

1909751

by Alex Williams

A LOT OF CONTENT WHICH LACKED SUBSTANCE.
GOOD EVIDENCE OF PROJECT MANAGEMENT
TECHNIQUES. 3 SOLUTIONS OFFERED AND FINAL
SOLUTION JUSTIFIED.

EXTENSIVE FEEDBACK FROM 1ST MARKER.

MARK AIREDA



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Summary

This report documents the research, design development and testing of a prototype to automatically control the turning on and off of the 14 extract fans and 8 evaporative coolers

at Amazon Swansea also known to as CWL1. Contained within the report and appendices are general and technical specifications for this project, a full set of electrical drawings and acceptance testing tables. Due to the physical refurbishment of all the extract fans and coolers, the project could only be taken as far as the simulation testing on the test rig.

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Acknowledgements

Dr. Jose Morales de los Rios

An acknowledgement to Dr. Jose Morales de los Rios for his guidance through the project. He shared valuable information and offered advice on software development and industry knowledge throughout the project.

Assumptions & Abbreviations

It is assumed that the reader has basic computing and electrical engineering knowledge. For ease of reference, the following abbreviations relating to Amazon terminology are listed below.

Amazon Associate – An employee of Amazon

Evap or Evaps – Evaporative coolers

FC – Fulfilment Centre

MCM - Modelled Change Management

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Good use of tables

1. Introduction and background reading

Amazon is a multinational company specialising in E-Commerce, Cloud Computing, Artificial Intelligence, and logistics. There are over 40 subsidiaries to Amazon with its most popular being Amazon Fulfilment which deals in E-commerce. However, other subsidiaries such as AWS (Amazon Web Services) are expanding rapidly and already has high profile clients such as Netflix and Airbnb.

To manage customer demand for its e-commerce, there are 26 fulfilment centres around the UK, including CWL1 based in Swansea where this project is based. Within these centres there are pick-towers. A multistorey infrastructure where various items are stored ready to be picked and sent out to customers. Due to the infrastructure of the pick-tower, it can have reduced air flow and can become very hot and humid in warmer weather making it uncomfortable to work in. To combat this, 8 evaporative coolers and 14 extract fans have been installed which are manually controlled on an HMI screen on the top floor of the pick-tower.

The Evaps working principle can be explained as “The fan draws dry, hot air into the machine and across the cooler pads. These thick pads absorb water from the reservoir and have many layers to increase the surface area. As the hot air crosses the pad, the water molecules on the surface evaporate, which causes the air temperature inside the cooler to drop” (Newair, 2018)

The cooler air then gets fed into the centre of the Pick-Tower, the roof extract fans are then based on the edge of the Pick-Tower, these fans then draw the cooler air from the middle of the building out towards the edge of the Pick-Tower.

Currently the system can only be operated manually on the HMI with no automatic sequence in place. The current process would require engineering to be called to turn the system on/off meaning an engineer going up to the 4th floor to do this manually. This can be time consuming to either pull an engineer away from a task or wait until one is free. Having the system automated will remove the need of the engineer attendance and the system should then be able to turn on and off the fans on its own.

The current system does make use of Profinet. Research into Profinet shows that the cable runs should not be longer than 100m. (Anon., 2016)

Research was carried out to use a RTD or thermocouple sensor. It was decided to go for a RTD due to being able to use an M12 connection to plug into the A/I module. It also is more robust to keep in stores, be easier to scale due to its linear properties. RTD can be more expensive but they do fit within the project budget. The table of comparison is shown in Table 1. Table 1 was from Sterling Sensors who are industry experts in sensing technology.

Good research carried out with relevant sources used

Comparison chart of RTD Sensors and Thermocouples		
Criteria	RTD Sensor (Pt100)	Thermocouple
Measurement range (max)	-200 to +850°C	-200 to +2600°C
Measurement range (typical)	-50 to 300 (Pt100 B)	0 to 1100°C (type K)
Long term stability	Good	Poor
Accuracy	Good	Poor
Repeatability	Good	Poor
Interchangeability	Excellent	Good
Tip sensitivity	Poor	Good
Signal strength	Higher – more resistant to EMI	Low – susceptible to EMI
Excitation	Yes	No
Cost	More expensive	Less expensive
Noise problems	No	Some
Extension cable	No	Yes – Must match Th/c
Best for	Consistent readings	High temperatures
Worst for	Surface readings	Long term stability
Hysteresis	Good	Excellent
Self-heating	Yes	No

Table 1: RTD vs Thermocouple Comparison (Sterling Sensors, n.d.)

Good comparison table that supports the explanation

2. Specification

To create an automated sequence that can control the turning on and off of the eight evaporative coolers and 14 extract fans.

The solution should make use of the existing system which includes the Siemens S7-1200 series PLC, the two remote I/O modules for the extract fans, and the 8 drives located on the roof for the Evaps.

The project will run in line with the 2020/21 academic year starting in October and finishing in April. A Gantt chart must be created and must be followed as far as reasonably practicable. The project will have a budget of £3,000 and also needs to be cost-efficient so it can pay for itself within 5 years, as per company policy as anything longer must be agreed by senior finance and senior engineering management. In order for the project to recover the investment it has to save 156 hours of labour of labour in 5 years.

Any solution must allow the engineering team to be able to select a mode between manual and automatic. The HMI must show a visual representation of what is running available for any user to see on the home screen. All operational features must be password protected so only engineering can operate the system.

All work must be completed to the latest industry and Amazon standards and be compliant with all legislation including the following:

- AMZN - controls Standard including forced ventilation
- AMZN – RME/Engineering standards of work
- AMZN – Process change standard
- AMZN – EU EHS standards
- AMZN - info-sec
- AMZN – Sustainability Standards
- Health & Safety at Work Act 1974 with appropriate risk assessments to ensure safe systems of work
- Electricity at Work Act in addition to other relevant legislation and regulations

*A detailed
specificati
on*

3. Planning

A Gantt chart was created to manage the timeline of the project and to track the progress. The full Gantt chart can be seen in Figure 4, Appendix A. The key for the Gantt chart is below in Figure 1. It can be split down to the planning and reality of the timings of events.

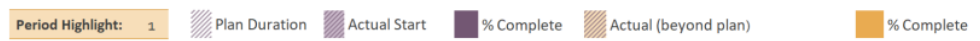


Figure 1: Gantt Chart Key

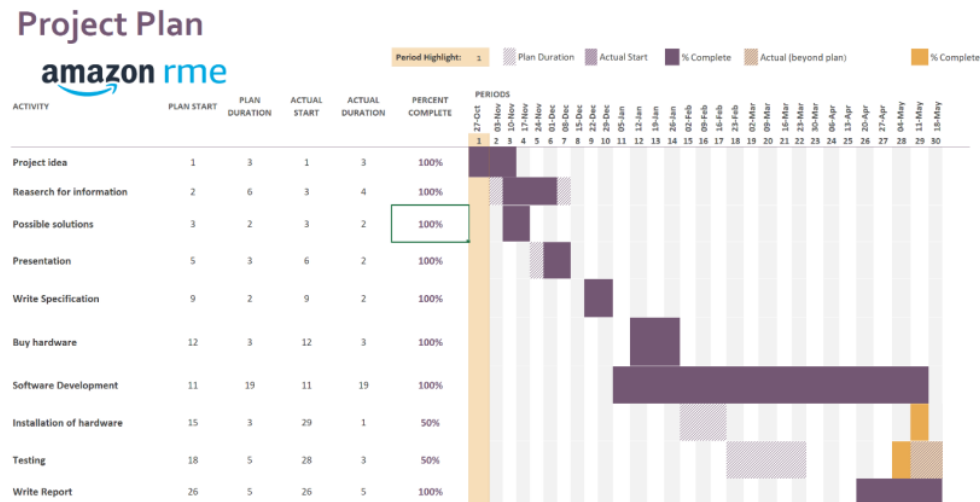


Figure 2: Gantt Chart

The Gantt chart highlighted key stages in the project that needs to be completed by the deadline to keep the project on track. The first stage on the Gantt chart involved coming up with the project idea and identifying the problem. Research for potential solutions could then be conducted and possible solutions identified. Solutions would then have to be analysed and the best solution should be selected. This solution should match the specification that has been written. These steps have to be completed before the hardware can be ordered. Parts of the project did align with the Gantt chart; other tasks were completed early where others were delayed and took longer.

A testing table will be developed which details all the requirements of the specification and expected outcomes. The testing table will then include practical tests in addition to specification comparison. All test must be first simulated on the test rig to ensure the code is correct before integrating with the existing system. This is to ensure success and minimise downtime.

Test plan table is in appendix

4. Solutions Considered

Three possible solutions were thought of and considered for the project. Each solution had to be considered and investigated. Solution 1 was to make use of the existing PLC and the current infrastructure. It would require installing temperature sensors in the FC. The PLC would then scale the readings and take an average temperature. The average temperature would then be compared against a setpoint and that would send the command to turn on the automated sequence. The set point would be able to be set on the HMI in addition to all temperature data being displayed. This solution would meet all the specification that has been set out as it makes use of existing hardware and software that is in place. The setpoint has to be password protected so only engineering access can change the value. In addition to the live temperature data the HMI can show the equipment on/off status and any faults or alarms present. The potential of this project leaves room for expansion with the ability to link with a BMS system to be controlled remotely. The solution would have to pass the MCM - modelled change management review.

This should have an image and ref source for support

Solution two is using a thermostat and a relay as input to the PLC. The thermostat would be triggered when the set point temperature has been breached, the output can then bring on a relay which will send a 24v signal into the PLC input card. This solution has a very similar concept to solution one. Utilising the existing PLC software and hardware to trigger an automatic cycle. This is the more basic solution of the two but has a lot of exploits. In Amazon sabotage is a regular occurrence, the thermostat would be in risk of being damaged or having the setpoint changed all of the time as it cannot be locked. The thermostat would not be able to provide live data into the HMI screen but it would only be able to provide details of what is running. The manual controls would still be able to be password protected but the thermostat would be open to abuse by people walking past. This is the cheaper option as remote I/O would not have to be purchased. As the PLC would only receive a digital input the control would be much harder. A thermostat would only be located in one position unless multiples thermostats could be installed and any one stat could turn on all the fans but the reliability could be much lower if it's not guarded access to only engineers.

Images and ref source would support this argument

Solution 3 would be to use a thermostat again under each Evap. Then when that thermostat reaches temperature, it will bring on a relay. The relay logic can then be hardwired into the motor starter and contractors in the Evap panels located on the roof. The potential issue with this solution is that different fans could be coming on at different times. This solution would control fans individually and not as a collective integrated system. Feedback could be given to the PLC for data of what is running to be displayed on the HMI but this would be much costlier in parts and offer much more distribution to operations during a lengthy installation process. With relay logic there is a higher risk of failure due to all of the moving components compared to a PLC where digital outputs can be used reducing the risk of failure.

Solution 3 does not meet many of the traced specification objectives and is a poor selection as it has much higher labour costs due to installing more hardware and having longer individual cable runs to the roof. Solution one is the preferred implementation as it will fulfil all the requirements and improvements beyond the current install. Using remote I/O and Profinet, the number of cables needed is small due to being able to send data over the Profinet comms link. Unlike all the other solution as the set point will be set digitally it can be password projected on the HMI. All the other controls also hold the same potential so only a higher user log in can operate the system. Due to the potential risk of sabotage on thermostats solution one is the strongest. With the use of remote I/O

Solution 1 is chosen and a good argument is put forward for this choice including constraints by Amazon requirements.

the system can then also be monitored remotely and hold the potential of future expansion with the BMS system.

5. Final Solution Design and Implantation

Solution one was the chosen solution for the project. Research had to be conducted to find the required sensors and then be installed across the top floor of the picker tower. Two options were available, due to the restrictions of the length of Profinet. It was decided that two remote I/O modules would be used. This would then allow the sensors to be more spread out to get a better reading.

The first research was carried out to find the best sensors suitable for the task. It was decided that PT100 probes would be used to read the temperature. These sensors would then give an analogue input into a remote I/O device. A Turck module was selected as Turck modules are used on other equipment on site so it was picked for continuity. The exact module chosen was a Turck TBEN-S2-4AI. This module was best suited for the task from the Turck range as the solution was looking at analogue readings. The module also had two installation options with the ability to be mounted on a din rail in a panel or bracket mounted in the field. The module is rated for the dusty field environment. It was then decided that due to how the Evaps works, it often feels very humid in the pick-tower so often feels hotter than it actually is. To accommodate the solution for this, it was decided to go off heat index compared to bare temperature values. To make this happen humidity sensors would also be required. After research, a hygrometer sensor that reads temperature and humidity was found. This suited the job well as it could add to the average temperature to get a better average. This meant then that all four analogue inputs would be used on the two modules with each module having 2x PT100 sensors and a temperature and humidity sensor.

The contractor who had completed the initial install of the Evaps was contacted for the latest version they have of the current software and the CAD files of the drawings as these would need updating during the design stage. The design of the two field panels could then start. A suitable CPU was selected and the panel was designed with the appropriate protection and room for future expansion. The design was then finalised on CAD and approved by the Senior Automation engineer. The drawings can be found in appendix B. Once all hardware was identified the order was placed through Amazon's Coupa catalogue following the correct process. All orders were recorded and calculated within the budget. The full expenditure list is shown in Appendix C, Figure 11. All other parts were sourced from current stock.

As identified in the research the maximum Profinet run should not exceed 100m. The Pick-Tower was scoped to find the best locations for the panels within the distance while being evenly spread along the Pick-Tower. The Pick-Tower was able to be split into quarters with one PT100 going to be placed in each quarter. With the locations selected a local contractor was engaged to purchase and run in the Profinet and power from the main PLC panel to the new field locations.

After the hardware had arrived. The panels could be constructed to the drawings. The panels can be seen in Appendix D, Figure 12.

The software development had the start delayed due to the wrong code being sent over by the contractor. This took some time to get resolved but is not represented in the Gantt chart as the software was still being designed in theory. A flow chart of the fundamental principles is shown below in Figure 3.

The stages are explained but there is no need for all this detail.

