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Industrial Controls (1)

By

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Lecture (8)

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PLC Industrial applications

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EX:(1): PLC Program for Motor Starter

- **PLC for motor starter It should have the following provisions:**

1. Push button: to start the motor, The motor should continue to rotat e even when the push button is released.
2. Stop Push button: to halt the motor after it started.
3. Over current protection : In case of over load, the motor should stop automatically by the signal coming from contactors of overloa d relay.
4. Limit switch : It should prevent the motor from starting and can also stop the running motor.
5. The motor starter should also have indicator (Lights) to show ON or OFF status of motor.

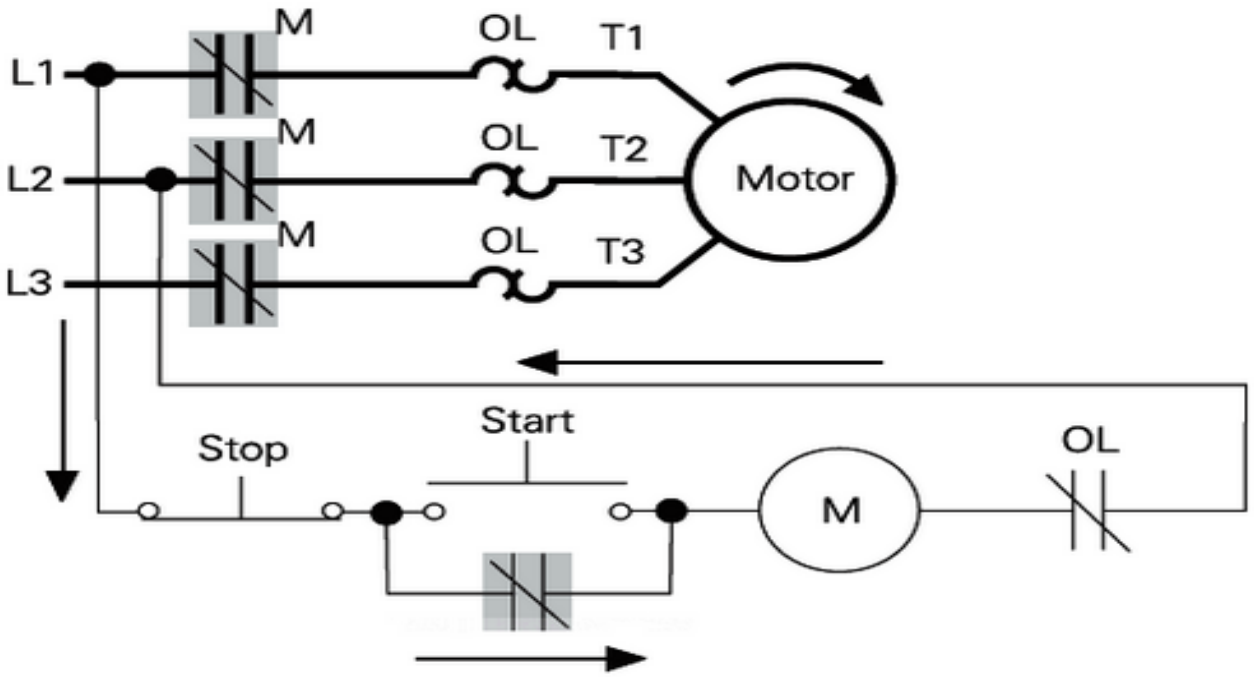

Figure (1): Motor Electrical Schematic

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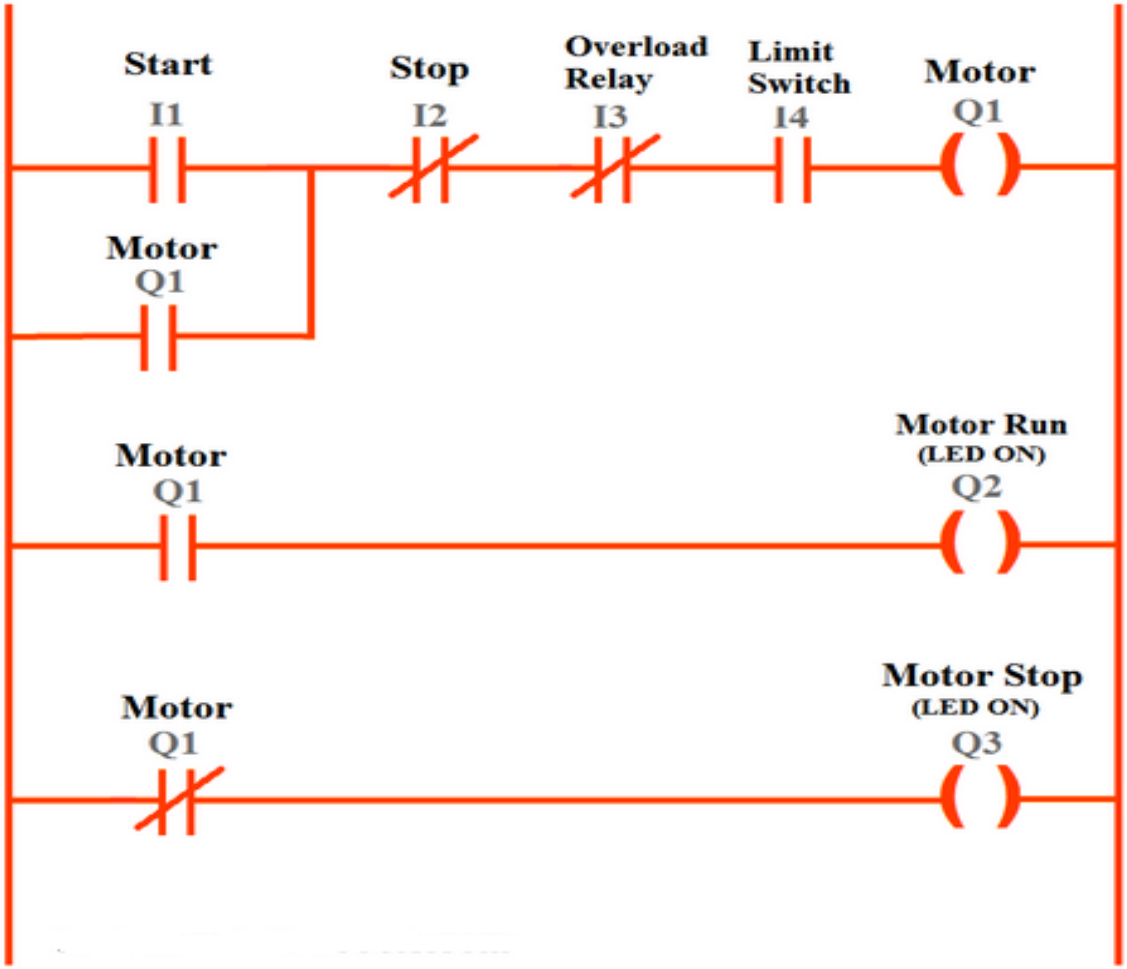

Ladder (1): Ladder diagram for Motor starter

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- **Observation:-**

1. **Start Button I1:**

Normally open contact (Make contact) is used because the motor should only start when the button is pressed.

2. **Stop Button I2 :**

Normally close (break contact) contact is used because the button should normally be closed or high so that the motor keeps on running. It should open when the button is pressed. It is opposite to start push button.

3. **Overload relay I3 :**

In normal condition, this relay should allow the motor to rotate so normally close contact is selected for it. In case of overload it will stop the motor by opening its contact.

4. **Limit switch I4 :**

The motor should only rotate when the limit switch is closed therefore normally open contact is used.

