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Research Article

Design And Operation of high frequency inverter with PFC In Wireless Charging Of Electric Vehicles

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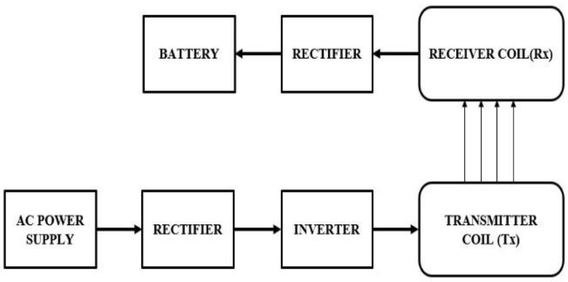
ABSTRACT

This paper presents a Wireless charging of a battery in an electric vehicle (EV) is crucial, hence the attention of the paper is on the proposal of an EV charging circuit employing a high frequency single phase inverter to achieve high voltage at receiver end by using voltage doublers. The proposed charging circuit includes a diode bridge rectifier, PFC converter, voltage double and single-phase inverter. To achieve a high output voltage on the receiver end, we use a voltage double rather than a rectifier to attain high output voltage over receiver end of the proposed system. The design and operation of the PFC converter and voltage double are explored. The purpose of a power factor correction converter (PFC) in proposed system is to increase of power factor and thus power quality. It also boosts efficiency and reduces ripple factor at dc vol. Vol. doublers is an electrical ckt. This is connected in receiver end ofthe system that creates an output value that is twice the input voltage. It is a vol. multiplier with a increase feature of 2. Hence output voltage is twice than the input voltage can be attained. To simulate and investigate a single-phase inverter, the sinusoidal PWM is selected for the planned system to achieve high frequency. Inductive power transfer (IPT) technology is used to charge electric vehicle battery. A simulation investigation of the suggested charging ckt is passed out in MATLAB / SIMULINK.

Keywords—EV, contactless, charging, PFCconverter, Voltage doublers, 20 kHz inverter

