



Chapter 7

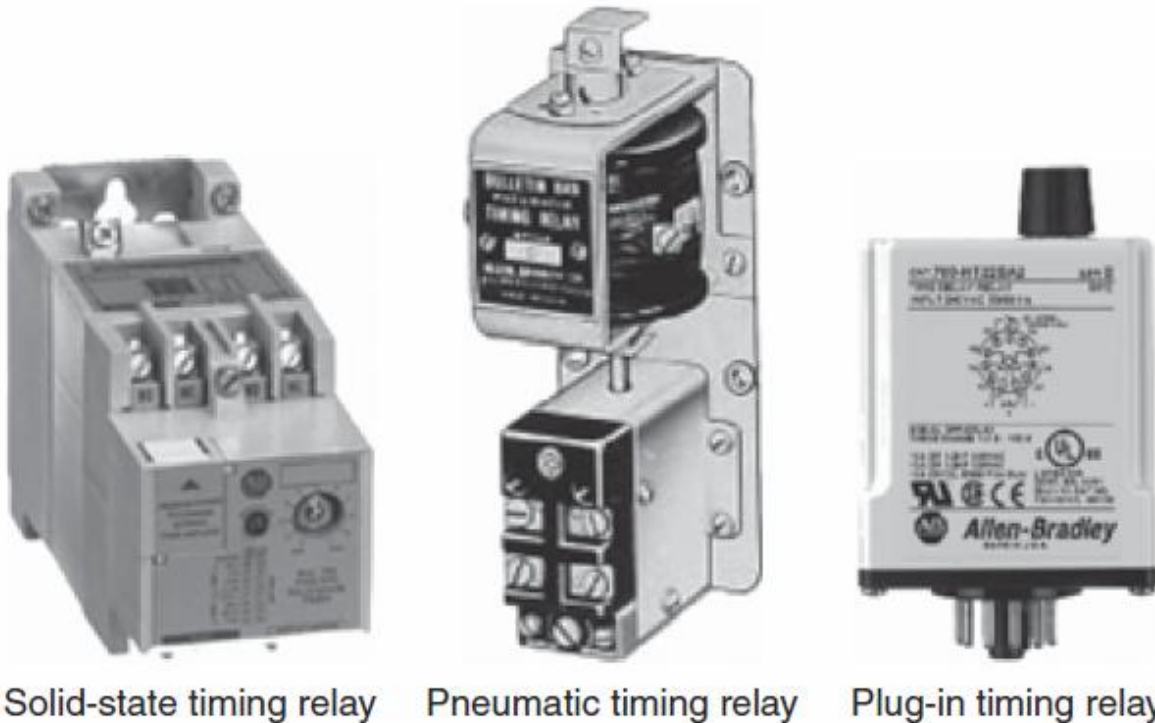
Programming Timers

7.1



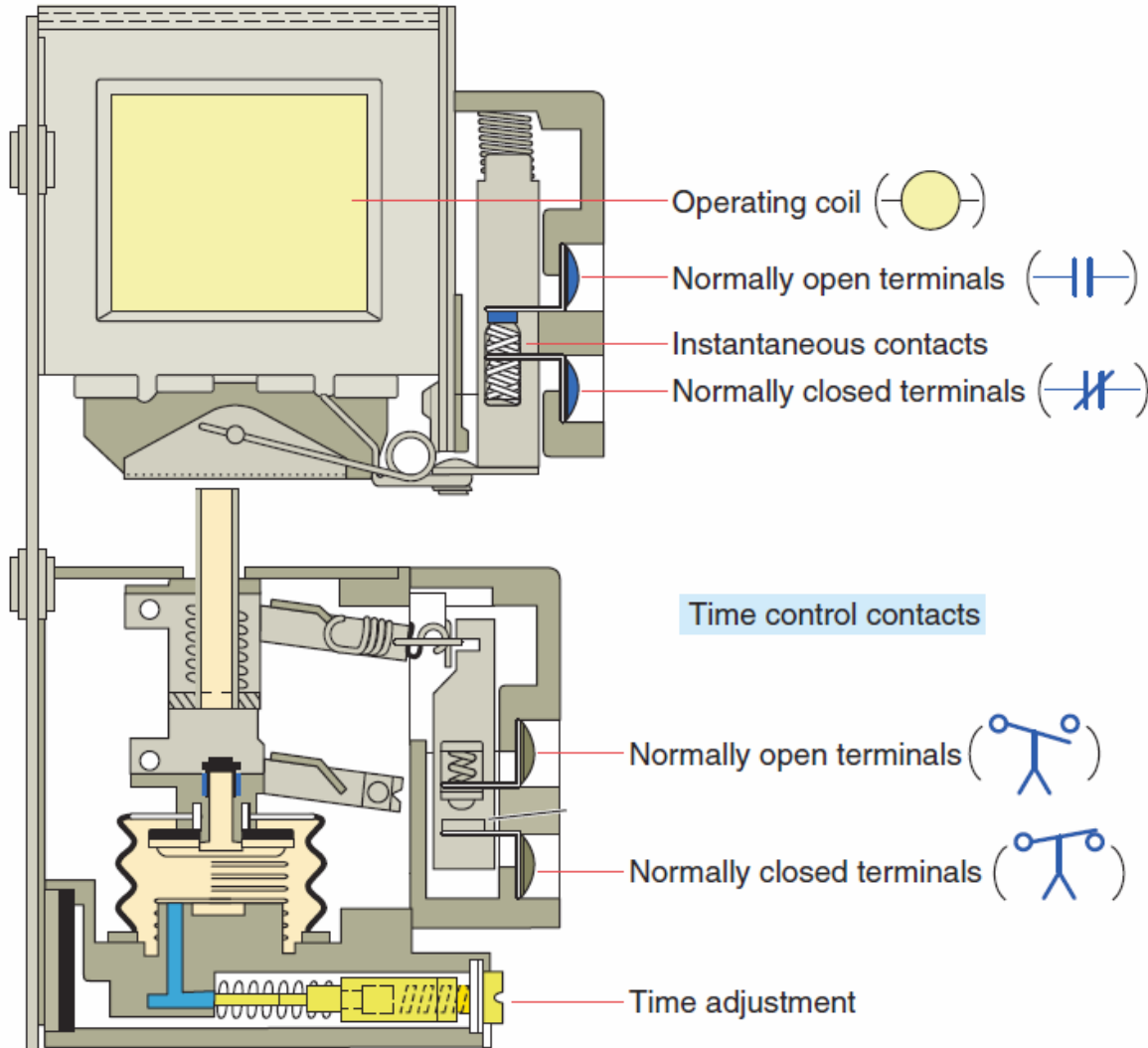
Mechanical Timing Relays

Mechanical timing relays are used to delay the opening or closing of contacts for circuit control.



Certain of their contacts are designed to operate at a preset **time interval**, after the coil is **energized** or **de-energized**.

On-delay pneumatic (air) timer.



The **instantaneous** contacts change state as soon as the timer coil is powered

The **delayed** contacts change state at the end of the time delay.

Relay *symbols* used for timed contacts.

On-delay,
provides
time delay
when the
relay coil is
energized.

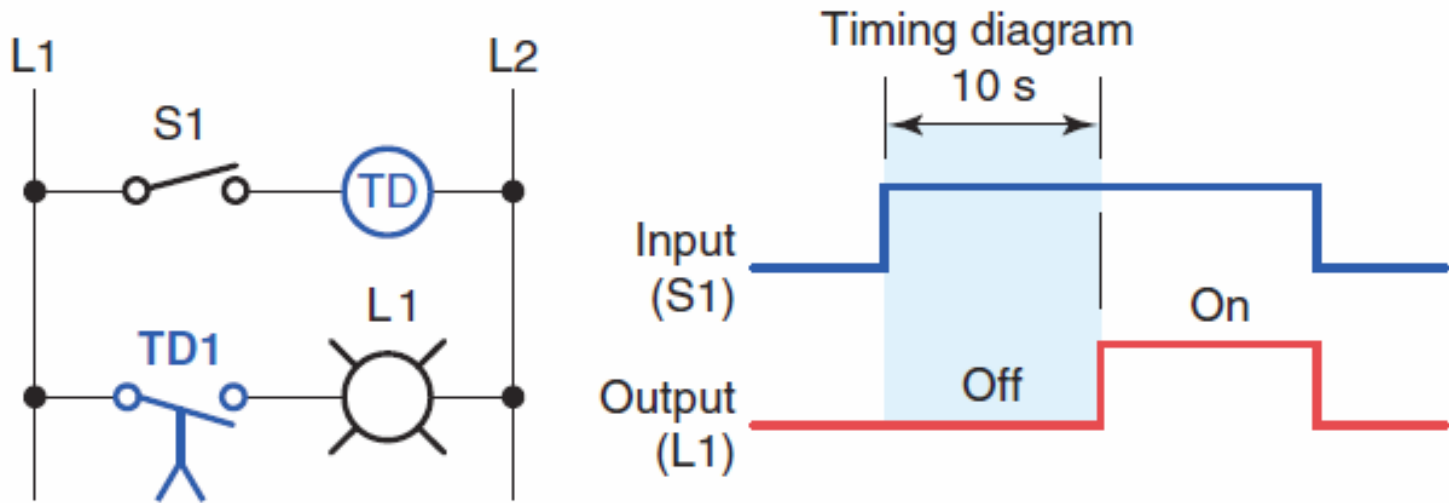
On-delay symbols	
 or 	 or 
Normally open, timed closed contact (NOTC). Contact is open when relay coil is de-energized. When relay is energized, there is a time delay in closing.	Normally closed, timed open contact (NCTO). Contact is closed when relay coil is de-energized. When relay is energized, there is a time delay in opening.

Relay *symbols* used for timed contacts.

Off-delay,
provides time
delay when
the relay coil is
de-energized.

Off-delay symbols	
 or 	 or 
Normally open, timed open contact (NOTO). Contact is normally open when relay coil is de-energized. When relay coil is energized, contact closes instantly. When relay coil is de-energized, there is a time delay before the contact opens.	Normally closed, timed closed contact (NCTC). Contact is normally closed when relay coil is de-energized. When relay coil is energized, contact opens instantly. When relay coil is de-energized, there is a time delay before the contact closes.

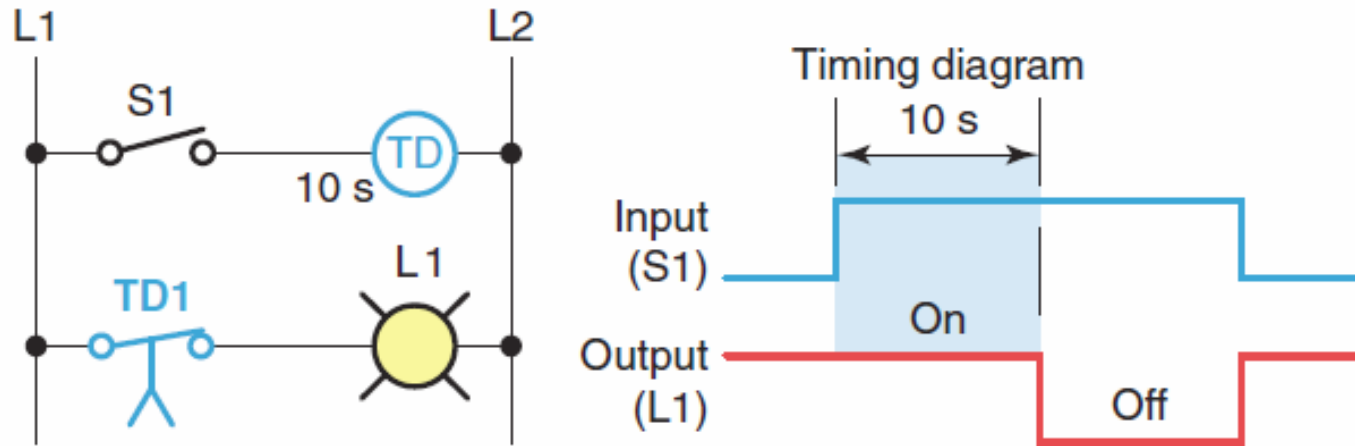
The on-delay timer is sometimes referred to as *DOE*, which stands for *delay on energize*.



When S1 is closed TD coil is energized and the timing period starts.

After the 10 s time-delay period has elapsed, TD1 contacts close and L1 is switched on.

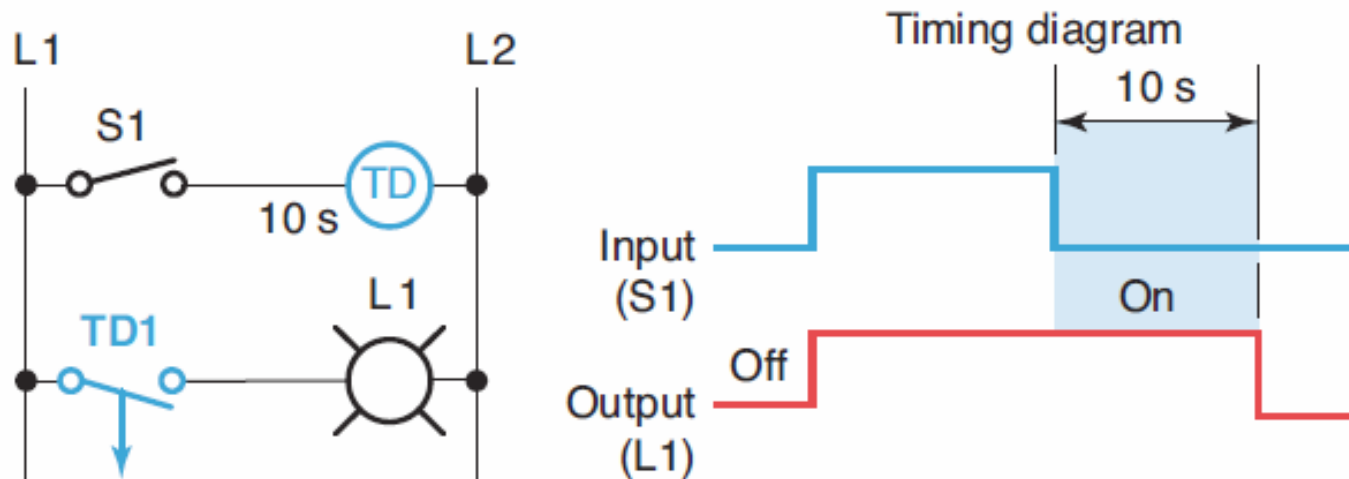
On-delay timer circuit that uses a *normally closed, timed open (NCTO)* contact.



When S1 is closed, TD coil is energized but TD1 contacts are delayed from opening so L1 remains on.

After the 10 s time-delay period has elapsed, TD1 contacts open and L1 is switched off.

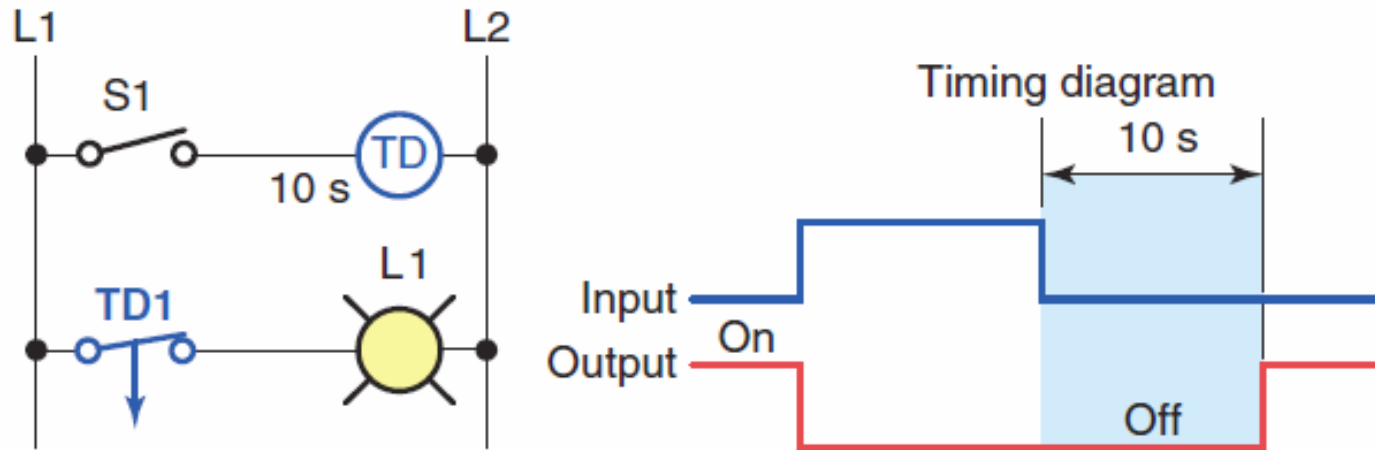
The off-delay timer is sometimes referred to as *DOD*, which stands for *delay on deenergize*.



When S1 is closed, TD coil is energized and TD1 contacts close instantly to switch light L1 on.

When S1 is opened, TD coil is de-energized the timing starts and after the 10 s TD1 contacts open to switch the light off.

Off-delay timer circuit that uses a *normally closed, timed closed (NCTC)* contact.



When S1 is closed, TD coil is energized and TD1 contacts open instantly to switch light L1 off.

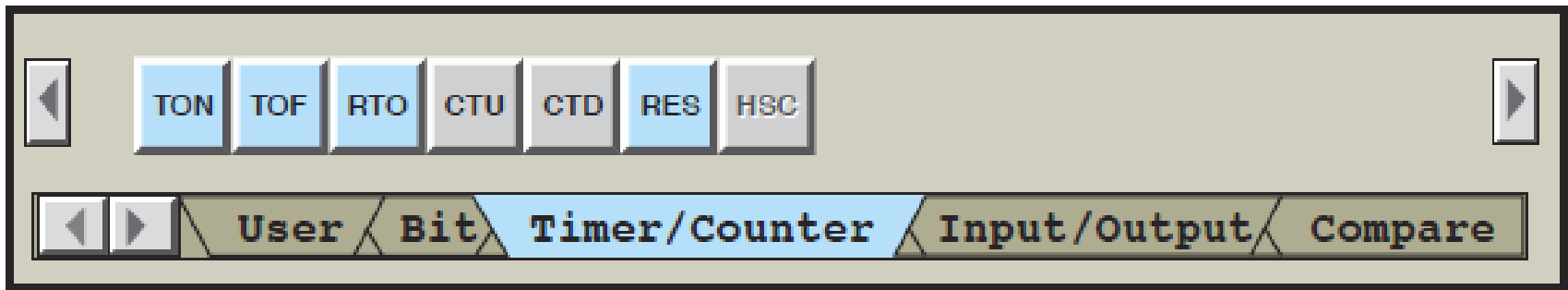
When S1 is opened, TD coil is de-energized the timing starts and after 10 s TD1 contacts close to switch the light on.

7.2



Timer Instructions

PLC timer instructions that provide the same functions as timing relays.



The most common Plc timer instructions are:

On-delay timer (TON)

Off-delay timer (TOF)

Retentive timer on (RTO)

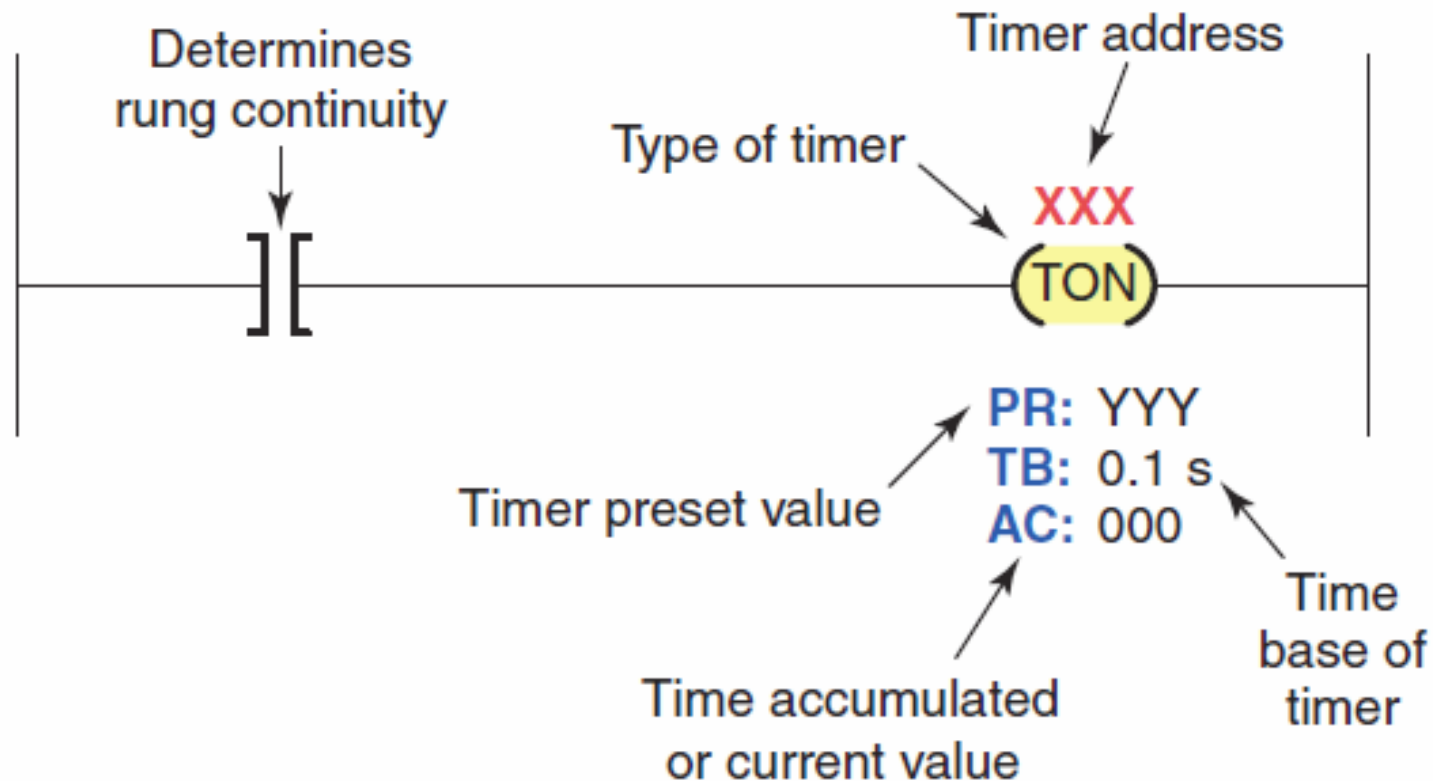
Quantities associated with the timer instruction.

