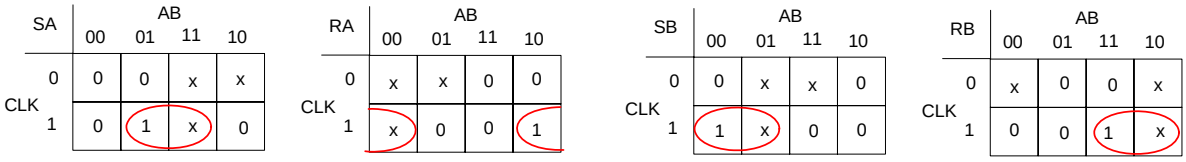
Homework #2: ECE 461 / 661

State Transitional Logic - Counters - Timers:. Due Wednesday, September 7th

A stoplight is to be designed with four states:

Present State		Duration	Next State	Red	Yellow	Green	Blue *(left turn arrow)*
00	Stop	5 sec	Left Turn	on	off	off	off
01	Left Turn	4 sec	Go	off	off	off	on
11	Go	5 sec	Caution	off	off	on	on
10	Caution	2 sec	Stop	off	on	off	off

1a) Use state transitional logic to design a ring counter which changes from state-to-state according to the above table. Change whenever a button is pressed.



$$S_A = CLK \cdot B \qquad S_B = CLK \cdot \overline{A}$$

$$R_A = CLK \cdot \overline{B} \qquad R_B = CLK \cdot A$$

1b) Use combinational logic so that the LEDs are on and off in the correct order based upon the present state.

