CSE-3103: Microprocessor and Microcontroller

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Mechanical Timing Relays

Mechanical timing relays →

used to delay opening or closing of contacts for circuit control.
= operations in control circuit automatically start and stop
at different time intervals.

2 types of contacts →

1) instantaneous contacts →

change state as soon as timer coil is powered.
used as holding or sealing contacts in control circuit.

2) timed contacts →

change state at end of time delay.

2 arrangements to provide time delay →

1) on delay →

provides time delay when relay coil is energized.
= DOE → delay on energize.
time delay of contacts begins once timer is switched on.

2) off delay →

provides time delay when relay coil is de-energized.

Mechanical Timing Relays

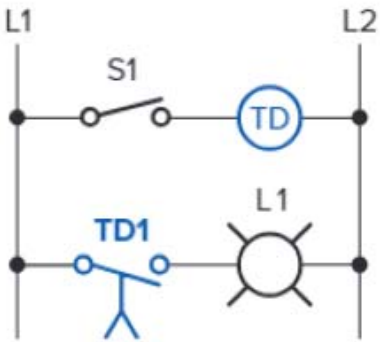
Different relay symbols used for timed contacts →

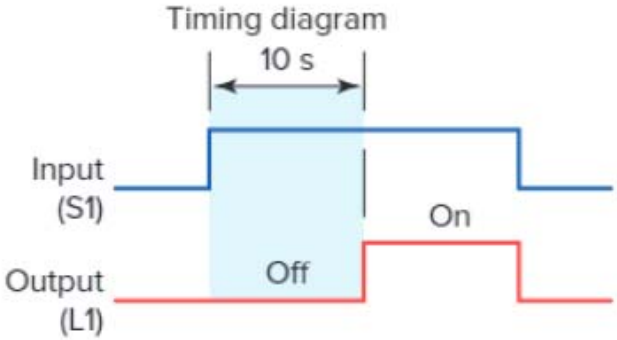
On-delay symbols		Off-delay symbols	
			
Normally open, timed closed contact (NOTC). Relay coil is de-energized = contact is open. Relay is energized = there is time delay in closing.	Normally closed, timed open contact (NCTO). Relay coil is de-energized = contact is closed. Relay is energized = there is time delay in opening.	Normally open, timed open contact (NOTO). Relay coil is de-energized = contact is open. Relay coil is energized = contact closes instantly. Relay coil is de-energized = there is time delay before contact opens.	Normally closed, timed closed contact (NCTC). Coil is de-energized = contact is closed. Relay coil is energized = contact opens instantly. Relay coil is de-energized = there is time delay before contact closes.

Mechanical Timing Relays

Operation of on-delay timer circuit,
normally open, timed closed (NOTC) contact →

S1 initially open →
- TD coil is de-energized,
- TD1 contacts are open,
- light L1 will be off.





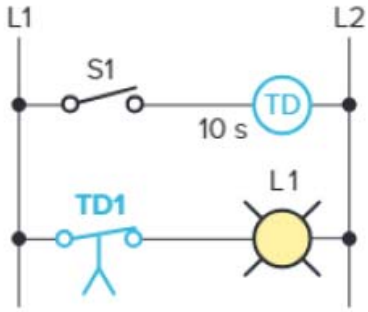
S1 is closed →
- TD coil is energized,
- timing period starts.
- TD1 contacts are delayed from closing,
- L1 remains off.

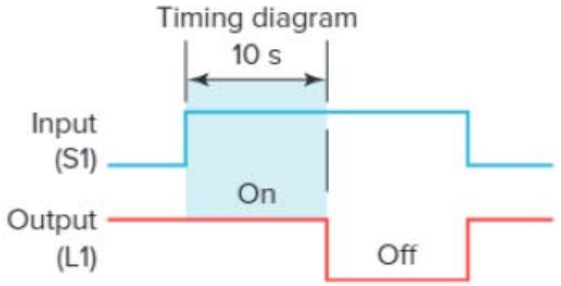
10 s time-delay period has elapsed →
- TD1 contacts close,
- L1 is switched on.

S1 is opened →
- TD coil is de-energized,
- TD1 contacts open instantly to switch L1 off.

