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Project Report on

“ELECTRICITY GENERATION BY NON-CONVENTIONAL SOURCE”

Submitted in partial fulfilment for the award of degree of

BACHELOR OF ENGINEERING

In

ELECTRONICS & COMMUNICATION ENGINEERING

Submitted by

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DECLARATION

We hereby declare that the entire work embodied in this Project Report titled "**ELECTRICITY GENERATION BY NON-CONVENTIONAL SOURCE**" has been carried out by us at Sahyadri College of Engineering & Management, Mangaluru under the supervision of **Mrs. Sumiksha Shetty** for **Bachelor of Engineering** in **Electronics & Communication Engineering**. This report has not been submitted to this or any other University for the award of any other degree.

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CERTIFICATE

This is to certify that project work entitled **"ELECTRICITY GENERATION BY NON-CONVENTIONAL SOURCE"** carried out by **AJAY M (4SF19EC401), GAGANDEEP Y (4SF19EC404), KARTHIKA BHAT (4SF18EC036), KAVYA NAGESH NAIK (4SF18EC039)** who are the bonafide students of Department of Electronics & Communication Engineering, Sahyadri College of Engineering & Management, Mangaluru in partial fulfillment for the award of Bachelor of Engineering in Electronics & Communication Engineering of the Visvesvaraya Technological University, Belagavi, during the academic year 2021-2022. It is certified that all corrections/suggestions indicated for Internal Assessment have been incorporated in the Report deposited in the Departmental library. The project report has been approved as it satisfies the academic requirements in respect of project work prescribed for the Bachelor of Engineering Degree.

Project Guide	Head of Department	Principal
Mrs. Sumiksha Shetty	Dr. Anush Bekal	Dr. Rajesha S

Name of the Examiners	**Signature with Date**
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ACKNOWLEDGEMENT

It is with great satisfaction and euphoria that we are submitting the Final Project report on **ELECTRICITY GENERATION BY NON-CONVENTIONAL SOURCE**. We have completed it as a part of the curriculum of Visvesvaraya Technological University, Belagavi in partial fulfillment of the requirements of the VIII semester in Bachelors of Engineering in Electronics & Communication Engineering (ECE).

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ABSTRACT

Piezo-electric sensors is a device which will convert pressure energy into electrical non-conventional energy. Project is implemented using rectifiers, basic inverters, voltage multiplier, DC - DC step up chopper. First quadrant chopper is implemented to get sufficient output DC voltage. Free running multivibrator is used as gate triggering method for Silicon Controlled Rectifier (SCR).

This type of approach can be considered as Non – Conventional Source of Power generation. In the current situation all are facing shortage of electricity and Fuel, Coal and other non- renewable materials required for the Generation of Power. By implementing our project in our country, one can manage electricity shortage at the much-needed areas. As Foot-steps are the main inputs for producing electricity, this makes conversation of Free Electricity generation.

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ACRONYMS

	Nomenclature
SCR	Silicon Controlled Rectifier
BJT	Bipolar Junction Transistor
RF	Radio Frequency
HWR	Half Wave Rectifier
FWR	Full Wave Rectifier
AC	Alternating Current
DC	Direct Current
LR	Load Resistance
PWM	Pulse Width Modulation

CHAPTER 1

INTRODUCTION

Power plays a crucial role in the nation's progress. Power is defined as a collection of physical marvels linked to a stream of charge. There are two types of power: static power, which can be kept constant, and dynamic electricity, which can flow from one potential to another. With the growing population and the creation of new groups and production lines, there has been a lot of interest in the demand for electricity to run the machines and other forms of equipment. Power can be transmitted from one area to another in the form of a flash or current in metal. Generators generate electricity in power plants.

In this paper, we are dealing with generation of electricity using piezo-electric materials. Piezo-electric sensors will convert pressure energy into electrical non-conventional energy. Project is implemented using rectifiers, basic inverters, voltage multiplier, DC - DC step up chopper. First quadrant chopper is implemented to get sufficient output DC voltage. Free running multivibrator is used as gate triggering method for Silicon Controlled Rectifier (SCR).

Although India generates huge electricity there will be issue of load shedding in the rural region. Execution of this project help to manage the above issue.

Fuel deposit inside the Earth will quickly burn up. In 2030 Fuel shortage could be maximum. Country like India might not have the Non-Renewable resources such as petroleum products. Keeping this risky scenario in mind we tried to utilize non-pollutant Renewable useful resource Electrical power. By implementing Electrical energy regenerator with least effect to the environment at low cost can replace the scarcity of Fossil Fuels which are depleting over the Few years. There are many other methods to produce the Electricity one of the formulae uses the nuclear power generators. This type of generators is more dangerous as they will emit the radiators in the form of radiation.

As we understand that mankind will be in no way lacking in energy. Today, it is liquid fluid, day after tomorrow it can be uranium with a detail of threat. Risk exists where ever there’s human and Generation of electricity

CHAPTER 2
PROBLEM STATEMENT

- In many countries, demand exceeds daily energy production, so we face power outages every hour or so, and industries are suffering from shortage of electricity.
- To meet their needs, people use rechargeable batteries or diesel/petrol engines. These are non-renewable sources.
- Standby generators are commonly used in industries and large offices.
- In our project, we will generate electrical energy through use of piezoelectric material which is used to produce electrical energy from mechanical stress and then control the output.

CHAPTER 3

LITERATURE SURVEY

Gothwal, Pushpa & Palliwal, Paridhi & Shubhangi.[1] The usage of a spherical piezoelectric ceramic as the power converter in this work provides a unique design of an effect mode piezoelectric energy generator that can perform across a broad frequency spectrum. The results of the assessment suggest that applying an oblique impact configuration can improve the output of the power generator. A shim plate is placed between the piezoelectric ceramic and the impact shape to achieve this type of setup. The output performance of this configuration will improve to around four to three times that of the direct impact design at a specific base excitation frequency.

Asry, A.M. & Mustafa, Farahiyah & Ishak, M. & Ahmad, Aznizam.[2] Because of the ever-increasing demand for transportable and wireless devices with long lifespans, the area of power harvesting has seen a significant rise in recent years. Electrochemical batteries must be built into cutting-edge transportable and wireless gadgets as the power source. Because of their limited lifespan, batteries can be difficult to utilize, necessitating their replacement on a regular basis. In the case of wireless sensors that are to be placed in remote areas, the sensor should be easily accessible or disposable to allow the instrument to function for extended periods of time.

Habib, A. and Ananta, A. [3] The present piezoelectric power production technology is focused on the problem of poor vibration energy collecting efficiency in the environment. A crucial technology of piezoelectric power production, which can collect vibration energy from numerous directions in the environment, is being explored in order to enhance the collection efficiency of vibration energy in the environment. The vibration mechanics analysis of the piezoelectric cantilever beam is carried out after the mathematical model of the piezoelectric cantilever beam is built using the basic theory of piezoelectric power generating technology. Then, using ANSYS, a finite element simulation of the piezoelectric cantilever beam is performed, and the natural frequency is found to be compatible with the natural frequency. Finally, a multi-directional piezoelectric power generating device is created, including theoretical analysis and practical testing.

The results of the experiments indicate that the main technology of multidirectional vibration piezoelectric power generation might improve the collection efficiency of vibration energy in the environment.

Al Mashaleh, Bayan.[4] The goal of this study is to provide a compelling argument for the creation of a steady quantity of energy by transforming mechanical power into electric energy using piezoelectric materials. The goal is to locate a suitable and efficient source of electrical energy by utilizing our surroundings. I've utilized the mechanical strength created by our footfall to produce a sufficient and consistent amount of power.

Basari, Amat Amir & Hashimoto, S. & Homma, B. & Okada, H. & Okuno,
H. & Kumagai, S. [6] It introduces piezoelectric transduction-based vibration-based complete electricity harvesting. Following a review of the major transduction methods for vibration-to- strength conversion, the benefits of piezoelectric transduction over the alternatives (mostly electromagnetic and electrostatic transductions) become clear. Only the self-charging form notion that employs flexible piezoceramics and thin-movie batteries is described as an inspiring example of multifunctional parts in the piezoelectric energy harvesting literature. The focus then turns to reviewing the literature on mathematical modelling of these devices for a variety of concerns, ranging from exploiting mechanical nonlinearities to collecting aero elastic strength.

Jbaily, Abdulrahman & Yeung, Ronald.[7] Piezoelectric materials are commonly implemented in sensing and actuation applications because they effectively transfer strain energy into electric energy and vice versa. They have been used in media that often vibrate, which enables small- scale power exploitation. The 1970s saw the emergence of concepts that the piezoelectric effect may be used as a power-take-off mechanism for ocean energy. This paper summarizes recent advancements in the application of piezoelectric processes to the ocean sector and serves as a basis for ocean engineers interested in such possibilities to do further study. The choice of piezoelectric materials for various applications in maritime engineering is discussed briefly.

Yang, Ying & Shen, Qinlong & Jin, Jiamei & Wang, Yiping & Qian, Wangjie& Yuan, Dewang.[8] In order to effectively excite the vibration modes of the piezoelectric cantilevers and attain better deformation, which improves the mechanical/electrical energy conversion, impact-induced resonance is proposed as a way to improve the output power of a rotational piezoelectric wind energy harvester. A piezoelectric bimorph cantilever polygon is formed and placed at the inside surface of the revolving fan to provide the impact force. Inside the polygon are balls made of elastic. The piezoelectric effect is used to create electricity when wind spins the device and the balls hit the cantilevers. The impact point is carefully selected to enhance the harvesting ability by making the most of the initial bending mode. Each bimorph can be struck in a comparable region because to the design, however each bimorph gets struck in that place at a different time. A rather steady output frequency can be attained as a consequence. By selecting various bimorph proportions, the output frequency may also be altered, further simplifying the device and lowering costs. Twelve piezoelectric cantilevers were used to build a prototype piezoelectric energy harvester. The lead zirconium titanate (PZT)-based bimorph cantilever had dimensions of 47 mm 20 mm 0.5 mm, the steel elastic balls had a diameter of 10 mm, and the piezoelectric cantilevers were constructed from phosphor bronze.

Pisharody, Hari Krishnan.[9] When the sun's strength became susceptible or non-existent, the opportunity power collecting technique drew a lot of attention as a solar energy producer. By use of piezoelectric forces to complement a shortage in a microscale solar generator device was tried as a continuous power capturing strategy. Effect-based piezoelectric generators have been investigated as a potential technology for high- performance electricity generators, and non-stop strength technology based on the non-stop effect has been tried to improve performance by increasing the impact duty cycle. Horizontal wind drift was transformed to rotating movement, and a few blades in the rotating wheel generated an excessive influence on the piezoelectric element by using a high-frequency spring movement.

The ability to provide enough energy to sustain a tiny energy sensor device was proven using this power harvesting system with cascaded connection of piezoelectric devices.

John Wiley & Sons.[10] This paper contains piezoelectric transduction as a method for vibration-based power harvesting. The advantages of piezoelectric transduction over other alternatives (specifically electromagnetic and electrostatic transductions) are discussed after a quick description of the basic transduction mechanisms that maybe utilized for vibration-to-strength conversion. Because the present review articles cited in this chapter provide a thorough overview of the piezoelectric strength harvesting literature, only the self-charging structure concept employing flexible piezoceramics and thin-movie batteries is summed up as a motivating illustration of multifunctional factors. The emphasis then shifts to a review of the literature on mathematical analysis of these devices for a variety of hobby concerns, tend to range from exploiting mechanical nonlinearities to collecting aero elastic strength. Besides from historical basis, the mathematical idea of linear piezoelectricity is briefly reviewed in order to obtain the constitutive equations for piezoelectric continuum based on the first law of thermodynamics, which are then simplified to reduce bureaucracy and applied throughout this work.

