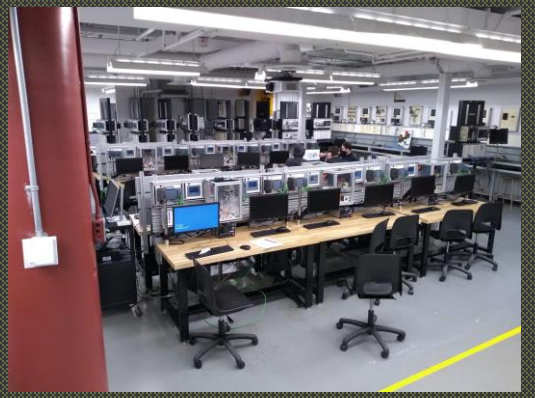


PROGRAMMABLE LOGIC CONTROLLERS
MENG 3500

HUMBER

TIMERS

PLC timers are used to delay actions or to keep an output on/off for a specified time.

Timers are used to:

- Turn outputs ON and OFF after a time delay
- Turn outputs ON or OFF for a set amount of time
- Keep track of the time an output is ON or OFF

Programming of timers is very convenient

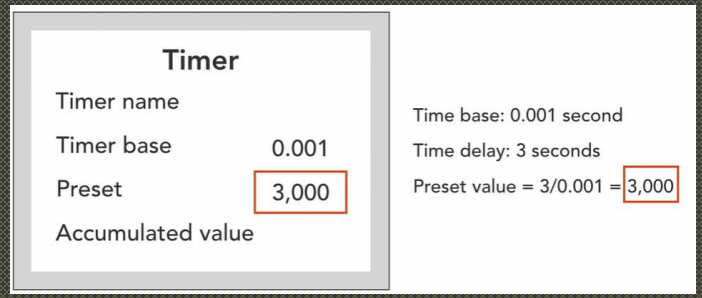
- The preset value of the timer can be easily changed
- The number of timers in the program depends on the needs of the application

There are three different PLC timer types (Rockwell standard):

- The *ON-delay timer (TON)*
- *OFF-delay timer (TOF)*
- *Retentive timer on (RTO).*

TIMERS

Timer parameters and status bits include:

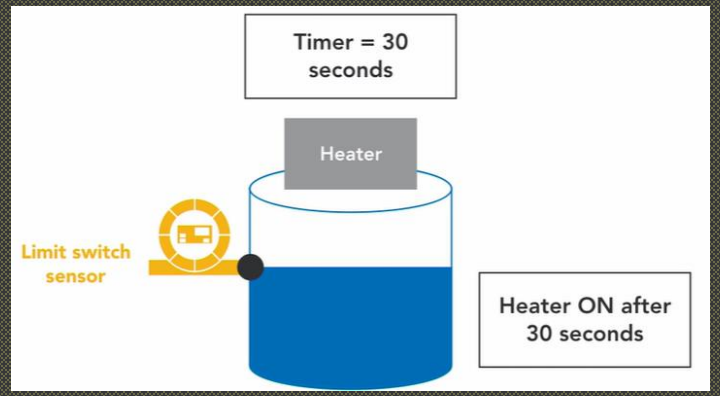


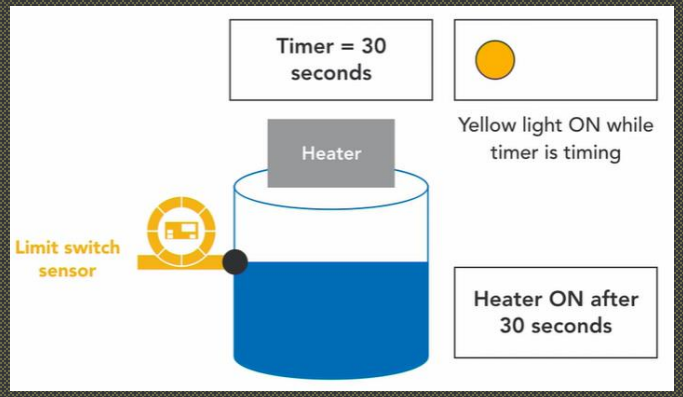
- **Tag Name** - User-friendly tag name for the timer
- **Preset (PRE)** - It is the length of time for which the timer is to run. The timer base specifies at what rate the timer will increment. It specifies the value (in milliseconds) which the timer must reach the desired time delay. The preset value is stored as a binary number (DINT). The time base in RSLogix 5000 is always 1 msec.
- **Accumulator (ACC)** - The accumulator value is the number of milliseconds the instruction has accumulated since being enabled. The accumulator value stops changing when ACC value = PRE value
- **Enable Bit (EN)** - The enable bit indicates the TON instruction is enabled. The EN bit is true when the rung input logic is true, and false when the rung input logic is false
- **Timer Timing Bit (TT)** - The timing bit indicates that a timing operation is in process. The TT bit is true only when the accumulator is incrementing. TT remains true until the accumulator reaches the preset value
- **Done Bit (DN)** - The done bit indicates that accumulated value (ACC) is equal to the preset (PRE) value. The DN bit signals the end of the timing process by changing states from false-to-true or from true-to-false depending on the type of time contact instruction used. The DN bit is the most used timer status bit

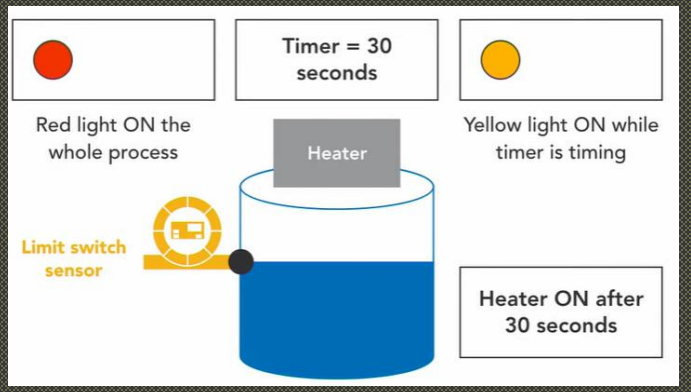
HUMBER

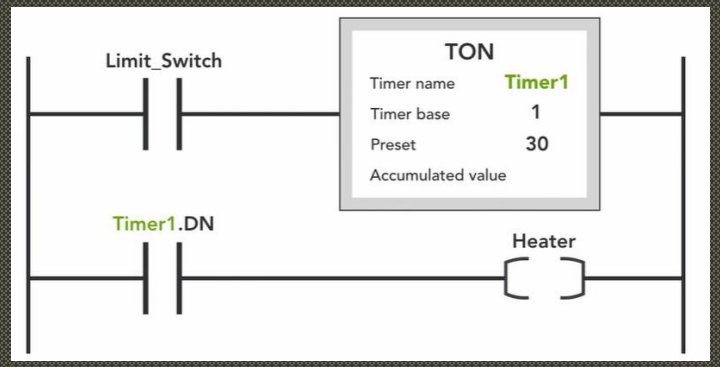
(Frank D. Petruzella Programmable Logic Controllers 4th edition)

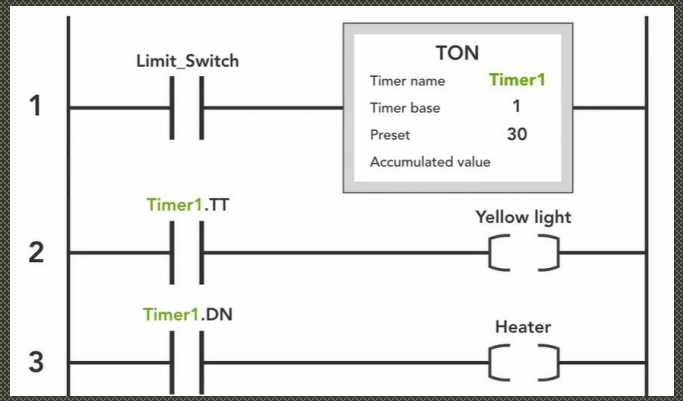
TIMERS

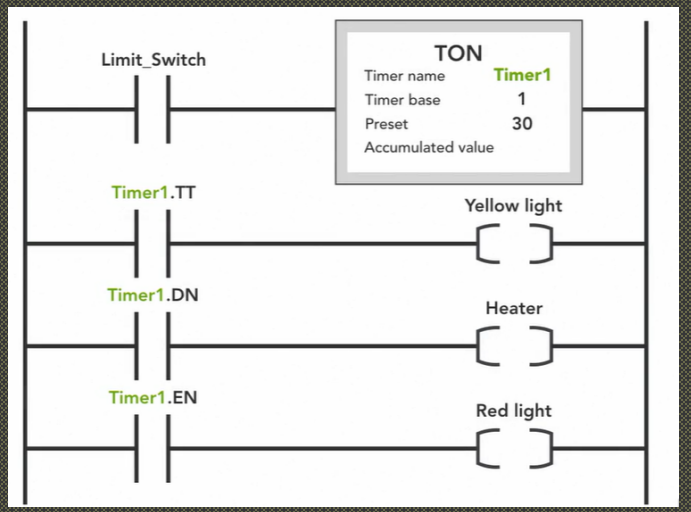












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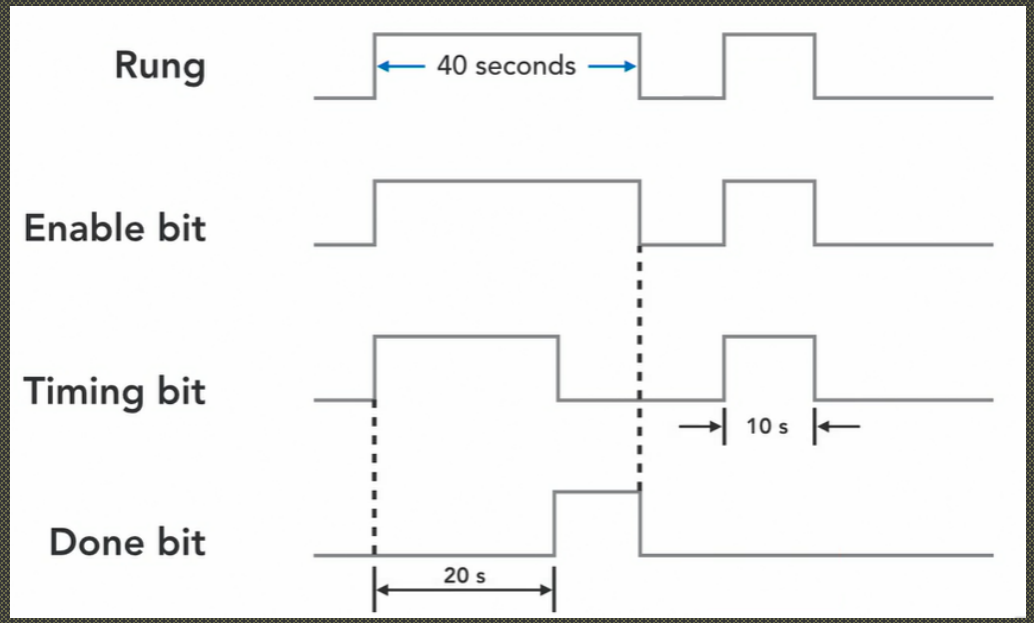
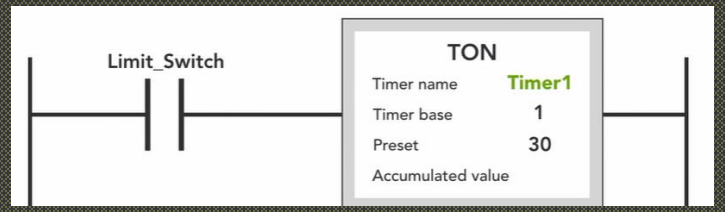
TIMER ON DELAY





Timer ON DELAY (TON)		
TON Instruction OFF	Enable Bit (EN)	0
	Timer Timing Bit (TT)	0
	Done Bit (DN)	0
	Accumulating	NO
TON Instruction ON	Enable Bit (EN)	1
	Timer Timing Bit (TT)	1
	Done Bit (DN)	0
	Accumulating	YES
Timed Out Accum = Preset	Enable Bit (EN)	1
	Timer Timing Bit (TT)	0
	Done Bit (DN)	1
	Accumulating	NO
Instruction OFF after timed out	Enable Bit (EN)	0
	Timer Timing Bit (TT)	0
	Done Bit (DN)	0
	Accumulating	Reset

What is the PRESET value of the timer?

HUMBER

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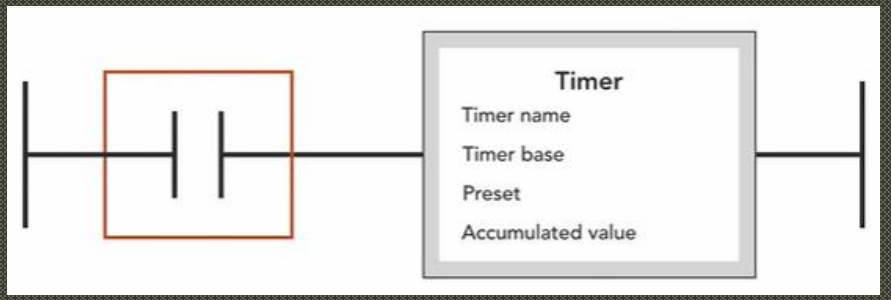
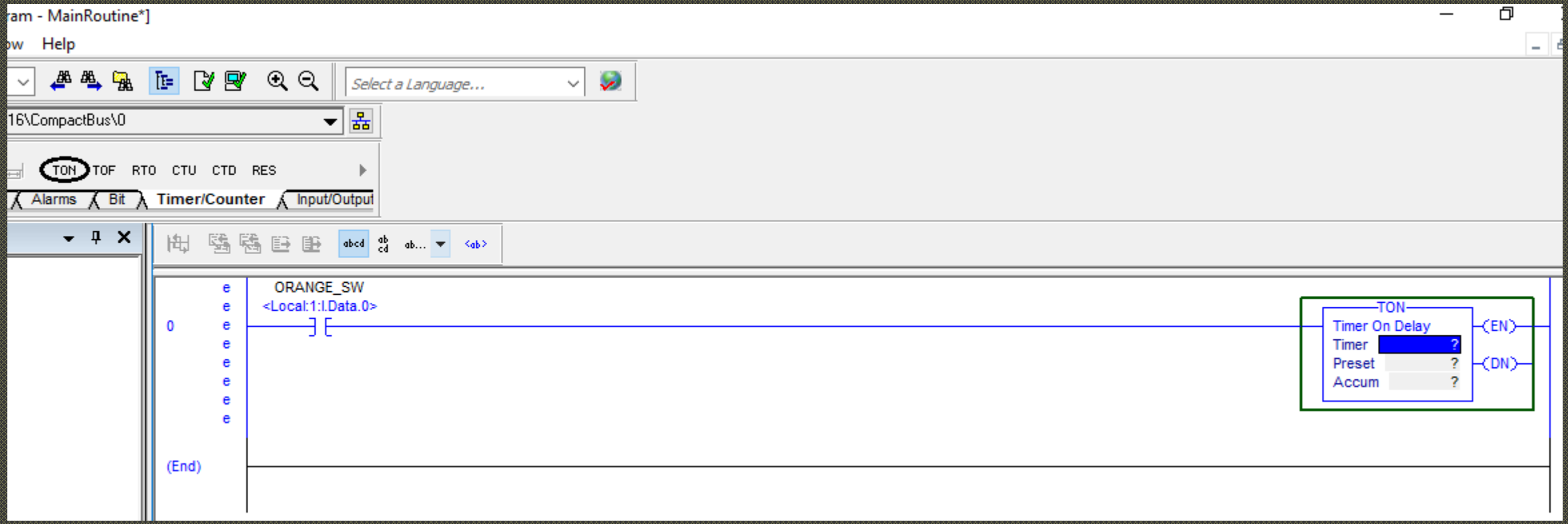
ON DELAY TIMER - TON

