

1909750

by Ethan Joel

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Good Structure

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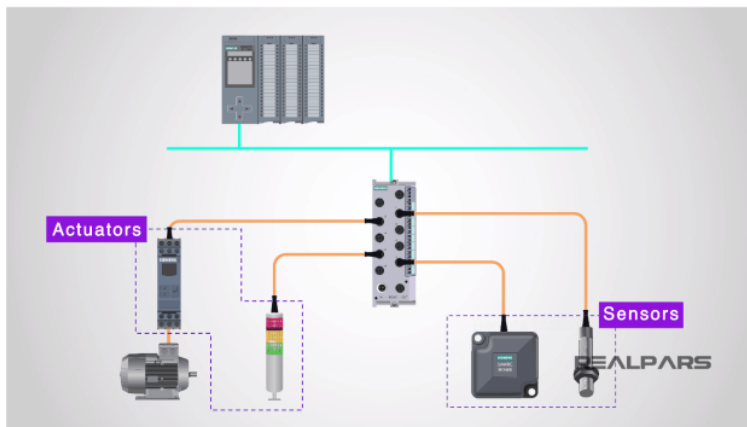
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1. Research

Industry 4.0 is a revolution within industry that describes the ongoing trend of technology and automation within industry (Anon., 2020). Industry 4.0 offers a more detailed approach to manufacturing within industry as it provides the wireless link between the physical parts of machines to various devices such as PLCs or web servers which is more accessible to humans.

Industry 4.0 has introduced the serial communication method being 'IO Link'. It's a communications protocol and is primarily used for communication between sensors and actuators (See figure 1 below). It also comes with relevant software to enable detailed analysis on the sensors parameters and characterises. (Jowett, 2019) Correctly cited



This was covered in assignment 1, you should be looking at Profinet communications between PLCs.

Figure 1 - IO Link

<https://realpars.com/io-link/>

IO Link is used in many organisations as it improves many aspects of manufacturing as it effectively makes the machine more 'automated'. It allows more precise data to be analysed which can help productivity and help the machine run more efficiently. On top of this, along with PLCs and HMIs, it can be a fault diagnostic tool to find more complex faults.

Linked to Industry 4.0 is M2M. Machine to machine (M2M) is the exchange of information between machines or devices without the need for any human interaction. It's used in many systems and processes within industry such as combining different devices together including PLCs, to connecting different measuring instruments to industrial networks. (Anon., 2020) It

also refers to a device that detects an action or event and forwards it to an application or actuator via the network. (Anon., 2020)

M2M was firstly introduced in industrial and manufacturing settings but has now been introduced into other applications in other sectors such as Healthcare and business. One of the main purposes of M2M is to obtain sensor data and transmit it to a network. It often uses public networks and access methods such as Ethernet as its more cost effective. (Shea, n.d.)



Figure 2 - M2M

https://cdn.ttgtmedia.com/rms/onlineimages/iota-m2m_apps_mobile.png

Some of the main features within an M2M system include a WIFI or cellular communications link as well as computer software to programme a network device. (Shea, n.d.)

Spelling

As well as industry, M2M is used in a variety of other organisations in different sectors including power, gas, and water networks where the system can allow for better visibility on spikes and shortages. (Lohman, 2013)

2. System Overview and Operation

Below is a system overview of the CIM system. As shown, there are 7 individual stations within the complete system each with their own PLC.

