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AN EFFECTIVE METHOD OF ELECTRICAL VEHICLE CHARGING BY WIRELESS POWER TRANSFER

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ABSTARCT

Electric vehicles are a viable solution for lowering greenhouse gas emissions. Electric vehicles not only reduce fossil fuel dependency, but they also minimise ozone damaging compounds and support large-scale renewable deployment. Despite extensive research on the qualities and attributes of electric vehicles, as well as the nature of their charging infrastructure, electric vehicle manufacturing and network modelling continue to evolve and be constrained. Various non-contact Plug-In Electric Vehicle charging methods are covered in this paper. They're either in the works or are already being used as flexible aftermarket choices in the light-duty vehicle industry. Wireless power transfer (WPT) is a commonly used name for wireless charging that includes inductive power transfer and magnetic resonance coupling. Wireless technology is still in its infancy, and there is a lack of standardisation, particularly in terms of interoperability, centre frequency selection, magnetic fringe field suppression, and power flow regulation methods.

I.INTRODUCTION

Because of this, the field of wireless charging for PEVs has exploded in recent years, and several companies are now offering commercial wireless chargers as a secondary market of the automotive industry, concerned with manufacturing products for better integration into light-duty passenger vehicles [1]. Because it fits into the V2I, wireless paradigm, WPT can be considered as a sudden influence on society in PEV charging. WPT has a new unique technology that is well known as a safe, flexible, convenient, and autonomous means of passenger vehicle charging that has the potential to fully replace today's conductive charging. There are no cords to trip over, no hefty plugs and cabling to battle with in inclement weather, and no worries about accidental disconnections.

The existing standards and hardware for safe and private wireless communications play an essential role in the context of connected vehicles and wireless communications. When a WPT-equipped vehicle is merely placed over a charging pad or buried into the floor in a domestic garage, auto port, or public parking structure, power is transferred via stationary charging technology. Recharging the PEV is self-contained, and the base WPT controller is created using a state control technique of algorithm.The communication series consists of vehicle to infrastructure short-range messaging to recognize the charger location, operational and eventually, with the in-motion charging of EVs, the ultimate in independent vehicle operation; dynamic wireless charging. Once the appropriate exchange of information is complete between the PEV and the WPT base unit (WPTB), the three level inverter provides excitation current to the tuned primary coil at a standardized centre frequency. Power is transferred across the nominal gap that is in the order of the PEV ground clearance. By the utility ac power and Active Front End rectifier via the three level converters, secondary power is rectified, filtered, and delivered to the energy storage system. Fig. 3 shows the functional blocks involved in the power transmission path. The utility AC power is converted to the controllable dc voltage by the active front end rectifier comprising a Power factor correction stage. Adjustable DC voltage is applied to the high-power rails of a three level converter having selectable duty ratio.

The three level inverter stages supply a sufficient amount of excitation current to the series-tuned primary coil to magnetise the air volume between it and the capture coil or vehicle-mounted secondary. The secondary voltage is rectified and provided to the car HV battery either directly from the wireless power transfer rectifier or indirectly through the vehicle on board charger. Standardization activities for WPT applications include interoperability, health and safety, communications, and field measurement. The availability of charging stations is one of the top worries among consumers, and it may be one of the most important elements affecting their decision to buy an electric vehicle [2], [3]. Fast chargers must be developed urgently in order to allow the widespread usage of electric vehicles in the future. If fast chargers can lower the time it takes for EVs to recharge to levels that are comparable to the time it takes for ICEVs to refuel, it will be a win-win situation. The unipolar dc bus can be achieved using two-level voltage source converters, while the bipolar dc bus can be realised using three-level neutral-point-clamped (NPC) converters. The three-level dc-dc converters have been used in renewable energy systems for power factor correction [4]. A NPC converter was originally used as the central grid-tied ac-dc converter in the bipolar dc bus architecture [5]. The bipolar dc bus provides increased power capacity and more flexible ways to connect loads to the dc bus. Furthermore, the two-level voltage source converter's line-to-line voltage waveform has three voltage levels. The NPC converter provides five voltage levels, and the corresponding switching frequency of the Neutral point clamped converter is double that of the device switching frequency, resulting in a lower dv/dt, less filtering, and greater current performance [6]–[10]. However, because each dc bus is independent of the other and their loads differ most of the time, the setup in [5] suffers from an uneven power between the positive and negative dc buses. Unbalanced power can cause grid-side current faults and unbalance the bipolar dc bus. Because unbalanced power leads to unbalanced voltage, which causes poor current performance and potentially equipment damage, a dc power balance management method is required. For high-power charging stations with a bipolar dc bus, this study provides comprehensive dc power balance control in conjunction with high-power three-level dc-dc converter based fast chargers. The suggested fast charger with dc power balance control reduces the need for additional balancing circuits and high-frequency transformers, resulting in increased overall system efficiency. At the same time, because the three-level dc-dc converters only perform part of the dc power balance management work, the central Neutral point clamped converter has more freedom to correctly control grid-side currents, resulting in higher power quality. The comprehensive dc power balance management is presented to address the unbalanced dc power problem between the positive dc bus and the negative dc bus. The working principles, balance limits, and circulating currents of active and passive dc power balance managements (APBM and PPBM) are explored. The efficient integration of APBM and PPBM is investigated, and a rapid charger control mechanism is developed.