Liang, Junrui & Liao, Wei-Hsin.[11] The influence of mechanical effect parameters on effect-mode piezoelectric ceramic electrical turbines is studied in this work using both analytical and experimental methods. The speed and mass are the two variables involved. A weight drop test has been used to analyses data. The results reveal that the immediate output voltage's height is proportional to the impact speed, and the output energy is miles in a straight line with the same parameter. The benefit of using heavy gadgets over light gadgets for the same effect velocity is obvious since their momentum and effect force are higher**.** However, with greater instantaneous output electricity, a change in impact velocity is shown to be more effective than a change in mass. The frequency responses of a vibration- based effect-mode piezoelectric ceramic strength generator is also effective in this regard.

Yang, Rusen & Qin, Yong & Dai, Liming & Wang, Zhong.[12] The capacity of nanowires to "scavenge" energy from ambient and environmental sources might be valuable for powering nanodevices. Converting mechanical energy into electricity could have uses in sensing, medical research, Defence technology, and personal electronics1.

Prior research on nanowire generators used vertically aligned piezoelectric nanowires that were free to move at one end and bonded to a substrate at the other. However, there were issues with the output stability, mechanical robustness, longevity, and environmental adaptation of such devices. Here, we present a flexible power generator that is packed on a flexible substrate, does not need sliding connections, and is based on the cyclic stretching and releasing of a piezoelectric thin wire that is securely attached to metal electrodes at both ends.

Feenstra, Joel & Granstrom, Jon & Sodano, Henry. [13] The usage of portable and wearable electronics has increased considerably over the last few decades. Although the performance of these devices has improved, this has led to a huge increase in the amount of power required to run the electronics. Due to the stagnate advancement of battery technology over the past ten years, this problem has become even more problematic. Researchers are looking at ways to generate energy from natural sources so that these devices may last longer. Recent advances in the subject have prompted the creation of a number of processes that may be used to produce electrical energy from a range of sources, such as thermal, solar, strain, inertia, etc.

Humans can use several of these energy sources, but their usage must be carefully planned to prevent parasite effects that can impair the user's endurance or gait. The goal of this project is to create a unique energy-harvesting backpack that can produce electrical energy from the forces that are generated between the user and the pack. With this approach, the wearer's endurance and dexterity won't be diminished because the energy harvesting device will be visible to them.

Tan, Y.K. & Hoe, K.Y. & Panda, Sanjib.[14] The usage of wireless sensor nodes in applications such as medical implants, embedded sensors in buildings, military applications, etc. has resulted in a significant growth in the field of small, low-cost, low-power wireless sensor nodes. However, there has not been any study done on the energy sources used mostly by wireless sensors so that the sensor nodes can run on their own. This study examines multiple renewable energy sources that can be used to power these wireless sensors. As opposed to other energy sources, the piezoelectric generator is particularly interesting to this study since it is straightforward and simple to collect mechanical force energy from people.

For wireless radio frequency (RF) transmitters, an energy-harvesting circuit design for piezoelectric pushbutton- generators is suggested and successfully implemented. By harvesting mechanical force energy from pushing the pushbutton that is connected to the energy harvesting circuit, this self-powered wireless transmitter can broadcast a 12-bit digital word of information. The experimental findings demonstrate that when the piezoelectric pushbutton is pressed, 67.61 muJ of electrical energy is scavenged, which is enough to transfer two complete 12-bit digital words of information via the RF unit. A word transmission using the RF unit uses 26.4 muJ of energy.

CHAPTER 4

HARDWARE COMPONETS AND DESCRIPTION

4.1 Piezo-Electric Transducer

Fig 4.1 Piezo-Electric Sensor[16]

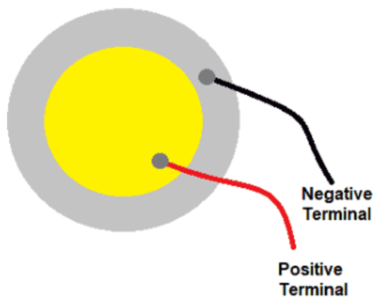


Fig 4.2 Piezo-Electric Pinout[16]

In 1880, Pierre Curie founded the piezoelectric material. In recent times, there are several materials include Quartz, Piezoceramics etc.

4.1.1 Piezo-Electric Effect

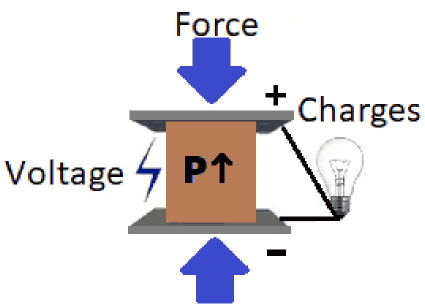


Fig 4.3 Piezo Effect[16]

Piezoelectric comes from the Greek word 'piezein,' which means 'to push, press, or squeeze.' Fig 4.3 shows a Piezoelectric effect is known as a piezoelectric material's ability to convert mechanical stress into electrical charge. When we apply mechanical stress to a piezoelectric material, we get an electrical charge at the output. The sensor stretches or compresses in the same way as it expands or compresses when electrical loads are applied to it.

Table 4.1 Pin Description

Pin Name	Description
Outer Circle	This gives Negative output voltage
Inner Circle	This gives positive output voltage

4.2 Rectifier

Rectifier is a electrical device which convert Alternating Current (AC) to Direct Current (DC) composed of many diode. Diode allow flow of current in only one direction. This process is called Rectification.

4.2.1 Types of Rectifiers

1. **Halfwave Rectifier**

Below Fig 4.4 shows the Halfwave Rectifier. Halfwave Rectifier which converts only half of the Alternating Current (AC) into Direct Current (DC).

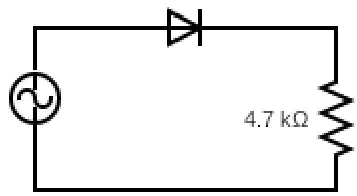


Fig 4.4 Halfwave Rectifier[17]

2. **Full wave Rectifier**

Full wave Rectifier which converts both positive and negative half cycle of Alternating Current (AC) into Direct Current (DC).

Types of Full wave Rectifier:

- Bridge Rectifier

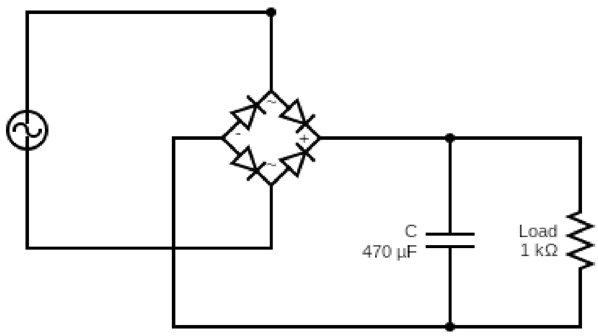


Fig 4.5 Bridge Rectifier[17]

- Center-Tap Rectifier

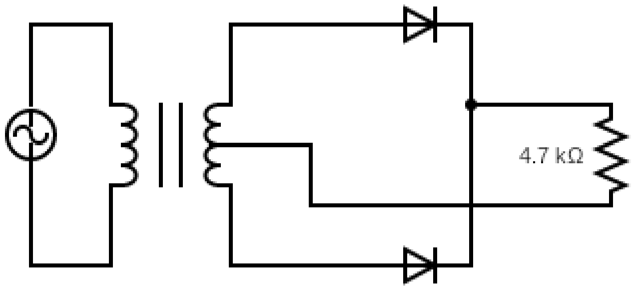


Fig 4.6 Center-Tap Rectifier [17]

Here we are using a full wave rectifier circuit which generates an output voltage or current that is either entirely or mainly DC. In compare to half wave rectifiers, full wave rectifiers have a few significant advantages. The full wave rectifier's output has far less ripple than the half wave rectifier's output, resulting in a smoother output waveform, and its average (DC) output voltage is higher than for half wave. A single load resistance (RL) is linked to two power diodes, each of which periodically supplies current to the load in the full wave rectifier circuit. Diode D1 conducts forward as shown by the arrows when the transformer's point A is positive relative to point C.

Diode D2 conducts in the forward direction and resistor R's current flows in the same direction for both half-cycles when point B is positive (in the negative half of the cycle) in relation to point C. This kind of full wave rectifier circuit sometimes is referred to as a "bi-phase" circuit because the output voltage across the resistor R is the phasor sum of the two combined waveforms.

4.3 Boost Converter

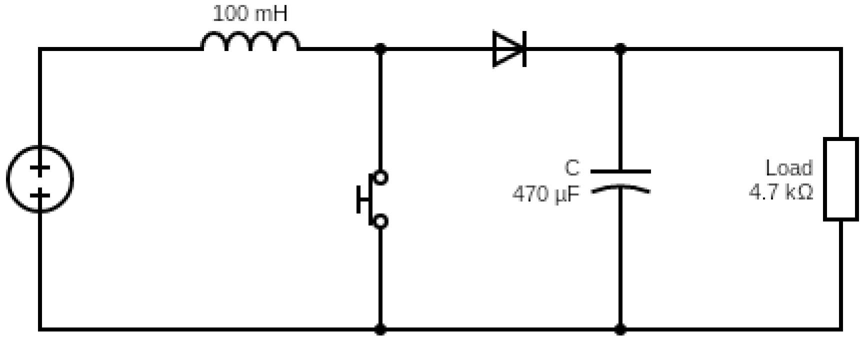


Fig 4.7 Dc-Dc Boost Converter [20]

Boost converter in fig 3.7 which increases the input DC voltage to a specified DC output voltage. Inductor L is either charged or discharged depending on the switching rate ‘S’.

4.3.1 Buck-Boost Converter

Below fig 4.8 shows Buck-Boost Converter which is a type of DC-DC converter. It has output Voltage whose magnitude is greater than or less than input voltage magnitude.

