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Design of An Arduino Uno Based Definite Time Over Current Relay

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ABSTRACT: Over Current Relay (OCR) is a protection relay used to detect and cut off electric current when there is excess current (fault current). The definite time type OCR has constant trip time characteristics, regardless of the magnitude of the fault current. OCR is widely used in electric power systems to protect equipment from damage due to fault currents. This final report discusses the design of Arduino Uno-based definite time OCR with the use of PZEM sensor components, I2C LCD, relay module, and Arduino Uno. This system is designed to be able to measure the load current, display the current value on the LCD, and cut off the current when the load current exceeds the specified setting value.

KEYWORDS: Arduino Uno, Definite time, LCD I2C, Over Current Relay (OCR), PZEM sensor, Relay module.

INTRODUCTION

Electric power systems are an essential part of modern human life. It provides the electrical energy needed for various activities, such as lighting, industry, and commerce. In power systems, various electronic equipment is used to distribute and control electrical energy. This equipment is vulnerable to damage due to fault currents, which are currents that exceed normal values. In this study, we as project implementers made a project that can be a safety for electronic devices and as a means of detecting overcurrent and short circuit interference.

Over Current Relay (OCR) is an important component in the electric power system that serves to protect equipment from damage due to fault currents. OCR definite time type has characteristics that when the current flowing exceeds the relay setting value will work according to the time setting given.

Arduino Uno is a popular and easy-to-use microcontroller component. This component has various features that make it ideal for the development of control and monitoring systems in this project-based learning.

LITERATURE REVIEW

A. *Previous Research*

There are several references used in the design of the Arduino Uno-based OCR TYPE Definite Time Design, the following explanation

From research conducted by Prawira Wijaya Kusuma with the title "ARDUINO-BASED OVER CURRENT PROTECTION RELAY DESIGN" Over Current Relay (OCR) is a type of protection used to stop overcurrent. The input is processed into a current value by this relay, which then compares the value with the set value. The delay is also applied in the relay settings to facilitate coordination with other relays.According to the results obtained, the OCR coordination tool applied can overcome the short circuit current of the power system. as a current sensor, the designed system has been able to work properly in protecting overcurrent."[1]

From research conducted by Deni Almanda and Habil Yusuf with the title "Prototype Design of Overload Current Protection on DC Loads Using Microcontrollers" overcurrent protection system designed using a microcontroller in the form of Arduino Nano and using ACS712 5A current sensors, the designed system has been able to work well in protecting overcurrent.[2]

From research conducted by Wahyono, Wiwik Purwati Widyaningsih, and Ajie Pribadi N, Choirul Nur H, Fidiyan Kelfin M, and Fitri Shafira with the title "Performance Testing of 3-Phase Inverse Time Overcurrent Relay to Support Protection System Practicum" shows a theory that can be used to support research on this Arduino Uno-Based Inverse Definite Minimum Time Overcurrent Protection Relay.[3]

From research conducted by Alfi Syahri and Andik Bintoro Kolom with the title "Arduino Uno-based Power Monitoring and Controlling Using PZEM-004T Sensor" shows the application of the PZEM-004T Sensor as a current sensor that can be used in this study.[4]

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In research conducted by Alfi Syahri and Andik Bintoro Kolom, with the title "Monitoring and Controlling Arduino Uno-Based Power Using PZEM-004T Sensors" shows that his research only focuses on controlling and controlling an Electric Current with a relay module output that can be controlled to disconnect an electric current that experiences overcurrent interference, but the research has weaknesses in terms of the rules of the Protection System [5].

B. *Arduino Uno Microcontroller*

Arduino Uno is one of the micro controller boards based on the Atmega328 datasheet. This controller board is the most popular open source because it is designed to facilitate electronic control in all fields. [5]

