

SGEL6000 Independent Project

DOUBLE MARKING SHEET AND COMBINED STUDENT FEEDBACK

Assessment 3 of 4

Assignment 2: Project Design, implementation and evaluation

2020-2021

Agreed mark

64

Student Name: **Phillip Rowe**

Student Number **1602827**

Generic Assessment Criteria	Marks available	1st Marker (RD)	2 nd Marker (MH)	Agreed Mark
1. Engagement with Literature Skills.				
Section 3: Judicial use and critical evaluation of technical literature in the design of the project: There is some evidence of the use of technical literature from manufacturers. Siemens literature was used extensively, no obvious appraisal on the validity of other sources though.	5	2	3	3
Section 4: Extent of reading, range of credible sources and use of Harvard method: The citation list is more of a Bibliography as few of the sources have been cited in the text of the report. However, there is good evidence of reading. A wide range of appropriate sources were used, reference list was compiled correctly using Harvard.	5	3	4	3
Total	10	5	7	6
2. Knowledge and Understanding Skills				
Section 3: Advanced knowledge and critical understanding demonstrated in the design of the project: There is evidence of knowledge and understanding. However, there are missed opportunities to give further explanations. The project design and implementation were well explained.	10	6	7	6
Total	10	6	7	6
3. Cognitive and Intellectual Skills				
Section 5: Testing and analysis of result: There is good evidence of testing. However, you could have analysed and explained the trends better. You could have fully exploited what you have achieved. The trend data could have revealed much more. Test schedule was included and carried out, tolerances on expected results were not included.	10	6	7	7
Section 5: Critical evaluation of the project outcomes: A good attempt made at evaluating the project outcomes You revisited each requirement of the FDS and explained in detail how each had been satisfied. Readability could have been improved by having headings for each.	10	7	8	7
Section 6: Conclusions and recommendations: Good conclusions offered with recommendation for expansion of the project in the future. However, these suggestions do not all relate directly to your project but seem to include integrating other parts of the plant to make use of the processing power you have made available. You could make much more use of the trend data	10	5	5	5

information and the PLC program provides you with far more opportunities to provide information to the operator and engineer than you have stated. The conclusions were a little generic and could have stated actual numbers, recommendations included replacing the SCADA screens with HMI versions.				
Total	30	18	20	19
4. Practical Application Skills				
Section 3: Formulation of innovative and creative design solution to the project problem: Appropriate hardware has been selected. Good interface with the IBA. However, the software is rather simple and the use of a resistor in the current loop suggests that the module has not been configured correctly. The chosen solution was appropriate and satisfied the FDS.	10	6	8	7
Section 4: Deployment method, use of material, tools, equipment and techniques in the construction of the project: Very good deployment of methods and installed according to company standards and regulations. However, the drawing are of a poor hand drawn quality and should have been drawn using professional software with company procedures stamped all over them. There were few photographs of the practical implementation, most images were of computer screens.	5	3	3	3
Section 4: Quality of the final product or system: A high-quality end result for the company with scope for future development. The system has been implemented and appears to work satisfactorily.	10	7	7	7
Section 5: Use of test equipment and presentation of results of the project: Good use of test equipment and results are clear except that the program itself is made up of photos of a screen rather than a printout. Appropriate test equipment was used and testing results were presented within the test schedule. Reasons for fails were explained in a comments column.	5	3	4	3
Sections 3 and 5: Management of the design process: The process has been managed well to deliver the project outcome on time and within budget. The WBS needed an extra layer and the Gantt could have been more detailed	5	4	3	4
Total	35	23	25	24
5. Transferable Skills for Life and Professional Practice				
Sections 1 and 2: Executive summary, acknowledgements and introduction: Briefly summarised and introduced but no acknowledgement given The Executive Summary could have given more specific values and the introduction could have included objectives. No acknowledgements were given.	5	3	2	2
All Sections: Quality of the report: Well structured. However, most of the images belong in the appendix. Writing style is awkward and contains many spelling, punctuation and grammatical errors. The report would be better presented as 1.5 line spacing with fully justified text. Some of the images are photos of a screen at an angle and are difficult to read.	5	2	1	2

The report was well written and presented in a logical order. Images were not well presented with too many photographs of your computer monitor and scruffy hand drawn diagrams.				
Word count: Not exceeded	5	5	5	5
Total	15	10	8	9
Grand Total	100	62	67	64

Phillip Rowe

by Phillip Rowe

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*Where is your acknowledgements
section?*

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1. Executive Summary *should be spaced 1.5 lines and fully justified*

In this report an effective weld monitoring system was build whilst closely following the FDS. The system was designed using the most logical equipment in order to meet the required specification. The project budget was taken into careful consideration along the way in order to maintain the making of a cost-effective system whilst still meeting the end goals. First draft design drawings were made ready and sent to the drawing office to be filed ready for the installation of the system. The system was installed in a timely manner sticking to a project time plan with then the final commissioning commencing at the end. The PLC programming was written with industry codes of practices in mind in order to make the system easy to interrogate. The PLC was also connected onto the works network to then allow communication with the IBA analyzer server in order to meet the requirement of being able to see live data and effectively monitor line welds. Throughout the project different management techniques were used in order to iron out any issues which were raised. At the end of the installation the FDS was then looked at again in order to see if anything had not been met or if any additions had been made. Everything on the original FDS had been provided however there was one addition of a temperature probe which was not included in the original FDS but was added at the time of installation. After looking over the FDS and comparing it rigorously to the final system, it was deemed that the project was a massive success as it had achieved all of the points raised in the FDS, stayed within the original budget and also been completed within the allocated time frame.

2. Introduction

In this report it was set out to design, install and commission a weld monitoring system, which met the FDS in assignment 1. The aim was to create a system which could effectively monitor the production line welds which were made on the cleaning line. The chosen method from assignment 1 was to make a system based off siemens S7 hardware, program using TIA portal and also have live and historical analysis mapped into IBA to aid fault finding and show degrading parts before they cause issues. The system needed to be completed and installed on time, whilst also tracking and sticking to a set budget.

3. Design and Implementation

The design chosen for the weld monitoring system was the Siemens system. The Siemens system will consist of one main processing hub which will be located in the central substation, then a remote I/O node will be placed local to the welder in order to input these analogue signals. The programming station for TIA Portal and IBA analyzer will be located in the central substation on the engineering desk.

3.1 Block diagram designs

In order to carefully and accurately design the system, block diagrams have been made in order to layout all devices needed for the system. Following below in figure 1 is the general block layout for the system.

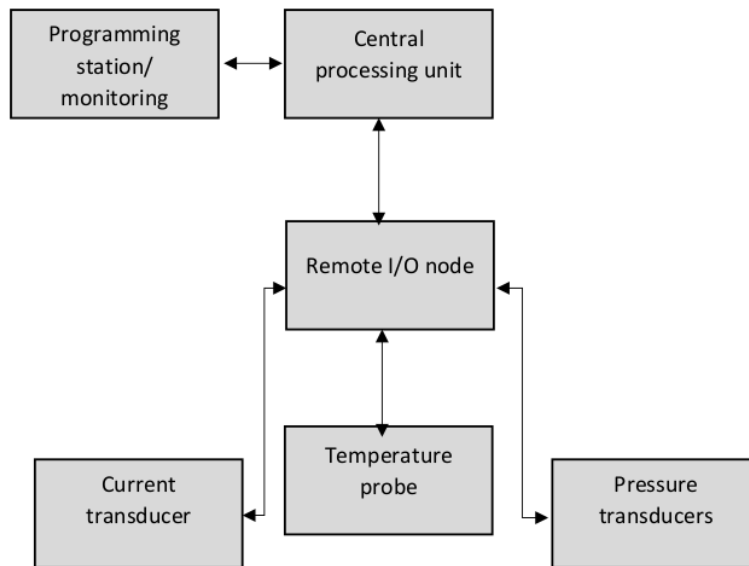


Figure 1- Block diagram of system

Now that the basic block diagram has been designed, a more in-depth diagram can be formed showing the forms of communication and also the signals which will be sent between devices. As shown below in figure 2 is the more detailed block diagram listing how each of the devices communicate with each other.

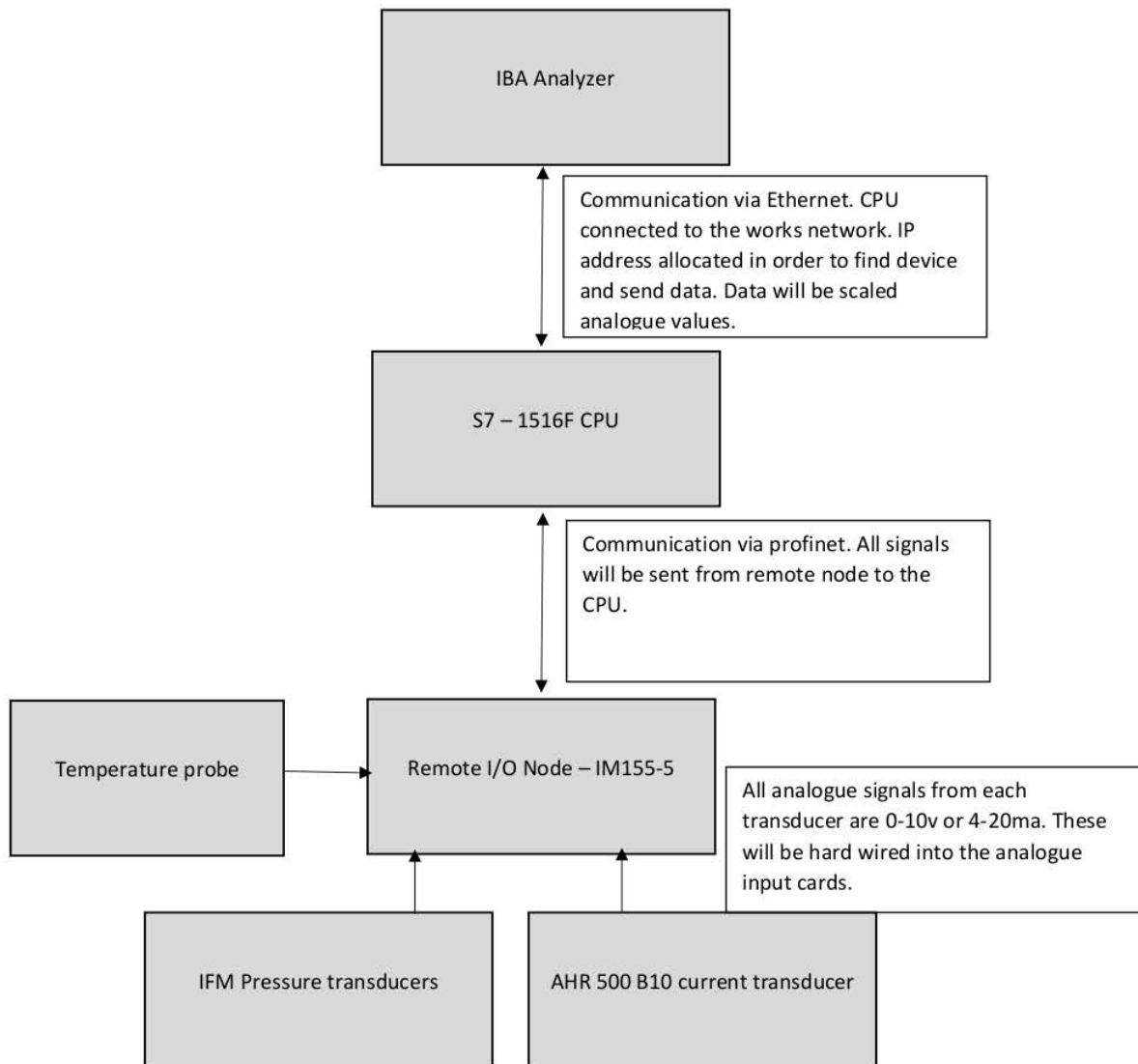


Figure 2- Block diagram of hardware components

Now that the general flow of the system has been designed. The components need to be selected in order to produce electrical drawings for the system.

3.2 Component choices

Based off the specification written, a list of components was chosen in order to meet the desired specification and project demands. Following below in table 1 is the list of items which have been chosen along with quantity and reasoning for choosing that item.

Item name	Quantity	Reason chosen
S7 1516F CPU	1	Fast processing speed, room for massive expansion for future demand.
S71500 PSU	1	Power supply unit which is required for the 1500 series PLCs.
S71500 Rail	50cm	Special rail used in order to mount the 1500 series devices.
Profinet connectors	4	Used to terminate profinet ends for network communications.
Module interface IM155-5	1	Remote node used for the 1500 series with a range of expandable input cards can be used with a higher current/voltage rating.
Siemens 20A PSU	1	Capacity for large number of devices to be used under this power supply.
AI input module	1	This card offers U/I and RTD capabilities. Type of input is changed by wiring and altering software.
AHR 500 B10 current transducer	1	This current transducer is fixed and will also measure within the current range needed of 0-2000A. It also offers 0-10v output.
IFM PN2571 pressure transducer	2	This pressure transducer offers the correct operating range, as well as the correct analogue signal of 0-10v output.
Calex CIRSPMHA201CT CRTMSD temperature probe	1	This will monitor the temperature of the strip and provide the correct output signal of 4-20ma.

Figure 3- Table 1

Since all of the general components have now been decided on, the electrical drawings were created in order to produce technical sheets which will be used in order to install and wire the system.

3.3 Technical drawings

Once the circuit was designed, electrical drawings were made in order to install the system. These drawings can be found in appendix 8.1.

3.4 PLC Coding

When designing the system, the PLC code needed to take raw analogue signals both 0-10v and 4-20ma, then convert and scale them into a useful number which the end user can understand. The first step was to design the networking side of the PLC in order to ensure proper communications between the CPU and the remote node. A new portal program was created and the correct

hardware devices were dragged in and the profinet network link was connected. This can be shown below in figure 4.

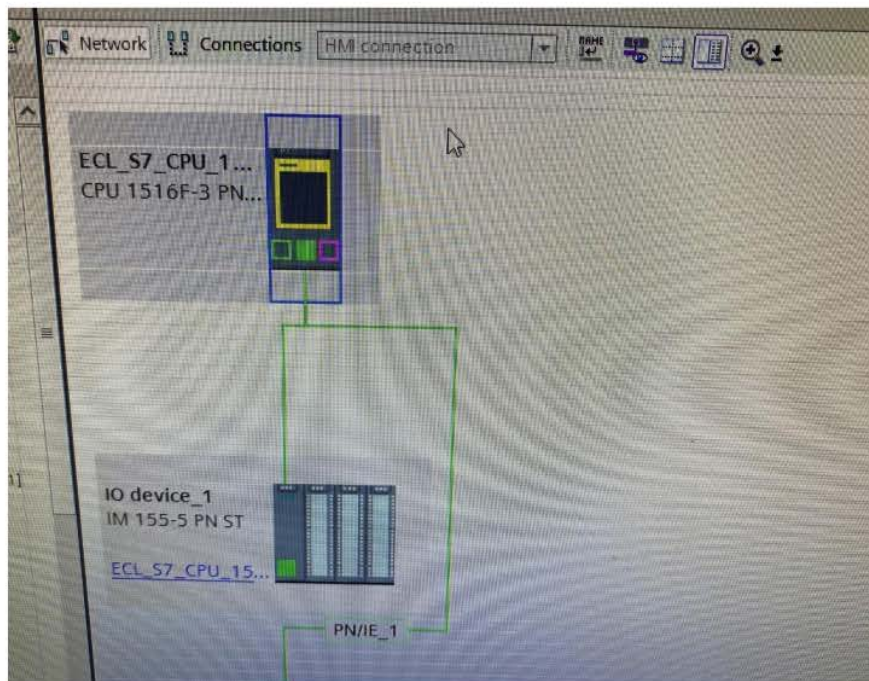


Figure 4- PLC

network topology

Both devices were given IP addresses in order to establish communications on power up. The next step was to enter all of the tags ready for when the analogue devices were wired in and the system was turned on. This can be seen below in figure 5 the full tag table for the devices put in.

Most of these images belong in the appendix

difficult to read, you could have used a better method of capturing this information

Name	Data type	Address	Origin	Access	Write	Visible	Supervise	Comment
Welder low pressure	Word	%M0.0						
Welder high pressure	Word	%M0.1						
Welder primary head current	Word	%M0.2						
Welder secondary head current	Word	%M0.3						
Welder temperature probe	Word	%M0.4						
SPARE(1)	Word	%M0.5						
SPARE(2)	Word	%M0.6						
SPARE(3)	Word	%M0.7						
Entry end hydraulic PT needs installing(1)	Word	%M0.8						
Entry end hydraulic PT needs installing(2)	Word	%M0.9						
Entry end hydraulic PT needs installing(3)	Word	%M1.0						
Welder temperature probe scaled	Real	%MD16						
Welder low pressure scaled	Real	%MD18						
Welder high pressure scaled	Real	%MD20						
Welder primary head current scaled	Real	%MD22						
Welder secondary head current scaled	Real	%MD24						
SPARE(4)	Real	%MD26						
SPARE(5)	Real	%MD28						
SPARE(6)	Real	%MD30						
Tag_9	Real	%MD32						
Tag_10	Real	%MD34						
Tag_11	Real	%MD36						
Tag_12	Real	%MD38						
Tag_13	Real	%MD40						
Tag_14	Real	%MD42						
Tag_15	Real	%MD44						
Tag_16	Real	%MD46						
Tag_17	Real	%MD48						
Tag_18	Real	%MD50						
Welder roll 7 pressure OP side	Word	%M100.0						
Welder roll 8 pressure OP side	Word	%M100.1						
Welder roll 9 pressure OP side	Word	%M100.2						
Welder roll 10 pressure OP side	Word	%M100.3						
Welder roll 11 pressure OP side	Word	%M100.4						
Welder roll 12 pressure OP side	Word	%M100.5						
Welder roll 13 pressure OP side	Word	%M100.6						
Welder roll 14 pressure OP side	Word	%M100.7						
Welder roll 15 pressure OP side	Word	%M100.8						
Welder roll 16 pressure OP side	Word	%M100.9						
Welder roll 17 pressure OP side	Word	%M101.0						
Welder roll 18 pressure OP side	Word	%M101.1						
Welder roll 19 pressure OP side	Word	%M101.2						
Welder roll 20 pressure OP side	Word	%M101.3						

Figure 5- PLC tag

list

In order to prepare fully and ensure the successful completion of the project, during the design stage all of the code was pre-written so that it would save time when commissioning. As shown below in figure 6 is the scaling code for all of the components used. This code was designed and written in order to provide high accuracy. The code takes the input word which is a 0-10v or 4-20ma signal from the transducer, converts it into a real value and then makes that value linear between two points in order to produce something which can be used and interpreted. The limits are set by using the transducers operating range. All other scaling functions can be found in appendix 8.2.

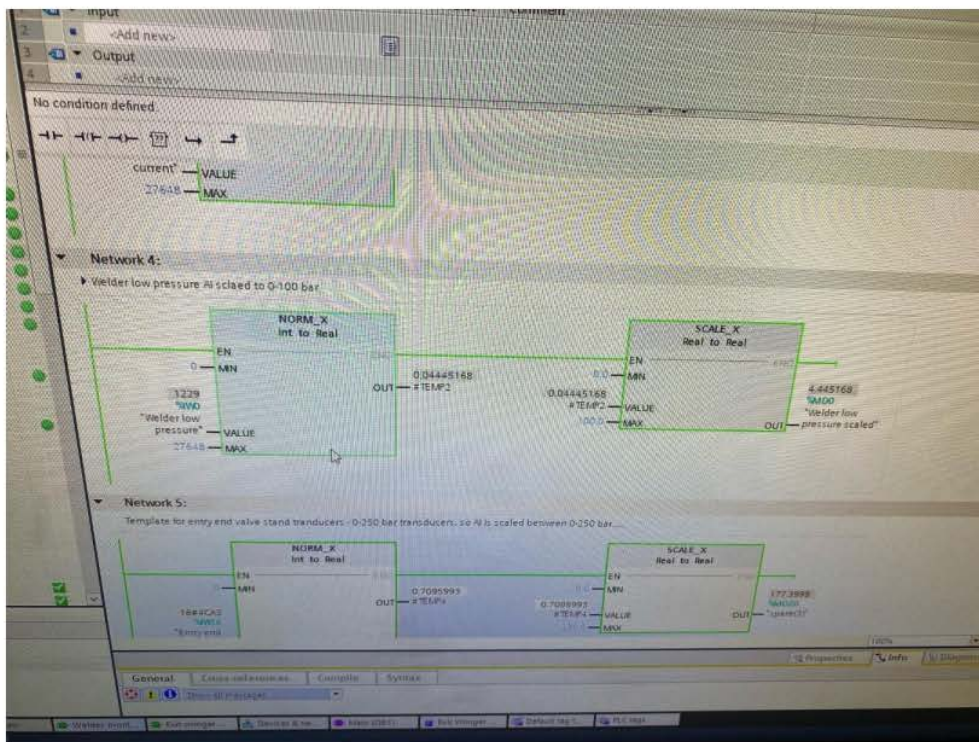


Figure 6 - Scaling code for transducers

The final coding design was to create an S7-Xplorer file on IBA which would allow the transmission of the created tags from the S7 PLC. As shown below in figure 7 is the new S7-Xplorer file which was created in order to import all of the tags from the PLC. This was designed like this so that any tags which were added into the PLC could be transferred straight into IBA by pressing the "load address book from S7".

