

# Wireless Power Based Charging of EV's Using Multilevel Inverter

Poornima B N

Student Member, IEEE, Dr. Jyoti P koujalagi, Member

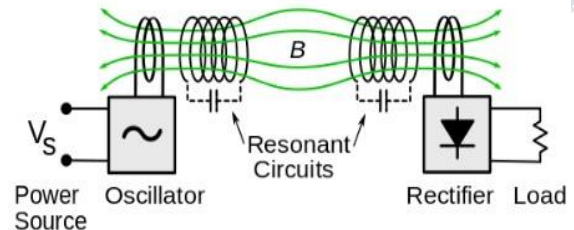
**Abstract-** Wireless power transfer (WPT) is more convenient and safer system to transfer the power from one end of system to another end system with coil having high inductance value. Wireless power transfer systems is employ to charge the battery pack of electric vehicles (EV) than conventional plug-in system. A wireless method of charging is suitable for charging massive electric vehicle by having multilevel inverter across input side of the system. In this paper we used the 5 level cascaded H bridge multilevel inverter. The multilevel inverter is employed to synthesis of several levels of dc voltages. The H bridge multilevel inverter can operate at both fundamental switching frequencies (SF) that are higher switching frequency and lower switching frequency. Even a switching frequency is low system will have lower switching loss and higher efficiency is achieved. The 5 level H bridge multilevel inverter can reduce torque and flux ripples. The using of H bridge multilevel inverter which helps in receiver side to have desired battery without any changes in its terminal voltage irrespective of its frequency by applying H bridge multi-level across the transmitter side battery gets charged.

**Index Terms—** Electric Vehicle (EV), Direct Current (DC), Switching Frequency (SF), Wireless Power Transfer (WPT).

## I. INTRODUCTION

WIRELESS Power transfer is commonly implemented using inductive coupling to transfer power between transmit and receive coils, this is commonly known as inductive power transfer (IPT) or 'near-field transfer'. Near-field IPT systems operate at frequencies determined by the desire to make both transmit and receive coils electrically resonant, and with power levels and transmission ranges typically of the order of watts over 10's cm range. In this paper IPT for body-worn sensors is considered, and hence the maximum power and maximum coil separation distance is limited by regulations governing the maximum magnetic field strength to which a person might be exposed. In an illustrative scenario the transmit coil is integrated within a chair arm and the receive coil is worn on the body, for instance as part of a wrist mounted health sensor. The power transfer between the coils of an IPT system is highly dependent on the magnetic coupling between them, which in turn is sensitive to distance and relative orientation of the coils and hence the dynamic body-worn scenario is challenging: if the system is designed for the peak coupling it may 'brown-out' for long periods; if it is designed for the lowest coupling then there will be periods when significant excess power must be dissipated. Additionally when one or both of the coils are flexible, a further degree of freedom is introduced as they can deform, affecting coupling and inductance key parameters in determining the operation of resonant coils. Flexible coils present their own challenges, particularly as it is more difficult to obtain both flexibility and the low coil resistance required for a high quality factor, which is

important in maximizing power transfer in a resonant system.



**Fig. 1. Block diagram of a Inductive power Transfer**

Inductive power transfer (IPT) technology can deliver energy from a high-frequency power source to loads through magnetic coupling without physical contact through a relative large air gap. This promising technique is developed rapidly and heretofore has been employed in miscellaneous applications such as wireless charging of biomedical implants, low-power portable electronic devices, under-water power supplies, electric vehicles and even train applications. Electric vehicles include large ones like buses and small ones even like electric bicycles (EBs), and the later ones are increasingly popular in some countries such as Europe and China. In China, the total number of EBs was over 200,000,000 at end of 2015. However the majority of EB's are still charged with traditional plug-in systems, which may be suffered from electric shot hazards, especially in adverse weather. IPT systems can offer a valid solution to mitigate the above mentioned problems and to save people from the wearisome plugging action. Thus, IPT system for EBs charging will play an important role in people's daily life and have extensive market prospect.

**International Journal of Engineering Research in Electronics and Communication Engineering (IJERECE)**  
Vol 5, Issue 6, June 2018

Usually, rechargeable lithium-ion batteries are essential power sources of EBs. The typical charging profile is illustrated, where the charging process includes a constant current (CC) charging mode and a constant voltage (CV) charging mode.

