DESIGN AND IMPLEMENTATION OF IOT BASED ELECTRICAL LOAD CONTROL AND MONITOR SYSTEM

A Project report submitted in partial fulfillment of the requirements for the degree of Bachelor of Science in Electrical and Electronic Engineering

Submitted By

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Certificate of Approval

The project titled "**Design and Implementation of Iot Based Electrical Load Control And Monitor System**" submitted by **Md. Naim Molla** , ID No: EEE-2001019122, has been accepted as satisfactory in partial fulfillment of the requirement for the degree of Bachelor of Science in Electrical and Electronic Engineering on September 2024.

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Declaration

This is to certify that the project titled “Design and Implementation of Iot Based Electrical Load Control and Monitor System” is the result of our study in partial fulfillment of the B.Sc. Engineering degree under the supervision of Md. Rais Uddin Mollah, Assistant Professor & Head (acting), Department of Electrical and Electronic Engineering (EEE), Sonargaon University, Bangladesh. It is also hereby declared that this project or any part of it has not been submitted elsewhere for the award of any degree.

Signature of the Candidate

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Acknowledgement

First of all, i would like to say thanks to almighty “ALLAH” for giving us the strength to finish the project as a partial fulfillment for the requirements for the Degree of B. Sc. In Electrical and Electronic Engineering

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We are also grateful to all the faculties of the Department of Electrical and Electronic Engineering of Sonargaon University, Bangladesh for giving us the opportunity to complete the work and necessary support during the period.

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ABSTRACT

The IOT Base Electrical Load Control and Monitoring System is give you all kind of load information over the internet. We can control electrical and electronics load using our smart phone and also from our computer. This is implemented using ESP NodeMCU. This paper presents the load monitoring system that reduced current consumption and control over current flow. This controller replaces the cable connections for load monitor, so that reduced costing. A LED indicator is used to demonstrate the working of the model. The system is a simple telemetry system, which transfer data automatically when user open the controlling application or software. The system automatically checks the load condition and power consumption. There is a Wi-Fi module inside of node-MCU which is connected to the internet. The data is to be transferred with Wi-Fi Module using 2.4GHz radio frequency. We will receive this data on mobile phone or computer over the internet. MCU controls the function of relay and turn on or off our load using relay interfacing circuit. This Monitoring System hardware used in this system is NodeMCU, Relay module, Current sensor (CS), and potential transformer (PT).

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LIST OF ABBREVIATIONS

A	Ampere
AC	Alternative Current
AFH	Adaptive Frequency Hopping
C	Capacitance
CDI	Capacitor Discharge Ignition
CMOS	Complementary Metal Oxide Semiconductor
CT	Current Transformer
DC	Direct Current
EDR	Enhance Data Rate
EEPROM	Electrically Erasable Programmable Read-Only Memory
EN	Enable
F	Farad
FTDI	Future Technology Devices International
GHz	Giga Harz
GND	Ground
GSM	Global System for Mobile Communication
IC	Integrated Circuit
I/O	Input Output
IRLED	Infrared Light Emitting Diode
IoT	Internet of Thinks
K	Kilo
KB	Kilo Byte
LCD	Liquid Cristal Display
LED	Light emitting Diode
mA	Mile Ampere
MAC	Media Access Control
Mbps	Mega Byte per Second
MCU	Microcontroller Unit
MHz	Mega Harz
MPU	Microprocessor Unit
N/O	Normally Open
N/C	Normally Close
PCB	Printed Circuit Board
PT	Potential Transformer
PWM	Pulse Wide Modulation
R	Resistance
RAM	Random Access Memory
RSR	Reset
RX	Receiver
RXD	Received Serial Data
R/W	Read Write

S/I	International System
SPDT	Single Pull Double Throw
SPP	Serial Port Protocol
TTL	Transistor-Transistor Logic
TX	Transmitter
TXD	Transmitted Serial Data
USB	Universal Serial Bus
V	Voltage
VCC	Voltage Common Collector
Vin	Input Voltage

LIST OF SYMBOLS

Ω	ohm
uF	Microfarad
nF	Nano farad
Ωt	Time Phase
°C	Degree Celsius
Q	Charge

CHAPTER 1

INTRODUCTION

1.1 Introduction

The IOT Base Electrical Load control and Monitoring System is give you all kind of load information over the internet. You can control electrical and electronics load using your smart phone and also from your computer. This is implemented using ESP NodeMCU. This paper presents the load monitoring system that reduced current consumption and control over current flow. This controller replaces the cable connections for load monitor, so that reduced costing and clear old wring system. A LED indicator is use to demonstrate the working of the model. The system is a simple telemetry system, which is transfer data automatically when user open controlling application or software. The system automatically checks whether, the load condition and also power consumption. There is a Wi-Fi module inside of node-MCU which is connected with internet. The data to be transferred with Wi-Fi Module using 2.4GHz radio frequency. We received this data on mobile phone or computer over the internet. MCU controls the function of relay and turn on or off our load using relay interfacing circuit. This Monitoring System hardware used in this system is NodeMCU, Relay module, Current sensor (CT), and potential transformer (PT).

1.2 Internet of Thing (IOT)

The Internet of Things (IOT) is a system of interrelated computing devices, mechanical and digital machines, objects, animals or people that are provided with unique identifiers (UIDs) and the ability to transfer data over a network without requiring human-to-human or human-to-computer interaction.

The definition of the Internet of Things has evolved due to the convergence of multiple technologies, real-time analytics, machine learning, commodity sensors, and embedded systems. Traditional fields of embedded systems, wireless sensor networks, control systems, automation (including home and building automation), and others all contribute to enabling the Internet of Things. In the consumer market, IOT technology is most synonymous with products pertaining to the concept of the "smart home", covering devices and appliances (such as lighting fixtures, thermostats,

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home security systems and cameras, and other home appliances) that support one or more common ecosystems, and can be controlled via devices associated with that ecosystem, such as smartphones and smart speakers.

1.3 Load Monitoring and Controlling

This IOT based electrical load monitoring system is fully a NodeMCU based system. Using this system, we can monitor our load from worldwide. Using this system, we can control any kind of load from our smart phone or computer over internet. We can determine load current flow and load power, also we can record this power data.

1.4 Problem Statement

There is a lot of industry and factory inside our world. And this factory's have a lot of electrical and electronics machine or appliance, but there are some switches for control this machine or appliances. When we turn on this switches all machine or appliance going to on or run Condition. But we don't need turn on all machine or appliances. In this case, we can solve this problem using this monitoring system from anywhere inside of world. Also we can turn of unused machine or any kind of load. This is the problem that leads to the development of the ideal of a Monitoring system.

1.5 Motivation

After reading various literature papers that wire based on monitoring system, we found this topic "IOT Base Electrical Load Monitoring System" as the most useful technology in the present growing technology. After reading many papers relative to this concept, we found one paper that was very much helpful to us in leading the project. In this technical paper, monitoring system explains how to establish an IOT base monitoring system. This monitoring system has various application like useful for Industry or Factory, office and also for home appliances. It's help to reduce current wastage and also protect over current flow. In all the above mention application, we will use NodeMCU, with a little change in the hardware. Along with this, I will explain you how this application is used to reduce current wastage.

1.6 Objectives

The goal or objectives of which the designed device is expected to accomplish are;

i. To design the IOT based electrical load monitoring system to reduced current wastage.
ii. To design the circuit, for improve load monitoring system.
iii. To develop a monitoring system for reduced load current flow.
iv. To study and understand the concept of IOT based communication.
v. To reduce electrical short circuit's.

1.7 Research Methodology

Here we designed a system, which allows check load weather the load is on or off status, load current flow, Over current detection, and unused load. We take all kind of load data like load power, load status, then we calculate all kind of data and send this data to monitor for monitoring over the internet. In this case we can monitor from anywhere. We can use a smart phone, Laptop or computer for monitor and controlling load.

During the preparation of the report help from several sources but here some are mentioned as for the proper references.

1.8 Conclusion

In this paper we have discussed about developing an “IOT based electrical load monitoring system: A Next Generation Smart monitoring system” by incorporating many features like Online monitoring, over current detection and online based load control unit, that are lacked in the conventional monitor or control system. Especially this monitor system is designed to reduce current wastage.

The design of IOT based electrical load monitoring system has shown the satisfactory results and works well for control from online. In future, this monitoring system can be enhanced by adding some other features like, GSM system for informing and individually sensing for individually load control.

1.9 Project Outline

This project is organized as follows:

Chapter 1 Introduction.

In this chapter we discus about this project.

Chapter 2 Analysis of the system component.

In this chapter we discus about all component, which component we used in this project. like NodeMCU, Current sensor, Relay module resistor, capacitor, diode, Transistor, etc.

Chapter 3 Hardware development.

In this chapter we discus about hardware developing. how we develop our project, how we make this project.

Chapter 4 Result and discussions.

In this chapter we discus about project output, we check switch status and load status.

Chapter 5 Conclusions.

CHAPTER 2

ANALYSIS OF THE SYSTEM COMPONENT

2.1 Introduction

The proposed system is The IOT Base Electrical Load Monitoring System. The system reduced current flow, by monitoring and controlling from smart phone or computer. The system will bear following functionalities:

- ✓ It will check all load status and measure load power.
- ✓ This monitor system can detect over current flow.
- ✓ This monitor system can detect short circuit.
- ✓ We can control it using smart phone from anywhere.
- ✓ We can get this all kind of data from smart phone or computer.

