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# ***Industrial Controls (1)***

*By*



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*Lecture (8)*  
*16– 05 - 2021*



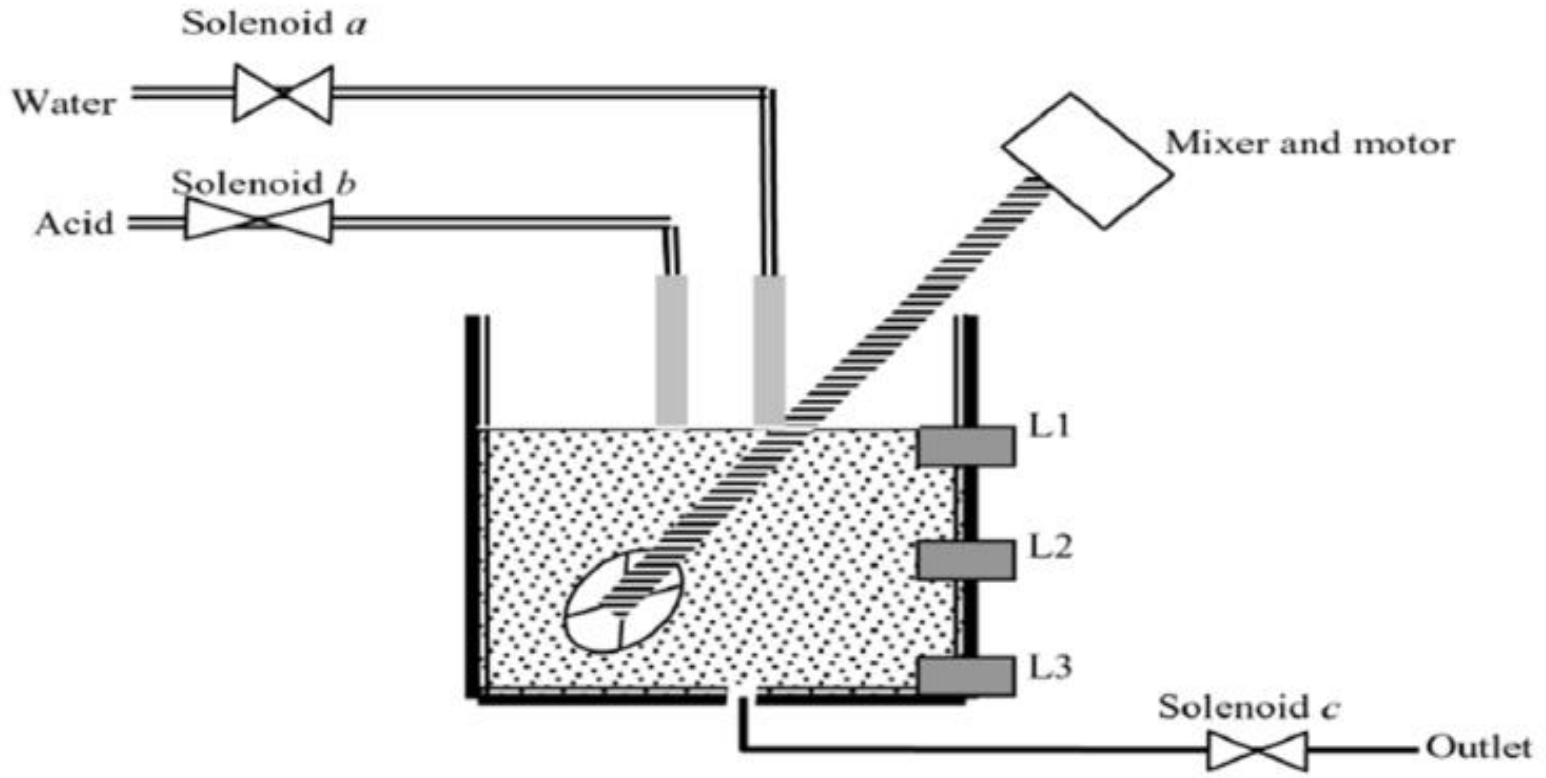
# *PLC Industrial applications*

# EX:(3): Batch mixing system

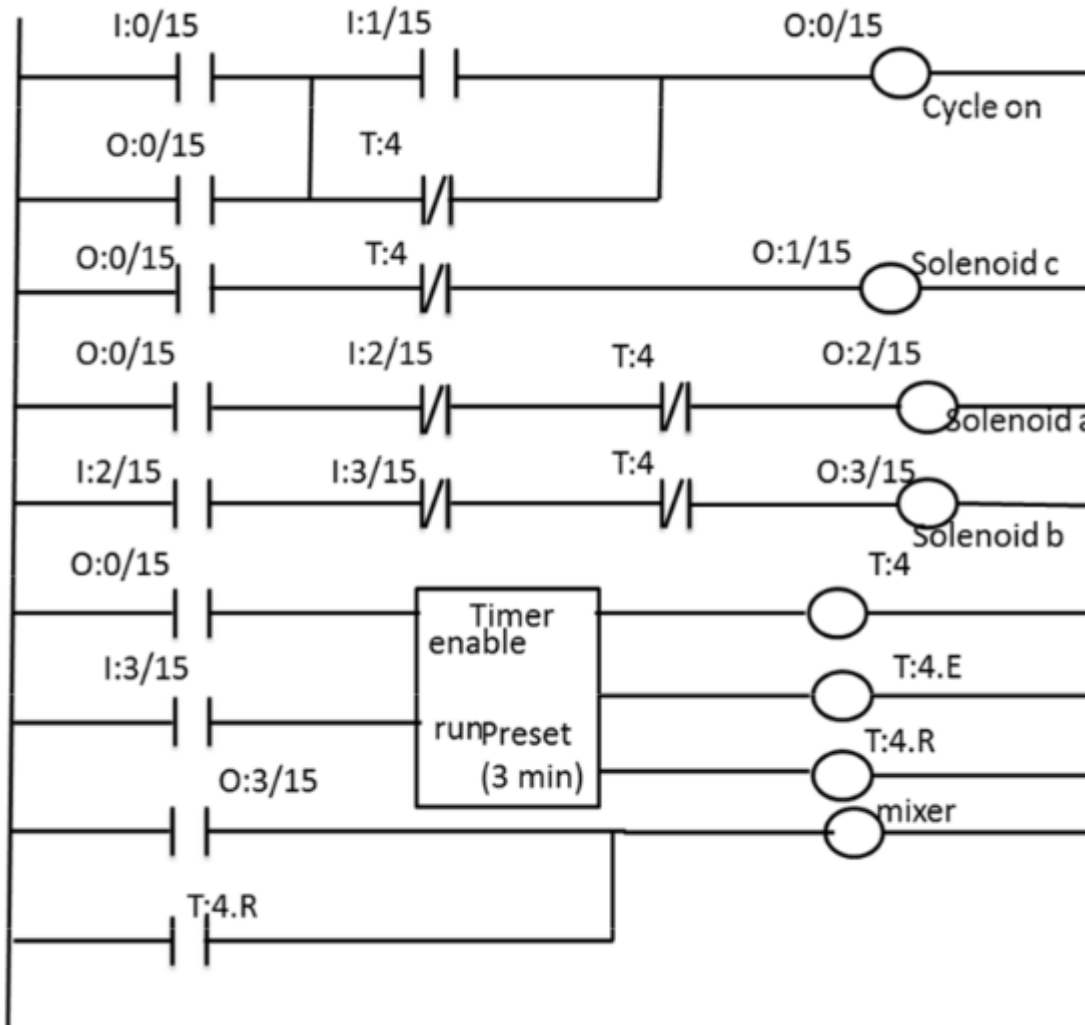
- This is another commonly applied application of PLC where **two liquids are mixed** in required proportion to form a batch.
- Rate of the flow is already fixed. We only control the time of the flow.
- Level of the liquids in the tank are sensed by the level sensor switches .