Preset time represents the time duration for the timing circuit.

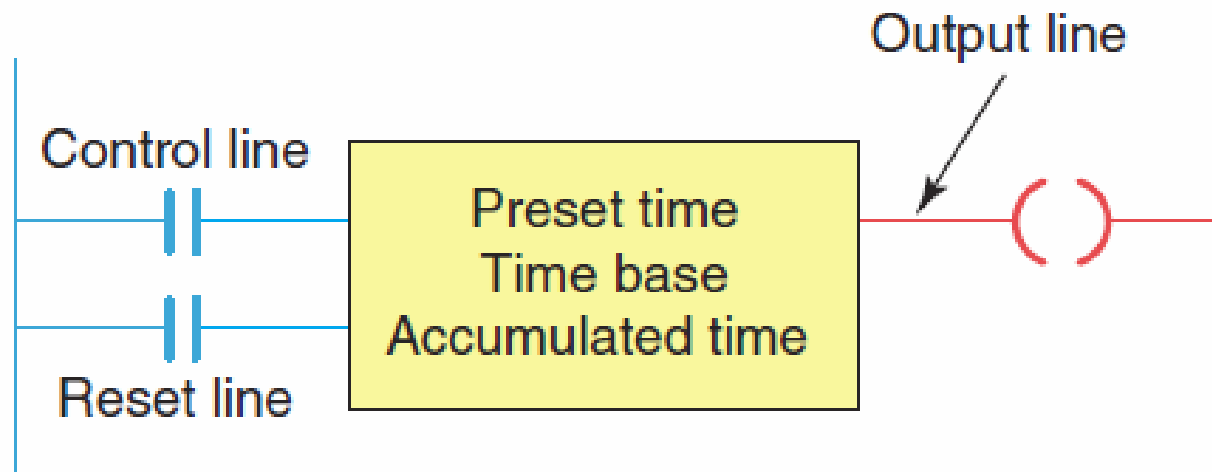
Accumulated time represents the amount of time that has elapsed from the moment the timing started.

Time Base is the intervals that the timers time out at. If a programmer entered 0.1 for the time base and 50 for the preset time, the timer would have a 5-s delay ($50 \times 0.1 \text{ s} = 5 \text{ s}$).

Coil formatted timer instruction.



Generic *block formatted* retentive timer.

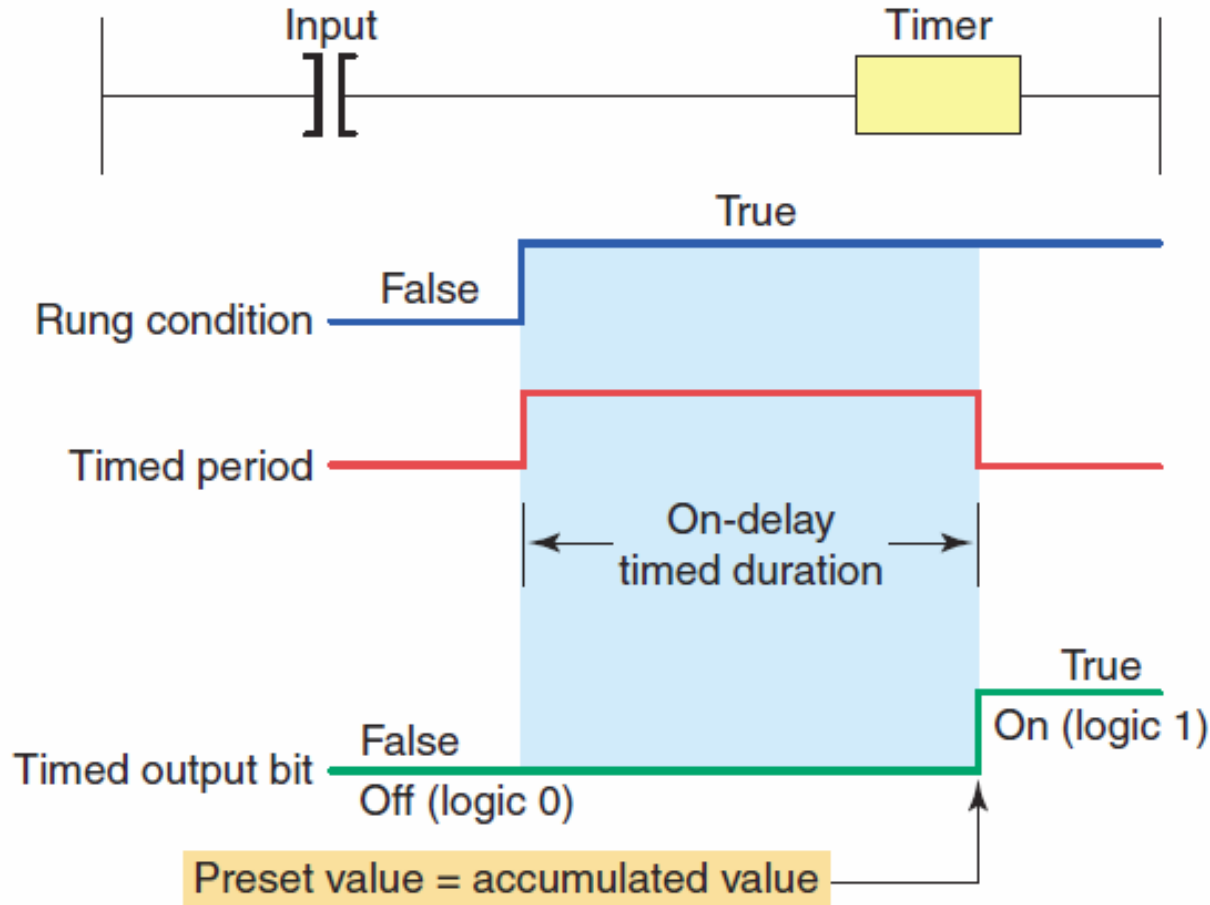


7.3

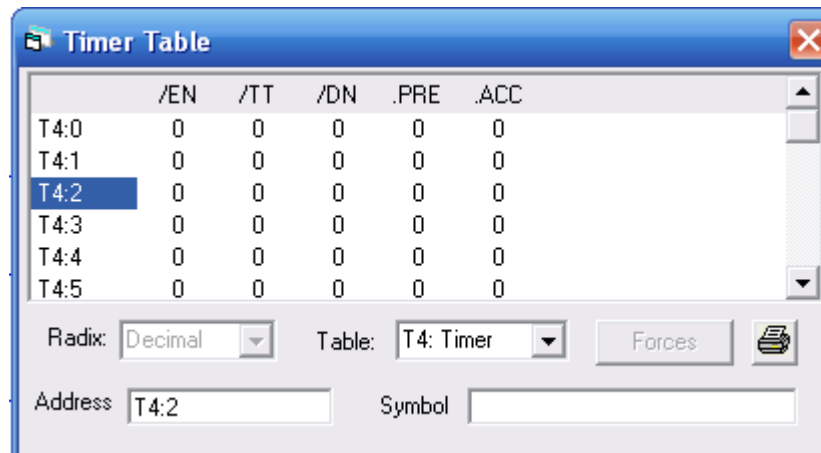
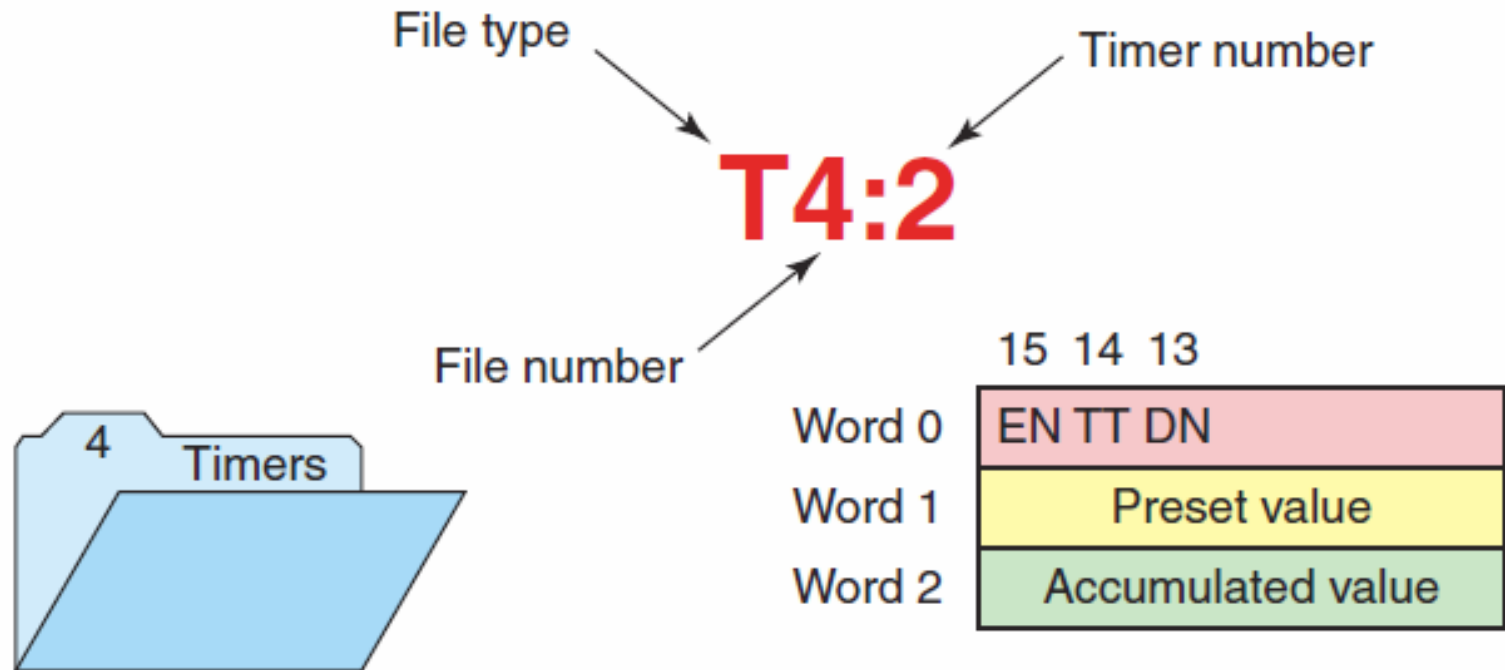


On-Delay Timer Instruction

An on-delay timer is used when you want a time delay to occur **before** an instruction becomes true.



The Allen-Bradley SLC 500 timer file is *file 4*.



	/EN	/TT	/DN	.PRE	.ACC
T4:0	0	0	0	0	0
T4:1	0	0	0	0	0
T4:2	0	0	0	0	0
T4:3	0	0	0	0	0
T4:4	0	0	0	0	0
T4:5	0	0	0	0	0

Radix: Table: Forces 

Address Symbol

Enable (EN) bit - is true (1) whenever the timer instruction is **true**.

Timer-timing (TT) bit - is true (1) whenever the accumulated value of the timer is **changing**.

Done (DN) bit - changes state whenever the **accumulated** value **reaches** the **preset** value. Its state depends on the type of timer being used.

Timer Table

	/EN	/TT	/DN	.PRE	.ACC
T4:0	0	0	0	0	0
T4:1	0	0	0	0	0
T4:2	0	0	0	0	0
T4:3	0	0	0	0	0
T4:4	0	0	0	0	0
T4:5	0	0	0	0	0

Radix: Table: Forces

Address Symbol

The ***preset value (PRE) word*** is the set point of the timer, that is, the value up to which the timer will time.

The ***accumulated value (ACC) word*** is the value that increments as the timer is timing. The accumulated value will stop incrementing when its value reaches the preset.

	/EN	/TT	/DN	.PRE	.ACC
T4:0	0	0	0	0	0
T4:1	0	0	0	0	0
T4:2	0	0	0	50	0
T4:3	0	0	0	0	0
T4:4	0	0	0	0	0
T4:5	0	0	0	0	0

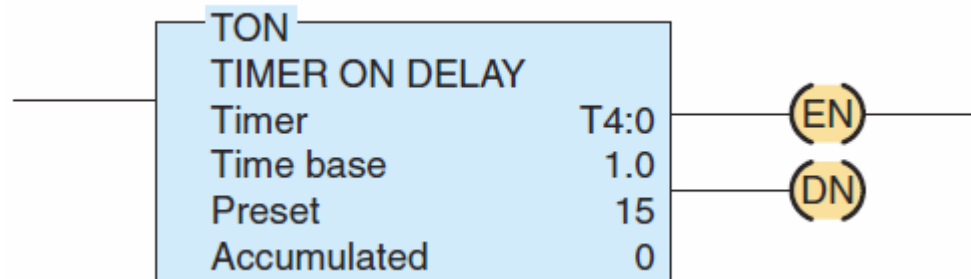
TON	
Timer On Delay	
Timer	T4:2
Time Base	0.1
Preset	50
Accum	0

Radix: Table: Forces

Address Symbol

The actual preset time is the time base multiplied by the value stored in the timer's preset word (**$50 \times 0.1 = 5s$**).

SLC 500 *On-delay* timer instruction.



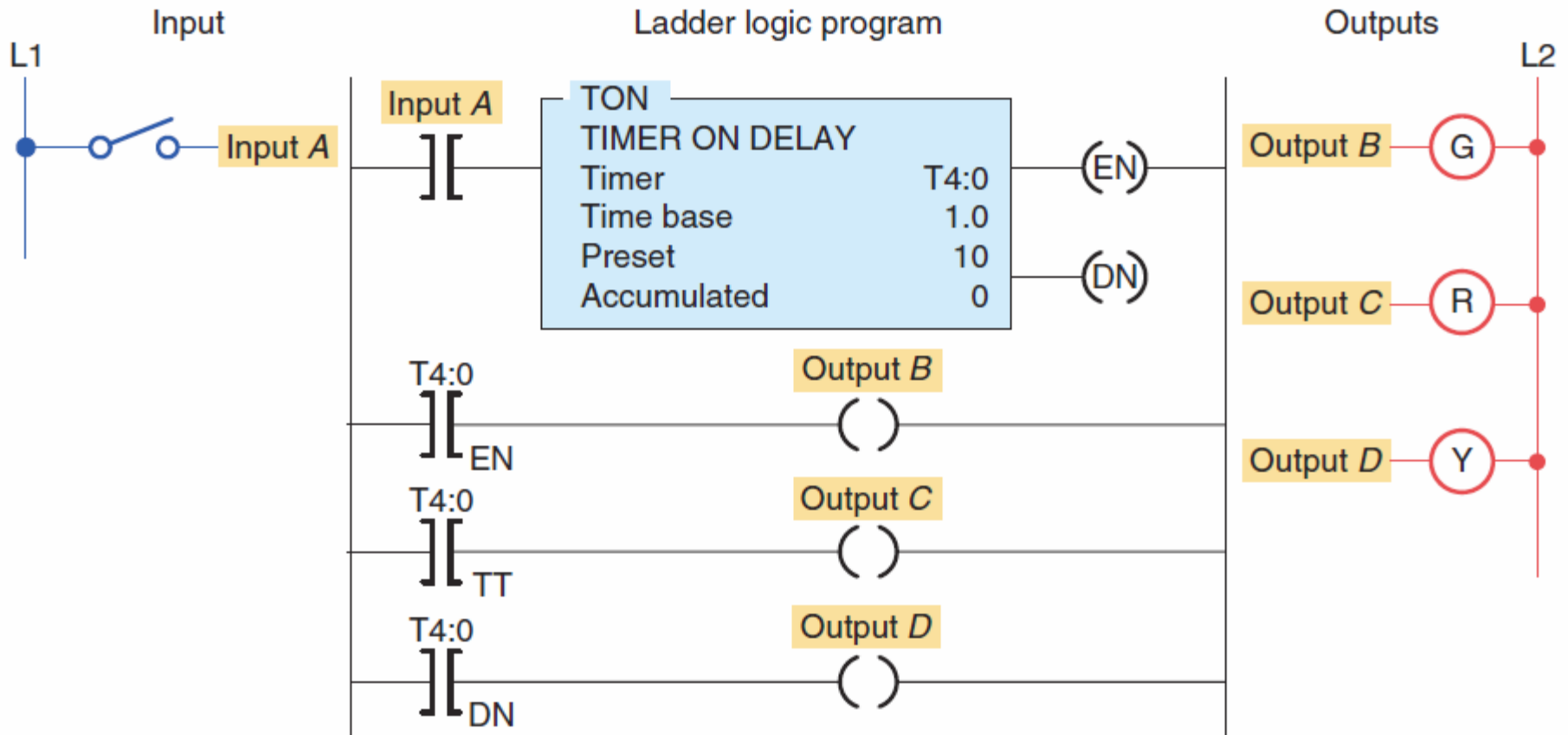
Timer number is **T4:0**, which represents timer file 4, timer 0 in that file.

Time base is always expressed in seconds and may be either 1.0 s or 0.01 s. In this case the time base is **1.0 s**.

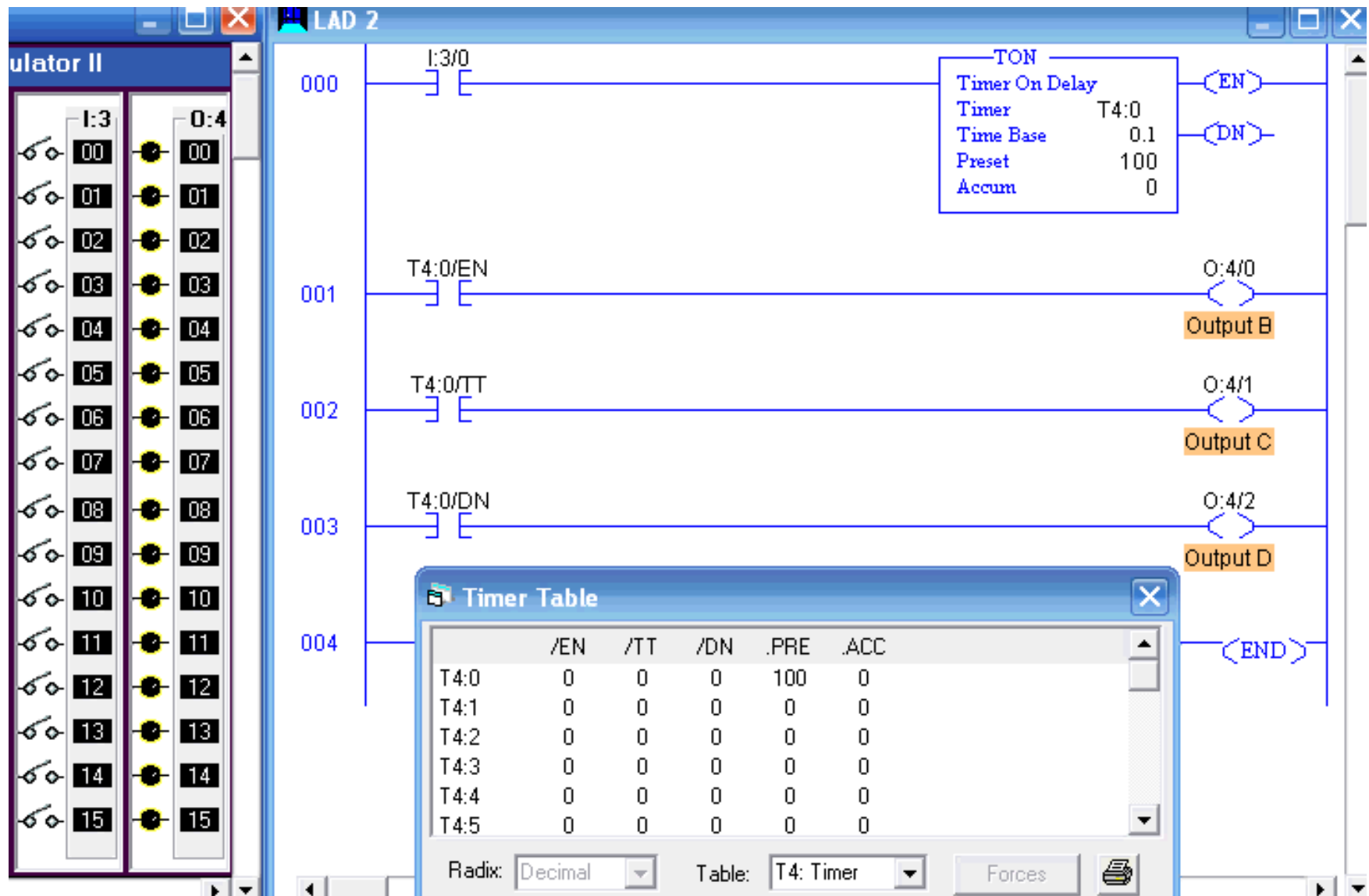
Preset value is **15**.

