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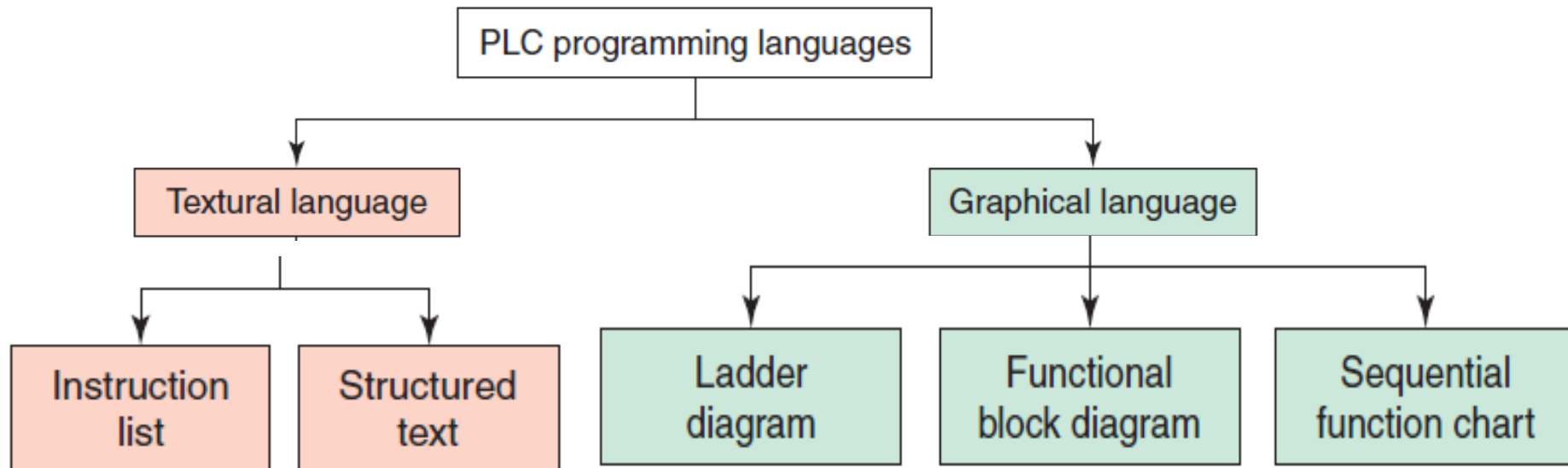
(A constituent unit of MAHE, Manipal)

Industrial Automation (ICE 3252)

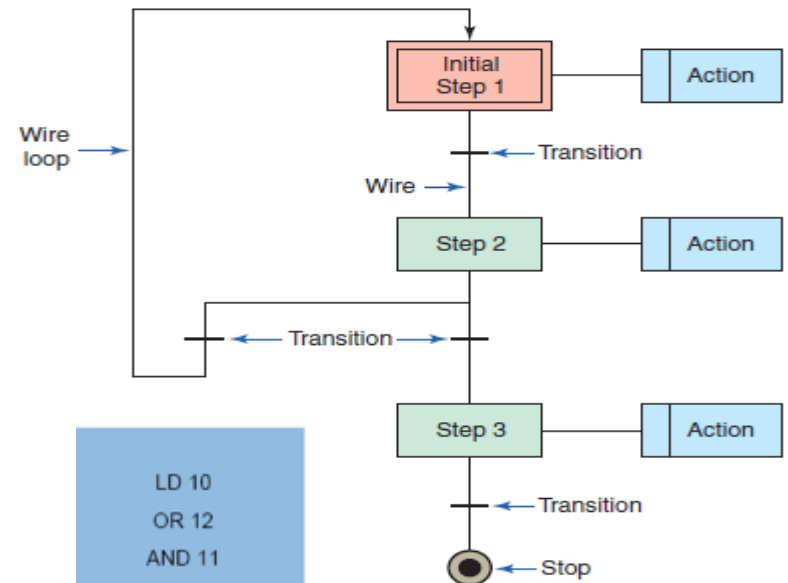
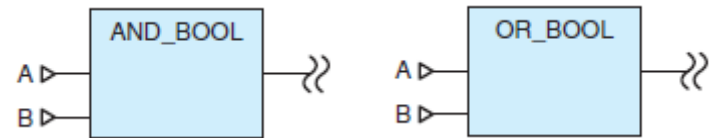
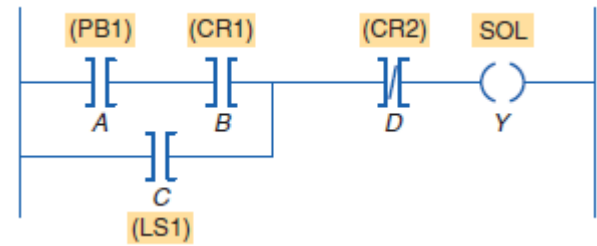
PLC Programming

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Manipal Institute of Technology
MAHE, Karnataka, India