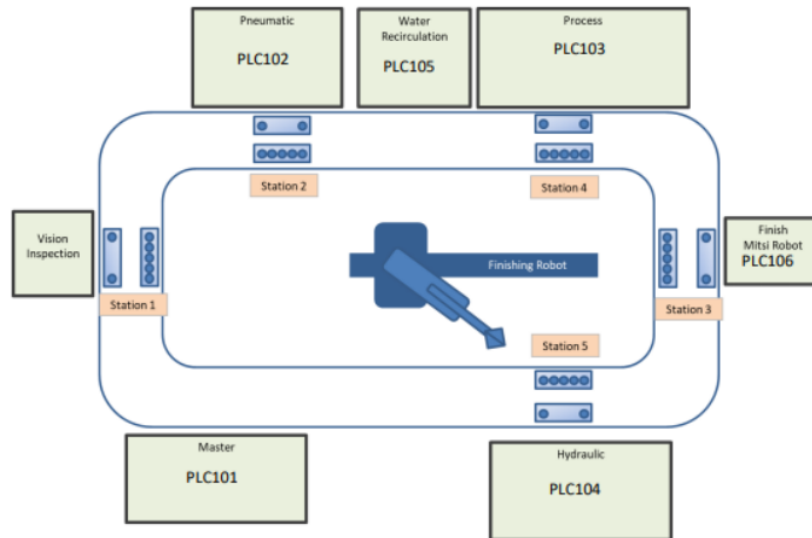


Figure 3 - System Overview

The CIM system contains various 'Wagon's which serves the purpose of carrying components around the conveyor belt through all the individual stations within the system. Each wagon has a unique binary code on the underside of each tray. At each of the individual stations, there are 5 proximity sensors which are used to identify the specific wagon at that current station. The specific wagon number will also appear on the main Cim HMI screen at each station shown below in Figure 4 Each station also contains an extra proximity sensor which serves the purpose of driving a piston which operates a pin which acts as a physical stop, to prevent the Wagon from continuing along the conveyor in order for the component to be processed. (Seen in figure 5)

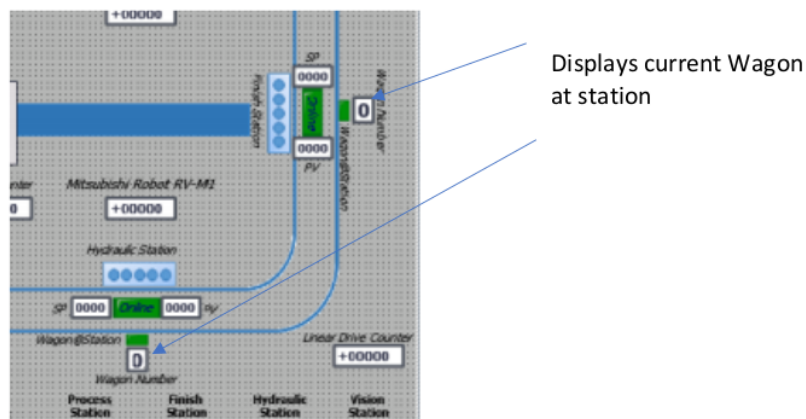


Figure 4 - Wagon System

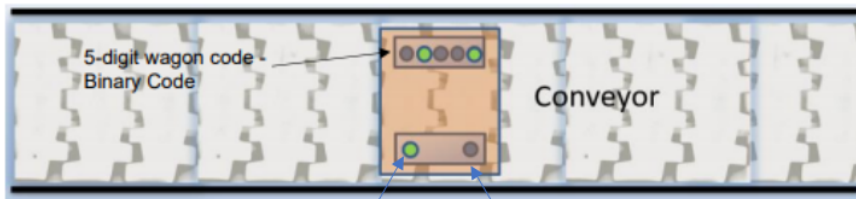


Figure 5 - Wagon Coding

'Wagon at station'
proximity sensor

'Wagon release' actuator

The scanning and tracking system works via a 4digit coding system. It works by memorizing the current state of that specific Wagon and what setpoint and process value has been set for each Wagon. There are various codes which represent what stage of processing that Wagon is currently at and where its next location is.

The software used for this system is 'Siemens TIA Portal' and contains various programme languages such as Function Block Diagram and Ladder.

With regards to integration, each individual PLC for each station is connected with the master PLC using PROFINET (Seen in figure 6 below). The Master PLC (101) contains a data block for each of the individual PLCs which contains PUT and GET signals. Also, each individual PLC has a data block which is linked to PLC 101 which again contains PUT and GET bits.

Some addresses within the system are hardwired whilst others use M2M as a communication method.



Figure 6 - Device Connection

This figure shows how all the PLCs and HMIs are connected.

