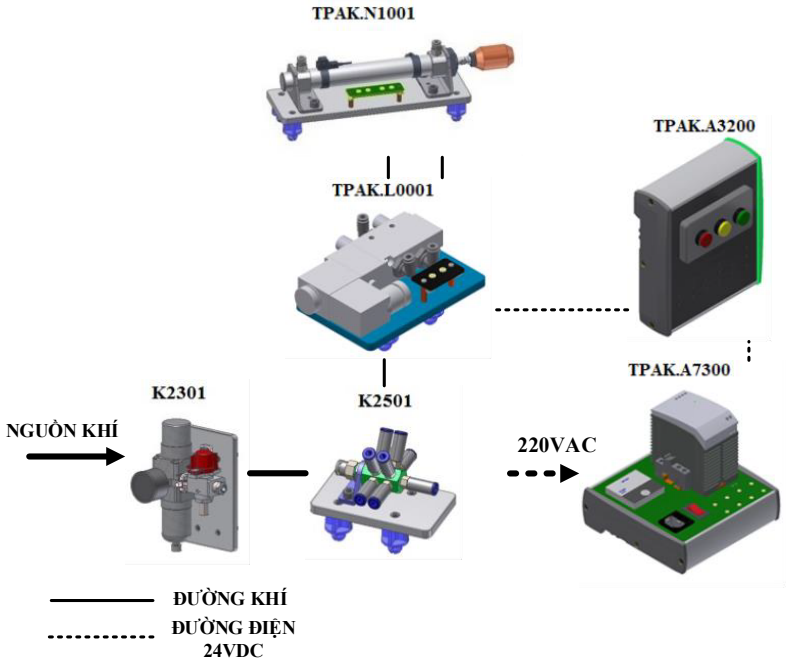
No.	Device	Device Name	Module Code	Qty
1		**Pneumatic Devices**		
1.1	0Z1	Filter Regulator with 3/2 Valve	TPAK.C0003	1
1.2	0Z2	Air Distributor	TPAK.C6000	1
1.3	1Y	5/2 Single Solenoid Valve	TPAK.L0001	1
1.4	1A	Single Acting Cylinder	TPAK.N1000	1
1.5		Double Acting Cylinder	TPAK.N1001	1
2		**Electric Devices**		
2.1		DC Power Supply Module	TPAK.A7300	1
2.2		Set of 3 Push buttons	TPAK.A3200	1
3		**Auxiliary Materials**		
3.1		Phi 4 Air tube	TU0425BU	3
3.2		Phi 6 Air tube	TU0604BU	1
3.3		4mm Air tube plug	KQ2P-04	1
3.4		Safety Plug Set		1

3.6. Connection Diagram

❖ Connection Diagram with Single Acting Cylinder



❖ Connection Diagram with Double Acting Cylinder



3.7. Operation Principle of the Electric-Pneumatic Circuit

When the button S1 OR button S2 is pushed, the electric circuit for the coil 1Y is closed, the 5/2 Solenoid Valve becomes active. The piston of the Single Acting Cylinder (or the Double Acting Cylinder) extends to the end of its stroke.

When the both buttons S1 and S2 is released, the electric circuit for the coil 1Y is opened, the 5/2 Solenoid Valve returns to its initial state thanks to the spring. The piston then returns to its initial position.

4. Practicing with Angling Circuit.

4.1. Objectives and Requirements

- Objectives:

  + Direct control on a Single-acting/Double Acting Cylinder
  + Indirect activation using OR logic signal.

- Requirements:

  + Complete wiring of an Angling Circuit

4.2. Operating Principle of the Exercise

Use the angling machine to pour liquid from a pot. By pushing the button, the pot tilts and pours out the liquid inside. Release the button to return the jar to an upright position.

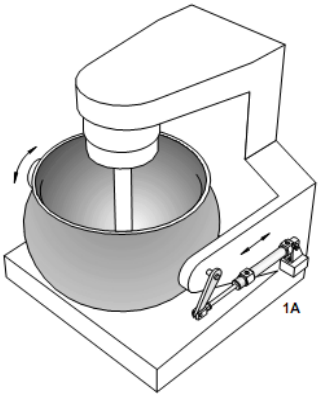
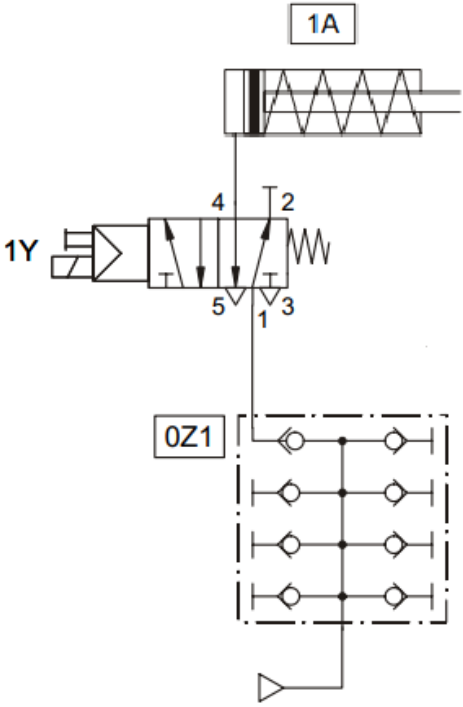


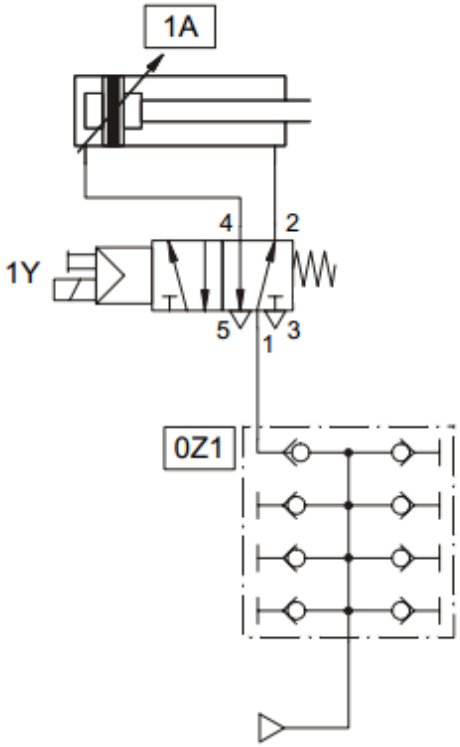
Figure 4: Exercise Illustration

4.3. Pneumatic Circuit Diagram

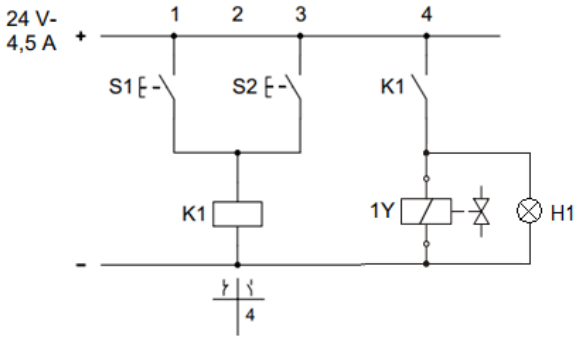
❖ Pneumatic Circuit Diagram with Single Acting Cylinder



❖ Pneumatic Circuit Diagram with Double Acting Cylinder



4.4. Electric Circuit Diagram

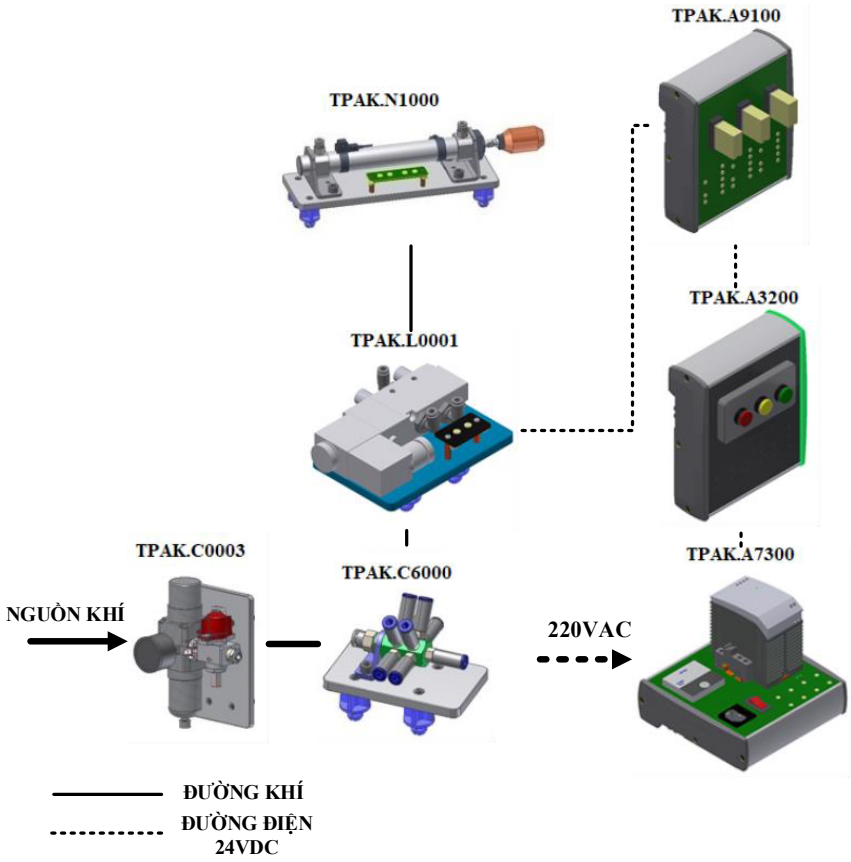


4.5. List of devices for the exercise

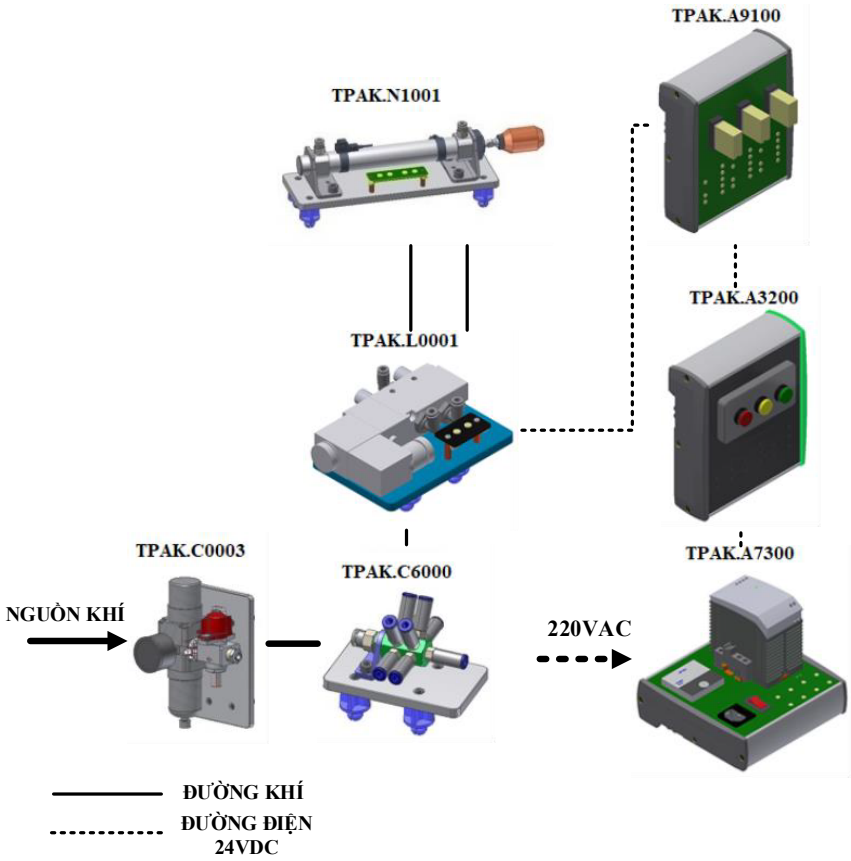
No.	Device	Device Name	Module Code	Qty
1		**Pneumatic Devices**		
1.1	0Z1	Filter Regulator with 3/2 Valve	TPAK.C0003	1
1.2	0Z2	Air Distributor	TPAK.C6000	1
1.3	1Y	5/2 Single Solenoid Valve	TPAK.L0001	1
1.4	1A	Single Acting Cylinder	TPAK.N1000	1
1.5		Double Acting Cylinder	TPAK.N1001	1
2		**Electric Devices**		
2.1		DC Power Supply Module	TPAK.A7300	1
2.2		Set of 3 Push buttons	TPAK.A3200	1
2.4		Set of 3 Relays	TPAK.A9100	1
3		**Auxiliary Materials**		
3.1		Phi 4 Air tube	TU0425BU	3
3.2		Phi 6 Air tube	TU0604BU	1
3.3		4mm Air tube plug	KQ2P-04	1
3.4		Safety Plug Set		1

4.6. Connection Diagram

❖ Pneumatic Circuit Diagram with Single Acting Cylinder



❖ Pneumatic Circuit Diagram with Double Acting Cylinder



4.7. Operation Principle of the Electric-Pneumatic Circuit

When the button S1 OR button S2 is pushed, the electric circuit for the coil 1Y is closed, the 5/2 Solenoid Valve becomes active. The piston of the Single Acting Cylinder (or the Double Acting Cylinder) extends to the end of its stroke.

When the both buttons S1 and S2 is released, the electric circuit for the coil 1Y is opened, the 5/2 Solenoid Valve returns to its initial state thanks to the spring. The piston then returns to its initial position.

5. Practicing with Lane Switching Circuit.

5.1. Objectives and Requirements

- Objectives:

  + Direct control on a Single-acting/Double Acting Cylinder
  + Direct activation from 2 inputs.

- Requirements:

  + Complete wiring of a Lane Switching Circuit.

5.2. Operating Principle of the Exercise

Use the Lane switching device to switch the parts from one conveyor belt to another. By pushing the button, the frame of the lane switching device is pushed forward; the part is moved to the other side and transferred in the opposite direction. By pushing another button, the device frame returns to its initial position.

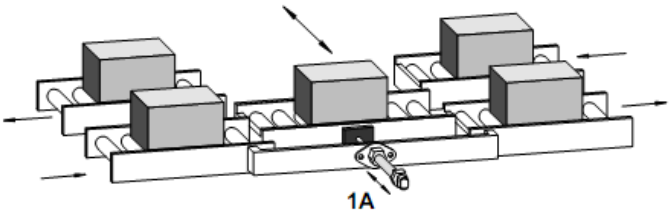
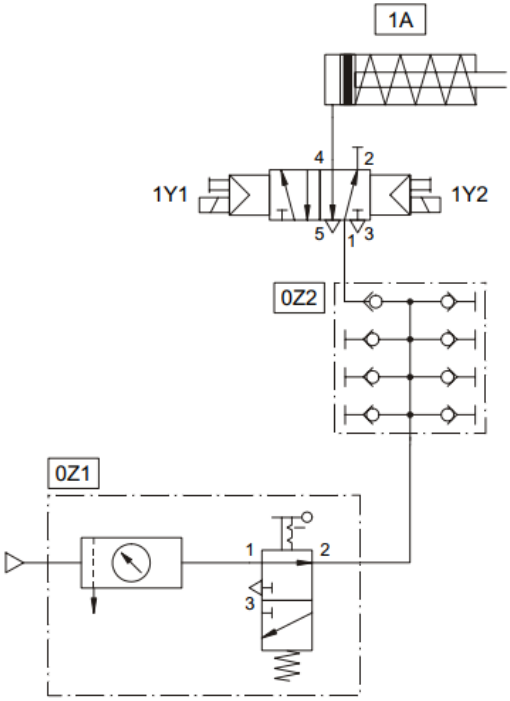


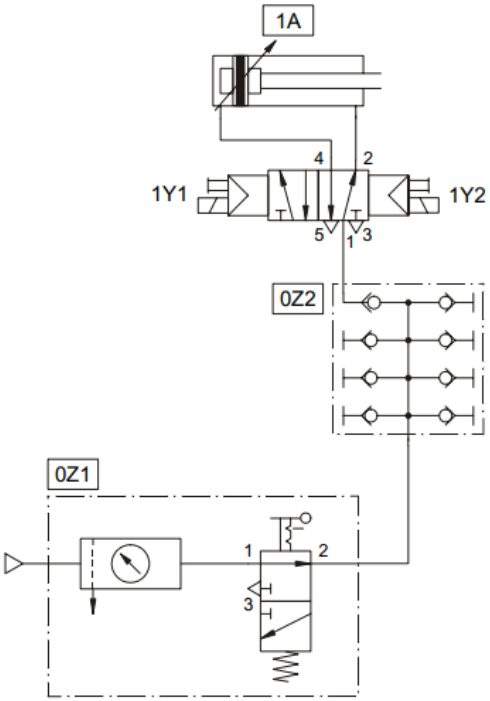
Figure 5: Exercise Illustration

5.3. Pneumatic Circuit Diagram

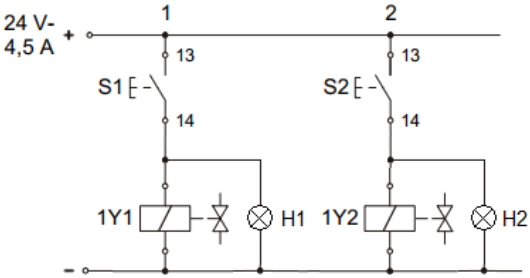
❖ Pneumatic Circuit Diagram with Single Acting Cylinder



❖ Pneumatic Circuit Diagram with Double Acting Cylinder



5.4. Electric Circuit Diagram

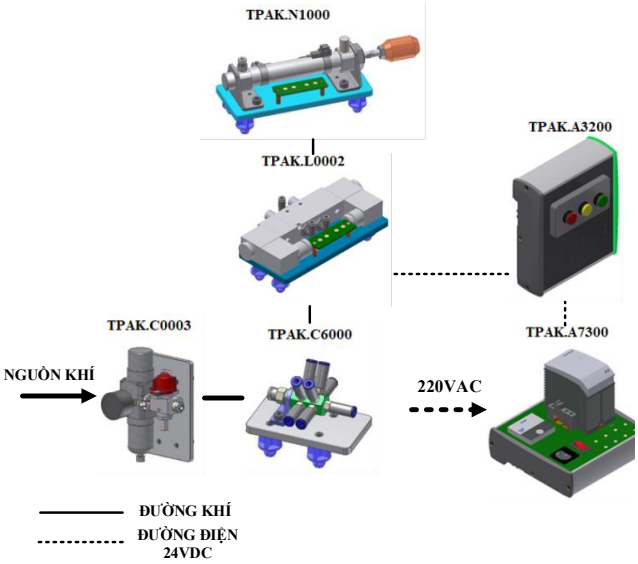


5.5. List of devices for the exercise

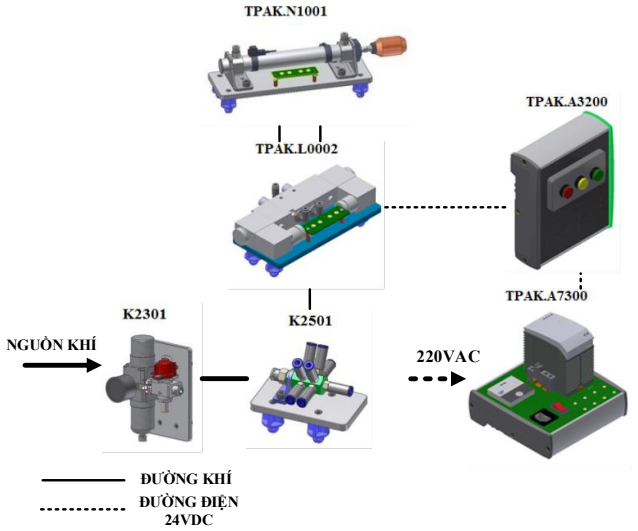
No.	Device	Device Name	Module Code	Qty
1		**Pneumatic Devices**		
1.1	0Z1	Filter Regulator with 3/2 Valve	TPAK.C0003	1
1.2	0Z2	Air Distributor	TPAK.C6000	1
1.3	1Y1, 1Y2	Double-Acting 5/2 Solenoid Valve	TPAK.L0002	1
1.4	1A	Single Acting Cylinder	TPAK.N1000	1
1.5		Double Acting Cylinder	TPAK.N1001	1
2		**Electric Devices**		
2.1		DC Power Supply Module	TPAK.A7300	1
2.2	S1, S2	Set of 3 Push buttons	TPAK.A3200	1
3		**Auxiliary Materials**		
3.1		Phi 4 Air tube	TU0425BU	3
3.2		Phi 6 Air tube	TU0604BU	1
3.3		4mm Air tube plug	KQ2P-04	1
3.4		Safety Plug Set		1

5.6. Connection Diagram

❖ Pneumatic Circuit Diagram with Single Acting Cylinder



❖ Pneumatic Circuit Diagram with Double Acting Cylinder



5.7. Operation Principle of the Electric-Pneumatic Circuit

When the button S1 is pushed, the electric circuit for the coil 1Y1 is closed, the Double Coil 5/2 Solenoid Valve becomes active, causing the Single Acting Cylinder (or the Double Acting Cylinder) to extend to the end of its stroke. When the button S1 is released, the electric circuit for the coil 1Y1 is opened.

When the button S2 is released, the electric circuit for the coil 1Y2 is closed, the Double Coil 5/2 Solenoid Valve becomes active, causing the Single Acting Cylinder (Double Acting Cylinder) to return to its initial position. When the button S2 is released, the electric circuit for the coil 1Y2 is opened.

