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Research Article

Power Measurement and Protection Circuit

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Abstract

Nowadays the demand for power increases constantly. To meet the demands, production units were established all around the country. Until the electricity reaches our house it transforms both up and down many times, thus power fluctuation occurs in our house. To overcome this issue we have developed this device to identify the fault parameters and protect our household appliances using relay

Keywords:

1. Introduction

The need for electricity regulation in houses arises due to improper supply of electricity. We are using more valuable appliances nowadays, and we also need to safeguard it from unequal electricity. Every appliance in our house is a product of a smart house project. As a result the current and voltage rating of the appliances were reduced to its smaller value due to the electronics part present in it. So we need to add stabilizers to run the electronics without burning. Inorder to use stabilizer the overall cost of an appliance increases to its maximum. The maintenance for each appliance is utmost important because we are using electronics in alternating current. We have to give the same importance in protecting the appliance and have to utilize it efficiently.

So we are with a power measurement and protection circuit in households, with this device we can both monitor the power consumption and also the protection during unnatural happenings using relays. The traditional methods used in our present households are MCB's, known as miniature circuit breakers. They have a long iron strip that acts as a switch, when high current passes the strip gets heated and expands, thus it opens the circuit. And when the current becomes normal the strip cools down to its normal closed circuit. In this scenario we have surveyed many literatures and some of them are: Hiren R. Zala, et al [1] states that the smart energy meter is made by combining the normal meter with an arduino and only collecting the necessary parameters for billing consumption. In this they didn't mention any of the digital sensors for measuring and displaying the circuit. Thus we have used necessary sensors of our own to measure the parameters and used LCD to display the parameters orderly.

A. A. Ali, N.H. Saad et al [2] states that the smart meteors made by combining with radio frequency module of arduino. Thus the cost of the models are easily transmitted to the station and billing makes it easier for the organization. In this model they didn't mention any of the protection systems for the appliances, they only focused on the monthly billing of electricity consumption and stores it in the cloud for ease of accessing the parameters.

We have used the latest measuring sensors for the measurement and the finest relay for the protection purpose. We also installed the buzzer to indicate the user for unusual activities of the electricity. The LCD will also display the error messages programmed according to the fault. There are various errors like low current, low voltage, high current, high voltage and high temperature.

During the error, the relay opens the circuit and checks for corrections at regular intervals. If the error is rectified then the relay closes the circuit or else remains open. The same LCD is used for both display of parameters and to display the error messages. The temperature for this is also measured and displayed in the LCD because the electronic sensors may burn up if over current passes and that burn should not affect our appliance to ensure utmost safety. We have used a temperature sensor.

2. Methodology

We have used many components for this device, and arranged it accordingly. Our work flow is depicted by the block diagram as follows

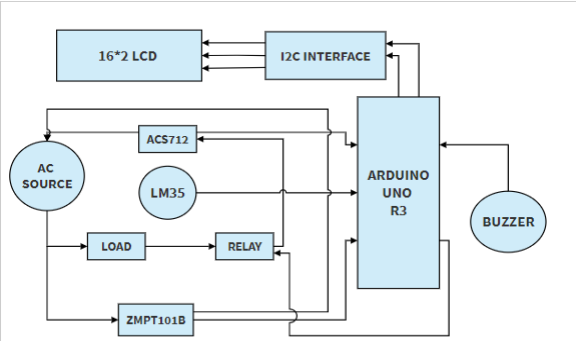

Fig 1. Block diagram

This block diagram is designed using smart draw cloud software, This is very unique and easier to draw. The blocks comprises the methodologies used and also clearly depicts our workflow of the circuit. The blocks start from the AC source which is the mains current. In this the wire is connected to the ACS712 current sensor. Then from the sensor the current flows to the relay module. It is connected in the series because, the circuit can be opened or closed only when the relay is connected in the series with the load, the relay gets its signal from the digital pin of the arduino. The relay is connected to NC state generally, and activated only if the fault is sensed by the microcontroller. Then the voltage sensor is connected to the AC source in parallel method, because voltage is measured in parallel method.

It measures the overall voltage from the mains. The output pin is connected to the arduino and processed and then displays the result. Then the LCD display is connected to the arduino through the I2C interface because it reduces the wires from 16 to 2, as it is a drastic difference. The LCD is programmed to display the appropriate values. in the correct of predefined positions. Then the buzzer is also connected to the arduino to indicate that some error has occurred. The temperature sensor is also connected to the arduino to find the internal temperature of the circuit. It also keeps an eye on the temperature as it is also important for our appliance safety.

