MCTA 3203 (MECHATRONICS SYSTEM INTEGRATION)

WEEK 5

TITLE:

Understanding both software and hardware aspects of PLC interfacing with Microcontrollers.

SEMESTER 1, 24/25

SECTION 1 – GROUP 9

LECTURER:
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ABSTRACT

The experiment involves interfacing an open Programmable Logic Controller (PLC) with an Arduino microcontroller. The aim is to create a fundamental ladder diagram using the open PLC software and then upload this diagram onto the Arduino microcontroller. This process integrates the functionalities of both the open PLC and Arduino, potentially demonstrating the compatibility and collaborative operation between these two systems. The ladder diagram likely represents a foundational control logic, showcasing the communication and interaction between the PLC and the Arduino for broader applications in automation and control systems. The experiment focuses on the synergy between an open Programmable Logic Controller (PLC) and an Arduino microcontroller. It involves the design and implementation of a basic ladder logic diagram using open PLC software. This diagram serves as a control program, outlining logic-based control functions. The integration process entails transferring this ladder logic from the open PLC to the Arduino microcontroller. This transfer likely involves translating the ladder logic into a format compatible with Arduino's programming environment, enabling Arduino to execute control instructions based on the defined logic.

TABLE OF CONTENT

OBJECTIVES

1. To implement PLC and microcontroller integration
2. To demonstrate ladder diagram creation and simulation
3. To test the functionality of the start-stop control circuit.

1. INTRODUCTION

This lab report focuses on using OpenPLC Editor software to integrate an Arduino microcontroller with a Programmable Logic Controller (PLC). The primary objective is to build a ladder diagram in the program, model its operation, and then transfer it to an Arduino for real-world use. The goal of this exercise is to use ladder logic to create a Start-Stop Control Circuit. Making a ladder diagram to regulate an LED's blinking is the first step in the experiment using this circuit. A timer block will be added later in the experiment to control the LED's blinking time interval, demonstrating how time-based control components can be used for many uses.

2. MATERIALS AND EQUIPMENT

• OpenPLC Editor software
• Arduino Board
• 2 Push Button Switches
• Jumper Wires
• LED
• Resistors
• Breadboard