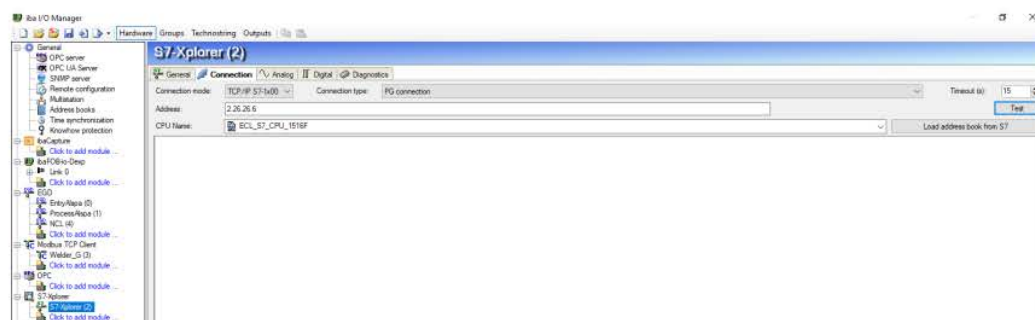


Figure 7- IBA Communication

The final coding design which was done was to create a tag table of the tags which were needed from the S7 PLC. This was done after the tags were transferred over the network and can be seen below in figure 8.

Name	Unit	Gain	Offset	S7 Symbol	S7 Data Type	Active
1 Default tag table/Welder low pressure		1	0	0 TAG2Tag.Default tag table/Welder low pressure	WORD	☒
2 Default tag table/Welder high pressure		1	0	0 TAG2Tag.Default tag table/Welder high pressure	WORD	☒
3 Default tag table/Welder Primary head current		1	0	0 TAG2Tag.Default tag table/Welder Primary head current	WORD	☒
4 Default tag table/Welder secondary head current		1	0	0 TAG2Tag.Default tag table/Welder secondary head current	WORD	☒
5 Default tag table/Welder temperature probe		1	0	0 TAG2Tag.Default tag table/Welder temperature probe	WORD	☒
6 Default tag table/SPARE		1	0	0 TAG2Tag.Default tag table/SPARE	WORD	☒
7 Default tag table/SPARE2		1	0	0 TAG2Tag.Default tag table/SPARE2	WORD	☒
8 Default tag table/Entry and hydraulic PT needs installing		1	0	0 TAG2Tag.Default tag table/Entry and hydraulic PT needs installing	WORD	☒
9 Default tag table/Entry and hydraulic PT needs installing2		1	0	0 TAG2Tag.Default tag table/Entry and hydraulic PT needs installing2	WORD	☒
10 Default tag table/Entry and hydraulic PT needs installing3		1	0	0 TAG2Tag.Default tag table/Entry and hydraulic PT needs installing3	WORD	☒
11 Default tag table/Entry and hydraulic PT needs installing4		1	0	0 TAG2Tag.Default tag table/Entry and hydraulic PT needs installing4	WORD	☒
12 Default tag table/Welder temperature probe scaled		1	0	0 TAG2Tag.Default tag table/Welder temperature probe scaled	REAL	☒
13 Default tag table/Welder low pressure scaled		1	0	0 TAG2Tag.Default tag table/Welder low pressure scaled	REAL	☒
14 Default tag table/Welder high pressure scaled		1	0	0 TAG2Tag.Default tag table/Welder high pressure scaled	REAL	☒
15 Default tag table/Welder Primary head current scaled		1	0	0 TAG2Tag.Default tag table/Welder Primary head current scaled	REAL	☒
16 Default tag table/Welder secondary head current scaled		1	0	0 TAG2Tag.Default tag table/Welder secondary head current scaled	REAL	☒

Figure 8 - IBA tag list from S7

3.5 FDS Consideration

Referring to the FDS which was created, there were some key requirements which needed to be met in order to deem the project a success. One item was not put into the FDS and was added last minute by the engineer in charge, this was a temperature probe. When designing the project around the FDS, it was important to make the system easy to use and also be as helpful engineering tool as possible. This influenced the choices made in the design phase, by putting a central processor on its own and then having a remote node on the line next to the devices kept everything together and easier to differentiate from. This means that any engineer can look at the monitoring devices used on the welder and will know that all the inputs go back into the welder I/O node. Now the FDS was looked at in order to prove that the design was based around making a system where faults and deuteriations could be easily seen. The FDS states that “

1. The system must be a standalone system.
2. The system must be able to be connected to the works network.
3. Welder speed, current and pressures must be monitored.
4. All data must be able to be mapped over into IBA analyzer
5. The installation must coincide with the company's MOC procedure.
6. Safety systems must NOT be interfered with.
7. The installation must be put inside of the existing welder panel.
8. The system must have the capability to be expanded in the future.
9. The existing welder operation MUST remain the same.
10. The system must have reliable fault finding help procedures.
11. **ADDITION** – Welder temperature probe to monitor strip temperature after a weld. “

(Rowe, 2021)

The ways in which these requirements were met are as followed. The system is a stand alone system, whilst it is connected to the works network to allow communications, it does not affect the process it only prevents long line delays and prevents future failings. This can be seen below in figure 9. By using IBA analyzer to look back at previous welds, the engineers can clearly see any deuteriation in components. An example of this would be that when the welder current is starting to track to earth, which will be indicated by the drop in current and temperature on IBA. This will point to either a breakdown in the copper conductors, a short to earth or even a incoming drive fault. Based off this data actions can then be taken in order to prevent detrimental failings.



Figure 9 - Good vs Bad current

The system is connected to the works network as this allows all of the data from the PLC to be sent into IBA via the network. This can be seen in figure 10 below as the PLC has been found on IBA with the correct address.

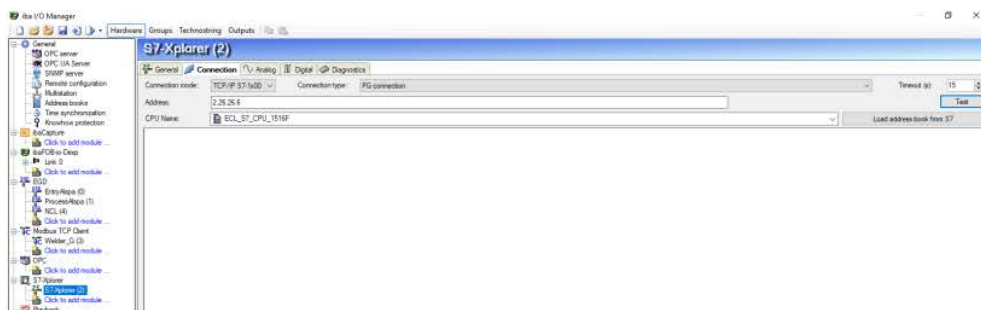


Figure 10 - S7- IBA comms

The welder speed, current and pressures can be monitored. This is displayed in figure 11. This shows the scaled analogue values from the PLC which give real word numbers.

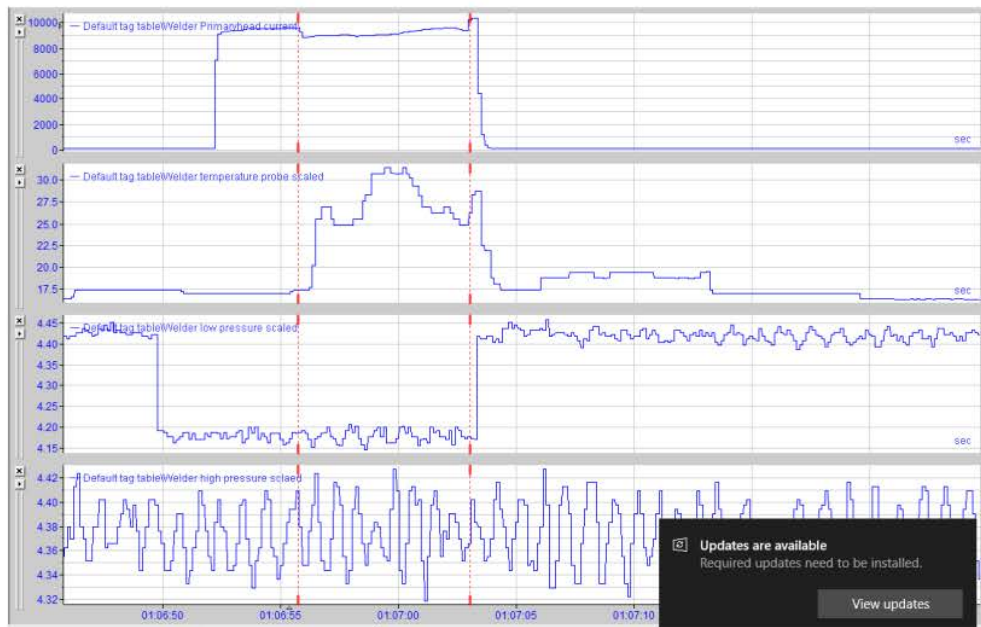


Figure 11 - All IBA AI

All requested data has been mapped over into IBA. This was done over the works ethernet and by using S7- Explorer in IBA. This can be seen in figure 12 showing the analogue tag lists from TIA portal.

Name	LPI	Gain	Offset	S7 Symbol	S7 Data type	Active
Default tag table/Welder low pressure	1	1	0	TAG2Tags.Default tag table/Welder low pressure	WORD	☒
Default tag table/Welder high pressure	1	1	0	TAG2Tags.Default tag table/Welder high pressure	WORD	☒
Default tag table/Welder Primary head current	1	1	0	TAG2Tags.Default tag table/Welder Primary head current	WORD	☒
Default tag table/Welder secondary head current	1	1	0	TAG2Tags.Default tag table/Welder secondary head current	WORD	☒
Default tag table/Welder temperature probe	1	1	0	TAG2Tags.Default tag table/Welder temperature probe	WORD	☒
Default tag table/SPARE	1	1	0	TAG2Tags.Default tag table/SPARE	WORD	☒
Default tag table/SPARE2	1	1	0	TAG2Tags.Default tag table/SPARE2	WORD	☒
Default tag table/SPARE3	1	1	0	TAG2Tags.Default tag table/SPARE3	WORD	☒
Default tag table/Entry and hydraulic PT needs installing	1	1	0	TAG2Tags.Default tag table/Entry and hydraulic PT needs installing	WORD	☒
Default tag table/Entry and hydraulic PT needs installing2	1	1	0	TAG2Tags.Default tag table/Entry and hydraulic PT needs installing2	WORD	☒
Default tag table/Entry and hydraulic PT needs installing3	1	1	0	TAG2Tags.Default tag table/Entry and hydraulic PT needs installing3	WORD	☒
Default tag table/Entry and hydraulic PT needs installing4	1	1	0	TAG2Tags.Default tag table/Entry and hydraulic PT needs installing4	WORD	☒
Default tag table/Welder temperature probe scaled	1	1	0	TAG2Tags.Default tag table/Welder temperature probe scaled	REAL	☒
Default tag table/Welder low pressure scaled	1	1	0	TAG2Tags.Default tag table/Welder low pressure scaled	REAL	☒
Default tag table/Welder high pressure scaled	1	1	0	TAG2Tags.Default tag table/Welder high pressure scaled	REAL	☒
Default tag table/Welder Primary head current scaled	1	1	0	TAG2Tags.Default tag table/Welder Primary head current scaled	REAL	☒
Default tag table/Welder secondary head current scaled	1	1	0	TAG2Tags.Default tag table/Welder secondary head current scaled	REAL	☒

Figure 12 - IBA Tags

Due to company data protection acts the companies MOC document cannot be shared, however due to the nature of this project the MOC was completed and signed off by the electrical engineer in charge Mr John Shannon. Not safety systems were altered or interfered with during this process as the system was a stand alone system and used for pure monitoring purposes.

The installation was completed inside of the current welder panel as shown below in figure 13 .This is the remote siemens node which is connected to the PLC in the electrical substation shown in figure 14.

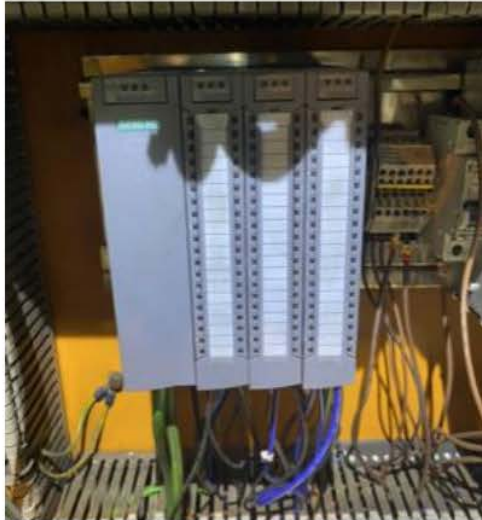


Figure 13 - Welder remote node



Figure 14 - 1516F CPU

The system is expandable as this is made up of remote I/O with a high powered siemens S7-1516F processing all of the data. With the simple addition of a scaleance switch, this network can be vastly expanded. The welder operation has not changed as the system is purely monitoring the process and not actuating or controlling anything it is purely for preventative maintenance and system improvements. The system has reliable fault finding procedures as if the line weld is poor, the engineer can use IBA to drag all the relevant data into a graph and look at real values in order to find a fault. This can be seen below in figure 15.

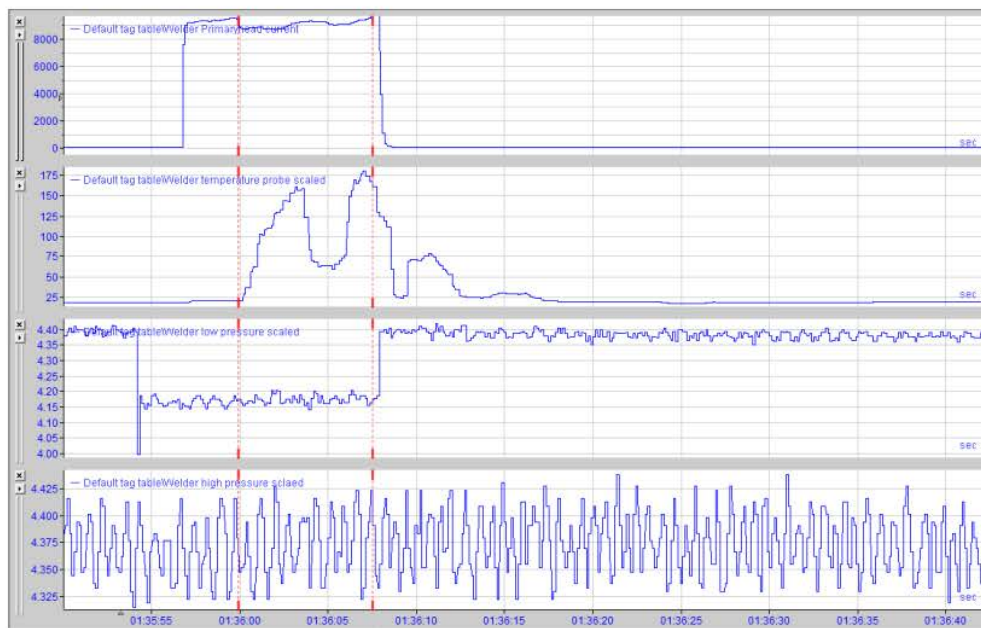


Figure 15- IBA Fault finding graph

The successful installation of the temperature probe shows that the strip temperature can be monitored and displayed on the screen whilst the operator is making a weld. If the operator sees a temperature below their set standard of 70 degrees, then they will make another line weld. The temperature probe can be seen below in figure 16 And the screen is displayed in figure 17.

A more detailed explanation of what these graphs mean is needed

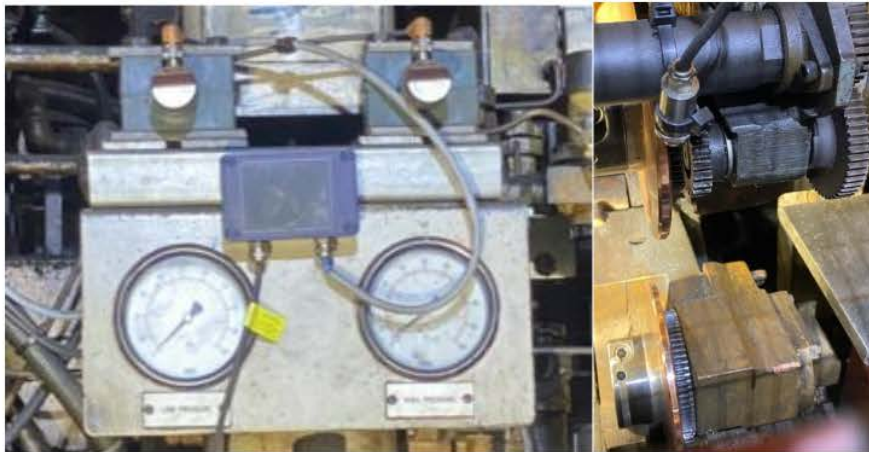


Figure 16 -

Temperature probe and screen



Figure 17 - SCADA screen

Looking back at all of these requirements set out in the FDS, they have all been met including 1 addition to the FDS which has also been successful. Comparing the final project to the FDS, it can be said that the system is successful as it provides all the tools needed in order to achieve the objectives of the project. The system needed to be able to show that components/functions of the welder are starting to fail as since the welder is controlled by an old GEM 80 PLC, it doesn't have any analogue monitoring facilities. This part has been achieved by the PLC processing the data, then IBA analyzer storing and monitoring the scaled data. This produces historical data which can be placed onto graphs and then can indicate areas of failing. Since the system has only been in a few weeks there are still some calculations going on in order to determine what the set standard values should be, however there are some very early indications which have directed engineers attention to failing components such as valves passing and metal filings tracking current to earth.

Looking at the requirement for future expansion in the FDS, it can clearly be seen that this requirement has been met and is successful as the FDS initially did not include a temperature probe to monitor the temperature, however it was added with ease simply by adding another analogue input card into the remote I/O rack. This addition sets the precedent for the complete modernisation of this welder GEM. It has been proved that the system can function on its own and the welder GEM 80 is its own controller, this means it does not talk to the line GEM80 so the upgrade would be considerably easier. As shown below in table 2 is the 3 main items the design would need to be based around.

Function	Description
Current monitoring.	Current monitoring on the primary and secondary side of the welder in order to see current trends. From this earthing on the welder will be able to be seen. (0-2000A)
Pressure monitoring.	Monitoring the high and low pressure of the welder in order to ensure the heads come together correctly every time. This is also referred to as snubbing pressure.(0-250 BAR)
Speed monitoring.	Carriage speed of the welder. The time is calculated from the welder wheels touch the strip, to when they stop touching the strip. (Time interval) as seen from IBA.

Figure 18 - Table 2

To finalise on the design process based on the FDS, the logical PLC to use was the 1516F due to its speed and processing power. This also allows the system to be expanded massively. The remote devices chosen in the design were applicable due to their parameter ranges and reliability, the devices has also been proven on different systems within the works therefore were highly recommended by other engineers. IBA analyzer is a system used on numerous production lines and has a track proven record of helping prevent major line delays by storing mass data and turning that into something useable.

3.6 Cost management Spelling

During the project it was vital the stay track on the budget side of things, the budget remained at £15,000 for the entire project so it was important to factor in costs of labour and every material which was needed. In order to maintain track of the budget a costing sheet was used and this was brought up during every annual maintenance meeting in order to stick within the budget. The budget plan is contain in section 3.11. During the design of the project, careful consideration was taken in order to carefully select which areas needed the most percentage of the budget. This means that the actual processing, storing and monitoring facilities of the project were given a larger slice of the budget compared to the installation side as there are alternatives for one but not the other. Company discounts were also taken into consideration as the more spent with one supplier the larger the discount is given, so this made logical sense to prepare for future expansion of the system, buy better components and receive a higher discount on the final total.

3.7 Problem solving

Since there was a variety of things that needed to be working from electrical wiring to network communications, a vast amount of problem solving techniques were used to create the design. The first issue would be the initial profinet communication to the works network. Since profinet is a siemens specific communication line, when connecting it into the works network switch, careful consideration had to be taken in order to ensure the correct port was programmed accordingly. Off the back of that, in order to obtain an IP address for the PLC, the level 3 administrators needed to provide an IP address in order to ensure there are no clashes.