3. Health and Safety, Maintenance and Reliability Requirements

Hazard	Person at Risk	Significance (0-5)	Likelihood (0-5)	Total Score (Significance x Likelihood)	Current Control Measures	New/Additional Control Measures	Significance (0-5)	Likelihood (0-5)	Total Score (Significance x Likelihood)
Moving Machinery	Personnel within the vicinity of the system	4	2	8	No unauthorised personnel to control the machine	Introduce guarding/safety beams to prevent any access to machinery whilst moving	3	1	3
Trip Hazards	Personnel within the vicinity of the system	2	4	8	Cable management methods used (conduit/trunking)	Create a housekeeping schedule to periodically ensure no trip hazards are present	2	1	2
Electricity	Personnel within the vicinity of the system	5	1	5	Warning signs and training provided	Ensure each panel is locked.	2	1	2
Risk of High-pressure	Personnel within the vicinity of	4	1	4	No unauthorised personnel to control the machine	Introduce a maintenance schedule to periodically	3	1	3

4. System Design Adaptation

4a

To setup GET and Put instructions between each of the individual station's PLC, a coil was placed in parallel with the physical inputs from each PLC. The coil is tagged to the relevant data block which allows instructions and features to be access remotely instead of locally.

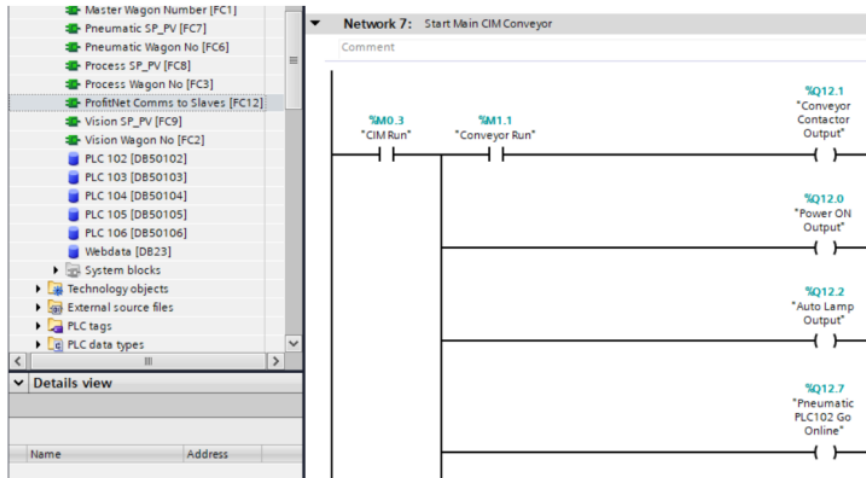


Figure 7 - GET and PUT (1)

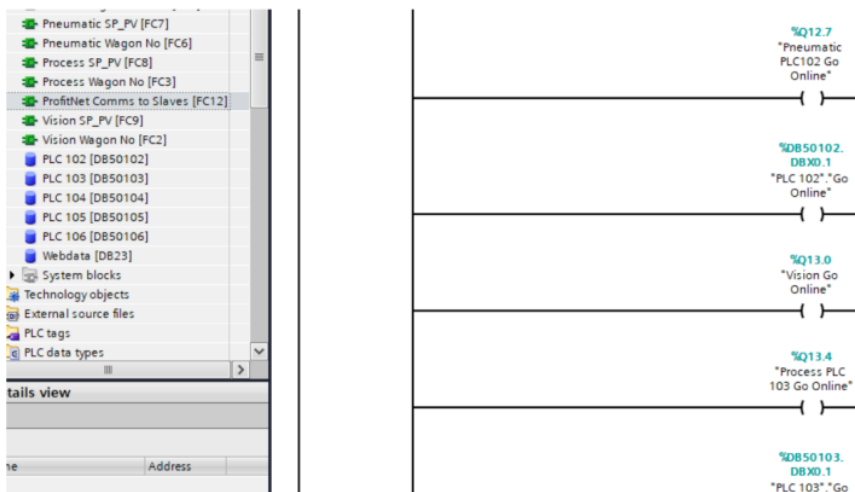


Figure 8 - GET and PUT (2)