4. Output Q1, Q2, Q3 :

Relay coil Q1, Q2 and Q3 represent motor output, motor indication ON and indication OFF respectively.

ON indicator gets input from normally open input which depends upon output Q1. OFF indicator is fed by normally close input which depends upon output Q2.

5. Input Q1 (for continuous rotation):

Since it is required that once push button is pressed, motor should run continuously even if the push button is released.

EX:(2): Continuous bottle filling system

- **Objective:**

1. will implement a control program that detects the position of a bottle via a limit switch then waits for 0.5 secs.
2. and then fills the bottle until a photodetector detects the filled condition of the bottle.
3. After the bottle is filled ,the buzzer sounds and the control program will again wait for 0.7 secs. before moving to the next bottle.
4. Until the limit switch signals ,the feed motor,M1 runs while there are fixed rollers which carries the filled bottles. Motor,M2 keeps running after the process has been started.

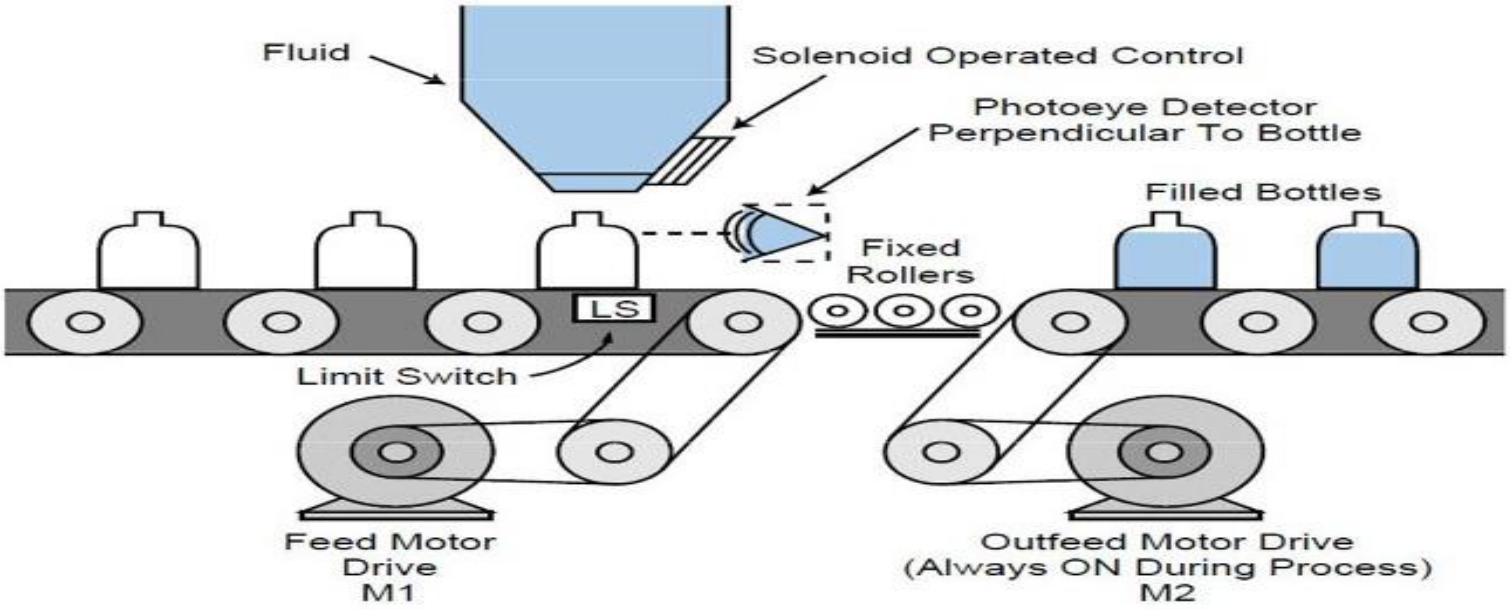
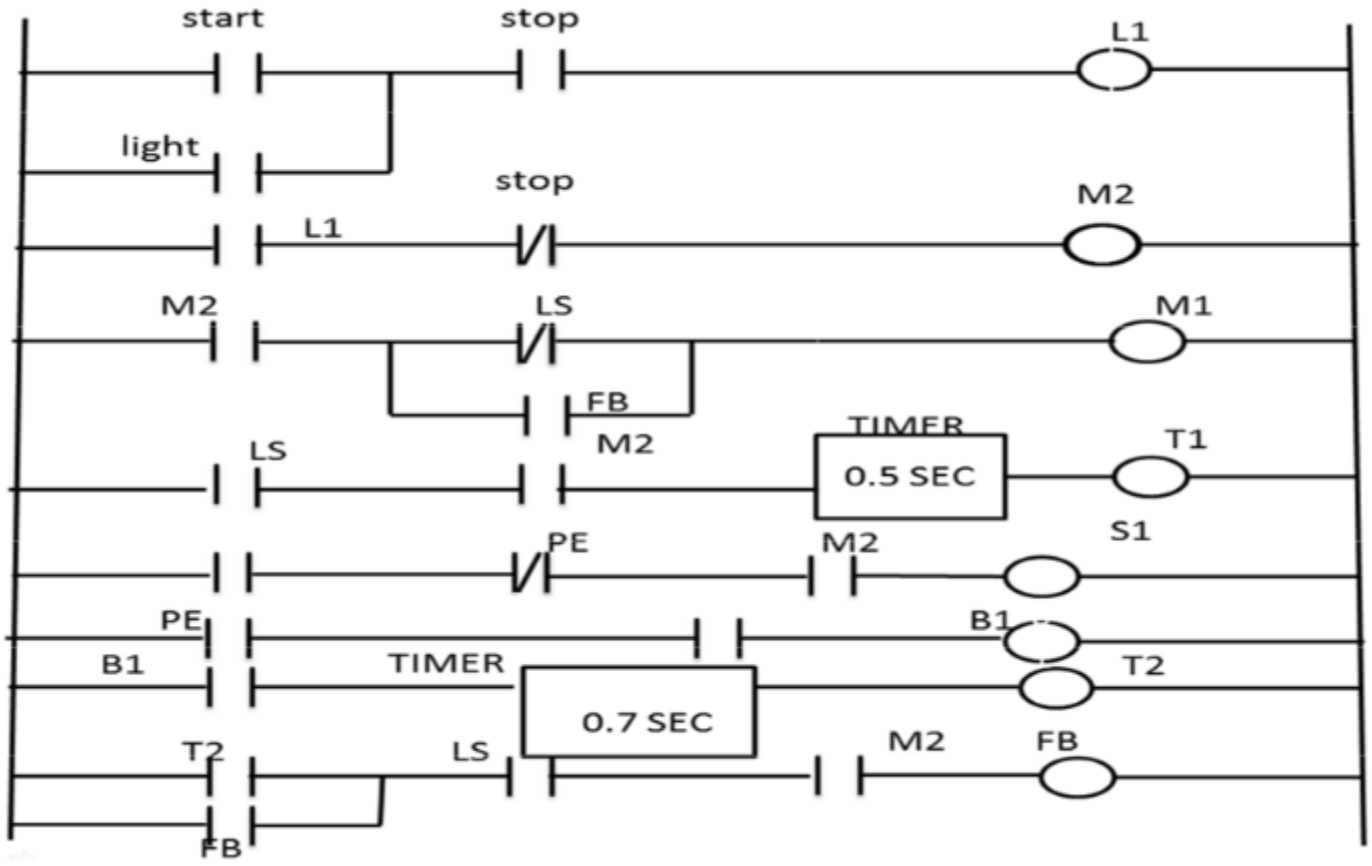


Figure (2): Bottle filling system

Inputs	address
Start	I0:15
Stop	I1:15
Limit switch(LS)	I2:15
Photo detector(PE)	I3:15

Outputs	address
Feed motor(M1)	O0:15
Outfeed motor(M2)	O1:15
Solenoid valve(S1)	O2:15
Light(L1)	O3:15
Buzzer(B1)	O4:15

Table (2): Inputs and outputs employed



ladder (2): ladder diagram for bottle filling system

- **Observation:-**

1. Once the start button is pressed the green light (L1) turns ON and remains ON until stop button is pressed. As light turns ON outfeed motor(M2) starts running.
2. After M2 runs and if either limit switch(LS) has not signaled or filled bottle condition is fulfilled motor(M1) starts.
3. After limit switch has signaled timer,T1 gets activated.
4. After T1 gives done (DN) signal and photo eye detector (PE) is disabled ,solenoid valve gets in operation. As PE signals solenoid stops and buzzer(B1) sounds after which timer,T2 gets enabled which stops the process for 0.7 seconds.
5. Once the filled bottle condition is activated the cycle starts again.

