AUTOMATED LOAD PROTECTION FROM VOLTAGE FLUCTUATIONS USING MICROCONTROLLER AND GSM COMMUNICATION

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ABSTRACT:
Voltage fluctuations, especially overvoltage and undervoltage conditions, can lead to severe damage to electrical appliances and disrupt system stability in distributed power systems. This paper presents a microcontroller-based automatic load protection system designed to detect voltage anomalies and isolate the load to prevent damage. The system integrates a GSM module to instantly alert the user of the fault condition through SMS. When the input voltage exceeds or falls below predefined thresholds, the microcontroller initiates a tripping mechanism that disconnects the load via a relay, and simultaneously sends a real-time alert to a registered mobile number. The design includes voltage sensing circuitry, an ATmega or similar microcontroller, and a GSM module (e.g., SIM800L). Experimental validation demonstrates the system's accuracy, responsiveness, and effectiveness in enhancing electrical safety and providing remote awareness, making it suitable for both residential and industrial distributed load applications.

I.INTRODUCTION

In modern distributed power systems, maintaining a stable voltage level is critical for ensuring the safe and reliable operation of electrical equipment. However, voltage fluctuations, including overvoltage and undervoltage conditions, remain common challenges due to factors such as poor grid regulation, sudden load changes, or faulty transformers. These fluctuations can degrade system performance, damage appliances, and in severe cases, lead to electrical fires or hazards. Traditional protection methods like circuit breakers offer basic safety but lack intelligence and communication capabilities. With the growing need for smarter, real-time monitoring in both urban and remote setups, there is a demand for automated and connected solutions that not only detect faults but also provide instant alerts to users.

This project introduces an automated voltage protection system using a microcontroller (e.g., ATmega328/PIC) and a GSM module, designed to monitor voltage levels continuously. When the voltage crosses user-defined safe limits, the system triggers a relay-based disconnection of the load and notifies the user via SMS. The objective is to provide a cost-effective, scalable, and intelligent protection system that enhances safety and minimizes damage to electrical infrastructure.

II.LITERATURE SURVEY

The sun rays fall on the solar cell in some particular direction then only we get maximum output, The solar cells output depends on the intensity of sunlight and the angle of incidence. Hence the solar cells are rotated in the direction of sun position where we get maximum efficiency. solar tracker is the best for receiving maximum radiation. According to the movement of sun by moving the solar panel we can always receive the maximum radiation. Solar panels are used convert into light energy into electrical energy. Efficient Solar Power generation System using moving panel is a efficient power generating system using sun light. Total four sensor are used two sensors is E-W and other two sensor is N-S directions to sense the direction of maximum intensity of light. The

difference between to the outputs of the sensors is given to the microcontroller (PIC18F877A). Microcontroller is used to process the input voltage from the parallel circuit and control the direction in which the motor has to be rotated so that it will receive maximum intensity of light from the sun. The power generated for this process is then stored in a lead acid battery. The proposed a system provides a indication of their relative angle to the sun by comparing with predefined measured readings. By using this method, sufficiently perpendicular angle the solar tracker was successfully maintained a solar array to the Sun.

III.DESIGN OF HARDWARE

This chapter briefly explains about the Hardware. It discuss the circuit diagram of each module in detail.

ARDUINO UNO

The Arduino Uno is a microcontroller board based on the ATmega328 (datasheet). It has 14 digital input/output pins (of which 6 can be used as PWM outputs), 6 analog inputs, a 16 MHz ceramic resonator, a USB connection, a power jack, an ICSP header, and a reset button. It contains everything needed to support the microcontroller; simply connect it to a computer with a USB cable or power it with a AC-to-DC adapter or battery to get started.

The Uno differs from all preceding boards in that it does not use the FTDI USB-to-serial driver chip. Instead, it features the Atmega16U2 (Atmega8U2 up to version R2) programmed as a USB-to-serial converter. Uno board has a resistor pulling the 8U2 HWB line to ground, making it easier to put into DFU mode. Arduino board has the following new features:

- 1.0 pin out: added SDA and SCL pins that are near to the AREF pin and two other new pins placed near to the RESET pin, the IOREF that allow the shields to adapt to the voltage provided from the board. In future, shields will be compatible both with the board that use the AVR, which operate with 5V and with the Arduino Due that operate with 3.3V. The second one is a not connected pin, that is reserved for future purposes.
- Stronger RESET circuit.
- Atmega 16U2 replace the 8U2.

"Uno" means one in Italian and is named to mark the upcoming release of Arduino 1.0. The Uno and version 1.0 will be the reference versions of Arduino, moving forward. The Uno is the latest in a series of USB Arduino boards, and the reference model for the Arduino platform; for a comparison with previous versions, see the index of Arduino boards.

