PROJECT REPORT ON

# "GYRATION OF DYNAMIC ENERGY USING FLYWHEEL"

Project report submitted in partial fulfillment of the degree of

**BACHELOR OF ENGINEERING**

BY

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SCHOOL OF ENGINEERING & TECHNOLOGY, NEW PANVEL

(Affiliated to University of Mumbai)

FOR

ACADEMIC YEAR **2016-17**

REPORT OF PROJECT WORK

# GYRATION OF DYNAMIC ENERGY USING FLYWHEEL

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# CERTIFICATE

Certified that the project report entitled **"GYRATION OF DYNAMIC ENERGY USING FLYWHEEL"** is a bonafied work done under my guidance by

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During the academic year **2016-17** in partial fulfillment of the requirements for the award of degree of **Bachelor of Engineering in Electrical Engineering** from **University of Mumbai.**

Date-

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## DECLARATION

I declare that this written submission represents my ideas in my own words and where others ideas or words have been included, I have adequately cited and referenced the original sources. I also declared that I have adhered to all principles of academic honesty and integrity and have not represented or fabricated or falsified any idea/data/fact/source in my submission. I understand that any violation of the above will be cause for disciplinary action by the Institute and can also evoke penal action from the sources which have thus not been properly cited or from whom proper permission have not been taken when needed.

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# ACKNOWLEDGEMENT

Among the wide panorama of people who provided us help and motivation to complete our project, we are grateful in presenting to you the rare shades oftechnology by documenting project “**GYRATION OF DYNAMIC ENERGY USING FLYWHEEL**”.

We wish to express our deep sense of gratitude to our **DIRECTOR DR. ABDULRAZAK HONNUTAGI** for providing us the facilities to bring this project a success.

We acknowledge our HOD**, Prof. SYED KALIM**, for providing us his guidance from time to time. His encouragement proved to be a boon in the path of our achievement.

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Last but not the least we also thank our lab technicians and all the non-teaching staff.

## ABSTRACT

Energy storage is a crucial condition for both transportation purposes and for the use of electricity. Flywheels can be used as actual energy storage but also as power handling device. Their high power capacity compared to other means of storing electric energy makes them very convenient for smoothing power transients. These occur frequently in vehicles but also in the electric grid. In both these areas there is a lot to gain by reducing the power transients and irregularities.

The research conducted at Uppsala university and described in this thesis is focused on an all-electric propulsion system based on an electric flywheel with double stator windings. The flywheel is inserted in between the main energy storage (assumed to be a battery) and the traction motor in an electric vehicle. This system has been evaluated by simulations in a Matlab model, comparing two otherwise identical drivelines, one with and one without a flywheel.

The flywheel is shown to have several advantages for an all-electric propulsion system for a vehicle. The maximum power from the battery decreases more than ten times as the flywheel absorbs and supplies all the high power fluxes occuring at acceleration and braking. The battery delivers a low and almost constant power to the flywheel. The amount of batteries needed decreases whereas the battery lifetime and efficiency increases. Another benefit the flywheel configuration brings is a higher energy efficiency and hence less need for cooling.

The model has also been used to evaluate the flywheel functionality for an electric grid application. The power from renewable intermittent energy sources such as wave, wind and current power can be smoothened by the flywheel, making these energy sources more efficient and thereby competitive with a remaining high power quality in the electric grid.

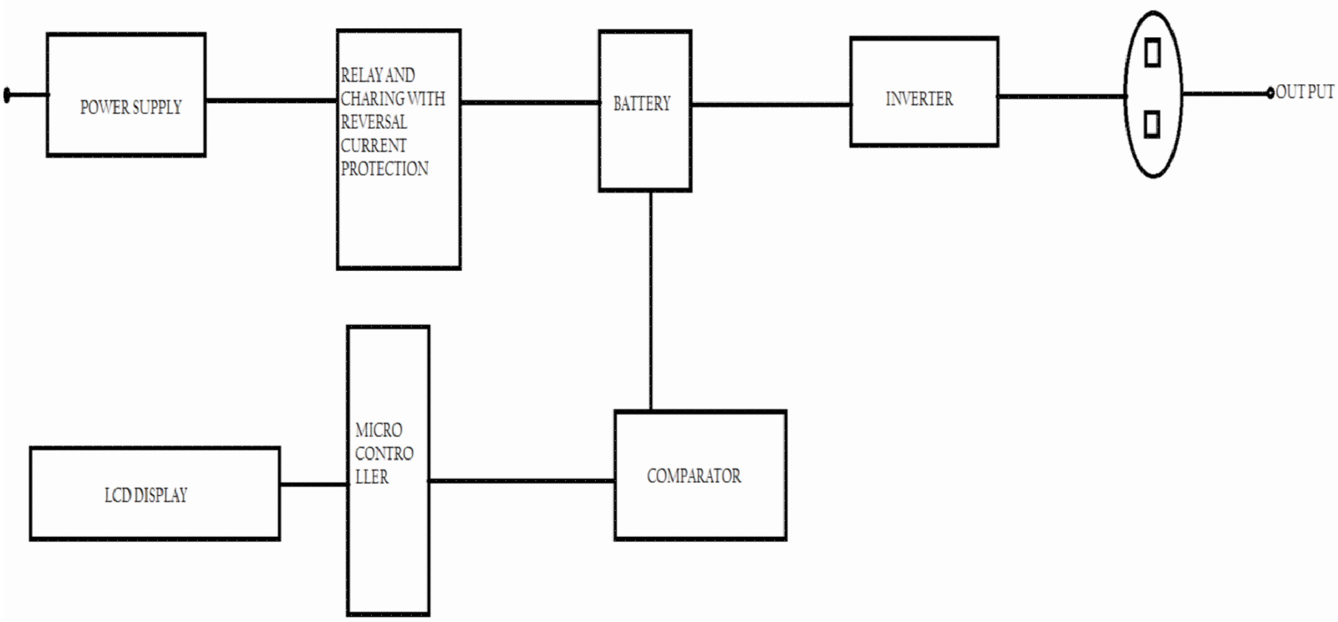
# INTRODUCTION

Several of humanity's great challenges are related to transportation and electricity generation. Energy storage is vital for both these sectors. It is crucial for vehicles to be able to go long distances non-stop, and for the electric grid to make it possible to supply, at every instant of time, exactly the amount of electricity demanded by millions of users connected to the grid.

The environmental problems associated with these sectors are unfortunately severe. The delicate conditions for life that all flora and fauna slowly and continuously adapt to are threatened by immense emissions of carbon that has been out of the natural carbon cycle for millions of years [1], nitrogen that the engine of a vehicle or the combustion chamber of a coal power plant transforms from stable and non-reactive $N_2$, inaccessible to most natural processes, to the reactive forms $N_2O$ or $NO_2$ [2] and a variety of numerous small particles created in the combustion process about whose impact on environment and health we now little or nothing. Additionally oil, the fuel driving the transportation sector, is running out .

Effective energy storage is a way to drastically reduce many of the negative impacts of transportation and electricity generation. Flywheels can have a great importance in both these sectors, providing an opportunity to store energy and thereby smoothen the power. Both the transportation and the energy sectors are huge - not to say the least. Thus, there is a huge economic impact potential and at the same time the possibility of making the world a little better place.

1.1 Block Diagram :




1. Power supply
2. Relay
3. Battery
4. Inverter and Out put
5. Comparator
6. Micro controller
7. Display

**1.1.1Power supply :**

In this project circuits, sensors & motor are used which require +12V & +5V(DC)supply, to fulfill this requirement we have used following circuit of power supply which provides regulated +12V & +5V.(DC)

**1.1.2 Relay :**

Relays driver is used to switch ON or OFF the RELAY. IC555 will send data to the base of transistor. If base of transistor is at zero volts then transistor is off and relay is in de-energized condition. Therefore NO contact remains NO.

If base of transistor is at +5 volts then transistor is ON and current flows through transistor as well as relay. Therefore relay is in energized condition. Therefore NO contact will become NC.

### 1.1.3 Battery:

We are using 12V, 4.5AH battery to store the energy. This battery is used to deliver the current to output .

### 1.1.4 Inverter:

Inverter is used to convert 12VDC into 230V ac. In this we are using IC CD4047 and MOSFET. IC CD4047 is free running astable multi vibrator. The transformer used is 12-0-12 Volts and 5 Amp.

### 1.1.5 Comparator :

A comparator is a device that compares two voltages or currents and outputs a digital signal indicating which is larger. It has two analog input terminals and and one binary digital output . The output is ideally.

### 1.1.6 Micro controller :

The AT89S52 is a low-power, high-performance CMOS 8-bit microcontroller with 8K bytes of in-system programmable Flash memory.
The on-chip Flash allows the program memory to be reprogrammed in-system or by a conventional non volatile memory programmer.

### 1.1.7LCD display :

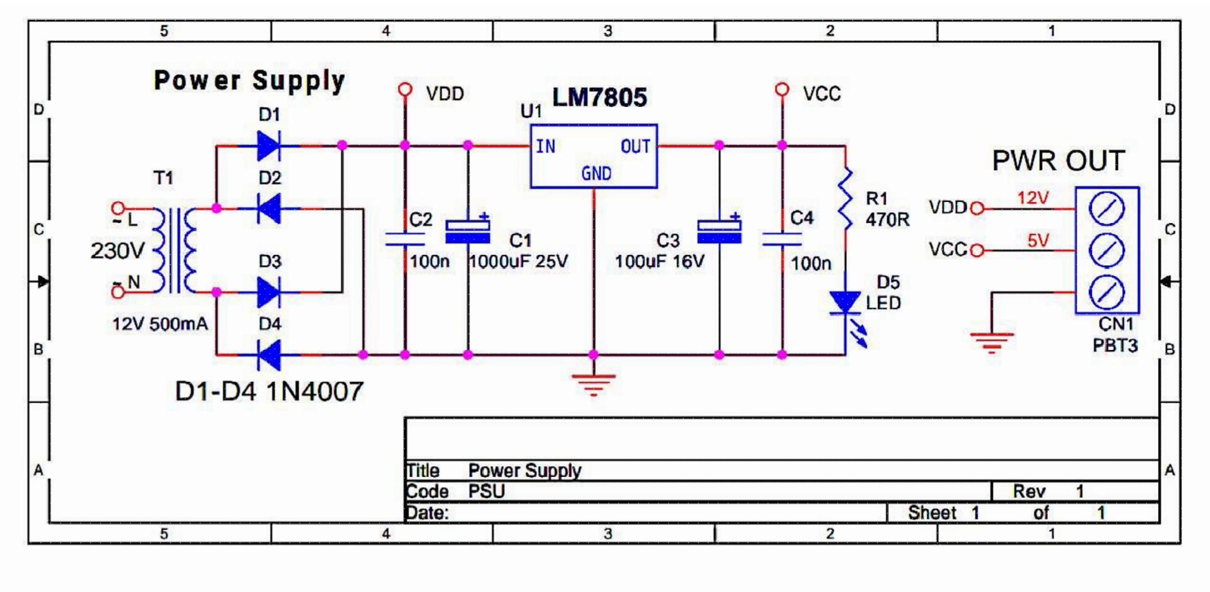
A liquid-crystal display (LCD) is a flat-panel display or other electronically modulated optical device that uses the light-modulating properties of liquid crystals.
Liquid crystals do not emit light directly, instead using a backlight or reflector to produce images in color or monochrome.

# POWER SUPPLY

A **power supply** is an electronic device that supplieselectric energyto anelectrical load. The primary function of a power supply is to convert one form of electrical energy to and, as a result, power supplies are sometimes referred to aselectric power converters. Some power supplies are discrete, stand-alone devices, whereas others are built into larger devices along with their loads. Examples of the latter include power supplies found indesktop computersandconsumer electronicsdevices.

Every power supply must obtain the energy it supplies to its load, as well as any energy it consumes while performing that task, from an energy source. Depending on its design, a power supply may obtain energy from various types of energy sources, including electrical energy transmission systems,energy storagedevices such as abatteriesandfuel cells, electromechanical systems such asgeneratorsandalternators,solar powerconverters, or another power supply.

All power supplies have a *power input*, which receives energy from the energy source, and a *power output* that delivers energy to the load. In most power supplies the power input and output consist ofelectrical connectorsor hardwired circuit connections, though some power supplies employwireless energy transferin lieu of galvanic connections for the power input or output. Some power supplies have other types of inputs and outputs as well, for functions such as external monitoring and control.