## • 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***



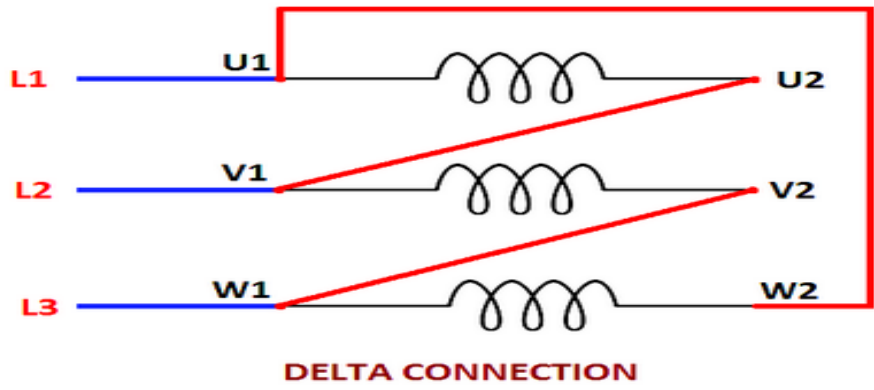
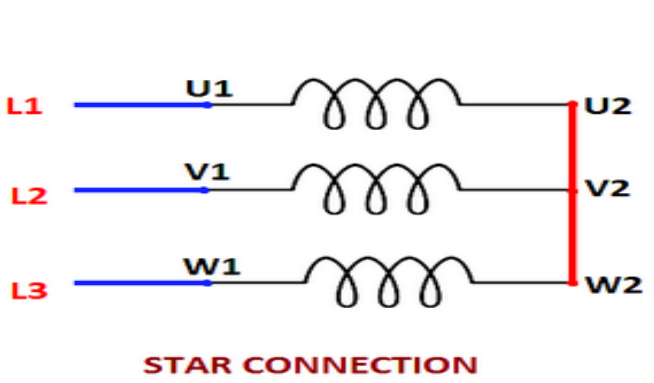
## • **Observation:-**

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.

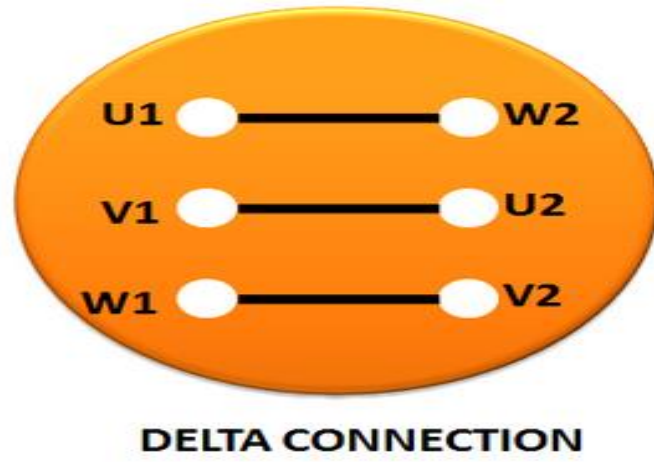
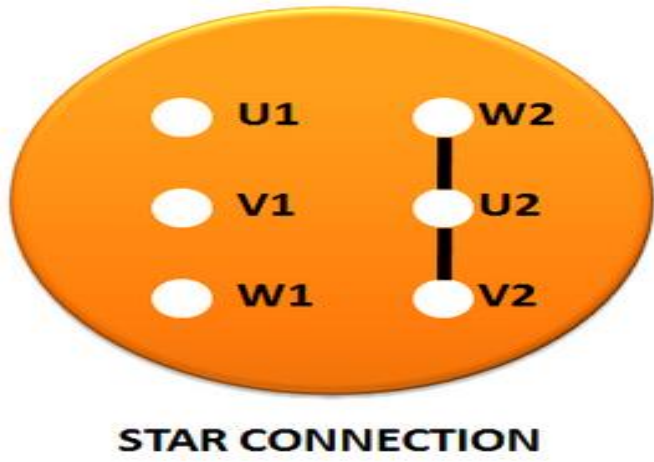
# EX:(4): Star Delta Motor Starter system

- **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** .

