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Performance Analysis of Bidirectional Grid-Connected Single-Power-Conversion

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Abstract- Power converter configuration targets improving the effectiveness. Yet, in a first approach and to characterize fundamental topologies, it is fascinating to expect that no misfortune happens in the converter procedure of an influence converter. With this theory, the fundamental components are of two kinds: – non-direct components, for the most part electronic switches: semiconductors utilized in substitution mode; – straight responsive components: capacitors, inductances and common inductances or transformers. These responsive parts are utilized for middle of the road vitality stockpiling for voltage and current shifting. They by and large speak to a significant piece of the size, weight, and cost of the hardware. This starting work audits and gives an exact meaning of fundamental ideas basic for the comprehension and the structure of converter topologies. Above all the sources and the switches are characterized. At that point, the key association controls between these fundamental components are checked on. From that point, converter topologies are determined. A few instances of topology combination are given. At last, the idea of hard and delicate compensation is presented. Simulation is done using MATLAB simulink software.

Keyword- Power converter, MATLAB, a bidirectional, low-input battery voltage.

I. INTRODUCTION

Power gadgets have been generally utilized in different applications since it was born. The single phase inverter, which changes over DC voltage/current into single phase AC voltage/current, is one of its generally important and prevalent converters. It has been broadly utilized in Uninterruptible Power Supplies (UPS), utilized in AC motor control, grid associated PV system, and so forth. Converters are electrical gadgets that convert current. Converters convert the voltage of an electric gadget, typically Alternating Current (AC) to Direct Current (DC). Power converter is a kind of electronic circuits for energy conversion, which converts electrical energy of the supply into the energy suitable for the load (e.g., voltage or current with suitable frequency and/or amplitude).

This investigation proposes a bidirectional grid associated single-power-conversion converter with low input battery voltage. The present improved bidirectional converter comprises of a bidirectional DC–AC converter and an unfolding bridge, and the power conversion arrange just corresponds to a bidirectional DC–AC converter. The bidirectional dc-dc converter can perform bidirectional power conversion between the low input battery voltage and a corrected sine wave because of its step-up/down voltage guideline capacities. The unfolding bridge unfurls the amended sine wave into the grid voltage and gives a current way to the grid. The investigation additionally proposes a control algorithm to direct the grid current through a single power-preparing stage. The control algorithm is contained a feed-forward ostensible voltage compensator and a dull control plot. The feed forward ostensible voltage compensator presets the working point to help the weight of the grid current control, and the dreary controller gives exact control of the grid current.

II. TYPES OF CONVERTER

There are different types of converter .some of them are discussed here.

1. Three-phase half-wave converter: The yield from single stage converter is little; when high power is required, three stage rectifiers are utilized. A three-stage half-wave rectifier with thyristors is appeared in figure underneath. The three-stage supply is given to this converter through a three-stage transformer with star associated auxiliary. It fills in as like the three-stage diode connect rectifier. In this, thyristor T1 is at most elevated positive anode voltage in the interim $\pi/6$ to $5\pi/6$.

During this interim, T1 can be made to direct by giving a terminating heartbeat to its door. This thyristor T1 keeps on leading till thyristor T2 is made to direct in the interim $5\pi/6 < wt < 3\pi/2$. Presently the heap current beginnings moving through T2. Essentially, thyristor T3 is begins leading once thyristor T2 is killed. In this, there are three beats of yield voltage during each total cycle of supply voltage. In this manner the wave recurrence is multiple times the inventory recurrence. Therefore, this converter is additionally called as 3-beat converter. This converter

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can be associated with various loads, for example, RL and RLE loads.

2.Three-phase full wave converter: It is acquired by interfacing a DC terminal of two three-beat converters in arrangement. It is likewise called as 6-beat connect converter. This sort converter is utilized in modern applications where two-quadrant activity is required. Here the heap is associated by means of a three-stage half wave association with one of three stockpile lines. Hence, there is no need of transformer; in any case, for disconnection reason a transformer is associated. Here thyristors T1, T3 and T5 structures a positive gathering, while thyristors T4, T6 and T2 structures a negative gathering. Furthermore, along these lines positive gathering SCRs are turned ON for positive stock voltage and negative gathering thyristors are turned ON for negative stockpile voltages.

