TIU – MED - 2022

PLC - LEC 5

Timers in PLC

Timer instructions

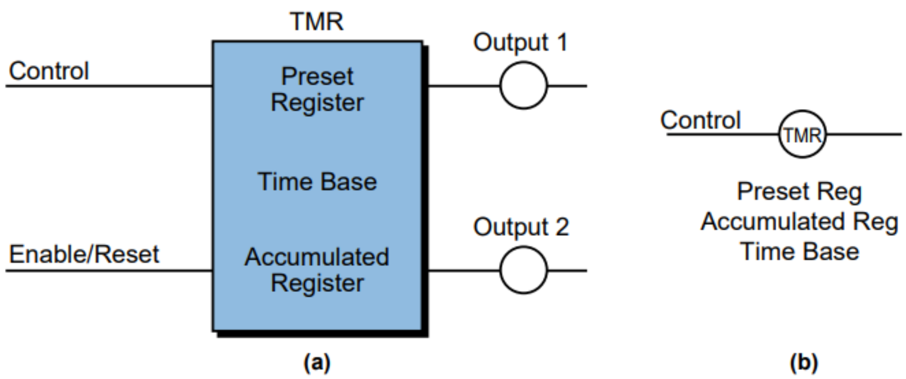
Timer instructions may have one or more time bases (TB) which they use to time an event. The time base is the resolution, or accuracy, of the timer. For instance, if a timer must time a 10 second event, the user must choose the number of times the time base must be counted to get to 10 seconds. Therefore, if the timer has a time base of 1 second, then the timer must count ten times before it activates its output. This number of counts is referred to as ticks. The most common time bases are 0.01 sec, 0.1 sec, and 1 sec. Table 9- 3 shows the number of ticks required for a 10 second count, based on different time bases

Required Time	Number of Ticks	Time Base (secs)
10 sec	10	1.00
10 sec	100	0.10
10 sec	1000	0.01
Note: Required time = (# of ticks)(Time base)		

PLCs provide several types of timer instructions. PLC manufacturers may provide different definitions for each type of timer function offered.

Timer Instructions *(Purpose: To provide hardware timer capabilities in a PLC)*		
Instruction	**Symbol**	**Function**
ON-Delay Energize Timer	TON —( )—	Energizes an output after a set time period when logic 1 exists
ON-Delay De-energize Timer	TON —( )—	De-energizes an output after a set time period when logic 1 exists
OFF-Delay Energize Timer	TOF —( )—	Energizes an ouput after a set time period when logic 0 exists
OFF-Delay De-energize Timer	TOF —( )—	De-energizes an output after a set time period when logic 0 exists
Retentive ON-Delay Timer	RTO —( )—	Energizes an output after a set time period when logic 1 exists and then retains the accumulated value
Retentive Timer Reset	RTR —( )—	Resets the accumulated value of a retentive timer

Two formats used for timers. A block format timer has one or two inputs, depending on the programmable controller. These inputs are called the control line and the enable/reset line. If the control line is TRUE (i.e., it has continuity) and the enable line is also TRUE, the block function will start timing.



. **(a)** Block format and **(b)** ladder format timer instructions.

A preset register is used to hold the preset value and an accumulated register to store the accumulated value.

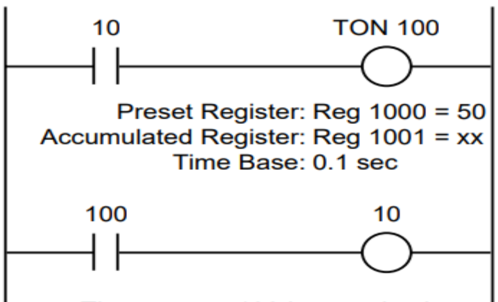
Some PLCs allow the user to enter a constant value directly into the timer to set the preset value. This particular value, however, must be entered into a predefined register for that specific timer address.

A timer's time base is selectable depending on the PLC used (e.g., 0.01 sec, 0.1 sec, 1.0 sec, etc.). When the accumulated tick count equals the preset count, the timer executes its timing function and sets the output condition, which depends on the type of timer used (e.g., ON-delay energize, etc.).

ON-DELAY ENERGIZE TIMER

Once the rung has continuity, the timer begins counting time-based intervals (ticks) and counts down until the accumulated time equals the preset time. When these two values are equal, the timer energizes the output and closes the timedout contact associated with the output

If logic continuity is lost before the timer times out, the timer resets the accumulated register to zero.



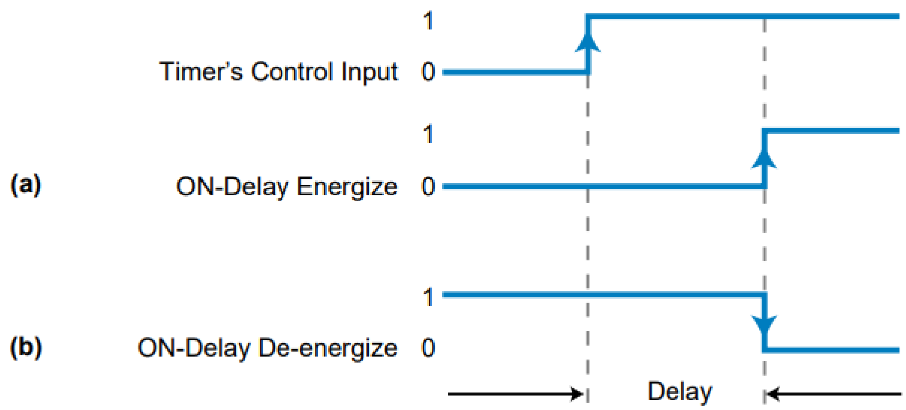
Timer output 100 is energized
5 seconds after contact 10 closes.