6. Practicing with Butterfly Valve Gate Control Circuit.

6.1. Objectives and Requirements

- Objectives:
  + Direct control on a Single-acting/Double Acting Cylinder
  + Direct actuation from 2 inputs
- Requirements:
  + Complete wiring of a Butterfly Valve Gate Control Circuit

6.2. Operating Principle of the Exercise

The material bunker is emptied through the hopper opening. By pushing the button, the hopper gate open, letting the materials go through. By pushing another button, the gate closes.

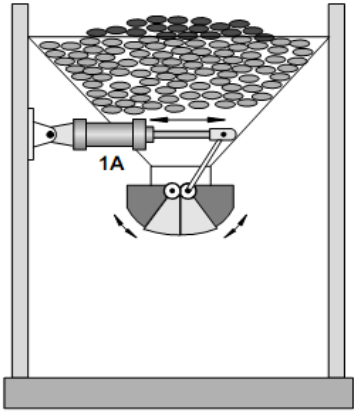
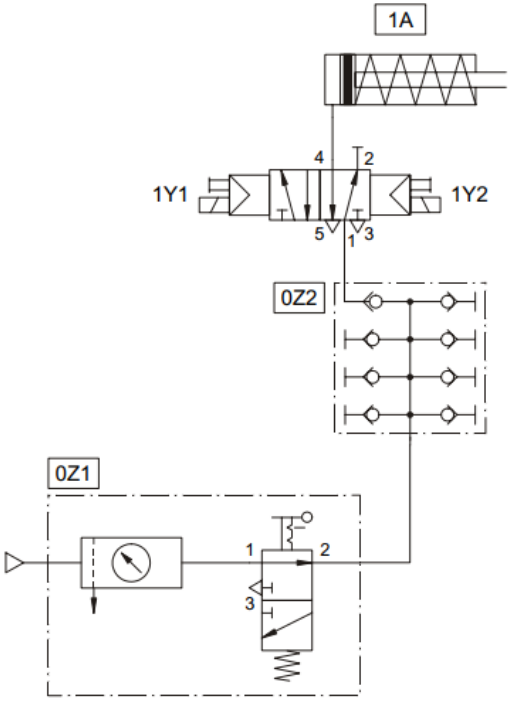


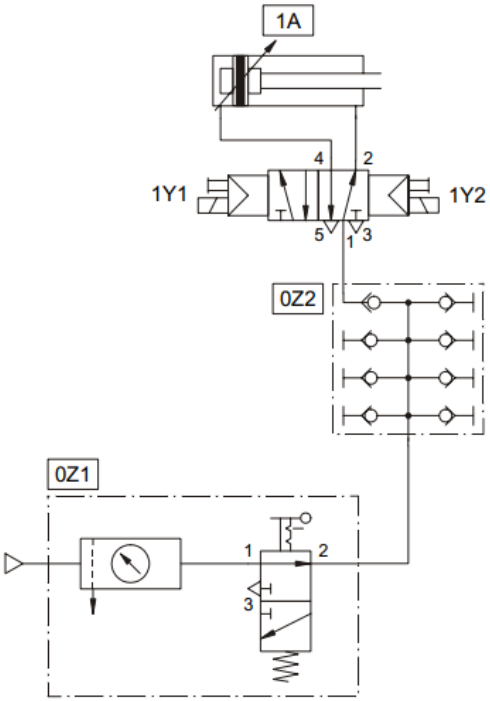
Figure 6: Exercise Illustration

6.3. Pneumatic Circuit Diagram

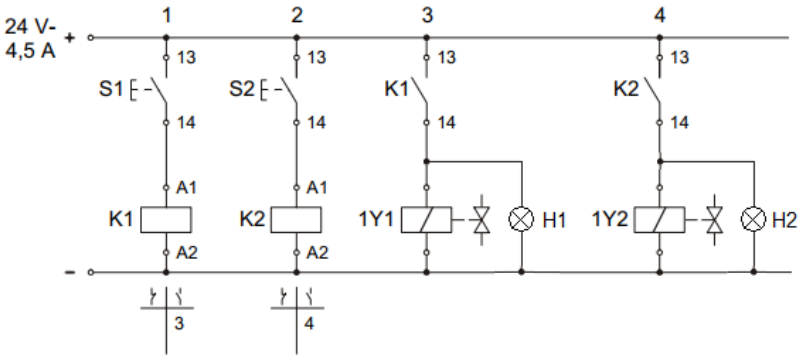
❖ Pneumatic Circuit Diagram with Single Acting Cylinder



❖ Pneumatic Circuit Diagram with Double Acting Cylinder



6.4. Electric Circuit Diagram

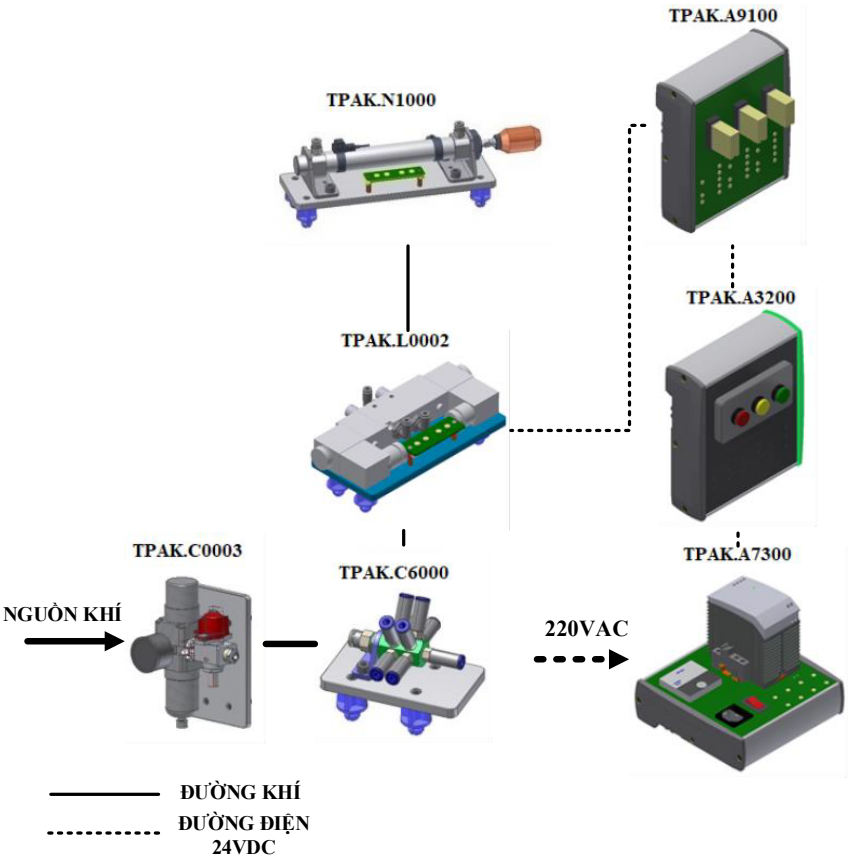


6.5. List of devices for the exercise

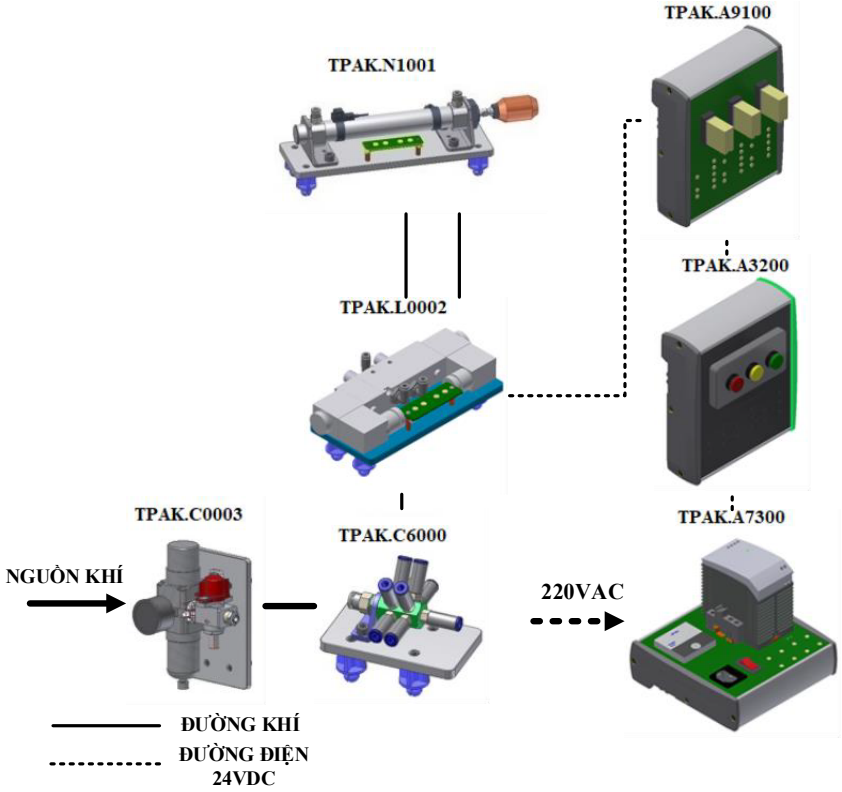
No.	Device	Device Name	Module Code	Qty
1		**Pneumatic Devices**		
1.1	0Z1	Filter Regulator with 3/2 Valve	TPAK.C0003	1
1.2	0Z2	Air Distributor	TPAK.C6000	1
1.3	1Y1, 1Y2	Double-Acting 5/2 Solenoid Valve	TPAK.L0002	1
1.4	1A	Single Acting Cylinder	TPAK.N1000	1
1.5		Double Acting Cylinder	TPAK.N1001	1
2		**Electric Devices**		
2.1		DC Power Supply Module	TPAK.A7300	1
2.2	S1,S2	Set of 3 Push buttons	TPAK.A3200	1
2.3	K1, K2	Set of 3 Relays	TPAK.A9100	1
3		**Auxiliary Materials**		
3.1		Phi 4 Air tube	TU0425BU	3
3.2		Phi 6 Air tube	TU0604BU	1
3.3		4mm Air tube plug	KQ2P-04	1
3.4		Safety Plug Set		1

6.6. Connection Diagram

❖ Pneumatic Circuit Diagram with Single Acting Cylinder



❖ Pneumatic Circuit Diagram with Double Acting Cylinder



6.7. Operation Principle of the Electric-Pneumatic Circuit

When the button S1 is pushed, the electric circuit for the Relay K1 is closed, causing the Relay to switch state, the contacts of K1 become closed, so the circuit for the coil 1Y1 becomes closed and the Double Coil 5/2 Solenoid Valve becomes active, causing the Single Acting Cylinder (or the Double Acting Cylinder) to extend to the end of its stroke. When the button S2 is released, the circuit for Relay K1 is opened, the Relay returns to its initial state, making the circuit for the coil 1Y1 also become opened.

When the button S2 is pushed, the electric circuit for the Relay K2 is closed, causing the Relay to switch state, the contacts of K2 become closed, so the circuit for the coil 1Y2 becomes closed and the Double Coil 5/2 Solenoid Valve becomes active, causing the Single Acting Cylinder (or the Double Acting Cylinder) to extend to the end of its stroke. When the button S2 is released, the circuit for Relay K2 is opened, the Relay returns to its initial state, making the circuit for the coil 1Y2 also become opened.

7. Practicing with Feeder Circuit

7.1. Objectives and Requirements

- Objectives:
  + Operation of Single Acting Cylinder
  + Direct actuation of Single Acting Cylinder
  + Use of 3/2 Solenoid Valve
  + Application of air on-off switch and air distributor
- Requirements:
  + Complete wiring of a Feeder Circuit

7.2. Operating Principle of the Exercise

The feeder device is used to supply aluminum workpieces for the next processing station. By pushing a button, the piston rod of the Single Acting Cylinder (1A) extends and push a workpiece out to the processing station. Releasing the button for the piston to return to its initial position.

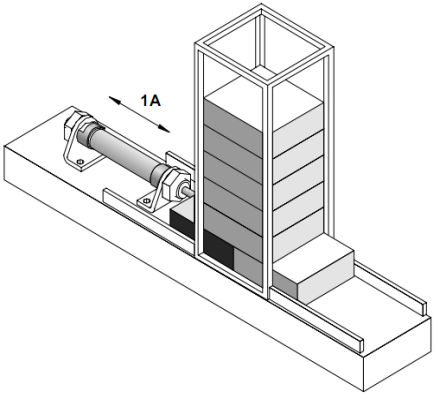
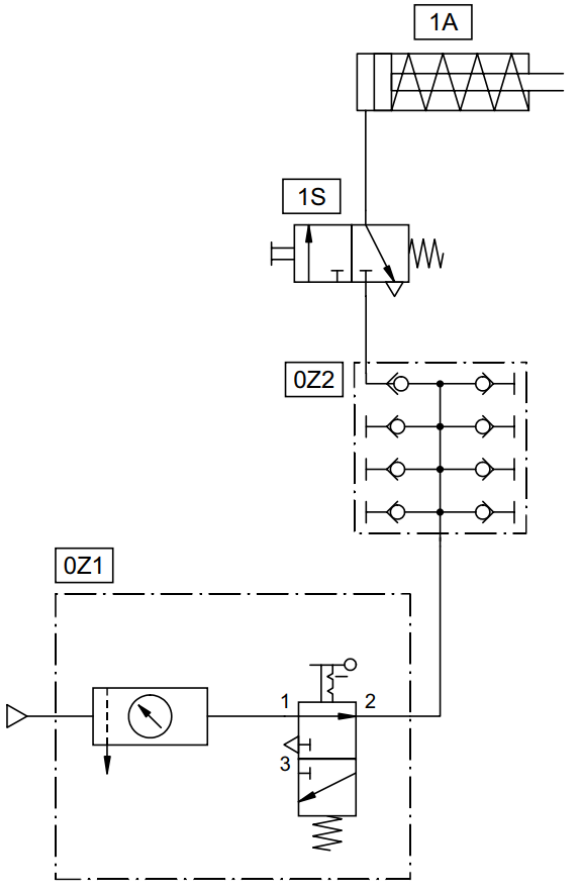
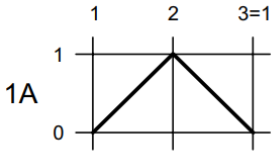


Figure 7: Exercise Illustration

7.3. Pneumatic Circuit Diagram



7.4. Step Diagram

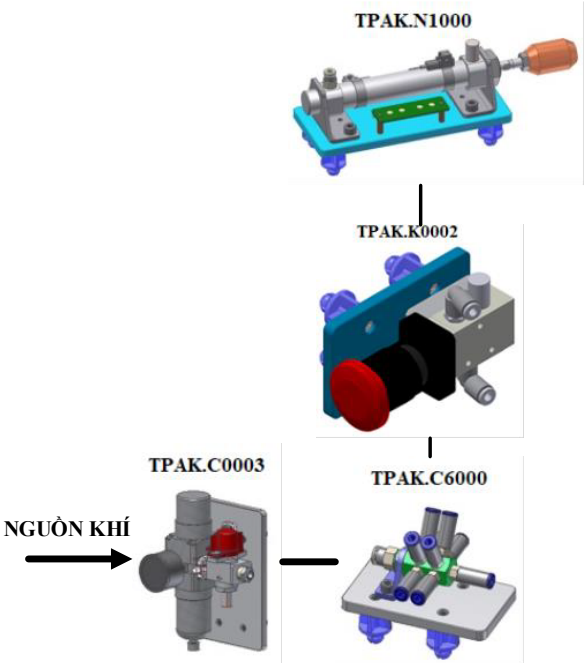


- **Step 1-2:** When the button on the 3/2 valve **1S** is pressed and held, the valve lets compressed air flow into the cylinder, causing the piston to extend to its full stroke.
- **Step 2-3:** Release the button **1S** to return the 3/2 valve to its initial position, the air in the cylinder flows out and the piston retracts.

7.5. List of devices for the exercise

No.	Device	Device Name	Module Code	Qty
1		**Pneumatic Devices**		
1.1	0Z1	Filter Regulator with 3/2 Valve	TPAK.C0003	1
1.2	0Z2	Air Distributor	TPAK.C6000	1
1.3	1A	Single Acting Cylinder	TPAK.N1000	1
1.4	1S	3/2 Push-button Valve	TPAK.K0002	1
2		**Auxiliary Materials**		
2.1		Phi 4 Air tube	TU0425BU	2
2.2		Phi 6 Air tube	TU0604BU	1

7.6. Connection Diagram



8. Practicing with Sorting Circuit.

8.1. Objectives and Requirements

- Objectives:
  + Direct actuation of Single Acting Cylinder
  + Use of 3/2 Solenoid Valve
  + Connection and adjustment of One-way Flow Control Valve
  + Connection of a Pressure Gauge
- Requirements:
  + Complete wiring of a Sorting Circuit.

8.2. Operating Principle of the Exercise

Through button activity, the metal workpieces located in random positions on the conveyor belt are sorted and transferred to another conveyor belt, the cylinder's full stroke time is about t=0,4s. Release the button to return the cylinder to its initial position.

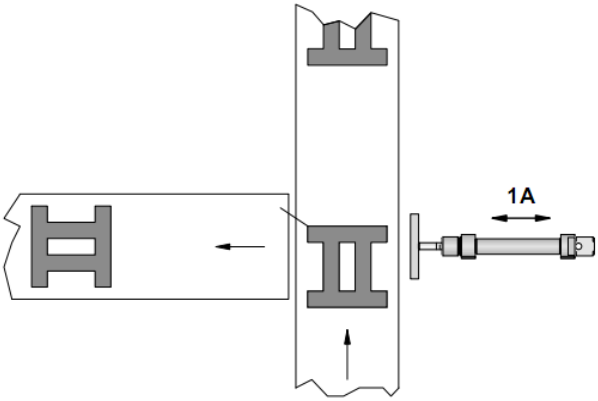
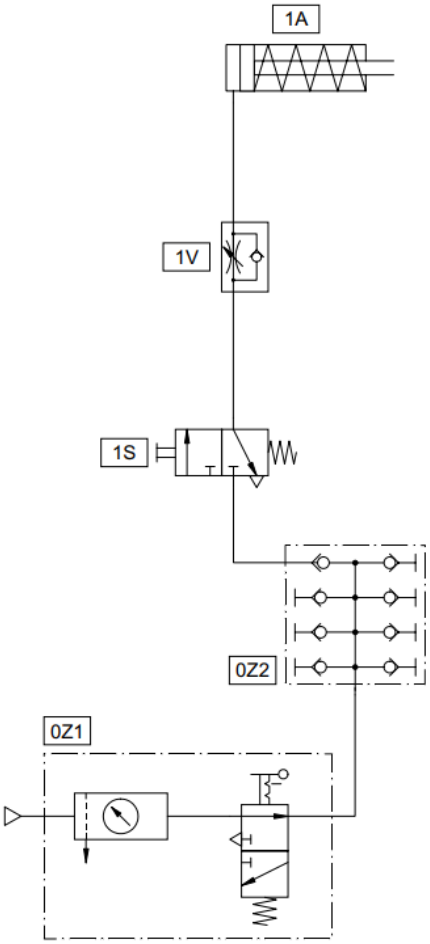


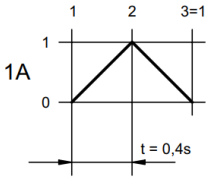
Figure 8: Exercise Illustration

8.3. Pneumatic Circuit Diagram



In practice, to ensure safety and convenience, pneumatic systems are installed with an additional Pneumatic Filter Regulator with 3/2 Valve (TPAK.C0003) and an Air Distributor (TPAK.C6000). To simplify the pneumatic circuit diagram, in the following exercises, the two modules will not be drawn on the pneumatic circuit diagram.

8.4. Step Diagram

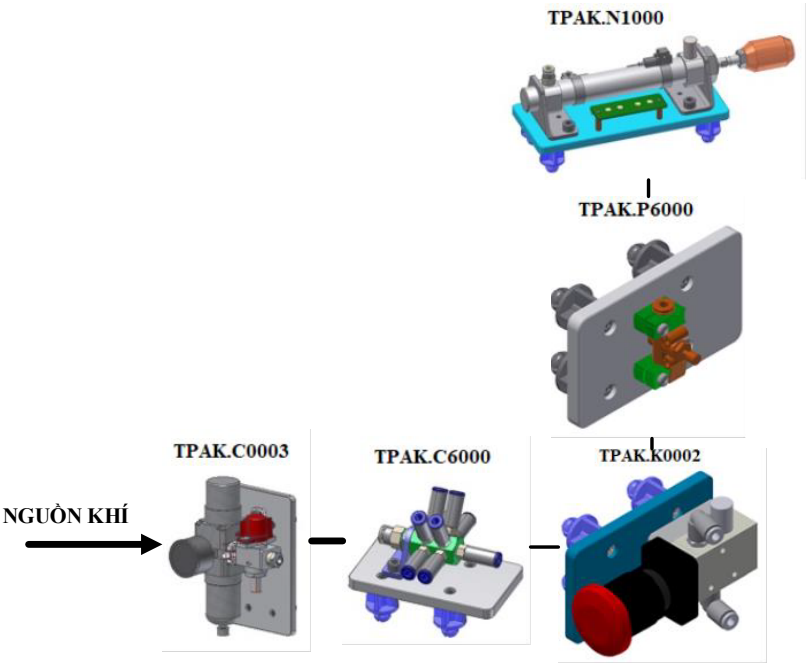


- **Step 1-2:** When the button on the valve **1S** is pushed, the 3/2 valve let the air flows through the Throttle valve into the cylinder, causing the piston to extend. The speed in which the piston extend depends on the Throttle valve, turn the knob on the Throttle valve to set the piston's full stroke time to 0,4s. If the button is held, the piston will continue to extend to its full stroke.
- **Step 2-3:** When the button **1S** is released, the 3/2 valve returns to its initial position, the air inside the cylinder flows out quickly because it does not go through the Throttle Valve, and the piston extracts.

