

POWER GENERATION FROM WASTE FOOD USING ARDUINO

Submitted in partial fulfillment of the requirements for the award of
Bachelor of Engineering Degree in
Electronics and Communication Engineering

by

KALYANAPU KEERTHI (40130093)

GANUGULA NEERAJA (40130063)



**DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING
SCHOOL OF ELECTRICAL AND ELECTRONICS**

SATHYABAMA

**INSTITUTE OF SCIENCE AND TECHNOLOGY
(DEEMED TO BE UNIVERSITY)**

CATEGORY -1 UNIVERSITY BY UGC

Accredited with Grade "A++" by NAAC | 12B Status by UGC | Approved by AICTE

JEPPIAAR NAGAR, RAJIV GANDHI SALAI, CHENNAI – 600119

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BONAFIDE CERTIFICATE

This is to certify that this Project Report is the bonafide work of **G.NEERAJA(40130063)** and **K.KEERTHI(40130093)** who carried out the project entitled "**POWER GENERATION FROM WASTE FOOD USING ARDUINO**" under my supervision from JUNE 2023 to APRIL 2024.

M R Ebenezer

Internal Guide

Dr.M.R.EBENEZAR JEBARANI, M.E., Ph.D.

[Signature]
Head of the Department

Dr. T. RAVI, M.E., Ph.D.,

Submitted for Viva voce Examination held on 17/04/2024

Internal Examiner

External Examiner

ACKNOWLEDGEMENT

DECLARATION

We **GANUGALA NEERAJA(40130063)** and **KALYANAPU KEERTHI(40130093)**, hereby declare that the Project Report entitled "**POWER GENERATION FROM WASTE FOOD USING ARDUINO**" is done by us under the guidance of **Dr.M.R.EBENEZAR JEBARANI, M.E., Ph.D.**, is submitted in partial fulfillment of the requirements for the award of Bachelor of Engineering degree in **Electronics and Communication Engineering**.

During the programme followed.

We would like to express our sincere and deep sense of gratitude to the Project Guide **Dr. M.R.EBENEZAR JEBARANI, M.E., Ph.D.**, for his valuable guidance, suggestions and constant encouragement paved way for the successful completion of my project work.

We wish to express the thanks to all Teaching and non-teaching staff members of the Department of Electronics and Communication Engineering who have helped in many ways for the completion of the project.

DATE:17-04-2024

PLACE:Chennai

1. G. Neeraja.
2. K. Keerthi.

SIGNATURE OF THE CANDIDATES

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ABSTRACT

India is the second most populated nation on the planet, estimating to a population of about 1.21 billion, and accounts for about 17.66% of the total world population. It is same as the combined population of Indonesia, Brazil, Pakistan, and Bangladesh. Population growth and rapid urbanization has had a huge impact on the waste generation.

Increase in the global population and the rising demand for food and other essentials, has led to a rise in the amount of waste being generated daily by each household. Waste has become one of the major environmental issues for every nation and is adversely affecting the lives on earth.

In a developing country like India, there are many places which suffer shortage of electricity to date. Ironically they are the places which have become landfills for garbage. This project gives a solution to the present scenario by converting food waste into electricity. This electricity is produced by the reaction between the electrodes with food waste as the medium. Different combinations and arrangements of electrodes are also taken into consideration.

This is where project plays an important role in finding an effective solution to the existing problem. Based on this project, it can generate 5w to 12w DC. Increase the number of electrode units could indeed lead to higher power output. Implementing industrial electrodes in the future could be significant for generating even more power.

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CHAPTER 1

INTRODUCTION

1.1 INTRODUCTION TO FOOD WASTE ENERGY

Nowadays there is an absence of energy sources and in comparative time the electrical weights and flow devices which are assembled basically and direct with respect to electric power are extending. The Food waste energy is a free and clean energy source. At the same time, it is an open and unused source. Physically Food waste is known as the eventual outcome of vibration of any substance which may be found in a vaporous state like air, or in a liquid state like water, or in a solid state like metals.

In the present situation a Mobile telephone is the essential need for everybody. An ongoing overview demonstrates that India is likewise the world's second biggest broadcast communications advertise, with complete supporter base of 1,183.51 million an unfathomably immense measure of electric energy is being used for the charging of cell phones. Different request about are being driven all over the place everywhere throughout the world to discover elective methods for charging cell phones. Utilizing traditional sources like body temperature, body vibrations and human exercises have been demonstrated to give a lot of electrical energy.

Food waste as an electric wellspring of vitality has a colossal potential that has been left, so to speak, new as further movement further towards utilizing interminable and convenient wellsprings of vitality changing over the Food waste waves into electrical vitality. The making of vitality through Food waste would thusly have the choice to be utilized in time of electrical vitality by one of the most quickly open sorts of sullyng. Food waste is sort of energy which goes as wave, mechanical wave that is a swaying of weight which needs a medium to travel. The medium can be air, water, wood, or some other material, the main spot where Food waste can't travel is a vacuum. Through liquid and gas state Food waste is transmitted as longitudinal wave however through solid it could be transmitted as both longitudinal wave and transverse wave.

The gadget which changes over Food waste energy into electrical energy is called Electrodes, informally nicknamed Button Electrodes is a OP-AMP that changes over Food waste into an electrical sign. In many research, researchers found the material of false lithium niobate could change over Food waste to electric under the state of high temperature and recurrence. At the point when Food waste waves experience such materials, the Food waste energy will be changed over into electrical energy. Changing over the made upheaval from outside thece to electric energy by utilizing an appropriate OP-AMP is the principle point of this examination. sensors are utilized to change over the Food waste waves to electric charges.

The wires by then pass on the electric vitality to a yield device for instance a speaker and the streams make. An amplifier is the most widely recognized case of a gadget that turns Food waste (Food waste) energy into electrical energy. Longitudinal waves will be waves in which the movement of the individual particles of the medium is toward a path that is parallel to the bearing of energy transport. A longitudinal wave can be made in a smooth if the smooth is extended a level way and the primary curls of the smooth are vibrated evenly. In such a case, every individual loop of the medium is set into vibrational movement in headings parallel to the cthese that the energy is shipped.

A transverse wave is a wave where particles of the medium move toward a path opposite to the heading that the wave moves. Assume that a smooth is extended an even way over the study hall and that a heartbeat is brought into the smooth on the left end by vibrating the primary loop here and there. Energy will start to be shipped through the smooth from left to right. As the energy is moved from left to right, the individual loops of the medium will be uprooted upwards and downwards. For this situation, the particles of the medium move opposite to the heading that the beat moves. This kind of wave is a transverse wave.

Transverse waves are constantly described by molecule movement being opposite to wave movement. Longitudinal waves are of rotating weight deviation from the harmony weight, causing neighborhood district of pressure and rarefaction, while transverse wave are surges of substituting shear and stress at right edge to the heading of causing. In air at standard temperature and weight, the comparing wavelengths Food waste waves extend from 17 m-17 mm. Be that as it may, how might utilize this Food

waste to take care of electric energy issues. This could be effectively comprehended by the third "law of thermodynamics" which expresses that the mechanical energy can be changed over to electrical energy. Food waste energy could be effectively changed over into warmth energy which could then change over into power however it isn't profoundly proficient as the misfortune in transformation will be more, though the other technique is changing over Food waste energy to power.

It is the transformation of mechanical strain to electric energy. So, it could be seen that hypothetically stable energy could be changed over into power. The proposed strategy produces electrical energy through promptly accessible Food waste energy. This method not just helps in creating electrical energy from clamor yet in addition helps in decreasing contamination. Power generation with the assistance of commotion as a sthede is another idea. The age of this energy should be possible at airplane terminals, railroad station at shows where commotion contamination is more. In this way the generation of energy from this accessible Food waste sthede can demonstrate to be helpful. This idea tests into the use of clean and speedily open wellspring of vitality.

The goal of this project is to show a compelling strategy for creating usable electric capacity to charge the battery from accessible Food waste energy around us from commotions. material is one of the best solid sensors. The manner in which it works is that the mechanical energy of Food waste is connected legitimately to a solid attribute. The OP-AMP will create a limited quantity of voltage in light of the utilization of mechanical energy. The limit of materials to get any vibration and to change over that into electric sign pulled in numerous analysts who attempted to execute circuits and frameworks for changing over weight and vibrations into electric power. A idea was looked into by DARPA in the United States in an undertaking called Energy Harvesting, which the finger weight during each stroke in a console can be gathered by materials to charge batteries for reinforcement supplies or for low control chip and remote radios.