3.DC to DC Converters: These can be unidirectional or bidirectional contraptions subject to the application it is made arrangements for. DC choppers are for the most part used in DC drives, i.e., electric vehicles and hybrid electric vehicles. A DC chopper is a static contraption that changes over a fixed input DC voltage to variable DC output or a fixed DC output of different enormity (which can be lower or higher) than input regard. The chopper circuit is related between DC input source and DC load. This chopper involves power electronic switching devices, for instance, thyristors which are related with the goal that they produce required DC voltage to the load.

4. Step-down Chopper or Buck converter: A step-down chopper conveys a normal output voltage lower than the input DC voltage. Here the switching fragment is a thyristor that switches the input voltage to the load when it is actuated at explicit minutes. A diode goes about as a freewheeling diode that allows the load current to flow through it when thyristor is murdered. In case this diode is feeling the loss of, a high prompted EMF in inductance may make hurt the switching device.

5. Step-up Chopper or Boost converter: In this chopper, the output voltage is constantly more prominent than input voltage. The arrangement of a lift converter is appeared in figure below. Here likewise a switch is utilized, which is associated in parallel with the load. This switch is a thyristor or a SCR. As like the buck converter, a diode is set in arrangement with the load that allows the load current to flow when the thyristor is killed. When the thyristor is turned ON, the diode is invert one-sided and thus it confines the load circuit from the source.

6. Buck/Boost converter: This chopper can be utilized both in step-down and step-up modes by consistently modifying its obligation cycle. The setup of buck-help converter is appeared in figure below that comprises of just one switching gadget, i.e., one thyristor. Alongside an inductor and diode, extra capacitor is associated in parallel with this circuit. When the thyristor is turned ON, the stock current flows to the inductor through the thyristor and incites the voltage in inductor. When the thyristor is OFF, the current in the inductor will in general decline with the initiated emf switching extremity. The output voltage of this converter stays consistent as capacitor is associated over the load.

III.BIDIRECTIONAL GRID CONNECTED SINGLE-POWER-CONVERSION CONVERTER

This investigation proposes a bidirectional grid-associated single-power-conversion converter with low-input battery voltage. The present bidirectional converter comprises of a bidirectional dc-dc converter and an unfolding bridge, and the power conversion organize just corresponds to a bidirectional dc-dc converter. The bidirectional dc-dc converter can perform bidirectional power conversion between the low input battery voltage and a redressed sine wave because of its step-up/down voltage guideline capacities.

The unfolding bridge unfurls the amended sine wave into the grid voltage and gives a current way to the grid. The investigation likewise proposes a control algorithm to manage the grid current through a single power-handling stage. The control algorithm is involved a feed-forward ostensible voltage compensator and a redundant control conspire. The feed-forward ostensible voltage compensator presets the working point to help the weight of the grid current control, and the redundant controller gives exact control of the grid current. In this way, the present bidirectional grid-associated single-power-conversion converter brings about high power quality and high efficiency. Test results dependent on a 250-W model module are directed to assess the performance of the converter and to confirm the investigation.

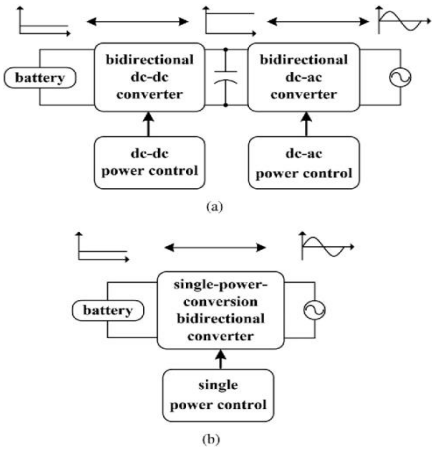


Figure 1. 2 bidirectional grid-associated single-power-conversion converter with low-input battery voltage

A bidirectional grid associated single-power-conversion converter with a low-input battery voltage and a control

