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"Review of Wireless Power Transfer System For Electrical Vehicle"

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Abstract: In this paper we discuss the advancements and challenges in wireless power transfer (WPT) systems for electric vehicles (EVs). It emphasizes the importance of addressing technological challenges and human safety concerns associated with high-power transmission through the air., it mentions the benefits of wireless charging for EVs and the efficiency improvements enabled by semiconductor technology. More than 400 W of electric power may be transferred with more than 90% efficiency by the dynamic charging mechanism that has been created the abstract sets the stage for exploring the potential of dynamic wireless charging systems for EVs and the promising future of WPT technology in enhancing convenience and sustainability in electric vehicle usage.

Key words: transmitter coil, receiving coil, battery.

Introduction

Nicola Tesla experimented with wireless power transfer a century ago. Wireless power transfer (WPT) has been the focus of much study in recent decades in an effort to speed up the adoption of electric devices in our daily life. Robots, electric cars (EVs), implanted medical gadgets, wireless charging cell phones, and home electronics are typical examples. Usually, an electromagnetic field is used to transfer power (EMF). WPT's inherent ease and potential for flawless operation without charging downtime, which are two significant issues with wired chargers, are the reasons for its vast uses and rising demand. WPT can be classified into three categories based on its working principles: (1) electromagnetic radiation (microwave or laser) WPT, which is used for long-distance power transmission, like that between solar power satellites and the earth; (2) electric induction/coupling WPT, also called capacitive coupling WPT, which is used for near field transmission. and (3) magnetic coupling WPT (inductive or resonant), which is likewise used for near-field transmission but, because of the strength of the electric field, is far less harmful to human health than electric induction/coupling WPT. This study focuses on magnetic coupling WPT for EV charging applications, which has been the subject of much work. WPT has different functioning modes: (1) static or stationary WPT, which charges while the car is still.

Electric vehicles (EVs) are anticipated to be a crucial technological advancement in enhancing energy sustainability for individual mobility in the future, as power may be produced from an array of sources, including renewable energies like sun and wind. geothermal energy, etc. However, because EVs require periodic battery recharging, their cruising range is still limited. Increasing battery power density and using cutting-edge automobiles like fuel cell and plug-in hybrids are some of the strategies suggested for increasing the cruising range. Wireless dynamic charging, which enables EV batteries to be charged while the cars are moving, is one of these advancements. therefore, greatly expanding their travel range. EV owners won't have to worry about range anxiety or the need to visit a charging station anywhere there is infrastructure for EVs.

Wireless power transfer's past

In 1820, André-Marie Ampère created Ampere's law, which shows how an electric current can produce a magnetic field. This served as the catalyst for the advancement of electromagnetic technologies. Joseph Henry and Michael Faraday discovered electromagnetic induction in 1831. James Clerk Maxwell developed the classical electromagnetic theory later. This created a coherent theory by combining all of the earlier findings, investigations, and equations pertaining to electricity, magnetism, and optical. Oliver Heaviside later improved this idea to produce the four well-known equations known as Maxwell's equations. Nikola Tesla first demonstrated the wireless transmission of energy in 1891. Michael Faraday's theories on electromagnetic technology served as the foundation for many of Tesla's groundbreaking advances in the realm of electromagnetism. As an alternative to transmission line power distribution, wireless power transmission was studied in the early 19th century. Heinrich Hertz and Nicola Tesla both investigated wireless power transfer theory. Using radio waves, Nicola Tesla demonstrated wireless power transfer in 1899 by illuminating fluorescent bulbs that were 25 miles from the power source. William C. Brown made a significant contribution to the current advancement of wireless microwave power transfer. In 1964, he demonstrated how to use a "rectenna" he designed to convert microwaves into DC current in order to power a helicopter. Using PCB technology, NASA scientists created a thin-film plastic rectenna in the early 1980s that weighed less than tenth of the most advanced rectenna at the time. These developments resulted in the creation of the Stationary High Altitude Relay Platform (SHARP) technology, which was applied to the development of unmanned aerial vehicles that transmitted microwave power. These days, a lot of study has been done on wireless power transfer because technology is advancing in so many different directions. Because of its intrinsic benefits, wireless charging of an electric car has been regarded as an incredibly realistic solution for EV charging. The benefits of current improvements in semiconductor technology allow for extremely efficient wireless charging.

