

# 1909757

*by* Scott Jones

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Good Structure

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## Research

Industry 4.0, also known as the fourth industrial revolution, is further expanding the capabilities of the technology that is in use today. It is powered by the Industrial Internet of Things (IIoT) and also cyber-physical systems which are autonomous systems that operate using computer-based algorithms. These algorithms allow the system to monitor and control things like robots, machinery and even autonomous vehicles.

(Epicor, 2021) Correctly cited

The industry 4.0 platform is built upon 9 main technology pillars, these are shown below.

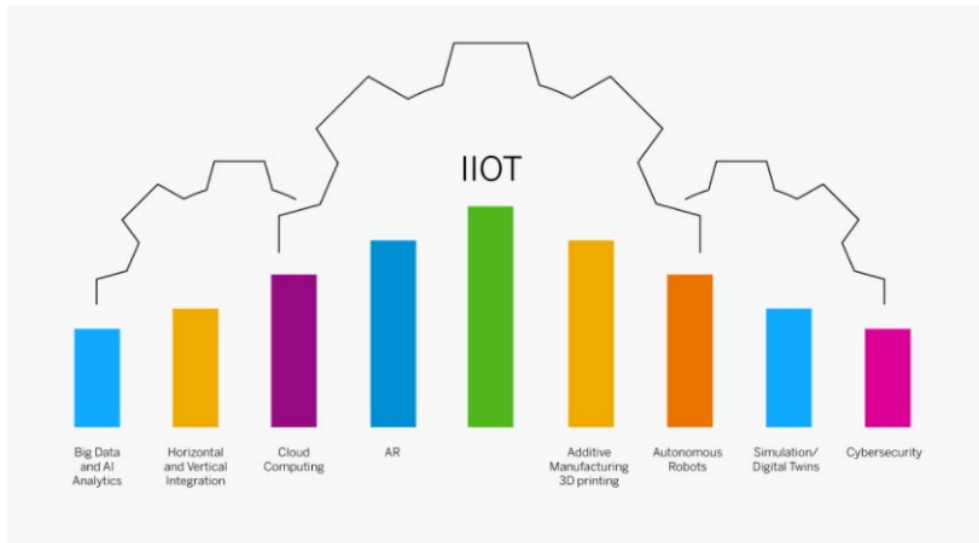


Figure 1 - Industry 4.0 Platform

(SAP Insights, 2021)

By implementing industry 4.0 into an industrial or manufacturing environment, it is possible to create a smart factory. These factories are digitized and employ a large amount of smart manufacturing processes, this makes it possible for the plant to streamline and become as cost effective as possible whilst still producing at a high level. Advanced technologies used in these smart factories include artificial intelligence and robotics, this will reduce the overhead costs of employing people to do the work and the robots will be intelligent enough to know when it needs more parts delivered so the production line in theory should never stop unless for planned maintenance activities.

(Moore, 2020) (Forbes, 2018) Sources should be separated, not cited together

It may also be possible for these robots to produce analytical data about themselves, this data can then be viewed in real time by technicians. Information displayed may include performance facts and production counters, problem troubleshooting and maintenance diagnostics, this information can then be reviewed to determine when the best time to carry out preventative and planned maintenance task will be meaning the technicians should see a reduction in unnecessary and unplanned downtime.

(TWI, 2021) (i-scoop, 2021) *Sources should be separated, not cited together*

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## System Overview and Operation

The CIM System (Computer Integrated Manufacturing System) is located in the G8 Laboratory at Coleg Sir Gar. The System is made up of 6 individual sub-stations which will be explained below. 5 of the stations are controlled by PLCs, these PLCs are then linked back to the Master PLC101 which controls the system. On the diagram below the Machine-to-Machine links are shown in orange. These links show the communication path between the PLCs

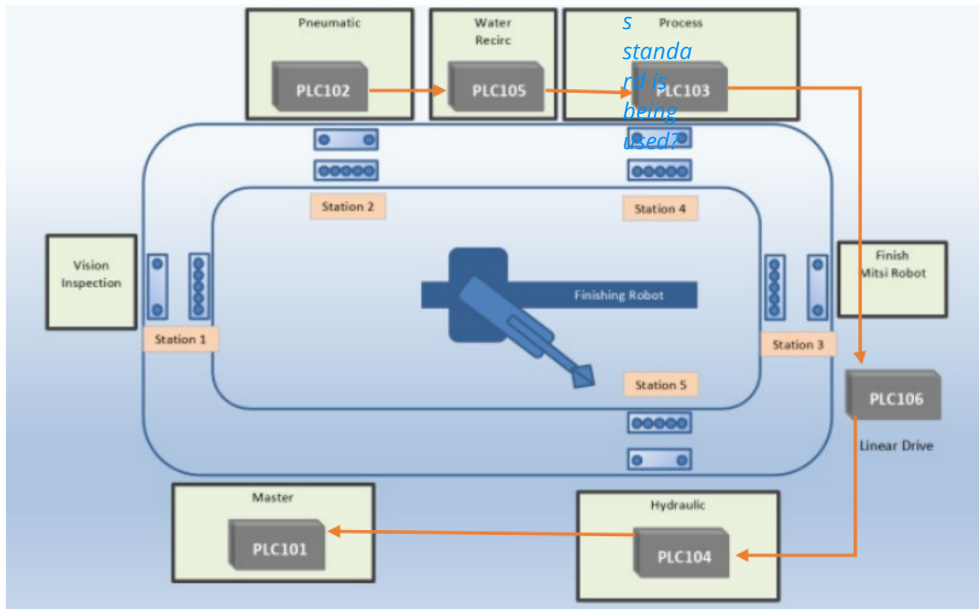


Figure 2 - CIM System Overview

Each of the stations shown above has a specific purpose and plays a crucial role in the manufacturing system. Each step of the manufacturing process is shown below.

1. **Vision Station** – At this station the content of the wagon is inspected, if the camera thinks the product produced is within specification, then it will pass, if the product is out of the specification requirements, then it will reject the wagon to remove the product.
2. **Pneumatic Station (PLC102)** – The Pneumatic Station has two arms which will load the appropriate wagons with material, the signal is received by PLC102 from PLC101 to load the material.
3. **Finish Station (Mitsubishi Robot/PLC106)** – At this station the Mitsubishi robot will move along the linear drive to the required position, which is determined by an encoder, and pick up the part from the wagon, the robot will then move back along the beam and place the

part at the hydraulic station where it is pressed. There is a proximity sensor at either end of the beam to prevent overtravel.

4. **Process Station (PLC103)** – At this stage the pick and place arm, which is attached to a belt for movement, will pick up the part and dip it into the cleaning solutions, the part is then rinsed off in water to remove any excess chemicals.
5. **Hydraulic Station (PLC104)** – This station is used to form the product, the hydraulic press comes down onto the part and presses it into the required form, this is then placed back onto the wagon to continue the rest of the process.

As shown on the image in Figure 2, at each station there are 5 proximity sensors. Each wagon has a different binary code underneath and this is picked up by the proximity sensors, different combinations of sensors are equivalent to a different wagon. There is also a proximity sensor present so the system knows when there is a wagon present at the station, next to this there is a shot-bolt or pin. This pin locks the wagon in place while the process is being carried out, once complete the pin drops and the wagon is free to continue.

Sections should be numbered according to the brief

## Health and Safety, Maintenance and Reliability Requirements

### Risk Assessment

Shown below is the risk assessment produced for the CIM system in G8. The Probability and Severity ratings are given out of a possible score of 5, these scores are then multiplied together to give the overall risk rating. The higher the risk rating the worse the hazard is considered to be.

| Hazard                          | Who may be Harmed?                   | Risk Rating |          |             | Precautions in place       | Further Actions Required                                                                                          |
|---------------------------------|--------------------------------------|-------------|----------|-------------|----------------------------|-------------------------------------------------------------------------------------------------------------------|
|                                 |                                      | Probability | Severity | Risk Rating |                            |                                                                                                                   |
| Fingers Jamming in the Conveyor | Anyone working/observing the machine | 3           | 3        | 9           | Guarding in some areas     | Guarding implemented in all areas and warning signs put in place                                                  |
| Electrocution                   | Anyone working on the machine        | 3           | 5        | 15          | Lockable Electrical Panels | Ensure that all panels are locked at all times, electrical warning signs to be displayed on all electrical panels |
| Access to moving robot          | Everyone around the machine          | 5           | 5        | 25          | None                       | Guarding around all robots preventing access unless isolated                                                      |

Table 1 - CIM System Risk Assessment

The risk assessment produced highlights some of the potential risks that were found whilst inspecting the CIM system in the G8 laboratory. The purpose of carrying out the risk assessment was to make everyone working on or around the machine aware of hazards that they may come across, these hazards can then be put forward so that they can be assessed further and if necessary, something can be implemented in the system to help reduce or remove the risk all together.

### Maintenance and Reliability

Due to the nature of the equipment used on the CIM system planned maintenance activities should be carried out regularly. The conveyor system should be checked for any signs of wear and tear, the system should also be cleaned to prevent foreign objects blocking or jamming the belt when it is running. The same can be said for the robot that is mounted on the linear drive, the beam should be cleaned and greased regularly so that the robot is able to move horizontally across the beam easily and without causing any extra wear on the components.

The hydraulic robot should be checked regularly for leaks which could cause oil to build up on the floor creating a hazard for anyone walking around the machine. The hydraulic pipes should be checked regularly for excess wear and they should be replaced if required before the pipe has the opportunity to burst. Oil level indicators should be examined regularly and the oil should be topped up if the level is found to be low.

Sensors should be cleaned before the CIM system is run, due to the positioning of the sensors it is possible for dust and foreign objects to rest on them. This may cause the sensor to switch and remain on constantly, this could then give inaccurate feedback to the PLC about the carriage that is present at the station causing issues on the production line.