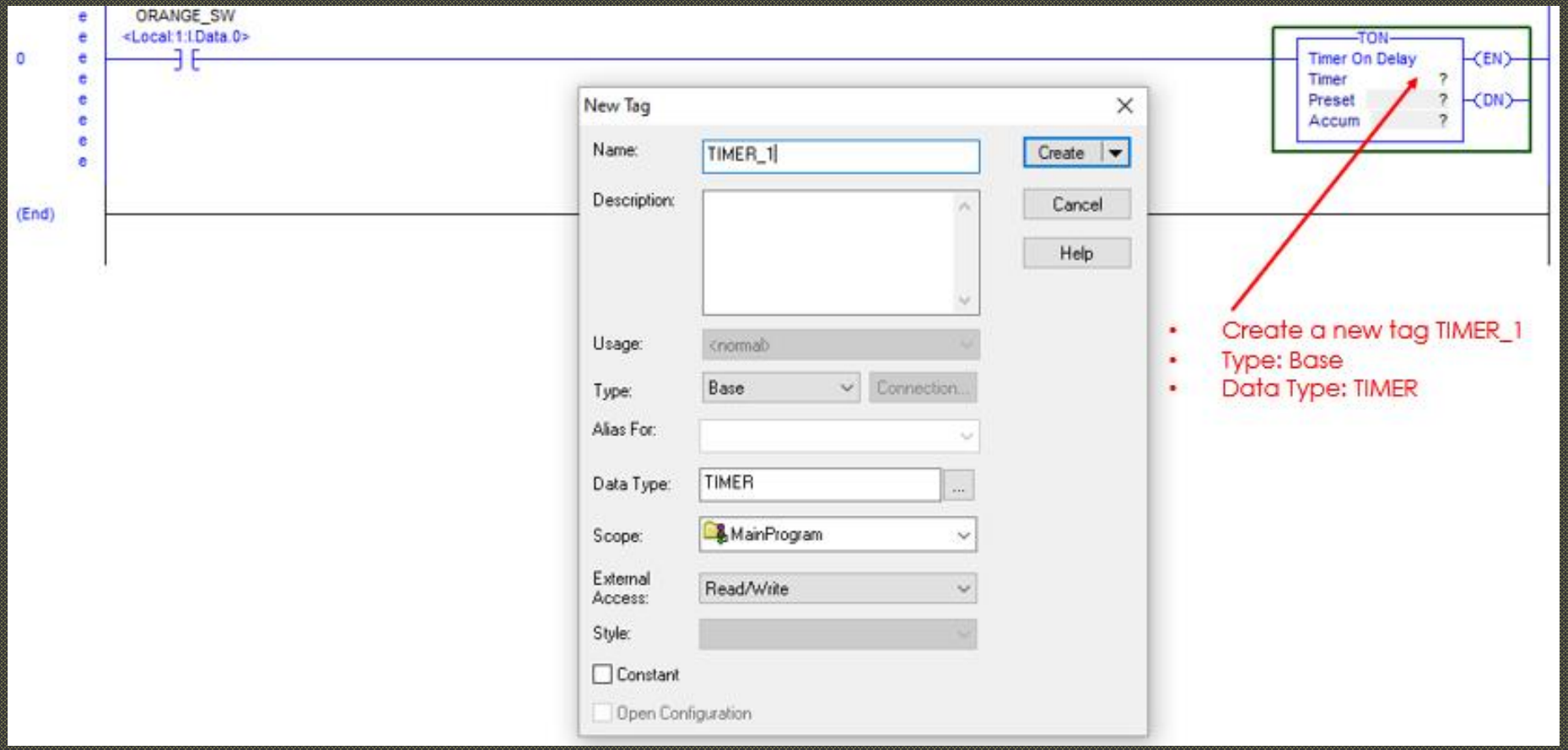


- **TON** - Counts time-based intervals when the instruction is true.
- **TON** is a non-retentive output instruction.
- **TON** is used when the application requires an action to occur at some time after the rung conditions for the timer become true.



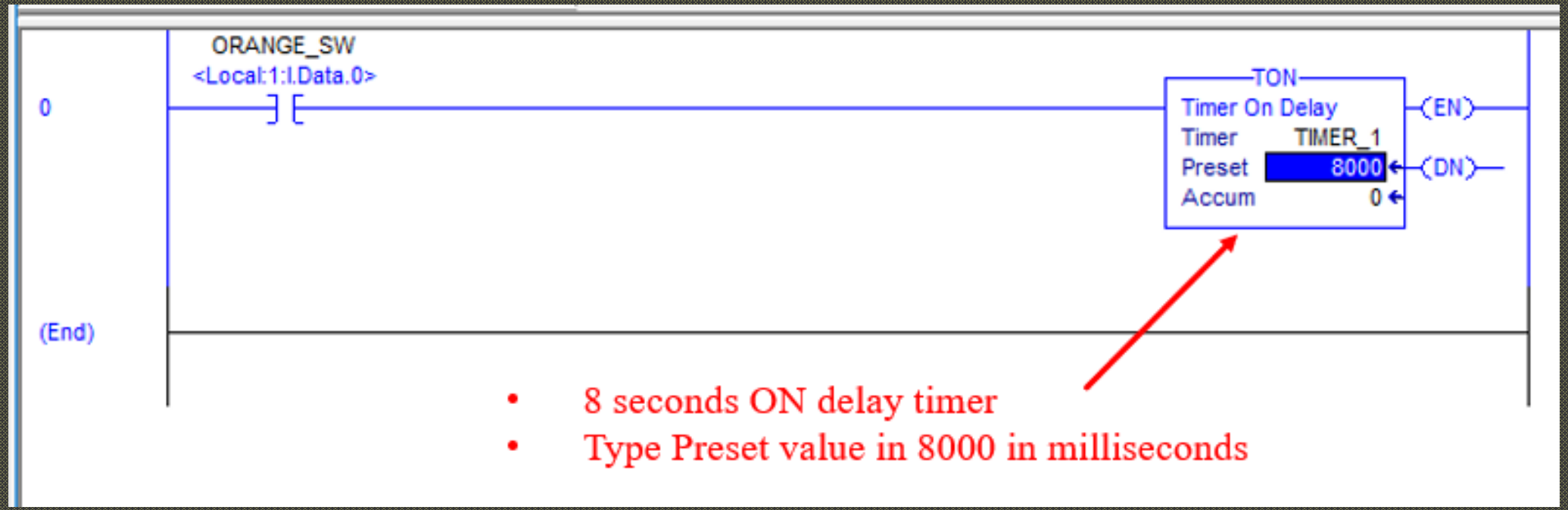
Timer starts timing when the rung condition is true. The input in the timer rung enables/disables the instruction. The timer resets when the rung goes false.

ON DELAY TIMER - TON



HUMBER

ON DELAY TIMER - TON



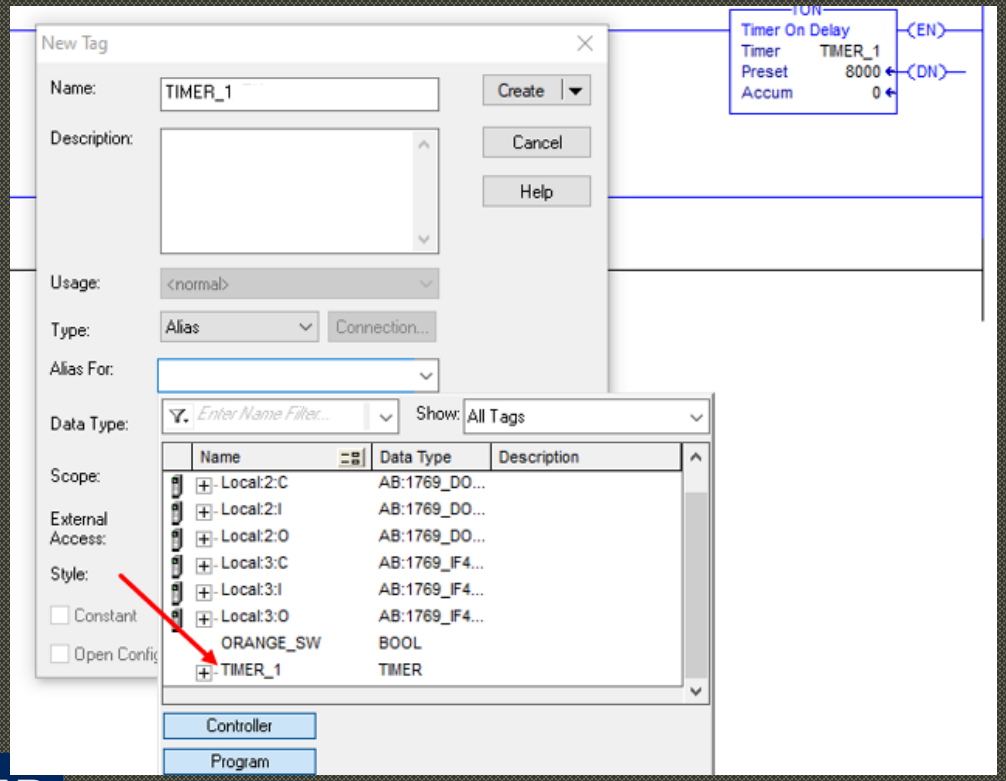
- 8 seconds ON delay timer
- Type Preset value in 8000 in milliseconds

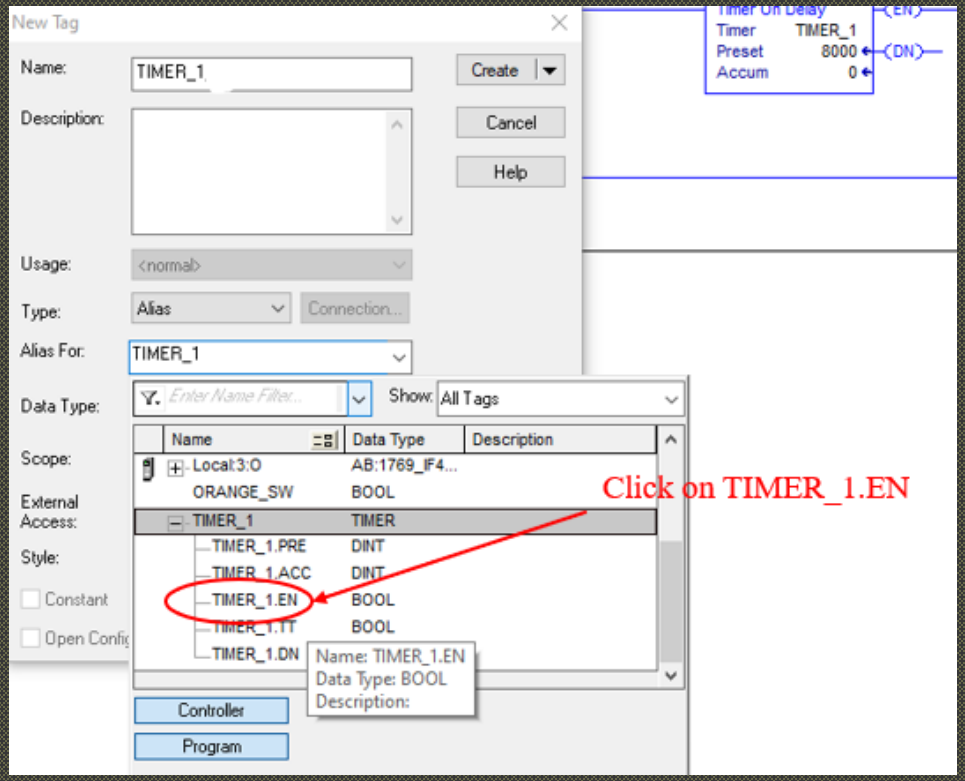
HUMBER

ON DELAY TIMER - TON

Click on the + Timer_1 and note its parameters for use in the ladder logic

- 2 Status words: TIMER_1.PRE, TIMER_1.ACC (Data type: DINT – Double Integer)
- 3 Status bits: TIMER_1.EN, TIMER_1.TT, TIMER_1.DN (Data type: BOOL - Boolean)

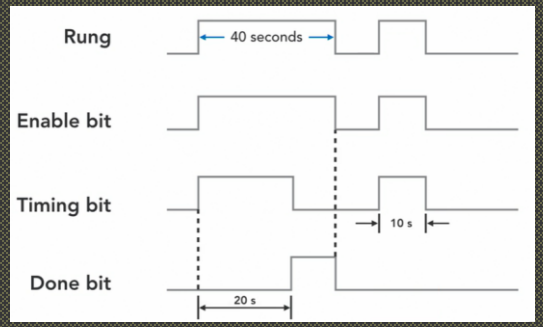


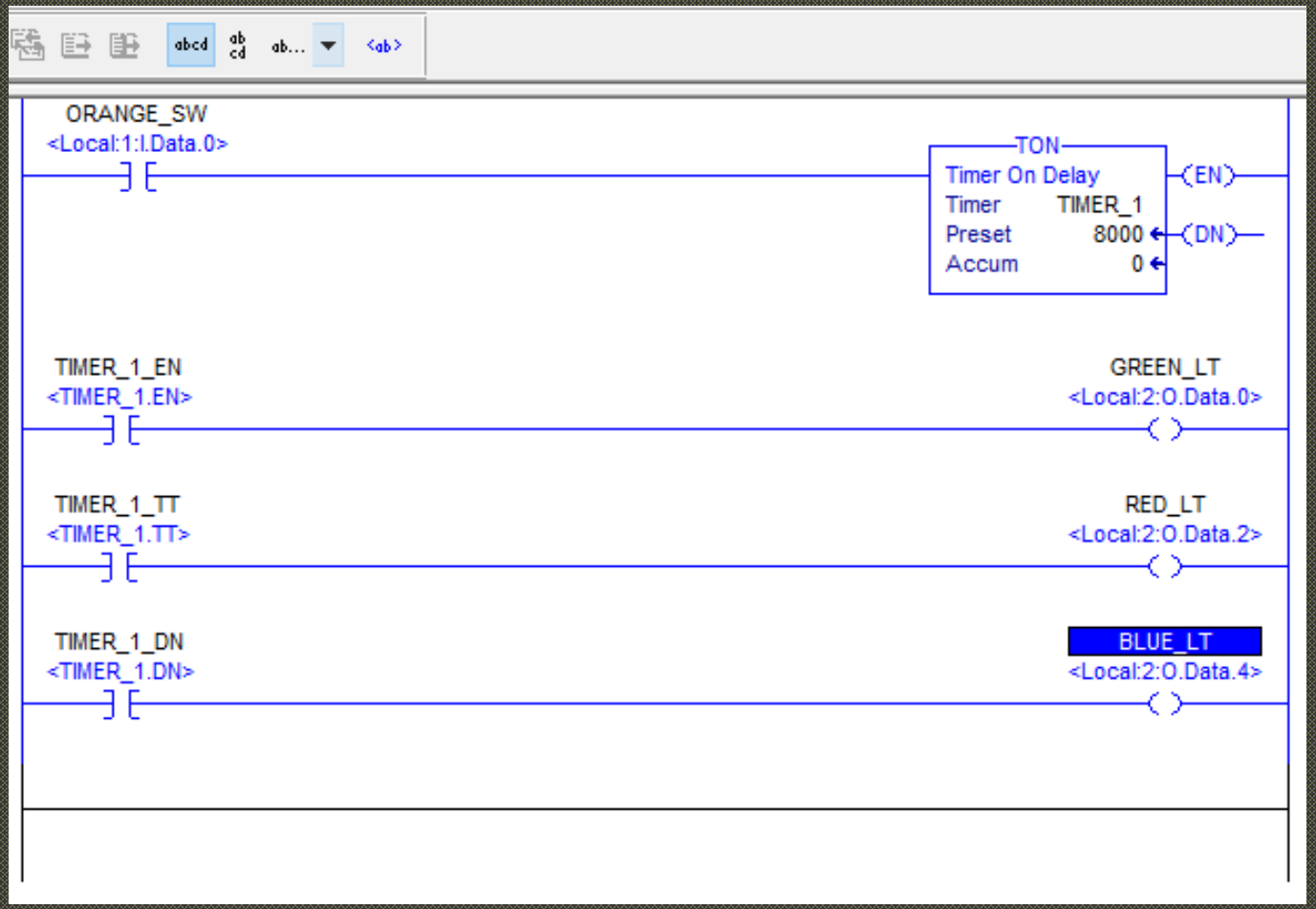


HUMBER

ON DELAY TIMER - TON

Include the next 3 rungs in the ladder logic and provide the status of the lights when the ORANGE_SW is pressed.