2.2 Required Component

The Smart Helmet has the following main components.

Table: 2.1 Required Component

Component	**Software**
NodeMCU	Arduino IDE
Current Sensor	Proteus
Relay Module.	Bylink
Voltage regulator IC	
Transformer.	
Power Switch.	
Power Connector.	
Diode.	
Resistor.	
Capacitor.	
Transistor.	
Opto Isolator.	
Vero-Board.	

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2.3 NodeMCU

NodeMCU is an open source IOT platform. It includes firmware which runs on the ESP8266 Wi-Fi SoC from Espressif Systems, and hardware which is based on the ESP-12 module. The term "NodeMCU" by default refers to the firmware rather than the development kits. The firmware uses the Lua scripting language. It is based on the eLua project, and built on the Espressif Non-OS SDK for ESP8266.

NodeMCU was created shortly after the ESP8266 came out. On December 30, 2013, Espressif Systems began production of the ESP8266. The ESP8266 is a Wi-Fi SoC integrated with a Tensilica Xtensa LX106 core, widely used in IOT applications. NodeMCU started on 13 Oct 2014, when Hong committed the first file of nodemcu-firmware to GitHub.

Two months later, the project expanded to include an open-hardware platform when developer Huang R committed the gerber file of an ESP8266 board, named devkit v0.9. Later that month, Tuan PM ported MQTT client library from Contiki to the ESP8266 SoC platform, and committed to NodeMCU project, then NodeMCU was able to support the MQTT IOT protocol, using Lua to access the MQTT broker.[4]

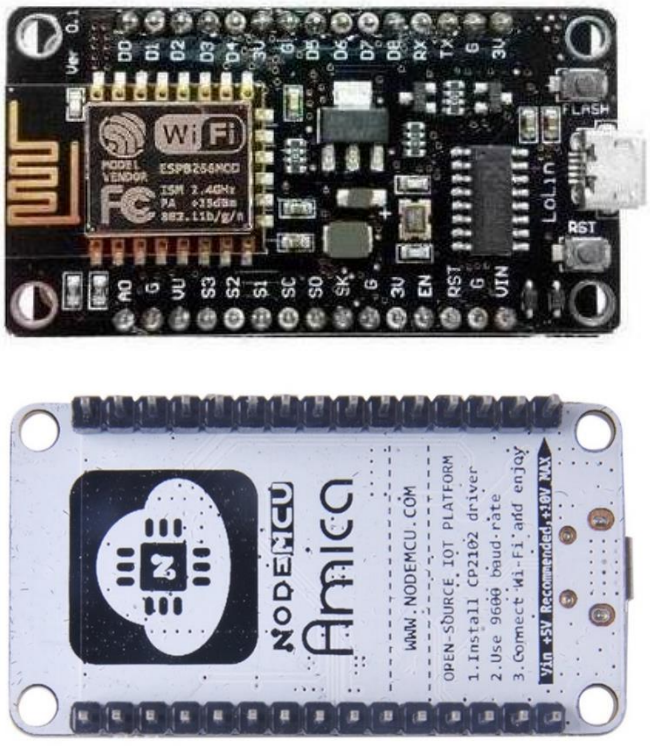


Fig: 2.1 NodeMCU.

2.3.1 Specification of NodeMCU

NodeMCU	
Microcontroller	Tensilica 32-bit RISC CPU Xtensa LX106
Operating Voltage	3.3V
Input Voltage	7-12V
Digital I/O Pins (DIO)	16
Analog Input Pins (ADC)	1
UARTs	1
SPIs	1
I2Cs	1
Flash Memory	4 MB
SRAM	64 KB
Clock Speed	80 MHz
Wi-Fi	IEEE 802.11 b/g/n

Table: 2.2 Specification of NodeMCU

2.3.2 Pin Function of NodeMCU

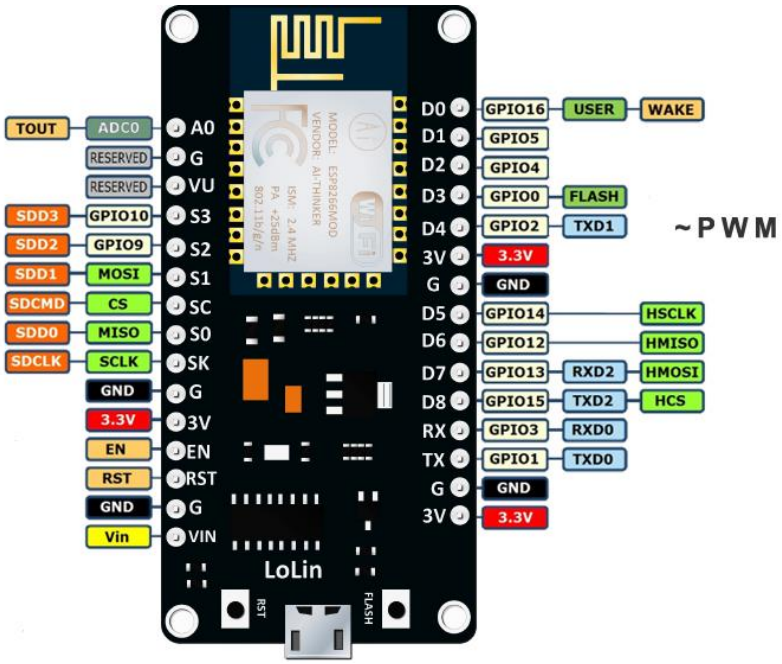


Fig: 2.2 Pin Function of NodeMCU.

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Table: 2.3 Pin function of NodeMCU.

Level	GPIO	Notes
A0		Analog to Digital Converter (ADC)
RSV		Reserved
RSV		Reserved
SD3	GPIO 10	
SD2	GPIO 09	
SD1	GPIO 08	Master Out Slave In (MOSI)
CMD	GPIO 06	CS/SDCMD
SD0	GPIO 07	Master In Slave Out (MISO)
CLK		Clock Signal
GND		Ground
3V3		3.3V Output
EN		Enable
RST		Reset
GND		Ground
Vin		Raw input Voltage
TX	GPIO 01	Serially data transmit
RX	GPIO 03	Serially data Received
D8	GPIO 15	CS
D7	GPIO 13	MOSI
D6	GPIO 12	MISO
D5	GPIO 14	SCLK
D4	GPIO 02	TXD 1
D3	GPIO 00	Flash
D2	GPIO 04	SDA
D1	GPIO 05	SCL
D0	GPIO 16	Wake

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2.4 Current Sensor

The Allegro ACS712 provides economical and precise solutions for AC or DC current sensing in industrial, commercial, and communications systems. The device package allows for easy implementation by the customer. Typical applications include motor control, load detection and management, switched-mode power supplies, and overcurrent fault protection. The device consists of a precise, low-offset, linear Hall sensor circuit with a copper conduction path located near the surface of the die. Applied current flowing through this copper conduction path generates a magnetic field which is sensed by the integrated Hall IC and converted into a proportional voltage. Device accuracy is optimized through the close proximity of the magnetic signal to the Hall transducer. A precise, proportional voltage is provided by the low-offset, chopper-stabilized BiCMOS Hall IC, which is programmed for accuracy after packaging. The output of the device has a positive slope (>VIOUT(Q)) when an increasing current flows through the primary copper conduction path (from pins 1 and 2, to pins 3 and 4), which is the path used for current sensing. The internal resistance of this conductive path is 1.2 mΩ typical, providing low power loss. The thickness of the copper conductor allows survival of the device at up to 5× overcurrent conditions. The terminals of the conductive path are electrically isolated from the sensor leads (pins 5 through 8). This allows the ACS712 current sensor to be used in applications requiring electrical isolation without the use of opto-isolators or other costly isolation techniques. [5]

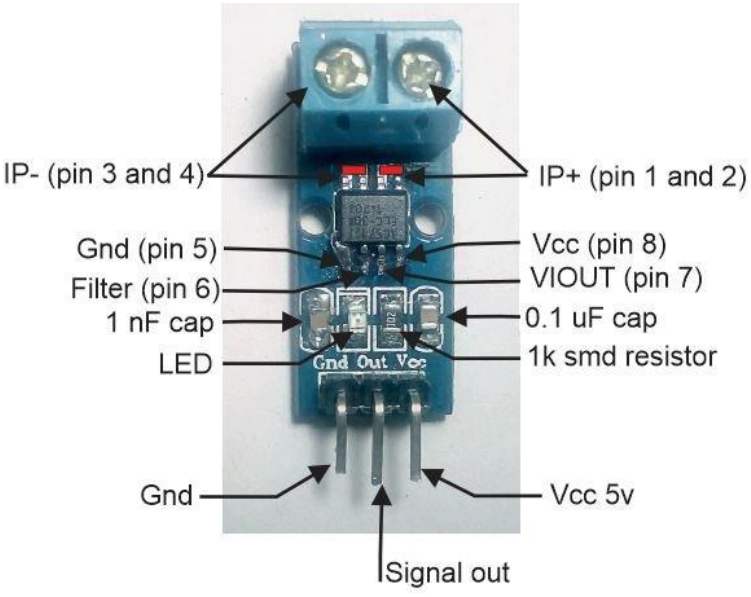


Fig: 2.3 Current Sensor ASC712

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2.4.1 Pin Function of ASC712 Current Sensor

Table: 2.4 Pin Function of ASC712 Current Sensor.

