International Journal of Scientific Research in Engineering and Management (IJSREM)
Volume: 06 Issue: 06 | June - 2022 Impact Factor: 7.185 ISSN: 2582-3930

Design and Analysis of Bidirectional Battery Charger with Grid-to-Vehicle, Vehicle-to-Grid and Vehicle-to-Home Technologies

Bugatha Ram Vara Prasad[1], K.Bhavani[2], M. Niharika[3], K. Shanmukhi[4], K. Aravind kumar[5]
[1] Assistant Professor, Department of Electrical and electronics engineering
[2,3,4,5] U.G students, Department of Electrical and electronics engineering
Lendi institute of Engineering and Technology, Vizianagaram, Andhra Pradesh, India

Abstract:

In this fast-changing world, Electric Vehicle (EV) is a giant leap in the world of transportation. In comparison with fossil fuel powered vehicles, EVs are more efficient, silent, emit less pollution while in use and they act as mobile power banks, these makes them a better alternative. This in turn can be used for Vehicle to Home (V2H) and Grid to Vehicle (G2V) operations using IOT as a platform to achieve control and monitoring, prototype IOT based car is considered as the EV in this research. In this research, IOT is used as the platform to implement V2H and G2V concepts.

This paper presents the development of an on-board bidirectional battery charger for Electric Vehicles (EVs) targeting Grid-to-Vehicle (G2V), Vehicle-to-Grid (V2G), and Vehicle-to-Home (V2H) technologies. During the G2V operation mode the batteries are charged from the power grid with sinusoidal current and unitary power factor. During the V2G operation mode the energy stored in the batteries can be delivered back to the power grid contributing to the power system stability. In the V2H operation mode the energy stored in the batteries can be used to supply home loads during power outages, or to supply loads in places without connection to the power grid. The adopted topology and control algorithms are accessed through computer simulations and validated by experimental results achieved with a developed laboratory prototype operating in the different scenarios.

KEYWORDS: *bidirectional Battery-charger, Grid-to-Vehicle (G2V); Vehicle-to-Grid (V2G); Vehicle-to-Home (V2H)*

I. INTRODUCTION

Electric Vehicles (EVs), represents a new concept in the transports sector around the world. Consequently, the interest in technologies for EVs has significantly increased in the last years, resulting in several scientific publications concerning this subject. It is expected that the market share of EVswillexponentiallygrowcomprising24%oftheU.S. light vehicle fleet in 2030,representing 64% light vehicle sales in this year. In this context, the EVs battery charging process (Grid-to-Vehicle, G2V) must be regulated to preserve the power quality in the power grids. Nevertheless, with the prolife ration of EVs a considerable amount of energy will be stored in their batteries, arising the opportunity of the energy flow in opposite sense (Vehicle-to-Grid,V2G).[1]

In the future smart grids, the interactivity with the EVs will be one of the key technologies, contributing to the power Grid autonomous operation. Nowadays several projects related with smart grids are under development around the world.[2] Regarding this new approach, especially in homes equipped with charging points for EVs, besides the G2V and V2G operation modes the EVs can also operates as voltage source capable to feed the home loads. This technology, begins to be denominated in the literatures Vehicle-to Home (V2H).[3]

II. Electric Vehicle

An electric vehicle (EV) is a vehicle that uses one or more electric motors or traction motors for propulsion. An electric vehicle may be powered through a collector system by electricity from off-vehicle sources, or may be self-contained with a battery, solar panels, fuel cells or an electric generator to convert fuel to electricity.[4]

EVs include, but are not limited to, road and rail vehicles, surface and underwater vessels, electric aircraft and electric spacecraft. EVs first came into existence in the mid-19th century, when electricity was among the preferred methods for motor vehicle propulsion, providing a level of comfort and ease of operation that could not be achieved by the gasoline cars of the time. Modern internal combustion engines have been the dominant propulsion method for motor vehicles for almost 100 years, but electric power has remained commonplace in other vehicle types, such as trains and smaller vehicles of all types[5].