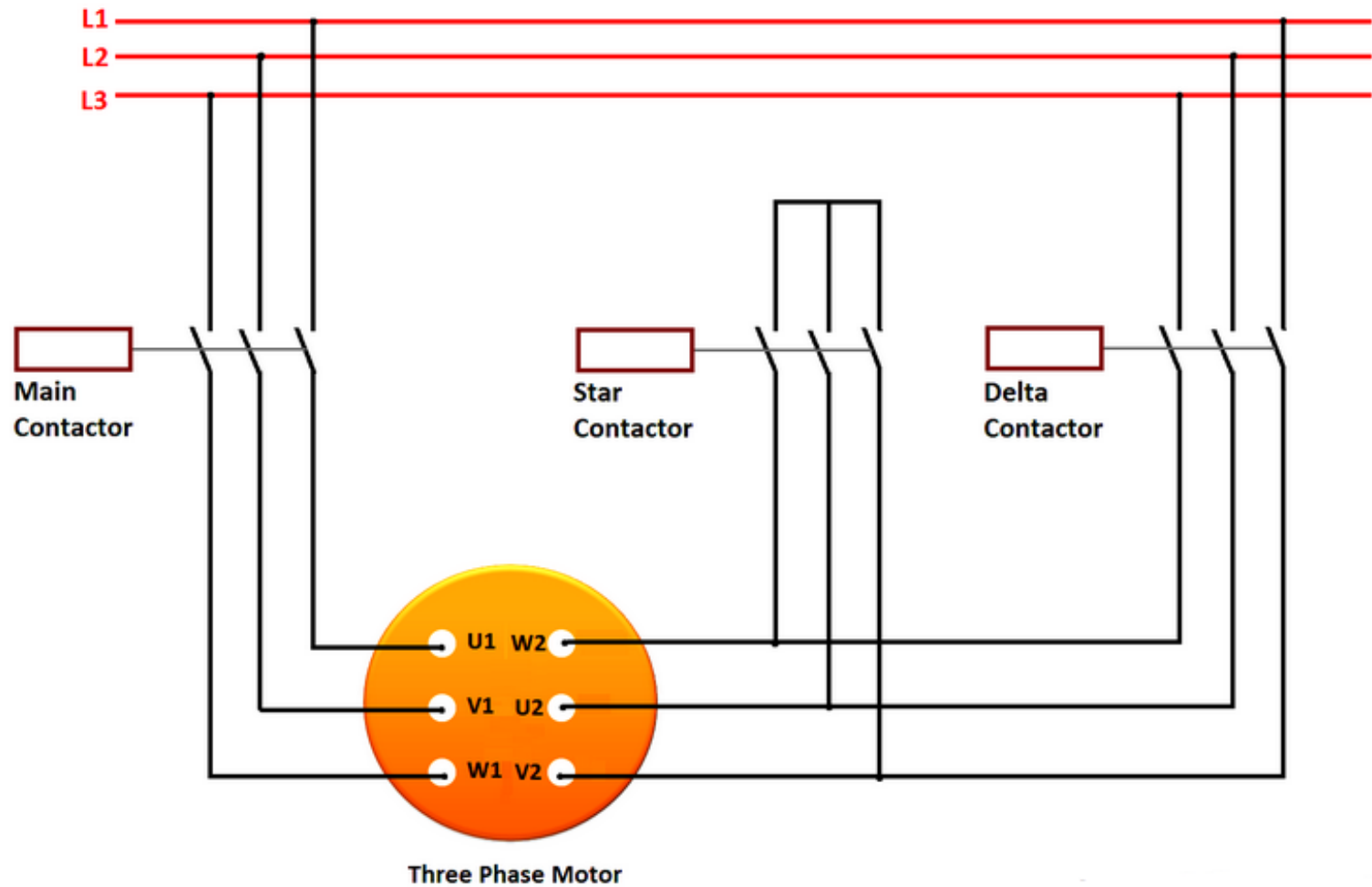
- The following figure shows the winding connections in star and delta configuration one by one.



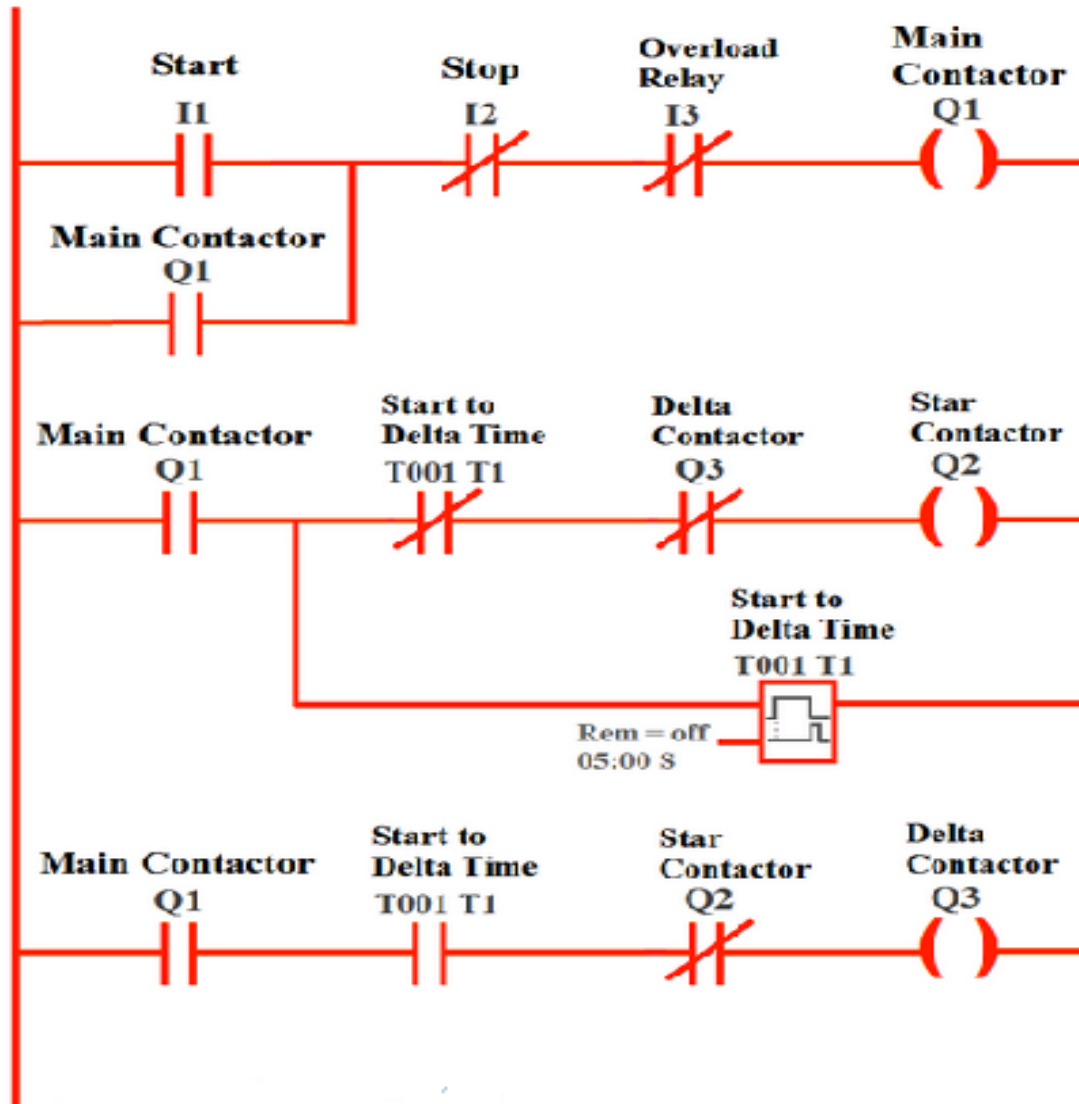
- It can be seen that in **star connection**, one end of all three windings are shorted to make **star point** while other end of each winding is connected to **power supply**.
- In delta configuration, the windings are connected such that to make a **close loop**.
- The connection of each winding is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



- 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.