Number	Name	Description
1	IP+	Terminals for current being sensed; fused internally
2	IP+	Terminals for current being sensed; fused internally
3	IP-	Terminals for current being sensed; fused internally
4	IP-	Terminals for current being sensed; fused internally
5	GND	Signal ground terminal
6	FILTER	Terminal for external capacitor that sets bandwidth
7	VIOUT	Analog output signal
8	VCC	Device power supply terminal

2.5 Relay Module

The relay module is a separate hardware device used for remote device switching. With it you can remotely control devices over a network or the Internet. Devices can be remotely powered on or off with commands coming from our NodeMCU, delivered over a local or wide area network. You can control computers, peripherals or other powered devices from across the office or across the world. The Relay module can be used to sense external On/Off conditions and to control a variety of external devices. The PC interface connection is made through the serial port. The Relay module houses two SPDT relays and one wide voltage range, optically isolated input. These are brought out to screw-type terminal blocks for easy field wiring. Individual LED's on the front panel monitor the input and two relay lines. The module is powered from voltage regulator IC.

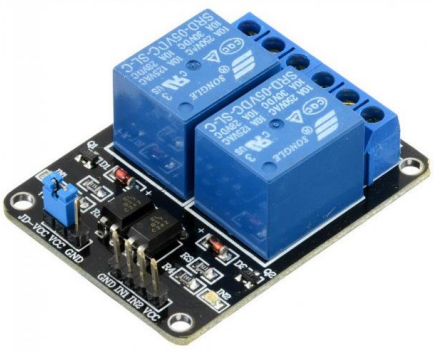


Fig: 2.4 Relay Module.

2.5.1 Specification of Relay Module

Table: 2.5 Specification of relay module.

VCC	5V DC
Current Consumption	50mA
Number Of Load	2
AC Input Voltage	180-270V AC
Load Current	10A
Opto-Isolated	Yes

2.5.2 Pin Function of Relay Module

Table: 2.6 Pin function of relay module.

Relay Module Pinout	
GND	Ground Pin.
IN 1	Relay 1 input signal
IN 2	Relay 2 input signal
VCC	Power 3.3v-5.0v
Screw 1	1st relay NC
Screw 2	1st relay common pin/AC IN
Screw 3	1st relay NO/AC OUT/Load 1
Screw 4	2nd relay NC
Screw 5	2nd relay common pin/AC IN
Screw 6	2nd relay NO/AC OUT/Load 2

In relay module input side have two pin header. Number one is trigger selection pin header, which is used for changing trigger polarity. That mean we can use negative voltage for turn on relay's. Number two is relay input signal pin header with biasing voltage pin. It has two input pin and two biasing pin. Output side have one screw base header. Which is used for AC input and load output connection. We can use NO or NC connection as we need.

2.6 Voltage regulator IC

Voltage sources in a circuit may have vacillations bringing about not giving settled voltage yields. A voltage controller IC keeps up the yield voltage at a consistent esteem.

7805 IC, an individual from 78xx arrangement of settled straight voltage controllers used to keep up such changes, is a mainstream voltage controller IC. The xx in 78xx demonstrates the yield voltage it gives. 7805 IC furnishes +5 volts controlled power supply with arrangements to include a warmth sink. [8]

2.6.1 Specification of 7805 Voltage Regulator IC

i. Input voltage range 7V to 35V.

ii. Output Current 1 A.

iii. Output voltage range V_{Max} = 5.2V, V_{Min} = 4.8V.

2.6.2 Pin Function of 7805 Voltage Regulator IC.

Table: 2.7 Pin Function of 7805 IC.

Pin NO	Pin Name
1	Input pin
2	Ground pin
3	Output pin

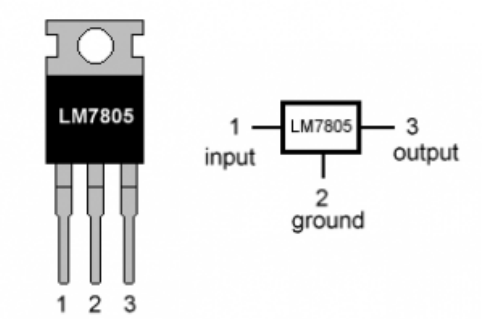


Fig: 2.5 Voltage Regulator IC.

2.7 Transformer

A transformer is a passive electrical device that transfers electrical energy between two or more circuits. A varying current in one coil of the transformer produces a varying magnetic flux, which, in turn, induces a varying electromotive force across a second coil wound around the same core. Electrical energy can be transferred between the two coils, without a metallic connection between the two circuits. Faraday's law of induction discovered in 1831 described the induced voltage effect in any coil due to changing magnetic flux encircled by the coil.

Transformers are used for increasing or decreasing the alternating voltages in electric power applications, and for coupling the stages of signal processing circuits.

Since the invention of the first constant-potential transformer in 1885, transformers have become essential for the transmission, distribution, and utilization of alternating current electric power. A wide range of transformer designs is encountered in electronic and electric power applications. Transformers range in size from RF transformers less than a cubic centimeter in volume, to units weighing hundreds of tons used to interconnect the power grid.

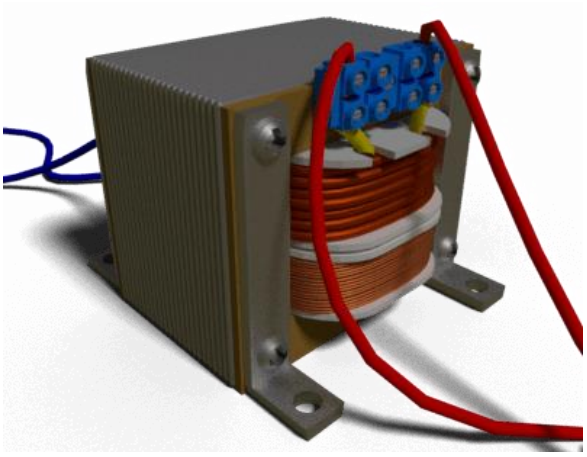


Fig: 2.6 Transformer.

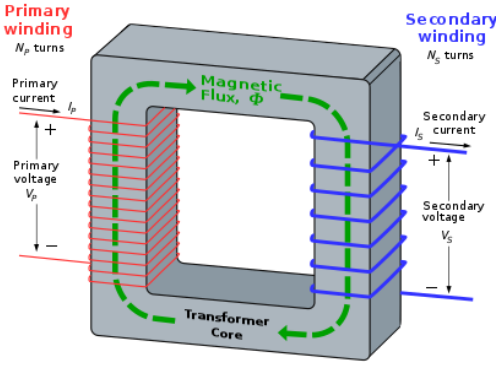


Fig: 2.7 Transformer working Principle.

Table: 2.8 Specification of Transformer

Specification	
Terminal	5
Input Terminal	2
Output Terminal	3
Input voltage	220V AC
Output Voltage	12-0-12 V AC
Power	12 W
Ratio	18:1

2.7.1 Potential Transformer

A Potential transformer is actually an instrument transformer that used in power systems to step down primary current voltages and secondary voltages from a higher level to lower secondary potential output voltage level. This transformer can be easily measured by the ordinary low voltage instrument like a voltmeter, wattmeter and watt-

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hour meters, etc. This kind of transformer is commonly referred to as a "step-down" voltage transformer which lowers the voltage of a high voltage circuit to a lower voltage circuit for the intention of measuring voltage drops. Potential transformers are connected across or parallel to the line which is being measured to record phase angle errors or ratio errors.

It is commonly found in electrical metering situations, and is designed to allows it to monitor single phase shifting voltages and three-phase terminal voltage. A potential transformer is also a kind of instrument transformer, known as a voltage transformer. There is still a primary winding and a transformers high voltage secondary winding. This special type of transformer allows a meter to take readings from electrical service connections with a higher voltage (potential) rating than the meter is normally capable of handling without at potential transformer.

The primary terminals can be connected either in line-to-line or in line-to-neutral configuration of voltages ratio. Fused transformer models are designated by a suffix of "F" for one fuse or "FF" for two fuses.
We used a same transformer for power supply and potential voltage measurement.

2.8 Power Switch

In electrical designing, a switch is an electrical segment that can "make" or "break" an electrical circuit, interfering with the flow or redirecting it starting with one conduit then onto the next. The system of a switch expels or reestablishes the directing way in a circuit when it is worked. A switch will have at least one arrangements of contacts, which may work at the same time, successively, or on the other hand. Switches in powerful circuits must work quickly to counteract ruinous arcing, and may incorporate unique highlights to aid quickly intruding on a substantial current. [15]

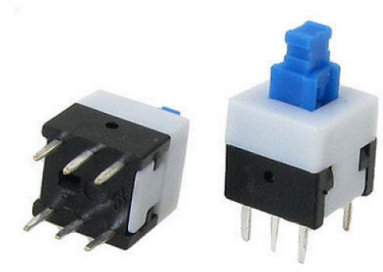


Fig: 2.8 SPDT Power Switch.

