
A Matrix Converter Structure for Wireless Vehicle to Vehicle (V2V) Power Transfer

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Abstract

Electric Vehicles (EVs) increasing and gaining popularity day by day due to its less dependency on gasoline and no harmful gases emission in the environment. But charging time and range anxiety issue in a battery technology is affecting slow development growth in EVs. The driver thinks that their EVs run out of charge during journey. This is demonstration of a structure examination on the application of wireless power transmit between in between two vehicle using single phase matrix converter system. By using single phase matrix converter is capable for converting fix to variable AC instead of existing system using converter such as rectifier for AC to DC & Inverter for DC to AC conversion process which make system bulky, more equipment & less efficient. A Single phase Matrix converter is cable as an active power filter to improve power factor & current waveform. It reduces harmonics by using LC Filter. This paper also addressing limited number of charging station available and reduce out of charge during journey. A transmitter and receiver shape of coil is also recommended for wireless V2V charging system with consideration of misalignment and geometrical matching between transmitter and receiver coil.

Keywords Vehicle to Vehicle (V2V) charging, Matrix Converter, Wireless Power Transfer (WPT) Technique.

1. INTRODUCTION

Now a day, the demand of Electric Vehicle rapidly increases due to advance technology, cheap renewable resources and awareness on air pollution for better environment. Automobile industry launching various segments in Electric vehicle field such as pure electric vehicle, hybrid electric vehicle etc. Majorly plug in charging technologies are using which are having several disadvantages such as physically plug and unplug charging cable, carry a charging cable, risk of high

voltage shock and leakage current during charging of EVs, life of charging cable reduce with respect to time and also hazardous situation during rain or bad weather condition [1].

The issues can be overcome by using Wireless Power Transfer (WPT) Technology by inductive charging system. Wireless Power Technology (WPT) is sufficient for both static and dynamic charging methods.

the most popular invention of wireless transmit electricity by Nikola Tesla, so WPT technology is based on wireless electricity transfer without any physical contact through inductive coil [2]. The best solution for wireless power transfer is through Electromagnetic Field (EMF) through inductive coil for transfer electrical power [3]. Just like a transformer similarly here is no physical contact in this proposed technique for power transfer. The main goal of wireless power transfer (WPT) is to provide new comfort in daily charging for electric vehicle additionally share vehicle to vehicle (V2V) Strategy when there is charging connection is busy with charging other EVs.

The Common vehicle to vehicle (V2V) indirect wireless technology using multiple converter such as rectifier for AC-DC, inverter for DC-AC, matrix converter for fix AC- variable AC & rectifier AC-DC for battery charging as shown in Figure 1.1.

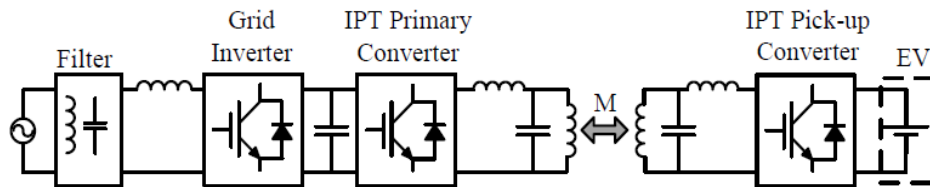


Figure 1.1 Grid inverter based IPT system

It Makes system become more bulky, increase system cost by using more equipment's, increase system losses and reduce efficiency [4]. By using matrix converter is solution for the existing V2V System.

There are two steps of matrix converter process in which first step voltage switching is involve and in second step current switching is involve for output current [5-6]. The power conversion produce harmonics distortion can be reduce by LC filters [7].

Figure 1.2 represents single phase topology of a matrix converter with four bidirectional switching technique can pass and blocks current in both directions as shown in figure 1.3. A single phase matrix converter is bidirectional switch which act as rectifier (AC-DC) & also act as inverter (DC-AC)

