International Research Journal of Innovations in Engineering and Technology (IRJIET)

ISSN (online): 2581-3048

Volume 7, Issue 4, pp 297-300, April-2023

https://doi.org/10.47001/IRJIET/2023.704048

Implementation of Dynamic Wireless Charging for Electric Vehicles

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***Abstract* -In reaction to the depletion of resources, electric vehicles are viewed as an alternate choice. Wireless power transfer (WPT) is seen as a solution to charge batteries since practical and dependable ways to charge EV batteries are crucial for increasing the use of EVs in daily life. This project involves designing and implementing a wireless charger prototype with a 60 kHz operating frequency. The drawbacks of plug-in electric vehicles (PEV) include the requirement for a cable and plug charger, the need for galvanic isolation of the on-board electronics, the bulk and high cost of this charger, and the requirement for sizable energy storage system (ESS) packs. however, by utilizing the wireless charging capability of the equipment. It offers convenience to the user, built-in electrical isolation, grid-side regulation, and on-board ESS size reduction through dynamic on-road charging. The primary objective of our project is to design and construct an antenna system that can be used for vehicles to charge electric vehicles wirelessly using resonant magnetic resonance technology. WPT use in EVs offers a clean, practical, and secure functioning. Both the primary and secondary coils are the heart of the WPT systems. The coupling coefficient of the system created by these coils ranges from 0.1 to 0.5. Resonant capacitors are required on both sides to tune them in order to transmit the rated power.The operating frequency is a crucial selection factor for all applications, and it has a significant impact on the power electronic circuit's component choices and coil size. Vehicle charging technology is developed with a resonant wireless transfer system.**

Keywords: wireless charging, electric vehicles, EV, dynamic charging, wireless power transfer, inductive coupling.

I. INTRODUCTION

In recent years, wireless power supply systems that provide electrical power to equipment without power connections or the like wirelessly (in the medium of air) have become widely used. The three forms of electromagnetic induction, radio reception, and resonance principles that enable wireless electric power transmission are commonly used to describe these technologies.

With magnetic flux acting as the channel, electromagnetic induction uses the phenomenon wherein applying an electric current to one of two adjacent coils causes an electromotive force to be induced in the other coil.A revolutionary technology called wireless power transfer (WPT) powers communication devices without the use of power supplies. Due to the recent impressive advancements, this technology has gained the interest of many researchers and R&D companies worldwide. Mobile appliances with rechargeable batteries, such as cell phones, PDAs, laptops, tablets, and other portable electronic devices have been increasingly popular in recent years. It is well known that electromagnetic waves propagate due to electromagnetic energy. Theoretically, wireless power transmission (WPT) can utilise any electromagnetic wave.

Efficiency is the only factor that defines the WPT apart from communication systems. The electromagnetic field and its strength are said to propagate in all directions, based on Maxwell's equations.

Even though we employ a communication channel to transport energy, the energy is spread out in all directions. Despite the fact that the received power is sufficient to convey information, the efficiency from transmitter to receiver is very poor. We do not refer to it as the WPT system as a result. The last several decades have seen a resurgence in interest in an electric transportation infrastructure due to concerns about the environmental effects of the petroleum-based transportation infrastructure and the threat of peak oil.

In a communication system, we transmit energy, but that energy is dispersed in all directions. Despite the fact that the received power is sufficient to convey information, the efficiency from transmitter to receiver is very poor. We do not refer to it as the WPT system as a result. The last several decades have seen resurgence in interest in an electric transportation infrastructure due to concerns about the environmental effects of the petroleum-based transportation infrastructure and the threat of peak oil.

The electricity may then be used to power a battery, flywheel, or super capacitors within the car to store it. Mostly, only one or a small number of sources, mostly non-renewable

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fossil fuels, can be used to power combustion-based engines found in vehicles. Regenerative braking and suspension, a feature of electric or hybrid electric vehicles that allows for the recovery of energy often lost during braking as electricity to be restored to the on-board battery, is a significant benefit. EVs, however, rely heavily on outside energy sources.

II. PROPOSED SYSTEM

The idea of electric vehicles that are powered by the roads has been put up in an effort to solve battery issues. This method allows for the charging of an electric vehicle.

