

2117072

by Daniel Thomas

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1. Work Plan for Lifelong Learning and Risk Assessment

Always start a sentence with a word e.g. Four, to avoid confusion with a numbered point

4 Tasks need to be completed in this assignment which are calibrations of pressure, temperature, level and position sensors. Before the tasks are started a risk, assessment will be carried out and completed. Each of these tasks will be completed in groups of three people, each person will be given a different job to do on each task, this is to make sure each person gets a fair and equal experience ^{of} the tasks. After each task is completed a set of results will be produced which will include errors a graph for each task will be produced to show the results and errors.

Sounds like a good plan

Where is your risk assessment?

2. System Investigation

Flow Control Loop 535

FC535 is a flow controller which produces a control variable which is then fed into the pump amplifier LY541. The process variable comes from FT535 which is a flow transmitter. Interlock will be needed with either V515 or V516 this is to ensure water that is being pumped is allowed to flow up to the tank B1.

Temperature Control Loop 511

TC511 produces a control variable which is then fed into a solid-state relay using a pulse width modulation which controls the heater the process variable is from TT511 which is a temperature transmitter the interlock which is required for this is provided by LS542 which is a low water level switch. The cooling fan solenoid valves V515 and V516 and LY541 which is a pump amplifier can all affect the temperature of the system by adding cold water.

Level Control Loop 541

Level in tank B1 is controlled by LC541 level controller, this is sensed by LT541 which is a level transmitter. V500 is the drain solenoid valve this is able to empty the tank whilst LY541 which is the pump amplifier controls the water flow for the tank. There is an interlock for the low water limit switch LS541

Water Input Flow Control Loop 531

Water flow is sensed by FT531 the pressure of this water come from the water being recirculated by the system. Whilst the flow is being controlled by VF531 which is a proportional valve that is being controlled from FC531 which is a flow controller. Water can enter each tank via multiple solenoid valves V510, V511, and V512.

Where is your investigation into each sensor?

3. Calibration of Pressure Sensor

The device that was being calibrated was a Druck LP 5380 series this device has an accuracy Citation Needed or $\pm 0.25\%$ FS BSL. This device also accurately measures differential pressures of fluids in the range of 0 to 5 bar FS and the output is 0 to 10 V FS. Working as a group Pressure was increased from 0 FSD to 5 bar which is the maximum pressure the device can go. The pressure had to rise to the maximum value and fall from the maximum value in increments of 0.5 bar whilst the output voltage measurement was taken at each increment.

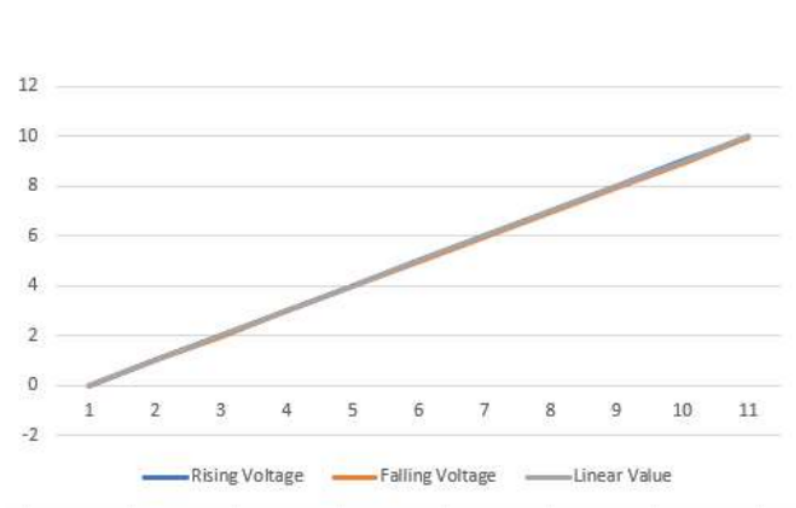


Figure 1 Pressure calibration graph

Figure 1 shows the Pressure calibration graph, from this graph it shows that the rising and falling voltage are mostly in line with the linear value.

What is the static sensitivity?

Figure 4 shows the Pressure calibration table of results, it shows the hysteresis error which the lowest is 0V and the highest is 0.11V

Max rising error = $9 - 9.04/10 \times 100 = -0.4\%$

Max falling error = $9 - 8.93/10 \times 100 = 0.7\%$

Max hysteresis error = $0.11/10 \times 100 = 1.1\%$

Good, but how do these values compare with manufacturer's data?

From calculating the max rising error, it was found that the tolerance was out by 0.15% whilst the max falling error was out of tolerance by 0.45% and the max hysteresis error was out of tolerance by 0.85%. this shows that the results found are out of tolerance.