1.2 PROBLEM OF THE STATEMENT

A lot of research has been done about Food waste pollution in the last 40 years, but yet there is still more to learn about how to control and lessen the affects that Food waste in day to day life. Food waste is a major factor in the planning, design, and construction of transportation corridors. Architects, Food wasteengineers and transportation planners are searching for creative ways to eliminate or greatly reduce noise levels. The challenge lies in attaining desired Food waste levels while simultaneously maintaining or enhancing the visual environment. In this project, an experiment has been set up to determine the new way to solve the problem of charging the mobile and also to solve out the Draining of charge from the mobile is a hectic problem of the mobile users.

1.3 OBJECTIVES OF THE STUDY

This research aimed to design and develop a device that has the ability to convert Food wasteinto electricity and store it for emergency use. The specific objectives were as follows:

1. To determine the components needed to develop the noise pollution based alternate sthece power bank in terms of Hardware and Software
2. To describe the Food waste pollution based new circuitry and design architecture
3. To determine the Food waste in decibels to be harvested to create power; process the Food waste into power as sthece of electricity
4. To determine how much electricity do the Food waste pollution based device will generate voltage, current, and resistance.
5. To determine the efficiency of the Food waste Pollution Based device when tested using different mobile gadget

CHAPTER 2

LITERATURE REVIEW

2.1 OVERVIEW OF LITERATURE

Random waste energy can be changed over into electrical energy utilizing transducer. The created electric energy capacitors which enhanced through adder and voltage multiplier circuits. Food waste can be detected through different sorts of Food waste sensors. material is one of the best solid sensors. The word implies power coming about because of weight. is the charge that aggregates in certain strong materials (remarkably precious stones and certain pottery) because of connected mechanical pressure. The impact is comprehended as the straight electro mechanical communication between the mechanical and the electrical state in some crystalline materials with no reversal balance. The impact is the procedure of interior age of electrical charge coming about because of a connected mechanical power the limit of materials to get any vibration and to change over that into electric sign pulled in numerous specialists who attempted to actualize circuits and frameworks for changing over weight and vibrations into electric power.

G. R. Ahmed Jamal ; Hamidul Hassan ; Amitav Das ; Jannatul Ferdous ; Sharmin A. Lisa [2023], states that a moderately less investigated wellspring of environmentally friendly power energy is proposed. Arbitrary Food waste energy around us can be treated as a wellspring of electric power after their productive transformation utilizing appropriate transducer. A viable method for delivering usable electric power from accessible irregular Food waste energy is displayed here. transducers are utilized for transformation of Food wastes into electric energy. The created electric energy from different transducers are put away in various supercapacitors which are then summed up and enhanced through snake and voltage multiplier circuits. The resultant electric power was utilized to charge a battery-powered DC battery in order to store this energy. A little 9 volt DC battery was observed to be completely energized inside thirty minutes from completely released stage utilizing medium Food waste sthece through the proposed transformation circuit. Thusly, irregular Food waste energy from various stheces around us can be put away as electric energy which can be utilized later to convey electric capacity to drive good little

stacks. The proposed thought can give another wellspring of environmentally friendly power energy and can contribute in worldwide quest for sustainable power sthece.

Alankrit Gupta, Vivek Goel, Vivek Yadav [2022], presents the work done on the change systems and philosophies of changing over Food waste energy to its electrical partner. It centers around the attainability and the ground zero use of the equivalent. The forecast of things to come advancement of these sort of wellsprings of energy is underscored other than generally referred to ones, for example, sun based energy, biogas, wind energy, etc. So one can suppose the option to change over the Food waste energy to power then can charge cell phone just by conversing with companions on portable itself.

Steven R. Anton and Henry A. Sodano [2019], The field of intensity collecting has encountered huge development in the cthese of recent years due to the consistently expanding want to create compact and remote gadgets with broadened life expectancies. Current convenient and remote gadgets must be intended to incorporate electrochemical batteries as the power sthece. The utilization of batteries can be irksome because of their restricted life expectancy, therefore requiring their occasional substitution. On account of remote sensors that are to be put in remote areas, the sensor must be effectively open or of an expendable sort to enable the gadget to work over broadened timeframes. Energy searching gadgets are intended to catch the encompassing energy encompassing the hardware and convert it into usable electrical energy. The idea of intensity gathering moves in the direction of creating self-controlled gadgets that don't require replaceable power supplies. Various wellsprings of harvestable surrounding energy exist, including waste warmth, vibration, electromagnetic waves, wind, streaming water, and sunlight based energy. While every one of these wellsprings of energy can be successfully used to control remote sensors, the basic and organic networks have set an accentuation on searching vibrational energy with materials. This article will survey late writing in the field of intensity gathering and present the present condition of intensity collecting in its drive to make totally self-controlled gadgets.

Tryhorn, Chris [2019] explains his point, an endeavor for improving the correspondence in provincial territories by building up an off-lattice versatile cellphone reinforcement charger which uses different types of sustainable power sthece. The different types of energy utilized in this undertaking are sun based, wind and warmth because of their accessibility and tidiness. With the progressions in power, presently it can collect energy from stheces which are difficult to gather utilizing conventional energy change techniques. In this task, a proposed converter for the phone charger was structured, developed, and afterward tried. Results demonstrate the usefulness of the proposed converter to charge Cell-telephones. Further improvement of configuration will likewise be portrayed.

Mehul Garg ; Devyani Gera ; Aman Bansal ; Arpan Kumar [2021], investigates a moderately less prominent wellspring of clean energy. Clamor (Food waste) energy can be changed over into practical wellspring of electric power by utilizing a reasonable transducer. This should be possible by utilizing aOP-AMPby changing over vibrations brought about by commotion into electrical energy. An application is proposed for the equivalent, where a speaker and a transformer are utilized to change over commotion delivered via vehicle horn into electrical energy. The vibrations made by clamor can be changed over into electrical energy through the guideline of electromagnetic acceptance. The got sign was ventured up utilizing a transformer. A comparative arrangement was set at separation of 1 meter from the fumes pipe of a 350 cubic centimeter motor of a motorbike. The showed thoughts test into a clean and promptly accessible wellspring of energy.

John JohnTherampilly[2021], states that the field of intensity reaping has encountered critical development in the cthese of recent years due to the regularly expanding want to create convenient and remote hardware with broadened life expectancies. Current convenient and remote gadgets must be intended to incorporate electrochemical batteries as the power sthece. The utilization of batteries can be irksome because of their restricted life expectancy, along these lines requiring their occasional substitution. On account of remote sensors that are to be set in remote areas, the sensor must be effectively available or of an expendable sort to enable the

gadget to work over broadened timeframes. Energy rummaging gadgets are intended to catch the encompassing energy encompassing the hardware and convert it into usable electrical energy. The idea of intensity reaping progresses in the direction of creating self-controlled gadgets that don't require replaceable power supplies. Various wellsprings of harvestable surrounding energy exist, including waste warmth, vibration, electromagnetic waves, wind, streaming water, and sun powered energy. While every one of these wellsprings of energy can be viably used to control remote sensors, the auxiliary and natural networks have put an accentuation on searching vibrational energy with materials. This article will survey late writing in the field of intensity collecting and present the present condition of intensity gathering in its drive to make totally self-fueled gadgets.

Littrell, Robert John [2022], portrays that amplifiers have been planned, manufactured utilizing MEMS methods, and tried. These structures are planned for limiting the clamor floor as this has restricted the pertinence of recently built MEMSElectrodes. So as to limit the clamor floor, models of both cantilever and stomach based Electrodes are created. This work introduces a shut structure answer for the affectability of a cantilever based receiver without making the little coupling suspicion and gives criteria to deciding the legitimacy of this supposition. The total Electrodes model incorporates a model of the intensifying gadgets also and, in the wake of looking at the total framework, an improvement parameter is exhibited for the enhancement of the MEMS OP-AMP which can be connected to any enhancing hardware. This advancement parameter is then used to decide the ideal gadget material and geometry for a MEMS receiver. This enhancement is utilized to structure two ages of gadgets. The original gadget was a basic, 4 cover gadget used to work out handling issues for the most part connected with aluminum nitride, the chose material. While these original gadgets did not have remarkable execution, estimations of the exhibition approved the models and featured the most pertinent creation issues. The second era gadget was an increasingly perplexing, 7 – 9 veil process which considered further improvement over the original gadget. The creation issues experienced in the original gadget were illuminated by this plan. Gadgets of different data transmissions and sizes were fabricated however a structure with a 790 μm x 790 μm zone and a

18.4 kHz thunderous recurrence displayed a 37 dBA commotion floor and a plan with a $960\text{ }\mu\text{m} \times 960\text{ }\mu\text{m}$ territory and a 12.4 kHz reFoodwasteing recurrence showed a 34 dBA clamor floor. Contrasted with the most reduced clamor Electrodes recently revealed, these amplifiers have a littler region and commotion levels in excess of multiple times lower making them suitable for a wide scope of utilizations.

