Industrial Automation (ICE 3252)

PLC Programming- Timers

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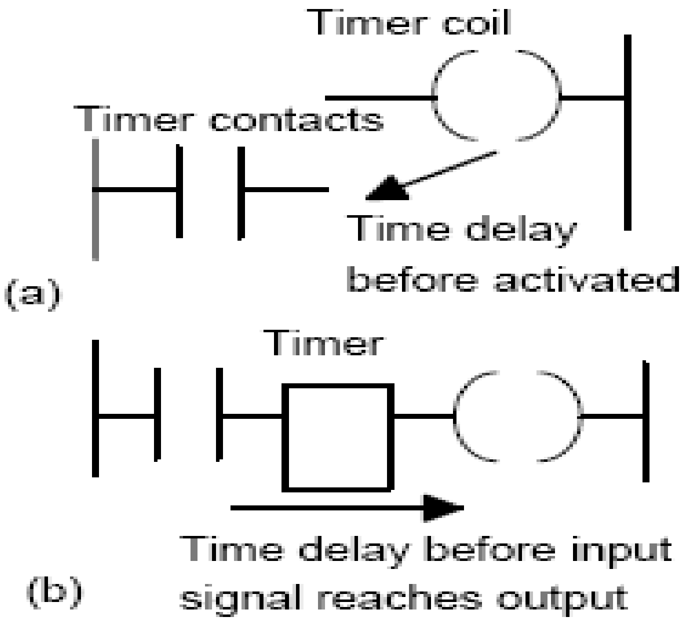
Timers

- Timer is a device that introduces a time delay in a circuit or a system during its ON or OFF condition.
- The most commonly used process control device after coils and contacts is the timer.
- The timers of a PLC are realized in the form of software modules and are based on the generation of digital timing
- The counted clock pulses are derived from the quartz generator of the microprocessor
- The desired time duration is set in the control program

What are timers?

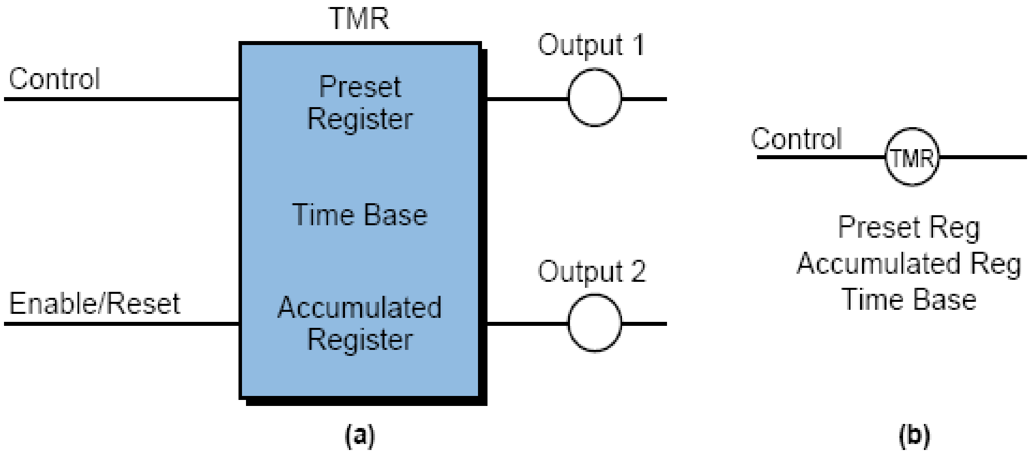
- In many control tasks there is a need to control time.
- PLCs have timers as built-in devices.
- Timers count *fractions* of seconds or seconds using the internal CPU clock.
- The timer is thus treated as an output for a rung with control being exercised over pairs of contacts elsewhere.

Treatment of Timers



- A common approach is to consider timers to behave like relays with coils which when energized result in the closure or opening of contacts after some preset time.
- The timer is thus treated as an output for a rung with control being exercised over pairs of contacts elsewhere.

Formats of Timers

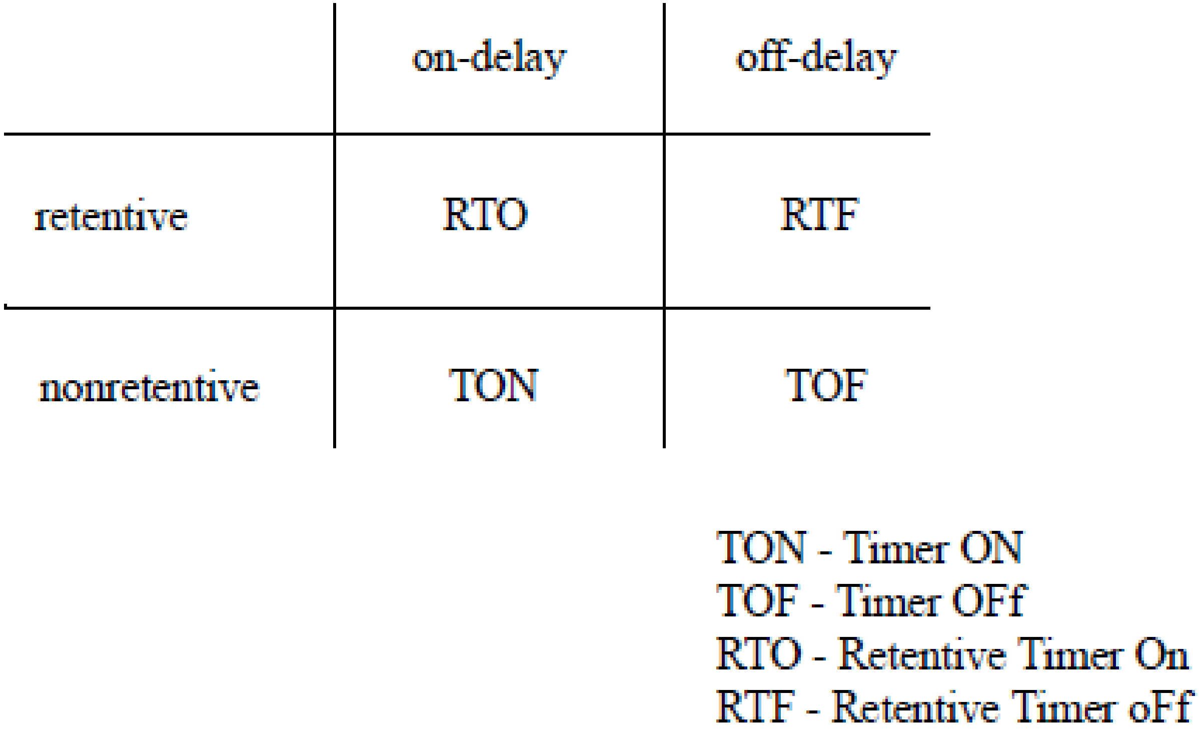


- The inputs are called the *control line* and the *enable/reset line.*
- *If the control line is TRUE (i.e., it has continuity) and the* enable line is also TRUE, the block function will start timing.
- A ladder format timer generally has only one input, which is the control line. If the control line is ON, the timer will start timing.