3.8 Technical knowledge and literature

During the design phase of the project, previous knowledge of remote systems were applied. There were different things that needed to be correct electrically in order to prevent fault finding on a system which was produced incorrectly. Firstly, networking the system in TIA portal on the network topology needed to be correct otherwise the system would produce a BUS FAULT. All components used must be suitably rated to provide reliable analogue signals back (4-20ma over 10m or 0-10v under 10M). The current transducer data was analysed and was found to be 0-10v (Lem, 2021).The pressure transducer data sheet was analysed and it was found that the signal loop is 4-20ma (IFM, 2021)The S7 1516F CPU was chosen based on the technical literature provided in the data sheet. The possible range of expansion is up to 31 extra modules just in the PLCs main rack which covers the design for this project and future additions. (Siemens, 2021)The processing speed of the PLC was also a big consideration factor in the design as in the design specification it required a PLC with a processing speed/ scan speed of 1ms, whereas the 1516F has a scan speed of 500µs. (Siemens, 2021)When designing the actual circuit, circuit protection and cable sizing needed to be taken into consideration, for this the IET current carrying capacity table was used. (IET, 2021)

3.9 Operation, maintenance and reliability

All components used in the design of the project were selected as they were within the operating range with a tolerance above. This meaning that say if for some reason the pressure switches were to experience a surge pressure for any reason, they are already over rated for the current application and will not break in the event of an accident. This same stance was taken for the current transducers, the components were over rated for their application in order to avoid component failure from over range conditions. This did not cause any issues with the programming as the scaling can be adjusted accordingly. All components used are maintenance free devices and are simply a plug and play replacement. This reduces any time spent carrying out reactive maintenance on

components. The sensors chosen were also chosen due to their proven reliability which has been proved by their use on other productions lines inside of the business.

3.10 Components and design

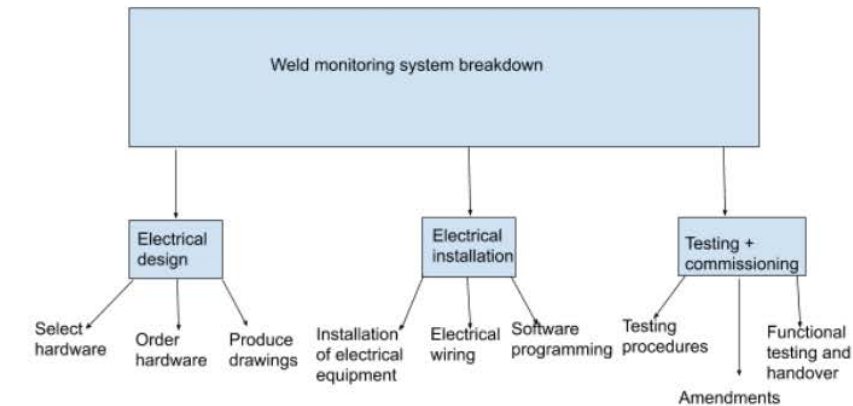
Firstly, all of the components were ordered through the companies bespoke SAP system. This provided access to discounts on orders and also faster guaranteed delivery dates. As shown below in table ... is the final table of all the components and consumables used.

Item name	Quantity	Price
S7 1516F CPU	1	£3229.15
S71500 PSU	1	£179.00
S71500 Rail	50cm	£62.00
Profinet connectors	4	£30.00
Module interface IM155-5	1	£315.00
Siemens 20A PSU	1	£140.00
AI input module	1	£210.00
AHR 500 B10 current transducer	1	£159.00
IFM PN2571 pressure transducer	2	£636.00
Calex CIRSPMHA201CT CRTMSD – temperature sensor	1	£400.00
0.5mm ² cable	20m	£14.99
1.0mm ² cable	20m	£20.00
2.5mm ² cable	20m	£30.00
Profinet cable	100m	£300.00
Bootlace Crimps	100	£10.00
Ferrules	100	£10.00
Electrical labour	200 hours	£4000.00
TIA license	1	£1500.00
IBA Analyzer	1	£1500.00

The total price of all the components/consumables selected was £12,745.14 which is under budget and leaves £2,254.86 left of the overall budget.

3.11 Work breakdown structure and contingencies

The work breakdown structure was closely followed throughout the implementation and construction of the project. The work breakdown structure can be seen below in figure 19.



Work breakdown structure

Figure 19 -

Since the electrical design of the project had already been completed, the next step was to prepare for the installation of the system. Since the system could only be installed on the annual maintenance and time was a critical aspect of this project, a contingency was put into place so that as much of the project was constructed before the annual maintenance so that time could be saved on the week of the maintenance. The PLC and remote node was connected together and the remote devices were put into place of the cleaning line when the line stopped for a cleaning stop. This saved a mass amount of time when it came to the installation. The PLC coding and IBA installation was also carried out weeks before the annual stop, which again saved time and allowed more time for the physical installation. On the week of the annual maintenance further contingencies were put into place just in the event of work not being complete. The installation of the project was prioritised so that the cabling was to be installed first, then the physical wiring of the system and then followed by the final checks before commissioning began. One hindrance did occur when mechanical colleagues needed to access the welder which prevented the electrical cables being installed until the second day of maintenance, the contingency put in place for this was that two electrical craftsmen were asked to work a nightshift in order to carry out the work when mechanical had finished in the area. Another hindrance that occur was that the programming PC failed with the saved software on and the engineer who has control over the back ups was off on long term sick, so as a contingency a programming laptop was borrowed from another line in order to commission and act as a way to communicate to the PLC without the failed program. During the commissioning phase there was a major problem with the 4-20ma loop where the signal was not producing the correct readings and showing massive discrepancies. So after applying some technical knowledge, it was decided to put a 500hm resistor across the loop which then creates a voltage input. Once this was done the loop actually started to work and the expected readings were displayed in the PLC. This is one example of the effective engineer contingencies used when doing this project.

Was the analogue module configured for current?

By adding the resistor to the loop you have converted the signal to a voltage which is the default configuration for an analogue module.

Remove the resistor and configure the module for current to get a better range.

Contingencies are planned and planned contingencies are not remedial actions

these are unnecessary details

3.12 Constraints

There were two major constraints which were initially highlighted, these were COVID-19 and the working from home issues raised. COVID-19 did have a massive impact on how the project was installed as the rules around working together meant that people were not allowed to work in bigger groups than 2 and also had to have more PPE on which produced harsher work environments. This issue was combatted by ensure anyone involved in this project were following the strict government guidelines and also a split shift approach was taken. This meant that colleagues would work alternative hours in order to reduce the chance of transmission. The working from home constraint did not prove much of an issue as it was agreed before hand that all individuals involved would be allowed to come into work during this week period. One constraint which was not highlighted initially but proved a massive issue in the end was time. The time frame given to this project was very front loaded and also very demanding. The way this was combatted was to allow craftsmen to work longer hours to complete the work however, this also posed another constraint which is workplace fatigue. Overwork could raise a safety risk so this meant that all the hours which were overtime needed to be approved by an area engineer in order to ensure no one would be working too many hours.

3.13 Time plan and achievements

Following below in figure 20 is the final time plan indicating the achievements on different days. Green marks the planned date for the tasks to be completed whilst red is when the tasks were actually completed. Due to the current climate tasks were not completed on time because the annual maintenance was moved forward. This did not alter the project but did change when different milestones were met.

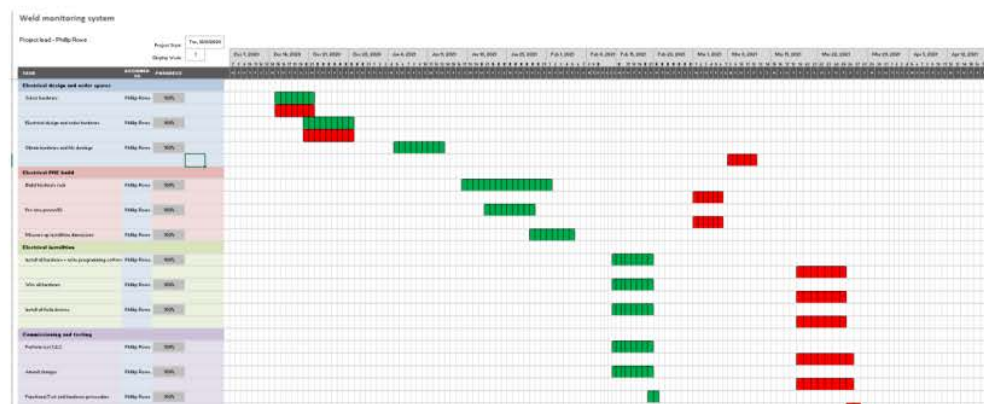


Figure 20 - Final timeline plan

3.14 Codes of practice

All electrical codes of practices were put into place and followed during the project. Skilled, competent craftsmen installed and terminated all electrical components and conductors. These craftsmen were also BS7671 18th edition trained meaning that they were competent to install the system to that standard. The installation was also verified by the electrical engineer in charge. BS EN 50110 and BS EN 60529 were both verified during the testing phase of the project.

4. Testing and results

After the installation of the project was completed, the next phase was to carry out commissioning on the system. A systematic approach was taken whilst closing following the specification in the FDS.

Awk.

4.1 Dead testing

This section is for the pre-functional tests to be carried out. This is to ensure that once powered up no hardware damage will be done.

	Test type	Test method	Expected result	Actual result	Pass/Fail	Amendment requirements
1	Continuity test of power +/- connections.	Continuity test	0.1 ohms	1.1ohms	PASS	N/A
2	Continuity test of remote I/O device supplies.	Continuity test	0.1 ohms	0.1ohms	PASS	N/A
3	Continuity test of AI connections	Continuity test	0.1 ohms	0.1 ohms	PASS	N/A
4	Tightness test of all connections	Terminal screwdriver	2.5nm torque setting	2.5nm	PASS	N/A
5	Security of all transducers	Physical touch	Secure by hand	Secure	PASS	N/A
6	Visual inspection of present earth/containment protection (BS EN 50110 and BS EN 60529)	Visual	Present	Present	PASS	N/A

4.2 Live Testing

This section will provide the live testing where the power will be turned on BUT there will be no functional testing.

	Test type	Test method	Expected result	Actual result	Pass/Fail	Amendment requirements
1	Power supply voltage tests with MCB's off.	Voltage tester - Multimeter.	20-28v - No circuit break trips.	24v	PASS	N/A
2	Power supply voltage tests with MCB's on.	Voltage tester - multimeter.	20-28v - No circuit breaker trips.	24V	PASS	N/A
3	Remote devices power cycle check.	Visual	Transducers to power on.	Power ON	PASS	N/A
4	Communications test.	Server PING test.	Reply from controller to programmer.	No reply	FAIL	Profinet cable damaged, remade cable and communications restored.
5	PLC to IBA communications	Find PLC on IBA software using internal PING function	Communications toggling	NO Comms	FAIL	Network switch not set up for profinet, change port properties and all communications working.

6	IBA to see S7 live tags	Look for data transfer from S7 into IBA taglist	Signals and live data present	Signals present	PASS	N/A
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4.3 Functional testing

This section will be where the operation of the system will be tested providing that all the other test procedures are completed successfully.

	Test type	Test method	Expected result	Actual result	Pass/Fail	Amendment requirements
1	AI signals test	Monitor values	Value range between 0-27648	Range set and signals tested	PASS	N/A
2	Scaling of transducers.	Set ranges and adjust as needed	I.e 0-27648 = 0-250 BAR.	Ranges set, one range found to be wrong.	FAIL	Range changed and all ok.
3	Live IBA graphs showing scaled values	Monitor live graphs	Scaled values should reflect real values, check display on transducers	Scaling out	FAIL	One transducer operating range found to be wrong in S7, changed and scaling now correct.
4	IBA recording data	Look at IBA database for stored results	Data files storing every 30 minutes	Files saving	PASS	N/A

4.4 Testing overview

After completing all of the testing, the system worked correctly. The major problem which occurred whilst commissioning this system was that the communication between the PLC and IBA was not working. Initially using the correct cable tester, a profinet cable was found to be defective. When this issue was rectified there was still a communications issue. Since the PLC was connected to the works network, through a managed switch it was decided to take that switch out of the loop in order to just prove simple communications. After this worked it narrowed the problem down to the managed switch. By interrogating the managed switch ports, it was found that the port was not set up for profinet communications. This was then changed to the correct protocol and the communications commenced.

It is not necessary to say what went wrong and how you fixed it, these details belong in a log book

5. Evaluation and Wider Issues

Once the project was fully tested and completed, a reflection of the FDS was made in order to see if the physical system met the FDS initially set. The FDS required an effective weld monitoring system which can prevent poor welds break inside of the line. It also required live variables to be monitored in order to assist during fault investigations of poor welds. A storage facility of this live monitoring was also needed in order to compare previous welds to a known set standard. It can conclusively be said that the system meets the FDS supplied as, the system effectively monitors every line weld which is done. The system also produces reproduceable and effective readings which are taken from input devices. One planned outcome of the FDS which was taken out was the alarming beacon. This would've alerted operators of a poor weld if one was made. The reason this was not met was because there has been a better alternative which is being designed at this moment. An interlock system is being designed to replace the alarm so that operators cannot proceed if there is a poor weld, so the alarm was left out as part of a cost saving procedure. One addition which was made to the FDS was the temperature probe. This was added just as another variable to enhance the probability of stopping poor welds getting through the production line. By installing a temperature probe this satisfied that part of the FDS.

Looking at the IBA section of the FDS, whilst there were some teething issues this section was met. This outcome was met as there is clear data which has been mapped over from the PLC into IBA analyser which is producing live trends and also saved previous data files. One of the biggest parts highlighted in the FDS was the need to have future expandability. Now that the system has been implemented and proved to effectively be fit for purpose, the system now could be expanded to replace older PLCs on the line. The room for future expansion is huge as the CPU which is processing all of the data from each remote node is powerful enough to run production lines. With its massive processing power, large memory and reliability this system can easily replace older CPU systems which are used. Looking at the budget initially set and comparing it to the actual spend during the project, there was effective cost management strategies which were put in place which have successfully ensure that the project has stayed within the budget. Although there was money left in the budget after the project was completed, there could have been more money spent on the networking side of things as when commissioning that's where the majority of issues were caused.

The first wider issue raised in the first report was the ethical issue, which was looking at the transparency of companies when it comes to cheap labour. All the manufacturing companies which made the devices which were used in the system all have clear, ethical and sustainable business promises on their website. The manufacturers also only have their factories in first world countries which have strict laws around minimum wage levels, this satisfied this ethical issue. The environmental issue raised was that all the components used are made from sustainable materials and are reliable in order to reduce waste and minimise the amount of raw materials used by buying that device. All items used were market leaders and after looking through their datasheets, the failure rate is low which a high component life expectancy. The final legal issue raised were that individuals cannot be in work longer than 16 hours a day and must have 2 days off every 14 days. This was met by ensuring all overtime had to be approved by the area engineer. The installation took place over 8 days so everyone would have had 2 days off prior to the project starting.

6. Conclusions and Recommendations

To conclude on the project as a whole, it can be deemed as a success. This can be said as the system met all of the points which were listed in the FDS and also was able to accommodate the late addition of a further requirement. The management of the project can also be deemed as a success because the system was designed, installed and commissioned within the time period given, but also the budget was adhered to. It can be said that the project is now providing an effective tool which can be used in order to save vast amounts of money. This is proved by the trending data in the IBA analyzer being able to show a deuteriation of components being a drastic and costly strip break happens.

Future recommendations for this project would be now that this system is in place, start to replace all of the older CPUs and other control systems and integrate them into this new system. This would provide one simple access hub for all of the functions, data and monitoring which would be needed. Another recommendation would be to not only replace the control side of the old systems, but also replace the SCADA screens with siemens WINCC HMI screens. This would mean that all the data would be drag and drop onto the HMI from the PLCs tag list making every item in one place and easier to access. The final recommendation would be to expand on the monitoring system which is already installed. This would mean adding more devices in order to monitor the welds as they are happening for example, this could mean using an infrared camera to look at the seam weld before tension is being applied.

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most of these sources have not
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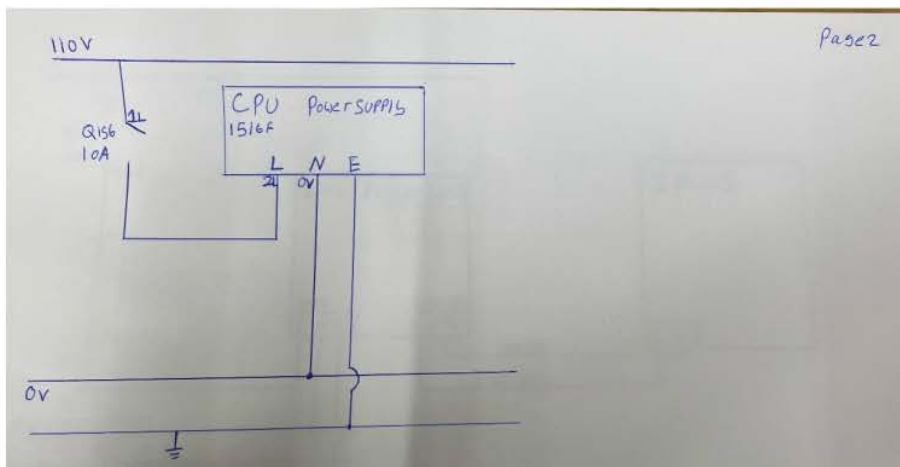
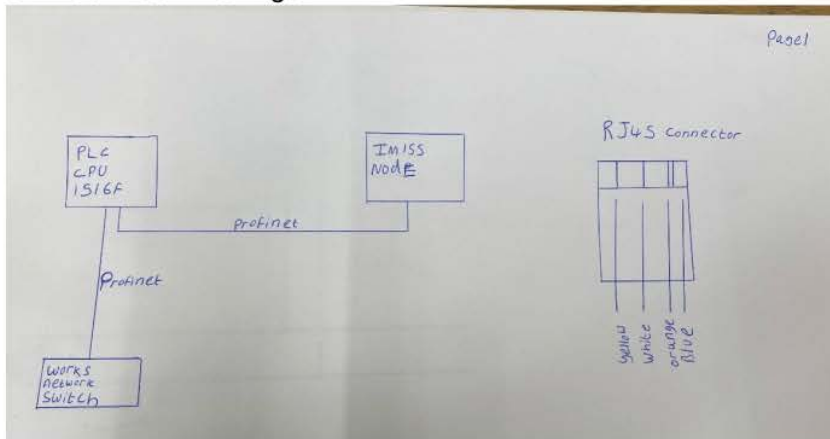
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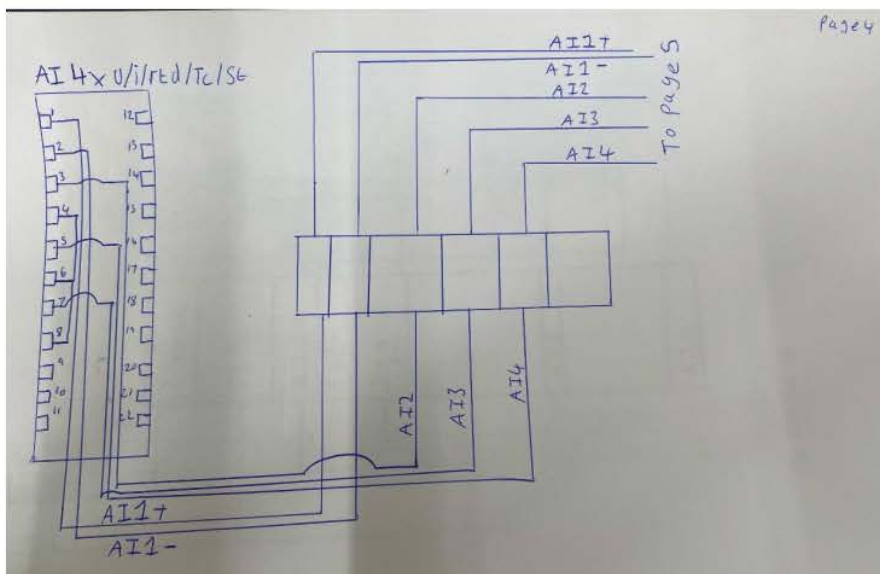
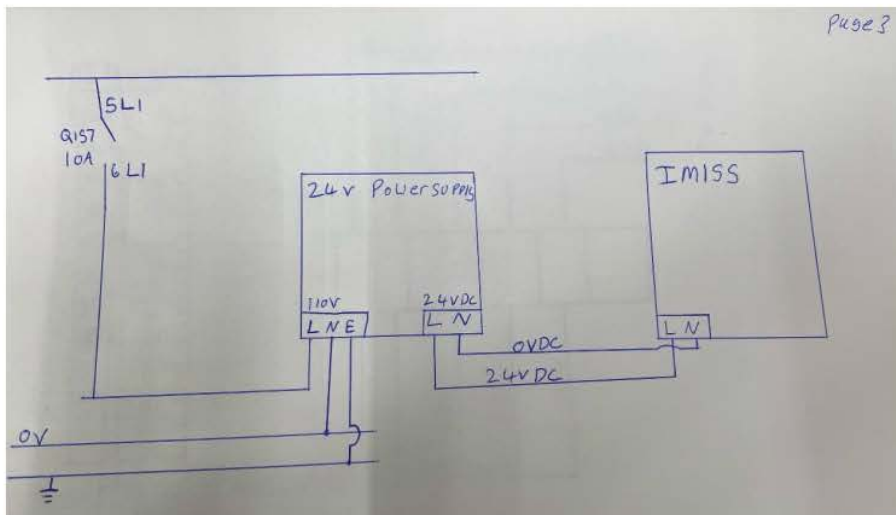
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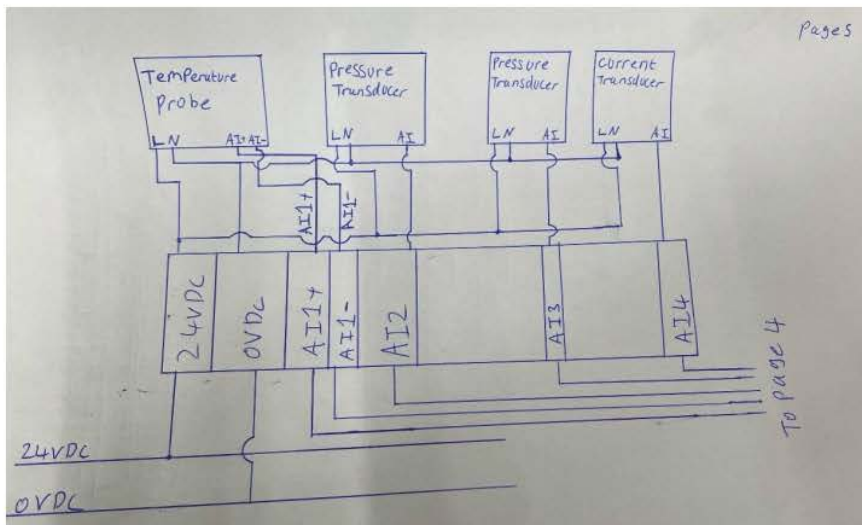
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8. Appendix *These should have been drawn professionally using CAD or similar*