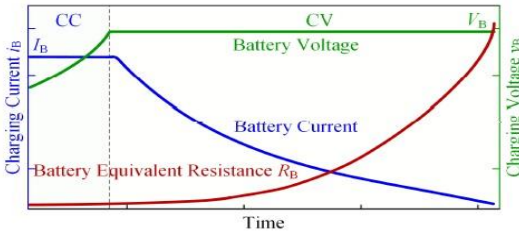


Fig. 2. Typical charging profile of a lithium-ion battery

At the beginning, the battery is charged in CC mode with the constant output current  $I_B$ , also named as charge current. Then, the battery voltage rises quickly to charge voltage  $V_B$ , and then the charging mode turns into CV mode with the constant output voltage immediately. In CV mode, the charging current decays exponentially and tapers until it hits the end condition of charging, where the charging current is typically set as one-tenth of charge current.

**II. METHODOLOGY**

The proposed system consists of a single phase inverter which will be connected to the battery charging circuit. The proposed IPT battery charging system can charge multiple EV's simultaneously with only H Bridge Multilevel inverter. The 5 level H Bridge multilevel gives a 5 levels of output voltage for an each cycle of input.

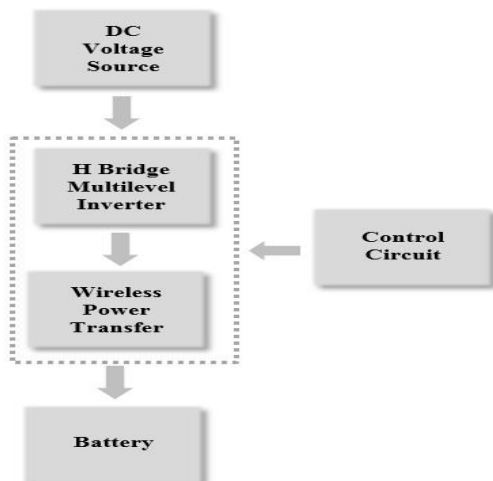


Fig. 3. Block diagram of WPT using Multilevel Inverter

In the control circuit if the voltage across the receiver side i.e. battery charging voltage is reduced the bridge inverter compensated that voltage and maintain minimum battery terminal voltage across the battery. By employ the multilevel inverter the batteries of the EV's gets charged quickly compared to normally wireless power based battery charging technology.

**III. SIMULATION ANALYSIS**

A multilevel inverter is a power electronic converter built to synthesize a desired AC voltage from several levels of DC voltages which the DC levels were considered to be identical in that all of them were batteries, solar cells, capacitors, etc. The multilevel inverter has gained much attention in recent years due to its advantages in lower switching loss better electromagnetic compatibility, higher voltage capability, and lower harmonics.

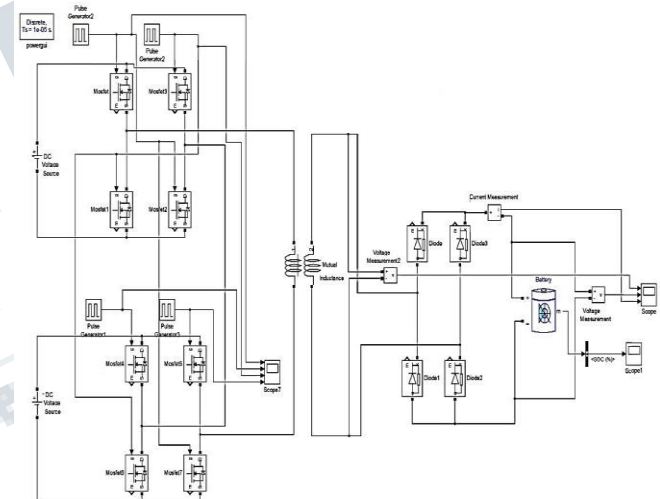
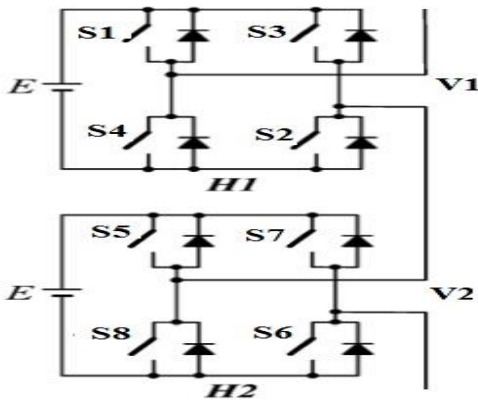


