

PLC Ryan O'sullivan

by Ryan O'Sullivan

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PLCs and Control Assignment

By

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Introduction

This report will investigate and apply P.I.D control system these will be used with a servo motor to drive a linear positioning unit. This will be used in conjunction with a drilling head to form holes in metal sheets. There will be safety features added, fault finding and error systems these will be implemented and showed on designed control screen these will display these errors/fault to the operator in an effective manner. Ladder logic programing will be used to create these links between the control screen and the plc this ladder logic will be used at the heart of all the plc programming creating a final product.

From the output files from the open loop response, this report will generate the transfer function needed to create an effective PID. Parameters will be generated to produce the control system need for the Operation specified in the assignment

Absolute Max response time (to steady state) 20secs.

Absolute Max over-shoot to a step-change 5%

Siemens PLC will be used to create the ladder logic for this project implementing all required alarms and functions. This PLC programming will be interlinked with control screen also design in this project for the best usability

Generating transfer function

Introduction

From the output file proved this report had to find the best transfer function For the PID controller this help keeping the PID in line with proved files. From this file this report will use Matlabs[1] to create the Vales for Kp(proportional gain), Ki(**integral** gain) and Kd(**derivative** gain) These will then be Programmed into PID controller at a later date.

PID Response function

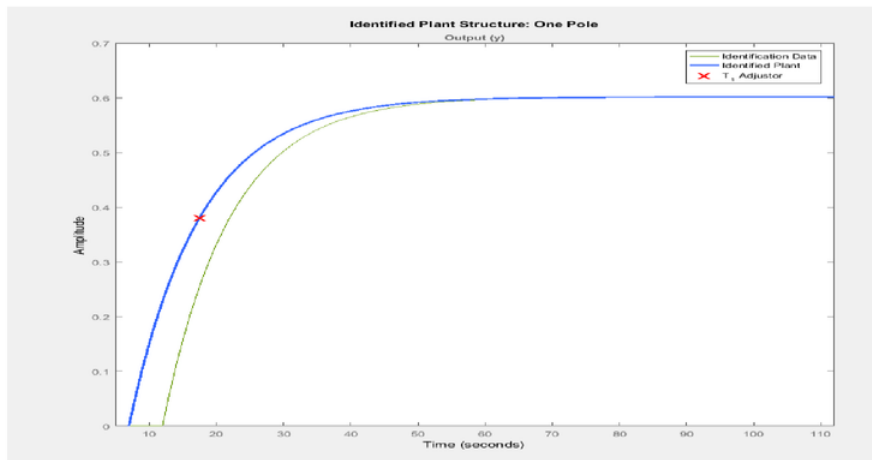
The PID controller will be defined in MATLAB[1] this will then provide a transfer function for this report.

1. First Variables was created for Ki,Kp, Kd in matlabs all = 1
2. Second, the Output files that have been proved need to Added into MATLAB's
3. Third The in-build PID Tool in MATLAB was Called

```
Academic License
>> kp=1
kp =
    1
>> ki=1
ki =
    1
>> N=100
N =
   100
>> kdl=1
kd =
    0
>> pidtool
Warning: MATLAB has disabled some advanced graphics rendering features by switching to software OpenGL.
For more information, click here.
fx >> |
```

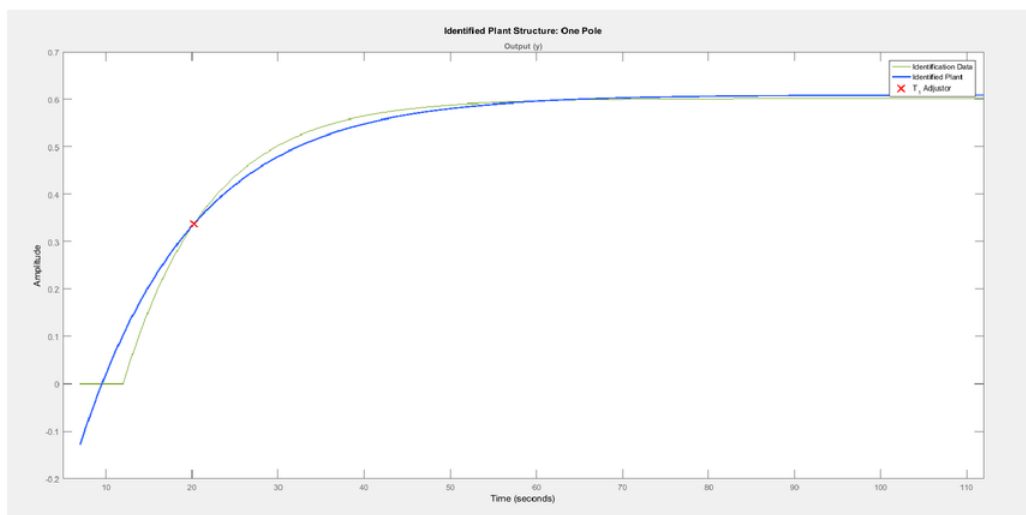
After inputting the output files provided then needed variable was added for Kp, Ki, Kd the next step call the PID tool within Matlabs The next task was to find a suitable Response There are 4 responses that could be suitable for this project all will be investigated to show Response rate and find the best fit for the open loop output files..

One pole did by hand



This response is not perfectly in line with output files this is tuned by hand and human error could be the issues you can see it about 10 seconds out and but does match the amplitude

One pole auto



The auto alinement did a much better job when setting the response this was still about 8 seconds out and overshoot on amplitude in the 30s and undershoots till 10 seconds in.

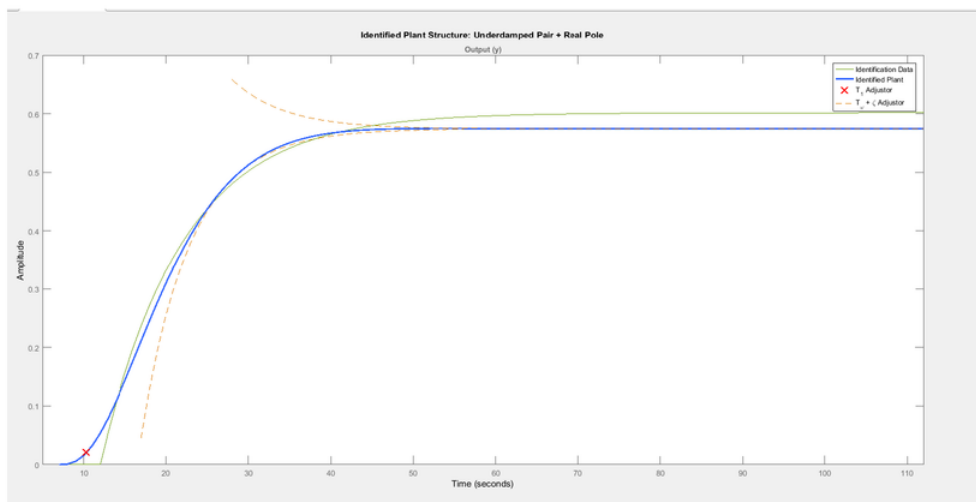
One pole Transfer function

$$\frac{K}{(T_1 s + 1)}$$

This transfer function is used within line with the one pole technique. This was not suitable for this project as there was a very big settle time and overshoot time. This did not work the best out of the 4 function tested here.

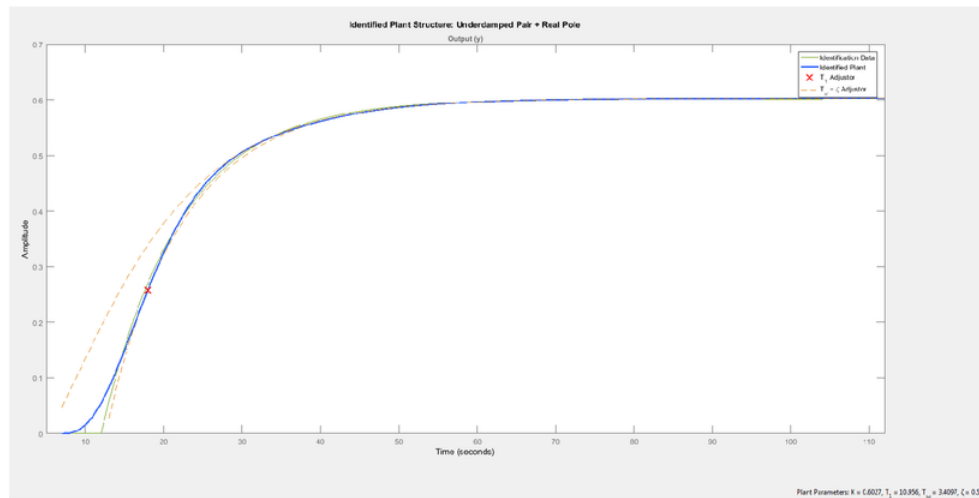
Underdamped pair + Real Pole

Underdamped pair + Real Pole done by hand



This response was very close when setting it by hand this response starts too early starting at 5 seconds not at 12 seconds and undershoot on amplitude by 0.01

Underdamped pair + Real Pole auto



When auto-configuring this response it got very close to the need response rate everything matched the origin input files but it again started too early by 5 seconds but it matches amplitude perfectly this response was nearly picked.

