An Arduino-Based Multi-Function Meter for Voltage and Resistance Measurement

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ABSTRACT

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ABSTRACT

This study introduces an Arduino-based multi-function meter designed for accurate measurement of both voltage and resistance within electrical circuits. The device incorporates innovative digital technology to provide a clear and user-friendly interface for displaying measured values. By leveraging the capabilities of Arduino microcontrollers, this meter offers versatility and precision in conducting assessments across a wide range of applications. The digital readout enhances readability and interpretation of voltage values, simplifying the measurement process compared to traditional analog meters. This research contributes to the development of accessible and efficient measurement tools for electrical engineering and related fields.

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CHAPTER I

INTRODUCTION

Background of the Study

The rapid advancement of technology has led to the development of innovative solutions in various fields, including electronics and instrumentation. In this context, the utilization of Arduino microcontroller technology has gained significant popularity due to its versatility, affordability, and ease of programming. Arduino-based projects have been widely adopted for prototyping and implementing electronic devices with diverse functionalities.

The need for accurate and reliable measurement devices for voltage and resistance in electrical circuits is crucial for engineers, hobbyists, students, and professionals working in the field of electronics. Traditional measuring instruments can be costly and may lack the flexibility to adapt to different measurement requirements. Therefore, there is a growing demand for cost-effective, user-friendly, and multi-functional measuring devices that can cater to a wide range of applications.

Ohm's law describes the relationship between voltage, current, and resistance in electrical circuits. It states that there is a linear relationship between the voltage drop across a circuit element and the current flowing through it. In Ohm's law, resistance is considered constant and independent of voltage and current. Specifically, the formula $V = iR$ represents this relationship, where V is the voltage in volts (V), i is the current in amperes (A), and R is the resistance in ohms (Ω)

An ohmmeter measures the resistance of a circuit or component. It normally works by running a known current through the component being tested and measuring the voltage drop across it. Ohm's Law states that resistance (R) is proportional to the voltage drop (V) divided by the current (I) flowing through a component.

$$R = V \div I$$

The proposed research aims to address this demand by developing an Arduino-based multi-function meter capable of measuring both voltage and resistance. By leveraging the capabilities of Arduino technology, such as analog-to-digital conversion, sensor interfacing, and programmability, the research seeks to create a versatile measuring device that offers accurate measurements, a user-friendly interface, and customization options.

Through this study, the researchers aim to contribute to the field of instrumentation by providing a practical solution for voltage and resistance measurement that combines the benefits of Arduino technology with the precision required in electronic testing and experimentation. The development of an Arduino-Based Multi-Function Meter for Voltage and Resistance Measurement holds promise for enhancing accessibility to measurement tools, promoting hands-on learning experiences, and fostering innovation in electronics applications.

OBJECTIVES

This paper aims to:

1. Develop an Arduino-based multi-function meter for voltage and resistance measurement.

2. Leverage Arduino capabilities, including analog-to-digital conversion, sensor interfacing, and programmability.
3. Create a versatile measuring device offering accurate measurements, a user-friendly interface, and customization options.

DESCRIPTION OF THE DEVICE

The Arduino-based multi-function meter for voltage and resistance measurement is a device that utilizes an Arduino board, resistors, and a probe to measure both voltage and resistance. The device works by setting up a voltage divider with a known resistor and an unknown resistor and then measuring the voltage between them with the Arduino. The program calculates the resistance from Ohm's Law and displays the readings on an LCD.

SIGNIFICANCE OF THE DEVICE

1. Accurate Measurement: With the utilization of an Arduino-based multimeter, you gain the capability to precisely measure both voltage (V) and resistance (Ω) within electrical circuits and systems. This innovative device provides a versatile toolset for conducting thorough assessments, enabling comprehensive analysis and diagnostics across a wide range of applications and scenarios.

2. Digital Readout : With an Arduino-based multimeter, you get a clear digital readout of the voltage and resistance, making it easier to understand compared to old-fashioned analog meters with needles.

3. Arduino's Analog Input Pins: The Arduino board has several analog input pins that connect to an analog-to-digital converter (ADC). These pins enable the Arduino to

read analog voltages and resistance then convert them into digital values that can be displayed on a screen or processed further.

4. Integration with LCD Display: The multimeter can be connected to a 16x2 liquid crystal display (LCD) to provide a visual representation of the measured voltage and resistance. This allows for easy monitoring and reading of the voltage and resistance value.

5. Ease of Implementation: Making a multimeter with Arduino is relatively simple, making it a popular choice for do-it-yourself (DIY) projects. Arduino provides a user-friendly development environment and a wide range of libraries and resources that simplify the process of building and programming the multimeter.

