

PSDE 4005 Assignment 3

by Ethan Howells

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HNC ELECTRICAL & ELECTRONIC ENGINEERING

ETHAN HOWELLS

PLC 1

ASSIGNMENT 3 !!!!

BYTRONIC INDUSTRIAL CONTROL TRAINER

SUBMISSION DATE: 08/05/2018



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System Description

The System we are working on in this assignment is the Bytronic Process Rig. The rig consists of several instruments that provide the rig to ability to pump, drain, divert, stir, cool and heat water. There are also sensors on the rig that provide us with feedback. The Sensors include:

- RTD (Sump Tank, Process Tank and Ambient Temperature)
- Flow Sensor
- Heater
- Cooling Fan
- Solenoid Valves (Divert and Drain)
- Pump
- Level Switch

The Process rig pumps cold water from the Sump Tank to the Process Tank, the water can also flow through the Cooler before the Process Tank, this is dependent on Divert Valve. The Water can then be heated in the Process Tank. There is also a Stirrer in the Process tank to speed up the heating process. The Water can be heated to a desired temperature that can be set on the HMI. The Water can then be drained back in to the Sump Tank, via the Drain Valve.

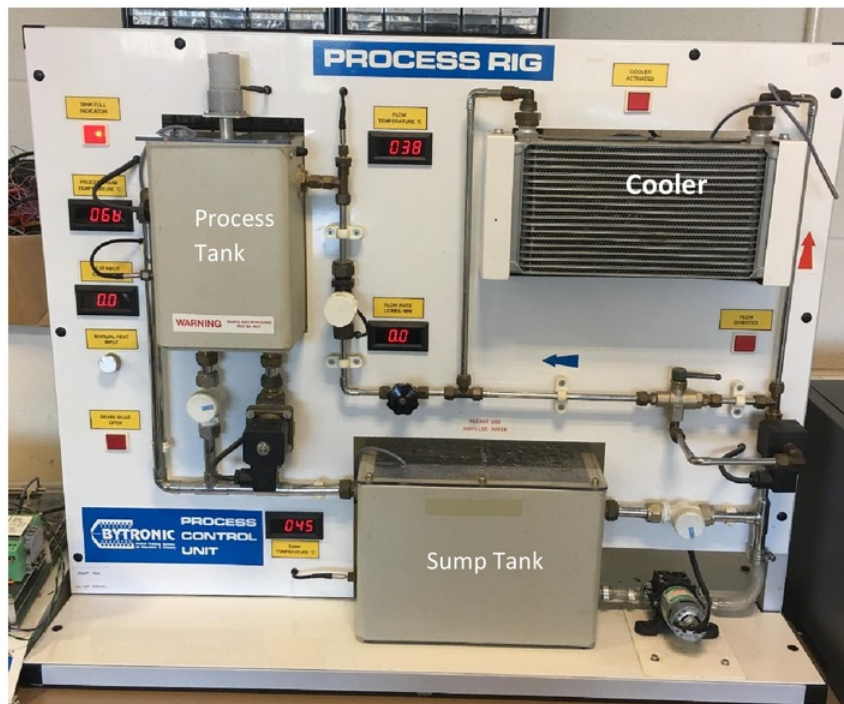


Figure 1- Bytronic Process Rig

PLC

The Bytronic Process Rig is controlled by a Siemens Simatic S7-1200 PLC, this PLC has a capacity of 14 digital inputs, 10 digital outputs and 1 analogue output. An additional analogue input card was, Siemens SM1231 AI, as this was needed for our RTDs and Flow sensor. The PLC can be seen in Figure 2.

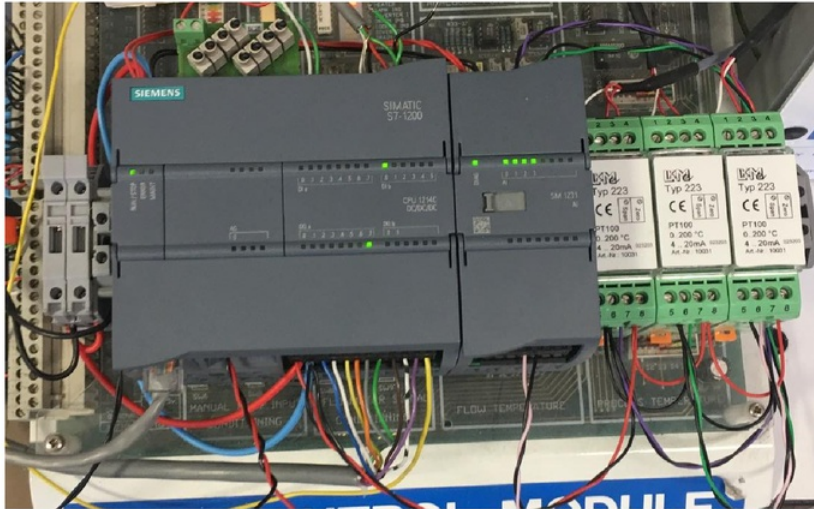


Figure 2- Siemens S7

Input/Output List

Input List	
Input	Address
Level Switch	I1.0
Flow Rate Sensor	IW66
RTD Process Tank Temp Sensor	IW96
RTD Sump Tank Temp Sensor	IW98
RTD Ambient Temp Sensor	IW100

Output List	
Output	Address
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,QW1002
Pump	Q1.1,QW1000

Resistance Temperature Devices (RTD)

There are three RTD's used in the Byronic Process Rig, one is used in the Sump Tank, to provide the temperature of the liquid in the Sump. One is used in the Process Tank, this will be used to provide feedback to help control the Temperature PID loop. The Final RTD is used to provide the ambient temperature of the room.

RTD use the fact that the resistance of a material changes as temperature rises. The Resistance change in the metal, rises almost linearly with the temperature (Training, 2017). The RTDs used in the Byronic Process Rig are PT100s, this uses Platinum as it is very accurate and offers a stable characteristic over a wider temperature range. The PT100 has a resistance of 100Ω at 0 Degrees Celsius.



Figure 4- RTD Ambient Temp



Figure 3- Sump Tank RTD



Figure 5- Process Tank RTD

Signal Converter

The RTD produces a signal that the PLC cannot use, and so for the PLC to be able to read the signal, it must first go through a signal converter. The Signal Converter will convert the signal into a standardised signal of either 4-20 mA or 0-10V. The Signal Converter we used was a LKM electronic type LKM 223, this converter can only be used with a PT100 and requires a 24V Supply. The LKM 223, has a Minimum Operating Temperature of -25°C and a Maximum Operating Temperature of 85°C, which is more than sufficient for our process.



Figure 6- Signal Converter

Cooler

There is a cooler located in the Bytronic process rig that is used to cool the hot water that comes from the Sump tank. The divert valve will allow the water through the cooler if closed. The Cooler contains a fan attached to the back which blows cool air through the water, cooling it down. The cooler can be seen in Figure 7.



Figure 7- Cooler

Flow Sensor

The Flow sensor used in the Bytronic Process Rig is a Turbine Flow meter, which can be seen in Figure 8. The Flowmeter contains a mechanism that spins when the flow passes, the faster the flow the faster then mechanism spins. When the mechanism spins, a sensor generates a pulse, so the faster the flow, the more spins of the mechanism and so the more pulses are generated. The Pulsed output generated is proportional to the flow rate. (Turbine Flowmeter Technology, 2018)

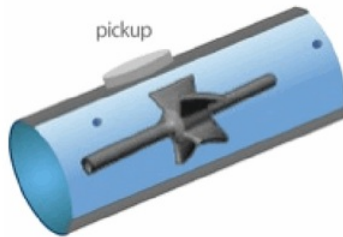


Figure 9- Flowmeter Technology (Turbine Flowmeter Technology, 2018)



Figure 8- Flowmeter

Pump

A Reciprocating Pump is used to pump water from the Sump tank to the Process tank. The Pump works by using a plunger, which is pulled back in order to increase the amount of water in pump. Once there is enough water in the pump, the plunger is then realised and pushes forward, creating a pressure difference which then forces the water out the other side of the pump. (Understand How Reciprocating Pumps Work, 2018) The Pump used in the Bytronic Process Rig requires a 12V DC supply, so an additional power supply is required.



Figure 12-Pump



Figure 10- DC Power Supply

Divert and Drain Valves

There are two solenoid valves used in the Bytronic Process Rig; Divert and Drain valves, these can be seen in Figure 13 and Figure 14. The Divert valve is used to divert the water to either the process tank or through the cooler. The Drain valve is used to simply drain the water from the Process Tank to the Sump Tank. When power is applied to the solenoid valve, an electromagnet field is created causing the plunger to move, therefore changing the state of the Valve which will then either stop the flow of water or allow water to pass through.

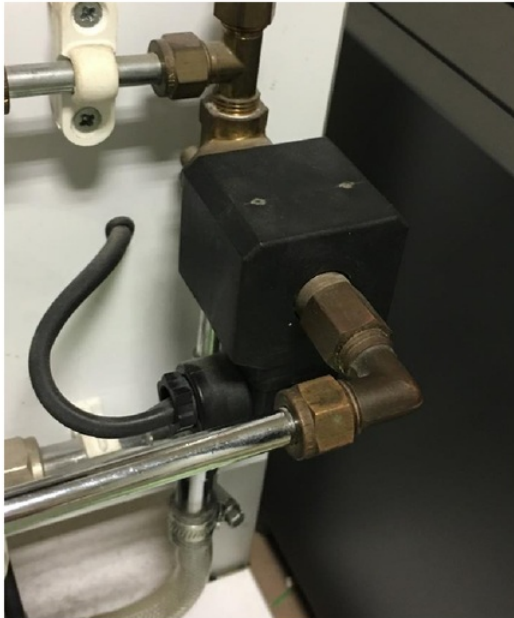


Figure 13- Divert Valve



Figure 14- Drain Valve

Heater

The Heater is located in the process tank, as seen in Figure 16 and is used to heat the water to the desired temperature. The heater requires an external 230v Supply that is located below the Bytronic Process Rig and can be seen in Figure 15. A Safety Interlock is needed to prevent the Heater energising when the tank is empty, so the level switch in the tank needs to be made before the heater can energize.



Figure 16- Heater



Figure 15- Heater Power Supply

Stirrer

The Stirrer is also located in the process tank, and energises when the heater energises. The Stirrer is used to increase the speed the water heats up. The Stirrer can be seen in Figure 17.



Figure 17- Stirrer

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Float Switch

A Normally Open Float Switch has been added to the process tank to provide a signal that proves the Process Tank is full. When the water level reaches a certain level, this will raise the float switch in the tank, closing the switch, and the switch will then send a signal back to the PLC as an input. The Level Switch can be seen outside the tank in Figure 18 and then inside the tank in Figure 19.



Figure 18- Float Switch Outside Tank



Figure 19- Float Switch inside Tank

Programme Documentation and Explanation

HMI Screens

The First task was to design our HMI screens. The first screen designed was Engineers Screen 1, which can be seen in Figure 20. Engineer's screen 1 contains the manual control for the outputs, these also have a corresponding LED that changes to green when the output is on. There is also a test lamp button, that tests all the lamps on the rig are working. A Auto manual switch was added to allow the engineer to be able to switch between Auto and Manual, a Start and Stop button for the Auto Sequence is available. A analogue inputs column was added, which shows the raw values and scaled values of the Analogue Inputs; Process Tank Temp, Sump Tank Temp, Ambient Temp and Flow Rate. The Raw and Scaled values were added to help with fault finding, as the raw value would give indication to a faulty sensor. The F Keys were added to allow the Engineer to view all the HMI screens.