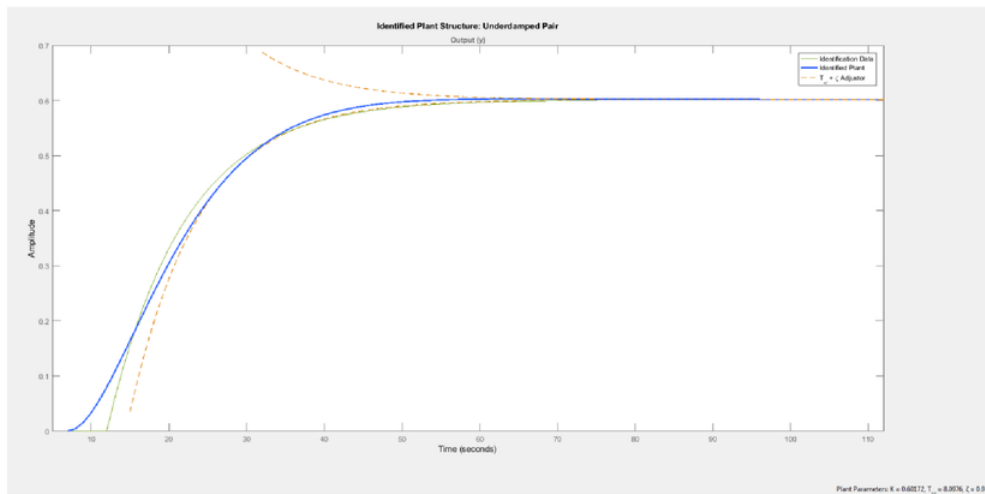
Underdamped pair + Real Pole Transfer function

$$\frac{K}{(T_1 s + 1)(T_\omega^2 s^2 + 2\zeta T_\omega s + 1)}$$

The Underdamped pair + Real Pole Transfer function was the second best response reviewed in this project this is very in line with the output files provided.

Underdamped pair

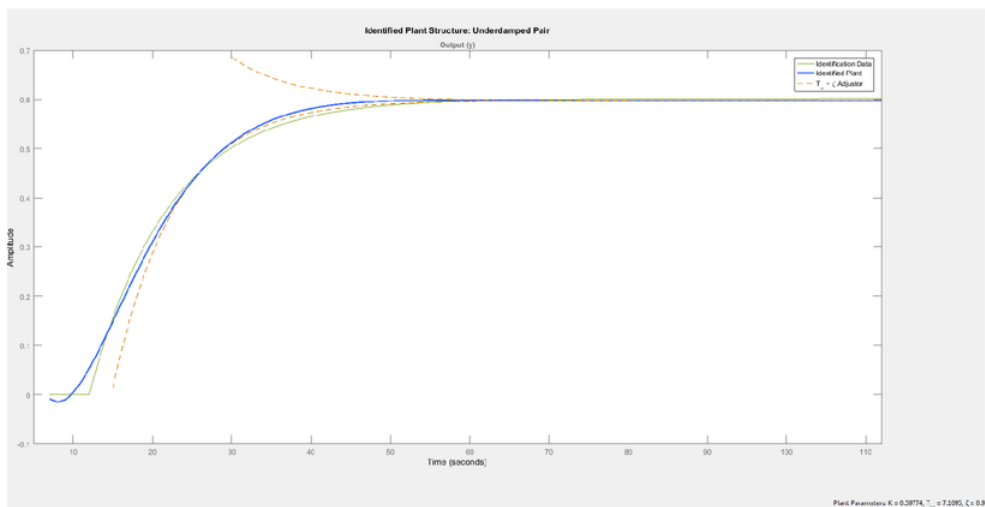
The underdamped pair is done by hand



The undamped pair was the nearest by hand response again like the

Underdamped pair auto Underdamped pair + Real Pole auto this response was starting too early but match amplitude perfectly

Underdamped pair auto



The Underdamped pair auto response had a few errors though being an out in amplitude at the 40s mark and responding a bit fast at the 10second mark.

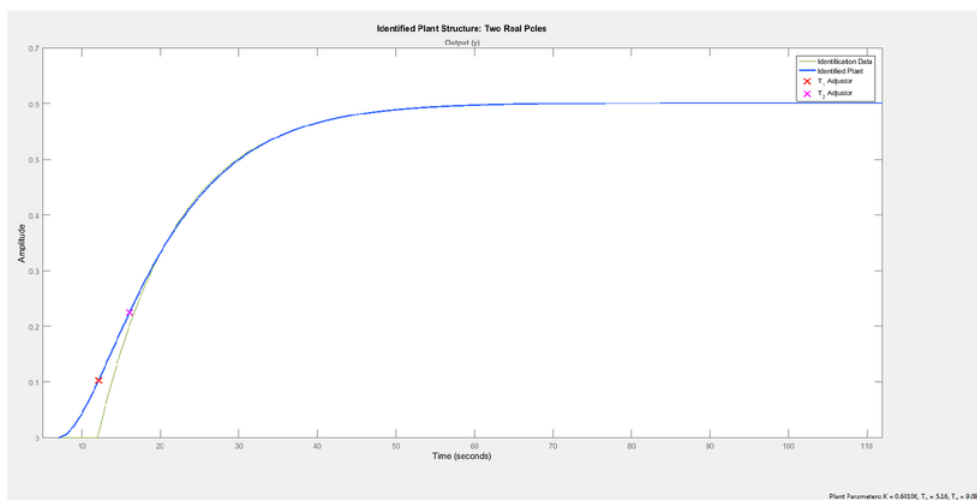
Underdamped pair Transfer function

$$\frac{K}{(T_{\omega}^2 s^2 + 2\zeta T_{\omega} s + 1)}$$

The underdamped pair Transfer function had some issues some of them are overshoot/undershoot amplitude this would have issues too with settle time and rise time for this PID too.

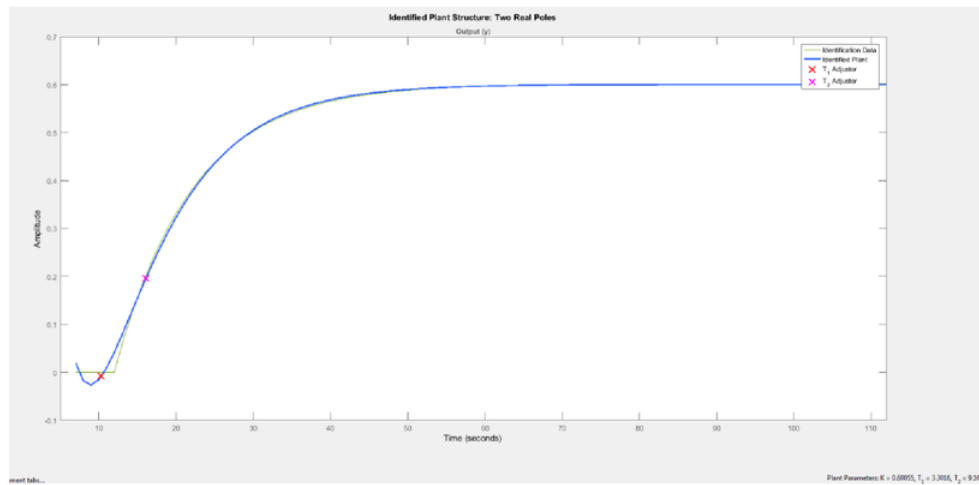
Two Real Poles

Two Real Poles did by hand



This response matched amplified perfectly but when creating it by hand it did not handle the Time need to respond in.

Two Real Pole auto



This is the response was picked for this project as it nearly matches every variable of amplitude and time it response exactly when need and only drops amplitude for 3 seconds on start-up but matches everything else perfectly this is why this was chosen for its very small error rate and near perfect response rate.

