SOLAR WIRELESS ELECTRIC VEHICLE CHARGING SYSTEM

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ABSTRACT:

This research paper introduces a groundbreaking Solar-powered wireless charging solution for electric vehicles, responding to the global shift toward sustainable transportation. The project employs solar panels to efficiently capture and store energy, utilizing wireless energy transfer technology for eco-friendly EV charging. Key objectives include harnessing solar energy, wireless power transmission, DC charging, and lowering our dependency on traditional grid electricity. The project's weight stems from its potential to advance sustainable transportation, reduce emissions, and drive innovation in wireless power transfer and solar technology. It serves as a proof-of-concept, demonstrating feasibility, inspiring investment, and promoting awareness of renewable energy's role in EV charging for a greener future.

Keywords : Future mobility trends, Innovation in charging technology, Sustainable transportation, Wireless energy transfer

1. INTRODUTION:

Global demand for electric cars (EVs) has led to a significant upheaval in the auto sector. The shift towards cleaner and more sustainable modes of transport is clear, owing to increased environmental concerns, government incentives, and technological improvements. This paradigm change has not only witnessed major automakers expanding their electric vehicle offerings but has also underscored the critical need for efficient and sustainable charging solutions.

Traditional EV chargers, reliant on grid electricity, pose challenges in aligning with sustainability goals. In response to this, a novel project has been conceived, aiming to explore an alternative charging approach that harnesses solar power and wireless energy transfer technology.

The proposed project involves the utilization of solar panels to capture energy from sunlight, subsequently converting and storing it in a battery. The stored DC power is then transformed into AC power using an inverter, which is transmitted wirelessly to an EV through a transmitting coil. This Wireless energy transmission removes the requirement for physical connections during charging. The ultimate goal is to employ a rectifier for the purpose of converting obtained power from AC back to DC, facilitating the charging of the EV's battery. This innovative approach not only reduces dependence on traditional grid electricity but also leverages renewable energy sources, contributing significantly to the sustainability and eco-friendliness of electric vehicle usage.

2. PROBLEM STATEMENT:

The increasing global adoption of electric vehicles (EVs) signifies a crucial shift towards sustainable transportation. The increased use of electric vehicles has highlighted a significant issue. There is a need for effective and eco-friendly charging techniques. Traditional EV chargers, often reliant on grid electricity, face challenges in terms of aligning with sustainability objectives. Moreover, the existing infrastructure limits the charging capabilities, especially in remote areas without access to traditional power grids. Our study intends to overcome these difficulties by developing a solar-powered wireless EV charging system, introducing a novel, an strategy for charging EVs while driving.

This initiative addresses the restrictions of current charging techniques. by exploring an alternative system. Through the utilization of solar panels, energy captured from sunlight is stored in a battery, and a wireless energy transfer system facilitates on-the-go charging. This solution not only reduces the dependence on traditional grid electricity but also opens avenues for off-grid charging in remote locations. By allowing EVs to charge while in motion, our project aims to revolutionize the charging infrastructure, enhancing the practicality and accessibility of electric vehicles in diverse geographical and infrastructural conditions.

3. OBJECTIVE:

This project envisions a revolutionary change in EV charging infrastructure. Our objective is to develop a solar-powered wireless charging system that removes the necessity for conventional cables and enables ongoing charging as electric vehicles transportation. The system will effectively harness solar energy via strategically placed panels. A wireless power transfer mechanism will then send this energy to the vehicle. Onboard receivers will convert the transferred AC current to DC, allowing for seamless integration with the EV's battery. This project promotes environmental responsibility by embracing renewable energy and reducing reliance on traditional grid power sources. The development process will result in a functional prototype that will be rigorously tested for technical efficiency, safety considerations, and overall environmental impact. Finally, this project aspires to be a pioneer in developing sustainable and universally accessible EV charging solutions, particularly in areas with limited access to conventional charging infrastructure.

