1910594

by Dominic Davies

A GOOD, REASONABLY WELL PRESENTED PROJECT REPORT THAT SATISFIED THE BRIEF. THERE WERE A LOT OF SCREENSHOTS THAT COULD HAVE GONE IN THE APPENDIX.

EXTENSIVE FEEDBACK BY THE 1ST MARKER, HOWEVER THE WORD COUNT HAS BEEN EXCEEDED BUT NOT PENALISED.

FILE	12367_DOMINIC_DAVIES_1910594_172462_1726291198.PDF (3.36M)		
TIME SUBMITTED	20-MAY-2021 12:39PM (UTC+0100)	WORD COUNT	6973
SUBMISSION ID	154080836	CHARACTER COUNT	35951

REDUCE MARK BY 5% TO 62%.

1910594

By Dominic Davies

HNC Electrical Electronic Engineering

SGEE4006 Electrical and Engineering Project

Final Report

1910594 - Dominic Davies

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Table of contents should be more detailed and should include a research section

There should be a list of figures here

Huntsman Cooperation

Huntsman is an American company founded by Jon Huntsman in 1970. Huntsman manufacture chemicals in 4 different business segments. These are Advanced Materials, Polyurethanes, Performance Products and Textile Effects. When Huntsman acquired Texaco for $1.1 billion in 1994, Huntsman took over the Texaco chemical plant in Llanelli. The Llanelli plant is part of the Performance Products sector which has had a recent investment of £3.5 million for expansion. Huntsman Llanelli is a flexible chemical with the ability to manufacture various chemicals in the 4 different business segments, making it one of the most profitable Huntsman sites in the world.

Background research is interesting

Introduction

Summary of Project

Huntsman chemical plant manufacture chemicals which are stored in product tanks on-site to sit until they are transported into tankers or pumped into drums. These tankers must be kept at a constant temperature in order to keep the chemical from scorching and de-colouring, but also to prevent the pump from overloading. The warm temperature improves the viscosity of the chemical in the tank, making it quicker and easier to pump away. As it stands, the tanks on site are heated via a steam coil, where steam enters at one end and condensate leaves at the other end. To maintain a constant temperature, the manual steam valve is opened and closed by an operator depending on the temperature display in the control room. At the control room, there is an alarm system to notify the operator of the temperature change. For example, if a tank needs to be 40 degrees, the high temperature alarm would be set to 42 degrees and the low temperature alarm would be set to 38 degrees. The figure below shows how the current temperature control system works.

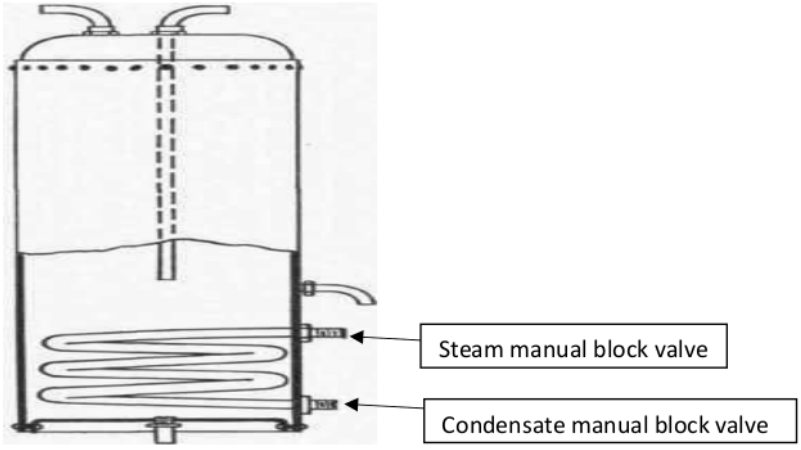


Figure - (Books, 2018)

This is an ineffective way of maintaining the tank temperature which is why the task has been set to design an automatic temperature control system which requires minimal human contribution.

The project will need to be programmed by either using a PLC which is an industrial controller that receives data from field sensors to produce an output based on the inputs (AMCI, n.d.), or an Arduino which is a microcontroller that does a similar job in that it reads inputs and decides on an output (Arduino, 2021). Research will be completed to decide which controller would be best suited to the project.

PLC

A PLC can be set up for PID control which is ideal for temperature control systems. PID control combines three control terms to give a single output to drive the setpoint (Eurotherm, 2020). The majority of PLCs have 5 programming languages and TIA portal provides a PID function block which makes using a PLC far more realistic for this job. Also, familiarity with PLC programming means less time is spent learning new programming techniques.



Figure - (Reichelt, 2020)

Good explanation supported with relevant source

Arduino – Microcontroller

Arduino is a common way to programme and, in most cases, easy. However, PLC programming using TIA portal would be best suited for this project purely on the basis of familiarity with the languages. Also, Arduino microcontrollers are less accessible than PLCs in college.



Figure - (Antratek, 2019)

The introduction to the Arduino and PLC here would be best explained in the solutions sections

This section should be after the solutions considered evaluation

PID Control using PLC

Based on the research of both methods, programming using a PLC is the best option in this case. The PLC will be programmed to monitor and control the temperature using PID control. The purpose of a PID controller is to maintain the output such that there is zero error between the process variable and the desired setpoint (Elprocus, 2020). To do this, the controller uses a control loop feedback mechanism to control process variables (Omega, 2019). PID control has been accepted as the most common form of control in industry. A PID temperature controller takes the operator's setpoint and the value recorded by the sensor to create an output to control. In this case, the sensor input value will be simulated between 0V and 10V using a potentiometer, with 0 equalling 0^{o}C and 10 equalling 200^{o}C. The figure below shows a PID controller response.

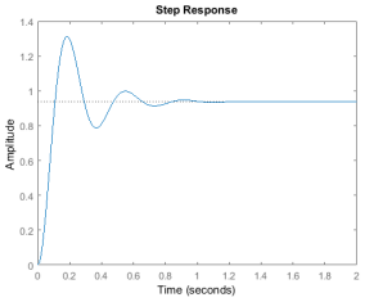
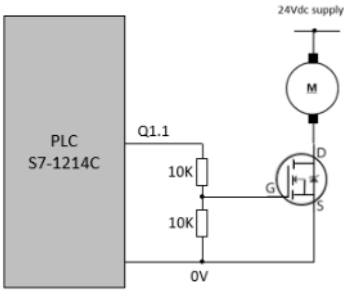


Figure - (CTMS, 2019)

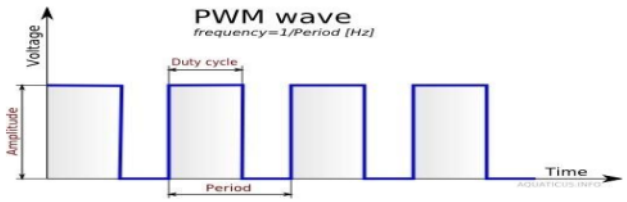
Good explanation of PID control

The control signal from the PID controller is converted into a PWM (Pulse Width Modulation) using a MOSFET. The figure below shows a MOSFET circuit used to drive a PWM output.



Circuit diagram is correct for driving the power MOSFET

This PWM output creates a switching signal. The purpose of the switching signal is to reduce power loss. The figure below shows a PWM output.



(Quora, 2021)

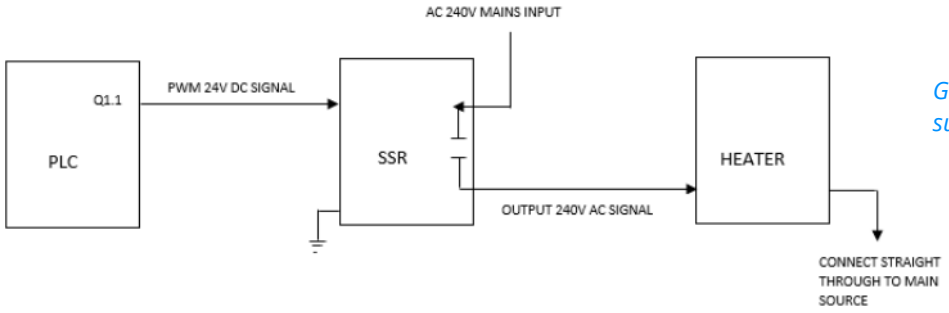
Good example

Specification

What the project must achieve?

The temperature controller must use PID control to maintain a constant temperature in tank. A setpoint display should be easily visible on the HMI screen for the operator to change. The process variable will be manually changed using a potentiometer (0-10V). Once the two variables are entered and an error is calculated, the PID controller in the PLC will calculate a duty cycle and produce a 24V PWM DC signal from Q1.1 which will energize a solid-state relay. The SSR output which is a 240V AC signal will then be used to power the heating element, turning it on and off to maintain a constant temperature. The heating element is powered from the mains supply.

The figure below shows a diagram of how the project will be set out.



Good block diagram to support explanation

Where is the project based?

The project will be built in college under the supervision of the lecturer (Robert Jenkins) but is based on an industrial concept.

Budget and Time

Instead of applying a heating element and a small-scale water tank, the AC signal produced by the solid-state relay will be hooked up to a Pico Scope which will simulate the AC signal on the computer screen. This will keep the costs down but will simulate the same response. The heating element would normally be connected across the SSR. From start to finish, the project will be completed in 1 academic year in correlation with the Gantt Chart.

Siemens 1214C PLC including licensing - £2000

MOSFET circuit components - £20

SSR - £20

Pico Scope - £120

Total - £2160

Good explanation of how the project will

User Needs

The temperature controller must maintain a constant temperature based on the setpoint entered by the operator. The user must be able to enter the setpoint easily. There must be a 3-stage alarm system notifying the operator of a change in temperature indicating a fault.

Good condition explanation

Health and Safety Requirements

Throughout the project, the BS7671 wiring regulations and Health and Safety at Work Act regulations will be abided by along with all Covid-19 guidelines. A list of all risks involved in building the project are stated below.

- Falls, slips and trips in the workshop.
- Potential of working near live equipment.
- Incorrect tools used during tasks.
- Cluttered workstations with sharp tools.

Ergonomics

During the programming, most of the work will be done using a computer at a desk. The set up of the circuitry is completed at an appropriate height at a workshop desk. When it comes to the customer, the HMI will be placed at eye level, so the operator can easily alter the setpoint and monitor the screen without putting any stress on their bodies that could cause potential injury.

Maintenance

Whilst the project is built, there will be weekly meetings with the lecturer to ensure the project is on track and working correctly. Any issues that are discovered will be resolved safely.

Environmental and Sustainability

All the components and equipment used in the project will be widely recycled and there will be no by-products or fumes that could impact the environment. The components can be easily replaced if they are faulty or damaged.

All misc items are covered here

Planning

A Gantt chart is constructed to ensure the project is kept on track to finish on time. A Gantt chart is structured guide which illustrates each stage of the process from beginning to end. For each stage, there is an expected timeline which runs parallel with an actual timeline. The expected timeline is coloured beforehand, and the actual timeline is shaded as each week goes on. The expected timeline will be shaded a different colour to the actual timeline to differentiate.

Chart key if defined here

The table below shows the Gantt Chart for the Automatic Control System.

Gantt Chart – Automatic Temperature Control

	Week Number																			
Activity	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Project Ideas																				
Research																				
Two Solutions																				
Discussion and Decision																				
Planning																				
Equipment List and Drawing																				
Wiring																				
Programming																				
Commissioning																				
Testing																				
Evaluation																				

Predicted plan is realistic

A testing plan table has been created for when the project needs to be tested. This is to ensure the product is working correctly and should cover all areas. The table will include each of the different tests that will take place. All the tests will be completed over 2 weeks in conjunction with the Gantt chart, provided everything goes to plan.

The table below shows the testing plan.

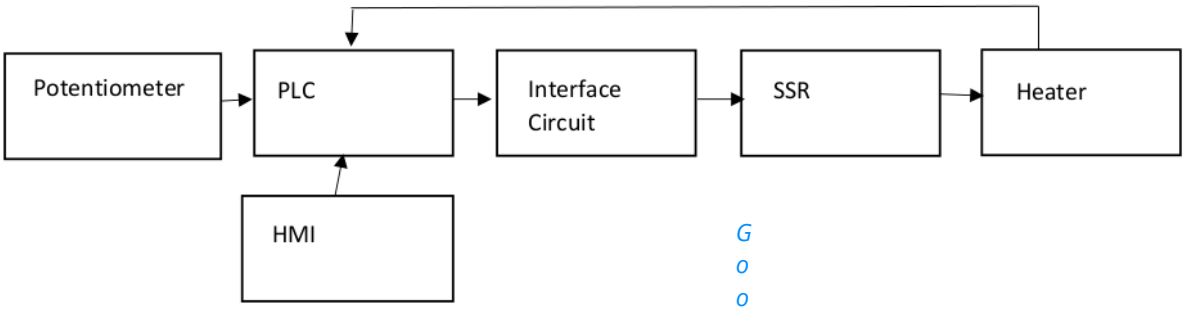
Test	**Week Number**	**Description**
Potentiometer Range 0-10V	17	Take temperature readings off the HMI screen at both 0V and 10V using a potentiometer. 0V = 0^{o}C. 10V = 200^{o}C
3 Stage Alarm Test	17	There should be 3 alarms indicating a temperature change from the setpoint.
PWM for PLC output	18	A random setpoint is entered on the HMI. The PWM output is then recorded using a Pico Scope at intervals between 0 and 100%. This will display the changing duty cycles. The larger outputs will create bigger duty cycles.
AC Test using solid-state relay	18	A random setpoint is entered on the HMI. Using a solid-state relay, the AC response can be displayed using a Pico Scope. The outputs will be the same as those used for the PWM test.