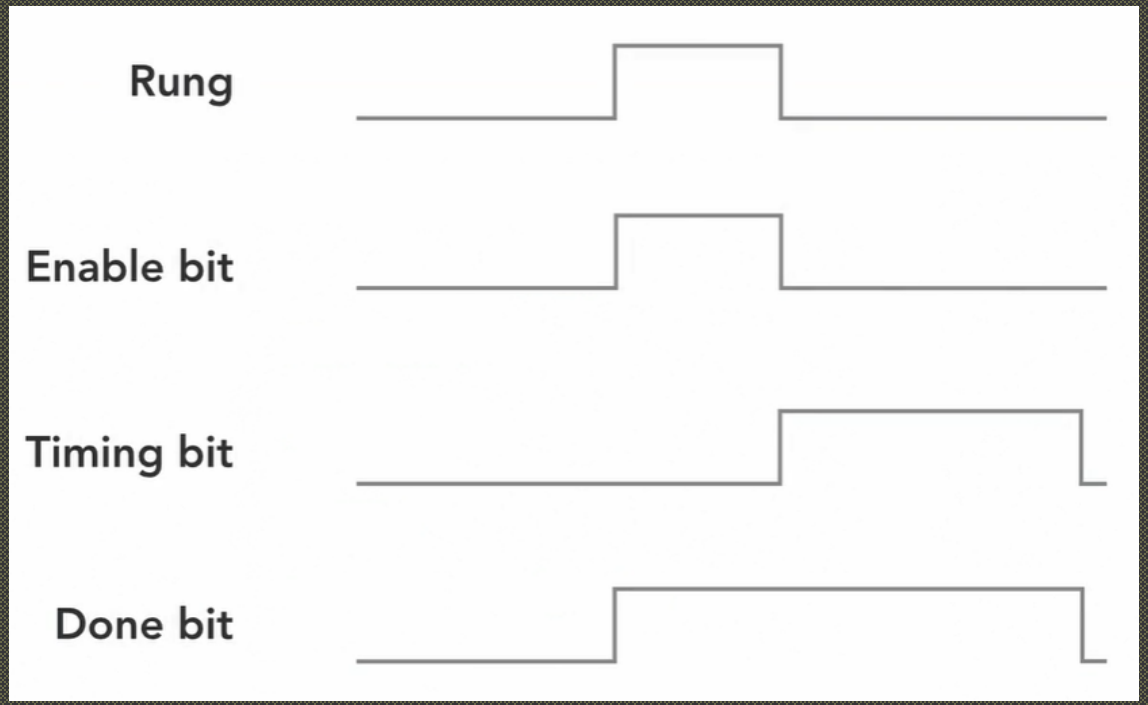


HUMBER

OFF DELAY TIMER - TOF

TOF
Timer name
Timer base
Preset
Accumulated value

The **OFF-delay timer (TOF)** operates in a fashion opposite to the TON on-delay timer.
Off Delay Timer is used when a timed delay is required to begin after the rung input goes false
An off-delay timer will turn on immediately when the rung of ladder logic is true, but it will delay before turning off after the rung goes false.



Timer OFF DELAY (TOF)		
TOF Instruction ON	Enable Bit (EN)	1
	Timer Timing Bit (TT)	0
	Done Bit (DN)	1
	Accumulating	NO
TOF Instruction OFF	Enable Bit (EN)	0
	Timer Timing Bit (TT)	1
	Done Bit (DN)	1
	Accumulating	YES
Timed Out Accum = Preset	Enable Bit (EN)	0
	Timer Timing Bit (TT)	0
	Done Bit (DN)	0
	Accumulating	NO
Instruction ON after timed out	Enable Bit (EN)	1
	Timer Timing Bit (TT)	0
	Done Bit (DN)	1
	Accumulating	Reset

HUMBER

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OFF DELAY TIMER - TOF

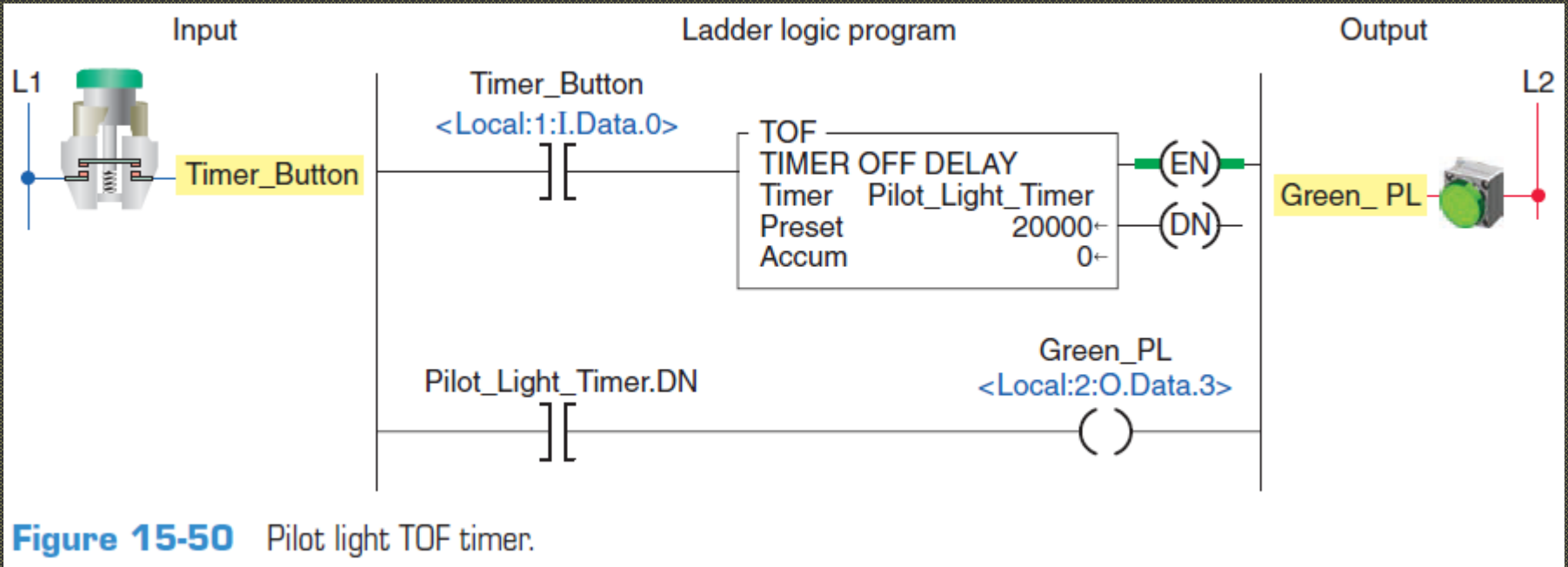
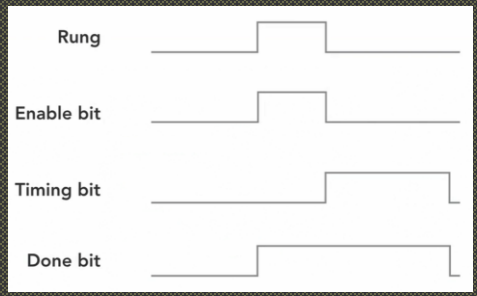


Figure 15-50 Pilot light TOF timer.



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RETENTIVE ON DELAY TIMER - RTO

A **retentive on-delay timer (RTO)** operates the same as a TON timer, except that the retentive timer retains (remembers) its ACC value even if:

- The rung goes false.
- The processor is placed in the program mode.
- The processor faults.
- Power to the processor is temporarily interrupted and the processor battery is functioning properly.
- The **RES** reset instruction must be used to reset the accumulated value of a retentive timer. The **RES** instruction must have the same tag name as the timer you want to reset.

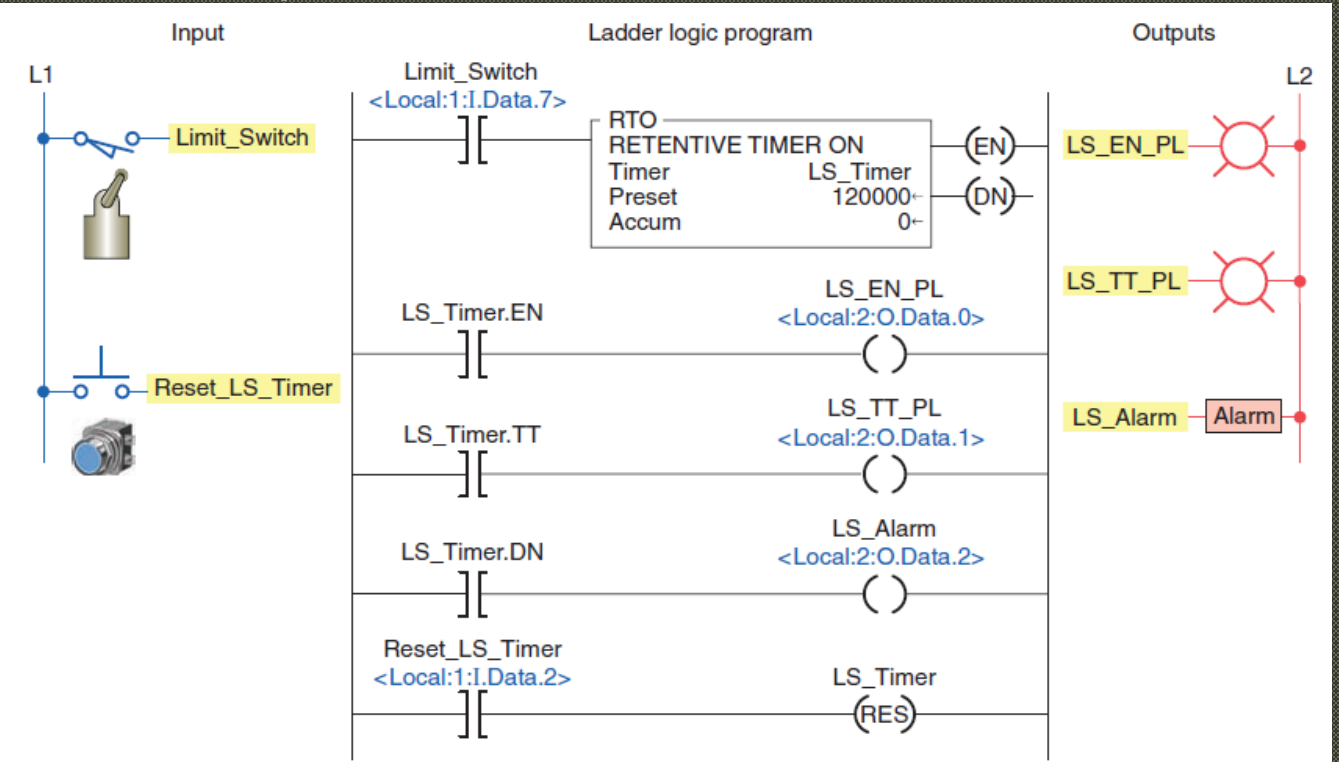

Figure 15-54 Limit switch RTO timer program.

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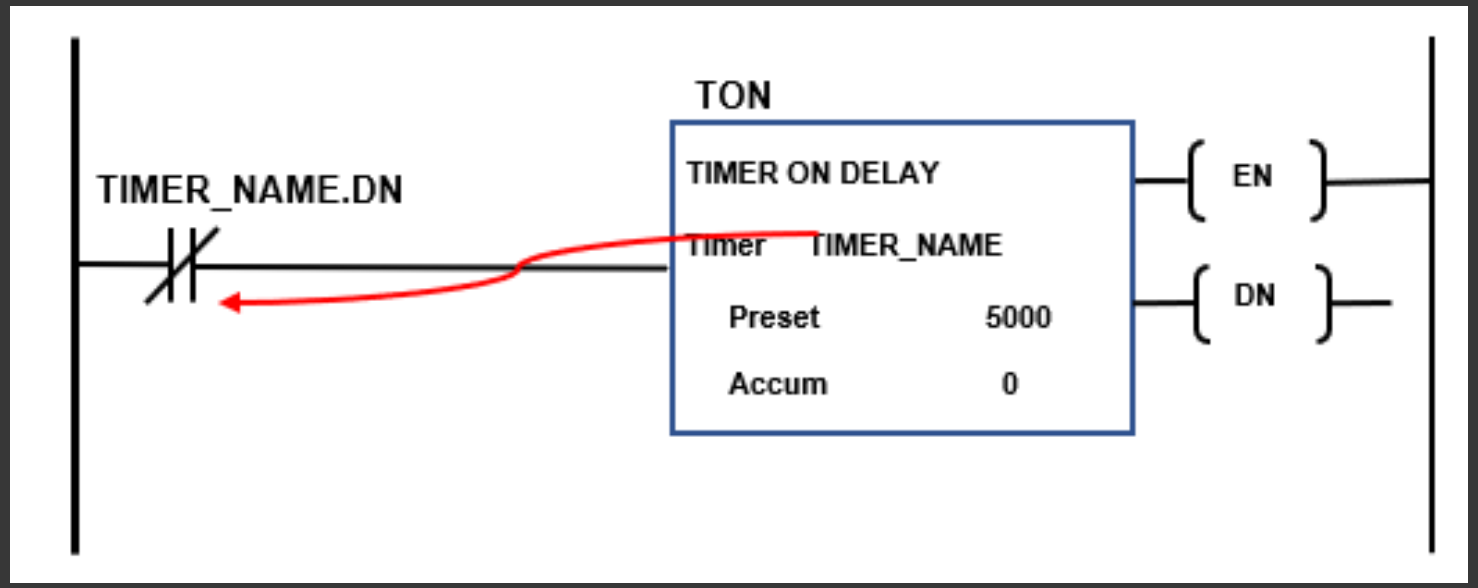
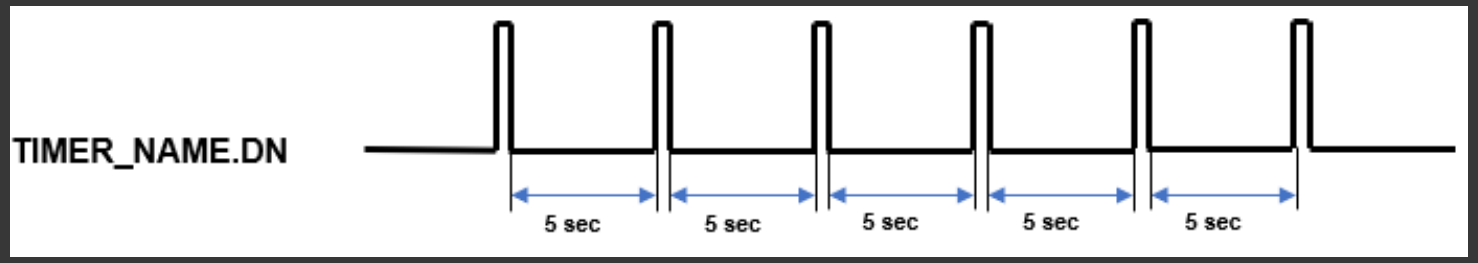
HUMBER

SCAN TIME PULSE GENERATOR (Self Resetting Timer)

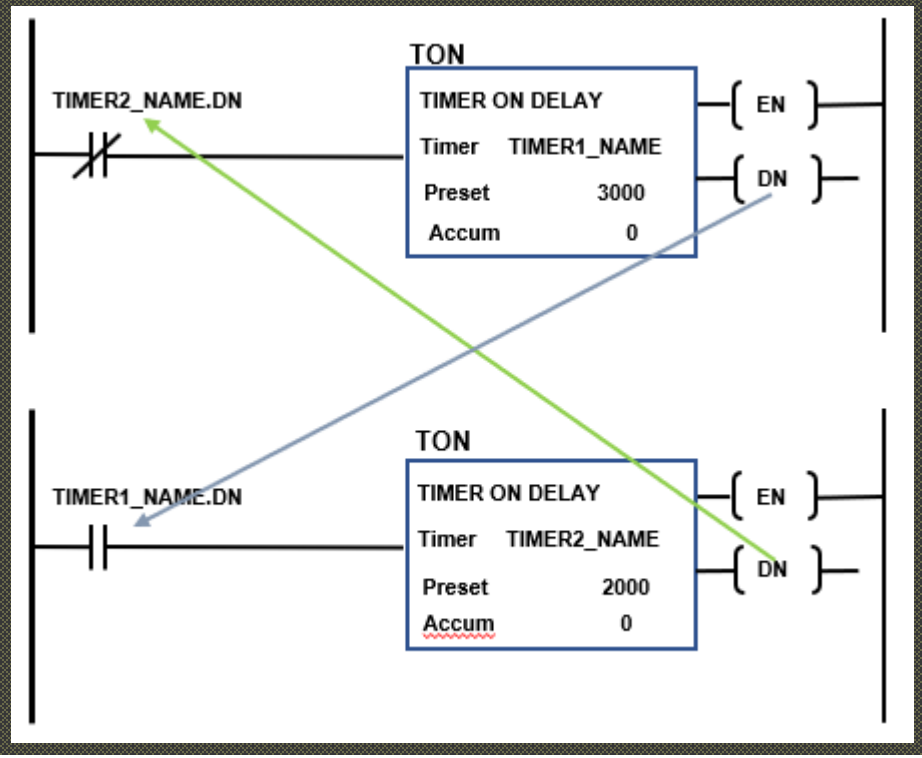
This type of generator is very useful in programs when the controlled actions happen in equal intervals of time. The DONE bit of the timer, TIMER_NAME will stay on for the duration of one scan time every 5 seconds.

