PLC Timing Instructions

The PLC timing instructions are software version or replacement of hardwired timers. They are an output instructions when activated they create time related actions (on delay action, off delay action, time limited on activity, and measure the time durations between two events).

ON Delay Timers

ON delay timers are used to create contact instructions (Q) that becomes active after preset time interval passage. These timers instructions are classified in to direct time setting timers (TON) in which the time setting is the time assigned to the input PT (here PT is of TIME data type) and indirect or integer time setting (TON_UINT) in which the time setting is the product of integer type preset time setting (PT) and integer type time unit (UNIT). Both has an enable input (IN) to activate or deactivate the instruction and an output variable ET to register and display the elapsed time. Figure 1 displays the ladder symbols of these timers and also their timing diagram.
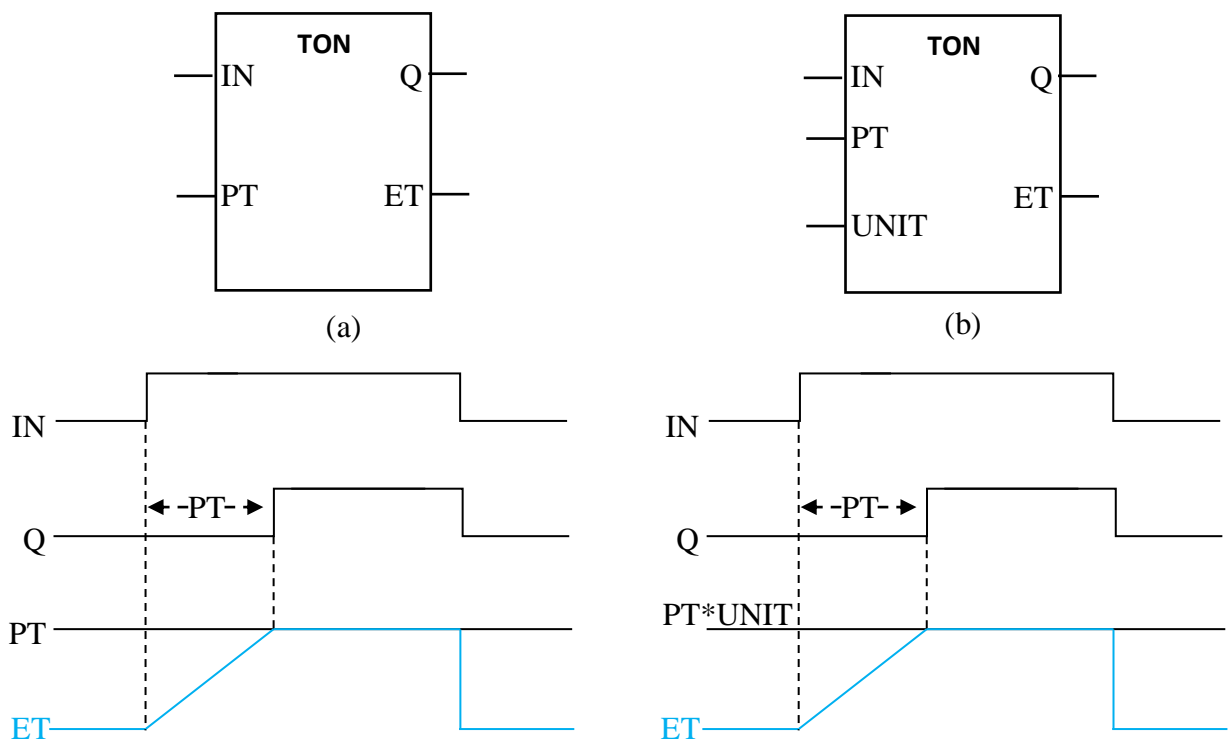

Figure 1: ON delay timers a): On timer b): On timer of integer setting.
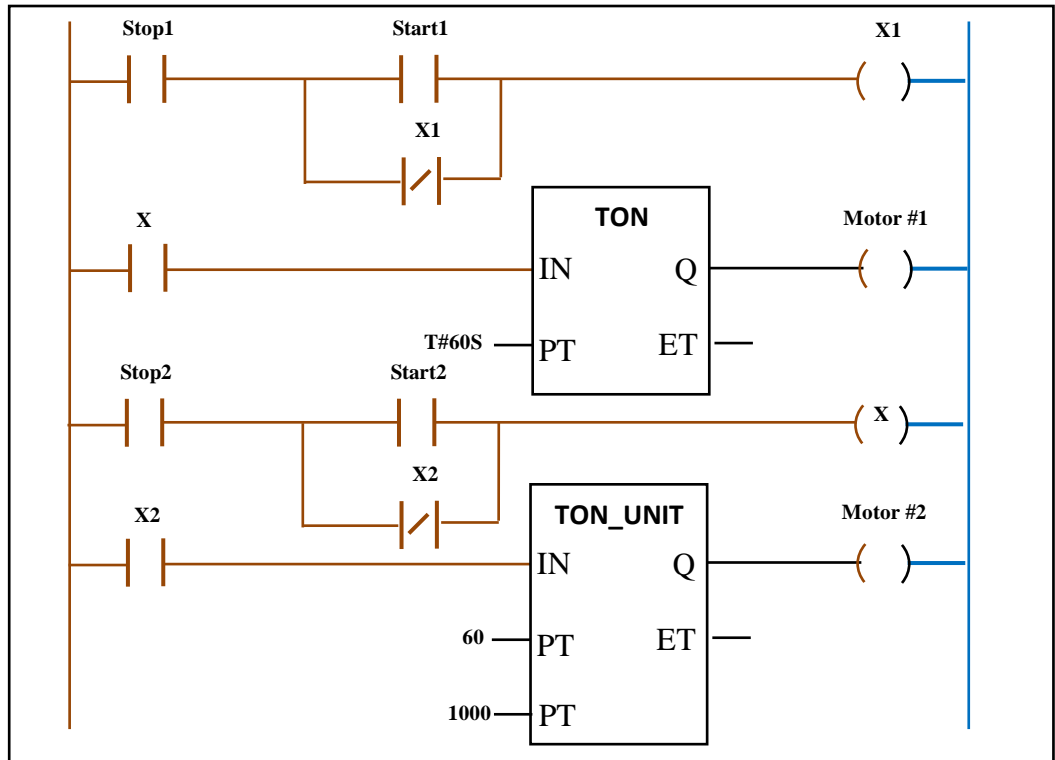
Example 1: ON delay Motor Starter.

