DESIGN & IMPLEMENTATION OF ELECTRICAL VEHICLE WIRELESS CHARGER

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A project
Submitted as partial fulfillment of the requirement for the degree of

BACHELOR OF SCIENCE IN ELECTRICAL AND ELECTRONIC ENGINEERING

Department of Electrical and Electronic Engineering

INTERNATIONAL ISLAMIC UNIVERSITY CHITTAGONG

MAY 2022

CERTIFICATE OF APPROVAL

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DECLARATION

It is hereby declared that this work has been done by us and no portion of the work contained in this thesis/project has been submitted elsewhere for the award of any degree or diploma.

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ACKNOWLEDGMENT

All praises and thanks to Allah, the Lord of the world, the most Beneficent, the most Merciful for helping us to accomplish this work.

We are beholden to a number of people, who supported us to carry out this work. It is a genuine pleasure, to express our deep sense of thanks and gratitude to our mentor, guide and supervisor, **Khandakar Abdulla Al Mamun,** Assistant Professor, Department of Electrical and Electronic Engineering, IIUC. His dedication and keen interest above all his overwhelming attitude to help his students and been solely and mainly responsible for completing our work. His timely advice, meticulous scrutiny, scholarly advice and scientific approach have helped us to a very extent to accomplish this task.

We are grateful to our parents and fellow classmates to enhance our spirit and interest towards this topic by providing enthusiastic encouragement.

In this project we have tried our best to achieve our goal. In early stage while we were collecting information related to our project many individuals have contributed towards this project. We would like to render our gratitude and grateful thanks to each one of them.

Authors

ABSTRACT

Wireless charging is becoming increasingly popular owing to the rising usage of EVs and consumer devices. This article discusses the design and execution of a contactless battery charger for electric cars. Systems based on double-D (DD) coils, which try to minimize core loss by designing and optimizing the core, are the subject of this study. You'll notice core loss if you utilize a wireless charging pad with medium to high power. Conventional approaches imply that the magnetic field in the core is equally distributed. With its non-uniformity, the core's magnetic field creates a large surge in core loss. This study focuses on the design and implementation of a multi-purpose wireless charger. Based on a Colpitts oscillator, the transmitter's core construction is fairly simple. The receiver coil's coupling efficiency has been boosted owing to advancements in the coil's construction. A workable system has been constructed and is ready to be pushed out into the world.

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ABBREVIATION

WPT	Wireless Power Transmission
WET	Wireless Energy Transmission
FCC	Federal Communications Commission
SHARP	Stationary High Altitude Relay Platform
SMPS	Switch Mode Power Supply
NTC	Negative Temperature Coefficient
PTC	Positive Temperature Coefficient
EV	Electric Vehicles
AC	Alternating Current
DC	Direct Current
LCD	Liquid Crystal Display

CHAPTER 1

INTRODUCTION

1.1 INTRODUCTION

Late 19th-century wireless charging has been around for decades. However, it was mostly a theoretical technology during the first 100 years as a commercially viable device, such as electric toothbrushes. Electricity may be transferred without using wires when it is sent wirelessly. There are a variety of ways to describe the topic. In order to disperse the electricity, the transmitter generates and sends out an electromagnetic field, which is received by a reception device. Eliminating cables and batteries using wireless power transfer technology increases the portability, ease of use, and security of electronic gadgets for everyone. Wireless power may be used when connecting cables is difficult, risky, or impossible [1].

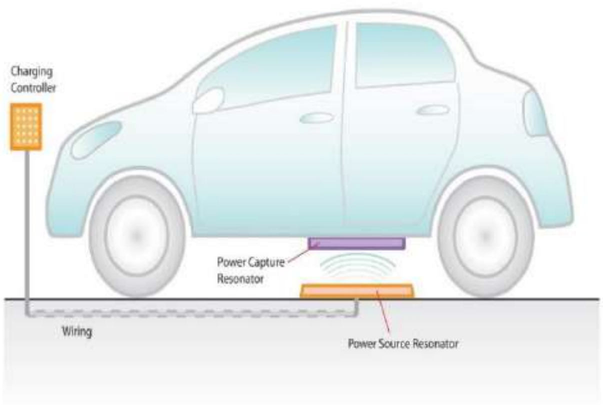


Fig 1.1: Wireless Car Parking [27]

Near- and far-field options are the most frequent when it comes to wireless power. In near-field or non-radiative processes, electricity may be transported across small distances by inductive or capacitive coupling between wire coils or metal electrodes. It is possible to employ inductive coupling in medical devices such as pacemakers, telephones, electric toothbrushes and RFID tags to wirelessly charge or transport electricity. Because of the electromagnetic radiation they release, methods that utilize far-field or radiative radiation, such as microwaves, are referred to as "power beaming." It is possible to travel large distances using these approaches, but the energy must be directed towards the recipient. It is feasible to use solar-powered drones and satellites for many purposes. Electromagnetic radiation protection must be addressed by all wireless power systems in order to safeguard humans and other living things.

An "energy harvesting" technique is one in which ambient energy from the environment is converted into electric power for use in remote, self-contained devices that do not need an external source of power to operate. Ambient energy sources include, for example, stray electric and magnetic fields or radio waves from nearby electrical equipment; light, heat, motion, and kinetic energy. Despite their poor conversion efficiency and typically little power, remote sensors and other tiny micropower wireless devices may be operated and recharged (milliwatts or microwatts). A new method is being developed to remove the need for wireless gadgets to be rechargeable or rechargeable.

1.2 NEAR FIELD TECHNIQUES

Electric and magnetic fields in the near-field exhibit quasi-static oscillating dipole fields at huge distances. The intensity of these fields diminishes with the square of the distance from the observer: $(\mathbf{D_{range}}/\mathbf{D_{ant}})^{-3}$ The power transmitted reduces by $(\mathbf{D_{range}}/\mathbf{D_{ant}})^{-6}$ or 60 decibels every decade since power is inversely related to field strength. When antennas are far apart, the power received is reduced by a factor of $2^6 = 64$ if the distance between them is doubled. Inductive and capacitive coupling can only be employed for short-range power transmission, within a few times the diameter of the antenna device $\mathbf{D_{ant}}$. For dipole fields, the highest coupling occurs when dipoles are positioned longitudinally, rather than transversely as in a radiative system [2], which maximizes radiation from the dipoles.

1.3 OBJECTIVES

The objectives of this project are given below:

1) To study WPT for EV.
2) To design a WPT for EV.
3) To implement a WPT system for EV.
4) To analyze the output and efficiency for different distance of WPT system.

1.4 CHAPTER OUTLINE

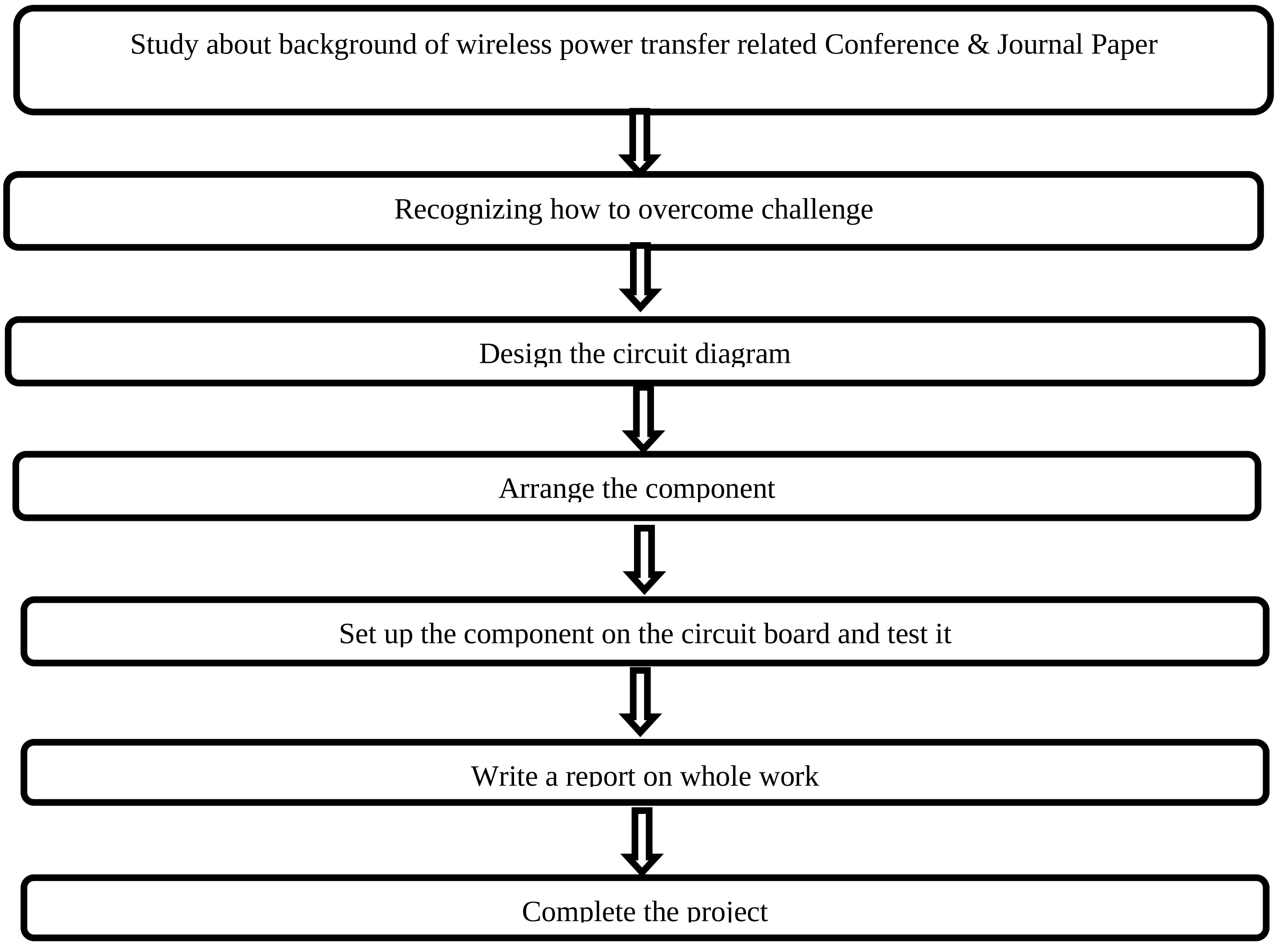
The architecture of this project has encompassed six chapters. The following is a list of each chapter's content:

- **Chapter 1** (Introduction): This chapter providing the outline, motivation and purpose of the project.
- **Chapter 2** (Literature Review): This chapter explored previous work or study related to this project.

- **Chapter 3** (System Design): The components of this project has been addressed in detail in this chapter.
- **Chapter 4** (Design Methodology): This section covers experimental setup of this project.
- **Chapter 5** (Implementation and Results): Discuss the execution of the project and the performance of the project.
- **Chapter 6** (Conclusion): The overview of this project is explored in more depth in this Chapter. The advantage of the project, the benefit and the possible future work of the project are addressed.

1.5 METHODOLOGY

The Methodology is as follow:



CHAPTER 02

LITERATURE REVIEW

2.1 INTRODUCTION

There were several hypotheses and counter-theories about how electrical energy may be transported in the nineteenth century. Electric current generates a magnetic field, according to André-Marie Ampère's circuit rule, originally proposed in 1826. Faraday discovered his law of induction in 1831 while researching electromagnetic at the University of Edinburgh in order to explain how time-varying magnetic flux induces a current through a conductor circuit. Many innovators and experimenters discovered that electrical energy could be transmitted without the need of wires, but this phenomenon was ascribed to electromagnetic induction since there was no unifying explanation for it. Electromagnetic theory was established in the 1860s by James Clerk Maxwell with the help of his Maxwell equations. According to this theory, electromagnetic waves would be the "wireless" means of transporting electromagnetic energy. Wireless power transfer systems may be studied using the Poynting vector and theorem, established by John Henry Poynting in the 1880s, which explain how electromagnetic radiation transmits power from one place to another. A year after that, in 1888, Heinrich Rudolf Hertz confirmed the existence of radio waves [5].

During the same time period, William Henry Ward (1871) and Mahlon Loomis (1872) wrongly concluded that a low-altitude electrified air stratum was accessible. In their patent filings, researchers said that a "Earth current" return channel might be utilized to transmit energy for lighting, heating, and motor power for wireless communication devices (instead of artificial batteries). Amos Dolbear's 1879 magneto electric telephone, which utilized ground conduction to talk over an estimated quarter-mile distance, provided a more realistic demonstration of wireless transmission by conduction.

