A Project Report of

AVAILABLE PHASE SELECTION IN A GIVEN THREE PHASE SUPPLY SYSTEM

Project report submitted in partial fulfillment of the Requirements for the Award of the Degree of B.Tech in Electrical and Electronics Engineering

by

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CERTIFICATE

This is to certify that the project report entitled AVILABLE PHASE SELECTION IN A GIVEN THREE PHASE SUPPLY SYSTEM being submitted by KOTHAPALLI MOUNIKA (133B1A0210), CHELLUBOINA DEEPAK (143B5A0202), NUNNA SURESH KUMAR (143B5A0207), BALE RAMYA SUMA BHARATHI (132E1A0202), JAMANDLAMUDI KARUNA KUMARI (132E1A0215) in partial fulfillment for the award of the Degree of Bachelor of Technology in Electrical and Electronics Engineering to the Jawaharlal Nehru Technological University, Kakinada is a record of bonafied work carried out under my guidance and supervision.

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ACKNOWLEDGEMENT

We are happy to present the report "AVAILABLE PHASE SELECTION IN A GIVEN THREE PHASE SUPPLY SYSTEM" in the partial fulfillment of the requirement for the award of Bachelor in Electrical & Electronics Engineering.

We would like to express our deep and sincere indebtedness to our esteemed guide Ms. R.R. MANISRI M. Tech Asst. Professor a source of constant motivation, for her inspiring guidance and infusing ideals and idea getting the project completed successfully.

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Lastly, we will be grateful to one and all that have contributed either directly or in directly involved in the completion of our project.

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This is a record of bonafied work carried out by us and the results embodied in this projects have not been reproduced or copied from any source. The results embodied in this project report have not been submitted to any other University or Institute for the award of any other degree.

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ABSTRACT

The main concept of this project is to maintain continuous AC supply to a single-phase load by an auto-changeover of load from the faulted phase to any available phase in a three-phase system.

The proposed system uses a rectified-power supply. In this system, three phases are connected to the control circuit through an Opto-isolator after reducing the voltage level and rectifying it to DC using a step-down transformer and a half-wave rectifier, respectively. The load is selected from any of the available three phases, automatically, using relays, which are interfaced to the relay driver IC. The logic gates are used for detecting the availability of the phase.

The circuit is connected in such a way that the relays connected to the phase feeding the load are always energized. In case of the failure of this phase, the logic gates automatically generate an output to drive, so that the next relay is activated to connect the other available phases to feed the load.

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LIST OF ABBREVATIONS

VR	Voltage Regulator
LED	Light Emitting Diode
IC	Integrated Circuit
GND	Ground
DC	Direct Current
ULN	Ultra Low Noise
NO	Normally Open
NC	Normally Close
V_S	Secondary Voltage
V_P	Primary Voltage
I_S	Secondary Current
I_P	Primary Current
N_S	Secondary Turns
N_P	Primary Turns
Z_S	Secondary Impedance
Z_P	Primary Impedance
AC	Alternating Current
TTL	Transistor Transistor Logic
UV	Ultra Violet
SPDT	Single Pole Double Throw
DPDT	Double Pole Double Throw
V_{CC}	Input Voltage
CMOS	Complementary Metal Oxide Semiconductor

INTRODUCTION

An electrical power system is growing in size and complexity in all sectors such as generation, transmission, distribution and the load center. Types of the faults like short circuit condition in the power system network results in severe economic losses and reduces the reliability of the electrical system. Electrical fault is an abnormal condition caused by the equipment failures such as transformers and rotating machines, human errors and environmental conditions. These faults cause interruption to the electric flows, equipment damages and even cause the death of humans, birds and animals. Electrical fault is the deviation of the voltages and currents from the nominal values or states. Under the normal operating conditions, power system equipment or line carries normal voltages and currents which results in a safer operation on the system. But when the fault occurs, it causes excessively high currents to flow which causes the damage to the equipment's and devices. Fault detection and analysis is necessary to select or design suitable switch gear equipment's, electro-mechanical relays, circuit breakers and other protection devices. These are mainly two types of faults in the electrical power system. Those are symmetrical and unsymmetrical faults.

1. Symmetrical faults. These are very severe faults and occur infrequently in the power systems. These are also called as balanced faults and are of two types namely line to line to line to ground and line to line to line. Symmetrical faults only 2-5 percent of system faults are symmetrical faults. If these faults occur, system remains balanced but results in severe damage to the electrical power system equipment's. Above figure shows two types of three phase symmetrical faults. Analysis of this fault is easy and usually carried by per phase basis. Three phase fault analysis or information is required for selecting set-phase relays, rupturing capacity of the circuit breakers and rating of the protective switch gear.

2. Unsymmetrical faults. These are very common and less severe than symmetrical faults. There are mainly three types namely line to ground, line to line and double line to ground faults. Unsymmetrical faults Line to ground fault is most common fault and 65-70 percent of faults are of this type. It causes the conductor to make contact with earth or ground. 15 to 20 percent of faults are double line to ground and causes the two conductors to make contact with ground. Line to line faults occur when two conductors

make contact with each other mainly while swinging of lines due to winds and 5- 10 percent of the faults are of this type. These are also called unbalanced faults since their occurrence causes unbalance in the system. Unbalance of the system means that that impedance values are different in each phase causing unbalance current to flow in the phases. These are more difficult to analyze and are carried by per phase basis similar to three phase balanced faults.

Weather conditions: It includes lighting strikes, heavy rains, heavy winds, salt deposition on overhead lines and conductors, snow and ice accumulation on transmission lines, etc. These environmental conditions interrupt the power supply and also damage electrical installations.

Equipment failures: Various electrical equipment's like generators, motors, transformers, reactors, switching devices, etc causes short circuit faults due to malfunctioning, aging, insulation failure of cables and winding. These failures result in high current to flow through the devices or equipment which further damages it.

Human errors: Electrical faults are also caused due to human errors such as selecting improper rating of equipment or devices, forgetting metallic or electrical conducting parts after servicing or maintenance, switching the circuit while it is under servicing, etc.

Over current flow: When fault occurs it creates a very low impedance path for the current flow. This results in a very high current being drawn from the supply, causing tripping of relays, damaging insulation and components of the equipment's.

Danger to operating personnel: Fault occurrence can also cause shocks to individuals. Severity of the shock depends on the current and voltage at fault location and even may lead to death.

Electrical fires: Short circuit causes flash overs and sparks due to the ionization of air between two conducting paths which further leads to fire as we often observe in news such as building and shopping complex fires. Fault limiting devices it is possible to minimize causes like human errors, but not environmental changes. Fault clearing is a crucial task in power system network. If we manage to disrupt or break the circuit when fault arises, it reduces the considerable damage to the equipment's and also property. Some of these fault limiting devices include fuses, circuit breakers, relays, etc. and are discussed below.

Fuse: It is the primary protecting device. It is a thin wire enclosed in a casing or glass which connects two metal parts. This wire melts when excessive current flows in circuit. Type of fuse depends on the voltage at which it is to operate. Manual replacement of wire is necessary once it blowout.

Our concentration was to develop a system which can reduce the problems or difficulties in our life. Also one more thing was in mind that to develop a system which can be applied for several applications associated with modern science and developments in technology. So the concept of available phase selection was selected which can be used in 3phase applications, if any one of the phase is in the fault condition then to shift the load automatically to the next phase. It is a simple circuit which consists of relays, logic gates, opto-isolators and transformers.

Power failure is a common problem. It hampers the production of industry, construction work of new plants and buildings. It can be overcome by using a backup power supply such as generator. But it is cost effective and also time consuming as certain time is required to switch on the generator manually. It is often noticed that power interruption in distribution system is about 70% for single phase faults while other two phases are in normal condition. Thus, in any commercial or domestic power supply system where 3phases are available, an automatic phase selector system is required for uninterrupted power to critical loads in the event of power failure in any phase. There is no requirement of backup power supply in that case. Also there is no time consumption as the phase is changed automatically within a few seconds. The main aim of this project is to present the real idea of an automatic phase switch for 230V ac supply. Although, there are many designs that can perform almost similar functions like, single phase change-over switches, two phase automatic transfer switch and three phase automatic change-over switch, but this model is about an automatic phase selector which is designed for only three phase ac input power to single phase output applications.

PROJECT DESCRIPTION

2.1 BLOCK DIAGRAM

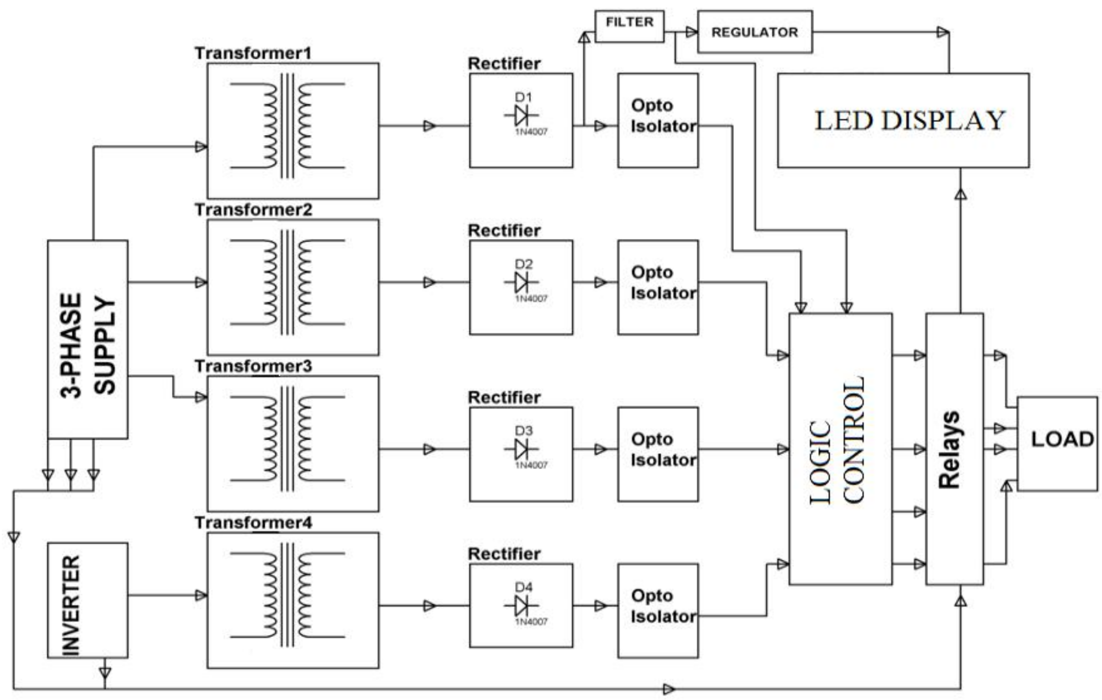


Fig. No: 2.1 Block diagram of proposed concept

From the above block diagram the three single phase transformers are connected in the system to change the level of input voltage to run the circuit i.e., stepping the level of voltage to 12v. Here the rectifier circuit is used to convert the ac voltage to the dc voltage. The filter circuit is used to filter the harmonics which are presented in the circuit which are forms by converting the voltage from ac to dc. Thus here we used the voltage regulator to maintain the constant voltage throughout the operation where we needed. In this circuit we employed the Opto-isolator which consists of one light emitting diode and Photo transistor in the internal circuit which denotes that the input of the IC is high then the led glows in the circuit then the photo transistor will operates then the 5v will send to the output which is input to the photo transistor given by the voltage regulator. Here the logic gates are used to send the logic outputs to the relay driver circuit. Here we used two logic gates those are not gate & and gate. The relay driver circuit is used to perform the inverter operation and gives the output either high or low thus the based on the input. Thus the output is connected to the relays. Thus the relay will operates when the input is low to the R-phase relay will be in the on state and the output is fed through the R-phase. When the input of the relay is high then the relay is in off state then it will shift the load to the available phase i.e., Y-phase or B-phase.