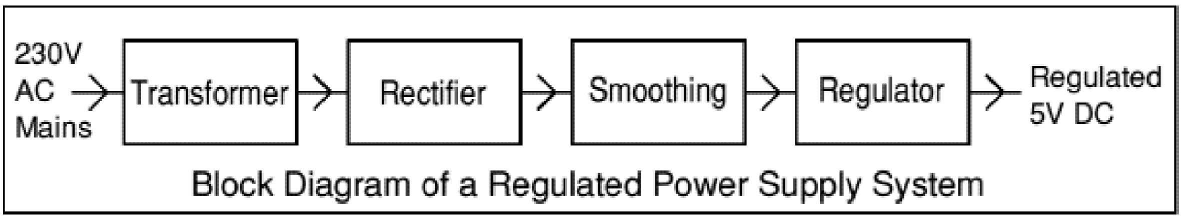

**2.1 WORKING:**

As shown above Transformer (15V/1A) is used to down convert the AC upto 15V.
4 diodes (IN4007) are connected to secondary of transformer in bridge for rectifying AC into DC. Capacitor 1000 mf & 1mf are used as a filter red led shows that rectification and filtering is ok. 7812 IC is used as a 12V regulator it converts 15V into regulated +12V DC YELLOW led shows that output of 7812 is ok.
7805 IC is used as a 5V regulator it converts 12V into regulated +5V DC green led shows that output of 7805 is ok.

## 2.2 Types of Power Supply

There are many types of power supply. Most are designed to convert high voltage AC mains electricity to a suitable low voltage supply for electronics circuits and other devices. A power supply can by broken down into a series of blocks, each of which performs a particular function.

For example a 5V regulated supply:



Block Diagram of a Regulated Power Supply System

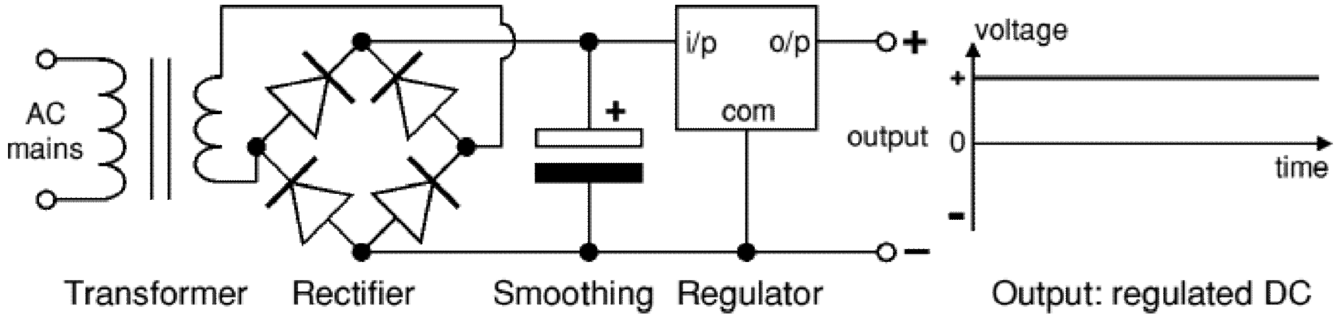
Each of the blocks is described in more detail below:

- Transformer- steps down high voltage AC mains to low voltage AC.
- Rectifier- converts AC to DC, but the DC output is varying.
- Smoothing- smooths the DC from varying greatly to a small ripple.
- Regulator- eliminates ripple by setting DC output to a fixed voltage.

Power supplies made from these blocks are described below with a circuit diagram and a graph of their output:

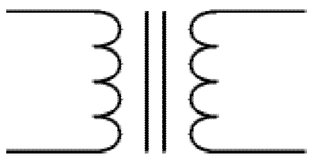
- Transformer only
- Transformer + Rectifier
- Transformer + Rectifier + Smoothing
- Transformer + Rectifier + Smoothing + Regulator

## 2.1 Transformer + Rectifier + Smoothing + Regulator




The **regulated DC** output is very smooth with no ripple. It is suitable for all electronic circuits.

## 2.3 Transformer



Transformer circuit symbol

Transformers convert AC electricity from one voltage to another with little loss of power. Transformers work only with AC and this is one of the reasons why mains electricity is AC.

Step-up transformers increase voltage, step-down transformers reduce voltage. Most power supplies use a step-down transformer to reduce the dangerously high mains voltage (230V in UK) to a safer low voltage.

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.

Transformers waste very little power so the power out is (almost) equal to the power in. Note that as voltage is stepped down current is stepped up.

The ratio of the number of turns on each coil, called the **turns ratio**, determines the ratio of the voltages. A step-down transformer has a large number of turns on its primary (input) coil which is connected to the high voltage mains supply, and a small number of turns on its secondary (output) coil to give a low output voltage.

| | | | | | |
|---|---|---|---|---|---|
| turns ratio = | Vp | = | Np | and | power out = power in |
| | Vs | | Ns | | Vs × Is = Vp × Ip |

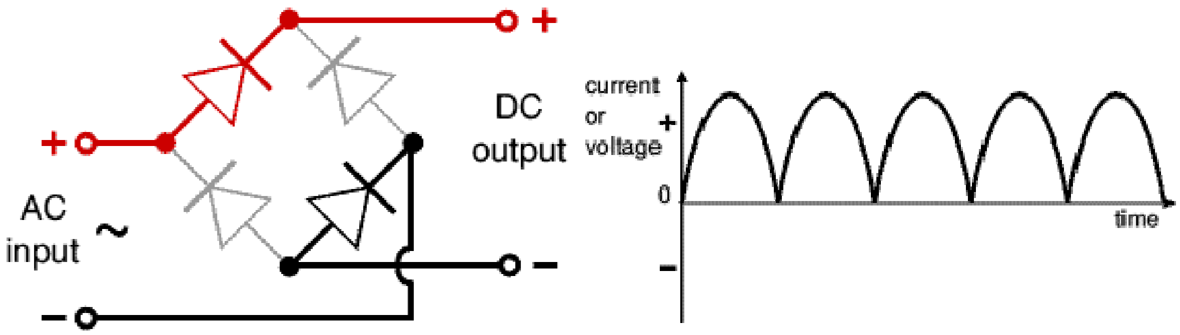
Vp = primary (input) voltage Vs = secondary (output) voltage
Np = number of turns on primary coil Ns = number of turns on secondary coil Ip = primary (input) current Is = secondary (output) current

**2.4 Rectifier**

There are several ways of connecting diodes to make a rectifier to convert AC to DC. The bridge rectifier is the most important and it produces **full-wave** varying DC. A full-wave rectifier can also be made from just two diodes if a centre-tap transformer is used, but this method is rarely used now that diodes are cheaper. A single diode can be used as a rectifier but it only uses the positive (+) parts of the AC wave to produce **half-wave** varying DC.

## 2.1.2 Bridge rectifier

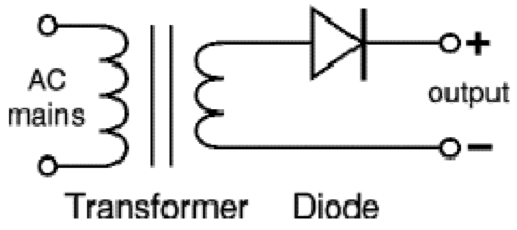
A bridge rectifier can be made using four individual diodes, but it is also available in special packages containing the four diodes required. It is called a full-wave rectifier because it uses all the AC wave (both positive and negative sections). 1.4V is used up in the bridge rectifier because each diode uses 0.7V when conducting and there are always two diodes conducting, as shown in the diagram below. The maximum current they can pass rates bridge rectifiers and the maximum reverse voltage they can withstand (this must be at least three times the supply RMS voltage so the rectifier can withstand the peak voltages). Please see the Diodes page for more details, including pictures of bridge rectifiers.



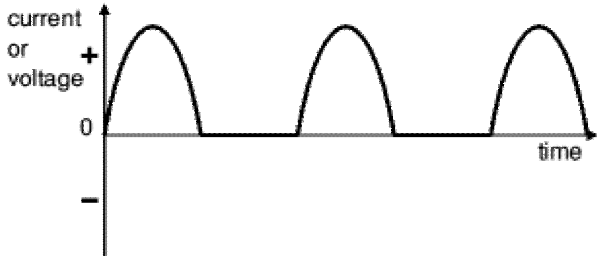

**Bridge rectifier** **Output: full-wave varying DC**
Alternate pairs of diodes conduct, changing over the connections so the alternating directions of AC are converted to the one direction of DC. (using all the AC wave)

## 2.5 Single diode rectifier

A single diode can be used as a rectifier but this produces **half-wave** varying DC which has gaps when the AC is negative. It is hard to smooth this sufficiently well to supply electronic circuits unless they require a very small current so the smoothing capacitor does not significantly discharge during the gaps. Please see the Diodespage for some examples of rectifier diodes.




**Single diode rectifier**

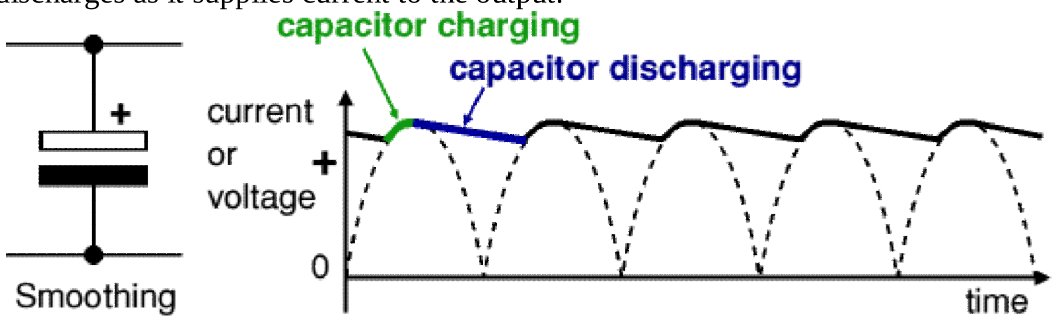



**Output: half-wave varying DC**

( using only half the AC wave )

## 2.6 Smoothing

Smoothing is performed by a large value electrolytic capacitor connected across the DC supply to act as a reservoir, supplying current to the output when the varying DC voltage from the rectifier is falling. The diagram shows the unsmoothed varying DC (dotted line) and the smoothed DC (solid line). The capacitor charges quickly near the peak of the varying DC, and then discharges as it supplies current to the output.



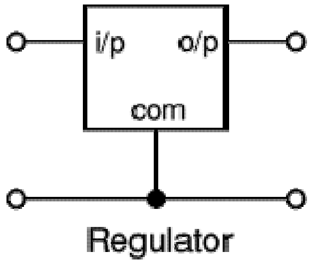

Note that smoothing significantly increases the average DC voltage to almost the peak value (1.4 × RMSvalue). For example 6V RMS AC is rectified to full wave DC of about 4.6V RMS (1.4V is lost in the bridge rectifier), with smoothing this increases to almost the peak value giving 1.4 × 4.6 = 6.4V smooth DC.

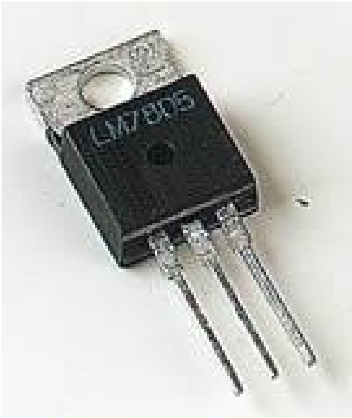
Smoothing is not perfect due to the capacitor voltage falling a little as it discharges, giving a small **ripple voltage**. For many circuits a ripple which is 10% of the supply voltage is satisfactory and the equation below gives the required value for the smoothing capacitor. A larger capacitor will give less ripple. The capacitor value must be doubled when smoothing half-wave DC.

Smoothing capacitor for 10% ripple, $C = \frac{5 \times Io}{Vs \times f}$

C = smoothing capacitance in farads (F)
Io = output current from the supply in amps (A)
Vs = supply voltage in volts (V), this is the peak value of the unsmoothed DC
f = frequency of the AC supply in hertz (Hz), 50Hz in the UK Regulator

Voltage regulator ICs are available with fixed (typically 5, 12 and 15V) or variable output voltages. They are also rated by the maximum current they can pass. Negative voltage regulators are available, mainly for use in dual supplies. Most regulators include some automatic protection from excessive current ('overload protection') and overheating ('thermal protection').




Many of the fixed voltage regulator ICs

have 3 leads and look like power transistors, such as the 7805 +5V 1A regulator shown on the right. They include a hole for attaching a heatsink if necessary.

## Electrical Relay

Thus far we have seen a selection of *Input* devices that can be used to detect or "sense" a variety o f physical variables and signals and are therefore called **Sensors**.

But there are also a variety of electrical and electronic devices which are classed as *Output* devices used to control or operate some external physical process. These output devices are commonly called **Actuators**.

Actuators convert an electrical signal into a corresponding physical quantity such as movement, force, sound etc. An actuator is also classed as a transducer because it changes one type of physical quantity into another and is usually activated or operated by a low voltage command signal. Actuators can be classed as either binary or continuous devices based upon the number of stable states their output has.

For example, a relay is a binary actuator as it has two stable states, either energised and latched or de-energised and unlatched, while a motor is a continuous actuator because it can rotate through a full $360^{o}$ motion. The most common types of actuators or output devices are **Electrical Relays**, **Lights**, **Motors** and **Loudspeakers**.