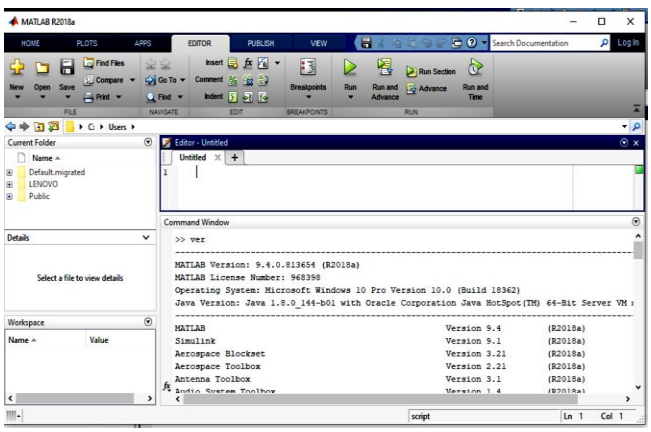
system. A single power-conversion strategy was utilized by the present converter to perform bidirectional power conversion between the battery and the grid through a single-power handling stage. An energy storage system (ESS) that uses a battery is an ongoing worry for energy self-supporting and adaptable energy the executives. It diminishes the general expense of power utilization and improves quality and efficiency of power by storing overabundance energy and discharging this energy when it is required. The ESS reacts to changes sought after to guarantee smooth changes in utilization during top load time and blackout. In this way, it is important to plan a bidirectional converter in the middle of the battery and grid for the ESS.

IV. METHODOLOGY

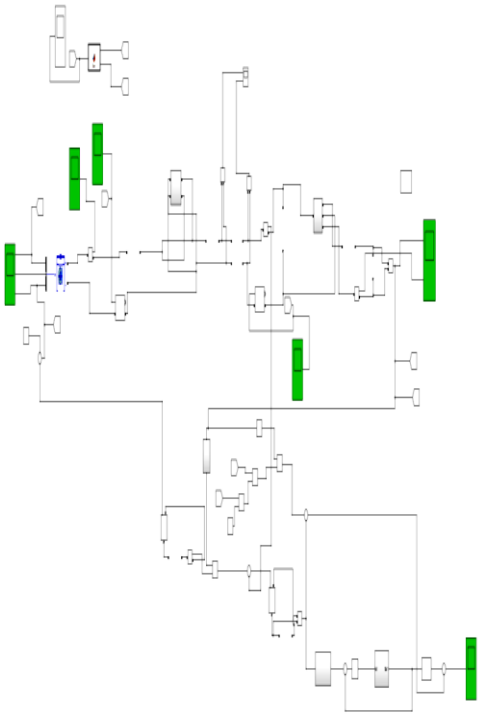
The present system is adjusted bidirectional grid-associated single-power-conversion converter with low-input battery voltage. It is vital for the present converter to perform bidirectional power flow control and fulfill utility interface measures, with just a single power-handling stage. The collapsed grid current input and output speaks to the power flow direction and the moved power level. It likewise remembers the power quality for the grid side. Along these lines, controlling the collapsed grid current input and output prompts the practicality of single-power conversion in the present converter.

1. Simulation Software

MATLAB (**mat**rix **lab**oratory) is a numerical figuring condition and fourth-age programming language. Created by Math Works, MATLAB allows lattice controls, plotting of capacities and information, execution of algorithms, making of UIs, and interfacing with programs written in different dialects, including C, C++, Java, and Fortran. In spite of the fact that MATLAB is expected principally for numerical processing, a discretionary tool stash utilizes the MuPAD emblematic motor, allowing access to representative figuring capacities. An extra bundle, Simulink, includes graphical multi-space reproduction and Model-Based Plan for dynamic and implanted systems.