2.2 CIRCUIT DIAGRAM

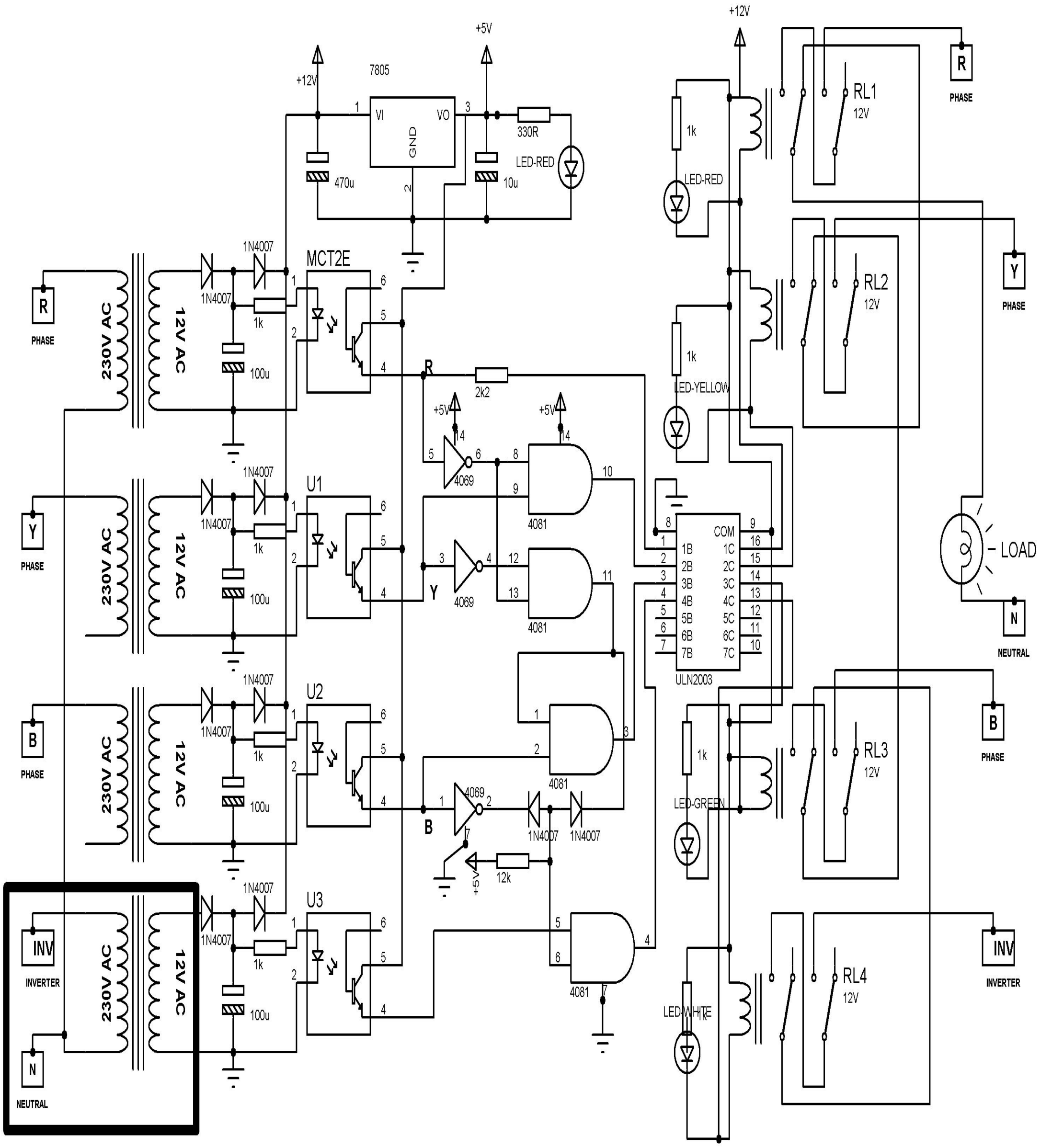


Fig. No: 2.2 Circuit Diagram of proposed concept

2.2.1 OPERATION OF OPTOCOUPLER

Opto coupler is a 6 pin IC. It is a combination of 1 LED and a transistor. Pin 6 of transistor is not generally used and when light falls on the Base-Emitter junction then it switches and pin5 goes to zero.

If input of the diode is zero and other end of diode is ground then the output is one.

- When logic zero is given as input then the light doesn't fall on transistor so it doesn't conduct which gives logic zero as output.
- When logic 1 is given as input then light falls on transistor so that it conducts, that makes transistor switched ON and it forms short circuit this makes the output is logic zero as collector of transistor is connected to ground.

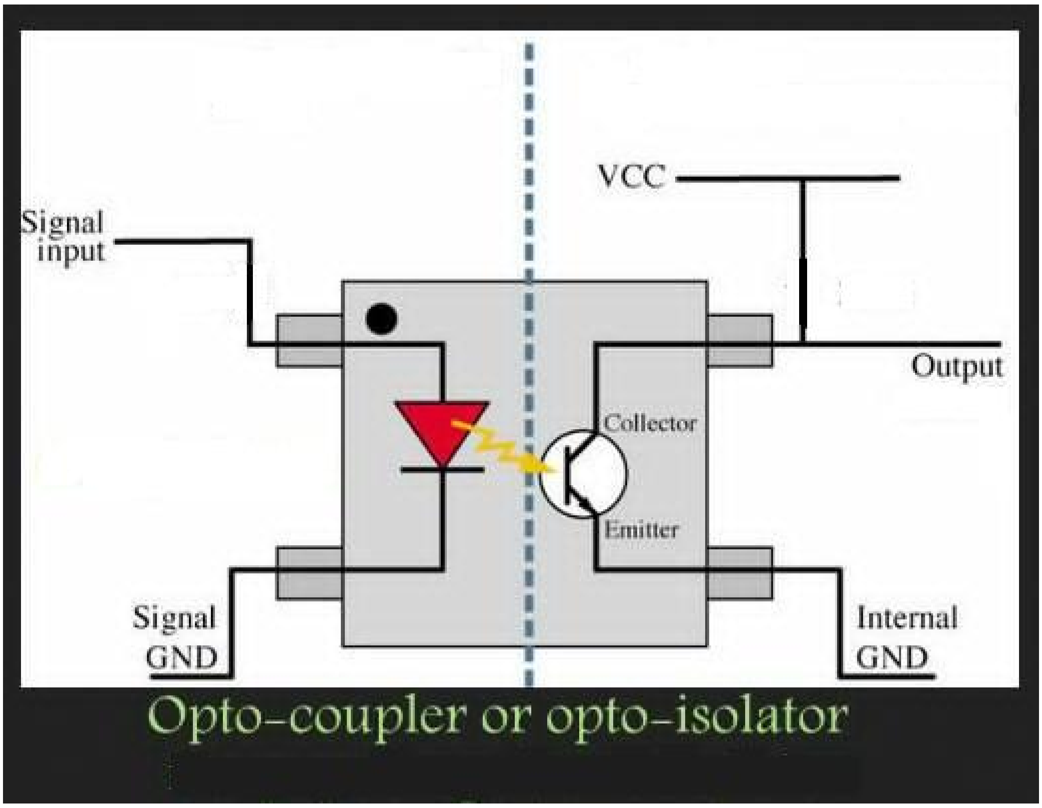


Fig. No: 2.3 Functional diagram of opto isolator

2.2.2 OPERATION OF ULN2003

ULN2003 is an IC which is used to interface relay with the logic gate IC. Since the output of the logic gate IC is 5V and is not practicable to operate relay with that voltage. ULN2003 is nothing but a set of inverters if logic high is given to the IC as input then its output will be logic low and vice-versa. Here in ULN2003 pins 1 to 7 are IC inputs and 10 to 16 are IC outputs.

For example let us operate a load using a relay which is interfaced with logic gate IC by a ULN2003 IC.

Positive voltage i.e., 12V is given to 9th pin of the ULN2003 IC and also to one end of the relay coil and the GND is connected to 8th pin. When logic gate IC gives logic high to the ULN2003, it gives an inverted output i.e., logic low which is connected to the other end of the relay coil. Due to this current flow through the coil which makes the relay ON and also the load is switched ON.

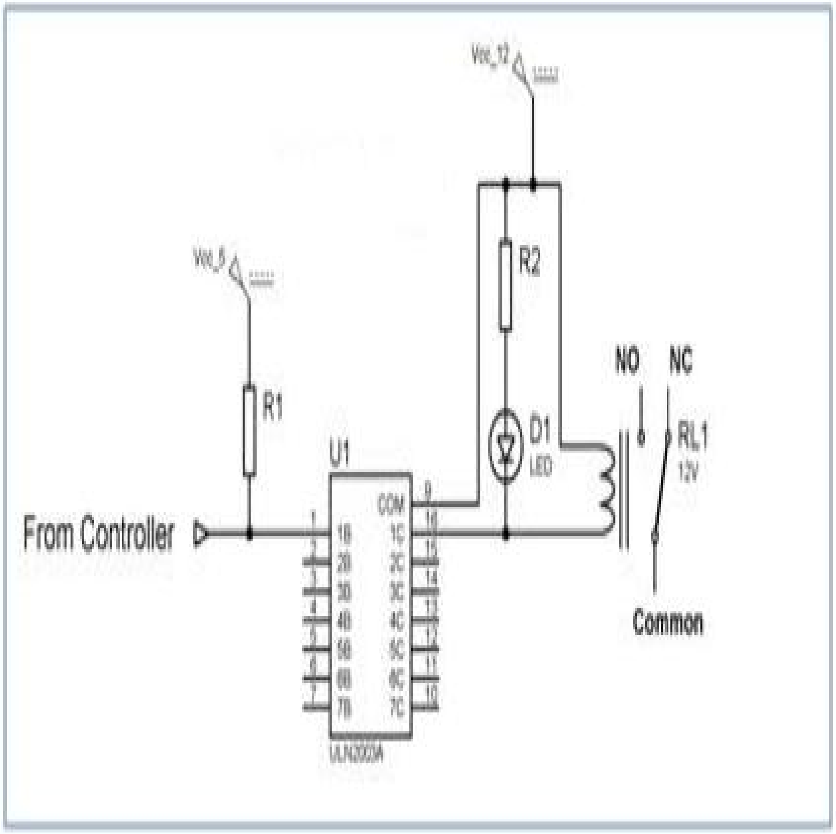


Fig. No: 2.4 Operation of Relay driver circuit

2.2.3 OPERATION OF AND GATE

Three phase supply are given to three independent transformers connected in together with another transformers from receiving supply, an inverter , the secondary of the transformers are used to develop DC by half wave rectification and then deriving four number of opto isolators individually. The DC supply from all the three phases and inverter supply are combined and then fed to the regulator IC 7805 for the circuit operation power.

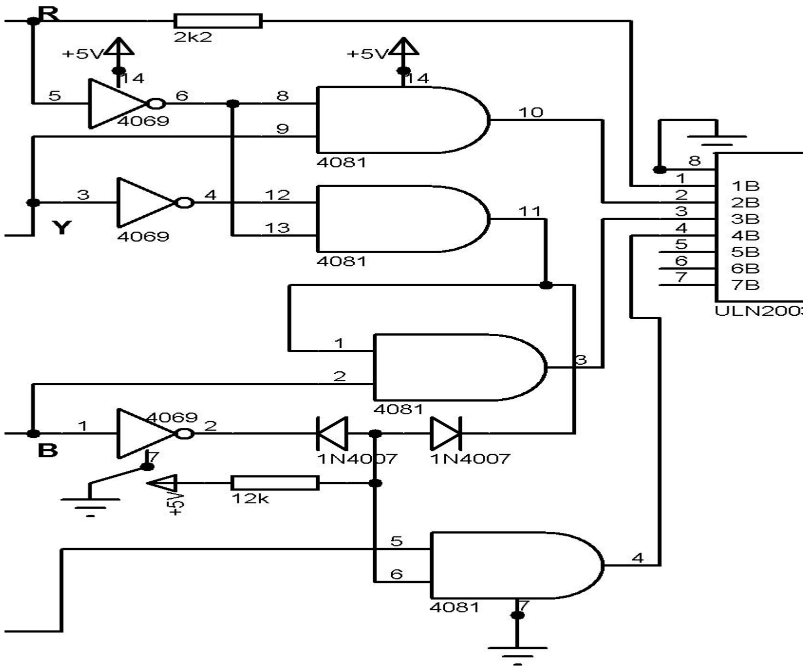


Fig. No: 2.5 Operation of Logic gate

One hex inverter CD4069 is used in combination with a quad AND CD4081 the output of which are fed to relay driver IC ULN2003 to operate relays for specific phase. While all the three phases R, Y, B are available the dc for R is directly given to ULN2003 pin number 1 such that the relay connected to pin 16 is operated and the load draws power from the R phase. The relays connected to pin number 15 and 14 of ULN2003 are held high as their corresponding input pin 2 and 3 are held low. This is because while R is high, pin 8 of 4081 is low through the inverter .Pin number 9 of 4081 is high since Y is available. Thus pin number 10 of 4081 provides low logic to ULN2003 pin number 2 to force the relay remain in OFF connected to pin number 15. The output of 4081 at pin number 11 is also low because of Y availability. Also since B is available pin number 2 of 4081 is held high while its pin number 1is held low because it is connected to pin number 11.Thus pin number 3 of 4081 is held low resulting in pin number 3 of ULN2003 also low and its pin number 14 remaining high ,hence the corresponding relay is OFF. When the R phase is missing the relay R stops and relay connected to pin number 15 is ON as per similar logic and load is supplied from Y phase. While Y phase is missing the relay 15 switches off and relay 14 switches ON similarly and the load is supplied from B phase. While B phase is available driving pin number 6 of 4081 low because of left side diode 4007 being forward biased .So the output pin 4 of 4069 remains low, forcing pin 13 of ULN2003 as high keeping the corresponding relay OFF. While all the three phases fail, 4069 pin 6 is held high because of pull up resistor and both the diodes in reverse biased condition. Hence the last AND gate can be used if an inverter is used such that while all the three phases fail it can supply power to the load. The relays connected drive the load with interlocking logic from the NO/NC contact of additional relays for handling the load.

Input				**Output**				**Active**
R	Y	B	INV	R	Y	B	INV	
1	1	1	1	1	Not in use	Not in use	Not in use	R-Phase
Fault	1	1	1	X	1	Not in use	Not in use	Y-Phase
Fault	Fault	1	1	X	X	1	Not in use	B-Phase
1	Fault	1	1	1	X	1	Not in use	R-Phase
1	1	Fault	1	1	X	1	Not in use	R-Phase
1	Fault	Fault	1	1	X	X	Not in use	R-Phase
Fault	1	Fault	1	X	1	X	Not in use	Y-Phase
Fault	Fault	Fault	1	X	X	X	1	Inverter

Table No: 2.1 Operating of Phases

1. In input side 1 means active phase.
2. In output side 1 means high signal which is able to operate the relay driver.
3. In the output side X stands for faulty places.

