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A Prototype of AC Voltage Measurement and Over & Under Voltage Protector Using Arduino

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Abstract: *The goal of this project is to trip the relay based on fluctuations in supply voltage to safeguard the electrical home and industrial equipment from overvoltage and under voltage. Electronic devices are extremely sensitive to voltage variations; as voltage variations occur in the supply, electronic equipment is quickly destroyed. In that case, an extra safeguard device is required to protect the equipment as a load. As voltage varies over or below the specified value, voltage comparator integrated circuits perform the decision of tripping the relay mechanism. The main advantage of this relay-based mechanism is that it also protects three-phase appliances from single phasing and fluctuation of voltage in ac voltage waveform.*

Keywords: *AC, Voltage, Overvoltage, Undervoltage, Arduino.*

1. Introduction

We cannot imagine modern life without electricity. The electrical power distribution system plays a vital role in ensuring continuous electrical supply by providing electricity to the system's users. A problem arises in this system. So, in order to reduce faults and enhance power efficiency, we need a strong protective system. This protection system will protect the generating and distribution systems from occurrences that disrupt the supply. In order to improve the security system in three phases, I believe automation would be quite and fix the problem automatically; if this is not feasible, it will locate the problem to be solved manually. This smart security gadget will also be useful in the house. As we all know, a circuit breaker is utilized for home safety, which is a typical protective mechanism in our nation When over and under voltage occurs, the circuit breaker burns out to safeguard the system's linked equipment such as the TV, fan, refrigerator, and so on. To use electricity, we must manually reset the circuit breaker, which is the major issue with circuit breakers. As a result, the goal of my project is to replace the circuit breaker with automation. That is, if a device exceeds the maximum voltage that it can withstand, the system will trip because two comparators are utilized as a window comparator, my device produces an error output if the input voltage surpasses the range beyond the voltage window. A relay can also be used to turn off the load for safety reasons. In this project, we will study about relays and circuit breakers, as well as their responses to over and under voltage conditions in a three-phase system.

2. Motivation

In this day and age, we are capable of obtaining mobility, efficiency, and flexibility; yet, we also want protection against the things we use to enhance our everyday lives. This prompted me to create a protection mechanism for over and under

voltage in three-phase systems that would safeguard both industrial and residential users. We can observe in the past that mishaps caused by an overabundance of electricity are becoming more common in our developing countries. I believe that this project will aid in the solution of the protection problem, as well as in the research and understanding of the protection system in general.

3. Literature review

Many Researchers have published different research paper related to this paper. A lot of paper has been published. In [1] the measurement of power and energy has been published by Srividyadevi P et.al. Shagun Malhotra et. al [2] have proposed and design a digital multimeter for AC voltage measurement. They have used PIC microcontroller to control or measure the voltage. Electronic circuit analysis-based AC-DC voltmeter has been proposed by Mohammad Yunus et. al [3]. They have used Arduino UNO, LM 341. Md. Mohasin Siddique has implemented a circuit of an AC to High DC generation. In [4] this circuit he has used transformer, Arduino to find or measure the voltage level of fourteenth stages. Halit Eren[5] has proposed a technique to measure voltage. In his research he uses the SCR to rectify the AC voltage. Manish Paul [6] et. al have proposed a undervoltage and over voltage protector. They have used PIC microcontroller to detect the overvoltage and Under voltage. Power quality problem identification and protection scheme for low voltage system has been focused by silicon institute of technology [7]. Characteristics of voltage sags in distribution system have been characterized by G. Yaleinkaya et al [8]. Over-Under Voltage Protection of electrical appliance has been proposed by C. H. Vithalani [9]. In [10-11] over voltage occurred by temperature and Control of over voltage have been discussed.

4. Objectives

This project is meant to automatically turn on and off the main power supply in the event of a fault with the AC main power supply, eliminating the need for anybody to operate it manually. It is intended to safeguard home appliances such as fans, televisions, refrigerators, and other items from under and overvoltage in the main power supply. This device is believed to be a precaution if there are any abnormalities in the AC supply since it contains three components.