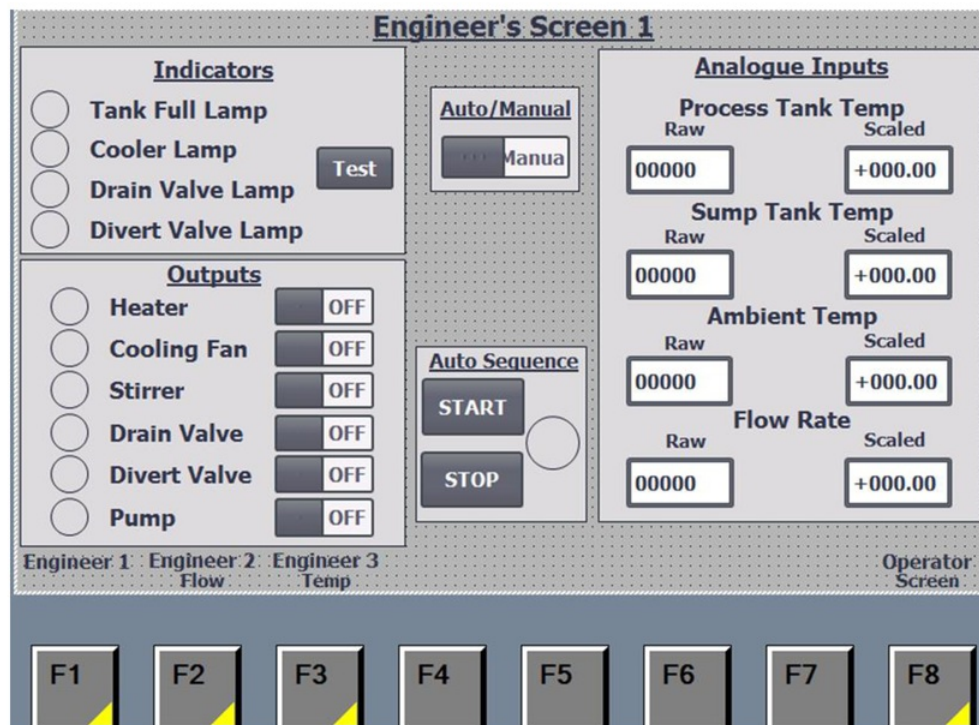


Figure 20- Engineers Screen 1

Figure 21 shows Engineers Screen 2, which is the Flow PID control. This screen allows the Engineer the ability to set the flow set point, it then shows the engineer the Process Value, which is taken away from the set point to give us our error. The Engineer can also set the Proportional Constant, Integral Constant and Derivative Constant. From this the engineer can see what the Control Value that is being sent to the pump. This screen will aid the engineer when fault finding. The screen also contains a start and stop button for the auto sequence.

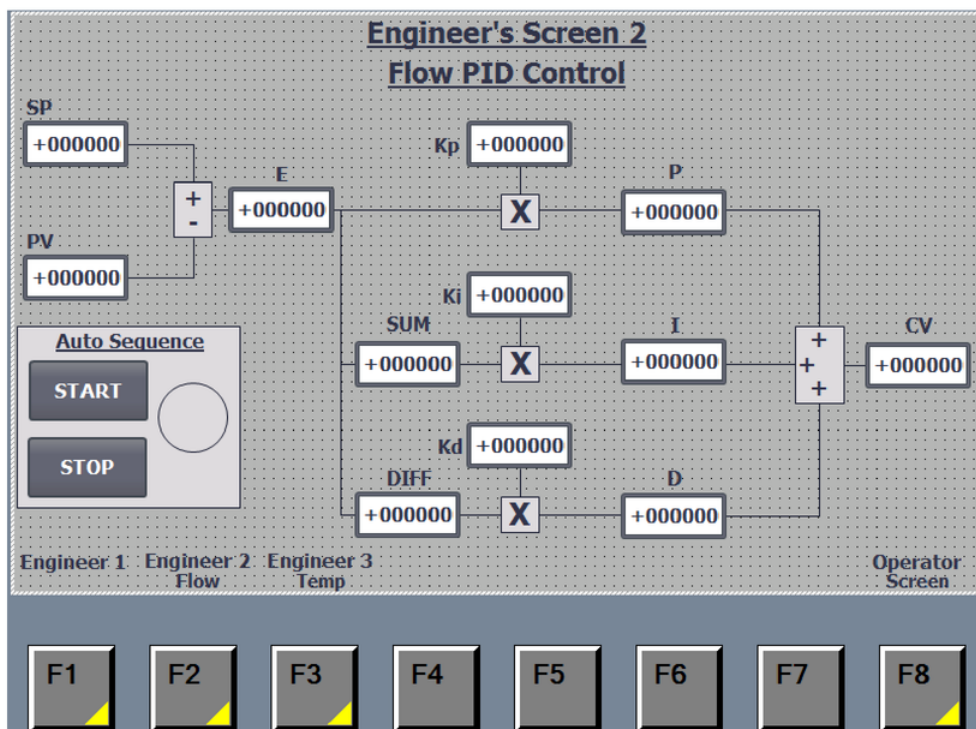


Figure 21- Engineers Screen 2 Flow PID

Figure 22 shows Engineers Screen 2, which is the Temperature PID control. This screen allows the Engineer the ability to set the temperature set point, it then shows the engineer the Process Value, which is taken away from the set point to give us our error. The Engineer can also set the Proportional Constant, Integral Constant and Derivative Constant. From this the engineer can see what the Control Value that is being sent to the pump. This screen will aid the engineer when fault finding. The screen also contains a start and stop button for the auto sequence.

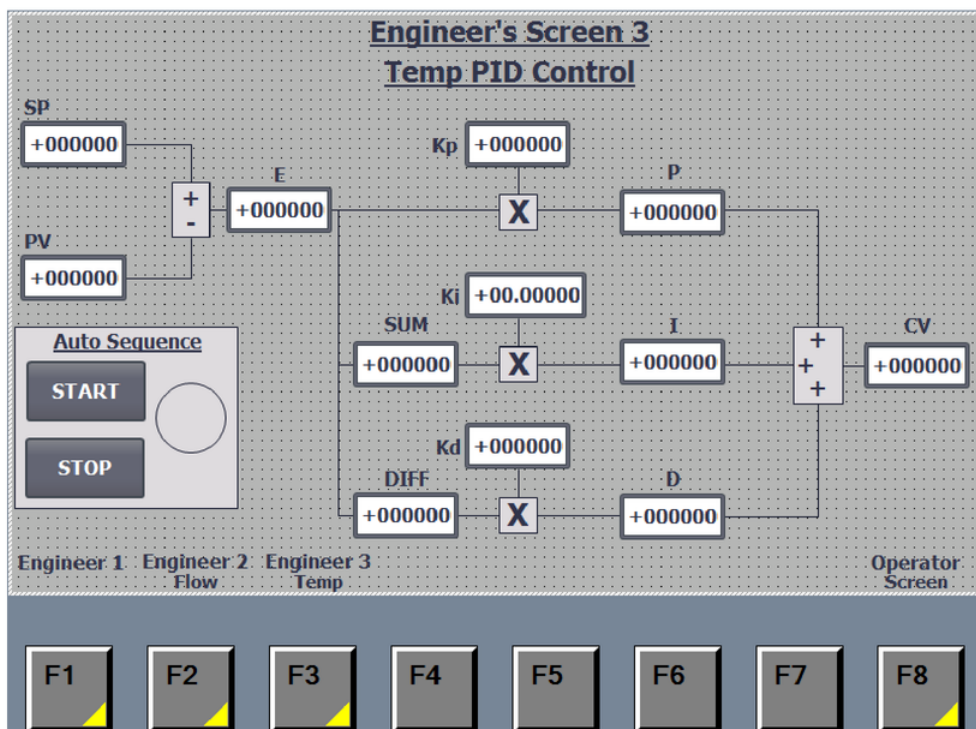


Figure 22- Engineers Screen 3 Temp PID

Figure 23 shows the Operators Screen HMI, this screen was designed specifically for the operator and contains basic controls. There is an auto manual switch, to allow the operator to put the sequence in to auto and also start the sequence by using the start stop button. The operators also have the ability to be able to set set-points for both flow and temperature control. The process value for both flow and temperature is located on the HMI.

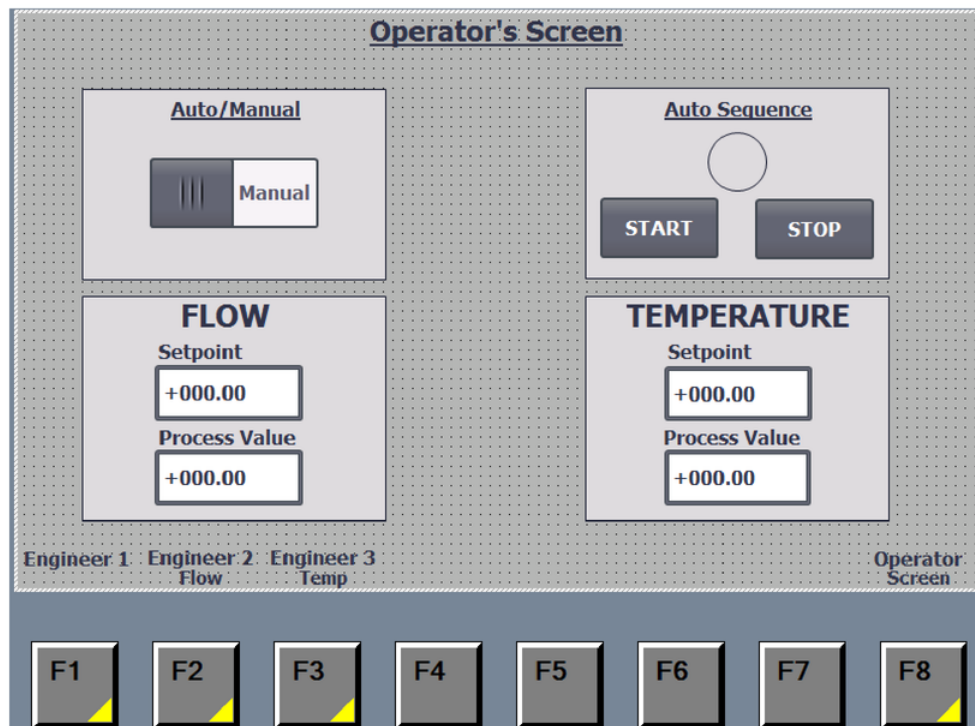


Figure 23- Operators Screen

Manual Outputs

The first stage was to create a programme block that would provide the engineer with the ability to manually operate the outputs on the Bytronic Process Rig, from the HMI.

Network 1 shows the Cooling Fan being operated in Manual mode. Figure 24 shows a detailed explanation of the Rung. The Cooling Fan Request (M1.1) is not used in the sequence, but this provides the engineer with a possibility of adding the Cooling Fan in the Sequence.