Accumulated value is **0**.

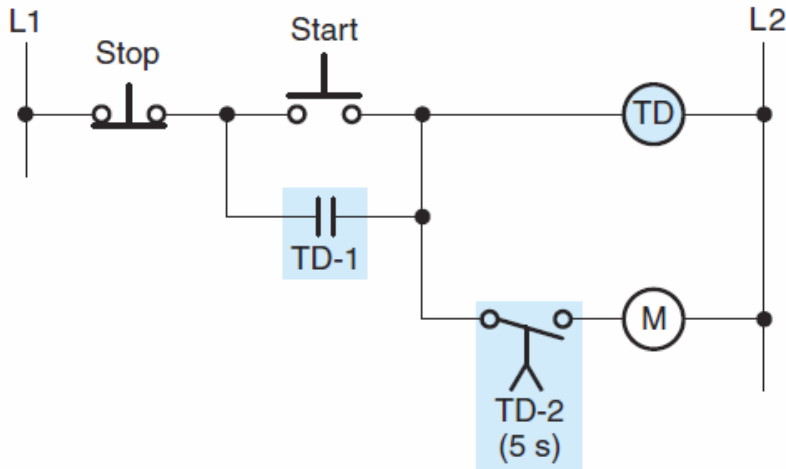
PLC on-delay timer program.



Simulated PLC on-delay timer program.

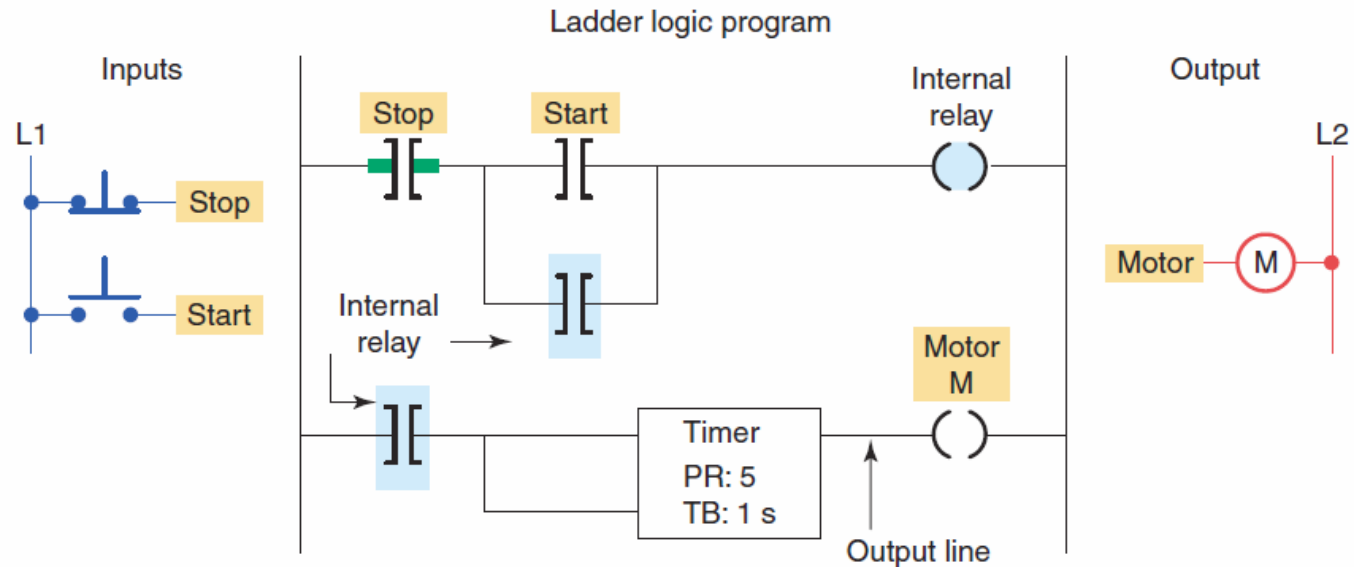


Instantaneous contact instruction programmed using an *internally* referenced relay coil.

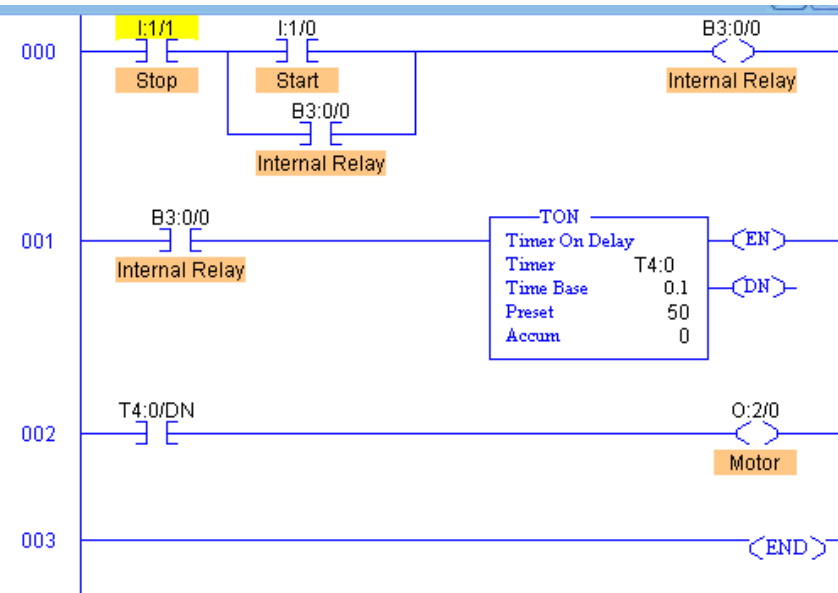
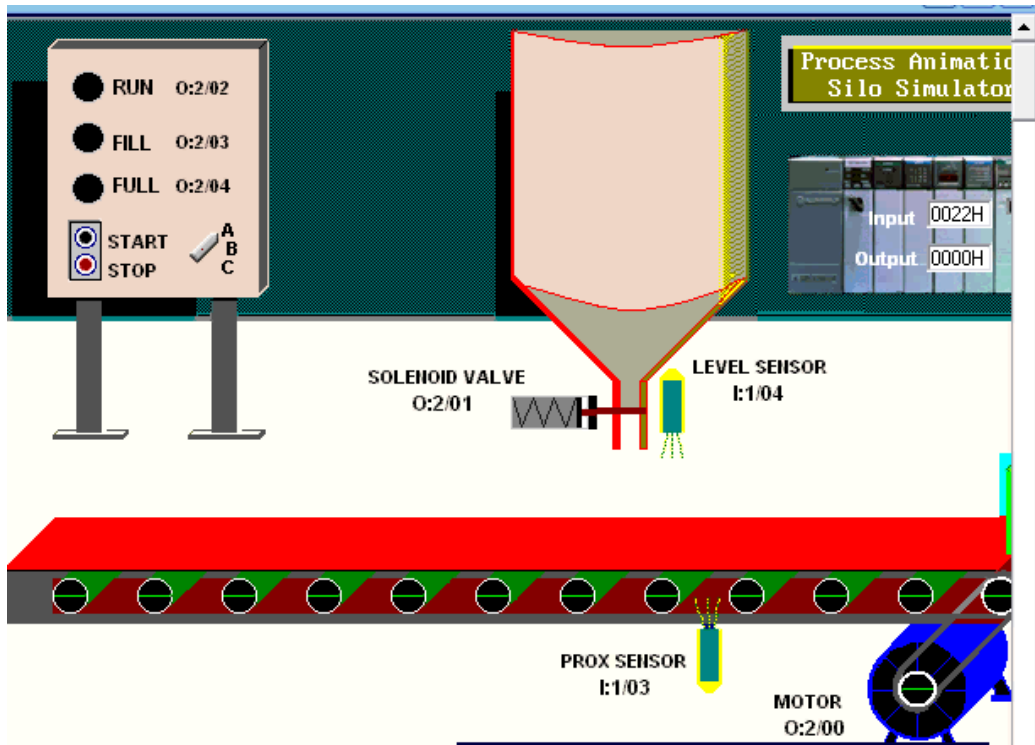


Hardwired Relay Circuit – motor starts 5 seconds after start button is actuated

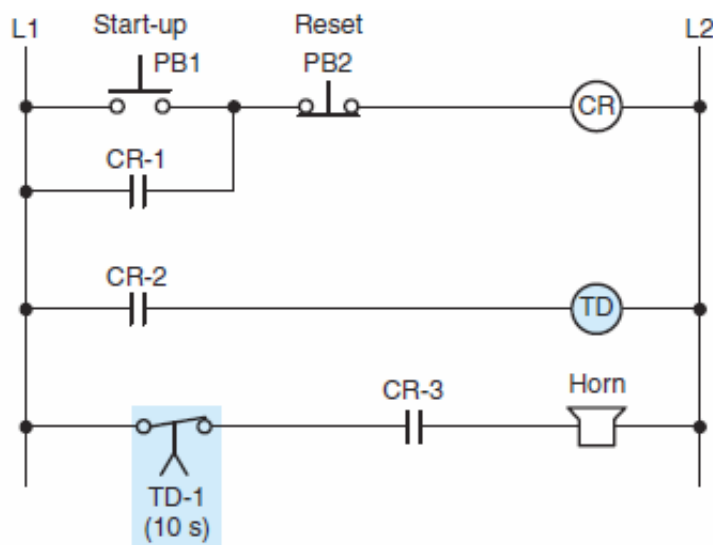
Equivalent
generic PLC
programmed
circuit



Equivalent simulated SLC 500 program.

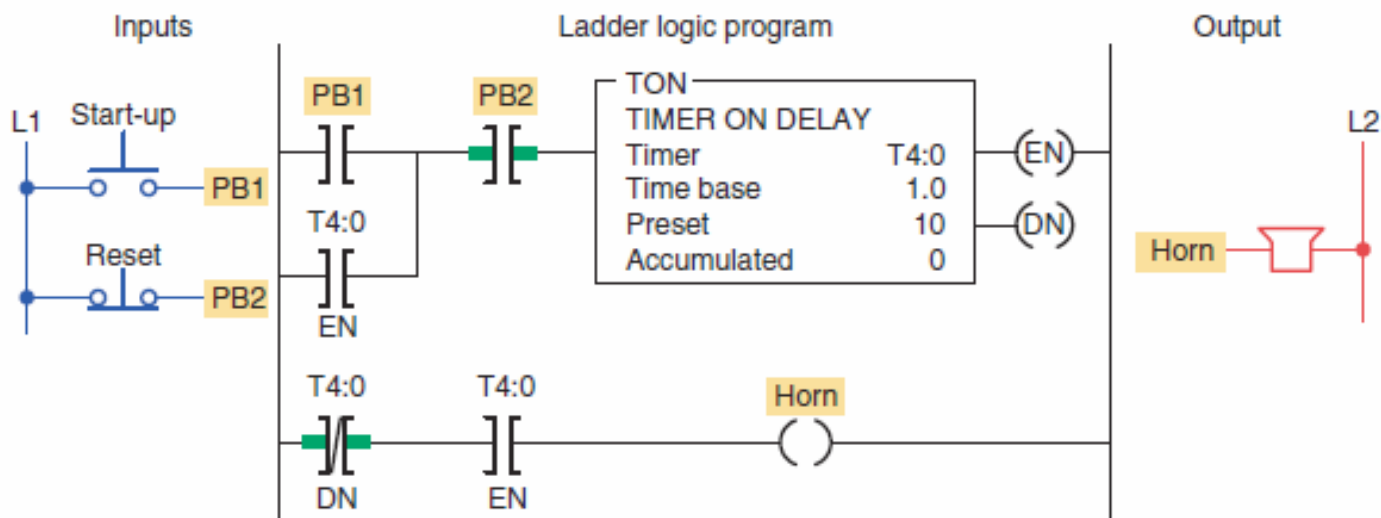


Conveyor warning signal circuit.

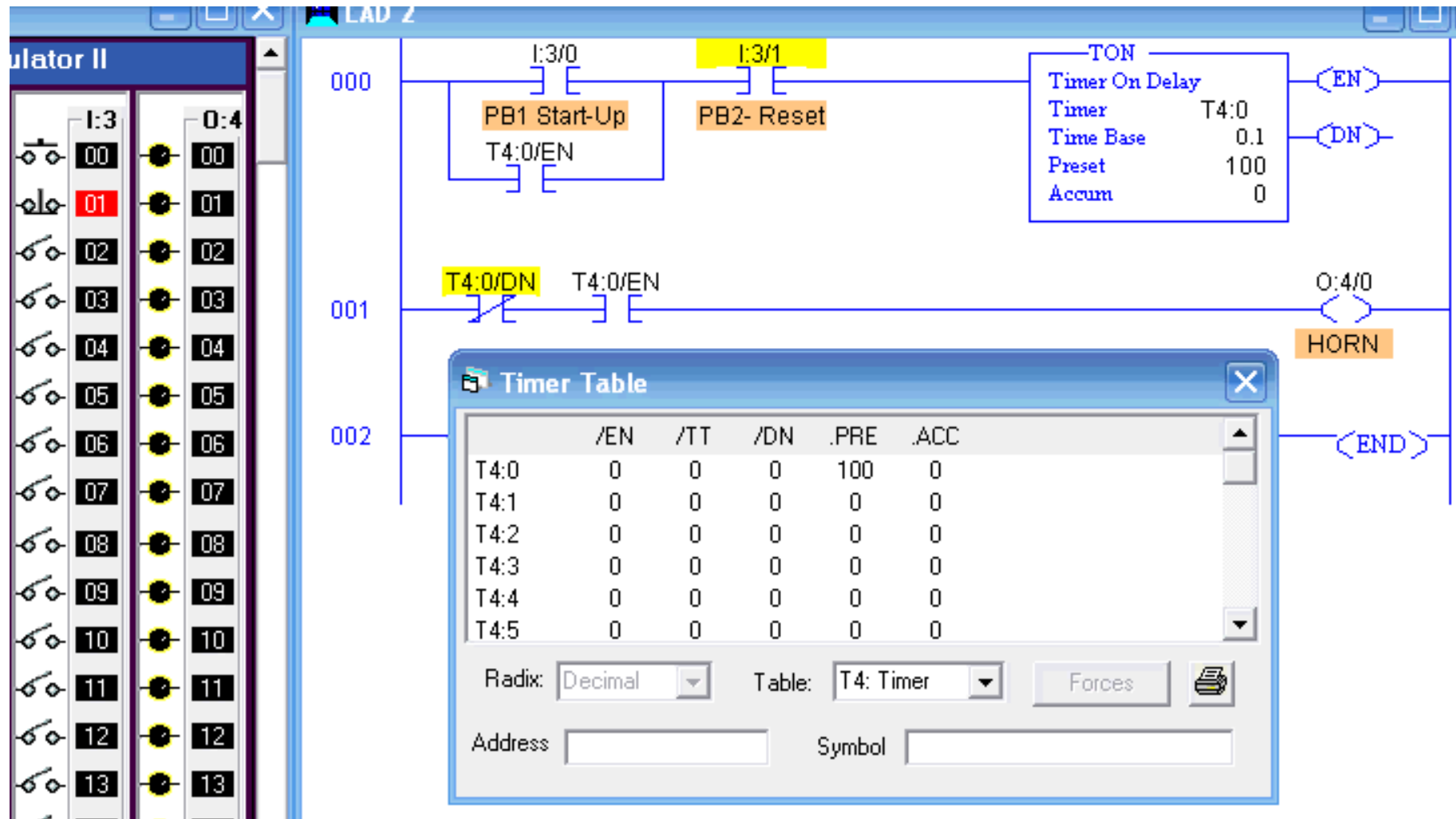


Hardwired Relay Circuit – warning horn sounds for 10 seconds whenever start button is actuated.

**Equivalent
SLC 500
programmed
circuit.**



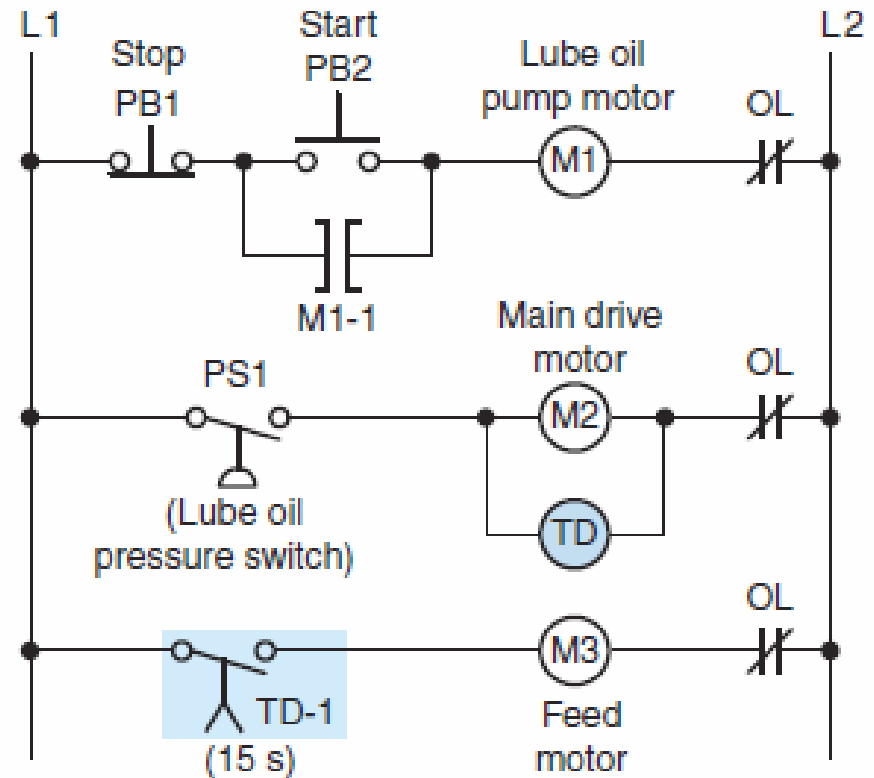
SLC 500 simulated program.



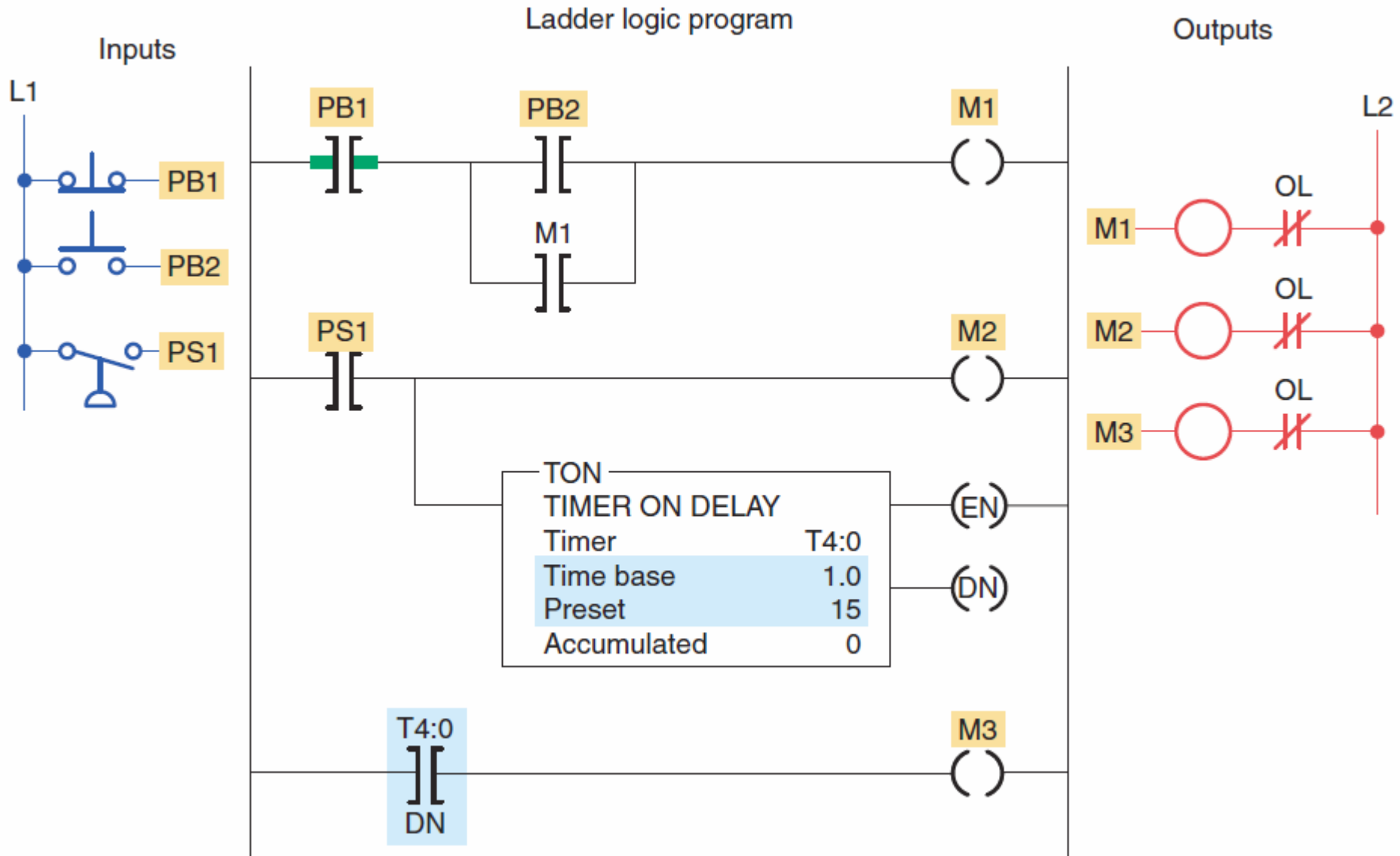
Automatic sequential motor control system.

