

2221115

by Owen Rees

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Title Page

Course: HNC Electrical and Electronic Engineering

Module: SGEE4004 Programmable Logic Controllers

Assignment: 2. Factory IO Control System

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Good Structure

Sections should be numbered according to the brief

Contents

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Sections should be numbered according to the brief

Work Plan for Lifelong Learning

This assignment will involve the design and creation of a PLC program for an industrial process involving level and flow control for a liquid in a tank. This will be done using FACTORY IO software and include the creation of HMI screens to allow different modes of control. This assignment will involve researching the different IEC languages available to PLC programmers and deciding on the most suitable for the job requirements. An I/O device list will be created, an electrical drawing and the design of the program and HMI screens. There will then be extensive testing, demonstration of customer and user needs being met, the drawing of conclusions and suggestions of possible improvements.

Paragraphs should be fully justified text as required in the brief

Line spacing should be 1.5

Sections should be numbered according to the brief

Research

PLCs use a variety of 'languages' depending on the type or manufacture being used. This program will be created using a Siemens PLC and thus will concentrate on languages supported by this system.

PLCs can be programmed in two ways, graphically or textually. There are 5 main languages that PLCs can be programmed in, these are;

- Ladder diagram (LD), graphical
- Function block diagram (FBD), graphical
- Structured text (ST), textual
- Instruction list (IL), textual (deprecated in 3rd edition of the standard^[3])
- Sequential function chart (SFC), has elements to organize programs for sequential and parallel control processing, graphical.

These are the International Electrotechnical Commission (IEC) languages. It is uncommon to use more than one or two languages when creating an automated program. Of the 5, 3 are supported by the TIA portal software being used for this project but examples of all 5 can be found in the appendix.

Use the third Person

Ladder diagram - You use LD to program the control function of the programmable controller – the user program or control program. The user program is organized in different types of blocks. A block is divided into sections referred to as “networks”. Each network contains at least one current path that may also have an extremely complex structure. Each network is terminated by at least one coil or box. (Berger, 2013) Ladder logic is the most popular method of PLC programming because it has an easy to use graphics based interface and the programming language resembles an electrical schematic drawing. Engineers, electricians and students find the transition from an electric circuit to ladder logic relatively easy. (Anon., 2021) an example of this language can be seen in figure 1 in the appendix.

Correctly cited

Function Block (FBD) In Function Block Diagram, program blocks are linked together to produce a program. A functional block can have two or more two inputs and outputs. All these inputs and outputs can be connected with other inputs and outputs of the other functional block, thus establishing a relationship between the output of one function and the input of another (Anon., 2023). Both Ladder and Function block use similar layout and symbols. Although it is possible to get many lines of code into a function box, for more complex systems they can end up quite messy. (See fig 2)

Structured Text (ST) is a text-based language and is used most often when complex mathematics is involved. (Learn PLC Programming, 2021). You can make the SCL program clearer and easier to read by using comments and empty lines. Comments and empty lines have no influence on the function of the SCL program. (Berger, 2013) (see figure 3)

Which language have you chosen?

Hardware Investigation and Input/Output List

The PLC being used is a Siemens CPU 1214C DC/DC/DC.

The inputs of the system are;

Start button %I0.0

Reset button %I0.1

Stop button %I0.2

Factory IO Running DI %I0.3

better in table format

Level meter AI Real %ID30

Flow meter AI Real %ID34

Setpoint potentiometer %ID38

The outputs of the system are;

Start Light %Q0.0

Reset Light %Q0.1

Stop Light %Q0.2

Fill valve AQ Real %QD30

Drain valve AQ Real %QD34

Setpoint panel meter %QD38

Process variable panel meter %QD42

Hardware design and configuration is missing

Program Design and Explanation

Manual Controls

The first things to be designed were the HMI screens. 4 screens were designed, The first was for manual control.

