Industrial Engineering Journal
ISSN: 0970-2555
Volume : 53, Issue 6, No.3, June : 2024

SOLAR WIRELESS ELECTRIC VEHICLE CHARGING SYSTEM

Amanda Murali, Mar Athanasius College of Engineering Kothamangalam, Kerala, India
Jishnu Soman, Mar Athanasius College of Engineering Kothamangalam, Kerala, India
Nevil Siby, Mar Athanasius College of Engineering Kothamangalam, Kerala, India
Prof. Dr. Jisha Kuruvilla P, Associate Professor, Dept. Of EEE Mar Athanasius College of Engineering Kothamangalam, Kerala, India
Prof. Siny Paul, Professor, Dept. Of EEE Mar Athanasius College of Engineering Kothamangalam, Kerala, India

Abstract
Electric Vehicle addition to helping the environment, have proven useful in cutting down on transportation costs by substituting expensive fuel with much more affordable power. EV's conventionally follows plug in charging, takes up a lot time and charging stations may not be readily available. Wireless charging system was designed as a solution to this. Solar Wireless Electric Vehicle Charging System uses the induction charging for the EV's. The energy required for the power transfer is attained from the solar panel which is harvested to a battery with MPPT. The system provides the need effective charging method that takes up less time than any other method. In induction type charging the transmitter coil are place on the charging platform and receiver coil under the vehicle. Solar panel, solar panel, battery, inverters, copper coils, AC to DC converter, atmega 10 controller, and LCD display are used to employ this system. The system enables the EV's from pulling over for charging. So, the technology proves the viability of a road-integrated, wireless charging system for EVs.

Keywords:
wireless systems, electric vehicle, wireless charging, solar energy, wireless power transfer

Introduction

In the relentless pursuit of technological progress, the advent of wireless charging systems has ushered in a new era of convenience and efficiency. Gone are the days of cumbersome cords and physical connectors; instead, the ability to transmit power seamlessly through the air has become a reality. Wireless charging operates on the principles of electromagnetic induction or resonance, allowing devices to draw power from charging stations without any direct physical contact. This transformative technology has not only liberated users from the constraints of traditional charging methods but has also paved the way for a clutter-free, user-friendly experience across a spectrum of electronic devices. As we embark on this exploration of wireless charging systems, we delve into the intricate mechanics, current applications, and the promising future of a world where the power to recharge is truly at our fingertips. The integration of solar technology into electric vehicles (EVs) through wireless charging systems represents a groundbreaking step towards sustainable and efficient transportation. This innovative approach capitalizes on harnessing the sun's energy to power electric vehicles without the constraints of physical connectors. Solar panels, strategically integrated into the design of these EVs, capture sunlight and convert it into electricity, providing a continuous source of renewable energy. The wireless charging system complements this solar capability, enabling seamless energy transfer between the charging infrastructure and the EV without the need for traditional charging cables. This holistic approach not only addresses concerns about limited EV range but also aligns with the global shift towards eco-friendly mobility solutions. As the automotive industry increasingly embraces solar wireless charging systems for EVs, the potential to reduce dependence on non-renewable energy sources and minimize the environmental impact of transportation becomes a tangible reality, promising a cleaner and more sustainable future for our roads.

In recent years, the global community has witnessed a paradigm shift towards sustainable practices, with an increased focus on mitigating climate change and reducing our carbon footprint. One of the key areas under scrutiny is transportation, a sector traditionally reliant on fossil fuels. As the world grapples with the environmental consequences of conventional vehicles, innovative solutions have emerged to address these challenges. Among these solutions, the integration of solar technology with wireless electric vehicle (EV) charging systems stands out as a promising avenue for sustainable and eco-friendly transportation. Electric vehicles have gained significant traction in the automotive industry, promising a cleaner and more efficient alternative to traditional combustion engine vehicles. However, the adoption of electric vehicles has faced challenges, including limited range, infrastructure concerns, and dependence on non-renewable energy sources for charging. Recognizing these obstacles, researchers and engineers have tirelessly worked to develop cutting-edge technologies that overcome these limitations, leading to the birth of solar wireless electric vehicle charging systems.

At the intersection of solar power and wireless charging technology lies a transformative concept: the ability to harness the sun's energy to charge electric vehicles without the need for physical connections. This innovation not only addresses range anxiety associated with electric vehicles but also contributes to a more sustainable and resilient energy infrastructure. As we delve into the intricacies of solar wireless electric vehicle charging systems, it becomes evident that this technology has the potential to redefine the future of transportation and usher in an era of cleaner and more efficient mobility. Solar wireless electric vehicle charging systems operate on a simple yet ingenious principle – capturing sunlight through photovoltaic panels and converting it into electrical energy to charge electric vehicles. These systems typically consist of solar panels integrated into charging stations, coupled with wireless charging technology that enables energy transfer without physical cables. The seamless integration of these components results in a user-friendly and environmentally conscious solution for powering electric vehicles.