Programming Languages



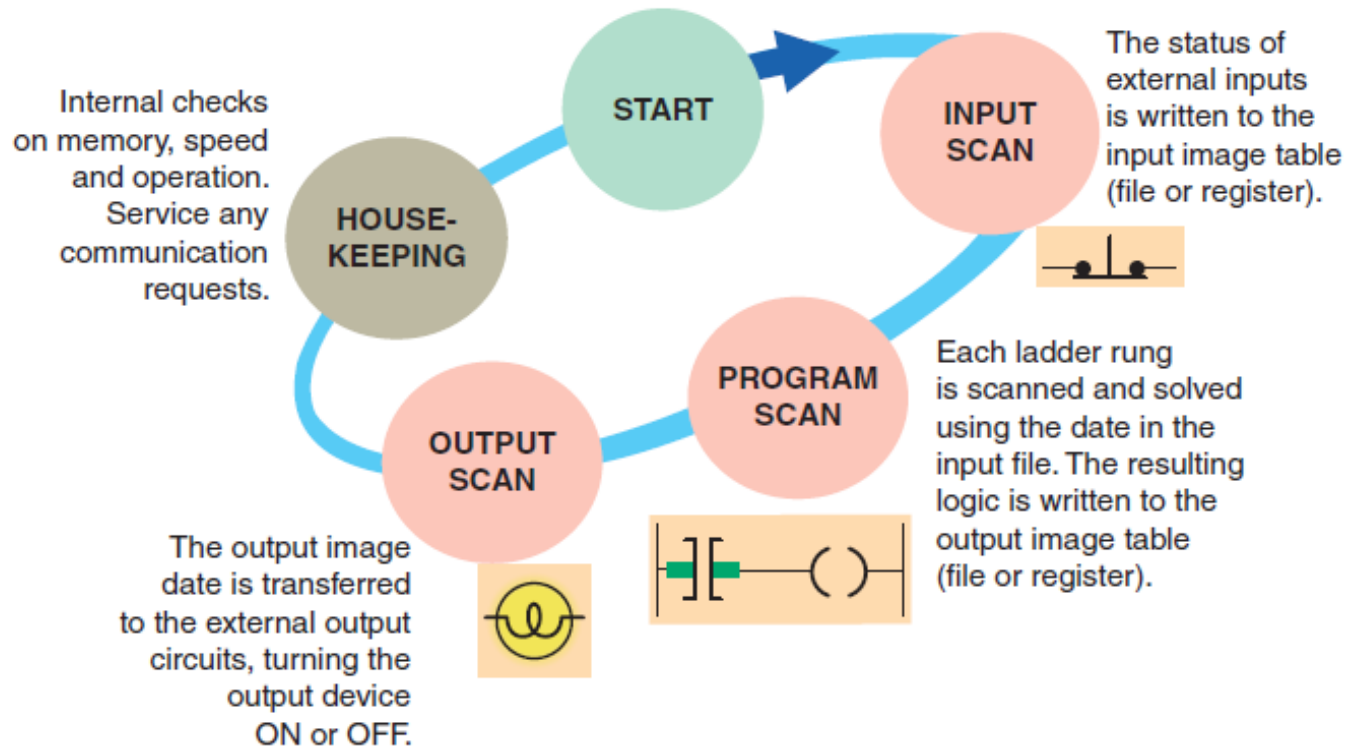
- **Ladder Diagram (LD):** A graphical depiction of a process with rungs of logic, similar to the relay ladder logic schemes that were replaced by PLCs.
- **Function Block Diagram (FBD):** A graphical depiction of process flow using simple and complex interconnecting blocks.
- **Sequential Function Chart (SFC):** A graphical depiction of interconnecting steps, actions, and transitions.
- **Instruction List (IL):** A low-level, text-based language that uses mnemonic instructions.
- **Structured Text (ST):** A high-level, text-based language such as BASIC, C, or PASCAL specifically developed for industrial control applications.



```
LD 10
OR 12
AND 11
OUT 40
```

```
IF Sensor_1 AND Sensor_2 THEN
  SOL_1 := 1;
ELSEIF Sensor_3 AND Sensor_4 AND NOT Sensor_5 THEN
  SOL_1 := 1;
END_IF;
```

Program Scan

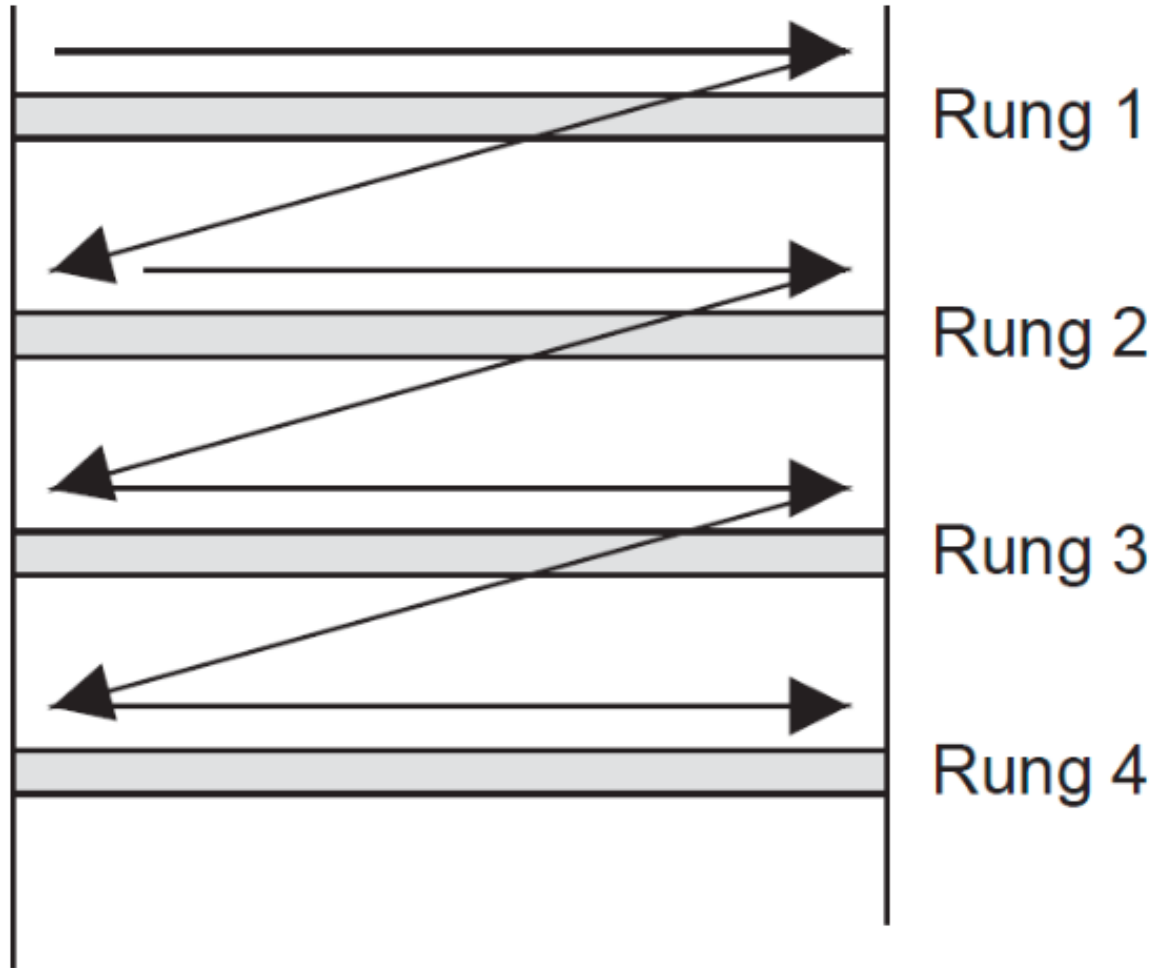


- The time it takes to complete a scan cycle is called the scan cycle time and indicates how fast the controller can react to changes in inputs.
- The time required to make a single scan can vary from about 1 millisecond to 20 milliseconds.

