Robot Programming

World coordinate system: End-of-arm moves are parallel to world axes.

Tool coordinate system: Moves are relative to axis system defined by tool orientation.

Precision point(确切点): A precision point is the robot location which is represented by exact position of the individual robot joints. It is a record of the degree of rotation of each of six joints(jt1,jt2...jt6) and is signified by #.

Example: #HOME

Transformation: A transformation is a robot independent representation of the position and orientation of the robot tool. It is represented by x, y, z(independent representation) and yaw, pitch, roll(tool orientation).

Example: HOME

Difference: For transformation, the joint configuration is not recorded, the arm will take the shortest distance to the location. For precision location, the configuration of the robot arm can be defined, like elbow up.

Explain how the correct movement of the robot is achieved.(模板)

Three locations are taught to the robot. (#Home, Pallet1 and Pallet2).
When the program is executed, the robot moves to #Home and the speed is always limited to 20%.

The SET command is used to create two new locations call Pick and Place which have the same coordinates as Pallet1 and Pallet2 respectively.

Two variables(countx, county) are used to count the number of the parts in

rows and columns. Both of them are zero for the beginning.

After every pick and place, the countx will be added 1. Then the set and shift command will change the coordinates of Pick by +50mm on x-axis (and Place by +50mm on y-axis).

After 10 times Pick and Place, the variable countx is 10. The county will be added 1. Then the set and shift command will change the coordinate of Pick(Place) by -500 on x-axis and by +50 on y-axis. The next Pick(Place) will start at the beginning of the second row.

If the county is not less than 10, the programme loops back and the robot continues to pick up and place parts. When county reaches 10, the pallet is fully empty. The robot will move back to #Home and wait 60s for a new loop.

Electropneumatics

Cylinder: pneumatic cylinders are mechanical devices which use the power of the compressed air to produce a force for linear movement or rotate.

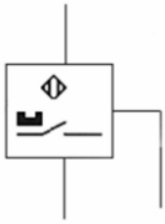
Single acting cylinder: Uses compressed air to create a driving force in one direction and a spring brings it to retract.

Double acting cylinder: Requires compressed air to extend and retract in both directions

Exhaust ports: Allow the compressed air to leave the cylinder.

Solenoids: Solenoids are powered by electric magnet to generate magnetic field to cause the iron core to move and used to switch the valve.

Limit switch: limit switch is a switch that can be activated by the motion of a machine part(cylinder).



Reed switch: Magnet on piston ring causes the contacts in the switch to close. It can be used to sense the position of the piston within the cylinder.

Relays: A relay is an electric mechanical device that uses a solenoid to activate the various contacts that are build into the relay. The voltage applies to the coil of relay, the magnet in the relay will be activated which causes the contact of the relay. It is possible to allow a small voltage to control the switch of large voltage sources.

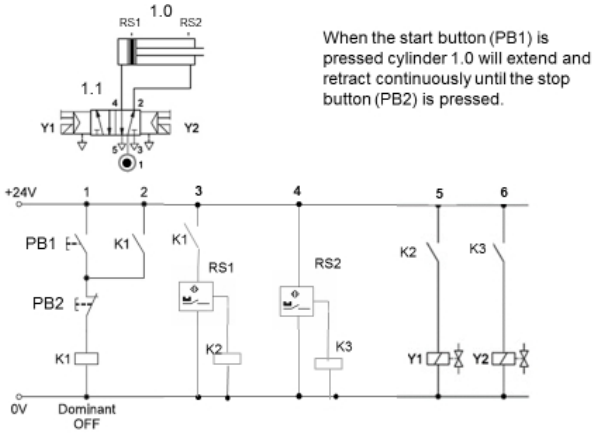
Valve: valves control the flow of air to the cylinder.

3/2 valve: it has 3 ports. Compressed air supply, connects to cylinder, exhaust. 2 position. Air flow from 1 to 2, air flow from 2 to 3.

Latch circuit: A latch is used to hold a relay on using one of its own contacts.

Explain of the electroPneumatic circuits.

ElectroPneumatic: pnenumatic diagram + electrical diagram



When the START button (PB1) is pressed and the STOP button(PB2) is not pressed the coil of the relay(K1) is powered up and all the contacts of it close.

The first contact of K1 is used for Latch and keeps itself on. PB1 can be released

and K1 will remain on.

The second contact of K1 will also be on which power up the reed switch(RS1). If the RS1 is on, then the coid of relay(K2) will be on. This will close the contact of K2 and power on the solenoid Y1 which switches the 5/2 way valve and cause cyclinder 1.0 to extend.

When cylinder 1.0 is fully extended the reed switch(RS2) will be activated. Then the coild of relay(K3) is powered up and causes the contact of K3 is on. So the solenoid Y2 is powered on which switches the 5/2 way valve and cause cyclinder 1.0 to retract.

