

AN EFFICIENT WIRELESS POWER TRANSFER SYSTEM BASED HYBRID CHARGING STATION FOR ELECTRIC VEHICLES

Submitted in partial fulfillment of the requirements for the award of

Bachelor of Engineering Degree in
Electrical and Electronics Engineering

by

MOHAN RAJ.K (39140032)

UDAYACHANDRAN.R (39140707)

FURKHAN MOHIDEEN.M (39140014)



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

SATHYABAMA

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

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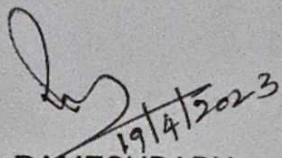
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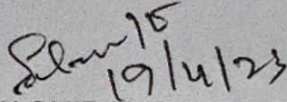


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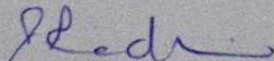
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MOHAN RAJ.K (Reg No: 39140032), UDAYACHANDRAN.R (Reg No: 39140707)
and **FURKHAN MOHIDEEN.M (Reg No: 39140014)** who carried out the project
entitled **"AN EFFICIENT WIRELESS POWER TRANSFER SYSTEM BASED
HYBRID CHARGING STATION FOR ELECTRIC VEHICLES"** under our supervision
from November 2022 to April 2023.


Dr. A. RAMESHBABU
Internal Guide

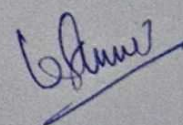

Dr. V. SIVACHIDAMBARANATHAN
Head of the Department

Submitted for Viva voce Examination held on 26/04/2023

Name: Dr. S. Raghava

Signature: 

Dr. V. Balaraman

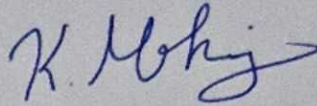


Internal Examiner

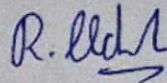
External Examiner

DECLARATION

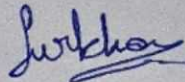
We MOHAN RAJ.K (Reg No: 39140032), UDAYACHANDRAN.R (Reg No: 39140707), and FURKHAN MOHIDEEN.M (Reg No: 39140014) hereby declare that the Project Report entitled "AN EFFICIENT WIRELESS POWER TRANSFER SYSTEM BASED HYBRID CHARGING STATION FOR ELECTRIC VEHICLES" done by us under the guidance of Dr. A. RAMESHBABU is submitted in partial fulfillment of the requirements for the award of Bachelor of Engineering degree in Electrical and Electronics Engineering.



1. MOHAN RAJ.K



2. UDAYACHANDRAN.R



3. FURKHAN MOHIDEEN.M

DATE: 19/04/2023

PLACE: CHENNAI

SIGNATURE OF THE CANDIDATES

ACKNOWLEDGEMENT

We are pleased to acknowledge our sincere thanks to Board of Management of **SATHYABAMA** for their kind encouragement in doing this project and for completing it successfully. We are grateful to them.

We convey our thanks to **Dr. N. M. Nandhita., Dean, School of Electrical and Electronics Engineering** and **Dr. V. Sivachidambaranathan, Head of the Department, Dept. of Electrical and Electronics Engineering** for providing us necessary support and details at the right time during the progressive reviews.

We would like to express our sincere and deep sense of gratitude to our Project Guide **Dr. A. RAMESHBABU** for her valuable guidance, suggestions and constant encouragement paved way for the successful completion of our project work.

We wish to express our thanks to all Teaching and Non-teaching staff members of the Department of Electrical and Electronics Engineering who were helpful in many ways for the completion of the project.

ABSTRACT

Hybrid wireless power transfer (WPT) technology for charging of electric vehicles (EV). The hybrid WPT is used to charge the EV in two ways. Firstly, the primary source of charging is photovoltaic (PV) based battery charging, and secondary charging is grid-based charging. The hybrid WPT consists of two main parts: the transmitter, which includes a PV-based battery charging unit, a grid-based charging unit, an Arduino, an IR sensor, an LCD display, and the transmitter coil. The second part is the receiver, which includes a BLDC motor, LCD display, temperature sensor, power controller, and receiver WPT module. The Arduino uses to control the transmitter side by using IR sensor the when the vehicle is detected, it decides which power source is used to transmit. Then the receiver side WPT receiver coil charges the battery and displays the temperature and battery percentage. Then the stored energy is used to run the EV BLDC motor.

TABLE OF CONTENTS

CHAPTER NO	TITLE	PAGE NO
	ABSTRACT	v
	LIST OF FIGURES LIST OF FIGURES	ix
	LIST OF SYMBOLS AND ABBREVIATIONS	xi
1	INTRODUCTION	
	1.1 GENERAL INTRODUCTION	1
	1.2 AIM	2
	1.3 SCOPE OF PROJECT	2
	1.4 OBJECTIVE	3
	1.5 METHODOLOGY	3
	1.4 APPLICATION	4
2	LITERATURE SURVEY	
	2.1 MAJOR FINDINGS FROM LITERATURE SURVEY	6
	2.2 PROBLEM IDENTIFICATION	13
	2.3 STANDARDS	14
	2.4 CONSTRAINTS	17
	2.5 TRADE OFFS	17
3	TRANSMITTER HARDWARE COMPONENTS	
	3.1 BLOCK DIAGRAM OF TRANSMITTER	18
	3.2 WORK FLOWCHART OF TRANSMITTER	20
	3.3 HARDWARE DESCRIPTION	22

3.3.1	MICROCONTROLLER ARDUINO	22
3.3.2	WIRELESS POWER TRANSFER MODULE	24
3.3.3	SOLAR PANEL (10 WATTS)	25
3.3.4	SINGLE CHANNEL RELAY	27
3.3.5	VOLTAGE SENSOR	28
3.3.6	IR SENSOR	29
3.3.7	LCD DISPLAY	30
3.3.8	BATTERY MANAGEMENT SYSTEM	31
3.3.9	POWER SUPPLY UNIT	33
3.4	SOFTWARE DISCRIPTION	34
3.4.1	ARDUINO IDE	34
3.4.2	EMBEDDED C	36
3.5	PROTOTYPE OF TRANSMITTER	37

4 RECEIVER HARDWARE COMPONENTS

4.1	BLOCK DIAGRAM OF RECEIVER	38
4.2	WORK FLOWCHART OF RECEIVER	40
4.3	HARDWARE DISCRIPTION	41
4.3.1	BLDC MOTOR	42
4.3.2	ESC	43
4.3.3	TEMPERATURE SENSOR	44
4.3.4	MICROCONTROLLER ARDUINO	45
4.3.5	POWER SUPPLY UNIT	45
4.4	PROTOTYPE OF RECEIVER	46

5	PROTOTYPE RESULT	
5.1	DEVELOPED PROTOTYPE	47
5.2	PROTOTYPE RESULTS	48
6	CONCLUSION AND FUTURE SCOPE	50
	REFERENCES	
	APPENDIX SOURCE CODE	
	PUBLICATION	61
	HARDWARE CIRCUIT LAYOUT DIAGRAM	

TABLE OF FIGURES

FIGURE NO	TITLE	PAGE NO
3.1	BLOCK DIAGRAM OF TRANSMITTER	18
3.2	WORK FLOWCHART OF TRANSMITTER	20
3.3	ARDUINO UNO	23
3.4	WPT MODULE	24
3.5	CIRCUIT DIAGRAM OF WPT MODULE	25
3.6	SOLAR PANEL	26
3.7	SINGLE CHANNEL RELAY	27
3.8	DC VOLTAGE SENSOR	28
3.9	IR SENSOR	20
3.10	LCD DISPLAY	30
3.11	BMS MODULE	31
3.12	BMS CONNECTION WITH BATTERY	33
3.13	ARDUINO IDE	34
3.14	EMBEDDED C	36
3.15	PROTOTYPE OF TRANSMITTER	37
4.1	BLOCK DIAGRAM FOR RECEIVER	38
4.2	WORK FLOWCHART OF RECEIVER	40
4.3	BLDC MOTOR	42
4.4	ESC	43
4.5	TEMPERATURE SENSOR	44

4.6	PROTOTYPE OF RECEIVER	46
5.1	DEVELOPED PROTOTYPE	47
5.2	VECHICLE NOT FOUND FOR CHARGING	48
5.3	CHARGING USING SOLAR SOURCE	48
5.4	CHARGING USING AC SUPPLY	49
5.5	REVEIVER SIDE LCD DISPLAY	49

LIST OF SYMBOLS AND ABBREVIATIONS

EV	–	Electric Vehicle
AC	–	Alternating Current
DC	–	Direct Current
PV	–	Photo Voltaic
PIC	–	Programmable Interface Controller
I/O	–	Input/output
Volt	–	Voltage
ADC	–	Analog to Digital Converter
PCB	–	Printed Circuit Board
LCD	–	Liquid-crystal display
BLDC	–	Brushless DC
ESC	–	Electronic speed controller
WPT	–	Wireless Power Transfer

CHAPTER 1

INTRODUCTION AND AIM

1.1 GENERAL INTRODUCTION

In upcoming future, the Electric Vehicles (EV) will be fully replaced by traditional cars that run on gasoline or diesel because electric vehicles produce zero tailpipe emissions, dramatically lowering smog and greenhouse gas emissions. The growth of EV's is dependent on battery technology and charging stations. The growth of EV's can also develop the charging method because charging is now done not only via wire but also via Wireless Power Transfer (WPT). WPT is used to transmit a combination of solar energy and grid as the power source. In an EV, the battery is too difficult to design because of its high power and energy density. In recent times, there have been many forms of batteries used in instruments, but lithium-ion batteries deliver the most suitable solution for electric-powered vehicles. Recently, the WPT has been a very effective topic in the transportation system. By introducing the latest achievements in WPT, we hope that this will achieve success around the world. Due to the limited availability of resources, it is necessary to develop alternative methods to generate energy. WPT is an approach to convenient and cost-efficient charging. It is calculated that 20–30% of losses are due to wires. Hence, wireless power transmission attempts to reduce these losses along with the pollution levels caused by currently used resources. WPT is used to charge portable electronic devices. The solar-powered satellites are being developed with the goal of photographing solar energy in areas for global use, and they are expected to begin operations in 2025–2030. The stand-alone power system (SPS) designs are, in large part, primarily based on WPT. But the contemporary most important utility is the charging of gas-much less rockets, electric automobiles, gas-less planes, and so forth. The simple working principle of inductive WPT charging is that there are two elements in the inductor. One element act as the primary winding, and the other acts as the secondary winding. The frequency changer is to convert the low-frequency AC electricity to high-frequency AC power. The excessive-frequency AC is transmitted from number one to the secondary aspect. The power is then converted to DC and supplied to the battery. The main goal of a Battery Management System (BMS) is to keep the battery within a safe operating range

in terms of voltage, current, and temperature during charge, discharge, and, in some cases, open circuit. The excessive-frequency AC is transmitted from number one to the secondary aspect. Using the full wave bridge rectifier, the AC is covert to DC Then it's far transformed to DC strength and is furnished to the battery percentage.

1.2 AIM

- The aim of a wireless power transfer (WPT) hybrid source of charging for electric vehicles (EVs) is to provide a more convenient and efficient charging experience for EV drivers while also reducing the overall cost and complexity of the charging infrastructure.
- By combining the benefits of wired and wireless charging, a WPT hybrid source can offer the convenience of wireless charging while also ensuring that EVs can be charged even when wireless charging is not available. This can help increase the adoption of EVs by making charging more accessible and user-friendly.
- Furthermore, a WPT hybrid source can also help reduce the cost of the charging infrastructure by allowing charging pads to be installed in strategic locations rather than having to install charging cables everywhere. This can make it easier and less expensive to expand the charging network, which can further accelerate the adoption of EVs.
- Overall, the aim of a WPT hybrid source of charging for EVs is to create a more efficient, accessible, and cost-effective charging experience for drivers while also supporting the transition towards a cleaner, more sustainable transportation system.

1.3 SCOPE OF PROJECT

- Technology for wireless power transmission has a great chance of becoming a common technology in the future.
- The wireless power transfer circuit, which is more closely related to real-world hardware, may be utilized to import the sophisticated circuit that was used for the coil design in the future.

- It is definitely feasible to produce wireless power charging stations that can charge electric vehicles, electric bicycles, or any heavy EVs from the same power charging station, at a high rate, with enough advancement and innovation in this industry. Quicker charging rate than the existing charging methods.