8.5. List of devices for the exercise

No.	Device	Device Name	Module Code	Qty
1		**Pneumatic Devices**		
1.1	0Z1	Filter Regulator with 3/2 Valve	TPAK.C0003	1
1.2	0Z2	Air Distributor	TPAK.C6000	1
1.3	1S	3/2 Push-button Valve	TPAK.K0002	1
1.5	1V	Double One-way Flow Control Valve	TPAK.P6000	1
1.6	1A	Single Acting Cylinder	TPAK.N1000	1
2		**Auxiliary Materials**		
2.1		Phi 4 Air tube	TU0425BU	5
2.2		Phi 6 Air tube	TU0604BU	1

8.6. Connection Diagram



9. Practicing with Package Lifting Circuit.

9.1. Objectives and Requirements

- Objectives:

  + Direct actuation of Single Acting Cylinder
  + Use of 3/2 Solenoid Valve
  + Knowing that Solenoid Valves have NO type (Normally Open) and NC type (Normally Closed)
  + Understand the position of Throttle Valves
  + Understand the function of Quick exhaust Valves

- Requirements:

  + Complete wiring of Package Lifting Circuit.

9.2. Operating Principle of the Exercise

The device is used to transfer the packages from a roller conveyor to an X-ray projector. The cylinder is attached to the package holder. Pushing the button to move the cylinder to the package receiving position. When the button is released, the cylinder extends to its full stroke; transfering the package to the X-ray projecting position. This extension takes 0,9s.

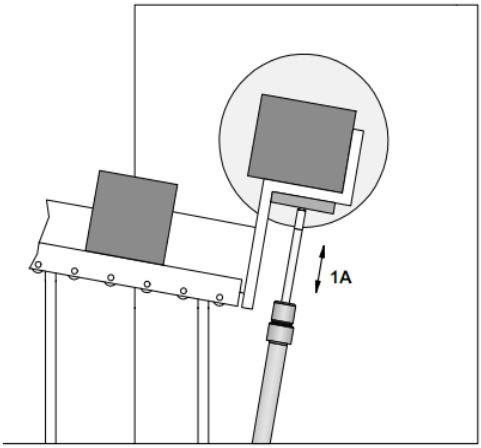
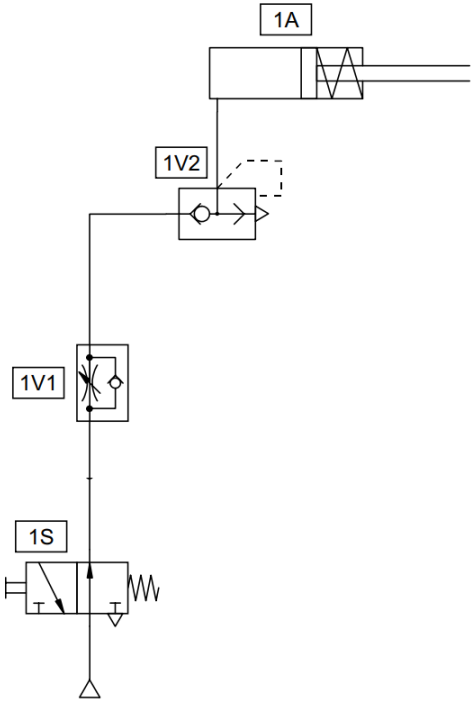
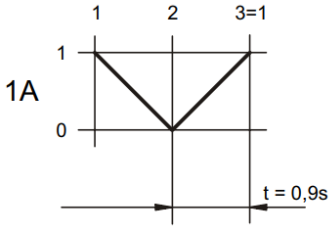


Figure 9: Exercise Illustration

9.3. Pneumatic Circuit Diagram



9.4. Step Diagram



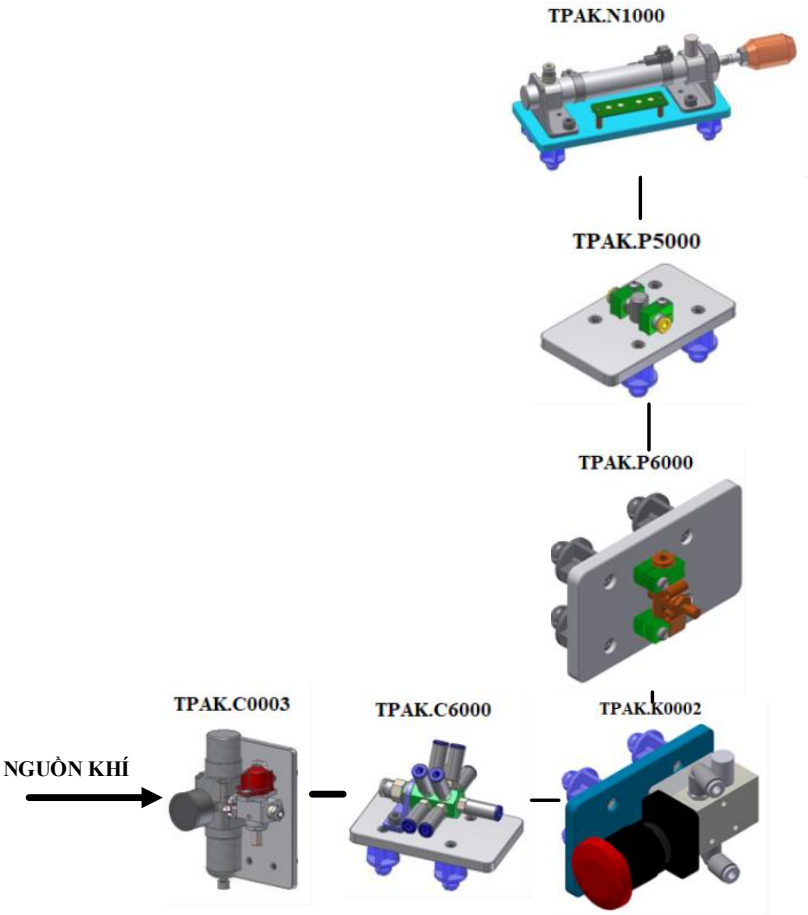
- **Note:** When the air supply is turned on, the Solenoid Valve **1S** is in a NO (Normally Open) state, the air flows through the valve and pushes the cylinder to extend to its full stroke.
- **Step 1-2:** When the button on the Valve **1S** is pushed, the air flows into the Quick exhaust Valve **1V2**, releasing the air inside the cylinder, causing the piston to retract.
- **Step 2-3:** When the button **1S** is released, the 3/2 Solenoid Valve returns to its initial state, the air can now flow through the valve into the cylinder. The speed in which the piston extend depends on the Throttle valve, turn the knob on the Throttle valve to set

the piston's full stroke time to 0,4s. If the button is held, the piston will continue to extend to its full stroke.

9.5. List of devices for the exercise

No.	Device	Device Name	Module Code	Qty
1		**Pneumatic Devices**		
1.1		Filter Regulator with 3/2 Valve	TPAK.C0003	1
1.2		Air Distributor	TPAK.C6000	1
1.3	1S	3/2 Push-button Valve	TPAK.K0002	1
1.4	1V1	Double One-way Flow Control Valve	TPAK.P6000	1
1.5	1V2	Quick exhaust Valve	TPAK.P5000	1
1.6	1A	Single Acting Cylinder	TPAK.N1000	1
2		**Auxiliary Materials**		
2.1		Phi 4 Air tube	TU0425BU	7
2.2		Phi 6 Air tube	TU0604BU	1

9.6. Connection Diagram



10. Practicing with Vertical Sorting for Metal Circuit.

10.1. Objectives and Requirements

- Objectives:
  + Direct actuation of Double Acting Cylinder
  + Operation of 5/2 Switch Valve (Hand Lever Valve)
- Requirements:
  + Complete wiring of Vertical Sorting for Metal Circuit.

10.2. Operating Principle of the Exercise

With the help of the sorting station, the heat-treated coal pieces are transferred to either a lower or higher conveyor belt by choice. The destination of the piece is controlled by this cylinder mechanism with a 2-position switch. The Double Acting Cylinder (1A) extension takes 3s and the extraction takes 2,5s. In the initial position, the cylinder is inactive, with the piston not yet extended. The air pressure at the cylinder's port is displayed.

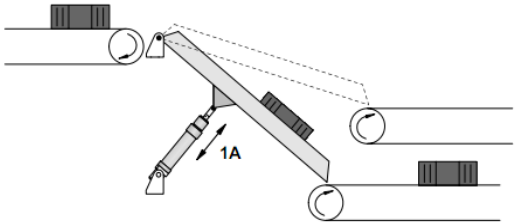
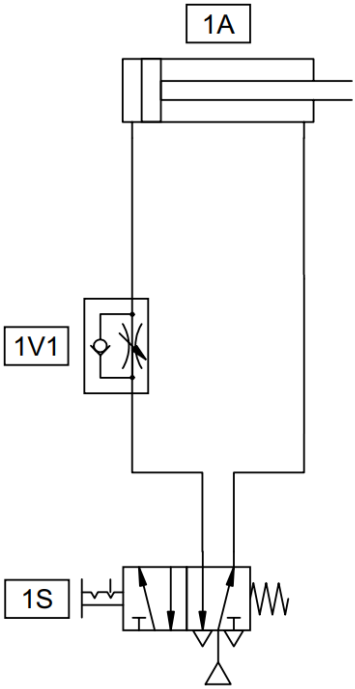
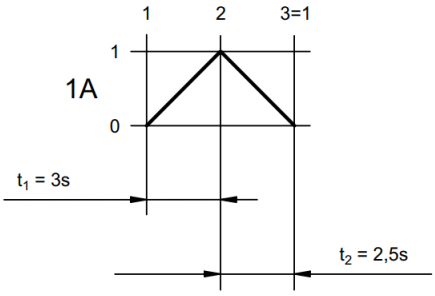


Figure 10: Exercise Illustration

10.3. Pneumatic Circuit Diagram



10.4. Step Diagram



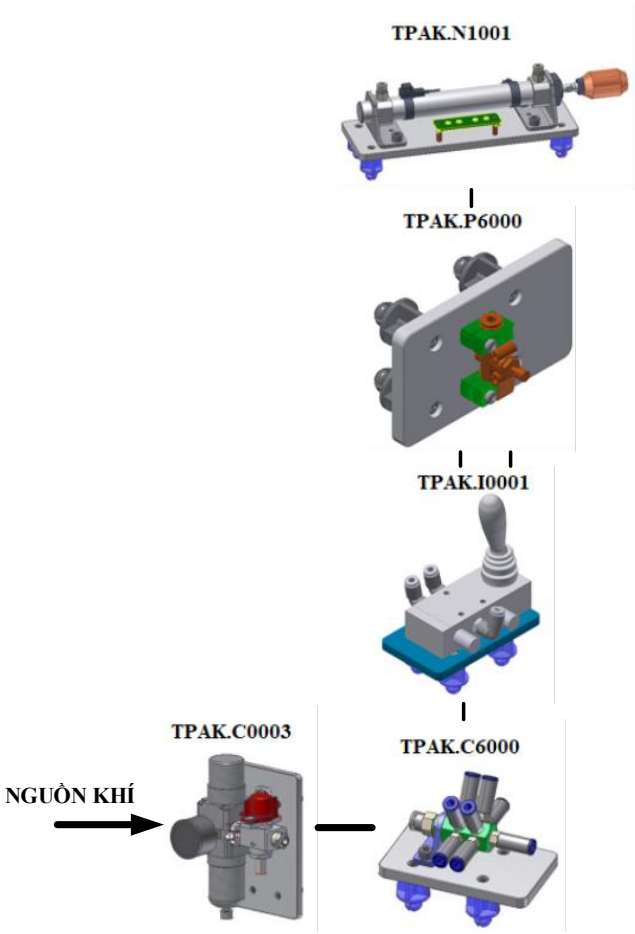
- **Step 1-2:** When valve **1S** is switched state, the 5/2 Solenoid Valve lets air flow through the Throttle Valve **1V1** into the Cylinder, causing the piston to extend to its full stroke. The cylinder speed depends on the Throttle valve, turn the knob on the Throttle valve to set the piston's full stroke time to 3s. The pressure gauge displays the pressure at the in and out ports of the cylinder.

- **Step 2-3:** When the valve **1S** is switched back to its initial state, the 5/2 Solenoid Valve also returns to its initial position, and the air flows into the opposite side of the cylinder, causing the piston to retract. Turn the knob on the Throttle Valve to set the piston's retract time to 2,5s.

10.5. List of devices for the exercise

No.	Device	Device Name	Module Code	Qty
1		**Pneumatic Devices**		
1.1		Filter Regulator with 3/2 Valve	TPAK.C0003	1
1.2		Air Distributor	TPAK.C6000	1
1.3	1S	5/2 Hand Lever Valve	TPAK.I0001	1
1.4	1V1	Double One-way Flow Control Valve	TPAK.I0001	1
1.5	1A	Double Acting Cylinder	TPAK.N1001	1
2		**Auxiliary Materials**		
2.1		Phi 4 Air tube	TU0425BU	7
2.2		Phi 6 Air tube	TU0604BU	1

10.6. Connection Diagram



III. References

Refer to the documents in the document set "**HP.K0010 – BASIC Pneumatic Training Kit**" by following the link or QR code below:

Link:

https://onedrive.live.com/?id=2B9D32B3D76DA171%219990&cid=2B9D32B3D76DA171

QR code:

Manual

ETEK AUTOMATION SOLUTIONS JSC
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PRACTICE MANUAL

BASIC HYDRAULIC TRAINING KIT

Code: *HP.T0010*

Manual

I. General introduction to the module

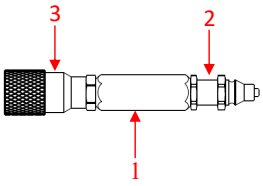
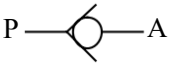
1. One-way valve 0.4 bar

User interface

1.1. Technical specifications

- Hydraulic devices of YUKEN
- Operating pressure range: 0.1– 0.35 MPa
- Maximum operating pressure: 25MPa
- Rated flow: 16L/Min
- Environment: Hydraulic fluid, oil, lubricant

1.2. User manual

Module's figure	Explanation	Symbol
	1. One-way valve 2. Male quick connector 3. Female quick connector	

Instructions

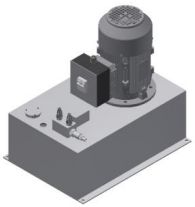
Step 1: Supply liquid to port P
Step 2: Liquid passes through one-way valve
Step 3: Liquid comes out from port A

1.3. Module's functions

Help students understand the operation principle and structure of one-way valves.

2. Hydraulic power module

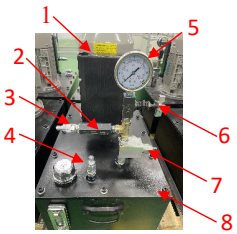
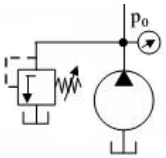
User interface



2.1. Technical specifications

- Operating pressure range: 0-10MPa
- Maximum operating pressure: 22MPa
- Rated flow: 30L/min
- Environment: Hydraulic fluid, oil, lubricant

2.2. User manual

Module's figure	Explanation	Symbol
	1. Single-phase electric motor 2. One-way valve 3. High-pressure line connector (P) 4. Discharge connector to oil tank (T) 5. Pressure gauge 6. Pressure gauge hand lever valve 7. Safety valve 8. Oil tank	

Step 1: Connect the connector (3,4) of the power supply to the hydraulic circuit, supply power to the pump to make the hydraulic circuit work.

2.3. Module's functions

Help students understand the operation principle and structure of one-way valve.

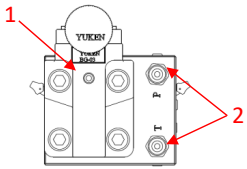
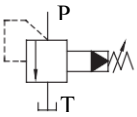
3. Pilot valve

User interface

3.1. Technical specifications

- Operating pressure range: 1.2-25MPa
- Maximum operating pressure: 25MPa
- Rated flow: 100L/min
- Environment: Hydraulic fluid, oil, lubricant

3.2. User manual

Module's figure	Explanation	Symbol
	1. Safety valve 2. Male quick connector	

Instructions

Step 1: Supply liquid to port P while port T is connected to the oil tank.
Step 2: Use the knob to increase or decrease the set pressure.
Step 3: When the pressure is greater than the set pressure, the valve will open and release pressure to port T.

3.3. Module's functions

Help students understand the operation principle and structure of safety valve.

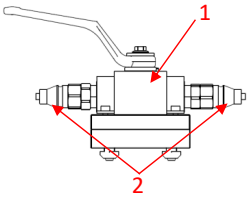
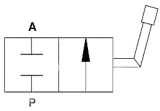
4. 2/2 hand lever valve

User interface

4.1. Technical specifications

- Operating pressure range: 7-21MPa
- Maximum operating pressure: 25MPa
- Rated flow: 35L/min
- Environment: Hydraulic fluid, oil, lubricant

4.2. User manual

Module's figure	Explanation	Symbol
	1. 2/2 hand lever valve 2. Male quick connect	

Instructions

Step 1: In the initial state the valve is closed.
Step 2: Move the lever and supply liquid at the same time, then the liquid goes from port P to port A.

4.3. Module's functions

Used to control cylinders or transfer hydraulic power

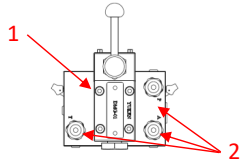
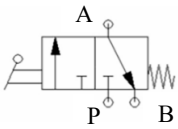
5. 3/2 hand lever valve

User interface

5.1. Technical specifications

- Operating pressure range:7-21MPa
- Maximum operating pressure: 25MPa
- Rated flow: 35L/Min
- Environment: Hydraulic fluid, oil, lubricant

5.2. User manual

Module's figure	Explanation	Symbol
	1. 3/2 hand lever valve 2. Male quick connector	

Instructions

Step 1: In the initial state, port P is blocked, and the exhaust port goes from port A to port B.
Step 2: When the lever is pushed, the liquid flows from port P to port A while port B is blocked.

5.3. Module's functions

Used to control cylinders or transfer hydraulic power

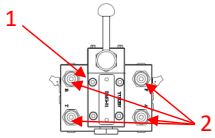
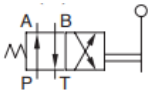
6. 4/2 hand lever valve

User interface

6.1. Technical specifications

- Operating pressure range: 7-21MPa
- Maximum operating pressure: 25MPa
- Rated flow: 35L/Min
- Environment: Hydraulic fluid, oil, lubricant

6.2. User manual

Module's figure	Explanation	Symbol
	1. 4/2 hand lever valve 2. Male quick connector	

Instructions

Step 1: In the initial state, the liquid flows from port P to A and the exhaust port goes from port B to T.
Step 2: When the lever is pushed, the liquid goes from port P to port B and the discharge port goes from port A to T.
Step 3: Push the lever again and the valve returns to its original state due to the spring.

6.3. Module's functions

Used to control cylinders or transfer hydraulic power

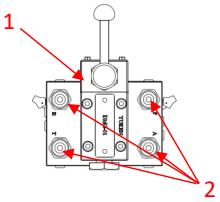
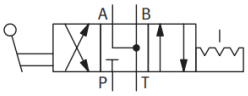
7. 4/3 A, B hand lever valve through T middle position

User interface

7.1. Technical specifications

- Operating pressure range: 7-21MPa
- Maximum operating pressure: 25MPa
- Rated flow: 35L/Min
- Environment: Hydraulic fluid, oil, lubricant

7.2. User manual

Module's figure	Explanation	Symbol
	1. 4/3 hand lever valve 2. Male quick connector	

Instructions

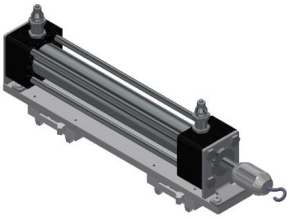
Step 1: In the initial state the valve is closed
Step 2: Move the lever to the right, the liquid goes from port P to port B and the exhaust port goes from port A to T
Step 3: Move the lever to the left, the liquid goes from port P to port A and the exhaust port goes from port B to T
Step 4: Push the lever again and the valve returns to its original state due to the spring.

7.3. Module's functions

Used to control cylinders or transfer hydraulic power

8. Double acting cylinder

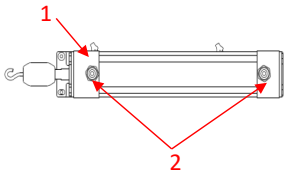
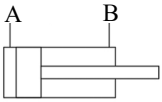
User interface



8.1. Technical specifications

- Diameter: 32mm
- Stroke: 200mm
- Operating pressure: 10MPa
- Maximum pressure: 25MPa

8.2. User manual

Module's figure	Explanation	Symbol
	1. Double acting cylinder 2. Male quick connector	

Instructions

Step 1: When liquid is supplied to port A, the cylinder piston comes out.

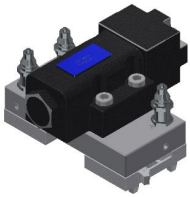
Step 2: When oil is supplied to port B, the cylinder piston enters

8.3. Module's functions

Help students understand the operation principle and structure of double acting cylinder.