Time base

- 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.
- *The most common time bases are 0.001sec, 0.01 sec, 0.1 sec, and 1 sec.*

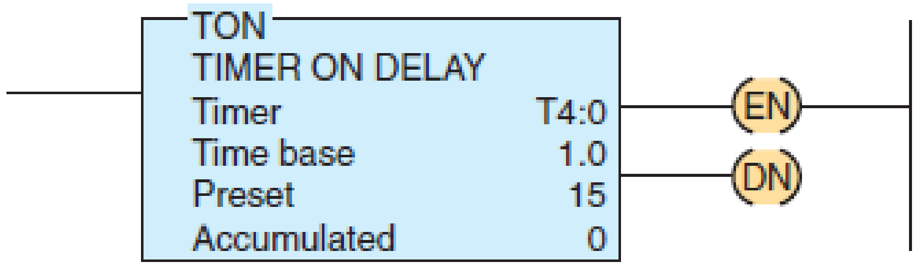
Timer types



	on-delay	off-delay
retentive	RTO	RTF
nonretentive	TON	TOF

TON - Timer ON
TOF - Timer OFf
RTO - Retentive Timer On
RTF - Retentive Timer oFf

ON delay Timer



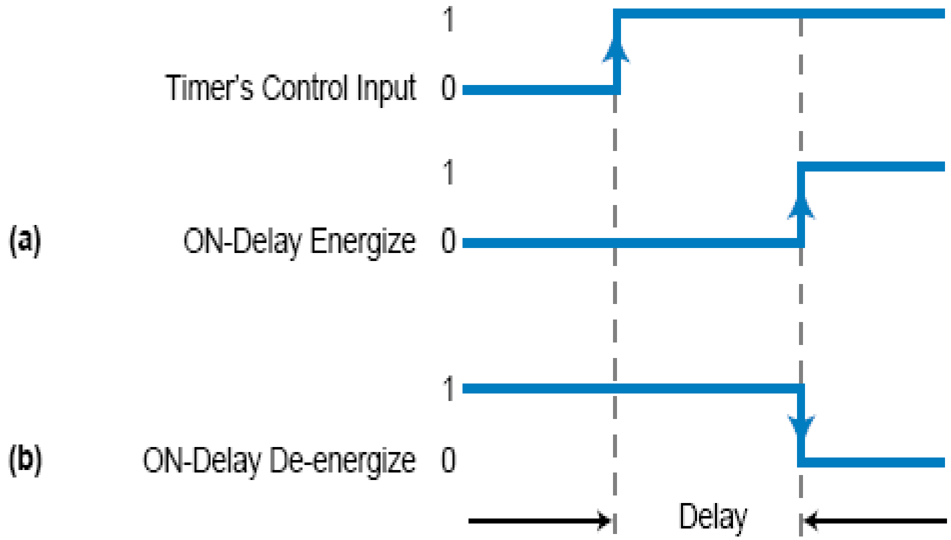
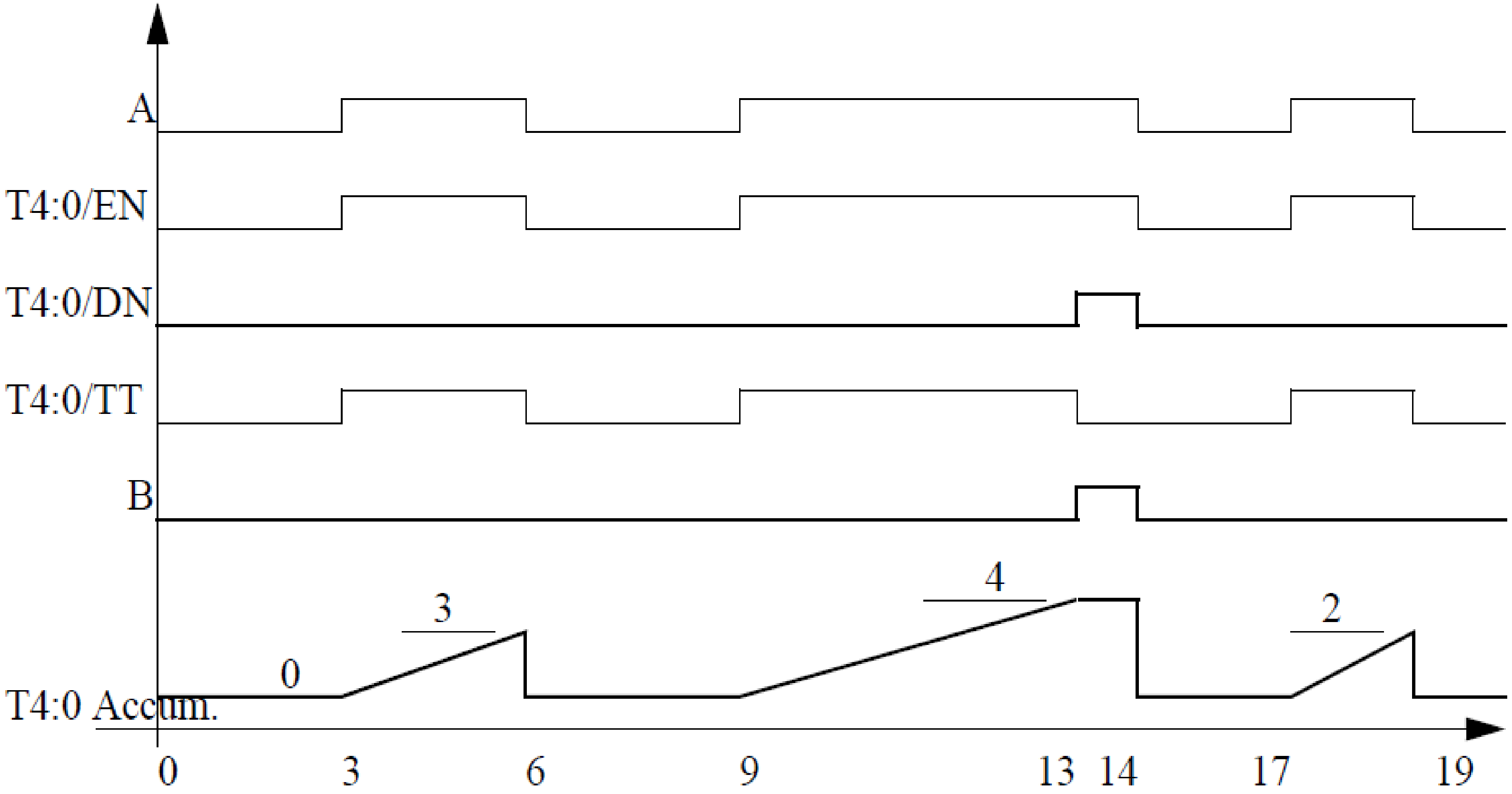


Figure Timing diagram for **(a)** an ON-delay energize timer and **(b)** an ON-delay de-energize timer.

- 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.