A closer examination of solar wireless charging systems reveals several key components working in harmony. Solar panels, typically installed on canopies or as standalone structures, capture sunlight and convert it into direct current (DC) electricity. This DC electricity is then fed into an inverter, converting it into alternating current (AC) suitable for charging electric vehicles. The wireless charging technology employs resonant inductive coupling or other wireless power transfer methods, allowing for efficient energy transfer between the charging station and the vehicle. The advantages of solar wireless electric vehicle charging systems are multifaceted. They not only offer a renewable and clean energy source but also provide flexibility in terms of installation locations, making them adaptable to various environments. However, challenges such as intermittency of sunlight, initial infrastructure costs, and technological complexities must be addressed for widespread adoption. As research and development progress, these challenges are gradually being mitigated, paving the way for a more sustainable and accessible future for electric mobility.

The deployment of solar wireless electric vehicle charging systems carries significant environmental implications. By reducing dependence on non-renewable energy sources, these systems contribute to a decrease in greenhouse gas emissions and air pollution. Furthermore, the economic benefits are noteworthy, as the reduced reliance on conventional energy grids can lead to lower operating costs and increased energy independence for both individuals and municipalities. Continued advancements in solar technology, energy storage, and wireless charging efficiency are pivotal for the widespread adoption of solar wireless electric vehicle charging systems. Ongoing research explores novel materials, improved energy conversion efficiencies, and enhanced wireless charging protocols. These endeavors aim to make the technology more efficient, affordable, and seamlessly integrated into existing urban infrastructures. As we stand on the cusp of a new era in transportation, where sustainability and innovation intersect, solar wireless electric vehicle charging systems emerge as a beacon of promise. The integration of solar power with wireless charging not only addresses the environmental concerns associated with traditional transportation but also contributes to the development of a resilient and decentralized energy infrastructure. This exploration will delve deeper into the technical intricacies, current applications, and potential future developments in this groundbreaking field, shedding light on the transformative potential of solar wireless electric vehicle charging systems.

Literature

Numerous studies have investigated the use of wireless and sensor systems in surveillance and security. Research by , Ahmed A. Shaier et al. (2018) paper discusses the potential of inductive power transfer technology in the electric vehicle charging process. The paper covers different types of compensation networks, power converters, and control techniques related to this technology. It also explains the challenges regarding the technology and opportunities that can tackle these challenges. Mainly three visions are there for implementing wireless EV charging technology, which includes static or stationary charging, in-motion, or dynamic charging, and quasi-dynamic or opportunistic charging. Xiaofeng Wu et.al proposes a lightweight secure management scheme for an energy-harvesting dynamic wireless charging system. The system aims to provide charging services for electric vehicles through wireless electromagnetic induction technology and convert natural energy into electricity. The scheme can effective authentication, secure communication, privacy protection, and reliable payment. Additionally, the paper divides the system to three different working states to ensure safe operation even in unfavourable weather conditions.

A research survey on the system by Young Jae Jang study and operation of wireless charging electric vehicles that look into the state-of-the-art operations and systems-related studies of wireless charging electric vehicles. The survey focuses on dynamic and quasi-dynamic types of wireless charging and the research on operations and systems issues prompted by wireless charging EVs. Consists of three parts, provide an orienting review of terminology specific to wireless charging EVs, research on the operations and systems issues prompted by wireless charging EVs, and propose future research aspects. Arman Fathollahi et.al article describes the optimal siting and sizing of wireless EV charging infrastructures considering traffic networks and power distribution systems. It discusses the challenges of limited driving range, long charging downtime, lack of charging stations, and high battery costs associated with the widespread deployment of electric vehicles and how dynamic wireless charging technology can overcome some of these problems. The article proposes a long-term stochastic scenario-based mathematical model for allocating and sizing DWC infrastructures that considers EV location-routing, power distribution system losses, and transportation network traffic, in the form of a Mixed Integer Non-Linear Programming (MINLP) model.

System Description

There are two types of charging method, wired charging method and wireless charging method. Wired charging, has several problems related to power loss during transmission. Hence, a static mode which can also be advanced to dynamic wireless charging. The Solar Energy is used to charge the battery(for storage purposes and later usage). The power generated is transmitted to the transmitting coil. The receiver coil is inductively charged and the power is obtained on the secondary side. Time and battery lifespan can be saved when compared with wired charging. It promotes the usage of EV’s and renewable energy

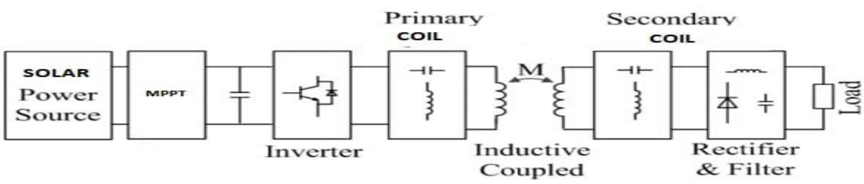

Fig 1: Power conversion architecture of WPT system

Industrial Engineering Journal
ISSN: 0970-2555
Volume : 53, Issue 6, No.3, June : 2024