9. Controlled one-way valve

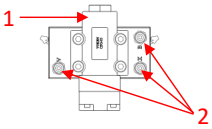
User interface



9.1. Technical specifications

- Operating pressure range: 7-21MPa
- Maximum operating pressure: 25MPa
- Rated flow: 40L/Min
- Environment: Hydraulic fluid, oil, lubricant

9.2. User manual

Module's figure	Explanation	Symbol
	1. Controlled one-way valve 2. Male quick connector	

Instructions

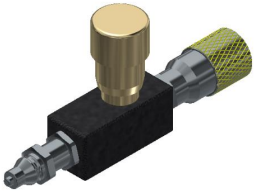
Step 1: When power is supplied to port B, liquid flows from B to A
Step 2: When power is supplied to port A, liquid is blocked from flowing to port B
Step 3: When applying pressure to port X, the valve opens allowing liquid to flow from A to B.

9.3. Module's functions

Help students understand the operation principle and structure of controlled one-way valve

10. One-way flow control valve

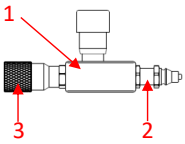
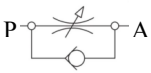
User interface



10.1. Technical specifications

- Operating pressure range: 7-20MPa
- Maximum operating pressure: 25MPa
- Rated flow: 30L/min
- Environment: Hydraulic fluid, oil, lubricant

10.2. User manual

Module's figure	Explanation	Symbol
	1. One-way flow control valve 2. Male quick connector 3. Female quick connector	

Instructions

Step 1: Supply liquid at port P
Step 2: Turn the knob on the Flow control valve to adjust the flow rate of the liquid.
Step 3: Liquid flow out at port A

10.3. Module's functions

Help students understand the operation principle and structure of One-way flow control valve

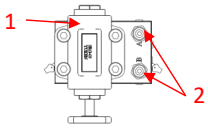
11. Flow control valve (Base Mounted Type)

User interface

11.1. Technical specifications

- Operating pressure range:7-20MPa
- Maximum operating pressure: 25MPa
- Rated flow: 30L/Min
- Environment: Hydraulic fluid, oil, lubricant

11.2. User manual

Module's figure	Explanation	Symbol
	1. Flow control valve 2. Male quick connector	

Instructions

Step 1: Supply liquid at port P

Step 2: Turn the knob on the Flow control valve to adjust the flow rate of fluid through the valve.

11.3. Module's functions

Help students understand the operation principle and structure of Flow control valve

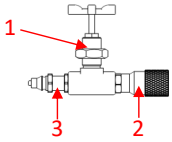
12. Shut-off valve

User interface

12.1. Technical specifications

- Operating pressure range:7-20MPa
- Maximum operating pressure: 25MPa
- Rated flow: 30L/min
- Environment: Hydraulic fluid, oil, lubricant

12.2. User manual

Module's figure	Explanation	Symbol
	1. Shut-of valve 2. Male quick connector 3. Female quick connector	

Instructions

Step 1: Supply liquid supply at port P

Step 2: Turn the lock on the Flow control valve to open and close the valve door.

Step 3: When the valve is open, the flow will go out at port A. When the valve is closed, the flow will be blocked.

12.3. Module's functions

Help students understand the operation principle and structure of shut-off valve

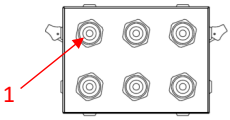
13. Hydraulic distribution module

User interface

13.1. Technical specifications

- Maximum operating pressure: 30MPa
- Environment: Hydraulic fluid, oil, lubricant

13.2. User manual

Module's figure	Explanation	Symbol
	1. Male quick connector	

Instructions

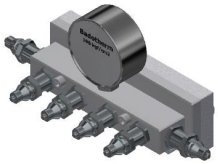
Step 1: Hydraulic distribution with 6 outputs

13.3. Module's functions

Used as oil return collector in hydraulic circuit

14. Hydraulic distribution module with pressure gauge

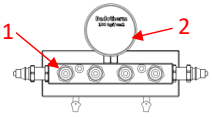
User interface



14.1. Technical specifications

- Inlet: 1 door
- Outlet: 5 doors
- Gauge measuring range: max 100kgf/cm2
- Environment: Hydraulic fluid, oil, lubricant

14.2. User manual

Module's figure	Explanation	Symbol
	1. Male quick connector 2. Hydraulic gauge	

Instructions

Step 1: Hydraulic distribution with 4 outputs

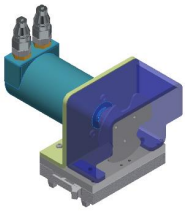
Step 2: Measure and display liquid pressure by needle on hydraulic gauge

14.3. Module's functions

Help students understand the operation principle and structure of hydraulic distribution module

15. Hydraulic motor

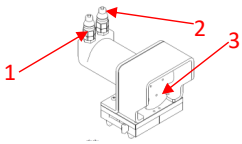
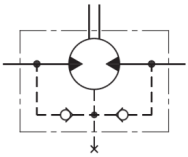
User interface

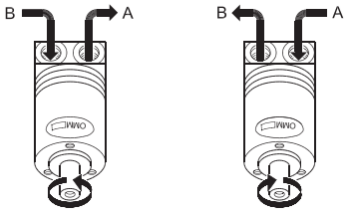


15.1. Technical specifications

- Max speed: 630 rpm
- Min speed: 30 rpm
- Max torque: 40 Nm
- Max output power: 2.4 KW
- Max oil flow: 20L/min
- Max starting pressure: 4 bar
- Environment: Hydraulic fluid, oil, lubricant

15.2. User manual

Module's figure	Explanation	Symbol
	1. Port A of motor 2. Port B of motor 3. Motor rotation disc	



15.3. Module's functions

Generates large rotational motion and torque

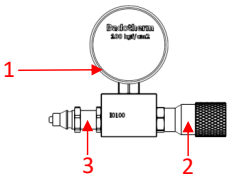
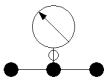
16. Pressure gauge module

User interface

16.1. Technical specifications

- Maximum operating pressure: 30MPa
- Environment: Hydraulic fluid, oil, lubricant

16.2. User manual

Module's figure	Explanation	Symbol
	1. Hydraulic gauge 2. Male quick connector 3. Female quick connector	

Instructions

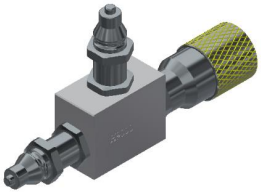
Step 1: Measure and display liquid pressure with needle

16.3. Module's functions

Pressure measurement at survey points

17. T-connector module

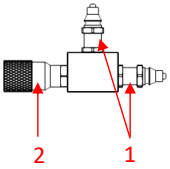
User interface



17.1. Technical specifications

- Maximum operating pressure: 30MPa
- Usage: Hydraulic fluid, oil, lubricant

17.2. User manual

Module's figure	Explanation	Symbol
	1. Male quick connector 2. Female quick connector	

Instructions

Step 1: Plug female quick connector into male quick connector on modules

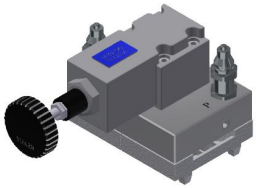
Step 2: Use hydraulic hose to connect 2 male quick connectors

17.3. Module's functions

Hydraulic power sharing

18. Pressure relief valve

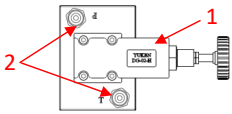
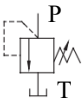
User interface



18.1. Technical specifications

- Hydraulic devices of YUKEN
- Operating pressure range: 5-18MPa
- Maximum operating pressure: 21MPa
- Rated flow: 16L/Min
- Environment: Hydraulic fluid, oil, lubricant

18.2. User manual

Module's figure	Explanation	Symbol
	1. Pressure relief valve 2. Male quick connector	

Pressure relief valve

Step 1: Supply liquid at port P, liquid flow out of port T

Step 2: Use the knob to increase or decrease the liquid pressure.

18.3. Module's functions

Help students understand the operation principle and structure of Pressure relief valve

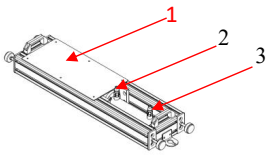
19. Load module

User interface

19.1. Technical specifications

- Operating pressure range: 7-21MPa
- Maximum operating pressure: 25MPa
- Rated flow: 35L/Min
- Usage: Hydraulic fluid, oil, lubricant

19.2. User manual

Module's figure	Explanation	Symbol
	1. Port A of double cylinder 2. Port B of double cylinder 3. 9kg load connect with double cylinder	

Step 1: When liquid is supplied to port A, the cylinder piston comes out with a 9kg load.

Step 2: When oil is supplied to port B, the cylinder piston enters with a 9kg load.

19.3. Module's functions

Create heavy loads to practice lifting and lowering loads

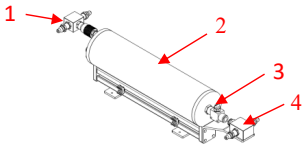
20. Hydraulic meter

User interface

20.1. Technical specifications

- 2-liter capacity container, with graduations
- Environment: Hydraulic fluid, oil, lubricant

20.2. User manual

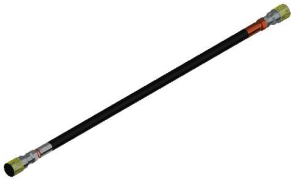
Module's figure	Explanation	Symbol
	1. Hydraulic oil supply port 2. Tank body 3. Shut-off valve 4. Drain port	

20.3. Module's functions

Measure the amount of oil in the tank

21. Hydraulic hose module 600

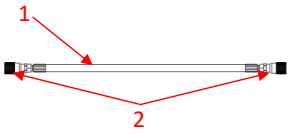
User interface



21.1. Technical specifications

- Specialized hydraulic hose, 2 ends are fitted with quick connectors.
- Usage: Hydraulic fluid, oil, lubricant
- Length: 600 mm
-

21.2. User manual

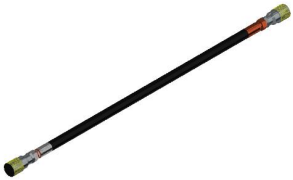
Module's figure	Explanation	Symbol
	1. Hydraulic hose 2. Female quick connector	

21.3. Module's functions

Connecting elements in hydraulic systems

22. Hydraulic hose module 1000

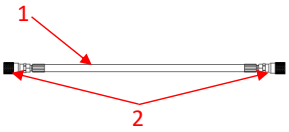
User interface



22.1. Technical specifications

- Hydraulic devices of YUKEN
- Specialized hydraulic hose, 2 ends are fitted with quick connectors.
- Environment: Hydraulic fluid, oil, lubricant
- Length:1000 mm

22.2. User manual

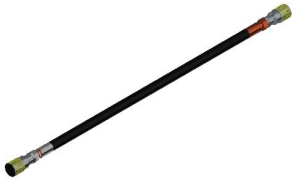
Module's figure	Explanation	Symbol
	3. Hydraulic hose 4. Female quick connector	

22.3. Module's functions

Connecting elements in hydraulic systems

23. Hydraulic hose module 1500

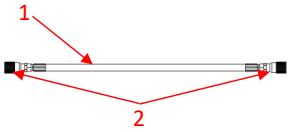
User interface



23.1. Technical specifications

- Specialized hydraulic hose, 2 ends are fitted with quick connectors.
- Environment: Hydraulic fluid, oil, lubricant
- Length: 1000 mm

23.2. User manual

Module's figure	Explanation	Symbol
	5. Hydraulic hose 6. Female quick connector	

23.3. Module's functions

Connecting elements in hydraulic systems

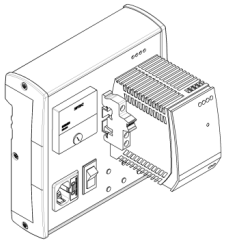
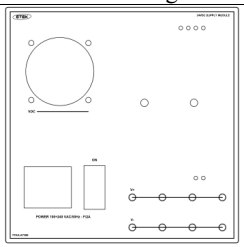
24. 24VDC power module

User interface

24.1. Technical specifications

- Input voltage: 100 - 240 VAC
- Output voltage: 24VDC/4.2A
- Power: 100 W
- Short circuit protection, LED display

24.2. User manual

Module's figure	Schematic diagram
	

Instructions

Step 1: Plug the power cord into a 3-prong outlet to supply 220 VAC – 50Hz power.

Step 2: Turn on the switch to supply 220VAC power to Phoenix Contact power supply.

Step 3: Take 24VDC voltage at +V plug, and 0VDC at -V plug

24.3. Module's functions

Used to supply 24VDC power to devices in the system.

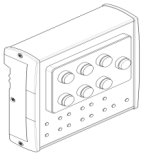
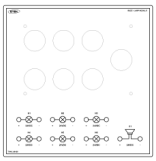
25. Indicator display

User interface

25.1. Technical specifications

- 02 blue 24VDC indicator lights
- 02 red 24VDC indicator lights
- 02 yellow 24VDC indicator lights
- 01 buzzer
- Can be used to display and distribute 24VDC power
- Power supply: 24VDC

25.2. User manual

Module's figure	Schematic diagram
	

Instructions

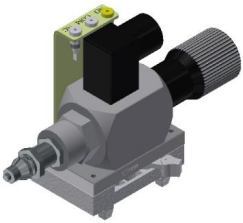
Step 1: When supply 24VDC to the red M2 plug and 0VDC to the green M2 plug of the light or buzzer, the light will turn on and the buzzer will make a sound.
Step 2: Plug the +V plug into the 24VDC source and the -V plug into the 0VDC source of the DC power supply. Then can get power from the M2 plug for other modules.

25.3. Module's functions

Used to warn of the status of modules in the electrical system by lights and buzzers.

26. Pressure switch

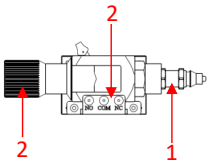
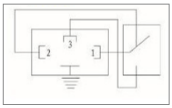
User interface



26.1. Technical specifications

- Operating pressure range: 0.6-4MPa
- Maximum operating pressure: 15MPa
- Usage: Hydraulic fluid, oil, lubricant

26.2. User manual

Module's figure	Explanation	Symbol
	1. Hydraulic plug 2. Output relay contact plug 3. Protective pressure setting knob	

Instructions

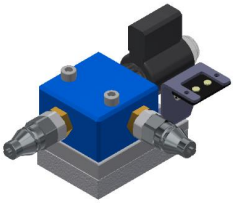
Step 1: Hydraulic head 1 is plugged into the pressure point to be protected on the system.
Step 2: Turn knob 3 to set the protection pressure for the system.
Step 3: Plug 2 connects to the valve or devices to disconnect the system (when the pressure on the system is greater than the pressure set on the knob, the 2 NC contacts on the pressure switch open to cut off the power supply to the valve, protecting the system)

26.3. Module's functions

Help students understand the operation principle and structure of pressure switch.

27. 2/2 single solenoid valve

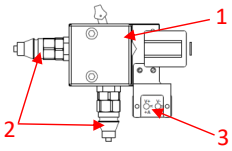
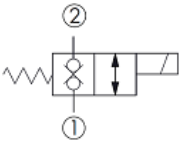
User interface



27.1. Technical specifications

- Maximum operating pressure: 35MPa
- Rated flow: 30L/Min
- Environment: Hydraulic fluid, oil, lubricant

27.2. User manual

Module's figure	Explanation	Symbol
	1. 2/2 Solenoid Valve 2. Male quick connector 3. 2-plug M2 connector	

Instructions

Step 1: Supply liquid at port 2, liquid goes from port 2 to port 1

Step 2: When the coil is energized, the liquid flowing from port 2 to port 1 is blocked.

Step 3: Disconnect the valve coil power and return it to its original state.

27.3. Module's functions

Used to control cylinders or transfer hydraulic power

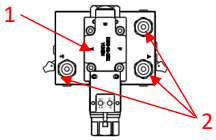
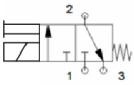
28. 3/2 single solenoid valve

User interface

28.1. Technical specifications

- Operating pressure range: 0.6-4MPa
- Maximum operating pressure: 35MPa
- Rated flow: 100L/Min
- Environment: Hydraulic fluid, oil, lubricant

28.2. User manual

Module's figure	Explanation	Symbol
	1. 3/2 solenoid valve 2. Male quick connector	

Instructions

Step 1: In the initial state, liquid supply at port P, the liquid flows from port P to A and the exhaust port goes from B to T.

Step 2: When the suction coil is energized, the liquid flows from port P to port B and the exhaust port flows from A to T.

Step 3: Disconnect the power supply and the valve coil returns to its original state due to the spring.

28.3. Module's functions

Used to control cylinders or transfer hydraulic power

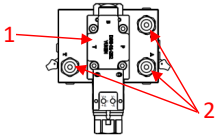
29. 4/2 single solenoid valve

User interface

29.1. Technical specifications

- Operating pressure range: 0-1.1MPa
- Maximum operating pressure: 35MPa
- Rated flow: 100L/Min
- Environment: Hydraulic fluid, oil, lubricant

29.2. User manual

Module's figure	Explanation	Symbol
	1. 4/2 solenoid valve 2. Male quick connector	

Instructions

Step 1: In the initial state, liquid supply at port P, the liquid flows from port P to A and the exhaust port goes from B to T.

Step 2: When the suction coil is energized, the liquid flows from port P to port B and the exhaust port flows from A to T.

Step 3: Disconnect the power supply and the valve coil returns to its original state due to the spring.

29.3. Module's functions

Used to control cylinders or transfer hydraulic power

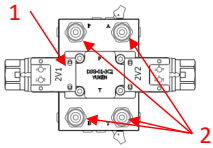
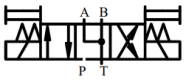
30. 4/3 T solenoid valve with relieving mid-position AB

User interface

30.1. Technical specifications

- Operating pressure range: 0.6-4MPa
- Maximum operating pressure: 35MPa
- Rated flow: 100L/Min
- Environment: Hydraulic fluid, oil, lubricant

30.2. User manual

Module's figure	Explanation	Symbol
	1. 4/3 solenoid valve 2. Male quick connector	

Instructions

Step 1: In the initial state, the valve is closed, the exhaust goes from port A to T and port B to T.
Step 2: Power supply to 2V1 suction coil, liquid goes from port P to A and exhaust port goes from B to T
Step 3: Supply power to 2V2 suction coil, liquid goes from port P to B and the exhaust port goes from A to T
Step 4: Disconnect the valve coil power and return it to its original state.

30.3. Module's functions

Used to control cylinders or transfer hydraulic power

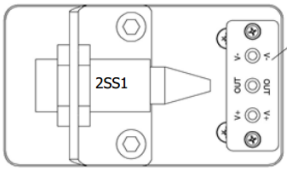
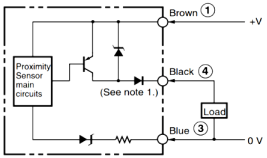
31. Magnetic proximity sensor module

User interface

31.1. Technical specifications

- Operating voltage: 12- 24VDC
- Detection distance: 8 mm ± 10%
- Adjustment distance: 0 - 6.4 mm
- Maximum impact frequency: 500Hz
- Output contact: NO, PNP
- Maximum output current: 200mA
- Consumption current: 10mA
-

31.2. User manual

Module's figure	Symbol
	

Instructions

Step 1: Supply 24VDC to plug V (+), pin 0VDC to plug V (-) of the sensor

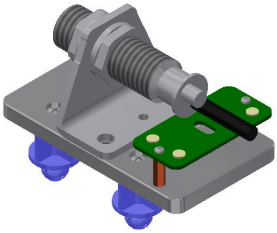
Step 2: When a magnetic object passes through the sensor, the red light on the sensor will appear and the sensor will output a 24VDC voltage signal at the OUT plug.

31.3. Module's functions

Help students understand the operation principle and structure of magnetic proximity sensor

32. Capacitive proximity sensor

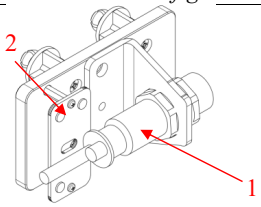
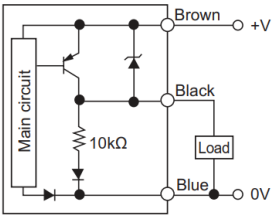
User interface



32.1. Technical specifications

- Power supply: 12-24VDC
- Detection distance: 8mm
- Current consumption: <15mA
- Response frequency: 50Hz
- Output current: max 200mA

32.2. User manual

Module's figure	*Explanation*	*Symbol*
	1- Capacitive sensor 2- Signal sensors plug	

Instructions

Step 1: Supply 24VDC power to (+V, 0V) plug. OUT plug, black wire connects to control devices, bring the object to be detected near the sensor head, the sensor output is activated.

32.3. Module's functions

Learn the principles and structure of sensors, practice connecting and using capacitive proximity sensors

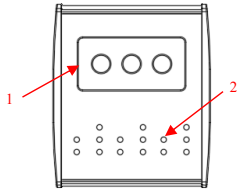
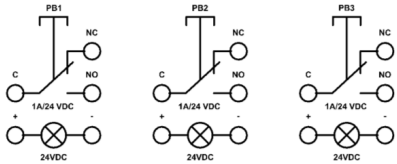
33. Set of 3 push buttons

User interface

33.1. Technical specifications

- Power supply: 24VDC
- 03 input buttons
- Maximum load current through contact: 1A

33.2. User manual

Module's figure		*Symbol*
	1. Push Button 2. Connector to push button 1 type Jack M2	

With non-retained push button: when pressing the push button, the NC contact opens and the NO contact closes and remains in that state until the hand is released from the push button, then the push button returns to its original position.

