Overview

The basic overview of this system is to design a PLC program using ladder logic to control the operation of an irrigation system. The system is designed so that each station (1-6) runs for a 20 second duration. The sequence of the stations is listed in the table below. Depending on the station, either a low or high flow is to be requested from the WSS. Flow indicators are debounced for an appropriate amount of time. Alarms are to be present if valves fail to open or close within a specified time, and if flow indicators are not active within a specified time. The system is not able to run with an alarm present and can be reset by the alarm reset button.

Functional Specifications

Sequence Step	Irrigation Target	High or Low Flow	Time
1	4	Low	20s
2	1	Low	20s
3	5	Low	20s
4	2	High	20s
5	3	High	20s
6	6	Low	20s

The on switch is used as an operator input to turn the system on. The system can run once the on switch is on, and the run command push button has been pressed. The system will not run if a WSS alarm is present of if the WSS is unavailable due to a fault.

Once the system is running the irrigation sequences will start. The first station is station 4. The system will hold the valve 4 open for 20 seconds unless an alarm is present. Once station 4 is completed, it will close the valve and move onto the next station until all stations have been completed. This will repeat for all irrigation stations until the last station has been completed. The running light will be active during each irrigation sequence to let operators know the system is running.

When a valve open command is active, it will request either a high or low flow water request from the WSS depending on which valve is open unless the WSS is inactive or in alarm.

The system will go into alarm and stop running in one of three conditions:

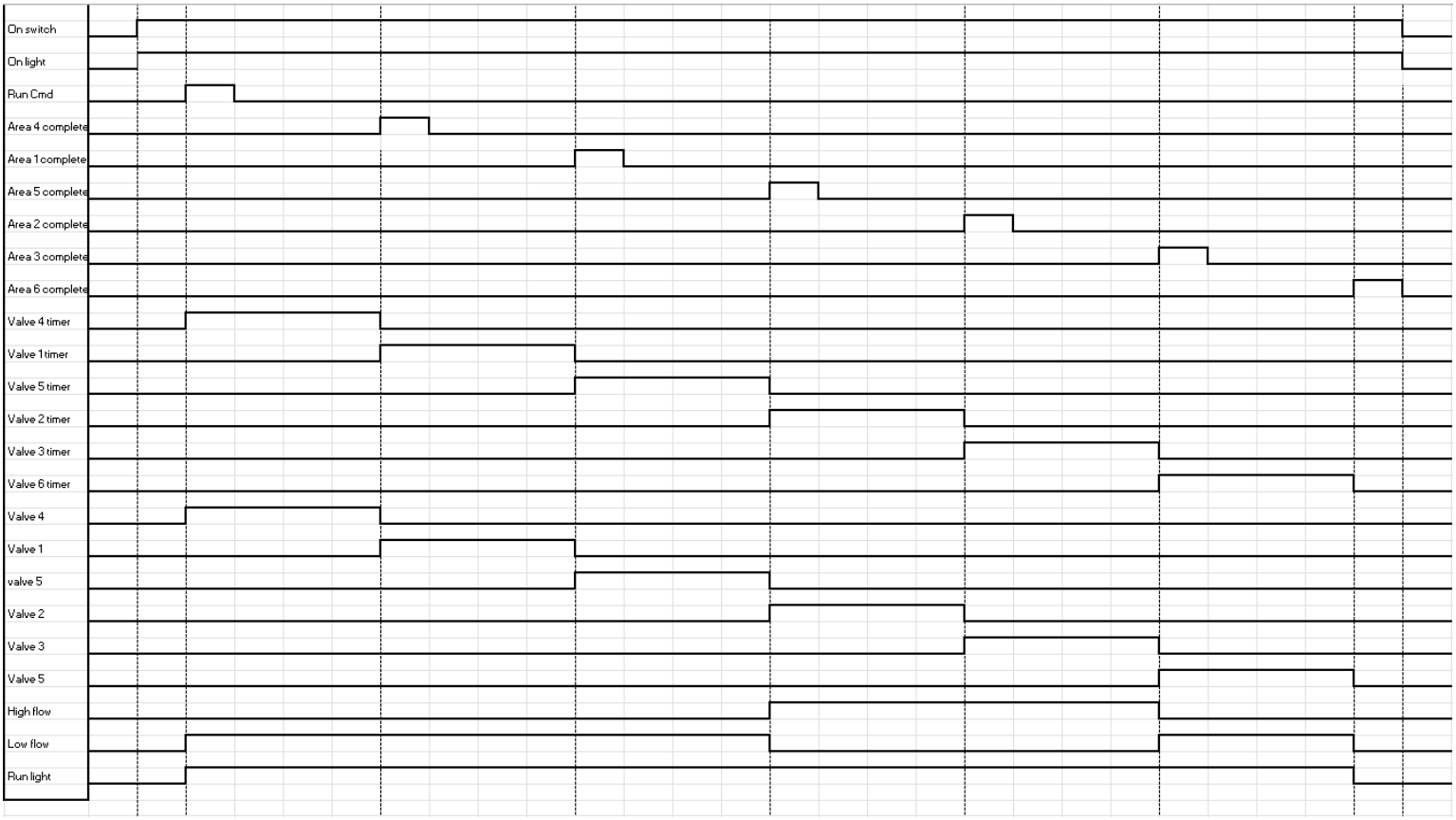
- valve failed to open
  - A valve open command is present, and its open indicator is not active within 5 seconds.
- valve failed to close
  - A valve open command is **not** present, and its closed indicator is not active within 5 seconds.
- flow alarm.
  - A valve open command is present, and its corresponding flow indicator is not active within 10 seconds.