- M1 is energized when PB2 is momentarily actuated.
- When the lube-oil pump pressure switch PS1 closes M2 and TD are energized to start M2 and begin the TD time delay period.
- After the time-delay period of 15 s, TD-1 contact closes to energize M3.

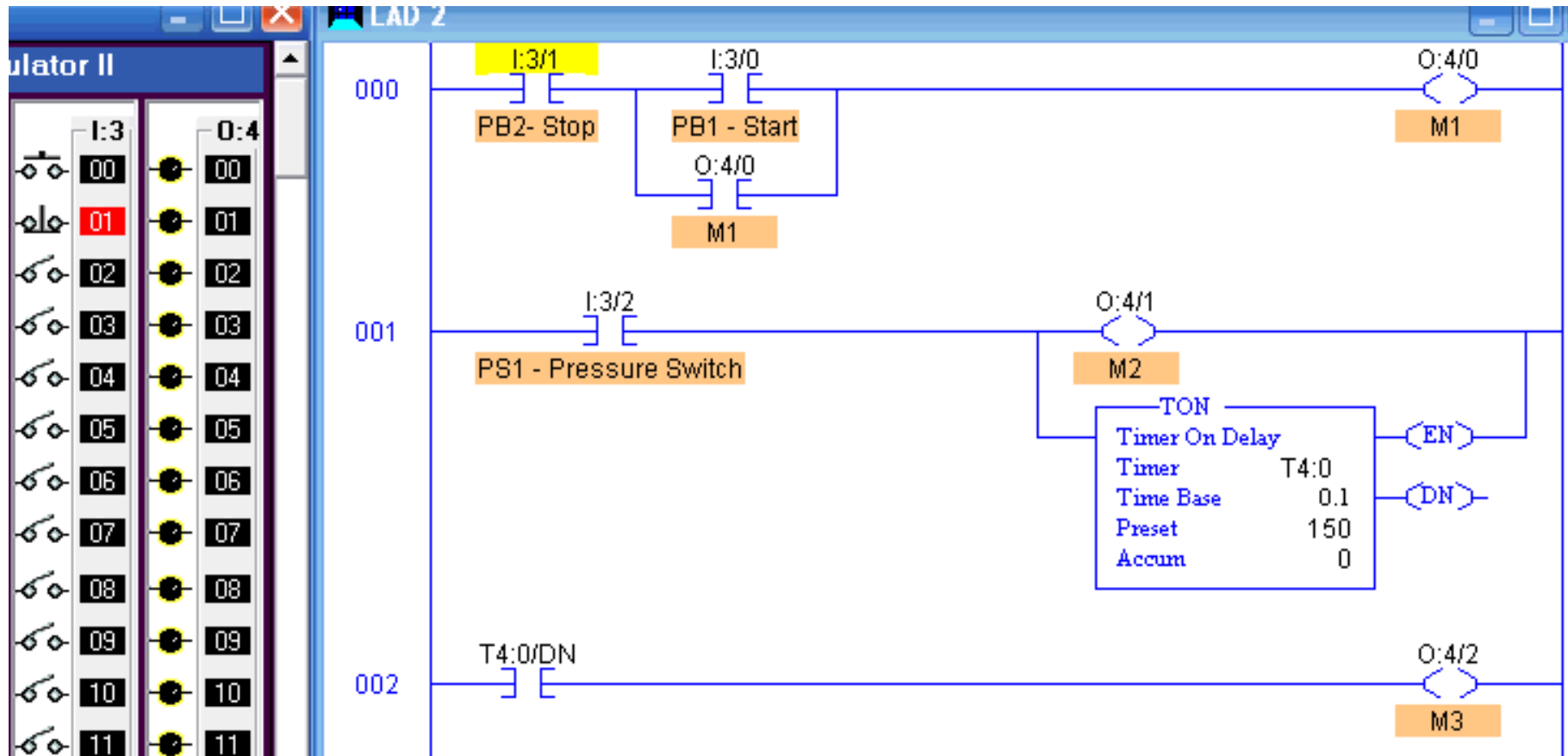
Hardwired relay circuit



PLC sequential motor control program.



Simulated sequential motor control program.

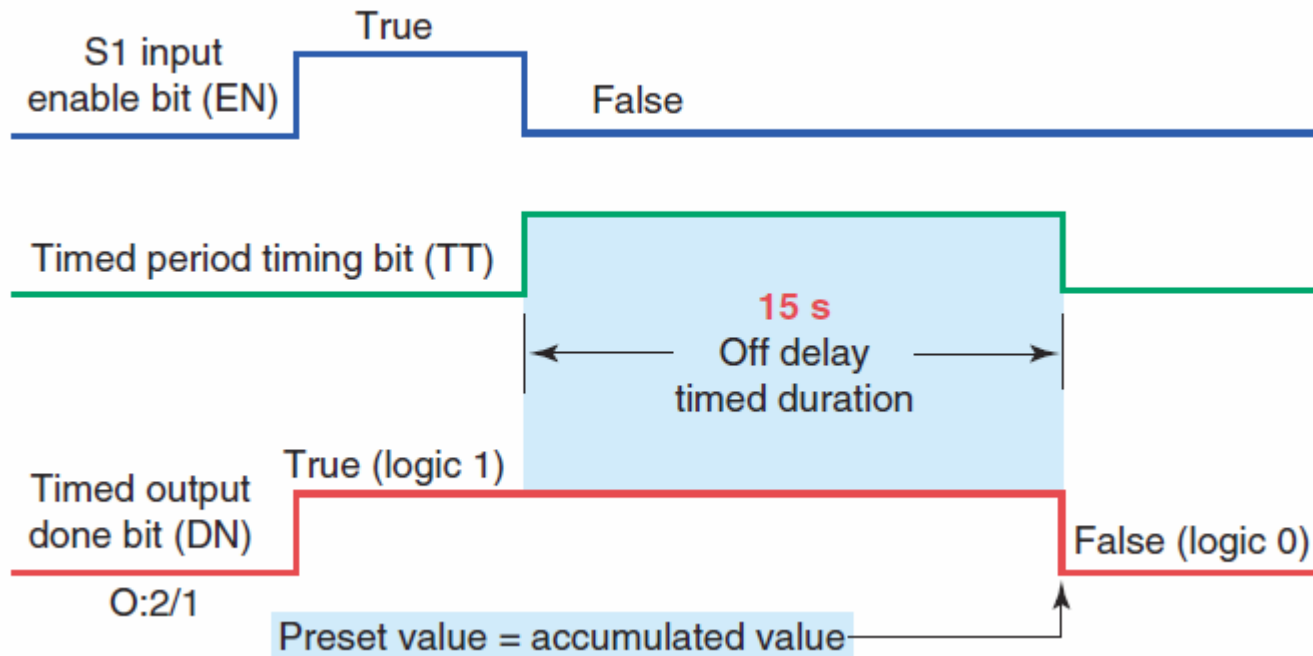
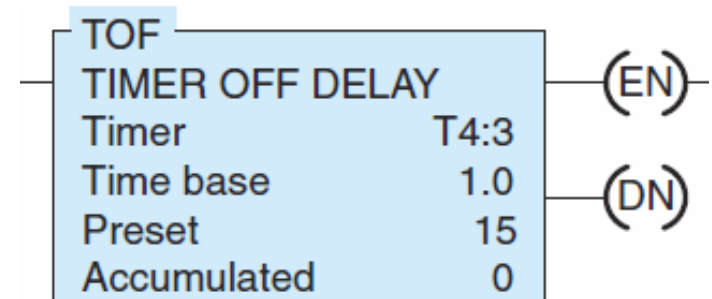


7.4

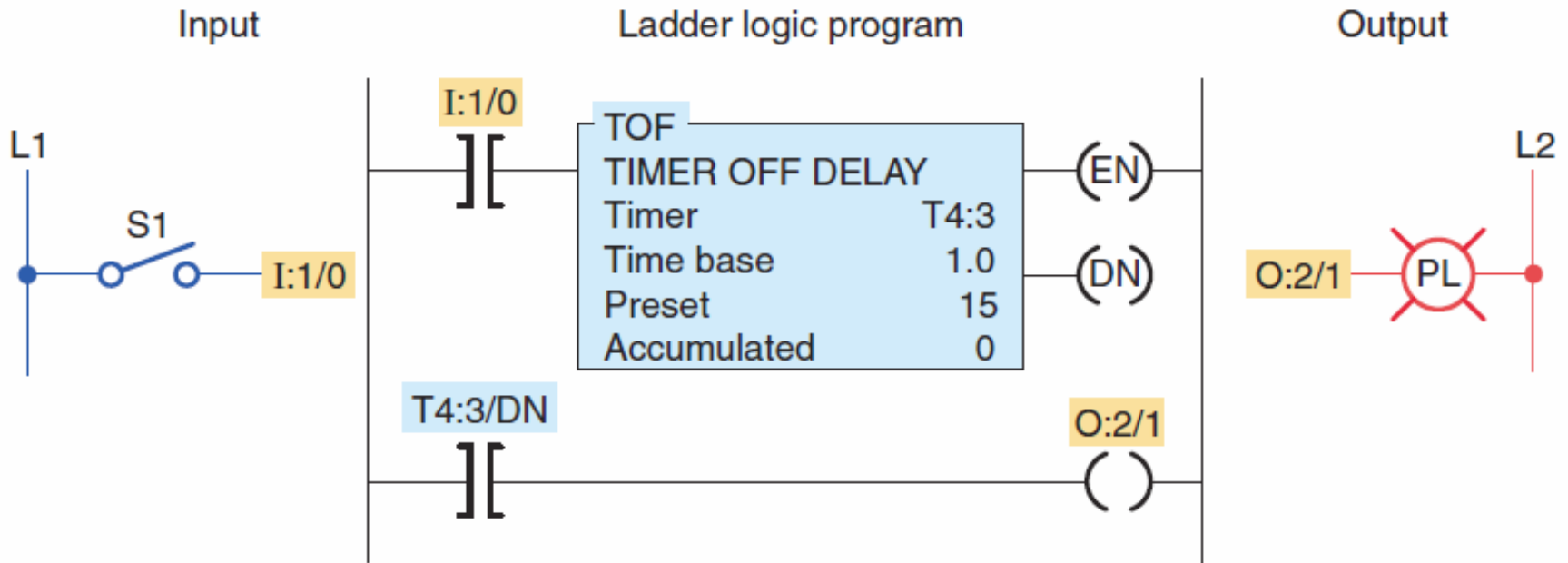


Off-Delay Timer Instruction

The *off-delay timer (TOF)* operation will keep the output energized for a time period after the rung containing the timer has gone *false*.



Off-delay timer (TOF) program

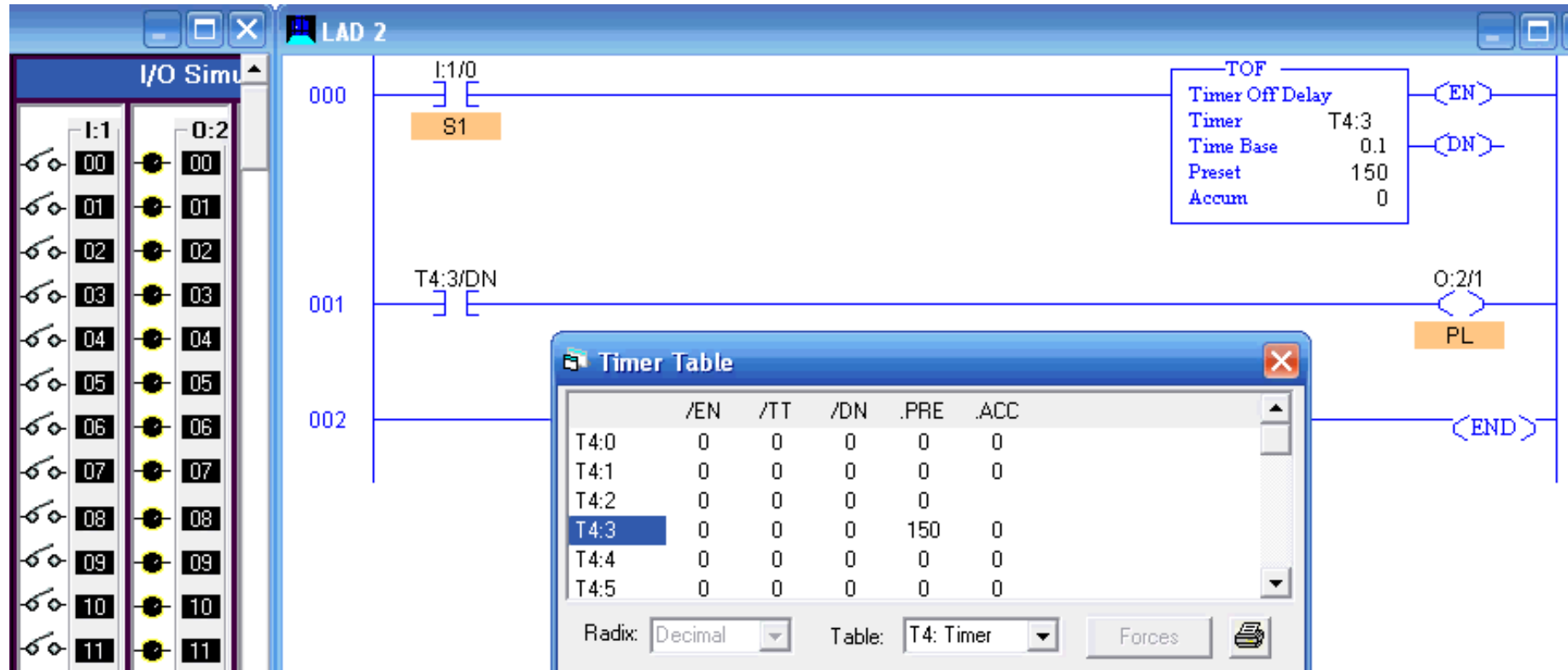


When the switch is first closed the lamp is switched on.

When switch is opened timing begins and the lamp switches off after a delay of 15 seconds.

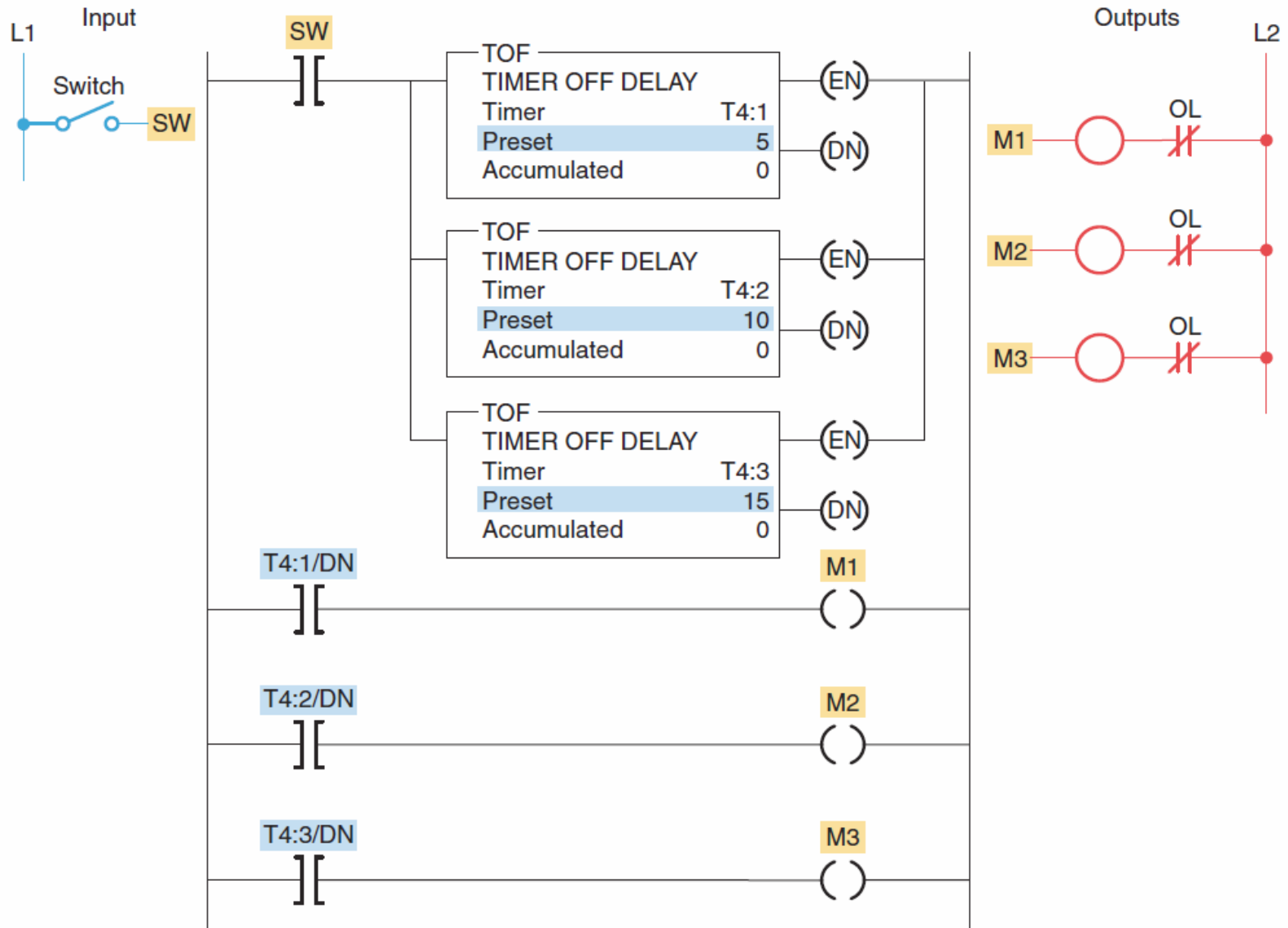
If logic continuity is gained before the timer is timed out, the accumulated time is reset to 0.

Simulated off-delay timer (TOF) program

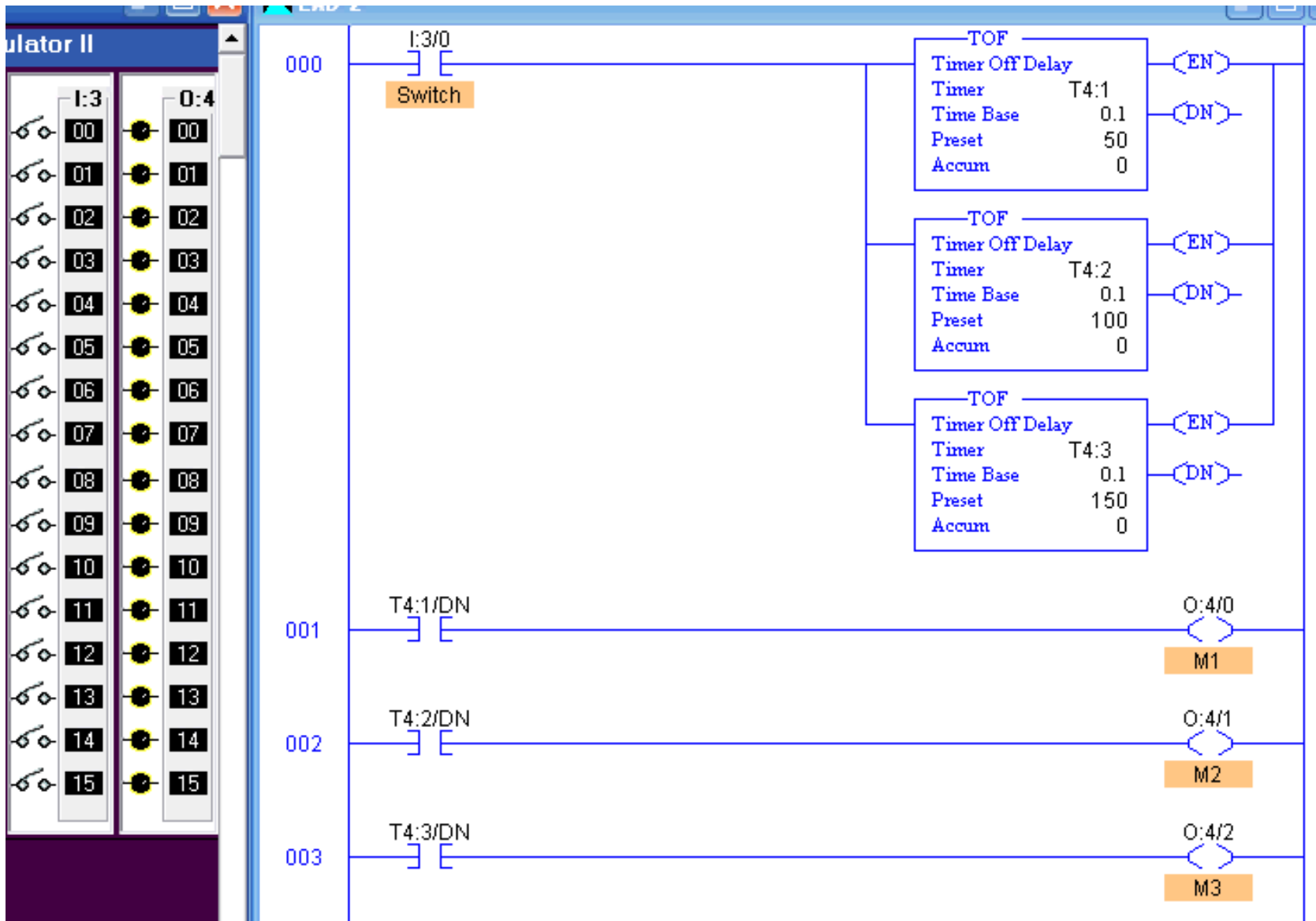


Program for switching motors off at 5 s intervals.

