

Calum Rhys De-Vlugt -PSDE 4005 PLC's-Assignment 3

by Calum De Vlugt

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HNC Electrical and Electronic Engineering

Module: PSDE 4005

PLC's

Assignment 3

Name: Calum Rhys De-Vlugt

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System design and I/O List

System Design

In this part of the report all nine hardware devices that make up the process rig will be examined as and their jobs within the process rig will be explained. Below is a photo of the process rig.



Figure 1- Process Rig

Process Tank and RTD Process Tank Temperature Sensor



Figure 2- Process Tank

The process tank is an important device within the process rig as this is where the water is taken to be heated. The process tank will keep filling up until it reaches maximum volume and then it will gradually be heated to the chosen temperature. The RTD process tank temperature sensor is inside the tank and helps keep track of the temperature of the water.

Sump Tank

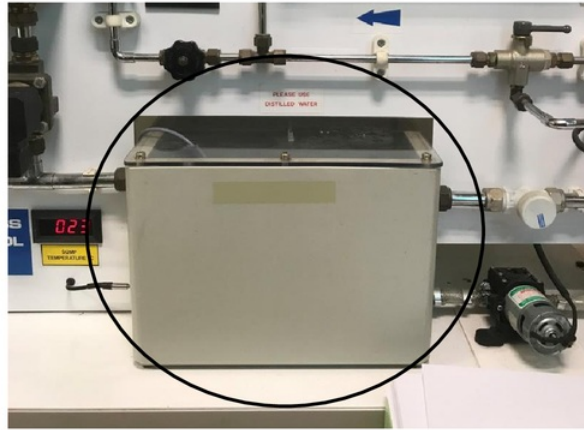


Figure 3- Sump Tank

The sump tank as shown in the picture above is where all excess water is diverted too, the sump tank can store a large amount of water and will keep it stored until it is needed elsewhere in the process rig.

Cooling Fan



Figure 4- Cooler

If the water is too hot within the process rig then it will be diverted to the cooler fan which is shown in the picture on the left. As the water travels through the cooler it will decrease in temperature before returning to the process tank.

Drain Valve



Figure 5- Drain Valve

Once the process tank has reached maximum volume and the water has been heated to the chose temperature then the drain valve underneath the process tank as shown in the picture on the left can open to release the excess water that is not needed back into the sump tank.

Divert Valve



Figure 6- Divert Valve

The divert valve shown on the left is used to divert the water flow to either flow straight to the process tank or to flow to the cooler.

Pump



The pump shown in the picture to the right is one of the main devices in the process rig as it pumps the water back up to either the process tank or the cooler. Without the pump the water wouldn't be able to leave the sump tank and circulate around the process rig.

Figure 7 - Pump

Stirrer



The stirrer as circled in the picture on the right stirs the water within the sump tank. This prevents the water from getting stagnant.

Figure 8 - Stirrer

Level Switch



The level switch is located within the process tank at the maximum volume that the tank can take so that when the water level reaches the level switch the pump will shut off so that the water stays at that level.

Figure 9 - Level Switch

I/O List

Inputs

Address	Tag Name
Level Switch	%I1.0
Flow Rate Sensor	%IW66
RTD Process Tank Temperature Sensor	%IW96
RTD Sump Tank Sensor	%IW98
RTD Ambient Temperature Sensor	%IW100

Outputs

Address	Tag Name
Cooling Fan	%Q0.0
Stirrer	%Q0.1
Drain Valve	%Q0.2
Divert Valve	%Q0.3
Cooler Lamp	%Q0.4
Drain Valve Lamp	%Q0.5
Divert Valve Lamp	%Q0.6
Tank Full Lamp	%Q0.7
Heater	%Q1.0
Pump	%Q1.1

system requirements

2. Program Design and Explanation

PLC Tags

PLC tags									
	Name	Tag table	Data type	Address	Retain	Acces...	Writa...	Visibl...	
1	 Level Switch	Default tag table	Bool	%I1.0					
2	 Flow Rate Sensor	Default tag table	Word	%IW66					
3	 RTD Process Tank Temp Sensor	Default tag table	Word	%IW96					
4	 RTD Sump Tank Temp Sensor	Default tag table	Word	%IW98					
5	 RTD Ambient Temp Sensor	Default tag table	Word	%IW100					
6	 Cooling Fan	Default tag table	Bool	%Q0.0					
7	 Stirrer	Default tag table	Bool	%Q0.1					
8	 Drain Valve	Default tag table	Bool	%Q0.2					
9	 Divert Valve	Default tag table	Bool	%Q0.3					
10	 Cooler Lamp	Default tag table	Bool	%Q0.4					
11	 Drain Valve Lamp	Default tag table	Bool	%Q0.5					
12	 Divert Valve Lamp	Default tag table	Bool	%Q0.6					
13	 Tank Full Lamp	Default tag table	Bool	%Q0.7					
14	 Heater	Default tag table	Bool	%Q1.0					
15	 Pump	Default tag table	Bool	%Q1.1					
16	 Flow %CV PWM Duty Cycle	Default tag table	Uint	%QW1000					
17	 Process Temperature %CV PWM...	Default tag table	Uint	%QW1002					
18	 Start Pump	Default tag table	Bool	%M100.0					
19	 Auto	Default tag table	Bool	%M100.1					
20	 HMI stirrer request	Default tag table	Bool	%M100.2					
21	 HMI drain valve request	Default tag table	Bool	%M100.3					
22	 HMI heater request	Default tag table	Bool	%M100.4					
23	 HMI pump request	Default tag table	Bool	%M100.5					
24	 HMI divert request	Default tag table	Bool	%M100.6					
25	 HMI cooler request	Default tag table	Bool	%M100.7					
26	 Stirrer auto request	Default tag table	Bool	%M101.0					
27	 Drain auto request	Default tag table	Bool	%M101.1					
28	 Heater auto request	Default tag table	Bool	%M101.2					
29	 Pump auto request	Default tag table	Bool	%M101.3					
30	 Divert auto request	Default tag table	Bool	%M101.4					
31	 Cooler auto request	Default tag table	Bool	%M101.5					
32	 HMI lamp test request	Default tag table	Bool	%M101.6					
33	 HMI Auto start	Default tag table	Bool	%M110.0					
34	 Auto Run	Default tag table	Bool	%M110.1					
35	 HMI Auto stop	Default tag table	Bool	%M110.2					
36	 Auto Flow	Default tag table	Bool	%M110.3					
37	 Auto Heater	Default tag table	Bool	%M110.4					
38	<Add new>								

Scale Data Blocks

Scale for Flowrate

Scale_DB process temp								
	Name	Data type	Start value	Retain	Accessible f...	Writa...	Visible in ...	Setpoint
1	▼ Input			☐	☐	☐	☐	☐
2	Raw	UInt	0	☐	☒	☒	☒	☐
3	Off set	Real	0.0	☐	☒	☒	☒	☐
4	Mul	Real	0.0	☐	☒	☒	☒	☐
5	Div	Real	0.0	☐	☒	☒	☒	☐
6	▼ Output			☐	☐	☐	☐	☐
7	Value	Real	0.0	☐	☒	☒	☒	☐
8	InOut			☐	☐	☐	☐	☐
9	Static			☐	☐	☐	☐	☐

Scale for Ambient Temperature

Scale_DB for ambient temp								
	Name	Data type	Start value	Retain	Accessible f...	Writa...	Visible in ...	Setpoint
1	▼ Input			☐	☐	☐	☐	☐
2	Raw	UInt	0	☐	☒	☒	☒	☐
3	Offset	Real	0.0	☐	☒	☒	☒	☐
4	Mul	Real	0.0	☐	☒	☒	☒	☐
5	Div	Real	0.0	☐	☒	☒	☒	☐
6	▼ Output			☐	☐	☐	☐	☐
7	Value	Real	0.0	☐	☒	☒	☒	☐
8	InOut			☐	☐	☐	☐	☐
9	Static			☐	☐	☐	☐	☐

Scale for Sump Temperature

Scale_DB for sump temp								
	Name	Data type	Start value	Retain	Accessible f...	Writa...	Visible in ...	Setpoint
1	▼ Input			☐	☐	☐	☐	☐
2	Raw	UInt	0	☐	☒	☒	☒	☐
3	Off set	Real	0.0	☐	☒	☒	☒	☐
4	Mul	Real	0.0	☐	☒	☒	☒	☐
5	Div	Real	0.0	☐	☒	☒	☒	☐
6	▼ Output			☐	☐	☐	☐	☐
7	Value	Real	0.0	☐	☒	☒	☒	☐
8	InOut			☐	☐	☐	☐	☐
9	Static			☐	☐	☐	☐	☐

Scale for Process Temperature

Scale_DB process temp								
	Name	Data type	Start value	Retain	Accessible f...	Writa...	Visible in ...	Setpoint
1	▼ Input			☐	☐	☐	☐	☐
2	Raw	UInt	0	☐	☒	☒	☒	☐
3	Off set	Real	0.0	☐	☒	☒	☒	☐
4	Mul	Real	0.0	☐	☒	☒	☒	☐
5	Div	Real	0.0	☐	☒	☒	☒	☐
6	▼ Output			☐	☐	☐	☐	☐
7	Value	Real	0.0	☐	☒	☒	☒	☐
8	InOut			☐	☐	☐	☐	☐
9	Static			☐	☐	☐	☐	☐