The battery can therefore be reduced in size and no waiting is required for charging when using wireless power charging while traveling. Our project's primary goal is to create an antenna and wireless power transfer system that is appropriate for moving electric cars (EVs).

The wireless power transfer technique for the electric car is created using the resonant magnetic coupling principle. The electrical power will flow from the transmitter coil inside the platform to the receiving coil inside the bottom of the electric vehicle when the power receiver's frequency is precisely set to the resonance frequency of the transmitter unit below the road. The design and execution of a wireless power transfer system for electric vehicles using the model EV system are discussed in this project.

The transmitter side of this device is a high frequency half bridge inverter. It transforms the input DC voltage into high frequency AC voltage in the 65KHz range. The receiver coil on the receiving end receives HF AC voltage, which is then converted into DC voltage by the rectifier and used to charge the battery in an electric vehicle. A microcontroller called an Arduino Nano is used to monitor the charging voltage and battery voltage, and it shows the charging status on an LCD display.

III. HARDWARE BLOCK DIAGRAM

AC Power Supply

The supply for the wireless power transmitter is taken from AC220v source.

AC-DC Adapter (SMPS)

Switching Mode power supply is used here to convert AC to DC. Here the input of the SMPS is 220v AC and output will be 12v DC.

High Frequency PWM Oscillator

High Frequency oscillator is designed using KA3525 IC. The IC circuit generates PWM switching pulses for driving the MOSFETs. The oscillator produces a PWM frequency of 65 KHz range. Here two separate PWM pulses PWM1 and PWM2 are produced which are supplied to the two MOSFET gate. Each PWM pulses are 90 degrees out of phase, which result in alternative switching of each MOSFETs.

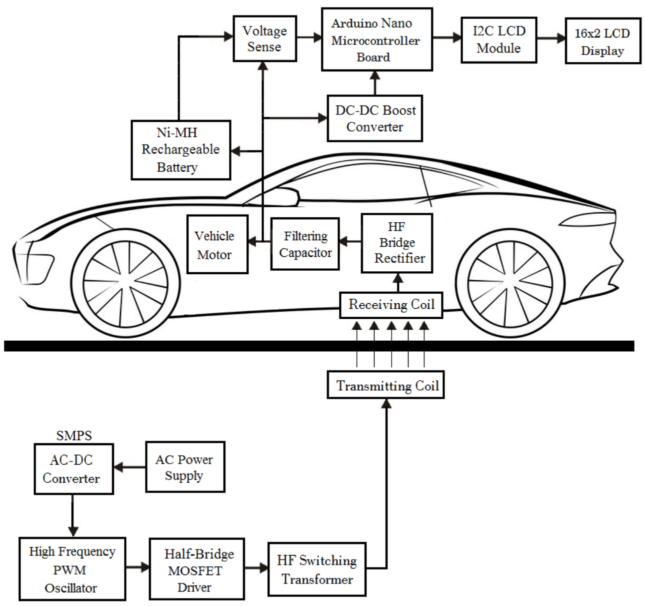

Figure 1: Hardware Block Diagram

Driver MOSFETs

Here two driver MOSFETs are used to switch the high frequency transformer. The two ends of the transformer primary is connected to the „Drain" pin of the two MOSFETs. When a MOSFET gets turned ON, then current flows through the primary winding of the transformer. Half of the primary gets turned ON by one MOSFET and another half by another MOSFET. Both MOSFETs switch alternatively producing a AC square wave in the primary of the transformer.

High Frequency Transformer

Here the DC-AC conversion takes place in the high-frequency switching transformer. Unlike normal transformer, the core of the HF transformer is made of ferrite which makes it capable of operating at higher frequencies. Due to high frequency switching the losses in conversion is very lower than normal transformer. Here the HF transformer converts DC current into a high-frequency AC current. The primary of transformer has three tappings, one is centre tap for DC current input and other two tapings for return path of the current through MOSFETs during switching. The secondary

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output will be HF AC current, which is given to the transmitter coil.

Half bridge Inverter

Half bridge inverter circuit driver consists of a high-frequency switching transformer and two MOSFETs. The switching transformer primary is connected to two MOSFETs and secondary is connected to transmitting coil. The half bridge inverter converts input DC voltage into a high frequency AC voltage.

Transmitting Coil

The transmitter coil is designed with windings of copper coils which convert the high frequency oscillating electrical current into electromagnetic waves resonating at a particular frequency.