II.ELECTRICAL VEHICLES

An electric vehicle is a car powered by one or more electric motors and powered by electricity stored in rechargeable batteries or an energy storage device. Electric motors provide rapid torque, allowing electric cars to accelerate quickly and smoothly. They are roughly three times as efficient as internal combustion engine vehicles. Electric vehicles are substantially quieter than autos with internal combustion engines. They do not produce exhaust pollutants, resulting in considerable reductions in local air pollution as well as greenhouse gas and other emissions. When compared to plug-in charging, wireless charging offers significant advantages in terms of user engagement, availability, reachargibility, and automation. An electric vehicle is a vehicle that uses electricity stored in rechargeable batteries or an energy storage device to power one or more electric motors. Electric motors provide a lot of torque, which enables electric automobiles to accelerate rapidly and smoothly. They are nearly three times as efficient as vehicles powered by internal combustion engines. Compared to internal combustion engines, electric vehicles are significantly quieter. They do not emit polluting exhaust, resulting in significant savings in local air pollution, greenhouse gas emissions, and other emissions. Wireless charging has major advantages over plug-in charging in terms of user involvement, availability, reachability, and automation. Parameters such as the coupling factor between the coils, which is dependent on coil geometry and coil inductivity, and coil distance quality factors of electromagnetic resonance circuits must be considered and personalised accordingly in order to further optimise the efficiency of the transmitted energy with achievement of the resonance frequency. Increased coil distances, reduced electromagnetic assumption risks, and more compact geometrical proportions in the (lower) kHz frequency band can achieve the best energy transfer rates and efficiency rates with wireless charging systems that follow the principle of inductive resonant energy transfer.

Utility interface
- Inverter Rand Controller (off-board)
- Coupled coils
- Power electronics (on-board)
- Communication interface between road-side and vehicle-side radios are all critical components of a wireless charging system.

III.EV BATTERY CHARGING TECHNOLOGIES

In order to achieve high efficiency range, big power transfer, and other qualities, various Electric Vehicle battery charging methods have been created. In terms of power level, air gap, and efficiency, the deployed methods have approached the various capacities.

A. Inductive power transfer (IPT)

The risk of direct metal-to-metal contact when charging plug-in electric automobiles is always present. To address this issue, electric vehicle charging systems have been designed using inductive power transfer (IPT) [4]. The electromagnetic induction phenomenon is used to transmit power through an air cored transformer with closely spaced main and secondary coils [2,4,14]. The coils appear to be physically connected, yet they are electrically isolated, as shown in Fig. 1. The charger is inserted into the car in the same way that gasoline is. Figure 1 is an IPT schematic diagram. Inductive power transfer has been effectively implemented for EV battery charging. This method showed promising high power transfer with an smaller air gap, though, when the air gap between the primary and secondary coils is increased the concert decreases significantly due to leakage inductance [2]. Inductively coupled power transfer The inductive power transfer offers the low efficiency when the gap of air is increased between charging coils and also involves wired chargers, whereas the design for full wireless charging systems have been developed to overcome the deficiencies of IPT and make the charging system suitable for the users. As shown in Fig. 1, inductively coupled power transfer (ICPT) uses capacitors linked to both the primary and secondary coils to compensate for leakage flux caused by the larger air gap. To ensure effective energy transfer at resonant frequency, both LC circuits rely on resonance phenomena [5]. The inductively coupled power transfer (ICPT) technology is well-known for its high power transmission in a wide range of applications, most notably electric automobiles [12]. It offers a quick charging procedure as well as improved power transmission through frequency fluctuation.

