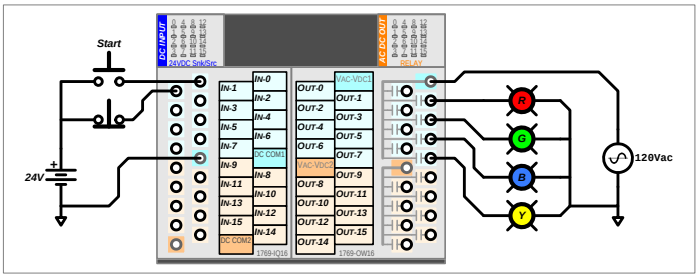
ECET 4530

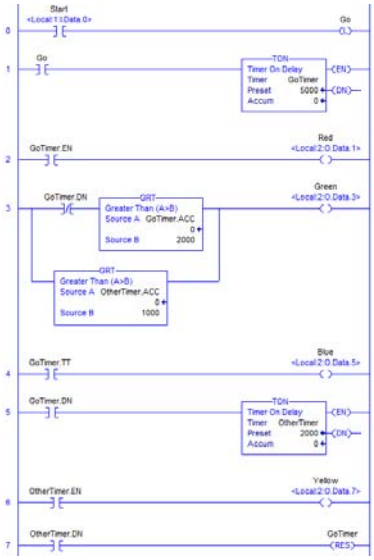
Industrial Motor Control

Ladder Logic Example Problem
Complex Timer Interaction

Example Problem

Given the following PLC-based system and the Ladder-Logic program that the PLC is executing:





If the "Start" button is pressed at time t = 0, specify the timespans during which each light is "ON" for the first 14 seconds of operation (after the Start button is pressed).

Example Problem

Step 1 – Analyze the ladder to determine the Conditions required to Enable or Reset the Timers.

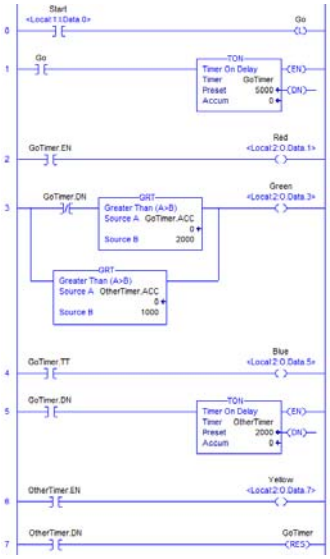
- **Rung 1 – GoTimer is Enabled when bit Go = 1.**
- **Rung 5 - OtherTimer is Enabled when GoTimer.DN = 1 (GoTimer is Done).**
- **Rung 7 - GoTimer is Reset when OtherTimer.DN = 1 (OtherTimer is Done).**

Note that, in the following slides, I will abbreviate:

"GoTimer" as "GT"

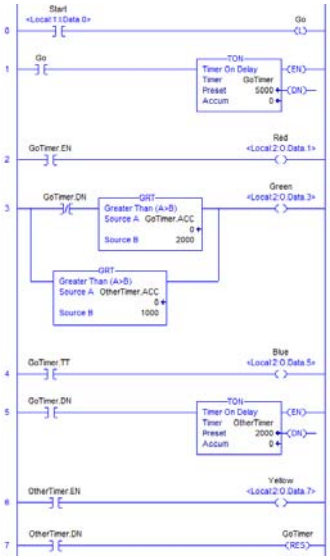
and

"OtherTimer" as "OT"



Example Problem

Step 2 – Determine the Timing Sequence that occurs once the system is activated (Start is Pressed).



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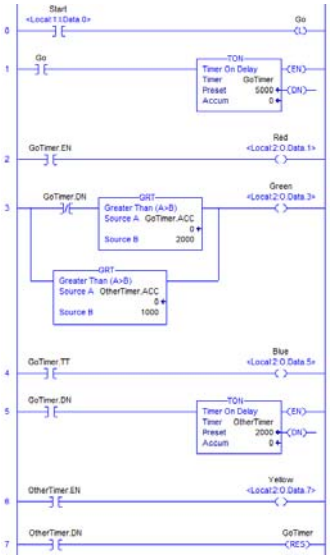
Step 2 – Determine the Timing Sequence that occurs once the system is activated (Start is Pressed).

- **At time t = 0 sec, Start is pressed → the Go bit is set (Go = 1) → GT is Enabled (GT.EN = 1).**

Thus, at t = 0, GT begins counting from 0 to 5000 (5 sec).



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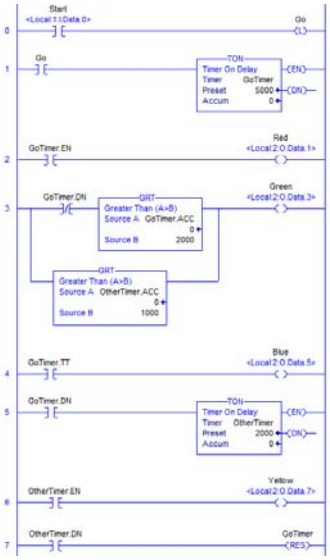
(Note that OT is Disabled while GT is actively counting.)