Mechanical Timing Relays

Operation of on-delay timer circuit,
normally closed, timed open (NCTO) contact →





S1 initially open →
- TD coil is de-energized,
- TD1 contacts are closed,
- light L1 will be on.

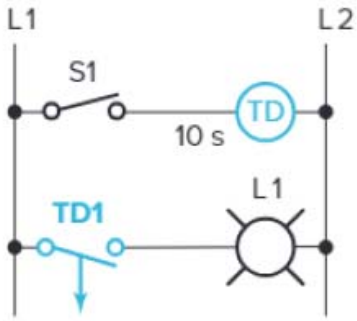
S1 is closed →
- TD coil is energized,
- TD1 contacts are delayed from opening,
- light L1 remains on.

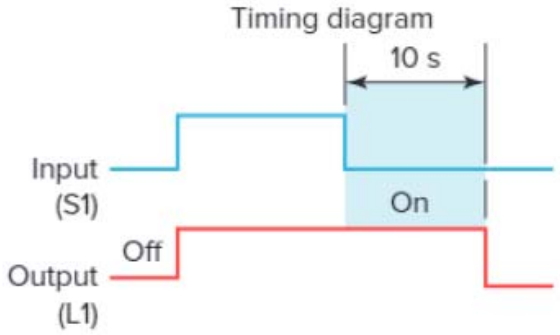
10 s time-delay period has elapsed →
- TD1 contacts open,
- L1 is switched off.

S1 is opened →
- TD coil is de-energized,
- TD1 contacts close instantly to switch L1 on.

Mechanical Timing Relays

Operation of off-delay timer circuit,
normally open, timed open (NOTO) contact →





S1 initially open →
- TD coil is de-energized,
- TD1 contacts are open,
- light L1 will be off.

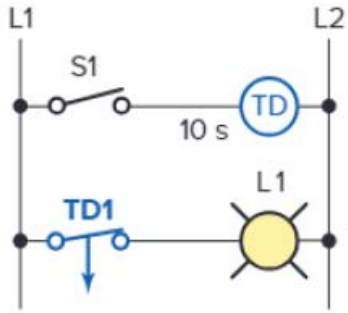
S1 is closed →
- TD coil is energized,
- TD1 contacts close instantly to switch light L1 on.

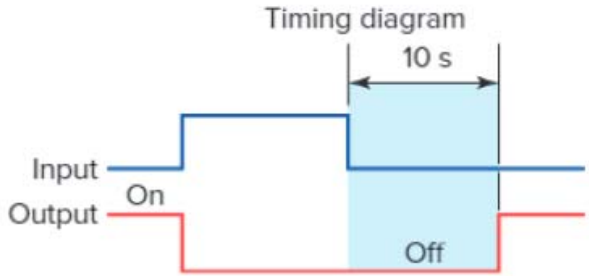
S1 is opened →
- TD coil is de-energized,
- timing period starts.

10 s time-delay period has elapsed →
- TD1 contacts open to switch light off.

Mechanical Timing Relays

Operation of off-delay timer circuit,
normally closed, timed closed (NCTC) contact →





S1 initially open →
- TD coil is de-energized,
- TD1 contacts are closed,
- light L1 will be on.

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

S1 is opened →
- TD coil is de-energized,
- timing period starts.
- TD1 contacts are delayed from closing,
- L1 remains off.

10 s time-delay period has elapsed →
- TD1 contacts close to switch light on.

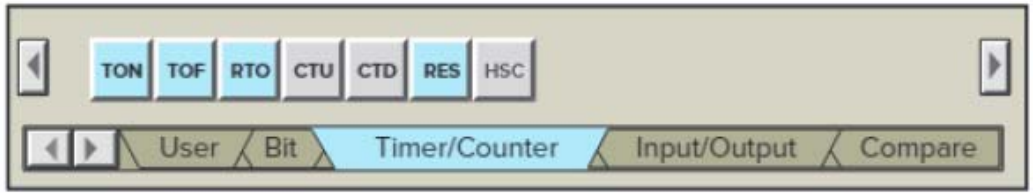
Timer Instructions

PLC timers →

= instructions that provide same functions as
on-delay and off-delay mechanical and electronic timing relays.
all PLC timers are output instructions.

