

psde 4005 assignment 1

by Sean Jones

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Assignment 1

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Bytronic Industrial Control
Trainer

HNC electrical and electronic
engineering

PSDE4005

Programmable Logic
Controllers

Submission date: 03/10/17

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In this contents, sections should be numbered and should not include the contents

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Research

Whilst trying to decide what PLC is most suitable for the system, research needs to take place to compare the PLC using cost and capability. The two PLCs that will be compared will be a Siemens 1211c unitary PLC and a 1511 modular PLC.

A 1211c PLC is small PLC that (siemens, 2017) suggests is good for between small and medium processes. It has good capability for its size and lots of function to use in the programming of it. The issue with this plc is that it will not provide expandability if a system needs extra I/O or a certain type of analogue or high speed input or output. The maximum number of communication modules is 3 so this is very limited as in comparison to the 1511 plc. The 1211c is part of the 1200 series which (siemens, 2017)say *"SIMATIC S7-1200 can be perfectly tailored to the specific automation task"* which gives more certainty on its ability for the system. Below in Figure 1 1211c PLC is a 1211c plc.



Figure 1 1211c PLC (distrelec, 2017)

A 1511 plc is part of the 1500 series of PLC which has been developed very well by Siemens and can perform a lot quicker than the 1200 series. (siemens, 2017)States that it has *"Less than 1 ns Bit processing time in the CPU"*. The cost for the 1511 is a £984 more than the 1211c according to (parmleygraham, 2017). The reason for this greater cost is that the 1511 has a lot more capability than the 1211c and also has separate modules for the input and output card to the CPU. This type of PLC would be better suited to a more complex system that may involve large amounts of i/o and more networking.

To easily compare these PLCs a comparison table has been made. The data filling the table was extracted from (siemens, 2017) and (parmleygraham, 2017) below in Table 1 PLC comparison

	1211 c	1511
Programing languages available	3	5
cost	£171	£1155
Number of inputs	6	16
Number of outputs	4	16
Expandability	Cannot be expanded	Can be largely expanded

Table 1 PLC comparison

There are 5 types of IEC programing languages available according to (horner, 2017) these are

LD - Ladder diagram (graphical) -This language is easy to use and understand. It is best used on a system where an engineer may need to modify the program often and needs to understand the code.

FBD - Function block diagram (graphical) -This program is best used on systems that don't require much logic and may need modifications in the future as it takes up more space than a ladder program.

ST - Structured text (textual) - is similar to c programing and takes up little space in the program. The issue with it many engineers may find it difficult to understand the logic when making modifications. So this system is more suitable for a machine which would require no future modifications

IL - Instruction list (textual) - this is rarely used in PLC programing and will only be used if the programing prefers this method of programing.

SFC - Sequential function chart- this is very simple to use and gives a very strong graphical representation of the programme. It is best used for training people to write logic or for people who have little experience with other logic languages.

Hardware Description and I/O List

The system is an “Industrial Control Trainer” it simulates the type of system that could be found in an industrial assembly production line. The system assembles a part which is made up from a metal peg and a plastic ring which sits on the metal peg. The system has 8 inputs and 5 outputs. The inputs used are capacitive, inductive or thru-beam. The capacitive sensors are used to detect the plastic parts or to detect anything within an area. The inductive sensor will only detect metal parts. The thru-beam sensor will detect anything that breaks its beam. The outputs used are solenoid which either push a part in a different direction or release a part. Another output type is the conveyors which run at a constant speed to move the parts. One of the conveyors is a belt and the other is a chain. The chain conveyor is used to carry the part up the slope which wouldn't be possible on the belt as the part would fall off. Below in Figure 2 is the system that is being used.

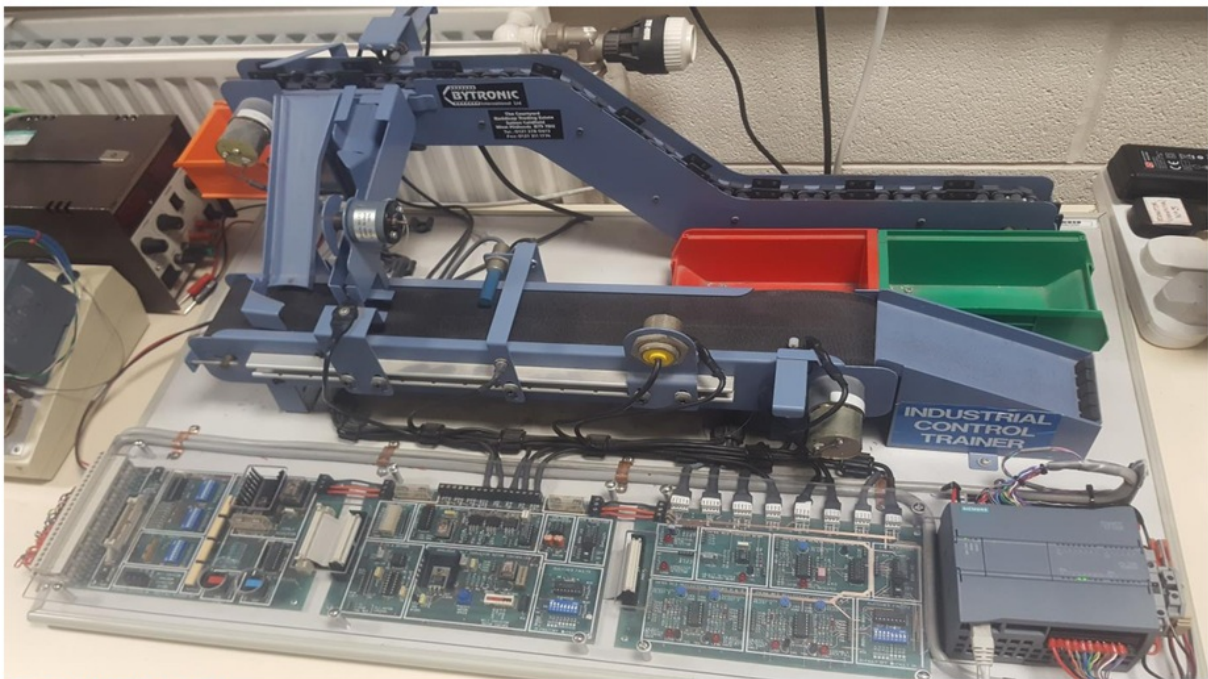


Figure 2 Byronic system

The system can be classified into different areas; these are the sort area, assembly area and the reject area. The sort area will filter between plastic rings and metal pegs. The plastic rings will be pushed down a chute whereas the metal peg will remain on the conveyor until it gets diverted down a chute onto the other conveyor so it can be assembled. The metal peg will then meet the plastic ring which will sit on the metal peg. The part will move along the conveyor