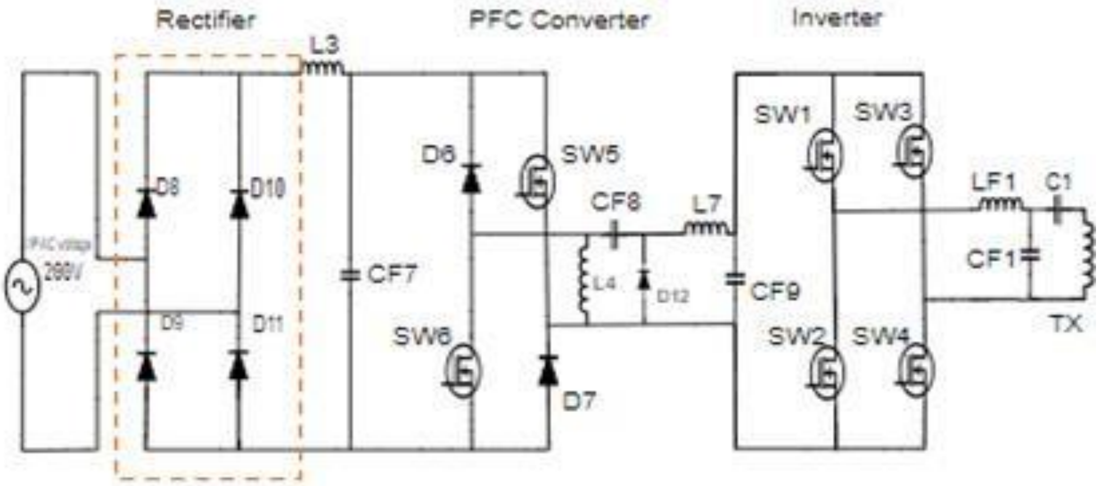


INTRODUCTION

The demand for electric vehicles has skyrocketed recently. The primary drawbacks of battery-powered cars are their high price, short range, and lengthy charging times. Customers are constantly searching for ways to improve the Efficiency of travel [1] & [2].Consequently, cable charging is now available at every petrol station. Some disadvantages of wired charging include socket locations, distance between charging stations, breaking of cables, and the requirement for the vehicle to change direction in order to connect to the charger. To address this, EV batteries now have access to a wireless charging. A method of transferring power to electrical devices for the purpose of recharging their batteries over an air gap is known as wireless charging [3]. The development of marketable devices & current progressions in wireless indicting skills have presented a possible auxiliary plan to deal with the energy traditional portable battery - powered plans are at a bottleneck

[4]. Since W P T technology has numerous intrinsic rewards over old-style power transmission methods, it has attracted aration of attention incurrent years and has been suggested for use in a variety of requests, from low - power bio/medical grafts (a few watts) to electrical vehicle chargers (a few kws) to railway automobiles (a few megawatts), with Effy. up to 96% or advanced in some sample systems [5].
A linked inductor is used in the proposed charging method, with both the main & subordinate edges fully charged. Isolated and unaffected by bodily interaction. As a result, the charging should be multifunctional, automated, safe, and user-friendly [6]. The demand for high power density, small size, and light weight without sacrificing dependability, affordability, or efficiency is driving the creation of high freq-link power converters [7]. As the demand for charging electric vehicle batteries has grown, more studies on battery charging have been conducted. We use an inductive contactless power transfer method in this paper (IPT). Two coil resonators, a 20 kHz inverter, a voltage doubler, and a PFC converter are all part of the proposed system. With a 20-kilohertz inverter High operation frequency can be attained, resulting in increased efficiency and power density. This paper includes the design and operation of PFC converter of high frequency inverter for electric vehicles, using a inductive power transfer system [8]. We use a rectifier with a PFC converter at the transmitter end, and a voltage doubler instead of a rectifierat the receiving end[9]&[10]. A vol. doubler is an electrical ckt. that creates an o/p vol. that is double as high as the i/p vol. It's a voltage multiplier with a factor of 2 for voltage multiplication [11]. The PFC converter pedals the primary side dc-link vol. and lowers (THD) of the i/p ct. Technique (SPWM) is used to emulate a single-phase inverter. The following section goes over the block diag. and ckt. Diag. of the planned system.
Fig.1 shows the block diag. of the planned system.
Section II discuss the design and operation of rectifier and PFC converter.
Section III discuss about the single-phase high frequency inverter (20kHz).
Section IV discuss about the voltage doublers on the receiver end.
Section V and Section VI shows the simulation circuit and simulation output for proposed system. Section VII discuss about the assessment between current and planned system. Section VIII provides the decision for the planned system respectively. Figure (1 & 2) shows the existing & proposed block diagram.

Fig.1.Existing blocks diag.of the planned EV system.



