MECHATRONICS SYSTEM INTEGRATION (MCTA 3203)

SEMESTER 1 2024/2025

WEEK 5: PLC INTERFACING

SECTION 2

GROUP 8

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ABSTRACT

This project demonstrates the development of a Start-Stop control circuit using ladder logic implemented in the OpenPLC environment and deployed on an Arduino Mega 2560. The setup involves designing a ladder diagram with basic control components using start and stop push buttons, a latching relay coil and an LED as the output. The project guides through configuring input and output variables, compiling and simulating the ladder logic within OpenPLC. It further includes uploading the compiled program to the Arduino, building the circuit on a breadboard and mapping pins for control. The experiment provides a hands-on approach to using programmable logic control (PLC) concepts for automation tasks on embedded systems, illustrating the principles of relay latching, circuit control and digital input-output management on Arduino hardware.

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INTRODUCTION

In the constantly evolving field of industrial automation, Programmable Logic Controllers (PLCs) are crucial in controlling and automating complicated electromechanical operations. This research analyses the critical components of connecting a PLC to a microcontroller, with an emphasis on hardware and software integration. Using the OpenPLC Editor and Arduino hardware, the project illustrates fundamental abilities in developing, modelling, and implementing ladder diagrams for specific control functions.

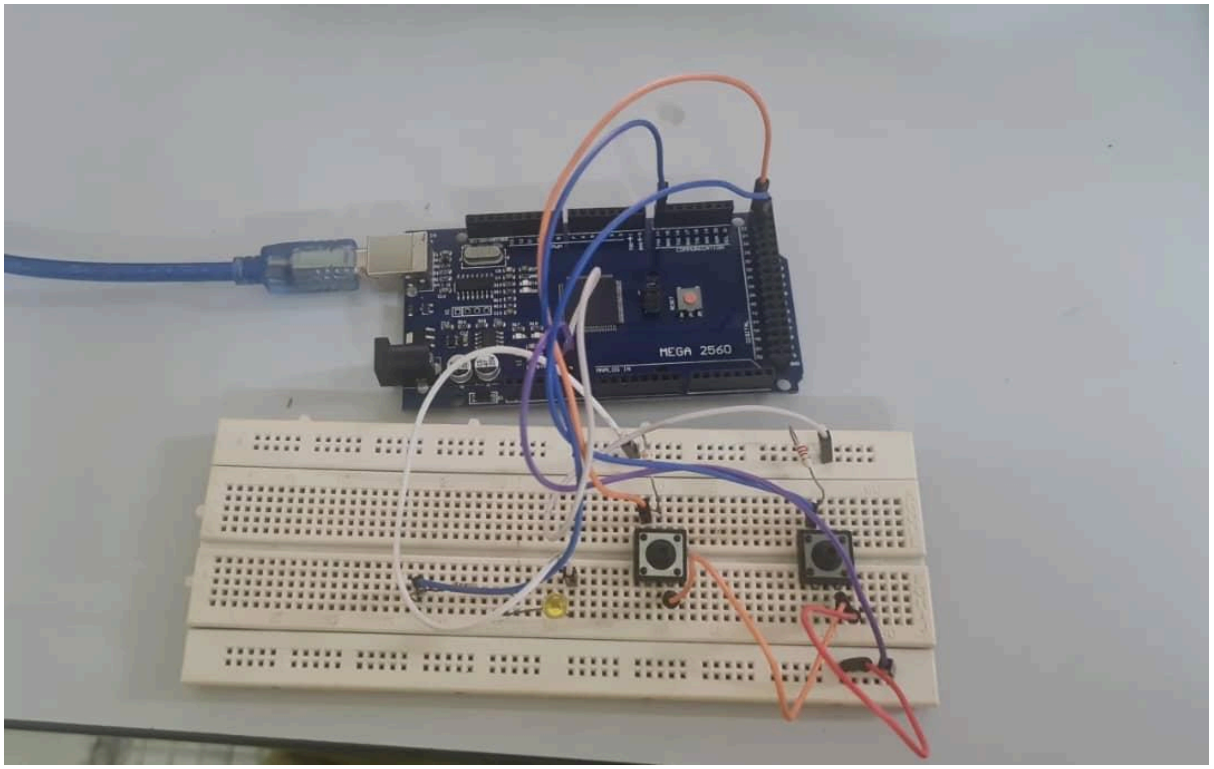
This practical exercise, which includes constructing a Start-Stop Control Circuit, provides students with hands-on experience with PLC programming principles such as establishing digital inputs and outputs, associating physical pins, and evaluating circuit operation. The results of this job demonstrate the value of PLCs in a variety of automation applications, particularly when combined with microcontroller technology to create cost-effective, dependable control systems.

