IJARSCT
ISSN (Online) 2581-9429
International Journal of Advanced Research in Science, Communication and Technology (IJARSCT)
Impact Factor: 6.252
Volume 2, Issue 1, November 2022

Review on Grid to Vehicle and Vehicle to Grid Bidirectional Power Transfer Systems for EV Application

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Abstract: *Wireless Power Transfer (WPT) for Electric Vehicle (EV) battery charging application is one of the key upcoming technologies. The possibility of using EVs to transfer power back to the grid, utilizing the concept of Bidirectional Wireless Power Transfer (BD-WPT) is extensively being explored. The effect of integration of EV on grid is also of concern. This paper presents analysis of complete grid integrated BD-WPT system for controlling power transfer between grid and EV battery, along-with ensuring Unity Power Factor (UPF) at grid side. Mathematical model of each component in the system is presented which is then used to design vehicle and grid side controllers for achieving desired output. Concepts stated analytically are validated by simulation in MATLAB (Simulink).*

Keywords: Photovoltaic (PV), Transformerless, Inverter

I. INTRODUCTION

The increasing global concern over depletion of fossil fuel reserves and their adverse effects on the environoment have resulted in fast development in technologies like renewable energy generation and EVs. Conductive charging has been long introduced but is still not preferred due to tripping hazards, leakage from old cracked cables (particularly in cold zones), risk of electric shock etc. Major drawback of present EVs is the power storage technology, usually battery, which has very unsatisfacotory performance. Long charging time of EV batteries is the main reason for its low popularity among consumers. Introduction of wireless power transfer for EV battery charging is thus being considered as a probable solution for aforementioned issues in conductive charging. Wireless charging technique provides several advantages like galvanic isolation, convenient and safe usage in addition to low maintenance due to no physical contacts or moving parts. Also, the battery capacity of EVs with wireless charging could be reduced to 20% or less compared to EVs with conductive charging . Most of the developments in WPT technology have mainly been in applications requiring unidirectional power transfer. In recent years, BD-WPT systems have become popular for implementing the concept of Vehicle to Grid (V2G) for grid integration of EVs . To reduce the effects caused due to intermittent nature of renewable energy systems and facilitate dynamic demand management, V2G concept can be used as cost-effective alternate energy storage unit.

In this work, a complete system depicting V2G and G2V concept for controlling desired power transfer between grid and EV battery, along-with ensuring unity power factor at grid side has been analyzed and simulated in MATLAB.

II. LITERATURE SURVEY

[1] Y. Tang, Y. Chen, U. K. Madawala, D. J. Thrimawithana and H. Ma:

In this paper the author has proposed a new controller that uses a measured active power (P) and reactive power (Q) at the resonant network of BD-WPT systems to regulate the power flow in both directions while providing synchronization between two sides without a dedicated communication interface for controlling of the power transfer of the system as well as they had obtained experimental results for 1 KW prototype system which showed good agreement with the stimulated results.

[2] G. Pandey, and Narsa Reddy T:
This paper presents the analysis of complete grid integrated BD-WPT system for controlling power transfer between grid and EV battery, along-with ensuring Unity Power Factor (UPF) at grid side. As well as mathematical modelling of each component in the system is presented which is used then to design vehicle and grid side controllers for achieving the desired output.

[3] Cristina-Adina Bilatiu, S.I. Cosman, R.A. Martis:
This paper deals with identification and evaluation of electric and hybrid propulsion variants for vehicles. The first part of the study identifies and studies the existing variants of propulsion systems for electric and hybrid vehicle whereas the next step involves a comparative study between the systems already analyzed in order to evaluate the performance of different system configurations.

[4] S. Li and C. C. Mi:
This paper basically focused on reviewing the technologies in the WPT area applicable for EV wireless charging, by introducing WPT in EVs, and the obstacles of charging time, range, and cost can be easily mitigated.