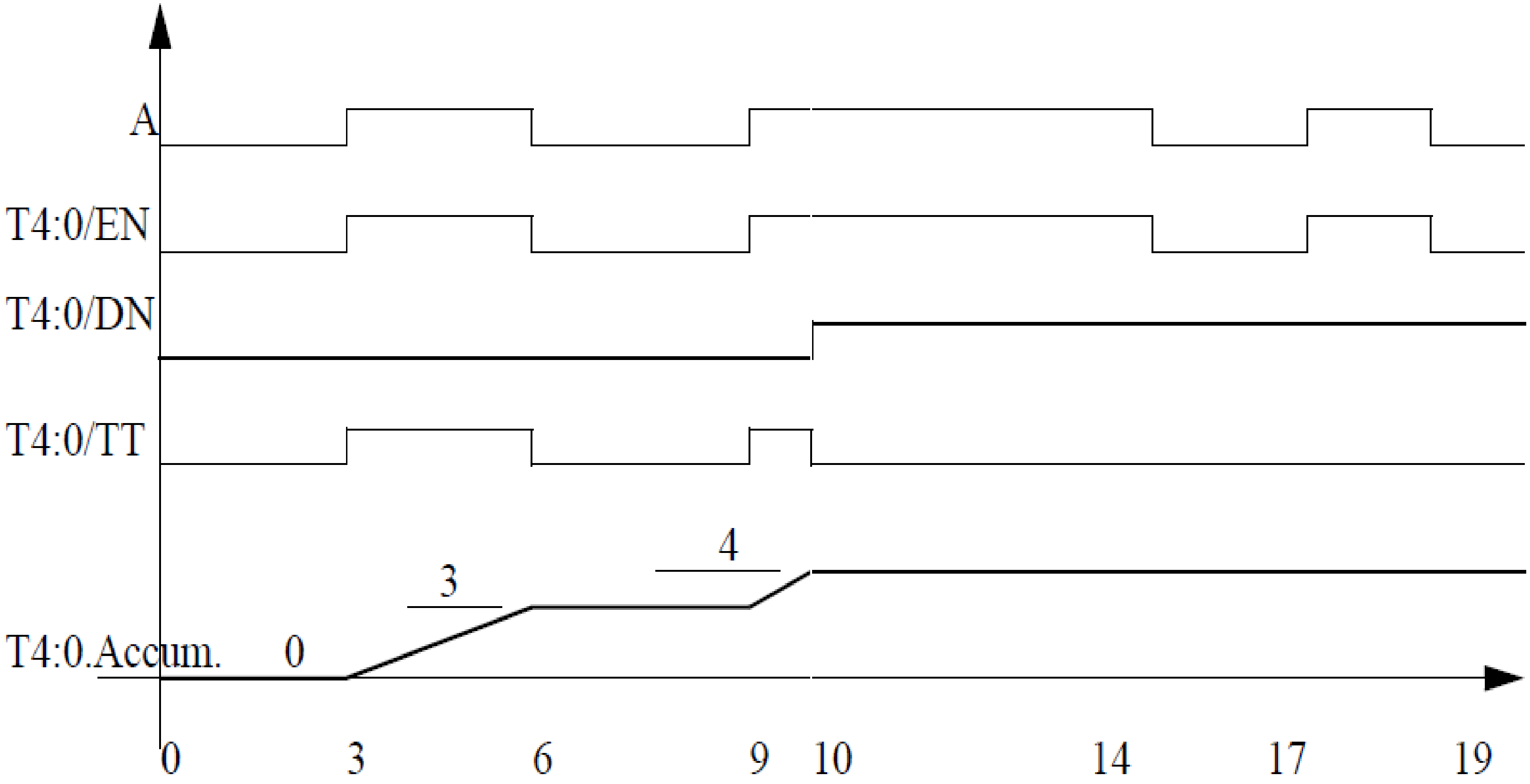
Allen-Bradley TON Timer



Retentive ON delay timer

- The Retentive On-Delay timer (TONR) functions in a similar manner to the On-Delay timer (TON).
- There is one difference. The Retentive On-Delay timer times as long as the enabling input is on, but does not reset when the input goes off.
- The timer must be reset with a RESET (R) instruction.

An Allen Bradley Retentive On-Delay



OFF Delay Timers

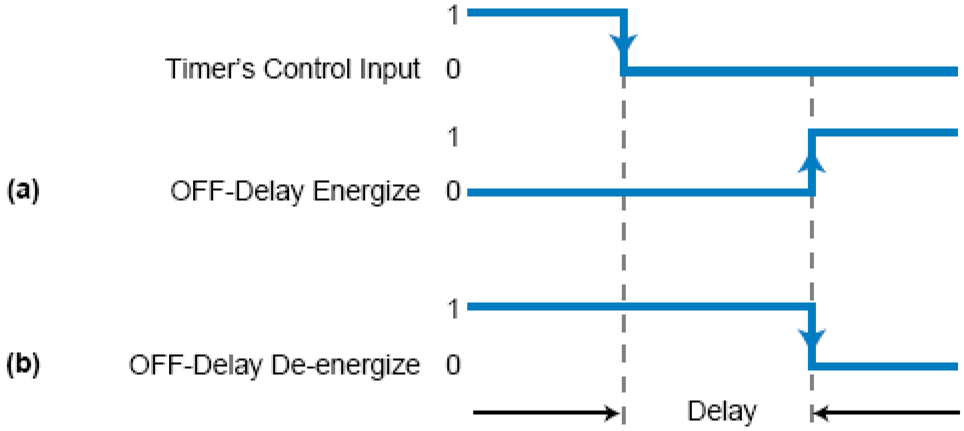
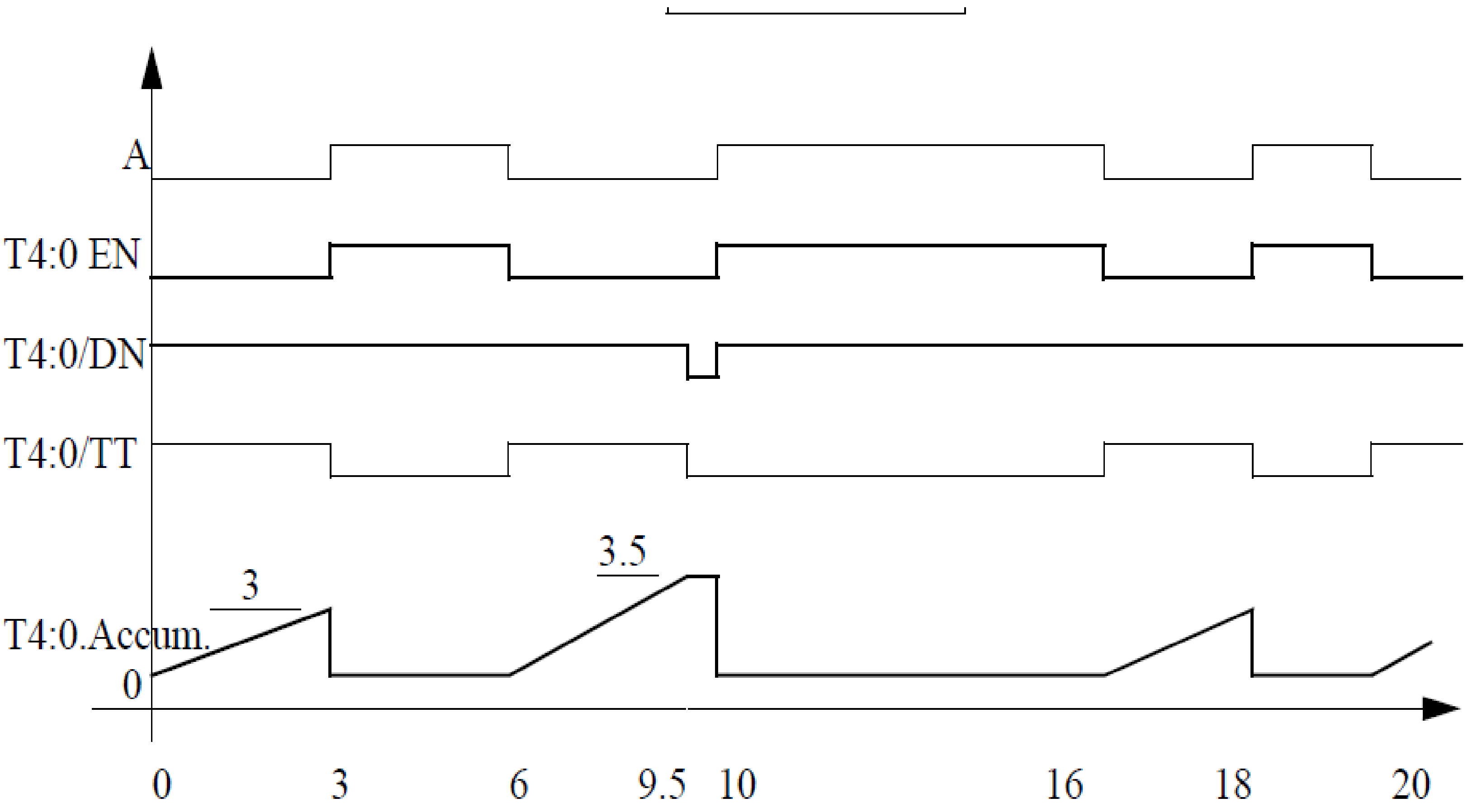


Figure Timing diagram for **(a)** an OFF-delay energize timer and **(b)** an OFF-delay de-energize timer.