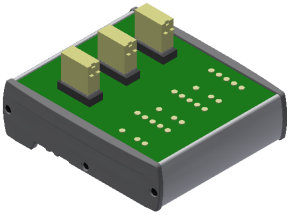
With the indicator light on the push button connecting the + plug to the 24VDC source and the - plug to the 0VDC source of the DC power light supply

33.1. Module's functions

Used to generate input signals for the system using electric push buttons.

34. Set of 3 Relays

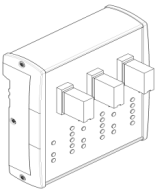
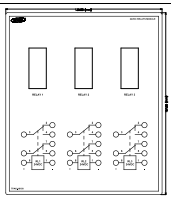
User interface



34.1. Technical specifications

- Coil voltage: 24VDC
- 03 relays, each relay has 2 pairs of contacts.
- Total load capacity: 90W
- Action time: 15ms
- Contact release time: 10ms
-

34.2. User manual

Module's figure	Symbol
	

Instructions

Step 1: Supply 24VDC to the (+) plug and 0VDC to the (-) plug of each relay.

Step 2: When the relay is energized, the NC contacts open and the NO contacts close and remain in the same state until the relay is de-energized, then the relay contacts return to their original position.

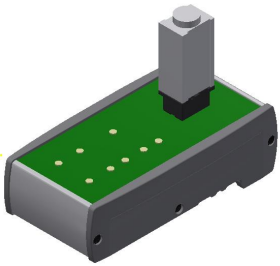
Step 3: Plug the +V plug into the 24VDC source and the -V plug into the 0VDC source of the DC power supply. Then you can get power from the M2 plugs for other modules.

34.3. Module's functions

Used to connect control signals to other executive modules in the system.

35. ON time relay

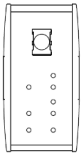
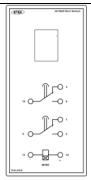
User interface



35.1. Technical specifications

- Power supply: 24 VDC
- Function: On Delay
- Time: 2-60s
- Maximum load current: 5A
-

35.2. User manual

Module's figure	Symbol
	

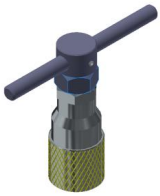
Supply 24VDC to the (+) plug and 0VDC to the (-) plug of the relay. Set the required time by turning the knob on the timer. After the set time, the NC contact opens and the NO contact closes.

35.3. Module's functions

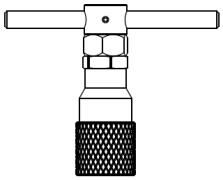
Used to practice switching and controlling other modules using ON time relay.

36. Excess pressure relief tool

User interface



36.1. User manual

Module's figure	Symbol
	

Connect to the quick connector that needs to release pressure. Turn the handle clockwise to release pressure.

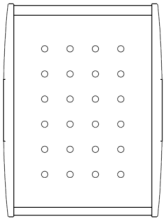
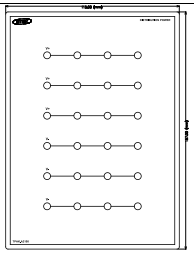
37. Power distribution board

User interface

37.1. Technical specifications

- Origin: Vietnam
- Can be used to connect complex circuits through a power splitter to multiple M2 plugs.

37.2. User manual

Module's figure	Symbol
	

Instructions

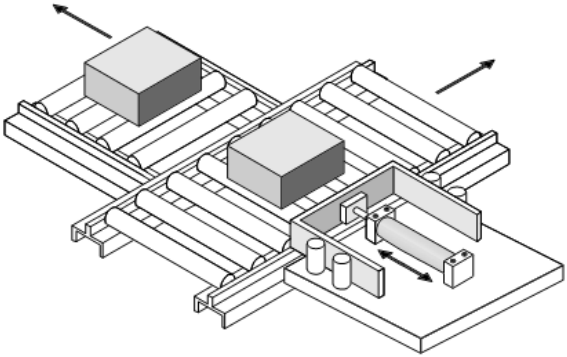
Step 1: Plug the +V plug into the 24VDC source and the -V lug into the 0VDC source of the DC power supply. Then you can get power from the M2 plugs for other modules.

37.3. Module's functions

Used to distribute 24VDC power to other modules in the system.

II. Practice exercises

1. Practice with Sorting Mechanism



1.1. Objectives and requirements

- Objectives:
  + Understanding of manually operated, direct acting circuits
  + Double-acting cylinder control using 4/2 solenoid valve
  + Name the most important elements of a double acting cylinder
  + Name the most important elements of the 4/2 solenoid valve
  + Understanding of using devices to input electrical signals
  + Select the necessary elements
  + Develop and draw circuit diagrams and hydraulics
  + Understand possible options for mounting elements on grooved aluminum panels
  + Install the elements on the support frame
  + Working with hydraulic hoses
  + Connect the electrical test line in accordance with the diagram
  + Put the control circuit into operation
- Requirements:
  + Practice sorting mechanism

1.2. Operating principle of the exercise

Sorting mechanism is used to classify heavy steel parts. When the START button is pressed, the double acting cylinder's piston rod pushes the adjacent part off the conveyor belt. When the START button is released, the piston rod returns to the fully retracted position.

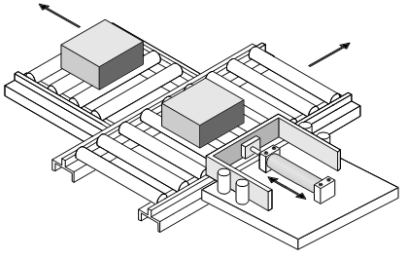
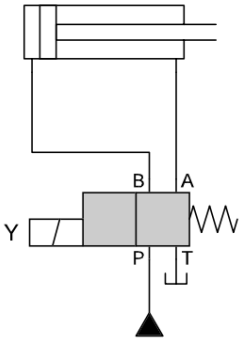


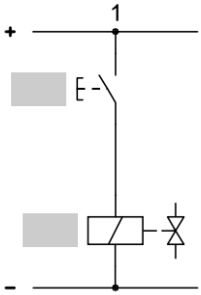
Figure 1: Simulation diagram

1.3. Exercises

❖ *Hydraulic circuit diagram*

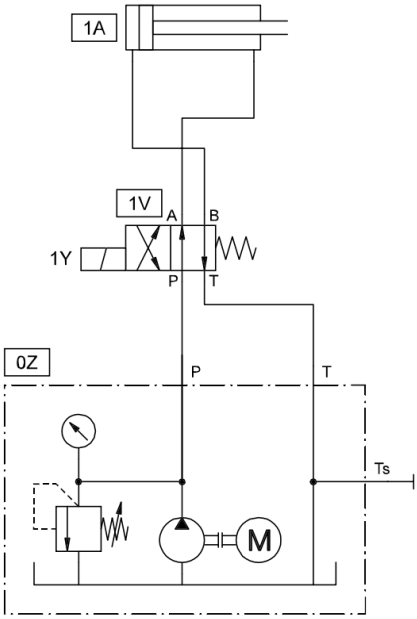


❖ *Circuit diagram*

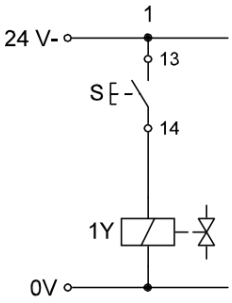


1.4. Exercise answer keys

1.4.1. Hydraulic circuit diagram



1.4.2. Circuit diagram



1.4.3. List of modules in the exercise

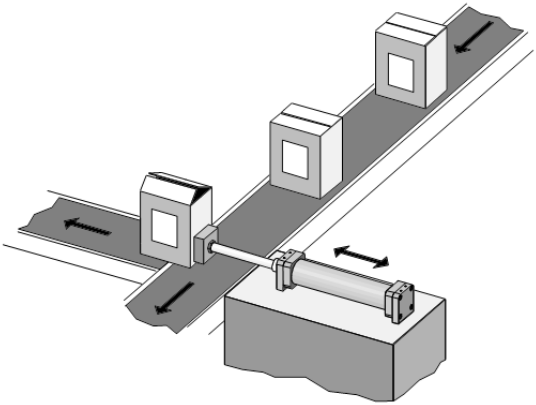
No.	Devices	Name of devices	Module's code	Quantity
1		**Hydraulic devices**		
1.1	0Z	Hydraulic power unit	TPAT.A1020	1
1.2	1V	4/2 Solenoid valve	TPAT.E0100	1
1.3	1A	Double acting cylinder	TPAT.F0100	1
1.4		600mm hydraulic hose	TPAT.A4000	4
1.5		1000mm hydraulic hose	TPAT.A4100	2
2		**Electrical supplies**		
2.1		DC power module	TPAK.A2100	1
2.2		Set of 3 relays	TPAK.A9100	1
2.3		Set of 3 push buttons	TPAK.A3200	1
3		**Additional supplies**		
3.1		Hydraulic oil distributor with pressure gauge	TPAT.A3100	1
3.2		Hydraulic oil distributor (P1, P2, T)	TPAT.A3000	1
3.3		Excess pressure release tool	TPAT.A5000	1
3.4		Safety jack set		1

1.4.4. Operating principle of circuit

When the S (START) push button is pressed, the circuit for the Y coil closes and the 4/2 solenoid valve reverses. The piston rod of the double-acting cylinder advances to the front end position.

When the START push button is released, the circuit for the Y coil is interrupted and the 4/2 solenoid valve returns to its start position. The cylinder piston rod returns to the fully retracted position.

2. Practice with Element Selection Mechanism on Conveyor



2.1. Objectives and requirements

- Objectives:
  + Understanding of manual, indirect action circuits
  + Understand the operating modes of flow control valves and one-way flow control valves
  + Understand the operating modes of pressure reducing valves
  + Understanding of using display and power distribution units
  + Understanding of using 3-block relays
  + Understand the function of relays
  + Understanding of contact identification
  + Select the necessary elements
  + Develop hydraulic and electrical circuit diagrams
  + Assemble the control circuit on a slotted aluminum board
  + Put the control circuit into operation
  + Calibrate the one-way flow control valve
  + Adjust cylinder movement time
- Requirements:
  + Install the element selection mechanism on the conveyor

2.2. Operating principle of the exercise

Double acting cylinders are used to push unsealed cartons from one conveyor belt to another. The cylinder's forward stroke is controlled manually. The forward stroke speed is adjustable, while the retract speed is fixed. Pressure can be measured at the cylinder inlet and the directional control valve.

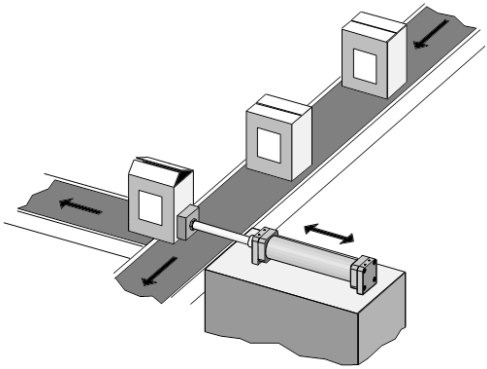
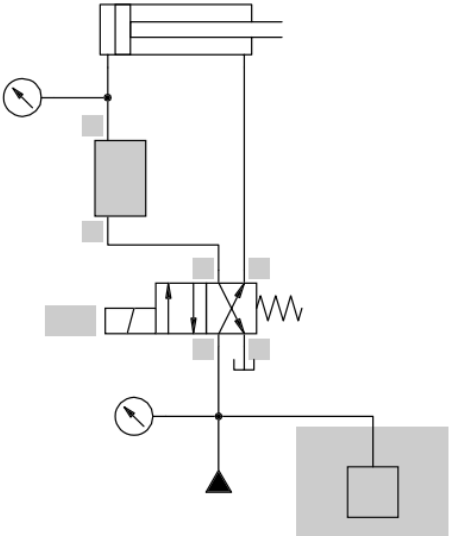


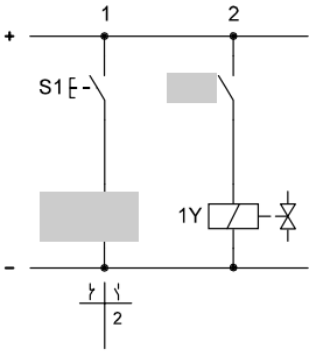
Figure 2: Simulation diagram

2.3. Exercises

❖ *Hydraulic circuit diagram*

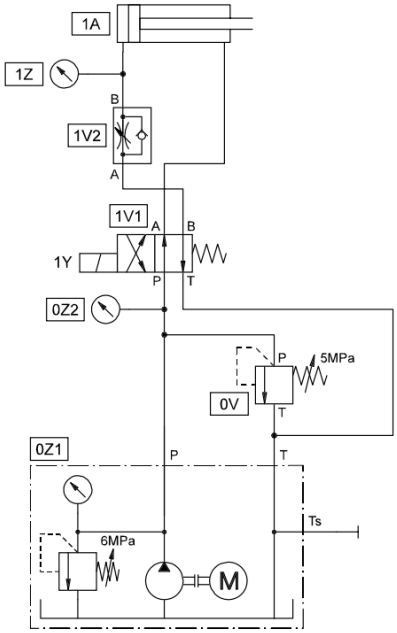


❖ *Circuit diagram*

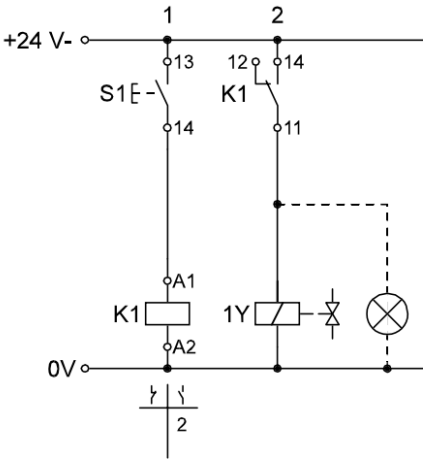


2.4. Exercise answer keys

2.4.1. Hydraulic circuit diagram



2.4.2. Circuit diagram



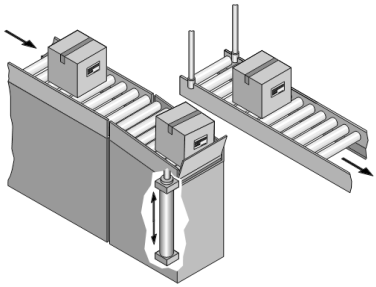
2.4.3. List of modules in the exercise

No.	Devices	Name of devices	Module's code	Quantity
1		**Hydraulic devices**		
1.1	0Z1	Hydraulic power unit	TPAT.A1020	1
1.2	0Z2,1Z	Pressure gauge	TPAT.I0100	2
1.3	0V	Pressure relief valve	TPAT.H4000	1
1.4	1V1	4/2 Solenoid valve	TPAT.E0100	1
1.5	1V2	One-way flow control valve	TPAT.H7000	1
1.6	1A	Double acting cylinder	TPAT.F0100	1
1.7		600mm hydraulic hose	TPAT.A4000	5
1.8		1000mm hydraulic hose	TPAT.A4100	3
2		**Electrical supplies**		
2.1		DC power module	TPAK.A2100	1
2.2		Set of 3 relays	TPAK.A9100	1
2.3		Set of 3 push buttons	TPAK.A3200	1
2.4		Indicator display unit	TPAK.A8100	1
3		**Additional supplies**		
3.1		Hydraulic oil distributor with pressure gauge	TPAT.A3100	1
3.2		Hydraulic oil distributor (P1, P2, T)	TPAT.A3000	1
3.3		Excess pressure release tool	TPAT.A5000	1
3.4		Safety jack set		1

2.4.4. Operating principle of electro-pneumatic circuit

When START push button S1 is pressed, relay K1 is energized. Normally open contact K1 supplies power to the 1Y solenoid and the 4/2 reversing solenoid valve. That causes the cylinder's piston rod to move forward. As soon as the START S1 push button is released, the piston rod retracts again. The piston rod does not stop near the conveyor belt if S1 is not pressed. Use a one-way flow control valve to adjust the output speed.

3. Practice with Lifting Mechanism



3.1. Objectives and requirements

- Objectives:
  + Understand how to use the 4/2 solenoid valve to act on a single acting cylinder
  + Prove that the 4/2 valve can be used as a 3/2 or 2/2 valve
  + Understand the difference between normally open and normally closed positions
  + Develop and draw hydraulic and electrical circuit diagrams
  + Assemble the control circuit on a grooved aluminum plate
  + Operating load of 9 kg
  + Put the control circuit into operation
  + Understand the effects of compressive loading
- Requirements:
  + Install the lift station circuit

3.2. Operating principle of the exercise

Wooden crates arriving on the conveyor must be lifted high to the packaging conveyor using a lifting table. The lifting table is raised and lowered by a single-acting hydraulic cylinder. The forward stroke is adjustable, while the incoming piston stroke is not adjusted and is governed by the load of the lifting table. Pressure must be measured at the cylinder inlet and directional control valve.

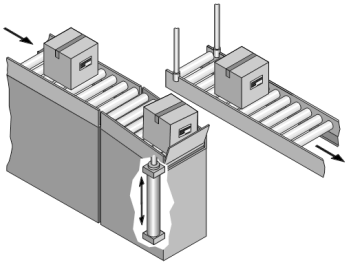
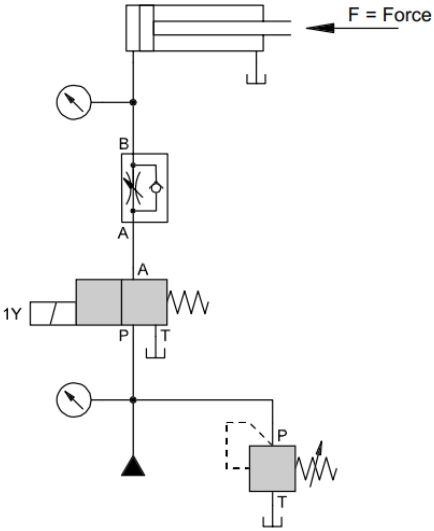


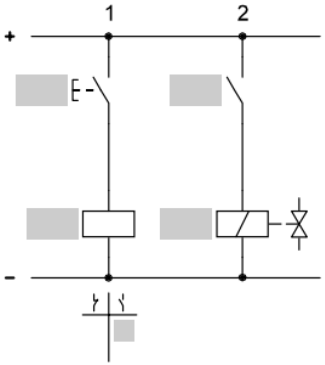
Figure 3: Simulation diagram

3.3. Exercises

❖ *Hydraulic circuit diagram*

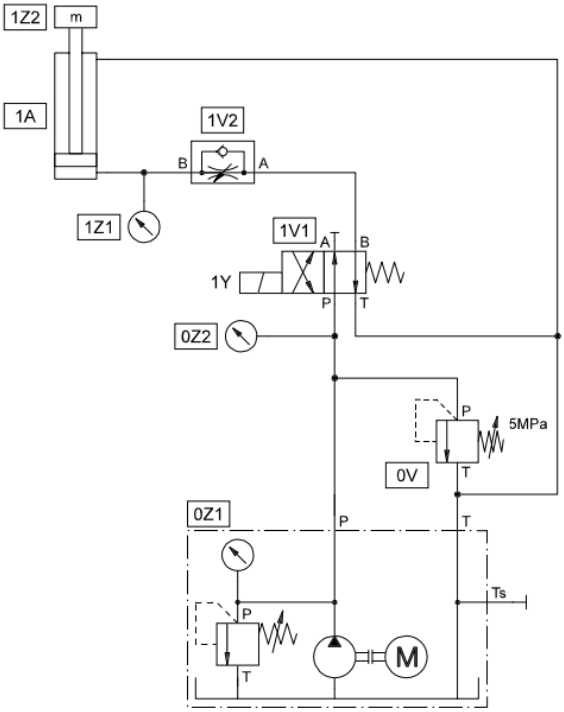


❖ *Circuit diagram*

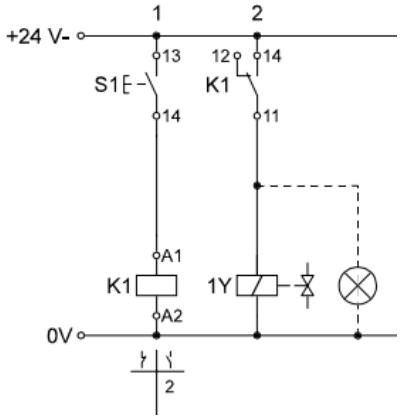


3.4. Exercise answer keys

3.4.1. Hydraulic circuit diagram



3.4.2. Circuit diagram



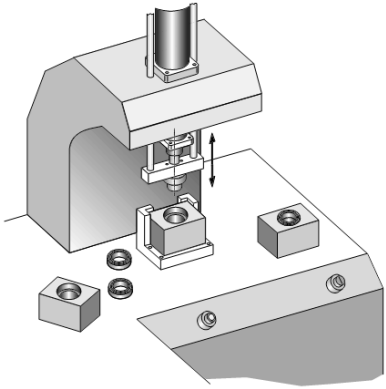
3.4.3. List of modules in the exercise

No.	Devices	Name of devices	Module's code	Quantity
1		**Hydraulic devices**		
1.1	0Z1	Hydraulic power unit	TPAT.A1020	1
1.2	0Z2, 1Z1	Pressure gauge	TPAT.I0100	2
1.3	0V	Pressure relief valve	TPAT.H4000	1
1.4	1V1	4/2 Solenoid valve	TPAT.E0100	1
1.5	1V2	One-way flow control valve	TPAT.H7000	1
1.6	1A	Double acting cylinder	TPAT.F0100	1
1.7	m	Load 9kg		1
1.8		600mm hydraulic hose	TPAT.A4000	4
1.9		1000mm hydraulic hose	TPAT.A4100	4
2		**Electrical supplies**		
2.1		DC power module	TPAK.A2100	1
2.2		Set of 3 relays	TPAK.A9100	1
2.3		Set of 3 push buttons	TPAK.A3200	1
2.4		Indicator display unit	TPAK.A8100	1
3		**Additional supplies**		
3.1		Hydraulic oil distributor with pressure gauge	TPAT.A3100	1
3.2		Hydraulic oil distributor (P1, P2, T)	TPAT.A3000	1
3.3		Excess pressure release tool	TPAT.A5000	1
3.4		Safety jack set		1

3.4.4. Operating principle of electro-pneumatic circuit

When the START push button (S1) is pressed, relay K1 is energized. Normally open contact K1 supplies power to the solenoid coil 1Y of solenoid valve 3/2. The piston rod now advances. When push button S1 is released, the circuit with K1 and 1Y is interrupted, the valve closes by spring force and the piston rod retracts due to load. The exit speed can be adjusted using a one-way flow control valve.