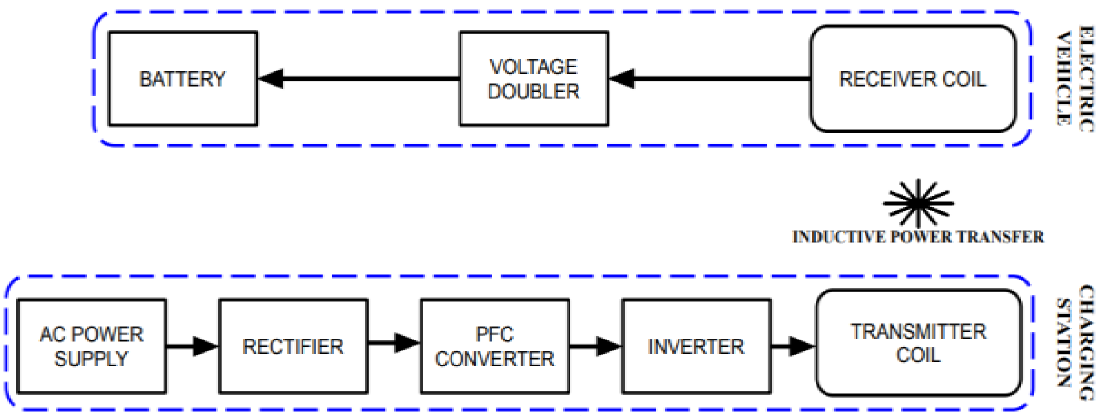
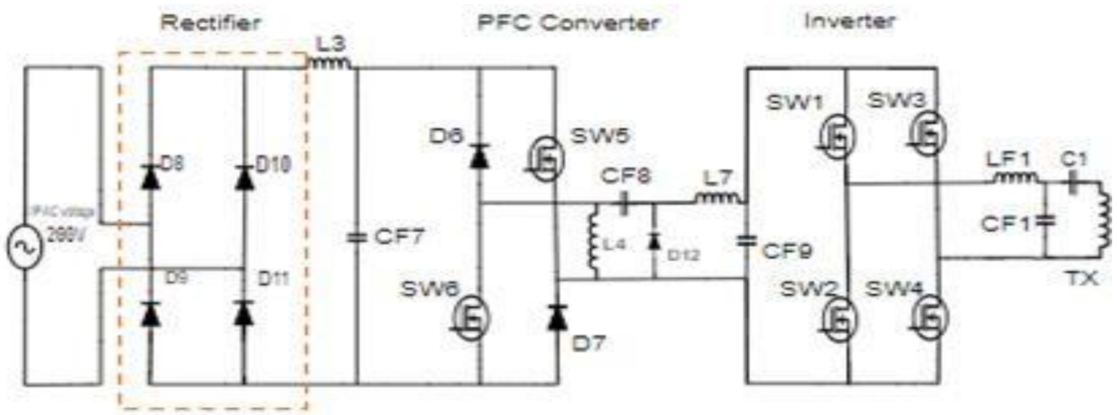


Fig.2.Proposed block diag.of the planned EV system.

RECTIFIERANDPFCCONVERTER

All AC/DC converters, in general, include a transformer after input filtering, which then goestoarectifier to produce rectified DC. Multi-stage conversion topologies are used in AC-DC converters. MOSFETs are employed as rectifiers in diode bridge rectifiers, which only carry current in one direction. During the positive half cycle of the i/p. volt, the higher end of the t/f. sec. winding is positive relative to the lesser end. Because of this, ct. flows through the load resistance during the first half of the cycle through diodes D1 and D3. Due to their reverse bias, the diodes D2 and D4 prevent current flow during the negative half of each input cycle,as shown in Fig.3. The secondary winding of the transformer has a positive relationship between its lower and higher ends during the second half of the i/p. volt. Cycle. Due to the onward biassing of diodes D2 and D4, ct. might flow through arm CB and into the load resistance. The process of connecting N PFC converters in similar at the equal switch freq. but with a 360/n phase shift is referred to as "interleaving".



