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A Study On CurrentFed Topology For Wireless Resonant Inductive Power Transfer Intelligent Battery Charging System of Electric Vehicles

Mr. Kuppireddy Krishna Reddy[1]

[1]Associate Professor, Department of Electrical and Electronics Engineering,
[1]Mother Theresa Institute of Engineering & Technology, Palamaner, Andhra Pradesh, India.
ORCID:0009-0000-8855-7863

Mr. Bosubabu Sambana[2]

[2]Assistant Professor, Department of Computer Science and Engineering,
[2]Raghu Engineering College (A), Visakhapatnam, JNTU Kakinada, Andhra Pradesh, India.
ORCID: 0000-0002-8665-9441

Abstract: New-age power generation systems based on renewable energy systems (RES) mainly constitute wind generators, solar PV, fuel cells, etc. Energy harvesting from solar PV or fuel cells calls for high step-up inversion owing to its low-voltage input. In this paper, battery-supported transportation systems called electrical vehicles (EV) and wireless charging topologies are presented. A conventional voltage source inverter (VSI) can only produce an AC output smaller than its input DC voltage under normal operation. VSI also requires dead-time compensation circuits as the shoot-through of an inverter leg is detrimental to its operation. The techniques are majorly based on current fed dc-dc converter topologies. Recently developed ZSI and its derivatives overcome these problems by allowing shoot-through and providing output AC voltage with buck-boost capability. This paper proposes a Current-Fed DC/DC Topology (CFT) based inverter which shows similar gain characteristics and advantages as the ZSI. This paper presents a detailed evaluation of electrical parameters, a comparison of various qualitative features of power transfer techniquesfor EV application, and the control strategies and challenges for EV battery charging. The proposed inverter requires only one LC-pair which is one less than the impedance network of ZSI. The proposed inverter is derived from CFT. The PWM control strategy of the inverter is explained. The parameters are evaluated and the results are presented in MATLAB/SIMULINK.

Keywords: Current-Fed Switched Inverter, electric vehicle, voltage source inverter (VSI), and Z-source inverter (ZSI).

I. INTRODUCTION

At present, worldwide on-road transportation primarily relies on petroleum. This causes the emission of enormous amounts of greenhouse gases, thereby making it harder to satisfy stringent environmental regulations [1].Transportation electrification enables the utilization of energy not only from fossil fuels but also from variable dc sources, such as hydropower, solar-PV, and wind power. In traction applications, the electrification of rail roads has been fully achieved in the past many years. However, there are some obvious challenges for the large-scale deployment of electric vehicles (EVs) [2]. Therefore, the mass deployment of EVs was never realized in spite of several government initiatives such as subsidies and tax incentives. Recharging an EV battery takes at least a lot more time than that required for refueling gasoline cars. Therefore, EVs cannot get ready immediately if the battery charge is over.

As the AC output of the traditional voltage source inverter (VSI) is always lower than the input DC-link voltage, a front-end DC-DC boost converter or a back-end high step-up transformer is added to get the necessary boost inversion.

Charging cables of EV is inconvenient and may lead to tripping, leakage due to aging of cracked old cables, and other additional hazards especially in cold zones. Wireless charging is convenient, safe and reliable due to elimination of direct electrical contact. The power transfer is unaffected in intimidating environment such as snow, water, dirt, wind, and chemicals. It provides galvanic isolation. Besides these general advantages, the WPT technology has merits which are specific to particular applications. In biomedical implants, for e.g., in

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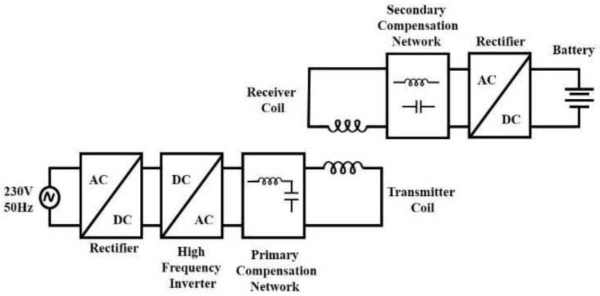
heart pump battery recharging, WPT technology is the most practical and convenient [5-6]. Similarly, WPT has found wide acceptance for recharging batteries of electronic gadgets, lighting, chemical plants, and underwater vehicles, etc. due to its flexible usage and the ability to prevent damages to the charging port



To connect capacitor in primary and secondary coil to compensate the reactive power is it the simple and short method for improvement the resonance frequency. Basically four basic types of compensation networks possible with this method i.e. series- series (SS), series-parallel (SP), parallelseries (PS) and parallel-parallel (PP). For inversion stage as current source inverter (CSI) than the primary side be connected as parallel connection of resonance compensation is quite common.

nverters with step-up transformers having a high turnsratio are generally bulky and modularity of the design is lost due to its weight and space requirement. Thus, the alternate way is to go for a transformer-less, more efficient and modular solution [1]-[3]. In transformer-less applications, conventionally, an inverter is cascaded with a high boost DC/DC converter [4]. Maximum gain of conventional boost, cascaded boost converters, or quadratic boost converters is limited which is achieved at extremely high duty-ratio (D), i.e., at near unity dutyratio. When a boost converter operates at near unity dutyratio, the diode and the output capacitor has to sustain a current of high amplitude with very small pulse-width. Also, at extreme duty-ratio operation, regulation of output voltage during load change becomes difficult as an increase in duty-ratio will result in decreased gain after peak gain point [5]. Converter with coupled inductor can deliver high gain without extreme duty-cycle operation, but the switching surge voltage due to leakage of the inductors result in associated losses and requirement of high-voltage-rated devices. Use of regenerative snubber or active voltage clamp circuits [6], [7] can prevent production of switch surge and minimize leakage loss but these methods increase circuit complexity and extra loss in the snubber or clamp circuit. Single switch high gain DC/DC converters using four terminal switched cells and switched-capacitor cells are presented in [8]. Though high gain at reduced switch stress is obtained, the number of passive circuit components and diodes are higher than the conventional boost topologies.

This voltage decides the inverter switch voltage rating. In this way, this limits theuse of current-fed topology in higher power applications, for example, EV battery charging [10]. The main advantage of current fed topology is lower current stress, short-circuit protection and high reliability.

In recently developed Z-Source Inverter (ZSI), Quasi-ZSI (q-ZSI) (shown in Fig. 1 (a) and Fig. 1 (b) respectively) and their derivatives, a network of passive elements is sandwiched in between the voltage source (or the DC-link capacitor) and the inverter structure to allow shorting of an inverter leg [9],[10]. Shoot-through state of the inverter enables it to have buck-boost capability and improved EMI noise immunity. However, a large dc inductor is required, this increases the efficiency and power transfer capability. The power flow direction is unidirectional or bidirectional. EV Battery Charging technologies have developed many different methods . The Different methods and coil air gap distance. The presentation of work is reviews the development for inductive power transfer of electric vehicle battery charging application, the inductive power transmission system is shown in Fig. 1.