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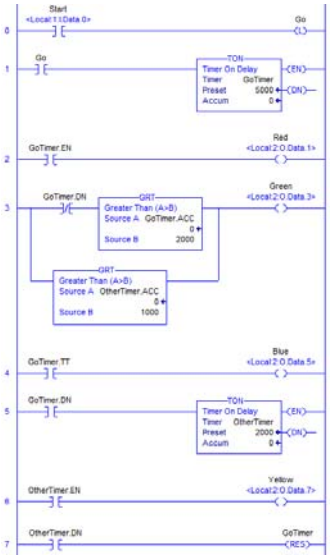
  Thus, at t = 0, GT begins counting from 0 to 5000 (5 sec).

- **At time t = 5 sec, GT.ACC = 5000 → GT is Done (GT.DN = 1) → OT is Enabled (OT.EN = 1).**

  Thus, at t = 5, OT begins counting from 0 to 2000 (2 seconds).



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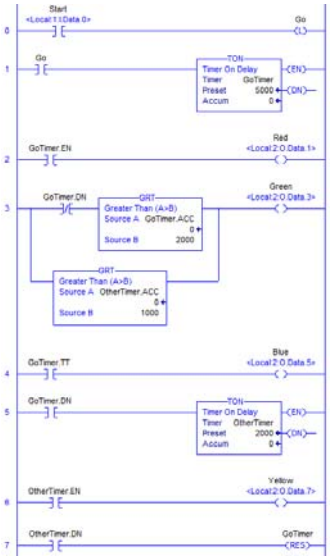
- **At time t = 5 sec, GT.ACC = 5000 → GT is Done (GT.DN = 1) → OT is Enabled (OT.EN = 1).**

  Thus, at t = 5, OT begins counting from 0 to 2000 (2 seconds).

(Note that GT.ACC remains at 5000 while OT is counting.)



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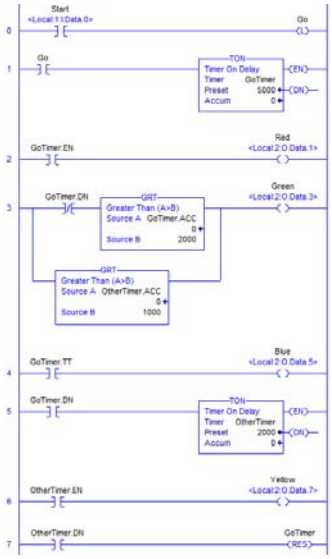
  Thus, at t = 5, OT begins counting from 0 to 2000 (2 seconds).

- **At time t = 7 sec, OT.ACC = 2000 → OT is Done (OT.DN = 1) → GT is Reset.**

  When GT is Reset, GT.ACC = 0, GT.DN = 0 → OT is Disabled.

  When OT is Disabled, OT.EN = 0, OT.ACC = 0, and OT.DN = 0.

  Thus, at t = 7, GT begins counting again from 0 to 5000 (5 sec).



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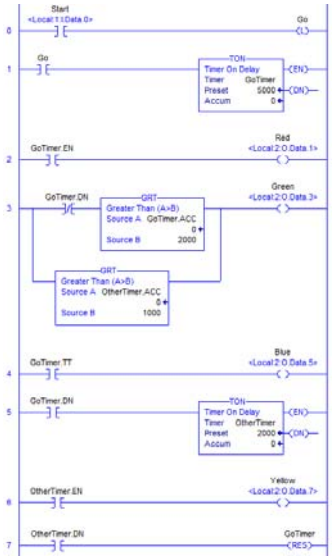
  When GT is Reset, GT.ACC = 0, GT.DN = 0 → OT is Disabled.

  When OT is Disabled, OT.EN = 0, OT.ACC = 0, and OT.DN = 0.

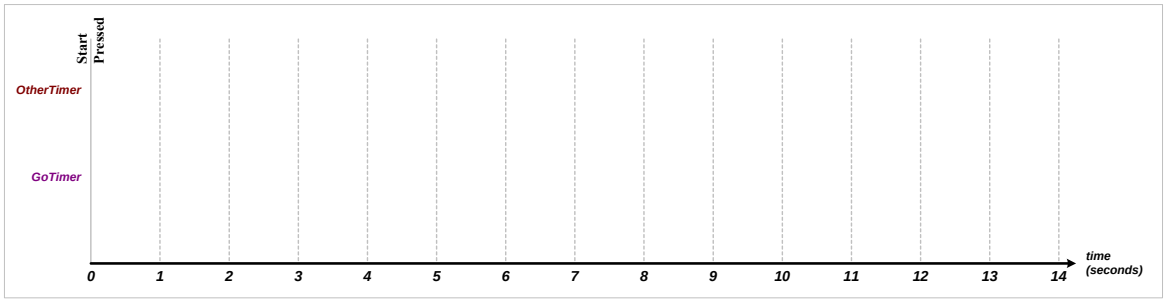
  Thus, at t = 7, GT begins counting again from 0 to 5000 (5 sec).

  Since this is equivalent to the conditions at t = 0, the process begins again.



Example Problem

Step 3 – Sketch the Timing Sequence that occurs when Start is Pressed.