We saw previously that solenoids can be used to electrically open latches, doors, open or close valves, and in a variety of robotic and mechatronic applications, etc. However, if the solenoid plunger is used to operate one or more sets of electrical contacts, we have a device called a *relay* that is so useful it can be used in an infinite number of different ways and in this tutorial we will look at Electrical Relays.

**Electrical Relays** can also be divided into mechanical action relays called "Electromechanical Relays" and those which use semiconductor transistors, thyristors, triacs, etc, as their switching device called "Solid State Relays" or SSR's.

## 3.1 The Electromechanical Relay

The term **Relay** generally refers to a device that provides an electrical connection between two or more points in response to the application of a control signal. The most common and widely used type of electrical relay is the electromechanical relay or EMR.

An Electrical Relay

The most fundamental control of any equipment is the ability to turn it "ON" and "OFF". The easiest way to do this is using switches to interrupt the electrical supply. Although switches can be used to control something, they have their disadvantages. The biggest one is that they have to be manually (physically) turned "ON" or "OFF". Also, they are relatively large, slow and only switch small electrical currents.

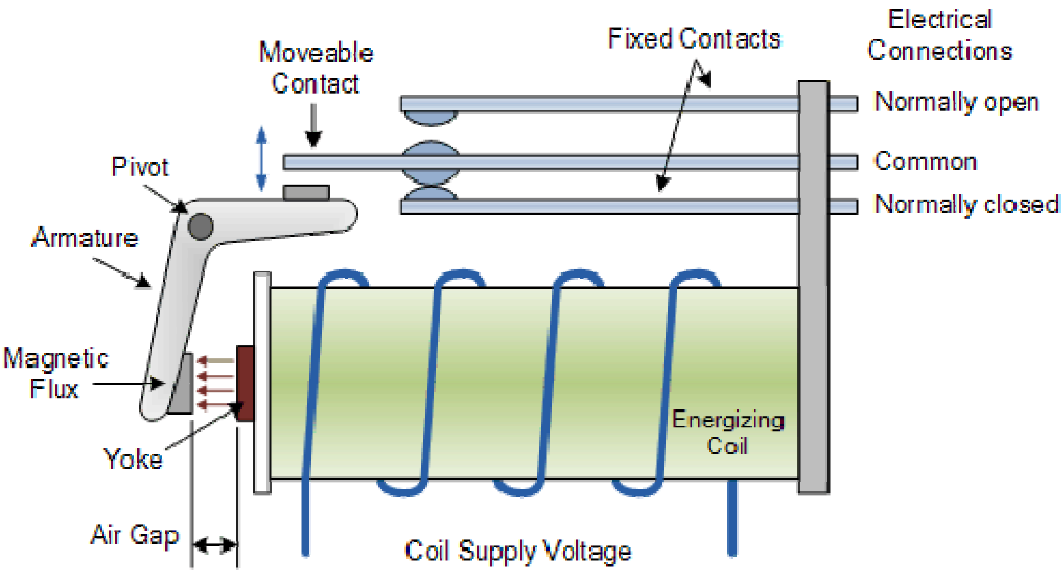
**Electrical Relays** however, are basically electrically operated switches that come in many shapes, sizes and power ratings suitable for all types of applications. Relays can also have single or multiple contacts within a single package with the larger power relays used for mains voltage or high current switching applications being called "Contactors".

In this tutorial about electrical relays we are just concerned with the fundamental operating principles of "light duty" electromechanical relays we can use in motor control or robotic circuits. Such relays are used in general electrical and electronic control or switching circuits either mounted directly onto PCB boards or connected free standing and in which the load currents are normally fractions of an ampere up to 20+ amperes. The relay circuit are common in Electronics applications.

As their name implies, electromechanical relays are *electro-magnetic* devices that convert a magnetic flux generated by the application of a low voltage electrical control signal either AC or DC across the relay terminals, into a pulling mechanical force which operates the electrical contacts within the relay. The most common form of electromechanical relay consist of an energizing coil called the "primary circuit" wound around a permeable iron core.

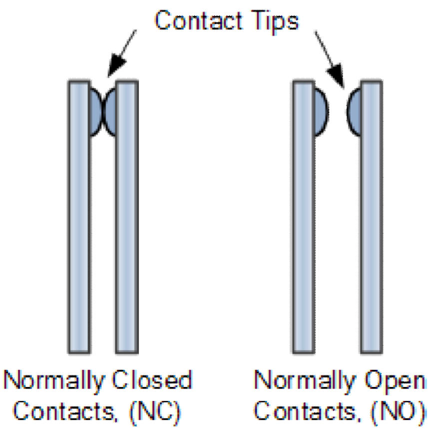
This iron core has both a fixed portion called the yoke, and a moveable spring loaded part called the armature, that completes the magnetic field circuit by closing the air gap between the fixed electrical coil and the moveable armature. The armature is hinged or pivoted allowing it to freely move within the generated magnetic field closing the electrical contacts that are attached to it. Connected between the yoke and armature is normally a spring (or springs) for the return stroke to "reset" the contacts back to their initial rest position when the relay coil is in the "de-energized" condition, i.e. turned "OFF".

## 3.2 Electromechanical Relay Construction




In our simple relay above, we have two sets of electrically conductive contacts. Relays may be "Normally Open", or "Normally Closed". One pair of contacts are classed as **Normally Open, (NO)** or make contacts and another set which are classed as **Normally Closed, (NC)** or break contacts. In the normally open position, the contacts are closed only when the field current is "ON" and the switch contacts are pulled towards the inductive coil.

In the normally closed position, the contacts are permanently closed when the field current is "OFF" as the switch contacts return to their normal position. These terms *Normally Open, Normally Closed* or *Make and Break Contacts* refer to the state of the electrical contacts when the relay coil is "de-energized", i.e, no supply voltage connected to the relay coil. Contact elements may be of single or double make or break designs. An example of this arrangement is given below.




The relays contacts are electrically conductive pieces of metal which touch together completing a circuit and allow the circuit current to flow, just like a switch. When the contacts are open the resistance between the contacts is very high in the Mega-Ohms, producing an open circuit condition and no circuit current flows.

When the contacts are closed the contact resistance should be zero, a short circuit, but this is not always the case. All relay contacts have a certain amount of “contact resistance” when they are closed and this is called the “On-Resistance”, similar to FET’s.

With a new relay and contacts this ON-resistance will be very small, generally less than 0.2Ω’s because the tips are new and clean, but over time the tip resistance will increase.

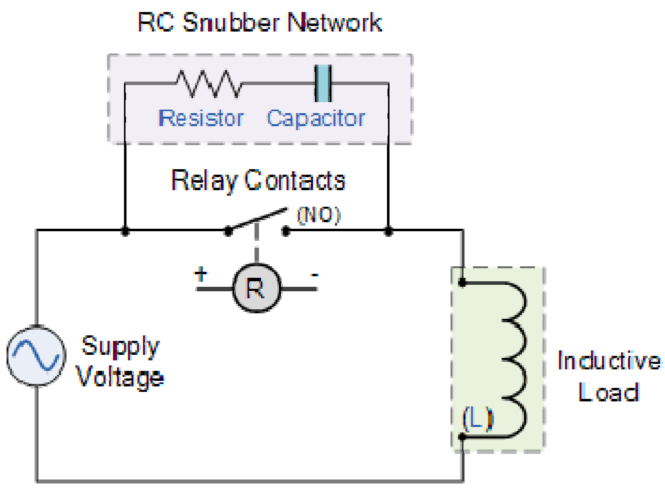
For example. If the contacts are passing a load current of say 10A, then the voltage drop across the contacts using Ohms law is 0.2 x 10 = 2 volts, which if the supply voltage is say 12 volts then the load voltage will be only 10 volts (12 – 2). As the contact tips begin to wear, and if they are not properly protected from high inductive or capacitive loads, they will start to show signs of arcing damage as the circuit current still wants to flow as the contacts begin to open when the relay coil is de-energized.

This arcing or sparking across the contacts will cause the contact resistance of the tips to increase further as the contact tips become damaged. If allowed to continue the contact tips may become so burnt and damaged to the point were they are physically closed but do not pass any or very little current.

If this arcing damage becomes to severe the contacts will eventually “weld” together producing a short circuit condition and possible damage to the circuit they are controlling. If now the contact resistance has increased due to arcing to say 1Ω’s the volt drop across the contacts for the same load current increases to 1 x 10 = 10 volts dc. This high voltage drop across the contacts may be unacceptable for the load circuit especially if operating at 12 or even 24 volts, then the faulty relay will have to be replaced.

To reduce the effects of contact arcing and high “On-resistances”, modern contact tips are made of, or coated with, a variety of silver based alloys to extend their life span as given in the following table.

## 3.3 Electrical Relay Snubber Circuit




### Electrical Relay Contact Types.

As well as the standard descriptions of Normally Open, (NO) and Normally Closed, (NC) used to describe how the relays contacts are connected, relay contact arrangements can also be classed by their actions. Electrical relays can be made up of one or more individual switch contacts with each “contact” being referred to as a “pole”. Each one of these contacts or poles can be connected or “*thrown*” together by energizing the relays coil and this gives rise to the description of the contact types as being:

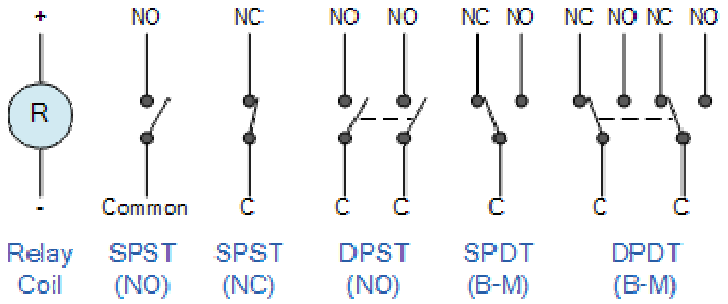
- SPST – Single Pole Single Throw
- SPDT – Single Pole Double Throw
- DPST – Double Pole Single Throw
- DPDT – Double Pole Double Throw

with the action of the contacts being described as “**Make**” (**M**) or “**Break**” (**B**). Then a simple relay with one set of contacts as shown above can have a contact description of:

“Single Pole Double Throw – (Break before Make)”, or SPDT – (B-M)

Examples of just some of the more common diagrams used for electrical relay contact types to identify relays in circuit or schematic diagrams is given below but there are many more possible configurations.

## 3.4 Electrical Relay Contact Configurations




- C is the Common terminal
- NO is the Normally Open contact
- NC is the Normally Closed contact

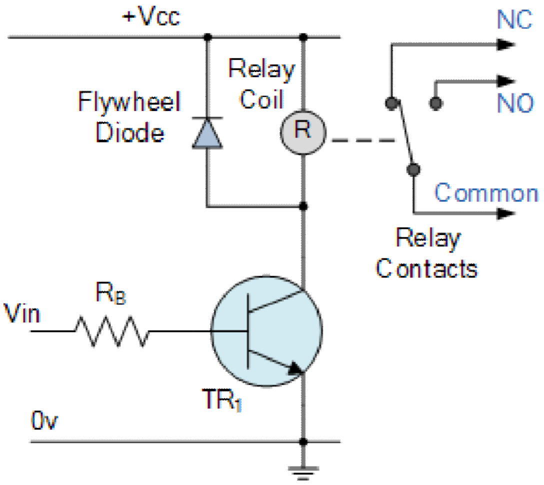
Electromechanical relays are also denoted by the combinations of their contacts or switching elements and the number of contacts combined within a single relay. For example, a contact which is normally open in the de-energised position of the relay is called a “Form A contact” or make contact. Whereas a contact which is normally closed in the de-energised position of the relay is called a “Form B contact” or break contact.

When both a make and a break set of contact elements are present at the same time so that the two contacts are electrically connected to produce a common point (identified by three connections), the set of contacts are referred to as “Form C contacts” or change-over contacts. If no electrical connection exists between the make and break contacts it is referred to as a double change-over contact.

One final point to remember about using electrical relays. It is not advisable at all to connect relay contacts in parallel to handle higher load currents. For example, never attempt to supply a 10A load with two relay contacts in parallel that have 5A contact ratings each, as the mechanically operated relay contacts never close or open at exactly the same instant of time. The result is that one of the contacts will always be overloaded even for a brief instant resulting in premature failure of the relay over time.

Also, while electrical relays can be used to allow low power electronic or computer type circuits to switch relatively high currents or voltages both “ON” or “OFF”. Never mix different load voltages through adjacent contacts within the same relay such as for example, high voltage AC (240v) and low voltage DC (12v), always use separate relays for safety.

