

LEVEL 4 ASSESSMENT SPECIFICATION

Student name:	Morgan Layton	Student ID number:	
Programme:	HNC Electrical/Electronic Engineering & HNC Instrumentation Engineering		
Module:	Programmable Logic Controllers		
Module code:	PCEE4005	Contribution to Overall Module Assessment (%):	50%
Lecturer:	Jason Pointer	Internal Verifier:	Lance Rutherford
Assignment Title:	PLC Program design and simulation	Word count (or equivalent):	2000
Submission deadline:	05/05/22	Return date of provisional marks & written feedback:	19/05/22
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	9.6
Engagement with a wide range of literature, including sources retrieved independently.		
2. Knowledge and Understanding Skills	30	18
Task 1 achieved 49%. Task 2 achieved 50% Task 3 achieved 85% Showed some competent knowledge of the basic underlying concepts and principles for assessment but could have been more detail in the explanation of Task 1 and 2. Need to include other examples of input devices. Excellent work producing the IL code for Task 3.		
3. Cognitive and Intellectual Skills	10	4.5
Little evaluation of the underlying concepts and principles applied to the construction of the programs for Task 4 and 5.		
4. Practical Application Skills	35	29.9
Task 4 achieved 85%. Task 5 achieved 86%. An excellent application of the different 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 within the classroom.		
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)		69%
	Up to 1 week late (40% Max)		
	Over 1 week late (0%)		

PLC ASSIGNMENT 2

Morgan Layton

STUDENT NUMBER: 172325

Summary

This is a detailed report into the workings of Programmable Logic Controllers (or PLC's) with respect to inputs and output devices as well as how they interface for human control and visual representation. The report also looks at 3 out of the 5 different programming methods generally accepted by IEC and example problems solved by creating programs using these different methods.

Index

- **PLC analogue and discrete I/O (Page 2)**
- **SCADA (Supervisory Control and Data Acquisition) (Page 3)**
- **Instructional List (Page 4)**
- **Temperature Alarm Panel (Page 6)**
- **Ladder Logic (Page 11)**

PLC Analogue and Discrete I/O

An example of a commonly used device used to measure temperature is a Resistance Temperature Detector (RTD). Walt Jung describes an RTD as coils of wire or film of “typically platinum” placed around a ceramic bobbin. (Jung, 2005) RTD’s work on the principle that different metals or semi-conductive materials have different resistance values at different temperatures allowing for a highly accurate and linear means of temperature measurement. However, while being highly accurate RTD’s are slower to respond to temperature changes than other devices such as thermocouples and thermistors due to having a relatively large thermal mass in comparison. (Turner, 2009) ✓

If you are using any direct quotes they need to be in quotation marks.

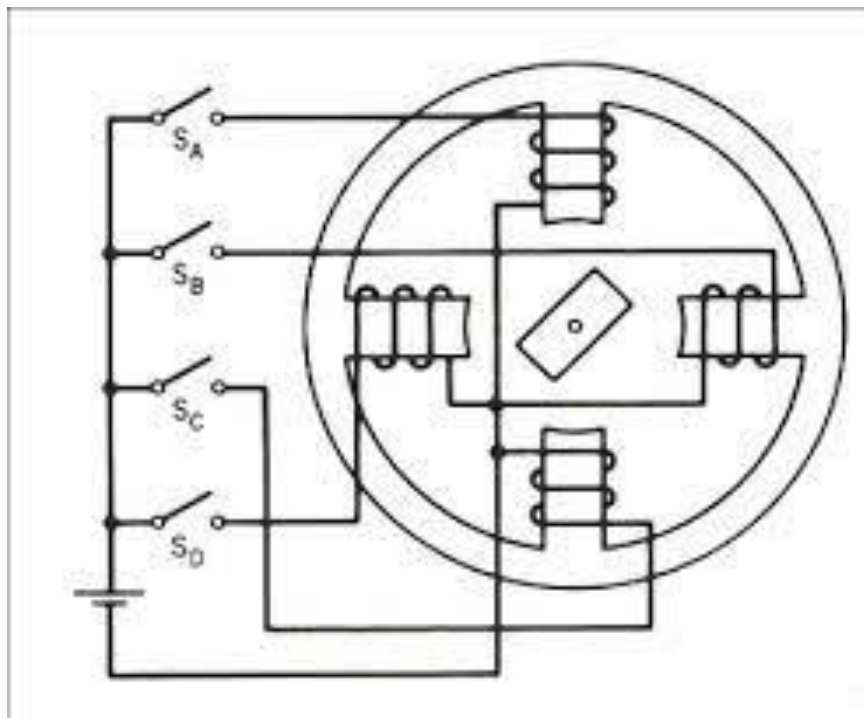
RTD’s are commonly built to follow what is known as the ‘DIN’ curve which specifies a base resistance of 100Ohms at 0 degrees with a temperature coefficient of 0.00385Ohm/Ohm/Degree. How accurately sensors follow this curve depends on which class they align with generally decided by the quality of materials used to produce the RTD and standard of production precision. In Test and Measurement: Know it all, Jon S. Wilson et al define these standard of classes as Class A which is $\pm(0.15 + .002|T|^{\circ}\text{C})$, Class B which is $\pm(0.3 + .005|T|^{\circ}\text{C})$ and Class C which is $\pm(1.2 + .005|T|^{\circ}\text{C})$. (Jon S. Wilson, 2008) ✓

Pressure is another common measurement in industries where PLC’s might be deployed. Piezoelectric pressure sensors work using a characteristic of some semiconductive materials to produce a charge when applied with pressure. This charge is proportional to the pressure change in both value and polarity allowing for a value of pressure to be obtained from the charge. These sensors take the form of thin films made up of a material with piezoelectric qualities such as lead zirconate titanate which Beeby describes as having “desirable piezoelectric properties”. (Beeby, 2004) The construction of piezoelectric pressure sensor’s offers an advantage over alternatives due to their relatively small size meaning they can detect pressures in very small spaces. ✓

Piezoelectric sensors are also highly accurate and respond very quickly to changes in pressure due to the material emitting a new charge value the reading is almost instant. Despite being very accurate these sensors are at a disadvantage due to piezoelectric materials being sensitive to large changes in temperature meaning they are unsuitable for certain applications. It is also the case that sensors will degrade over long periods of time when compared to a differential sensor for example which are generally more robust and easier to perform maintenance on as they are located outside the vessel where pressure needs to be monitored. (Changhai Ru, 2015) ✓

You should have discussed 2 types of each.

A stepper motor is an example of an output device that could be controlled via a PLC. A stepper motor is described by Hanselman as a “type of brushless synchronous DC motor” that instead of continually rotating while a DC voltage is applied the current is passed through a series of coils which can be turned on and off quickly in succession allowing for very accurately controlled movements. (Hanselman, 2006) ✓



(Ravi, 2020)

In the diagram above we can see a four-wire stepper motor set up. As each winding has a current applied to it a magnetic force is generated pulling or pushing the shaft depending on polarity. Unlike a normal brushed motor where a current is passed through a coil encased in magnets to generate this force a stepper motors coils are separate and surround a toothed series of magnets spinning at the centre and as a result each coil only generates enough force to move it a small distance allowing for greater control through digital pulses generated by a PLC for example. This control means a position can be fixed for any length of time and this advantage is used in a wide range of applications from robotics to textile machinery. However, stepper motors are inefficient when compared with DC motors due to constant maximum current draw meaning they tend to generate a lot of heat as well as sound due to the number of teeth on the magnet. (Jain, 2004)