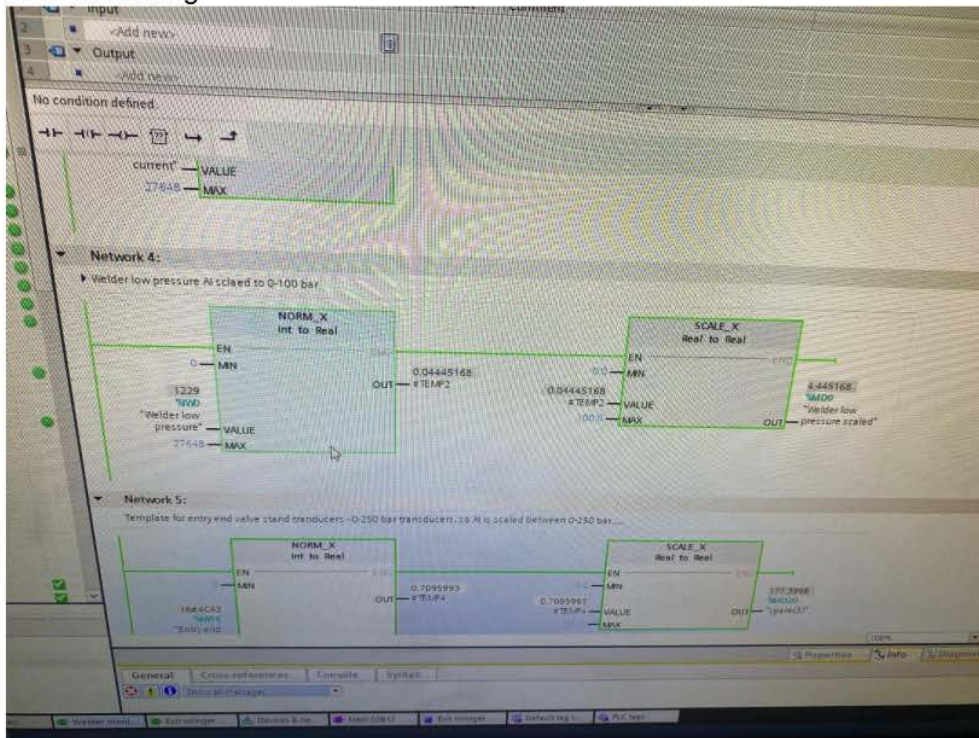
8.1 Technical Drawings

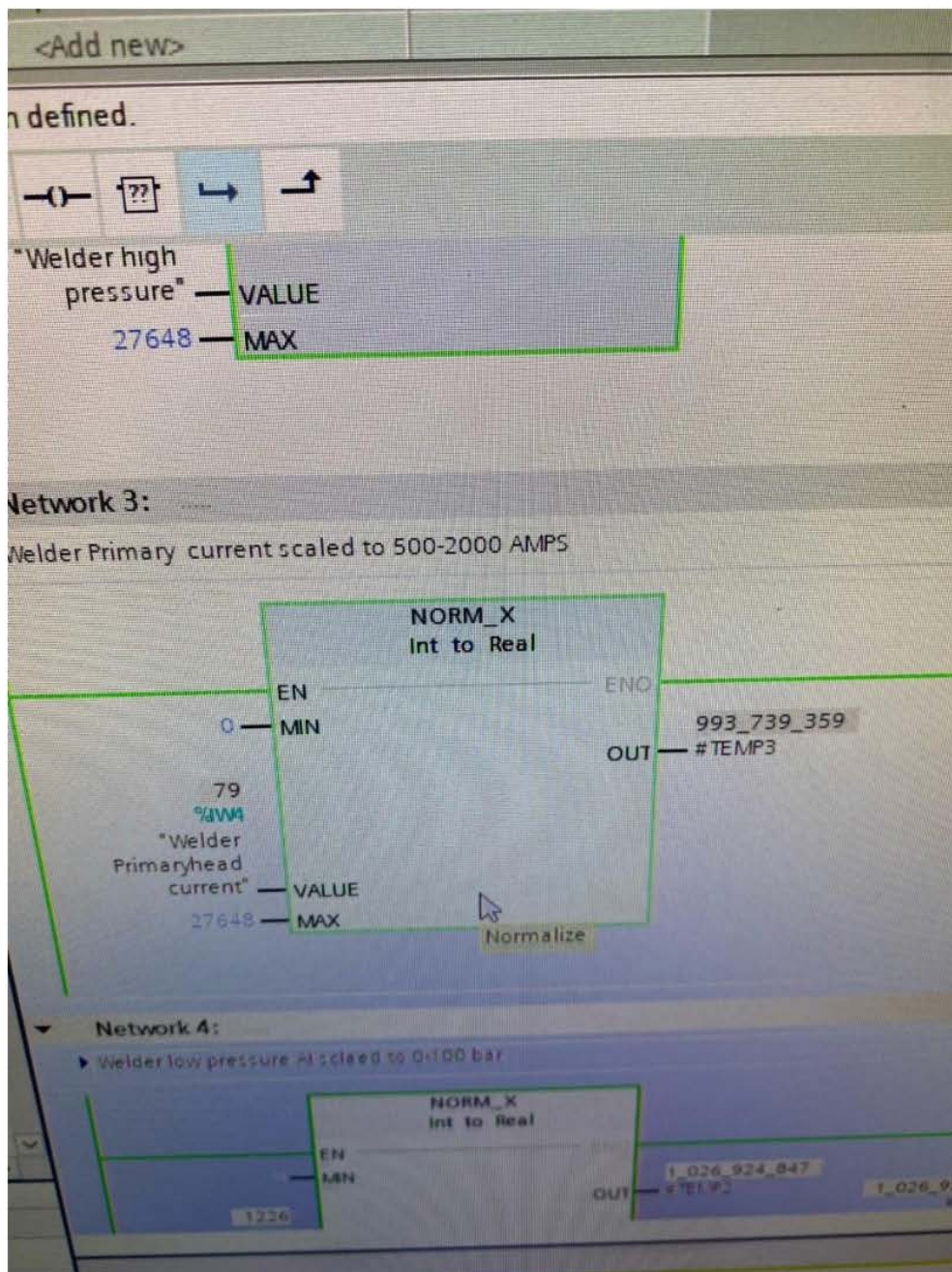


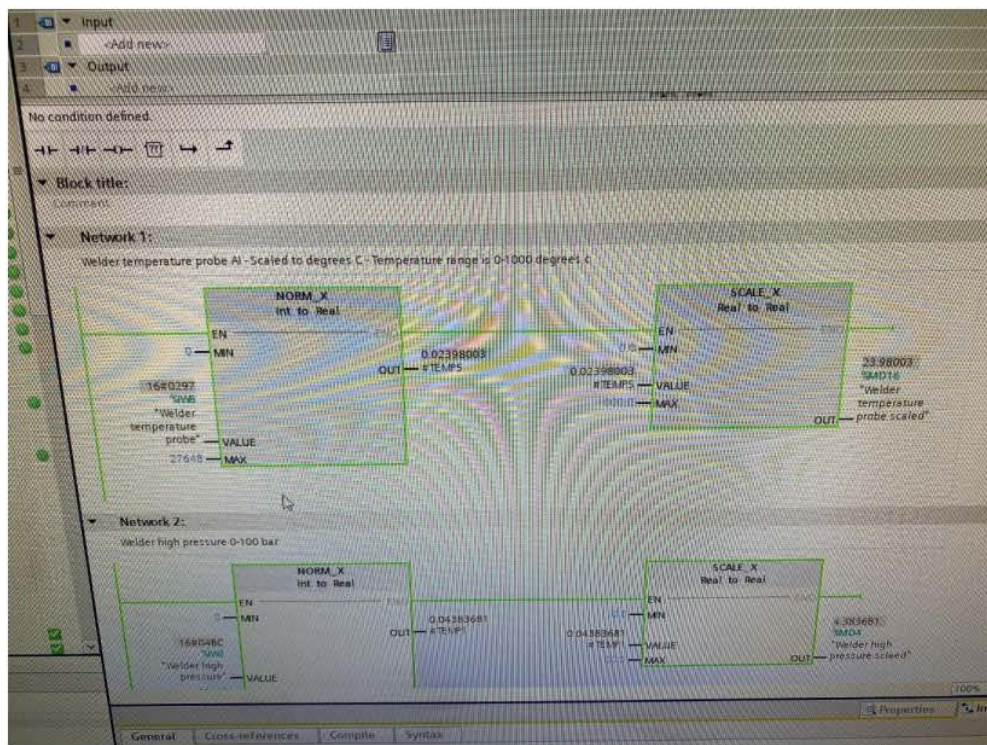


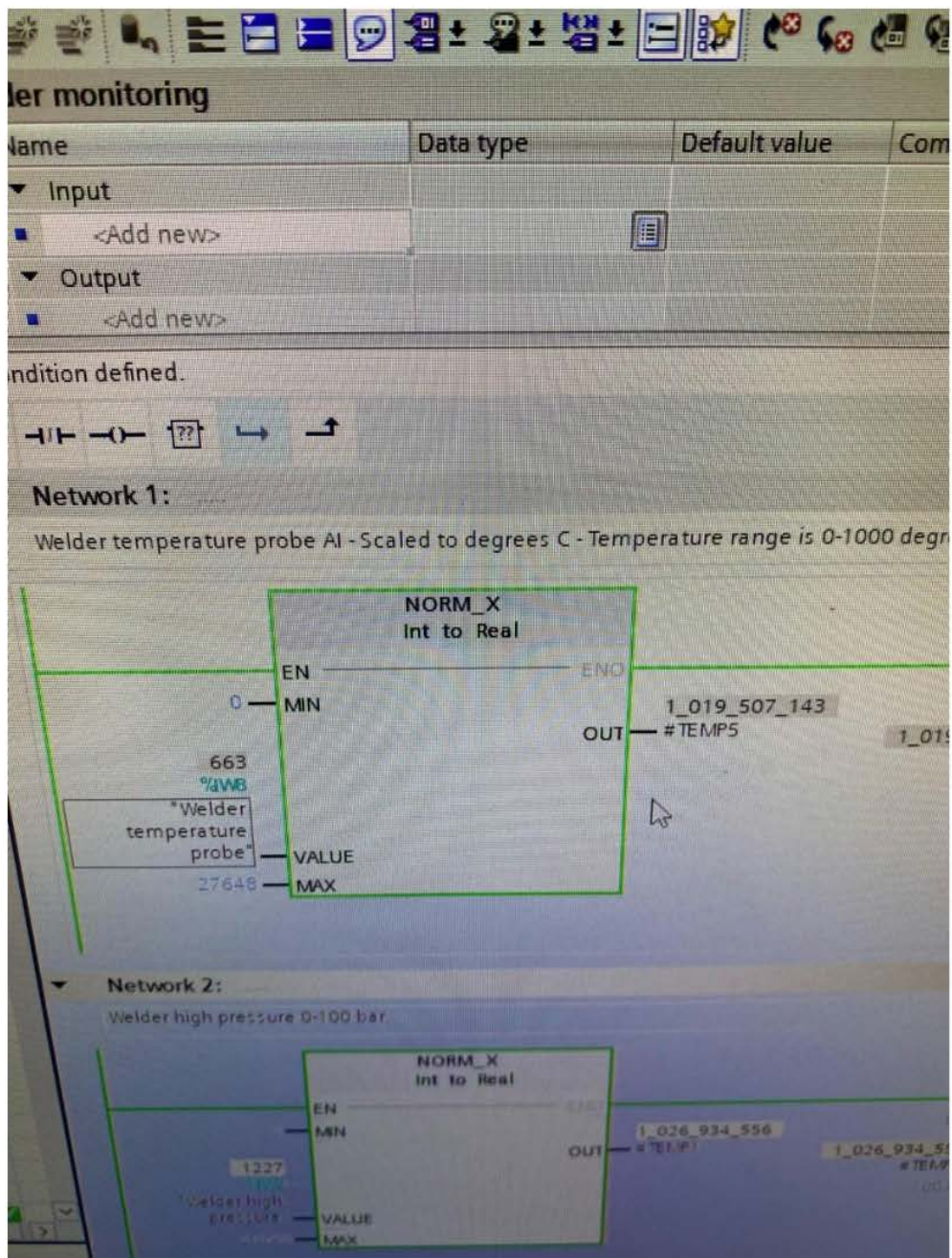


8.2 PLC coding









FINAL GRADE

GENERAL COMMENTS

Instructor

64/100

PAGE 1

PAGE 2

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Good Structure

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Text Comment. Where is your acknowledgements section?

PAGE 3

PAGE 4

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PAGE 5

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PAGE 10

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PAGE 11



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Text Comment. Remove the resistor and configure the module for current to get a better range.

PAGE 22

PAGE 23



Awk.

Awkward:

The expression or construction is cumbersome or difficult to read. Consider rewriting.

PAGE 24

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GRADING FORM: NEW CSG-RUBRIC

PHILLIP ROWE

64

1. ENGAGEMENT WITH LITERATURE



Section 3: Judicial use and critical evaluation of technical literature in the design of the project: There is some evidence of the use of technical literature from manufacturers. Siemens literature was used extensively, no obvious appraisal on the validity of other sources though. Section 4: Extent of reading, range of credible sources and use of Harvard method: The citation list is more of a Bibliography as few of the sources have been cited in the text of the report. However, there is good evidence of reading. A wide range of appropriate sources were used, reference list was compiled correctly using Harvard. (6/10)

6

2. KNOWLEDGE AND UNDERSTANDING



Section 3: Advanced knowledge and critical understanding demonstrated in the design of the project: There is evidence of knowledge and understanding. However, there are missed opportunities to give further explanations. The project design and implementation were well explained. (6/10)

6

3. COGNITIVE AND INTELLECTUAL



Section 5: Testing and analysis of result: There is good evidence of testing. However, you could have analysed and explained the trends better. You could have fully exploited what you have achieved. The trend data could have revealed much more. Section 5: Critical evaluation of the project outcomes: A good attempt made at evaluating the project outcomes Section 6: Conclusions and recommendations: Good conclusions offered with recommendation for expansion of the project in the future. However, these suggestions do not all relate directly to your project but seem to include integrating other parts of the plant to make use of the processing power you have made available. You could make much more use of the trend data information and the PLC program provides you with far more opportunities to provide information to the operator and engineer than you have stated. (19/30)

19

4. PRACTICAL APPLICATION



Section 3: Appropriate hardware has been selected. Good interface with the IBA. However,

24

the software is rather simple and the use of a resistor in the current loop suggests that the module has not been configured correctly. Section 4: Very good deployment of methods and installed according to company standards and regulations. However, the drawing are of a poor hand drawn quality and should have been drawn using professional software with company procedures stamped all over them. Section 4: A high-quality end result for the company with scope for future development. Section 5: Good use of test equipment results are clear except that the program itself is made up of photos of a screen rather than a printout. Sections 3 and 5: The process has been managed well to deliver the project outcome on time and within budget. (24/35)

5. TRANSFERABLE SKILLS

 Sections 1 and 2: Executive summary, acknowledgements and introduction: Briefly summarised and introduced but no acknowledgement given The Executive Summary could have given more specific values and the introduction could have included objectives. No acknowledgements were given. All Sections: Quality of the report: Well structured. However, most of the images belong in the appendix. Writing style is awkward and contains many spelling, punctuation and grammatical errors. The report would be better presented as 1.5 line spacing with fully justified text. Some of the images are photos of a screen at an angle and are difficult to read. The report was well written and presented in a

logical order. Images were not well presented with too many photographs of your computer monitor and scruffy hand drawn diagrams. Word count: Not exceeded (9/15)

SECOND MARKER - MH

1

Course: BSc (Hons) Electrical and Electronic Engineering
Module: SGEL6000 Independent Project
Assignment: 2. Project Design, implementation and evaluation
Name: Phillip Rowe
University number: 1602827
Date submitted: 26/04/2021
Word count: 6125

① REFERENCE LIST WAS EXTENSIVE, COULD HAVE INCLUDED AUTHORITIES ON WIDER ISSUES.

② IMPLEMENTATION OF PROTECT DESIGN WAS WELL EXPLAINED.

③ TESTING SCHEDULE WAS DETAILED WITH APPROPRIATE SUCCESS/FAIL METRICS.
CONCLUSIONS WERE GENERIC AND COULD HAVE BEEN MORE SPECIFIC
GOOD RECOMMENDATIONS.

④ PRACTICAL DEPLOYMENT WAS COMPETENTLY APPLIED AND WELL EXPLAINED.
TESTING RESULTS WERE COMPREHENSIVE.

⑤ REPORT WAS WRITTEN, HOWEVER THERE TOO MANY PHOTOS OF A COMPUTER MONITOR OR HANDWRITTEN DIAGRAMS. THESE DETRACTED FROM AN OTHERWISE WELL PRESENTED REPORT.

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1. Executive Summary

In this report an effective weld monitoring system was build whilst closely following the FDS. The system was designed using the most logical equipment in order to meet the required specification. The project budget was taken into careful consideration along the way in order to maintain the making of a cost-effective system whilst still meeting the end goals. First draft design drawings were made ready and sent to the drawing office to be filed ready for the installation of the system. The system was installed in a timely manner sticking to a project time plan with then the final commissioning commencing at the end. The PLC programming was written with industry codes of practices in mind in order to make the system easy to interrogate. The PLC was also connected onto the works network to then allow communication with the IBA analyzer server in order to meet the requirement of being able to see live data and effectively monitor line welds. Throughout the project different management techniques were used in order to iron out any issues which were raised. At the end of the installation the FDS was then looked at again in order to see if anything had not been met or if any additions had been made. Everything on the original FDS had been provided however there was one addition of a temperature probe which was not included in the original FDS but was added at the time of installation. After looking over the FDS and comparing it rigorously to the final system, it was deemed that the project was a massive success as it had achieved all of the points raised in the FDS, stayed within the original budget and also been completed within the allocated time frame.

YOU NEED TO GIVE SPECIFIC EXAMPLES / NUMBERS IN THE ES RATHER THAN MAKING GENERALISED STATEMENTS OF BUDGET, MANAGEMENT TECHNIQUES AND SUCCESS CRITERIA.

2. Introduction

In this report it was set out to design, install and commission a weld monitoring system, which met the FDS in assignment 1. The aim was to create a system which could effectively monitor the production line welds which were made on the cleaning line. The chosen method from assignment 1 was to make a system based off siemens S7 hardware, program using TIA portal and also have live and historical analysis mapped into IBA to aid fault finding and show degrading parts before they cause issues. The system needed to be completed and installed on time, whilst also tracking and sticking to a set budget.

You could include AIMS AND OBJECTIVES
 WHERE :
 AIMS = WHAT YOU WILL DO
 OBJECTIVES = HOW YOU ACHIEVE THE AIMS.

3. Design and Implementation

The design chosen for the weld monitoring system was the Siemens system. The Siemens system will consist of one main processing hub which will be located in the central substation, then a remote I/O node will be placed local to the welder in order to input these analogue signals. The programming station for TIA portal and IBA analyzer will be located in the central substation on the engineering desk.

3.1 Block diagram designs

In order to carefully and accurately design the system, block diagrams have been made in order to layout all devices needed for the system. Following below in figure 1 is the general block layout for the system.

