

LEVEL 4 ASSESSMENT SPECIFICATION

Student name:	Heather Raymond	Student ID number:	
Programme:	HNC Electrical/Electronic Engineering & Instrumentation Engineering		
Module:	Programmable Logic Controllers		
Module code:	PCEE4005	Contribution to Overall Module Assessment (%):	50%
Lecturer:	Jason Pointer	Internal Verifier:	Nigel Richards
Assignment Title:	Introduction to PLC Systems & Program Design	Word count (or equivalent):	2000
Submission deadline:	11/01/24	Return date of provisional marks & written feedback:	25/01/24
Submission method:	All written assessments, where practical and possible, must be submitted via Turnitin unless otherwise instructed by the Lecturer. (Please DO NOT put this assessment specification into Turnitin or it will match many similarities with other students' submissions.) Alternative submission method (if applicable): Late submission of the assessment will result in a late penalty mark. Penalties for late submission: Up to one week late, maximum mark of 40%. Over one week late, 0%. Only the Extenuating Circumstances Panel may approve a change to submission dates.		
Academic honesty / referencing:	Academic honesty is required. In the main body of your submission you must give credit to authors on whose research and ideas your work is based. Append to your submission a reference list that indicates the books, articles, etc. that you have used, cited or quoted in order to complete this assessment.		

Module Learning Outcomes (from module syllabus)

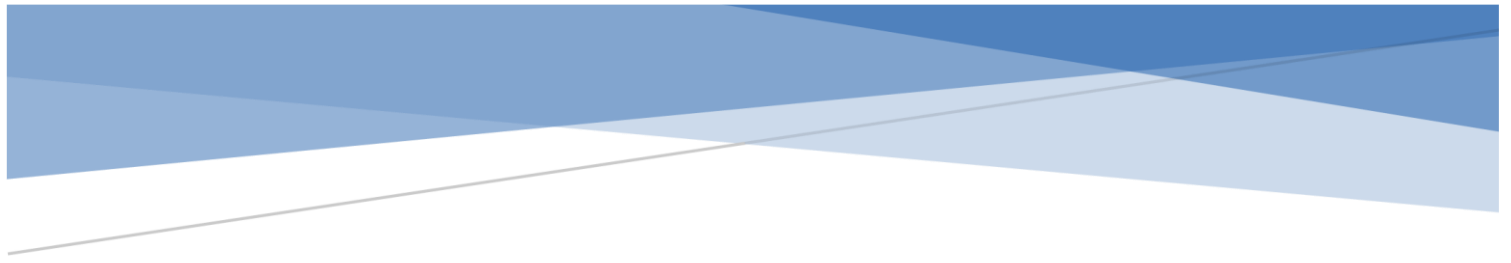
1. Demonstrate an understanding of the concepts of process control using an industry standard PLC.
2. Undertake basic PLC system design and implementation processes, comparing theoretical expectations to actual outputs ensuring correct operation and consideration of maintenance and reliability.

STUDENT FEEDBACK FORM

This section details the *extent* to which the assessment criteria are demonstrated by you, which in turn determines your mark. The marks available for each category of skill 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.

Generic Assessment Criteria	Marks available	Marks awarded
1. Engagement with Literature Skills	15	9
Engagement with a wide range of literature sources, including sources retrieved independently. Generally sound referencing, with very few inaccuracies.		
2. Knowledge and Understanding Skills	30	18.4
Task 1 achieved 62%. Task 2 achieved 67%, Task 3 achieved 55%. Competent knowledge of the basic underlying concepts and principles of the work required for Task 1 and 2. Showed basic knowledge and understanding of the requirements of Task 3.		
3. Cognitive and Intellectual Skills	5	2
Limited evaluation of the underlying concepts and principles applied to the construction of the auto drill system.		
4. Practical Application Skills	40	32.4
Task 4 achieved 82%. Task 5 achieved 80%. An excellent application of the software to produce fully functional programs to cover the requirements of Task 4 and 5. Required very little support in the development of these programs and was able to show full operation.		
5. Transferable Skills for Life and Professional Practice	10	6.5
Work is accurate, coherent, fluent, well-structured and organised.		

Assessment 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)		68%
	Up to 1 week late (40% Max)		
	Over 1 week late (0%)		



PCEE 4005

Programmable Logic Controllers

Abstract

HNC Electronic and Electronic engineering and HNC instrumentation engineering,
Programmable Logic Controllers Assignment

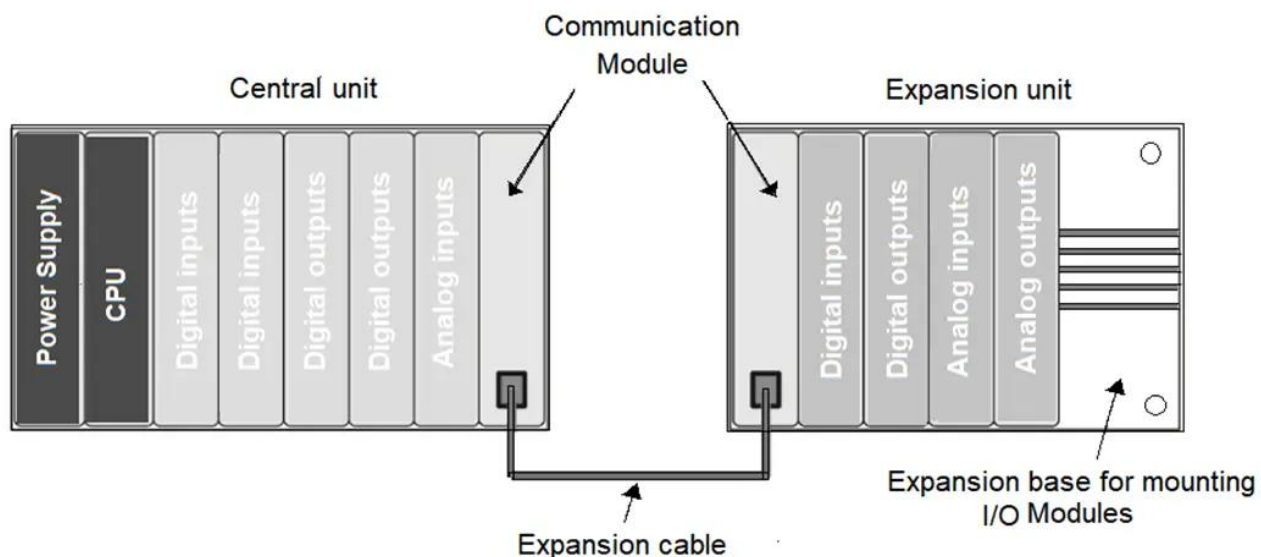
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Task 1 – Programmable Logic Controller types

- a) Through your own research, describe in detail the two types of PLCs available. Include in your research the specifications that define each type, possible applications and any considerations that need to be assessed when selecting a specific PLC type.

Modular PLC

This type of PLC allows multiple expansions in the form of modules, as shown in *figure 1*. These give the programmable logic controller high scalability and additional features, such as, increasing the number of I/O units and expanded memory. Typically, the components are all separate and require manual connections. Modular PLCs are typically rack mounted. (*Phillips, R. 2022*). This type of PLC is usually well suited to large industrial applications, Vapour Recovery Units at oil refineries for example. These PLCs are typically easy to troubleshoot and require less downtime for maintenance as compared to Unitary PLCs- as modules can be removed and replaced on the run. Disadvantages of this type of PLC include high initial costs and complex structure. The choice depends upon the budget of the company and the complexity of the task being automated. (*Ismail, A. 2022*). ✓



Inst Tools

Modular PLC with I/O expansion unit

Figure 1, Diagram of a Modular PLC with an expansion unit, (*Jagan Mohan, R. (2023)*).

Appendix A shows the specification for a common type of modular plc, brand named Tricon, used at a local oil refinery. This includes a list of available I/O modules.

Unitary PLC

This type of compact PLC has all its components in built- from the microprocessor, to memory, an individual power supply and various IO modules. It is advisable to use this type mainly for small- size automation applications, locally mounted. (Jagan Mohan, R. (2023)). Advantages of using smaller scale PLCs like this include lower costs compared to Modular PLCs, faster scan rates and ease of troubleshooting due to the scale of the system. Disadvantages include lack of expansion options, limited inputs and outputs as well as, only having the capacity to perform basic control functions. (Bolton W. 2015.) ✓

Could have included a picture

- b) Explain with the aid of a diagram the main components within a PLC and show the appropriate connections to and from the outside world.**

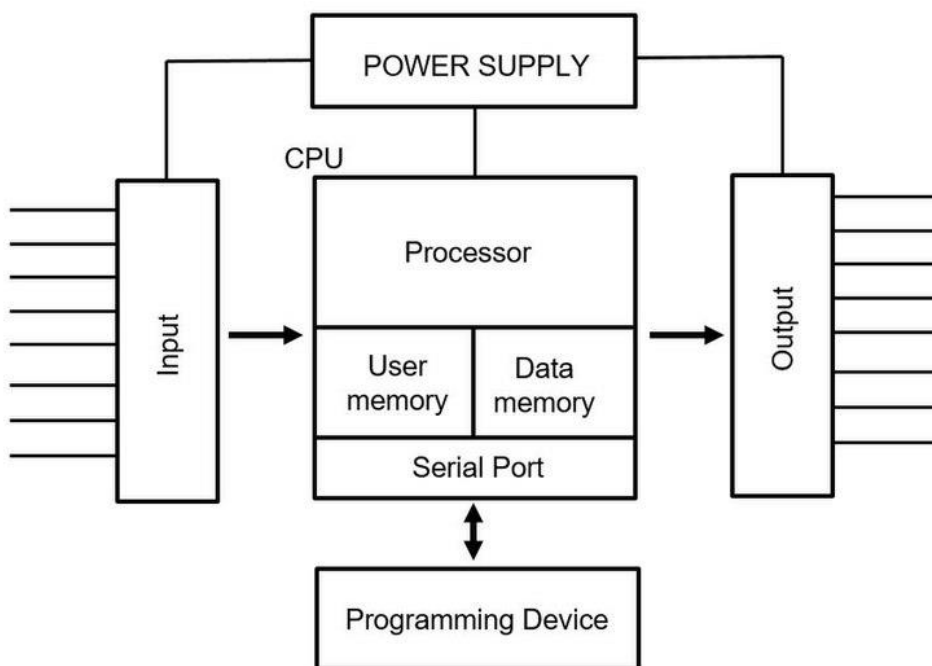


Figure 2, PLC main components, (Source: ProVision, 2022).