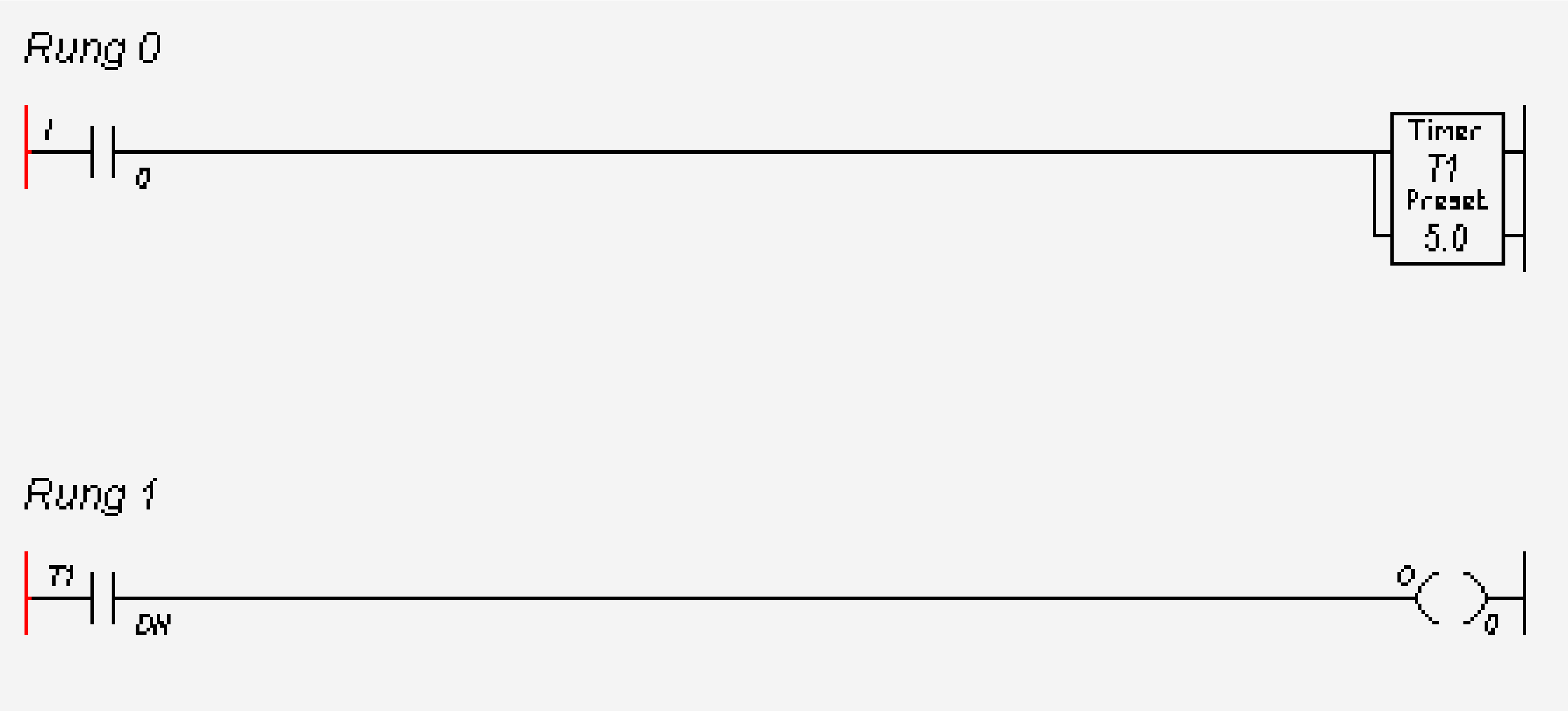
- An *OFF-delay de-energize timer (TOF) instruction is similar to its OFF-delay* energize counterpart; however, this timer's output is ON and will be de-energized once the rung loses continuity and the time interval has elapsed(accumulated register value = preset register value).

Allen Bradley Off-Delay Timer

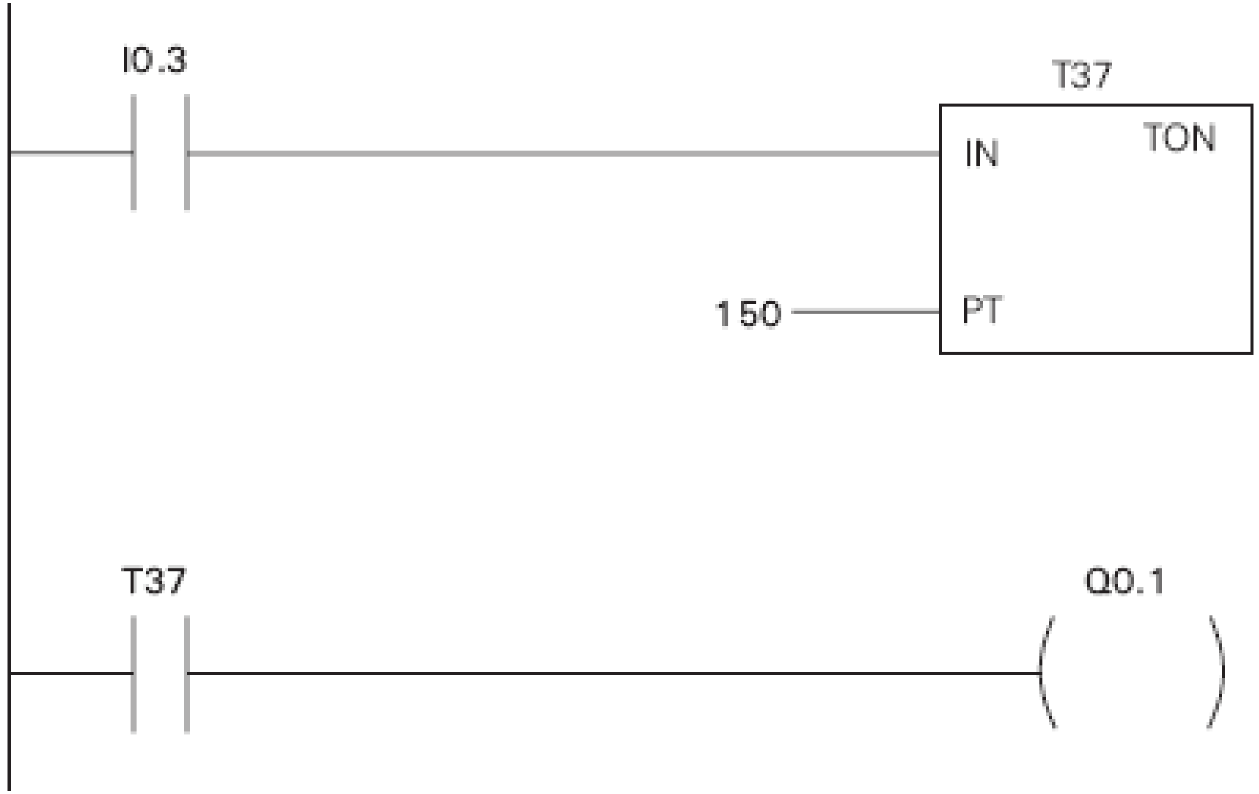


- **Enable (EN) bit** —The enable bit is true (has a status of 1) whenever the timer instruction is true. When the timer instruction is false, the enable bit is false (has a status of 0).
- **Timer-timing (TT) bit** —The timer-timing bit is true whenever the accumulated value of the timer is changing, which means the timer is timing. When the timer is not timing, the accumulated value is not changing, so the timer-timing bit is false.
- **Done (DN) bit** —The done bit changes state whenever the accumulated value reaches the preset value. Its state depends on the type of timer being used.
- The *preset value (PRE) word* is the set point of the timer, that is, the value up to which the timer will time. The preset word has a range of 0 through 32,767.