Solar Charge Controller

A solar charge controller is a critical component in photovoltaic (PV) systems designed to regulate and manage the charging of batteries with solar panels. As solar panels generate direct current (DC) electricity from sunlight, the solar charge controller ensures optimal charging by preventing overcharging and deep discharge of batteries, thereby prolonging their life. This device acts as an intermediary between the solar panels and the batteries, controlling the voltage and current flowing from the panels to the batteries. Mainly there are three types of battery:

1] Simple on-off Controller
2] Pulse Width Modulation Controller
3] Maximum Power Point Tracking Controller

PWM controllers adjust the charging voltage to the battery as needed, while MPPT controllers go a step further by dynamically optimizing the power output of the solar panels to maximize efficiency. Solar charge controllers play a crucial role in off-grid solar systems for applications such as solar lighting, remote monitoring systems, and standalone power systems by ensuring reliable and efficient energy storage.

Solar PV Panel

Solar Photovoltaic (PV) panels are devices designed to convert sunlight directly into electricity through the photovoltaic effect. Comprising numerous interconnected solar cells made of semiconductor materials like silicon, these panels capture photons from sunlight, causing the release of electrons and generating an electric current. The electrical energy produced by solar PV panels is direct current (DC), which can be used to power devices directly or converted into alternating current (AC) for household and industrial applications through inverters. Solar PV technology has witnessed significant advancements in recent years, resulting in increased efficiency, reduced costs, and a wider range of applications. With a focus on sustainability and renewable energy, solar PV panels have become a key player in the global transition toward cleaner and more environmentally friendly power sources, contributing to the growth of solar energy as a vital component of the overall energy mix.

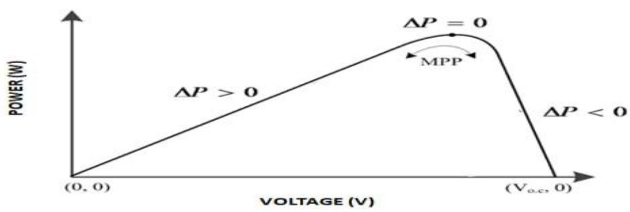

Fig 2: Solar PV Graph

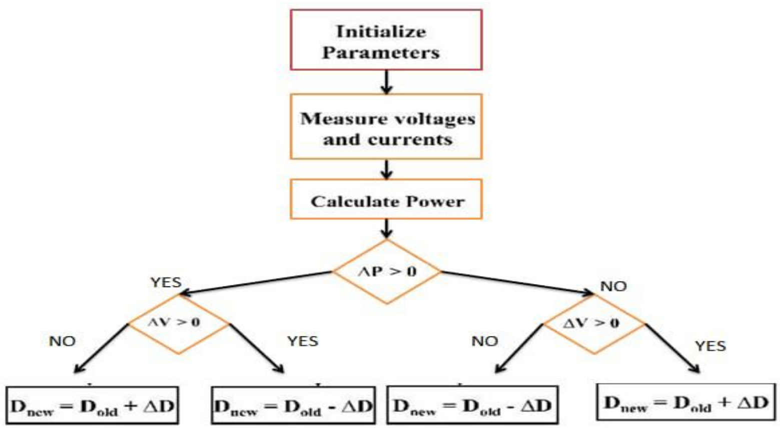

Fig .3: MPPT Algorithm

Industrial Engineering Journal
ISSN: 0970-2555
Volume : 53, Issue 6, No.3, June : 2024

Wireless Power Transfer

Wireless Power Transfer (WPT) is a technology that enables the transmission of electrical energy without the need for physical conductors. Instead of traditional wired connections, WPT relies on electromagnetic fields to transfer power from a source to a receiver. There are two main methods of wireless power transfer: near-field and far-field. Near-field WPT, also known as magnetic resonance or inductive coupling, is suitable for short-range applications where the distance between the transmitter and receiver is relatively small. The major wireless power transfer methods are:

1. Inductive WPT
2. Capacitive WPT
3. Magnetic gear WPT
4. Resonant WPT

1. Inductive WPT (IWPT):

Inductive Wireless Power Transfer (IWPT) is a technology that harnesses the principle of magnetic induction to transmit electrical energy wirelessly between a source and a device. In an inductive WPT system, two coils, a transmitter coil, and a receiver coil, play a central role. The transmitter coil, connected to a power source, produces a varying magnetic field when an alternating current passes through it. This magnetic field induces a voltage in the receiver coil located on the device side, utilizing electromagnetic induction. Subsequently, the induced voltage is converted back into electrical power to charge batteries or power electronic devices. Inductive WPT is commonly employed in applications with relatively short distances between the transmitter and receiver, making it well-suited for wireless charging pads, electric toothbrushes, and various consumer electronics. Efficient power transfer in inductive WPT systems is influenced by factors such as coil alignment, resonance tuning, and the separation distance between the coils.