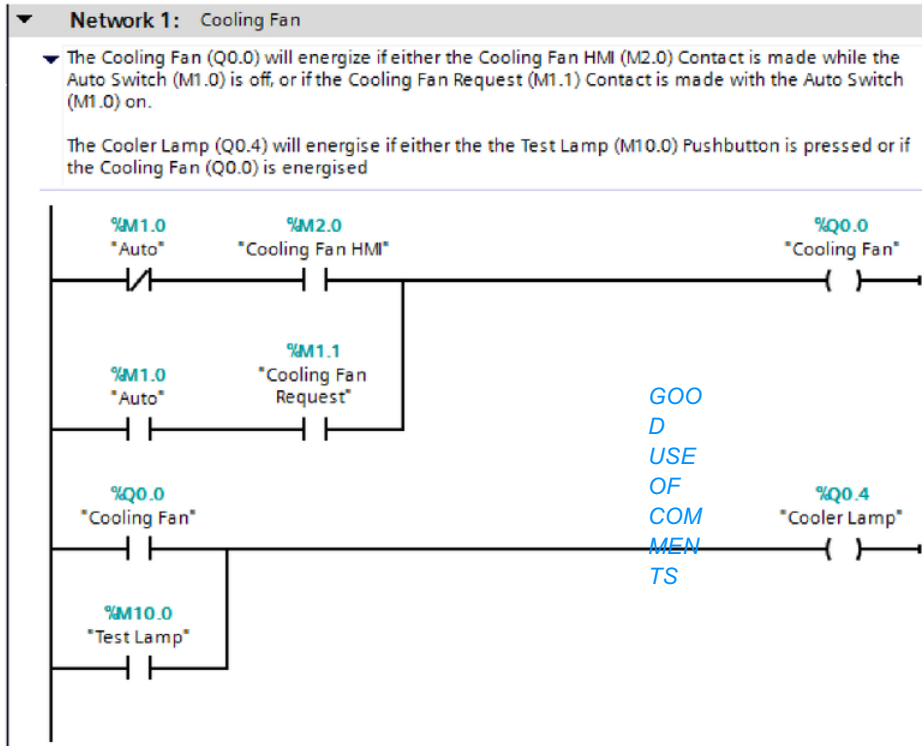


Figure 24- Manual Outputs Network 1

Figure 25, Network 2 shows the Manual Control of the Stirrer. The Stirrer will energise once the programme is in manual mode and the Stirrer HMI (M2.1) has been pressed. The Stirrer will also energise once the Auto Heater (M70.0) is made.

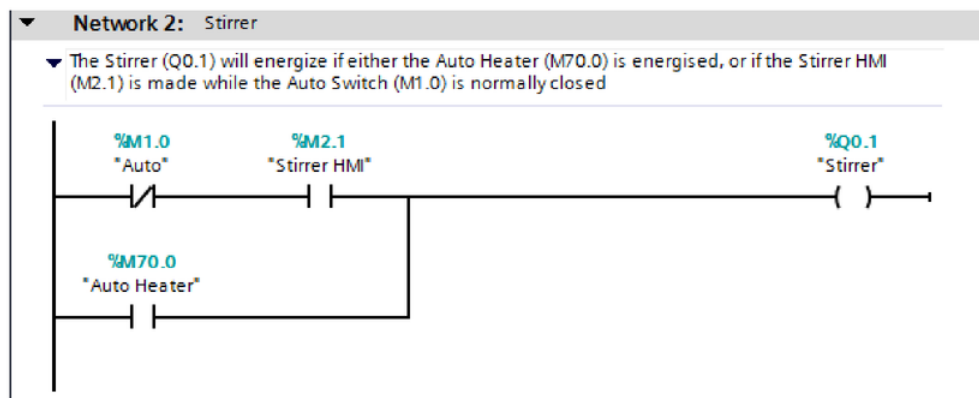


Figure 25- Manual Outputs Network 2

Figure 26, Network 3 shows the Drain Valve in Manual Control. The Drain Valve will energise if the system is in manual control, and the Drain Valve button has been pressed on the HMI. The Drain Valve will also energise if the system is in auto and the Drain Valve Request is made, this function has not been used however provides the engineer with the opportunity to add the drain valve into a sequence.

A Normally Open Contact was taken of the Drain Valve, which will bring the Drain Valve lamp on when it energises. A Test Lamp contact was added, to allow the engineer the ability to test the Lamp.

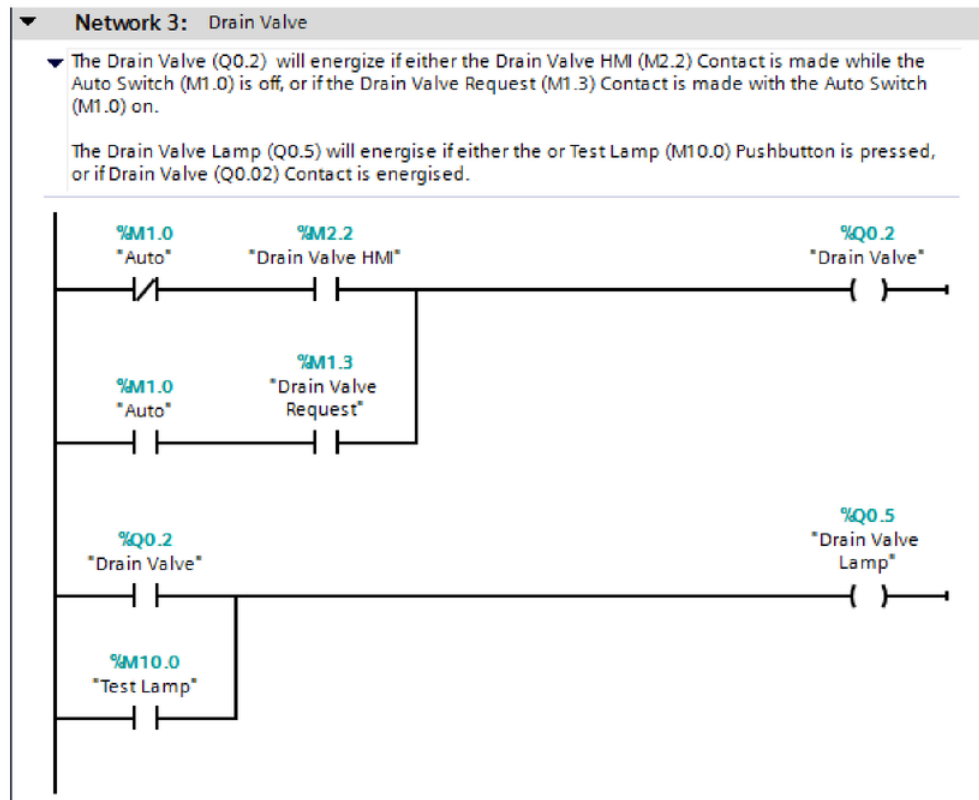


Figure 26- Manual Outputs Network 3

Figure 27, Network 4 shows the Divert Valve in Manual Control. The Divert Valve will energise if the system is in manual control, and the Divert Valve button has been pressed on the HMI. The Divert Valve will also energise if the system is in auto and the Divert Valve Request is made, this function has not been used however provides the engineer with the opportunity to add the drain valve into a sequence.

A Normally Open Contact was taken of the Divert Valve, which will bring the Divert Valve lamp on when it energises. A Test Lamp contact was added, to allow the engineer the ability to test the Lamp.

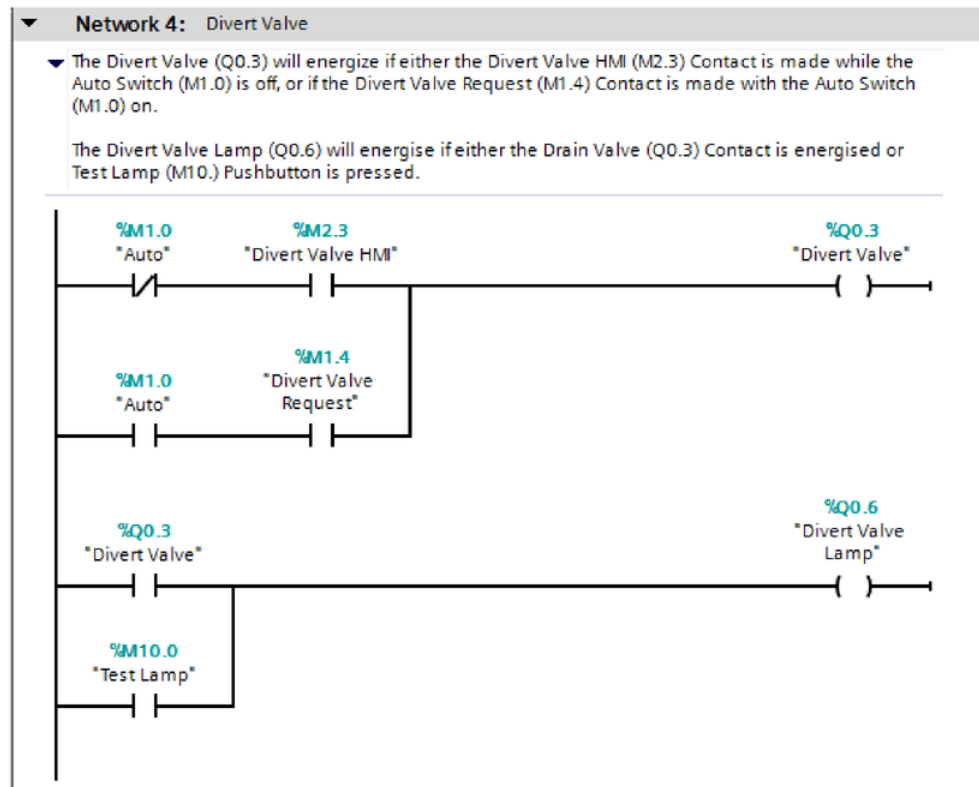


Figure 27- Manual Outputs Network 4

Figure 28 shows Network 5, which contains the Tank Full Lamp. The Tank Full lamp will energise, once the Tank Full Level Switch has made, indicating the tank is full. When the Test Lamp button is energised on the HMI, this will also bring on the Tank Full Lamp.

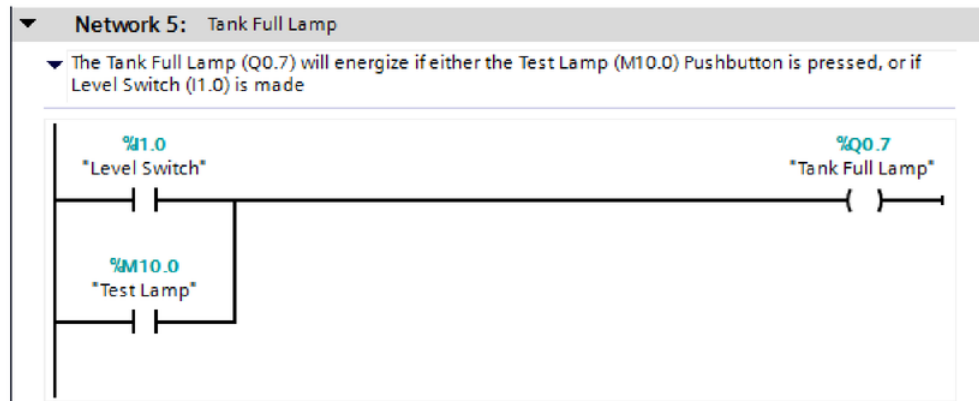


Figure 28- Manual Outputs Network 5

Figure 29 shows network 6, which shows manual control of the Heater. The Heater will only energise once the system is in manual and the heater is selected on the HMI. A safety interlock as added to prevent the heater energising if the tank is empty, this was done by adding a normally open contact for the Level switch. The Move Function was added to ensure the Heater was on at its maximum when it manual control.