U. K. Singh and R. H. Middleton [2023], procedure of procuring the energy encompassing a framework and changing over it into usable electrical energy is named power collecting. With piezoceramic materials, it is conceivable to collect control from vibrating structures. It has been demonstrated that small scale to milliwatts of intensity can be produced from vibrating frameworks. The undertaking focuses on the change of mechanical vibration into electrical energy utilizing material. In some mining applications, eg water stream penetrating; huge high recurrence vibrations might be available. In the event that effectively collected, this energy could be utilized to dispense with batteries in remote sensors. This article shows a model of a transducer, a mechanical vibration range, the reenactment of the model, model of the power rummaging circuit, trial results and its future points of view.

Y C Shu¹ and I C Lien [2021], states that Power reaping alludes to the act of obtaining energy from nature which would be generally squandered and changing over it into usable electric energy. Much work has been done on examining the ideal AC power yield, while little has considered the AC–DC yield. This article explores the ideal AC–DC control age for a corrected gadget. Interestingly with appraisals dependent on different degrees of guess in the ongoing writing, a scientific articulation for the AC–DC power yield is inferred under unfaltering state activity. It demonstrates that the gathered power relies upon the info vibration qualities (recurrence and increasing speed), the mass of the generator, the electrical burden, the normal recurrence, the mechanical damping proportion and the electromechanical coupling coefficient of the framework. A successful power standardization plan is given to analyze the relative execution and proficiency of gadgets. The hypothetical forecasts are approved and observed to be in great concurrence with both exploratory perceptions and numerical recreations. At long

last, a few structure rules are recommended for gadgets with huge coupling coefficient and quality factor.

B. Li, A. J. Laviage, J. H. You, Y. J. Kim [2022], Due to the high electro-mechanical energy conversion efficiency of materials, micro power generators have received much attentions in the past decades. With a solitary shaft put inside the cylinder resonators, the collected voltage, control become the most extreme close to the cylinder open bay where the Food waste weight slope is at the most extreme. As the shaft is moved to the cylinder shut end, the voltage and control step by step decline because of the diminished Food waste weight inclination. Various crystal shafts have been set along the center line of the cylinder resonators so as to increment the measure of collected energy. Due to the interference of Food waste air molecule movement brought about by the bars, it is discovered that setting shafts close to the shut cylinder end isn't useful.

2.2 RELATED WORKS

The project will demonstrate to be an extraordinary aid to the world, since it will almost certainly remove electrical energy. For example, squander Food waste and weight and numerous kinds of various energies of inexhaustible kind. There are different wellsprings of Food waste and weight that go unnoticed. The utilization of transducers to change over Food waste and weight into energy exhibits that commotion can go about as an elective wellspring of energy. This structure can be actualized in regions where enormous measure of clamor or Food waste energy or weight is produced like in atomic power plants, substantial hardware as this structure will generate environmentally friendly power energy as well as assistance in decreasing clamor contamination levels. Additionally in different exercise center types of gear and apparatus the demonstrates to be an incredible sthce to create power. Henceforth there are numerous applications regions wherein this strategy can be used and power can be created effectively and shortage of power can be decrease.

CHAPTER 3

MATERIALS AND EXPERIMENTAL TECHNIQUES

3.1 PROPOSED MODEL

The demand for an alternate energy source is quickly increasing. Instead of disposing of food waste in landfills, using it to generate renewable energy has the potential to lower electricity prices. In this project, household food waste is gathered and given an electrode treatment. Electricity is produced by the reaction between the electrodes. The load will be then connected to the buck-boost converter which enhances the voltage and allows the device to run smoothly. A crystal oscillator is additionally utilized to regulate the CPU frequency over a broad range. Without a main source, the energy generated can be used to charge the battery.

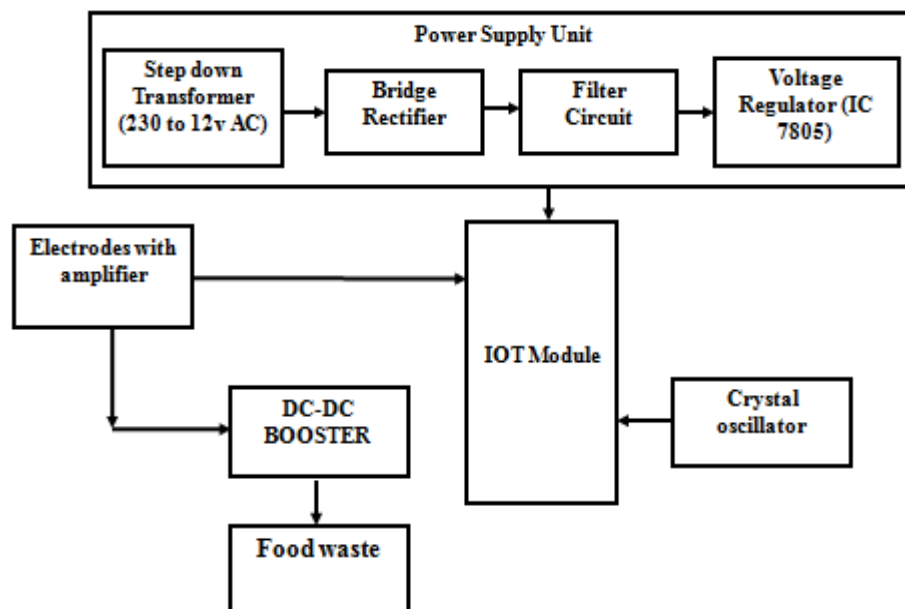


Fig.3.1:PROPOSED METHOD BLOCK DIAGRAM

Fig.3.1.It shows the proposed method block diagram like the components used in project and how the components connected

3.2.HARDWARE AND SOFTWARE REQUIREMENTS

HARDWARE REQUIREMENTS

- Node Mcu
- Power Supply
- Dc-Dc Converter
- Battery
- Electrodes

SOFTWARE REQUIREMENTS

- Arduino Ide
- Embedded C

3.3.HARDWARE DESCRIPTION

POWER SUPPLY

Power supply is a reference to a source of electrical power. A device or system that supplies electrical or other types of energy to an output load or group of loads is called a power supply unit or PSU. The term is most commonly applied to electrical energy supplies, less often to mechanical ones, and rarely to others.

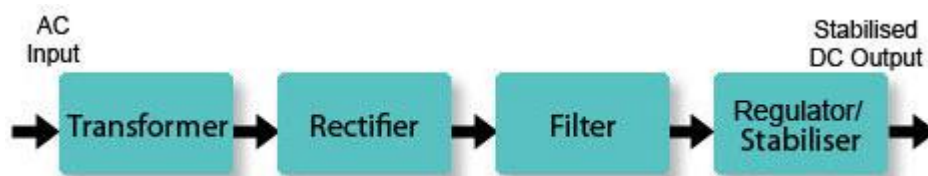


Fig.3.2.Power Supply

FIG.3.2.shows how the power supply is working for the project ,like how AC input is converted into stabilized DC output.

TRANSFORMERS

The transformer stage must be able to supply the current needed. If too small a transformer is used, it is likely that the power supply's ability to maintain full output voltage at full output current will be impaired. With too small a transformer, the losses will increase dramatically as full load is placed on the transformer.

As the transformer is likely to be the most costly item in the power supply unit, careful consideration must be given to balancing cost with likely current requirement. There may also be a need for safety devices such as thermal fuses to disconnect the transformer if overheating occurs, and electrical isolation between primary and secondary windings, for electrical safety.