PID Data Blocks

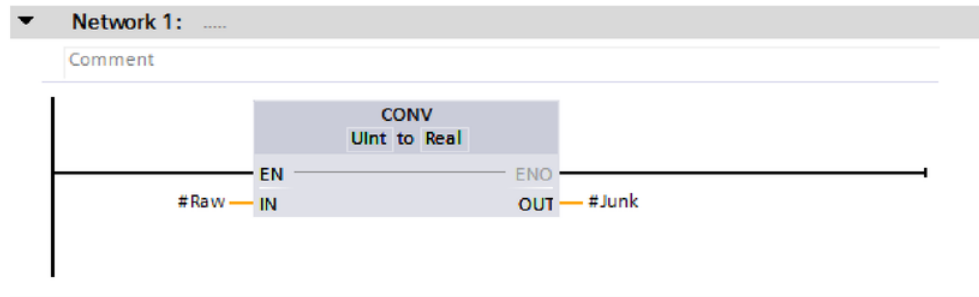
PID for Flow Control

PID_DB for flow control								
	Name	Data type	Start value	Retain	Accessible f...	Writa...	Visible in ...	Setpoint
1	▼ Input			☐	☐	☐	☐	☐
2	■ sp	Real	0.0	☐	☒	☒	☒	☐
3	■ pv	Real	0.0	☐	☒	☒	☒	☐
4	▼ Output			☐	☐	☐	☐	☐
5	■ cv	Real	0.0	☐	☒	☒	☒	☐
6	InOut			☐	☐	☐	☐	☐
7	▼ Static			☐	☐	☐	☐	☐
8	■ error	Real	0.0	☐	☒	☒	☒	☐
9	■ old error	Real	0.0	☐	☒	☒	☒	☐
10	■ int_accum	Real	0.0	☐	☒	☒	☒	☐
11	■ kp	Real	0.0	☐	☒	☒	☒	☐
12	■ kd	Real	0.0	☐	☒	☒	☒	☐
13	■ ki	Real	0.0	☐	☒	☒	☒	☐
14	■ int_accum_max	Real	0.0	☐	☒	☒	☒	☐
15	■ diff	Real	0.0	☐	☒	☒	☒	☐
16	■ p part	Real	0.0	☐	☒	☒	☒	☐
17	■ I part	Real	0.0	☐	☒	☒	☒	☐
18	■ d part	Real	0.0	☐	☒	☒	☒	☐

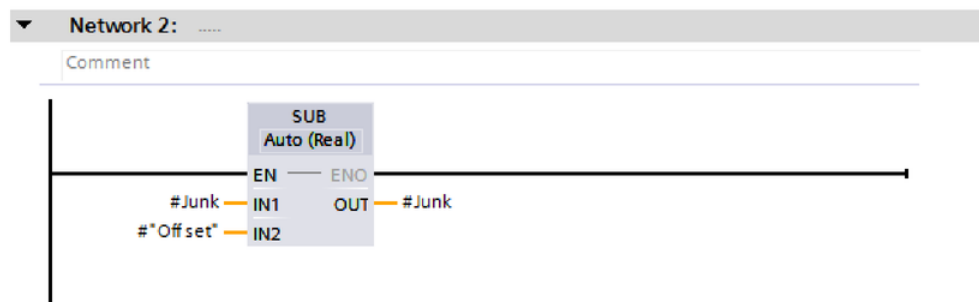
PID for Temperature Control

PID_DB for temperature control								
	Name	Data type	Start value	Retain	Accessible f...	Writa...	Visible in ...	Setpoint
1	▼ Input			☐	☐	☐	☐	☐
2	■ sp	Real	0.0	☐	☒	☒	☒	☐
3	■ pv	Real	0.0	☐	☒	☒	☒	☐
4	▼ Output			☐	☐	☐	☐	☐
5	■ cv	Real	0.0	☐	☒	☒	☒	☐
6	InOut			☐	☐	☐	☐	☐
7	▼ Static			☐	☐	☐	☐	☐
8	■ error	Real	0.0	☐	☒	☒	☒	☐
9	■ old error	Real	0.0	☐	☒	☒	☒	☐
10	■ int_accum	Real	0.0	☐	☒	☒	☒	☐
11	■ kp	Real	0.0	☐	☒	☒	☒	☐
12	■ kd	Real	0.0	☐	☒	☒	☒	☐
13	■ ki	Real	0.0	☐	☒	☒	☒	☐
14	■ int_accum_max	Real	0.0	☐	☒	☒	☒	☐
15	■ diff	Real	0.0	☐	☒	☒	☒	☐
16	■ p part	Real	0.0	☐	☒	☒	☒	☐
17	■ I part	Real	0.0	☐	☒	☒	☒	☐
18	■ d part	Real	0.0	☐	☒	☒	☒	☐

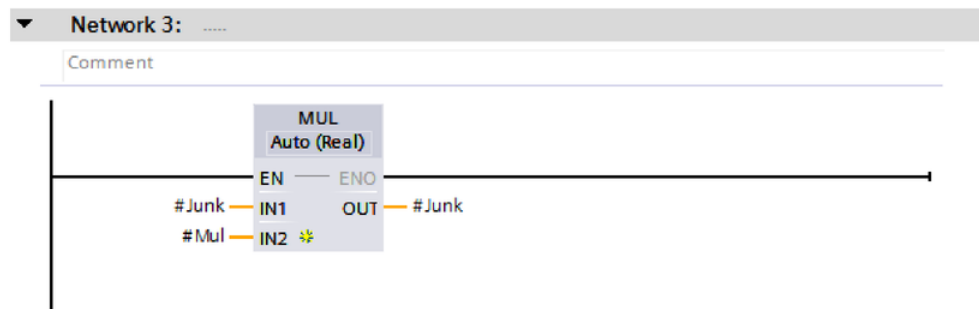
Function Block for Scale



In network 1 the raw value obtained from a sensor which is a unit integer will be converted into a real value output which is shown as 'Junk'.



The converted real output value from network 1 is the input 1 into network 2. The second input is a chosen offset value which is subtracted from the input 1 value to create the new junk output value.

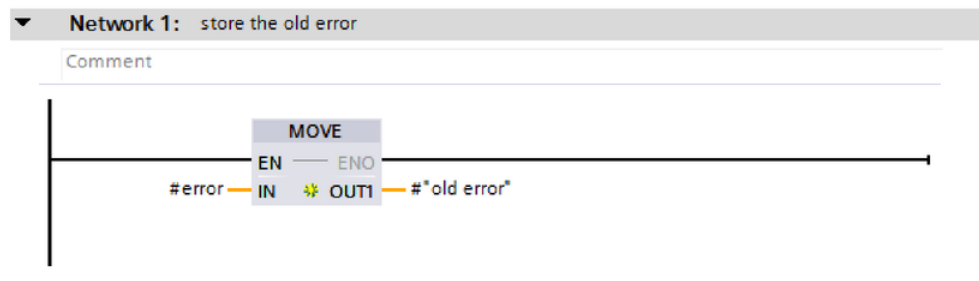


The output value from network 2 is the input 1 value for network 3. The second input value is a chosen from the main organisation block. This value which will be multiplied with the junk value to create the new junk output value.

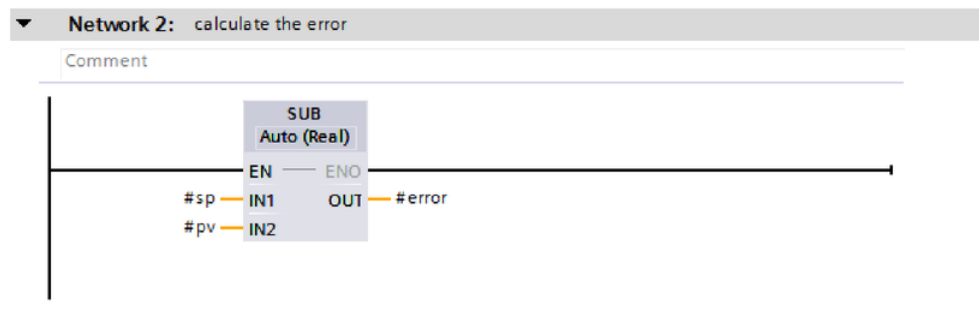


The output value from network 3 is the input 1 value for network 4. The second input value is chosen value from the main organisation block. The junk value will be divided by the chosen input 2 value to create a final output value.

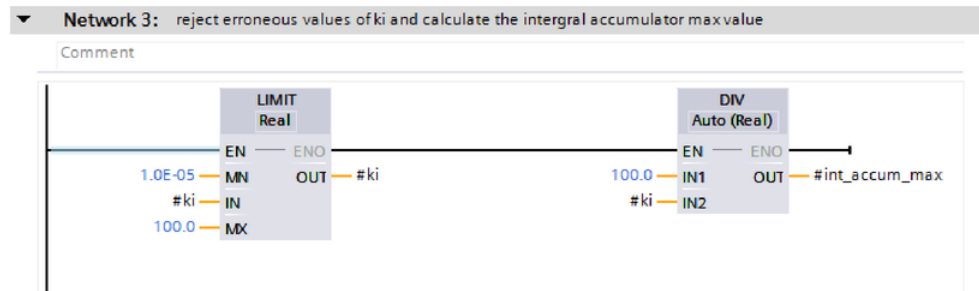
Function Block for PID



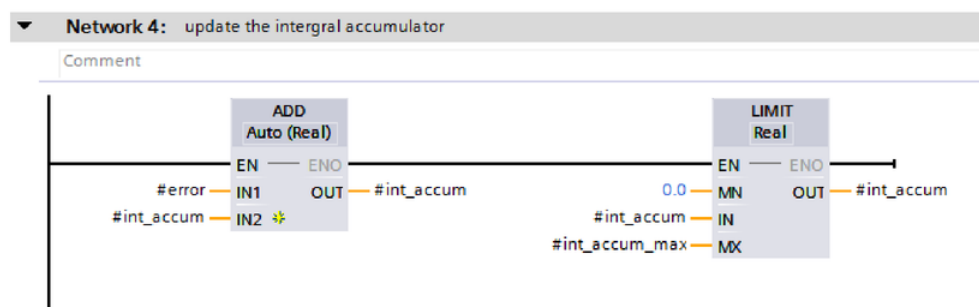
In network 1 the input value which is shown as 'error' moves to the output and is stored as the old value which is shown as 'old error' so that there is a continue update of the new value.



In network 2 the input 1 (sp) value and the input 2 (pv) value are both real values that are chosen on the PID control HMI screen. The sp value is subtracted by the pv value to create the output error value.



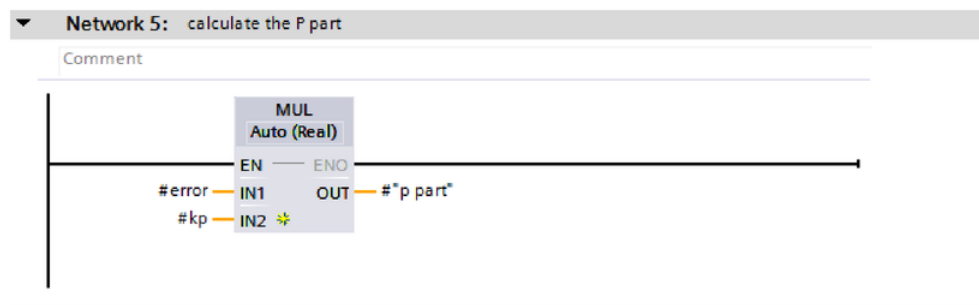
In network 3 the chosen k_i from the HMI PID control screen is limited between a minimum of $1.0E-0.5$ and a maximum of 100. A value of 100 is then divided by the new limited value of k_i to calculate the integer accumulator maximum value.