One of the more important parts of any electrical relay is its coil. This converts electrical current into an electromagnetic flux which is used to mechanically operate the relays contacts. The main problem with relay coils is that they are “highly inductive loads” as they are made from coils of wire. As the current flows through the coil a self induced magnetic field is generated around it. When the current in the coil is turned “OFF”, a large back emf (electromotive force) voltage is produced as the magnetic flux collapses within the coil (transformer theory). This induced reverse voltage value may be very high in comparison to the switching voltage, and may damage any semiconductor device such as a transistor, FET or micro-controller used to operate the relay coil.




One way of preventing damage to the transistor or any switching semiconductor device, is to connect a reverse biased diode across the relay coil.

When the current flowing through the coil is switched “OFF”, an induced back emf is generated as the magnetic flux collapses in the coil.

This reverse voltage forward biases the diode which conducts and dissipates the stored energy preventing any damage to the semiconductor transistor.

When used in this type of application the diode is generally known as a **Flywheel Diode**, **Free-wheeling Diode** and even **Fly-back Diode**, but they all mean the same thing. Other types of inductive loads which require a flywheel diode for protection are solenoids, motors and inductive coils.

As well as using flywheel Diodes for protection of semiconductor components, other devices used for protection include **RC Snubber Networks**, **Metal Oxide Varistors** or **MOV** and **Zener Diodes**.

# BATTERY

An electric **battery** is a device consisting of one or more An electric **battery** is a device consisting of one or moreelectrochemical cellswith external connections provided to power electrical devices such asflashlights,smartphones, andelectric cars.[1]When a battery is supplyingelectric power, its positive terminal is thecathodeand its negative terminal is theanode.[2]The terminal marked negative is the source of electrons that when connected to an external circuit will flow and deliver energy to an external device. When a battery is connected to an external circuit,electrolytesare able to move as ions within, allowing the chemical reactions to be completed at the separate terminals and so deliver energy to the external circuit. It is the movement of those ions within the battery which allows current to flow out of the battery to perform work.[3]Historically the term "battery" specifically referred to a device composed of multiple cells, however the usage has evolved to additionally include devices composed of a single cell.[4]

Primary(single-use or "disposable") batteries are used once and discarded; theelectrodematerials are irreversibly changed during discharge. Common examples are thealkaline batteryused forflashlightsand a multitude of portable electronic devices.Secondary (rechargeable) batteriescan be discharged and recharged multiple times usingmains powerfrom a wall socket; the original composition of the electrodes can be restored by reverse current. Examples include thelead-acid batteriesused in vehicles andlithium-ionbatteries used for portable electronics such aslaptopsandsmartphones.

Batteries come in many shapes and sizes, from miniature cells used to powerhearing aidsand wristwatches to small, thin cells used insmartphones, to largelead acid batteriesused in cars and trucks, and at the largest extreme, huge battery banks the size of rooms that provide standby or emergency power fortelephone exchangesand computerdata centers.

Batteries have much lowerspecific energy(energy per unit mass) than commonfuelssuch as gasoline. This is somewhat offset by the higher efficiency of electric motors in producing mechanical work, compared to combustion engines.

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## 4.1 Principle of operation

Batteries convert chemical energy directly to electrical energy. A battery consists of some number of voltaic cells. Each cell consists of twohalf-cellsconnected in series by a conductive electrolyte containing anions and cations. One half-cell includes electrolyte and the negative electrode, the electrode to whichanions(negatively charged ions) migrate; the other half-cell includes electrolyte and the positive electrode to whichcations(positively charged ions) migrate.Redoxreactions power the battery. Cations are reduced (electrons are added) at the cathode during charging, while anions are oxidized (electrons are removed) at the anode during charging. During discharge, the process is reversed. The electrodes do not touch each other, but are electrically connected by theelectrolyte. Some cells use different electrolytes for each half-cell. A separator allows ions to flow between half-cells, but prevents mixing of the electrolytes.

Each half-cell has anelectromotive force(or emf), determined by its ability to drive electric current from the interior to the exterior of the cell. The net emf of the cell is the difference between the emfs of its half-cells. Thus, if the electrodes have emfs  and  then the net emf is ; in other words, the net emf is the difference between thereduction potentialsof thehalf-reactions.

The electrical driving force or across theterminalsof a cell is known as the *terminal voltage (difference)* and is measured involts. The terminal voltage of a cell that is neither charging nor discharging is called theopen-circuit voltageand equals the emf of the cell. Because of internal resistance, the terminal voltage of a cell that is discharging is smaller in magnitude than the open-circuit voltage and the terminal voltage of a cell that is charging exceeds the open-circuit voltage. An ideal cell has negligible internal resistance, so it would maintain a constant terminal voltage of until exhausted, then dropping to zero. If such a cell maintained 1.5 volts and stored a charge of onecoulombthen on complete discharge it would perform 1.5joulesof work. In actual cells, the internal resistance increases under discharge and the open circuit voltage also decreases under discharge. If the voltage and resistance are plotted against time, the resulting graphs typically are a curve; the shape of the curve varies according to the chemistry and internal arrangement employed.

The voltage developed across a cell's terminals depends on the energy release of the chemical reactions of its electrodes and electrolyte.Alkalineandzinc–carboncells have different chemistries, but approximately the same emf of 1.5 volts; likewiseNiCdandNiMHcells have different chemistries, but approximately the same emf of 1.2 volts. The high electrochemical potential changes in the reactions oflithiumcompounds give lithium cells emfs of 3 volts or more.

## 4.2 Types of battery

**Batteries are classified into primary and secondary forms:**

- *Primary* batteries are designed to be used until exhausted of energy then discarded. Their chemical reactions are generally not reversible, so they cannot be recharged. When the supply of reactants in the battery is exhausted, the battery stops producing current and is useless.[22]
- *Secondary* batteries can be recharged; that is, they can have their chemical reactions reversed by applyingelectric currentto the cell. This regenerates the original chemical reactants, so they can be used, recharged, and used again multiple times.[23]

Some types of primary batteries used, for example, fortelegraphcircuits, were restored to operation by replacing the electrodes.[24]Secondary batteries are not indefinitely rechargeable due to dissipation of the active materials, loss of electrolyte and internal corrosion.

### 4.2.1 Primary

Primary batteries, orprimary cells, can produce current immediately on assembly. These are most commonly used in portable devices that have low current drain, are used only intermittently, or are used well away from an alternative power source, such as in alarm and communication circuits where other electric power is only intermittently available. Disposable primary cells cannot be reliably recharged, since the chemical reactions are not easily reversible and active materials may not return to their original forms. Battery manufacturers recommend against attempting to recharge primary cells. In general, these have higherenergy densitiesthan rechargeable batteries, but disposable batteries do not fare well under high-drain applications withloadsunder 75ohms(75 Ω). Common types of disposable batteries includezinc–carbon batteriesandalkalinebatteries.

### 4.2.2 Secondary

Secondary batteries, also known as *secondary cells*, or *rechargeable batteries*, must be charged before first use; they are usually assembled with active materials in the discharged state. Rechargeable batteries are (re)charged by applying electric current, which reverses the chemical reactions that occur during discharge/use. Devices to supply the appropriate current are called chargers.

The oldest form of rechargeable battery is thelead–acid battery, which are widely used inautomotiveandboatingapplications. This technology contains liquid electrolyte in an unsealed container, requiring that the battery be kept upright and the area be well ventilated to ensure safe dispersal of thehydrogengas it produces during overcharging. The lead–acid battery is relatively heavy for the amount of electrical energy it can supply. Its low manufacturing cost and its high surge current levels make it common where its capacity (over approximately 10 Ah) is more important than weight and handling issues. A common application is the moderncar battery, which can, in general, deliver a peak current of 450amperes.

The sealedvalve regulated lead–acid battery(VRLA battery) is popular in the automotive industry as a replacement for the lead–acid wet cell. The VRLA battery uses an immobilizedsulfuric acidelectrolyte, reducing the chance of leakage and extendingshelf life. VRLA batteries immobilize the electrolyte. The two types are:

*Gel batteries*(or "gel cell") use a semi-solid electrolyte.

*Absorbed Glass Mat*(AGM) batteries absorb the electrolyte in a special fiberglass matting.

Other portable rechargeable batteries include several sealed "dry cell" types, that are useful in applications such as mobile phones andlaptop computers. Cells of this type (in order of increasingpower densityand cost) includenickel–cadmium(NiCd),nickel–zinc(NiZn),nickel metal hydride(NiMH), andlithium-ion(Li-ion) cells. Li-ion has by far the highest share of the dry cell rechargeable market. NiMH has replaced NiCd in most applications due to its higher capacity, but NiCd remains in use inpower tools,two-way radios, andmedical equipment.

In the 2000s, developments include batteries with embedded electronics such asUSBCELL, which allows charging an AA battery through aUSBconnector,nanoball batteriesthat allow for a discharge rate about 100x greater than current batteries, andsmart batterypacks with state-of-charge monitors and battery protection circuits that prevent damage on over-discharge.Low self-discharge(LSD) allows secondary cells to be charged prior to shipping.

## 4.3 Capacity and discharge


A device to check battery voltage

A battery's *capacity* is the amount ofelectric chargeit can deliver at the rated voltage. The more electrode material contained in the cell the greater its capacity. A small cell has less capacity than a larger cell with the same chemistry, although they develop the same open-circuit voltage.[30]Capacity is measured in units such asamp-hour(A·h). The rated capacity of a battery is usually expressed as the product of 20 hours multiplied by the current that a new battery can consistently supply for 20 hours at 68 °F (20 °C), while remaining above a specified terminal voltage per cell. For example, a battery rated at 100 A·h can deliver 5 A over a 20-hour period atroom temperature. The fraction of the stored charge that a battery can deliver depends on multiple factors, including battery chemistry, the rate at which the charge is delivered (current), the required terminal voltage, the storage period, ambient temperature and other factors.

The higher the discharge rate, the lower the capacity. The relationship between current, discharge time and capacity for a lead acid battery is approximated (over a typical range of current values) byPeukert's law:

Batteries that are stored for a long period or that are discharged at a small fraction of the capacity lose capacity due to the presence of generally irreversible *side reactions* that consume charge carriers without producing current. This phenomenon is known as internal self-discharge. Further, when batteries are recharged, additional side reactions can occur, reducing capacity for subsequent discharges. After enough recharges, in essence all capacity is lost and the battery stops producing power. Internal energy losses and limitations on the rate that ions pass through the electrolyte cause batteryefficiencyto vary. Above a minimum threshold, discharging at a low rate delivers more of the battery's capacity than at a higher rate. Installing batteries with varying A·h ratings does not affect device operation (although it may affect the operation interval) rated for a specific voltage unless load limits are exceeded. High-drain loads such asdigital camerascan reduce total capacity, as happens with alkaline batteries. For example, a battery rated at 2 A·h for a 10- or 20-hour discharge would not sustain a current of 1 A for a full two hours as its stated capacity implies.

## 4.4 Fast-charging, large and light batteries

As of 2013, the world's largest battery was inHebei Province, China. It stored 36 megawatt-hours of electricity at a cost of $500 million. Another large battery, composed ofNi–Cdcells, was inFairbanks, Alaska. It covered 2,000 square metres (22,000 sqft)—bigger than a football pitch—and weighed 1,300 tonnes. It was manufactured byABBto provide backup power in the event of a blackout. The battery can provide 40 megawatts of power for up to seven minutes.Sodium–sulfur batterieshave been used to storewind power. A 4.4 megawatt-hour battery system that can deliver 11 megawatts for 25 minutes stabilizes the output of the Auwahi wind farm in Hawaii.

Lithium–sulfur batterieswere used on the longest and highest solar-powered flight. The recharging speed of lithium-ion batteries can be increased by manufacturing changes.

## Battery Life time

Battery life (and its synonym battery lifetime) has two meanings for rechargeable batteries but only one for non-chargeables. For rechargeables, it can mean either the length of time a device can run on a fully charged battery or the number of charge/discharge cycles possible before the cells fail to operate satisfactorily. For a non-rechargeable these two lives are equal since the cells last for only one cycle by definition. (The term shelf life is used to describe how long a battery will retain its performance between manufacture and use.) Available capacity of all batteries drops with decreasing temperature. In contrast to most of today's batteries, theZamboni pile, invented in 1812, offers a very long service life without refurbishment or recharge, although it supplies current only in the nanoamp range. TheOxford Electric Bellhas been ringing almost continuously since 1840 on its original pair of batteries, thought to be Zamboni piles.

### 4.5 Self-discharge

Disposable batteries typically lose 8 to 20 percent of their original charge per year when stored at room temperature (20–30 °C). This is known as the "self-discharge" rate, and is due to non-current-producing "side" chemical reactions that occur within the cell even when no load is applied. The rate of side reactions is reduced for batteries are stored at lower temperatures, although some can be damaged by freezing.

Old rechargeable batteries self-discharge more rapidly than disposable alkaline batteries, especially nickel-based batteries; a freshly charged nickel cadmium (NiCd) battery loses 10% of its charge in the first 24 hours, and thereafter discharges at a rate of about 10% a month.