4. Calibration of Temperature Sensor

The device that was being calibrated was a ConLAB RTT-2 Pt100. The RTT-2 is a non-isolated two-wire transmitter that converts the measuring signal of a resistance temperature detector (RTD) into a standardized load-independent current, w Citation Needed / proportional to the measured temperature. This device has an accuracy of 0.1% working in a group the temperature was increased in 10°C intervals up to 100°C and back down from 100°C to 0°C at each interval the amperage was measured.

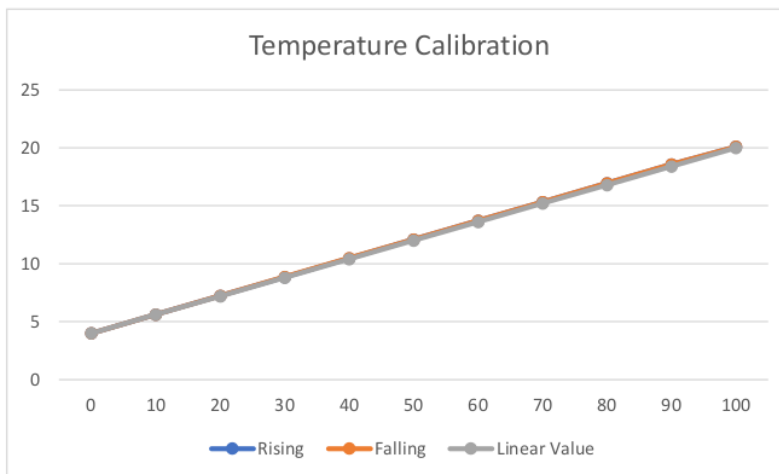


Figure 2 Temperature calibration graph

what was the static sensitivity?

Figure 2 shows the Temperature calibration graph, from this graph it shows that the rising and falling Amperage are mostly in line with the linear value.

Figure 5 shows the Temperature calibration table of results, it shows the hysteresis error which only 30°C, 40°C, and 50°C have a hysteresis error of -0.01A

Max rising error = $18.4 - 18.57/10 \times 100 = -1.7\%$

Max falling error = $18.4 - 18.57/10 \times 100 = -1.7\%$

Max hysteresis error = $-0.01/10 \times 100 = -0.1\%$

Good, but how do these values compare with manufacturer's data?

From calculating the max rising error, it was found that the tolerance was out by 1.6% whilst the max falling error is also out of tolerance by 1.6% and the max hysteresis error was within tolerance at 0.1%. this shows that the max rising and falling errors are out of tolerance.

5. Calibration of Level Sensor

The device that was being calibrated was a pressure transmitter which was a Cerabar PMC 133 this device is capable of gauge and absolute pressure measurement; this device can also measure in 4-20mA the output span is 16.5 mA but there is a minimum voltage of 13V across the terminals. The device has an accuracy of 0.2%. Working in a group the water level was increased in 1cm intervals up to 23cm and drained in 1cm intervals down from 23cm to 0cm at each interval the amperage was measured by a multimeter for the rising and falling.

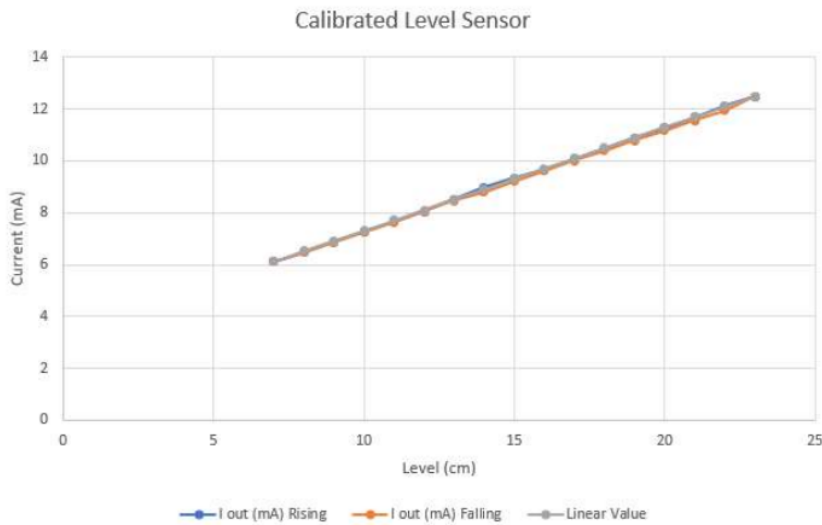


Figure 3 Level calibration graph

Figure 3 shows the Level calibration graph, from this graph it shows that the rising and falling Amperage are mostly in line with the linear value.