DC-TO-DC CONVERTER

DIRECT CURRENT

The term DC stands for direct current, which is unidirectional flow of electric charge. People use DC power sources such as solar cells, batteries, and thermocouples. DC is flexible and able to transfer through conductors, such as wire, as well as through insulators, semiconductors, and even through a vacuum. The current always flows in just a single direction, which is the thing that differentiates it from AC, or alternating current, which can change direction.

People often use direct current as a means to charge batteries and their electronic devices. They also use DC power for third rail power systems and railway propulsion. While DC means direct current, it also means constant polarity. Some types of DC will have variances in their voltage, while most will not. A good example of varying voltage would be fluctuating voice signals on a power line. One should never try to reverse the polarity in a DC device, unless it features a diode bridge that will allow for the switch. Most of the battery-powered devices that people use do not have this bridge, so trying to alter the polarity would actually destroy the device.

The automotive industry and aircraft often use these types of systems. Most of the time, vehicles will use 12-volt power, although a select few may have 42-volt or 6-volt systems. Most light aircraft use 12-volt or 28-volt. Phone systems will often use both AC and DC components in them. Anything that contains a battery is running on DC power, from portable radios to toys.

DIFFER FROM AC

Inventor Thomas Edison was a champion of DC power. He and others saw that electrical energy and magnetic fields had a close relationship. When there is a magnetic field near wires, it causes the electrons in the wire to flow in a single direction, which we've already established as being direct current. They flow because they are either attracted or repelled by the magnetic poles. This discovery showed scientists that it was possible to hold energy in a battery and then harness it.

However, DC was not the only source for electricity. Another scientist, Nikola Tesla, worked on the alternating current system because it was able to transfer power more efficiently, he thought. He did not make use of magnetism on the wire in a steady direction. Instead, the magnet rotated, offering alternating power. When the magnet was in a certain position, the electrons would flow in one direction. Changing, or alternating, the position of the magnet would change the way the electrons flowed. One of the biggest differences in AC and DC is the amount of energy they can carry. DC voltage can produce a certain amount of constant electricity. The further it travels the weaker it becomes. AC voltage from generators can change their strength, increasing or decreasing it when they travel through transformers.

DC-TO-DC CONVERSION

DC-DC converter is a type of electronic circuit that takes the DC source and then converts it from the current voltage into another voltage. In some instances, one may have to increase or decrease the voltage. This is actually very common when it comes to automobiles. Some devices might use in vehicle, such as a portable DVD player for the kids, require a certain amount of power to run. Too much power and it could destroy the devices. Too little power and it would not run. Since the device needs to draw from the vehicle's battery, and the battery might be too powerful, there needs to be a conversion of power. However, it needs to remain DC voltage. To accomplish this, a variety of different types of DC-DC converters is available.

The converters will actually take the power from the battery and cut it down to a usable level. In the cases of devices that might need more power, a converter can step up the power. Many of the devices that use in the vehicle come with adapters that can

plug into the vehicle. The adapters will convert the power to ensure device works appropriately. It is important to make sure are always using the right adapter with the device though. Otherwise, it could be drawing too much power, which could seriously damage the electronics.

NECESSARY TO CONVERT DC TO DC

Unlike AC power, it is not possible to increase or decrease the voltage level with a transformer. In some cases, it might be necessary to step down from the power coming from a large truck battery running on 24 volts to 12 volts in order to power a radio. In cars, the 12-volt battery provides too much power to some connected devices, such as a phone. So, they need to have a converter that will drop the power even further and make it safe for the device.

The basic DC-DC converter will take the current and pass it through a switching element. This turns the signal into a square wave, which is actually AC. The wave then passes through another filter, which turns it back into a DC signal of the appropriate voltage necessary.

DIFFERENCE BETWEEN ISOLATED AND NON-ISOLATED DC-DC CONVERTERS

Two of the terms commonly found around DC-DC converters are non-isolated and isolated converters. The non-isolated converters are often used when the change in voltage is small. Five different types of converters fall into this group. The input and output terminals share a common ground. The DC-DC converters are very common, and they are generally a cheaper solution for most devices. One of the disadvantages with the non-isolated converters is that they do not have much in the way of protection for high electrical voltages. They often have more noise as well.

Buck – The buck converter is used whenever one needs to reduce the amount of voltage.

Boost – A boost converter does the opposite of the buck converter. It steps up the voltage level.

BuckBoost – This type of converter can work as either bucking or boosting the voltage. The most common usage for the converter is to reverse polarity.

Cuk – This type of converter is similar to buck-boost converters. The biggest difference is really the name. The Cuk was named after Slobodan Cuk, the man who created it.

Charge-Pump – This converter is used for stepping the voltage up or down in applications that have low power.

With an isolated DC-DC converter, there is a separation between the input and output terminals. These converters have high isolation voltage properties. They are useful for negative or positive grounds, and they can also be used as a floating ground for different types of equipment, such as telecommunications equipment. Unlike non-isolating converters, they have the ability to block noise and interference. This allows them to provide a cleaner DC source. In addition, they are generally safer. Two basic types of isolated converters exist.

Fly back Converter – The converter works similarly to the buck-boost converter in the non-isolating category. The difference is that it makes use of a transformer to store the energy instead of an inductor.

Forward Converter – Forward converters are very different. The converter will use the transformer to send the energy between input and output in a single step.

There are three classes of isolation

Operational – This offers isolated output with fault protection.

Basic – The basic form of isolation will offer a transformer with single fault protection.

Reinforced – This features two isolation layers that can offer actual physical separation.

Both the isolating and non-isolating converters have their uses, and the right choice will always depend on the application and individual needs. Even the best converters will have some loss in energy. Choosing the right converters can help to limit loss, and it ensures are using the best option for each application no matter the size.

TYPES OF DC-DC CONVERTERS EXIST

Fixed Installation Car Power Adapters – The power that comes into vehicle from the battery may be too high for powering some of the modules and devices, so the manufacturers will often utilize power adapters to ensure are receiving the right voltage for the devices. They are available at various input and output voltages to ensure the

best and safest performance. They also have surge protection and short circuit protection.

Isolated DC-DC Converters – As mentioned, these have internal transformers that will transform the input to a different output voltage for use with equipment. With this converter, the output is isolated from the input.

Non-Isolated DC-DC Converters – As the name suggests, they do not have any isolation between the input and output. They are typically used for smaller voltages. They can step the voltage up or down, and some of the converters have the ability to do either.

Portable Car Power Adapters – Portable car power adapters are very handy devices that people can use with all sorts of electronics to make them usable with their vehicle. They can serve as an adapter for a DVD player, CD player, phone connector, and more. The purpose of these adapters is to take the DC power that comes in from the vehicle's battery and step it down so that it can work with personal electronic devices without providing them with a voltage that is too high and that might damage them. It is important to purchase the correct adapters to ensure they actually provide the correct protection for the electrical devices.

NODE MCU

NodeMCU is an open source IoT platform. It includes firmware which runs on the ESP8266 Wi-Fi SoC from Espressif Systems, and hardware, which is based on the ESP-12 module. The term "NodeMCU" by default refers to the firmware rather than the dev kits. The firmware uses the Lua scripting language. It is based on the eLua project and built on the Espressif Non-OS SDK for ESP8266. It uses many open source projects, such as Lua-cjson and spiffs. Lua based interactive firmware for Espressif ESP8266 Wi-Fi SoC, as well as an open source hardware board that contrary to the \$3 ESP8266 Wi-Fi modules includes a CP2102 TTL to USB chip for programming and debugging, is breadboard-friendly, and can simply be powered via its micro USB port.

FEATURES

Wi-Fi Module – ESP-12E module similar to ESP-12 module but with 6 extra GPIOs.

USB – micro USB port for power, programming and debugging

Headers – 2x 2.54mm 15-pin header with access to GPIOs, SPI, UART, ADC, and power pins
Misc – Reset and Flash buttons

Power – 5V via micro USB port

Dimensions – 49 x 24.5 x 13mm

Arduino-like hardware IO

Advanced API for hardware IO, which can dramatically reduce the redundant work for configuring and manipulating hardware. Code like Arduino, but interactively in Lua script.

Nodejs style network API

Event-driven API for network applications, which facilitates developers writing code running on a 5mm5mm sized MCU in Nodejs style. Greatly speed up IOT application developing process.

Development Kit

The Development Kit based on ESP8266, integrated GPIO, PWM, IIC, 1-Wire and ADC all in one board. Power development in the fastest way combining with NodeMcu Firmware!