2.2 TESLA WIRELESS POWR TRANSFER

Nikola Tesla experimented with high-voltage AC transmission utilizing spark-excited radio frequency resonant transformers circa 1890. In order to transfer electricity, inductive and capacitive coupling were used. He used near-field inductive and capacitive coupling to light Geissler tubes and even incandescent light bulbs while working on a wireless lighting system. Resonant circuits may be used to extend the bulb's illuminating range by increasing the distance at which it can be lit. Coupling is done by inductive means. Tesla's resonant inductive coupling technology is currently extensively employed in electronics and in short-range wireless power systems, despite his failure to sell his innovation.

A wireless power system developed by Tesla may transport energy over long distances to private residences and commercial establishments. In order to supply megavolts of electricity across long distances, Mahlon Loomis' ideas appeared to have an early impression on him. Using this technology, electrodes may be sent and received at altitudes up to 30,000 feet (9,100 meters). When he arrived in Colorado Springs in 1899, he created a low-pressure air conductivity laboratory there. When he studied the electrical noise of lightning strikes, he came to the mistaken conclusion that the whole Earth might be used as a conduit for electricity. A grounded Tesla coil generates electromagnetic pulses at the Earth's resonance frequency when the Earth's potential is vibrating. A capacitive antenna calibrated to resonance with the alternating current could pick it up anywhere on the earth with little power loss, Tesla felt certain. This led him to the conclusion that a few hundred feet above the Earth's surface, he could "break the air stratum down" by using a high voltage in a coil to build his atmospheric return circuit. Elon Musk and Tesla would propose a "Planet Wireless System" for transmitting data and electricity throughout the planet the following year. He was unable to finish the building of Wardenclyffe Tower in 1901 because he ran out of money [6].

2.3 NEAR-FIELD AND NON-RADIATIVE TECHNOLOGIES

Inductive power transfer between adjacent wire coils has been used since the 1800s, when the transformer was invented. Induction heating has been used since the early 1900s. In order to minimize electric shock from wet-environment items like electric toothbrushes and razors, charging stations using induction technology have been developed in conjunction with the proliferation of cordless electronics. Electric locomotives were one of the first use of inductive transfer technology. In 1892, Maurice Hutin and Maurice Leblanc invented a device that enabled trains to be powered wirelessly at a frequency of 3 kHz. In the early 1960s, resonant wireless energy transmission was used to implant devices like pacemakers and artificial hearts. These coils were used in the early systems, although resonant transmitters were used in later systems as well. Devices designed for optimal efficiency and minimal power consumption may tolerate low-power electronics and coil misalignment and dynamic twisting. The spacing between the coils in implanted applications is typically less than 20 cm. Resonant inductive energy transfer is a standard approach for powering commercially available medical implanted devices. First RFID (Radio Frequency Identification) technology was developed by Mario Cardullo (1973) and Koelle et al. (1975), who used it in proximity cards and contactless smartcards in the 1990s. This need for mid-range wireless power and charging technologies has been expanding over the past several decades because of the development in popularity of mobile wireless communication devices like smartphones, tablets, and laptops. The Wireless Power Consortium was founded in 2008, and its goal is to develop standards that may be utilized by a variety of manufacturers. To power and charge portable electronics up to 5 watts at a distance of 4 cm, the Qi inductive power standard was released in August 2009. (1.6 inches). A flat charger plate (which may be embedded in table tops in cafes, for example) delivers power from a flat coil in the charger to a coil in the wireless device. With the time, MIT researchers led by Marin Soljai discovered that a dual-resonance transmitter and secondary coil with a diameter of 25 cm (one-eighth of the diameter of the transmitter coil) could broadcast 60 W of electricity across a distance of 2 meters (6.6 ft) at 40% efficiency. The Nevada Lightning Lab's Greg Leyh and Mike Kennan team used a grounded dual resonance transmitter and a matching grounded dual resonance receiver in 2008 to transfer power across a distance of 12 meters utilizing coupled electric fields and an earth current return circuit. 39 feet Using a 10-centimeter (3.9-inch) diameter coil and a resonant frequency of 27.50 MHz, Dr. Christopher A. Tucker and Professor Kevin Warwick of the University of Reading demonstrated 60 percent efficiency in transmitting power over a distance of 4 meters (13 feet) using Tesla's 1900 patent number 0,645,576.

2.4 MICROWAVES AND LASERS

Power transmission using radio waves had made little headway before to World War II, due to the wide dispersion and low energy of radio waves, which were originally meant for communication rather than power transfer. A new source of energy is used to amplify weak signals at the receiver. Transmitters that can generate high-frequency microwaves and concentrate them into tiny beams toward a receiver are required for power transfer [7].

Radiative (far-field) approaches were made possible by the invention of microwave technology during World War II, such as klystron and magnetron tubes and parabolic antennas. The first long-distance wireless power transfer was made possible in the 1960s. Brown designed and demonstrated a workable rectenna while working on the first ever wirelessly powered aircraft (a miniature helicopter driven by microwaves radiating from the ground) in 1964. The goal to create a solar-powered satellite satellite was a major driving force behind microwave research in the 1970s and 1980s. Solar cells would be utilized to change solar radiation into microwaves, which would then be transported to enormous rectennas and converted into grid-ready electrical energy. JPL/Raytheon program technical director Brown used 475 watts of microwave power and a 54 percent microwave to DC efficiency in groundbreaking 1975 tests to transfer data across a mile-long distance. It was transmitted by him and Robert Dickinson from a 26-meter dish at NASA's Jet Propulsion Laboratory to a 7.3 x 3.5-meter array of rectennas. The rectenna's RF-to-DC conversion efficiency was about 80%. High-power microwave transmissions were successfully tested in 1983 by Japan's Microwave Ionosphere Nonlinear Interaction Experiment (MINIX). Since 1959, Raytheon Airborne Microwave Platform (RAMP) has provided financial support to Brown University's research on remotely piloted aircraft. In 1987, the Communications Research Center of Canada developed SHARP (Standard High Altitude Relay Platform), a low-cost alternative to a communications satellite system. At its highest height of 13 miles, the rectenna kept it flying for months at a time (21 kilometers). The MILAX was created in 1992 by a team from Kyoto University (Microwave Lifted Airplane Experiment).

2.5 ELECTRIC VEHICLES SYSTEM

Each of an EV's electric motors serves as the vehicle's primary means of propulsion and acceleration. It is possible for a collector system to be fueled by external energy or a battery, or it may operate entirely on its own (sometimes charged by solar panels, or by converting fuel to electricity using fuel cells or a generator). To carry people and goods in and out of space, as well as on earth, a variety of electric vehicles are available. Electric vehicles (EVs) were developed in the mid-19th century when electricity became a prevalent mode of propulsion for automobiles. In the past, gasoline-powered vehicles lacked the comfort and convenience of electric vehicles. For more than a century, internal combustion engines dominated the road, while electric motors took control in trains and other smaller vehicles. There has been an increase in popularity of electric automobiles in the twenty-first century owing to technology advancements in the fight against global warming and other environmental issues. According to Project Drawdown, electric vehicles are among the top 100 most effective ways to combat global warming in the 21st century [8].

A decade ago, incentives were put in place by both governments in the US and Europe to entice consumers to buy electric cars. Because of this, the industry grew at a tremendous pace in the following decades. Electric vehicle sales are predicted to rise sharply as a result of public interest and knowledge, as well as institutional incentives like as those seen in the green recovery from the COVID-19 epidemic. To reach their climate change targets by 2021, countries need pass tight legislation governing electric vehicles, according to the International Energy Agency (IEA) (IEA). Electric car sales are expected to rise from 2% of worldwide sales in 2016 to 30% by 2030, according to a recent study. Electric four-wheeled automobiles are unlikely to see a rise in usage in underdeveloped nations, while electric two-wheeled vehicles are expected to. Two or three wheels are the most common configurations for electric cars on the road today. Car designers must take into account everything from the vehicle's interior space to its dynamic performance to its safety and connection. Automobiles powered by internal combustion engines and those powered by batteries both follow the same basic principles in their construction. The design of an electric vehicle's driving unit and battery pack will be the subject of many publications in the future. Same calculations may be used when it comes to adapting an existing car to run on electric power.

2.6 RELETED PAPER

We read some journal paper which is related to our system, those journal summaries are the below:

2.6.1 WIRELESS CHARGING SYSTEM FOR ELECTRIC VEHICLES

There has been a rise in the usage of wireless power transmission (WPT) in a range of sectors. Interconnections aren't necessary when electricity is transferred from a source to a load. In instances where physical wiring is difficult or impossible, WPT can deliver power to electrical devices. In this system, mutual inductance is crucial. The automotive sector, especially electric automobiles, is a possible future usage. Research and development is done in this project on wireless charging systems for electric automobiles. Resonance coupling and the building of charging systems are the key aims. An AC source, transmission coil, reception coil, converter, and an electric load, which is a battery, are all part of the systems under examination. For millennia, humanity have depended on autos to get from one region to another. These cars are propelled by IC engines. There has been a rise in emissions from internal combustion engines and a decrease in the usage of fossil fuels as a consequence of the proliferation of vehicles. The most current advancements in the vehicle business have made it viable to enhance fuel efficiency and limit emissions.. It is feasible to minimize pollution while still preserving engine performance utilizing hybrid automobiles, which combine internal combustion (IC) engines with electric motors to power the wheels.

The future, on the other hand, includes emissions-free green energy. Electric cars are currently a prominent subject in the automobile market. Batteries are expensive, have limited range, and take a long time to recharge. Consumers are constantly on the lookout for new and better ways to travel, and this is no secret. Every gas station now has a wired charging system. There are several drawbacks to using a charging station with an extension cable, including the restricted number of ports, the amount of space taken up by the charging station, and the length of the extension cord. Wireless charging for electric cars may be able to alleviate these issues. Charging may be done in a variety of places, including the house, garage, parking lot, and so on. A automobile and its wireless charging system may be seen in this photograph. This technique may be implemented via wireless power transfer technologies. These systems employ coils to carry electricity [9].

2.6.2 LATEST EV CHARGING TECHNOLOGIES

Because of the harm pollution does to the environment, more and more people are contemplating switching to electric vehicles for their own transportation needs. As a result, a system capable of handling the surge of clients is essential. Chargers that utilize electricity and those that don't are analyzed in this research, which is broken into three levels: basic to intermediate to advanced (rapid charging). In this article, several battery types are compared and contrasted. A new technology called vehicle-to-grid, or V2G, will be discussed in the next sections, making it simpler to pump electricity into the grid.

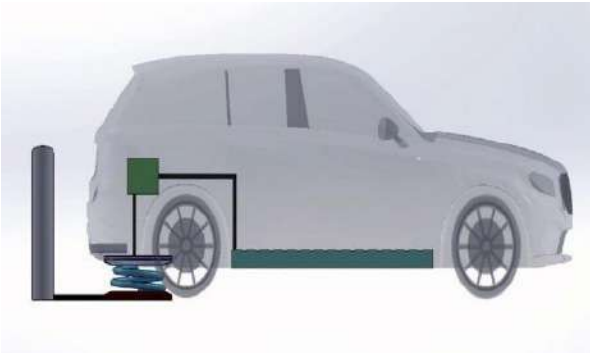


Fig 2.1: Inductive charging representation [28]

Using the system, you can see all of the many parts that go into the charging process. AC power is used to power the HF converter, which converts the low-frequency signal to high-frequency. As a result, a signal is sent to the transmission coil (TX). Resonant coupling is used to link the receiving coil (RX) to the transmitter. To power a battery in our system, we may use an AC-DC converter. Magnetic resonators are the coils in the wireless power transmission project. Coils are fed with fast-oscillating current at a certain resonance frequency by means of a high-frequency converter. Tuning the receiving coil to the same resonance frequency as the transmission coil may link an oscillating magnetic field to an electrical current. A resonant coupling between a transmission and reception coil produces this response, which is referred to as a "coupled magnetic response." The power may be used to recharge a battery. There are a wide variety of gadgets that can be powered by this energy source. The basic circuit model of the WPT system is configured in series with each other. In view of the system's complexity, the simplified equivalent network model is simpler to study. The circuit's primary and secondary windings are identified by the letters L_1 and L_2, respectively. The primary and secondary sides of R_1, C_1 and R_2, C_2 are each connected. These sections have a linear and passive nature. It has a resonance property in the RLC circuit. It is possible to produce a resonance frequency of between 10 kHz and 30 kHz by changing the LC settings. The primary coil I_1's current flow is determined by the primary coil's input voltage V_1 and the secondary coil's total impedance as seen by the primary coil. The induced voltage in the secondary, given by M in the mutual inductance, where $M=L_{12}=L_{21}$, may be kept constant in amplitude by adjusting the input voltage in relation to R1. The series-to-series design delivers constant output current as a constant current source. It is possible to calculate the resonant frequency of a circuit using the capacitances C_1 and C_2. The mutual inductance M is influenced by the distance and position of the primary and secondary coils [10].

