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# POWER QUALITY AND THD MITIGATION IN ELECTRIC VEHICLE CHARGING STATION BY THE ANN CONTROLLER

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**Abstract:** *These EVs have a major impact on the power grid & distribution networks due to the consequences of huge power demand to recharge their batteries. A large number of EV charging station when integrated with the utility grid, it produces harmonics, affect the voltage profile, finally affects the power quality. Artificial Neural Network (ANN) is presented in this study for simple operation and high optimization approaches. ANN control technique regulates the system's THD and enhances charging system optimization, enabling two-way power delivery that is from the grid to vehicle and the vehicle to grid. An ANN-based current controller model that achieves fast-dynamic reaction and that improves grid current harmonic characteristics is proposed in this study. In this paper, battery supported transportation systems called electrical vehicles (EV) and the wireless charging topologies are presented. The techniques are majorly based on current fed dc-dc converter topologies. This paper presents the detailed evaluation of electrical parameters, comparison of various qualitative features of power transfer techniques, IPT for EV application, the control strategies and challenges for EV battery charging. In this paper, the impact of an electric vehicle charging station on the power grid and distribution networks is analyzed in terms of power demand, harmonics, Voltage sag & swelling, and transformer power loss. Also, the mitigation technique for reducing power quality disturbances is analyzed in this paper. The system's THD is reduced by the ANN controller being suggested. The parameters are evaluated and the results are presented in MATLAB/SIMULINK*

***Keywords: E****lectrical vehicles (EV), EV charging station, batteries, Artificial Neural Network (ANN), grid, distribution networks.*

## I. INTRODUCTION

At present, worldwide on-road transportation primarily relies on petroleum. This causes the emission of enormous amount 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. Electric Vehicle is comparatively new concept in the transportation sector. Due to several benefits i.e. less environmental pollution, cheaper mode of transportation, use of less petroleum, EV becomes very much attractive now-a-days. There are mainly three types of electric vehicle available in world-wide i.e. Plug-in-hybrid electric vehicle (PHEV), Hybrid electric vehicle (HEV) and Battery electric vehicle (BEV). In traction applications, the electrification of rail road's has been fully achieved in the past many years. However, there are some obvious challenges for 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 subsidy and tax incentives. The most competitive solution for EV is Li-ion batteries, which has an energy density of about 90-100Wh/kg, whereas for gasoline it is about 12000Wh/kg [3-4]. 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. Charging cables of EV are 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 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

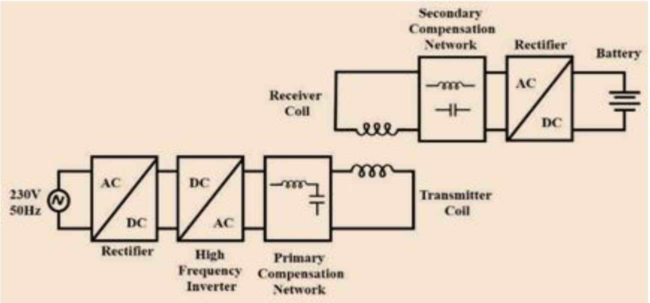


Fig. 1. General Block diagram of the Inductive power transfer system.

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. Also VSI as inverter LCL [7] and CLCL [8] compensation topologies are also used for improved power factor at inverter output and better performance with improved power range. The current fed topologies have been mostly used in research point because of it has merits in IPT circuit when compensation capacitor is associated in parallel with ttransmitter coil (TC) [9].The current-fed IPT topology with parallel type tank net-takes a shot at TC and RC circuits. The resonance connection of parallel capacitor it allows the high frequency to occurs through transmitter coil. Be that as it may, since the parallel capacitor, Cp alone gives the necessary receptive capacity to approximately coupled TC; subsequently, for higher power applications, this parallel capacitor encounters higher voltage. 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. 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