*Advanced PLC*  
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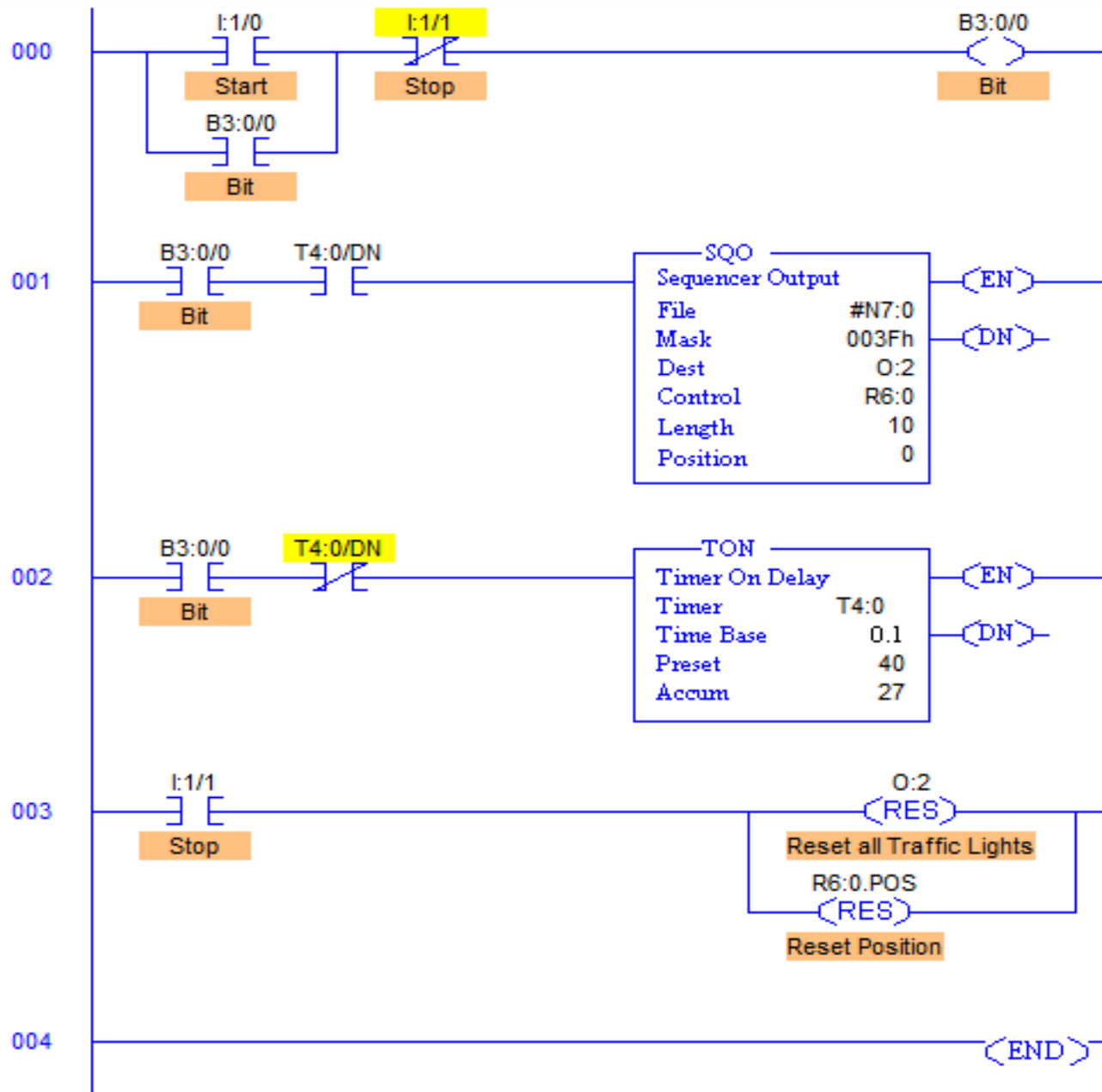


# EX:(5): control traffic light

- 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)
SQ0	= 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)