Figure 2 shows the main components within a PLC system. The power supply typically supplies 5V DC voltage to other modules in the rack, via converting the mains AC voltage. (Engineering College, M. (2022)). The processor (CPU) implements the logic, via control of comms between the modules. The CPU accepts input data from various sensing devices, executes stored programs and provides output commands to control devices. (Petruszella F D. (2016)). The memory unit stores the logic/ program and usually a log of data to show historical actions. The programming device is required to enter the program into the memory of the processor, this could be in the form of a laptop with the appropriate software. The program is typically developed in the device, then transferred to the memory module of the PLC. (Kamel K, Kamel E. (2013)). ✓

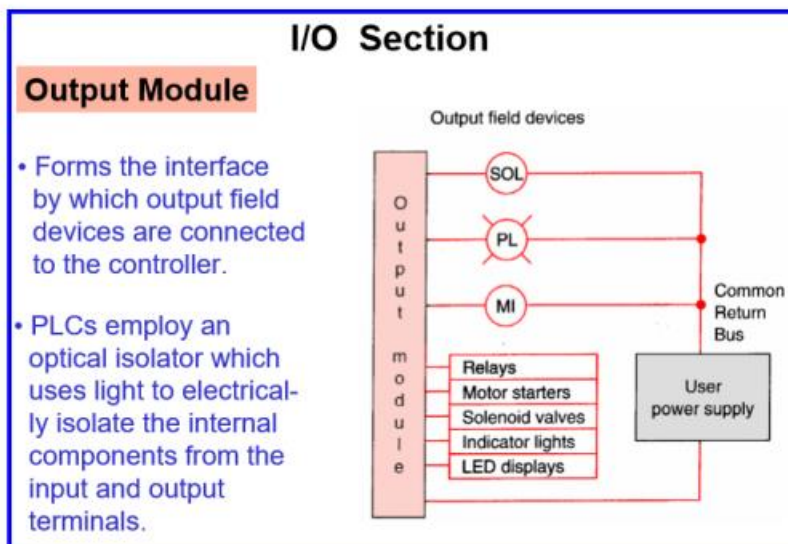
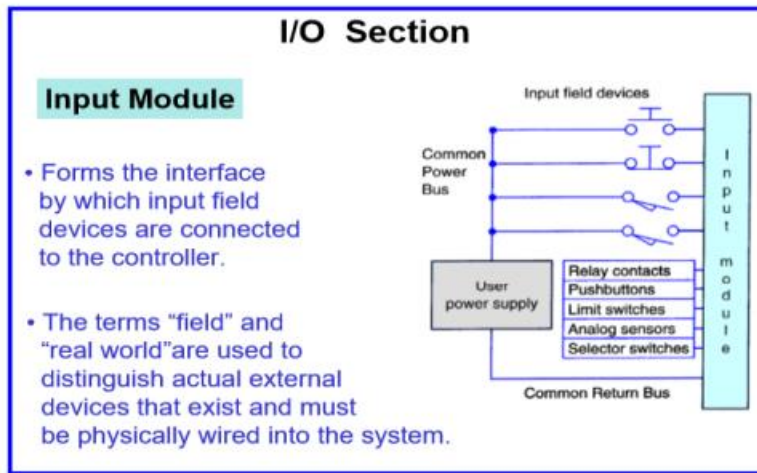


Figure 3, I/O sections to the outside world, source: Engineering College, M. (2022)

As shown in *figure 3*, the plc has input and output modules. Input modules convert process signals from sensors to data that can be read by the CPU. This data is processed and is used to output signals to drive equipment, devices and actuators as an example. Input field devices can be in the form of relay contacts, push buttons and limit switches to name a few. Optical isolators are commonly used to protect the internal components of the PLC from the input and output terminals- in order to achieve appropriate connections to and from the outside world. Input and output devices give 3 different types of signals to and from the PLC, discrete, digital or analogue. Discrete or digital signals are typically given when the states are on or off. Analogue devices give signals whose size is proportional to the size of the variable being monitored. (Petruzella F D. (2016)).

- c) **Identify methods of protecting a PLC input/output interface from potential electrical overloads or fault conditions that may occur in the field devices and explain how they are incorporated into the input and output interface.**

The simplest protection for inputs is to use current limiting resistors within the circuit. The input resistor is sized so that the voltage drops across it does not affect the microcontroller input. This forms a basic voltage divider. A capacitor can be included in the input loop, to form a low pass filter for the circuit. Zener diodes can be implemented to control the flow of current through the circuitry. Fuses, trip amps and circuit breakers can provide surge protection from field devices and power supplies. *Cubed, S. (2012).*

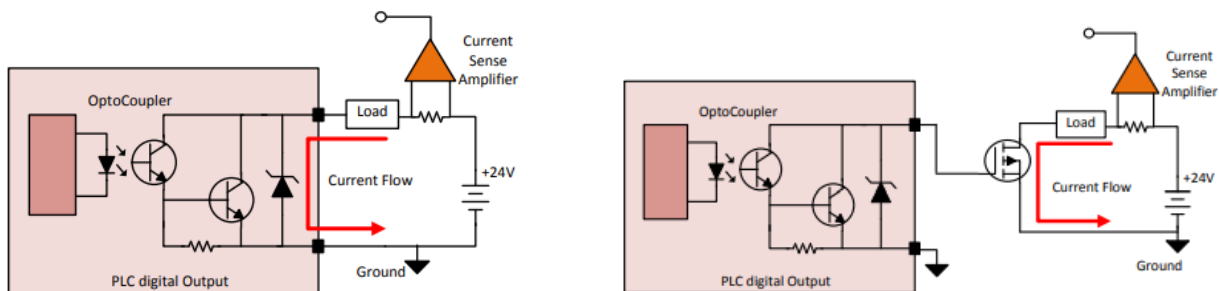


Figure 4, PLC digital output protection, source: Texas Instruments (2022)

As shown in *figure 4*, PLC output modules are often optocoupled in industrial environments. Discrete current sensors connected in series with the load are used to continuously monitor current flowing to the load and feedback the presence of excessive currents to the controller to react. PLC digital outputs can swing from -0.7V to 24V, so the use of an 'high-side current sense amplifier with low-offset and low-gain error enables safety for high-output drives.' *Texas Instruments (2022).* Considering the PLC digital output drive can be high, the sinking current capability is a key safety parameter. PLC outputs are designed with NPN transistors, which have built-in diodes for over voltage protection. Also shown in *figure 4*, is the connection of a PLC digital output to an external low RDS on FET will further increase the output drive strength. A current sensing amplifier used in conjunction with the FET can ensure that the PLC system is operating safely, via monitoring the load current. *Texas Instruments (2022).*

Task 2 – Logic diagrams and truth tables

There are many control situations that require actions to be initiated when a certain combination of conditions is realised. Such situations can involve the use of logic gates to produce an output when certain input conditions are met.

- a) Produce a truth table and the Boolean equation for the logic circuit shown below (figure 5). Comment on the circuit output with respect to the inputs, noting any issues that may arise when using this configuration of logic gates.

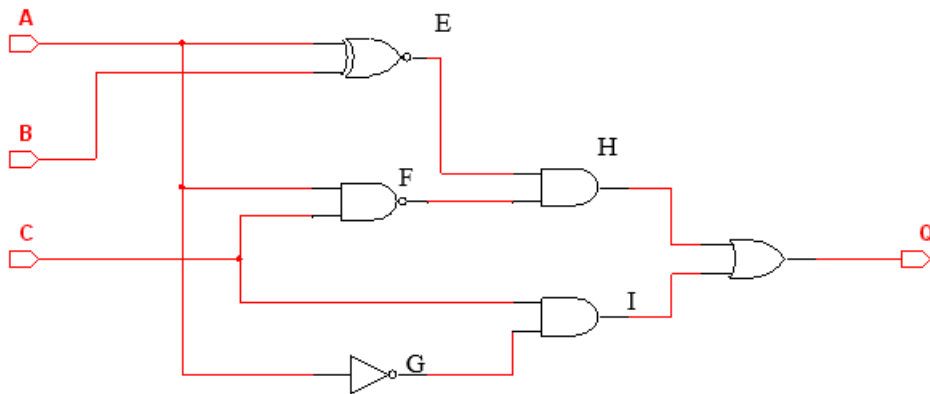


Figure 5

A	B	C	E	F	G	H	I	Q
0	0	0	1	1	1	1	0	1
0	0	1	1	1	1	1	1	1
0	1	0	0	1	1	0	0	0
0	1	1	0	1	1	0	1	1
1	0	0	0	1	0	0	0	0
1	0	1	0	0	0	0	0	0
1	1	0	1	1	0	1	0	1
1	1	1	1	0	0	0	0	0

$$\text{output } Q = \bar{A}.\bar{B}.\bar{C} + \bar{A}.\bar{B}.C + \bar{A}.B.C + A.B.\bar{C} \quad \checkmark$$

The main issue with building the circuit shown in *figure 5* is the need for multiple ICs to be used. The circuit could be simplified to produce the same Q output, with the use of more complex gates, as single input gates can only be used as inverters or buffers. Instead of using 2 input gates as per *figure 5*, 3 input gates could be used to reduce the number of ICs required for the logic circuit. Via the use of Karnaugh maps, the Boolean equation can be simplified and ladder logic designed for the circuit.

- b) Simplify the Boolean equation and produce the ladder logic diagram for the circuit. Simulate the ladder logic design using suitable software and confirm function.

	BC	00	01	11	10
A	0	1	1	1	0
1		0	0	0	1

$$Q = A.B.\bar{C} + \bar{A}.\bar{B} + \bar{A}.C \quad \checkmark$$

See figure 6, on page 9 for an example of the ladder logic design built using multi-Sim software. Here the output Q is only present when the truth table/ Boolean equation is satisfied.

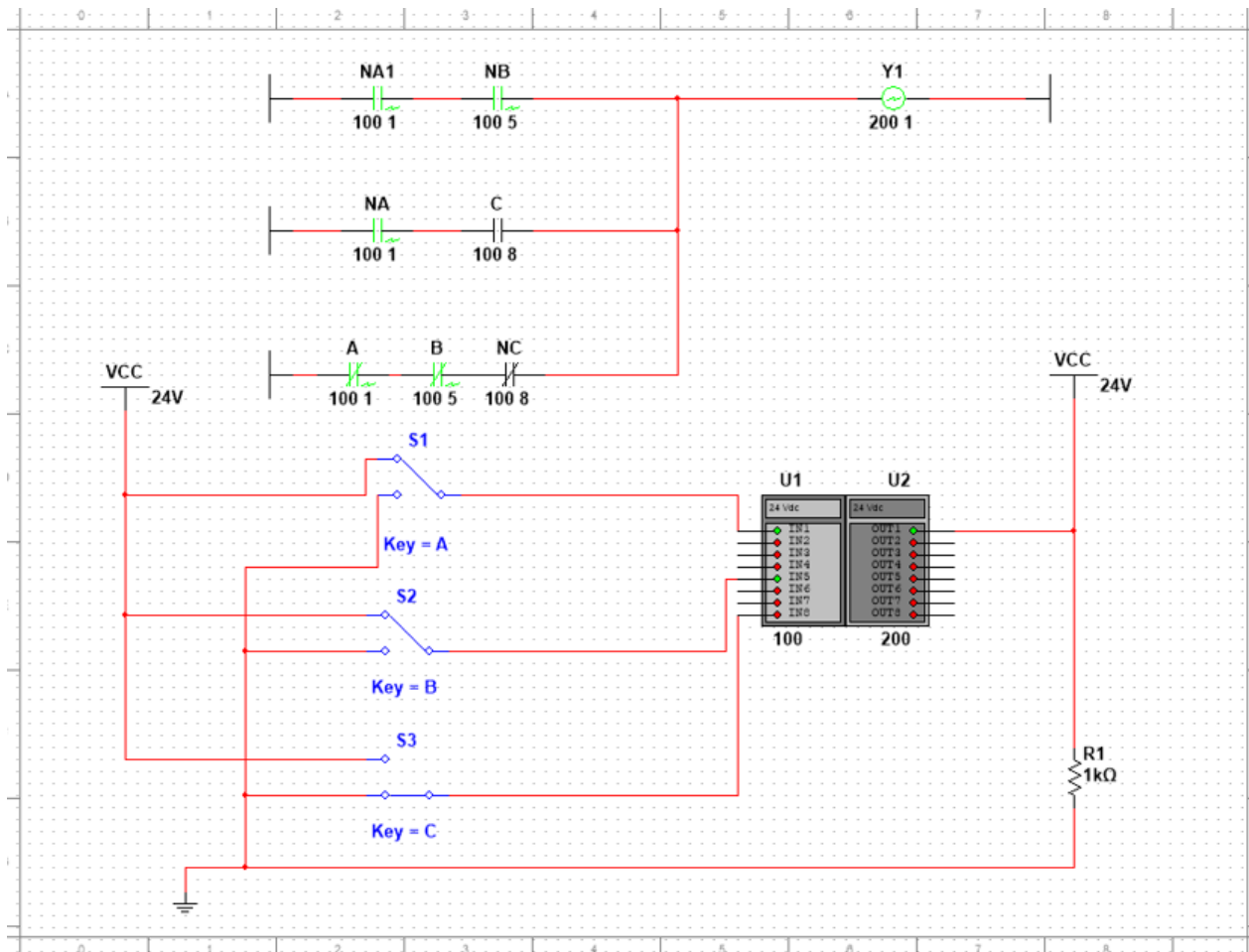


Figure 6, working example of the Boolean expression/ ladder logic circuit

Should include a statement that the ladder logic was correct when compared to the truth table.