2.7 WIRELESS POWER TRANSFER EQUATIONS

Materials with charged particles, such as electrons, are capable of generating electric and magnetic forces. Electrostatic fields are created when a charge is applied to a surface with static electricity. Depending on Drange, moving electric charges in a transmitting and receiving component may be divided into two zones.

Short-range: Up to one diameter, arrange a $D_{range} \leq D_{TX\text{-}RX\ section}$. In this area, non-resonant capacitive or inductive coupling may be used to transfer realistic amounts of power.

Mid-range: The $D_{range} \leq 10_{TX\text{-}RX\ Section}$ may be arranged up to 10 times larger than the WPT diameter. In this range, resonant capacitive or inductive coupling may transmit a fair amount of power.

Whether or not a receiver is present, radiative energy is any energy that escapes a transmitter coil after it has completed a rotation. Radiative energy is electromagnetic wave energy that leaves a coil turn beyond about 1 wavelength (**λ**). The mechanism discards the energy that does not touch the receiving coil. The wavelength of electromagnetic waves decreases as the frequency: **λ** = ***c/f*** rises, resulting in a reduction in power output from a transmitter coil-turn. Antennas at low frequencies (*f*) provide very little power when compared to the wave's size, D_{coil} turn.

Many aspects were taken into account while choosing how many turns and how wide the main and secondary coils should be. As the number of turns becomes smaller, so do the voltage and flux density. A higher flux density is achieved at the expense of greater fluctuations and losses. Flux density and voltage drop with decreasing number of turns of a coil.

$B = \mu \frac{N}{1} I$ In Tesla

Where,

N= number of turns

l= length of coil,

I= current in Amps And

μ = permeability of free space.

When the area of the conductor grows, so does the flux per Webber, and as the flux density decreases, so does the flux radiated between the coils. The radiated flux is supplied by: Ø = flux = A * B Where, A=area of the coil.

CHAPTER 03

SYSTEM ANALYSIS

3.1 INTRODUCTION

In this chapter, we discuss hardware. This document describes the theoretical information of this project. All functional components of this project are described in great detail. This document can help us quickly understand all device interface specifications. This project consists of an Arduino Nano, LCD, relay, current sensor, NTC thermistor, transformer coil, Buck Converter Module. All the details of this equipment are discussed below.

3.2 ARDUINO NANO

Microcontrollers for digital devices may be built using Arduino's single-board microcontrollers and kits, which are open-source hardware and software. Each and every Arduino board and piece of software may be used and distributed for free thanks to the GPL and the LGP licenses (LGPL). Aside from the commercially available pre-assembled Arduino boards, DIY kits are also readily available. The microprocessors and controllers that make up Arduino boards come from a variety of manufacturers. Expansion boards, bread boards, and other devices may be connected to the I/O ports of the boards. Certain versions of the boards incorporate USB connections for loading applications from personal computers. C and C++ may be used to program embedded microcontrollers. Additionally, the Arduino project offers an integrated development environment (IDE) built on top of the Processing language project in addition to typical compiler toolchains. During a semester project at Italy's Ivrea Institute of Interaction Design in 2005, students created Arduino. Making interactive devices at a low cost is possible for people of all skill levels using the Arduino platform. These types of rudimentary gadgets, such as robots, thermostats, and motion sensors, are popular with aspiring amateurs [11].

3.2.1 Power

USB connections and power supply that range from 5 V to 20 V may be used to power the Arduino Nano (pin 30). This pin is (pin 27). The most voltage-dense sources are used to choose the power supply.

3.2.2 Memory

In total, the ATmega328 holds 32 KB (including the bootloader's 2 KB). Atmega328 has a total of 2 KB of SRAM and a total of 1 KB of EEPROM on-board.

3.2.3 Input and Output

You may use these routines to access any of the Nano's 14 digital input or output pins. A 5 volt battery powers them. On each pin, there is an integrated pull-up resistor (disconnected by default) that can provide or receive up to 40 mA... As an example, a number of pins are utilized for certain purposes:

- Serial numbers begin with zero (for RX) and one (for TX) (TX). Data in the TTL serial format may be received and sent with this device. Here are the pins that correlate to the FTDI USB-to-TTL Serial chip's pins.
- 2 and 3 external interruptions It is possible to trigger an interrupt on these pins with low values, rising or falling edges, and changes in value. Any questions or concerns should be directed to attach Interrupt ().
- This is how it works: The analog Write () function may be used to produce PWM for the following values: 3 5 6 9 10 11.
- MISO and MOSI appear in SS, 11, 12, and 13 (SPI) (SCK). The Arduino programming language does not presently enable SPI communication on these pins.
- One 13-watt LED. Digital pin 13 is coupled to a built-in LED. At both the HIGH and LOW settings, the LED is on, however it is turned off at the middle setting [8].

Each analog input on the Nano is capable of a resolution of 10 bits, despite the device's diminutive stature (i.e., 1024 different values). You may modify the top limit of their measurement range by using the analog Reference () function. It is not possible to utilize the analog pins 6 and 7 as digital pins. In addition, a few pins have additional functions:

- I2C SDA and ADC A4 and A5 (SCL). To connect to I2C, you may make use of the Wire library (documentation on the Wiring website).

The board has a few more pins, including:

- There's an AREF there. The analog inputs' reference voltage is derived from this value. An Analog Reference is required ().
- Perform a system restart. Resetting the microcontroller may be as simple as setting this wire to LOW (zero). It is often used to add a reset button to shields that clash with the board's native reset button.

3.2.4 Communication

The Arduino Nano may connect to other microcontrollers, a computer, or even another

Arduino in a variety of ways. Digital pins 0 (RX) and 1 (TX) provide access to the ATmega328's 5-volt TTL serial connection (TX). It's possible to utilize the Arduino board in computer programs as a virtual com port for serial communication by using an FTDI FT232RL and FTDI drivers (included with Arduino software). Using the serial monitor provided in Arduino's software, you may send and receive text data to and from the board. While data is being delivered to the computer through the FTDI chip and USB connection, the board's RX and TX LEDs blink (but not for serial communication on pins 0 and 1). Digitized pins on the Nano may be used for serial communication through a Software Serial library. I2C (TWI) and SPI communication are supported by the ATmega328. The Wire library is included in the Arduino software to make it easier to utilize the I2C bus. The ATmega328 datasheet may be found if you want to utilize SPI communication [12].

3.2.5 Programming

The Arduino Nano may be programmed using the Arduino software (download). Choose "Arduino Duemilanove or Nano with ATmega328" from the Tools > Board menu (according to the microcontroller on your board). Since a bootloader has been pre-burned into the Arduino Nano's ATmega328, you don't need a hardware programmer to upload new code to it. The STK500 communication protocol is still in use. Arduino ISP and the ICSP (In-Circuit Serial Programming) header may be used to directly program the microcontroller, bypassing the bootloader entirely.

3.2.6 Automatic (Software) Reset

As demonstrated in the illustration, the Arduino Nano may be reset by software running on a networked computer rather than by physically pushing the reset button before an upload. Atmega328's reset line is connected to the DTR hardware flow control line of the FT232RL via a 100 nanofarad capacitor. When the reset line is asserted, the reset line drops for long enough to reset the chip (taken low). To make uploading code to the board as fast and simple as possible, the Arduino software makes advantage of this functionality. The upload timeout for the bootloader may be shortened in this situation since the decrease in DTR coincides with the upload. [8] As a result of this structure, there are several consequences. The Nano goes through a reset cycle as soon as it is linked to a computer running Mac or Linux (via USB). The bootloader of the Nano is triggered in a matter of seconds. In spite of the fact that the board is designed to reject incorrect data, the board intercepts the first few bytes of data that are delivered to the board when a connection is established. Before transmitting data to a sketch running on the board that requires one-time setup or other information at its inception, you must wait for the connection to be opened and before transferring any data. Table 3.1 presents the Arduino Nano Specification, whereas picture 3.1 depicts a high-level view of the board's hardware components.

Table 3.1: Arduino Specification

Microcontroller	ATmega328
Architecture	AVR
Operating Voltage	5 V
Flash Memory	32 KB of which 2 KB used by bootloader
SRAM	2 KB
Clock Speed	16 MHz
Analog IN Pins	8
EEPROM	1 KB
DC Current per I/O Pins	40 mA (I/O Pins)
Input Voltage	7-12 V
Digital I/O Pins	22 (6 of which are PWM)

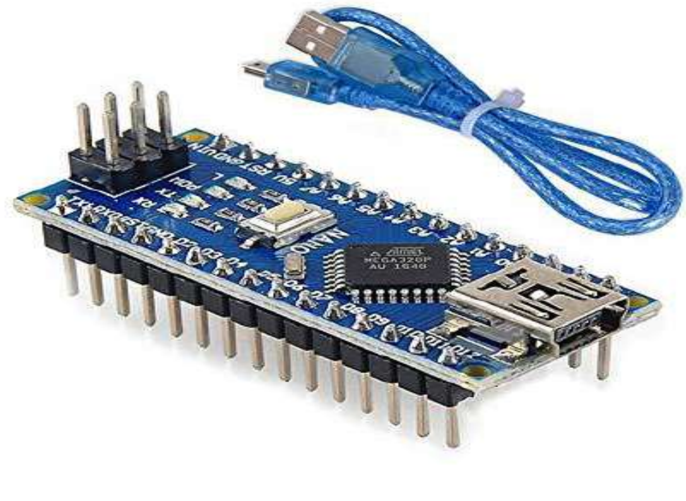


Fig. 3.1 Arduino Nano [12]

3.3 LIQUID-CRYSTAL DISPLAY

In LCDs, which are flat-panel displays or other electronically controlled optical devices, the light modulating capabilities of liquid crystals are paired with polarizers. Liquid crystals may be used as a backlight or reflector to produce color or monochrome pictures. LCDs may either show random images (as in a general-purpose computer display) or fixed graphics with limited information content, depending on the application (such as pre-set text, numbers, and seven-segment displays, as in a digital clock). Basic technology is used by everyone, however some displays employ tiny pixels to build up random pictures, while others use bigger components. LCDs may be switched on (positive) or off (negative) depending on how the polarizer is set up (negative). Character positive LCDs with backlights, for example, have black letters on black backgrounds, and the backlight is the same color as the letters on the screen. Figure 3.11 depicts a high-level perspective of the 16*2 LCD. This LCD can show up to 32 characters at a time.