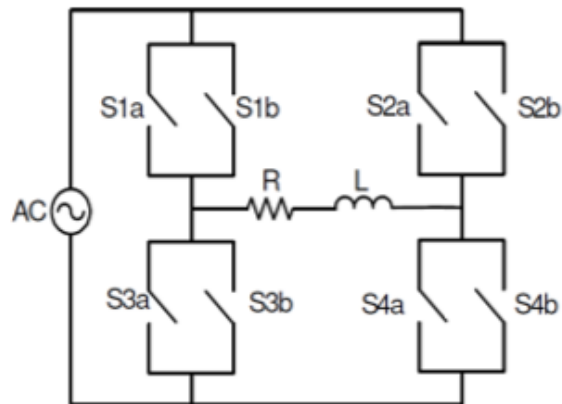


Figure 1.2 Single Phase Matrix Converter (Four bidirectional Switches) Topology

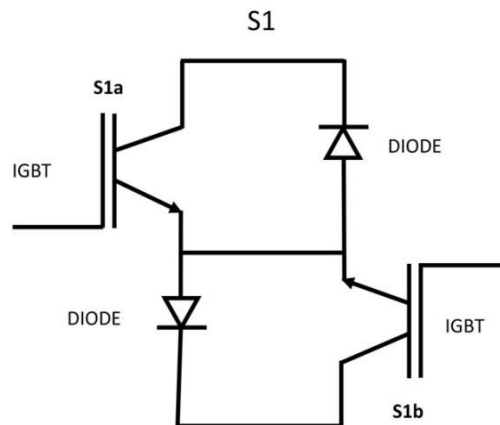


Figure 1.3 Bidirectional Switch contain Two IGBT & Two Diode

2. PROPOSED MATRIX CONVERTER FOR WIRELESS VEHICLE TO VEHICLE (V2V) POWER TRANSFER

Following Fig. 2 shows the recommended block diagram of vehicle to vehicle (V2V) power transfer operation in which there is only two stage power conversion is using due to matrix converter is cable to transfer power on the basis of single stage conversion technologies. Here is power conversion technique is vehicle 1 DC to high frequency AC & then AC to DC for Vehicle 2 via magnetic field. The single phase matrix converter of vehicle 2 is converting high frequency of AC to Dc power for vehicle 2 battery charging.

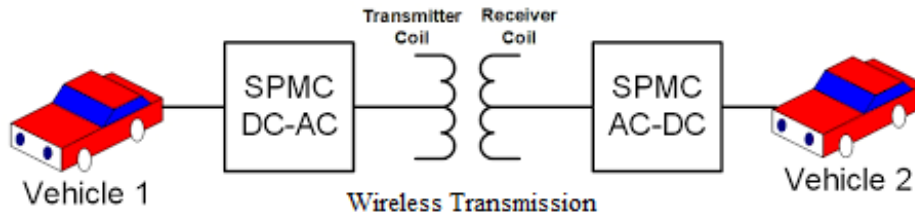
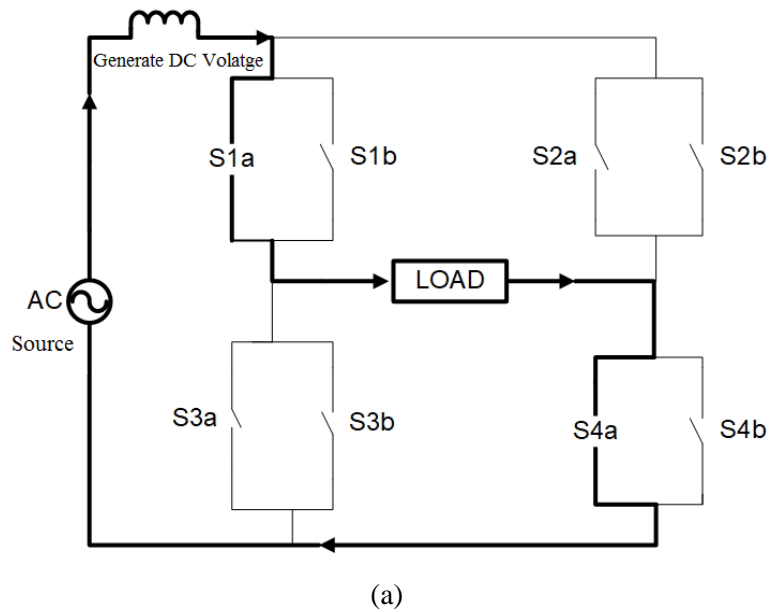


Figure 2 Wireless Vehicle to Vehicle (V2V) Power Transfer

2.1 Single Phase Matrix Converter Rectifier (AC to DC) Mode

Single phase matrix converter on rectifier mode is showing in the fig. 2.1 first input supply positive half cycle, two switches S1a and S4a will be turn ON. As outcomes current flows through the switch S1a to load and Switch S4a to generate DC voltage across the load. During input negative half cycle, a pair of switches S3b and S2b turns ON. As outcomes current flow through the switch S3b to load and S2b to generate DC voltage across the load. That matrix converter is generating DC voltage across the load on both positive and negative cycle.