EX:(3): Batch mixing system

- This is another commonly applied application of PLC where two liquids are mixed in required proportion to form a batch.
- Rate of the flow is already fixed. We only control the time of the flow.
- Level of the liquids in the tank are sensed by the level sensor switches .

- **Objective:-**

1. a simple blending of water and acid in a container where we only have three level sensors (L1,L2, and L3) and two liquids flowing in through two solenoid valves, solenoid A (water control) and solenoid B (acid control) and draining out through solenoid C (blend outflow).
2. The batch is to be controlled by timer.
3. After required level of blend is sensed (by L1) the mixer runs for 3 mints. by the motor.
4. They are mixed in ratio of 3:2.
5. The process initiates with the drain valve open, water and acid valves closed, mixer motor is off, and the tank is empty.

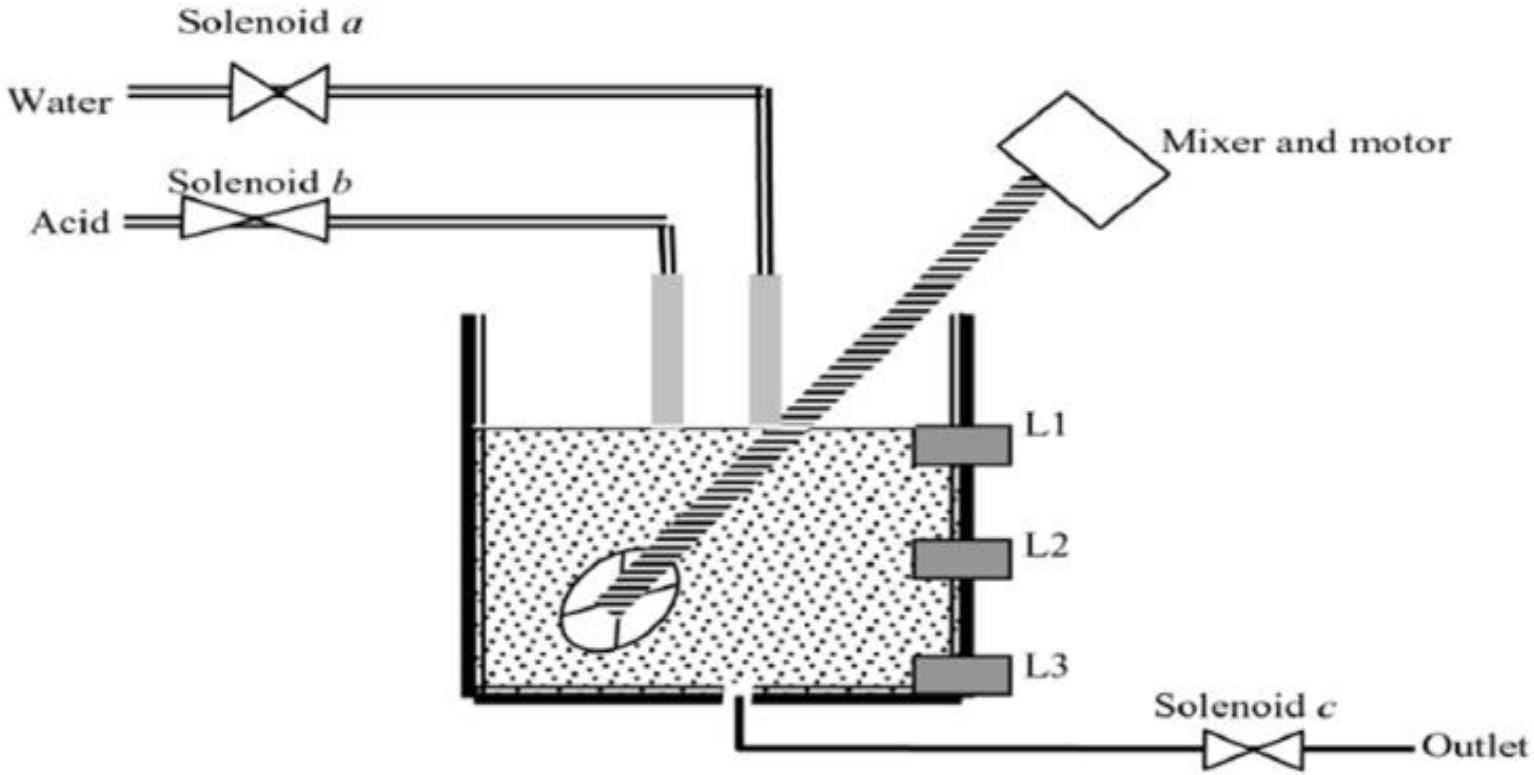
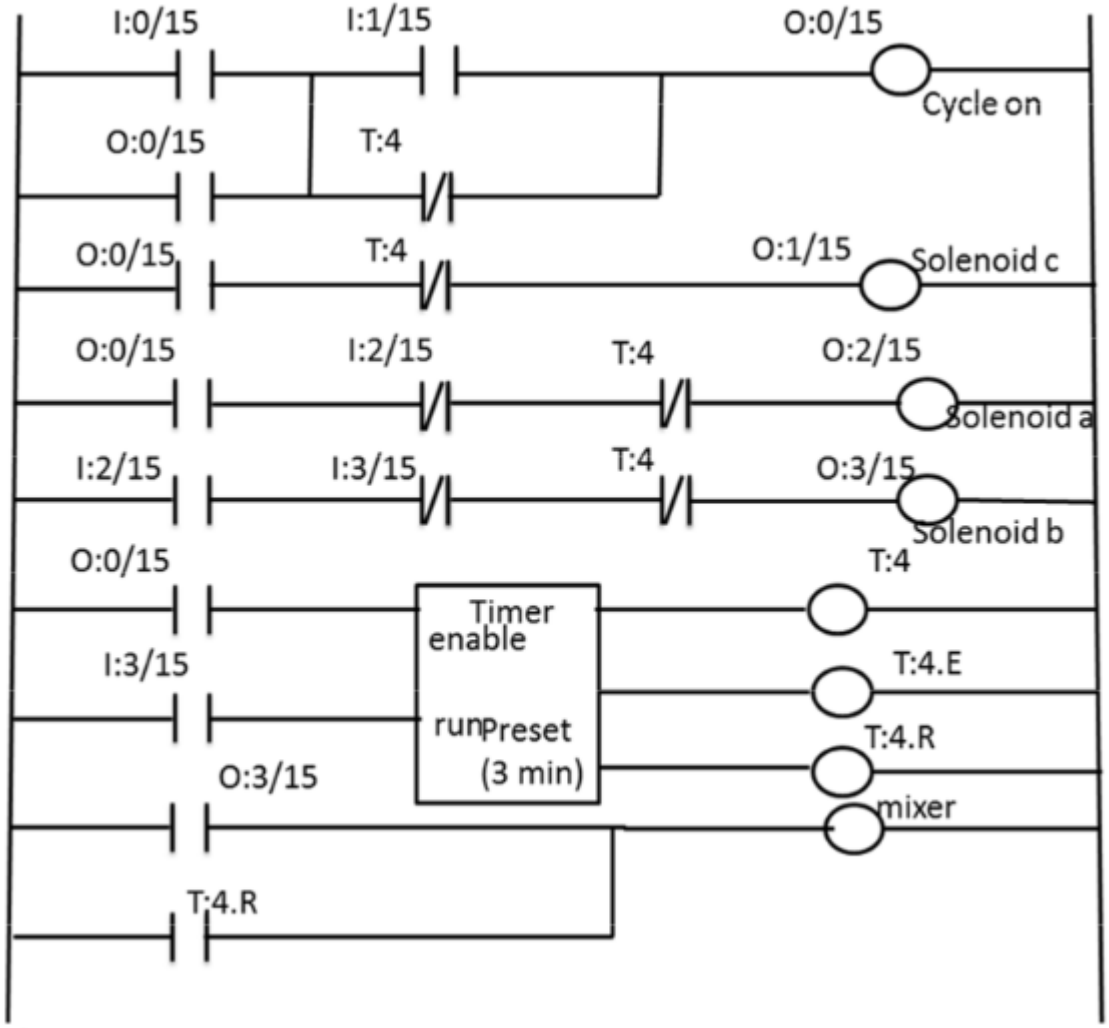