Figure 2: ON delay Motor Starter.

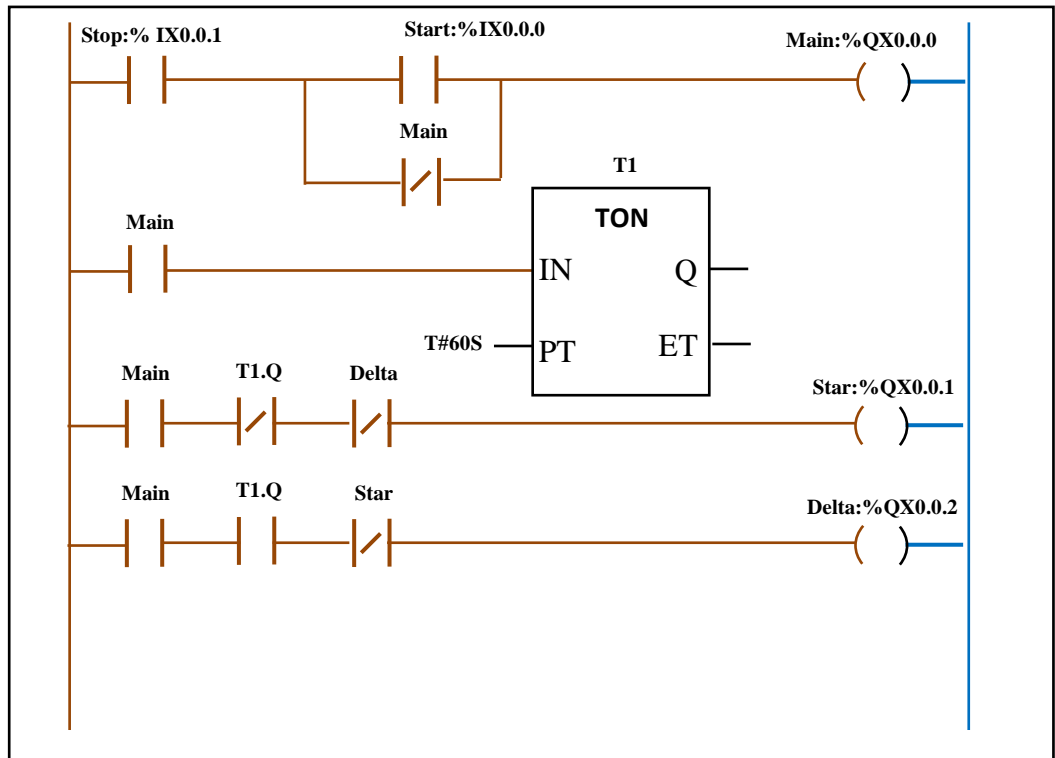Example 2: Three phase induction motor star delta starter.

Figure 3: Three phase induction motor star

OFF Delay Timers

OFF delay timers are used to delay the off activities. When activated (IN=1), these timers instantaneously close their normally open contacts but when deactivated (IN=0) they delay the opening of these contacts until the preset time delay is elapsed. These timers instructions are classified in to direct time setting timers (TOF without rest facility and TOF_RST with reset facility) in which the time setting is the time assigned to the input PT (here PT is of TIME data type) and indirect or integer time setting (TOF_UINT) in which the time setting is the product of integer type preset time setting (PT) and integer type time unit (UNIT). Each has an enable input (IN) to activate or deactivate the instruction and an output variable ET to store the elapsed time. Figure 4 displays the ladder symbols of these timers and also their timing diagram.
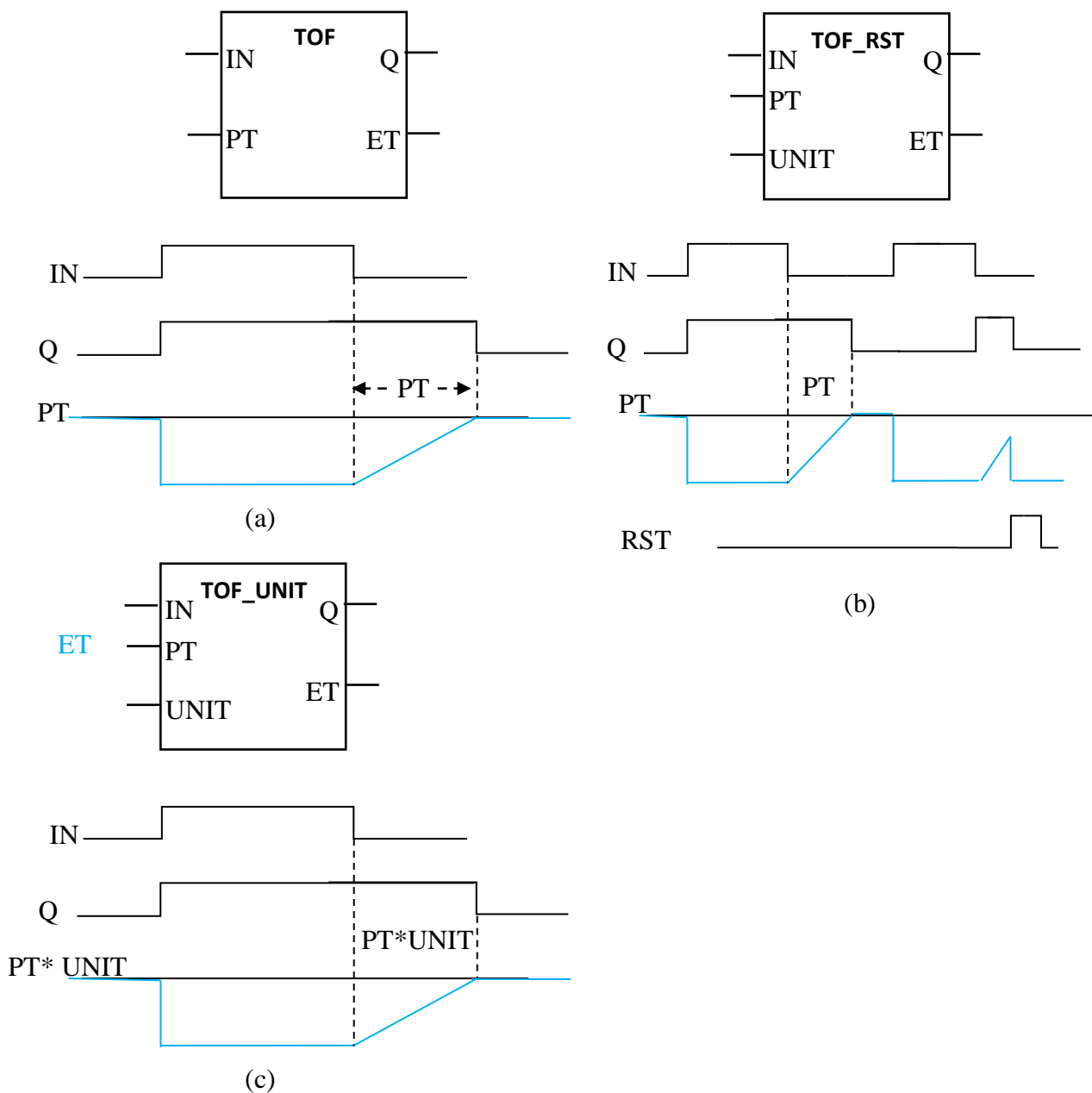