5. Proposed System

To protect single phase loads from fluctuations, overvoltage and over voltage disturbances, a device consisting of discrete electronic and electrical components is built to act as a voltage sensor and measure the voltage at all times and make sure the device to be protected is operating under nominal voltage value. The microcontroller takes a decision according to its instruction. In Fig 1 the whole system is supplied with 5v DC power. The AC voltage of 220V is applied to the Transformer (Step Down). The transformer then converts the high voltage AC into Low voltage AC. Then this converted voltage is applied to a rectifier diode and a zener diode is also used in this circuit to control the stable output which is applied to controller. According to the measurement of AC voltage by the Arduino the controller shows the reading of AC voltage to LCD and make a decision to OFF and ON the load.

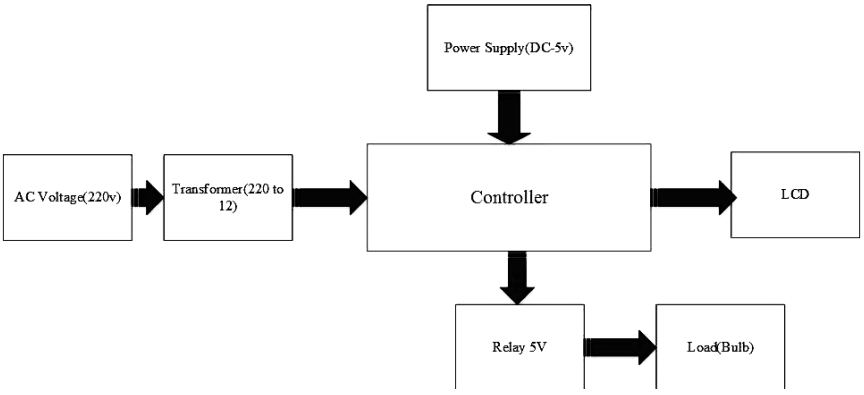

Figure 1: Block Diagram of Proposed System

6. Implementation Technique

1. VARIABLE x:
X is the input analog value received (voltage) from pin A0 i.e.,
x = pinMode (A0, INPUT); // set pin a0 as input pin

2. VARIABLE y
Task of this variable is most important in whole program i.e., to convert the input analog value into the actual ac voltage from mains. As in the code:
y= (m*.304177); // convert into ac voltage

x or actual analog value is multiplied by .304177 because of the following reason:
So, by simulating the circuit, we observed that when input a.c voltage is 311 volts, 5 v or 1023 analog value is obtained at pin A0. This voltage is the maximum value that can be measured by this circuit. Above this voltage Zener diode will breakdown. Hence:
311-volt mains supply corresponds to 1023 analog value.
So, any random analog value obtained is equal to (311/1023) *x ac volts, where x is obtained analog value. Hence, we arrive at this formula: y= (311/1023) *x volts or y=(x*.304177).