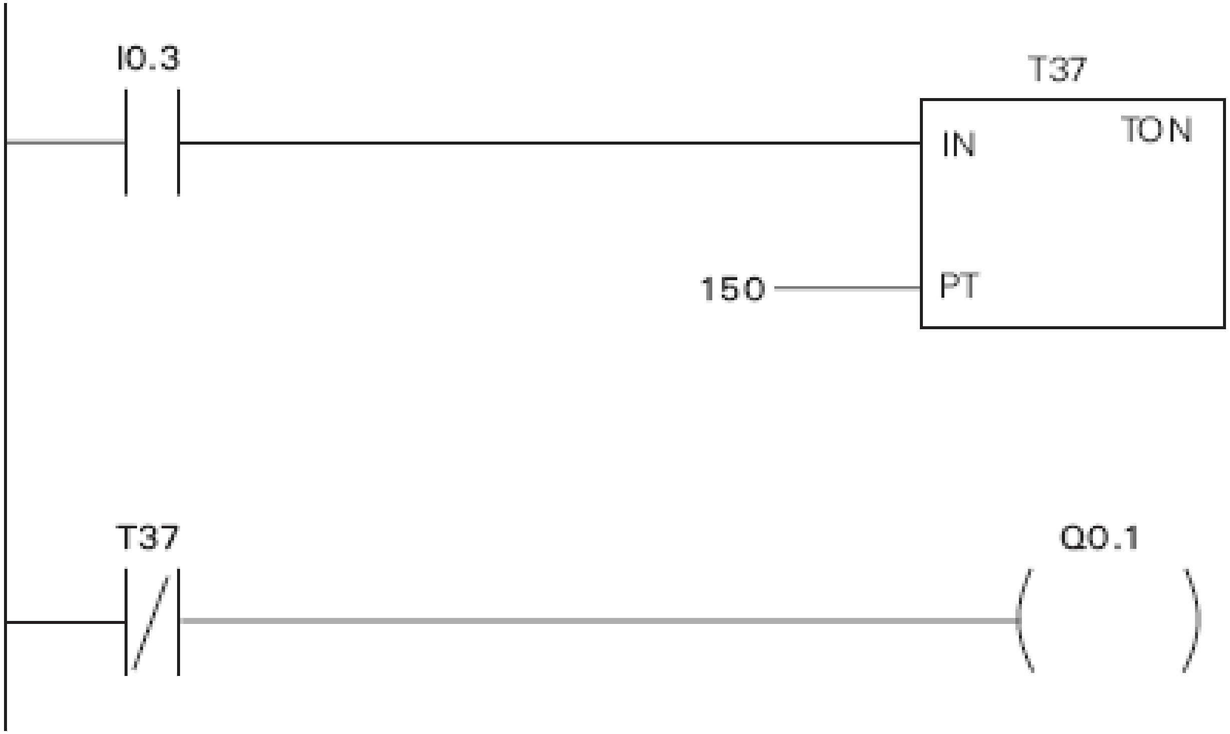
Program in LADSIM



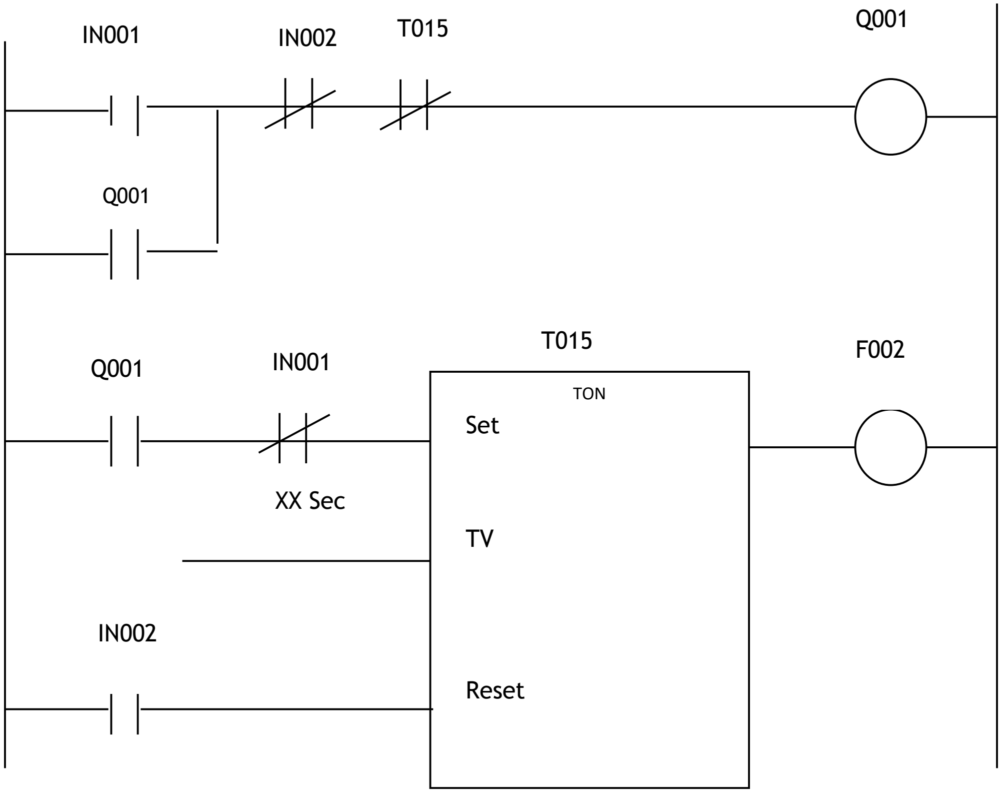
Program in Step 7



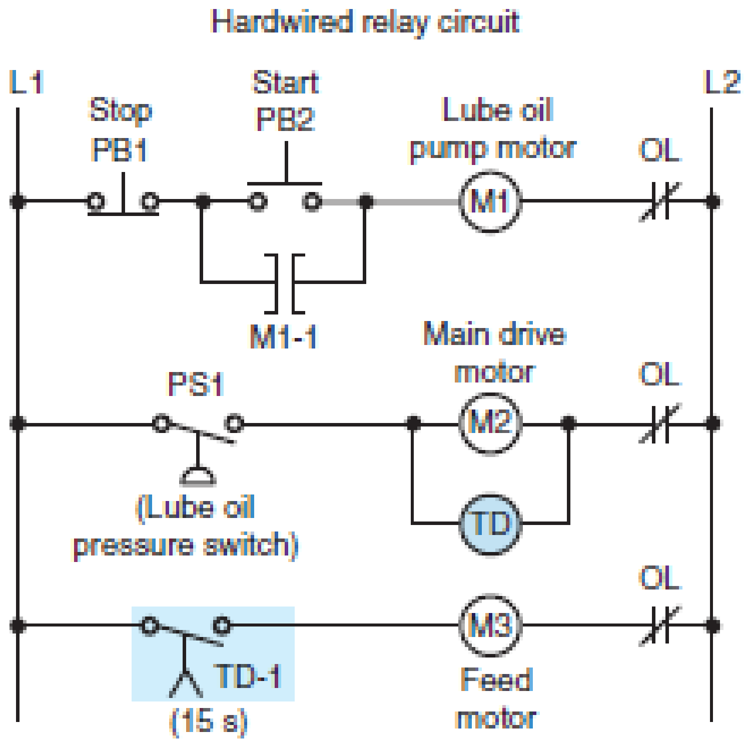
What will be the output of this program?