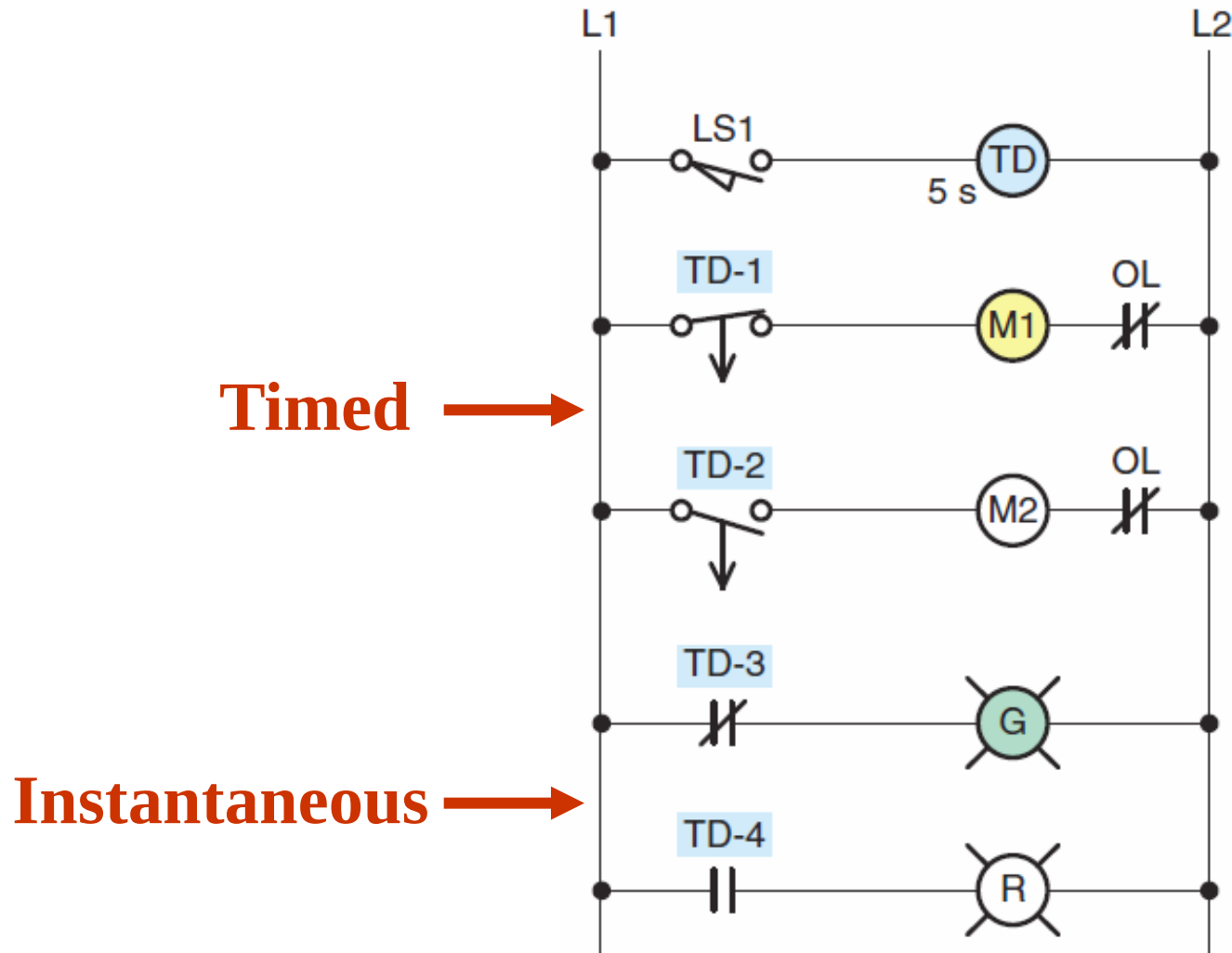
Ladder logic program



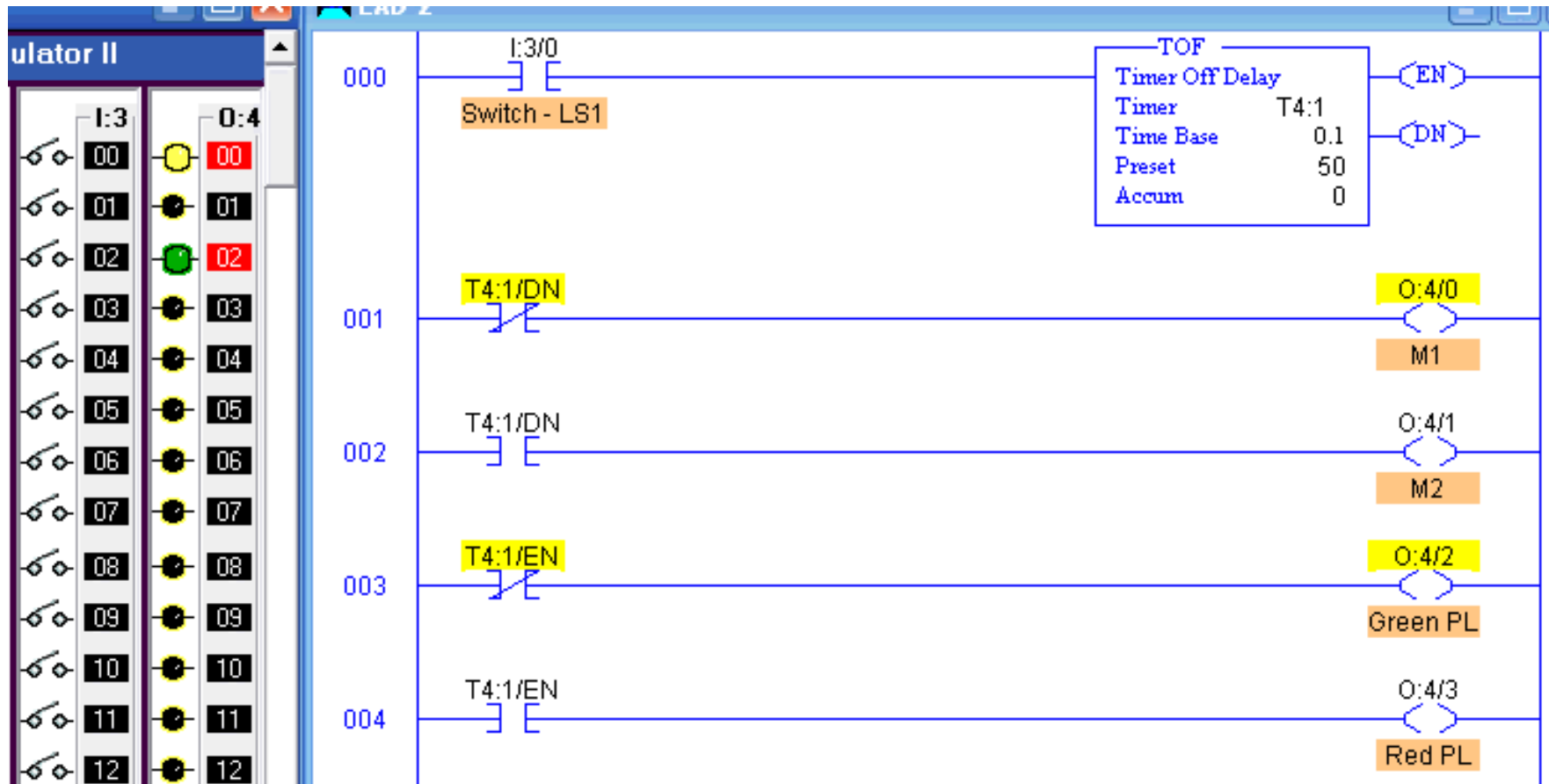
Simulation for switching motors off at 5 s intervals.



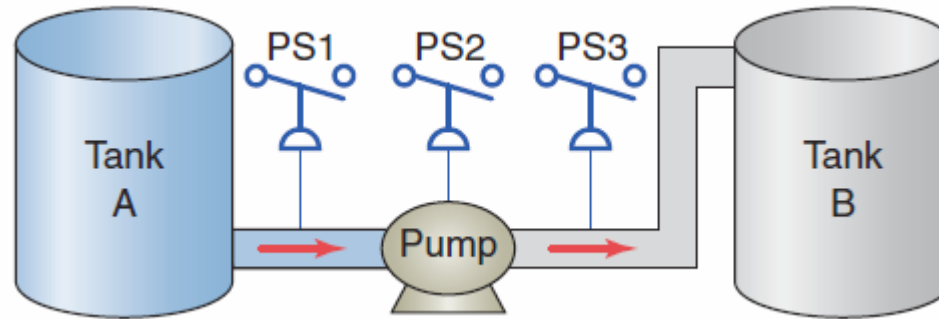
Hardwired off-delay timer relay circuit with both *instantaneous* and *timed* contacts.



Programmed off-delay timer relay circuit with both *instantaneous* and *timed* contacts.



Fluid pumping process.



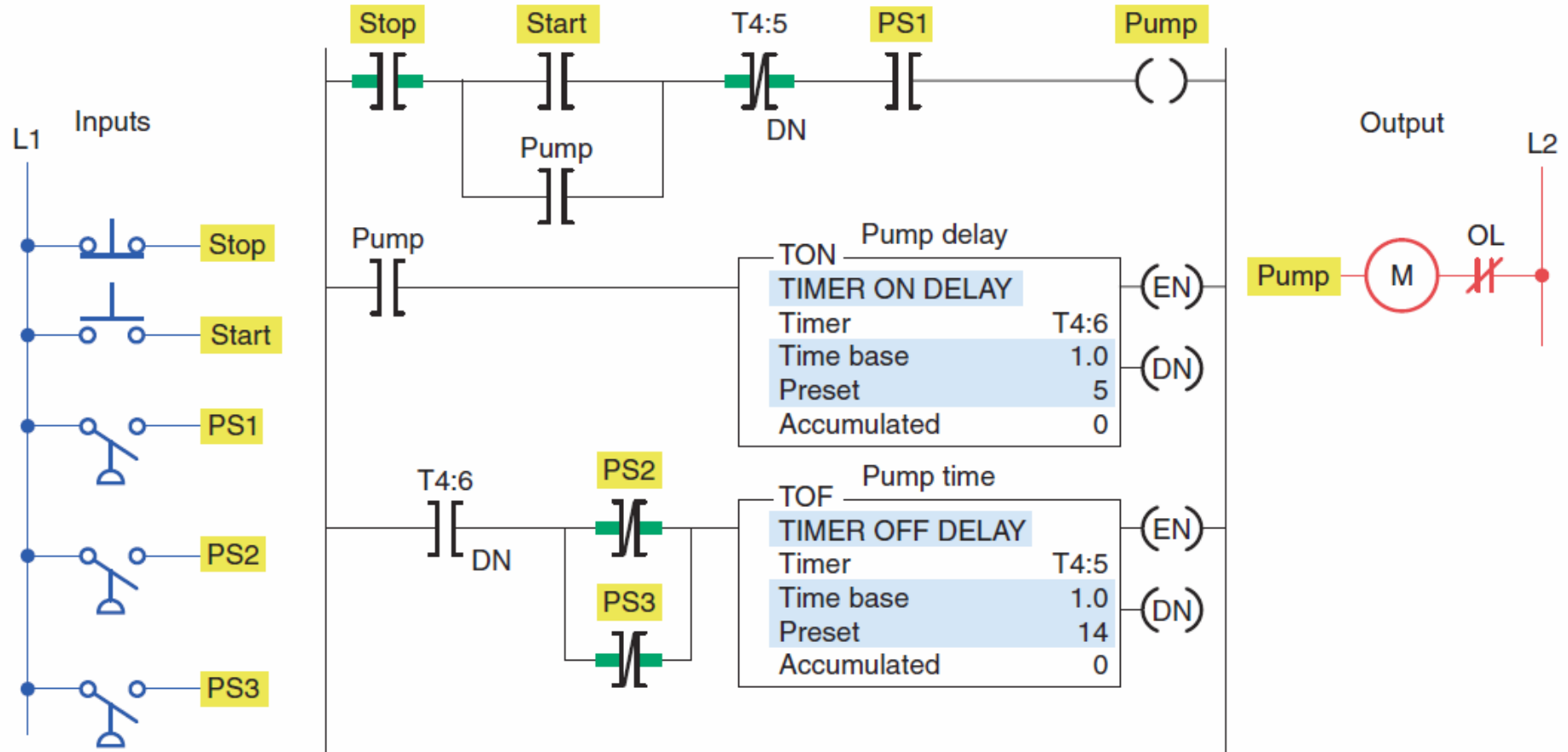
The process involves pumping fluid from tank A to tank B.

Before starting, PS1 must be closed.

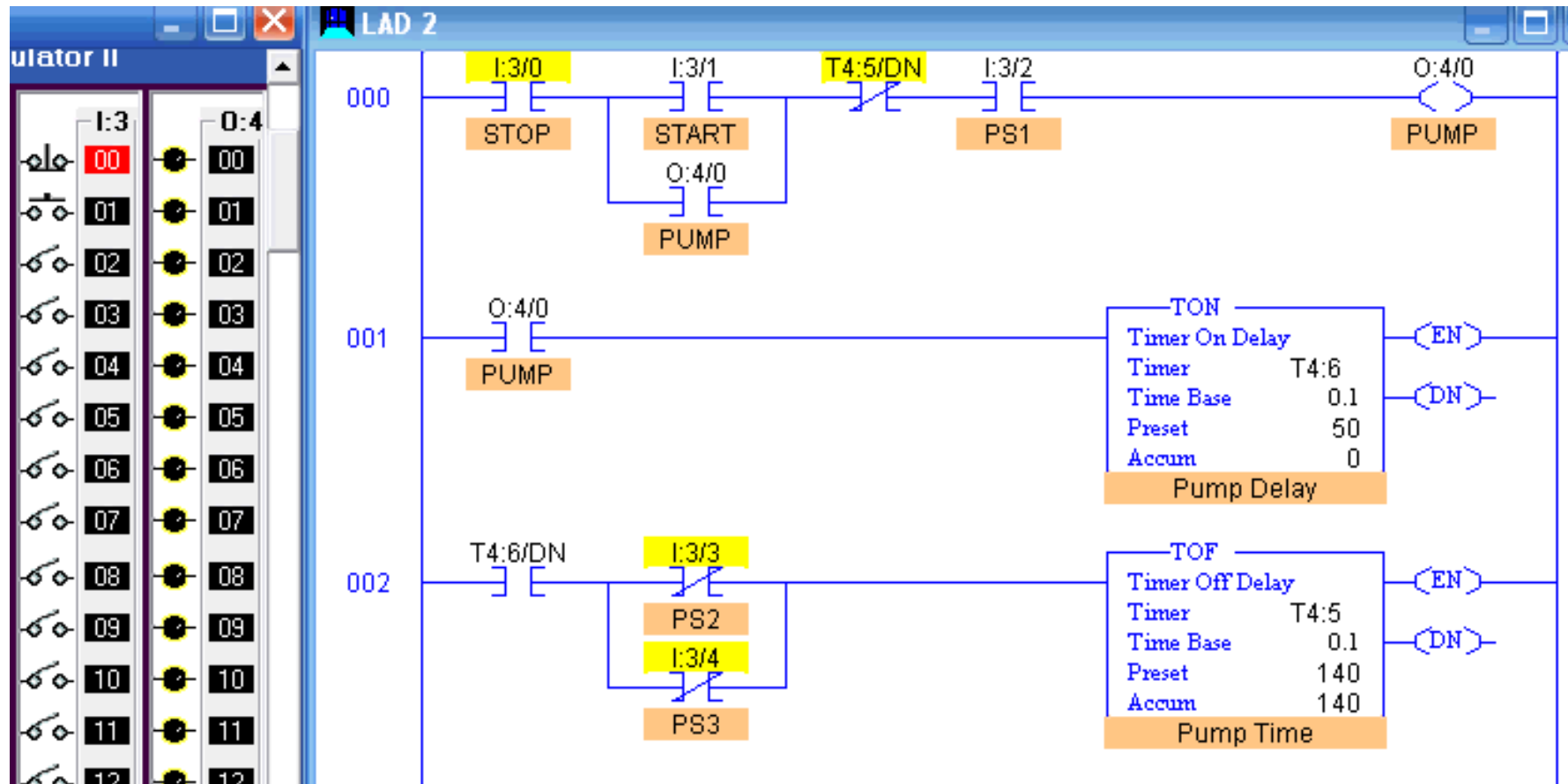
When the start button is pushed, the pump starts.

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.

Program for the fluid pumping process.



Simulated program for the fluid pumping process.



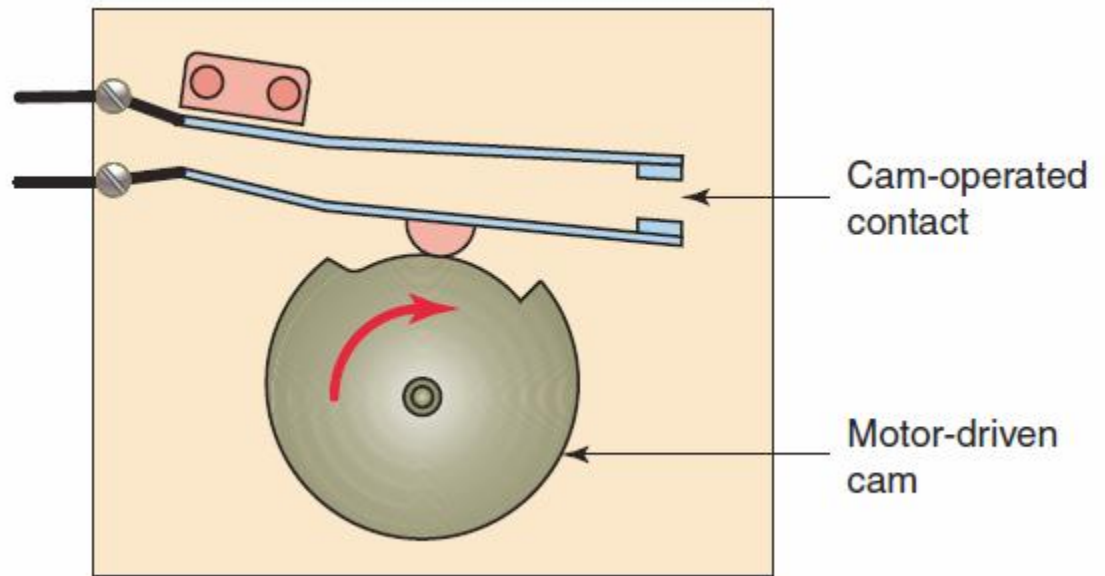
7.5



Retentive Timer

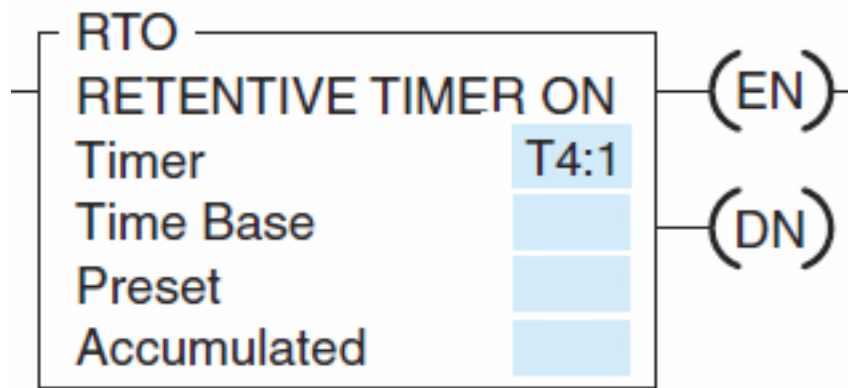
A retentive timer accumulates time whenever the device receives power, and it maintains the current time should power be removed from the device.

Electromechanical **retentive** timer.

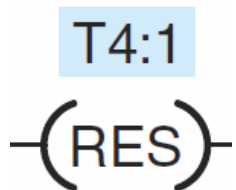


If power is removed from the motor, the shaft stops but **does not reset**.

A PLC retentive timer is used when you want to *retain accumulated time* values through power loss or the change in the rung state from true to false.

