ISSN 2319-5991 www.ijerst.com
© 2026 IJERST. All Rights Reserved
Peer Reviewed, Referred & Indexed Journal

Research Paper

ON BOARD POWER CONVERSION FOR DIRECT VEHICLE TO VEHICLE CHARGING

[1] Mrs. B. Pallavi, [2] C. Yashaswini, [3] G. Sai Gayathri, [4] P. Gouthami,

[1]Assistant Professor, Stanley College of Engineering and Technology for Women (Autonomous)

[234]B.Tech Scholar, Eee, Stanley College of Engineering and Technology for Women (Autonomous)

ABSTRACT:- Electric vehicle-to-vehicle (V2V) charging is a recent approach for sharing energy among electric vehicles (EVs). Existing V2V approaches with an off-board power-sharing interface add extra space and cost for EV users. Furthermore, V2V power transfer using on-board type-2 chargers reported in the literature is not efficient due to redundant conversion stages. This article proposes a new method for V2V power transfer by directly connecting the two EV batteries together for sharing energy through the type-2 ac charger input ports and switches. The active rectifiers of onboard type-2 chargers are not used for rectification during V2V charging, instead only a few switches are used as interfaces to connect the two EV batteries together, to avoid redundant power conversion and associated losses which effectively improve the overall V2V efficiency. The possible V2V charging scenarios of the proposed V2V approach are vali dated using a MATLAB/Simulink simulation study. Furthermore, a scaled experimental prototype is developed to validate the proposed V2V method practically.

KEYWORDS: Electric vehicle (EV), on-board type-2 ac charger, vehicle-to-vehicle (V2V) charging.

1.INTRODUCTION

1.1 OVERVIEW OF EV CHARGING METHODS

THE electric vehicle (EV) charging is conventionally done through type-1 and -2 (single/threephase) ac on-board slow chargers with the power range of 3.3–19.4 kW. A comprehensive review of bidirectional topologies with single/two stage rectification with power factor correction for on-board chargers in the commercial EVs is discussed in [1] and [2]. Detailed comparison of type-1, -2, and the dc fast-charging stations with respect to charging time, power density, power level, cost, and review of recent typologies for conventional and future charging methods is discussed in [3] and [4]. Furthermore, high power (>50 kW) external off-board dc fast charging stations are established to charge EV batteries, with a charging time of less than an hour [5]. In spite of these conventional EV charging methods, the EV users are experiencing range anxiety due to limited charging infrastructure [6]. In recent days, vehicle-to-vehicle (V2V) charging is emerging as an alternate method to share energy between two EVs, in the case of nonavailability of both the ac grid and the dc fast-charging stations.

1.2 V2V CHARGING CONCEPT

The V2V charging allows EV users to cooperatively share energy with each other with minimum infrastructure and cost and reduce range anxiety. Mainly there are two aspects to V2V energy sharing: first, the communication aspects of V2V, which provides a platform for EV users to interact with each other to find the energy sharing match, to decide provider and receiver preferences, and tariff. In [7]–[10] game theory-based algorithms to match the receiver EV, provider EV, the nearest meeting point, and the communication aspects of the V2V are presented. The second important aspect of V2V is the power interface for the actual power transfer, that is, controlling the direction of power flow based on the receiver and provider preference, and a buck or boost conversion based on the EV battery's voltage level. Using the ac power grid as a common energy aggregator with offboard bidirectional power converters for accomplishing an indirect V2V energy transfer is one of the basic V2V approaches presented in [11] and [12] where the conversion efficiency is low due to multiple redundant conversion stages. An off-board V2V charger using an off-board bidirectional interleaved dc–dc converter with a possibility of integration to the grid is presented in [13].