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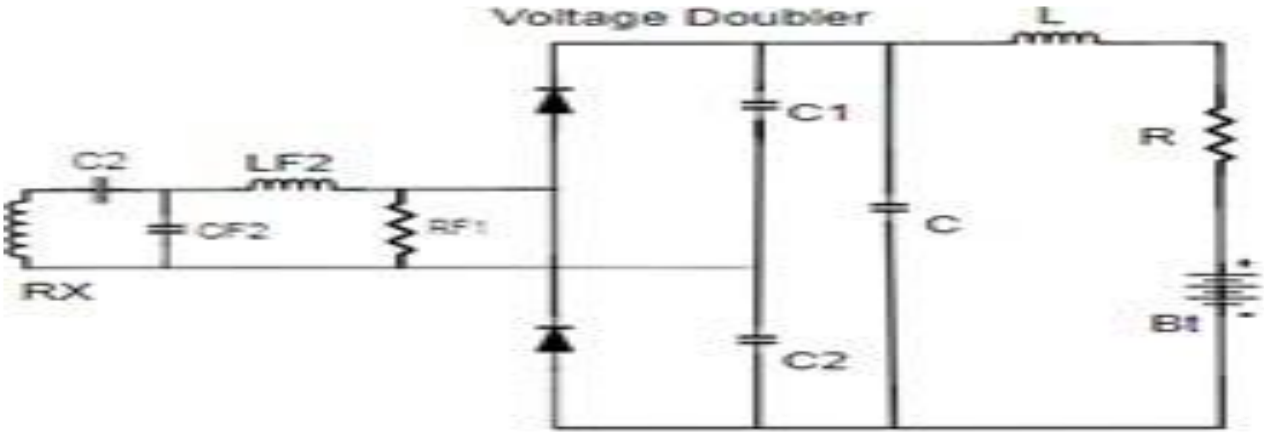
Power factor correction (PFC) is a set of techniques used by electronic device makers to increase the power factor of their products. Low ripple content in i/p & o/p vol, lowered top ct. charge, and high ripple freq. are all advantages of a PFC converter. As a result, there is a high level of efficiency and dependability. Because the planned converter runs at a high freq., the size and dead of the planned converter are significant. In this paper, a two-phase PFC converter is investigated, with pulses to switches exiled by180 deg. When compared to a typical converter, this divides the current flow into two routes, resulting in lower conduction (I2R) losses and higher overall efficiency. Because the 2 phases are merged at the o/p cap., the ripple freq. is doubled, making ripple vol. reduction calmer. Similarly, as the input capacitors are staggered, the ripple needs are lowered.

SINGLEPHASE20KHZFREQUENCYINVERTER

The inverter is a key component in the alteration of secure dc to flexible ac. RES or a dc source obtained from an ac supply can both be used as inverter inputs. The single-phase inverter is made up of two arms, each of which comprises four semiconductor switches coupled byan anti-parallel diode. The opposite ct. passes via anti-parallel diode when the s/w are turned off. The s/w's (S1, S2, S3, and S4) are switched on in order to prevent any switch on the same leg from conducting, resulting in a' shoot-through problem.' However, both switches were switched off for a period of time known as blanking time to prevent short circuiting. The power transfer in is determined by the bus volt, operation freq, and common inductance between the 2 inductive pads. The frequency is kept constant and equal to the resonant frequency to produce the lowest commutation losses. Extreme power will be obtained for supremebus volt. and maximum common inductance. The alignment of two inductive coils is quite important. Maximum coupling is achieved when two coils are close to one other, and when 2 coils are parted, the bus volt. is condensed. As a result, single-phase inverter features limit the alignment characteristic of inductive power transfer systems. An iterative design approach must be framed in order to keep inductive coils aligned properly. The resonant freq. is solely resolute by the self-inductance values of each inductive pad.

VOLTAGEDOUBLER

To obtain a dc output voltage that is twice as high as the input voltage, a voltage doublers is utilized instead of a rectifier circuit at the receiver end as shown in figure 4. A voltage doubler is a multiplier circuit that doubles the highest possible amplitude of the ac i/p supply volt. to produce a dc o/p volt. As the name suggests a volt. doubler is a volt. multiplier circuit with a volt. multiplication factor of 2. The ckt. consists of just two diodes, two capacitors, and an oscillating AC i/p volt. (a PWM waveform might also be used). The peak-to-peak value of the sinusoidal i/p. is equal to the DC o/p volt. of this simple diode-capacitor pump circuit. Stated differently, the reason the diodes and capacitors effectively double the voltage.