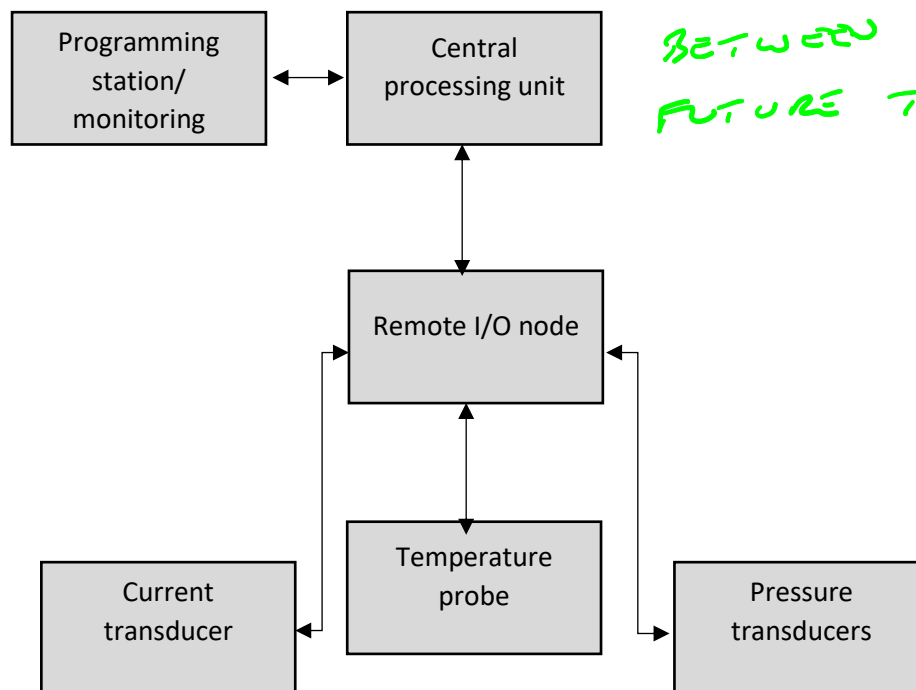


Figure 1- Block diagram of system

YOU ARE SWITCHING
BETWEEN PAST AND
FUTURE TENSES.

Now that the basic block diagram has been designed, a more in-depth diagram can be formed showing the forms of communication and also the signals which will be sent between devices. As shown below in figure 2 is the more detailed block diagram listing how each of the devices communicate with each other.

↑
THESE 2 DIAGRAMS LOOK
FUNCTIONALLY DIFFERENT?

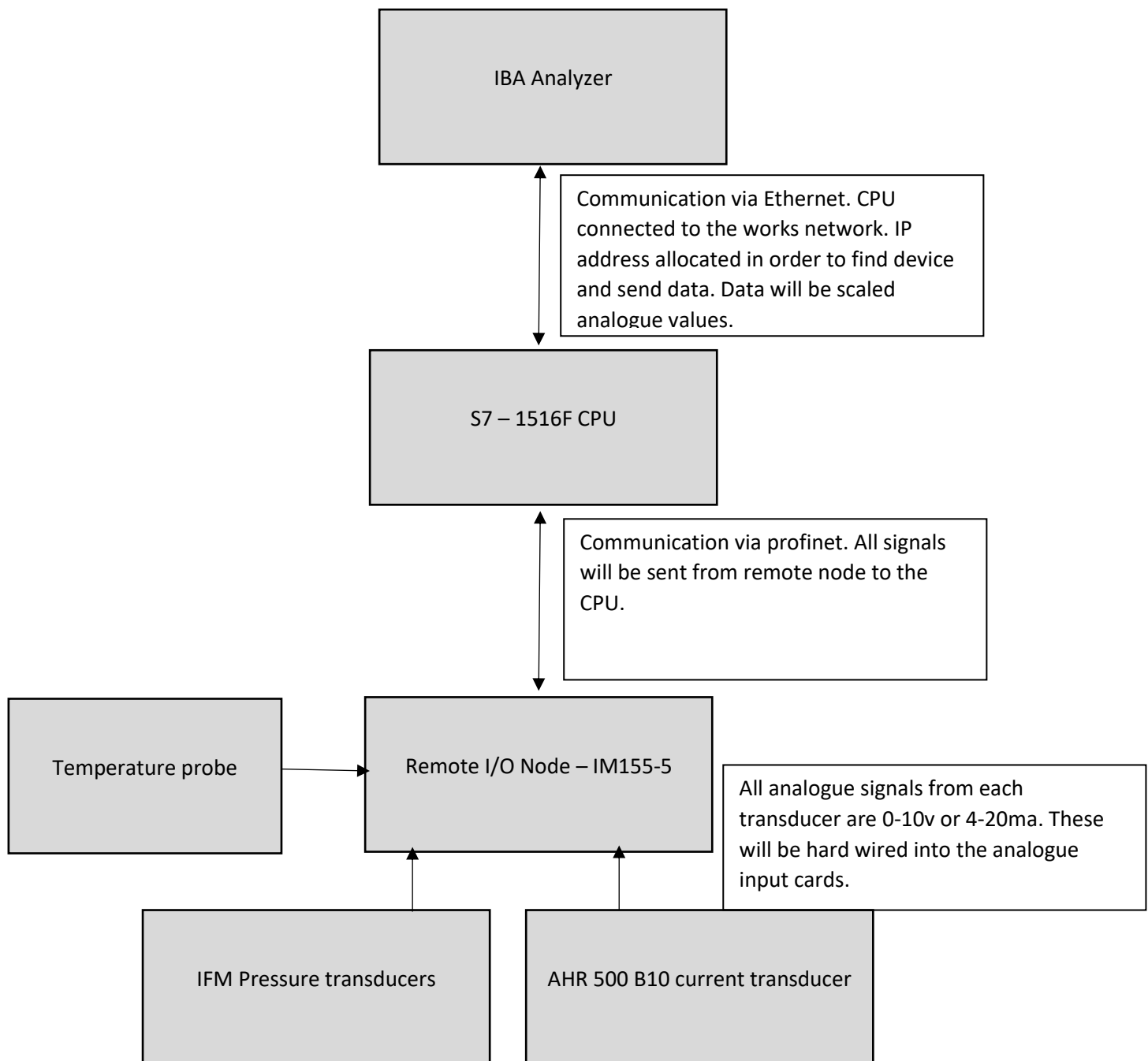


Figure 2- Block diagram of hardware components

Now that the general flow of the system has been designed. The components need to be selected in order to produce electrical drawings for the system.

3.2 Component choices

Based off the specification written, a list of components was chosen in order to meet the desired specification and project demands. Following below in table 1 is the list of items which have been chosen along with quantity and reasoning for choosing that item.

Item name	Quantity	Reason chosen
S7 1516F CPU	1	Fast processing speed, room for massive expansion for future demand.
S71500 PSU	1	Power supply unit which is required for the 1500 series PLCs.
S71500 Rail	50cm	Special rail used in order to mount the 1500 series devices.
Profinet connectors	4	Used to terminate profinet ends for network communications.
Module interface IM155-5	1	Remote node used for the 1500 series with a range of expandable input cards can be used with a higher current/voltage rating.
Siemens 20A PSU	1	Capacity for large number of devices to be used under this power supply.
AI input module	1	This card offers U/I and RTD capabilities. Type of input is changed by wiring and altering software.
AHR 500 B10 current transducer	1	This current transducer is fixed and will also measure within the current range needed of 0-2000A. It also offers 0-10v output.
IFM PN2571 pressure transducer	2	This pressure transducer offers the correct operating range, as well as the correct analogue signal of 0-10v output.
Calex CIRSPMHA201CT CRTMSD temperature probe	1	This will monitor the temperature of the strip and provide the correct output signal of 4-20ma.

Figure 3- Table 1

Since all of the general components have now been decided on, the electrical drawings were created in order to produce technical sheets which will be used in order to install and wire the system.

3.3 Technical drawings

Once the circuit was designed, electrical drawings were made in order to install the system. These drawings can be found in appendix 8.1.

3.4 PLC Coding

When designing the system, the PLC code needed to take raw analogue signals both 0-10v and 4-20ma, then convert and scale them into a useful number which the end user can understand. The first step was to design the networking side of the PLC in order to ensure proper communications between the CPU and the remote node. A new portal program was created and the correct

hardware devices were dragged in and the profinet network link was connected. This can be shown below in figure 4.

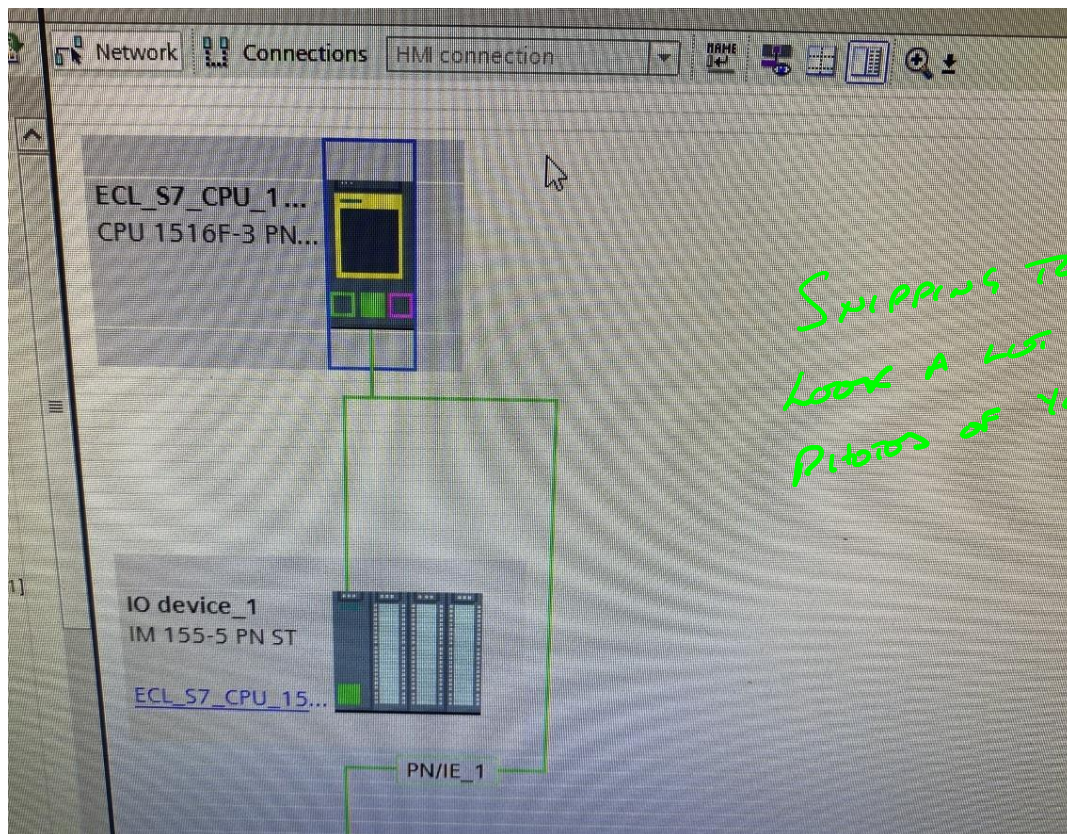


Figure 4- PLC

network topology

Both devices were given IP addresses in order to establish communications on power up. The next step was to enter all of the tags ready for when the analogue devices were wired in and the system was turned on. This can be seen below in figure 5 the full tag table for the devices put in.

Name	Data type	Address	Retain	Access	Write	Visible	Supervis	Comment
1 Welder low pressure	Int	%W0						
2 Welder high pressure	Word	%W2						
3 Welder Primary head current	Word	%W4						
4 Welder secondary head current	Word	%W6						
5 Welder temperature probe	Word	%W8						
6 SPARE	Word	%W10						
7 SPARE(1)	Word	%W12						
8 SPARE(2)	Word	%W14						
9 Entry end hydraulic PT needs installing	Word	%W16						
10 Entry end hydraulic PT needs installing(1)	Word	%W18						
11 Entry end hydraulic PT needs installing(2)	Word	%W20						
12 Entry end hydraulic PT needs installing(3)	Word	%W22						
13 Welder temperature probe scaled	Real	%MD16						
14 Welder low pressure scaled	Real	%MD0						
15 Welder high pressure scaled	Real	%MD8						
16 Welder Primary head current scaled	Real	%MD12						
17 Welder secondary head current scaled	Real	%MD20						
18 spare(3)	Real	%MD24						
19 spare(4)	Real	%MD28						
20 spare	Real	%MD32						
21 Tag_9	Real	%MD36						
22 Tag_10	Real	%MD40						
23 Tag_11	Real	%MD44						
24 Tag_12	Real	%MD48						
25 Tag_13	Real	%MD52						
26 Tag_14	Real	%MD56						
27 Tag_2	DWord	%MD60						
28 Winger roll 7 pressure OP side	Word	%W32						
29 Winger roll 8 pressure OP side	Word	%W34						
30 Winger roll 10 pressure DRIVE side	Word	%W36						
31 Winger roll 8 pressure DRIVE side	Word	%W38						
32 Winger roll 7 pressure DRIVE side	Word	%W40						
33 Winger roll 10 pressure OP side	Word	%W42						
34 Tag_3	Bool	%M100.0						
35 Tag_5	Bool	%M100.1						
36 Tag_6	Bool	%M100.2						
37 Tag_7	Bool	%M100.3						
38								

Figure 5- PLC tag

list

In order to prepare fully and ensure the successful completion of the project, during the design stage all of the code was pre-written so that it would save time when commissioning. As shown below in figure 6 is the scaling code for all of the components used. This code was designed and written in order to provide high accuracy. The code takes the input word which is a 0-10v or 4-20ma signal from the transducer, converts it into a real value and then makes that value linear between two points in order to produce something which can be used and interpreted. The limits are set by using the transducers operating range. All other scaling functions can be found in appendix 8.2.

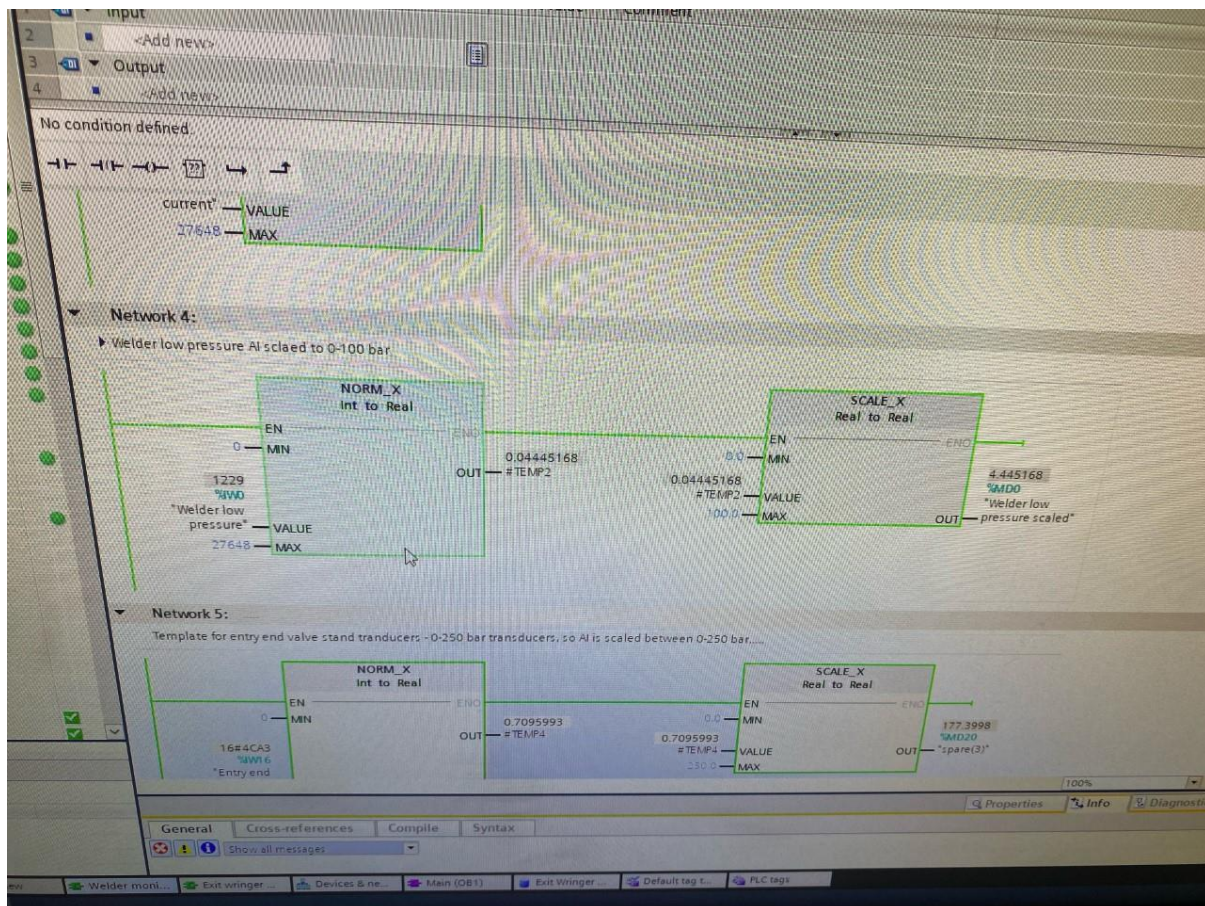


Figure 6 - Scaling code for transducers

The final coding design was to create an S7-Xplorer file on IBA which would allow the transmission of the created tags from the S7 PLC. As shown below in figure 7 is the new S7-Xplorer file which was created in order to import all of the tags from the PLC. This was designed like this so that any tags which were added into the PLC could be transferred straight into IBA by pressing the “load address book from S7”.

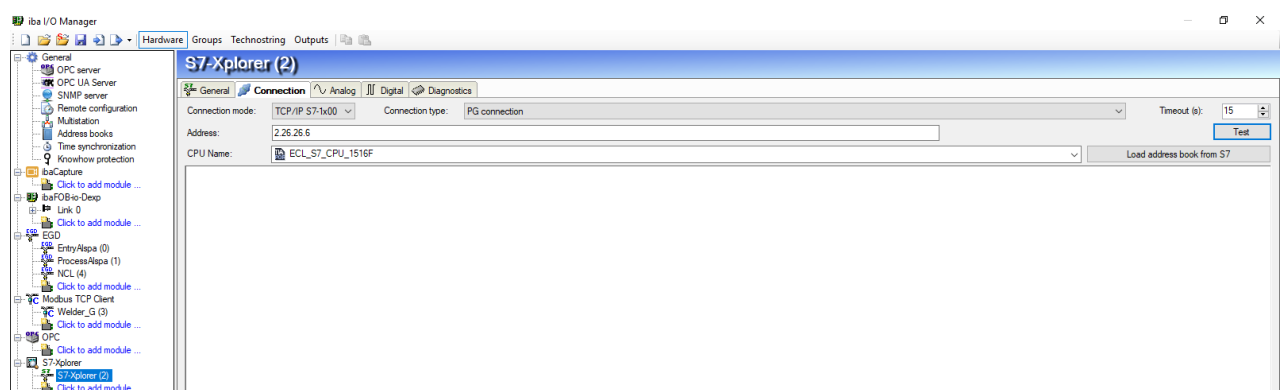


Figure 7- IBA Communication

The final coding design which was done was to create a tag table of the tags which were needed from the S7 PLC. This was done after the tags were transferred over the network and can be seen below in figure 8.

