الجامعة التقنية الوسطى
الكلية التقنية الهندسية الكهربائية
قسم هندسة تقنيات الحاسوب

PROGRAMMABLE LOGIC CONTROLLER

(PLC)

المرحلة الثالثة
المادة: المسيطرات الرقمية

"PLC"

1. Output Control Devices

A variety of output control devices can be operated by the PLC output to control traditional industrial processes. These devices include pilot lights, control relays, motor starters, alarms, heaters, small motors, and horns. Similar electrical symbols are used to represent these devices both on relay schematics and PLC output connection diagrams. Figure 1 shows common electrical symbols used for various output devices.

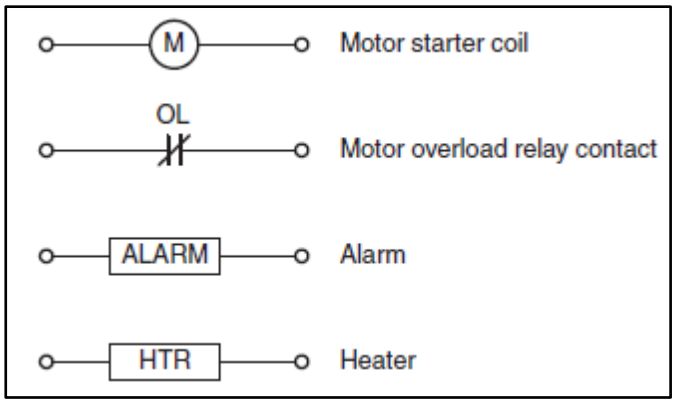


Figure (1): Symbols for output control devices.

1.1 Actuator:

In the electrical sense, is any device that converts an electrical signal into mechanical movement. An electromechanical solenoid is an actuator that uses electrical energy to magnetically cause mechanical control action. Figure 2 shows the basic construction and operation of a solenoid.

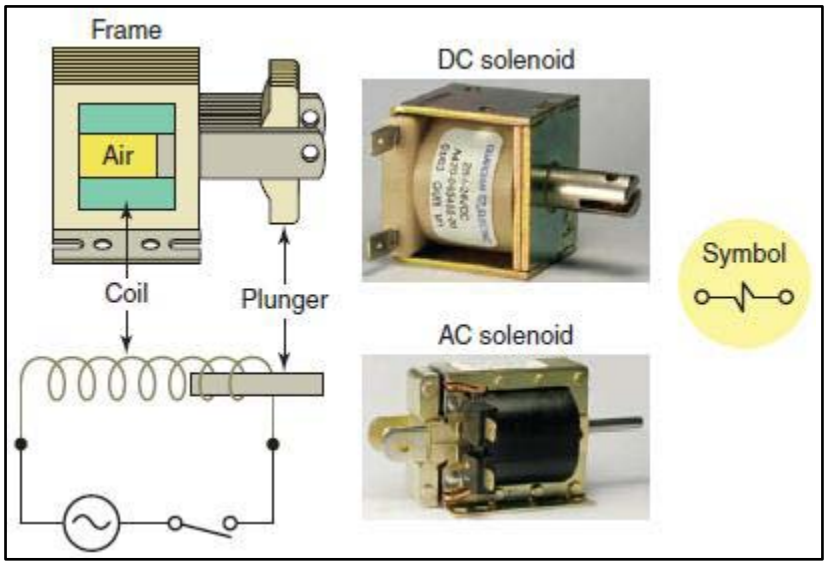


Figure (2): Solenoid construction and operation.

1.2 Stepper motors

This device as shown in figure 3 operate differently than standard types, which rotate continuously when voltage is applied to their terminals. The shaft of a stepper motor rotates in discrete increments when electrical command pulses are applied to it in the proper sequence. Every revolution is divided into a number of steps, and the motor must be sent a voltage pulse for each step. The amount of rotation is directly proportional to the number of pulses, and the speed of rotation is relative to the frequency of those pulses.

