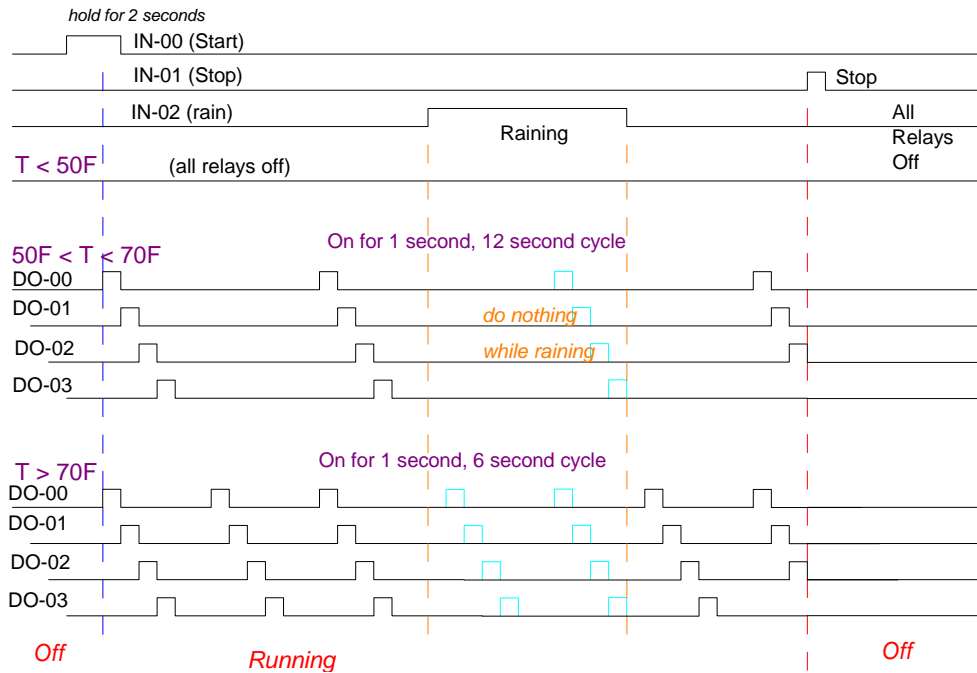


Test #1: ECE 461 / 661

PLC Programming.: Due Monday, September 19th

Note: This is a midterm so please work alone or in groups of 2. If you work in a group of 2, please turn in one solution with both of your names on your solution. If another student needs help with something basic, like getting the PLC to communicate with the PC, feel free to help. If another student needs help doing the test, please ask them to see the instructor (Jake Glower).



Write a PLC program (ladder diagram or structured text) to implement an irrigation system:

Input:

- AI03: Temperature 0F (0000) to 100F (1000)
- DI-00: On. Turn on the irrigation system. Button must be held for 2 seconds to turn on.
- DI-01: Stop: Turn off immediately (no delay) and it remains off until turned on
- DI-02: Rain Sensor. It's raining if the button is pressed.

Output: Four relays which control four separate sprinklers - only one of which should be on at any time.

Function:

When off or its raining, all sprinklers are turned off (relay = off)

