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Multi-Output Fast Wireless Charging for Electric Vehicle

Electric Vehicle Charging

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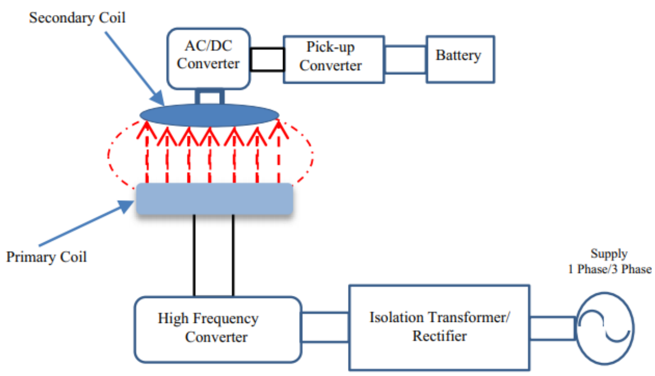
***Abstract* — To ensure a greener and cleaner ecology it is necessary to progressively reduce carbon emission from our earth. This can be typically achieved by a substantial cut in fossil fuel-run vehicles and shifting to electric cars which consume generated electricity as fuel, providing fewer emissions than a conventional vehicle, and will be zero-emission if used electricity comes from a renewable source. Electric vehicles are typically powered by batteries, which need to be recharged from generated electricity from the grid. Batteries can be charged either by plug-in methods or by wireless charging. As charging the battery pack requires quite a lot of time throw wireless charging. This research explores the Proposed multi-output charging method for the fast charging of the electric vehicle in this method we will divide the battery pack into four stacks and will charge every battery stack with a different output terminal (multi-output) terminal by using three winding transformers. This system can help in reduce the charging time of the electric vehicle. The conclusion has been made on the basis of calculation study of multi-output system.**

Keywords—Wireless charging system; Electric vehicle; Multi-output system; charging time.

INTRODUCTION OF WIRELESS CHARGING

Electric vehicles are observed as an alternative option in response to the depletion of resources. In order to increase the use of EVs in daily life, practical and reliable methods to charge batteries of EVs are absolutely important. The wireless charging has started an alternative methodology for charging electrical gears. As charging of battery throw wireless technology for Electric Vehicles (EVs) arise numerous issues like the power pad, coil arrangement plan's and most significant is charging time for batteries of an electric vehicle, power converters for high recurrence power change, and also electromagnetic field securities. All the above challenges are extremely important to research and to develop the solutions. In this holograph, our focus is on the fast charging analysis of the electric vehicles throw a multi-output charging arrangement to minimize the charging time for an Electric vehicle.

Inductive wireless Inductive wireless charging uses the principle of mutual induction by linking the transmitter and receiver to a time-varying magnetic field. The elements of the wireless charging system include a low-frequency ac / dc converter, high-frequency dc / ac converter, transmitter and receiver coils, secondary side high-frequency ac / DC The power is being transferred from the grid to the battery wirelessly through an ac/dc converter which converts grid supply to DC. This dc is then converted to high-frequency ac through the dc/ac converter. The primary and secondary coils are coupled to transfer the power at high frequency. Secondary side high-frequency ac/dc converter sends the current to variable dc which is regulated and fed to the battery for charging. The power transfer efficiency can be improved by combining the LCL or LC resonant circuit's charged using inductive power transfer can be charged in the static mode as well as dynamic mode. Both of the cases need to have proper alignment between the transmitter and receiver.

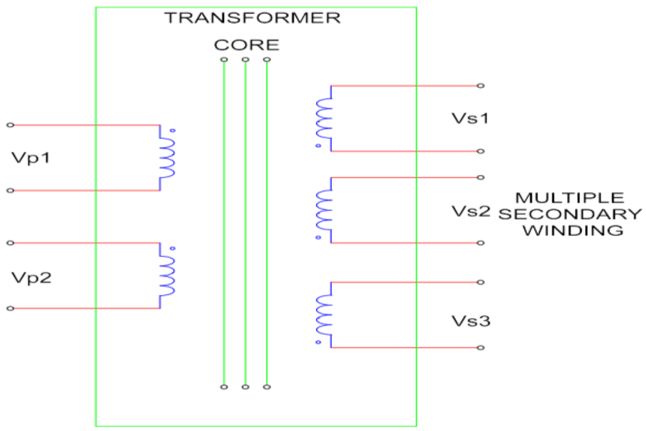


TYPICAL EV WIRELESS CHARGING SYSTEM

THEORY OF THE PROPOSED IDEA

- In this proposed idea we are using a multiple winding transformer concept for fast wireless charging. Multi tuned circuit comprise of one essential winding in primary and at least two secondary winding. The fundamental freedom of this type of circuit is that it allows one to have either the main or secondary side with more than one winding.

