Scientific Journal of Impact Factor (SJIF): 5.71
e-ISSN (O): 2348-4470
p-ISSN (P): 2348-6406
International Journal of Advance Engineering and Research Development
Volume 5, Issue 10, October -2018

# AUTO SELECTION OF ANY AVAILABLE PHASE, IN 3 PHASE SUPPLY SYSTEM

Sreejith S, Ajose Thomas, Jestin P Johnson

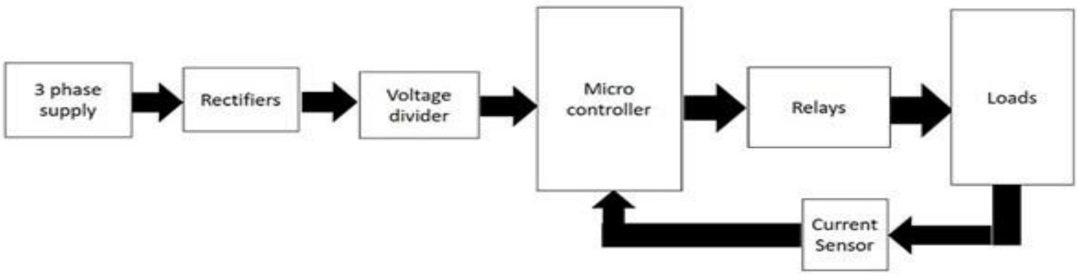
*Electrical&Electronics Engineering, College of Engineering Chengannur*
*Electrical&Electronics Engineering, College of Engineering Chengannur*
*Electrical&Electronics Engineering, College of Engineering Chengannur*

**Abstract**—*Power failure is a common problem. It hampers the production of industry, construction work of new plants and building. It can be overcome by using a backup power supply such as a generator. But it is cost effective and also time consuming as a certain time is required to switch on the generator manually. It is often noticed that power interruption in distribution system is about 70 percent for single phase faults while other two phases are in normal condition. Thus, in any commercial or domestic power supply system where three phases is available, an automatic phase selector system is required for uninterrupted power to critical loads in the event of power failure in any phase. This project presents a system which is a power based auto select technology which automatically selects an alternating current (A.C) phase out of three phases instead of the usual manual changing of cut out fuses which is tedious and prone to human error. The purpose of this project is to use the system of automation to carry out the selection of an Alternating current (A.C) power phases using a combination of power, microcontroller and relay (switch) circuit thereby eliminating every form of human involvement in the process. This project also includes a current sensing circuit which is fed back to the microcontroller for balancing of the three phases. The goal of A.C phase automatic selection was achieved using fewer components, lesser consumption of energy as well and at a lesser cost compared to the usual, conventional way (manual switching) of phase selection.*

## I. INTRODUCTION

Most firms Industrial, commercial and domestic necessities are depending on public power supply which have erratic supply such as phase failure, phase imbalances or total power lapse due to frequent technical problems in power generation, transmission or distribution. Hence, it is highly necessary to make automation in phase change during phase failure or total power failure so as to protect consumer appliances from epileptic supply of power. In most cases, many manufacturing firms, be it domestic or industrial, which employs single phase equipment for its operation might come across challenges during unbalance voltages, overloads and under-voltages in supply of power, where much time would be required in the process of manual change over. This means that time and the process needed for the phase change may cause serious damages to machines and even the products. Hence, there is need for automatic phase switching system and this system will provide a single phase correct voltage in the same power supply lines through relays from other phase where correct voltage is available. The system operates by stepping down 220 Volts AC to 12 Volts DC, rectified and fed into the microcontroller through the voltage divider circuit. The microcontroller compares the three phases and switches the relays through the transistor drives.

## II. BLOCK DIAGRAM AND DISCRIPTION




PHASE INPUT: It is the input source of the device. Contains three identical phase lines represented by R,Y,B respectively. POWER SUPPLY: Provides necessary power supply to the circuit components. Uses rectifiers, filters and voltage regulators to ensure the input voltage between safe operative range. CURRENT SENSING CIRCUIT: Senses the output voltage of the loads. Feedback provided by the current transformer eliminates load unbalanced condition. RELAY BOX: Depending upon the output of controllers the relay circuit get energized or de energized.
CONTROLLER UNIT: The output of the controller unit drives the relay which distributes the load in a most economical way during phase and load unbalance.