Figure (3): Batch mixing system



ladder (3): Ladder diagram for batch mixing system

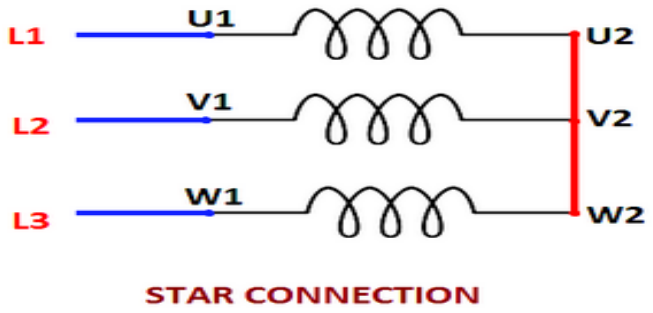
- **Observation:-**

1. When start button is pressed water is filled up to L2 and it ends as L2 is closed. First of all as start is pressed output O:0/15 turns ON and remains ON until tank is emptied.
2. Rung 2 closes normally open drain valve, before timer T:4 activates.
3. Rung 3 energizes solenoid A until L2 doesn't signal, once it signals solenoid A gets de-energized.
4. Then motor is turned ON and mix it for 3 mints. Similarly acid is filled up to L3 by solenoid B .as level gets detected by L3 solenoid B de-energizes. And then mixer gets started and it runs for 3 minutes.
5. After time delay of 3 mints solenoid C opens and the blend gets drained out .Once the blend gets out completely ,the process cycle restarts.

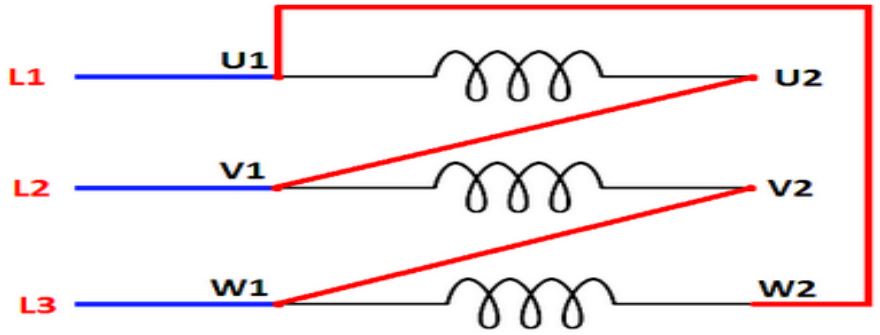
EX:(4): Star Delta Motor Starter system

- **Objective:**
- In DC motors there is no back emf at starting therefore initial current is very high as compared to the normal current.
- To protect the motor from these high starting currents we use a star and delta starter.
- Simply in Star connection, supply voltage to motor will be less. so we use star connection during starting of the motor, after motor running we will change the connection form star to delta to gain full speed of the motor.
- in the tank are sensed by the level sensor switches .

- The following figure shows the winding connections in star and delta configuration one by one.

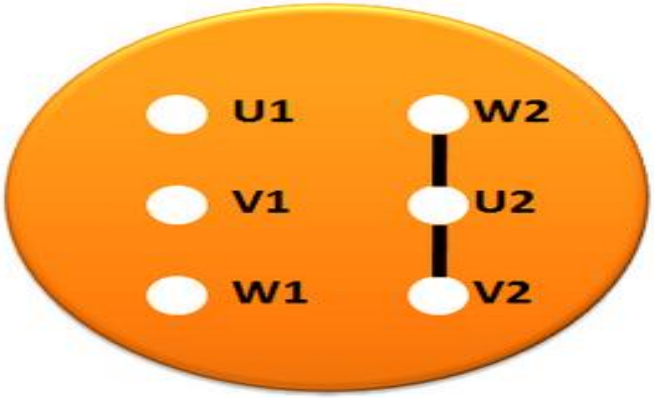


STAR CONNECTION

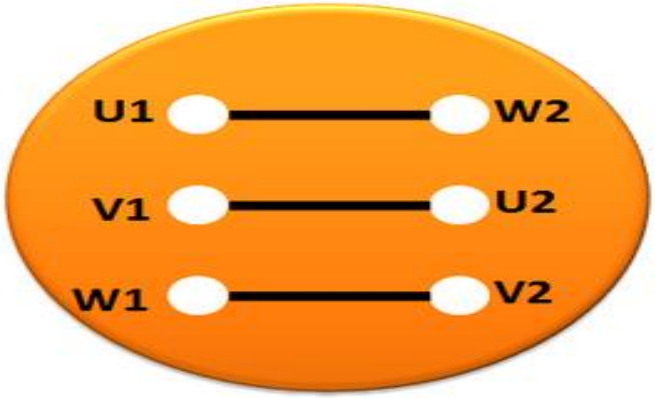


DELTA CONNECTION

- It can be seen that in star connection, one end of all three windings are shorted to make star point while other end of each winding is connected to power supply.
- In delta configuration, the windings are connected such that to make a close loop.
- The connection of each winding is shown in above figure. In actual motor the three phase connections are provided in the following order as shown