## INVERTER

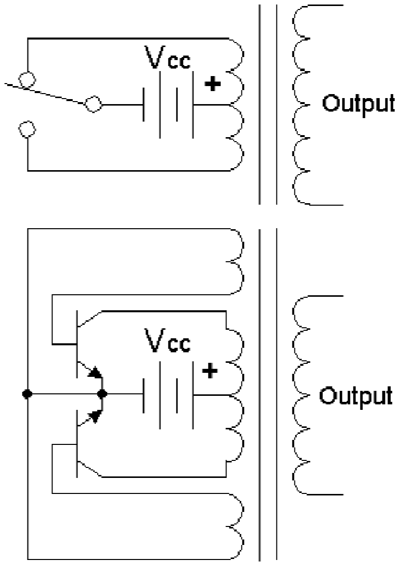
### 5.1 Basic design

In one simple inverter circuit, DC power is connected to a transformer through the center tap of the primary winding. A switch is rapidly switched back and forth to allow current to flow back to the DC source following two alternate paths through one end of the primary winding and then the other. The alternation of the direction of current in the primary winding of the transformer produces alternating current (AC) in the secondary circuit.

The electromechanical version of the switching device includes two stationary contacts and a spring supported moving contact. The spring holds the movable contact against one of the stationary contacts and an electromagnet pulls the movable contact to the opposite stationary contact. The current in the electromagnet is interrupted by the action of the switch so that the switch continually switches rapidly back and forth. This type of electromechanical inverter switch, called a vibrator or buzzer, was once used in vacuum tube automobile radios. A similar mechanism has been used in door bells, buzzers and tattoo machines.

As they became available with adequate power ratings, transistors and various other types of semiconductor switches have been incorporated into inverter circuit designs. Certain ratings, especially for large systems (many kilowatts) use thyristors (SCR). SCRs provide large power handling capability in a semiconductor device, and can readily be controlled over a variable firing range.

The switch in the simple inverter described above, when not coupled to an output transformer, produces a square voltage waveform due to its simple off and on nature as opposed to the sinusoidal waveform that is the usual waveform of an AC power supply. Using Fourier analysis, periodic waveforms are represented as the sum of an infinite series of sine waves. The sine wave that has the same frequency as the original waveform is called the fundamental component. The other sine waves, called *harmonics*, that are included in the series have frequencies that are integral multiples of the fundamental frequency.




### 5.2 INVERTER IC4047

The IC 4047 is one of those devices which promises an unlimited range of circuit application solutions. The IC is so versatile that on many occasions it easily outsmarts it's close rival, the IC 555, let's study the datasheet and pinout details of this versatile chip.In-built oscillator with variable frequency option through an external RC network.

Complementary push-pull outputs with a separate active clock output, the clock output is actually an extension of the internal oscillator frequency output.

Duty cycle locked to 50% for precision, fail proof operation of the external stages.

The IC 4047 can be configured as a free running astable MV, and also as a monostable MV.

In the astable mode the chip provides the option of integrating external triggering inputs, also called true gating and compliment gating modes.

The monostable mode enables positive edge triggering as well as negative edge triggering of the IC. It further alowsretriggerable feature for extending the output timing to the desired calculated level. Meaning after the normal trigger is applied to the IC, more number subsequent triggers can be applied so that the output adds up the timing, generating further delay at the output.

### 5.3 IC 4047 configuration

In the free running astable mode, connect pins 4, 5, 6, 14 to positive or Vdd, connect pins 7, 8, 9, 12 to ground or Vss.

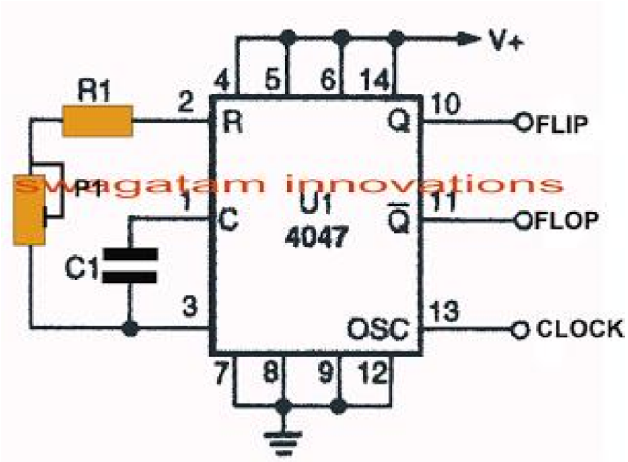
In gated astable mode connect pins 4, 6, 14 to positive or Vdd, connect pins 7, 8, 9, 12 to ground or Vss, connect pin 5 to the reset pin of the external trigger IC, while output of the external chip to pin 4 of the IC 4047.

For the above modes, the output may be obtained across pin 10, 11 (push-pull) while clocks at pin 13.

In positive trigger monostable mode, connect pins 4, 14 to positive or Vdd, connect pins 5, 6, 7, 9, 12 to ground or Vss, connect pin 8 to the reset pin of the external trigger IC, while output of the external chip to pin 6 of the IC 4047.

For the above modes, the output may be obtained across pin 10, 11.

**5.4 Fundamental Free Running Astable Mode IC 4047**




As shown in the figure above, the IC 4047 can be used as a free running astablemultivibrator or oscillator by configuring the chip in the above suggested method.

Here R1, P1 and C1 determine the oscillator frequency of the IC and the output at pin10, 11 and 13.

Basically R1, P1 together must not be less than 10K, and above 1M, while C1 should not be less than 100pF (higher value have no restrictions) in order to maintain proper functioning of the chip.

Pin 10 and 11 are complementary outputs which behave in a push-pull manner, meaning when pin10 is high pin11 is low and vice versa.

Pin 13 is the clock output of the IC 4047, each high pulse measured at this output enables pin10/11 to change positions with their logic levels, while low logics does not influence any response on pin10/11.

Pin13 is normally kept open when not in use, it may be applied in cases where a frequency or pulsed output may be required for the other stages of the circuit for enhancing purposes, such as for making modified PWM based inverters etc.

# COMPARATOR

Inelectronics, a **comparator** is a device that compares twovoltagesorcurrentsand outputs a digital signal indicating which is larger. It has two analog input terminals and and one binary digital output The output is ideally

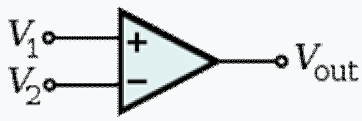
A comparator consists of a specialized high-gaindifferential amplifier. They are commonly used in devices that measure and digitize analog signals, such asanalog-to-digital converters(ADCs), as well asrelaxation oscillators.

## 6.1 Different voltage

The differential voltages must stay within the limits specified by the manufacturer. Early integrated comparators, like the LM111 family, and certain high-speed comparators like the LM119 family, require differential voltage ranges substantially lower than the power supply voltages (±15 V vs. 36 V).[1]*Rail-to-rail* comparators allow any differential voltages within the power supply range. When powered from a bipolar (dual rail) supply,or, when powered from a unipolar TTL/CMOS power supply

Specific rail-to-rail comparators with p-n-p input transistors, like the LM139 family, allow the input potential to drop 0.3 volts *below* the negative supply rail, but do not allow it to rise above the positive rail.[2]Specific ultra-fast comparators, like the LMH7322, allow input signal to swing below the negative rail *and* above the positive rail, although by a narrow margin of only 0.2 V. Differential input voltage (the voltage between two inputs) of a modern rail-to-rail comparator is usually limited only by the full swing of power supply.

## 6.2 Op-amp voltage comparator




A simple op-amp comparator

An operational amplifier (op-amp) has a well balanced difference input and a very high gain. This parallels the characteristics of comparators and can be substituted in applications with low-performance requirements.[4]

In theory, a standard op-amp operating in open-loop configuration (without negative feedback) may be used as a low-performance comparator. When the non-inverting input (V+) is at a higher voltage than the inverting input (V-), the high gain of the op-amp causes the output to saturate at the highest positive voltage it can output. When the non-inverting input (V+) drops below the inverting input (V-), the output saturates at the most negative voltage it can output. The op-amp's output voltage is limited by the supply voltage. An op-amp operating in a linear mode with negative feedback, using a balanced, split-voltage

power supply, (powered by ± $V_S$) has its transfer function typically written as: . However, this equation may not be applicable to a comparator circuit which is non-linear and operates open-loop (no negative feedback)

In practice, using an operational amplifier as a comparator presents several disadvantages as compared to using a dedicated comparator

1. Op-amps are designed to operate in the linear mode with negative feedback. Hence, an op-amp typically has a lengthy recovery time from saturation. Almost all op-amps have an internal compensation capacitor which imposes slew rate limitations for high frequency signals. Consequently, an op-amp makes a sloppy comparator with propagation delays that can be as long as tens of microseconds.
2. Since op-amps do not have any internal hysteresis, an external hysteresis network is always necessary for slow moving input signals.
3. The quiescent current specification of an op-amp is valid only when the feedback is active. Some op-amps show an increased quiescent current when the inputs are not equal.
4. A comparator is designed to produce well limited output voltages that easily interface with digital logic. Compatibility with digital logic must be verified while using an op-amp as a comparator.
5. Some multiple-section op-amps may exhibit extreme channel-channel interaction when used as comparators.
6. Many op-amps have back to back diodes between their inputs. Op-amp inputs usually follow each other so this is fine. But comparator inputs are not usually the same. The diodes can cause unexpected current through inputs

### 6.3 Working

A dedicated voltage comparator will generally be faster than a general-purpose operational amplifier pressed into service as a comparator. A dedicated voltage comparator may also contain additional features such as an accurate, internal voltage reference, an adjustable hysteresis and a clock gated input.

A dedicated voltage comparator chip such as LM339 is designed to interface with a digital logic interface (to a TTL or a CMOS). The output is a binary state often used to interface real world signals to digital circuitry (see analog to digital converter). If there is a fixed voltage source from, for example, a DC adjustable device in the signal path, a comparator is just the equivalent of a cascade of amplifiers. When the voltages are nearly equal, the output voltage will not fall into one of the logic levels, thus analog signals will enter the digital domain with unpredictable results. To make this range as small as possible, the amplifier cascade is high gain. The circuit consists of mainly Bipolar transistors. For very high frequencies, the input impedance of the stages is low. This reduces the saturation of the slow, large P-N junction bipolar transistors that would otherwise lead to long recovery times. Fast small Schottky diodes, like those found in binary logic designs, improve the performance significantly though the performance still lags that of circuits with amplifiers using analog signals. Slew rate has no meaning for these devices. For applications in flash ADCs the distributed signal across eight ports matches the voltage and current gain after each amplifier, and resistors then behave as level-shifters.

The LM339 accomplishes this with an open collector output. When the inverting input is at a higher voltage than the non inverting input, the output of the comparator connects to the negative power supply. When the non inverting input is higher than the inverting input, the output is 'floating' (has a very high impedance to ground). The gain of op amp as comparator is given by this equation V(out)=V(in)