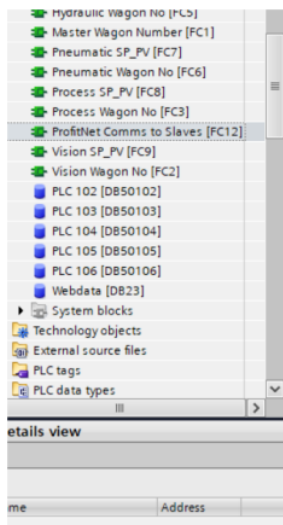
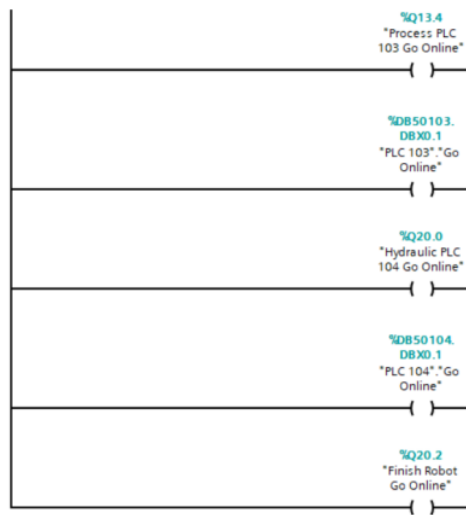


Figure 9 - GET and PUT (3)



4b

This subtask involved setting up GET and PUT instructions between the Main PLC (101) and the Linear Drive PLC (106). To create this the encoder value will have to be converted from a 'Real' value to an 'integer'. This can be shown in figure 10 below.