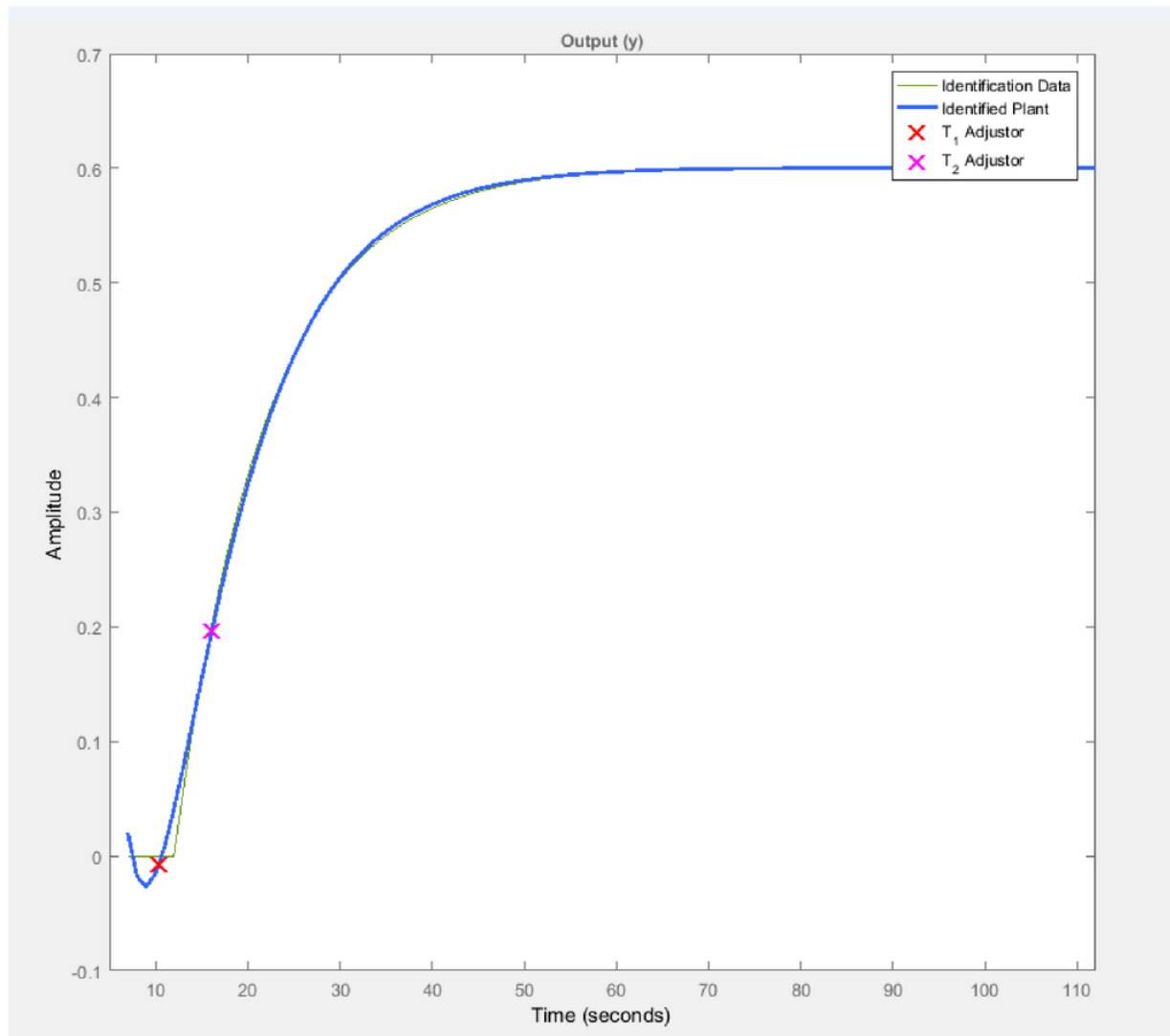
Two Real Pole Transfer function

$$\frac{K}{(T_1 s + 1)(T_2 s + 1)}$$

This is the chosen transfer function for this PID this was chosen as it matched the output files provided very well with perfect amplitude and time. This will help for a better rise/settle time with very little overshoot.

Final response

After reviewing all response used in mat labs using the manual tune and automatic tuning the two poles automatic response was chosen as it was the nearest to the most effective response from the output files provided.

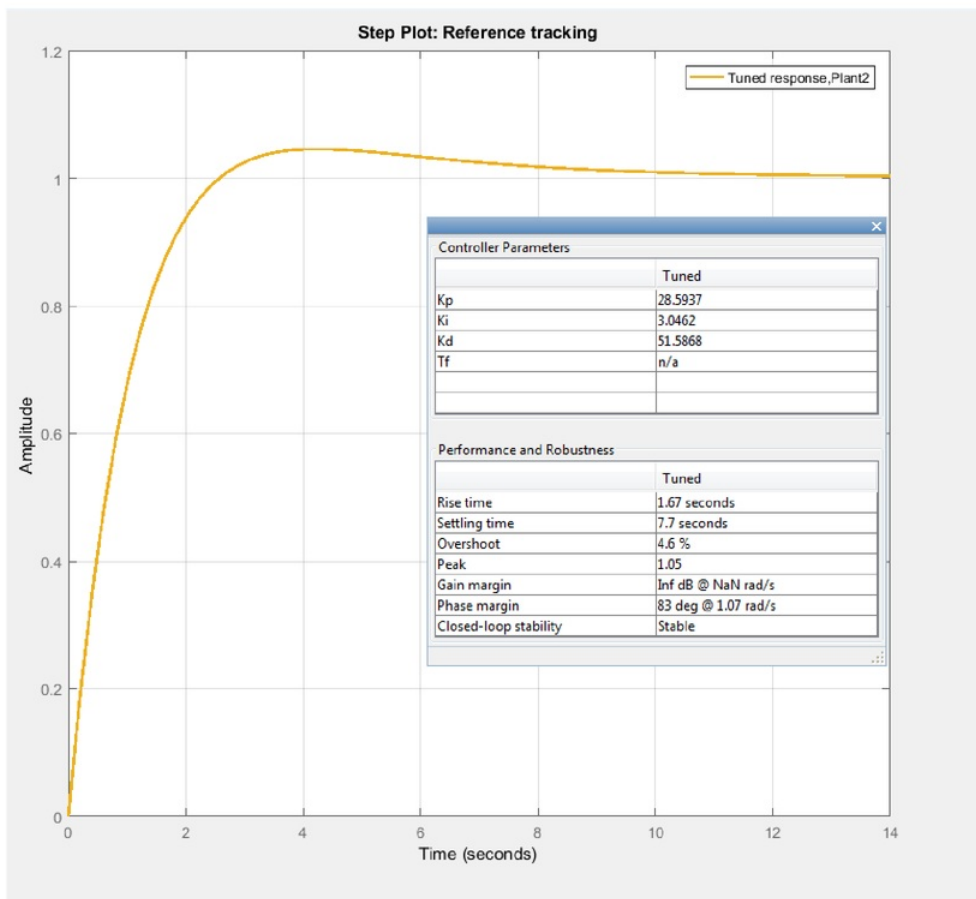


As you can see from this two pole response that it fit the output files nearly perfectly on time and amplitude. This would help the project with it time and overshoot limits when moving on the next process fine-tuning.

of the open loop after this it was possible to move on to change in the response time and transient behaviour to achieve the goals set out of Absolute Max response time 20sec and Absolute Max over-shoot to a step-change 5% from using a chart of Characteristics of P, I, and D Controllers it was easy to narrow in the response time and overshoot



After final tune was done All element was achieved as set out so that the Absolute Max response time was no more 20secs. Absolute Max over-shoot was no larger than step-change 5%.



Performance and robustness

Performance and Robustness	
	Tuned
Rise time	1.67 seconds
Settling time	7.7 seconds
Overshoot	4.6 %
Peak	1.05
Gain margin	Inf dB @ NaN rad/s
Phase margin	83 deg @ 1.07 rad/s
Closed-loop stability	Stable

this shows that the Performance and robustness at within the limits with an overshoot of 4.6% under 5% and a response time of 9.37 seconds way under the Max response time of 20 seconds. This would increases performance by having a fast response time and a low overshoot. Closed loop Stability shows that this design is stable and will work as functioned.

Control parameters

Controller Parameters	
	Tuned
Kp	28.5937
Ki	3.0462
Kd	51.5868
Tf	n/a

These final control parameters state the Kp, Ki, Kd values will be used in the PID controller to operate within the PLC programming system. These will help decrees overshoot and have a give the better response rate time available to create a control system which operates within the stated specification.

Observed findings of PID open loop Response

From the proved output files from the open loop response, this report was asked to find the best possible transfer function of the system. Using the transfer function generate the required values for Kp, Ki and Kd to operate the system within the given specification this will created PMW output files for the system these will be used as PMW signal for controlling the motor.

Using Matlab to create the PID responses made this process a lot more streamlined and simple to implement calling the in build PID function and uploading the Output files will start the PID TOOL.

From the four response available on

- One Pole
- Two pole
- Undamped pair
- Two poles Undamped pair

Reviewing each response and fine-tuning by hand and using the auto function gave the ability to observe what function was the most suitable.

The auto fine tune Two pole response was chosen as this was the best on amplitude and timing form the given output files of the PMW.

Meaning the transfer function used in this project will be

$$\frac{K}{(T_1 s + 1)(T_2 s + 1)}$$

After picking a transfer function the next set would be fine-tuning the reference Tracking this would use fine-tuning transient behavior and response time for

KP proportional gain

Increasing the proportional gain this tends to reduce, but not eliminate, the **steady-state error**. Proportionally increasing the control signal.

KI integral term

Tends to help reduce steady-state error if persistent, increasing the control signal and driving the error down

KD derivative term the controller to "anticipate" error anticipation tends to add damping to the system control signal can become large if the error begins sloping upward.

The general effects of each controller parameter (K_p , K_d , K_i) on a closed-loop system are summarized in the table below. Note, these guidelines hold in many cases, but not all. If you truly want to know the effect of tuning the individual gains, you will have to do more analysis or will have to perform testing on the actual system.

Changing the variables of PID gave a understand on how of these function can affect the

- Rise time
- Overshoot
- Settling time
- Errors

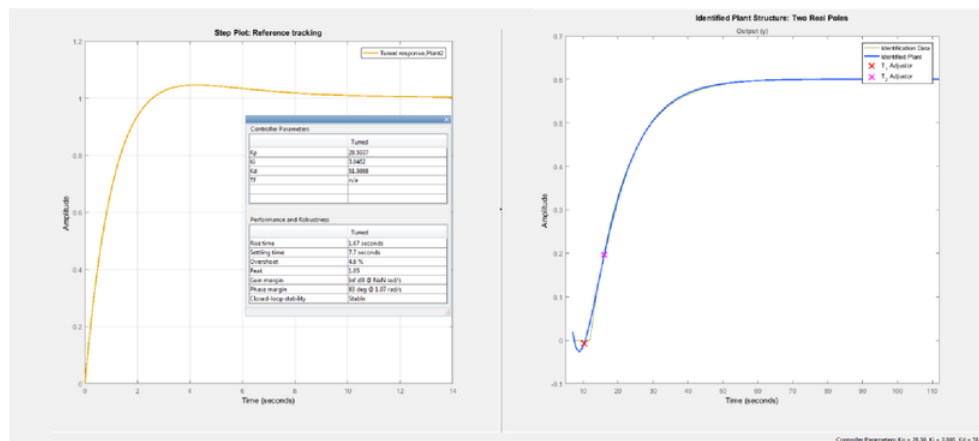
This chart shows how from observation each of these variables effects the open loop final response function.