2.3 ADVANTAGES

1. Automatic switching of the load will decrease human errors.
2. The switching time is less because if which the fault duration n the system is very less.
3. Reduce circuit size and easier implementation with the use of relay driver.
4. The problem of unwanted rotation of gear motor does not arise.
5. The problem of sparking between the selector switch and the phase connection does not arise.

2.4 LIMITATIONS

The ratings of the distribution transformer have to be made higher so that it can support the load of other phases when single phase fault occur in them. It can made the distribution process costly but with the advantage of providing uninterrupted power supply to the domestic or single phase loads.

2.5 APPLICATIONS

- It can be useful to domestic loads.
- Used near the distribution transformer to shift the load between phases.

HARDWARE REQUIREMENTS

3.1 TRANSFORMER

One of the greatest advantage of alternating current over dc is that the ac can be easily transferable from low voltage to high voltages or high voltages to the low voltages as per requirements in the different stages of electrical network such as Generation, Distribution, Transmission and Utilization. This is possible with a device called as “Transformer”.

Transformers convert voltage from one level to another level without change in frequency. Step-up transformers used to increase the voltage, step-down transformers used to reduce the voltage. Most power supplies use a step-down transformer to reduce the dangerously high voltage to a safer low voltage.

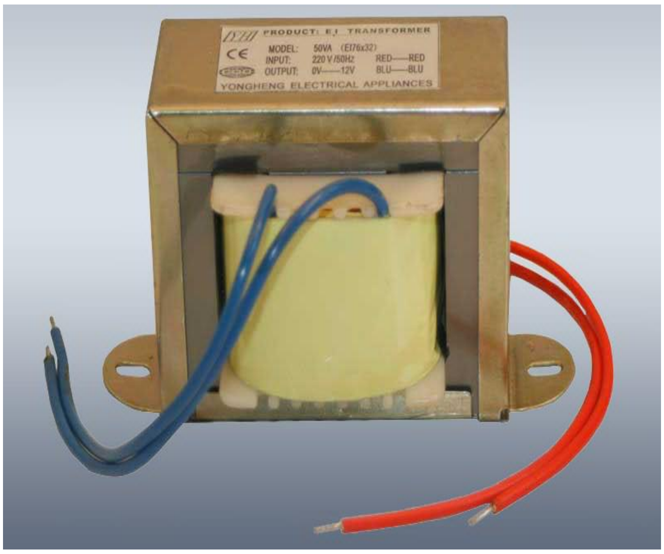
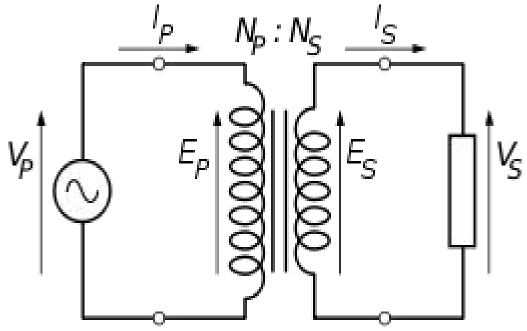


Fig. No: 3.1 Transformer

The input coil is called the primary and the output coil is called the secondary. There is no electrical connection between the two coils instead they are linked by an alternating magnetic field created in the soft-iron core of the transformer. The two lines in the middle of the circuit symbol represent the core. Losses in a transformer are very low thus the efficiency of the transformer is high. Note that as voltage is stepped down and current is stepped up.

3.1.1 IDEAL POWER EQUATION



$$\frac{V_P}{V_S} = \frac{I_S}{I_P} = \frac{N_P}{N_S}$$

Fig. No: 3.2 Ideal transformer internal diagram

If the secondary coil is attached to a load that allows current to flow, electrical power is transmitted from the primary circuit to the secondary circuit. Ideally, the transformer is perfectly efficient; all the incoming energy is transformed from the primary circuit to the magnetic field and into the secondary circuit. If this condition is met, the incoming electric power must equal the outgoing power:

$$P_{incoming}=I_pV_p=P_{outgoing}=I_sV_s \qquad \text{----------3.1}$$

Giving the ideal transformer equation

$$\frac{V_s}{V_p} = \frac{N_s}{N_p} = \frac{I_p}{I_s}. \qquad \text{----------3.2}$$

Transformers normally have high efficiency, so this formula is a reasonable approximation. If the voltage is increased, then the current is decreased by the same factor. The impedance in one circuit is transformed by the square of the turn's ratio. For example, if an impedance Z_s is attached across the terminals of the secondary coil, it appears to the primary circuit to have an impedance of $(N_p/N_s)^2Z_s$. This relationship is reciprocal, so that the impedance Z_p of the primary circuit appears to the secondary to be $(N_s/N_p)^2Z_p$.

3.2 VOLTAGE REGULATOR

A voltage regulator is designed to automatically maintain the constant voltage level. A voltage regulator may be a simple "feed-forward" design or may include negative feedback control loops. It s may use an electro-mechanical mechanism, or electronic components. Depending on the design, it may be used to regulate one or more AC or DC voltages.

Electronic voltage regulators are found in devices such as computer power supplies where they stabilize the dc voltages used by the processor and other elements. In automobile alternators and central power distribution system, voltage regulators may be installed at a substation or along the distribution lines so the all customers receive steady voltage independent of how much power is drawn from the line.

Here we are using the IC 7805 is an easy to use voltage regulator IC witch output 5volts and 1A max. It takes an unregulated voltage input which can be fluctuating within its input limits and converts this fluctuating voltage input into a regulated 5volts power output.

For example, a 12volt lead acid battery when fully charged gives the approximately 12.70 volts and when fully discharged, it gives out 10.50 volts. This difference can be even more under load or under charging state. If we use this battery as an input source for our IC 7805 output voltage will be remain constant as 5 volts during discharge and charging period.

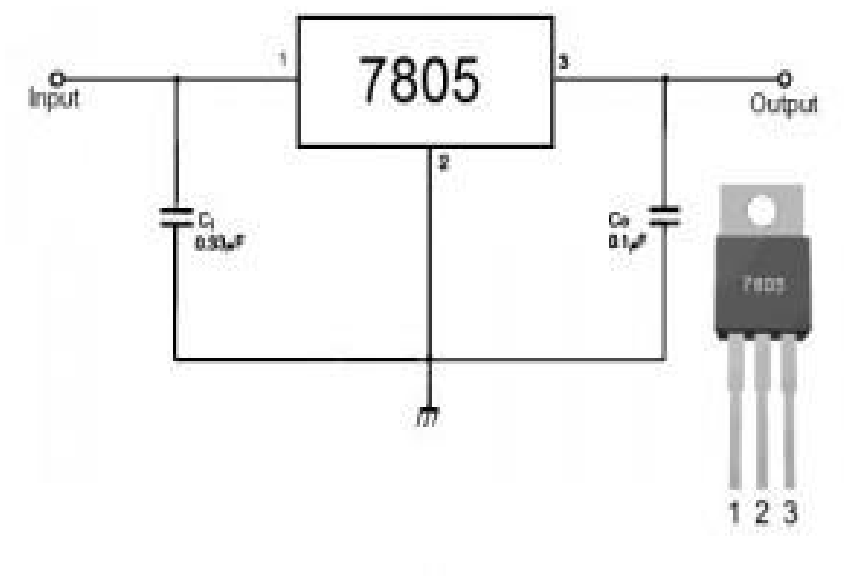


Fig. No: 3.3 Voltage regulator

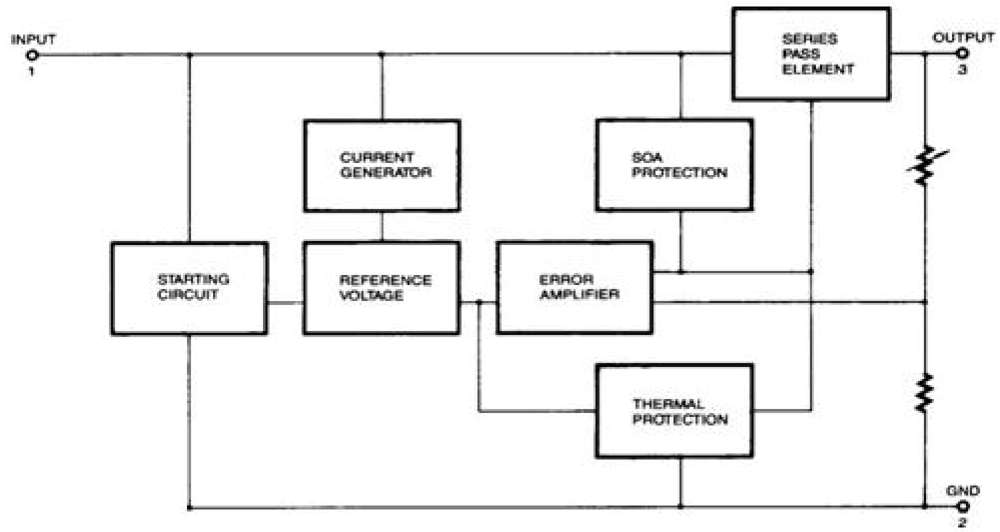


Fig. No: 3.4 Internal diagram of voltage regulator

The LM78XX/LM78XXA series of three-terminal positive regulators are available in the TO-220/D-PAK package and with several fixed output voltages, making them useful in a wide range of applications. Each type employs internal current limiting, thermal shutdown and safe operating area protection, making it essentially indestructible. If adequate heat sinking is provided, they can deliver over 1A output Current. Although designed primarily as fixed voltage regulators, these devices can be used with external components to obtain adjustable voltages and currents.

It is the most important and commonly used electrical components. These are responsible for maintaining a steady voltage across an electronic system. Voltage fluctuation may result in undesirable effect on the electronic system, so to maintain a steady constant voltage in necessary according the voltage requirement in the circuit.

3.3 RECTIFIER

Rectifier may be defined as electronic device, such as a semi conductor diode is used for conversion. The output from the transformer is fed to the rectifier circuit. It converts the alternating current into the pulsating direct current. The rectifier may be the half wave or full wave rectifier. In this project we used half wave rectifier.

Rectifiers may be classified onto two types depending upon the period conduction. They are

1. Half-wave Rectifiers
2. Full-wave Rectifiers

HALF WAVE RECTIFIER

A half wave rectifier circuit is one which conducts current only during the positive half cycles of input supply. The negative half cycles of the input supply are suppressed during the negative half cycles, no current is conducted and hence there is no voltage appears across the load. Therefore current always flows in one direction through the load only.

The input voltage to be rectified is applied to the input of the transformer and the transformer permits two advantages. Firstly, it allows use to step up or step down the input ac voltage. Secondly, the transformer isolates the rectifier circuit from power line and thus reduces the risk of electric shock.

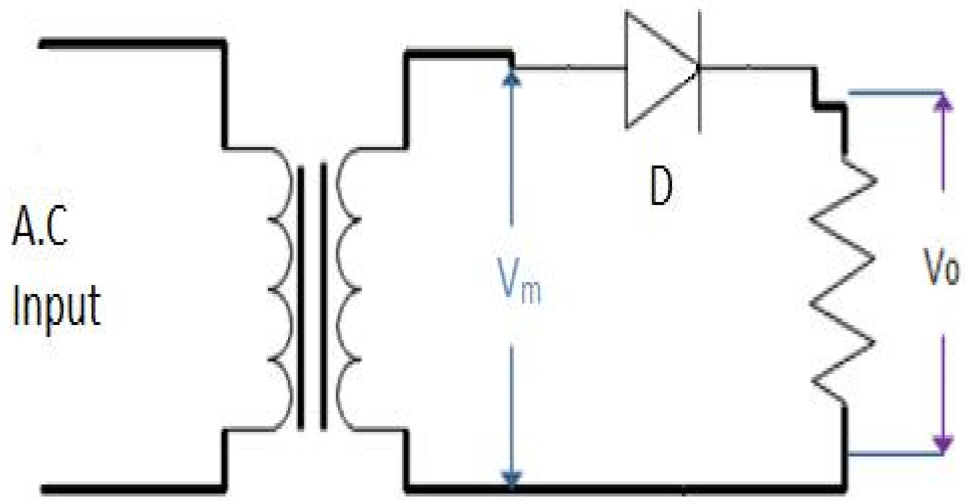


Fig.no: 3.5 Circuit Diagram of Half wave Rectifier

The ac voltage across the secondary winding AB changes polarities after every half cycle. During the positive half cycle of input ac voltage, end of A becomes positive with respect to end B. This makes the diode forward biased and hence it conducts current. During the negative half cycle end of A is negative with respect to end B. Under this condition the diode is said to be in the reverse biased and it does not conducts current. Therefore, current flows through the diode during positive half cycle of input ac voltage only. In this way , current flows through the load in same direction. Hence dc output is obtained across the output terminals.