2. Capacitive WPT

Capacitive Wireless Power Transfer (CWPT) is an innovative technology that enables the wireless transmission of electrical energy through the use of electric fields rather than magnetic fields, as seen in inductive WPT. In capacitive WPT systems, two electrodes, one on the transmitter side and the other on the receiver side, create an electric field between them. This electric field induces an electric potential in the receiver, allowing for the transfer of electrical power. Unlike inductive WPT, capacitive WPT is influenced by factors such as the dielectric properties of the materials between the electrodes and the separation distance. While capacitive WPT offers the advantage of potentially longer-range power transfer and reduced electromagnetic interference compared to inductive methods, it faces challenges related to efficiency, especially over larger distances.

3. Magnetic gear wireless power transfer

Magnetic gear wireless power transfer (MG-WPT) represents a novel approach to wireless energy transmission that leverages the principles of magnetic gearing for efficient power transfer over short to moderate distances. In this technology, magnetic gears, which consist of interacting rotors and stators with permanent magnets, are utilized to transfer power between the transmitter and receiver. The magnetic gears operate based on the magnetic interaction between the gear elements, avoiding the need for physical contact. This allows for a contactless and potentially more reliable method of wireless power transfer compared to traditional inductive or capacitive approaches. MG-WPT systems are being explored for various applications, including robotics, electric vehicles, and renewable energy systems. The technology shows promise in enhancing efficiency, reducing wear and tear, and improving the overall reliability of wireless power transfer, making it an area of active research and development within the field of wireless energy transmission.

4. Resonant inductive power transfer:

Resonant Inductive Power Transfer (RIPT) is an advanced form of wireless power transfer that optimizes the efficiency of energy transmission over short to moderate distances. At the core of this technology is the use of resonant circuits, typically comprised of coils with capacitors, to achieve a near-perfect match between the frequencies of the transmitter and receiver. By resonating at the same frequency, the system minimizes energy losses and enhances the power transfer efficiency. RIPT operates on the principles of electromagnetic induction, where the transmitter coil generates a magnetic field, and the resonantly tuned receiver coil efficiently captures and converts this energy back into electrical power. This resonant coupling allows for greater flexibility in the positioning and alignment of the coils, mitigating issues associated with variations in distance and orientation. RIPT finds applications in various fields, including electric vehicle charging, consumer electronics, and medical devices, where high efficiency and flexibility in wireless power transmission are crucial considerations.

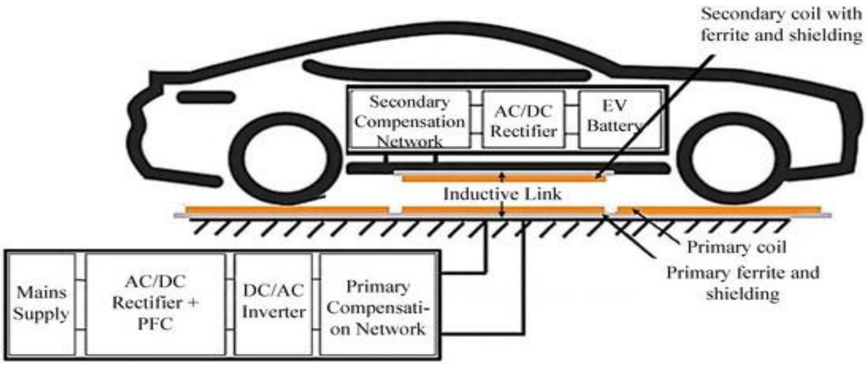

Fig 4: Generic presentation of Wireless charging system for EV.

COMPENSATION NETWORK

A compensation network, in the context of electrical engineering, is a system or set of components designed to correct or enhance the performance of an electrical circuit. The primary goal of a compensation network is to adjust the frequency response, stability, or other characteristics of the circuit to meet specific design requirements. This may involve adding passive components such as resistors, capacitors, or inductors to modify the circuit's impedance or phase characteristics. Compensation networks are frequently employed in electronic systems, especially in feedback control systems, amplifiers, and filters, to achieve desired performance parameters and ensure stability. The careful design and implementation of compensation networks are essential for achieving optimal performance in various electrical and electronic applications. Engineers use compensation networks to fine-tune circuit behavior, mitigate unwanted effects, and ensure the system meets the desired specifications under different operating conditions. There are 4 basic compensation topologies, which are series-series (SS), series-parallel (SP), parallel-parallel (PP), and parallel-series(PS). The compensation technique implemented in this project is SS topology.

1. SS Topology

Series-series (SS) compensation topology is a configuration commonly employed in electronic circuits, particularly in the realms of power electronics and filter design. In this arrangement, components are interconnected in series on both the input and output sides of the circuit. This topology is often utilized to manipulate the impedance characteristics of a system or control its overall response. In power systems, for instance, series-series compensation involves incorporating series-connected components, such as capacitors or inductors, to modify the impedance of a transmission line. This strategic use of series configuration enables engineers to enhance the stability and performance of the system. Whether applied to filter networks or power transmission, series-series compensation topology plays a crucial role in tailoring the electrical characteristics of circuits to meet specific design requirements and optimize overall functionality.