4. SOLUTION:

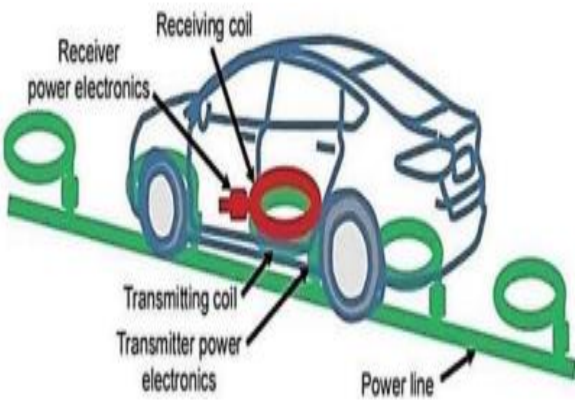

Fig 1 : Solar based wireless EV charging system

Furthermore, the system's ability to efficiently convert transmitted AC power into DC, suitable for charging EV batteries for, is consistent with current vehicle power storage systems. This compatibility increases the wireless charging solution's versatility and applicability within the existing EV infrastructure. By reducing reliance on conventional grid electricity, the system not only promotes environmental sustainability but also allows off-grid charging. This is particularly beneficial in isolated places with restricted access to conventional power sources.
The ongoing development of a proof-of-concept prototype seeks to demonstrate the practicality and efficacy of this novel solution. Key objectives include addressing safety concerns about wireless charging, improving energy efficiency to reduce losses during power transfer, and assessing the potential environmental impact of widespread adoption. The project aims to install confidence in the wireless charging system's reliability and effectiveness through rigorous testing and performance validation under a variety of conditions.
In addition, a preliminary cost analysis will be conducted to determine the economic feasibility of

scaling up the technology for widespread implementation. Decision-makers and stakeholders in the EV industry must understand the financial implications and potential cost savings when compared to conventional charging methods. This analysis will shed light on the long-term viability and affordability of deploying wireless charging solutions on a larger scale, ultimately helping to advance sustainable transportation infrastructure.

5. WORKING:

A. Transmitter – Receiver Circuit:

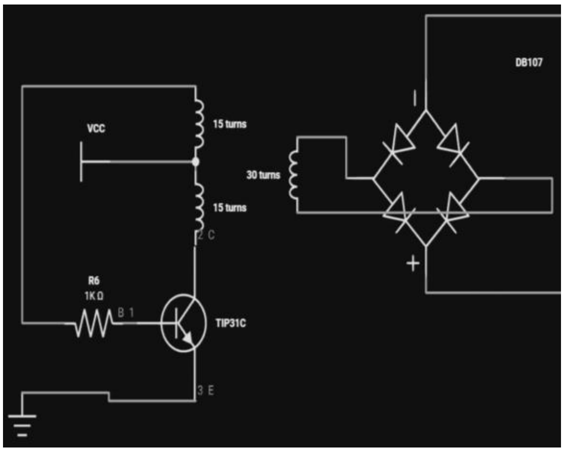

Fig 2 : Transmitter – Receiver Circuit

i. Solar Charging System:

The process begins with the installation of solar panels, which capture solar energy and despite convert it into electricity. This energy is used to charge a 12V battery, ensuring a constant power supply to the transmitter circuit variations in solar intensity.

ii. Power Conversion:

The transmitter circuit's input is the battery's 12V DC output. To produce an oscillating magnetic field, inductive power transmission requires alternative current (AC). The DC power from the battery is then sent into the transmitter circuit, specifically through the TIP31C transistor, which rapidly turns the current on and off to simulate an alternating current.

iii. Induction Coil:

The series-connected transmitter coils, made of 26 AWG copper wire with a 7 cm diameter, are the conduits through which the alternating current generated by the TIP31C transistor travels. Because of the coils' inductance, the current creates an alternating magnetic field around them as it passes through them.

iv. Resonance and Power Transfer:

The vehicle's receiver and transmitter coils were carefully designed to resonate at a common frequencies. This resonance allows for seamless power exchange among transmitter and receiver throughout an atmospheric distance. Electromagnetic induction causes a current to flow through a vehicle's receiver coil when it comes into contact with the transmitter's magnetic field.