4. Practice with Details Installation Mechanism



4.1. Objectives and requirements

- Objectives:
  + Understand the structure of functional diagrams
  + Read and understand functional diagrams
  + Use pressure switch
  + Understand self-maintaining electrical circuits
  + Select the necessary elements
  + Develop and draw hydraulic and electrical circuit diagrams
  + Assemble the control circuit on a grooved aluminum plate
  + Put the control circuit into operation
  + Compile a list of elements
  + Set pressure values
  + Complete the practice sheet
- Requirements:
  + Install the detailed assembly press equipment circuit

4.2. Operating principle of the exercise

A pressing device is used to assemble the parts. If the preset pressure is exceeded (e.g. parts are not aligned correctly), the piston rod must be retracted for safety reasons. After performing the correct pressing and mounting process, the piston entry stroke must be started when the preset pressure value on the pressure switch of 3 MPa (30 bar) is reached. The one-way flow control valve is installed on the cylinder's power supply line. Describe the precise moment after the circuit is turned on at which the pressure switch is activated if pressure is measured on the inlet side of the throttle.

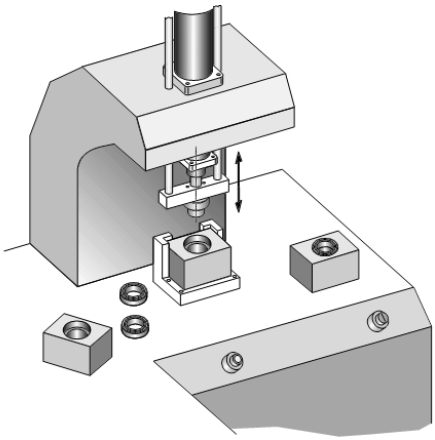
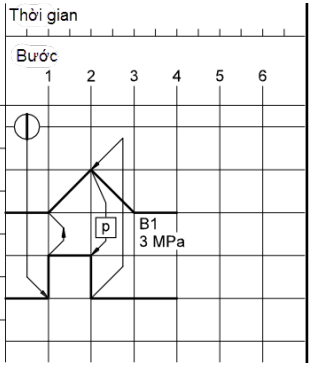


Figure 4: Simulation diagram

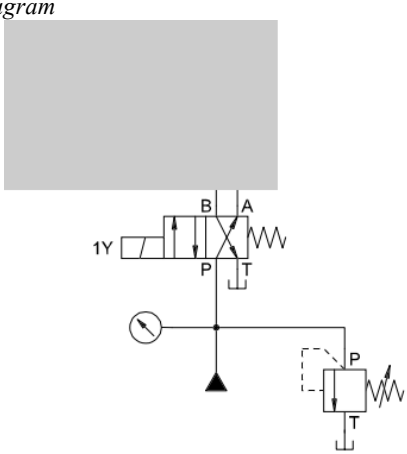
4.3. Step diagram

Phần tử	Kí hiệu	Tín hiệu
Nút nhấn	S1	ON
Xi lanh		2
		1
Van điện từ 4/2	1Y	a
		b

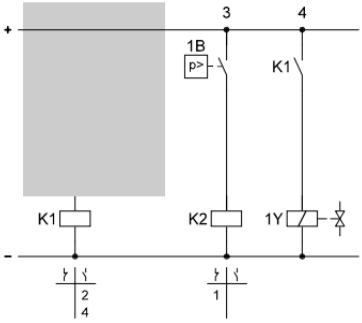


4.4. Exercises

❖ *Hydraulic circuit diagram*

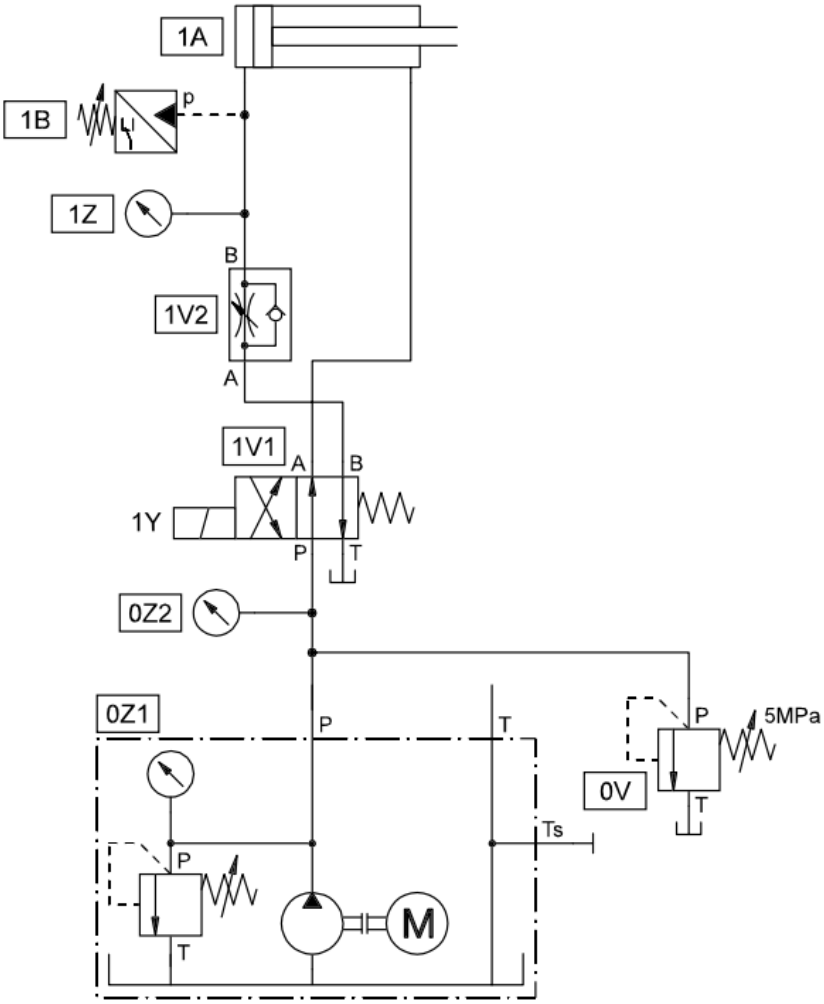


❖ *Circuit diagram*

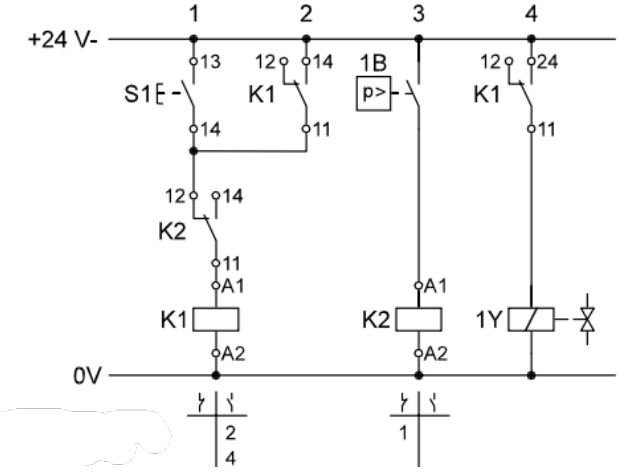


4.5. Exercise answer keys

4.5.1. Hydraulic circuit diagram



4.5.2. Circuit diagram



4.5.3. List of modules in the exercise

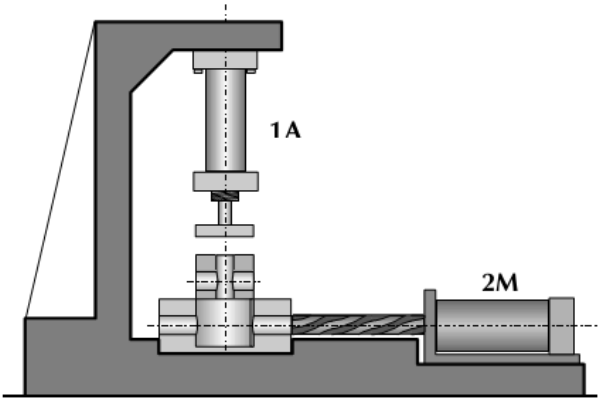
No.	Devices	Name of devices	Module's code	Quantity
1		**Hydraulic devices**		
1.1	0Z1	Hydraulic power unit	TPAT.A1020	1
1.2	0Z2,1Z	Pressure gauge	TPAT.I0100	2
1.3	0V	Pressure relief valve	TPAT.H4000	1
1.4	1V1	4/2 Solenoid valve	TPAT.E0100	1
1.5	1V2	One-way flow control valve	TPAT.H7000	1
1.6	1A	Double acting cylinder	TPAT.F0100	1
1.7	1B	Pressure switch	TPAT.C3000	1
1.8		600mm hydraulic hose	TPAT.A4000	4
1.9		1000mm hydraulic hose	TPAT.A4100	4
2		**Electrical supplies**		
2.1		DC power module	TPAK.A2100	1
2.2		Set of 3 relays	TPAK.A9100	1
2.3		Set of 3 push buttons	TPAK.A3200	1
2.4		Indicator display unit	TPAK.A8100	1
3		**Additional supplies**		
3.1		Hydraulic oil distributor with pressure gauge	TPAT.A3100	1
3.2		Hydraulic oil distributor (P1, P2, T)	TPAT.A3000	1
3.3		Excess pressure release tool	TPAT.A5000	1
3.4		Safety jack set		1

4.5.4. Operating principle of electro-pneumatic circuit

When the START push button (S1) is pressed, relay K1 is energized; The first normally open contact K1 maintains the power supply to relay K1. At the same time, the circuit for solenoid 1Y is closed through the next contact of K1. Valve 4/2 reverses and the piston rod advances until the preset pressure on pressure switch 1B is reached. The pressure switch acting through K2 clears the self-maintaining circuit of K1. It also breaks the circuit for coil 1Y. The 4/2 solenoid valve reverses by spring force and the piston rod returns to the starting position.

Install the pressure sensor above the one-way flow control valve. If the exit speed is controlled by a flow control valve, which exhibits very high resistance, when the circuit is turned on, the pressure in front of the valve increases to more than 30 bar. As a result, the pressure switch initiates its return stroke before reaching the correct assembly pressure. Pressure therefore must be measured directly in front of the cylinder's power supply port.

5. Practice with Assembly Devices



5.1. Objectives and requirements

- Objectives:
  + Design functional diagrams by independent work of students
  + Use 4/2 solenoid valve to act on the hydraulic motor
  + Assemble a pressure dependent sequential control system with 2 actuators
  + Select the necessary elements
  + Develop and draw hydraulic and electrical circuit diagrams
  + Assemble the control circuit on a grooved aluminum plate
  + Put the control circuit into operation
  + Compile a list of elements
  + Set pressure values

- Requirements:
  + Install the assembly device

5.2. Operating principle of the exercise

An assembly device is used to squeeze a plastic brush into the steel part. A screw is then screwed in to secure the connection.

When the START S1 push button is pressed, the 1A vertical double-acting pressing cylinder presses the plastic brush into the steel part. When the pressure in the piston chamber of the press cylinder reaches 4.5 MPa (45 bar), the 3M horizontal hydraulic motor turns the fine threaded screw with left pitch.

When RETURN button S2 is pressed, press cylinder 1A retracts and motor M stops.

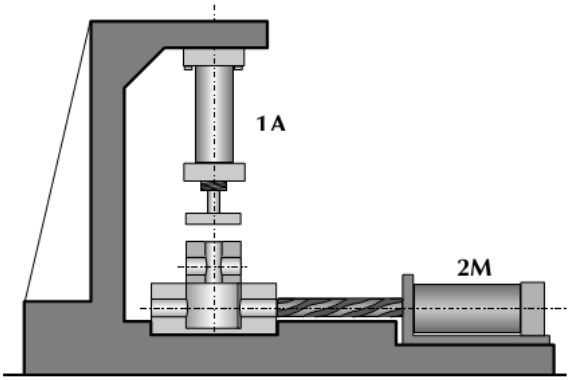


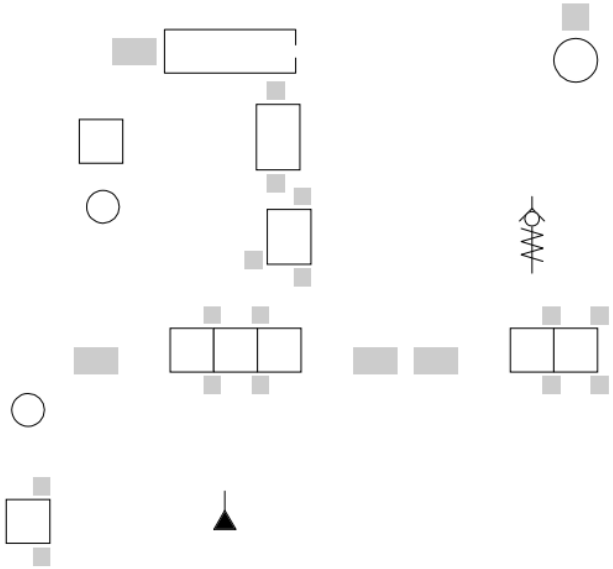
Figure 5: Simulation diagram

5.3. Step diagram

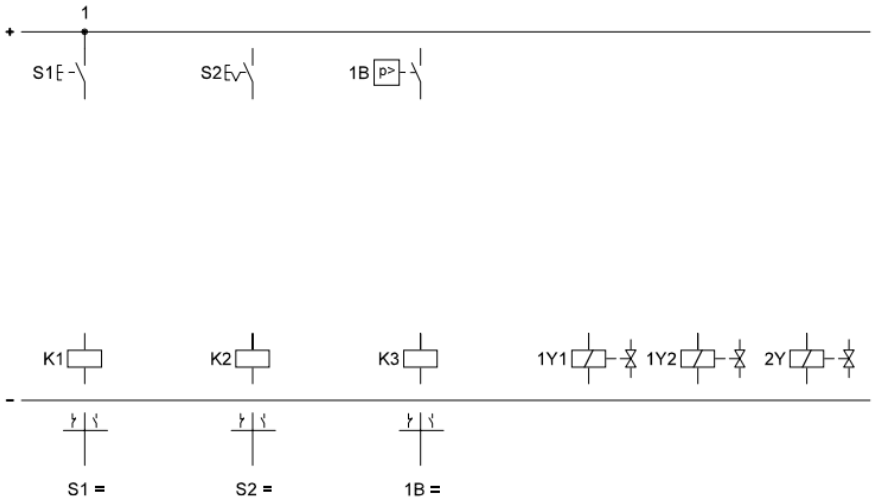
Phần tử	Kí hiệu	Tín hiệu	Thời gian / Bước 1 2 3 4 5 6
Nút nhấn START	S1	ON	
Nút nhấn RETURN	S2		
Xi lanh	1A	2	
		1	
Van điện từ 4/3	1Y1	a	
		0	
	1Y2	b	
Động cơ	2M	2	
		1	
Van điện từ 4/2	2Y	a	
		b	

5.4. Exercises

❖ Hydraulic circuit diagram



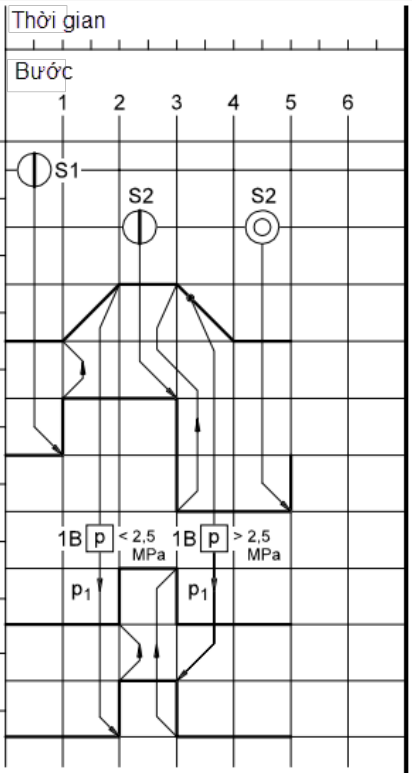
❖ Circuit diagram



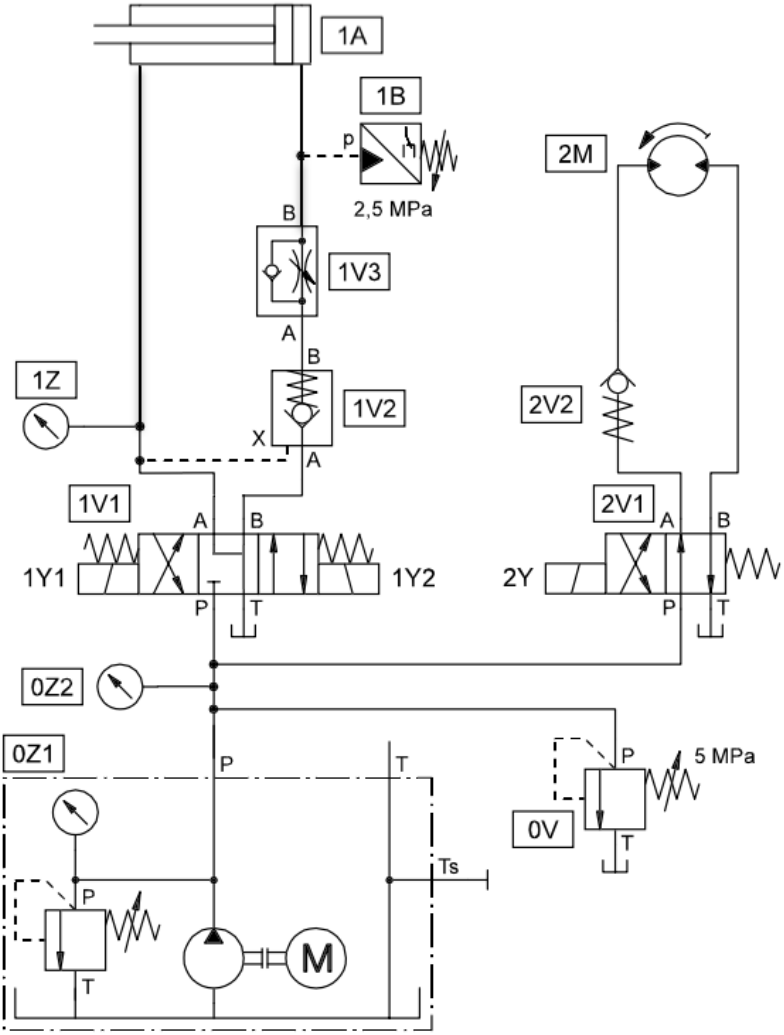
5.5. Exercise answer keys

5.5.1. Step diagram

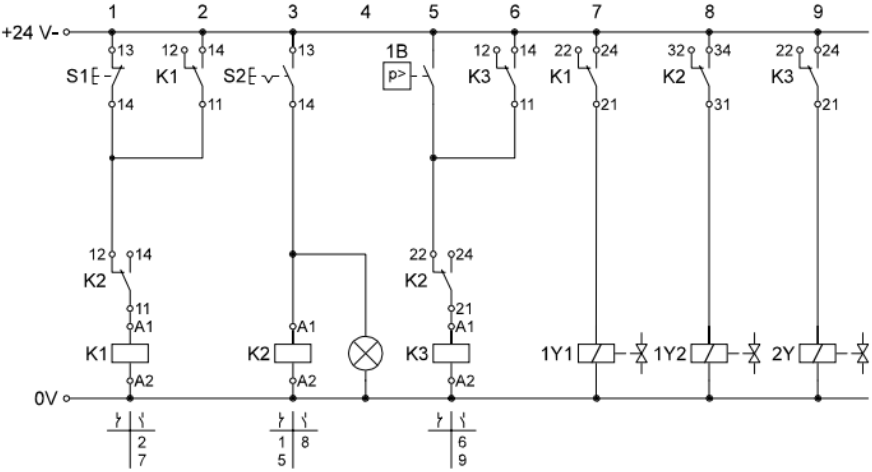
Phần tử	Kí hiệu	Tín hiệu
Nút nhấn START	S1	ON
Nút nhấn RETURN	S2	
Xi lanh	1A	2
		1
Van điện từ 4/3	1Y1	a
		0
	1Y2	b
Động cơ	2M	2
		1
Van điện từ 4/2	2Y	a
		b



5.5.2. Hydraulic circuit diagram



5.5.3. Circuit diagram



5.5.4. List of modules in the exercise

No.	Devices	Name of devices	Module's code	Quantity
1		**Hydraulic devices**		
1.1	0Z1	Hydraulic power unit	TPAT.A1020	1
1.2	0Z2, 1Z	Pressure gauge	TPAT.I0100	2
1.3	0V	Pressure relief valve	TPAT.H4000	1
1.4	1V3	One-way flow control valve	TPAT.H7000	1
1.5	1V2	Controlled one-way valve	TPAT.H1000	1
1.6	1B	Pressure switch	TPAT.C3000	1
1.7	1A	Double acting cylinder	TPAT.F0100	1
1.8	1V1	4/3 solenoid valve with relieving mid-position	TPAT.E1130	1
1.9	2M	Hydraulic motor	TPAT.G0120	1
1.10	2V1	4/2 Solenoid valve	TPAT.E0100	1
1.11	2V2	One-way flow control valve 5 bar	TPAT.H6000	1
1.12		600mm hydraulic hose	TPAT.A4000	10
1.13		1000mm hydraulic hose	TPAT.A4100	5
1.14		T-connector	TPAT.H9000	3
2		**Electrical supplies**		
2.1		DC power module	TPAK.A2100	1
2.2		Set of 3 relays	TPAK.A9100	1
2.3		Set of 3 push buttons	TPAK.A3200	1
2.4		Indicator display unit	TPAK.A8100	1
3		**Additional supplies**		

3.1		Hydraulic oil distributor with pressure gauge	TPAT.A3100	1
3.2		Hydraulic oil distributor (P1, P2, T)	TPAT.A3000	1
3.3		Excess pressure release tool	TPAT.A5000	1
3.4		Safety jack set		1

5.5.5. Exercise answer keys

❖ *Describe the solution.*

When START push button S1 is pressed, relay K1 is energized and self-maintaining. The normally open contact of K1 in power path 7 supplies power to the solenoid 1Y1 of valve 4/3. It causes the piston rod of cylinder 1A to move forward.