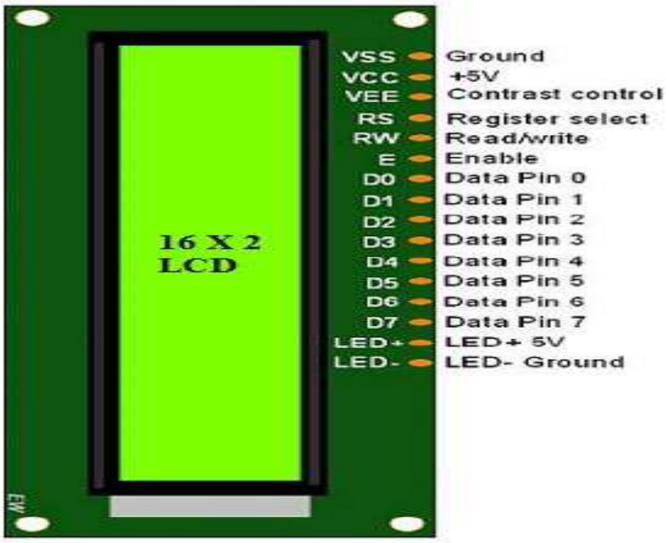


Fig 3.2: LCD Display [13]

These days, LCD screens may be used in a variety of applications, from TVs to computers to cockpit displays aboard planes. These small LCD screens may be found in a wide variety of consumer electronics, including digital cameras, watches, calculators, and mobile phones. You may find LCD panels on DVD players, game systems, and even alarm clocks. – LCD screens In recent years, LCD panels, which are smaller and lighter than their predecessors, have mostly replaced CRT screens. More screen sizes are available for LCDs than for CRTs and plasmas. Small digital watches to large flat-screen TVs all use LCD displays, which are available in a variety of sizes. Because of its reduced reaction time, larger color gamut, almost infinite contrast and virtually unlimited viewing angles, OLEDs are replacing LCDs as the preferred display technology. OLEDs may be built into any design. Because OLED screens utilize just one glass panel, they are lighter and thinner than LCD screens that use two glass panels, however this is more visible on LCD screens. OLEDs may also consume less electricity (as the display is only "on" where needed and there is no backlight). Due to their usage of costly electroluminescent materials or phosphors, OLEDs are still more expensive per display size than LCDs. Recyclability of LCDs is still a problem because of a lack of recycling technologies. Burn-in is a problem with OLED panels, and there is currently no method to recycle them. Quantum dot displays have the potential to extend the useful life of LCDs [13].

Specifications

- Affirmation LCD screens have how many rows and columns? 1024 x 768 is the standard for LCD monitors. Red, green, and blue subpixels make up the majority of each pixel. This was one of the few constants in LCD design. Quattron, a technology that attempts to boost a display's apparent resolution by sharing sub-pixels amongst pixels, has met with mixed reactions in recent designs, on the contrary.
- When viewing a screen from a close distance, a common way to determine the overall resolution is to count the number of pixels per inch, or dot pitch. This is normal practice in the printing industry. TVs tend to have low density, whereas mobile devices tend to have higher density for information viewing at a distance. Having a broad viewing angle is critical in certain applications, but this can only be done via the use of particular display technologies.
- For example, the display's temporal resolution is a measure of how quickly and precisely the display is able to present rapidly changing pictures. Even at low refresh rates, LCD panels do not flicker as a result of the flicker caused by the refresh process. Smearing or ghosting might appear in fast-moving video because of the reduced refresh rate. As a result of the sluggish reaction time of each individual pixel and the display's inherent latency, artifacts may be created.
- A broad variety of phrases are used to characterize the color performance of a display. Our focus here is on the precision with which a spectrum may be separated when we talk about color depth and color gamut. You're unlikely to see a lot of attention on color gamut in marketing brochures unless you are an expert. In order to improve their performance, displays are limited to a certain range of colors. LCD color and color management also includes aspects of LCD color management, such as white point and gamma correction [13].

➢ The contrast ratio is calculated by comparing a pixel's full-on to full-off brightness. For lighting, a backlight, either fluorescent or LED, is employed instead of the LCD's own light source. It is possible that the brightness of the LCD's backlight might have a substantial influence on its overall brightness. However, the more light there is, the less battery life there is.

3.4 RELAY

Electricity is used to turn on a relay. A wide variety of relays are made using both electromagnets and more modern technologies like solid-state relays. It is possible to create low-power signals (complete electrical isolation) or several circuits controlled by one signal using a relay. As telegraphy progressed, relays were utilized to retransmit signals from one circuit to another. Logic operations in early computers and telephone exchanges were significantly reliant on relays, which were used in large numbers. To operate an electric motor or other heavy loads directly, a contactor is a relay type that can handle the high power required. Solid-state relays, which control power circuits by switching a semiconductor device, do not have any moving parts. Protective relays [14] are still often referred to as "protective relays" because they perform the same functions in modern electric power networks, but with digital instruments instead of mechanical relays. As may be seen in Figure 3.17, the 05-pin relay symbol and pinout are shown.

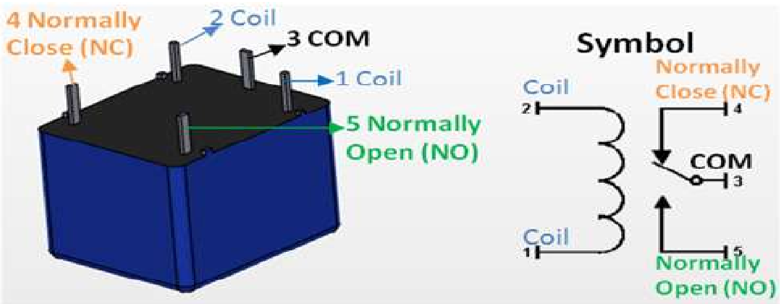


Fig 3.3: Relay [14]

3.4.1 RELAY SWITCH CIRCUIT

An electromagnet is used in electrical relays to change the state of two movable contacts from open to closed. In spite of their low power consumption, relays may be used to control a wide range of high-power devices, including motors, heaters, lights and AC circuits. There are a wide number of shapes, sizes, and configurations for electro-mechanical relays (output devices) in electrical circuits. Relays may be used to turn relatively large currents and voltages "ON" and "OFF" in computer or electronic circuits with minimal power, but a relay switch circuit is required to control it. Because the transistor may give quick DC switching (ON/OFF) control of the relay coil from a number of input sources, below is a brief sample of the most frequent methods to switch relays [15].

3.4.2 NPN RELAY SWITCH CIRCUIT

The coil voltage is controlled by an NPN transistor switch, TR1, in a typical relay switch circuit. Base voltage of the transistor creates an open switch (or negative). The relay coil is de-energized if no current passes into the Base and Collector since they are both current devices [15].

When the NPN transistor is saturated, it is feasible to control the larger current flowing through the transistor from the collector to the emitter by feeding a significant amount of positive current into the Base. There are a wide variety of relay coil voltages required to get the bipolar transistor into saturation, from 50 to 800 times the base voltage. In general, the beta value () of the BC109 is about 290 at 2 mA. (Datasheet). The NPN transistor switching circuit seen in Figure 3.18 is based on a 05-pin relay.

NPN Relay Switch Circuit

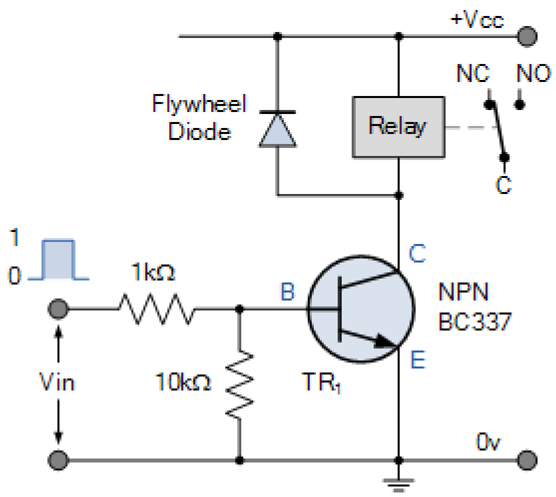


Fig. 3.4 NPN Relay Switching Circuit [15]

A magnet and an inductor combine in the relay coil, as previously stated. Coil DC resistance (I = V/R) determines the maximum current flow when the transistor is turned on, as calculated by Ohms Law (I = V/R). Relay coil magnetic field preserves some of this energy.

When the transistor is switched "OFF," the current through the relay coil decreases and the magnetic field decreases. To keep the current flowing in the relay coil, the coil generates a reverse voltage. It is possible that the switching NPN transistor may be destroyed by a significant voltage spike across the relay coil when this is done [15].

3.5 CURRENT SENSOR

An electrical current sensor monitors the flow of current and provides a signal proportional to the amount of current flowing through a wire. Digital or analog outputs are all possibilities. Signals from an ammeter or data gathering device may be used to display or store the measured current.

The output signal and the detected current may be:

- Alternating current input,
    - analog output that reproduces the waveform of the observed current.
    - In order to mimic the waveform of the current being measured, the sensor generates a bipolar output.
    - the average or RMS value of the observed current is proportional to a unipolar output.
- Direct current input,
    - unipolar, with a unipolar output that mirrors the wave pattern of a detected current.
    - the measured current must be greater than a certain threshold before the digital output will turn on.

3.5.1 TECHNOLOGIES

- There are many options for a Hall effect sensor (suitable for AC current only).
- Fluxgate Transformer Type 2 is also available (suitable for AC or DC current).
- Voltage is directly proportional to current flow through the Shunt Resistor.
- The phase shift in light caused by a magnetic field is detected by an interferometer in a fiber optic current sensor.

- High-frequency bursts of high-frequency current may be measured with an AC meter (HFP).
- The GMR sensor is more precise than the Hall effect for measuring AC and DC current. Exactly like the magnetic field.

A current sensor based on the Hall Effect was developed in 1879 by Edwin Hall. Hall Effect current sensors can detect a wide range of current signals (i.e., AC, DC, or pulsating current). These sensors are currently widely used across a wide number of sectors due to the vast range of applications and outputs they give [16].

Table 3.2 Current Sensor Specifications:

VCC	Sensor Measured Watts / Amps	Output Voltage Range
3.3V	2 watts to 3000 watts	.05V to 2.8V
5V	2 watts to 3000 watts	.05V to 4.5V

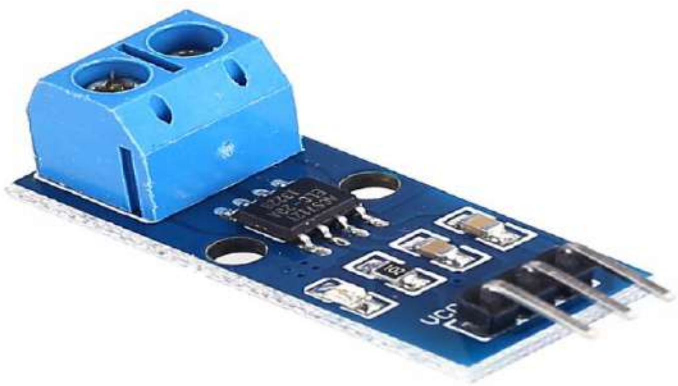


Fig 3.5: Current Sensor [29]

3.6 THERMISTOR

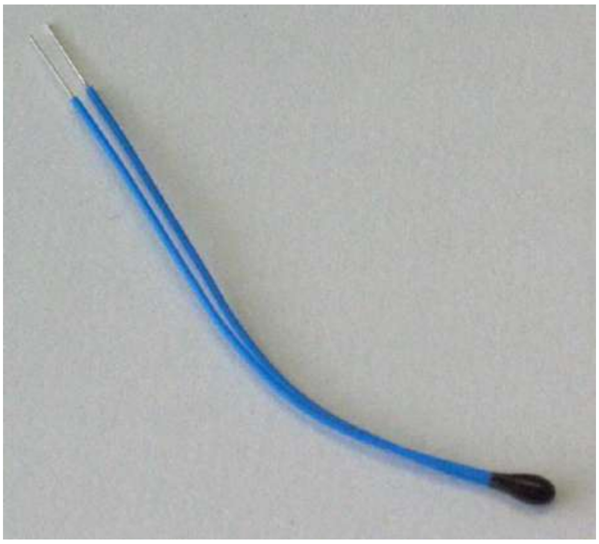


Fig 3.6: NTC Thermistor [30]

The resistance of thermistors varies with temperature, which makes them a special kind of resistor. "Thermal resistor" and "thermal resistor" are a mashup of the two terms. Many different types of temperature sensors (most often NTC type) and overcurrent protection devices (such as temperature sensors) rely on thermometers as a standard component (positive temperature coefficient or PTC type typically).

The most common types of thermometers are:

⇒ NTC thermistors have a decreased resistance as the temperature rises. Coupling an NTC serially with another device makes it an inrush current limiter as well as a temperature sensor (see figure).

⇒ To measure changes in resistance with temperature, PTC thermistors are used. To prevent overcurrent, PTC thermistors are often employed as resettable fuses.

A common ingredient in thermometers is powdered metal oxides. To far, NTC thermistors have been able to attain very high long-term stability and accuracy across large temperature ranges (0.1 to 0.02 degrees Celsius) because to improved formulations and processes (0 to 70 degrees Fahrenheit). It is possible to find NTC thermistors in a wide variety of forms, including rod and discs, along with glass-encapsulated diodes, epoxy-coated chips, lead wires of various types, and surface-mounting options. Glass-body thermistors, on the other hand, typically operate in the -55 to +150°C temperature range [17]. In contrast to RTDs and thermistors, thermistors frequently employ ceramic or polymer as their principal material. RTDs have a wider temperature range, while thermistors are more precise, with a typical temperature range of 90–130 degrees Celsius.