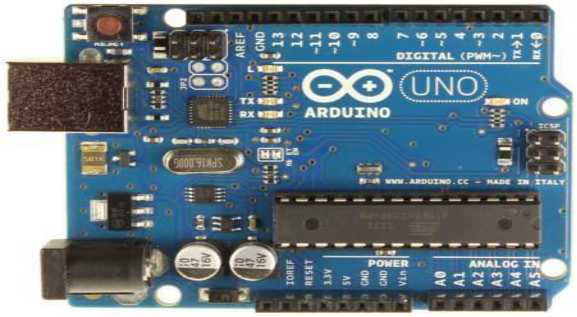


Fig: ARDUINO UNO

POWER SUPPLY:

The power supplies are designed to convert high voltage AC mains electricity to a suitable low voltage supply for electronic circuits and other devices. A power supply can by broken down into a series of blocks, each of which performs a particular function. A d.c power supply which maintains the output voltage constant irrespective of a.c mains fluctuations or load variations is known as “Regulated D.C Power Supply”.

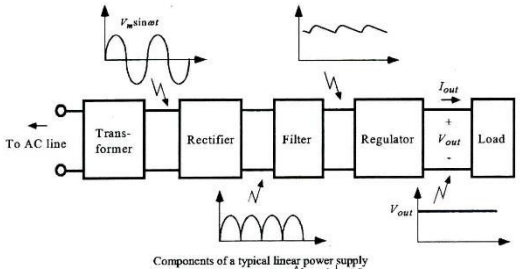


Fig: Block Diagram of Power Supply

LCD DISPLAY

A model described here is for its low price and great possibilities most frequently used

in practice. It is based on the HD44780 microcontroller (Hitachi) and can display messages in two lines with 16 characters each. It displays all the alphabets, Greek letters, punctuation marks, mathematical symbols etc. In addition, it is possible to display symbols that user makes up on its own. Automatic shifting message on display (shift left and right), appearance of the pointer, backlight etc. are considered as useful characteristics.

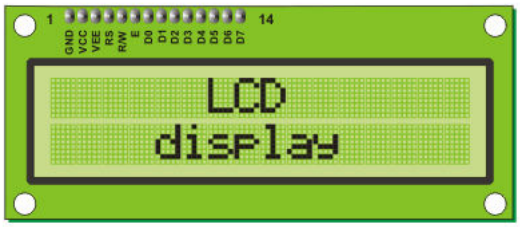
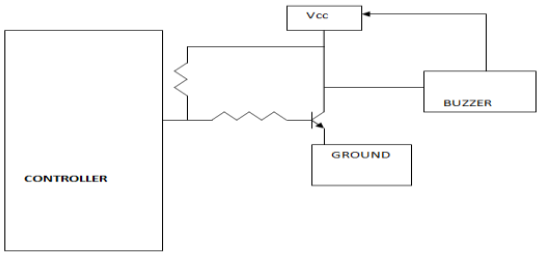


Fig: LCD

BUZZER

Digital systems and microcontroller pins lack sufficient current to drive the circuits like relays, buzzer circuits etc. While these circuits require around 10milli amps to be operated, the microcontroller's pin can provide a maximum of 1-2milli amps current. For this reason, a driver such as a power transistor is placed in between the microcontroller and the buzzer circuit.



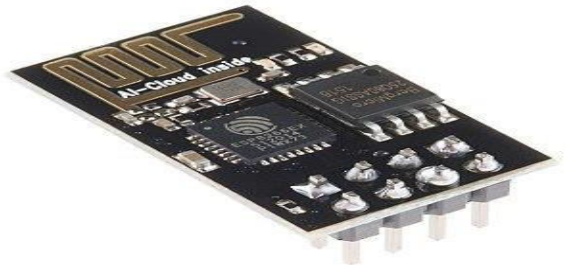
WIFI MODULE:

The **ESP8266** is a low-cost Wi-Fi microchip with full TCP/IP stack and microcontroller capability produced by Shanghai-based Chinese manufacturer, Espressif Systems.[1]

The chip first came to the attention of western makers in August 2014 with the **ESP-01** module, made by a third-party manufacturer, Ai-Thinker. This small module allows microcontrollers to connect to a Wi-Fi network and make simple TCP/IP connections using Hayes-style commands. However, at the time there was almost no English-language documentation on the chip and the commands it accepted.[2] The very low price and the fact that there were very few external components on the module which suggested that it could eventually be very inexpensive in volume, attracted many hackers to explore the module, chip, and the software on it, as well as to translate the Chinese documentation.[3]

The **ESP8285** is an ESP8266 with 1 MiB of built-in flash, allowing for single-chip devices capable of connecting to Wi-Fi.[4]

The successor to these microcontroller chips is the ESP32.



RELAYS

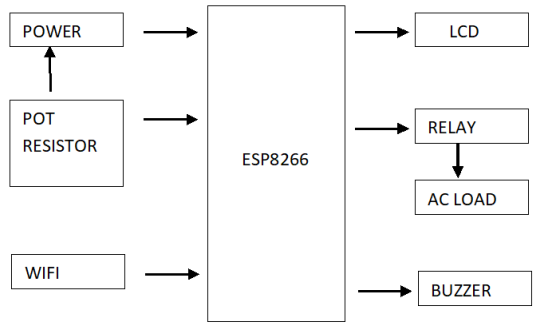
We know that most of the high end industrial application devices have relays for their effective working. Relays are simple switches which are operated both electrically and mechanically. Relays consist of a n electromagnet and also a set of contacts. The switching mechanism is carried out with the help of the electromagnet. There are also other operating principles for its working. But they differ according to their applications. Most of the devices have the application of relays.