Figure 4: OFF delay timers a): OF timer b): OF with reset c) OF timer with integer setting.

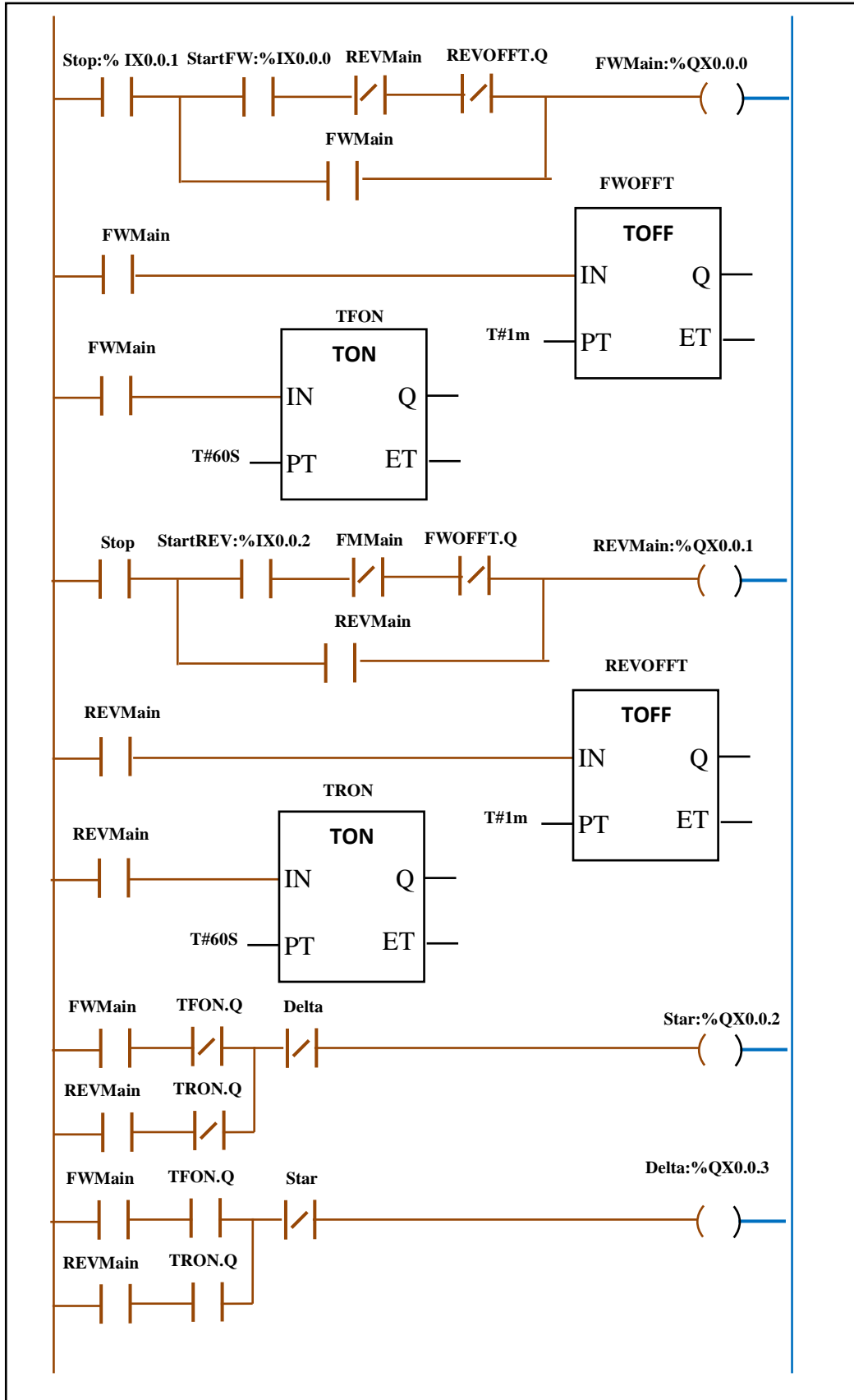Example 3: Three phase induction motor bidirectional star delta starter.

Figure 5: Three phase induction motor bidirectional star delta starter.