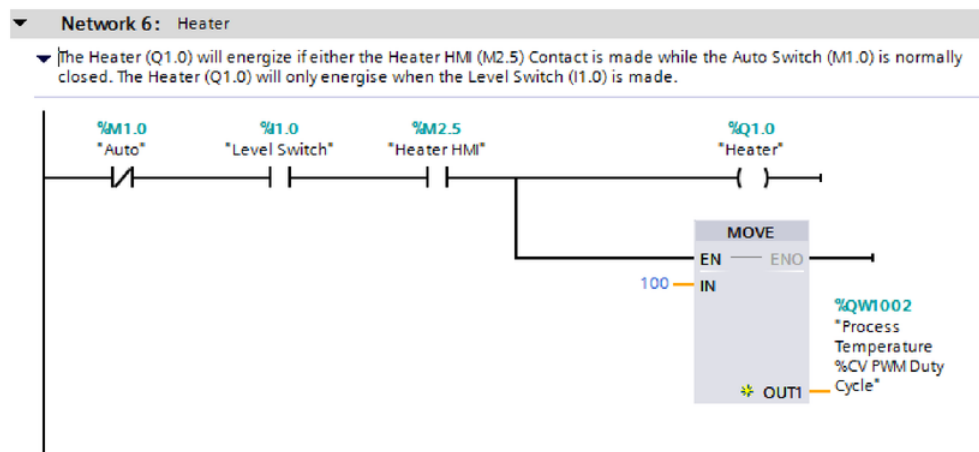


Figure 29- Manual Outputs Network 6

Error! Reference source not found. shows Network 7, which controls the Pump in Manual Mode. The pump will only energise if the system is in Manual mode and the Pump has been selected on the HMI, the Level Switch will de-energise the pump when it opens, as this will mean the Process Tank is full. The Move Function was added to ensure the Pump was on at its maximum when it manual control.

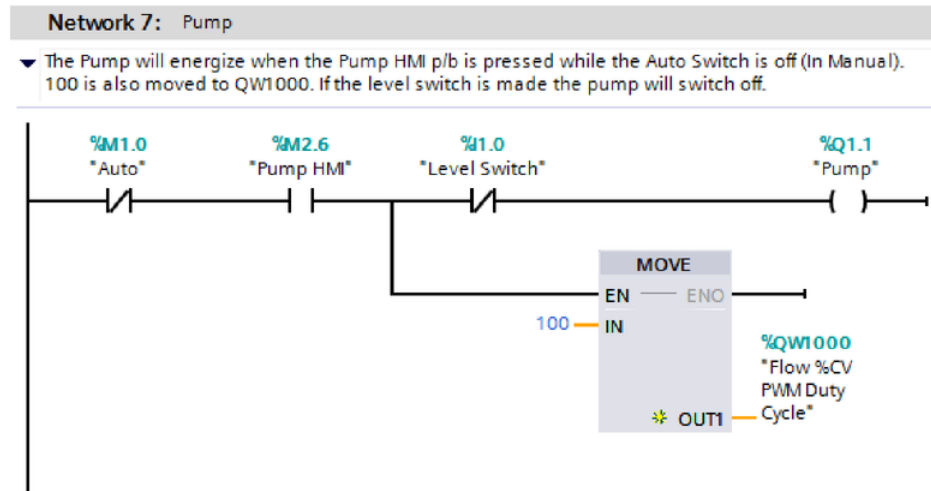


Figure 30- Manual Outputs Network 7

Main (OB1)

Figure 31 shows the Manual Output Program block in Main, this must be added to ensure the PLC reads the function block.

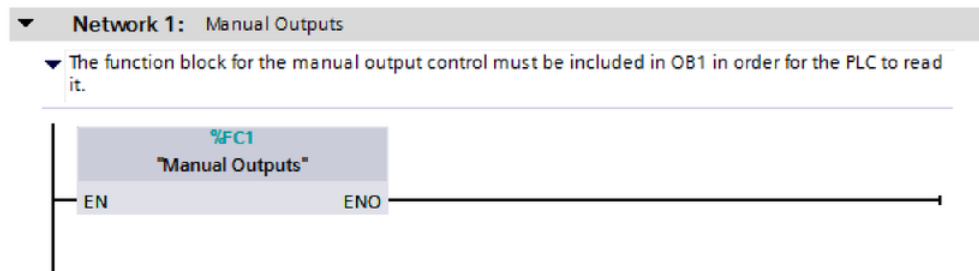


Figure 31- Main Network 1

Figure 32 shows the Scaling Function of the Sump Tank temperature. The Raw value enters the scaling block, from the RTD, and is then offset by 40, multiplied by 100 and divided by 13760. This will then produce a scaled value that represents temperature in degree Celsius, for the engineer and operator to understand.

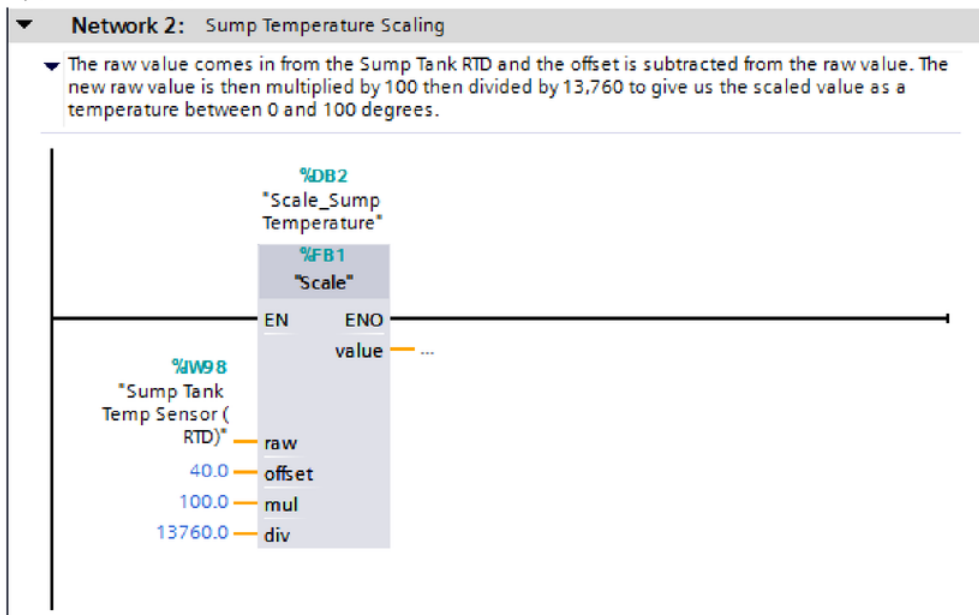


Figure 32- Temp Scale Function

Figure 33 shows the Scaling Function of the Ambient temperature. The Raw value enters the scaling block, from the Ambient Temp RTD, and is then offset by 40, multiplied by 100 and divided by 13760. This will then produce a scaled value that represents temperature in degree Celsius, for the engineer and operator to understand.

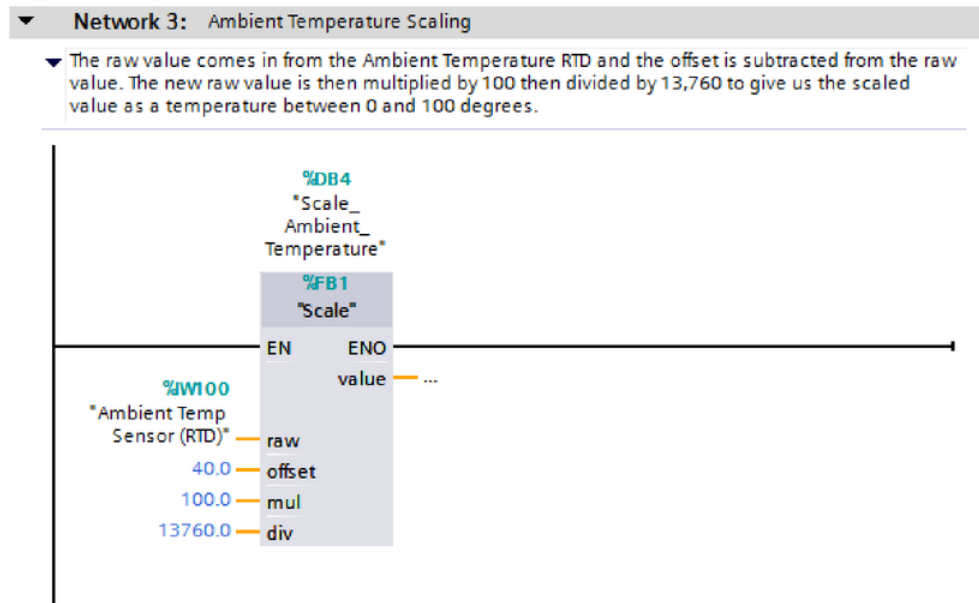


Figure 33- Ambient Temp Scaling

Figure 35, shows the Pulse Width Modulation control for the pump. This block is used to control the output signal to pump, to control the flow rate. The CTRL_PWM will only be energised once the Auto Flow (M60.0) is selected.

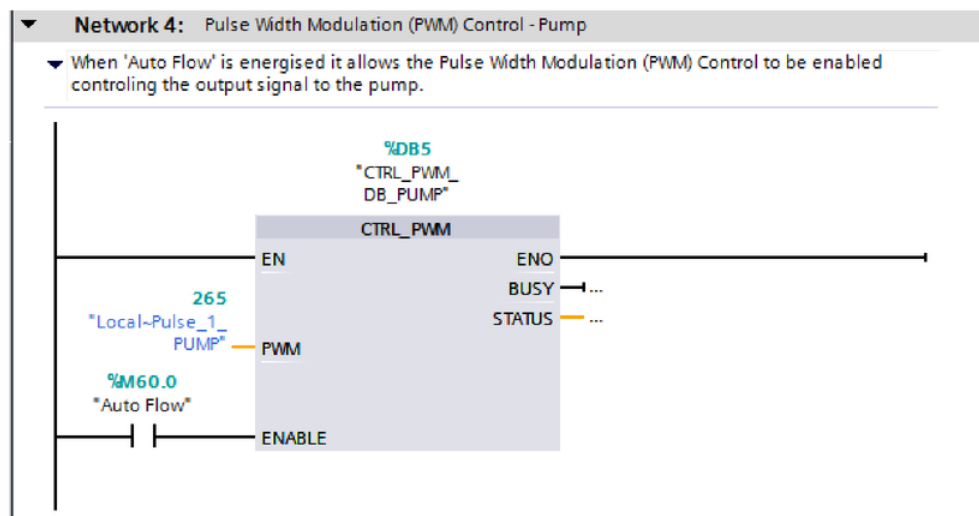


Figure 35- PWM Control Pump

Figure 36, shows the Pulse Width Modulation control for the Process Temperature. This block is used to control the output signal to heater, to control the temperature. The CTRL_PWM will only be energised once the Auto heater (M70.0) is selected.

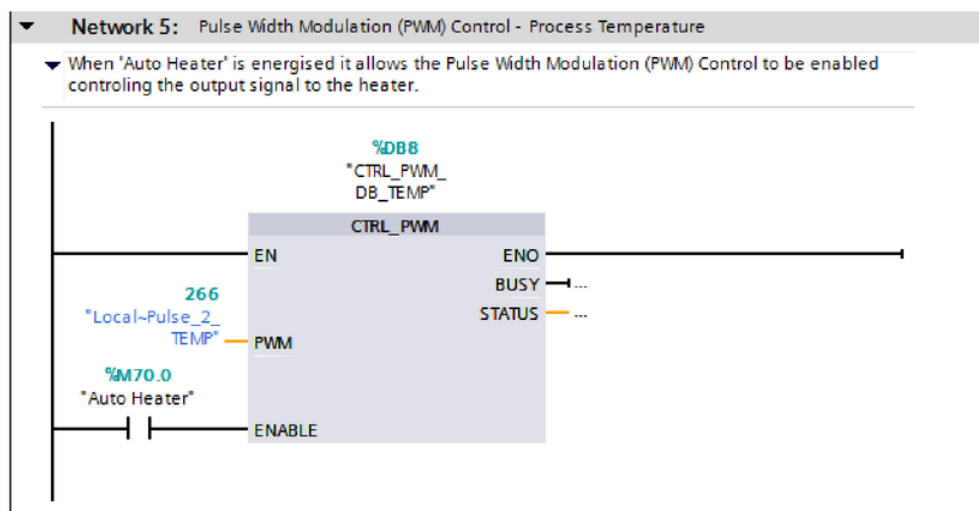


Figure 36- PWM Control Process Temp

Figure 37 shows the Automatic Control Function block in main. This needs to be in main to ensure the PLC reads it. The Auto (M1.0) switch also needs to be selected on the HMI.