ON-DELAY DE-ENERGIZE TIMER

An ON-delay de-energize timer (TON) instruction operates in a manner similar to an ON-delay energize timer instruction, except that the timer's output is already ON. This instruction de-energizes the output once the rung has continuity and the time interval has elapsed (accumulated register value = preset register value).

PLC manufacturers provide either ON-delay energize or ON-delay de-energize timers, since it is easy to program one from the other.

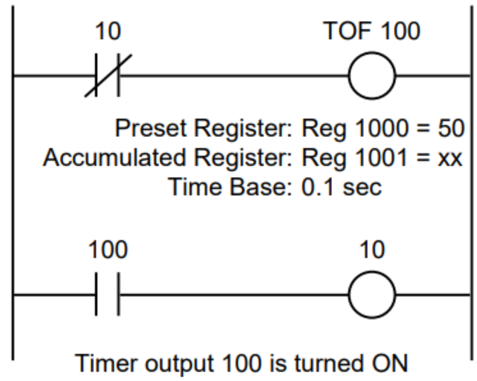
Figure illustrates a timing diagram for both types of ON-delay timer instructions.



OFF-DELAY ENERGIZE TIMER

An OFF-delay energize timer (TOF) output instruction provides timedelayed action. If the control line rung does not have continuity, the timer begins counting time-based intervals until the accumulated time value equals the programmed preset value. When these values are equal, the timer energizes the output and closes the timed-out contact associated with the output.

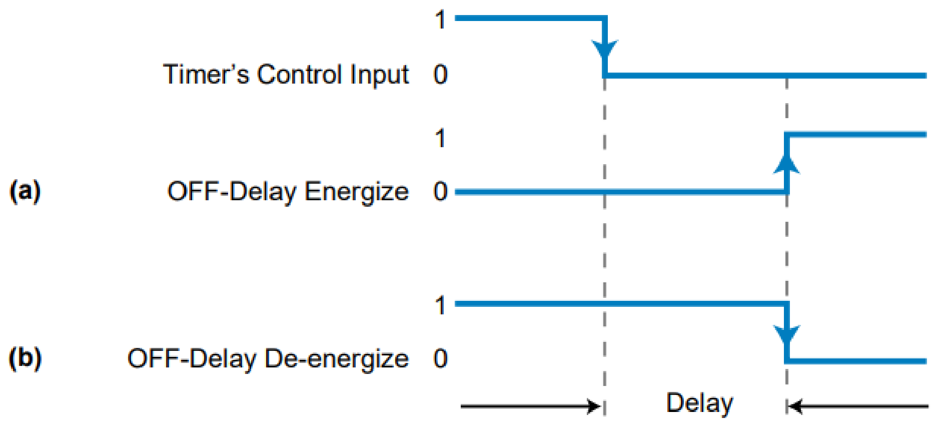
If logic continuity occurs before the timer times out, the accumulated value resets to zero.



Timer output 100 is turned ON
5 seconds after contact 10 opens.

OFF-DELAY DE-ENERGIZE TIMER

An OFF-delay de-energize timer (TOF) instruction is similar to its OFF-delay energize counterpart; however, this timer's output is ON and will be deenergized once the rung loses continuity and the time interval has elapsed (accumulated register value = preset register value). Like ON-delay timers, PLC manufacturers usually provide either OFF-delay energize or de-energize timers. Figure 9-47 shows timing diagrams for both types of OFF-delay timers.



RETENTIVE ON-DELAY TIMER

A retentive ON-delay timer (RTO) output instruction is used if the timer's accumulated value must be retained even if logic continuity or system power is lost. If any rung path has logic continuity, the timer begins counting timebased intervals until the accumulated time equals the preset value. The accumulated register retains this accumulated value, even if power or logic continuity is lost before the timer has timed out

Again, these timer contacts can be used throughout the program as normally open or normally closed contacts.

A retentive timer reset instruction resets a retentive timer's accumulated value.

PULSE TIMERS

Pulse timers are used to produce a fixed duration output from some initiating input. Figure 9.13(a) shows a ladder diagram for a system that will give an output from Out 1 for a predetermined fixed length of time when there is an input to In 1, the timer being one involving a coil. There are two outputs for the input In 1. When there is an input to In 1, there is an output from Out 1 and the timer starts. When the predetermined time has elapsed, the timer contacts open. This switches off the output. Thus the output remains on for just the time specified by the timer.