SCADA

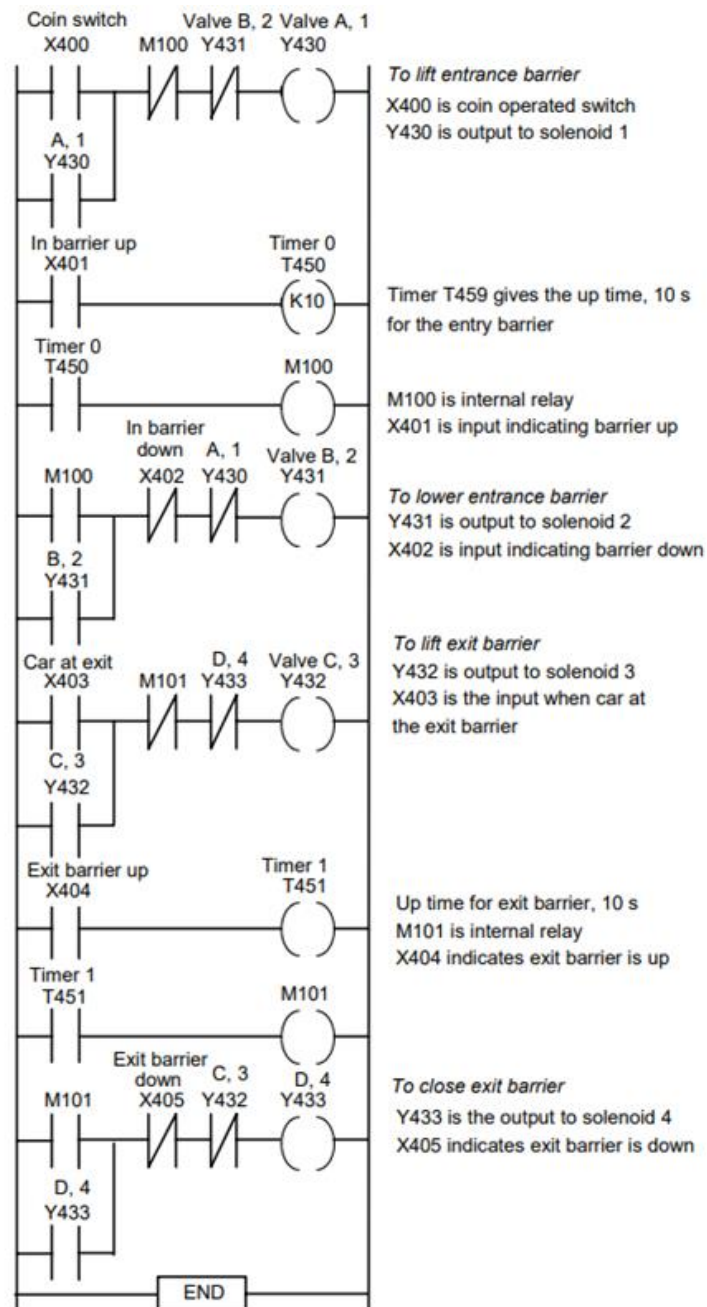
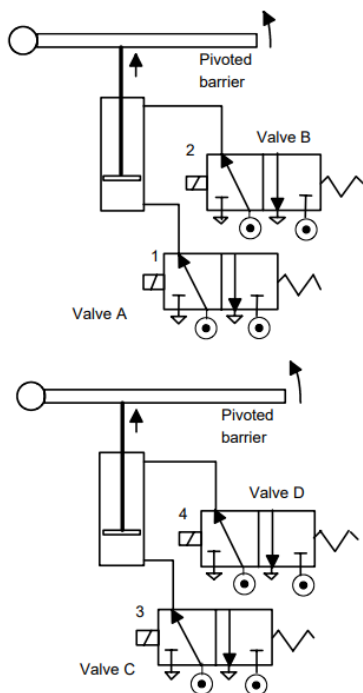
SCADA or Supervisory Control and Data Acquisition is very closely related to HMI or Human Machine Interface in terms that they perform a similar function within a larger industrial process. SCADA essentially forms a network of sensors that monitor equipment and feedback to a user interface for a person to monitor or scalp data for reports and analysis. (David Bailey, 2003) SCADA differentiates from HMI in that it has a focus on data and system overview rather than optimal ease of use for a human being. An example of SCADA in action could be for example the monitoring of temperature and environmental cooling in a large data centre from an office on-site or the monitoring of an automated production line. According to Bou-Harb et al, SCADA is becoming increasingly absorbed by IoT or Internet of Things as industrial process control is becoming increasingly remote. An advantage of keeping SCADA on-site is that it is far more secure as data is held on-site and only accessible locally, whereas IoT with all cloud networks has a potential to be infiltrated meaning security

can be an issue and many companies are hesitant to deploy the technology until cyber security improves. (Elias Bou-Harb, 2020) ✓

Would like more detail and diagram showing a SCADA system.

Instructional List

Instructional lists are one of the main programming languages for PLC's that are defined in IEC 61131-3. (IEC, 2022) As the lists are not graphical in nature, they can be more challenging to use when compared with ladder logic or functional blocks. However, an instructional list is far smaller or condensed in comparison and requires less processing power for a PLC interface to input and process which is useful if size of PLC is a priority of use. The following ladder logic example has been converted into an instructional list below.



Ladder Logic Converted to Instructional List

LD X400
OR Y430
ANI M100
ANI Y431 ✓
OUT Y430 ✓
LD X401
OUT T450 ✓
K 100 ✓
LD T450
OUT M100 ✓
LD M100
OR Y431
ANI X402
ANI Y430
OUT Y431 ✓
LD X403
OR Y432
ANI M101
ANI Y433 ✓
OUT Y432 ✓
LD X404
OUT T451 ✓
K100 ✓
LD T451
OUT M101 ✓
LD M101
OR Y433
ANI X405
ANI Y432
OUT Y433 ✓

*Next time include line spaces
it will make it easier to see the
different sections of the
code.*

Temperature Alarm Panel

A PLC program was created to meet the following specification using functional blocks on Mitsubishi Alpha software:

Table 1 – Alarm Outputs

Temperature Settings (°C)	Blue light	Green Light	Yellow Light	Red Light	Sounder
0 to 25	On				
26 to 50		On			
51 to 70			On		
71 to 100	On	On	On	On	On

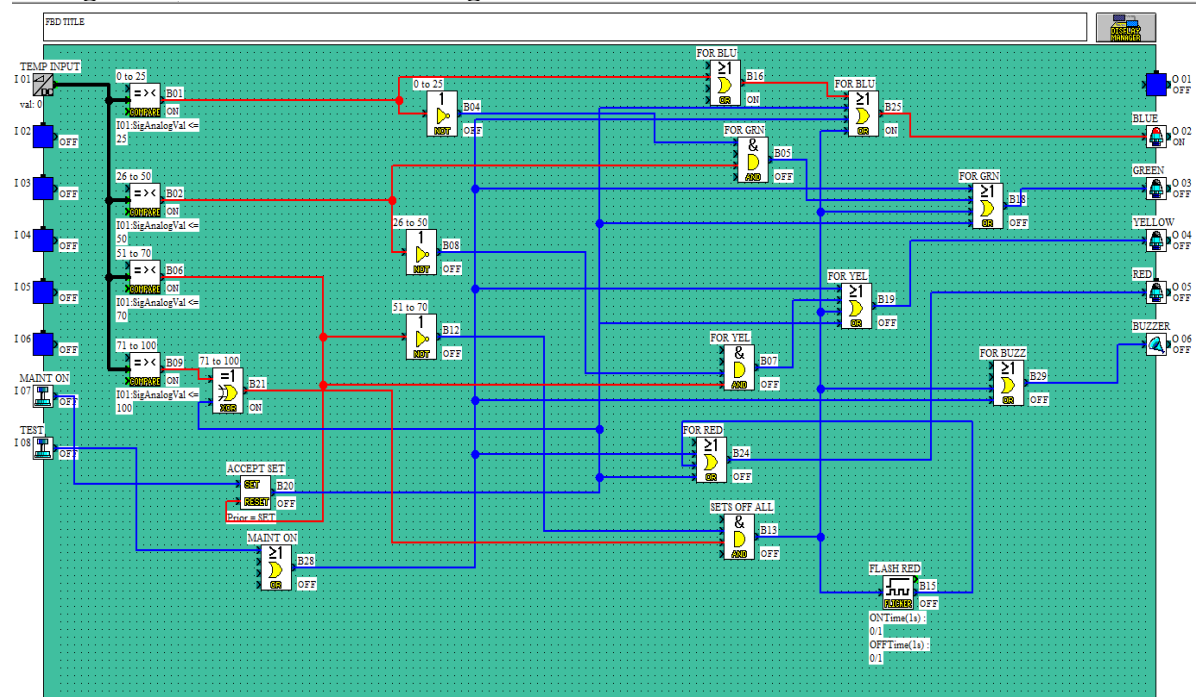
When the temperature is in the highest range all light will be on, the red light will be flashing, and a sounder will be activated.

The system will include the following controls:

- A momentary 'alarm accept' button that should cancel the audible alarm and set the visual alarm from flashing to a steady state condition.

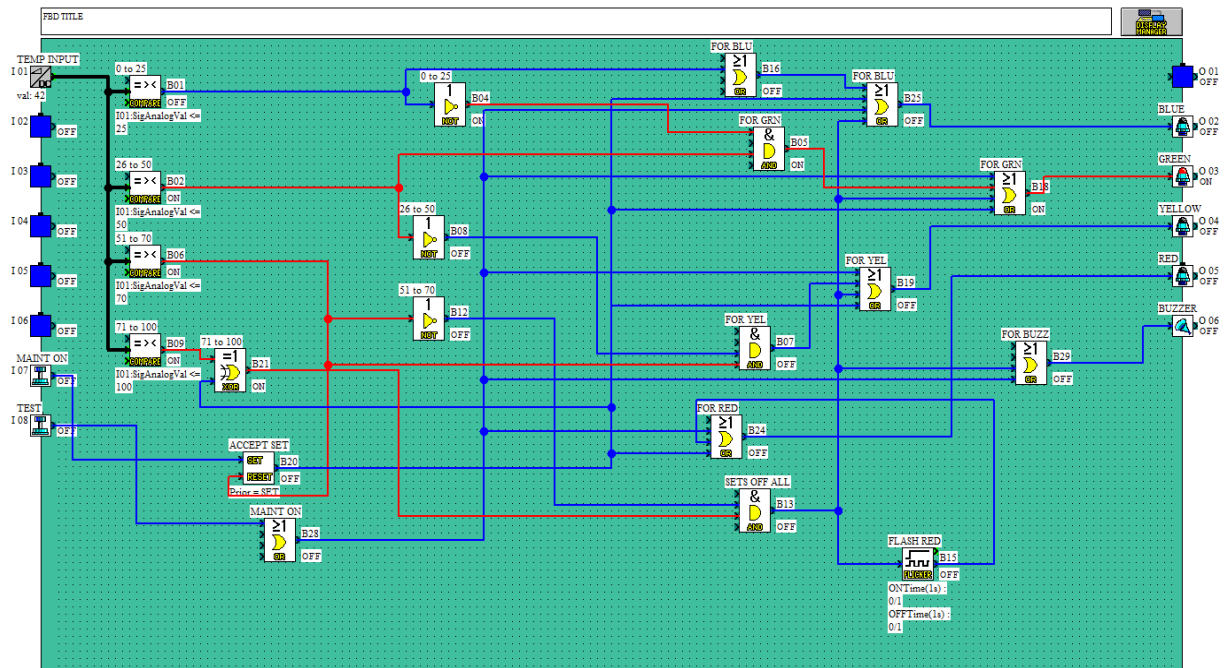
A momentary 'alarm test' button that allows the user to check the lamps and audible alarm are functioning correctly.