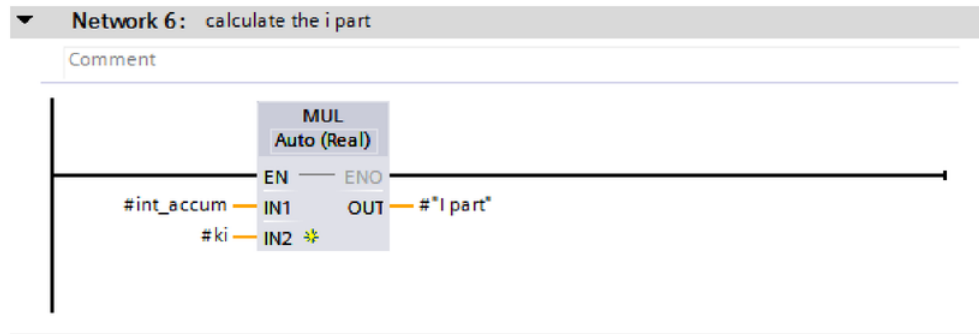
network 4

Spelling

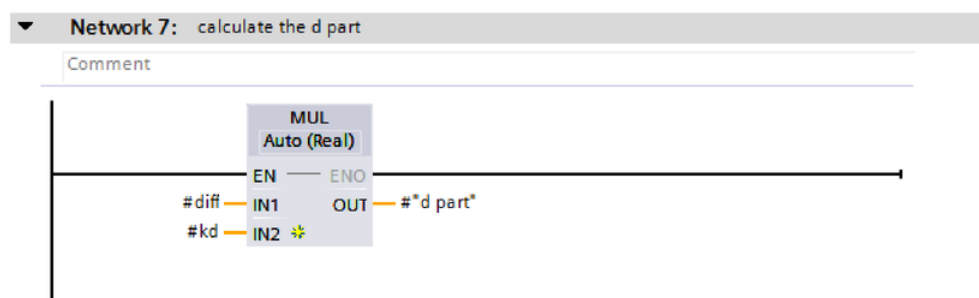
In input 4 the value of the previously calculated error from network 2 is added to the *integral* accumulator value to create an updated output integer accumulator value. The updated integer accumulator value is then limited between a minimum value of 0 and the maximum integer accumulator value calculated in network 3.



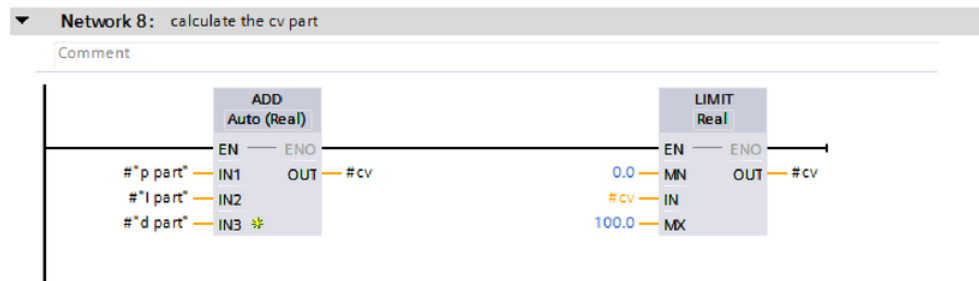
In network 5 the calculated error value multiplied by the chosen k_p value on the HMI PID control screen to calculate the 'part p' output value.



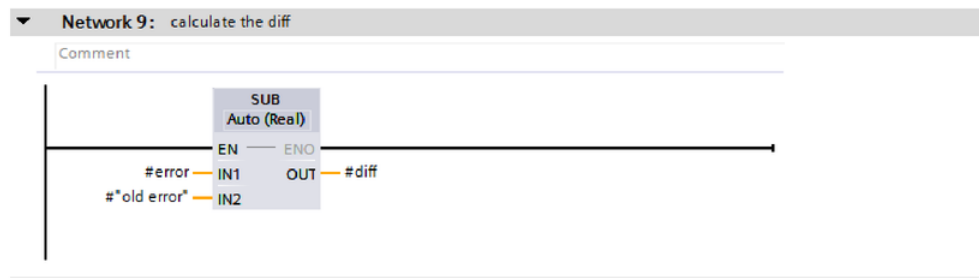
In network 6 the limited integer accumulator value calculated in network 4 is multiplied by the limited ki value to calculate the output value for the 'I part'.



In network 7 the input 1 diff value is multiplied by the chosen jd value on the HMI PID control screen to calculate the output 'd part' value.

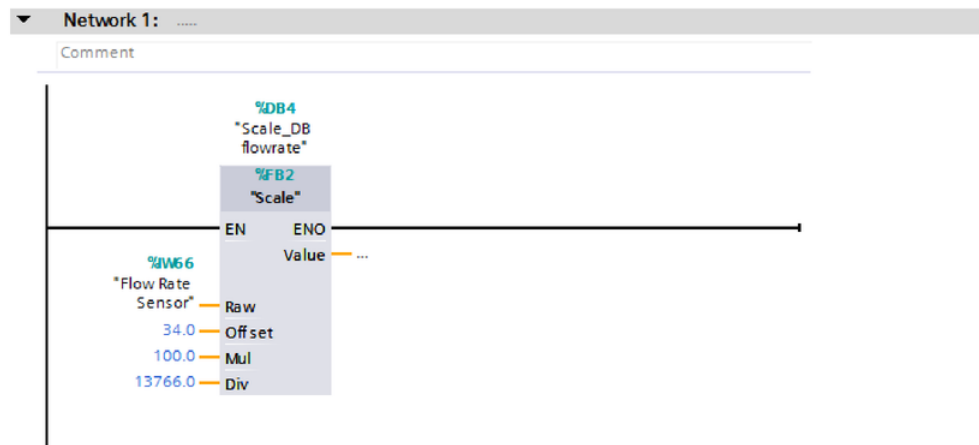


In network 8 all three calculated output values (p part, I part and d part) are added together to calculate the cv value. The cv value is then limited between a minimum of 0 and a maximum of 100 as it is not possible to have a percentage value outside of these numbers.

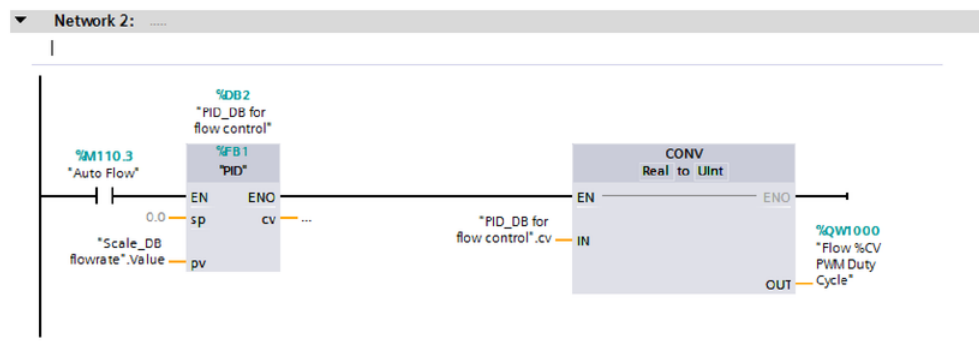


In network 9 the old error value is subtracted from the error value obtained in network 2 to calculate difference between the two.

Cyclic Interrupt for Flow Control

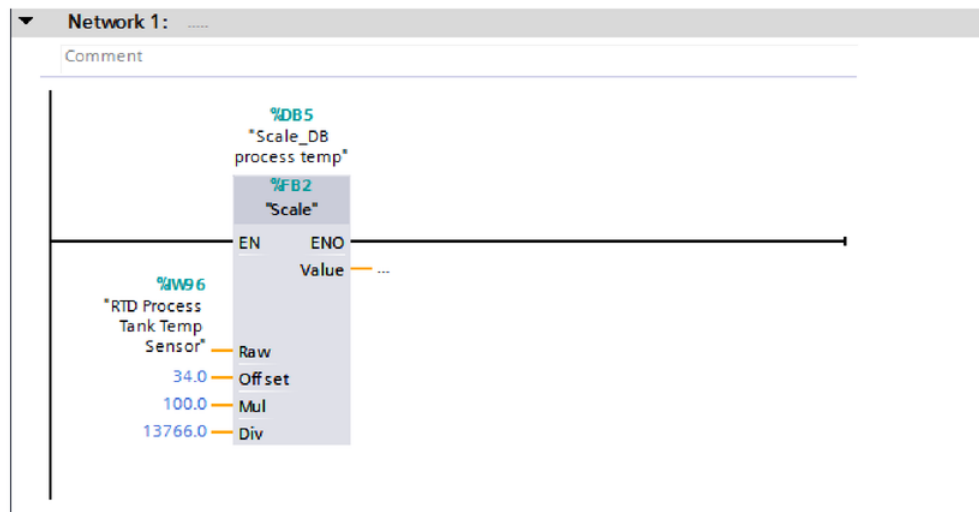


In network 1 the flow rate sensor gives off an integer value which is called a 'raw' value. This raw value is then converted into real data. Once converted to a real value an offset of 34 is subtracted from the real value. The result of this is then multiplied by 100. After this the new value is divided by 13766.0 to give the end output flowrate value.