[5] T. Payarou and P. Pillay:
This paper basically proposes and analyses a novel multipurpose power electronic interface (MPEI) designed for the new generation plug-in electric vehicles (PEVs), and plug-in hybrid electric vehicles (PHEVs). The proposed topology allows vehicle to grid (V2G) and grid to vehicle (G2V) operation to support the grid in times of high load or stress. The operation principles of the MPEI in its different modes are explained and practical results obtained using a real-time controller are discussed and validated in this paper.

III. METHODOLOGY

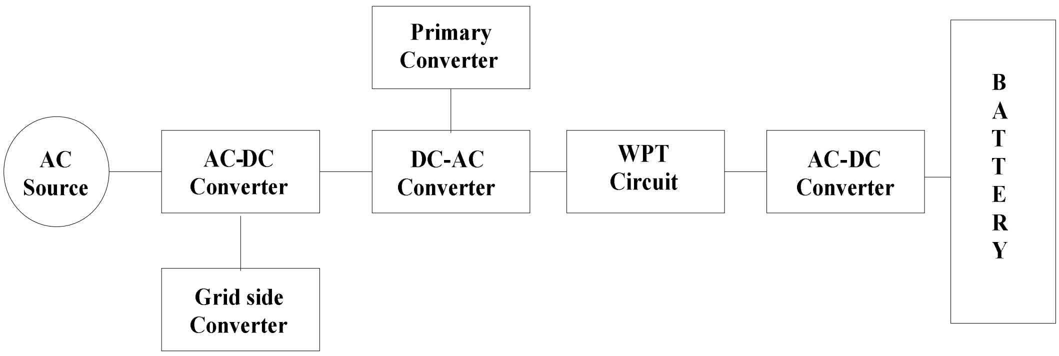

Fig 1: Block Diagram of proposed System

A block diagram broadly describing the elements of a bidirectional wireless power transfer system is shown in Fig. 1. It consists of two sides: primary and secondary. Primary side is connected to the utility grid via a dc link and is usually embedded under the road in places like traffic signals, bus stops, vehicle charging stations etc. The secondary side is connected with EV battery and is placed at the bottom of electric vehicle. As can be seen in Fig. 1. both sides consist of coupling coils, high frequency (HF) converters, compensation circuit and dedicated controllers. When power flows from grid to EV battery (forward direction), primary converter acts as an inverter (DC/AC) and secondary converter acts as a controlled rectifier (AC/DC). Similarly, when EV battery supplies power to the grid (reverse direction), the role of converters is reversed. As already mentioned, there are compensation networks on both primary and secondary sides.

This is the concept used by researchers to increase the power transfer efficiency in WPT system. Primary side resonance is used to reduce the Volt-Ampere(VA) rating of the power electronic converter and secondary side resonance to reduce VA rating of the coil [2]. Based on application, suitable converter topology, compensation technique and control technique are chosen. In this work, full bridge Voltage Source Converter (VSC) with LCL compensation topology at both primary and secondary sides will be analyzed. Following are the parameter considering while design the proposed system.

Table-1 System Parameter

Sr. NO	Parameter
1	Grid voltage
2	Filter inductor (Lf)
3	Primary side DC link Capacitor (Cdc)
4	Line Frequency
5	EV battery Voltage
6	Controller Parameter
7	Wireless Coupling coil parameter

IV. PROBLEM FORMULATION

A block diagram broadly describing the elements of a bidirectional wireless power transfer system is shown in Fig. 1. It consists of two sides: primary and secondary. Primary side is connected to the utility grid via a dc link and is usually embedded under the road in places like traffic signals, bus stops, vehicle charging stations etc. The secondary side is connected with EV battery and is placed at the bottom of electric vehicle. As can be seen in Fig. 1. both sides consist of coupling coils, high frequency (HF) converters, compensation circuit and dedicated controllers. When power flows from grid to EV battery (forward direction), primary converter acts as an inverter (DC/AC) and secondary converter acts as a controlled rectifier (AC/DC). Similarly, when EV battery supplies power to the grid (reverse direction), the role of converters is reversed. As already mentioned, there are compensation networks on both primary and secondary sides.