PID Response	Error	settling time	overshoot	rise time
P	reduce	Small change	rise	reduce
I	No errors	rise	rise	reduce
D	Small change	reduce	reduce	small change

From this you can see there are no errors in the integral term this term was chosen for the best response with proportional gain and derivative term both being manipulated to give best results on the integral term.

System Operation findings

From the response rate chosen for this project, the system operators should find that only the first 10 -13 seconds of the start-up of PID should there be any issues after 10 seconds the response is in line with output files this should give the system operators and ideal when errors may happen. The reference track shows that will only be a 4.6% overshoot and a settling time of 7.7s rise time of 1.67s the chosen loop for this stable meaning there should not be many issues with the PID all specs are in line with 5% overshoot and 20seconds of start-up time.



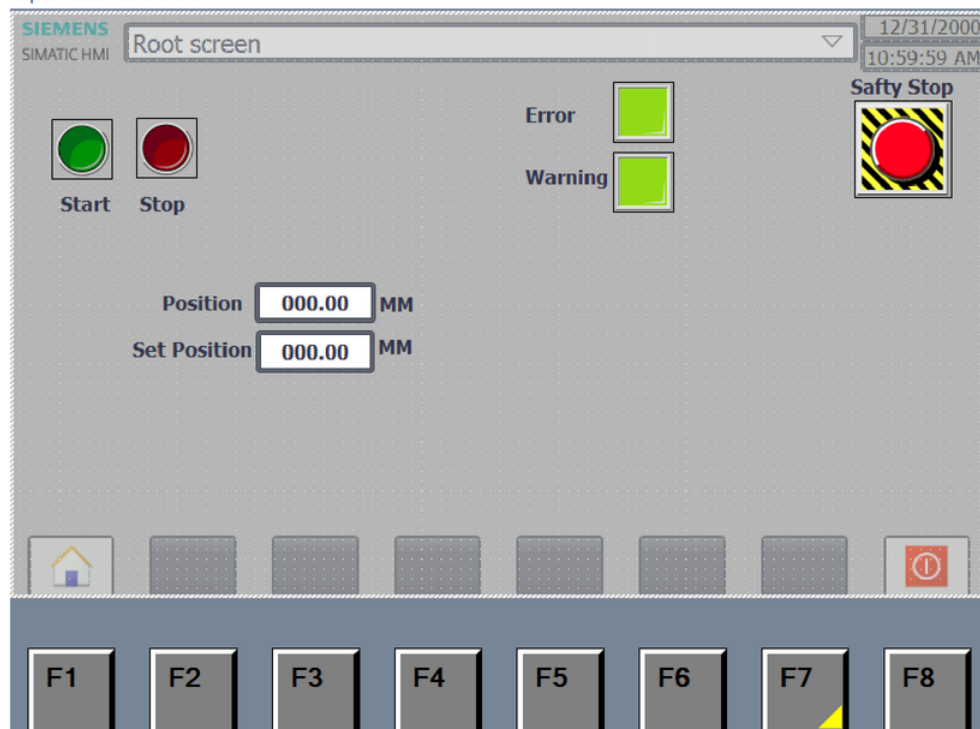
Rise time	1.67 seconds
Settling time	7.7 seconds
Overshoot	4.6 %
Peak	1.05
Gain margin	Inf dB @ NaN rad/s
Phase margin	83 deg @ 1.07 rad/s
Closed-loop stability	Stable

Screen Speciation's and layout

Introduction

Efficient Layout of all screens and parameters needed for this PID to help users and engineers with navigation and correctly recognize error when alerted. These screens have been laid out as being used on a factory floor All screen are reachable from the main screen Engineer function are hidden under f5 button this is so the operator is not able to set PID levels. The diagnostic screen will show all error in more detail explain what error has occurred. These errors will reset when stepping back out of the Diagnostic screen with the back button. The emergency stop has been placed on the main screen this will also be reset by going to the Diagnostic screen and stepping back.

Operations screen



Pressing the start button will start the PLC

Before this happen Pressing F7 will take the engineer to setting screen to input Errors and warning.

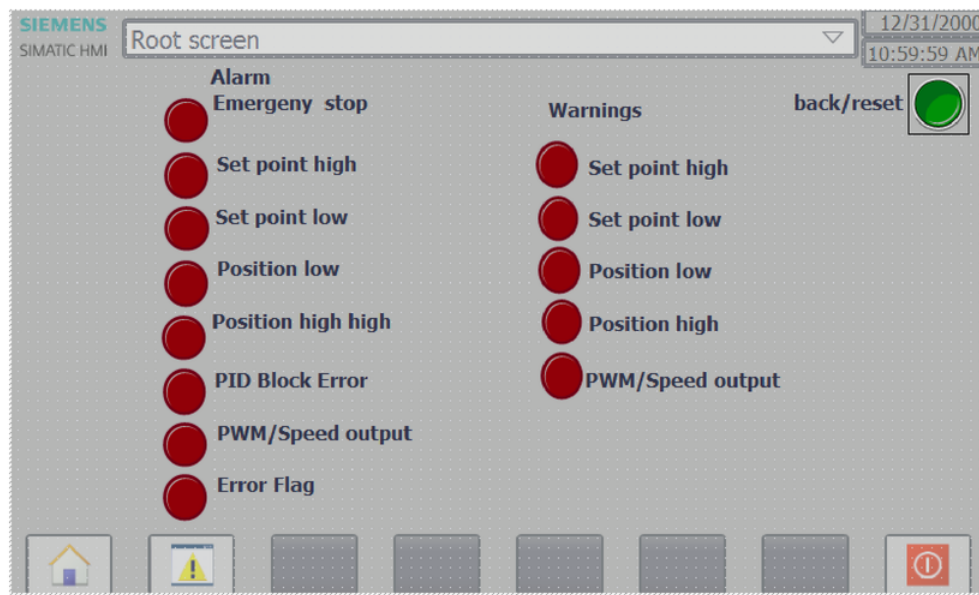
When an error or warning happens in this PID the 2 buttons will change colour from green to red. These are reset by going into diagnostics and stepping back once the error is cleared. This screen will show the PLC set position and the analogy position

If an emergency happens while in use the emergency stop button will stop the PLC and will be reset back going into errors that will light up red and step back to operations

This screen has been keeping clutter free and clear for the user this was done to keeping this screen easy to use for the operator being down the risk of human error

Diagnostic

Creating a simple design for this screen is very important as if an alarm or a warning has gone off then the operator must be able to see clearly what has happened. Alarms will stop the PLC programming and make the P.I.D. control system stop this could cause faulty errors you once the error is cleared if all alarms are cleared then no light will show up as shown here you can press back/reset to restart the programming. If any warning arises they will light up here and on the operation screen these will not stop the PLC but just warn the operator. Again if errors are cleared they all light will go off as shown here you just press back/reset the errors if all cleared the light will be green on the operations screen.



Warning strategy

Setting warning strategies gave the ability to understand what parameters are needed to be controlled for Safety of the user and product. These warning will not stop the PLC controls they will just warn the user that it is nearing alarm levels they will light up on the Operations screen and be reset by going into the Diagnostic screen stepping back to Operations screen

Warning Strategy

- Warning if the position is greater than 80% of max
- Warning if the position is less than 20% of max
- Warning if the set position is greater than 80% of max
- Warning if the set position is less than 20% of max
- Warning if PWM output is greater than 80% of max
- Warning if output exceeds 75% of max

Alarm strategy

- Alarm if the position is greater than 90% of max
- Alarm if the position is less than 10% of max
- Alarm if the position is less than 10% of max
- Alarm if the set position is greater than 85% of max
- Motor Drive – PWM. Max drive PWM output 85%
- Alarm if PWM output is greater than 85% of max
- E-stop button
- The error flag is used if any alarms go off

Setting

Setting alarm and warning function is something only a trained personnel should do this is why this button is not on the main operation screen but hidden within F5 on the main screen. From here are alarm stratagem can be input into the PLC controls. If any alarms or warning are set while the plc is in operation and causes and Alarm or a warning will show up here if you click on one of these red light it will take you to diagnostic to see where the error has occurred and allowed for the rest of these alarms/warnings.

From here the set point, position and PMW Motor Speed Upper and lower warning/errors can be set by clicking on the boxes and inputting the need variables.

When putting in Alarms and warning the operator should keep in mind how these function work within programming if your setting a high/low alarm the alarm/warning will be activated once that is hit so if alarm setpoint high is set to 200 and the point is at 200 or more the alarm will go off and will need to be cleared and reset in diagnostics

	Alarm	Warning
Set points High	+0000000	+0000000
Set points Low	000.00	000.00
Posision High	+0000000	+0000000
possision Low	+0000000	+0000000
Speed	+0000000	+0000000

 Error

 Warning

main

F1 F2 F3 F4 F5 F6 F7 F8

Concluding screens

Designing the screen layout for the PLC controller has given good insight on how to lay out effective and efficient design keeping in mind human error by hiding the setting screen that is only designed to be seen by a technician, not operators in setting all specified alarm and warning can be set. The operator will find from the operations screen they will be able to get a good overview of how the PLC results are from the PID and if any errors have occurred.