Good use of table for test plan

Solutions

Solution 1

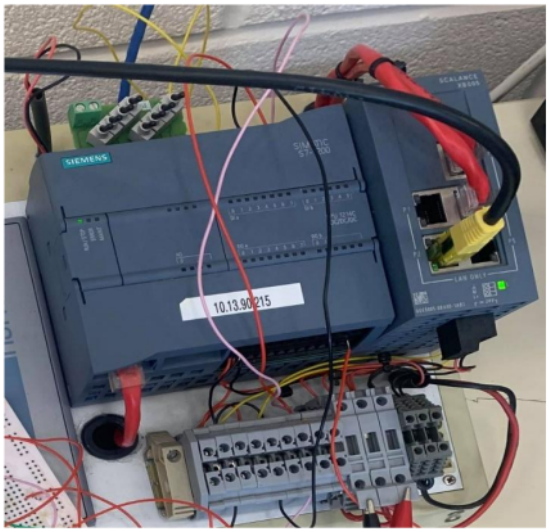
PLC



Good block diagram

The idea behind this solution is to set up the PLC as a PID controller in order to maintain a constant temperature. An output can be entered by the operator via the HMI screen and the process variable is applied by adjusting the potentiometer. The potentiometer is set up between 0-10V, with 0V representing 0°C and 10V representing 200°C. Once the SP and the PV have been entered, the PLC, which will be set up for PID control, will calculate an error and create a 24V PWM DC signal. This output signal will go through an interface circuit, which is used for amplifying or switching signals, to energize the solid-state relay. The SSR produces a 240V AC signal which powers the heating element, turning it on and off to maintain a constant temperature. The speed at which the heater is powered on and off depends on the PWM duty cycle. The heating element is powered from the mains supply.

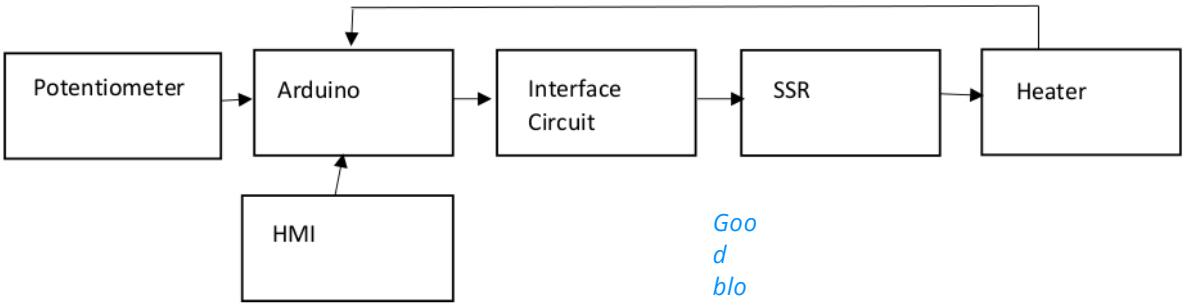
The chosen PLC for this solution is the Siemens S7-1200C. This solution will cost around £2160 including the price of the software license. The software used to program the PLC will be TIA Portal.



A good valid passible solution for this project

Solution 2

Arduino



Good block diagram to support explanation

This solution uses an Arduino Microcontroller instead of a PLC. Arduino consists of a physical programmable circuit board which is programmed by a computer software. The software enables you to write computer code and upload it to the circuit board via a USB cable. Similarly, the Arduino board can also be programmed to operate as a PID controller. Its simplicity makes it a very good option for electronic projects. Unlike TIA portal, where the programming techniques and languages are familiar, the new Arduino coding will have to be learnt beforehand which could take a long time. *A good point here*

The Arduino UNO microcontroller is the preferred option for this solution. This solution is the cheaper option with an estimated price of £240.



Solution Analysis **3 = Good, 2 = Moderate, 1 = Bad**

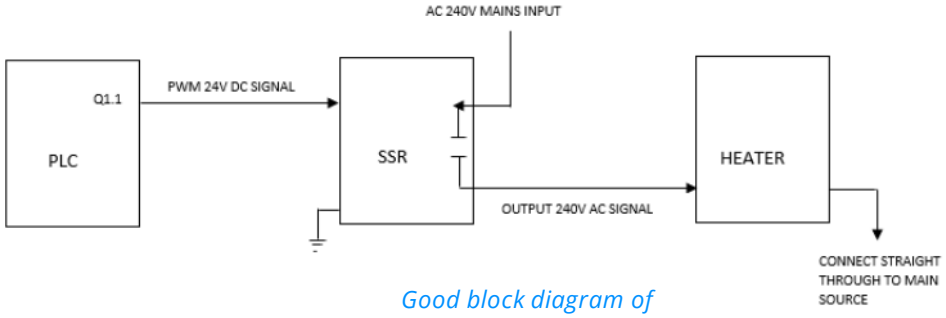
	Solution 1 (Chosen Solution)	**Solution 2**
Ergonomics	The HMI screen will be placed at a safe and appropriate level for the customer to operate. This will also minimise the risk of neck and back injuries. The HMI and PLC will both be Siemens as they are very accessible at college. Score = 3	The Arduino display will be located at eye level for the customer. This will minimise the risk of neck and back injuries. The correct display may be slightly more difficult to find. Score = 2
Ease of Use	Once the program has been tested and is working correctly, the system should be very simple to use. On the HMI screen, there will be a display that shows the output and a display for the operator to enter a temperature setpoint. Score = 3	Once the computer code has been uploaded to the Arduino and is working correctly, the system should be simple to use. The display screen will provide the output to the operator but to alter the setpoint, the computer code will need changing. Score = 2
Sustainability	All the equipment and components used in this solution can easily be replaced. Score = 3	All the equipment and components used in this solution can easily be replaced. Score = 3
Familiarity	PLC programming using TIA Portal is a commonly used software. Several projects in the past have been successful using TIA Portal. Score = 3	Arduino computer coding is a new and unfamiliar software for programming. This solution would require hours of work to learn the computer coding. Score = 1
Environmental Impact	All equipment can be widely recycled. Score = 3	All equipment can be widely recycled. Score = 3
Price	More expensive. Score = 1	Less expensive. Score = 3
Total Score	**16**	**14**

A very good meth

Final Solution

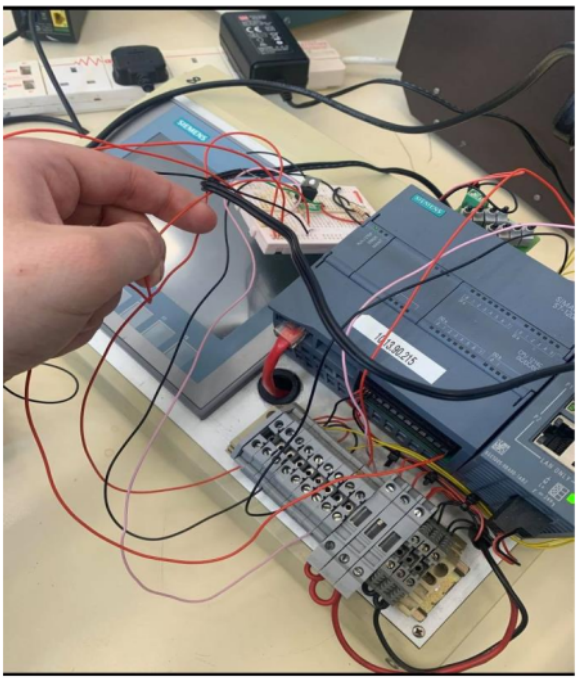
After weighing up and comparing both solutions, an agreement was made to use a PLC to program and control the project. The Siemens S7-1200C PLC has been chosen and set up in the college. But before programming the PLC, it was agreed that the project hardware would be set up first. This would provide a better understanding on what needed to be done.

The project overview block diagram is shown in the figure below.

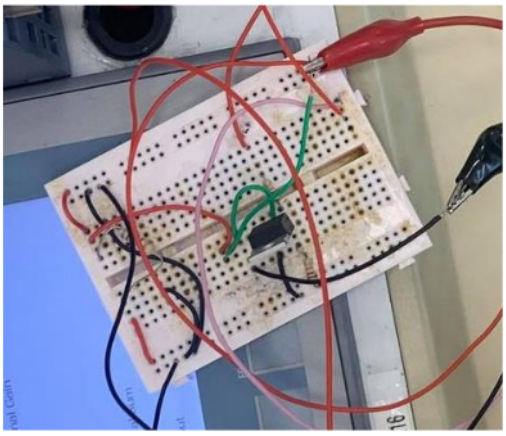


Good block diagram of system

The figure below shows how the PLC is set up with the HMI.



The figure below shows the voltage divider circuit used.



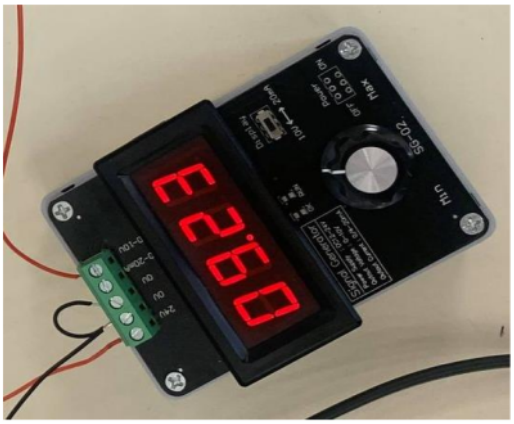
Good images of equipment setup

In order to drive the heater, or in this case a Pico Scope, a solid-state relay is needed to turn a 12V DC signal into a 240V AC signal. The SSR is shown in the figure below.



Good example of SSR connections

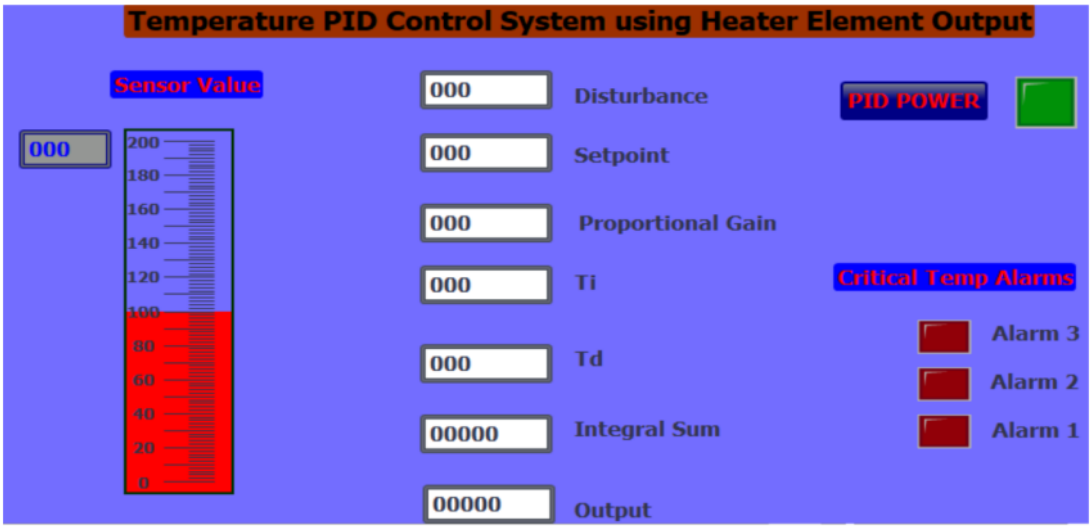
The input using a 0-10V potentiometer is shown in the figure below.



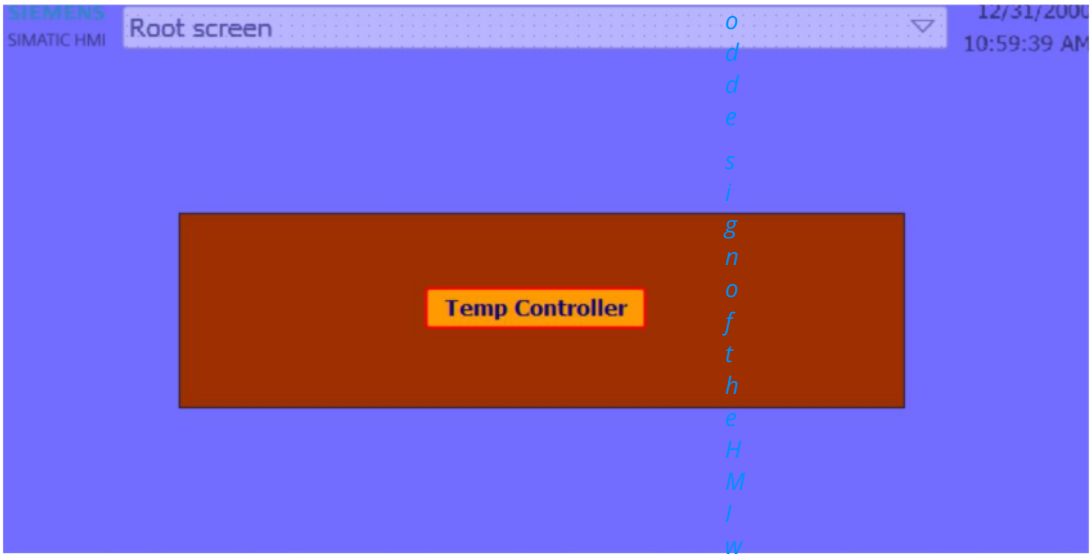
A neat instrument for analogue input simulation

Once all the equipment has been set up and working correctly, the next stage is to begin the design of the HMI screen.

The figure below shows the main temperature control screen. It provides the operator with a sensor value on the left-hand side which will be simulated using a potentiometer. It also includes all the values of the PID controller which will make fault finding easier during maintenance. A PID power button has also been included for convenience, and in order to meet the specification, a 3-stage alarm system has been added to alert the operator of a temperature drop. The setpoint can be changed by simply touching the setpoint display and inserting a value.



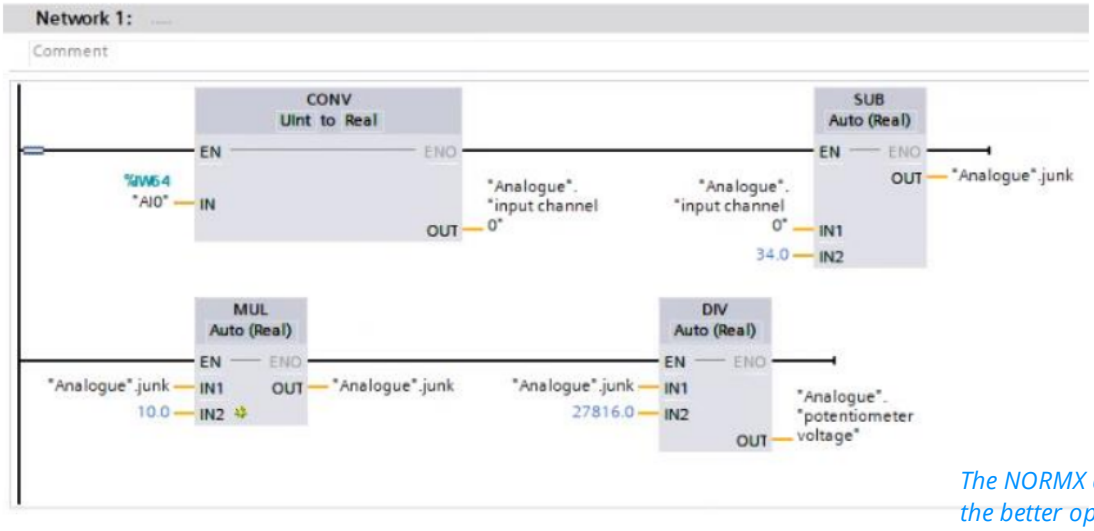
The figure below shows the root screen.