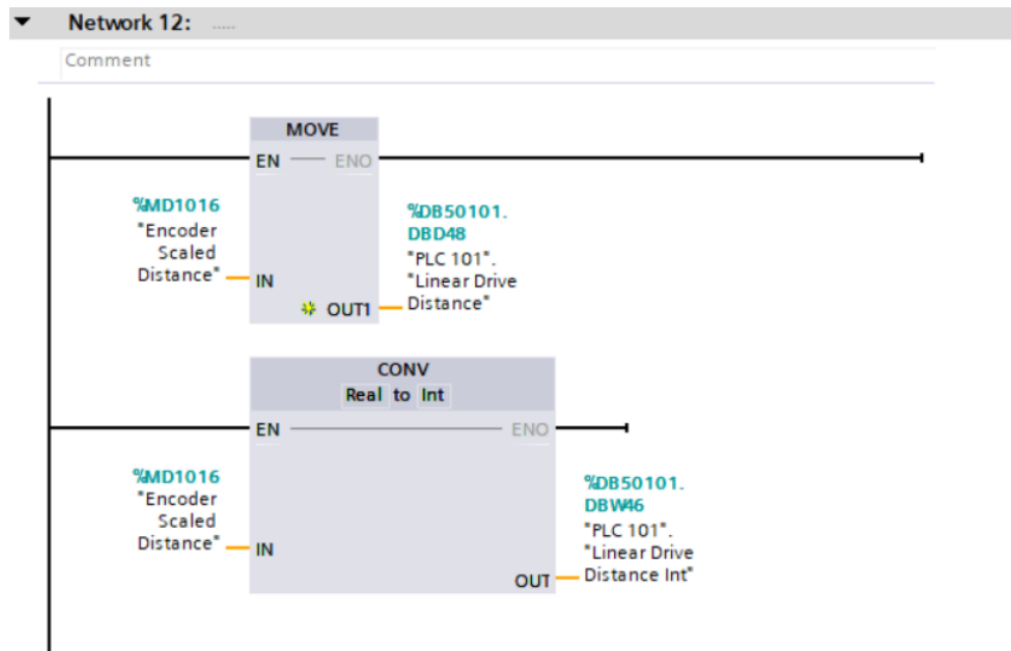


Figure 10 - 101 - 106

4c

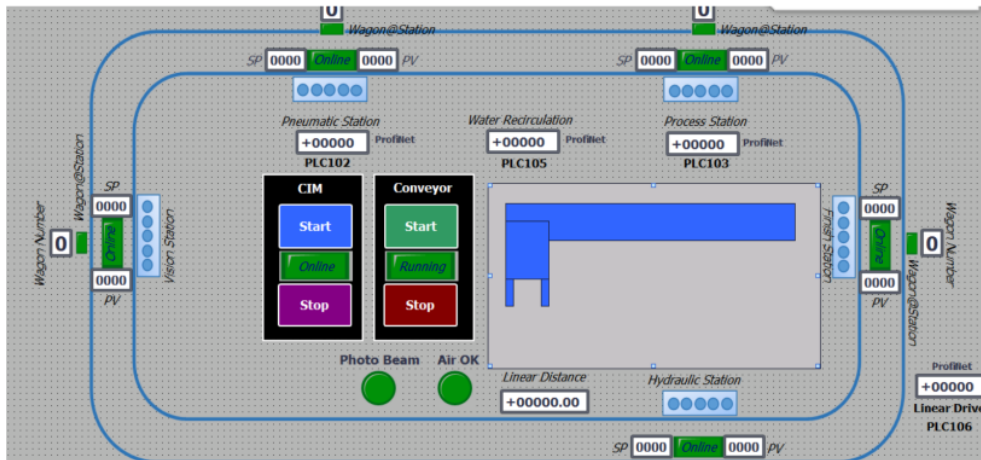


Figure 11 - Robot Animation

Figure 11 shows a newly designed robot animation on the main HMI screen. As the robot moves left to right on the machine, this is accurately represented on the HMI, assisting the engineer with a fault diagnostics tool with regards to robot positioning. Aswell as the robot animation, a linear distance display was added to display the encoder value for the X axis. To create this animation, a movement command was created for the robot which enables the animation to obtain the value from the encoder to accurately represent the robots exact position on the machine.

The movement command can be seen in figure 10 on page 12

4d

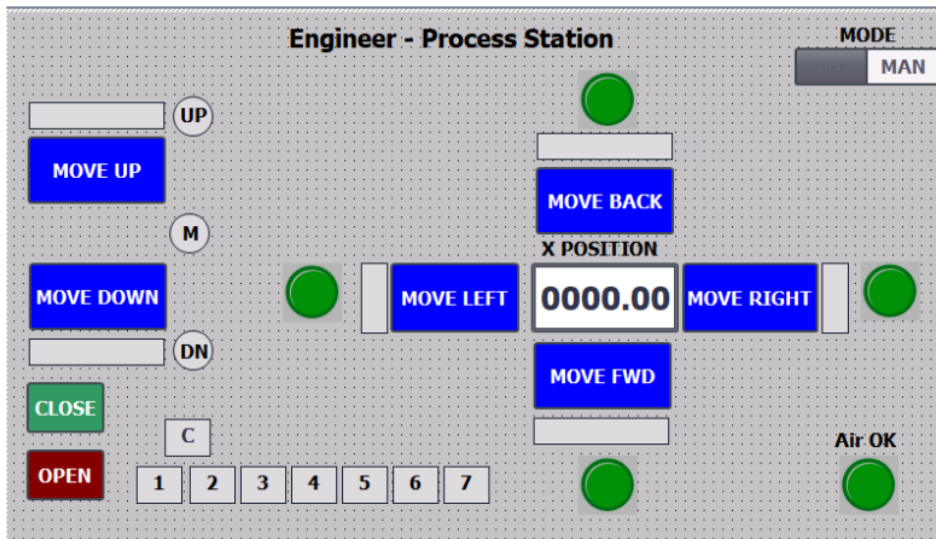


Figure 12 - HMI 1

This subtask involved creating two new HMI screens on the Main HMI to assist the engineer with fault finding and diagnostics. The first screen as shown in figure 12, displays the process station. It contains manual controls for the robot in each direction aswell as a display to show the horizontal position of the robot via the X axis encoder.