II. THE STATE OF ART ON INDUCTIVE POWER TRANSFER SYSTEMS

Wireless Power Transfer System Implementation of wireless charging in EV applications provides remarkable outcomes. Along with the aforementioned merits, it can reduce the battery storage requirement to 20% through opportunistic charging techniques [8-9]. For EVs, opportunistic charging is possible by placing the wireless chargers in different parking areas, for e.g., home, office, service, shopping complexes and other general parking areas. Also, these chargers can be installed in the traffic signal areas for quick recharging. For recharging electric buses it can be installed in bus terminals, bus-stops and traffic signals. Three types of WPT

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Technologies In this section a brief overview and qualitative comparison of all the possible WPT technologies are reported in Table I. Based on this study, the most effective technology is selected for medium power (fraction of kW to several kW) and midrange air gap (about 100mm-350mm) applications, which are especially suitable for EV battery charging.

B. Inductive WPT Inductive charging application for the most part comprise of an source side power converter, an inductive interface transformer, and an load converter [10]. The interface transformer is distinct along the attractive circuit with the goal that one of the windings can be physically evacuated, dispensing with the requirement for ohmic, i.e., metal-tometal, contact of electric wires. In such a transformer, the shape and area of the attractive center material and windings are significant structure decisions. This technology is already implemented in EV charging systems such as the GM EV1 [11] as shown in Fig. 2. The charging point of pin (the essential coil) of the inductively coupled charger is fixed in as it is done in the auxiliary. The embedded into the focal point of the auxiliary curl allowed charging of the EV1 with no contacts or connectors at either 6.6 kW or at 50 kW.

C. Capacitive Power Transfer The Wireless power transfer by capacitive than its known as (CPT) technology is the alternatively wireless power transfer solution. [10]. Fig. 3 shows a typical CPT system fed from a half bridge current source inverter and the primary /transmitter and secondary/receiver side compensation networks are LC type. As shown in Fig. 3, the pair of coupling capacitor as connect across interface around. The operating principle is same as usual parallel capacitors, where the dielectric medium is only air. Inductive coupling requires LC compensation networks. This technology finds suitable applications in low power level such as biomedical implants, or in charging of spaceconfined systems such as robots or mobile devices [11], [12], [3]. Its design flexibility and low cost make it ideal for power delivery in reconfigurable and moving systems, such as robot arms, latches, and in-track- moving systems [11]. However, owing to lower power density, the CPT technology is not preferred for higher power applications such as EV charging [7]

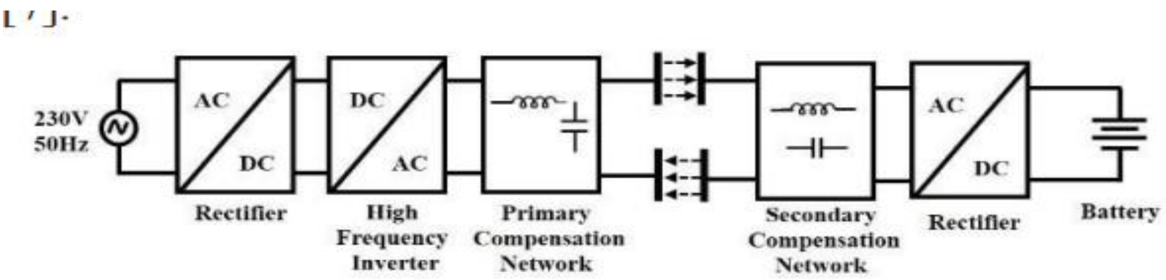

Fig. 3. Capacitive power transfer system.

Battery Swapping System It is possible to recognize in the previous lines one of the greatest disadvantages of EVs: the recharging procedure can take up to hours to be completed. An alternative approach in order to speed up the "refueling" is called "battery swap".

Fig. 4 consists of a physical substitution of the discharged a dedicated station [4]. This action can eliminate the delay related to the fully charged. Battery Swapping introduces different advantages to the electric vehicle sector. The main ones are: x Fast battery swapping operation, it takes less than five minutes; x Problems of limited driving range are solved where battery switch stations are available; x Drivers do not get out the car during the replacement of the battery; Drivers do not own the battery and costs related to its management are transferred to the services, enhancing the evolution towards smart grids [9]. However, also severe drawbacks should be considered. The major issue is the huge costs of the components needed to obtain an efficient switching station. Moreover, in order to perform battery swap it is necessary to have suitably designed cars

A. Wired System and Wireless System Comparison Electric vehicles were reintroduced in the last few decades as a reaction to the environmental sensibility that we, as humans, developed [11]. Moreover, the volatility of fuel prices and reduction of electricity bills made investments in this field more interesting. At the beginning, designers had to find a way to recharge the on-board batteries in a manner that could be comparable to the way

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we already fill the tanks of traditional cars or somehow even better. That was and still is a challenging target since at present, no EV storage can be charged as quickly as any internal combustion vehicle tank filling. Concerning technical issues, they can be discussed: Electrical danger represented by insulation breakdown due to aging of the component, fulguration is a real possibility; The same security is endangered also by external events that could put at stake safety of the charging operation; Interoperability is not ensured in most of the cases, car manufacturers developed proprietary plugs; The electrical pins must be thoroughly cleaned from dust and debris in order to perform an optimal connection between car and recharging tower. On the other hand, from an amenity point of view it can be said: The cable is not aesthetic; It requires some manual actions that make it not very functional. Resonance power transfer up to approximately 10 meter and operating frequency is in the MHz range. However, for several kW power transfer with air gap suitable for EV applications, this RAPT technology is essentially same as IPT technology.

III. INDUCTIVE POWER TRANSFER SYSTEM POWER CONVERTER

For wireless charging systems of EVs, power electronics play an important role for maximum system efficiency at power conversion stage. This is very crucial for primary stage of wireless charging of EVs. Therefore, in power conversion stage, half bridge or full bridge is preferred. Because of the alternating current in the magnetic coupling between the loops, input voltages over the essential and the optional side are exchanging. Two control converters are required, one in the essential side and the other one in the optional side. In the essential side, a twofold stage is commonly utilized, consisting of an AC-DC and a DC-AC (this DC-AC is the one featured in Fig. 5 and Fig. 6). The objective of this twofold stage is to build the power transfer from 50 Hz (or 60 Hz) of the network to kHz of the IPT. In the auxiliary side an AC/DC stage is required. The recent research for the most part, centersaround the essential DC segment and the auxiliary DC segment. The increase in reactive current losses increases the VA ratings of the input source as more active power transfer to the load is required. To avoid this, compensation networks are used in parallel and series configuration. A. Primary Side DC-AC Various arrangements be explored, about the essential conversion is DC/AC organize and the optional AC/DC arrange. To the extent the auxiliary plane is concerned, two conceivable outcomes have been predominantly abused to interface the optional source side to the load side battery: either an aloof rectifier in addition to a DC-DC converter or a functioning AC-DC arrange. [7]. Generally, the half bridge or full bridge converter topology for primary side to transmit the power quality capability is preferred. Full bridge current fed converter is used in this work, with this a higher voltage transfer capability is possible.