III. Introduction To battery charger topology

3.1: UNIDIRECTIONAL BATTERY CHARGER:

The unidirectional battery charging means the flow of the charge in only one direction i.e., either from the Grid to Vehicle (G2V) or from the Vehicle to grid(V2G). Unidirectional V2G is especially attractive because it requires little if any additional infrastructure other than communication between the EV and an aggregator The unidirectional v2g refer to the single power flow from the power grid to the EV the unidirectional v2g needs the participation of grid operation to control and limit charging time location and power flow during EV charging event.

3.2: OPERATION OF BIDIRECTIONALCHARGER:

The presented battery charger is composed by two power converters that share a DC link .One is to interface the power grid and the other is to interface the traction batteries. In order to interface the power grid is used a full-bridge AC-DC bidirectional converter. This converter can operate as active rectifier with sinusoidal current and unitary power fact or during the G2V operation mode.

During theV2G and V2H operation modes this power converter operates as inverter. In the V2G mode the converter operates as controlled current source to inject the required power in the power grids In order to interface thebatteriesisusedareversibleDC-DCconverter.IntheG2Voperationmodethisconverteroperates as buck converter to control the current and voltage during the

International Journal of Scientific Research in Engineering and Management (IJSREM)
Volume: 06 Issue: 06 | June - 2022 Impact Factor: 7.185 ISSN: 2582-3930

current and voltage batteries charging stages, respectively.

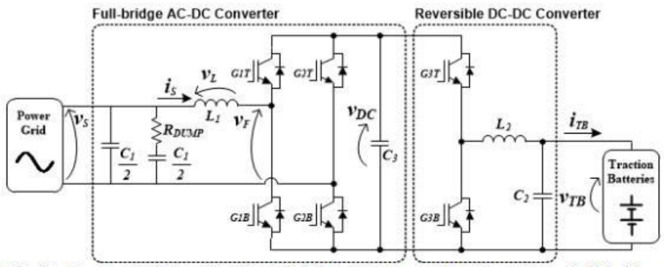
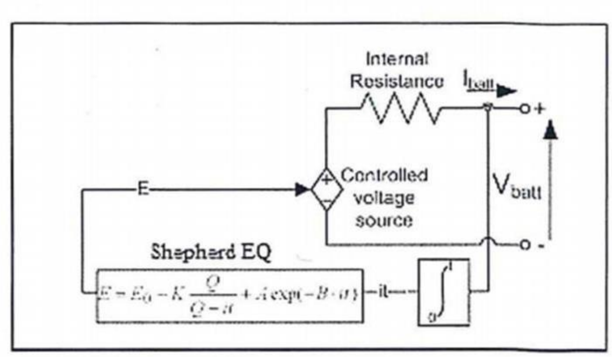


Fig. 2. Battery charger composed by two power converters: Full-bridge AC-DC bidirectional converter and Reversible DC-DC converter.

3.3: Battery modelling Block Diagram

Since the most widely used batteries for electric vehicles are lithium-ion (Li-Ion) and nickel-metalhy dride(Ni-MH),From the perspective of power grid, an EV is viewedasa load during charging and as a source during discharging. An appropriate battery model is necessary to accurately represent the characteristics of an EV battery. Likewise, a state of charge (SOC) must be implemented in the controls to select between the two scenarios. The electric circuit-based model is best due to its capability to represent the electric characteristics of a battery.



IV. Hardware Requirements

4.1 Hardware Components

1. Digital Tester

2. Dc Fan
3. Inverter Circuit Board
4. Ac to Dc Converter
5. Dc to Dc Buck Converter
6. Voltmeter Ammeter Monitor Panel
7. Electric Vehicle

4.1.1: Digital Tester

Tapuria tools started manufacturing hand tools in 1969 in India in technical collaboration with a reputed company by the name of banco of Sweden. It has been since then consistently producing all the hand tools in India with the exact technology of its collaborators. Its range is quite wide and is continually expanding. The quality, the features, the looks, the packing's etc., of the tools is continually improved and always appreciated around the world.