When on and it's not raining

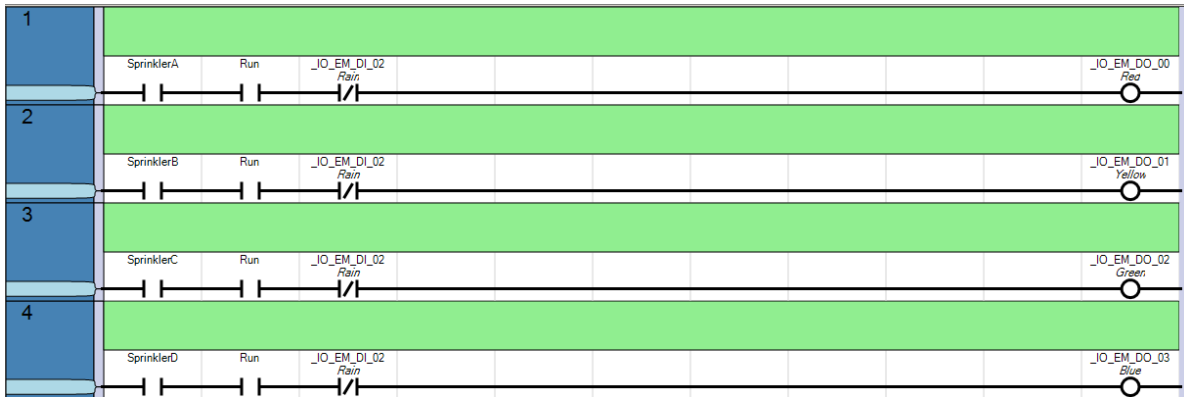
- If the temperature is less than 50F, all sprinklers are turned off.
- If the temperature is between 50F and 70F (A/D reads 500 to 700), turn on the sprinklers sequentially for one second every 12 seconds.
- If the temperature is above 70F (A/D reads 701 or more), turn on the sprinklers sequentially for one second every 6 seconds.

At any time, hitting Stop (DI-01) will turn off all relays immediately (safety kill switch).

Solution (Ladder Logic):

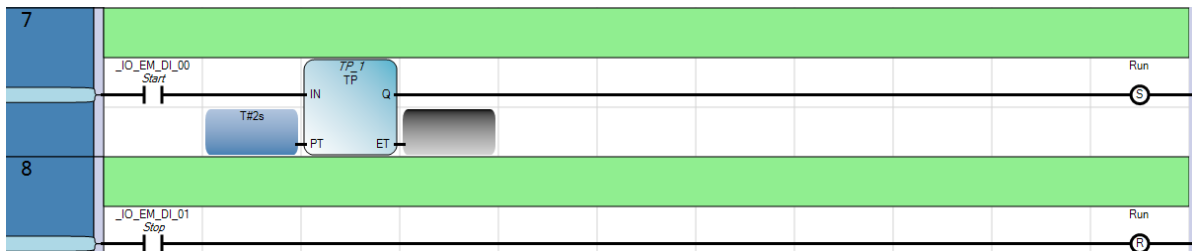
Start with the output logic. Assume you have four outputs to control the four sprinklers. The output goes high if

- It's time for the sprinkler to go on, and
- It's running, and
- It's not raining.

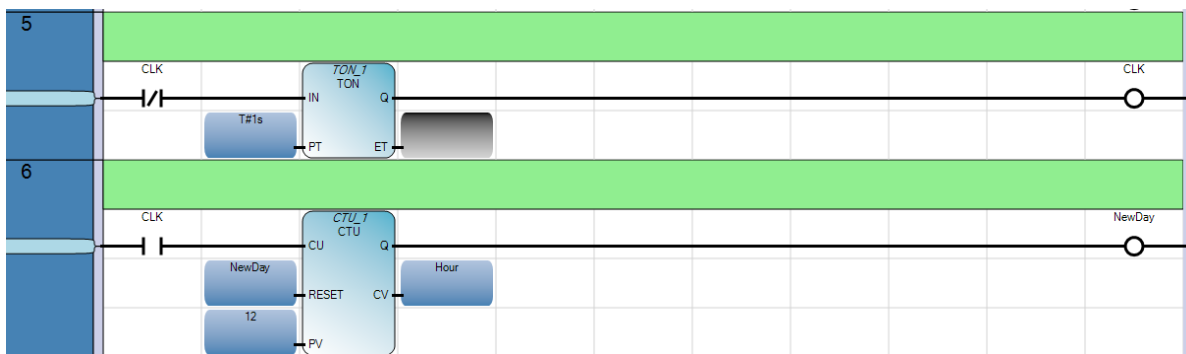


To enter running mode,

- You have to hold down the Start button (button 0) for 2 seconds to start running.
- If you ever hit the kill button (button 1), it stops running