1.4 OBJECTIVE

- The objective of WPT hybrid power source-based charging is to provide a sustainable and efficient charging solution for EVs that reduces the reliance on traditional fossil fuel-based power sources and reduces greenhouse gas emissions.
- By combining WPT technology with a hybrid power source, such as solar panels and wind turbines, EVs can be charged using renewable energy sources whenever possible, and supplemented with traditional grid power when necessary. This approach provides greater flexibility and efficiency in charging, while also reducing the environmental impact of transportation.
- The use of WPT technology also provides a convenient and flexible charging solution, as EVs can be charged wirelessly in various locations, such as at home, at work, or in public parking lots. This helps to encourage the adoption of EVs and supports the transition to a more sustainable and low-carbon transportation system.
- Overall, the objective of WPT hybrid power source-based charging is to provide a cost-effective, sustainable, and efficient charging solution for EVs that helps to reduce greenhouse gas emissions and mitigate climate change.

1.5 METHODOLOGY

- Hybrid power source: A combination of renewable energy sources, such as solar panels and wind turbines, and traditional grid power are used to generate electricity.
- Wireless power transfer: WPT technology is used to transfer power wirelessly from the charging infrastructure to the EV. The WPT system consists of a charging pad that is installed on the ground, and a receiving pad that is installed on the underside of the EV.

- Intelligent charging management: An intelligent charging management system is used to optimize the charging process. This system monitors the battery state of charge, charging rates, and power source availability to determine the most efficient way to charge the EV.
- Flexible charging: With WPT technology, the EV can be charged in various locations, such as at home, at work, or in public parking lots. This provides greater flexibility and convenience for EV owners.
- Cost-effective: The use of renewable energy sources and WPT technology can significantly reduce the cost of charging an EV, making it a more cost-effective alternative to traditional fossil fuel-based vehicles.
- Environmental benefits: By using renewable energy sources and reducing the reliance on fossil fuels, WPT hybrid power source-based charging can significantly reduce greenhouse gas emissions and help to mitigate climate change.

1.6 APPLICATION

- Electric vehicles: WPT hybrid power source-based charging can be used to charge electric vehicles (EVs) using renewable energy sources, such as solar panels and wind turbines, as well as traditional grid power. This provides a more sustainable and efficient charging solution for EVs, while also reducing the environmental impact of transportation.
- Public transportation: WPT hybrid power source-based charging can also be used to charge public transportation vehicles, such as buses and trains, using renewable energy sources. This helps to reduce greenhouse gas emissions and improve air quality in urban areas.
- Industrial applications: WPT hybrid power source-based charging can also be used in industrial applications to power electric machinery and equipment using renewable energy sources. This can help to reduce energy costs and improve the sustainability of industrial operations.

- Military applications: WPT hybrid power source-based charging can also be used in military applications to power electric vehicles, equipment, and weapons using renewable energy sources. This helps to reduce the reliance on traditional fossil fuel-based power sources and improve the sustainability of military operations.

CHAPTER 2

LITERATURE SURVEY

2.1 MAJOR FINDINGS FROM LITERATURE SURVEY

Solar energy is used for wireless power transfer in electrical vehicles 2020 by Pranav Kauishik: The traditional method of connecting components in a circuit is by wired technology, but it needed more knowledge and ingenuity. In recent years, Wireless Power Transmission has become a viable option for supplying power to devices at great distances and in locations that are difficult to reach via wires and cables. With this technique, electrical energy is wirelessly transferred between a transmitter and a receiver that are apart from one another. The concept here is to transport electricity over a distance without the usage of wire connections by using a sustainable energy source, such solar energy. In this instance, PV panels are utilized because they are essential for producing renewable energy, in contrast to other modern nonrenewable energy sources. By using the photovoltaic effect, the PV panels transform solar energy into electrical energy. The resulting voltage is then delivered to the transmitter, which uses one coil at the transmission end and another at the receiving end to send energy in the form of Electro Magnetic (EM) waves. The sent wave is decoded at the receiving end, which creates the same voltage as that seen at the sending end. The entire setup is contained in a panel that can be placed on rooftops and terraces and provides transmission and reception range across a sizable area, which may encompass a living room or a workspace.

Wireless Power Transfer in Electrical Vehicles 2019 by Fatemeh Jozi, Kazem Mazlumi, and Hadi Hosseini: Wireless Power Transfer [WPT] employing magnetic induction technology might prevent people from dangerous accidents brought on by the usage of wires. The inverter increases the efficiency of power transfer between the coils by producing an output with high frequency to the use of MOSFET switches. This higher frequency output generation makes it possible to charge batteries quickly and effectively. The solar panel may be used to continually charge the supply battery by being connected

to it. The users will benefit from this if they drive continuously. These developments make the WPT particularly appealing for stationary and dynamic electric car charging applications. The difficulties of charging time, range, and cost may be readily controlled by implementing WPT in electric vehicles. The WPT technology has advanced quickly in recent years.

A wireless power transfer system for electric car charging 2020 by Khaja Mohiuddin, author: The method for transferring electricity without utilizing wires is wireless power transmission. Areas without access to reliable power sources can be connected to wireless power transfer. Everyone has access to green and clean wireless electricity. In the future, every gadget will connect wirelessly to the power source. For a number of years, wireless charging for electric cars (EVs) has been under research in anticipation of the increased usage of these vehicles. Today's wireless charging technologies provide an effective, adaptable way to charge EVs from many classes and at various power levels from a common ground source. Activities to standardize are actively being pursued to assure system compatibility across manufacturers and locations. The successful experimental attempts to send electricity wirelessly and the potential applications for WPT in electric cars are discussed in this study.

Electric vehicles using wireless power transfer by Kishore Naik Mude 2016: Systems for WPT do not need any wires to move electricity from a source to a load. Due to their benefits over their wired counterparts, such as the lack of exposed wires, simplicity of charging, and fearless transfer of power under challenging environmental circumstances, WPTs are appealing for many industrial applications. Some businesses are interested in using WPTs to recharge an electric vehicle's (EV) on-board batteries, and work is being done to create and enhance the many related topologies. WPT is made possible by a low-cost inductive connection between the transmitter and receiver coils. Transmitter coils are buried in the road for EV charging applications, while receiver coils are installed inside the car. Due to its higher efficiency, inductive WPT of the resonant type is frequently utilised for medium-high power transfer applications like EV charging.

Roadway-powered Electric Vehicles Wireless Power Transfer Systems 2022 by Katherine: Recent advancements in EVs technology have been largely influenced by the need to lessen greenhouse gas emissions, particularly CO₂ emissions, and to mitigate air pollution, particularly in urban areas. Numerous electric cars need batteries to store energy, therefore their availability and technological advancement are significantly dependent on batteries. Due to battery's restricted utility for instantaneous energy recuperation, hybrid electric vehicles are becoming more and more common. In contrast, because they use dynamic WPT to obtain the power while they are travelling on roads, roadway powered electric vehicles (RPEV) and other electric vehicles do not always need battery energy storage for their propulsion. This is thought to be a good choice for small automobiles, taxis, buses, trams, lorries, and trains in the future. Even cars powered by internal combustion engines may find it competitive.

Wireless Power Transfer for Electric Vehicle 2022 by Katherine: The most recent report from Syndicated Analytics, "Wireless Power Transfer for Electric Vehicle Manufacturing Plant Project Report: Industry Trends, Manufacturing Process, Plant Setup, Machinery, Raw Materials, Investment Opportunities, Cost and Revenue 2022-2027," provides insightful data on the performance of the industry, key success and risk factors, manufacturing requirements, project costs and economics, and experience data. This study is a must-read for all those who are planning to enter the wireless power transfer for electric vehicle industry in any way, including entrepreneurs, investors, researchers, consultants, and business strategists. It is based on desk research and multiple waves of primary qualitative research. Transfer of electricity wirelessly (WPT) refers to the procedure of charging battery-operated automobiles without connecting them into a live power source for electric vehicles. WPT is made possible by the relatively cheap inductive connection between receiver coils within the car and hidden transmitter coils in the road. It is a practical and dependable technology that does away with connections and cords. In addition, wireless power transfer has a number of benefits over its wired version,

including simple charging, no exposed cables, and brave power delivery in challenging environmental circumstances.

Wireless Power Transfer for Electric Vehicle Applications 2015 by Shubhangi Das: Magnetic resonance-based WPT technology has the potential to liberate people from obtrusive cables. The WPT really uses the same fundamental idea that has been researched for at least 30 years under the name inductive power transfer. The WPT technology has advanced quickly in recent years. With a grid to load efficiency of above 90%, the transfer distance rises from a few millimeters to several hundred millimeters at kilowatt power levels. The improvements make the WPT particularly appealing to the EV charging applications in situations for both fixed and moving charging. This article examined the WPT-related technologies that are relevant to EV wireless charging. By beginning WPT The challenges of charging time, range, and cost in EVs may be readily overcome. With the widespread use of EVs, battery technology is no longer important. It is hoped that academics would be inspired by the cutting-edge accomplishments and accelerate the development of WPT and the growth of EV.

A comprehensive list of wireless power transfer (WPT) techniques, encompassing short- and medium-range transmission, is provided in "9 Wireless Power Transfer in Electric Vehicles 2018" by Shubhangi Das. The technology and science underpinning WPT and its potential future applications are thoroughly explained. Although this subject has been the subject of much research over the past ten years, much of it remains unexplored. The Roadway Powered Electric Vehicles (RPEVs) and the Online Electric Vehicles are further subjects covered (OLEVs). These cars have the potential to transform the way we travel. However, their starting costs are substantial. The Solar Power Satellite (SPS), which intends to transfer solar energy and use it for wireless power transmission, is discussed in more detail. There are active efforts to commercialize the WPT-using cars, and we also cover the benefits and drawbacks of doing so.

Wireless Power Transfer by Hadi Hosseini, Kazem Mazlumi, and Fatemeh Jozi year 2017: The requirement to charge electric vehicles has emerged as one of the key concerns in the distribution system due to the widespread usage of these vehicles. Additionally, by leveraging vehicle-to-grid (V2G) capabilities, these cars may serve as energy-generating sources. Therefore, to make the most use of these energy storage resources, the charging and discharging processes of electric car batteries must be coordinated. In this study, many approaches are suggested. Regarding changing power rates, parking restrictions for electric vehicles, and the erratic and unexpected nature of quantities, such as the entry and leave of electric vehicles from the parking lot, charging and discharging electric vehicles is a challenge. The profit of an electric car parking lot may be increased by using such tactics, as the parking lot is responsible for charging and discharging the vehicles. The findings demonstrate that different parking tactics provide varying profitability.

Energy Saving Opportunity in Charge Depletion Mode of Real Time Controller for Plug-in Hybrid Electric Vehicles by: Amir Rezaei, Jeffrey B. Burl, Mohammad Rezaei, and Bin Zhou 2020: The energy management (EM) of plug-in Charge-depletion mode and charge-sustaining mode are the two most prevalent operating modes for hybrid electric vehicles (HEVs). This study proposes the ideal adaptation rule for plug-in HEVs operating in charge-depletion mode with any adaptive energy consumption minimization strategy (ECMS). An adaptive ECMS known as CESO, in particular, is chosen to offer the best legislation. For series and parallel HEVs in charge-sustaining mode, CESO was previously introduced. Here, CESO technique is extended to charge-depletion mode for plug-in HEVs by proposing the optimal adaptation rule.

Design of an On-Line Electric Vehicle High Power Transfer Pickup by Boyune Song, Jaegue Shin, Seokhwan Lee, Seungyong Shin, Yangsu Kim, Sungjeub Jeon, and Guho Jung are the authors in 2019. The battery-powered electric vehicles of today have a number of issues, including high costs, weight, long driving distances, lengthy charging times, and the risk of electric shock. Electric cars can get around these issues by adopting contactless power transfer thanks to an inductive power transfer pickup similar to the

pickup of a conventional transformer. Additionally, the inductive power transfer pickup has a wide air gap, high power, high efficiency, and other benefits. This study examined the wireless transmission capabilities of an inductive power pickup that was constructed utilising a series capacitor with ferrite cores and several windings. When the pickup's output power and efficiency were evaluated, they were found to be 20kW and 86.7%, respectively, at 20 kHz and 250mm air gap.

Reserving Charging Strategy for Electric Vehicles Based on Combined Model of Road-Charging Station-Electric Vehicle: Haoming Liu, Man Niu, Weijie Wan in 2018: Charging resources in the charging stations are limited. How to make electric vehicles get charging service with small cost is worth studying. All factors related to the specific value are converted to weights and then given to the corresponding edges of the traffic lines. The electric vehicle charging model is designed according to the needs of the customer, taking into account the traffic conditions and the current charging capacity at the charging point. The Dijkstra algorithm is introduced to achieve the solution of the model built. Finally, the network is used for simulation and the results show that the proposed EV reservation optimization model can meet the different needs of customers.