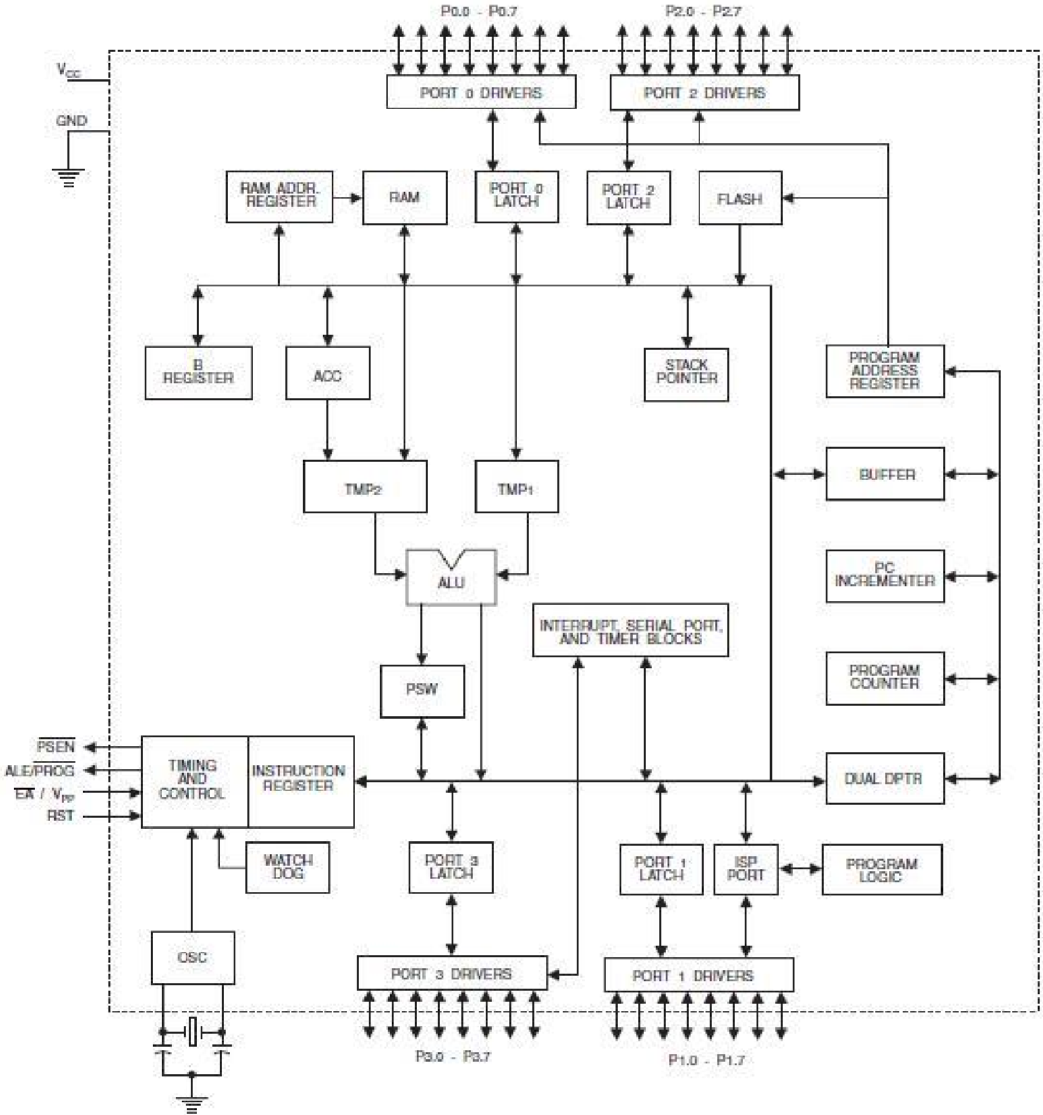
# MICROCONTROLLER AT89S52

The AT89S52 is a low-power, high-performance CMOS 8-bit microcontroller with 8K bytes of in-system programmable Flash memory. The device is manufactured using Atmel's high-density non volatile memory technology and is compatible with the industry standard 80C51 instruction set and pin out. The on-chip Flash allows the program memory to be reprogrammed in-system or by a conventional non volatile memory programmer. By combining a versatile 8-bit CPU with in-system programmable Flash on a monolithic chip, the Atmel AT89S52 is a powerful microcontroller which provides a highly-flexible and cost-effective solution to many embedded control applications. The AT89S52 provides the following standard features: 8K bytes of Flash, 256 bytes of RAM, 32 I/O lines, Watchdog timer, two data pointers, three 16-bit timer/counters, a six-vector two-level interrupt architecture, a full duplex serial port, on-chip oscillator, and clock circuitry. In addition, the AT89S52 is designed with static logic for operation down to zero frequency and supports two software selectable power saving modes. The Idle Mode stops the CPU while allowing the RAM, timer/counters, serial port, and interrupt system to continue functioning. The Power-down mode saves the RAM contents but freezes the oscillator, disabling all other chip functions until the next interrupt or hardware reset.

**7.1 Features:**

- Compatible with MCS®-51 Products
- 8K Bytes of In-System Programmable (ISP) Flash Memory – Endurance: 10,000 Write/Erase Cycles
- 4.0V to 5.5V Operating Range
- Fully Static Operation: 0 Hz to 33 MHz
- Three-level Program Memory Lock
- 256 x 8-bit Internal RAM
- 32 Programmable I/O Lines
- Three 16-bit Timer/Counters
- Eight Interrupt Sources
- Full Duplex UART Serial Channel
- Low-power Idle and Power-down Modes
- Interrupt Recovery from Power-down Mode
- Watchdog Timer
- Dual Data Pointer
- Power-off Flag
- Fast Programming Time
- Flexible ISP Programming (Byte and Page Mode)
- Green (Pb/Halide-free) Packaging Option

## 7.2 Block Diagram of AT89S52:




BLOCK DIAGRAM OF AT89S52

**7.3 Pin Configurations of AT89S52**

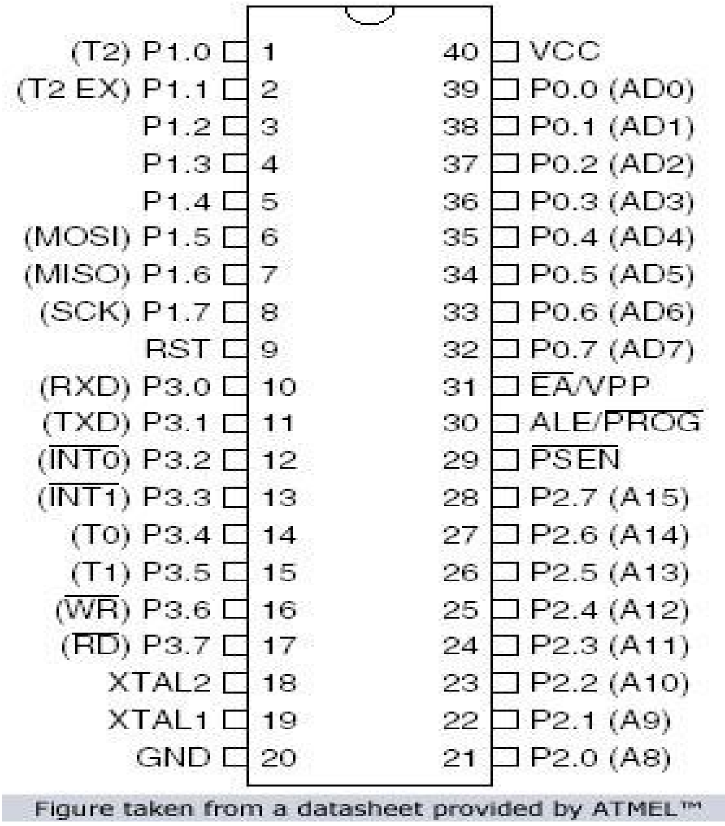



FIG 4.5(b): PIN DIAGRAM OF AT89S52

## 7.4 Pin Description:

### VCC:

Supply voltage.

### GND:

Ground.

### Port 0:

Port 0 is an 8-bit open drain bidirectional I/O port. As an output port, each pin can sink eight TTL inputs. When 1s are written to port 0 pins, the pins can be used as high-impedance inputs. Port 0 can also be configured to be the multiplexed low-order address/data bus during accesses to external program and data memory. In this mode, P0 has internal pull-ups. Port 0 also receives the code bytes during Flash programming and outputs the code bytes during program verification. External pull-ups are required during program verification.

## Port 1:

Port 1 is an 8-bit bidirectional I/O port with internal pull-ups. The Port 1 output buffers can sink/source four TTL inputs. When 1s are written to Port 1 pins, they are pulled high by the internal pull-ups and can be used as inputs. As inputs, Port 1 pins that are externally being pulled low will source current (IIL) because of the internal pull-ups. In addition, P1.0 and P1.1 can be configured to be the timer/counter 2 external count input (P1.0/T2) and the timer/counter 2 trigger input (P1.1/T2EX).

## Port 2:

Port 2 is an 8-bit bidirectional I/O port with internal pull-ups. The Port 2 output buffers can sink/source four TTL inputs. When 1s are written to Port 2 pins, they are pulled high by the internal pull-ups and can be used as inputs. As inputs, Port 2 pins that are externally being pulled low will source current (IIL) because of the internal pull-ups. Port 2 emits the high-order address byte during fetches from external program memory and during accesses to external data memory that use 16-bit addresses (MOVX @ DPTR). In this application, Port 2 uses strong internal pull-ups when emitting 1s. During accesses to external data memory that use 8-bit addresses (MOVX @ RI), Port 2 emits the contents of the P2 Special Function Register.

## Port 3:

Port 3 is an 8-bit bidirectional I/O port with internal pull-ups. The Port 3 output buffers can sink/source four TTL inputs. When 1s are written to Port 3 pins, they are pulled high by the internal pull-ups and can be used as inputs. As inputs, Port 3 pins that are externally being pulled low will source current (IIL) because of the pull-ups.

## RST:

Reset input. A high on this pin for two machine cycles while the oscillator is running resets the device. This pin drives high for 98 oscillator periods after the Watchdog times out. The DISRTO bit in SFR AUXR (address 8EH) can be used to disable this feature. In the default state of bit DISRTO, the RESET HIGH out feature is enabled.

## ALE/PROG:

Address Latch Enable (ALE) is an output pulse for latching the low byte of the address during accesses to external memory. This pin is also the program pulse input (PROG) during Flash programming.

In normal operation, ALE is emitted at a constant rate of 1/6 the oscillator frequency and may be used for external timing or clocking purposes. Note, however, that one ALE pulse is skipped during each access to external data memory.

## PSEN:

Program Store Enable (PSEN) is the read strobe to external program memory. When the AT89S52 is executing code from external program memory, PSEN is activated twice each machine cycle, except that two PSEN activations are skipped during each access to external data memory.

## EA/VPP:

External Access Enable. EA must be strapped to GND in order to enable the device to fetch code from external program memory locations starting at 0000H up to FFFFH. Note, however, that if lock bit 1 is programmed, EA will be internally latched on reset. EA should be strapped to VCC for internal program executions. This pin also receives the 12-volt programming enable voltage (VPP) during Flash programming.

## XTAL1:

Input to the inverting oscillator amplifier and input to the internal clock operating circuit.

## XTAL2:

Output from the inverting oscillator amplifier.

## 7.5 Oscillator Characteristics:

XTAL1 and XTAL2 are the input and output, respectively, of an inverting amplifier which can be configured for use as an on-chip oscillator, as shown in Figure 1. Either a quartz crystal or ceramic resonator may be used. To drive the device from an external clock source, XTAL2 should be left unconnected while XTAL1 is driven as shown in Figure 6.2. There are no requirements on the duty cycle of the external clock signal, since the input to the internal clocking circuitry is through a divide-by-two flip-flop, but minimum and maximum voltage high and low time specifications must be observed.

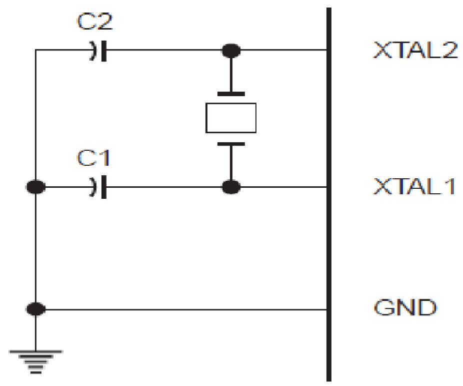



FIG 4.5(c): Oscillator Connections

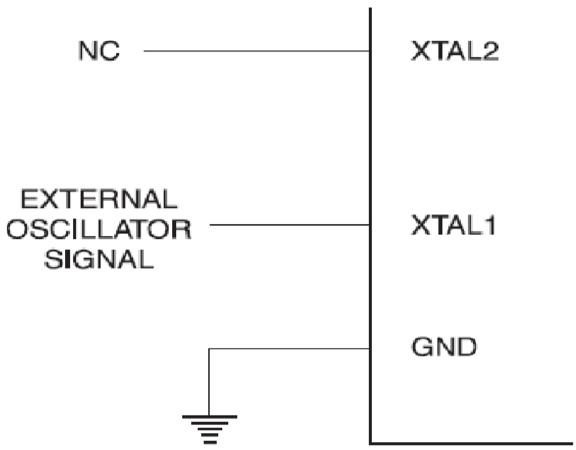



FIG 4.5(d): External Clock Drive Configuration

## 7.6 Idle Mode

In idle mode, the CPU puts itself to sleep while all the on chip peripherals remain active. The mode is invoked by software. The content of the on-chip RAM and all the special functions registers remain unchanged during this mode. The idle mode can be terminated by any enabled interrupt or by a hardware reset.

## 7.7 Power down Mode

In the power down mode the oscillator is stopped, and the instruction that invokes power down is the last instruction executed. The on-chip RAM and Special Function Registers retain their values until the power down mode is terminated. The only exit from power down is a hardware reset. Reset redefines the SFRs but does not change the on-chip RAM. The reset should not be activated before VCC is restored to its normal operating level and must be held active long enough to allow the oscillator to restart and stabilize.

# LCD display

## 8.1 Basics of LCD Displays:

The liquid-crystal display has the distinct advantage of having a low power consumption than the LED. It is typically of the order of microwatts for the display in comparison to the some order of milliwatts for LEDs. Low power consumption requirement has made it compatible with MOS integrated logic circuit. Its other advantages are its low cost, and good contrast. The main drawbacks of**LCD**s are additional requirement of light source, a limited temperature range of operation (between 0 and 60° C), low reliability, short operating life, poor visibility in low ambient lighting, slow speed and the need for an ac drive.

