MECHATRONICS SYSTEM INTEGRATION (MCTA 3203)

SEMESTER 2 2024/2025

WEEK 6: DAQ INTERFACING WITH MICROCONTROLLERS.

SECTION 1

GROUP 5

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ABSTRACT

This experiment focused on interfacing an Arduino Uno with PLX-DAQ to perform real-time data acquisition and visualization using Microsoft Excel. Temperature and light intensity were measured using analog sensors (LM35 and LDR), and their values were monitored over time. Additionally, register values from analog inputs were recorded to observe sensor response dynamics. The collected data was plotted to analyze fluctuations and patterns, offering insights into sensor behavior and the effectiveness of live data logging. The results demonstrated that while temperature readings remained relatively stable, light intensity showed abrupt changes due to environmental shifts. The experiment highlighted the importance of sensor calibration, proper setup, and data interpretation when working with microcontroller-based systems.

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1.0 INTRODUCTION

Data acquisition (DAQ) is the process of collecting and analyzing physical or electrical signals using a system composed of sensors, amplifiers, analog-to-digital converters (ADC), and software. DAQ systems are widely used in various fields such as industrial automation, scientific research, and environmental monitoring. The purpose of this experiment is to design and build a basic Data Acquisition (DAQ) system using Arduino as the central controller. By integrating two sensors, the LM35 temperature sensor and the LDR (Light Dependent Resistor), the system will be able to collect, convert, and log real-time data.

The LM35 is a widely used analog temperature sensor that provides a linear voltage output corresponding to the temperature. The LDR is a type of resistor whose resistance decreases as the intensity of light increases. It works based on the principle that its resistance is inversely proportional to the amount of light falling on it. PLX-DAQ is a software tool that interfaces with Excel to log data from sensors in real-time. By using serial communication, it receives data from the Arduino and records it in an Excel spreadsheet, where it can be further analyzed and plotted. PLX-DAQ allows for easy integration of Arduino with Excel for simple data logging and analysis.

From this experiment, it is expected that the Arduino successfully reads the temperature data from the LM35 sensor and the light intensity data from the LDR. The digital data from the sensors is correctly transmitted to Excel via the PLX-DAQ interface. It is also expected that meaningful plots will be generated in Excel, showing the temperature data as a function of time and the light intensity data based on varying light conditions and the data will be stored and displayed in a manner that allows further analysis of how temperature and light intensity change over time.

2.0 MATERIALS AND EQUIPMENT

- PLX-DAQ
- Arduino Board
- LDR
- LM35
- Jumper Wires
- Resistor
- Breadboard

3.0 EXPERIMENTAL SETUP

<u>LM35</u>

1. Connect the VCC pin of the LM35 to the 5V pin of the Arduino.
2. Connect the GND pin of the LM35 to the GND pin of the Arduino.
3. The Output pin of the LM35 is connected to A0 on the Arduino

LDR

1. Connect one end of the LDR to 5V on the Arduino.
2. Connect the other end of the LDR to one end of the 10kΩ resistor.
3. The other end of the resistor is connected to GND.
4. The junction between the LDR and resistor is connected to A1.

4.0 METHODOLOGY

The purpose of this experiment was to interface an Arduino Uno microcontroller with Microsoft Excel using the PLX-DAQ (Parallax Data Acquisition) tool, enabling real-time data acquisition and monitoring of environmental variables. The setup utilized a temperature sensor (LM35) and a light-dependent resistor (LDR) to measure ambient temperature and light intensity, respectively.

The Arduino board was programmed to read analog sensor values and transmit them over serial communication at a baud rate of 9600. PLX-DAQ was configured to log this serial data into Excel in real time. Two separate experiments were conducted: one to record temperature and light intensity, and another to monitor raw register values from analog input channels.

The PLX-DAQ interface was connected through COM port 6, with options enabled for auto-reset on connect, ensuring consistent session initialization.

5.0 DATA COLLECTION

The data collection process was executed by initiating the PLX-DAQ interface and allowing it to continuously log sensor readings into Excel. The datasets collected included:

- Timestamped temperature and light intensity values, showing environmental variations over a defined time period.

- Register values, representing analog signal readings from the microcontroller's ADC, collected over an increasing time counter labeled "Started Time".

Data was visualized directly within Excel using line plots to track changes over time and identify any anomalies or patterns.