2. Present Model-



3. Sub-Model and Result Discussion

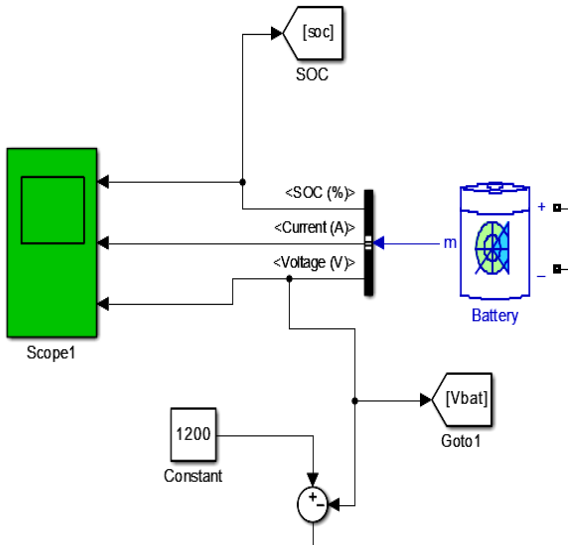


Figure 2 Battery Circuit.

Figure 2 is indicating battery circuit, it actualizes a conventional battery that model most mainstream battery types. Uncheck the "Utilization parameters dependent on Battery type and ostensible qualities" parameter to alter the discharge attributes.

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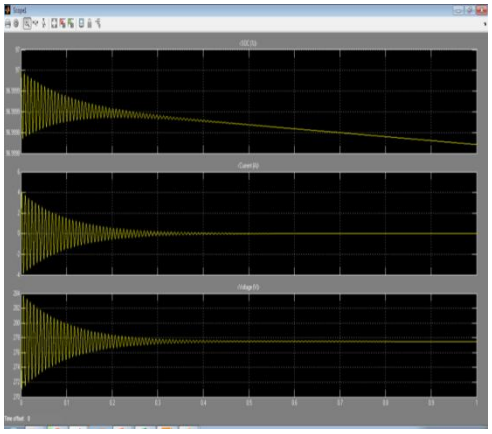

Figure 3: Battery Output

In figure 3, it is clear that the state of charge (SOC), voltage and current of output performance of applied battery.

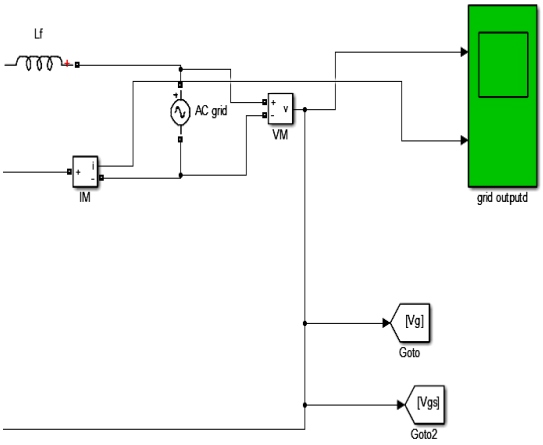

Figure 4 AC Grid Section

Figure 4 is indicating AC grid, an electrical grid is an interconnected network for conveying electricity from makers to customers. It comprises of creating stations that produce electrical power, high voltage transmission lines that convey power from removed sources to request focuses, and circulation lines that interface singular customers.

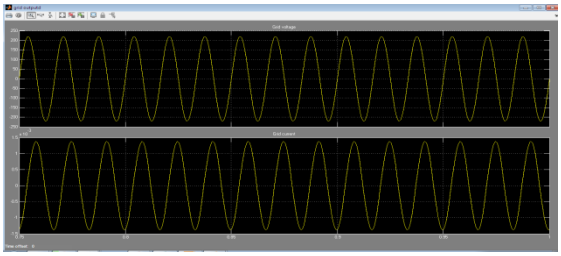

Figure 5 AC Grid outputs

Figure 5 is showing output voltage and current of applied AC grid.

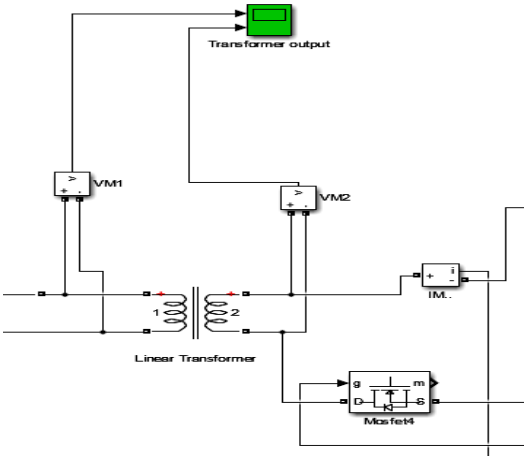

Figure 6: Transformer section

Figure 6 is presenting transformer and MOSFET circuit of present model.