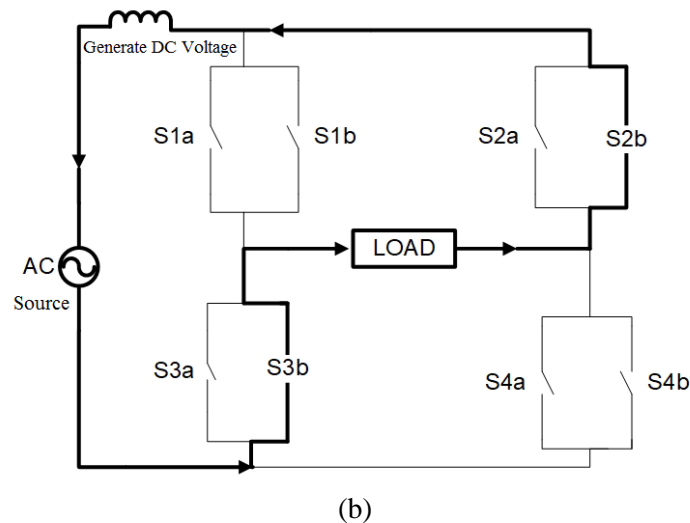


Figure 2.1. Single Phase Matrix Converter as rectifier Mode during (a) half-positive cycle and (b) Half negative cycle of AC voltage.

3. ARRANGEMENT STRUCTURE OF WIRELESS POWER TRANSFER IN VEHICLE TO VEHICLE (V2V)

The recommended technology of power transfer from one vehicle to another vehicle is majorly for two applications; first method is plug in EVs charging and wireless V2V alliance system as shown in figure 3.1. Second method is vehicle to vehicle (V2V) power transfer called by V2V Assistance method as shown in fig. 3.2.

3.1 Plug in Wireless V2V Charging System

Today's charging station is having limited number of chargers and it require continuous maintenance to ensure that all equipment of charging station working properly. So that problem can be resolve by one to another wireless vehicle charging as shown in fig. 3.1 having frontal coil as a transmitter and rear coil as an receiver are installed. The first car is charge by plug in and simultaneously provides wireless charging to the car behind it without any charging station infrastructure.

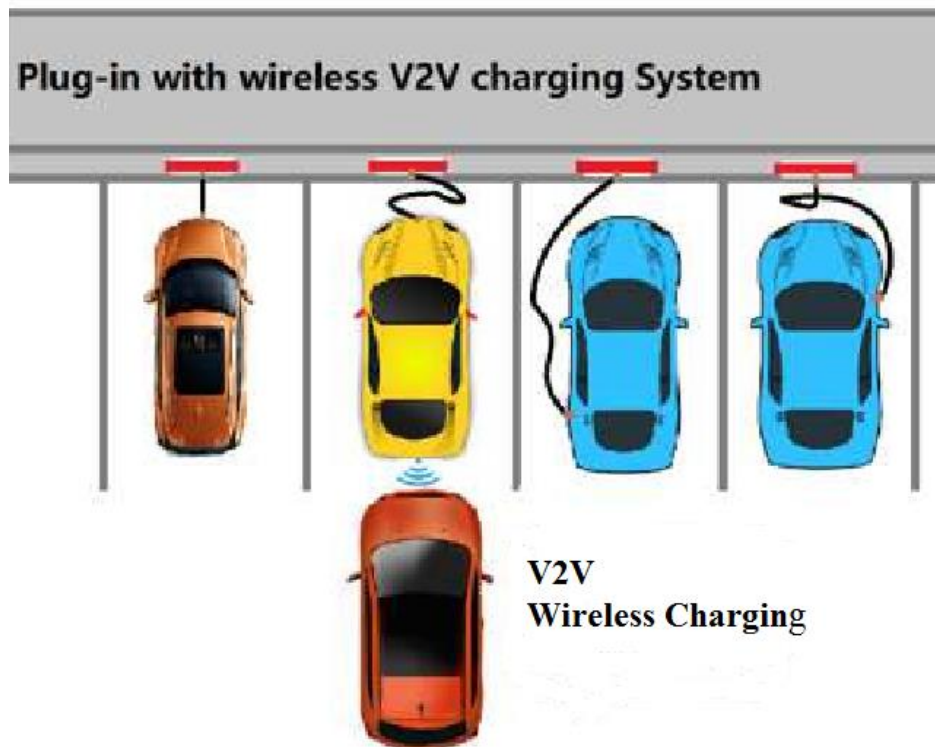


Figure 3.1 charging station with wireless V2V charging system

3.2 Vehicle to Vehicle (V2V) Associate with wireless Charging System

Fig. 3.2 shows the vehicle to vehicle associate with charging system. If the Electric vehicle battery runs low, it can be charge by wireless through other vehicle. In this method various auxiliary system work on it such as vehicle to vehicle communication, GPS, state of charge (SOC) indicator of available charging, depth of discharge (DOD) indicator of used charging and State of Health (SOH) Monitor battery health condition etc. the driver can communicate though smart device to donor vehicle about charging, distance, pricing etc. the concept can reduce range anxiety in EVs. The wireless power technology (WPT) by inductive charging coil as a transmitter and receiver is best suited for this concept.[8-9].