until it reaches the reject area where it will either pass through and slide into the good parts area or be rejected into the failed parts box.

The control of this system will be done by a Siemens 1200 dc/dc/dc PLC. This PLC is suited to this system as it has just enough inputs and outputs for the job. If the system was ever to be expanded, the 1200 PLC can easily adapt and have I/O modules added onto it. This PLC is cost effective for this system as well whereas the 1500 series would be unnecessary for the about of capability that is needed in this small system. Below in Figure 3 is the PLC that is used on the system



Figure 3 PLC used

A HMI is integrated to the PLC for the operator to run the machine with ease as any information will be displayed onto the HMI. The HMI used is a KTP 700 as shown in Figure 4.



Figure 4 HMI used

Below is Table 2 showing the I/O list. This list will assist in programming the system as it's an easy reference to find which sensors go to which input and what output controls which solenoid or conveyor.

Input Address	Tag
I0.0	Assembly Area Sensor
I0.1	Sort Area Sensor
I0.2	Reject Area Sensor
I0.3	Capacitive Area Sensor
I0.4	Metal Peg Detect
I0.5	Infa-red Through-beam Sensor
I0.6	Capacitive Sensor
I0.7	Inductive sensor
Input Address	Tag
Q0.0	Sort Solenoid
Q0.1	Rotary Solenoid
Q0.2	Reject Solenoid

Q0.3	Chain Conveyor
Q0.4	Belt Conveyor

Table 2 I/O configuration

Below in Figure 5 I/O layoutFigure 5 shows where the I/O is on the system itself.

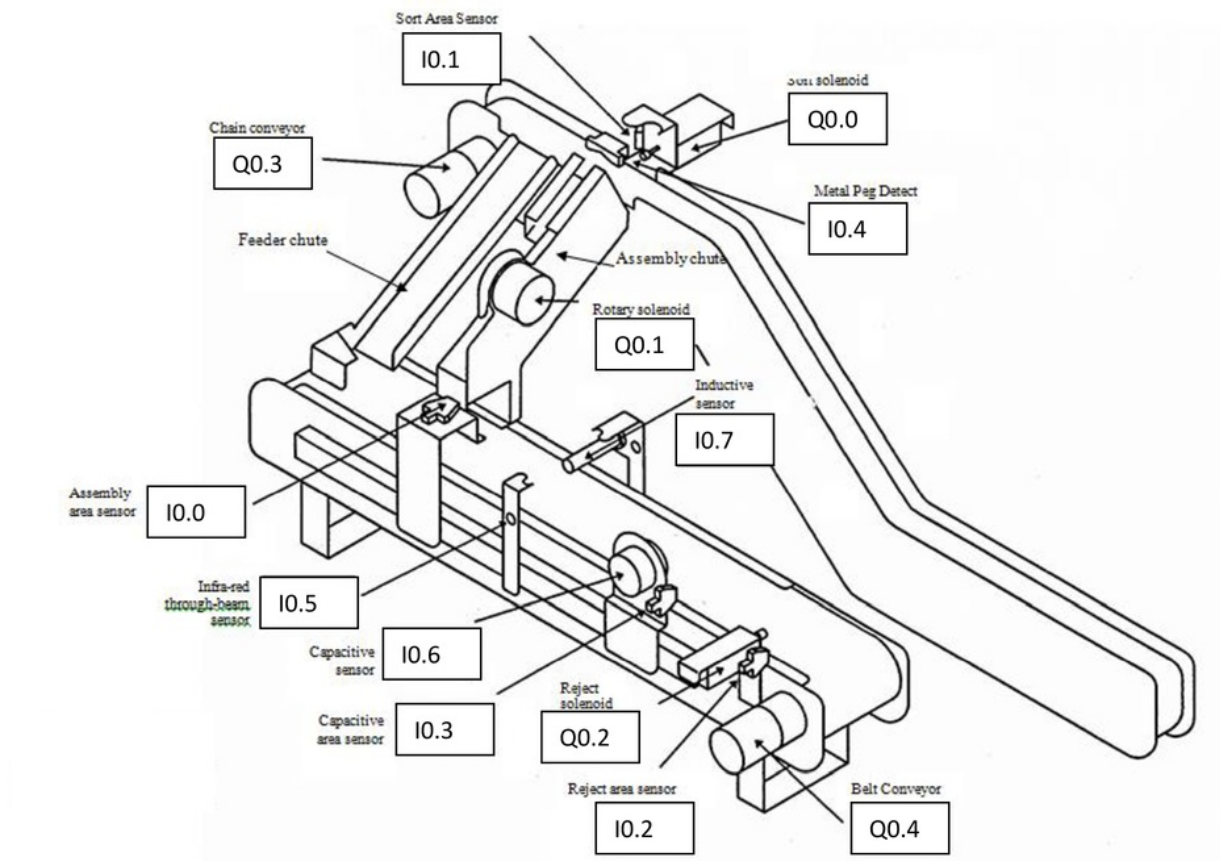


Figure 5 I/O layout

PROGRAM EXPLANATION

The program is where the logic of the system is designed. To make the system easy to modify in the future and to fault find when being created, it was made up in sections of its control. This is shown in Figure 6.