Figure 6 shows the Level calibration table of results, it shows the hysteresis error which the lowest is 0A and the highest is 0.19A

$$\text{Max rising error} = 8.91 - 8.99/10 \times 100 = -0.8\%$$

$$\text{Max falling error} = 12.09 - 11.94/10 \times 100 = 1.5\%$$

$$\text{Max hysteresis error} = 0.19/10 \times 100 = 1.9\%$$

Good, but how do these values compare with manufacturer's data?

From calculating the max rising error, it was found that the tolerance was out by 1.0% whilst the max falling error is also out of tolerance by 1.3% and the max hysteresis error was also out of tolerance by 1.7%. this shows that the max rising and falling errors are out of tolerance.

6. Calibration of Position Sensor

The device that was being calibrated was a position sensor the part number was O1DLF3KG this device has a max range of 10m and has an operating distance of 0.2-10m it uses a red light laser to measure the distance the device operates between 18V-30V. Working in a group the position sensor was moved in intervals of 100mm from 0m up to 1.3m and back down from 1.3m to 0m at each interval the distance was measured using the HMI screen.

Figures 7 and 8 show the Position calibration table of the results. Which shows the encoder offset and laser offset with the error between them also being shown. The highest error in the table of results is -17.41mm whilst the lowest error is -0.36mm

Good, but how do these values compare with manufacturer's data?

7. Research

Industry 4.0

Industry 4.0 is an improvement from industry 3.0 as it has advanced and new technologies IBM states that “Manufacturers are integrating new technologies, including Internet of Things (IoT), cloud computing and analytics, and AI and machine learning into their production facilities and throughout their operations”. (2022) Correctly cited

This automation creates a system where machines are equipped in factories with wireless connectivity and sensors to monitor an entire production line and make autonomous decisions. TWI Global states that “Wireless connectivity and the augmentation of machines will be greatly advanced with the full rollout of 5G. This will provide faster response times, allowing for near real-time communication between systems”. (2022) Industry 4.0 has digital twin technologies these technologies create virtual versions of worldwide installations, processes, and applications that can then be tested to make a cost-effective decision.

The goal of industry 4.0 is to enable automatic decision-making processes which can monitor assets and processes in real-time I-Scoop states that “the technologies making Industry 4.0 possible leverage existing data and ample additional data sources, including data from connected assets to gain efficiencies on multiple levels, transform existing manufacturing processes, create end-to-end information streams across the value chain and realize new services and business models” (2022)

IO-Link

According to Banner Engineering (2022), IO-Link is an open standard serial communication protocol that allows the exchange of data from devices and sensors that are supported with IO-Link. This master can transmit all this data over numerous networks such as fieldbuses and backplane buses which makes the data accessible for immediate action or stored for long-term analysis by an industrial information system such as a PLC or an HMI.

Some advantages of IO-Link are increased data availability, remote configuration and monitoring, simple device replacement, advanced diagnostics, and reduced wiring. Together these advantages result in the overall cost being reduced and efficiency increases with the machine also improving the machine’s availability.

Level Sensor

From which manufacturer?

The new level sensor that can be used is an FXPL003 this sensor works with all different types of liquids such as pasty or sticky liquids. This sensor is also compatible with IO-Link 1.1 it also has two adjustable switching outputs which would improve the maintenance and reliability of the system as IO-Link can predict when maintenance is required and speed up maintenance time meaning less downtime for the machine.

Flow Sensor

From which manufacturer?

The new flow sensor that can be used is an FXFF007 this sensor can simultaneously flow velocity and the temperature of aqueous liquids regardless of position and flow direction. This device has 2 outputs which can be configured with IO-Link to adapt the sensor to a certain application. This sensor is also prepared for industry 4.0 and IO-Link 1.1. This device can improve the maintenance and reliability of the machine by simplifying the equipment replacement as the parameter settings are stored in the host automation system. This reduces maintenance costs and reduces downtime of the machine.

Temperature Sensor

From which manufacturer?

The new Temperature sensor that can be used is an FXTT018 this sensor can ensure precise temperature measurement of liquid and gases and the outputs can be switched to suit device needs. Also, these devices can be configured via IO-Link to flexibly adapt the sensors to their desired application. This sensor is ready for Industry 4.0 and compatible with IO-Link 1.1. this device can improve the maintenance and reliability of the machine as IO-Link monitors the real-time condition of the sensor and can detect the build-up of dirt by reading the sensor strength in real time. This reduces maintenance costs and reduces downtime of the machine.