In this case, the system will not run until an operator has inspected/rectified the issue and reset the alarm. The system will then start running again with the run command push button.

The alarm light will flash if any alarms are present, and the run light will turn off.

Once the system has completed all 6 irrigation steps, it will return to idle and wait for an operator to push the run command push button to start another cycle.

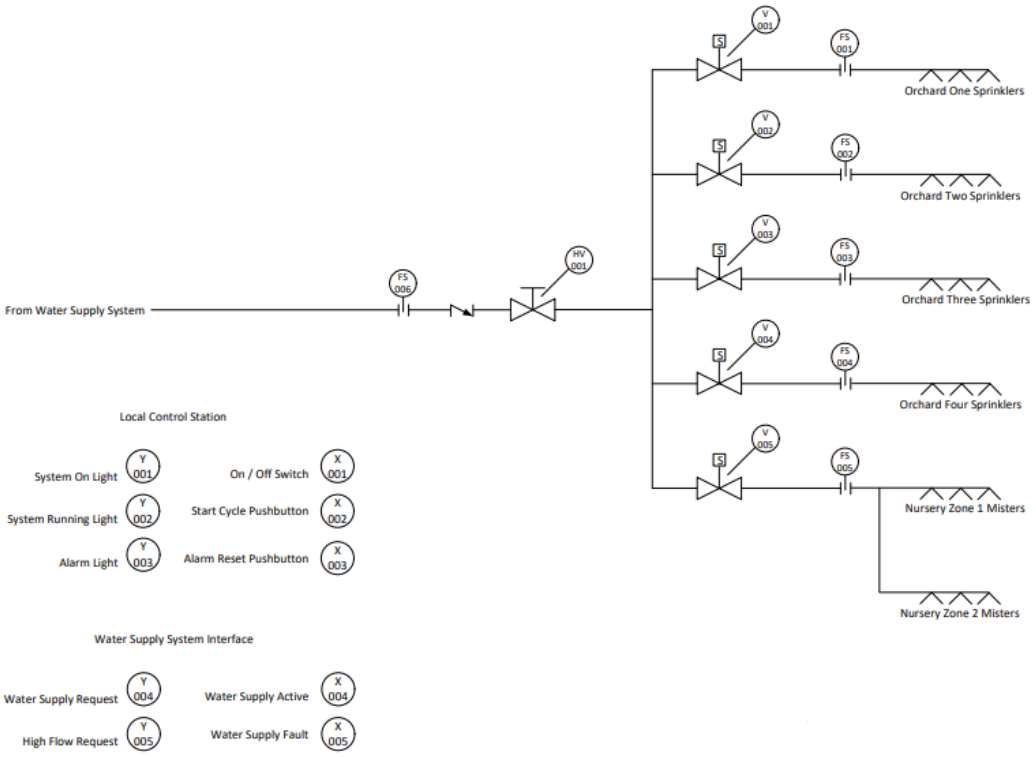
Timing chart



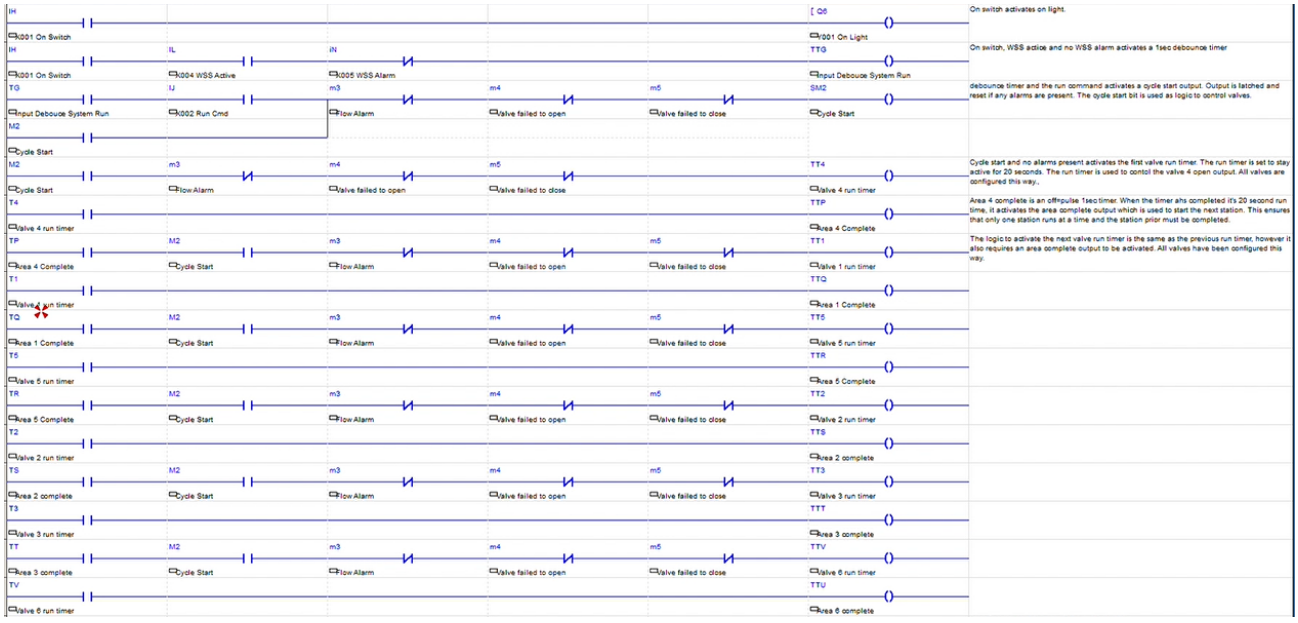
Code description

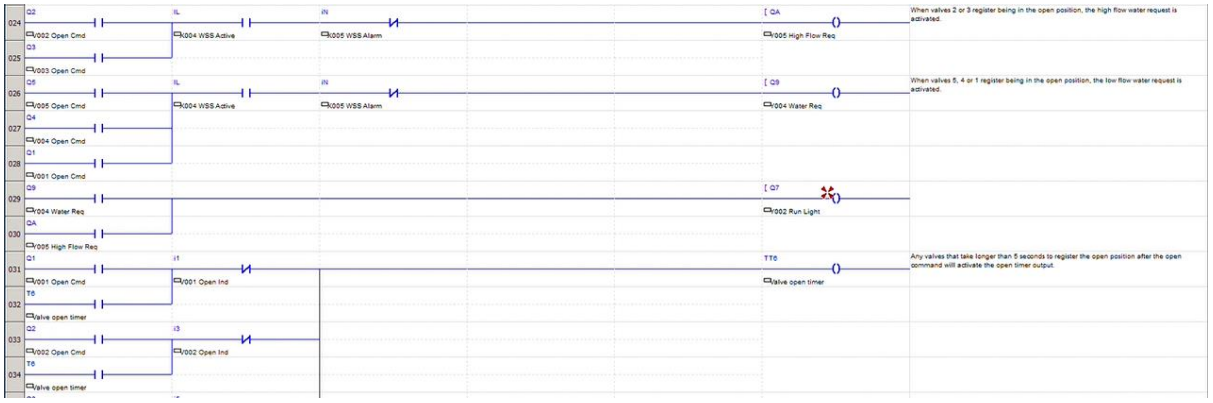
- To activate the on light, the on switch must be active.
- The on switch, WSS active and no WSS alarms are configured to activate an input debounce timer called Input System Run. System run will not activate unless the WSS is active and not in alarm.
- If the input system run and run command are active, and if no flow or valve alarms are present, a cycle start output will be activated. This is latched so the run push button does not need to be held on.
- Cycle start output with no alarms will activate the Valve 4 run timer.
- Each valve has a run timer that is configured to activate its corresponding valve open command. The run timer is configured to hold the run timer open for 20 seconds if no alarms are present.
- Once a valve run timer input is deactivated (after 20 seconds) an off-pulse timer called Area Complete will be activated. This is used with the cycle start output to trigger the valve run timer for the next station. This is implemented so that a station cannot run unless its previous station has completed.
