



ON ROAD CHARGING OF ELECTRIC VEHICLE

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ABSTRACT

In recent years with the rapid development of the electrical vehicle (EV) of new energy industry, higher requirements are put forward for convenience, safety and reliability of the charging of electric vehicles. Contactless Power Transfer (CPT) systems are applicable for charging electric vehicles (EVs) without any physical interconnection. These systems can be installed on roadways in order to charge the vehicles while driving. The implementation of such on-road charging systems in order to extend the driving range and decrease the EV battery size is investigated in this paper. The percentage of road that should be covered and the power transfer capability of the system are estimated. Some design considerations, such as the distribution and the length of the CPT segments over the road, are explained. Finally, the total power demand for all the passing-by vehicles using the system is calculated and the possibility of powering the EVs directly from renewable energy sources is discussed.

Key Words: *Electrical Vehicle, Inductive Coupling, Fuel Consumption, Time of Charging, Wireless Electric Vehicle Charging System (WEVCS)*

INTRODUCTION

EVs first came into existence in the mid-19th century, when electricity was among the preferred methods for motor vehicle propulsion, providing a level of comfort and ease of operation that could not be achieved by the gasoline cars of the time. In the 21st century, EVs saw a resurgence due to technological developments, and an increased focus on renewable energy. A great deal of demand for electric vehicles developed and a small core of do-it-yourself (DIY) engineers began sharing technical details for doing electric vehicle conversions. An electric vehicle (EV) uses one or more electric motors or traction motors for propulsion. An electric vehicle may be powered through a collector system by electricity from off-vehicle sources, or may be self contained with a battery, solar panels or an electric generator to convert fuel to electricity.

The equivalent circuit analysis and characteristics of the Inductively coupled power transfer (ICPT) system and the research progress in respect of the designs for the charging coil, leakage inductance compensation topologies, power level enhancement and misalignment toleration is discussed in paper [1]. The current available wireless power transfer technology for EVs are mentioned in paper [2]. The paper presents a nonintrusive design of power supply to support the sensor network applied in the smart grid. Design considerations for this specific type of scavenger have been discussed, and optimized energy harvester prototypes have been fabricated, which are further tested on a power line platform [3].

Dynamic charging can help lower the price of EVs by reducing the size of the battery pack. Indeed, if the recharging energy is readily available, the batteries do not have to support the whole driving range but only

supply power when the inductive power transfer (IPT) system is not available. Depending on the power capability, the use of dynamic charging may increase driving range and reduce the size of the battery pack.[4]

PRINCIPLE OF OPERATION

Inductive coupling can be done in both stationary and dynamic conditions. By reconfiguring the transformer and altering high frequency, energy is being transferred with low energy loss and fewer demands on the primary circuit. Sufficient power for the battery can be transferred by the primary to the secondary without sufficient energy loss. Receiving coils are fixed under the vehicle to convert the oscillating magnetic field to high frequency AC. The high frequency AC is converted into a stable DC supply which can be used by the on board batteries. To avoid any kind of health and safety issues and stable operation the power control, communications, and battery management system (BMS) are used. To reduce any harmful leakage fluxes and to improve magnetic flux distribution, magnetic planar ferrite plates are used at both transmitter and receiver sides.

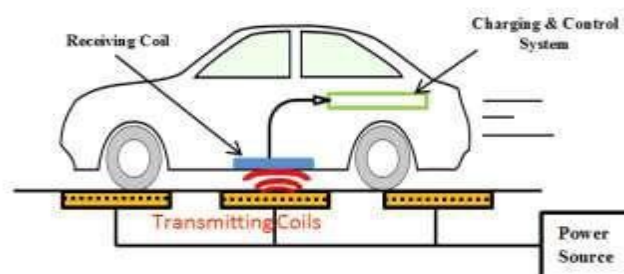


Fig.1: Schematic WEVCS

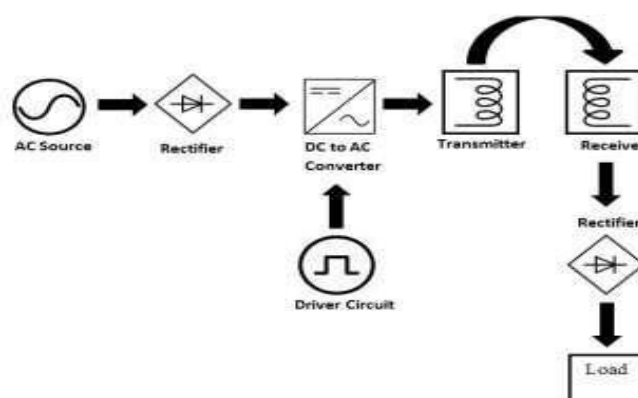


Fig.2: Block diagram of end to end system

The main component of this system is the various ways of stepping down the incoming voltage. A conventional 220Vrms/50 Hz means is stepped down using the transformer to our required voltage and then converted to DC