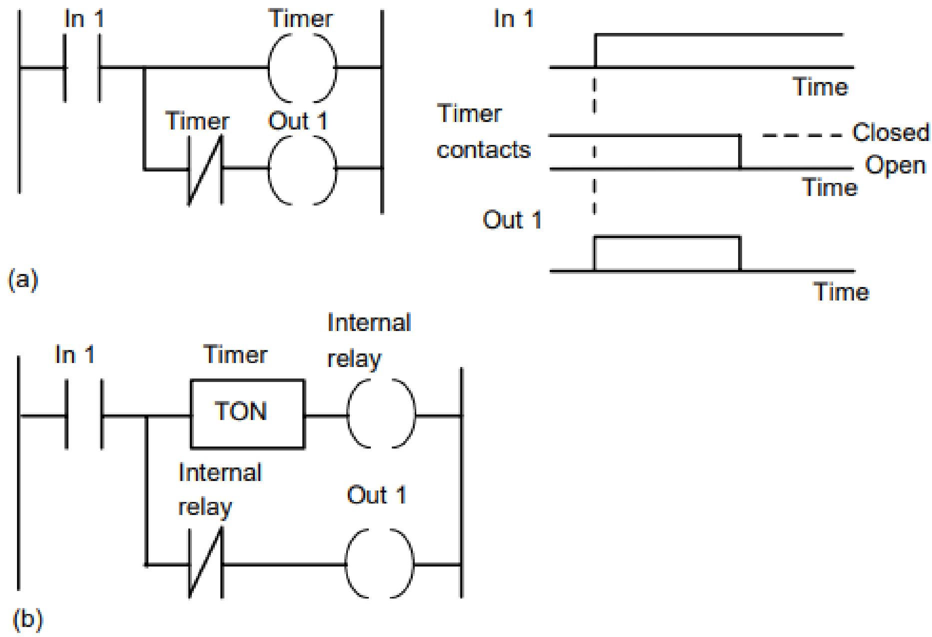


Figure 9.13 *Pulse-on timer*

Figure 9.13(b) shows an equivalent ladder diagram to Figure 9.13(a) but employing a timer which produces a delay in the time taken for a signal to reach the output. In Figure 9.13, the pulse timer has an output switched on by an input for a predetermined time, and then switching off. Figure 9.14 shows another pulse timer that switches an output on for a predetermined time after the input ceases. This uses a timer and two internal relays. When there is an input to In 1, the internal relay IR 1 is energized The timer does not start at this point because the normally closed In 1 contacts are open. The closing of the IR 1 contacts means that the internal relay IR 2 is energised. There is, however, no output from Out 1 at this stage because, for the bottom rung, we have In 1 contacts open.

---When the input to In 1 ceases, both the internal relays remain energised and the timer is started.

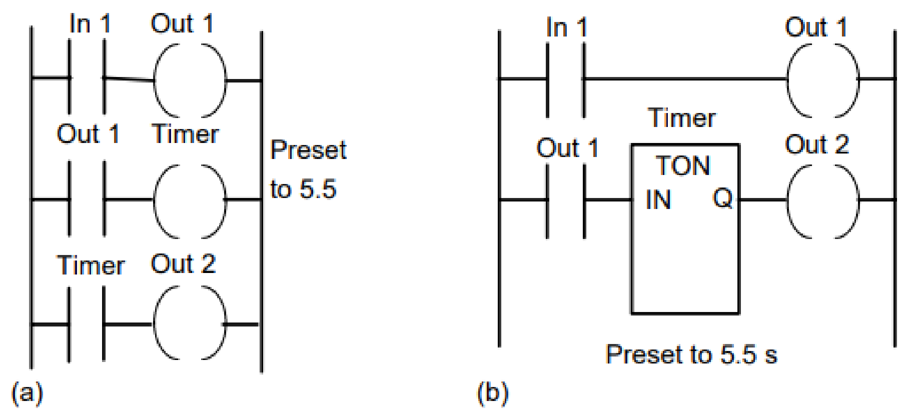
---After the set time, the timer contacts, which are normally closed, open and switch off IR 2.

----This in turn switches off IR 1. It also, in the bottom rung, switches off the output Out 1. Thus the output is off for the duration of the input, then being switched on for a predetermined length of time.

Sequencing

consider the ladder diagram shown in Figure below . When the input In 1 is on, the output Out 1 is switched on. The contacts associated with this output then start the timer. The contacts of the timer will close after the preset time delay, in this case 5.5 s. When this happens, output Out 2 is switched on. Thus, following the input In 1, Out 1 is switched on and followed 5.5 s later by Out 2. This illustrates how timed sequence of outputs can be achieved

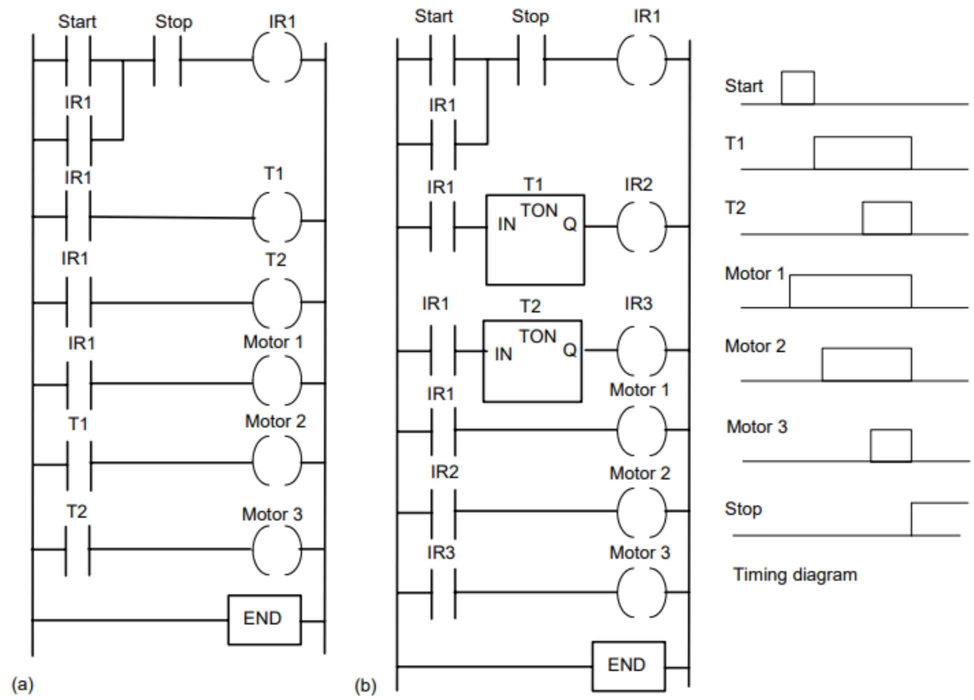
Figure (b) shows the same operation where the format used by the PLC manufacturer is for the timer to institute a signal delay.



