

2321142

by Endaf Williams

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Title Page

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The rest of these figures should be identified

Good list of figures

Introduction

This project investigates the development of a temperature monitoring and control system designed for use in a server room. The system employs an analogue temperature sensor with a 0–10V output to continuously measure ambient temperature. Based on the sensor's readings, the system activates a heavy-duty fan via a driver circuit to maintain a safe operating environment. *Good description*

Due to the secretive nature of QinetiQ the practical side of this project will be conducted in college. However, once the project is completed the system could easily be transferred into a real-world situation. *Good point*

QinetiQ Pendine, located in Carmarthenshire, Wales, is a key site for weapons and munitions testing, environmental trials, and defence evaluation activities. It provides vital support to the UK Ministry of Defence and other international clients by conducting live firing trials, blast assessments, and system performance evaluations. The facility includes extensive test ranges and specialised infrastructure designed to simulate real-world conditions, ensuring that defence systems are safe, reliable, and effective. QinetiQ Pendine plays a crucial role in the research and development of military technologies, supporting innovation, validation, and capability assurance for current and future defence platforms and equipment. (QinetiQ, n.d.) *Good background with ref source*



Reason for the Project:

Server rooms contain heat-sensitive equipment that must operate within a specified temperature range. Without effective cooling, excessive heat can lead to system instability, equipment failure, or data loss. Therefore, a reliable and automatic cooling solution is essential to prevent these risks.

Problem to Be Solved:

Currently, there is no automated mechanism in place to regulate the server room's temperature based on real-time conditions. This project aims to solve this problem by designing and implementing a control system that activates a fan when the temperature exceeds a predefined threshold. The use of an analogue sensor provides continuous temperature feedback, allowing the system to respond efficiently to temperature changes. *Good argument for project*

Not enough research to meet requirements

Solutions Considered

Relays and Timers

Using relays and timers to complete this project would be a cost effective solution as they are cheap and easy to use. The main advantages are their ease of implementation, reliability and independence from complex programming or digital systems. However, this approach would have notable drawbacks, including limited flexibility, lack of real time temperature feedback and reduced precision when comparing to microcontrollers or sensor based systems. They would also not have the capability to adapt dynamically to the constant temperature changes within a server room which would greater hinder the cooling effect and the overall efficiency of the system. (Abood and Fuller, 2023)



Good image and ref source

Figure 1 - Image of Relay and Timers

Arduino Mega

Using an Arduino Mega to complete this project would offer several advantages, including lower cost compared to industrial controllers, compatibility with various display options such as HMIs or LabVIEW interfaces, and a compact size suitable for installation in tight spaces. However, it also presents challenges: it requires programming in C++, which can be more complex than traditional PLC languages, lacks intuitive drag-and-drop programming environments, and can be less efficient for maintenance due to less readable code. Additionally, while chosen in some industries for cost-effectiveness, Arduino systems may be less reliable in demanding environments, potentially leading to increased maintenance efforts and downtime. (Arduino, 2025)

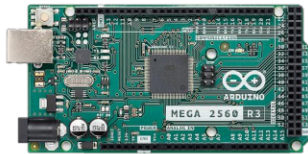


Figure 2 - Image of Arduino Mega

Good argumnt for solution and correct citation

Programmable Logic Controllers (PLC)

Finally, using a Programmable Logic Controller (PLC) to complete the project would be a highly reliable and scalable solution, particularly suited for industrial environments. PLCs are designed to operate consistently under harsh conditions such as elevated temperatures, electrical noise, and dust, making them ideal for server room applications. They also support multiple inputs and outputs, allowing for future expansion such as the integration of additional fans or temperature sensors. With wide availability of spare parts and strong technical support, PLCs offer long-term maintainability. Furthermore, they use industry-standard programming languages like ladder logic, which are tailored for automation tasks and easy to interpret during troubleshooting. While the initial cost and power consumption are higher compared to alternatives like Arduino, the reliability and robustness of PLCs make them the preferred choice for critical, continuous use systems. (Siemens, 2025)



Figure 3 - Image of PLC

Industrial Fan – NF-F12 IndustrialPPC-3000 PWM



The Noctua NF-F12 industrialPPC-3000 PWM is a high-performance 120mm cooling fan designed for demanding industrial applications. Operating at speeds up to 3000 RPM, it delivers strong airflow and static pressure, making it suitable for environments that require efficient heat dissipation. Built from fibre-glass reinforced polyamide, it offers durability and can withstand temperatures up to 140°C, with an IP52 rating for dust and water protection. Its advanced SSO2 bearing and three-phase motor ensure reduced vibrations, high reliability, and a long service

life of over 150,000 hours, although it produces noticeable noise at maximum speed (Noctua, 2024).

Again, due to the sensitive nature of QinetiQ the physical work was done in college and therefore a suitable fan was considered for the college environment. Once the work has been completed then the fan can easily be swapped for larger scale fans.

Figure 4 - Image of Industrial Fan

Good information, but this is purely research, not a relevant solution as this is part of the system regardless.

Specification

This project involves the design and implementation of a closed-loop temperature monitoring system using an analogue temperature sensor and a Programmable Logic Controller (PLC).

The system will:

Good opening statement

- Continuously measure temperatures within a range of 0°C to 60°C.
- Transmit the measured data via a 0–10V analogue signal to the PLC.
- Display real-time temperature readings on a Human Machine Interface (HMI) screen for operator monitoring.

The PLC chosen for this project is the **Siemens 1214 DC/DC/DC**, featuring:

Alarm conditions missing here

- 8192 bits of internal memory
- 14 digital inputs and 10 digital outputs
- Support for analogue I/O through expansion modules
- Programming via **TIA Portal** software

HMI Integration

Temperature values will be displayed on an HMI screen, providing operators with:

- Real-time visual feedback
- User-friendly monitoring capabilities
- Efficient troubleshooting if process anomalies occur

System Scalability

The system is designed with future expansion in mind:

- Although only one analogue temperature sensor is implemented initially, the infrastructure supports additional analogue sensor inputs.
- This approach aligns with industry standards for flexible and scalable monitoring systems.

Project Justification

This project effectively demonstrates the integration of:

- Analogue sensing
- PLC logic
- HMI visualization

The combination results in a robust and reliable process monitoring solution suitable for industrial environments.

Project Constraints and Considerations

- **Minimal Risk of Delays:** As the project is conducted within the college environment, the likelihood of project delays is very low.
- **No Management Pressure:** There is no external pressure from managers or budgetary constraints beyond the normal college equipment use.
- **Equipment Cost:** Although the equipment is expensive, it is readily available within the college, making it essentially free for students to use.