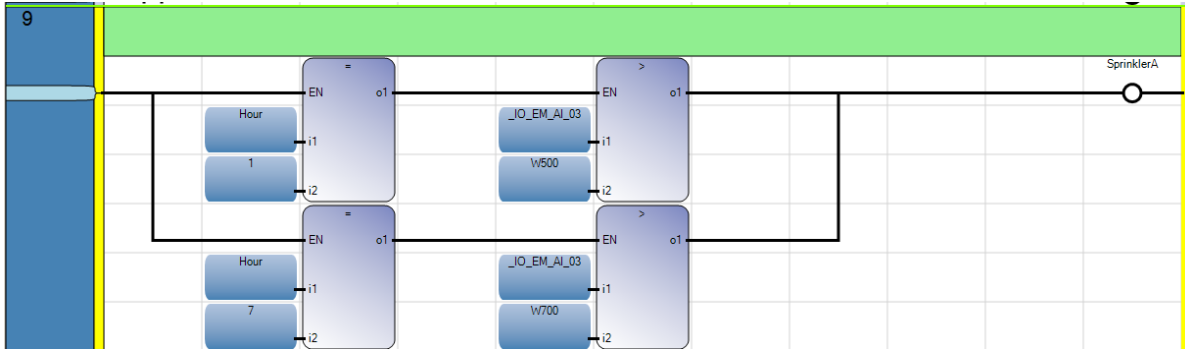
Keep track of time from 0 ..11 seconds using a ring counter (modeling a 12-hour day).