3. EXPERIMENT SETUP

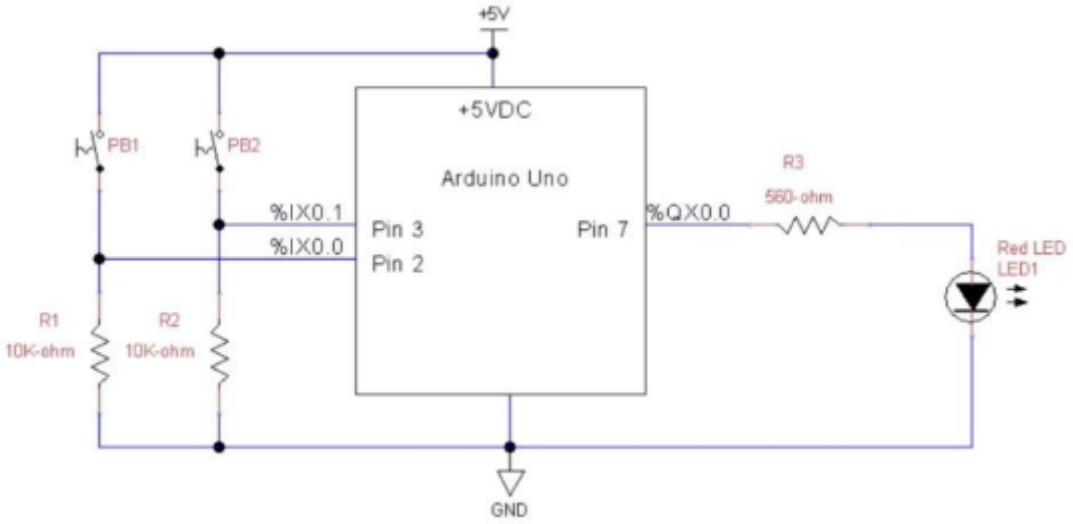


Fig : Start-Stop Control Circuit

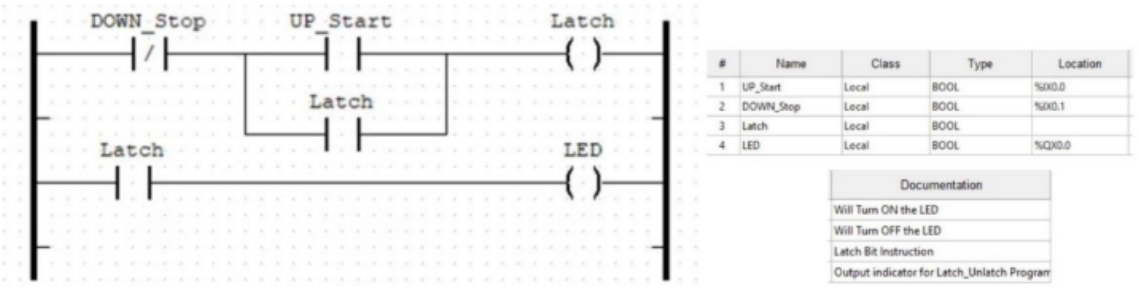
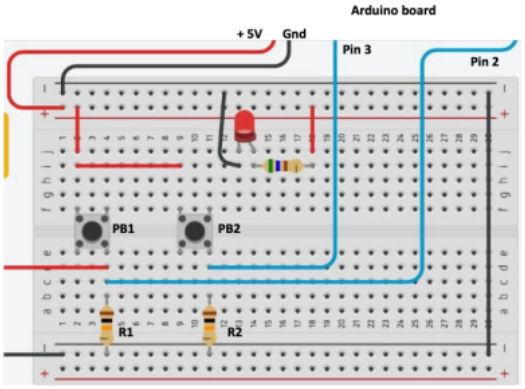


Fig : Ladder Diagram for the Start-Stop Control Circuit

This circuit was made on the breadboard and tested once the ladder diagram was uploaded to the Arduino board, the right COM port number was chosen, and all pin relationships between the OpenPLC variables and the Arduino board were confirmed:



4. METHODOLOGY

Using a ladder diagram made in OpenPLC, we construct a Start-Stop Control Circuit in this experiment. We then compile, simulate, and move the ladder diagram program to the Arduino Board. The pin arrangement for the circuit is displayed. Using an Arduino UNO board, the push buttons are connected to pins 2 and 3. This needs to be typed into the location of the variable associated Digital Output pin on the OpenPLC Editor which is %IX0.0 and %IX0.1 respectively. The same goes for LED going to Pin 7 associated with location %QX0.0. The latch in the ladder diagram function ensures that once the motor LED is light, it remains running until a stop command is given.

PROCEDURE

1. Start a new project in the OpenPLC Editor by creating a new file.
2. Name the file accordingly and select the language of LD (ladder diagram).
3. Create the variables and specify them. Refer the associated pin between OpenPLC variables and Arduino Uno from the OpenPLC Editor website.
4. Start creating the ladder diagram by right-clicking and choosing Add.
5. Compile the ladder diagram.
6. Choose the correct board and COM port number.
7. Press the Transfer to PLC button.
8. Test the functionality and do troubleshooting.

5. DATA COLLECTION

As for the data collection, the behaviour of the LED that was controlled by the ladder diagram's logic, was visually observed during the simulation within the OpenPLC Editor upon transfer to the Arduino board. The focus was on observing the functionality and response of the LED under different ladder diagram applications, such as the addition of the timer and with that the modifications to the blinking time interval

6. DATA ANALYSIS

For example, after we created the ladder diagram in the OpenPLC and uploaded it onto Arduino, we can observe that the LED was blinking rapidly. Therefore, in the exercise part, we have modified the ladder diagram by adding the block timer to increase and control the time interval between each blink. We can detect that the blinking of the LED is slower than the first part as the timer gives some delay to the LED. The operation of the Start-Stop control circuit was checked by engaging with the push buttons and observing the LED's behaviour. Pressing the Start push button should start the process, and pressing the Stop push button should stop it. The start push button will turn on the LED if pressed and the stop push button will turn off the LED if it was pressed.