voltage. By using an inverter, the DC is converted to AC of our desired high frequency. The power is then transmitted through the transmitter coil to the receiver coil through inductive coupling. The receiver coil is placed at a particular distance and AC power is delivered at the end. This power is then rectified and regulated using a bridge rectifier and Zener diode circuit. Afterwards, the energy is harnessed to charge the battery. The transmitter and the receiver coils were designed to achieve maximum quality factor to maximize power transfer at the frequency of operation.

APPLICATION OF WEVCS

Wireless electric vehicle charging systems can be divided into two different incidents to channel power from the source to the battery bank and into the car based on their applications.

3.1 Static wireless electric vehicle charging system

(S-WEVCS)

WEVCS creates an innovative way to provide a user friendly environment for users and prevents any safety related problems with the plug-in charging system. Static WEVCS is able to replace easily the plug-in charging system with less driver participation and it is able to solve related safety issues such as trip and electric shock hazards. The primary coil is usually installed below the electric vehicle's front, back or center. The energy received from the electric vehicle is first converted from AC to DC by using a power converter and then it is transferred and stored in the battery bank. Power control and battery management systems are linked with a wireless communication network so as to receive any feedback from the primary side, thus it is able to overcome any safety issues. The charging time of the electric vehicle depends upon the power level of the source, size of the charging pad and air-gap distance between the two windings. In light weight vehicles the average air gap distance between the two coils is about 150–300mm. By a lever mechanism the distance between the coils can be reduced to applicable level. Static WEVCS can be implemented in parking places, car parking facilities, residential areas, commercial and industrial buildings, shopping malls etc.

3.2 Dynamic wireless electric vehicle charging system (D-WEVCS)

Two major obstacles suffered by the plug-in hybrid electric vehicles are cost and range. EVs are needed to be charged quite frequently or need to install a larger battery pack which leads to additional issues such cost and weight. Also frequent charging of an electric vehicle is not economical. Thus by implementing dynamic wireless electric vehicle charging system (D-WEVCS) the problems associated with range and cost of electric vehicles can be reduced. Thus D-WEVCS becomes the only answer for future of electric vehicle automation. It is also known as a „roadway powered”, “on-line” or “in-motion” WEVCS. With high voltage, high frequency AC source and compensation circuits to the micro grid, the primary coils are inserted inside the road surface at a preset distance. The secondary coil is placed below the vehicles similar to the static WEVCS. Whenever the electric vehicles passes over the transmitting coil, the vehicle receives a magnetic field through the receiving

coil and converts it into DC it is used to charge the battery bank by using the power converter and BMS. When comparing with the current electric vehicles, here by using frequent charging facilities of electric vehicles reduces the overall battery requirement to about 20%.

Necessary transmitting coil pads and power supply components need to be installed on specific locations and pre-defined routes. When comparing with the segmented scheme, the centralized scheme has lower efficiency, higher losses, higher installation and maintenance costs. However, the initial infrastructure installation of this technology will be expensive. In future with the help of a self-driving vehicles, it would be able to produce perfect alignment between the transmitter and receiver coils, thus it could greatly increase the overall efficiency of the power transfer. Dynamic-WEVCS can be implemented in many electric vehicle transportation applications like light duty vehicles, bus, and rail and for fast transportation.

CONCLUSION

Here we have found out an innovative technology to charge electric vehicles wirelessly through inductive coupling. In this prototype, when we gave an input voltage of 30V DC we were able to get an output voltage of 5V with 700mA at a distance of 20mm.

We can improve the efficiency by following methods :- * By a lever mechanism we can adjust the distances between receiving and transmitting coils which will increase the power transmission between the coils.

* By increasing the frequency level to MHz range.

* By making the system to magnetic resonance coupling.

* Increasing the number of turns of the coils by proper coil design. The prototype we made is of lower efficiency because the power input given to the prototype is used for meeting the constant loss as well as magnetic leakage. But we are sure that as the power rating of the prototype increases the overall efficiency of the system also get improved as better.

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