## III. CIRCUIT DIAGRAM AND WORKING

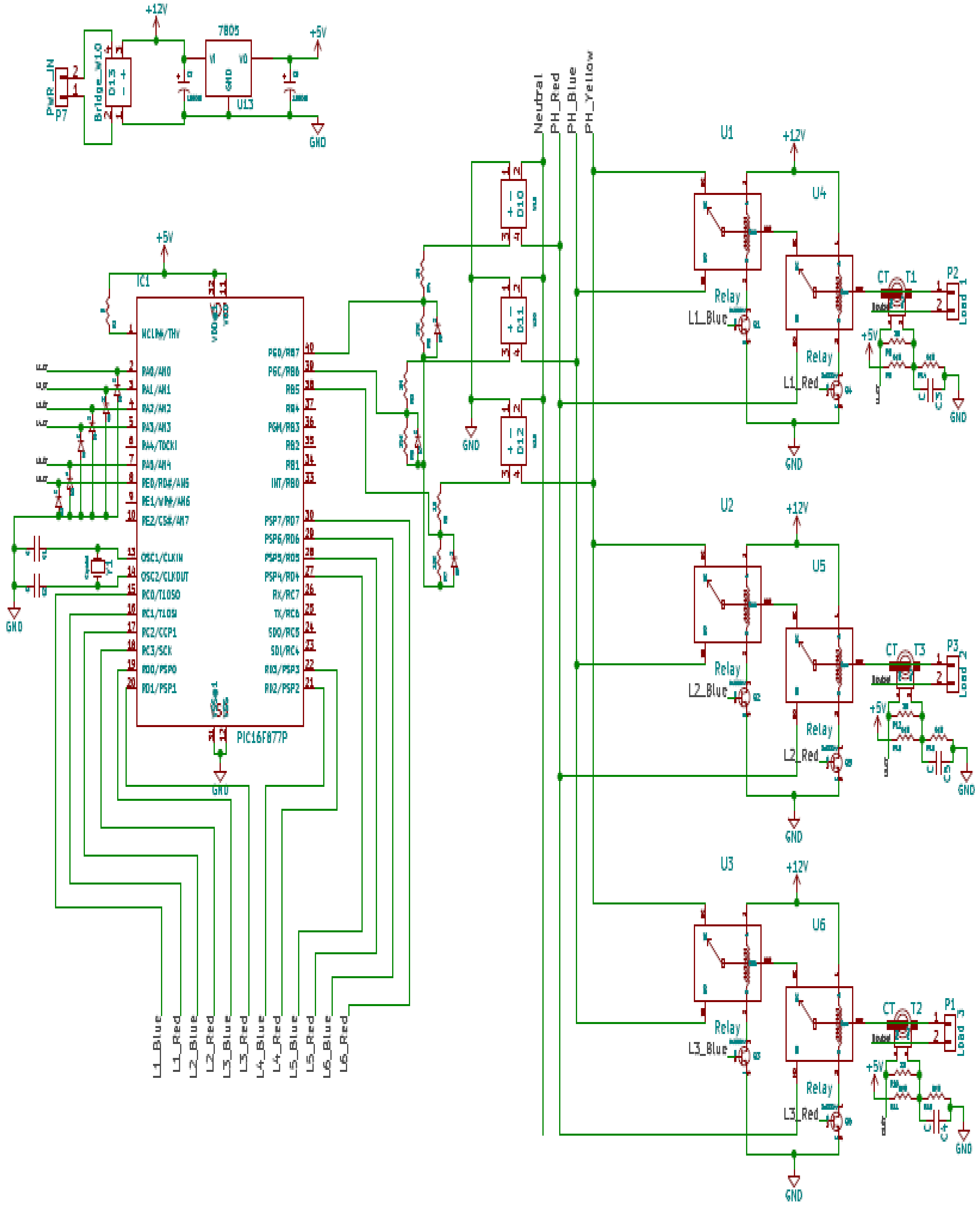



Figure 3.1.