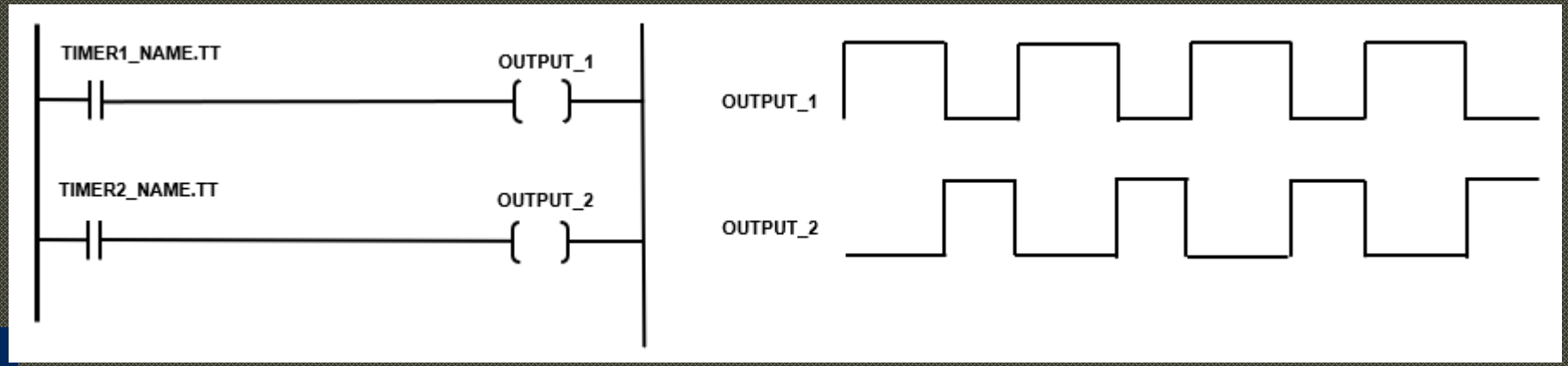




HUMBER

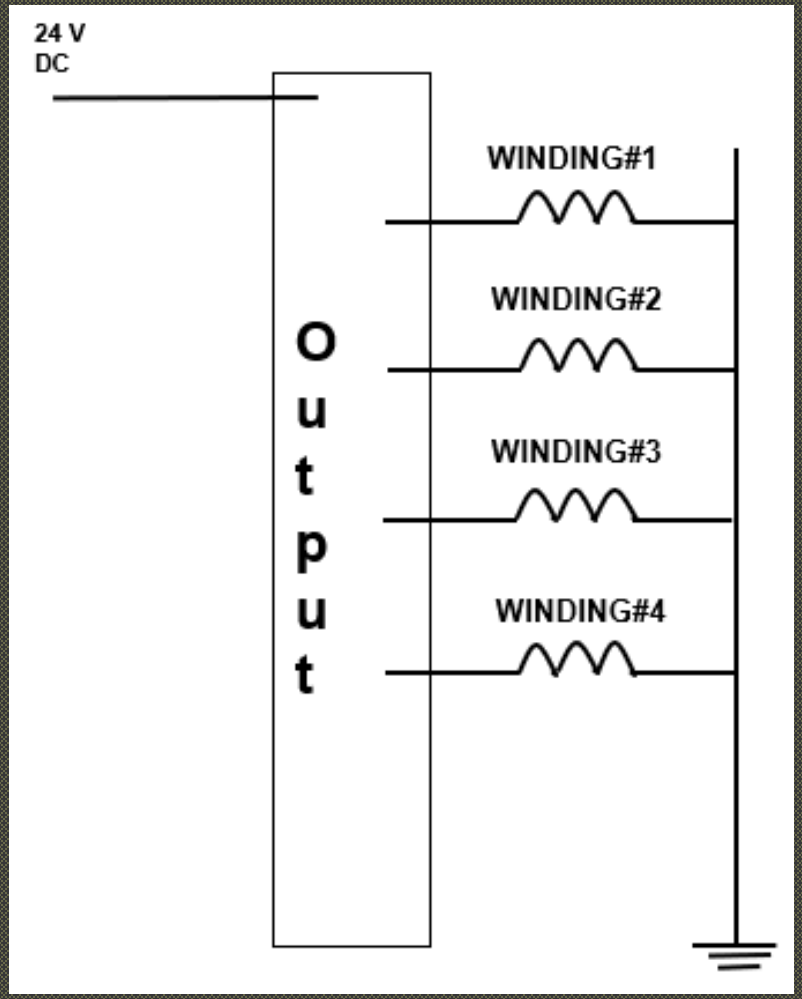
RECTANGULAR SHAPE PULSE GENERATOR





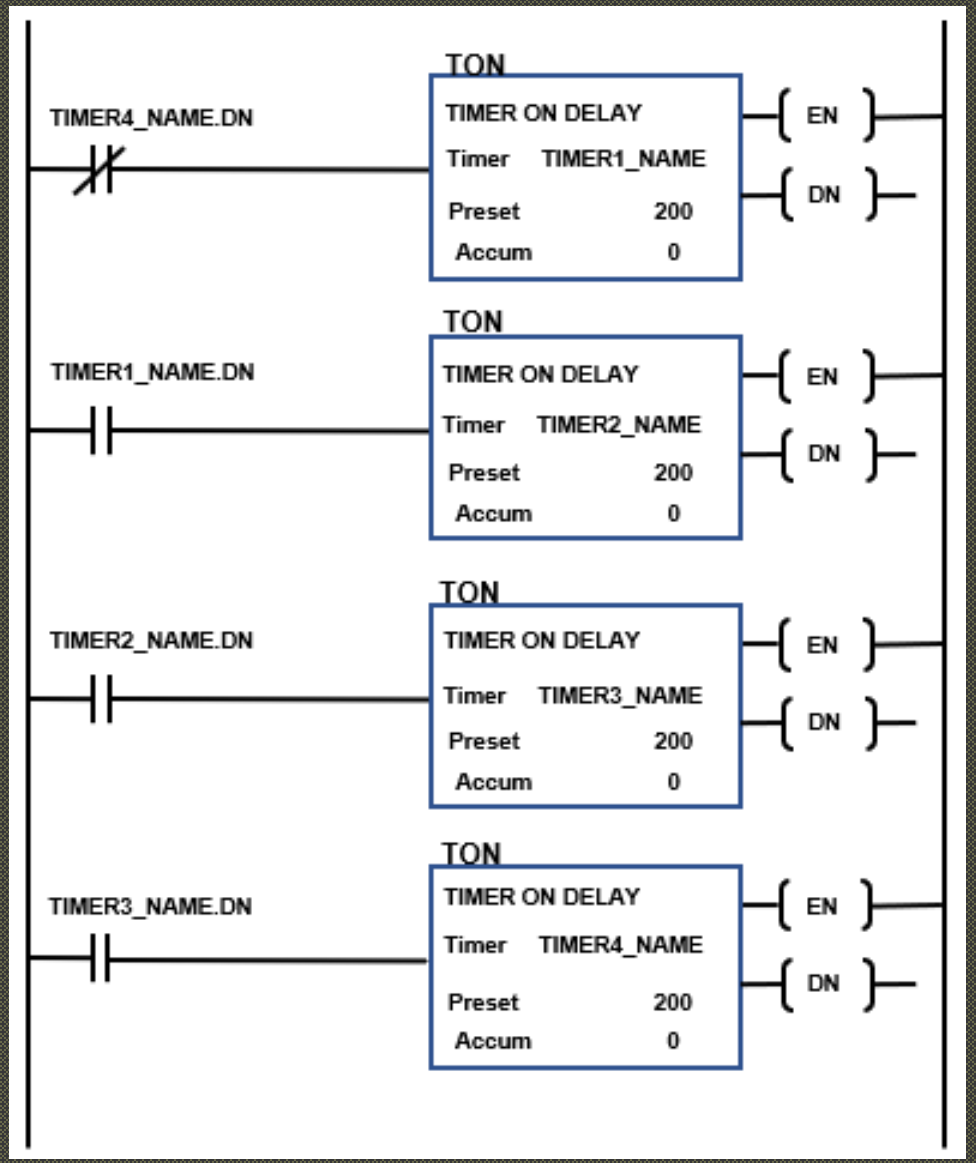
HUMBER

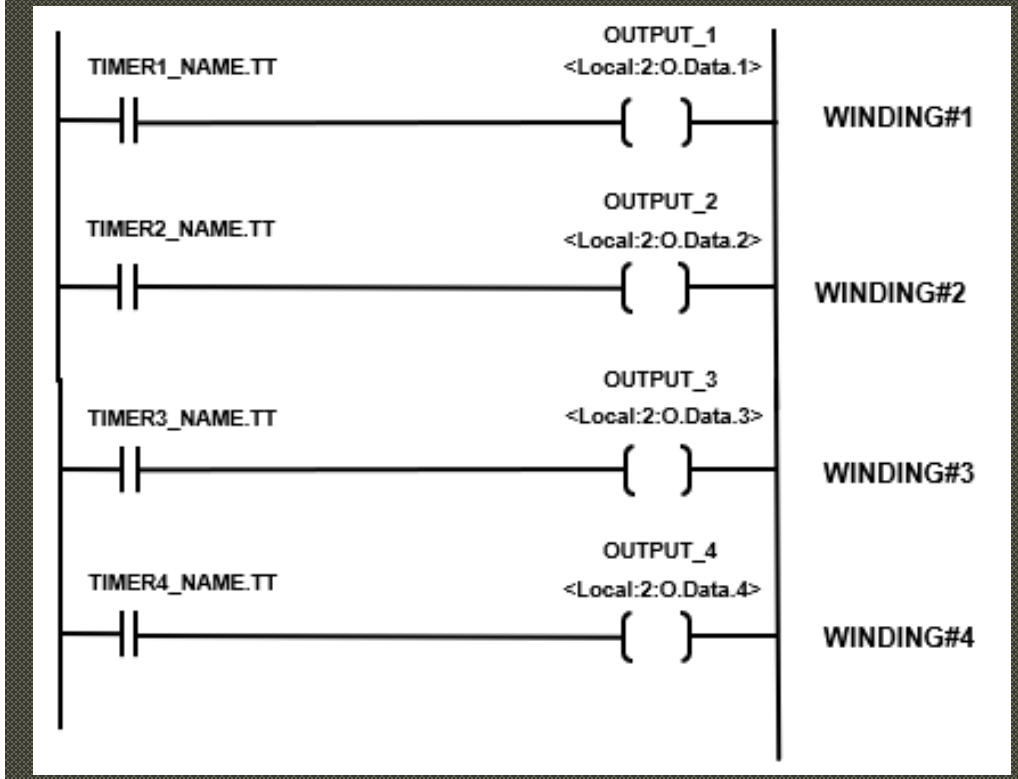
Four winding stepper motor one direction control



SEQUENCES AND CASCADES

Four winding stepper motor one direction control program



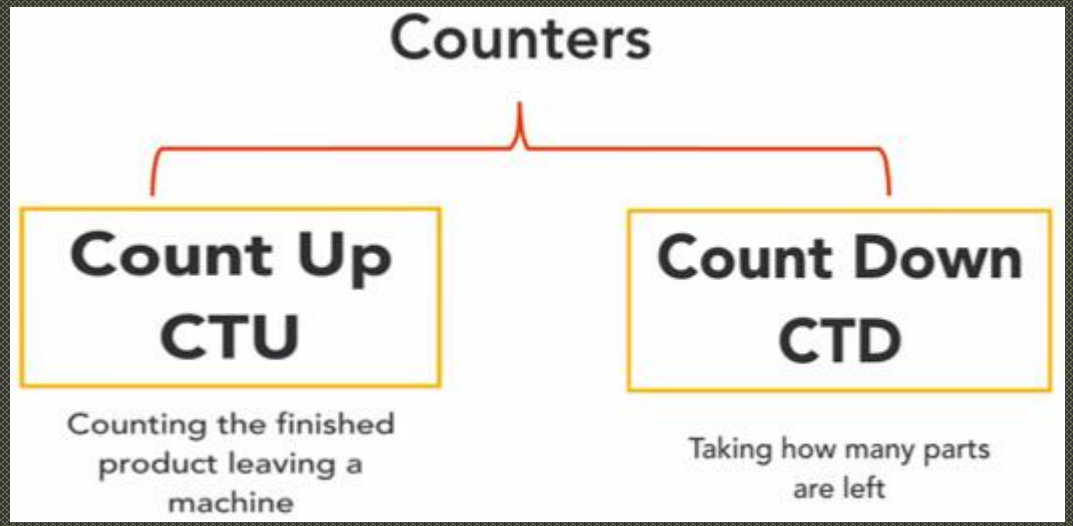


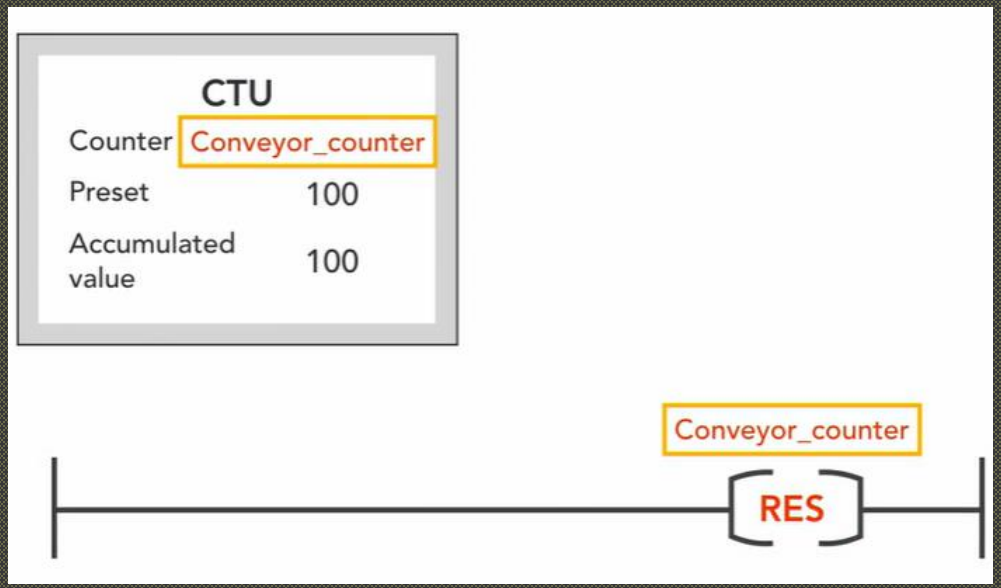
HUMBER

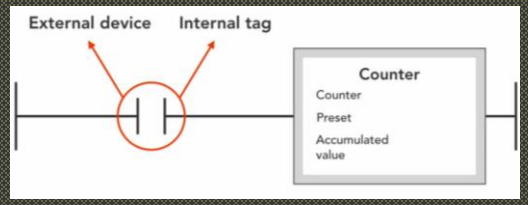
COUNTERS

PLC counters are generally triggered by a change in an input field device that causes a false-to-true transition of the counter ladder rung. It does not matter how long the rung stays true or false - it is only the transition that counts.

- There are two basic counter types: Count-up **(CTU)** and Count-down **(CTD).**
- All counters are retentive; the accumulated value of any counter is retained, even during a power failure, until reset.