When cylinder 1.0 is fully retracted RS1 will be activated and if K1 is still latched on then Y1 will be activated and cylinder will extend again.

The loop will be still on until STOP button(PB2) is pressed to break the latch and switch of K1.

Sequential Control

在画 function chart 之前要画 Latch

Explain with, reference to the function chart, how the shift register is used to achieve the desired sequence.

When I0.1, I0.3 and M1 is **on,** a SET command is given to the shift register(Set SBR0.0) which will put a logic 1 into the first bit of the register. **This will activate** the **Step**2 of the sequence. Q0.1 will be turn on so the cylinder 1.0 extends.

When 1.0 is **fully extended,** I0.2 will be on. This will give a shift command to the

register(CU SBR0) so the logic 1 will shift from the first bit of the register to the second bit. This will **deactivate** Step2 and **activate** Step3. Q0.3 will be turn on so the cylinder 2.0 extends.

When 2.0 is fully extended, I0.4 will be on. This will give a shift command to the register so the logic 1 will shift to the third bit. Step3 is activated and TM1 will be turn on for delay 8 seconds.

After the delay, TM1.Q will be on. This will activate Step4 so Q0.4 will be on and the 2.0 retracts.

After 2.0 is fully retracted, I0.3 will be on. This will activate Step5 so Q0.2 will be on and the 1.0 retracts.

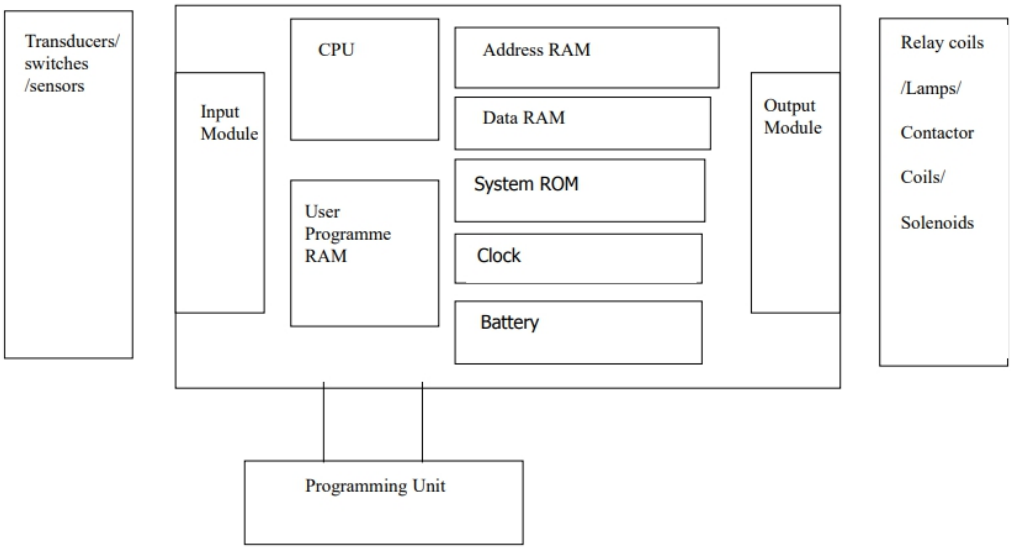
After 1.0 is fully retracted, I0.1 will be on. This will activate Step6 so TM2 will be on and delay for 10 seconds.

After 10s delay, TM2.Q is on. **This will activate Step1 again.** If the I0.1, I0.3 and M1 is still on, a set command is given to the register **again.** A logic 1 goes into SBR0.0, Step2 will be activated so 1.0 will extend **again**.

If M1 or I0.1 or I0.3 **is not on, the sequence stops.**

PLC Hardware

Main functional units of a plc

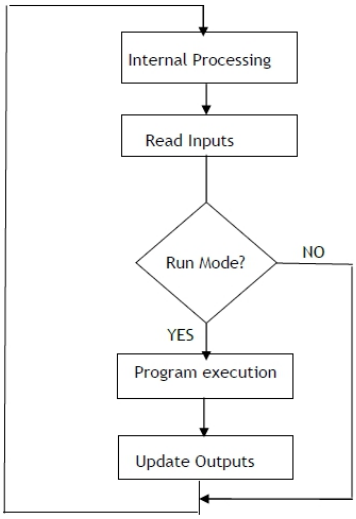


Volatile memory: It will loses all the data when the power to it is switched off.

Memory map: It is a diagram which shows the allocation of memory addresses to ROM, RAM and I/O.

Shift register: The bits stored in shift register can be moved one position to the left or right. So it can be used in the sequence control.

Operation of the PLC(Programme Execution):



First, the CPU will check the structure of the program and read values of timers and counters.

Second, the inputs are read. If the PLC is in the running mode, it will execute the program from top to the bottom and decide the status of outputs(on or off).