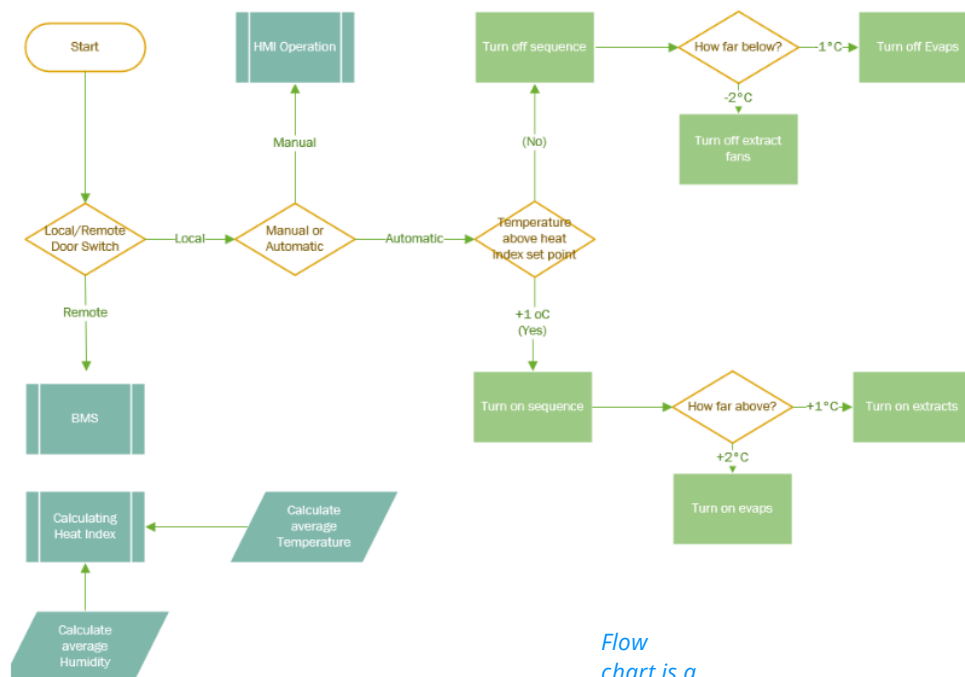


Figure 3: Auto sequence flow chart

Flow chart is a good method or representing sequence operations

The flow chart shows the option for local or remote. This was added to the project with the scope of the future BMS project that is being installed in the FC. The software was then developed in TIA portal. To make the code more structured, a function block was used as a multi-instant to standardise the code for all 8 Evaps and another for the 14 extracts fans. It is within this function block the call for the automatic sequence would take place. The calculations however were in a different function block.

The raw values were scaled into real values and control limits set for the average temperatures. Conditions were set for the average calculation that at least 3 out of 6 temperature sensors must have a reading within the limit for the average to calculate. In the same function block is the compare conditions for the request of the automatic sequence. This is shown in Appendix E, Figure 16.

The request auto bit would then be used within the logic block for the Evaps and extract fans. This logic can be seen in Appendix E, Figure 23.

The existing maintenance plan should continue to take place on the extract fans and Evaps. The automatic solution that has been implemented is maintenance-free as there is no moving parts. However, as part of the weekly walk around for the extracts and Evaps, monitoring of the sensor data has been added to the check-list to ensure that readings are within limits. The PT100 will also be calibrated annually to ensure they are accurate.

Steps were taken for environmental protection and sustainability by ensuring that all material orders had sufficient parts to make the shipping justifiable i.e., one shipment of multiple components, not

several shipments of single components. Orders for different projects but from the same supplier were combined to cut down on emissions from delivery and to reduce packaging and all waste material was disposed of appropriately.

An MCM was raised and approved for the hardware upgrade in the main panel. The Ethernet switch needed to be upgraded from 8 port to 16 port to allow for the extra two ports needed and to allow for further expansion. The two circuits were added in with the correct protection as per BS7671. This can be seen in Figure 13.

There is far too much unwanted written content here. The use of images would be a much improved method.

6. Testing and Results

The code was first simulated on the test rig in the workshop to ensure that the modules and sensors had the correct configuration as seen in Figure 14 and Figure 15. The PLC, I/O Modules and sensors were set up on the test rig and the code downloaded to the PLC. Using the monitoring the PLC code was watched to see the inputs and outputs. Using commission memory bits inputs could be simulated and the expected outcomes could be monitored. This was completed for both the Evaps and the extract fans. Some of the simulations can be seen in Figure 18 to Figure 20 which shows the outputs turning on.

All of the Scaled values were inserted into a watch table along with the calculated heat index and the request bits that activates one of the conditions of the automatic sequence. This is shown in Table 2.

	Name	Display format	Monitor value	Mi
1	"21_TT01_TT02_Inputs_DB".TT01_LKM445-RH_Scaled"	Floating-point nu...	55.70849	
2	"21_TT01_TT02_Inputs_DB".TT01_LKM445-Temperature_Scaled"	Floating-point nu...	35.70849	
3	"21_TT01_TT02_Inputs_DB".TT01_PT100_Left_Scaled	Floating-point nu...	18.85	
4	"21_TT01_TT02_Inputs_DB".TT01_PT100_Right_Scaled	Floating-point nu...	18.16	
5				
6	"21_TT01_TT02_Inputs_DB".TT02_LKM445-RH_Scaled"	Floating-point nu...	52.17444	
7	"21_TT01_TT02_Inputs_DB".TT02_LKM445-Temperature_Scaled"	Floating-point nu...	32.17444	
8	"21_TT01_TT02_Inputs_DB".TT02_PT100_Left_Scaled	Floating-point nu...	18.58	
9	"21_TT01_TT02_Inputs_DB".TT02_PT100_Right_Scaled	Floating-point nu...	18.73	
10				
11	"Request_Auto_EVAP"	Bool	TRUE	
12	"Request_Auto_Extract_Fan"	Bool	TRUE	
13	"22_Heat_Index_PV_DB".PV_Heat_Index	Floating-poin...	25.23424	
14				

Table 2: Scaled sensor values

The function blocks could then also be monitored to see the status of the I/O of the call. With the block showing the outputs on, proving the simulation is successful as seen in Figure 21. The alarms were also tested on the test rig. The functions of a wire break on the sensors and communication fault to the module could be tested. If these alarms occur, the value of the sensor should be moved to -274 and then excluded from the average temperature calculation. This was tested on each module and each sensor with a 100% success rate. This proved the test rig simulation to be successful and that the project is ready to move forwards to full installation.

The full testing table can be seen in Table 3, Appendix G.

7. Discussion, Conclusions and Recommendations

The project was completed complying with all relevant legislation and company policy. The control panels were built as per the drawings that were designed. The modules and sensors were successfully tested on the test rig and the full testing table was completed. This included features that was above the initial specification. To aid maintenance purposes the option was integrated into the HMI to disable fans while in automatic mode. This is different from the manual operation. Having this feature means if one fan required work, it could be removed from the automatic sequence allowing all other fans to run as required without the need to swapping to manual mode to disable one fan.

*A good
improvement*

The existing HMI was also redesigned to make it more user friendly and to meet the required specification. A page was added for the reading of data. The HMI was also redesigned to have all the manual Evap controls on one page as previously they were on two. The overview page was changed to only show equipment status and not have any operational controls. All automatic controls were then moved to a new page on the HMI. This then allowed the specification of all operational controls to be password protected.

*This can be regarded as an
implemented
recommendation*

The project was within budget. As seen in the expenditure list the total cost for parts bought for the project was £2,590.43 leaving £409.57 in the budget. The return of investment now drops to 135 hours of labour. The solution also differentiates between mode. The manual and automatic mode can be selected by the key switch on the pain PLC panel. A second key switch was added for the future expansion with the BMS project that is in development. The second key switch allows for local or remote operation. The BMS will then take part of the remote operation.

The solution complies with all the required Amazon standards and policies and all relevant legislation.

The timing of the project was not as smooth as first indicated in the Gantt chart. The delays were based around the installation of hardware. The installation of the hardware got delayed for several reasons. The software development which continuously takes place took longer in the initial stage. As software development is always continuous it is hard to represent this in the Gannt chart. The configuration of the modules in the software took longer than expected and with the delay in receiving the initial code. This set back the timing for the testing which is shown on the Gantt chart.

Due to all 14 extract fans and 8 evaporative coolers receiving a refurbishment before the summer taking place. This pushed the installation back as the system could not be tested as a whole if fans were out of service so the decision was made to hold back on the installation. Additionally, the drawings supplied do not match the current installation of the panel. A meeting was held to discuss that when the installation takes place if the panel was going to be correct to meet the drawing or the drawings changed to meet the current installation. The decision was made to correct the current installation to meet the drawings. This will be carried out with the rest of the hardware installation.

The project could still be developed further. Currently, an average reading is taken across the floor and turns on all of the fans. This could be changed to introduce zones. As each sensor is evenly spread in the pick-tower, this could allow for each sensor to represent one zone. There would then be two evaporative coolers in each zone paired with three zone of 4 extract fans and one zone of two extract fans due to the physical location of the fans. This could potentially be more energy efficient only turning on the cooling in the parts of the pick-tower that require it saving energy by using less electricity.

Throughout the project and during all work completed, high levels of professionalism and ethical conduct were demonstrated. There was often discussion on various aspects of the project such as how the code should be constructed and the contracting out of the installation of power and data. During these discussions all parties were treated with respect. Ethical conduct was demonstrated by not letting friendships with local contractors' influence the decision on which firm was awarded the tender to install the data cables, thus ensuring equality and fairness.

*The conclusion is good
and includes relevant
recommendations. The
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count for this task.*

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[Accessed 22 March 2021].

*More
reference
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should have
been used*

Appendix

Appendix A – Gantt Chart

Appendix B – Panel Drawings

Appendix C – Project Expenditures

Appendix D – Hardware Installation

Appendix E – PLC Code

Appendix G – Testing Table

Appendix A

Project Plan

amazonrme

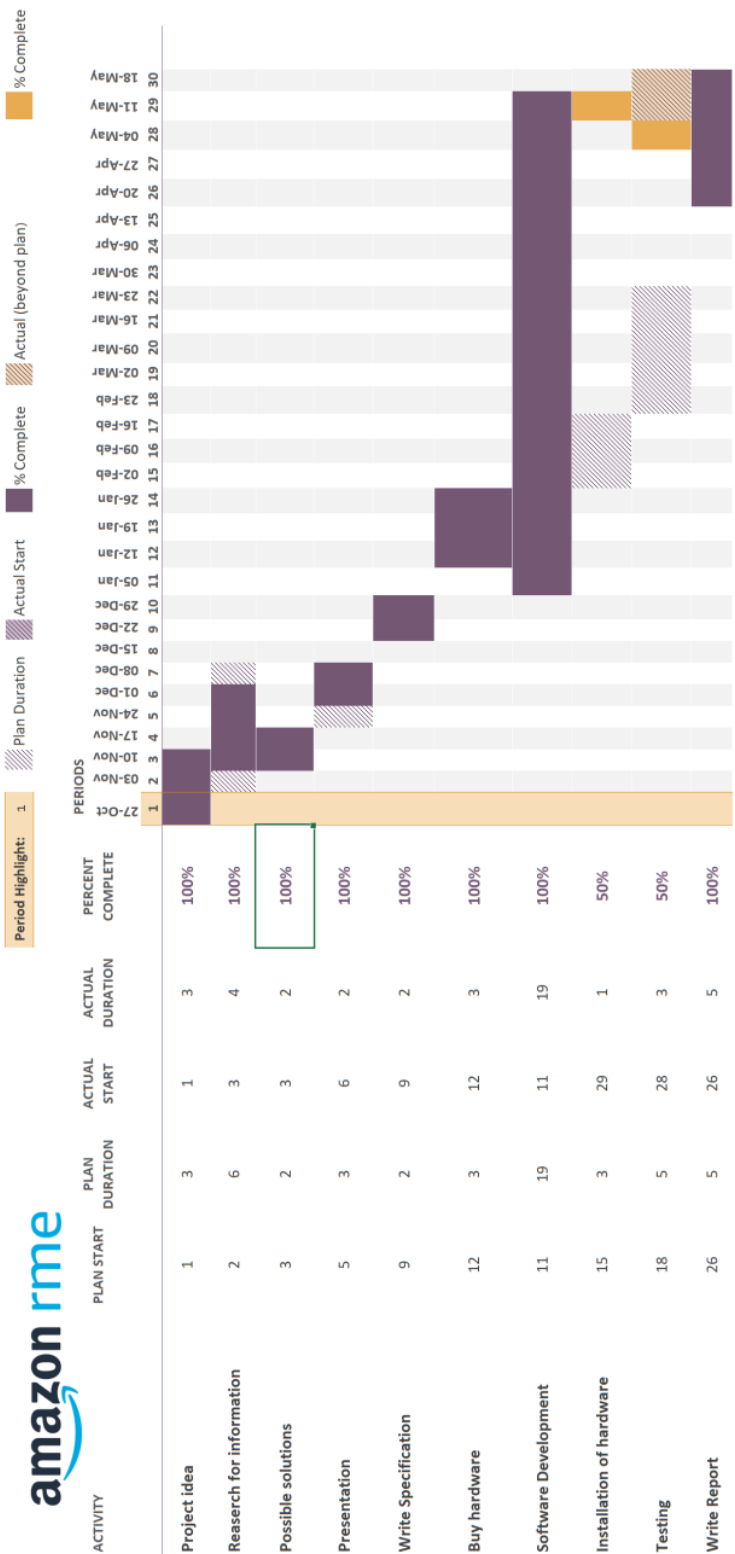


Figure 4: Gantt Chart

Good comparison Gantt chart

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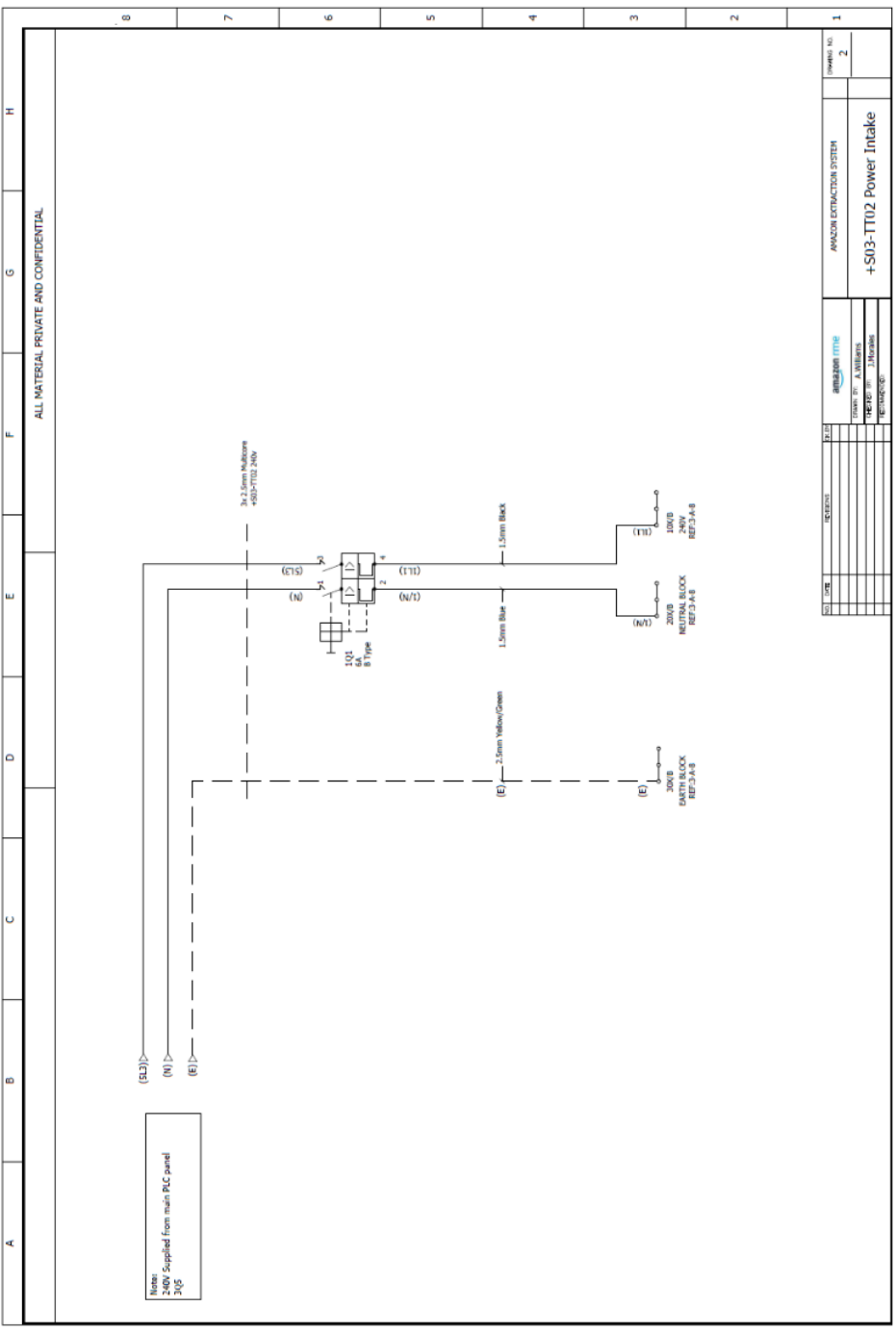