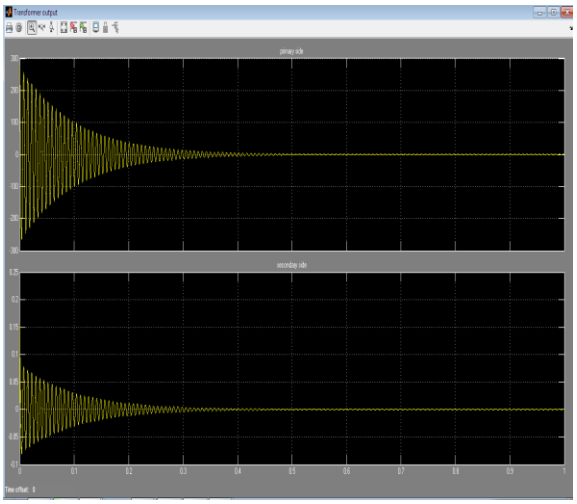

Figure 7: Transformer output.

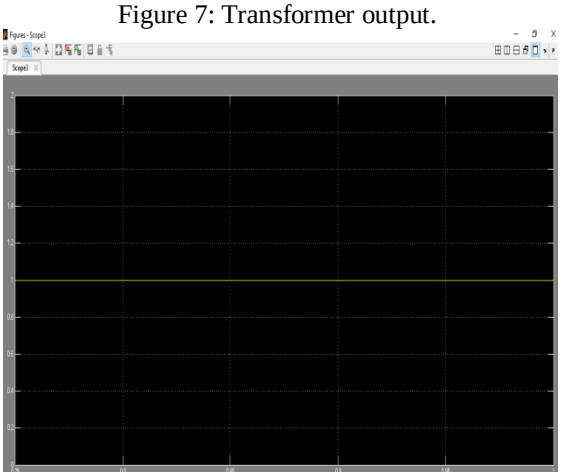

Figure 8: MOSFET output.

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Figure 8 shows output of MOSFET, When the input voltage, (V_{in}) to the door of the transistor is zero, the MOSFET leads basically no current and the output voltage (V_{out}) is equivalent to the stock voltage VDD. So the MOSFET is "OFF" working inside its "cut-off" locale and the other way around.

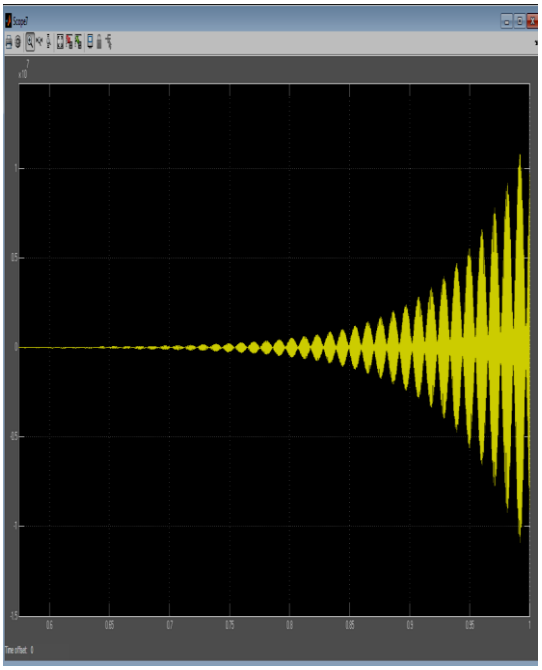

Figure 9: Battery Charges.

Figure 9 shows battery charges state from input source. SOC characteristics shows the charging and releasing (i.e) It expanding implies Charging and it diminishing methods Releasing Additionally this will occured on - Terminal voltage is lower than the battery voltage.

