ELECTO-STEP

Major Project Report

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ELECTO-STEP

A Project Report

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DIPLOMA

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ELECTRONICS AND COMMUNICATION ENGINEERING

(SEMESTER-VI)

UNDER THE GUIDANCE OF

ANUJ KALRA (Lecturer)

PUSA INSTITUTE OF TECHNOLOGY

New Delhi

PUSA INSTITUTE OF TECHNOLOGY
Electronics and Communication Engineering, Pusa

CERTIFICATE

*This is to certify that the project report entitled **"Electo-Step"** submitted by **Mr. Vansh Mittal (1908081076), Satyam Mishra (1908081069), Sagar Khowal (1908081065), Sahil Durrani (1908081066) and Ram Prakash (1908081057**) is submitted during the academic year 2021-22 of the Diploma in Electronics and Communication Engineering (ECE), at Pusa Institute of Technology, New Delhi. The Major Project was done under the supervision of Mr. Anuj Kalra (Lecturer).*

Sign of Project Supervisor
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Sign of HOD
Mrs Shivani Neb

ACKNOWLEDGEMENT

First, we would like to express a great pleasure & sincere gratitude to our honourable Principal

Dr O.P Singh for providing us the opportunity to work on our project under the guidance of sir Mr. Anuj Kalra for carving our path and making us able to achieve successful completion of our project.

We also express our sincere gratitude towards **HOD-ECE**. **Mrs Shivani Neb** for successful completion of our academic semester. We record it as my privilege to deeply thank for providing us the efficient faculty and opportunity to make our ideas into reality.

We again, thanks to our project supervisor **Mr. Anuj Kalra** for his novel association of ideas, encouragement, appreciation and intellectual zeal which motivated us to venture this project successfully

Lastly, we would like to thank our parents for their moral support and our friends who helped us in the successful completion of this project.

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ABSTRACT

Motion electricity generator is a simple circuit that generates electricity when the user or operator walk or do other motion activities involves walking. It is a very helpful and advantageous gadget that the today's generation or youngsters must need to have.

This system contains piezo-electric crystals which plays the crucial role of electricity generation. Using this system in day-to-day life of a normal working adult or a collage teenager is able to solve their gadgets common outdoor charging issues.

There are many expensive power banks to provide outdoor charging to their devices but their issue is they are not self-chargeable and need an external power source to charge. on the other hand, then motion electricity generator does not require any kind of external electrical source they get their charging by the day-to-day walking of the client. This system has a very simple circuit design and made by using only some piezo crystals, a rectifier circuitry, a charging module and some battery.

Introduction

We are developed a mechanism to convert the mechanical energy generated during the person walking into electrical form by using piezo crystal transducers and store them for future use in purposes like mobile charging etc. this system provides the user an extra backup energy source to charge their appliances (mobile phone) in cases like when there is an absence of a power source near the user or the user is at an outstation area like a hill or a farmland. In this kind of scenario, the user is able to charge its application just by the electricity which generated during its normal walk or run without any kind of additional efforts or anything.

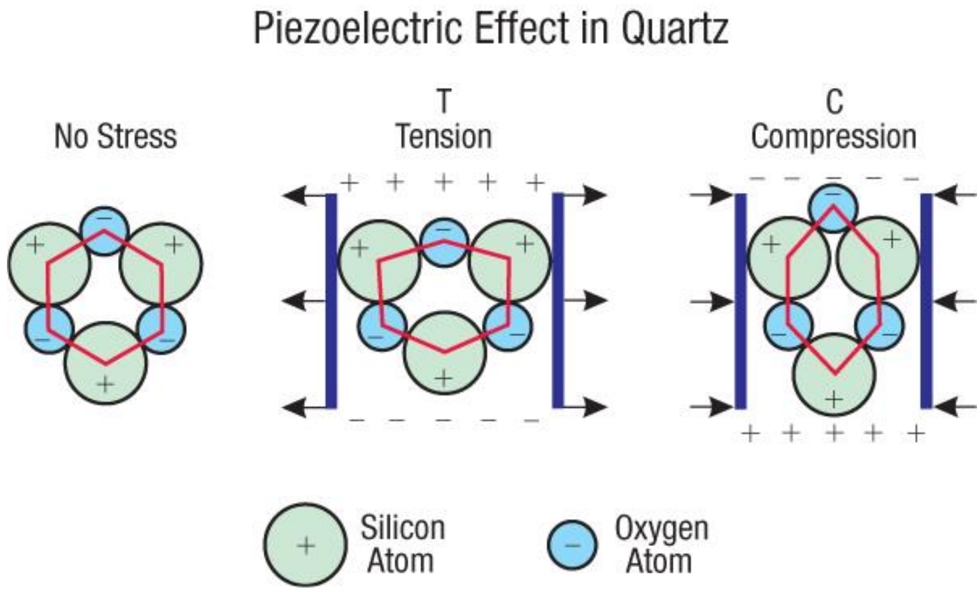
The Charging module which having TP4056 IC is used in this machine to store the electricity generated by the piezo crystals into a chargeable battery source. This module plays a significant part in the charging bank by regulating the in and out flow of charge from the battery.

Principle of working

The Electo-Step is work on the principle of current generation in a piezoelectric crystal. The word piezoelectric originates from the Greek word piezein, which means to squeeze or press. Instead of squeezing grapes to make wine, we're squeezing crystals to make an electric current! Piezoelectricity is found in a ton of everyday electronic devices, from quartz watches to speakers and microphones. Means:

Piezoelectricity is the process of using crystals to convert mechanical energy into electrical energy, or vice versa

There are other crystals that get lumped together as **piezoelectric materials**. The structure in these crystals isn't symmetrical but they still exist in an electrically neutral balance. However, if you apply mechanical pressure to a piezoelectric crystal, the structure deforms, atoms get pushed around, and suddenly you have a crystal that can conduct an electrical current. If you take the same piezoelectric crystal and apply an electric current to it, the crystal will expand and contract, converting electrical energy into mechanical energy.



Modules

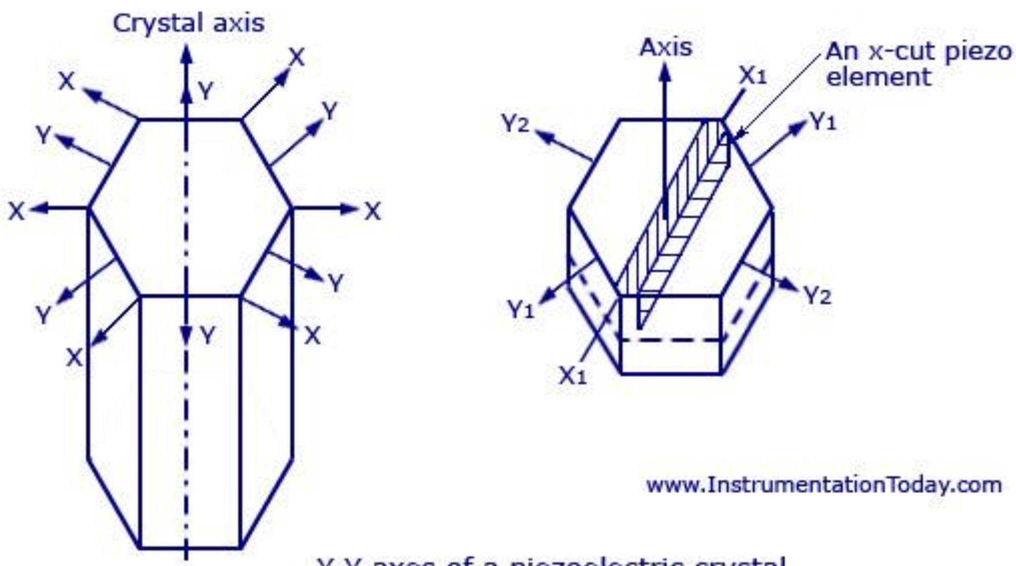
Generator Pad

❖ Piezo crystals

A piezoelectric crystal transducer/sensor is an active sensor and it does not need the help of an external power as it is self-generating.

Piezoelectric Effect

The X-Y axis of a piezoelectric crystal and its cutting technique is shown in the figure below.



X-Y axes of a piezoelectric crystal

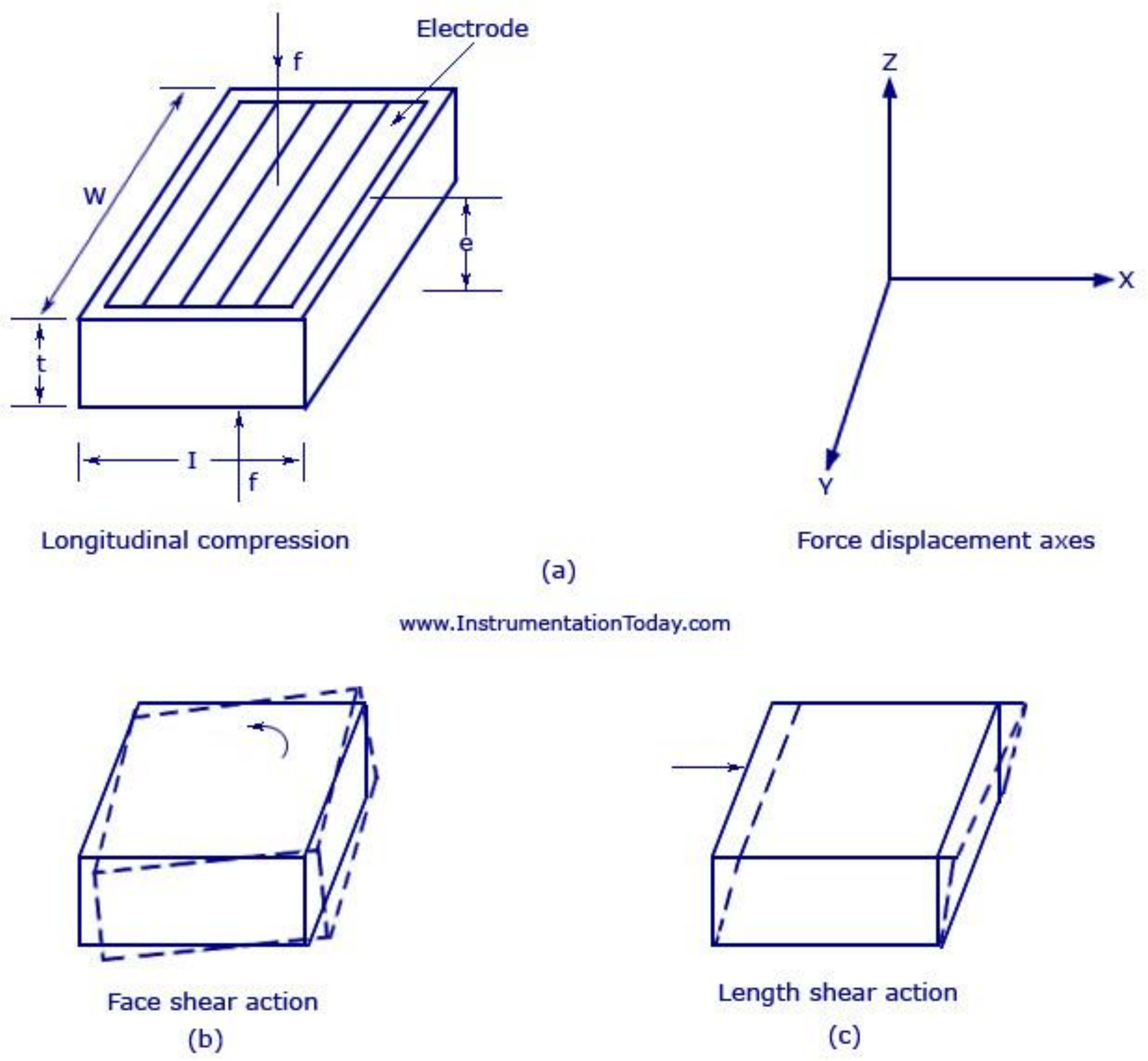
The direction, perpendicular to the largest face, is the cut axis referred to.