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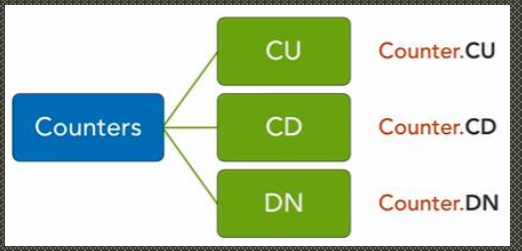
COUNTERS



Counter parameters and status bits include:t

- **Preset (PRE) Value** - Specifies the value the counter must reach before the done (DN) bit turns ON
- **Accumulated (ACC) Value** - Is the number of false-to-true transitions of the counter run. ACC is reset to zero when a reset (RES) instruction (of the same counter address) is executed
- **CU (Count-Up Enable Bit)** - The count-up enable bit indicates the **CTU** instruction is enabled
- **CD (Count-Down Enable Bit)** - The count-down enable bit indicates the CTD instruction is enabled
- **DN (Count-Up Done Bit)** - Is set ON when ACC value is equal to or greater than the PRE value. Is reset by the RES instruction
- **OV (Overflow Bit)** - The overflow bit indicates the counter exceeded the upper limit. Is set when the ACC value is greater than +2,147,483,647 and reset when the reset instruction is executed.
  Note that the accumulated value keeps incrementing even after the ACC value equals the PRE value
- **UN (Underflow Bit)** - Indicates that the counter exceeded the lower limit of - 2,147,483,648

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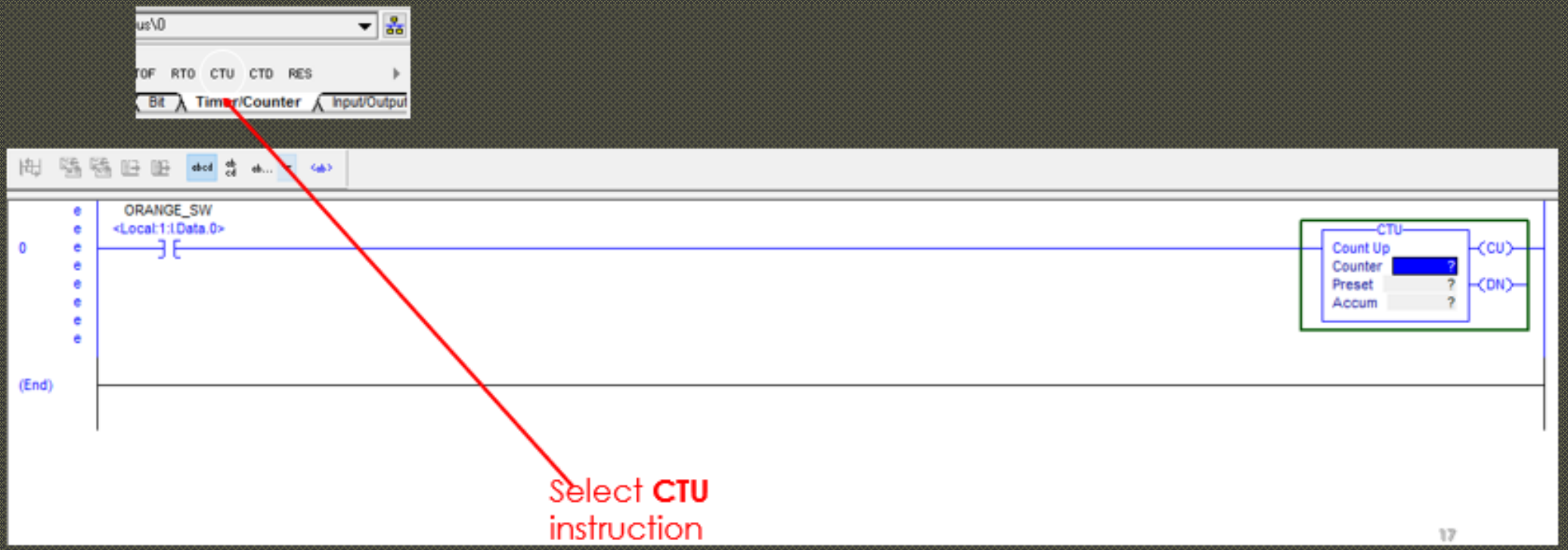
COUNT UP (CTU) and COUNT DOWN (CTD) COUNTERS

Count-Up (CTU) Counter

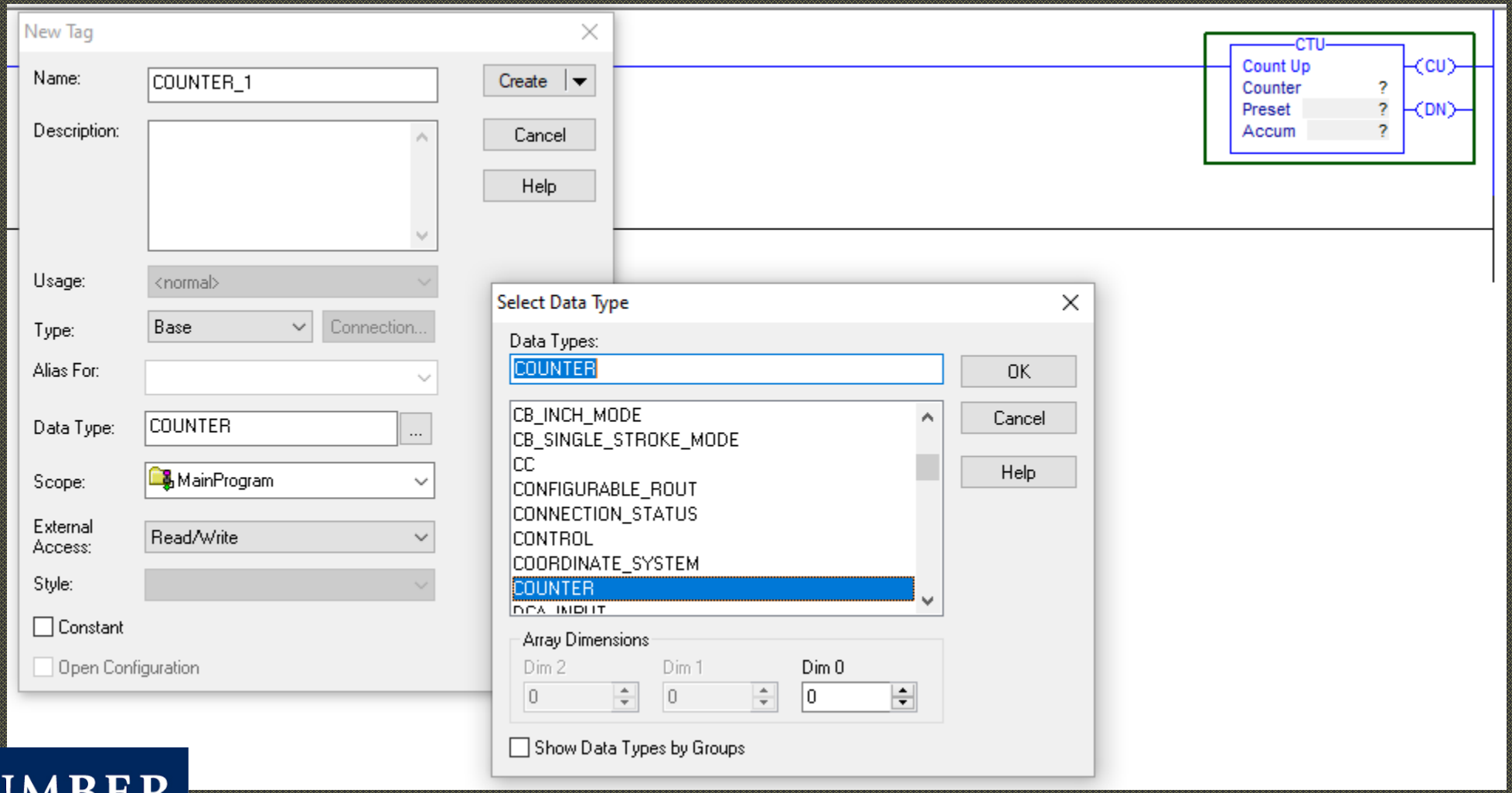
Count-up (CTU) counters will cause the accumulated count to increase by 1 every time there is a FALSE-to-TRUE transition of the ORANGE_SW.



HUMBER

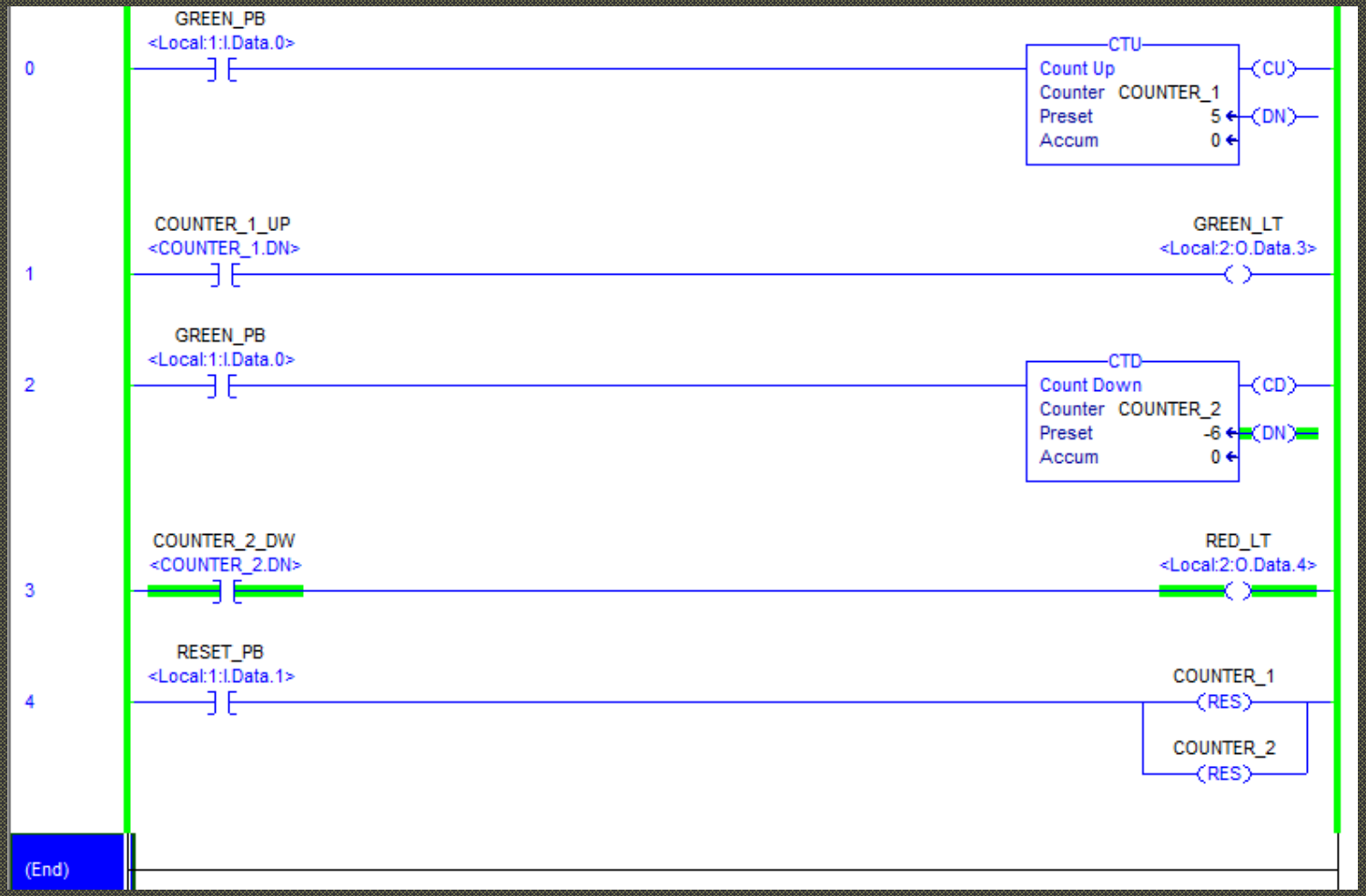
COUNT UP (CTU) and COUNT DOWN (CTD) COUNTERS

- Create a new COUNTER_1 tag
- Type Preset value: 5



COUNT UP (CTU) and COUNT DOWN (CTD) COUNTERS

CTD counters will cause the accumulated count to decrease instead of increase by one every time there is a false-to-true transition of the counter ladder rung.

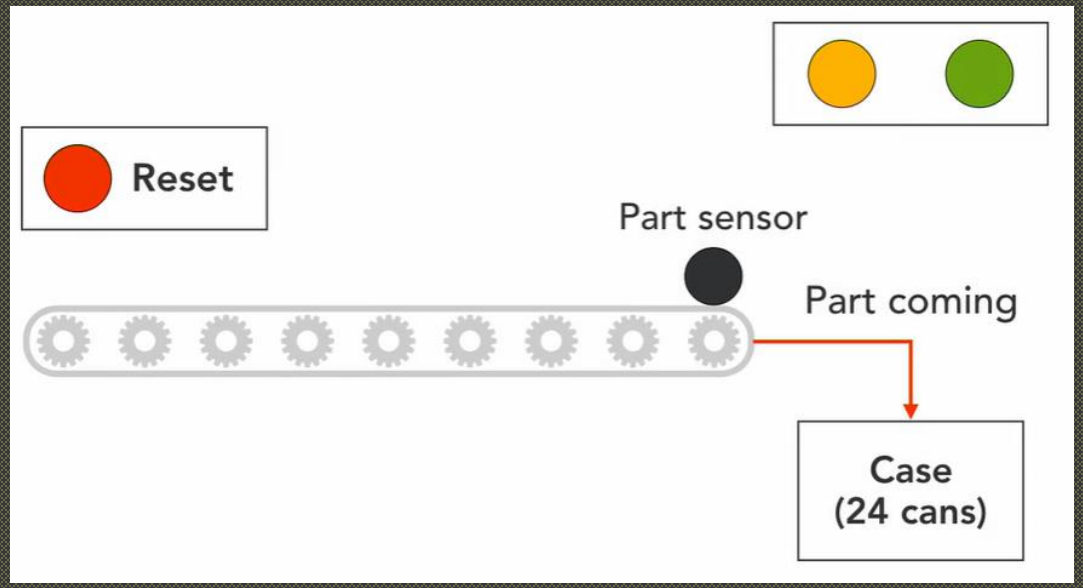


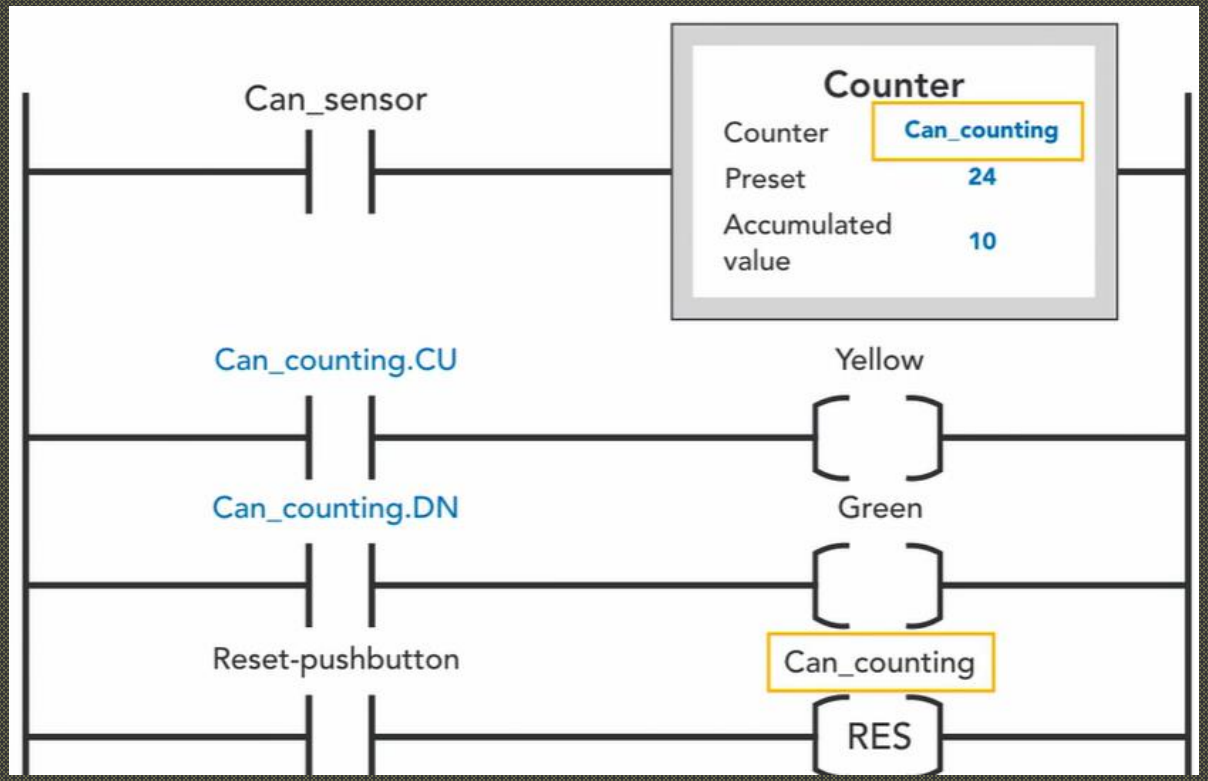
The CTD instruction is typically used with a CTU instruction that references the same counter structure.