The diagnostic screen allows all errors to be shown individually and then cleared on the returning if the problem has not been resolved then a technician will have to come and change the alarm functions or you have a malfunctioning part.

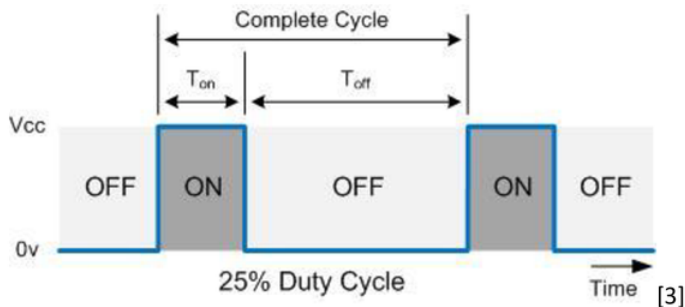
In this design, a simple basic layout has been achieved to keep this system simple for operations all specifications have been meeting showing all results and alarms/warning set out in the warning strategy.

PWM Introduction

The Pulse Width Modulation (PWM) is a system that uses a fixed cycle time with a variable duty cycle time this means when if there was a 10% duty cycle the device will be 10% on and 90% off. This ability to make a device function at a variable Operation speed is widely used in motors to control a speed of drills.

PLCs are perfect for working with PMWs as they have solid state switches this means they can give nearly an unlimited switching cycles.

Being able to provide a way through programming to adjust the control speed and timing of a machining device. This could be used to allow the operator of this device to verify and change machining devices speed, timing.[2]



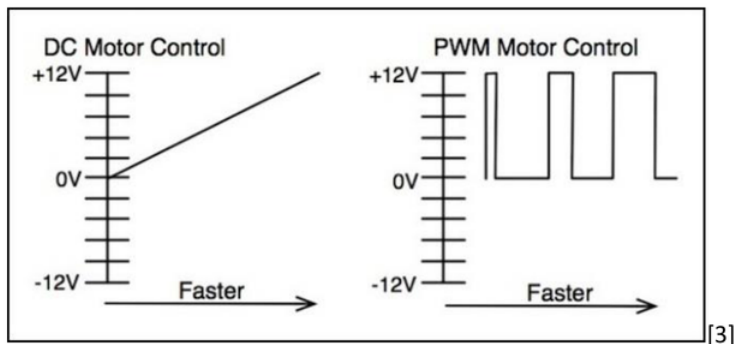
This shows a duty cycle of 25% this means this device will only be on 25% or running at 25% of its full speed. Induction of the drill will make the current average but will still keep the torque in proportion this means the device will not jitter it will seem smooth. This does not happen in variable voltage control.[4]

By manipulating the duty cycle speed controls can be controlled with high quality while efficiency in the process it's a form of *digital to analogue conversion method*.

Reduce the life of the motor by turning the motor on and off

Operating an LED at a current higher than its rated current will cause an unusual phenomenon where the resistance of the LED will actually start to fall as it gets warmer. This starts a vicious cycle where the LED receives more current, so it gets hotter

This show a traditional analogy powered motor increasing speed the other shows a PWM motor increasing speed by giving longer duty cycles,



PMW issues

The Pulse Width Modulation has a few issues when comparing it to analogy method. If any issues arise with the frequency of the pulses such as if the frequency is too high or too slow, this will cause the current averaging not to happen within the drill. This would make this device not operate at all; this is known as "flickering". This is solved by keeping the frequency to around 2kHz to 16 kHz, making this issue non-existent. [5]

EMF (electromagnetic field) noise can be created by a PWMs; this is caused if cables are not well shielded. If this issue is not resolved, communications could malfunction as EMF interrupts the data stream.

Some systems can find that PWM can cause damage to DC and AC motors due to the pulsing effect of current. This can be solved by grounding the motor, which is normally done by the manufacturer.

Advantages

There are many advantages of both PMW and traditionally analogy both are the best suit in my different environments.[6]

PMW

- PMW can operate devices *over there its* normal maximum this can allow for a more effective machine. Pushed to their limits for a point for short periods of time.
- Has incredible precision for speed control this gives a massive advantage over analogue controls that can be less precise
- PWM has more readings range than traditional analogy this as reading from traditional analogy that is only able to read 1023 readings from 0-5v.
- Faster responding controller need for suddenly stop
- PWM has ultra-low power dissipation compared to the traditional analogy that can create a loss of torque
- PMW keep a high torques
- Massive range of varied frequencies
- PWM has a Low impact of noise as the logic 0 would have to be changed to a logic 1 that would need a lot of noise.
- enhanced noise resistance
- PWM is able to communicate over a further distance traditionally analogy

PMW conclusion

In short, when dealing with power control a PWM device can have a massive advantage over its analogy counterpart. This is due to its Advantages described having a much precision. This is why PWM devices are normally used for light brightness and speed control of motors this was by using current averaging. For this project, a PWM was the right device for this project gives the operator a wider range of controllers over speed. But also being able to program the speed on the PLC over an Analogue allowed for a smoother transition of speed. One of the major advantages for the operator will be the Faster responding controllers when a sudden stop is needed.

PLC Programming

Introduction

TIA

The PLC software chosen for this project was a part of Siemens Totally Integrated Automation Portal with allows unrestricted access to a rang if services.

SIMATIC STEP 7 (TIA Portal) was used for all plc programming in this project this Professional grade PLC ladder logic software this the ultimate PLC Programming tool compatible with all SIMATIC controllers.[7]

- Many Functions such as
- drag & drop,
- copy & paste
- Auto-Completion
- Error compiling

Make work PLC programming much quicker and easier.

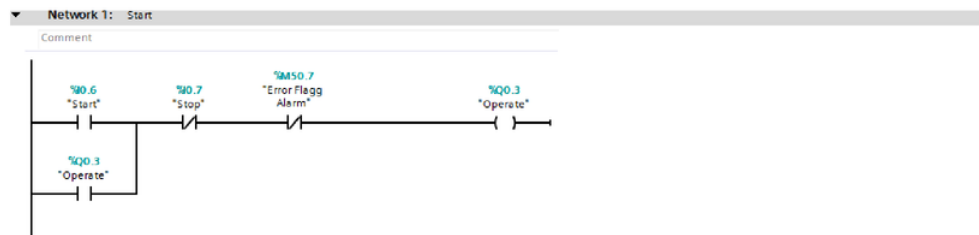
What is Ladder Logic

Ladder logic is used in most Morden PLC and is a programming language. its based on a relic of the past relay logic control. Ladder logic user symbols to represent components or actions that are interconnected by a line these show the flow of logic operations. PLC ladder logic is standards and is set by PLC Open this standard is called IEC 61131-3. Over the last few years, the number of components that are used in ladder logic has increased to provide a high level of usability.[8]

Logic ladder Programming

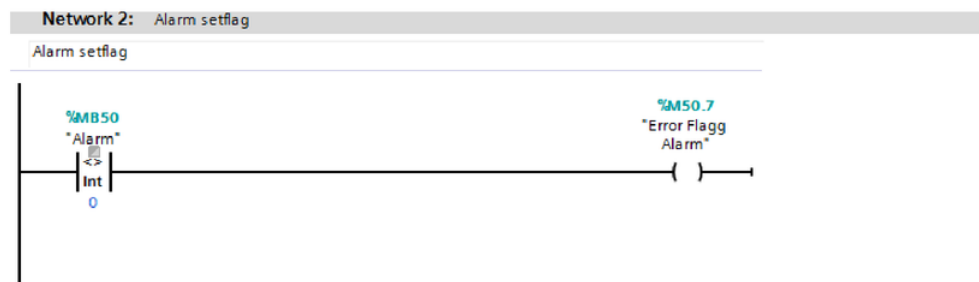
Network 1

Network one contain all start and stop function as needed for this project once a start has been pressed the operations will start unless there is an alarmed flagged or the stop buttons being pressed. when the start button this will also trigger the green light on the PLC and the Stop or alarm will trigger the red light to show operation have stopped.



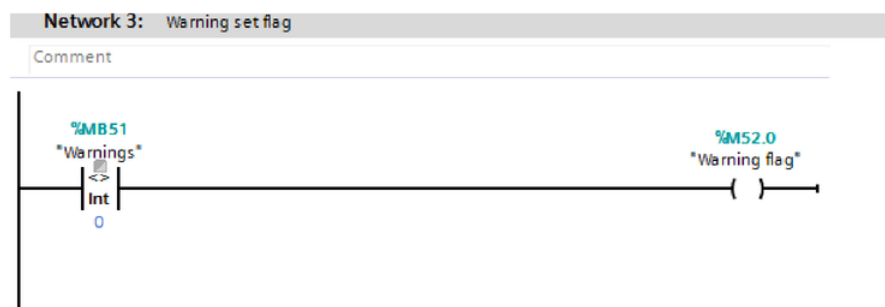
Network 2

Network 2 is created set the Error Flag alarm if any alarms are set this will then stop the operation in network 1



Network 3

If any warning go off this will set the warning flag triggering an error light will go red on the operation screen

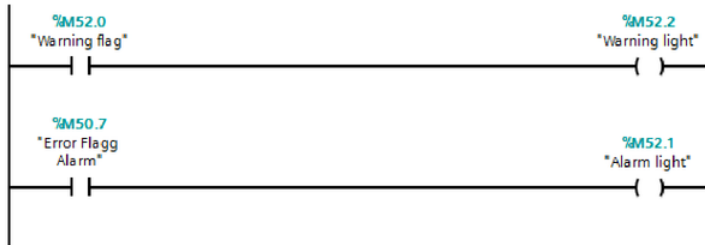


Network 4

This section will set the warning light and alarm light for the PLC control screen if any alarm or Error is triggered this will then light up the represented light on the operation screen.