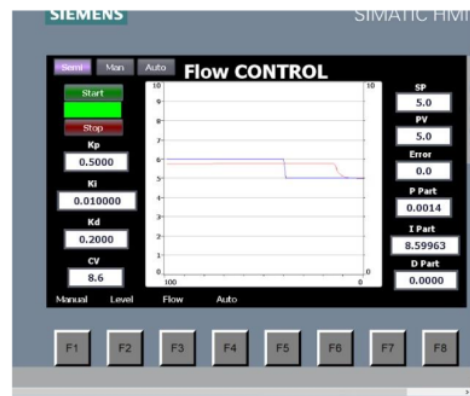
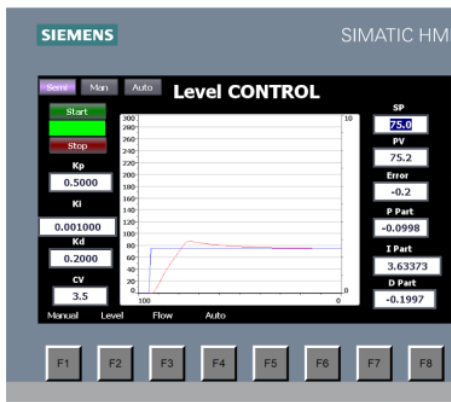


Figure 6 -manual control screen

This screen can allow the filling and draining of the tank by pressing start and stop buttons.

This process can be sped up or slowed using the increment/decrement buttons on the screen for either flow control or level control. These controls, as well as the visual tank depiction and live flow and level readings give the engineer the ability to easily control the tanks inputs and outputs.

Semi-automatic control



Figures 7&8 – semi-auto level and flow control screens

Two more screens have been created to ensure the tuning and setting of the process in semi-auto mode. These screens allow the engineer to tune and set the process to the customers' requirements. The engineer can select a set point (SP) and the proportional gain (Kp). The (PV) refers to the process variable and is generated by the amount of liquid in the tank system. The error is determined by the difference between the SP and PV. The CV is the control variable, this is

calculated by the sum of values in the PID control, which will be shown in the programming sequence.

When the setpoints of each flow and level are selected and the system is put into semi-auto mode, the fill valve and drain valve will open enough to fulfil customer requirements regarding level and flow.

Automatic mode

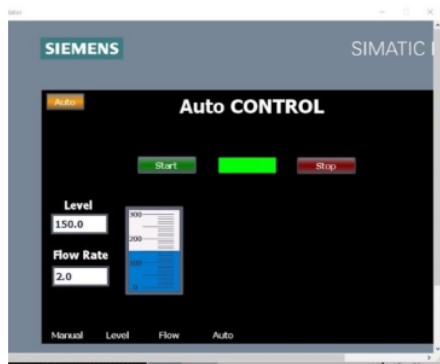


Figure 9 – Auto control screen

A screen has been created to run fully automatic mode. This is a screen for use by the operator. They would have the ability to start and stop the process only. They would also be able to observe the tank level and flow rate to ensure system is running as it should.

Main Program

you forgot to include in your appendix

The main program contains 8 networks (figures 10-14 in appendix).

There is also the flow cyclic interrupt (figure 15) and the Level cyclic interrupt (figure 16), which both utilise the PID control.

All tags for the PLC and HMI can be found in the appendix.

not included

Simulation Testing

It is important to test the program to ensure it is functional before it goes to the customer. Having created a program on TIA portal and designing various HMI's to allow this program to work on the system. Testing using a tank simulation on Factory IO software was performed. These are the results;

Manual testing

none of these figures are present in the report

Test	Expected result	Actual result	Pass/Fail	Evidence
Manual control				
Fill to level 25%	Using increment and decrement buttons to open and close valve, tank should fill to 25%	Tank filled to 75L	P	See fig 22
Fill to level 50%	Using increment and decrement buttons to open and close valve, tank should fill to 50%	Tank filled to 150L	P	See fig 23
Fill to level 75%	Using increment and decrement buttons to open and close valve, tank should fill to 75%	Tank filled to 225L	P	See fig 24
Fill to level 100%	Using increment and decrement buttons to open and close valve, tank should fill to 100%	Tank filled to 300L	P	See fig 25
Empty to 75%	Using increment and decrement flow control buttons to open and close valve, tank should empty to 75%	Tank emptied to 225.3L	P	See fig 26
Empty to 50%	Using increment and decrement flow control buttons to open and close valve, tank should empty to 50%	Tank emptied to 149.6L	P	See fig 27
Empty to 25%	Using increment and decrement flow control buttons to open and close valve, tank should empty to 25%	Tank emptied to 75.2L	P	See fig 28
Empty to 0%	Using increment and decrement flow control buttons to open and close valve, tank should empty to 0%	Tank emptied to 0.1L	P	See fig 29

