Electrical Techniques Advanced
Exam Preparation

Programmable Logic Controllers

Typical PLC's have four parts:

1. Power Supply
2. CPU
3. Input / Output (IO)
4. Programming Device / Terminal

- PLC's can be fixed or modular. Modular meaning expandable.
- IO can be local or remote to save wiring in large enviroments.
- One Coil per rung.Inputs are things you control like a button or switch. Can be used an infinite number of times.
- NO normally open.
- NC normally closed.

Looks for a voltage	Looks for no voltage
Looks for a 1	Looks for a 0
Looks for a True	Looks for a false

"Looks for" meaning "examine"
When power examines its way from one side of the ladder over to the coil, the coil can activate. Or de-activate depending on how your bit's are set up.

- Bits in parallel can be thought of as "OR" Logic

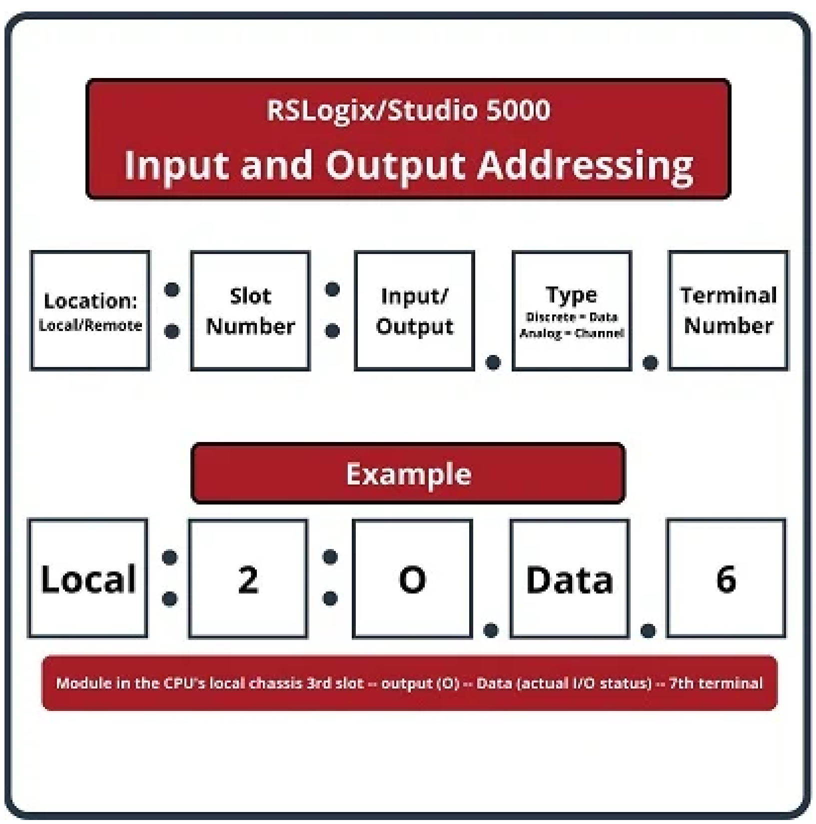
- Bits in series can be thought of as "AND" Logic

Timers

Timer ON delay	starts when rung conditions become true
Timer OFF delay	starts when rung conditions become false
Retentive	timer state is not lost if power is interupted

Counters

Count Up	Count Down
Counts false to true transitions of the rung and increments the counter	counts false to true transitions of the rung and decrements the counter



Instrumentation

Key points

Blue = Exhaust
Red = Air Input
NC = No Flow (when you close the valve on your garden hose, theres no flow)
NO = Flowing

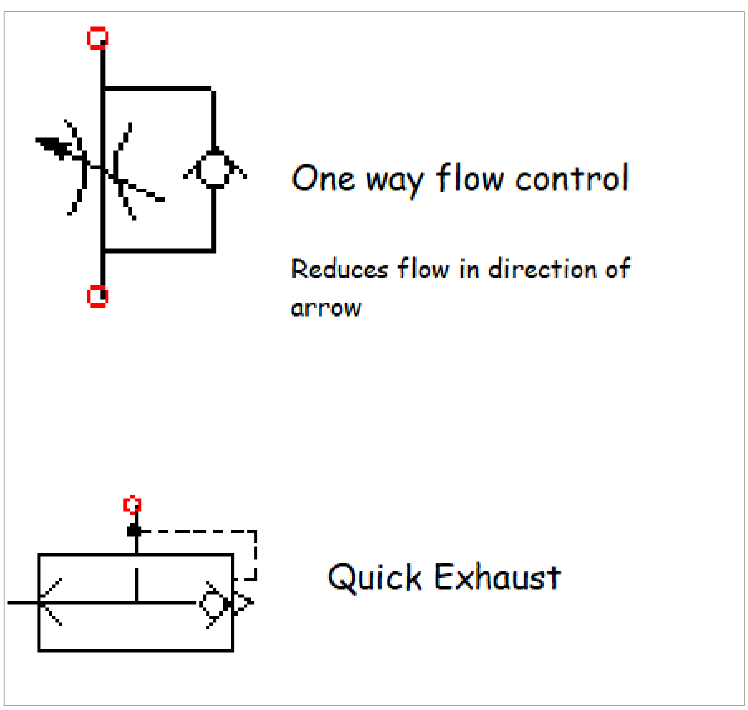
Directional Control Valves

- Number of ports / Number of positions
- Ex. 3/2 has 3 ports and two positions
- Can be actuated by rollers, push buttons with spring return, toggle, solenoid etc