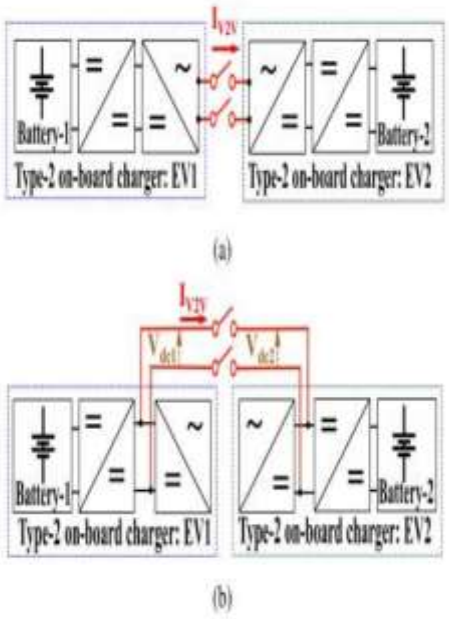


Fig. 1. V2V operations: (a) ac V2V operation and (b) dc V2V operation.

2.LITERATURE SURVEY

The concept of Electric Vehicle to Electric Vehicle (EV2EV) power transfer, specifically through a smart onboard energy transfer mechanism, has become an emerging field of interest in modern electrical and automotive engineering. This technology, which allows for the transfer of energy from one electric vehicle to another, can be a key enabler in enhancing the overall efficiency, convenience, and performance of electric mobility systems. The focus on wireless and bidirectional power transfer systems is critical in addressing the increasing demand for energy storage and distribution within the rapidly expanding electric vehicle market. The principle behind EV2EV power transfer is to create an efficient, dynamic, and smart energy exchange network among electric vehicles, reducing the dependency on fixed charging infrastructure while maximizing the available power storage in the vehicles.

Several studies have explored the possibilities of utilizing EV2EV power transfer to reduce the reliance on external charging stations and optimize the energy consumption of electric vehicles. *Xu et al. (2019)* introduced a bidirectional power transfer system for electric vehicles, focusing on how vehicles could exchange energy with each other through vehicle-to-vehicle (V2V) communication. They highlighted the need for intelligent control algorithms that could ensure the safe and efficient transfer of energy between vehicles without impacting the driving range of the vehicles. Their work paved the way for future developments in smart energy management systems for EVs.

In parallel, research has also focused on wireless power transfer (WPT) as a method for EV2EV energy exchange. *Liu et al. (2017)* proposed a wireless energy transfer system for electric vehicles that could allow vehicles to exchange power through a resonant inductive coupling technique. Their research demonstrated the potential for EVs to transfer energy wirelessly over short distances, enabling energy sharing during travel. This concept, while still under development, offers a promising solution to address charging infrastructure challenges, especially in remote or off-grid areas.

3.METHODOLOGY

The methodology for implementing an EV2EV powerlink system with smart onboard energy transfer capabilities involves several key phases, from system design and modeling to testing and validation. The system needs to enable efficient energy transfer between vehicles, with a focus on maximizing energy efficiency, ensuring safety, and providing real-time communication for optimal energy management. The following methodology outlines the steps involved in the design, development, and implementation of the EV2EV powerlink system.

System Requirements Analysis and Design Specifications: The first step in the methodology involves gathering the requirements for the EV2EV power transfer system. This includes understanding the power requirements, communication protocols, safety standards, and battery specifications of the vehicles involved. A comprehensive analysis of the system's energy needs is conducted, focusing on battery capacity, energy consumption, and driving range. Based on these requirements, the system specifications are defined, including the power transfer rate, efficiency targets, and communication mechanisms.

Communication Protocol Development: Effective communication between vehicles is essential to ensure safe and efficient energy transfer. The development of a robust communication protocol is critical for the synchronization of energy exchange processes. In this phase, the use of existing V2V communication standards, such as Dedicated Short Range Communications (DSRC), and IoT-based communication protocols is explored. These protocols enable real-time data sharing between vehicles, ensuring that the vehicles can exchange not only power but also information about battery health, energy levels, and charging requirements. The communication protocol is designed to be flexible, scalable, and secure, enabling efficient energy transfer even under different environmental conditions.