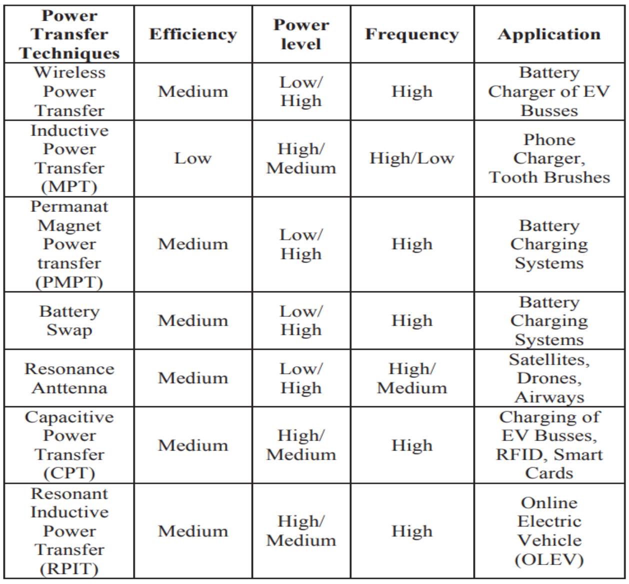
Wireless Power Transfer System Implementation of wireless charging in EV applications provides remarkable outcomes. Along with the aforementioned merits, it can reduce the battery storage requirement to 20% through opportunistic charging techniques [8-9]. For EVs, opportunistic charging is possible by 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 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.

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. 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.

### 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]

TABLE I. QUALITATIVE FEATURES OF POWER TRANSFER TECHNIQUES



| Power Transfer Techniques | Efficiency | Power level | Frequency | Application |
|---|---|---|---|---|
| Wireless Power Transfer | Medium | Low/ High | High | Battery Charger of EV Busses |
| Inductive Power Transfer (MPT) | Low | High/ Medium | High/Low | Phone Charger, Tooth Brushes |
| Permanat Magnet Power transfer (PMPT) | Medium | Low/ High | High | Battery Charging Systems |
| Battery Swap | Medium | Low/ High | High | Battery Charging Systems |
| Resonance Anttenna | Medium | Low/ High | High/ Medium | Satellites, Drones, Airways |
| Capacitive Power Transfer (CPT) | Medium | High/ Medium | High | Charging of EV Busses, RFID, Smart Cards |
| Resonant Inductive Power Transfer (RPIT) | Medium | High/ Medium | High | Online Electric Vehicle (OLEV) |

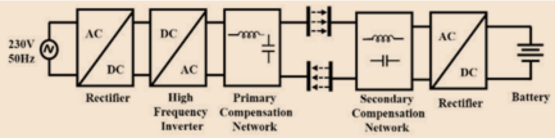


Fig. 2. Capacitive power transfer system.

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".

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

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 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. 3 and Fig. 4). 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, centers around 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.

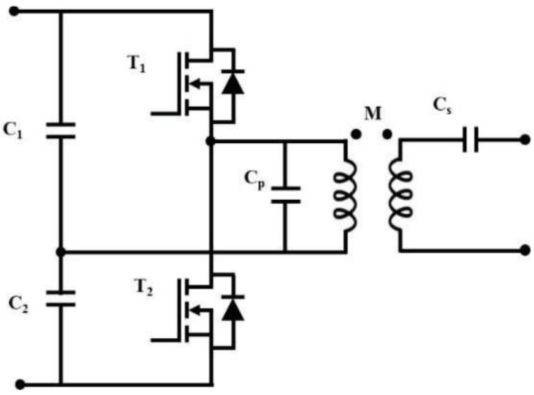


Fig. 3. Half Bridge DC-AC Converter.

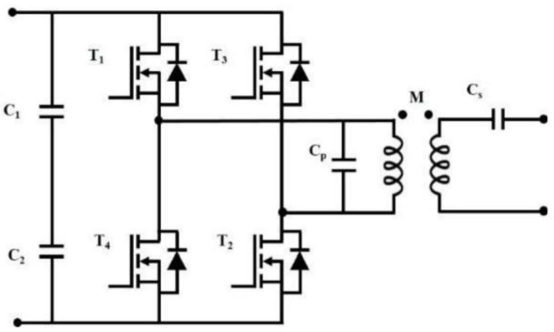


Fig. 4. Full bridge DC-AC converter.