The below screen shots show the PLC developed using functional blocks to meet the criteria outlined in the brief. Here the temperature input from the temperature sensor is between 0 and 25 degrees where we see the blue light activated.

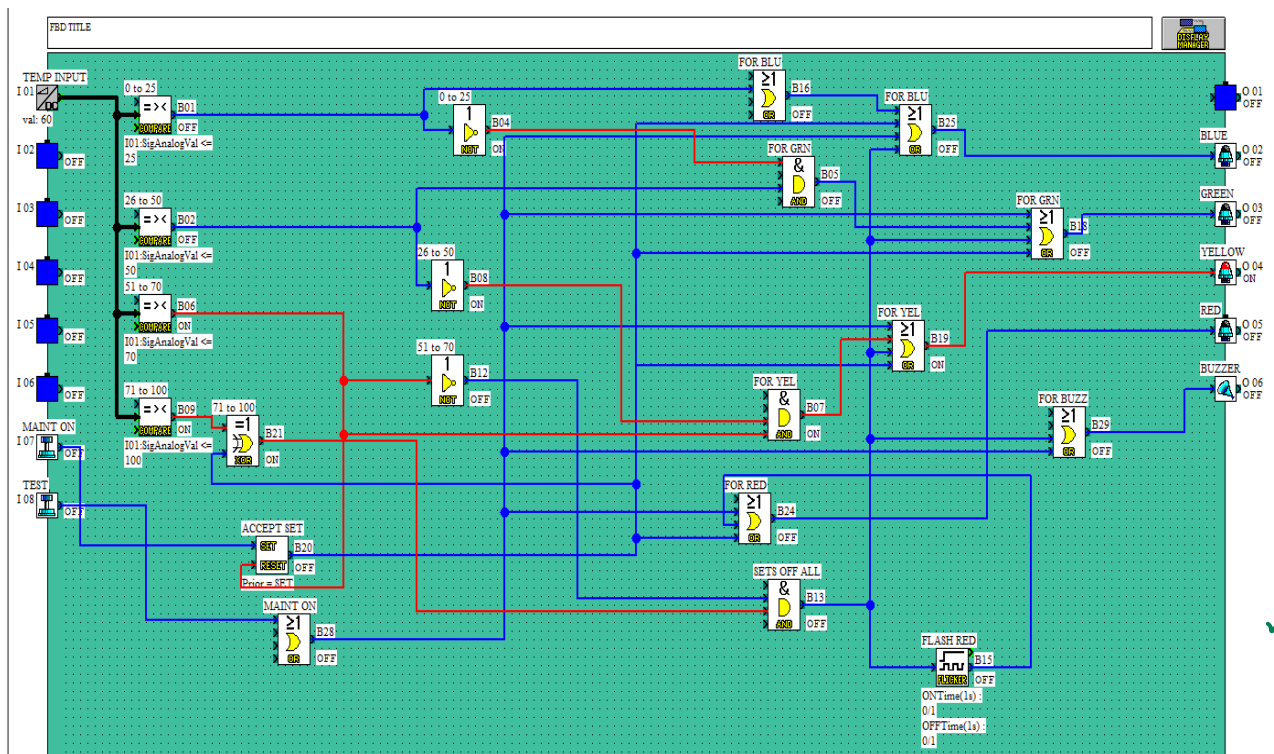


Next the temperature has risen to the next range outline din the brief of 26 to 50 degrees and we see the green light has been activated while blue light has been extinguished.

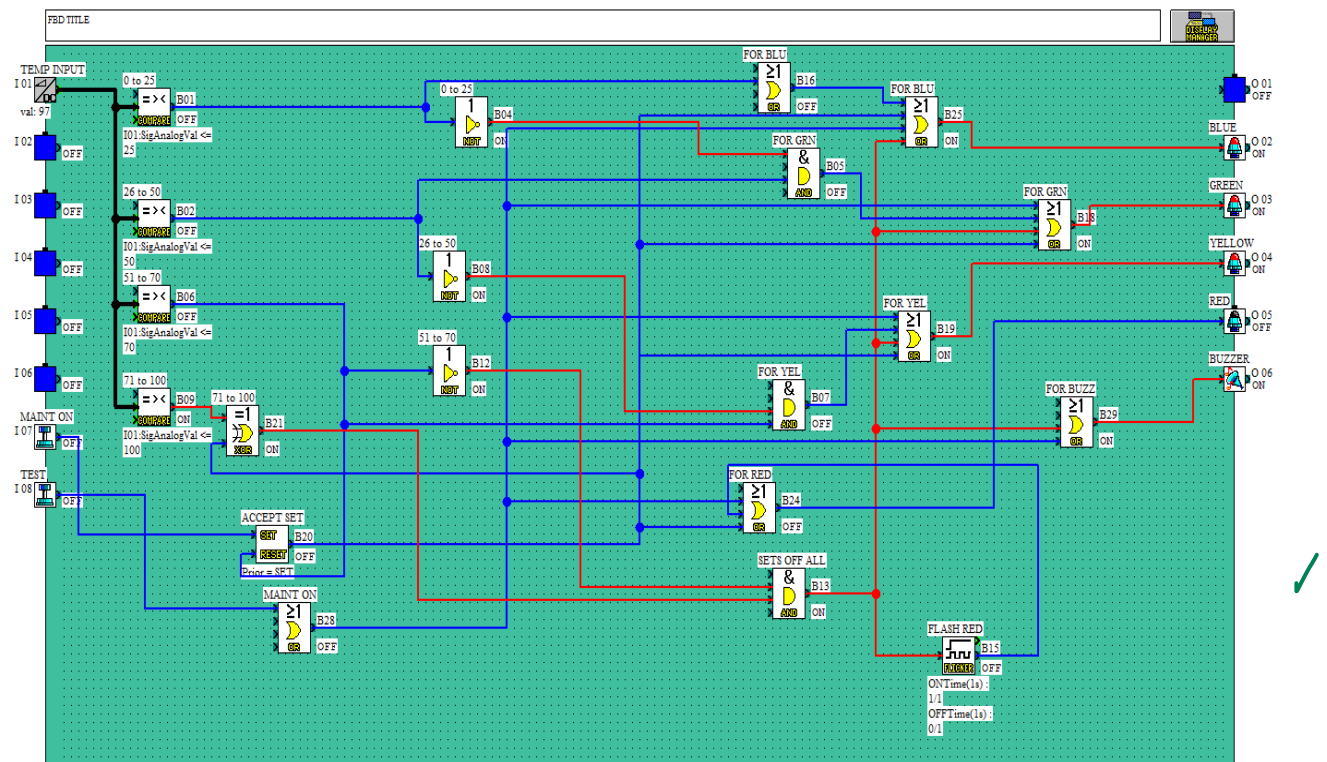
An excellent design.



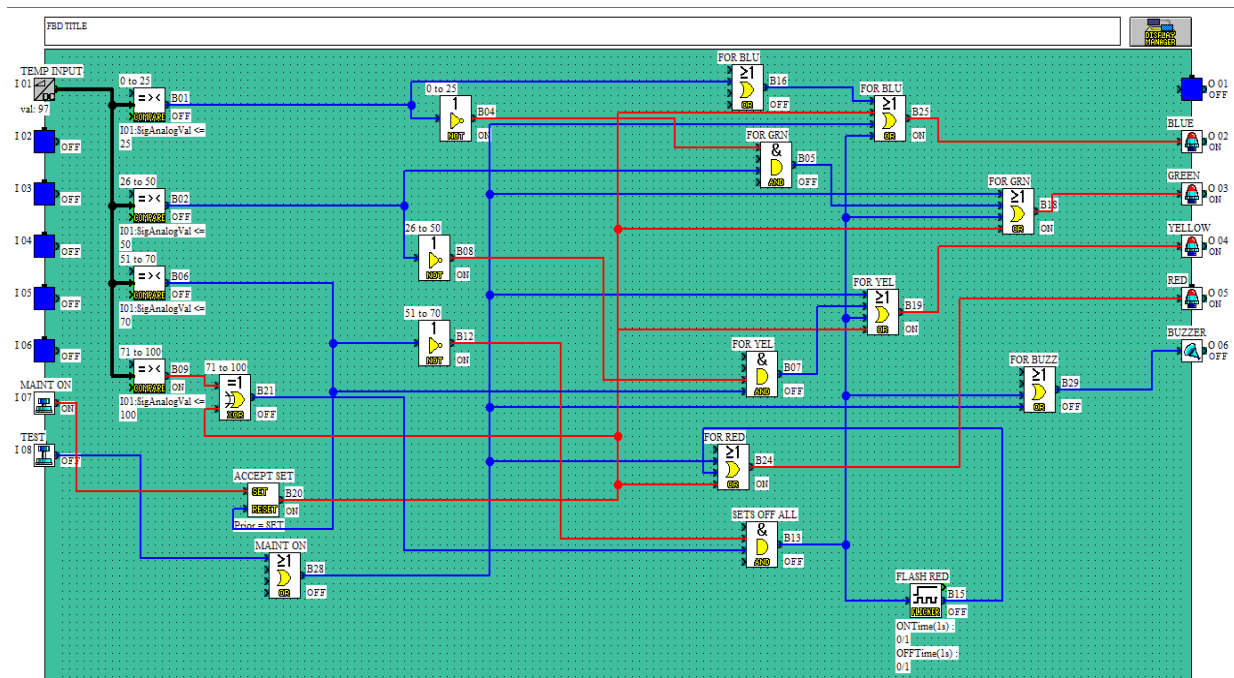
Below the next range of 51 to 70 degrees is input and the yellow light has been illuminated.