Parameter	Observed Range	Behavior Notes
Temperature (°C)	21.51 – 30.79	Stable fluctuations in a controlled range
Light (units)	20 – 70+	Variable, large jump observed near the end
Register Value	0 – 1023	Full-range detection, quick variation shown

6.0 DATA ANALYSIS

Temperature and Light Data:

The temperature values recorded ranged from 21.51°C to 30.79°C, suggesting slight variations in room temperature, likely due to environmental factors or sensor response delay. Light intensity readings fluctuate widely, between 20 to 70+ units, reflecting potential manual disturbances such as covering or exposing the LDR sensor to light.

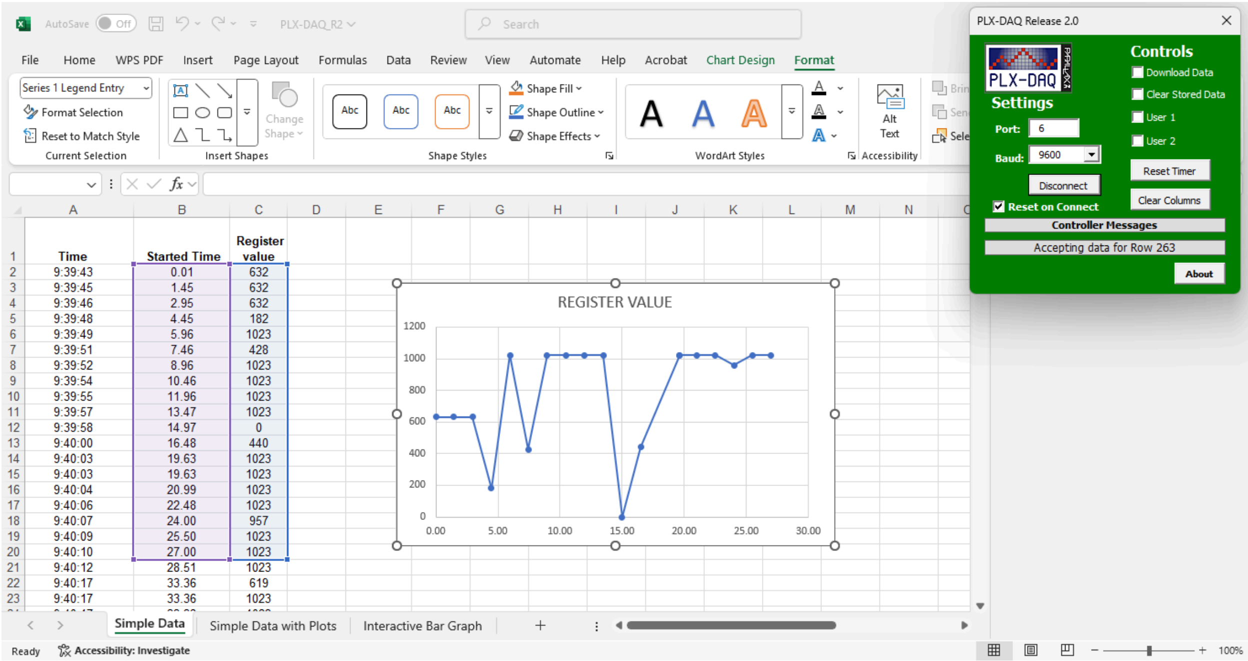
Both data sets exhibited real-time responsiveness and correlated changes, with a significant increase in light readings observed toward the end of the session.