Third, when the code has been scanned, PLC will update the outputs. And the process will start from beginning again. If the PLC is in stop mode, the process will beginning again.

I/O Imaging:

I/O RAM/memory: A special memory in the CPU' s I/O RAM is used as a buffer between the control program and the I/O unit.

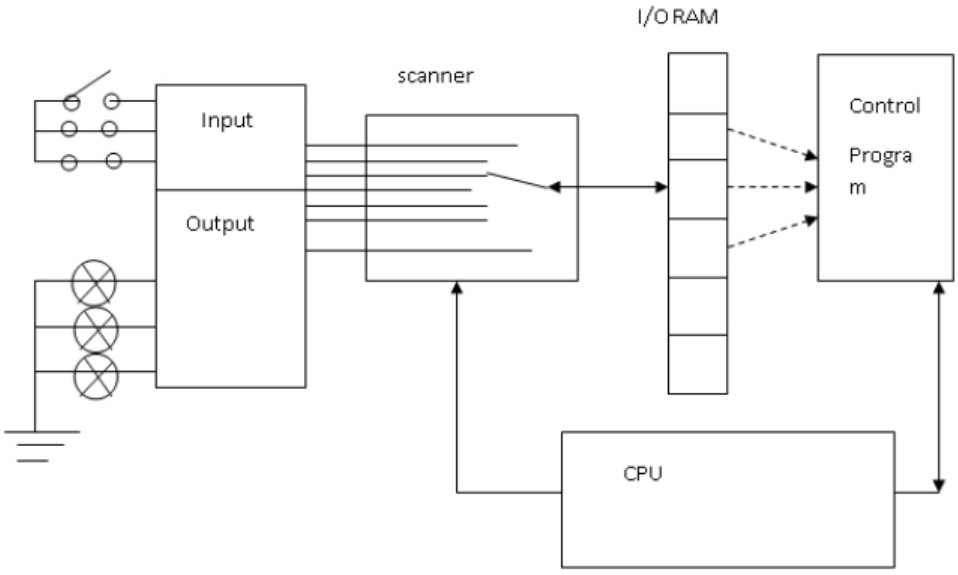


Figure 3-5 Principle of I/O Imaging

First, the CPU scans all the inputs from the input module. If the input is on, then a logic 1 will be put in the bit representing an input in the I/O RAM. Otherwise, it will be put a logic 0.

Second, the CPU will scan the first rung of the ladder based on the recorded

input data and decide to turn on or off the output. If the output should be on, then the bit representing an output in the I/O RAM will be put a logic 1. Otherwise, it will be put a logic 0.

Third, the ladder diagram will be scanned line by line and the I/O RAM will update. So the state of each output will be updated to reflect the I/O RAM.

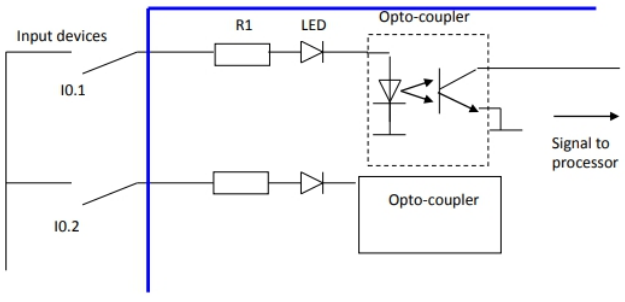
Last, the sequence will be repeated from the beginning.

Scan rate: It is the speed with which PLC scans the memory. The scan rate depends the clock rate of the CPU.

Phasing errors: The CPU doesn't scan the input directly but scan the image memory. When the memory is scanned, it won't change. But the state of input may change. So the phasing error occur when CPU scan misses a change of state of an input port.

Response time: It is the delay between an input changing and the output responding the changing.

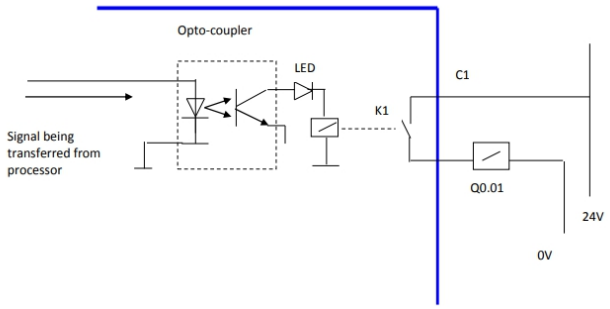
Input Module:



When a voltage is applied to the input port, a current flows through the opto-coupler LED. This causes it to transmit light and turn on the phototransistor. This allows the input signal to be transmitted without any transfer of voltage and

provide a very large degree of electrical isolation between two circuits.

Output Module:



When the signal for the CPU indicates the output should be on, a current flows through the opto-coupler LED. This will transmit light and turn on the phototransistor. Then to the coil of the relay K1 will be on. So the contact closes, switch on the output.