 Main [OB1]
 Conveyor & Sorting [FC1]
 Dispenser timing [FC2]
 Parts monitoring [FC4]
 Reject sorting [FC3]

Figure 6 program layout

Below in Figure 7 is the tag list. This includes all the tags used to make the PLC program work including memory bits.

PLC tags				
	Name	Tag table	Data type	Address
1	 Assembly Area Sensor	Default tag table	Bool	%I0.0
2	 Sort Area Sensor	Default tag table	Bool	%I0.1
3	 Reject Area Sensor	Default tag table	Bool	%I0.2
4	 Capacitive Area Sensor	Default tag table	Bool	%I0.3
5	 Metal Peg Detect	Default tag table	Bool	%I0.4
6	 Infra-Red Through-Beam Sensor	Default tag table	Bool	%I0.5
7	 Capacitive Sensor	Default tag table	Bool	%I0.6
8	 Inductive Sensor	Default tag table	Bool	%I0.7
9	 Sort Solenoid	Default tag table	Bool	%Q0.0
10	 Rotary Solenoid	Default tag table	Bool	%Q0.1
11	 Reject Solenoid	Default tag table	Bool	%Q0.2
12	 Chain Conveyor	Default tag table	Bool	%Q0.3
13	 Belt Conveyor	Default tag table	Bool	%Q0.4
14	 Manual Reset	Default tag table	Bool	%M0.0
15	 Metal Peg Detected On Belt	Default tag table	Bool	%M0.1
16	 reject area sensor pulse	Default tag table	Bool	%M0.2
17	 assembled product	Default tag table	Bool	%M0.3
18	 machine fault	Default tag table	Bool	%M0.4

Figure 7 PLC tag list

Main program

The main program is where all the function blocks are enabled. Without these enables the function blocks won't perform their functions. This is shown in Figure 8.

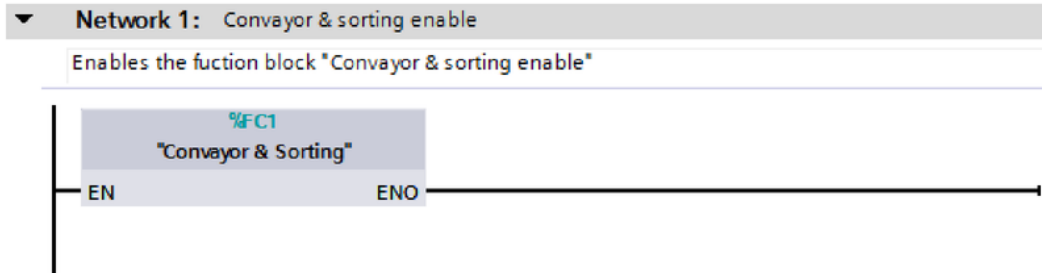


Figure 8 conveyor & sorting enable

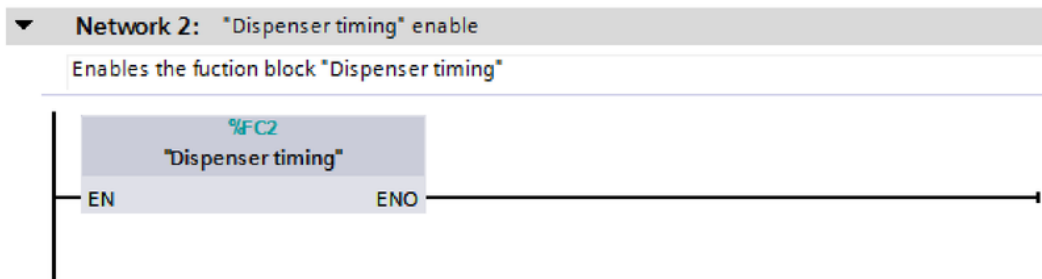


Figure 9 Dispenser timing enable

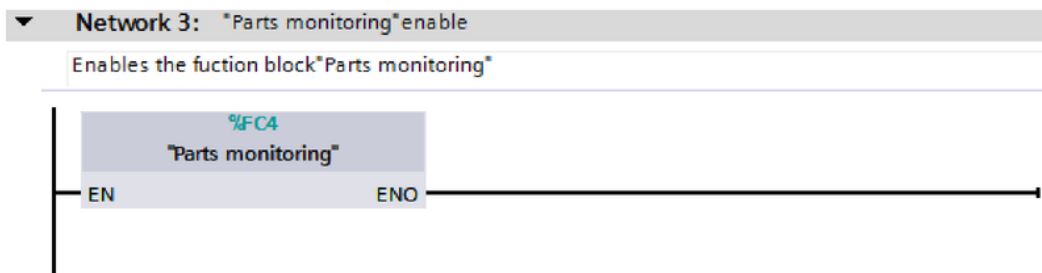


Figure 10 Parts monitoring enable

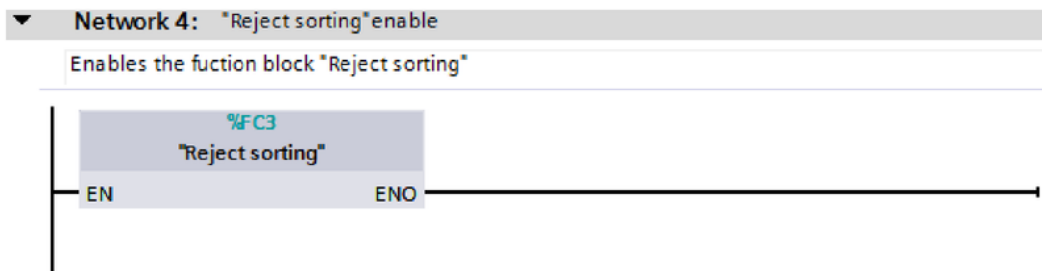


Figure 11 Reject sorting enable

Conveyor & Sorting

Conveyor and sorting is a function block which only contains the conveyor enables and the sorting. The first network in Figure 12 enables the two conveyors to come on when the PLC is booted up. This is because the conveyors don't need to be switched on at any specific instance.