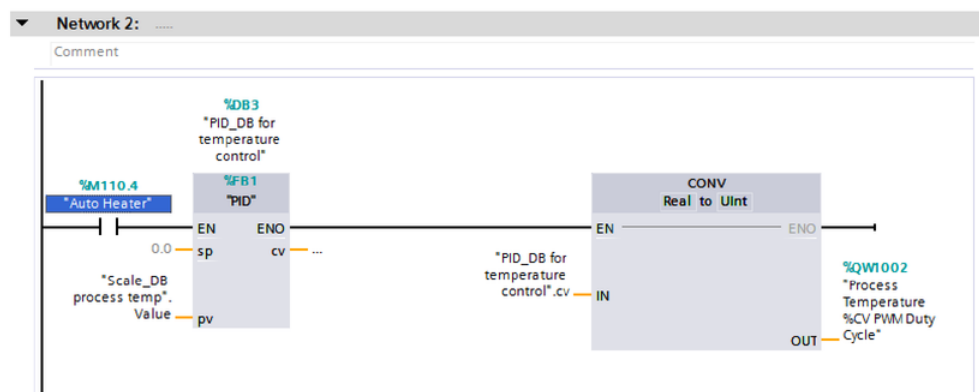


The cyclic interrupt for flow control OB30 is set for 10 milliseconds therefore when auto flow is activated the error value runs through the PID function block to give out a real value which is updated every 10 milliseconds. The real value is then converted into a unit integer output for flow %CV PWM Duty Cycle.

Cyclic Interrupt for Temperature Control



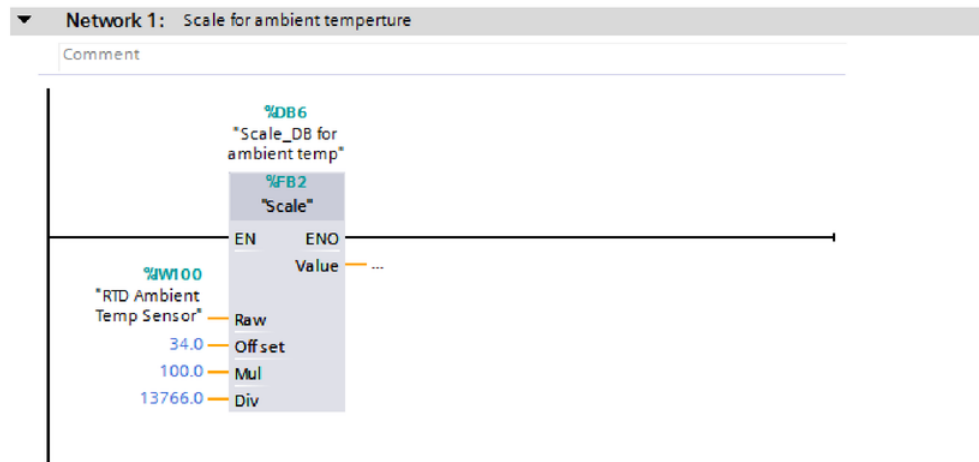
In network 1 the process tank temperature sensor gives off an integer value which is called a 'raw' value. This raw value is then converted into real data. Once converted to a real value an offset of 34 is subtracted from the real value. The result of this is then multiplied by 100. After this the new value is divided by 13766.0 to give the end output process tank temperature value.



The cyclic interrupt for temperature control OB31 is set for 100 milliseconds therefore when auto heater is activated the error value runs through the PID function block to give out a real value which is updated every 100 milliseconds. The real value is then converted into a unit integer output for Process Temperature %CV PWM Duty Cycle.

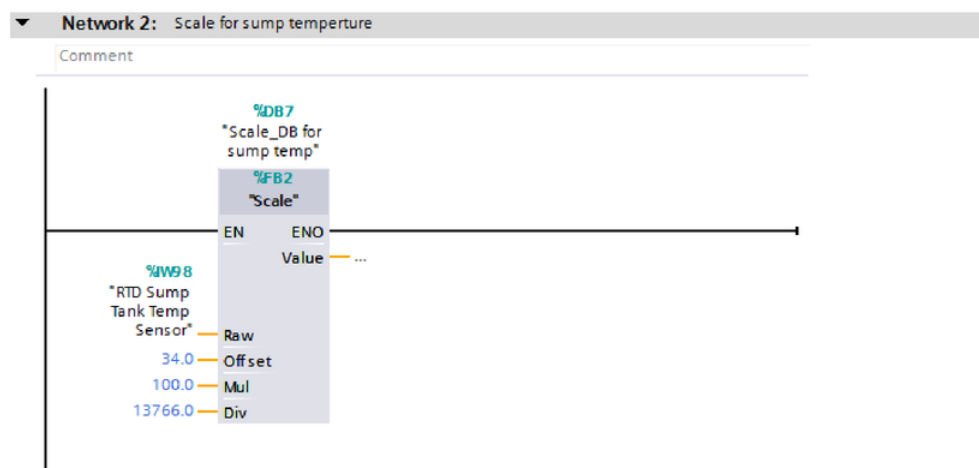
Main Organization Block OB1

Network 1



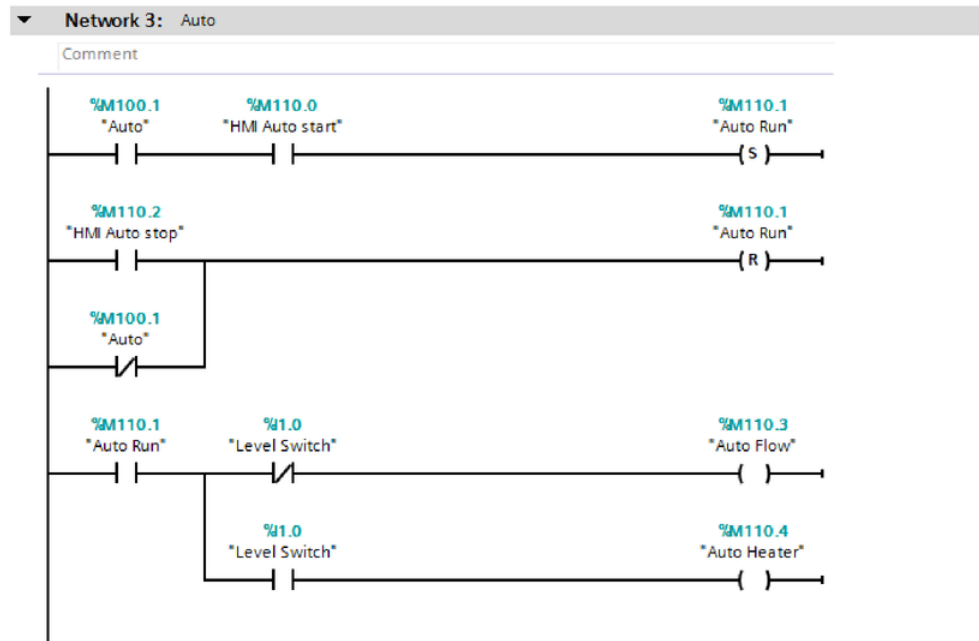
In network 1 the ambient temperature sensor gives off an integer value which is called a 'raw' value. This raw value is then converted into real data. Once converted to a real value an offset of 34 is subtracted from the real value. The result of this is then multiplied by 100. After this the new value is divided by 13766.0 to give the end output ambient temperature value.

Network 2



In network 2 the sump tank temperature sensor gives off an integer value which is called a 'raw' value. This raw value is then converted into real data. Once converted to a real value an offset of 34 is subtracted from the real value. The result of this is then multiplied by 100. After this the new value is divided by 13766.0 to give the end output sump temperature value.

Network 3

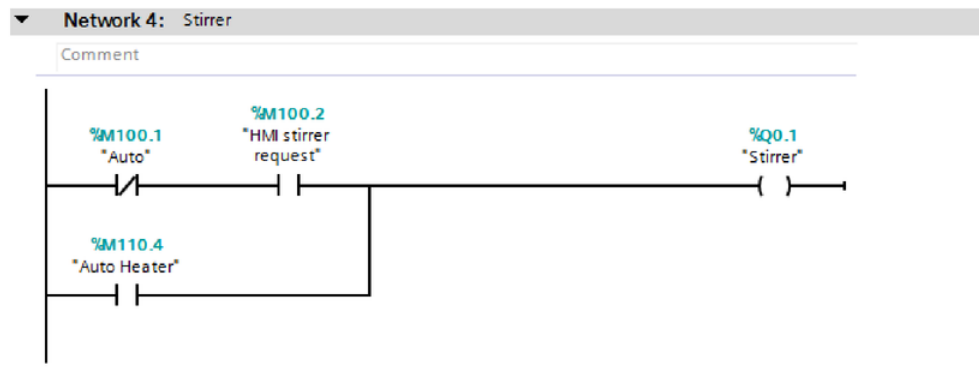


If auto is on and the HMI auto start button is pressed then the auto run condition starts.

If either the HMI auto stop is set or if auto is off then the auto run condition is reset.

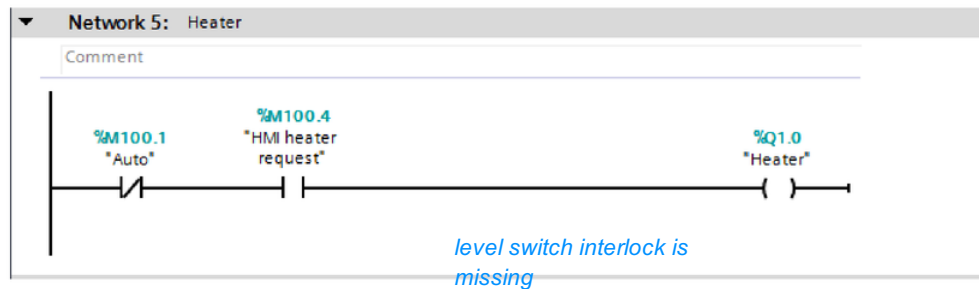
If auto run is on and the level switch is not made then the auto flow turns on, or if the auto switch is on and the level switch is made then the auto heater turns on.

Network 4



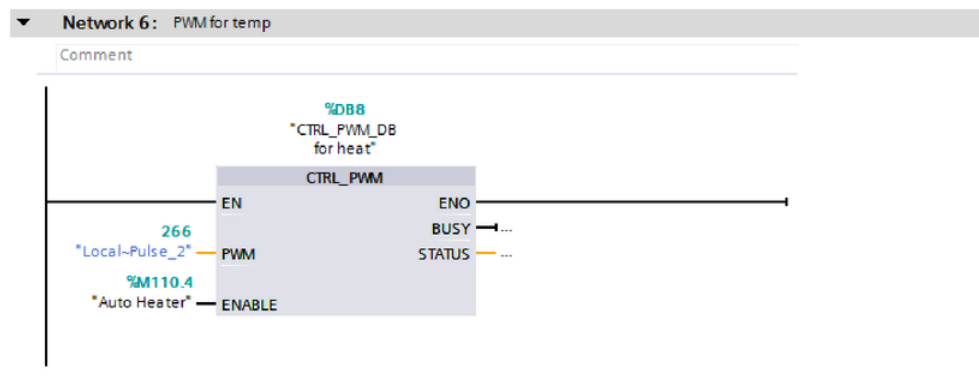
If auto is off and the HMI heater request is made then the stirrer turns on. As well as this if auto heater is on then the stirrer is turns on.