3.6.1 NTC (NEGATIVE TEMPERATURE COEFFICIENT)

a switched-mode power supply's inrush current limiter failed (blew) because of an NTC thermistor. There are several NTC thermistors that are made by pressing sintered metal oxides, a semiconducting material, into various shapes such as a plate or a bead. The active charge carriers in a semiconductor's conduction band may conduct electricity as the temperature rises. The amount of charge carriers in a substance determines how much current it can transport. In n-type semiconductors, such as Fe_2O_3 doped with titanium, electrons act as charge carriers (Ti). Doping nickel oxide (NiO) with lithium may produce p-type semiconductors, which use holes as charge carriers (Li). Calibration is necessary when temperature fluctuations are large enough to warrant it. Material resistance changes linearly over small temperature changes if the right semiconductor is used. Several types of semiconducting thermistors are available, ranging in temperature from 273.14 °C to 2,200 °C. An NTC thermistor's symbol includes a "t°" underneath the rectangle.

3.6.2 PTC (POSITIVE TEMPERATURE COEFFICIENT)

A distinctive property of temperature-sensitive polycrystalline ceramic ($BaTiO_3$) thermistors is that their resistance rapidly increases when they reach a specific temperature. The dielectric constant of barium titanate varies with temperature because it is ferroelectric. A high dielectric constant limits the creation of potential barriers, which precludes the building of barriers between crystal grains. Nearly of the gadget's negative temperature coefficient is eliminated here. If the dielectric constant goes below the Curie point temperature and the resistance rises significantly, there may be barriers at grain boundaries. The material returns to NTC behavior at higher temperatures. A silistor, a thermally sensitive silicon resistor, is another kind of thermistor. silicon is semiconductive, hence diodes composed of this material are called diodes of silica. Ceramic PTC thermistors have a nearly linear resistance-to-temperature relationship, while silistors do not. For ceramics, a certain voltage may be employed, but the power required depends on how much heat is lost through ceramic [18]. Because of its ability to respond to changes in temperature, PTC thermistors are also useful. When it's cold, the voltage source's resistance is incredibly low, and as it warms up, the voltage source draws less current (and so cools down) than it did when it was cold. The fusible connection may be replaced with the current-limiting effect. Thermistors are used in the degaussing circuitry of CRT displays and television sets. The degaussing effect becomes more effective as the current decreases over time. There are several circuits that can be enhanced by adding a heating element to reduce the current. Polymer PTC thermistors are also known as "Polyswitch," "Semifuse," and "Multifuse," and are sold under these brand names. A combination of plastic and carbon fibers are used to produce this product. Because all of the carbon grains are in direct touch with one another, there are no gaps in the device's conductive channel. Polyethylene granules separate when they heat up, resulting in higher temperatures and faster resistance increases. Nonlinear resistance/temperature response is ideal for thermal or circuit control, not for temperature measurement like the BaTiO3 thermistor. Self-limiting heaters in the form of wires or strips may be used for heat tracing. The PTC-thermistors don't return to their low resistance state until the temperature drops enough to release their "latch". A simple latch or memory circuit may be constructed by connecting two PTC thermistors in series, one of which is cold and the other of which is hot.

Fig 3.7: PTC Thermistor [31]

3.7 TRANSFORMER

A passive electronic device like this may be used to transfer energy between two or more electrical circuits. The variable currents in one coil create different magnetic flux, which alters the electromotive force in other coils in the transformer's core. Without a metal (conductive) contact between the two coils, electrical energy may be conveyed. When the magnetic flux surrounding a coil change, an induced voltage effect develops. This is the basis of Faraday's law of induction, which he formulated in 1831. Step-up and step-down transformers are frequently employed in electric power applications and signal processing circuits to link stages with low AC voltages at high current (a step-up transformer). It is possible to utilize transformers for isolation since the voltages in and out are separate [19].

Since the advent of the constant-potential transformer in 1885, electric power transmission and distribution has depended on transformers. Electronic and electrical power transformers are available in a variety of shapes and sizes. Because of their small size, they are able to carry hundreds of tons of weight.

3.7.1 PRINCIPLES

To put it simply, in principle a theoretical perfect transformer is one that is lossless and ideally linked. In order to obtain perfect coupling, the magnetic permeability of the core and the inductance of the windings must be very high (i.e. $i_p n_p - i_s n_s = 0$) [19].

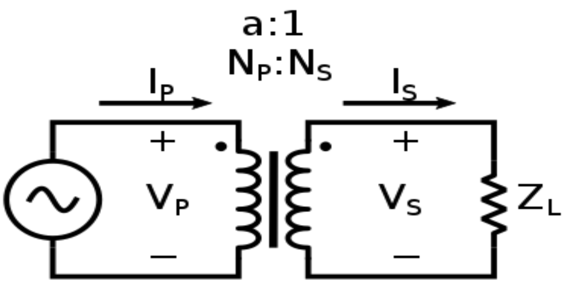


Fig 3.8: Coil of the transformer [32]

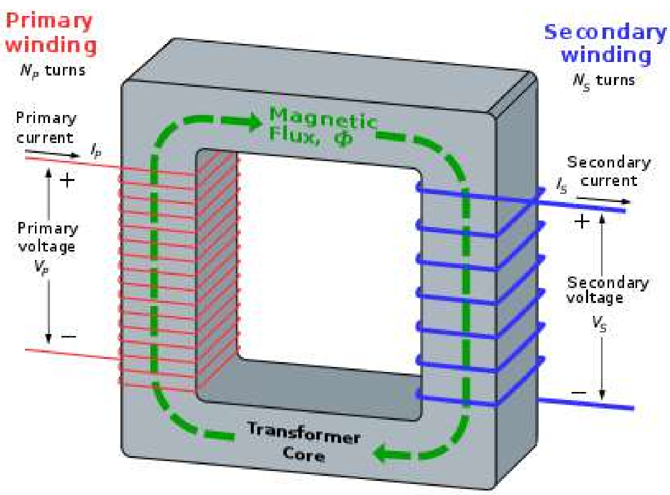


Fig 3.9: Ideal transformer and induction law [33]

The secondary winding of a transformer controls the magnetic flux in the core by varying the current in the main winding. An EMF (voltage) is generated at the other end by a fluctuating flux at one end of one of these coils, and this EMF is equal to and opposite the flux formed by the main winding, according to Lenz's law. Primary and secondary windings are wrapped around a core of infinite magnetic permeability to guarantee that all magnetic flux flows through the core. Magnetomotive force is zero since the primary and secondary windings are connected to a voltage source and a load. If you use Faraday's law of induction, each winding generates a voltage proportionate to the number of windings in an ideal transformer. Winding voltage ratios grow with increasing number of turns of a transformer. Ideal transformer identity stated in equation 5 is a decent approximation for a typical commercial transformer with voltage ratio and winding turns both having an opposite connection to current. The load impedance of the main circuit is equal to the ratio squared times the secondary circuit's load impedance, as stated in the table.

3.7.2 REAL TRANSFORMER

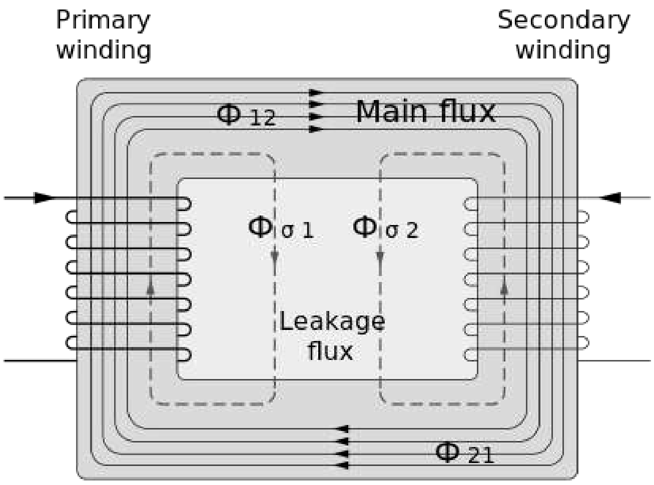


Fig 3.10: Leakage flux of a transformer [34]

The main and secondary windings of a transformer cannot be connected to all of the flux in a transformer owing to the nature of transformers. Even if the core's maximal flux connects the transformer's two windings, there will still be flux connecting only one of them. Instead of the transformer's core, this "leakage flux" passes via the transformer's insulation and insulating oil on its windings. Secondary windings have a leaky reactance because to transformer flux leakage. The leaking reactance of a transformer is all there is to a transformer's reaction resistance. Transformers have a problem known as Magnetic leakage, which occurs often.

3.7.3 DEVIATIONS FROM IDEAL TRANSFORMER

The ideal transformer model does not take into consideration some of the fundamental linear properties of real transformers:

(a) Core losses, often known as magnetizing current losses, include the following:

- Eddy current losses owing to joule heating in the core, which are proportional to the square of the transformer's applied voltage, and
- Hysteresis losses caused by non-linear magnetic effects in the transformer core

(b) Unlike the ideal model, real transformers have non-zero resistances and inductances:

- • Resistance losses in the main and secondary windings cause joule losses.
- There are two types of reactive impedance: primary reactive impedance and secondary reactive impedance [20].

(c) As with inductors, the self-resonance and parasitic capacitance properties are similar. Three different forms of parasitic capacitance have their closed-loop equations provided.

- Capacitance is determined by the difference between the capacitance of neighboring turns.
- from one layer to another
- Core-to-external capacity differences

Fig 3.11: Transformer [35]

3.7.4 APPLICATIONS

Transformers come in a variety of shapes and sizes to accommodate the wide range of electrical applications. The design and electrical qualities of a transformer may be customized to match the needs of a particular installation or circuit, but all transformers follow the same basic concept. Transformers enable the transmission of higher voltages while avoiding heat loss. Customers may have to travel a long distance to go to these facilities to save money. Almost all of the electrical energy in the world has been converted by the time it reaches the end consumer through a series of transformers. A switch mode power supply or a voltage transformer is required for many electronic devices in order to convert the distribution wire voltage into circuit-friendly values. Signal and audio transformers are often used to link amplifier stages and devices such as microphones and record players to amplifier inputs. You can transport two-way calls over a single pair of cables using audio transformers. A balun transformer may be used with a source external to the device and an output inside to the device. Protection against leakage current is provided by isolation transformers in medical and construction equipment. Tesla coils and receiver stages may be connected using resonant transformers. [21]

3.8 ENAMELED WIRE (20 AWG)

It is possible to utilize copper or aluminum for enameled wire, which has a thin coating of insulation put to it. Transformers, inductors, actuators for hard disk heads, and guitar pickups are just a few examples of the many electrical devices that make use of this material. Copper wire may be purified and annealed using electrolytic methods. Large transformers and motors may benefit from the usage of aluminum magnet wire. Many varieties of polymer film insulation are not limited to vitreous enamel, as the name suggests. Copper is the metal of choice for magnet wire applications because of its excellent magnetic properties. This conductor of choice for magnet wire is copper for its remarkable chemical, physical and mechanical properties. Electromagnetic coils may be wrapped more securely using copper magnet wire that has been thoroughly annealed and electrolytically cleaned. When operating in a reducing environment or using hydrogen gas as a coolant, oxygen-free copper grades are employed. Large transformers and motors are commonly powered by aluminum magnet wire rather than steel because of its lower cost. The same DC resistance may be achieved with 1.6 times the cross-sectional area of aluminum wire as with copper wire [22].