The output wave forms of the half wave rectifier are shown below

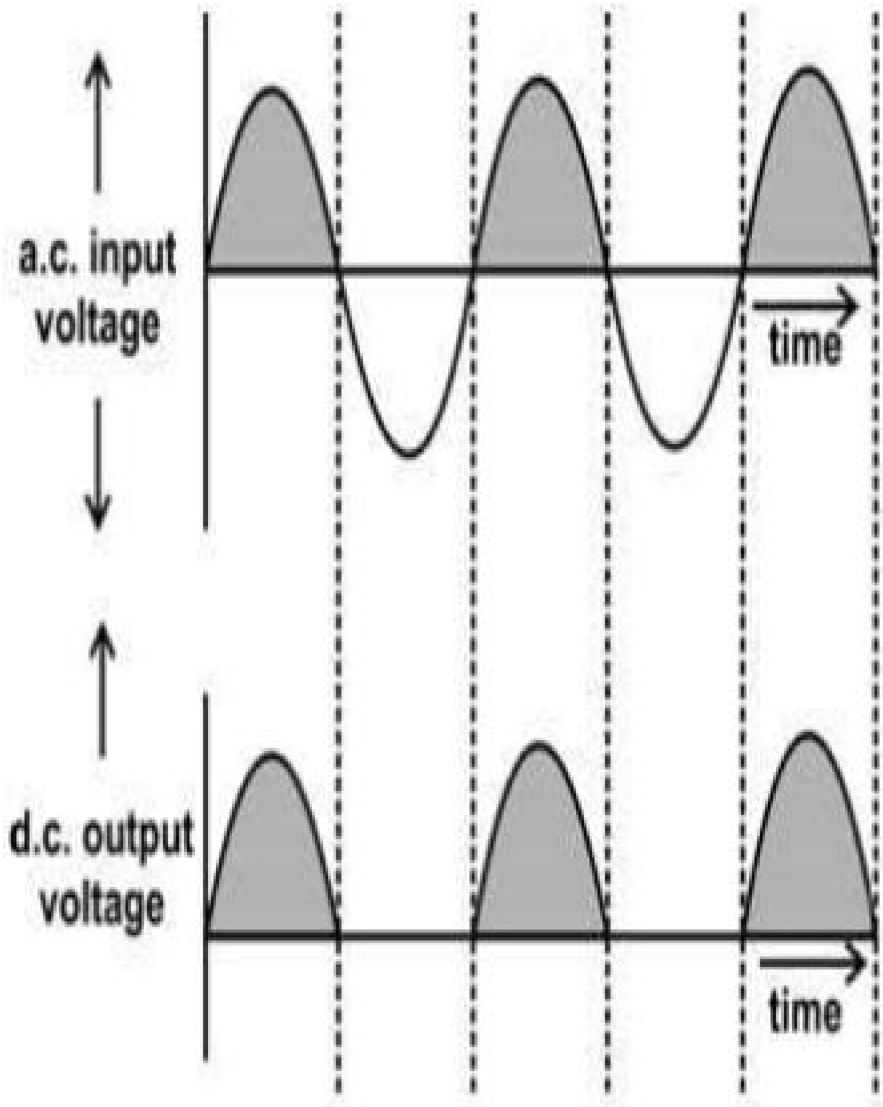


Fig no: 3.6 Output wave forms of Half wave Rectifier

3.4 FILTER

The output of rectifier is pulsating dc that it contains both ac and dc components. The ac components is undesirable and must be kept away from the load. The filter circuit is used to remove the ac component and to allow only the dc component to reach the load.

Types of filters

1. Capacitor filter
2. LC filter
3. CLC filter

Capacitive filter is used in this project. It removes the ripples from the output of rectifier and smooth the D.C. output received from this filter is constant until the mains voltage and load is maintained constant. However, if either of the two is varied, D.C. voltage received at this point changes. Therefore a regulator is applied at the output stage.

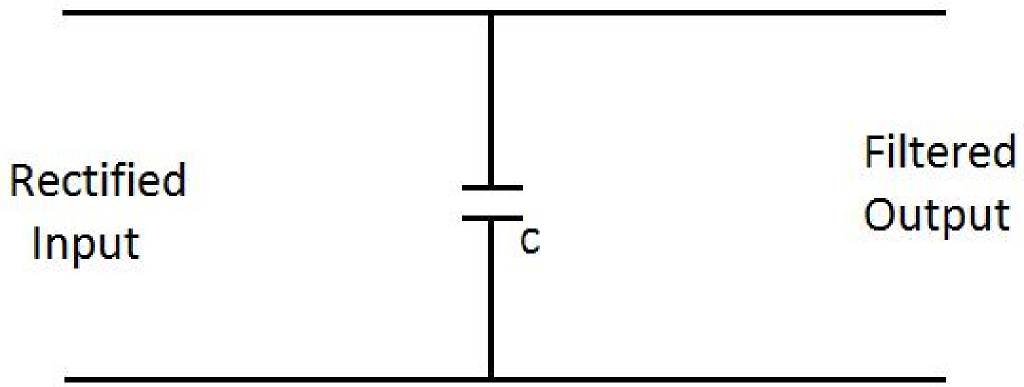


Fig 3.7 Circuit diagram of Capactive Filter

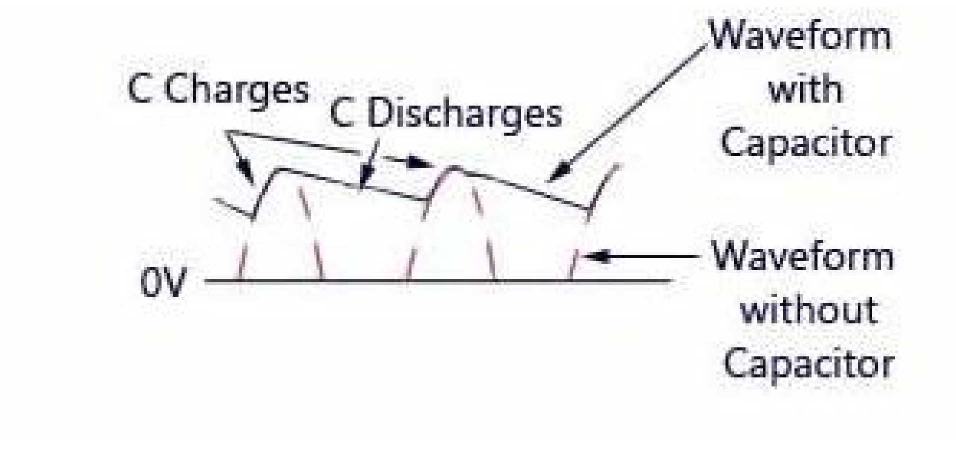


Fig 3.8 Output wave form of Capacitive filter

The simple capacitor filter is the most basic type of power supply filter. The use of this filter is very limited. It is sometimes used on extremely high-voltage, low-current power supplies for cathode-ray and similar electron tubes that require very little load current from the supply. This filter is also used in circuits where the power-supply ripple frequency is not critical and can be relatively high.

3.5 RELAY DRIVE IC

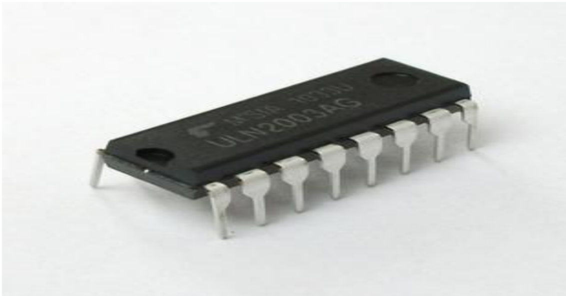


Fig. No: 3.9 Relay driver IC

ULN2003 is a high voltage and high current Darlington transistor array IC. It contains seven open collector Darlington pairs with common emitters. A Darlington pair is an arrangement of two bipolar transistors. ULN2003 is belongs to the family of ULN200X series of IC. Different versions of this family interface to different logic families. ULN2003 is for 5v TTL, CMOS logic device. These IC are used when driving wide range of loads and are used as relay drives, display drivers, line drivers etc, ULN2003 is also commonly used while stepping the stepper motors. The inputs and the outputs are provided opposite to each other in the pin layout. Each driver also contains a suppression diode to dissipate voltage spikes while driving the inductive loads.

3.5.1 DESCRIPTION

The ULN2003 is a monolithic high voltage and high current Darlington transistor arrays. It consists of seven NPN Darlington pairs that feature high-voltage outputs with common-cathode Clamp diode for switching inductive loads. The collector-current rating of a single Darlington pair is 500mA. The Darlington pairs may be paralleled for higher current capability. Applications include relay drivers, hammer drivers, lamp drivers, display drivers (LED gas discharge), line drivers, and logic buffers.

3.5.2 FEATURES

1. No.of Pins:16
2. Transistor Polarity: NPN
3. Transistors : 7
4. Minimum operating temperature:-20°C
5. Maximum operating temperature:-85°C
6. Base Number:2003
7. Current, Output Max:500mA
8. Input Type: TTL, CMOS 5V
9. Output Type: Open Collector
10. Transistor Type: Power Darlington
11. Voltage, Input Max:5V
12. Voltage, Output Max:50V

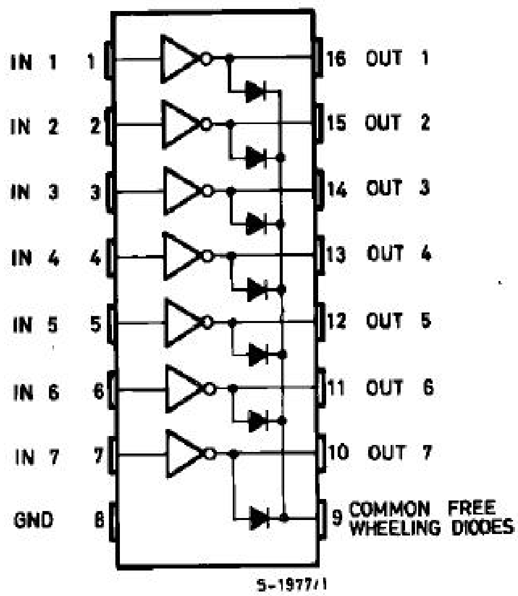


Fig. No: 3.10 Pin diagram of ULN2003

3.6 RELAY

A relay is an electrically operated switch. Many relays use an electromagnet to operate a switching mechanism mechanically, but other operating principles are also used. Relays are used where it is necessary to control a circuit by a low-power signal (with complete electrical isolation between control and controlled circuits), or where several circuits must be controlled by one signal.

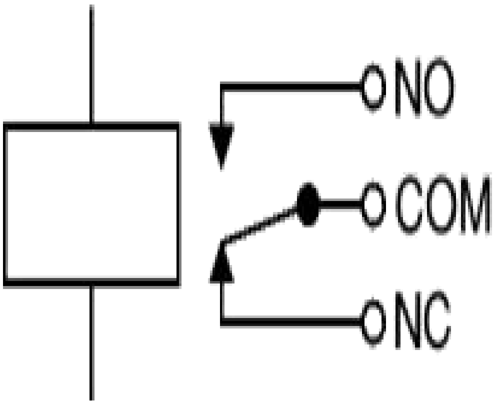


Fig. No: 3.11 Relay

A relay is an electrically operated switch. Current flowing through the coil of the relay creates a magnetic field which attracts a lever and changes the switch contacts. The coil current can be on or off so relays have two switch positions and most have double throw (changeover) switch contacts as shown in the diagram.

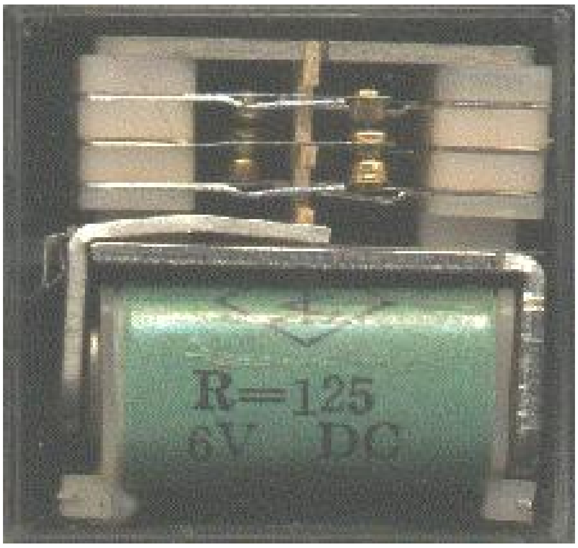


Fig. No: 3.12 Relay contacts internal

Relays allow one circuit to switch a second circuit which can be completely separate from the first. For example a low voltage battery circuit can use a relay to switch a 230V AC mains circuit. There is no electrical connection inside the relay between the two circuits; the link is magnetic and mechanical.

The coil of a relay passes a relatively large current, typically 30mA for a 12V relay, but it can be as much as 100mA for relays designed to operate from lower voltages. Most IC (chips) cannot provide this current and a transistor is usually used to amplify the small IC current to the larger value required for the relay coil. The maximum output current for the popular 555 timer IC is 200mA so these devices can supply relay coils directly without amplification.

Relays are usually SPDT or DPDT but they can have many more sets of switch contacts, for example relays with 4 sets of changeover contacts are readily available. For further information about switch contacts and the terms used to describe them please see the page on switches. Most relays are designed for mounting on printed circuit boards but we can solder wires directly to the pins providing you take care to avoid melting the plastic case of the relay.

The supplier's catalog should show you the relay's connections. The coil will be obvious and it may be connected either way round. Relay coils produce brief high voltage 'spikes' when they are switched off and this can destroy transistors and ICs in the circuit. To prevent damage you must connect a protection diode across the relay coil.

The figure shows a relay with its coil and switch contacts. You can see a lever on the left being attracted by magnetism when the coil is switched on. This lever moves the switch contacts.