If an electric stress is applied in the directions of an electric axis (X-axis), a mechanical strain is produced in the direction of the Y-axis, which is perpendicular to the relevant X-axis. Similarly, if a mechanical strain is given along the Y-axis, electrical charges will be produced on the faces of the crystal, perpendicular to the X-axis which is at right angles to the Y-axis.

Some of the materials that inherit piezo-electric effect are quartz crystal, Rochelle salt, barium titanate, and so on. The main advantages of these crystals are that they have high mechanical and thermal state capability, capability of withstanding high order of strain, low leakage, and good frequency response, and so on.

How Piezoelectricity Works

We have specific materials that are suited for piezoelectricity applications, but how exactly does the process work? With the Piezoelectric Effect. The most unique trait of this effect is that it works two



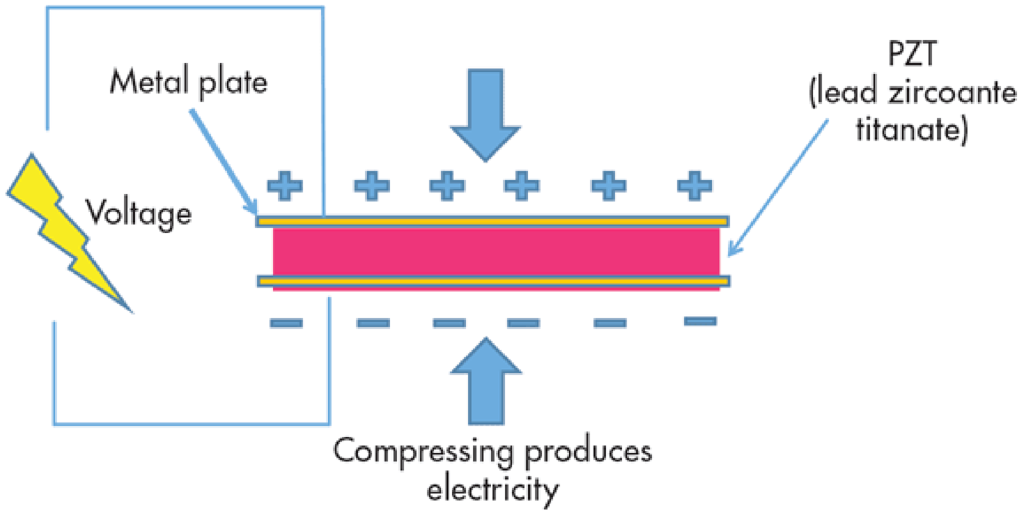
ways. You can apply mechanical energy or electrical energy to the same piezoelectric material and get an opposite result.

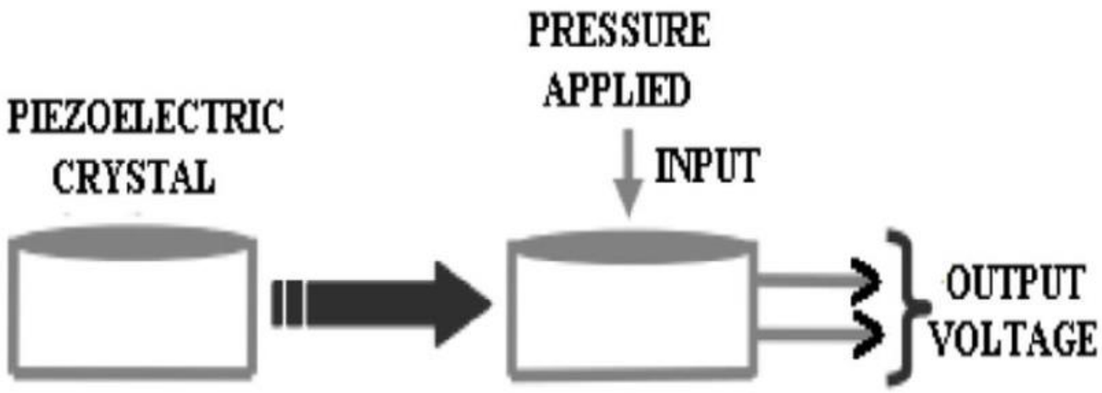
Applying mechanical energy to a crystal is called a **direct piezoelectric effect** and works like this:

I. A piezoelectric crystal is placed between two metal plates. At this point the material is in perfect balance and does not conduct an electric current.

II. Mechanical pressure is then applied to the material by the metal plates, which forces the electric charges within the crystal out of balance. Excess negative and positive charges appear on opposite sides of the crystal face.

III. The metal plate collects these charges, which can be used to produce a voltage and send an electrical current through a circuit.





Piezoelectricity Today

In today's world of electronics piezoelectricity is used everywhere. Asking Google for directions to a new restaurant uses piezoelectricity in the microphone. There's even a subway in Tokyo that uses the power of human footsteps to power piezoelectric structures in the ground. You'll find piezoelectricity being used in these electronic applications:

- Actuators

- Speakers & Buzzers
- Drivers
- Sensors
- Power
- Motors

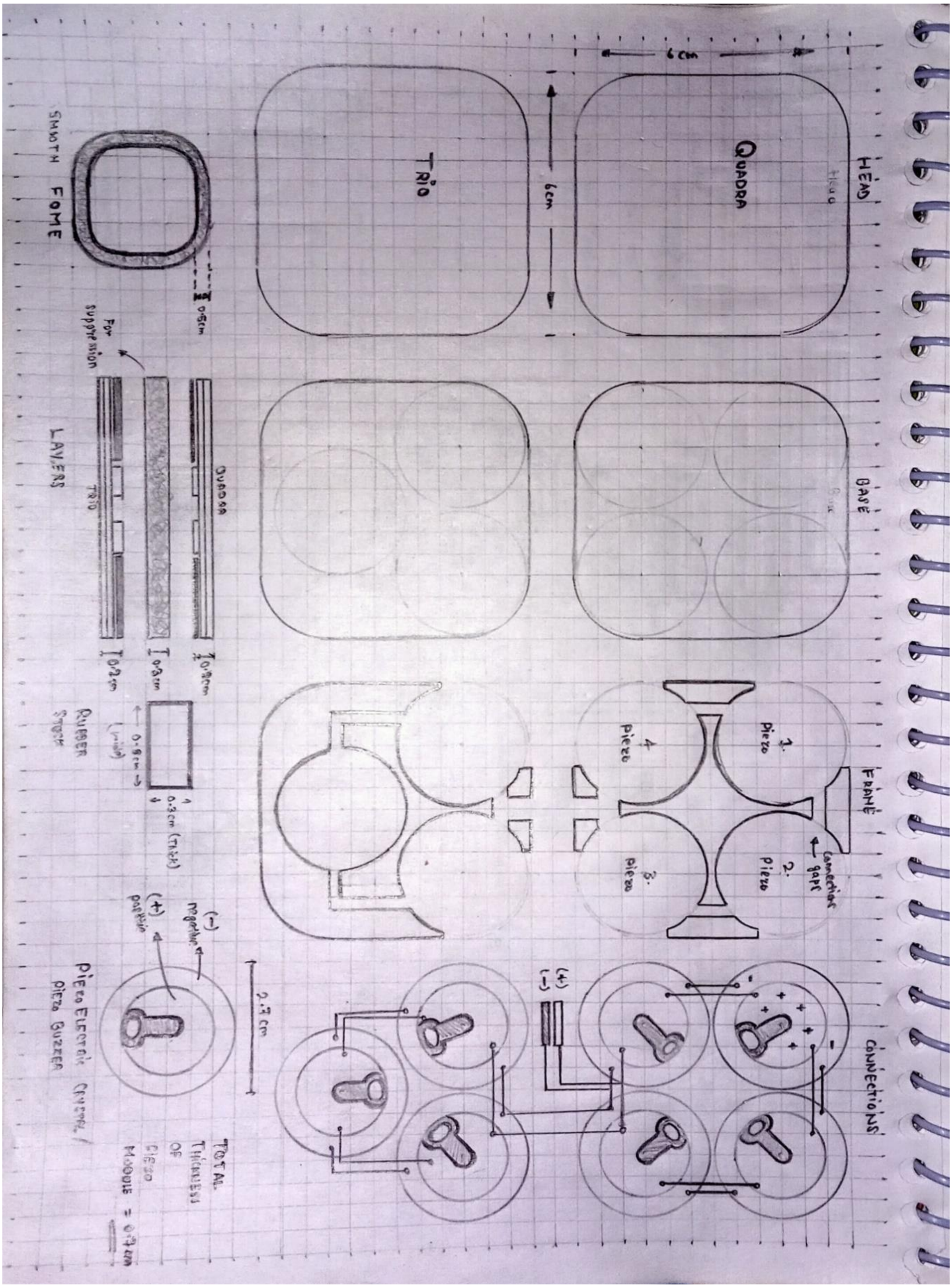
Piezoelectricity and the Future

What does the future hold for piezoelectricity? The possibilities abound. One popular idea that inventors are throwing around is using piezoelectricity for energy harvesting. Imagine having piezoelectric devices in your smartphone that could be activated from the simple movement of your body to keep them charged.

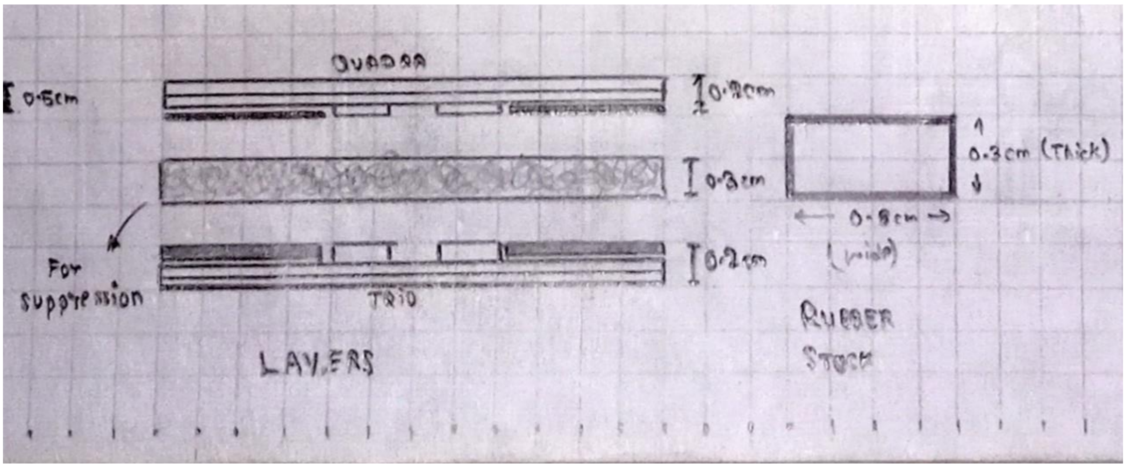
Thinking a bit bigger, you could also embed a piezoelectric system underneath highway pavement that can be activated by the wheels of traveling cars. This energy could then be used light stoplights and other nearby devices. Couple that with a road filled with electric cars and you'd find yourself in net positive energy situation.