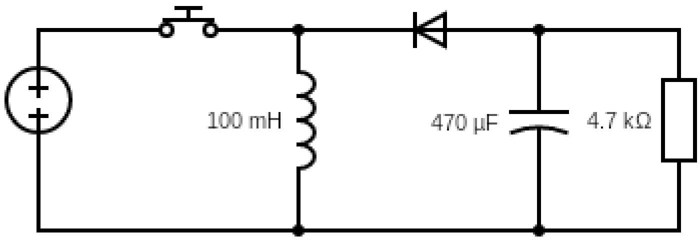


Fig 4.8 Buck- Boost Converter [23]

4.4 Inverter

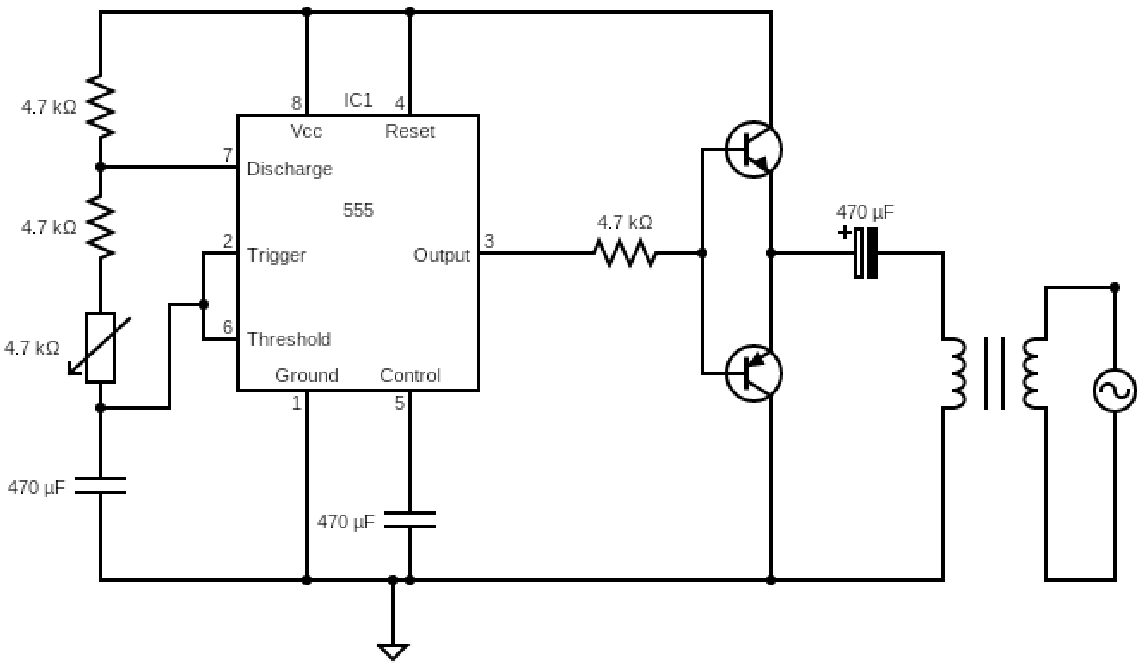


Fig 4.9 Astable Multivibrator with Switching Circuit [18]

The timer IC555, which acts as a switching pulse oscillator, lies at the core of this12 V to 220 V inverter circuit design (50 Hz) in Fig 4.9. To produce a continuous switching pulse, the IC 555 is set as an astable multivibrator.

The pulse input at the base drives two switching transistors, TIP41A (NPN) and TIP42A (PNP), which drive the transformer T_1. The transformer is 230V main to 9V secondary, however it is wired backwards to work as a step-up transformer.

Table 4.2 Part List for Inverter

Parts	Specifications
NE555	Multivibrator
Resistor	10K , 100K , 100r , POT 50K
Capacitor	100uF , 2200uF, 104 , 103
Transistor	TIP41A , TIP42A
Transformer	Depends on load

4.4.1 Types of Inverters

- Square Wave Inverter
- Sine Wave Inverter
- Modified Sine Wave Inverter

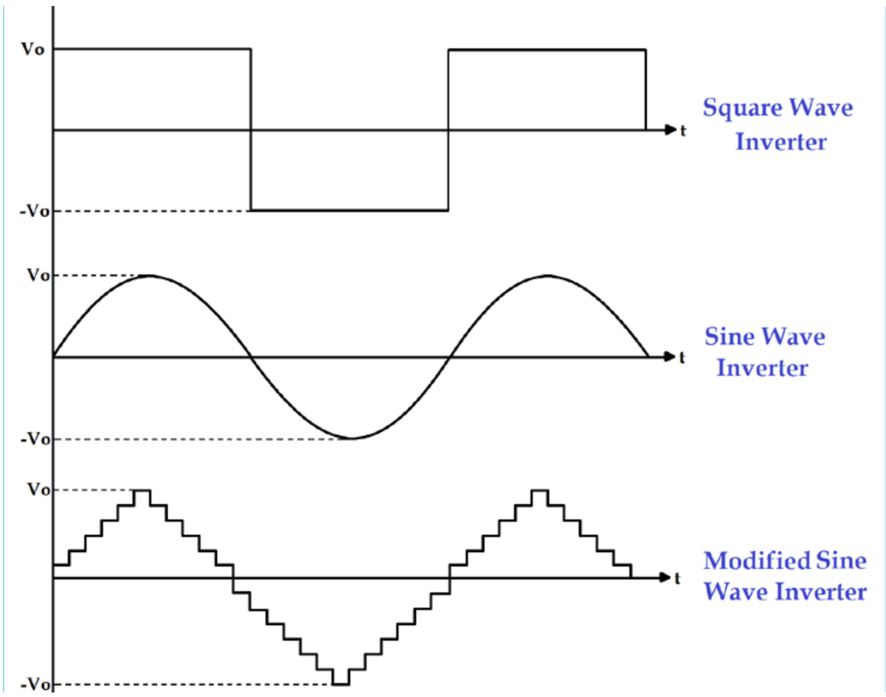


Fig 4.10 Inverter Waveform [22]

4.5 Voltage Multiplier

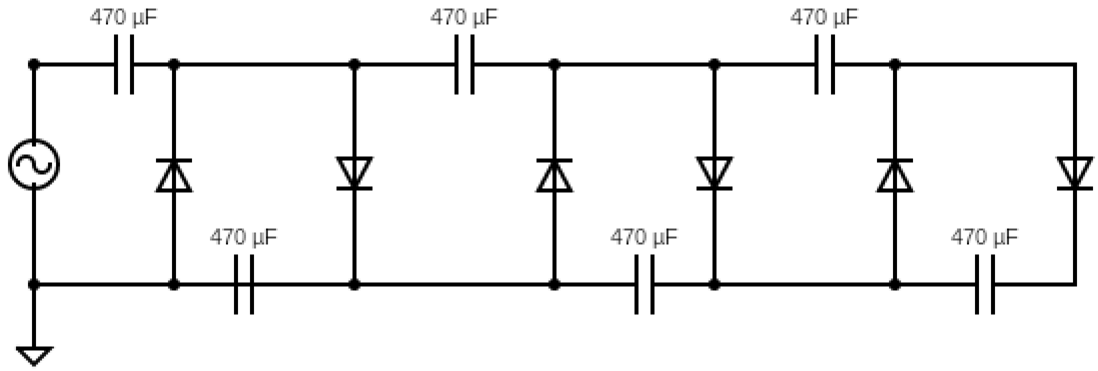


Fig 4.11 Voltage Multiplier [19]

Cockcroft Walton Voltage Multiplier is a very well-developed high voltage generation technology.

Low cost, compact size, and simple circuit partition are preferred by Cockcroft – Walton multiplier circuits as shown if Fig 4.11. Another benefit of the multiplier circuit is that it multiplies the Peak – to – Peak voltage at each level. The 'n' stage multiplier is designed using D1, D2, D3, Dn and C1, C2,C3,C4,...Cn.

Another advantage of the multiplier circuit voltage is that the peak-to-peak voltage is multiplied at each stage.

4.6 Audio Amplifier

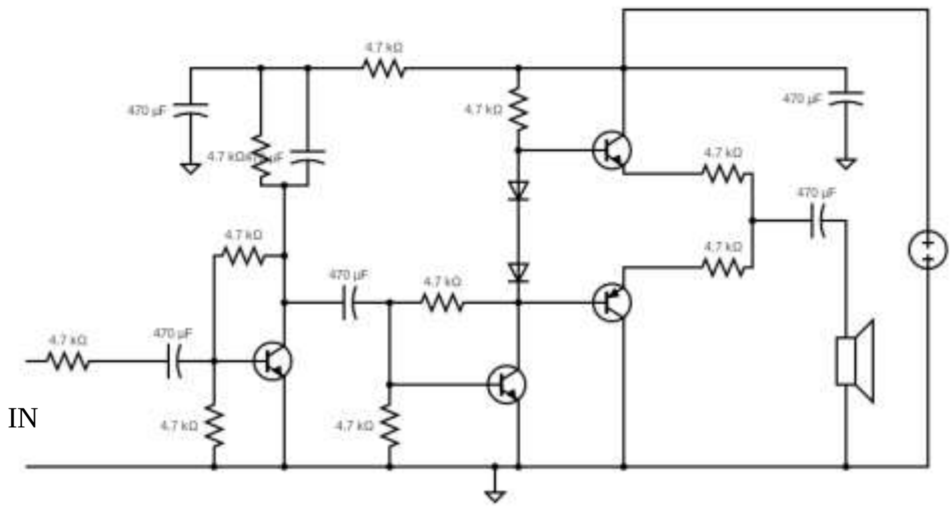


Fig 4.12 Audio Amplifier [21]

Above Fig 4.12 shows the audio amplifier. Before it is delivered to the speakers, an amplifier creates a large replica of the input signal from a source, such as a laptop, turntable, or CD player.

Mains electricity, which is sent directly to the amplifier's power source, provides the energy to do this. Here, the alternating current is changed to a direct current that only travels in one direction before being sent to the transistor.

A main power amplifier that is made to take an audio source of low strength as input and produce an output signal of high strength. The various domains where an electrical signal is converted into an audio signal make use of this amplification process. Audio amplifiers are this kind of amplifier. The audio amplifier is present both at the input and the output of every circuit that handles audio signals. For instance, before further processing a sound wave input signal is received by a microphone, the signal has to be pre-amplified. Similarly, before sending an electrical signal to a speaker, it needs to be amplified.

CHAPTER 5

DESIGN AND IMPLEMENTATION

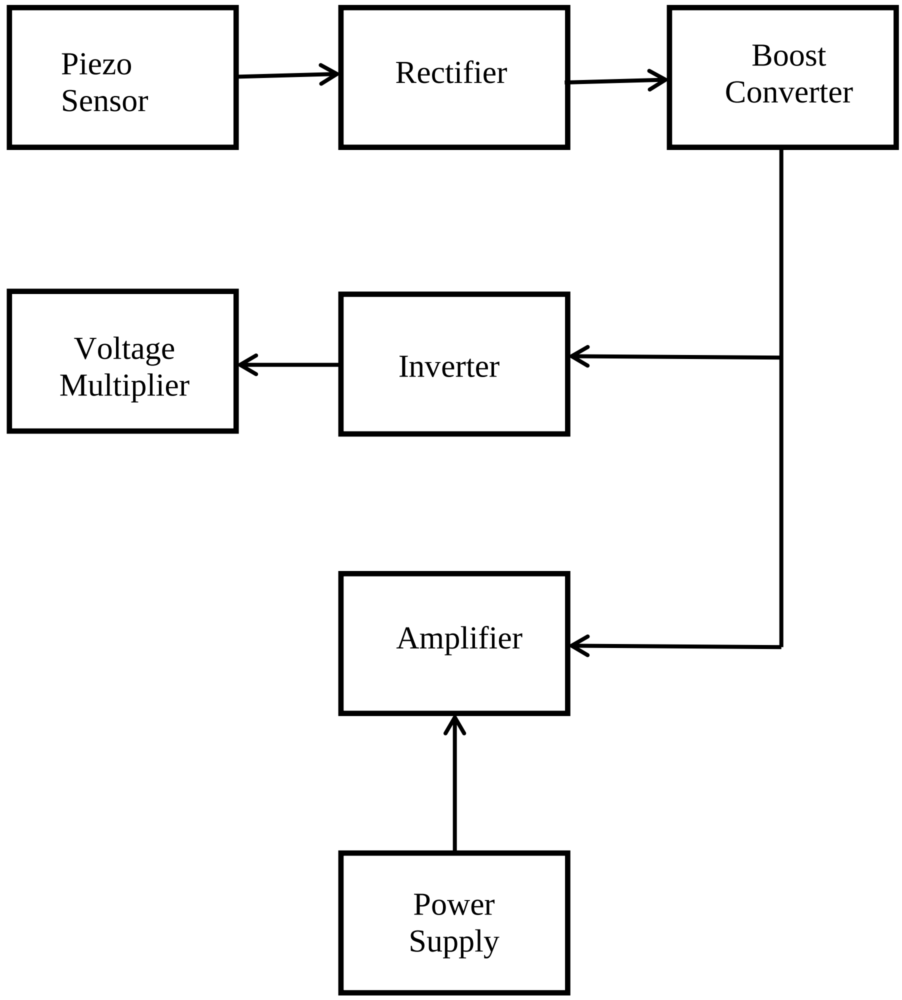


Fig 5.1 Block Diagram

The working principle of this project is conversion of pressure to electrical energy. When some force or pressure is applied on Piezo-Electric sensor, it produces around 12V Alternating Current (AC) Voltage.