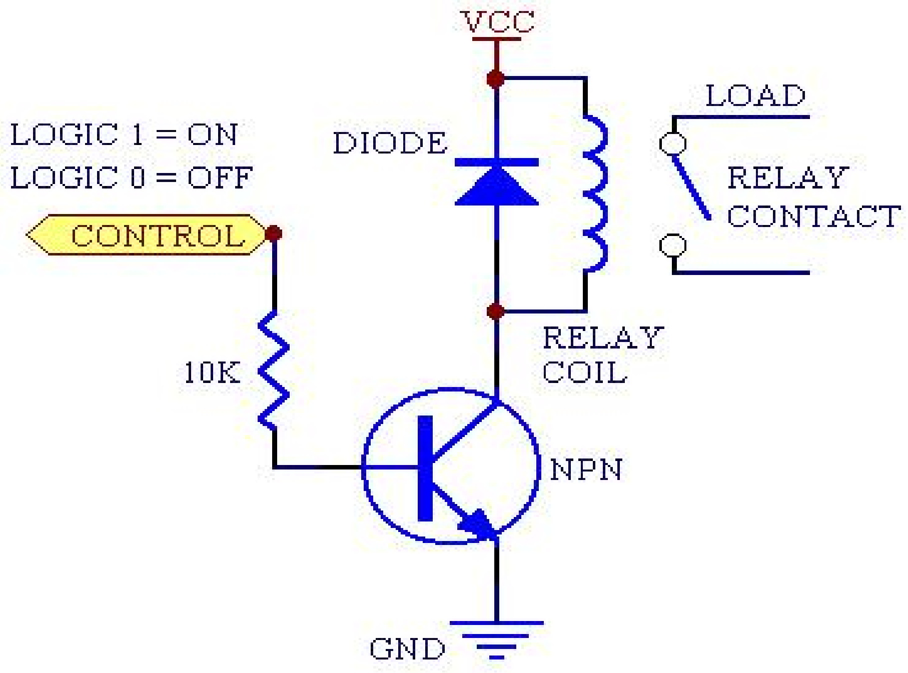


Fig. No: 3.13 Circuit diagram of relay

There is one set of contacts (SPDT) in the foreground and another behind them, making the relay DPDT.

The relay's switch connections are usually labelled COM, NC and NO:

- COM = Common, always connect to this; it is the moving part of the switch.
- NC = Normally Closed, COM is connected to this when the relay coil is off.
- NO = Normally Open, COM is connected to this when the relay coil is on.

3.6.1 USES OF RELAY

1. Control a high-voltage circuit with a low-voltage signal, as in some types of modems or audio amplifiers.
2. Control a high-current circuit with a low-current signal, as in the starter solenoid f an automobile.
3. Detect and isolate faults on transmission and distribution lines by opening and closing circuit breakers.
4. Time delay functions. Relays can be modified to delay opening or delay closing a set of contacts. A very shorts (a fraction of a second) delay would use a copper disk between the armature and moving blade assembly. Current flowing in the disk maintains magnetic field for a short time, lengthening release time. For a slightly longer (up to a minute) delay, a dashpot is used. A dashpot is a piston filled with fluid that is allowed to escape slowly. The time period can be varied by increasing or decreasing the flow rate. For longer time periods, a mechanical clockwork timer is installed.

3.7 OPTO ISOLATOR

Opto-isolators, or Opto-couplers, are made up of a light emitting device, and a light sensitive device, all wrapped up in one package, but with no electrical connection between the two, just a beam of light. The light emitter is nearly always an LED. The light sensitive device may be a photo diode, photo transistor, or more esoteric devices such as thyristors, triacs e.t.c.

A lot of electronic equipment nowadays is using opto coupler in the circuit. An opto coupler or sometimes refer to as opto isolator allows two circuits to exchange signals yet remain electrically isolated. This is usually accomplished by using light to relay the signal. The standard opto coupler circuits design uses a LED shining on a photo transistor usually it is a NPN transistor and not PNP. The signal is applied to the LED, which then shines on the transistor in the IC.

The light is proportional to the signal, so the signal is thus transferred to the photo transistor. Opto couplers may also comes in few module such as the SCR, photo diodes, TRIAC of other semiconductor switch as an output, and incandescent lamps, neon bulbs or other light source.

The opto-coupler usually found in switch mode power supply circuit on much electronic equipment. It is connected in between the primary and secondary section of power supplies. The opto-coupler application or function in the circuit is to:

1. Monitor high voltage
2. Output voltage sampling for regulation
3. System control micro for power ON/OFF
4. Ground isolation

If the opto-coupler IC breakdown, it will cause the equipment to have low power, blink, no power, erratic power and even power shut down once switch on the equipment. Many technicians and engineers do not know that they can actually test the opto-coupler with their analog multi meter. Most of them thought that there is no way of testing an IC with an analog meter.

This is the principle used in which are readily available in Integrated circuit (I.C.) form, and do not need very complex circuitry to make them work. Simply provide a small pulse at the right time to the Light Emitting Diode in the package. The light produced by the LED activates the light sensitive properties of the Triac or Thyristor gate and the power is switched on. The isolation between the low power and high power circuits in these optically connected devices is typically several thousand volts.

Fig 3.14: Opto Isolator

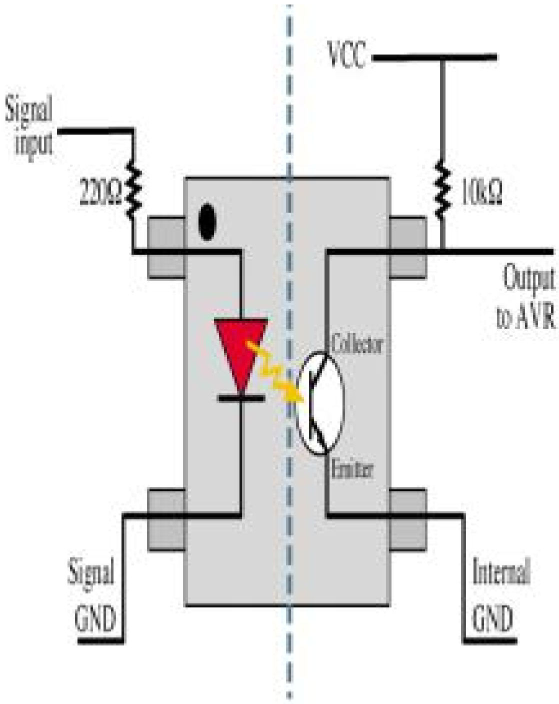


Fig 3.15: Internal Circuit of Opto Isolator

3.7.1 OPTO ISOLATOR PARAMETERS

COLLECTOR-EMITTER VOLTAGE

This is the maximum voltage that can be present from the collector to the emitter of the receiving photo transistor (when it is turned off – no light) before it may break-down.

CREE PAGE DISTANCE

This is physically how far a spark would have to travel around the outside of the package to get from one side to the other. If the package has contaminants on it, solder flux, or dampness, then a lower-resistance path can be created for noise signals to travel along.

FORWARD CURRENT

This is the current passing through the sending LED. Typically, an Opto-isolator will require about 5mA turn the output transistor on.

FORWARD VOLTAGE

This is the voltage that is dropped across the LED when it is turned on. Most normal diodes drop about 0.7v, but with LEDs it is typically 1 – 2 volts.

COLLECTOR DARK CURRENT

This is the current that can flow through the output photo transistor when it is turned off.

COLLECTOR-EMITTER SATURATION VOLTAGE

When the output transistor is fully turned on (saturated), this is the voltage there will be between the collector and emitter.

ISOLATION RESISTANCE

This is the resistance from a pin in the input side to a pin on the output side. It should be very high.

RESPONSE TIME

The rise and fall times are the times that the output voltage takes to get from zero to maximum. The rise time is very much dependent on the load resistor, since it is this that is pulling the output up. Therefore this value is always quoted with a fixed load resistance. Note however that the value, 100 Ohms, is much less than you are likely to use in practice. This is another of the manufacturer’s attempts to make the product look better than it is.

CUT-OFF FREQUENCY

This is effectively the highest frequency of square wave that can be sent through the Opto-isolator. It is actually the frequency at which the output voltage is only swinging half the amplitude than at DC levels (-3Db = half). It is therefore linked with the rise and fall times.

CURRENT TRANSFER RATIO

This is the ratio of how much collector current in the output transistor that you get given a certain amount of forward current in the input side LED. It is affected by how close the LED and photo transistor are inside the device, how efficient they both are, and many other factors. In fact it is not a constant but varies wildly with LED forward current.

3.8 AND GATE IC 4081

The 4081 is a member of the 4000 Series CMOS range, and contains four independent CMOS AND gates, each with two inputs. The layout diagram, given on the right, is the standard two-input logic gate IC layout:

1. Pin 7 is the negative supply
2. Pin 14 is the positive supply
3. Pins 1&2, 5&6, 8&9, 12&13 are gate inputs
4. Pins 3, 4, 10, 11 are gate outputs

The truth table for one of the four gates is shown below

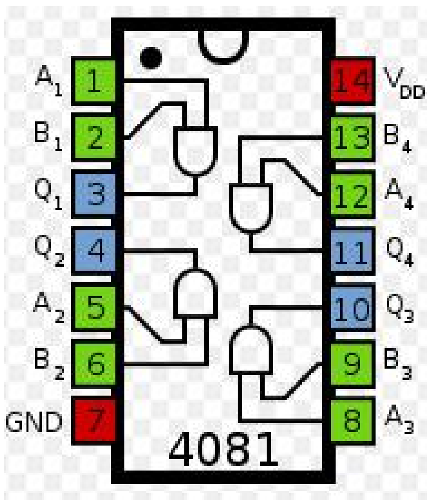


Fig 3.16 pin diagram of IC 4081

Truth Table (One Gate)

A	B	Q
0	0	0
0	1	0
1	0	0
1	1	1

Truth Table: 3.1 Operation of AND gate

3.9 INVERTER IC 4069

1. Medium-speed operation at 10v
2. Quiescent current specified to 20v for hcc device
3. Standardized symmetrical output characteristics
4. 5v, 10v, and 15v parametric ratings input current of 100na at 18v and 25°c for hcc device
5. 100% tested for quiescent current

3.9.1 DESCRIPTION

The HCC4069UB (extended temperature range) and HCF4069UB (intermediate temperature range) are monolithic integrated circuit, available in 14-lead dual in-line plastic or ceramic package and plastic micro package.

The HCC/HCF4069UB consists of six COS/MOS inverter circuits. This device is intended for all general purpose inverter applications where the medium-power TTL-drive and logic-level-conversion capabilities of circuits such as HCC/HCF4049B Hex Inverter/Buffers are not required.

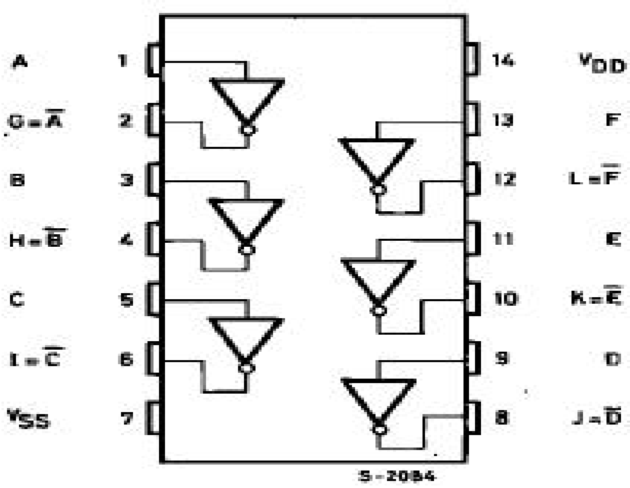


Fig. No: 3.17 Pin diagram of IC4069

3.10 LED

Light Emitting Diodes (LED) have recently become available that are white and bright, so bright that they seriously compete with incandescent lamps in lighting applications. They are still pretty expensive as compared to a glow lamp but draw much less current and project a fairly well focused beam.

The diode in the photo came with a neat little reflector that tends to sharpen the beam a little but doesn't seem to add much to the overall intensity.

When run within their ratings, they are more reliable than lamps as well. Red LEDs are now being used in automotive and truck tail lights and in red traffic signal lights. You will be able to detect them because they look like an array of point sources and they go on and off instantly as compared to conventional incandescent lamps.