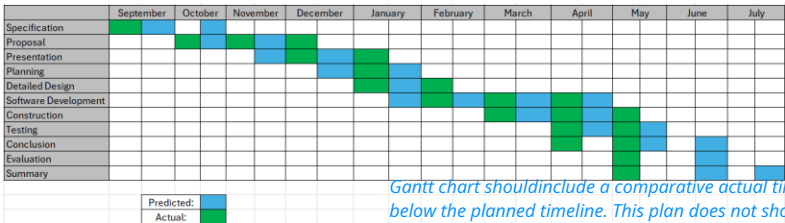
Maintenance Requirements

- The use of a Siemens PLC ensures extremely low maintenance due to the high reliability of the equipment.
- The only component likely to require regular maintenance is the mechanical part of the system, such as the fan.

There are significant parts missing from this section!

Planning

Time Management



Gantt chart should include a comparative actual timeline directly below the planned timeline. This plan does not show discrepancies

The table shows a predicted and actual representation of how the time was spent during the completion of the project. The initial time frame took the work up until July however with the deadline being moved forward there was a push to get the work completed in a shorter time frame. This can be seen when looking at the green boxes within the months. Having the flexibility to adjust was crucial for completing this task whilst also ensuring the work was completed to a high standard on the first attempt meant there was no need to redo anything which again saved on the overall completion time for the project.

There is no explanation for discrepancies

Test Plan

A short but simple test plan was created to ensure the operation of the system met the desired outcomes needed for the project

Test Description
Ensure that the programme is error free before downloading and connecting to the whole system
Test the system under a range of temperature conditions to verify that the fan speed is adjusted appropriately
Ensure the fan operates efficiently, maintaining safe temperature limits and preventing overheating.
Maintaining a detailed log of temperature sensor data and fan speeds for analysis and troubleshooting will ensure any anomalies will be easily seen

This needs more detail. Poor

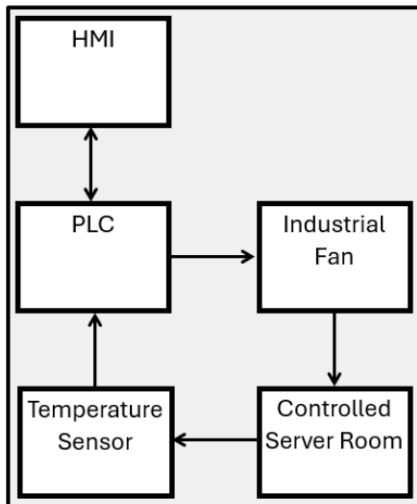
Final Solution and Implementation

Functional Design

Incorrect

The final solution will consist of two main parts: Initial initialisation and a monitoring loop. The initialisation consists of the system being powered on. Meaning the HMI, Fan and Temperature Sensor are ready to communicate between one and another. Whilst the monitoring loop is constantly reading the temperature to ensure system is within desired range. If the temperature is too high, then the fans will speed up. Oppositely the fans will slow down if the room is within range. All of this will be displayed back to the user on the HMI. Please see an adequate block diagram below.

This is far too basic and does not detail any function



Good block diagram

Figure 5 - Block Diagram of System

Final Programme

Below the final programme can be seen with adequate comments made on what is happening within the networks.

Network 1

If the manual override is active (TRUE), the system sets the 'manual mode' to TRUE. This enables manual control of the motor

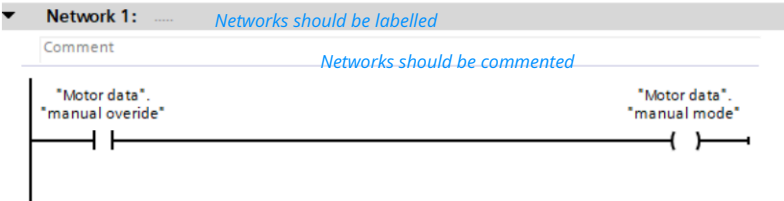


Figure 6 - Network 1

Network 2

When the system is enabled and not in manual mode, the 'Analog_Input' function block is activated. This allows analog input processing to run only during automatic operation.

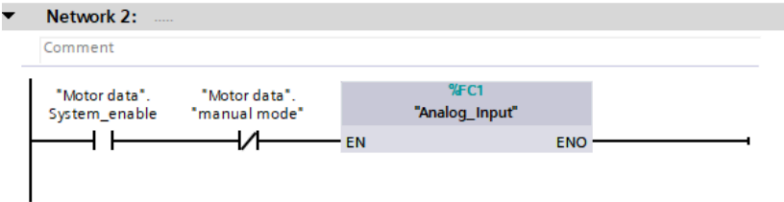


Figure 7 - Network 2

Network 3

Similar to Network 2, if the system is enabled and in automatic mode, the 'SCL Level Conditions' function block is enabled. This handles the level condition logics based on the code within the SCL for the programme. *This was not in spec*

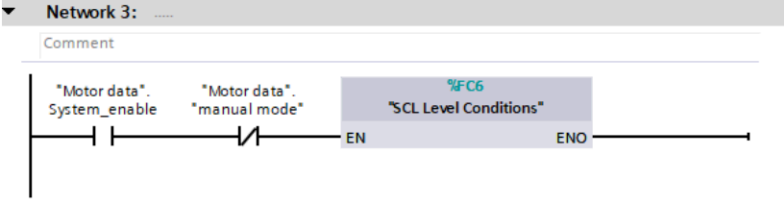


Figure 8 - Network 3

Network 4

If the motor has power, then the system is enabled by setting the 'System_enable' to TRUE

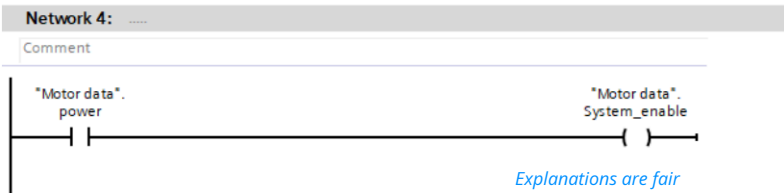
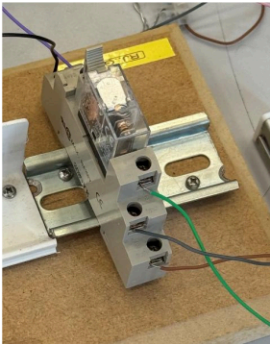


Figure 9 - Network 4

Network 5

Following on from Network 4, once the system is enabled, Network 5 activates the PWM controller. An additional comparison block was added to ensure the PWM value exceeds 40, as this was identified as the minimum threshold needed to drive the fan at different speeds. To ensure proper operation, a relay was added to the circuit, which activates only after the PWM controller begins outputting a value above this threshold, effectively turning on the fan.

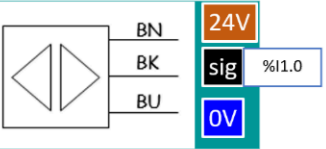


Relay purpose is explained

Network 5 should be here to show conditions for relay operation

Figure 10 - Image of Relay used within Circuit

Below is the connection procedure used to ensure that the relay was correctly added into the circuit and would operate as intended.