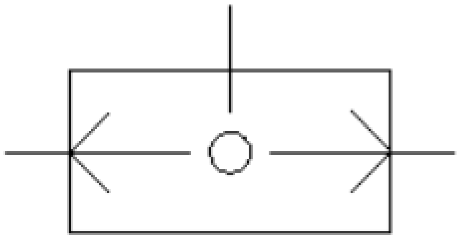
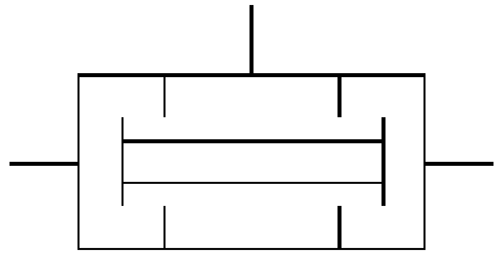
Port numbers

1	Input
2, 4	Output
3, 5	Exhaust

Controlling flow and Exhaust

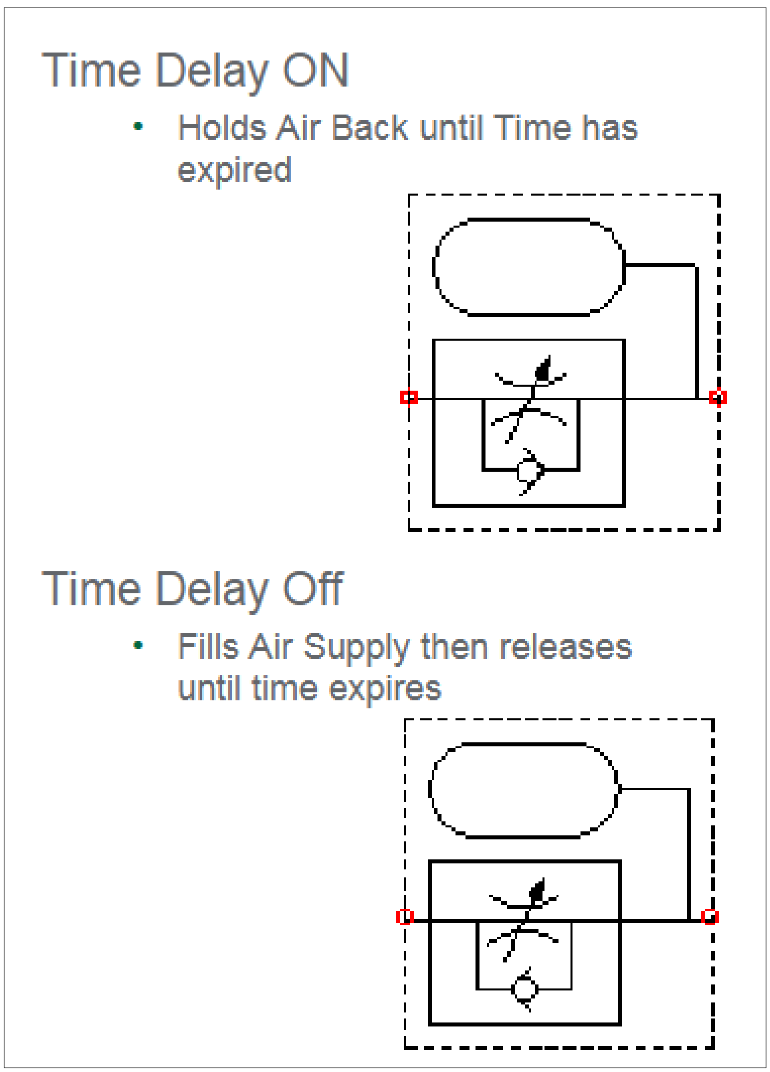


Logic Gates

Or Gate / Shuttle Valve	And Gate / Dual Pressure
	

Timers

Arrows point to output



Electronics

RMS / Average / Peak

Average DC Power – refers to average amount of electrical power delivered by a DC source over time.

$$P_{average} \text{ (in watts)} = V \times I$$

For a constant DC voltage and current, the average power is simply the product of the voltage and current.
However, if the voltage or current varies over time, the average power can be calculated by integrating the instantaneous power over a specific time period and then dividing by that time period.

Peak Voltage

Maximum absolute value in sinewave.

$$Vrms = V_{peak} / \sqrt{2}$$
$$V_{peak} = V_{rms} \times 2 = 120V \times 1.414 = 169.7V$$

Peak to Peak

Total difference between positive peak and negative peak. Twice the peak voltage.

$$V_{p\text{-}p} = 2 \text{ X } V_{peak}$$

Rectifier vs Inverter

Rectifiers change A/C to D/C. Inverters output an A/C voltage when given a D/C voltage.