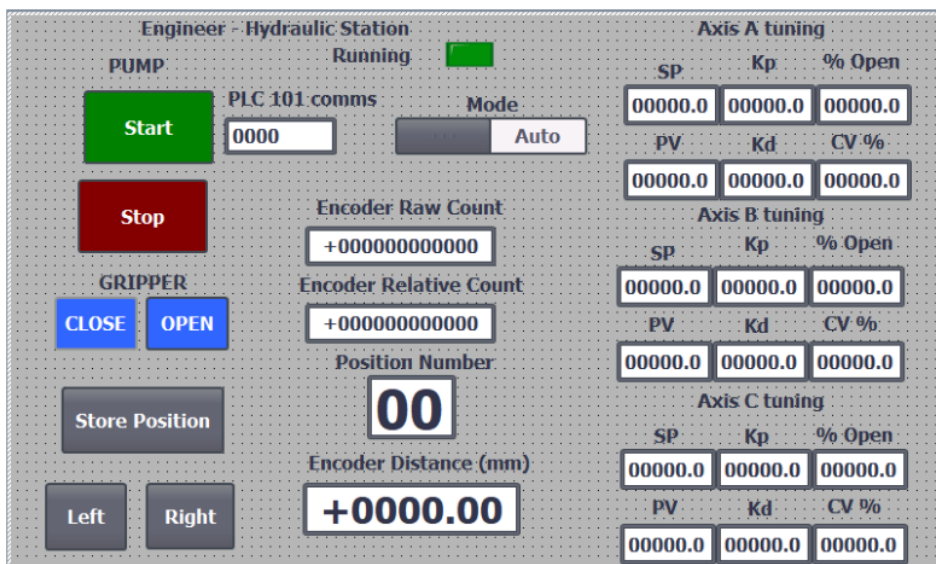


Figure 13 - HMI 2

HMI 134 contains screens for the linear drive and the hydraulic robot axes, you appear to have confused the two systems, they do not belong on the same screen

The second screen in figure 13 shows a re-worked Hydraulic Station screen. The screen displays the setpoint and P and D values in terms of tuning for each of the 3 axes. It also displays the raw value of the encoder aswell as the relative value according to the scale. The screen also contains a start/stop control for the hydraulic pump aswell as manual controls for the gripper.

4e

This subtask involved creating an interlock which stopped the conveyor from running if the air pressure wasn't high enough.

The interlock for the air was created by creating a PLC tag within PLC 101 and placing in on the coil for the conveyor to run. Due to it being in series as a normally open contact, this meant that the conveyor could only run if the contact closed (air level being high enough).