- The principle of operation of multi tuned circuit is same as of an ordinary transformer all the calculations such as primary and secondary current, transformation ratio is all calculated the same way. But in the multi tuned circuit, we must pay exceptional attention to the voltage polarities of each coil wrapping, and also the dot convention reflects the winding's positive or negative polarities when we interface the two windings together.
- The multi-tuned circuit also known as the multi-coil transformer which consists of more than one winding either on the primary or secondary wound on a common laminated core. A multi-tuned circuit can be used as the step up and step-down circuit or the combination of both. This multi-tuning system may also include multiple secondary windings with a different voltage or a different current level output. Since the tuned circuit works under the mutual induction principle, each individual winding of a multiple winding transformer is firmly support's the same volt / ampere product per turn, which means NP / NS = VP / VS with any turn's ratio between the individual coil windings being relative to the primary supply.
- A multi-coil transformer or a multi-tuned circuit is routinely used to supply different components of the electronic circuit with adjustable lower voltage levels. In power supplies and Triac switching converters, the main application of multi tuned circuits is A multi-coil transformer / multi-tuned circuit may also have a number of distinct secondary windings that are electrically isolated from each other, as both primary and secondary windings are electrically isolated from each other. In that instance, every individual secondary coils will produce a voltage that refers to the number of turns of their coils.

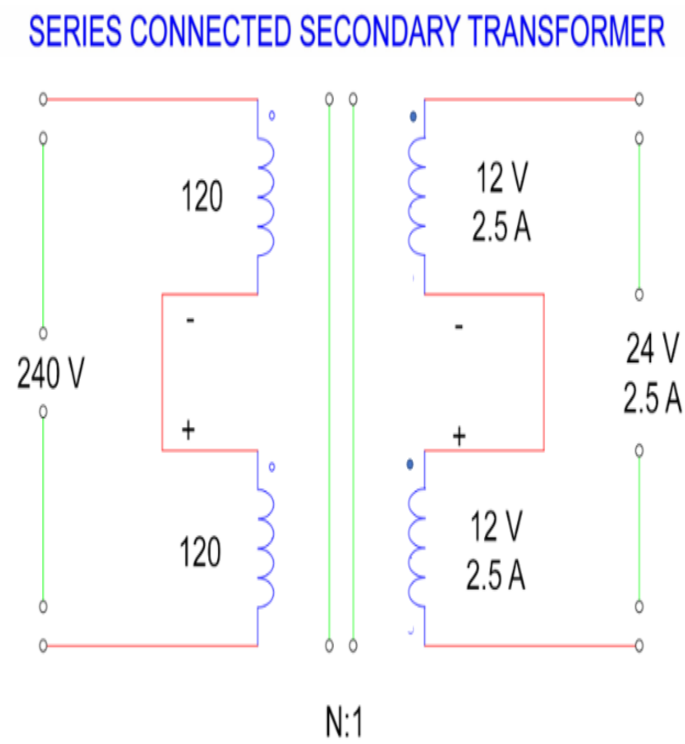


MULTI-WINDING TRANFORMER CONCEPT

Fig-1 is a typical multiple winding transformer in this case, which has multiple secondary windings with different voltage levels. The primary winding can be used separately or linked together to operate the higher supply voltage transformer

The secondary winding may be connected in different configurations to generate a higher voltage or current supply. It should be remembered that parallel winding connections are only possible if the two windings are electrically similar in order to be equal to their current and voltage ratings.

SERIES CONNECTED SECONDARY TRANSFORMER



- In this example the two 120 V rated primary winding are connected together in series across a 240 V supply as the two windings are identical. Half the supply voltage normally 120 V is dropped across each winding and the same primary current flows through both.
- The two secondary winding rated at 12 V, 2.5 A each is connected in series with the secondary terminal voltage which is the sum of two individual winding voltage giving 24 V.
- As the two windings are connected in series the same amount of current flows through each winding, as the secondary current is the same in both secondary windings which are 2.5 A. so in a series-connected secondary, the output is rated at 24 V and 2.5 A

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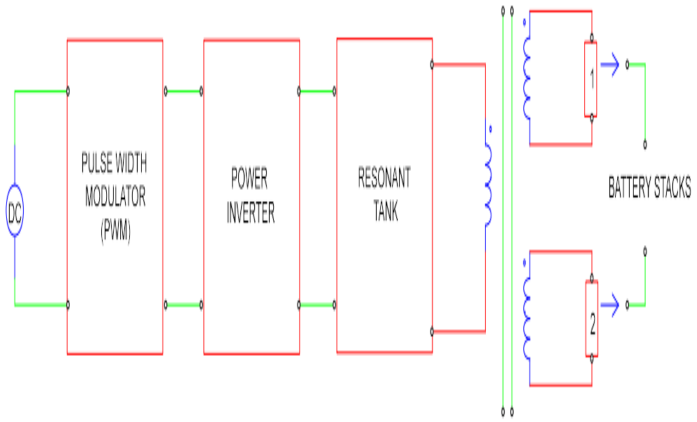
PROPOSED MODEL



PULSE WIDTH MODULATOR

A method of reducing the mean power supplied by a signal by effectively cutting it in discrete sections is pulse-width (PWM) or pulse-duration (PDM). By switching between the supply and load, the average voltage value (and current) supplied to the load is regulated at rapid speed. The higher the total power supplies to the load, the longer the switch is turned on, the higher the total power supplied to the load. The PWM switching frequency must be high enough to not affect the load.