Example:

Shows how timers can be used to start three outputs, e.g. three motors, in sequence following a single start button being pressed. Explain the sequence of operations.

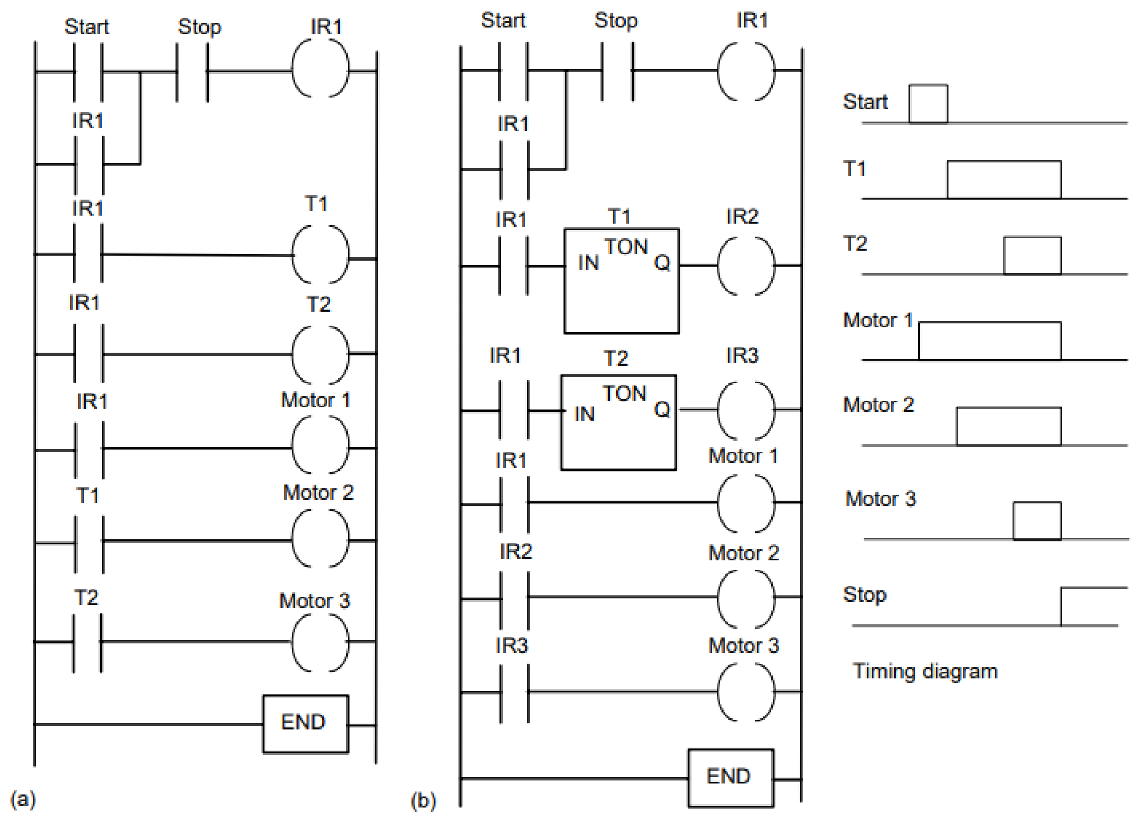
Solution



In (a) the timers are programmed as coils, whereas in (b) they are programmed as delays. When the start push button is pressed there is an output from internal relay IR1. This latches the start input. It also starts both the timers, T1 and T2, and motor 1. When the preset time for timer 1 has elapsed then its contacts close and motor 2 starts. When the preset time for timer 2 has elapsed then its contacts close and motor 3 starts. The three motors are all stopped by pressing the stop push button. Since this is seen as a complete program, the end instruction has been used