B. Secondary Side AC-DC In the optional side, an AC-DC stage is required to change over the AC voltage emerging from the inductive power move into a DC voltage valuable to supply the battery. As per issues of proficiency and controllability, two elective arrangement are usable for the AC-DC organize: a detached rectifier or a functioning rectifier. AC/DC converter is used to correct the power factor at the utility to meet the load total harmonic distortion (THD). The primary side, a constant DC voltage is converted to high frequency voltage pulses with adjustable duty cycle which is fed to the compensation network. After this, different compensation networks are used depending on application. For optimum power transfer, load impedance needs to be matched with the source impedance. The passive rectifier regularly comprises of a customary four-diode connect which essentially corrects the AC sign emerging from the attractively coupled curls. The delivered DC voltage must be prepared so as to supply the batterypowered battery. Along these lines, a DC-DC middle of the road stage is required between the detached rectifier and the battery, with the goal that the charging current can be appropriately controlled. This solution is shown in Fig. 7. C. Classifications Based on Power Converter Topologies The input power of IPT inverter is usually supplied from a dc source, such as PV modules or a rectified ac grid. The purpose of this converter is to feed high frequency ac to primary resonant tank, and maintain load power to desired level. A number of IPT power converter topologies are reported in literature, and these are classified as follows. 1) Voltage Source Inverter Topologies: However, the output voltage of the neutral point between two capacitors is normally unbalanced during the switching process of two switches. Another limitation of the half-bridge topology is that the converter can only generate ac output with the amplitude of $\pm v_{dc}/2$, which limits its application only in lower power. Therefore, in practice, H-bridge converters are preferable in most of applications. The voltage source inverter topologies are shown in Fig. 8

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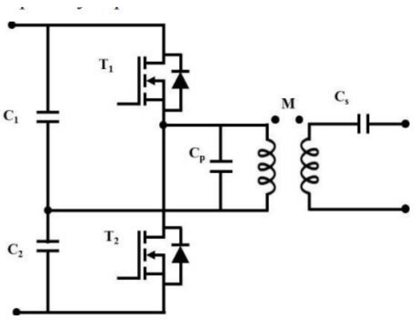

Fig. 5. Half Bridge DC-AC Converter.

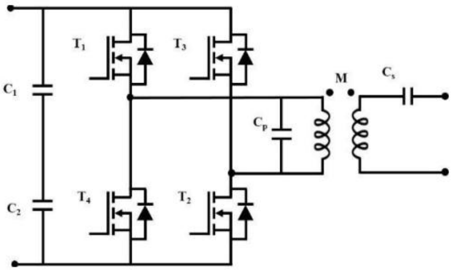

Fig. 6. Full bridge DC-AC converter.

2) Current Source Inverter Topologies: Occasionally, current source inverter (CSI) is also used in IPT systems [5-7]. Fig. 9 shows the existing IPT systems fed from a current-fed push-pull inverter, where the transmitter coil tank network is parallel LC type. Following merits of these systems are reported in literature. The evaluated parameters for inductive

power transmission are shown in Table II.

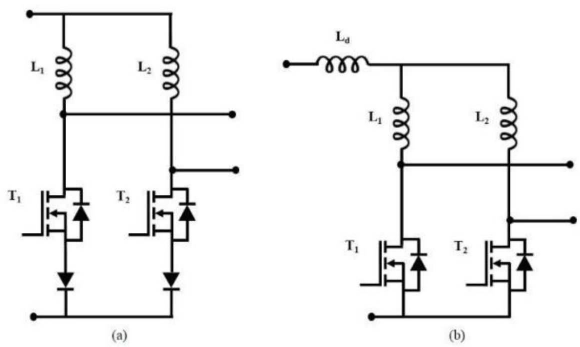

Fig. 9. Current source inverter topologies

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TABLE II. EVALUATED PARAMETERS FOR INDUCTIVE POWER TRANSMISSION

Parameters	Values
Output Voltage, V_0	48V
Output Current, I_0	12A
Source Votage, $V_{s,\ rms}$	44V
Source Current, $I_{s,\ rms}$	15A
Inverter Votage, $V_{peak,\ rms}$	230V
Load Resistance, R_0	10Ω
Input Inductance, L_d	56µH
Primary Inductance, L_p	39µH
Secondary Inductance, L_s	28µH
Mutual Inductance, M	7.6µH
Primary Capacitor, C_p	100nF
Secondary Capacitor, C_s	150nF

IV. INDUCTIVE POWER TRANSFER MODELLING CURRENT-FED CONVERTER

Resonant Antennae Power Transfer (RAPT) is also pioneered and patented by Nikola Tesla, and has recently been studied by MIT [13] and Intel. The fundamental operating principle of this technology is similar to IPT. The air gap length can be much longer than IPT system due to use of high-quality factor coils and high frequency of operation. The possible at distances up to approximately 10meters and operating frequency is in the MHz range. However, for several kW power transfer with air gap suitable for EV applications, this RAPT technology is essentially same as IPT technology. Evaluated power transfer capability in this technique is observed for a VA rating, power input from the source is transferred to the load. The reactive current increases due to losses, to avoid this, high compensation networks are connected to cancel the leakage inductance. A typical current fed converter for WPT application is shown in Fig. 10, for lower circulating current, parallel resonance is employed. Parallel capacitors form the low impedance path for circulating current path. Voltage stress increases with power transfer.

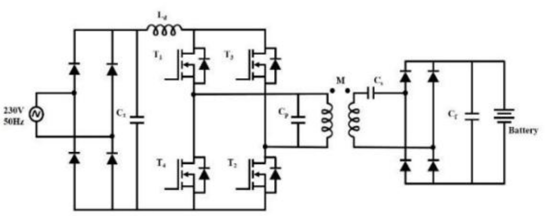

Fig. 10. Schematic diagram of current-fed inductive power transfer system for a single transmitter and receiver.

General Resonance Compensation Topologies In a typical IPT system for EVs, there are four basic topologies: SS-connected, SP-connected, PP-connected and PS-connected circuits are shown in Fig. 11 [14]. The advantages are high power transfer with quality power supply, minimized VA rating, constant voltage, constant current depending upon load application, high efficiency, bifurcation tolerance, high misalignment tolerance.