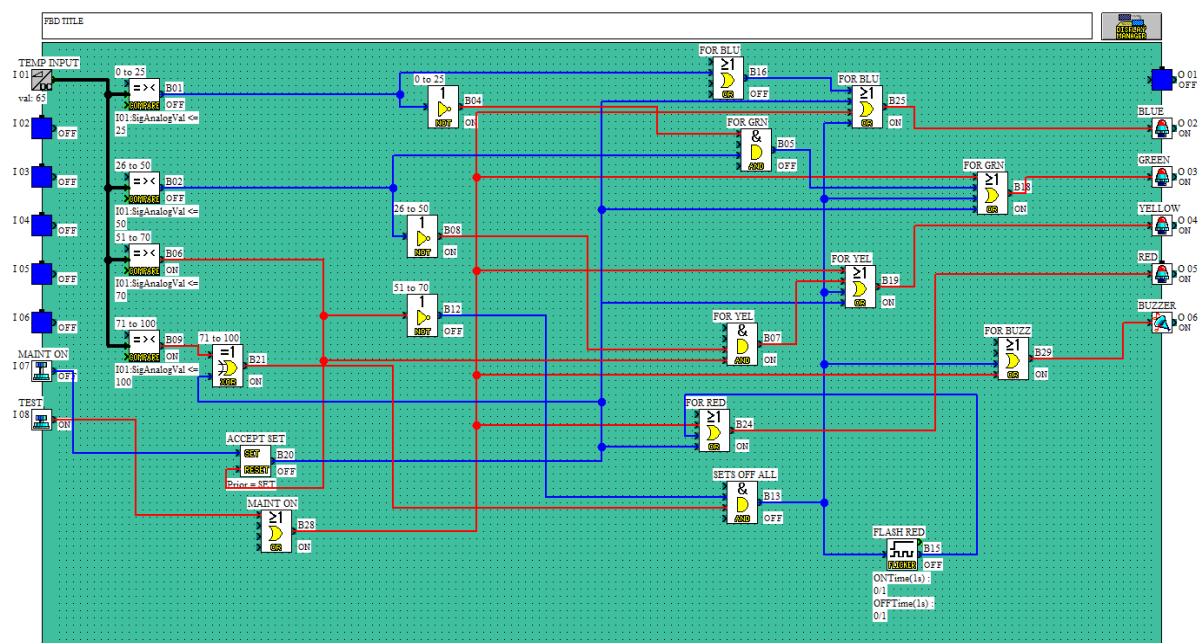
Below screen shot show what happens when the final range of 71-100 degrees is reached everything is activated while the red light will turn on and off for 1 second intervals creating a flashing effect for the red light only.



Below the functionality of the maintenance button is shown below as the lights are shown on while the buzzer is turned off.



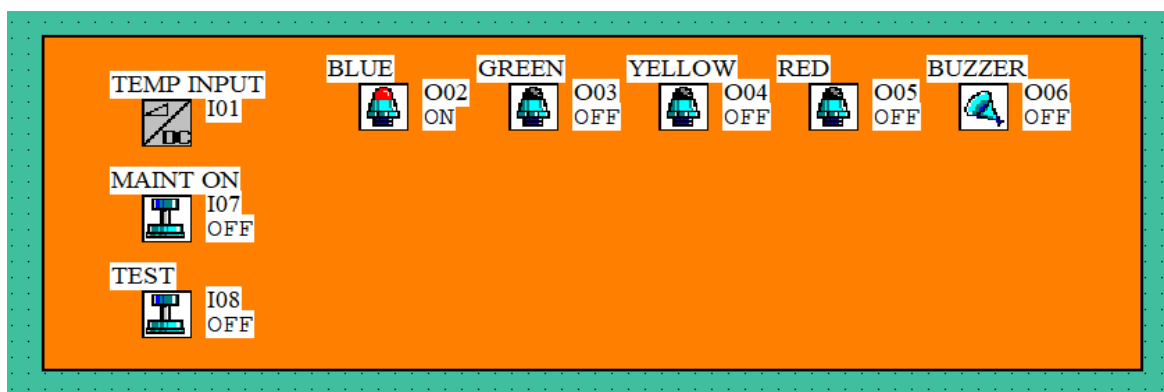
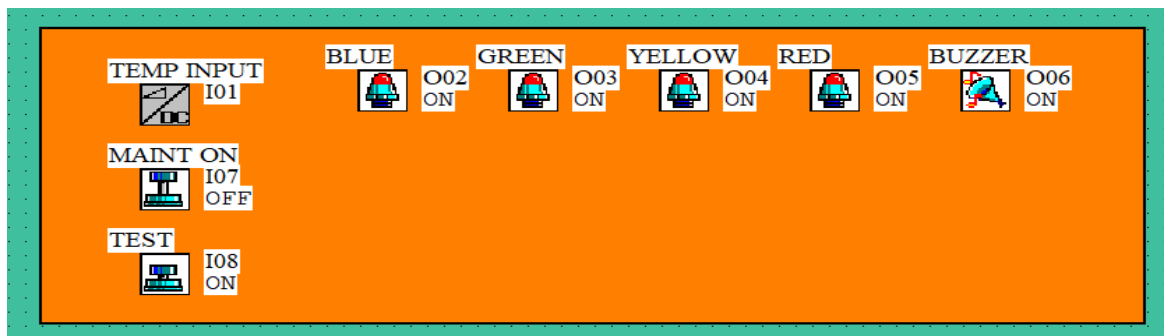
Below the functionality of the test button is shown as when the button has been pressed everything should be turned on confirming the working of all output devices.



Program is fully functional.
Well done.

Below the HMI or Human Machine interface has been implemented using the Mitsubishi alpha software so a user can visually see what is going on without actually having to physically look at the lights or hear the buzzer. They can also remotely set off the test and maintenance buttons offsite making testing and diagnostics easier on a large or hazardous

site. The software on the Mitsubishi alpha software is somewhat lacking in the HMI department and a much better example could be shown using other software but for the purposes of this report it is adequate.



Mitsubishi FX PLC Lift Ladder Logic Program

A PLC program was created to meet the following specification using ladder logic on Mitsubishi GX Works software:

Lift Motor Control: The control system is required to move the lift carriage to the required level on pressing a releasing the appropriate level 'call' button.

1. Prior to operating any switches the lift motor should be stationary with the lift carriage at a fixed level position. The level light should be on to indicate to the operator the current carriage position.
2. On pressing and releasing the 'call' button for a level the motor should engage and move the carriage to that level. During this operation the previous level light should turn off and the new level light will turn on.
3. The door for the lift will be manually opened and closed. When closed the door will be locked in position and cannot be open until the lift is at the required level. There will be a 5 second delay once the lift is in a stationary position before the door lock will disengage and a light will turn on to indicate the door can be opened.

4. The lift cannot move position if the door is open.

Note: A safety feature should be installed in your program to ensure that once the carriage is in motion it cannot be 'called' to any other level until it has completed its transit between levels.

PLC and Simulator Termination

PLC Input		PLC Output	
01	Level 1 call button	01	Motors up
02	Level 1 sensor	02	Motor down
03	Level 2 call button	03	Level 1 indicator light
04	Level 2 sensor	04	Level 2 indicator light
05	Level 3 call button	05	Level 3 indicator light
06	Level 3 sensor	06	Solenoid latch for door
07	Locked door sensor	07	Open door indicator light