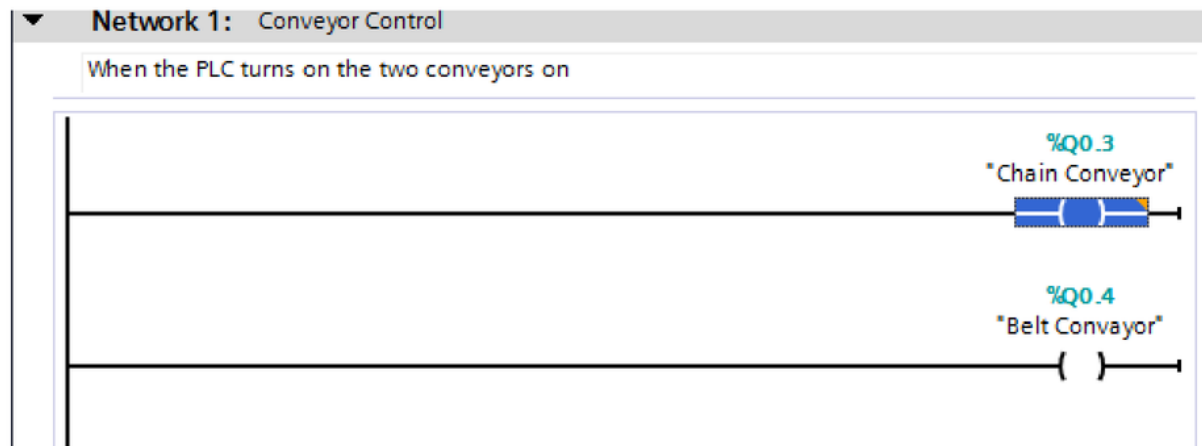


Figure 12 switching on the conveyors

Below in Figure 13 shows how the sort solenoid is enabled and held on for 0.5 seconds. It needs to be on if there's a part in the area sensor that doesn't trigger the inductive sensor. This will mean that the plastic rings will go down the chute but not the metal pegs. Also the solenoid needs to be active for

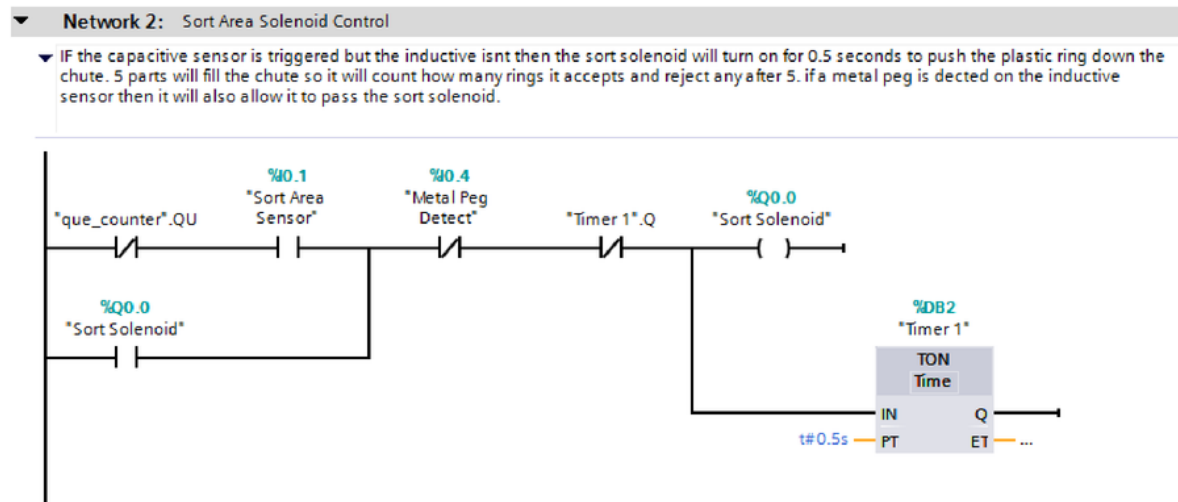


Figure 13 energizing the sort solenoid

Figure 14 shows the queue counter and how the sort solenoid increments it and the rotary solenoid decrements it. It gives an output when it reaches 5 and has to be reset by a manual reset button linked into the HMI.

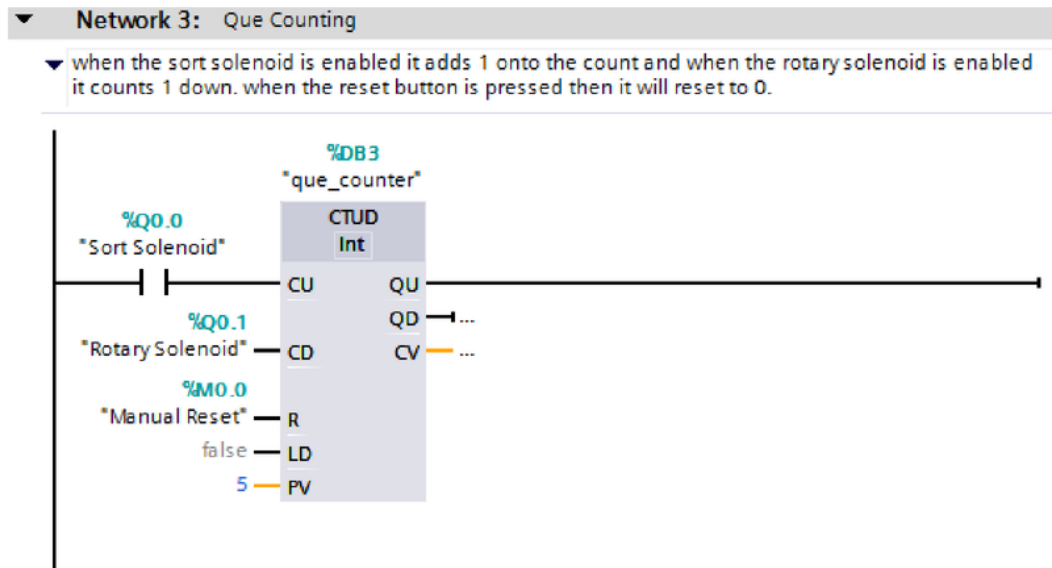


Figure 14 queue counter

Dispenser timing

At the bottom of the chute is a dispenser which dispenses a plastic ring onto the assembly area where it can combine with a metal peg. The dispenser is controlled with the rotary solenoid which allows the ring to move. This solenoid should only energize if there's nothing in the assembly area for longer than two seconds and if the queue count is greater or equal to 1. The rotary solenoid will not be energized after 0.5 seconds. Figure 15 shows how the rotary solenoid works.