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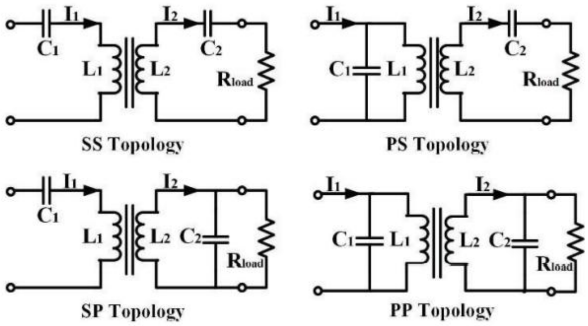
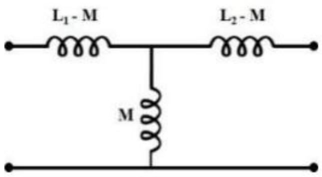


Fig. 11. Resonance topologies.

Using a mutual-inductance model, the equivalent circuit of the resonant inductances is shown in Fig. 12, where M is the mutual inductance between the transmitting and receiving coils or pads.



ig. 12. Equivalent circuit of inductances.

A. Modeling of Resonance Inductive WPT The essential Equivalent circuit outline for P-S Compensation Current-bolstered reverberation inductive remote force transmission is appeared in Fig. 13. The transmission of intensity yield proficiency can be determined.

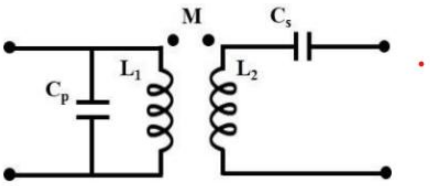


Fig. 13. Compensation circuit.

The transmitting voltage,

$$\bar{V}_1 = \bar{I}_1 r_1 + jw L_1 \bar{I}_1 - jw M \bar{I}_2 \qquad (1)$$

$$jw M \bar{I}_1 = jw L_2 \bar{I}_2 + R_L \bar{I}_2 \qquad (2)$$

Transmitting and receiving coil currents,

$$\bar{I}_2 = \frac{jw M \bar{I}_1}{jw L_2 + r_2 + R_L} = \frac{jw M \bar{I}_1}{Z_2} \qquad (3)$$

Z2 is equivalent impedance receiving side, Equation (4) in (1)

$$\bar{V}_1 = r_1 \bar{I}_1 + jw L_1 \bar{I}_1 + \frac{\omega^2 M^2}{Z_2} \qquad (4)$$

Total Impedance (Z t) from transmitting coil

$$Z_t = r_1 \bar{I}_1 + j\omega L_1 + \frac{\omega^2 M^2}{Z_2} \qquad (5)$$

Z r Reflected impedance

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$$Z_r = \frac{w^2 M^2}{Z_2} \qquad (6)$$

Equation (2) and (6)

$$k = \frac{M}{\sqrt{L_1 L_2}} \qquad (7)$$

(since: k=0.1 to 0.5 range)

$$\frac{\bar{I}_2}{\bar{I}_1} = \frac{jw\ M}{R_L + r_2 + jw\ L_2} \qquad (8)$$

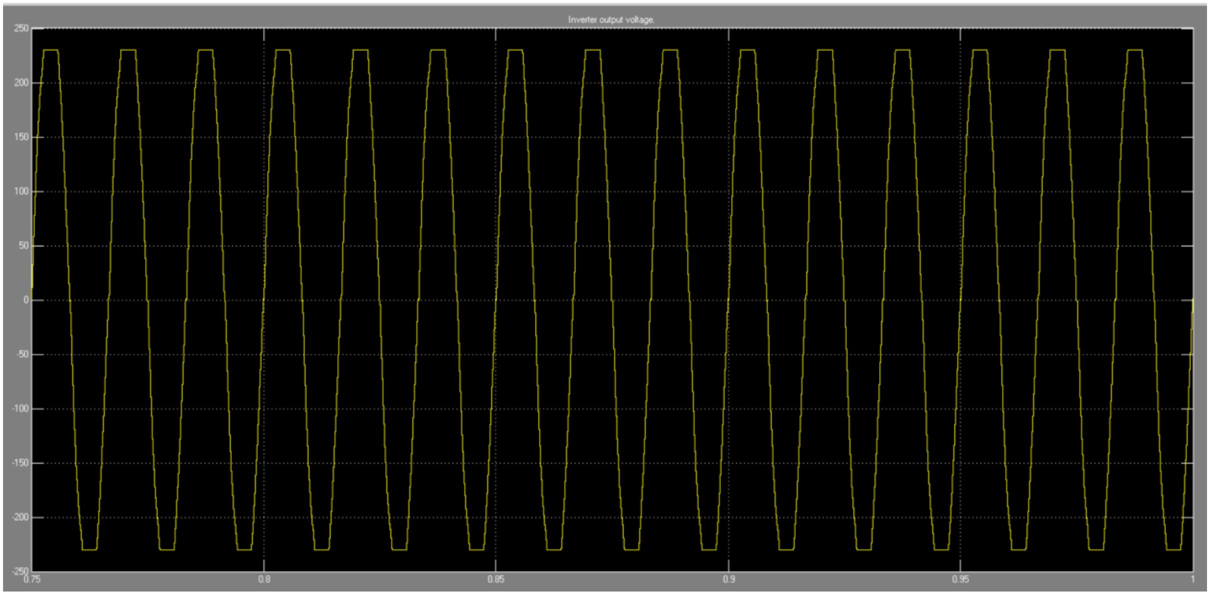
Inductive power transfer efficiency, maximum power transfer is given equation (9) and (10)

$$\eta = \frac{|\bar{I}_2|^2 R_L}{|\bar{I}_1|^2 Re\{Z_t\}} = \frac{R_L}{r_1 \frac{L_2^2}{M^2} + (R_2 + r_2)\left[1 + \frac{r_1 (R_L + r_2)}{w^2 + M^2}\right]} \qquad (9)$$

$$P_{L,max} = \frac{1}{2} \frac{(\omega\ M\ I_1)^2}{\omega L_2} \qquad (10)$$

Here by we observed that from the compensation of P-S compute the electrical components for pursue of mutual inductance value that have been give performance of the characteristics. In P-S configuration, the main advantages of the impedance transferred are high efficiency, high power factor at relatively low mutual inductance, large range of variation of load, but the power factor is not at unity, current fed input avoids any instantaneous changes in voltage, primary capacitor depends on load and coupling factor, inverter device voltage is higher, it does not allow zero coupling, but in voltage source it allows. The evaluated parameters are simulated in MATLAB/Simulink and the performance of transmitter coil for inductive power transmission is shown in Fig. 14, performance of receiver coil for inductive power transmission is shown in Fig. 15. The load voltage and load current are shown in Fig. 16

V. RESULTS



(a) Inverter output voltage.