Lift System

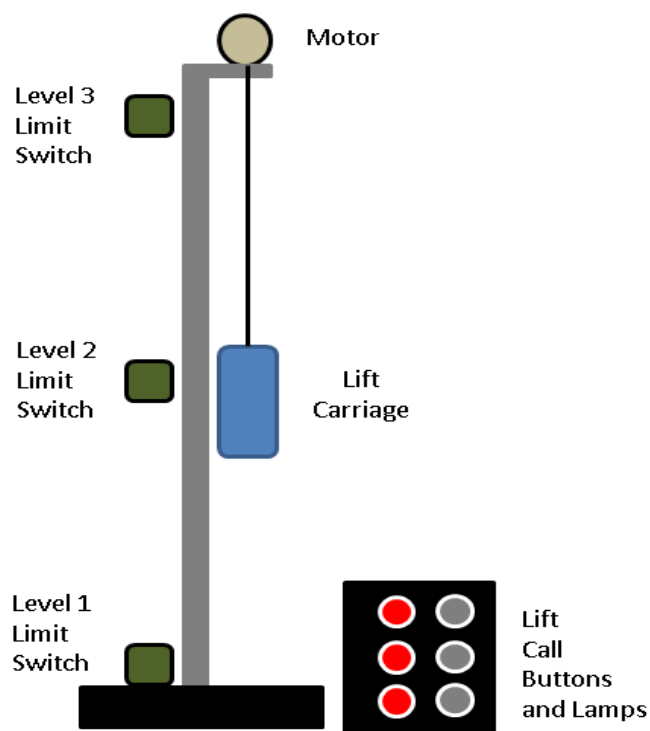
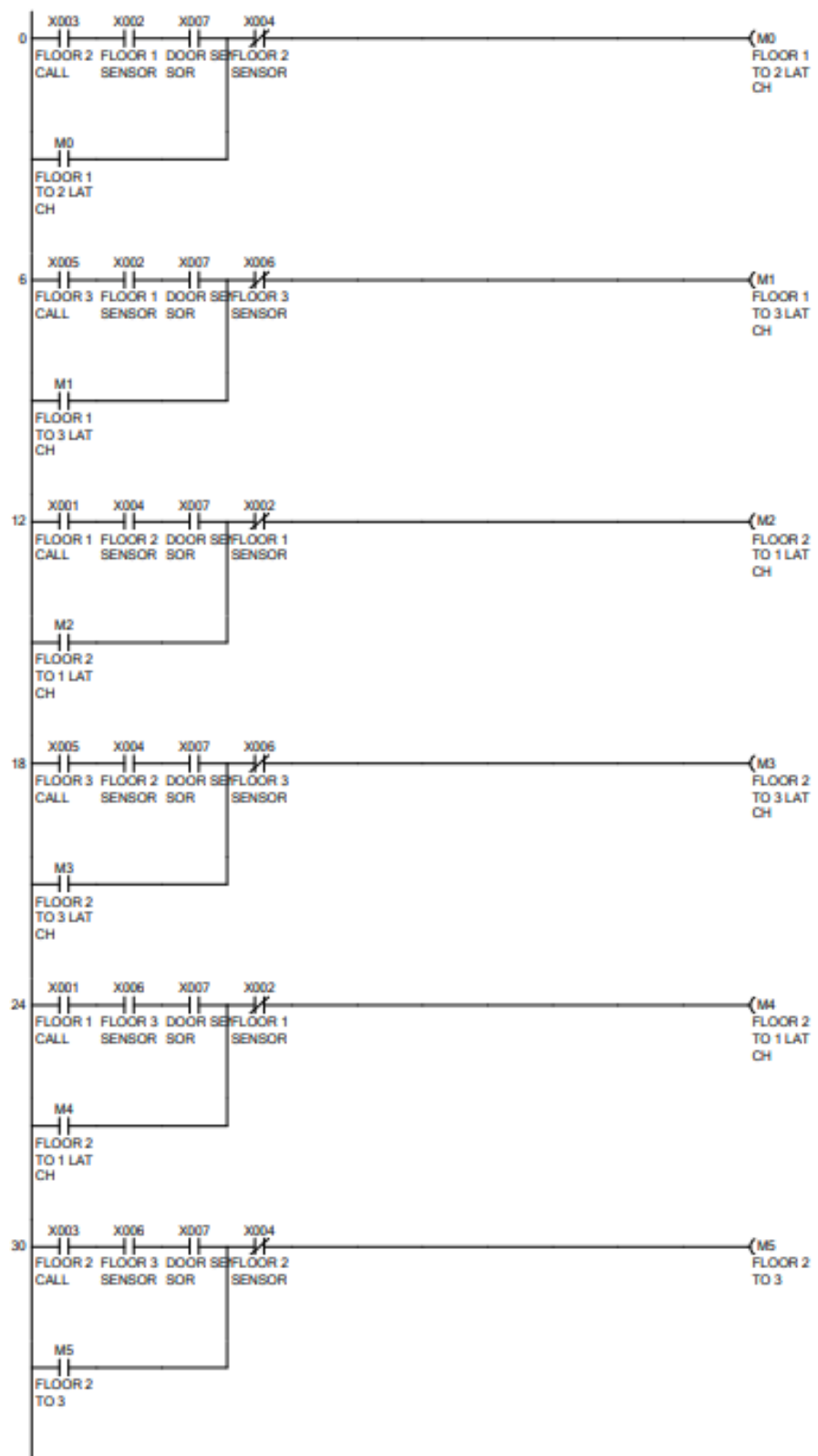
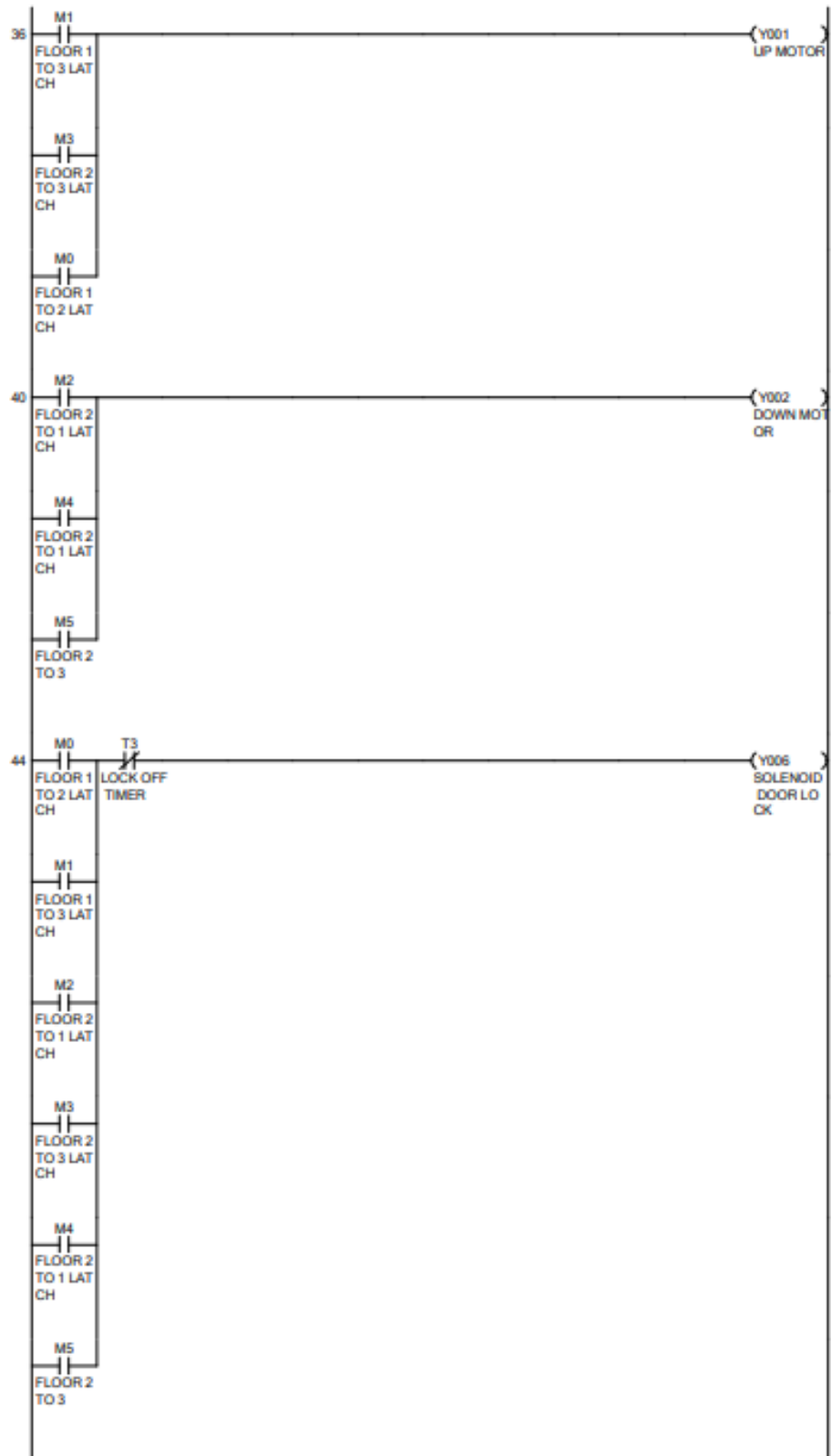
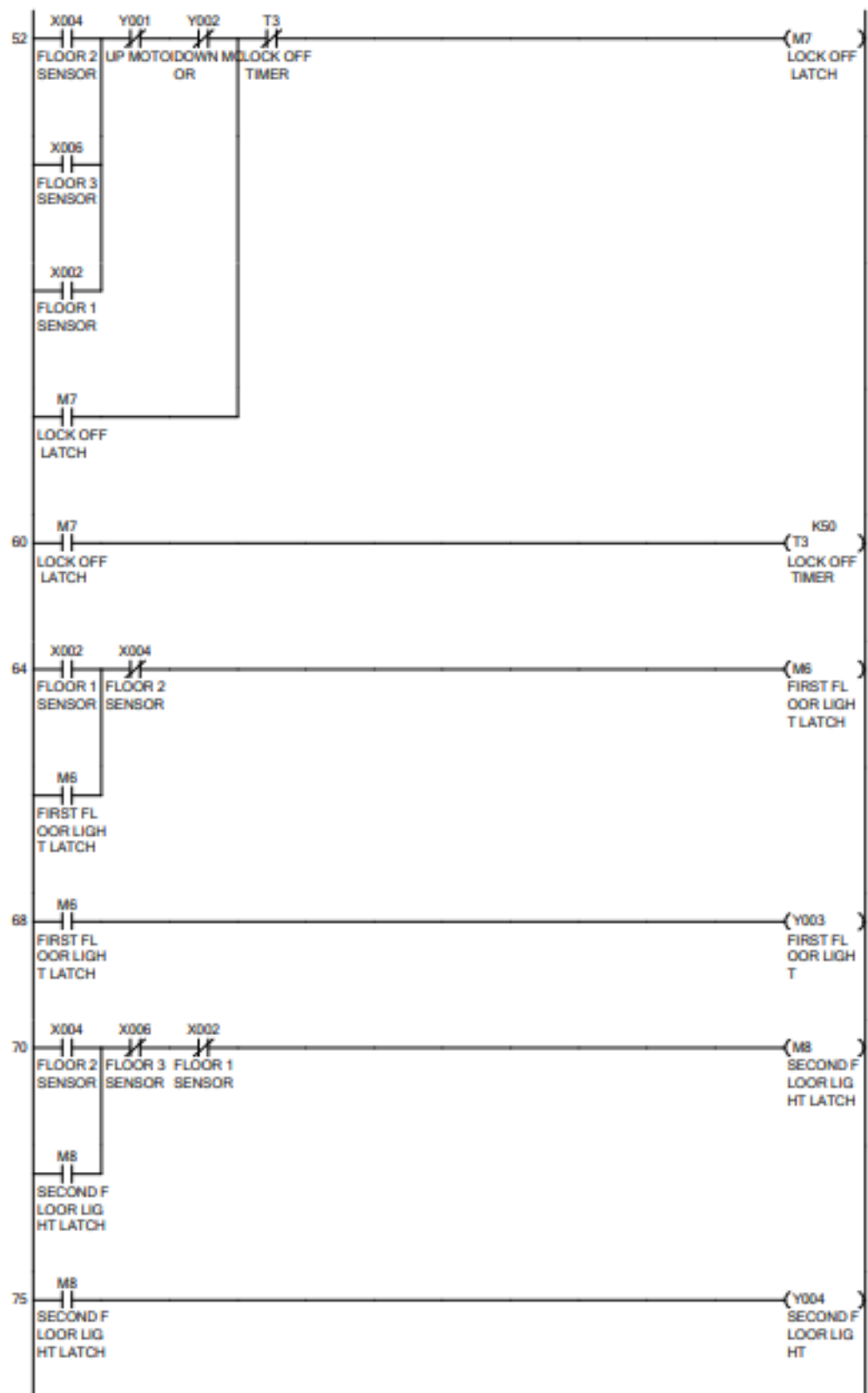