- Once the system has been through all stations, the last output used is the Area 6 complete. This output is used to turn the run light off (to let operators know the system is no longer running).
- Each valve timer will activate its corresponding valve open command if no alarms are present.
- Valves 2 and 3 open commands will send a High Flow Water Request to the WSS if the WSS is active and no WSS alarms are present.
- Valves 5, 4 and 1 will send a Low Flow Water Request to the WSS if the WSS is active and no WSS alarms are present.
- High or low water request will activate system running light.
- If a valve has an open command does not register being in the open position, it will start a 5 second timer. If the valves open position is not reached within 5 seconds, it will activate a valve failed to open alarm. This alarm is latched for operators to inspect before resetting.
- If a valve does not have an open command does not register being in the closed position, it will start a 5 second timer. If the valve's closed position is not reached within 5 seconds, it will activate a valve failed to close alarm. This alarm is latched for operators to inspect before resetting.
- Each flow indicator runs through a 1 second debounce timer as per assignment specification. If a valve has an open command and its corresponding flow indicator does not register any flow it will start a 10 second timer. If no flow is seen within 10 seconds, it will register a flow alarm. This alarm is latched for operators to inspect before resetting.
- The alarm light is activated if either valve or flow alarm is activated. They are individually latched.
- With all alarms there is a memory bit to disable the output to the alarms. This is in place to allow for testing of the system without alarms interfering.