Piezo Crystal

❖ Frame



Blueprint



Blueprint

The following structure is designed to generate the maximum amount of electricity possible by the required no of piezo crystal with comparatively high sensitivity of current generation then normal means,

Charging Bank

❖ Rectifier Circuit

Bridge Rectifier

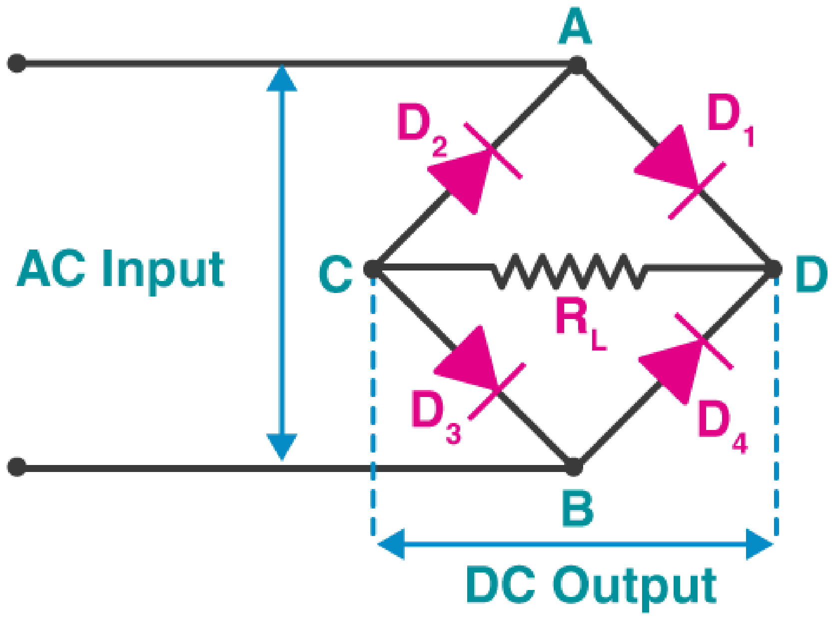
Many electronic circuits require a rectified DC power supply to power various electronic basic components from the available AC mains supply. Rectifiers are used to convert an AC power to a DC power. Among the rectifiers, the bridge rectifier is the most efficient rectifier circuit.

We can define bridge rectifiers as a type of full-wave rectifier that uses four or more diodes in a bridge circuit configuration to efficiently convert alternating (AC) current to a direct (DC) current. In the next few sections, let us learn more about its construction, working, and more

.

- Construction

The construction of a bridge rectifier is shown in the figure below. The bridge rectifier circuit is made of four diodes D_1, D_2, D_3, D_4, and a load resistor R_L. The four diodes are connected in a closed-loop configuration to efficiently convert the alternating current (AC) into Direct Current (DC). The main advantage of this configuration is the absence of the expensive centre-tapped transformer. Therefore, the size and cost are reduced.

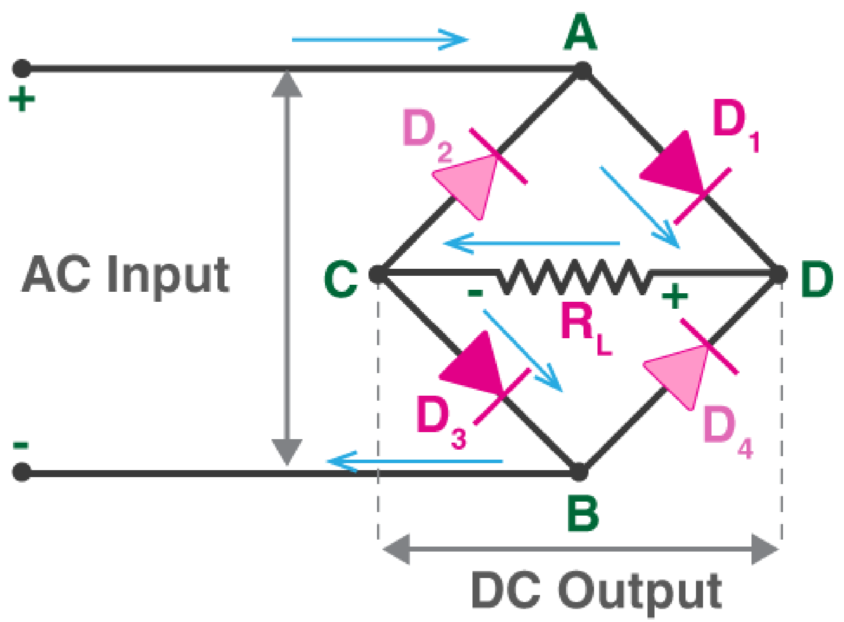


The input signal is applied across terminals A and B and the output DC signal is obtained across the load resistor R_L connected between terminals C and D. The four diodes are arranged in such a way that only two diodes conduct electricity during each half cycle. D_1 and D_3 are pairs that conduct electric current during the positive half cycle/. Likewise, diodes D_2 and D_4 conduct electric current during a negative half cycle.

- Working

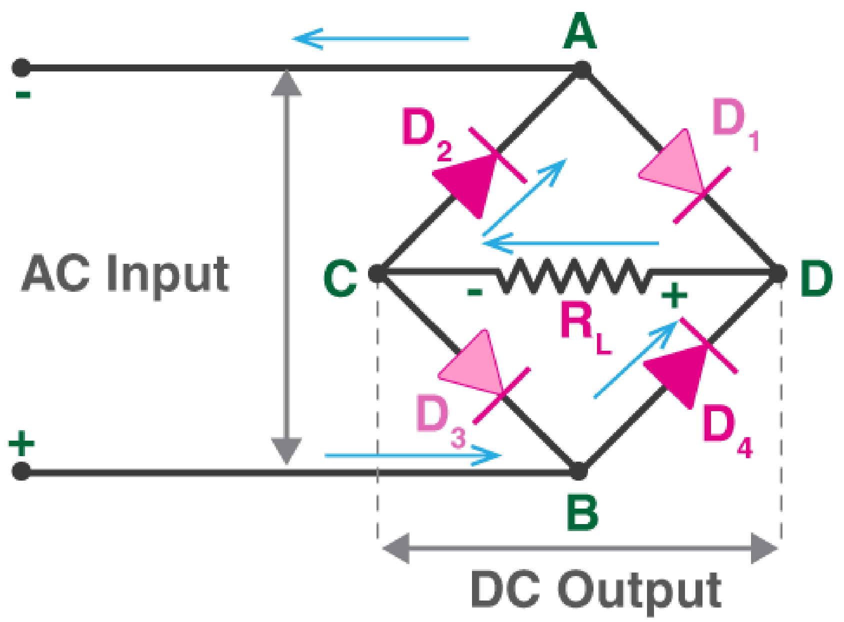
When an AC signal is applied across the bridge rectifier, during the positive half cycle, terminal A becomes positive while terminal B becomes negative. This results in diodes D_1 and D_3 to become forward biased while D_2 and D_4 become reverse biased.

The current flow during the positive half-cycle is shown in the figure below:



During the negative half-cycle, terminal B becomes positive while the terminal A becomes negative. This causes diodes D_2 and D_4 to become forward biased and diode D_1 and D_3 to be reverse biased.

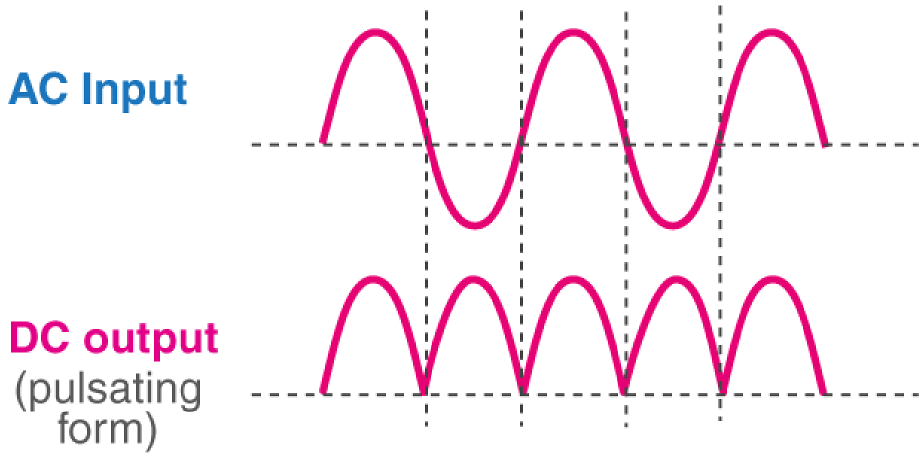
The current flow during the negative half cycle is shown in the figure below:



From the figures given above, we notice that the current flow across load resistor R_L is the same during the positive half cycle and the negative half cycles. The output DC signal polarity may be either completely positive or negative. In our case, it is completely positive. If the direction of diodes is reversed then we get a complete negative DC voltage.

Thus, a bridge rectifier allows electric current during both positive and negative half cycles of the input AC signal.

The output waveforms of the bridge rectifier are shown in the below figure.



- Efficiency

The rectifier efficiency determines how efficiently the rectifier converts Alternating Current (AC) into Direct Current (DC). Rectifier efficiency is defined as the ratio of the DC output power to the AC input power. The maximum efficiency of a bridge rectifier is 81.2%.

$$\eta = \frac{DC Output Power}{AC Output Power}$$

- Advantages

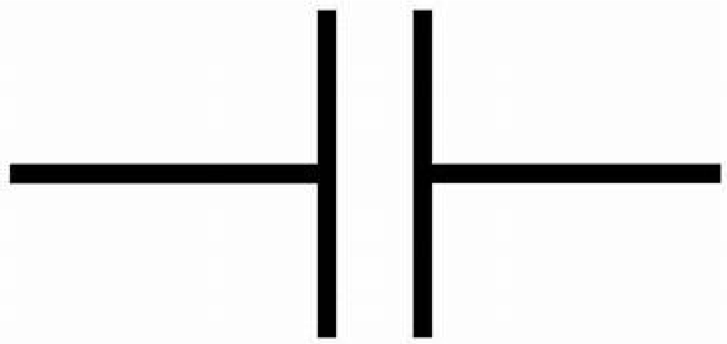
  - The efficiency of the bridge rectifier is higher than the efficiency of a half-wave rectifier. However, the rectifier efficiency of the bridge rectifier and the centre-tapped full-wave rectifier is the same.
  - The DC output signal of the bridge rectifier is smoother than the output DC signal of a half-wave rectifier.
  - In a half-wave rectifier, only half of the input AC signal is used and the other half is blocked. Half of the input signal is wasted in a half-wave rectifier. However, in a bridge rectifier, the electric current is allowed during both positive and negative half cycles of the input AC signal. Hence, the output DC signal is almost equal to the input AC signal

❖ Filter Circuit

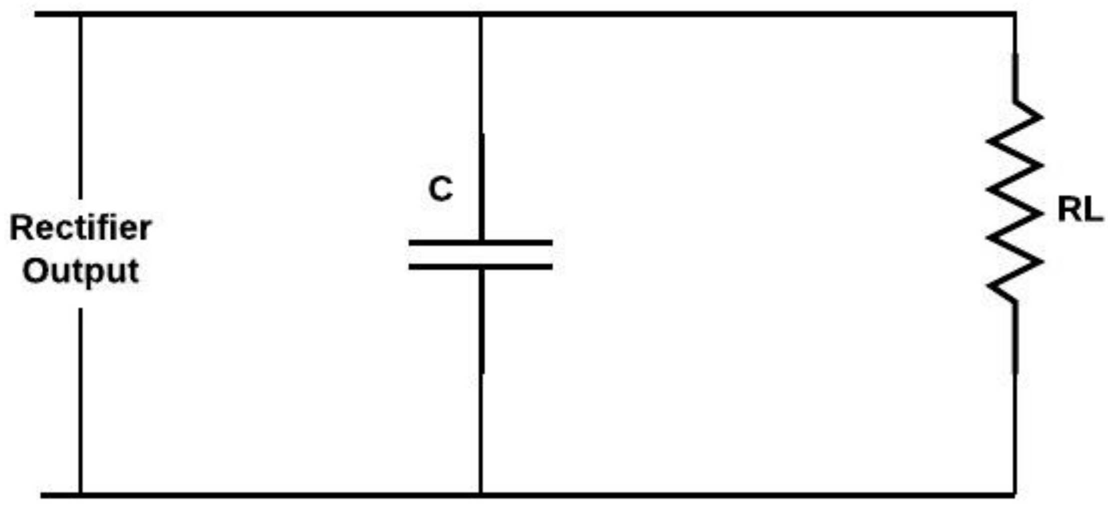
The capacitor is a reactive component, used in analogy electronic filters because the capacitor impedance is a function of frequency. The capacitor that affects a signal can be frequency-dependent. So, this property is widely used in designing the filter. Analog electronic filters like LPF can be used to execute a function of predefined signal processing. The main function of this filter is to allow low frequencies and block high frequencies.