A Review of Wireless Power Transfer Systems for Charging the Batteries of Electric Vehicles with a Special Emphasis on Inductive Coupling by Iman Okasili and Ahmad Elkhateb 2022: This article, which focuses on inductive power transfer, categorises, discusses, and critically evaluates various compensation techniques, converter topologies, control strategies, and coil designs of WPT systems for electric car battery charging. It charts a course from the invention of the technology to its contemporary and cutting-edge state. For a better understanding of how the systems work and are designed, the fundamentals of inductive coupling power transmission are provided first. Then, soft-switching methods and compensating topologies are introduced. new converter. We provide typical architectures for power electronics. In addition to topologies, detailed descriptions of control processes and control concepts are also provided. This article

discusses several important aspects of wireless power transmission, such as coil design, infrastructure, cost and safety standards, to give readers a better understanding of the technology. Discussions and recommendations are also provided. The goal of this article is to discuss the technology, its current advancements, and its importance. Since the need for electrification is increasing and the automotive industry is at the forefront of concern recent advancements in wireless power transfer will surely play a significant part in the next years in assisting electric cars to become the preferred mode of transportation Wireless Power Charging.

S. Prabhu Ram is the author of "Electrical Vehicles" 2020. Electrical energy may be wirelessly transferred from a transmitter to a receiver thanks to Wireless Power Transfer (WPT) technology. WPT technology, which has several benefits over power transmission by wires, is a better fit and more appropriate option for many industrial applications. Utilizing WPT technology will enhance power transmission mechanisms and lessen wire irritation. The WPT has recently given charging the electric vehicle's on-board batteries a lot of attention (EV). Numerous reputable auto manufacturers start making an attempt to embrace and improve WPT technology. WPT can therefore be accomplished through a low-cost inductive connection between two coils known as a transmitter and a receiver coil. Receiver coils are inserted in the EV, while transmitter coils are buried beneath the road in EV charging applications. Because it produces superior energy efficiency, the inductive WPT of the resonant type is typically used in medium-high power transfer applications like EV charging. Various WPT technologies are examined and put to the test in this chapter's applications for wireless EV charging. In-depth information is also provided on creating a cutting-edge WPT technology that can transmit the most power while operating at its highest efficiency.

Solar-Powered Charging Station for Wireless Electric Vehicle Charging by Rajbansi Devmani Kamalbahadur, 2021: One of the main factors contributing to environmental pollution is the burning of fossil fuels. Due to the pollution and depletion of fossil fuels, the market for electric cars has expanded, and the usage of renewable energy sources has become more popular. Major limitations of the plug-in-based charging technique for

electric vehicles include the need to charge one vehicle at a time, decreased dependability, and space problems. Due to its many benefits, this article suggests employing the wireless power transfer (WPT) technology to charge electric vehicles in parking lots and charging ports while resolving these issues. The efficiency of the parallel-parallel compensator is also thoroughly examined in this work.

2.2 PROBLEM IDENTIFICATION

- Most WPT systems have a limited range, and as the distance between the transmitter and receiver increases, the power that can be transferred decreases. This means the receiver must be in close proximity to the transmitter in order to receive power.
- There are some challenges associated with WPT that need to be addressed. One of the challenges is the efficiency of the transfer process. When power is transferred wirelessly, some of the transferring energy is lost as heat during the transfer process, which reduces the overall efficiency.
- Interference is also a potential problem with WPT. If there are other wireless devices operating in the same frequency range, they can interfere with the power transfer and reduce the efficiency of the system. This can be especially problematic in environments where there are multiple wireless devices operating in close proximity.
- Thermal management: Batteries generate heat during charging and discharging, and high temperatures can damage the battery or reduce its lifespan. Effective thermal management is essential to prevent overheating and ensure the safe and reliable operation of the battery.
- Charging infrastructure: One of the biggest challenges facing EVs is the lack of charging infrastructure. This can cause range anxiety for drivers, and limit the usefulness of EVs for long-distance travel. Additionally, charging infrastructure must be designed and installed to ensure safe and reliable charging of the battery.
- Maintenance: Hybrid power source-based charging systems require regular maintenance to ensure that they are operating efficiently and safely. This can add to the cost and complexity of the charging system.

- **Battery capacity:** The battery capacity of the electric vehicle may not be sufficient to store enough energy from a hybrid power source charging system. This can make it difficult to rely solely on renewable energy for charging an electric vehicle.

2.3 STANDARDS

2030.1.1-2021 - IEEE Standard for Technical Specifications of a DC Quick and Bidirectional Charger for Use with Electric Vehicles

IEEE P2030.1.2 is another standard that specifies the requirements for the design of safe, reliable, and compact ultra-high-power DC chargers for electric vehicles with power ratings of 500 kW or more. This standard enables dynamic current control and bi-directional charging for vehicle-to-home, vehicle-to-building, and vehicle-to-grid power transfers. IEEE's portfolio of standards, test suite specification, and conformity assessment program are crucial to the further deployment of safe and efficient DC rapid EV chargers. IEEE's Electric Vehicle Charging Conformity Assessment Program allows power ratings of 500 kW or more, enables dynamic current control and bi-directional charging, and is backward compatible with existing DC fast charging standards. In recent years, the research interest in off-grid and hybrid charging systems for EVs has increased, and IEEE has published articles and reviews on the topic. However, it is unclear if IEEE has developed specific standards for off-grid and hybrid charging systems for EVs.

P2030.1.2 - IEEE Standard Technical Specifications for Ultra-High-Power Electric Vehicle Chargers

The IEEE has several standards related to wireless power transfer, including IEEE P2030.1.2, which defines requirements for the design of safe, reliable, and compact ultra-high-power DC chargers for electric vehicles. However, the search results do not provide information on specific IEEE standards for wireless power transfer. Instead, the search results provide an overview of wireless power transfer techniques, technical challenges, metamaterials, and typical applications. Wireless power transfer is a novel pattern of energization that offers a new way to acquire energy for electric-driven devices, thus

reducing the dependence on batteries. The search results suggest that wireless power transfer is a growing area of research and development, and IEEE is likely to develop more standards related to wireless power transfer in the future.

IEEE 1526-2020 IEEE Recommended Practice for Testing the Performance of Stand-Alone Photovoltaic Systems

IEEE has several standards related to solar photovoltaic (PV) systems. IEEE 1526-2020 is a recommended practice for testing the performance of stand-alone photovoltaic systems. The methodology includes testing the system outdoors in prevailing conditions and verifying the system design.

IEEE 1547-2018 IEEE Standard for Interconnection and Interoperability of Distributed Energy Resources with Associated Electric Power Systems Interfaces

IEEE 1547-2018 is a standard that eases the integration of distributed energy resources (DER), like solar energy and energy storage, into the electric power system. IEEE 1547-2018 is a revised standard for the interconnection and interoperability of distributed energy resources (DER) with associated electric power system interfaces. The standard aims to ease the integration of DER, like solar energy and energy storage, into the electric power system. The revision was motivated in part by the need to address the changing landscape of DER technologies and the need for greater grid flexibility. The standard was created through a consensus-building process that involved more than 120 technical experts from the distributed generation and energy storage industries, including solar, utilities, equipment vendors, and academia. The standard specifies the technical specifications for, and testing of, the interconnection and interoperability between utility electric power systems (EPSs) and DERs. The standard is intended to provide a framework for DER interconnection and interoperability that can be used by utilities, regulators, and DER developers.

IEEE 2700-2017 Standard for Sensor Performance Parameter Definitions

IEEE 2700-2017 is a standard for sensor performance parameter definitions, that provides a common framework for sensor performance specification terminology, units, conditions, and limits for various sensors, including accelerometers, magnetometers, gyroscopes, barometers, pressure sensors, hygrometers, humidity sensors, temperature sensors, ambient light sensors, and proximity sensors. The standard presents a standard methodology for defining sensor performance parameters with the intent to ease system integration burden and accelerate time to market (TTM). Within the standard, a minimum set of performance parameters is defined with required units, conditions, and distributions for each sensor. The standard is intended for sensor technologies with digital I/O interfaces.

2.4 CONSTRAINTS

- **Cost:** The cost of designing and implementing a wireless power transfer system for electric vehicles with hybrid electric energy storage can be high, which can limit the feasibility and affordability of the project.
- **Efficiency:** Wireless power transfer systems can have lower efficiency than wired charging systems, which can result in longer charging times and higher energy losses.
- **Safety:** Safety is a critical concern when designing and implementing a wireless power transfer system, and the system must be designed to minimize the risk of electric shock, fire, or other hazards.
- **Standards and Regulations:** Compliance with industry standards and regulations, such as the IEEE 2030.7-2017 standard, is necessary to ensure the safety and reliability of the system.

2.5 TRADE OFFS

- **Charging Speed vs. Efficiency:** Increasing the charging speed of the system can reduce the charging time for electric vehicles, but it can also decrease the efficiency of the system.
- **Power Output vs. Cost:** Increasing the power output of the system can improve the charging speed of electric vehicles, but it can also increase the cost of the system.
- **Flexibility vs. Cost:** Adding more features to the system, such as bidirectional charging or vehicle-to-grid (V2G) capabilities, can increase the flexibility of the system but can also increase the cost of the project.
- **User Experience vs. Cost:** Improving the user experience, such as through the use of wireless charging pads or automated charging systems, can improve the convenience of the system but can also increase the cost of the project.

CHAPTER 3

TRANSMITTER HARDWARE COMPONENTS

3.1 BLOCK DIAGRAM OF TRANSMITTER

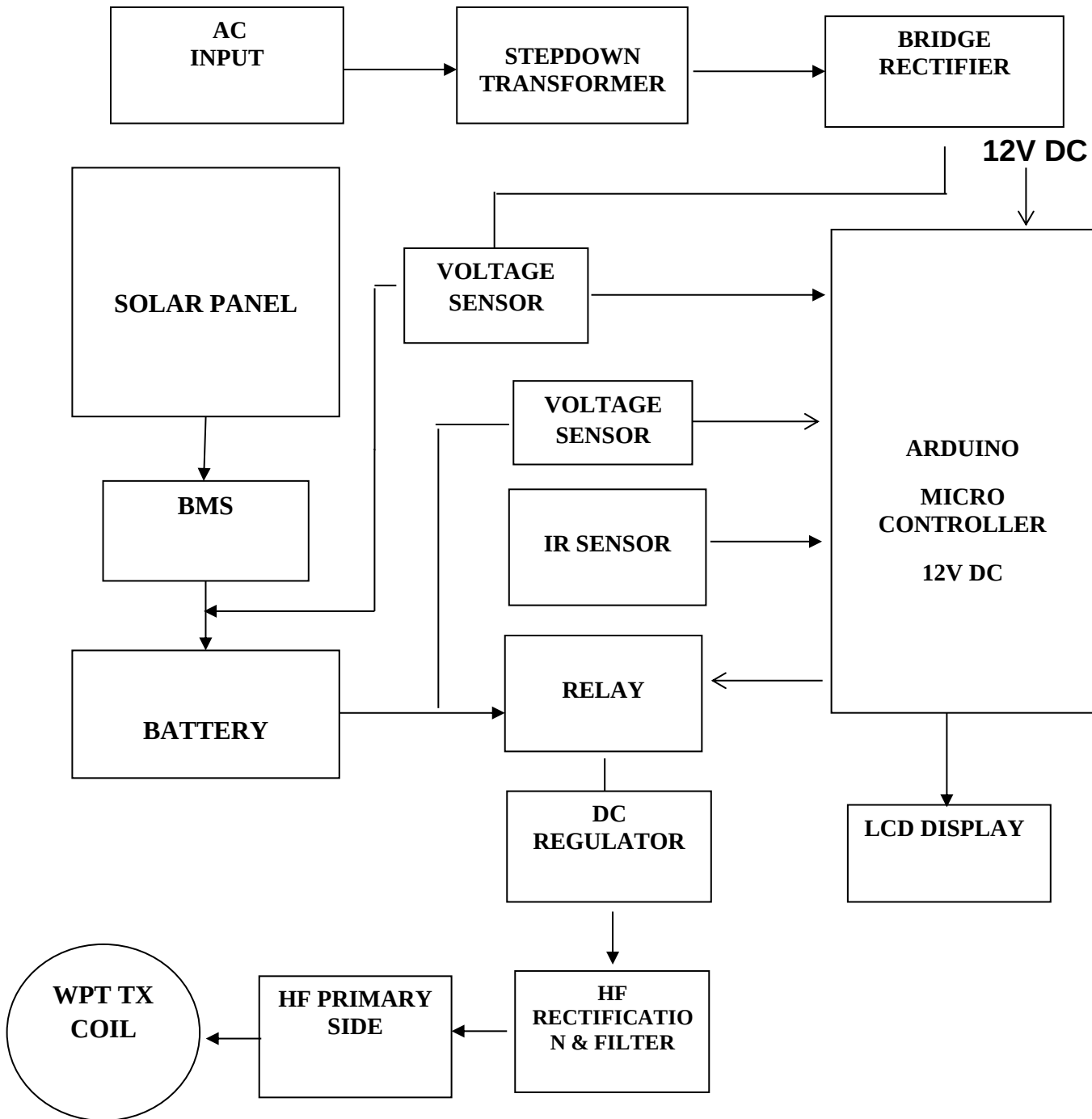


Fig 3.1 Block diagram of transmitter

The proposed system, depicted in Fig 3.1 is based on wireless power transfer (WPT) and hybrid modes of power transmission. The block diagram is created using two sources of power: one is an alternating current source, and the other is a solar source using a solar panel. The AC source, which is stepped down to 12 V via a transformer. There are two voltage sensors used in this. One voltage sensor is used to track the total power supplied and total power consumed from the AC source. And another voltage sensor is connected to the battery of the solar power source to get the voltage rate from the battery. Two voltage sensors are connected in parallel to the Arduino board, and the output is displayed on the LCD display. On the Arduino board, the LCD display, IR sensor, and relay are connected. The LCD display is used to display the voltage consumption, the voltage that is transmitted through the wireless power transfer module (WPT), and also displays "vehicle found" and "no vehicle found." The IR sensor is used to find or identify whether the vehicle is placed in the WPT module or not. If the vehicle is discovered, a signal is sent to the Arduino microcontroller. Then the Arduino was set to turn "on" the relay, which is connected to the wireless power transfer (WPT) module. When no vehicle is found, the Arduino's microcontroller does not activate the relay. Based on the IR sensor signal, the Arduino can turn on and off the relay, and power is transferred from the transmitter WPT to the receiver WPT. There are two relays used and connected in series to the WPT module. One relay is used to transfer power from the alternating current source to the WPT. And another one is used to transfer power from a solar source to the WPT.