The ESP8266 chip requires 3.3V power supply voltage. It should not be powered with 5 volts like other arduino boards.

NodeMCU ESP-12E dev board can be connected to 5V using micro USB connector or Vin pin available on board.

The I/O pins of ESP8266 communicate or input/output max 3.3V only. i.e. the pins are NOT 5V tolerant inputs.

BATTERY

In electricity, a battery is a device consisting of one or more electrochemical cells that convert stored chemical energy into electrical energy. A common power source for many household and industrial applications. There are two types of batteries: primary batteries (disposable batteries), which are designed to be used once and discarded, and secondary batteries (rechargeable batteries), which are designed to be recharged and used multiple times. Batteries come in many sizes from miniature cells used to power hearing aids and wristwatches to battery banks the size of rooms that provide standby power for telephone exchanges and computer data centers.

A battery is a device that converts chemical energy directly to electrical energy. It consists of a number of voltaic cells; each voltaic cell consists of two half-cells connected in series by a conductive electrolyte containing anions and cations. One half-cell includes electrolyte and the electrode to which anions migrate, i.e., the anode or negative electrode; the other half-cell includes electrolyte and the electrode to which cations migrate, i.e.,

The cathode or positive electrode. In the redox reaction that powers the battery, cations are reduced at the cathode, while anions are oxidized at the anode. The electrodes do not touch each other but are electrically connected by the electrolyte. Some cells use two half-cells with different electrolytes. A separator between half-cells allows ions to flow, but prevents mixing of the electrolytes. Batteries are classified into two broad categories, each type with advantages and disadvantages. Primary batteries irreversibly transform chemical energy to electrical energy.

When the initial supply of reactants is exhausted, energy cannot be readily restored to the battery by electrical means. Secondary batteries can be recharged; that is, they can have their chemical reactions reversed by supplying electrical energy to the cell, restoring their original composition. Some types of primary batteries used, for example, for telegraph circuits, were restored to operation by replacing the components of the battery consumed by the chemical reaction. Secondary batteries are not indefinitely rechargeable due to dissipation of the active materials, loss of electrolyte and internal corrosion.

PRIMARY BATTERIES

Primary batteries can produce current immediately on assembly. Disposable batteries are intended to be used once and discarded. These are most commonly used in portable devices that have low current drain, are used only intermittently, or are used well away from an alternative power source, such as in alarm and communication circuits where other electric power is only intermittently available.

Disposable primary cells cannot be reliably recharged, since the chemical reactions are not easily reversible and active materials may not return to their original

forms. Battery manufacturers recommend against attempting recharging primary cells. Common types of disposable batteries include zinc–carbon batteries and alkaline batteries. In general, these have higher energy densities than rechargeable batteries, but disposable batteries do not fare well under high-drain applications with loads under 75 ohms ($75\ \Omega$).

SECONDARY BATTERIES

Secondary batteries must be charged before use; they are usually assembled with active materials in the discharged state. Rechargeable batteries or secondary cells can be recharged by applying electric current, which reverses the chemical reactions that occur during its use. Devices to supply the appropriate current are called chargers or rechargers.

The oldest form of rechargeable battery is the lead–acid battery. This battery is notable in that it contains a liquid in an unsealed container, requiring that the battery be kept upright and the area be well ventilated to ensure safe dispersal of the hydrogen gas produced by these batteries during overcharging. The lead–acid battery is also very heavy for the amount of electrical energy it can supply. Despite this, its low manufacturing cost and its high surge current levels make its use common where a large capacity is required or where the weight and ease of handling are not concerns.

BATTERY CHARGERS

Battery supply several related chargers that are very easy to use. All of the units have an internal computer-on-a-chip that makes possible the exact performance required for lead-acid batteries, whether they are manually-filled, sealed electrolyte, or Gell-cells. There are no switches to set. All battery chargers are fully regulated and automatic; continuously shorting the battery leads will not harm the chargers

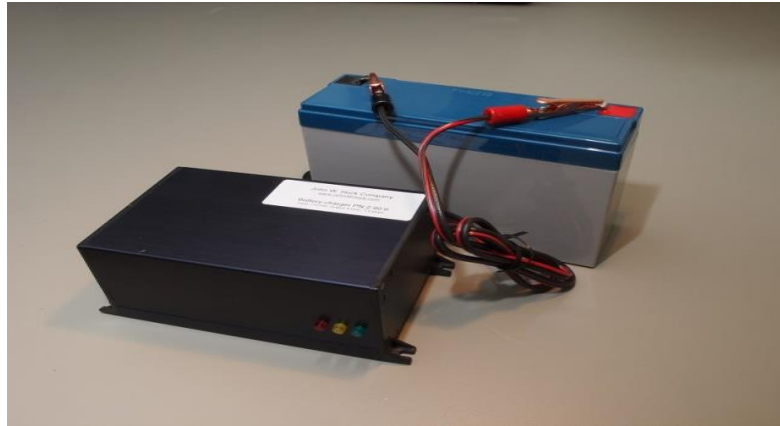


FIG.3.3:Battery

FIG.3.3 shows the battery working in the project and how the electricity is stored ,and how it is used for charging the mobile.

CAUTION

CARE SHOULD BE EXERCISED WHEN CHARGING A DEPLETED BATTERY. These chargers will become HOT, not just warm, and should not be touched until after the GREEN light comes on. The case can cause burns if not handled properly.

CONNECTING THE CHARGER- The sequence of connections is very important for the charger's computer operation. First, connect the color-coded leads to the battery. Then, plug the charger into the AC outlet. If mistakenly connect the battery backwards (negative to positive) or short the charger leads together, no damage or sparks occur—only a RED light comes on to indicate the possible mistake.

INITIAL – When the charger is initially plugged in, the unit's computer sends intermittently, a small current into the battery and then monitors the battery's response to determine its charge state. A RED light may come on briefly if the battery was excessively discharged, but it should go off within the first few minutes.

BULK CHARGE MODE – When the charger determines that the battery can safely take a charge, it goes into the bulk mode where the full capacity of the charger is applied to the battery until it is 80% charged. In this mode, the YELLOW light comes on.

ABSORPTION CHARGE MODE- Once the battery is 80% charged, the computer within the charger tapers the current from 100% to 33% of charger capacity until the battery reaches full charge. The light will remain YELLOW during this phase.

FLOAT CHARGE- After full charge has been reached, a GREEN light comes on, indicating the battery is ready for use. The computer switched to the 4th part of the cycle, that of a temperature compensated float charger. The unit is now in its maintenance mode, keeping the battery in its ideal charged state. Once the battery has reached this ideal state, all of chargers maintain this condition without causing “boil-off”, heating, or permitting the battery’s lead plates to sulfate. This means can leave batteries connected to the charger overnight, over the weekend, or indefinitely, knowing that when take them to the field, they are in the ideal state.

The black and white figure of charging characteristics above is for illustration. How long batteries take to charge depends on which model is used and how depleted the battery was. The example shown above is for a 15 Amp-Hr battery that has been depleted 10 Amps being charged by a 1.5 Amp-Hr charger. The process will take about 12 hths.

BATTERY TYPES

LEAD-ACID BATTERIES

The lead-acid batteries use a gelled-electrolyte in a sealed, high impact plastic case. The construction of these high power-to-weight batteries eliminates the need to ever water or worry about spilling acid. The units are completely rechargeable and weigh 4 and 8 lbs for the 6 and 12 VDC versions, respectively. The 6 V version is rated at 12 amp-hths and the 12 V version at 10 amp-hths. See for additional battery sizes. Please contact us with questions regarding appropriate chargers, batteries, or charging techniques for application.

DISPOSABLE BATTERIES:

For individuals desiring the convenience of disposable batteries, all of 6 volt traps are available with a 4-D Cell Battery Holder (Model 1.50) that will hold 4 D-cells – enough capacity for 1 or 2 night’s operations, depending on trap and battery type.

SOLAR-POWERED BATTERY CHARGERS:

The solar-powered battery chargers are available in 6 or 12 VDC units depending upon voltage and amperage requirements of traps. Solar Charger Model SA is for 6 volt traps; it is capable of replenishing the power used during the previous night during the following day. The Solar Charger Model CD is for 12 volt traps and can recharge a single battery which has been used to power a backlight trap for 10 or more hthes. Both units complete with power cords, stands, and instructions. Both are protected from reverse-polarity connection.