KEY FEATURES OF THE DEVICE

- It is a digital multimeter that can measure voltage and resistance.
- It can measure both voltage and resistance at the same time.
- The Arduino board has analog pins that can read analog input voltage and resistance then convert it into a digital value.
- The multimeter can be connected to a 16x2 liquid crystal display (LCD) to display the measured voltage.
- It is relatively easy to make a multimeter with Arduino, making it a popular choice for DIY projects.
- The Arduino board can be powered by a standard 9V battery pack.

II

DEVICE DESIGN

HARDWARE COMPONENTS

1. Arduino UNO

   A well-known microcontroller board built on the ATmega328P is the Arduino UNO. Functioning as the project's central processing unit, it features analog and digital input/output pins, a USB connection, a power port, and a reset button. It reads data from the voltage sensor, controls the display, and executes the code for the solar panel voltage measurement.

2. Resistors

   Voltage Measurement: 10kΩ and 4.7kΩ

   Resistance Measurement: 100kΩ, 10kΩ, and 1kΩ

   A resistor is an electronic component that is used to limit the flow of electric current in a circuit. It is designed to have a specific amount of resistance measured in ohms and is used to control the amount of current flowing through a circuit. Resistors are commonly used in electronic circuits to adjust signal levels, divide voltages, and limit current flow to protect components. They come in various shapes and sizes and are made from materials that have high resistance, such as carbon, metal, or metal oxide.

3. 16X2 LCD with I2C Module

   An LCD (Liquid Crystal Display) screen is a type of electronic display module with several uses. It has a Hitachi driver. 16x2 LCD information (two rows and sixteen columns). where you may print 16 characters into one row.

4. Battery

   A battery is a device that stores chemical energy and converts it into electrical energy. It typically consists of one or more electrochemical cells, each containing positive and negative electrodes with an electrolyte solution in between. When connected to an external circuit, a chemical reaction occurs within the cell, producing electrons that flow through the circuit, generating electrical energy. Batteries come in various sizes and types, including disposable and rechargeable versions, and are used to power a wide range of devices, from small electronics to large vehicles and industrial equipment.

5. USB Cable (for uploading the code)

   The USB cable connects the Arduino to a computer for programming, code uploading, and powering the board during development and testing.

6. Universal PCB

   A Universal PCB, also known as a perfboard or general-purpose PCB, is a type of circuit board used for prototyping electronic circuits. It consists of a grid of holes with copper pads or dots arranged in a pattern. These dots are used to solder electronic components onto the board and create electrical connections. Universal PCBs are commonly used by students, hobbyists, and professionals for quick prototyping and testing of circuit designs. They provide a convenient platform for building and experimenting with electronic circuits before they are finalized and manufactured on a more permanent PCB.

7. USB Cable (for uploading the code)

   The USB cable connects the Arduino to a computer for programming, code uploading, and powering the board during development and testing.

8. Probe

   The probe is used to create a temporary connection between an electrical circuit under test and a measuring instrument or component. It enables the multimeter to measure electrical parameters such as voltage and resistance.

SCHEMATIC DIAGRAM

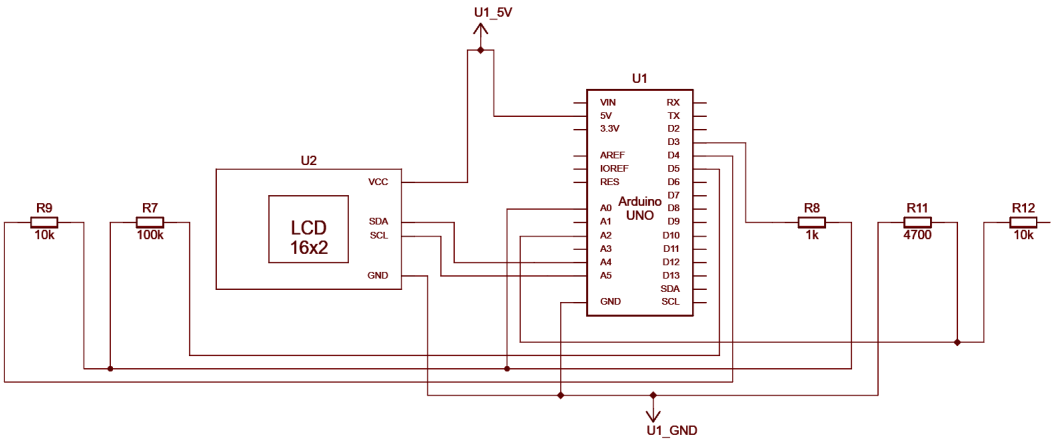

Figure 1: The Schematic Diagram presents a graphical representation of the connections and the layout of the device.