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 battery powered 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. 5.

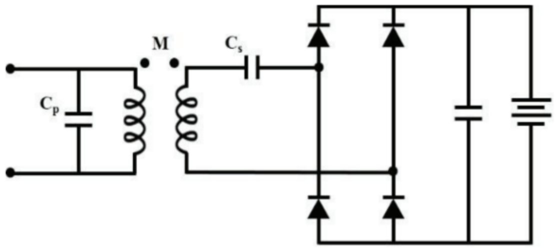


Fig. 5. The secondary side AC-DC converter.

B. 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 ±vdc/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. 6

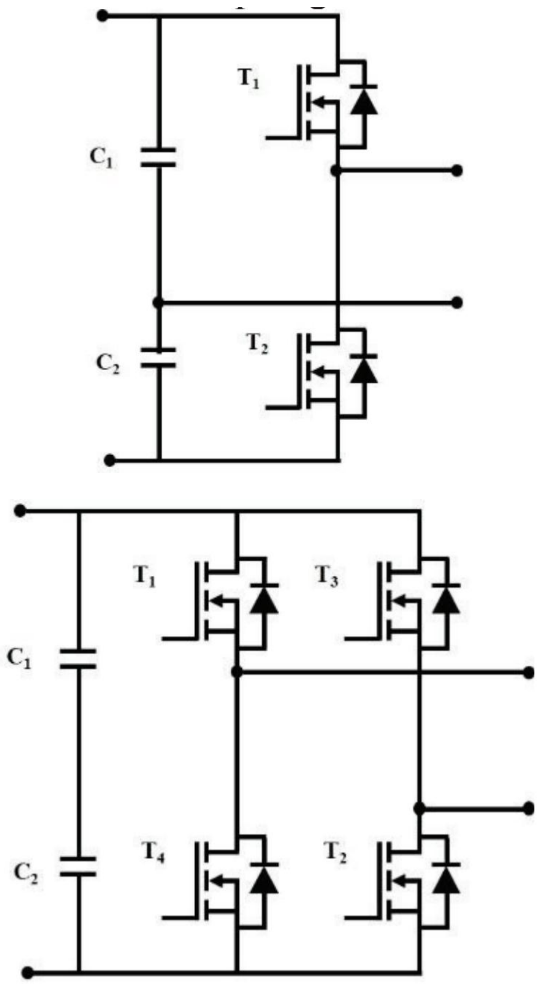


Fig. 6. Voltage source inverter topologies.

2) Current Source Inverter Topologies:

Occasionally, current source inverter (CSI) is also used in IPT systems [5-7]. Fig. 7 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.