3.4.SOFTWARE DESCRIPTION

EMBEDDED C COMPILER

Embedded C is the most popular embedded software language in the world. Most embedded software is written in Embedded C. It is a set of language extensions for the C Programming language by the C Standards committee to address commonality issues that exist between C extensions for different embedded systems. Historically, embedded C programming requires nonstandard extensions to the C language in order to support exotic features such as fixed-point arithmetic, multiple distinct memory banks, and basic I/O operations. The C programming language is perhaps the most popular programming language for programming embedded systems.

Most C programmers are spoiled because they program in environments where not only there is a standard library implementation, but there are frequently a number of other libraries available for use. The cold fact is, that in embedded systems, there rarely are many of the libraries that programmers have grown used to, but occasionally an embedded system might not have a complete standard library, if there is a standard library at all. Few embedded systems have capability for dynamic linking, so if standard library functions are to be available at all, they often need to be directly linked into the executable. Oftentimes, because of space concerns, it is not possible to link in an entire library file, and programmers are often forced to "brew their own" standard c library

implementations if they want to use them at all. While some libraries are bulky and not well suited for use on microcontrollers, many development systems still include the standard libraries which are the most common for C programmers.

C remains a very popular language for micro-controller developers due to the code efficiency and reduced overhead and development time. C offers low-level control and is considered more readable than assembly. Many free C compilers are available for a wide variety of development platforms. The compilers are part of an IDEs with ICD support, breakpoints, single-stepping and an assembly window. The performance of C compilers has improved considerably in recent years, and they are claimed to be more or less as good as assembly, depending on who the ask. Most tools now offer options for customizing the compiler optimization. Additionally, using C increases portability, since C code can be compiled for different types of processors.

Embedded C, even if it's similar to C, and embedded languages in general requires a different kind of thought process to use. Embedded systems, like cameras or TV boxes, are simple computers that are designed to perform a single specific task. They are also designed to be efficient and cheap when performing their task. For example, they aren't supposed to use a lot of power to operate and they are supposed to be as cheap as possible. As an embedded system programmer, they will have simple hardware to work with.

They will have very little RAM, ROM and very little processing power and stack space. The reason why most embedded systems use Embedded C as a programming language is because Embedded C lies somewhere between being a high level language and a low level language. Embedded C, unlike low level assembly languages, is portable. It can run on a wide variety of processors, regardless of their architecture. Unlike high level languages, Embedded C requires less resources to run and isn't as complex. Some experts estimate that C is 20% more efficient than a modern language like C++. Another advantage of Embedded C is that it is comparatively easy to debug.

There are a variety of different compilers on the market, manufactured by different companies that use Embedded C. One of the more popular ones is the Keil compiler. Because of this, Embedded C is also sometimes known as Keil C. Embedded

C has several keywords that are not present in C (learn more about the concept of keywords in this cthese). These keywords are associated with operations needed by microprocessors. They will need to be familiar with all of them to be able to write Embedded C programs.

bdata: The bdata keyword lets the store a declared variable in the bit addressable memory. Take a look at this example:

Using: This keyword lets the execute a function by letting it access a register bank. There are three possible values: 1, 2 and 3.

EMBEDDED SYSTEMS PROGRAMMING

Embedded systems programming is different from developing applications on a desktop computers. Key characteristics of an embedded system, when compared to PCs, are as follows:

Embedded devices have these constraints (limited ROM, limited RAM, limited stack space, less processing power)

Components used in embedded system and PCs are different; embedded systems typically use smaller, less power consuming components. Embedded systems are more tied to the hardware.

3.5. EMBEDDED SYSTEMS USING DIFFERENT TYPE OF LANGUAGES:

- Machine Code
- Low level language, i.e., assembly
- High level language like C, C++, Java, Ada, etc.
- Application level language like Visual Basic, scripts, Access, etc.

DIFFERENCE BETWEEN C AND EMBEDDED C

Though C and embedded C appear different and are used in different contexts, they have more similarities than the differences. Most of the constructs are same; the difference lies in their applications. C is used for desktop computers, while embedded C is for microcontroller based applications. Accordingly, C has the luxury to use

resources of a desktop PC like memory, OS, etc. However, embedded C has to use with the limited resources (RAM, ROM, I/Os) on an embedded processor. Thus, program code must fit into the available program memory. If code exceeds the limit, the system is likely to crash. Compilers for C (ANSI C) typically generate OS dependant executables. Embedded C requires compilers to create files to be downloaded to the microcontrollers/microprocessors where it needs to run. Embedded compilers give access to all resources which is not provided in compilers for desktop computer applications.

Embedded systems often have the real-time constraints, which is usually not there with desktop computer applications. Embedded systems often do not have a console, which is available in case of desktop applications. So, what basically is different while programming with **Embedded C** is the mindset; for embedded applications, need to optimally use the resources, make the program code efficient, and satisfy real time constraints, if any. All this is done using the basic constructs, syntaxes, and function libraries of 'C'.

ADVANTAGES

- It is small and reasonably simpler to learn, understand, program and debug.
- C Compilers are available for almost all embedded devices in use today, and there is a large pool of experienced C programmers.
- Unlike assembly, C has advantage of processor-independence and is not specific to any particular microprocessor/ microcontroller or any system. This makes it convenient for a user to develop programs that can run on most of the systems.
- As C combines functionality of assembly language and features of high level languages, C is treated as a 'middle-level computer language' or 'high level assembly language'
- It is fairly efficient
- It supports access to I/O and provides ease of management of large embedded projects

Many of these advantages are offered by other languages also, but what sets C apart from others like Pascal, FORTRAN, etc. is the fact that it is a middle level language; it provides direct hardware control without sacrificing benefits of high level languages.

3.6.ARDUINO SOFTWARE (IDE)

The Arduino Integrated Development Environment or Arduino Software (IDE) contains a text editor for writing code, a message area, a text console, a toolbar with buttons for common functions and a series of menus. It connects to the Arduino and Genuino hardware to upload programs and communicate with them.

Verify/Compile

Checks the sketch for errors compiling it; it will report memory usage for code and variables in the console area.

Upload

Compiles and loads the binary file onto the configured board through the configured Port.

Upload Using Programmer

This will overwrite the boot loader on the board; they will need to use Tools > Burn Boot loader to restore it and be able to Upload to USB serial port again. However, it allows them to use the full capacity of the Flash memory for the sketch. Please note that this command will NOT burn the fuses. To do so Tools -> Burn Bootloader command must be executed.

Export Compiled Binary

Saves a .hex file that may be kept as archive or sent to the board using other tools.

Show Sketch Folder

Opens the current sketch folder.

Include Library

Adds a library to the sketch by inserting #include statements at the start of the code. For more details, see libraries below. Additionally, from this menu item they can access the Library Manager and import new libraries from .zip files.

Add File...

Adds a sketch file to the sketch (it will be copied from its current location). The new file

appears in a new tab in the sketch window. Files can be removed from the sketch using the tab menu accessible clicking on the small triangle icon below the serial monitor one on the right side of the toolbar.

TOOLS

Auto Format

this formats the code nicely: i.e. indents it so that opening and closing curly braces line up, and that the statements inside curly braces are indented more.

Archive Sketch

Archives a copy of the current sketch in .zip format. The archive is placed in the same directory as the sketch.

Fix Encoding & Reload

Fixes possible discrepancies between the editor char map encoding and other operating systems char maps.

Serial Monitor

Opens the serial monitor window and initiates the exchange of data with any connected board on the currently selected Port. This usually resets the board, if the board supports Reset over serial port opening.

Board

Select the board that you're using. See below for descriptions of the various boards.

PORT

This menu contains all the serial devices (real or virtual) on the machine. It should automatically refresh every time the open the top-level tools menu.

PROGRAMMER

For selecting a hardware programmer when programming a board or chip and not using the onboard USB-serial connection. Normally they won't need this, but if you're burning a bootloader to a new microcontroller, they will use this.

BURN BOOT LOADER

The items in this menu allow them to burn a bootloader onto the microcontroller on an Arduino board. This is not required for normal use of an Arduino or Genuino board but is useful if they purchase new ATmega microcontrollers (which normally come

without a bootloader). Ensure that you've selected the correct board from the Boards menu before burning the bootloader on the target board. This command also set the right fuses.