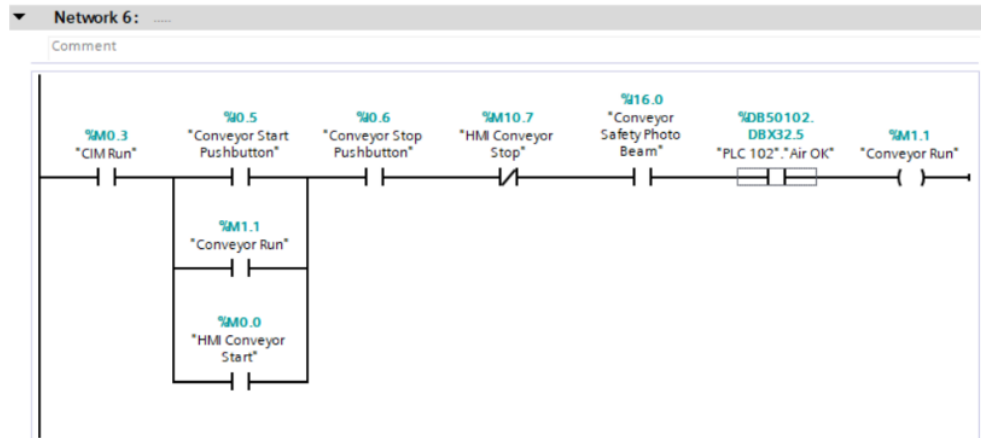


Figure 14 - Air Interlock

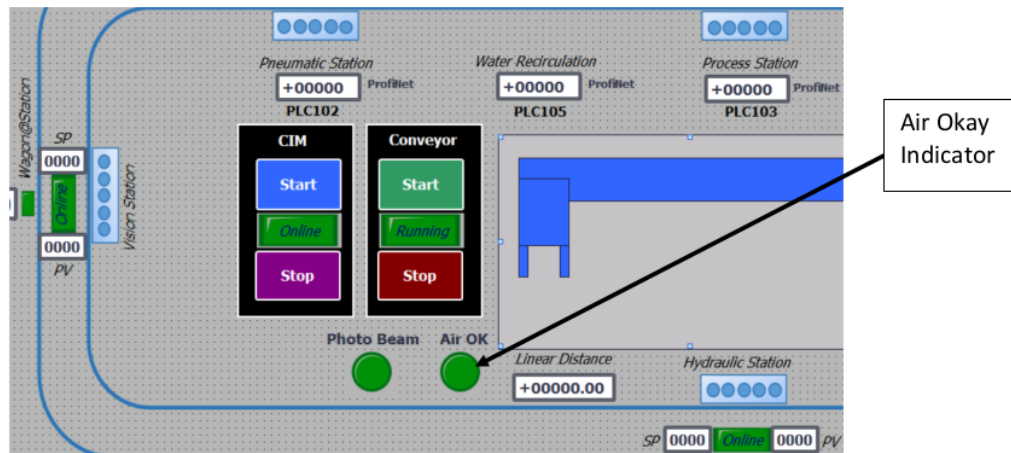


Figure 15 - Air Okay Indication

4f

For this subtask, the Water recirculation screen was edited and improved to contain more diagnostics on the main HMI. The main features added was the PWM Flow mode control switch aswell as the value for the PWM duty cycle value. Also, a display box was added to display the comms between both the main PLC and PLC 105.

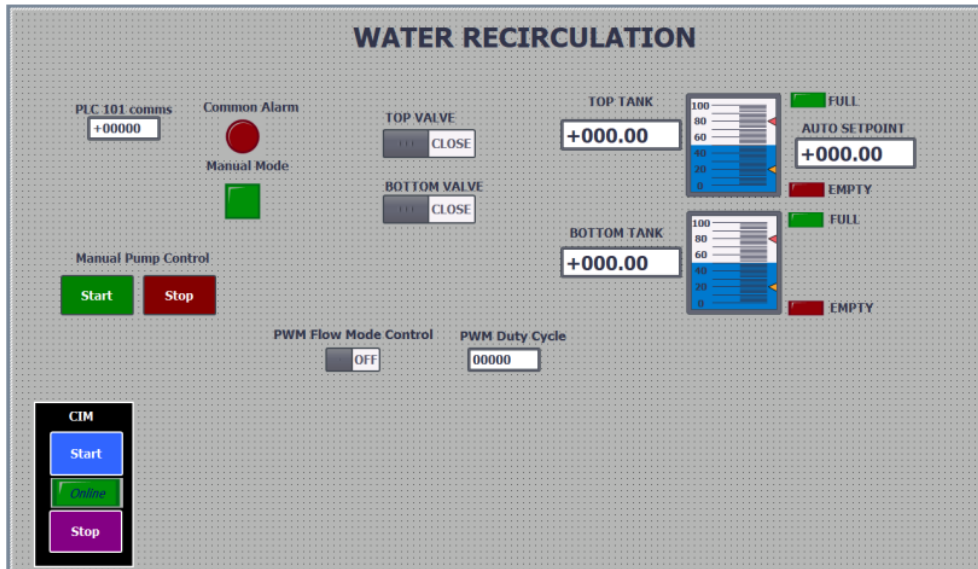


Figure 16 - Water Recirculation

Testing Table *Another column would be useful to point your reader to the evidence to support each test*

Test	Expected Result	Actual Result	Pass/Fail
Linear Drive Counter	The counter should start counting	The counter started counting	Pass
Mitsubishi Robot Animation	The animation should match the robots movement on the screen	The animation moved matching the robots movement on the machine	Pass
Air Pressure Okay	The indicator should illuminate when the air pressure is ok	The indicator illuminated when the air pressure was sufficient	Pass
Air Pressure Conveyor interlock	The conveyor shouldn't be able to start when the pressure is low	The conveyor didn't start as the pressure was too low	Pass

Table 2 - Testing Table

There is good evidence for design adaptation and testing

5. Conclusions and Recommendations

This assignment introduced the author to Industry 4.0 and its impacts within industries today. It also highlighted how different industries are expanding and improving their efficiency by following this movement. The assignment also highlighted to the author about integration between PLCs, in terms of how PLCs can be connected together as well as using PUT and GET signals to input and output signals from one PLC to another.