Distance Sensor

From which manufacturer?

The new Distance Sensor that can be used is a P1PY101 this sensor functions with dynamic sensitivity technology (DS) which enables previously unattainable reception sensitivity with weak signals. This device also has a working range of up to 10m and can detect shiny and dark objects. This sensor is ready for industry 4.0 and compatible with IO-Link 1.1. this device can improve the maintenance and reliability of the machine as extensive condition monitoring enables trouble-free operation and predictive maintenance. This reduces maintenance costs and reduces downtime of the machine.

8. Environmental, Maintenance and Reliability

This section does not really answer the task set.

The subsystems gather large amounts of data from all the sensors, this large collection of data can make a major difference to the running cost of the machine as the data can be used to predict when maintenance is needed and exactly where maintenance is needed reducing costs. Also, the overall quality of the product will improve as the parameters can be set to a specific point and monitored 24 hours a day to ensure they don't drop. Also, the reliability of the subsystems will improve as maintenance will fix any problems with the subsystems faster speeding up production time and improving the reliability of the system.

9. Conclusions and Recommendations

From what has been gathered it was found that all four sensors were out of tolerance to the calibrations some of these errors could be down to human error as the buttons and valves were all done by hand rather than automatically done by the machines. Also, with the information gathered from the tasks a calibration can be carried out on various types of sensors. Furthermore, valuable information was gathered on industry 4.0 and IO-Link such as how they work and the benefits of using them with modern sensors such as reduced running cost and cheaper maintenance. Calibration tests can be carried out on different types of sensors such as vibration sensors humidity sensors and piezo sensors

10. Team Working

Write in the third person

For the four calibration tasks a team of three people was chosen, my team was Elias and Cerys it was decided that It was best to spread out the workload between the group for example on the calibration of the level sensor Elias was given the task to control the valve whilst Cerys was given the task to read the level of the tank at each set point. I was given the task to write down all results into a table and make the graphs for the group. The roles were switched around for each task to make it equal and included everyone in the group.

Write in the third person

It was beneficial to work as a team as it decreased the amount of time it took to complete the task which made completing the task easier rather than working individually. Also knowledge and understanding was increased because as a group we discussed our thoughts and experience after carrying out each task.

11. Citation List

Correct method of listing.

Good range of sources

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12. Appendix

Measured and Pressure (Bar)	Output Voltage (Volts)		Linear Value (Volts)	Non-linearity error (Volts)		Hysteresis Error (Volts)
	Rising	Falling		Rising	Falling	
0	-0.03	-0.03	0	0	0	0
0.5	1.04	0.99	1	0.04	-0.01	0.05
1	2.03	1.97	2	0.03	-0.03	0.06
1.5	3.02	2.98	3	0.02	-0.02	0.04
2	4	3.97	4	0	-0.03	0.03
2.5	5	4.98	5	0	-0.02	0.02
3	6	5.97	6	0	-0.03	0.03
3.5	7.01	6.95	7	0.01	-0.05	0.06
4	8.02	7.94	8	0.02	-0.06	0.08
4.5	9.04	8.93	9	0.04	-0.07	0.11
5	9.99	9.99	10	-0.01	-0.01	0

Figure 4 Pressure calibration table of results

Temperature	Temperature rising (mA)	Temperature Falling (mA)	Linear value	Rising Error	Falling Error	Hysterisis Error
0	4	4	4	0	0	0
10	5.62	5.62	5.6	0.02	0.02	0
20	7.24	7.24	7.2	0.04	0.04	0
30	8.85	8.86	8.8	0.05	0.06	-0.01
40	10.47	10.48	10.4	0.07	0.08	-0.01
50	12.09	12.1	12	0.09	0.1	-0.01
60	13.71	13.71	13.6	0.11	0.11	0
70	15.33	15.33	15.2	0.13	0.13	0
80	16.95	16.95	16.8	0.15	0.15	0
90	18.57	18.57	18.4	0.17	0.17	0
100	20.1	20.1	20	0.1	0.1	0