Figure 6: TT02 Power Intake



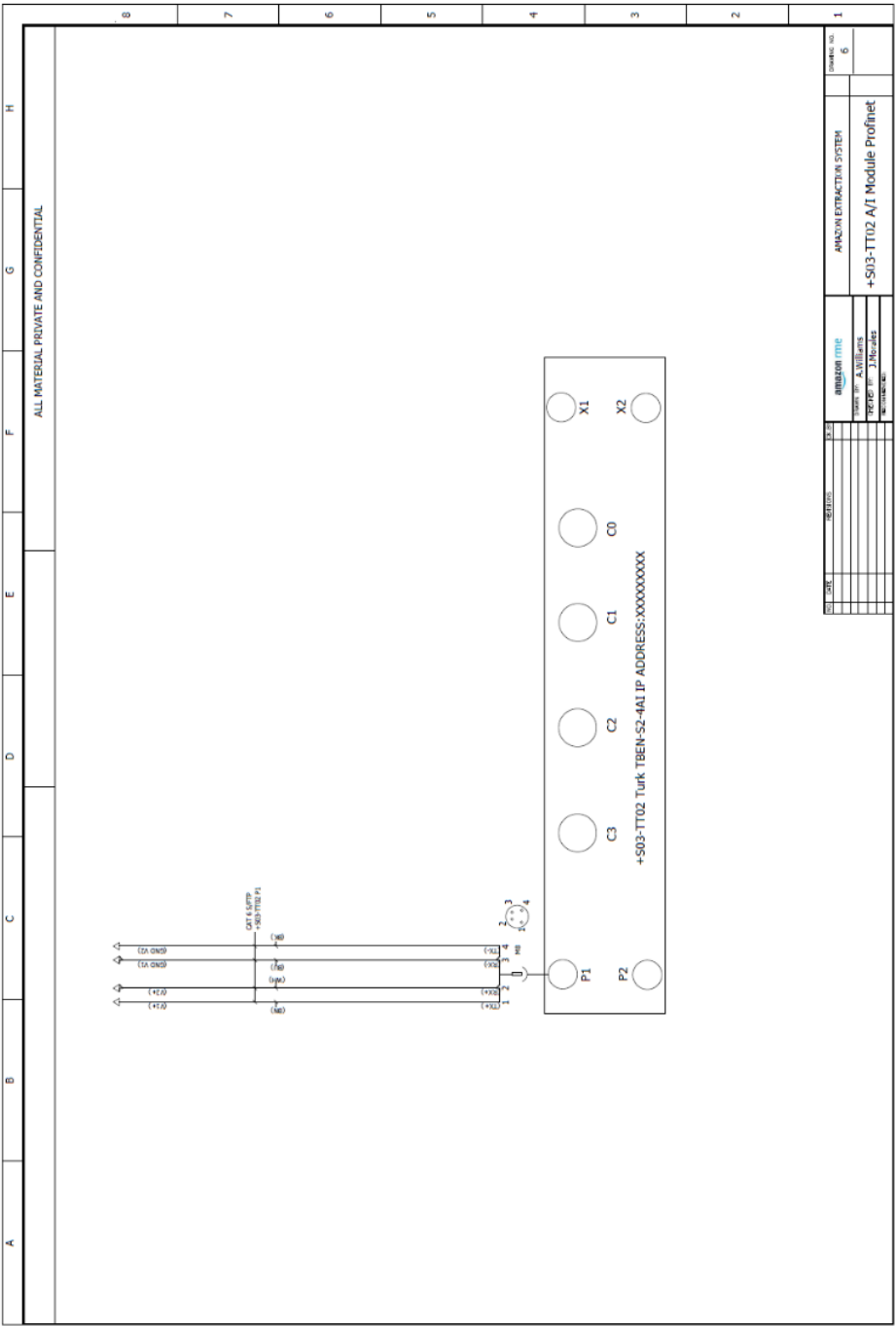


Figure 10: TT02 A/I Module Profinet

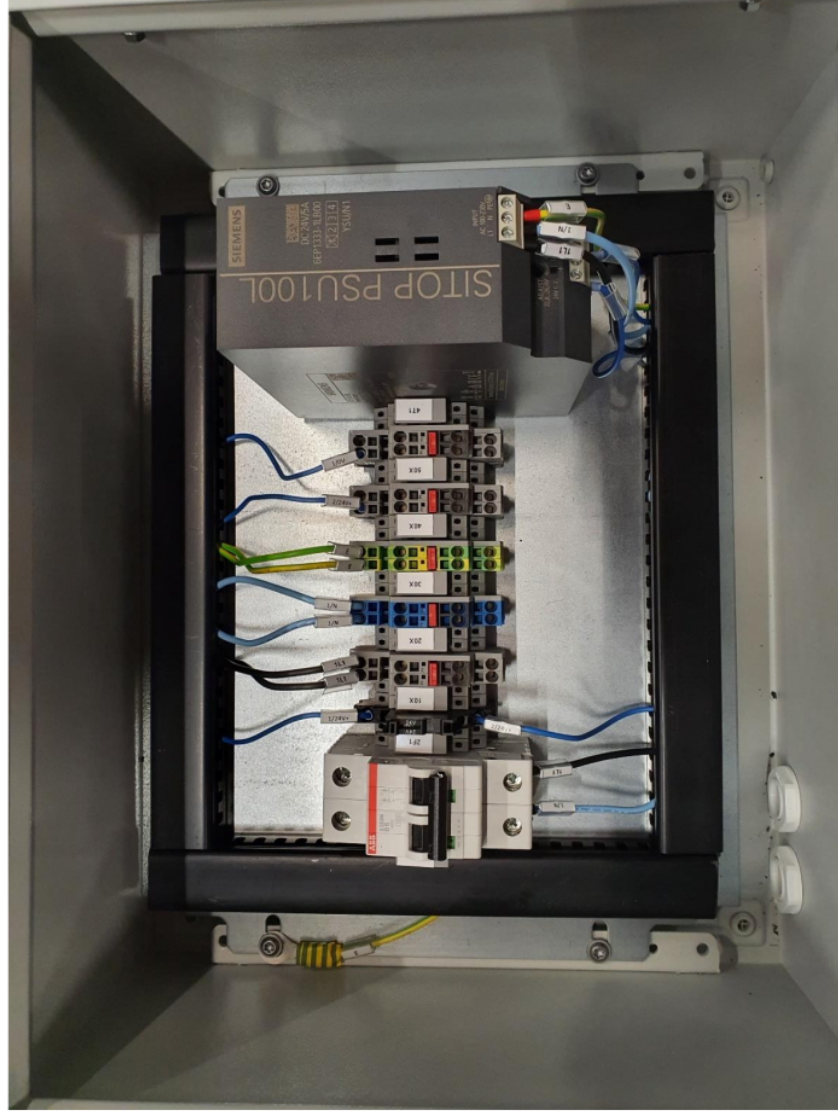
Appendix C

Cost List										
PO No	Supplier	Description	Part No.	QTY	Cost	Line total	Net Total	£ 2,590.43	Budget left	£ 409.57
5738466	Parmley	COMPACT MULTIPROTOCOL I/O MODULE 4AI	TBEN-S2-4AI / 6814025	2	£ 313.09	£ 626.17				
	Graham	SCALANCE XB116 unmanaged IE switch, 16x 10/100 Mbit/s RJ45 ports; for setting up small star and line topologies; LED diagnostics, IP20, Redundant power supply, 24 V AC/DC	6GKS1160 BA002AB 2							
	Parmley	SITOP PSU100L 120/230VAC-24VDC 5A	6EP13331 LB00	2	£ 25.00	£ 50.00				
	Graham	Standard Carriage & Packaging	CARRIAGE	1	£ 8.20	£ 8.20				
	Graham									
5766532	Parmley	KX E-BOX 380X300X155MM IP66	1576.000	2	£ 45.49	£ 90.97				
	Graham	AX WALL BRACKET 15MM STEEL (PACK 4)	2508.020	2	£ 11.34	£ 22.68				
	Parmley	Standard Carriage & Packaging	CARRIAGE	1	£ 15.00	£ 15.00				
5789659	Amberwell	8Hrs Electrician & Mate (Normal working hours)		8	£ 43.95	£ 351.60				
	Amberwell	Materials		1	£ 456.55	£ 456.55				
5838265	RS	Jumo 902815/10-380-1011-3-6-50-104-24/000 PT100 RTD Temperature Probe	7645344	4	£ 70.62	£ 282.48				
						£ -				
5827026	RS	Electrotherm Hygrometer	9130860	2	£ 105.23	£ 210.46				
						£ -				
5888716		Cabling RJ Connector	8787411	2	£ 6.07	£ 12.14				
		Male Cat6a RJ45 Connector	8787405	2	£ 14.33	£ 28.66				
		Schneider Electric - bus bar caps	7762831	2	£ 8.33	£ 16.66				
		Schneider Electric Acti 9 Busbar	8067222	1	£ 24.80	£ 24.80				
		Schneider Electric Acti 9 6A MCB Mini Circuit Breaker, 1P Curve B	7913152	2	£ 15.35	£ 30.70				
		ABB System M Pro 6A MCB Mini Circuit Breaker, 2P Curve B	132093	2	£ 44.48	£ 88.96				