Spelling

It also enhanced the authors understanding of the CIM system of how the machine works as well as its detailed scanning and tracking system to identify each Wagon and its stage within the process.

Task 4 displayed some modifications that were made to the system and table 2 proves that the changes were indeed successful.

With regards to the recommendations within the CIM system. A 'PILZ' or a safety relay system could be implemented along with an alarm screen created on a HMI to display the current state of all safety features on the system. It would also provide the engineer with a fault finding diagnostic as well as a visual screen for the safety features within the system. Laser beams and guard interlocks can be introduced to further limit the chances of any incidents from occurring. Overrides can be put in place for authorised personnel only, which would enable the engineers to access to the restricted areas for fault finding etc...

Also as previously mentioned, another HMI screen to view the Inputs and Outputs from each PLC would be a time saving option with regards to fault finding.

6. Team Working

There was a total of four team members within the team namely being Ethan Joel, Jason Sanger, Joshua Rees, and Aaron Rees. Joshua's job was to create the GET and INPUT instructions between the PLCs. Aaron's role within the team was to create the two engineers HMI screens to aid with diagnostics. Ethan's job was testing the programme including the robot animation and the basic operation of the system. Finally, Jason had the role of testing the interlocks within the system. This included testing the air interlock for the conveyor. Once everyone had completed their own task, all other members of the team were informed, and discussions were made for any further recommendations/improvements.

7. Citation List

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8. Appendix

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GRADEMARK REPORT

FINAL GRADE

GENERAL COMMENTS

Instructor

62/100

PAGE 1

PAGE 2

QM

Good Structure

Report is structured exactly as stated in the assignment brief.

PAGE 3

PAGE 4

QM

Correctly cited

Citation method conforms to Harvard standard, well done.

Text Comment. This was covered in assignment 1, you should be looking at Profinet communications between PLCs.

PAGE 5

QM

Spelling

Spelling error

PAGE 6

PAGE 7

PAGE 8

PAGE 9

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PAGE 11

PAGE 12

PAGE 13

PAGE 14

Text Comment. HMI 134 contains screens for the linear drive and the hydraulic robot axes, you appear to have confused the two systems, they do not belong on the same screen

PAGE 15

PAGE 16

PAGE 17

PAGE 18

Text Comment. Another column would be useful to point your reader to the evidence to support each test

Text Comment. There is good evidence for design adaptation and testing

PAGE 19

QM

Spelling

Spelling error

PAGE 20

PAGE 21

PAGE 22

GRADING FORM: NEW CSG-RUBRIC

ETHAN JOEL

62

1. ENGAGEMENT WITH LITERATURE



Engagement with a limited range of mostly relevant and credible sources but with some reliance on information gained through class contact. Some omissions and minor errors. Referencing conventions evident though not always applied accurately or consistently. (9/20)

9

2. KNOWLEDGE AND UNDERSTANDING



Competent knowledge of the basic underlying concepts and principles. Exhibits very good understanding. (13/20)

13

3. COGNITIVE AND INTELLECTUAL



Excellent evaluation of the underlying concepts and principles. Can interpret qualitative and quantitative data accurately and with some insight. Excellent ability to devise arguments using evidence and make appropriate and valid judgements. (14/20)

14

4. PRACTICAL APPLICATION



An advanced application of a range of taught, basic methods, materials, tools and/or techniques. The context of the application is well considered, and insightful. Excellent evidence of different approaches to problem-solving in particular contexts and proposes appropriate solutions. (14/20)

14

5. TRANSFERABLE SKILLS



Work is accurate, coherent, fluent, well-structured and organised. Can work effectively independently and/or as part of a team, with very good contribution to group activities. Demonstrates very good skills for employment requiring the exercise of some personal responsibility, with just occasional minor weakness. (12/20)

12