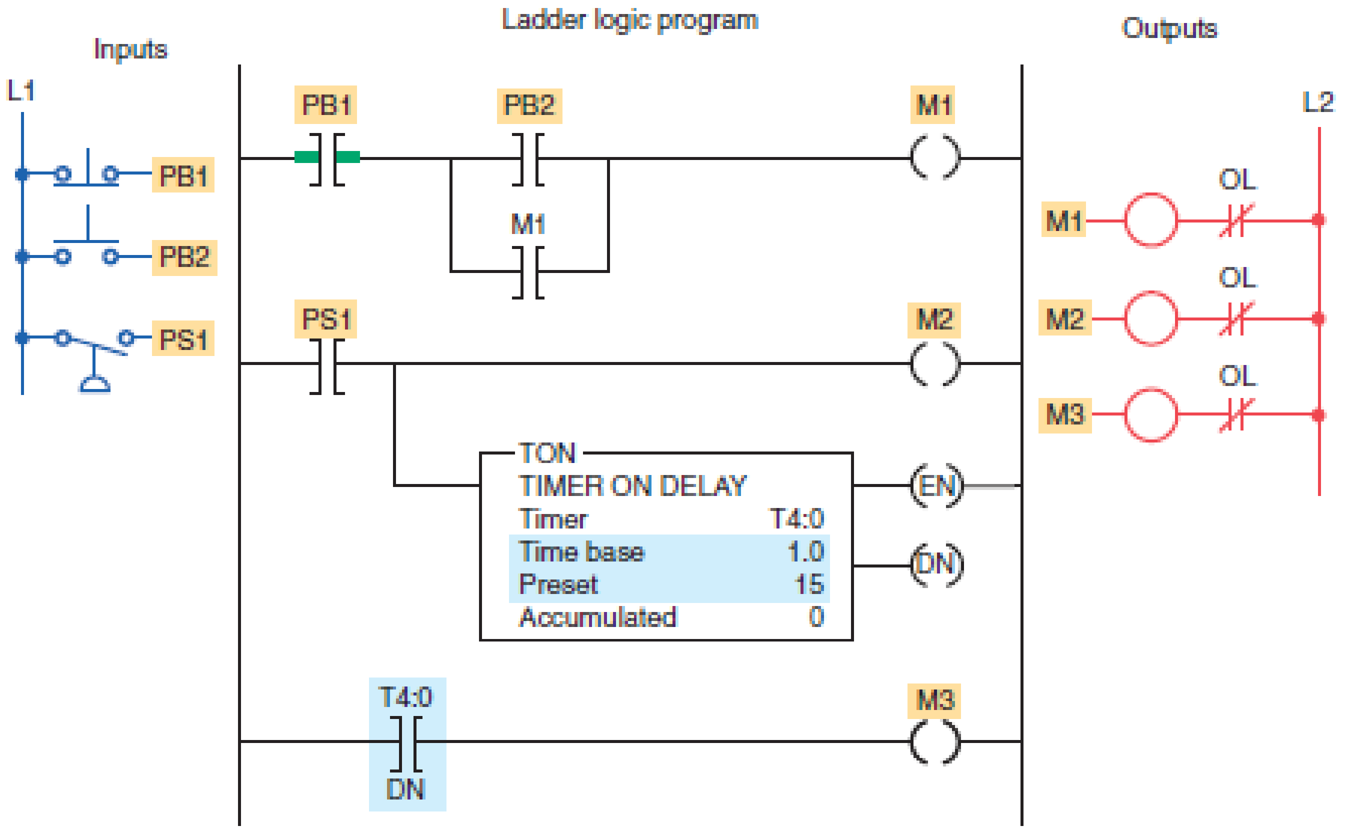


Off Delay timer using an On-Delay timer

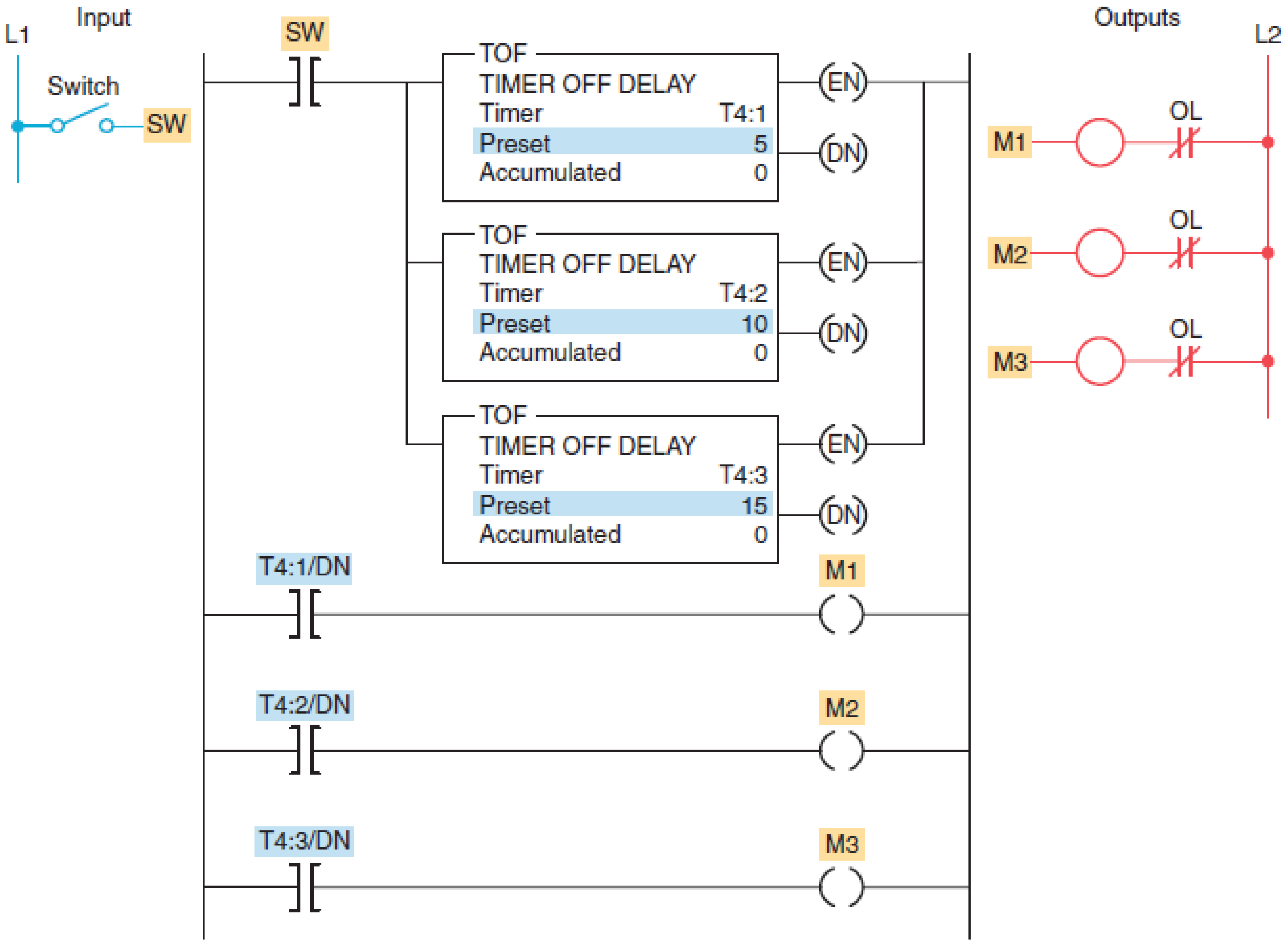


Example1-Timers used as part of automatic sequential control systems.