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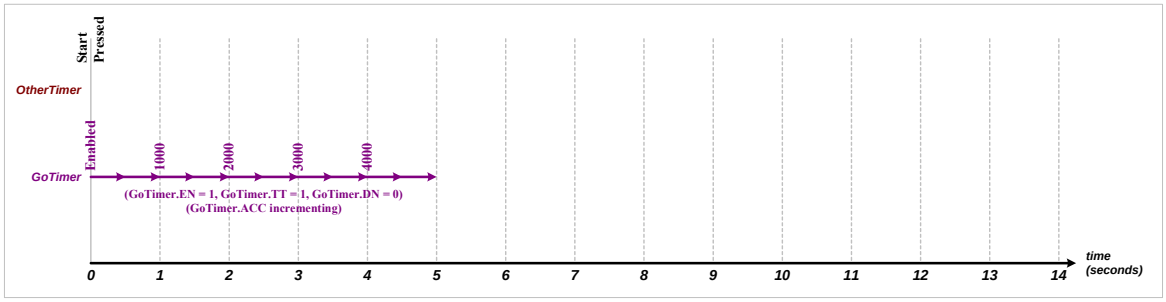

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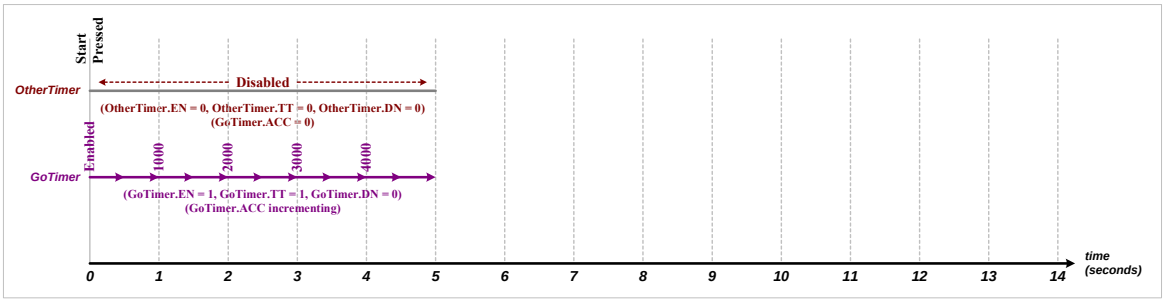
- At time t = 0 sec, Start is pressed → the Go bit is set (Go = 1) → GT is Enabled (GT.EN = 1).

  Thus, at t = 0, GT begins counting from 0 to 5000 (5 sec).

  During this time (0 sec → 5 sec), OT is Disabled.



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- **At time t = 5 sec, GT.ACC = 5000 → GT is Done (GT.DN = 1) → OT is Enabled (OT.EN = 1).**

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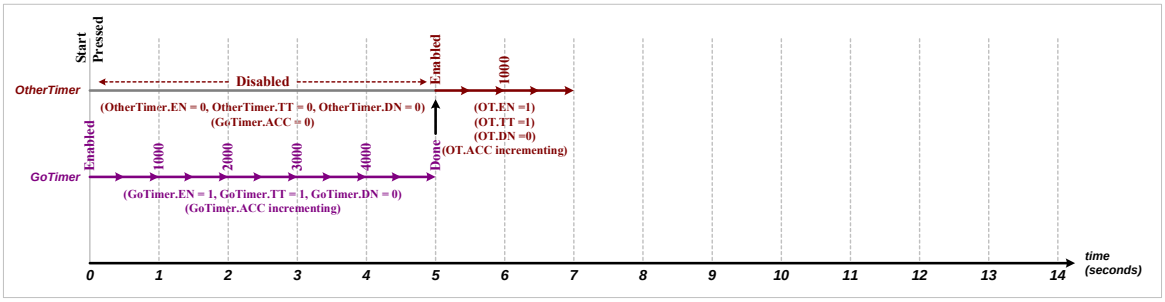

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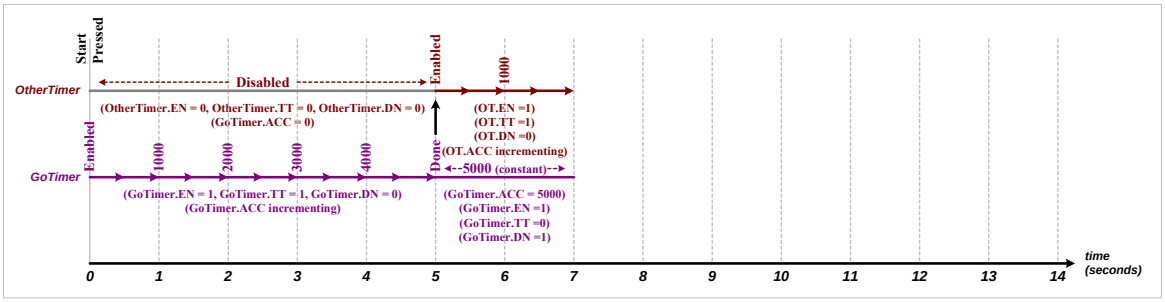
  Thus, at t = 5, OT begins counting from 0 to 2000 (2 seconds).

  During this time (5 sec → 7 sec), GT.ACC remains at 5000.