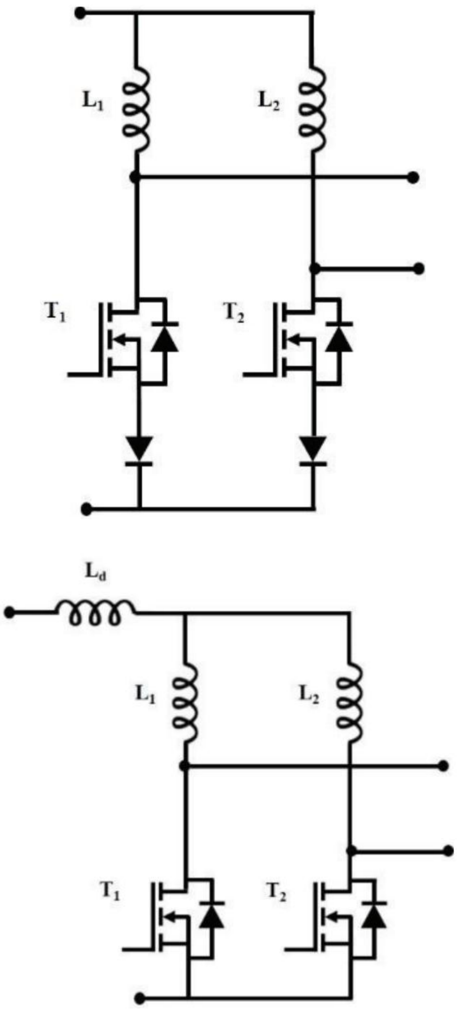


Fig. 7. Current source inverter topologies

## 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. 8, 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.

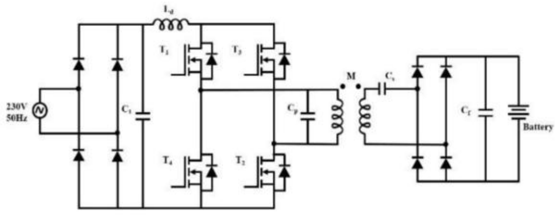


Fig. 8. Schematic diagram of current-fed inductive power transfer system for a single transmitter and receiver.

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. 9 [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.

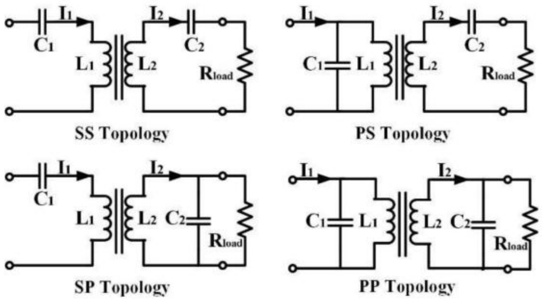


Fig. 9. Resonance topologies.

Using a mutual-inductance model, the equivalent circuit of the resonant inductances is shown in Fig. 10, where M is the mutual inductance between the transmitting and receiving coils or pads.

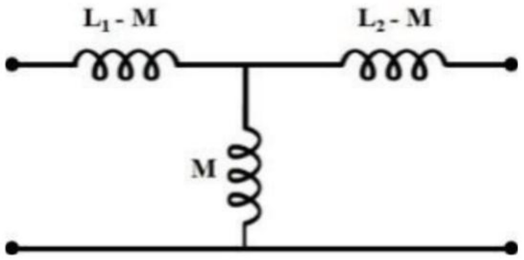


Fig. 10. Equivalent circuit of inductances.

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. 11. The transmission of intensity yield proficiency can be determined.

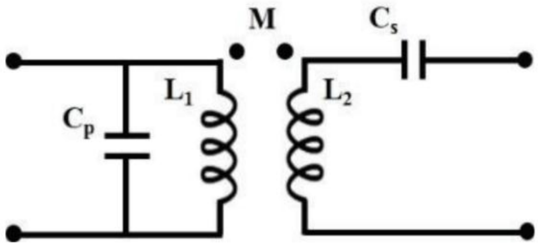


Fig. 11. Compensation circuit.

The transmitting voltage,

$$\overline{V}_1 = \overline{I}_1 r_1 + jw\ L_1\ \overline{I}_1 - jw\ M\ \overline{I}_2$$

$$jw\ M\ \overline{I}_1 = jw\ L_2\ \overline{I}_2 + R_L \overline{I}_2$$

Transmitting and receiving coil currents,

$$\overline{I}_2 = \frac{jw\ M\ \overline{I}_1}{jw\ L_2 + r_2 + R_L} = \frac{jw\ M\ \overline{I}_1}{Z_2}$$

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

$$\overline{V}_1 = r_1\ \overline{I}_1 + jw\ L_1\ \overline{I}_1 + \frac{\omega^2\ M^2}{Z_2}$$

Total Impedance (Z t) from transmitting coil

$$Z_t = r_1 \overline{I}_1 + j\omega\ L_1 + \frac{\omega^2\ M^2}{Z_2}$$

Z r Reflected impedance

$$Z_r = \frac{w^2 M^2}{Z_2}$$

Equation (2) and (6)

$$k = \frac{M}{\sqrt{L_1 L_2}}$$

(since: k=0.1 to 0.5 range)

$$\frac{\overline{I}_2}{\overline{I}_1} = \frac{jw\ M}{R_L + r_2 + jw\ L_2}$$

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

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

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

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.