By using Full wave Rectifier, we can convert This Voltage into Direct Current (DC) Voltage. Power Diodes can be connected together to form a full wave rectifier that convert AC voltage into pulsating DC voltage for use in power supplies.

To increase DC Voltage Boost Converter is used which is also called as Chopper. In this converter an inductor is connected to the source of the input voltage. The solid-state device which works as a switch is linked across the source.

The second switch is utilized is a diode. As seen in the above diagram, the load is linked in parallel with the diode, which is connected to a capacitor.

The Boost converter is viewed as the constant current input source since the inductor attached to the input source results in a constant input current. And the load may be thought of as a source of continuous voltage. Pulse width modulation is used to turn the controlled switch on and off (PWM). PWM may be frequency- or time- based. The Boost converter operates in two modes. When the switch is turned on and conducting, it is the first mode.

Case 1:

When the switch is ON, it represents a short circuit and will provide zero resistance to the flow of current, enabling all current to pass through it and back to the DC input source. Let's say that the switch is on for time T_{ON} and off for time T_{OFF}. The time period T is defined as follows:

$$T_{ON} + T_{OFF} \tag{5.1}$$

Frequency is given by Duty Cycle is

$$f=1/T \tag{5.2}$$

$$D=T_{ON}/T \tag{5.3}$$

Since the switch is closed $T_{ON}=D_T$ we can assume that $\Delta t=DT$

$$(\Delta i_L)_{closed}=(V_{in}/L)DT \tag{5.4}$$

While performing Boost Converter analysis, following steps need to be followed

- The current though inductor is continuous and can be done by choosing value of L.
- In steady state, inductor current enhances resulting in a positive slope and attains optimum value during conducting state and returns to initial value with negative gradient. Hence the net charge of the inductor is zero.

Case 2:

The inductor conducts in reverse direction since polarity is negative. The current stored in inductor is released and it is stored at the load. This helps to carry the current flow in one direction through load and increase the output voltage.

Since switch is open.

For Case 2, in steady state using KVL,

$$V_{in} = V_l + V_o$$

$$V_l = L\frac{diL}{dt} = V_{in} - V_o$$

$$\frac{diL}{dt} = \frac{\Delta iL}{\Delta t} = \frac{\Delta iL}{(1-D)T} = \frac{Vin-Vo}{L} \tag{5.5}$$

Since the switch is open

$$T_{OFF} = T - T_{ON} = T - DT = T(1-D) \tag{5.6}$$

we can say assume that,

$$\Delta t = (1-D)T \tag{5.7}$$

$$(\Delta i_L)_{open} = \frac{Vin-Vo}{L}(1-D)T \tag{5.8}$$

By net charge of the inductor is zero,

$$(\Delta i_L)_{open} + (\Delta i_L)_{closed} = 0$$

$$\frac{Vin-Vo}{L}(1\text{-}D)T = \frac{-Vo}{L}DT = 0$$

$$\frac{Vo}{Vin} = \frac{1}{1-D} \tag{5.9}$$

D is known to vary between 0 and 1. The equation above shows that, however, if D is 1, the ratio of the steady-state output voltage to the input voltage goes to infinity, which is not physically possible. In practice, because the Boost converter is a non-linear circuit, if the duty cycle, D, is kept at a value higher than 0.7, instability will result. Below is a diagram of a boost converter's circuit as well as its waveforms. The resistive load is 20, the inductance, L, is 20 mH, and the capacitor, C, is 100 F. One kHz is used for switching. The duty cycle is 0.5 and the input voltage is 100V DC.

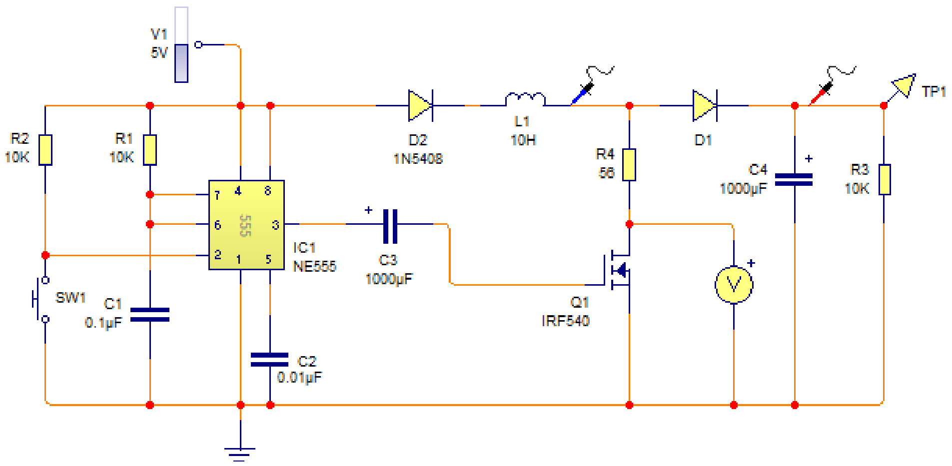


Fig 5.2 Boost Converter Simulation

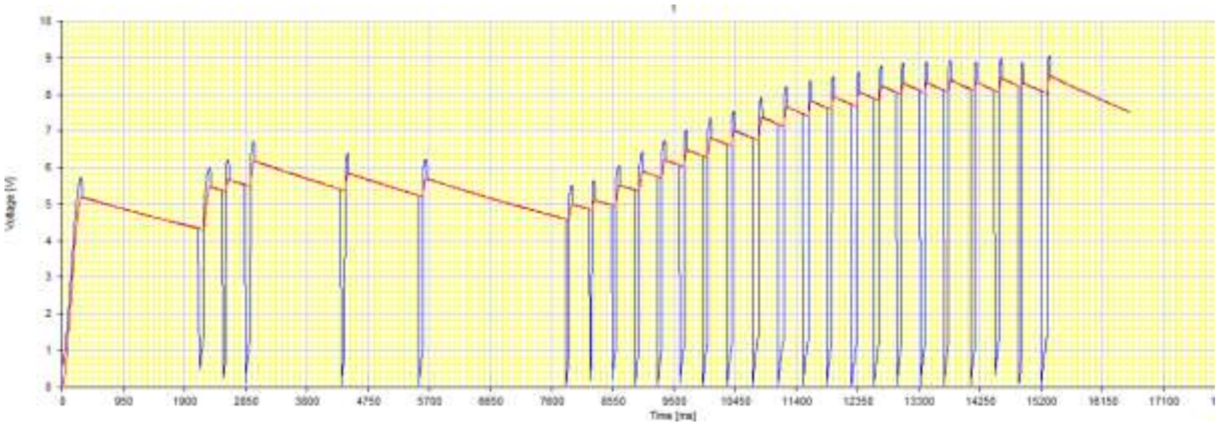


Fig 5.3 Boost Converter Output Voltage Waveform

The output of this boost converter is direct current (DC) voltage. For the conversion of DC to AC voltage an Inverter with 555 timer is used.

The timer IC555, which acts as a switching pulse oscillator, is at the center of this12 V to 220 V inverter circuit schematic (50 Hz). A continuous switching pulse is produced by an IC 555 set as an astable multivibrator.

According to the pulse input at the base, the transformer T_1 is driven by two switching transistors, TIP41A (NPN) and TIP42A (PNP). The transformer has a reverse connection from its 230V primary to 9V secondary, allowing it to function as a step-up transformer.

With a +5V to +15V DC bias, we can achieve 110V to 230V AC at a frequency of 50Hz to 60Hz. However, it only produces pulsated AC, not a perfect sine wavelike a PWM inverter.

$$f=1/T=1.44/(R_1+2R_2)C_1 \qquad (5.10)$$

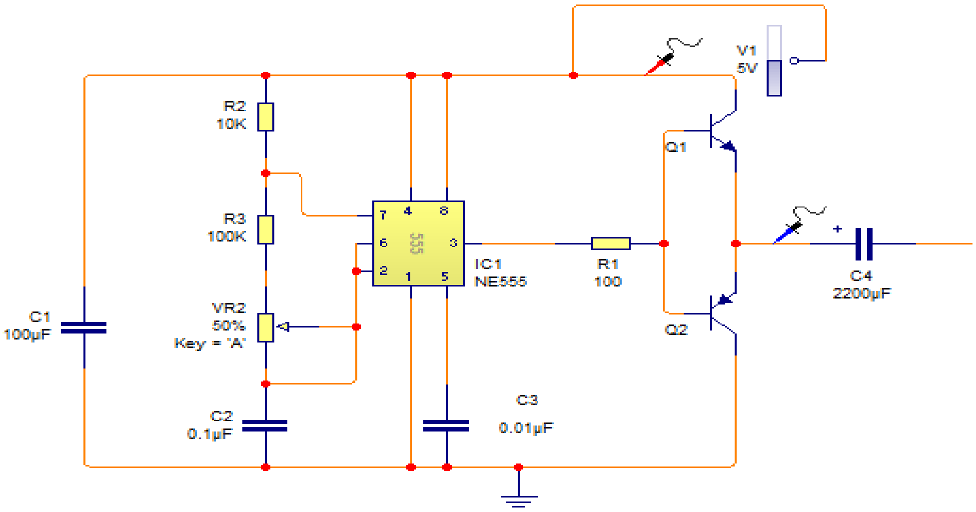


Fig 5.4 Inverter Simulation

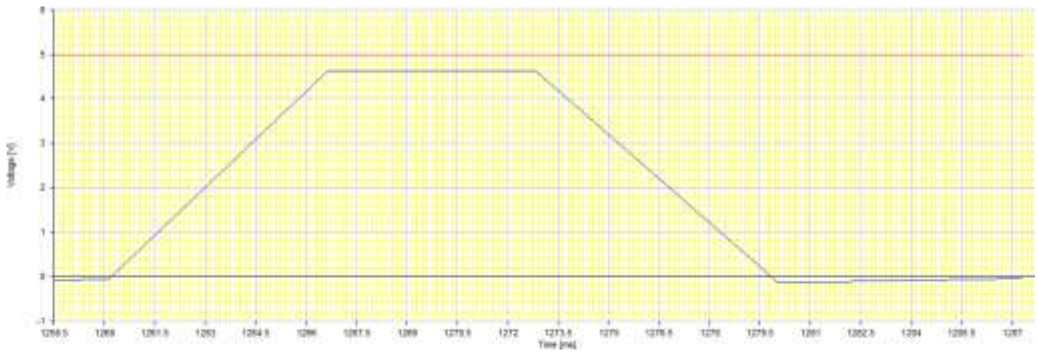


Fig 5.5 Inverter Output Voltage Waveform

Voltage multiplier is used to get high voltage at low current is used. An expensive high voltage transformer is not needed with this supply, at least not to the same extent as with a standard supply.