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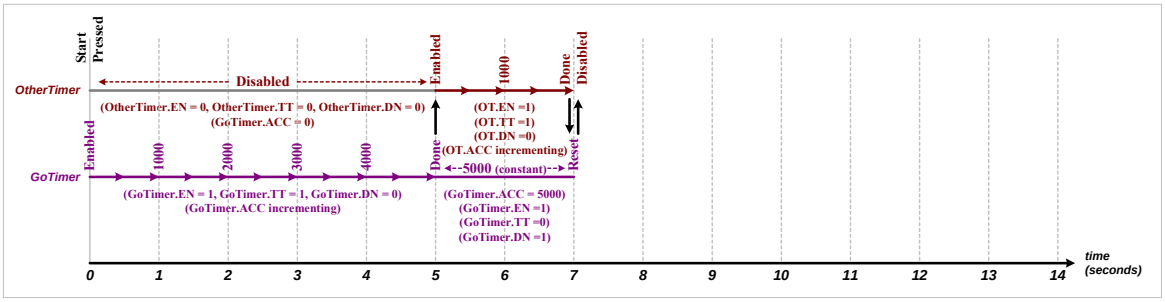
- **At time t = 7 sec, OT.ACC = 2000 → OT is Done (OT.DN = 1) → GT is Reset.**

  When GT is Reset, GT.ACC = 0, GT.DN = 0 → OT is Disabled.



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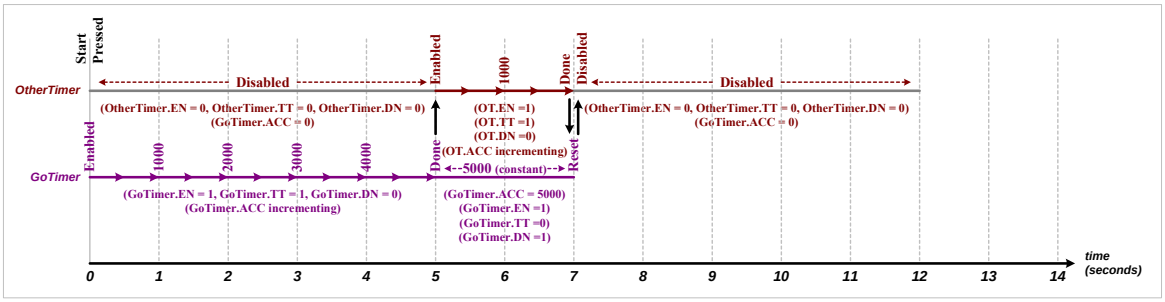
  When GT is Reset, GT.ACC = 0, GT.DN = 0 → OT is Disabled.

  When OT is Disabled, OT.EN = 0, OT.ACC = 0, and OT.DN = 0.

  (OT will remain disabled until GT is Done again.)

  (Note that this also prevents the RES on Rung 7 from resetting GT again.)



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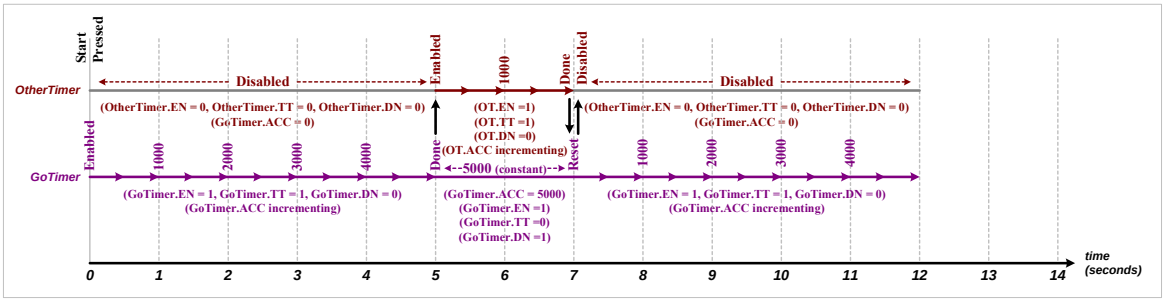

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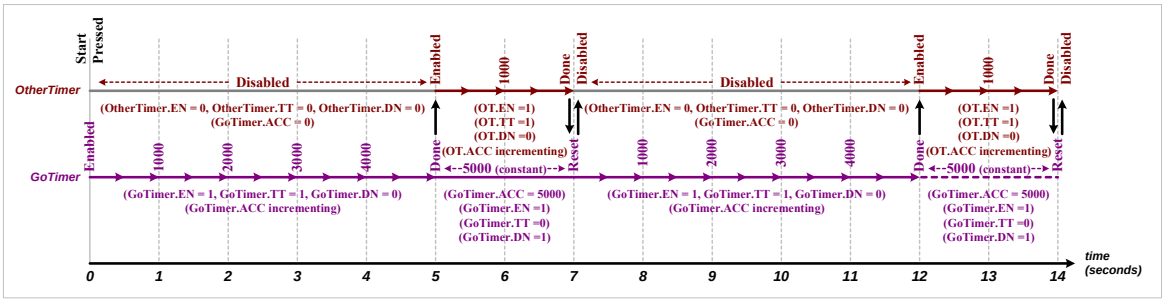
  When OT is Disabled, OT.EN = 0, OT.ACC = 0, and OT.DN = 0.