3 different PLC timer types →

on-delay timer (TON),
off-delay timer (TOF),
retentive timer on (RTO).



timer selection toolbar for Allen-Bradley SLC 500 PLC →

Timer commands →

TON (Timer On Delay) →

Counts time-based intervals when instruction is true.

TOF (Timer Off Delay) →

Counts time-based intervals when
instruction transitions from true to false condition.

Timer Instructions

Timer commands →

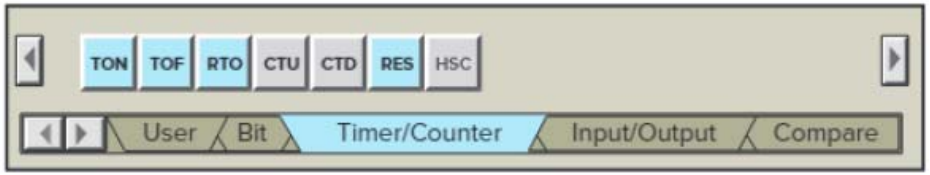
RTO (Retentive Timer On) →

Counts time-based intervals when instruction is true.

retains accumulated value when →

instruction goes false or

power cycle occurs.



RES (Reset) →

Resets retentive timer's accumulated value to zero.

Quantities associated with timer instruction →

1) Time Base →

unit of time used by timer to time event.

= 1 ms (0.001 s), 10 ms (0.01 s), 100 ms (0.1 s), or 1 second intervals.

time base = 0.01 second, timing = 5 seconds long →

PLC will wait until time base has occurred 500 times

before timer times out.

Timer Instructions

Quantities associated with timer instruction →

2) Preset Value →

time duration for timing circuit.

total timing interval = preset value × time base.

preset value = 100, time base = 0.1 s →

total timing interval = 100 × 0.1 s = 10 seconds.

3) Accumulated Value →

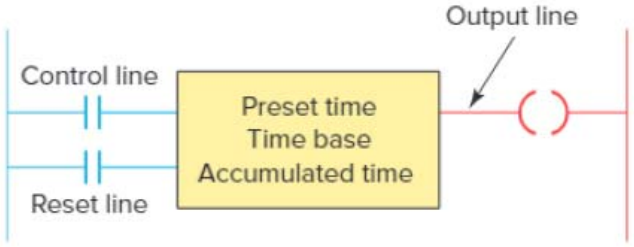
amount of time that has elapsed from moment timing started.

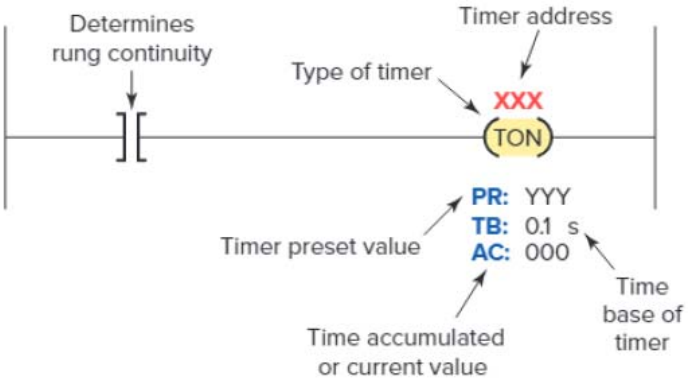
keeps track of how many times time base has occurred.

Representation of timers on ladder logic program →

1) coil-formatted timer instruction.

2) block-formatted timer instruction.