A half-wave doubler is made up of the pair of capacitors and diodes to the left of nodes 1 and 2 in the diagram above. Figure Prior is produced by rotating the bottom capacitor by 90 degrees and the diodes by 45 degrees counterclockwise (a). For a possible x8 multiplication factor, four of the doubler parts are cascaded to the right. Node 1 features a clamper waveform (not displayed), which is a sinewave with a 1x upshift (5 V). Sinewaves are clamped to increasing voltages at the other odd-numbered nodes.

CHAPTER 6

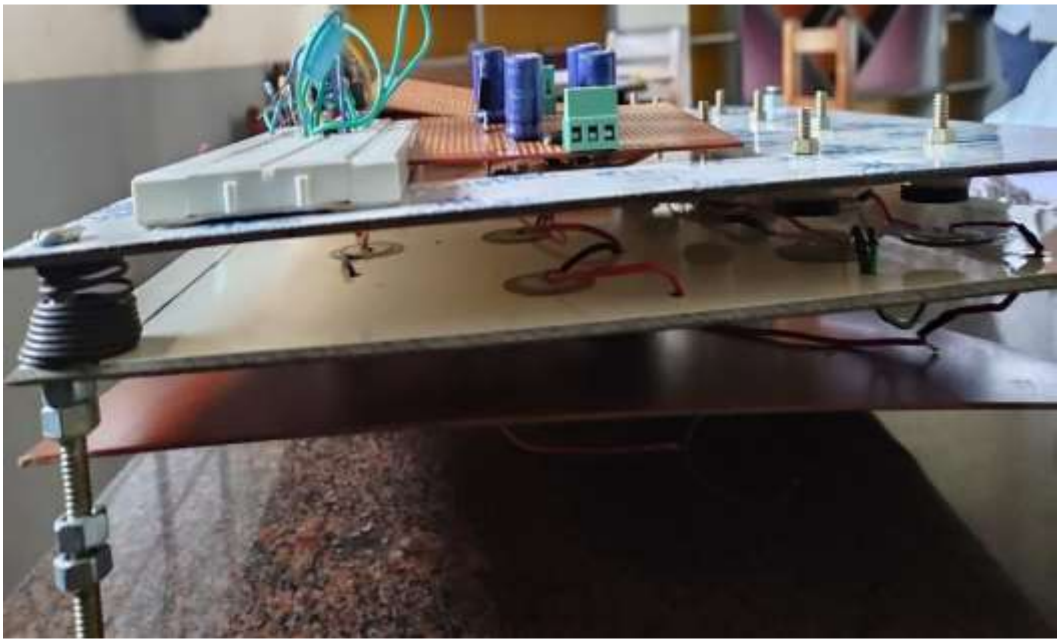
RESULT AND DISCUSSION

Below Fig 5.1 shows the implementation of Electricity Generation by Non-Conventional source. Piezoelectric sensors produce electricity when mechanical stress is applied to them. The piezoelectric sensor produces around 12v AC voltage as its output and it is depending on the diameter of the Piezo sensor. A complete bridge rectifier is what we're utilizing to convert it from AC to DC. A 47uF capacitor is attached across the rectifier's output. The capacitor stores the voltage that the piezoelectric sensor produces. Then Boost converter is used to covert output DC voltage to DC.

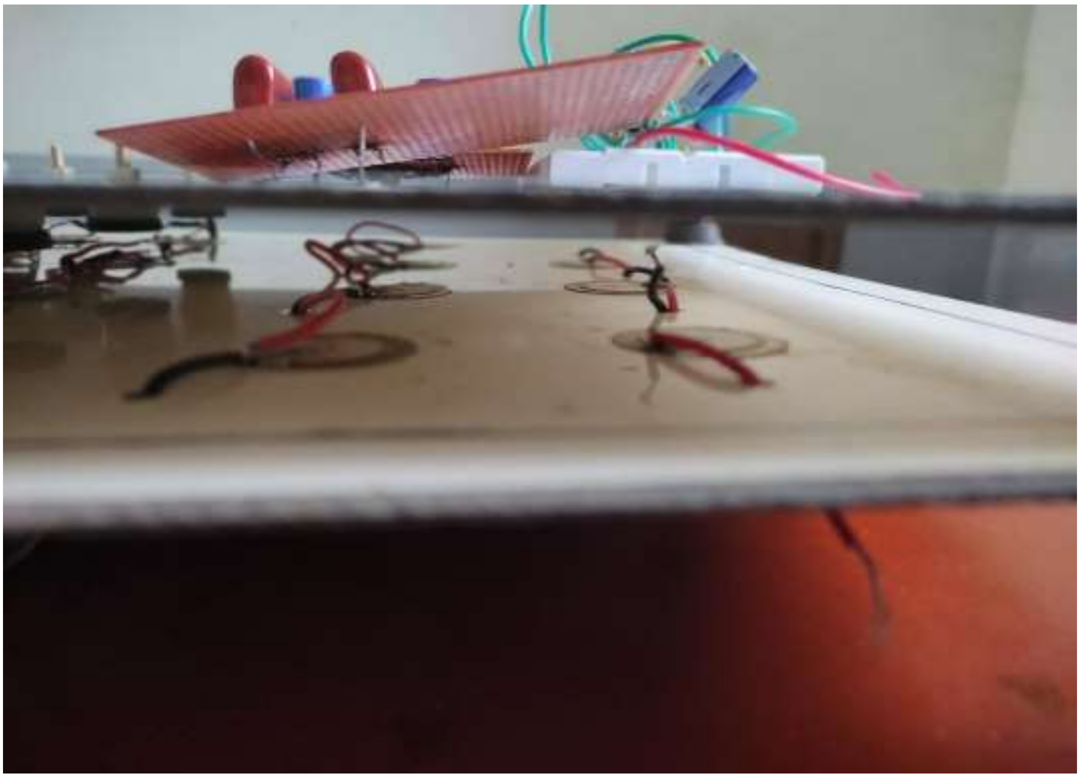
Table 5.1 describes the way in which mechanical stress is converted into electrical energy and later stored in battery.

Table 6.1 Power Description

SI. No	Weight(kg)	Power(W)
1.	12	0.011
2.	22	0.023
3.	52	0.605



(a)



(b)

Fig 6.1 (A) Project Implementation, (B) Prototype

Table 6.2 Boost Converter Voltage Values

SI. No	Potentiometer (%)	Output(V)
1.	0	28
2.	50	13.899
3.	75	8.879
4.	100	0

CHAPTER 7

CONCLUSION

In summarizing the points made in our project, it should be noted that the renewable energy sources are used in the power generating process that uses footstep. By implementing our project in our country, we can manage electricity shortage at the much-needed areas. As Foot-steps are the main inputs for producing electricity, this makes conversation with Free Energy generation. While we are Processing Foot- step which is a form of energy (Pressure / Force) it cannot be considered as a Free Energy Sources. This type of energy does not require electricity from the mains and produces less pollution. It is very beneficial to the locations where all of the roads and various types of foot traffic are employed to produce unconventional energy, such as electricity.

Lastly, this project is an attractive approach for obtaining sustainable energy and is highly consumer friendly.

CHAPTER 8

FUTURE SCOPE

Piezoelectric crystals have begun to be used more effectively, with positive results. Maximum public movement is observed in many countries at railway stations, airports, and shopping malls. As a result, this location can be used to generate electricity using piezoelectric crystals. Apart from all of the above locations, efforts are being made to develop energy from our daily lives by incorporating piezoelectric in shoes, so that at each step, a piezoelectric crystal can be compressed, generating enough power to charge a cell phone, MP3 player, and so on.

The proposed work depicts the idea of Piezoelectric Energy Harvesting, and the results obtained after execution are extremely promising. Future work of the proposed idea includes encouraging a greater degree of intensification of the precious stone yield. The future lies in the consideration of propelled material used to plan the piezoelectric precious stone, which additionally enhances the gem yield in terms of voltage and current. A review of the assortment of piezoelectric precious stones could be performed, and after reviewing the results, the ideal material for the best performing precious stone could be conceived.

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APPENDIX

Calculations:

Boost Converter

Inputs:

Sl.No	Inputs	Value (Unit)	Description
1.	Minimum V_{in}	1.5 V	The Lowest Expected Input Voltage
2.	Maximum V_{in}	20 V	The Highest Expected Input Voltage
3.	Minimum V_{out}	12 V	The Lowest Desired Output Voltage
4.	Maximum V_{out}	30 V	The Highest Desired Output Voltage
5.	I_{out}	0.020 A	Output Current drawn
6.	V_{Ripple}	0.1 V	Maximum allowable Voltage Ripple

Outputs :

Sl.No	Inputs	Value (Unit)	Description
1.	Minimum Duty Cycle	- 66 %	$D_{min} = 1 – (V_{imax} / V_{Omax})$
2.	Minimum Duty Cycle	95 %	$D_{max} = 1 – (V_{imin} / V_{omax})$
3.	Minimum Inductor Size	3555.555	$L > D * V_{in} * (1 – D) / (freq * 2 * l_{out})$
4.	Peak Inductor Current	0.060000	$I_{pk} = (V_{inmax} * D) / (f * L)$
5.	Minimum Capacitor	6.399999	$Cap > lout / (V_{Ripple} * freq)$
6.	Minimum Schottky diode	30 V 0.060 A	$V_{breakdown} > = V_{out}$ & $I_{diode} > = I_{pk}$

Cockcroft Walton Voltage Calculator

Sl.No	Description	Value (Unit)
1.	Stages	4
2.	Frequency	50 Hz
3.	Capacitances	0.01 uF
4.	Load Current	0.1 mA
5.	Input	5 V_{rms}
6.	V_{Ripple}	9999.1 V
7.	V_{Max}	0.056 KV
8.	V_{Min}	-9.9431 KV
9.	Lin	-198.86 mA
10.	W_{in}	-0.9943

Astable Multivibrator

Duty Cycle

The charging and discharging time constants depends on the values of the resistors R1 and R2. Generally, the charging time constant is more than the discharging time constant. Hence the HIGH output remains longer than the LOW output and therefore the output waveform is not symmetric. Duty cycle is the mathematical parameter that forms a relation between the high output and the low output. Duty Cycle is defined as the ratio of time of HIGH output i.e., the ON time to the total time of a cycle.

If TON is the time for high output and T is the time period of one cycle, then the duty cycle D is given by:

$$D = T_{ON} / T$$

Therefore, percentage Duty Cycle is given by:

$$\%D = (TON / T) * 100$$

T is sum of T_{ON} (charge time) and T_{OFF} (discharge time).

The value of T_{ON} or the charge time (for high output) T_C is given by:

$$T_{ON} = T_C = 0.693 * (R_1 + R_2) * C$$

The value of T_{OFF} or the discharge time (for low output) T_D is given by

$$T_{OFF} = T_D = 0.693 \ * \ R_2C$$

Therefore, the time period for one cycle T is given by

T = TON + TOFF = TC + TD

T = 0.693 * (R1 + R2) C + 0.693 * R2C

T = 0.693 * (R1 + 2R2) C

Therefore,

$\%D = (T_{ON}/ T) * 100$

$\%D = (0.693 * (R_1 + R_2) C) / (0.693 * (R_1 + 2R_2) C) * 100$

$\%D = ((R_1 + R_2) / (R_1 + 2R_2)) * 100$

If $T = 0.693 * (R_1 + 2R_2) C$,

then the frequency f is given by

$f = 1 / T = 1 / 0.693 * (R_1 + 2R_2) C$

$f = 1.44 / ((R_1 + 2R_2) C)$ Hz

Selection of R_1, R_2 and C_1

The Selection of values of R_1, R_2 and C_1 for different frequency range are as follow:

R_1 and R_2 should be in the range 1KΩ to 1MΩ. It is best to Choose C_1 first (because capacitors are available in just a few values and are usually not adjustable, unlike resistors) as per the frequency range from the following table.