HUMBER

COUNT UP (CTU) and COUNT DOWN (CTD) COUNTERS

Example 1





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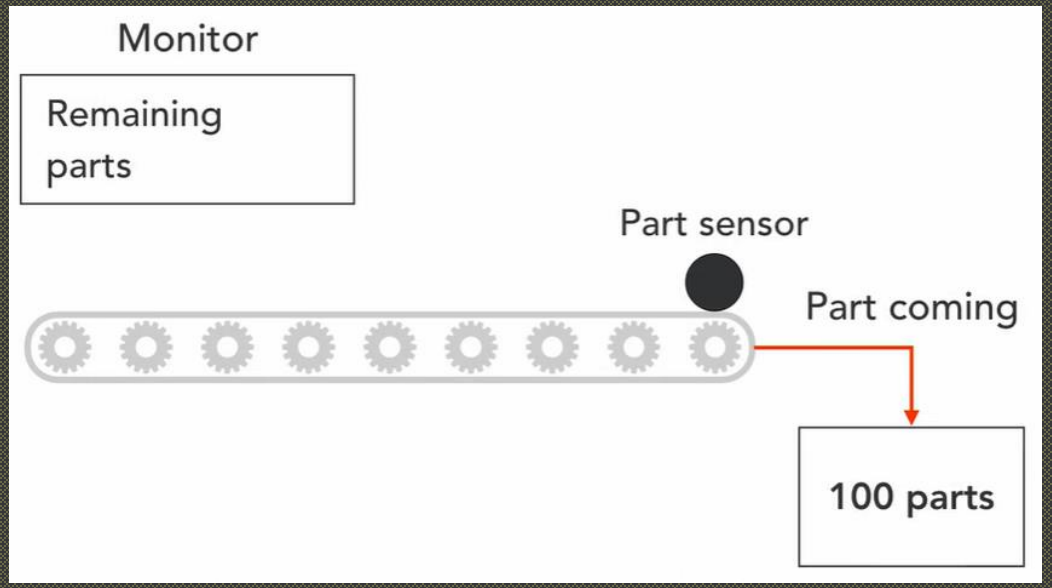
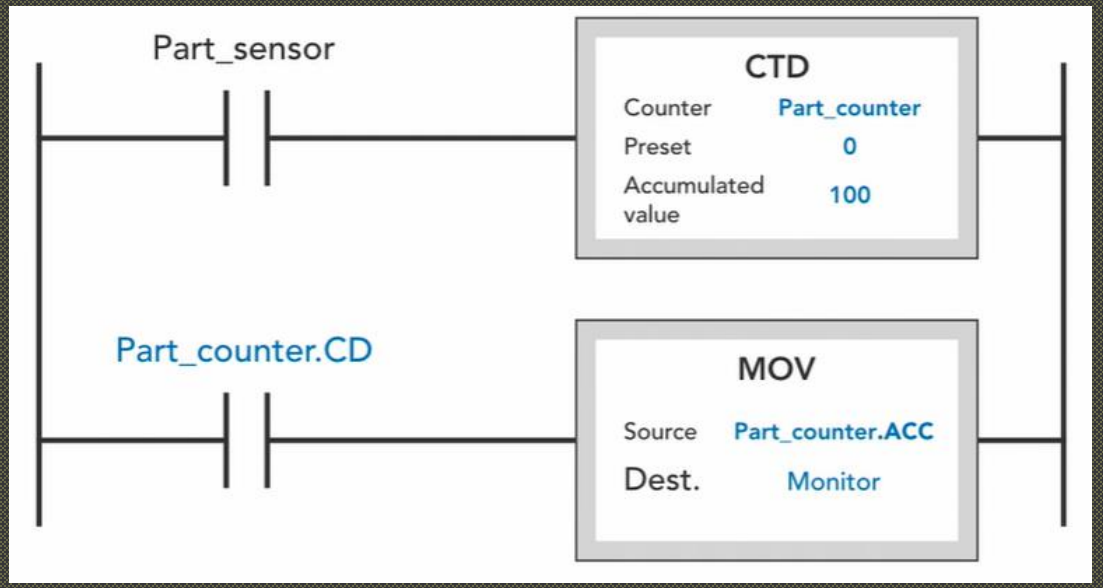
COUNT UP (CTU) and COUNT DOWN (CTD) COUNTERS

Example 2





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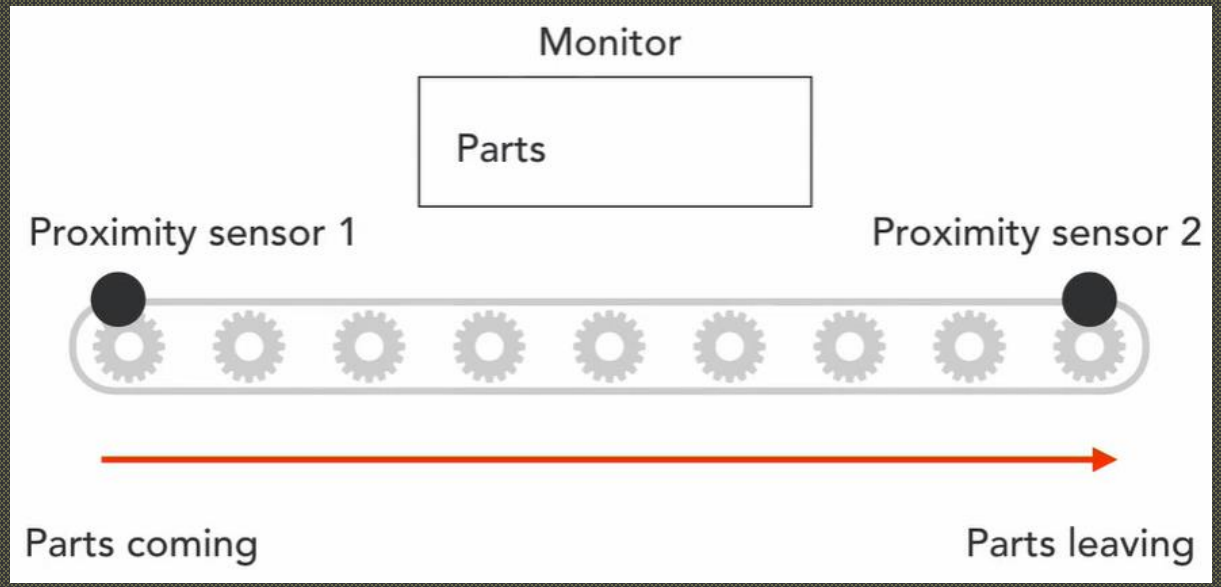
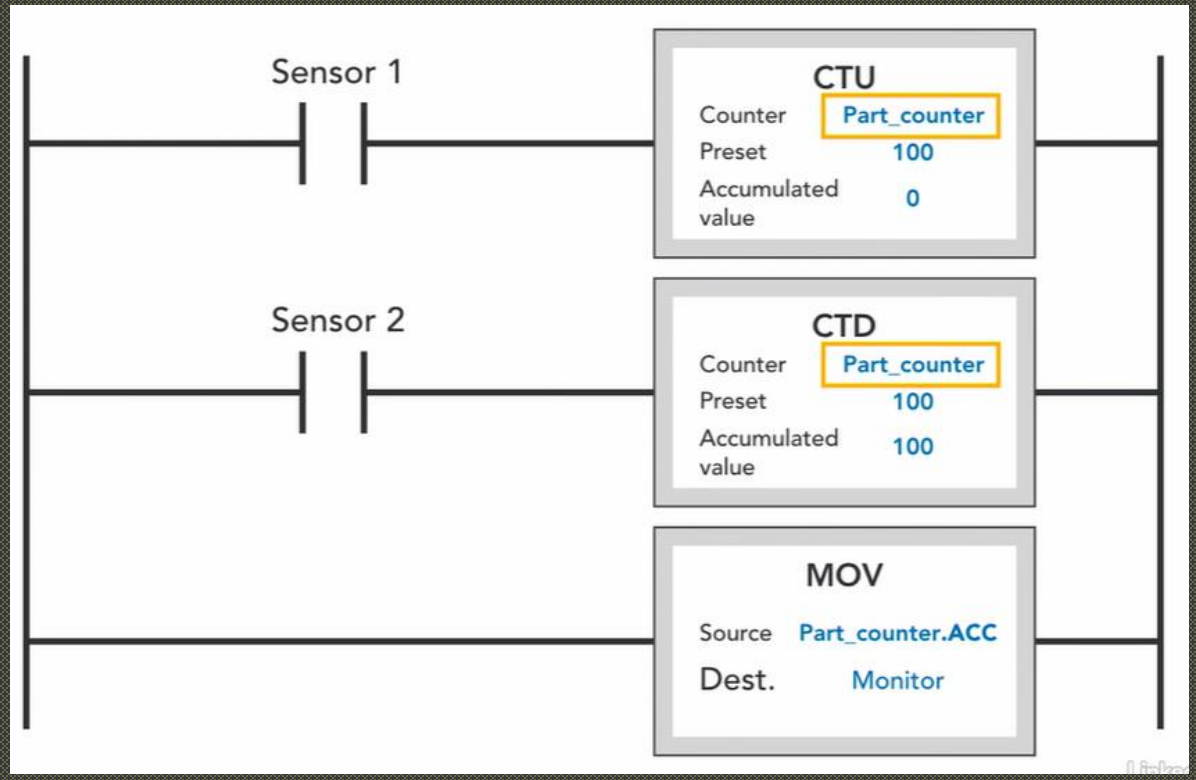
COUNT UP (CTU) and COUNT DOWN (CTD) COUNTERS

Example 3





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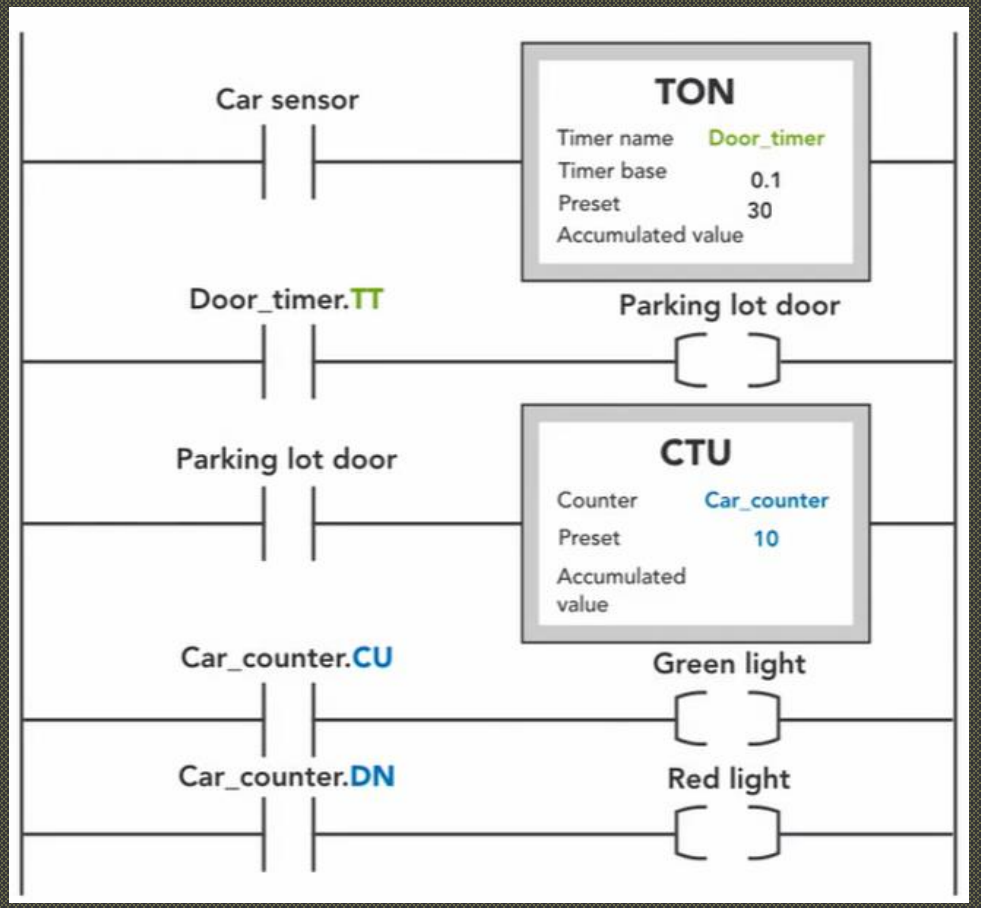
COUNT UP (CTU) and COUNT DOWN (CTD) COUNTERS

Example 4



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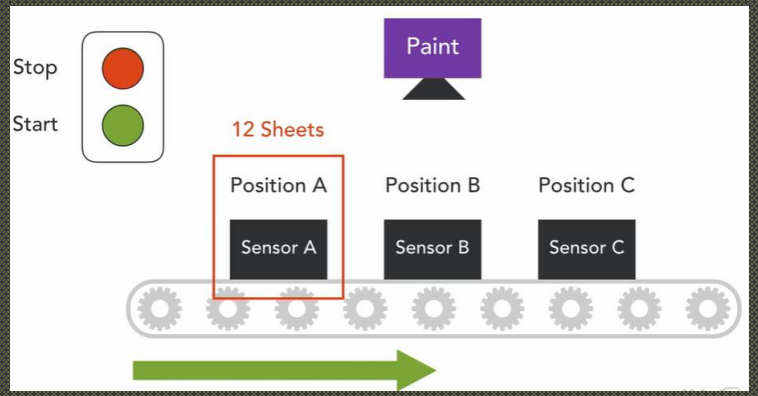
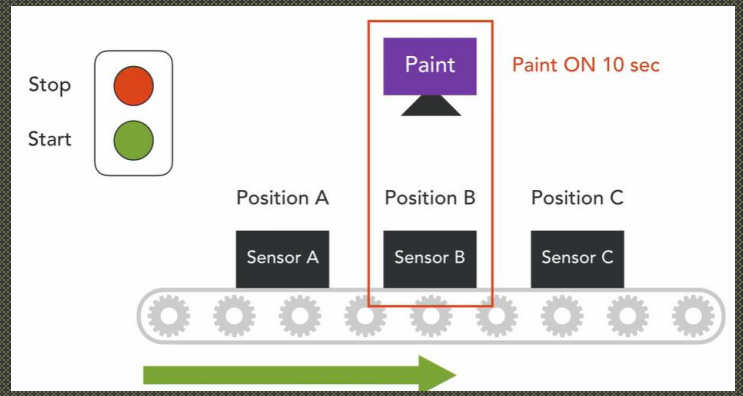
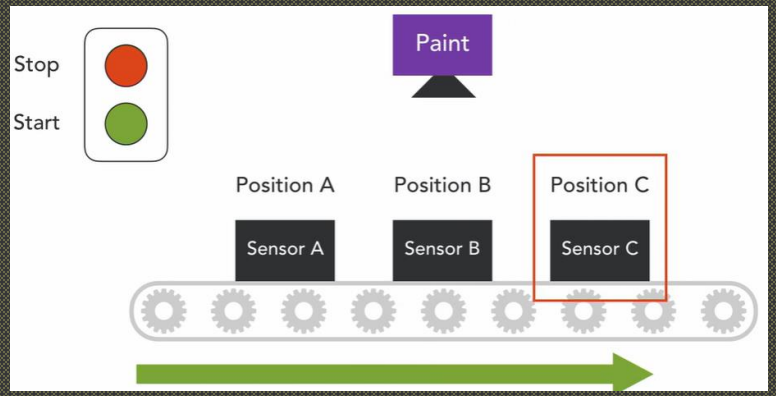
COUNT UP (CTU) and COUNT DOWN (CTD) COUNTERS

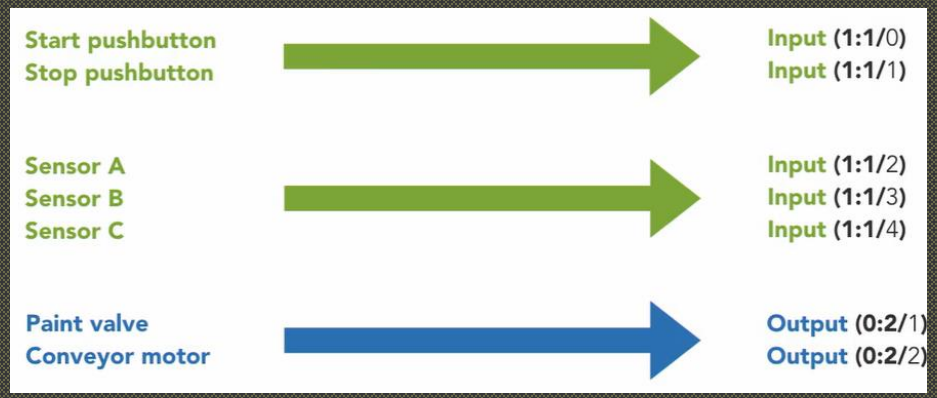
Example 5

All physical inputs except Stop PB are N.O.