Depending on how much the system is used and how regularly the water recirculation system is put to use it may be useful to flush the system once every 6-12 months, this would clear out the pipework on the machine and reduce the chance of blockages due to material build up in the system. This is required to keep the flow rate and water pressure at the desired level all year round.

## System Design Adaptation

In order for the system to keep up to date with the new Industry 4.0 technology the hard-wired handshaking signals needed to be replaced with more modern ethernet connections. Rather than having individual wires coming to and from each PLC for each input and output there would be one ethernet cable between each PLC, this cable would provide the system with all of the communications required to complete the tasks whilst making the system simpler and less time consuming to wire and fault find.

In order to make this possible the 'Get' and 'Put' instructions would need to be modified to allow the communication via the ethernet cable to take place. The modifications to the PLC program involved the addition of the ethernet I/O alongside the hardwired I/O so the system would still be able to run whilst all of the changes were being implemented over time. In the Siemens software the ethernet I/O that would eventually be replacing the hardwired handshaking signals were added in parallel with the existing I/O. Once all of the adaptations are complete and the system is Industry 4.0 compliant the old hardwired handshaking signals can be deleted from the PLC program freeing up space and making the program more user friendly and simplified. These adaptations are shown in the appendix from figures 2-9, the adaptations have been circled in orange.

Get and put instructions were also added between the new Linear Drive (PLC 106) and the Main PLC 101 (shown in the appendix from figures 10 – 13). The program blocks for the 'Get' command from PLC101 was then added to the software (Figure 14) and the 'Put' command into PLC106 was also added (Figure 15). This was done to enable the PLCs to communicate with each other allowing them to send and receive the relevant information for the liner drive such as position and status. By doing this the data for the linear drive position can be shown on the main HMI screen on the Master 131 HMI, this is shown in figure 16 in the appendix. The display counter was added to the main screen on the Master HMI 131 to show that there is communication between the PLCs, shown in figure 17.

The image of the Mitsubishi Robot on the main HMI screen was re-designed and animated so that the image would move horizontally depending on the actual position of the linear drive. The new robot image is shown with the animation outline in figure 18. This image was then grouped and tagged up as shown in Figure 19.

Two screens were also added to the Master HMI131, these are additional diagnostic screens to help engineers working on the machine have access to a collection of controls and data all in one place. The purpose of these screens is to assist the engineer in fault finding, they are shown in figures 20 and 21.

An interlock was required to prevent the conveyor from starting if the Air was not on. An indicator light for 'Air OK' was added to the Main HMI screen so that it could be seen clearly, it has also been added to the new Engineer Diagnostic Screen 1 so that the engineer can clearly see if the air is on or not. The software adaptation for the interlock is shown in figure 22 and the Air OK indicator is shown on the main HMI Screen in figure 23. The tag for the Air OK indicator is shown in Figure 24.

Adaptations were needed for other parts of the software so that they could be manually controlled off of the new HMI screens that were added, these adaptations included adding additional 'Get' and 'Put' instructions in the data blocks for PLC 104 and 106. They also included making edits to the program rungs associated with the action trying to be performed. These are shown in the appendix from Figures 25 – 36.

A good testing table should contain 5 columns (1) Test description (2) Expected Result (3) Actual Result (4) Pass/Fail decision (5) Evidence

### Testing

Table 2 - Testing Table

| Requirement                                  | Result | Evidence                           |
|----------------------------------------------|--------|------------------------------------|
| Water Recirculation Control from New Screen  | Pass   | Shown in Figure 41                 |
| Communication Counter for PLC106 on Main HMI | Pass   | Shown in Figure 42 and Figure 43   |
| Animate the Mitsubishi Robot                 | Pass   | Shown in Figure 43                 |
| Diagnostic Screen 1 Functioning              | Pass   | Shown in Figure 38 and Figure 39   |
| Diagnostic Screen 2 Functioning              | Pass   | Shown in Figure 40 and Figure 41   |
| Air OK Indicator Illuminates                 | Pass   | Shown in Figures 38, 39, 42 and 43 |
| Air/Conveyor Interlock                       | Pass   | Shown in Figure 44 and 45          |
| Robot can be moved in Manual Mode            | Pass   | Shown in Figure 46                 |

## Conclusions and Recommendations

Throughout this assignment all of the assessment criteria have been satisfied, the software requirements have all been met and appropriate evidence has been supplied in the form of tabulated results and images. Relevant research was carried out on Industry 4.0 and an overview of the CIM System was provided explaining the function of each section of the machine. All of the old handshaking signals were updated with new ProfiNet based signals, the relevant changes to the tag tables were made in order to make this possible. The software was amended to include the new ProfiNet adaptations which were implemented in parallel with the old signals so that they can still be used for the time being until all of the necessary work has been completed to bring the machine to a level where it is fully compliant with Industry 4.0 standards. Existing HMI screens were amended to show new and relevant information such as the 'Air OK' indication, alongside the existing screens two new screens were implemented into the Main HMI131. These new screens are Engineer Diagnostic Screens, their purpose is to provide the Engineer with all of the important information and manual controls required to assess the machine during a planned maintenance activity or breakdown. The screens aim to bring all of the required controls to one central location to help make the tasks easier and more efficient for the Engineer.

Spelling

Throughout the assignment the author has developed their knowledge and understanding of Industry 4.0 and the modern solutions to issues such as running out of I/O. The author has developed their understanding of tag tables and how to properly create and tag HMI screens so that they are able to function correctly and display accurate information. The author has also been exposed to new areas of PLC programming such as using the Master and Slave PLCs and how to programme them, what to do if there aren't enough I/O available for a particular PLC and how to set up new communication channels between a PLC and its Slaves.

In order to improve the program further the author could go back through to reorganise and tidy the program so that it is able to flow better and become easier to read, this will also help the scan rate of the program as there would be less rungs for the PLC to scan through, this would only make a minor difference in this case but it is good practice. Some parts of the program may not have rung comments so these could be added to make navigating the program easier in the future not only for themselves but also for others, this will help reduce the amount of downtime during a breakdown as rungs would be much easier to identify.

## Team Working

This assignment was carried out as a group task, the group consisted of Matthew Davies and the Author of the assignment. The workload was shared out between the two members, Matthew was involved in the Get and Put instructions and the implementation of the handshaking signal adaptations. The Author was involved in the design and creation of the two new Diagnostic HMI Screens and also the adaptations of the existing HMI screens such as the editing and animation of the Mitsubishi Linear Drive Robot. Testing was carried out as a team so test results will be the same, however the rest of the assignment was carried out as an individual task.

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[Accessed 29 April 2021].