Semi auto testing

Test	Expected result	Actual result	Pass/Fail	Evidence	Comment
Semi auto					
Fill to level 25%	Using PID to open and close fill valve and selecting set point of 75L, tank should fill to 25%	Tank filled to 75L	P	See fig 30	
Fill to level 50%	Using PID to open and close fill valve and selecting set point of 150L, tank should fill to 50%	Tank filled to 150L	P	See fig 31	
Fill to level 75%	Using PID to open and close fill valve and selecting set point of 225L, tank should fill to 75%	Tank filled to 225L	P	See fig 32	
Fill to level 100%	Using PID to open and close fill valve and selecting set point of 300L, tank should fill to 100%	Tank filled to 300L	P	See fig 33	
Set flow rate to 1	Using PID to open and close drain valve to control flow rate, Flow rate should hold at 1.0	Flow rate should reach 1.0	P	See fig 34	
Set flow rate to 2.5	Using PID to open and close drain valve to control flow rate, Flow rate should hold at 2.5	Flow rate should reach 2.5	P	See fig 35	
Set flow rate to 5	Using PID to open and close drain valve to control flow rate, Flow rate should hold at 5.0	Flow rate should reach 5.0	P	See fig 36	
Set flow rate to 7.5	Using PID to open and close drain valve to control flow rate, Flow rate should hold at 7.5	Flow rate should reach 7.5	F	See fig 37	Flow rate incapable of reaching 7.5. 7 seems to be the maximum when fill valve is open 100%

Sections should be numbered according to the brief

Meeting the Customer Needs

The customer required functional program operated by HMI screens that would allow the control of level and flow to a tank. The customer required the ability for engineers to tune the system for semi-automatic running or be able to manually fill or empty when needed. A fully automatic program was also requested with a HMI screen designed for an operator to use.

Conclusions and Recommendations

It has been shown through the simulation testing that most of the requirements of the brief has been met. There are fully functioning manual and semi-auto functioning programs using ladder logic and utilising a PID system. These programs have accompanying HMI screens to operate those programs. These HMIs are all accessible through one another for ease of operation.

The automatic sequence was unable to function, this would require further consult with colleagues to become operational. It may be the case that writing the programs in structured text would have made for a more efficient program and would have got the automatic sequence operational within the set time period allowed for this project.

Your team working section is missing

Citation List

Wrong method of listing, this is not Harvard

Works Cited

Anon., 2021. Ladder Logic Basics. *ladderlogicworld.com*.

Anon., 2023. *EdrawMax*. s.l.:s.n.

Anon., 2023. How PLCs work. *PLCdev*.

Aries, B., 2023. The Types of PLCs. *Techwalla*.

Berger, H., 2013. *Automating with SIMATIC S7-1200*. s.l.:s.n.

Evans, P., 2021. Programmable Logic Controller Basics Explained. *The Engineering Mindset.com*.

plcacadamy.com, n.d. s.l.:s.n.

Rees, O., 2023. *Pick and Place Robot*, s.l.: s.n.

ResearchGate, 2018. s.l.:s.n.

xslmaker.com, 2023. *Sequential Function Chart to PLC Ladder Logic Translation (2023)*. s.l.:s.n.

Appendix

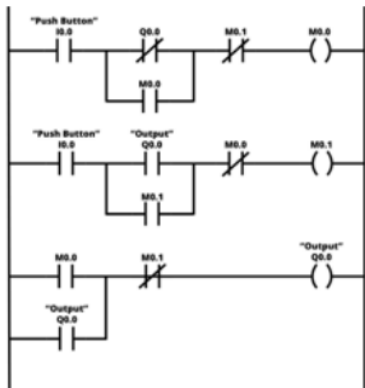


Fig 1 – Ladder diagram
(plcacadamy.com, n.d.)

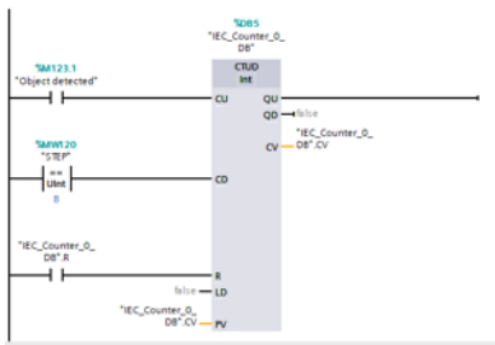


Figure 2 – Function block diagram
(Rees, 2023)

```

1:
  "Left AUTO request" := 1;
  "OUT AUTO request" := 1;
  "Open AUTO request" := 1;
  IF ("LEFT sensor" = 1) AND ("OUT sensor" = 1) AND ("Gripper open sensor" = 1) AND NOT "Pause" AND ("Object delay" = 1) THEN
    "Left AUTO request" := 0;
    "OUT AUTO request" := 0;
    "Open AUTO request" := 0;
    IF "IEC_Counter_0_DB".CV = 3 THEN
      "next_STEP" := 2;
    END_IF;
    IF "IEC_Counter_0_DB".CV = 2 THEN
      "next_STEP" := 10;
    END_IF;
    IF "IEC_Counter_0_DB".CV = 1 THEN
      "next_STEP" := 18;
    END_IF;
  END_IF;