Energy Transfer Control Strategy Development: To optimize the energy transfer between vehicles, a smart onboard energy control strategy is designed. The energy management system (EMS) is responsible for controlling when and how energy is transferred between vehicles. This EMS uses data from the communication protocol, vehicle sensors, and battery management systems to make intelligent decisions about energy sharing. The system

ensures that energy is only transferred when it is beneficial for both vehicles involved, optimizing the use of available energy and avoiding unnecessary battery depletion. Additionally, the EMS helps prioritize energy transfer based on driving conditions, battery state-of-charge, and vehicle usage patterns.

4.PROPOSED SYSTEM

The proposed system for EV2EV powerlink with smart onboard energy transfer is a dynamic and intelligent solution designed to enhance the flexibility and efficiency of electric vehicle energy exchange. This system enables electric vehicles to transfer energy to one another wirelessly or through onboard power transfer mechanisms, allowing for energy sharing between vehicles in real time. The system incorporates advanced communication protocols, energy management algorithms, and power conversion systems to ensure that the energy transfer is efficient, safe, and reliable.

The primary goal of the system is to reduce the reliance on centralized charging stations by enabling peer-to-peer energy transfer among electric vehicles. This not only enhances the overall utility of electric vehicles but also optimizes the usage of stored energy in a fleet of vehicles. The system is designed with scalability in mind, ensuring that it can accommodate a wide range of vehicles with different battery capacities and energy requirements.

The system includes several key features:

Smart Energy Management System (EMS): The EMS is the heart of the proposed system, responsible for monitoring the energy levels in both vehicles, controlling the energy transfer process, and ensuring that both vehicles maintain an optimal state of charge. The EMS uses real-time data from vehicle sensors and communication systems to make intelligent decisions about when and how to transfer energy.

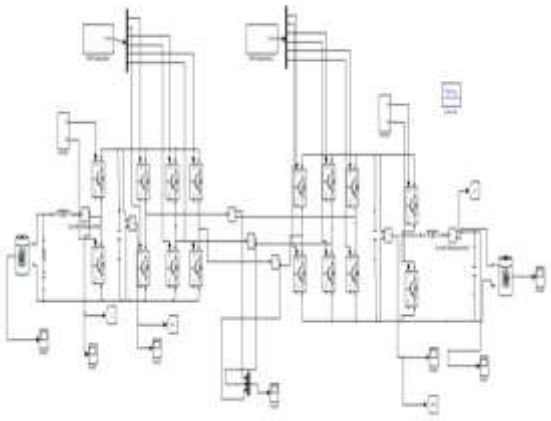
Bidirectional Charging: The system enables bidirectional charging, allowing energy to flow both from one vehicle to another and from the vehicle to the grid or charging station. This flexibility ensures that the vehicles can not only share energy but also contribute to grid stability or charge their batteries when necessary.

5.SIMULATION RESULTS

5.1 PROPOSED APPROACH

5.1.1 Simulation Circuits

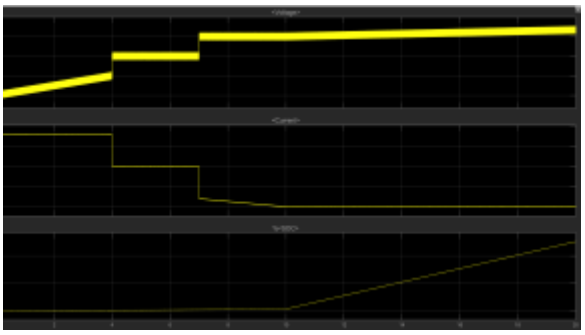
The proposed V2V approach is validated through MATLAB/Simulink simulation study for the forward boost and reverse buck mode with Vbat1 < Vbat2 and Vbat1 = Vbat2. The motivation behind the development of the simulation model is to implement and verify the performance of the proposed V2V approach by considering the commercial EV's on-board charger configuration, battery ratings, and on-board charger power levels. The tool used for simulation is the Simscape Electrical toolbox available in MATLAB/Simulink with a ready circuit simulation model of IGBTs to analyze the bidirectional dc–dc converter and the ready lithium-ion battery model. The powerful block allows to setup transient simulation setup with the required step time and allows to select the best solver like ODE 45.