Results & Discussion

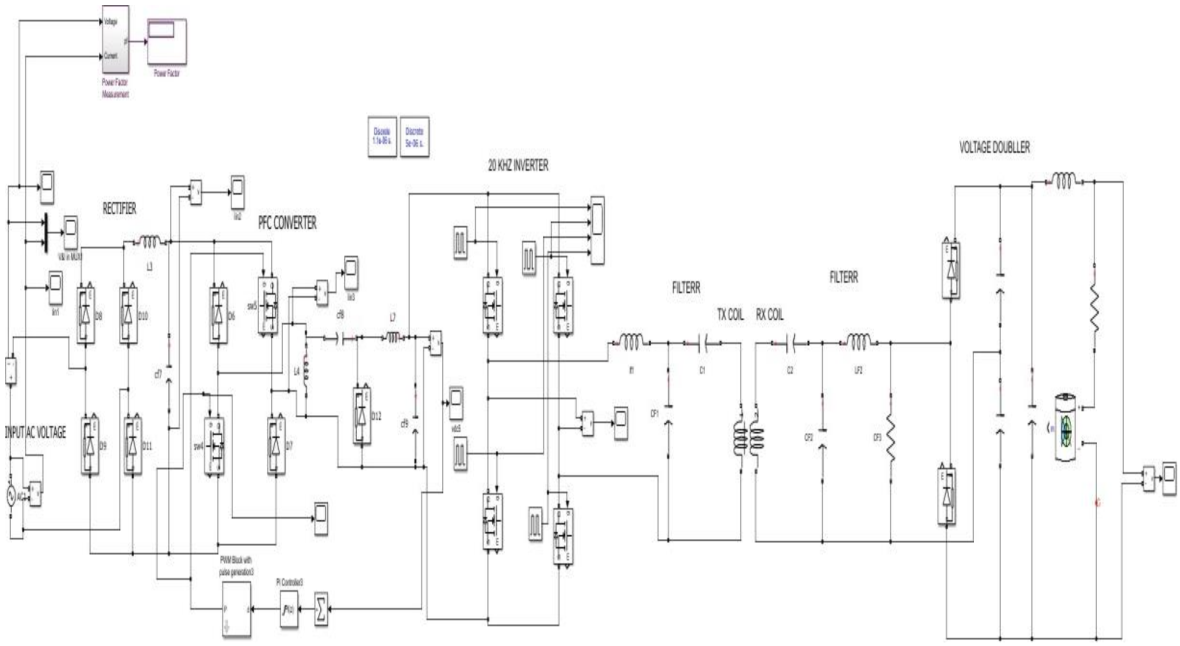


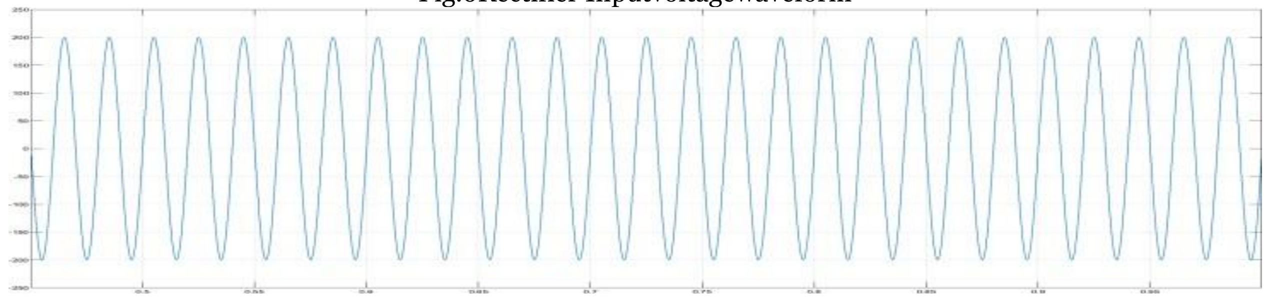
Fig.5Simulationcircuitoftheproposedsystem