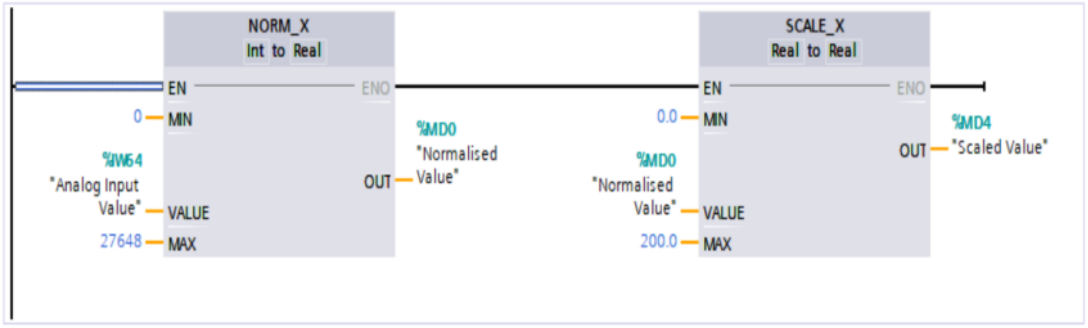
A good design of the HMI will hold

The next stage is to begin the program.

The figure below shows how the analogue input from the 0-10V potentiometer is scaled to a temperature value (NORM_X to SCALE_X). The potentiometer is manually rotated to change the sensor value. It will be scaled so 0V = 0°C and 10V = 200°C. The potentiometer (analogue input) represents the sensor value.

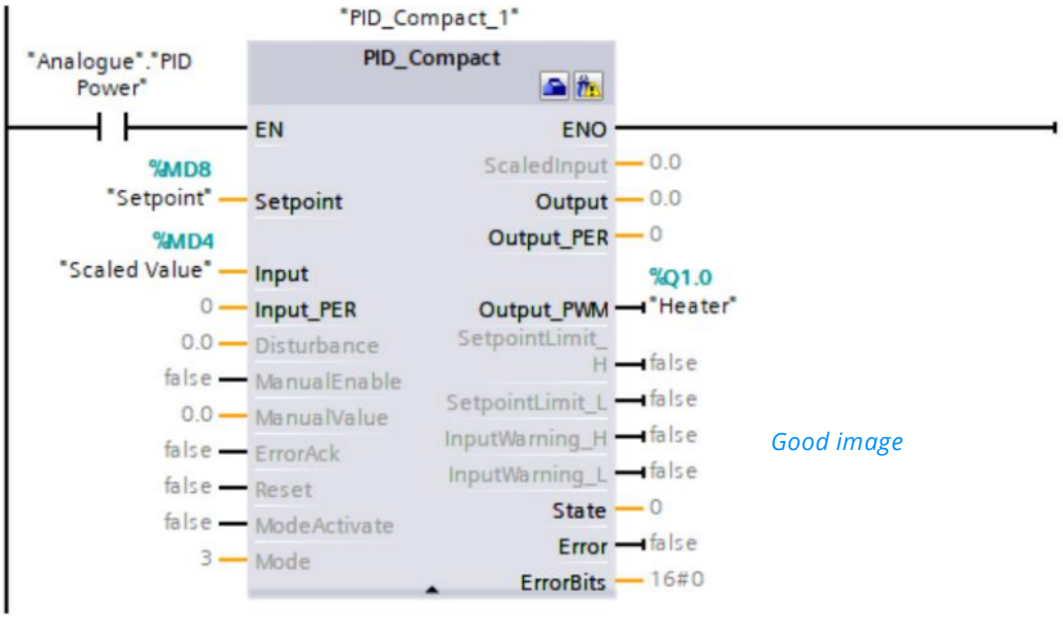


The NORMX and SCALE X is the better option here



In order to set up the PLC for PID control, a PID compact block is introduced. For this to work, a 'PID power' N/O contact is tagged to the PID power button, which must be pressed by the operator beforehand. The LED should illuminate if it is working correctly. The selected PID tuning parameters (Proportional, Integral and Derivative) were advisory to begin with, but were fine tuned using trial and error. This fine tuning ensures the PID controller reduces deviation from the setpoint and reacts quickly to setpoint changes and disturbances with minimal overshoot. The setpoint and scaled value are inputs to the controller. The controller will then calculate an error which will be converted into a PWM output signal at Q1.0. This PWM signal is what powers the heater which controls the temperature.

Good explanation



Good image

The 3-stage alarm system is written in SCL. The figure below shows how the alarms will work.

If the scaled value is more than 150, then no alarms will light up.

If the scaled value is more than 100, but less than 150 then alarm 1 will light up.

If the scaled value is more than 50, but less than 100 then alarm 1 and alarm 2 will light up.

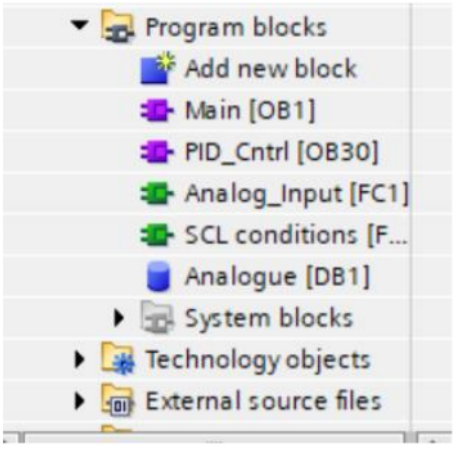
If the scaled value is less than 50, then all 3 alarms will light up.

Explanation is clear and a good image of the SCL to support the explanation

```
1  IF ("Scaled Value" < 50) THEN
2      "Analogue".Alarm1 := 1;// Statement section IF
3      "Analogue".Alarm2 := 1;
4      "Analogue".Alarm3 := 1;
5  END_IF;
6  IF ("Scaled Value" > 50) AND ("Scaled Value" < 100) THEN
7      "Analogue".Alarm1 := 1;// Statement section IF
8      "Analogue".Alarm2 := 1;
9      "Analogue".Alarm3 := 0;
10 END_IF;
11 IF ("Scaled Value" > 100) AND ("Scaled Value" < 150) THEN
12     "Analogue".Alarm1 := 1;// Statement section IF
13     "Analogue".Alarm2 := 0;
14     "Analogue".Alarm3 := 0;
15 END_IF;
16 IF ("Scaled Value" > 150) THEN
17     "Analogue".Alarm1 := 0;// Statement section IF
18     "Analogue".Alarm2 := 0;
19     "Analogue".Alarm3 := 0;
20 END_IF;
```

All the conditions are correct for the spec requirements

Throughout the program, everything is kept organised to avoid confusion. The figure below shows the separate program blocks.



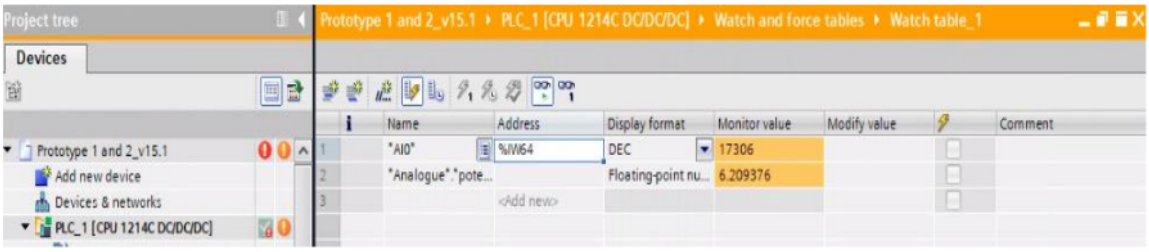
PLC directory tree explains the program content

Testing and Results

Potentiometer Range 0-10V Scaling

Before physically testing the scaling accuracy, the accuracy is tested using a live watch table.

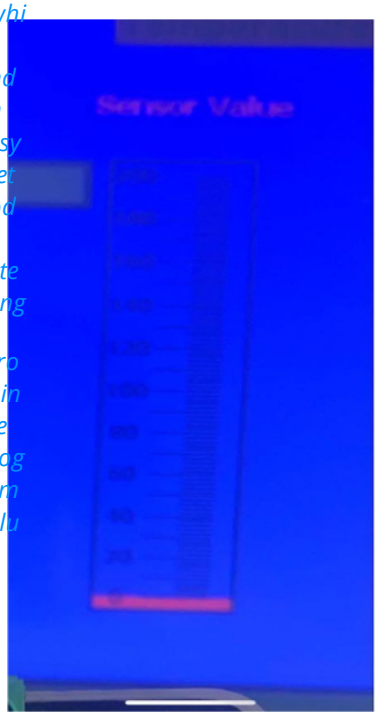
The figure below shows the live watch table for analogue scaling.



Watch table test is worthwhile and an easy method of detecting errors in the program values

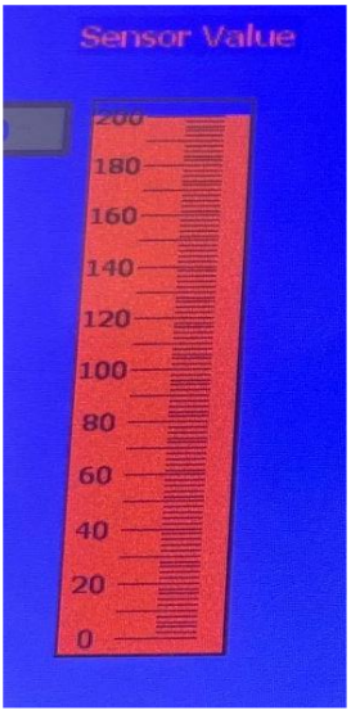
Next, the potentiometer is rotated to display 0V and the sensor value shows 0°C. This is shown in the figures below.





Now the potentiometer is rotated to display 10V and the sensor value shows 200^{o}C. This is shown in the figures below.





A good test to indicate the correct operation of the scale settings

3 Stage Alarm Test

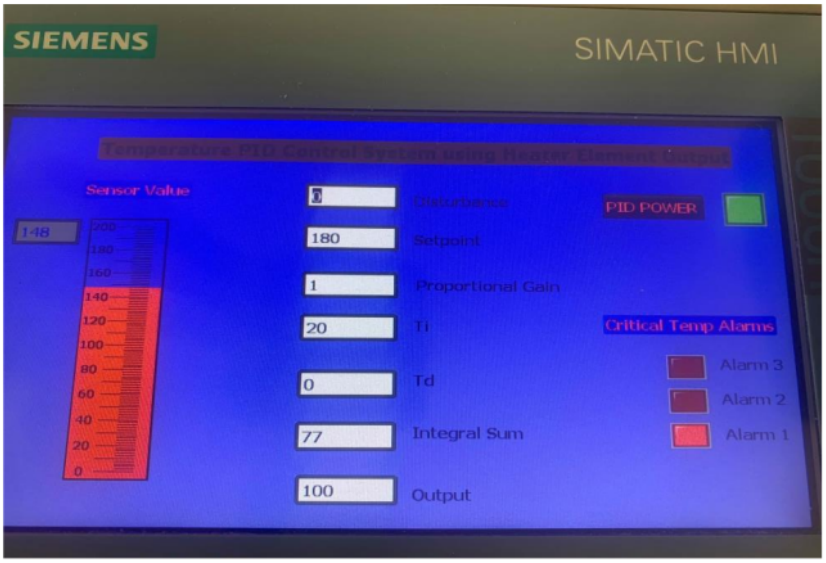
The 3-stage alarm system is tested to ensure the alarm LEDs illuminate at the correct temperature differences. The figures below show the results.

No alarms if the scaled value is more than 150.



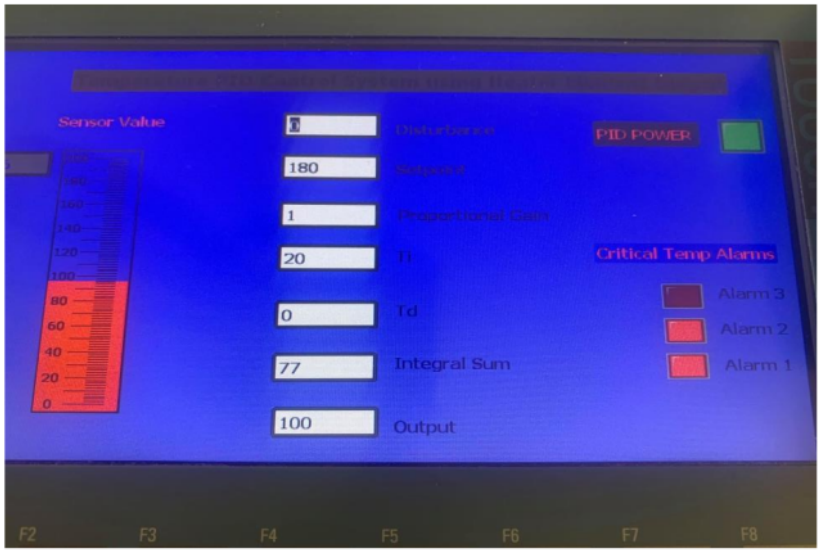
Test looks correct on HMI

Alarm 1 lights up if the scaled value is more than 100, but less than 150. As you can see in the figure below, alarm 1 lights up when the potentiometer is rotated to achieve a scaled value of roughly 148.