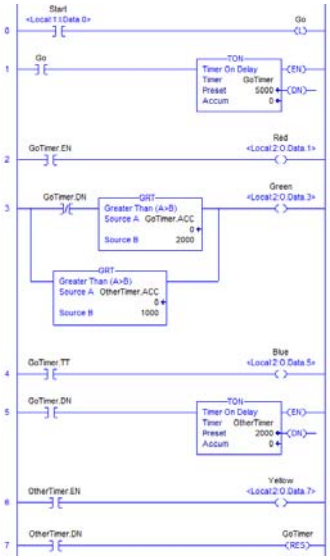
  Thus, at t = 7, GT begins counting again from 0 to 5000 (5 sec).

  This is equivalent to the conditions at t = 0 when Start was Pressed → the process repeats.



Example Problem

Step 4 – Determine the Conditions required for each of the Indicator Lamps to become Illuminated.



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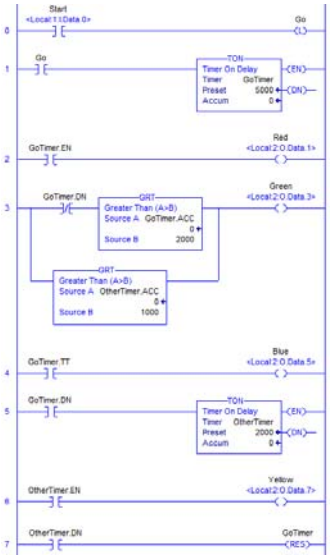
Red: **GT.EN = 1 (GoTimer Enabled)**



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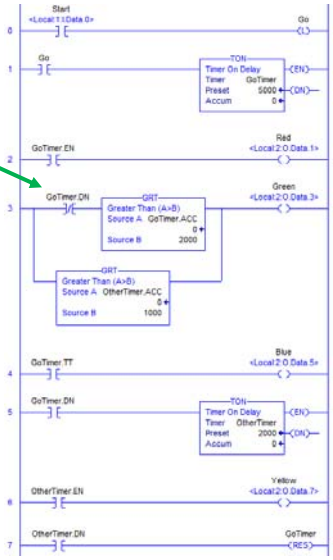
Step 4 – Determine the Conditions required for each of the Indicator Lamps to become Illuminated.

Red: GT.EN = 1 (GoTimer Enabled)

Green: **GT.DN ≠ 1 (GoTimer <u>not</u> Done) and GT.ACC > 2000**



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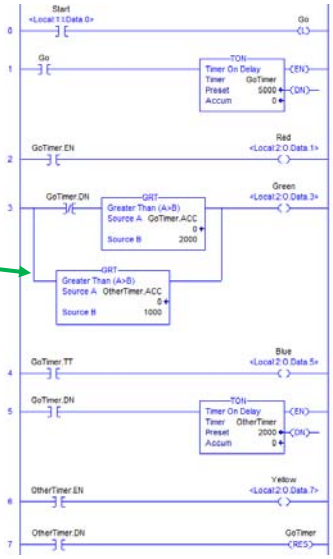
Step 4 – Determine the Conditions required for each of the Indicator Lamps to become Illuminated.

Red: GT.EN = 1 (GoTimer Enabled)

Green: GT.DN ≠ 1 (GoTimer not Done) and GT.ACC > 2000

or

OT.ACC > 1000



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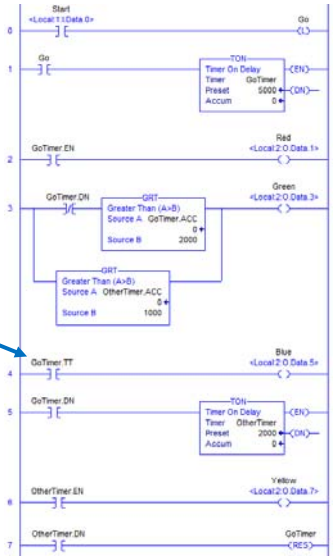
OT.ACC > 1000

Blue: **GT.TT = 1 (GoTimer is actively counting)**



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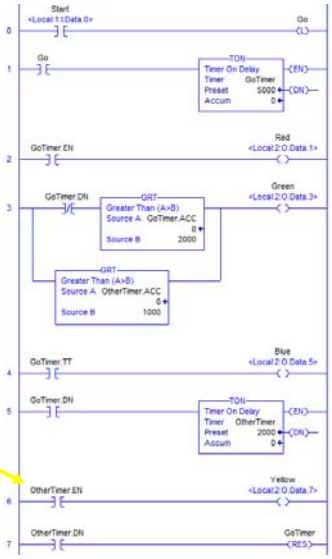
Blue: GT.TT = 1 (GoTimer is actively counting)

Yellow: OT.EN = 1 (OtherTimer Enabled)



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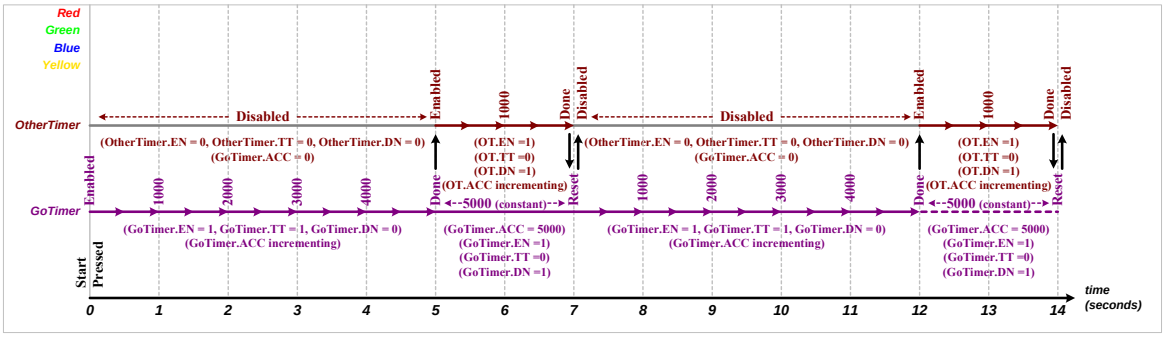
Step 5 – Based on the timing sequence, determine the times at which the Lamps are Illuminated.