MATERIALS AND EQUIPMENTS

1. ARDUINO MEGA 2560
2. PUSH BUTTON
3. LED
4. RESISTOR
5. BREADBOARD

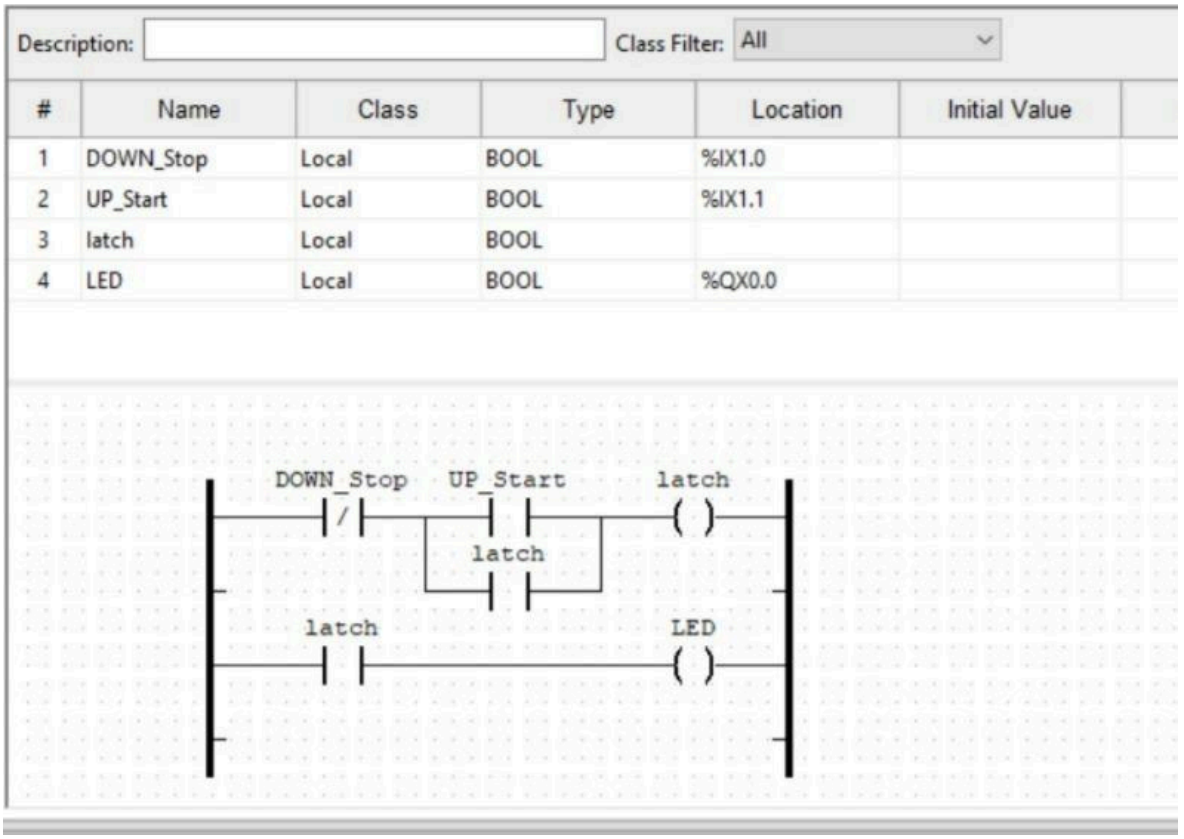
EXPERIMENTAL SETUP

1. **Button and LED setup**
    - Connect the LED's anode with a resistor to pin D14 on the Arduino
    - Connect the LED's cathode to the GND on the Arduino
    - Connect one of the first Button's legs to the A13 on the Arduino
    - Connect one of the second Button's legs to the pin A14 on the Arduino



METHODOLOGY

1. Setup the Arduino Mega 2560, push button and LED
2. PLC implementation
3. Testing
4. UP_Start will turn on the LED
5. DOWN_Stop will turn off the LED
6. PLC diagram



DATA COLLECTION

UP_Start	DOWN_Stop	Led
-	-	off
pushed	-	on
released	-	on
-	pushed	off

DATA ANALYSIS

From the collected data:

1. When the **Start Push Button (**UP_Start**)** is pressed, it sends a TRUE input to the circuit, allowing current to flow. This activates the latch and turns the LED **ON**.
2. After releasing the UP_Start, it no longer sends a TRUE signal. However, the LED remains **ON** because of the latching mechanism in the circuit. The latch creates a parallel path for the current, maintaining the circuit's state even when the start button is no longer pressed.
3. When the **Stop Push Button (**DOWN_Stop**)** is pressed, it breaks the circuit or disables the latch, causing the LED to turn **OFF**. This stops the current flow and resets the system.