Fig 3.12: Enameled Wire [36]

Enamelized wire, despite the phrase "enameled," doesn't in reality contain a layer of enamel paint or fused glass powder. The polymer film insulation of modern magnet wire offers a long-lasting, continuous insulating layer. These include polyvinyl formal (Formvar) and polyurethane as well as polyester and polyimide-polyamide-polyimide (or amide-polyimide). Tolerates temperatures as high as 482 degrees Fahrenheit. An insulating varnish is applied to the finished windings after the thicker square or rectangular magnet wire is wrapped with high-temperature polyimide or fiberglass tape to increase insulation strength and long-term dependability. There must be at least two layers of wire wrapped in thermoplastic for self-supporting coils to stand up on their own. Transformers and reactors aren't the only things that need insulation; a wide range of other devices also do. Other extensively used materials include varnished fiberglass yarn, aramid paper, Kraft paper, mica, and polyester film. On a few instances, silver wires have been utilized in lieu of copper in the music industry. Cotton and polytetrafluoroethylene (Teflon) are common insulators, but they aren't the only choices accessible to consumers concerned about the safety of their electronic gadgets. Cotton, paper, and silk can only withstand temperatures up to 105 degrees Fahrenheit (221 degrees Celsius). Manufacturing may be simplified by using soldering to remove the insulation from low-temperature magnet wire. There are no need to remove insulation from either end of the cable to make electrical connections in this manner.

3.8.1 CURRENT DENSITY

As much as 2.5 A/mm2 to 6 A/mm2 is possible for the highest air current density of a wire. When high-frequency currents (over 10 kHz) are present, the conductor's ability to distribute current across its whole length may be hindered by the skin effect. Higher current densities may be achieved using active cooling methods such as blowing air or flowing water. For the same DC resistance, an aluminum wire must have a cross-sectional area 1.6 times bigger than a copper wire. So, copper magnet wires help to increase equipment efficiency like electric motors [23].

CAHPTER 04

SYSTEM DESIGN AND IMPLEMENTATION

4.1 INTRODUCTION

This chapter contains the methodology of our project. The project block diagram and flow chart are shown clearly in Figures 4.1 and 4.2. The step by step working process of our project is shown through the block diagram and flow chart. The project circuit diagram are shown clearly in Figures 4.3 and 4.4 the circuit diagram shows how the components of the project are connected to the circuit diagram.

4.2 BLOCK DIAGRAM

The below figure 4.1 show the whole system block diagram, which are included the controlling device, controlling device to input output configuration etc.

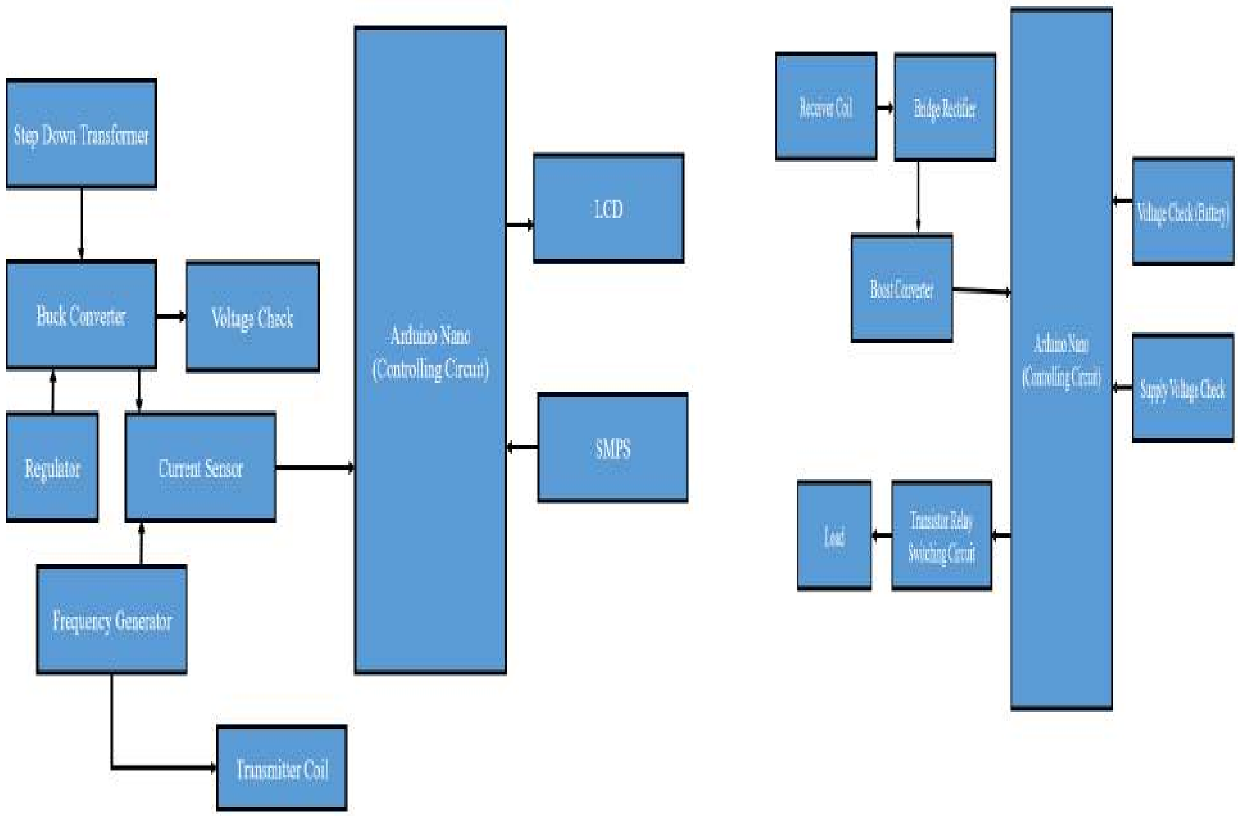


Fig. 4.1 System Block Diagram

4.3 FLOW CHART

The below figure 4.2 show the whole system flow chart, which are included whole system working process, work done to step by step, checkup the condition of sensor etc.

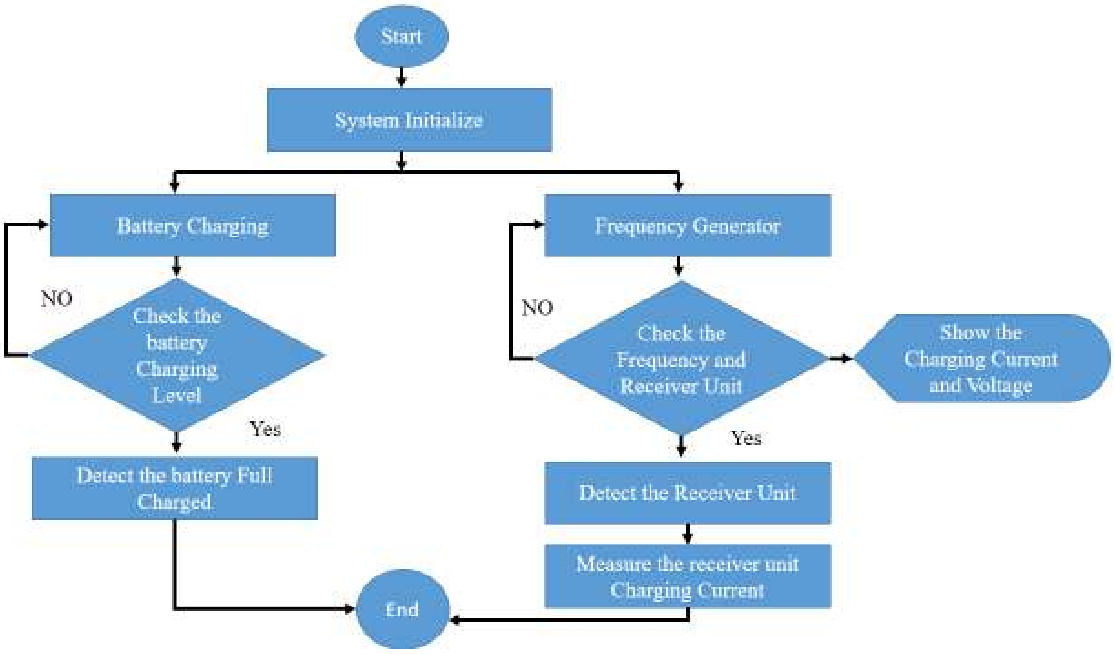


Fig. 4.2 System Flow Chart

4.4 CIRCUIT DIAGRAM

The below figure 4.3 show the whole system circuit diagram of transmit unit, which in include the controlling device to another parameter like LCD, current sensor, transformer coil, etc. In Fig.4.3 Transmitting circuit diagram is shown. This is the power transmitter's circuit. Here we have used 6 loops with center tap in the middle. This circuit will automatically generate the resonance frequency, and it will adapt even if the load is changed. Because the MOSFET's gate is connected to the coil. When the voltage oscillates, the transistor turns on and off, causing oscillations. In this section we also have used ACS712 Current Sensor Module and Arduino Nano to display the input voltage and current.

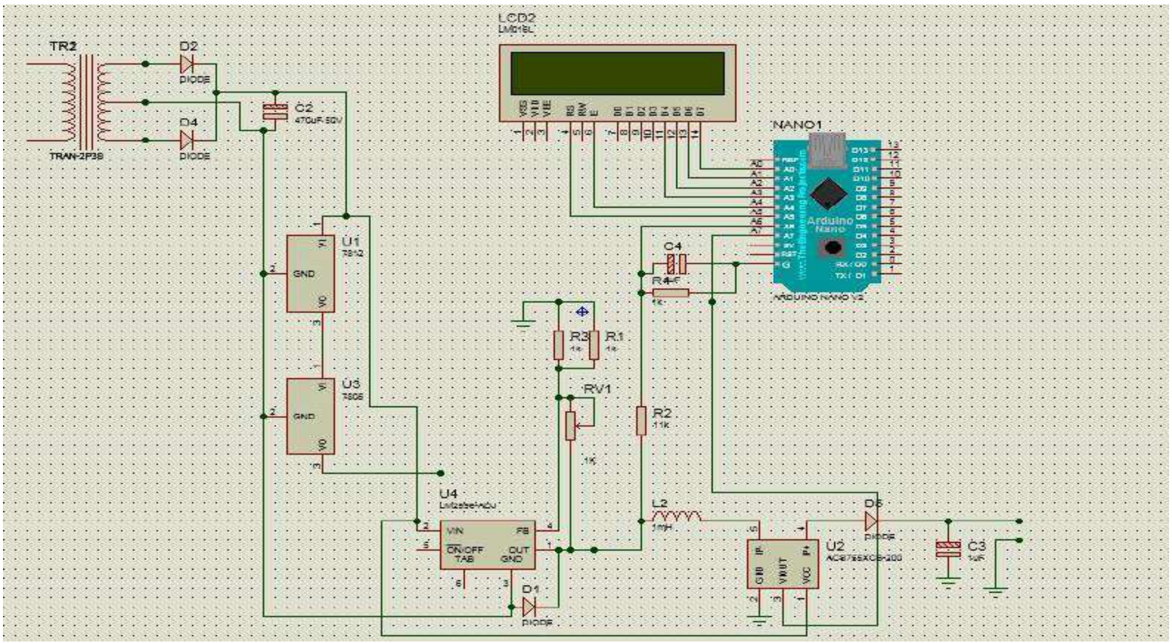


Fig 4.3: The diagram of a transmitting circuit

The below figure 4.4 show the circuit diagram of receiving unit which is contain the Arduino Nano, transformer coil, rectifier diode, electrolytic capacitor etc. In Fig.4.4 Receiving circuit diagram is shown. We designed the coil with 10 turns to get a bit more voltage out of it. The signal is then rectified using the diodes bridge as the first step. With those capacitors, we filter the spikes and then regulate the output at 4.6 volts using boost converter. Even if the receiver coil voltage is 16 volts, the boost converter will maintain a maximum output voltage of 4.6 volts. Here we used 4v dc battery, the output voltage is enough to charge the battery.