What is a Filter Capacitor?

A typical **capacitor filter** circuit diagram is shown below. The designing of this circuit can be done with a capacitor (C) as well as load resistor (RL). The rectifier's exciting voltage is given across the terminals of a capacitor. Whenever the voltage of the rectifier enhances then the capacitor will be charged as well as supplies the current to the load.

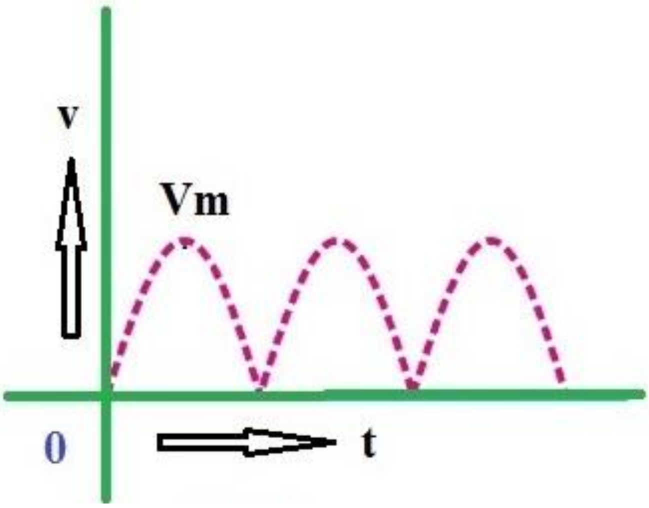


Filter Capacitor Symbol



Capacitor Filter

At the last part of the quarter phase, the capacitor will be charged to the highest rectifier voltage value that is denoted with Vm, and then the voltage of the rectifier starts to reduce. As this happens, the capacitor starts discharging through the voltage across it and load. The voltage across the load will reduce little only because the next peak voltage occurs instantaneously to charge the capacitor. This procedure will repeat many times and the output waveform will be seen that very slight ripple is missing in the output. Furthermore, the output voltage is superior because it remains significantly close to the highest value of the output voltage of the rectifier.

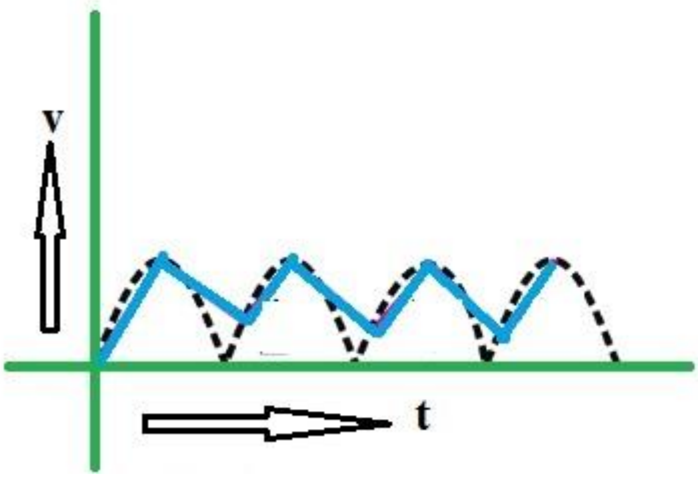


Input

A capacitor gives an infinite reactance to DC. For DC, f=0

$$X_c = 1/2\pi fc = 1/2\pi \times 0 \times C = \text{infinite}$$

Therefore, a capacitor doesn’t permit DC to flow through it.



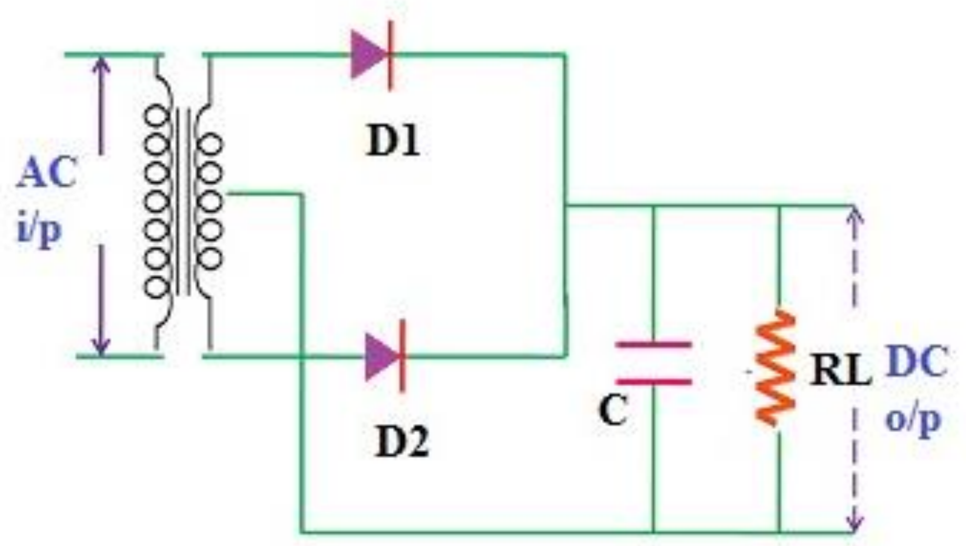
Output

The capacitor filter circuit is very famous due to its features like low cost, less weight, small size, & good characteristics. The capacitor filter circuit is applicable for small load currents

Full Wave Rectifier with Capacitor Filter

The main function of full wave rectifier is to convert an AC into DC. As the name implies, this rectifier rectifies both the half cycles of the I/p AC signal, but the DC signal acquired at the o/p still have some waves. To decrease these waves at the o/p this filter is used.

In the full wave rectifier circuit using a capacitor filter, the capacitor C is located across the RL load resistor. The working of this rectifier is almost the same as a half wave rectifier. The only dissimilarity is half wave rectifier has just one-half cycles (positive or negative) whereas in full wave rectifier has two cycles (positive and negative).



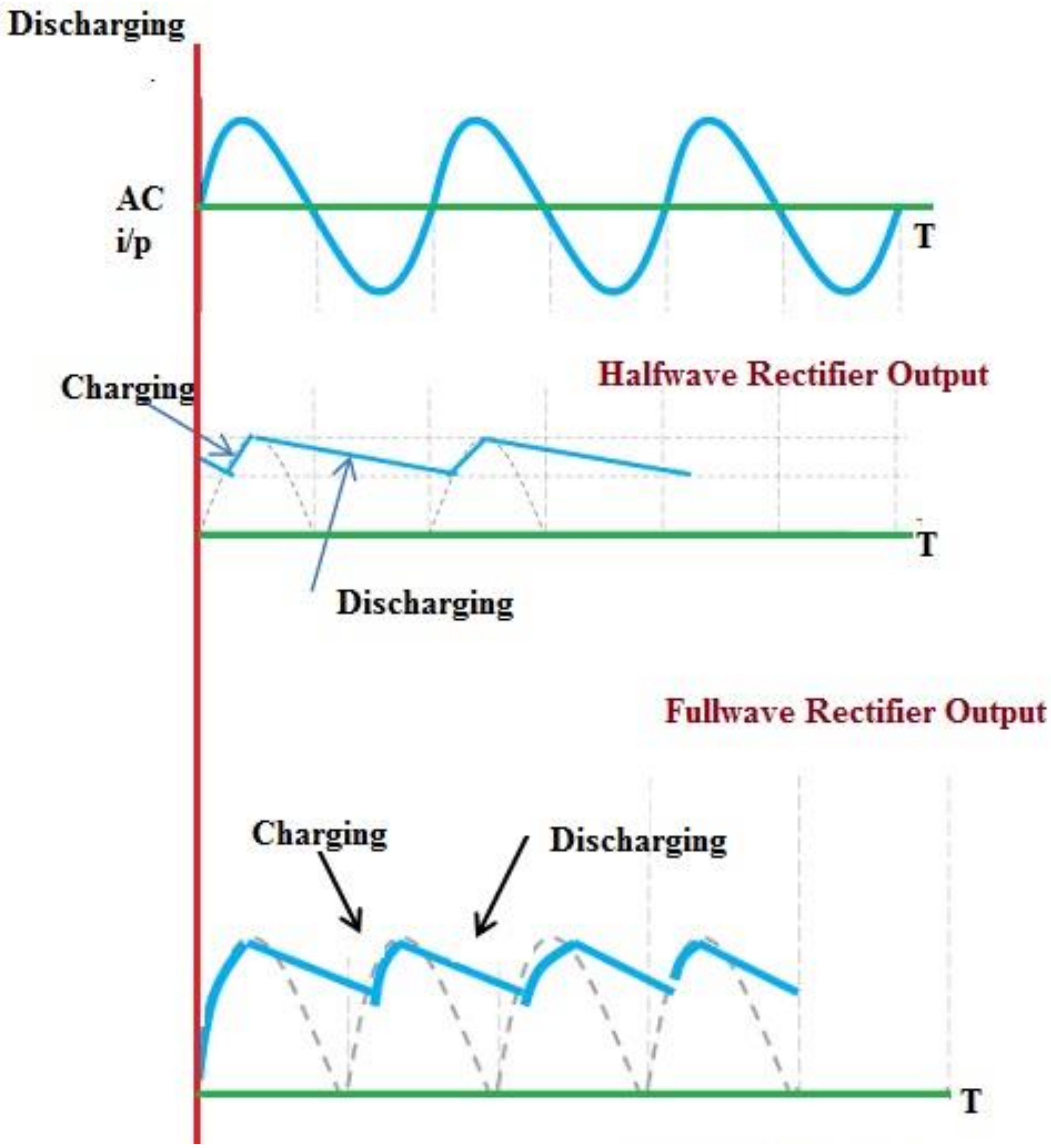
Once the i/p AC voltage is applied throughout the positive half cycle, then the D1 diode gets forward biased and permits flow of current while the D2 diode gets reverse biased & blocks the flow of current.

Throughout the above half cycle, the current in the D1 diode gets the filter and energizes the capacitor. But the capacitor charging will occur just when the voltage which is applied is superior to the capacitor voltage. Firstly, the capacitor will not charge, as no voltage will stay among the capacitor plates. So, when the voltage is switched on, then the capacitor will get charged immediately.

Throughout this transmission time, the capacitor gets charged to the highest value of the I/p voltage supply. The capacitor includes a highest charge at the quarter waveform in the positive half cycle. At this end, the voltage supply is equivalent to the voltage of the capacitor. Once the AC voltage begins falling & turns into less than the voltage of the capacitor, after that the capacitor begins discharging gradually.