Name	Unit	Gain	Offset	S7 Symbol	S7 Data Type	Active
0 Default tag table\Welder low pressure			1	0 TAGS\Tags.Default tag table\Welder low pressure	INT	☒
1 Default tag table\Welder high pressure			1	0 TAGS\Tags.Default tag table\Welder high pressure	WORD	☒
2 Default tag table\Welder Primary head current			1	0 TAGS\Tags.Default tag table\Welder Primary head current	WORD	☒
3 Default tag table\Welder secondary head current			1	0 TAGS\Tags.Default tag table\Welder secondary head current	WORD	☒
4 Default tag table\Welder temperature probe			1	0 TAGS\Tags.Default tag table\Welder temperature probe	WORD	☒
5 Default tag table\SPARE			1	0 TAGS\Tags.Default tag table\SPARE	WORD	☒
6 Default tag table\SPARE(1)			1	0 TAGS\Tags.Default tag table\SPARE(1)	WORD	☒
7 Default tag table\SPARE(2)			1	0 TAGS\Tags.Default tag table\SPARE(2)	WORD	☒
8 Default tag table\Entry end hydraulic PT needs installing			1	0 TAGS\Tags.Default tag table\Entry end hydraulic PT needs installing	WORD	☒
9 Default tag table\Entry end hydraulic PT needs installing(1)			1	0 TAGS\Tags.Default tag table\Entry end hydraulic PT needs installing(1)	WORD	☒
10 Default tag table\Entry end hydraulic PT needs installing(2)			1	0 TAGS\Tags.Default tag table\Entry end hydraulic PT needs installing(2)	WORD	☒
11 Default tag table\Entry end hydraulic PT needs installing(3)			1	0 TAGS\Tags.Default tag table\Entry end hydraulic PT needs installing(3)	WORD	☒
12 Default tag table\Welder temperature probe scaled			1	0 TAGS\Tags.Default tag table\Welder temperature probe scaled	REAL	☒
13 Default tag table\Welder low pressure scaled			1	0 TAGS\Tags.Default tag table\Welder low pressure scaled	REAL	☒
14 Default tag table\Welder high pressure scaled			1	0 TAGS\Tags.Default tag table\Welder high pressure scaled	REAL	☒
15 Default tag table\Welder Primary head current scaled			1	0 TAGS\Tags.Default tag table\Welder Primary head current scaled	REAL	☒
16 Default tag table\Welder secondary head current scaled			1	0 TAGS\Tags.Default tag table\Welder secondary head current scaled	REAL	☒

Figure 8 - IBA tag list from S7

3.5 FDS Consideration

Referring to the FDS ~~which was created~~, there were some key requirements which needed to be met in order to deem the project a success. One item was not put into the FDS and was added last minute by the engineer in charge, this was a temperature probe. When designing the project around the FDS, it was important to make the system easy to use and also be as helpful engineering tool as possible. This influenced the choices made in the design phase, by putting a central processor on its own and then having a remote node on the line next to the devices kept everything together and easier to differentiate from. This means that any engineer can look at the monitoring devices used on the welder and will know that all the inputs go back into the welder I/O node. Now the FDS was looked at in order to prove that the design was based around making a system where faults and deuteriations could be easily seen. The FDS states that “

1. The system must be a standalone system.
2. The system must be able to be connected to the works network.
3. Welder speed, current and pressures must be monitored.
4. All data must be able to be mapped over into IBA analyzer
5. The installation must coincide with the company's MOC procedure.
6. Safety systems must NOT be interfered with.
7. The installation must be put inside of the existing welder panel.
8. The system must have the capability to be expanded in the future.
9. The existing welder operation MUST remain the same.
10. The system must have reliable fault finding help procedures.
11. **ADDITION** – Welder temperature probe to monitor strip temperature after a weld. “

(Rowe, 2021)

The ways in which these requirements were met are as followed. The system is a stand alone system, whilst it is connected to the works network to allow communications, it does not affect the process it only prevents long line delays and prevents future failings. This can be seen below in figure 9. By using IBA analyzer to look back at previous welds, the engineers can clearly see any deuteriation in components. An example of this would be that when the welder current is starting to track to earth, which will be indicated by the drop in current and temperature on IBA. This will point to either a breakdown in the copper conductors, a short to earth or even a incoming drive fault. Based off this data actions can then be taken in order to prevent detrimental failings.

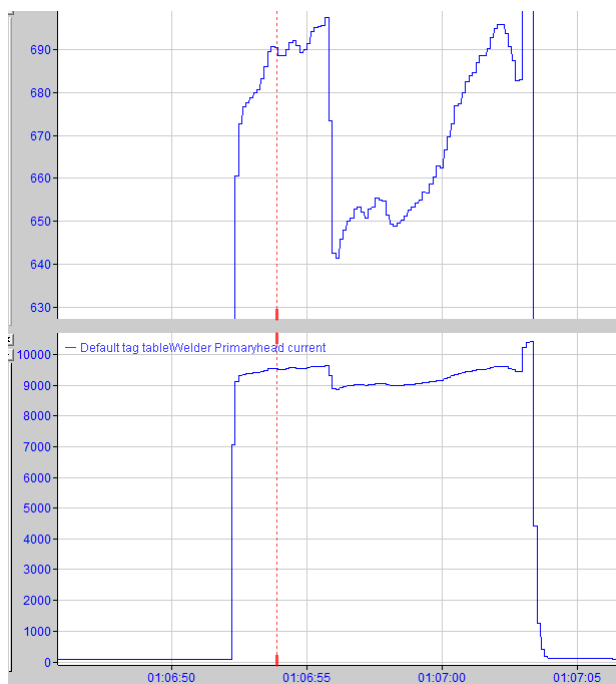


Figure 9 - Good vs Bad current

The system is connected to the works network as this allows all of the data from the PLC to be sent into IBA via the network. This can be seen in figure 10 below as the PLC has been found on IBA with the correct address.

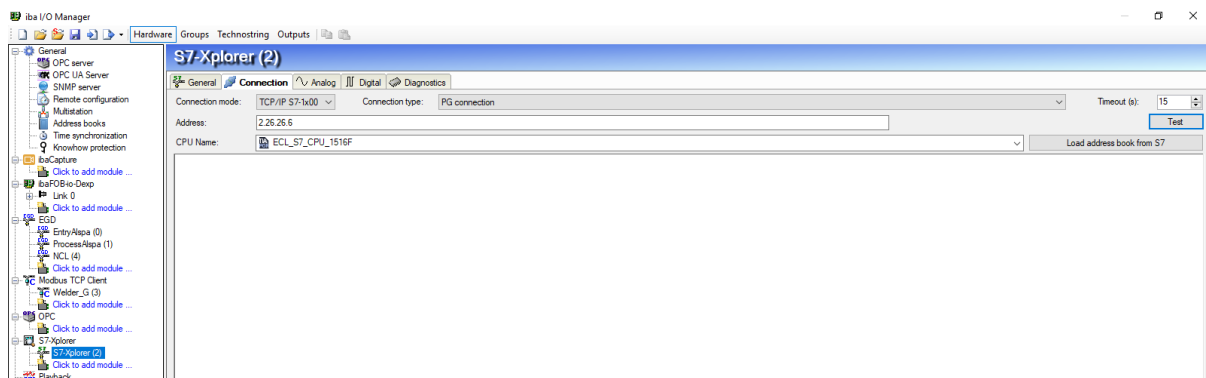


Figure 10 - S7- IBA comms

The welder speed, current and pressures can be monitored. This is displayed in figure 11. This show the scaled analogue values from the PLC which give real word numbers.

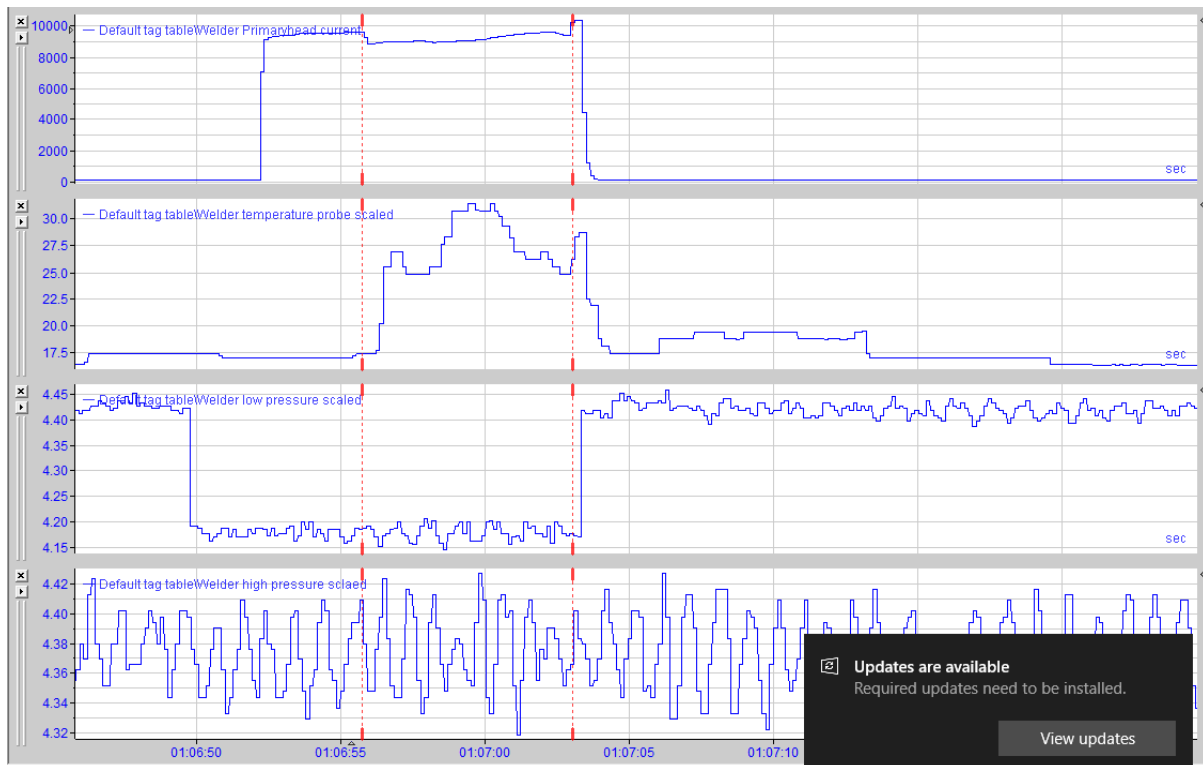


Figure 11 - All IBA AI

All requested data has been mapped over into IBA. This was done over the works ethernet and by using S7- Explorer in IBA. This can be seen in figure 12 showing the analogue tag lists from TIA portal.

Name	Unit	Gain	Offset	S7 Symbol	S7 Data Type	Active
0 Default tag table\Welder low pressure		1	0	TAGS\Tags.Default tag table\Welder low pressure	INT	☒
1 Default tag table\Welder high pressure		1	0	TAGS\Tags.Default tag table\Welder high pressure	WORD	☒
2 Default tag table\Welder Primary head current		1	0	TAGS\Tags.Default tag table\Welder Primary head current	WORD	☒
3 Default tag table\Welder secondary head current		1	0	TAGS\Tags.Default tag table\Welder secondary head current	WORD	☒
4 Default tag table\Welder temperature probe		1	0	TAGS\Tags.Default tag table\Welder temperature probe	WORD	☒
5 Default tag table\SPARE		1	0	TAGS\Tags.Default tag table\SPARE	WORD	☒
6 Default tag table\SPARE(1)		1	0	TAGS\Tags.Default tag table\SPARE(1)	WORD	☒
7 Default tag table\SPARE(2)		1	0	TAGS\Tags.Default tag table\SPARE(2)	WORD	☒
8 Default tag table\Entry end hydraulic PT needs installing		1	0	TAGS\Tags.Default tag table\Entry end hydraulic PT needs installing	WORD	☒
9 Default tag table\Entry end hydraulic PT needs installing(1)		1	0	TAGS\Tags.Default tag table\Entry end hydraulic PT needs installing(1)	WORD	☒
10 Default tag table\Entry end hydraulic PT needs installing(2)		1	0	TAGS\Tags.Default tag table\Entry end hydraulic PT needs installing(2)	WORD	☒
11 Default tag table\Entry end hydraulic PT needs installing(3)		1	0	TAGS\Tags.Default tag table\Entry end hydraulic PT needs installing(3)	WORD	☒
12 Default tag table\Welder temperature probe scaled		1	0	TAGS\Tags.Default tag table\Welder temperature probe scaled	REAL	☒
13 Default tag table\Welder low pressure scaled		1	0	TAGS\Tags.Default tag table\Welder low pressure scaled	REAL	☒
14 Default tag table\Welder high pressure scaled		1	0	TAGS\Tags.Default tag table\Welder high pressure scaled	REAL	☒
15 Default tag table\Welder Primary head current scaled		1	0	TAGS\Tags.Default tag table\Welder Primary head current scaled	REAL	☒
16 Default tag table\Welder secondary head current scaled		1	0	TAGS\Tags.Default tag table\Welder secondary head current scaled	REAL	☒

Figure 12 - IBA Tags

Due to company data protection acts the companies MOC document cannot be shared, however due to the nature of this project the MOC was completed and signed off by the electrical engineer in charge Mr John Shannon. Not safety systems were altered or interfered with during this process as the system was a stand alone system and used for pure monitoring purposes.

The installation was completed inside of the current welder panel as shown below in figure 13 .This is the remote siemens node which is connected to the PLC in the electrical substation shown in figure 14.

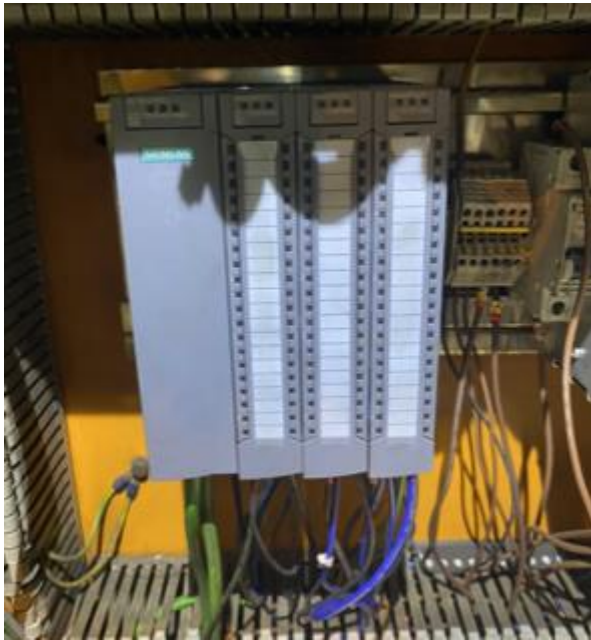


Figure 13 - Welder remote node



Figure 14 - 1516F CPU

The system is expandable as this is made up of remote I/O with a high powered siemens S7-1516F processing all of the data. With the simple addition of a scaleance switch, this network can be vastly expanded. The welder operation has not changed as the system is purely monitoring the process and not actuating or controlling anything it is purely for preventative maintenance and system improvements. The system has reliable fault finding procedures as if the line weld is poor, the engineer can use IBA to drag all the relevant data into a graph and look at real values in order to find a fault. This can be seen below in figure 15.

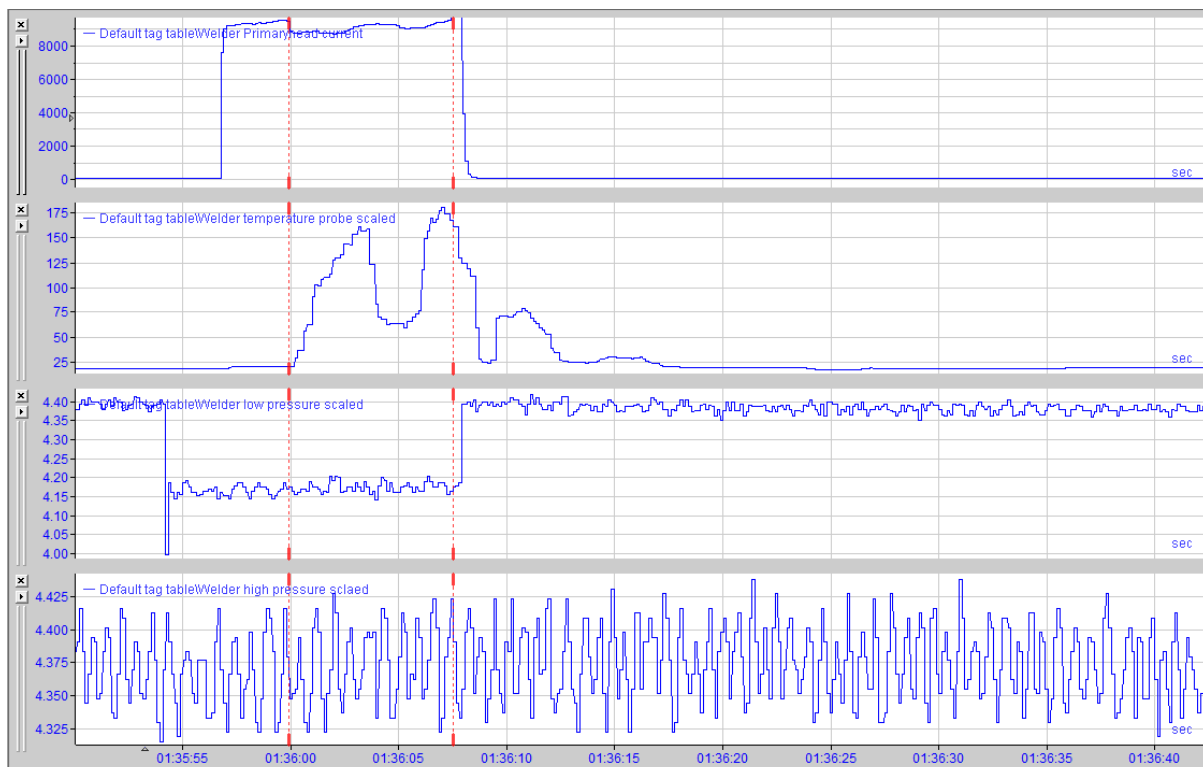


Figure 15- IBA Fault finding graph

The successful installation of the temperature probe shows that the strip temperature can be monitored and displayed on the screen whilst the operator is making a weld. If the operator sees a temperature below their set standard of 70 degrees, then they will make another line weld. The temperature probe can be seen below in figure 16 And the screen is displayed in figure 17.

A GOOD EVALUATION OF THE FDS BEING SATISFIED. YOU COULD HAVE GIVEN EACH OF THE PARAGRAMS A NUMBERED LEADING IN ACCORDANCE WITH THE BULLETED ITEMS FROM PAGE 12.

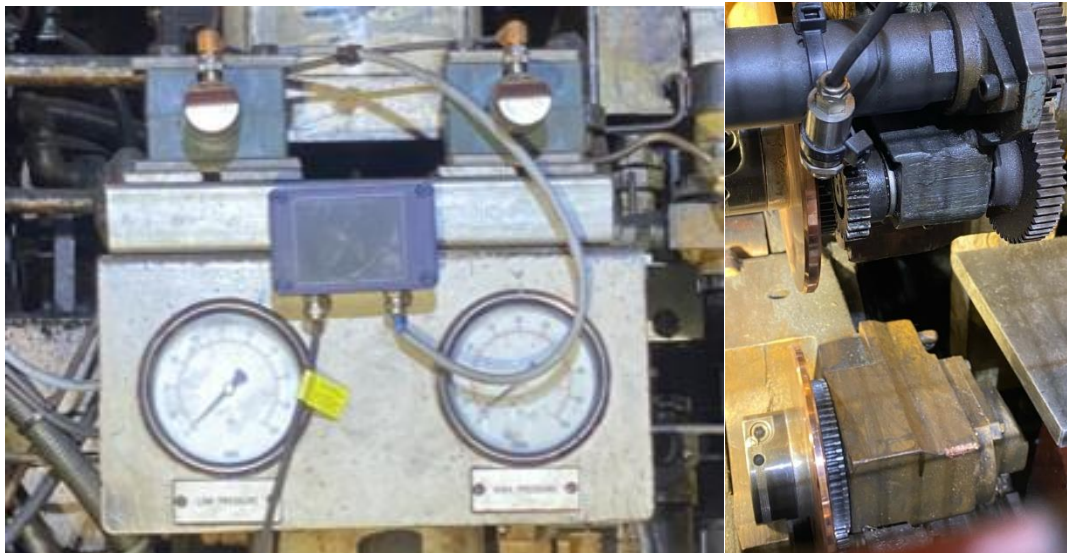


Figure 16 -

Temperature probe and screen

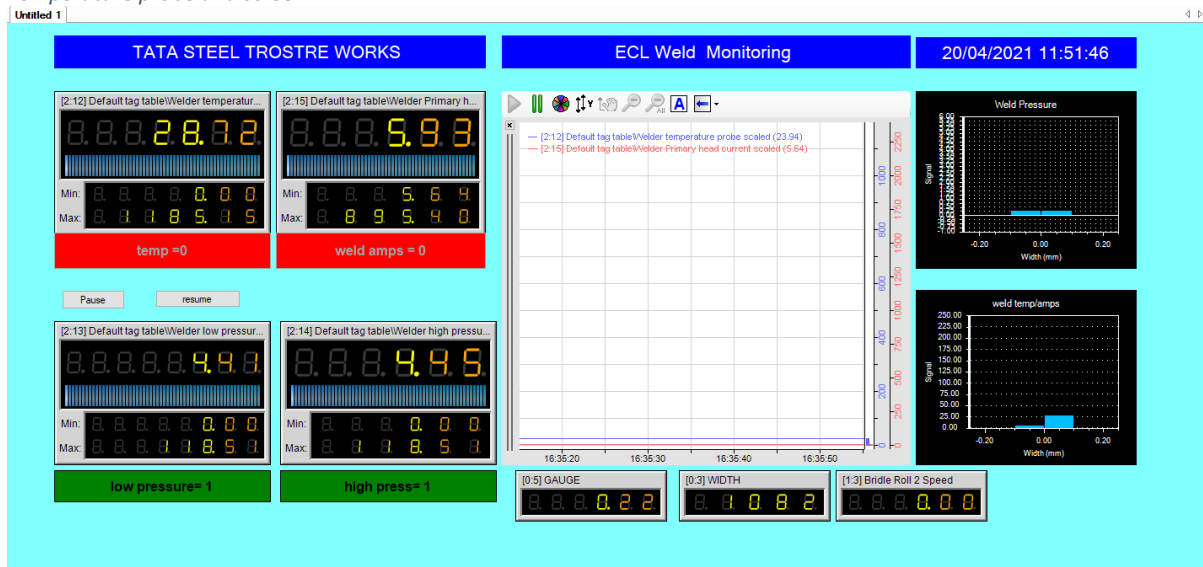


Figure 17 - SCADA screen

Looking back at all of these requirements set out in the FDS, they have all been met including 1 addition to the FDS which has also been successful. Comparing the final project to the FDS, it can be said that the system is successful as it provides all the tools needed in order to achieve the objectives of the project. The system needed to be able to show that components/functions of the welder are starting to fail as since the welder is controlled by an old GEM 80 PLC, it doesn't have any analogue monitoring facilities. This part has been achieved by the PLC processing the data, then IBA analyzer storing and monitoring the scaled data. This produces historical data which can be placed onto graphs and then can indicate areas of failing. Since the system has only been in a few weeks there are still some calculations going on in order to determine what the set standard values should be, however there are some very early indications which have directed engineers' attention to failing components such as valves passing and metal filings tracking current to earth.