Connection Procedure:	
Step 1 – Connect the proximity sensor with the signal input to %I1.0 as shown in the cct diagram.	
Use the symbol diagram connections as a guide.	
	<i>This is not needed. Proximity sensor is not used!</i>
Step 2 – Connect the relay coil contacts labelled +5 on relay holder to %Q0.0 PLC output, and -1 on relay holder to gnd (0V) as shown in the cct diagram.	
Step 3 – Connect the relay wiper labelled 4 on the relay holder to 24V on the connector block.	
Step 4 – Connect the relay N/C contact labelled 2 on the relay holder to %I1.1 PLC input as indicated on the cct diagram.	
Step 5 – Connect the relay N/O contact labelled 3 on the relay holder to %I1.2.PLC input as indicated on the cct diagram.	

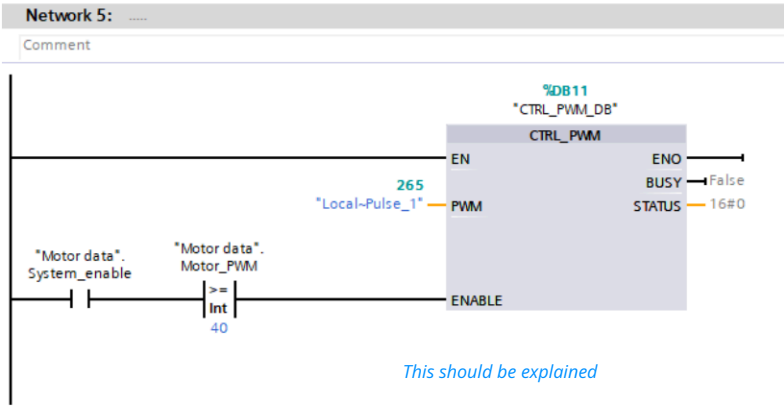


Figure 11 - Network 5

Network 6

This network reads the PWM signal value from the output word address %QW1000, which in this instance represents the fan motor speed, and then the function block is used to move this information and store it into the 'Motor data. Motor PWM'. This operation is used to monitor the actual output sent to the fan, which is helpful for diagnostic purposes in the control system.

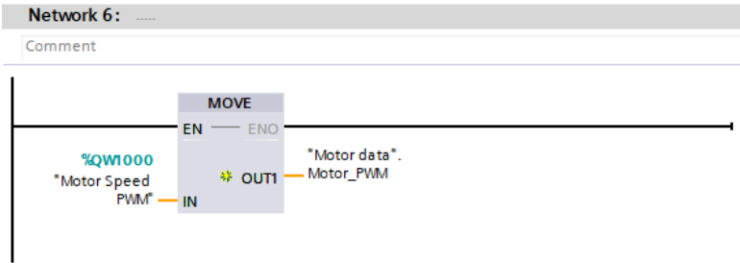
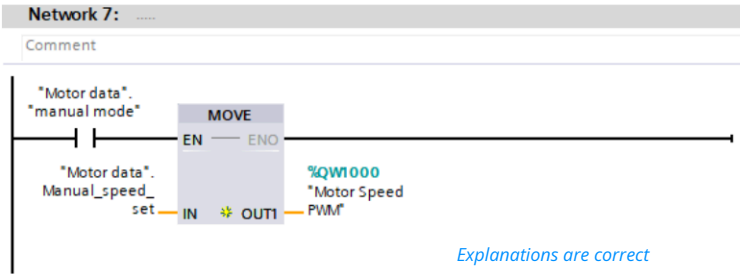


Figure 12 - Network 6

Network 7

When manual mode is TRUE, this network allows the user defined manual speed value to override the automatic control by writing it directly to the 'Motor Speed PWM'. This enables manual control of the fan speed for testing or maintenance purposes by bypassing the temperature based automatic control logic.



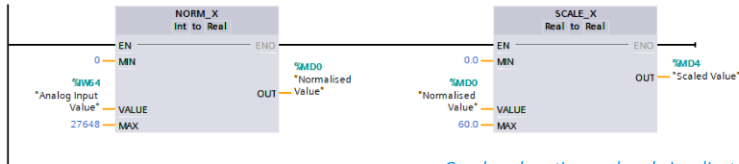
Explanations are correct

Figure 13 - Network 7

Network 8

This network is used to convert the raw analog signal from the temperature sensor into usable temperature value in degrees Celsius. The left block has a adequate MIN and MAX for the PLC used. The Min is in relation to 0V and then the Max value of 27648 corresponds to the value for when 10V is inputted to the PLC. The output is then a scaled value between 0.0 and 1.0 and is stored in %MD0 'Normalised Value'.

The right block is then used to scale the normalised value to a temperature. Scaling from the 0.0-1.0 range to 0.0-60.0°C. This final value is then outputted as the 'Scaled Value' and shows the user the upper and lower temperature limits that will be expected of the system.



Good explanation and scale is adjusted to suit the temp max point

Figure 14 - Network 8

SCL Code

The SCL code below controls the fan speed based on the temperature within the server room. For the first snippet of code seen, when the temperature is between 31 and 38 Degrees Celsius the system sets the fan speed to 55 and activates alarms 0 to 3. Similarly when the temperature rises (>38 and <45) the fan speed is raised to 60 and alarms 0 to 4 can be seen to be activated. This code ensures that the fan operates at a adequate speed based on the temperature within the server room.

```

32 IF ("Scaled Value" > 31) AND ("Scaled Value" < 38) THEN
33   "Level condition data".Alarm0 := 1; // Statement section IF
34   "Level condition data".Alarm1 := 1;
35   "Level condition data".Alarm2 := 1;
36   "Level condition data".Alarm3 := 1;
37   "Level condition data".Alarm4 := 0;
38   "Level condition data".Alarm5 := 0;
39   "Motor Speed PWM" := 55;
40 END IF;
41 IF ("Scaled Value" > 38) AND ("Scaled Value" < 45) THEN
42   "Level condition data".Alarm0 := 1; // Statement section IF
43   "Level condition data".Alarm1 := 1;
44   "Level condition data".Alarm2 := 1;
45   "Level condition data".Alarm3 := 1;
46   "Level condition data".Alarm4 := 1;
47   "Level condition data".Alarm5 := 0;
48   "Level condition data".Alarm6 := 0;
49   "Motor Speed PWM" := 60;
50 END IF;

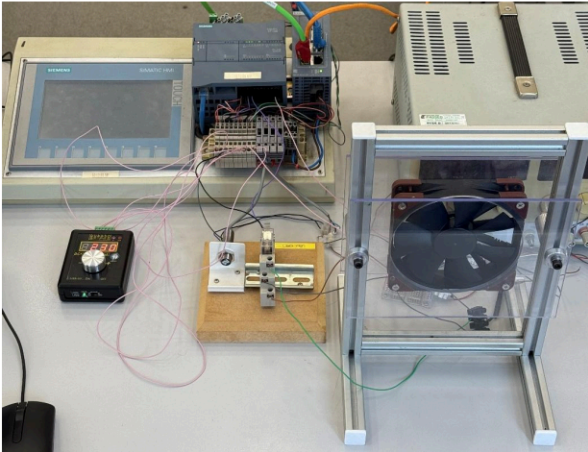
```

Figure 15 - Snippet of SCL Code

All the other temperature and speed parameters follow the same coding sequence and can be found within the appendix ranging from 'FIGURE 30' to 'FIGURE 32'

Final System

The image below displays the completed system built for this project. The developed code was successfully downloaded to the PLC, and all hardware components were correctly wired. Located beneath the PLC and HMI are the PWM module, temperature sensor, relay, and fan. These components constitute all the essential hardware required to meet the project specifications.