## V. MATHEMATICAL MODELING

As a non-linear load, EV charger produces harmonics, low voltage profile and power loss in distribution transformer. In Bangladesh, for EV charging level 2 type AC charging scheme is used where maximum current rating is 16 A and maximum power rating is 3.3 kW. Most of the electric vehicles have power ranges from 0.5 kW to 1 kW and all of them use single phase 240 V, 50 Hz supply system. In this section, we have developed mathematical modeling for harmonics, voltage profile and transformer overloading due to EV charging.

Power Demand Electric Vehicle battery takes charge from the power distribution system. The increased power demand affects the stability of the system due to non-linearity. The power demand by an EV can be expressed as in Equation (1).

$$P_{EV} = \frac{C_{Batt} * (SOC_{\max} - SOC_{\min})}{T_D}$$

Where CBatt is the battery capacity, TD is the duration of charging. Battery SOC is a factor whether the EV takes high or small power. The gross power demand of the EVs is the summation of individual power demand of all EVs which likely signifies as in Equation (2).

$$P_{Gross} = \sum_{N=1}^{N} P_{EV}$$

Harmonics The rise in high frequency components of voltage and current with compared to fundamental frequency is defined as harmonics. Harmonics distorts the voltage & current waveforms and thereby affecting power quality. It can be measured by total harmonic distortion (THD) of current & voltage.

$$THD_i = \frac{\sqrt{\sum_{n=2}^{N} I_n^2}}{I_1} \times 100\%;$$

$$THD_v = \frac{\sqrt{\sum_{n=2}^{N} V_n^2}}{V_1} \times 100\%;$$

Equation (3) & (4) express the Total Harmonic Distortion (THD) for current and voltage respectively [6]. For slow charging THDi, THDv will be less than the fast charging. Thus, the EV with low SOC will have a great chance to produce harmonics.

Voltage profile .
The low voltage profile becomes a threatening issue induced by EV charging. Voltage stability refers to the ability that the power network being stable after the sudden increase or decrease in the loads. EV loads take large amount of power at a very short duration. Thus, voltage profile will be degraded and grid will be unstable.
Transformer performance
Mass deployment of EVs creates an additional stress on distribution transformers and their life cycles. Another problem is that, the EV charging rate should be limited per day and charging stations should keep far away from transformer for reducing power loss. Harmonic current is responsible for occurring load losses in transformer whereas harmonic voltage incurs no load loss. Due to these harmonic losses, heating is increased relative to the pure sinusoidal wave. This harmonic withstand capability can be measured by a factor called k- factor.

$$K - factor = \sum_{n=1}^{N} n^2 [\frac{I_n}{I_R}]^2 ;$$

In is the current related to nth harmonic and IR is the rated load current. The presence of harmonics causes overheating in the transformer. Thus, the transformer should be selected according to the withstand capability at higher harmonic current for non-linear loading [7].

## THE NEURON

Although it has been proposed that there are anything between 50 and 500 different types of neurons in our brain, they are mostly just specialized cells based upon the basic neuron. The basic neuron consists of synapses, the soma, the axon and dendrites. Synapses are connections between neurons - they are not physical connections, but miniscule gaps that allow electric signals to jump across from neuron to neuron. These electrical signals are then passed across to the soma which performs some operation and sends out its own electrical signal to the axon. The axon then distributes this signal to dendrites. Dendrites carry the signals out to the various synapses, and the cycle repeats.

Just as there is a basic biological neuron, there is basic artificial neuron. Each neuron has a certain number of inputs, each of which have a weight assigned to them. The weights simply are an indication of how 'important' the incoming signal for that input is. The net value of the neuron is then calculated - the net is simply the weighted sum, the sum of all the inputs multiplied by their specific weight.

Each neuron has its own unique threshold value, and it the net is greater than the threshold, the neuron fires (or outputs a 1), otherwise it stays quiet (outputs a 0). The output is then fed into all the neurons it is connected to.