CIRCUIT DIAGRAM

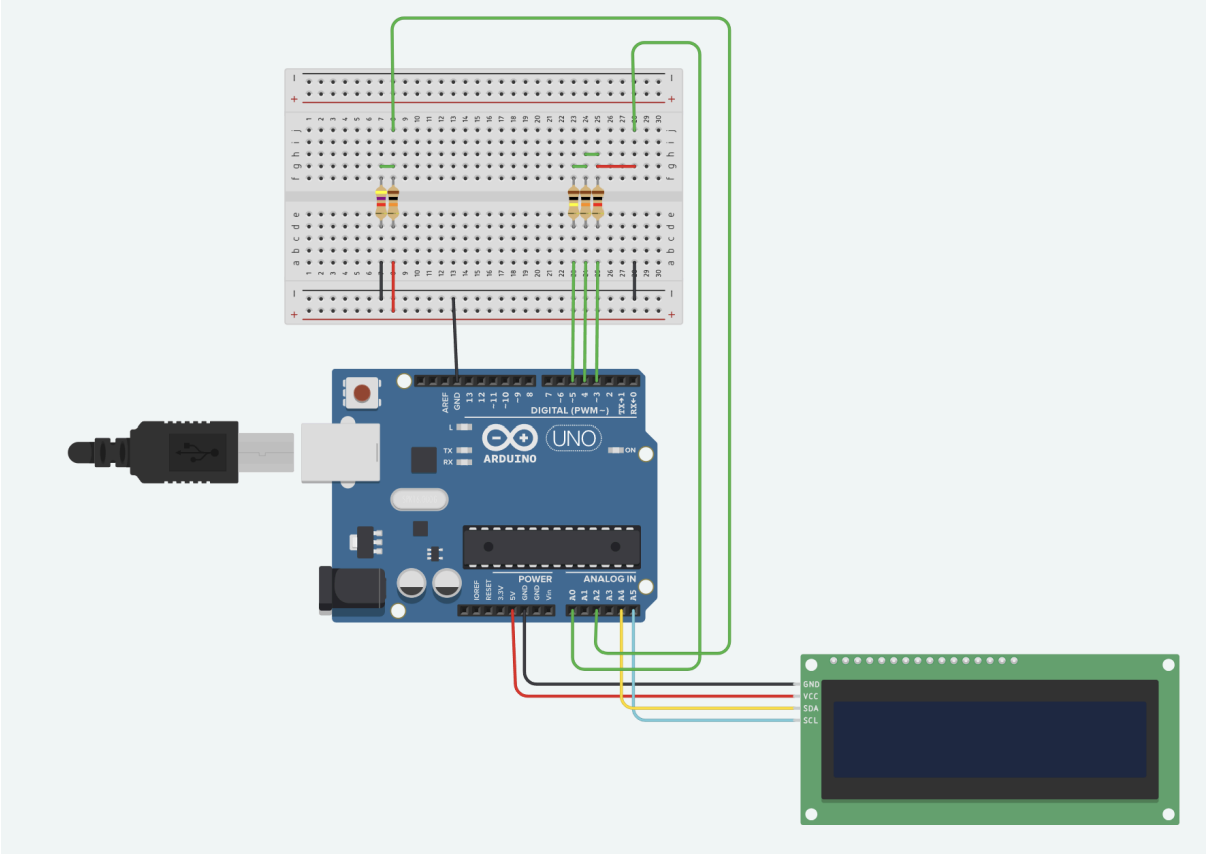

Figure 2: The circuit diagram presents a visual representation of the connections and layout of the components of the device.

ARDUINO PROGRAM FLOW

1. Start
2. Setup
    - Initialize serial communication at 9600 baud
    - Initialize LCD display
    - Clear LCD display
    - Turn on LCD backlight
3. Loop (Continuously)
    - Call calculate_voltage function

- Calculate voltage based on ADC reading and reference voltage
- Print voltage to serial monitor and LCD
- Call calculate_resistor function
- Set pins R1, R2, R3 as outputs in sequence
- Take multiple ADC readings for each pin configuration (R1 high, R2 high, R3 high)
- Calculate resistance based on reference resistors and voltage readings
- Check which pin was high based on calculated resistance ranges
- Print resistance value to serial monitor with appropriate unit (ohm, kohm, Mohm) based on range
- Display resistance value on LCD with appropriate unit
- Delay for 2 seconds