This mechanism is commonly referred to as **latching mode**. The latch ensures that the LED remains in its current state (ON or OFF) until a specific action (pressing Stop_PB) explicitly changes it. This behaviour is typical in control circuits, such as motor starters or toggle switches.

RESULT

In this experiment, we successfully designed, simulated, and implemented a Start-Stop Control Circuit using the OpenPLC Editor software interfaced with an Arduino board. Following the setup instructions, the Start and Stop push buttons were configured to control an LED. The ladder logic was developed in OpenPLC Editor, where we created the necessary power rails, contacts, and coil as illustrated in the circuit diagram.

Upon compiling and simulating the ladder diagram in OpenPLC Editor, we verified the control sequence and proper function of the Start-Stop logic. After uploading the ladder diagram to the Arduino, the hardware circuit was assembled with the specified pin configurations, and the correct COM port was selected for communication.

Testing confirmed that pressing the Start button successfully powered on the LED, while pressing the Stop button turned it off, demonstrating the functionality of a Start-Stop control circuit on an Arduino. This exercise effectively showcased the integration of PLC logic with microcontroller hardware and provided hands-on experience in configuring control circuits for automation tasks.

DISCUSSION

The experiment was generally successful in demonstrating basic PLC to microcontroller interfacing and ladder logic application. The blinking LED and start-stop circuit both functioned as expected, illustrating how PLC programming principles can be used for straightforward automation tasks. This experiment has implications for broader applications, as it shows how microcontrollers like Arduino can perform control tasks when integrated with OpenPLC. It provides a foundation for more complex industrial processes that require reliable control systems.

Some potential sources of errors can to include:

- COM Port and Pin Mapping Errors: During the initial setup, selecting the incorrect COM port or misconfiguration pin mappings can lead to issues in interfacing.

CONCLUSION

The experiment successfully demonstrated how to use OpenPLC software to create, simulate, and implement ladder logic diagrams on an Arduino microcontroller. We achieved control of a blinking LED and built a start-stop control circuit, which showcased the feasibility of programming Arduino with ladder logic. The experiment supported the hypothesis that ladder logic created in OpenPLC could be used to control physical components on an Arduino board. Both the blinking LED and the start-stop control circuit operated as anticipated, validating the hypothesis that PLC programming can be effectively applied to Arduino for simple control tasks.

In practical terms, the experiment points to potential applications in small-scale automation, where inexpensive microcontrollers could control simple machinery or processes using well-established PLC logic. Overall, this work opens doors for integrating PLC concepts into the expanding realm of IoT (Internet of Things), where microcontrollers and PLCs could collaborate to manage smart devices, contributing to the development of more sophisticated and interconnected control systems in the future.

RECOMMENDATIONS

We recommend implementing status indicators for example, Status_LED to show the status of latch. Status_LED could turn on whenever Latch is active. This can help operators or maintenance personnel quickly diagnose the system state without needing to check UP_Start or DOWN_Stop inputs.

REFERENCES

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- https://control.com/technical-articles/plc-ladder-logic-on-an-arduino-building-a-start-stop-circuit/

APPENDICES

Controllino Mega		
Digital In	A5, A6, A7, A8, A9, A10, A11, A12 A13, A14, A15, I16, I17, I18, IN0, IN1	%IX0.0 - %IX0.7 %IX1.0 - %IX1.7
Digital Out	D12, D13, D14, D15, D16, D17, D18, D19 R0, R1, R2, R3, R4, R5, R6, R7 R8, R9, R10, R11, R12, R13, R14, R15	%QX0.0 - %QX0.7 %QX1.0 - %QX1.7 %QX2.0 - %QX2.7
Analog In	A0, A1, A2, A3, A4	%IW0 - %IW4
Analog Out	D0, D1, D2, D3, D4, D5, D6, D7 D8, D9, D10, D11	%QW0 - %QW7 %QW8 - %QW11

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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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