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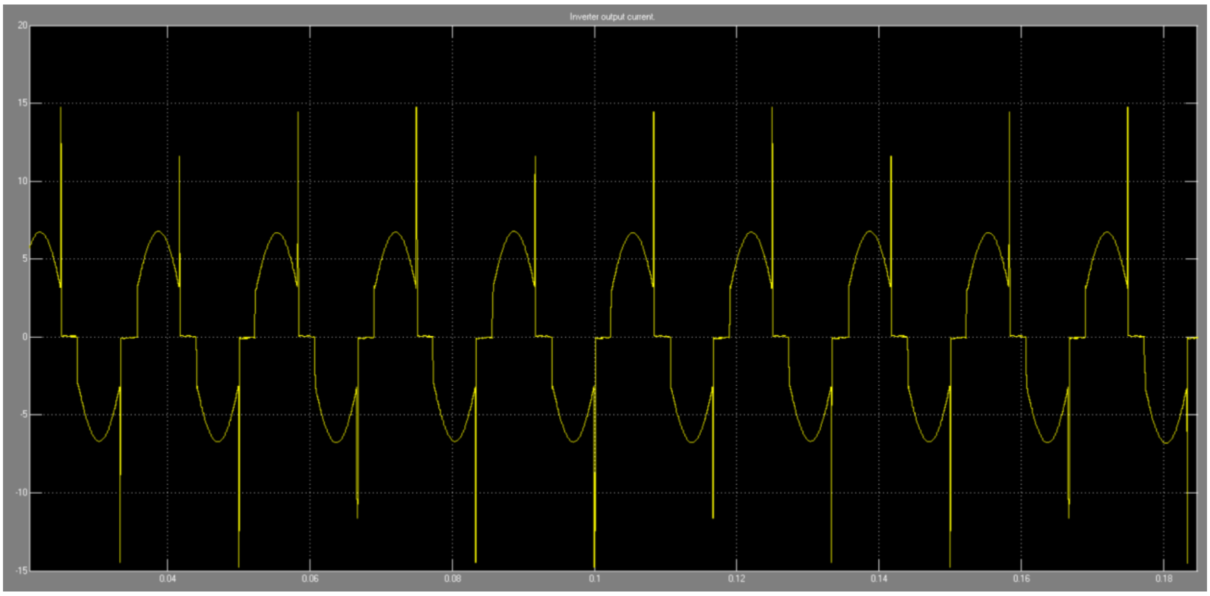
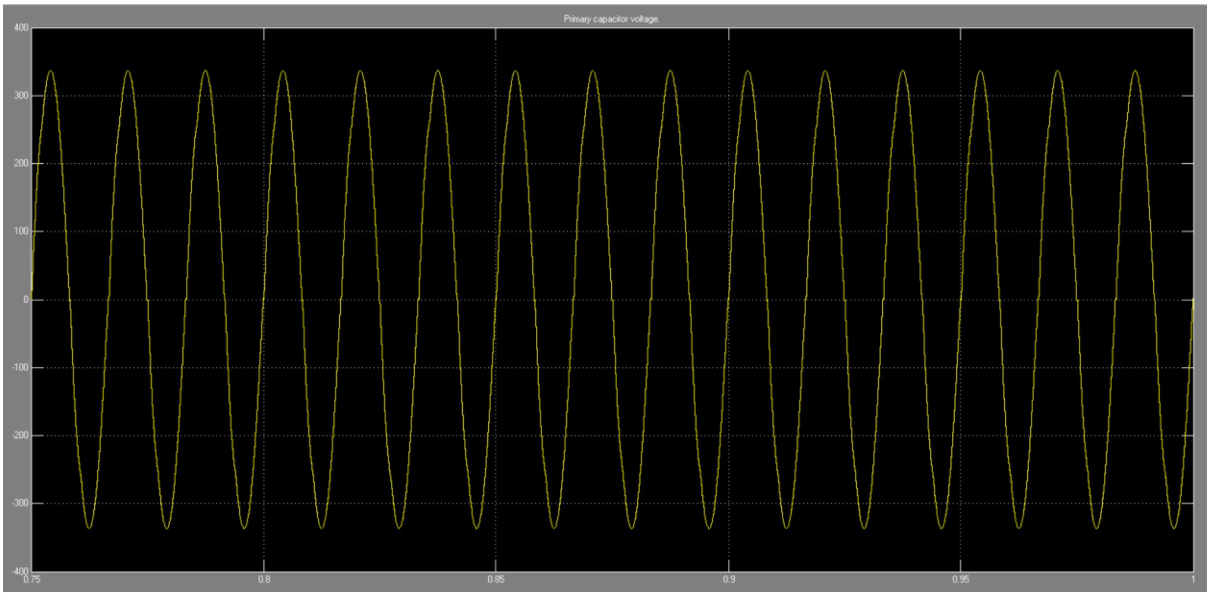


(b) Inverter output current.



(c) Primary capacitor voltage.