2. SP Topology

Series-Parallel compensation, represents a specific arrangement of components in electronic circuits, particularly in the field of power electronics. In this configuration, series and parallel elements are strategically combined to achieve desired performance characteristics. By incorporating both series and parallel-connected components, engineers can fine-tune the impedance and response of the system. The Series-Parallel compensation topology is often applied in power systems to enhance stability and control the flow of electrical energy. This approach allows for a versatile design, enabling engineers to balance various factors such as transient response, bandwidth, and stability. The SP compensation topology exemplifies the ingenuity in circuit design, offering a flexible solution for optimizing electronic systems across different applications, from voltage regulators to more complex power distribution networks.

3. PS Topology

Parallel-Series (PS) compensation topology is a specific configuration used in electronic circuits, particularly in applications related to power electronics. In this arrangement, components are strategically connected in parallel on one side of the circuit and in series on the other. This topology is often employed to tailor the impedance characteristics and control the behavior of the system. In power systems, for instance, Parallel-Series compensation involves the integration of both parallel and series-connected elements, such as capacitors or inductors, to influence the impedance of a circuit. This dualconfiguration approach allows engineers to optimize various parameters, including stability, transient response, and bandwidth. By skillfully combining parallel and series elements, the Parallel-Series compensation topology provides a versatile solution for designing circuits that meet specific requirements in diverse applications, ranging from power distribution systems to advanced electronic filters.

4. PP Topology

Parallel-Parallel (PP) compensation topology represents a specialized configuration within electronic circuits, prominently utilized in power electronics and related applications. In this arrangement, components are strategically interconnected in parallel on both the input and output sides of the circuit. This topology is deployed to manipulate impedance characteristics and control the overall response of the system. In power systems, for example, Parallel-Parallel compensation involves incorporating parallelconnected components such as capacitors or inductors to modify the impedance of a network. This approach allows engineers to fine-tune the electrical characteristics, enhance stability, and optimize performance. The Parallel-Parallel compensation topology showcases the adaptability of circuit design, providing an effective solution for a diverse array of applications, from power converters to intricate electronic systems, where tailoring impedance and controlling responses are paramount.

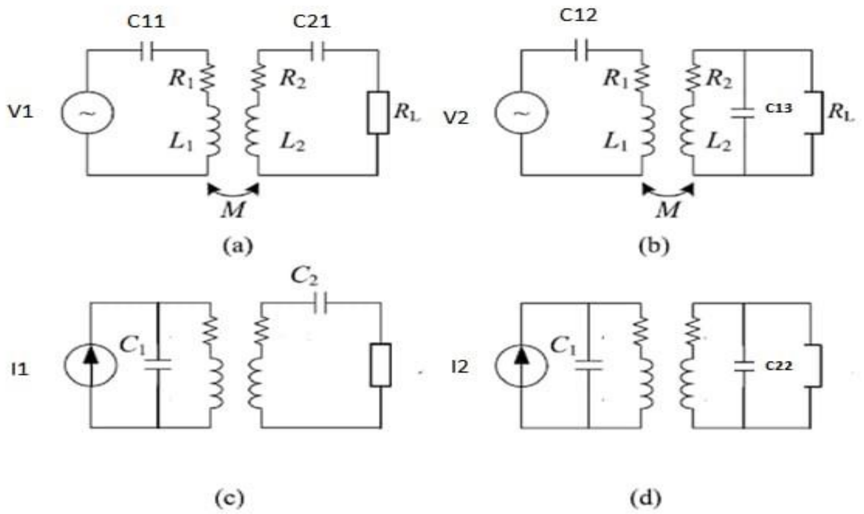

Fig 5: basic compensation topologies. (a) SS (b) SP (c) PS (d) PP

6. Power Electronics Converters for Wpt

Power electronics converters play a crucial role in Wireless Power Transfer (WPT) systems, facilitating the efficient transmission of electrical energy without the need for physical connections. In WPT, converters are employed to transform the electrical energy from the source into a form suitable for wireless transmission and then convert it back to the desired voltage or current at the receiver end. These converters typically include components such as inverters and rectifiers, enabling the conversion between AC and DC power as needed in the WPT process. Additionally, advanced control algorithms are often integrated into these converters to optimize efficiency, regulate power flow, and ensure safe and reliable wireless energy transfer. The design and performance of power electronics converters significantly impact the overall efficiency and effectiveness of WPT systems, making them a focal point of research and development in the field of wireless power transmission.

Considering all the charging method wireless charging is more convenient than the wired and plug-in. Inductive wireless power transfer is chosen for the power transfer as they are more influenced by factors and efficient. Battery is charged by solar energy. Maximum Power Point Tracking Controller is used to control the voltage and current that is to be stored in battery from the solar panel. MPPT act the bond between battery and solar panel. The system requires to convert ac to dc and vice versa. This is possible by power electronic converters mainly rectifiers and inverters. The system itself is divided to two system power supply system and the other wireless power transfer system.