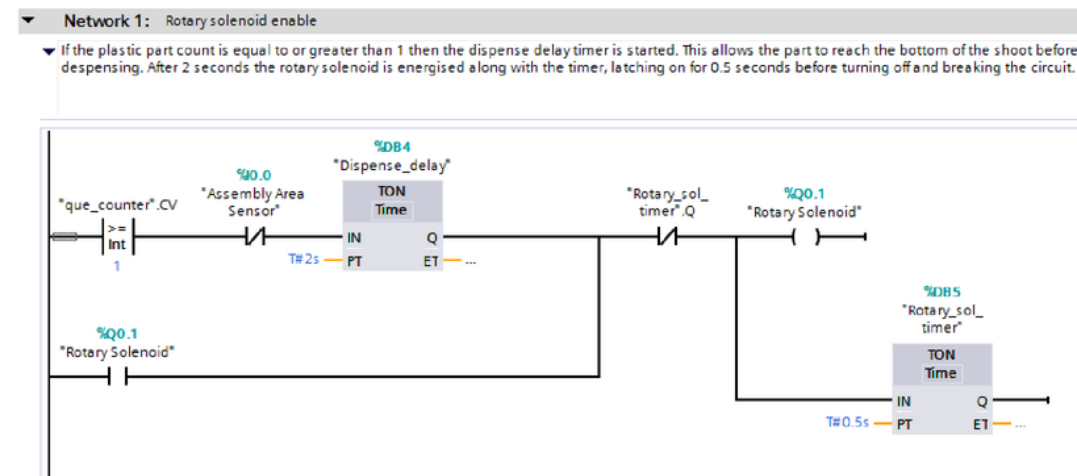


Figure 15 rotary solenoid enable

Parts monitoring

Parts monitoring is where the logic is contained to give the operator and engineer feedback on the HMI. This is to improve the ease whilst running the machine and to reduce breakdown fault finding time as a problem may be highlighted as the machine counts wasted and failed parts. Below in Figure 16 is the passed parts counter. This only counts up as there is no need for it to count down.

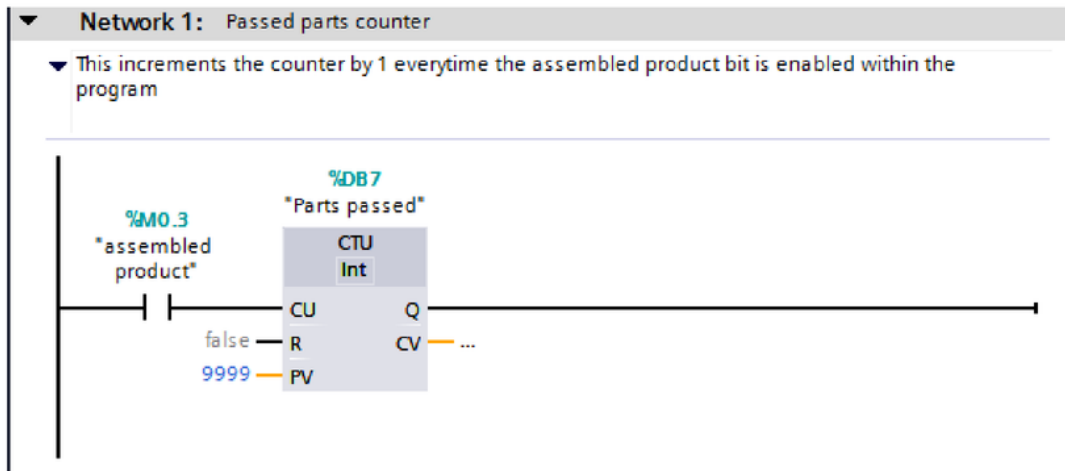


Figure 16 passed parts

A machine fault bit is created to let the operator or engineering know that the machine is failing too many parts. Figure 17 shows how this bit is enabled

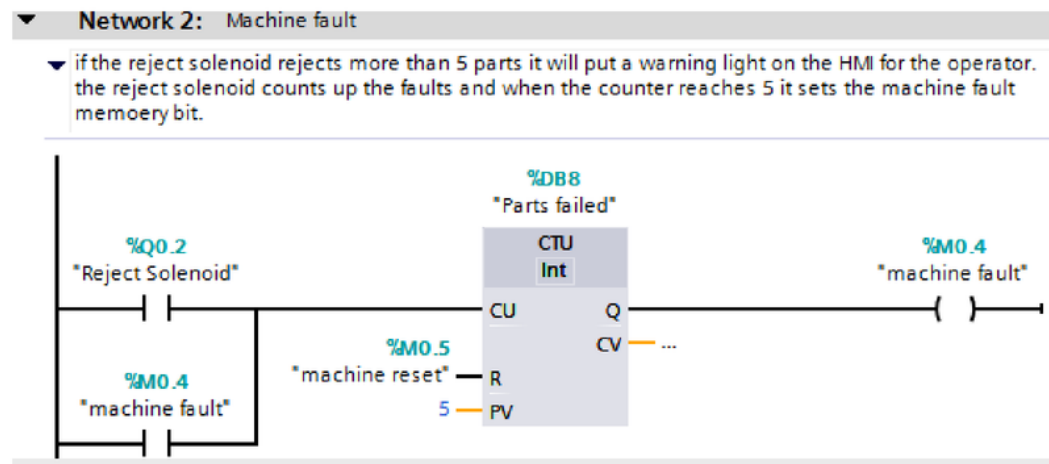


Figure 17 machine fault

Network 3: Wasted rings counter

- ▼ This is incrementing the counter whenever a part that is not metal, a part passed through the "sort area sensor", the sort solenoid wasn't extended and the queue counter is full.