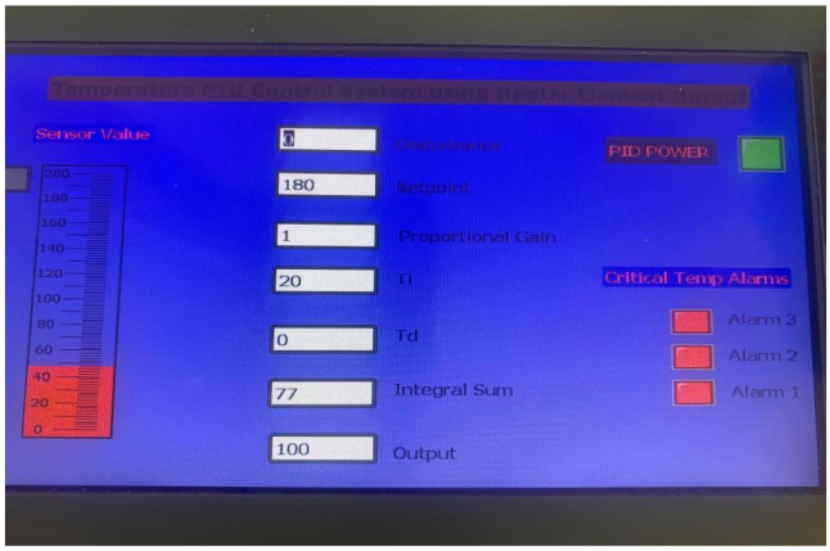
Alarm 1 test is correct

Alarm 1 and alarm 2 light up if the scaled value is more than 50, but less than 100. As you can see in the figure below, alarm 2 lights up when the potentiometer is rotated to achieve a scaled value of roughly 97.



Alarm 2 test is correct

Alarm 1, alarm 2 and alarm 3 light up if the scaled value is less than 50. As you can see in the figure below, alarm 1, 2 and 3 light up when the potentiometer is rotated to achieve a scaled value of roughly 48.



Alarm 3 test is correct

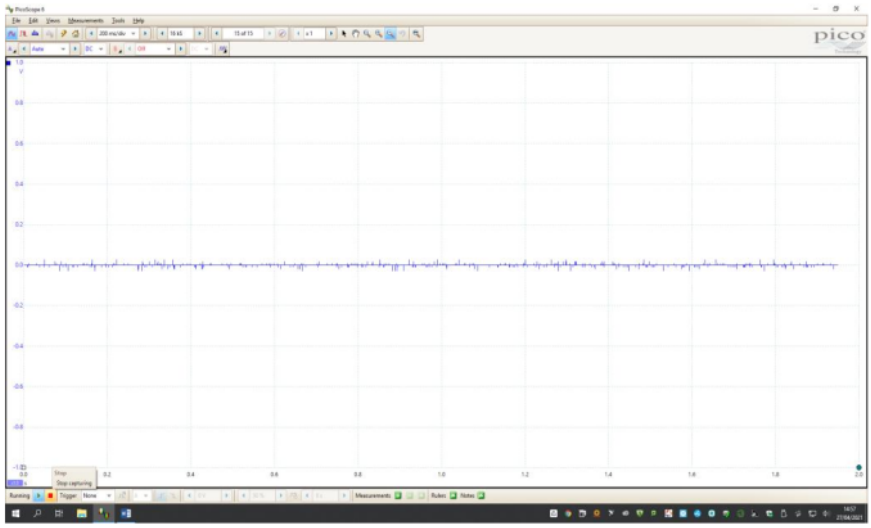
PWM for PLC Output

The PWM output is recorded at intervals between 0 and 100%. To change the output, the potentiometer is rotated. At each of the outputs, the duty cycles should be different. When the PWM signal is low (0), the heater would be turned off and when the PWM signal is high (1), the heater will be turned on. The larger outputs will create bigger duty cycles, which will keep the heater on for longer, thus increasing the temperature.

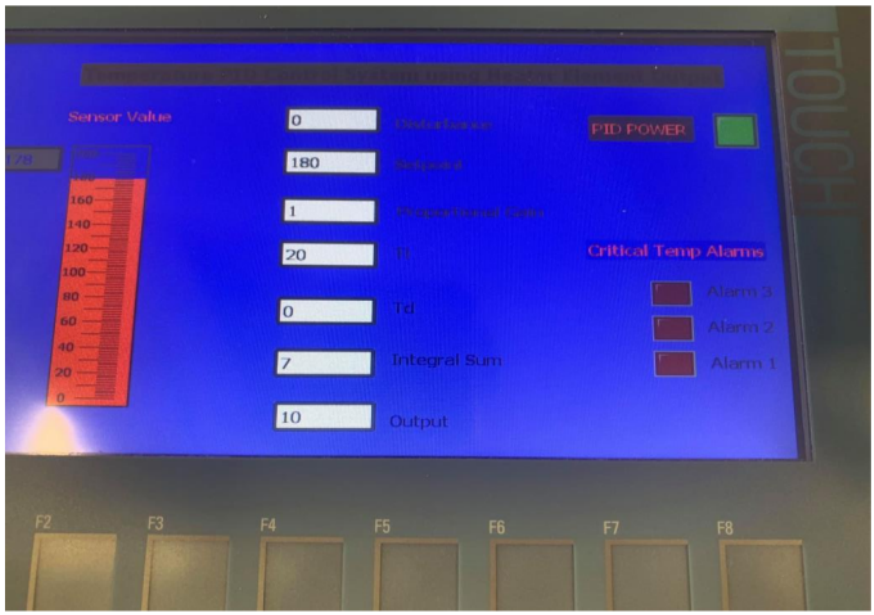
The figures below show the different outputs (0 – 100%) with their corresponding PWM signal. The setpoint chosen for this test is set to 180^{0}C.