3.2 WORK FLOWCHART OF TRANSMITTER

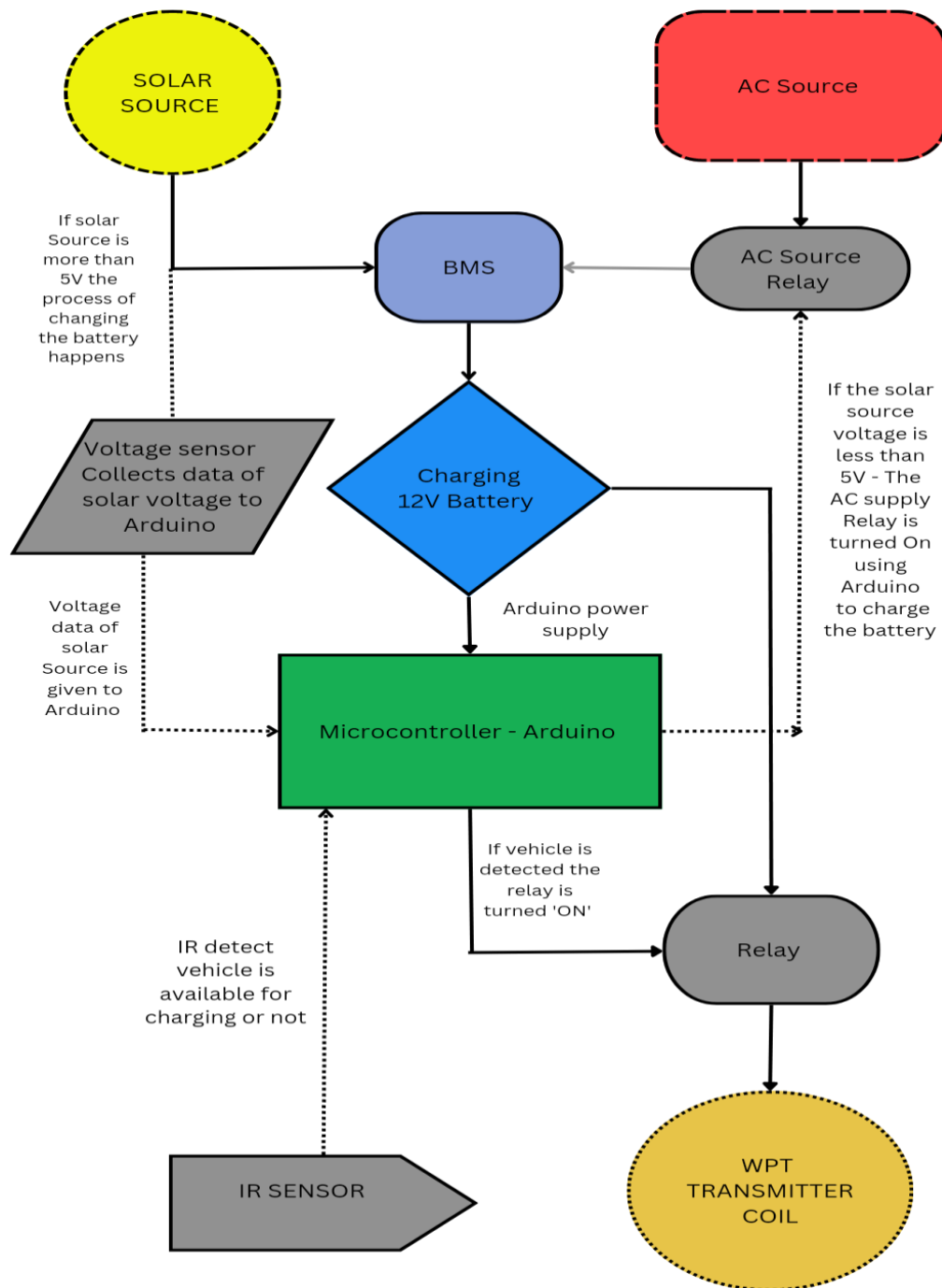


Fig 3.2 Work flowchart of transmitter

Primary source – Solar source. The primary source of the project is solar energy, and here the solar source is available during the day when the source is available. The solar power source from photovoltaics (PV) is transmitted through the battery management system (BMS) module to a 12 V battery for charging.

- the solar source voltage is greater than 5 volts, then it is used to charge the battery. The voltage data of the solar source is collected by a voltage sensor on the Arduino microcontroller.
- If the solar source voltage is less than 5V, the microcontroller Arduino switches on the relay of the ac supply to charge the battery.

Secondary source - Ac supply. The secondary source of project is normal AC supply, this source is considered the secondary or backup source.

- When the solar source is not available, the ac source is used, and supply is given to the BMS, which then charges the battery.
- The charged battery is used to power up the Arduino, and it also used to transmit power through the wireless power transfer technology.
- The IR sensor is used to find whether the vehicle is found or not; if it is, the relay is used to turn on the power supply from the battery to the WPT transmitter coil.

3.3 HARDWARE DESCRIPTION

Hardware requirements typically refer to the minimum or recommended specifications for a computer or other electronic device to run certain software or perform certain tasks efficiently. The hardware components of modern electronic systems are made up of a variety of components that work together to perform a specific task.

- MICROCONTROLLER ARDUINO
- WIRELESS POWER TRANSFER MODULE
- SOLAR PANNEL
- SINGLE CHANNEL RELAY
- VOLTAGE SENSOR
- IR SENSOR
- LCD DISPLAY
- BATTERY MANAGEMENT SYSTEM
- POWER SUPPLY UNIT

3.3.1 MICROCONTROLLER ARDUINO

Arduino Uno is an open-source microcontroller board based on the ATmega328P chip. It was designed to make it easier for hobbyists and students to create interactive projects by providing a simple, low-cost platform for programming and controlling electronics.

The board has 14 digital input/output pins, 6 analog inputs, a 16 MHz quartz crystal, a USB connection, a power jack, and a reset button. It can be programmed using the Arduino IDE (Integrated Development Environment), which is a free software tool that allows users to write, compile, and upload code to the board.

Arduino Uno can be used for a wide range of applications, including robotics, home automation, environmental monitoring, and more. Its simplicity and versatility make it a popular choice among makers, students, and educators.

One of the key advantages of Arduino Uno is its large and active community, which provides support, tutorials, and a wide range of libraries and example code. This makes it easier for beginners to get started with the board and for advanced users to build complex projects.

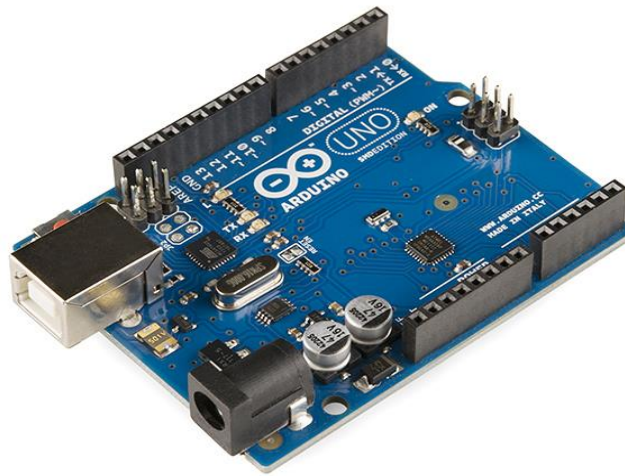


Fig 3.3 Arduino UNO

Overall, Arduino Uno is a powerful and flexible tool for creating interactive electronics projects, and its open-source nature and large community make it a valuable resource for anyone interested in exploring the world of electronics and programming.

An Arduino micro-controller is a configurable integrated circuit that can perform a variety of functions based on how it is programmed. It used to control the IR sensor and display whether the vehicle was found or not, then operated the relay to transmit power to the transmitter's WPT coil. It is also used to display whether the power transmission transmitted is using PV or AC power and also shows the voltage of both supplies in the display.

3.3.2 WIRELESS POWER TRANSFER MODULE

Wireless power transfer module, also known as wireless charging module, is a technology that allows electrical energy to be transmitted from a power source to a device without the need for physical wires. This technology has been gaining popularity in recent years, particularly in the field of mobile devices.

The wireless power transfer module consists of two main components: the transmitter and the receiver. The transmitter generates an electromagnetic field that is picked up by the receiver, which then converts it back into electrical energy to power the device. The transmitter and receiver can be separated by a short distance or even be in the same device.

There are several different types of wireless power transfer modules available on the market, including magnetic induction, magnetic resonance, and radio frequency. Magnetic induction is the most commonly used technology, which uses two coils - one in the transmitter and one in the receiver - to transfer energy between them.



Fig 3.4 WPT module

One of the main advantages of wireless power transfer modules is convenience. Users can simply place their devices on a charging pad or surface, without the need to plug in a physical cable. This can also reduce the wear and tear on charging ports, which can be a common issue with wired charging. Wireless power transfer modules can also be used for a wide range of applications, including medical devices, automotive applications, and industrial machinery. They can also be used in public spaces, such as airports and coffee shops, to provide wireless charging for mobile devices.

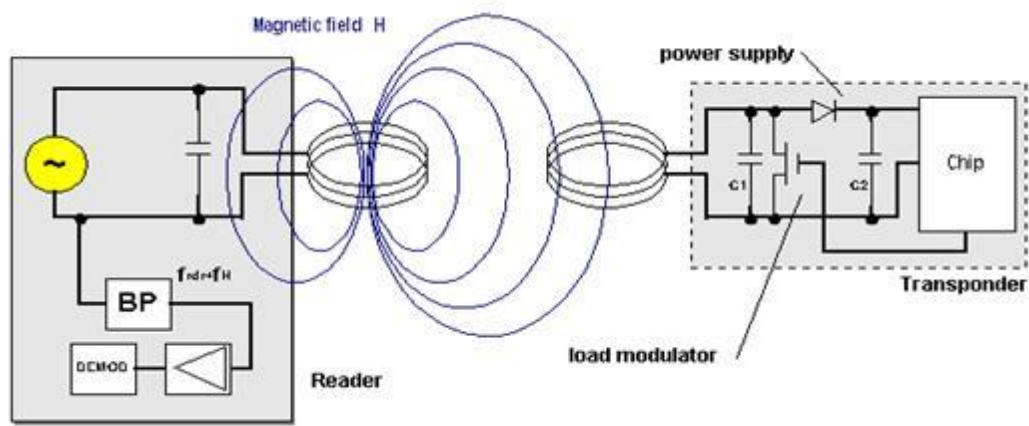


Fig 3.5 Circuit diagram of WPT module

Overall, wireless power transfer modules provide a convenient and flexible solution for powering devices without the need for physical wires, and their applications are expected to continue to expand in the future.

3.3.3 SOLAR PANEL (10 WATTS)

Solar energy begins with the sun. Solar panels (also known as "PV panels") are used to convert light from the sun, which is composed of particles of energy called "photons", into electricity that can be used to power electrical loads. Solar panels can be used for a wide variety of applications including remote power systems for cabins, telecommunications equipment, remote sensing, and of course for the production of electricity by residential and commercial solar electric systems.