3 Software Design

For this project simulation we used proteus software, The Proteus Design Suite is a proprietary software tool suite used primarily for electronic design automation. The software is used mainly by electronic design engineers and technicians to create schematics and electronic prints for manufacturing printed circuit boards. It was developed in Yorkshire, England by Labcenter Electronics Ltd and is available in English, French, Spanish and Chinese languages.

The microcontroller simulation in Proteus works by applying either a hex file or a debug file to the microcontroller part on the schematic. It is then co-simulated along with any analog and digital electronics connected to it. This enables its use in a broad spectrum of project prototyping in areas such as motor control, temperature control and user interface design.

The PCB Layout module is automatically given connectivity information in the form of a netlist from the schematic capture module. It applies this information, together with the user specified design rules and various design automation tools, to assist with error free board design. PCB's of up to 16 copper layers can be produced with design size limited by product configuration.

We have designed our entire project and simulated using this software. The below picture depicts our simulation results.

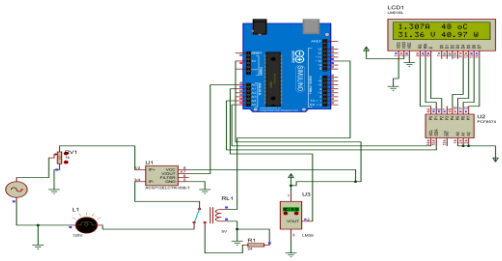

Fig 8. Proteus simulation

In this design simulation we have used the already mentioned components like arduino uno r3. The programming is done in the arduino IDE then it is compiled and the hex code is copied and pasted in the proteus file such that the board works as in real life.

Then we used the components of sensing units like the current sensor, temperature sensor and relay and then the buzzer. The current sensor is connected in series with the load, the relay and the source. It is of the order of source to current sensor, then sensor to relay, then relay to load and atlast load to the source. Thus the circuit is complete and closed. The current flowing is found only by series connection so the method is as follows. The relay is also connected in series because when it is opened and closes the circuit to make its impact it should be in the series with the load. The load won't be affected if the series process went well. The same process is followed in the proteus software and the lamp glows as expected.

Next the microcontroller interfacing for this the output of the current sensor is connected to the A0 pin of Aduino. Then the normally closed pin of the relay module is connected to the digital pin 10 of the arduino. It is generally low and becomes high when fault occurs to open the circuit.

There is no voltage sensor in this software so we omitted it. Next is the temperature sensor, we used the lm35 module for this purpose. It is also connected to the +5v and gnd pins of the arduino. Then the third pin is connected to the A2 pin of arduino. Then the arduino processes the temperature and displays it. In this software the temperature sensor works manually. We can see the temperature and can vary it ourselves.

Next we used LCD with I2C interface, both the components were available in this software. The A4 and A5 pin of the Arduino is connected to the SCl and SDA of the I2C interface. Then the interface is connected to the LCD pins appropriately.

Lastly we programmed the whole project in the arduino ide and then compiled it proof read it many times and copied the hex code of the program. Then opened the designed circuit in the proteus, double clicked the arduino board, a dialog box will appear. in that box paste the copied hex code, then click a green triangle at the bottom of the window. The circuit will begin to run.

By pausing the simulation we can print the window to make it as a screen shot for future reference. As far as we concern this is the best circuit simulation software. It has various in-built components or else we can download the library and add it to the proteus.

4. Hardware Design

In this, all the components are connected to the Arduino board. In Current sensor, the GPIO Pin is connected to the A0 pin of Arduino, Voltage sensor, The GPIO pin is connected to A2 Pin and Temperature sensor connected to A1, Relay is connected to A10 pin and Buzzer is connected to 9 Pin.

Fig 9. Hardware design

Load is connected to single phase supply through Potentiometer to control the current and voltage. Relay is connected across to Load and supply and acts a switch. LCD displays are connected to Arduino through I2C to display measured parameters like current, voltage, temperature and Power. And have to supply 5 to 12 DC to Arduino. The circuit works as our expectations then the output works as programmed**.** We have predefined here 5 error messages like:

1. Low Current

In this scenario the current from the mains is decreased with the help of the regulators, Thus the current through the load also reduces if it reaches a low point, the relay opens the circuit and the buzzer beeps and the LCD displays the Low Current error message. And the relay checks for normal operation at regular intervals if it is correct then closes the circuit otherwise it remains open and continus the beep.