PULSE Timers

Pulse timers are used to produce fixed duration output after being excited by their left side rung positive transition. On the positive transition of IN, these timers instantaneously close their normally open contacts and remain so till the elapsed time reaches the preset time, the moment the contacts return to their state. Negative transition of RST resets the elapsed time output (ET) and allow for new cycle. Any toggling for IN in the period from the positive transition to the preset time is neglected. These timers instructions are classified into direct time setting timers (TP without rest facility and TP_RST with reset facility) and indirect or integer time setting (TP_UINT). Figure 6 displays the ladder symbols of these timers and also their timing diagram.
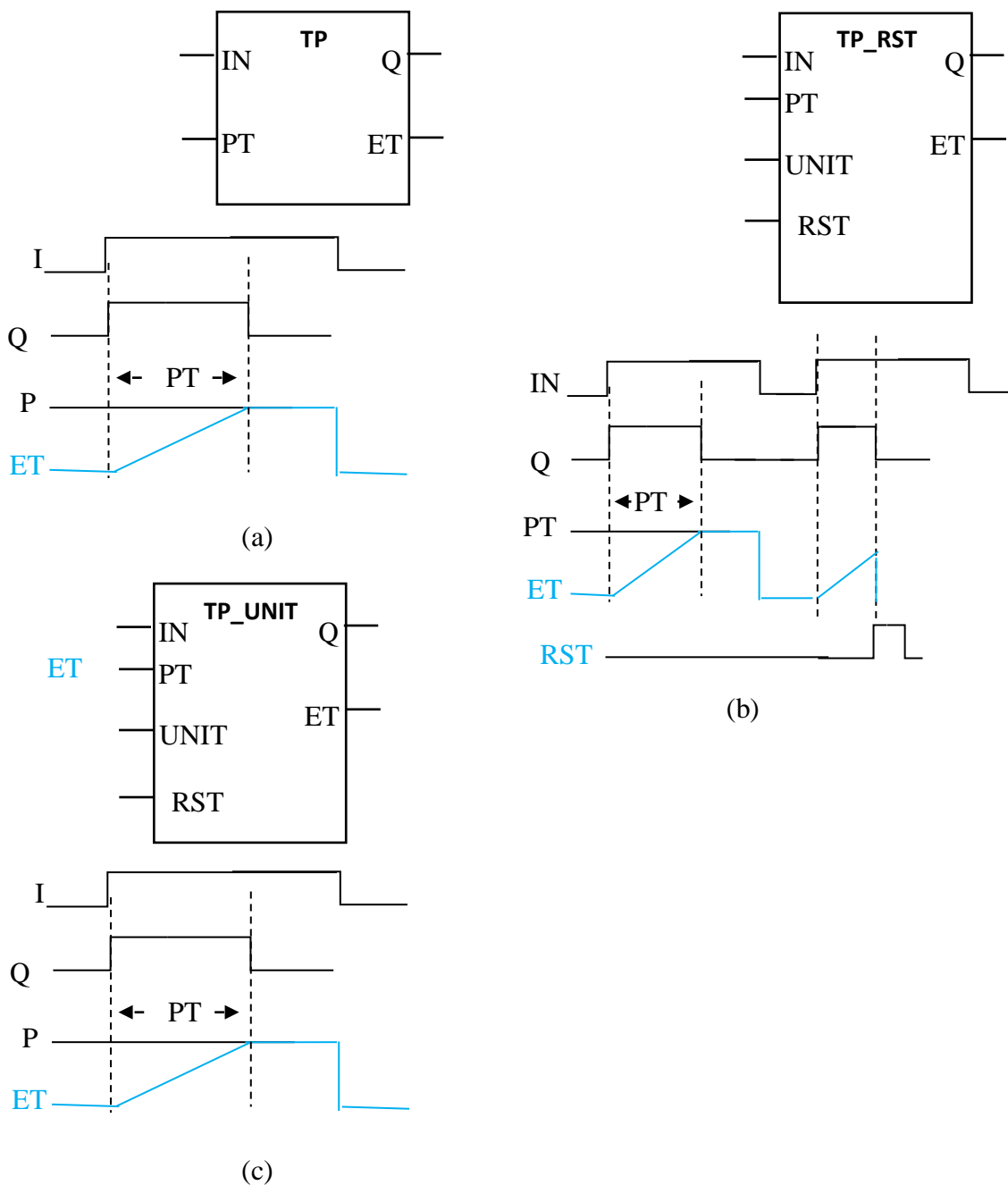

(a)

(b)

(c)

Figure 6: OFF delay timers a): OF timer b): OF with reset c) OF timer with integer setting.

Example 4: Automatic liquid mixing machine.