## Appendix

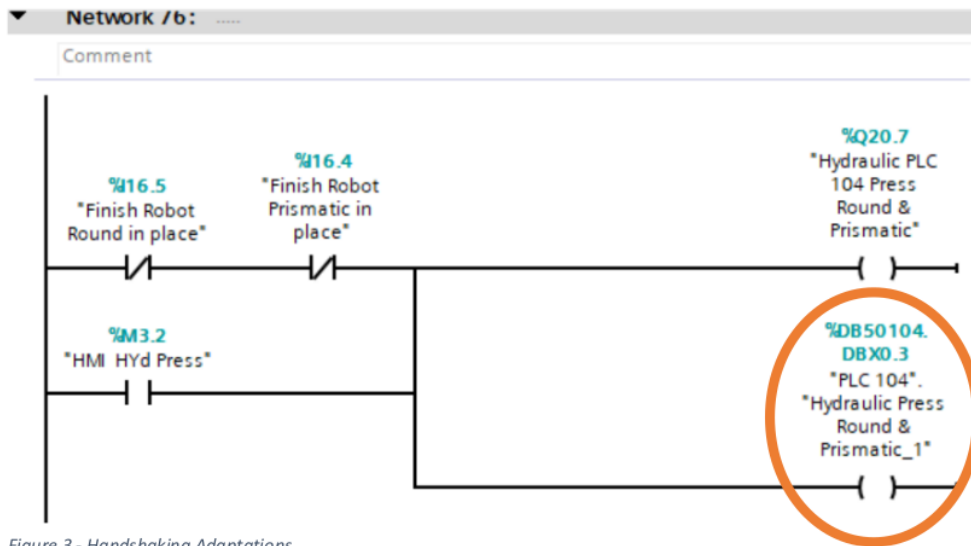


*Figure 3 - Handshaking Adaptations*

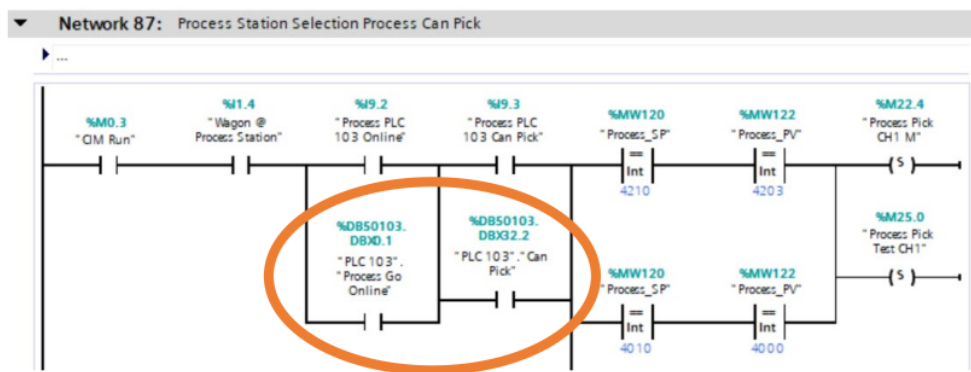
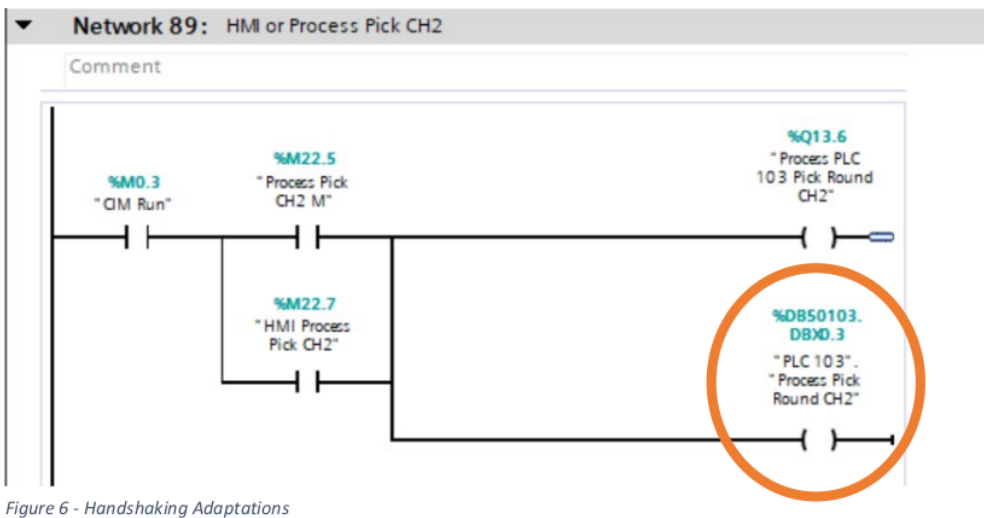
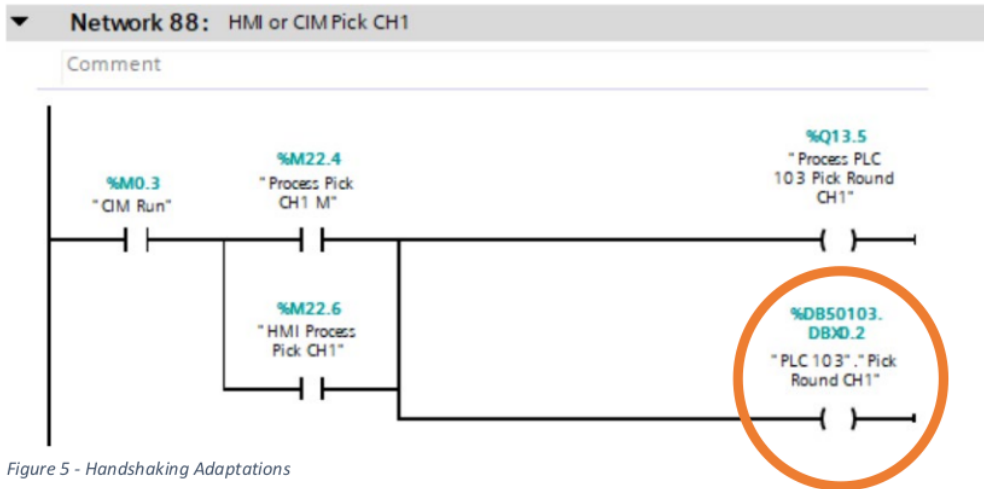
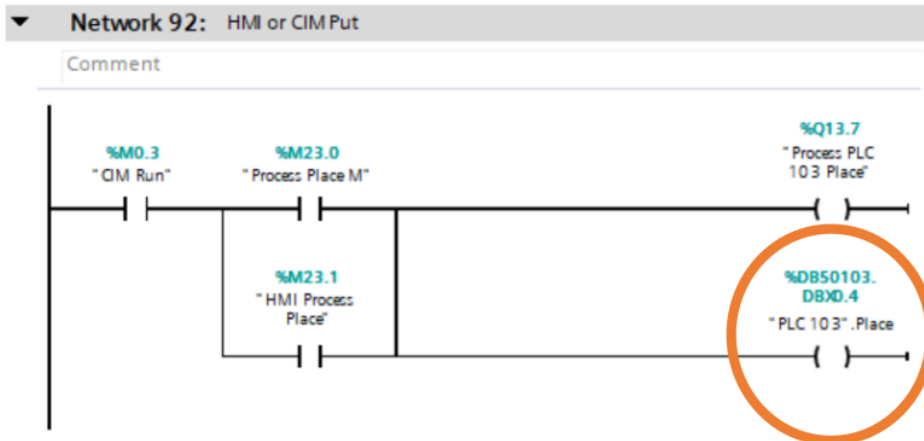
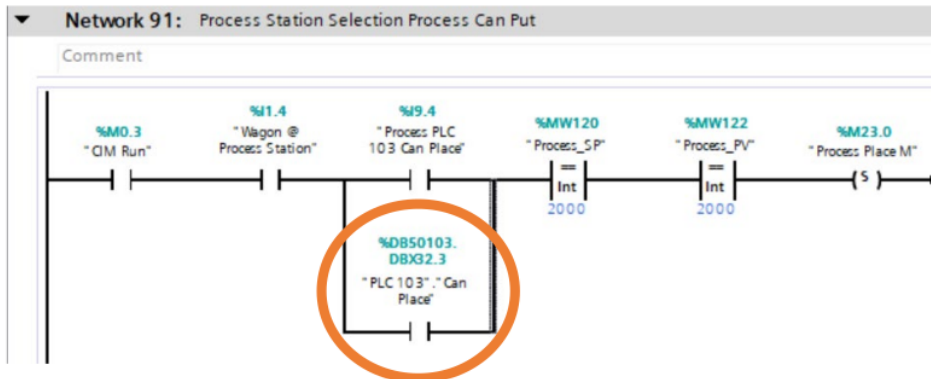
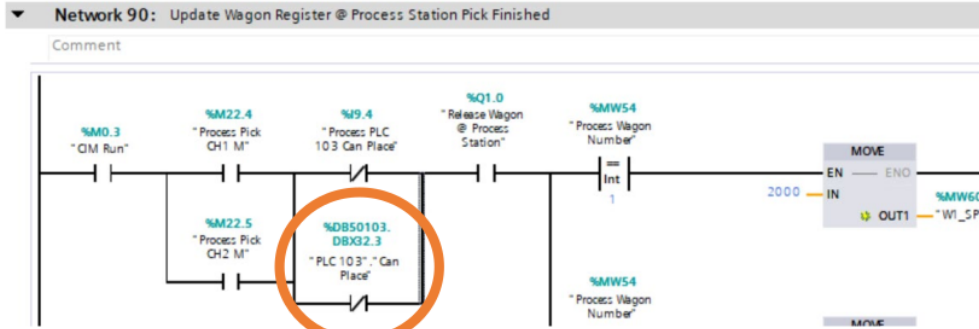


Figure 4 - Handshaking Adaptations





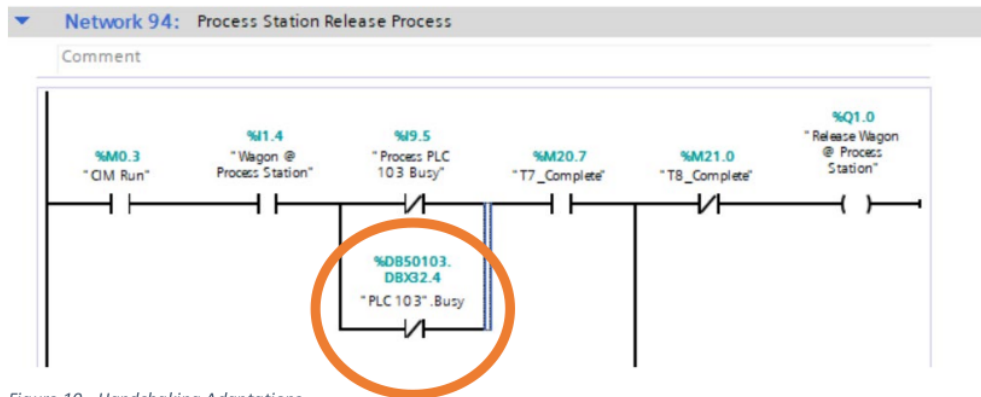


Figure 10 - Handshaking Adaptations

...e System\_V16 ▸ PLC 101 Master - 0 [CPU 1214C DC/DC/DC] ▸ Program blocks ▸ PLC 106 [DB50106]

PLC 106 (snapshot created: 2/28/2020 5:09:49 PM)

|   | Name                       | Data type | Offset | Start value | Retain | Accessible f...                     | Writa...                            | Visible in...                       |
|---|----------------------------|-----------|--------|-------------|--------|-------------------------------------|-------------------------------------|-------------------------------------|
| 1 | Static                     |           |        |             |        |                                     |                                     |                                     |
| 2 | Get Bit 0 - clock test bit | Bool      | 0.0    | false       |        | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> |
| 3 | Go Online                  | Bool      | 0.1    | false       |        | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> |
| 4 | Pick Prod or Prism         | Bool      | 0.2    | false       |        | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> |
| 5 | Pick Round                 | Bool      | 0.3    | false       |        | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> |
| 6 | Pick Fail Prism or Rou...  | Bool      | 0.4    | false       |        | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> |
| 7 | Pick Fail Round CH2        | Bool      | 0.5    | false       |        | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> |
| 8 | Get Bit 6                  | Bool      | 0.6    | false       |        | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> |

Figure 11 - Master PLC101 Data Block for PLC106

...e System\_V16 ▸ PLC 101 Master - 0 [CPU 1214C DC/DC/DC] ▸ Program blocks ▸ PLC 106 [DB50106]