Design of Circuits

1. Design for mppt

MPPT technology is used to reduce the wastage of excessive voltage by converting to current which in-turn increases the efficiency. The PCB for MPPT Charge Controller is designed using Arduino and electronic components. The Arduino is programmed to visualize all of the charging parameters of MPPT Solar Charging Controller on an d LCD screen. With the help of the code Solar Panel Voltage, Current, Power, Battery Voltage, Charger state, SOC, PWM duty cycle and status of the load are measured. The charge controller has these features that based on MPPT algorithm multiple LED indication for the state of charge cane be formed. A 20 4 LCD display for displaying voltages, current, power, load state, etc. Overvoltage / Lightning protection Short Circuit, Overload and Reverse Polarity protection is possible. The Charge controller has rated Voltage= 12V, maximum current = 5A, maximum load current =10A and an input voltage based on solar panel with Open circuit voltage from 12 to 25V.

2. Design for wpt circuit

The various equations for designing the various elements of the WPT circuit is given below in order to accomplish the power transfer from transmitter coil to the reciever coil. Let the desired output power be Po which is 100W, switching frequency to be 85kHz, For an output voltage of 48V and with supply voltage 12V, the value of load resistance can be calculated by

$$P_o = \frac{V_o^2}{P_o} \quad (4.1)$$

04Ω (4.2)

$$R_o = \frac{48 * 48}{100} = 23.$$

675Ω (4.3)

$$R_L = \frac{8 * V_o^2}{\pi^2 * P_o} = 18.$$

The RMS currents at primary and secondary sides can be found using

$$V_{rms} = \frac{2\sqrt{2}V_o}{\pi} = \frac{2\sqrt{2} * 48}{\pi} = 43.215V \quad (4.4)$$

$$I_{srms} = \frac{V_{rms}}{R_L} = 2.314A \quad (4.5)$$

$$I_{prms} = \frac{P_o}{V_{prms}} = \frac{100}{12} = 8.33A \quad (4.6)$$

The mutual inductance is given by

$$M = \frac{I_{srms} * R_L}{I_{prms} * \omega_o} = \frac{2.134 * 18.67}{8.33 * 2\pi * 85000} = 9.7 * 10^{-6} \quad (4.7)$$

The primary and secondary inductances can be found out using

$$L_s = Q_s \frac{R_L}{W_o} = 4 * \frac{18.675}{2\pi * 8500} = 1.39 * 10^{-6} H \quad (4.8)$$

$$R_s = \frac{1}{Q_c}\sqrt{1 - \frac{1}{4Q_s^2}} = \frac{1}{4}\sqrt{1 - \frac{1}{4 * 4^2}} = 0. \quad (4.9)$$

$$L_p = \frac{M^2}{L_s * K^2} = \frac{(9.7 * 10^{-6})^2}{1.398 * 10^{-4} * (0.25)^2} = 1.68 * 10^{-5} H \quad (4.10)$$

The value of compensating capacitors

$$C_p = \frac{1}{L_p * w_o^2} = \frac{1}{1.68 * 10^{-5} * (2\pi * 85000)^2} = 2.08 * 10^{-7} F \quad (4.11)$$

$$C_s = \frac{1}{L_s * W_o^2} = \frac{1}{8.75 * 10^{-6} * (2\pi * 85000)^2} = 2.5 * 10^{-8} F \quad (4.12)$$

DESIGN FOR RECTIFIER:

$$FilterCapacitor, C = \frac{I_o * R_L}{2 * f * V_{ripple}} = \frac{2.2 * 18.675}{2 * 85000 * 41.502} = 60\mu F \quad (4.13)$$

The values calculated from the above equation are given in the table below Load Resistance 10W

Table 1: WPT Circuit Parameters

PARAMETERS	VALUES
Supply voltage	12W
Primary Inductance	0.588μH
Secondary Inductance	0.69μH
Primary Capacitance	0.585μF
Secondary Capacitance	0.5μF
Mutual Inductance	1.29μH

3. COIL DESIGN

Circular – Circular coil is considered for wireless power transfer as it has the highest magnetic coupling when compared with other equally sized coil configurations. Circular coils are non-polarised or unipolar flux distribution kind. As a result of the symmetrical geometry of the coil the circular coil has the advantage of having a uniform flux distribution. This helps the coupling be uniform and helps the power transferred be similar in all direction. The uniform power transfer reduces the stress on the power electronic part of the secondary side of the system. The various coil parameters can be designed using the following equation:

$$d_{xo} = d_{xi} + 2[N * d_w + (N - 1) * \gamma] \quad (4.14)$$

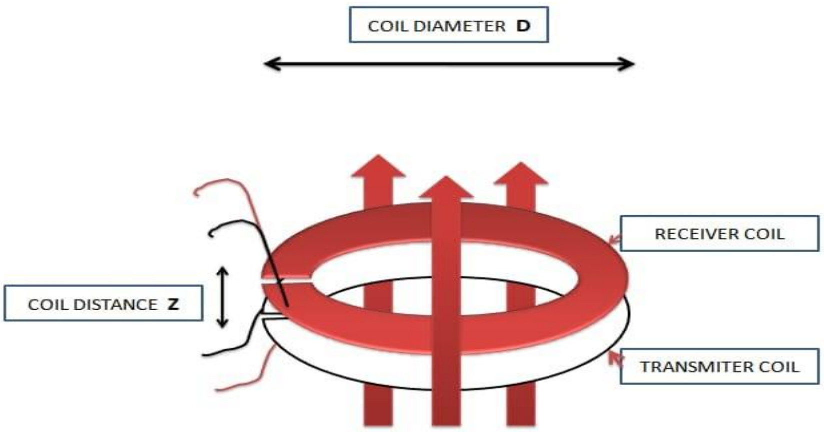

Fig 6: circular Coil Diagram

where, dxo is the outer diameter, dxi is the inner diameter, dw is the diameter of the coil, N is the number of turns and (gamma) is the spacing between each turn the coil parameters are designed for the values as given in the table

Table 2: Coil Parameters

Parameters	Value
Outer Diameter	12 cm
Inner Diameter	6 cm
Coil Gauge	20 swg
No. of Turns	8
Spacing Between Coils	0.5 mm
Inductance	33μF

Industrial Engineering Journal
ISSN: 0970-2555
Volume : 53, Issue 6, No.3, June : 2024

MPPT algorithms are instrumental in extracting the maximum available power from solar panels or other renewable energy sources. By continuously adjusting the operating point of the power source to match the varying environmental conditions, MPPT ensures optimal power conversion efficiency, thereby maximizing energy yield. WPT enables the wireless transmission of power, offering convenience and versatility in various applications such as electric vehicles, consumer electronics, and medical devices. By eliminating the need for physical connectors, WPT facilitates seamless power transfer over short to medium distances, offering new possibilities for device integration and mobility.

Hardware Implementation and Output:

The circuit diagram for the MPPT and WPT are designed. PCB design for the circuits is created and manufactured by JLCP PCB prototype manufacturer**.**

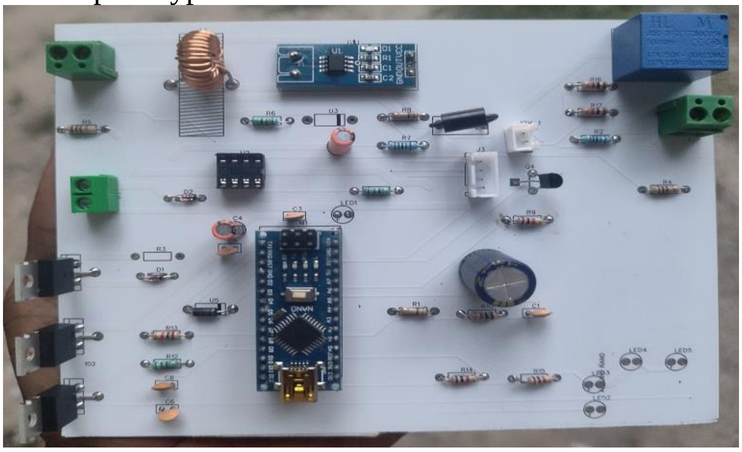

Fig 8: Hardware of MPPT

Fig 9: Hardware of WPT

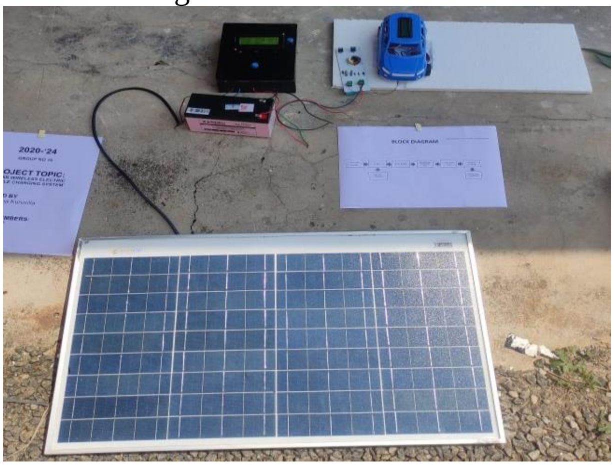

Fig 10: Hardware setup of Solar Wireless Electric Vehicle Charging System

The MPPT hardware is setup to the back box for convenience. The WPT hardware is implemented by placing the transmitter side induction coil above the platform and the receiver side under vehicle. From the solar panel, the generation of 12 V battery voltage is obtained by MPPT Circuit. The LCD display on the MPPT gives the solar voltage and current, battery voltage and battery percentage and load pulse modulation. for wireless power transfer the 12 V is supplied to the WPT circuit. The transmitter side is placed on a platform and receiver side under the vehicle. By the principle of electromagnetic induction power is transmitted wirelessly from transmitter coil to receiver.