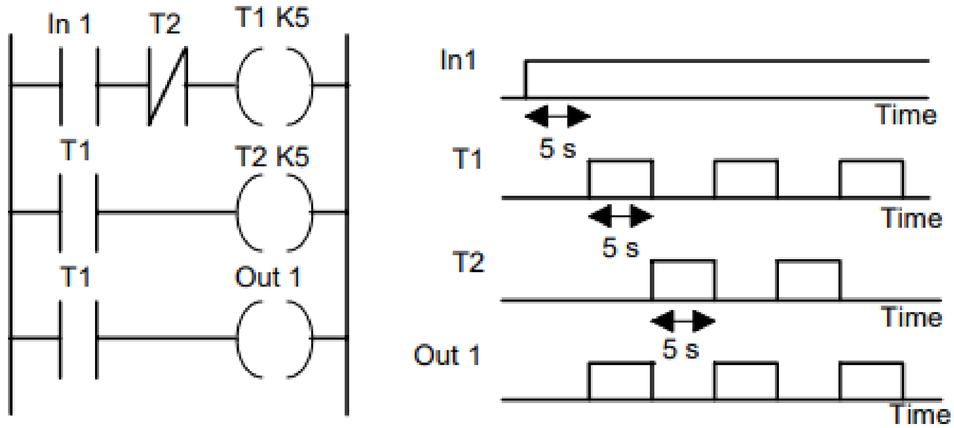
Cascaded timers

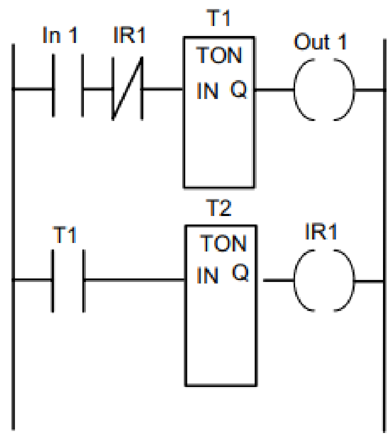
Timers can be linked together, the term cascaded is used, to give longer delay times than are possible with just one timer. Figure below shows the ladder diagram for such an arrangement. Thus we might have timer 1 with a delay time of 999 s. This timer is started when there is an input to In 1. When the 999 s time is up, the contacts for timer 1 close. This then starts timer 2. This has a delay of 100 s. When this time is up, the timer 2 contacts close and there is an output from Out 1. Thus the output occurs 1099 s after the input to In 1.



Example On-off cycle timer

Figure shows how on-delay timers can be used to produce an on-off cycle timer. The timer is designed to switch on an output for 5 s, then off for 5 s, then on for 5 s, then off for 5 s, and so on. When there is an input to In 1 and its contacts close, timer 1 starts. Timer 1 is set for a delay of 5 s. After 5 s, it switches on timer 2 and the output Out 1. Timer 2 has a delay of 5 s. After 5 s, the contacts for timer 2, which are normally closed open. This results in timer 1, in the first rung, being switched off. This then causes its contacts in the second rung to open and switch off timer 2. This results in the timer 2 contacts resuming their normally closed state and so the input to In 1 causes the cycle to start all over again.





Timer Instructions Address for Multiple PLC Brands

. There are four main values that timer deals with.

- Timer Address
- Preset Value
- Timer Base Value
- Accumulated value

Each timer instruction has three very useful status bits. These bits are…

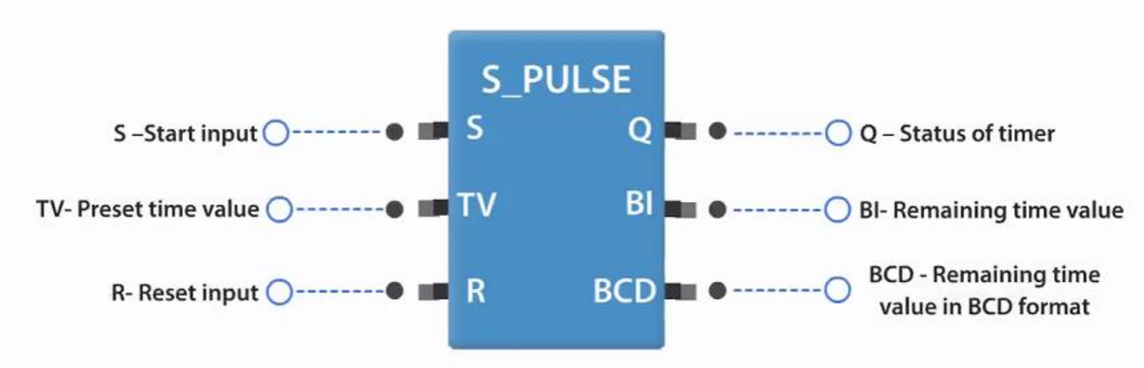
1. Enable bit (EN)
2. Timer Timing bit (TT)
3. Done Bit (DN).

1. Addressing for Siemens PLC

In the Siemens, LD program can be written with the five types of timers.

- Pulse timer (S_Pulse)
- Pulse extended timer (S_PExT)
- On delay timer (S_ODT)
- On delay extended timer (S_ODTS)
- Off delay timer (S_OffDT)

The general block diagram of the timer (In Siemens PLC),



Where,

S – Set value or signal for the timer

TV – Time Variable. It is used to store time value in the form of

S5T#tv

You can enter the time value from 1 to 9990 seconds.

R- Reset value of the timer

Q – Output of the timer

BI – Current time in binary code

BCD – Current time in binary decimal code

2. Addressing for Delta PLC

For the WPLSoft software (Delta PLC), you can use timer addressing ranging from ‘**T0′** to ‘**T127**‘.

In Delta PLC, input timer address is shown like general representation (T0, T1,…….. T127).
And Output coil is written in the form of

T(Address rang) K(10*timer value)

Where,

'T0' is timer address and 'K' is the constant term

Delta PLC timer block diagram:

For Delta PLC, the timer starts for a 10-second. It should be written in the form of 'T0 K100'.

3. Addressing for Mitsubishi PLC

Both, Mitsubishi PLC and Delta PLC, use the same timer addressing format.

4. Addressing for ABB PLC

In the ABB PLC programming, we can simply write the I/O timer address of the ladder diagram.
We can set the timer value in ranges from '**T0**' to '**T255**'.

You can see the above diagram of the I/O contact representation.

5. Addressing for AB (Rockwell) PLC

For the AB PLC, the timer has the address ranging from '**T4:0′** upto '**T4:255**'.
Where, T4 is the file type.