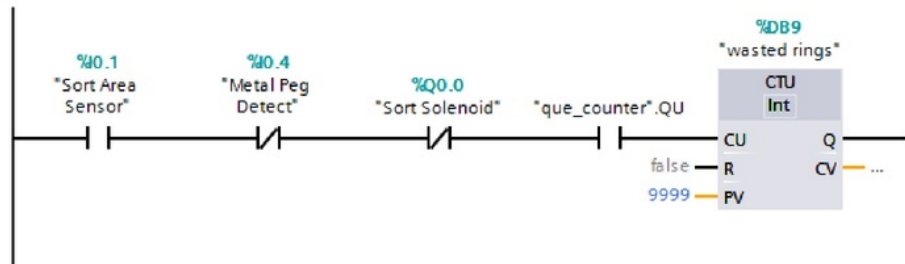


Figure 18wasted rings count

Network 4: metal pegs failed counter

- ▼ If there is a metal peg on the bed and the reject solenoid is fired, this means a metal peg was rejected so it will increment the counter by 1

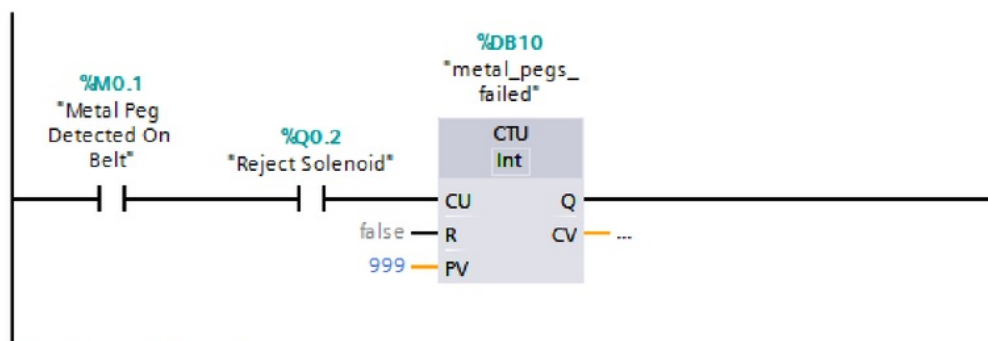


Figure 19 metal peg reject count

Network 5: rings rejected counter

- ▼ if there isn't a metal peg on the bed, it isn't an assembled product and the reject solenoid is fired, then it must be a plastic ring rejected so it will increment the counter by 1.

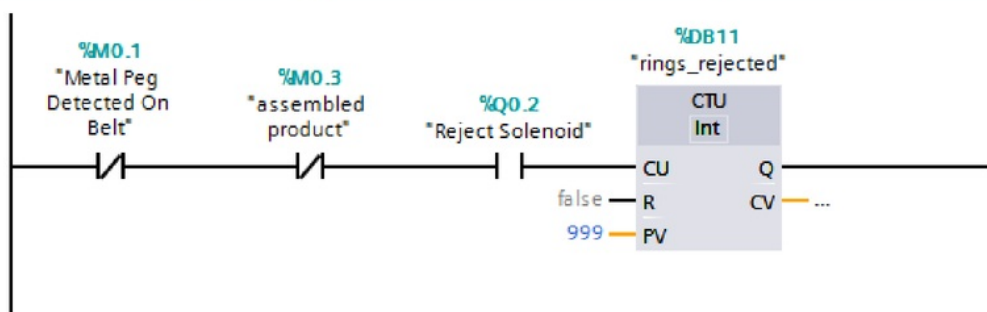


Figure 20 rings rejected

Reject sorting

Network 1: Metal Peg Detection On Belt

When the inductive sensor is active then the "Metal Peg Detected On Belt" bit is set



Figure 23 metal peg on belt set bit

Network 2: Reject solenoid control

- The reject solenoid has a timer to switch it off after 0.5secs of it being latched on by itself. When an object is in the reject area and it is not an assembled product, it is rejected.

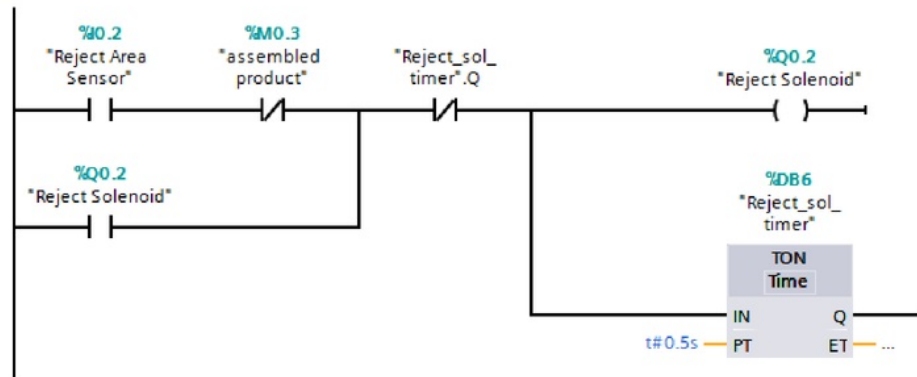


Figure 22 reject solenoid control

Network 3: Bit resetting

- When the negative edge of the reject area sensor is seen then the "Metal Peg Detected On Belt" and the "assembled product" bits are reset.