Network 4: Warning/Alarm lights

Comment



Network 5

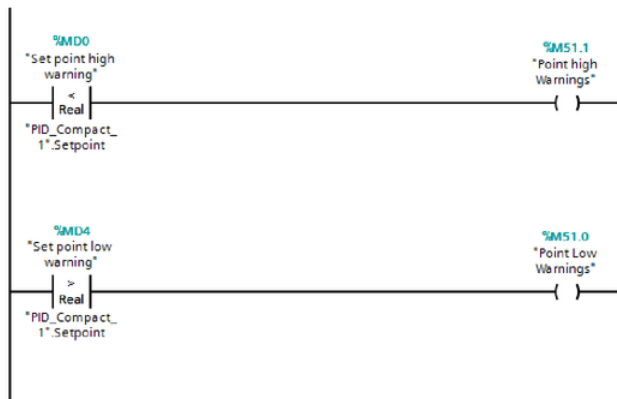
This section configuring the setPoint warnings limits these will be set manually in the setting screen High and low limits will work on the calculation o

(Setpoint high warning) if greater than (PID compact (real PID results)) = Setpoint high warning

(Setpoint low warning) if less than (PID compact (real PID results)) = Setpoint low warning

Network 5: Set Point Warnings

Set Point Warnings

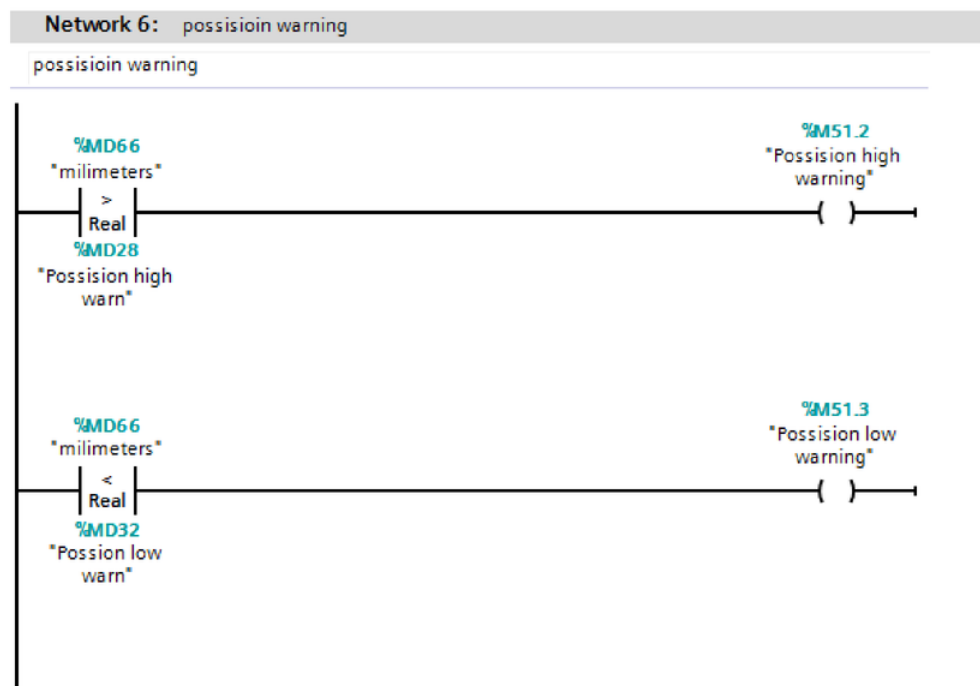


Network 6

This shows the position warnings the get there reading from the analogue input that is converted to millimetres.

(Position high warning) if greater than (millimetres) = Position high warning

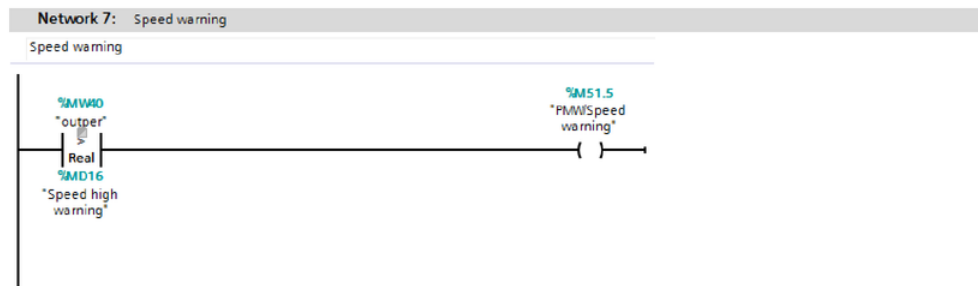
(Position low warning) if less than (millimetres) = Position low warning



Network 7

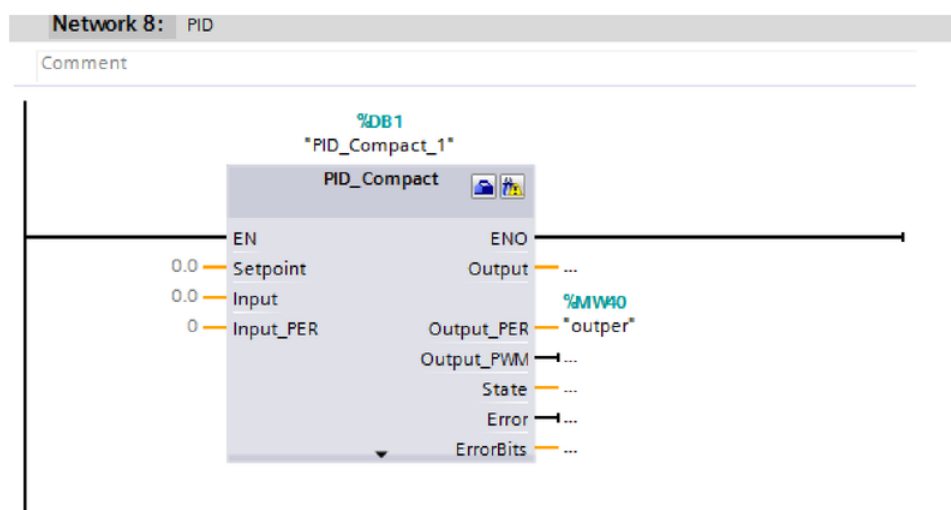
This will set the warning high levels for the speed of the motor ouper is the output of PER

(Speed high warning) if more than (ouper(real speed) = PMW/speed warning



Network 8

This is the PID block that builds into Siemens this will provide data on the set point data and Speed. Are KP, KI, KD will be inputted to the PID Compact.



Network 9

This network is designed to check the set point values from PID this then compares it to see if setpoint high alarm and setpoint low alarm making sure it always in its alarm limits or operations will stop.

(Setpoint high Alarm) if greater than (PID compact (real PID results)) = Setpoint high Alarm

(Setpoint low Alarm) if less than (PID compact (real PID results)) = Setpoint low Alarm



Network 10

Network 10 will set the alarms for a position high and low

(Position high Alarm) if greater than (Millimetres) = Setpoint high Alarm

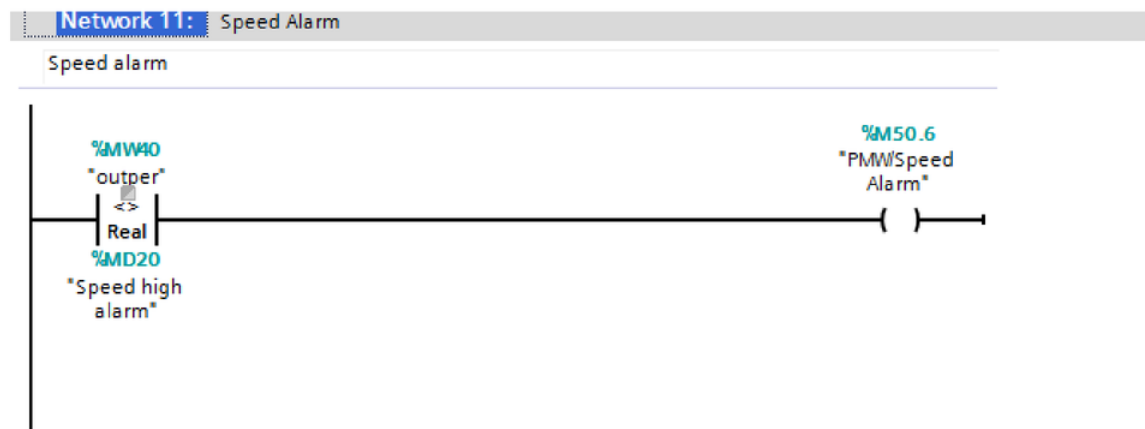
(Position low Alarm) if less than (Millimetres) = Setpoint low Alarm



Network 11

Network 11 set the last alarm to need to fulfil are alarm strategy this will use the speed output from the PID_PER(outper).

(Speed high alarm) if greater or less than (outper) = Setpoint high Alarm



Network 12

This is the final network used in this plc system in converts the analogue input to millimetres.