HELP

Here the find easy access to a number of documents that come with the Arduino Software (IDE). They have access to Getting Started, Reference, this guide to the IDE and other documents locally, without an internet connection. The documents are a local copy of the online ones and may link back to the online website.

Find in Reference

this is the only interactive function of the Help menu: it directly selects the relevant page in the local copy of the Reference for the function or command under the cursor.

SKETCHBOOK

The Arduino Software (IDE) uses the concept of a sketchbook: a standard place to store the programs (or sketches).

The sketches in the sketchbook can be opened from the File > Sketchbook menu or from the Open button on the toolbar.

The first time they run the Arduino software, it will automatically create a directory for the sketchbook. They can view or change the location of the sketchbook location from within the Preferences dialog.

TABS, MULTIPLE FILES, AND COMPILATION

Allows them to manage sketches with more than one file (each of which appears in its own tab). These can be normal Arduino code files (no visible extension), C files (.c extension), C++ files (.cpp), or header files (.h).

Once you've selected the correct serial port and board, press the upload button in the toolbar or select the Upload item from the File menu. Current Arduino boards will reset automatically and begin the upload.

With older boards (pre-Diecimila) that lack auto-reset, you'll need to press the reset button on the board just before starting the upload. On most boards, you'll see the RX and TX LEDs blink as the sketch is uploaded. The Arduino Software (IDE) will display a message when the upload is complete, or show an error. When the upload a

sketch, you're using the Arduino bootloader, a small program that has been loaded on to the microcontroller on the board. It allows to upload code without using any additional hardware. The bootloader is active for a few seconds when the board resets; then it starts whichever sketch was most recently uploaded to the microcontroller. The bootloader will blink the on-board (pin 13) LED when it starts (i.e. when the board resets).

LIBRARIES

Libraries provide extra functionality for use in sketches, e.g. working with hardware or manipulating data. To use a library in a sketch, select it from the Sketch > Import Library menu. This will insert one or more `#include` statements at the top of the sketch and compile the library with the sketch. Because libraries are uploaded to the board with the sketch, they increase the amount of space it takes up.

If a sketch no longer needs a library, simply delete its `#include` statements from the top of the code. There is a list of libraries in the reference. Some libraries are included with the Arduino software. Others can be downloaded from a variety of sources or through the Library Manager. Starting with version 1.0.5 of the IDE, the IDE can import a library from a zip file and use it in an open sketch. See these instructions for installing a third-party library.

THIRD-PARTY HARDWARE

Support for third-party hardware can be added to the hardware directory of the sketchbook directory. Platforms installed there may include board definitions (which appear in the board menu), core libraries, boot loaders, and programmer definitions. For details on creating packages for third-party hardware, see the Arduino IDE 1.5 3rd party Hardware specification.

CHAPTER 4

OVERVIEW

4.1 TECHNIQUES

Power generation from food waste using Arduino offers several advantages, making it a promising and sustainable technology. Here are some key techniques:

- **Renewable Energy Source:**

Food waste can be a continuous and renewable source of energy. It helps reduce reliance on finite fossil fuels, contributing to a cleaner and more sustainable energy mix.

- **Decentralized Energy Generation:**

Arduino-based food waste power generation systems can be deployed at various scales, from households to communities. This decentralization enhances energy access and resilience, especially in remote or underserved areas.

- **Cost-Effective Solution:**

The technology is cost-effective, as it utilizes readily available food waste as a feedstock and Arduino microcontrollers, which are affordable and versatile. This can result in longterm cost savings on energy bills and waste disposal.

4.2. STANDARDS

- **Waste Management Standards:**

Standards such as ISO for environmental management systems provide guidelines for managing waste in an environmentally responsible manner.

- **Electrical Standards:**

Depending on the electrical systems used in the process, standards like IEC 60364 for electrical installations in buildings or IEC 61400 for wind turbines (if applicable) may be relevant.

- **Emissions Regulations:**

Emissions standards set limits on pollutants released during the conversion process. These may include standards for air quality, water quality, and greenhouse gas emissions.

- **Health and Safety Regulations:**

Occupational health and safety regulations ensure the safety of workers involved in the conversion process. Standards such as OSHA (Occupational Safety and Health Administration) regulations or equivalent local regulations would apply.

- **Quality Management Standards:**

Standards such as ISO for quality management systems may be relevant for ensuring consistent and reliable production of electricity from food waste.

4.3 CONSTRAINTS

Addressing these constraints requires careful planning, stakeholder engagement, and collaboration among various stakeholders, including government agencies, and environmental organizations.

- **Technological Constraints:**

The efficiency and effectiveness of the conversion process depend on the technology used. Constraints such as the availability of suitable equipment, scalability, and reliability of the technology can impact the feasibility of the project.

- **Resource Constraints:**

Adequate resources such as food waste feedstock, water, and electricity are needed to operate the conversion process. Limited availability of these resources could constrain the implementation of the project.

- **Financial Constraints:**

Converting food waste into electricity may require significant initial investment for equipment, infrastructure, and operational costs. Financial constraints, such as limited funding or high costs of technology, could impede the progress of the project.

- **Regulatory Constraints:**

Compliance with regulations and standards related to waste management, emissions, health and safety, and energy production is essential. Failure to meet regulatory requirements could lead to legal issues and project delays.

- **Social and Cultural Constraints:**

Public acceptance and community engagement are crucial for the success of waste-to-energy projects. Social and cultural factors, such as attitudes towards waste management practices and perceptions of renewable energy, can influence project implementation.

- **Environmental Constraints:**

Environmental considerations, such as land use, air and water quality, and impacts on ecosystems, need to be addressed. Ensuring that the conversion process does not cause harm to the environment is essential for sustainable development.

4.4 TRADE OFFS

Navigating these trade-offs requires careful consideration of various factors, including technological capabilities, economic feasibility, environmental sustainability, and social acceptance. Finding the right balance among these competing priorities is essential for developing effective and sustainable waste-to-energy solutions.

- **Environmental Impact vs. Energy Production:**

One trade-off is between the environmental impact of waste management practices and the amount of electricity generated. Some methods of waste conversion may have lower environmental impact but produce less energy, while others may generate more energy but have higher emissions or other environmental consequences.

- **Cost vs. Efficiency:**

Another trade-off is between the cost of implementing waste-to-energy technology and the efficiency of electricity production. More efficient technologies may have higher initial costs but lower long-term operational expenses, while cheaper technologies may be less efficient or require more maintenance.

- **Resource Use vs. Energy Generation:**

There's a trade-off between the resources used in the conversion process and the energy generated. For example, using large amounts of water or other inputs

for the conversion process may compete with other uses or have environmental consequences.

- **Social Acceptance vs. Environmental Impact:**

There's often a trade-off between social acceptance of waste-to-energy projects and their potential environmental impact. Some communities may support projects that address waste management issues and provide renewable energy, while others may oppose them due to concerns about pollution or other negative impacts.

- **Short-Term vs. Long-Term Benefits:**

Balancing short-term benefits, such as waste reduction and energy production, with long-term considerations, such as environmental sustainability and resilience, is another trade-off. Some waste-to-energy projects may provide immediate benefits but have negative consequences in the long run, while others may require more investment upfront but offer greater long-term benefits.

CHAPTER 5

RESULTS AND DISCUSSION, PERFORMANCE ANALYSIS

5.1 RESULTS

- Food is stored for 10 days and then combining with different types of chemicals, some electricity is produced.
- By the combination of aluminium and copper ,2.5volts produced.
- By the combination of aluminium and zinc ,1.7 volts produced
- By the combination of zinc and copper ,3.3 volts produced
- By using lime powder ,4-4.5 volts produced.

TABLE.5.1:VOLTAGE OBTAINED FROM DIFFERENT PAIRS OF ELECTRODES

Combination	Voltage (in V) Existing Model	Voltage (in V) Proposed Model
Aluminium-Copper	0.72	2.5
Aluminium-Zinc	0.4	1.7
Zinc-Copper	0.9	3.3

Table.5.1 It shows how much voltage produced from using different pair of electrodes in the project.