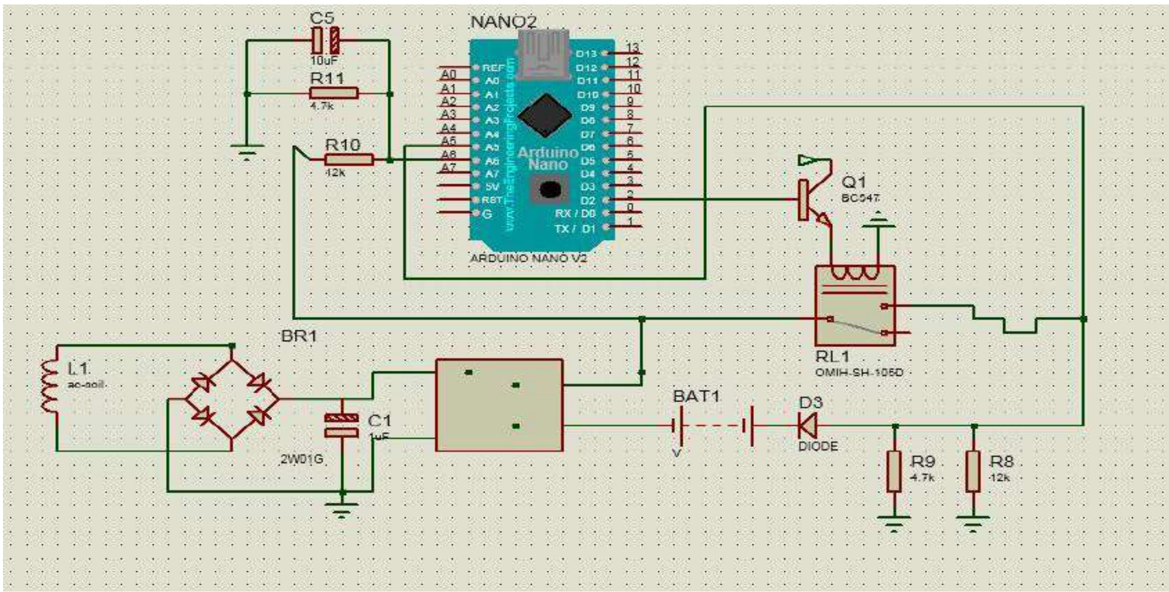


Fig 4.4: Circuit Diagram of receiving unit

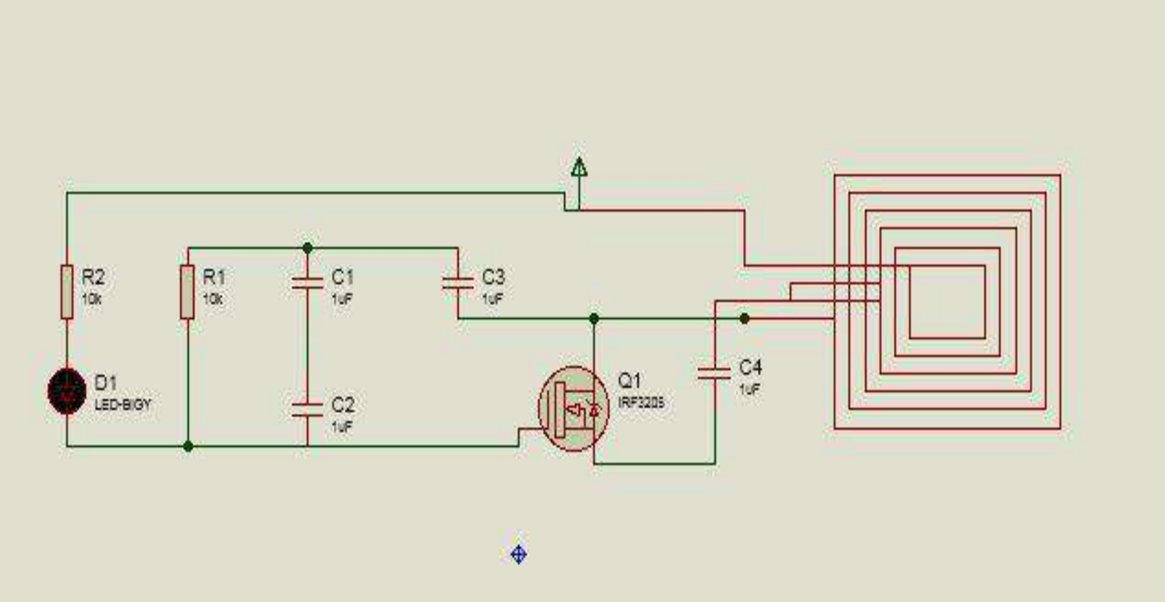


Fig 4.5: Wireless Power Transfer Circuit Diagram

The LC tank's resonance frequency is influenced by the coil's construction and the 220nF capacitor it contains. The diameter of the coil and the number of loops in the coil are critical design factors. The center tap was in the midst of three of the loops, for a total of six. For testing, the diameter was 8cm in diameter. Resonance frequency is created automatically using this circuit, and the circuit automatically responds to variations in load. The MOSFET is a bipolar device because the coil is connected to the gate of the MOSFET. The transistor is cycled on and off every time the voltage changes, resulting in the oscillations. An LED is added to the circuit's termination to serve as a visual indicator of its functionality. Using two large wires, the MOSFET is able to accept two inputs. Loops on both sides: 3 on each side. Because of this, the central tape has been evenly distributed on both sides. We used a 10-turn coil in the receiver unit to boost output voltage. The first step is to rectify the signal using a diode bridge. After filtering out spikes using capacitors, we utilize the AMS1117 regulator to maintain a 5-volt output. When the output is fitted with a filter cap, the receiver is complete. Even if the receiver coil's voltage is 16V, a maximum output voltage of 5V can be maintained.

4.5 SYSTEM WORKING PRINCIPLE

An electric car can be charged wirelessly, and the current and voltage may be monitored across great distances. Using a transformer, we can now lower the voltage from 220AC to 120VAC. We'll obtain 12 volts of AC from the step-down transformer. Now that we have it, we must convert from AC to DC. DC was filtered out by a diode and a capacitor. When it came time to lower the voltage of the battery, we turned to an on-board buck converter for help. This was accomplished by using a voltage divider and current sensor to measure voltage and current. An Arduino was used to display this information on the LCD. The LCD and Arduino were both powered by a 5V SMPS. A 12-volt DC supply and a six-turn square transmitting coil are used in this circuit to transfer power. The resonance frequency will be generated by this circuit of its own. A MOSFET powers this oscillator's transistor, which turns on and off in response to the oscillation. This is the reason of the oscillation. The output voltage is increased by 10 turns in the receiver. The voltage received has formed an alternating current (AC). We utilized a full-wave bridge rectifier to convert AC to DC. We will be able to generate DC voltage using this technique. A boost converter was employed to increase and stabilize the voltage. The charging current in the receiver will be controlled by Arduino and transistor relay switching. Both a green and a red light signify that the battery is charging or has been completely charged.

CHAPTER 05

RESULT ANALYSIS

5.1 INTRODUCTION

This chapter contains the total system result, hardware picture, controlling method of the project. Our project represents the power transfer without wire. We showed some result which result we collected our project.

5.2 RESULT

The below figure 5.1 and 5.2 and 5.3 are shown the charging voltage and charging current of vehicle. The Arduino nano read the voltage level and charging current which are shown the 16*2 LCD.

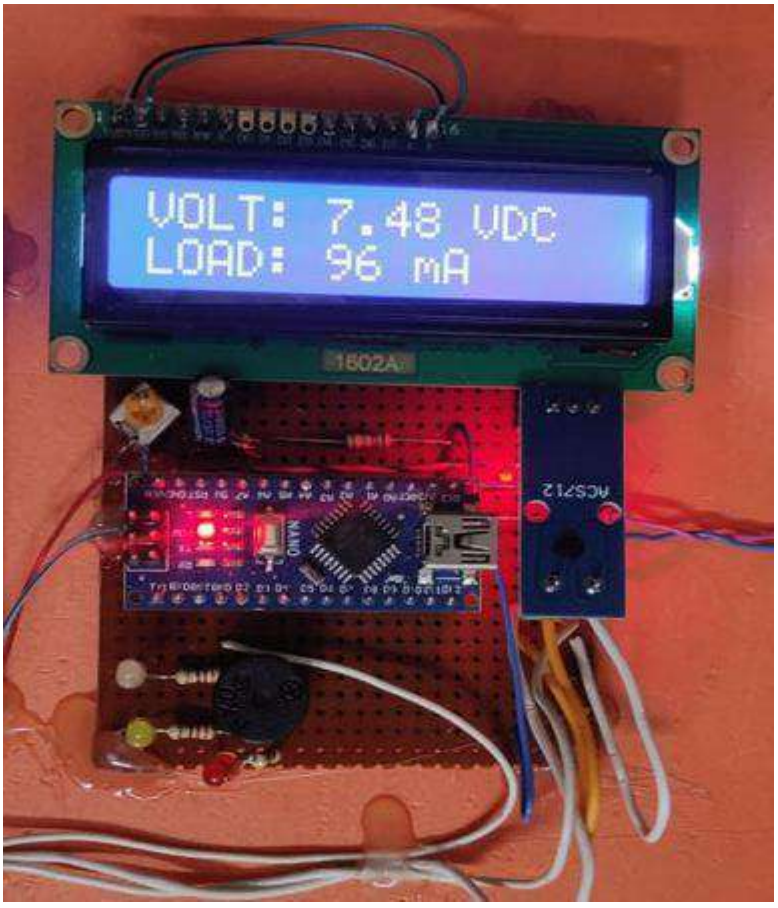


Fig 5.1: Charging Current and voltage

Fig 5.2: Receiver voltage

The above figure 5.2 are show the receiver section voltage after using the buck converter module used

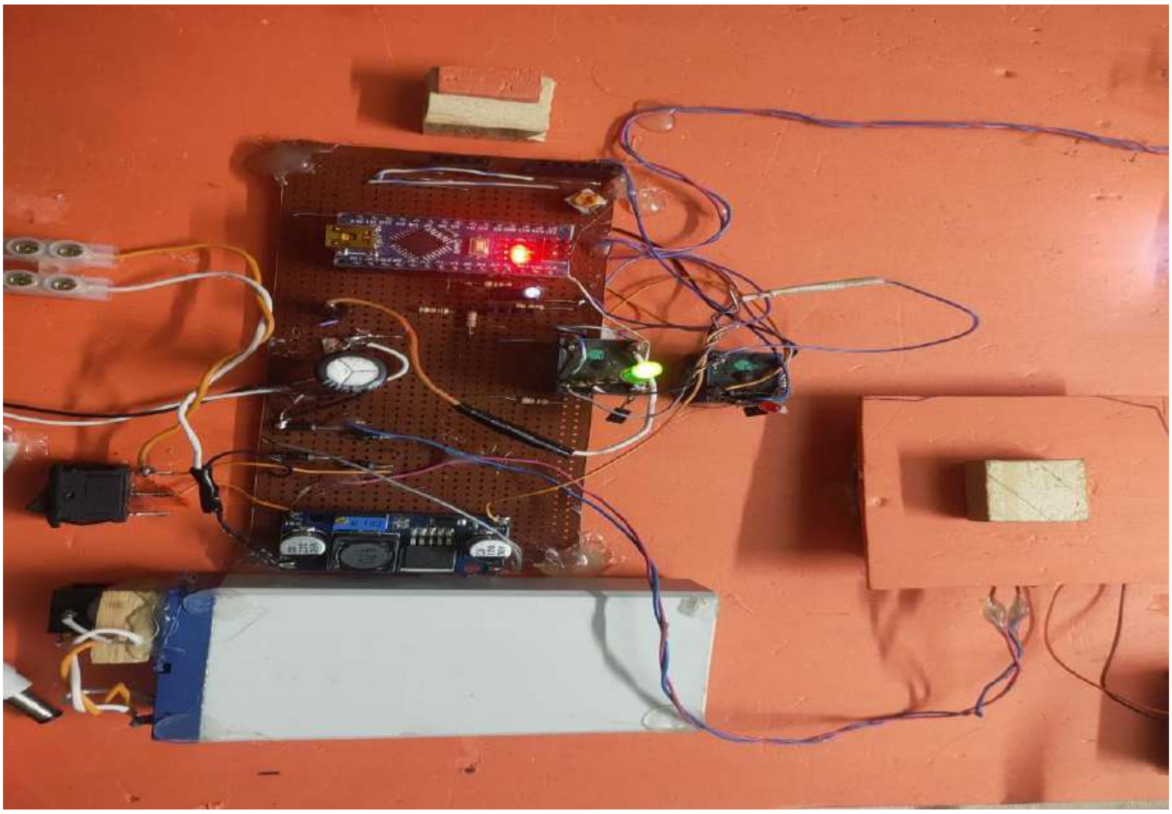


Fig 5.3: Battery is fully charged

The above figure 5.3 is showing measured the battery level, when battery charging level full the relay turns on and green LED on.

Below the table 4.1 shows the distance wise output and input voltage. Here input voltage is fixed 7v, but output voltage varies with distance. For 1 inch distance of transmitting and receiving coil the output voltage is 14.5v and for 3.5 inch it is 3. 30v. From the table it is cleared that output voltage is decreasing with the increasing of distance.