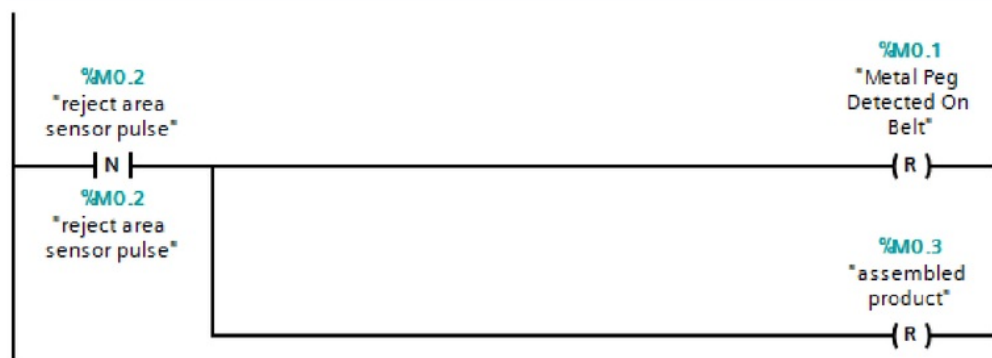


Figure 21 bit resetting

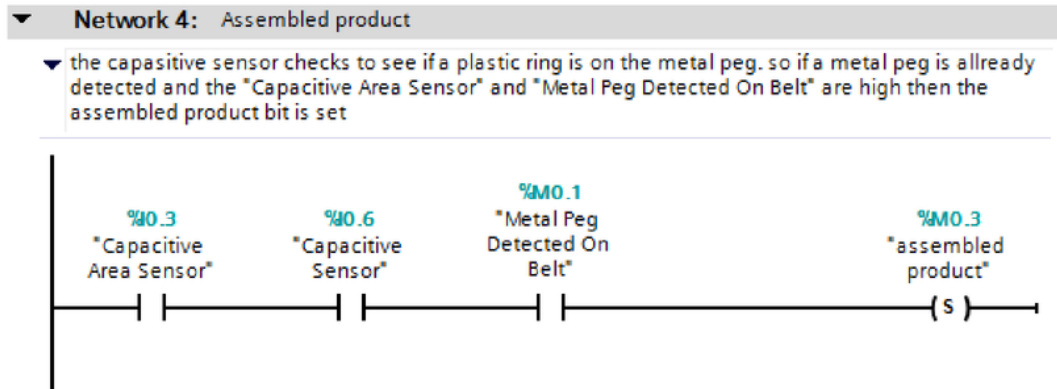


Figure 24 assembled product set bit

HMI

the HMI is for the operator to run the machine hassle free and for the engineer to fault find easy. On this machine for simple and easy to use operation there are only two HMI screens one for the operator one for diagnostics as shown in Figure 25.

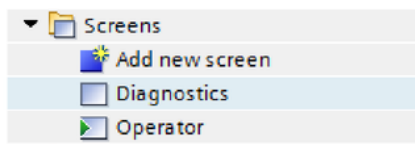


Figure 25 HMI screens layout

The operator screen has basic functions and information to run the machine. The parts passed and the wasted/ rejected parts are displayed so an operator can note down this information at the end of a shift. This screen also has basic feedback displays such as lamps to indicate if the conveyors are running and the machine running and machine fault lamp if there's a problem. There is a button for the engineer to press to get onto the diagnostics screen. Figure 26 shows the operator screen.

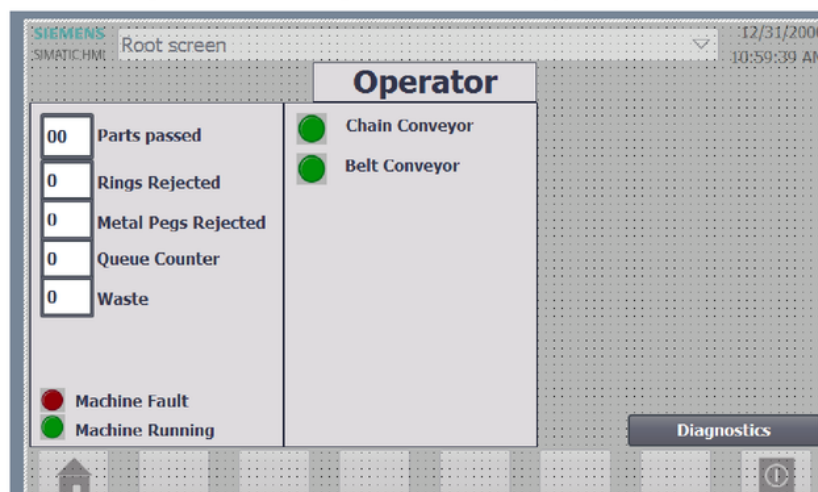


Figure 26 HMI operator's screen

Below in Figure 27 is the diagnostics screen. This screen allows the engineer to see all the I/O of the machine including memory bits. The outputs also have a test function to ensure that they work when fault finding a problem. The queue count can also be manually reset here. The engineer can easily navigate back to the operators screen by pressing the “operator” button on the screen.

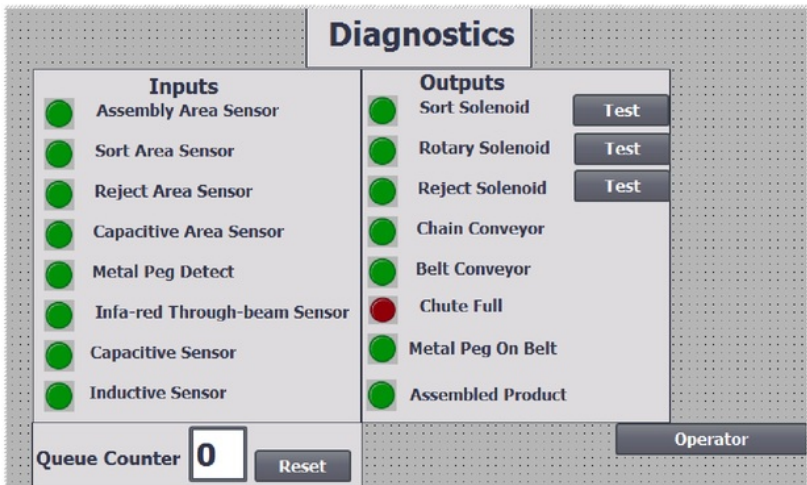


Figure 27 HMI diagnostics screen

System Testing and Evaluation

After all the programming is complete and commissioned, the system gets put through an acceptance test to see if it meets its original design specification and to ensure it runs correctly and that reliability is kept throughout the testing. A testing table shown in Table 3 is used to easily test the machine as it quickly compares how the system should be working to how it's working now. This will also prove the strength of the program whilst putting the system through every scenario that may occur whilst in production.