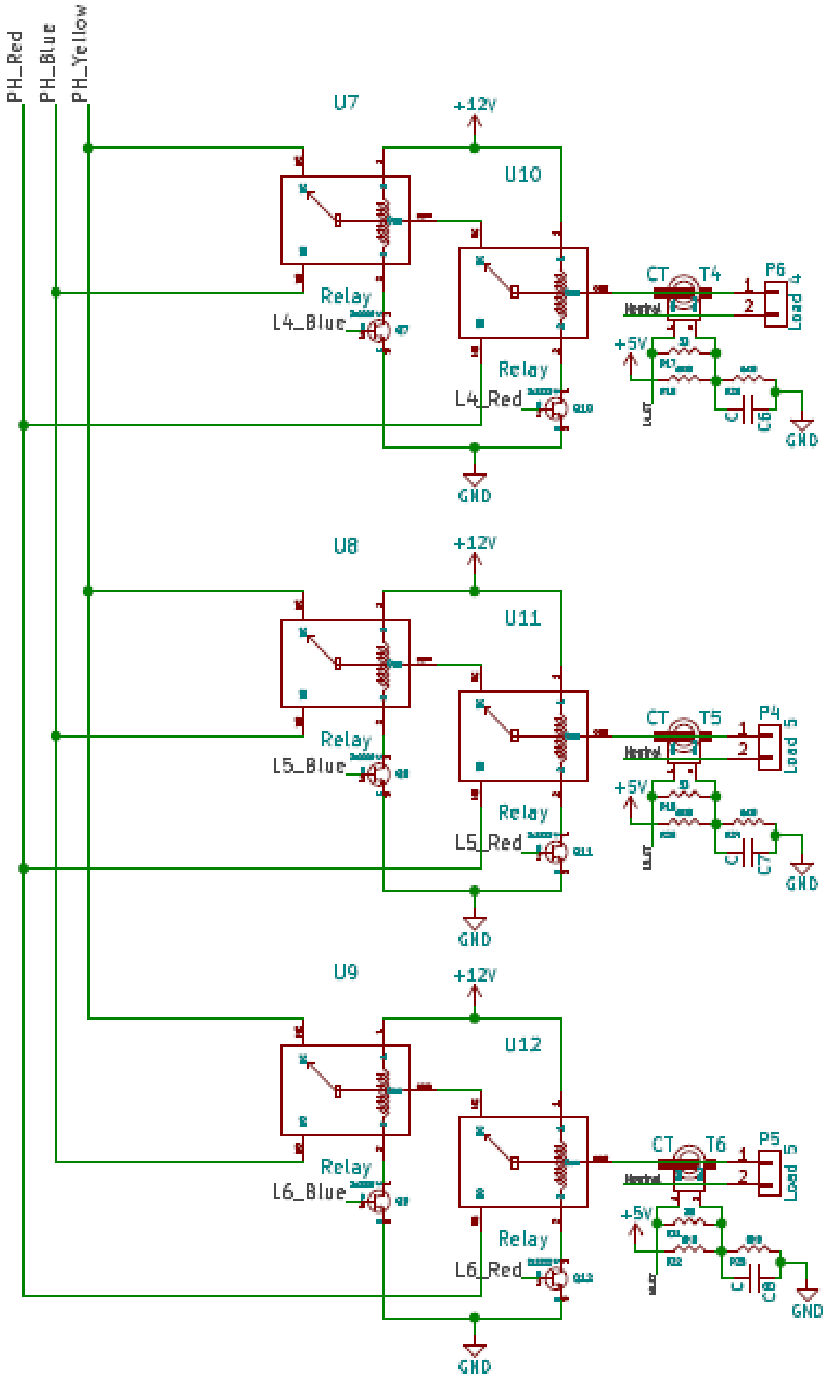



Figure 3.2.