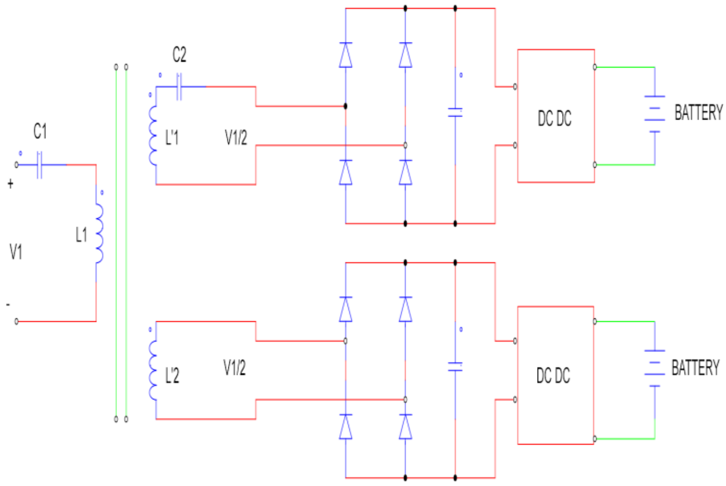
POWER INVERTER

A power converter or inverter is a power electronic unit or circuit that converts DC into AC. Each system or circuit depends on the input voltage, output voltage, frequency, and general power management. There is no power-producing inverter; the DC source provides electricity. A power inverter may be fully electrical, or a combination of mechanical and electronic effects (such as a rotary device). Static inverters do not use moving parts during the conversion process.

RESONANT TANK

The electrical circuit which mainly consists of an inductive circuit, defined by letter L, and a capacitor, represented by letter C, linked together; this type of circuit is often referred to as the resonant circuit, a tank circuit, or a tuning device. The circuit acts as an electrical resonator, a tuning fork analog, that stores oscillating energy at the resonant circuit frequency. LC circuits are either used for signal generation in a specific frequency or for signal selection from a more complex signal at a certain frequency; this purpose is known as a bandpass filter. The LC circuit is an idealized model since it assumes that there is no energy dissipation due to resistance. The aim of the LC circuit is typically to oscillate with minimal damping making the resistance as low as possible. though there is no practical circuit without losses

CIRCUIT DIAGRAME OF THE PROPOSED MODEL



CALCULATION

CASE – 1 WITHOUT MULTI-OUTPUT CHARGING
ASSUMING
RATING OF BATTERY – 120 A/HR
CHARGING CURRENT – 12 A
TIME OF CHARGING - 120/12 = 10 HOURS
NOW, IF THERE ARE 2 STACKS OF BATTERY PACK IN OUR PROPOSED MODEL.
FOR THE FIRST STACK OF BATTERY PACK
A/HR RATING = 60 A/HR
CHARGING CURRENT = 12 A
TIME OF CHARGING = 60/2.5 = 5 HOURS
FOR THE SECOND STACK OF BATTERY PACK
A/HR RATING = 60 A/HR
CHARGING CURRENT = 12 A
TIME OF CHARGING = 60/2.5 = 5 HOURS
THIS METHOD WILL CHARGING OUR BATTERY IN ALMOST HALF THE TIME TAKEN IN NORMAL CASE (WITHOUT USING MULTI-OUTPUT CHARGING)

CASE- 2- WITHOUT MULTI-OUTPUT CHARGING
TAKING HIGH CHARGING CURRENT
RATING OF BATTERY – 120 A/HR
CHARGING CURRENT – 20 A
TIME OF CHARGING - 120/20 = 6 HOURS
NOW, IF THERE ARE 2 STACKS OF BATTERY PACK IN OUR PROPOSED MODEL.
FOR THE FIRST STACK OF BATTERY PACK
A/HR RATING = 60 A/HR
CHARGING CURRENT = 20 A
TIME OF CHARGING = 60/20 = 3 HOURS
FOR THE SECOND STACK OF BATTERY PACK
A/HR RATING = 60 A/HR
CHARGING CURRENT = 20 A
TIME OF CHARGING = 60/20 = 3 HOURS
THIS METHOD WILL CHARGE OUR BATTERY IN ALMOST HALF THE TIME TAKEN IN NORMAL CASE (WITHOUT USING MULTI-OUTPUT CHARGING)

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The main purpose of this model is that instead of charging the whole battery pack at a time we instead divided the battery pack into number of stacks and thus charging each individual stack with Multi winding this will reduce the charging time as shown in the calculation.

DISCUSSION AND CONCLUSION

This paper contains a review of the Inductive wireless power transfer technologies and applications in transportation. In this paper, we have discussed the new concept and design of the multi-output wireless charging of the electric vehicle. The proposed system can independently charge several output batteries of EVs at the same time with the help of a multi output winding. As the future belongs to electric vehicles and the main problem which exists is the charging time of the electric vehicle thus by using this topology, we can actually reduce the charging time of Electric vehicles.

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