FIG 3.6 Solar panel

A 10W solar panel is a type of photovoltaic module that is designed to convert sunlight into electrical energy. These panels are typically used in small-scale applications, such as charging small electronic devices, powering LED lights, and providing electricity to off-grid cabins and RVs. A 10W solar panel consists of several solar cells, which are made of semiconductor materials that convert sunlight into direct current (DC) electricity. The cells are connected in series or parallel to create a module, which can then be connected to a charge controller and battery to store the energy for later use. The efficiency of a 10W solar panel depends on several factors, including the quality of the solar cells, the angle and orientation of the panel, and the amount of sunlight available. In general, a 10W solar panel can produce between 30 and 50 watt-hours (Wh) of electricity per day, depending on the conditions. One of the main advantages of a 10W solar panel is its portability and ease of installation. It can be mounted on a variety of surfaces, including roofs, walls, and even backpacks, making it a convenient source of energy for outdoor activities and remote locations. Another advantage is that solar energy is renewable and environmentally friendly, as it does not produce any greenhouse gases or other pollutants. This makes solar panels a sustainable and low-carbon alternative to traditional sources of energy.

Overall, a 10W solar panel is a small but versatile source of renewable energy that can be used for a variety of applications. Its portability, ease of installation, and sustainability make it a valuable resource for anyone looking to reduce their reliance on fossil fuels and harness the power of the sun.

3.3.4 SINGLE CHANNEL RELAY

A single-channel relay is an electronic device used for controlling the on/off state of a single circuit. It consists of a coil, a set of contacts, and a switching mechanism. When a current is applied to the coil, it creates a magnetic field that pulls the contacts together, closing the circuit and allowing current to flow. Single-channel relays are commonly used in a wide range of applications, such as home automation, robotics, and industrial control systems. They can be used to control lights, fans, motors, and other electrical devices.



Fig 3.7 Single channel relay

One of the main advantages of single-channel relays is their simplicity and ease of use. They can be easily integrated into existing circuits, and their on/off state can be controlled by a simple electrical signal. They also provide electrical isolation between the control circuit and the device being controlled, which can help to protect sensitive electronics from damage.

Single-channel relays come in a variety of configurations, such as normally open (NO) or normally closed (NC), and can be activated by a variety of input signals, such as voltage or current. They are typically rated for a certain voltage and current, and should be selected based on the requirements of the application.

Overall, single-channel relays are a reliable and cost-effective way to control the on/off state of electrical circuits. Their simplicity and ease of use make them a popular choice for a wide range of applications, and their electrical isolation can help to protect sensitive electronics from damage.

3.3.5 VOLTAGE SENSOR

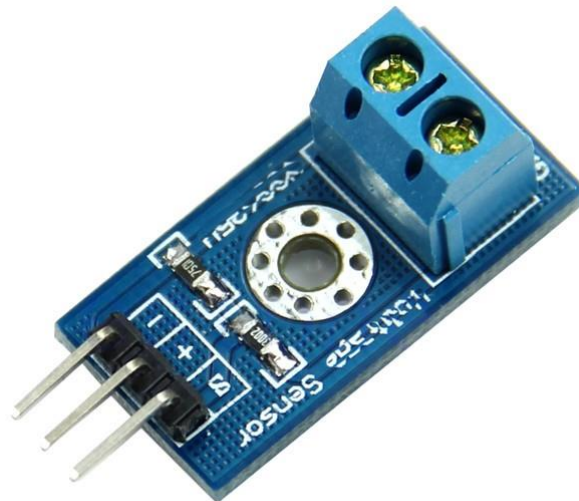


Fig 3.8 DC Voltage sensor

A DC voltage sensor is an electronic device that is used to measure the voltage of a direct current (DC) circuit. It is commonly used in a variety of applications, such as monitoring battery voltage in automotive and solar power systems, and measuring voltage levels in industrial control systems. The basic principle of a DC voltage sensor is to measure the voltage across a known resistance in the circuit and convert it into a proportional electrical signal. The output signal can be displayed on a digital or analog meter, or transmitted to a computer or other device for further processing.

There are several types of DC voltage sensors available, including analog and digital sensors. Analog sensors provide a continuous reading of the voltage level, while digital sensors provide a discrete output signal that indicates the voltage level in steps. DC voltage sensors can also be categorized based on their voltage range and accuracy. Some sensors are designed to measure low voltages, while others are capable of measuring higher voltages up to several hundred volts. The accuracy of the sensor is also an important factor, and should be selected based on the requirements of the application. One of the main advantages of DC voltage sensors is their ease of use and portability. They can be easily integrated into existing circuits, and their compact size and lightweight design make them ideal for use in mobile or remote applications.

3.3.6 IR SENSOR

An infrared sensor is an electronic device, that emits in order to sense some aspects of the surroundings.

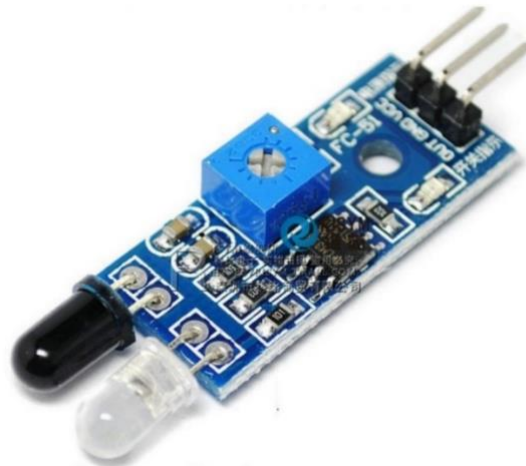


Fig 3.9 IR Sensor

An infrared (IR) sensor is an electronic device that detects infrared radiation in its surrounding environment. It is commonly used in a wide range of applications, such as motion detection, temperature sensing, and distance measurement. The basic principle of an IR sensor is to detect the presence of IR radiation and convert it into an electrical signal. IR radiation is emitted by all objects with a temperature above absolute zero, and

can be used to detect the presence and movement of objects in its vicinity. There are several types of IR sensors available, including passive and active sensors. Passive sensors detect IR radiation emitted by objects in its surrounding environment, while active sensors emit IR radiation and measure the reflected signal to determine the distance or position of an object. IR sensors can also be categorized based on their detection range and accuracy. Some sensors are designed to detect IR radiation over short distances, while others can detect IR radiation over several meters. The accuracy of the sensor is also an important factor, and should be selected based on the requirements of the application. One of the main advantages of IR sensors is their non-contact nature, which makes them ideal for use in applications where physical contact is not possible or desirable. They are also immune to interference from electromagnetic radiation, which can make them more reliable in noisy environments

IR sensor interfacing includes amplification, filtering, and other signal conditioning, as well as analog-to-digital conversion. A microcontroller may contain an analog-to-digital converter (ADC), but the sensor must be compatible with the ADC input. The IR sensor used detects the vehicle and sends a signal to the Arduino. Then the relay is used to switch on and off the power supply for transferring the power from the transmitter coil.

3.3.7 LCD DISPLAY

A 16x2 LCD (Liquid Crystal Display) is a type of alphanumeric display that can display up to 16 characters on each of its two lines. It is commonly used in a variety of applications, such as home automation, automotive systems, and industrial control systems.



Fig 3.10 LCD Display

The display consists of a grid of pixels that can be turned on or off to form characters and symbols. Each pixel is made up of a liquid crystal material that changes its polarization in response to an electric field. By selectively applying an electric field to each pixel, the display can form the desired characters and symbols. The 16x2 LCD display is controlled by a microcontroller or other device that sends commands and data to the display. The controller sends signals to the display's control pins to select the desired line and position, and then sends data to the display's data pins to display the desired characters. One of the main advantages of the 16x2 LCD display is its simplicity and ease of use. It can be easily integrated into existing circuits and controlled by a wide range of microcontrollers and other devices. It is also highly readable and provides a clear and crisp display of text and symbols.

The 16x2 LCD display can also be customized with different fonts and character sets, and can be backlit for use in low-light environments. It is available in a variety of colors and sizes, making it a versatile display solution for a wide range of applications.

3.3.8 BATTERY MANAGEMENT SYSTEM

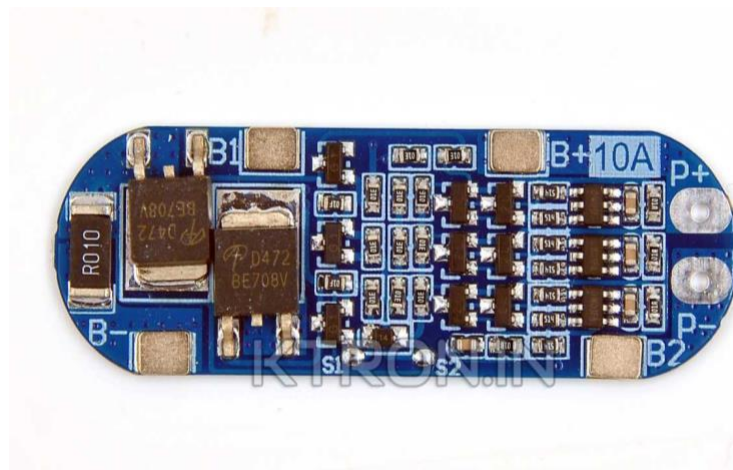


Fig 3.11 BMS module

A battery management system (BMS) module is an electronic device that is used to monitor and control the charging and discharging of rechargeable batteries. It is commonly used in applications such as electric vehicles, solar power systems, and

portable electronic devices. The BMS module is designed to protect the battery from overcharging, over discharging, and overcurrent conditions. It consists of a microcontroller or other control circuit, along with sensing and protection components such as current sensors, voltage sensors, and temperature sensors. The BMS module continuously monitors the battery's state of charge and state of health, and adjusts the charging and discharging rates to maintain optimal battery performance and prevent damage. It also provides alerts and shutdown features in case of a fault condition, such as an overvoltage or overtemperature event.

The BMS module can also communicate with other devices in the system, such as a battery charger or an electric vehicle controller, to optimize the charging and discharging process and maximize battery life.

One of the main advantages of a BMS module is its ability to extend the life of the battery by preventing overcharging and over discharging, which can cause permanent damage to the battery. It also improves the safety of the system by preventing overcurrent and overtemperature conditions, which can lead to fires or explosions.

Overall, a BMS module is an essential component in rechargeable battery systems. It provides the necessary protection and control to maintain optimal battery performance and prevent damage, while also improving the safety and reliability of the system.

Full Charge Voltage: 12.6V to 13V

- Over Current Protection
- Under Voltage (Over discharge) protection
- Maximum Discharge Current: $8A \pm 2A$
- Maximum Charging Current: $10A \pm 1A$
- Short Circuit Protection
- Quiescent Current: $< 30 \mu A$
- Working Temperature: $-40^{\circ} \sim 50^{\circ} C$
- Effective life: > 30000 Hours

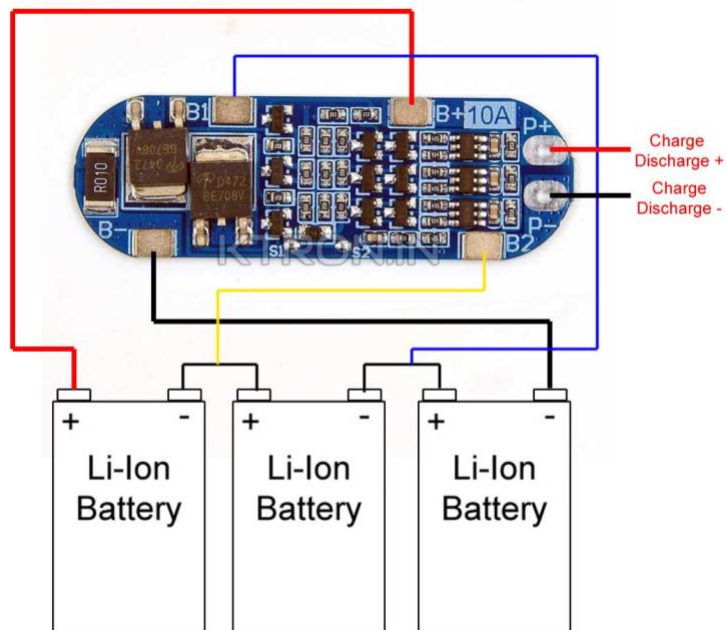


Fig 3.12 BMS connection with battery

3.3.9 POWER SUPPLY UNIT

In a PSU, mains AC power is converted to short-voltage regulated DC energy. It is used to convert 120 volts of AC mains electricity into something more convenient, such as 12 volts DC. There are two types of linear power supplies and switch-mode power supplies. A converter is used in a linear power supply to decrease the voltage. A high direct current voltage is generated by rectifying and regulating the alternating current signal.