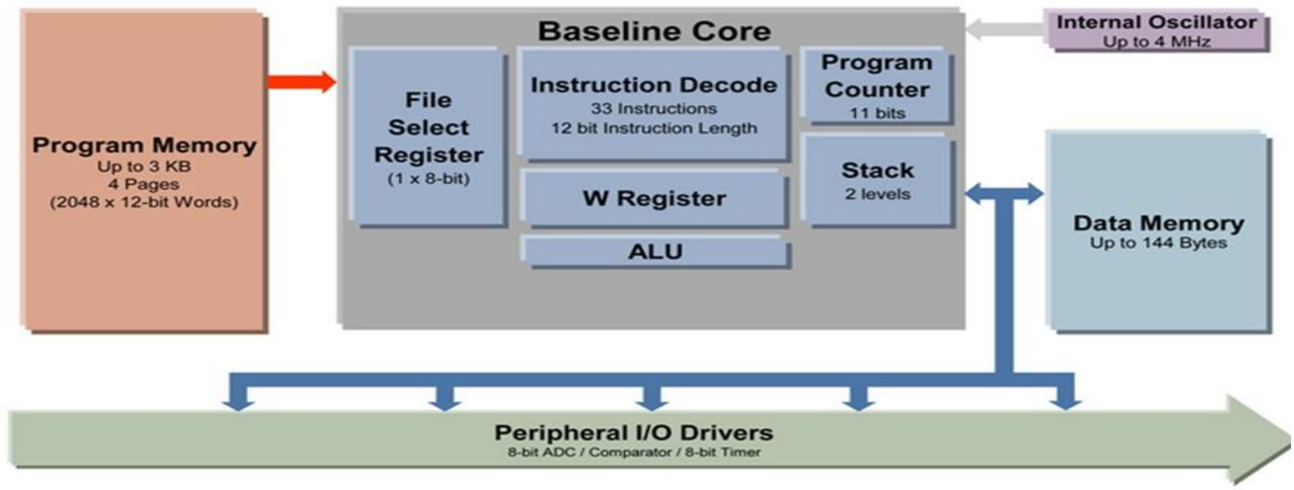
The main 3 phase supply is rectified using three bridge rectifiers which convert 230V AC to 230V DC. Three sets of voltage regulators and filters follow the bridge rectifiers which regulate the DC. Using voltage divider circuit 230V is stepped down to 5V and is given to the ADC pins of microcontroller. This continuously checks the availability of all the three phases. A total of 6 loads are used in the prototype. Two relays are used to switch between 3 phases for each load. Each relay is energized or de-energized using transistors whose base is connected to the output ports microcontroller. The PIC16F877P microcontroller is being used. A VCC of 5V is given to the microcontroller. A clock signal is given to the microcontroller using a crystal oscillator. Two capacitors are connected in parallel to crystal oscillator to stabilize the oscillations. Each load is connected to two relays to switch between three phases. The normally open (NO) and normally closed (NC) terminals of the first relay are connected to the blue phase and yellow phase respectively. Similarly the NC and NO terminals of the second relay are connected to the output of first relay and red phase respectively. When any one of the phase undergoes any fault, it is detected by the microcontroller. A signal is send to the corresponding output port. The respective transistor connected to that port turns ON and energizes the respective relay. Hence the switching action takes place. The loads are switched according to the priority. Loads 1, 2 and 3 are given highest priority. Loads 4, 5 and 6 are given priority in the decreasing order. Current transformers are used as the current sensing element. Each load is connected to the primary of a current transformer and the secondary is connected to a voltage divider circuit. It is then fed back to the microcontroller which senses the condition of the load. Thus according to the condition of the load balancing of three phases is done.

## IV. EXPERIMENTAL SETUP

### 4.1. PIC MICROCONTROLLER

PIC16F877 is a 40-pin 8-Bit CMOS FLASH microcontroller. The core architecture is high-performance RISC CPU with 35 single word instructions. As it is following the RISC architecture, all single cycle instructions consume only one instruction cycle except for program branches which take two cycles. The microcontroller comes with 3 operating frequencies 4, 8, or 20MHz as clock input. As each instruction cycle takes four operating clock cycles, these instruction takes 0.2s when 20MHz oscillator is implemented. It occupies two types of internal memories: program memory and data memory. Program memory is incorporated with 8K words of FLASH memory. The data memory has two sources. i.e., one type of data memory is a 368-byte RAM and the other is 256-byte EEPROM. The core feature comprises interrupt capability of up to 14 sources, power saving SLEEP mode, and single 5V In-Circuit serial programming (ICSP) facility. The sink/source current, which depicts the driving energy from I/O port, is high with 25mA. Power consumption is much less than 2mA in 5V operating condition. The peripheral features comprises: (a) 3 time blocks: Timer0 for 8-bit timer/counter; Timer1 for 16-bit timer/counter; and Timer2: 8-bit timer/counter with 8-bit period registers, prescaler and postscaler. (b) Two capture compare, PWM modules for capturing, comparing 16-bit, and PWM generation with 10-bit resolution. (c) 10-bit multi-channeled (max 8) Analog-to-Digital converter module. (d) Synchronous Serial Port (SSP) with SPI (Master Mode) and I2C2 (Master/Slave) (e) Universal Synchronous Asynchronous Receiver Transmitter (USART/SCI) with 9-bit address plotting (f) Parallel Slave Port (PSP) 8-bits wide, with RD externally, WR and CS controls (g) I/O ports.




### 4.2. CURRENT TRANSFORMER

The current transformer produces 0 to 5A ac signal with a 0 to 100A ac primary current. It is Class 1.0 which means it is suitable for metering and can be used with a 3 phase Power Meter ALT-022. The included DIN-rail base clip could be mounted either vertical or horizontal. The primary hole can accommodate conductors up to 22 mm.