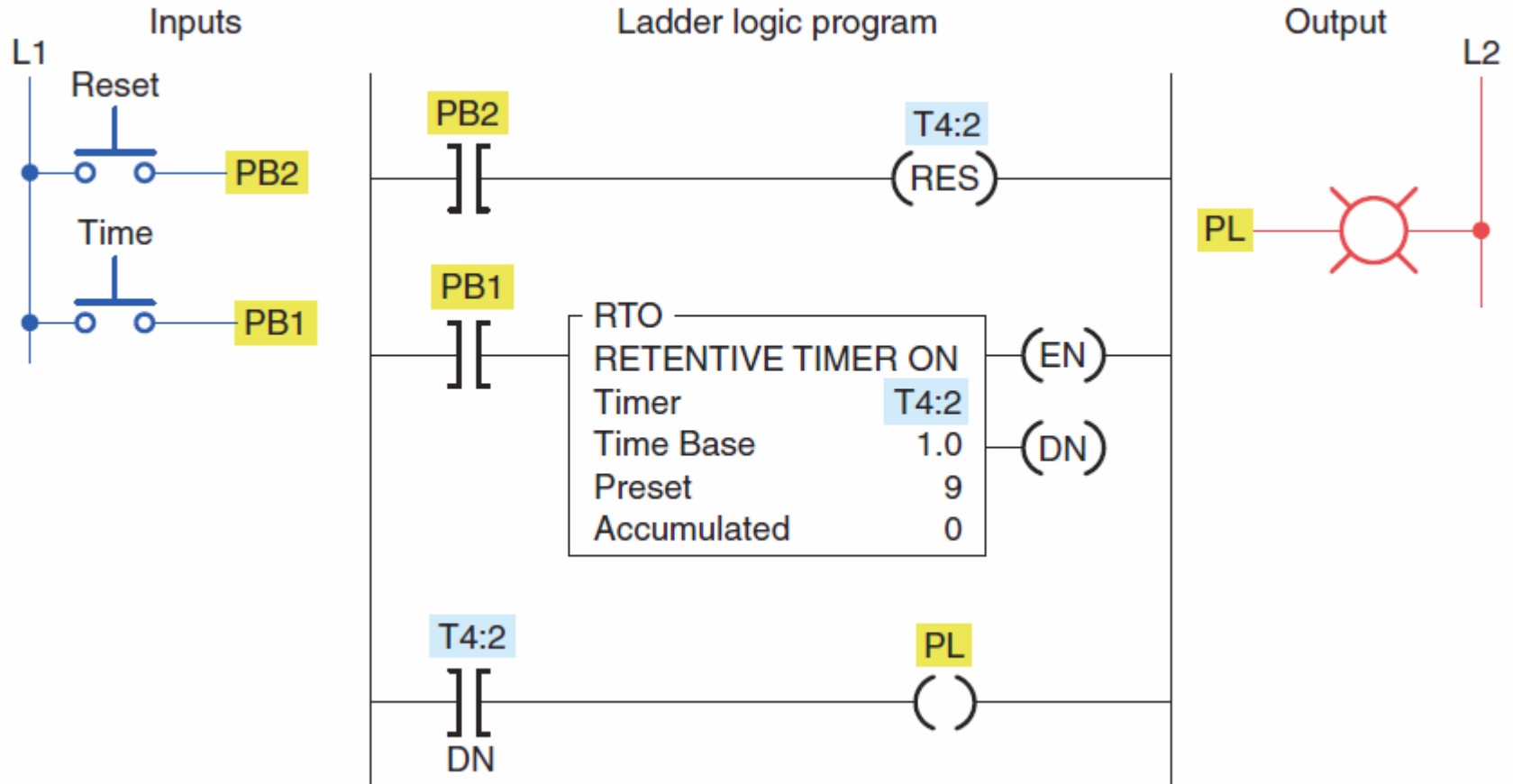


This timer must be accompanied by a **timer reset instruction** to reset the accumulated value of the timer to 0.

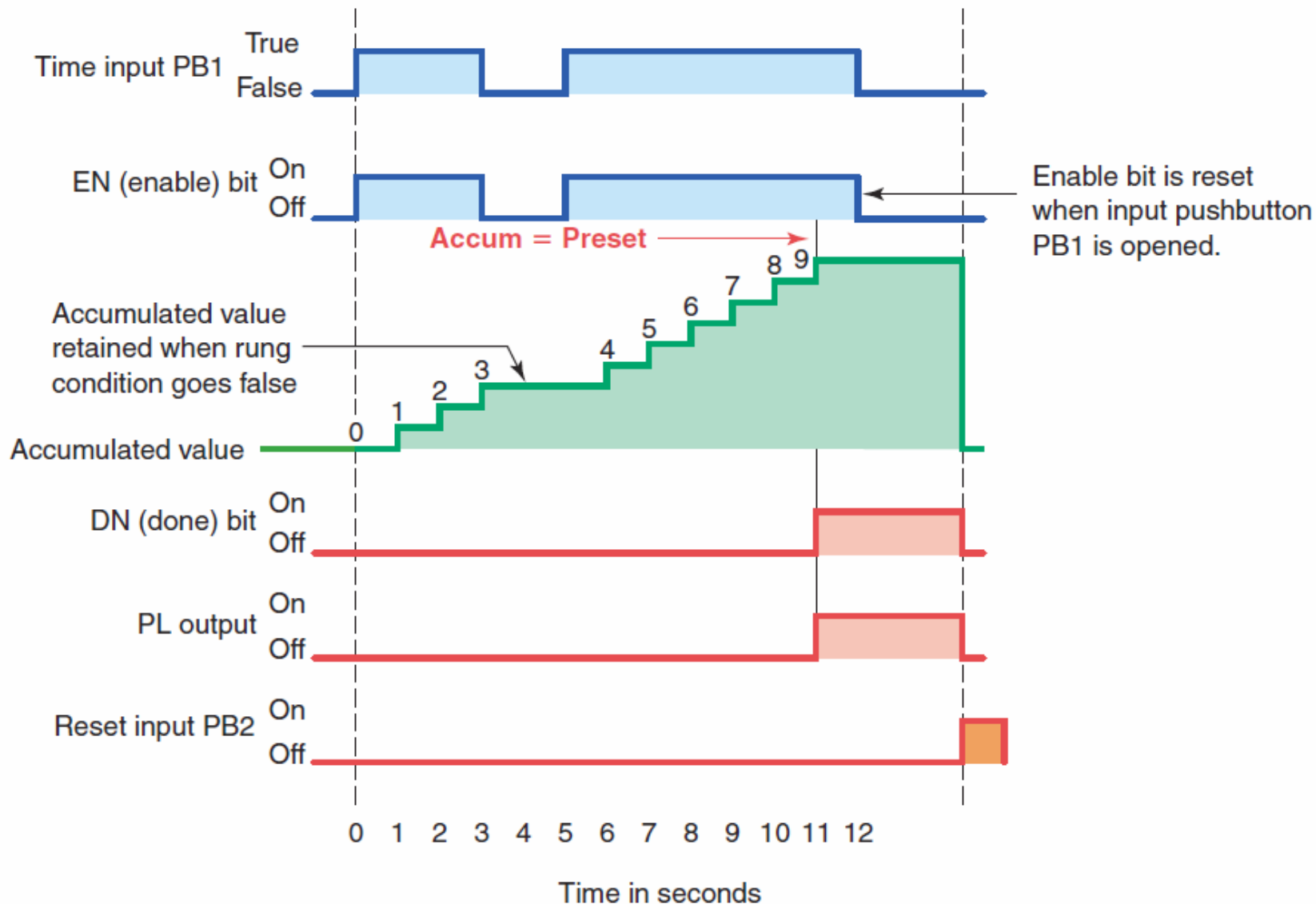


The RES instruction has the **same address** as the timer it is to reset.

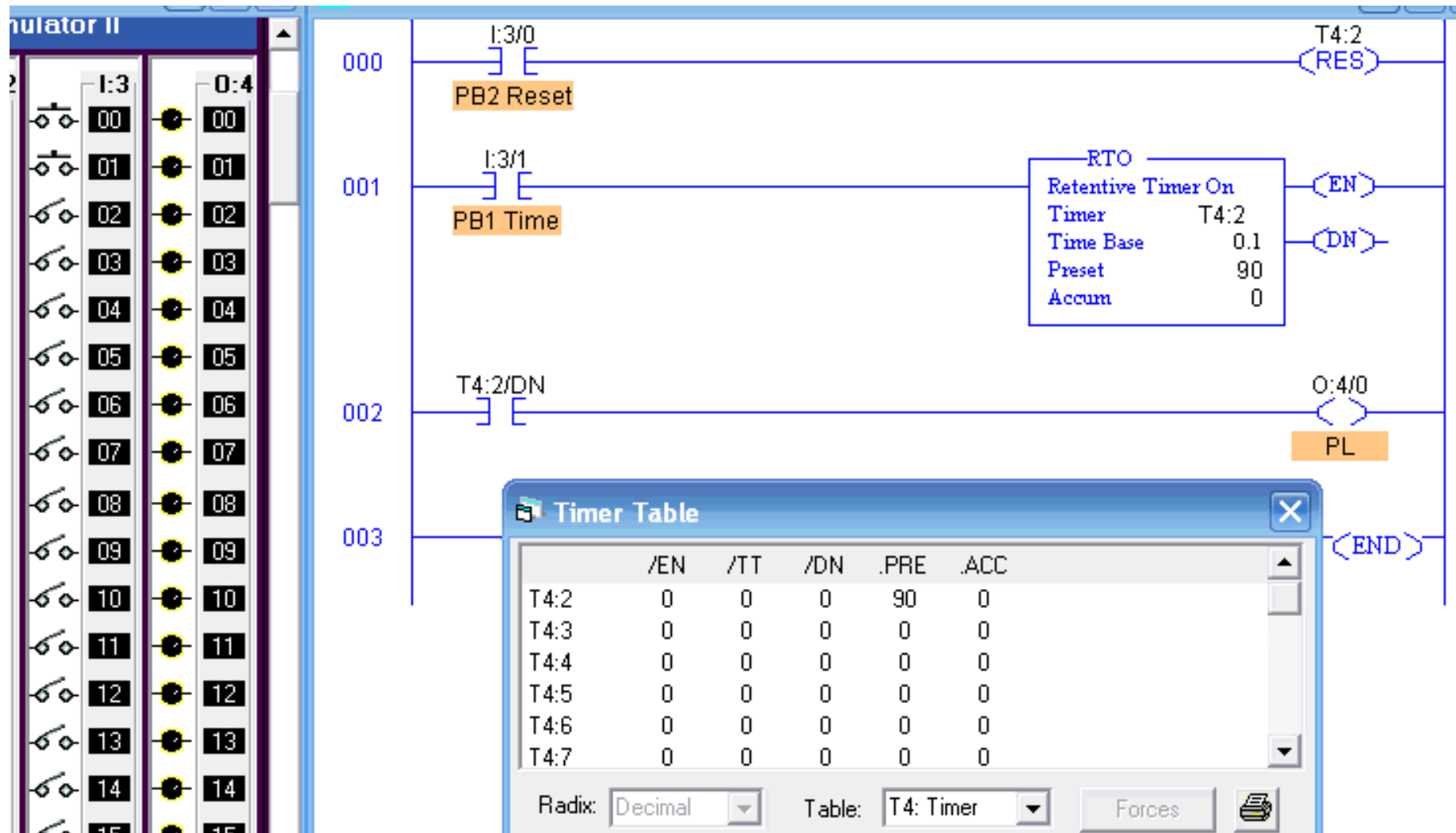
Retentive on-delay timer program.



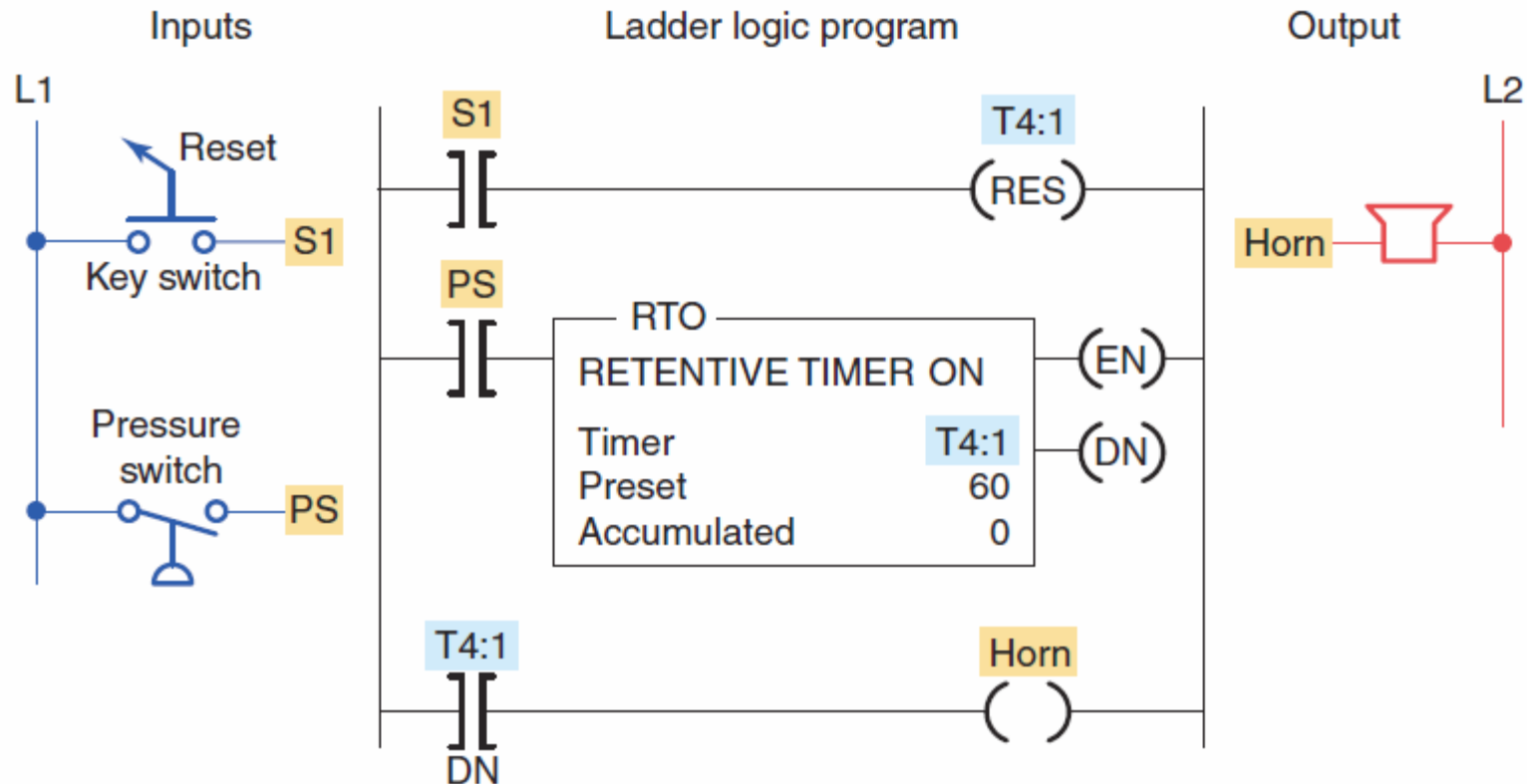
Retentive on-delay timer timing chart.



Simulated retentive on-delay timer program.

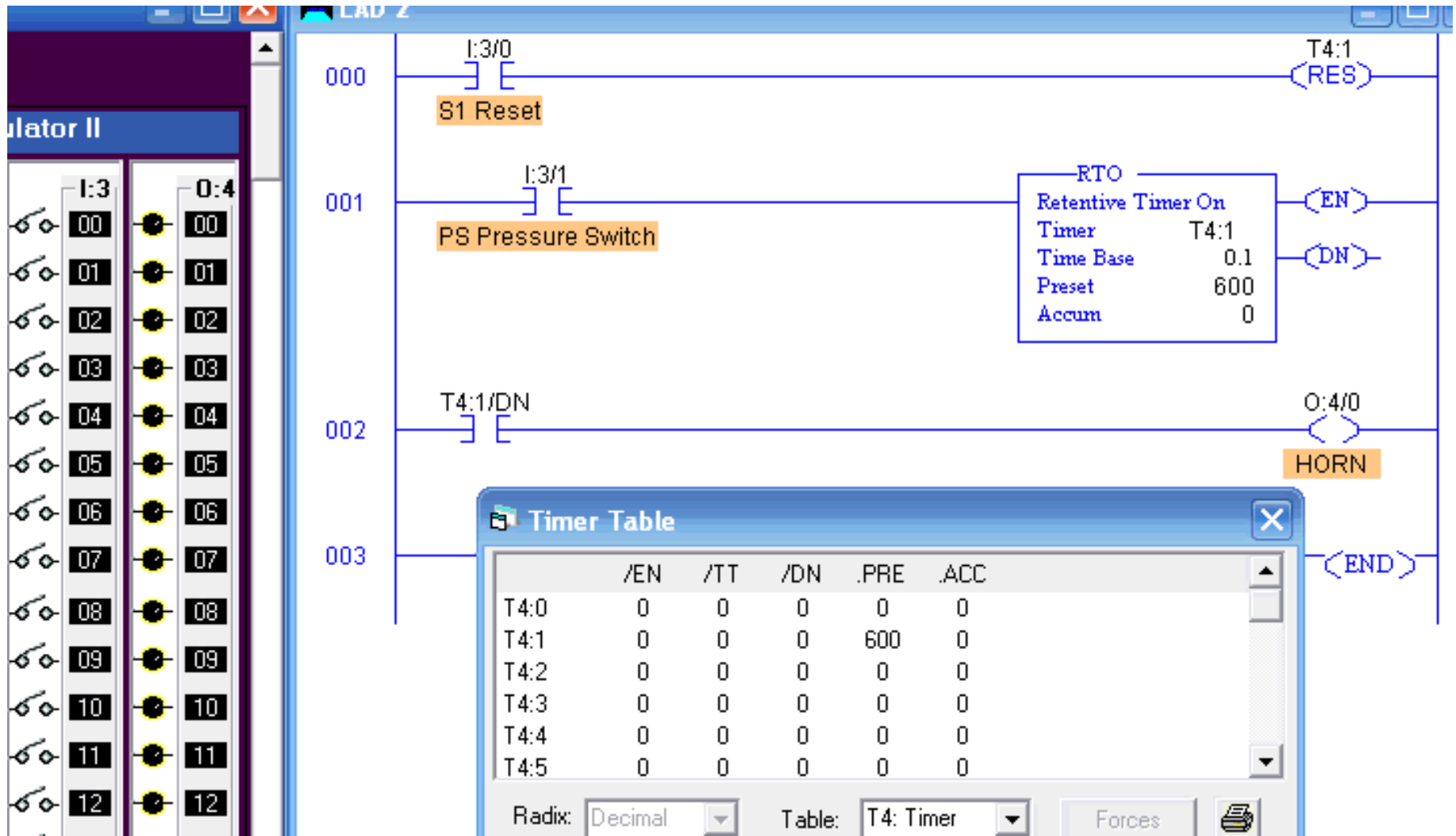


Retentive on-delay timer alarm program.

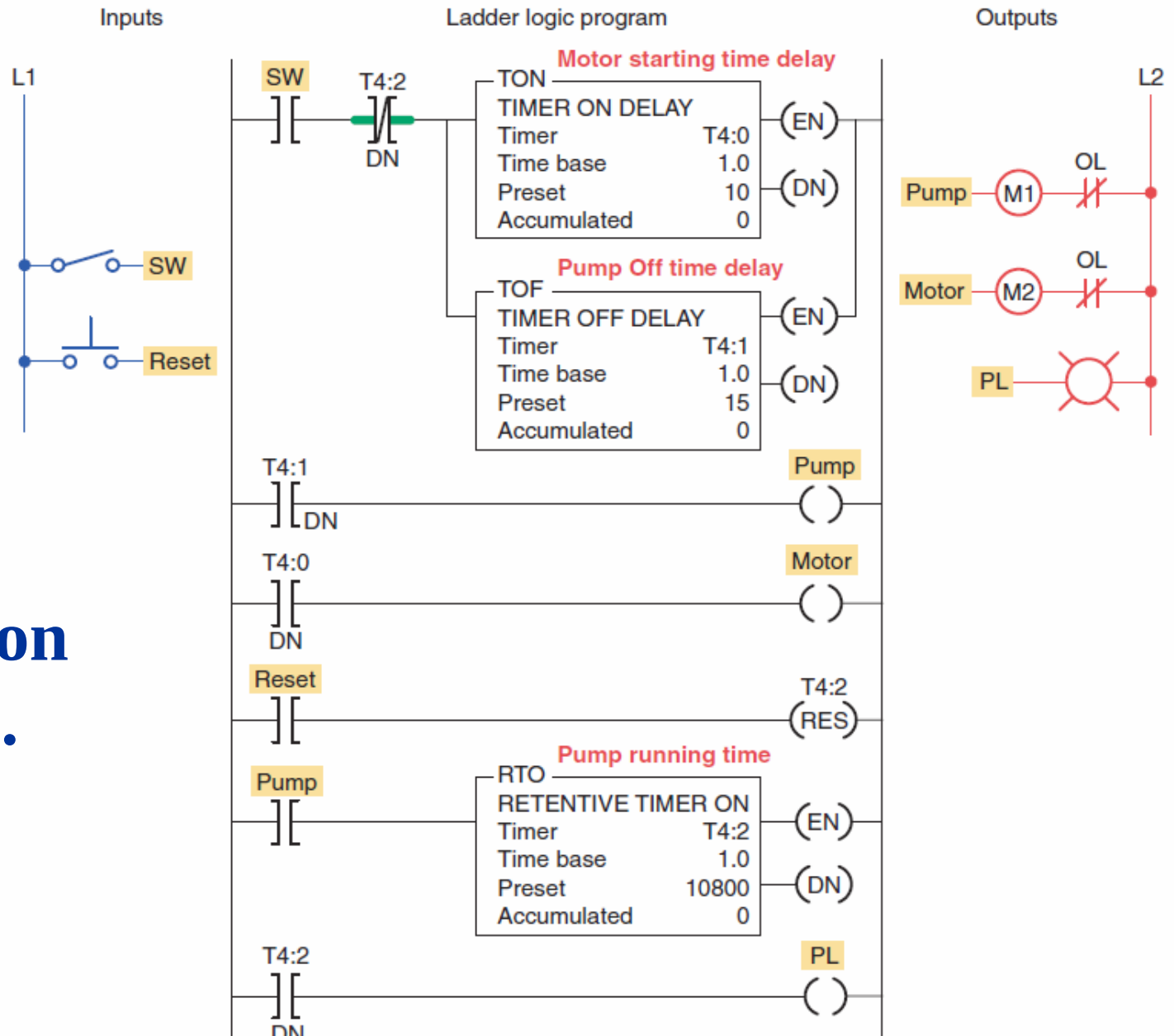


The purpose of the RTO timer is to detect whenever a piping system has sustained a **cumulative overpressure** condition for **60 s**.