4.1.2: Dc Fan

Mini-van or car will be able to sit in comfort with cool air blowing in all directions! The oscillating motion of the fan allows the air to be circulated throughout your whole car so no one will be left out solar a c unit ac fan motor 1.5ton outdoor fan for car fancy fan dc motor fan 12volt dc car fan.

The 12V Oscillating Auto Fan plugs right into your car's cigarette lighter so you don't need any extra batteries! This fan is ideal for cars, trucks, buses, off-road equipment, boats, and other recreational vehicles. auto rotate car fan 6inch 12v cooler for trucks vehicle fan 12volt dc car fan car fan.

4.1.3: Inverter Circuit Board

The board is high frequency square wave dc output so it cannot drive general inductive electric appliances, such as electromotor, electric fan, coil transformer, etc.

4.1.4: Ac to Dc Converter

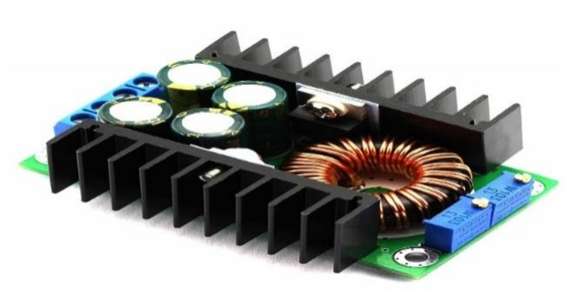
Electricity supplied to homes is typically 100V or 200V AC. On the other hand, most electronic devices operate at 3.3V or 50DC. Consequently, it is necessary to convert from AC to DC voltage.

4.1.5: Dc to Buck Converter

Use a dedicated benchmark IC, and high-precision current sensing resistor, High output current, the max output current can reach 9A.

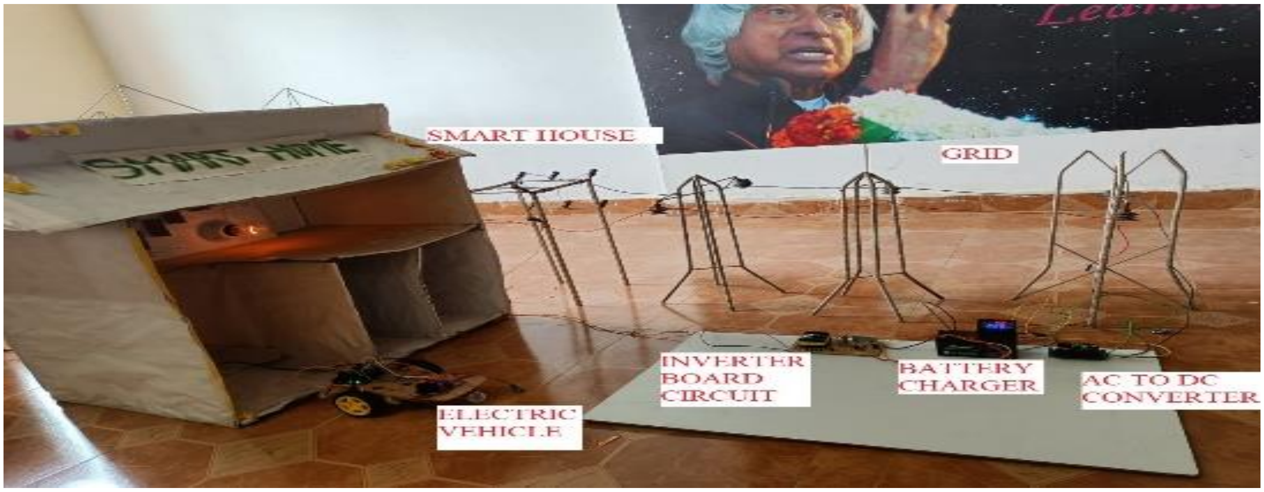
Input voltage: 7-40V Output voltage: 1.2-35V (continuously adjustable) Output Current: 8A (power tube temperature exceeds 65 Degree C please add cooling fan)