This image should be annotated

Figure 16 - Final System

Costs

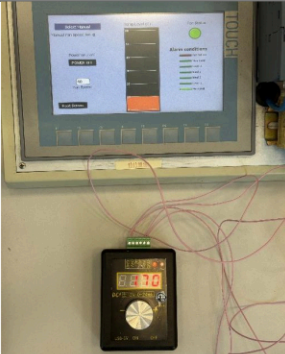
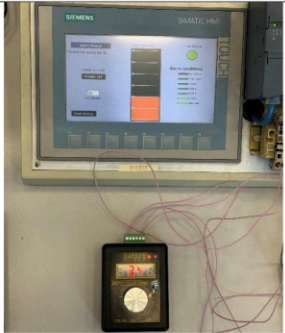
Now that the system has been created the final costs for the whole project was calculated. Again, as the physical work was carried out in college a lot of the materials were already available and therefore reducing the final cost down to just the hardware required for the project.

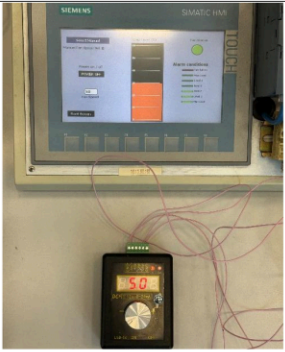
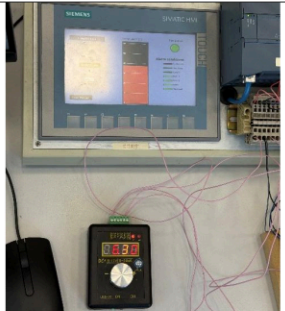
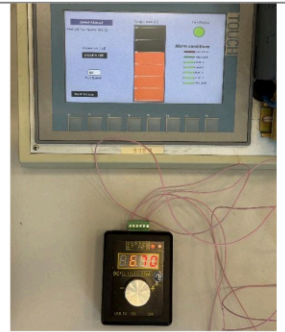
HMI	£800
PLC	£450
Industrial Fan	£150
Sensor	£100
Total	£1500

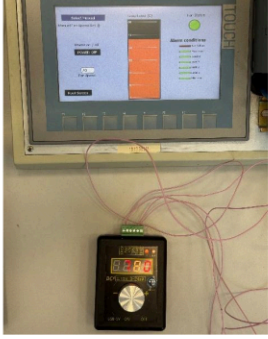
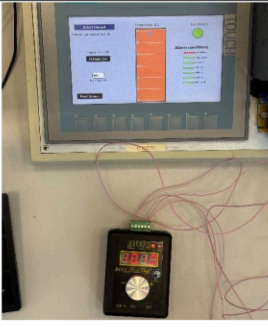
This does not belong in this section

Testing and Results

The testing table below shows evidence of the final system working as expected. 7 tests were completed to cover the different levels programmed into the system. It is seen that the expected temperature, voltage values and fan speed all match up with the results seen in person. The HMI created clearly shows the user the adequate temperature and fan speed whilst the PWM *Not clearly* controller shows the user the voltage required. The tests provide confidence that the system is behaving as it should, and all the different conditions and situations were conducted when completing these tests.

Test No	Expected			Actual HMI Result
	Temp	Value (V)	Speed (% duty cycle)	
1	>10	1.7	40	
2	>17	3.4	45	

3	>24	5.0	50	
4	>31	6.3	55	
5	>38	6.7	60	

6	>45	7.8	70	
7	>60	10.1	80	

Good table of results with good evidence

An explanation is included

Testing Evidence using Watch Table

Below, another form of system testing can be seen. This time using the watch table which is built into the programming software. This table provides a clear view of the Voltage figure, the different level conditions and the fan speed. Again, the tests were completed at several different levels to ensure that all the level conditions were met and that the system is operating as it should.

>10

	i	Name	Address	Display format	Monitor value
1		"Scaled Value"	%MD4	Floating-point nu...	10.66406
2		"Level condition ...		Bool	☐ FALSE
3		"Level condition ...		Bool	☐ FALSE
4		"Level condition ...		Bool	☐ FALSE
5		"Level condition ...		Bool	☐ FALSE
6		"Level condition ...		Bool	☐ FALSE
7		"Level condition ...		Bool	☐ FALSE
8		"Level condition ...		Bool	☒ TRUE
9		"Motor data".Mot...		DEC+/-	40
10		"Motor data".pow...		Bool	☒ TRUE
11			<Add new>		

Figure 17 - Watch Table >10

>17

	i	Name	Address	Display format	Monitor value
1		"Scaled Value"	%MD4	Floating-point nu...	18.44184
2		"Level condition ...		Bool	☐ FALSE
3		"Level condition ...		Bool	☐ FALSE
4		"Level condition ...		Bool	☐ FALSE
5		"Level condition ...		Bool	☐ FALSE
6		"Level condition ...		Bool	☐ FALSE
7		"Level condition ...		Bool	☒ TRUE
8		"Level condition ...		Bool	☒ TRUE
9		"Motor data".Mot...		DEC+/-	45
10		"Motor data".pow...		Bool	☒ TRUE

Figure 18 - Watch Table >17

All the other watch table tests follow the same sequence and can be found in the appendix ranging from 'FIGURE 19' to 'FIGURE 25'

This is a good test for the alarm conditions with PWM values

Discussion, Conclusion & Recommendations

This project successfully achieved the development of a temperature monitoring and control system tailored for use in a server room environment. The system, which integrates a reliable analogue temperature sensor with a 0–10V output and a driver circuit to control a heavy-duty fan, performed consistently and as intended throughout testing. It effectively maintained ambient temperature within safe operating limits, ensuring the protection and longevity of sensitive electronic equipment.

All project objectives were met within the defined timeframe, with the system being completed ahead of the scheduled end date outlined in the planning phase. The project remained within budget, thanks in part to the use of existing programmable logic controllers (PLCs) available in the college. These PLCs proved to be both sustainable and reliable, aligning the project with environmentally conscious practices by reducing the need for new hardware and minimising maintenance requirements.