TABLE1SpecificationsforwirelesschargingofEV

PARAMETERS	RATING
InputACVoltage	200V
Rectifier Input Voltage	200V
OutputVoltage	190V
Inductor	3.8mH
Capacitor	330µF
PFCConverter OutputVoltage	220V
Inductor	70µH
Capacitor	330µF
Inverter OperatingFrequency	20kHz
OutputVoltage	220V
Inductor	40µH
Capacitor	79.68nF
SecondarySideVoltage	24V
VoltageDoubler OutputDCVoltage	350V
Inductor	500mH
Capacitor	200µF
BatteryRange	6.5Ah

The simulation studies are passed out in MATLAB / SIMULINK with i/p. volt. of 200V. The simulation outcomes are presented below. The conditions are registered in TABLE.I.

Fig.6Rectifier Inputvoltagewaveform



In Fig. 6, input voltage waveform, fig. 7 shows the rectifier o/p is seen. In Fig. 8, the power factor correction output, fig. 9 shows the output of reduced ripple factor. In fig. 10 & 11, shows o/p volt. of the simulated single-phase inverter with sine PWM and filter.Fig. 12 shows the secondary side inductive coil's o/p volt.Figure 13 displays the charging circuit's o/p. volt.

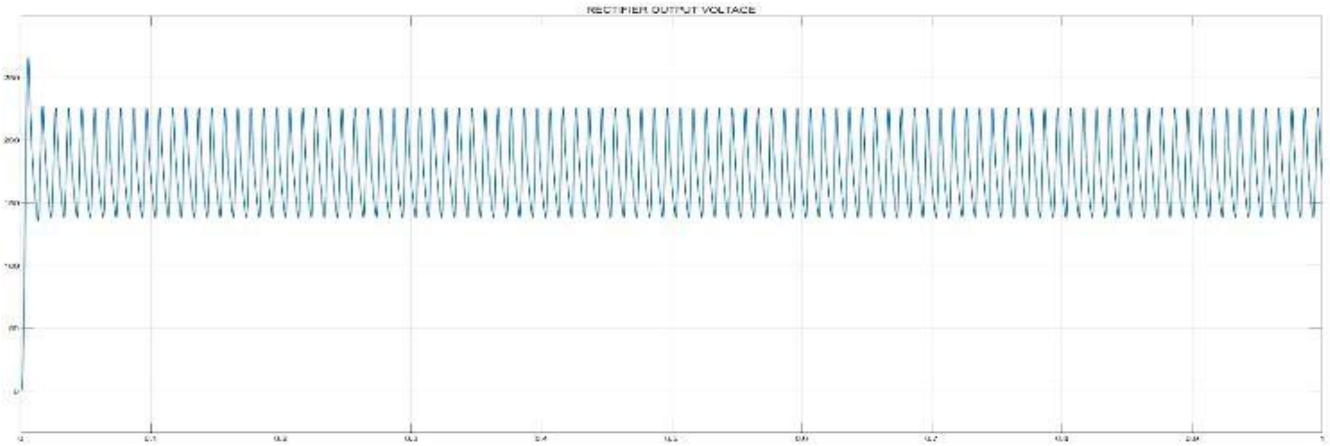


Fig.7Rectifieroutputvoltagewaveform

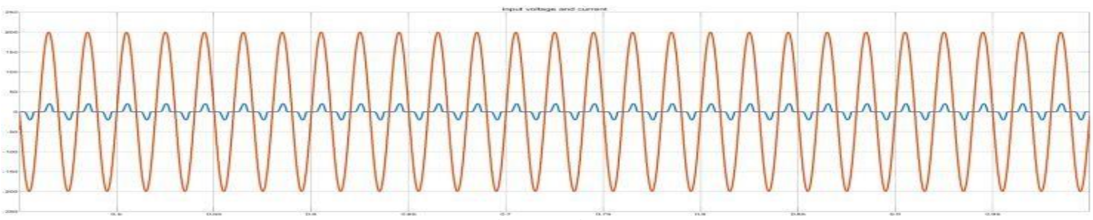


Fig.8.Outputofpowerfactor correction