File tpye: Element Number/ Bit status

1. Enable bit (EN) address is ranging from 'T4:0/EN' upto 'T4:255/EN'.
2. The addressing for Timer timing bit (TT) is ranging from 'T4:0/TT' upto 'T4:255/TT'.

3. Done bit (DN) address is ranging from ‘T4:0/DN’ upto ‘T4:255/DN’.

Example

Consider a program (Figure 9.15) that could be used to flash a light on and off as long as there is some output occurring. We might have both timer 0 and timer 1 set to 1 s

Discussing the LD

When the output occurs, then timer 0 starts and switches on after 1 s.

-- This closes the timer 0 contacts and starts timer 1. This switches on after 1 s and, in doing so, switches off timer 0.

--In so doing, it switches off itself. The lamp is only on when timer 0 is on and so we have a program to flash the lamp on and off as long as there is an output.

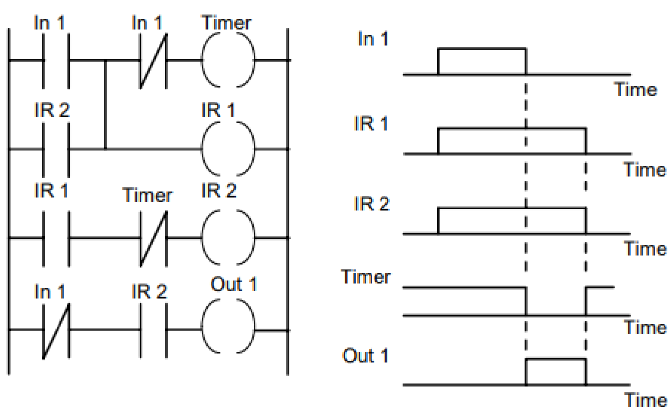


Fig. 9.15

Example

Traffic Control System using PLC LD Programming

Here, we need useful software functions like input (I), output (O), memory (M), and timer (T) for writing the LD program.

These input and output functions consider as switches and lamps in the compact PLC, respectively.

Tools recruitment are as follow.

1. Two Push-Button [PB1 & PB2]
2. Three Lamp Signal [Q1, Q2 & Q3]
3. One Memory [M]
4. Three Timers [T1, T2 & T3]

The LD diagram looks like with these components is shown in fig bellow

Now explaining each connected LD diagram components one by one:

Inputs:

Push- Botton (PB): There are two push buttons- PB1 and PB2. The PB1 (I1) get NO (Normally Open) contact and PB2 (I2) get NC (Normally Closed) contact.

PB1 is used for the start signal.
PB2 is used for the stop the signal or emergency off purpose.

Outputs:

There are three outputs (Q1, Q2, and Q3), considered as lamp or output coil.

- The Q1 is considered as the red lamp.
- The Q2 is considered as the yellow lamp.
- And Q3 is considered as the green lamp.

Memory [M]

It is used for latching process and to store extra energy supply. This memory depicts input or output functions (or coil).

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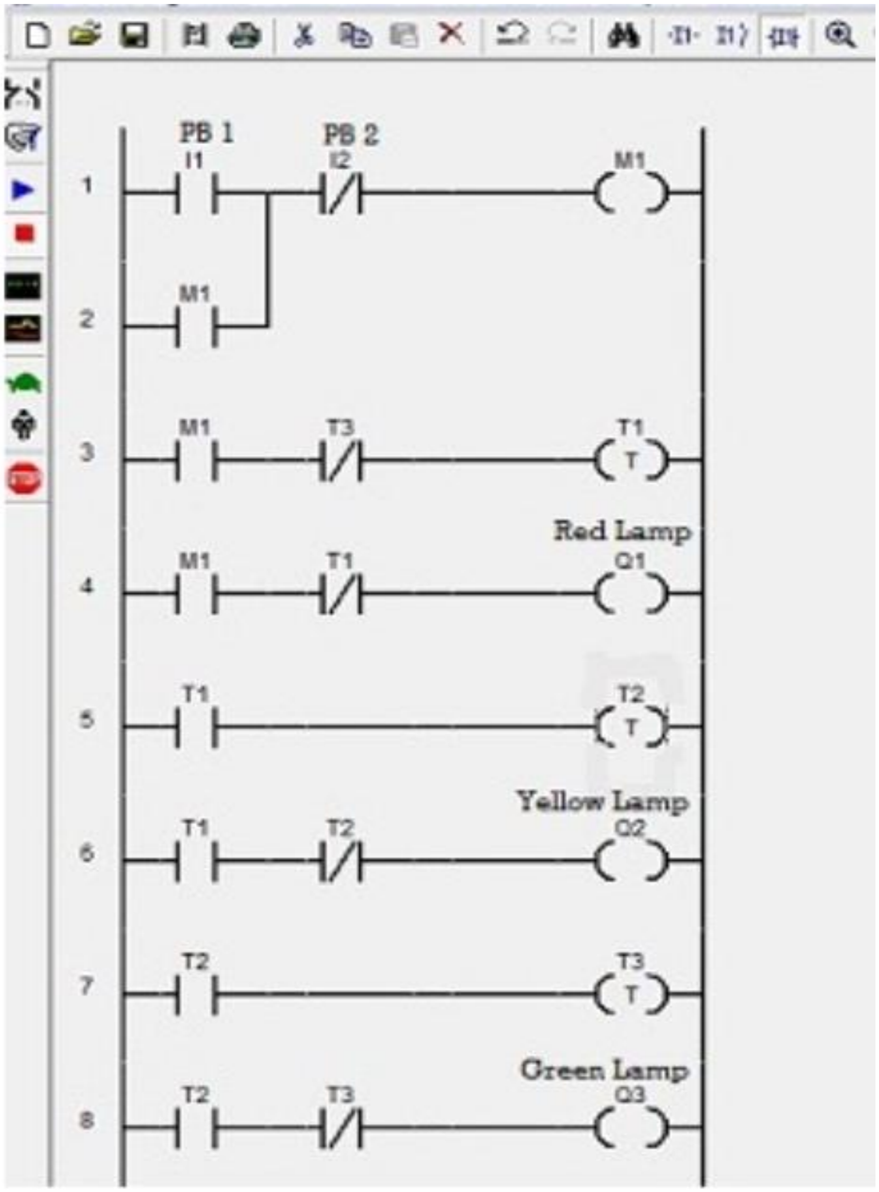