Output Power: Maximum power is about 300W (power tube temperature exceeds 65 Degree C please add cooling fan) Size: Approx. 2.55 x 1.88 x 0.94inch / 6.5 x 4.8 x 2.4cm (Length x width x thickness). Low output frequency capacitor reduces output ripple



4.1.6: Voltmeter Ammeter Monitor Panel

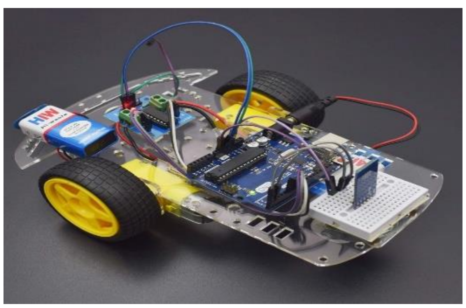
100% Brand New. Size: 48mm x 29mm x21mm. Display color: Red & Blue LED (dual display). Display: 0.28" LED digital. Measure current: 10A (direct measurement, built-in shunt). Operating temperature: -10 to 65Ã‚°c. Operating Humidity: 10 to 80% (non-condensing). Mounting cutout: 45.5mm x 26.5mmEasy to maintain.



4.1.7: Electric vehicle

Its functionality also depends upon the AT commands which are very limited in this particular circuit. It can be only a slave and not master. We can prepare wireless serial bridge with its functioning. This particular circuit is being executed with the help of an android application. It is capable enough to move Forward, Backwards, Left and Right respectively.

V. HARDWARE OUTPUTS:



The grid to vehicle and vehicle to home hardware result and the description is that the supply is given to the grid where by tap changing process we will connect it to converter i.e., ac to dc converter and the converted current will be given to the battery charging. Where it will charge the battery charger and it will be sent to the inverter board circuit. It will be connected to the load that is load which is dc fan in the smart house.

VI. Conclusion and Future Scope

This project presents the development of an on-board bidirectional battery charger for Electric Vehicles (EVs) capable of work in the operating modes Grid-to-Vehicle (G2V),Vehicle-to-Grid (V2G) which consist in important technologies for targeting the future smart grids scenario. A bidirectional converter is the primary requirement for an EV charger with advanced charging modes like V2G.

The passive elements are designed for efficient converter operation during both V2G and G2V modes. The hardware topology and the control algorithms of the presented battery charger are validated through computer simulations, using the MATLAB software, and also through experimental results, achieved with a developed laboratory prototype.

Experimental results show that the proposed system supports both G2V and V2H.7 Different tests are performed to study the dynamics and robustness of the proposed hardware system. Experiments also indicate that V2H can only be performed in local distribution network and the performance of V2H depends heavily upon the load profile of the distribution network. The experimental results obtained with the two operation modes (G2V, V2H) are in accordance with the expected, validating the viability of the proposed topology.

Future Scope:

Research following this proposed G2V/V2H system should include two subjects of interest: on G2V/V2H hardware side, improvement is needed to extend the maximum power and increase its efficiency. On software side, reactive power compensation, Total harmonic distortion (THD) and voltage regulation should be improved and must be implemented to show how the existing platform can contribute to world. As future work, the power converters will be redesigned in order to obtain a prototype with size and weight adequate to be integrated in an EV.

VI: REFERENCES:

[1] Kang Miao, Bidirectional battery charger for electric vehicles, Asia (ISGT Asia) 2018.

[2] Pinto, J. G. Bidirectional battery charger with Grid-to-vehicle, Vehicle -to-Grid and Vehicle-to-Home technologies, IEEE 2020.

[3] Bugatha Ram Vara prasad, “Solar Powered BLDC Motor with HCC Fed Water Pumping System for Irrigation,” *Int. J. Res. Appl. Sci. Eng. Technol.*, vol. 7, no. 3, pp. 788–796, 2019, doi: 10.22214/ijraset.2019.3137.

[4] Gallardo-Lozano, Milanes-Monster, Guerrero-Martinez, Three-phase bidirectional battery charger for smart electric vehicles, International Conference-Workshop 2021.