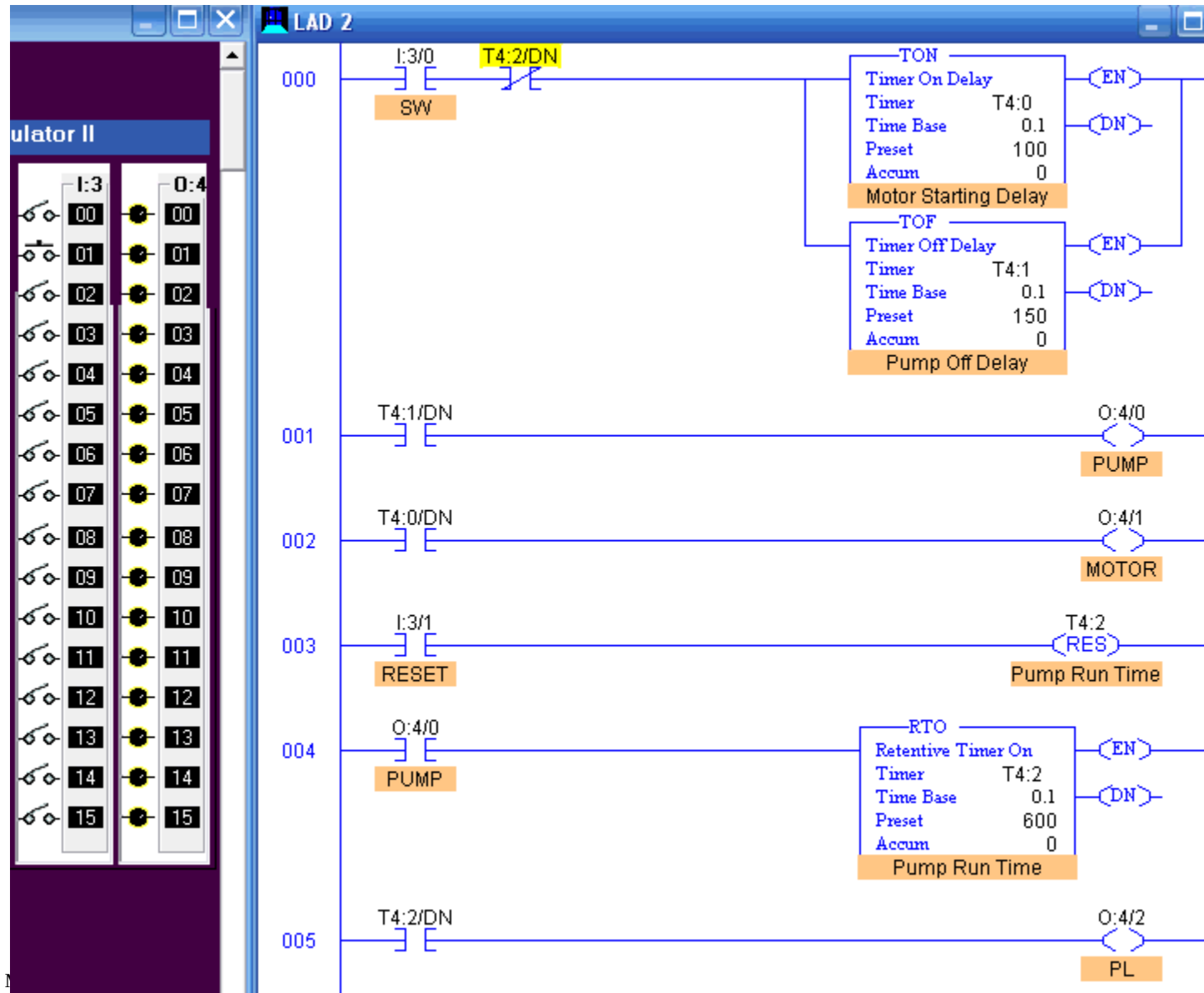
Simulated retentive on-delay timer alarm program.



Bearing lubrication program.



Simulated bearing lubrication program.



7.6

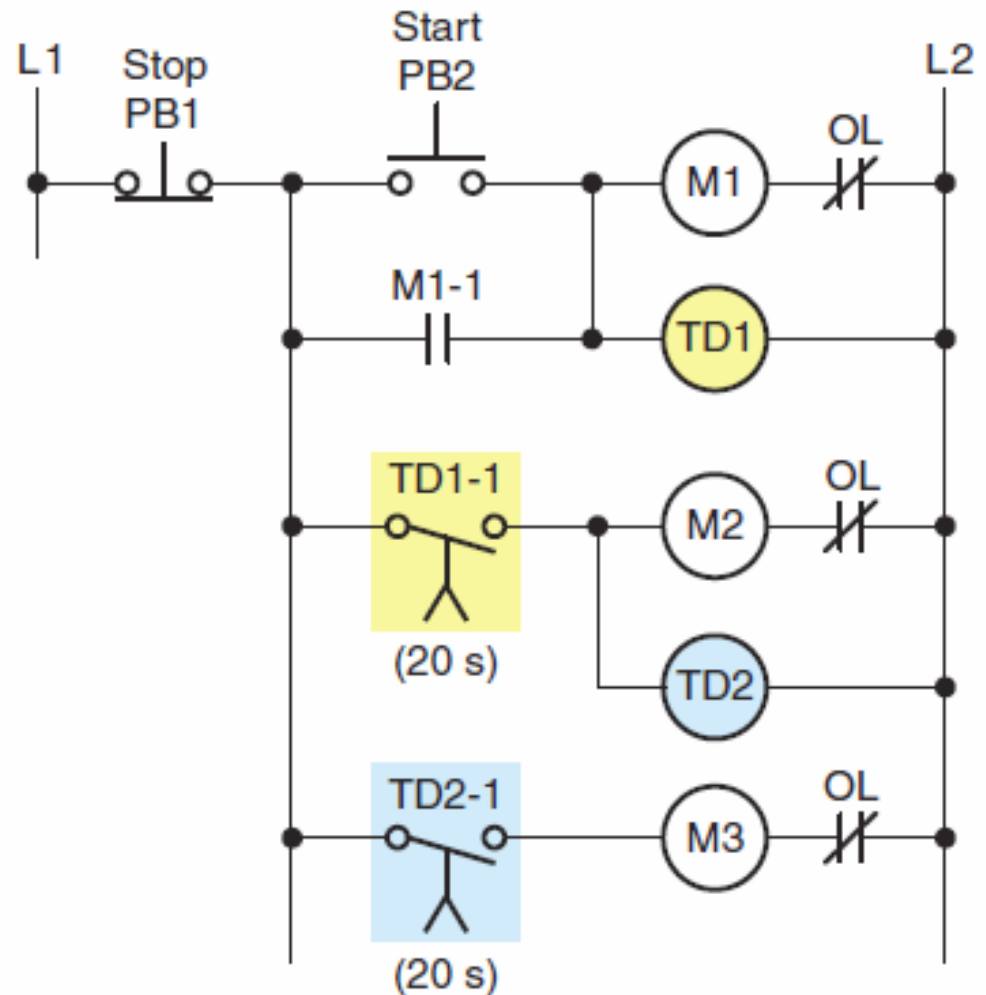


Cascading Timers

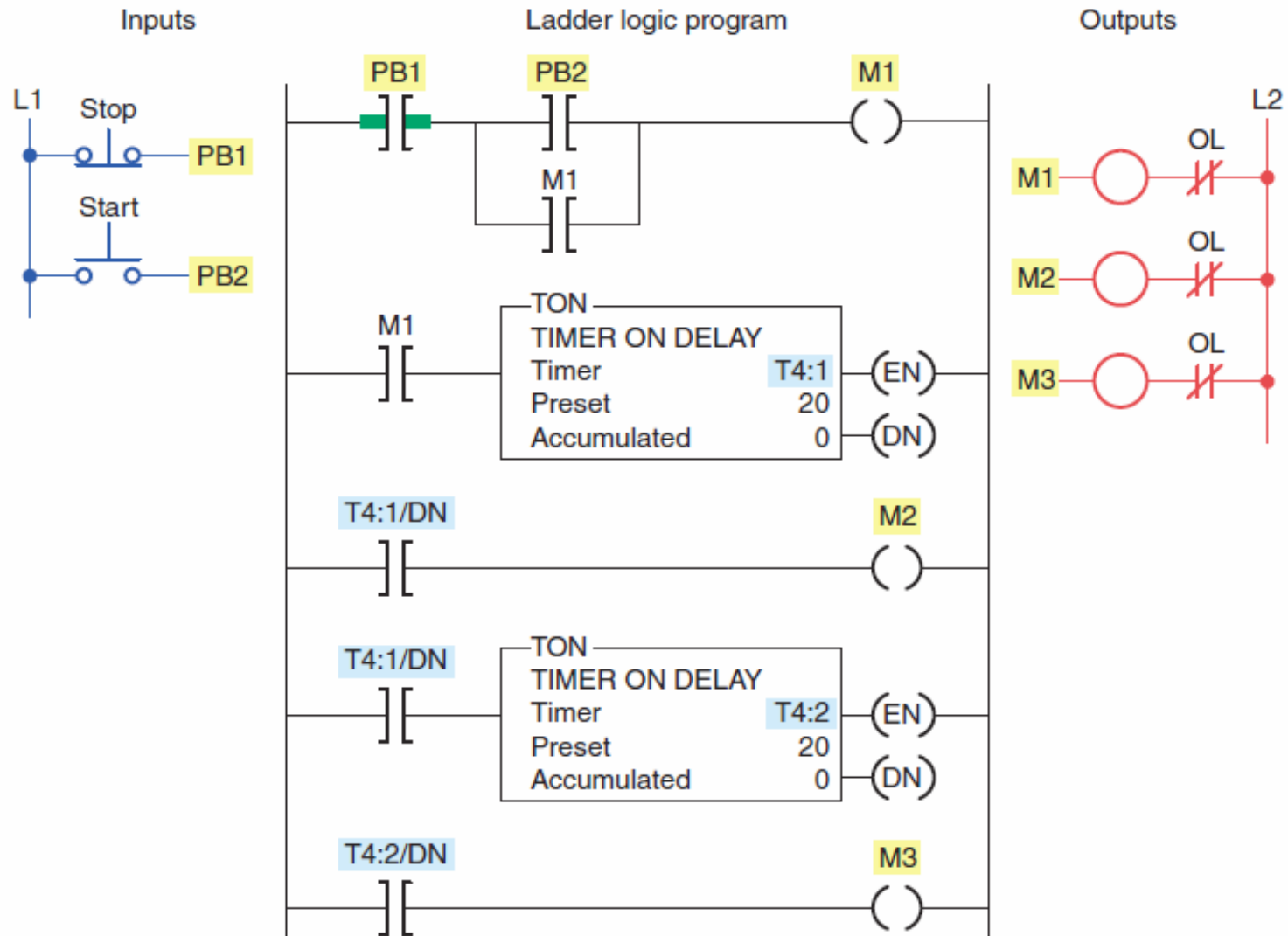
The programming of two or more timers together is called *cascading*.

Motors are started automatically in sequence with a **20 s time delay** between each

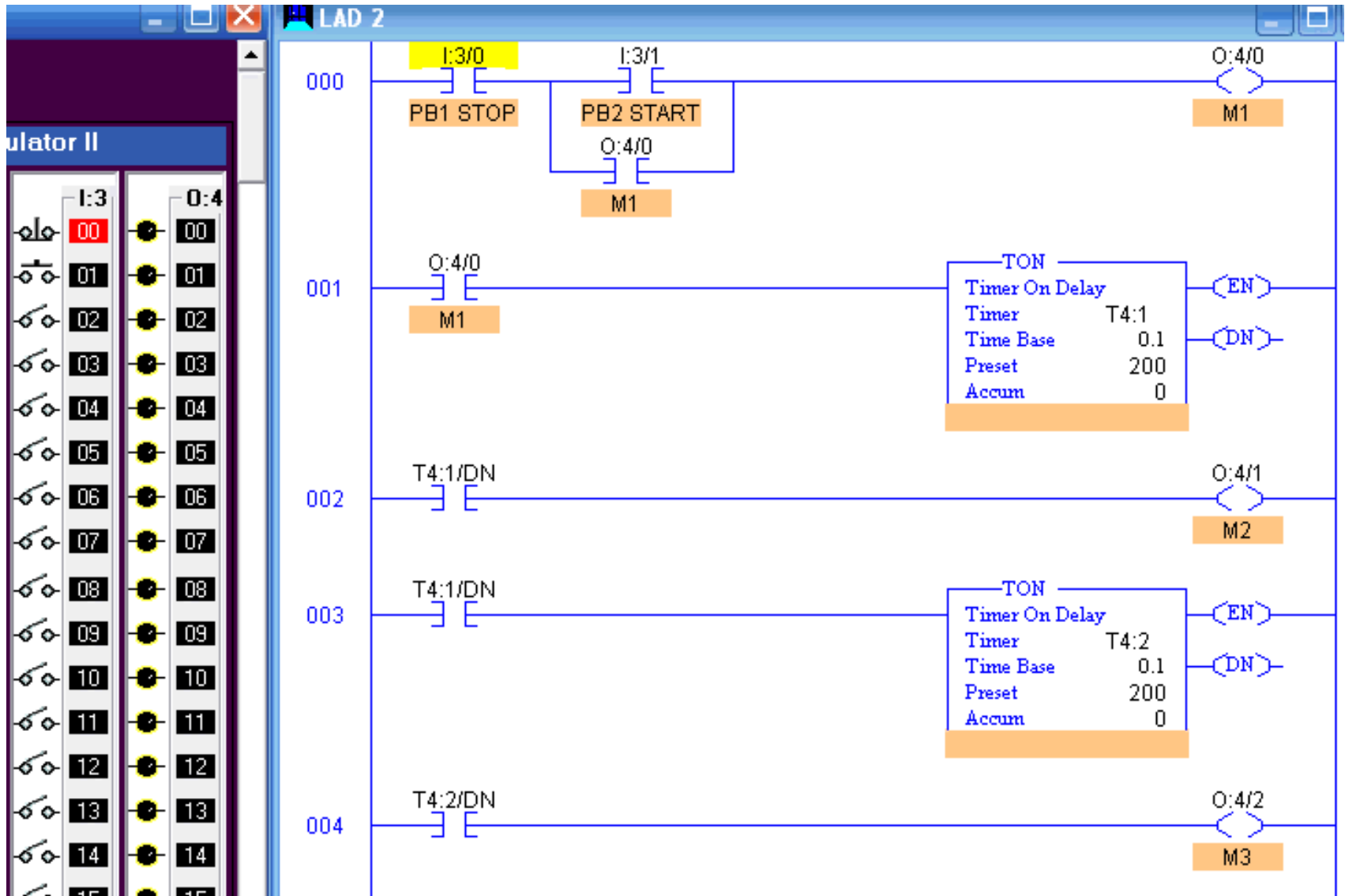
Hardwired sequential time-delayed motor starting circuit.



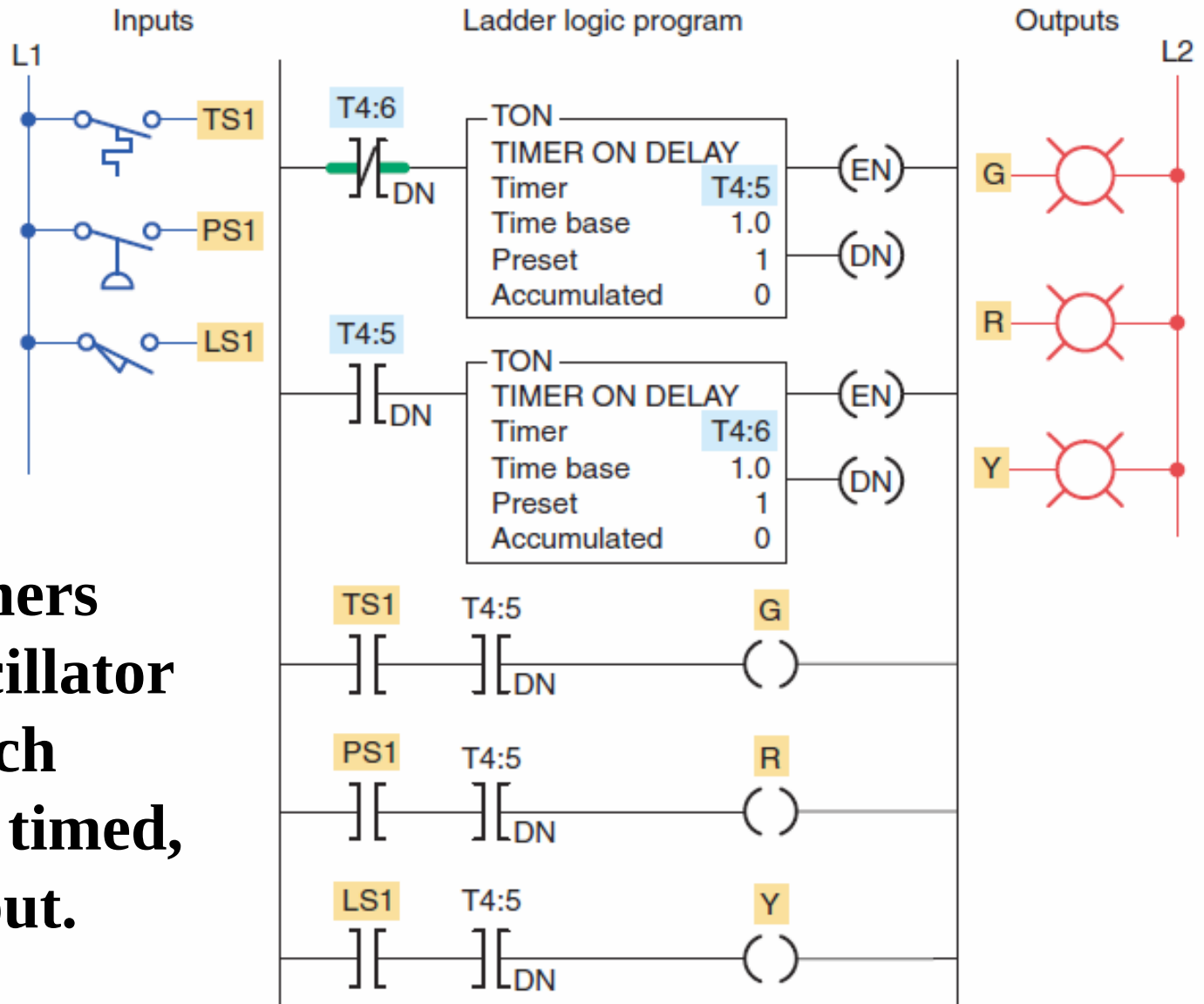
Programmed sequential motor starting circuit.



Simulated sequential motor starting circuit.