v. TIP31C NPN Transistor:

The TIP31C transistor is critical to the transmitter circuit because it quickly switches the current from the battery through the transmitter coils at a frequency defined by the circuit design. This rapid switching action generates the alternating magnetic field required for efficient power transmission.

vi. Magnetic Field Oscillation:

As the TIP31C transistor toggles, electrical energy from the battery is converted to magnetic energy near the coils. This magnetic field oscillates at the same frequency as the current, influenced by the coils' physical properties.

vii. Energy Transfer Efficiency:

The power transmission effectiveness is affected by alignment, the gap among both the transmitter and receiver coils, and frequency matching. When the resonant frequencies of the transmitter and receiver coils coincide, maximum energy transfer occurs due to resonance, allowing for power transfer over longer distances with the minimal losses.

viii. Safety and Regulation

To ensure safe operation, the transmitter circuit includes features that regulate current and voltage, protecting against potential hazards like short circuits or thermal overload. The circuit's components, such as resistors, diodes, and capacitors, control energy flow, filter out noise, and stabilise oscillations.

B. Buck Boost Chopper Circuit:

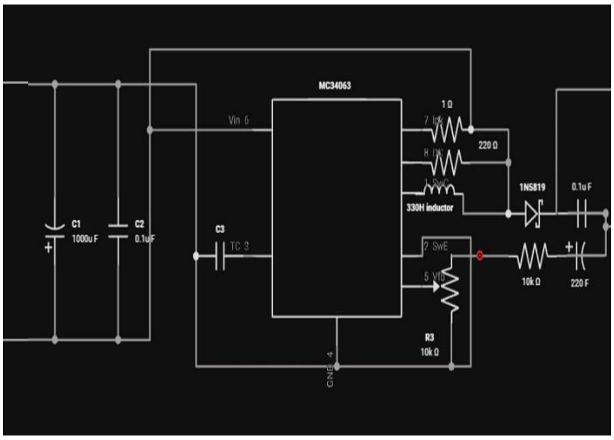

Fig 3: Buck Boost Circuit

The operation associated with the Buck-Boost network, which uses the MC34063 integrated circuit (IC), is critical in adjusting the voltage precisely to meet the specifications for charging the vehicle's battery using the wireless charging system. After obtaining rectified DC from the DB107 bridge rectifier, the MC34063 constantly steps up or down the voltage as needed to ensure optimal charging performance. The MC34063 IC is made up of a complex network made up of internal components, including a switch (transistor), oscillator, comparator, reference voltage unit, and control circuitry. These elements work together to modulate voltage using a technique known as pulse-width modulation (PWM). The internal oscillator controls the frequency of operation, which is critical for calibrating the size of external components such as inductors and capacitors.

The duty cycle of the signal in PWM precisely regulates the duration of the switch's on and off states, thereby intricately controlling the output voltage. During the switch's active phase, energy is efficiently stored in an external inductor. As a result, during the inactive phase, this stored energy is smoothly transferred to the load, which in this case is the vehicle battery. This rhythmic cycle repeats at the frequency of the oscillator, allowing the circuit to dynamically adjust the voltage to exactly the desired level.

The circuit also includes a diode to ensure that energy flows in the most productive direction. This diode is critical in refocusing the energy stored in the inductor during the switch's inactive phase to the output, avoiding waste by preventing it from looping back to the IC.

In fundamental terms, the Buck-Boost circuit's proficient energy storage and transfer mechanism, powered by the MC34063 IC, provides a highly efficient method of stepping up or down voltage. This adaptability ensures seamless compatibility with the vehicle's battery charging requirements, improving the overall performance of the wireless charging system.