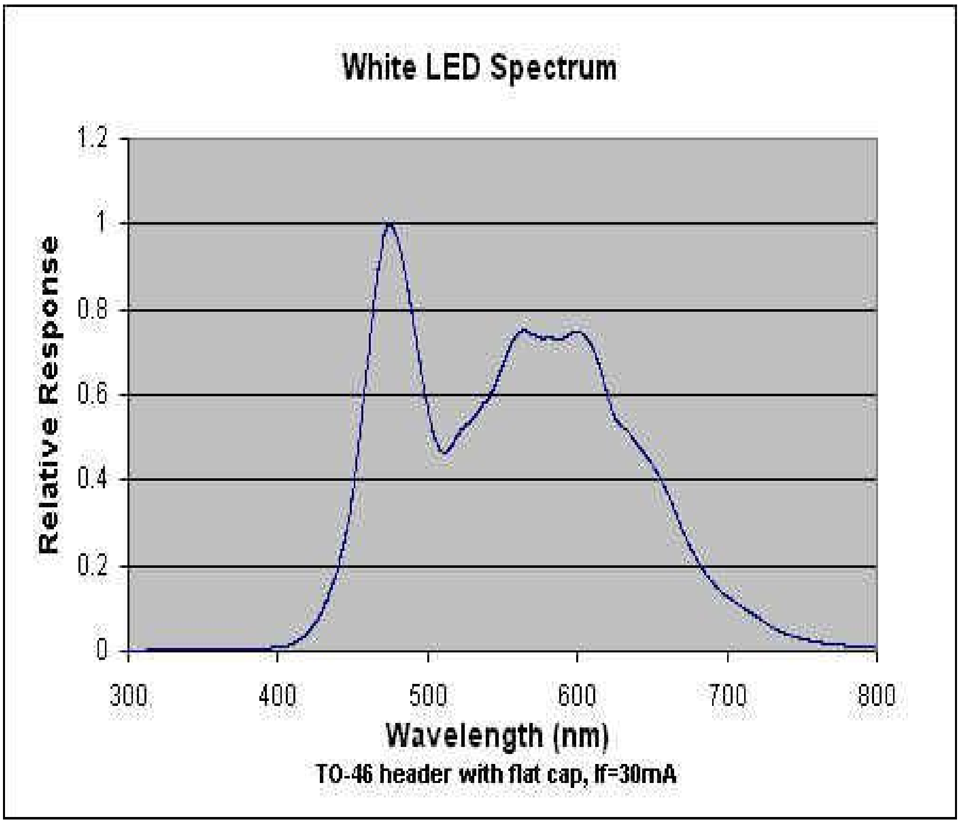


Fig. No: 3.18 Wave length graph of led

LEDs are monochromatic (one color) devices. The color is determined by the band gap of the semiconductor used to make them. Red, green, yellow and blue LEDs are fairly common. White light contains all colors and cannot be directly created by a single LED. The most common form of "white" LED really isn't white. It is a Gallium Nitride blue LED coated with a phosphor that, when excited by the blue LED light, emits a broad range spectrum that in addition to the blue emission, makes a fairly white light.

There is a claim that these white LED's have a limited life. After 1000 hours or so of operation, they tend to yellow and dim to some extent. Running the LEDs at more than their rated current will certainly accelerate this process.

There are two primary ways of producing high intensity white-light using LED'S. One is to use individual LED'S that emit three primary colours—red, green, and blue and then mix all the colors to form white light. The other is to use a phosphor material to convert monochromatic light from a blue or UV LED to broad-spectrum white light, much in the same way a fluorescent light bulb works. Due to mesmerism, it is possible to have quite different spectra that appear white.

LEDs are semiconductor devices. Like transistors, and other diodes, LEDs are made out of silicon. What makes an LED give off light are the small amounts of chemical impurities that are added to the silicon, such as gallium, arsenide, indium, and nitride.

When current passes through the LED, it emits photons as a byproduct. Normal light bulbs produce light by heating a metal filament until it is white hot. LEDs produce photons directly and not via heat, they are far more efficient than incandescent bulbs.

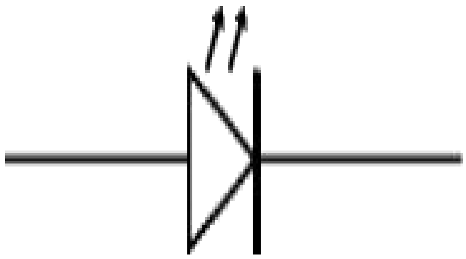


Fig. No: 3.19 Symbol of led

Not long ago LEDs were only bright enough to be used as indicators on dashboards or electronic equipment. But recent advances have made LEDs bright enough to rival traditional lighting technologies. Modern LEDs can replace incandescent bulbs in almost any application.

LEDs are produced in an array of shapes and sizes. The 5 mm cylindrical package is the most common, estimated at 80% of world production. The color of the plastic lens is often the same as the actual color of light emitted, but not always. For instance, purple plastic is often used for infrared LEDs, and most blue devices have clear housings. There are also LEDs in extremely tiny packages, such as those found on blinkers and on cell phone keypads. The main types of LEDs are miniature, high power devices and custom designs such as alphanumeric or multi-colour.

3.11 DIODE

Diodes are used to convert AC into DC these are used as half wave rectifier or full wave rectifier. Three points must he kept in mind while using any type of diode.

1.Maximum forward current capacity

2.Maximum reverse voltage capacity

3.Maximum forward voltage capacity

Fig. No: 3.20 Diode

The number and voltage capacity of some of the important diodes available in the market are as follows:

1. Diodes of number 1N4001, 1N4002, 1N4003, 1N4004, 1N4005, 1N4006 and 1N4007 have maximum reverse bias voltage capacity of 50V and maximum forward current capacity of 1 Amp.

2. Diode of same capacities can be used in place of one another. Besides this diode of more capacity can be used in place of diode of low capacity but diode of low capacity cannot be used in place of diode of high capacity. For example, in place of 1N4002, 1N4001 or 1N4007 can be used but 1N4001 or 1N4002 cannot be used in place of 1N4007.The diode BY125made by company BEL is equivalent of diode from 1N4001 to 1N4003. BY 126 is equivalent to diodes 1N4004 to 4006 and BY 127 is equivalent to diode 1N4007.

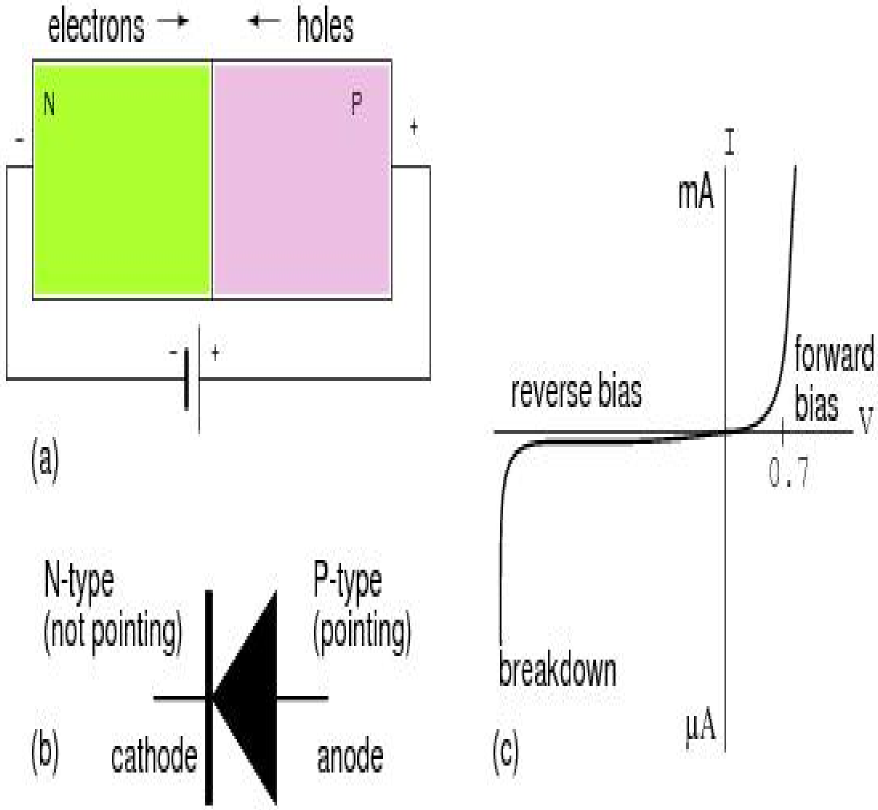


Fig. No: 3.21 P-N Junction

3.11.1 P-N JUNCTION OPERATION

Now that you are familiar with P- and N-type materials, how these materials are joined together to form a diode, and the function of the diode, let us continue our discussion with the operation of the PN junction. But before we can understand how the PN junction works, we must first consider current flow in the materials that make up the junction and what happens initially within the junction when these two materials are joined together.

Current Flow in the N-Type Material

Conduction in the N-type semiconductor, or crystal, is similar to conduction in a copper wire. That is, with voltage applied across the material, electrons will move through the crystal just as current would flow in a copper wire. This is shown in figure 1-15. The positive potential of the battery will attract the free electrons in the crystal. These electrons will leave the crystal and flow into the positive terminal of the battery. As an electron leaves the crystal, an electron from the negative terminal of the battery will enter the crystal, thus completing the current path. Therefore, the majority current carriers in the N-type material (electrons) are repelled by the negative side of the battery and move through the crystal toward the positive side of the battery.

Current Flow in the P-Type Material

Current flow through the P-type material is illustrated. Conduction in the P material is by positive holes, instead of negative electrons. A hole moves from the positive terminal of the P material to the negative terminal. Electrons from the external circuit enter the negative terminal of the material and fill holes in the vicinity of this terminal. At the positive terminal, electrons are removed from the covalent bonds, thus creating new holes. This process continues as the steady stream of holes (hole current) moves toward the negative terminal

3.12 RESISTORS

A resistor is a two-terminal electronic component designed to oppose an electric current by producing a voltage drop between its terminals in proportion to the current, that is, in accordance with Ohm's law:

$$V = IR \qquad \text{----------- } 3.3$$

Resistors are used as part of electrical networks and electronic circuits. They are extremely commonplace in most electronic equipment. Practical resistors can be made of various compounds and films, as well as resistance wire (wire made of a high-resistivity alloy, such as nickel/chrome).

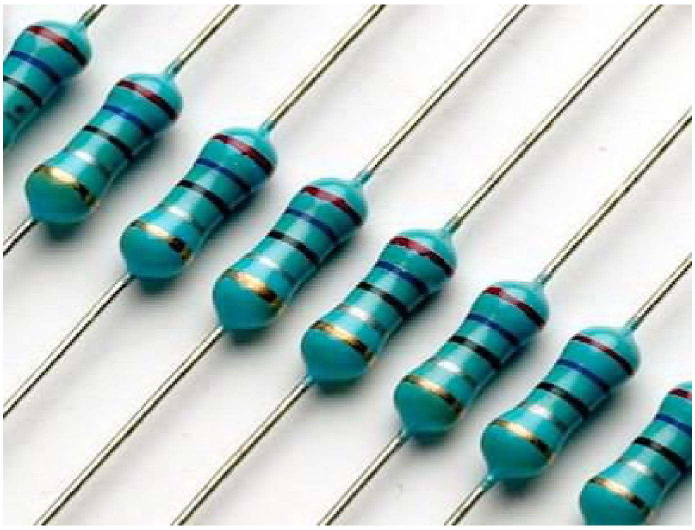


Fig. No: 3.22 Resistors

The primary characteristics of resistors are their resistance and the power they can dissipate. Other characteristics include temperature coefficient, noise, and inductance. Less well-known is critical resistance, the value below which power dissipation limits the maximum permitted current flow, and above which the limit is applied voltage. Critical resistance depends upon the materials constituting the resistor as well as its physical dimensions; it's determined by design.

Resistors can be integrated into hybrid and printed circuits, as well as integrated circuits. Size, and position of leads (or terminals) are relevant to equipment designers; resistors must be physically large enough not to overheat when dissipating their power.

A resistor is a two-terminal passive electronic component which implements electrical resistance as a circuit element. When a voltage V is applied across the terminals of a resistor, a current I will flow through the resistor in direct proportion to that voltage. The reciprocal of the constant of proportionality is known as the resistance R, since, with a given voltage V, a larger value of R further "resists" the flow of current I as given by Ohm's law:

$$I = \frac{V}{R} \qquad \text{---------- 3.4}$$

Resistors are common elements of electrical networks and electronic circuits and are ubiquitous in most electronic equipment. Practical resistors can be made of various compounds and films, as well as resistance wire (wire made of a high-resistivity alloy, such as nickel-chrome). Resistors are also implemented within integrated circuits, particularly analog devices, and can also be integrated into hybrid and printed circuits.

The electrical functionality of a resistor is specified by its resistance: common commercial resistors are manufactured over a range of more than 9 orders of magnitude. When specifying that resistance in an electronic design, the required precision of the resistance may require attention to the manufacturing tolerance of the chosen resistor, according to its specific application. The temperature coefficient of the resistance may also be of concern in some precision applications. Practical resistors are also specified as having a maximum power rating which must exceed the anticipated power dissipation of that resistor in a particular circuit: this is mainly of concern in power electronics applications. Resistors with higher power ratings are physically larger and may require heat sinking. In a high voltage circuit, attention must sometimes be paid to the rated maximum working voltage of the resistor.

The series inductance of a practical resistor causes its behaviour to depart from ohms law; this specification can be important in some high-frequency applications for smaller values of resistance. In a low-noise amplifier or pre-amp the noise characteristics of a resistor may be an issue. The unwanted inductance, excess noise, and temperature coefficient are mainly dependent on the technology used in manufacturing the resistor. They are not normally specified individually for a particular family of resistors manufactured using a particular technology. A family of discrete resistors is also characterized according to its form factor, that is, the size of the device and position of its leads (or terminals) which is relevant in the practical manufacturing of circuits using them.

The ohm (symbol: Ω) is the SI unit of electrical resistance, named after Georg Simon Ohm. An ohm is equivalent to a volt per ampere. Since resistors are specified and manufactured over a very large range of values, the derived units of milliohm (1 $m\Omega = 10^{-3}\ \Omega$), kilo ohm ($1\ k\Omega = 10^{3}\ \Omega$), and mega ohm ($1\ M\Omega = 10^{6}\ \Omega$) are also in common usage.

The reciprocal of resistance R is called conductance $G = 1/R$ and is measured in Siemens (SI unit), sometimes referred to as a mho. Thus a Siemens is the reciprocal of an ohm: $S = \Omega^{-1}$. Although the concept of conductance is often used in circuit analysis, practical resistors are always specified in terms of their resistance (ohms) rather than conductance.

Most axial resistors use a pattern of coloured stripes to indicate resistance. Surface-mount resistors are marked numerically, if they are big enough to permit marking; more-recent small sizes are impractical to mark. Cases are usually tan, brown, blue, or green, though other colours are occasionally found such as dark red or dark gray.