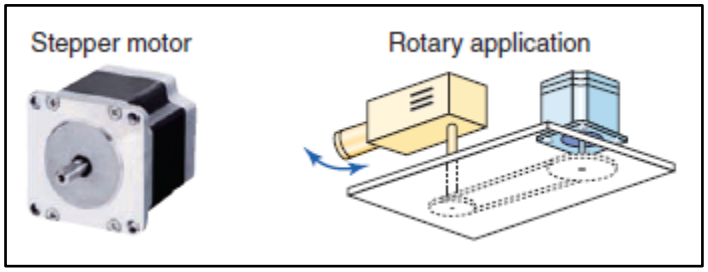


Figure (3): shows the stepper motor.

2. Programming Timers

There are very few industrial control systems that do not need at least one or two timed functions. Mechanical timing relays are used to delay the opening or closing of contacts for circuit control. The operation of a mechanical timing relay is similar to that of a control relay, except that certain of its contacts are designed to operate at a preset time interval, after the coil is energized or de-energized. Typical types of mechanical and electronic timing relays are shown in Figure 4. Timers allow a multitude of operations in a control circuit to be automatically started and stopped at different time intervals.

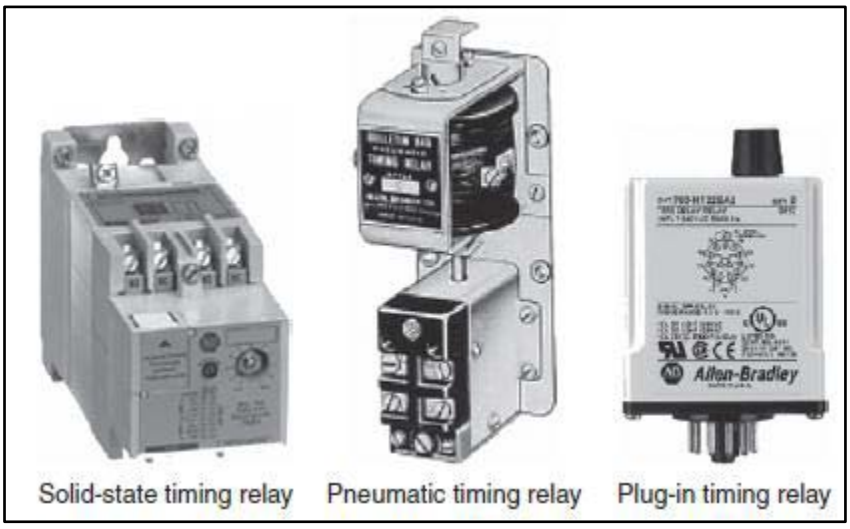


Figure 4: Timing relays.

Mechanical timing relays provide time delay through two arrangements. The first arrangement, on delay, provides time delay when the relay coil is energized. The second arrangement, off delay, provides time delay when the relay coil is de-energized. Figure 5 illustrates the different relay symbols used for timed contacts.

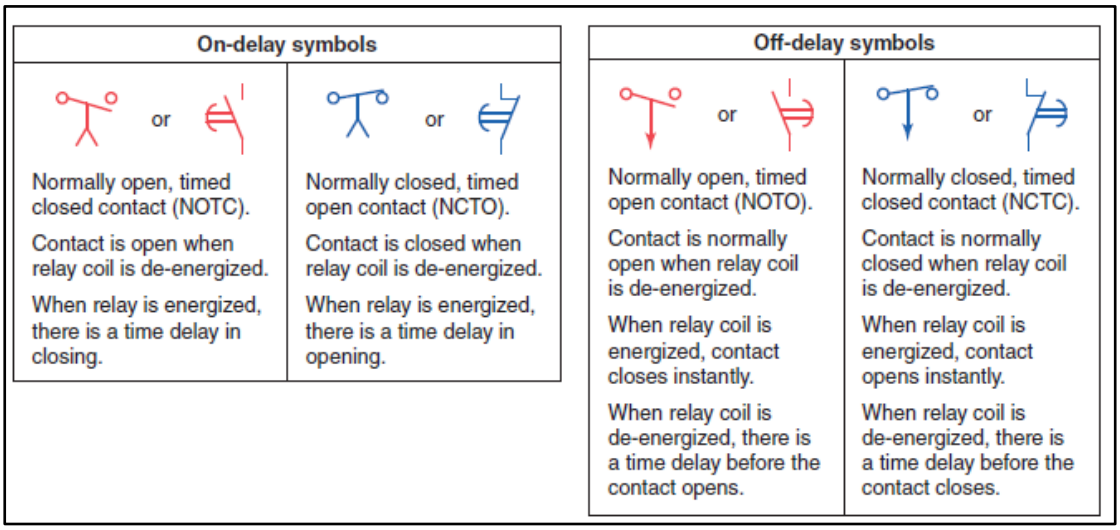


Figure 5: Timed contact symbols.