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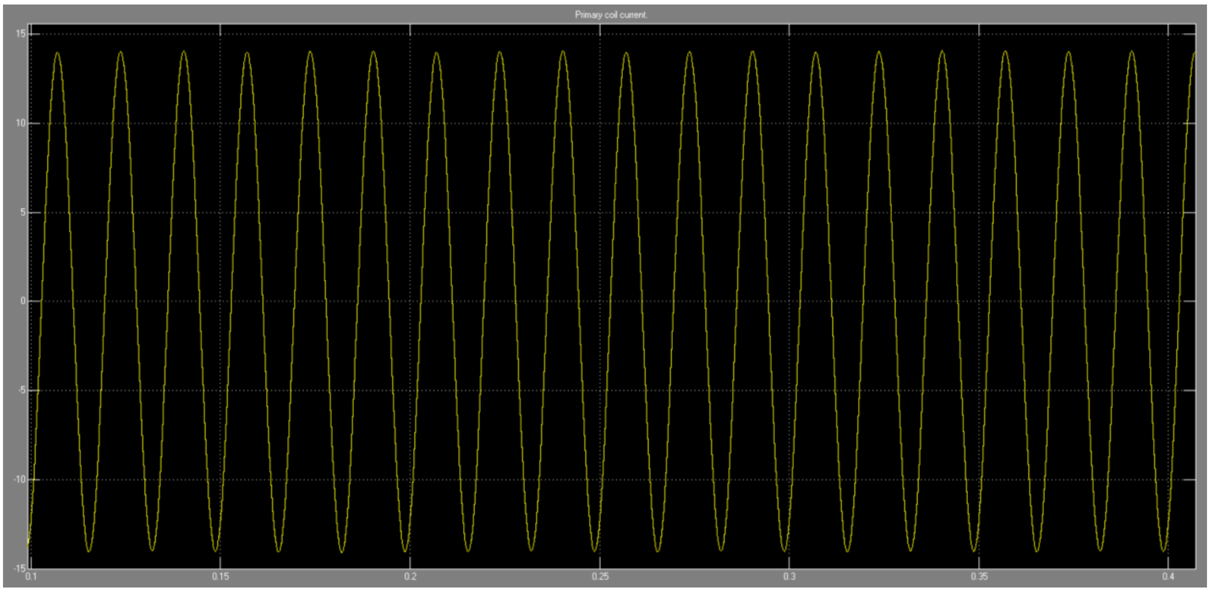
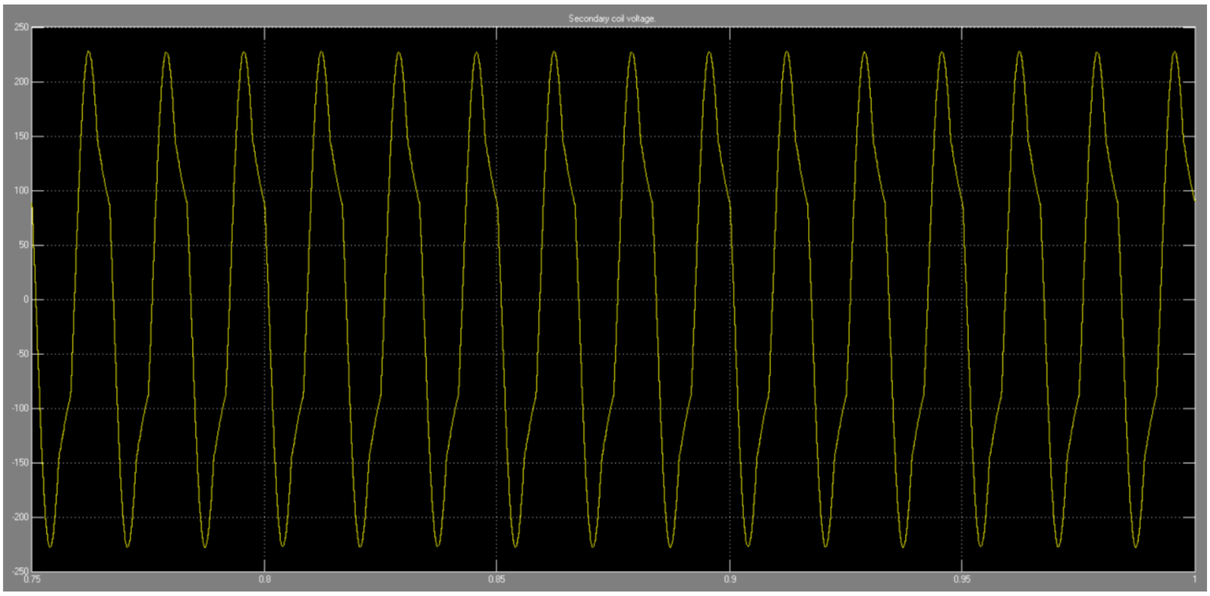


(c) Primary coil current.

Fig. 14. Performance of Transmitter coil Inductive Power Transmission.



Secondary coil voltage.

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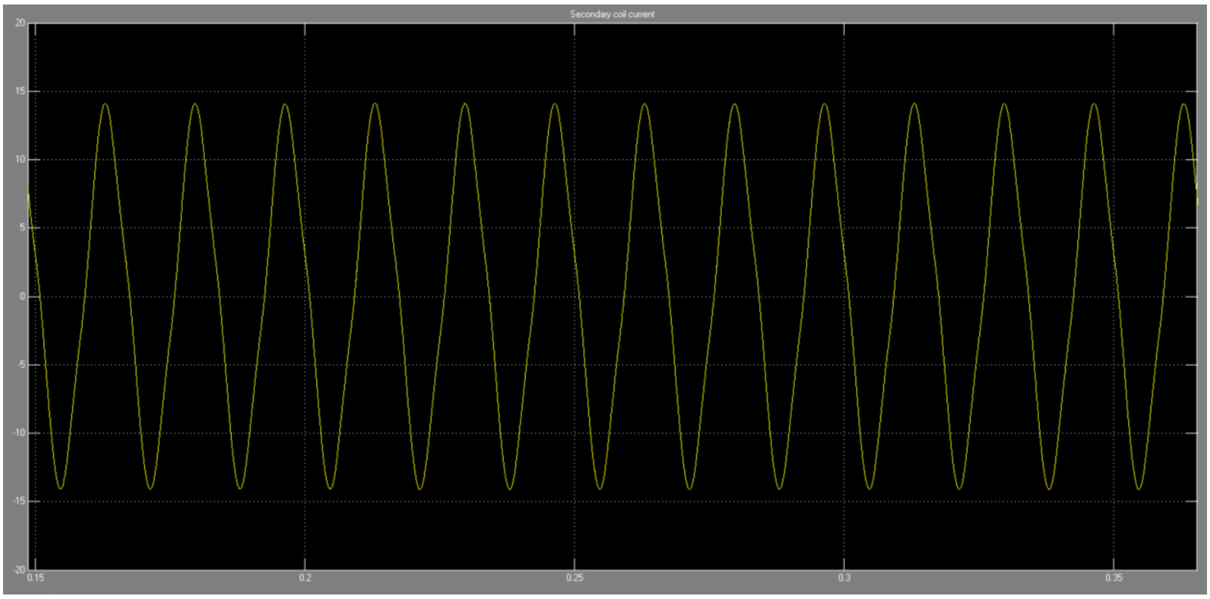
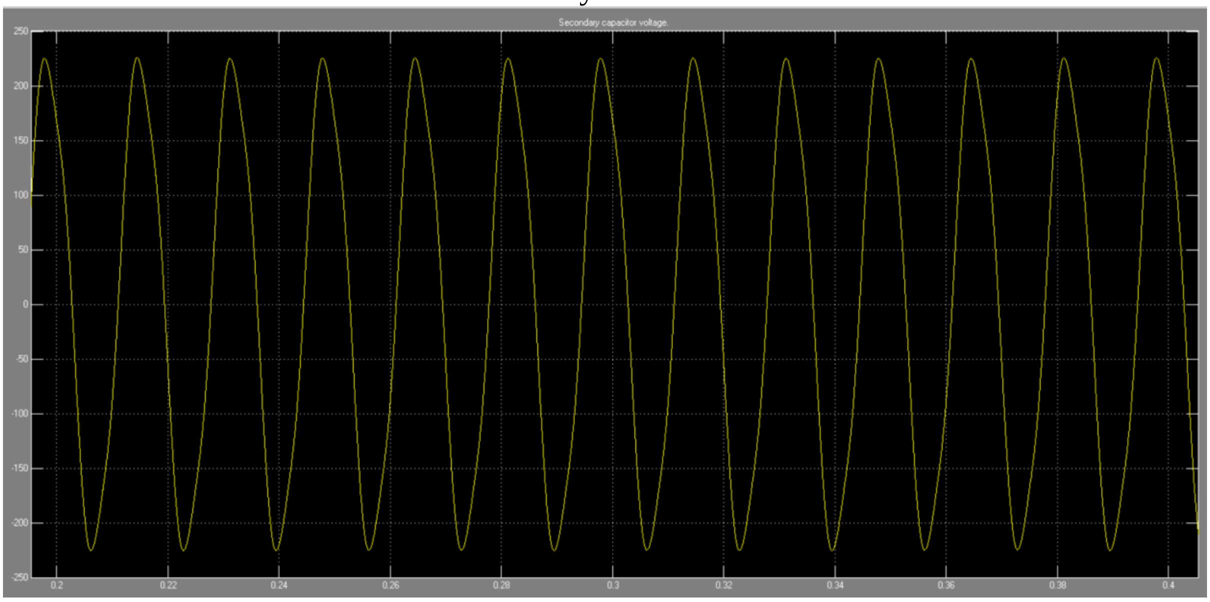