TEST NUMBER	WHAT ACTION WAS MADE?	WHAT SHOULD HAPPEN?	DID THIS HAPPEN? IF NOT THEN WHAT HAPPENED?
1	Turn power on	PLC will power up and the two conveyors will start	YES
2	Place a plastic ring on the chain conveyor	Ring should get the sort area and the sort solenoid extend for 0.5 seconds	YES
3	Place a metal peg on the conveyor	Peg should go passed sorting area and slide down onto the belt conveyor	YES
4	Place more than 5 plastic rings on chain conveyor	the sort solenoid should push into the chute and waste the remaining ones. Also should increment the waste counter by the amount that was wasted	YES
5	Nothing in the assembly area but a plastic ring in assembly chute	2 second delay and then Rotary energized for 0.5 seconds. Also the queue count should decrement 1	YES
6	Place another plastic ring on the chain conveyor	This should be pushed into the chute	YES

7	Place a metal peg on belt conveyor	This should move all the way down the conveyor and get rejected. Also increments the peg rejected counter	YES
8	Plastic ring placed on belt conveyor	Should get rejected and increment the rings rejected counter	YES
9	Place a good part on the belt conveyor but upside down	Should get rejected and increment the parts failed counter	YES
10	Place a good part on the belt conveyor	Should not get rejected and increment the pass parts counter	YES
11	5 consecutive failed parts to be placed on belt conveyor	All 5 should be rejected and put the machine fault lamp on the HMI	YES
12	A metal peg should now be placed on chain conveyor	The peg should run through the system collect a plastic ring and fall into the passed parts box if the part is deemed to be sound	YES

Table 3 testing table

The system proved it could pass all the requirements that were given which prove the program was strong enough. Also the HMI gave all the relevant information to perform these tests whilst developing the system.

Conclusions and Recommendations

The system programming was very successful as it met all the requirements that were originally set out. The programme even included extra parts in it which made the usability of the system easier for the operator and engineer. The PLC was ideal for the system as there was spare I/O at the end so expandability is still available on the system without adding more modules.

The system programme could have been improved by developing tracker for a part as it goes through the system to allow more than one part to progress through the rejection area at once. In the current state of the machine it is not possible for a queue of parts to go through this area as it will give false results. This significantly reduces the parts produced per minute and could make the machine more efficient if development was made here. Time prevented this development the makings of the systems program. If there was more time to complete the project then the system could have had this modification and maybe a few other tweaks to making it process parts faster.

Too much time was spent designing the programme as opposed to the commissioning the software but this was benefited as the stronger programme made the commissioning a quicker task.

The commissioning of the software was a fairly easy task as very few alterations were made but the layout of the program using the function blocks made any alteration very easy. The parts passed and rejection counters took the longest to get right with the software but were very reliable after this.

In all the system worked really well for the costing of it and timescale used to complete it in.

Collaboration

The software and commissioning of the system was done in a team of two people. All work was carried out quickly and efficiently due to the work load being halved. Discussion was used to improve the system as ideas were shared to develop the system whereas 1 person may not have thought of the ideas themselves. Working out the logic was made easier as either party had strength in doing certain parts of the programing where the other one lacked. The commissioning of the system was very efficient as both parties of the group threw ideas into the mix to quickly discover what the problems where and how they could be overcome.

Without the asset of working in a group the quality of the final product would have been reduced as the amount time to complete the programing would have virtually been less as half the work rate would be performed.

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psde 4005 assignment 1

GRADEMARK REPORT

FINAL GRADE

GENERAL COMMENTS

Instructor

62/100

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GRADING FORM: CSG-RUBIC

SEAN JONES

62

RESEARCH-INFORMED LITERATURE



Section 1: Your research - Two types of PLC have been briefly described together with brief statements for each of the three languages. A higher mark could have been achieved if the rack mounted PLC had been considered together with machine applications and fuller descriptions for each language with applications and images showing what they look like. (8/15) Section 8: Your use of Harvard for citing and listing - Harvard method mostly used correctly. However, not all sources listed have been cited. (2/5)

10

KNOWLEDGE AND UNDERSTANDING

-  Section 2: Hardware Description and I/O list - A good description of the hardware provided with clear images and a good I/O list with reference diagram. A higher mark could have been obtained by giving more details of each sensor and actuator. (6/10) Section 3: Program Explanation –Detailed comments provided with clear images of screens showing operator and diagnostic functions. (8/10)

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ANALYSIS

-  Section 4: System Testing and Evaluation - Good testing table with a brief evaluation. Further marks were available for supporting photographic evidence. (6/10) Section 5: Conclusions and Recommendations - Some conclusions and recommendations offered showing that an evaluation has taken place and the system was successfully tested with consideration of how it could be improved. (7/10)

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PRACTICAL APPLICATION AND DEP.

-  Section 3: Program Design and Network Comments - Program is well designed and networks contain detailed comments. (9/10) Section 3: HMI Screen Designs – Good screen designs. (6/10) Section 4: Presentation of Test Results - A well presented table. Further marks were available for photographic evidence of testing. (5/10)

20

SKILLS FOR PROFESSIONAL PRAC.



All sections - Good structured and generally well written with good presentation. Further marks were available for a more accurate structure with each section numbered according to the brief. (3/5)
Section 6: Team working - Some consideration given to collaboration. (2/5)

5