The on-delay timer is sometimes referred to as DOE, which stands for delay on energize. The time delay of the contacts begins once the timer is switched on; hence the term on-delay timing. Figure 6 shows an on-delay timer circuit that uses a normally open, timed closed (NOTC) contact.

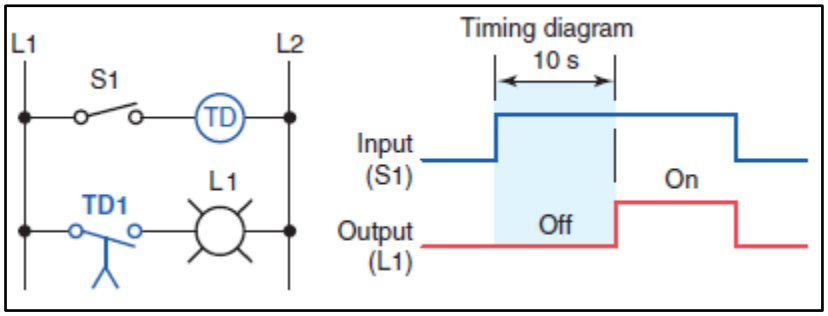


Figure 6: On-delay timer circuit that uses a normally open, timed closed (NOTC) contact.

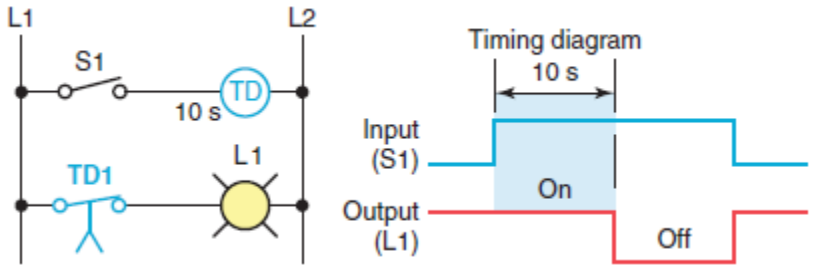


Figure 7: On-delay timer circuit that uses a normally closed, timed open (NCTO) contact.

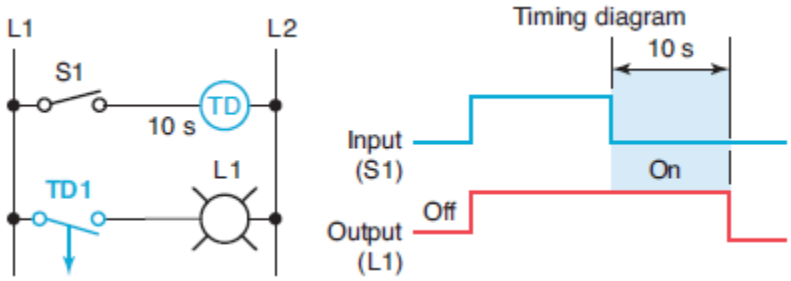


Figure 8: Off-delay timer circuit that uses a normally open, timed open (NOTO) contact.

2.1 On-Delay Timer Instruction

Allen-Bradley SLC 500 timer file is file 4. Each timer is composed of three 16-bit words, collectively called a timer element as shown in figure(9).

There can be up to 256 timer elements.

Addresses for timer file 4, timer

Element number 2 (T4:2),are listed below.

T4 5 timer file 4: 25 timer element number 2 (0–255timer elements per file).

T4:2/DN is the address for the done bit of the timer.

T4:2/TT is the address for the timer-timing bit of the timer.