C. Voltage Regulator Circuit:

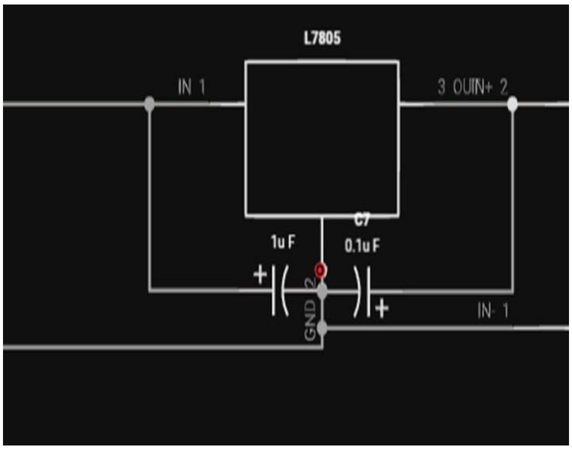

Fig 4: Volage Regulator circuit

The LM7805 voltage regulator is critical in ensuring a steady controlled voltage supply within the wireless charging system. Following the voltage adjustments performed by the MC34063, the LM7805 takes over to ensure that the voltage output remains constant at 5V. This constant voltage level is essential for the proper operation of subsequent stages and components, protecting them from voltage fluctuations and ensuring safe operation.

Furthermore, the LM7805 includes several protective features that improve the charging system's reliability and safety. Its built-in thermal overload protection functions as a failsafe mechanism, automatically shutting down the regulator if excessive internal temperatures are detected, preventing damage caused by overheating.

In addition, the regulator includes short-circuit protection, which responds quickly to wiring defects or short circuits, preventing possible system damage. To improve efficiency and security, filtering and bypass capacitors are usually employed at the LM7805's input and output terminals. These capacitors effectively minimise noise from the power supply and suppress transient voltage spikes, resulting in a smooth and consistent voltage output from the regulator.

D. Charging Module:

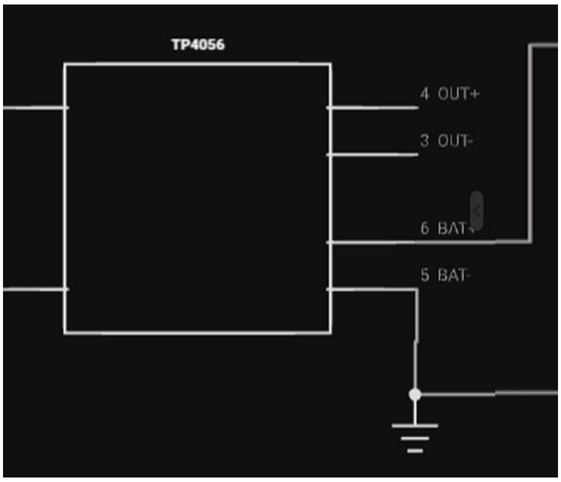

Fig 5: Charging Module circuit

The TP4056 charging module is a key component of the wireless vehicle charging system, providing a complete solution for charging single-cell lithium-ion batteries. Its small size and versatile features make it ideal for portable applications, and its specifications perfectly match those of the system.

At the heart of the TP4056 module is a sophisticated charging algorithm that uses a constant-current/constant-voltage scheme. This algorithm ensures efficient and safe battery charging by continually altering the charging parameters in response to the battery's state. When the battery is low on charge, the module first delivers a constant electrical current to quickly charge it. As the battery approaches its peak voltage, the TP4056 smoothly transitions to constant voltage mode, preventing overcharging and extending the battery's life.

When the battery reaches full capacity and the charge current drops to a predetermined level, the module automatically stops charging, eliminating the possibility of overcharging. Furthermore, if the battery voltage falls below a predetermined threshold, the module automatically starts charging, ensuring that the battery is adequately charged for operation.