The main operation of a relay comes in places where only a low-power signal can be used to control a circuit. It is also used in places where only one signal can be used to control a lot of circuits. The application of relays started during the invention of telephones. They played an important role in switching calls in telephone exchanges. They were also used in long distance

telegraphy. They were used to switch the signal coming from one source to another destination.

The basics for all the relays are the same. Take a look at a 4 – pin relay shown below. There are two colours shown. The green colour represents the control circuit and the red colour represents the load circuit. A small control coil is connected onto the control circuit. A switch is connected to the load. This switch is controlled by the coil in the control circuit. Now let us take the different steps that occour in a relay.

IV. BLOCK DIAGRAM:



Working: Air conditioning supply is ventured down to 12 V by utilizing a stage down transformer. The AC supply is changed over to DC supply through scaffold rectifier. The supply is then sifted by capacitors associated crosswise over rectifier to decrease music. At that point the unregulated supply is then given to voltage controller whose yield is given to the comparators IC LM324 and transfer as supply as shown in fig. 15. The unregulated supply from connect rectifier is set to set 1 and set 2 as info. The set 1 and set 2 are potentiometer ckt.1 and potentiometer ckt.2 individually associated with comparators IC LM324 as information. Further, the comparators and load are associated with hand-off. At whatever point there is overvoltage or under voltage the comparators look at the set conditions and gives the flag to the hand-off and hand-off outings and the heap will turned off. With the goal that it secures the electrical apparatus.

• When the line voltage is lower than 180V, the voltage at the upsetting terminal (stick 6) of operational enhancer N2 is beneath the voltage at the nonmodifying terminal (6V) as shown in fig. 16. Subsequently the yield of operational speaker N2 goes high and it empowers the hand-off through transistor T1. The AC supply is separated from the framework and electrical apparatuses kill. • Subsequently the machines are secured against under-voltage. IC1 is wired for a directed 12V supply. • The transfer invigorates in two conditions: in the first place, if the voltage at stick 3 of IC2 is past 6.8V, and second, if the voltage at stick 6 of IC2 is lower than 6V. • Over-voltage and under-voltage levels can be adjusted utilizing sets VR1 and VR2, individually. 3.5 Hardware Implementation • It includes the points of interest of the arrangement of outline details. The equipment plan comprises of, the choice of framework segments according to the prerequisite, the points of interest of subsystems that are required for the total usage of the framework has been completed. It includes the part determination, segment portrayal and equipment subtle elements of the framework outlined.

V.CONCLUSION

The proposed system offers a comprehensive solution for automatic load protection against overvoltage and undervoltage conditions in distributed electrical systems. Through the integration of microcontroller-based voltage monitoring and GSM communication, the system effectively isolates the load during abnormal conditions and promptly informs the user, ensuring both protection and situational awareness.

Testing under various voltage scenarios validated the system's high sensitivity, quick response time, and reliable SMS notification capability. This makes it particularly beneficial in remote or unattended installations, where manual supervision is limited.

In conclusion, the system not only enhances the safety and longevity of electrical appliances but also contributes to the advancement of smart grid infrastructure by incorporating automation and communication features. Future work can expand the design with IoT-based dashboards, Wi-Fi/Bluetooth connectivity, and integration into home energy management systems for more extensive monitoring and control.

REFERENCES:

1. J.B GUPTA (2018) A COURSE IN POWER SYSTEMS, PART-III: Switchgear and Protection, Chapter-9.

2. ROBERT L. BOYLESTAD, LOUIS NASHELSKY (2015) Electronic Devices and Circuit Theory 11th Edition, Chapter-10.

3. "IEEE Recommended Practice for Monitoring Electric Power Quality," IEEE Std. 1159-1995, June 1995.

4. Girish Chandra Thakur, Kumar Shantanu Kaushal, Manish Ranjan, Sandip kumar Gupta. "Implementation of single phasing, over voltage, under voltage, Protection of Three Phase Appliances without using Microcontroller" , Int. journal of Engineering Research and Applications,ISSN:2248-9622, vol. 5, Issue 5, (Part-6), pp.110-115,May 2015.

5. Sourav Ghosh, Soumik Bakshi, saurav Ghosh, Rahul kundu, Indrajit Koleys. "Development of a low cost under voltage and over current protection device", Int. Journal of Advance Research in Electrical, Electronics and Instrumentation Engineering, ISSN: 2278-8875, vol.5, Issue 5, May 2016.

6. Gorkshanath Bhosale, Aakash Vakhare, Abhishek Kaystha, Amol Aher, Vishal Pansare. "Overvoltage, Undervoltage, Protection of Electrical Equipment", Int. Research Journal of Engineering and Technology(IRJET), ISSN: 2395- 0056, vol.5, Issue 2, Feb 2018.