MixingMotor
SValve2
LS2
SValve1
LS1
MixerOutlet

Stop:% IX0.0.1	Start:%IX0.0.0	LS1:%IX0.0.2	SVslve1:%QX0.0.0

```
Stop:% IX0.0.1   Start:%IX0.0.0           LS1:%IX0.0.2              SVslve1:%QX0.0.0
  ─┤ ├──────┬──────┤P├────────┬──────────┤/├────────────────────────( )──
            │      SValve1     │
            └──────┤ ├─────────┘


Stop:% IX0.0.1      LS1              LS2                  SVslve2:%QX0.0.1
  ─┤ ├───────┬──────┤ ├──────┬───────┤/├────────────────────────( )──
             │    SValve1     │
             └─────┤ ├────────┘


  SValve2                  ┌──────────────┐      MixingMotor:%QX0.0.2
  ─┤ ├────────────────────┤ IN    TP_UNIT  Q├──────────────( )──
                           │                │
              %MW2 ────────┤ PT             │
                           │                │
              1000 ────────┤ UNIT           │
                           │                │
                 0 ────────┤ RST            │
                           └──────────────┘


  MixingMotor:%QX0.0.2     ┌──────────────┐      MixerOutlet:%QX0.0. 3
  ─┤N├────────────────────┤ IN    TP_UNIT  Q├──────────────( )──
                           │                │
              %MW3 ────────┤ PT             │
                           │                │
              1000 ────────┤ UNIT           │
                           │                │
                 0 ────────┤ RST            │
                           └──────────────┘
```
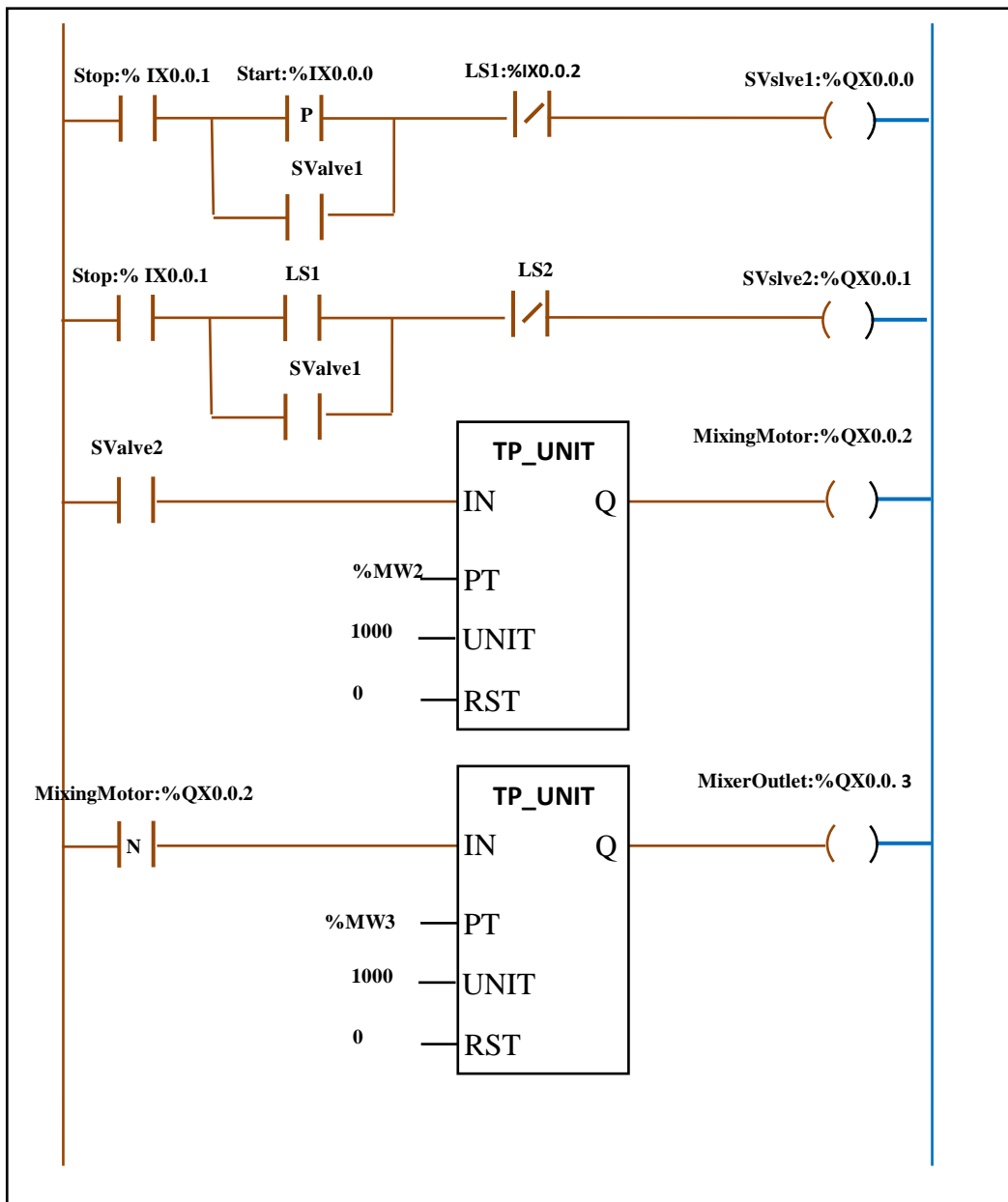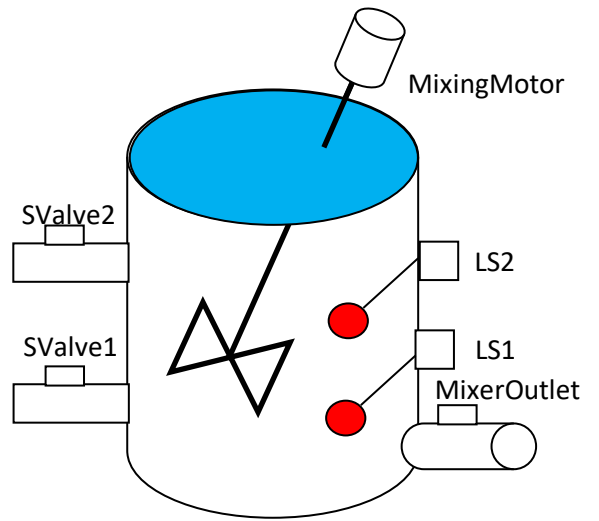
Figure 7: Automatic liquid mixing machine