7. RESULT

The blinking LED ladder diagram was successfully modified, and the timer block was effectively regulated to control the blinking time interval. The Start-Stop control circuit was successfully developed, and the ladder diagram that governs its behaviour was successfully uploaded to the Arduino board without any error. During testing, pressing the Start push button was supposed to start the process, and pressing the Stop push button was supposed to stop it. As we already expected and predicted, If the start push button is pressed, the LED will turn on, and if the stop push button is pressed, the LED will turn off.

In short, this experiment exhibits a successful synergy of open-source PLC programming (OpenPLC), ladder logic diagrams, and Arduino-based microcontroller technology, demonstrating a smooth integration for operating a physical circuit. This successful integration demonstrates OpenPLC's usefulness as a programming platform for controlling industrial processes, as well as the Arduino board's suitability as a microcontroller in this configuration.

8. DISCUSSION

- **ArduinoUNO**
  The experiment utilises the Arduino UNO board as the central hardware platform. Connected to this board are two push buttons, strategically wired to pins 2 and 3. Additionally, an LED is connected to Pin 7 on the Arduino UNO board, serving as an output device.

- **Software Configuration- OpenPLC Editor**
  To interface the hardware with the control logic, the OpenPLC Editor is employed. The push buttons, acting as input devices, are mapped to specific digital input pins in the OpenPLC Editor, namely %IX0.0 and %IX0.1. Simultaneously, the LED, functioning as an output device, is associated with a digital output pin, identified as %QX0.0. This software configuration enables communication between the physical world (Arduino) and the control logic programmed in the OpenPLC Editor.

- **LadderDiagram and Latch**
  The ladder diagram incorporates a latch mechanism to ensure a robust Start-Stop functionality. When the "Start" push button is pressed, the associated digital input is activated (%IX0.0), initiating the latch and turning on the LED (%QX0.0). Importantly, this latch ensures that even if the "Start" push button is released, the LED, representing a motor, remains powered

9. CONCLUSION

In conclusion, the experiment successfully demonstrated the integration of an open Programmable Logic Controller (PLC) with an Arduino microcontroller. By creating a basic ladder logic diagram using open PLC software and uploading it onto the Arduino, the experiment showcased the interoperability and collaborative potential of these two distinct control systems. Effective integration of an open Programmable Logic Controller (PLC) with an Arduino microcontroller is demonstrated through experiments, which supports the theory. A seamless control logic implementation demonstrated on the Arduino platform confirms that ladder logic diagrams can be transferred and implemented from open PLC software to Arduino. The results match the predictions, showing that it is possible and functional to integrate these two control systems. The experiment underscores the potential for open-source platforms to collaborate effectively. This could lead to increased adoption of open-source control solutions in industrial settings, where traditionally proprietary systems have dominated.

10. RECOMMENDATION

1. Expand and Diversify Control Logic:

Additional features and functionalities could be integrated into the control logic which involved adding more sensors and implementing more complex control algorithms into the experiment. This will provide a broader understanding of the capabilities of OpenPLC and Arduino in industrial automation to generate the output desired.

2. Optimization and Efficiency:

Evaluate the efficiency of the ladder logic and Arduino code by optimizations to improve the performance of the control system. Improve efficiency usually involves refining the timer settings, reducing unnecessary delays, or streamlining the ladder diagram for better clarity and functionality.