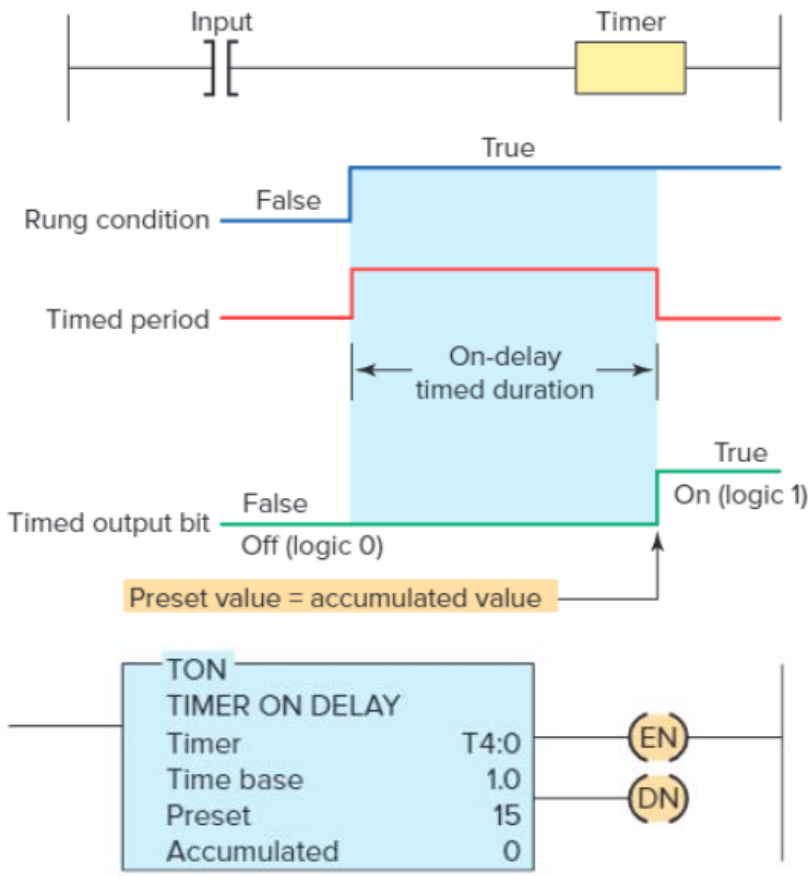




On-Delay Timer Instruction

Principle of operation of on-delay timer →
- rung containing timer is true →
  - timer time-out period commences.
- length of time delay → adjusted by preset value.

On-delay timer instruction of Allen-Bradley SLC 500 controller →
- Timer number →
  - T4:0 = timer file 4, timer 0 in that file.
- Time base = 1.0 s.
- Preset value = 15 (0 – 32,767).
- Accumulated value = 0 →
  - entered as 0,
  - timer value = 0 whenever timer is reset.



On-Delay Timer Instruction

Operation of PLC program that uses on-delay timer →

timer is activated by input switch A.

input switch A is closed (true or set to 1) →

processor starts timer T4:0 timing,

sets EN and TT bits to true or 1.

outputs B and C turns ON.

accumulated value increases in 1 s time base intervals.

accumulated time = preset time (10 s) →

DN bit is set to 1,

output D is turned ON,

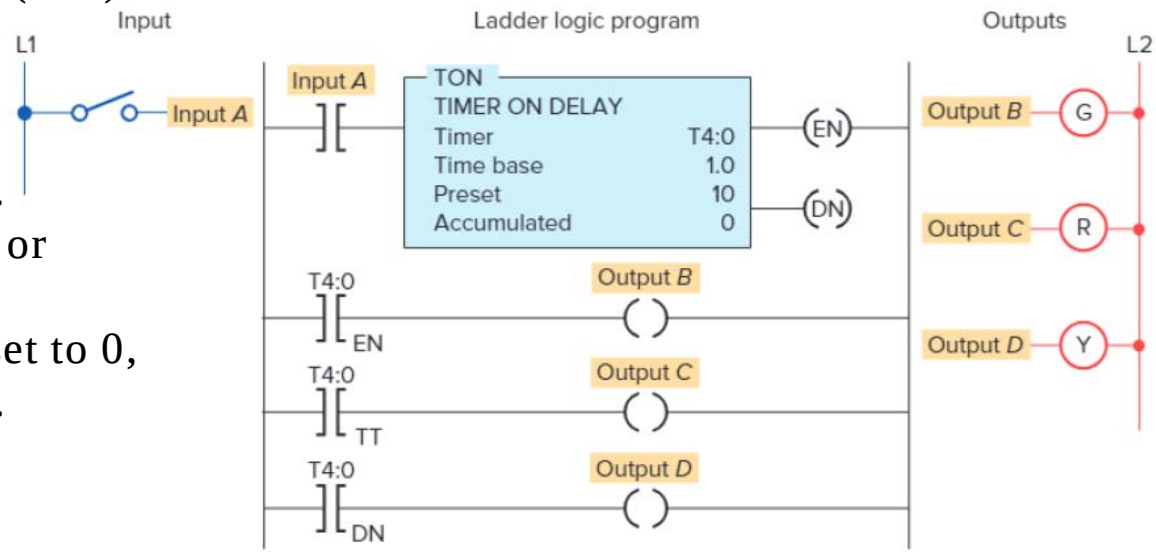
TT bit is reset to 0,

output C is turned OFF.

input switch A is opened before or after timer has timed out →

accumulated time is reset to 0,

output B is turned OFF.