Fig5.1:Waste Food Storage

Fig.5.1 Shows how the food is stored in the container and how much voltage produced in the project

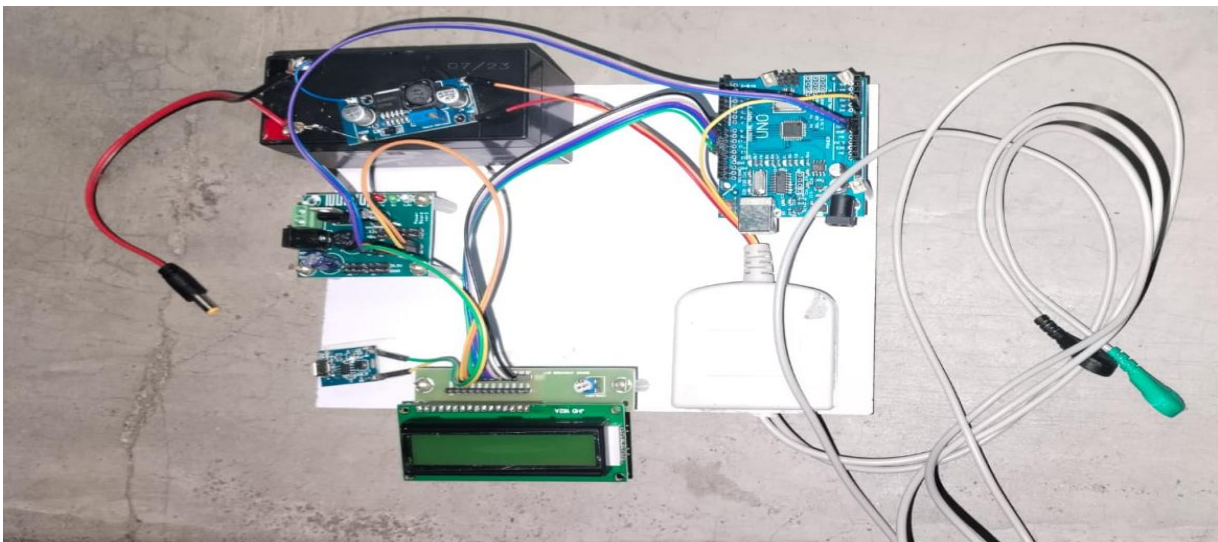


Fig.5.2: Hardware Implementation

Fig.5.2 Shows the hardware implementation, and it gives the idea about how components are connected to each component



Fig.5.3:Alert For Storing Power

Fig.5.3 It shows the alert message ,what the LCD displays while the power is turned on for the project

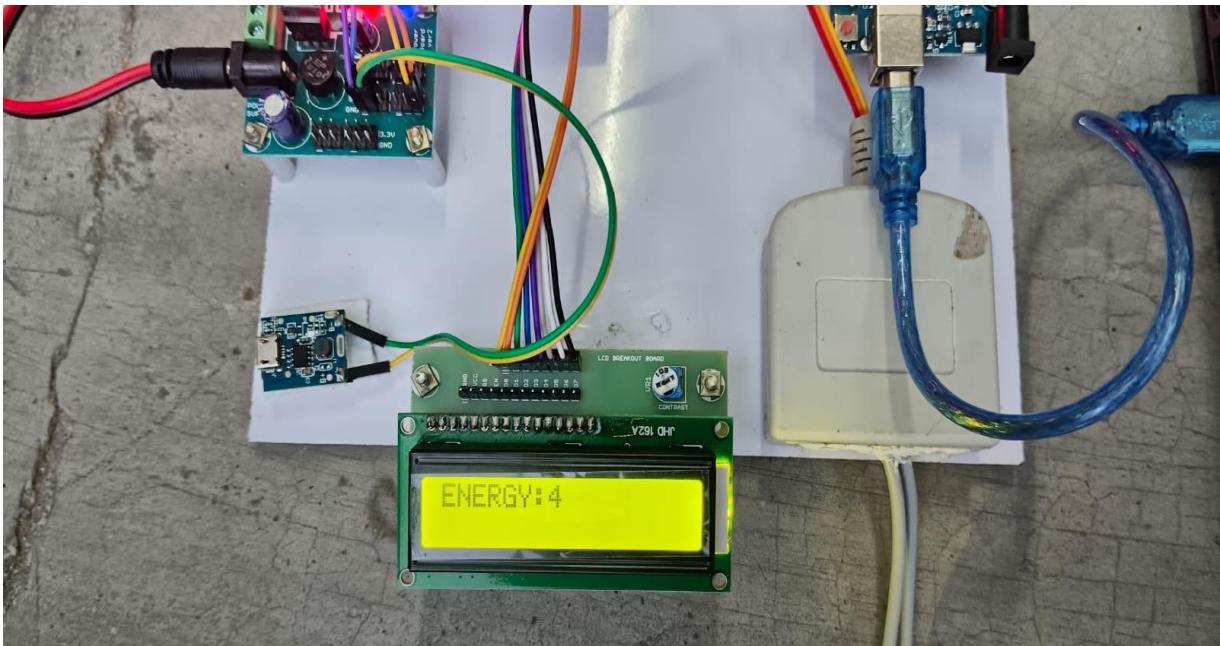


Fig.5.4:Storing Power From Waste

Fig.5.4 It shows how much voltage is produced by using the project and it displays it in the form of ENERGY



Fig.5.5:Charging the mobile through MCU

Fig.5.5 shows how the mobile is charging through Mobile Charging Unit(MCU) using produced electricity by project

CHAPTER 6

CONCLUSIONS AND FUTURE SCOPE

The research on power generation from food waste utilizing electrodes, a DC-DC converter, a battery, and Node MCU has yielded promising results, showcasing the potential of harnessing energy from organic waste through microbial digestion. The integration of innovative technologies and real-time monitoring has opened avenues for sustainable energy solutions and waste management practices. Microbial Digestion as a Sustainable Energy Source. The study demonstrated the viability of microbial digestion as a sustainable energy.

The breakdown of food waste by microorganisms leads to the generation of electrons, forming the basis for voltage production. This eco-friendly process aligns with circular economy principles, offering an innovative approach to waste-to-energy initiatives. **Steady Voltage Generation and Optimization Strategies** The system exhibited consistent voltage generation, emphasizing the stability of the microbial digestion process. While the results are promising, further exploration into optimization strategies is essential. Adjusting microbial composition, waste input parameters, and environmental conditions could enhance voltage output, ensuring sustained and reliable energy production.

Efficient DC-DC Conversion and Battery Storage. The DC-DC converter played a crucial role in regulating and converting the generated voltage, contributing to efficient energy harvesting. The charged battery acted as a storage reservoir, providing a consistent energy supply. Ongoing research could focus on optimizing battery technologies to improve storage efficiency and overall system performance. The significance of continuous monitoring cannot be overstated, as it ensures the system's long-term sustainability and effectiveness. **Environmental and Economic Implications** Harnessing energy from food waste carries significant environmental and economic implications. Addressing waste management challenges while simultaneously contributing to renewable energy generation reflects a holistic and sustainable approach. This technology has the potential to play a pivotal role in waste treatment facilities, decentralized energy systems, and regions facing energy poverty.

Generating power from waste food using biogas and Arduino technology has several potential future scopes and opportunities. This innovative approach aligns with sustainability goals, waste reduction, and renewable energy generation. Here are some future prospects for this technology:

Waste-to-Energy in Urban Environments: As urbanization continues to increase, so does the generation of food waste. Biogas generation from food waste using Arduino-controlled systems can become a viable solution for decentralized energy production in cities. Implementing this technology in urban settings can help reduce landfill waste and provide localized renewable energy.

Energy Access in Developing Countries: In regions with limited access to electricity, small scale biogas systems powered by Arduino controllers can provide a sustainable source of energy. These systems can be deployed in rural areas to improve the quality of life, power essential appliances, and support economic development.

Waste should be taken in semi solid or completely in liquid form; else the solid waste or peels etc should be lightly grinded before use. Addition of chemicals does not increase the voltage but speeds up the rate of reaction. The electrodes must be immersed in separate containers in method II as opposed to method I, because when many cells are immersed in single container it acts a single cell. The electrons move randomly and hence won't give the desired results.

Immersing in separate containers constitutes every container acting as a cell hence gives the actual result. Depending on the load requirements, the cells can be arranged in series parallel combination.

Zinc and copper combination gives the best result among the rest. The electrodes are taken into consideration depending upon their surface area, more the surface area more flow of electrons. Adding to this, the electrodes should be kept close to each other, as a result of which the current increases and therefore increases the rate of reaction.

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