2.9 Power Connector

Barrel connectors are ordinarily found on minimal effort purchaser hardware which can be connected to divider control by means of massive AC divider connectors. Divider connectors are generally accessible, in an assortment of intensity evaluations and voltages, making barrel connectors a typical means for interfacing capacity to little tasks. The female barrel connector can be obtained in a few assortments: PCB mounted link mount, or board mount. A portion of these connectors will have an extra contact that enables the application to identify whether a power supply is connected to the barrel jack or not, in this manner enabling the gadget to sidestep batteries and spare battery life when running on outside power. [16]

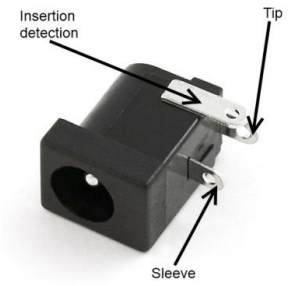


Fig: 2.9 Power Connector Port.

2.10 Diode

Diode, an electrical component that allows the flow of current in only one direction. In circuit diagrams, a diode is represented by a triangle with a line across one vertex.
The most common type of diode uses a *p*-*n* junction. In this type of diode, one material 'N' in which electrons are charge carriers abuts a second material 'P' in which holes (places depleted of electrons that act as positively charged particles) act as charge carriers. At their interface, a depletion region is formed across which electrons diffuse to fill holes in the *P*-side. This stops the further flow of electrons. When this junction is forward biased (that is, a positive voltage is applied to the *P*-side), electrons can easily move across the junction to fill the holes, and a current flows through the diode. When the junction is reverse biased (that is, a negative voltage is applied to the *P*-side), the depletion region widens and electrons cannot easily move across. The current remains very small until a certain voltage (the breakdown voltage) is reached and the current suddenly increases.

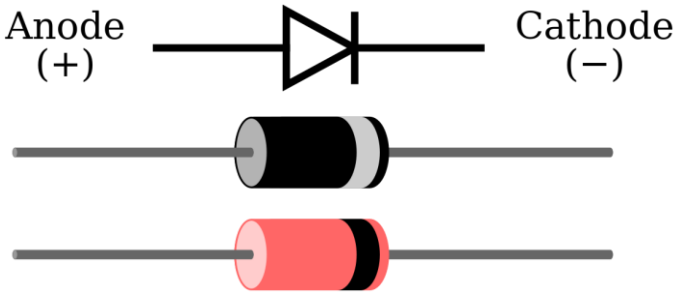


Fig: 2.10 Diode.

2.11 Resistor

A resistor is a passive two-terminal electrical component that implements electrical resistance as a circuit element. In electronic circuits, resistors are used to reduce current flow, adjust signal levels, to divide voltages, bias active elements, and terminate transmission lines, among other uses. High-power resistors that can dissipate many watts of electrical power as heat, may be used as part of motor controls, in power distribution systems, or as test loads for generators. Fixed resistors have resistances that only change slightly with temperature, time or operating voltage. Variable resistors can be used to adjust circuit elements (such as a volume control or a lamp dimmer), or as sensing devices for heat, light, humidity, force, or chemical activity.

Resistors are common elements of electrical networks and electronic circuits and are ubiquitous in electronic equipment. Practical resistors as discrete components can be composed of various compounds and forms. Resistors are also implemented within integrated circuits. The electrical function of a resistor is specified by its resistance: common commercial resistors are manufactured over a range of more than nine orders of magnitude. The nominal value of the resistance falls within the manufacturing tolerance, indicated on the component.



Fig: 2.11 Fixed Resistor Symbol.



Fig: 2.12 Fixed Resistor Symbol (ANSI).

2.12 Capacitor

A capacitor is a device that stores electrical energy in an electric field. It is a passive electronic component with two terminals. The effect of a capacitor is known

as capacitance. While some capacitance exists between any two electrical conductors in proximity in a circuit, a capacitor is a component designed to add capacitance to a circuit. The capacitor was originally known as a condenser. This name and its cognates are still widely used in many languages, but rarely in English, one notable exception being condenser microphones, also called capacitor microphones.[8]

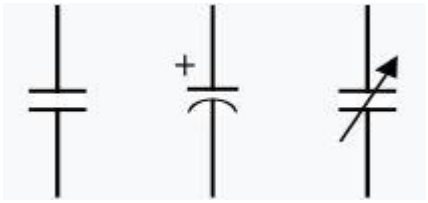


Fig: 2.13 Symbol of Capacitor.

The physical form and construction of practical capacitors vary widely and many types of capacitor are in common use. Most capacitors contain at least two electrical conductors often in the form of metallic plates or surfaces separated by a dielectric medium. A conductor may be a foil, thin film, sintered bead of metal, or an electrolyte. The non-conducting dielectric acts to increase the capacitor's charge capacity. Materials commonly used as dielectrics include glass, ceramic, plastic film, paper, mica, air, and oxide layers. Capacitors are widely used as parts of electrical circuits in many common electrical devices. Unlike a resistor, an ideal capacitor does not dissipate energy, although real-life capacitors do dissipate a small amount. When an electric potential, a voltage, is applied across the terminals of a capacitor, for example when a capacitor is connected across a battery, an electric field develops across the dielectric, causing a net positive charge to collect on one plate and net



Fig: 2.14 Different Type of Capacitors.

negative charge to collect on the other plate. No current actually flows through the dielectric. However, there is a flow of charge through the source circuit. If the condition is maintained sufficiently long, the current through the source circuit ceases. If a time-varying voltage is applied across the leads of the capacitor, the source experiences an ongoing current due to the charging and discharging cycles of the capacitor. [9]

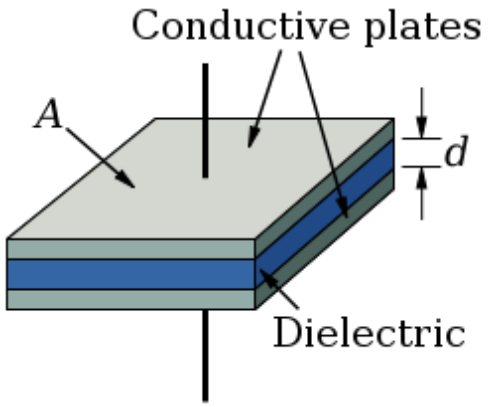


Fig: 2.15 Internal Architecture of Capacitor.

Capacitance is defined as the ratio of the electric charge on each conductor to the potential difference between them. The unit of capacitance in the International System of Units (SI) is the farad (F), defined as one coulomb per volt (1 C/V). Capacitance values of typical capacitors for use in general electronics range from about 1 pico-farad (pF) (10^{-12} F) to about 1 mille-farad (mF) (10^{-3} F). [22]

$$C = \frac{Q}{V}$$

An ideal capacitor is characterized by a constant capacitance C, in farads in the SI system of units, defined as the ratio of the positive or negative charge Q on each conductor to the voltage V between them.

A capacitance of one farad (F) means that one coulomb of charge on each conductor causes a voltage of one volt across the device. Because the conductors are close together, the opposite charges on the conductors attract one another due to their electric fields, allowing the capacitor to store more charge for a given voltage than when the conductors are separated, yielding a larger capacitance. In practical devices, charge build-up sometimes affects the capacitor mechanically, causing its capacitance to vary. In this case, capacitance is defined in terms of incremental changes. [22]

$$C = \frac{\mathrm{d}Q}{\mathrm{d}V}$$

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2.13 Transistor

A transistor is a semiconductor device used to amplify or switch electronic signals and electrical power. It is composed of semiconductor material usually with at least three terminals for connection to an external circuit. A voltage or current applied to one pair of the transistor's terminals controls the current through another pair of terminals. Because the controlled (output) power can be higher than the controlling (input) power, a transistor can amplify a signal. Today, some transistors are packaged individually, but many more are found embedded in integrated circuits.

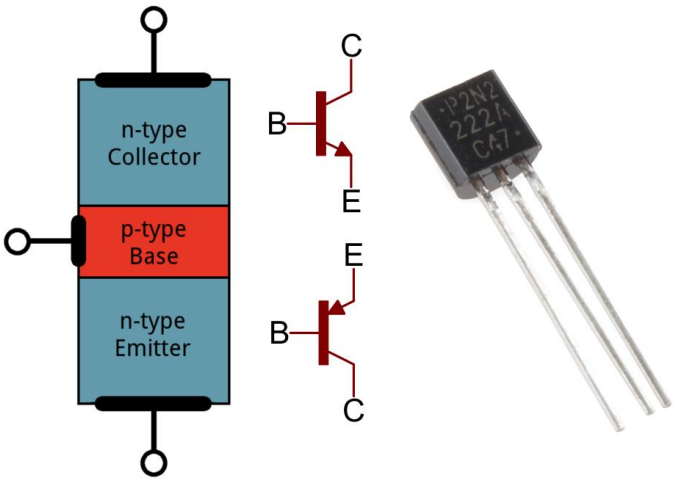


Fig: 2.16 Symbol & Internal Layer of Transistor.