$$Red = \overline{A} \cdot \overline{B}$$

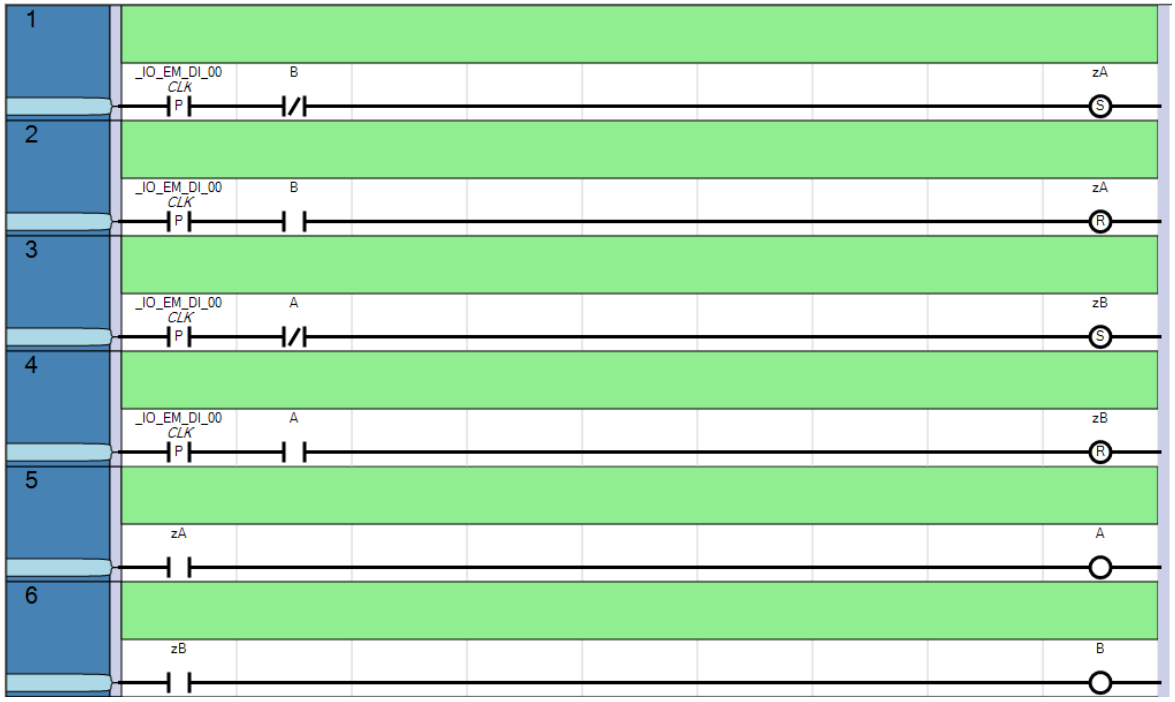
$$Yellow = A \cdot \overline{B}$$

$$Green = A \cdot B$$

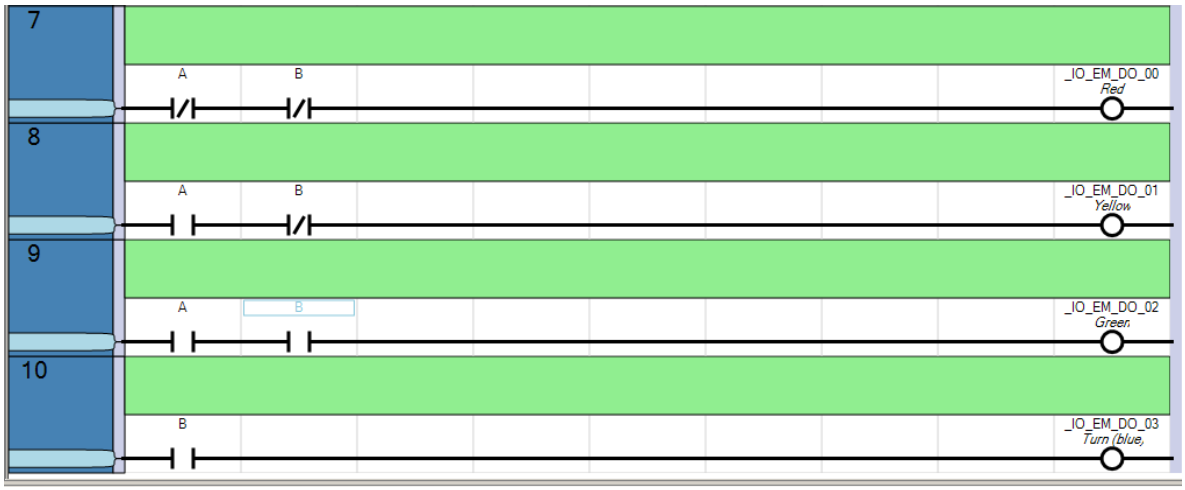
$$Blue = \overline{A} \cdot B + A \cdot B = B$$

Resulting Ladder Logic Program: With state-transition logic, this is a 10-line program. (note: you need additional logic to create the clock pulse if you want to automate the clock operator)

State Transition Logic:

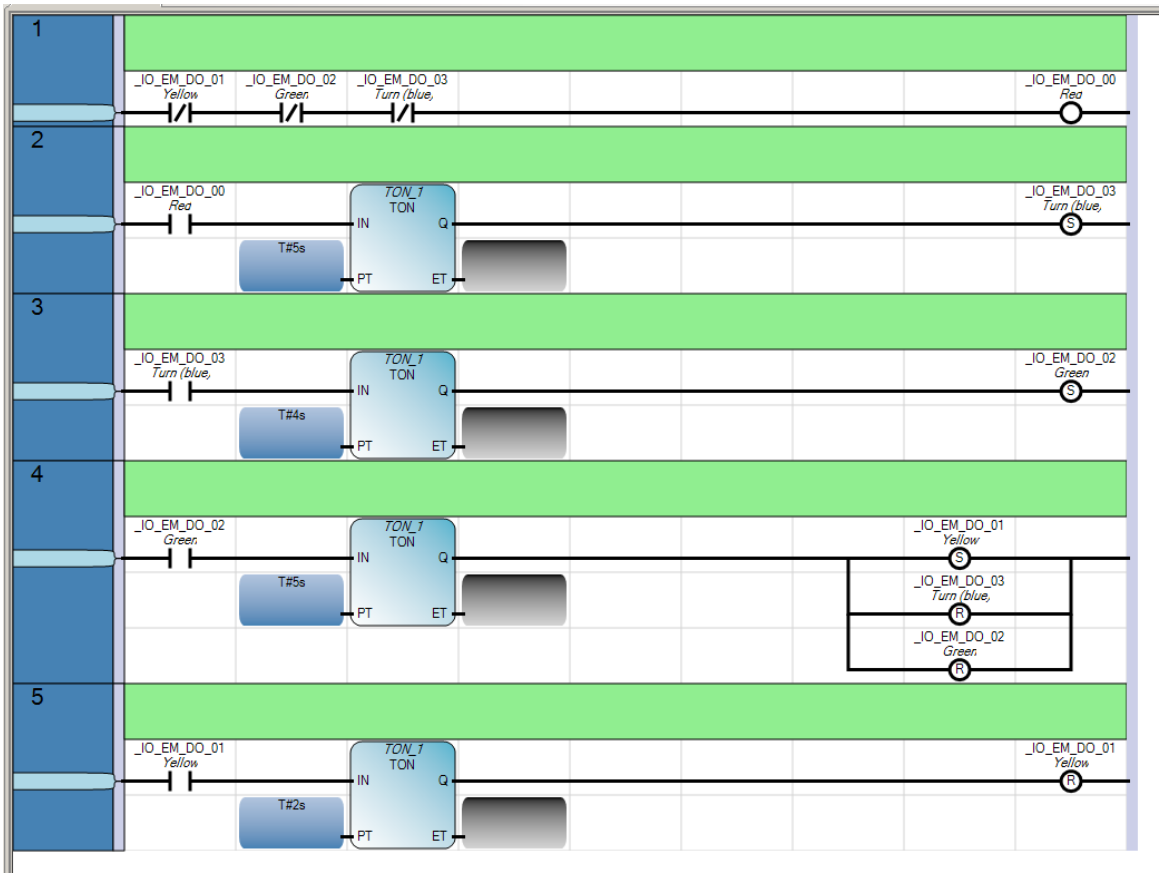


Outputs (lights)



2) Repeat problem #1 using timer blocks.

With timer blocks, this is a 5-line program. More if you want the left turn arrow to blink on green (more on this later)



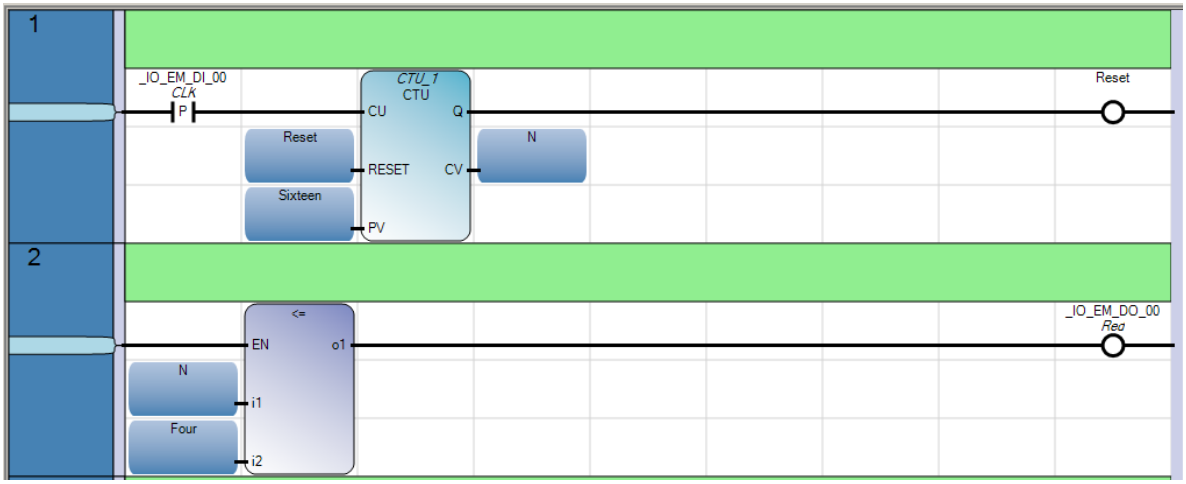
3) Repeat problem #1 using counter blocks with a count to 16 (seconds - one cycle):

Time		Red	Yellow	Green	Blue
Red Light (5 sec)	0	on	off	off	off
	1	on	off	off	off
	2	on	off	off	off
	3	on	off	off	off
	4	on	off	off	off
Left Turn (4 sec)	5	off	off	off	on
	6	off	off	off	on
	7	off	off	off	on
	8	off	off	off	on
Green Blink Left Turn (5 sec)	9	off	off	on	off
	10	off	off	on	on
	11	off	off	on	off
	12	off	off	on	on
	13	off	off	on	off
Yellow (2 sec)	14	off	on	off	off
	15	off	on	off	off

Solution: With counters, this is a 5-line program. 6 if you want a clock pulse to happen every second.