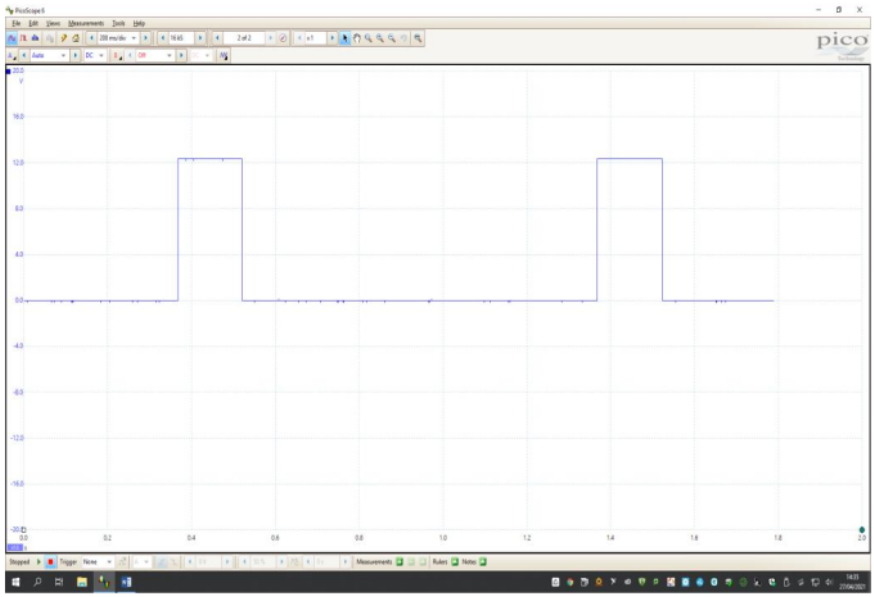
0% Duty Cycle





10% Duty Cycle

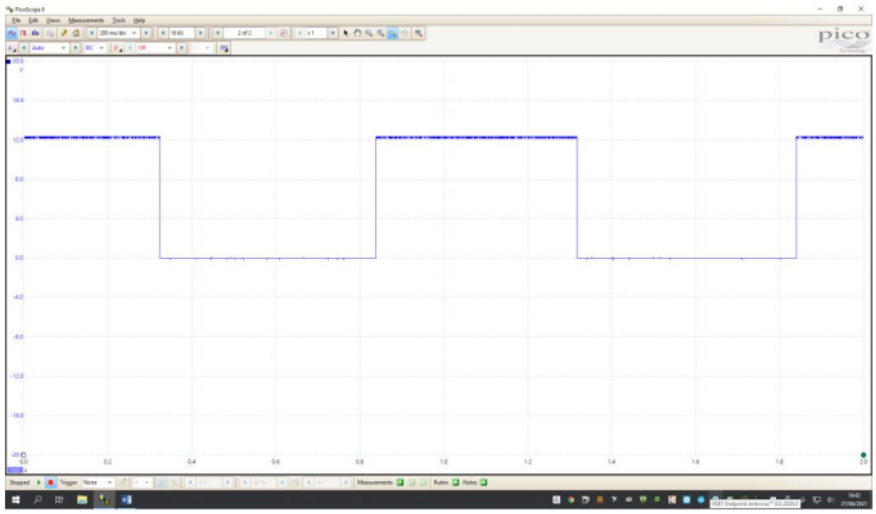




Test is correct at 10%

30% Duty Cycle

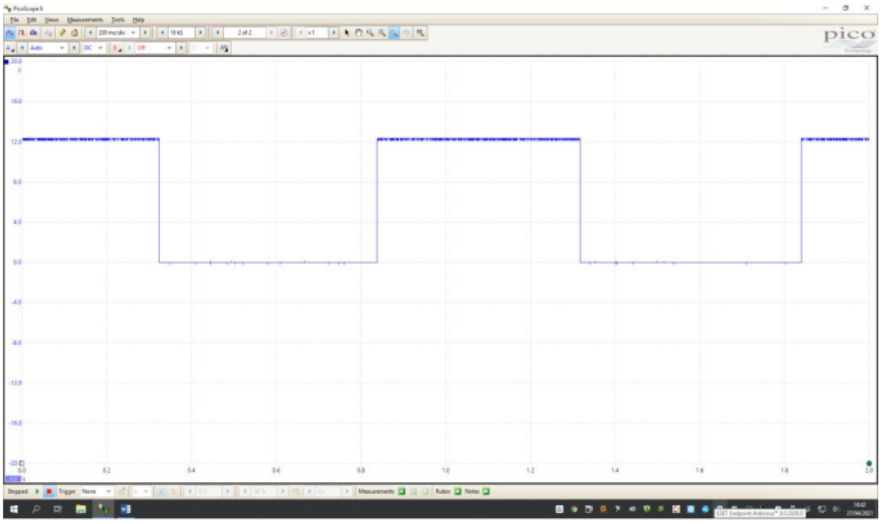




Test is correct at 30%

50% Duty Cycle

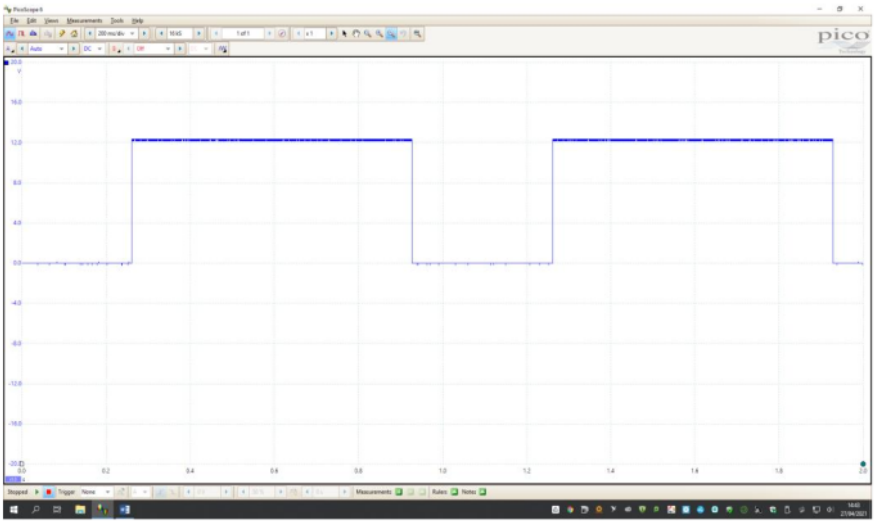




Test is correct at 50%

70% Duty Cycle

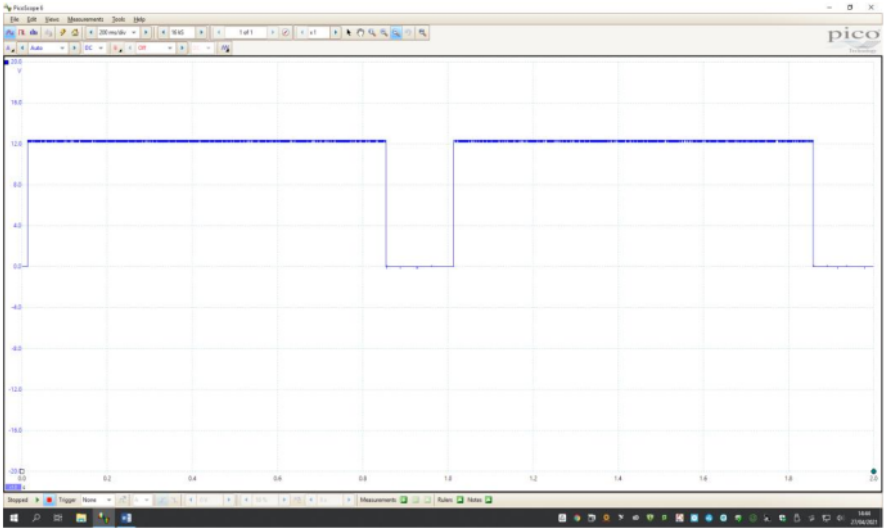




Test is correct at 70%

90% Duty Cycle

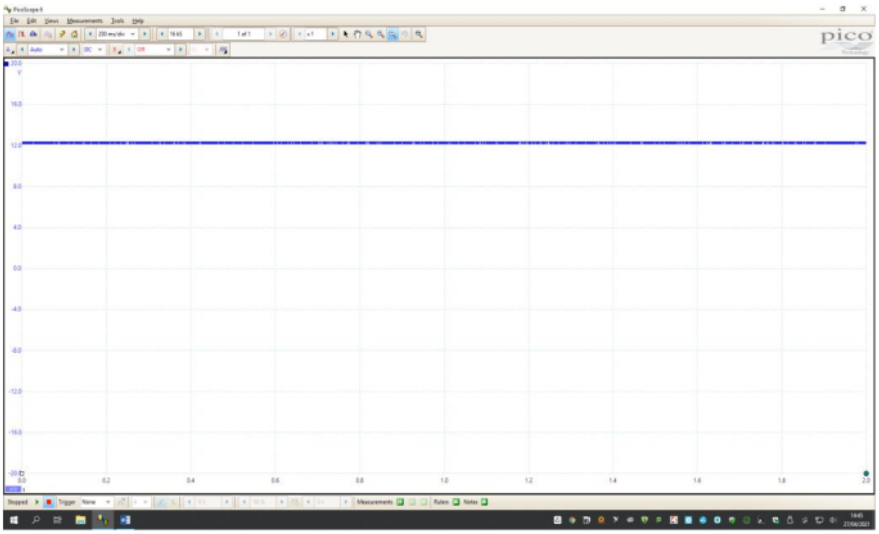




Test is correct for 90%

100% Duty Cycle

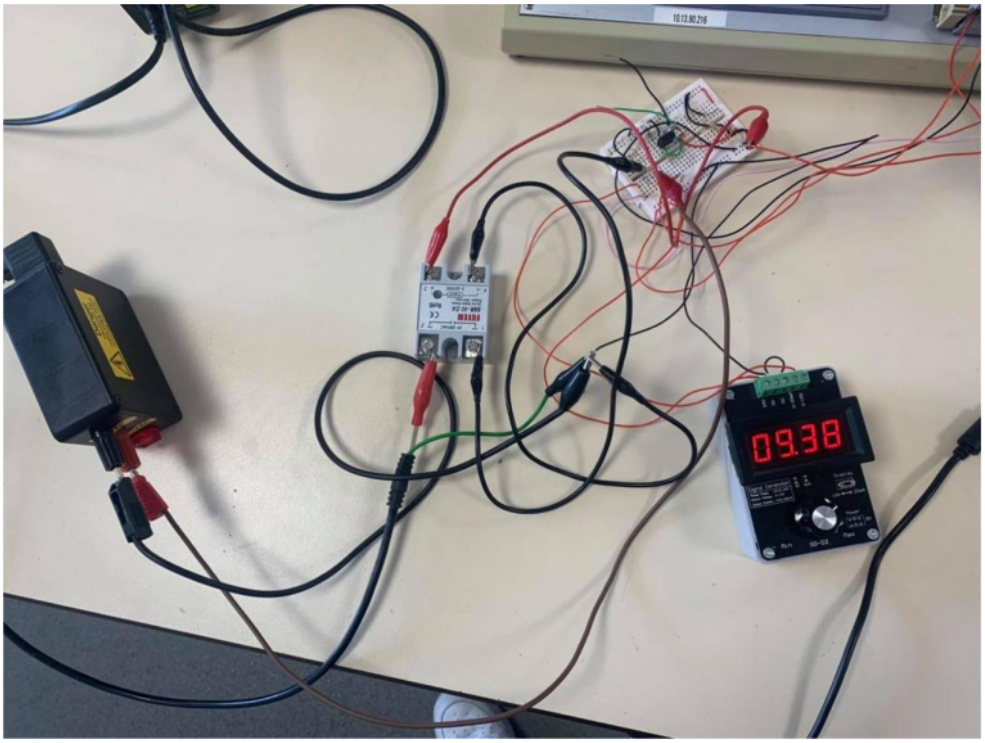




Test is correct at 100%

AC Signal Test

In order to see a visual AC signal, a Pico Scope is connected across the SSR instead of the heater. The figure below shows how it is set up.



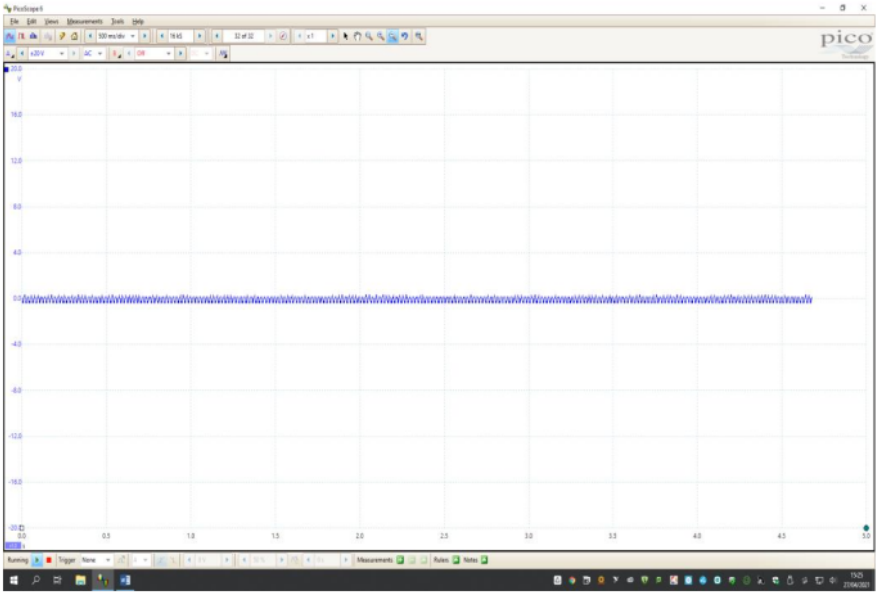
Good image of equipment setup

Similarly, the AC signal is recorded at outputs between 0 and 100%. To change the output, the potentiometer is rotated. At each of the outputs, the signals should be different. The AC signals should follow the same pattern as the PWM signals. The larger outputs will create bigger duty cycles, which will keep the heater on for longer, thus increasing the temperature. This is the closest test of accuracy without implementing the heating element.

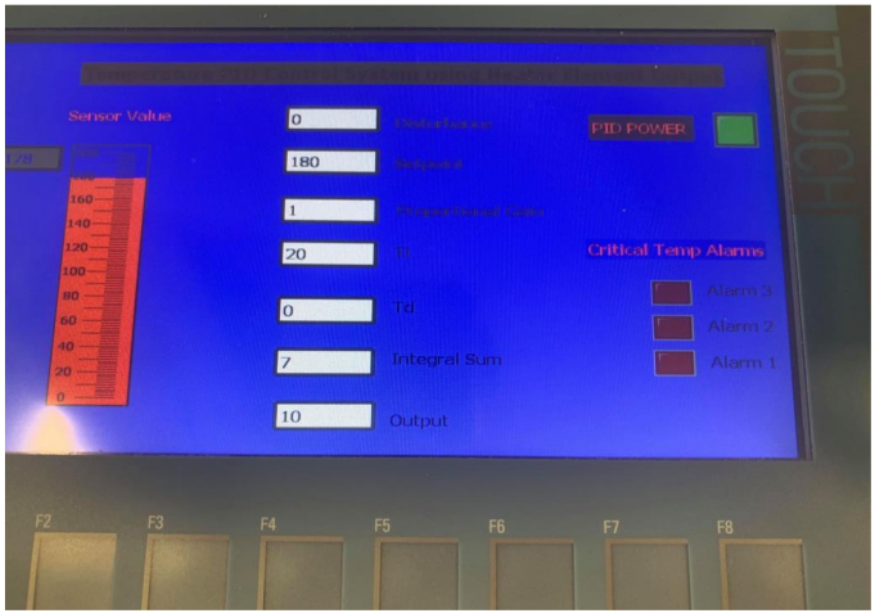
The figures below show the different outputs (0 – 100%) with their corresponding AC signal. The setpoint chosen for this test is set to 180^{o}C.