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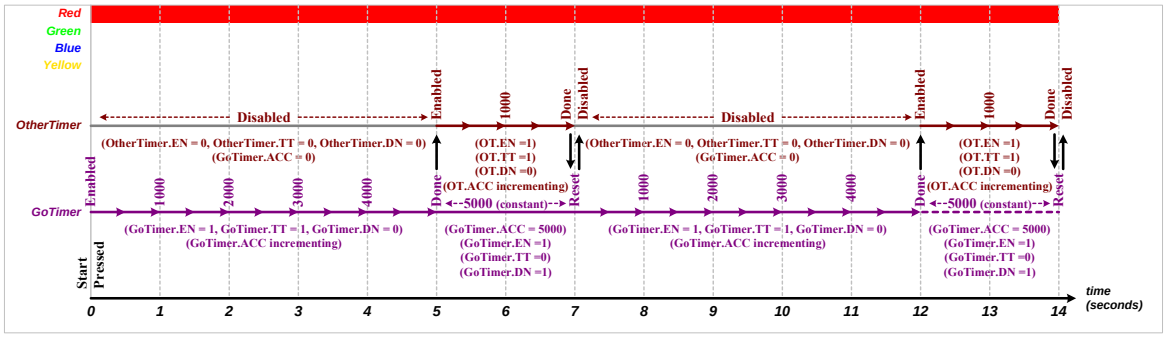

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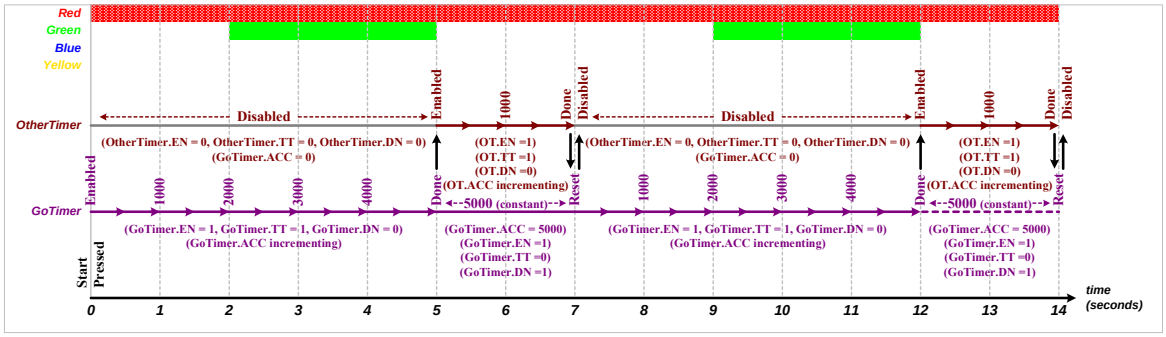

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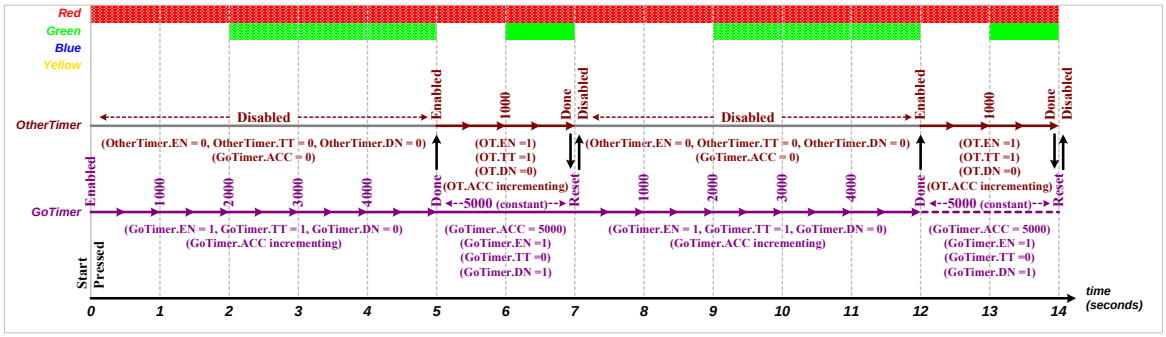