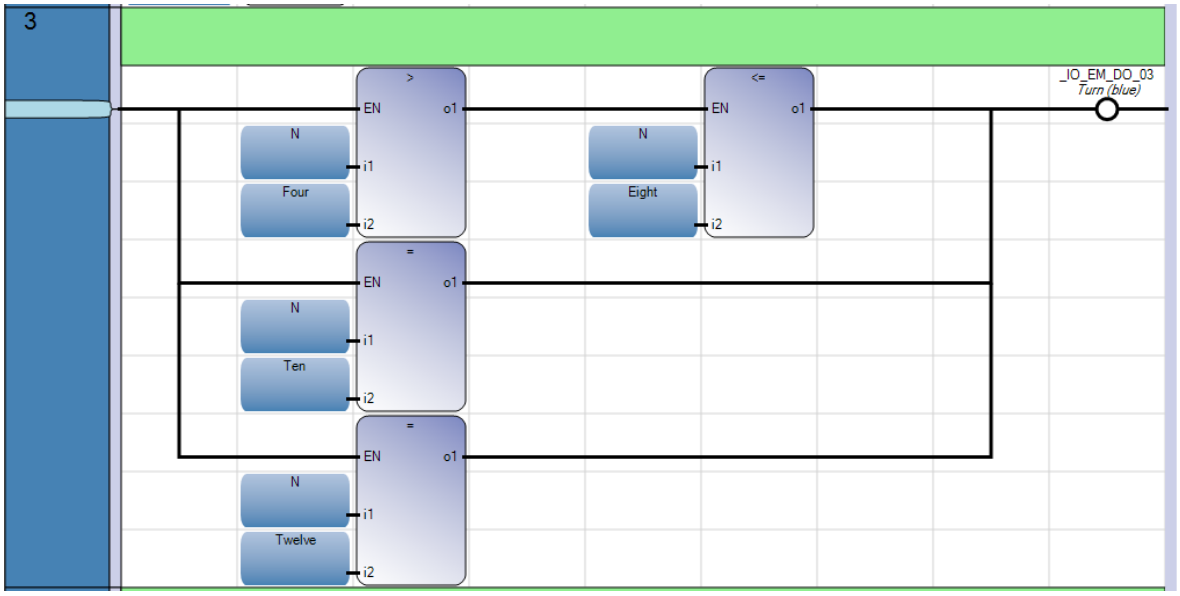
Rung 1: Count to 16 and repeat

Rung 2: The red light is on when the count is less than or equal to 4



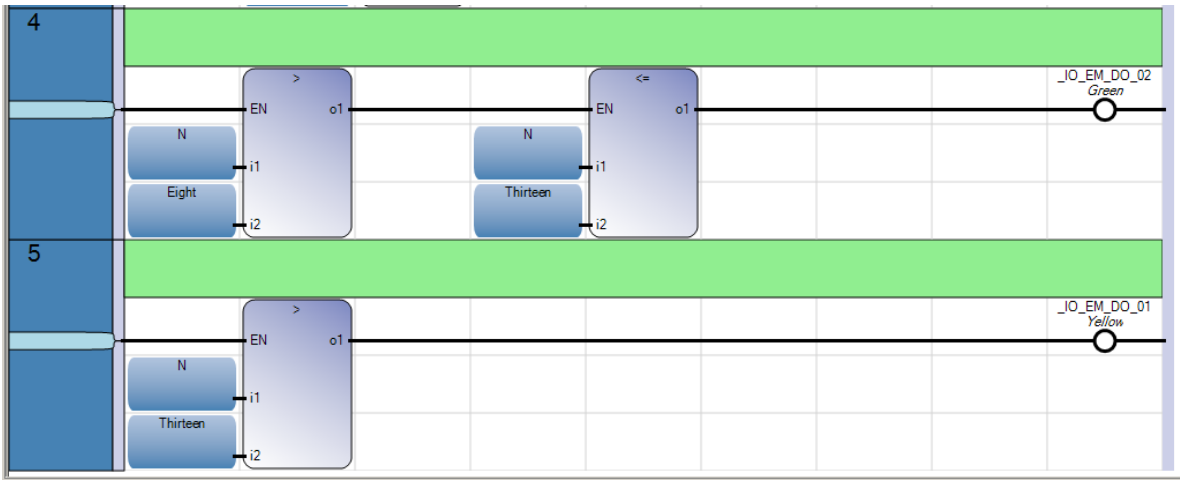
Rung 3: The turn arrow (blue) is on when the count is

- Between 5 and 8,
- or equal to 10
- or equal to 12



Rung 4: Green light is on if the count is between 9 and 13

Rung 5: Yellow light is on if the count is 14 or 15 (more than 13)



Rung 6: (optional) If you want to autmoate the clock so that it pulses once per second (rather than manually hitting it)

Manual clock is nice for debugging

Automate clock is nice for operation