T4:2/EN is the address for the enable bit of the timer.

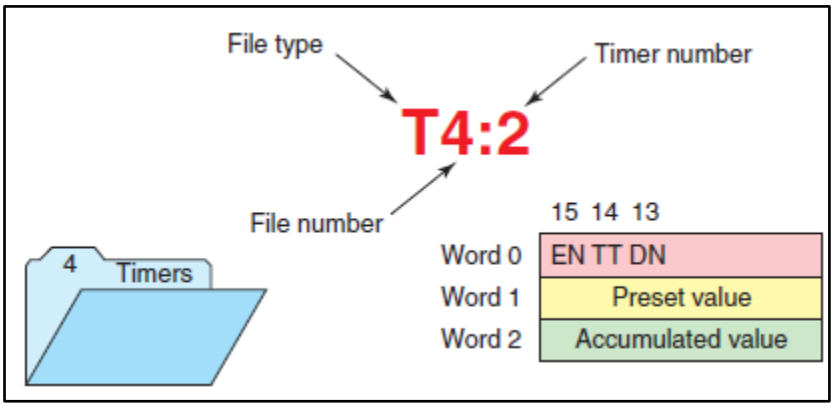


Figure (9): shows the timer elements.

For ON-Delay timer (TON) this group of instructions must be entered:

1. Timer number: for example T4:0 represent timer file 4, timer 0 in the file.

2. Time base always given in second like (1.0s,0.1s,0.01 s) .

3. Preset value can give to any value from (0 to 32767).

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

Figure (10) shows an example of the on-delay timer instruction used as part of the Allen-Bradley PLC-5 and SLC 500 controller instruction sets

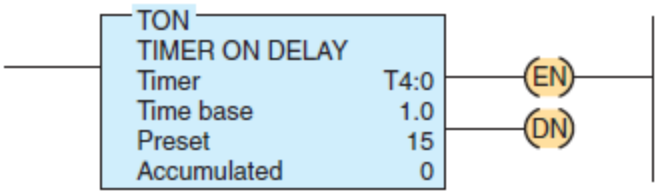


Figure (10): On-delay timer instruction.

The on-delay timer (TON) is the most commonly used timer. Figure (11) shows a PLC program that uses an on delay timer. The operation of the program can be summarized as follows:

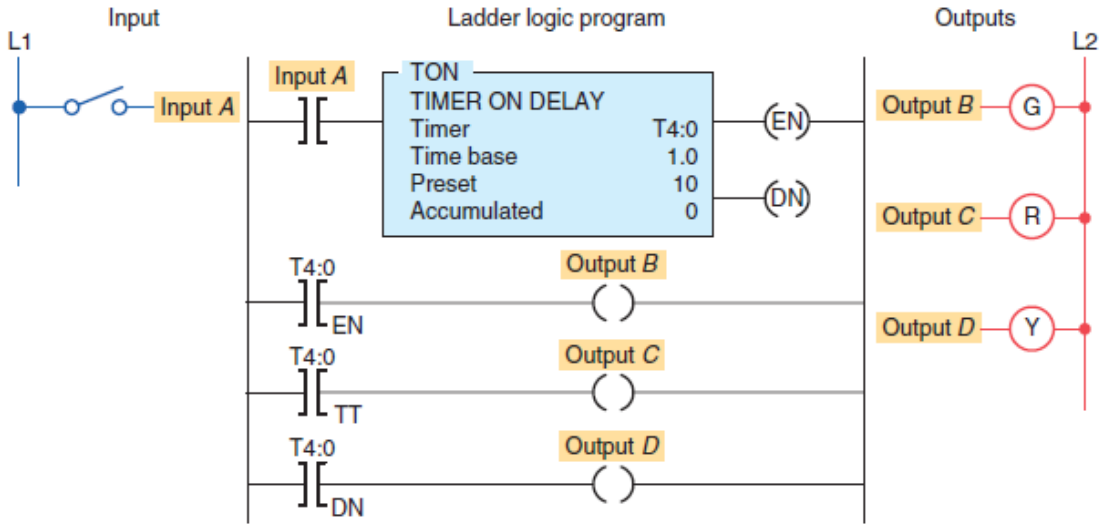


Figure (11): shows the PLC program using an ON delay timer.