Rules for constructing ladder logic

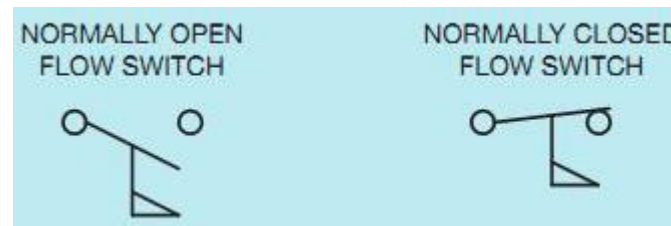
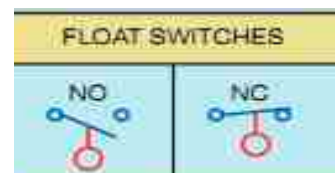
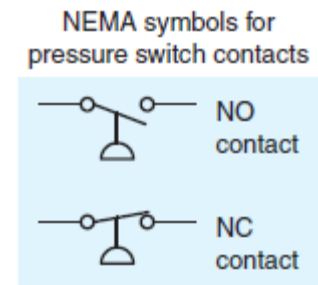
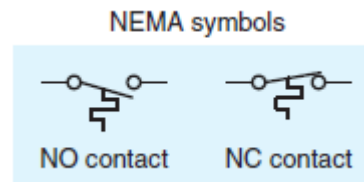
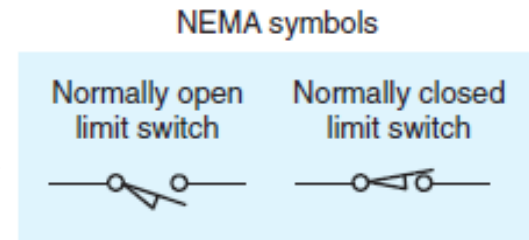
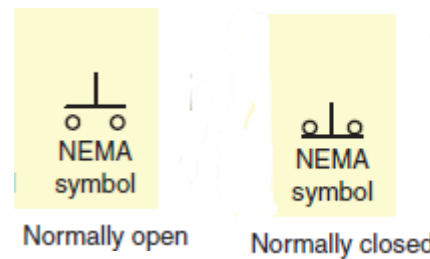
- Inputs can be used in Series as well as Parallel to form a connection
- Outputs (or coil) can be used only in Parallel
- One Input can be used in multiple times in one program
- One Output cannot be used multiple times in one program, except in Set/Reset and Latch/ Unlatch functions
- Input Address cannot be used as an Output Address
- Outputs Address can be used as Inputs Address

- Some PLC manufacturers have virtually no limitations on allowable series elements, parallel branches, or outputs.
- Generally, a maximum of seven parallel lines and 10 series contacts per rung is possible.
- Only one output per rung and the output must be located at the end of the rung.
- The only limitation on the number of rungs is memory size.

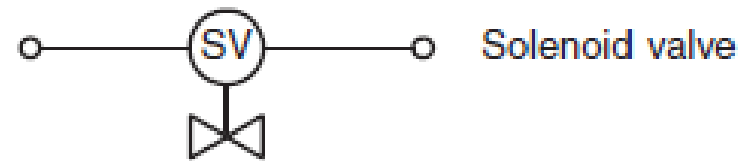
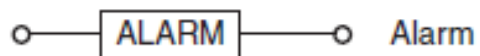
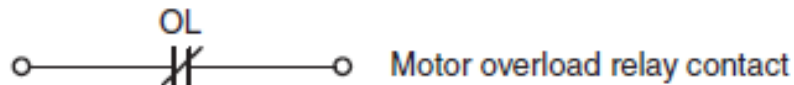
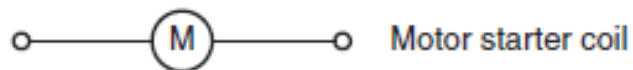
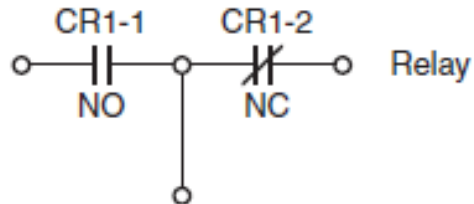
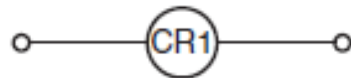
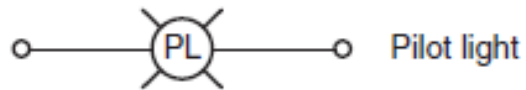


Input Output Representations

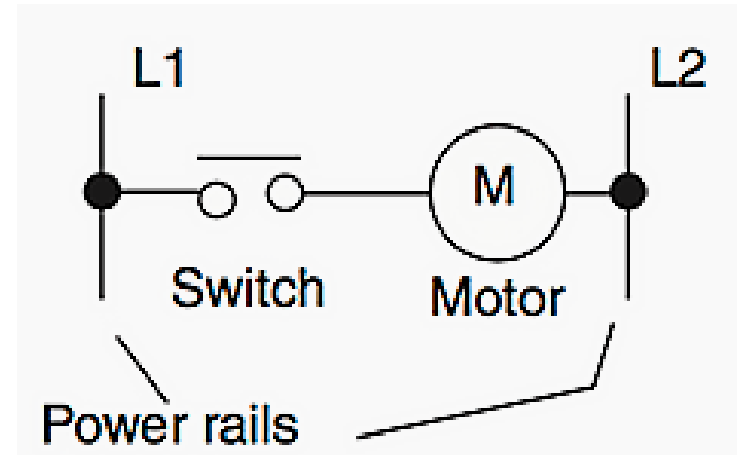
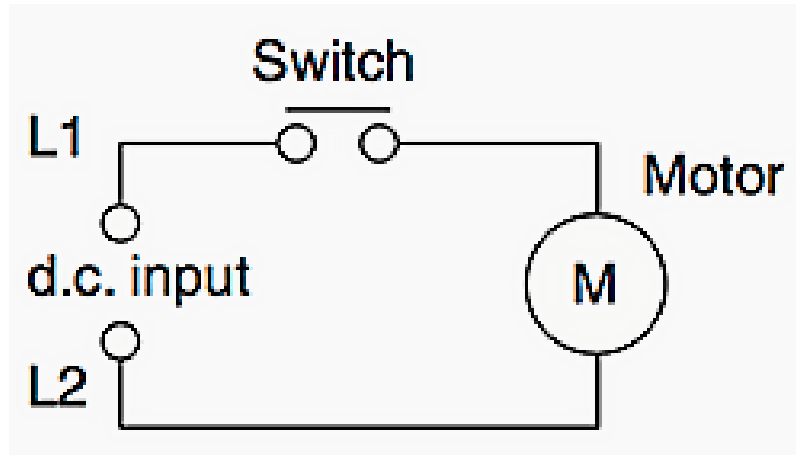
- IEC (International Electrotechnical Commission)
- National Electrical Manufacturers Association (NEMA).
- *Manually operated switches*
- *Mechanically operated switch*
—Limit switch
- *Temperature switch, or thermostat*
- *Pressure Switch*
- *Level Switch float type*
- *Proximity Sensor*
- *Flow switch*