Throughout the project, a high level of professionalism and ethical conduct was shown at all times. Clear and accurate records of progress were kept, which helped to track the development of the system and supported good project management. All safety procedures were followed carefully to avoid risks during testing and construction. College equipment and resources were used responsibly and with respect, making sure nothing was damaged or wasted. Decisions were made with practical thinking, aiming for long-term reliability and sustainable use of materials and components.

An area for improvement would be replacing the current analogue temperature sensor with a digital alternative. Digital sensors offer higher accuracy, better resistance to electrical noise, and improved long-term stability, which is particularly beneficial in environments like server rooms where interference is common. Additionally, incorporating a battery backup or uninterruptible power supply (UPS) would enhance system reliability during power outages. Currently, the system is dependent on mains power, so a loss of power would disable temperature monitoring and fan control. A UPS would allow the system to continue functioning in critical moments, protecting sensitive equipment from overheating and ensuring continuous operation until power is restored or further action is taken.

In summary, the project not only met its technical and operational goals but also reflected a thoughtful and professional execution, delivering a robust solution that is ready for real-world application.

Conclusion is missing the significant points

One recommendation is relevant with using a digital temp sensor

Reference List

QinetiQ. (n.d.). *QinetiQ's work at MOD Pendine*. [online] Available at:

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QinetiQ+3QinetiQ+3QinetiQ+3 [Accessed 13 February 2025]

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Noctua (2024) *NF-F12 industrialPPC-3000 PWM*. [online] Available at:

<https://noctua.at/en/nf-f12-industrialppc-3000-pwm/specification> [Accessed: 18 April 2025].

Should be more ref sources

Appendix

Testing Evidence using Watch Table

>10

	i	Name	Address	Display format	Monitor value
1		"Scaled Value"	%MD4	Floating-point nu...	10.66406
2		"Level condition ...		Bool	☐ FALSE
3		"Level condition ...		Bool	☐ FALSE
4		"Level condition ...		Bool	☐ FALSE
5		"Level condition ...		Bool	☐ FALSE
6		"Level condition ...		Bool	☐ FALSE
7		"Level condition ...		Bool	☐ FALSE
8		"Level condition ...		Bool	☒ TRUE
9		"Motor data".Mot...		DEC+/-	40
10		"Motor data".pow...		Bool	☒ TRUE
11			<Add new>		

Figure 19

>17

	i	Name	Address	Display format	Monitor value
1		"Scaled Value"	%MD4	Floating-point nu...	18.44184
2		"Level condition ...		Bool	☐ FALSE
3		"Level condition ...		Bool	☐ FALSE
4		"Level condition ...		Bool	☐ FALSE
5		"Level condition ...		Bool	☐ FALSE
6		"Level condition ...		Bool	☐ FALSE
7		"Level condition ...		Bool	☒ TRUE
8		"Level condition ...		Bool	☒ TRUE
9		"Motor data".Mot...		DEC+/-	45
10		"Motor data".pow...		Bool	☒ TRUE

Figure 20

>24

	i	Name	Address	Display format	Monitor value
1		"Scaled Value"	%MD4	Floating-point nu...	25.625
2		"Level condition ...		Bool	 FALSE
3		"Level condition ...		Bool	 FALSE
4		"Level condition ...		Bool	 FALSE
5		"Level condition ...		Bool	 FALSE
6		"Level condition ...		Bool	 TRUE
7		"Level condition ...		Bool	 TRUE
8		"Level condition ...		Bool	 TRUE
9		"Motor data".Mot...		DEC+/-	50
10		"Motor data".pow...		Bool	 TRUE

Figure 21

>31

	i	Name	Address	Display format	Monitor value
1		"Scaled Value"	%MD4	Floating-point nu...	33.40278
2		"Level condition ...		Bool	 FALSE
3		"Level condition ...		Bool	 FALSE
4		"Level condition ...		Bool	 FALSE
5		"Level condition ...		Bool	 TRUE
6		"Level condition ...		Bool	 TRUE
7		"Level condition ...		Bool	 TRUE
8		"Level condition ...		Bool	 TRUE
9		"Motor data".Mot...		DEC+/-	55
10		"Motor data".pow...		Bool	 TRUE

Figure 22

>38

1		"Scaled Value"	%MD4	Floating-point nu...	39.40321
2		"Level condition ...		Bool	 FALSE
3		"Level condition ...		Bool	 FALSE
4		"Level condition ...		Bool	 TRUE
5		"Level condition ...		Bool	 TRUE
6		"Level condition ...		Bool	 TRUE
7		"Level condition ...		Bool	 TRUE
8		"Level condition ...		Bool	 TRUE
9		"Motor data".Mot...		DEC+/-	60
10		"Motor data".pow...		Bool	 TRUE

Figure 23

>45

	i	Name	Address	Display format	Monitor value
1		"Scaled Value"	%MD4	Floating-point nu...	46.58637
2		"Level condition ...		Bool	☐ FALSE
3		"Level condition ...		Bool	☒ TRUE
4		"Level condition ...		Bool	☒ TRUE
5		"Level condition ...		Bool	☒ TRUE
6		"Level condition ...		Bool	☒ TRUE
7		"Level condition ...		Bool	☒ TRUE
8		"Level condition ...		Bool	☒ TRUE
9		"Motor data".Mot...		DEC+/-	70
10		"Motor data".pow...		Bool	☒ TRUE

Figure 24

>60

1		"Scaled Value"	%MD4	Floating-point nu...	60.95486
2		"Level condition ...		Bool	☒ TRUE
3		"Level condition ...		Bool	☒ TRUE
4		"Level condition ...		Bool	☒ TRUE
5		"Level condition ...		Bool	☒ TRUE
6		"Level condition ...		Bool	☒ TRUE
7		"Level condition ...		Bool	☒ TRUE
8		"Level condition ...		Bool	☒ TRUE
9		"Motor data".Mot...		DEC+/-	80
10		"Motor data".pow...		Bool	☒ TRUE