## ARCHITECTURE

This area of neural networking is the "fuzziest" in terms of a definite set of rules to abide by. There are many types of networks - ranging from simple Boolean networks (perceptrons), to complex self-organizing networks (Kohonen networks), to networks modeling thermodynamic properties (Boltzmann machines)! There is, though, standard network architecture.

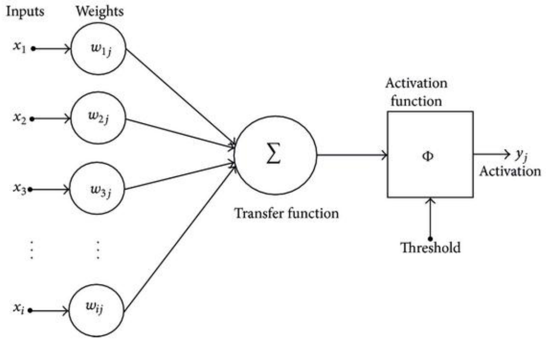


Fig12. Architecture of ANN

The network consists of several "layers" of neurons, an input layer, hidden layers, and output layers. Input layers take the input and distribute it to the hidden layers (so-called hidden because the user cannot see the inputs or outputs for those layers). These hidden layers do all the necessary computation and output the results to the output layer, which (surprisingly) outputs the data to the user. Now, to avoid confusion, I will not explore the architecture topic further. To read more about different neural nets, see the Generation5 essays.

Even after discussing neurons, learning and architecture we are still unsure about what exactly neural networks do!

## THE FUNCTION OF ANNS

Neural networks are designed to work with patterns - they can be classified as pattern classifiers or pattern associators. The networks can takes a vector (series of numbers), then classify the vector.

For example, my ONR program takes an image of a number and outputs the number itself. Or my PDA32 program takes a coordinate and can classify it as either class A or class B (classes are determined by learning from examples provided). More practical uses can be seen in military radars where radar returns can be classified as enemy vehicles or trees (read more in the Applications in the Military essay).

Pattern associators take one vector and output another. For example, my HIR program takes a 'dirty' image and outputs the image that represents the one closest to the one it has learnt.

Again, at a more practical level, associative networks can be used in more complex applications such as signature/face/fingerprint recognition.

## VI. RESULTS

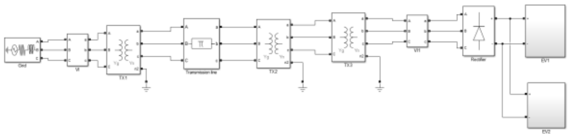
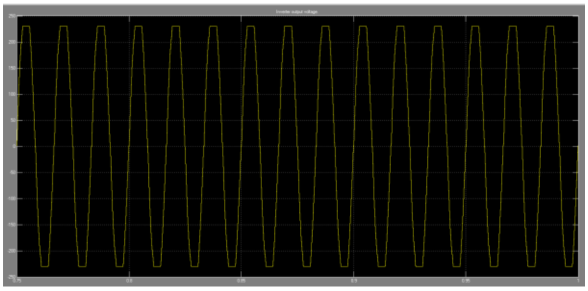
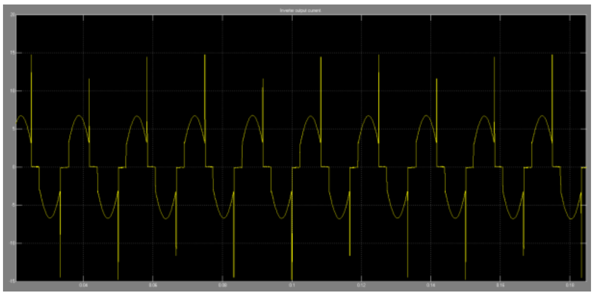