Network 5



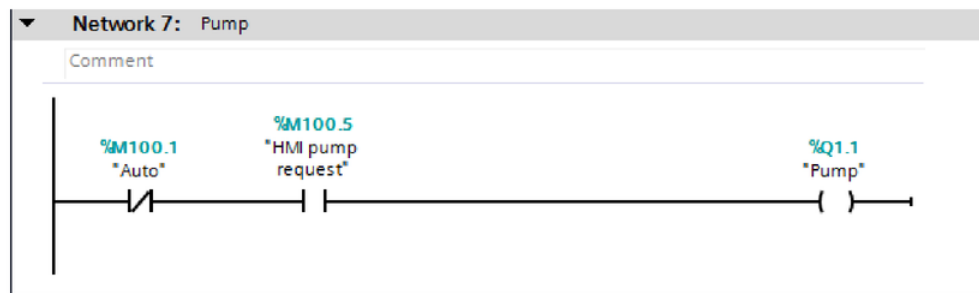
If auto is off and the HMI heater request is made then the heater will turn on.

Network 6



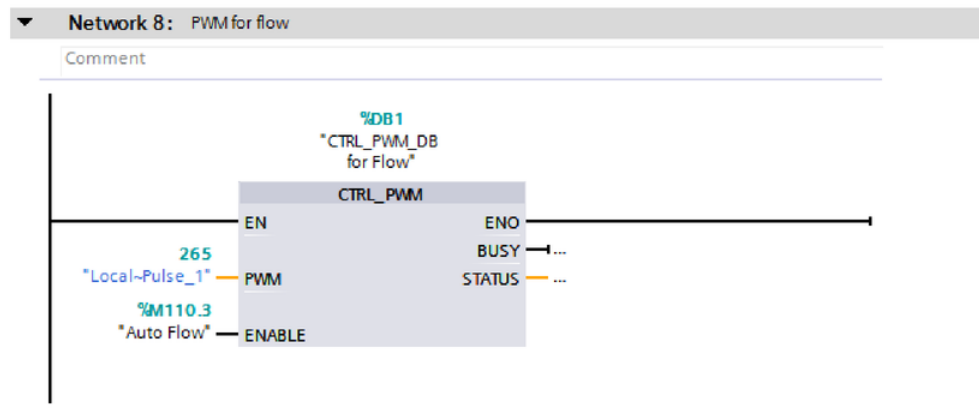
If the auto heater is on then a pulse is generated which will activate the pulse width modulation (PWM). This will moderate the cycle time and pulse duration at local_pulse_2 which will moderate the rate that the temperature increases.

Network 7



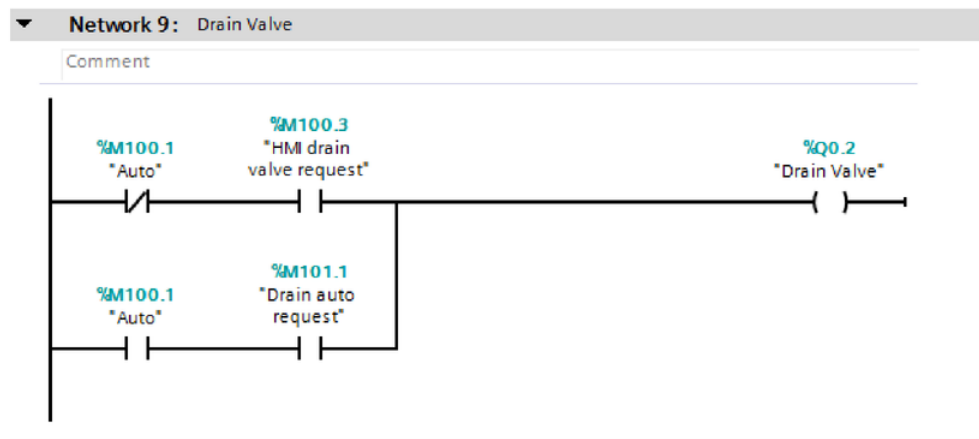
When auto is off and the pump request is made on the HMI then the pump is activated.

Network 8



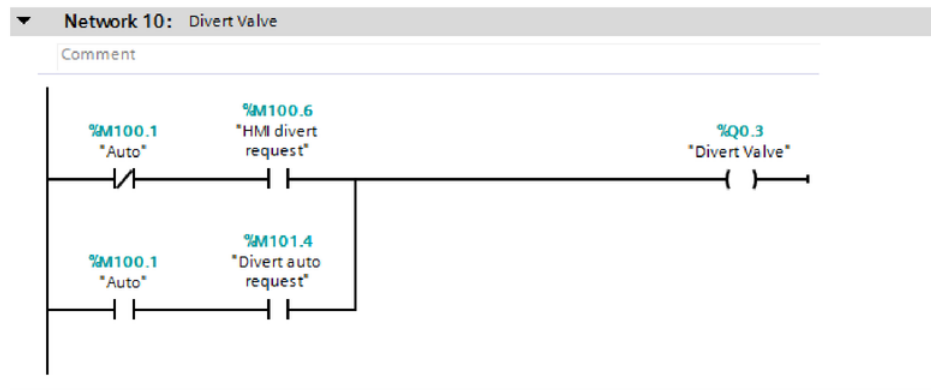
If the auto flow is on then a pulse is generated which will activate the pulse width moderation (PWM). This will moderate the cycle time and pulse duration at local_pulse_1 which will moderate the rate water flow.

Network 9



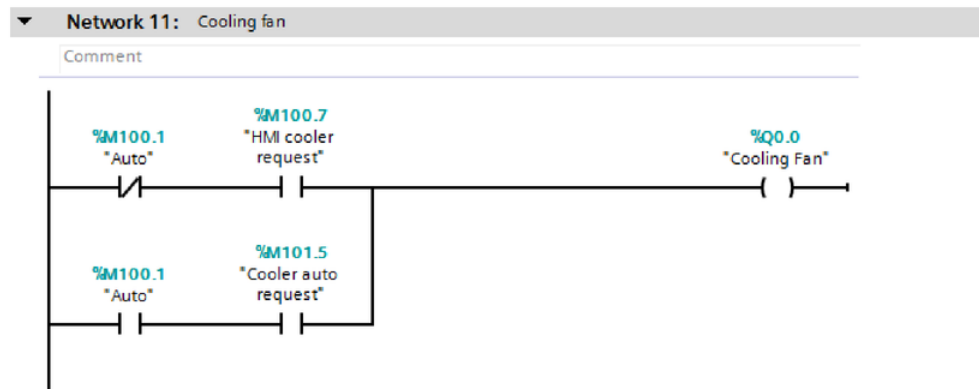
When the auto condition is off and the HMI drain valve request is made then the drain valve is activated. Or if the auto condition is on and the drain auto request is made then the drain valve is activated.

Network 10



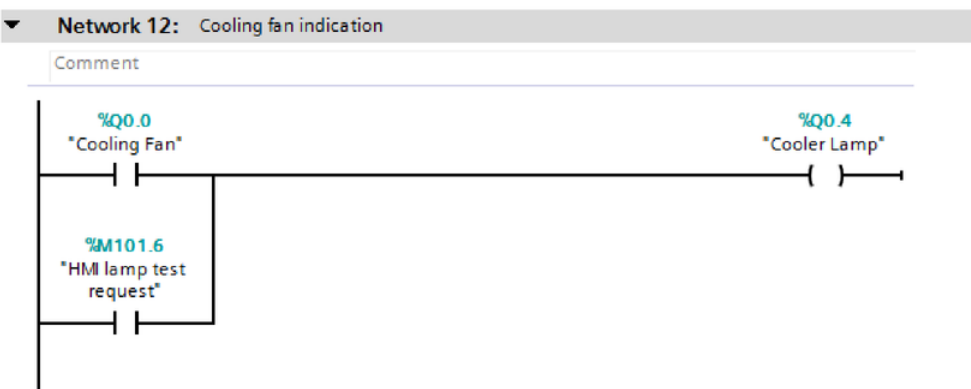
When the auto condition is off and the HMI divert request is made then the divert valve is activated.
Or if the auto condition is on and the divert auto request is made then the divert valve is activated.

Network 11



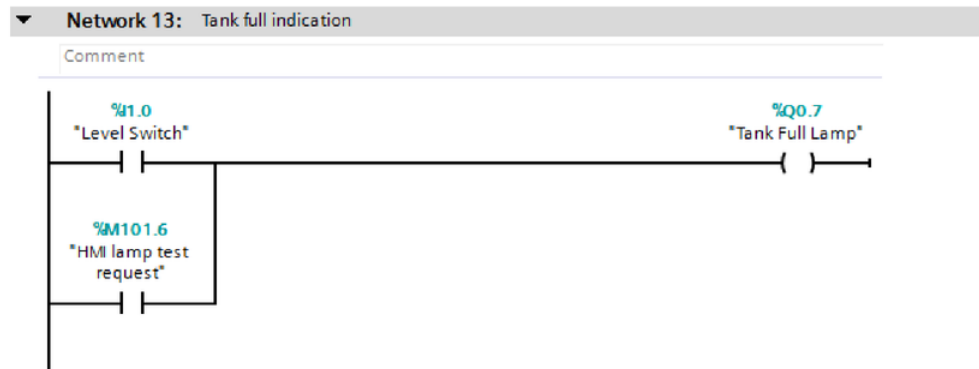
When the auto condition is off and the HMI cooler request is made then the cooling fan is activated.
Or if the auto condition is on and the cooler auto request is made then the cooling fan is activated.