### Basic structure of an LCD

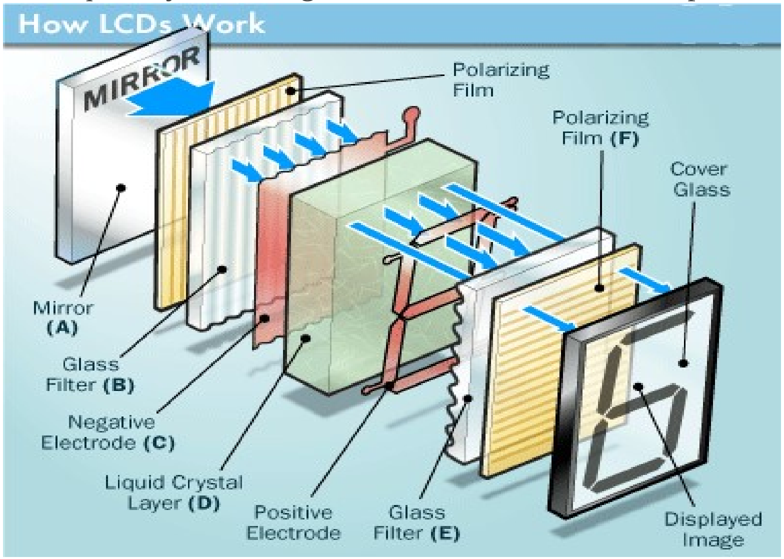
A liquid crystal cell consists of a thin layer (about 10 u m) of a liquid crystal sandwiched between two glass sheets with transparent electrodes deposited on their inside faces. With both glass sheets transparent, the cell is known as *transmittive type cell.* When one glass is transparent and the other has a reflective coating, the cell is called *reflective type.* The LCD does not produce any illumination of its own. It, in fact, depends entirely on illumination falling on it from an external source for its visual effect

## 8.2 Types of LCD/Liquid Crystal Displays.

**Two types of display available are dynamic scattering display and field effect display.**

When dynamic scattering displayis energized, the molecules of energized area of the display become turbulent and scatter light in all directions. Consequently, the activated areas take on a frosted glass appearance resulting in a silver display. Of course, the unenergized areas remain translucent.

Field effect *LCD* contains front and back polarizers at right angles to each other. Without electrical excitation, the light coming through the front polarizer is rotated 90° in the fluid. Now, let us take a look at the different varieties of liquid crystals that are available for industrial purposes. The most usable liquid crystal among all the others is the neumatic phase liquid crystals.



## 8.3 Working principle:

The main principle behind liquid crystal molecules is that when an electric current is applied to them, they tend to untwist. This causes a change in the light angle passing through them. This causes a change in the angle of the top polarizing filter with respect to it. So little light is allowed to pass through that particular area of LCD. Thus that area becomes darker comparing to others.

For making an LCD screen, a reflective mirror has to be setup in the back. An electrode plane made of indium-tin oxide is kept on top and a glass with a polarizing film is also added on the bottom side. The entire area of the LCD has to be covered by a common electrode and above it should be the liquid crystal substance. Next comes another piece of glass with an electrode in the shape of the rectangle on the bottom and, on top, another polarizing film. It must be noted that both of them are kept at right angles. When there is no current, the light passes through the front of the LCD it will be reflected by the mirror and bounced back. As the electrode is connected to a temporary battery the current from it will cause the liquid crystals between the common-plane electrode and the electrode shaped like a rectangle to untwist. Thus the light is blocked from passing through. Thus that particular rectangular area appears blank.

## 8.4 Colour Liquid Crystal Display

Colour LCDs are those that can display pictures in colours. For this to be possible there must be three sub-pixels with red, green and blue colour filters to create each colour pixel. For combining these sub-pixels these LCDs should be connected to a large number of transistors. If any problem occurs to these transistors, it will cause a bad pixel.

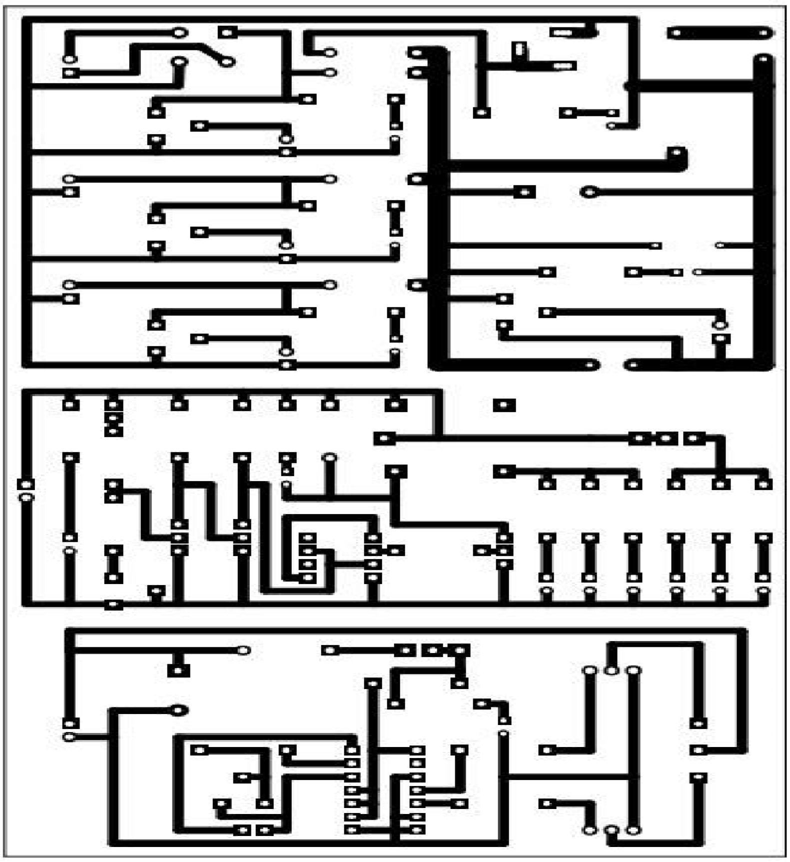
One of the main disadvantages of these types of LCDs is the size. Most manufacturers try to reduce the height than gain it. This is because more transistors and greater pixels will be needed to increase the length. This will increase the probability of bad pixels.  It is very difficult or also impossible to repair a LCD with bad pixels. This will highly affect the sale of LCDs.

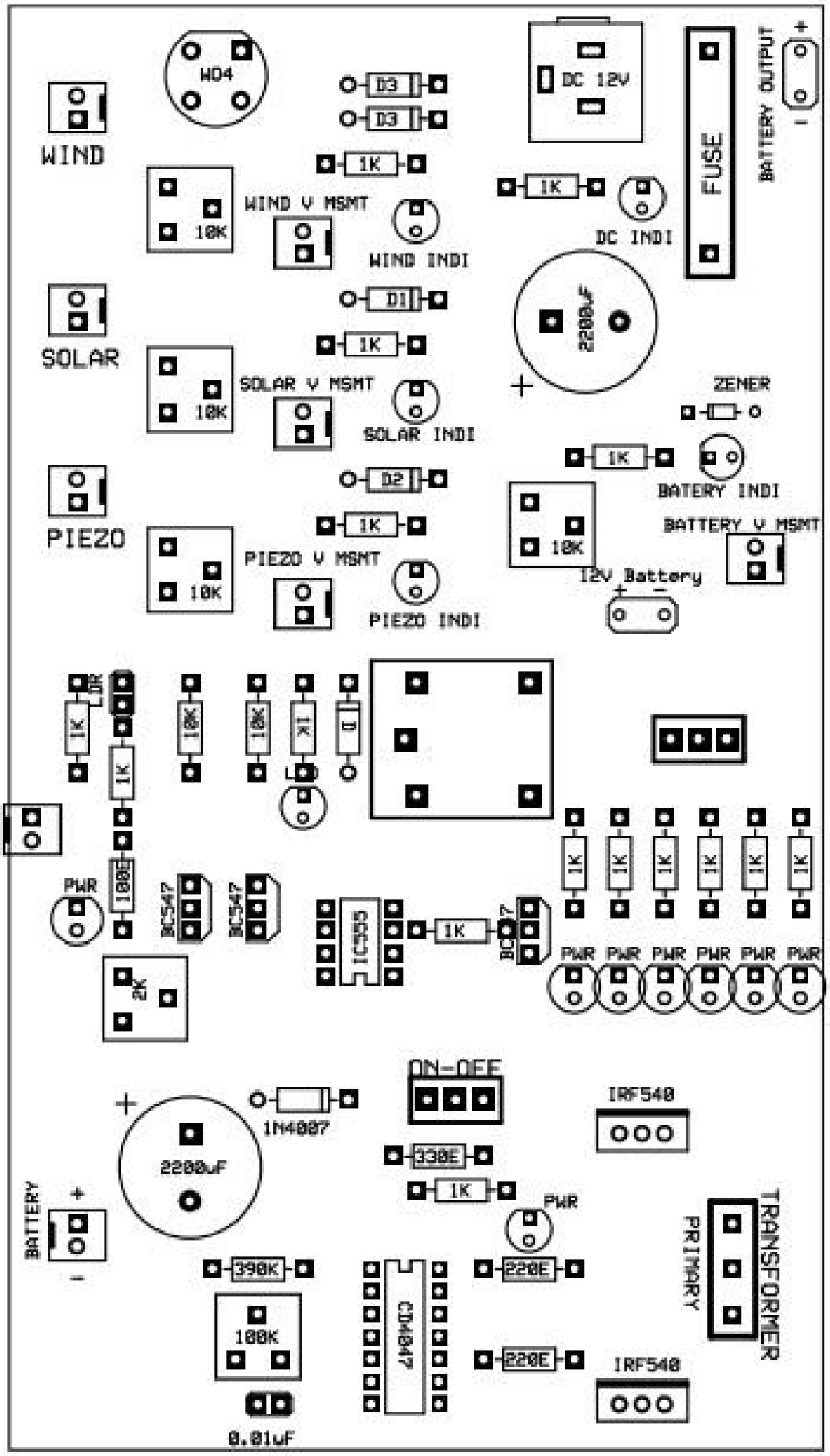
# PCB artwork

## 9.1 PCB Designing:

For designing the PCB we have used Express PCB software. This software is downloaded from internet. It is user friendly and very simple. We made the PCB layouts in this software. The main disadvantage of this software is, that we can’t take the mirror image directly.

To eliminate this disadvantage we have to take the printout on tracing paper. After taking the print out reversing the tracing paper we will get the mirror image of the PCB layout. After getting the PCB layout we gave it to screen printer. The screen printer will paint that mirror image on Copper clad. After painting allow it to dry. After that using Ferric Chloride solution remove the unwanted Cu. Process of removing the unwanted copper is known as ‘Etching’. After the process of etching we remove the colour.




WD4
D3
D3
DC 12V
FUSE
BATTERY OUTPUT
WIND
1K
10K
WIND V MSMT
WIND INDI
DC INDI
D1
2200uF
SOLAR
SOLAR V MSMT
SOLAR INDI
ZENER
D2
BATERY INDI
BATTERY V MSMT
PIEZO
PIEZO V MSMT
PIEZO INDI
12V Battery
LDR
PWR
100E
BC547
IC555
2K
ON-OFF
IRF540
1N4007
330E
TRANSFORMER
PRIMARY
BATTERY
390K
100K
CD4047
220E
0.01uF

# List of components and its description

In our project we use following hardware

10.1 Relay

10.2 Capacitors

10.3 Diodes

10.4 Light Emitting Diodes (LEDs)

10.5 Presets

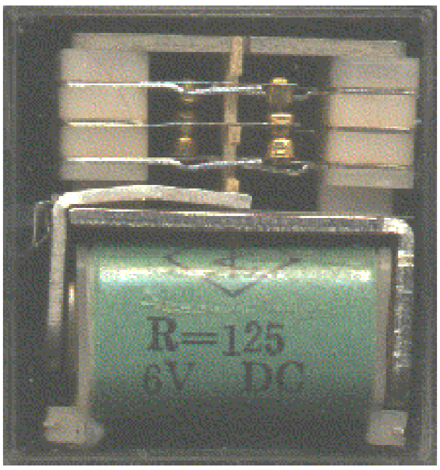
10.6 IC 555

10.7 LDR

10.8 IC CD4047

10.9 MOSFET IRF540

## 10.1 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 they are double throw (changeover) switches.

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 ICs (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 PCB mounting but you can solder wires directly to the pins providing you take care to avoid melting the plastic case of the relay.

The supplier's catalogue 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 animated picture shows a working 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. There is one set of contacts (SPDT) in the foreground and another behind them, making the relay DPDT

## Choosing a Relay

You need to consider several features when choosing a relay: Physical size and pin arrangement.

If you are choosing a relay for an existing PCB you will need to ensure that its dimensions and pin arrangement are suitable. You should find this information in the supplier's catalogue.

## Coil Voltage :

The relay's coil voltage rating and resistance must suit the circuit powering the relay coil. Many relays have a coil rated for a 12V supply but 5V and 24V relays are also readily available. Some relays operate perfectly well with a supply voltage which is a little lower than their rated value.