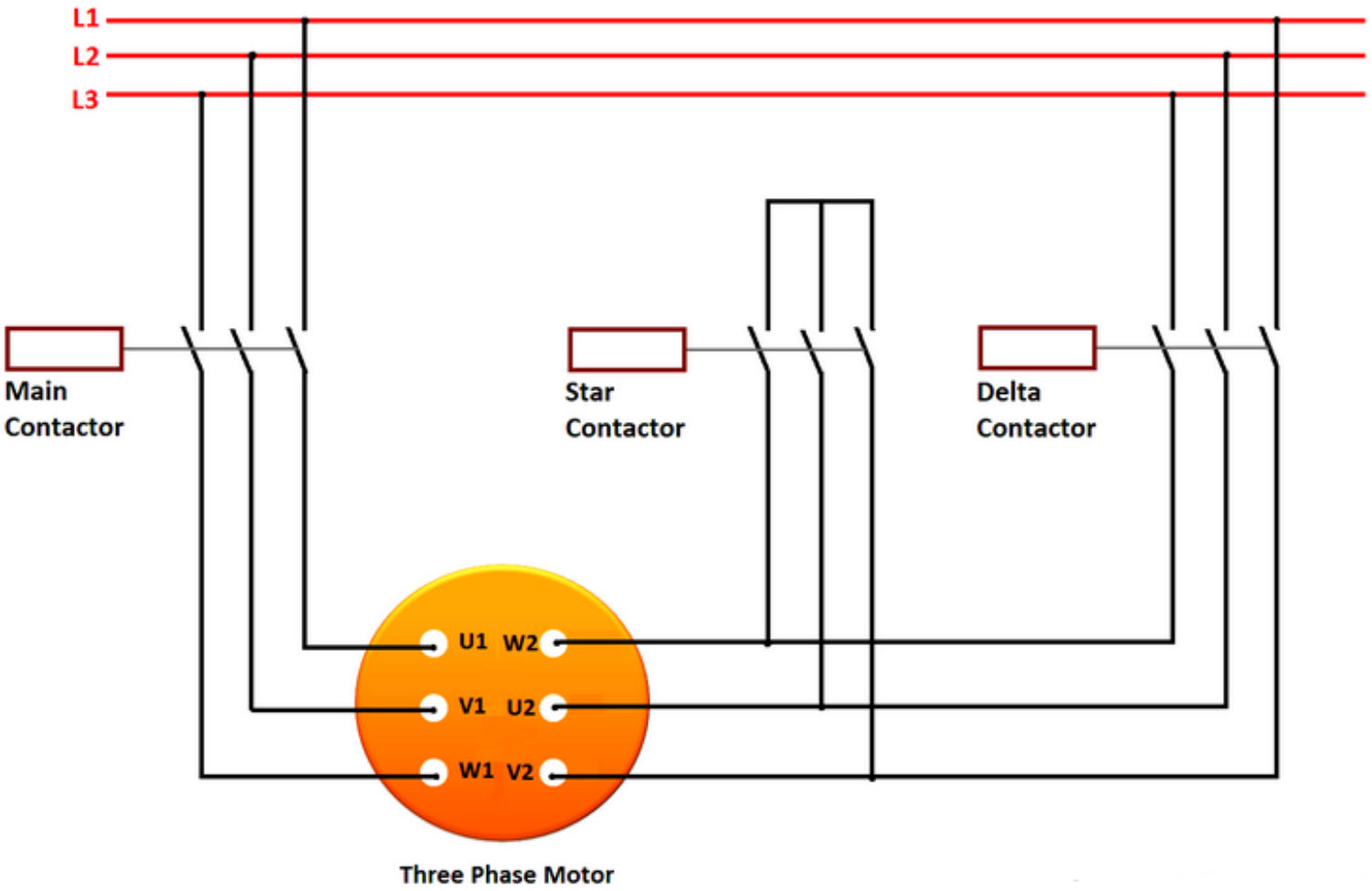


STAR CONNECTION

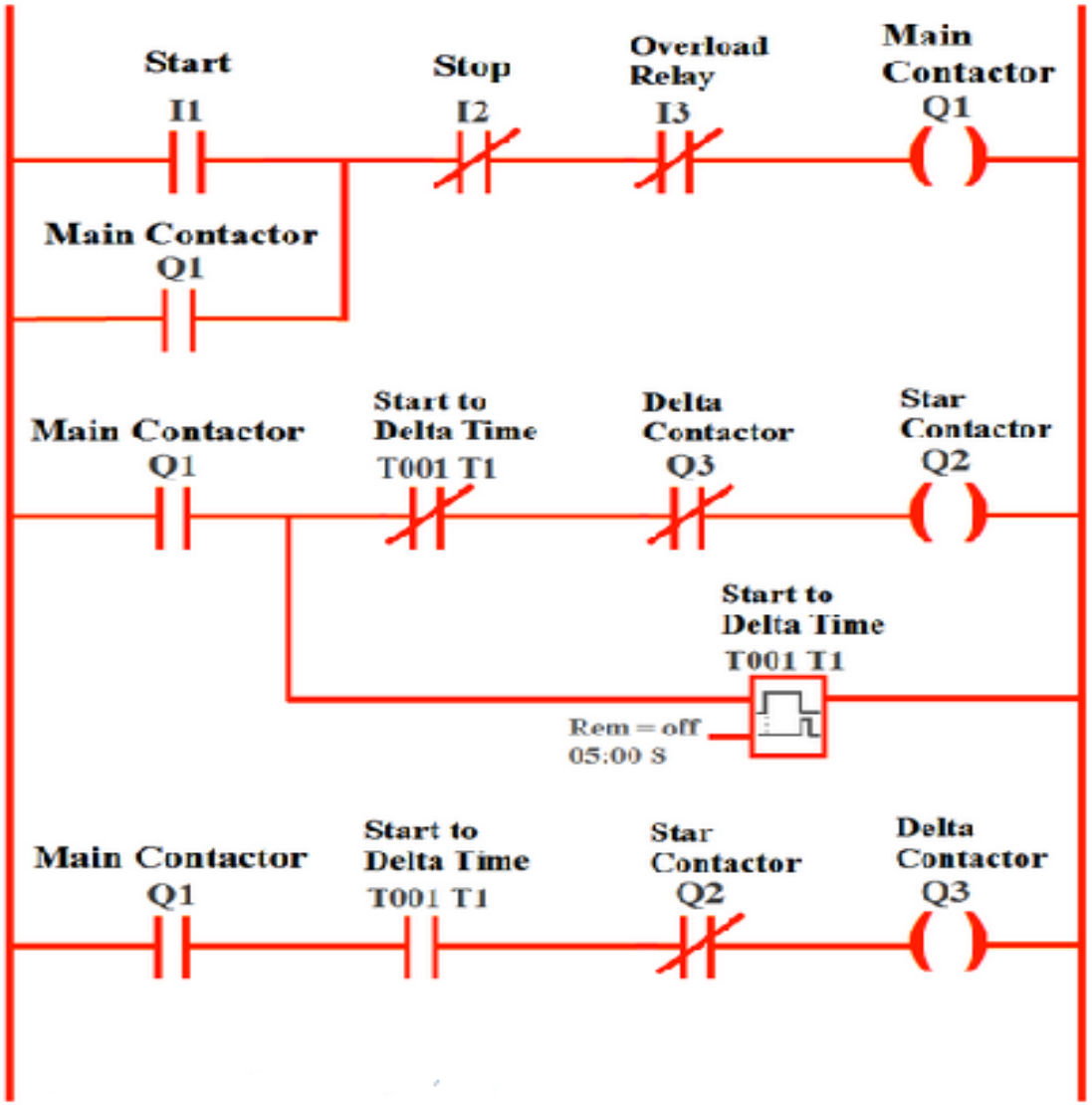


DELTA CONNECTION

- winding connection in star and delta style in practical motor



- PLC program for star delta motor starter :



- **Observation:-**

1. **Rung 1 Main contactor :**

- The main contactor depends upon the normally open input start push button (I1), normally closed stop button (I2) and normally closed overload relay.
- It means that Main contactor will only be energized if start button is pressed, while stop is not pressed and overload relay is not activated.
- A normally open input named (Q1) is added in parallel to the start button I1.
- By doing so, a push button is created which means that once motor is started, it will be kept started even if start button is released

2. **Rung 2 Star contactor:**

- Star contactor depends upon main contactor, normally close contacts of timer (T1), and normally close contacts of output delta contactor (Q3).
- So star contactor will only be energized if main contactor is ON, time output is not activated and delta contactor is not energized.
- **Timer T1:**
- Timer T1 measures the time after which the winding connection of star delta starter is to be changed. It will start counting time after main contactor is energized.