Figure 25

Good test method and explanation

Main Block

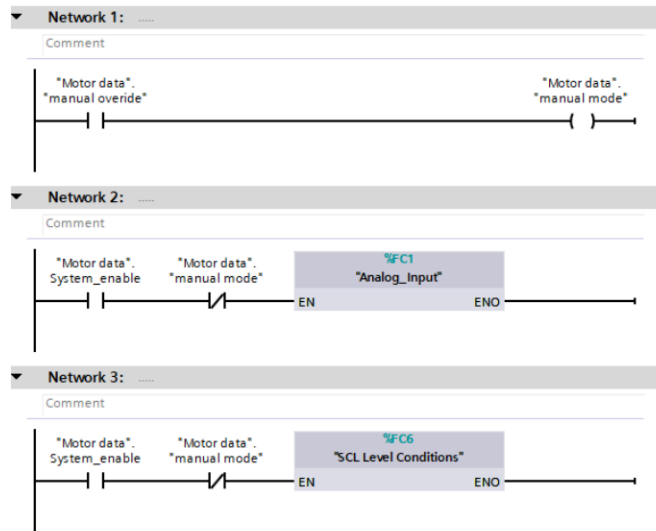


Figure 26

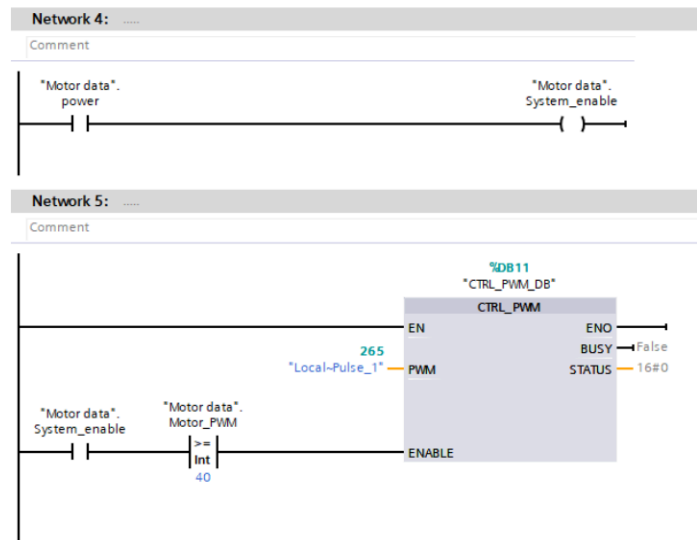


Figure 27

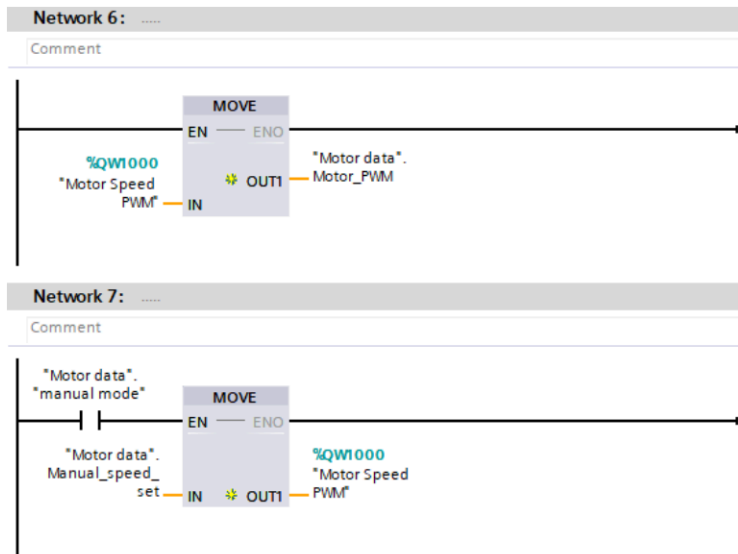


Figure 28

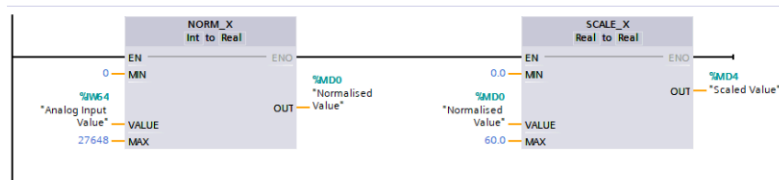


Figure 29

Good LDR program listing

Level Conditions SCL Code

```
1
2 IF ("Scaled Value" > 10) AND ("Scaled Value" < 17) THEN
3     "Level condition data".Alarm0 := 1; // Statement section IF
4     "Level condition data".Alarm1 := 0;
5     "Level condition data".Alarm2 := 0;
6     "Level condition data".Alarm3 := 0;
7     "Level condition data".Alarm4 := 0;
8     "Level condition data".Alarm5 := 0;
9     "Level condition data".Alarm6 := 0;
10    "Motor Speed PWM" := 40;
11 END_IF;
12 IF ("Scaled Value" > 17) AND ("Scaled Value" < 24) THEN
13     "Level condition data".Alarm0 := 1; // Statement section IF
14     "Level condition data".Alarm1 := 1;
15     "Level condition data".Alarm2 := 0;
16     "Level condition data".Alarm3 := 0;
17     "Level condition data".Alarm4 := 0;
18     "Level condition data".Alarm5 := 0;
19     "Level condition data".Alarm6 := 0;
20     "Motor Speed PWM" := 45;
21 END_IF;
22 IF ("Scaled Value" > 24) AND ("Scaled Value" < 31) THEN
23     "Level condition data".Alarm0 := 1; // Statement section IF
24     "Level condition data".Alarm1 := 1;
25     "Level condition data".Alarm2 := 1;
26     "Level condition data".Alarm3 := 0;
27     "Level condition data".Alarm4 := 0;
28     "Level condition data".Alarm5 := 0;
29     "Level condition data".Alarm6 := 0;
30     "Motor Speed PWM" := 50;
31 END_IF;
```

Figure 30

```

32 IF ("Scaled Value" > 31) AND ("Scaled Value" < 38) THEN
33     "Level condition data".Alarm0 := 1; // Statement section IF
34     "Level condition data".Alarm1 := 1;
35     "Level condition data".Alarm2 := 1;
36     "Level condition data".Alarm3 := 1;
37     "Level condition data".Alarm4 := 0;
38     "Level condition data".Alarm5 := 0;
39     "Motor Speed PWM" := 55;
40 END_IF;
41 IF ("Scaled Value" > 38) AND ("Scaled Value" < 45) THEN
42     "Level condition data".Alarm0 := 1; // Statement section IF
43     "Level condition data".Alarm1 := 1;
44     "Level condition data".Alarm2 := 1;
45     "Level condition data".Alarm3 := 1;
46     "Level condition data".Alarm4 := 1;
47     "Level condition data".Alarm5 := 0;
48     "Level condition data".Alarm6 := 0;
49     "Motor Speed PWM" := 60;
50 END_IF;
51 IF ("Scaled Value" > 45) AND ("Scaled Value" < 60) THEN
52     "Level condition data".Alarm0 := 1; // Statement section IF
53     "Level condition data".Alarm1 := 1;
54     "Level condition data".Alarm2 := 1;
55     "Level condition data".Alarm3 := 1;
56     "Level condition data".Alarm4 := 1;
57     "Level condition data".Alarm5 := 1;
58     "Level condition data".Alarm6 := 0;
59     "Motor Speed PWM" := 70;
60 END_IF;