[5] M. C. Kisacikoglu, “Vehicle-to-grid (V2G) reactive power operation analysis of the EV/PHEV bidirectional battery charger,” Ph.D. dissertation, University of Tennessee, Knoxville, 2019.

[6] BUGATHA RAM VARA PRASAD, C. PRASANTHI, G. JYOTHIKA SANTHOSHINI, K. J. S. V. KRANTI KUMAR, and K. YERNAIDU, “Smart Electrical Vehicle,” *i-manager’s J. Digit. Signal Process.*, vol. 8, no. 1, p. 7, 2020, doi: 10.26634/jdp.8.1.17347.

[7] X. Zhou, S. Lukic, S. Bhattacharya, and A. Huang, “Design and control of grid-connected converter in bi-directional battery charger for plug-in hybrid electric vehicle application,” in Proc. IEEE Vehicle Power and Propulsion Conference (VPPC), 2019, pp. 1716–1721.

[8] Bugatha Ram Vara prasad, D. V. S. J. Poojitha, and K. Suneetha, “Closed-Loop Control of BLDC Motor Driven Solar PV Array Using Zeta Converter Fed Water Pumping System,” vol. 04, no. 17, pp. 2795–2803, 2017.

[9] Sagolsem Kripachariya singh, T. S. Hasarmani, and R. M. Holmukhe wireless transmission of electrical power

overview of recent research and development, international journal of Computer and Electrical Engineering, Vol.4, No.2, April 2019.

[10] Bugatha Ram Vara prasad, K. M. Babu, K. Sreekanth, K. Naveen, and C. V. Kumar, "Minimization of Torque Ripple of Brushless DC Motor Using HCC with DC-DC Converter," vol. 05, no. 12, pp. 110–117, 2018.

[11] A. W. Green and J. T. Boys, "10KHz inductively coupled power transfer-concept and control,"in roc. 5th Int. Conf. Power Electron.Variable-Speed Drives, Oct. 2019, pp.694-699.

[12] Bugatha Ram Vara prasad T. deepthin. satyavathiv. satish varma r. hema kumar, "Solar charging station for electric vehicles," *Int. J. Adv. Res. Sci. Commun. Technol.*, vol. 7, no. 2, pp. 316–325, 2021, doi: 10.48175/IJARSCT-1752.

[13] T. D. Nguyen, S. Li, W. Li, and C.Mi, "feasibility study on bipolar pads for efficient wireless power chargers,"in Proc. APEC Expo., Fort Worth, TX, USA 2020.

[14] M. Singh, K. Thirugnanam, P. Kumar, I. Kar Real-time coordination of electric vehicles to support the grid at the distribution substation level IEEE Syst J, 9 (2019), pp. 1000-1010, 10.1109/JSYST.2013.2280821.

[15] R. Das, K. Thirugnanam, P. Kumar, R. Lavudiya, M. Singh Mathematical modeling for economic evaluation of electric vehicle to smart grid interaction IEEE Trans Smart Grid, 5 (2020), pp. 712-721, 10.1109/TSG.2013.2275979

[16] Bugatha Ram Vara Prasad, T. Deepthi, N. Satyavathi, V. Satish Varma, R. Hema Kumar, A Comprehensive Review on Photovoltaic Charging Station for Electric Vehicles, *World Academics Journal of Engineering Sciences*, Vol.8, Issue.2, pp.45-49, 2021.

AUTHOR PROFILES

[1] **Bugatha Ram Vara Prasad** received UG degree in Electrical and Electronics Engineering from JNTU-Kakinada. He received PG degree in the stream of Power & industrial drives (PID) from JNTU-Kakinada. His area of interest includes Electric vehicles, Power electronic converters and Renewable energy, IOT. He is currently working as Assistant Professor in department of electrical and electronics engineering at Lendi institute of engineering and technology, Vizianagaram and has more than 5 years of teaching experience. He had published papers in international conferences and journals and having one patent.