```

Figure 3 – Structured Text

(Rees, 2023)

1.	LD	Start	;Bit Instructions
2.	O	Flag	
3.	A	Stop	
4.	A	BLK	
5.	=	Flag	
6.	L	Time	;Byte Instruction
7.	<u>SD</u>	<u>Timer</u>	;Byte-Bit Instr.
8.	<u>LD</u>	<u>Timer</u>	
9.	=	Start Up	;Bit Instruction
10.	LD	Start Up	;Bit Instruction
11.	L	SP_cur	;Byte Instructions
12.	L	SP_nom	
13.	<u>A>=I</u>		;Byte-Bit Instr.
14.	=	Out	;Bit Instructions

Figure 4 – Instruction list

(ResearchGate, 2018)

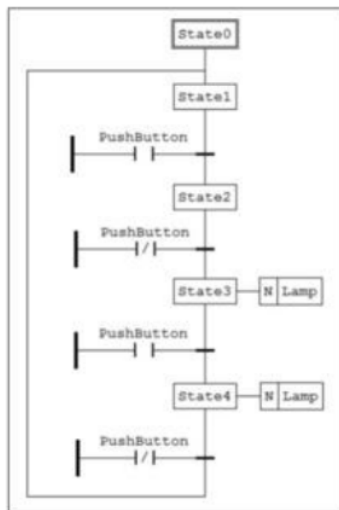


Figure 5 – Sequential function chart
(xslmaker.com, 2023)

FINAL GRADE

GENERAL COMMENTS

Instructor

40

/100

PAGE 1

Text Comment. Not needed

PAGE 2

QM

Good Structure

Report is structured exactly as stated in the assignment brief.

QM

Sections should be numbered according to the brief

Text Comment. Page numbers should be auto-generated by MS Word

PAGE 3

QM

Sections should be numbered according to the brief

QM

Paragraphs should be fully justified text as required in the brief

QM

Line spacing should be 1.5

This allows the marker to put comments in between your lines

PAGE 4

QM

Sections should be numbered according to the brief

QM

Use the third Person

You are referring to first or second persons (I, we, you, us etc) whereas you should use the third person thus depersonalising it.



Correctly cited

Citation method conforms to Harvard standard, well done.



Correctly cited

Citation method conforms to Harvard standard, well done.

Text Comment. Which language have you chosen?

PAGE 5

Text Comment. better in table format

Text Comment. Hardware design and configuration is missing

PAGE 6

PAGE 7

Text Comment. you forgot to include in your appendix

Text Comment. not included

PAGE 8

Text Comment. don't instruct your reader

Text Comment. none of these figures are present in the report

PAGE 9



Sections should be numbered according to the brief

PAGE 10

Text Comment. Your team working section is missing

PAGE 11



Wrong method of listing, this is not Harvard

GRADING FORM: NEW CSG-RUBRIC

OWEN REES

48

1. ENGAGEMENT WITH LITERATURE



Good evidence of reading from a range of sources, cited correctly not not listed correctly. Only 3 languages researched. 10/20

10

2. KNOWLEDGE AND UNDERSTANDING



Good knowledge and understanding demonstrated in your IO list and hMI screen design explanations. However, no ladder program included so no comments could be seen. No hardware design included. 10/20

10

3. COGNITIVE AND INTELLECTUAL



Excellent testing table but no evidence in appendix. Good conclusions and recommendations. 10/20

10

4. PRACTICAL APPLICATION

	Ladder program no included so no evidence of practical work other than HMI screens. 8/20	8
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5. TRANSFERABLE SKILLS

	A good work plan but no explanation of team working. Report is well structured and presented with clear diagrams but sections should be numbered. Word count not exceeded but format of text is not according to the brief and you must learn to write in the third person. 10/20	10
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