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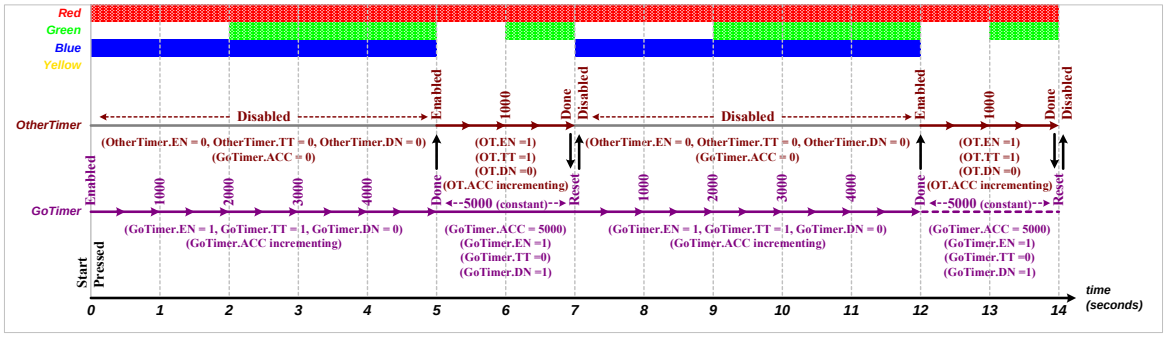

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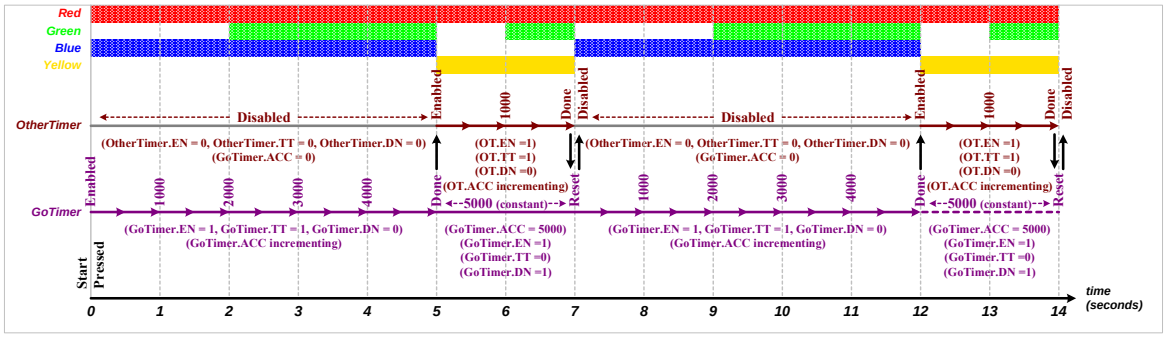
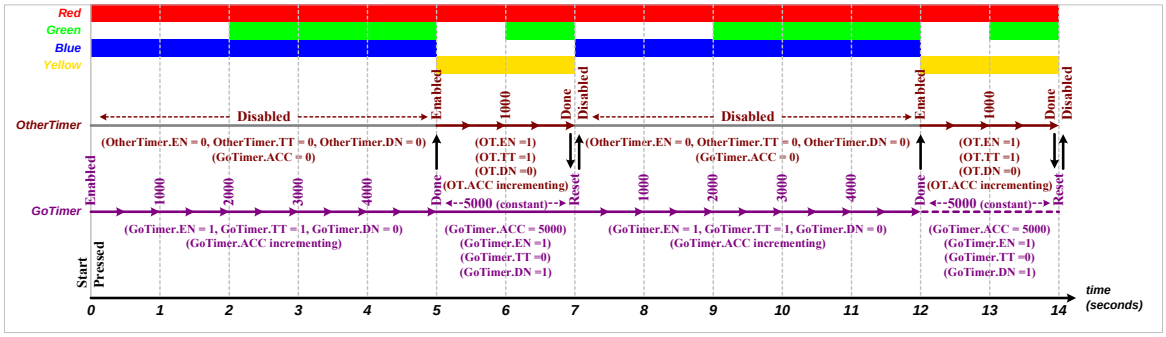


Example Problem

Step 6 – Specify the timespans during which each light is "ON" in the following table:

timespan (seconds)	0→1	1→2	2→3	3→4	4→5	5→6	6→7	7→8	8→9	9→10	10→11	11→12	12→13	13→14
Red														
Green														
Blue														
Yellow														



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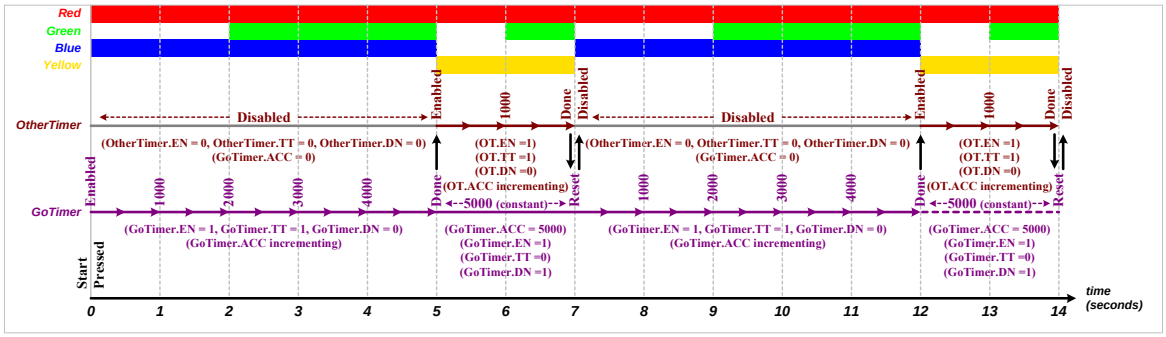
Red	On	On	On	On	On	On	On	On	On	On	On	On	On	On