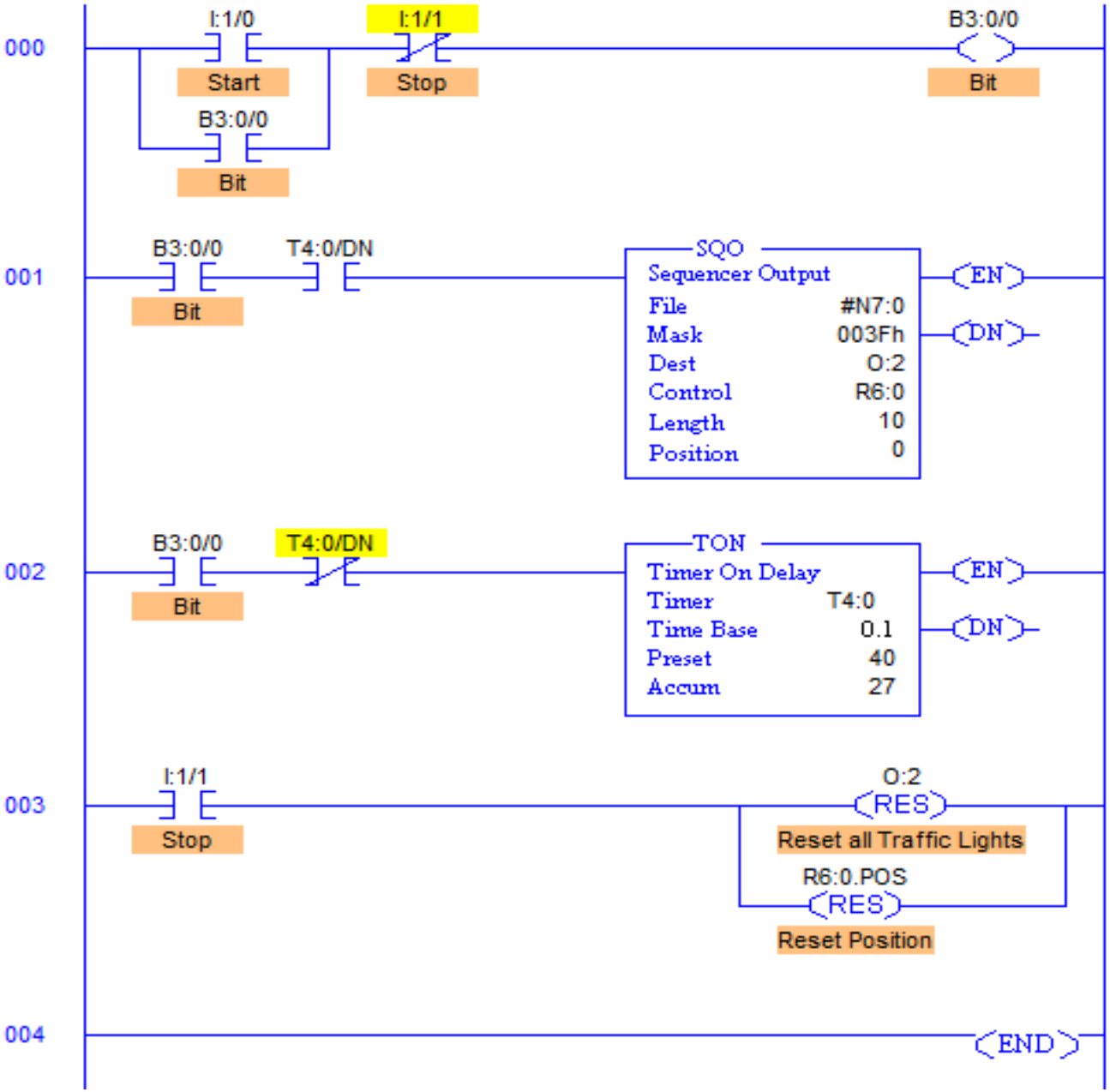
3. **Rung 3 Delta contactor:**

- Delta contactor will be energized when main contactor (Q1) is energized, timer T1 is activated and star contactor (Q3) is de-energized.

EX:(5): control traffic light

- **List of I/P and O/P:**

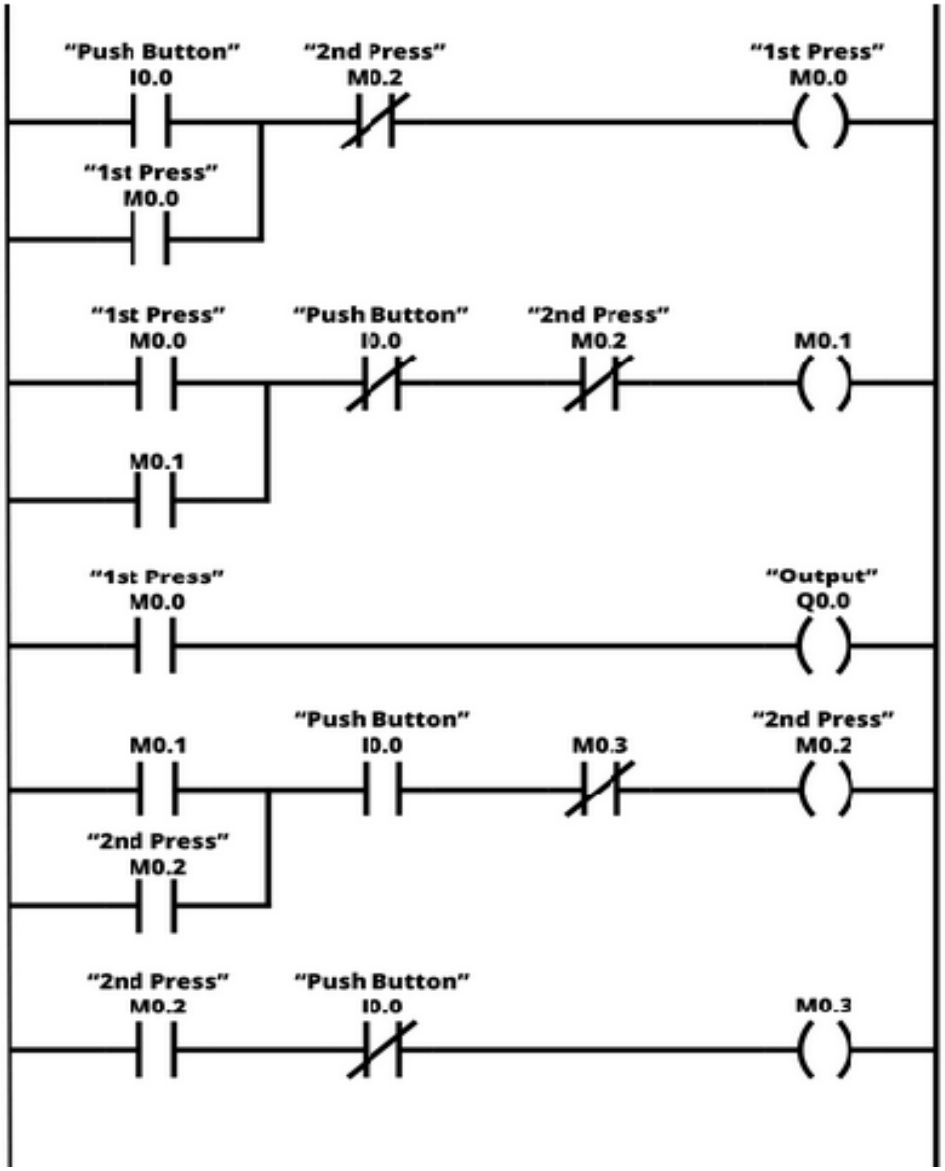
```
List of Inputs and Outputs
 I:1/0   = Start                                  (Input)
 I:1/1   = Stop                                   (Input)
 B3:0/0  = Latched Coil Bit                       (Bit)
 T4:0    = Timer to update output sequence        (Timer)
 SQO     = Sequencer output                       (Sequencer)
 O:2/0   = North-South Green Light                (Output)
 O:2/1   = North-South Yellow Light               (Output)
 O:2/2   = North-South Red Light                  (Output)
 O:2/3   = East-West Green Light                  (Output)
 O:2/4   = East-West Yellow Light                 (Output)
 O:2/5   = East-West Red Light                    (Output)
```