Fig. 4. Circuit of WPT using H Bridge Multilevel Inverter

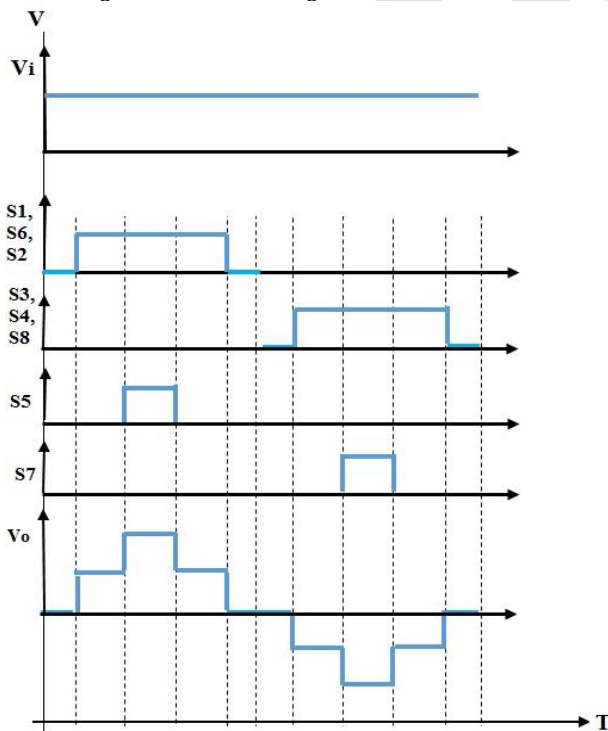
In the fig.4 circuits consists of 8 MOSFET'S which acts as a switches. The bottom is one leg of a standard 3-leg inverter with a dc power source (VDC), the top is a hybrid in series with each standard inverter leg that the H-bridge inverter can use a separate dc power source. When a DC voltage applied across the inverter during first half cycle Switches S1, S2, S6 triggered and later on switch S5 gets triggered and during another half switches S3, S4, S8 triggered later S7 gets triggered from these switch input dc voltage is converted into AC voltage by using multilevel inverted circuit ac voltage gets synthesis from the dc voltage. The converted AC voltage is applied across the inductance i.e. transmitter side. By using the concept of mutual inductance voltage is transfer to receiving side of the inductance

**International Journal of Engineering Research in Electronics and Communication  
Engineering (IJERECE)  
Vol 5, Issue 6, June 2018**

without any physical contact the voltage gets induced in receiving side. To charge batteries of EV's need have DC voltage across battery. To convert ac to dc voltage use a rectifier circuit. The rectifier circuit consists of 4 diodes during first half cycle D1 and D2 conducts and during negative half cycle D3 and D4 conducts thus dc voltage will appear across the battery. The batteries of EV's gets charged through this process.



**Fig. 4. 5 level H Bridge Multilevel Inverter**



**Fig. 4. Switching Operation of H Bridge Multilevel Inverter**

Switching State				V1	V2	Pole Voltage
S1	S2	S6	S5			
1	0	1	0	E	E	2E
1	0	1	1	E	0	E
1	0	0	0	E	0	
1	1	1	0	0	E	
0	0	1	0	0	E	0
0	0	0	0	0	0	
0	0	1	1	0	0	
1	1	1	1	0	0	-E
1	0	0	1	E	-E	
0	1	1	0	-E	E	
0	1	1	1	-E	0	-E
0	1	0	0	-E	0	
1	1	0	1	0	-E	
0	0	0	1	0	-E	-2E
0	1	0	1	-E	-E	

**Tab. 1. 5-Level H Bridge Multilevel Inverter Switching Operations**

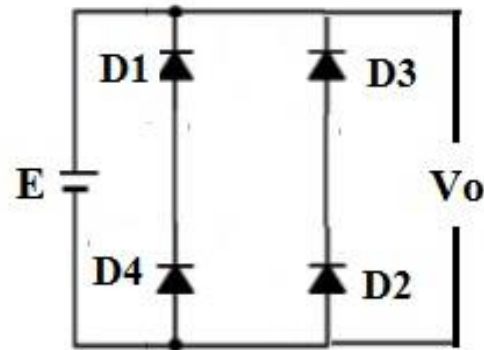
The no of voltage levels in a cascaded H bridge inverter can be found from

$$M = (2H+1)$$

Where, H is a no of H bridge cells per phase per leg.