PV panel 12V (10 watts) is used as the other source of supply where the solar DC power is stored via charging unit-battery management system (BMS) module is used to charge the 12V battery and the power stored in the battery is used to transmit the power form transmitter WPT to receiver WPT coil.

This type of external energy supply is often housed in a case like an AC plug, also known as an AC/DC adapter. Chargers and rechargers are converters for rechargeable batteries gadgets (battery chargers). A power adapter connects to a mains power source to provide

voltage and power to electrical devices that need power but do not have internal components to draw power from it. An external power supply's inbuilt circuit board is very similar to that of a built-in or internal power supply.

3.4 SOFTWARE DESCRIPTION

The hardware is incomplete without the software. The software-dependent hardware microcontroller Arduino needs some software to complete or run the module and follow the instructions, to complete tasks, or to perform specific tasks, etc.

- ARDUINO IDE
- EMBEDDED C

3.4.1 ARDUINO IDE

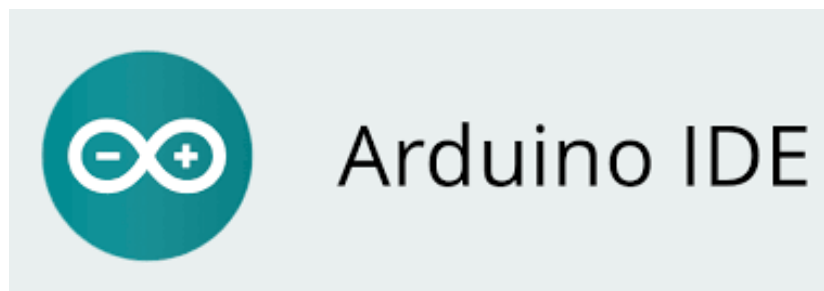


Fig 3.13 Arduino IDE

The Arduino IDE (Integrated Development Environment) is a free open-source software tool used for programming and uploading code to Arduino boards. It is designed to be user-friendly and accessible to beginners, while also providing advanced features for more experienced users.

The Arduino IDE is compatible with a wide range of Arduino boards, including the popular Arduino Uno, as well as newer boards like the Arduino Nano and Arduino Mega. It supports a variety of programming languages, including C and C++, which allows users to write and upload custom code to their Arduino boards.

The IDE features a code editor with syntax highlighting, code completion, and other useful tools for writing and debugging code. It also includes a serial monitor, which allows users to send and receive data between their Arduino board and their computer.

One of the key advantages of the Arduino IDE is its large and active community, which provides support, tutorials, and a wide range of libraries and example code. This makes it easier for beginners to get started with programming their Arduino boards, and for advanced users to build more complex projects.

The IDE is also highly customizable, with a range of third-party plugins and extensions available to enhance its functionality. This allows users to tailor the software to their specific needs and preferences.

Overall, the Arduino IDE is a powerful and versatile tool for programming and uploading code to Arduino boards. Its user-friendly interface and large community make it a valuable resource for anyone interested in exploring the world of electronics and programming.

3.4.2 EMBEDDED C

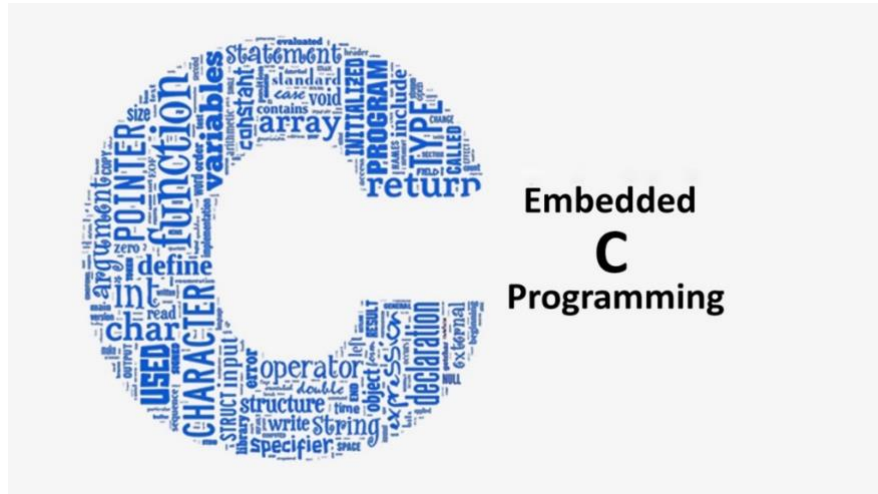


Fig 3.14 Embedded C

Embedded C is a programming language used for developing software for embedded systems. Embedded systems are computer systems designed to perform specific tasks, such as controlling industrial equipment, automotive systems, and home appliances. The language is a variant of the C programming language, but it is designed to be more efficient and optimized for use in resource-constrained embedded systems. Embedded C is used to develop software that runs on microcontrollers, which are small and low-cost computers that are designed to control a specific device or system. One of the key features of Embedded C is its ability to interact directly with hardware peripherals, such as timers, serial ports, and analog-to-digital converters. This allows the programmer to write code that directly interfaces with the hardware, making it easier to control and monitor the device. Embedded C also supports low-level programming, allowing the programmer to write code that executes faster and consumes fewer resources. This is important for embedded systems, which are often resource-constrained and must operate within tight performance and power constraints.

The language is used in a wide range of applications, including automotive systems, medical devices, home automation, and industrial control systems. It is also used in the development of firmware for consumer electronics devices, such as digital cameras, mobile phones, and gaming consoles.

3.5 PROTOTYPE OF TRANSMITTER

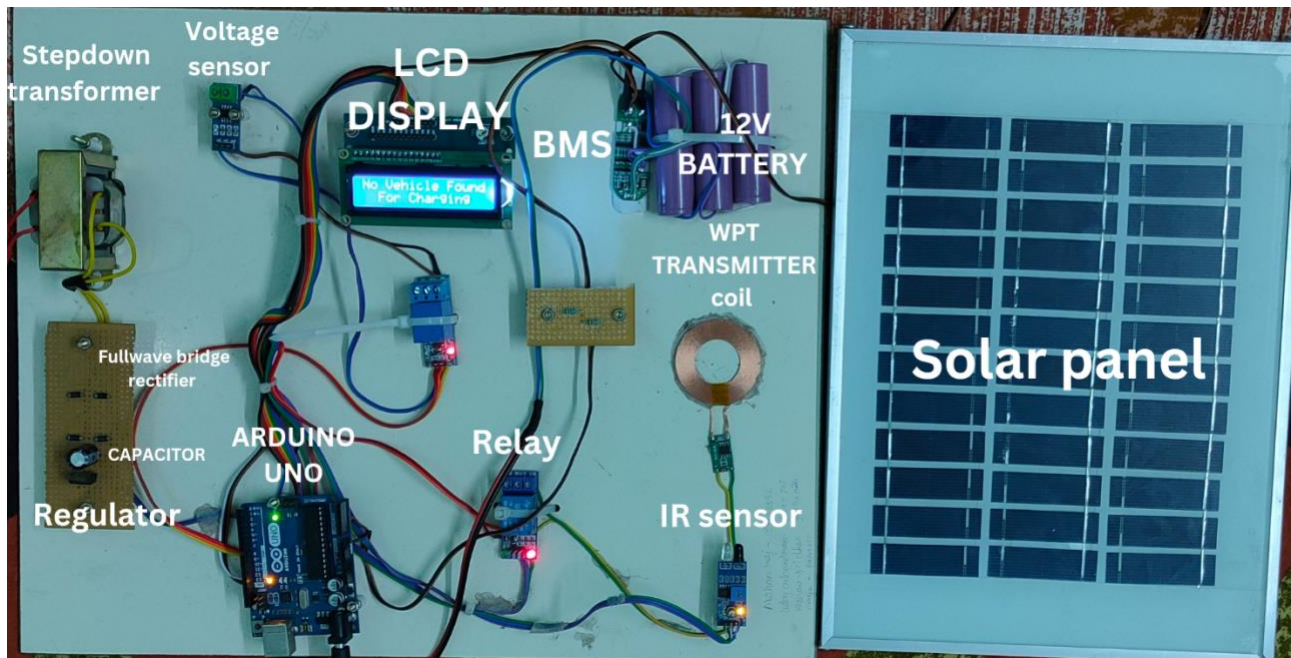


Fig 3.15 PROTOTYPE OF TRANSMITTER

The above fig 3.15 shows the proposed work of transmitter side which is consider as a hybrid mode of charging availability using microcontroller, sensors, relays etc. To achieve the uninterrupted mode of power supply availability is shown as prototype.

CHAPTER 4

RECEIVER HARDWARE COMPONENTS

4.1 BLOCK DIAGRAM OF RECEIVER

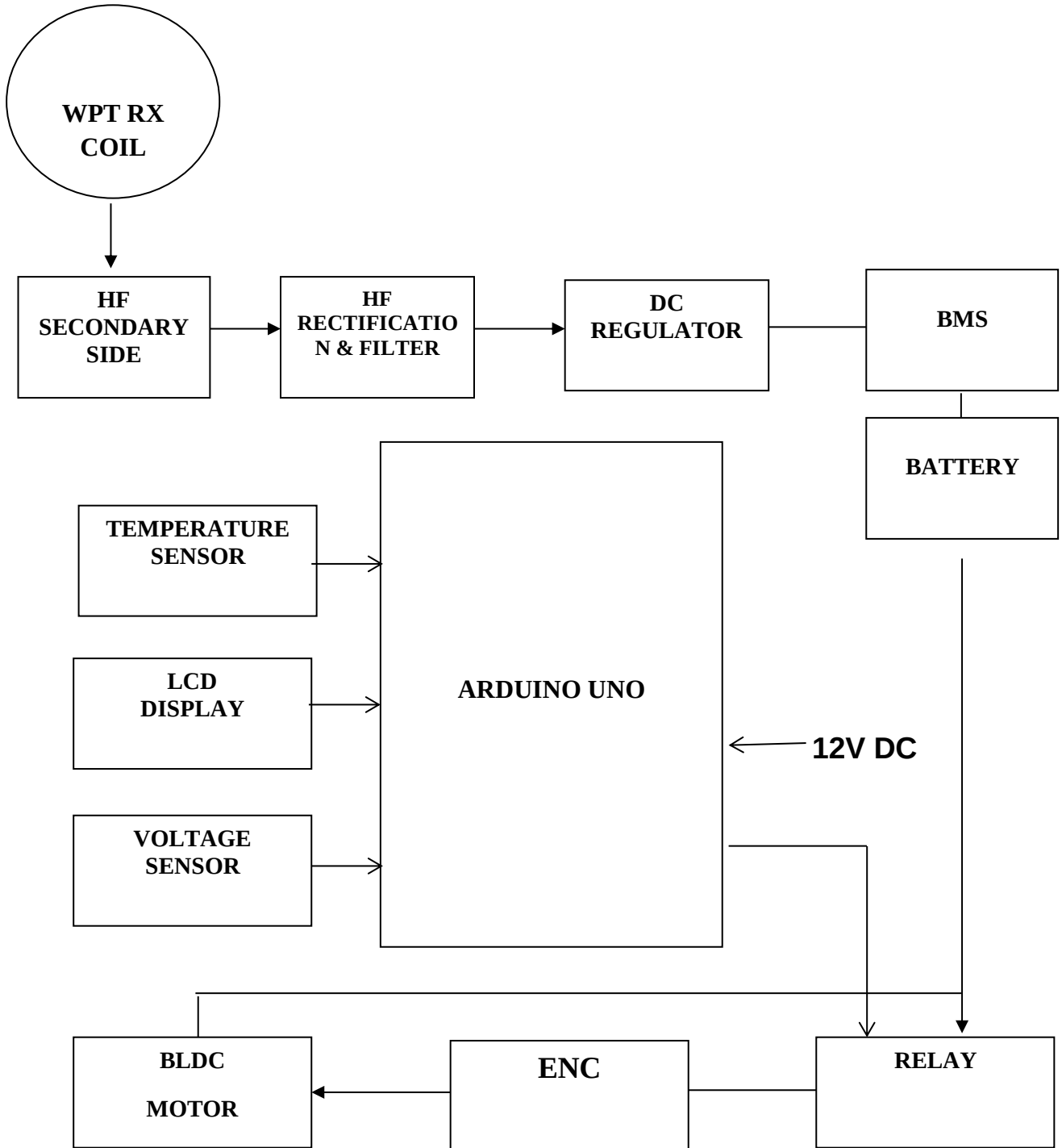


Fig 4.1 Block diagram of receiver

Fig. 4.1 depicts the receiver block diagram of the existing system. The receiver's wireless power transfer (WPT) module is connected to the charging circuit, followed by the BMS. The Arduino microcontroller is then linked to a temperature sensor, a voltage sensor, and an LCD display. The temperature sensor is used to identify the temperature of the battery, and the voltage sensor is used to identify the voltage transmitted from the receiver WPT to the battery. The battery percentage, status, and temperature are all displayed on the LCD display. The battery is used to store the power that is transmitted from the transmitter coil to the receiver coil. Finally, the stored energy is used or checked by running the BLDC motor. By using the Arduino Uno and the Arduino IDE software, the program is written in embedded C and ported to the transmitter and receiver Arduino.