Features:
100:5A Current Ratio
720 VAC rated
Built-in hinged terminal covers
22 mm diameter primary hole
DIN rail mount in two orientations

SPECIFICATIONS

Primary Current (Ip): 100 A Secondary Current (Is): 5 A
Standard Approvals: IEC60044-1, EN60044-1, Rated Frequency: 50/60 Hz
Rated Test Voltage (1 minute): 3 kVAC

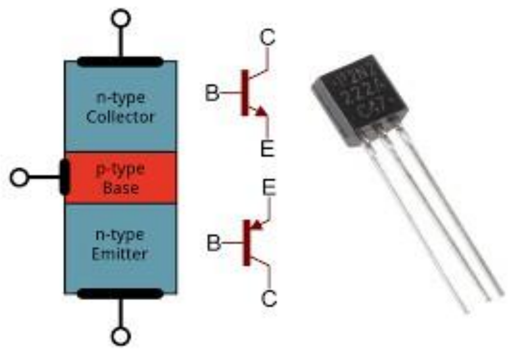
 

Rated Short-Time Thermal Current: 40Ip
Rated Dynamic Current: 2.5Ith
Rated Voltage: 720 VAC Continuous Overload (Id): 1.2 Ip Operating Temperature: -10 to 50 C

**4.3. RELAY**

A relay is an electrically operated switch. Many relays use an electromagnet to mechanically operate as a switch, but other operating principles are also employed, such as SSR. Relays are used where it is pertinent to control a circuit by a different low-power signal, or where several circuits must be controlled by one signal. The first relays were used in long transmission telegraph circuits as amplifiers: it repeats the signal coming in from one circuit and re-transmits it onto another circuit. Relays were used ubiquitously in telephone exchanges and early computers to perform logical operations. A type of relay that can handle the high power required to directly control an electric motor or other loads is called a contractor. SSR control power circuits with no moving parts, instead using a semiconductor device to perform switching. Relays calibrate operating characteristics and sometimes multiple operating coils are used to protect electrical circuits from overloads or faults; in modern electric power systems these functions are done by digital instruments called “protective relays”. A simple electromagnetic relay consists of a coil of wire wrapped around a soft iron core, an iron yoke which provides a less reluctance path for magnetic flux, a movable iron armature, and one or more sets of contacts (there are two contacts in the relay pictured). The armature is clinged to the yoke and mechanically attached to one or more sets of moving contacts. The armature is kept in place by a spring so that when the relay is de-energized there is an air gap in the magnetic circuit. When an electric current is passed through the coil it generates a magnetic field that activates the armature, and consequently the movement of the movable contact either makes or breaks (depending upon construction) a connection with a fixed contact. If the set of contacts is closed when the relay was de-energized, then the movement opens the contacts and breaks the connection, and vice versa if the contacts were open. When the current to the coil is switched off, the armature is returned by a force, nearly half as strong as the magnetic force, to its relaxed position. Generally this force is provided by a spring, but gravity is also used commonly in industrial motor starters. Most relays are manufactured to operate quickly. In a low-voltage application this reduces noise; in a high voltage application it reduces arcing. When the coil is energized with direct current, a diode is often placed to dissipate the energy from the collapsing magnetic field at deactivation, which would otherwise generate a voltage spike which is dangerous to circuit components. Such diodes were not widely used before the application of transistors as relay drivers, but soon ubiquitous as early germanium transistors were easily damaged by these surges. Some automotive relays has a diode inside the relay case. If the relay is driving a large, or especially a reactive load, there may be a similar problem of surge currents around the relay output contacts. In this case a snubber circuit (a capacitor and resistor in series) across the contacts is introduced which absorbs the surge. Suitably rated capacitors and resistor are sold as a single packaged component for this commonplace use. If the coil is designed to be energized with alternating current (AC), some method is used to split the flux into two out-of-phase components which add together, increasing the minimum pull on the armature during the AC cycle. Literally this is done with a small copper "shading ring" which is crimped around a portion of the core that creates the delayed, out-of-phase component that holds the contacts during the zero crossings of control voltage.