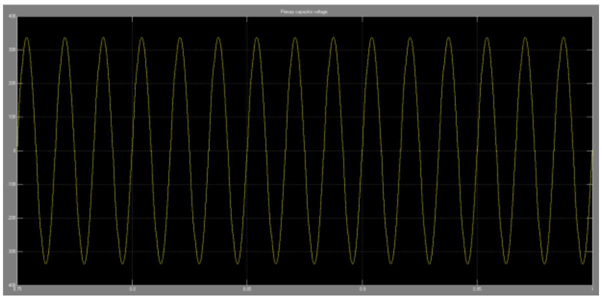
Fig13. Simulation Diagram of the Proposed system



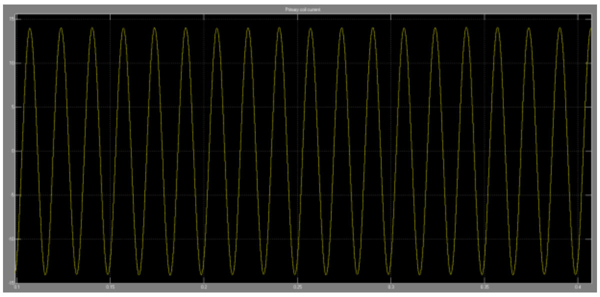
(a) Inverter output voltage.



(b) Inverter output current.

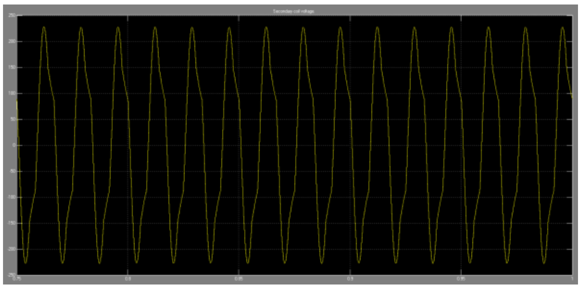


(c) Primary capacitor voltage.

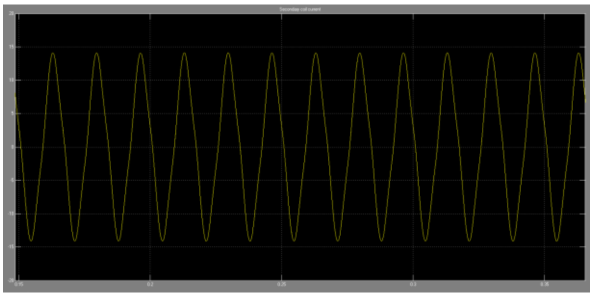


(c) Primary coil current.

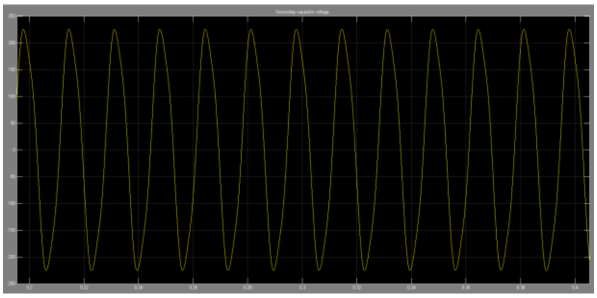
Fig. 14. Performance of Transmitter coil Inductive Power Transmission.



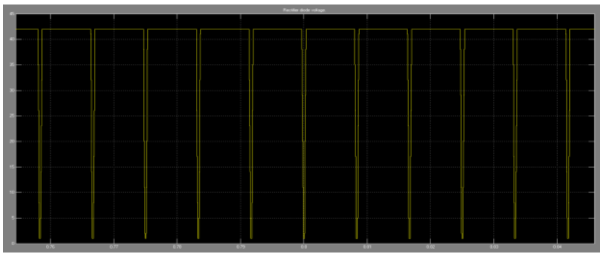
(a) Secondary coil voltage.



(b)Secondary coil current



(C) Secondary capacitor voltage



(D) Rectifier diode voltage.