Figure 3 – Lift System

The below diagram is the ladder logic program designed to meet the above criteria set out for the lift system using Mitsubishi GX works 2 software which was confirmed working in workshop with the lecturer who created the brief.



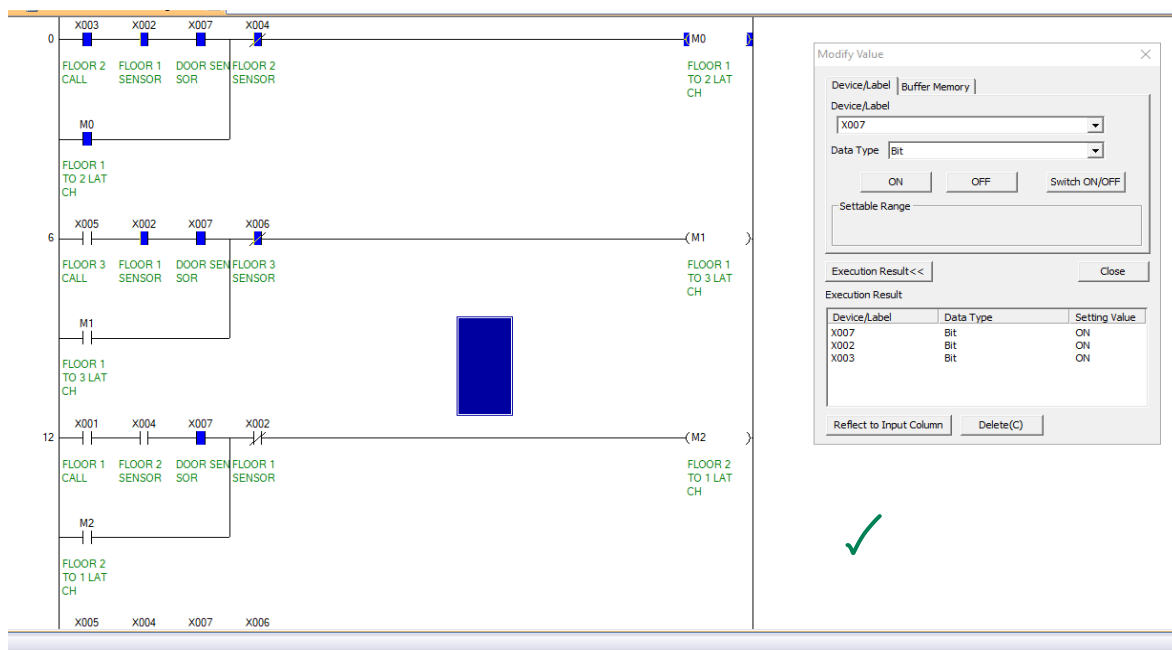




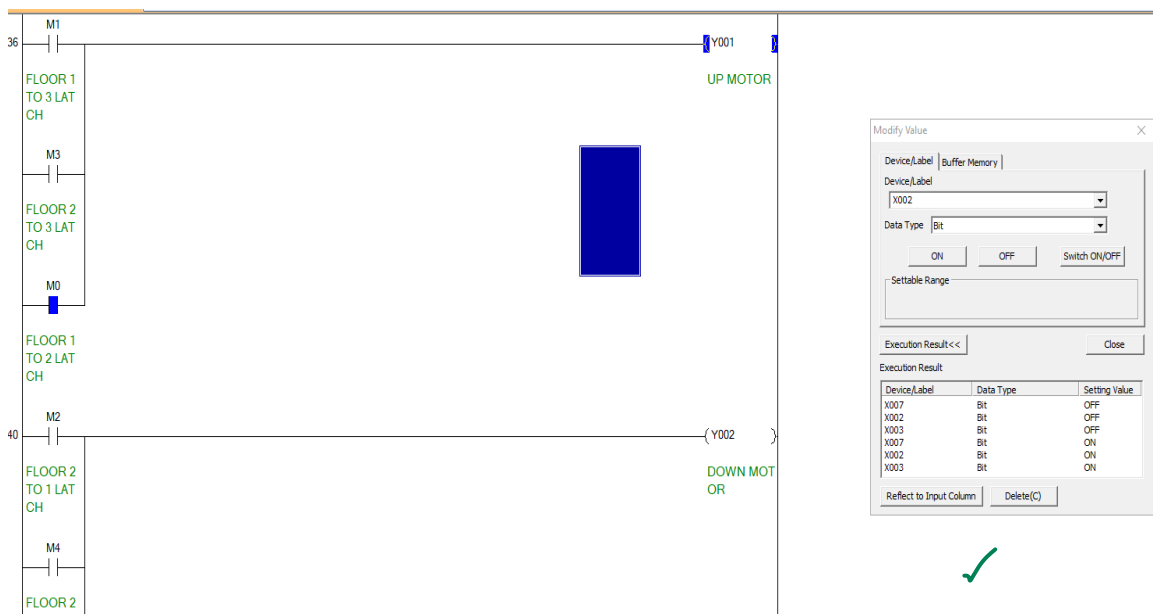


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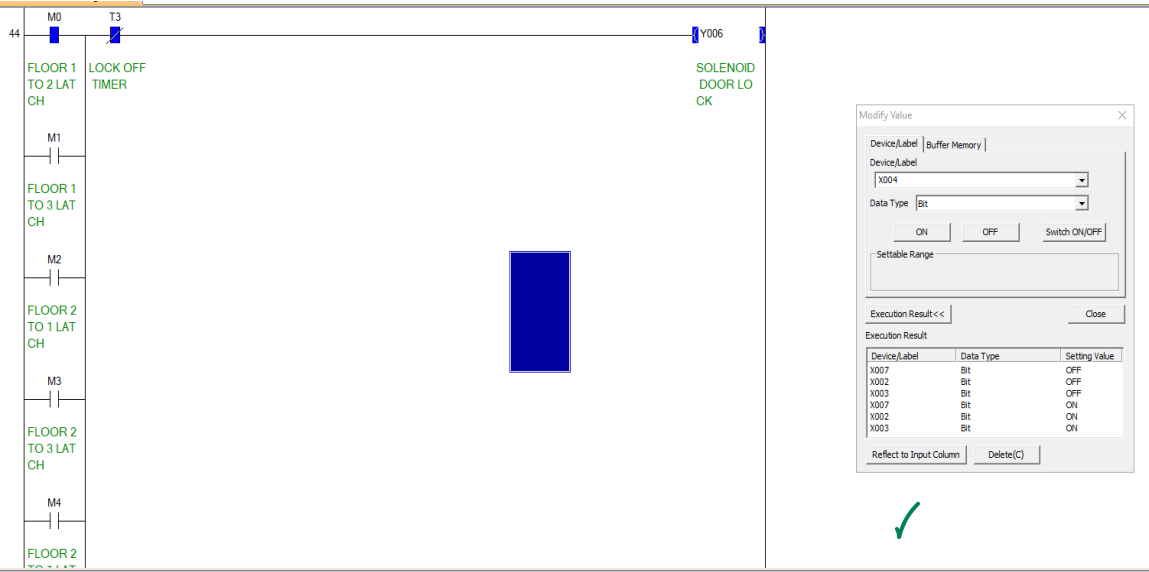
Here the floor 2 call button has been pressed while the floor 1 sensor and door sensor have also been activated. This results in a memory coil latch being activated until the floor 2 sensor in a normally closed state is activated.