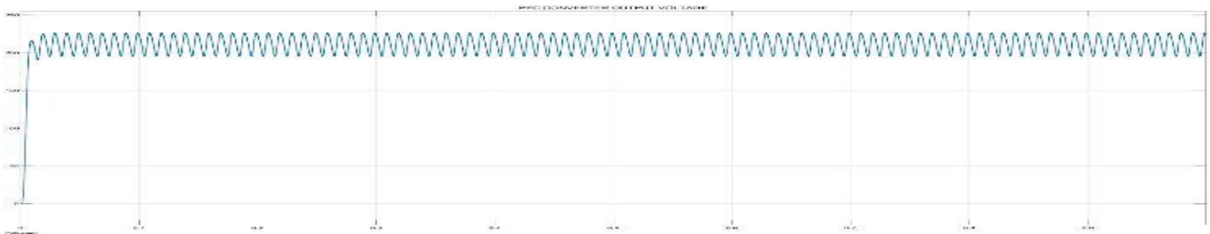


Fig.9PFC Converter Output voltage

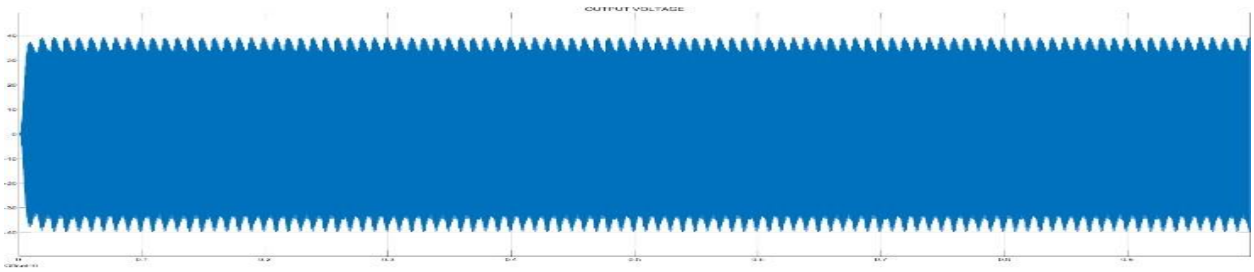


Fig.10Inverteroutput voltage

Fig.11Inverter Gate Pulse

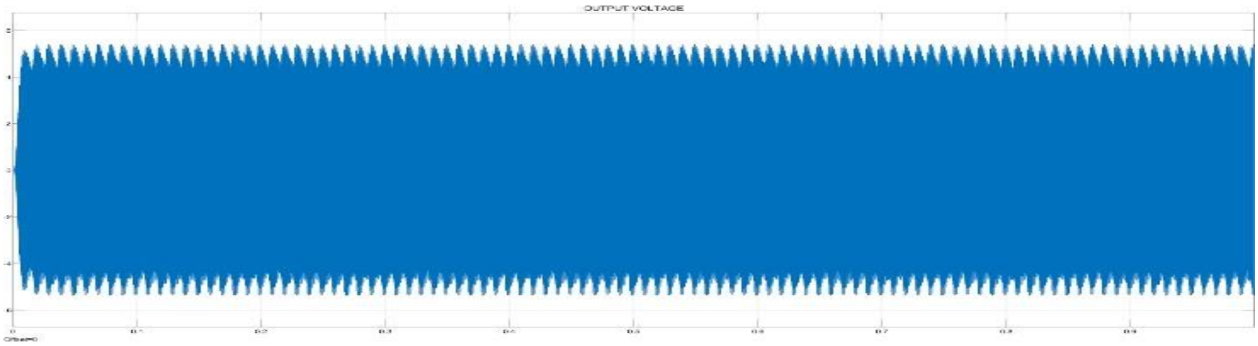


Fig.12Secondarysidecoiloutput voltage

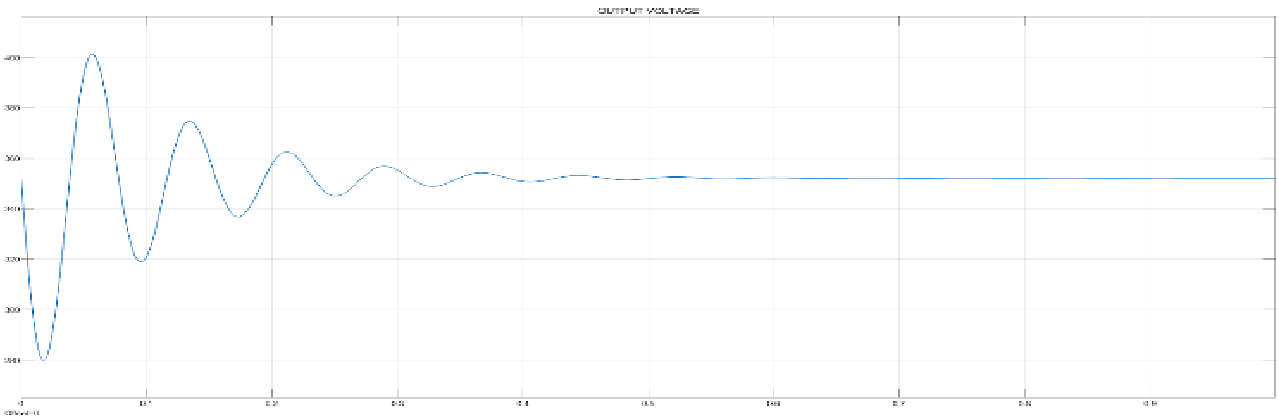


Fig.13Outputvoltageofcharging circuit

COMPARISONOFPROPOSEDSYSTEMANALYSIS WITH EXISTING SYSTEM

PARAMETERS	EXISTINGSYSTEM	PROPOSEDSYSTEM
InputACVoltage	220V	200V
Rectifier Input Voltage	12V	200V
OutputVoltage	12V	190V
Inductor	-	3.8mH
Capacitor	1mF	330μF
PFCConverter OutputVoltage	-	220V
Inductor	500μH	70μH
Capacitor	220μF	330μF
Inverter OperatingFrequency	16kHz	20kHz
OutputVoltage	22V	220V

Inductor	33mH	40µH
Capacitor	220µF	79.68nF
SecondarySideVoltage	12V	24V
VoltageDoubler OutputDCVoltage	-	350V
Inductor	33mH	500mH
Capacitor	220µF	200µF
BatteryRange		6.5Ah

TABLE.2Specifications of existing system compared with proposed system.

CONCLUSION

The proposed charging circuit has been tested and found to provide twice the input voltage. The wireless charging circuit Simulink model is built, and the results are discussed. The primary advantage of this design, which allows a PFC converter to be used on the transmitter side to maintain power factor during AC to DC conversion while also lowering ripple factor. The output of a PFCconverter is fed in to a singlephase20kHz frequency in order to convert dc voltage to alternating current voltage using the SPWM technique. This technique allows for the output AC voltage's harmonics content to be completely removed. To get dc output voltage that is twice the input voltage, a voltage double is utilized on the receiver end in place of a rectifier. The MATLAB/SIMULINK platform was used for the simulation. With the use of simulation, a comparison of the proposed and existing systems shows that the suggested topology has higher output dc voltage, less overall harmonic distortion, less ripple content, and more efficiency than the latter. In this paper, the simulation's outcomes are illustrated. Future work on the aforementioned project may be expanded to boost the effectiveness of wireless charging for electric vehicles by constructing the coils and widening the space between them to withstand the power of the proposed system.

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