PLC 106 (snapshot created: 2/28/2020 5:09:49 PM)

|   | Name                       | Data type | Offset | Start value | Retain | Accessible f...                     | Writa...                            | Visible in...                       |
|---|----------------------------|-----------|--------|-------------|--------|-------------------------------------|-------------------------------------|-------------------------------------|
| 1 | Static                     |           |        |             |        |                                     |                                     |                                     |
| 2 | Get Bit 0 - clock test bit | Bool      | 0.0    | false       |        | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> |
| 3 | Go Online                  | Bool      | 0.1    | false       |        | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> |
| 4 | Pick Prod or Prism         | Bool      | 0.2    | false       |        | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> |
| 5 | Pick Round                 | Bool      | 0.3    | false       |        | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> |
| 6 | Pick Fail Prism or Rou...  | Bool      | 0.4    | false       |        | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> |
| 7 | Pick Fail Round CH2        | Bool      | 0.5    | false       |        | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> |
| 8 | Get Bit 6                  | Bool      | 0.6    | false       |        | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> |

Figure 12 - Get and Put Instructions from PLC101 to PLC 106

|    |                            |      |      |       |                          |                                     |                                     |                                     |
|----|----------------------------|------|------|-------|--------------------------|-------------------------------------|-------------------------------------|-------------------------------------|
| 33 | Put Bit 0 - clock test bit | Bool | 32.0 | false | <input type="checkbox"/> | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> |
| 34 | Online                     | Bool | 32.1 | false | <input type="checkbox"/> | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> |
| 35 | Can Pick                   | Bool | 32.2 | false | <input type="checkbox"/> | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> |
| 36 | Busy                       | Bool | 32.3 | false | <input type="checkbox"/> | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> |
| 37 | Prismatic in place         | Bool | 32.4 | false | <input type="checkbox"/> | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> |
| 38 | Round in place             | Bool | 32.5 | false | <input type="checkbox"/> | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> |
| 39 | Put Bit 6                  | Bool | 32.6 | false | <input type="checkbox"/> | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> |

Figure 13 - Get and Put Instructions from PLC101 to PLC106

| ...ng Station [CPU 1212C AC/DC/Rly] ▸ Program blocks ▸ ProfiNet Comms using GET and PUT_DB [DB8] |                          |           |             |                          |                                     |                                     |                                     |                          |
|--------------------------------------------------------------------------------------------------|--------------------------|-----------|-------------|--------------------------|-------------------------------------|-------------------------------------|-------------------------------------|--------------------------|
| ProfiNet Comms using GET and PUT_DB (snapshot created: 1/17/2020 3:29:43 PM)                     |                          |           |             |                          |                                     |                                     |                                     |                          |
|                                                                                                  | Name                     | Data type | Start value | Retain                   | Accessible f...                     | Writa...                            | Visible in ...                      | Setpoint                 |
| 1                                                                                                | Input                    |           |             | <input type="checkbox"/> | <input type="checkbox"/>            | <input type="checkbox"/>            | <input type="checkbox"/>            | <input type="checkbox"/> |
| 2                                                                                                | Output                   |           |             | <input type="checkbox"/> | <input type="checkbox"/>            | <input type="checkbox"/>            | <input type="checkbox"/>            | <input type="checkbox"/> |
| 3                                                                                                | InOut                    |           |             | <input type="checkbox"/> | <input type="checkbox"/>            | <input type="checkbox"/>            | <input type="checkbox"/>            | <input type="checkbox"/> |
| 4                                                                                                | ▼ Static                 |           |             | <input type="checkbox"/> | <input type="checkbox"/>            | <input type="checkbox"/>            | <input type="checkbox"/>            | <input type="checkbox"/> |
| 5                                                                                                | PLC                      | Word      | 16#0        | <input type="checkbox"/> | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | <input type="checkbox"/> |
| 6                                                                                                | Comms Run                | Bool      | false       | <input type="checkbox"/> | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | <input type="checkbox"/> |
| 7                                                                                                | PLC_101 GET error sta... | Word      | 16#0        | <input type="checkbox"/> | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | <input type="checkbox"/> |
| 8                                                                                                | PLC_101 GET status v...  | Word      | 16#0        | <input type="checkbox"/> | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | <input type="checkbox"/> |
| 9                                                                                                | PLC_101 GET counter      | Word      | 16#0        | <input type="checkbox"/> | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | <input type="checkbox"/> |
| 10                                                                                               | PLC_101 GET error        | Bool      | false       | <input type="checkbox"/> | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | <input type="checkbox"/> |
| 11                                                                                               | PLC_101 GET ndr          | Bool      | false       | <input type="checkbox"/> | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | <input type="checkbox"/> |
| 12                                                                                               | PLC_101 PUT error sta... | Word      | 16#0        | <input type="checkbox"/> | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | <input type="checkbox"/> |
| 13                                                                                               | PLC_101 PUT status v...  | Word      | 16#0        | <input type="checkbox"/> | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | <input type="checkbox"/> |
| 14                                                                                               | PLC_101 PUT counter      | Word      | 16#0        | <input type="checkbox"/> | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | <input type="checkbox"/> |
| 15                                                                                               | PLC_101 PUT error        | Bool      | false       | <input type="checkbox"/> | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | <input type="checkbox"/> |
| 16                                                                                               | PLC_101 PUT done         | Bool      | false       | <input type="checkbox"/> | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | <input type="checkbox"/> |
| 17                                                                                               | PLC_101 step 1           | Bool      | false       | <input type="checkbox"/> | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | <input type="checkbox"/> |
| 18                                                                                               | PLC_101 step 2           | Bool      | false       | <input type="checkbox"/> | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | <input type="checkbox"/> |
| 19                                                                                               | PLC_101 step 3           | Bool      | false       | <input type="checkbox"/> | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | <input type="checkbox"/> |
| 20                                                                                               | PLC_101 step 4           | Bool      | false       | <input type="checkbox"/> | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | <input type="checkbox"/> |
| 21                                                                                               | PLC_101 step 5           | Bool      | false       | <input type="checkbox"/> | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | <input checked="" type="checkbox"/> | <input type="checkbox"/> |