• The timer is activated by input switch A.

• The preset time for this timer is 10 s, at which time output D will be energized.

• When input switch is A is closed, the timer becomes true and the timer begins counting and counts until the accumulated time equals the preset value; the output D is then energized.

• If the switch is opened before the timer is timed out, the accumulated time is automatically reset to 0.

2.2 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.Figure 12 illustrates the programming of an off-delay timer that uses the SLC 500 TOF timer instruction. If logic continuity is lost, the timer begins counting time-based intervals until the accumulated time equals the programmed preset value.

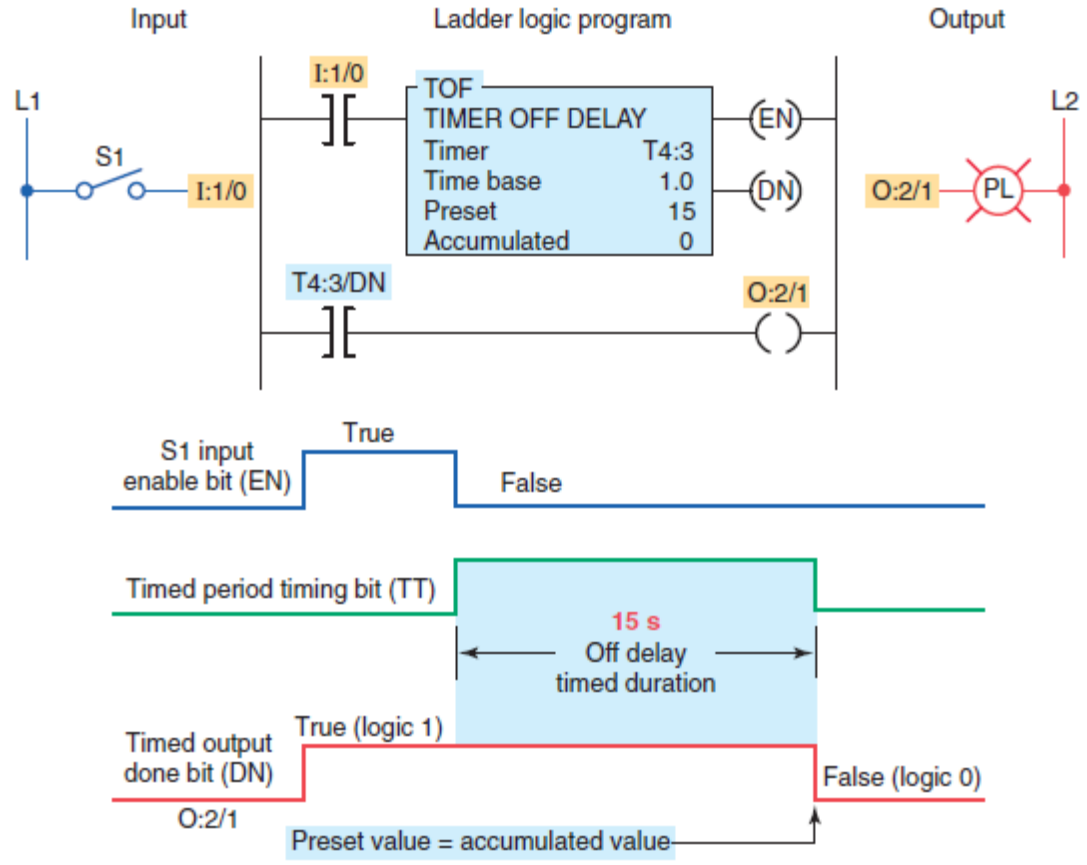


Figure (12): Off-delay programmed timer.

3. Programming counters

Programmed counters can serve the same function as mechanical counters. Figure 13 shows the construction of a simple mechanical counter. Every time the actuating lever is moved over, the counter adds one number Electronic counter, can count up, count down, or be combined to count up and down. In PLC OneCommon counter application is keeping track of the number of items moving past a given point.

