

Lab #2: Water Filling System - Ladder Diagram

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Problem Statement

It is required to design a ladder diagram for the following operation:

- A pump is used to fill 2 storage tanks.
 - The pump is manually started by the operator (using a pushbutton) and can also be closed manually by another pushbutton.
 - The pump stops after 3 seconds from pressing the close pushbutton.
 - When the pump is started, the circuit will fill the first tank.
 - When the first tank is full, the circuit must be able to automatically fill the second.
 - If the first tank was emptied while filling the second tank, the circuit should continue filling the second tank until it is full and then start refilling first tank.
 - When both tanks are full, the pump must automatically shut down and an “end operation” lamp will light.
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Pins (Inputs / Outputs)

Flag 0 (F0) is used to simulate the pulse coming from the timer to turn the system OFF

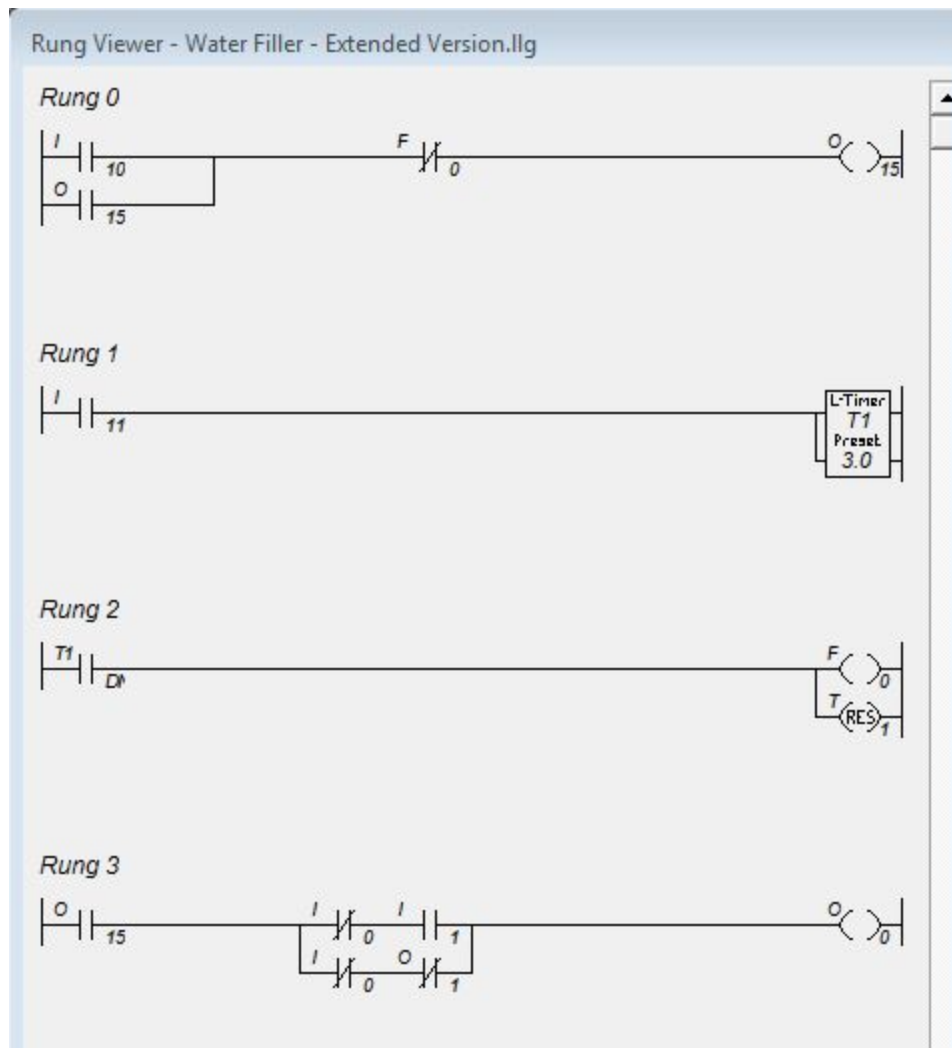
Element	Input/Output	Pin	Description
Push Button ON	Input	Input 10	Turning the system ON
Push Button OFF	Input	Input 11	Turning the system OFF
Float Switch (S1)	Input	Input 1	S1 = 1 when the first tank is full
Float Switch (S2)	Input	Input 2	S2 = 1 when the second tank is full
Limit Switch (L1)	Input	Input 3	L1 = 1 when the first valve is fully opened (Acknowledgment)
Limit Switch (L2)	Input	Input 4	L2 = 1 when the second valve is fully opened (Acknowledgment)
Coil Valve (V1)	Output	Output 1	V1 = 1 indicated that the first valve is to be fully opened by the solenoid part of it
Coil Valve (V2)	Output	Output 2	V2 = 1 indicated that the second valve is to be fully opened by the solenoid part of it
Pump Valve (P)	Output	Output 11	P = 1 indicates that the pump is pushing water through the system
Indicator Lamp (D)	Output	Output 15	D = 1 is a flash LED when the system finishes successfully