Austro-Hungarian physicist Julius Edgar Lilienfeld proposed the concept of a field-effect transistor in 1926, but it was not possible to actually construct a working device at that time.[1] The first working device to be built was a point-contact transistor invented in 1947 by American physicists John Bardeen and Walter Brattain while working under William Shockley at Bell Labs. They shared the 1956 Nobel Prize in Physics for their achievement.[2] The most widely used transistor is the MOSFET (metal–oxide–semiconductor field-effect transistor), also known as the MOS transistor, which was invented by Egyptian engineer Mohamed Atalla with Korean engineer Dawon Kahng at Bell Labs in 1959.[3][4][5] The MOSFET was the first truly compact transistor that could be miniaturized and mass-produced for a wide range of uses.[11]

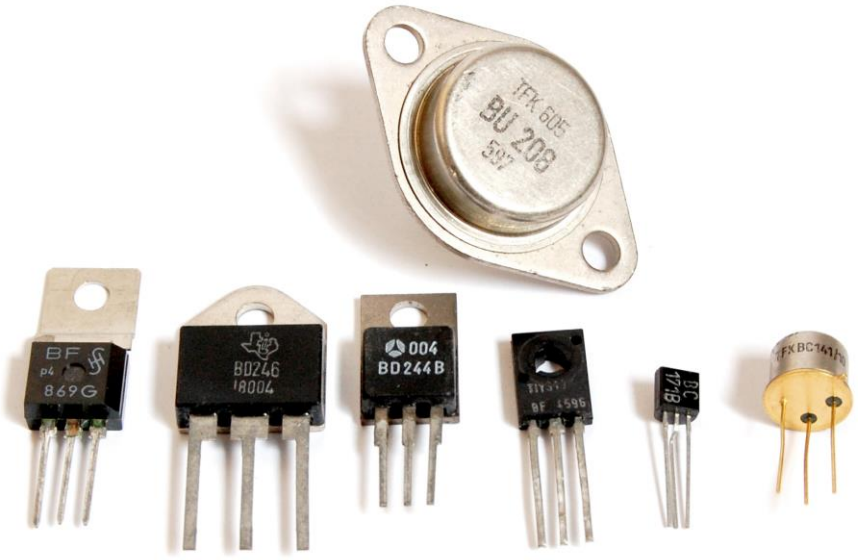


Fig: 2.17 Different Type of Transistor.

Transistors revolutionized the field of electronics, and paved the way for smaller and cheaper radios, calculators, and computers, among other things. The first transistor and the MOSFET are on the list of IEEE milestones in electronics. The MOSFET is the fundamental building block of modern electronic devices, and is ubiquitous in modern electronic systems. An estimated total of 13 sextillion MOSFETs have been manufactured between 1960 and 2018 (at least 99.9% of all transistors), making the MOSFET the most widely manufactured device in history.[11]

Most transistors are made from very pure silicon, and some from germanium, but certain other semiconductor materials can also be used. A transistor may have only one kind of charge carrier, in a field-effect transistor, or may have two kinds of charge carriers in bipolar junction transistor devices. Compared with the vacuum tube, transistors are generally smaller, and require less power to operate. Certain vacuum tubes have advantages over transistors at very high operating frequencies or high operating voltages. Many types of transistors are made to standardized specifications by multiple manufacturers.

2.14 Opto Isolator

An opto-isolator is an electronic component that transfers electrical signals between two isolated circuits by using light. Opto-isolators prevent high voltages from affecting the system receiving the signal. Commercially available opto-isolators withstand input-to-output voltages up to 10 kV and voltage transients with speeds up to 25 kV/μs.

A common type of opto-isolator consists of an LED and a phototransistor in the same opaque package. Other types of source-sensor combinations include LED-photodiode, LED-LASCR, and lamp photo-resistor pairs. Usually opto-isolators transfer digital signals, but some techniques allow them to be used with analog signals. [12]

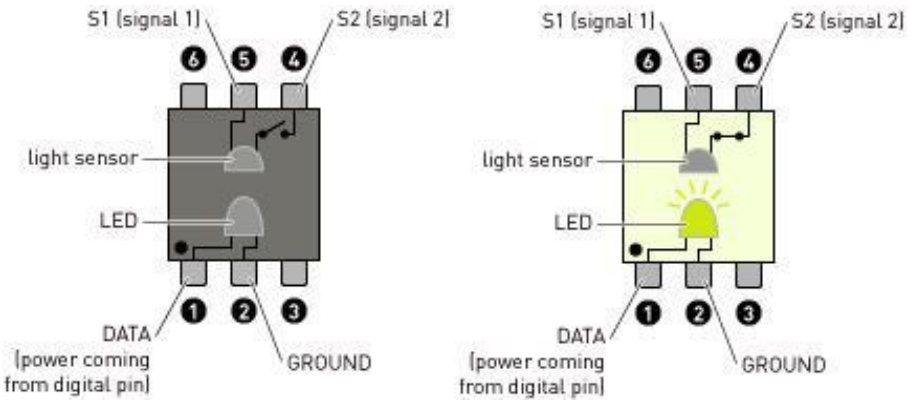


Fig: 2.18 Internal architectural of Opto Isolator.

An opto-isolator contains a source of light, almost always a near infrared light-emitting diode, that converts electrical input signal into light, a closed optical channel and a photo-sensor, which detects incoming light and either generates electric energy directly, or modulates electric current flowing from an external power supply. The sensor can be a photo-resistor, a photodiode, a phototransistor, a silicon-controlled rectifier (SCR) or a TRIAC. Since LEDs can sense light in addition to emitting it, construction of symmetrical, bidirectional opto-isolators is possible. An

opto-coupled solid-state relay contains a photodiode opto-isolator which drives a power switch, usually a complementary pair of MOSFETs. A slotted optical switch contains a source of light and a sensor, but its optical channel is open, allowing modulation of light by external objects obstructing the path of light or reflecting light into the sensor.[12]

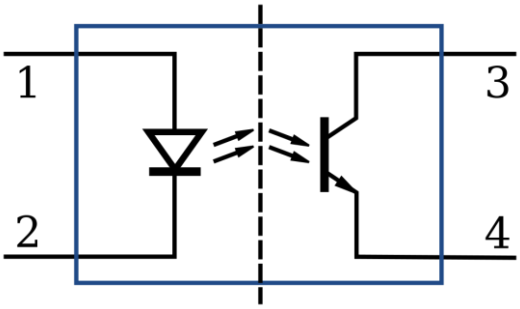


Fig: 2.19 Circuit Diagram of Opto Isolator.

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Electronic equipment and signal and power transmission lines can be subjected to voltage surges induced by lightning, electrostatic discharge, radio frequency transmissions, switching pulses (spikes) and perturbations in power supply. Remote lightning strikes can induce surges up to 10 kV, one thousand times more than the voltage limits of many electronic components. A circuit can also incorporate high voltages by design, in which case it needs safe, reliable means of interfacing its high-voltage components with low-voltage ones.

2.15 Vero Board

Strip board is the generic name for a widely used type of electronics prototyping board characterized by a 0.1 inch (2.54 mm) regular (rectangular) grid of holes, with wide parallel strips of copper cladding running in one direction all the way across one side of the board. It is commonly also known by the name of the original product Vero board, which is a trademark, in the UK, of British company Vero Technologies Ltd and Canadian company Pixel Print Ltd. In using the board, breaks are made in the tracks, usually around holes, to divide the strips into multiple electrical nodes. With care, it is possible to break between holes to allow for components that have two pin rows only one position apart such as twin row headers for IDCs.

Strip board is not designed for surface-mount components, though it is possible to mount many such components on the track side, particularly if tracks are cut/shaped with a knife or small cutting disc in a rotary tool.

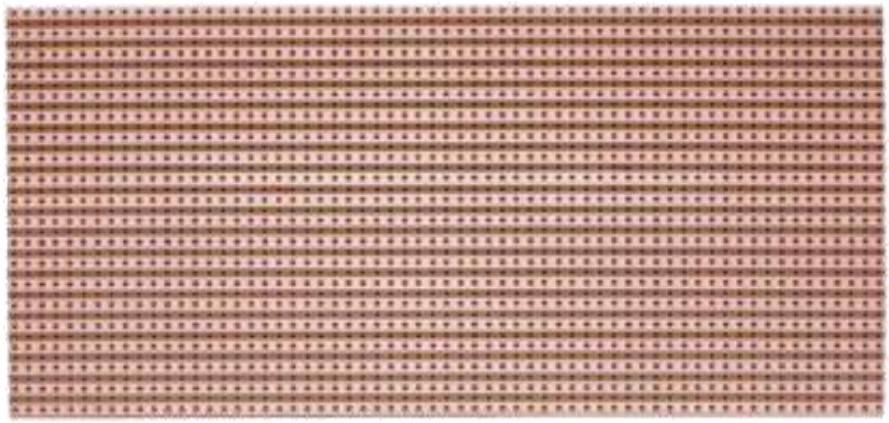


Fig: 2.20 Vero Board.

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2.16 Connecting Wire

A wire is a single, usually cylindrical, flexible strand or rod of metal. Wires are used to bear mechanical loads or electricity and telecommunications signals. Wire is commonly formed by drawing the metal through a hole in a die or draw plate. Wire gauges come in various standard sizes, as expressed in terms of a gauge number. The term *wire* is also used more loosely to refer to a bundle of such strands, as in 'multi stranded wire', which is more correctly termed a wire rope in mechanics, or a cable in electricity.

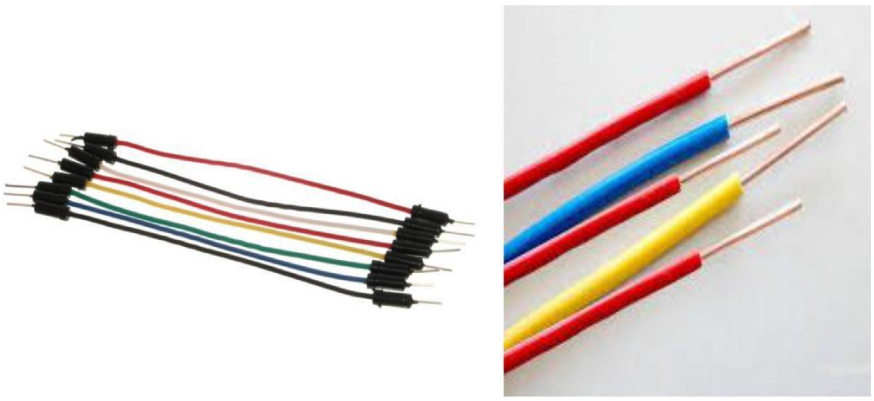


Fig: 2.21 Connecting Wire.