Task 3 – Timers

a) With the aid of suitable timing diagrams explain the operation of each timer type listed below:

- On-delay timer
- Off-delay timer
- Pulse timer.

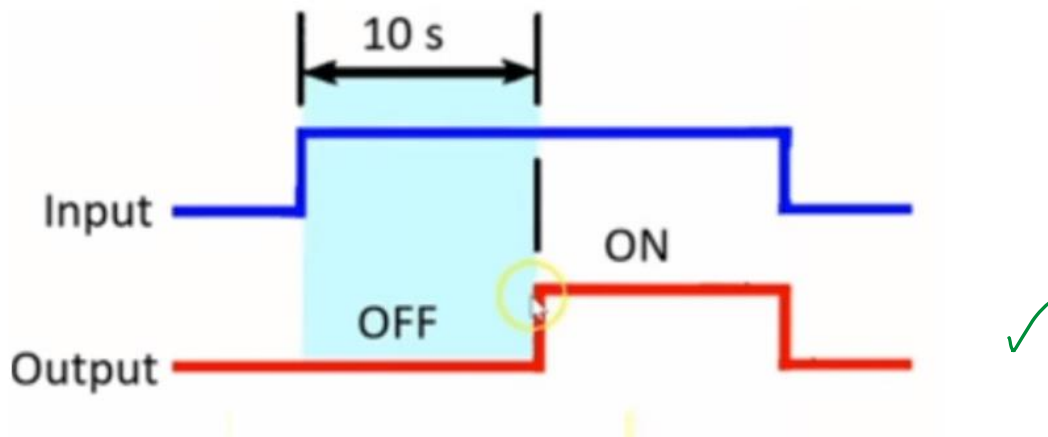


Figure 7, On-delay timer, source: GEYA Electrical Equipment Supply

Time relays are types of devices that operate a load after a delay, this can be either electromechanical or solid state in nature. These relays work off of 2 inputs- an activation signal combined with a timing circuit. The On-delay style timer, demonstrated in *figure 7*, Shows how the output is delayed in reaction to an 'ON' input, by a delay of 10s in this instance. ✓

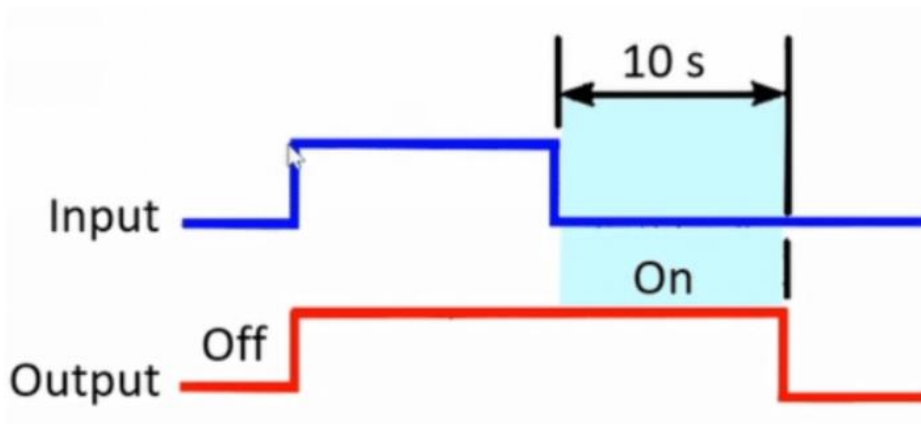


Figure 8, Off-delay timer, source: GEYA Electrical Equipment Supply

Figure 8 shows an example of an off-delay timer. With this style the input will switch from 'ON' to 'OFF' position but the output won't change state for a specified time in the logic, in this example 10s, before reflecting the input value. ✓

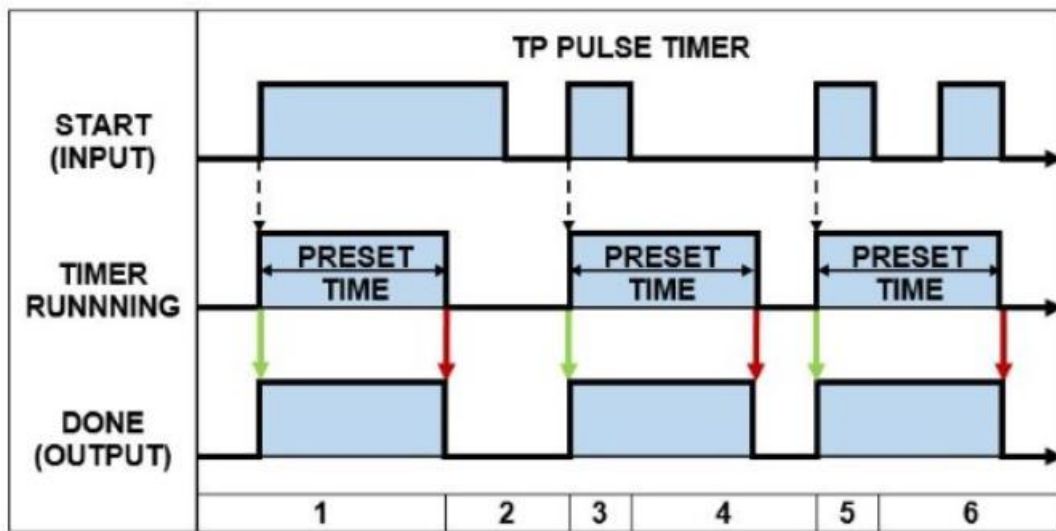


Figure 9, Pulse Timer, source: Ladder Logic World (2023).

As shown in figure 9, 'The Pulse Timer creates an output PULSE with a pulse duration equal to that of the preset time value. In simple terms, the TP timer output is ON when the timer is running and is OFF all other times.' Bartlett, S. (2023). The output generates a pulse that has a specific time duration. The output of the pulse timer is set TRUE when the input changes state to TRUE. The output will then stay TRUE until the preset time expires, regardless of the state of its input.

b) Explain how they can be used for sequences outputs and cascaded timers.

Cascading timers are locked together in such a format that when one timer completes its sequence the next timer is triggered. This can be used in startup sequences in industrial applications, where various conditions have to be met (say, appropriate fuel gas supply, air and ignition timing within a boiler) or within a lighting sequence as with traffic control.

Cascading timers can have repeating timers as much as the design of the system requires. Wilborne, T. (2021).

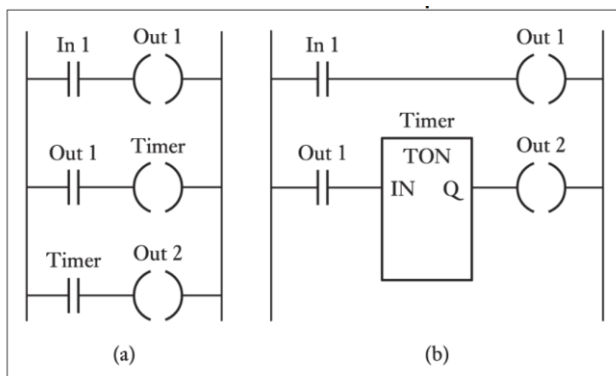


Figure 9 shows a sequence of outputs implementing timers to change the timings of 'ON' and 'OFF' conditions. Depending on the nature of the timers, outputs can be delayed or held in position, controlled via pulses and counts- say in an factory setting with a drilling machine as an example.

Figure 10, source: https://web.itu.edu.tr/yalcinme/files/courses/MMG/ch19_2%20PLC.pdf

Have not really explained how sequence timers work.

Task 4 – Programming Problems

Unitary PLCs are widely used in industry where sequential control of small processes or manufacturing operations are required. Typically, these systems use development software employing graphic symbols to aid in the construction of a PLC program. For this part of the assignment, you will investigate the use of this type of development software to design a range of PLC programs. To complete the tasks, you are required to demonstrate the operation of your programs and attach a Tutor verified copy of the program to your report.

Use the Mitsubishi Alpha software to develop programs to meet the following sequential operations:

- a) For a food processing blending system the following timings are required for each stage of mixing:
1. 30 seconds of slow blending
 2. 20 seconds of fast blending
 3. 60 seconds period containing pulses of 10 second fast blending and 5 second off.

The cycle should be started using a momentary 'on' switch, run automatically and terminate once the pulse period has finished. Indicator lights should be used to inform the user of each stage of the cycle.

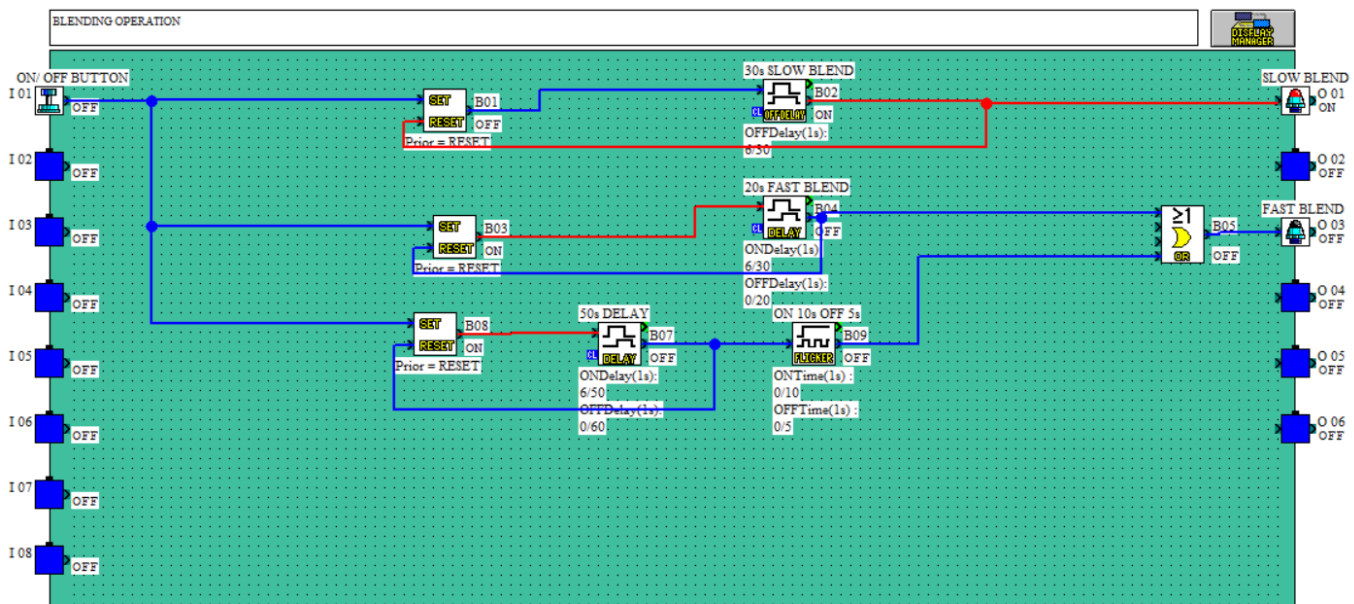


Figure 11, see program built with an ON/OFF Button switching the slow & fast blend functions