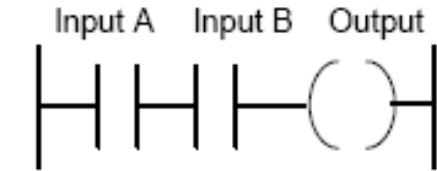
Output Control Devices



Ladder Diagrams



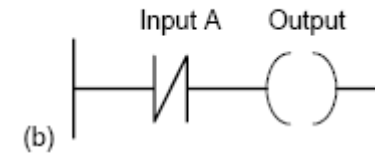
Basic Gate Operation



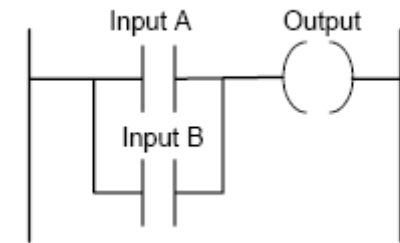
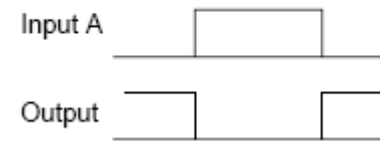
(a)



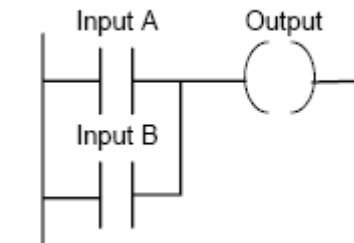
(b)



(b)



(a)

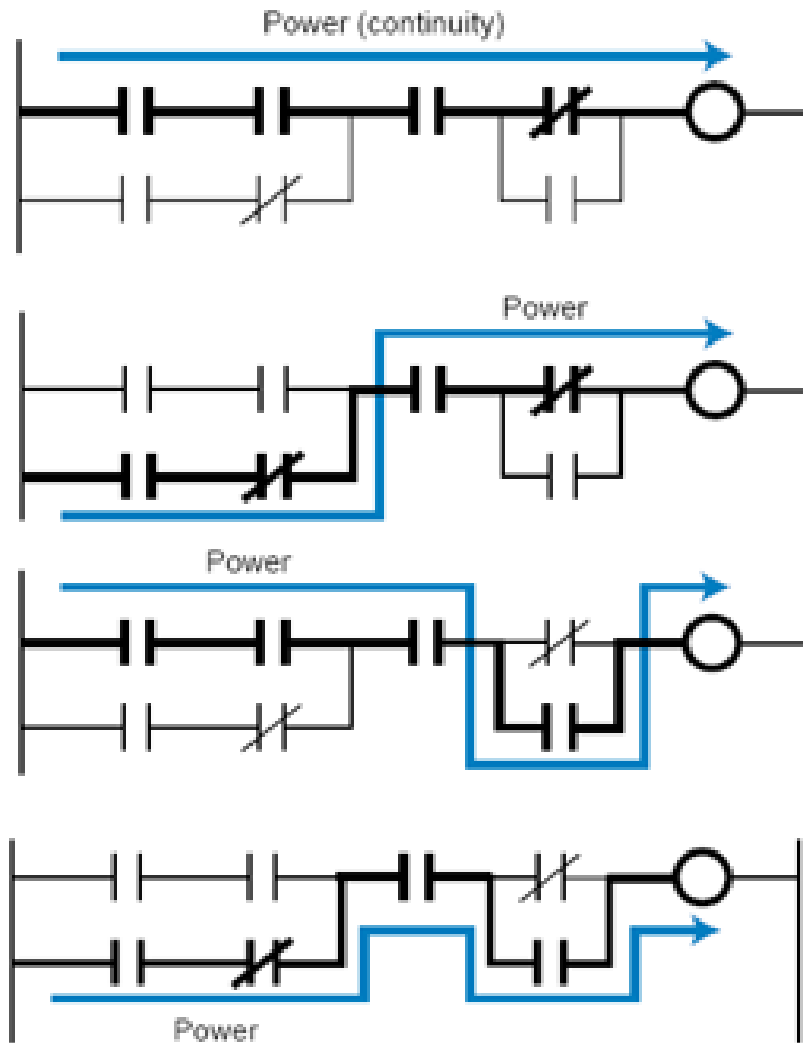


(b)



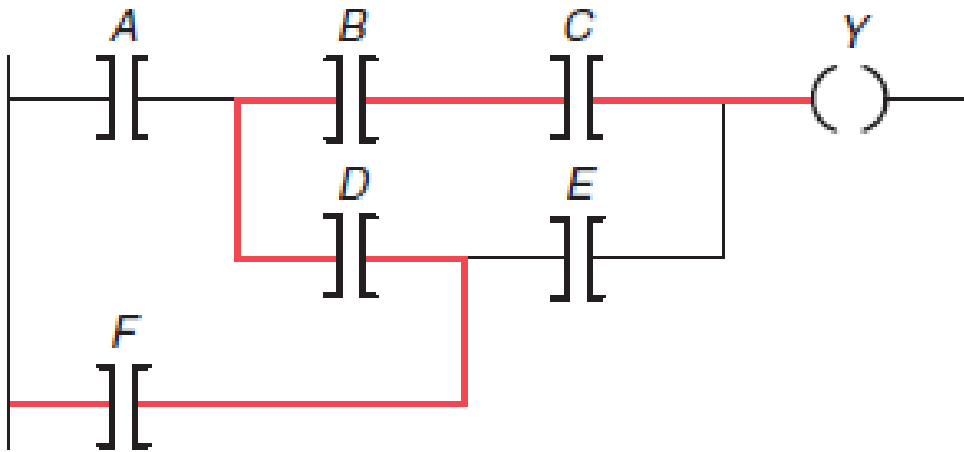
(c)

Power Continuity in a rung...