TMR Timers

Integration timers (TMR) integrate the ON period or periods of their inputs marked IN and store the accumulated time in the elapsed time variable (ET). When ET reaches the preset time (PT in case of TMR and PT*UNIT in case of TMR_UNUIT), the instructions assign "1" to their outputs Q. New cycle can be initiated after stropping the RST inputs. Figure 8 shows their ladder symbol and timing diagrams.
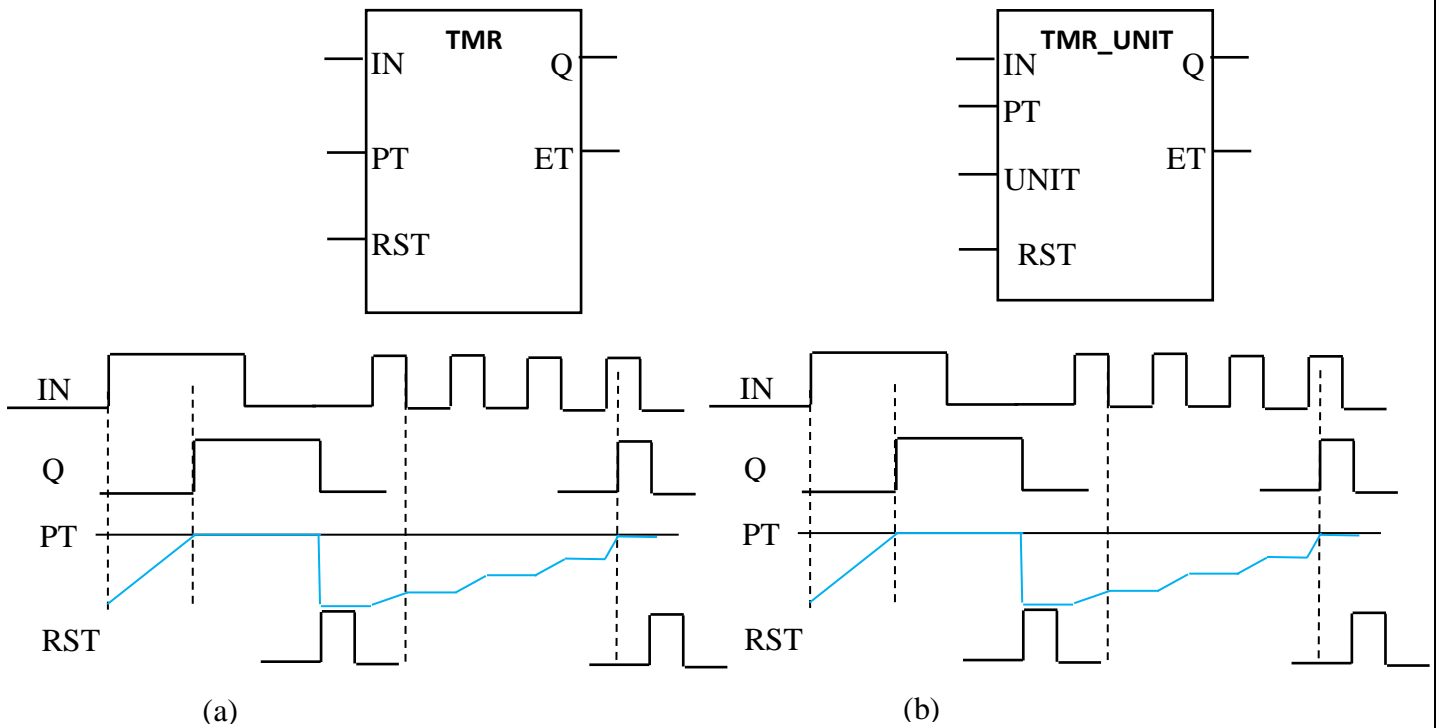

Figure 8: TMR timers (a): Direct TMR   (b): TMR with integer setting

Example 5: Ice cream cone filling machine with teaching function.
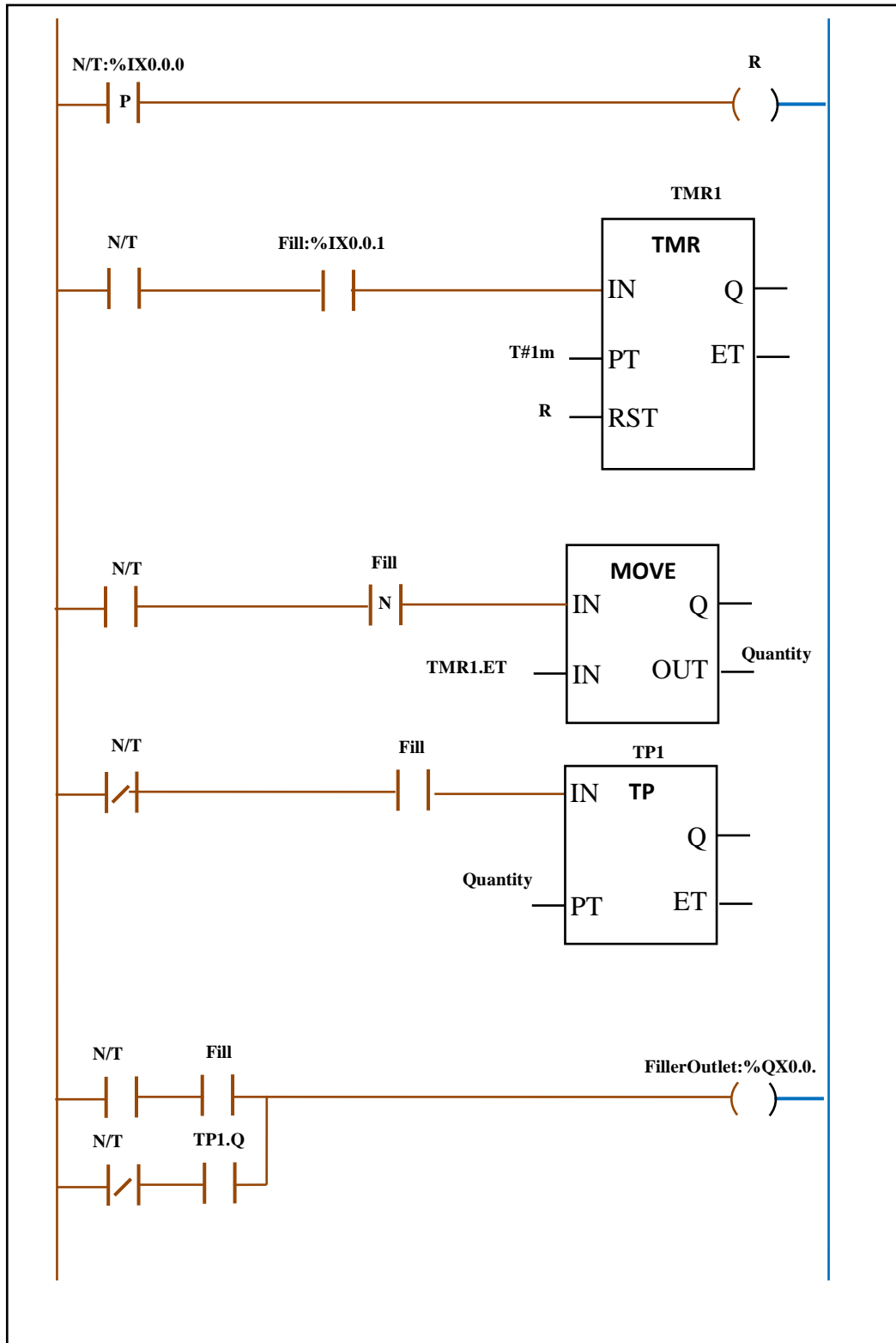
Figure 9: Ice cream cone filling machine