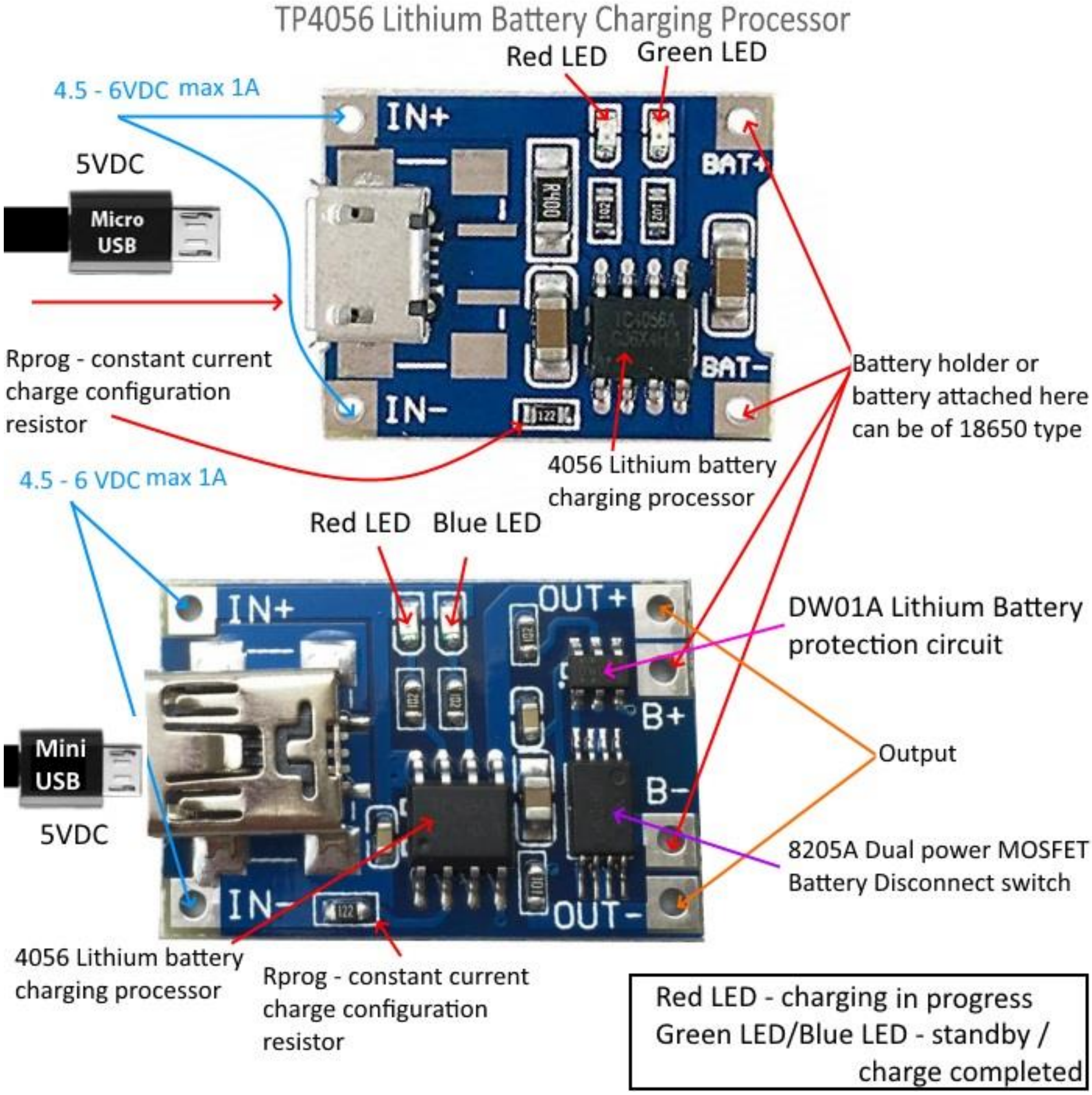
As the a/p AC voltage supply gets the negative half-cycle, then the D1 diode gets reverse biased but the D2 diode is forward biased. Throughout the negative half cycle, the flow of current in the second diode gets the filter to charge the capacitor. But the capacitor charging occurs simply while the applied AC voltage is superior to the voltage of the capacitor.

The capacitor in the circuit is not charged fully, so the charging of this does not occur instantly. Once the voltage supply becomes superior to the voltage of the capacitor, the capacitor gets charging. In both the half cycles, the flow of current will be in the similar direction across the RL load resistor. Thus, we acquire either whole positive half cycle otherwise negative half cycle. In this case, we can get the total positive half cycle.

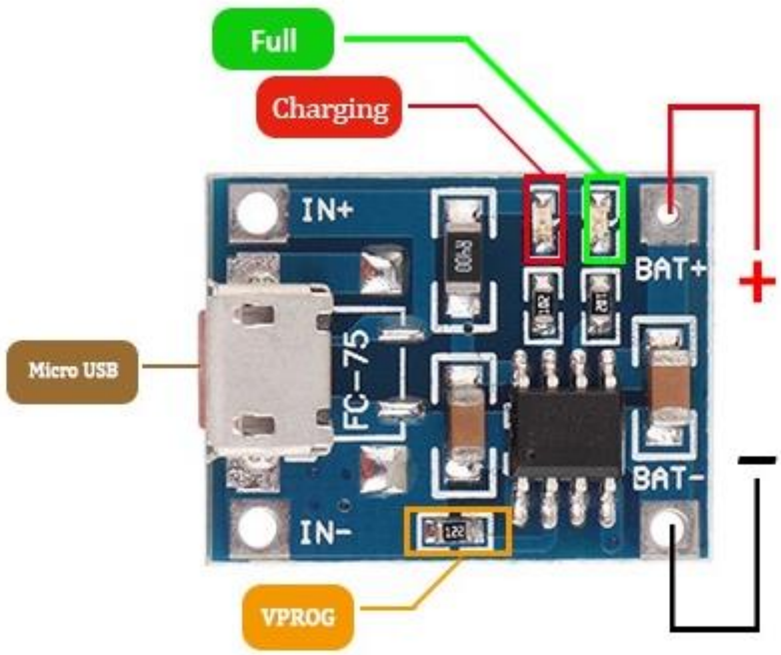

Discharging
AC
i/p
T
Halfwave Rectifier Output
Charging
T
Discharging
Fullwave Rectifier Output
Charging
Discharging
T

❖ Charging module TP4056

TP4056 Linear Lithium -Ion Battery Charging Module



TP4056 module is a linear charger lithium-ion battery. This module can charge batteries consists of single cells. Most importantly, it supports constant current and constant voltage modes of charging operations. Users can select both modes. This module offers a 1-ampere charging current. Almost all the electronic devices run with batteries. And these batteries can get discharged. Therefore, chargers are used to charge them by putting energy into them. TP4056 is also a battery charger that has a fixed charge voltage of 4.2 volts.



Charging module pin diagram

Pin Configuration Description

This module consists of TP4056 charger IC and the DW01A protection IC for Lithium-Ion battery. The diagram showing all the pins of this module is given below.

- Pin#1 OUT+

  This is the output pin which supplies the positive voltage of a battery. It is connected to the circuit which needs power from a battery.

- Pin#2 B+

  Connect the Positive terminal of lithium battery with this pin using a battery connector.

- Pin#3 B-

  Connect the Negative terminal of lithium battery with this pin using a battery connector.

- Pin#4 OUT-

  This the output pin which supplies the negative voltage of the battery. It is connected to the circuit which needs power from a battery.

- Pin#5 IN+ and Pin#6 IN-

  These pins are used to charge the battery by providing +5V at IN+ and -5V at IN- terminals when you don't have a USB cable. Otherwise, you can directly charge from USB supply by using a USB cable.

- Pin#7 Red and Pin#8 Green LED

  These two LEDs indicate the status of charging. When a battery is charging, Red LED glows, and when it is fully charged, the Green LED turns on.

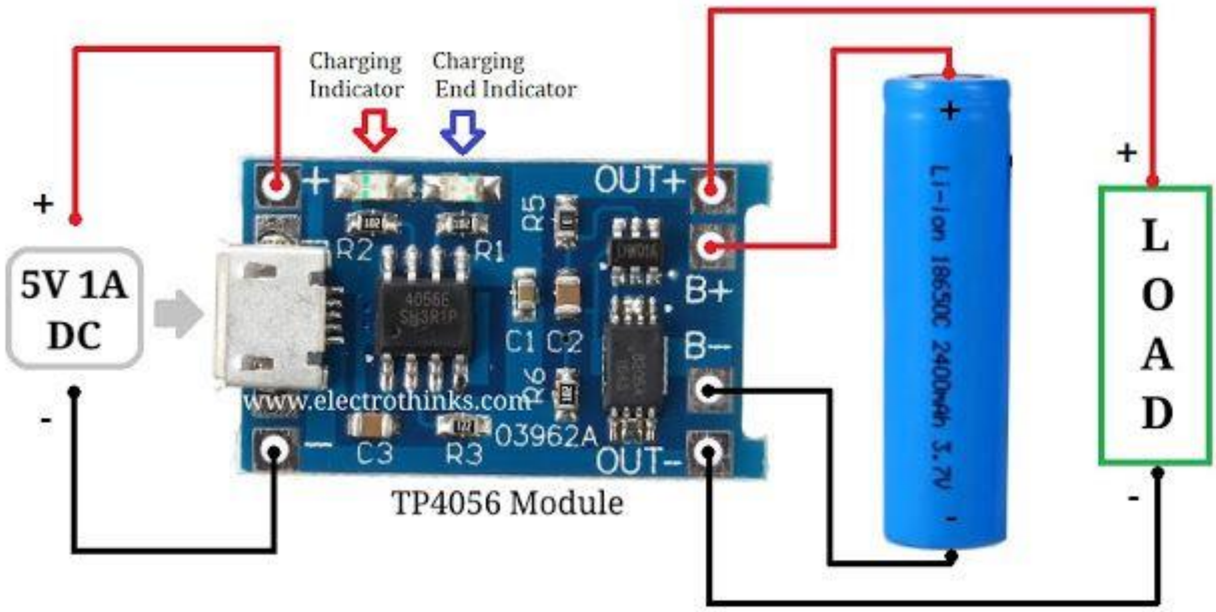
Where to Use it?

Due to its capability of supplying 4.2V, it is highly suitable for charging 18650 cells and other 3.7V batteries. It requires minimum external components; therefore, you can use this module in portable applications. Mobile Phones, Tablets, Laptops, Cameras, power banks and many other electronic devices run on battery and hence use this module for charging the battery. This module can also be used within a wall adapter and USB.