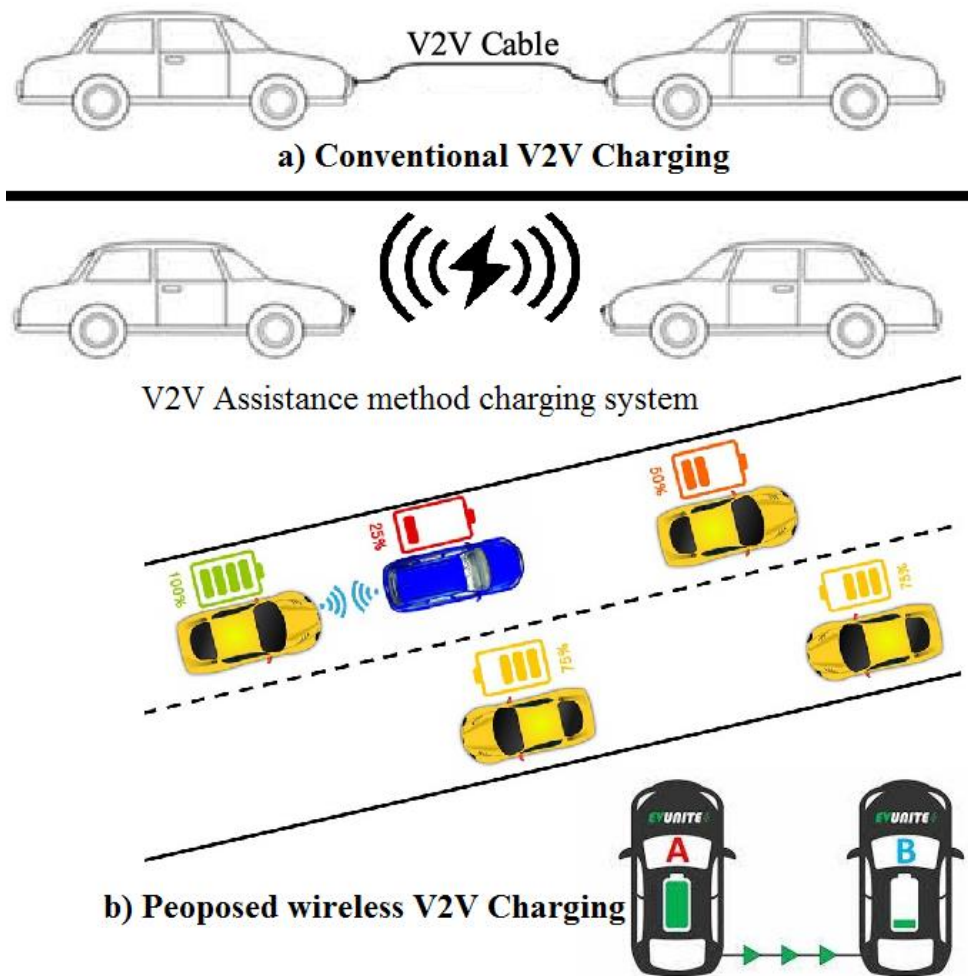


Figure 3.2 V2V Assistance method charging system a) Conventional V2V Charging
b) Proposed wireless V2V charging

4. CONCLUSION

This paper proposes new system of vehicle to vehicle (V2V) wireless charging and it can solve the problem of limited number of charging station and also reduces range anxiety problem on highways. By using matrix converter is capable of converting power by single stage conversion process instead of multi stage existing converter. Matrix converter is beneficial for system become less bulky, high efficiency, compact and smooth operation. This paper also present Vehicle to Vehicle (V2V) transmitter and receiver coil designing with consideration of alignment and angular offset. A triangular shape transmitted coil and rectangular shape receiver coil is recommended in this paper for angular misalignment

problem. The high power fast charging setup can implement in future for V2V wireless charging. Transmitter coil should be in ground and the receiver coil in vehicle. But wireless V2V system, the transmitter coil is installed at front and receiver coil is installed at rear side of EV. We will also focus on hardware prototype model for this wireless vehicle to vehicle power charging system.

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