It does this by dividing the analogue input by 32.767.



PLC TAGS

This shows all the PLC tags that are used in this report as you can see some item have been retained this is so the trephination does not have to enter alarms and errors every time the machines are turned off. Other items are used to connect them from operations screens to their ladder logic counterpart.

	Name	Tag table	Data type	Address	Retain	Visibl...	Acces...
1	Start	Default tag table	Bool	%I0.6	☐	☒	☒
2	Stop	Default tag table	Bool	%I0.7	☐	☒	☒
3	Operate	Default tag table	Bool	%Q0.3	☐	☒	☒
4	Set point high warning	Default tag table	Real	%MD0	☒	☒	☒
5	Set point low warning	Default tag table	Real	%MD4	☒	☒	☒
6	Set point high Alarm	Default tag table	Real	%MD8	☒	☒	☒
7	Set point low Alarm	Default tag table	Real	%MD12	☒	☒	☒
8	Speed high warning	Default tag table	Real	%MD16	☒	☒	☒
9	Speed high alarm	Default tag table	Real	%MD20	☒	☒	☒
10	Alarm	Default tag table	Byte	%MB50	☐	☒	☒
11	Warnings	Default tag table	Byte	%MB51	☐	☒	☒
12	E-Stop Alarm	Default tag table	Bool	%M50.0	☐	☒	☒
13	Alarm Set Point Low	Default tag table	Bool	%M50.1	☐	☒	☒
14	Alarm Set Point High	Default tag table	Bool	%M50.2	☐	☒	☒
15	Alarm posision High	Default tag table	Bool	%M50.3	☐	☒	☒
16	Alarm posision Low	Default tag table	Bool	%M50.4	☐	☒	☒
17	Pid Block Alarm	Default tag table	Bool	%M50.5	☐	☒	☒
18	PMW/Speed Alarm	Default tag table	Bool	%M50.6	☐	☒	☒
19	Error Flagg Alarm	Default tag table	Bool	%M50.7	☐	☒	☒
20	Point Low Warnings	Default tag table	Bool	%M51.0	☐	☒	☒
21	Point high Warnings	Default tag table	Bool	%M51.1	☐	☒	☒
22	Possision high warning	Default tag table	Bool	%M51.2	☐	☒	☒
23	Possision low warning	Default tag table	Bool	%M51.3	☐	☒	☒
24	PMW/Speed warning	Default tag table	Bool	%M51.5	☐	☒	☒
25	Warning flag	Default tag table	Bool	%M52.0	☐	☒	☒
26	Alarm light	Default tag table	Bool	%M52.1	☐	☒	☒
27	Warning light	Default tag table	Bool	%M52.2	☐	☒	☒
28	Possision low alarm	Default tag table	Real	%MD24	☒	☒	☒
29	Possision high warn	Default tag table	Real	%MD28	☒	☒	☒
30	Possision low warn	Default tag table	Real	%MD32	☒	☒	☒
31	Possision high alarm	Default tag table	Real	%MD36	☒	☒	☒
32	PMW/Speed warning set	Default tag table	Real	%MD18	☒	☒	☒
33	PMW/Speed alarm set	Default tag table	Real	%MD19	☒	☒	☒
34	analog	Default tag table	Int	%IW64	☐	☒	☒
35	milimeters	Default tag table	Real	%MD66	☐	☒	☒
36	outper	Default tag table	Int	%MW40	☐	☒	☒
37	<Add new>				☐	☒	☒

Final implementation and testing

After creating all the Operation screen and PLC ladder logic it was possible to upload this item on the Siemens plc and observe the behavior or the final product. Testing took place to see if all alarm/warning function worked correctly this made sure the final product worked effectively.

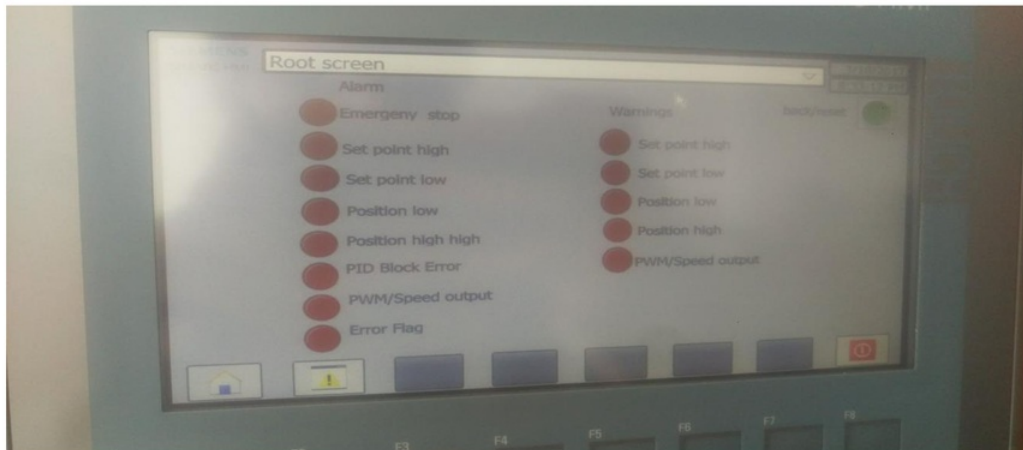
Operation screen with no errors

This show what a good operation should look like if the screen shows all green on errors (Alarms) and warning you cannot see the setting screen from here but it is hidden behind F7 button for the safety of the operations.



Diagnostics with no errors

When there are no light up alarms and warning this show all everything if functioning correctly pressing reset/back will take you back to operations screen.



Setting screen

This screen is hidden under f7 and is only to be used by train personnel only. This show what and normal warning and alarms inputs should look like. Their nominal values were entered for testing purposes from here errors and warning can be viewed in case the technician triggers and alarms and need to reset them pressing the warning light or error light will take you to diagnostic to investigate the problem and reset alarms.



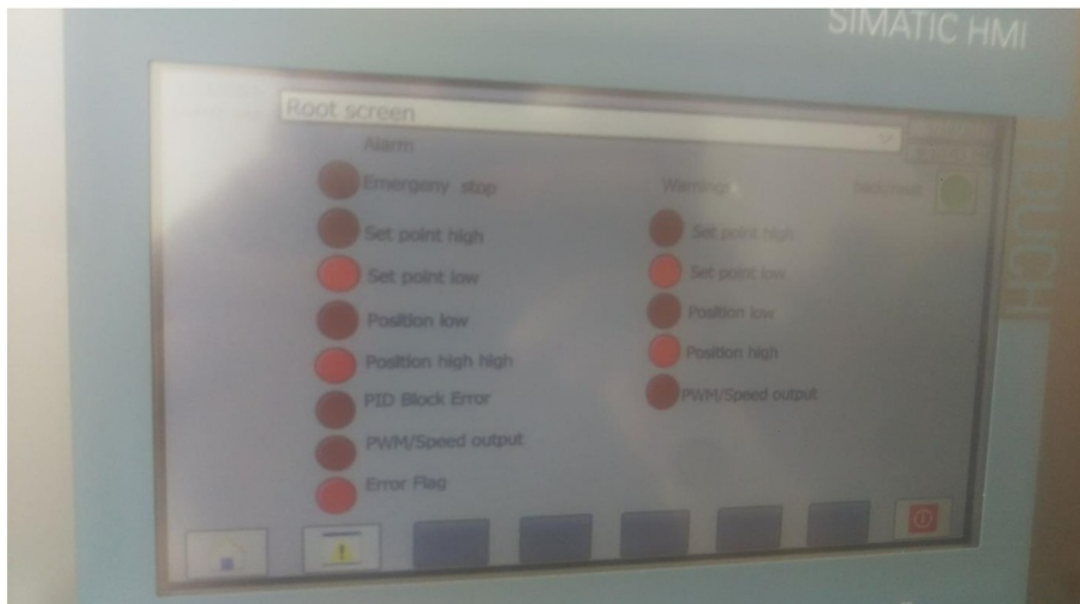
Operations with alarms and errors

If any alarms or warnings happen within this program they will turn they represent light red as shown here with the error and warning light as red.



Diagnostics with alarms and errors

When alarms or warning are triggered as shown here they will glow red they can be reset by pressing the green back/reset button.



After implementing and testing all the ladder logic and control screen it was possible to confirm this project meet all its goals and set out specifications. All programming worked correctly and control screen is easy to follow and keep in mind safety and lowering human error.

Improvements

Adding more sensor and precisions to the motor-driven that is used for the creating holes in heavy metal sheets could increase the safety of this product. Proximity sensor to make sure operators are away from degrees arrears could save life with little extra programming.

When looking for a transfuse function then using the transfer function generates the required values for K_p , K_i and K_d this project could have set harder limits only asking for

- Absolute Max response time (to steady state) 10secs
- Absolute Max over-shoot to a step-change 3%
- Having a more efficient layout to operations screen could lessen human error.
- This report could have made a manual for both the operator and technician for training and basic information on operations.
- A higher knowledge PLC Coding and ladder logic could create a more advanced system.

Reasons for the Improvements

The improvement above could increase productivity with setting harder limits on the Open loop response. Adding more alarm system could help save a life with the addition of more sensor to avoid an accident within the workplace or a product malefaction. Make sure operation screen are clear and well set out can stop human error and increases performance.