Figure 14 - Get and Put Instructions from PLC106 to PLC101

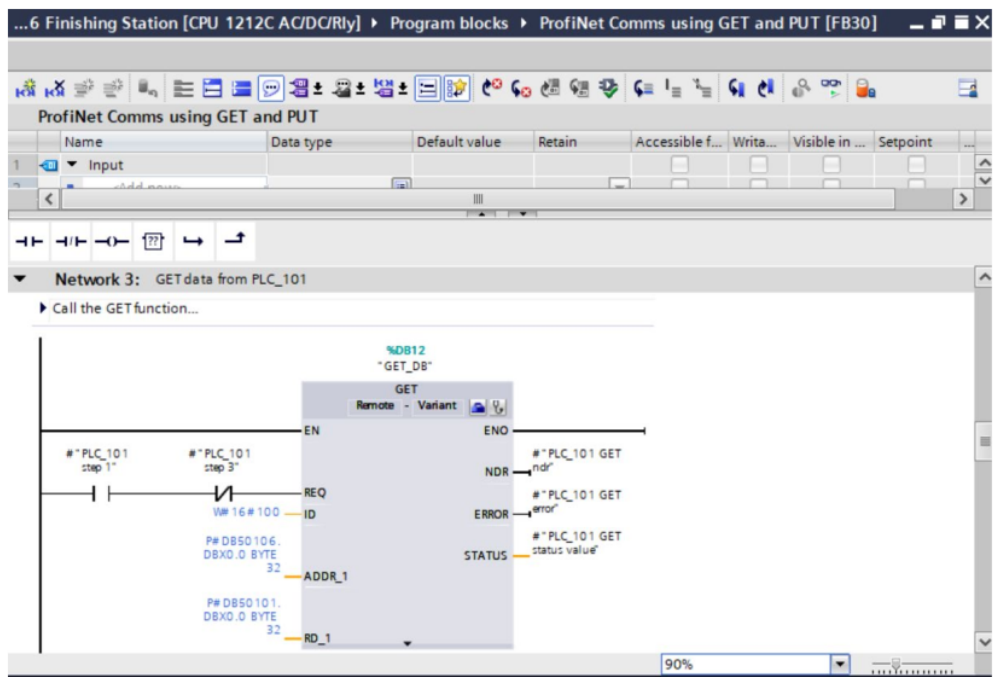


Figure 15 - Get instruction from PLC101

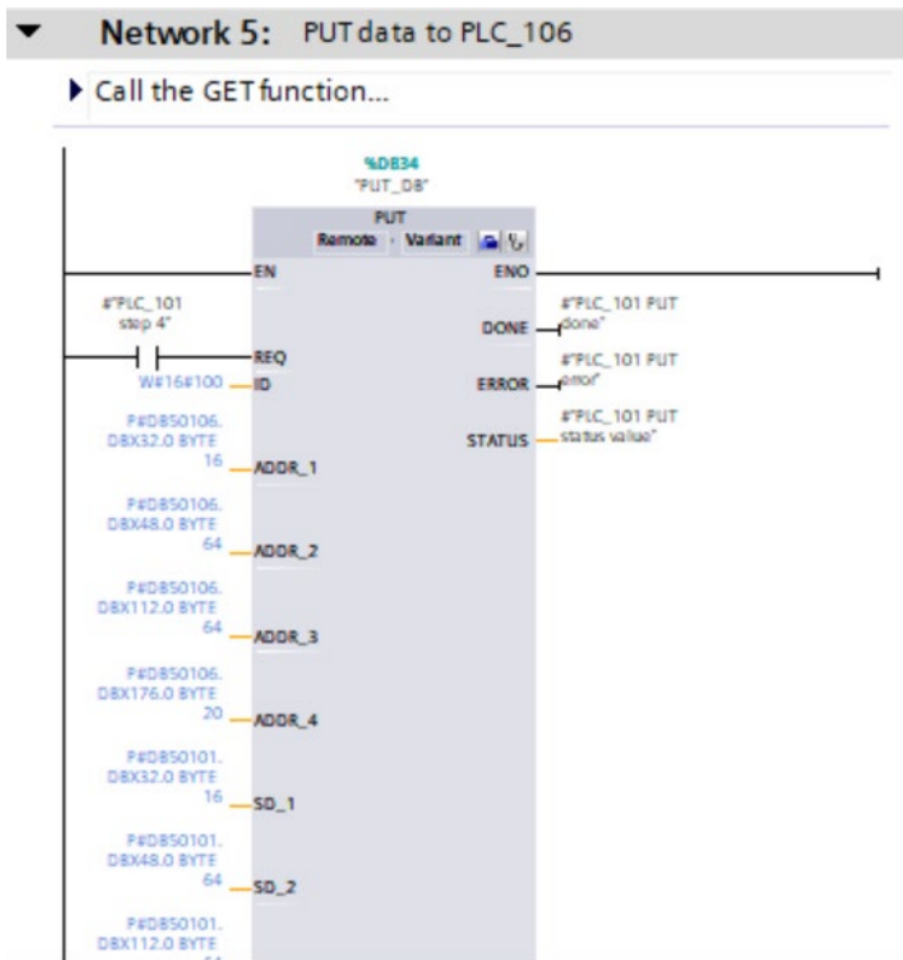


Figure 16 - Put Instruction to PLC106

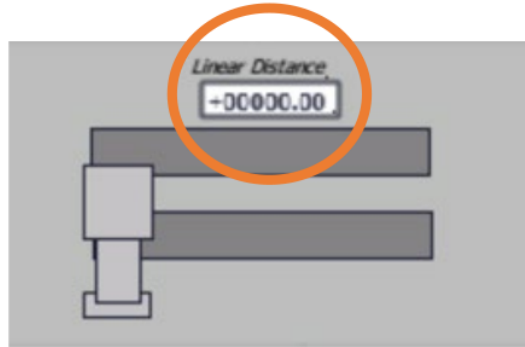


Figure 17 - Linear Drive Position

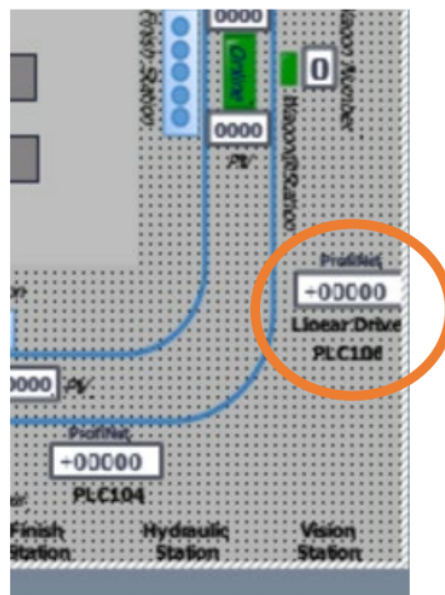


Figure 18 - Counter Showing Connection Between PLCs

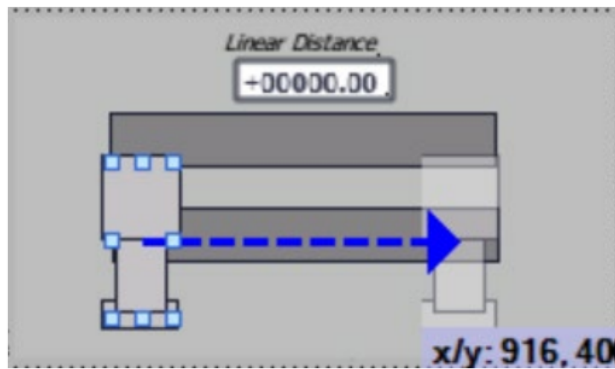


Figure 19 - Animated Robot Image



Figure 20 - Linear Drive Robot Tag

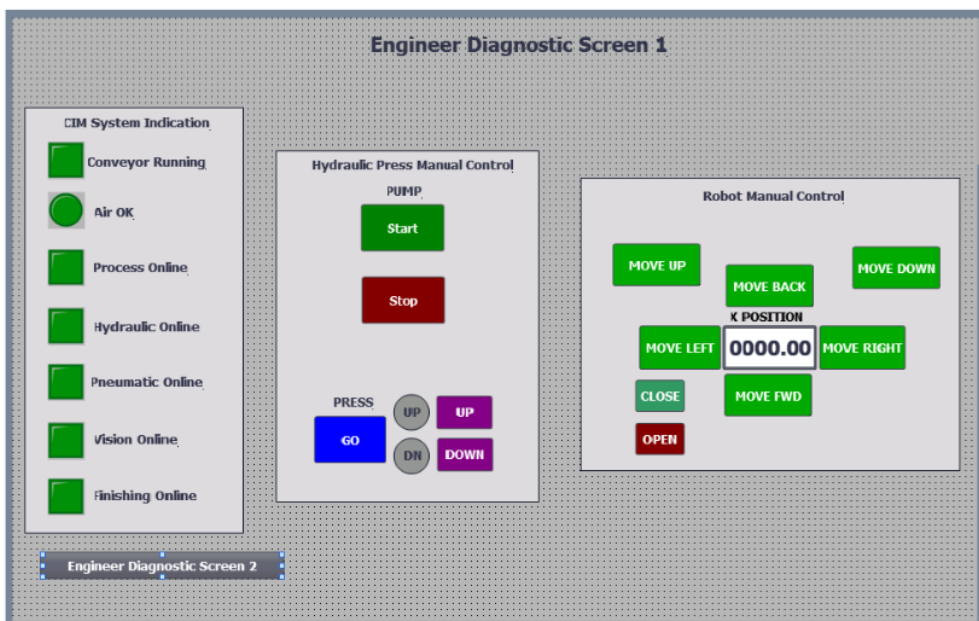


Figure 21 - Engineer Diagnostic Screen 1

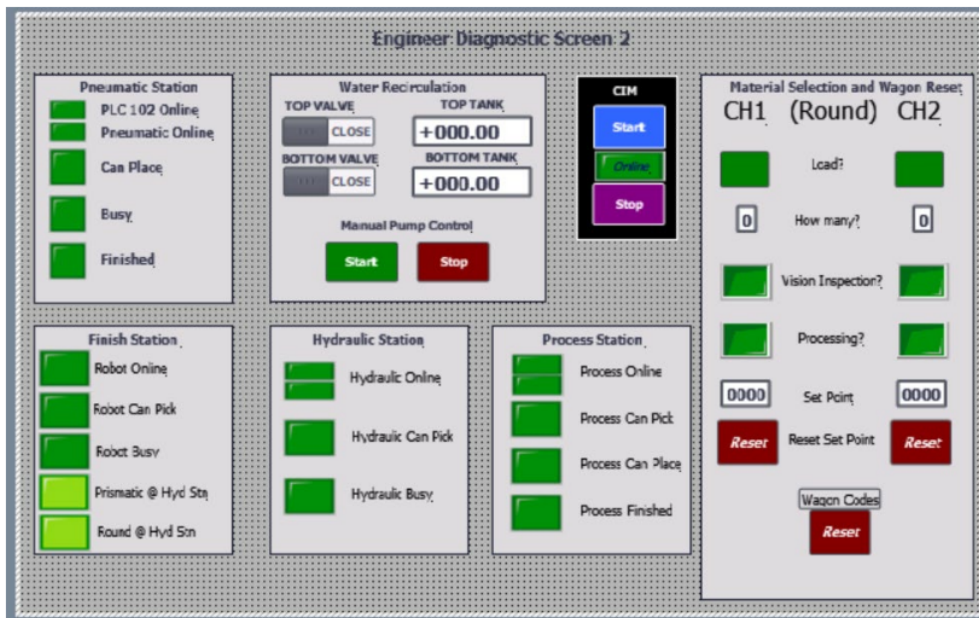


Figure 22 - Engineer Diagnostic Screen 2

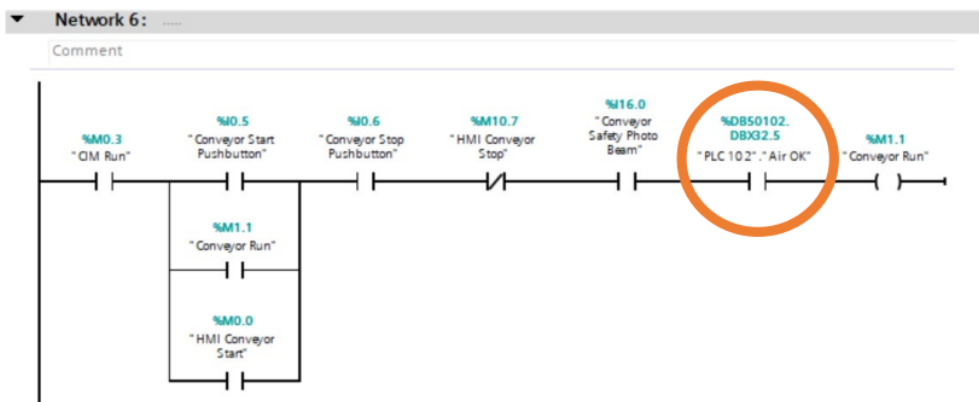


Figure 23 - Air OK Interlock

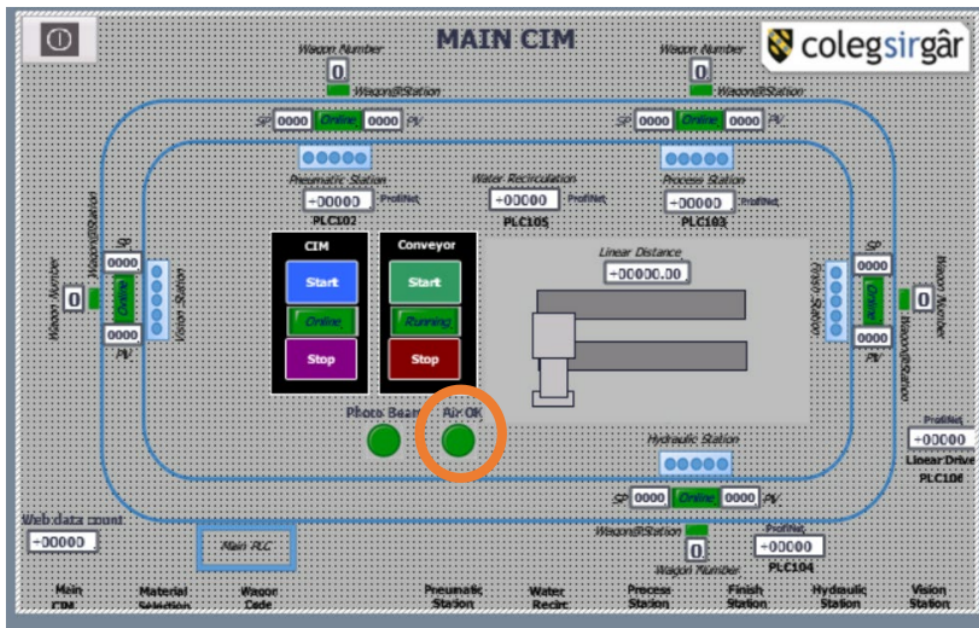


Figure 24 - Main HMI Screen with Air OK Indicator



Figure 25 - Air OK Indicator Tag

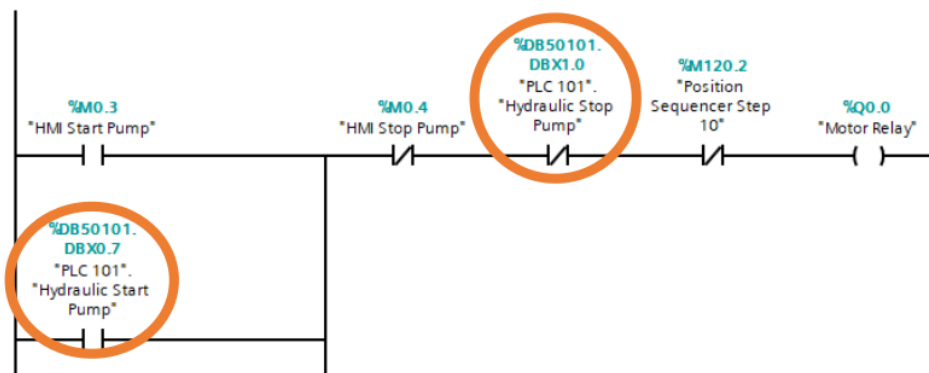


Figure 26 - HMI Manual Control Adaptation

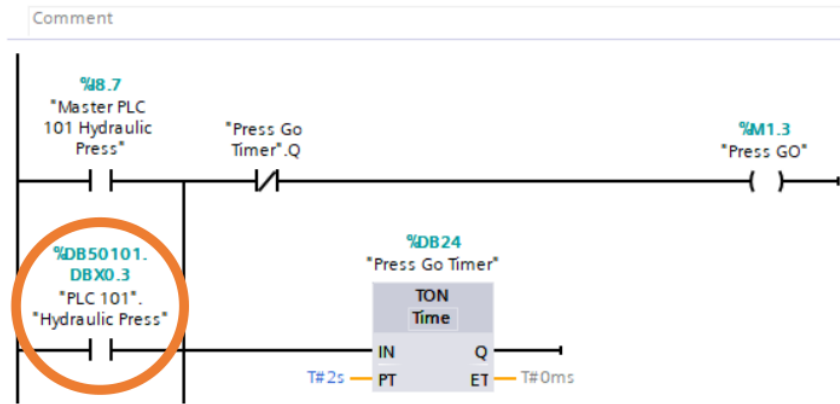


Figure 27 - HMI Manual Control Adaptation

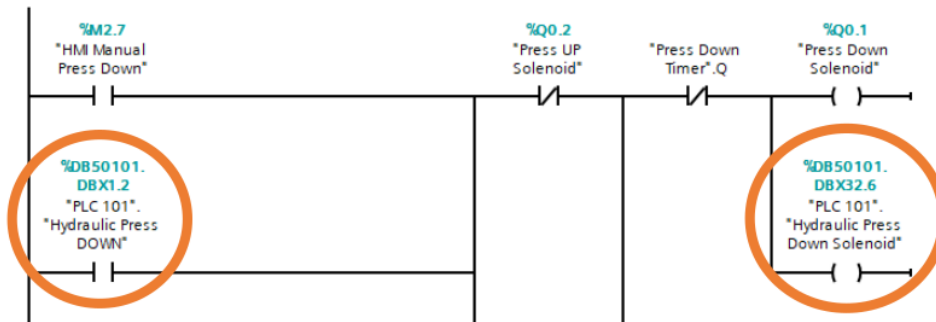


Figure 28 - HMI Manual Control Adaptation

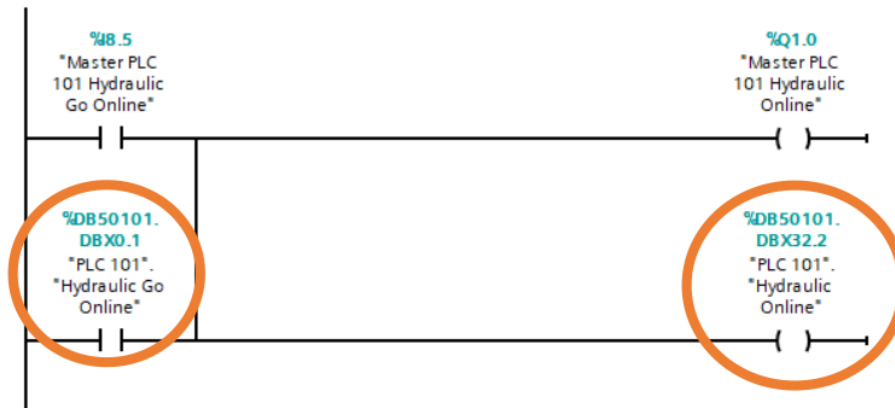


Figure 29 - HMI Manual Control Adaptation

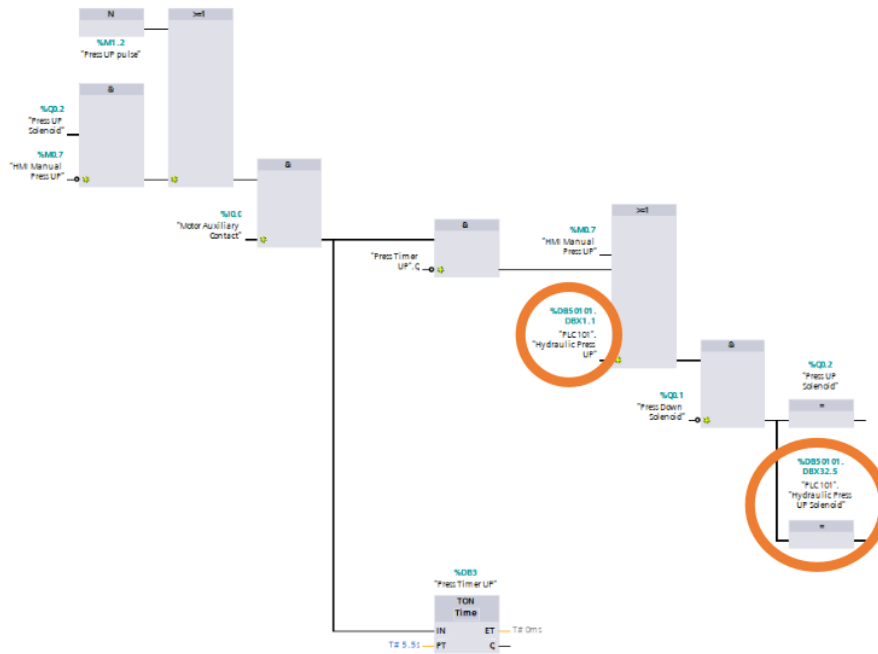