On-Delay Timer Instruction

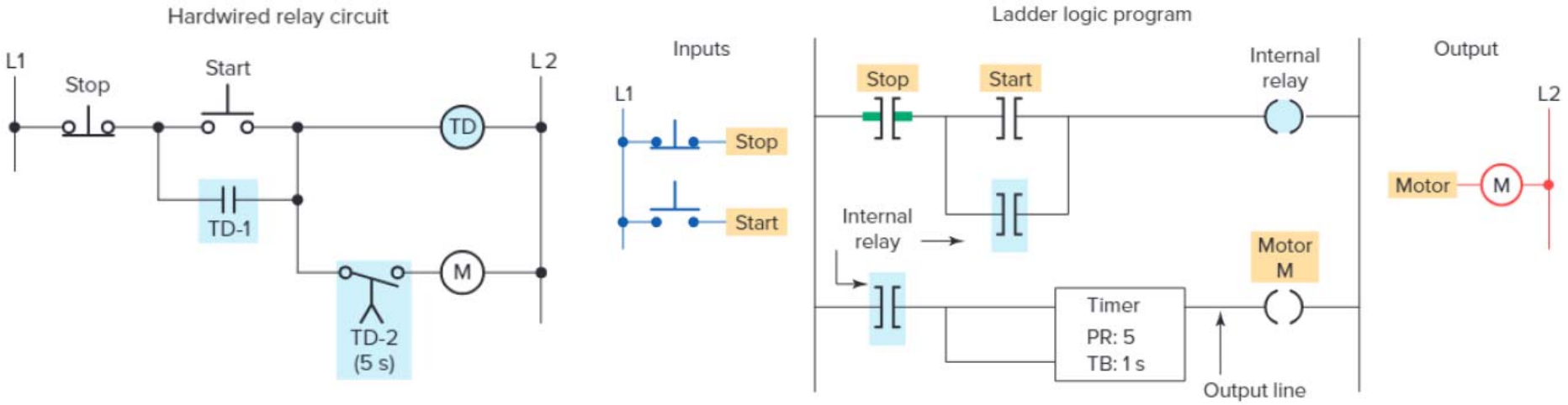
Operation of on-delay timer →

Hardwired relay circuit →

coil M is to be energized 5 s after start pushbutton is pressed.
contact TD-1 = instantaneous contact,
contact TD-2 = timed contact.

Ladder logic program →

contact instruction is referenced to internal relay.
instantaneous contact = internal relay coil,
time-delay contact = timer output coil.



On-Delay Timer Instruction

Operation of on-delay timer that uses NCTO contact →

Hardwired relay circuit →

start pushbutton PB1 is momentarily actuated →

coil CR is energized.

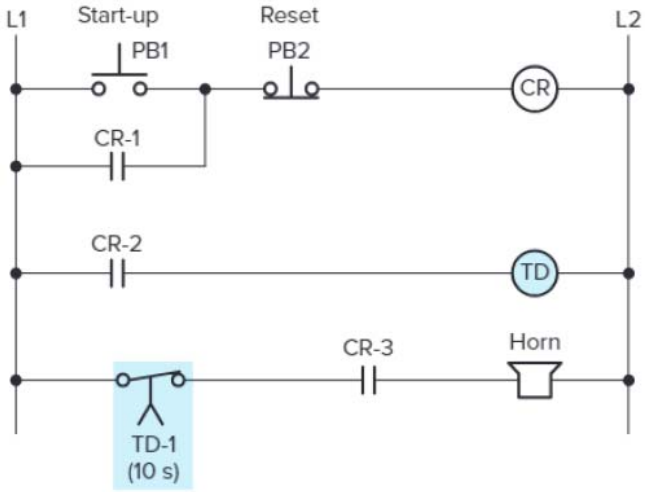
contact CR-1 closes to seal in CR coil,

contact CR-2 closes to energize timer coil TD,

contact CR-3 closes to sound horn.