Ladder(5): Ladder Diagram to control Traffic Light

EX:(6): Single Push Button On/Off Ladder Logic

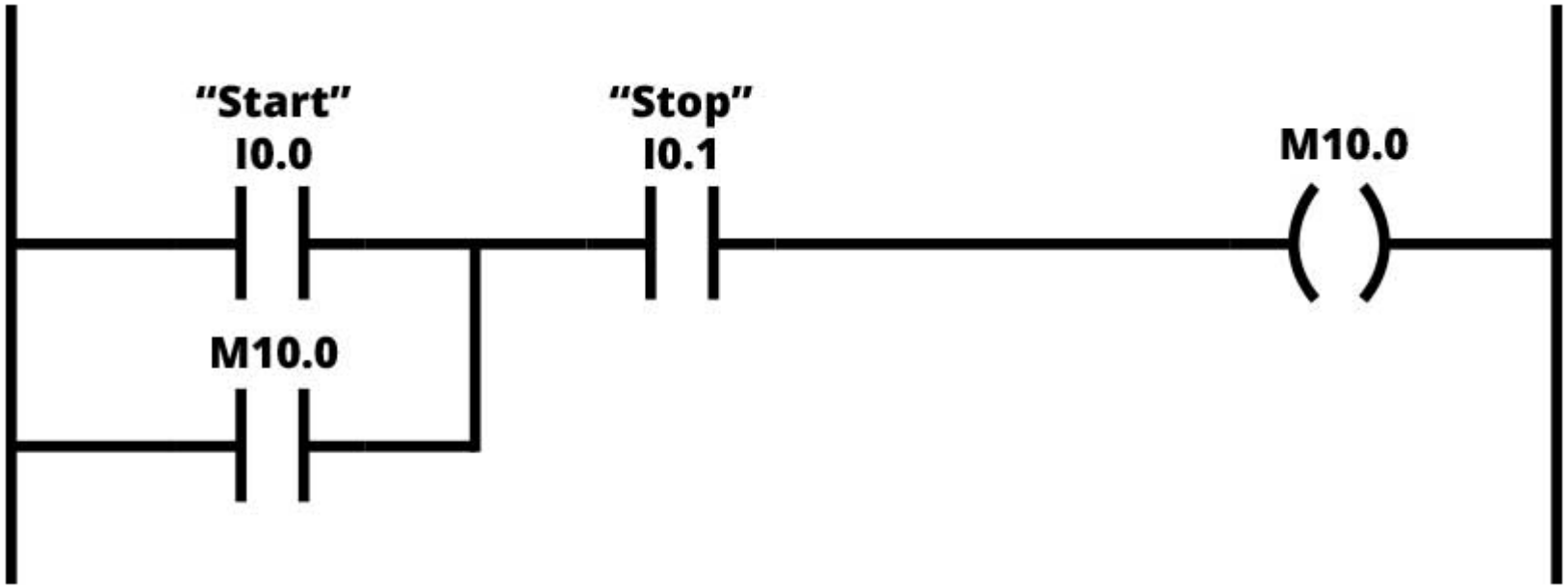
- This function is also called push on push off logic sometimes even flip-flop or toggle function.
- It is the same function as the on/off button on your computer or mobile phone.
- When you push the button the first time, the output will be activated. Now, when you push the button for the second time, the output will deactivate and turn off.
- The single push button has two functions: on and off.



Ladder(6): Single push button ON/OFF ladder logic

EX:(7): Start/Stop Ladder Logic Relay

- This is how the ladder diagram looks for a simple start/stop function. The function can be used to start and stop anything like a motor start/stop.
- **In this ladder logic example, there are two inputs.**
  - "Start button" or PLC input I0.0.
  - "Stop button" or PLC input I0.1.
- The start button will activate the relay, or ladder logic relay M10.0. When the start button is released, the relay will still be activated, because of the latch in ladder rung 2. This latching will be broken when the stop button is activated.



Ladder(7): Start/Stop Ladder Logic Relay

Advanced PLC
Industrial applications

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EX:(8): PLC Program for a car parking system

- **Problem Description**

A parking plot has total capacity of Cars. Number of empty spots are displayed on the display outside the Parking Plot and which spots are a vailable is to be indicated by LEDs.