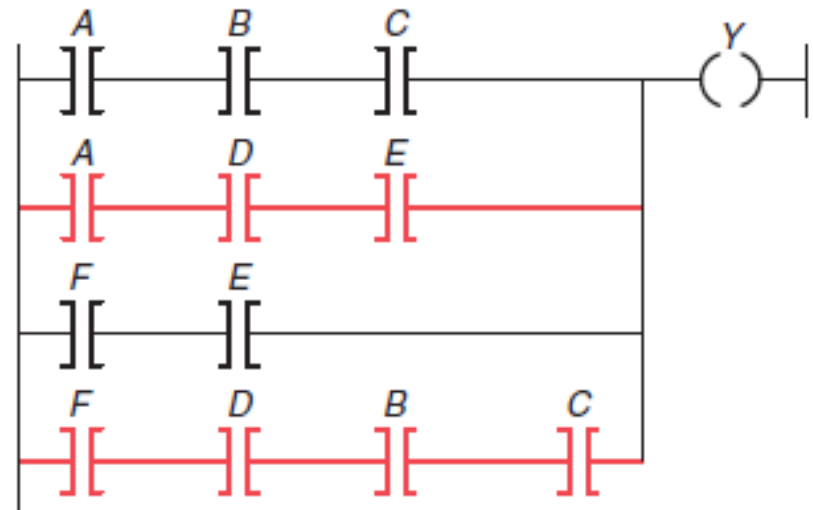


Example: What is wrong in the given solution

Boolean equation: $Y = (ABC) + (ADE) + (FE) + (FDBC)$

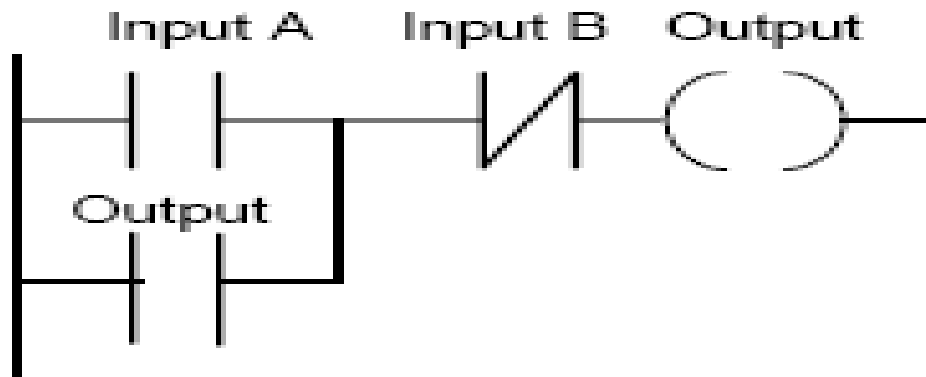


Right
Answer



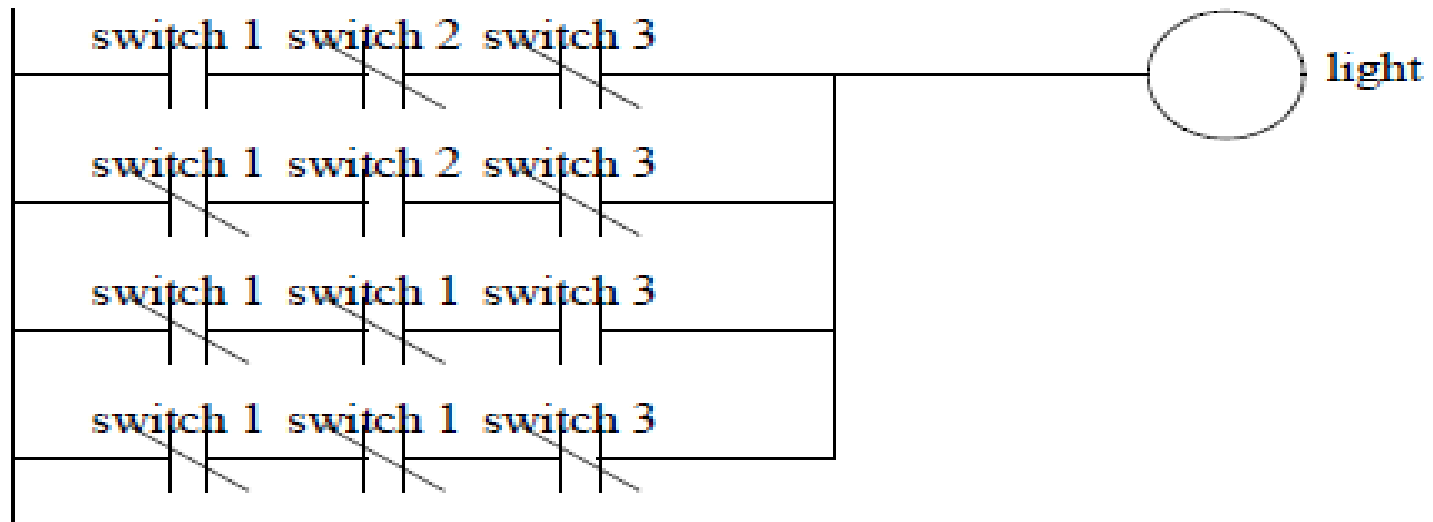
Latched circuit

- Latched circuits are used where it is necessary for contacts to stay open and/or closed even though the coil is energized only momentarily.