Choose R_2 to give the frequency (f) you require.

$R_2 = 0.7 / (f \times C_1)$

Choose R_1 to be about a tenth of R_2 (1KΩ min.)

C1	R1	R2	FREQUENCY (HZ)
1 µF	1.5K Ω	15K Ω	45.71
10 µF	1.5K Ω	15K Ω	4.571
0.1 µF	1.5K Ω	15K Ω	457.14
0.01 µF	1.5K Ω	15K Ω	4.5714 K

AMPLIFIER CALCULATION

To calculate I_b ;

1. $I_c = hFE * I_b$;

2. $I_b = I_c / hFE$;

hFE : DC Current Gain ;

Min : 110 ; Max : 800 ;

Cond : $V_{ce} = 5v$; Ic = 2mA ;

For CE config : $V_{ce} = 10v$; $I_c = 3mA$;

$I_b = 3x10^{-3} / 110$;

$I_b = 27x10^{-6}A$;

xx555 Precision Timers

1 Features

- Timing From Microseconds to Hours
- Astable or Monostable Operation
- Adjustable Duty Cycle
- TTL-Compatible Output Can Sink or Source Up to 200 mA
- On Products Compliant to MIL-PRF-38535, All Parameters Are Tested Unless Otherwise Noted. On All Other Products, Production Processing Does Not Necessarily Include Testing of All Parameters.

2 Applications

- Fingerprint Biometrics
- Iris Biometrics
- RFID Reader

3 Description

These devices are precision timing circuits capable of producing accurate time delays or oscillation. In the time-delay or mono-stable mode of operation, the timed interval is controlled by a single external resistor and capacitor network. In the a-stable mode of operation, the frequency and duty cycle can be controlled independently with two external resistors and a single external capacitor.

The threshold and trigger levels normally are two-thirds and one-third, respectively, of V_{CC}. These levels can be altered by use of the control-voltage terminal. When the trigger input falls below the trigger level, the flip-flop is set, and the output goes high. If the trigger input is above the trigger level and the threshold input is above the threshold level, the flip-flop is reset and the output is low. The reset (RESET) input can override all other inputs and can be used to initiate a new timing cycle. When RESET goes low, the flip-flop is reset, and the output goes low. When the output is low, a low-impedance path is provided between discharge (DISCH) and ground.

The output circuit is capable of sinking or sourcing current up to 200 mA. Operation is specified for supplies of 5 V to 15 V. With a 5-V supply, output levels are compatible with TTL inputs.

Device Information(1)

PART NUMBER	PACKAGE	BODY SIZE (NOM)
xx555	PDIP (8)	9.81 mm × 6.35 mm
	SOP (8)	6.20 mm × 5.30 mm
	TSSOP (8)	3.00 mm × 4.40 mm
	SOIC (8)	4.90 mm × 3.91 mm

(1) For all available packages, see the orderable addendum at the end of the datasheet.

4 Simplified Schematic

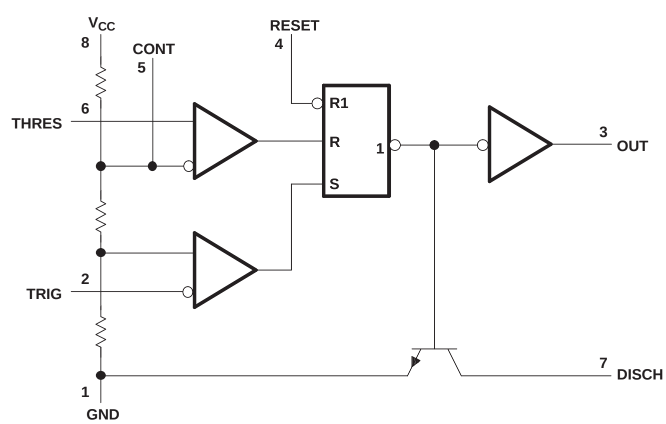


Table of Contents

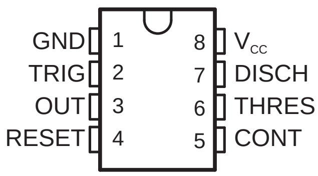
5 Revision History

Changes from Revision H (June 2010) to Revision I — **Page**

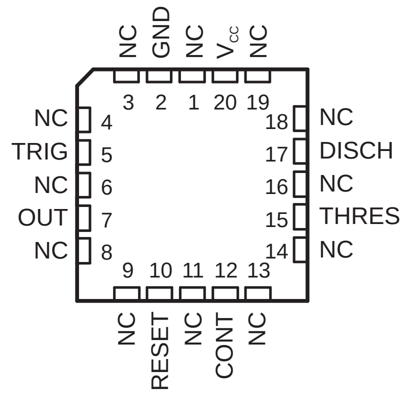
- Updated document to new TI enhanced data sheet format. 1
- Deleted Ordering Information table. 1
- Added Military Disclaimer to Features list. 1
- Added Applications. 1
- Added Device Information table. 1
- Moved T_{stg} to Handling Ratings table. 4
- Added DISCH switch on-state voltage parameter. 5
- Added Device and Documentation Support section. 19
- Added ESD warning. 19
- Added Mechanical, Packaging, and Orderable Information section. 19

6 Pin Configuration and Functions

NA555...D OR P PACKAGE
NE555...D, P, PS, OR PW PACKAGE
SA555...D OR P PACKAGE
SE555...D, JG, OR P PACKAGE
(TOP VIEW)



SE555...FK PACKAGE
(TOP VIEW)



NC – No internal connection

Pin Functions

PIN			I/O	DESCRIPTION
NAME	D, P, PS, PW, JG	FK		
	NO.			
CONT	5	12	I/O	Controls comparator thresholds, Outputs 2/3 VCC, allows bypass capacitor connection
DISCH	7	17	O	Open collector output to discharge timing capacitor
GND	1	2	–	Ground
NC		1, 3, 4, 6, 8, 9, 11, 13, 14, 16, 18, 19	–	No internal connection
OUT	3	7	O	High current timer output signal
RESET	4	10	I	Active low reset input forces output and discharge low.
THRES	6	15	I	End of timing input. THRES > CONT sets output low and discharge low
TRIG	2	5	I	Start of timing input. TRIG < ½ CONT sets output high and discharge open
V_{CC}	8	20	–	Input supply voltage, 4.5 V to 16 V. (SE555 maximum is 18 V)

7 Specifications

7.1 Absolute Maximum Ratings(1)

over operating free-air temperature range (unless otherwise noted)

			MIN	MAX	UNIT
V_{CC}	Supply voltage(2)			18	V
V_I	Input voltage	CONT, RESET, THRES, TRIG		V_{CC}	V
I_O	Output current			±225	mA
θ_{JA}	Package thermal impedance(3)(4)	D package		97	°C/W
		P package		85	
		PS package		95	
		PW package		149	
θ_{JC}	Package thermal impedance(5)(6)	FK package		5.61	°C/W
		JG package		14.5	
T_J	Operating virtual junction temperature			150	°C
	Case temperature for 60 s	FK package		260	°C
	Lead temperature 1,6 mm (1/16 in) from case for 60 s	JG package		300	°C

(1) Stresses beyond those listed under *Absolute Maximum Ratings* may cause permanent damage to the device. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those indicated under *Recommended Operating Conditions* is not implied. Exposure to absolute-maximum-rated conditions for extended periods may affect device reliability.
(2) All voltage values are with respect to GND.
(3) Maximum power dissipation is a function of T_J(max), θ_{JA}, and T_A. The maximum allowable power dissipation at any allowable ambient temperature is $P_D = (T_J(max) - T_A) / \theta_{JA.}$ Operating at the absolute maximum T_J of 150°C can affect reliability.
(4) The package thermal impedance is calculated in accordance with JESD 51-7.
(5) Maximum power dissipation is a function of T_J(max), θ_{JC}, and T_C. The maximum allowable power dissipation at any allowable case temperature is $P_D = (T_J(max) - T_C) / \theta_{JC}$. Operating at the absolute maximum T_J of 150°C can affect reliability.
(6) The package thermal impedance is calculated in accordance with MIL-STD-883.

7.2 Handling Ratings

PARAMETER	DEFINITION	MIN	MAX	UNIT
T_{stg}	Storage temperature range	–65	150	°C

7.3 Recommended Operating Conditions

over operating free-air temperature range (unless otherwise noted)

			MIN	MAX	UNIT
V_{CC}	Supply voltage	NA555, NE555, SA555	4.5	16	V
		SE555	4.5	18	
V_I	Input voltage	CONT, RESET, THRES, and TRIG		V_{CC}	V
I_O	Output current			±200	mA
T_A	Operating free-air temperature	NA555	–40	105	°C
		NE555	0	70	
		SA555	–40	85	
		SE555	–55	125	

7.4 Electrical Characteristics

V_{CC} = 5 V to 15 V, T_A = 25°C (unless otherwise noted)

PARAMETER	TEST CONDITIONS		SE555			NA555 NE555 SA555			UNIT
			MIN	TYP	MAX	MIN	TYP	MAX	
THRES voltage level	V_{CC} = 15 V		9.4	10	10.6	8.8	10	11.2	V
	V_{CC} = 5 V		2.7	3.3	4	2.4	3.3	4.2	
THRES current(1)				30	250		30	250	nA
TRIG voltage level	V_{CC} = 15 V		4.8	5	5.2	4.5	5	5.6	V
		T_A = –55°C to 125°C	3		6				
	V_{CC} = 5 V		1.45	1.67	1.9	1.1	1.67	2.2	
		T_A = –55°C to 125°C			1.9				
TRIG current	TRIG at 0 V			0.5	0.9		0.5	2	μA
RESET voltage level			0.3	0.7	1	0.3	0.7	1	V
	T_A = –55°C to 125°C				1.1				
RESET current	RESET at V_{CC}			0.1	0.4		0.1	0.4	mA
	RESET at 0 V			–0.4	–1		–0.4	–1.5	
DISCH switch off-state current				20	100		20	100	nA
DISCH switch on-state voltage	V_{CC} = 5 V, I_O = 8 mA						0.15	0.4	V
CONT voltage (open circuit)	V_{CC} = 15 V		9.6	10	10.4	9	10	11	V
		T_A = –55°C to 125°C	9.6		10.4				
	V_{CC} = 5 V		2.9	3.3	3.8	2.6	3.3	4	
		T_A = –55°C to 125°C	2.9		3.8				
Low-level output voltage	V_{CC} = 15 V, I_{OL} = 10 mA			0.1	0.15		0.1	0.25	V
		T_A = –55°C to 125°C			0.2				
	V_{CC} = 15 V, I_{OL} = 50 mA			0.4	0.5		0.4	0.75	
		T_A = –55°C to 125°C			1				
	V_{CC} = 15 V, I_{OL} = 100 mA			2	2.2		2	2.5	
		T_A = –55°C to 125°C			2.7				
	V_{CC} = 15 V, I_{OL} = 200 mA			2.5			2.5		
	V_{CC} = 5 V, I_{OL} = 3.5 mA	T_A = –55°C to 125°C			0.35				
	V_{CC} = 5 V, I_{OL} = 5 mA			0.1	0.2		0.1	0.35	
		T_A = –55°C to 125°C			0.8				
	V_{CC} = 5 V, I_{OL} = 8 mA			0.15	0.25		0.15	0.4	
High-level output voltage	V_{CC} = 15 V, I_{OH} = –100 mA		13	13.3		12.75	13.3		V
		T_A = –55°C to 125°C	12						
	V_{CC} = 15 V, I_{OH} = –200 mA			12.5			12.5		
	V_{CC} = 5 V, I_{OH} = –100 mA		3	3.3		2.75	3.3		
		T_A = –55°C to 125°C	2						
Supply current	Output low, No load	V_{CC} = 15 V		10	12		10	15	mA
		V_{CC} = 5 V		3	5		3	6	
	Output high, No load	V_{CC} = 15 V		9	10		9	13	
		V_{CC} = 5 V		2	4		2	5	

(1) This parameter influences the maximum value of the timing resistors R_A and R_B in the circuit of Figure 12. For example, when V_{CC} = 5 V, the maximum value is $R = R_A + R_B \approx 3.4$ MΩ, and for V_{CC} = 15 V, the maximum value is 10 MΩ.