**4.4. TRANSISTOR**

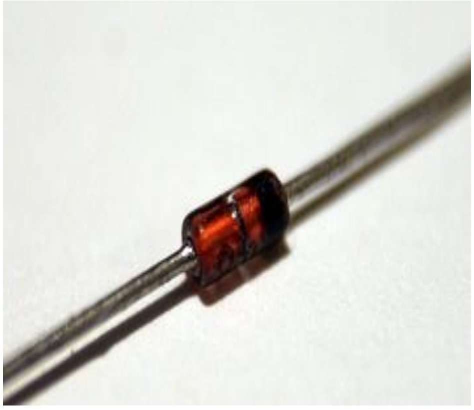



A transistor is a semiconductor device used in amplification or switch electronic signals and electrical power. It is composed of semiconductor material usually with at the least three terminals for connection to an external circuit. A voltage or current applied to one set of the transistor’s terminals controls the current through another pair of terminals. Because the controlled (output) power can be higher than the controlling (input) power, a transistor could amplify a signal that is essential of a transistor comes from its ability to use a minute signal given between one pair of its terminals to control a very strong and large signal at another pair of terminals, this phenomenon is called gain. It can produce a higher output signal whereby a voltage or current can be made proportional to a weaker input signal; i.e.: it can work as an amplifier. Alternatively, the transistor can be incorporated in a circuit to turn current on or off, as an electrically controlled switch, where the amount of current is determined by other circuit elements. Transistors are of two, which have slight disparity in how they are implemented in a circuit. A bipolar transistor has terminals labeled base, collector, and emitter. A small current at the base terminal (that is, flowing between the base and the emitter) can limit or switch a huge current between the collector and emitter terminals. For a FET, the terminals are gate with labels, source, and drain, and a voltage at the gate can control a current between source and drain. BJT which is utilized as an electronic switch, in grounded- emitter configuration. Transistors are implemented in large scale in digital circuits as electronic switches which can either be in ”ON” or ”OFF” state, both for high-power applications such as switched-mode power supplies and for low-power uses such as logic gates. The main parameters for this application involves the current switched, the voltage handled, and the switching speed, characterized by the rise and fall times. In a grounded-emitter transistor configuration, such as the light-switch circuit has shown, as the base voltage raises, the emitter and collector current increases drastically. The collector voltage drops because of mitigated resistance from collector to emitter. If the voltage disparity between the collector and emitter were zero (or near zero), the collector current would be limited only by the load resistance (light bulb) and the supply voltage. This is called saturation as the current is flowing freely from collector to emitter. When saturated, the switch is said to be on. Providing sufficient base drive current is the main problem in the use of bipolar transistors as switches. The transistor provides current gain, allowing a huge current in the collector to be switched by a much smaller current into the base terminal. The ratio of these currents changes depending on the type of transistor, and even for a particular type, varies depending on the collector current. In the example light-switch circuit shown, the resistor is chosen to provide sufficient base current to ensure the transistor will be in saturated state. In a switching circuit, the idea is to refresh, as near as possible, the ideal switch having the properties of open circuit when off, short circuit when on, and an immediate transition between the two states. Parameters are chosen such that "off" output is limited to leakage currents too small to affect connected circuitry; the resistance of the transistor in the ”on” state is too small to affect circuitry; and the transition between both states are fast enough not to have a detrimental effect.

### 4.5. BRIDGE RECTIFIER

A diode bridge is a model of four (or more) diodes in a bridge circuit configuration that provides the same polarity of output for either polarity of input. When used for its most common application, in conversion of an alternating current (AC) input into a direct current (DC) output, it is known as a bridge rectifier. A bridge rectifier provides full-wave rectification from a two-wire AC input, resulting in lower cost and weight as compared to any rectifier with a 3-wire input from a transformer with a center- tapped secondary winding. According to the traditional models of current flow (originally established by Benjamin Franklin) current is defined to be positive when it flows through electrical conductors from the positive to the negative pole. In reality, free electrons in a conductor nearly flow from the negative to the positive pole. In major number of applications, the actual direction of current flow is impertinent.