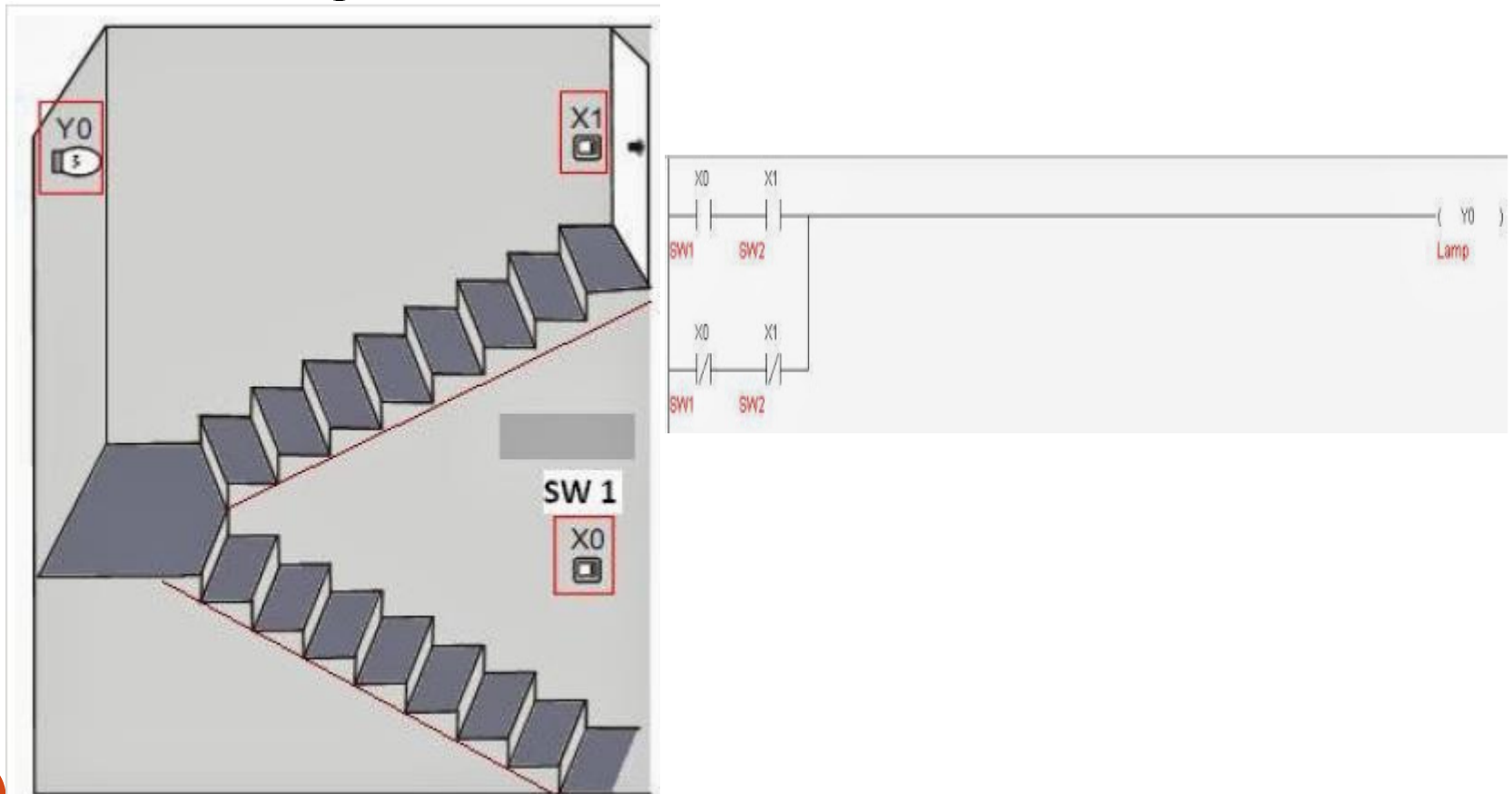
Example 1

- Try to develop a relay based controller that will allow three switches in a room to control a single light.
- Assumes that 3 switches can turn the light on or off, regardless of the states of the other switches



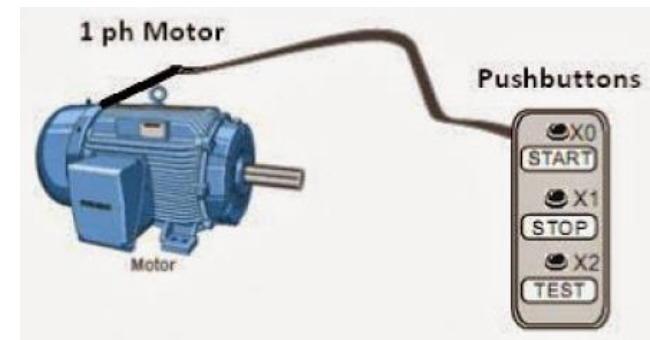
Example 2

- Switching on/off the Lamp whether they are at the bottom or the top of the staircase.



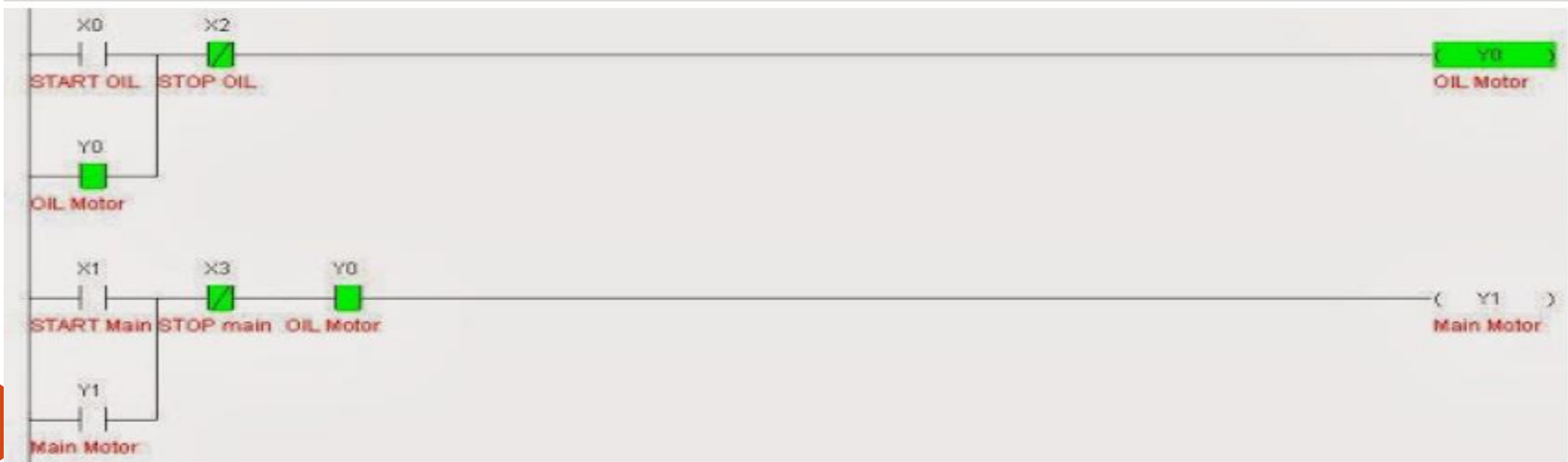
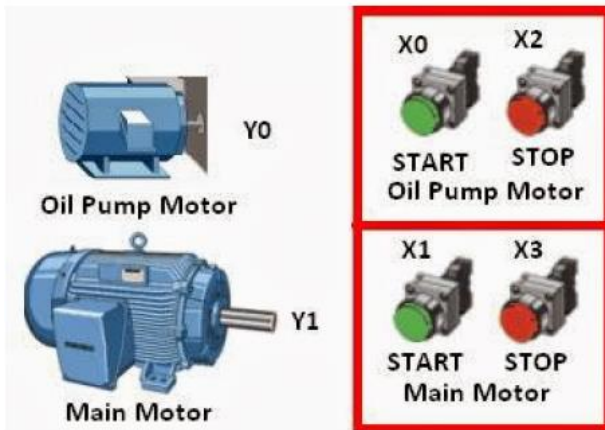
Example 2

- Controlling the running state of the 1 ph motor by pressing START and STOP pushbuttons i.e. motor should remain in ON state after START pushbutton is pressed and should OFF when STOP pushbutton is pressed. Checking if the Motor is running normally by pressing TEST pushbutton. Motor should go OFF when any error occurs.