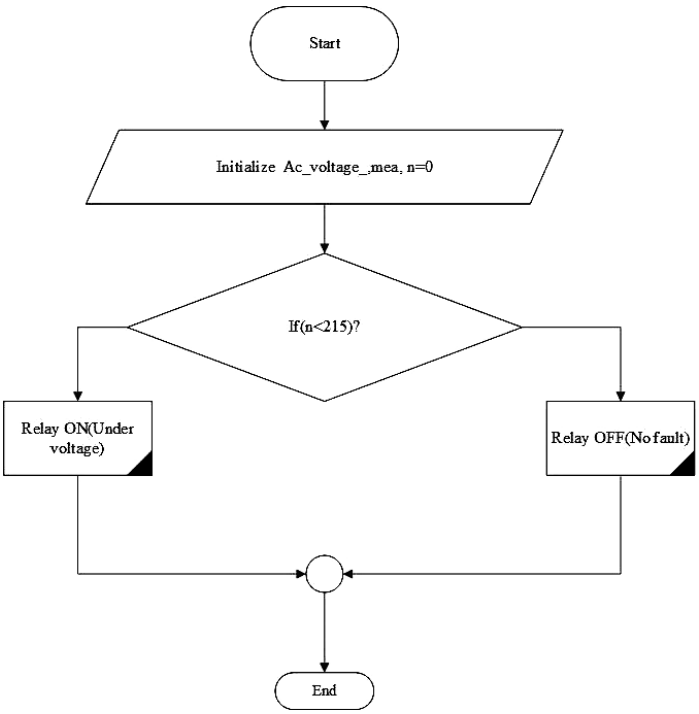

Figure 2: Flow diagram of under voltage protection

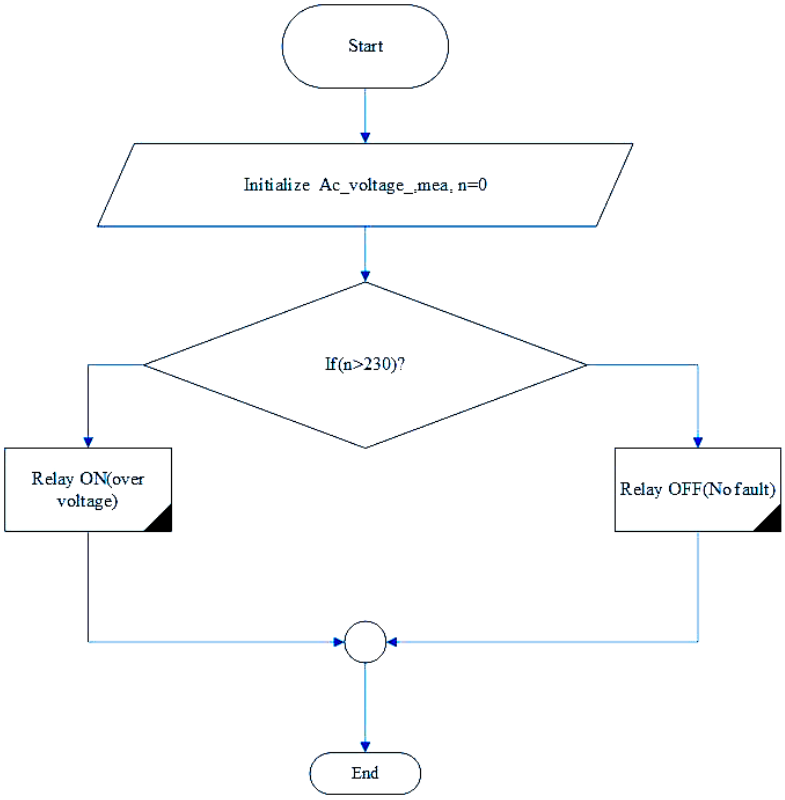

Figure 3: Flow diagram of over voltage protection

7. Hardware

A user must be familiar with the workings of the components in order to create a circuit. Each component's operational knowledge contributes to the development of a new system idea. A proper examination of a component will provide guidance on how to use it. All of the knowledge gathered from the functions of the components is used to build and build a huge system, and if all of the components perform well, it will be used in the constructed circuit. If every circuit performs its duty, the intended system will be created.

The ATmega328P-based Arduino Uno is a microcontroller board (datasheet). It features 14 digital I/O pins (six of which may be used as PWM outputs), six analog inputs, a 16 MHz ceramic resonator (CSTCE16M0V53-R0), a USB connection, a power connector, an ICSP header, and a reset button. It includes everything required to support the microcontroller.

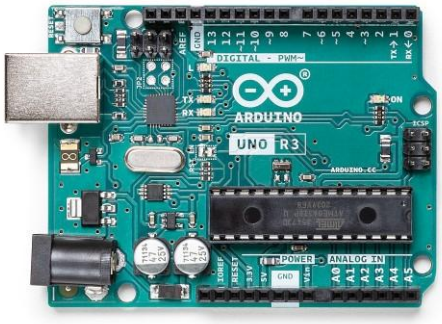

Figure 4: Arduino Uno

A transformer is a passive electrical device that uses electromagnetic induction to transmit electrical energy from one circuit to another. It's most often utilized to raise ('step up') or lower ('step down') voltage levels between circuits.

Figure 5: 12V Transformer

A liquid-crystal display (LCD) is a flat-panel display or other electronic visual display that makes advantage of liquid crystals' light-modulating capabilities. Liquid crystals do not directly emit light.