Objectives

- Press start pushbutton to start process
- After 12 sheets, conveyor starts
- At position B conveyor stops; paint ON for 10 seconds
- After 10 seconds, conveyor starts again
- At position C, conveyor stops

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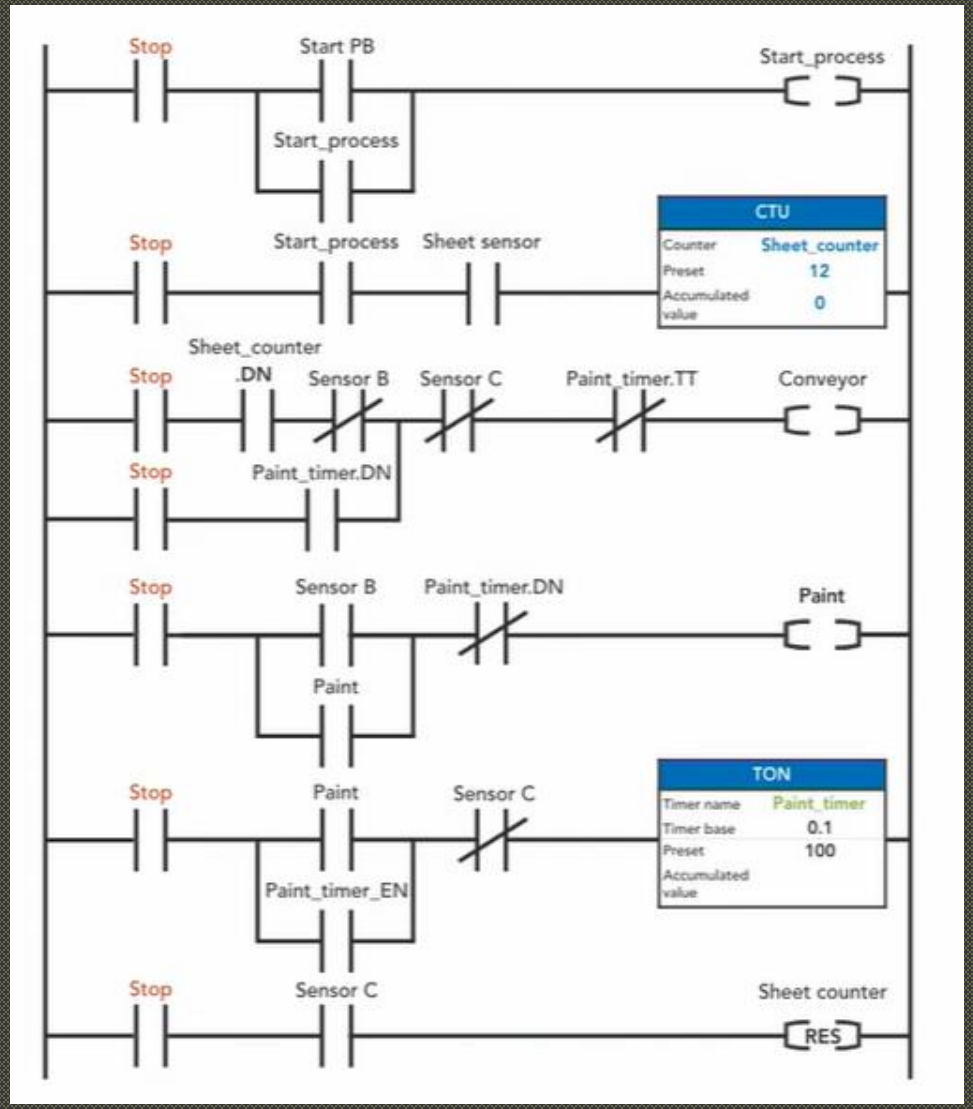
COUNT UP (CTU) and COUNT DOWN (CTD) COUNTERS

Example 5



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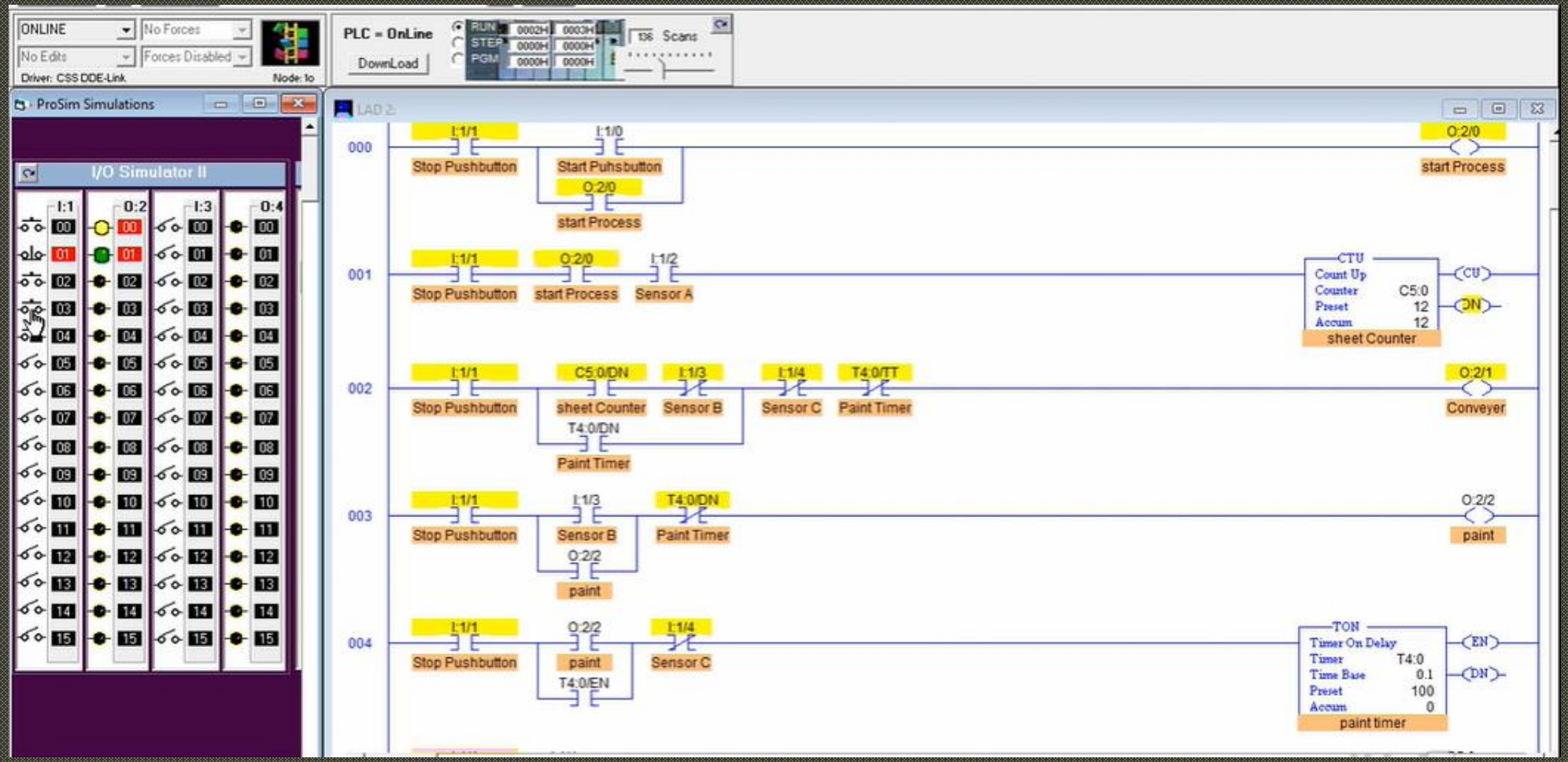
COUNT UP (CTU) and COUNT DOWN (CTD) COUNTERS

Example 5



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COUNT UP (CTU) and COUNT DOWN (CTD) COUNTERS

Example 6

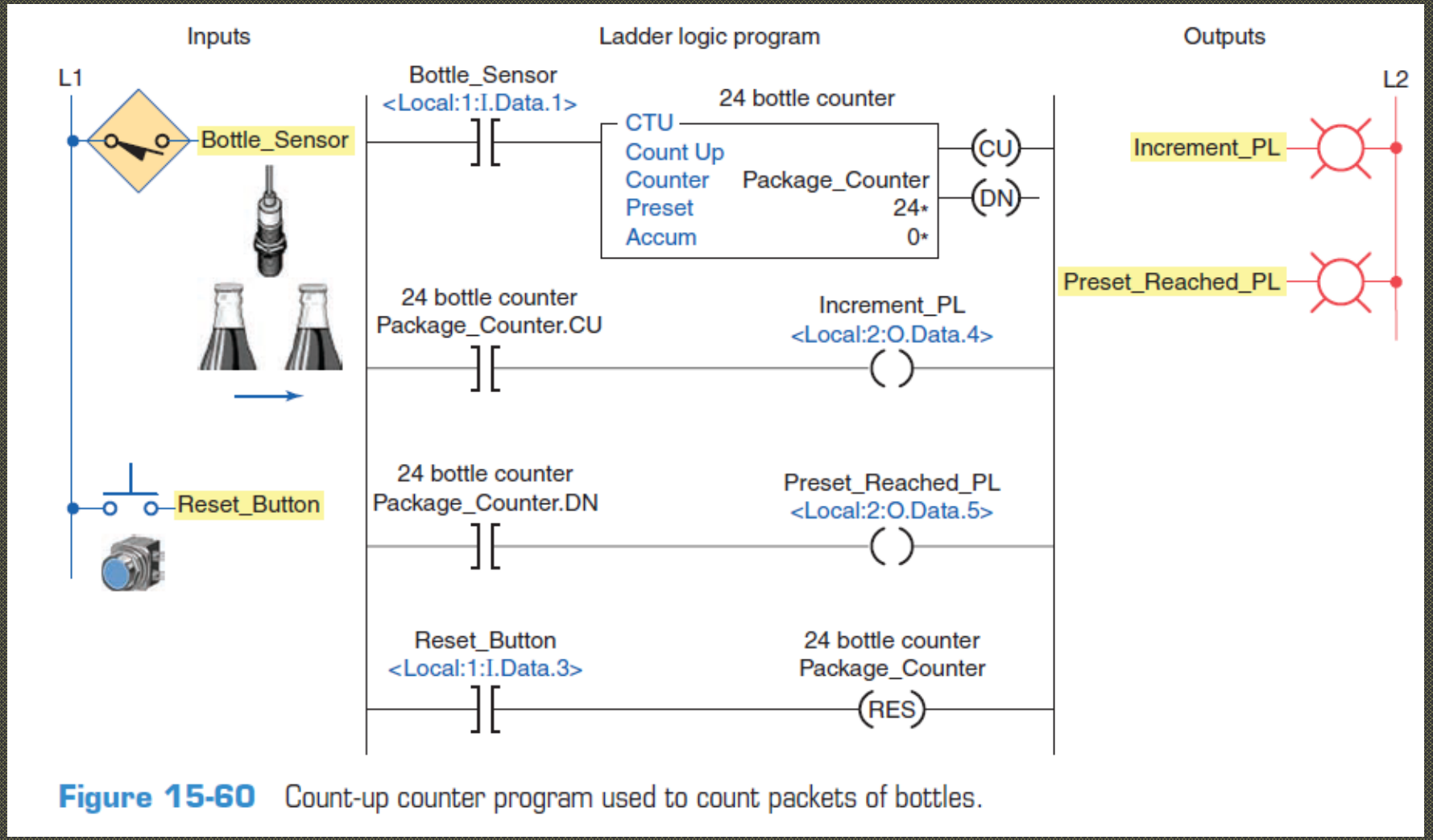


Figure 15-60 Count-up counter program used to count packets of bottles.

(Frank D. Petruzella Programmable Logic Controllers 4th edition)