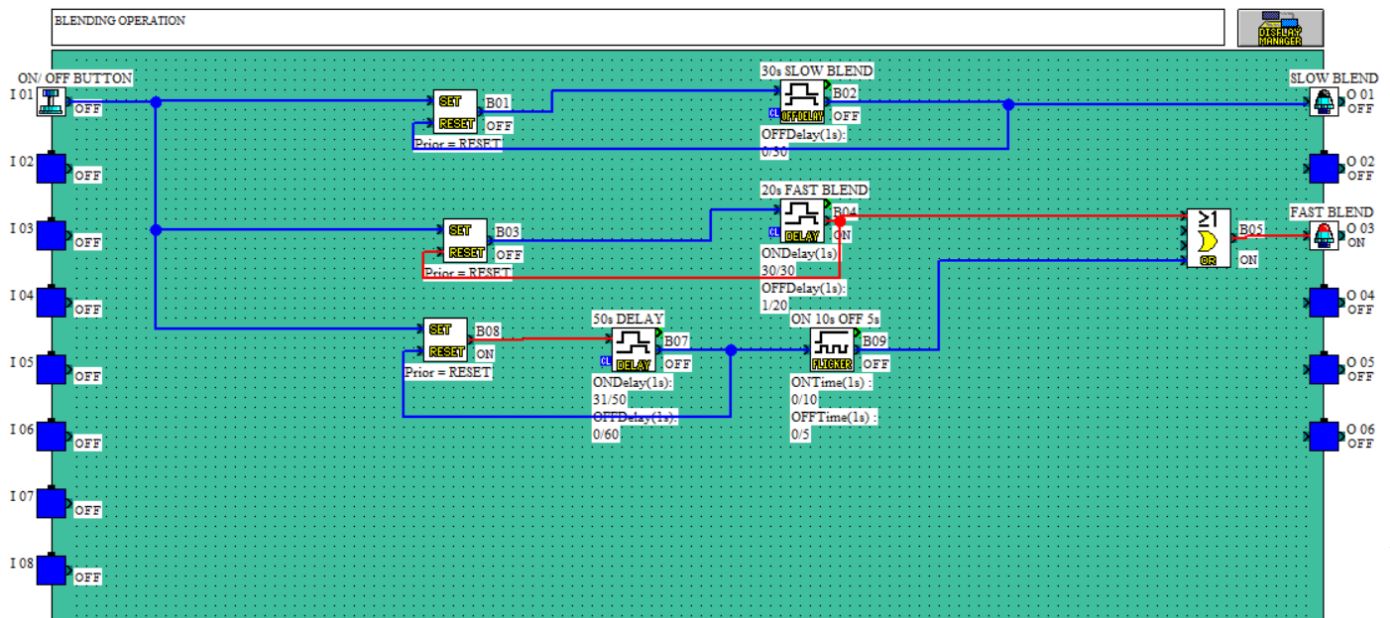


Figure 12, once the 30s slow blend has finished, the 20s fast blend is activated

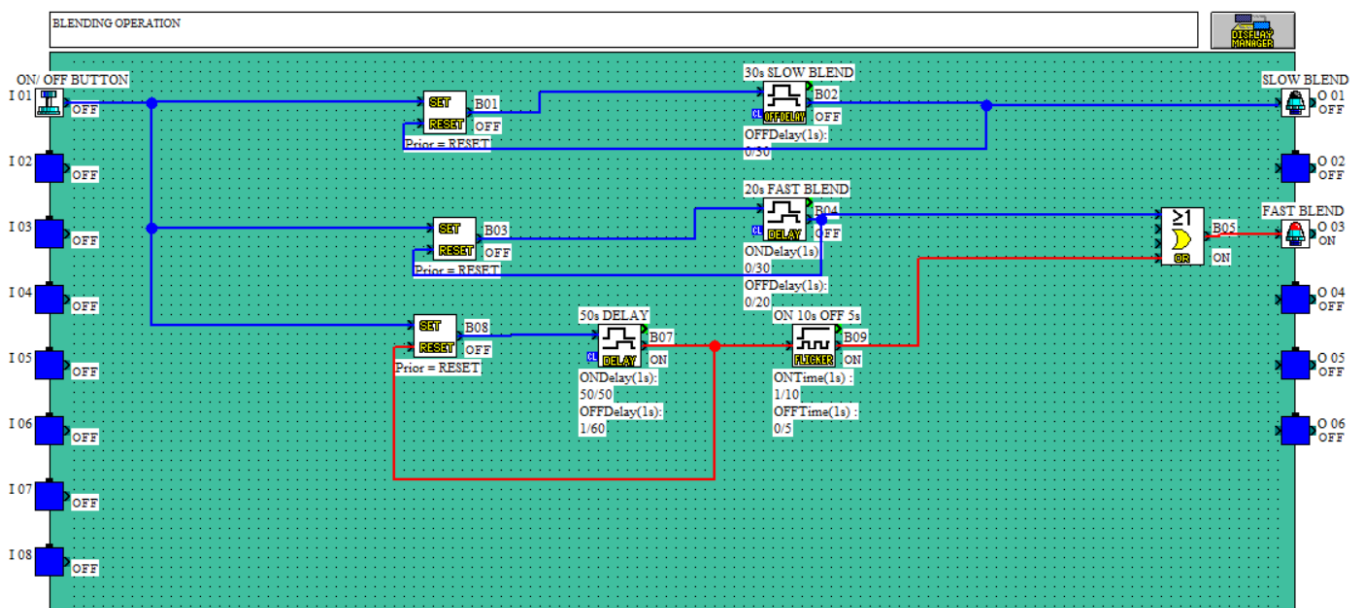


Figure 13, at the end of the sequence, the fast blend is pulsed at 10 & 5s intervals

As shown in figures 11-14 the program is built with a one input switch and a fast & slow output on 01, 03. The 30s blend is controlled via an off-delay timer of 30s after the switch is initially pressed on and off. A reset is linked to this output to reset the slow blend indication after 30s have passed. The 20s fast blend lamp has a 30s on delay and then a 20s off delay- the amount of time required by the program to perform the fast blend. Once this is completed its state resets as per the setup with the slow blender. To create the pulse of 10s fast blending and 5s breaks for 60s, the flicker has a 50s on delay and a 60s off delay. The flicker then has the 10s and 5s intervals specified in the program. And a reset as per the previous functions. The Program resets to OFF condition at the end.

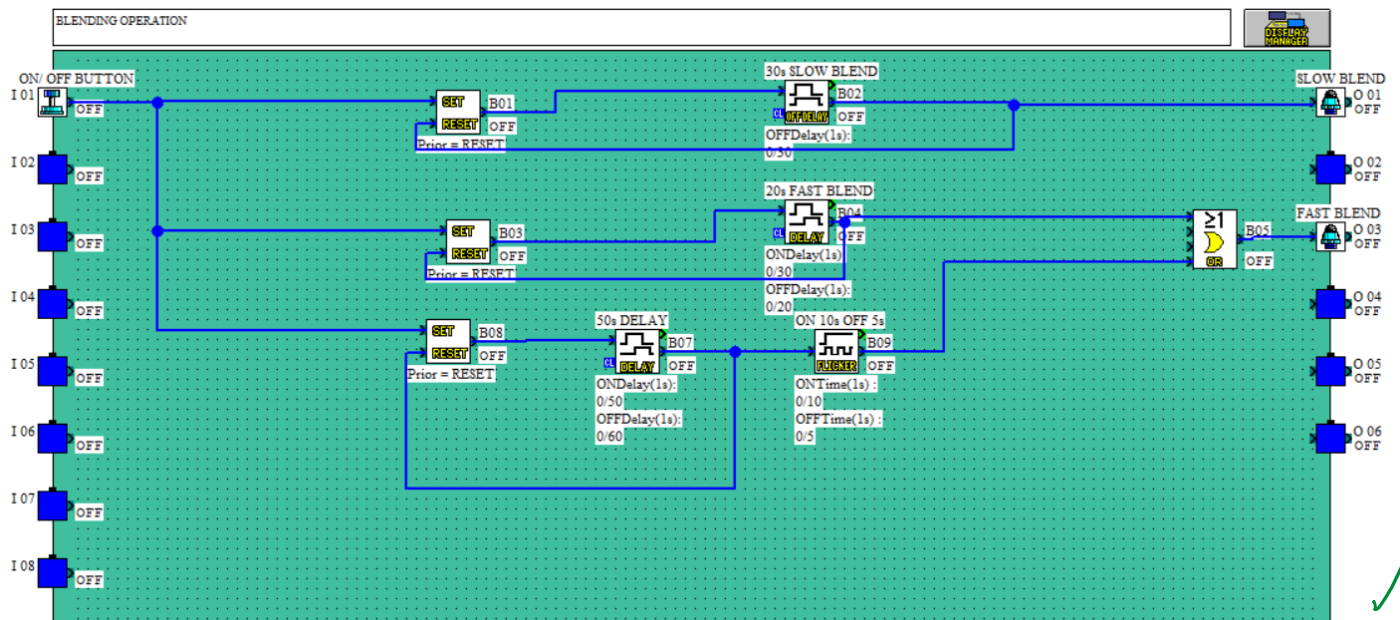


Figure 14, at the end of the sequence the lamps reset

- b) A coin counting system is required to determine the totals of 10, 20 and 50 pence coins. Each time a coin reaches the total of a pound a different colour light will come on for each coin total. Also, a running total of every pound will be monitored and a final light will come on when the total has reached 10 pounds.