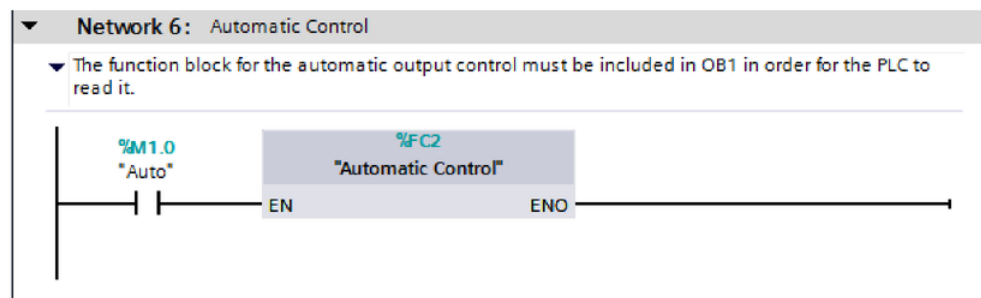


Figure 37- Automatic Control

Automatic Control

Figure 38 shows Network 1, Automatic Sequence Select. Auto Run will set once Auto has been selected on the HMI and the Auto Start button has been pressed.

The Auto Run will then re-set if the system is put back into manual mode or if the Stop pushbutton is pressed.

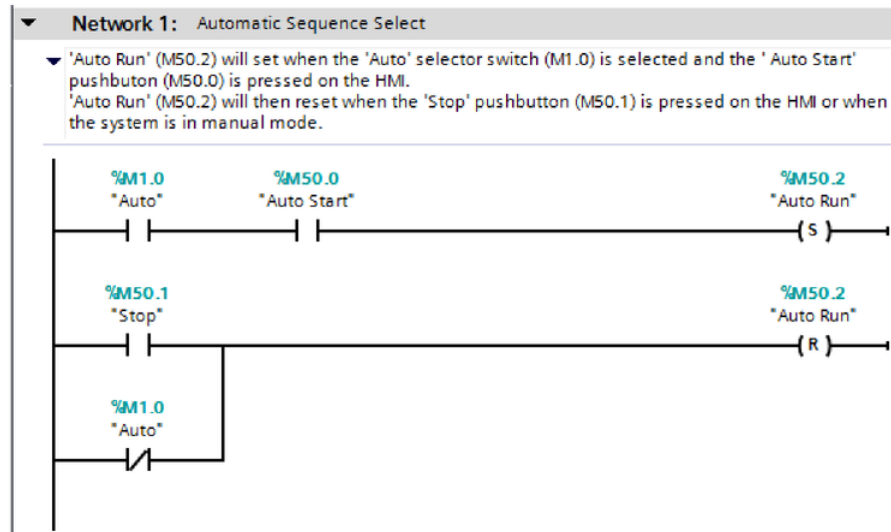


Figure 38- Automatic Sequence Select

Figure 39 shows the Automatic Pump/Heater selection. Auto Flow will be made once Auto Run is selected on the HMI and the limit Switch has not been made, ensuring Process Tank is empty. The Auto Flow memory word (M60.0) will be used to energise the Pulse Width Modulation Control for the Pump.

Auto Heater will be made once Auto Run is selected on the HMI and the limit Switch has been made, ensuring Process Tank is full. The Auto Heater memory word (M70.0) will be used to energise the Pulse Width Modulation Control for the Heater.

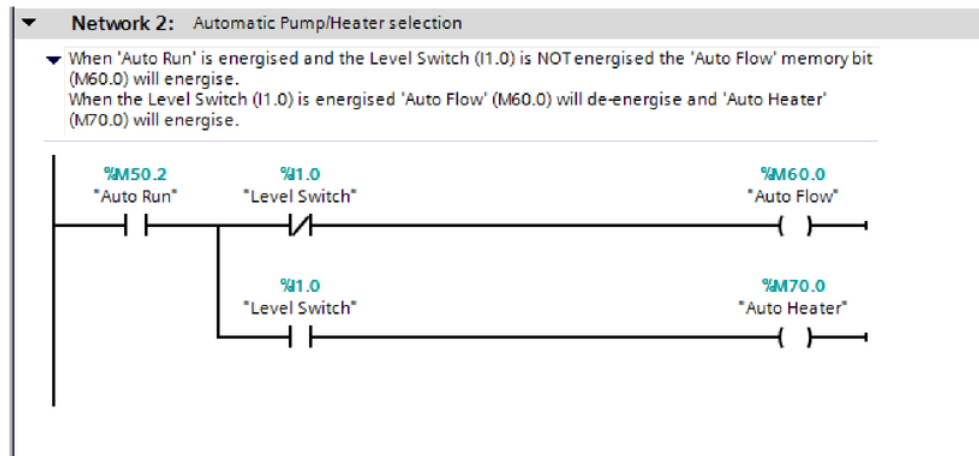


Figure 39- Automatic Pump/Heater Selection

Cyclic Interrupt Flow

Figure 40 shows the Real Words created to allow the PID to be controlled for the Pump and also scale the Flow rate.

PID_DB_Pump		
	Name	Data type
1	Input	
2	SP	Real
3	PV	Real
4	Output	
5	CV	Real
6	InOut	
7	Static	
8	Error	Real
9	Old_Error	Real
10	Int_Accum_Max	Real
11	Int_Accum	Real
12	Diff	Real
13	P Part	Real
14	I Part	Real
15	Kd	Real
16	Ki	Real
17	Kp	Real
18	D Part	Real

Figure 40- PID Pump Real Words

Figure 43 shows the Scaling Function of the Flow Rate. The Raw value enters the scaling block, from the Flow Rate Sensor, and is then offset by 34, multiplied by 100 and divided by 13766. This will then produce a scaled value that represents flow, for the engineer and operator to understand.

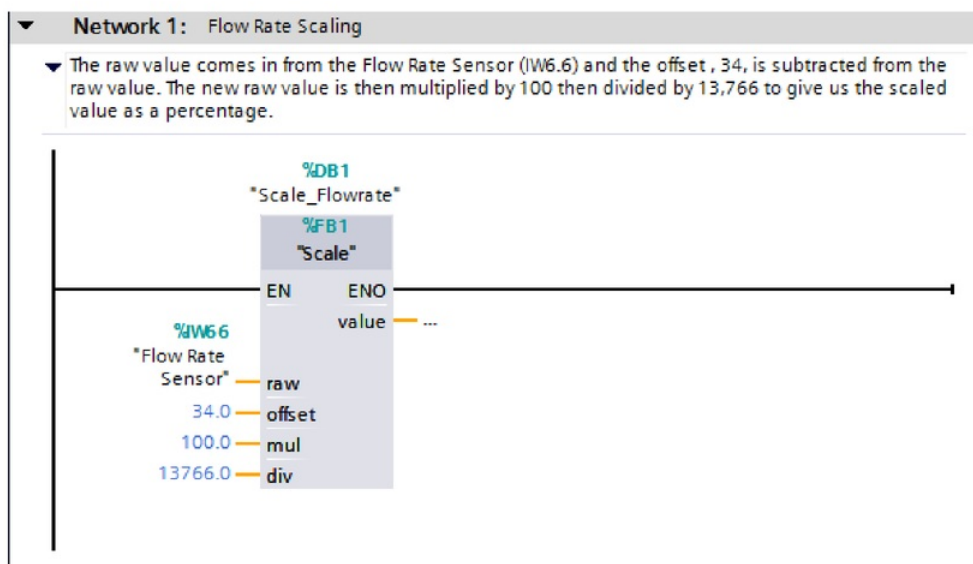


Figure 41- Flow Rate Scaling

Figure 42 shows the PID control for the Pump. When Auto Flow is selected the Control Value will be calculated, by taking the Process Value, Scale Flowrate Value, away from the Set point. The Control Value will then be converted from a real value to an unsigned integer that will control the PWM of the pump.

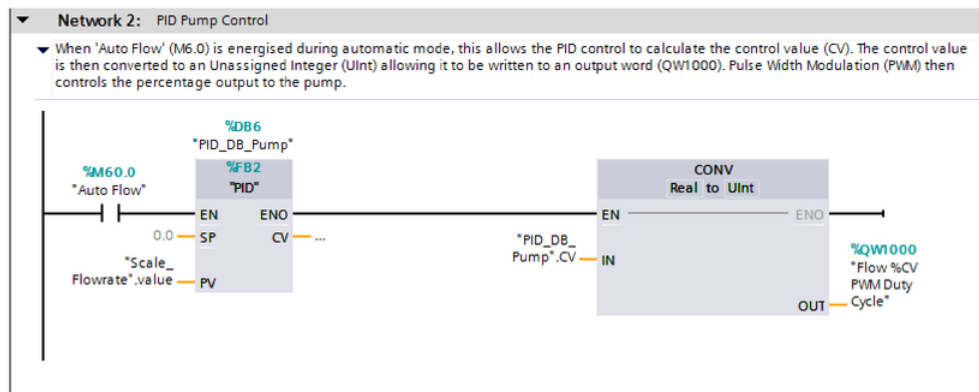


Figure 42- PID Pump Control

Cyclic Interrupt Temp

Figure 44 shows the Real Words created to allow the PID to be controlled for the HEATER and also scale the Temperature.

PID_DB_Temp		
	Name	Data type
1	Input	
2	SP	Real
3	PV	Real
4	Output	
5	CV	Real
6	InOut	
7	Static	
8	Error	Real
9	Old_Error	Real
10	Int_Accum_Max	Real
11	Int_Accum	Real
12	Diff	Real
13	P Part	Real
14	I Part	Real
15	Kd	Real
16	Ki	Real
17	Kp	Real
18	D Part	Real

Figure 44- Temp PID

Figure 45 shows the Scaling Function of the Process Temperature. The Raw value enters the scaling block, from the Process Tank RTD, and is then offset by 40, multiplied by 100 and divided by 13760. This will then produce a scaled value that represents temperature, for the engineer and operator to understand.

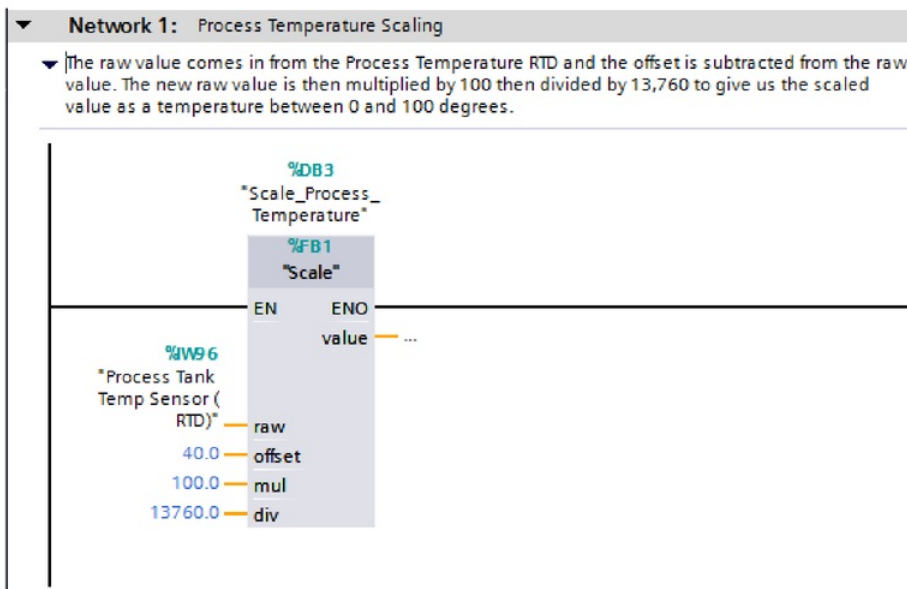


Figure 45- Process Temp Scaling

Figure 46 shows the PID control for the Heater. When Auto Flow is selected the Control Value will be calculated, by taking the Process Value, Scale Process Temperature Value, away from the Set point. The Control Value will then be converted from a real value to a unassigned integer that will control the PWM of the Heater.