Budget breakdown is referenced in report

Figure 11: Project Expenditures

Appendix D



Good image o support implementation

Figure 12: Field Panel



Figure 13: Main Panel Hardware Install

Good images that support explanations in main report



Figure 14: Test Rig PLC



Figure 15: Test Rig PT100

Appendix E

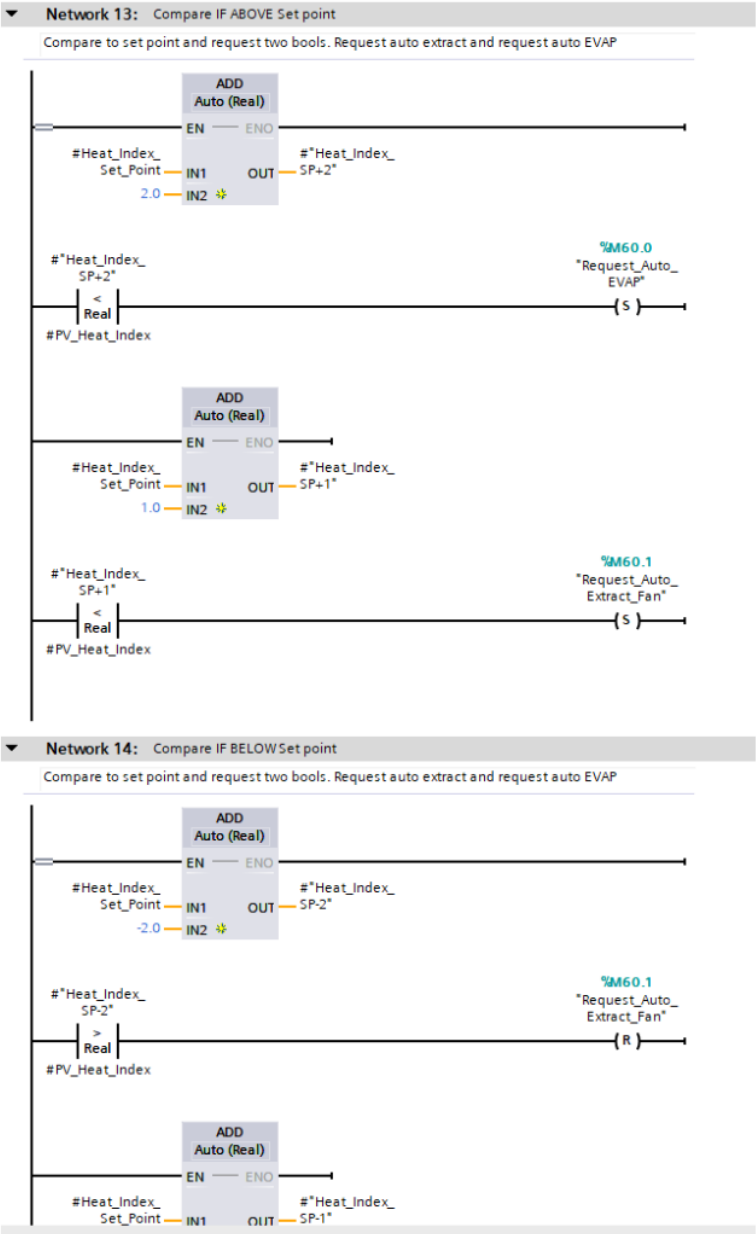


Figure 16: Compare Set Points

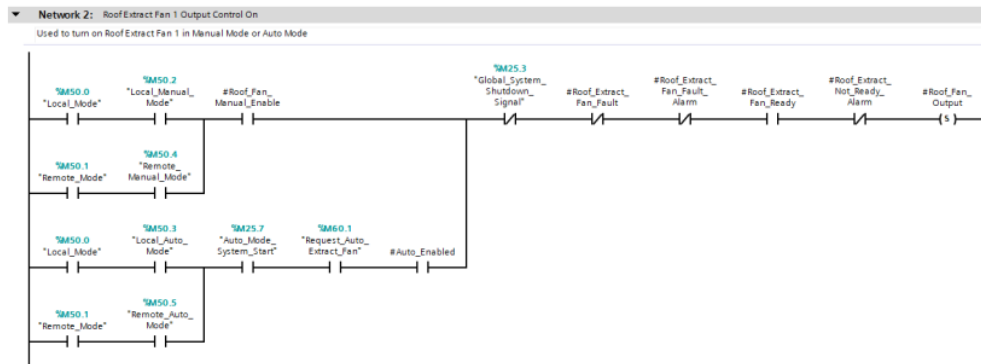


Figure 17: Request Extract on Logic

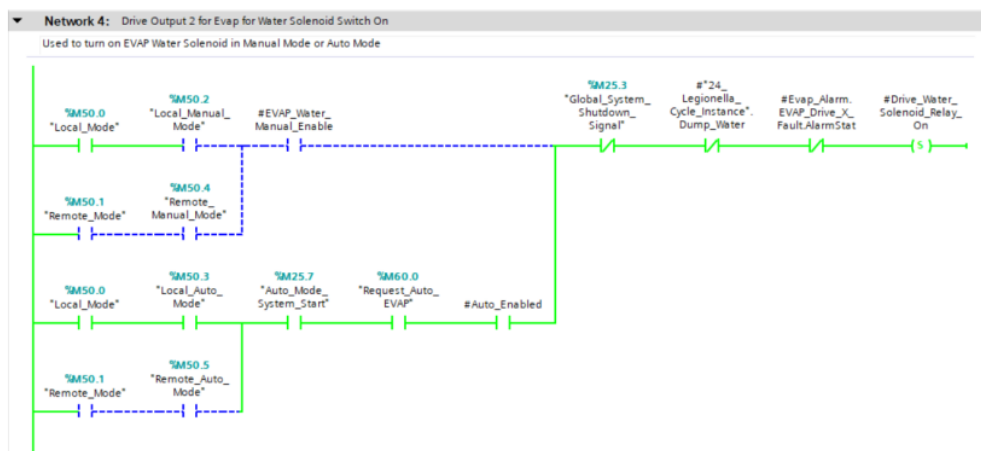


Figure 18: Test Rig Simulation 1

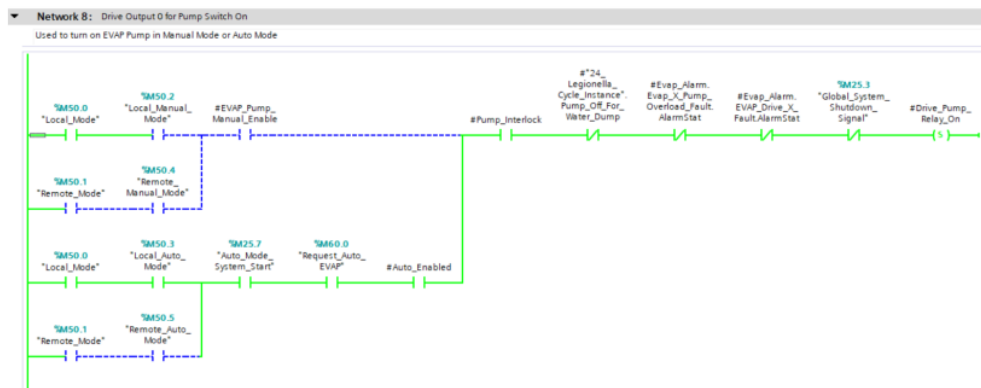


Figure 19: Test Rig Simulation 2

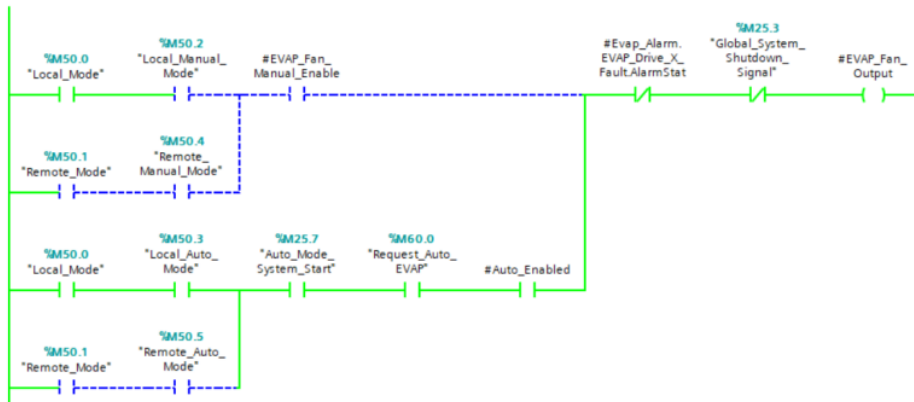


Figure 20: Test Rig Simulation 3

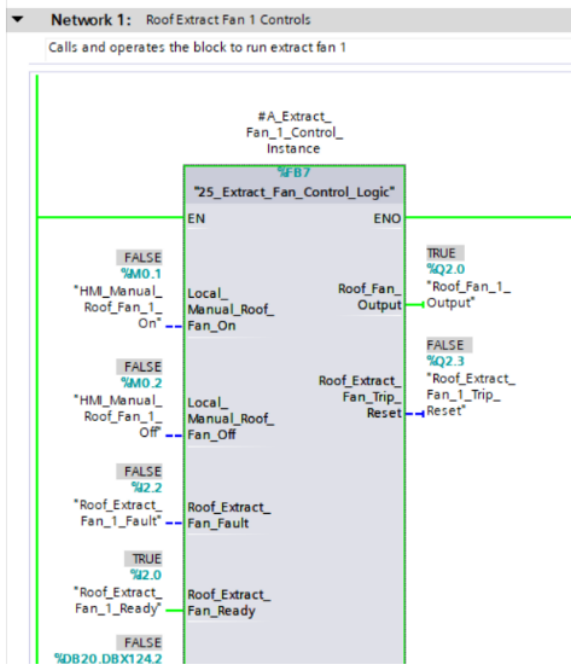


Figure 21: Test Rig Simulation 4

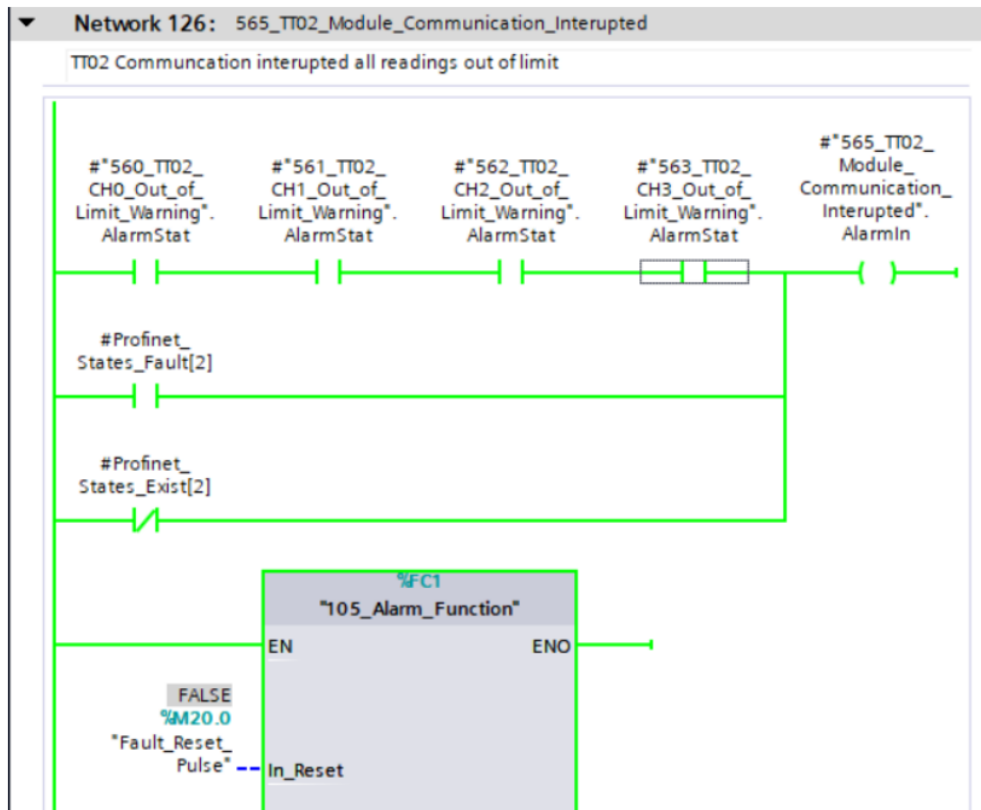


Figure 22: Test Rig Simulation 5

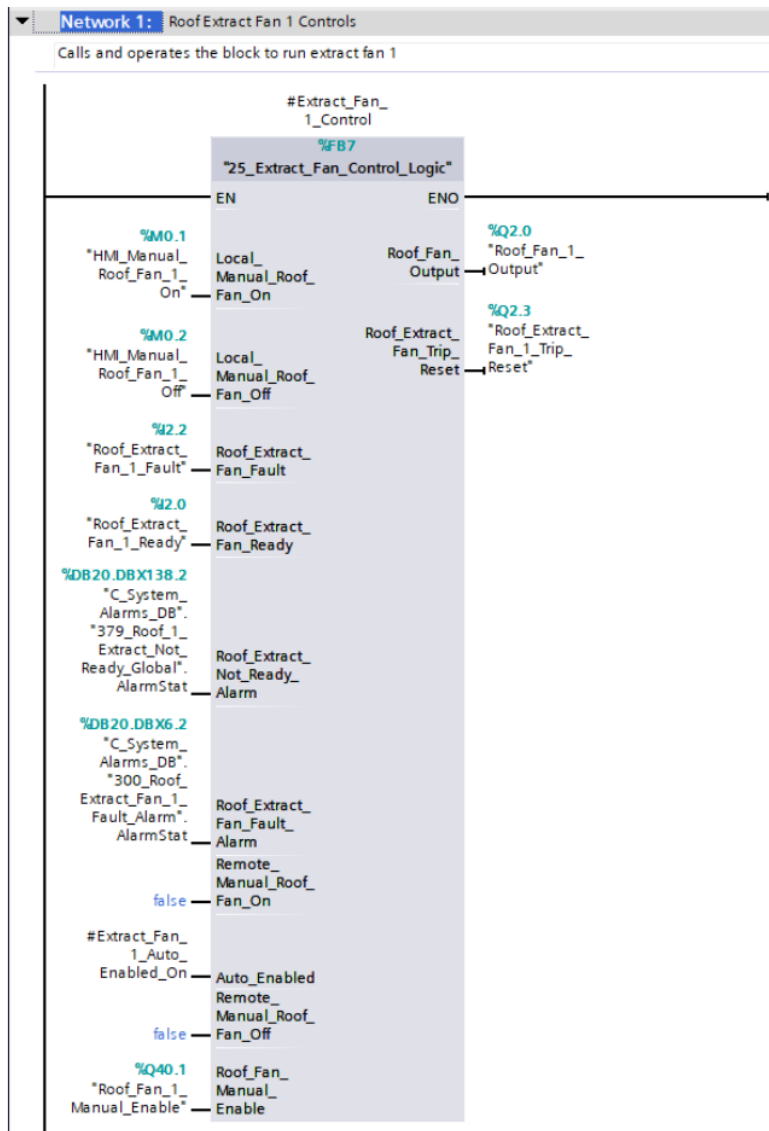


Figure 23: Extract Fan Control Block

PLC program is
implemented and tested
using online test method

Appendix G

Table 3: Simulation Testing Table

Event	Expected Outcome	Actual Outcome	Pass/Fail
Sensor TT01-LKM445-RH connected and not in fault	Data is read and stored in the average humidity calculation	Data is read and stored in the average humidity calculation	Pass
Sensor TT01-LKM445-Temperature connected and not in fault	Data is read and stored in the average temperature calculation	Data is read and stored in the average temperature calculation	Pass
Sensor TT01-PT100-Left connected and not in fault	Data is read and stored in the average temperature calculation	Data is read and stored in the average temperature calculation	Pass
Sensor TT01-PT100-Right connected and not in fault	Data is read and stored in the average temperature calculation	Data is read and stored in the average temperature calculation	Pass
Sensor TT02-LKM445-RH connected and not in fault	Data is read and stored in the average humidity calculation	Data is read and stored in the average humidity calculation	Pass
Sensor TT02-LKM445-Temperature connected and not in fault	Data is read and stored in the average temperature calculation	Data is read and stored in the average temperature calculation	Pass
Sensor TT02-PT100-Left connected and not in fault	Data is read and stored in the average temperature calculation	Data is read and stored in the average temperature calculation	Pass
Sensor TT02-PT100-Right connected and not in fault	Data is read and stored in the average temperature calculation	Data is read and stored in the average temperature calculation	Pass
Sensor TT01-LKM445-RH disconnected	Data is not received and the alarm is triggered. The reading will get set to -274 and is removed from the average humidity calculation	Data is not received and the alarm is triggered. The reading will get set to -274 and is removed from the average humidity calculation	Pass
Sensor TT01-LKM445-Temperature disconnected	Data is not received and the alarm is triggered. The reading will get set to -274 and is removed from the average temperature calculation	Data is not received and the alarm is triggered. The reading will get set to -274 and is removed from the average temperature calculation	Pass
Sensor TT01-PT100-Left disconnected	Data is not received and the alarm is triggered. The reading will get set to -274 and is removed from the average temperature calculation	Data is not received and the alarm is triggered. The reading will get set to -274 and is removed from the average temperature calculation	Pass
Sensor TT01-PT100-Right disconnected	Data is not received and the alarm is triggered.	Data is not received and the alarm is triggered.	Pass

	The reading will get set to -274 and is removed from the average temperature calculation	The reading will get set to -274 and is removed from the average temperature calculation	
Sensor TT02-LKM445-RH disconnected	Data is not received and the alarm is triggered. The reading will get set to -274 and is removed from the average humidity calculation	Data is not received and the alarm is triggered. The reading will get set to -274 and is removed from the average humidity calculation	Pass
Sensor TT02-LKM445-Temperature disconnected	Data is not received and the alarm is triggered. The reading will get set to -274 and is removed from the average temperature calculation	Data is not received and the alarm is triggered. The reading will get set to -274 and is removed from the average temperature calculation	Pass
Sensor TT02-PT100-Left disconnected	Data is not received and the alarm is triggered. The reading will get set to -274 and is removed from the average temperature calculation	Data is not received and the alarm is triggered. The reading will get set to -274 and is removed from the average temperature calculation	Pass
Sensor TT02-PT100-Right disconnected	Data is not received and the alarm is triggered. The reading will get set to -274 and is removed from the average temperature calculation	Data is not received and the alarm is triggered. The reading will get set to -274 and is removed from the average temperature calculation	Pass
Module TT01 loss of power	All readings that are transmitted through the module will be moved to -274 and the loss of communication alarm will be triggered. All 4 readings will be removed from the average calculations	All readings that are transmitted through the module will be moved to -274 and the loss of communication alarm will be triggered. All 4 readings will be removed from the average calculations	Pass
Module TT01 loss of communication	All readings that are transmitted through the module will be moved to -274 and the loss of communication alarm will be triggered. All 4 readings will be removed from the average calculations	All readings that are transmitted through the module will be moved to -274 and the loss of communication alarm will be triggered. All 4 readings will be removed from the average calculations	Pass
Module TT02 loss of power	All readings that are transmitted through the module will be moved	All readings that are transmitted through the module will be moved	Pass

	to -274 and the loss of communication alarm will be triggered. All 4 readings will be removed from the average calculations	to -274 and the loss of communication alarm will be triggered. All 4 readings will be removed from the average calculations	
Module TT02 loss of communication	All readings that are transmitted through the module will be moved to -274 and the loss of communication alarm will be triggered. All 4 readings will be removed from the average calculations	All readings that are transmitted through the module will be moved to -274 and the loss of communication alarm will be triggered. All 4 readings will be removed from the average calculations	Pass
Temperature goes +1 above set point while in automatic mode	Extract fans turn on	Extract fans output turns on	Pass
Temperature goes +2 above set point while in automatic mode	Evaps turn on	Evap outputs turn on	Pass
Temperature goes -1 below set point while in automatic mode	Evaps turn off	Evap outputs turn off	Pass
Temperature goes -2 below set point while in automatic mode	Extract fans turn off	Extract fans outputs turn off	Pass
Auto enable turned off	Specific fan/Evap should be turned off	Specific fan/Evap turns off	Pass