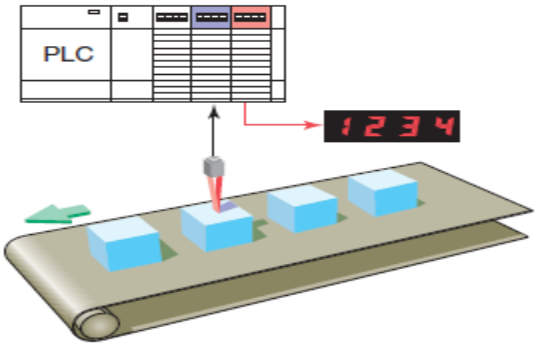


Figure (13): Counter application.

The two methods used to represent a counter within a PLC's ladder logic program are the coil format and the block format. Figure 14 shows a typical coil-formatted up-counter instruction. The up-counter increments its accumulated value by 1 each time the counter rung makes a false-to-true transition. When the accumulated count equals the preset count the counter output is energized or set to 1. Shown as part of the instruction are the:

Counter type

Counter address

Counter preset value

Accumulated count

Figure 15 shows a coil-formatted counter instruction with a separate instruction for resetting the counter.

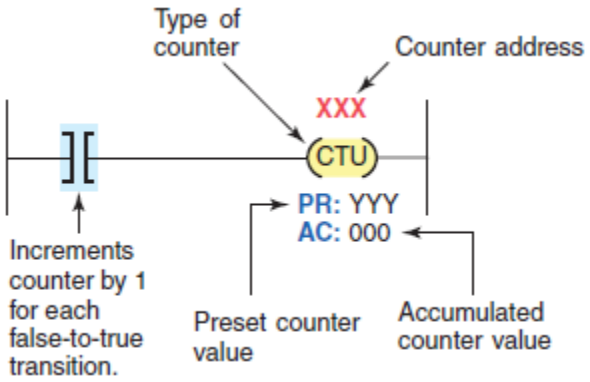


Figure 14 Coil-formatted up-counter instruction.

Figure 15 shows a coil-formatted counter instruction with a separate instruction for resetting the counter. When programmed, the counter reset coil (CTR) is given the same reference address as the counter (CTU) that it is to reset. In this Example the reset instruction is activated whenever the CTR rung Condition is true.

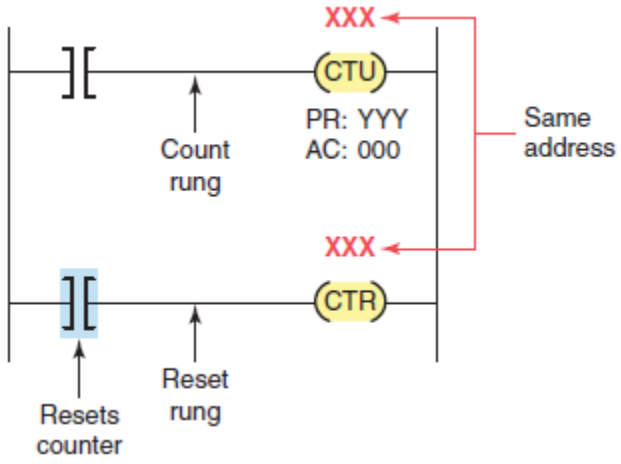


Figure 15 Coil-formatted counters and reset instructions.

Figure 16: shows a block-formatted counter. The instruction block indicates the type of counter (up or down), along with the counter's preset value and accumulated or current value. The counter has two input conditions associated with it, namely, the count and reset. All PLC countersoperate, or count, on the leading edge.