4.2 WORK FLOWCHART OF RECEIVER

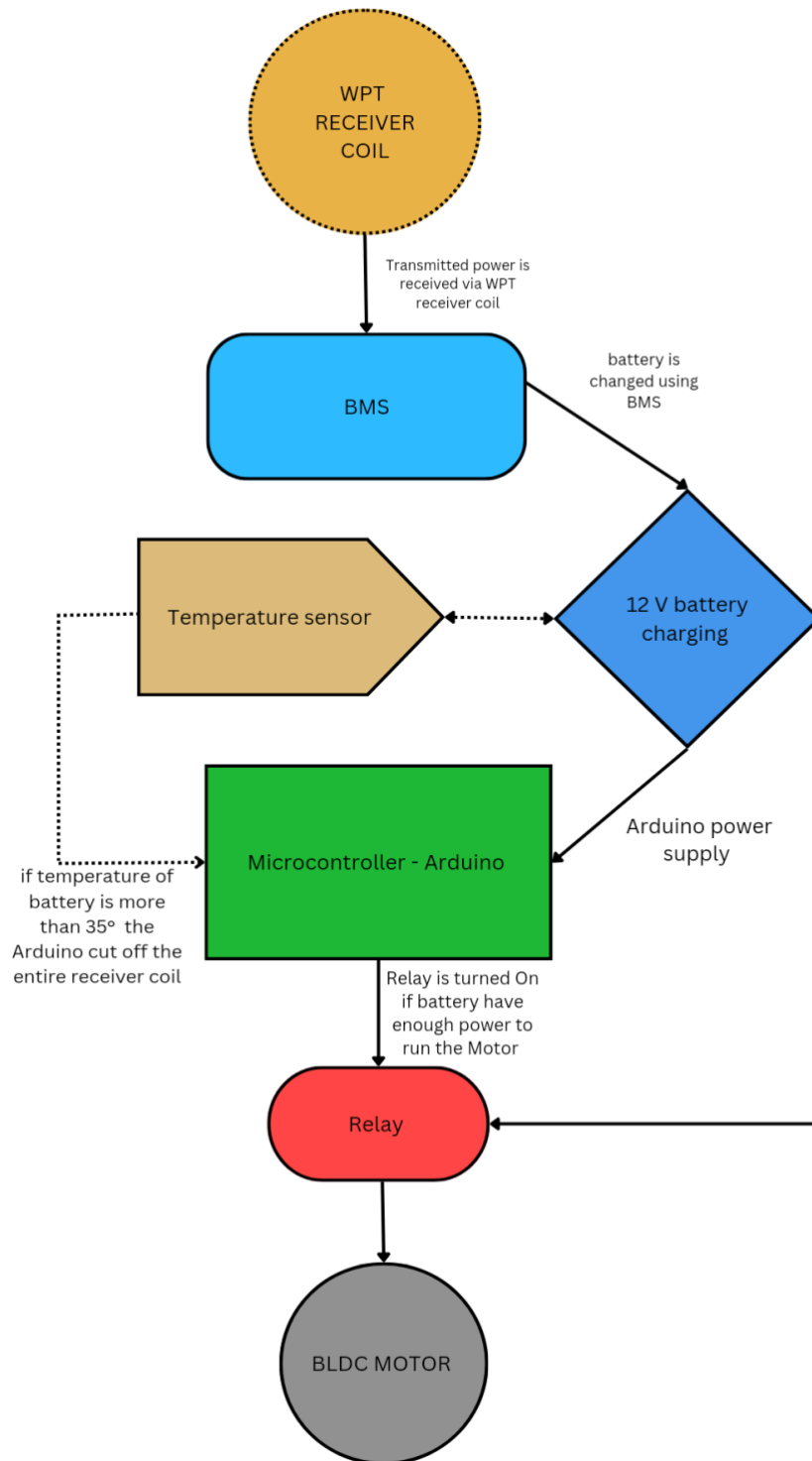


Fig 4.2 Work flowchart of receiver

- The power transmitter through transmitter WPT coil to receiver WPT coil is stored in 12V battery of the receiver side through the BMS module.
- The stored energy in the battery is used to power up the Arduino and also used to run the BLDC motor.
- The temperature sensor is attached to battery to identify the temperature of battery to protect battery from explosion and damages. The sensor data is collected to Arduino, if the temperature raises the entire receiver circuit has been cut off.

4.3 HARDWARE DISCRPTION

Hardware requirements typically refer to the minimum or recommended specifications for a computer or other electronic device to run certain software or perform certain tasks efficiently. The hardware components of modern electronic systems are made up of a variety of components that work together to perform a specific task. Most of the components are already included in the transmitter side and the same hardware are used in receiver side also. The new and existing hardware used in the receiver side are

- MICROCONTROLLER ARDUINO
- WIRELESS POWER TRANSFER MODULE
- TEMPERATURE SENSOR
- SINGLE CHANNEL RELAY
- VOLTAGE SENSOR
- LCD DISPLAY
- BMS

These above hardware devises are already described in last chapter. The new hardware used in receiver side are:

- BLDC MOTOR
- ESC
- TEMPERATURE SENSOR
- MICRCONTROLLER ARDUINO
- POWER SUPPLY UNIT

4.3.1 BLDC MOTOR

A BLDC (Brushless DC) motor is an electric motor that uses a permanent magnet rotor and a stator with electronically controlled windings. It is commonly used in a wide range of applications, such as robotics, drones, electric vehicles, and industrial machinery. Unlike traditional DC motors, BLDC motors do not use brushes to transfer power between the stationary and rotating parts. Instead, they use an electronic control system to switch the current in the motor windings, generating a rotating magnetic field that interacts with the permanent magnets on the rotor. This interaction causes the rotor to rotate, producing mechanical power. The electronic control system for a BLDC motor is typically a microcontroller or other control circuit that uses feedback from sensors, such as hall effect sensors or encoders, to determine the position and speed of the rotor. This information is used to adjust the current in the motor windings, ensuring smooth and efficient operation.

One of the main advantages of BLDC motors is their high efficiency and reliability. They produce less heat and noise than traditional motors, and their brushless design eliminates the need for regular maintenance and replacement of brushes. They also offer higher torque and power density, making them a popular choice for high-performance applications.



Fig 4.3 BLDC MOTOR

BLDC motors are available in a variety of sizes and configurations, ranging from small motors used in drones and consumer electronics to large motors used in electric vehicles and industrial machinery. They are also customizable, with options for different winding configurations and control algorithms to optimize performance for specific applications.

4.3.2 ESC - Electronic Speed Controller

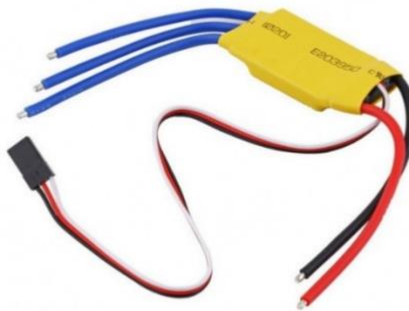


Fig 4.4 ESC

An Electronic Speed Controller (ESC) is an electronic circuit that is used to control the speed and direction of a motor, typically a brushless DC motor. It is commonly used in a variety of applications, including drones, electric vehicles, and industrial machinery. The ESC consists of a microcontroller or other control circuit, along with power electronics components such as MOSFETs, capacitors, and resistors. It is designed to receive input signals from a motor controller, such as a radio control transmitter or a microcontroller, and adjust the current flowing through the motor windings to control its speed and direction. The ESC can also provide additional features such as battery monitoring, temperature monitoring, and overcurrent protection to ensure the safe and reliable operation of the motor. One of the main advantages of an ESC is its ability to provide smooth and precise control over the motor speed and direction. It uses a pulse-width modulation (PWM) signal to adjust the voltage and current supplied to the motor, allowing

for fine control over its rotation speed and direction. ESC is commonly used in drones to control the speed of the motors, which is essential for maintaining stable flight. They are also used in electric vehicles to control the speed of the motor and improve overall efficiency. In industrial applications, they are used to control the speed and torque of machinery, improving productivity and reducing energy consumption.

Overall, an ESC is an essential component in any system that uses a brushless DC motor. It provides precise control over the motor speed and direction, improving performance and reliability. Its ability to provide additional features such as battery monitoring and overcurrent protection ensures safe and reliable operation of the motor.

4.3.3 TEMPERATURE SENSOR



Fig 4.5 Temperature sensor

A temperature sensor with water resistance is a type of sensor that is designed to accurately measure temperature in wet or humid environments. This type of sensor is commonly used in applications such as swimming pools, hot tubs, and aquariums. The sensor is typically made up of a thermistor, which is a type of resistor that changes its resistance with changes in temperature. The thermistor is enclosed in a waterproof housing, such as a stainless-steel probe, to protect it from moisture and corrosion.

One of the main advantages of a water-resistant temperature sensor is its ability to provide accurate temperature readings even in wet or humid environments. This is essential for applications such as swimming pools or hot tubs, where accurate temperature control is important for user safety and comfort. Water-resistant temperature sensors are available in a variety of configurations, including digital and analog sensors, with options for different temperature ranges and accuracy levels. They can be connected to a variety of controllers, such as microcontrollers or programmable logic controllers (PLCs), to provide precise temperature control and monitoring.

This sensor is used to measure the temperature of the battery, and it converts analogue data to digital using an Arduino. When the temperature of the battery is increased with the help of the microcontroller, the entire power supply to the receiver side or to the supply to run the BLDC motor is cut off. This is used to prevent or protect the battery from damage and explosion of the battery. The temperature is then monitored on the LCD with the help of an Arduino.

4.3.4 MICROCONTROLLER ARDUINO

The Arduino micro-controller is a configurable integrated circuit that can perform a variety of functions based on how it is programmed. The Arduino identifies the battery percentage and temperature of the battery using a temperature sensor. The data of temperature and percentage of battery are displayed in LCD display using Arduino. It also operates the relay for the BLDC motor to run if enough power is stored in the battery to run the motor. If the temperature rises above 35 degrees, the whole receiver circuit is cut off with the help of an Arduino.

4.3.5 POWER SUPPLY UNIT

On the receiver side, the power is transferred from the transmitter WPT coil to the receiver WPT coil. The transmitted power is passed through the BMS to the 12V battery for charging. The stored power in the battery is given to the Arduino microcontroller and BLDC motor.

4.4 PROTOTYPE OF RECEIVER

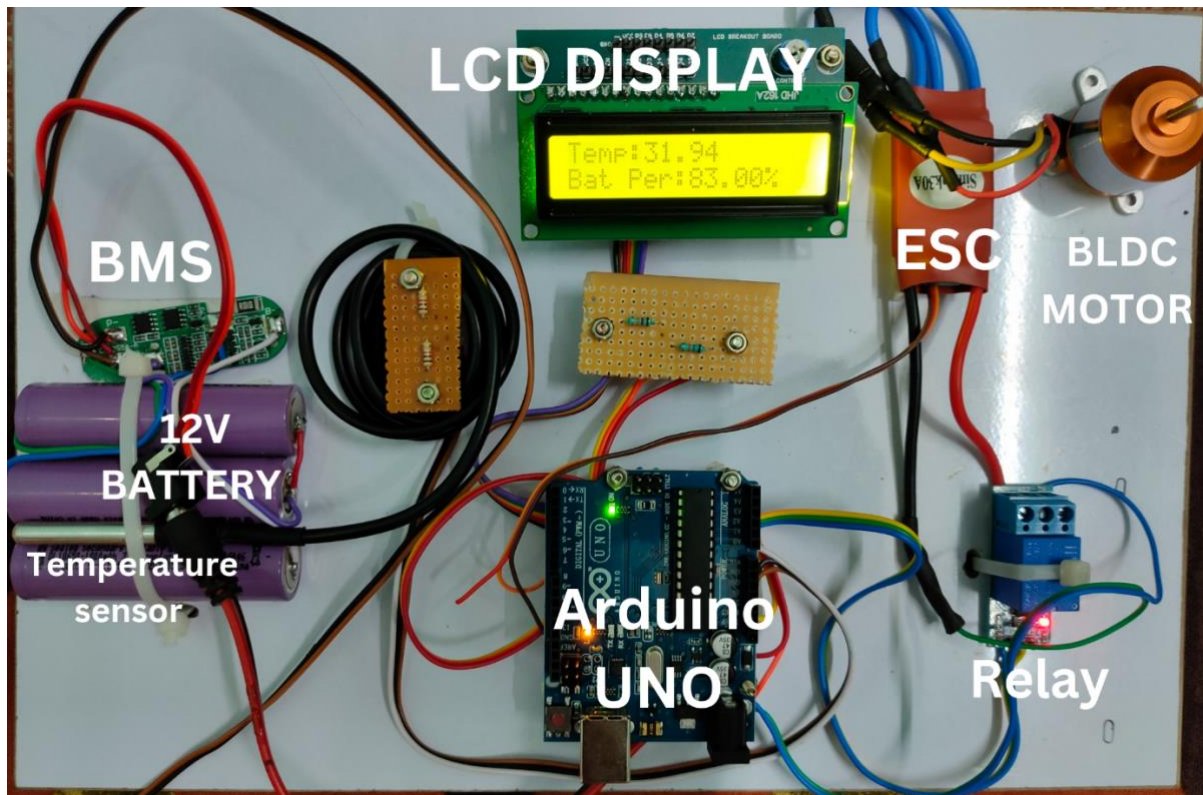


Fig 4.6 Prototype of receiver

The above fig 4.6 shows the proposed work of receiver side which is consider as a car charging is made with WPT receiver coil using microcontroller, sensors, relays etc. And the stored energy in the battery is used to run the EV BLDC motor, it considers as the electric vehicle motor and it is operated successfully.