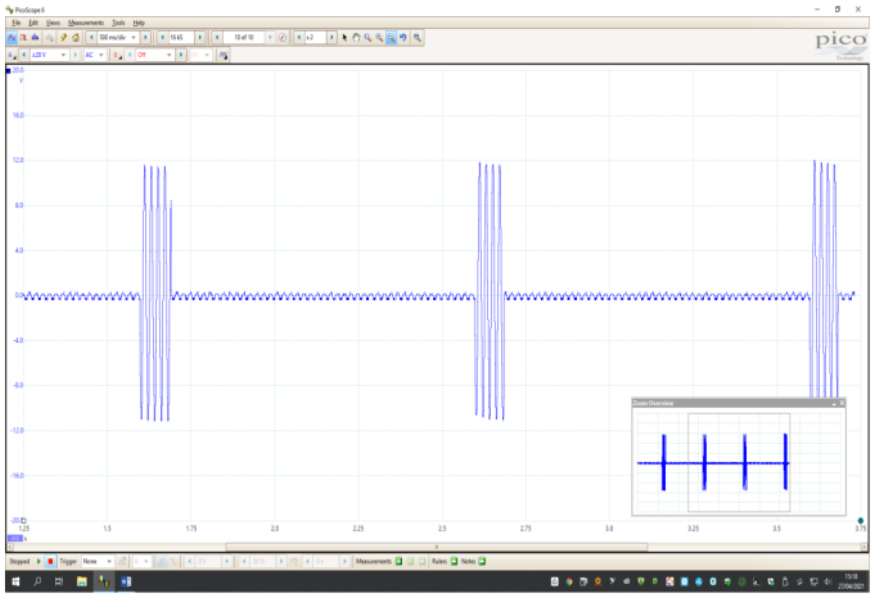
0% Duty Cycle





10% Duty Cycle

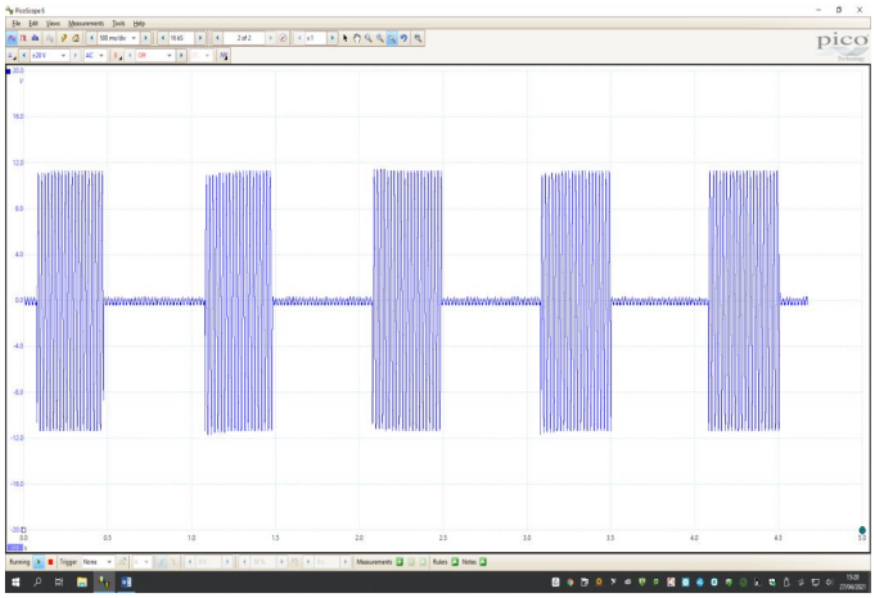




Good AC output test @ 10%

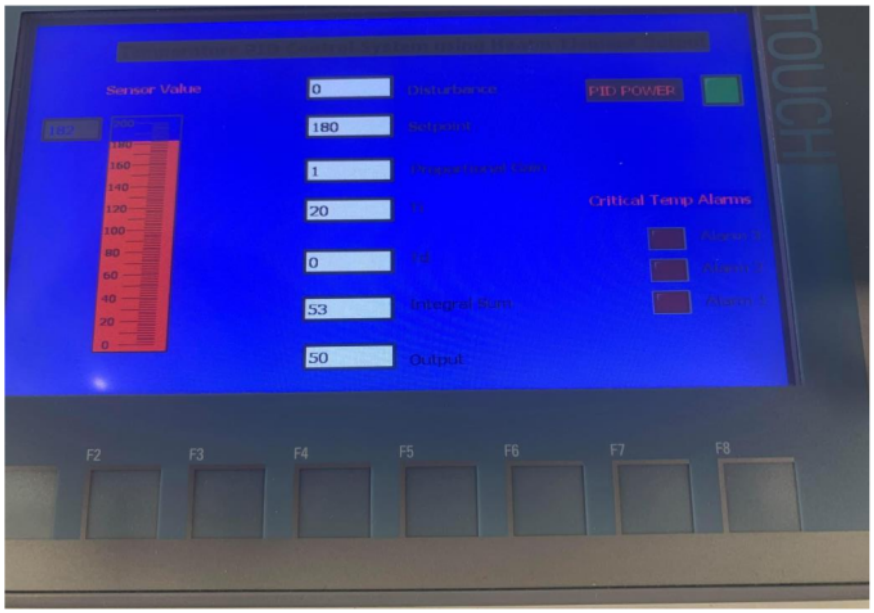
30% Duty Cycle

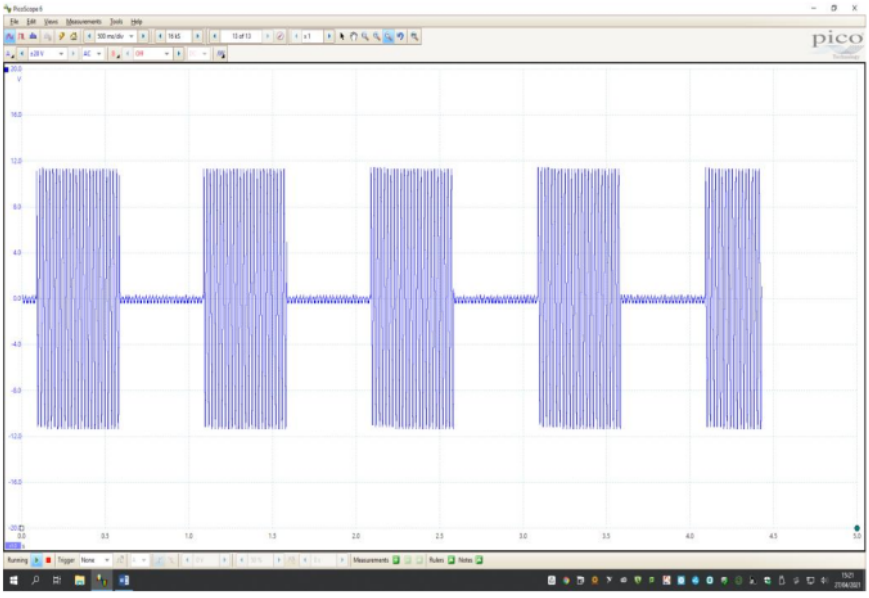




Good AC output test @ 30%

50% Duty Cycle

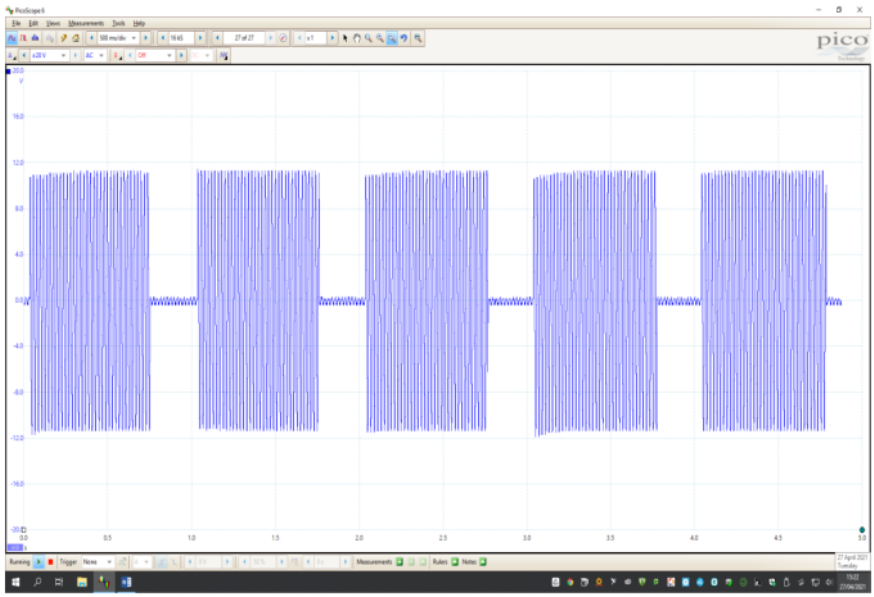




Good AC output test @ 50%

70% Duty Cycle

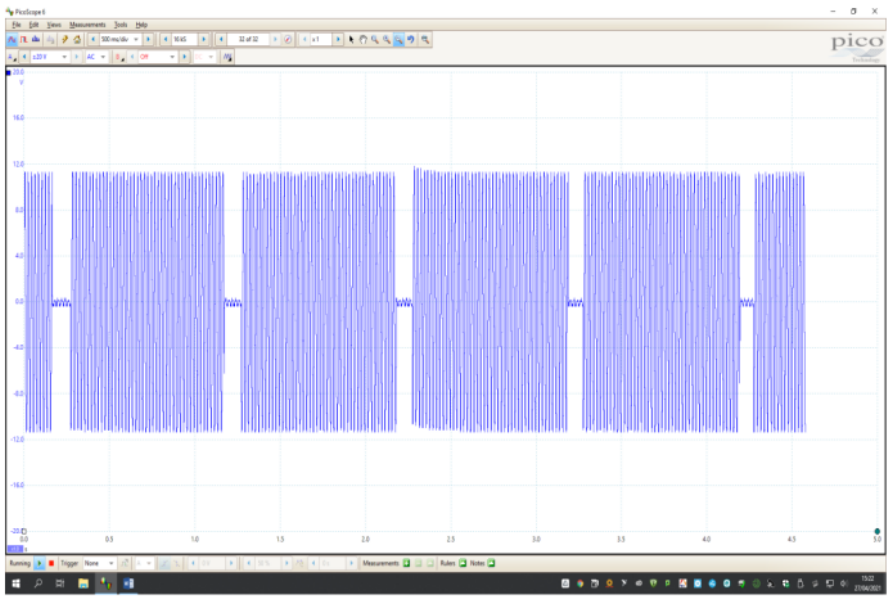




Good AC output test @ 70%

90% Duty Cycle

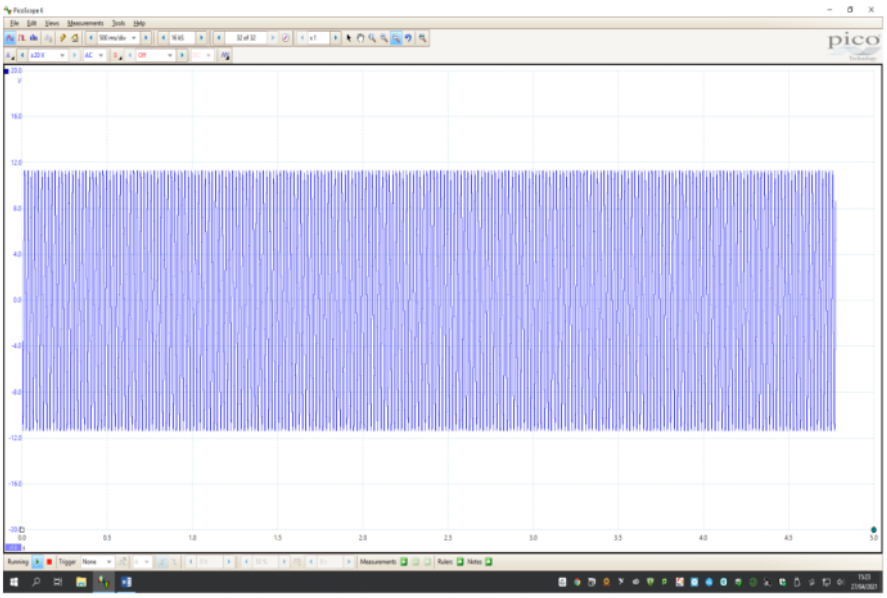




Good AC output test @ 90%

100% Duty Cycle





Good AC output test @ 100%

Testing Table

Test	Expectation	Result	Pass / Fail
0-10V Scaling	Take temperature readings off the HMI screen at both 0V and 10V using a potentiometer. 0V = 0°C. 10V = 200°C	The potentiometer was set to 0V and the scaled value was 0°C. The potentiometer was then set to 10V and the scaled value was 200°C.	Pass
3-Stage Alarms	There should be 3 alarms indicating a temperature change from the setpoint.	As the potentiometer was rotated to alter the scaled value, the 3 alarms lit up at the correct temperatures.	Pass
PWM Signal Test	A random setpoint is entered on the HMI. The PWM output is then recorded using a Pico Scope at intervals between 0 and 100%. This will display the changing duty cycles. The larger outputs will create bigger duty cycles.	With a 180°C setpoint, the PWM signals were recorded at various outputs between 0-100%. The larger the output, the bigger the duty cycle.	Pass
AC Signal Test	A random setpoint is entered on the HMI. Using a solid-state relay, the AC response can be displayed using a Pico Scope. The outputs will be the same as those used for the PWM test.	With a 180°C setpoint, the AC signals were recorded at various outputs between 0-100%. The larger the output, the bigger the duty cycle.	Pass

All tests carried out were successful as you can see from the table above.

A good table of test results evaluation

Discussion, Conclusion and Recommendations

	Specification Requirements	Outcome (Did the project meet the requirements?)
Project based	The project will be built in college under the supervision of the lecturer (Robert Jenkins) but is based on an industrial concept.	Yes, the project was built in college under the supervision of the lecturer. All the equipment was supplied by the college.
Environmental and Sustainability	All the components and equipment used in the project will be widely recycled and there will be no by-products or fumes that could impact the environment. The components can be easily replaced if they are faulty or damaged.	Yes, all equipment used was widely recyclable. The electronic components are readily available for replacing at the college.
User Needs	The temperature controller must maintain a constant temperature based on the setpoint entered by the operator. The user must be able to enter the setpoint easily. There must be a 3-stage alarm system notifying the operator of a change in temperature indicating a fault.	Yes, various tests were carried out to confirm the temperature would control itself automatically based on the setpoint entered by the operator. A 3-stage alarm test was also carried out to ensure the safety of the customer.
Ergonomics	The setup of the circuitry is completed at an appropriate height at a workshop desk. When it comes to the customer, the HMI will be placed at eye level, so the operator can easily alter the setpoint and monitor the screen without putting any stress on their bodies that could cause potential injury.	The wiring of the circuitry was completed at a workshop desk. However, the HMI was not placed at eye level. The HMI testing took place at a desk because it was secured to the PLC.
Maintenance	Whilst the project is built, there will be weekly meetings with the lecturer to ensure the project is on track and working correctly. Any issues that are discovered will be resolved safely.	Yes, weekly tie-ins with the lecturer ensured the project had no issues and was on track.
Health and Safety	Throughout the project, the BS7671 wiring regulations and Health and Safety at Work Act regulations will be abided by along with all Covid-19 guidelines.	All regulations were abided by throughout the project including strict Covid-19 regulations in the classroom.
Budget	Budget of £2160 to cover all equipment and licensing costs.	Total spend of £2050

A good method for rev

At the beginning of the project, the idea was to achieve an automatic temperature control system that would maintain a constant temperature in an industrial sized tank. However, after various discussions with the lecturer it was more realistic to view the PWM response and AC signals via a Pico Scope. This would prove that the temperature would control automatically without heating up a tank in college. This idea of proving the project works before investing further is far more realistic. The outcome was very successful. All the requirements stated in the specification were met to some extent and the final tests were all successful. In terms of time management, the Gantt chart was excellent in ensuring the project was kept on track. The completed Gantt chart is shown in the figure on the next page. Once the project was agreed on, and a plan was put in place, the components and equipment were ordered and arrived on time with no issues.

One recommendation to improve the project would be to add a button to both screens which would enable the operator to switch between screens. This would be a simple change but was simply forgotten at the time of designing it. Another recommendation would be to create another screen called 'Engineers Screen'. This would include all the live variables of the PID controller to make fault finding easier. All these live variables that are on the main temperature control screen can be unnecessary and confusing to the operator. The main temperature control screen or 'Operator's Screen', which includes the setpoint, output, PID power, sensor value and alarms would be easier to operate. The reason for this change is to avoid confusion.

Throughout the project, the author was honest and behaved in a correct and professional manner by respecting others and offering help where necessary whilst maintaining a social distance. The author abided by various health and safety regulations throughout the project such as Electricity at Work Act when in the workshop. In the workshop, good organisation ensured no components went missing. With the current pandemic going on, the author, lecturer and other students wore a mask at all times in the workshop to limit the risk of spreading the virus All PC documents were saved to the C drive and backed up to a USB stick.

Finally, the project was successful and very enjoyable. The author has developed a greater knowledge on electronics, PLC programming and PID control. Aspects of self-organisation and communication with the lecturer are skills that can be used in other areas of life.

A very good conclusion and valid recommendations

Gantt Chart – Automatic Temperature Control																					
	Week Number																				
Activity	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
Project Ideas																					
Research																					
Two Solutions																					
Discussion and Decision																					
Planning																					
Equipment List and Drawing																					
Wiring																					
Programming																					
Commissioning																					
Testing																					
Evaluation																					

Good Gantt chart and key is stated in

References

AMCI, n.d. *AMCI.* [Online]
Available at: https://www.amci.com/industrial-automation-resources/plc-automation-tutorials/what-plc/

Antratek, 2019. *Antratek.* [Online]
Available at: https://www.antratek.com/arduino-uno

Arduino, 2021. *Arduino.* [Online]
Available at: https://www.arduino.cc/en/guide/introduction

Books, C. o., 2018. *Chest of Books.* [Online]
Available at: https://chestofbooks.com/home-improvement/construction/plumbing/Principle-Practice/Steam-Coils.html

CTMS, 2019. *CTMS.* [Online]
Available at:
https://ctms.engin.umich.edu/CTMS/index.php?example=Introduction&section=ControlPID

Elprocus, 2020. *Elprocus.* [Online]
Available at: https://www.elprocus.com/the-working-of-a-pid-controller/

Eurotherm, 2020. *Eurotherm.* [Online]
Available at: https://www.eurotherm.com/en/temperature-control-en/plc-or-pid-controller-whats-the-difference-and-how-do-you-decide-what-technology-you-need/

Omega, 2019. *Omega.* [Online]
Available at: https://www.omega.co.uk/prodinfo/pid-controllers.html

Quora, 2021. *Quora.* [Online]
Available at: https://www.quora.com/What-is-PWM

Reichelt, 2020. *Reichelt.* [Online]
Available at: https://www.reichelt.com/de/en/simatic-s7-1200-cpu-1214c-24-v-dc-s7-1214c-dc-p201772.html

Good number of sources in list

Log Book

Log Sheet

Log No	1
No hrs	2
Running total hrs	2

- An introduction to the course was presented to us today followed by an explanation on how to create a successful project.
- https://www.quora.com/What-are-some-innovative-project-ideas-for-chemical-engineering
- https://iprojectng.medium.com/chemical-engineering-project-topics-and-materials-439cb09a57f7
- I spent some time researching project ideas.
- I brainstormed various problems that occur in industry on a daily basis.
- The project will be completed and simulated in college but the problem will come from industry.

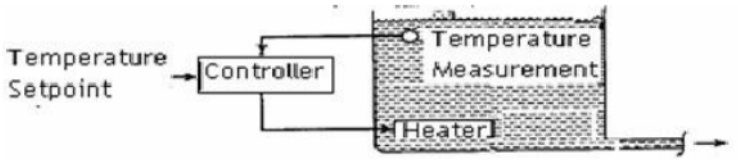
- Next time, I will do further research into project ideas.

Student signature	D. Davies
Supervisor Signature	
Lecturer Signature	

Log Sheet

Log No	2
No hrs	2
Running total hrs	4

- I spent more time researching project ideas and came up with a few different ideas.
- I weighed up the positives and negatives of each project idea and game to a final decision.
- I discussed the project idea with my Mentor (Robert Jenkins), and came to an agreement to write a project proposal on a Temperature Control System.
- In order to make the project relate to an industry problem, the system will control the temperature of water in a tank.
- The problem in industry is that tanks are heated manually by a hand valve. This is an issue if the operator forgets and the product begins to get too hot. If it gets too hot, the product can 'burn' and won't meet the colour specification for the customer. An automated heating system will solve this problem and keep a steady temperature in the tank.



- The image above is a basic drawing of the project.

Student signature	D.Davies
Supervisor Signature	
Lecturer Signature	

Log Sheet

Log No	3
No hrs	1
Running total hrs	5

- I wrote a project proposal based on what my Mentor and I had agreed on last week.
- This included a brief explanation on what the project will be, a block diagram and various sub headings such as 'what', 'where', 'when' and 'how much'.
- I researched how much each component costs and gave a budget in the proposal.
- https://www.automation24.co.uk/siemens-cpu-1214c-6es7214-1ag40-0xb0
- I also briefly discussed another solution if I have to overcome a problem that the project may present. This will be developed further next week.

- Next week I will do some extensive research into Solution 2 for the project.