TMR_FLK Timers

Integration timers with flickers (TMR_FLK) produces an out signal Q with mark equals to the time assigned to ON time input variable and space equals to the time assigned to the OFF time input variable. Figure 10 pictures the ladder symbol used and state the operating principle of this timing instruction.
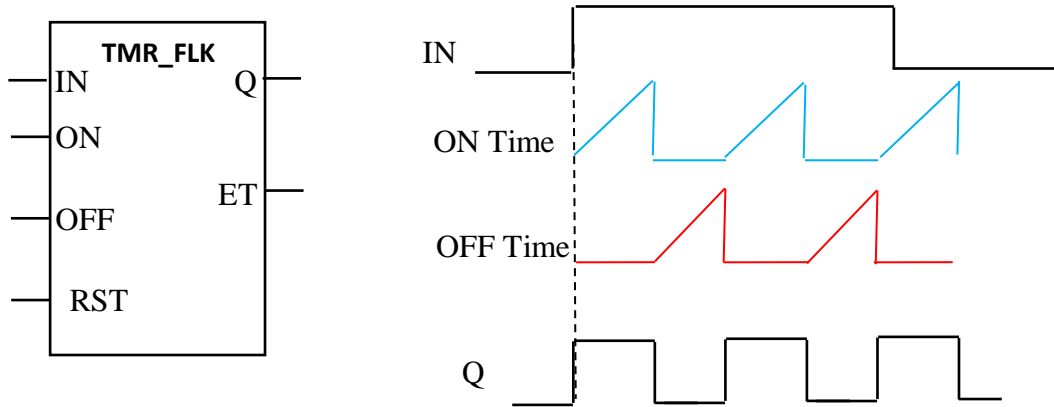

Figure 10: TMR with flickers
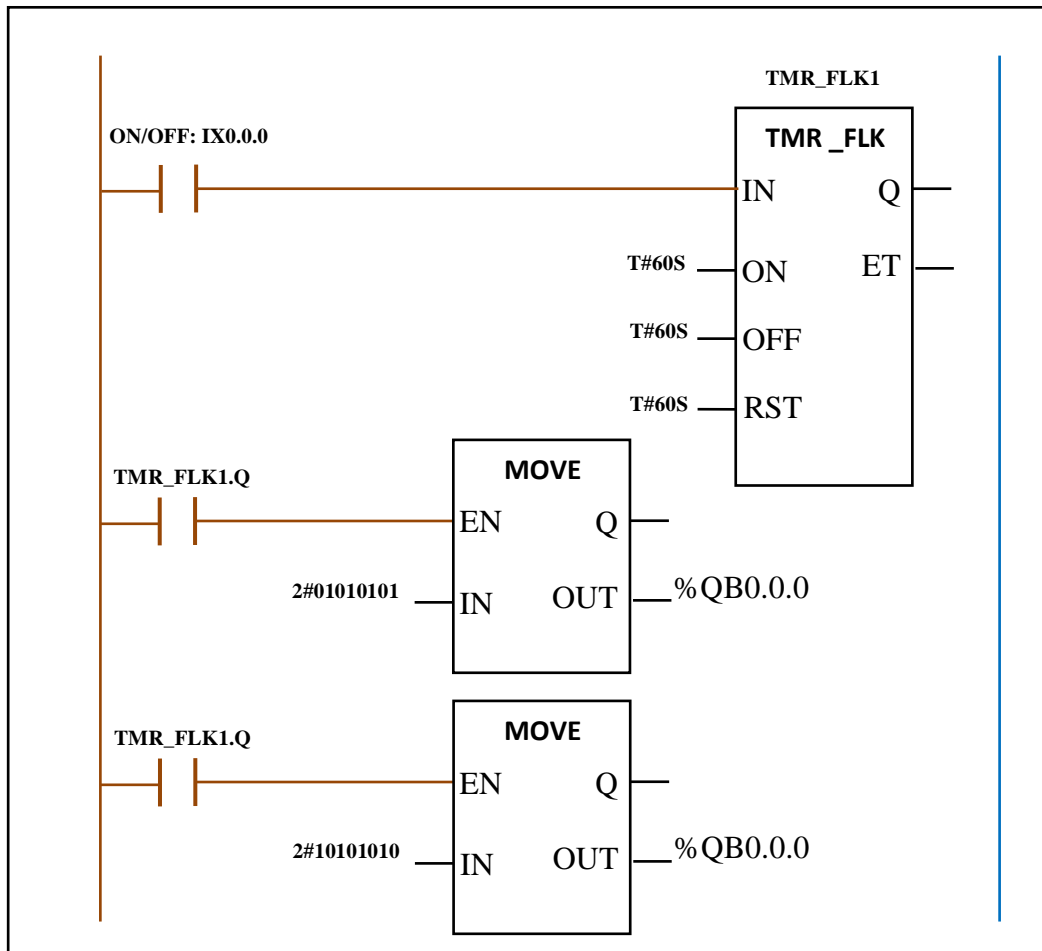
Example 6: Flashing Odd /Even lamps.