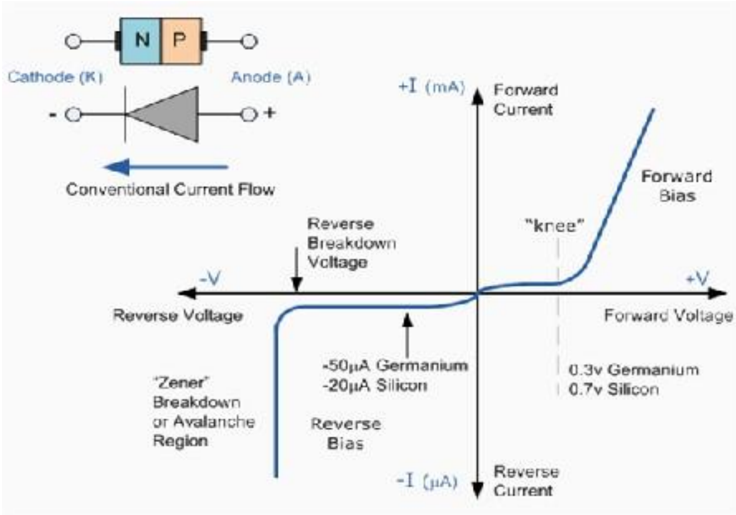
### 4.6. ZENER DIODE



A Zener diode allows current to flow from anode to cathode like any normal semiconductor diode, but it also permits current to flow in the reverse direction. Zener diodes have a highly doped p-n junction. Normal diodes will also break down when a reverse voltage is applied but the voltage and sharpness of the knee are not as well defined as for a Zener diode. Also common diodes are not manufactured to operate in the breakdown region, but Zener diodes can comfortably operate in this region. The device was named after the scientist Clarence Melvin Zener, who discovered the Zener effect. Zener reverse breakdown is due to electron quantum tunneling which is caused by a very high strength electric field. However, many diodes described as "Zener" diodes mostly rely on avalanche breakdown. Both breakdown types are commonly used in Zener diodes with the Zener effect predominating working under 5.6V and avalanche breakdown above. Zener diodes are hugely used in electronic equipments of all kinds and are one of the fundamental building blocks of electronic circuits. They have wide applications especially to generate low power stabilized supply rails from a higher voltage and to provide reference voltages to circuits, especially consistent stabilized power supplies. They are also used in protection circuits due to over-voltage, especially electrostatic discharge (ESD).

### 4.7. DIODE




Diodes only allow electricity to flow in single direction. The arrow in the symbol shows the direction in which the current would flow. Diodes are the electrical version of a valve and early diodes were actually known as valves. During forward voltage drop, electricity uses up quite little energy pushing its way through the diode. This means that there is a small voltage across a conducting diode, it is called the forward voltage drop and it's about 0.7V for most of the normal diodes which are made from silicon. The forward voltage drop of a diode is almost consistent to the current passing through the diode so they have a very steep characteristic (current - voltage graph). Reverse Voltage: When a reverse voltage is applied to a perfect diode, it does not conduct, but all real diodes leak small currents of a few A or less. This can be ignored in most of the circuits because it will be smaller than the current flowing in the forward direction. However, all diodes have a maximum reverse voltage (usually 50V or more) and if this is exceeds, the diode will fail and pass a large current in the reverse direction, this is called breakdown current.

### 4.8. CAPACITOR


The capacitor (also known as a condenser) is a passive two-terminal electrical component used for storing energy electrostatically in an electric field. The forms of practical capacitors has wide variety, but most contain at least two electrical conductors (plates) separated by a dielectric (i.e., insulator). The conductors are mostly thin films of metal, aluminum foil or disks, etc. The 'non-conducting' dielectric acts to increase the capacitor's charge capacity. A dielectric medium can be glass, ceramic, plastic film, air, paper, mica, etc. Capacitors are used as parts of electrical circuits in many electrical devices. Unlike a resistor, a capacitor does not dissipate much energy. Instead, a capacitor stores the energy in the form of an electrostatic field between the plates. When there occurs a potential difference between the conductors (e.g., when a capacitor is attached across a battery), an electric field develops across the dielectric, causing positive charge (+Q) to collect on one side of the plate and negative charge (-Q) to collect on the other plate. If a battery is attached to a capacitor for a given amount of time, no current can flow through the capacitor. However, if an accelerating or alternating voltage is given/applied across the leads of the capacitor, a displacement current can occur**.**

## V. PCB LAYOUT

The Printed Circuit Board (PCB) mechanically holds and electrically connects electronic components using conductive tracks, pads and other features etched from copper sheets laminated onto a non-conductive substrate. PCB's has few variants: single sided (one copper layer), double sided (two copper layers) or multi-layer. Conductors on different layers are connected using plated-through holes called vias. Advanced PCBs may contain components-capacitors, resistors or active devices - embedded on the substrate. PCBs are used in all even in the basic electronic products. Variants to PCB's include wire wrap and P2P construction. PCB's needs the additional design effort to lay out the circuit but manufacturing and assembly can be made automated. Manufacturing circuits with PCBs is cost effective and faster than with other wiring methods as components are mounted and wired on one single part. Further, operator wiring errors are also eliminated.