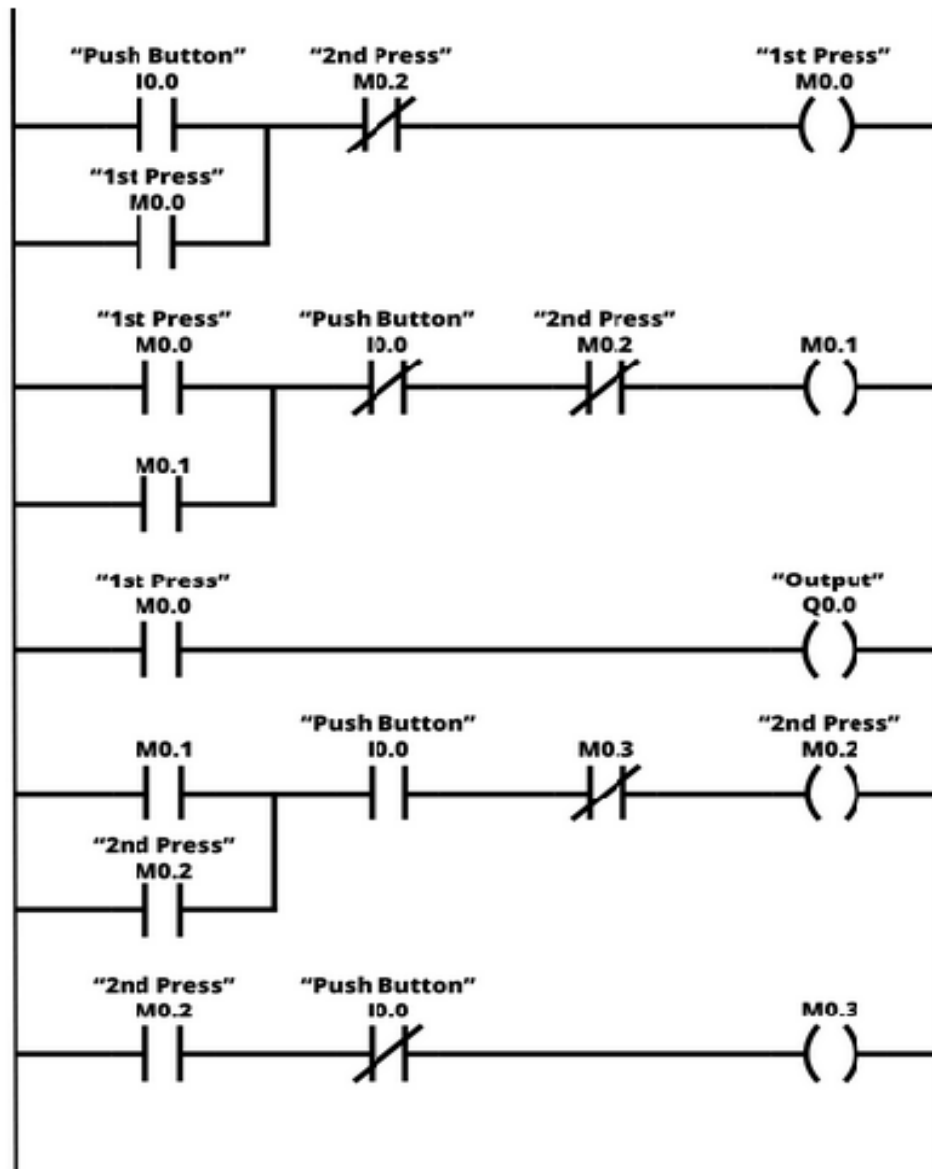


**Ladder(5): Ladder Diagram to control Traffic Light**

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

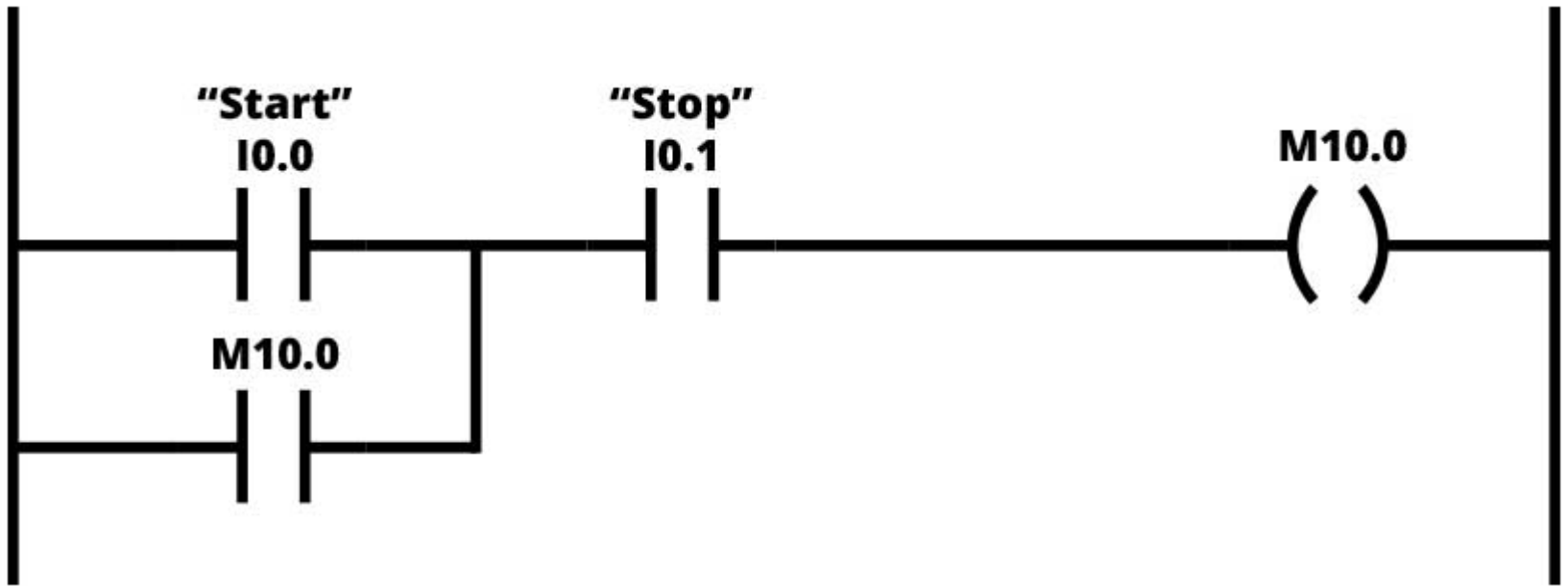
- This function is also called **push on push off logic** sometimes even flip-flop or toggle function.
- It is the same function as the **on/off button** on your computer or mobile phone.
- When you push the button the first time, the output will be **activated**. Now, when you push the button for the 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*

# 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 available 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 car.
- **Value of counter** is displayed on the display which is mounted outside the parking plot.