Figure 30 - HMI Manual Control Adaptation

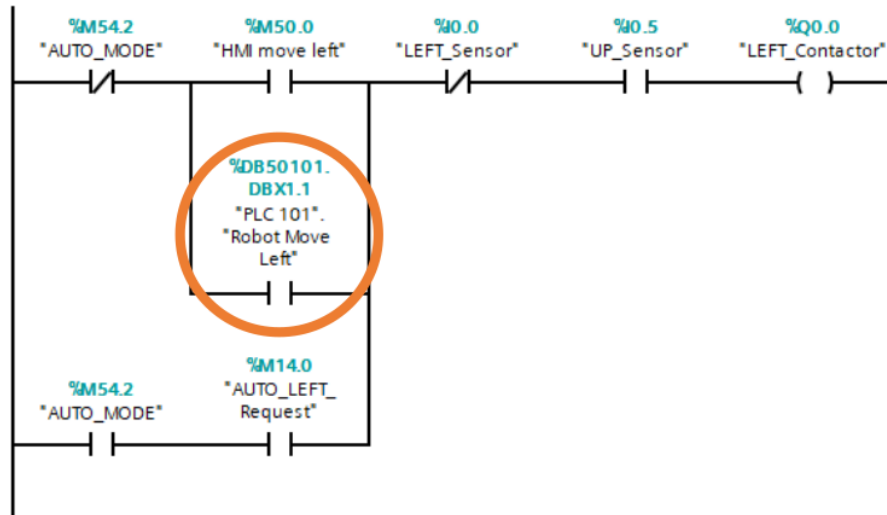


Figure 31 - HMI Manual Control Adaptation

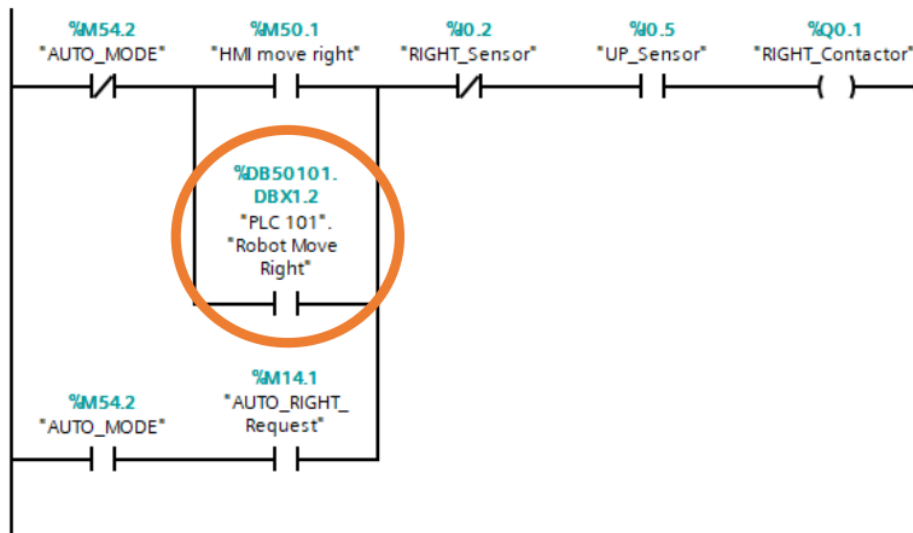


Figure 32 - HMI Manual Control Adaptation

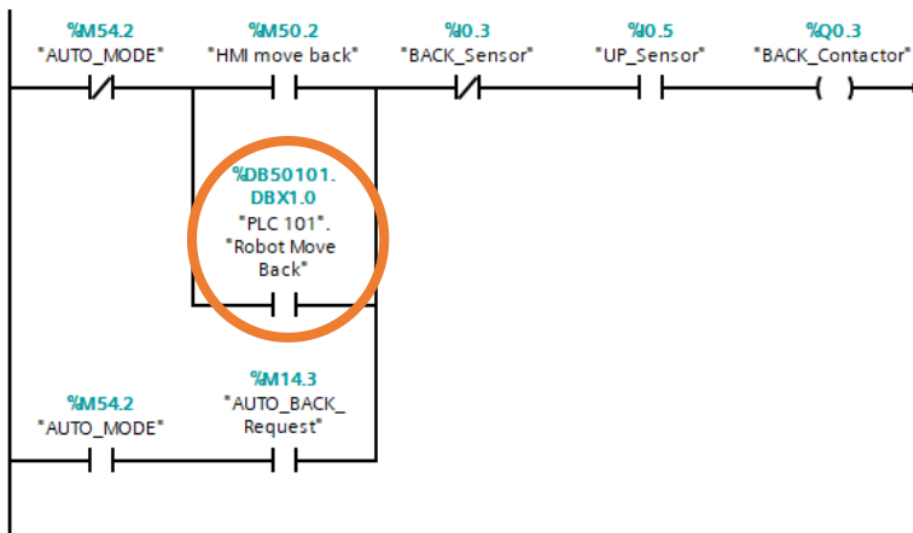


Figure 33 - HMI Manual Control Adaptation

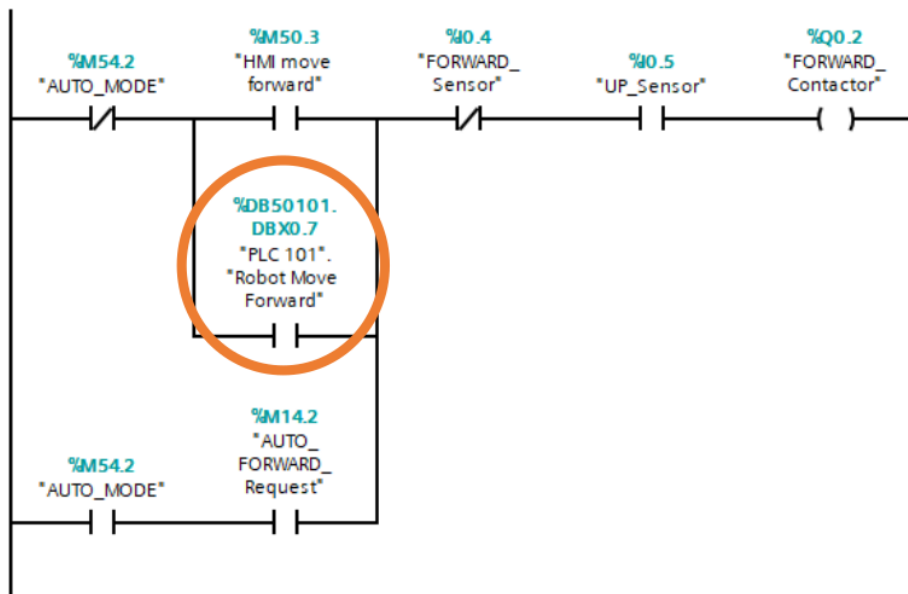


Figure 34 - HMI Manual Control Adaptation

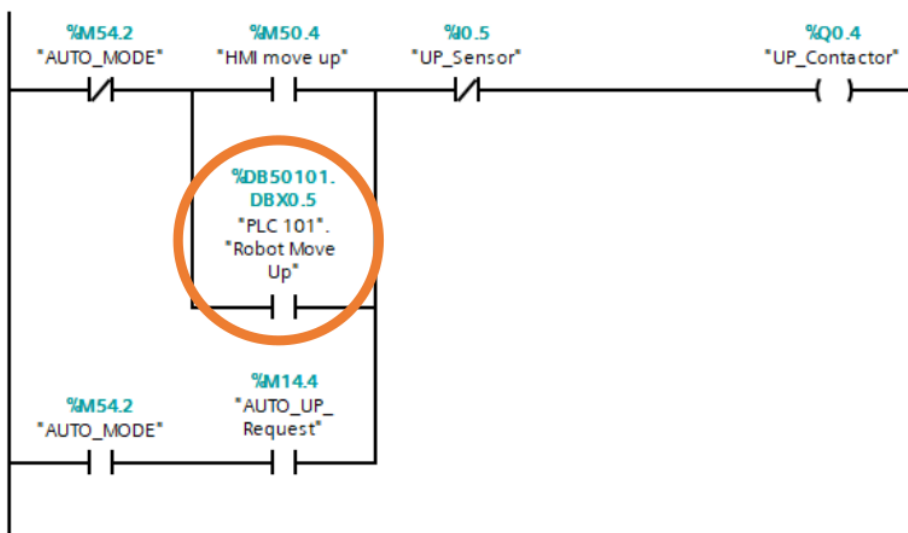


Figure 35 - HMI Manual Control Adaptation

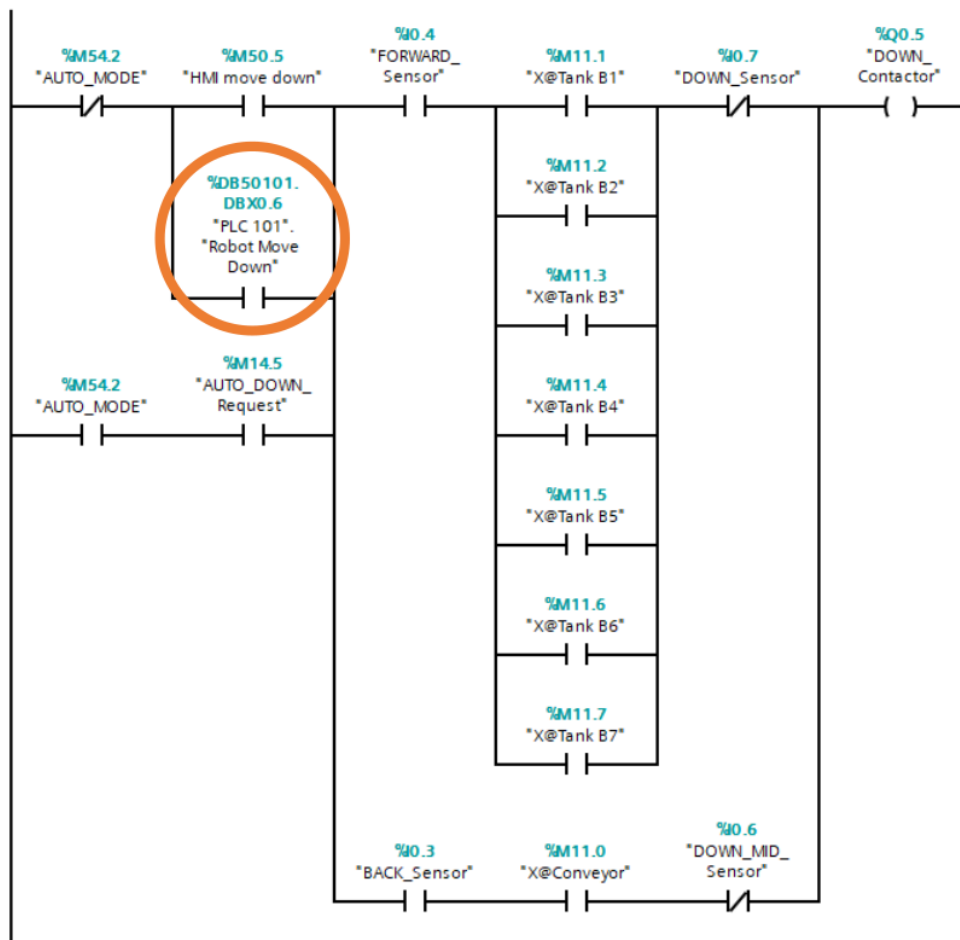


Figure 36 - HMI Manual Control Adaptation

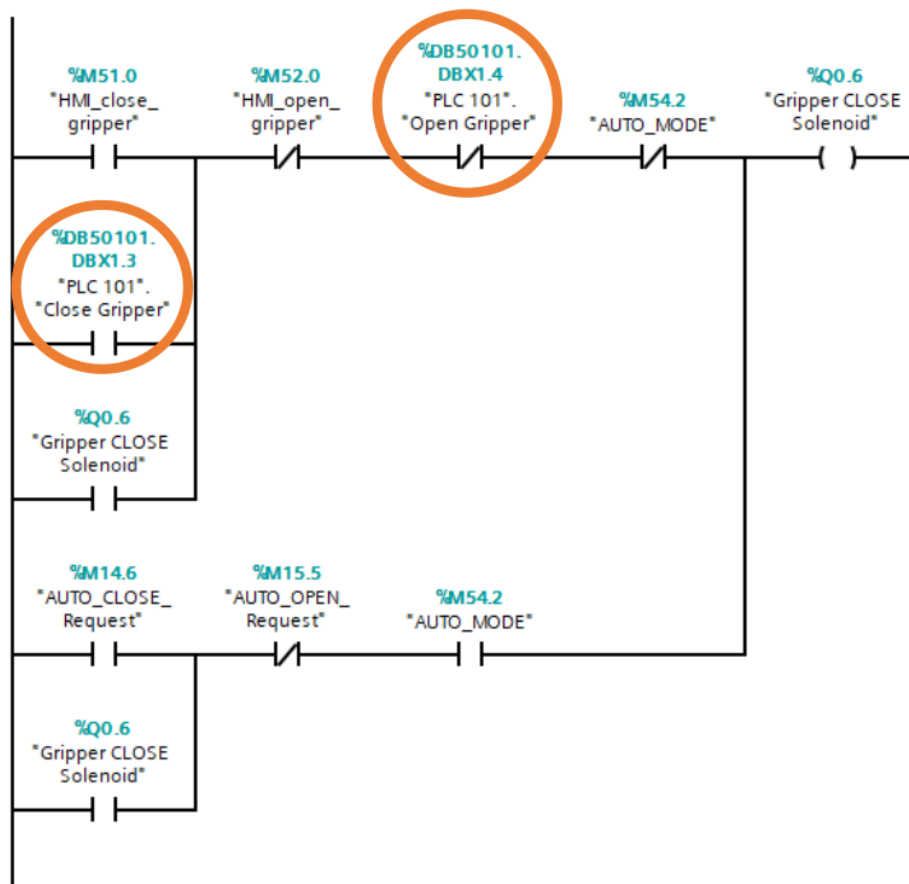


Figure 37 - HMI Manual Control Adaptation

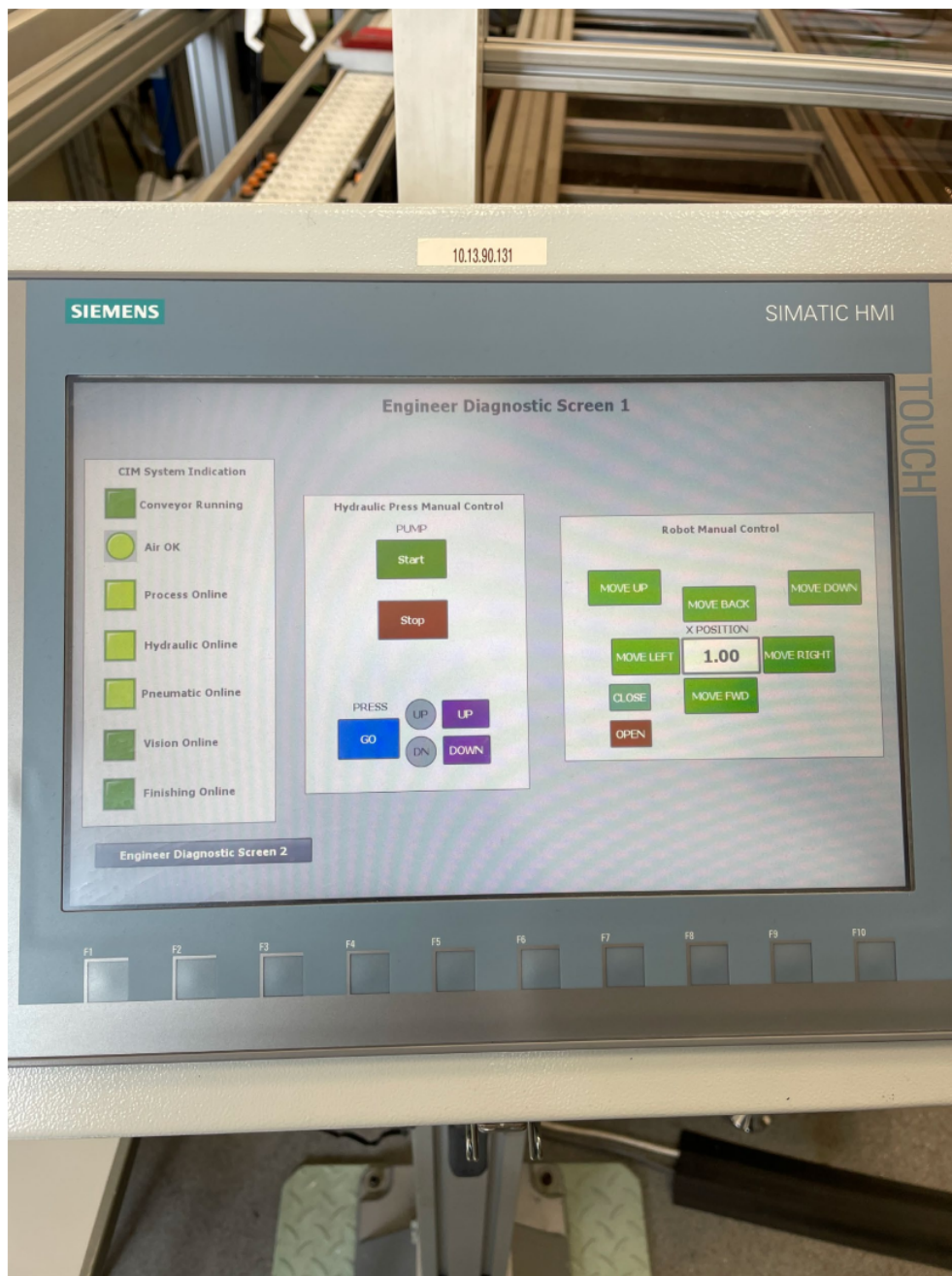


Figure 38 - Engineer Diagnostic Screen 1 Hydraulic Pump OFF



Figure 39 - Engineer Diagnostic Screen 1 Hydraulic Pump ON



Figure 40 - Engineer Diagnostic Screen 2 CIM OFFLINE



Figure 41 - Engineer Diagnostic Screen 2 CIM ONLINE



Figure 42 - Main HMI after Adaptations



Figure 43 - Main HMI Robot Animation Test



Figure 44 - Linear Drive HMI Encoder Position Test



*Figure 45 - Robot Manually Moved from Home Position*



Figure 46 - Conveyor Interlock Test

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GRADEMARK REPORT

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FINAL GRADE