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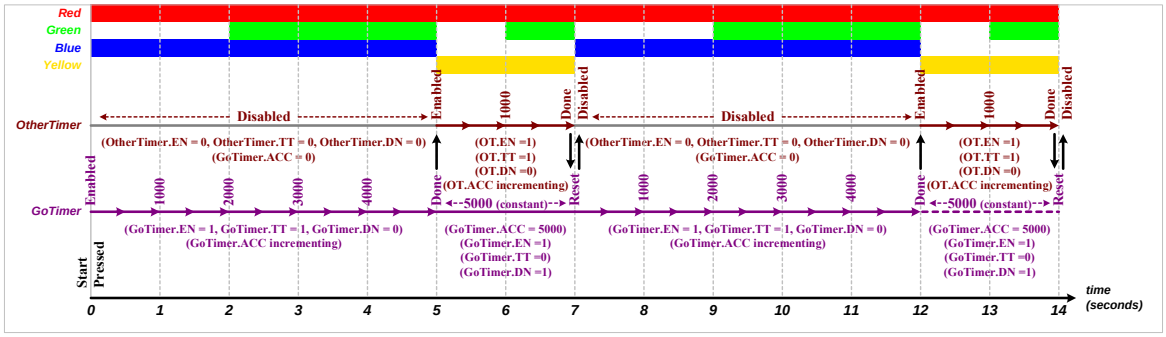
Red	On	On	On	On	On	On	On	On	On	On	On	On	On	On
Green			On	On	On		On			On	On	On		On



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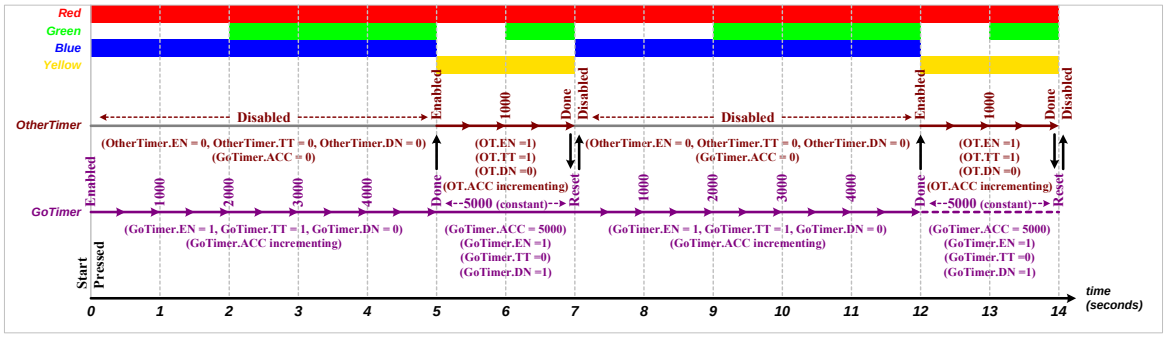
Red	On	On	On	On	On	On	On	On	On	On	On	On	On	On
Green			On	On	On		On			On	On	On		On
Blue	**On**	**On**	**On**	**On**	**On**			**On**	**On**	**On**	**On**	**On**		



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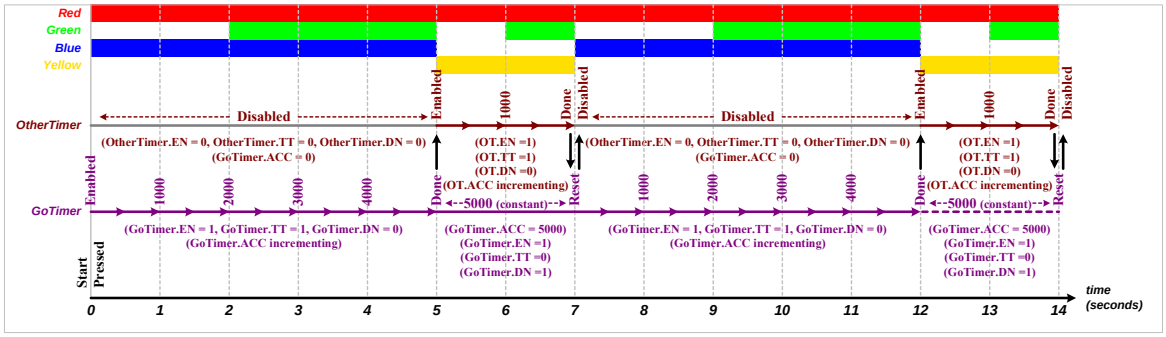
Red	On	On	On	On	On	On	On	On	On	On	On	On	On	On
Green			On	On	On		On			On	On	On		On
Blue	On	On	On	On	On			On	On	On	On	On		
Yellow						**On**	**On**						**On**	**On**



Example Problem

Step 6 – Specify the timespans during which each light is "ON" in the following table:

timespan (seconds)	0➡1	1➡2	2➡3	3➡4	4➡5	5➡6	6➡7	7➡8	8➡9	9➡10	10➡11	11➡12	12➡13	13➡14
Red	On	On	On	On	On	On	On	On	On	On	On	On	On	On
Green			On	On	On		On			On	On	On		On
Blue	On	On	On	On	On			On	On	On	On	On		
Yellow						On	On						On	On