Receiving Coil

The receiver coil receives electromagnetic waves from the transmitter antenna and converts back into high frequency electrical output.

HF Bridge Rectifier

High Frequency (HF) bridge rectifier consists of fast switching rectifier diodes which converts HF AC voltage from the receiving coil into a DC voltage.

Filtering Capacitor

The filtering capacitor filters out the ripple generated at the rectifier and produces as smooth and stable DC voltage output which can be used for driving the vehicle motor or for battery charging purpose.

NI-MH Rechargeable Battery

Electric vehicle has a rechargeable Ni-MH battery which is charged by the received voltage from the wireless power receiver at the bottom side of the vehicle.

Arduino Nano Microcontroller

Arduino nano microcontroller is used to monitor the charging voltage of the wireless power receiver and battery voltage level of the rechargeable vehicle battery. It measures the charging and battery voltages and displays charging status in a LCD display.

I2C LCD Display

Provides I2C protocol based interface of LCD display module to arduino board through two wire communication. Thus the pin count required for LCD interfacing is reduced.

16x2 LCD Display

2-Line LCD display is used to display the chaging status of the wireless power receiver and also the battery voltage.

DC-DC Boost Converter

DC-DC boost converter boosts the output voltage of the battery to provide required operating voltage to the arduino charge monitoring circuit.

Prototype of Hardware

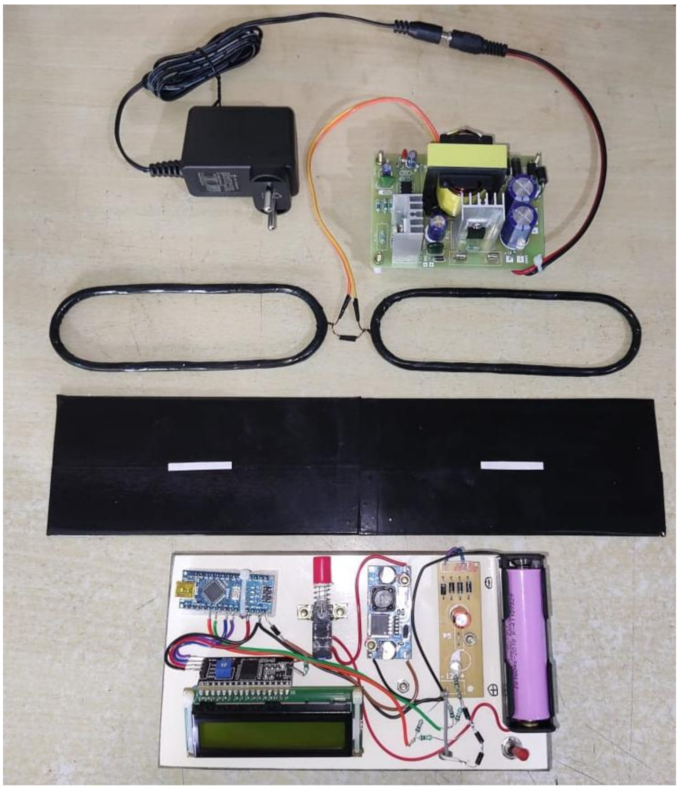

Figure 2: Prototype of Hardware

IV. CONCLUSION

In this project, we created a controller for wireless EV charging systems, which may be utilized to charge electric vehicles without using cables. There is no longer a requirement for switching frequency tuning because the suggested controller can self-tune the converter's switching operations to the resonance frequency of the WPT system. Additionally, it permits soft-switching operations in the converter, which will greatly improve the power electronic converter's efficiency. A new technology called contactless

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electric vehicle (EV) charging, which is based on inductive power transfer (IPT) systems, makes using EVs more convenient and secure. It is a safe, dependable, and durable device because it does not have any electrical contacts, so it will not be harmed by rain, snow, dust, or dirt a reliable and efficient method of charging electric automobiles that lowers the possibility of electric shock.

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Citation of this Article:

Akula Sharath Chandra, Gurram Adarsh, Marri Hitesh Reddy, S.Sree Hari, "Implementation of Dynamic Wireless Charging for Electric Vehicles" Published in *International Research Journal of Innovations in Engineering and Technology - IRJIET*, Volume 7, Issue 4, pp 297-300, April 2023.

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