MARKING CRITERIA AND STUDENT FEEDBACK

This section details the assessment criteria. The *extent* to which these are demonstrated by you determines your mark. The marks available for each criterion are shown. Lecturers will use the space provided to comment on the achievement of the task(s), including those areas in which you have performed well and areas that would benefit from development/improvement.

Common Assessment Criteria Applied	Marks available	Marks awarded
1. Research-informed Literature Extent of research and/or own reading, selection of credible sources, application of appropriate referencing conventions.	10	5
Good.		
2. Knowledge and Understanding of Subject Extent of knowledge and understanding of concepts and underlying principles associated with the discipline.	25	16
Very good		
3. Analysis Analysis, evaluation and synthesis; logic, argument and judgement; analytical reflection; organisation of ideas and evidence	25	16
Very good.		
4. Practical Application and Deployment Deployment of methods, materials, tools and techniques; application of concepts; formulation of innovative and creative solutions to solve problems.	30	25
Exceptional.		
5. Skills for Professional Practice Attributes in professional practice: individual and collaborative working; deployment of appropriate media; presentation and organisation.	10	6
Very good.		

Assignment Mark (Assessment marks are subject to ratification at the Exam Board. These comments and marks are to give feedback on module work and are for guidance only until they are confirmed.)	**Late Submission Penalties (tick if appropriate)**		
	Up to one week late		68 %
	First Attempt?	✓	

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GUIDANCE FOR STUDENTS IN THE COMPLETION OF TASKS

1. Research-informed Literature: You must provide evidence of individual research with respect to PLC and systems theory and operation, and provide relevant referencing.

2. Knowledge and Understanding of Subject: Your report should show you gained knowledge of the PLCs and associated systems used in this assignment.

3. Analysis: The report should show analysis of the research and experimental programming work.

4. Practical Application and Deployment: Verify program design and operation against expected theoretical and calculated outcomes. Although the practical exercises may be completed as part of a group exercise the resulting report and analysis of data must be an independent piece of work. You will need a verified copy of your program design (screen shot) to confirm the PLC program has been demonstrated and witnessed.

5. Skills for Professional Practice: Your work should be well organised and presented in a professional manner.

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PDSE4005 - PROGRAMMABLE LOGIC CONTROLLERS

PLC Program design and simulation

Richard Wray

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Background

Modular PLCs are used in commercial processes to automate operations. PLC where originally made to replace old relays. One PLC could do the job of hundreds of relays. PLC can be found just about everywhere you look, from the traffic lights at roundabouts to roller coasters and ATM machines. Modular PLCs are widely used in the electronics industry, there are many reasons that this type of PLC is used over fixed type PLC. Modular PLCs can be expanded and modified easily, if more inputs are required then another input card can be added. If more outputs are required then another output card can be added. This means that it has great flexibility and is able to be expanded if require when the operation or device that it is controlling grows. As the number of IO (Inputs and Outputs) grow so does the demand for more memory and processing power, with modular PLC more memory or CPUs can be added to the system.

Task 1. PLC Analogue and discrete I/O

a) Input Devices

There is a vast range of device that can be connected to PLC`s. I will look at 5 different devices ranging from simple switches through to an ultrasonic sensor. The most common type of input is discrete. A discrete input is a digital input that is simply on or off. The other most common type of input is analog. Analog inputs normally accept a range of voltages or range of resistance depending on the device.

Switch

A switch is probably one of the most basic and common device to be connected to a PLC. Switches come in verity of shapes and sizes for a wide range of applications. Switches are also designed to handle a different input voltages and currents, to match the PLC that can accept different voltage ranges.

Flow Switch

There are two main types of flow switch, digital and analog. Digital flow switches are designed to give an output once a desired flow rate has been met. Analog flow switches give a proportional voltage or resistance output depending on the flow rate in the sensor. There are a wide range of every day uses for this type of input device. For example, a Combi central

heating boiler will not light the burner if there is no water in the tank which is detected by the input and output flow switches.