Secondary coil current



Secondary capacitor voltage

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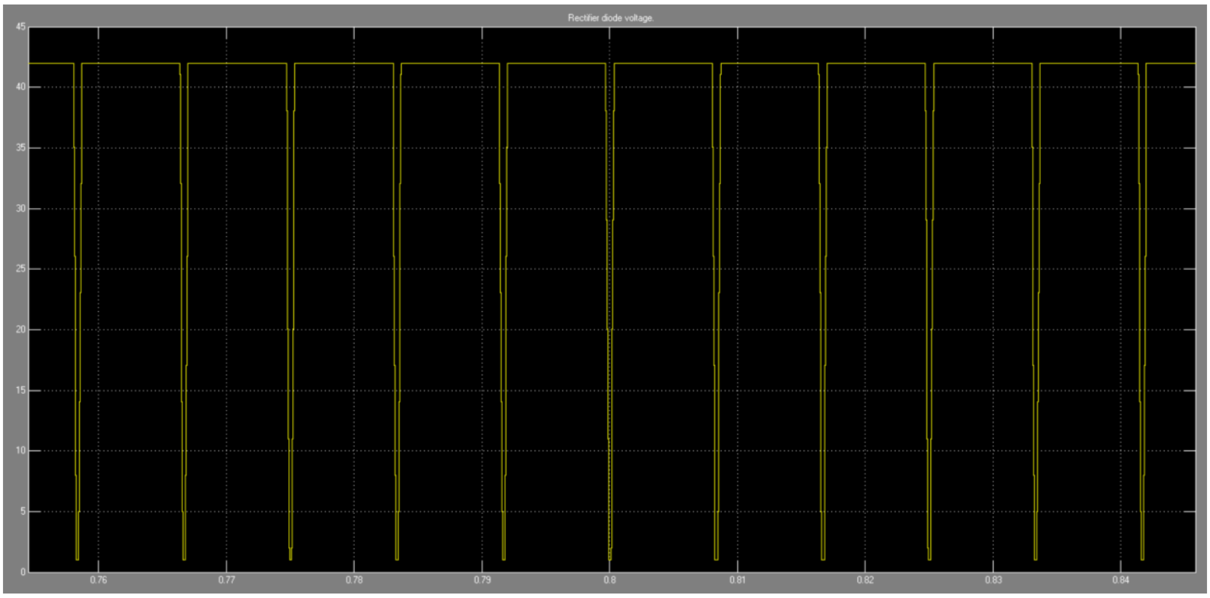
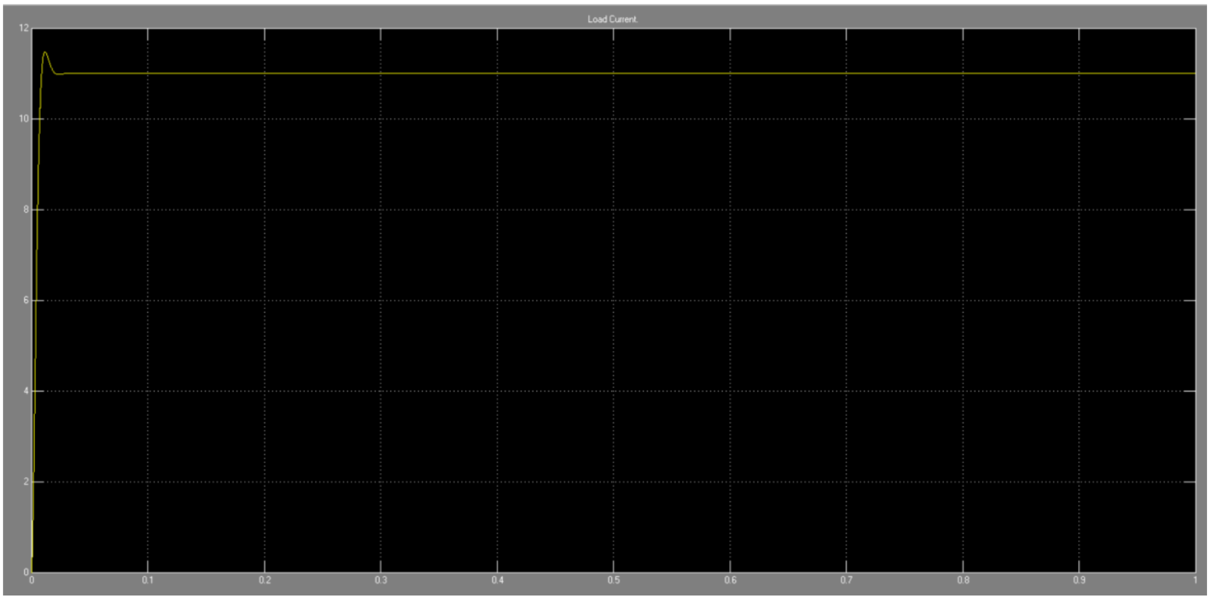


Rectifier diode voltage.

Fig. 15. Performance of Receiver coil Inductive Power Transmission



Load Current.