TP4056 Equivalent Modules:

TP4056A (only charging),

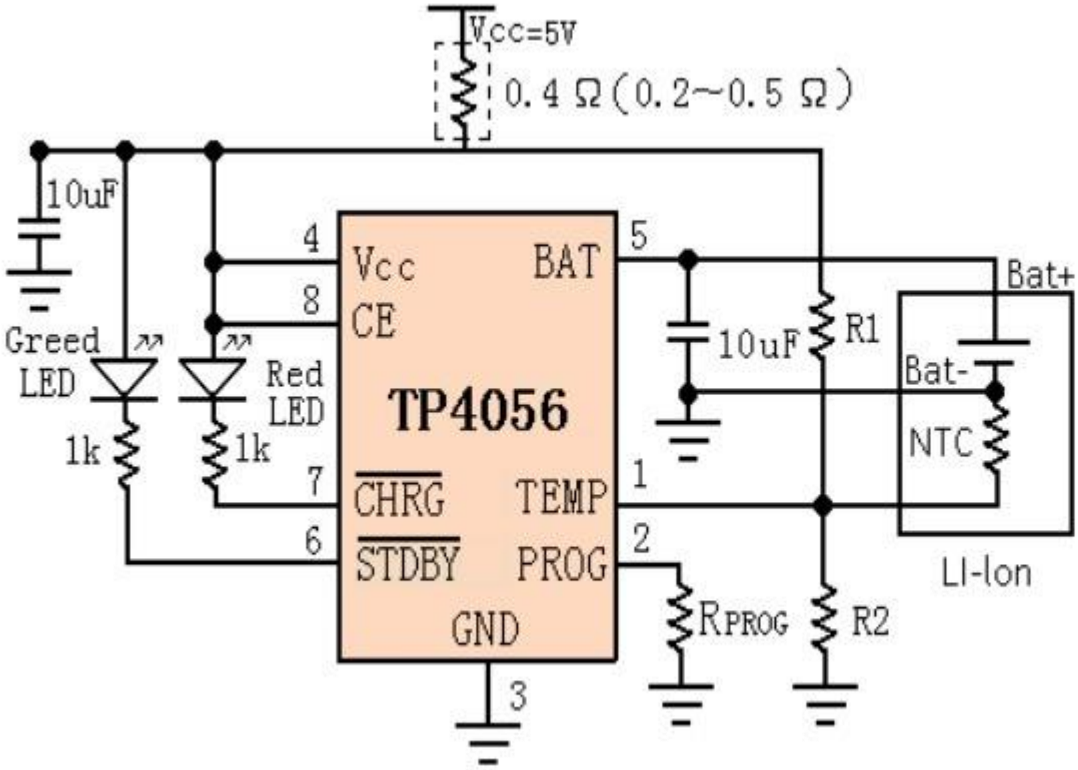
TP541



Connection Diagram

TP4056 applications

- It is used for charging batteries and therefore can be used in all those devices which run on battery. Few applications of this module include:
- Portable electronics like laptops, chargers, USB Bus-Powered Chargers, power banks, etc.
- Safe charging and discharging of lithium cells.
- It can be used in projects for powering Arduino.



Module Internal Circuit Diagram

How to use TP4056

TP4056 module operates by supplying 5V power from either micro-USB cable or the IN+ and IN- solder pads. At least, the current of 1A is required for the charger to correctly charge a battery connected at the output terminals. Connect the cell you need to charge between B+ and B- terminals. The OUT+ and OUT- pads are used to supply the power of the battery. So, if you are running a load, you can connect that load between these two pads. But remember if you are charging a cell, disconnect the load from the module.

❖ Chargeable Battery

Lithium -Ion Batteries

A lithium-ion battery or Li-ion battery is a type of rechargeable battery composed of cells in which lithium ions move from the negative electrode through an electrolyte to the positive electrode during discharge and back when charging. Li-ion cells use an intercalated lithium compound as the material at the positive electrode and typically graphite at the negative electrode. Li-ion batteries have a high energy density, no memory effect (other than LFP cells)[10] and low self-discharge. Cells can be manufactured to either prioritize energy or power density.[11] They can however be a safety hazard since they contain flammable electrolytes and if damaged or incorrectly charged can lead to explosions and fires.

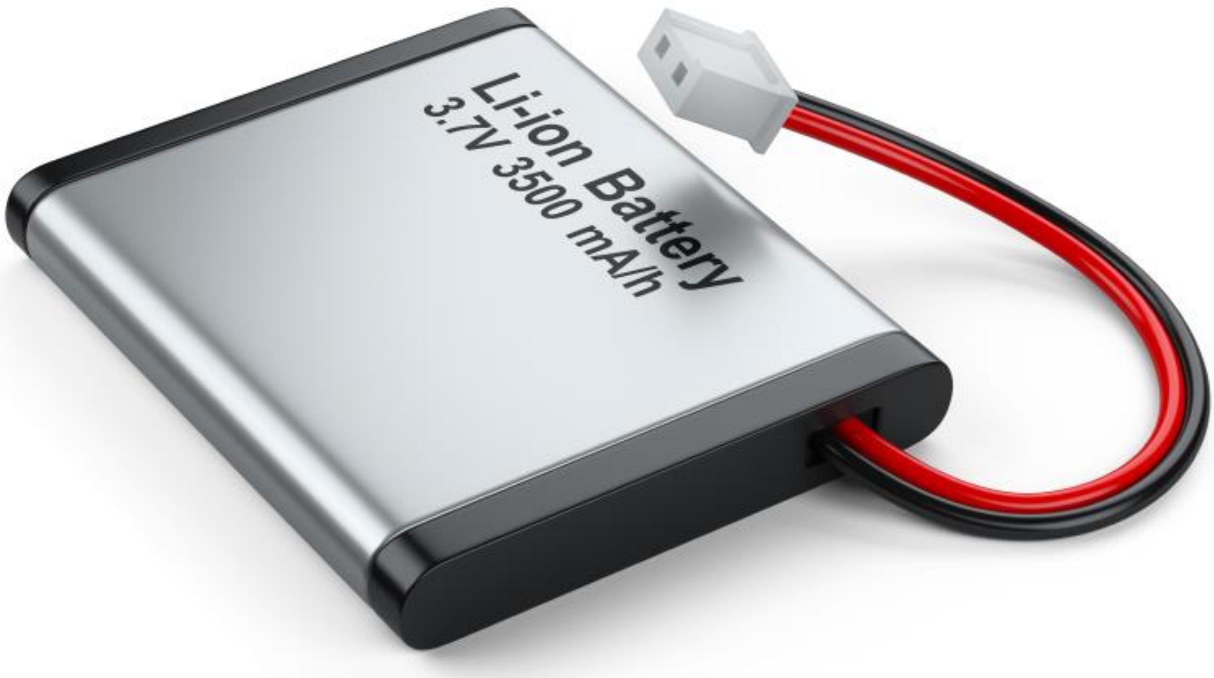
A lithium-ion (Li-ion) battery is an advanced battery technology that uses lithium ions as a key component of its electrochemistry. During a discharge cycle, lithium atoms in the anode are ionized and separated from their electrons. The lithium ions move from the anode and pass through the electrolyte until they reach the cathode, where they recombine with their electrons and electrically neutralize. The lithium ions are small enough to be able to move through a micro-permeable separator between the anode and cathode. In part because of lithium's small size (third only to hydrogen and helium), Li-ion batteries are capable of having a very high voltage and charge storage per unit mass and unit volume.

Li-ion batteries can use a number of different materials as electrodes. The most common combination is that of lithium cobalt oxide (cathode) and graphite (anode), which is most commonly found in portable electronic devices such as cell phones and laptops. Other cathode materials include lithium manganese oxide (used in hybrid electric and electric automobiles) and lithium iron phosphate. Li-ion batteries typically use ether (a class of organic compounds) as an electrolyte.

What are some advantages of Li-ion Batteries?

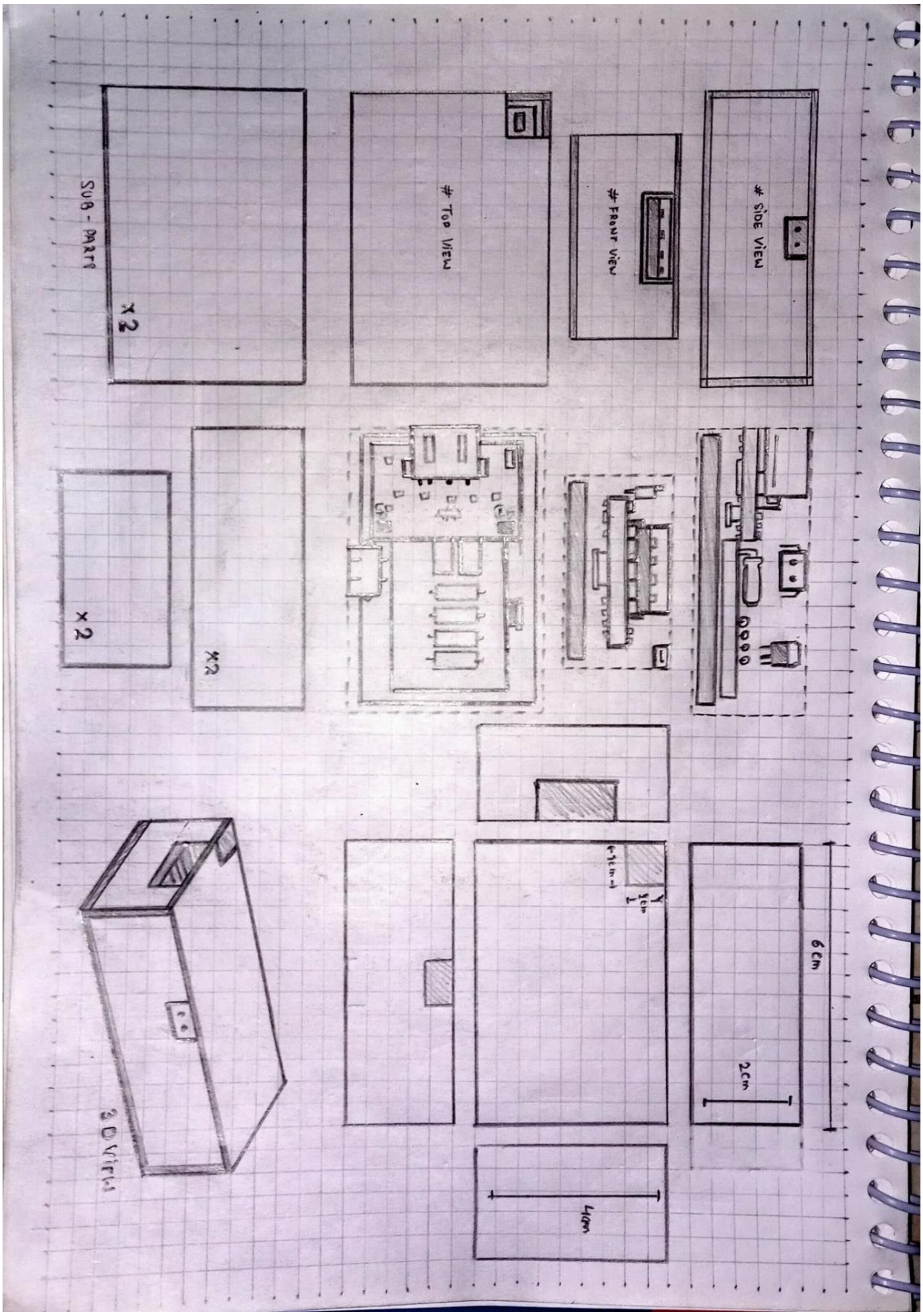
Compared to the other high-quality rechargeable battery technologies (nickel-cadmium or nickel-metal-hydride), Li-ion batteries have a number of advantages. They have one of the highest energy densities of any battery technology today (100-265 Wh/kg or 250-670 Wh/L). In addition, Li-ion battery cells can deliver up to 3.6 Volts, 3 times higher than technologies such as Ni-Cd or Ni-MH. This means that they can deliver large amounts of current for high-power applications, which has Li-ion batteries are also comparatively low maintenance, and do not require scheduled cycling to maintain their battery life. Li-ion batteries have no memory effect, a detrimental process where repeated partial discharge/charge cycles can cause a battery to 'remember' a lower capacity. This is an advantage over both Ni-Cd and Ni-MH, which display this effect. Li-ion batteries also have low self-discharge rate of around 1.5-2% per month. They do not contain toxic cadmium, which makes them easier to dispose of than Ni-Cd batteries.