Table of results is extensive

Log Book
Log Sheet

Log No:	1
Hours:	2
Running total Hours	2

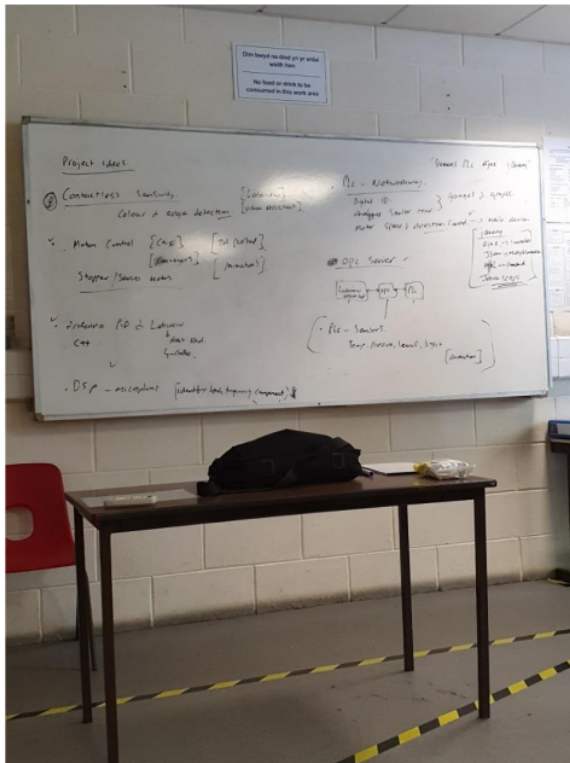
Introduction into the module. Looked through the module handbook and discusses the assessment process.

Student Signature	<i>A. Williams</i>
Supervisor Signature	<i>J. Williams</i>
Lecturer Signature	

Log Sheet

Log No:	2
Hours:	2
Running total Hours	4

Discussed different project ideas. Also talked about the presentation, what to expect and what will be required.



Student Signature	<i>A. Williams</i>
Supervisor Signature	<i>J. Williams</i>
Lecturer Signature	

Log Sheet

Log No:	3
Hours:	2
Running total Hours	6

At work spoke with mentor about what project are suitable from previous week in college. Possible project. Identified project is using the pick tower Evap cooling fans. Currently they only have a manual on/off function and no automatic sequence. I will look at installing temperature sensors to take a temperature reading and if the reading is above X°C then the PLC will send an output to turn on the fans.

Student Signature	<i>A. Williams</i>
Supervisor Signature	<i>J. Williams</i>
Lecturer Signature	

Log Sheet

Log No:	4
Hours:	2
Running total Hours	8

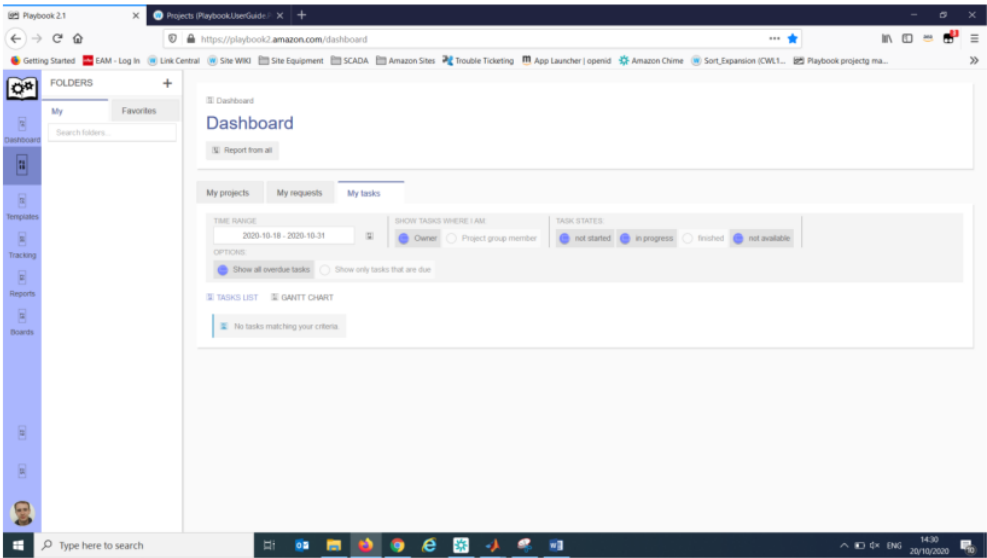
Agreed project with mentor and lecturer. I started and completed my project proposal. These included details of the project such as where, what, why, how and a block diagram of the sequence.

Student Signature	<i>A. Williams</i>
Supervisor Signature	<i>J. Williams</i>
Lecturer Signature	

Log Sheet

Log No:	5
Hours:	2
Running total Hours	10

Discussed timeline with lecturer with regards to interim presentation. Research different software to create a Gannt chart with. Looking at Amazon Playbook or Microsoft Project.



Student Signature	<i>A. Williams</i>
Supervisor Signature	<i>J. Williams</i>
Lecturer Signature	

Log Sheet

Log No:	6
Hours:	2
Running total Hours	12

Online meeting with lecture. Discussed that a second solution needs to be found and mentioned about the presentation and what is required.

Student Signature	<i>A. Williams</i>
Supervisor Signature	<i>J. Williams</i>
Lecturer Signature	

Log Sheet

Log No:	7
Hours:	2
Running total Hours	14

In work discussed alternative solution to the project. Looked into using a thermoset to bring in an auxiliary contact to turn on the fans.

STEBO, Enclosure Thermostat, Adjustable, NO, DIN Rail, 120 → 250 V ac

RS Stock No.: 697-4446 | Mfr. Part No.: 01141.0-00 | Brand: STEBO

637 In stock - FREE next working day delivery available

Price Each

£15.85

(exc. VAT)

£19.02

(inc. VAT)

Units	Per unit
1 - 4	£15.85
5 - 9	£14.99
10 - 24	£14.75
25 - 49	£14.20
50 +	£13.62

FA-DUINO-128A - Industrial A...

RS PRO Logic Module, 110 → 21...

990768b14ed774.pdf

Courses

arduino board - Google Search

+

google.com/search?q=arduino+board

Apps

My Cloud Home

Home

Coleg Sir Gar - Cate...

UWTSO Email

Google Classroom

Enterprise Asset Ma...

Other bookmarks

Google

arduino board

Q All

Images

Shopping

Videos

News

More

Settings

Tools

About 90,700,000 results (0.60 seconds)

Ads · See arduino board

Products

Comparison Sites

Arduino Uno Rev 3...

£20.40

RS Component

By smec

Arduino Portenta H7

£92.75

OKdo

By smec

Breadboard, Solderless...

£4.08

Farnell - United

By smec

Arduino Mega 2560 Rev 3...

£35.70

RS Component

By smec

RS PRO Breadboard...

£9.98

RS Component

By smec

www.arduino.cc › main › boards

Boards - Arduino

ARDUINO UNO. This is the latest revision of the basic Arduino USB board. It connects to the computer with a standard USB cable and contains everything else you need to program and use the board. It can be extended with a variety of shields: custom daughter boards with specific

ARDUINO

Computing platform

Arduino is an open-source hardware and software company, project and user community that designs and manufactures single-board microcontrollers and microcontroller kits for building digital devices.

Wikipedia

CPU: Atmel AVR (8-bit), ARM Cortex-M0+ (32-bit), ARM Cortex-M3 (32-bit), Intel Quark (x86) (32-bit)

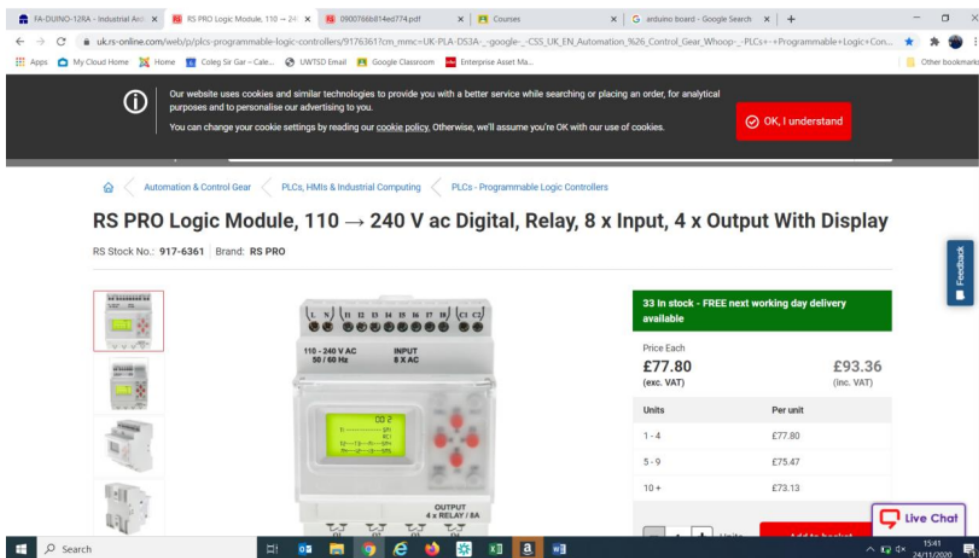
Memory: SRAM

Storage: Flash, EEPROM

Code

Model

44 | Page



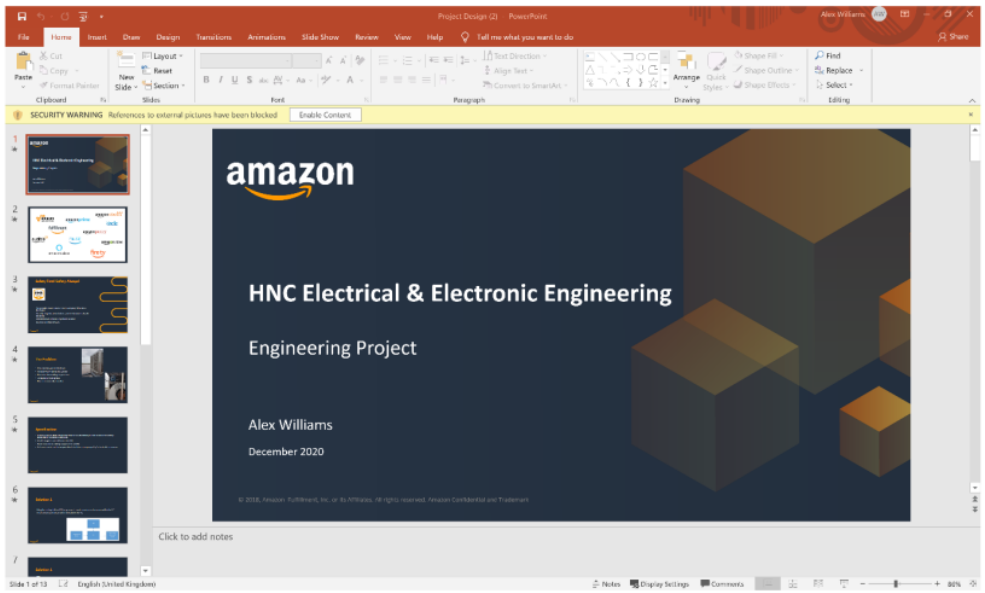


Student Signature	<i>A. Williams</i>
Supervisor Signature	<i>J. Williams</i>
Lecturer Signature	<i>[Signature]</i>

Log Sheet

Log No:	8
Hours:	2
Running total Hours	16

Worked on presentation.

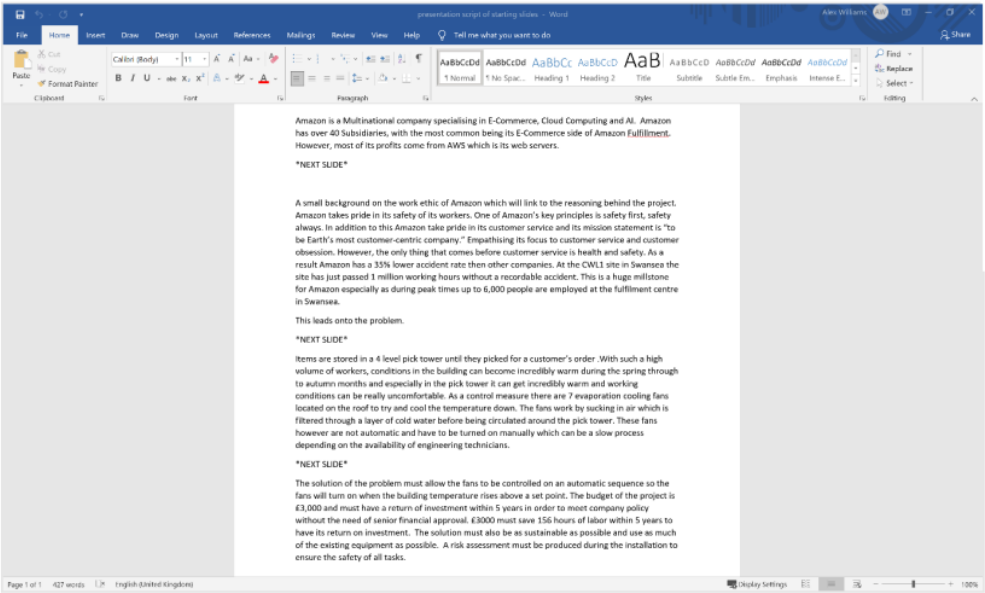


Student Signature	<i>A. Williams</i>
Supervisor Signature	<i>J. Williams</i>
Lecturer Signature	

Log Sheet

Log No:	9
Hours:	2
Running total Hours	18

Made notes for presentation and delivered presentation



Student Signature	<i>A. Williams</i>
Supervisor Signature	<i>J. Williams</i>
Lecturer Signature	<i>[Signature]</i>

Log Sheet

Log No:	10
Hours:	2
Running total Hours	20

Collected the current drawings of the Evaps and extracts from the "Z-drive" where all the digital copies of drawings are kept at CWL1. Also emailed manufacturer for latest code and original drawing file in e-plan/AutoCAD

Student Signature	<i>A. Williams</i>
Supervisor Signature	<i>J. Williams</i>
Lecturer Signature	

Log Sheet

Log No:	11
Hours:	4
Running total Hours	24

Using the CAD files of the pick-tower. Collected information on pick-tower length. Walked P4 looking for suitable places that panels and sensors could be mounted. Investigated current containment and potential cable routing.