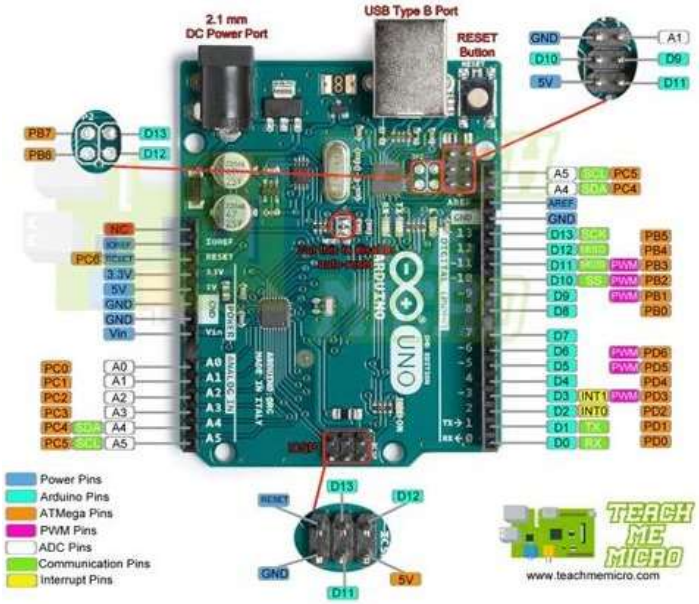

Figure 1. Arduino Uno [5]

C. *Relay*

Relay is a switch component that is controlled using electricity and is one of the Electromechanical components consisting of 2 main parts, namely the magnetic coil (coil) and the mechanical part (switch / switch contact). Relay works based on electromagnetic principles to move its contacts so that only with a small electric current (low power) can deliver higher voltage electricity. The shape and symbols on the relay can be seen in Figure 2 below. [6]

Figure 2. Relay shape and symbol [6]

This electronic component uses electromagnetic principles to move the switch so that with a small electric current (low power) can deliver higher voltage electricity. [7]

D. *PZEM-004T Sensor*

PZEM-004T is an electronic module that functions to measure voltage, current, power, frequency, energy, and power factor of AC electricity. This module is equipped with a split core CT connector, PZEM-004T can be used to measure the current of the power source passing through it. [The PZEM-004T sensor is an electronic sensor module that has the function of measuring current, voltage, frequency, power, energy and also power factor and this sensor is also equipped with an integrated CT [8].

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Figure 3. PZEM-004T [8]

The PZEM-004T board has dimensions of 3.1 × 7.4 centimeters. The PZEM-004T material is wrapped using a 3mm diameter current transformer coil that can be used for optimal current detection of 100A. The wiring of this module has two parts, namely from the connected wiring including voltage and current, as well as the information transmission wiring. Based on the needs, this module has anTTL pin board to support information transmission communication between hardware [9].

E. ***16x2 LCD***

16x2 LCD is an electronic device used to display data and messages is known as 16×2 LCD. As the name suggests, it includes 16 Columns & 2 Rows so it can display a total of 32 characters (16×2=32) & each character will be created with 5×8 (40) Pixel Dots. So the total pixels in this LCD can be calculated as 32 x 40 or 1280 pixels. For the pins contained in the 16x2 LCD can be seen in Figure 4. the following. [10]

Figure 4. Pins on 16x2 LCD[10]

To connect an LCD to an Arduino, you need to connect the pins on the LCD to the I/O pins on the Arduino board. The wiring scheme and program code used will depend on the type of LCD and the needs of your project. In general, Arduino LCDs are used in various applications such as displaying sensor data, text messages, and status information in DIY projects, robotics, and automation systems[11].

F. ***Push Button (Reset)***

Is a component that functions to connect and disconnect an electricity flow by pressing and releasing. Push Button is widely used in control circuits, because this component is one of the most important components in a control system for signaling. The word momentary can be interpreted with a moment. So a Push Button that operates momentary can be interpreted that the Push Button works only for a moment when pressed, the physical form of this component can be seen in Figure 5. the following. [12]

Figure 5. Push Button [12]

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G. I2C microcontroller

Microcontroller and sensors or other devices. I2C is designed to connect various devices in a system using a shared communication path. I2C is widely used in several devices, such as sensors, EEPROM, RTC and various other types of chips that support communication via I2C.

I2C communication on Arduino is usually done using two pins, namely SDA (Serial Data Line) and SCL (Serial Clock Line). SDA is used to send data and SCL is used to send clock signals that will set the communication timing between connected devices [13].