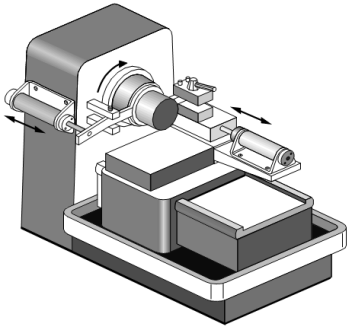
When the pressure set at 1B is reached, relay K3 is energized. The result is that the normally open contact of K3 in power path 9 closes and the hydraulic motor rotates clockwise. The piston rod continues to move forward until switch S2 is activated.

When switch S2 is activated, its brake position is indicated by the indicator light. S2 clears the maintenance circuit of K1 and K3, causing the 4/3 valve to switch over and start the return stroke of the cylinder. At the same time, the pressure drops. The pressure switch causes relay K3 to become de-energized, resulting in the opening of the normally open contact of K3 in power path 9. 2Y is therefore also de-energized and valve 4/2 is reversed by the return spring. The engine stops.

Only after switch S2 is released (indicator light goes out) does valve 4/3 move to its middle position, allowing the duty cycle to start.

In practice, the pressure sensor is not used alone to determine whether cylinder 1A has reached its final position. An additional work limit switch is used to provide actual detection of the end position.

6. Practice with Automatic Lathe



6.1. Objectives and requirements

- Objectives:
  + Draw a hydraulic circuit diagram
  + Practice assembling hydraulic circuits
  + Relationship between flow and pressure
- Requirements:
  + Install automatic lathe

6.2. Operating principle of the exercise

The main shaft of the automatic lathe is driven by a hydraulic motor, while a hydraulic cylinder is used to carry out the reciprocating movement of the workpiece slide. The rotation speed of the spindle is set constant throughout the machining time. Evaluate the relationship between flow and system pressure.

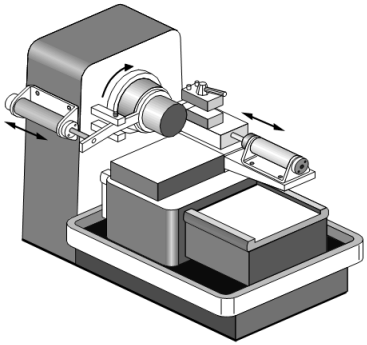


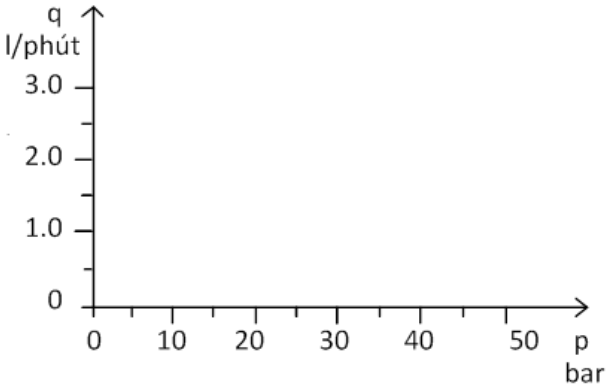
Figure 6: Simulation diagram

6.3. Exercises

❖ *Evaluation table:*

System pressure p	15	20	25	30	35	40	45	50	bar
Flow q									l/min

❖ *Characteristic curve:*



❖ *Conclusion*

How will flow increase as pressure increases??

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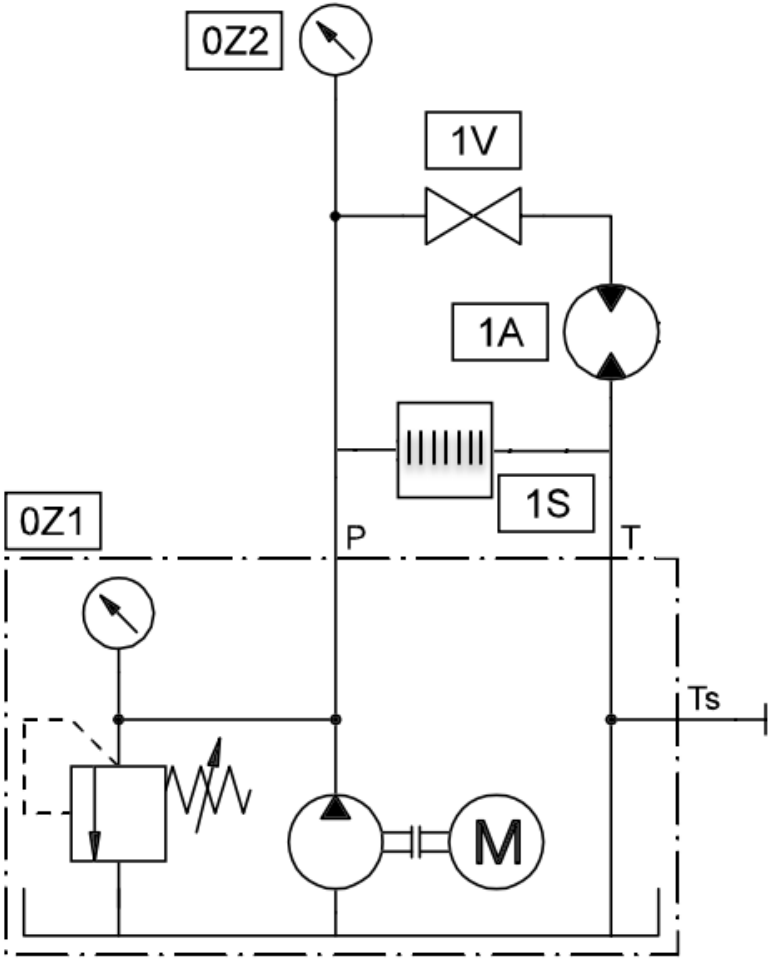
6.4. Exercise answer keys

6.4.1. Hydraulic circuit diagram



6.4.2. List of modules in the exercise

No.	Devices	Name of devices	Module's code	Quantity
1		**Hydraulic devices**		
1.1	0Z1	Hydraulic power unit	TPAT.A1020	1
1.2	0Z2	Pressure gauge	TPAT.I0100	1
1.3	1V	Shut-off valve	TPAT.H5000	1
1.4	1A	Hydraulic motor	TPAT.G0120	1
1.5	1S	Flow meter	TPAT.I1200	
1.6		600mm hydraulic hose	TPAT.A4000	
1.7		1000mm hydraulic hose	TPAT.A4100	
2		**Additional supplies**		
2.1		Hydraulic oil distributor with pressure gauge	TPAT.A3100	1
2.2		Hydraulic oil distributor (P1, P2, T)	TPAT.A3000	1
2.3		Excess pressure release tool	TPAT.A5000	1
2.4		Stopwatch		1

6.4.3. Exercise answer keys

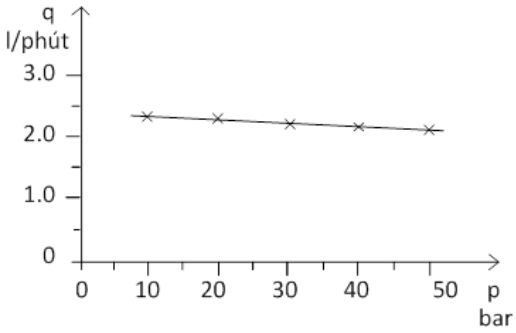
❖ *Describe the solution*

Once the hydraulic circuit is installed, the valve must be fully open. Now close this valve gradually to establish the first p-value indicated in the manometer. The maximum pressure that can be achieved is 60 bar, controlled by a Pressure relief valve installed in the pump that has been set to this value.

❖ *Evaluate*

System pressure p	15	20	25	30	35	40	45	50	bar
Flow q	233	2.31	2.29	2.28	2.26	2.24	2.22	2.20	l/min

Pump characteristics:

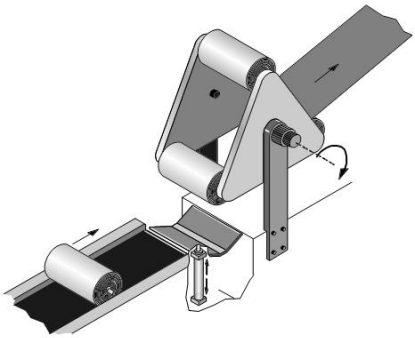


❖ *Conclusion:*

As the pressure increases, the pump flow rate decreases slightly. In theory, the pump characteristic curve should be straight. The reduction in pump capacity is due to internal leakage losses, which become larger as the pressure increases. The ratio of the pump's measured delivered power to the theoretical delivered power is the volume efficiency of the pump.

For technical conclusions, the instantaneous measured value recorded in this exercise is the power consumption of the electric motor or the early opening of the Pressure relief valve. The pump is dimensioned for a maximum pressure of 250 bar (see technical specifications). Electric motors with relatively high power can achieve that. That doesn't make sense when exercises are only performed with a maximum pressure of 60 bar.

7. Practice with Workpiece Feeder for Laminating Machine



7.1. Objectives and requirements

- Objectives:
  + Helps students fully understand the application of check valves
  + Indicates the operation of a single-acting cylinder using a 2/2 valve
  + Draw a hydraulic circuit diagram
  + Practice assembling hydraulic circuits
- Requirements:
  + Install the feeder for the laminating machine

7.2. Operating principle of the exercise

The paper roll is loaded into the laminating machine by a lifting device. The lifting device is controlled by a single acting cylinder. When the hydraulic power station is energized, the pump delivers hydraulic flow directly into the cylinder. The 2/2 valve is closed in the normal position and installed in the branch to the oil tank. One-way valve to ensure that the pump is protected against oil back pressure. The pressure relief valve is installed in the line after the check valve to protect the pump against residual pressure.

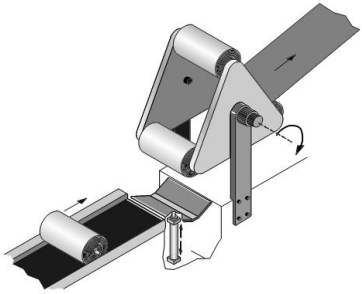
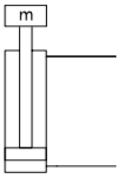
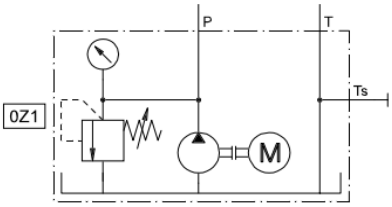


Figure 7: Simulation diagram

7.3. Exercises

❖ *Hydraulic circuit diagram*





❖ *Conclusion*

What is the advantage of this circuit?

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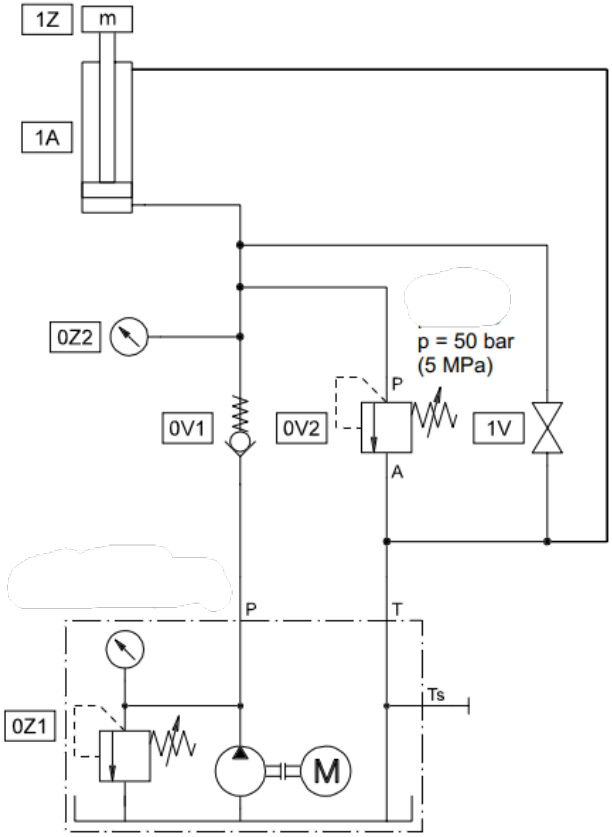
7.4. Exercise answer keys

7.4.1. Hydraulic circuit diagram



7.4.2. List of modules in the exercise

No.	Devices	Name of devices	Module's code	Quantity
1		**Hydraulic devices**		
1.1	0Z1	Hydraulic power unit	TPAT.A1020	1
1.2	0Z2	Pressure gauge	TPAT.I0100	1
1.3	0V1	One-way valve 5 bar	TPAT.H6000	1
1.4	0V2	Pressure relief valve	TPAT.H4000	1
1.5	1V	Shut-off valve	TPAT.H4100	1
1.6	1A	Double acting cylinder + load	TPAK.N8200	1
1.8		T-connector	TPAT.H9000	2
1.9		600mm hydraulic hose	TPAT.A4000	6
1.10		1000mm hydraulic hose	TPAT.A4100	3
2		**Additional supplies**		
2.1		Hydraulic oil distributor with pressure gauge	TPAT.A3100	1
2.2		Hydraulic oil distributor (P1, P2, T)	TPAT.A3000	1
2.3		Excess pressure release tool	TPAT.A5000	1

7.4.3. Exercise answer keys

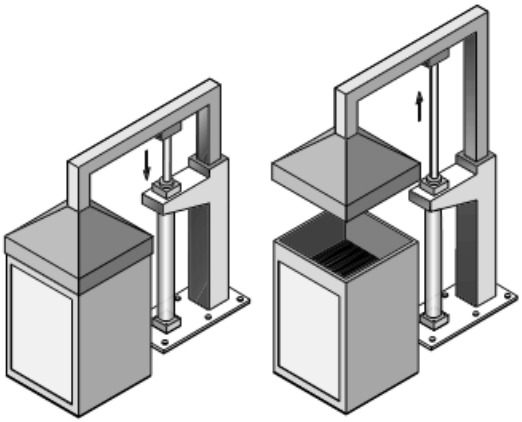
❖ *Describe the solution*

In this exercise, the cylinder is bolted to the practice board on the left side of the groove board and loaded with a 9kg Load. When the cylinder is piped, it is essential that the upper connection is connected to the oil tank. After the circuit is installed, the Pressure relief valve 0V2 must first be fully opened. The hydraulic power unit must then be turned on and valve 0V2 slowly closed. The piston rod then moves to its highest final position. Continue to close valve 0V2 until pressure gauge 0Z2 indicates 50 bar. Now turn off the hydraulic power unit. This can be simulated by rapidly opening the 1V stopcock so that the 0V1 check valve prevents the 1Z Load from the lower side even further and the return flow of hydraulic oil during the piston entry stroke can only be achieved through the valve. 1V.

❖ *Conclusion:*

The piston rod can only retract when the pump is turned off. That is deliberately arranged in the system as indicated here.

8. Practice with Lifting Mechanism for the Cap of the Furnace



8.1. Objectives and requirements

- Objectives:
  + Help students fully understand the application of 3/2 valve
  + Show how to determine the time, pressure and force in the piston exit stroke of a single acting cylinder
  + Draw a hydraulic circuit diagram
  + Practice assembling hydraulic circuits
- Requirements:
  + Install the lifting mechanism for the cover of the furnace

8.2. Operating principle of the exercise

The cap of the heat treatment furnace is pulled up by a single acting cylinder. The cylinder is actuated by a 3/2 valve. A force equivalent to 9kg will be applied to the cylinder to compress it down. Measure and calculate the following parameters:

- Moving pressure, load pressure, impedance, feedback pressure.
- Piston exit stroke time and speed.

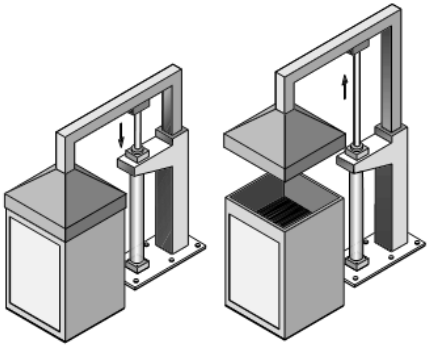


Figure 8: Simulation diagram

8.3. Exercises

❖ *Evaluation table:*

Direction	Displacement pressure	Time shifting
Piston exit stroke		
Piston entry stroke		

❖ *Conclusion*

Typical parameters required for calculation:

Load apply: F_G= 90 N

Piston area: A_{PN}= 2 cm^2

Stroke length: giây = 200 mm

Pump output flow: q = 2 l/min

Load pressure:

$$p_L = \frac{F_G}{A_{PN}}$$

p_L =

Hydraulic resistance = Displacement pressure - load pressure

p_{res} =

⇨ How large is the back pressure in relation to the hydraulic resistance?

……
……
……
……
……
……

Piston exit stroke speed:

$$v_{adv} = \frac{q}{A_{PN}}$$

v_{adv} =

Piston exit stroke time:

$$t_{adv} = \frac{s}{v_{adv}}$$

t_{adv} =

⇨ Calculated and measured piston stroke time are the same?

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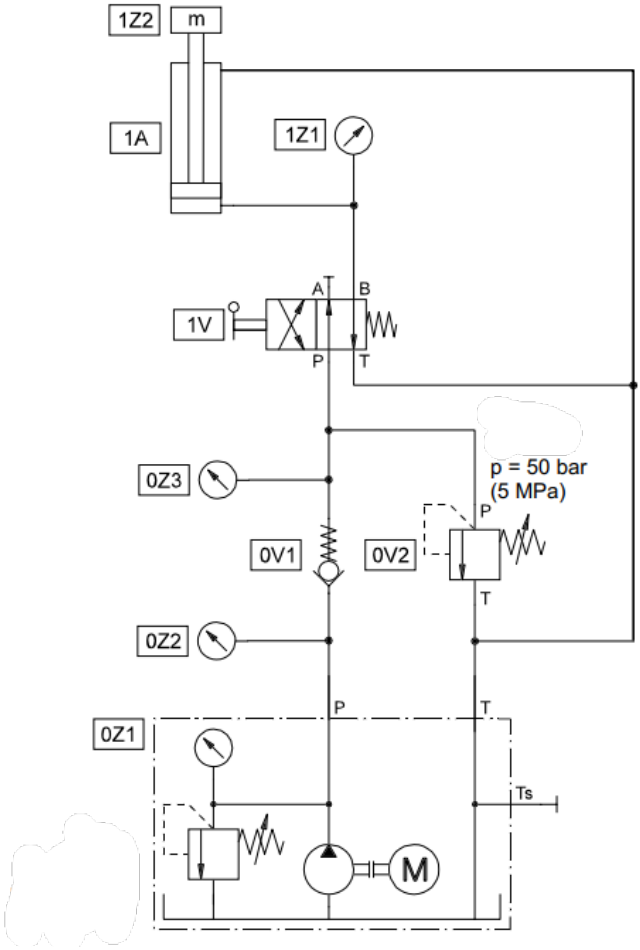
……
……
……
……
……

8.4. Exercise answer keys

8.4.1. Hydraulic circuit diagram



8.4.2. List of modules in the exercise

No.	Devices	Name of devices	Module's code	Quantity
1		**Hydraulic devices**		
1.1	0Z1	Hydraulic power unit	TPAT.A1020	1
1.2	0Z2,0Z3,1Z1	Pressure gauge	TPAT.I0100	3
1.3	0V1	One-way valve 5 bar	TPAT.H6000	1
1.4	0V2	Pressure relief valve	TPAT.H4000	1
1.5	1V	4/2 hand-lever valve	TPAT.D0100	1
1.6	1A	Double acting cylinder + load	TPAK.N8200	1
1.7		T-connector	TPAT.H9000	1
1.8		600mm hydraulic hose	TPAT.A4000	8
1.9		1000mm hydraulic hose	TPAT.A4100	4
2		**Additional supplies**		
2.1		Hydraulic oil distributor with pressure gauge	TPAT.A3100	1
2.2		Hydraulic oil distributor (P1, P2, T)	TPAT.A3000	1
2.3		Excess pressure release tool	TPAT.A5000	1
2.4		Stopwatch		1

8.4.3. Exercise answer keys

❖ *Describe the solution*

For this exercise, the cylinder is bolted to the practice board on the left side of the groove board and loaded with Load. When the cylinder is piped, it is essential that the upper connection is connected to the oil tank. In place of the 3/2 valve, the 4/2 valve is now used, with a sealed connection. After the circuit is assembled, PRV 6 must first be fully opened. The hydraulic power unit is then turned on and PRV 6 is slowly closed until pressure gauge 3 indicates 50 bar. The 4/2 valve can now be slowly reversed, which causes the cylinder piston rod to come out. This valve is designed so that it can be reversed slowly, the entire valve cross section does not open immediately. Initially, the supply pump to the cylinder will be throttled. As soon as the valve returns to its original position, the cylinder piston rod returns to its lowest final position.