Student Signature	<i>A. Williams</i>
Supervisor Signature	<i>J. Williams</i>
Lecturer Signature	

Log Sheet

Log No:	12
Hours:	2
Running total Hours	25

Sourced contractor and Walked job to explain what the requirements were. Gave contractor the location of the runs and details of the cable:

2 runs of 1.5mm YY cable

2 runs of cat 6 S/F TP PVC.

Student Signature	<i>A. Williams</i>
Supervisor Signature	<i>J. Williams</i>
Lecturer Signature	

Log Sheet

Log No:	13
Hours:	5
Running total Hours	30

Researched parts and selected hardware to be used. A parts list was made and an email sent to suppliers asking for quotes.

Student Signature	<i>A. Williams</i>
Supervisor Signature	<i>J. Williams</i>
Lecturer Signature	

Log Sheet

Log No:	14
Hours:	4
Running total Hours	34

Raised PO and ordered all of the required parts. AutoCAD was downloaded and installed and collected licence from Amazon Server.

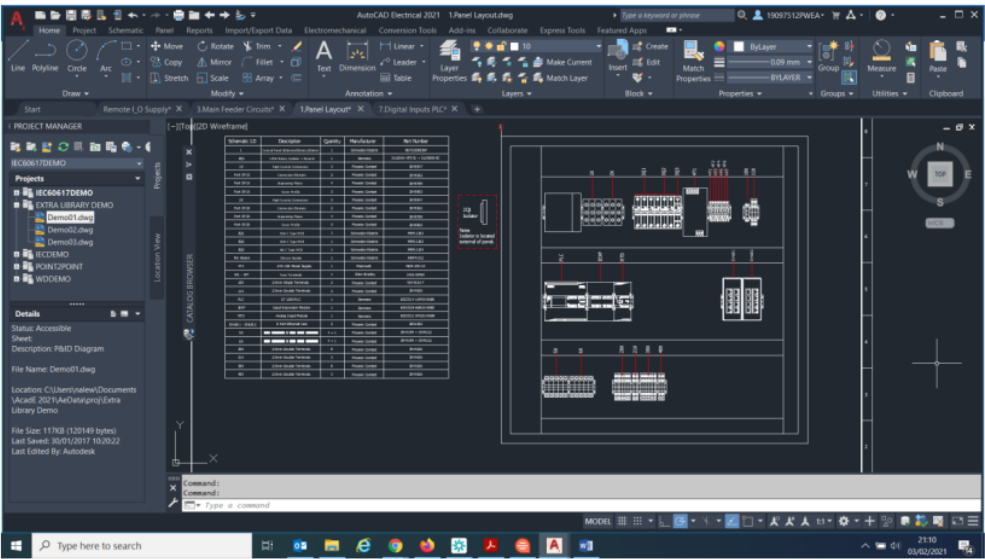
Student Signature	<i>A. Williams</i>
Supervisor Signature	<i>J. Williams</i>
Lecturer Signature	

Log Sheet

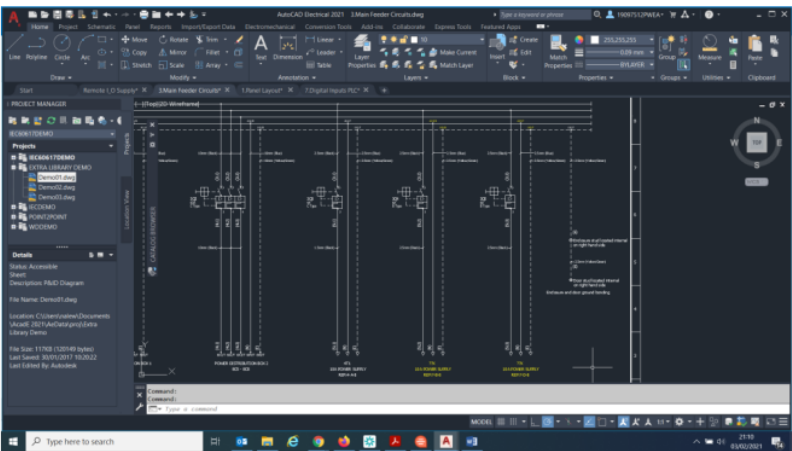
Log No:	15
Hours:	10
Running total Hours	44

Design schematics – collect dimensions of components

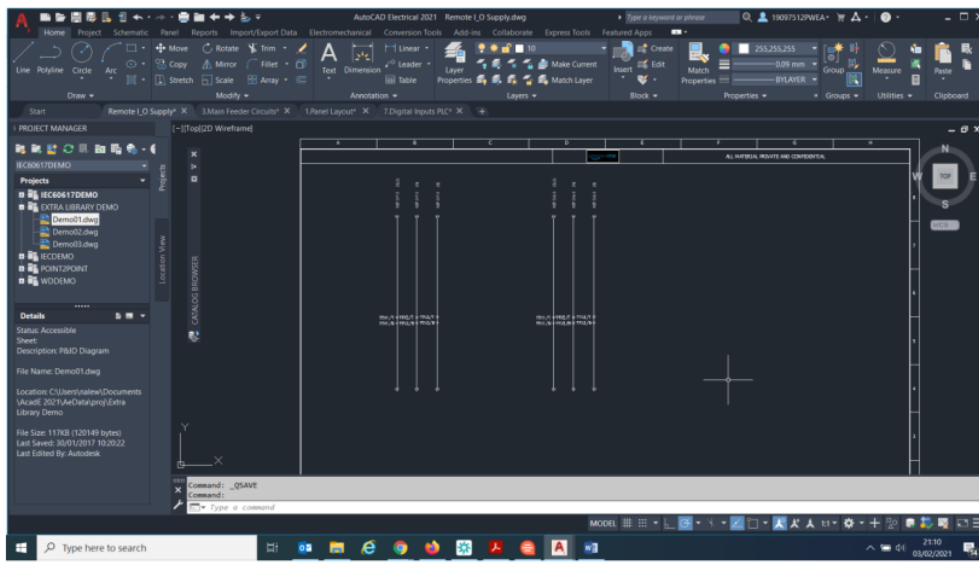
Started edit original drawings:



panel layout



main feeder circuits



remote I/O supply

Student Signature	<i>A. Williams</i>
Supervisor Signature	<i>J. Williams</i>
Lecturer Signature	<i>[Signature]</i>

Log Sheet

Log No:	16
Hours:	2
Running total Hours	46

Received schematics and code from Tribotics, had to install TIA portal V14

Student Signature	<i>A. Williams</i>
Supervisor Signature	<i>J. Williams</i>
Lecturer Signature	

Log Sheet

Log No:	17
Hours:	10
Running total Hours	56

Continued with the design and CAD drawings of remote I/O panels

Student Signature	<i>A. Williams</i>
Supervisor Signature	<i>J. Williams</i>
Lecturer Signature	

Log Sheet

Log No:	18
Hours:	2
Running total Hours	58

Submitted Amberwell (contractor) RAMS (Risk assessment, Method Statement) for review by Level 5 management and health and safety department.

Student Signature	<i>A. Williams</i>
Supervisor Signature	<i>J. Williams</i>
Lecturer Signature	

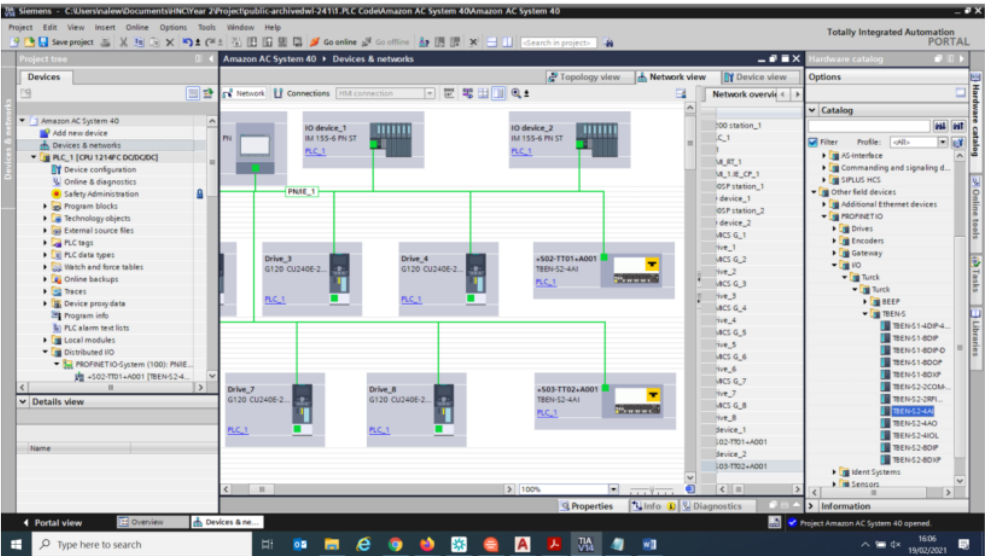
Log Sheet

Log No:	19
Hours:	10
Running total	68
Hours	

Final drawings approved by Jose, Senior AE

Downloaded General Station Description files (GSD file) from manufacture website and then installed on TIA portal

Added Turck I/O module into TIA portal network and assigned the names to the module.



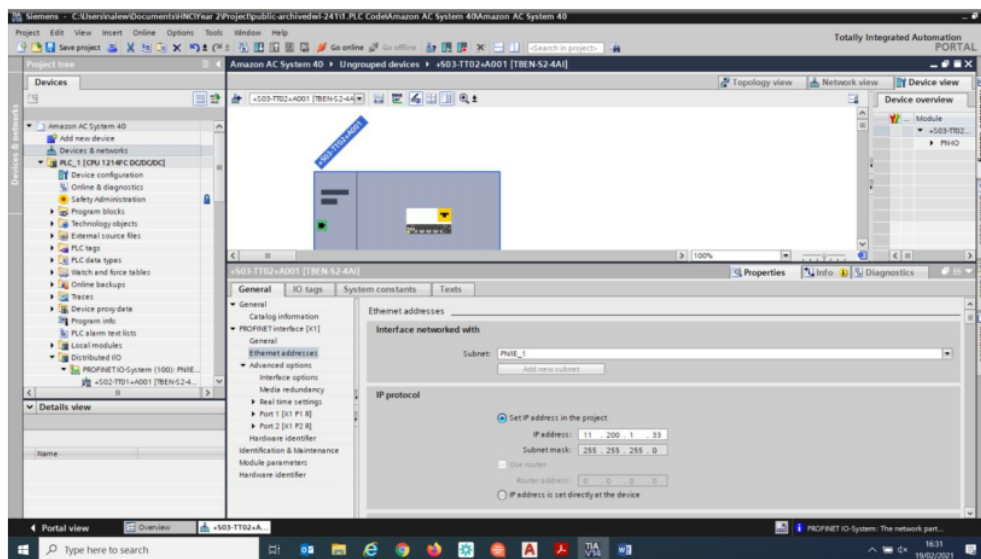
Correct existing IP addresses on all Profinet devices on the system to conform with the new amazon standard

Turck module I/O device configuration

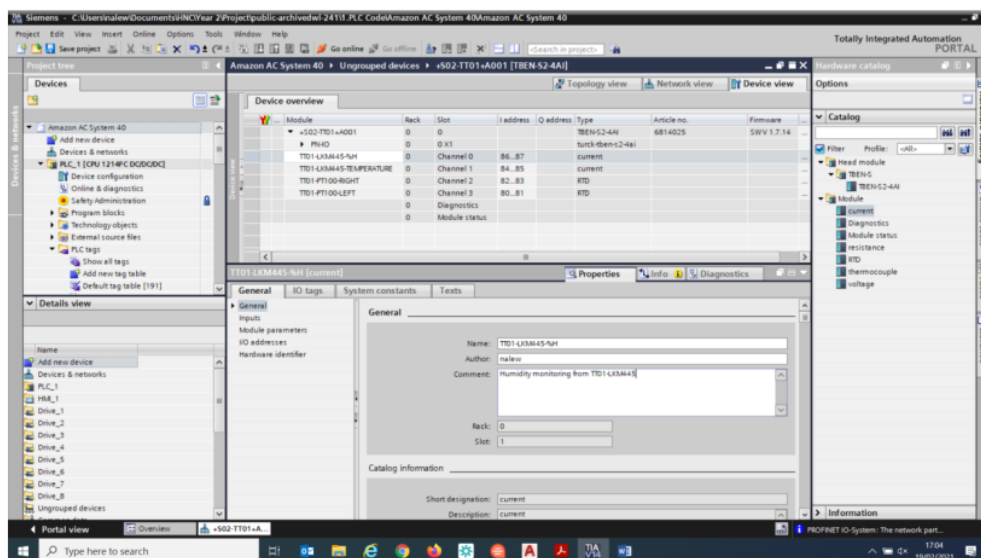
Set IP addresses

+S02-TT01-A001: 11.200.1.32

+S03-TT02-A001: 11.200.1.33



Setting up device functions. channels 1 and 2 to measure current. Channels 3 and 4 to measure RTD



Student Signature	<i>A. Williams</i>
Supervisor Signature	<i>J. Williams</i>

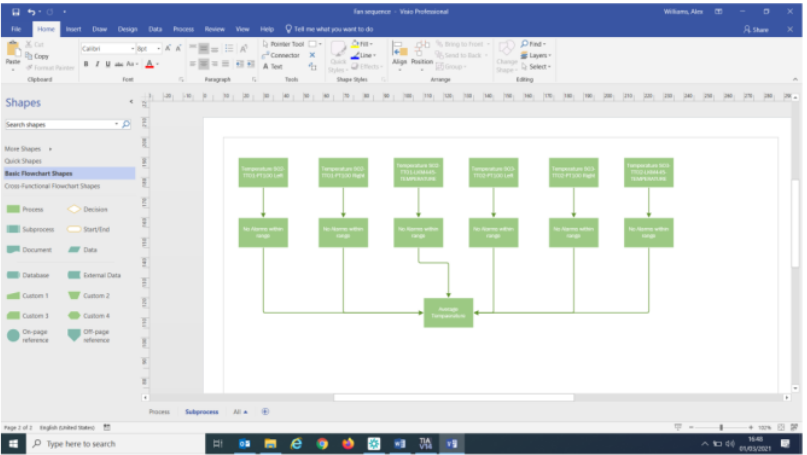
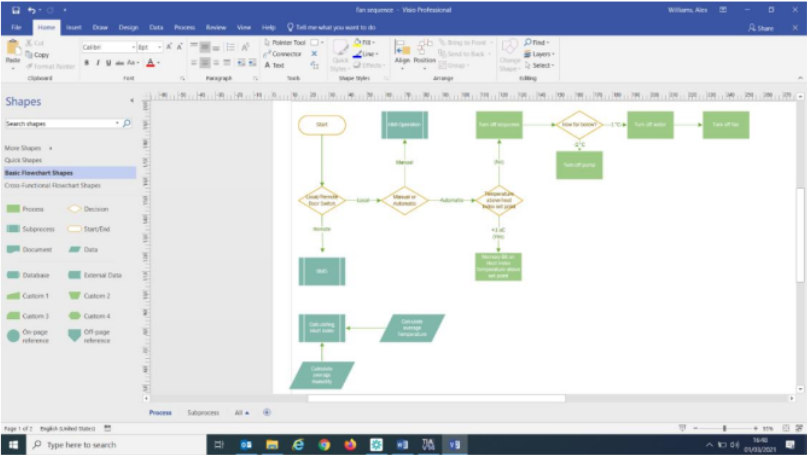
Lecturer Signature

A handwritten signature in black ink, consisting of a large, stylized 'A' followed by a series of connected loops and a horizontal stroke at the end.