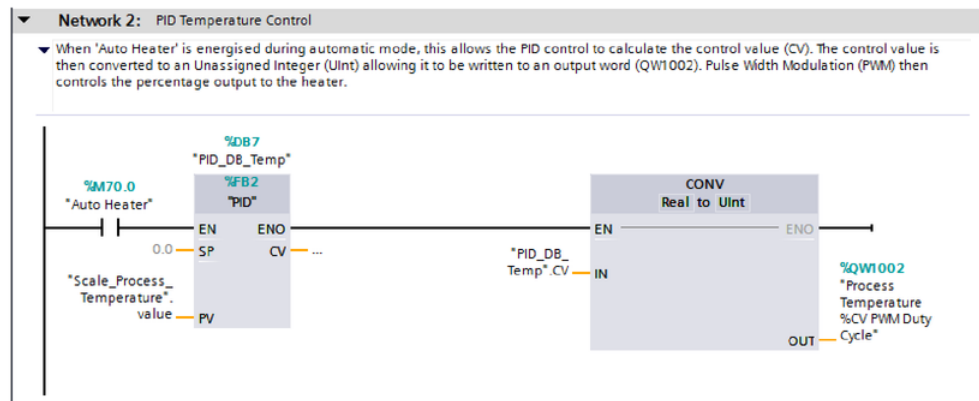


Figure 46- PID Temperature Control

PID

Figure 47 shows Network 1 and 2 of the PID programme block.

Network 1 contains a Move function that will convert the 'Error' into the 'Old_Error'

Network 2 contains a subtraction block that takes away the 'Process Value' from the 'Set Point' to give us our 'Error'

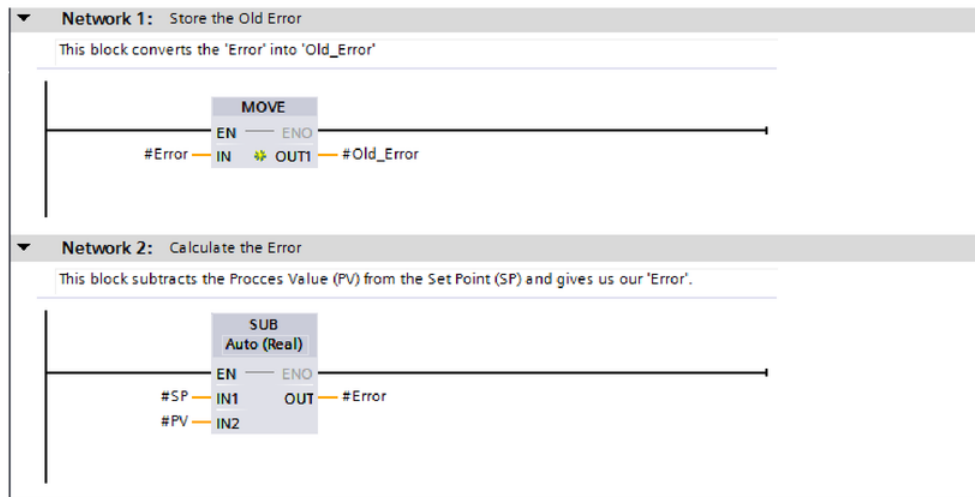


Figure 47- Network 1 & 2 PID

Figure 48 shows Network 3 and 4 of the PID programme block.

Network 3 calculates the P Part, by multiplying the Error by the Kp.

Network 4 is used to reject erroneous values of Ki. This is done by first limiting the value by setting a minimum and maximum value. The Ki is then divided by 100 to produce our 'Int_Accum_Max'.

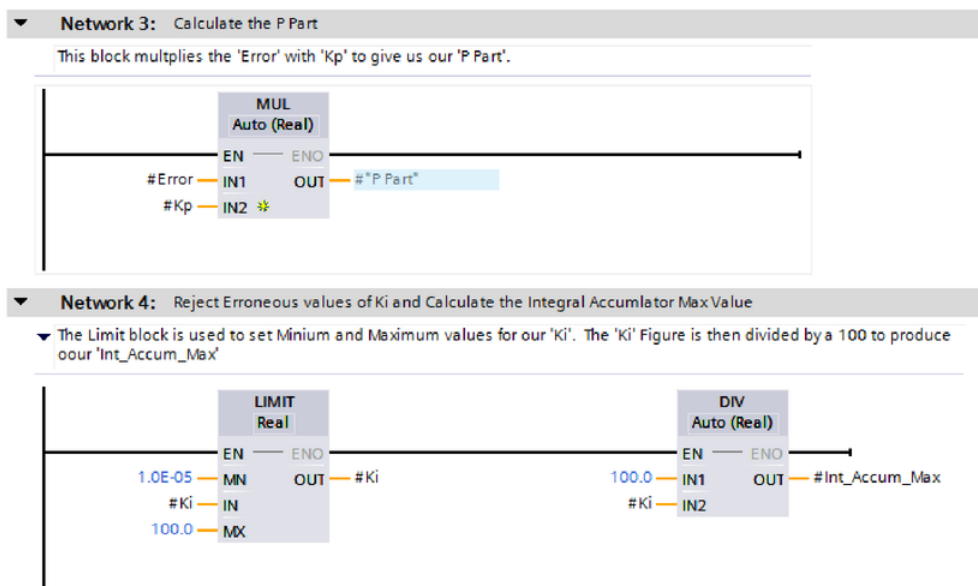


Figure 48- Network 3 & 4 PID

Figure 49 shows Network 5 and 6 of the PID programme block.

Network 5 is used to update the Integral Accumulator. This is done by adding the 'Error' to the 'Int_Accum' to update the 'Int_Accum'. This value is then limited with a minimum value of 0 and the maximum value coming from the 'Int_Accum_Max'.

Network 6 calculates the I part. This is done by multiplying 'Int_Accum' by 'Ki'.

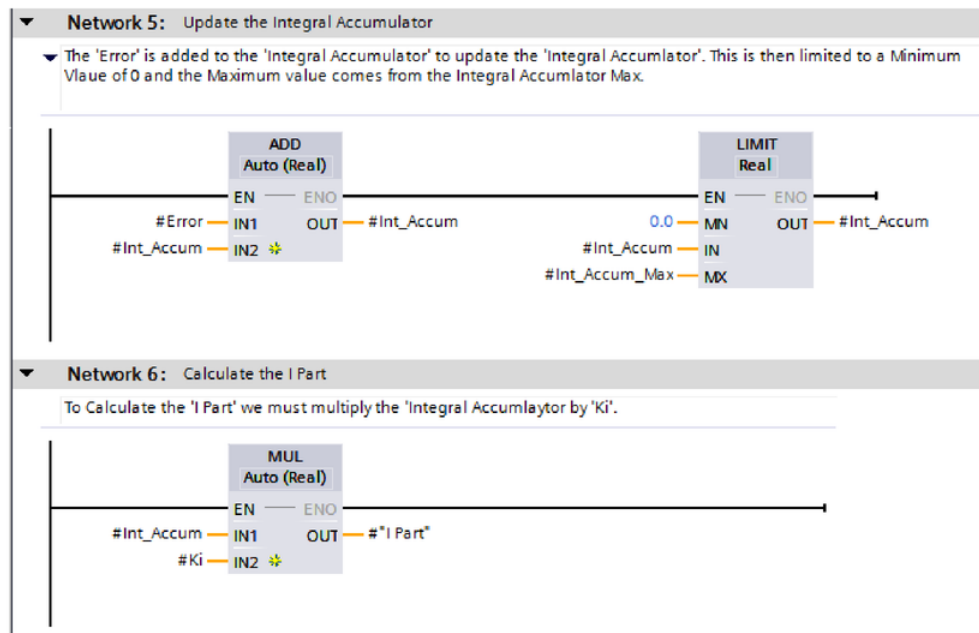


Figure 49- Network 5 & 6 PID

Figure 50 shows Network 7 and 8 of the PID programme block.

Network 7 is used to calculate the difference. This is done by subtracting the 'Old_Error' from the 'Error'.

Network 8 is used to Calculate the D Part. This is done by multiplying the 'Difference' by the 'Kd'.

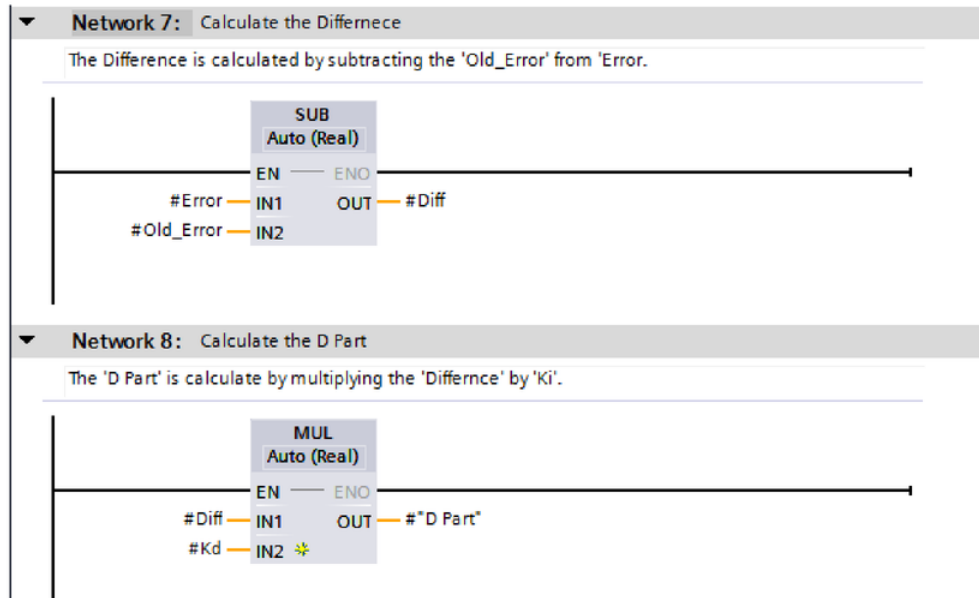


Figure 50- Network 7 & 8 PID

Figure 51 shows Network 9 of the PID programme block.

This network is used to calculate and limit the Control Value. This is firstly done by adding the 'P Part', 'I Part' and 'D Part' together. The Control Value is then limited by a minimum value of 0 and a maximum value of 100.