Network 12



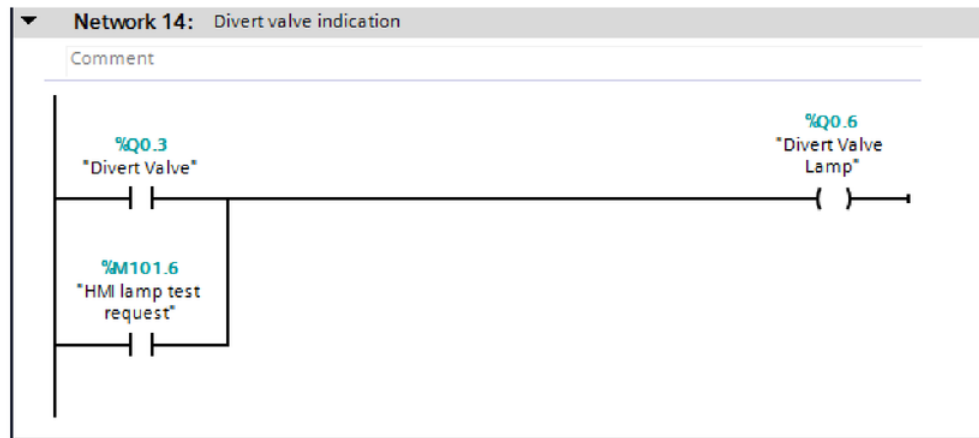
Either when the cooling fan is activated or when the HMI lamp test request is made then the cooler lamp will turn on.

Network 13



Either when the level switch is activated or when the HMI lamp test request is made then the tank full lamp will turn on.

Network 14

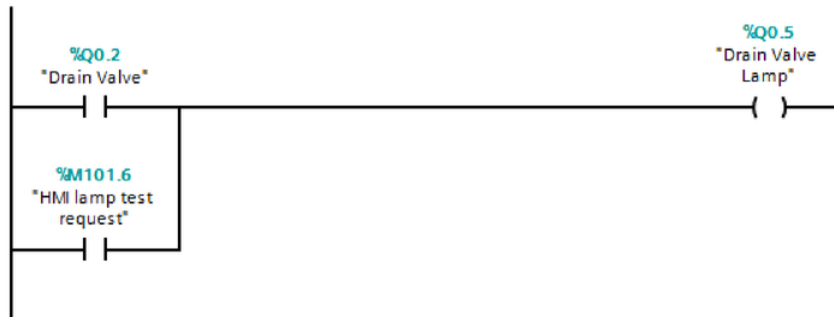


Either when the divert valve is activated or when the HMI lamp test request is made then the divert valve lamp will turn on.

Network 15

Network 15: Drain Valve indication

Comment



Either when the drain valve is activated or when the HMI lamp test request is made then the drain valve lamp will turn on.

HMI Screens

Engineers Screen 1

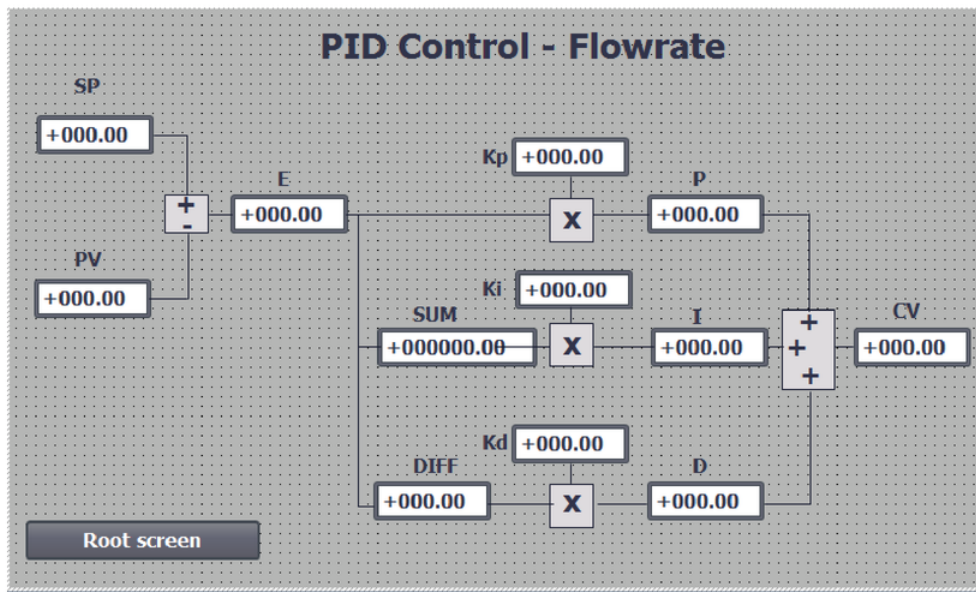
Engineer's Screen

	ADC	Scaled		
Flow Rate:	00000	+000.000	☐ OFF	Stirrer
Process Temperature	00000	+000.000	☐ OFF	Heater
Sump Temperature:	00000	+000.000	☐ OFF	Pump
RTD Ambient Temperature:	00000	+000.000	☐ OFF	Drain
			☐ OFF	Divert
			☐ OFF	Cooler

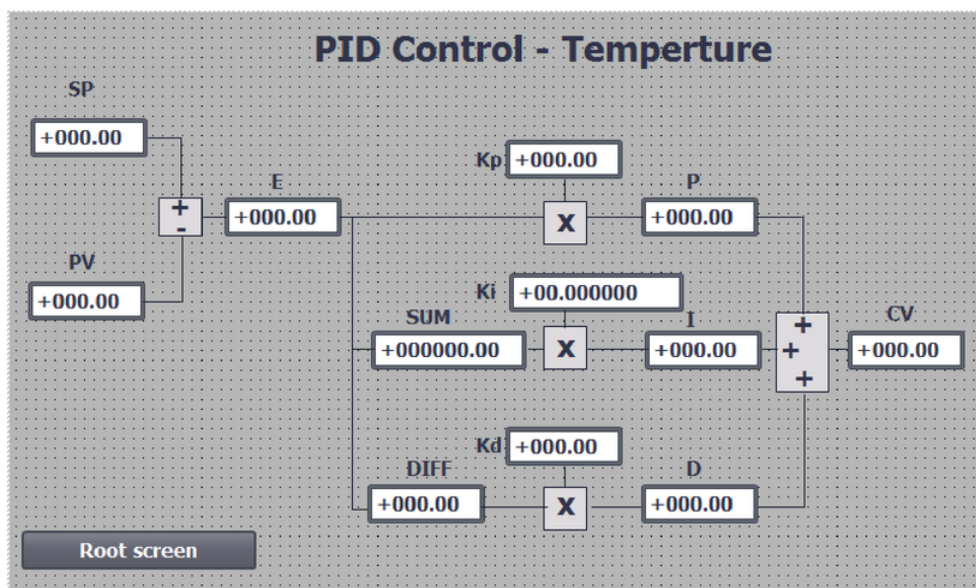
Mode:

Tank Full

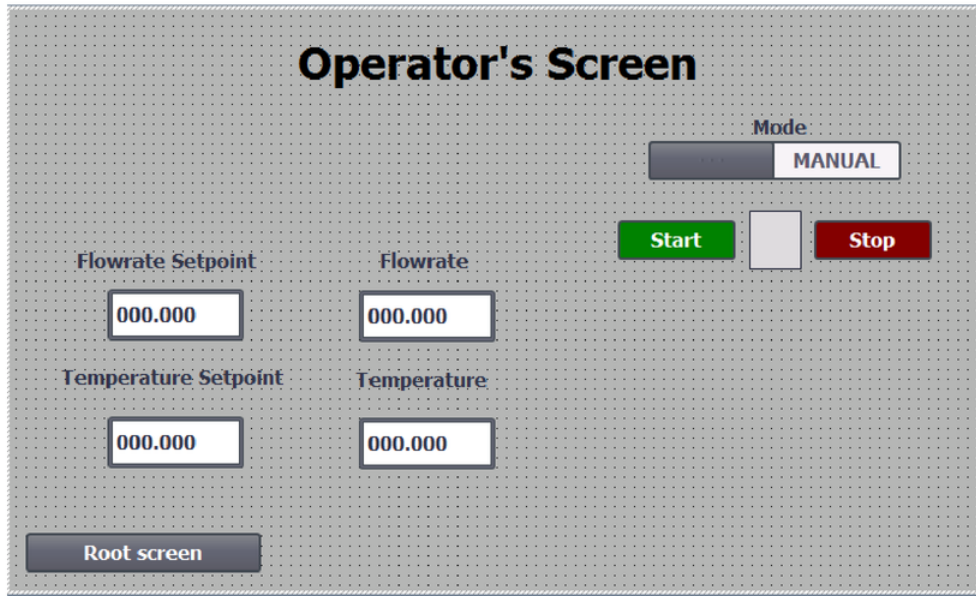
Engineers Screen 2



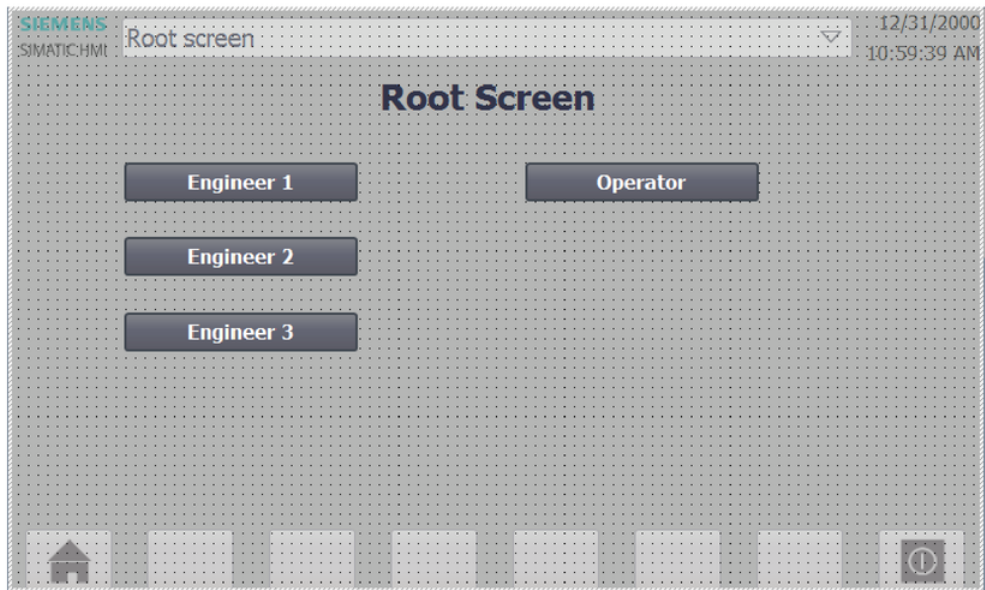
Engineers Screen 3



Operators Screen



Root Screen



3. Program Testing, Results and Evaluation

Testing Table for Manual Program				
Number	Description	Expected result	Actual result	Test success / Evidence
#1	Press the switch button for manual and automatic modes on the engineers screen.	The program should automatically switch between both manual and automatic modes.	The program switched between both modes.	Pass (Figure 11)
#2	Press the switch button for manual and automatic modes on the operators screen.	The program should automatically switch between both manual and automatic modes.	The program switched between both modes.	Pass (Figure 14)
#3	Press the stirrer manual test switch.	Once the button is pressed the stirrer should activate and begin to rotate.	The stirrer activated and started rotating.	Pass
#4	Press heater manual test switch.	Once the switch is turned on the heater in the process tank should activate and start heating the water.	The heater activated in the process tank and the water temperature began to rise.	Pass (Figure 10)
#5	Press the pump manual test switch.	Once the switch is turned on the pump should activate and start pumping water up to either the cooler or the process tank.	The pump activated and water started flowing up to the process tank.	Pass
#6	Press the drain manual test switch.	Once the switch is turned on then the drain valve should open and water should start flowing down to the sump tank.	When the switch was turned on the drain valve open and water started draining into the sump tank.	Pass (Figure 10)
#7	Press the divert manual test switch.	Once the switch is turned on then the direction of the water flow should divert from the process tank to the cooling fan.	The water flow diverted from the process tank to the cooler.	Pass (Figure 10)
#8	Press the cooler manual test switch.	Once the switch is turned on then cooling fan should	The cooling fan activated and started	Pass (Figure 10)

		activate.	cooling the water temperature.	
#9	Press the lamp test button on the engineers screen.	All lights lamps on the process rig should turn on.	All four lamps on the process rig lit up.	Pass (Figure 11) (Figure 12)
#10	Check the flow rate on the HMI engineers' screen.	Both ADC and Scaled values should be shown for flow rate.	ADC and Scaled values were given for the flow rate.	Pass (Figure 13)
#11	Check the process temperature on the HMI engineers' screen.	Both ADC and Scaled values should be shown for process temperature.	ADC and Scaled values were shown for the process temperature.	Pass (Figure 13)
#12	Check the sump temperature on the HMI engineers' screen.	Both ADC and Scaled values should be shown for sump temperature.	ADC and Scaled values were shown for the sump temperature.	Pass (Figure 13)
#13	Check the ambient temperature on the HMI engineers' screen.	Both ADC and Scaled values should be shown for ambient temperature.	ADC and Scaled values were shown for the ambient temperature.	Pass (Figure 13)



Figure 10 – manual testing photograph 1

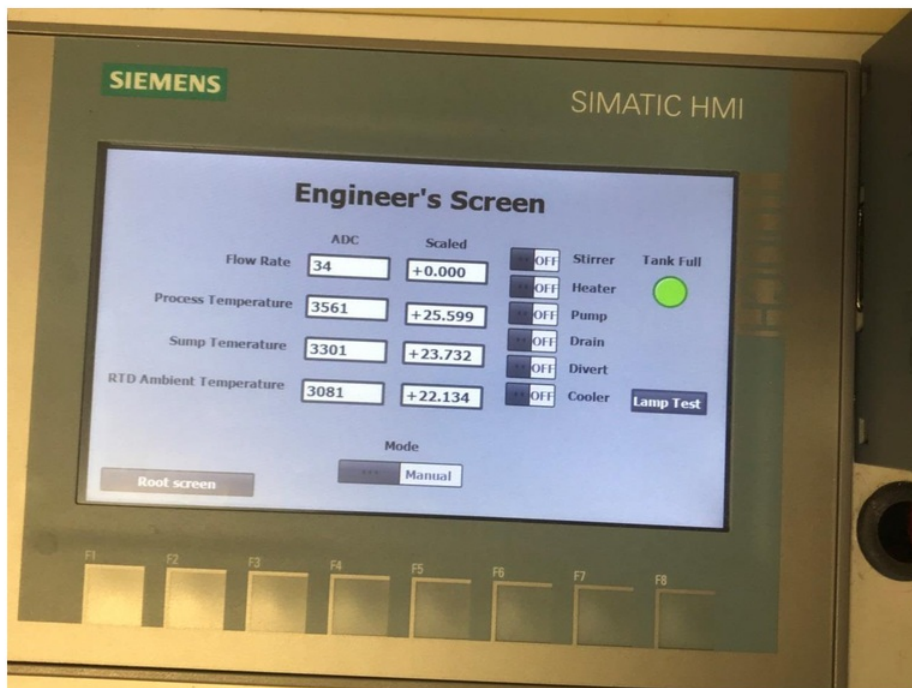


Figure 11 – manual testing photograph 2



Figure 12 manual testing photograph 3

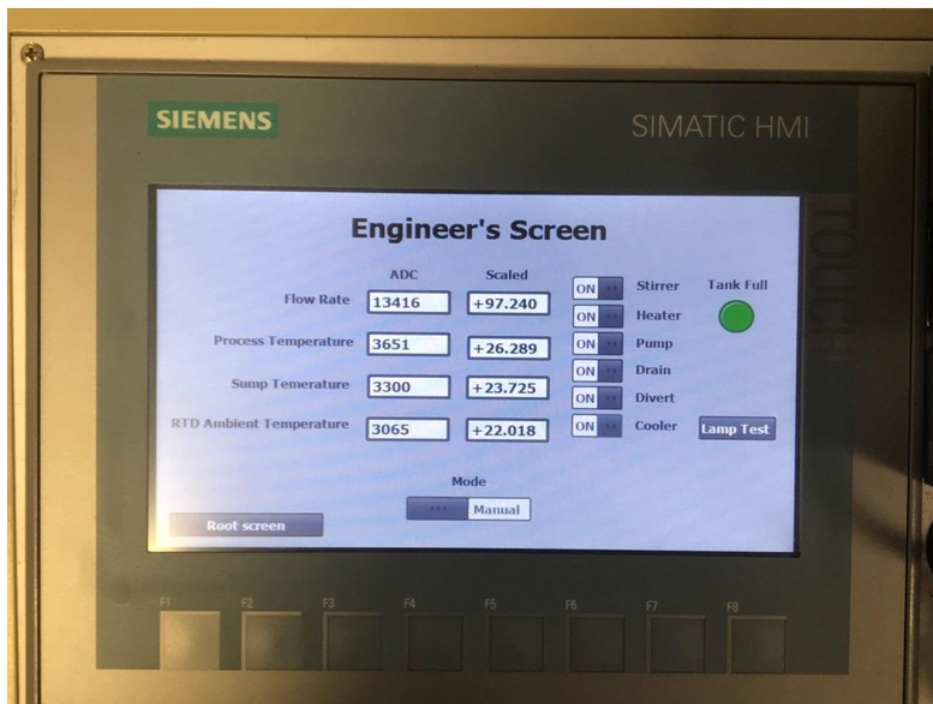


Figure 13 - manual testing photograph 4

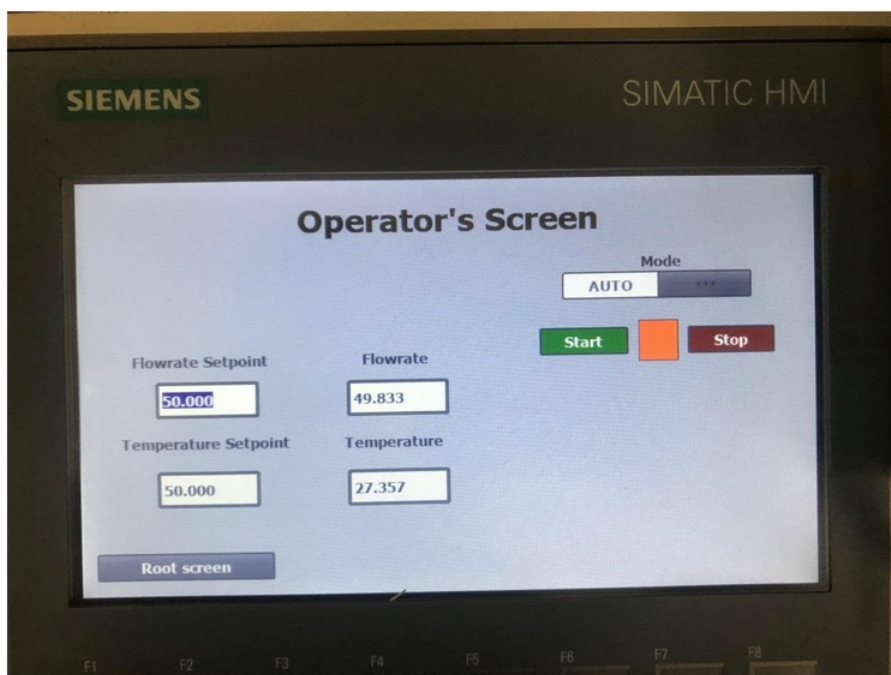


Figure 14 - manual testing photograph 5

Testing Table for Automatic Program				
Number	Description	Expected result	Actual result	Test success / Evidence
#1	Test program automatic run.	The process rig should start working automatically.	The process rig started to run automatically.	Pass (Figure 14)
#2	Test program automatic stop.	When the process rig is running automatically it should stop when the stop button is pressed.	Once the stop button was pressed the process rig stopped working.	Pass
#3	Test the PID automatic flowrate values.	The PID screen for the flowrate should start running. As well as this the flowrate set point and the actual flowrate values should be displayed on the operator screen.	The flowrate PID screen started to run as well as the values for the flowrate were displayed and changed constantly as expected.	Pass (Figure 14) (Figure 15)
#4	Test the PID automatic temperature values.	The PID screen for the temperature should start running. As well as this the temperature set point and the actual temperature values should be displayed on the operator screen.	The temperature PID screen started to run as well as the values for the temperature were displayed and changed constantly as expected.	Pass (Figure 14) (Figure 16)