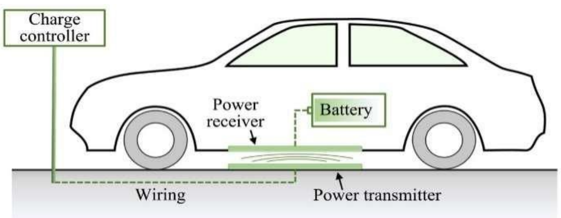
Affecting Factors and Safety Considerations for WPT

Because of the WPT systems' longer range of electromagnetic field generation, the majority of EV buyers have concerns about them, such as "whether these systems are safe or not." WPT systems, according to Eric Giler, are far safer than radiation from cell phones. The new phase shifter was proposed by H. Moon et al. and uses a double shielding coil to prevent magnetic flux leakage. By producing an opposing field, this kind of double shielding stops flux leakage. WPT offers several benefits.

for EV charging, including increased cost-effectiveness, compactness, speed, and power density. One of the amazing benefits of wireless charging is that it eliminates the need to attach the charger port to the car and disconnect it whenever it exits the charging lane. It may not be necessary to install separate fast-charging infrastructure and batteries with a longer range because dynamic charging lanes are likely to be included in toll plazas and traffic signals. Nevertheless, WPT increases the electromagnetic field's stress by requiring a higher electrical energy transfer (measured in watts). The WPT system's efficiency and dependability are decreased by the increased EMF value. Setting up the safety features on the sending and receiving ends is essential to preventing EMF exposures. It can be controlled by means of a pacemaker-style configuration across primary and secondary coils composed of aluminum or titanium. At low frequencies (20 kHz), this kind of pacemaker is frequently utilized in wirelessly charged medical devices. Compared to plug-in charging, wireless charging has greater restrictions, mainly on power transfer efficiency and battery charging time. It is necessary to convey massive power within a 1-2 mm airgap. A number of variables could impact the WPT. The fundamentals of airgap distance, system load, compensatory topologies, coil diameters, weight, coil alignment position, and frequency levels are usually relevant to its efficiency. More focus is needed, particularly on dynamic wireless charging, vehicle speed, and appropriate control mechanisms Aside from these technological challenges, human safety concerns during high power transmission through the air must be given additional consideration before this technology is implemented. A fire or electric shock are just a couple of the issues that could arise from the high-power wires and surrounding electromagnetic fields. To address these safety issues, all EV manufacturers ought to base their primary coil installations and car prototypes on comparable designs. The International Committee on Electromagnetic Safety (ICES), the International Commission on Non-Ionizing Radiation Protection (ICNIRP), the Institute of Electrical and Electronic Engineers (IEEE), the International Electrotechnical Commission (IEC), SAE, and Underwriter Laboratories (UL) developed those standard prototypes. For wireless charging, the operating frequency, magnetic flux leakage, and magnetic field strength setpoints are fixed by IEEE and ICNIRP. The WPT technology is being used by automakers and research institutions, enhancing performance in a secure setting with standardized prototypes.

Wireless charging system

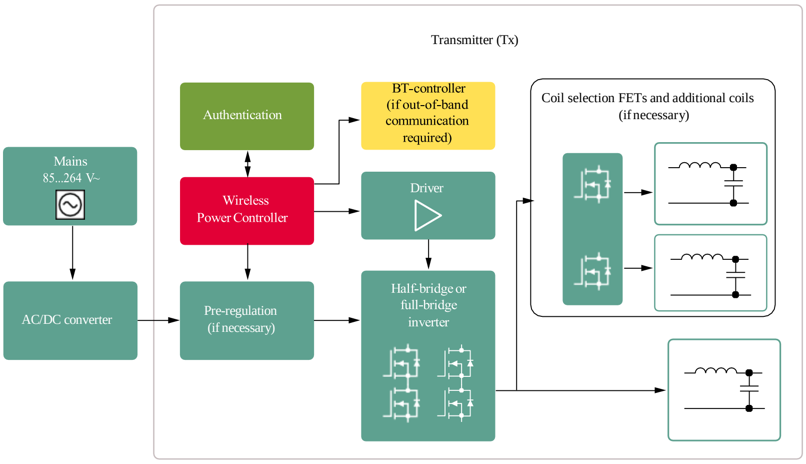
static charging systems operate on a similar premise. Toll plazas, traffic lights, and vehicle parking places can all use this billing technique. The current static wireless charging system was defined by Lukic and Pantic, who also coordinated the enhancement of industry-wide standard guidelines by the SAE. Static wireless charging is more efficient for electric vehicles. In static WPT, misalignment of the transmitter and receiver coils can have an impact on efficiency. With the right mechanical and compensatory technology, this can be avoided Numerous