Figure 6. I2C microcontroller [13]

H. *LM7805 Regulator IC*

IC Regulator 7805 is a popular integrated circuit (IC) that functions as a voltage regulator by maintaining a constant output voltage (usually +5V) even though the input voltage and load on the circuit vary. positive voltage regulator type, meaning that it provides a stable positive output voltage with application. commonly used to power various electronic components and circuits that require a stable 5V supply and can deliver currents up to 1.5A. can be seen the physical form of the following IC [14]

Figure 7. LM7805 Regulator IC [14]

I. Buzzer

Buzzer is an electronic component that functions to convert electrical vibrations into sound vibrations. Basically the working principle of the buzzer is almost the same as the loud speaker, so the buzzer also consists of a coil attached to the diaphragm and then the coil is electrified so that it becomes an electromagnet, the coil will be pulled in or out, depending on the direction of the current and the polarity of the magnet, because the coil is mounted on the diaphragm, each coil movement will move the diaphragm back and forth so that it makes the air vibrate which will produce sound. Buzzers are commonly used as an indicator that the process has been completed or an error occurs in a device (alarm).

Figure 8. Buzzer [15]

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DESIGN METHOD

A. Time and Location

The time used for this PBL design was carried out from February 2024 to May 2024 in the microcontroller laboratory and protection laboratory.

B. *Types of Data and Data Sources*

In this PBL design there are three stages, namely when pre-designing, designing, and operating parameters. The types and sources of data used during pre-design are datasheets or better known as specifications of components. The types of data sources used during design are books, websites, and journals as well as circuit simulations using Proteus software. Operating parameters are data obtained from the implementation of the Arduino Microcontroller-Based Overcurrent Protection Relay PBL implementation in the Microcontroller Laboratory.

C. *System Overview*

System overview The design of the system that will be made on the Arduino Uno-based PBL Over Current Relay seen in the Microcontroller Block Diagram gets a voltage supply from a 5V adapter, on the microcontroller there are three outputs and there are three inputs consisting of current sensors, and NodedMCU ESP8266.

1. The electricity supply used to activate the Arduino Uno R3 system is a 7-12 VDC power supply and the 220 VAC load supply is the electricity supply used by the load.
2. The output voltage of the Arduino Uno R3 is connected to the breadboard which will be used to supply 5 VDC voltage for relays, buzzers and current sensor PZEM-004T.
3. When the current sensor reads a current that exceeds the specified current setting, the current sensor will send a signal to the Arduino Uno.
4. When Arduino Uno receives a signal from the current sensor, the signal will be processed and then sent to the relay, then the relay disconnects the electric current to the load.
5. When the electric current has been cut off, the Arduino Uno sends data to the buzzer so that the buzzer can sound and provide an alarm signal that there is an overcurrent disturbance and or a short circuit.
6. The potentiator is used to increase the voltage on the load to provide more current for the current sensor.

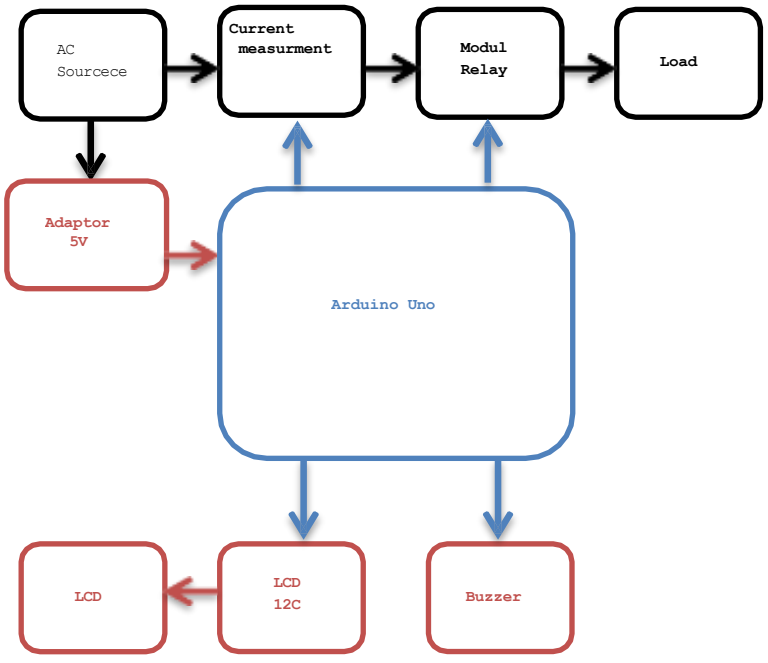

Figure 9. Block diagram of System overview

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RESULTS AND DISCUSSION

A. Design Results

The manufacture of this Arduino-based Over Current Relay Type Definite Time is a prototype, which hopefully if successful can be implemented for the public and industry. Figure 7. Below is the result of making an Arduino Uno-based Over Current Relay Type Definite Time tool.