Program on ABB PLC Software

Timers:

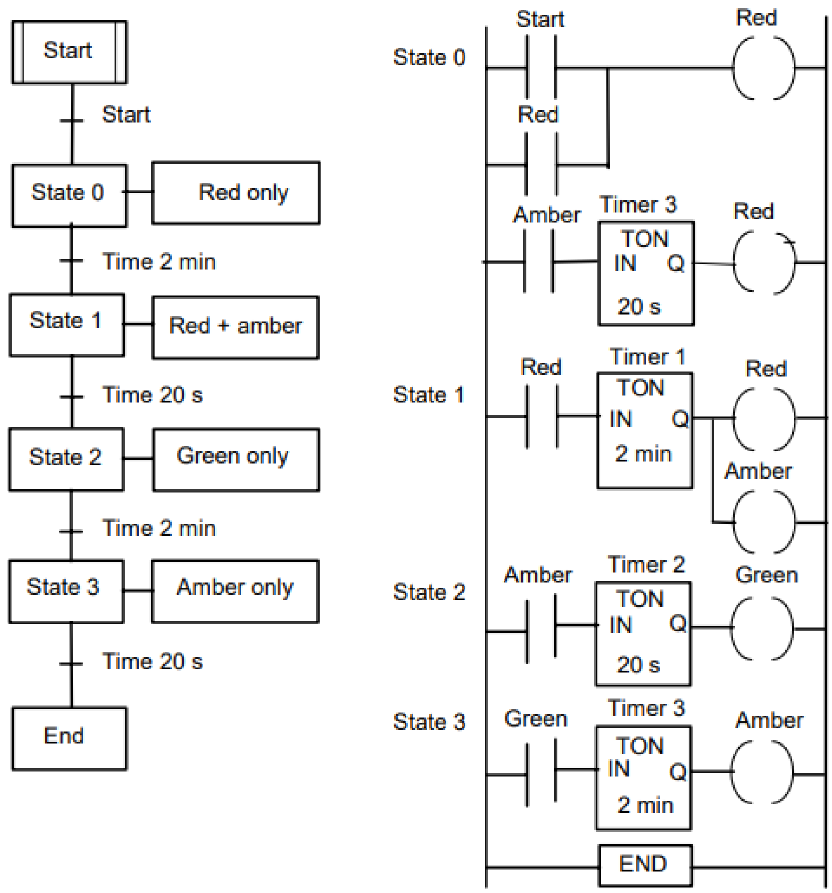
- T1 is connected to the red lamp (Q1) for the 5 seconds.
- T2 is connected to the yellow lamp (Q2) for the 10 seconds.
- And T3 is connected to the green lamp (Q3) for the 15 seconds.

EXAMPLE: Traffic light

As an illustration of programming involving timers consider the sequencing of traffic lights to give the sequence red only, red plus amber, green, amber.

Solution

A simple system might just have the sequence triggered by time, with each of the possible states occurring in sequence for a fixed amount of time. Figure 9.16 shows the sequential function chart and a possible ladder program to give the sequence.



PROBLEMS

Problems 1 to 3 refer to Figure 9.17 which shows a ladder diagram with an on-delay timer, an input In 1 and an output Out 1.

1. Decide whether each of these statements is True (T) or False (F). When there is an input to In 1 in Figure 9.17: (i) The timer starts. (ii) There is an output from Out 1.

(A- (i) T (ii) T (B- (i) T (ii) F C- (i) F (ii) T D- (i) F (ii) F

2. Decide whether each of these statements is True (T) or False (F).

The timer in Figure 9.17 starts when:

(i) There is an output.

(ii) The input ceases.

A- (i) T (ii) T

B- (i) T (ii) F

C- (i) F (ii) T

D- (i) F (ii) F

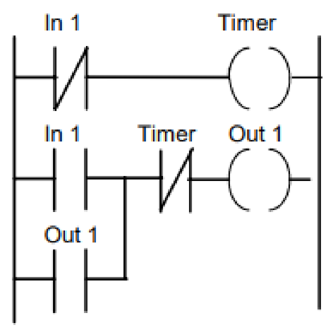


Figure 9.17 *Problems 1 to 3*

3. Decide whether each of these statements is True (T) or False (F).

When there is an input to In 1, the output is switched:

(i) On for the time for which the timer was preset.

(ii) Off for the time for which the timer was preset.

A- (i) T (ii) T

B- (i) T (ii) F

C- (i) F (ii) T

D- (i) F (ii) F

Problems 4 to 6 refer to Figure 9.18 which shows two alternative versions of a ladder diagram with two inputs In 1 and In 2, two outputs Out 1 and Out 2 and an on-delay timer.