Looking at the requirement for future expansion in the FDS, it can clearly be seen that this requirement has been met and is successful as the FDS initially did not include a temperature probe to monitor the temperature, however it was added with ease simply by adding another analogue input card into the remote I/O rack. This addition sets the precedent for the complete modernisation of this welder GEM. It has been proved that the system can function on its own and the welder GEM 80 is its own controller, this means it does not talk to the line GEM80 so the upgrade would be considerably easier. As shown below in table 2 is the 3 main items the design would need to be based around.

Function	Description
Current monitoring.	Current monitoring on the primary and secondary side of the welder in order to see current trends. From this earthing on the welder will be able to be seen. (0-2000A)
Pressure monitoring.	Monitoring the high and low pressure of the welder in order to ensure the heads come together correctly every time. This is also referred to as snubbing pressure.(0-250 BAR)
Speed monitoring.	Carriage speed of the welder. The time is calculated from the welder wheels touch the strip, to when they stop touching the strip. (Time interval) as seen from IBA.

Figure 18 - Table 2

To finalise on the design process based on the FDS, the logical PLC to use was the 1516F due to its speed and processing power. This also allows the system to be expanded massively. The remote devices chosen in the design were applicable due to their parameter ranges and reliability, the devices has also been proven on different systems within the works therefore were highly recommended by other engineers. IBA analyzer is a system used on numerous production lines and has a track proven record of helping prevent major line delays by storing mass data and turning that into something useable.

3.6 Cost management

During the project it was vital to stay track on the budget side of things, the budget remained at £15,000 for the entire project so it was important to factor in costs of labour and every material which was needed. In order to maintain track of the budget a costing sheet was used and this was brought up during every annual maintenance meeting in order to stick within the budget. The budget plan is contained in section 3.11. During the design of the project, careful consideration was taken in order to carefully select which areas needed the most percentage of the budget. This means that the actual processing, storing and monitoring facilities of the project were given a larger slice of the budget compared to the installation side as there are alternatives for one but not the other. Company discounts were also taken into consideration as the more spent with one supplier the larger the discount is given, so this made logical sense to prepare for future expansion of the system, buy better components and receive a higher discount on the final total.

3.7 Problem solving

Since there was a variety of things that needed to be working from electrical wiring to network communications, a vast amount of problem solving techniques were used to create the design. The first issue would be the initial Profinet communication to the works network. Since Profinet is a Siemens specific communication line, when connecting it into the works network switch, careful consideration had to be taken in order to ensure the correct port was programmed accordingly. Off the back of that, in order to obtain an IP address for the PLC, the level 3 administrators needed to provide an IP address in order to ensure there are no clashes.

3.8 Technical knowledge and literature

During the design phase of the project, previous knowledge of remote systems were applied. There were different things that needed to be correct electrically in order to prevent fault finding on a system which was produced incorrectly. Firstly, networking the system in TIA portal on the network topology needed to be correct otherwise the system would produce a BUS FAULT. All components used must be suitably rated to provide reliable analogue signals back (4-20mA over 10m or 0-10V under 10M). The current transducer data was analysed and was found to be 0-10V (Lem, 2021). The pressure transducer data sheet was analysed and it was found that the signal loop is 4-20mA (IFM, 2021). The S7 1516F CPU was chosen based on the technical literature provided in the data sheet. The possible range of expansion is up to 31 extra modules just in the PLC's main rack which covers the design for this project and future additions. (Siemens, 2021) The processing speed of the PLC was also a big consideration factor in the design as in the design specification it required a PLC with a processing speed/ scan speed of 1ms, whereas the 1516F has a scan speed of 500µs. (Siemens, 2021) When designing the actual circuit, circuit protection and cable sizing needed to be taken into consideration, for this the IET current carrying capacity table was used. (IET, 2021)

3.9 Operation, maintenance and reliability

All components used in the design of the project were selected as they were within the operating range with a tolerance above. This meaning that say if for some reason the pressure switches were to experience a surge pressure for any reason, they are already over rated for the current application and will not break in the event of an accident. This same stance was taken for the current transducers, the components were over rated for their application in order to avoid component failure from over range conditions. This did not cause any issues with the programming as the scaling can be adjusted accordingly. All components used are maintenance free devices and are simply a plug and play replacement. This reduces any time spent carrying out reactive maintenance on

components. The sensors chosen were also chosen due to their proven reliability which has been proved by their use on other productions lines inside of the business.

3.10 Components and design

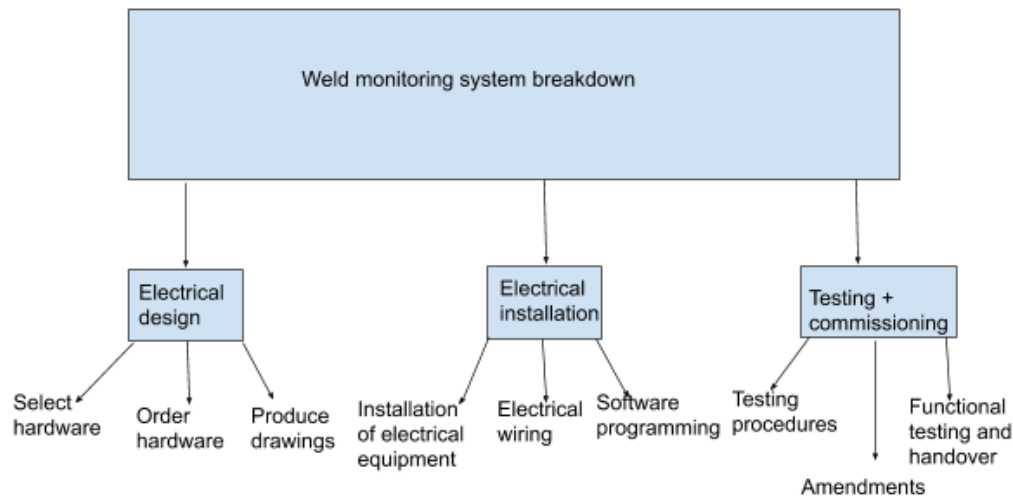
Firstly, all of the components were ordered through the companies bespoke SAP system. This provided access to discounts on orders and also faster guaranteed delivery dates. As shown below in table ... is the final table of all the components and consumables used.

Item name	Quantity	Price
S7 1516F CPU	1	£3229.15
S71500 PSU	1	£179.00
S71500 Rail	50cm	£62.00
Profinet connectors	4	£30.00
Module interface IM155-5	1	£315.00
Siemens 20A PSU	1	£140.00
AI input module	1	£210.00
AHR 500 B10 current transducer	1	£159.00
IFM PN2571 pressure transducer	2	£636.00
Calex CIRSPMHA201CT CRTMSD – temperature sensor	1	£400.00
0.5mm2 cable	20m	£14.99
1.0mm2 cable	20m	£20.00
2.5mm2 cable	20m	£30.00
Profinet cable	100m	£300.00
Bootlace Crimps	100	£10.00
Ferrules	100	£10.00
Electrical labour	200 hours	£4000.00
TIA license	1	£1500.00
IBA Analyzer	1	£1500.00

The total price of all the components/consumables selected was £12,745.14 which is under budget and leaves £2,254.86 left of the overall budget.

3.11 Work breakdown structure and contingencies

The work breakdown structure was closely followed throughout the implementation and construction of the project. The work breakdown structure can be seen below in figure 19.



Work breakdown structure

Figure 19 -

Since the electrical design of the project had already been completed, the next step was to prepare for the installation of the system. Since the system could only be installed on the annual maintenance and time was a critical aspect of this project, a contingency was put into place so that as much of the project was constructed before the annual maintenance so that time could be saved on the week of the maintenance. The PLC and remote node was connected together and the remote devices were put into place of the cleaning line when the line stopped for a cleaning stop. This saved a mass amount of time when it came to the installation. The PLC coding and IBA installation was also carried out weeks before the annual stop, which again saved time and allowed more time for the physical installation. On the week of the annual maintenance further contingencies were put into place just in the event of work not being complete. The installation of the project was prioritised so that the cabling was to be installed first, then the physical wiring of the system and then followed by the final checks before commissioning began. One hindrance did occur when mechanical colleagues needed to access the welder which prevented the electrical cables being installed until the second day of maintenance, the contingency put in place for this was that two electrical craftsmen were asked to work a nightshift in order to carry out the work when mechanical had finished in the area. Another hindrance that occur was that the programming PC failed with the saved software on and the engineer who has control over the back ups was off on long term sick, so as a contingency a programming laptop was borrowed from another line in order to commission and act as a way to communicate to the PLC without the failed program. During the commissioning phase there was a major problem with the 4-20ma loop where the signal was not producing the correct readings and showing massive discrepancies. So after applying some technical knowledge, it was decided to put a 500hm resistor across the loop which then creates a voltage input. Once this was done the loop actually started to work and the expected readings were displayed in the PLC. This is one example of the effective engineer contingencies used when doing this project.

3.12 Constraints

There were two major constraints which were initially highlighted, these were COVID-19 and the working from home issues raised. COVID-19 did have a massive impact on how the project was installed as the rules around working together meant that people were not allowed to work in bigger groups than 2 and also had to have more PPE on which produced harsher work environments. This issue was combatted by ensure anyone involved in this project were following the strict government guidelines and also a split shift approach was taken. This meant that colleagues would work alternative hours in order to reduce the chance of transmission. The working from home constraint did not prove much of an issue as it was agreed before hand that all individuals involved would be allowed to come into work during this week period. One constraint which was not highlighted initially but proved a massive issue in the end was time. The time frame given to this project was very front loaded and also very demanding. The way this was combatted was to allow craftsmen to work longer hours to complete the work however, this also posed another constraint which is workplace fatigue. Overwork could raise a safety risk so this meant that all the hours which were overtime needed to be approved by an area engineer in order to ensure no one would be working too many hours.

3.13 Time plan and achievements

Following below in figure 20 is the final time plan indicating the achievements on different days. Green marks the planned date for the tasks to be completed whilst red is when the tasks were actually completed. Due to the current climate tasks were not completed on time because the annual maintenance was moved forward. This did not alter the project but did change when different milestones were met.

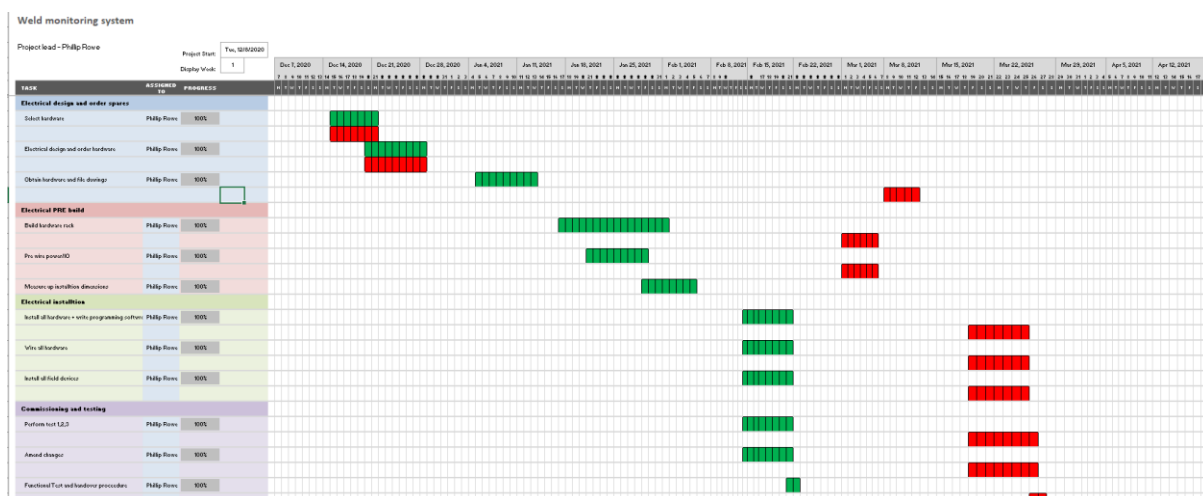


Figure 20 - Final timeline plan

3.14 Codes of practice

All electrical codes of practices were put into place and followed during the project. Skilled, competent craftsmen installed and terminated all electrical components and conductors. These craftsmen were also BS7671 18th edition trained meaning that they were competent to install the system to that standard. The installation was also verified by the electrical engineer in charge. BS EN 50110 and BS EN 60529 were both verified during the testing phase of the project.

YOU COULD HAVE INCLUDED H&S, ETHICAL ENGINEERING AND SUSTAINABILITY HERE.

4. Testing and results

After the installation of the project was completed, the next phase was to carry out commissioning on the system. A systematic approach was taken whilst closing following the specification in the FDS.

4.1 Dead testing

This section is for the pre-functional tests to be carried out. This is to ensure that once powered up no hardware damage will be done.

	Test type	Test method	Expected result	Actual result	Pass/Fail	Amendment requirements
1	Continuity test of power +/- connections.	Continuity test	0.1 ohms	1.1ohms	PASS	N/A
2	Continuity test of remote I/O device supplies.	Continuity test	0.1 ohms	0.1ohms	PASS	N/A
3	Continuity test of AI connections	Continuity test	0.1 ohms	0.1 ohms	PASS	N/A
4	Tightness test of all connections	Terminal screwdriver	2.5nm torque setting	2.5nm	PASS	N/A
5	Security of all transducers	Physical touch	Secure by hand	Secure	PASS	N/A
6	Visual inspection of present earth/containment protection (BS EN 50110 and BS EN 60529)	Visual	Present	Present	PASS	N/A

4.2 Live Testing

This section will provide the live testing where the power will be turned on BUT there will be no functional testing.

	Test type	Test method	Expected result	Actual result	Pass/Fail	Amendment requirements
1	Power supply voltage tests with MCB's off.	Voltage tester - Multimeter.	20-28v - No circuit break trips.	24v	PASS	N/A
2	Power supply voltage tests with MCB's on.	Voltage tester - multimeter.	20-28v - No circuit breaker trips.	24V	PASS	N/A
3	Remote devices power cycle check.	Visual	Transducers to power on.	Power ON	PASS	N/A
4	Communications test.	Server PING test.	Reply from controller to programmer.	No reply	FAIL	Profinet cable damaged, remade cable and communications restored.
5	PLC to IBA communications	Find PLC on IBA software using internal PING function	Communications toggling	NO Comms	FAIL	Network switch not set up for profinet, change port properties and all communications working.

6	IBA to see S7 live tags	Look for data transfer from S7 into IBA taglist	Signals and live data present	Signals present	PASS	N/A
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4.3 Functional testing

This section will be where the operation of the system will be tested providing that all the other test procedures are completed successfully.

	Test type	Test method	Expected result	Actual result	Pass/Fail	Amendment requirements
1	AI signals test	Monitor values	Value range between 0-27648	Range set and signals tested	PASS	N/A
2	Scaling of transducers.	Set ranges and adjust as needed	I.e 0-27648 = 0-250 BAR.	Ranges set, one range found to be wrong.	FAIL	Range changed and all ok.
3	Live IBA graphs showing scaled values	Monitor live graphs	Scaled values should reflect real values, check display on transducers	Scaling out	FAIL	One transducer operating range found to be wrong in S7, changed and scaling now correct.
4	IBA recording data	Look at IBA database for stored results	Data files storing every 30 minutes	Files saving	PASS	N/A

4.4 Testing overview

After completing all of the testing, the system worked correctly. The major problem which occurred whilst commissioning this system was that the communication between the PLC and IBA was not working. Initially using the correct cable tester, a profinet cable was found to be defective. When this issue was rectified there was still a communications issue. Since the PLC was connected to the works network, through a managed switch it was decided to take that switch out of the loop in order to just prove simple communications. After this worked it narrowed the problem down to the managed switch. By interrogating the managed switch ports, it was found that the port was not set up for profinet communications. This was then changed to the correct protocol and the communications commenced.

5. Evaluation and Wider Issues

Once the project was fully tested and completed, a reflection of the FDS was made in order to see if the physical system met the FDS initially set. The FDS required an effective weld monitoring system which can prevent poor welds break inside of the line. It also required live variables to be monitored in order to assist during fault investigations of poor welds. A storage facility of this live monitoring was also needed in order to compare previous welds to a known set standard. It can conclusively be said that the system meets the FDS supplied as, the system effectively monitors every line weld which is done. The system also produces reproduceable and effective readings which are taken from input devices. One planned outcome of the FDS which was taken out was the alarming beacon. This would've alerted operators of a poor weld if one was made. The reason this was not met was because there has been a better alternative which is being designed at this moment. An interlock system is being designed to replace the alarm so that operators cannot proceed if there is a poor weld, so the alarm was left out as part of a cost saving procedure. One addition which was made to the FDS was the temperature probe. This was added just as another variable to enhance the probability of stopping poor welds getting through the production line. By installing a temperature probe this satisfied that part of the FDS.

Looking at the IBA section of the FDS, whilst there were some teething issues this section was met. This outcome was met as there is clear data which has been mapped over from the PLC into IBA analyser which is producing live trends and also saved previous data files. One of the biggest parts highlighted in the FDS was the need to have future expandability. Now that the system has been implemented and proved to effectively be fit for purpose, the system now could be expanded to replace older PLCS on the line. The room for future expansion is huge as the CPU which is processing all of the data from each remote node is powerful enough to run production lines. With its massive processing power, large memory and reliability this system can easily replace older CPU systems which are used. Looking at the budget initially set and comparing it to the actual spend during the project, there was effective cost management strategies which were put in place which have successfully ensure that the project has stayed within the budget. Although there was money left in the budget after the project was completed, there could have been more money spent on the networking side of things as when commissioning that's where the majority of issues were caused.

The first wider issue raised in the first report was the ethical issue, which was looking at the transparency of companies when it comes to cheap labour. All the manufacturing companies which made the devices which were used in the system all have clear, ethical and sustainable business promises on their website. The manufacturers also only have their factories in first world countries which have strict laws around minimum wage levels, this satisfied this ethical issue. The environmental issue raised was that all the components used are made from sustainable materials and are reliable in order to reduce waste and minimise the amount of raw materials used by buying that device. All items used were market leaders and after looking through their datasheets, the failure rate is low which a high component life expectancy. The final legal issue raised were that individuals cannot be in work longer than 16 hours a day and must have 2 days off every 14 days. This was met by ensuring all overtime had to be approved by the area engineer. The installation took place over 8 days so everyone would have had 2 days off prior to the project starting.

SOME REFERENCES TO RECOGNISED AUTHORITIES
ARE NEEDED HERE.

6. Conclusions and Recommendations

To conclude on the project as a whole, it can be deemed as a success. This can be said as the system met all of the points which were listed in the FDS and also was able to accommodate the late addition of a further requirement. The management of the project can also be deemed as a success because the system was designed, installed and commissioned within the time period given, but also the budget was adhered to. It can be said that the project is now providing an effective tool which can be used in order to save vast amounts of money. This is proved by the trending data in the IBA analyzer being able to show a deuteriation of components being a drastic and costly strip break happens.

Future recommendations for this project would be now that this system is in place, start to replace all of the older CPUs and other control systems and integrate them into this new system. This would provide one simple access hub for all of the functions, data and monitoring which would be needed. Another recommendation would be to not only replace the control side of the old systems, but also replace the SCADA screens with siemens WINCC HMI screens. This would mean that all the data would be drag and drop onto the HMI from the PLCs tag list making every item in one place and easier to access. The final recommendation would be to expand on the monitoring system which is already installed. This would mean adding more devices in order to monitor the welds as they are happening for example, this could mean using an infrared camera to look at the seam weld before tension is being applied.