CHAPTER 5

PROTOTYPE RESULTS

5.1 DEVELOPED PROTOTYPE

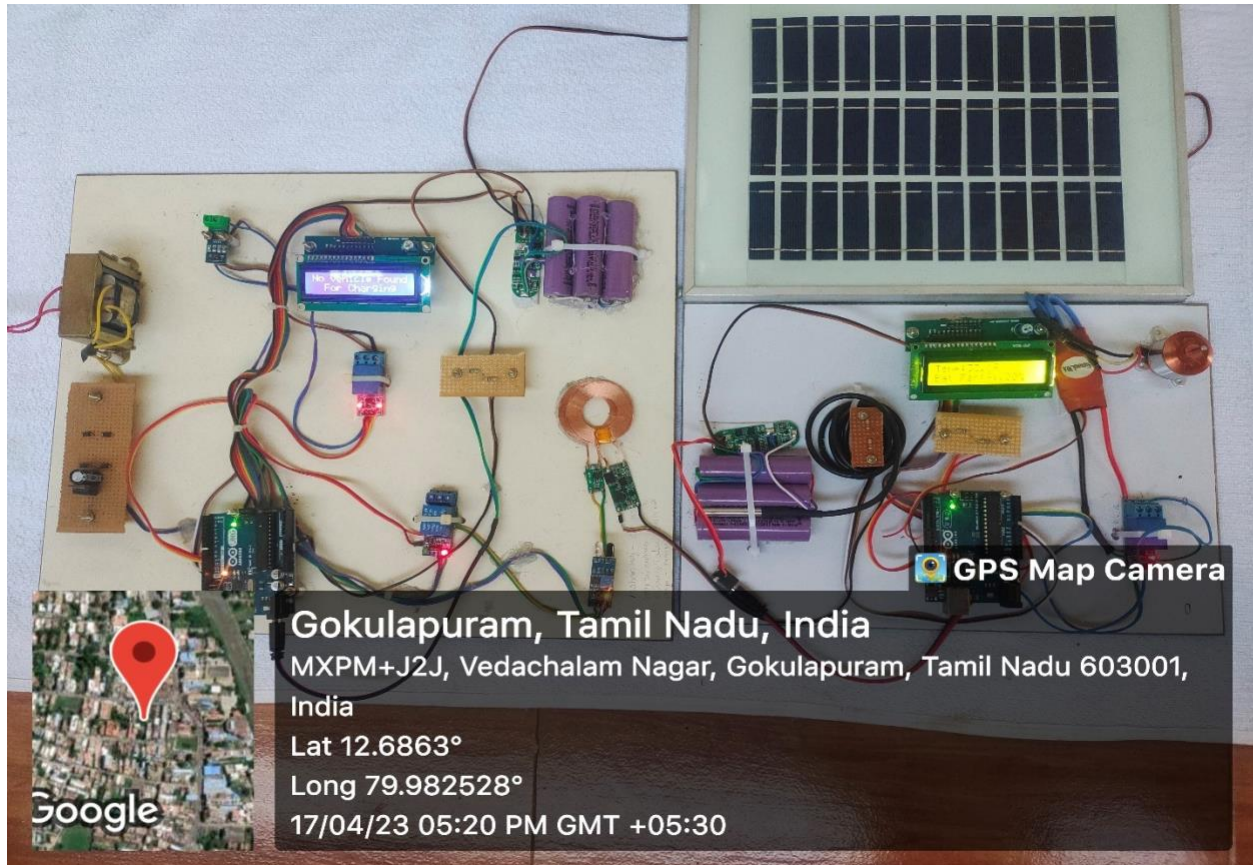


Fig 5.1 Developed prototype

The completed prototype based on Wireless power transfer with hybrid mode of charging the electric vehicle is performed as a prototype given below fig 5.1. The transmitter and receiver side of the prototype has been shown above. combination of these side performs the hybrid mode of charging. where the transmitter side is considered as charging station and the receiver side is consider as electric vehicle. And the output of this project is done by running the BLDC motor which is also known as EV bldc motor.

5.2 PROTOTYPE RESULTS

The Wireless power transfer involves in multiple areas, along with magnetics, communication, power electronics, and electric engineering. The Proposed study of a WPT system can be very complex over the areas of nature and the ambiguous of the system.

The below figure 5.2 shows the LCD Display that shows vehicle is found or not for charging using IR sensor.



Fig 5.2 vehicle not found for charging

The below figure 5.3 shows the LCD Display that shows charging status and voltage power. This is based on solar power supply.



Fig 5.3 Charging using solar source

The below figure 5.4 shows the LCD Display that shows changing status through current power of AC. This is based on AC power supply.



Fig 5.4 Charging using AC Supply

The receiver side LCD display shows temperature of the vehicle and battery percentage of the system in fig 5.5.



Fig 5.5 Receiver Side LCD display

The given fig 5.1 is the final outcome of the project. This contains both transmitter and receiver and solar panel. This project is the future reference for the e-vehicle hybrid charging process using WPT technology.

CHAPTER 6

CONCLUSION AND FUTURE SCOPE

The Hybrid based charging station for electric vehicle using WPT technology is presented. The proposed technique provides the solar based charging and grid-based charging of electric vehicle. The experimental results are confirming that the proposed system working in hybrid mode of operation. Thus, the uninterruptable charging of EV is obtained using the proposed technique.

Wireless power transfer technology is a field that has a huge potential of becoming a mainstream technology in the future because in today's world charging the EV is only happens through the plug in and out cable mode. The proposed wireless power transfer circuit can be used for EV charging applications. With the necessary research and development in this field, in the future, the advanced circuit as used the coil design can be imported from the wireless power transfer circuit that is closer to the real-world hardware. With adequate development and innovation in this field, it is certainly possible to create wireless power charging stations capable of charging in hybrid mode which uses 2 or more source of energy like solar, wind etc. For electric bicycles and electric cars or any heavy EVs from the same power charging station, at a faster charging rate than currently available charging techniques.

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APPENDIX SOURCE CODE

PROGRAM USED ARDUNIO TRANSMITTER

```
#include <LiquidCrystal.h>
const int rs = 7, en = 6, d4 = 5, d5 = 4, d6 = 3, d7 = 2;
LiquidCrystal lcd(rs, en, d4, d5, d6, d7);
float current;
int ir;
int solar = 0;
float solar_voltage;
float R1 = 18000.0;
float R2 = 12000.0;
void setup()
{
  Serial.begin(9600);
  lcd.begin(16, 2);
  lcd.setCursor(0, 0);
  lcd.print(" Wireless Power ");
  lcd.setCursor(0, 1);
  lcd.print("Transfer For e-V");
  delay(2500);
  pinMode(8, OUTPUT);
  pinMode(9, OUTPUT);
  pinMode(A0, INPUT);
  pinMode(A1, INPUT);
  pinMode(A2, INPUT);
  digitalWrite(8, HIGH);
  digitalWrite(9, HIGH);
}
void loop()
{
```

```

solar = analogRead(A2);
solar_voltage = solar * (5.0 / 1024) * ((R1 + R2) / R2);
current = 0;
for (int i = 0; i < 1000; i++)
{
    current = current + (.0264 * analogRead(A1) - 13.51) / 1000;
    delay(1);
}
ir = digitalRead(A0);
Serial.print("solar_voltage = "); Serial.println(solar_voltage);
Serial.print("Current = "); Serial.println(current);
Serial.print("Ir = "); Serial.println(ir);
// delay(250);
if (ir == 0)
{
    if (solar_voltage > 5)
    {
        digitalWrite(8, LOW);
        digitalWrite(9, HIGH);
        lcd.clear();
        lcd.setCursor(0, 0);
        lcd.print("Charging Started");
        lcd.setCursor(0, 1);
        // lcd.print("Cur:");
        // lcd.print(current);
        lcd.print("S.Volt:");
        lcd.print(solar_voltage);
        delay(1000);
    }
    else
    {

```

```

    digitalWrite(8, LOW);
    digitalWrite(9, LOW);
    lcd.clear();
    lcd.setCursor(0, 0);
    lcd.print("Charging Started");
    lcd.setCursor(0, 1);
    lcd.print("Cur:");
    lcd.print(current);
    lcd.print(" Ac");
    //    lcd.print(solar_voltage);
    delay(1000);
}
}
else
{
    digitalWrite(8, HIGH);
    lcd.clear();
    lcd.setCursor(0, 0);
    lcd.print("No Vehicle Found");
    lcd.setCursor(0, 1);
    lcd.print(" For Charging ");
    delay(2000);
}
}

```

PROGRAM USED IN ARDUINO RECEIVER

```

#include <LiquidCrystal.h>
#include <OneWire.h>
#include <DallasTemperature.h>
#include <Servo.h>

```

```

Servo myservo;
const int rs = 12, en = 11, d4 = 5, d5 = 4, d6 = 3, d7 = 2;
LiquidCrystal lcd(rs, en, d4, d5, d6, d7);
#define ONE_WIRE_BUS A0
OneWire oneWire(ONE_WIRE_BUS);
DallasTemperature sensors(&oneWire);
float Celcius = 0;
float Temp;
int battery = 0;
float battery_voltage;
float battery_volt;
float R1 = 18000.0;
float R2 = 12000.0;
void setup()
{
  Serial.begin(9600);
  sensors.begin();
  lcd.begin(16, 2);
  lcd.setCursor(0, 0);
  lcd.print(" Wireless Power ");
  lcd.setCursor(0, 1);
  lcd.print("Receiver For e-V");
  delay(2500);
  pinMode(7, OUTPUT);
  pinMode(A0, INPUT);
  pinMode(A1, INPUT);
  digitalWrite(7, LOW);

```

```

myservo.attach(8);
myservo.write(55);
delay(5000);
}
void loop()
{
  myservo.write(90);
  //
  // delay(100);
  sensors.requestTemperatures();
  Celcius = sensors.getTempCByIndex(0);
  Temp = Celcius;
  battery = analogRead(A1);
  battery_voltage = battery * (5.0 / 1024) * ((R1 + R2) / R2);
  battery_volt = map(battery_voltage, 0, 12, 0, 100);
  Serial.print("battery_voltage = "); Serial.println(battery_voltage);
  Serial.print("Temperature = "); Serial.println(Temp);
  // delay(250);
  lcd.clear();
  lcd.setCursor(0, 0);
  lcd.print("Temp:");
  lcd.print(Temp);
  lcd.setCursor(0, 1);
  lcd.print("Bat Per:");
  lcd.print(battery_volt);
  lcd.print("%");
  // delay(1000);

```

```
if (Temp > 35 )  
{  
    digitalWrite(7, HIGH);  
    delay(200);  
}  
else  
{  
    digitalWrite(7, LOW);  
    delay(200);  
}  
}
```

PUBLICATION

Journal Name - semiconductor optoelectronics

ISSN - 1001-5868

Journal publication website link - <https://www.bdtgd.cn/>

Indexing URL - <https://www.scopus.com/sourceid/13218#tabs=2>

Coverage - "Multidisciplinary (Electrical and Electronic Engineering)"

Name of the Publisher - Chongqing Guangdian Jishu Yanjiusuo

Transstellar Journal Publications and Research Consultancy Private Limited -
<http://www.tjprc.org/>