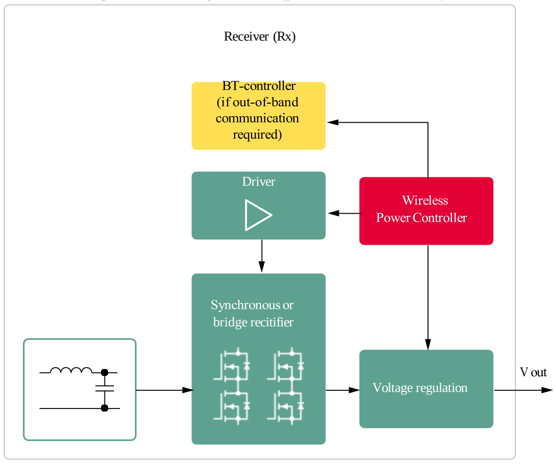


researchers help to solve static WPT's misalignment issues. The schematic diagram for the static WPT of EV is displayed in Figure. By focusing on each stage of conversion, the effectiveness of the system can be increased. There are two phases to the entire block diagram. A high-frequency inverter and input power from a DC or AC source make up the first stage. If the input power is AC, it needs to be shared with the high-frequency inverter after being converted to DC using power factor correction. Deductive To transfer power efficiently, all that is needed is high-frequency AC power. The high-frequency inverter can share direct access to solar or DC input power, as demonstrated by the authors' suggested system in. The DC power is then transformed into high-frequency AC power via an inverter. With the method. Inductive coils, compensation networks, and an AC-to-DC converter make up the last stage. Based on Ampere's law, an electromagnetic field is created around the primary coil after the AC power from the high-frequency inverter is transferred to it. According to Faraday's law of electromagnetic, the reception coil, which is positioned a certain distance from the transmitter coil, generates the electromagnetic field. Subsequently, the converter will transform the AC power into DC power, which will be stored in the battery. A lot of automakers are developing EV static wireless charging. With appropriate compensation topologies, Qualcomm, and Oak Ridge National Laboratory (ORNL) have previously marketed their products with an efficiency of 95% or higher. Despite the efficiency and established nature of conductive/wired charging technology, scientists are investigating wireless charging of electric vehicles as a means of mitigating the drawbacks of wired charging and improving charging comfort. Five different technologies—radio frequency, microwaves, electromagnetic, electrostatic, etc.—can be used to transport electricity wirelessly. Wireless power transfer systems have seen numerous advancements and commercialization’s since the early 19th century.

Overview of the WPT

Using wired devices, such as charging cables, for a variety of consumer goods, such as laptops, iPads, and mobile phones, may be highly complicated and annoying at times. It is particularly painful for someone who is traveling to distinguish between several charging cables; in these circumstances, wireless charging is highly helpful. Many electrical and electronics goods as well as apps that enable wireless charging and wireless power transmission are available on the market today. Systems for far-field and near-field wireless power transfer are the two highest categories for wireless power transfer. In order to transfer power wirelessly, far-field systems use radiative power transfer technologies such as radio frequency, ultrasound, microwave, and similar technologies that operate at very high frequencies of orders ranging from MHz to GHz. It is mostly utilized in sensor networks and low power communications applications where power transfer efficiency is not a major concern. For efficiency and safety concerns, however, this is not appropriate for high power transmission and consumer electronics charging applications. Near-field systems use inductive coupling and electrostatic/capacitive coupling power transfer technologies to transfer power wirelessly via electromagnetic fields with or without resonance. Out of the two types of coupling, inductive coupling can function at frequencies lower than 100 kHz. Frequencies used for capacitive power transfer range from a few hundred kHz to a few MHz For the transmitter and receiving coil, a circular coil of diameter 10-cm with 28-turn has been constructed. A schematic of the transmitter coil employed in this investigation





Conclusion

The research paper explores the potential of dynamic wireless charging systems for electric vehicles, highlighting the benefits of charging while in motion using road embedded transmitter coils. The study demonstrates the efficiency of transferring electric power through this innovative technology, offering advantages such as increased cruising range, reduced range anxiety, and minimized onboard battery size and cost. However, successful implementation requires careful planning and infrastructure investment. Overall, the research underscores the promising future of wireless power transfer technology in enhancing the convenience and sustainability of electric vehicle usage.

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