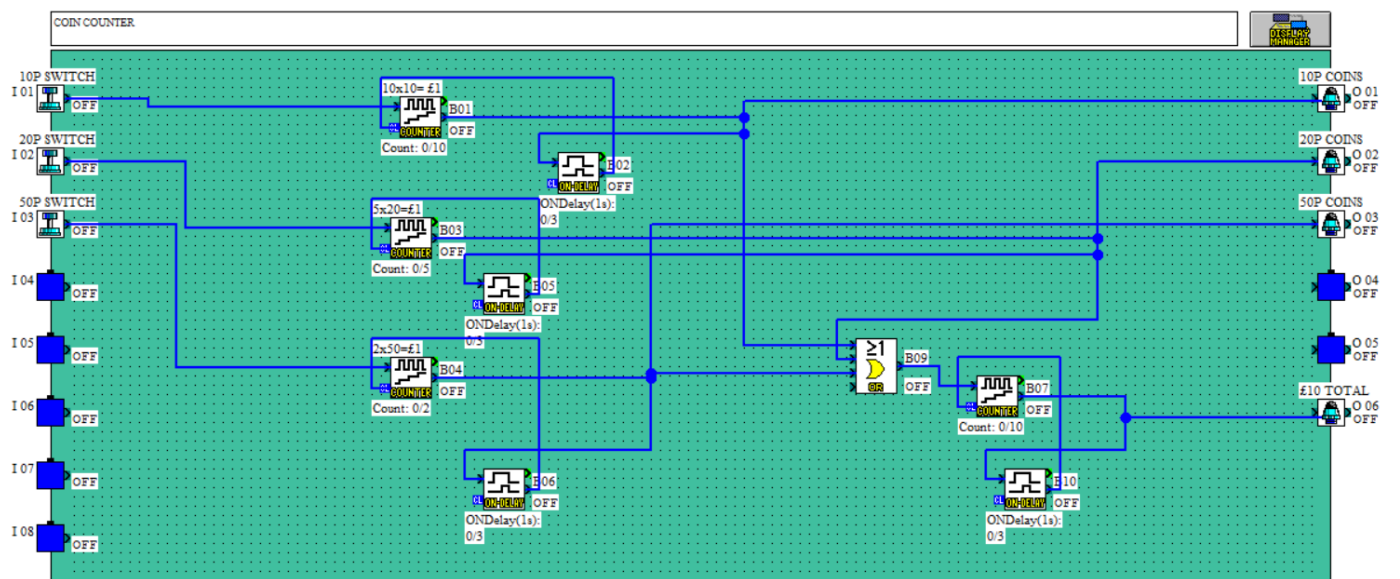


Figure 15, Coin counting program built, 3 inputs, 4 outputs

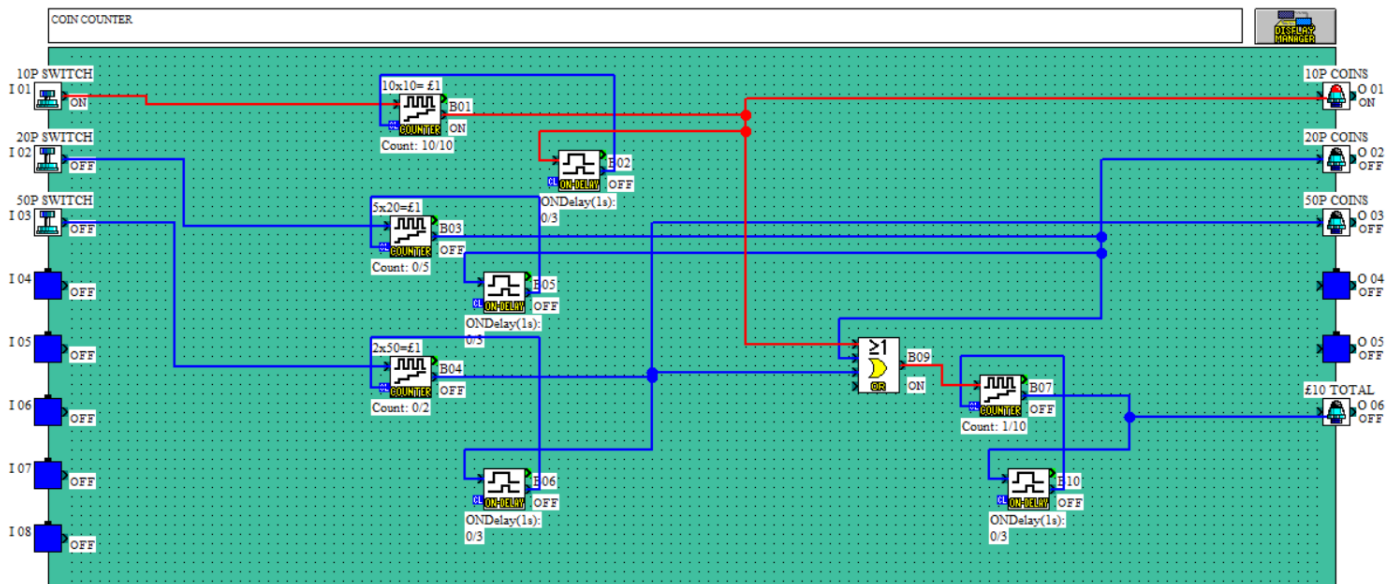


Figure 16, here the 10p switch is turned ON & OFF and the count is registered

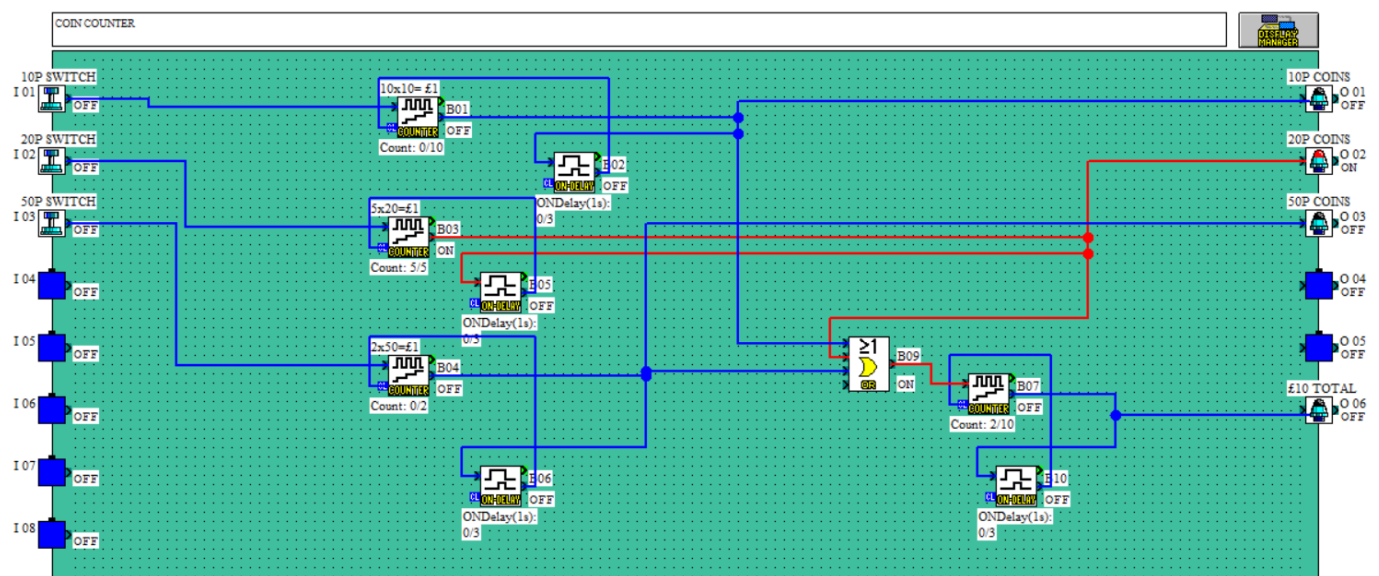


Figure 17, demonstration of the 20p count working

Figures 15-19 show the program performing the desired function. Once the 10p counter has reached 10 counts and a pound is counted, the lamp at output 1 will activate. The same applies to the 20p count with 5 counts and a lamp at output 2. And with the 50p switch with a 2 count counter and lamp at output 3 indicating when a £1 total is reached. ON delays are included as part of the circuit in order for the counters to reset correctly within the program. An OR gate is required to connect multiple counters to output 6, the £10 total indication. Once a 10 count is reached the £10 lamp activates. The program then resets.

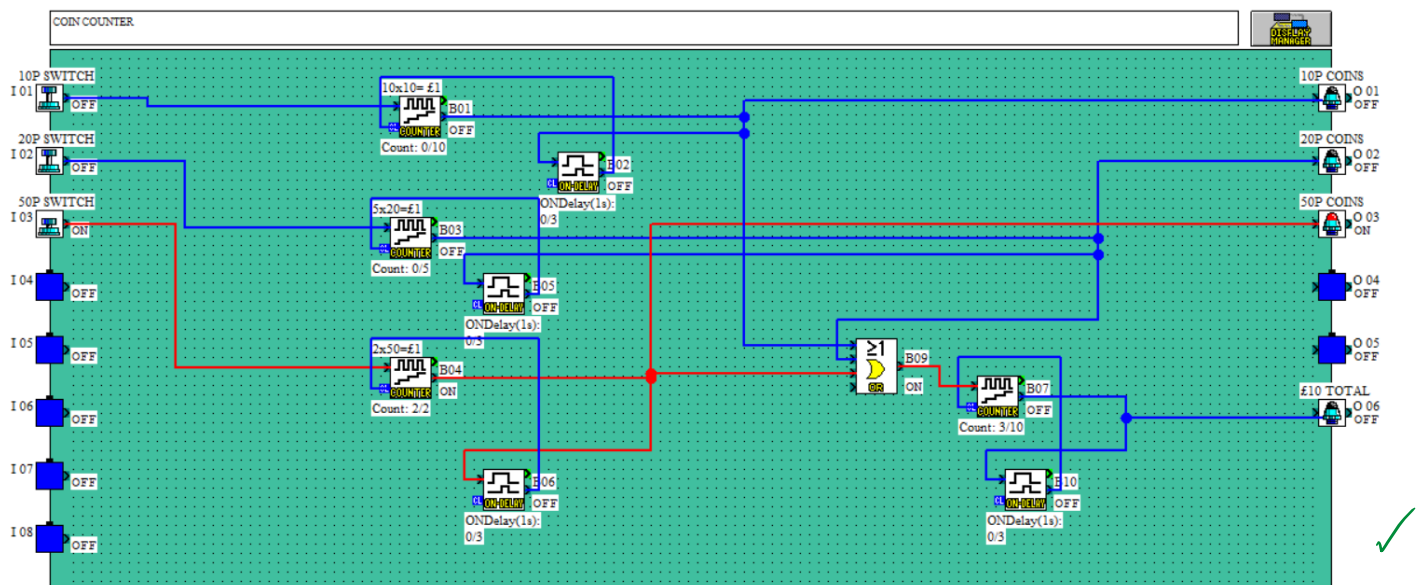


Figure 18, 50p count lamp activation

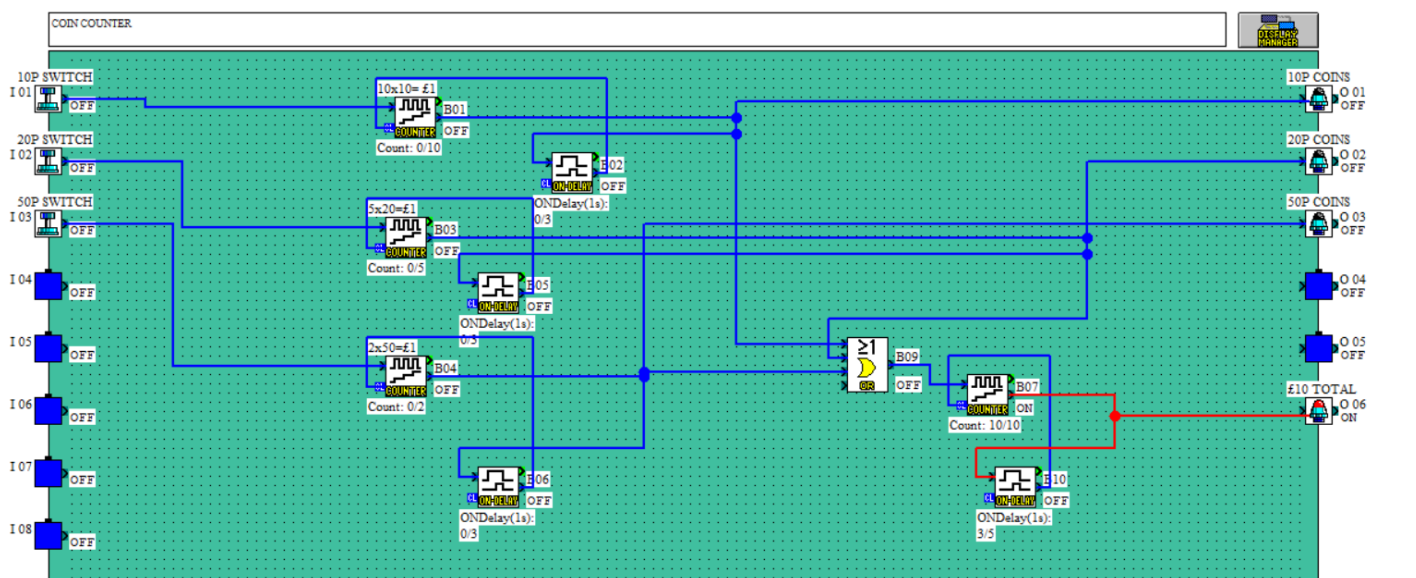


Figure 19, £10 Count activated at the end of the sequence

Task 5 – Automatic Drilling System

For this task you are required to develop a PLC program using functional blocks to control an automatic drilling system shown in figure 2.