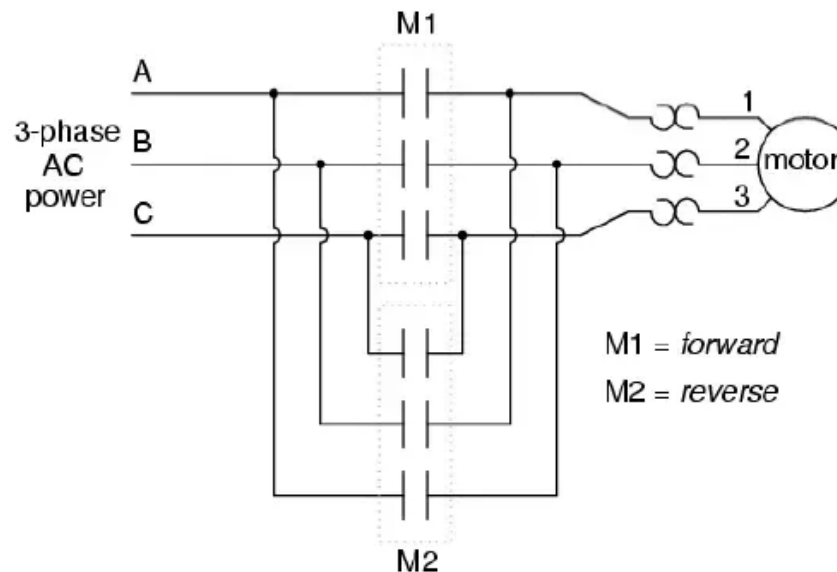
Example 3

- Providing lubricant for the gear box before the lathe spindle starts to run which aims to ensure that the oil pump motor starts first and the main motor starts subsequently

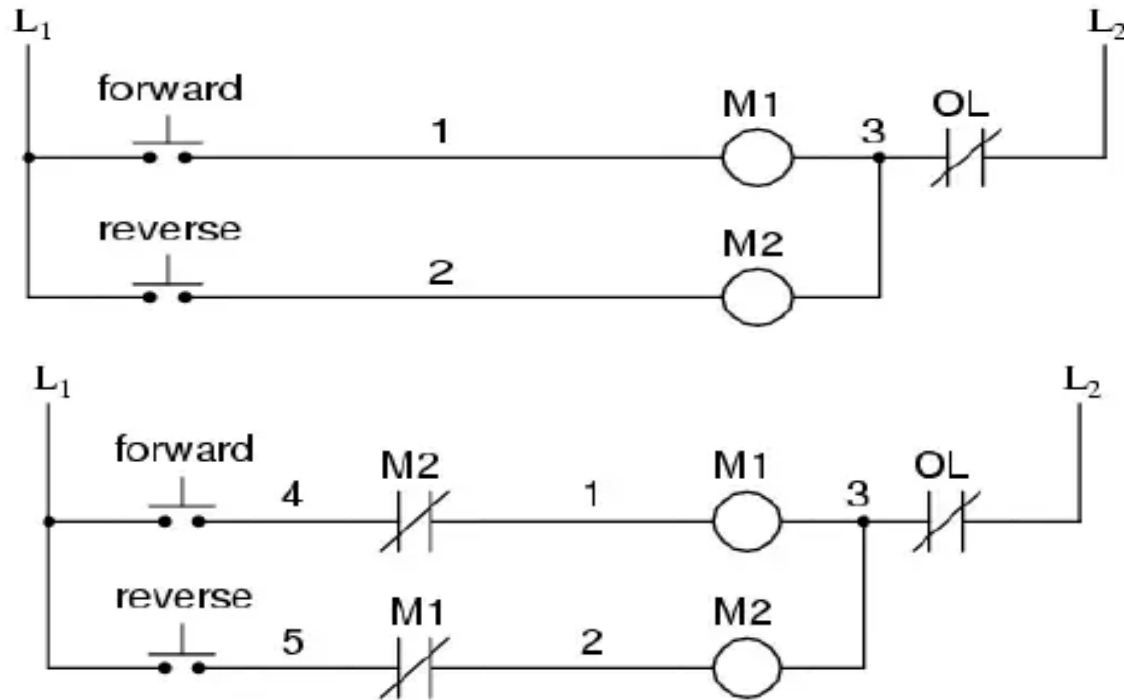


Interlocking:

- Practical application of relay logic is in control systems where we want to ensure two incompatible events cannot occur at the same time.
- An example of this is in reversible motor control, where two motor contactors are wired to switch polarity (or phase sequence) to an electric motor, and we don't want the forward and reverse contactors energized simultaneously:



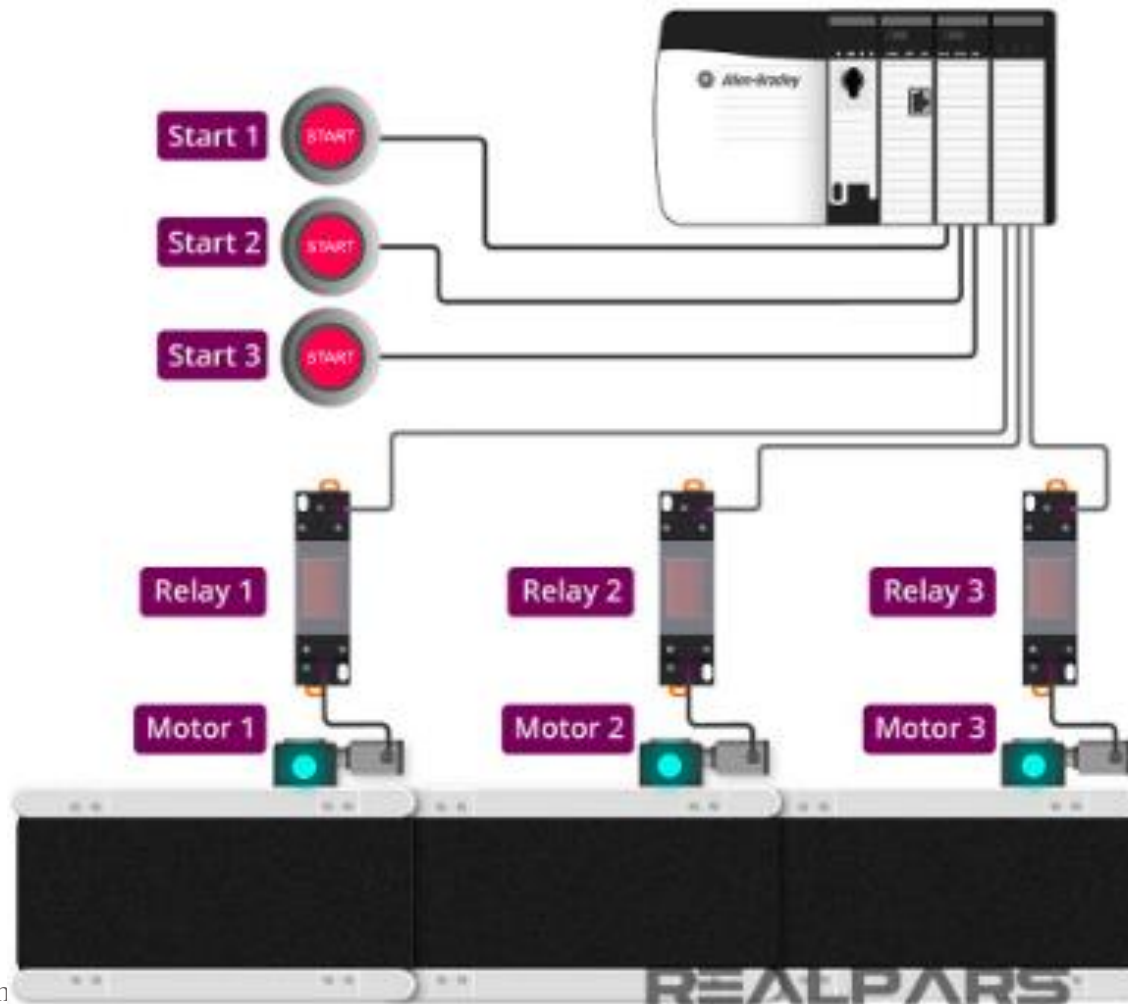
Control circuit for these two contactors:

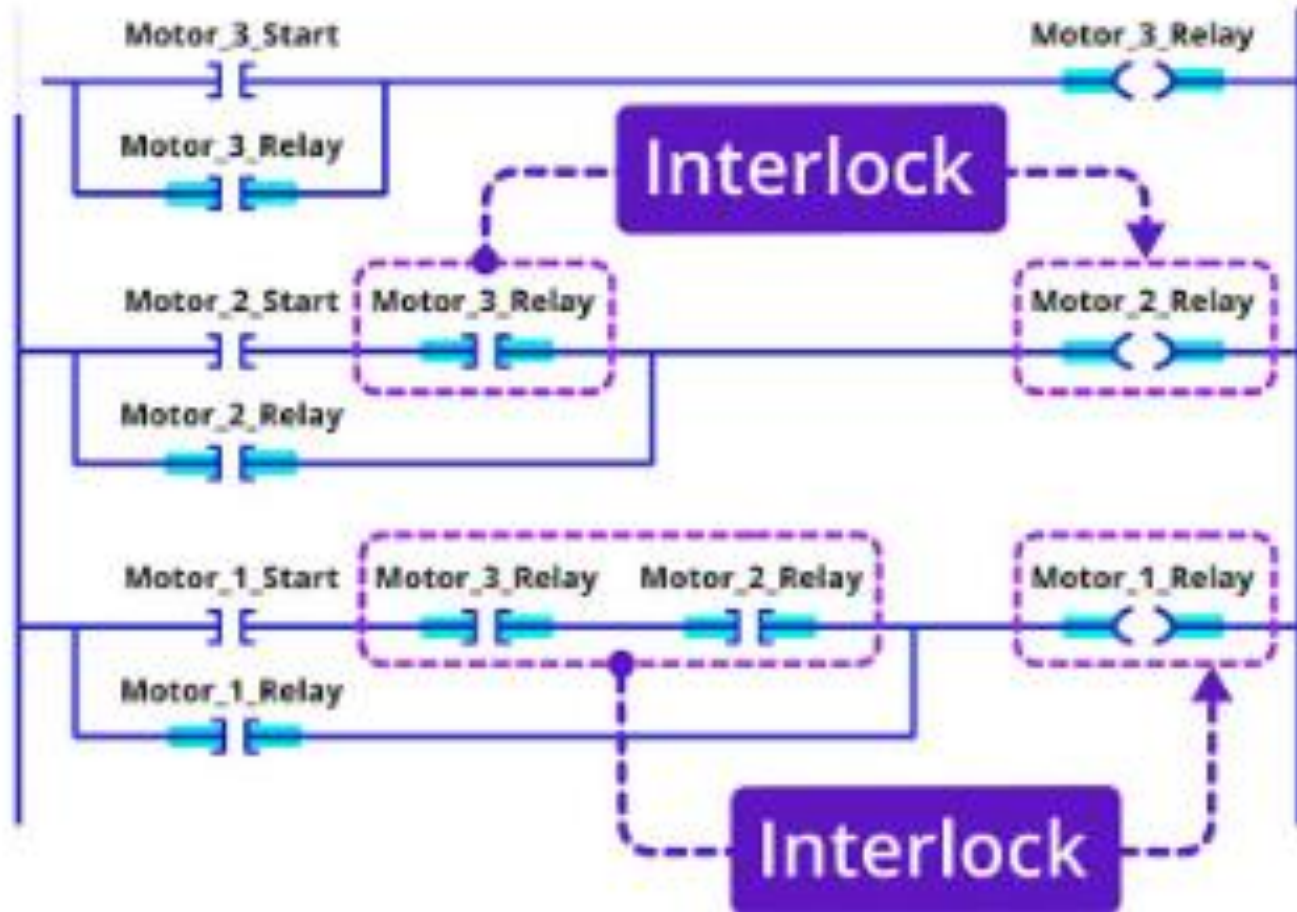


- To prevent this occurrence from happening, we can design the circuit so that the energization of one contactor prevents the energization of the other. This is called *interlocking*
- Interlocks are conditions that must be TRUE in order for a particular output to be allowed to be energize.

Example 4:

- Develop a ladder logic diagram for a cascading conveyor system





Always ON and Always OFF

- how to create always ON and OFF bit?
- In the plant when the machine lost its power and comes back after some time, then we need some functions to perform automatically when starting the machine.

Reerence

- Frank D. Petruzella, *Programmable Logic Controllers*, MGH, (2e), 1997.