❖ *Evaluate*

Direction	Displacement pressure	Time shifting
Piston exit stroke	8 bar	1.1 seconds
Piston entry stroke	0 bar	1.4 seconds

❖ *Conclusion:*

Typical parameters required for calculation:
Characteristic data needed for calculations:
Load apply: F_G= 90 N
Piston area: A_{PN}= 2 cm^2
Stroke length: second = 200 mm
Pump output flow: q = 2 l/min
Load pressure:

$$p_L = \frac{F_W}{A_{PN}} = \frac{90\ N}{2\ cm^2} = \frac{45\ N}{cm^2} = 4.5\ bar$$

Hydraulic resistance = Displacement pressure - load pressure

$$p_{res} = 8\ bar - 4.5\ bar = 3.5\ bar$$

⇨ The backpressure is significantly lower than the hydraulic resistance. Cylinder displacement can be achieved when this is done. The value of back pressure depends on the hydraulic resistance. It will be very small when the liquid flows into the oil tank.

Piston exit stroke speed:

$$v_{adv} = \frac{q}{A_{PN}} = \frac{2\frac{l}{min}}{2\ cm^2} = \frac{\frac{2000\ cm^3}{60\ s}}{2\ cm^2}$$

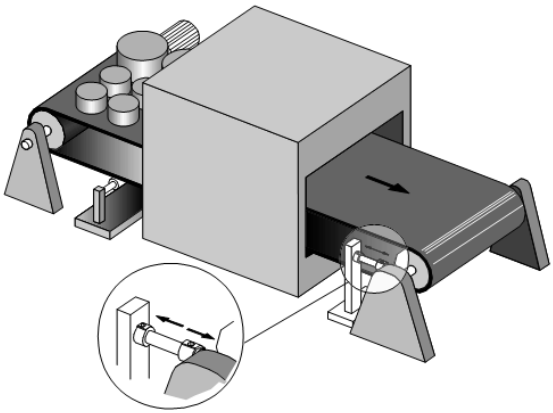
$$v_{adv} = 16.67\frac{cm}{s} = 0.17\frac{m}{s}$$

Piston exit stroke time:

$$t_{adv} = \frac{s}{v_{adv}} = \frac{0.2\ m}{0.17\frac{m}{s}} = 1.2\ s$$

⇨ The piston stroke time is measured at 1.1 seconds, which is not significantly smaller than the calculated time. This result may mean that the flow rate of a new pump is sometimes greater than 2 l/min.

9. Practice with Conveyor Tensioning Mechanism



9.1. Objectives and requirements

- Objectives:
  + Help students fully understand the application of 4/2 valve
  + Indicates the operation of a single-acting cylinder using a 2/2 valve
  + Draw a hydraulic circuit diagram
  + Practice assembling hydraulic circuits
- Requirements:
  + Install circuits of conveyor tensioning mechanism

9.2. Operating principle of the exercise

Machine parts are loaded into the drying oven on a steel chain conveyor. The conveyor belt must be precisely aligned with chain tensioning devices to ensure that the belt does not run off its pulleys. These devices consist of a fixed steel shaft at one end and a movable shaft at the other end using a double acting cylinder. The hydraulic power unit must operate continuously. The hydraulic system must switch to circulating mode (overflow pump) when the direction control valve is not activated. The holding station causes a continuous reverse force on the cylinder. The auxiliary control check valve is used to prevent the piston rod of the piston rod from slipping when the directional control valve leaks oil.

For comparison purposes, first calculate the required driving power for the circuit with the 4/3 valve in the middle position recirculating, and next with the 4/3 valve in the middle position closed.

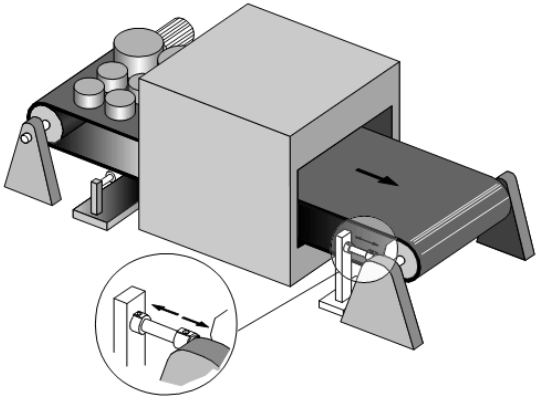


Figure 9: Simulation diagram

9.3. Exercises

❖ *Evaluation table:*

Direction	Valve location	System pressure	Displacement pressure and back pressure	
		P_2	P_7	P_8
Piston exit stroke →				
Piston entry stroke ←				
Middle position				

❖ *Conclusion*

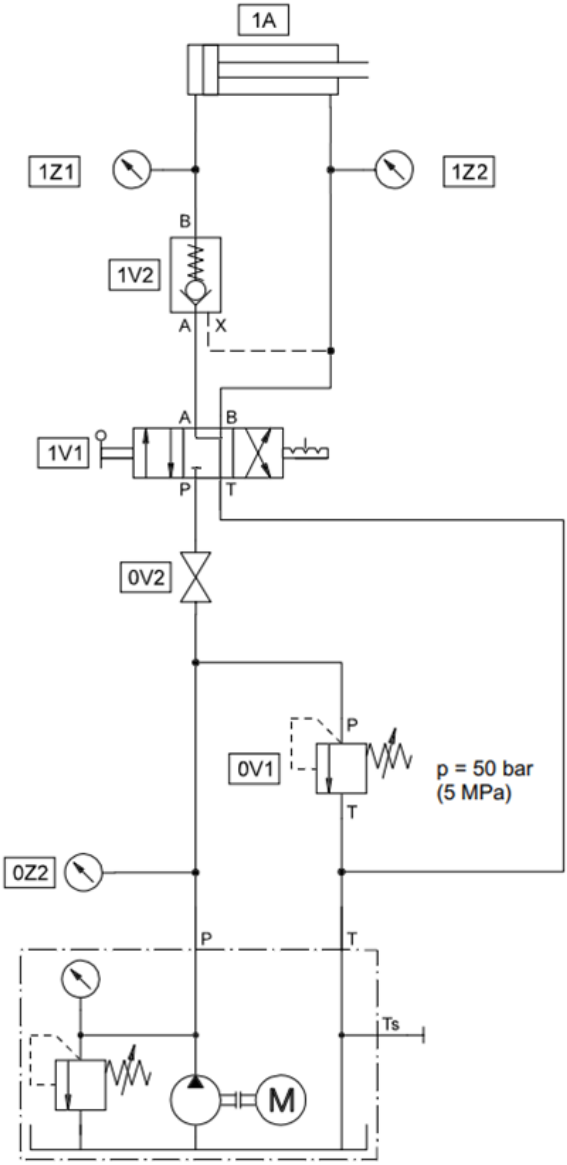
$$P_{DR} = \frac{p \cdot q}{\eta}$$

Typical parameters required for calculation:
P_{DR} = Required drive power
p = Pump supply system pressure: Maximum 50 bar
q = Pump flow: constant 2 l/min
η = Pump performance: approx. 0.7
Drive power with middle position closed:
P_{DR}=
Drive power with mid-circulation position:
P_{DR}=

⇨ What are the advantages of cyclic circuits?
……
……
……

9.4. Exercise answer keys

9.4.1. Hydraulic circuit diagram



9.4.2. List of modules in the exercise

No.	Devices	Name of devices	Module's code	Quantity
1		**Hydraulic devices**		
1.1	0Z1	Hydraulic power unit	TPAT.A1020	1
1.2	0Z2,1Z1,1Z2	Pressure gauge	TPAT.I0100	3
1.3	0V1	Pressure relief valve	TPAT.H4000	1
1.4	0V2	Shut-off valve	TPAT.H4100	1
1.5	1V1	4/3 T solenoid valve with relieving mid-position AB	TPAT.E1130	1
1.6	1V2	Controlled one-way valve	TPAT.H1000	1
1.7	1A	Double acting cylinder	TPAT.F0100	1
1.8		T-connector	TPAT.H9000	2
1.9		600mm hydraulic hose	TPAT.A4000	11
1.10		1000mm hydraulic hose	TPAT.A4100	4
2		**Additional supplies**		
2.1		Hydraulic oil distributor with pressure gauge	TPAT.A3100	1
2.2		Hydraulic oil distributor (P1, P2, T)	TPAT.A3000	1
2.3		Excess pressure release tool	TPAT.A5000	1
2.4		Stopwatch		1

9.4.3. Exercise answer keys

❖ *Describe the solution*

After the circuit is assembled and tested, stop valve 4 closes and Pressure relief valve 3 opens. Turn on the hydraulic power unit and close PRV 3 until pressure gauge 2 indicates 50 bar.

Shut-off valve 4 can now open. Observe as you do this, the pressure gauge shows an immediate pressure drop from the set pressure of 50 bar to nearly 3 bar, from the middle position of the 4/3 valve releasing the fluid flow to the oil tank. The piston rod can reach any position required by 4/3 valve action. When this valve is brought to its middle position, the piston rod stops immediately.

The check valve prevents the piston rod from being pushed back by the reverse force.

In combination with an auxiliary control check valve, a 4/3 valve located between "A and B direct to T" and "P closed" must be used in sequence to depressurize the control line and pressure supply line for one-way valve. The one-way valve can close only when the pressure is released. The mid-circulation 4/3 valve, included in the kit, can also be used for this exercise. Internal leakage losses as a result of this valve's design also cause the check valve to close.

❖ *Evaluate*

Direction	Valve location	System pressure	Displacement pressure and back pressure	
		P_2	P_7	P_8
Piston exit stroke →		8 bar	2.2 bar	1.6 bar
Piston entry stroke. ←		2.2 bar	9.4 bar	17.9 bar
Middle position		3.1bar	1.6 bar	1.7 bar

❖ *Conclusion:*

$$P_{DR} = \frac{p \cdot q}{\eta}$$

Typical parameters required for calculation:
P_{DR} = Required drive power
p = Pump supply system pressure: Maximum 50 bar
q = Pump flow: constant 2 l/min
η = Pump performance: approx. 0.7
Drive power with middle position closed:

$$P_{DR} = \frac{50\,\text{bar} \cdot 2\,\frac{\text{l}}{\text{min}}}{0.7} = \frac{50\,\text{kp} \cdot 2\,\text{dm}^3}{0.7\,\text{cm}^2 \cdot 60\,\text{s}} = \frac{50 \cdot 10\,\text{N} \cdot 2 \cdot 1000\,\text{cm}^3}{0.7\,\text{cm} \cdot 60\,\text{s}}$$

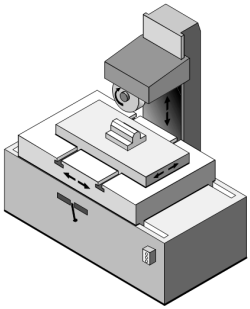
$$P_{DR} = \frac{50 \cdot 2}{0.7 \cdot 60} \cdot 10000\,\frac{\text{Ncm}^3}{\text{cm}^2 \cdot \text{s}} = \frac{50 \cdot 2}{0.7 \cdot 60} \cdot 100\,\frac{\text{Nm}}{\text{s}} = 238\,\text{W}$$

Drive power with mid-circulation position:

$$P_{DR} = \frac{3.1\,\text{bar} \cdot 2\,\frac{\text{l}}{\text{min}}}{0.7} = \frac{3.1 \cdot 2}{0.7 \cdot 60} \cdot 100\,\frac{\text{Nm}}{\text{s}} = 15\,\text{W}$$

⇨ The 4/3 valve with the mid-circulation position is mainly used in cases where the cylinder or engine is driven by a fixed flow pump. In the mid-circulation position, the hydraulic oil is discharged to the oil tank at almost zero pressure, which means the temperature rise is very small. The disadvantage of using this valve is that it cannot operate in subsequent hydraulic circuits.

10. Practice with Surface Grinder



10.1. Objectives and requirements

- Objectives:
  + Help students fully understand the design and application of various circuits
  + Demonstrate effects of pressure, force, speed, and travel time
  + Draw a hydraulic circuit diagram
  + Practice assembling hydraulic circuits
- Requirements:
  + Install the Surface Grinder Devices circuit

10.2. Operating principle of the exercise

The grinding workpiece clamp of the surface grinding machine is driven by a hydraulic cylinder. Until the same speed is achieved in both directions, the hydraulic control circuit must be designed to compensate for the difference in volume in the two chambers of the cylinder. Proposed differential circuit with 3/2 valve and flow control valve for speed correction.

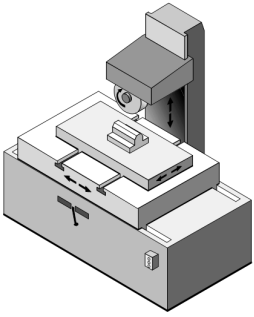
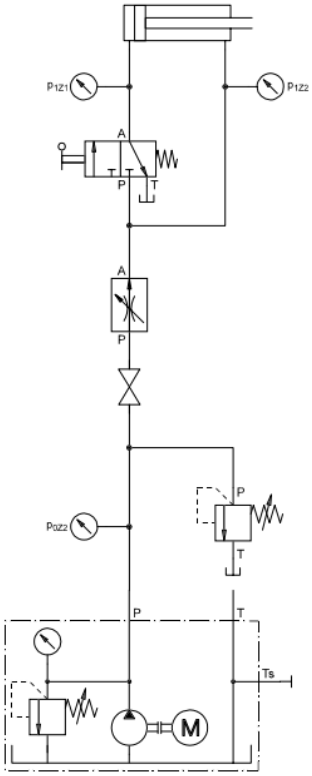


Figure 10: Simulation diagram

10.3. Exercises

❖ *Hydraulic circuit diagram*



❖ *Evaluation table:*

Measure the following quantities:

P7 = Pressure on the piston side of the cylinder

P8 = Pressure on the annulus side of the cylinder

System pressure = 50 bar

t → = The cylinder's exit stroke time is about 4 seconds

Direction	**P_7**	**P_8**	t
Piston exit stroke			
Piston entry stroke			

❖ *Conclusion*

Cylinder dimensions:
Piston area: APN= 2.0 cm^2
Ring area: APR= 1.2 cm^2
Cylinder stroke: second = 0.2 m
Area ratio:

$$\alpha = \frac{A_{PN}}{A_{PR}} =$$

Time ratio:

$$\frac{t_{adv}}{t_{ret}} =$$

Force ratio:

$$\frac{F_1}{F_2} = \frac{A_{PN} \cdot p_{1Z1}}{A_{PR} \cdot p_{1Z2}} =$$

Flow during the piston exit stroke:
Piston side:

$$q_{PN} = A_{PN} \cdot \frac{s}{t_{adv}} =$$

Piston ring side:

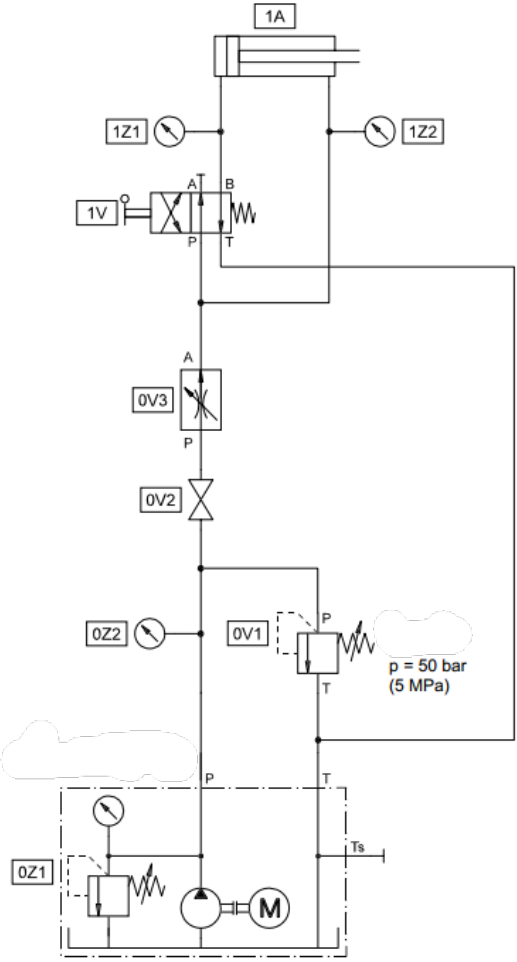
$$q_{PR} = A_{PR} \cdot \frac{s}{t_{adv}} =$$

Flow control valve element: $q_{FCV} = q_{PN} - q_{PR} =$
Flow during the piston entry stroke:
Piston ring side:

$$q_{PR} = A_{PR} \cdot \frac{s}{t_{ret}} =$$

10.4. Exercise answer keys

10.4.1. Hydraulic circuit diagram



10.4.2. List of modules in the exercise

No.	Devices	Name of devices	Module's code	Quantity
1		**Hydraulic devices**		
1.1	0Z1	Hydraulic power unit	TPAT.A1020	1
1.2	0Z2,1Z1,1Z2	Pressure gauge	TPAT.I0100	3
1.3	0V1	Pressure relief valve	TPAT.H4000	1
1.4	0V2	Shut-off valve	TPAT.H4100	1
1.5	0V3	Flow control valve (Base Mounted Type)	TPAT.H0100	1
1.6	1V	4/2 hand-lever valve	TPAT.D0100	1
1.7	1A	Double acting cylinder	TPAT.F0100	1
1.8		T-connector	TPAT.H9000	2
1.9		600mm hydraulic hose	TPAT.A4000	10
1.10		1000mm hydraulic hose	TPAT.A4100	4
2		**Additional supplies**		
2.1		Hydraulic oil distributor with pressure gauge	TPAT.A3100	1
2.2		Hydraulic oil distributor (P1, P2, T)	TPAT.A3000	1
2.3		Excess pressure release tool	TPAT.A5000	1
2.4		Stopwatch		1

10.4.3. Exercise answer keys

❖ *Describe the solution*

Assemble and test the circuit. Close the Shut-off valve and Flow control valve. Now turn on the Hydraulic Power Unit and set the system pressure to 50 bar using the Pressure relief valve. Now open the Shut-off valve and also open the Flow control valve until the piston rod comes out. Now the measurement can be carried out.

❖ *Evaluation.*

P_7 = Pressure on the piston side of the cylinder
P_8 = Pressure on the annulus side of the cylinder
p_2 = System pressure = 50 bar
t = Cylinder exit travel time is nearly 4 seconds

Direction	P_7	P_8	t
Piston exit stroke	3.5 bar	5 bar	4.31 giây
Piston entry stroke	0 bar	4.5 bar	6.57 giây

❖ *Conclusion:*

Cylinder dimensions:
Piston area: APN= 2.0 cm^2
Ring area: APR= 1.2 cm^2
Cylinder stroke: second = 0.2 m
Area ratio:

$$\alpha = \frac{A_{PN}}{A_{PR}} = \frac{2\ cm^2}{1.2\ cm^2} = 1.67 \approx 1.7$$

Time ratio:

$$\frac{t_{adv}}{t_{ret}} = \frac{4.31\ s}{6.57\ s} = 0.656$$

Force ratio:

$$\frac{F_1}{F_2} = \frac{A_{PN} \cdot p_{1Z1}}{A_{PR} \cdot p_{1Z2}} = \frac{2\ cm^2 \cdot 3.5\ bar}{1.2\ cm \cdot 5\ bar} = 1.2 < \alpha$$

Traffic on the outbound journey:
Piston side:

$$q_{PR} = A_{PR} \cdot \frac{s}{t_{adv}} = 1.2\ cm^2 \cdot \frac{20\ cm}{4.31\ s}$$

Piston ring side:

$$q_{PR} = 5.57\ \frac{cm^3}{s} = 334\ \frac{cm^3}{min} \approx 0.3\ \frac{l}{min}$$

Traffic during the stroke shrinks to:

$$q_{PR} = A_{PR} \cdot \frac{s}{t_{ret}} = 1.2\ cm^2 \cdot \frac{20\ cm}{6.57\ s}$$

Piston ring side

$$q_{PR} = 3.65\ \frac{cm}{s} = 219\ \frac{cm^3}{min} = 0.2\ \frac{l}{min} = q_{FCV}$$

III. References:

Refer to the documents in the document set "**HP.T0010 – Basic Hydraulic Training Kit**" by following the link or QR code below:

Link:

https://onedrive.live.com/?id=2B9D32B3D76DA171%219989&cid=2B9D32B3D76DA171

QR code:

Manual

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