Fig. 15. Performance of Receiver coil Inductive Power Transmission

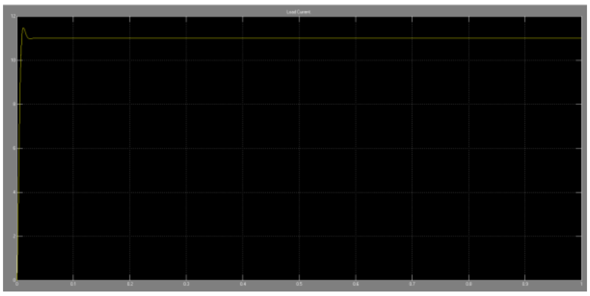


Fig 16. Load Current.

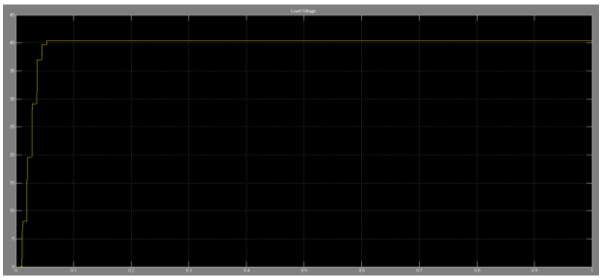
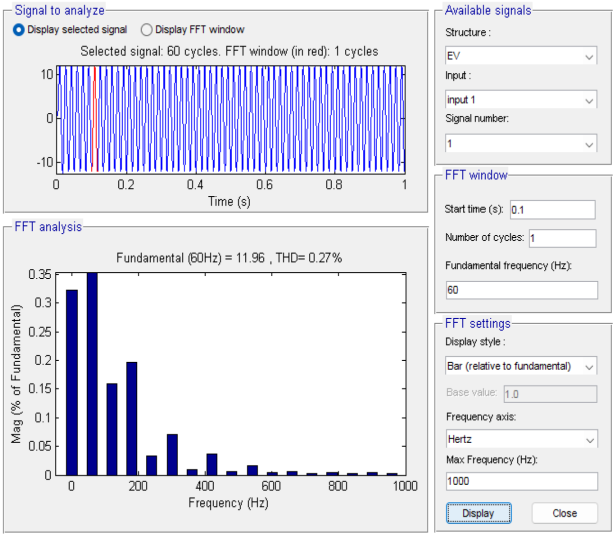


Fig 17. Load Voltage at the EV side



Signal to analyze

● Display selected signal ○ Display FFT window

Selected signal: 60 cycles. FFT window (in red): 1 cycles

FFT analysis

Fundamental (60Hz) = 11.96 , THD= 0.27%

Available signals

Structure : EV

Input : input 1

Signal number: 1

FFT window

Start time (s): 0.1

Number of cycles: 1

Fundamental frequency (Hz): 60

FFT settings

Display style : Bar (relative to fundamental)

Base value: 1.0

Frequency axis: Hertz

Max Frequency (Hz): 1000

Fig18. Load current THD% with ANN

## CONCLUSIONS

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. As maximum EVs are charged at residential connection due to the lack of charging stations, the power sector has been failed to earn the profit from this sector. However, due to some reasons EVs penetration makes power system more vulnerable and hampers power quality. In this paper, the power quality issues like harmonics, voltage fluctuation, transformer power losses are analyzed using MATLAB Simulink. ANN control technique regulates the system's THD and enhances charging system optimization, enabling two-way power delivery that is from the grid to vehicle and the vehicle to grid. An ANN-based current controller model that achieves fast-dynamic reaction and that improves grid current harmonic characteristics is proposed in this study. Although the EVs have several benefits as like stabilizing the grid at under loaded condition, lower GHG emission but the power quality issues should regulate properly for sustainable development in the power sector. 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] Devendra Patil, Marco Sirico, Lei Gu, Babak Fahimi Patil, 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.

[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] Pradipta Patra, Susovon Samanta, Amit Patra, Souvik Chattopadhyay, "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] Suvendu Samanta, 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] Vaka Ravikiran, Ritesh Kumar Keshri, Manuele Bertoluzzo, "Efficient Wireless Charging of Batteries With Controlled Temperature and Asymmetrical Coil Coupling" IEEE International Conference on Power Electronics, Drives and Energy Systems (PEDES).

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