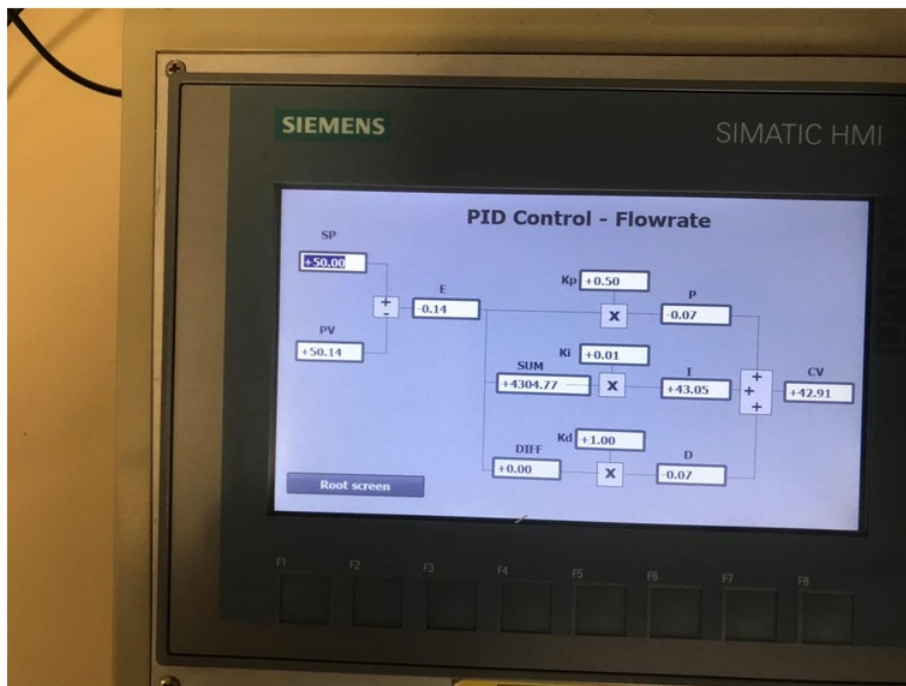


Figure 15 - automatic testing photograph 1

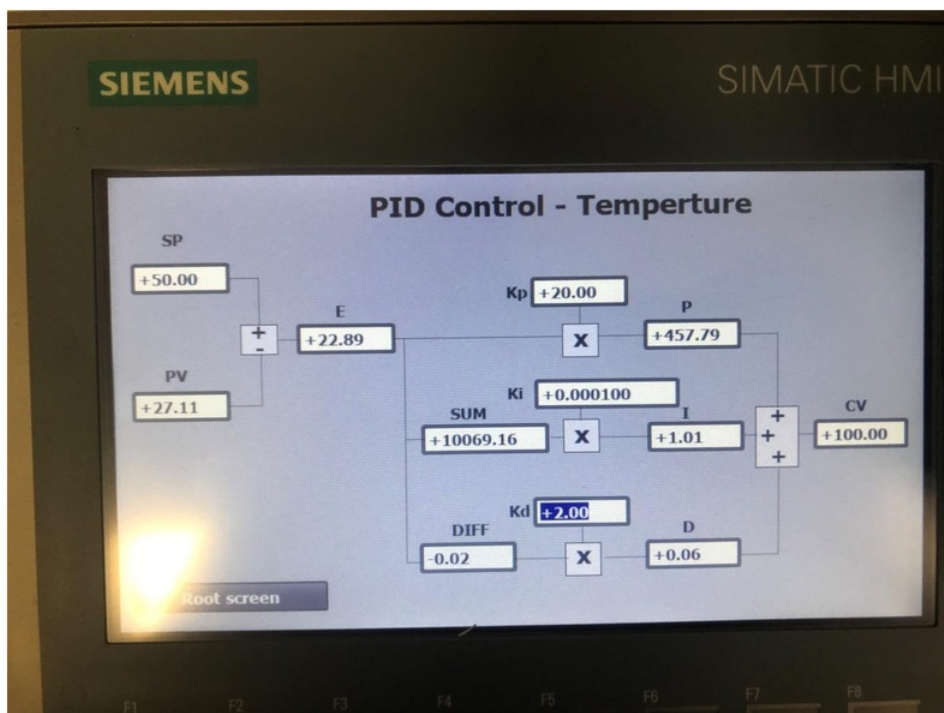


Figure 16 - automatic testing photograph 2

4. Safety, Maintenance, Reliability and Sustainable Development

Risk Assessment of Process Rig

What is the hazard?	Likely hood of hazard occurring	Who could be harmed and how?	What is already being done to prevent this?	What else could be done to prevent this?
Spillage of boiling water from process tank and sump tank	Medium	Anyone who is standing near the process rig, most likely the operator.	There is a piece of acrylic covering the tops of both tanks however this could easily be knocked off.	A sealed guard could be secured to the top of both tanks so no boiling water splash out of the top of the tanks.
Burning skin on hot pipes. As the pipes are metal if there is a constant flow of hot water running through them they will become very hot	Medium	The operator who has contact with the process tank	There is no protective covering on the pipes	Heat proof gloves should be worn when working with the process rigs. Foam insulation should be placed over the metal pipes to reduce the risk of contact with skin
Bits of clothing and hair could get caught in the rotating stirrer	low	An operator if they have long hair or loose clothing	There is a sheet of acrylic covering most of the stirrer	Long hair should be tied back and loose clothing should be removed when working with the process rig. a secured guard should be placed around the visible part of the stirrer

Maintenance and reliability of the process rig

The process rig as described in the first part of this report has a lot of crucial components that need to be regularly maintained to keep a good standard of reliability. If any of these crucial components were to malfunction to whole process rig would be affected and intern taking it out of action.

As all the pipes in this process rig are metal and the fact there is a constant flow of hot and cold water there is a high chance that lime scale could build up within the pipes as well as all components such as the pump cooler and tanks. If these all pipes and components are not regularly cleaned then the lime scale will start to build up reducing the water flowrate and as the flowrate slows down the rate that the lime scale will builds up increase which will eventually clog the pies and components. If this happens then the process rig will become less reliable and the clogged components and pipes will have to be changed therefore adding extra costs which could have been avoided through regular maintenance.

Calum Rhys De-Vlugt

The process tank will also need to be cleaned regularly otherwise the build-up of lime scale within the tank will effectively increase the process tank's energy consumption as lime scale covering the heating element will make it take longer to heat the water to the chosen level.

All valves need to be checked regularly to ensure that they are still tight; if the valves are loose then boiling water could be leaking from the rig which is a safety hazard as well as affecting the flow rate of the water.

All the electrics that make it possible for the process rig and the analogue outputs to work properly need to be checked for faults; any faults in the wiring could cause the visual outputs to give out false readings.

5. Conclusions and Recommendations

When looking at the design of the process rig at the start of this assignment it was clear to see that with all nine components working in conjunction with each other there had to be a fair amount of program so that they could work automatically together and individually through manual testing. It was also clear from the design brief that the flow of the water and temperature of the water will have to be controlled by PID algorithms in conjunction PWM (Pulse Width Moderations). As a group we decided that the best PLC language to write the program in was Ladder as that is the language we are most proficient in. As well as this when writing the algorithms for the PID and the scaling it was clear that ladder was the best choice as the calculations on each network would give the calculated output needed for the next step in the algorithm. In ladder the PID loops are also able to work in conjunction with the PWM so that the PIDs will loop at a chosen time scale.

By comparing the expected results with the actual results in the testing table it is clear to see that our program worked exactly the way it should have. The testing table for the manual results show that all the components work independently of each other as well as the scaling program. This is backed up by the photographs of the manual testing. When looking at the testing table for the automatic program it shows that the auto start and stop buttons work as well as the PID algorithms for the flow and temperature control which is again backed up by the photographs for the automatic testing.

Looking at the risk assessment it is clear that there could be some changes in the process rig which would make it more reliable. One of these changes is changing the pipes and valves from steel to PVC as there is no lime scale build up in PVC. This would reduce the amount of maintenance that needs to be carried out on the process rig. Another change to the rig that would make it safer would be by changing the acrylic lids on top of the tanks to secure guards so that no boiling water can spill from the rig.

6. Description of Team Working

When tasked with writing a program for the process rig that conforms with the design brief we were split up into groups and my group consisted of Josh, Dan and I. first of all before we attempted to write the program for the rig it was important for us to understand how the rig works therefore we had a discussion about the components involved in the rig and what their jobs were which gave us an insight on the best way to go about writing a program to make it work. Discussion was a big part of our method on writing the program. As Dan has had more experience in PLCs than Josh and I he took charge in writing the program and he would regularly send us the program so that Josh and I could read over it so that we could make suggestions that we thought would work better. Due to the fact that we were all new to PIDs and scaling it took a lot of team work from everyone for us to work through the problems we were having with the program to come out with effective solutions.

When it came to testing our program, we all needed to work together so that it was possible to capture the photos of the HMI screens at the same time as the photos of the visual output values on the process rig.

Calum Rhys De-Vlugt -PSDE 4005 PLC's-Assignment 3

GRADEMARK REPORT

FINAL GRADE

GENERAL COMMENTS

Instructor

72/100

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QM

Spelling

Spelling error

PAGE 5

QM

Spelling

Spelling error

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Text Comment. system requirements

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QM

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Spelling error

Text Comment. network 4

Text Comment. integral

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Text Comment. level switch interlock is missing

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Spelling

Spelling error

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CALUM DE VLUGT**72****RESEARCH-INFORMED LITERATURE**

n/a

KNOWLEDGE AND UNDERSTANDING

Section 1: System description – Good photos identifying each part of the system. Good I/O list but could contain more detail. Good description of each part but overall requirements and PLC details needed. (11/15) Section 2: Program explanation – Some rungs contain titles but none have comments built-in. Tag list given with data blocks. Each network has been explained mostly accurately. (11/15)

22**ANALYSIS**

Section 3: Testing – Large number of tests listed in table for manual and auto modes. Interlock between level switch and heater not tested. (9/10) Section 3: Results and Evaluation – Test results linked to photographic evidence for manual and auto tests. Overall evaluation needed. (9/10) Section 4: Conclusions and Recommendations – Good with some recommendations. (6/10)

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PRACTICAL APPLICATION AND DEP.



Section 2: Program design – Generally good with well laid out screens. (8/10) Section 4: Safety, Maintenance, Reliability and Sustainable development – Risk assessment provided and maintenance and reliability covered. However, no mention given for sustainable development. (8/15)

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SKILLS FOR PROFESSIONAL PRAC.



All sections – Generally good, report is well structured. However, there are some spelling errors. (6/10) Section 6: Team working – Each member of the team was identified and good explanation given. (4/5)

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