2. High Current

In this scenario the current from the mains is increased with the help of the regulators, Thus the current through the load also increases if it reaches a high point, the relay opens the circuit and the buzzer beeps and the LCD displays the High Current error message. And the relay checks for normal operation at regular intervals if it is correct then closes the circuit otherwise it remains open and continus the beep.

3. Low Voltage

In this scenario the voltage from the mains is decreased with the help of the regulators, Thus the voltage through the load also reduces if it reaches a low point, the relay opens the circuit and the buzzer beeps and the LCD displays the Low Voltage error message. And the relay checks for normal operation at regular intervals if it is correct then closes the circuit otherwise it remains open and continus the beep.

4. High Voltage

In this scenario the voltage from the mains is increased with the help of the regulators, Thus the voltage through the load also increases if it reaches a high point, the relay opens the circuit and the buzzer beeps and the LCD displays the High Voltage error message. And the relay checks for normal operation at regular intervals if it is correct then closes the circuit otherwise it remains open and continus the beep.

5. High Temperature

In this scenario we for demo purpose uses the soldering gun heated it up to its max and placed it near the temperature sensor, the sensor absorbs the heat and increased as much as it can, we predefined a values in programming, so when it exceeds the values the relay opens the circuit and the buzzer beeps then the LCD displays the High Temperature error message. This is specifically used to protect and observe the internal circuit temperature because all the sensors and microcontroller mainly use electronic components as it may lead to over usage or sometimes burns, and it may have chances to burn our appliances too.

5 Results and Discussion

In this project our desired output is to display four parameters like current(A), voltage(V), Power(W) and Temperature(oC). LCD displays the parameters along with the error messages if occurred, Buzzer will beep if error occurred.

Relay will open the circuit, these actions will happen simultaneously. The microprocessor will check for error at a regular interval and reacts according to it. The device works fine and the output is as we expected. The four parameters are shown in the diagram. The SI units system is strictly followed to measure the values. The final outcome is the measured parameters and the error message only if the predefined fault occurs.

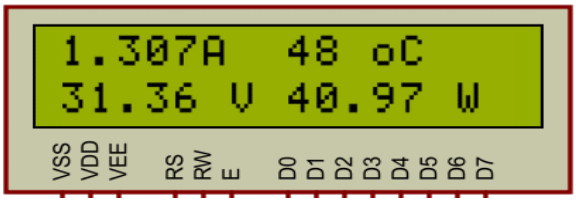

Fig 10. Results of project

Thus, from our study our device can measure all the basic electrical parameters using sensors and stores the information in the Arduino Atmega328 8 – bit microprocessor. This microprocessor communicates with the I2C interface LCD, and displays the parameters in a sequential manner.

Buzzer is used to indicate the errors and simultaneously the values appear in LCD, the 5v relay channel will open the circuit and the domestic appliances are saved without any unwanted damages.

6. Conclusion

Some of the market available digital meters were manufactured by:

- Genus Power Infrastructures Ltd.
- HPL India Ltd.
- Iron India Pvt. Ltd.
- Landis + Gyr Ltd.
- Larson and Toubro Limited (L&T)
- Schneider Electric India Pvt. Ltd.
- Towa Engineering works.

In the situation of the growing technologies, we should bring a change in something. So, we are bringing a traditional method by changing relay. The implementation is done according to our design made and software test. The hardware also gets success by giving the accurate value by obtaining the programs given by us.

Our future objective is to interlink this device with Iot. Which makes our interface more user friendly. And also we can access our protection system from any part of the world. We will build a mobile application to view our meter reading and also a button is made available, which is connected to relay. When it is pressed the relay will open the circuit and vice versa. This option makes our project more protective and handy in terms of working users. IOT leads to future tech because the automation starts from that. The major part of cloud computing and human-machine interaction will be entertained.

ESP 8266 is the module we choose to use in our future projects. This module ESP8266EX is capable of functioning consistently in industrial environments, due to its wide operating temperature range. With highly-integrated on-chip features and minimal external discrete component count, the chip offers reliability, compactness and robustness. The ESP8266 arduino compatible module is a low-cost Wi-Fi chip with full TCP/IP capability, and the amazing thing is that this little board has a MCU (Micro Controller Unit) integrated which gives the possibility to control I/O digital pins via simple and almost pseudo-code like programming language.

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