4. End (Loop repeats)

III

RESULTS

Device

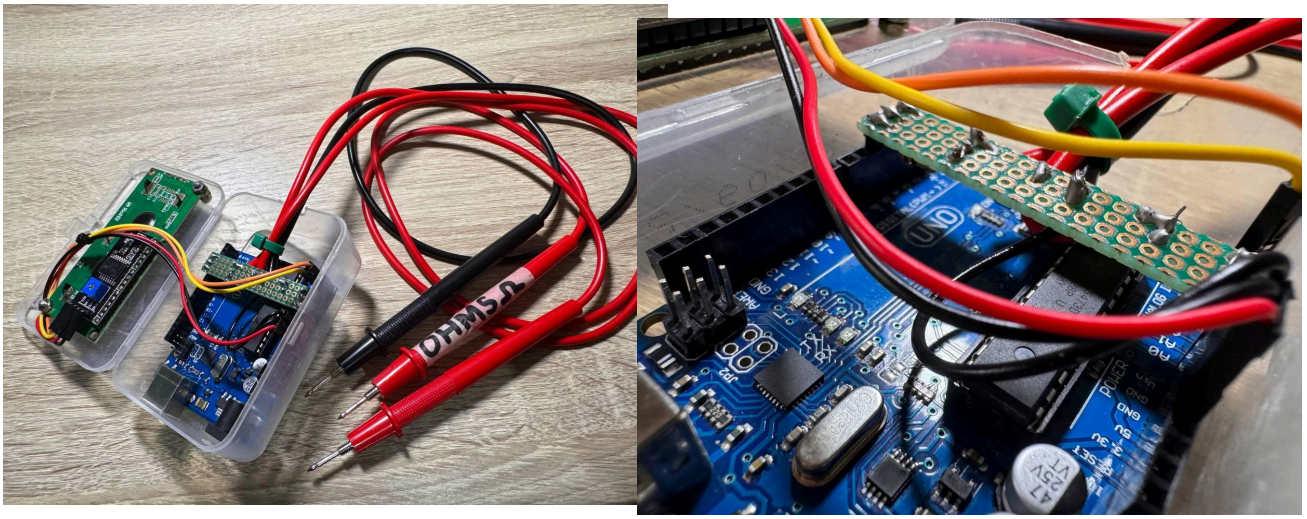

Figure 3: The finished device

The Device Measuring Voltage

Figure 4: The device is measuring the voltage of the battery.

The Device Measuring Resistance

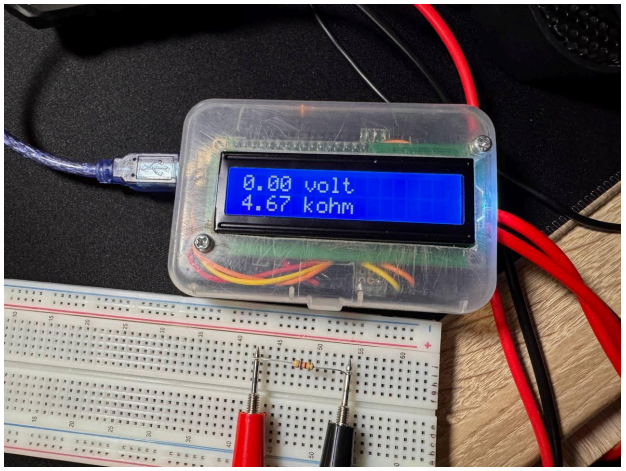

Figure 5: The device is measuring the resistance of the resistor.

CHAPTER V

SUMMARY AND CONCLUSION

Summary

The system was designed to measure voltage and resistance levels then display the readings on the LCD screen in a user-friendly manner. The project involved using analog voltage sensors, interfacing with the Arduino Uno, and programming the arduino to process and display the readings. The arduino based multimeter provided an affordable and user-friendly solution for measuring voltage and resistance levels in various electronic circuits and systems.

Conclusion

The implementation of the multimeter with Arduino Uno and the LCD proved to be successful in achieving the project objectives. The system provided an effective and accessible tool for measuring voltage and resistance levels, making it suitable for both hobbyist and professional use. The project also demonstrated the versatility and flexibility of the Arduino platform in developing custom measurement tools. Future work could involve enhancing the accuracy and precision of the multimeter, expanding its measurement range, and integrating additional features for more advanced applications. Overall, the multimeter with Arduino Uno and the LCD showcased the potential for innovative and practical uses of microcontroller-based systems in electronic measurements, and essential hardware components establishing a reliable platform for obtaining precise voltage and resistance readings.

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