The total no of active switches (MOSFET'S) used in cascaded H bridge inverter can be calculate by:

$$N = 6(M-1)$$



**Fig. 4 Rectifier Circuit for Battery Charging**

**International Journal of Engineering Research in Electronics and Communication  
Engineering (IJERECE)  
Vol 5, Issue 6, June 2018**



**Fig. 6. Waveforms of WPT.**

#### IV. CONCLUSION

In this paper 5 level cascaded H bridge multilevel inverter is operation is analyzed with respective to their wave forms. In transmitter side instead of single level inverter employed a multilevel inverter. Main function of multilevel is used for a wireless power transfer even the switching frequency is low the switching low the system will have lower switching loss and high efficiency can be achieved. 5 level cascaded H bridge inverter provides synthesis AC voltage irrespective of any DC voltage. Multilevel inverter provide the desired battery terminal voltage even is frequency changes in it. Using inductive coil the battery gets charged without any physical circuit contact. The receiving side fast switching diode used to convert the ac voltage in to dc voltage which has less switching losses and high efficiency battery gets charged quickly. If use multiple cascaded circuits the massive EV's batteries can be charged.

#### REFERNECES

[1] J. T. Boys, G. A. Covic and G. A. J. Elliott, "Pick-up transformer for ICPT applications," *Electronics Letters*, vol. 38, no. 21, pp. 1276-1278, 10 Oct. 2002.

[2] J. U. W. Hsu, A. P. Hu and A. Swain, "A Wireless Power Pickup Based on Directional Tuning Control of

Magnetic Amplifier," *IEEE Trans. Ind. Informat.*, vol. 56, no. 7, pp. 2771-2781, Jul. 2009.

[3] Y. L. Li, Y. Sun and X. Dai, "μ-Synthesis for Frequency Uncertainty of the ICPT System," *IEEE Trans. Ind. Electron.*, vol. 60, no. 1, pp. 291-300, Jan. 2013.

[4] S. Li and C. C. Mi, "Wireless Power Transfer for Electric Vehicle Ap- plications," *IEEE J. Emerg. Sel. Topics Power Electron.* vol. 3, no. 1, pp. 4-17, Mar. 2015.

[5] Y. Li; R. Mai; L. Lu; Z. He, "Active and Reactive Currents Decomposi- tion based Control of Angle and Magnitude of Current for a Parallel Multi-Inverter IPT System," *IEEE Trans. Power Electron.*, vol. PP, no.99, pp.1-1, doi: 10.1109/TPEL.2016.2550622

[6] . S. Lai and F. Z. Peng, "Multilevel converters – A new breed of power converters," *IEEE Trans. Ind. Applica*, vol. 32, no. 3, pp. 509-517, May/June 1996.

[7] L. M. Tolbert, F. Z. Peng, and T. G. Habetler, "Multilevel converters for large electric drives," *IEEE Trans. Ind. Applica.*, vol.35, no.1, pp. 36-44, Jan./Feb.1999.

[8] K. A. Corzine, M. W. Wielebski, F. Z. Peng, and J. Wang, "Control of Cascaded Multilevel Inverters," *IEEE Trans. power electron*, vol.19, no.3, pp. 732-738, May 2004.

[9] M. Fracchia, T. Ghiara, M. Marchesoni, and M. Mazzucchelli, "Optimized modulation techniques for the generalized N-level converter," in *proc. IEEE power electronics specialist conf*, 1205-1213, Madrid, Spain, 1992.

[10] K. A. Corzine and J. R. Baker, "Reduced parts-count multilevel rectifiers," *IEEE Trans. Ind. Electron.* vol.49, no.3, pp. 766-774, Aug. 2002.

[11] L. M. Tolber and T. G. Habetler, "Novel Multilevel Inverter Carrier based PWM Method," *IEEE Trans. Ind. Applic*, vol. 35, pp. 1098-1107, Sep/Oct 1999.

[12] B. P.McGrath and Holmes, "Multicarrier PWM strategies for multilevel inverter," *IEEE Trans. Ind. Electron*, vol. 49, no. 4, pp. 834-841, Aug 2002.

[13] A. M.Hava, R. J.Kerman, and T.A.Lipo "Carrier-based PWM-VSI Overmodulation Strategies: Analysis, Comparison, and Design," *IEEE Trans. Power Electron*, vol. 13, no. 4, pp. 834-841, Jul. 1998.

[14] [11] S. Khomfoi, L. M. Tolbert, "Multilevel Power Converters," "2nd ed. *Power Electronics Handbook*," Elsevier, 2007, ch. 31, pp. 1-50.