Weight monitor

Weight monitors are devices that can measure the weight of just about anything. They come in many different variants to suit a broad range of applications from measuring in grams right the way through to Tons. Weight monitors normally work with an analog input and the voltage is proportional to the weight on the device. Some example uses of a weight monitor is, filling a bag of flour on a food packing line where the monitor needs to be extremely accurate, right the way through to a weight bridge for big artic lorry's leaving and entering plants or quarries. ✓

RPM Sensor

RPM sensors are used just about everywhere there is a motor these days. RPM sensors normally come in two different types analog and digital. Digital RPM sensors are normally configured to give a high output when a predetermined speed has been reached. Analog RPM sensors work in a similar way to other analog device in the way that, they give an output in voltage or resistance which is proportional to the speed the sensors are reading. An example a where an RPM sensor might be used is a cooling operation where they need to check the speed of the fans. ✓

Ultrasonic level sensor

Ultrasonic level sensors are devices that uses sound waves to measure the distance of objects within its path. Ultrasonic sensors are analog only devices. Ultrasonic sensors come in many different shapes and sizes, for example some can measure just a couple of feet, where as some can measure hundreds of feet under water. A common use case for an ultrasonic sensor is tank levels, in large manufacturing processes. ✓

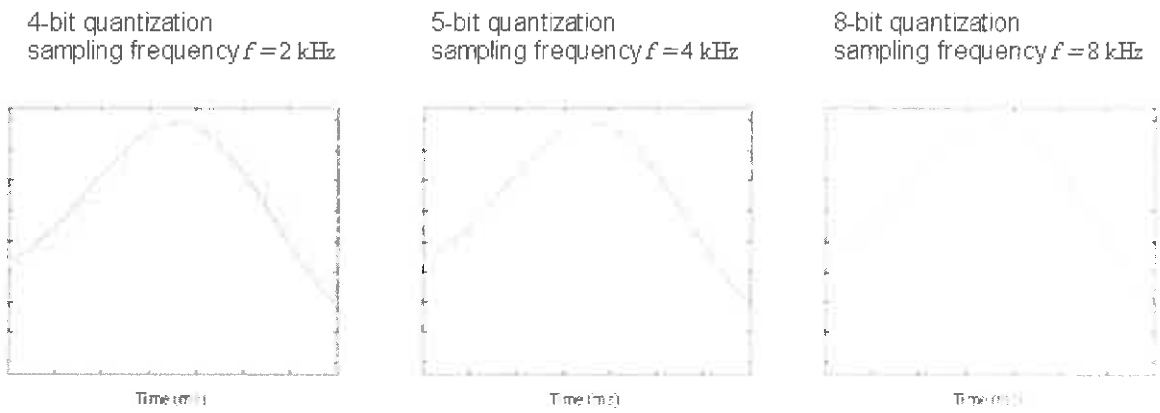
Good choice 3 Sensors

b) PLC ADC

When a PLC is given an analog input the CPU is unable to directly process the data, this is where an ADC (Analog to Digital Conversion) takes place. The analog data is converted to a binary word, which is then stored as a binary number. The binary number then corresponds to the analog value at the given time. This process happens based on the sample rate of the PLC, some can be extremely quick some slower. When the analog value is

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converted into a binary number a process takes place called quantization. Quantization errors take place because it`s almost imposable to represent analog data as discrete data, the level of error can be reduced by increasing the sample rate. As can be seen in the figure below.



[1]

c) Output Devices

LED on HMI

When a PLC is running a large segment of a plant or operation an HMI (Human Machine Interface), is used. A common output of an PLC is a LED for the HMI. LED`s come in a range of form factors, with an extensive range of voltages and current ratings.

Valve

Valves are commonly found in industry as PLC outputs, valves come in a few different types, digital and analog. Digital valves are normally open or closed. Analog valves can accept a range of voltages, these voltages are then proportional to the amount the valves open, allowing different flow rates through them. Valves can be small for low pressure and small flow rate there are also much larger valves up to a few meters in diameter such as ones used in Hydroelectric generation plants, all with the same basic operation method.