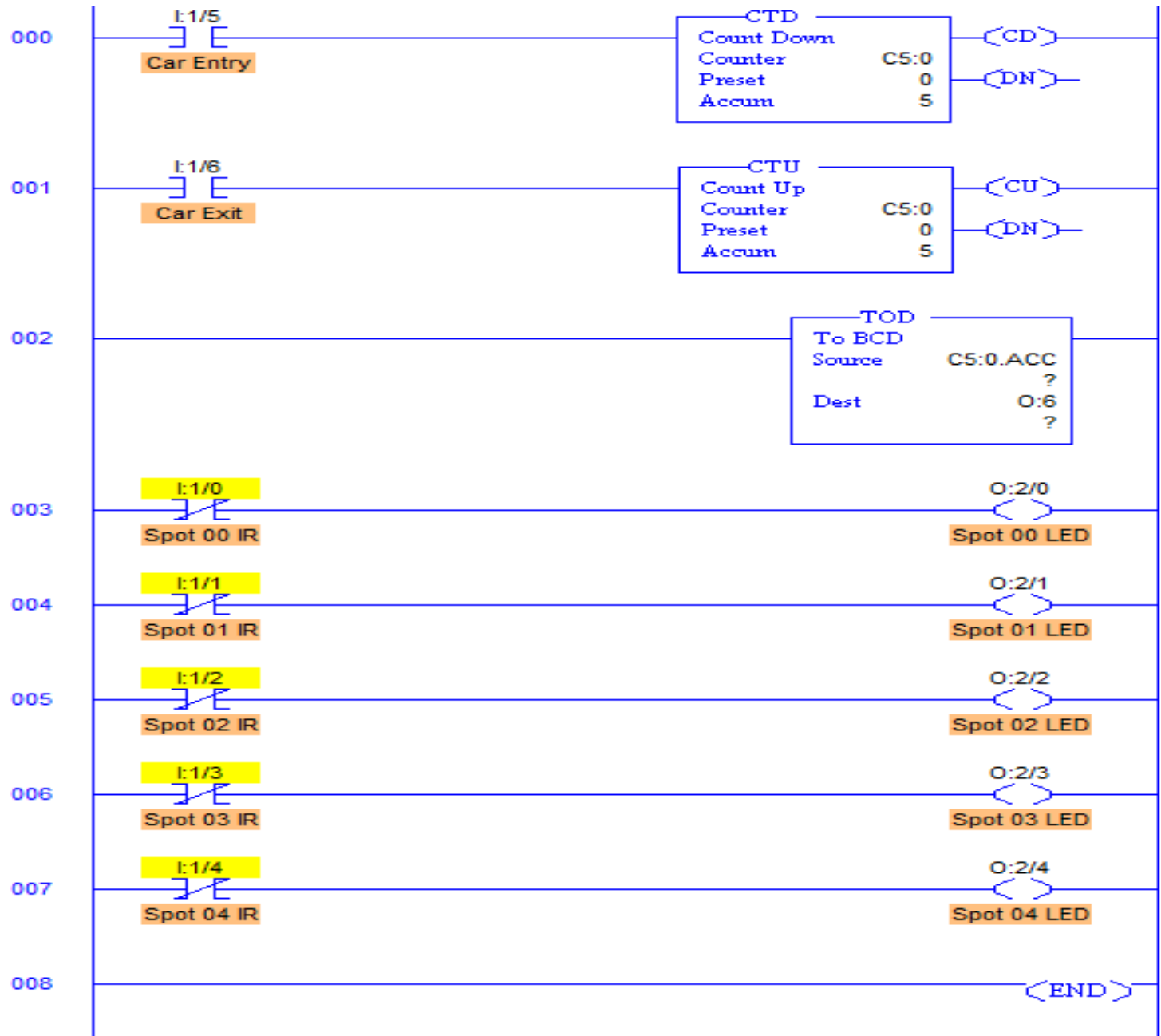
- **PLC Program**

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**

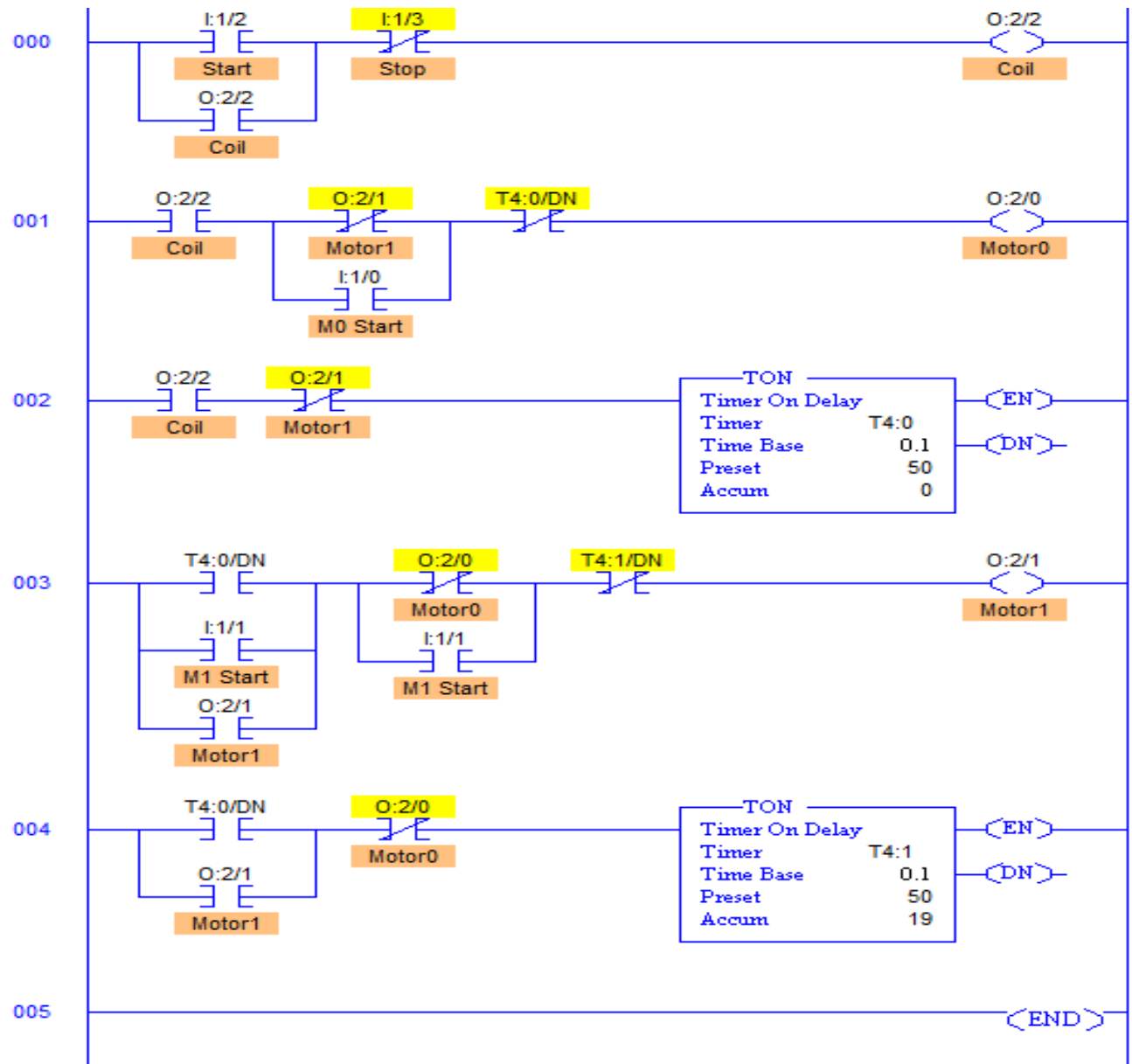
- I. Define addresses of motors.
- II. Create latching seal in contact to start and stop the sequential operation.
- III. Use TON timer to generate a particular time delay, same or different.
- IV. Use DN bit of first timer to energize 2nd motor coil and activate second timer.
- V. No need to use Reset coils, program will reset the timers itself after completion of each cycle.
- 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