E. Charging Display Circuit

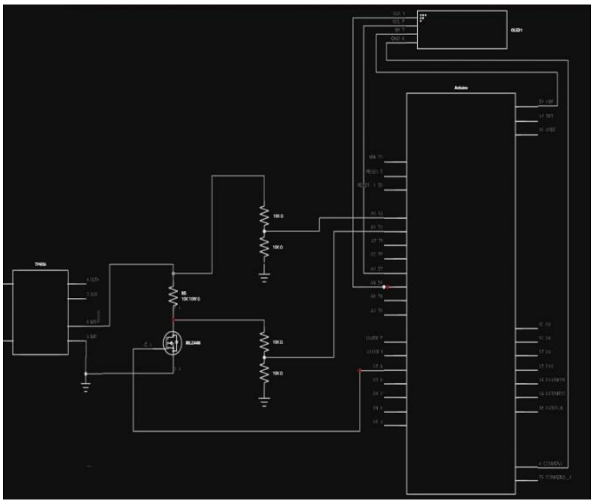

Fig 6: Charging Display circuit

The Arduino-based battery monitoring and charging system circuit is a critical component of the overall wireless vehicle charging system, offering vital features for tracking and handling the charging process in real time. The Arduino microcontroller is at the centre of this circuit, where it manages time intervals, calculates current and power, and reads analogue voltages. The Arduino regulates the overall flow of the charging procedure and drives the LCD display to provide information to the user.

The MOSFET, which functions as an electronic switch and is controlled by the Arduino, is critical to the circuit's functionality. This MOSFET provides programmed control over the charging process, permitting the Arduino to start or stop charging as needed.

Analogue pins A0 and A1 are used to measure voltage and current, both of which are critical for determining the state of charge of the battery. The load resistor, defined by its resistance value, is critical in current measurement because it ensures that the current flowing through the circuit is correctly determined. The LiquidCrystal I2C LCD display is the interface through which the user receives real-time data such as voltage, current, power, and capacity. Current, power, and capacity are calculated and updated in real time using

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Arduino code, giving users helpful insights into the charging process.

6.BLOCK DIAGRAM:

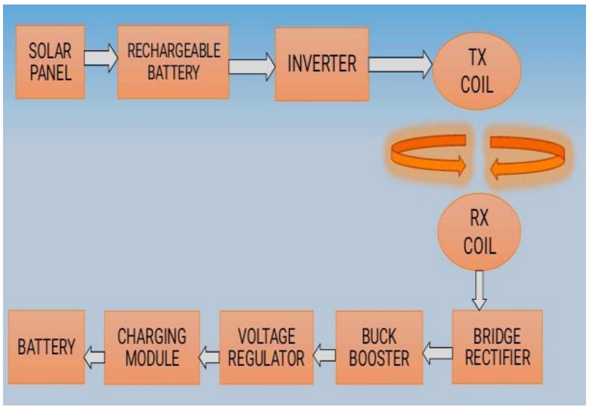

Fig 7: Block Diagram

7. CIRCUIT IMPLEMENTATION

i. Transmitter Circuit

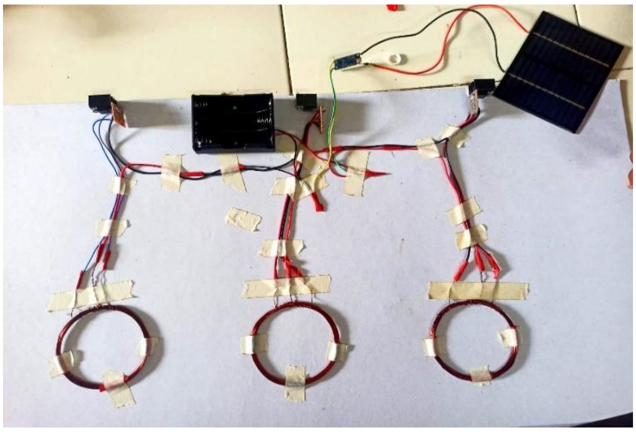

Fig 8: Transmitter Circuit

ii. Receiver Circuit

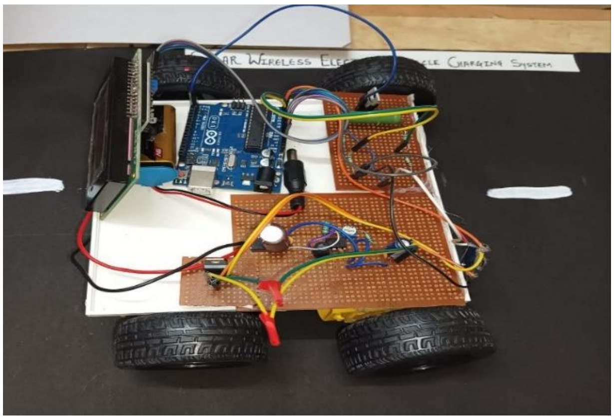

Fig 9: Receiver Circuit

8. OUTPUT

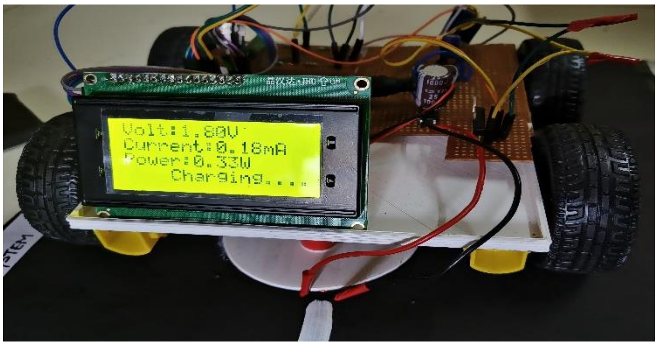

Fig 10: Output

9. MATHEMATICAL ANALYSIS:

➢ **MC34063 Calculations:**

Input Parameters**:**

- Input Voltage (Vin): 3.3 V
- Input Current (Iin): 2.2 A

Output Parameters:

- Output Voltage (Vout): 7 V
- Output Current (Iout): 1 A

1. Input Power (Pin):

Pin = Vin × Iin Pin

Pin = 3.3 V × 2.2 A

Pin = 7.26 W

2. Output Power (Pout):

Pout = Vout × Iout

Pout = 7 V × 1 A

Pout = 7 W

➢ **Power Efficiency Calculations:**

Efficiency (η) (Across one Coil):

η = (Pout / Pin) × 100% η
= (7 W / 7.26 W) × 100% η
= 0.96 × 100% η = 96.41%
Therefore, the efficiency of the system is 96.41%.

- **Charging Time:**
  Charging Time = Battery Capacity (Ah) / Charging Current (A)
  Charging Time ≈ 2.2 Ah / 2.2 A
  ≈ 1 hour

10. OBSERVATIONS:

Component	Voltage (V)	Current (A)	Power (W)	Additional Information
Battery	12	2.2	26.4	
Transmitter Coil	3.3	2.2	7.26	Diameter: 7cm
Receiver Coil	2.9	1.6	4.46	Diameter: 7cm
Solar Panel	12	0.1	1.08	

- Distance Between Two Transmitter (Tx) Coil: 9cm
- Distance Between Transmitter &Receiver Coil: 1cm

11. ADVANTAGES:

- **Sustainability and Environmental Impact:** Reduces greenhouse gas emissions by relying on solar power.
- **Continuous On-Road Charging:** Enables EVs to charge while in motion, enhancing practicality and convenience.
- **Off-Grid Charging:** Facilitates charging in remote areas without traditional infrastructure.
- **Energy Independence:** Enhances energy security by locally generating power through solar panels.
- **Reduced Infrastructure Dependency:** Minimizes the need for extensive charging infrastructure, particularly in challenging locations.
- **Technological Innovation:** Integrates solar technology and wireless power transfer, contributing to advancements in clean energy solutions.
- **Cost Savings for EV Owners:** Potential for lower energy costs, improving the economic appeal of electric vehicles.

10. CONCLUSION:

Finally, the solar-powered wireless electric vehicle charging system is a pioneering solution at the cutting edge of sustainable transportation. Its use of solar power and Wireless energy transmission primarily resolves environmental issues, additionally boosts the convenience of electric vehicles by allowing for continuous on-road charging and off-grid capabilities. Beyond reducing reliance on traditional grid electricity, the project represents a significant step forward in technological innovation, providing cost savings for EV owners, raising educational awareness, and influencing urban planning decisions. As a proof-of-concept, this system not only addresses current challenges, but also this functions as an inspiration for clean and accessible electric vehicle charging, leading to a greater sustainable and environmentally friendly journey in future.

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