2.17 Summary

The components used are studied individually. Their purpose in the system is explained along with their ratings, pinouts and connections.

CHAPTER 3

HARDWARE DEVELOPMENT

3.1 Introduction

This chapter will be explaining about the construction of three main section of this project.

- Power Section.
- Controller unit.
- Relay Section.

We divided whole circuit in three section for understanding this hardware easily. At first we make a power section for supplying constant voltage for NodeMCU, Relay Module, and Current Sensor. We also use this power section as a potential transformer for measuring line voltage. We use NodeMCU as controller unit, for control whole circuit. We collect some input data from PT, CT, and input switch, then calculate this data and decide what should do right now. Then transfer this decided data to Relay module. We use relay module for control ac load.

3.2 Block Diagram:

There are three block diagram, number one is for power section, number tow is for control unit, and number three is for relay module.

3.2.1 Block Diagram of Power Section.

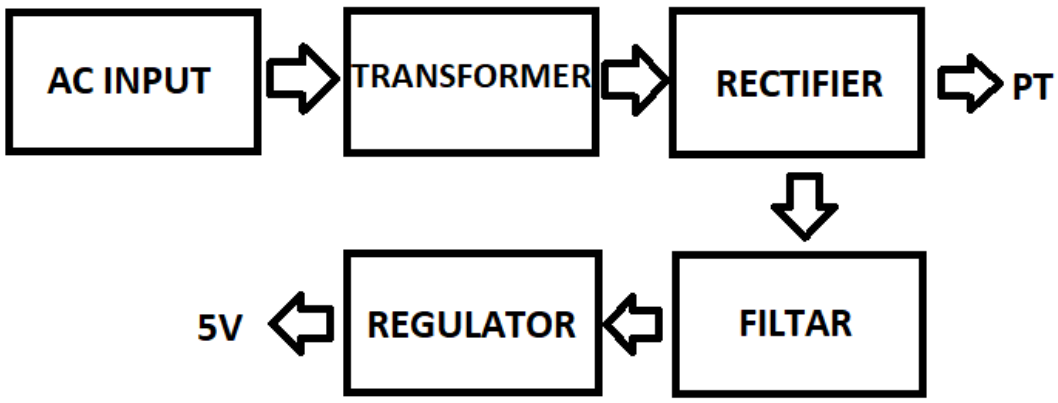


Fig: 3.1 Block Diagram of Power section.

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In this Figure: 3.1 we can see, there is five block inside of power section block diagram. First one is AC line input block, it's come from our current sensor or CT. Second one is Transformer block diagram. It's convert our line voltage 220v AC to 12v AC. Third one is rectifier section. In this section our voltage will be rectified from AC to pulsating DC. There is two output line, number one is going to PT section, and number two is connected with filter section. 4th block is filter section; in this section our pulsating DC will be filtered into pure DC. Now, final block is regulator section; in this section our 12v DC will be convert into 5v DC. Now it's ready to feed up in our whole circuit.

3.2.2 Block Diagram of Controller Unit

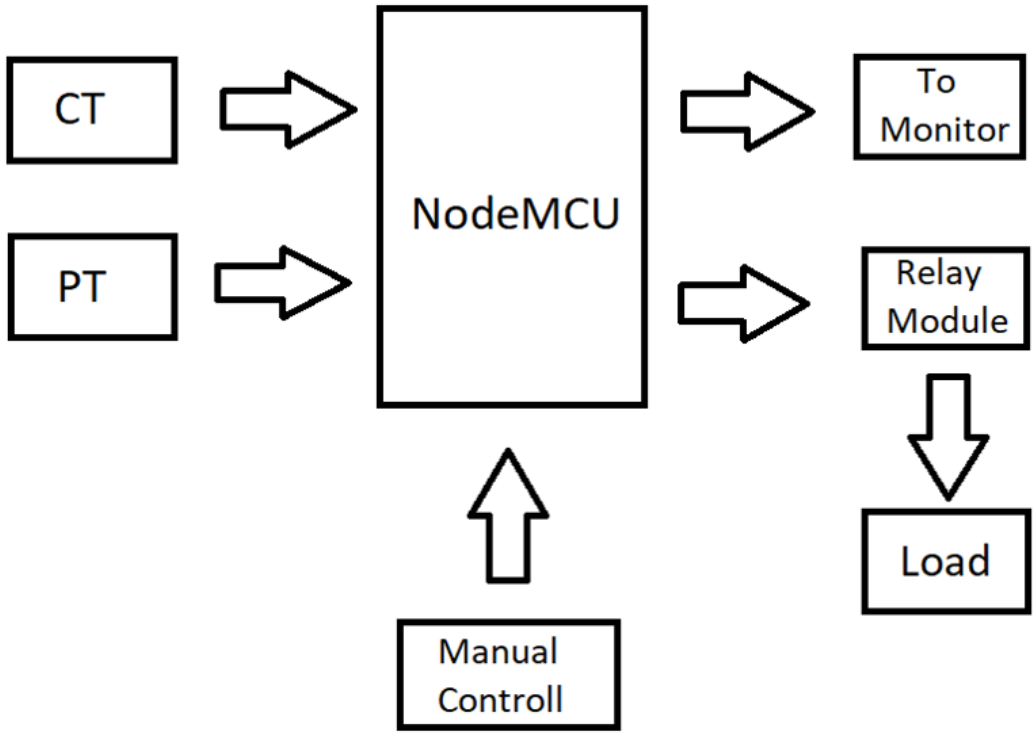


Fig: 3.2 Block Diagram of Control unit.

Figure 3.2 is main block diagram of this project. In this block diagram we can see there are three input and two output block diagram connect with NodeMCU blocks. CT is an input blocks, which is collect load current flow, and give this data to NodeMCU, PT blocks is same like CT blocks, but it's give line potential voltage to NodeMCU. Manual control block is like a load switch, which is give load control signal. NodeMCU block in calculate this three input data, and send this data to monitor blocks and relay blocks.

3.2.3 Block Diagram of Relay section

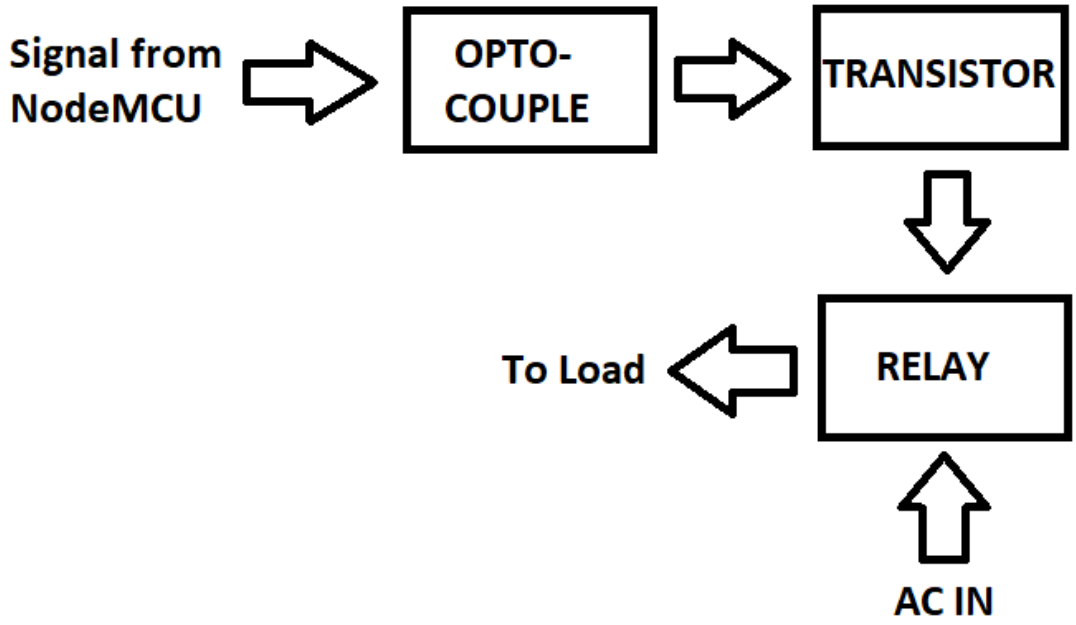


Fig: 3.3 Block Diagram of Relay section.

Figure: 3.3 is a block diagram of relay section, which is give us a clear concept of relay operation. In relay section signal come from NodeMCU and it's filtered by opto-coupled or opto-isolator which is first block of relay section. Then this signal is feed up to transistor base or transistor blocks. This transistor block is control relay blocks for load control.

3.3 Designing Software

There are many circuit deigning software, we prefer "Proteus Design Suite" for deign our circuit. 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.

Schematic capture in the Proteus Design Suite is used for both the simulation of designs and as the design phase of a PCB layout project. It is therefore a core component and is included with all product configurations.

3.4 Circuit Diagram

Circuit diagram of “IOT based Electrical Load Monitoring System” is shown in below.