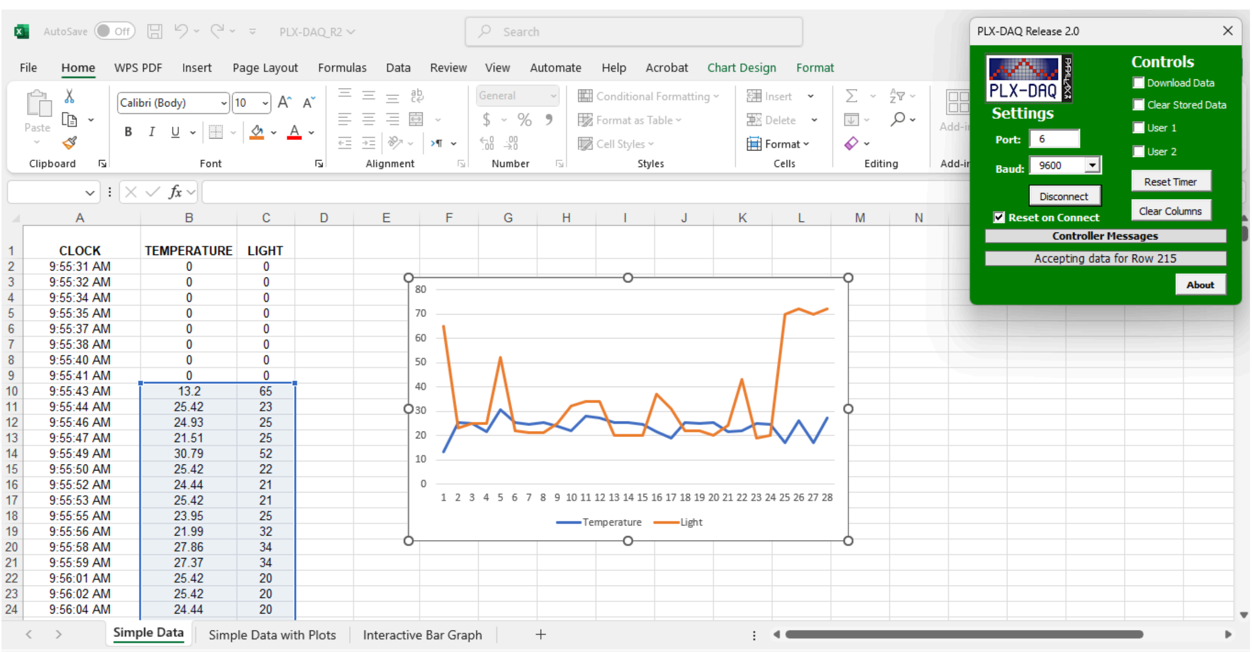
Register Value Data:

The register values varied between 0 and 1023, consistent with a 10-bit ADC input range. The plot revealed sudden drops and recoveries in analog readings, particularly a distinct dip near the 15-second mark, indicating a sharp change in the signal possibly due to input stimulus or sensor adjustment.

This data confirms the microcontroller's ability to detect and log rapidly changing analog signals.

7.0 RESULT


PLX-DAQ_R2
Time
Started Time
Register value
9:39:43 0.01 632
9:39:45 1.45 632
9:39:46 2.95 632
9:39:48 4.45 182
9:39:49 5.96 1023
9:39:51 7.46 428
9:39:52 8.96 1023
9:39:54 10.46 1023
9:39:55 11.96 1023
9:39:57 13.47 1023
9:39:58 14.97 0
9:40:00 16.48 440
9:40:03 19.63 1023
9:40:03 19.63 1023
9:40:04 20.99 1023
9:40:06 22.48 1023
9:40:07 24.00 957
9:40:09 25.50 1023
9:40:10 27.00 1023
9:40:12 28.51 1023
9:40:17 33.36 619
9:40:17 33.36 1023
REGISTER VALUE
PLX-DAQ Release 2.0
Controls
Download Data
Clear Stored Data
User 1
User 2
Settings
Port: 6
Baud: 9600
Disconnect
Reset Timer
Clear Columns
Reset on Connect
Controller Messages
Accepting data for Row 263
About
Simple Data
Simple Data with Plots
Interactive Bar Graph


PLX-DAQ_R2
CLOCK
TEMPERATURE
LIGHT
9:55:31 AM 0 0
9:55:32 AM 0 0
9:55:34 AM 0 0
9:55:35 AM 0 0
9:55:37 AM 0 0
9:55:38 AM 0 0
9:55:40 AM 0 0
9:55:41 AM 0 0
9:55:43 AM 13.2 65
9:55:44 AM 25.42 23
9:55:46 AM 24.93 25
9:55:47 AM 21.51 25
9:55:49 AM 30.79 52
9:55:50 AM 25.42 22
9:55:52 AM 24.44 21
9:55:53 AM 25.42 21
9:55:55 AM 23.95 25
9:55:56 AM 21.99 32
9:55:58 AM 27.86 34
9:55:59 AM 27.37 34
9:56:01 AM 25.42 20
9:56:02 AM 25.42 20
9:56:04 AM 24.44 20
Temperature
Light
PLX-DAQ Release 2.0
Controls
Download Data
Clear Stored Data
User 1
User 2
Settings
Port: 6
Baud: 9600
Disconnect
Reset Timer
Clear Columns
Reset on Connect
Controller Messages
Accepting data for Row 215
About
Simple Data
Simple Data with Plots
Interactive Bar Graph
Average: 29.02285714 Count: 56 Sum: 1625.28