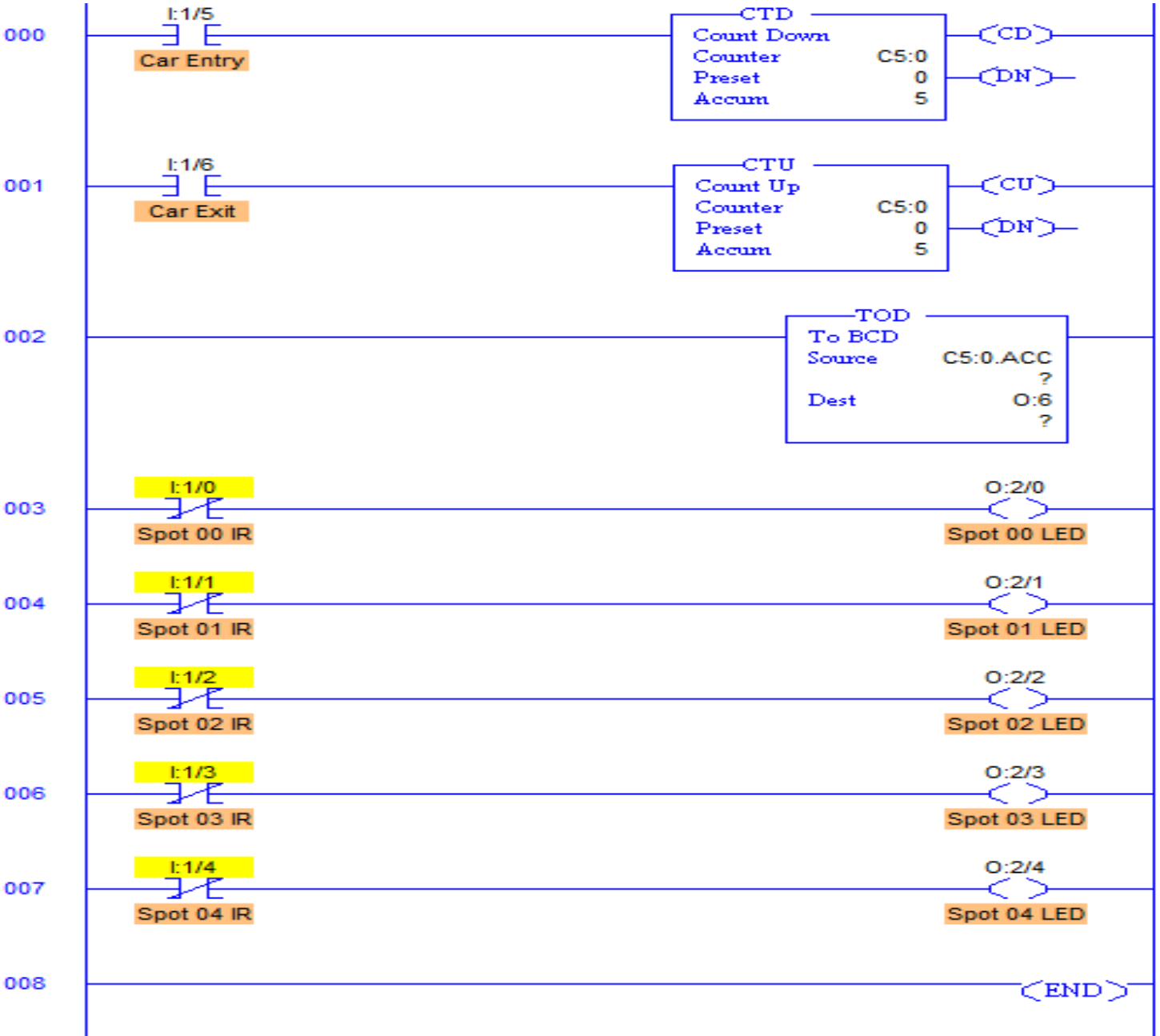
- **Problem Solution**

➢ Counter is used to count the number of empty spots.
➢ Proximity Sensors or IR Sensors are used to detect the presence of c ar.
➢ Value of counter is displayed on the display which is mounted outsi de the parking plot.

- **PLC Program**

```
List of Inputs and Outputs
 I:1/0 to I:1/4 = IR Sensor to detect the presence of cars (Inputs)
 O:2/0 to O:2/4 = LEDs to indicate presence of car spots   (Outputs)
 C5:0           = To increment when Car exits              (Counter Up)
 C5:0           = To decrement when Car enters             (Counter Down)
 O:6            = Display address                          (Output)
```

- # Ladder Diagram for Car Parking System



EX:(9): PLC Program to Drive Motors Simultaneously with Interlocking

- **Problem Description**

Two Motors are running in a sequence one by one for a particular time. If the start button is pressed Motors run in sequence such that 1st Motor stays ON for 5secs and then 2nd Motor is turned ON and stays ON for 5secs. And the cycle is repeated until it is interrupted. While motors are running in the sequence, if one motor is running and the button of other motor is pressed, then the running Motor should stop and the other motor should run.

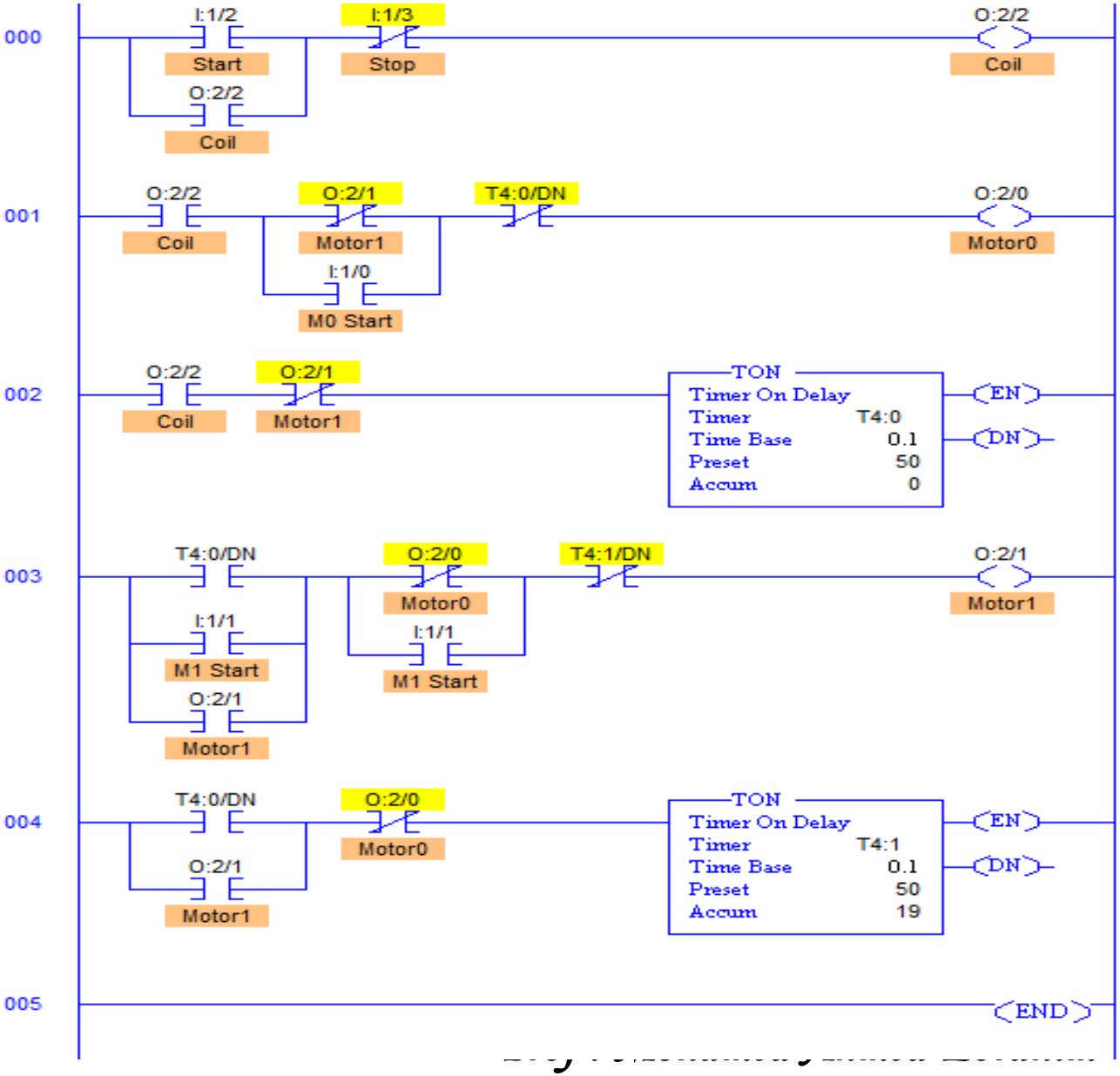
- **Problem Solution**

I. Define addresses of motors.
II. Create latching seal in contact to start and stop the sequential operation.
III. Use TON timer to generate a particular time delay, same or d ifferent.
IV. Use DN bit of first timer to energize 2nd motor coil and acti vate second timer.
V. No need to use Reset coils, program will reset the timers itse lf after completion of each cycles.
VI. Use Parallel Start Motor contact to start one motor when other motor is running.

- **PLC Program**

```
List of Inputs and Outputs
 I:1/0   = Motor0 Start              (Input)
 I:1/1   = Motor2 Stop               (Input)
 I:1/2   = Master Start              (Input)
 I:1/3   = Master Stop               (Input)
 O:2/2   = Master Coil               (Output)
 O:2/0   = Motor0                    (Output)
 T4:0    = Motor0 Timer              (Timer)
 O:2/1   = Motor1                    (Output)
 T4:1    = Motor1 Timer              (Timer)
```

- # Ladder Diagram for sequential operation of Motors with Interlocking



Thank You For Your Attention

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