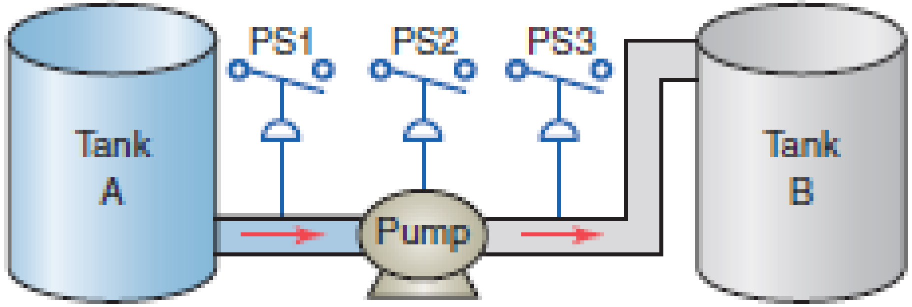

Ladder logic program
Inputs
Outputs
L1
L2
PB1
PB2
PS1
PB1
PB2
M1
M1
PS1
M2
TON
TIMER ON DELAY
Timer T4:0
Time base 1.0
Preset 15
Accumulated 0
EN
DN
T4:0
DN
M3
M1
M2
M3
OL
OL
OL

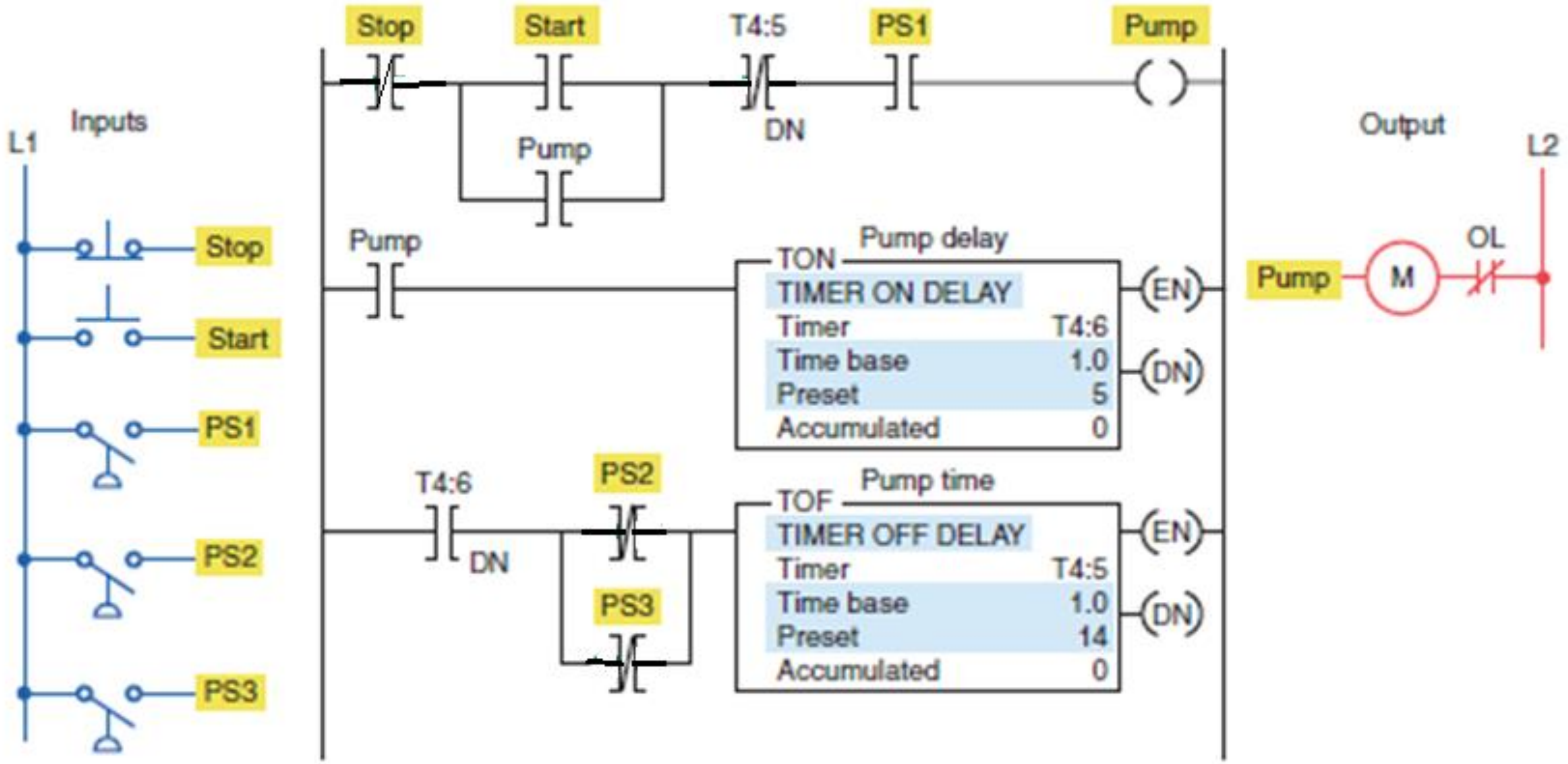
Example 2: Program to switch motors *off* sequentially at 5 second intervals.



Example 3-Pumping fluid from tank A to tank B.

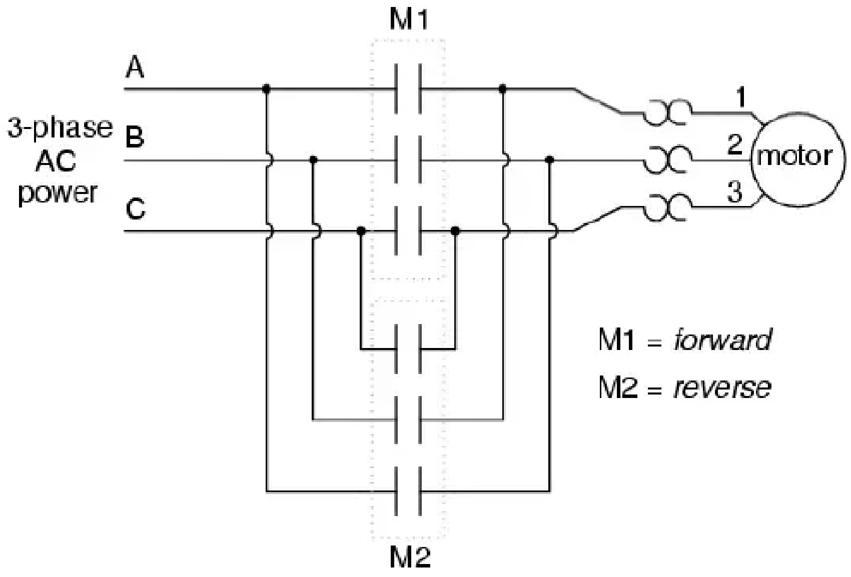
- Before starting, PS1 must be closed.
- When the start button is pushed, the pump starts. The button can then be released and the pump continues to operate.
- When the stop button is pushed, the pump stops.
- PS2 and PS3 must be closed 5 s after the pump starts. If either PS2 or PS3 opens, the pump will shut off and will not be able to start again for another 14 s.