CONCLUSIONS ARE A LITTLE BASIC AND
 GENERIC. YOU WOULD HAVE BEEN MORE SPECIFIC OF
 WHAT THE FINAL BUDGET WAS + HOW MUCH MONEY WAS
 SAVED.
 RECOMMENDATIONS ARE VALID

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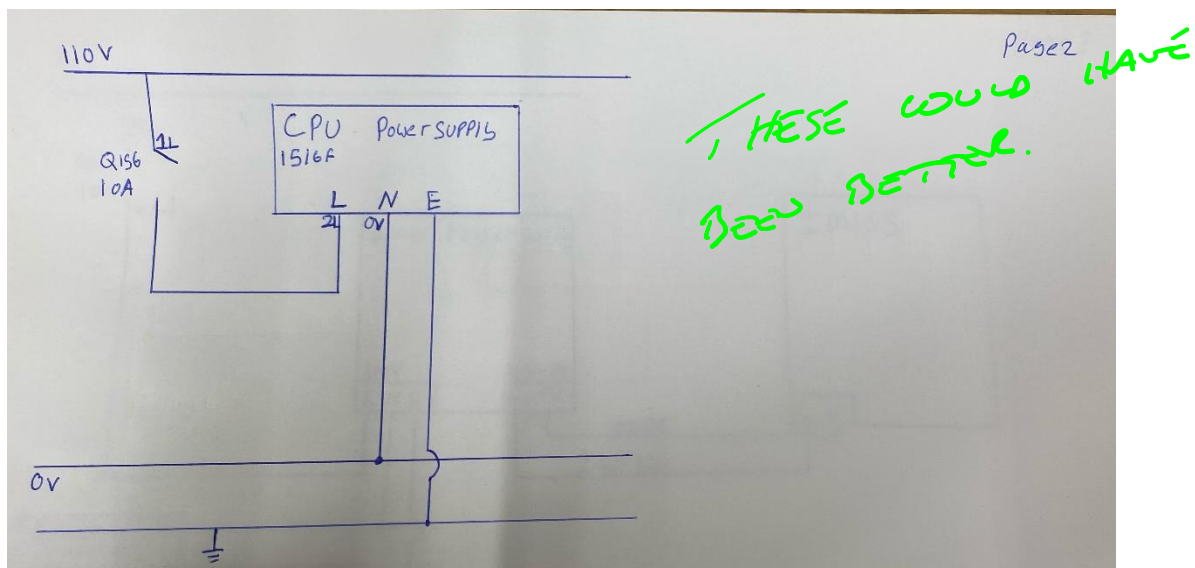
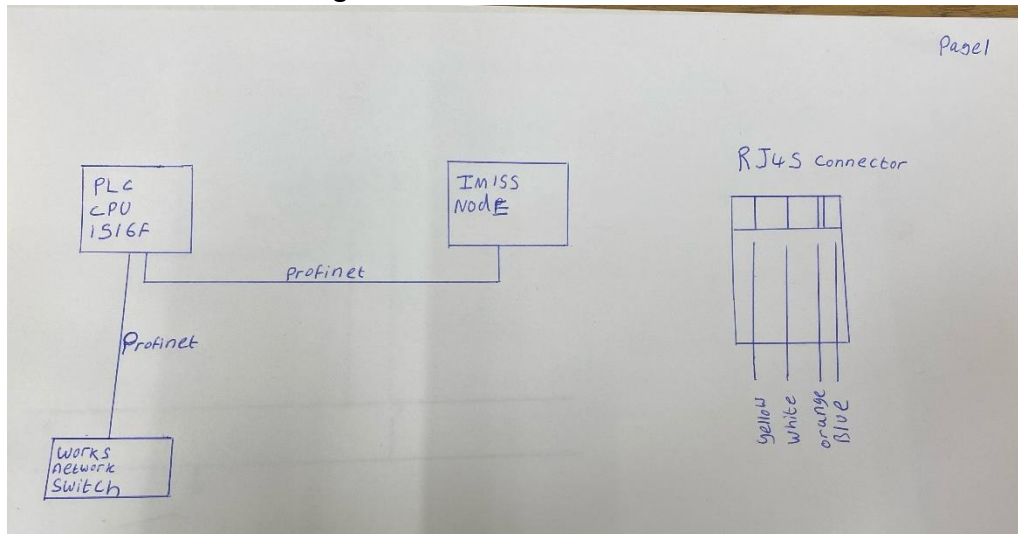
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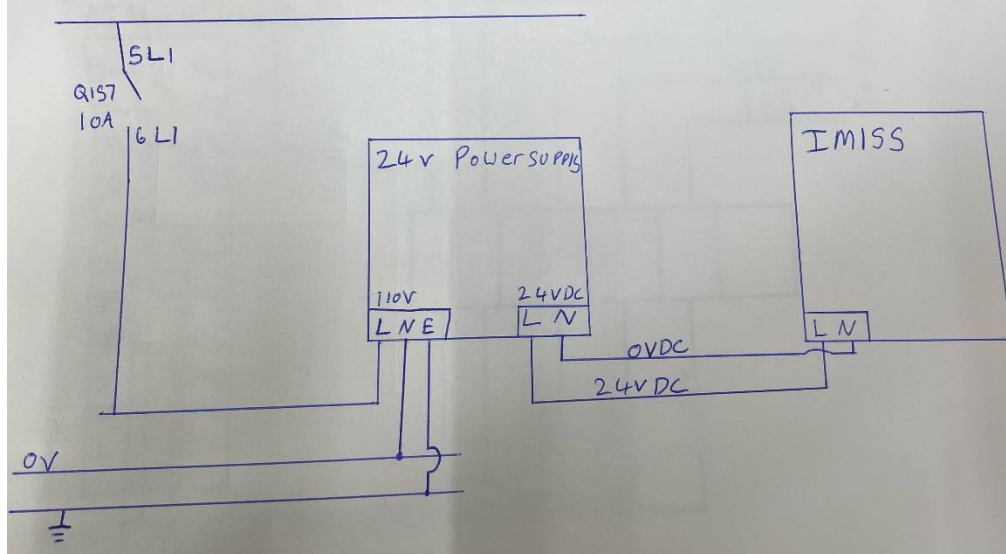
GOOD RANGE OF SOURCES WITH
CORRECT CONVENTIONS USED.

8. Appendix

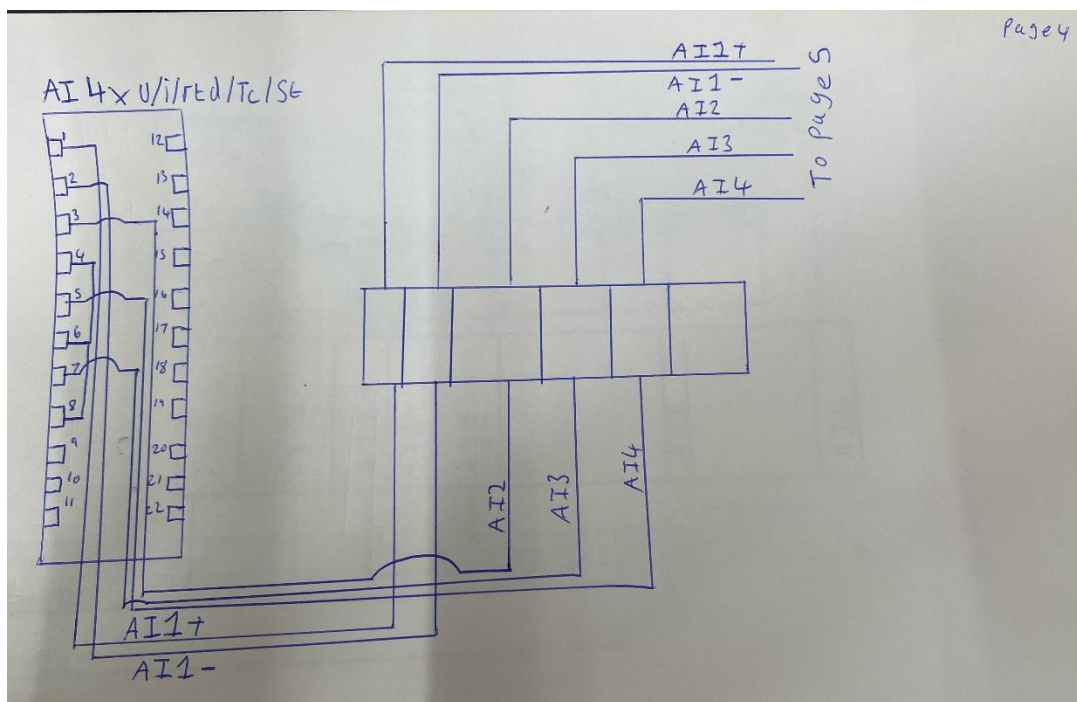
8.1 Technical Drawings

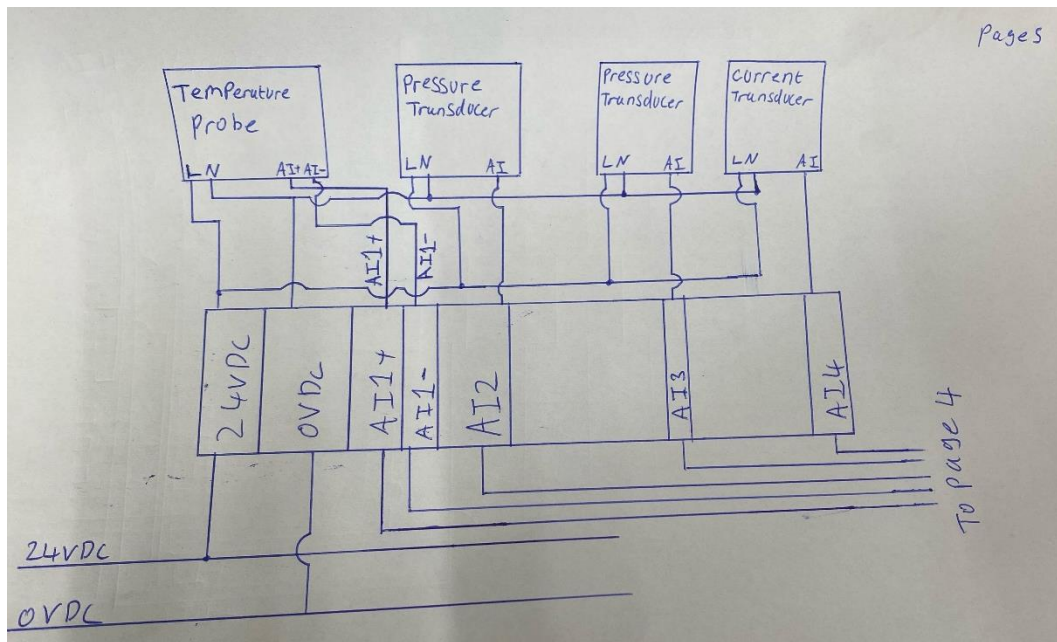


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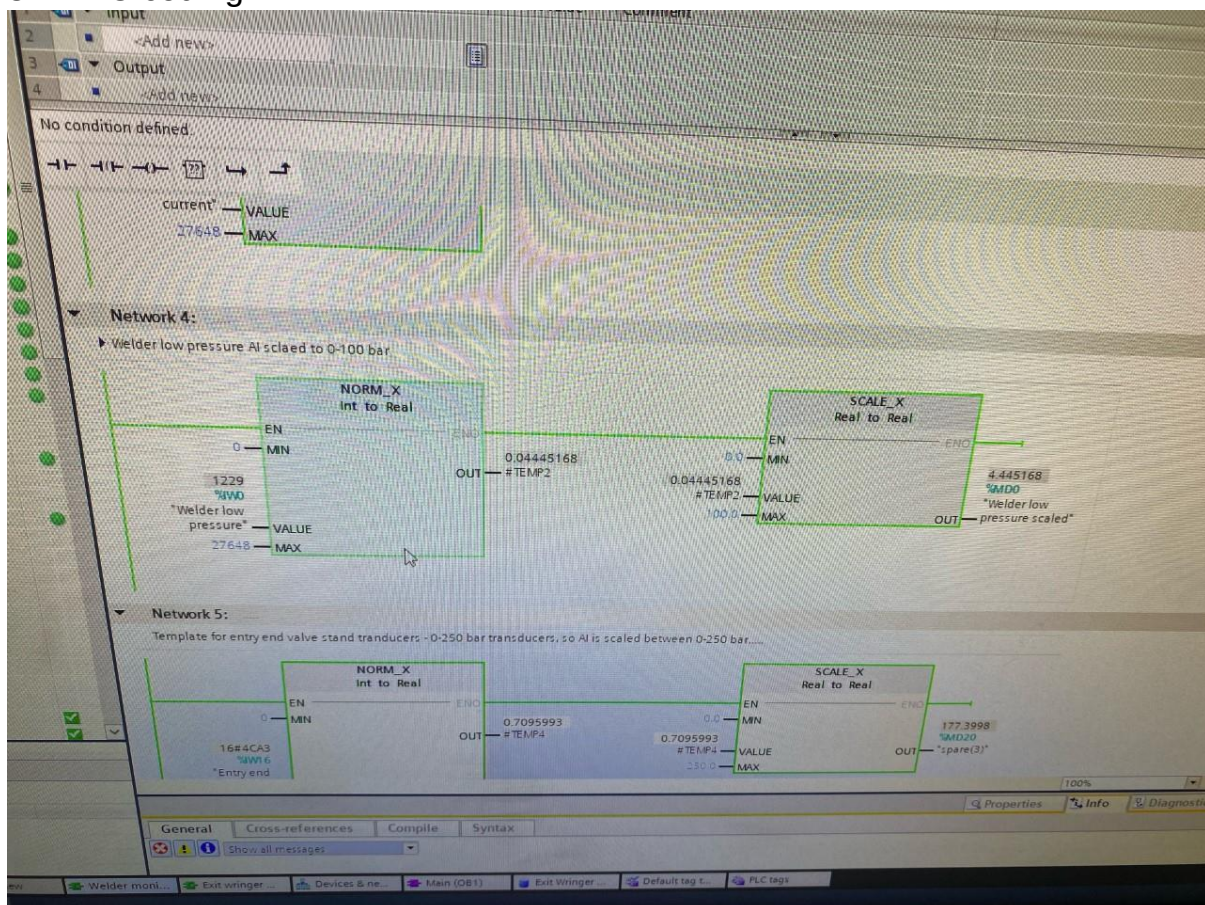


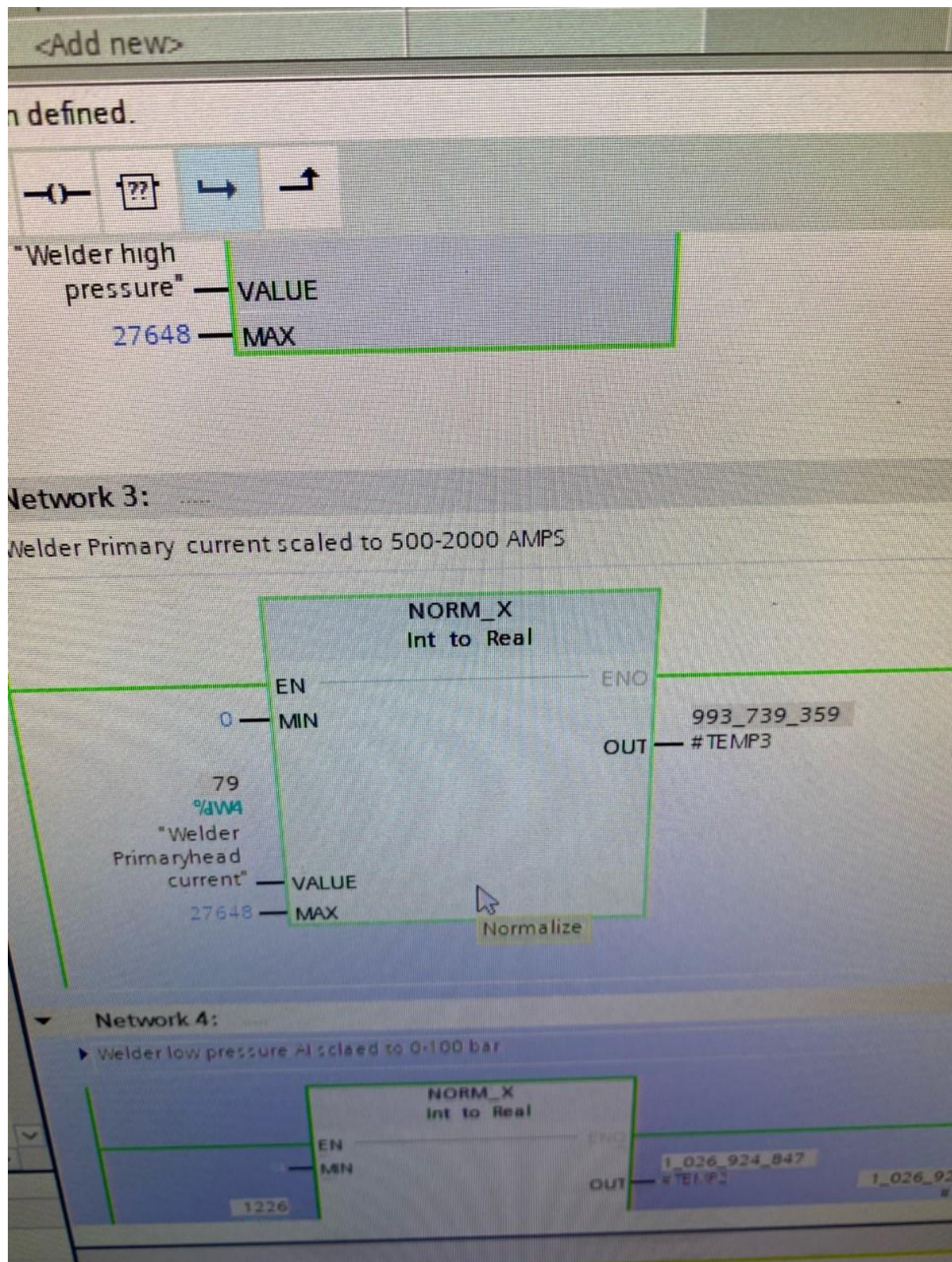
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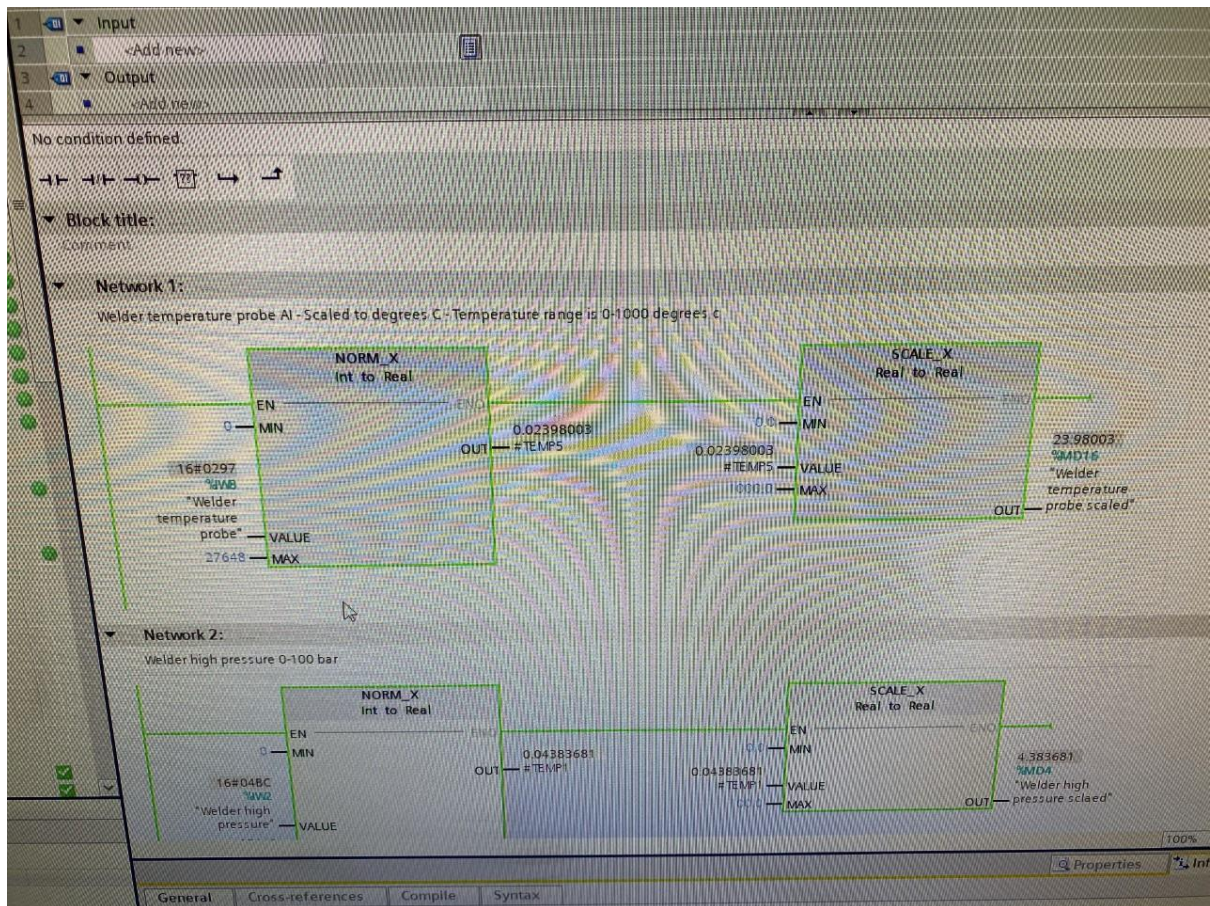




8.2 PLC coding







Welder monitoring

Name	Data type	Default value	Comments
▼ Input			
<Add new>			
▼ Output			
<Add new>			

Condition defined.

Network 1:
Welder temperature probe AI - Scaled to degrees C - Temperature range is 0-1000 degrees

Network 2:
Welder high pressure 0-100 bar