```

Figure 31

```

61 IF ("Scaled Value" > 60) THEN
62     "Level condition data".Alarm0 := 1; // Statement section IF
63     "Level condition data".Alarm1 := 1;
64     "Level condition data".Alarm2 := 1;
65     "Level condition data".Alarm3 := 1;
66     "Level condition data".Alarm4 := 1;
67     "Level condition data".Alarm5 := 1;
68     "Level condition data".Alarm6 := 1;
69     "Motor Speed PWM" := 80;
70 END_IF;
71 IF ("Scaled Value" < 10) THEN
72     "Level condition data".Alarm0 := 0; // Statement section IF
73     "Level condition data".Alarm1 := 0;
74     "Level condition data".Alarm2 := 0;
75     "Level condition data".Alarm3 := 0;
76     "Level condition data".Alarm4 := 0;
77     "Level condition data".Alarm5 := 0;
78     "Level condition data".Alarm6 := 0;
79     "Motor Speed PWM" := 0;
80
81 END_IF;

```

Figure 32

HMI Control Screen

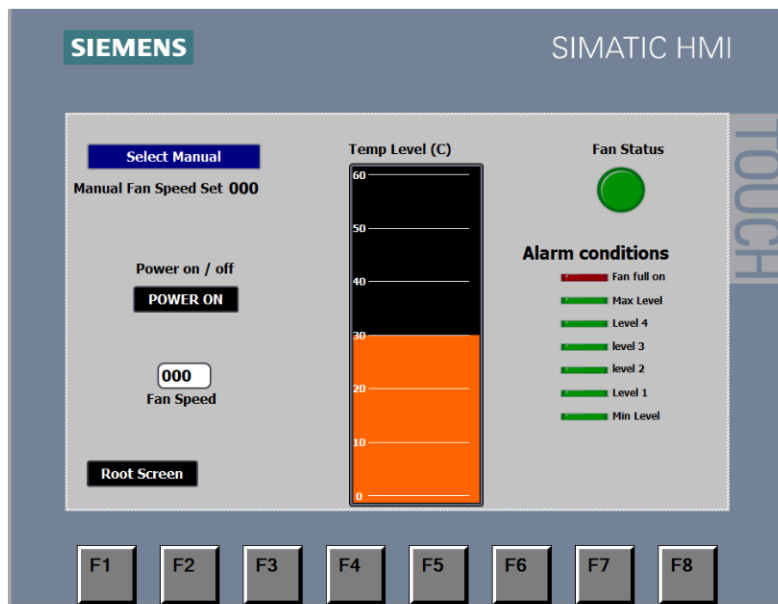


Figure 33

Good HMI design that should have been ref from the impenetation section

Logbooks

Log Sheet

Log No	1
No hrs	14
Running total hrs	14

Research

Below are the topics researched for the project. Three solutions were considered for the main brains of the project whilst one industrial fan option was also considered and researched.

Relays and Timers



Arduino Mega



Programmable
Logic Controllers



Industrial Fan

Student signature	<i>E. Williams</i>
Supervisor Signature	
Lecturer Signature	<i>RL</i>

Log Sheet

Log No	2
No hrs	6
Running total hrs	20

Specification

A snippet of the specification can be seen below. This part was crucial as the spine of the project was then visioned by completing the specification. The whole specification can be found in the assignment.

The PLC chosen for this project is the **Siemens 1214 DC/DC/DC**, featuring:

- 8192 bits of internal memory
- 14 digital inputs and 10 digital outputs
- Support for analogue I/O through expansion modules
- Programming via **TIA Portal** software

HMI Integration

Temperature values will be displayed on an HMI screen, providing operators with:

- Real-time visual feedback
- User-friendly monitoring capabilities
- Efficient troubleshooting if process anomalies occur

Student signature	<i>E. Williams</i>
Supervisor Signature	
Lecturer Signature	<i>[Signature]</i>

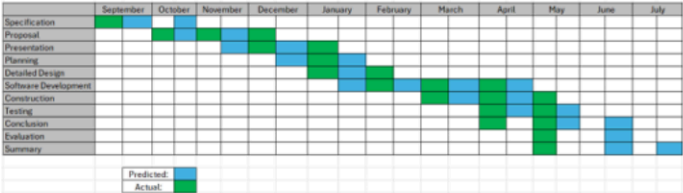
Log Sheet

Log No	3
No hrs	4
Running total hrs	24

Planning Table

An adequate table was created to provide an expected time period whilst also having a column for the actual time period for the completion of the project.

The table can be seen below;



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Supervisor Signature	
Lecturer Signature	<i>RL</i>

Log Sheet

Log No	4
No hrs	6
Running total hrs	30

Creating Adequate Tag Lists:

Planning was required to plan put the tags that were required.

PLC tags								
	Name	Tag table	Data type	Address	Retain	Acces...	Writa...	Visibl...
1	Motor Speed PWM	Default tag table	Word	%QW1000	☐	☒	☒	☒
2	Motor RUN	Default tag table	Bool	%I0.4	☐	☒	☒	☒
3	Motor PWM output	Default tag table	Bool	%Q1.1	☐	☒	☒	☒
4	Analog Input Value	Default tag table	Int	%IW64	☐	☒	☒	☒
5	Normalised Value	Default tag table	Real	%MD0	☐	☒	☒	☒
6	Scaled Value	Default tag table	Real	%MD4	☐	☒	☒	☒
7	Fan Relay	Default tag table	Bool	%Q0.1	☐	☒	☒	☒
8	<Add new>				☐	☒	☒	☒

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Supervisor Signature	
Lecturer Signature	<i>RL</i>

Log Sheet

Log No	5
No hrs	14
Running total hrs	44

Creating the PLC Programme:

A sample of the ladder logic and SCL code can be seen below. All the other photos can be found within the project.



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Lecturer Signature	<i>Ad</i>

Log Sheet

Log No	6
No hrs	2
Running total hrs	46

Test Plan

The following table shows the test plan created which was used to ensure the final system operated as it should.

Test Description
Ensure that the programme is error free before downloading and connecting to the whole system
Test the system under a range of temperature conditions to verify that the fan speed is adjusted appropriately
Ensure the fan operates efficiently, maintaining safe temperature limits and preventing overheating.
Maintaining a detailed log of temperature sensor data and fan speeds for analysis and troubleshooting will ensure any anomalies will be easily seen

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Lecturer Signature	<i>Ad</i>

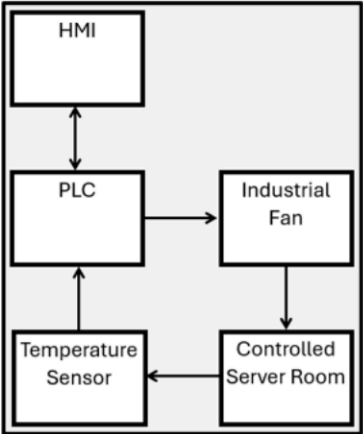
Log Sheet

Log No	7
No hrs	20
Running total hrs	66

Final Solution and Implementation

This was the main section of the project and required the most work. The solution was finalised, and the physical work was completed. This included downloading all the code and wiring up the hardware components.