Log Sheet

Log No:	20
Hours:	10
Running total Hours	78

Started design of automatic sequence. Created function call in programme for alarms.



Student Signature	<i>A. Williams</i>
Supervisor Signature	<i>J. Williams</i>

Lecturer Signature

A handwritten signature in black ink, consisting of a large capital 'A' followed by a stylized, cursive 'L' and a horizontal line.

Log Sheet

Log No:	21
Hours:	2
Running total Hours	80

Communicated to other apprentices on what was required for the panel build. Issue's drawings and parts to them. On completion visual check of panel was carried out before accepting job as complete.

Student Signature	<i>A. Williams</i>
Supervisor Signature	<i>J. Williams</i>
Lecturer Signature	

Log Sheet

Log No:	21
Hours:	10
Running total Hours	90

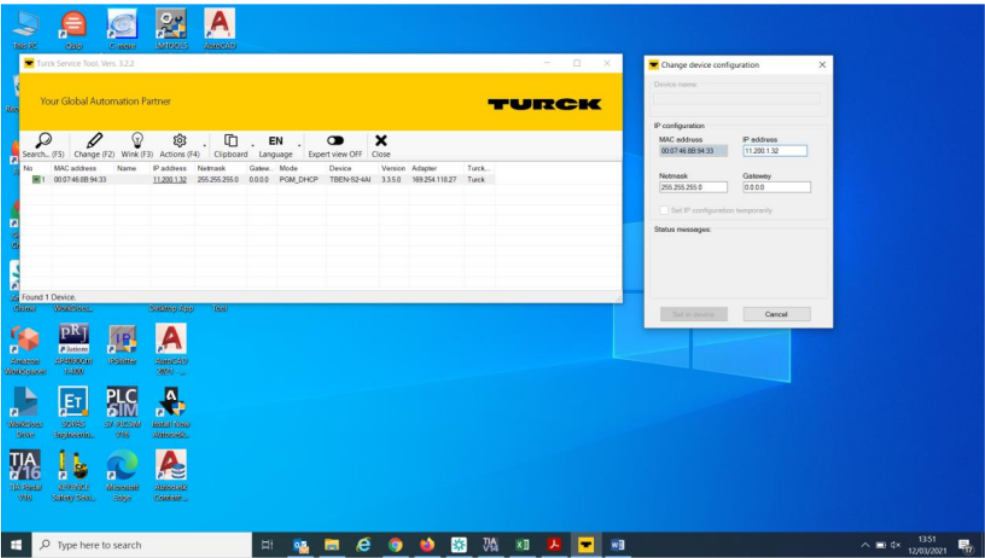
Wrote/finished alarms for module status and diagnostic and put into code

Set up plc on test rig

Made 2x m8 male Profinet

Made 2x m8 female power

Using Turck service tool assigned the modules their IP address



Student Signature	<i>A. Williams</i>
Supervisor Signature	<i>J. Williams</i>
Lecturer Signature	<i>[Signature]</i>

Log Sheet

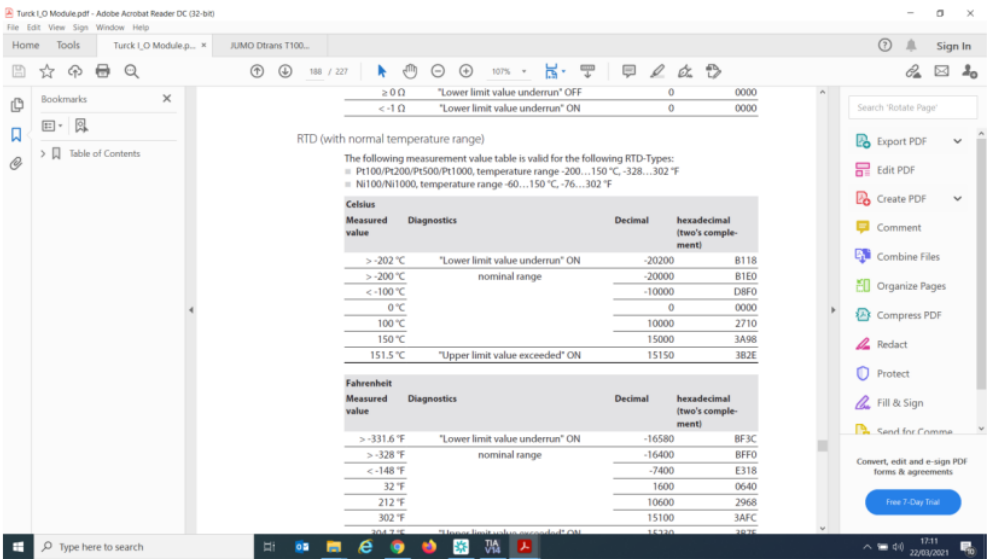
Log No:	22
Hours:	10
Running total Hours	100

Added OB blocks to prevent CPU going to stop when loses Profinet devices

Wired in all inputs

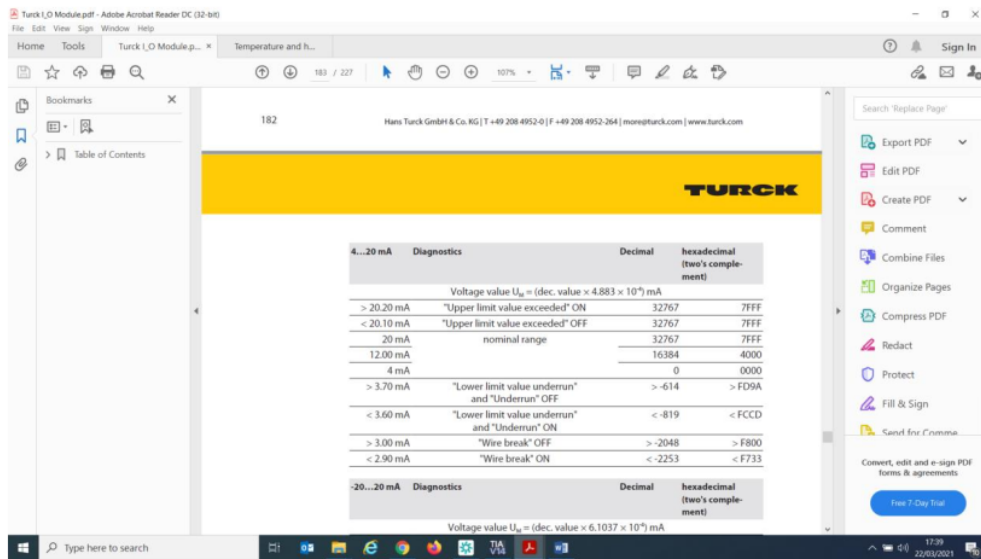
Tested to see communication between I/O and PLC

Scaled RTD's



(Turck, n.d.)

10,000/100 = 100 so divide incoming decimal by 100 and offset is 0.



Temp

-20 deg c = 4mA = 0

80 deg c = 20mA = 32,767

= $100/32767 = 0.0030518509$

Offset -20

Humidity

0 % = 4mA = 0

100% = 20mA = 32,767

= $100/32767 = 0.0030518509$

Offset = 0

Student Signature	<i>A. Williams</i>
Supervisor Signature	<i>J. Williams</i>
Lecturer Signature	<i>[Signature]</i>

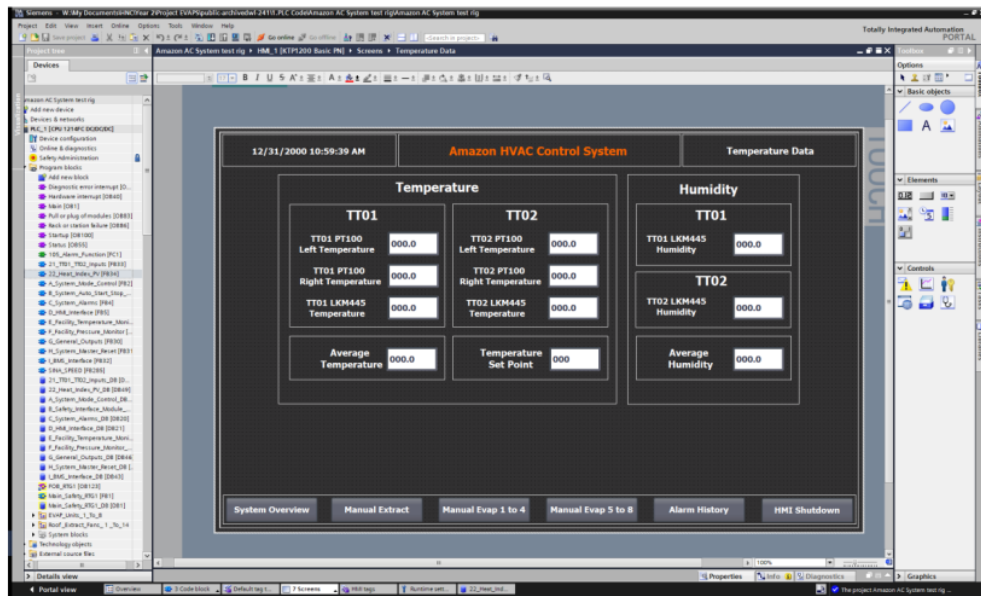
Log Sheet

Log No:	23
Hours:	10
Running total Hours	110

Wrote code to calculate average temperature and humidity

Wrote code to compare PV against set point and bring on the auto sequence

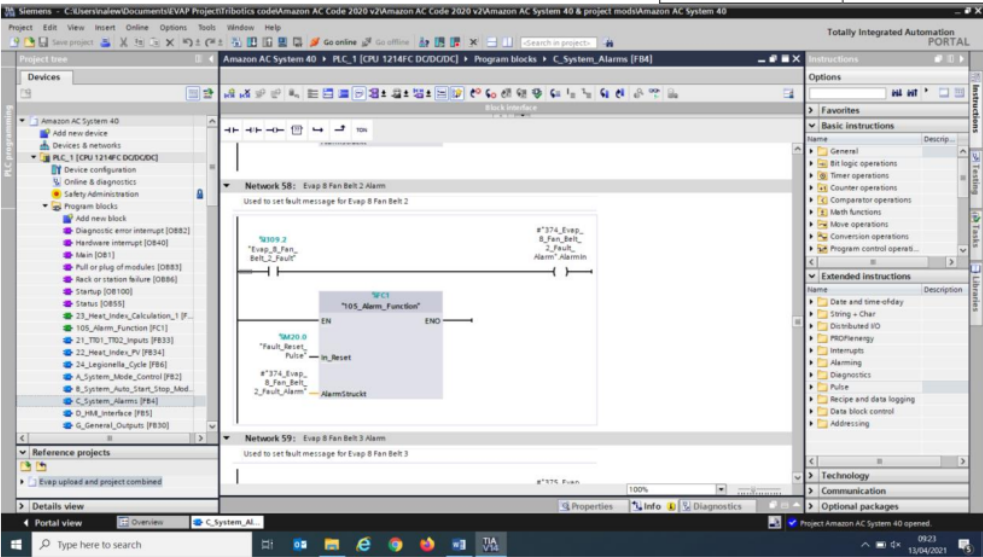
Designed temperature data HMI screen



Student Signature	<i>A. Williams</i>
Supervisor Signature	<i>J. Williams</i>
Lecturer Signature	

Log Sheet

Log No:	24
Hours:	5
Running total	115
Hours	



Modified code to use an alarm function call for each network for the alarms.