Early 20th century resistors, essentially uninsulated, were dipped in paint to cover their entire body for colour coding. A second colour of paint was applied to one end of the element, and a colour dot (or band) in the middle provided the third digit. The rule was "body, tip, dot", providing two significant digits for value and the decimal multiplier, in that sequence. Default tolerance was ±20%. Closer-tolerance resistors had silver (±10%) or gold-coloured (±5%) paint on the other end.

Four-band identification is the most commonly used colour-coding scheme on resistors. It consists of four coloured bands that are painted around the body of the resistor. The first two bands encode the first two significant digits of the resistance value, the third is a power-of-ten multiplier or number-of-zeroes, and the fourth is the tolerance accuracy, or acceptable error, of the value. The first three bands are equally spaced along the resistor; the spacing to the fourth band is wider. Sometimes a fifth band identifies the thermal coefficient, but this must be distinguished from the true 5-color system, with 3 significant digits.

For example, green-blue-yellow-red is $56\times10^4\ \Omega = 560\ k\Omega \pm 2\%$. An easier description can be as followed: the first band, green, has a value of 5 and the second band, blue, has a value of 6, and is counted as 56. The third band, yellow, has a value of 10^4, which adds four 0's to the end, creating 560,000 Ω at ±2% tolerance accuracy. 560,000 Ω changes to 560 kΩ ±2% (as a kilo- is 10^3).

Early resistors were made in more or less arbitrary round numbers; a series might have 100, 125, 150, 200, 300, etc. Resistors as manufactured are subject to a certain percentage tolerance, and it makes sense to manufacture values that correlate with the tolerance, so that the actual value of a resistor overlaps slightly with its neighbours. Wider spacing leaves gaps; narrower spacing increases manufacturing and inventory costs to provide resistors that are more or less interchangeable.

A logical scheme is to produce resistors in a range of values which increase in a geometrical progression, so that each value is greater than its predecessor by a fixed multiplier or percentage, chosen to match the tolerance of the range. For example, for a tolerance of ±20% it makes sense to have each resistor about 1.5 times its predecessor, covering a decade in 6 values. In practice the factor used is 1.4678, giving values of 1.47, 2.15, 3.16, 4.64, 6.81, 10 for the 1-10 decade (a decade is a range increasing by a factor of 10; 0.1-1 and 10-100 are other examples); these are rounded in practice to 1.5, 2.2, 3.3, 4.7, 6.8, 10; followed, of course by 15, 22, 33, … and preceded by … 0.47, 0.68, 1. This scheme has been adopted as the E6 range of the IEC 60063 preferred number series. There are also E12, E24, E48, E96 and E192 ranges for components of ever tighter tolerance, with 12, 24, 96, and 192 different values within each decade. The actual values used are in the IEC 60063 lists of preferred numbers.

A resistor of 100 ohms ±20% would be expected to have a value between 80 and 120 ohms; its E6 neighbours are 68 (54-82) and 150 (120-180) ohms. A sensible spacing, E6 is used for ±20% components; E12 for ±10%; E24 for ±5%; E48 for ±2%, E96 for ±1%; E192 for ±0.5% or better. Resistors are manufactured in values from a few milli ohms to about a Giga ohm in IEC60063 ranges appropriate for their tolerance.

Earlier power wire-wound resistors, such as brown vitreous-enamelled types, however, were made with a different system of preferred values, such as some of those mentioned in the first sentence of this section.

5-band identification is used for higher precision (lower tolerance) resistors (1%, 0.5%, 0.25%, 0.1%) to specify a third significant digit. The first three bands represent the significant digits, the fourth is the multiplier, and the fifth is the tolerance. Five-band resistors with a gold or silver 4th band are sometimes encountered, generally on older or specialized resistors. The 4th band is the tolerance and the 5th the temperature coefficient.

3.12.1 VARIABLE RESISTORS

A resistor may have one or more fixed tapping points so that the resistance can be changed by moving the connecting wires to different terminals. Some wire wound power resistors have a tapping point that can slide along the resistance element, allowing a larger or smaller part of the resistance to be used.

Where continuous adjustment of the resistance value during operation of equipment is required, the sliding resistance tap can be connected to a knob accessible to an operator. Such a device is called a rheostat and has two terminals.

3.12.2 POTENTIOMETER

A potentiometer is a manually adjustable resistor. The way this device works is relatively simple. One terminal of the potentiometer is connected to a power source. Another is hooked up to ground (a point with no voltage or resistance and which serves as a neutral reference point), while the third terminal runs across a strip of resistive material. This resistive strip generally has a low resistance at one end; its resistance gradually increases to a maximum resistance at the other end. The third terminal serves as the connection between the power source and ground, and is usually interfaced to the user by means of a knob or lever. The user can adjust the position of the third terminal along the resistive strip in order to manually increase or decrease resistance. By controlling resistance, a potentiometer can determine how much current flow through a circuit. When used to regulate current, the potentiometer is limited by the maximum resistivity of the strip.

The power of this simple device is not to be underestimated. In most analog devices, a potentiometer is what establishes the levels of output. In a loud speaker, for example, a potentiometer directly adjusts volume; in a television monitor, it controls brightness.

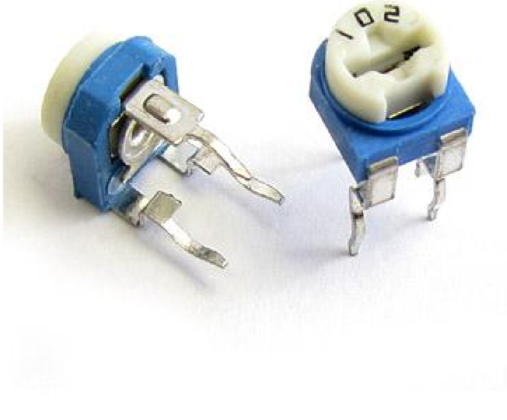


Fig. No: 3.23 Potentiometer

A potentiometer can also be used to control the potential difference, or voltage, across a circuit. The setup involved in utilizing a potentiometer for this purpose is a little bit more complicated. It involves two circuits: the first circuit consists of a cell and a resistor. At one end, the cell is connected in series to the second circuit, and at the other end it is connected to a potentiometer in parallel with the second circuit. The potentiometer in this arrangement drops the voltage by an amount equal to the ratio between the resistance allowed by the position of the third terminal and the highest possible resistivity of the strip. In other words, if the knob controlling the resistance is positioned at the exact halfway point on the resistive strip, then the output voltage will drop by exactly fifty percent, no matter how high the potentiometer's input voltage. Unlike with current regulation, voltage regulation is not limited by the maximum resistivity of the strip.

3.13 CAPACITORS

A capacitor or condenser is a passive electronic component consisting of a pair of conductors separated by a dielectric. When a voltage potential difference exists between the conductors, an electric field is present in the dielectric. This field stores energy and produces a mechanical force between the plates. The effect is greatest between wide, flat, parallel, narrowly separated conductors.

Fig. No: 3.24 Capacitors

An ideal capacitor is characterized by a single constant value, capacitance, which is measured in farads. This is the ratio of the electric charge on each conductor to the potential difference between them. In practice, the dielectric between the plates passes a small amount of leakage current. The conductors and leads introduce an equivalent series resistance and the dielectric has an electric field strength limit resulting in a breakdown voltage.

The properties of capacitors in a circuit may determine the resonant frequency and quality factor of a resonant circuit, power dissipation and operating frequency in a digital logic circuit, energy capacity in a high-power system, and many other important aspects.

A capacitor (formerly known as condenser) is a device for storing electric charge. The forms of practical capacitors vary widely, but all contain at least two conductors separated by a non-conductor. Capacitors used as parts of electrical systems, for example, consist of metal foils separated by a layer of insulating film.

Capacitors are widely used in electronic circuits for blocking direct current while allowing alternating current to pass, in filter networks, for smoothing the output of power supplies, in the resonant circuits that tune radios to particular frequencies and for many other purposes.

A capacitor is a passive electronic component consisting of a pair of conductors separated by a dielectric (insulator). When there is a potential difference (voltage) across the conductors, a static electric field develops in the dielectric that stores energy and produces a mechanical force between the conductors. An ideal capacitor is characterized by a single constant value, capacitance, measured in farads. This is the ratio of the electric charge on each conductor to the potential difference between them.

The capacitance is greatest when there is a narrow separation between large areas of conductor hence capacitor conductors are often called "plates", referring to an early means of construction. In practice the dielectric between the plates passes a small amount of leakage current and also has an electric field strength limit, resulting in a breakdown voltage, while the conductors and leads introduce an undesired inductance and resistance.

3.13.1 OPERATION OF CAPACITOR

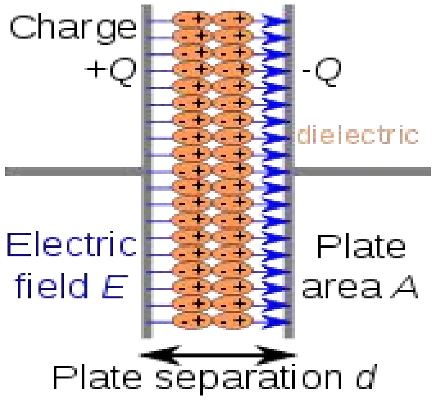


Fig. No: 3.25 Operation of Capacitor

Charge separation in a parallel-plate capacitor causes an internal electric field. A dielectric (orange) reduces the field and increases the capacitance.

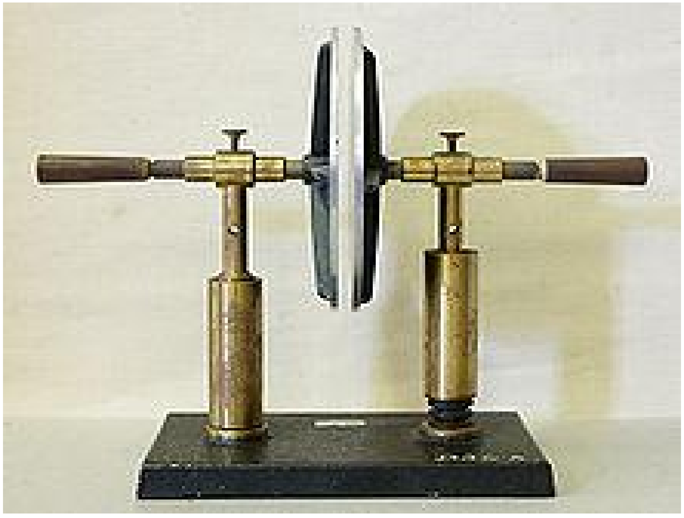


Fig. No: 3.26 Simple capacitor

A simple demonstration of a parallel-plate capacitor. A capacitor consists of two conductors separated by a non-conductive region. The non-conductive region is called the dielectric or sometimes the dielectric medium. In simpler terms, the dielectric is just an electrical insulator. Examples of dielectric mediums are glass, air, paper, vacuum, and even a semiconductor depletion region chemically identical to the conductors. A capacitor is assumed to be self-contained and isolated, with no net electric charge and no influence from any external electric field. The conductors thus hold equal and opposite charges on their facing surfaces, and the dielectric develops an electric field. In SI units, a capacitance of one farad means that one coulomb of charge on each conductor causes a voltage of one volt across the device.

The capacitor is a reasonably general model for electric fields within electric circuits. An ideal capacitor is wholly characterized by a constant capacitance C, defined as the ratio of charge ±Q on each conductor to the voltage V between them:

$$C = \frac{Q}{V} \qquad \text{---------- 3.5}$$

Sometimes charge build-up affects the capacitor mechanically, causing its capacitance to vary. In this case, capacitance is defined in terms of incremental changes:

$$C = \frac{\mathrm{d}q}{\mathrm{d}v} \qquad \text{---------- 3.6}$$

3.13.2 ENERGY STORAGE

Work must be done by an external influence to "move" charge between the conductors in a capacitor. When the external influence is removed the charge separation persists in the electric field and energy is stored to be released when the charge is allowed to return to its equilibrium position. The work done in establishing the electric field, and hence the amount of energy stored, is given by:

$$W = \int_{q=0}^{Q} V\,\mathrm{d}q = \int_{q=0}^{Q} \frac{q}{C}\,\mathrm{d}q = \frac{1}{2}\frac{Q^2}{C} = \frac{1}{2}CV^2 = \frac{1}{2}VQ. \qquad \text{---------- 3.7}$$

Current-voltage relation

The current i(t) through any component in an electric circuit is defined as the rate of flow of a charge q(t) passing through it, but actual charges, electrons, cannot pass through the dielectric layer of a capacitor, rather an electron accumulates on the negative plate for each one that leaves the positive plate, resulting in an electron depletion and consequent positive charge on one electrode that is equal and opposite to the accumulated negative charge on the other. Thus the charge on the electrodes is equal to the integral of the current as well as proportional to the voltage as discussed above. As with any anti-derivative, a constant of integration is added to represent the initial voltage v (t_0). This is the integral form of the capacitor equation,

$$v(t) = \frac{q(t)}{C} = \frac{1}{C}\int_{t_0}^{t} i(\tau)\mathrm{d}\tau + v(t_0)\quad .$$ ---------- 3.8

Taking the derivative of this, and multiplying by C, yields the derivative form,

$$i(t) = \frac{\mathrm{d}q(t)}{\mathrm{d}t} = C\frac{\mathrm{d}v(t)}{\mathrm{d}t}\quad .$$ ---------- 3.9

The dual of the capacitor is the inductor, which stores energy in the magnetic field rather than the electric field. Its current-voltage relation is obtained by exchanging current and voltage in the capacitor equations and replacing C with the inductance L.