Logic

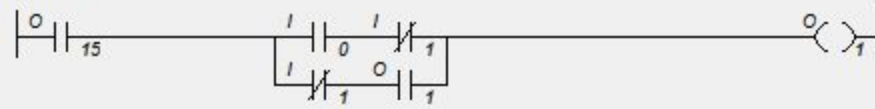
S1	S2	V1'	V2'	V1	V2	D
0	0	0	0	1	0	0
0	0	0	1	0	1	0
0	0	1	0	1	0	0
0	0	1	1	x	x	0
0	1	0	0	1	0	0
0	1	0	1	1	0	0
0	1	1	0	1	0	0
0	1	1	1	x	x	0
1	0	0	0	0	1	0
1	0	0	1	0	1	0
1	0	1	0	0	1	0
1	0	1	1	x	x	0
1	1	0	0	0	0	1
1	1	0	1	0	0	1
1	1	1	0	0	0	1
1	1	1	1	x	x	1

V1	V2	L1	L2	P
0	0	0	0	0
0	0	0	1	0
0	0	1	0	0
0	0	1	1	0
0	1	0	0	0
0	1	0	1	1
0	1	1	0	0
0	1	1	1	0
1	0	0	0	0
1	0	0	1	0
1	0	1	0	1
1	0	1	1	0
1	1	0	0	x
1	1	0	1	x
1	1	1	0	x
1	1	1	1	x

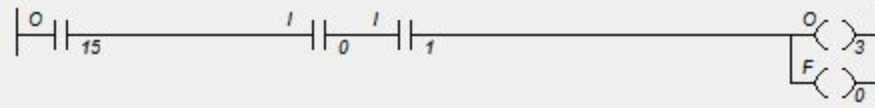
Ladder Diagram (Screenshots)



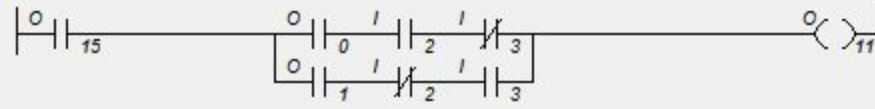
Rung 4



Rung 5



Rung 6



Explanation:

- Rungs 0 - 2 are used for providing the power ON and OFF push buttons of the system
 - i/p 10 causes the Flag to be asserted ($F = 1$) indicating that the system is powered on
 - i/p 11 is used to trigger a timer of 3 seconds where the timer will be used after these 3 seconds to deassert the flag ($F = 0$) indicating that the system is powered off
- Rungs 3 - 4 are used for handling the logic of the selondidal part of the values
 - These two rungs are based on the truth table discussed above in the logic section (For handling the values of V1 and V2)
- Rung 5 is used for handling the flash LED indicating that the system has completed its function successfully
 - This rung is also based on the truth table discussed above in the logic section (For handling the value of D)
- Rung 6 is used for **“Safety Purposes”** where the pump valve is adjusted based on the values of the limit switch
 - A possible scenario for a disaster without using a limit switch
 - Tank 1 is not full
 - Tank 1 is ready be filled by our circuit logic
 - Signal is given for the solenoid of the first tank to make the valve fully open
 - Solenoid may be broken and the valve is not fully open
 - Water is pumped to a closed valve making the system is possible to be exploded
 - The presence of the limit switch will prevent many problems from occurring at our system where it will automatically shut down the pump to prevent any damage
 - This rung is also based on the truth table discussed above in the logic section (For handling the value of P)