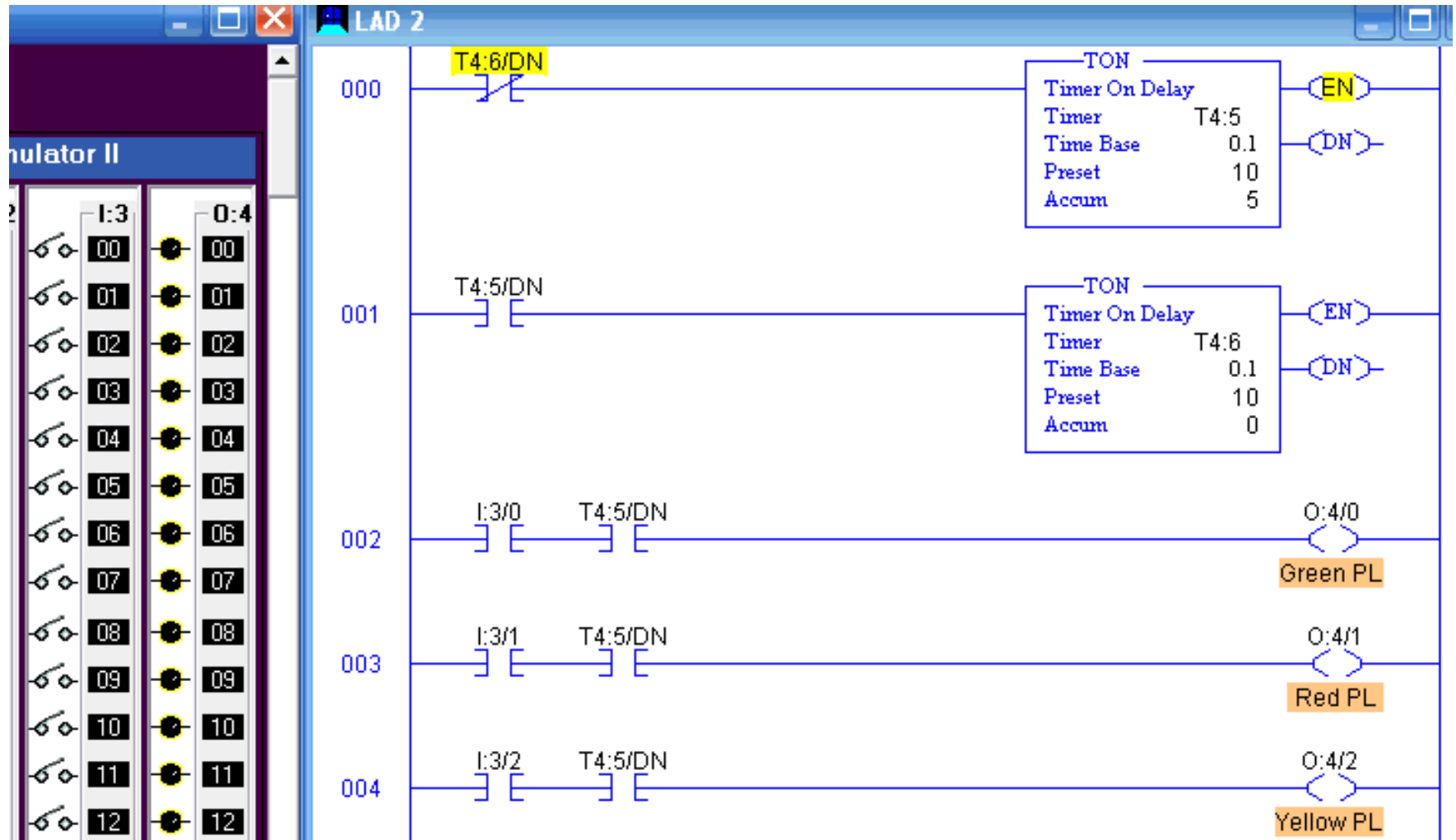


Annunciator *flasher* alarm program.

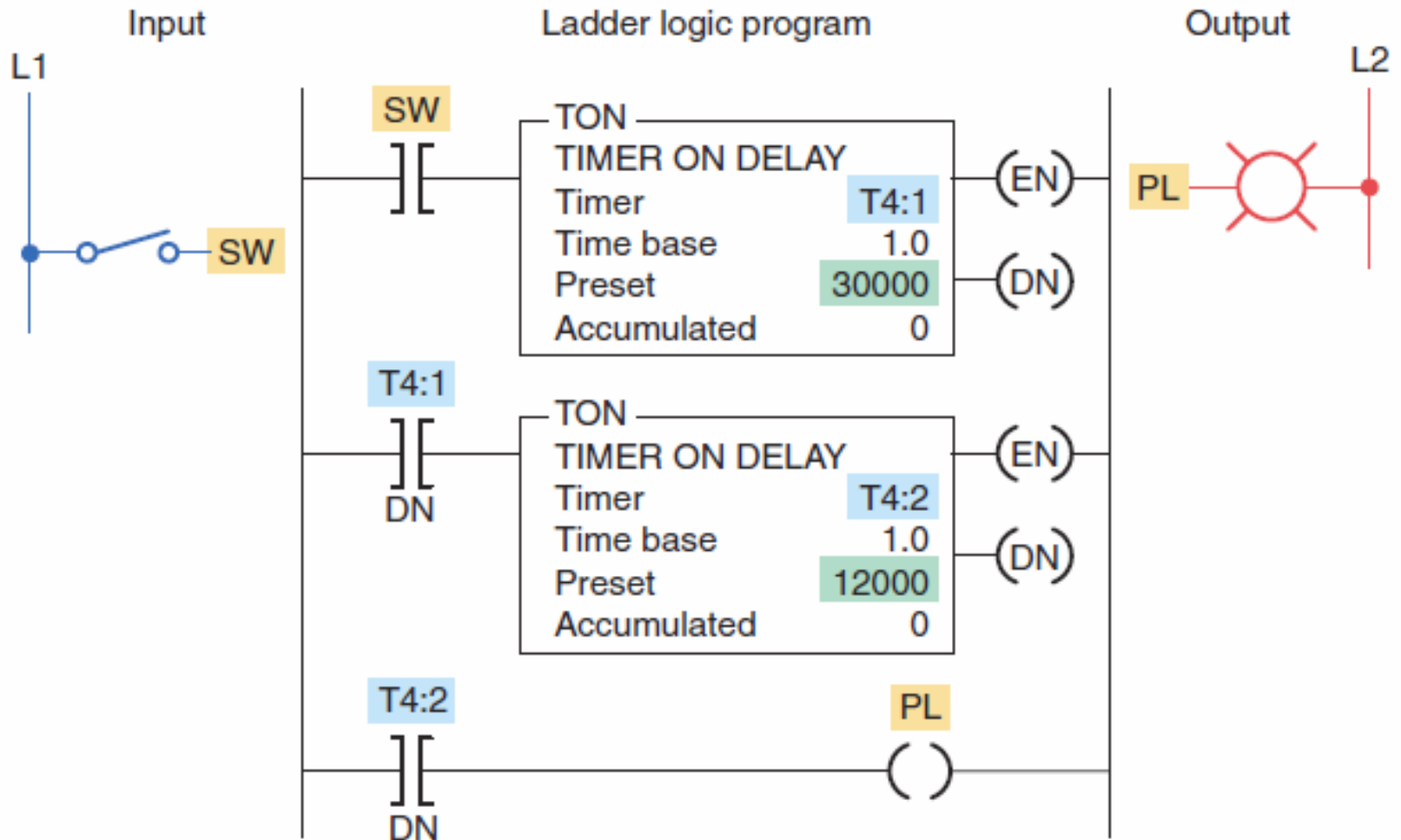


The two timers form an oscillator circuit, which generates a timed, pulsed output.

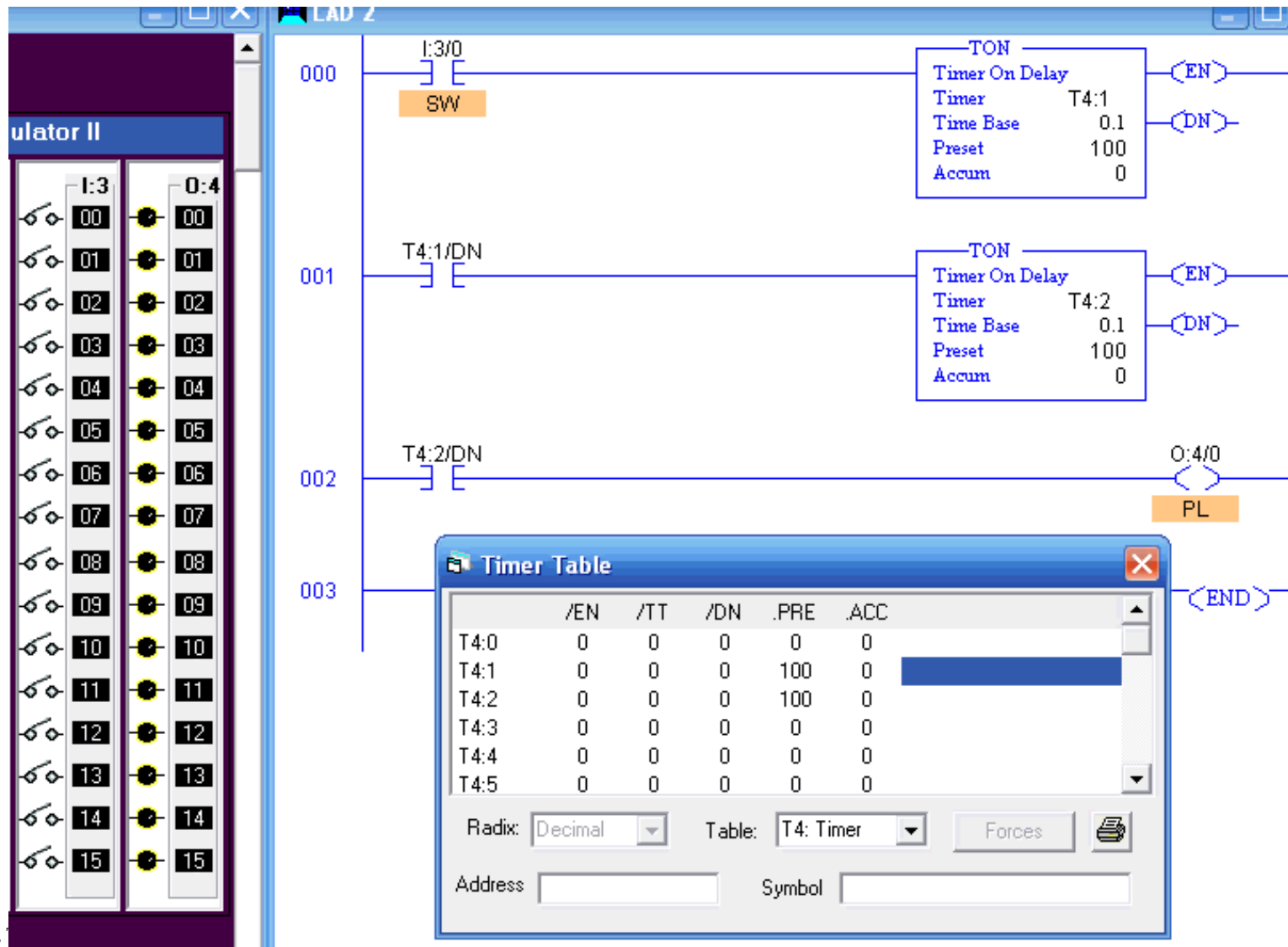
Simulated annunciator flasher alarm program.



Cascading of timers for *longer time delays*.

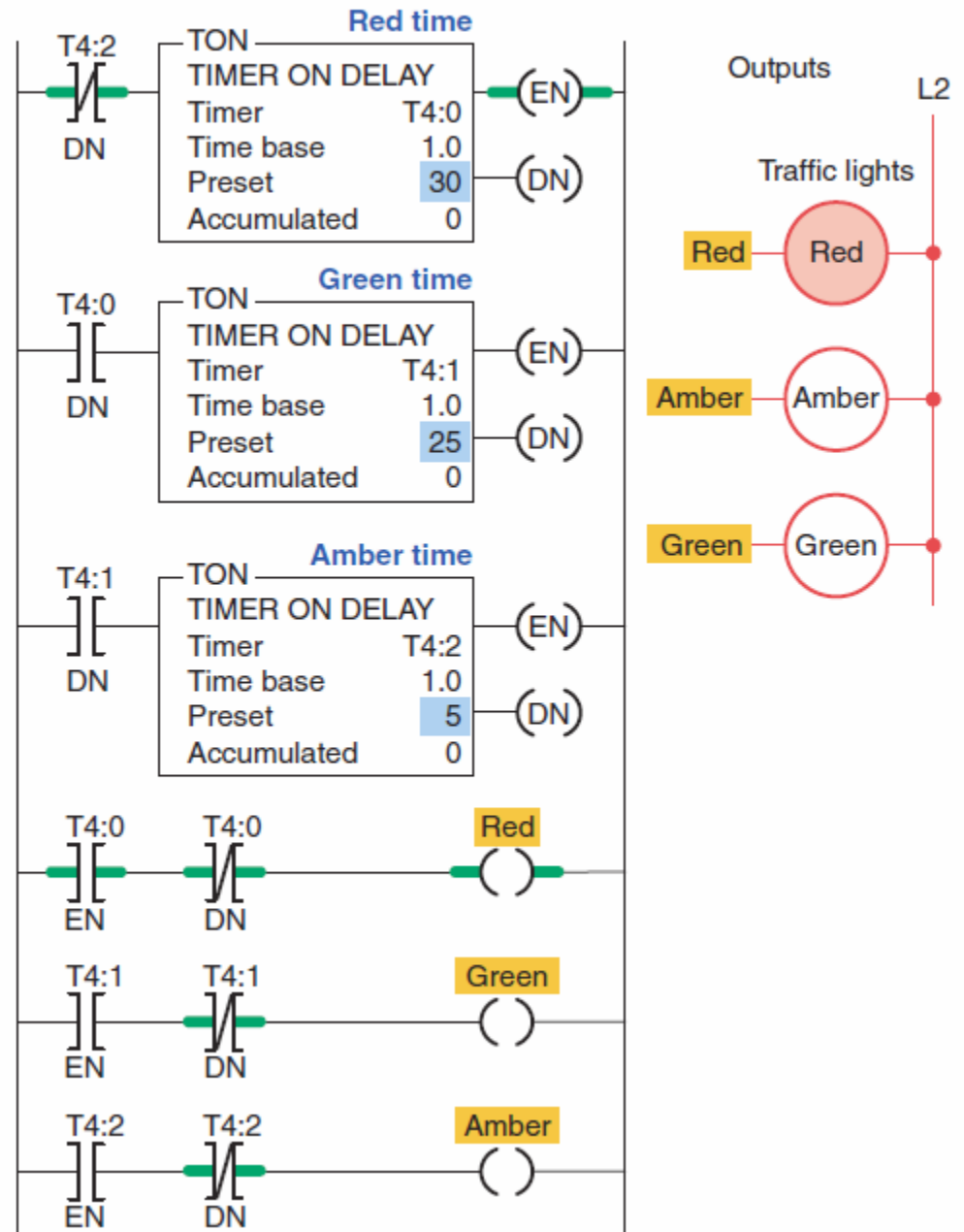


Simulation of cascading of timers for longer time delays.

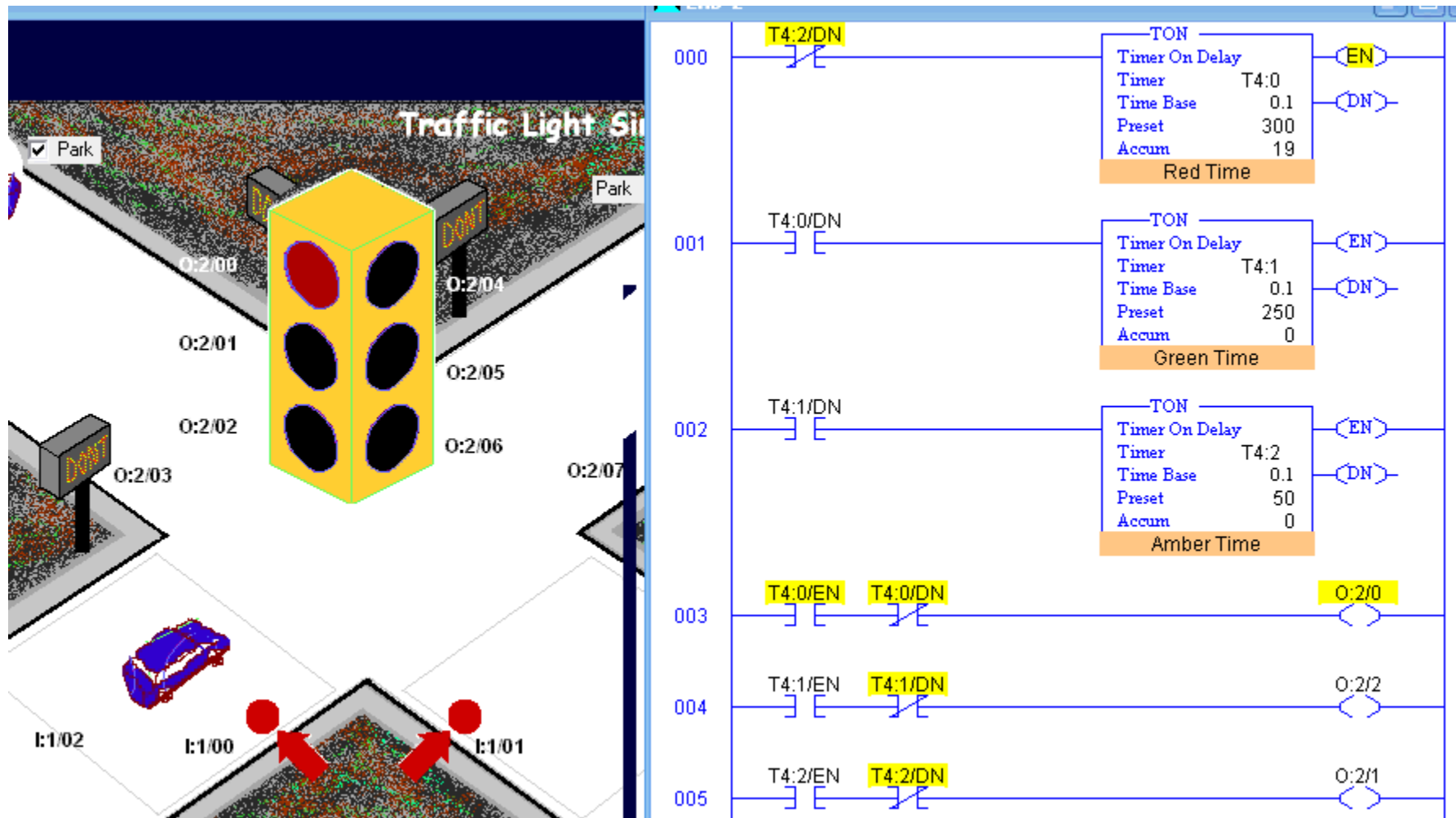


Program for control of traffic lights in one direction.

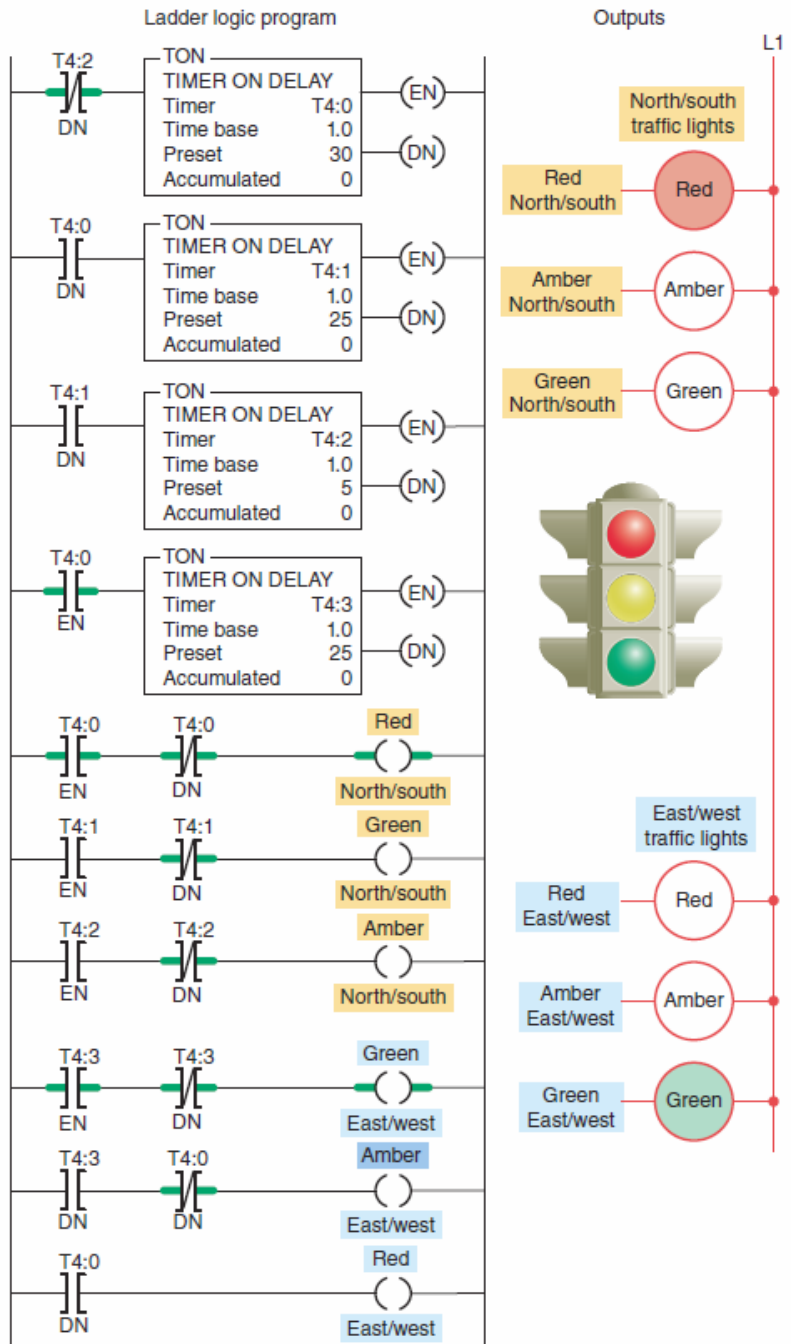
Ladder logic program



Simulation for control of traffic lights in one direction.



Control of traffic lights in two directions.



Simulation for control of traffic lights in two directions.