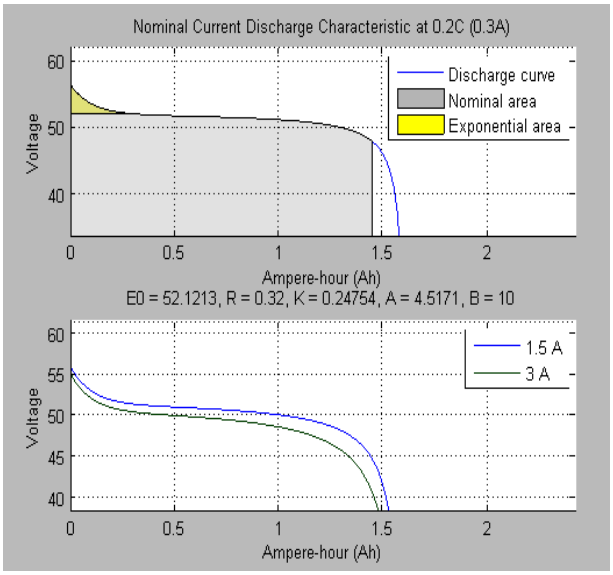

Figure 10: Current discharge characteristic

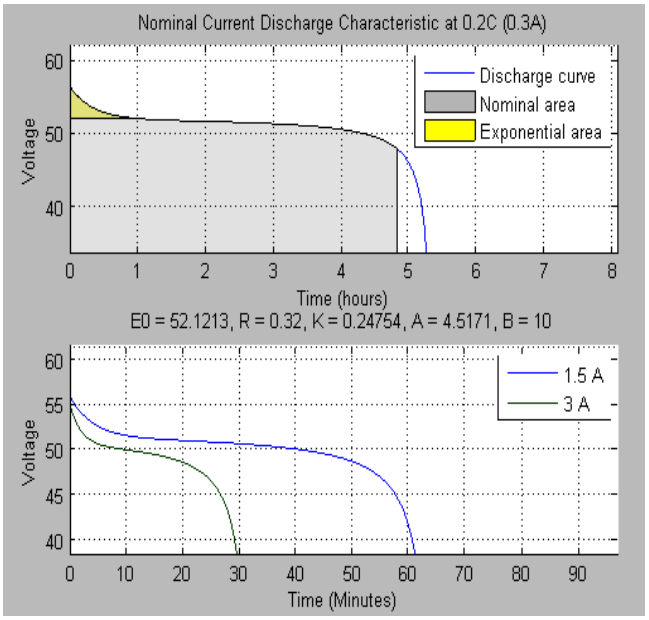

Figure 11 Battery discharge time

Table 1 Simulation Parameter.

Sr. No.	Parameter	Value
1	Nominal battery voltage	55V
2	Grid voltage	230 Vrms
3	Grid frequency	50 Hz
4	Switch	MOSFETs

Table 2: Comparison of present design result with previous design result

Parameter	Previous Model	Present Model	Improvement in Percentage
The number battery pack	2	1	NA
Battery Output Voltage	24 V	55V	More than 2 times
AC Output voltage	220 Vrms	230 Vrms	5%

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Rated power	250 W	260 W	5%
Battery State of Charge	95%	97%	2.2%

Table 2 showing comparison of present model results with previous design model results in terms of output voltage, rated power, efficiency etc. Therefore above result shows, present model give significant improved result rather than then the existing model.

V.CONCLUSION

This research work included researching a bidirectional grid associated single-power-conversion converter with a low-input battery voltage and a control system. Also, theoretical examination and trial results are introduced. A single power-conversion method was utilized by the present converter to perform bidirectional power conversion between the battery and the grid through a single-power preparing stage. The test results utilizing a 250-W model confirm that the present converter has a bidirectional DC–AC power conversion ability with an efficiency that surpasses those of regular grid-associated converters and that the created control system is reasonable for the present converter.