Table 4.1: **Result Data Chart**

SL No	Distance (Inch)	Input Voltage	Output Voltage
01	1	7	14.5
02	1.5	7	11.3
03	2	7	6.9
04	2.5	7	5.3
05	3	7	4.13
06	3.5	7	3.30

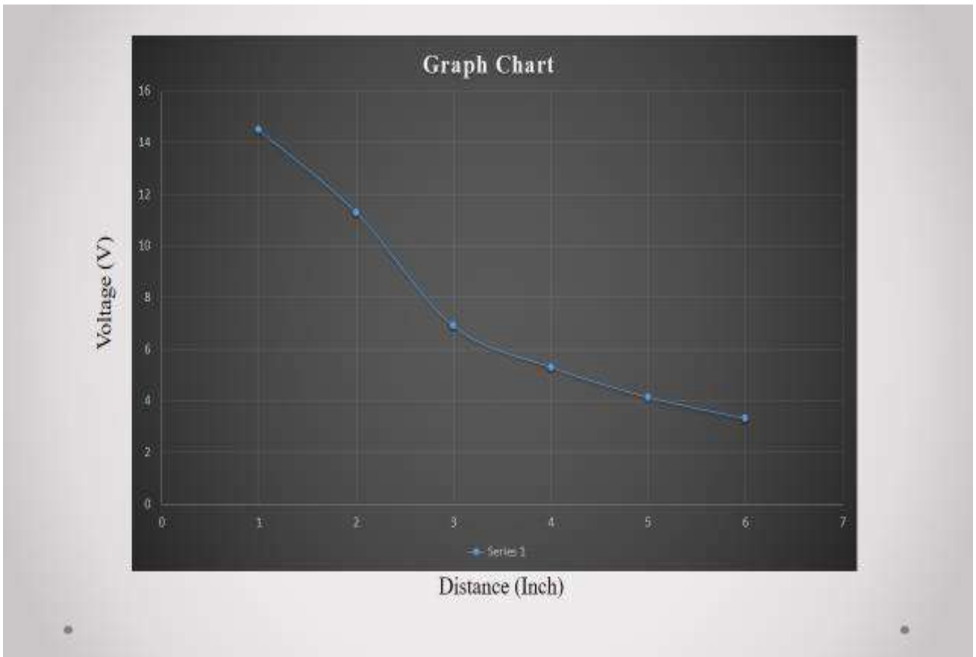


Fig 5.4: Graph Chart

The above figure 5.4 shows the graph chart of the WPT system. The above table 4.1 values are shown in figure 5.4 in the form of a graph. The graph represents how much voltage we are getting according to the distance.

5.3 HARDWARE IMPLEMENTATION

The below figure 5.5 is shown the system overview which contain the whole project, transmitter section, receiver section.

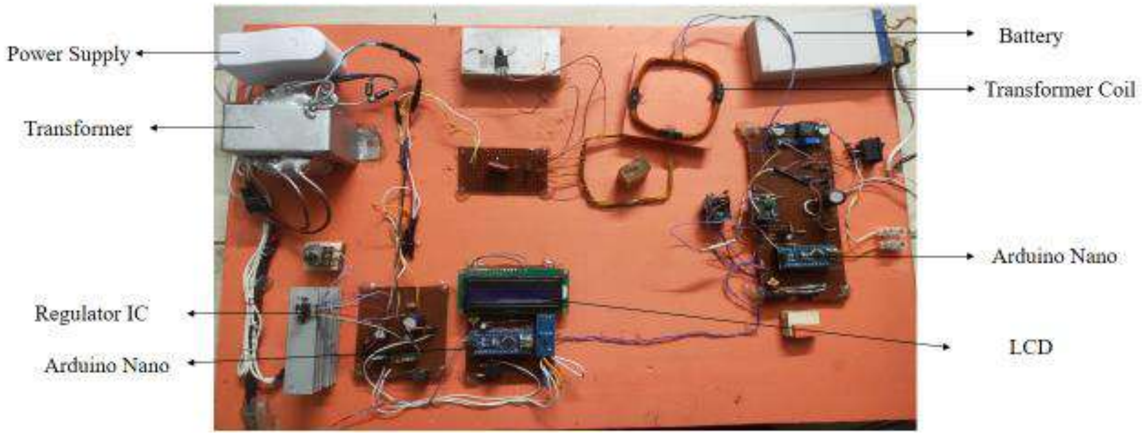


Fig 5.5: System Overview

The below figure 5.6 is showing the Transmitter unit. Here we converted 12v ac to 12 dc, then to 7v dc using buck converter and then using transmitting coil to transmit ac. We also used display to show the input voltage and current.

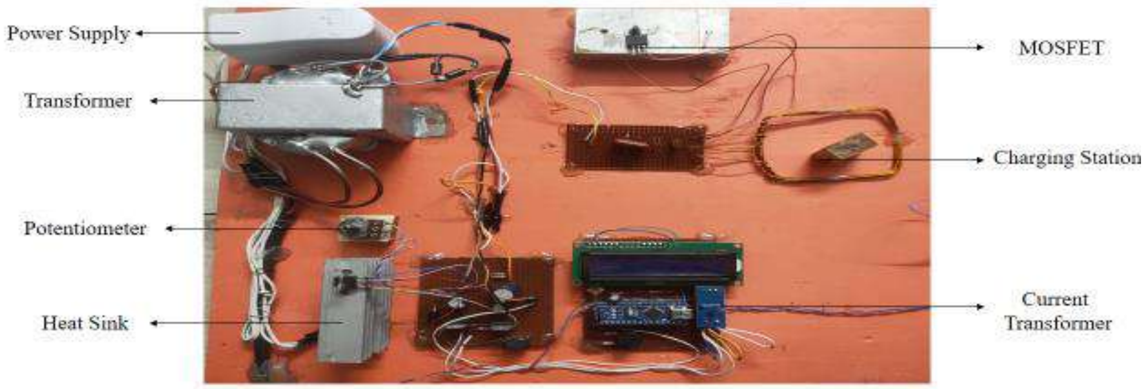


Fig 5.6: Transmitter Section

The below figure 5.7 is showing the receiver circuit. A 4-volt battery may be used in place of the receiver coil, Arduino nano, and relay to trip when the battery is full.

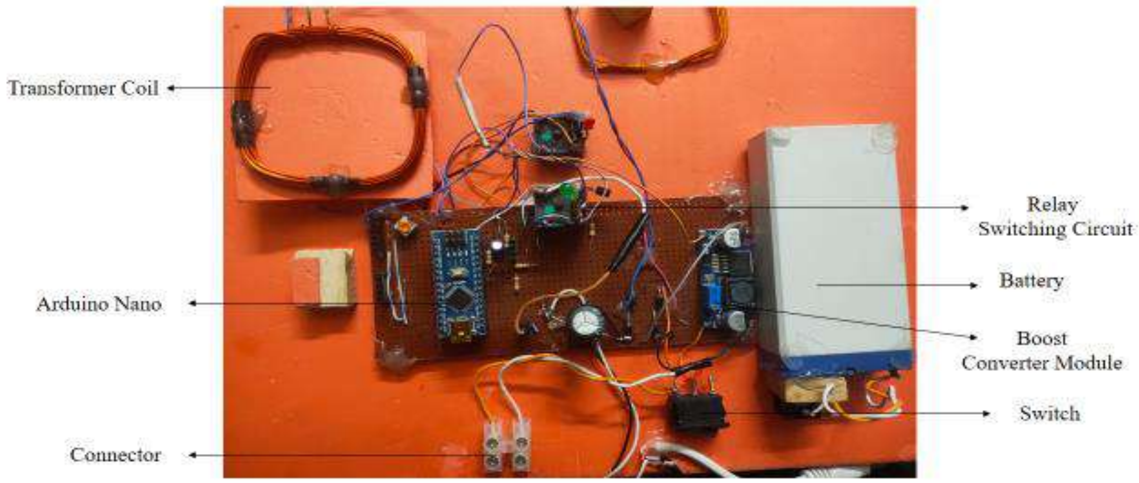


Fig 5.7: Receiver Section

5.4 IMPLEMENTATION TOOLS

- Operating system
  - Windows 10
- Languages
  - C/C++
  - HTML, CSS & JavaScript
- IDE
  - Arduino IDE
  - Brackets (text editor)

5.5 DISCUSSION

Computer programs may be replaced by physical devices or electrical circuits in order to complete the job at hand. Hardware implementations are more time-consuming and hence more expensive to develop. It's more effective and can't be easily tampered with or reprogrammed after it's been built. **Wireless Power Transformer Implementation for Embedded System Hardware Design Challenges Embedded Systems'** Security Crisis During the testing process, a significant amount of power is lost in the embedded system.

CHAPTER 06

CONCLUSION

6.1 INTRODUCTION

Finally, this is the end of this report. We'll discuss the project's conclusion in this chapter. We'll also discuss the project's possible uses and advantages, as well as its limits.

6.2 CONCLUSION

To give a high-level overview of WPT technology and the many benefits and applications it provides, this article was written. We began by discussing the WPT system's foundations. Wireless power transfer (WPT) minimizes the frequency of plugging in devices while also minimizing the risk of electric shock. We hope that we've got a basic comprehension of this topic by the end of this course.

6.3 ADVANTAGES

- Simple design
- Lower frequency operation
- Low cost
- Practical for short distance
- Multiple devices may be charged at the same time. Using larger charging surfaces, such as table tops and benches, may allow us to alter the coil's shape.
- Despite the fact that wireless charging is now slower than standard cable charging, the future seems bright for this technology.
- It also enables for more mobility between the gadget and its power source, thanks to wireless power transmission. Although the two are not perfectly aligned, power may still be transferred.
- If you're doing deep sea research, you may want to consider small, waterproof equipment that doesn't need a charging wire.
- The danger of corrosion and sparking has been reduced by eliminating mechanical connections and wire contacts.
- Consequently, the cost of mechanical connection replacements and maintenance may be reduced.

6.4 APPLICATIONS

- Consumer electronics
- Transport
- Heating and ventilation
- Industrial engineering
- Model engineering

6.5 FUTURE IMPROVEMENT

- We will bring the whole system under CC camera so that we can monitor the system.
- We can add charging vehicle by payment method.
- In future we will be added multi slot for vehicle charging.

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APPENDIX

(A) Receiving Unit

```
#define BATT_FULL 4.0  // full charge volt Change for requirement
#define relay 2
float svolt, bvolt;
bool full;
void setup() {
  Serial.begin(9600);
  pinMode(relay, OUTPUT);
  digitalWrite(relay, 0);
}
void loop() {
  bvolt = analogRead(A5) / 55.74;
  svolt = analogRead(A6) / 38.49;
  if (bvolt > 5) bvolt = 0;
  if (bvolt >= BATT_FULL && full == 0) {
    digitalWrite(relay, 1);
    full = 1;
  }
  else if (bvolt <= BATT_RECONN && full == 1) {
    digitalWrite(relay, 0);
    full = 0;
  }
}
  delay(2000);
}
```

(B) Transmitting Unit

```
#include <LiquidCrystal.h>
#include <Robojax_AllegroACS_Current_Sensor.h>

LiquidCrystal lcd(A5, A4, A3, A2, A1, A0);
Robojax_AllegroACS_Current_Sensor acs712(0, A7);

float volt;
int amp;

void setup() {
  Serial.begin(9600);
  lcd.begin(16, 2);
}

void loop() {
  volt = analogRead(A6) / 35.55;
  amp = acs712.getCurrentAverage(300) * 1000;

  lcd.setCursor(0, 0);
  lcd.print((String)"VOLT: " + volt + " VDC  ");
  lcd.setCursor(0, 1);
  lcd.print((String)"LOAD: " + amp + " mA  ");
  delay(500);
}
```

(C) COST OF THE COMPONENTS

The below table 3.3 of Cost of these project equipment's are given below:

Table: Cost of the Components

SL. No	Components Name	Price(BDT)
01	Arduino Nano	350/-
02	Thermistor	90/-
03	LCD Display	300/-
04	Diode	20/-
05	Resistor & Variable Resistor	30/-
06	Electrolytic Capacitor	20/-
07	Transformer & Transformer Coil	450/-
08	Current Sensor	130/-
09	Battery	140/-
10	Relay	40/-
11	Switch	20/-
12	PVC Board	400/-
14	Others	1000/-
	Total =	**3010/-**