7.5 Operating Characteristics

V_{CC} = 5 V to 15 V, T_A = 25°C (unless otherwise noted)

PARAMETER		TEST CONDITIONS(1)	SE555			NA555 NE555 SA555			UNIT
			MIN	TYP	MAX	MIN	TYP	MAX	
Initial error of timing interval(2)	Each timer, monostable(3)	T_A = 25°C		0.5	1.5(4)		1	3	%
	Each timer, astable(5)			1.5			2.25		
Temperature coefficient of timing interval	Each timer, monostable(3)	T_A = MIN to MAX		30	100(4)		50		ppm/°C
	Each timer, astable(5)			90			150		
Supply-voltage sensitivity of timing interval	Each timer, monostable(3)	T_A = 25°C		0.05	0.2(4)		0.1	0.5	%/V
	Each timer, astable(5)			0.15			0.3		
Output-pulse rise time		C_L = 15 pF, T_A = 25°C		100	200(4)		100	300	ns
Output-pulse fall time		C_L = 15 pF, T_A = 25°C		100	200(4)		100	300	ns

(1) For conditions shown as MIN or MAX, use the appropriate value specified under recommended operating conditions.
(2) Timing interval error is defined as the difference between the measured value and the average value of a random sample from each process run.
(3) Values specified are for a device in a monostable circuit similar to Figure 9, with the following component values: R_A = 2 kΩ to 100 kΩ, C = 0.1 µF.
(4) On products compliant to MIL-PRF-38535, this parameter is not production tested.
(5) Values specified are for a device in an astable circuit similar to Figure 12, with the following component values: R_A = 1 kΩ to 100 kΩ, C = 0.1 µF.

P2N2222A

Amplifier Transistors

NPN Silicon

Features

- These are Pb−Free Devices*

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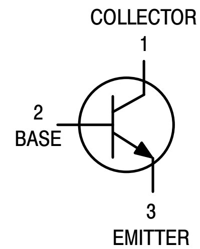


MAXIMUM RATINGS (T_A = 25°C unless otherwise noted)

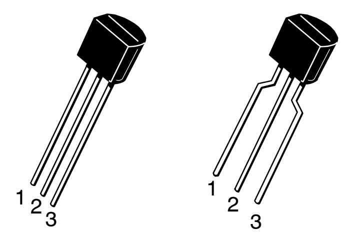
Characteristic	Symbol	Value	Unit
Collector−Emitter Voltage	V_{CEO}	40	Vdc
Collector−Base Voltage	V_{CBO}	75	Vdc
Emitter−Base Voltage	V_{EBO}	6.0	Vdc
Collector Current − Continuous	I_C	600	mAdc
Total Device Dissipation @ T_A = 25°C Derate above 25°C	P_D	625 5.0	mW mW/°C
Total Device Dissipation @ T_C = 25°C Derate above 25°C	P_D	1.5 12	W mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	−55 to +150	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	200	°C/W
Thermal Resistance, Junction to Case	$R_{\theta JC}$	83.3	°C/W

Stresses exceeding Maximum Ratings may damage the device. Maximum Ratings are stress ratings only. Functional operation above the Recommended Operating Conditions is not implied. Extended exposure to stresses above the Recommended Operating Conditions may affect device reliability.

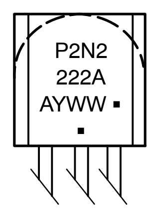
TO−92
CASE 29
STYLE 17



STRAIGHT LEAD
BULK PACK

BENT LEAD
TAPE & REEL
AMMO PACK

MARKING DIAGRAM



A = Assembly Location
Y = Year
WW = Work Week
▪ = Pb−Free Package
(Note: Microdot may be in either location)

ORDERING INFORMATION

Device	Package	Shipping†
P2N2222AG	TO−92 (Pb−Free)	5000 Units/Bulk
P2N2222ARL1G	TO−92 (Pb−Free)	2000/Tape & Ammo

†For information on tape and reel specifications, including part orientation and tape sizes, please refer to our Tape and Reel Packaging Specification Brochure, BRD8011/D.

*For additional information on our Pb−Free strategy and soldering details, please download the ON Semiconductor Soldering and Mounting Techniques Reference Manual, SOLDERRM/D.

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Characteristic	Symbol	Min	Max	Unit
OFF CHARACTERISTICS				
Collector–Emitter Breakdown Voltage (I_C = 10 mAdc, I_B = 0)	$V_{(BR)CEO}$	40	–	Vdc
Collector–Base Breakdown Voltage (I_C = 10 μAdc, I_E = 0)	$V_{(BR)CBO}$	75	–	Vdc
Emitter–Base Breakdown Voltage (I_E = 10 μAdc, I_C = 0)	$V_{(BR)EBO}$	6.0	–	Vdc
Collector Cutoff Current (V_{CE} = 60 Vdc, $V_{EB(off)}$ = 3.0 Vdc)	I_{CEX}	–	10	nAdc
Collector Cutoff Current (V_{CB} = 60 Vdc, I_E = 0) (V_{CB} = 60 Vdc, I_E = 0, T_A = 150°C)	I_{CBO}	– –	0.01 10	μAdc
Emitter Cutoff Current (V_{EB} = 3.0 Vdc, I_C = 0)	I_{EBO}	–	10	nAdc
Collector Cutoff Current (V_{CE} = 10 V)	I_{CEO}	–	10	nAdc
Base Cutoff Current (V_{CE} = 60 Vdc, $V_{EB(off)}$ = 3.0 Vdc)	I_{BEX}	–	20	nAdc
ON CHARACTERISTICS				
DC Current Gain (I_C = 0.1 mAdc, V_{CE} = 10 Vdc) (I_C = 1.0 mAdc, V_{CE} = 10 Vdc) (I_C = 10 mAdc, V_{CE} = 10 Vdc) (I_C = 10 mAdc, V_{CE} = 10 Vdc, T_A = –55°C) (I_C = 150 mAdc, V_{CE} = 10 Vdc) (Note 1) (I_C = 150 mAdc, V_{CE} = 1.0 Vdc) (Note 1) (I_C = 500 mAdc, V_{CE} = 10 Vdc) (Note 1)	h_{FE}	 35 50 75 35 100 50 40	 – – – – 300 – –	–
Collector–Emitter Saturation Voltage (Note 1) (I_C = 150 mAdc, I_B = 15 mAdc) (I_C = 500 mAdc, I_B = 50 mAdc)	$V_{CE(sat)}$	 – –	 0.3 1.0	Vdc
Base–Emitter Saturation Voltage (Note 1) (I_C = 150 mAdc, I_B = 15 mAdc) (I_C = 500 mAdc, I_B = 50 mAdc)	$V_{BE(sat)}$	 0.6 –	 1.2 2.0	Vdc
SMALL–SIGNAL CHARACTERISTICS				
Current–Gain – Bandwidth Product (Note 2) (I_C = 20 mAdc, V_{CE} = 20 Vdc, f = 100 MHz)C	f_T	300	–	MHz
Output Capacitance (V_{CB} = 10 Vdc, I_E = 0, f = 1.0 MHz)	C_{obo}	–	8.0	pF
Input Capacitance (V_{EB} = 0.5 Vdc, I_C = 0, f = 1.0 MHz)	C_{ibo}	–	25	pF
Input Impedance (I_C = 1.0 mAdc, V_{CE} = 10 Vdc, f = 1.0 kHz) (I_C = 10 mAdc, V_{CE} = 10 Vdc, f = 1.0 kHz)	h_{ie}	 2.0 0.25	 8.0 1.25	kΩ
Voltage Feedback Ratio (I_C = 1.0 mAdc, V_{CE} = 10 Vdc, f = 1.0 kHz) (I_C = 10 mAdc, V_{CE} = 10 Vdc, f = 1.0 kHz)	h_{re}	 – –	 8.0 4.0	X 10^{-4}
Small–Signal Current Gain (I_C = 1.0 mAdc, V_{CE} = 10 Vdc, f = 1.0 kHz) (I_C = 10 mAdc, V_{CE} = 10 Vdc, f = 1.0 kHz)	h_{fe}	 50 75	 300 375	–
Output Admittance (I_C = 1.0 mAdc, V_{CE} = 10 Vdc, f = 1.0 kHz) (I_C = 10 mAdc, V_{CE} = 10 Vdc, f = 1.0 kHz)	h_{oe}	 5.0 25	 35 200	μMhos
Collector Base Time Constant (I_E = 20 mAdc, V_{CB} = 20 Vdc, f = 31.8 MHz)	$rb'C_c$	–	150	ps
Noise Figure (I_C = 100 μAdc, V_{CE} = 10 Vdc, R_S = 1.0 kΩ, f = 1.0 kHz)	N_F	–	4.0	dB

1. Pulse Test: Pulse Width ≤ 300 μs, Duty Cycle ≤ 2.0%.
2. f_T is defined as the frequency at which $|h_{fe}|$ extrapolates to unity.

P2N2907A

Amplifier Transistor

PNP Silicon

Features

- These are Pb-Free Devices*

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector-Emitter Voltage	V_{CEO}	-60	Vdc
Collector-Base Voltage	V_{CBO}	-60	Vdc
Emitter-Base Voltage	V_{EBO}	-5.0	Vdc
Collector Current - Continuous	I_C	-600	mAdc
Total Device Dissipation @ T_A = 25°C Derate above 25°C	P_D	625 5.0	mW mW/°C
Total Device Dissipation @ T_C = 25°C Derate above 25°C	P_D	1.5 12	W mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	-55 to +150	°C

THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction to Ambient	$R_{\theta JA}$	200	°C/W
Thermal Resistance, Junction to Case	$R_{\theta JC}$	83.3	°C/W

Stresses exceeding Maximum Ratings may damage the device. Maximum Ratings are stress ratings only. Functional operation above the Recommended Operating Conditions is not implied. Extended exposure to stresses above the Recommended Operating Conditions may affect device reliability.

*For additional information on our Pb-Free strategy and soldering details, please download the ON Semiconductor Soldering and Mounting Techniques Reference Manual, SOLDERRM/D.