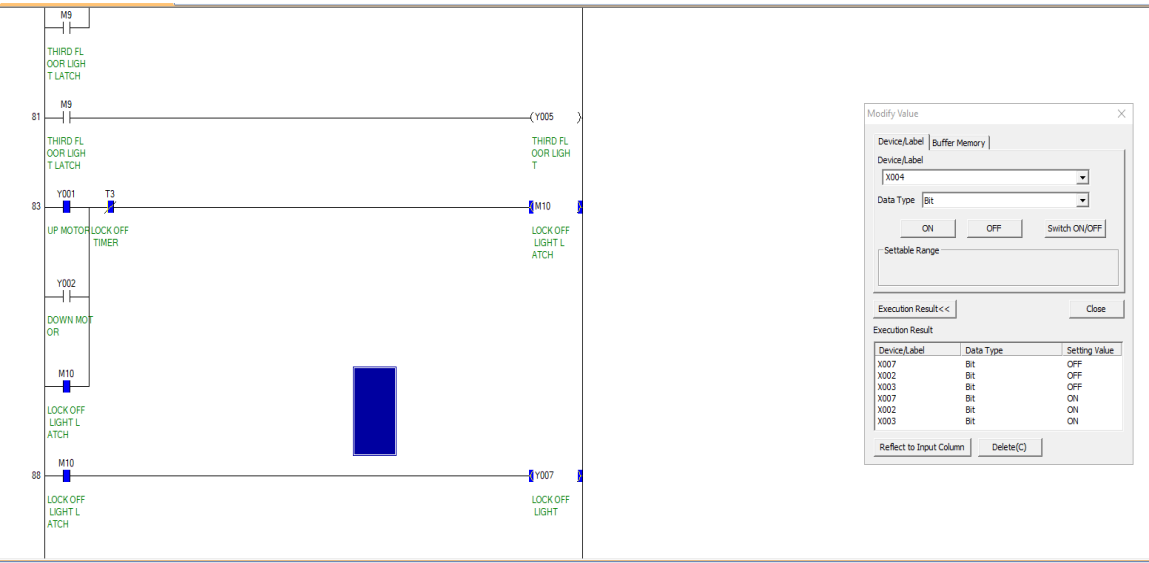
Further down the ladder we can see the activated memory coil activating the up motor.

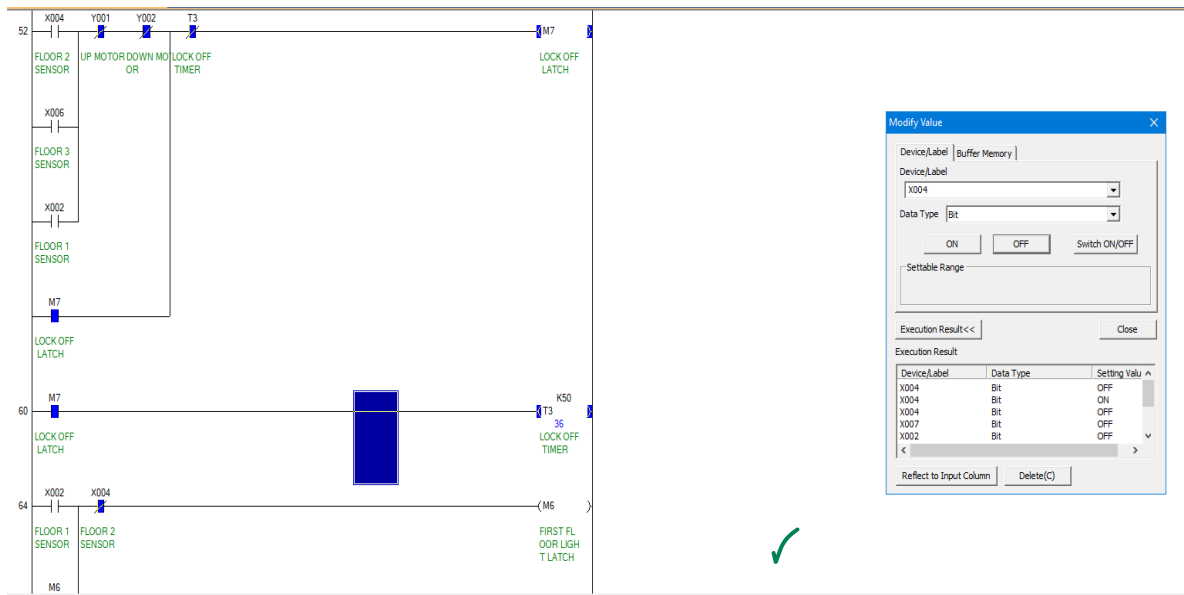


Below we can also see the solenoid door lock being activated meaning the door cannot be opened during motion.

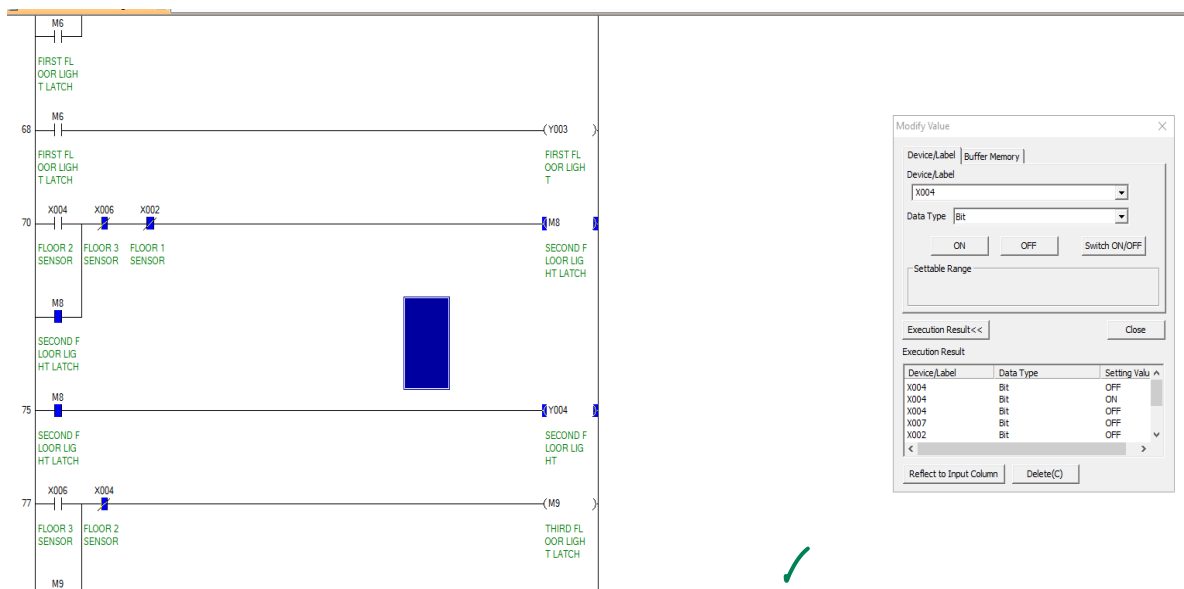


Here we can see the lock off light has been activated after a successful activation of an on-delay arrangement using a 5 second timer to ensure the door cannot be opened before the lift is properly in place.