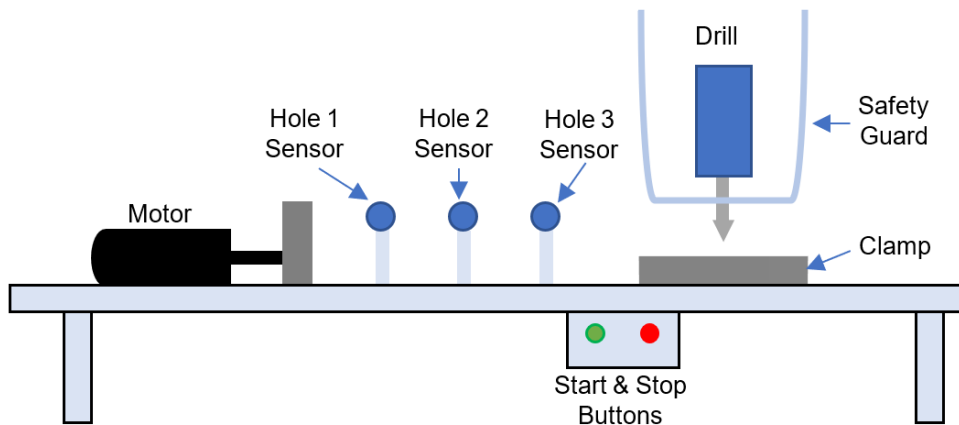


Figure 2 – Automatic Drilling System

The system will drill a series of three hole into a steel bar, the YouTube clip shows an example of such a system:

[Automatic drilling machine - YouTube](#)

Automatic drilling system specifications:

1. The process will start when the safety guard is pulled down and start button is pressed.
2. The motor will move the bar to position 1, this will start the drill.
3. The bar will be clamped and the drill will be lowered. It will take 10 seconds to drill through the bar and 5 seconds to return to its start position.
4. The clamp will be released and the motor will move the bar to position 2 and step 3 is repeated.
5. The clamp will be released and the motor will move the bar to position 3 and step 3 is repeated.
6. The drill will stop, bar will be unclamped and the motor will return to start position. If the stop button is pressed the drill will return to its up position and stop. The bar will be unclamped and the motor return to its start position.

System Technical Information

Table 1. PLC simulator I/O configuration.

PLC I/O Connection			
Input		Output	
1	Start button	1	Motor forward
2	Stop button	2	Motor backward
3	Proximity sensor 1	3	Drill servo up control
4	Proximity sensor 2	4	Drill servo down control
5	Proximity sensor 3	5	Clamp
6	Safety Guard	6	Drill on
7	Clamp sensor		

To complete this task, you are required to demonstrate the operation of your program and discuss its functionality including any improvements that could be made to the system.

Program file has been made available to tutor/ assessor, and the program has been demonstrated. Please see the following images that show the system and it’s required functionality.

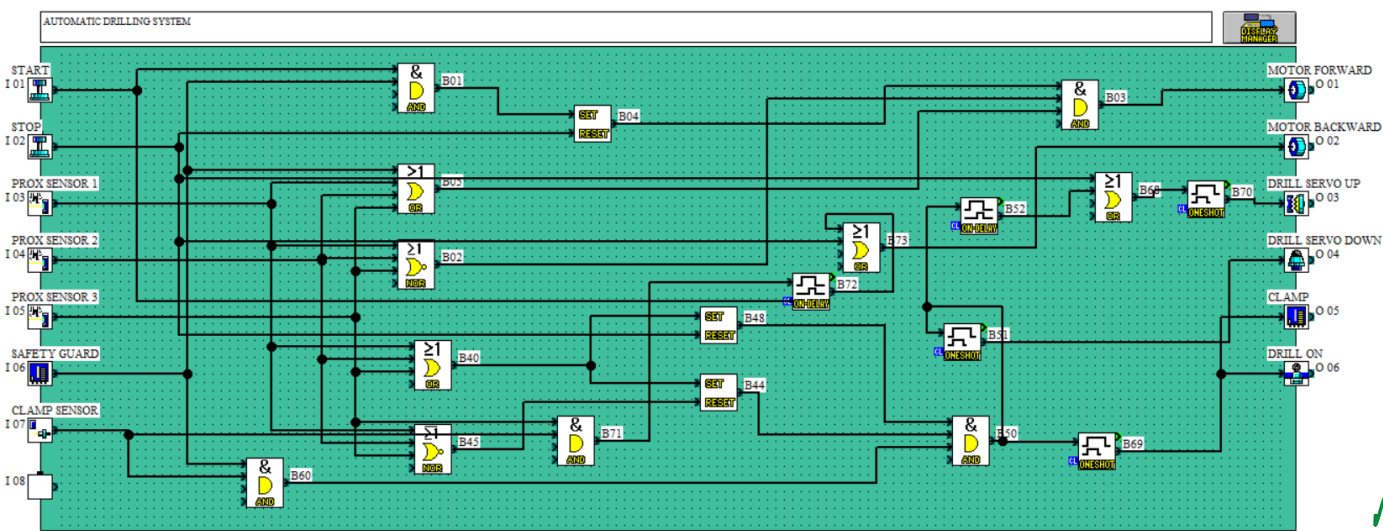


Figure 20

Figure 20 shows the design of the program in the Alpha software. 7 inputs and 6 outputs are labelled and setup as per the system specifications. One thing to note is that an improvement to the program could be made by adding an additional sensor to input 8 to reverse the motor and return the system to its starting position, after moving past proximity sensor 3. With the way the program is designed, the stop button must be depressed to achieve this function. A series of gates, reset modules, one shot times and an on-delay have been used within the automation.

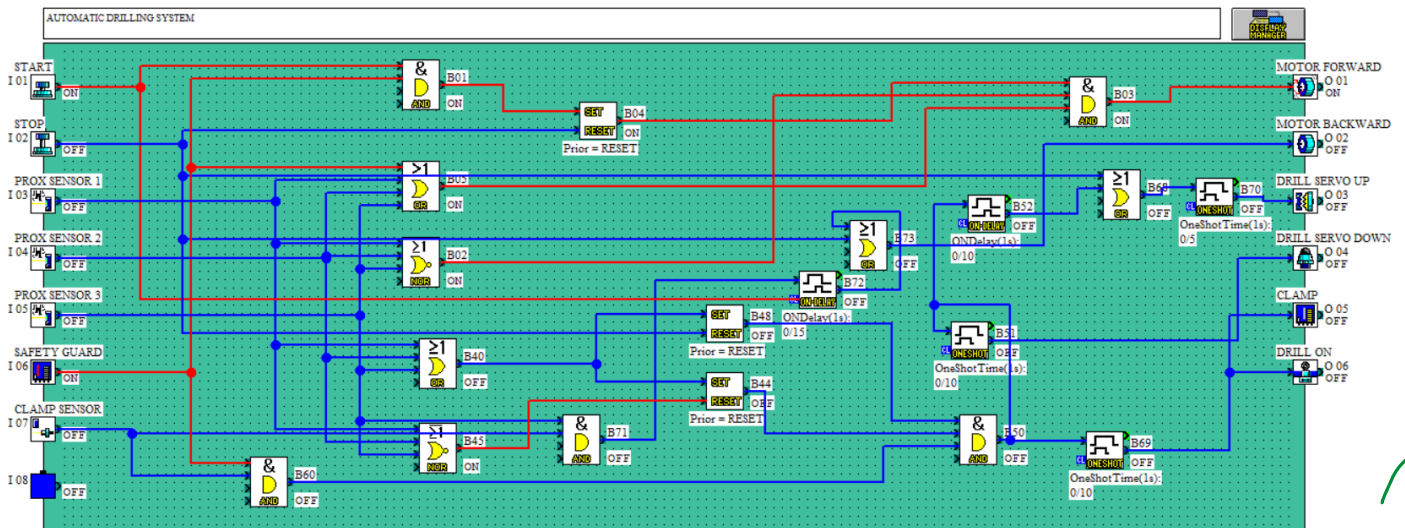


Figure 21

Step 1- The process will start when the safety guard is pulled down and start button is pressed. If the safety guard is pulled up at any point the motor will stop driving forward and all other processes will stop.

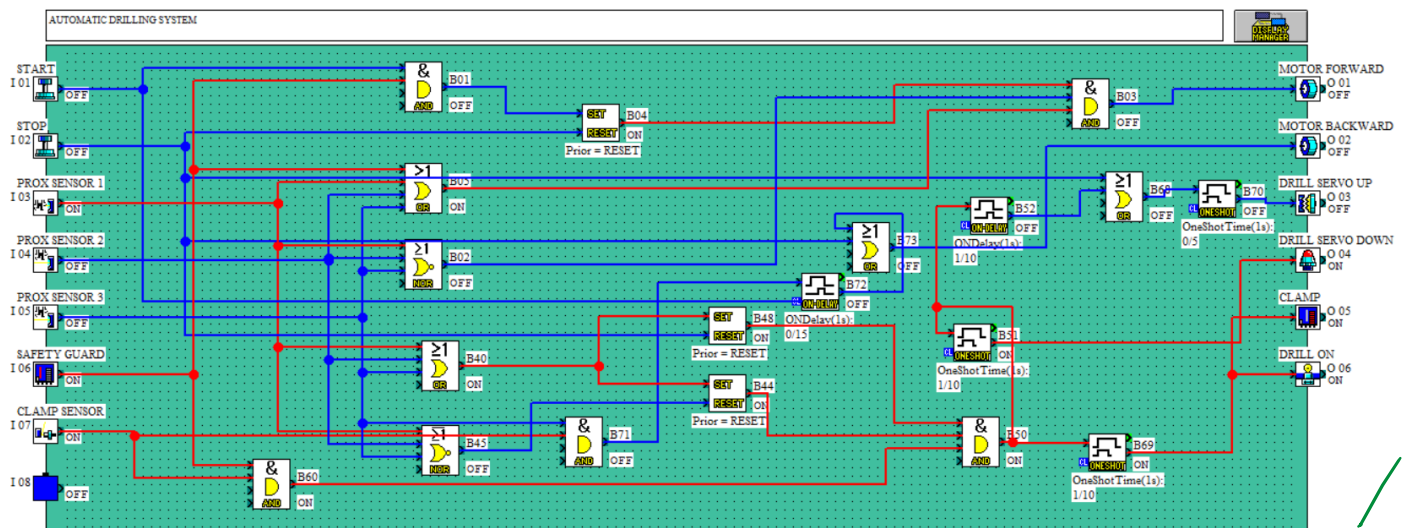


Figure 22

Step 2- The motor will move the bar to position 1, proximity sensor 1 will activate, this will start the drill. The bar will be clamped and the drill will be lowed, this all happens at once. It will take 10 seconds to drill through the bar. This has been achieved via the use of NOR and OR gates. The timers reset themselves after the sensor is deactivated or the stop button pressed. The clamp sensor has to be active for this sequence to happen.