The sprinklers turn on depending upon the time of day and the temperature

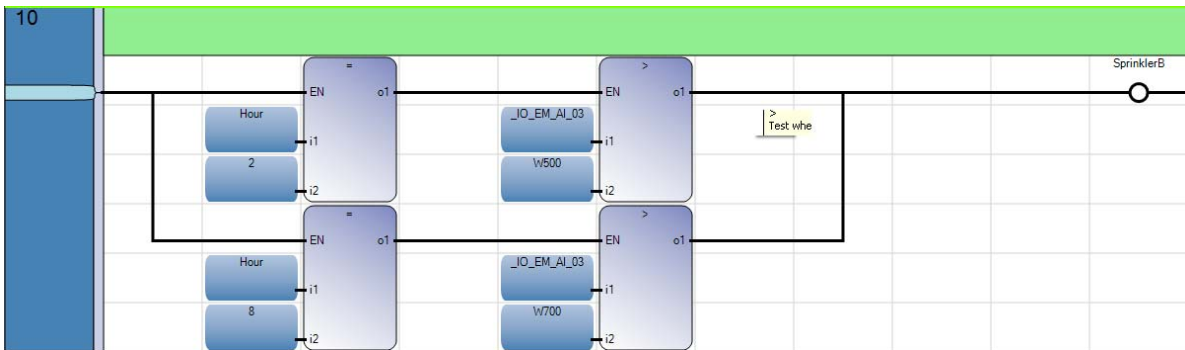
SprinklerA turns on if

- $T > 50F$ and it's 1:00, or
- $T > 70$ and it's 7:00



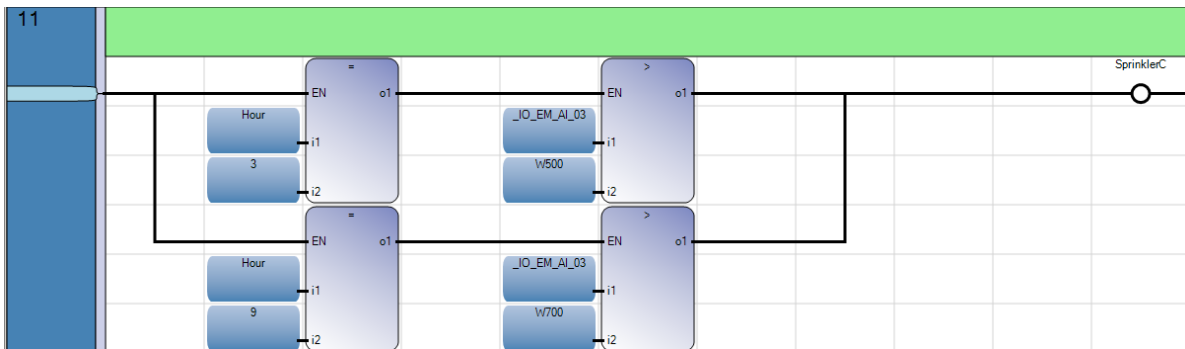
SprinklerB turns on if

- $T > 50F$ and it's 2:00, or
- $T > 70$ and it's 8:00



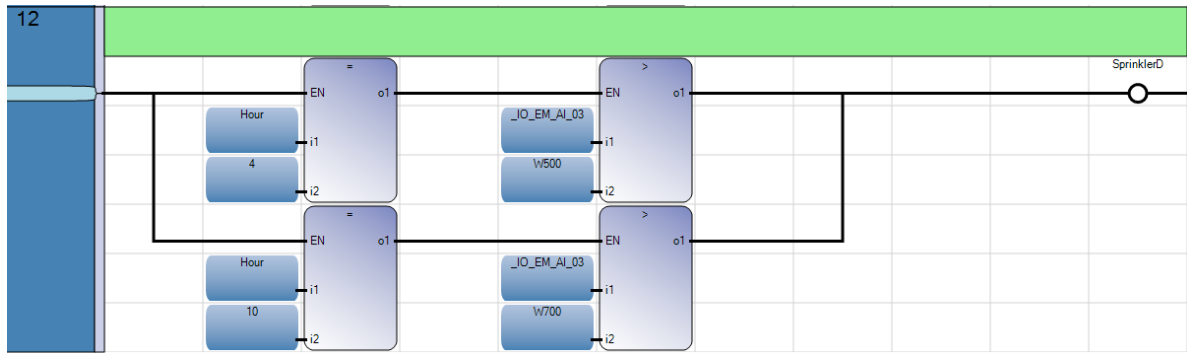
SprinklerC turns on if

- $T > 50F$ and it's 3:00, or
- $T > 70$ and it's 9:00

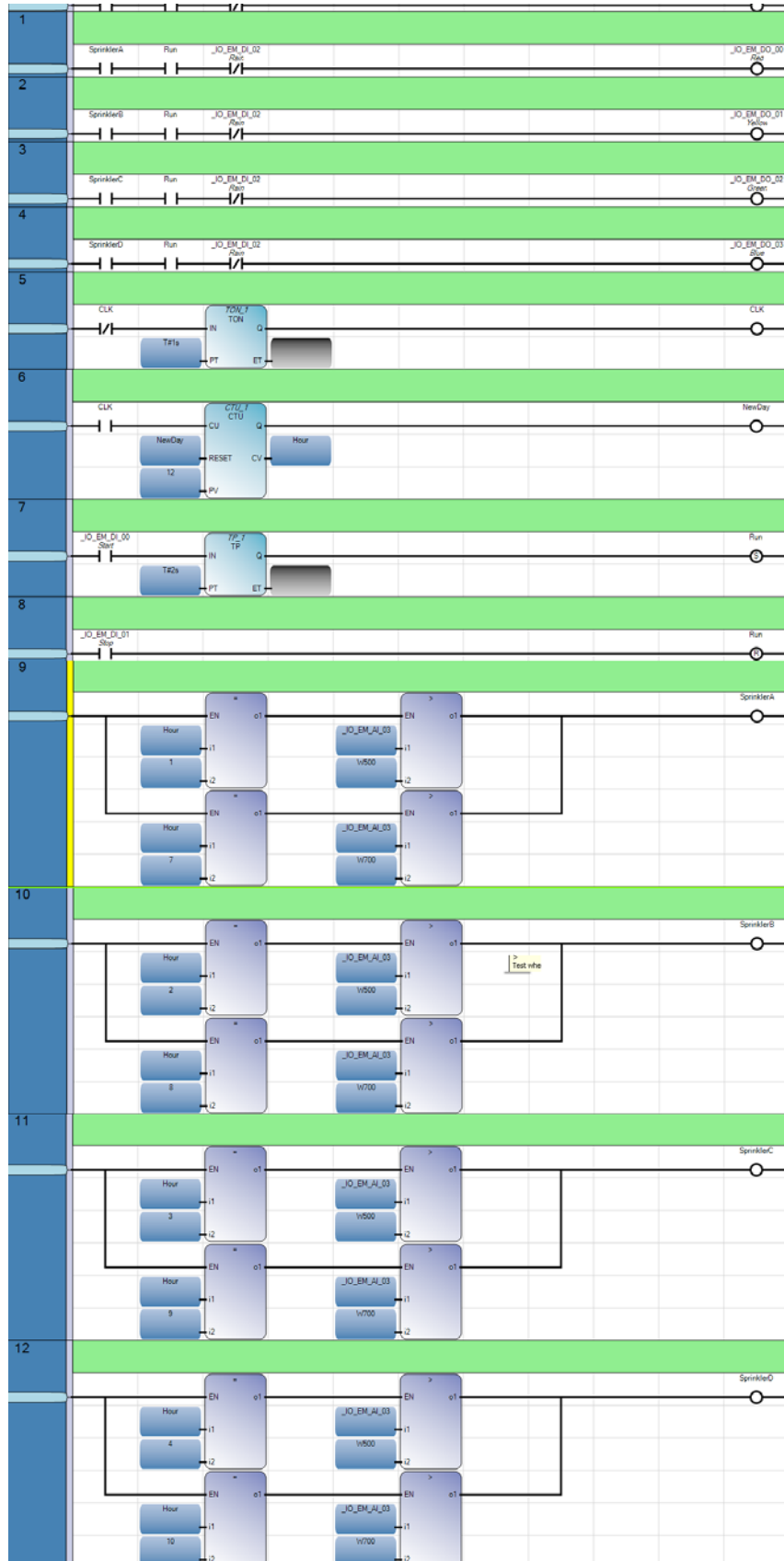


SprinklerD turns on if

- $T > 50F$ and it's 4:00, or
- $T > 70$ and it's 10:00



Whole Program:



Structured Text Version:

```
(* Water Irrigation System *)

(* Input Buttons *)
Start := _IO_EM_DI_00;
Stop  := _IO_EM_DI_01;
Rain  := _IO_EM_DI_02;
Temperature := _IO_EM_AI_03;

(* Output Logic for the sprinklers *)
_IO_EM_DO_00 := SprinklerA and Run and NOT(Rain);
_IO_EM_DO_01 := SprinklerB and Run and NOT(Rain);
_IO_EM_DO_02 := SprinklerC and Run and NOT(Rain);
_IO_EM_DO_03 := SprinklerD and Run and NOT(Rain);