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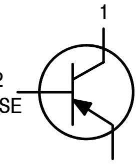
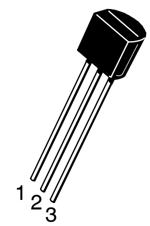
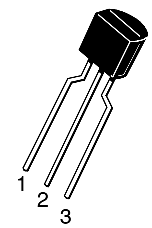
COLLECTOR
1
2
BASE

3
EMITTER

TO-92
CASE 29
STYLE 17

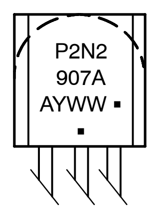


STRAIGHT LEAD
BULK PACK



BENT LEAD
TAPE & REEL
AMMO PACK

MARKING DIAGRAM



A = Assembly Location
Y = Year
WW = Work Week
▪ = Pb-Free Package
(Note: Microdot may be in either location)

ORDERING INFORMATION

Device	Package	Shipping†
P2N2907AG	TO-92 (Pb-Free)	5000 Units / Bulk
P2N2907ARL1G	TO-92 (Pb-Free)	2000 / Tape & Reel

†For information on tape and reel specifications, including part orientation and tape sizes, please refer to our Tape and Reel Packaging Specification Brochure, BRD8011/D.

ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Characteristic	Symbol	Min	Max	Unit
OFF CHARACTERISTICS				
Collector-Emitter Breakdown Voltage (Note 1) (I_C = −10 mAdc, I_B = 0)	$V_{(BR)CEO}$	−60	−	Vdc
Collector-Base Breakdown Voltage (I_C = −10 μAdc, I_E = 0)	$V_{(BR)CBO}$	−60	−	Vdc
Emitter-Base Breakdown Voltage (I_E = −10 μAdc, I_C = 0)	$V_{(BR)EBO}$	−5.0	−	Vdc
Collector Cutoff Current (V_{CE} = −30 Vdc, $V_{EB(off)}$ = −0.5 Vdc)	I_{CEX}	−	−50	nAdc
Collector Cutoff Current (V_{CB} = −50 Vdc, I_E = 0) (V_{CB} = −50 Vdc, I_E = 0, T_A = 150°C)	I_{CBO}	− −	−0.01 −10	μAdc
Emitter Cutoff Current (V_{EB} = −3.0 Vdc)	I_{EBO}	−	−10	nAdc
Collector Cutoff Current (V_{CE} = −10 V)	I_{CEO}	−	−10	nAdc
Base Cutoff Current (V_{CE} = −30 Vdc, $V_{EB(off)}$ = −0.5 Vdc)	I_{BEX}	−	−50	nAdc
ON CHARACTERISTICS				
DC Current Gain (I_C = −0.1 mAdc, V_{CE} = −10 Vdc) (I_C = −1.0 mAdc, V_{CE} = −10 Vdc) (I_C = −10 mAdc, V_{CE} = −10 Vdc) (I_C = −150 mAdc, V_{CE} = −10 Vdc) (Note 1) (I_C = −500 mAdc, V_{CE} = −10 Vdc) (Note 1)	h_{FE}	 75 100 100 100 50	 − − − 300 −	−
Collector-Emitter Saturation Voltage (Note 1) (I_C = −150 mAdc, I_B = −15 mAdc) (I_C = −500 mAdc, I_B = −50 mAdc)	$V_{CE(sat)}$	 − −	 −0.4 −1.6	Vdc
Base-Emitter Saturation Voltage (Note 1) (I_C = −150 mAdc, I_B = −15 mAdc) (I_C = −500 mAdc, I_B = −50 mAdc)	$V_{BE(sat)}$	 − −	 −1.3 −2.6	Vdc
SMALL-SIGNAL CHARACTERISTICS				
Current-Gain − Bandwidth Product (Notes 1 and 2) (I_C = −50 mAdc, V_{CE} = −20 Vdc, f = 100 MHz)	f_T	200	−	MHz
Output Capacitance (V_{CB} = −10 Vdc, I_E = 0, f = 1.0 MHz)	C_{obo}	−	8.0	pF
Input Capacitance (V_{EB} = −2.0 Vdc, I_C = 0, f = 1.0 MHz)	C_{ibo}	−	30	pF

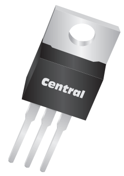
SWITCHING CHARACTERISTICS

Characteristic	Conditions	Symbol	Min	Max	Unit
Turn-On Time	(V_{CC} = −30 Vdc, I_C = −150 mAdc, I_{B1} = −15 mAdc) (Figures 1 and 5)	t_{on}	−	50	ns
Delay Time		t_d	−	10	ns
Rise Time		t_r	−	40	ns
Turn-Off Time	(V_{CC} = −6.0 Vdc, I_C = −150 mAdc, I_{B1} = I_{B2} = −15 mAdc) (Figure 2)	t_{off}	−	110	ns
Storage Time		t_s	−	80	ns
Fall Time		t_f	−	30	ns

1. Pulse Test: Pulse Width ≤ 300 μs, Duty Cycle ≤ 2.0%.
2. f_T is defined as the frequency at which $|h_{fe}|$ extrapolates to unity.

TIP42
TIP42A
TIP42B
TIP42C

PNP SILICON
POWER TRANSISTOR



TO-220 CASE

www.centralsemi.com

DESCRIPTION:

The CENTRAL SEMICONDUCTOR TIP42 SERIES types are PNP Epitaxial-Base Silicon Power Transistors designed for power amplifier and high speed switching applications.

MARKING: FULL PART NUMBER

MAXIMUM RATINGS: (T_C=25°C)	**SYMBOL**	**TIP42**	**TIP42A**	**TIP42B**	**TIP42C**	**UNITS**
Collector-Base Voltage	V_{CBO}	40	60	80	100	V
Collector-Emitter Voltage	V_{CEO}	40	60	80	100	V
Emitter-Base Voltage	V_{EBO}	5.0				V
Continuous Collector Current	I_C	6.0				A
Peak Collector Current	I_{CM}	10				A
Continuous Base Current	I_B	2.0				A
Power Dissipation	P_D	65				W
Power Dissipation (T_A=25°C)	P_D	2.0				W
Operating and Storage Junction Temperature	T_J, T_{stg}	-65 to +150				°C

ELECTRICAL CHARACTERISTICS: (T_C=25°C unless otherwise noted)

SYMBOL	**TEST CONDITIONS**	**MIN**	**TYP**	**MAX**	**UNITS**
I_{CEO}	V_{CE}=30V (TIP42, TIP42A)			0.7	mA
I_{CEO}	V_{CE}=60V (TIP42B, TIP42C)			0.7	mA
I_{CES}	V_{CE}=Rated V_{CEO}			0.4	mA
I_{EBO}	V_{EB}=5.0V			1.0	mA
BV_{CEO}	I_C=30mA (TIP42)	40			V
BV_{CEO}	I_C=30mA (TIP42A)	60			V
BV_{CEO}	I_C=30mA (TIP42B)	80			V
BV_{CEO}	I_C=30mA (TIP42C)	100			V
$V_{CE(SAT)}$	I_C=6.0A, I_B=0.6A			1.5	V
$V_{BE(ON)}$	V_{CE}=4.0V, I_C=6.0A			2.0	V
h_{FE}	V_{CE}=4.0V, I_C=0.3A	30			
h_{FE}	V_{CE}=4.0V, I_C=3.0A	15		75	
h_{fe}	V_{CE}=10V, I_C=0.5A, f=1.0kHz	20			
f_T	V_{CE}=10V, I_C=0.5A, f=1.0MHz	3.0			MHz
t_{on}	I_C=6.0A, I_{B1}= I_{B2}=0.6A, R_L=5.0Ω		0.4		μs
t_{off}	I_C=6.0A, I_{B1}= I_{B2}=0.6A, R_L=5.0Ω		0.7		μs

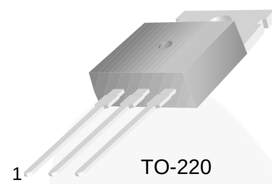
R2 (22-July 2014)

November 2014

TIP41A / TIP41B / TIP41C
NPN Epitaxial Silicon Transistor

Features

- Medium Power Linear Switching Applications
- Complement to TIP42 Series



TO-220

1.Base 2.Collector 3.Emitter

Ordering Information

Part Number	Top Mark	Package	Packing Method
TIP41A	TIP41A	TO-220 3L (Single Gauge)	Bulk
TIP41B	TIP41B	TO-220 3L (Single Gauge)	Bulk
TIP41C	TIP41C	TO-220 3L (Single Gauge)	Bulk
TIP41CTU	TIP41C	TO-220 3L (Single Gauge)	Rail

Absolute Maximum Ratings

Stresses exceeding the absolute maximum ratings may damage the device. The device may not function or be operable above the recommended operating conditions and stressing the parts to these levels is not recommended. In addition, extended exposure to stresses above the recommended operating conditions may affect device reliability. The absolute maximum ratings are stress ratings only. Values are at T_C = 25°C unless otherwise noted.

Symbol	Parameter		Value	Unit
V_{CBO}	Collector-Base Voltage	TIP41A	60	V
		TIP41B	80	
		TIP41C	100	
V_{CEO}	Collector-Emitter Voltage	TIP41A	60	V
		TIP41B	80	
		TIP41C	100	
V_{EBO}	Emitter-Base Voltage		5	V
I_C	Collector Current (DC)		6	A
I_{CP}	Collector Current (Pulse)		10	A
I_B	Base Current		2	A
T_J	Junction Temperature		150	°C
T_{STG}	Storage Temperature Range		-65 to 150	°C

Thermal Characteristics

Values are at $T_C = 25°C$ unless otherwise noted.

Symbol	Parameter	Value	Unit
P_C	Collector Dissipation ($T_C = 25°C$)	65	W
	Collector Dissipation ($T_A = 25°C$)	2	

Electrical Characteristics

Values are at $T_C = 25°C$ unless otherwise noted.

Symbol	Parameter		Conditions	Min.	Max.	Unit
$V_{CEO}(sus)$	Collector-Emitter Sustaining Voltage(1)	TIP41A	$I_C = 30$ mA, $I_B = 0$	60		V
		TIP41B		80		
		TIP41C		100		
I_{CEO}	Collector Cut-Off Current	TIP41A	$V_{CE} = 30$ V, $I_B = 0$		0.7	mA
		TIP41B / TIP41C	$V_{CE} = 60$ V, $I_B = 0$		0.7	
I_{CES}	Collector Cut-Off Current	TIP41A	$V_{CE} = 60$ V, $V_{EB} = 0$		400	µA
		TIP41B	$V_{CE} = 80$ V, $V_{EB} = 0$		400	
		TIP41C	$V_{CE} = 100$ V, $V_{EB} = 0$		400	
I_{EBO}	Emitter Cut-Off Current		$V_{EB} = 5$ V, $I_C = 0$		1	mA
h_{FE}	DC Current Gain(1)		$V_{CE} = 4$ V, $I_C = 0.3$ A	30		
			$V_{CE} = 4$ V, $I_C = 3$ A	15	75	
$V_{CE}(sat)$	Collector-Emitter Saturation Voltage(1)		$I_C = 6$ A, $I_B = 600$ mA		1.5	V
$V_{BE}(on)$	Base-Emitter On Voltage(1)		$V_{CE} = 4$ V, $I_C = 6$ A		2.0	V
f_T	Current Gain Bandwidth Product		$V_{CE} = 10$ V, $I_C = 500$ mA, f = 1 MHz	3.0		MHz

Note:

1. Pulse test: pw ≤ 300 µs, duty cycle ≤ 2%.

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