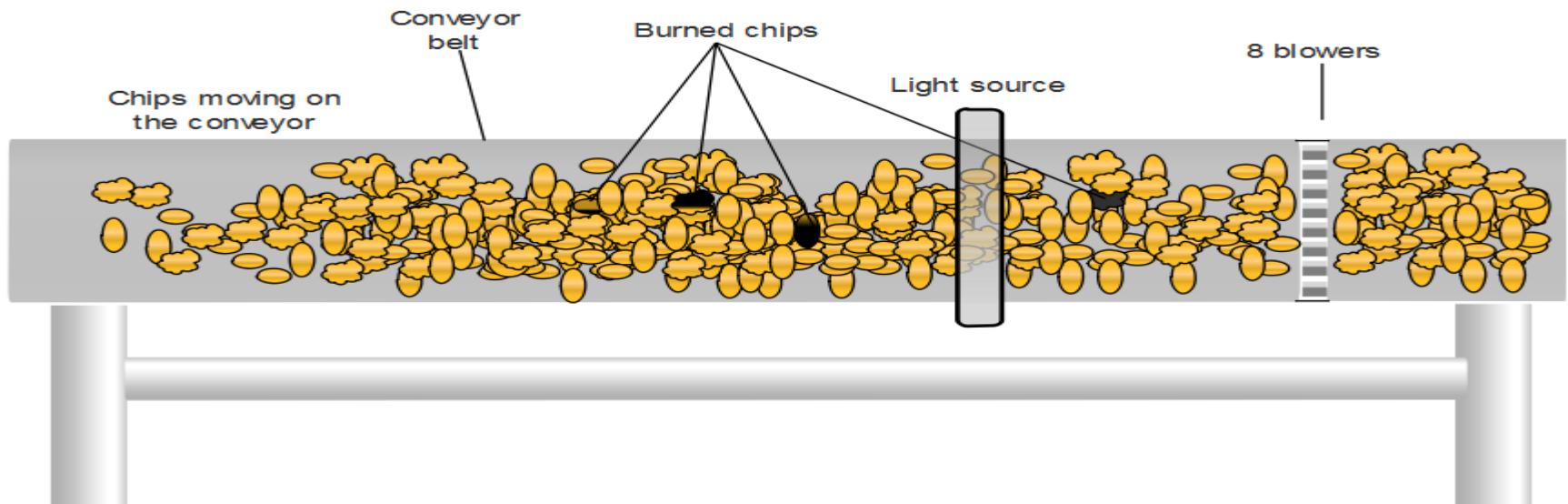


# EX:(1):PLC Program to Detect Burned Chips and Remove Them

- **Problem Description**

Potato chips are made and ready to be packed. But before that, it goes through a conveyor in which final quality check is done, burnt chips are detected and removed from the process line.

- **Problem Diagram**

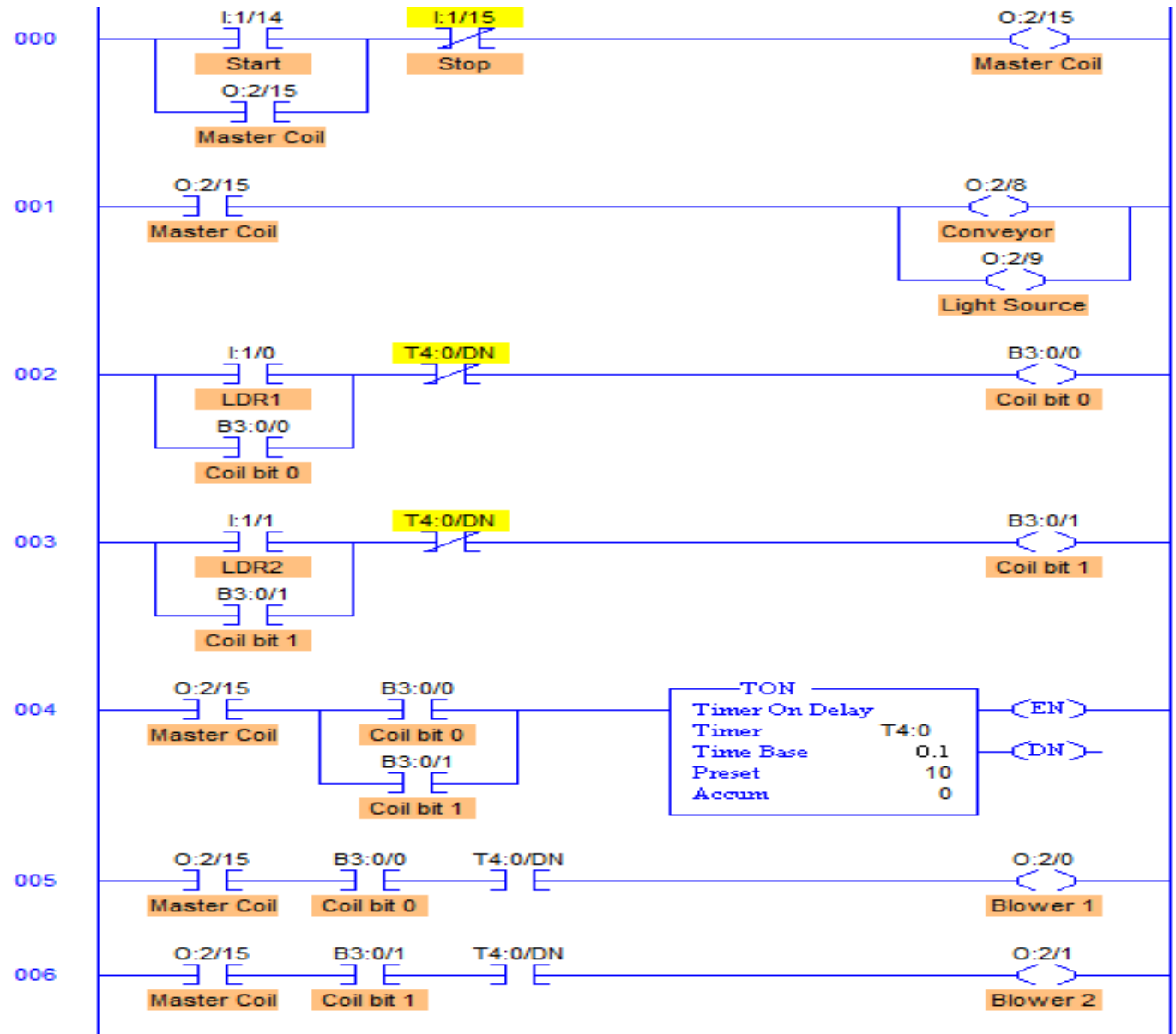


- **PLC Program**

List of Inputs and Outputs

I:1/14	= Start	(Input)
I:1/15	= Stop	(Input)
O:2/15	= Master Coil	(Input)
O:2/8	= Conveyor	(Output)
O:2/9	= Light Source	(Output)
I:1/0 to I:1/7	= Light Dependent Resistors	(Input)
B3:0/0 to B3:0/7	= Bit latching	(Bits)
O:2/0 to O:2/7	= Blowers	(Output)
T4:0	= Timer to activate blower after 1sec	(Timer)