3. Documentation and Reproducibility:

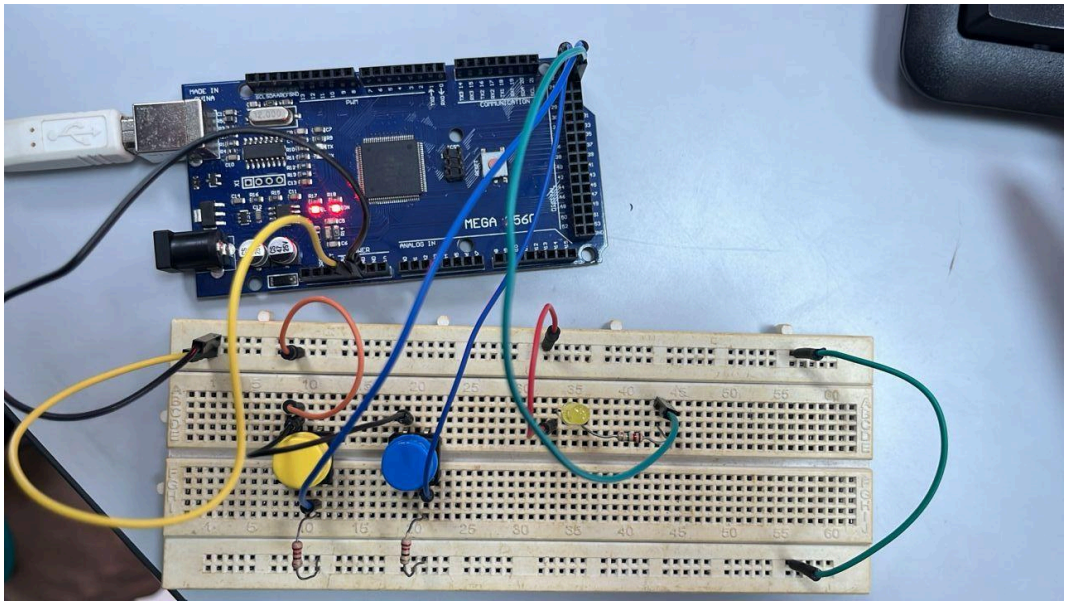
The ladder diagram and the entire setup could be documented thoroughly including detailed instructions on the experiment's steps. It can serve as a valuable resource for revision and further studies on the use of the connection between the PLC and Arduino. It should be a guide that highlights the key points in the integration process like the specific configurations, settings, or dependencies that might be crucial for success.

By implementing these recommendations, we can improve the system's reliability and efficiency. Hence, it will reduce the errors that might occur in the future.

11. REFERENCES

- Zulkifli. (2014). Mechatronics Interfacing Lab Manual, (Rev. ed.). Unpublished Class Materials

12. APPENDICES



The final result for the start-stop control circuit

13. ACKNOWLEDGEMENT

We want to thank everyone who helped, guided, and supported us throughout this endeavour. First and foremost, we thank Assoc Prof Dr. Zulkifli Bin Zainal Abidin and also Dr. Wahyu Sediono for providing extensive guidance and supervision during the experiment. Their comments, suggestions, and excitement helped us understand Arduino programming.

Our fellow group members deserve special recognition for their teamwork and support. Our conversations, information sharing, and problem-solving sessions dramatically improved our understanding of the experiment's topics and the overall learning experience. Our group members' joint efforts not only enhanced our learning experience, but also greatly contributed to the effective completion of this project.

14. STUDENTS DECLARATION

Certificate of Originality and Authenticity

This is to certify that we are **responsible** for the work submitted in this report, that **the original work** is our own except as specified in the references and acknowledgement, and that the original work contained herein have not been untaken or done by unspecified sources or persons.

We hereby certify that this report has **not been done by only one individual** and **all of us have contributed to the report.** The length of contribution to the reports by each individual is noted within this certificate.

We also hereby certify that we have **read** and **understand** the content of the total report and no further improvement on the reports is needed from any of the individual's contributors to the report.

We therefore, agreed unanimously that this report shall be submitted for **marking** and this **final printed report** has been **verified by us.**

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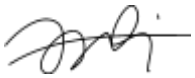
SIGNATURE		
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