REFERENCE

1. O. Kwon, J. Kim, J. Kwon and B. Kwon, "Bidirectional Grid-Connected Single-Power-Conversion Converter With Low-Input Battery Voltage," in IEEE Transactions on Industrial Electronics, vol. 65, no. 4, pp. 3136-3144, April 2018.
2. N. Vamanan and V. John, "Dual-Comparison One-Cycle Control for Single-Phase Bidirectional Power Converters," in IEEE Transactions on Industry Applications, vol. 54, no. 5, pp. 4621-4631, Sept.-Oct. 2018.
3. M. Mellincovsky, V. Yuhimenko, Q. Zhong, M. Mordechai Peretz and A. Kuperman, "Active DC Link Capacitance Reduction in Grid-Connected Power Conversion Systems by Direct Voltage Regulation," in IEEE Access, vol. 6, pp. 18163-18173, 2018.
4. Y. Jeong, S. Lee, S. Jeong, J. Kwon and B. Kwon, "High-Efficiency Bidirectional Grid-Tied Converter Using Single Power Conversion With High-Quality Grid Current," in IEEE Transactions on Industrial Electronics, vol. 64, no. 11, pp. 8504-8513, Nov. 2017.
5. S. Lee, W. Cha and B. Kwon, "High-Efficiency Soft-Switching AC–DC Converter With Single-Power-Conversion Method," in IEEE Transactions on Industrial Electronics, vol. 64, no. 6, pp. 4483-4490, June 2017
6. K. Lo, Y. Chen and Y. Chang, "Bidirectional Single-Stage Grid-Connected Inverter for a Battery Energy Storage System," in IEEE Transactions on Industrial Electronics, vol. 64, no. 6, pp. 4581-4590, June 2017.
7. M. A. Hernandez Navas, F. Lozada G., J. L. Azcue Puma, J. A. Torrico A. and A. J. Sguarezi Filho, "Battery Energy Storage System Applied to Wind Power System Based On Z-Source Inverter Connected to Grid," in IEEE Latin America Transactions, vol. 14, no. 9, pp. 4035-4042, Sept. 2016.
8. J. Pereda and T. C. Green, "Direct Modular Multilevel Converter With Six Branches for Flexible Distribution Networks," in IEEE Transactions on Power Delivery, vol. 31, no. 4, pp. 1728-1737, Aug. 2016.
9. S. Jeong, W. Cha, S. Lee, J. Kwon and B. Kwon, "Electrolytic Capacitor-Less Single-Power-Conversion On-Board Charger With High Efficiency," in IEEE Transactions on Industrial Electronics, vol. 63, no. 12, pp. 7488-7497, Dec. 2016.
10. K. Kim, S. Lee, W. Cha, J. Kwon and B. Kwon, "Bidirectional Single Power-Conversion DC–AC Converter With Noncomplementary Active-Clamp Circuits," in IEEE Transactions on Industrial Electronics, vol. 63, no. 8, pp. 4860-4867, Aug. 2016
11. Y. Cho, W. Cha, J. Kwon and B. Kwon, "High-Efficiency Bidirectional DAB Inverter Using a Novel Hybrid Modulation for Stand-Alone Power Generating System With Low Input Voltage," in IEEE Transactions on Power Electronics, vol. 31, no. 6, pp. 4138-4147, June 2016.
12. G. Yamada, T. Norisada, F. Kusama, K. Akamatsu and M. Michihira, "Operation analysis of high efficiency grid connected bi-directional power conversion system for various storage battery systems with bi-directional switch circuit topology," 2016 IEEE Applied Power Electronics Conference and Exposition (APEC), Long Beach, CA, 2016, pp. 2607-2612.
13. M. Pahlevani and P. Jain, "A Fast DC-Bus Voltage Controller for Bidirectional Single-Phase AC/DC Converters," in IEEE Transactions on Power Electronics, vol. 30, no. 8, pp. 4536-4547, Aug. 2015.
14. W. Cha, Y. Cho, J. Kwon and B. Kwon, "Single Power-Conversion LED Backlight Driving System With High Power Factor Control," in Journal of Display Technology, vol. 10, no. 5, pp. 407-413, May 2014.
15. Y. Cho, J. Kwon and B. Kwon, "Single Power-Conversion AC--DC Converter With High Power Factor and High Efficiency," in IEEE Transactions on