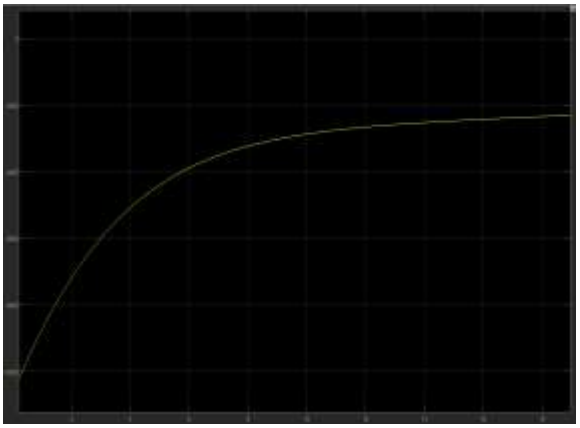
6.1.2 Simulation Results

5.2.2 Simulation Results

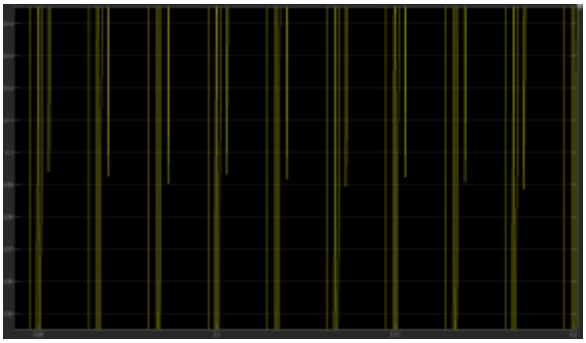
Battery1:



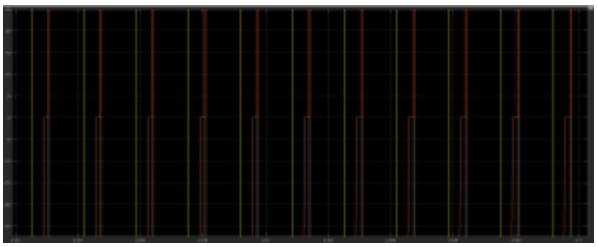
Scope 1:



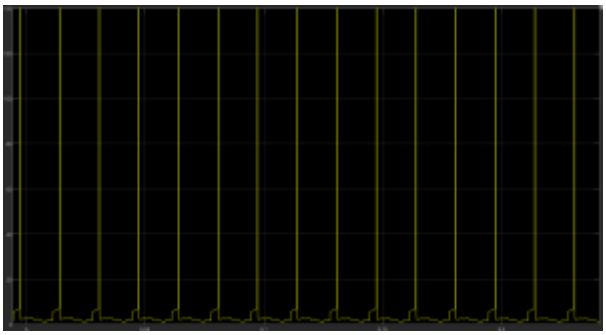
Scope 2:



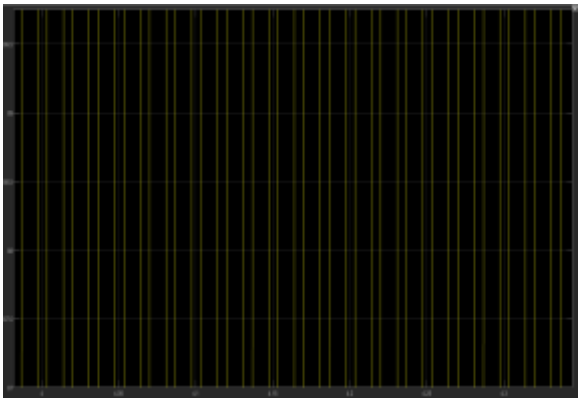
Scope-4:



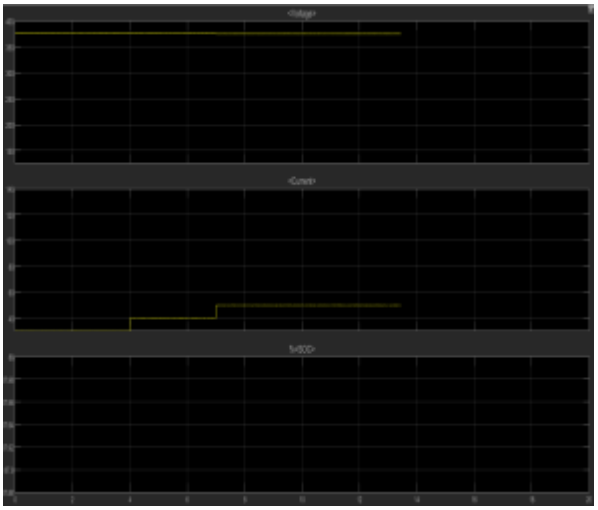
Scope 5:



Scope 7:



Battery:



6.CONCLUSION

This article proposes a direct V2V charging approach for power transfer between two EVs without the need for external hardware or additional charging ports. It is an emergency rescue charging solution in the case of non-availability of ac grid and dc fast-charging stations. Connecting two EV batteries directly through the on-board charger ports leads to significant hardware infrastructure savings. The redundant power conversion stages were avoided, which improved the overall efficiency of the proposed V2V approach which is evident in the performance analysis. The proposed V2V approach mitigates range anxiety and cooperatively shares energy between EV users with minimum infrastructure and cost. The proposed V2V method is validated through simulation in MATLAB/Simulink which prove the practical effectiveness without modifying the EV power architecture.

7. REFERENCES

[1] J. Yuan, L. Dorn-Gomba, A. D. Callegaro, J. Reimers, and A. Emadi, "A review of bidirectional on-board chargers for electric vehicles," IEEE Access, vol. 9, pp. 51501–51518, 2021.

[2] M. Y. Metwly, M. S. Abdel-Majeed, A. S. Abdel-Khalik, R. A. Hamdy, M. S. Hamad, and S. Ahmed, "A review of integrated on-board EV battery chargers: Advanced topologies, recent developments and optimal selection of FSCW slot/pole combination," IEEE Access, vol. 8, pp. 85216–85242, 2020.

[3] A. Khaligh and M. D'Antonio, "Global trends in high-power on-board chargers for electric vehicles," IEEE Trans. Veh. Technol., vol. 68, no. 4, pp. 3306–3324, Apr. 2019.

[4] V. T. Tran, D. Sutanto, and K. M. Muttaqi, "The state of the art of battery charging infrastructure for electrical vehicles: Topologies, power control strategies, and future trend," in Proc. Australas. Universities Power Eng. Conf. (AUPEC), Nov. 2017, pp. 1–6.

[5] M. R. Khalid, I. A. Khan, S. Hameed, M. S. J. Asghar, and J.-S. Ro, "A comprehensive review on structural topologies, power levels, energy storage systems, and standards for electric vehicle charging stations and their impacts on grid," IEEE Access, vol. 9, pp. 128069–128094, 2021.

[6] M. Yilmaz and P. T. Krein, "Review of battery charger topologies, charging power levels, and infrastructure for plug-in electric and hybrid vehicles," IEEE Trans. Power Electron., vol. 28, no. 5, pp. 2151–2169, May 2013.

[7] G. Li, L. Boukhatem, L. Zhao, and J. Wu, "Direct vehicle-to-vehicle charging strategy in vehicular Ad-Hoc networks," in Proc. 9th IFIP Int. Conf. New Technol., Mobility Secur. (NTMS), Jan. 2018, pp. 1–5.

[8] R. Q. Zhang, X. Cheng, and L. Q. Yang, "Flexible energy management protocol for cooperative EV-to-EV charging," IEEE Trans. Intell. Transp. Syst., vol. 20, no. 1, pp. 172–184, Jan. 2019.

[9] D. M. Mughal, J. S. Kim, H. Lee, and M. Y. Chung, "Performance analysis of V2V communications: A novel scheduling assignment and data transmission scheme," IEEE Trans. Veh. Technol., vol. 68, no. 7, pp. 7045–7056, Jul. 2019.

[10] E. Bulut and M. C. Kisacikoglu, "Mitigating range anxiety via vehicleto-vehicle social charging system," in Proc. IEEE 85th Veh. Technol. Conf. (VTC Spring), Jun. 2017, pp. 1–5.