(* Ring counter to tell you the time of day ( 0 .. 11 ) *)
CTU_1(CLK, CTU_1.Q, 12);
Hour := CTU_1.CV;
TON_1(NOT(CLK), T#1s);
CLK := TON_1.Q;

(* Start by holding down button #0 for 2 seconds *)
TON_2(Start, T#2s);
IF(TON_2.Q) THEN
    RUN := TRUE;
END_IF;

(* Master kill if you ever press button #1 *)
IF(Stop) THEN
    Run := FALSE;
END_IF;

(* Logic for when the sprinklers are on *)
SprinklerA := FALSE;
SprinklerB := FALSE;
SprinklerC := FALSE;
SprinklerD := FALSE;

CASE (Hour) OF
0: IF (Temperature > 500) THEN SprinklerA := TRUE; END_IF;
1: IF (Temperature > 500) THEN SprinklerB := TRUE; END_IF;
2: IF (Temperature > 500) THEN SprinklerC := TRUE; END_IF;
3: IF (Temperature > 500) THEN SprinklerD := TRUE; END_IF;
6: IF (Temperature > 700) THEN SprinklerA := TRUE; END_IF;
7: IF (Temperature > 700) THEN SprinklerB := TRUE; END_IF;
8: IF (Temperature > 700) THEN SprinklerC := TRUE; END_IF;
9: IF (Temperature > 700) THEN SprinklerD := TRUE; END_IF;
END_CASE;
```