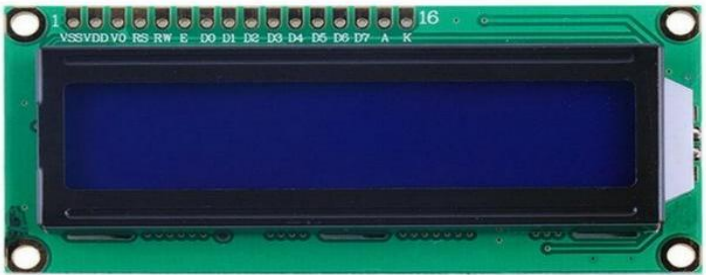

Figure 5: liquid-crystal display (LCD) 16*2

The main functional region of 2N2222 is included within the TO-18 package. It is the most widely used transistor because to its inexpensive cost and tiny size.

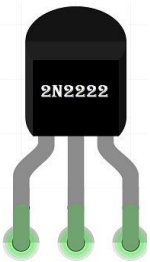

Figure 5: 2N2222 Transistor

The SRD-05VDC-SL-C relay features three high voltage terminals (NC, C, and NO) for connecting to the device to be controlled. On the opposite side, there are three low voltage pins (Ground, Vcc, and Signal) that link to the Arduino.

Figure 6: Relay

8. Results and Discussion

8.1 Result:

The typical supply range is set between 215 V and 230V by utilizing a transformer and a regulator. The supply voltage, as displayed by the LCD, is 220 volts, therefore the safety circuit is closed and the load is turned on. When the protection circuit detects a normal supply, the usually open contact of the relay closes. The lamp attached as a load is turned on.

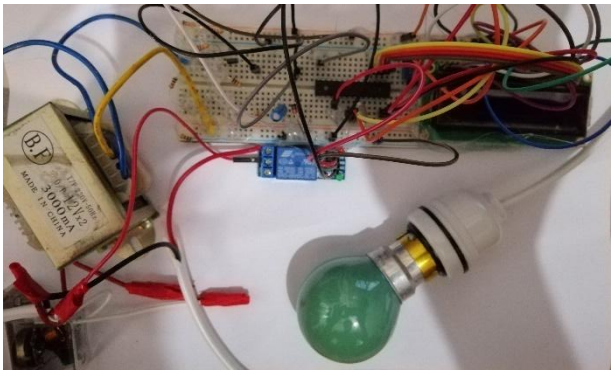

Figure 7:Circuit connection with load

As a result, for any defined range of voltage selected, the safety circuit remains closed and the load is turned on. 230 V is the standard voltage rating for all domestic equipment.

When the supply voltage to the transformer falls below 215 V, the controller checks the voltage at the terminal (A0). As a result, the Controller's output becomes high, energizing the relay. When the relay is activated, the protection circuit acts as an open circuit, disconnecting the AC supply and turning off the load.The above image illustrates the operation of the safety circuit in an undervoltage supply, and the undervoltage value recorded by the multimeter is 210. As a result, when there is a voltage drop, the protection circuit instantly switches off the load and safeguards it.

Figure 8:Over voltage Load OFF

When the supply voltage to the transformer falls below 230 V, the controller checks the voltage at the terminal (A0). As a result, the Controller's output becomes high, energizing the relay. When the relay is activated, the protection circuit acts as

an open circuit, disconnecting the AC supply and turning off the load.The image above illustrates the operation of a safety circuit in an overvoltage supply, and the overvoltage value recorded by a multimeter is 210. As a result, when there is an overvoltage, the protective circuit instantly turns off the load and protects it.