RESULT

The result of this project is discussed by the three single phase transformers are connected in the system to change the level of input voltage to run the circuit i.e., stepping the level of voltage to 12v. Here the rectifier circuit is used to convert the ac voltage to the dc voltage. The filter circuit is used to filter the harmonics which are presented in the circuit which are forms by converting the voltage from ac to dc. Thus here we used the voltage regulator to maintain the constant voltage throughout the operation where we needed. Here the logic gates are used to send the logic outputs to the relay driver circuit. Here we used two logic gates those are not gate & and gate. The relay driver circuit is used to perform the inverter operation and gives the output either high or low thus the based on the input. Thus the output is connected to the relays. Thus the relay will operates when the input is low to the R-phase relay will be in the on state and the output is fed through the R-phase. When the input of the relay is high then the relay is in off state then it will shift the load to the available phase i.e., Y-phase or B-phase. The output of the project is shown below:

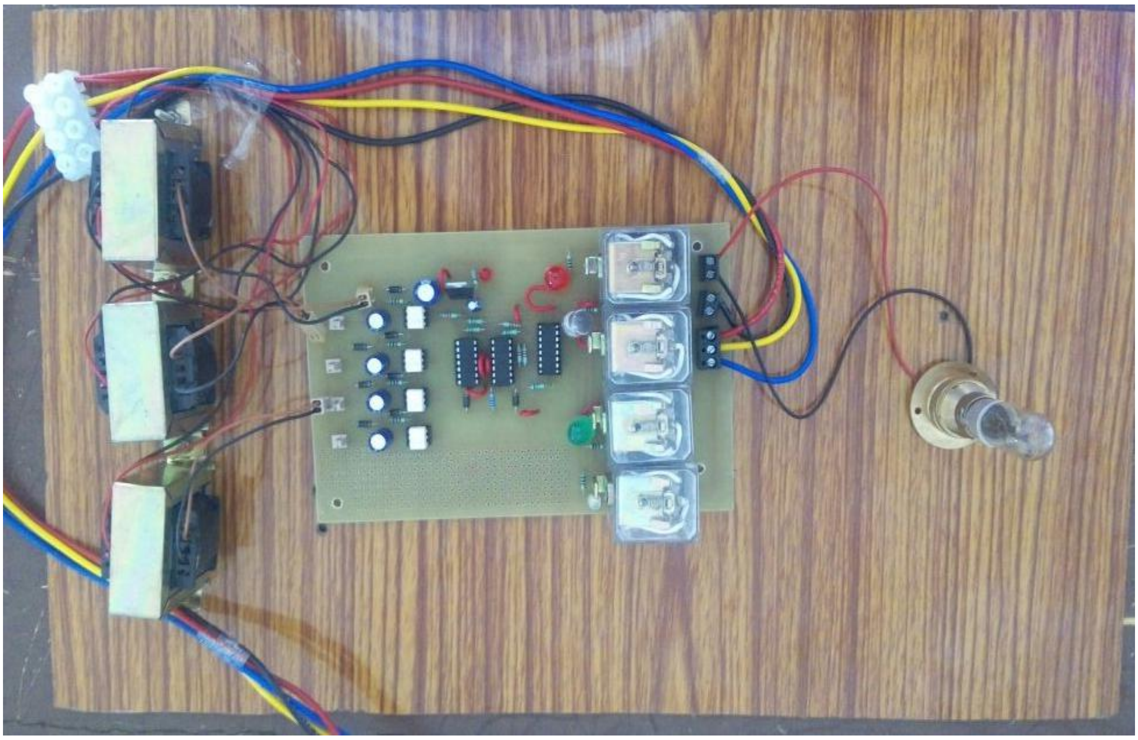


Fig. No: 4.1 Prototype

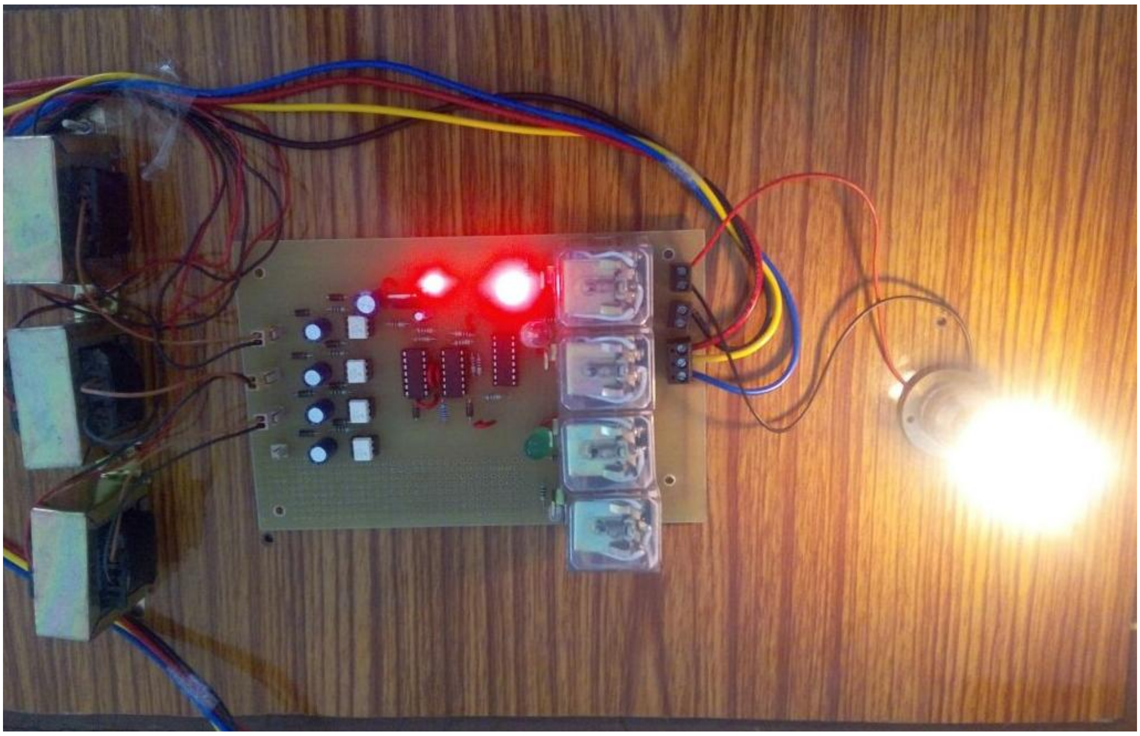


Fig. No: 4.2 When R-Phase is active

During healthy condition the loads which are connected0 to the line are operated on R-Phase supply.

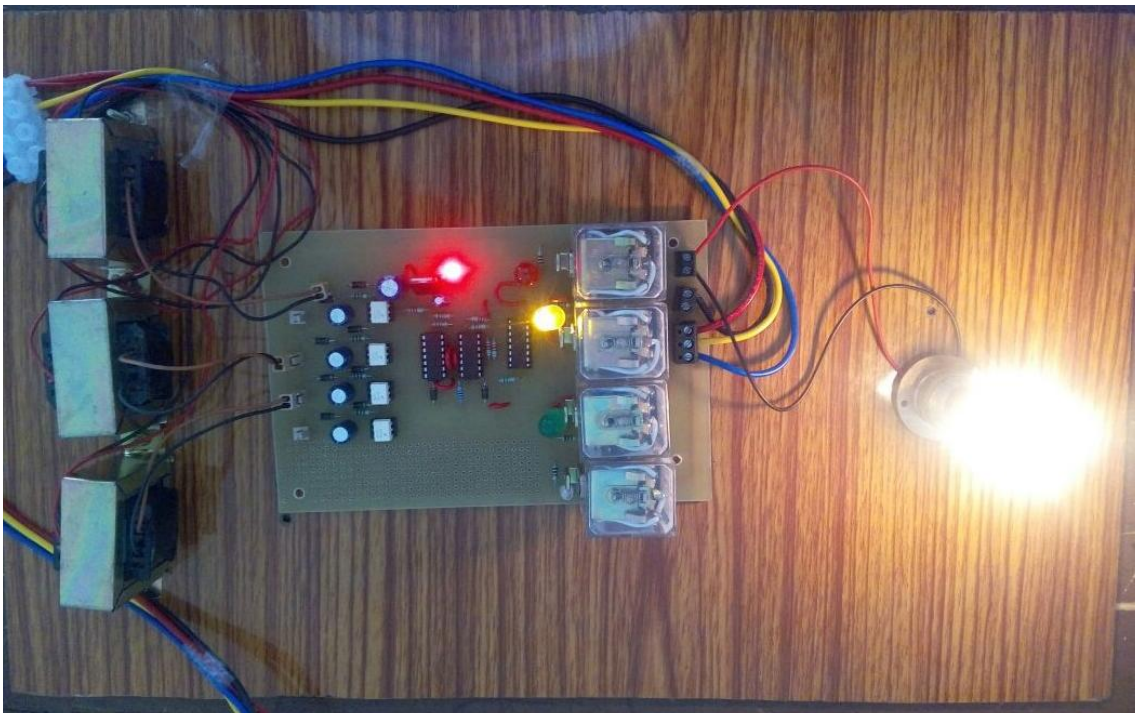


Fig. No: 4.3 When Y-Phase is active

During fault occurs in the R-Phase then the loads are shifted to the Y-Phase automatically by means of the relay driver IC and the load is operated by the Y-Phase during this condition.

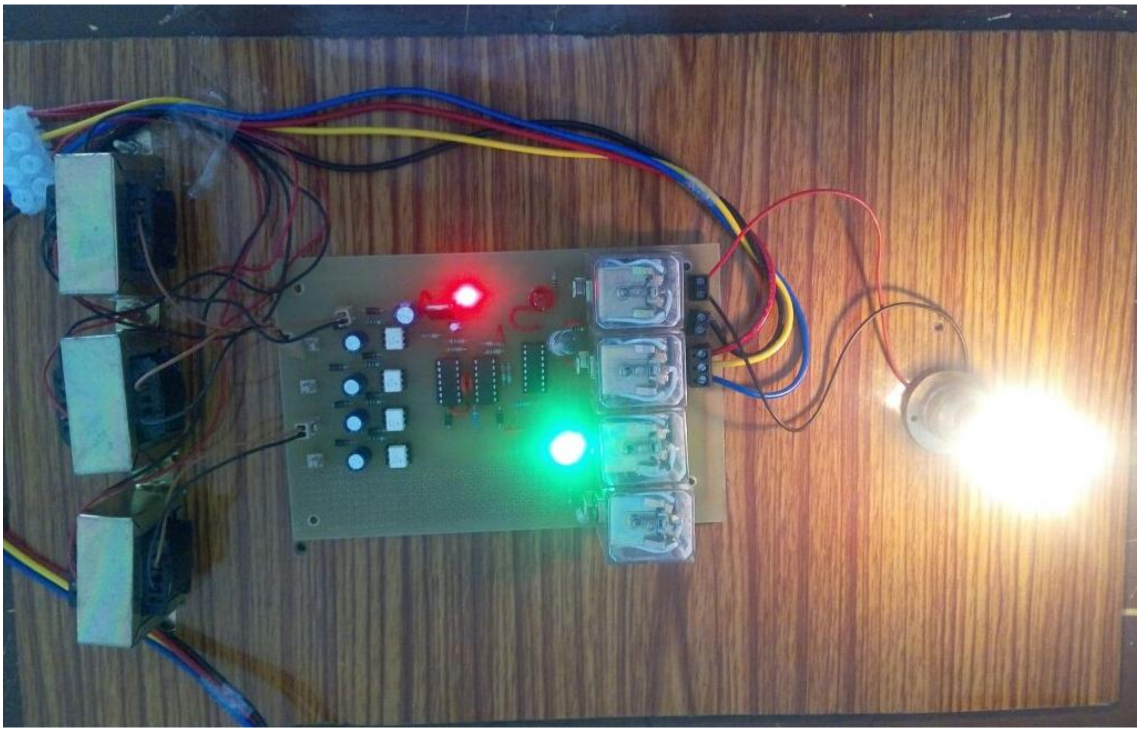


Fig. No: 4.4 When B-Phase is active

When R-Phase and the Y-Phase both are under the fault condition then the load is operated by using the B-Phase supply.

Finally there is the continuous of the supply to the single phase loads by connecting them to the three phase supply when in any case one of the phase is under the fault condition then the load is shifted to the another phase automatically by the help of relay driver IC and the selection of the phases are in the order R-Phase is first and then next it will chooses the availability of Y-Phase if the Y-Phase is also under the fault condition then it will chooses the B-Phase simultaneously.

CONCLUSION AND FUTURE SCOPE

CONCLUSION

This project "Available Phase Selection in a Given Three Phase Supply System" is successfully tested and implemented which is best economical, affordable energy solution to the common people. We aimed that to shift the load to the available phase in the given three phase supply system to get the continuous supply of the load. In this project that is obtained by the relays and those are controlled by the relay driver IC. Finally we obtained the result when any one of the phase is under the fault condition of the given supply then the load is automatically shifted to the available phase in a given three phase supply system.

FUTURE SCOPE

This project in future enhanced by incorporating power semiconductor devices such as SCR/IGBT for instantaneous changeover to the next available phase. This overcomes the drawback of the changeover time greatly witnessed by the relay switching operations.

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