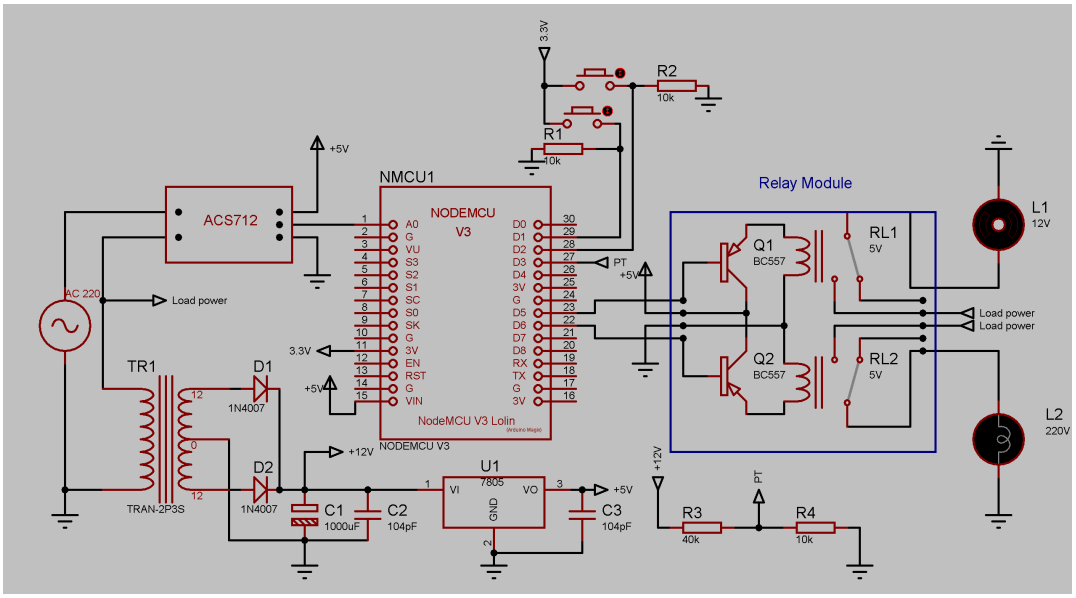


Fig: 3.4 Circuit Diagram of IOT based Electrical Load Monitoring System.

3.5 Construction of main Circuit

At first we need to collect all equipment and component as list in chapter-2. Then we should arrange all component as shown in figure: 3.4. We use a NodeMCU as a main controller. It’s a programmable chip with Wi-Fi capable. At first we connect NodeMCU with our PCB (Vero board) using a female IC rail.

Then we make a power supply. We use a center tap 12v-0-12v step down. Transformer have total 5 pins, 2 is for primary side and other 3 is for secondary side. We connect from primary side, pin number 1 is connect with our current sensor, and pin number 2 is connect with neutral. Now it’s time to secondary side, in this side have 3 pins, we connect two diodes D1 and D2 with pin 3 and pin 5, and pin 4 is connect with common GND. Then we short two cathode pin from diode and connect two capacitors C1 1000uf and C2 104pf with it. Others two pins of capacitor is connected with common GND. Now it’s make a 12v DC pin header.

Then we connect a voltage regulator IC LM7805. It has 3 pins, number one is connect with 12v supply, number two is connected with GND and number three is 5V DC pin header. We connect a decupling capacitor C3 104pf between 5V and GND.

We design a voltage divider for alternative of PT. We use a 40k ohm resistor and a 10k ohm resistor for make a divider. This voltage divider has three pins, number one is connect with 12V, number three is connect with GND, and number two is connect with GPIO3 pin of NodeMCU.

We use a ASC712 current sensor as a CT. It has two side. In high voltage side have two pins, number one is already connect with transformer, and number two is connect with AC 220v. other side have total three pins, number one connect is positive 5V, number two is connect with A0 from NodeMCU, and number three is connect with common GND.

Then we attached two input switch with PGB. We connect switch with NodeMCU using a small wire. We use GPIO5 and GPIO4 pins as an input pins and connect this two pins with two switches. We also connect two 10k ohm resistors with GPIO5 and GPIO4 pins for resolving signal holding problem. Other two pins of switch are connected with GND.

Now it's time to connect relay module. In relay module have two side, number one is input side, which have 4 pins. And number two is output side, which have six screw pins. In input side have one VCC pin, which is connect with 5V DC. One GND pin which is connected with common GND. And two input pins, which is connected with NodeMCU. On other hand, have six screw pins which is connected with AC phase and Load phase.

3.6 Working Principle

After assembling the system, what remains is to observe its operation and efficiency. This IOT based electrical load monitoring system is fully a NodeMCU based system. When we turn on IOT based electrical load monitoring system power, then at first turn on NodeMCU and try to connect with internet. If NodeMCU is connected with internet, then check load switch status. If load switch is turn off, then it sends a data to user and again check switch status. If switch is turn on, then it turns on load. And calculate load power, then send it to user. If load power is excess than required power, then it turn off this load and send warning message to user.

In this IOT based electrical load monitoring system, we can control load using our smart phone or from computer. We can also control load from manual switches.

3.7 Flow chart

We can understand whole working process by using a single image, which called Flow chart.

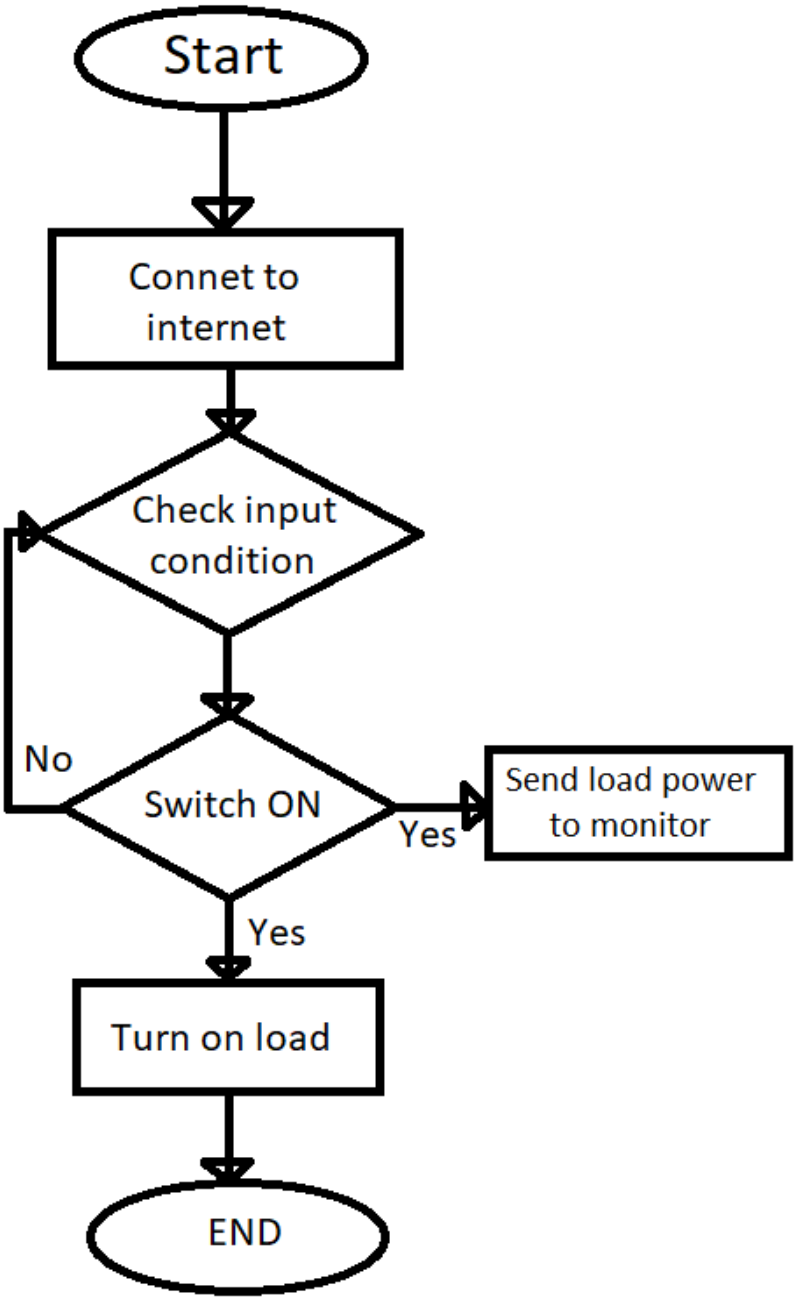


Fig: 3.5 Flow chart of IOT based electrical load monitoring system.

At first program will be start, then it will be try to connect with internet. After connecting, it will be checked switch status. If any switch turns on, then it will be turn load and send load power to monitor. After completing whole process, it will be return to “Check Input Condition” section. And again it will be ready to work.

3.7.1 Step by Step Operation

i. When we connect our project with AC 220v. then our transformer steps down this voltage with AC 12v.
ii. Full wave rectifier, rectified this voltage with pulsating DC 12v.
iii. Filter capacitor, filter this voltage from pulsating DC to pure DC and store this 12v voltage.
iv. Decoupling capacitor block high frequency. Then we get pure 12v DC power. Then this voltage feed up to voltage regulator.
v. Voltage regulator convert this DC 12v to fixed DC 5v. second decoupling capacitor decouple this voltage regulator.
vi. This DC 5v feed up to NodeMCU, Relay module, and Current sensor.
vii. Now, automatically turn on all sensor, module and devices.
viii. Then NodeMCU connect with internet, and check switch status.
ix. If any switch status is changed, then turn on load depending on switch.
x. Then calculate line voltage and load current. Then calculate instant load power, then send this data to monitor.
xi. Again check switch status.