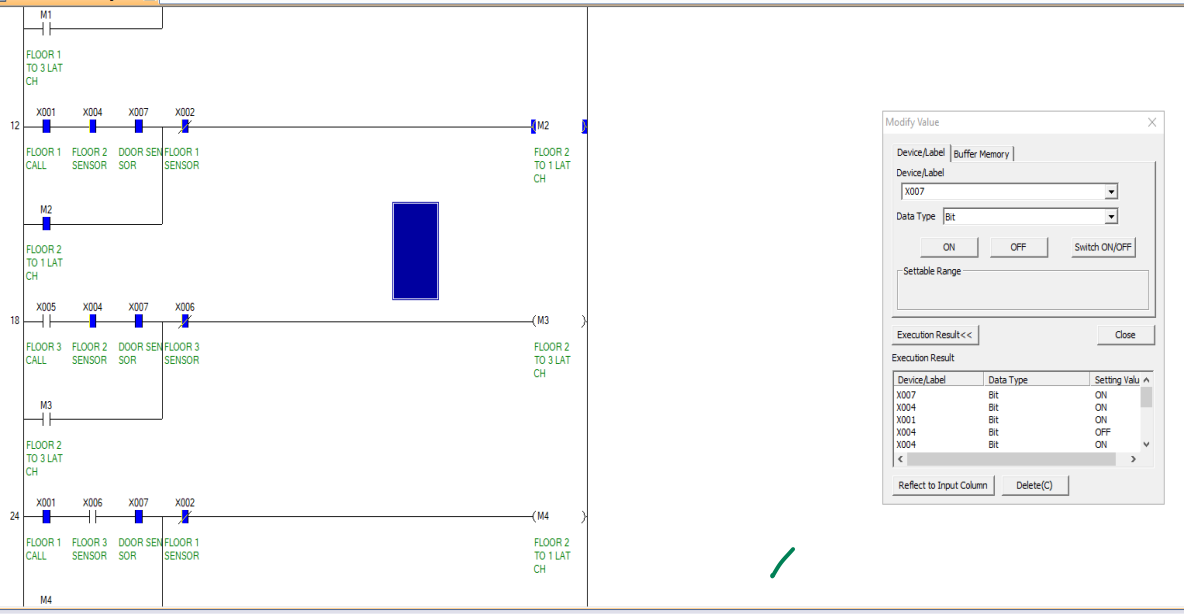




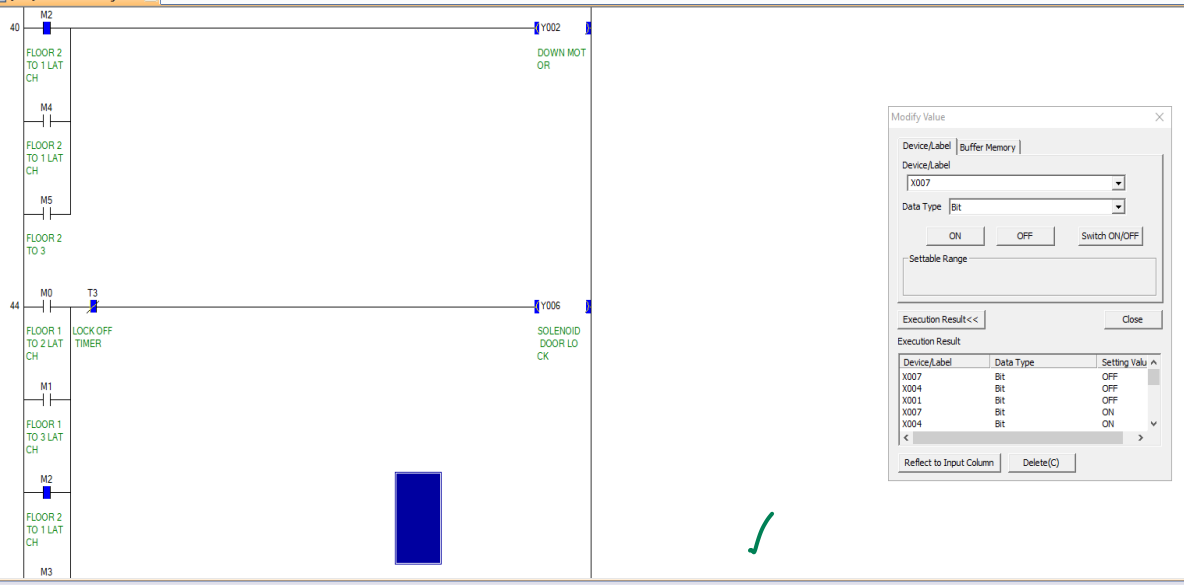
Below the successful activation of the second-floor indicator light basic latch has been activated after the second floor sensor has been activated.



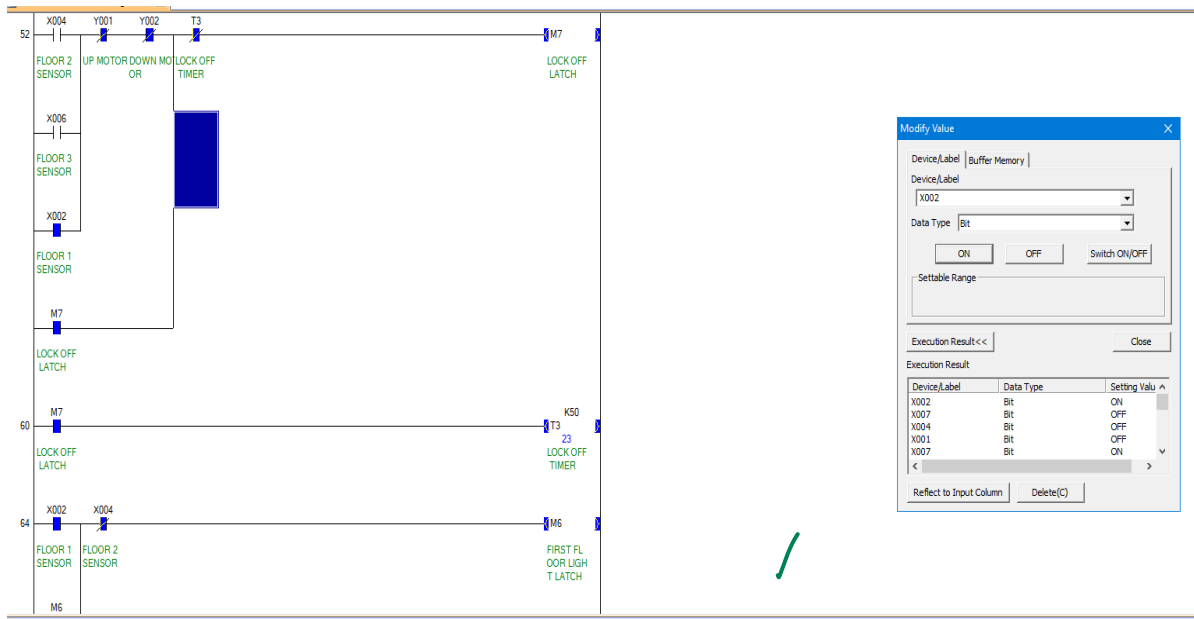
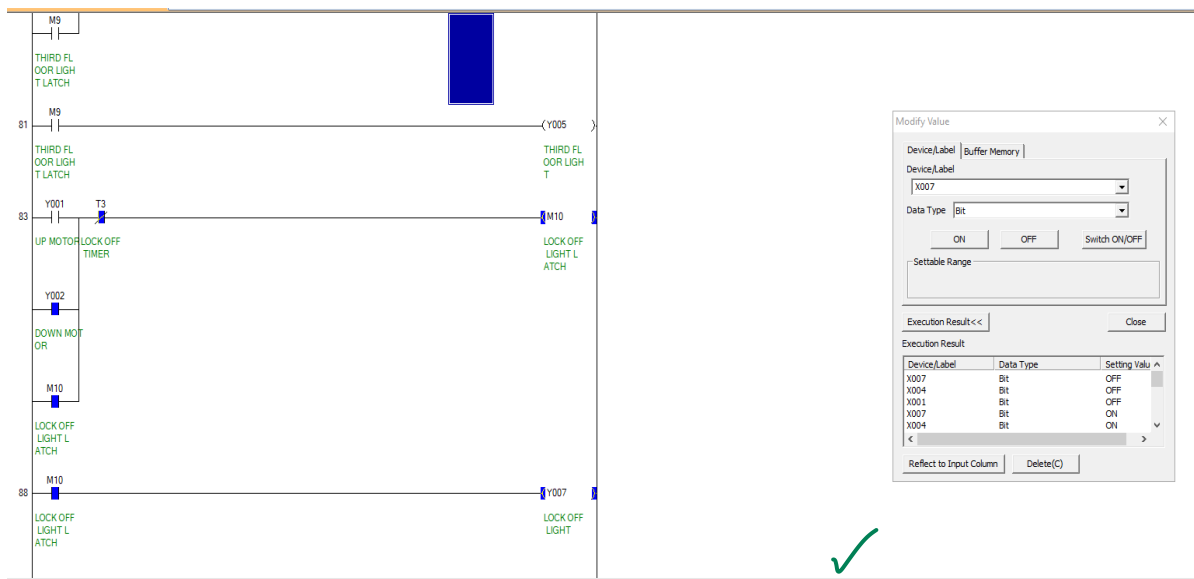
Below the successful activation of the floor 1 call from floor 2 latch can be seen.



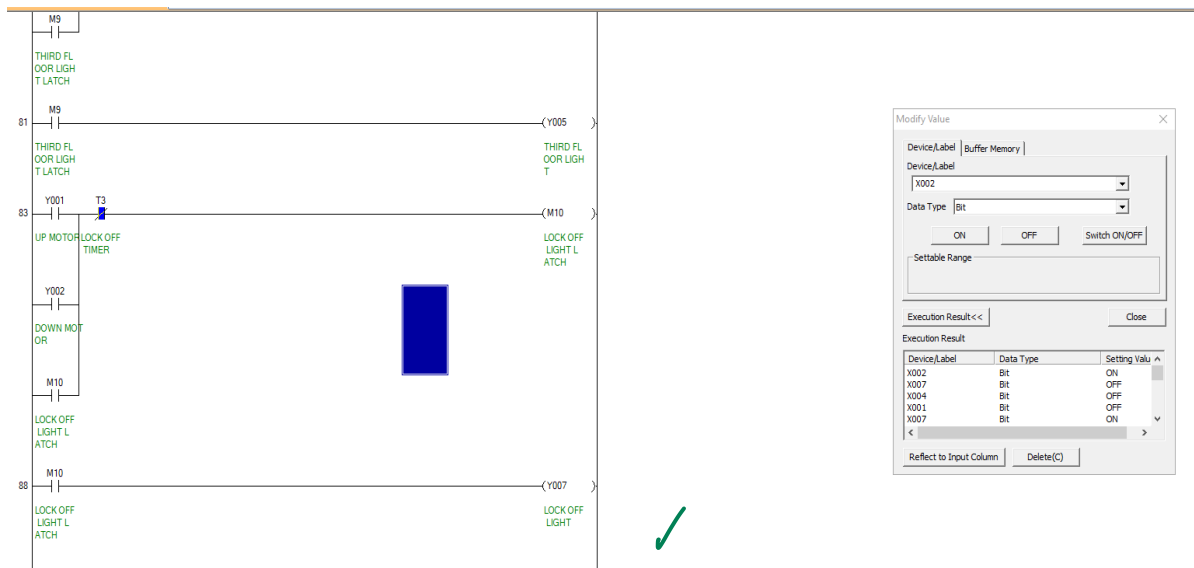
Subsequently, the down motor and solenoid door lock latches can be seen to be activated.



Below, as shown in the up-motor example, the lock off light latch is own to be activated after setting off an on delay latch with a 5 second timer coil and then returning back to normal.



Your program was fully functional but are there any improvement that could be made in the future.



References — this should be on a new page.

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A good selection of text books.

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