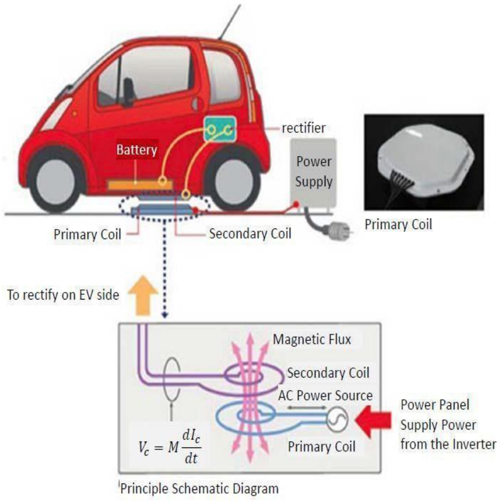

Fig.1 Schematic Diagram of Inductive Power Transfer System for EVs.

B.WIRELESS POWER TRANSFER METHODS

Inductive coupling and magnetic resonance coupling are examples of wireless power transfer technology used in electrical vehicles. These technologies can be classified into three groups based on their transmission range, power rating, and cost. Wireless energy transfer technologies can be classified into two types based on power transmission distance: near field and distant field. Near field approaches are based on inductive coupling and magnetic resonance coupling. Near-field inductively coupled techniques can be utilised to efficiently transport high power across short distances (up to several centimeters). Status of the WPT functional cascade and overall efficiency goals, as well as assistance in alignment. The PEV's three-level inverter provides excitation current to the tuned component of the primary coil at a standardised centre frequency after the proper power exchange between the PEV and the WPT base unit (WPTB) is completed. The power is transferred through a notional gap of about the same size as the ground clearance of a PEV. Secondary electricity from a three-level inverter is rectified, filtered, and sent to the Energy storage system. The wireless power transfer base unit controller's power tracking algorithm automatically adjusts the frequency to meet gap fluctuations in the coupler. The regulatory loop through the radio channel is completed by power flow sensors, connections, and grid-side control. The functional blocks involved in the power transmission path are shown in Figure 1. The Active front end, which includes a Power factor adjustment step, converts utility ac power to adjustable dc voltage. The high-power rails of a three-level full-bridge inverter with changeable duty ratio are fed with adjustable dc voltage. The three-step inverter stage provides a sufficient amount of excitation current to the series-tuned primary coil to magnetise the air volume between it and the vehicle-mounted secondary, or capture coil. The voltage generated at the secondary is rectified, filtered, and given to the vehicle's high voltage battery either directly or indirectly via the vehicle's onboard charger.

IV. ADVANTAGES OF WIRELESS POWER TRANSFER

- Wireless power transfer is a cutting-edge technology that provides a safe, flexible, convenient, and autonomous means of charging passenger vehicles that has the potential to fully replace today's conductive charging.
- There are no cords to trip over, no heavy plugs and wiring to wrestle with in bad weather, and no worries about unintended disconnection.
- Lower the costs of keeping direct connectors in good working order.
- Improved charging convenience for everyday electronic devices

- Safe power transfer to applications that must be kept sanitary or hermetically sealed. Electronics can be completely encased, which reduces the risk of corrosion caused by oxygen and water.

- Power distribution to spinning, highly mobile industrial equipment that is reliable and efficient.

- Delivers dependable power to mission in the most sensitive systems, as well as in unclean and dynamic situations.

V. CONCLUSION

This study expresses the most significant aspect of a new analysis process for wireless charging technology calculation. The core notion is that primary-side power regulation is chosen and developed with the goal of reducing vehicle on-board complexity, size, and cost while maintaining essential scalability features required for future higher-power wireless power transfer applications. The power electronic fundamentals needed to determine the electric current flow from an ac source via the line inductance into a fixed dc voltage load, such as a battery, via a diode rectifier are not used in this method. A separate study of the primary and secondary sides of the magnetic resonance coupler is another unique approach of regulation. The analysis of a utility network or micro grid in which reactive power compensation is used for voltage control, which in a wireless power transfer system is the voltage appearing at the full-wave rectifier's input. On the other hand, the main side of the coupler is handled as a centre frequency selectivity stage, which is required to ensure that a high mutual flux is created, which enables power transmission.

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