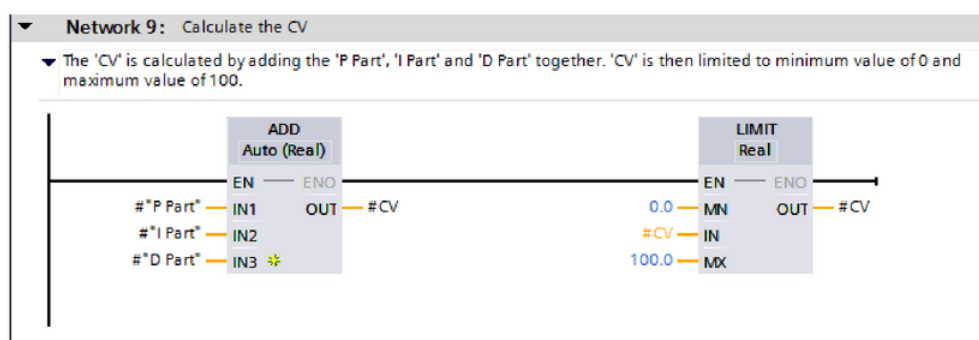


Figure 51- Network 9 PID

Scale

Figure 52 shows Network 1 and 2 of the Scale Programme block.

Network 1 is used to get our Junk value. This is first done by converting our real unassigned integer, to a real value 'Junk'. The 'offset' is then subtracted from the 'junk' to give us the real value 'junk'.

Network 2 is our Scale Value. To get this the 'Junk' was multiplied with the 'mul'. The 'Junk' was then divided by 'Div' to give us our 'value'.

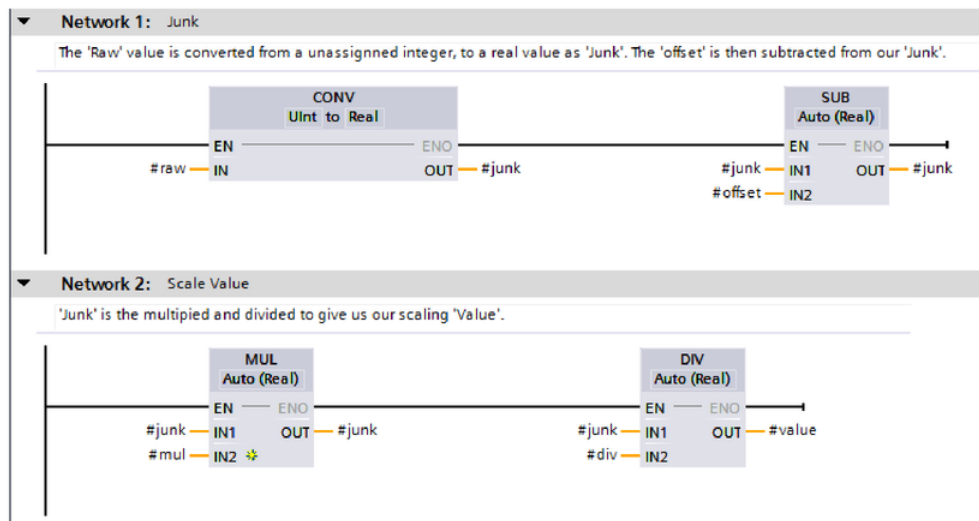


Figure 52- Network 1 & 2 Scale Programme Block

We used the scale programme block in order to scale:

- Flow Rate
- Process Temp
- Sump Tank Temp
- Ambient Temp

Once these are scaled the corresponding data block tables were produced as can be seen in

Scale_Process_Temperature		
	Name	Data type
1	▼ Input	
2	raw	UInt
3	offset	Real
4	mul	Real
5	div	Real
6	▼ Output	
7	value	Real
8	InOut	
9	▼ Static	
10	junk	Real

Figure 53- Process Temp Data Block

Scale_Flowrate		
	Name	Data type
1	▼ Input	
2	raw	UInt
3	offset	Real
4	mul	Real
5	div	Real
6	▼ Output	
7	value	Real
8	InOut	
9	▼ Static	
10	junk	Real

Figure 54- Flow Rate Data Block

Scale_Sump Temperature		
	Name	Data type
1	▼ Input	
2	raw	UInt
3	offset	Real
4	mul	Real
5	div	Real
6	▼ Output	
7	value	Real
8	InOut	
9	▼ Static	
10	junk	Real

Figure 56- Sump Temp Data Block

Scale_Ambient_Temperature		
	Name	Data type
1	▼ Input	
2	raw	UInt
3	offset	Real
4	mul	Real
5	div	Real
6	▼ Output	
7	value	Real
8	InOut	
9	▼ Static	
10	junk	Real

Figure 55- Ambient Temp Data Block

Program Testing, Results and Evaluation

Testing Table		
Test	Expected Result	Actual Result
Manual Tests		
1.		
Manual Pushbutton pressed for Cooling Fan.	Cooling fan should start, when energised and the Cooler Lamp should light on rig and HMI.	Cooling Fan Energised and Cooler Lamp on HMI and rig came on. Figure 57 Figure 60
2.		
Manual Pushbutton pressed for Stirrer.	The Stirrer should start, when energised and light on HMI so could on.	The Stirrer energised and light came on. Figure 57 Figure 60
3.		
Manual Pushbutton pressed for Drain Valve.	The Drain Valve should Open when energised and the Drain Valve Lamp on rig and HMI should light.	The Drain Valve Open and Drain Valve Lamp on rig and HMI came on. Figure 57 Figure 60
4.		
Manual Pushbutton pressed for Divert Valve.	The Divert Valve should open when energised, and Divert Lamp on rig and HMI should light.	The Divert Valve Open and Divert Lamp on HMI and rig energised. Figure 57 Figure 60
6.		
Manual Pushbutton pressed for the Heater.	The Heater should energise ,and start heating the tank if the tank is full. Light on HMI should light.	Heater energised when tank was full, light came on. Figure 57 Figure 60
6.		
Manual Pushbutton pressed for the Pump.	The Pump should energise, and start pumping. Light on HMI should light	Pump energised and starting Pumping, light came on. Figure 57 Figure 60
7.		
Test Lamps Pushbutton pressed.	All Lamps on Bytronic Process Rig and HMI should come on.	All Lamps came on. Figure 58 Figure 57 Figure 60

*EXCELLENT TABLE WITH EVIDENCE
LINKED TO TEST*

Auto Tests		
1.		
Automatic Sequence selected and Process Temperature Set Point set to 70 degrees Celsius.	Temperature should rise to 70 degrees Celsius, if the tank is full, and the temperature should be maintained at 70 Degrees Celsius.	When the tank was full the Temperature heated to 70 degrees Celsius and was maintained at this temperature. Figure 59 Figure 62 Figure 61
2.		
Automatic Sequence selected and Flow Rate Set Point set to 50 litres per minute.	Flow Rate should rise to 50 litres per minute and the temperature should be maintained at 50 litres per minute, and should stop pumping once process tank is full.	The Flow rate reached 50 litres per minute and was maintained at this level until the tank was full. Figure 63