To be continue……..

3.5 Summary

A circuit diagram (electrical diagram, elementary diagram, electronic schematic) is a graphical representation of an electrical circuit. A pictorial circuit diagram uses simple images of components, while a schematic diagram shows the components and interconnections of the circuit using standardized symbolic representations. The presentation of the interconnections between circuit components in the schematic diagram does not necessarily correspond to the physical arrangements in the finished device.

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CHAPTER 4

RESULT AND DISCUSSION

4.1 Introduction

Most monitoring system is make for only monitor purpose. It can't control load. And this type of monitor can give us only analog data using galvanometer. it can only show volt and ampere, but did not show real power. This type of monitor size is bigger, and it has a fixed place by this cause, we need a man power to monitor this load status. We realize this problem, and make a small IOT based electrical load monitoring system. Is has all feature, which was we need. Now we can control load from monitor. And it gives us a digital data, this data we can see from our smart phone in any place. We can also control load from manual control and online control.

This chapter will present all the results, calculations, and relevant discussions.

4.2 Result

The experimental model was made according to the circuit diagram, and the results were as expected. If the NodeMCU is connected with internet, then our system will monitor our load and we can control our load from smart phone. Using this system, we can reduce our valuable electricity, and we can reduce our valuable time.

4.3 Advantage of Monitor System

1. This monitor system can reduce current waste.
2. This monitor system can control load over internet.
3. This monitor system does not cause any environmental pollution.
4. It is size is quite small.
5. Safety monitoring of the environment.
6. It is connect wirelessly with internet.
7. Wireless security is very high.
8. It is does not affected by temperature, humidity, smoke, etc.
9. Quick searching and can able to give the warning.
10. It is maintenance cost is very low.
11. All the component required are easily available.

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4.4 Disadvantage of Monitor System

1. Initial cos high.
2. Installation process is difficult.
3. Without internet, it does not work**.**

4.5 Cost Estimation of the Project

Table: 4.1 Price list and component quantity.

Serial No	Particulars	Quantity	Cost in BDT
01	NodeMCU (ESP-8266)	1	1800
02	Current Sensor (ASC-712)	1	220
03	Relay Module (2 channel)	1	125
04	Voltage Regulator IC (LM-7805)	1	20
05	Transformer (12-0-12)	2	500
06	Transistor (BC-557)	2	10
07	Capacitor (1000uF)	2	50
08	Capacitor (104pF)	5	15
09	Resistor 220 ohm	1	1
10	Resistor 10k ohm	6	6
11	Diode (1N4007)	5	10
12	Opto-Isolator	2	40
13	Switch SPDT	2	10
14	Vero Board	1	20
15	Rail (I & L)	2	40
16	Connecting Wire (Male to female)	7	35
17	Other Wire	4	50
18	2-Pin plug	1	20
19	Bulb Holder	2	50
20	Bulb	2	70
21	Pump	1	500
22	Soldering lead	5	90
23	Glue Strike	3	60
24	Heatsink	1	20
Total			**3902**

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4.6 Application of Monitor System

1. Industry: for control various machine.
2. Factory: for control any kind of motor or pump.
3. Garments: for control jacquard machine.
4. School or College: for control light, fan, air conditioner, projector.
5. Office: for control computer, light, fan, AC, photocopy machine etc.
6. Home: any kind of home appliance.

4.7 Summary

The conventional monitor used large CT PT which is costliest, and they used galvanometer which result is not perfect. In this case we can solve this problem using our monitor system.

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CHAPTER 5

CONCLUTION

5.1 Conclusions

1. It can be real time safety system; we can implement the whole circuit into small module later.
2. Less power consuming safety system.
3. This safety system technology can further be enhancing for power plant.

The goal of the IOT based electrical load monitoring system is, significantly reduced current waste, and increase safety and awareness for industry and also industry's worker. It can be reducing electrical short circuit. This monitor system can be real time safety system; we can implement the whole circuit into small module later. It is a less power consuming monitoring system. We allows detect load power, line voltage current flow. This system calculates load data automatically.

5.2 Future Scopes of Modification

In this paper we have discussed about developing a "IOT based Electrical Load Monitor System: A Next Generation Smart Gadget" by incorporating many features like Online monitor, online control and manual control unit, that are lacked in the conventional monitor. Especially the monitor system is designed for reduced current wasted.

We practically check this monitor system, and we get perfect data from monitor, we can easily control our load thought internet. Finally, we satisfied to our monitor system.

1. It can be implement with auto cutoff system.
2. We can add GSM system with it.
3. We can add individually sensor for individually monitor.

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APPENDIX

Controller Code:

```
#define BLYNK_PRINT Serial

#define BLYNK_TEMPLATE_ID "TMPL6sYPcMlOB"

#define BLYNK_TEMPLATE_NAME "IOT based load controll"

#define BLYNK_AUTH_TOKEN "xixQHVjXqbS0Tpfq6_xD8z9XnRE1KwjF"

#include <ESP8266WiFi.h>

#include <BlynkSimpleEsp8266.h>

char ssid[] = "Black-ops-2";

char pass[] = "SpiderMan";


#define t_bounce 500

#define t1 10


float R = 10.0;


int sw1 = 13; //D7

int sw1_value = 0;

int sw2 = 15; //D8

int sw2_value = 0;

int load_1 = 12;  //D6//12

int load_2 = 14;  //D5

int p_led = 2;

int sw1_virtual = 0;
```

```
int sw2_virtual = 0;


const int sensorIn = A0;
int mVperAmp = 240; //170, 220, 450, 240
double Voltage = 0;
double VRMS = 0;
double AmpsRMS = 0;
float j=0;
float amp=0;


int power = 0;


int pt_pin = 16;
int pt_val = 0;
int line_volt = 0;


int i = 0;
//int j = 0;
int k = 0;
int t = 0;


 BLYNK_WRITE(V0)
   {
     sw1_virtual = param.asInt();
```


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```
  }

 BLYNK_WRITE(V1)
  {
    sw2_virtual = param.asInt();
  }

void setup()
{
 Serial.begin(9600);
 Blynk.begin(BLYNK_AUTH_TOKEN, ssid, pass);

 pinMode(sw1, INPUT);
 pinMode(sw2, INPUT);
 pinMode(load_1, OUTPUT);
 pinMode(load_2, OUTPUT);

 pinMode(p_led, OUTPUT);
 digitalWrite(p_led, LOW);

 //pinMode(ct_pin, INPUT);
 pinMode(pt_pin, INPUT);
}
```


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```
void loop()
{

 if((digitalRead(sw1) == HIGH) || (sw1_virtual == 255))
 {
  sw1_value ++;
  if(sw1_value > 1)
  {
   sw1_value = 0;
  }
  delay(t_bounce);
 }

 if((digitalRead(sw2) == HIGH) || (sw2_virtual == 255))
 {
  sw2_value ++;
  if(sw2_value > 1)
  {
    sw2_value = 0;
  }
  delay(t_bounce);
 }

 if (sw1_value == 1)
```


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```
{
  digitalWrite(load_1, LOW);
}
if (sw1_value == 0)
{
  digitalWrite(load_1, HIGH);
}

if (sw2_value == 1)
{
  digitalWrite(load_2, LOW);
}
if (sw2_value == 0)
{
  digitalWrite(load_2, HIGH);
}
/**********************Current Calculation**************/
current();
//Blynk.virtualWrite(V2, amp);
Serial.println(amp);

/******************Volt Calculation*********************/
 volt();
 Serial.println(line_volt);
```


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```
  // Blynk.virtualWrite(V3, line_volt);


    /****************Power Calculation*****************/
    power = (line_volt * amp);
   // Blynk.virtualWrite(V4, power);
    Serial.println(power);



  Blynk.virtualWrite(V2, amp);
  Blynk.run();


  Blynk.virtualWrite(V3, line_volt);
  Blynk.virtualWrite(V4, power);
}
void volt()
{
  if(amp< 0.15)
  {
    line_volt = 238;
  }
  if(amp<0.35 && amp> 0.15)
  {
    line_volt=(65/amp);
  }
```


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```
 if(amp>0.35 && amp<0.50)
 {
  line_volt=(95/amp);
 }
 if(amp>0.50)
 {
  line_volt=(150/amp);
 }
}

void current()
 {
  for(int i=0; i<10; i++)
    {
      Voltage = getVPP();
      VRMS = (Voltage/2.0) *0.707;
      AmpsRMS = (VRMS * 1000)/mVperAmp;
      j=j+AmpsRMS;
      delay(10);
    }
  amp=j/10;
  j=0;
 }
```


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```
float getVPP()
{
  float result;
  int readValue;
  int maxValue = 0;
  int minValue = 1024;

   uint32_t start_time = millis();
   while((millis()-start_time) < 100)
    {
       readValue = analogRead(sensorIn);
       if (readValue > maxValue)
        {
           maxValue = readValue;
         }
       if (readValue < minValue)
        {
           minValue = readValue;
        }
    }
   result = ((maxValue - minValue) * 3.3)/1024.0; //3.3 nodemcu
   return result;
 }
```


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