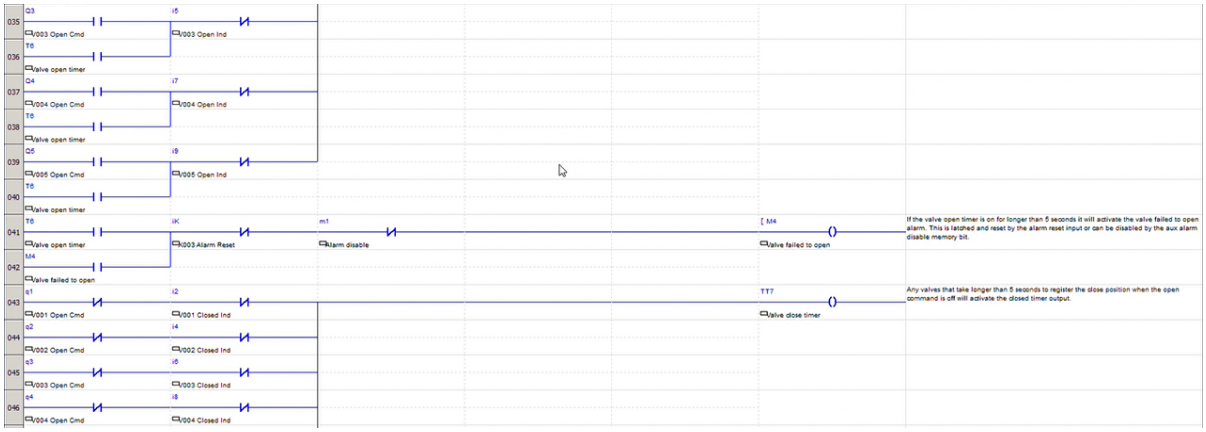
PID



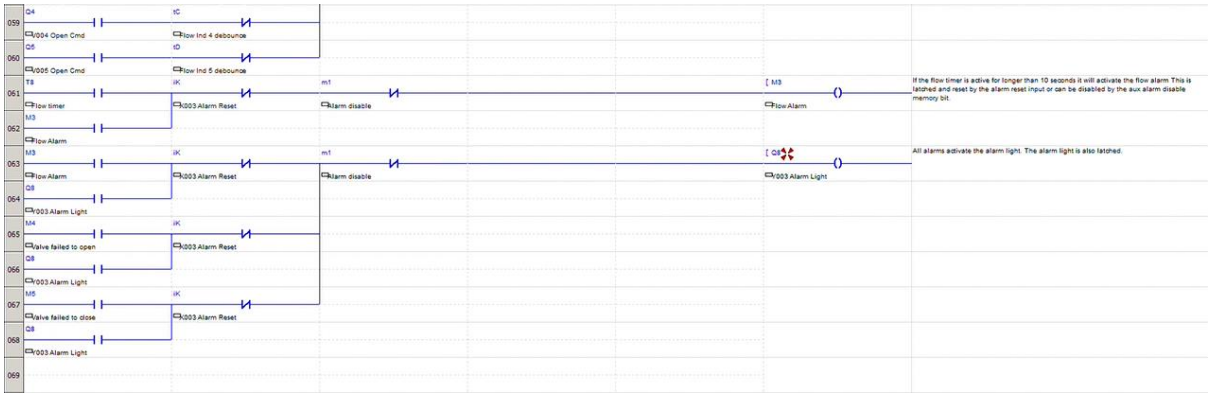
Ladder Logic




Q2
/002 Open Cmd
Q3
/003 Open Cmd
Q5
/005 Open Cmd
Q4
/004 Open Cmd
Q1
/001 Open Cmd
Q9
/004 Water Req
QA
/005 High Flow Req
T6
/alve open timer
I04 WSS Active
I05 WSS Alarm
[QA
I005 High Flow Req
When valves 2 or 3 register being in the open position, the high flow water request is activated.
[Q9
I004 Water Req
When valves 5, 4 or 1 register being in the open position, the low flow water request is activated.
[Q7
I002 Run Light
I01 Open Ind
I03 Open Ind
TT6
/alve open timer
Any valves that take longer than 5 seconds to register the open position after the open command will activate the open timer output.


I05 Open Ind
I07 Open Ind
I09 Open Ind
I03 Alarm Reset
m1
Alarm disable
[M4
/alve failed to open
If the valve open timer is on for longer than 5 seconds it will activate the valve failed to open alarm. This is latched and reset by the alarm reset input or can be disabled by the aux alarm disable memory bit.
q1
q2
q3
q4
I01 Closed Ind
I02 Closed Ind
I04 Closed Ind
I06 Closed Ind
I08 Closed Ind
TT7
/alve close timer
Any valves that take longer than 5 seconds to register the close position when the open command is off will activate the closed timer output.