Figure 5 Temperature calibration table of results

Level (cm)	I out (mA) Rising	I out (mA) Falling	Linear Value	Error Rising	Error Falling	Hysterisis Error
0	4.02	4.02	0	4.02	4.02	0
7	6.12	6.11	6.12	0	-0.01	0.01
8	6.47	6.48	6.518125	-0.048125	-0.038125	-0.01
9	6.87	6.87	6.91625	-0.04625	-0.04625	0
10	7.27	7.25	7.314375	-0.044375	-0.064375	0.02
11	7.67	7.65	7.7125	-0.0425	-0.0625	0.02
12	8.05	8.05	8.110625	-0.060625	-0.060625	0
13	8.51	8.46	8.50875	0.00125	-0.04875	0.05
14	8.99	8.8	8.906875	0.083125	-0.106875	0.19
15	9.33	9.22	9.305	0.025	-0.085	0.11
16	9.64	9.62	9.703125	-0.063125	-0.083125	0.02
17	10.08	10	10.10125	-0.02125	-0.10125	0.08
18	10.48	10.4	10.499375	-0.019375	-0.099375	0.08
19	10.88	10.78	10.8975	-0.0175	-0.1175	0.1
20	11.28	11.18	11.295625	-0.015625	-0.115625	0.1
21	11.68	11.57	11.69375	-0.01375	-0.12375	0.11
22	12.13	11.94	12.091875	0.038125	-0.151875	0.19
23	12.49	12.49	12.49	0	0	0

Figure 6 Level calibration table of results

Encoder right (mm)	Level right(mm)	Encoder offset	laser offset	Error
7.3	213.74	0	0	0
103.2	300.74	95.9	87	8.9
203	402.12	195.7	188.38	7.32
302.2	512	294.9	298.26	-3.36
401.3	602.47	394	388.73	5.27
500.9	712.02	493.6	498.28	-4.68
601.3	818.73	594	604.99	-10.99
705.8	927.62	698.5	713.88	-15.38
807.4	1026.41	800.1	812.67	-12.57
902.4	1121.41	895.1	907.67	-12.57
1020.1	1238.74	1012.8	1025	-12.2
1105.3	1321.72	1098	1107.98	-9.98
1203	1415.69	1195.7	1201.95	-6.25
1313.8	1528.21	1306.5	1314.47	-7.97

Figure 7 Position calibration table of the results (right)

Encoder left(mm)	Level left(mm)	Encoder offset	laser offset	Error
1313.8	1528.21	0	0	0
1201.3	1413.73	112.5	114.48	-1.98
1097.1	1312.22	216.7	215.99	0.71
1000	1214.05	313.8	314.16	-0.36
898.7	1114.69	415.1	413.52	1.58
799.9	1014.84	513.9	513.37	0.53
705.6	920.68	608.2	607.53	0.67
600	813.94	713.8	714.27	-0.47
498.1	703.37	815.7	824.84	-9.14
399.2	599.97	914.6	928.24	-13.64
297	495.44	1016.8	1032.77	-15.97
196.4	398.08	1117.4	1130.13	-12.73
100.6	297.6	1213.2	1230.61	-17.41
7.2	209.26	1306.6	1318.95	-12.35

Figure 8 Position calibration table of the results (left)

FINAL GRADE

GENERAL COMMENTS

Instructor

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PAGE 1

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PAGE 3

PAGE 4

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Text Comment. Sounds like a good plan

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PAGE 5

Text Comment. Where is your investigation into each sensor?

PAGE 6



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Text Comment. Good, but how do these values compare with manufacturer's data?

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PAGE 9

PAGE 10

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Correctly cited

Citation method conforms to Harvard standard, well done.

PAGE 12

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PAGE 13

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PAGE 14

PAGE 15

QM

Write in the third person

Avoid personal pronouns such as I, me, we, my, our you, your etc

QM

Write in the third person

Don't refer to your self as I, me, my or others as you etc. Avoid personal references. If absolutely necessary, refer to self as "the author".

PAGE 16

QM

Correct method of listing.

You have listed your sources correctly according to the Harvard method.

QM

Good range of sources

You have demonstrated reading from a good range of sources shown by your list below

PAGE 17

PAGE 18

PAGE 19

PAGE 20

GRADING FORM: NEW CSG-RUBRIC

DANIEL THOMAS

61

1. ENGAGEMENT WITH LITERATURE

 A good research section with evidence of reading from a good range of sources cited and listed correctly using the Harvard method. 13/20 **13**

2. KNOWLEDGE AND UNDERSTANDING

 Good knowledge demonstrated in your system investigation, explanation of calibration procedure and environment/maintenance section. However, you could have looked at the sensors and obtained data from manufacturers. 11/20 **11**

3. COGNITIVE AND INTELLECTUAL

 Good analysis of results and conclusions/recommendation presented. However, you could have calculated static sensitivities and compare your results to manufacturer's data. 12/20 **12**

4. PRACTICAL APPLICATION

 Good use of calibration equipment and presentation of results. 14/20 **14**

5. TRANSFERABLE SKILLS



A good work plan but no risk assessment. Good explanation of team working. Report is well structured and presented with clear diagrams. Word count not exceeded. You must improve your writing style and always write in the third person.

11/20