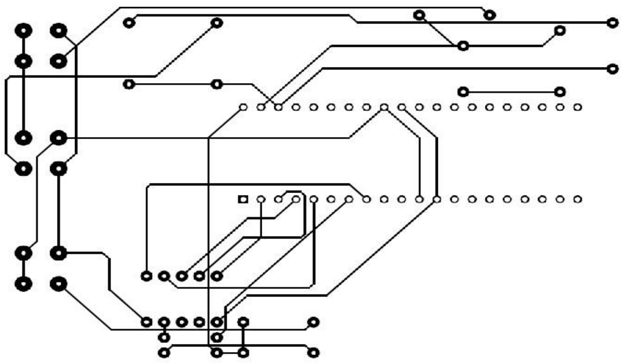


Figure5.1. Control section

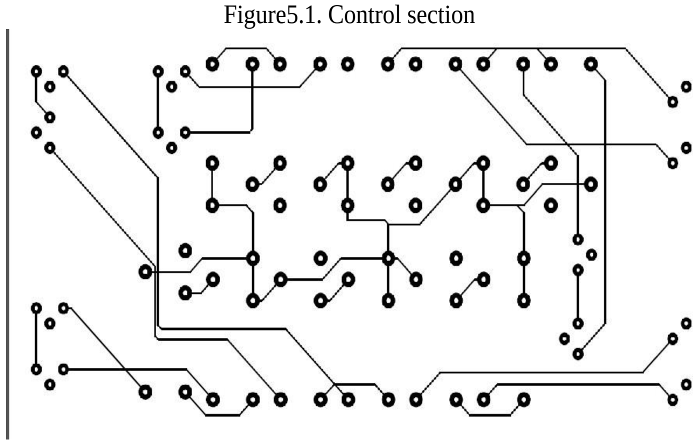
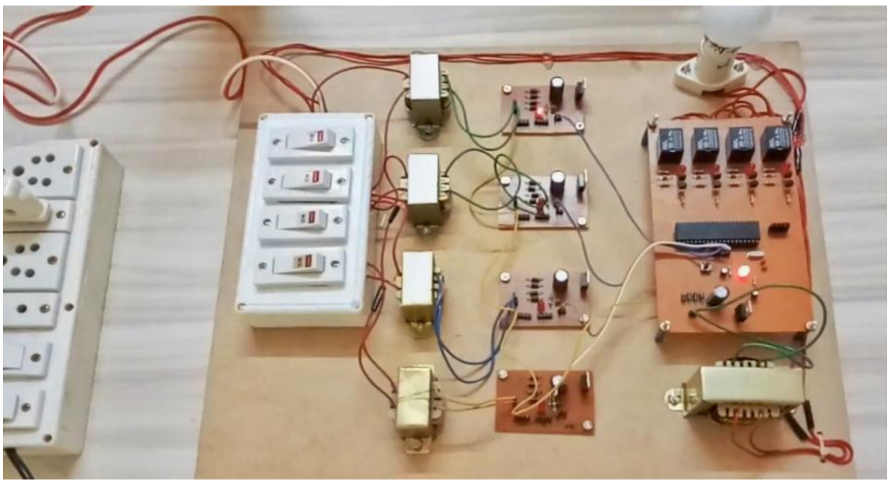


Figure 5.2. Relay Section

## VI. EXPERIMENTAL RESULT



## VII. CONCLUSION AND FUTURE SCOPE

Automatic phase changer holds wide application in modern industry. During the earlier days, if there was any power failure in any one of the three phases, we had to manually switch to the available phase. By using the automatic phase changer it automatically shifts to the necessary phase where correct voltage is available. It automatically supplies voltage in up to 2 of the 3 incoming phases in case of power failure or low voltage. Automatic Phase Changer automatically cuts supply during low voltage, thus it protects the equipment from the harmful effects of unhealthily low voltage. It can be used in

1) Residential buildings
2) Commercial offices.
3) Factories operating with 1 phase machineries.
4) Hospitals/Banks/Institutions

Automatic phase changer finds huge application in the modern world .This device is more cost effective, reliable and of maintenance free.

## VIII. REFERENCES

[1] Liyi Li, Member, IEEE, Jiwei Cao, Baoquan Kou, Member, IEEE, Zhengnan Han, Qingquan Chen, FellowIEEE, and Anbin Chen, “ ”Design of the HTS Permanent Magnet Motor With Superconducting Armature Winding”,IEEE Transactions On Ap- plied Superconductivity, Vol. 22, No. 3, June 2012

[2] G. Stumberger, M. T. Aydemir, D. Zarko, and T. A. Lipo, “Design of a linear bulk superconductor magnet synchronous motor for electromagnetic aircraft launch systems”, IEEE Trans. Appl. Supercond., vol. 14, no. 1, pp. 5462, Mar. 2004.

[3] L. Li and K. T. Chau, “A novel HTS PM vernier motor for direct-drive propulsion”,IEEE Trans. Appl. supercond, vol. 21, no. 3, pp. 11751179, Jun. 2011.