q5
I05 Closed Ind
T7
M5
/alve failed to close
[M5
If the valve close timer is on for longer than 5 seconds it will activate the valve failed to close alarm. This is latched and reset by the alarm reset input or can be disabled by the aux alarm disable memory bit.
IB
IC
ID
IE
IF
IG
S001 Flow Ind
S002 Flow Ind
S003 Flow Ind
S004 Flow Ind
S005 Flow Ind
S006 Flow Ind
TT9
TTA
TTB
TTC
TTD
TTE
low Ind 1 debounce
low Ind 2 debounce
low Ind 3 debounce
low Ind 4 debounce
low Ind 5 debounce
low Ind 6 debounce
All flow indicators are debounced for 1 second.
t9
tE
TT8
low timer
If a valve opens and the downstream flow indicator debounce does not activate within 10 seconds, the flow timer output will activate. Additional logic is included to ensure flow is seen through the individual station and the main WSS supply flow indicator.


tC
tD
M3
low Alarm
[M3
low Alarm
If the flow timer is active for longer than 10 seconds it will activate the flow alarm. This is latched and reset by the alarm reset input or can be disabled by the aux alarm disable memory bit.
Q8
/003 Alarm Light
[Q8
/003 Alarm Light
All alarms activate the alarm light. The alarm light is also latched.