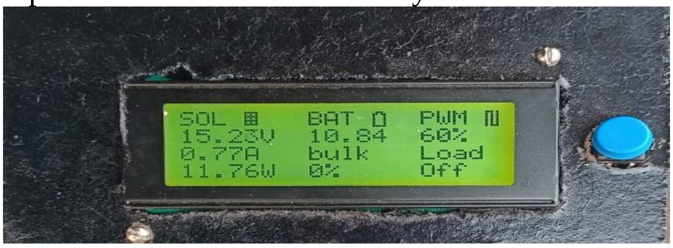

Fig 11: Output obtained at MPPT

Inverter output of high frequency voltage is supplied to primary side of coil. Output waveform as observed in DSO is given in figure 11. Primary voltage value (peak-peak) = 42V.

Fig 12: Transmitter Side Output

Output voltage is induced through magnetic induction and output voltage is obtained as given in figure 12.

Secondary voltage value (peak-peak) = 28V.

Fig 13. Receiver Side Output

When the receiver coil on the car encounters the transmitter coil on the platform the vehicle gets charged which is displayed as battery charging on the LCD display screen. The battery charging indicates that the vehicle battery is being charged.

Conclusion:

The Solar Wireless Electric Vehicle Charging System represents a paradigm shift in the sustainable evolution of electric transportation. Harnessing the power of the sun, this innovative system seamlessly integrates solar energy harvesting with wireless induction charging technology. The wireless induction charging is effective and efficient than any other wireless methods in charging. By using solar panels in harvesting sustainability and clean energy from sun the system reduces reliance on traditional grid-based electricity. The MPPT used provides the ideal voltage for charging the EV which is stored in the battery as DC. The DC is converted to AC for wireless transferring of power. As the receiver coil under EV is aligned. The integration of solar panels enhances the energy independence of the EV charging infrastructure. This not only reduces the environmental impact but also contributes to the resilience of the charging network, in remote or off-grid locations. As of now Solar Wireless Charging of the EV is done by halting the vehicle over the transmitter induction coil and transmitting energy electromagnetically. Considering the future aspects constructing a separate lane of transmission coils that are mounted on the road eliminates the need to halt vehicle for charging. When the vehicle needs to be charged, it can move to the charging lane enabling dynamic charging. This feature is the next step on the field of electric transportation.

VII. References:

[1] Ahmed A. S. Mohamed, Ahmed A. Shaier, Hamid Metwally, "An Overview of Inductive Power Transfer Technology for Static and Dynamic EV Battery Charging," Transportation Electrification: Breakthroughs in Electrified Vehicles, Aircraft, Rolling Stock, and Watercraft, IEEE, 2023, pp.73-104.
[2] M. R. R. Razu et al., "Wireless Charging of Electric Vehicle While Driving,"IEEE Access, vol. 9, pp. 157973-157983, 2021.
[3] Young Jae Jang, "Survey of the operation and system study on wireless charging electric vehicle systems," Transportation Research Part C: Emerging Technologies, Volume 95, 2018, Pages 844-866,
[4] A. Fathollahi, S. Y. Derakhshandeh, A. Ghiasian and M. A. S. Masoum, "Optimal Siting and Sizing of Wireless EV Charging Infrastructures Considering Traffic Network and Power Distribution System," IEEE Access, vol. 10, pp. 117105117117, 2022.
[5] X. Wu, G. Li and J. Zhou, "A Lightweight Secure Management Scheme for Energy Harvesting Dynamic Wireless Charging System," IEEE Access, vol. 8, pp. 224729-224740, 2020,
[6] Fisher, T., Farley, K., Gao, Y., Bai, H., Tse, "Electric vehicle wireless charging technology: A state-of-the-art review of magnetic coupling systems," Wireless Power Transfer,2014, 87-96.
[7] Patil, Dipalee S., et al, "Wireless Charging of Electric Vehicle Using Solar Roadways Vol no. 2," July 2020, p. 320.
[8] Yash Baviskar , Madhavi Patil , Sandeep Ushkewar, "Efficient Wireless Charging for Electric Vehicle," International Journal of Engineering Reasearch and Technology (IJERT), Volume 09, Issue 10, October 2020.
[9] O. N. Nezamuddin, C. L. Nicholas and E. C. d. Santos, "The Problem of Electric Vehicle Charging: State-of-the-Art and an Innovative Solution," IEEE Transactions on Intelligent Transportation Systems, vol. 23, no. 5, pp. 4663-4673, May 2022.
[10] H. Wang, U. Pratik, A. Jovicic, N. Hasan and Z. Pantic, "Dynamic Wireless Charging of Medium Power and Speed Electric Vehicles," IEEE Transactions on Vehicular Technology, vol. 70, no. 12, pp. 12552-12566, Dec. 2021.