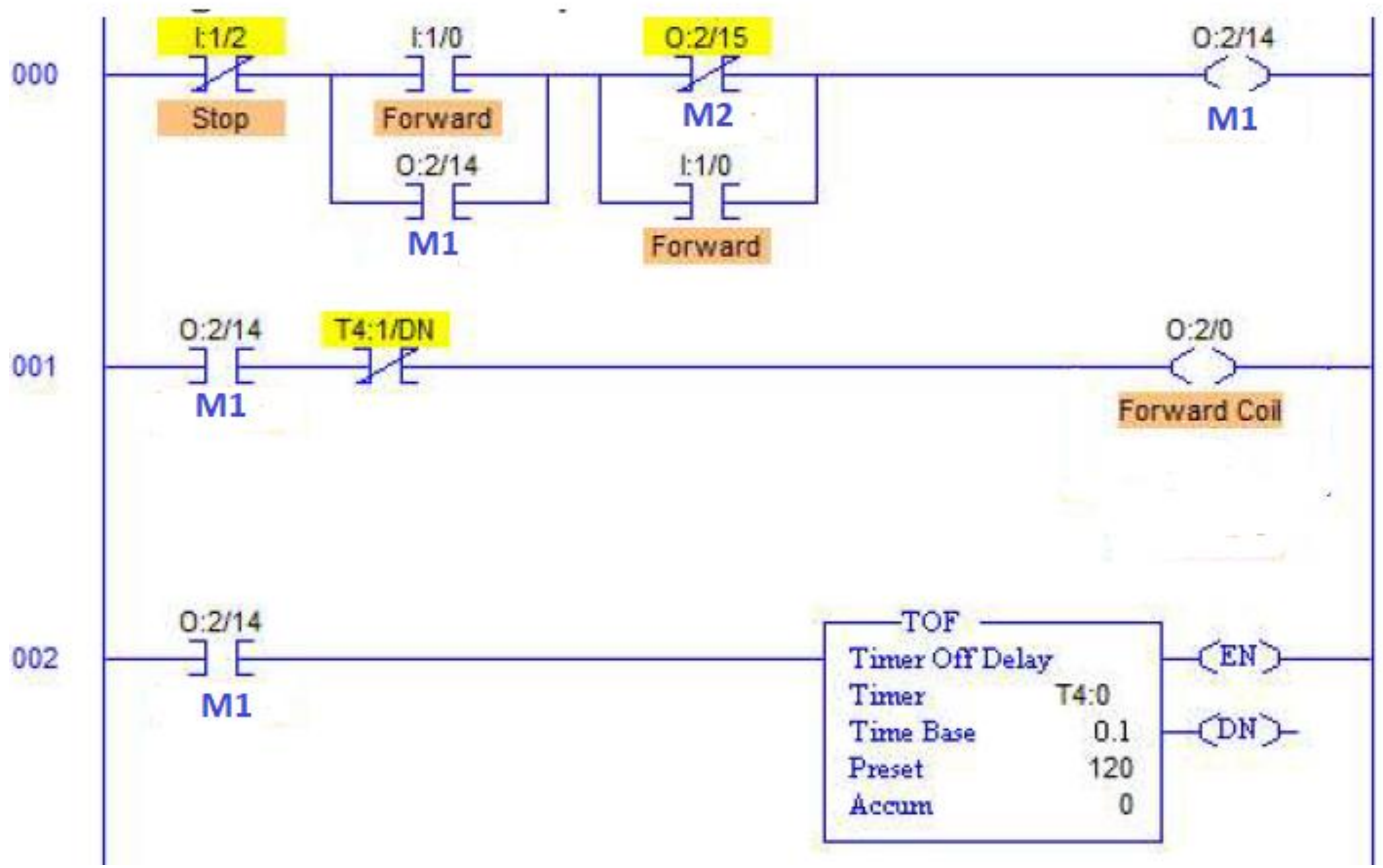


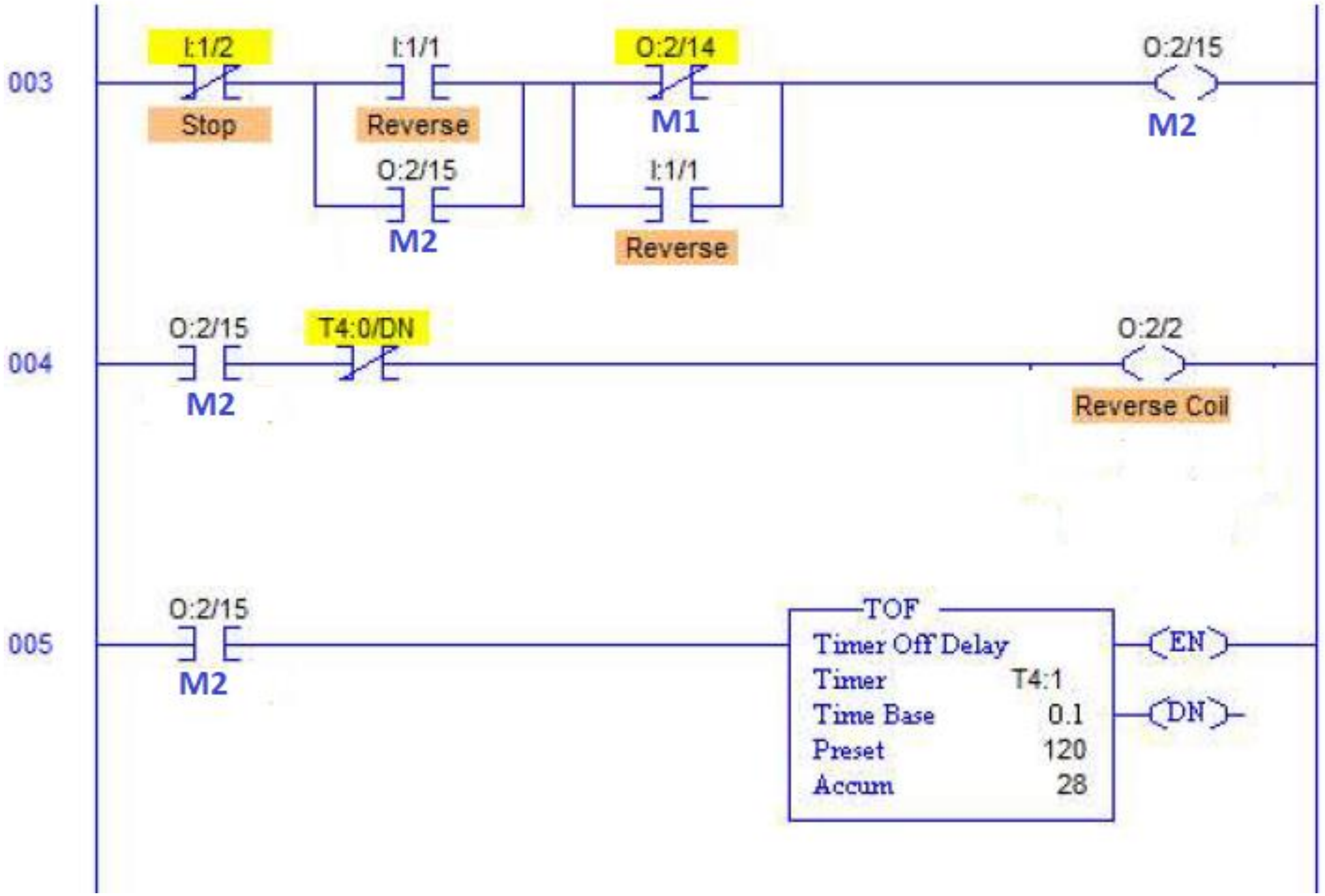

Inputs
L1
Stop
Start
PS1
PS2
PS3
Stop
Start
T4:5
DN
PS1
Pump
Pump
Pump
TON
Pump delay
TIMER ON DELAY
Timer T4:6
Time base 1.0
Preset 5
Accumulated 0
EN
DN
T4:6
DN
PS2
PS3
TOF
Pump time
TIMER OFF DELAY
Timer T4:5
Time base 1.0
Preset 14
Accumulated 0
EN
DN
Output
L2
Pump
M
OL

Example 4: Changing the direction of a three phase motor with a time delay.

- Assume that the motor takes 10 seconds to come down to its rest state before it changes the direction. Motor has Stop, forward and Reverse push buttons.




000
I:1/2
Stop
I:1/0
Forward
O:2/14
M1
O:2/15
M2
I:1/0
Forward
O:2/14
M1
001
O:2/14
M1
T4:1/DN
O:2/0
Forward Coil
002
O:2/14
M1
TOF
Timer Off Delay
Timer T4:0
Time Base 0.1
Preset 120
Accum 0
EN
DN


003
I:1/2
Stop
I:1/1
Reverse
O:2/15
M2
O:2/14
M1
I:1/1
Reverse
O:2/15
M2
004
O:2/15
M2
T4:0/DN
O:2/2
Reverse Coil
005
O:2/15
M2
TOF
Timer Off Delay
Timer T4:1
Time Base 0.1
Preset 120
Accum 28
EN
DN

Example 5: One-way Traffic Problem

- Initially Red signal of the road is ON. After 30 seconds Red signal of the road goes off and Green signal of the road is ON. After 25 seconds Green signal of the road goes off and Orange signal is ON for 5 seconds and the cycle repeats.

Reerence

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