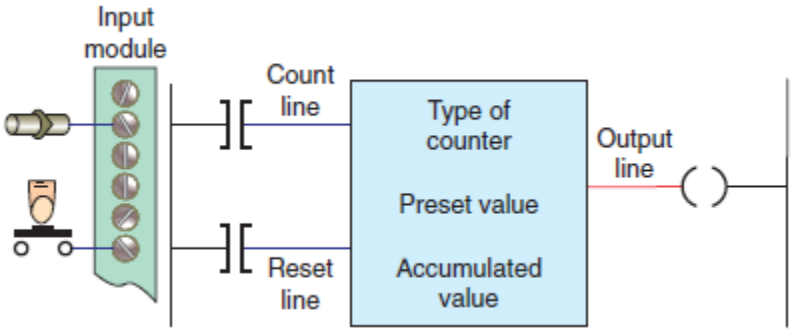
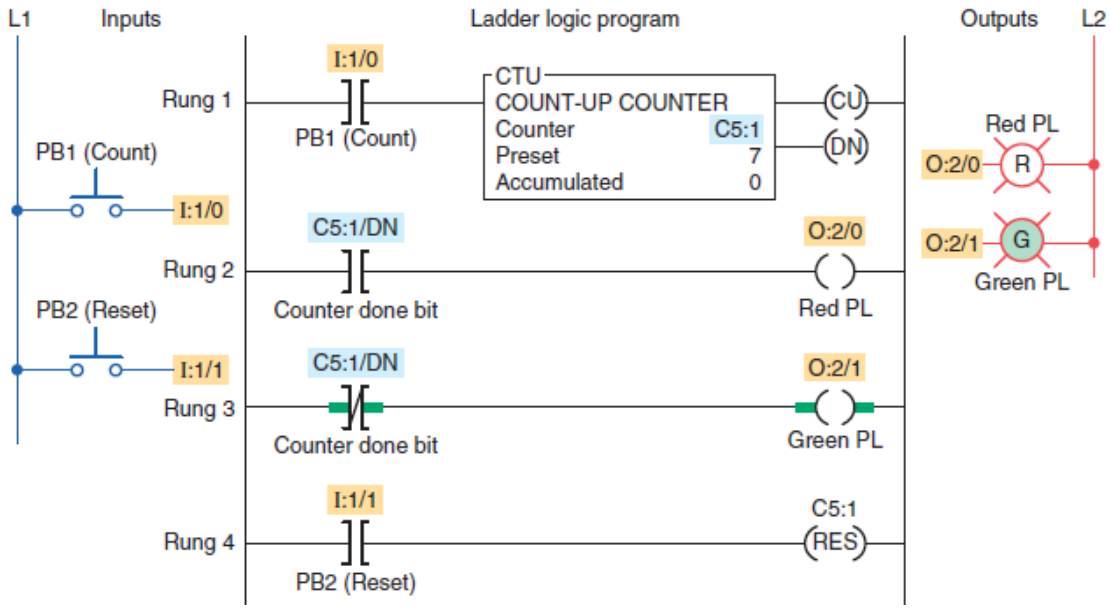


Figure 16: Block-formatted counter instruction.

8.1 Up-Counter

The up-counter is an output instruction whose function is to increment its accumulated value on false-to-true transitions of its instruction. It thus can be used to count false to true transitions of an input instruction and then trigger an event after a required number of counts or transitions. The up-counter output instruction will increment by 1 each time the counted event occurs. Figure 17 shows the program and timing diagram for an SLC 500 Count-Up Counter.