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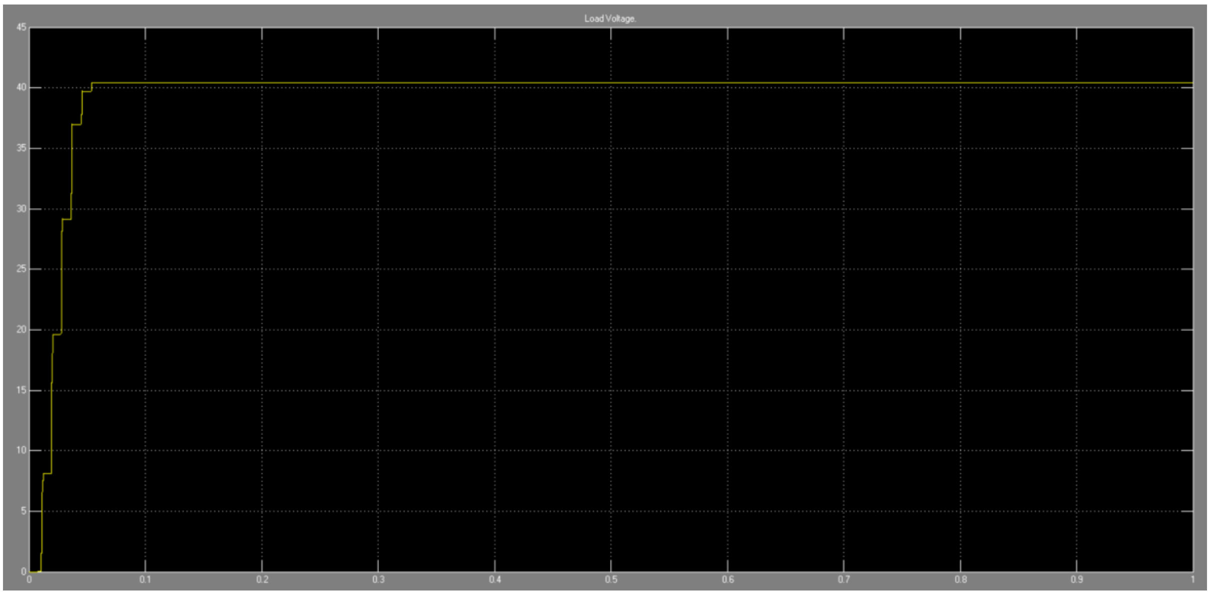

Load Voltage.

VI. CONCLUSION

The wireless power transfer for electrical vehicle charging techniques is presented in this paper and a comparison among all the existing methods in terms of efficiency, power level, frequency, and application are shown. The electrical parameters for inductive power transmission are evaluated and the performance is verified in Matlab/Simulink. It is concluded that inductive WPT performance has low voltage stress on transmitted side, the voltage stress on inverter is within limits, protection of source is provided, weight of coil is less. But the difficulties are in the design of receiver coil and the controlled operation of converters. The current fed topology for inductive power transfer in WPT is compatible.

REFERENCES

[1] G. A. Covic, and J. T. Boys, "Inductive power transfer," Proceedings of the IEEE , vol.101, no.6, pp.1276,1289, June 2013.

[2] A. Kurs, A. Karalis, R. Moffatt, J. D. Joannopoulos, P. Fisher, and M. Soljacic, "Wireless power transfer via strongly coupled magnetic resonances," Science, Vol. 317, 83-86, 2007.

[3] F. Musavi, and W. Eberle, "Overview of wireless power transfer technologies for electric vehicle battery charging," Power Electronics, IET , vol.7, no.1, pp.60,66, January 201, vol.61, no.5, pp.2307,2315, May 2014.

[4] A. Khaligh and S. Dusmez, "Comprehensive Topological Analysis of Conductive and Inductive Charging Solutions for Plug-In Electric Vehicles," in IEEE Transactions on Vehicular Technology, vol. 61, no. 8, pp. 3475-3489, Oct. 2012.

[5] D. Patil, M. Ditsworth, J. Pacheco and W. Cai, "A magnetically enhanced wireless power transfer system for compensation of misalignment in mobile charging platforms," IEEE ECCE, 2015, pp. 1286-1293. [6] C. J. Kaufman, Rocky Mountain Research Lab., Boulder, CO, private communication, May 1995.

[7] Y. Yorozu, M. Hirano, K. Oka, and Y. Tagawa, “Electron spectroscopy studies on magneto-optical media and plastic substrate interfaces(Translation Journals style),” IEEE Transl. J. Magn.Jpn., vol. 2, Aug. 1987, pp. 740–741 [Dig. 9th Annu. Conf. Magnetics Japan, 1982, p. 301].

[8] K. Aditya; S. Williamson, "A Review of Optimal Conditions for Achieving Maximum Power Output and Maximum Efficiency for a Series-Series Resonant Inductive Link," in IEEE Transactions on Transportation Electrification , vol. no.99, pp.1-1.

[9] DevendraPatil, Marco Sirico, Lei Gu, BabakFahimiPatil, M. Sirico, L. Gu and B. Fahimi, " Maximum efficiency tracking in wireless power transfer for battery charger: Phase shift and frequency control”, Proc. IEEE Energy Conversion Congress and Exposition (ECCE), 18- 22 Sept. 2016, Milwaukee, WI, USA.

ISSN PRINT 2319 1775 Online 2320 7876
Research paper **© 2012 IJFANS. All Rights Reserved, Volume 10, Iss 9, 2021**

[10] B. Mangu and B. G. Fernandes, "Multi-Input Transformer Coupled DC-DC converter for PV-Wind based Stand-Alone Single Phase Power Generating System," IEEE Energy Conversion Congress and Exposition, ECCE'2014, Pittsburgh, Pennsylvania, USA, Sept. 2014.
[11] Susheela and P.Satish Kumar "Analysis and Comparison of Various Pulse Width Modulation Strategies for Hybrid Inverter with Reduced Number of Components," International Journal of Inventions in Engineering & Science Technology (IJIEST), vol. no. 3, pp.12-26, JanDec 2017.
[12] PradiptaPatra, SusovonSamanta, Amit Patra, SouvikChattopadhyay, "A Novel Control Technique for Single-Inductor Multiple-Output DCDC Buck Converters", IEEE International Conference on Industrial Technology, Mumbai, India, 15-17 Dec. 2006.
[13] SuvenduSamanta, Akshay Kumar Rathore, Sanjib Kumar Sahoo, "Current-fed full-bridge and half-bridge topologies with CCL transmitter and LC receiver tanks for wireless inductive power transfer application", IEEE Region 10 Conference (TENCON), Singapore, 22- 25 Nov. 2016.
[14] VakaRavikiran, Ritesh Kumar Keshri, ManueleBertoluzzo, "Efficient Wireless Charging of Batteries With Controlled Temperature and Asymmetrical Coil Coupling" IEEE International Conference on Power Electronics, Drives and Energy Systems (PEDES).

[15]Hareesh Sita, Reddy, P Umapathi Reddy& Kiranmayi, R. (2020). Optimal location and sizing of UPFC for optimal power flow in a deregulated power system using a hybrid algorithm. International Journal of Ambient Energy,.Vol.43, No.1, pp.1413-1419, 2020..

[16] K Krishna Reddy, D V Kiran, B Gurappa, A Nagaraju. "**Modeling simulation and analysis of pv cell boost converter fed induction motor drive with closed loop speed control**",
Grenze ID: 02.CSPE.2015.4.28, Page(S): 127-136

[17]K Krishna Reddy, N V Kishore Kumar. "A New Z-Source Multilevel Inverter for Induction Motor Drives", IJSETR,ISSN2319-8885,Vol.04,Issue.10,April-2015,Pages:1901-1906.

[18]K Krishna Reddy, D V Kiran. "Torque Ripple and Harmonics Reduction in BLDC Drive using Multilevel Inverter",IJATIR,ISSN 2348–2370, Vol.07, Issue.03,April-2015,Pages: 0367-0373.