Relay

A relay is a really multipurpose device which is probably one of the most common output devices of a PLC. A relay can help protect a PLC, for

[1] http://slideplayer.com/slide/1429505/

example if 230v found its self to be feeding back to the PLC it would just damage the outputs of the PLC, if a relay where to be used the voltage would not get to the PLC if the relay was closed. A relay can also switch a different voltage to the one that is turning it on and off. For example, a PLC could be working at 12v DC, the output could turn on the relay which would then turn on a 230v load on the other side.

Stepper Motor

A stepper motor is a motor that has a lot more control and accuracy, when compared to a normal motor. Stepper motors are normally used for opening and closing valves that need precise control. Some stepper motors would need to be connected to a controller and then to the PLC, but some don't need this controller and can be directly connected to the PLC.

Invertor Drive

Invertor Drives are commonly used in the manufacturing industry for variable speed motors. The drives allow for a variable voltage input which is then proportional to the output frequency hence change the speed of the motor. The PLC can be connected to the Invertor drive through one of its analog outputs. A common uses case could be a water pump in a chemical mixing plant where the flow of water needs to be controlled.

d) PLC Outputs

PLC`s have two common output types, relay and transistor.
Relays are normally used where a high voltage or current is needed to be switched. As the Digital I/O document on tri-plc.com state "A relay is an electrically operated switch. Current flowing through the coil of the relay creates a magnetic field which attracts a lever and changes the switch contacts. This means that relays allow one circuit to switch a second circuit which can be completely separate from the first." Relays are mechanical device, as always there is more chance of failure with devices containing moving parts.

Transistors

Transistor PLC outputs normally have a fixed switching voltage, which is normally the voltage the PLC is operating at for example 24v DC.
Transistors can also only switch a small load normally up to 0.3A.
Transistors do have some advantages over there counter parts,

transistors are solid state device. This means that they have no physical moving parts, this also allows them to operate at a high switching frequency. A transistor can also be connected to a relay, which would then give the operator the best of both worlds. Should they need fast switching speeds they could simply use the transistor outputs, or if they where switching big loads an external relay could be used.

When comparing relays to transistors, there isn't really one that's better then the other, it all depends on the application its going to be used for. If the PLC was going into a big manufacturing process then a relays output PLC would properly be more suited. ✓

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Task 2. PLC maintenance and reliability

a) General PLC maintenance

When PLC are working 24 hours a day 7 day a week, there needs to be a number of different route checks carried out. When a new PLC is purchased the manufacture will often have a document relating to the PLC including recommendations on checks that should be carried out. There is also a set of guidelines knows as GAMP (Good Automated Manufacturing Practice). GAMP helps make sure that products that are manufactured using Automated processes are of a suitable standard. ✓

GAMP

The GAMP guidelines are used all over the world in the automated manufacturing industry. GAMP covers all areas of a PLC right from the design, manufacture right the way through to the final operation. GAMP is manly aimed at making sure that equipment is regularly checked and review. GAMP suggests that the PLC Program is also review, and two backups are kept in secure locations so should the PLC ever fail another could be put in its place and the software be uploaded to it, helping keep downtime to a minimum. GAMP also recommends that there be multiple layers of safety implemented into the program. As PLC Preventative Maintenance Checklist states[2] "the central processing unit and I/O system are not designed to be dust proof." Keeping PLC`s free from dust and debris is important, if the unit becomes dusty this could result in initial overheating therefore catastrophic failure could occur. Backup battery's need to be checked on a scheduled basis to ensure their viability. ✓

Good points.

[2] http://plcmaintenance.com/plc_preventative_maintenance_checklist/

b) PLC Monitoring and Fault diagnostics

When designing a PLC program its vital that all possible scenarios are covered, in both usage and failure. There also needs to be a fault-finding procedure in place to try and help predict any problems that might occur with the system. Some mission critical operations need 100% uptime, in this case hardware such as sensors and other input device could have two sensors installed when only one is required known as failover, this would allow the system to operate if one of the sensors where to fail. Another way of helping to reduce downtime is to have two PLC running identical programs with the same inputs from sensors, and event battery backup units installed so should the power fail the system can shut down safely.