GENERAL COMMENTS

Instructor

71 /100

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PAGE 2

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QM

**Good Structure**

Report is structured exactly as stated in the assignment brief.

QM

**Sections should be numbered according to the brief**

PAGE 3

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PAGE 4

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PAGE 5

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QM

**Sections should be numbered according to the brief**

QM

**Correctly cited**

Citation method conforms to Harvard standard, well done.

**Text Comment.** Sources should be separated, not cited together

PAGE 6

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**Text Comment.** Sources should be separated, not cited together

PAGE 7

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QM

**Sections should be numbered according to the brief**

**Text Comment.** Always begin a sentence with a word not a number.

## Text Comment. Which comms standard is being used?

PAGE 8

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PAGE 9

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QM

Sections should be numbered according to the brief

PAGE 10

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QM

A good testing table should contain 5 columns (1) Test description (2) Expected Result (3) Actual Result (4) Pass/Fail decision (5) Evidence reference.

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QM

Spelling

Spelling error

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GRADING FORM: NEW CSG-RUBRIC

SCOTT JONES

71

## 1. ENGAGEMENT WITH LITERATURE



Engagement with an appropriate range of literature, including sources retrieved

11

independently. Some over-reliance on texts rather than other sources. Referencing may show minor inaccuracies or inconsistencies. (11/20)

## 2. KNOWLEDGE AND UNDERSTANDING

 Excellent knowledge and understanding of the basic underlying concepts and principles of the subject. (14/20) **14**

## 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. (16/20) **16**

## 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. (16/20) **16**

## 5. TRANSFERABLE SKILLS



Work is coherent, very fluent and is presented professionally. Can work effectively independently and/or as part of a team, with an excellent contribution to group activities. Demonstrates excellent skills for employment requiring the exercise of some personal responsibility with an appetite for further development. (14/20)