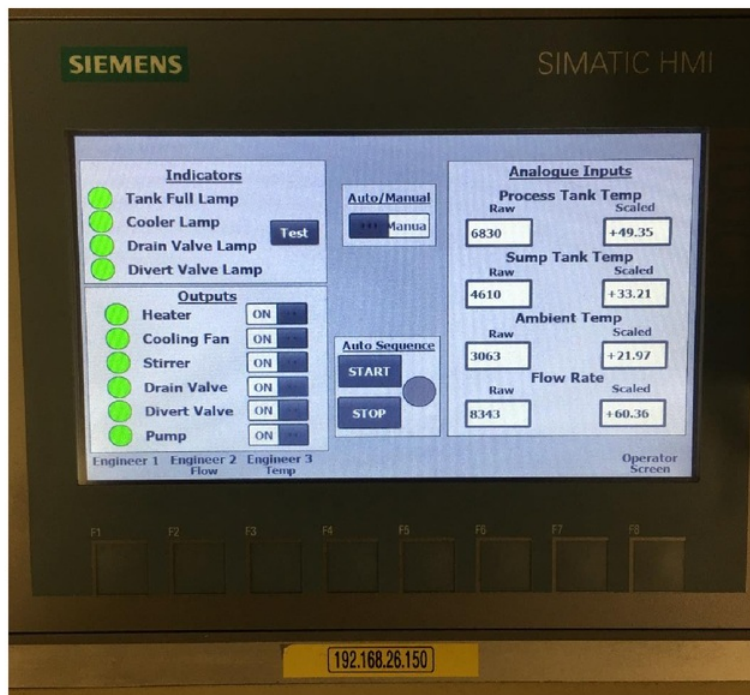


Figure 57- Manual Outputs all Energized

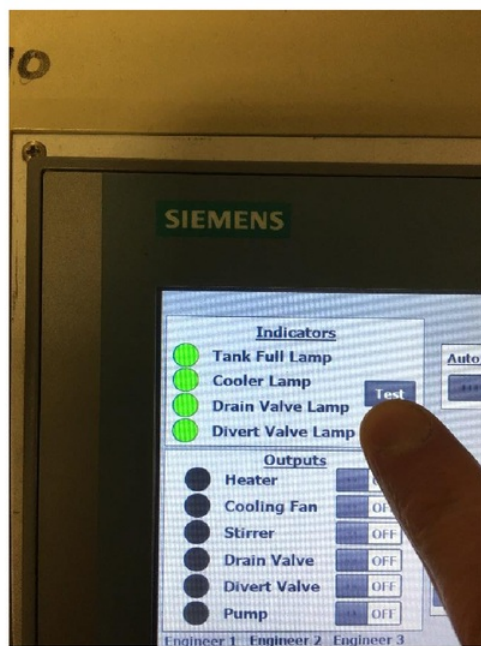


Figure 58- Test Lamp PB being pressed



Figure 60- Lamps all on

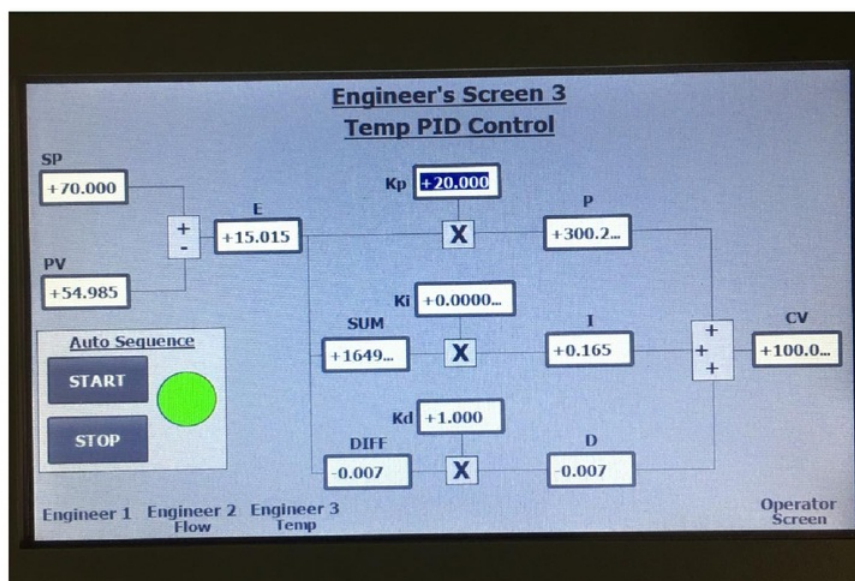


Figure 59- Temp PID 1

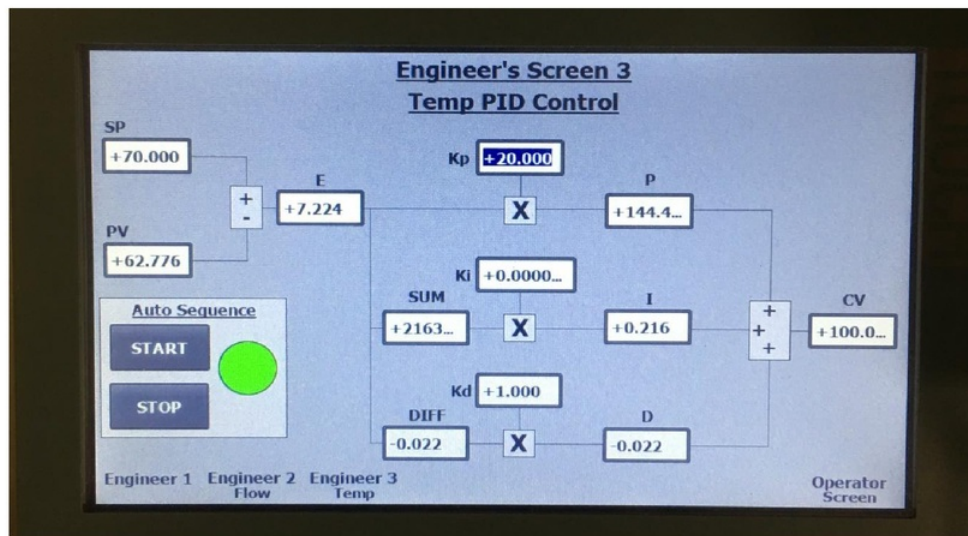


Figure 62- Temp PID 2

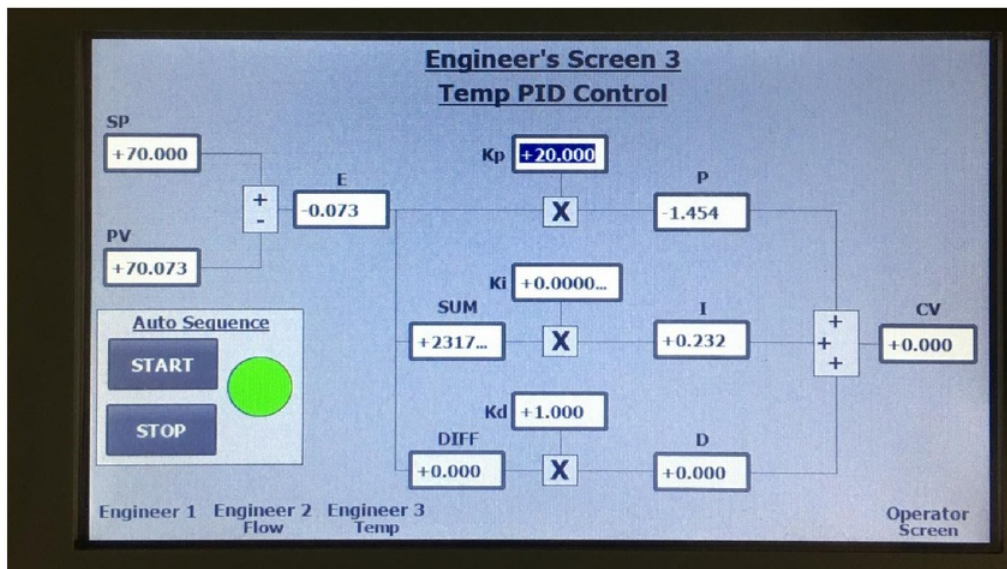


Figure 61- Temp PID 3

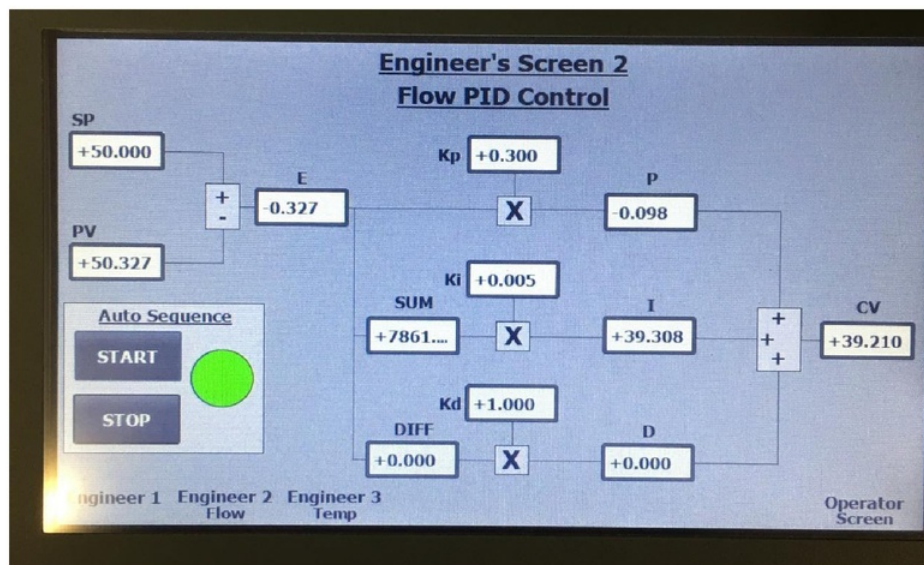


Figure 63- Flow PID 1

Safety, Maintenance, Reliability and Sustainable Development

Risk Assessment

Figure 64 shows the Risk Assessment created for the Bytronic Process Rig. All risks were considered and the safety precautions already in place were noted and suggestions were made for further health and safety precautions.

Company name: **Coleg Sir Gar**

Date of risk assessment: **30/04/2018**

What are the hazards?	Who might be harmed and how?	What are you already doing?	Do you need to do anything else to control this risk?	Action by who?	Action by when?	Done
Slips and trips	Staff and visitors may be injured if they trip over objects or slip on spillages.	General good housekeeping is carried out. All areas well lit, including stairs. No trailing leads or cables. Staff keep work areas clear, eg no boxes left in walkways, deliveries stored immediately. Water is kept in sealed tanks and pipework.	Better housekeeping near Bytronic Process Rig Keep Bytronic Process Rig in tank, to ensure any spilled water is safely collected and not on the floor.	All staff, supervisor to monitor Manager	From now on 30/04/2018	N/A
Hot Water	Staff (Operators and Engineers)	The Water tank is covered. Work area well-lit to ensure all staff are aware of the water tank.	Cover the Process Tank, with interlocked guarding, as this can also get hot with increasing water temperature.	All staff, supervisor to monitor Manager	From now on 30/04/2018	N/A
Electric Shock	Staff (Operators and Engineers)	The Electrical Connections are already away from the water tank.	Put PLC and all connections in a Control Panel that only Engineers and Electricians have access to.	All staff, supervisor to monitor Manager	From now on 30/04/2018	N/A
Moving Parts	Staff (Operators and Engineers)	The Stirrer prong is already covered in the process tank.	Create guarding to cover the	All staff, supervisor to monitor Manager	From now on 30/04/2018	N/A

First Aid box and Accident Book is located in G8 in case of accident or emergency. There are also numerous first aid trained staff within the building.

Figure 64- Risk Assessment (HSE, 2018)

Reliability

When programming and designing the Bytronic Process Rig, it was important that it was reliable. Once the programme was designed, the system was run several times in Automatic mode, varying the setpoints for both temperature and flow, to ensure the system was reliable and that no errors were introduced over time. To maintain the systems reliability, a maintenance schedule would be recommended every 3-4 weeks to ensure that there is no blockage of pipes and that all components are working as intended. It is important that all instrumentation equipment (RTDs, Flow Sensor) are calibrated annually to ensure there is no feed-back errors as this could affect the PID systems. The Engineers HMI contains information that could also help with maintenance, such as test lamp button and the raw and scaled feedback from the RTD's and flow sensors, this allows the instrumentation to be tested to see if they are functioning as expected.

**ENGINEER'S SCREEN, PID
TUNING ?**

Promotion of Sustainable Development through energy saving

Energy saving plays a large role in the promotion of a sustainable development, with more energy saved the less energy is needed and therefore saving money and saving resources. There are several features of the Bytronic Process rig that can help save energy. The power supply for the heater contains a solid state relay. A Solid State Relay is made up of three circuits, input ,control and output circuit. The input circuits acts as the coil and energises when a voltage reaches a certain level and de-energises when it goes below this limit. Solid State relays also differ to Electromechanical relays as they do not contain moving parts and since the relay does not have to energise a coil, it uses 75% less power than your standard relay. (McCallum-Boles, 2018)

Pulse Width Modulation (PWM) is used to control the pump and heater and can also be used to save energy, this works as it rapidly changes a fixed voltage between its on and off condition. This will then reduce the overall energy supplied to either the pump or the heater. (Delivering Efficiency with Pulse Width Modulation, 2018)

PID ALSO SAVES ENERGY

Conclusion and Recommendations

To conclude, the system worked as initially intended with both the temperature and flow rate set points be met with only a small overshoot. Four HMI screens were developed to a good standard; with three screens for the Engineer to allow for fault find, maintenance issues and to control the system in manual with sensory information provided to show the object working as intended and one screen for the Operator, that allowed the operator to switch between Auto and Manual and also set setpoints for flow and temperature.

To test the system was reliable and working as intended, a testing table was developed that should predicted results and actual results, this allowed a comparison between both.

The hardware of the Bytronic process rig was also described to a good standard, showing how the hardware worked and what it contributed to the process rig.

In Summary, the system was designed to a good standard as all actual test results matched my predicted results and also proved the system was reliable by running the system several times. However to improve the system, a low level limit switch could be added in to the process tank to provide a signal of when the tank is almost empty. Limit switches could also be added in the Sump Tank that would provide a signal to the PLC of when the Sump Tank is full and almost empty. Password protection could also be added to the Engineers HMI screens to prevent the Operator entering the Engineers HMIs.

Description of Team Working

This assignment contained several tasks that required working as a team, I worked with Jed Davies throughout this assignment. We first worked together when describing the systems hardware, however we individually wrote all the documentation in the assignment. We then worked as a team when designing the PLC programme, however we ensured we would split the work load to ensure that we would complete the task on time. We decided that we would develop half the programme each and then design two HMI's each, to allow us to develop in skills in both these areas. We individually added network comments and described the programme in our assignments. Task 4 also required us to work as a team, in order to test the programme. We tested the programme as a team but individually designed a test table and concluded our results. Task 5 also required team working and this included carrying out a risk assessment. We worked together when designing the risk assessment to ensure we covered all the risks.

Citation List

References

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PSDE 4005 Assignment 3

GRADEMARK REPORT

FINAL GRADE

GENERAL COMMENTS

Instructor

83/100

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GRADING FORM: CSG-RUBIC

ETHAN HOWELLS

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RESEARCH-INFORMED LITERATURE



n/a

KNOWLEDGE AND UNDERSTANDING



Section 1: System description – Each part of the system has been described with supporting photos. A good I/O list and PLC description with instruments and actuators. However, system requirements are not given. (13/15) Section 2: Program explanation – All networks have titles and detailed comments built in. Screens have been explained together with each network and data block. (14/15)

27

ANALYSIS



Section 3: Testing - Detailed list of tests for manual and auto control. (9/10) Section 3: Results and evaluation - Testing table shows actual results with links to supporting evidence. However, there is no overall evaluation in this section or pass/fail for each test. (9/10) Section 4: Conclusions and recommendations - Good with some recommendations . (7/10)

25

PRACTICAL APPLICATION AND DEP.



Section 2: Program design - Excellent design. (10/10) Section 4: Safety, maintenance, reliability and sustainable development - Detailed risk assessment provided and all areas considered. Further issues could have been mentioned. (10/15)

20

SKILLS FOR PROFESSIONAL PRAC.



All sections – Report is well structured with clear images. However, sections should be numbered according to the brief and the wrong date is in the header. Figures have been numbered and listed correctly but title page should say assignment 3 not PLC1. (7/10) Section 6: Team working – Good explanation given (4/5)

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