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Power Electronics, vol. 29, no. 9, pp. 4797-4806, Sept. 2014
16. B. Su, H. Wen, J. Zhang and Z. Lu, "A soft-switching post-regulator for multi-outputs dual forward DC/DC converter with tight output voltage regulation," in IET Power Electronics, vol. 6, no. 6, pp. 1069-1077, July 2013.
17. X. Lu, J. Guerrero, R. Teodorescu, T. Kerekes, K. Sun and L. Huang, "Control of parallel-connected bidirectional AC-DC converters in stationary frame for microgrid application," 2011 IEEE Energy Conversion Congress and Exposition, Phoenix, AZ, 2011, pp. 4153-4160.
18. H. Krishnaswami and N. Mohan, "Three-Port Series-Resonant DC–DC Converter to Interface Renewable Energy Sources With Bidirectional Load and Energy Storage Ports," in IEEE Transactions on Power Electronics, vol. 24, no. 10, pp. 2289-2297, Oct. 2009.
19. M. Brenna, G. C. Lazaroiu, G. Superti-Furga and E. Tironi, "Bidirectional Front End Converter for DG With Disturbance Insensitivity and Islanding-Detection Capability," in IEEE Transactions on Power Delivery, vol. 23, no. 2, pp. 907-914, April 2008.
20. Chia-Chou Yeh and M. D. Manjrekar, "A reconfigurable uninterruptible power supply system for multiple power quality applications," Twentieth Annual IEEE Applied Power Electronics Conference and Exposition, 2005. APEC 2005., Austin, TX, 2005, pp. 1824-1830 Vol. 3.
21. H. Tao, A. Kotsopulos, J. L. Duarte, M. A. M. Hendrix, "Family of multiport bidirectional dcdc converters", Inst. Electr. Eng. Proc. Elect. Power Appl., vol. 153, no. 15, pp. 451-458, May 2006.
22. J. L. Duarte, M. A. M. Hendrix, M. G. Simoes, "Three-port bi-directional converter for hybrid fuel cell systems", IEEE Trans. Power Electron., vol. 22, no. 2, pp. 480-487, Mar. 2007.
23. H. Tao, A. Kotsopoulos, J. Duarte, M. Hendrix, "Transformer-coupled multiport ZVS bidirectional dc-dc converter with wide input range", IEEE Trans. Power Electron., vol. 23, no. 2, pp. 771-781, Mar. 2008.
24. H. Tao, J. Duarte, M. Hendrix, "Three-port triple-half-bridge bidirectional converter with zero-voltage switching", IEEE Trans. Power Electron., vol. 23, no. 2, pp. 782-792, Mar. 2008.
25. H. Tao, J. L. Duarte, M. A. M. Hendrix, "High-power three-port three-phase bidirectional dcdc converter", Proc. IEEE Ind. Appl. Soc. 42nd Annu. Meet. (IAS 2007), pp. 2022-2029.
26. D. Liu, H. Liu, "A zvs bi-directional dcdc converter for multiple energy storage elements", IEEE Trans. Power Electron., vol. 21, no. 5, pp. 1513-1517, Sep. 2006.
27. H. Al Atrash, F. Tian, I. Batarseh, "Tri-modal half-bridge converter topology for three-port interface", IEEE Trans. Power Electron., vol. 22, no. 1, pp. 341-345, Jan. 2007.
28. F. Z. Peng, M. Shen, K. Holland, "Application of z-source inverter for traction drive of fuel cell battery hybrid electric vehicles", IEEE Trans. Power Electron., vol. 22, no. 3, pp. 1054-1061, May 2007.
29. Y.-M. Chen, Y.-C. Liu, S.-C. Hung, C.-S. Cheng, "Multi-input inverter for grid-connected hybrid pv/wind power system", IEEE Trans. Power Electron., vol. 22, no. 3, pp. 1070-1077, May 2007.
30. G.-J. Su, L. Tang, "A multiphase modular bidirectional triple-voltage dc-dc converter for hybrid and fuel cell vehicle power systems", IEEE Trans. Power Electron., vol. 23, no. 6, pp. 3035-3046, Nov. 2008.
31. H. Krishnaswami, N. Mohan, "A current-fed three-port bi-directional dcdc converter", Proc. IEEE Int. Telecommun. Energy Conf. (INTELEC 2007), pp. 523-526.
32. B. Dobbs, P. Chapman, "A multiple-input dcdc converter topology", IEEE Power Electron. Lett., vol. 1, no. 1, pp. 6-9, Mar. 2003.

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