Program fault finding

There are numerous ways of fault finding a system, through software and hardware. Most PLC system have something called an HMI (Human Machine Interface). HMI`s most commonly have LED`s to represent the output of the PLC. This can assist a technician in finding faults in a system. On HMI`s there normally error indications lights to show why a process might not be running.

Fault finding can also be done through the development software that the program was originally developed in. One of the most common methods of fault finding is simulation on a physical rig, when a program is being tested on a computer real life variable can't affect it. Most of the time when a program is being developed a miniature test rig will be created to allow the program to test and debug the program on before putting it into operation on a real rig.

90% of the time faults will be caused by external devices, like sensors or switches. When working on a system its important that its well labelled and documented. It's also important to keep the system clear as there is a much higher likely hood of a system developing faults if its not clean and well maintained.

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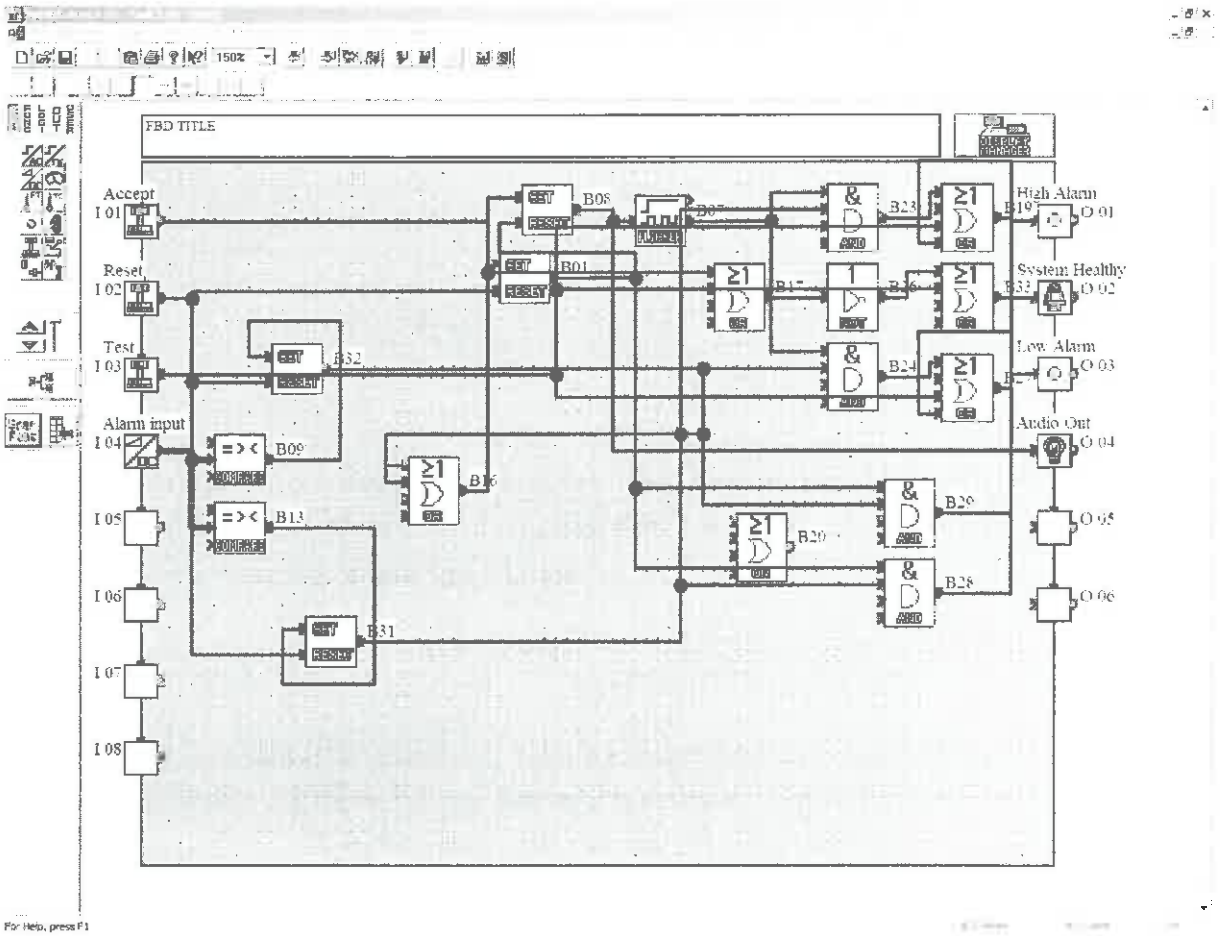
Part B