B. Over Current Relay Testing

Testing is done by setting the nominal current setting and disconnection time, the test results show the relay works with a time setting of 2 seconds and can show any change in the integrated current value does not affect the acceleration of the current flowing, the test results can be seen in the following table.

Table 1. Test results when over current relay occurs

Current (A)	Time (S)
1	2
1.1	2
1.2	2
1.3	2
1.4	2
1.5	2
1.6	2
1.7	2
1.8	2
1.9	2
2	2
2.1	2
2.2	2
2.3	2
2.4	2
2.5	2
2.6	2
2.7	2
2.8	2
2.9	2
3	2
3.1	2
3.2	2
3.3	2
3.4	2
3.5	2
3.6	2
3.7	2
3.8	2
3.9	2
4	2
4.1	2
4.2	2

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4.3	2
4.4	2
4.5	2
4.6	2
4.7	2
4.8	2
4.9	2
5	2

Based on Table 1, a graph of the characteristics of the overload current protection relay is obtained in the following Figure 10.

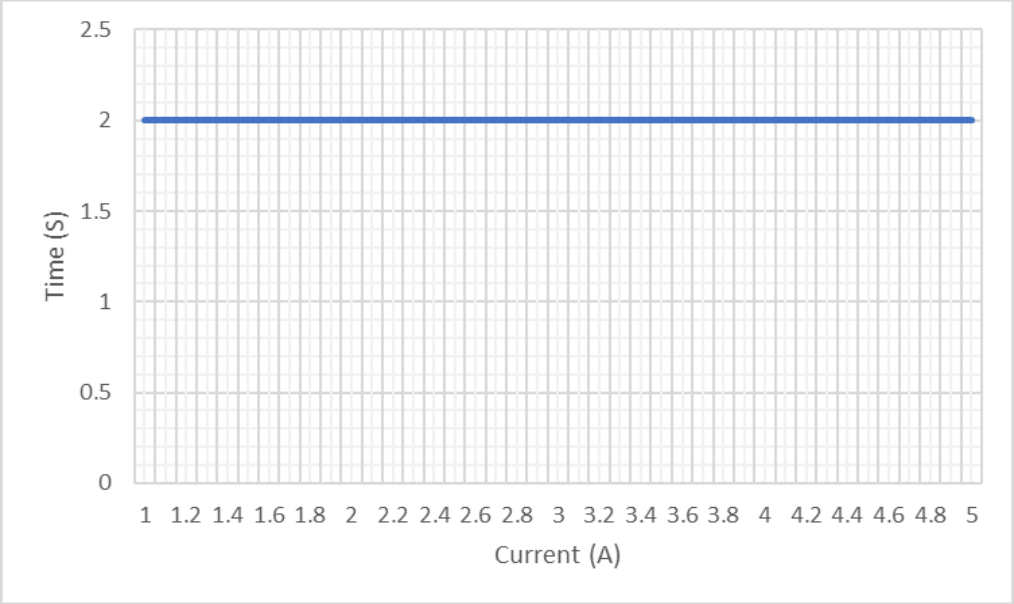

Figure 10. Definite Time Over Current Relay characteristic curve

CONCLUSIONS AND SUGGESTIONS

A. *Conclusion*

This research is focused on current variations ranging from 0.1 to 4 amperes and setting the detection time of 2 seconds. Through the implementation of Arduino Uno technology, the results that have been obtained are in accordance with the initial working principle of definite time, namely with the working principle when the current value exceeds its nominal, the relay will work by breaking the current after passing the specified time limit.

B. *Suggestion*

Basens as follows:

1. Conduct further tests with different load variations and operating conditions to evaluate system performance and reliability more comprehensively.
2. Consider integrating additional features such as wireless communication (WiFi or Bluetooth) to allow remote monitoring and control.

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