COUNT UP (CTU) and COUNT DOWN (CTD) COUNTERS

Example 7

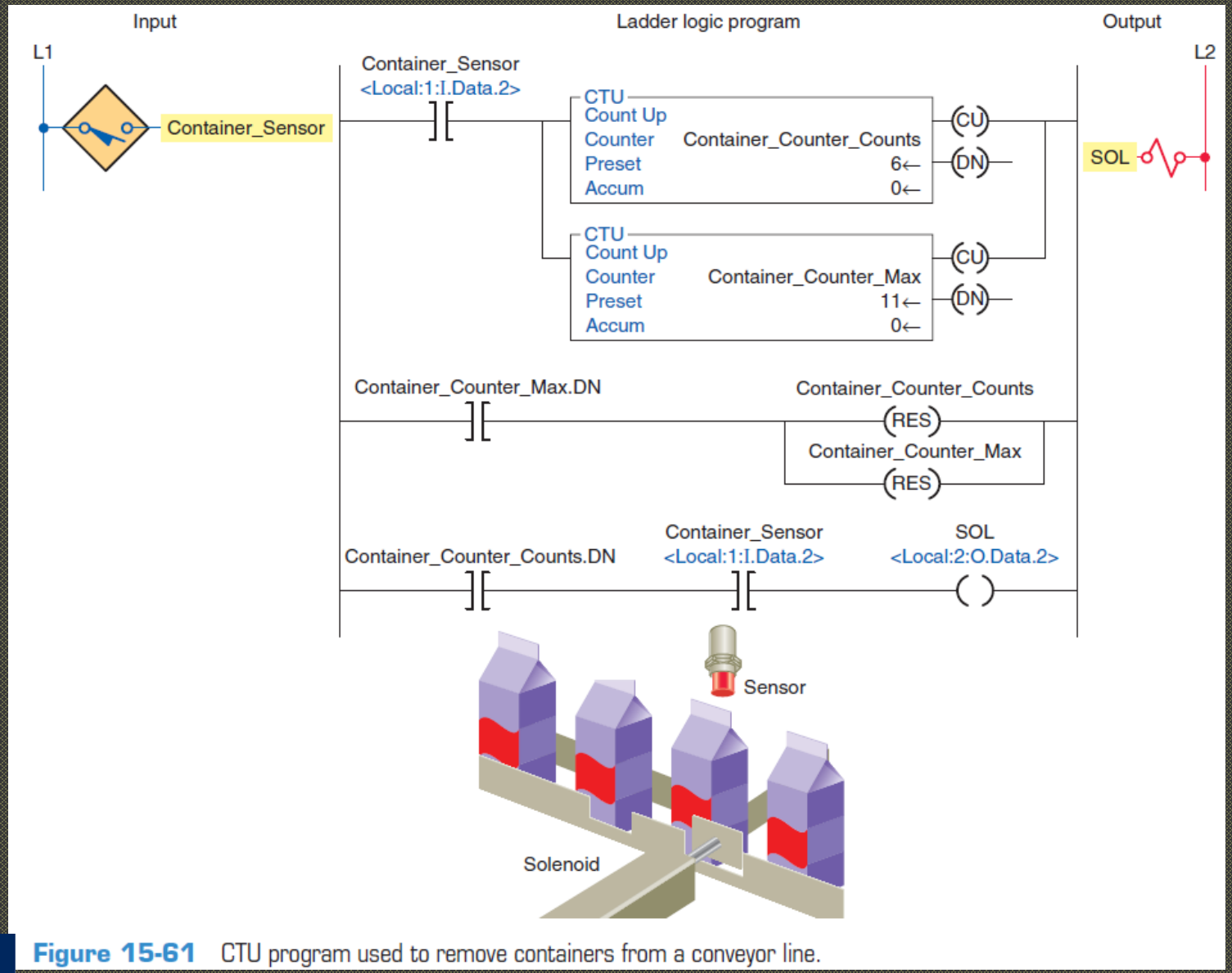


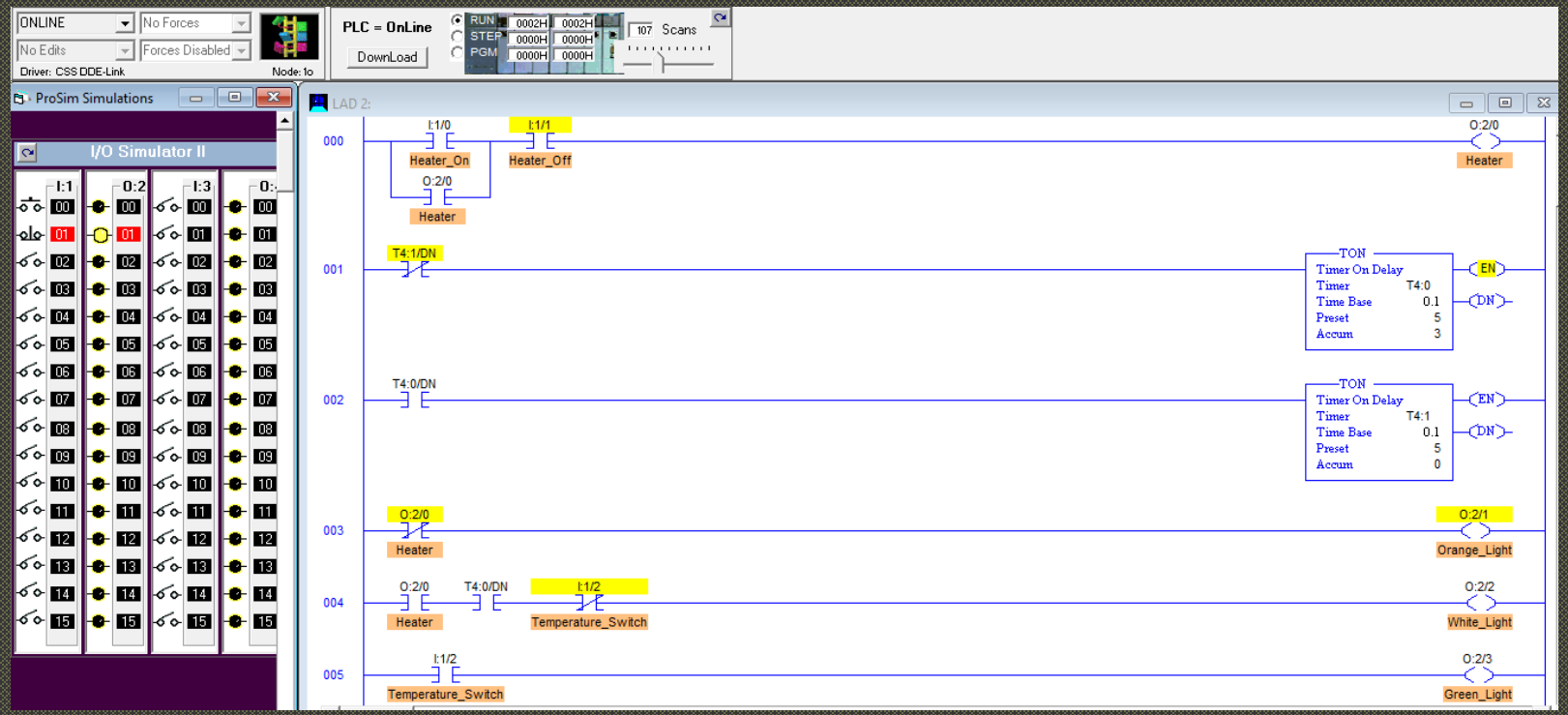
Figure 15-61 CTU program used to remove containers from a conveyor line.

(Frank D. Petruzella Programmable Logic Controllers 4th edition)

TIMER and COUNTER APPLICATIONS

Problem 1. A heater control system is equipped with the heater itself, N.O. Heater ON button, N.C. Heater OFF button, normally OFF temperature switch, and a light tower, consisting of three lights: GREEN, WHITE and ORANGE. When the heater is OFF, the ORANGE light illuminates solid. After turning the heater ON, the WHITE light flashes 0.5 sec ON and 0.5 sec OFF until the temperature switch changes its status to ON, turning ON the GREEN light.

- Draw the wiring diagram of the system,
- Design the PLC program to control the heater and the lights.



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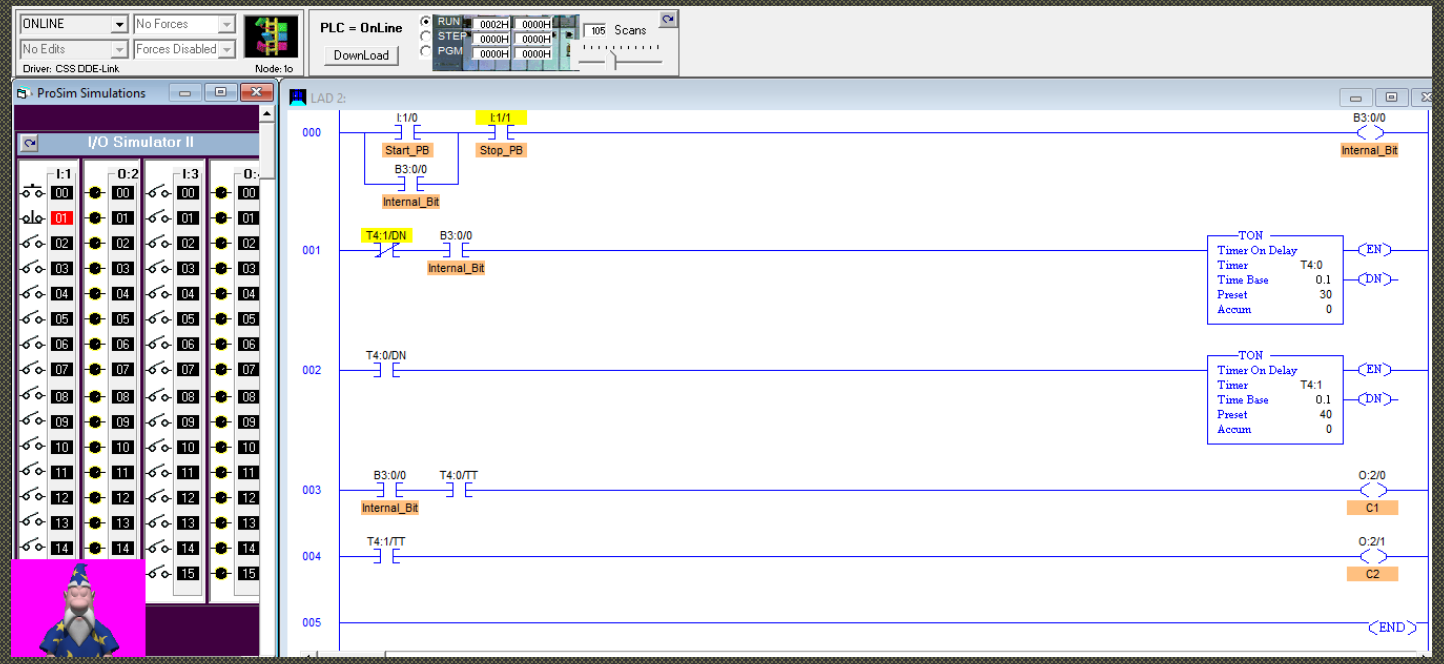
TIMER and COUNTER APPLICATIONS

Problem 2. A N.O. START P.B. and N.C. STOP P.B. are used to start and stop the cycling of two air cylinders C1 and C2 in the following sequence:

- C1 extends and stays extended for 3 seconds;
- C1 retracts, C2 extends and stays extended for 4 seconds;
- C2 retracts.
- Cycle repeats continuously.
- Pressing the STOP P.B. will retract all the cylinders immediately.

- Design the PLC program to control the cylinders.



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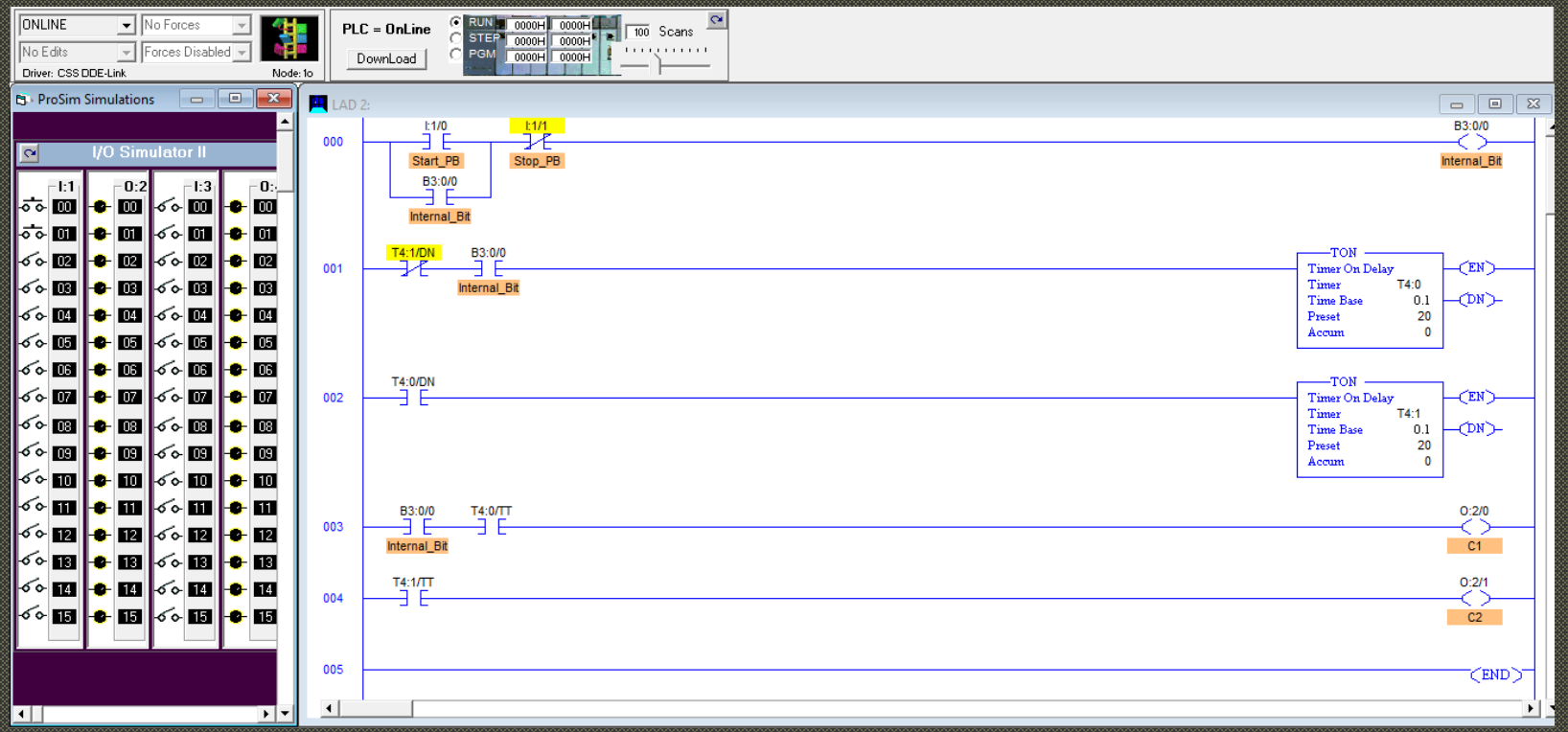
TIMER and COUNTER APPLICATIONS

Problem 3. Two conveyors supply a mechanical parts of two types into two boxes. The conveyors work alternatively for 2 minutes each. The operations will start automatically after pressing the N.O. momentary START PB and will stop after the N.O. STOP pushbutton is pressed.

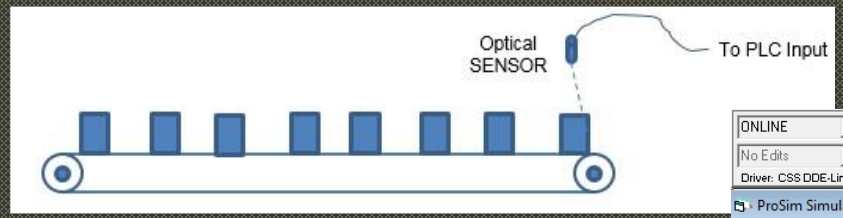
- Write a PLC program to provide the control of the conveyors.

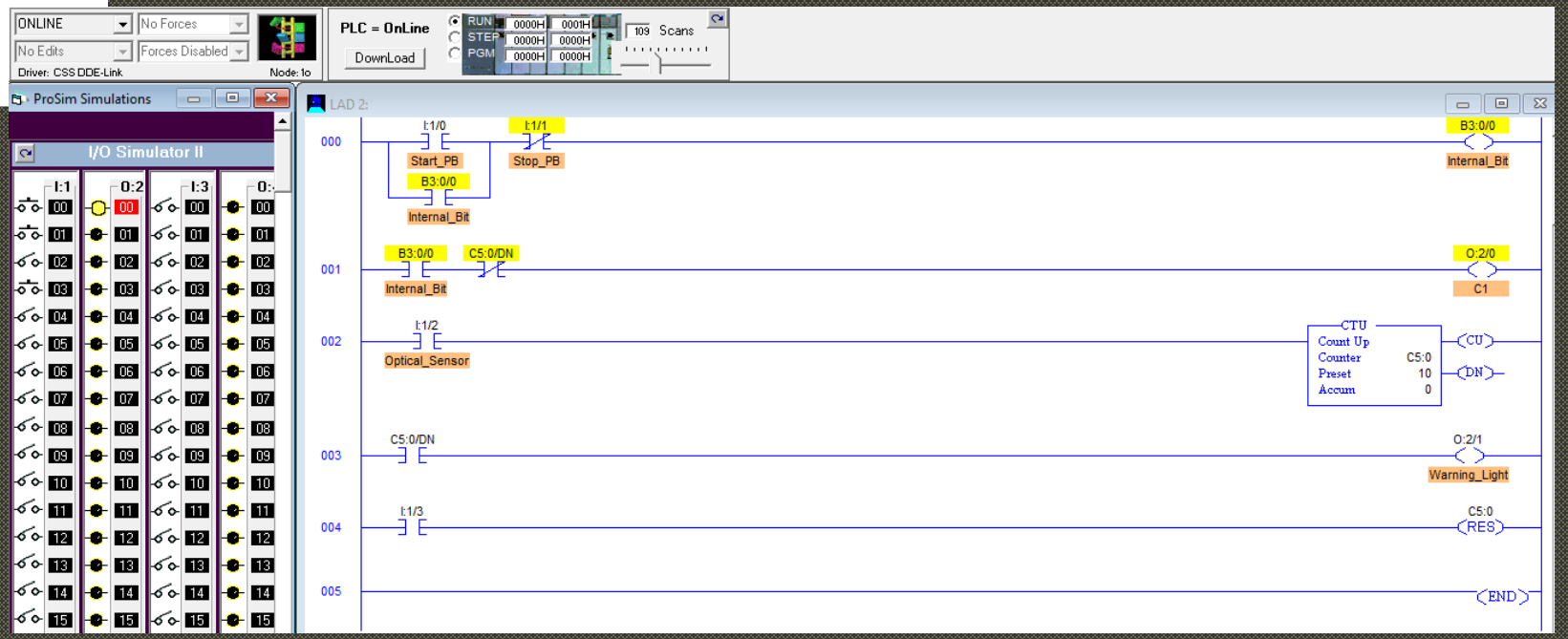


TIMER and COUNTER APPLICATIONS

Problem 4. An optical SENSOR is connected to the PLC input terminal to count the number of the mechanical parts exiting the conveyor. When the number of the parts reaches 100, the conveyor WARNING light will turn on, the motor will stop and will not be able to restart unless the N.O. momentary RESET pushbutton is pressed. Use N.O. START and N.O. STOP pushbuttons to control the conveyor motor.

- Write a PLC program to control the conveyor motor and the light.





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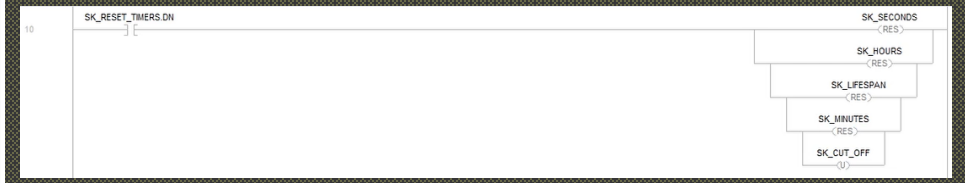
TIMER and COUNTER APPLICATIONS

Problem 5. An ultraviolet irradiation lamp is designed for 1000 hours of maximum intensity. After that it must be replaced. Write a PLC program to turn the lamp ON and OFF with N.O. Start and N.C. Stop pushbuttons and with an automatic interlock from 1000-hour clock. Use timers and counters to program the clock. The program must indicate the number of hours, minutes and seconds. This information must be retentive.
The lamp cannot be turned on again after 1000 hours unless the RESET pushbutton is pressed for 3 seconds.



PROGRAMMABLE LOGIC CONTROLLERS
Timers and Counters

Erickson, K. (2016) Programmable logic controllers: An emphasis on design and application (3rd edition). Rolla MO: Dogwood Valley Press.

Chapter 5

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Thank you!

Discussions?