- Ladder diagram to accomplish quality control by removing defected chips





# EX:(2):PLC Program to do mathematical functions

- **Problem Solutions**

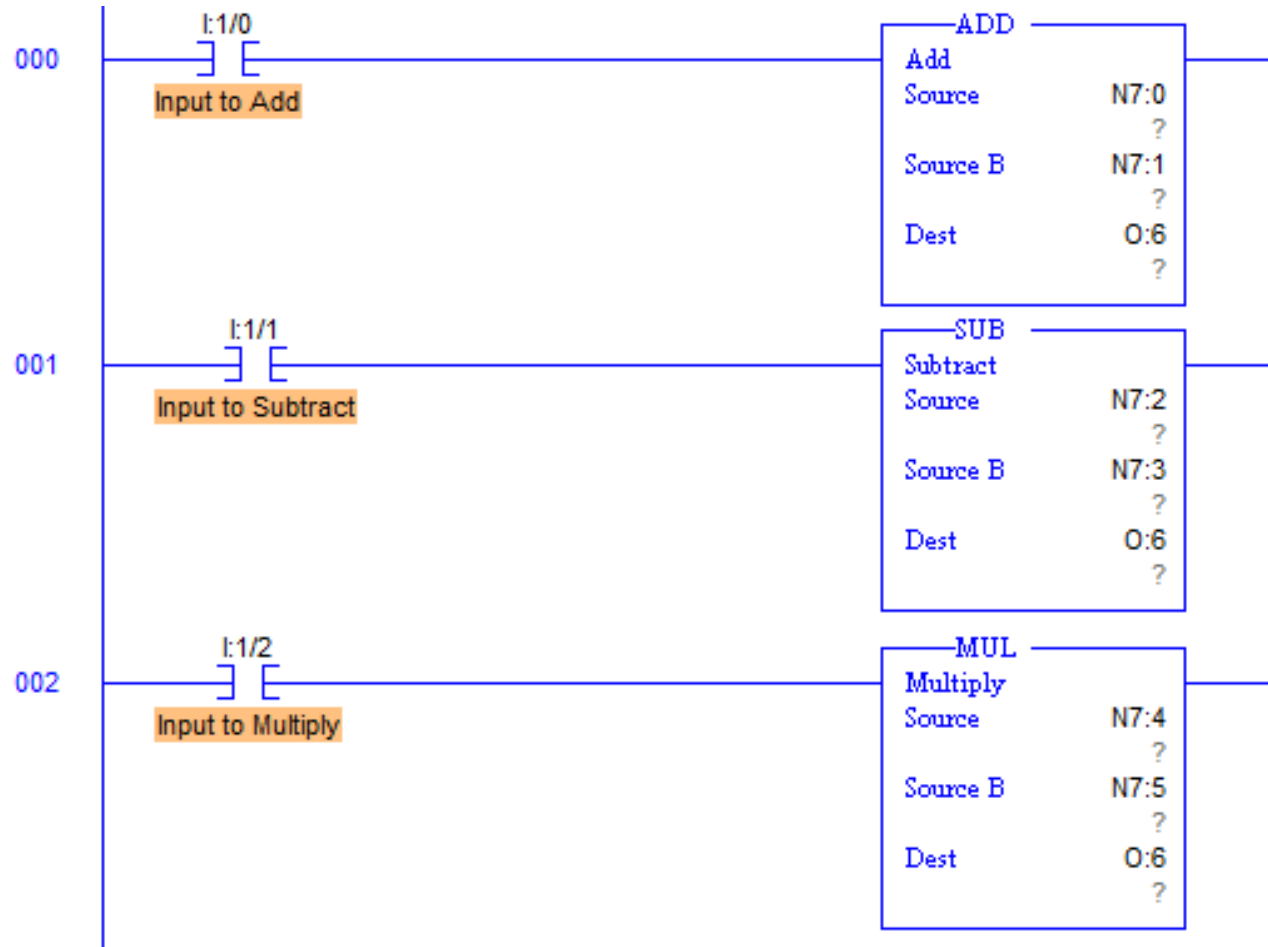
- I. Use all the Math Instructions to implement various Mathematical Arithmetic Functions.
- II. Use **ADD** to add one piece of data to another.
- III. Use **SUB** to subtract one piece of data from another.
- IV. Use **MUL** to multiply one piece of data by another.
- V. Use **DIV** to divide one piece of data by another.
- VI. Use **SQR** to find the square root of a piece of data.
- VII. Use **NEG** to change the sign of a piece of data.

- **PLC program**

List of Inputs and Outputs

I:1/0	= Input to Add	(Input)
I:1/1	= Input to Subtract	(Input)
I:1/2	= Input to Multiply	(Input)
I:1/3	= Input to Divide	(Input)
I:1/4	= Input to find Square Root	(Input)
I:1/5	= Input to change the sign of a Number	(Input)
N:7/0 to N:7/9	= Integer Number Location	(Input)
O:6	= Display	(Output)

- Ladder Diagram to implement mathematical arithmetic functions





# *PLC Testing Methods*

# PLC Testing Methods

## 1. Hardware test stand

Hardware test stand used to simulate the I/Os of hardware devices in the field.



**Typical hardware Test Stand.**

The Test Stand is made by many LED indicators, toggle switches, analog signal generators, and meters that are wired to the PLC's input and output modules. The toggle switches and the analog signal generators are used to simulate the sensor inputs and the LED indicators and the meters are used to indicate the PLC outputs.

## 2. Human Machine Interface (HMI) Based Simulator

- Another approach that is often used for simulating the PLC I/Os is a HMI based software simulation.
- In this approach, a HMI control screen is developed and used for the PLC I/O simulation. The HMI control screen can be made as a SCADA system screen or a standalone Operator Terminal screen.
- it is still a manual simulation and it's time-consuming to make the I/O simulation screens themselves.
- A HMI based simulator can be used to test all functions of a PLC program. But the timing between a command and the response for the command is not automated.

### 3. New approach “virtual” simulator

This research proposes an automated testing tool that can simulate the PLC I/O signals via “virtual” wires and automate the test execution. There are no physical hard wires connected between LogixPlcTester and the PLC being tested. This tool helps PLC software developers and testers test PLC programs during the entire software development stage and the testing stage. It can be used for both unit testing and system testing. The goal of this tool is to assure quality of PLC programs and to deliver reliable PLC programs for industrial control systems.



**Thank You**  
**For Your Attention**



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