A block diagram of the final solution was created, and this can be seen below.



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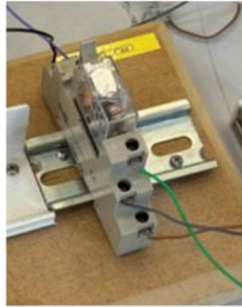
Log Sheet

Log No	8
No hrs	5
Running total hrs	71

Addition of Relay

It was found that there was a need for a relay within the circuit. This was mainly due to a minimum speed/ voltage required for the fan to operate. This relay was researched and added into the circuit as required

An image of the relay can be seen below and the instructions used to wire the relay into the circuit can be found in the assignment.



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Lecturer Signature	<i>Ad</i>

Log Sheet

Log No	9
No hrs	15
Running total hrs	86

Testing

The test table was followed, and all adequate tests were completed. Ensuring the system was put through various tests to ensure smooth operations under all circumstances. The tests compiled of comparing data seen on the programme, HMI and visually inspecting the fans operations.

A couple screenshots from the testing can be seen below and the rest of the testing evidence can be found in the assignment.



	Name	Address	Display format	Monitor value
1	"Scaled Value"	%MD4	Floating-point nu...	10.66406
2	"Level condition ...		Bool	☐ FALSE
3	"Level condition ...		Bool	☐ FALSE
4	"Level condition ...		Bool	☐ FALSE
5	"Level condition ...		Bool	☐ FALSE
6	"Level condition ...		Bool	☐ FALSE
7	"Level condition ...		Bool	☐ FALSE
8	"Level condition ...		Bool	☒ TRUE
9	"Motor data" Mot...		DEC+-	40
10	"Motor data" pow...		Bool	☒ TRUE
11		<add new>		

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Lecturer Signature	<i>AL</i>

Log Sheet

Log No	10
No hrs	5
Running total hrs	91

Discussion, Conclusion and Recommendation

Now all the physical work and testing was complete an adequate summary can be made on how the project went. Ensuring to also look at the negatives within the system and what could be improved. The opening paragraph for the discussion, conclusion and recommendation can be seen below.

This project successfully achieved the development of a temperature monitoring and control system tailored for use in a server room environment. The system, which integrates a reliable analogue temperature sensor with a 0–10V output and a driver circuit to control a heavy-duty fan, performed consistently and as intended throughout testing. It effectively maintained ambient temperature within safe operating limits, ensuring the protection and longevity of sensitive electronic equipment.

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Lecturer Signature	<i>AL</i>

Log Sheet

Log No	11
No hrs	10
Running total hrs	101

Report

The final report was then constructed. Ensuring that all work completed was within and submitted before the final deadline.

The cover page of the report can be seen below.

Title Page
Your Name: Endaf Williams
University Number: 2321142
Course: HNC Electrical / Electronic Engineering Project
Module Code: SGEE4006
Assignment Title: Final Report and Logbook
Date Submitted: 15/05/2025
Word Count: 3328
1 2321142

Student signature	<i>E. Williams</i>
Supervisor Signature	
Lecturer Signature	<i>AL</i>

53

/100

PAGE 1

PAGE 2

Text Comment. Research

Text Comment. Table of contents should be more detailed

PAGE 3

Text Comment. Good list of figures

Text Comment. The rest of these figures should be identified

PAGE 4

Text Comment. Good description

Text Comment. Good point

Text Comment. Good background with ref source

Text Comment. Good argument for project

Text Comment. Not enough research to meet requirements

PAGE 5

Text Comment. Good image and ref source

Text Comment. Good argument for solution and correct citation

Text Comment. Good argument for solution

Text Comment. Correct citation

PAGE 6

Text Comment. Good information, but this is purely research, not a relevant solution as this is part of the system regardless.

Text Comment. Good opening statement

Text Comment. Alarm conditions missing here

PAGE 7

Text Comment. There are significant parts missing from this section!

PAGE 8

Text Comment. Gantt chart should include a comparative actual timeline directly below the planned timeline. This plan does not show discrepancies

Text Comment. There is no explanation for discrepancies

Text Comment. This needs more detail. Poor

PAGE 9

Text Comment. Incorrect

Text Comment. This is far too basic and does not detail any function

Text Comment. Good block diagram

PAGE 10

Text Comment. Networks should be labelled

Text Comment. Networks should be commented

Text Comment. This was not in spec

PAGE 11

Text Comment. Explanations are fair

Text Comment. Relay purpose is explained

Text Comment. Network 5 should be here to show conditions for relay operation

PAGE 12

Text Comment. This is not needed. Proximity sensor is not used!

Text Comment. This should be explained

PAGE 13

Text Comment. Explanations are correct

Text Comment. Good explanation and scale is adjusted to suit the temp max point

Text Comment. Good evidence of SCL conditions with explanations

Text Comment. HMI design missing

Text Comment. This image should be annotated

Text Comment. This does not belong in this section

Text Comment. Not clearly

Text Comment. Good table of results with good evidence

Text Comment. An explanation is included

Text Comment. This is a good test for the alarm conditions with PWM values

Text Comment. Conclusion is missing the significant points

Text Comment. One recommendation is relevant with using a digital temp sensor

Text Comment. Should be more ref sources

Text Comment. Good test method and explanation

Text Comment. Good LDR program listing

Text Comment. Good SCL program listing

Text Comment. Good HMI design that should have been ref from the implementation section

GRADING FORM: CSG-RUBIC

ENDAF WILLIAMS

0

RESEARCH-INFORMED LITERATURE



Research includes background of company and solutions considered with good ref sources. There could be more information on the type of system needed with examples from web sites.
5 ref sources is not enough for the requirements.

11/20

KNOWLEDGE AND UNDERSTANDING



Spec includes some of the requirements, but not the alarm conditions and controlled PWM from the fan speed. The real purpose is also not included.

10/20

Solutions considered are relevant and include good arguments for the system. However, there should be an evaluation carried out and an explanation to justify solution chosen. 6/10

ANALYSIS



Good table of results with evidence and a very good test method used for testing alarm conditions. 7.5/10

Conclusion is missing the significant points such as the reason for the relay, alarm conditions set values and plan discrepancies.

One recommendation is relevant. 3.5/10

11/20

PRACTICAL APPLICATION AND DEP.



Planning section includes a Gantt chart with no comparative timeline and no explanation for discrepancies. The test plan is poor. 2/5

Solutions considered have good arguments for practical deployment, but no evaluation for final choice has been carried out to justify PLC. 5/10

Implementation includes the LDR program and reasonable explanations with real purpose explained. SCL is included and explained.

HMI design is missing and no explanations of the functions.

Cytron driver is not explained. 4/10

11/25

SKILLS FOR PROFESSIONAL PRAC.



Report has structure. Table of contents should be more detailed. Content is disjointed in some sections.

10/15