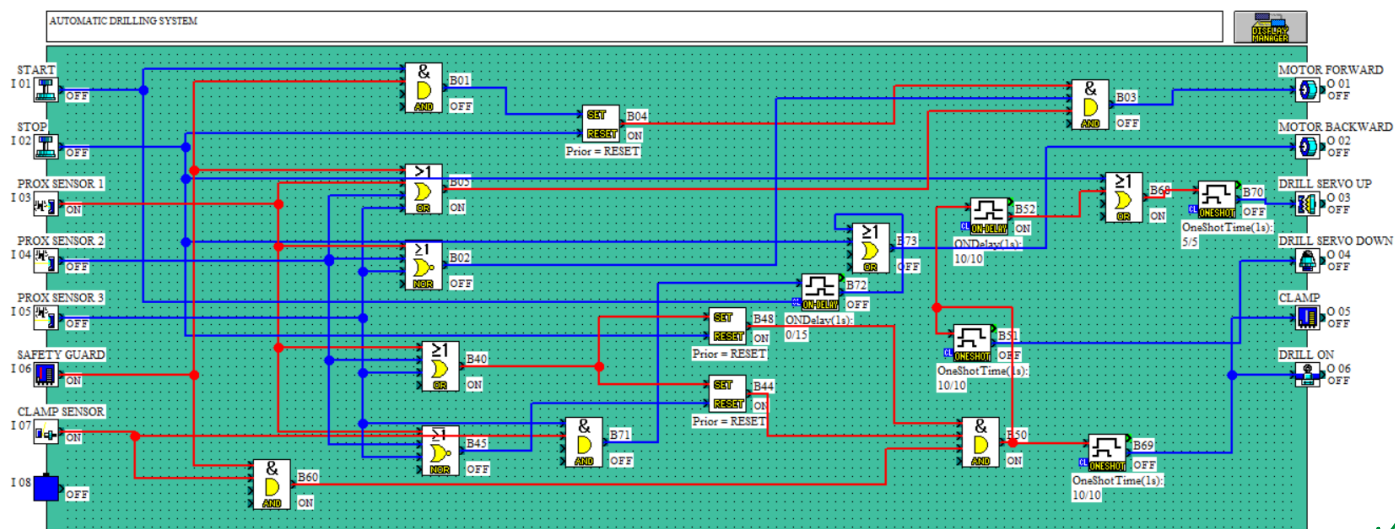


Figure 23

Step 3- It will take 5 seconds for the drill to return to its start position, as per figure 22. The drill servo will then turn off, the clamp has been released and the drill is off.

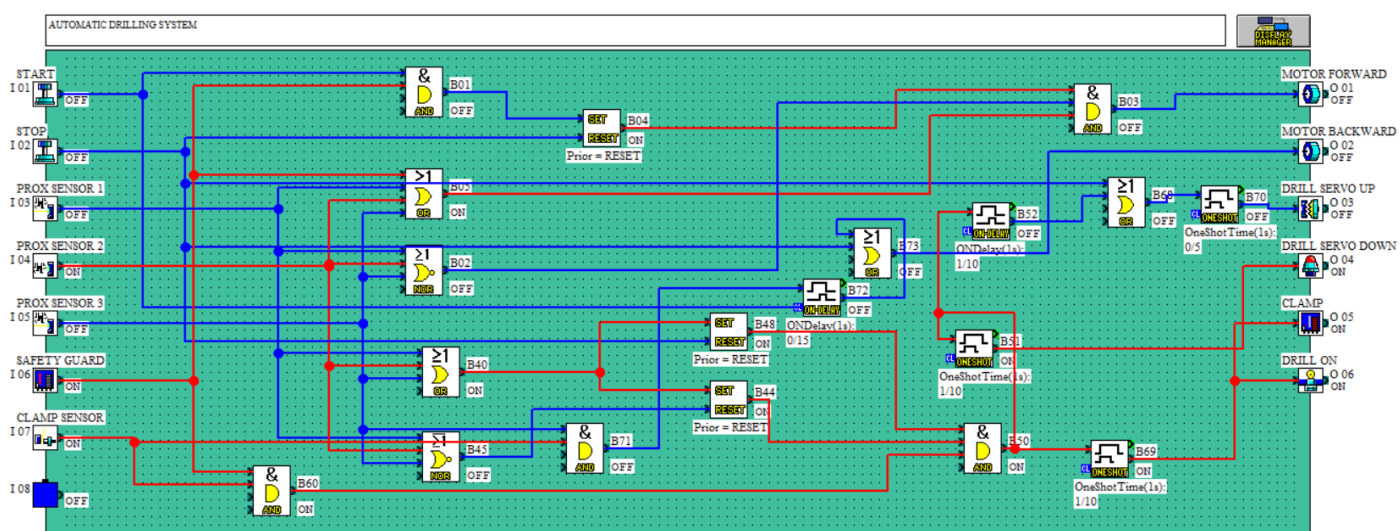


Figure 24

Step 4- The clamp will be released and the motor will move the bar to position 2 and step 3 is repeated. The issue with the system is that the first proximity sensor has to deactivate in order for the next stage to happen. This might be difficult in a real-world situation where the bar continually is moving forward through the machine past the line of sensors.

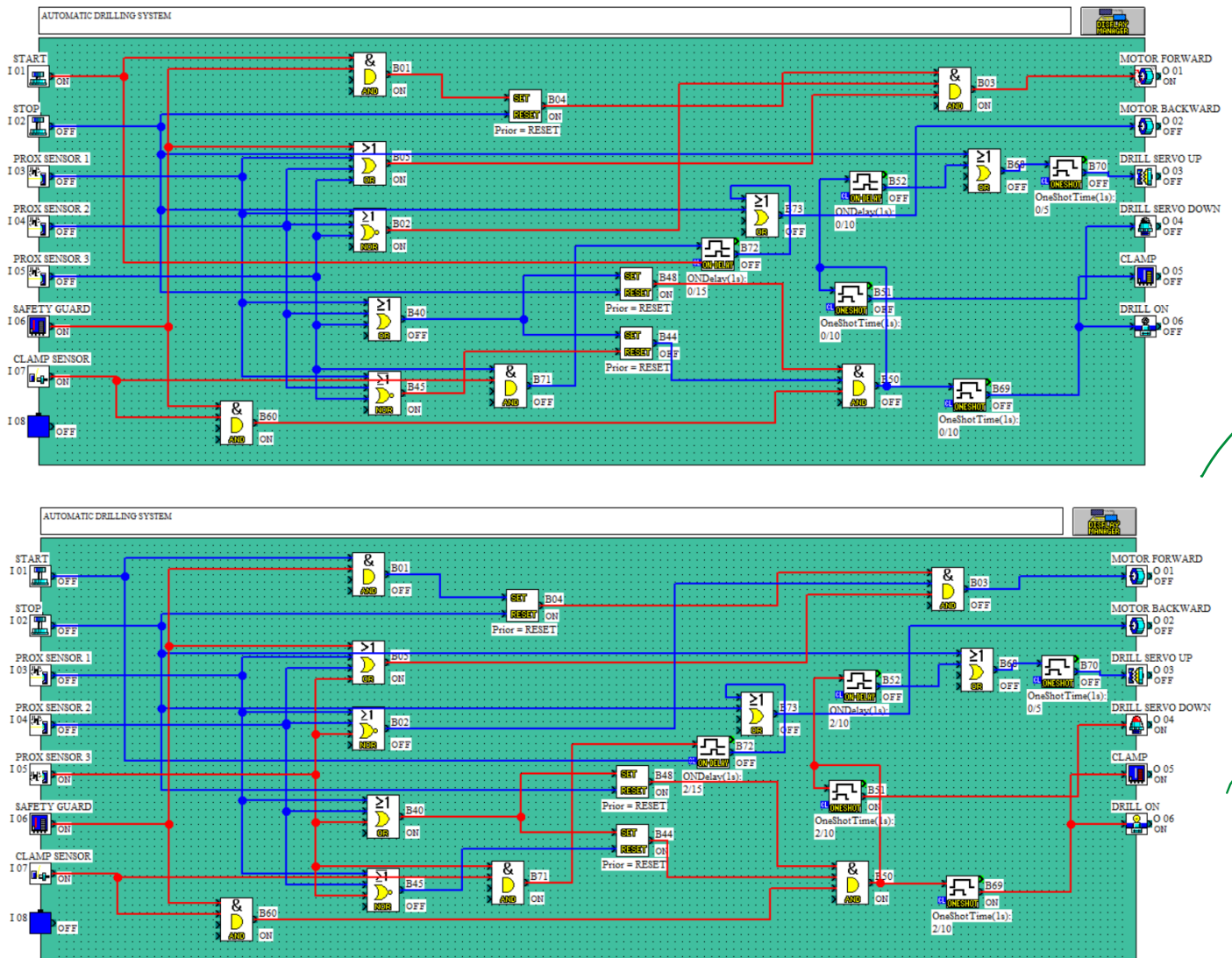


Figure 25

Step 5- Between sensors the motor will move forward, as per figure 25. The clamp will be released and the motor will move the bar to position 3 and step 3 is repeated.

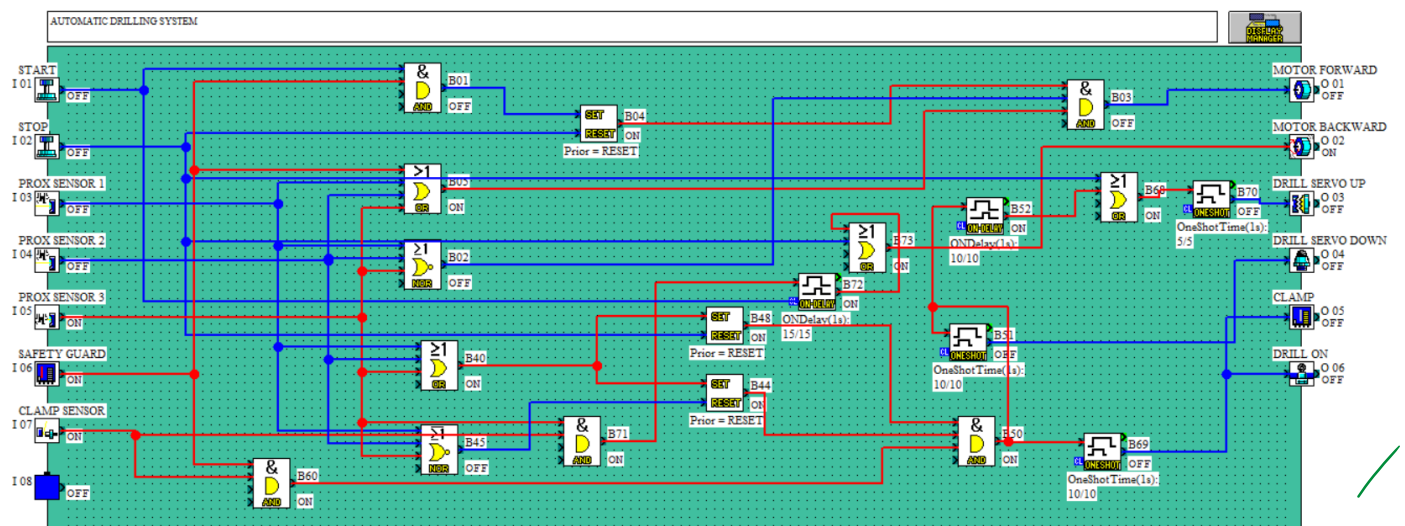


Figure 26

Step 6- The drill will stop; bar will be unclamped and the motor will return to start position.