Figure 9:Under voltage load OFF

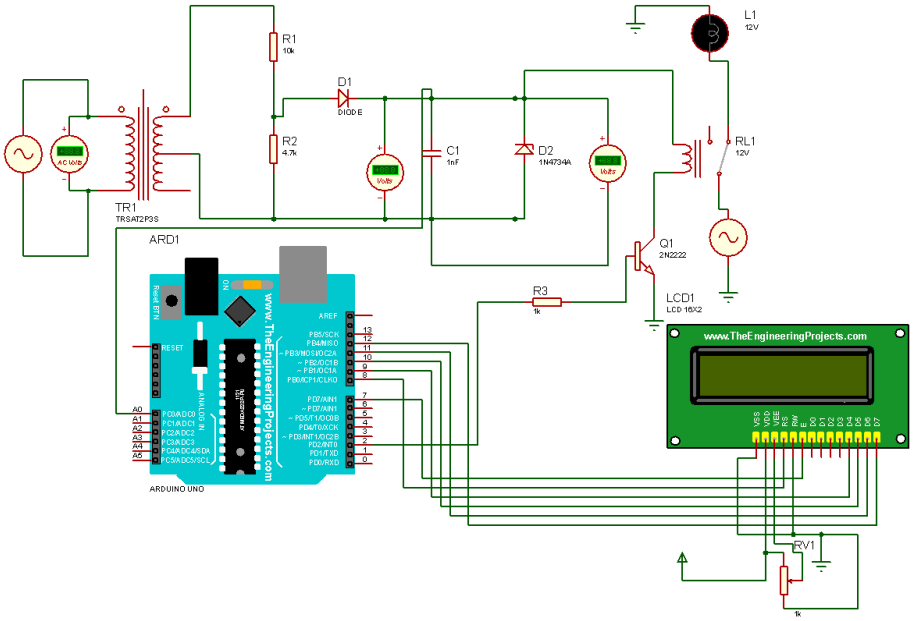

Figure 10:Implemented Circuit of over and under voltage protection

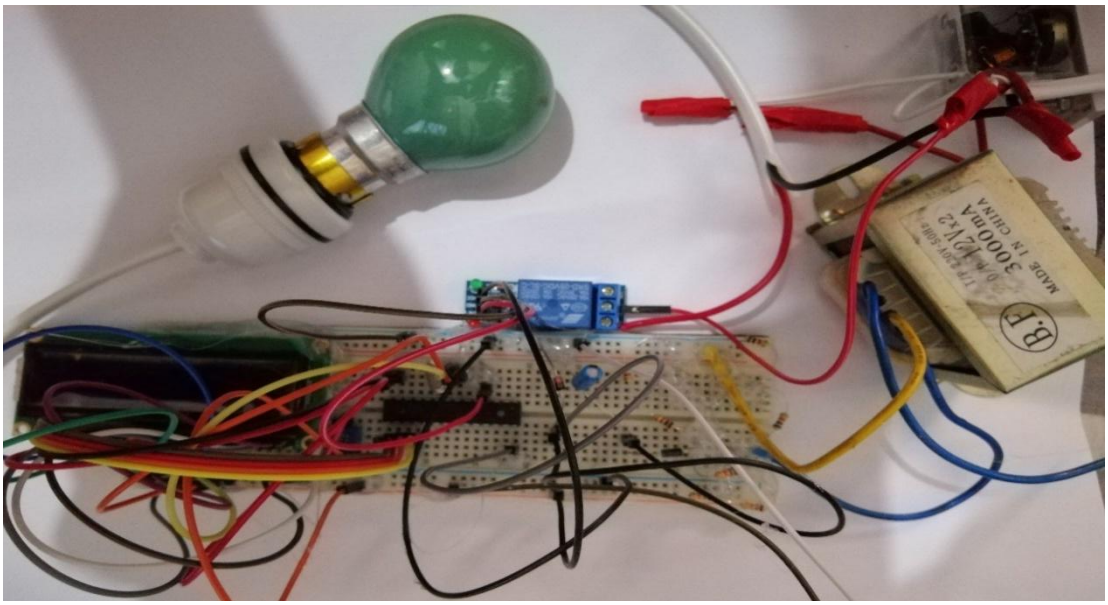

Figure 11: Implemented Circuit

8.2 Discussion:

From the above result in the figure 7,8 & 9 we have showed that this implemented system work properly and we believe that this system will help to protect a circuit.Now a days it is very important to use circuit protector in any circuit. This will help us to protect our electronic instruments. Our implemented circuit is working accurately to protect the abnormality of over and under voltage.

9. Conclusion

The protection circuit can be used to protect the costly electrical appliances from abnormal conditions like sag, swell, under voltage and overvoltage and avoid appliances being affected from harmful effects. In Bangladesh the Normal line voltage may be fluctuate from 220V to 230V. But many of time the instantaneous voltage is over and under the normal voltage. This will damage the electric devices. This implemented circuit can show the current line voltage and also protect the device. Over voltage can burn the electronic device and Undervoltage can also damage the by turn off the device because off less power supply.

Copyright

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