Student signature	D.Davies
Supervisor Signature	
Lecturer Signature	

Log Sheet

Log No	4
No hrs	2
Running total hrs	7

- After submitting the project proposal and getting it approved, I proceeded onto the next stage of the project.
- I researched into another solution for the project. The second solution will be to use an Arduino instead of the PLC.
- When deciding on a second solution, I had to make sure they both met the specification.
- https://learn.sparkfun.com/tutorials/what-is-an-arduino/all
- https://www.circuito.io/blog/arduino-code/
- I am still yet to critically analyse the second solution in terms of cost, efficiency and reliability etc.

- Next week I will finish the research into the second solution and start the presentation PowerPoint.

Student signature	D.Davies
Supervisor Signature	
Lecturer Signature	

Log Sheet

Log No	5
No hrs	3
Running total hrs	10

- Further research into a second solution to the project.
- https://www.instructables.com/How-to-Interface-Arduino-to-LabVIEW-Simple-Steps/
- https://circuitdigest.com/microcontroller-projects/arduino-labview-interfacing-tutorial
- Myself and my tutor (Rob Jenkins) had a conversation on this second solution and agreed it was suitable.
- I made a start on the presentation using PowerPoint.
- I also looked at presenting tips and techniques.
- https://business.tutsplus.com/articles/37-effective-powerpoint-presentation-tips--cms-25421

- Next week I will continue the presentation.

Student signature	D.Davies
Supervisor Signature	
Lecturer Signature	

Log Sheet

Log No	6
No hrs	3
Running total hrs	13

- This week I had to do some research for the presentation.
- One of the slides in the presentation include health and safety so I visited various sites on this topic.
- https://www.hse.gov.uk/agriculture/topics/maintenance-3.htm
- https://www.hsa.ie/eng/Your_Industry/Quarrying/Maintenance_Operations/Workshop_Safety/
- I priced up the total cost of solution 2, weighed up the pros and cons of each solution and came to a final decision.

- Next week I will continue the presentation and plan how I will test the project.

Student signature	D.Davies
Supervisor Signature	
Lecturer Signature	

Log Sheet

Log No	7
No hrs	2
Running total hrs	15

- This week I planned how I will test the project once it is complete.

Temperature Set Point (^{o}C)	Heater Response	
	Activated (✓ / X)	Deactivated (✓ / X)
20		
30		
40		
50		

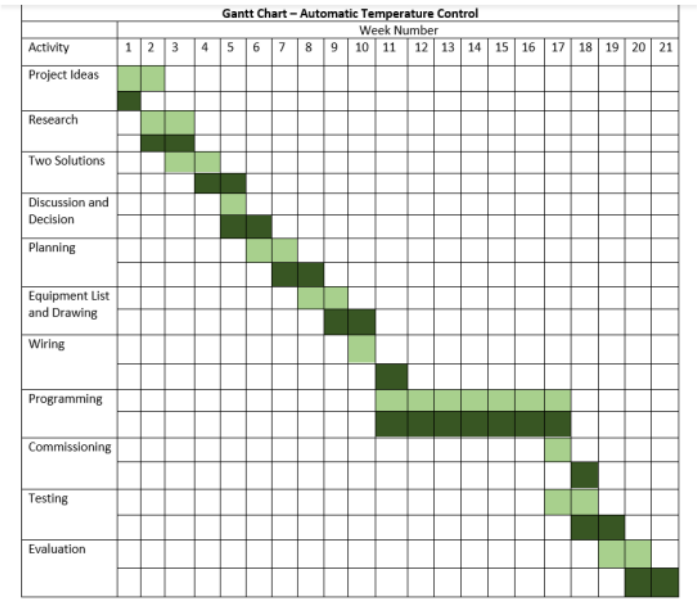
- I advanced through the presentation and spent some time reciting it in preparation for 2 weeks.
- The only section missing from the presentation is the Gantt chart. This will be completed next week.

Student signature	D.Davies
Supervisor Signature	
Lecturer Signature	

Log Sheet

Log No	8
No hrs	3
Running total hrs	18

- This week I planned what needed to be included in the Gantt chart and how long I must spend on each section.



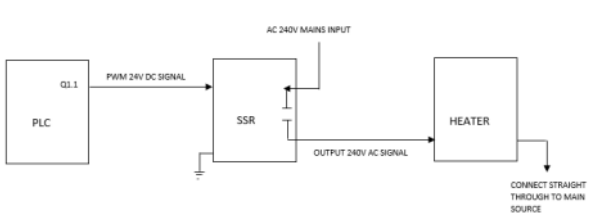
- In preparation for the presentation next week, I spent some time reciting the entire PowerPoint.
- I also did some research on environmental impact, ethical conduct and legal requirements in case I am asked any questions on these topics.
- https://www.researchgate.net/figure/The-meaning-of-ethical-conduct_tbl1_242399993
- https://www.bbc.co.uk/bitesize/guides/zwg987h/revision/2

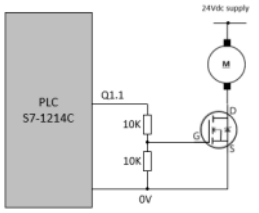
Student signature	D.Davies
Supervisor Signature	
Lecturer Signature	

Log Sheet

Log No	9
No hrs	5
Running total hrs	23

- After the presentation, an agreement on the project was made.
- The lecturer gave feedback on how the project can be improved, and which is the best way temperature can be controlled.
- It was agreed that PID would be the best way to automatically control temperature.
- Once I knew how the project would be set up, I began to draw the Mosfet circuit which would drive a PWM output. I also sketched a and basic project drawing.





- These drawings gave an idea on what equipment was needed.

- Next week, I will provide the list of equipment to my lecturer for authorisation.
- Begin a testing plan

Student signature	D.Davies
Supervisor Signature	
Lecturer Signature	

Log Sheet

Log No	10
No hrs	4
Running total hrs	27

- This week, the equipment list was confirmed by the lecturer.
- The lecturer was happy with the drawings too. These will help when it comes to wiring the circuit.
- The equipment was ordered.
- I spent some time researching solid-state relays and how they can produce an AC signal.
- https://www.electronics-tutorials.ws/power/solid-state-relay.html
- I brainstormed various ways the project could be tested in terms of accuracy, efficiency and safety.
- A testing plan was constructed.

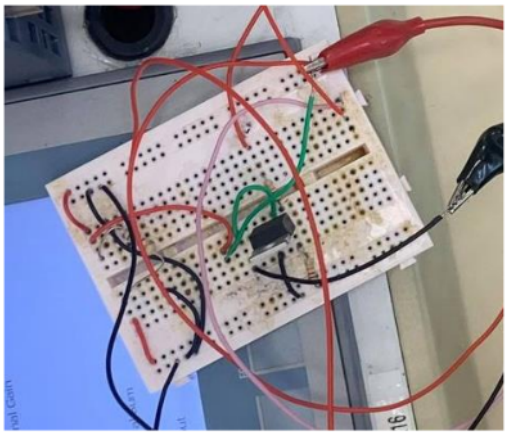
Test	Week Number	Description
Potentiometer Range 0-10V	17	Take temperature readings off the HMI screen at both 0V and 10V using a potentiometer. 0V = 0^{o}C. 10V = 200^{o}C
3 Stage Alarm Test	17	There should be 3 alarms indicating a temperature change from the setpoint.
PWM for PLC output	18	A random setpoint is entered on the HMI. The PWM output is then recorded using a Pico Scope at intervals between 0 and 100%. This will display the changing duty cycles. The larger outputs will create bigger duty cycles.
AC Test using solid-state relay	18	A random setpoint is entered on the HMI. Using a solid-state relay, the AC response can be displayed using a Pico Scope. The outputs will be the same as those used for the PWM test.

- If the equipment arrives by next week, I can make a start on the wiring.

Student signature	D.Davies
Supervisor Signature	
Lecturer Signature	

Log Sheet

Log No	11
No hrs	5
Running total hrs	32

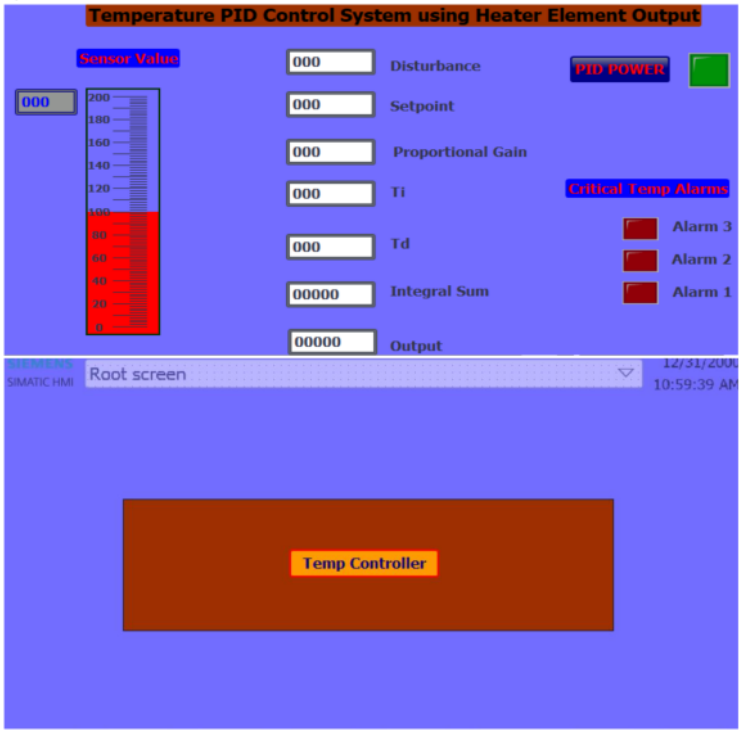
- The equipment arrived on time and I wired of the circuit.
- The final circuit is shown below.
- 
- Once this circuit was complete, it was connected to the correct output terminal on the PLC Q1.0.
- When the Pico scope was setup. I spent some time familiarising myself with the software.
- When the hardware was set up, I created a new TIA project on my laptop ready for next week.

Student signature	D.Davies
Supervisor Signature	
Lecturer Signature	

Log Sheet

Log No	12
No hrs	6
Running total hrs	38

- This week, I designed 2 HMI screens, one as the main root screen, and the other as the temperature control screen.
- The root screen is basic, and the control screen includes all the requirements from the specification.



- Next week I will be researching analogue inputs and implementing it into the program.

Student signature	D.Davies
Supervisor Signature	
Lecturer Signature	

Log Sheet

Log No	13
No hrs	6
Running total hrs	44

- Prototype 1
- This week was the first stage of programming.
- Researched analogue inputs and analogue scaling.
- https://instrumentationtools.com/plc-analog-input-scaling/
- https://www.digi.com/resources/examples-guides/802-15-4-analog-input-with-a-potentiometer
- Following the research and some guidance from the lecturer, I began scaling the analogue input. I needed to achieve a 0-10V input and scale it into a temperature that ranges between 0-200 degrees.



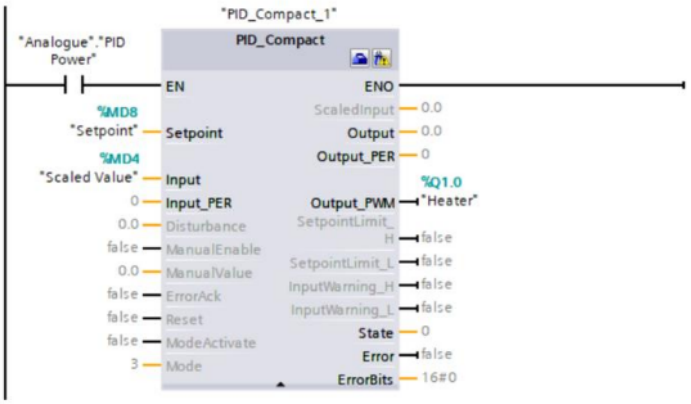
- Next week I will begin the PID control.

Student signature	D.Davies
Supervisor Signature	
Lecturer Signature	

Log Sheet

Log No	14
No hrs	6
Running total hrs	50

- Prototype 2
- Research on PID control
- https://www.machinedesign.com/automation-iiot/sensors/article/21831887/introduction-to-pid-control
- This video provided a lot of information on PID control.
- https://www.youtube.com/watch?v=Vianw940hw4
- Added PID compact block



- The inputs and output were tagged appropriately.

- Next week I will continue on PID control and maybe start the 3-stage alarm system.

Student signature	D.Davies
Supervisor Signature	
Lecturer Signature	

Log Sheet

Log No	15
No hrs	12
Running total hrs	62

- Following from last week, I also included a 'PID power' N/O contact, which means the operator will need to press the PID power button on the screen beforehand. This is a safety addition.
- All new items were tagged.
- It was then decided that the 3-stage alarm system would be best written in SCL.
- By writing in SCL, it would expand my knowledge on the use of different programming languages.
- Researched SCL language.
- https://www.dmcinfo.com/latest-thinking/blog/id/9540/efficient-scl-development-in-tia-portal-v14
- I familiarised myself with SCL by watching a video.
- https://www.youtube.com/watch?v=02qxYRA5eUs

- Next week I will write the 3-stage alarm system using SCL.

Student signature	D.Davies
Supervisor Signature	
Lecturer Signature	

Log Sheet

Log No	16
No hrs	12
Running total hrs	74

- Prototype 3
- I had a brief discussion with the lecturer on what would be the best values for each of the alarms to ensure the operator's safety.
- Decided on appropriate values for alarms
- Each of the alarms should light up when the scaled value is adjusted.
- The following temperatures were decided on:
- No alarms – 150
- Alarm 1 – more than 100 but less than 150
- Alarm 1 and 2 – More than 50 but less than 100
- Alarm 1, 2 and 3 – Less than 50
- I then wrote the 3-stage alarm system using SCL

```
IF ("Scaled Value" < 50) THEN
    "Analogue".Alarm1 := 1;// Statement section IF
    "Analogue".Alarm2 := 1;
    "Analogue".Alarm3 := 1;
END_IF;
IF ("Scaled Value" > 50) AND ("Scaled Value" < 100) THEN
    "Analogue".Alarm1 := 1;// Statement section IF
    "Analogue".Alarm2 := 1;
    "Analogue".Alarm3 := 0;
END_IF;
IF ("Scaled Value" > 100) AND ("Scaled Value" < 150) THEN
    "Analogue".Alarm1 := 1;// Statement section IF
    "Analogue".Alarm2 := 0;
    "Analogue".Alarm3 := 0;
END_IF;
IF ("Scaled Value" > 150) THEN
    "Analogue".Alarm1 := 0;// Statement section IF
    "Analogue".Alarm2 := 0;
    "Analogue".Alarm3 := 0;
END_IF;
```

- Next week I will compile everything and ensure there aren't any errors.