## Coil Resistance

The circuit must be able to supply the current required by the relay coil. You can use Ohm's law to calculate the current:

$$\text{Relay coil current} = \frac{\text{supply voltage}}{\text{coil resistance}}$$

For example: A 12V supply relay with a coil resistance of 400Ω passes a current of 30mA. This is OK for a 555 timer IC (maximum output current 200mA), but it is too much for most ICs and they will require a transistor to amplify the current.

## Switch ratings (voltage and current) :

The relay's switch contacts must be suitable for the circuit they are to control. You will need to check the voltage and current ratings. Note that the voltage rating is usually higher for AC, for example: "5A at 24V DC or 125V AC".

## Switch contact arrangement (SPDT, DPDT etc)

Most relays are SPDT or DPDT which are often described as "single pole changeover" (SPCO) or "double pole changeover" (DPCO). For further information please see the page on switches.

## Relays and transistors compared

Like relays, transistors can be used as an electrically operated switch. For switching small DC currents (< 1A) at low voltage they are usually a better choice than a relay. In these cases a relay will be needed, but note that a low power transistor may still be needed to switch the current for the relay's coil! The main advantages and disadvantages of relays are listed below:

## Advantages of relays:

Relays can switch AC and DC, transistors can only switch DC.

Relays can switch high voltages, transistors cannot.

Relays are a better choice for switching large currents (> 5A).

Relays can switch many contacts at once.

## Disadvantages of relays:

Relays are bulkier than transistors for switching small currents.

Relays cannot switch rapidly (except reed relays), transistors can switch many times per second.

Relays use more power due to the current flowing through their coil.

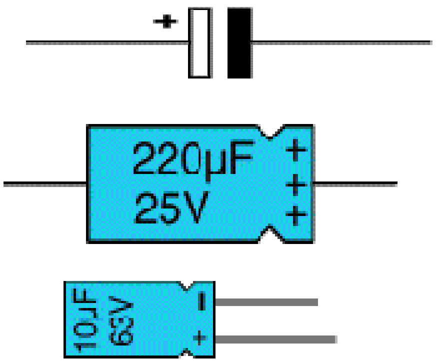
Relays require more current than many chips can provide, so a low power transistor may be needed to switch the current for the relay's coil.

## 10.2 Capacitors

Capacitors store electric charge. They are used to smooth varying DC supplies by acting as a reservoir of charge. They are also used in filter circuits because capacitors easily pass AC

(changing) signals but they block DC (constant) signals.

**Polarised capacitors (large values, 1µF +)**

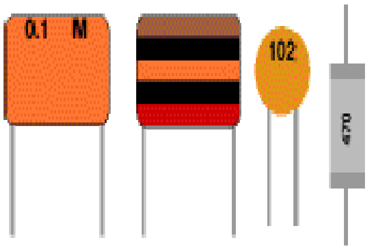


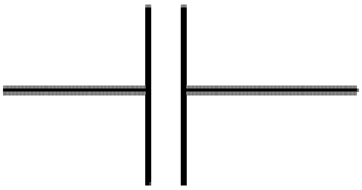

Electrolytic capacitors are polarized and they must be connected the correct way round, at least one of their leads will be marked + or -. They are not damaged by heat when soldering.

There are two designs of electrolytic capacitors; axial where the leads are attached to each end (220µF in picture) and radial where both leads are at the same end (10µF in picture). Radial capacitors tend to be a little smaller and they stand upright on the circuit board.

It is easy to find the value of electrolytic capacitors because they are clearly printed with their capacitance and voltage rating. The voltage rating can be quite low and it should always be checked when selecting an electrolytic capacitor.

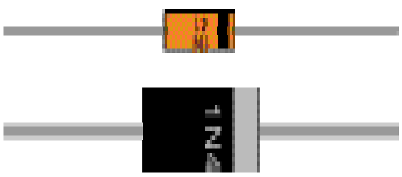
## Unpolarised capacitors (small values, up to 1µF)



Small value capacitors are unpolarised and may be connected either way round. They are not damaged by heat when soldering, except for one unusual type (polystyrene). It can be difficult to find the values of these small capacitors because there are many types of them and several different labeling systems. Many small value capacitors have their value printed but without a multiplier, so you need to use experience to work out what the multiplier should be!

## 10.3 Diodes



Diodes allow electricity to flow in only one direction. The arrow of the circuit symbol shows the direction in which the current can flow. Diodes are the electrical version of a valve and early diodes were actually called valves.

## Forward Voltage Drop

Electricity uses up a little energy pushing its way through the diode, rather like a person pushing through a door with a spring. This means that there is a small voltage across a conducting diode, it is called the forward voltage drop and is about 0.7V for all normal diodes, which are made from silicon. The forward voltage drop of a diode is almost constant whatever the current passing through the diode so they have a very steep characteristic (current-voltage graph).

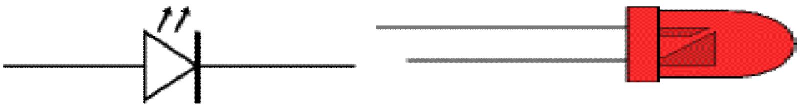
## Reverse Voltage

When a reverse voltage is applied a perfect diode does not conduct, but all real diodes leak a very tiny current of a few µA or less. This can be ignored in most circuits because it will be very much 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 exceeded the diode will fail and pass a large current in the reverse direction, this is called breakdown.

Ordinary diodes can be split into two types: Signal diodes which pass small currents of 100mA or less and Rectifier diodes which can pass large currents. In addition there are LED (which have their own page) and Zener diodes (at the bottom of this page).

## 10.4 Light Emitting Diodes (LEDs)

LEDs emit light when an electric current passes through them.



## Colours of LEDs

LEDs are available in red, orange, amber, yellow, green, blue and white. Blue and white LEDs are much more expensive than the other colours.

The colour of an LED is determined by the semiconductor material, not by the colouring of the 'package' (the plastic body). LEDs of all colours are available in uncoloured packages which may be diffused (milky) or clear (often described as 'water clear'). The coloured packages are also available as diffused (the standard type) or transparent.

## 10.5 Presets

These are miniature versions of the standard variable resistor. They are designed to be mounted directly onto the circuit board and adjusted only when the circuit is built. For example to set the frequency of an alarm tone or the sensitivity of a light-sensitive circuit. A small screwdriver or similar tool is required to adjust presets.

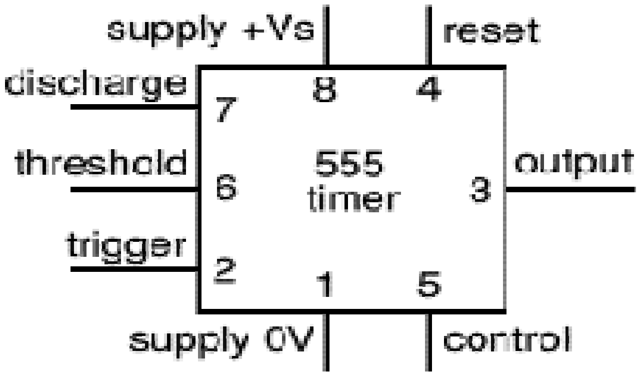
Presets are much cheaper than standard variable resistors so they are sometimes used in projects where a standard variable resistor would normally be used.

Multi-turn presets are used where very precise adjustments must be made. The screw must be turned many times (10+) to move the slider from one end of the track to the other, giving very fine control.

## 10.6 IC 555 (Timer): -

IC 555 is highly stable controller capable of producing accurate time delays or oscillations. Additional terminals are provided for triggering and resetting if desired. In time delay mode of operation, the time is precisely controlled by external resister and capacitors.

**Pin Out.**




**Pin (1) Ground:-**

All voltage are measured with respect to this terminal.

**Pin (2) Trigger: -**

The output of the timer depends on the amplitude of the external trigger pulse applied to this pin

**Pin (3) output: -**

There are two ways a load can be connecting to the output the output terminal either between pin 3 and GND, and load is connected between pin 3 and supply voltage + Vcc (pin 8)

**Pin (4) Reset: -**

The device IC 555 is reset by applying a negative pulse to this pin when the reset function is not in use the reset terminal should be connected to +Vcc to avoid any possibility of false trigger.

**Pin (5) Control Voltage: -**

An external voltage applied to this terminal changes the threshold as well as trigger voltage. When no used the control pin should be by passed to ground with 0.001□f. input capacitor to prevent any noise disturbance.

## Pin (6) Threshold: -

This is the non-inverting terminal of comparator C1 which monitors the voltage across the external capacitor, when the voltage at this pin is greater than or equal to 2/3 Vcc the output of comparator C1 goes high which in turns switches the output of the timer low.

## Pin (7) Discharge: -

The pin is connected internally to the collector of transistor when the output is high Q1 is off & acts as open circuit to the external capacitor connected between pin 7 and ground. On the other hand when the output is low Q1 is saturated and acts as a short circuit. Shorting out the external capacitor C to ground.

## Pin (8) + Vcc: -

The supply voltage of +5V to +18 V is applied to this pin with respect to ground (pin 1)

## 10.7 LDR (light dependent resistor):

It is also called photo resistive device or photo resister. When it is illuminated drops in resistance. Such devices have dark resistance at low irradiated. The light sensitive semiconductor powder is deposited on a dielectric (insulating) base in vacuums. This metal film kept on this and is connected to metal leads. The area of the sensitive material varies from 0.5 – 30 $mm^2$. The four-semiconductor material normally employed in photo resistor are a cadmium solenoid (cdse), cadmium sulphide (cds), lead sulphide (phs) and thallium sulphide (ts)

This construction gives minimum length and maximum area. It is seen that when not illuminated, the LDR has a resistance of more than 100k ohms. It is known as dark resistance.

The special response of cds LDR is it is sensitive to visible light.

## 10.8 IC CD4047:

The CD4047B is capable of operating in either the monostable or astable mode. It requires an external capacitor (between pins 1 and 3) and an external resistor (between pins 2 and 3) to determine the output pulse width in the monostable mode, and the output frequency in the astable mode.

Astable operation is enabled by a high level on the astable input or low level on the astable input. The output frequency (at 50% duty cycle) at Q and Q outputs is determined by the timing components. A frequency twice that of Q is available at the Oscillator Output; a 50% duty cycle is not guaranteed.

Monostable operation is obtained when the device is triggered by LOW-to-HIGH transition at + trigger input or HIGH-to-LOW transition at − trigger input. The device can be retriggered by applying a simultaneous LOW-to-HIGH transition to both the + trigger and retrigger inputs. A high level on Reset input resets the outputs Q to LOW, Q to HIGH.

## 10.9 MOSFET IRF540:

An IRF540N is Power MOSFET that is used in many projects. It is very Fast Switching than general transistor. The IRF540N is N-channel have Drain current maximum about 27A-33A and Vdss (drain -source voltage) about 100V.

## APPLICATION

- It can be used at places where there is shorted of energy or where energy is not available i.e rural areas, hilly, mountain areas, etc where there is inconsistency in power supply . The power plant can be installed there or at any place according to purpose, availability and requirement of use for the system and supplies the power to mankind residing at such places.

- It can be used as the backup power plant for the major power plant like thermal, hydro power plant, etc. as these power plant comprises of major source of generation of power in INDIA. Thermal power plant acquires 64.75% and hydra power plant acquires 21.73% of total pwer generation in INDIA. As in our project we used non-conventional source for power generation as demand is increasing and major priority is given to non-conventional energy sources. Therefore these power plant can be used in conjuction or as backup for major power plant for reducing power requirement and cost of the major power plant.

- It can be used for the small purposes like military, soldier, navy, airforce, etc. for their basic requirement as they mostly live or stay in shed, tents, ports ans ships in case of navy as small setup can be installed at any particular place to provide power for their use.

# CONCLUSION:

Microgrid is an extension of main grid providing on-site generation capable of fulfilling its local load demand. A microgrid architecture requires to be added to the main grid to increase the reliability, improve power quality, avoid the use of depleting fossil fuels, improve the technical performance and reduce the greenhouse gases emissions. The microgrid can be connected in an islanded or isolated or autonomous and grid connected modes. Depending on the requirement these renewable energy sources are connected in the main grid or operate separately. Because of these reasons, operation, control and grid integration of renewable resources is a task of fundamental importance in modern power system. Microgrid operating modes and dispatch strategies must be studied. Furthermore, as renewable energy sources are intermittent in nature, energy storage schemes are required to store the energy and retrieve the energy at times required. Thus, it is desirable to develop reliable microgrid operation and effective energy storage algorithms which would enhance the performance of hybrid power systems. This thesis is devoted to the development of techno-economic analysis algorithms, different dispatch strategies algorithms and life cycle cost benefit analysis of energy storage schemes algorithms for different hybrid power system configurations in grid connected and islanded modes. In addition, the thesis also includes development of algorithm for flywheel energy storage system and compares the performance of battery and flywheel energy storage systems.

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- **GOPAL K DUBEY**
- **R A GAYAKWAD**
- **A K SHAWNEY**