Thyristors

like a relay, can be controlled by current or voltage

SCR

Switched on by positive gate pulse or forward breakover voltage
and off by Anode current interuption OR Forced commutation (reverse polarity) OR shunting/shorting

Diode for A/C – **Diac**

voltage sensitive switch, triggers like UJT and bi directional

Triode for A/C – **Triac**

current flows in both direction. Used in dimmers, motor speed controls.

Unijunction Transistor – UJT

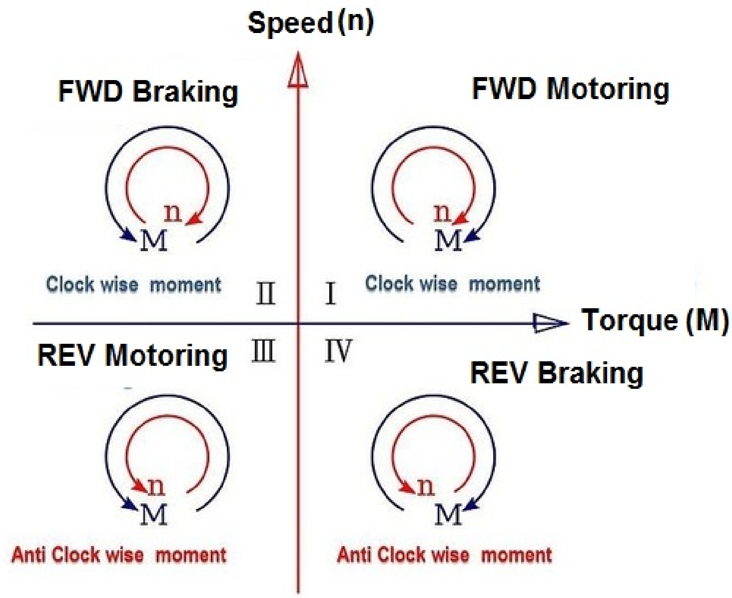
current controlled

Field Effect Transistor – FET

voltage controlled

4 Quadrant control

Braking, Driving,
Braking, Driving



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High input impedance, low output impedance

Encoders

Operation: Encoders convert the position or motion of a shaft into an electrical signal. There are two main types: incremental and absolute encoders. Incremental encoders generate pulses as the shaft rotates, which can be counted to determine position or speed. Absolute encoders provide a unique code for each shaft position, allowing for precise position tracking.

Applications: Encoders are widely used in robotics, CNC machines, and industrial automation to provide accurate position and speed feedback. They are essential in applications requiring precise control of motion, such as in servo motors and robotic arms.

Resolvers

Operation: Resolvers are rotary transformers that convert angular position into an analog signal. They consist of a rotor and stator, with windings that induce voltages proportional to the sine and cosine of the shaft angle. These signals can be processed to determine the exact position of the shaft.

Applications: Resolvers are used in harsh environments where high reliability and robustness are required, such as in aerospace, military, and industrial applications. They are often found in servo systems, radar antennas, and gimbal systems due to their ability to withstand extreme conditions.

Tachogenerators

Operation: Tachogenerators are electromechanical devices that convert rotational speed into an electrical voltage. As the shaft rotates, the tachogenerator produces a voltage proportional to the speed of rotation. This voltage can be used to measure and control the speed of the motor.

Applications: Tachogenerators are commonly used in speed control systems for DC motors, such as in elevators, conveyor belts, and machine tools. They provide real-time speed feedback, allowing for precise speed regulation and control.

VFD

A three-phase AC Variable Speed Drive (VSD) Controller is used to control the speed and torque of an AC motor by varying the frequency and voltage supplied to the motor. Here's a breakdown of its operation:

Operation

1. **Rectification**: The AC input power is first converted to DC using a rectifier. This process involves converting the three-phase AC voltage into a DC voltage.
2. **DC Link**: The rectified DC voltage is then smoothed and filtered in the DC link section, which typically includes capacitors to store energy and reduce voltage ripple.
3. **Inversion**: The DC voltage is converted back to AC using an inverter. The inverter uses semiconductor switches (such as IGBTs or MOSFETs) to create a variable frequency and variable voltage AC output. By adjusting the switching frequency and duty cycle of these switches, the inverter can control the output frequency and voltage.

4. **Control System**: The VSD controller includes a control system that monitors the motor's speed and adjusts the inverter's output to match the desired speed. This control system can be either open-loop or closed-loop, depending on whether feedback from the motor is used.
5. **Output to Motor**: The variable frequency and voltage AC output from the inverter is supplied to the motor, allowing precise control of the motor's speed and torque.

Applications

Three-phase AC VSD controllers are used in a wide range of applications, including:

- **Industrial Automation**: Controlling the speed of conveyor belts, pumps, and fans.
- **HVAC Systems**: Regulating the speed of compressors and blowers to improve energy efficiency.
- **Electric Vehicles**: Managing the speed and torque of electric motors in vehicles.
- **Renewable Energy Systems**: Controlling the output of wind turbines and solar inverters.

These controllers are essential for improving energy efficiency, reducing wear and tear on mechanical components, and providing precise control over motor-driven systems.