Figure 11: Flashing Odd /Even lamps.

A/M   Fill

TRTG Timers

Retriggerable timers produce an out signal Q with pulse width equals to the time assigned to PT in case of (TRTG) type and equals to PT*UINT in case of TRTG_UINT one. Here the new pulse can only be generated after the elapsed of the preset time (until ET=PT) and occurrence of positive transition of the instruction input IN. Figure 12 pictures the ladder symbol used and gives more deep understanding to the relationship between the various variables of this timing instruction.

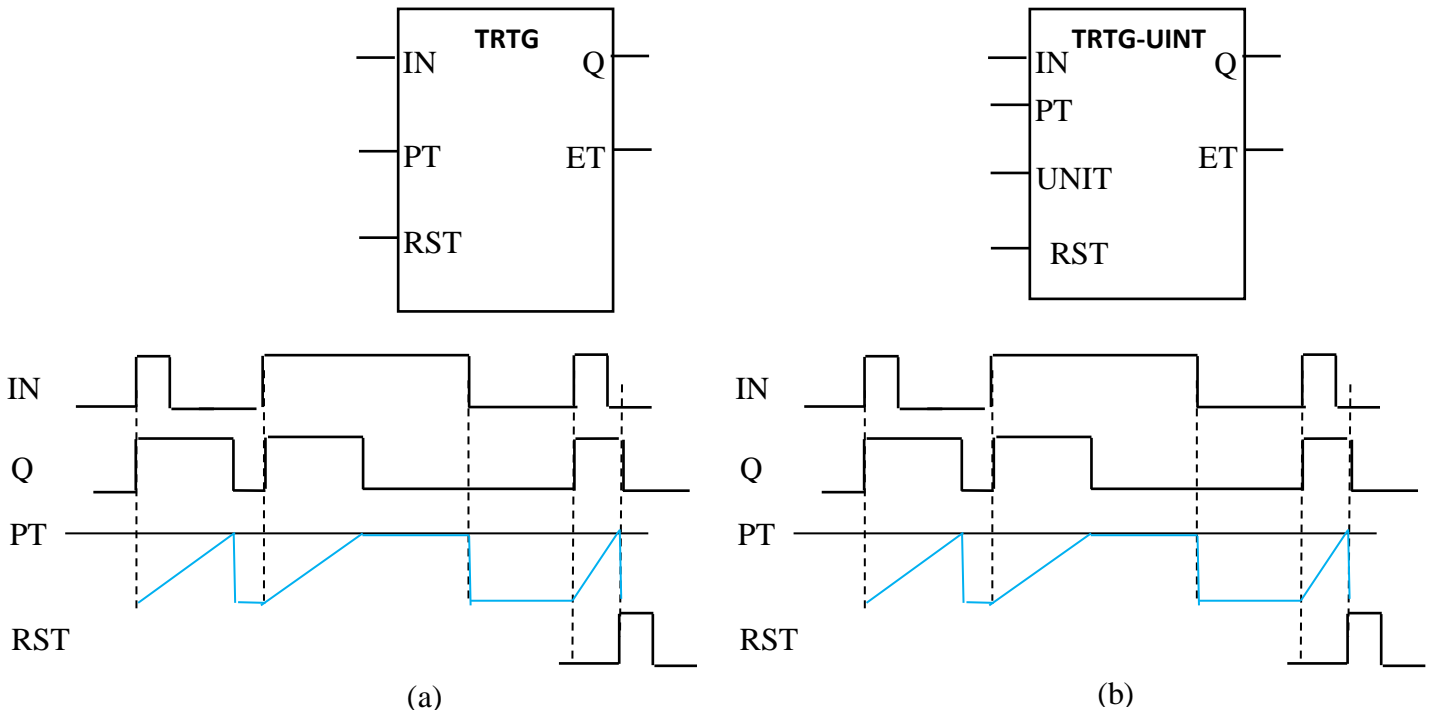(a)   (b)

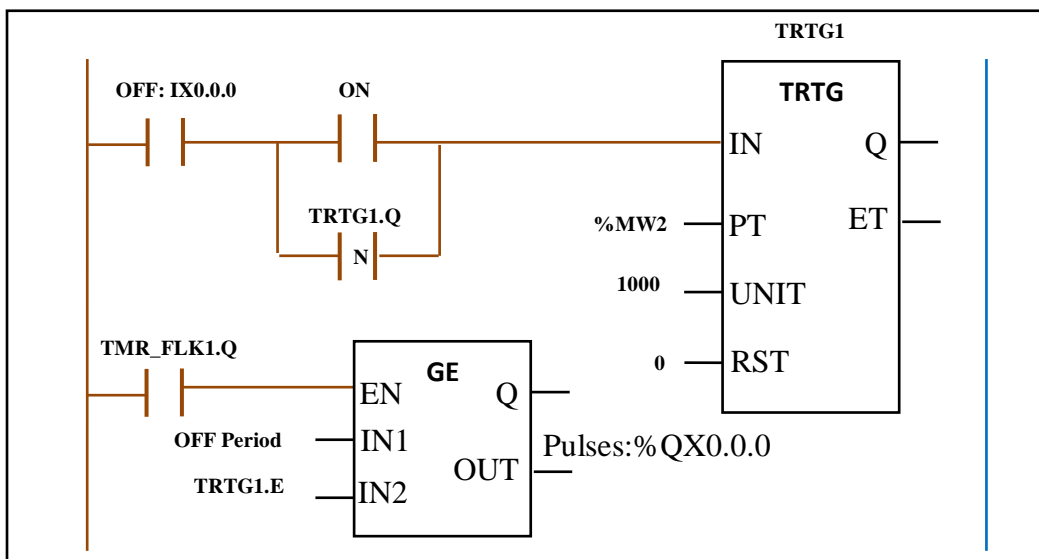Figure 12: TRTG timers (a): Direct TRTG   (b): TRTG with integer setting

Example 7: PWM Heater Control.

Figure 13: PWM Heater Control