Evaluation

The final production of the PID controller contained all the programming, response and control screen have been created meeting all specifications asked in the before this design is well set-out with a description of programming throughout this had made for an easy to follow programming contain 12 networks. The control screen is set out for a basic design to keep the product simple and to avoid human errors all alarms and errors are named and connected to the partners within the programming being light up in red next to the represented issues. The PID transfer function for this system is well chosen to be the most suitable for this device. Fine tuning the transfer function that was generated the values for K_p , K_i and K_d made this project meet its goals with low overshoot and response time.

Conclusion.

This project was able to meet all set-out specification creating a device that is effective and efficient with an easy to use operations screens. With low levels of ladder logic programming knowledge when starting this project it has given the ability of learning and advance knowledge of PLC as a whole from setting tags to creating screen and programming. Creating every part of this product was well rewarding being able to simulate it win in the class to observer operation and perform testing was one of the major sets and some faults cannot be observed through programming alone from this the programme was able to be used to check for a good usability making everything a bit bigger and more visible was need that was noticed from testing human error can cause a lot of issues so make sure the operator did not click the wrong boxes would help a lot. This project has made me think differently about how things in development should help the operator to stop errors.

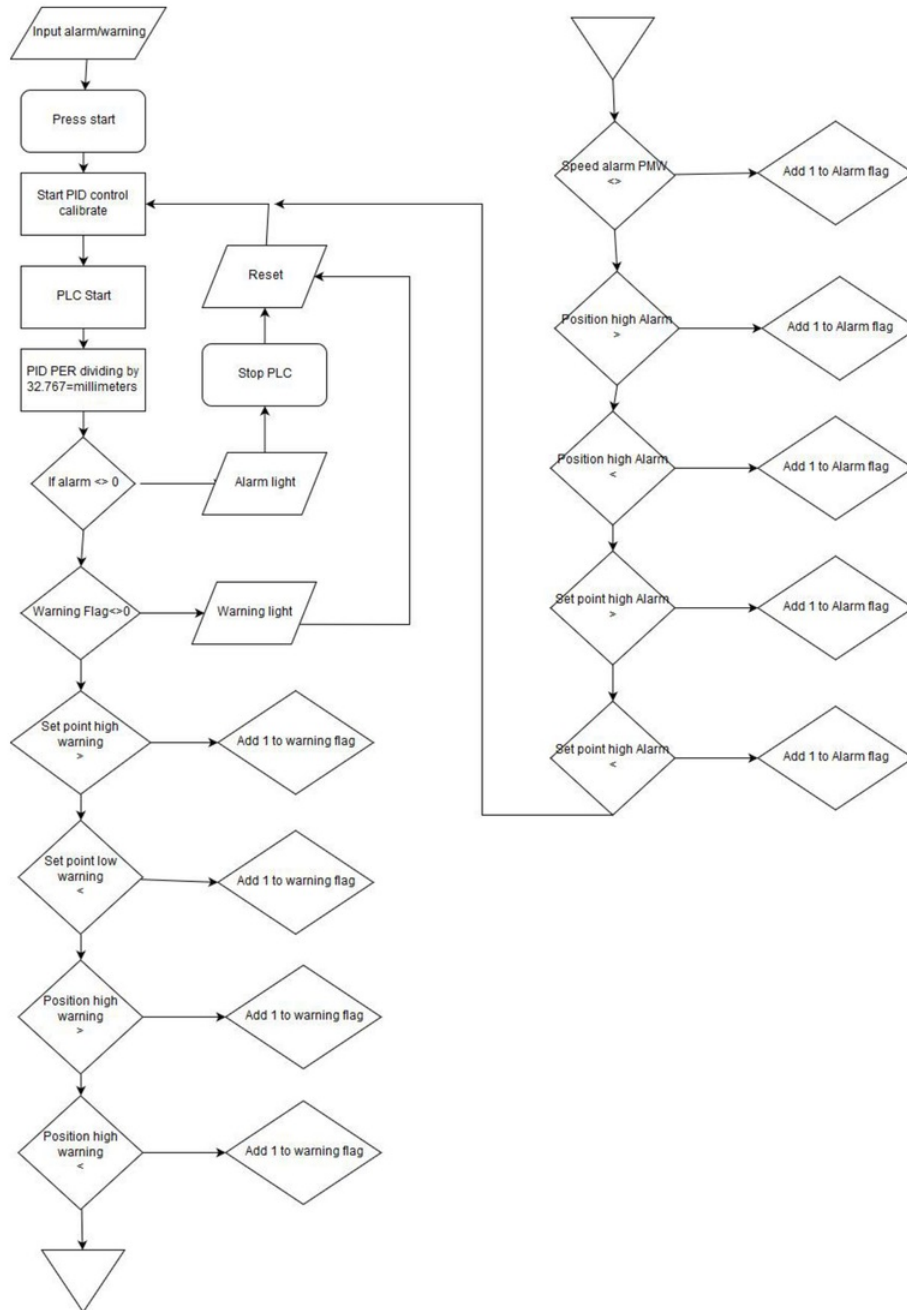
The response is chosen and transfuse function meet all goals set out using MathLabs showed how easy taking some open loop files and using the inbuild PID tool can be to create a well-tuned PID from the knowledge of open loop response and finding a response that working effectively with the Final PWM controls.

Having a larger understanding of Pulse wave modulation have their advantages and disadvantages have shown why PMW is chosen for this product and why Traditional **Analogue** has it a disadvantage when dealing with Speed control as a lot of power is dissipated and lost when using **Analogue** to control speed this can also create a loss of torque. PWM has none of these issues creating a High torque low power dissipation and low noise disruption solution to speed/ power control.

Overall this project created a Program that is set for purpose being keep within all specification Setting all required alarms and errors to the PID control and technical inputs. It found the perfect values for Kp Ki KD by using it well-tuned transfer function allowing for a more stable PID.

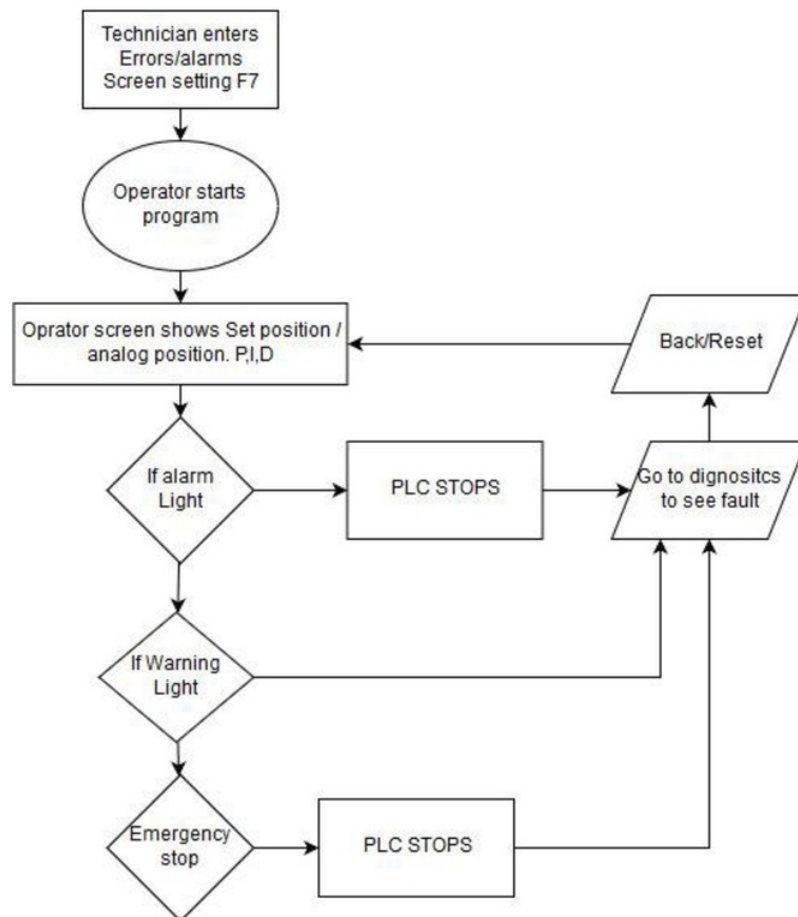
Operational Flow Chart

This show the outline of the PLC programming applying all specification for alarms and warnings. When an alarm/warnings are triggered they add a number to their error/alarm flags allowing for the further functions of stopping the plc and setting warning lights.



Operator flowchart

This show the operator how to use the PLC control screen in case there is any malfunction following these step should keep the PID system working If alarms still are continuing after resetting the alarm and clearing the issues a technician needs to change the Error and alarm function.



Referencing

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FINAL GRADE

GENERAL COMMENTS

Instructor

62/100

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GRADING FORM: SMU GENERIC_GJ

RYAN O'SULLIVAN

62

RESEARCH-INFORMED LITERATURE



The literature review is clear with good background

9.75

information but would have been improved with a few more simple illustrations, along with an advantage/disadvantage table. 65%

KNOWLEDGE AND UNDERSTANDING



The ladder logic program is clear and documented.
63%

15.75

ANALYSIS



The mechanism for generating the transfer function from the plant input output response curve is good. Your method is a little muddled but documented with good graphics. 60%

15

PRACTICAL APPLICATION AND DEP.



Your screens are functional and uncluttered and very well documented. All screens are nicely laid out and make it easy to identify faults/warnings and allow for user input and navigation. Good fault audit document. Reasonable attempt at improvements. 70%

14

SKILLS FOR PROFESSIONAL PRAC.



The report is reasonably well presented with the author using sufficient images and illustrations to allow the reader to digest information readily. 50%

7.5