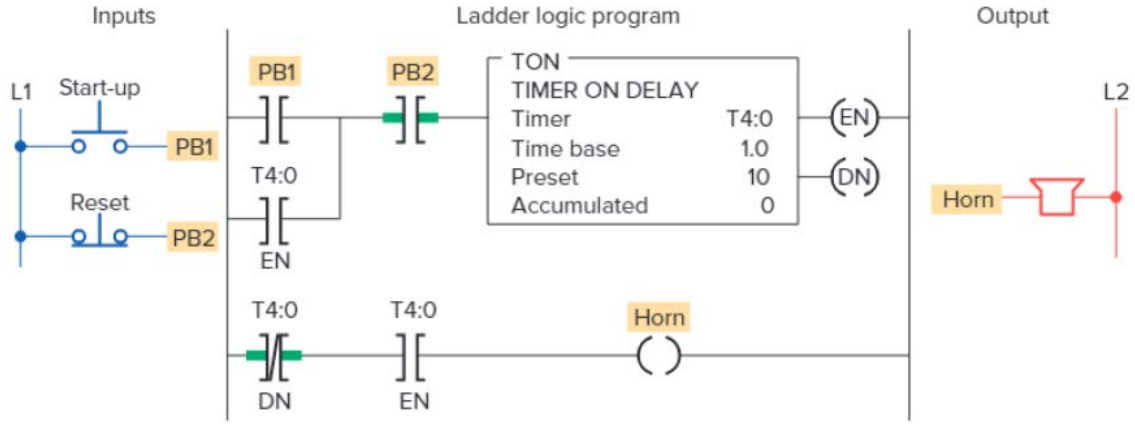
after 10 s time-delay period →

timer contact TD-1 opens to switch horn off.



Ladder logic program →

logic on last rung = timer-timing bit.



On-Delay Timer Instruction

Operation of on-delay timer →

timers as part of automatic sequential control systems = series of motors can be started automatically with only one start/stop control station.

Relay ladder schematic →

start pushbutton PB2 is momentarily actuated →

lube-oil pump motor starter coil M1 is energized.

M1-1 control contact closes to seal in M1,

lube-oil pump motor starts.

lube-oil pump builds up sufficient oil pressure →

lube-oil pressure switch PS1 closes.

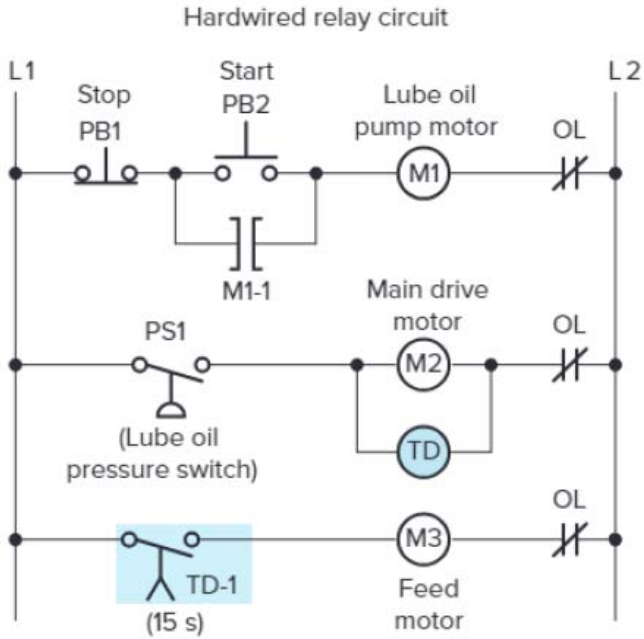
coil M2 energizes to start main drive motor,

coil TD energizes to begin time-delay period.

after preset time-delay period of 15 s →

TD-1 contact closes to energize coil M3,

start feed motor.



On-Delay Timer Instruction

Operation of on-delay timer →

Ladder logic program →

enable bit is used to seal in timer,

continues to time until

preset value = accumulated value.

actuating reset button =

program sequence is reset.