Student signature	D.Davies
Supervisor Signature	
Lecturer Signature	

Log Sheet

Log No	17
No hrs	9
Running total hrs	83

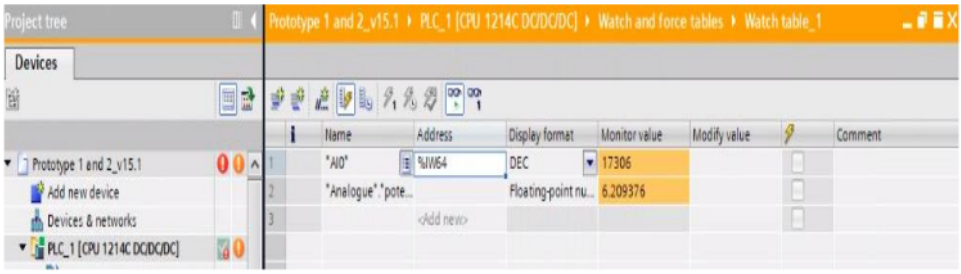
- This week was mainly spent preparing everything ready for testing next week.
- It was agreed that I would download the program to the PLC and HMI by connecting to a wireless router which has an Ethernet connection.
- No errors were found during the check.
- Finished the program and ran a quick simulation
- We discovered a broken ground wire which was causing the HMI to become powerless.
- This was quickly resolved by replacing the ground wire.

Student signature	D.Davies
Supervisor Signature	
Lecturer Signature	

Log Sheet

Log No	18
No hrs	10
Running total hrs	93

- Set everything up, including the router which is a wireless method of connecting to the PLC and HMI.
- I couldn't download to the PLC because of a software issue but it was resolved immediately with some guidance from the lecturer.
- Downloaded the program to the PLC and HMI by searching wirelessly.
- This week, it was decided that the analogue scaling would be tested using a live watch table on the program software before it is tested properly.
- Analogue scaling test using live watch table on TIA Portal shown below
-



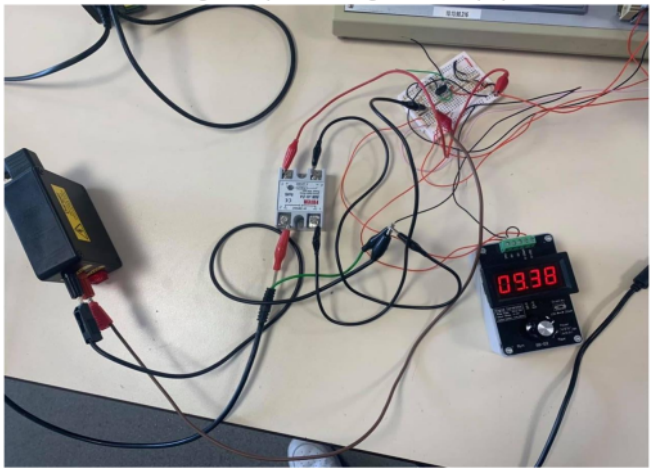
- Next week, the hardware will be connected and the remaining tests will be completed.

Student signature	D.Davies
Supervisor Signature	
Lecturer Signature	

Log Sheet

Log No	19
No hrs	11
Running total hrs	104

- The equipment was all set up and connected ready for the test
- The first test was the analogue scaling. The potentiometer was rotated to 0V and the scaled value showed 0 degrees. The potentiometer was then rotated to 10V and the scaled value showed 200 degrees.
- The lecturer and I were happy with these results so we could proceed.
- The next test was PWM output using a Pico Scope. The purpose of this test was to see if the varying outputs would affect the length of the duty cycle. This test was successful.
- Finally, to test the AC signal, a solid-state relay was introduced. Similarly, the purpose of this was to see if the varying outputs would affect the length of the duty cycle. This test was also successful.
- This was the testing set up. Showing all the equipment.



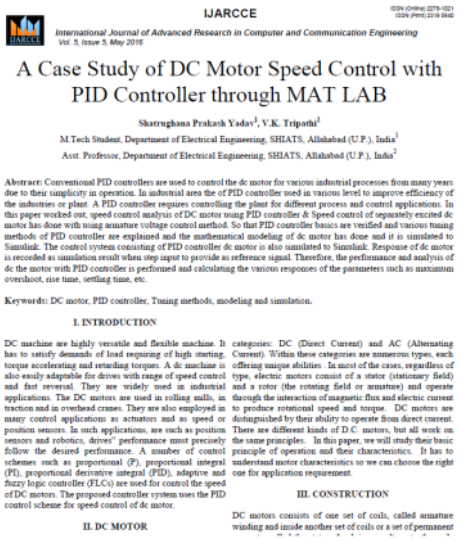
- Next week we will discuss how the project went.

Student signature	D.Davies
Supervisor Signature	
Lecturer Signature	

Log Sheet

Log No	20
No hrs	10
Running total hrs	114

- This week, the lecturer and I had a discussion on how the project went.
- We agreed that it was a success.
- I asked the question of how this could be implemented on an industrial scale.
- I also asked how PID could be used to control things other than temperature such as flows, pressures and speeds.
- I looked at some case studies on different PID applications.
- https://www.researchgate.net/publication/323993640_Methodology_of_PID_Control_-_A_Case_Study_for_Servomotors
- Case study on DC motor speed control – PDF



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A Case Study of DC Motor Speed Control with PID Controller through MAT LAB

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Abstract: Conventional PID controllers are used to control the dc motor for various industrial processes from many years due to their simplicity in operation. In industrial area the of PID controller used in various level to improve efficiency of the industries or plant. A PID controller requires controlling the plant for different process and control applications. In this paper worked out, speed control analysis of DC motor using PID controller & Speed control of separately excited dc motor has done with using armature voltage control method. So that PID controller basics are verified and various tuning methods of PID controller are explained and the mathematical modeling of dc motor has done and it is simulated to Simulink. The control system consisting of PID controller dc motor is also simulated to Simulink. Response of dc motor is recorded as simulation result when step input to provide as reference signal. Therefore, the performance and analysis of dc the motor with PID controller is performed and calculating the various responses of the parameters such as maximum overshoot, rise time, settling time, etc.

Keywords: DC motor, PID controller, Tuning methods, modeling and simulation.

I. INTRODUCTION

DC machine are highly versatile and flexible machine. It has to satisfy demands of load requiring of high starting, torque accelerating and retarding torques. A dc machine is also easily adaptable for drives with range of speed control and fast reversal. They are widely used in industrial applications. The DC motors are used in rolling mills, in traction and in overhead cranes. They are also employed in many control applications as actuators and as speed or position sensors. In such applications, are such as position sensors and robotics, drives' performance must precisely follow the desired performance. A number of control schemes such as proportional (P), proportional integral (PI), proportional derivative integral (PID), adaptive and fuzzy logic controller (FLCs) are used for control the speed of DC motors. The proposed controller system uses the PID control scheme for speed control of dc motor.

II. DC MOTOR

categories: DC (Direct Current) and AC (Alternating Current). Within these categories are numerous types, each offering unique abilities. In most of the cases, regardless of type, electric motors consist of a stator (stationary field) and a rotor (the rotating field or armature) and operate through the interaction of magnetic flux and electric current to produce rotational speed and torque. DC motors are distinguished by their ability to operate from direct current. There are different kinds of D.C. motors, but all work on the same principles. In this paper, we will study their basic principle of operation and their characteristics. It has to understand motor characteristics so we can choose the right one for application requirement.

III. CONSTRUCTION

DC motors consists of one set of coils, called armature winding and inside another set of coils or a set of permanent

- Next week will be the final stages of the project evaluation.

Student signature	D.Davies
Supervisor Signature	
Lecturer Signature	

Log Sheet

Log No	21
No hrs	7
Running total hrs	121

- This week I did a full write up on the project including a table which compared the outcome to the specification requirements.
- I completed the testing table that I created in the earlier stages.

Testing Table

Test	Expectation	Result	Pass / Fail
0-10V Scaling	Take temperature readings off the HMI screen at both 0V and 10V using a potentiometer. 0V = 0°C. 10V = 200°C	The potentiometer was set to 0V and the scaled value was 0°C. The potentiometer was then set to 10V and the scaled value was 200°C.	Pass
3-Stage Alarms	There should be 3 alarms indicating a temperature change from the setpoint.	As the potentiometer was rotated to alter the scaled value, the 3 alarms lit up at the correct temperatures.	Pass
PWM Signal Test	A random setpoint is entered on the HMI. The PWM output is then recorded using a Pico Scope at intervals between 0 and 100%. This will display the changing duty cycles. The larger outputs will create bigger duty cycles.	With a 180°C setpoint, the PWM signals were recorded at various outputs between 0-100%. The larger the output, the bigger the duty cycle.	Pass
AC Signal Test	A random setpoint is entered on the HMI. Using a solid-state relay, the AC response can be displayed using a Pico Scope. The outputs will be the same as those used for the PWM test.	With a 180°C setpoint, the AC signals were recorded at various outputs between 0-100%. The larger the output, the bigger the duty cycle.	Pass

- Upon finishing the Gantt chart, I discovered that I was 1 week longer than expected. This could have been a lot worse without a Gantt chart. It helped massively.

Student signature	D.Davies
Supervisor Signature	
Lecturer Signature	

A good log book which is in a good logical order of how the project was created.

1910594

GRADEMARK REPORT

FINAL GRADE

67 /100

GENERAL COMMENTS

Instructor

PAGE 1

PAGE 2

PAGE 3

Text Comment. Table of contents should be more detailed and should include a research section

Text Comment. There should be a list of figures here

PAGE 4

Text Comment. Background research is interesting

PAGE 5

Text Comment. Good explanation supported with relevant source

Text Comment. The introduction to the Arduino and PLC here would be best explained in the solutions sections

PAGE 6

Text Comment. This section should be after the solutions considered evaluation

Text Comment. Good explanation of PID control

Text Comment. Circuit diagram is correct for driving the power MOSFET

Text Comment. Good example of PWM

PAGE 7

Text Comment. Good block diagram to support explanation

Text Comment. Good explanation of how the project will be implemented

PAGE 8

Text Comment. Good condition explanation

Text Comment. All misc items are covered here

PAGE 9

Text Comment. Chart key if defined here

Text Comment. Predicted plan is realistic

PAGE 10

Text Comment. Good use of table for test plan

PAGE 11

Text Comment. Good block diagram

Text Comment. A good valid passible solution for this project

PAGE 12

Text Comment. Good block diagram to support explanation

Text Comment. A good point here

PAGE 13

Text Comment. A very good method of evaluating the options and the score justifies the solution

PAGE 14

Text Comment. Good block diagram of system

PAGE 15

Text Comment. Good images of equipment setup

Text Comment. Good example of SSR connections

Text Comment. A neat instrument for analogue input simulation

PAGE 16

Text Comment. A good design of the HMI with all the tuning parameters and disturbance sim option

Text Comment. HMI design is practical and has all the necessary options for tuning and simulation

PAGE 17

Text Comment. The NORMX and SCALE X is the better option here

PAGE 18

Text Comment. Good explanation

Text Comment. Good image

PAGE 19

Text Comment. Explanation is clear and a good image of the SCL to support the explanation

Text Comment. All the conditions are correct for the spec requirements

Text Comment. PLC directory tree explains the program content

PAGE 20

Text Comment. Watch table test is worthwhile and an easy method of detecting errors in the program values

PAGE 21

Text Comment. A good test to indicate the correct operation of the scale settings

PAGE 22

Text Comment. Test looks correct on HMI

Text Comment. Alarm 1 test is correct

PAGE 23

Text Comment. Alarm 2 test is correct

Text Comment. Alarm 3 test is correct

PAGE 24

PAGE 25

Text Comment. Test is correct at 10%

PAGE 26

Text Comment. Test is correct at 30%

PAGE 27

Text Comment. Test is correct at 50%

PAGE 28

Text Comment. Test is correct at 70%

PAGE 29

Text Comment. Test is correct for 90%

PAGE 30

Text Comment. Test is correct at 100%

PAGE 31

Text Comment. Good image of equipment setup

PAGE 32

PAGE 33

Text Comment. Good AC output test @ 10%

PAGE 34

Text Comment. Good AC output test @ 30%

PAGE 35

Text Comment. Good AC output test @ 50%

PAGE 36

Text Comment. Good AC output test @ 70%

PAGE 37

Text Comment. Good AC output test @ 90%

PAGE 38

Text Comment. Good AC output test @ 100%

PAGE 39

Text Comment. A good table of test results evaluation

PAGE 40

Text Comment. A good method for evaluation and conclusion

PAGE 41

Text Comment. A very good conclusion and valid recommendations

PAGE 42

Text Comment. Good Gantt chart and key is stated in the report

PAGE 43

Text Comment. Good number of sources in list

PAGE 44

PAGE 45

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PAGE 63

PAGE 64

Text Comment. A good log book which is in a good logical order of how the project was created.

PAGE 65

GRADING FORM: CSG-RUBIC

DOMINIC DAVIES	**0**

RESEARCH-INFORMED LITERATURE

There is evidence that research has been carried out and using a good number of relevant sources. More content should have been included in this section. 5.5/10 The sources are listed and used in the text using correct method. 5.5/10

11/20

KNOWLEDGE AND UNDERSTANDING

Specification needs more detail. The spec is in a logical sequence and clear. 6.5/10 Solutions considered are valid and explained in good clear detail. The justification of the chosen solution is explained and there is an evaluation. 7.5/10

14/20

ANALYSIS

Testing and results are clear and presented using a good method. Tables and images are included as evidence and a good test plan has been followed. 8/10 Conclusion covers all the significant points in the project. There are good valid recommendations made 8/10

16/20

PRACTICAL APPLICATION AND DEP.

Good planning methods have been implemented and a comparison of the actual and predicted plan timeline is included and explained. 3.5/5 Solutions considered are valid for the project and a good

17/25

comparison carried out to justify solution. 7/10 Implementation has been explained in good detail. Each section is identified clearly. A good set of logs which indicate a successful and logical sequence of tasks to complete the project. 7.5/10

SKILLS FOR PROFESSIONAL PRAC.

Some sections are in the incorrect sequence and there should be a list of figures, but overall the report is good.

9/15