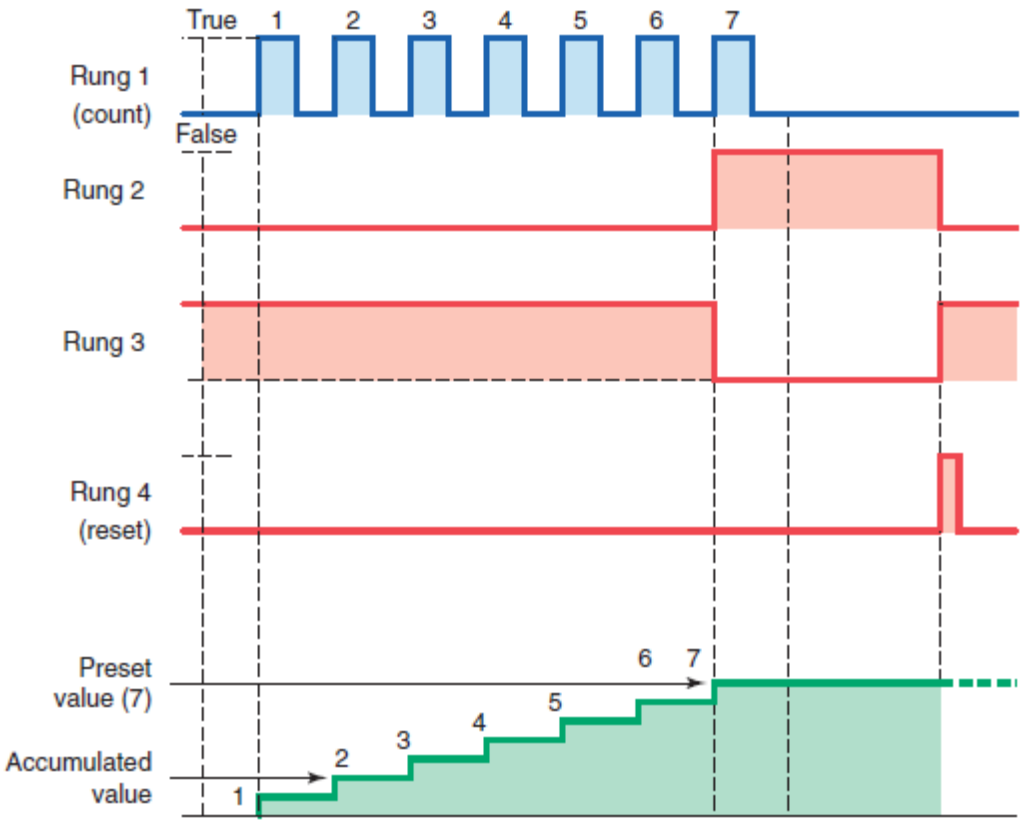


Figure 17: Simple up-counter program. (a) Program. (b) Timing diagram.

Figure 18 shows a PLC counter program used to stop a motor from running after 10 operations.

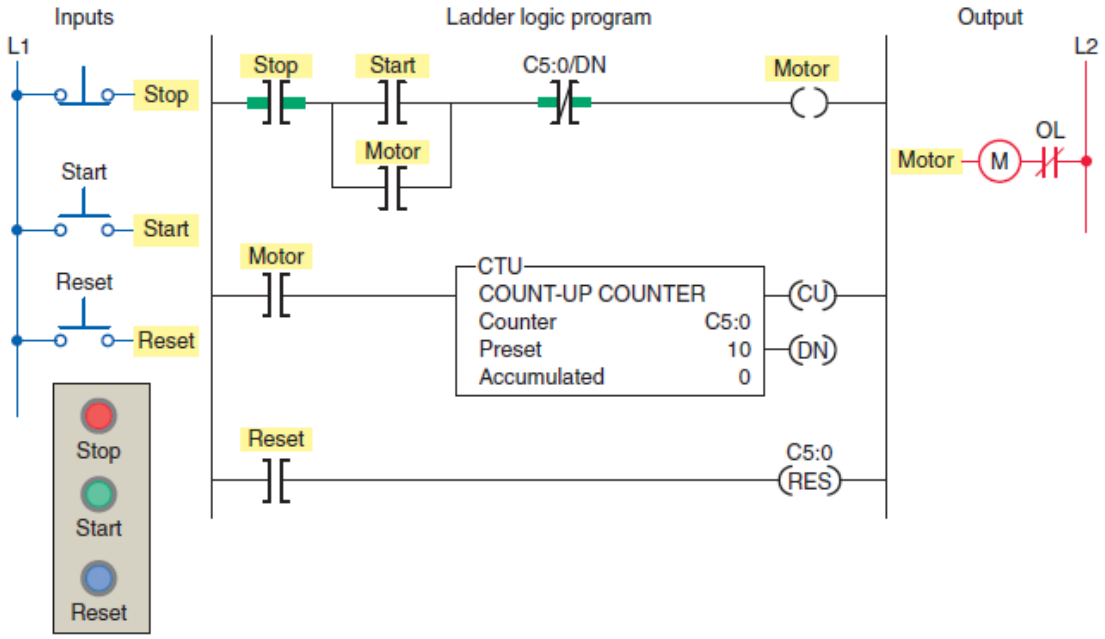


Figure 18: PLC counter program used to stop a motor from running after 10 operations.