4. Decide whether each of these statements is True (T) or False (F). When there is just an input to In 1:

The timer starts. (ii) There is an output from Out 2.

A (i) T (ii) T B (i) T (ii) F C (i) F (ii) T D (i) F (ii) F

5. Decide whether each of these statements is True (T) or False (F). When there is just an input to In 2:

(i) The timer starts. (ii) There is an output from Out 2

A (i) T (ii) T B (i) T (ii) F C (i) F (ii) T D (i) F (ii) F

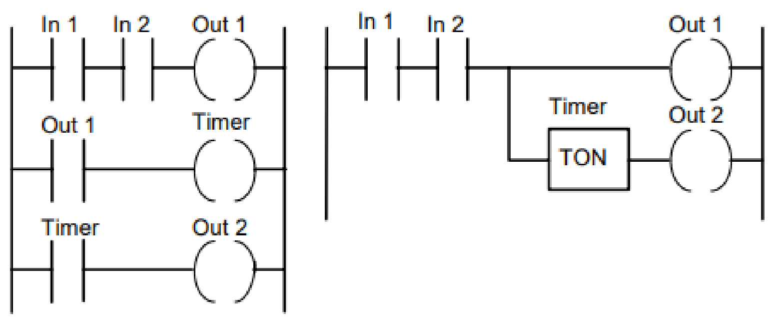


Figure 9.18 *Problems 4 to 6*

6. Decide whether each of these statements is True (T) or False (F).

When there is an input to In 1 and no input to In 2, there is an output

from Out 2 which:

(i) Starts immediately.

(ii) Ceases after the timer preset time.

A (i) T (ii) T

B (i) T (ii) F

C (i) F (ii) T

D (i) F (ii) F

Problems 11 and 12 refer to Figure 9.19 which shows a system with an input In 1, an on-delay timer and an output Out 1. The timer is set for a time of 6 s. The graph shows how the signal to the input varies with time.

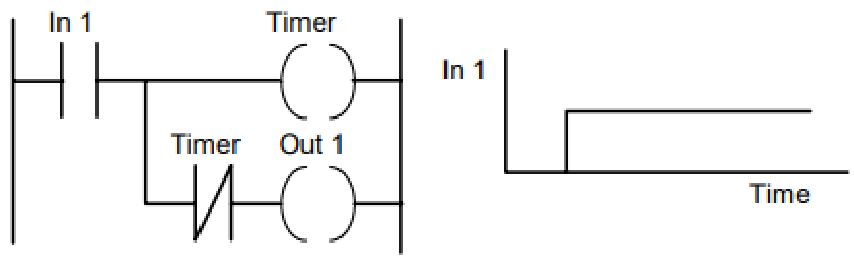


Figure 9.19 *Problems 11 and 12*

7. Decide whether each of these statements is True (T) or False (F).

The output from Out 1:

(i) Starts when the input starts.

(ii) Ceases 6 s after the start of the input.

A (i) T (ii) T

B (i) T (ii) F

C (i) F (ii) T

D (i) F (ii) F

8. Decide whether each of these statements is True (T) or False (F).

The timer contacts:

(i) Remain closed for 6 s after the start of the input.

(ii) Open 6 s after the input starts.

A (i) T (ii) T

B (i) T (ii) F

C (i) F (ii) T

D (i) F (ii) F

Problems 13 to 15 refer to Figure 9.20 which shows a ladder program for a Toshiba PLC involving internal relays, denoted by the letter R, and a TON timer with a preset of 20 s.

9. Decide whether each of these statements is True (T) or False (F).

The internal relay R000 in Figure 9.20:

(i) Is used to latch the input X001.

(ii) Is used to start the timer T001.

A (i) T (ii) T

B (i) T (ii) F

C (i) F (ii) T

D (i) F (ii) F

10. Decide whether each of these statements is True (T) or False (F).

With no input to X002 in Figure 9.20, the output Y020 is:

(i) Energised when there is an input to X001.

(ii) Ceases when there is no input to X001.

A (i) T (ii) T

B (i) T (ii) F

C (i) F (ii) T

D (i) F (ii) F

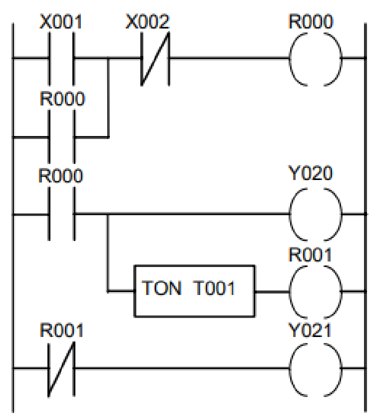


Figure 9.20 *Problems 13 to 15*

11. Decide whether each of these statements is True (T) or False (F).

With no input to X002 in Figure 9.20:

(i) The output Y021 is switched on 20 s after the input X001.

(ii) The output Y020 is switched off 20 s after the input X001.

A (i) T (ii) T

B (i) T (ii) F

C (i) F (ii) T

D (i) F (ii) F

Problems 16 to 19 refer to Figure 9.21 which shows an Allen-Bradley program and Figure 9.22 which shows a number of time charts for a particular signal input to I:012/01.

12. For the input shown in Figure 9.22, which is the output from

O:013/01?

13. For the input shown in Figure 9.22, which is the output from

O:013/02?

14. For the input shown in Figure 9.22, which is the output from

O:013/03?