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Fig-1: Grid Connected BD-WPT System

Wireless Power Transfer (WPT) for Electric Vehicle (EV) battery charging application is one of the key upcoming technologies. The possibility of using EVs to transfer power back to the grid, utilizing the concept of Bidirectional Wireless Power Transfer (BD-WPT) is extensively being explored. The effect of integration of EV on grid is also of concern. This paper presents analysis of complete grid integrated BD-WPT system for controlling power transfer between grid and EV battery, along-with ensuring Unity Power Factor (UPF) at grid side. Mathematical model of each component in the system is presented which is then used to design vehicle and grid side controllers for achieving desired output. Concepts stated analytically are validated by simulation in MATLAB (Simulink)

V. EXPECTED CONCLUSION

The work will presents a new high efficiency transformer-less inverter for grid tied PV systems. The key benefits of this research work in brief as:

1. Proposed converter will the overall efficiency.
2. By keeping common mode voltage fixed at center point of bus DC voltage due to this less leakage current will flow through the network than H6 topology.
3. The illustrated work, which minimizes THD at output side, does not require PWM dead time.

REFERENCES

[1] L. Zhang, K. Sun, Y. Xing and M. Xing, "H6 Transformerless Full-Bridge PV Grid-Tied Inverters," in IEEE Transactions on Power Electronics, vol. 29, no. 3, pp. 1229-1238, March 2014, doi: 10.1109/TPEL.2013.2260178.

[2] L. Zhang, K. Sun, Y. Xing and M. Xing, "H6 Transformerless Full-Bridge PV Grid-Tied Inverters," in IEEE Transactions on Power Electronics, vol. 29, no. 3, pp. 1229-1238, March 2014, doi: 10.1109/TPEL.2013.2260178.

[3] H. Wang, S. Burton, Y. Liu, P. C. Sen and J. M. Guerrero, "A systematic method to synthesize new transformer less full-bridge grid-tied inverters," 2014 IEEE Energy Conversion Congress and Exposition (ECCE), Pittsburgh, PA, 2014, pp. 2760-2766, doi: 10.1109/ECCE.2014.6953772.

[4] Y. Dai, W. Li, C. Zhou and S. Zhuang, "Research on transformerless dual-buck full-bridge grid-connected inverter with H5-type for PV systems," in IET Power Electronics, vol. 12, no. 1, pp. 44-50, 12 1 2019, doi: 10.1049/iet-pel.2018.5196.

[5] J. Fang, M. Shi, H. Xiao and R. Wang, "A Zero-Voltage-Transition H5-Type Transformerless Photovoltaic Grid-Connected Inverter," in IEEE Access, doi: 10.1109/ACCESS.2019.2946976.

[6] M. Islam, S. Mekhilef, and M. Hasan, "Single phase transformerless inverter topologies for grid-tied photovoltaic system: A review," Renewable and Sustainable Energy Reviews, vol. 45, pp. 69-86, 2015.

[7] Yong-Won, C., Woo-Jun, C., Jung-Min, K., et al.: 'Improved single-phase TL inverter with high power density and high efficiency for grid-connected photovoltaic systems', IET Renew. Power Gener., 2016, 10, (2), pp. 166–174 [15] Li,

[8]W., Gu, Y., Luo, H., et al.: 'Review and derivation methodology of single phase TL photovoltaic inverters for leakage current suppression', IEEE Trans. Ind. Electron., 2015, 62, (7), pp. 4537–4551

[9] Jaber, F.A., Yam, P.S., Mehran, S., et al.: 'S4 gridconnected single-phase TL inverter for PV application'. IEEE Conf., 2016

[10] Yong-Won, C., Woo-Jun, C., Jung-Min, K., et al.: 'Improved single-phase TL inverter with high power density and high efficiency for grid-connected photovoltaic systems', IET Renew. Power Gener., 2016, 10, (2), pp. 166–174