Task 3. Process Alarm Panel

As can be seen from the screen capture below a process alarm panel has been made using the Mitsubishi PLC and programming function block software. The program uses 4 inputs, one being an analog which senses

between 0 and 100 percent. The system then has an alarm accept, alarm reset and alarm test inputs. The system has 3 outputs all-digital, high alarm, system healthy and a low alarm.

Below can be seen a screen capture of the program in the development software.



In the following screen capture can be seen the HMI that was created using the development software.

Program windows and HMI design screen.



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Task 4

For the final task of this assignment the design brief was to develop a program to control the fruit beverage blending operation shown below, using either the Mitsubishi Alpha AL2 PLC or the Mitsubishi FX PLC.

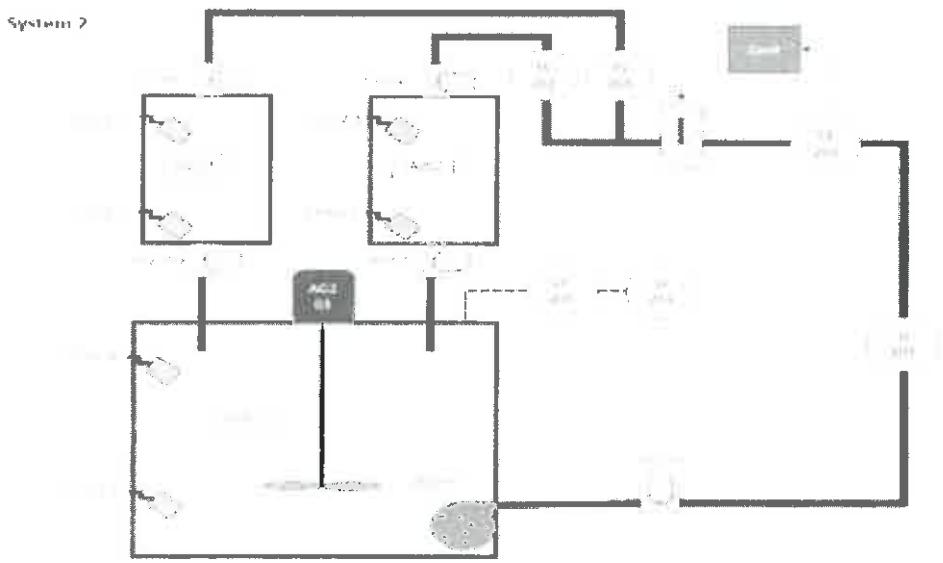
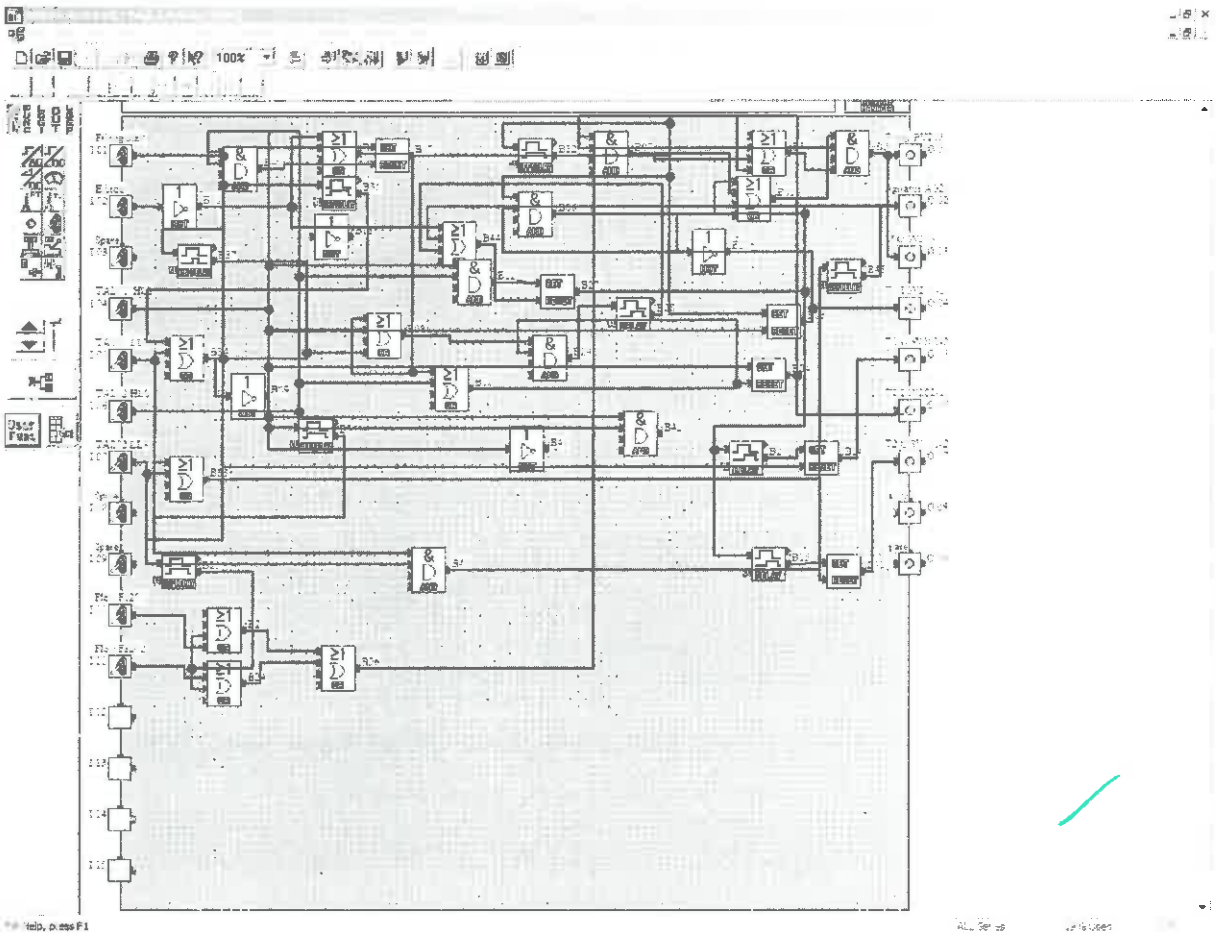


Figure 2. Fruit beverage blending system

I chose to use the Alpha AL2 PLC as this was programmed using the function block method, which I was more comfortable using and working with. I also chose this PLC because the software was more users friendly when testing prior to uploading the program to the simulator.

Below can be seen a screen capture of the program in the developments software.



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Program worked as some timing issues with cycle

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References

Book References

Bolton, W., 2006. Programmable Logic Controllers. Newnes.

Website

EET260: A/D and D/A conversion - ppt download. 2018. EET260: A/D and D/A conversion - ppt download. [ONLINE] Available at: http://slideplayer.com/slide/1489349/. [Accessed 15 May 2018].

05 analog control_sp15. 2018. 05 analog control_sp15. [ONLINE] Available at: https://www.slideshare.net/jtodora/05-analog-controlsp15. [Accessed 15 May 2018].