Student Signature	<i>A. Williams</i>
Supervisor Signature	<i>J. Williams</i>
Lecturer Signature	<i>[Signature]</i>

Log Sheet

Log No:	25
Hours:	10
Running total Hours	125

Rebuilt hardware in new project so own safety password can be set

Student Signature	<i>A. Williams</i>
Supervisor Signature	<i>J. Williams</i>
Lecturer Signature	

Log Sheet

Log No:	26
Hours:	5
Running total Hours	130

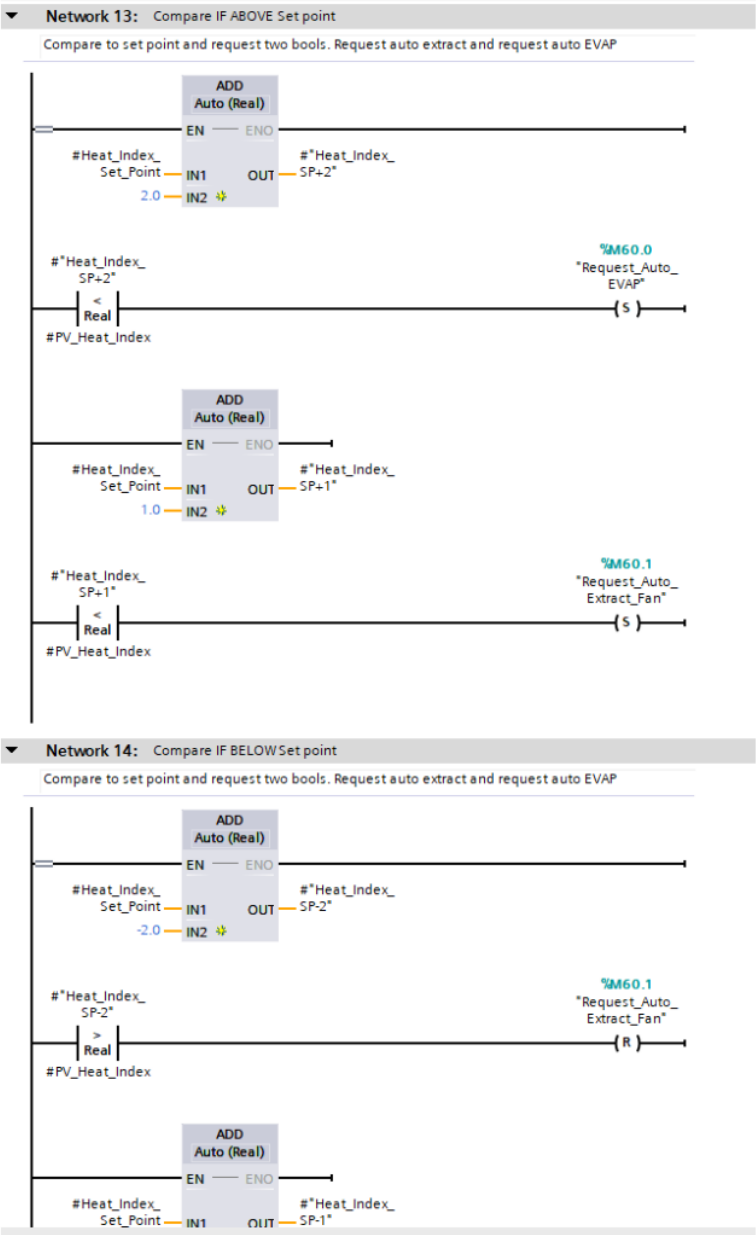
Started HMI re-development

Student Signature	<i>A. Williams</i>
Supervisor Signature	<i>J. Williams</i>
Lecturer Signature	

Log Sheet

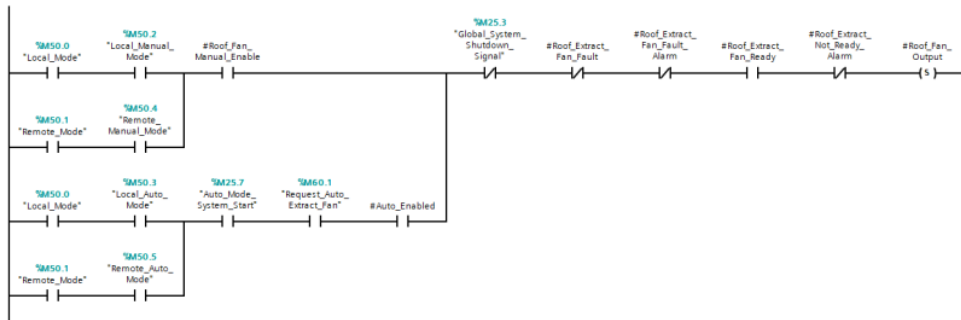
Log No:	27
Hours:	10
Running total Hours	140

Stared test rig testing including completing testing table.



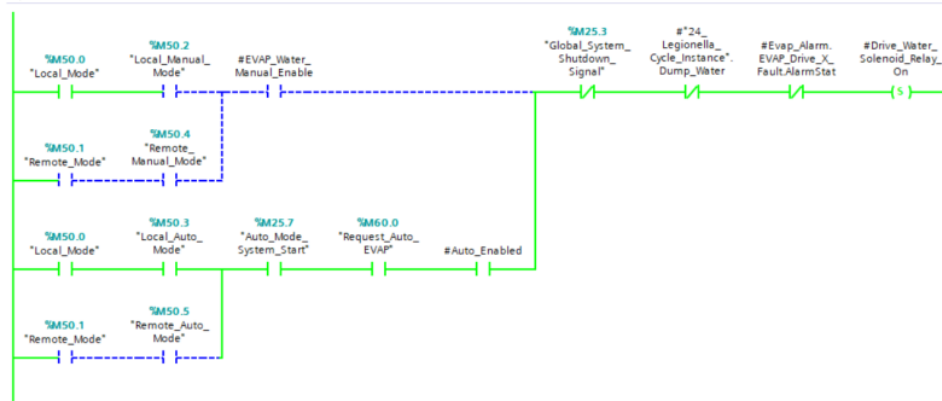
Network 2: Roof Extract Fan 1 Output Control On

Used to turn on Roof Extract Fan 1 in Manual Mode or Auto Mode



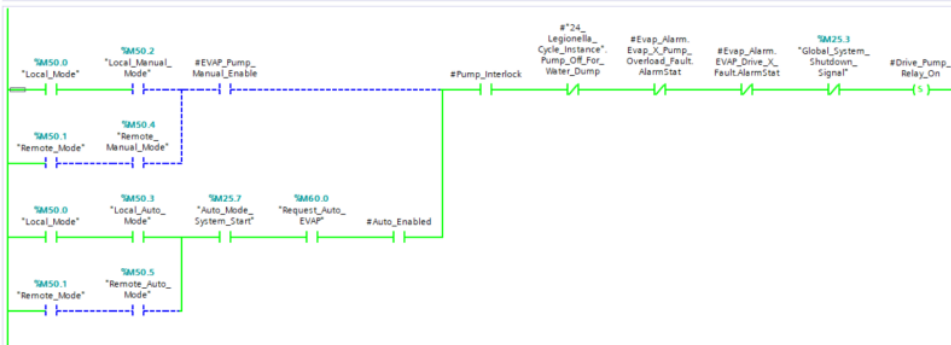
Network 4: Drive Output 2 for Evap for Water Solenoid Switch On

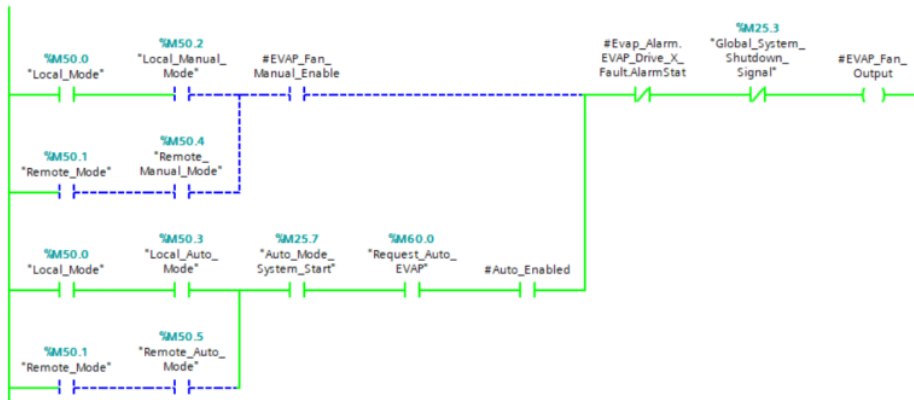
Used to turn on EVAP Water Solenoid in Manual Mode or Auto Mode



Network 8: Drive Output 0 for Pump Switch On

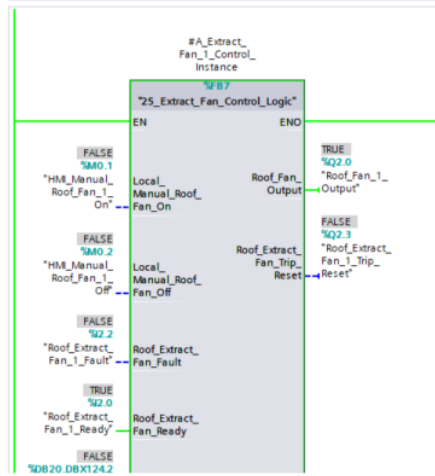
Used to turn on EVAP Pump in Manual Mode or Auto Mode





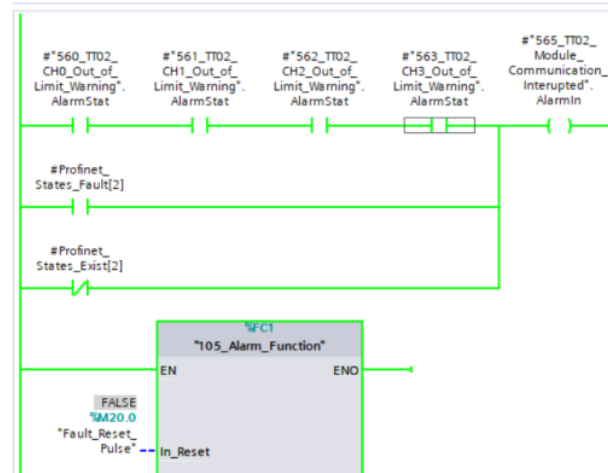
Network 1: Roof Extract Fan 1 Controls

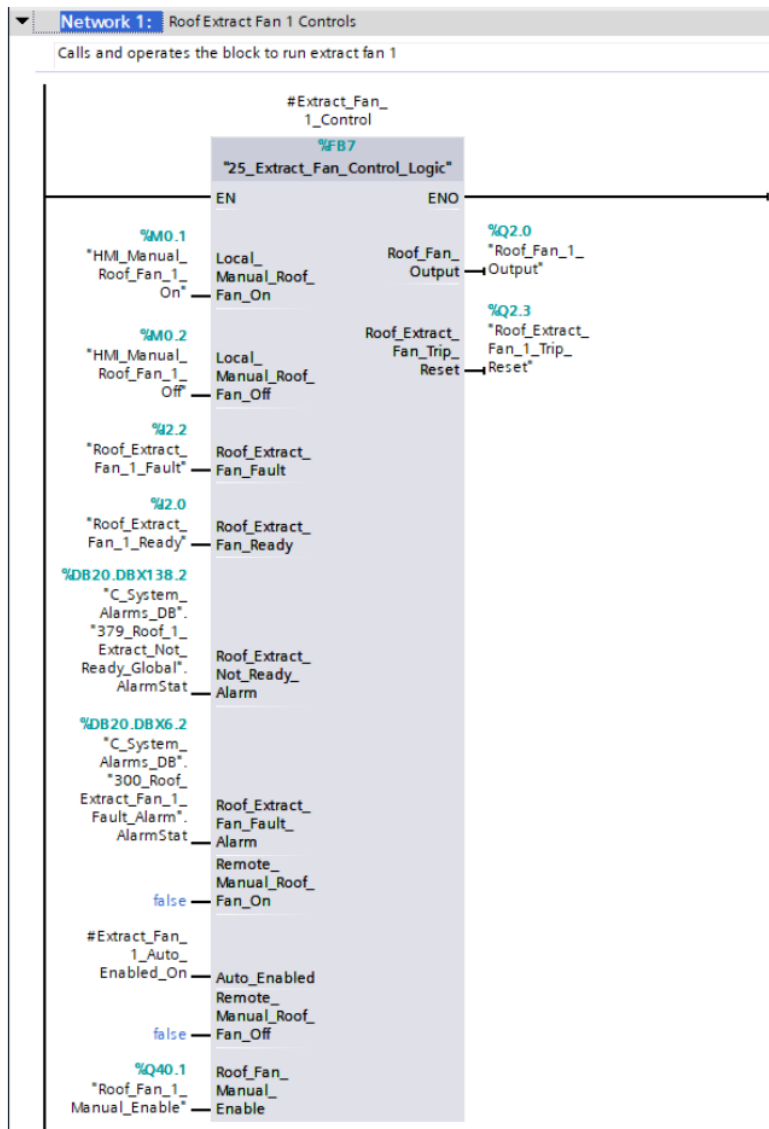
Calls and operates the block to run extract fan 1



Network 126: 565_TT02_Module_Communication_Interrupted

TT02 Communication interrupted all readings: out of limit





Student Signature	<i>A. Williams</i>
Supervisor Signature	<i>J. Williams</i>

Lecturer Signature

A handwritten signature in black ink, consisting of a large, stylized 'A' followed by a series of connected loops and a horizontal stroke at the end.

1909751

GRADEMARK REPORT

FINAL GRADE

GENERAL COMMENTS

Instructor

59/100

PAGE 1

PAGE 2

Text Comment. Summary outlines the report content

PAGE 3

PAGE 4

Text Comment. Table of contents could be further divided into more detailed sections

PAGE 5

Text Comment. Good list of figures

Text Comment. Good use of tables

PAGE 6

Text Comment. Good research carried out with relevant sources used

PAGE 7

Text Comment. Good comparison table that supports the explanation

PAGE 8

Text Comment. A detailed specification

PAGE 9

Text Comment. Test plan table is in appendix

Text Comment. This should have an image and ref source for support

Text Comment. Images and ref source would support this argument

Text Comment. Solution 1 is chosen and a good argument is put forward for this choice including constraints by Amazon requirements.

Text Comment. This should be implementation

Text Comment. Restriction is identified

Text Comment. The stages are explained but there is no need for all this detail.

Text Comment. Flow chart is a good method or representing sequence operations

Text Comment. There is far too much unwanted written content here. The use of images would be a much improved method.

Text Comment. The watch table tests are a good method for real time test simulation

Text Comment. Test procedure is explained and referencing supporting images in the appendix

Text Comment. A good improvement

Text Comment. This can be regarded as an implemented recommendation

Text Comment. The conclusion is good and includes relevant recommendations. The re should be less word count for this task.

PAGE 18

Text Comment. More reference sources should have been used

PAGE 19

PAGE 20

Text Comment. Good comparison Gantt chart

PAGE 21

PAGE 22

PAGE 23

PAGE 24

PAGE 25

PAGE 26

Text Comment. Panel drawings are referenced in the report implementation stage.

PAGE 27

Text Comment. Budget breakdown is referenced in report

PAGE 28

Text Comment. Good image o support implementation

PAGE 29

Text Comment. Good images that support explanations in main report

PAGE 30

PAGE 31

PAGE 32

PAGE 33

Text Comment. PLC program is implemented and tested using online test method

Text Comment. Table of results is extensive

PAGE 57

PAGE 58

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GRADING FORM: CSG-RUBIC

ALEX WILLIAMS

0

RESEARCH-INFORMED LITERATURE



Research has good content but limited ref sources. 4/10
This limits the relevance of the research. 4/10
There should be more sources included. 4/10

8/20

KNOWLEDGE AND UNDERSTANDING



Specification is detailed and informative of requirements and constraints. 7/10 Solutions considered have good arguments and application explanations. There are no sources used in this section or images to support arguments. This could have supported the research section. There is a good relevant argument for the final solution chosen. There is far too much unnecessary content here. 5/10

12/20

ANALYSIS



Testing and results have a good explanation and a table of results from a relevant simulated test sequence. There is no test carried out for the HMI which could have been carried out in simulation mode. However the tests that have been carried out are extensive. 6/10 There is a good conclusion and recommendations. Some of the recommendations have already been implemented. 7/10

13/20

PRACTICAL APPLICATION AND DEP.



Very good planning section with Gantt chart indicating issues with the project timeline due to the industry. Test plan is included. Explanations are detailed. 4/5 Solutions considered have application descriptions in the arguments but there are no images or ref sources to support the arguments. 5.5/10 Implementation stage has far too much unnecessary content. There are good descriptive elements included with reference to good supporting images in the appendix.. The simulation is noted due to issues outside college control. There should have been a HMI design implemented. 6.5/10 .

16/25

SKILLS FOR PROFESSIONAL PRAC.



Report layout is good. Far too much text content in certain sections. Good organised appendix.

10/15