Li-ion Cells



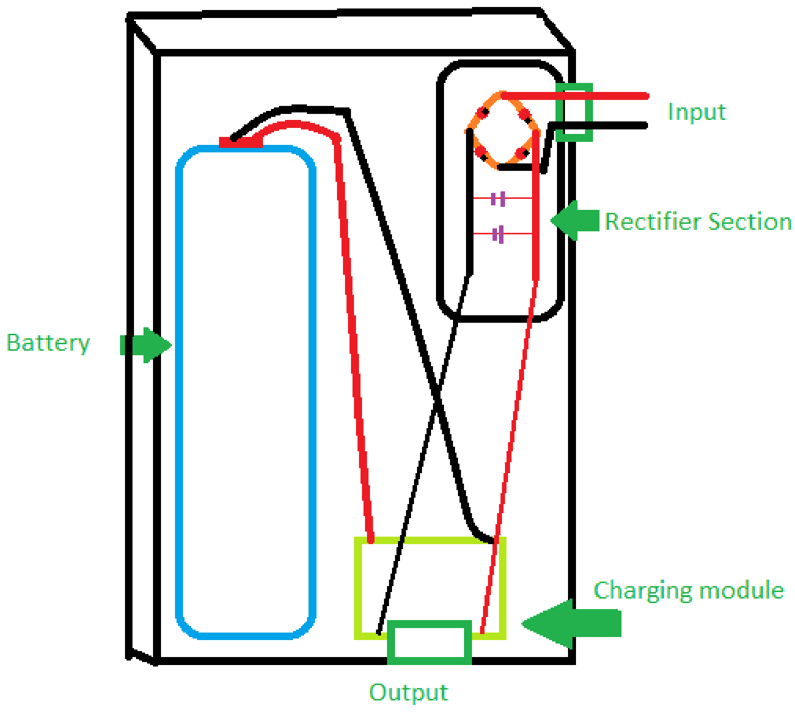
Li-ion Battery

❖ Frame



Blueprint

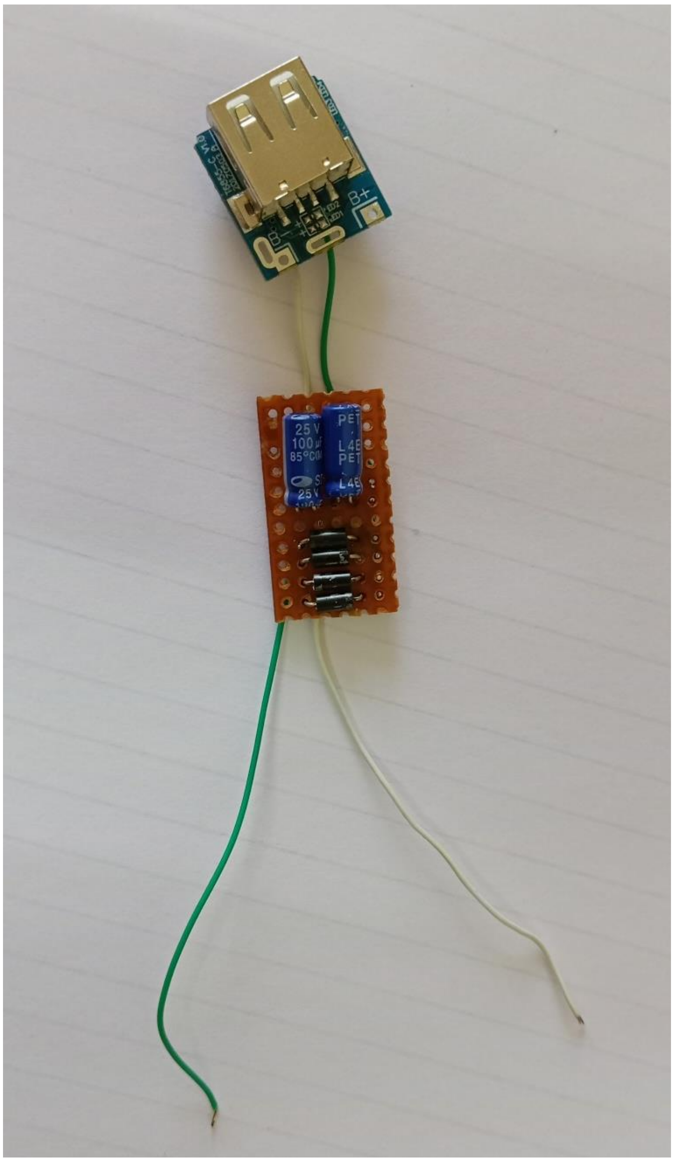
Circuit Diagram

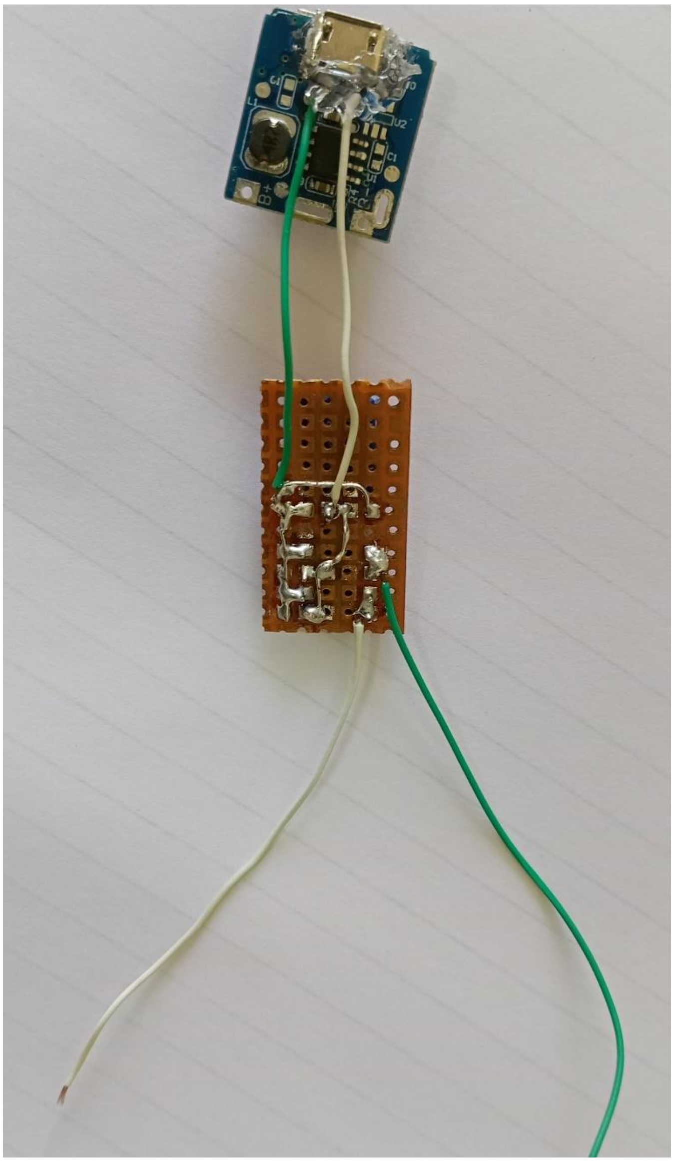


Raw Figure

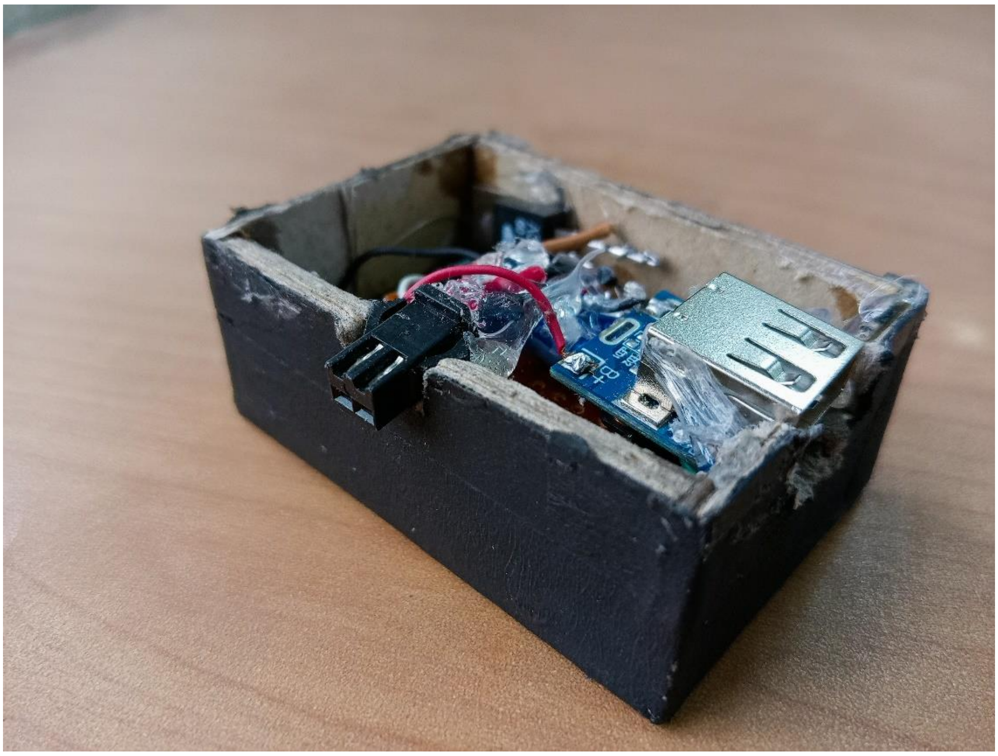
Frame Design

Module Connection

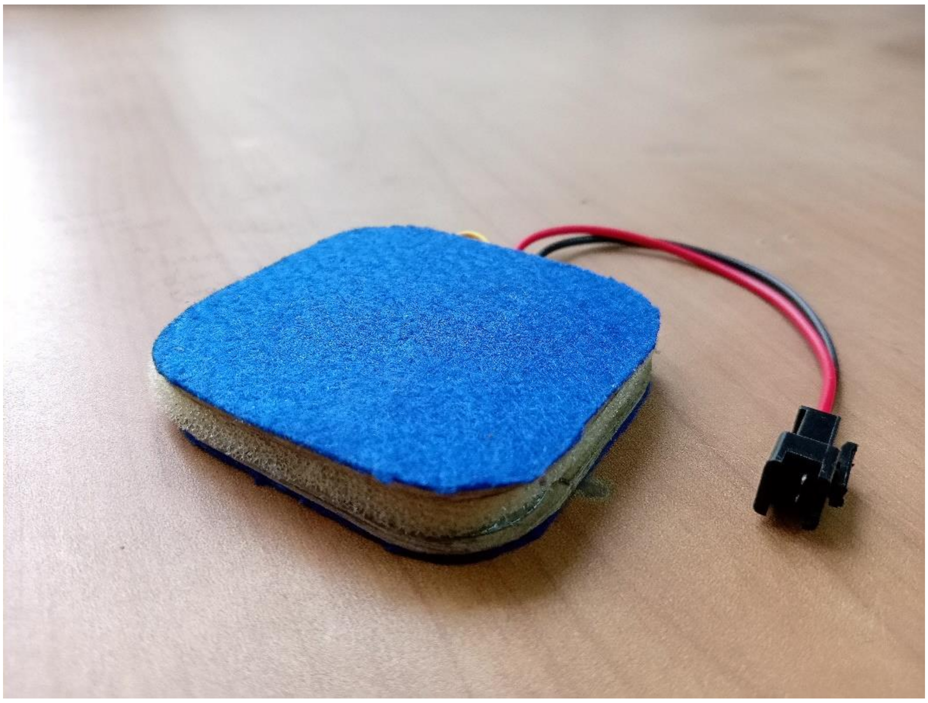




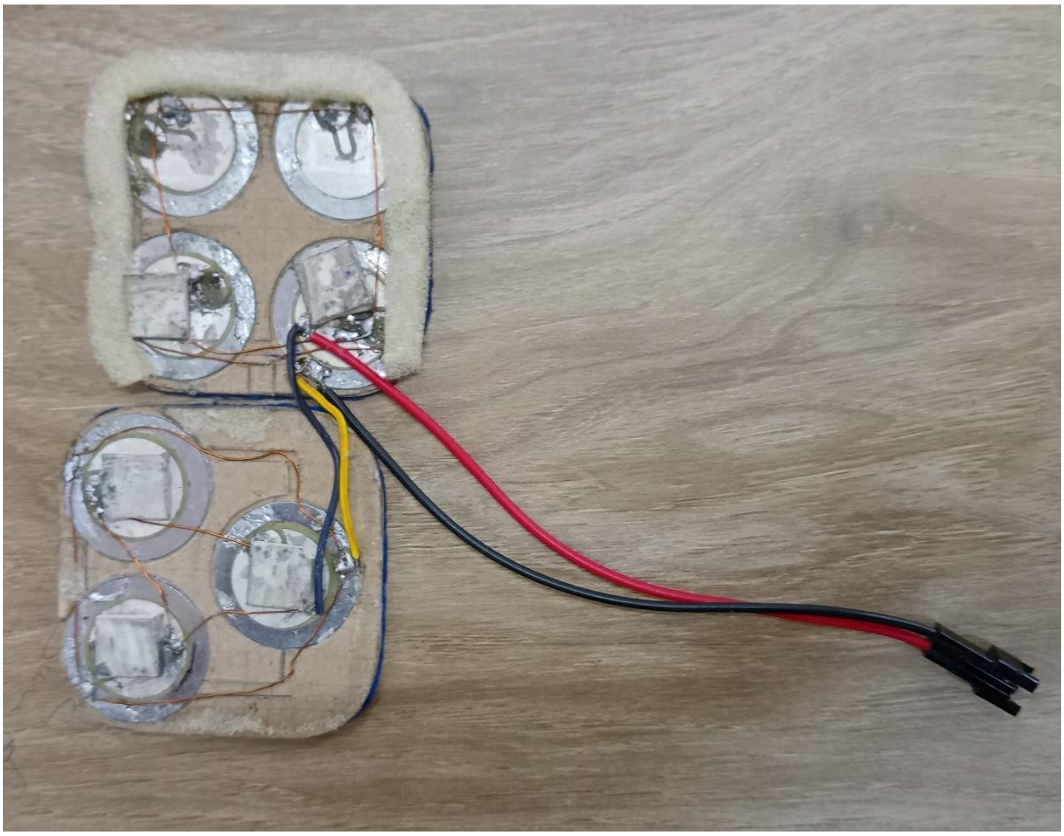
Outer View



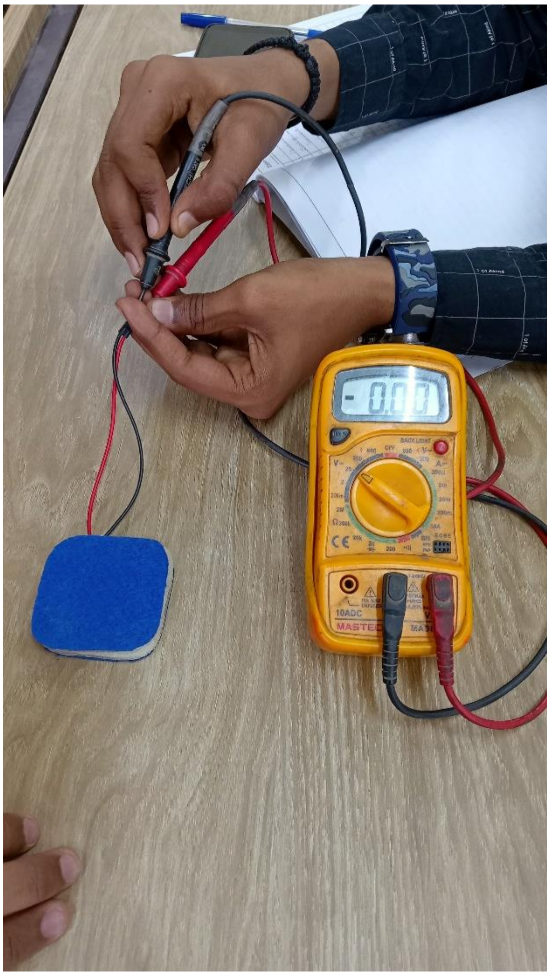
Inner View

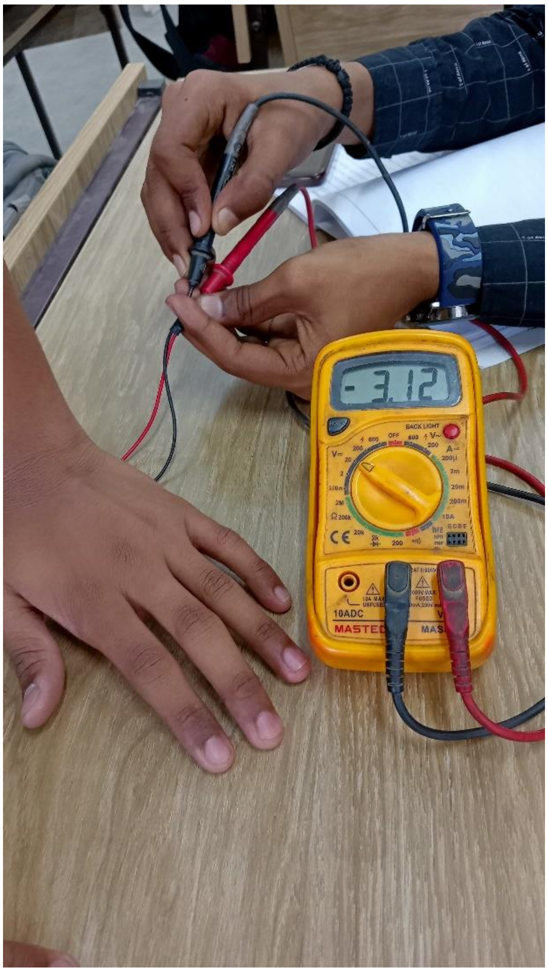


Outer View

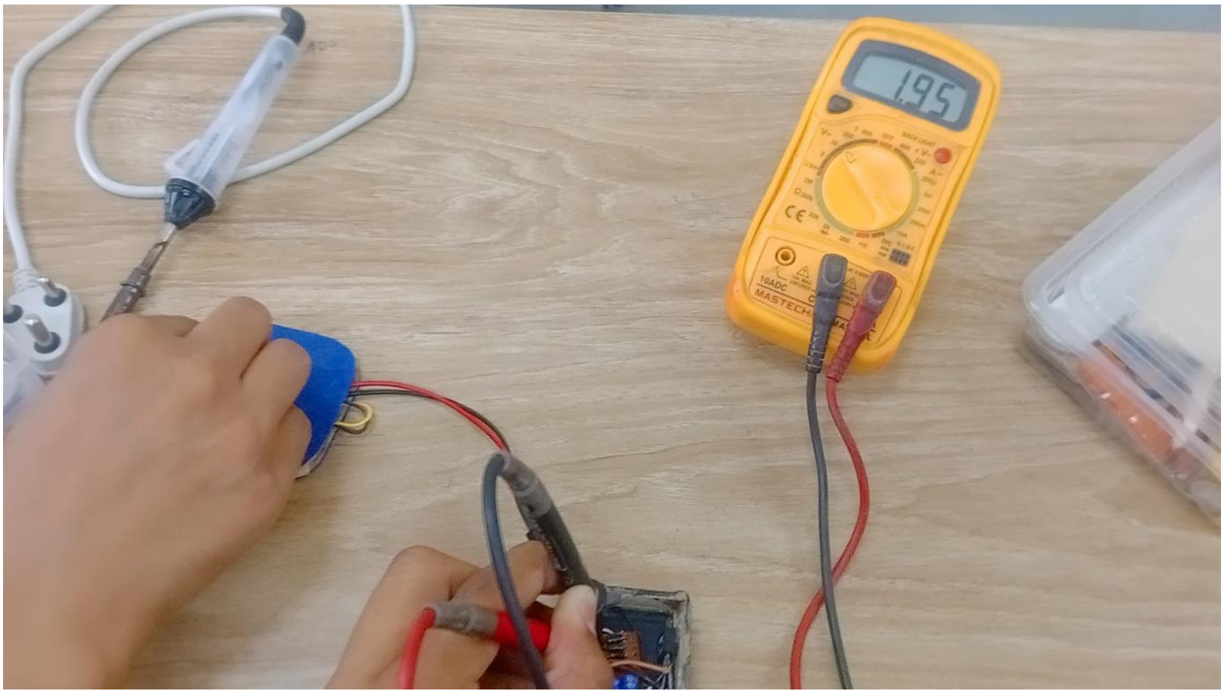


Inner View



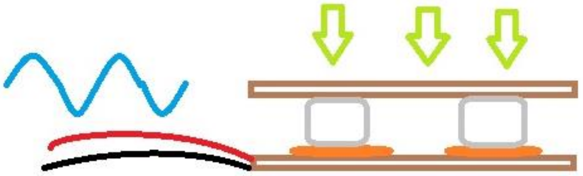


Testing’s

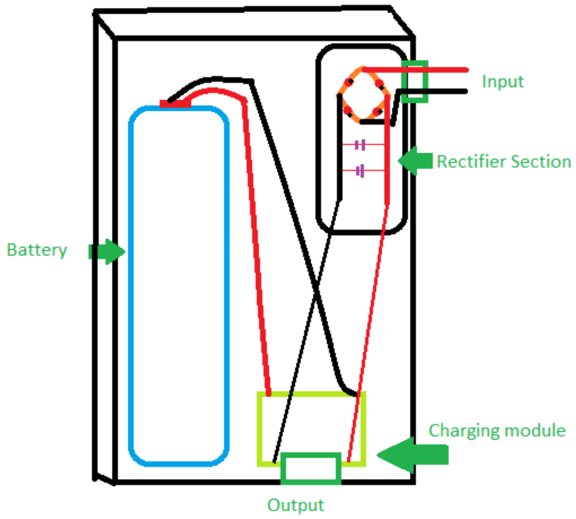


Working

The above showed diagram is of generator pad and its side angle view in which we clearly see the piezo crystal placed between two parallel plates along with a rubber for pressure distribution.



In the above diagram when a pressure is applied on the piezo crystals by the mechanical force exerted by the user during running a voltage pulse is generated,



This generated pulse then applied to the Charging Bank where it is first goes to the regulator section where it is first rectify then filtered and regulated using IC 7805.

The regulated output goes to the input of the charging module where the charging module stores this energy in the Li-battery.

We can also access the stored energy by using the output port and use it in the purposes like charging our smartphone power any small device.

Observations

❖ Advantages & Disadvantages

- Less complex
- Easy to understand and use
- Cheap in cost
- Components are easily available
- Compact and durable

  - Less Voltage generation
  - Take time till full charge
  - Reliability Rate is a little low
  - A little heavy due to his Cheap side

❖ Applications

- Used for mobile charging
- Used in hilly areas
- At remote places a good source for some power
- Used to run small devices
- Act as a power source

Conclusion

*"Here, we have come to the end of the project and its report on the topic "**Electro-step**". We tried our best to include all the necessary points that are required related to our topic like its working and its specifications. Some of the information about different components we wrote in this project report were taken from the internet and practical testing failures and learnings. This project also includes our observations regarding our project on the terms and criteria like durability, reliability, usability, sustainability etc. This project contains information of Our project design, its components, and their working that how it is work and generate power from human walk. We do hope that our project will be interesting, new, well executed and may be even knowledgeable."*

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