8.0 DISCUSSION

This experiment provided hands-on experience in using an Arduino Uno with PLX-DAQ for real-time data logging. The main goal was to understand how analog signals from sensors can be read, transmitted, and visualized in Excel. From the temperature and light readings, the temperature remained relatively stable (around 21°C to 30°C), while the light sensor showed sudden spikes most likely due to a quick exposure to a strong light source. This highlights the LDR's sensitivity and the importance of consistent sensor placement.

In the register value dataset, we observed fluctuations from 0 to 1023, indicating changes in analog input. A noticeable dip to 0 suggested either a sudden environmental change or possible sensor disconnection. Plotting these values helped visualize and understand real-time behavior, even though the raw data alone lacked context.

The Arduino-PLX-DAQ setup was efficient for simple data acquisition, though it had limitations in terms of timing precision and sensor calibration. For example, while the LM35 provided values in °C, the LDR’s output lacked units, making interpretation harder without calibration.

Overall, the experiment deepened my understanding of sensor behavior, real-time data acquisition, and the importance of proper setup and visualization in making sense of raw data.

9.0 CONCLUSIONS

The experiment successfully demonstrated the use of Arduino as a Data Acquisition (DAQ) device to collect real-time data from analog sensors, namely the **LM35 temperature sensor** and **LDR (Light Dependent Resistor)**. The integration with **PLX-DAQ** allowed the collected data to be directly logged into Microsoft Excel for easy visualization and analysis.

Our objective is to interface sensors with a microcontroller and observe the data through PLX-DAQ. The resulting plots clearly showed changes in temperature and light intensity, confirming that the system could reliably convert physical measurements into digital data.

This experiment supported the hypothesis that a microcontroller, such as Arduino, when properly coded and connected, can function as an efficient data acquisition (DAQ) system. The real-time data logging into Excel proved to be a practical method for analyzing trends and sensor behavior, especially for educational or prototyping purposes.

Beyond the scope of this experiment, such systems can be applied to various real-world applications such as home automation (e.g., monitoring light and temperature), environmental monitoring, or innovative agriculture systems. The ease of integrating hardware with familiar software, such as Excel, makes this approach accessible and scalable.

10.0 RECOMMENDATIONS

To improve future iterations of this experiment, the following suggestions are offered:

Add more sensors: To get a more rigid and accurate value of temperature, it can be determined with the average temperature reading.

- **Graphical Interface**: Implement a more dynamic visualization tool, such as a Python GUI or web dashboard, for real-time graphing beyond Excel.

- **Error Handling**: Add code that checks for sensor disconnection or data anomalies to make the system more robust.

- **Data Storage**: Include options to save data to a text or CSV file automatically, providing backup and flexibility in analysis.
- **Alternative Software to PLX-DAQ**: While PLX-DAQ is convenient for Excel integration, it can be difficult to access or operate on some computers due to its age and compatibility limitations. Consider using **more modern and widely supported software** such as:
    - **Python with libraries like Matplotlib and Pandas** for data logging and visualization,

    - **Arduino IDE Serial Plotter** for simple real-time graphs,

    - **Processing** or **MATLAB** for more advanced interfaces and analysis.

11.0 REFERENCES

1. *CS50x 2025 - Lecture 7 - SQL*. (2025). Cs50.Io. https://video.cs50.io/ZA25WHO62ZA?screen=HI8um-uyJzI&start=2871
2. *Can I improve the accuracy of LM35 temperature sensors by averaging the readings of multiple units?* (n.d.). Electrical Engineering Stack Exchange. https://electronics.stackexchange.com/questions/22658/can-i-improve-the-accuracy-of-lm35-temperature-sensors-by-averaging-the-readings
3. (2025). Youtu.be. https://youtu.be/_lr8lEqxBwY?si=IuUF39SU-QPthIlE

12.0 APPENDICES

13.0 ACKNOWLEDGEMENT

Special thanks to ZULKIFLI BIN ZAINAL ABIDIN & WAHJU SEDIONO for their guidance and support during this experiment.

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 qno 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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