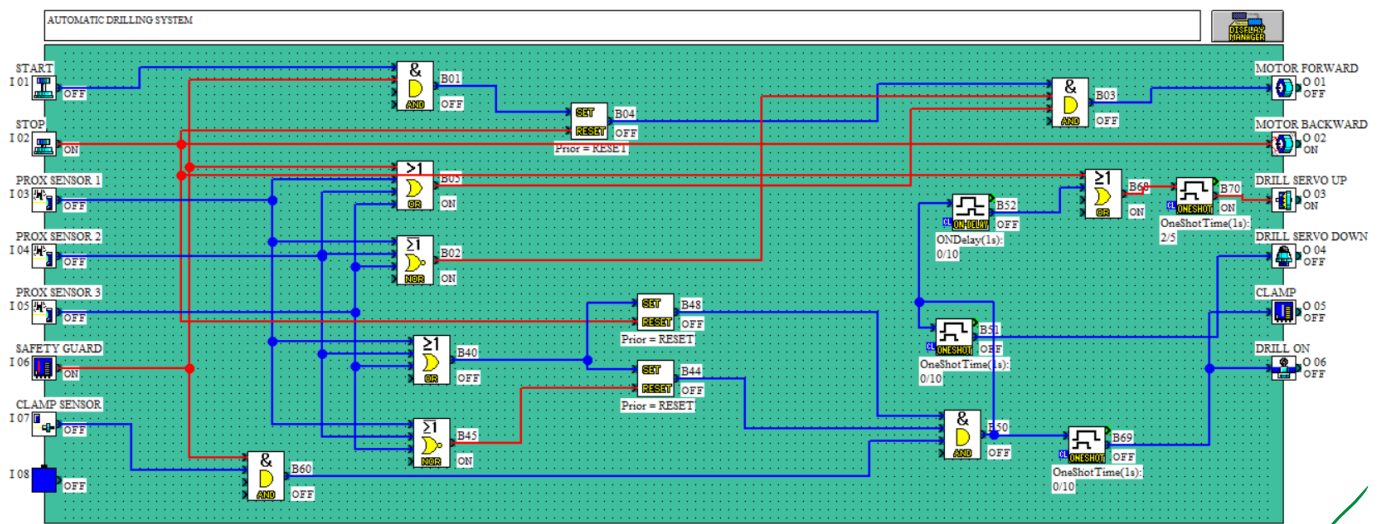


Figure 27

Stop conditions- If the stop button is pressed the drill will return to its up position and stop. The bar will be unclamped and the motor return to its start position. What would be useful is a return position sensor, as the motor will continue moving backwards if the stop button is held depressed.

Product Specifications

The Triconex product family includes a comprehensive range of modules. This section includes: a summary of the system components and their uses, a table that lists standard products and their model numbers, and a summary of specifications for each standard product in the Tricon family.

See the *Tricon Planning and Installation Guide* for complete information.

Summary of Tricon Components

Chassis

- **Main Chassis**—houses main processors, memory back-up batteries, communication modules and I/O modules.
- **Expansion Chassis**—for additional I/O modules up to 100 feet (30 meters) away from the main chassis. In restricted applications, operation up to 1,000 feet (300 meters) is supported.
- **RXM Chassis**—for I/O modules up to 7.5 miles (12 kilometers) away from the main chassis.
- **Mechanical Keying**—Each slot in the Tricon is mechanically keyed to correspond with a specific type of module. This prevents the installation of modules into improper slots.

For chassis mounting and enclosure specifications, see [page 23](#).

Power Supply Modules

- Provide logic power to modules in the main, expansion or RXM chassis. Available in 24 VDC, 115 VAC and 230 VAC versions. The power rating of each power supply is 175 watts at 140 °F (60° C).

Main Processors

The main processors execute the system diagnostics and the user-written control program.

Communication Modules

- **Tricon Communication Module (TCM)** supports a number of Triconex protocols and applications and user-written applications on Ethernet (802.3) networks, including TriStation, Modbus TCP and OPC. It also supports RS-232 and RS-485 serial communication with Modbus devices, TriStation, and GPS for time synchronization.
- **Enhanced Intelligent Communication Module (EICM)** supports RS-232, RS-422 and RS-485 serial communication with Modbus devices and TriStation.
- **Network Communication Module (NCM)** supports a number of Triconex protocols and applications and user-written applications on Ethernet (802.3) networks, including TriStation.
- **Safety Manager Module (SMM)** acts as an interface between a Tricon controller and a Honeywell Universal Control Network (UCN), one of three principal networks of the TDC 3000 DCS.
- **Hiway Interface Module (HIM)** acts as an interface between a Tricon controller and a Honeywell TDC 3000 Hiway Gateway and Local Control Network (LCN).
- **Advanced Communication Module (ACM)** allows a Tricon controller to interface with a Foxboro Industrial Automation (I/A) Series DCS and TriStation.

Fiber-Optic Remote Extender Modules (RXM)

For operation of Expansion Chassis up to 7.5 miles (12 kilometers) away from the Main Chassis, with exceptional immunity against electro-static and electro-magnetic interference.

I/O Modules

- **Digital Input Modules** receive discrete signals of these nominal voltages: 115 VAC/VDC, 48 VAC/VDC, and 24 VAC/VDC. All voltages are available in TMR modules. Non-TMR modules are available in 24 VDC and 48 VDC only. Speed input and totalization modules are also available.
- **Supervised Digital Output Modules** produce discrete output signals of these nominal voltages, with diagnostic coverage of the field circuit and load device: 115 VAC, 120 VDC, 48 VDC and 24 VDC.
- **Digital Output Modules** produce discrete output signals of these nominal voltages: 115 VAC, 120 VDC, 24 and 48 VDC. Dual output modules are also available.
- **Analog Input Modules** receive analog signals of these types: 0-5 VDC, -5 to +5 VDC, 0-10 VDC and Thermocouple types J, K, T and E. Available in both isolated and DC-coupled versions.
- **Analog Output Module** drives eight 4-20 mA analog output signals. The high-current AO module includes 6 points at 4-20 mA and 2 points at 20-320 mA.

Tricon I/O Modules

Voltage	Description	Type	Model No.	Points	For Details, See
Digital Input Modules					
115 VAC/VDC	Opto-Isolated, Non-Commoned	TMR	3501E/3501T	32	page 33
48 VAC/VDC	Commoned in Groups of 8, Self-Test	TMR	3502E	32	page 33
24 VAC/VDC	Commoned in Groups of 8, Self-Test	TMR	3503E	32	page 33
24/48 VDC	High Density, DC Coupled	TMR	3504E	64	page 34
24 VDC	Low Threshold with Self-test, Commoned	TMR	3505E	32	page 33
24 VDC	Single, Opto-Isolated, Commoned	Single	3564	64	page 34
Pulse Input	Differential, AC Coupled	TMR	3511	8	page 35
Pulse Totalizer	Opto-isolated, Non-commoned	TMR	3515	32	page 36
Digital Output Modules					
115 VAC	Opto-Isolated, Non-commoned	TMR	3601E/3601T	16	page 37
120 VDC	Opto-Isolated, Non-commoned Opto-Isolated, Commoned	TMR	3603B, 3603E/3603T	16	page 37
24 VDC	Opto-Isolated, Non-commoned	TMR	3604E	16	page 37
48 VDC	Opto-Isolated, Non-commoned	TMR	3607E	16	page 37
115 VAC	Galvanically Isolated, Commoned., Supv.	TMR	3611E	8	page 39
48 VDC	Galvanically Isolated, Commoned, Supv.	TMR	3617E	8	page 39
120 VDC	Opto-Isolated, Commoned, Supervised	TMR	3623/3623T	16	page 38
24 VDC	Opto-Isolated, Commoned, Supervised	TMR	3624	16	page 38
24 VDC	Supervised/Non-Supervised, Commoned	TMR	3625	32	page 38
24 VDC	Opto-Isolated, Commoned	Dual	3664	32	page 40
24 VDC	Opto-Isolated, Commoned	Dual	3674	32	page 40
Relay Output	Non-triplicated, Normally Open	Non-triplicated	3636R/3636T	32	page 35
Analog Input Modules					
0-5 VDC	Differential, DC Coupled	TMR	3700A	32	page 41
0-10 VDC	Differential, DC Coupled	TMR	3701	32	page 41
0-5, 0-10 VDC	Differential, Isolated	TMR	3703E	16	page 41
0-5, 0-10 VDC	High-Density, Differential, DC Coupled	TMR	3704E	64	page 41
Thermocouple	Differential, DC Coupled	TMR	3706A	32	page 44
Thermocouple	Differential, Isolated	TMR	3708E	16	page 44
0-5 VDC	Single-Ended	TMR	3720	64	page 41
0 to 5 or -5 to +5 VDC	Differential, DC Coupled	TMR	3721	32	page 41
Analog Output Modules					
4-20 mA	Current Loop, DC Coupled	TMR	3805E	8	page 43
4-20 mA and 20-320 mA	Current Loop, DC Coupled	TMR	3806E	6 and 2	page 43

Product Specifications

General Environmental and EMC Specifications

Other than the optional conformal coating of all PCB assemblies, the Tricon is not explicitly protected against dust, corrosive atmospheres or falling debris. Atmospheric and airborne-particle protection must be provided by housing the Tricon in an appropriate NEMA-rated enclosure.

Operating Temperature	32° to 140° F (0° to 60° C), ambient, as measured at the bottom of the chassis, per IEC 60080-2-1 Test Nb
Storage Temperature	-40° to 167° F (-40° to 75° C), per IEC 60068-2-14, Test Na
Relative Humidity	5% to 95%, non-condensing, per IEC 60068-2-2, Test Bb, and IEC 60068-2-3 test Db
Sinusoidal Vibrations per Axis	2 G @ 10 to 150 Hz, per IEC 60068-2-6, Test Fc
Shock	15 G for 6-11 ms in each axis, per IEC 60068-2-27
Electrostatic Discharge	IEC 61000-4-2, 4 kV air, 8kV contact
Conducted Susceptibility	IEC 61000-4-4, Fast Transient/Burst, 2 kV power, 1kV signal lines and IEC 61000-4-5, Surge Withstand, 2 kV CM AC power lines, etc. IEC 61000-4-6, RFI, 0.15-80 MHz, 10V
Radiated Susceptibility	IEC 61000-4-3, 26-1000 MHz, 10V/m and IEC 61000-4-8, 50-60 Hz, 30A/m
Conducted Emissions	CISPR 16, Class A, 0.15-30MHz, 73-79db when installed per the guidelines of the P&I Guide.
Radiated Emissions	CISPR 11, Class A, 30-1000 MHz @ 10m, 4-47 db when installed per the guidelines of P&I Guide.

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STUDENT FEEDBACK FORM

Generic Assessment Criteria	Marks available	Marks awarded
1. Engagement with Literature Skills	15	
2. Knowledge and Understanding Skills	30	
3. Cognitive and Intellectual Skills	5	
4. Practical Application Skills	40	
5. Transferable Skills for Life and Professional Practice	10	

Assessment 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 1 week late (40% Max)		
	Over 1 week late (0%)		