IJCRT.ORG ISSN : 2320-2882

INTERNATIONAL JOURNAL OF CREATIVE RESEARCH THOUGHTS (IJCRT)

An International Open Access, Peer-reviewed, Refereed Journal

DESIGN AND IMPLEMENTATION OF BI-DIRECTIONAL DC-DC CONVERTER FOR ENERGY STORAGE SYSTEM

Swathy.S[1], Thirumalai vasan L[2], Boopathi P[3], Dhivyan k[4], Ramanidharan R[5]

Assistant Professor[1],

Karpagam College of Engineering, Coimbatore,

UG Students[2345]

Karpagam College of Engineering, Coimbatore,

Abstract: **The abstract of this paper to design and implementation of bi-directional dc-dc converter for energy storage system. In upcoming generation, the global energy level may increase 2% per year. The conventional electrical power generation produce environmental pollution and global warming. By using the renewable energy like solar and geo thermal energy we can consume the power generation without any natural causes. It also gives clean and eco-friendly. The energy storage device and unidirectional boost converter (UDC), are also maintain constantly and made the energy conversion. This type of method converts into AC to DC, Boost the level of voltage and get output of consistent from the solar panel. The solar panel, inverter, bi-directional converter (BDC) are connected to load/grid. This is called solar energy electrical system (SEES). The system is operatives in five different modes that is solar sourced battery output mode, solar sourced battery mode, battery sourced output mode and grid battery mode. This circuit were designed through MATLAB/SIMULINK with all the modes**

Index Terms **- DC-DC Converter, PI controller, Buck-boost converter, solar energy, MATLAB/SIMULINK.**

Introduction

The consumption of electrical energy in the world will be increasing every year and that should be calculated as (1.6 to 1.7) % for the year. The consumer of electrical power may grow 28TW by the year of 2050. The maximum electrical power can be obtained from burning of coals, fossil fuels, due to this air pollution may occurs. So we need to reduce the air pollution from the thermal plant and other power stations. And also its efficiency of output is only 15 %.

The pollution from the conventional form of power produce also cause to increase the acid rain and also spoiled the public health. The conventional electricity disadvantage is, to increase the toxic, environment pollution, less-efficiency and the power plant is located near to the load center. So there is transmission cost is increases. So, it can be change into non-conventional energy sources like solar, wind, geothermal and hydroelectric. The almost 50% of renewable energies are satisfied for power global demand, but the extinguishing TW, and hydro power 7.2 TW, etc. But our power demand in global level is only 15 TW.

The system was converted by solar energy into electrical energy is called energy conversion and each conversional energy have conversional device. The solar is high efficiency than others. So, there is use primary source in solar panel, when there is no power in the power grid, we can use the solar panel to produce the power to the grid. And it can be continuous power produce to the electrical loads. The open loop analysis of solar energy contained of current converter with controller, charge control circuit and energy storage device (ESD) the solar power is more efficient when the modes of operation. The component loses were reduces from the converter and increases the system performance. The project where implement in MATLAB/SIMULINK. The input source is get from solar and delivers the current using bidirectional converter. Then its supply to motor load and light loads (Lamp).

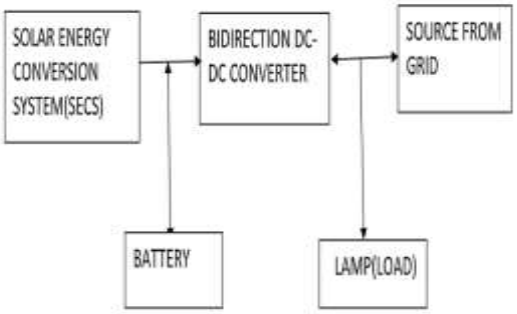

Fig 1: Solar energy electrical system

System configuration of converter:

There is two type of converter is act in this, one is boost and another is buck converter. It is called DC-DC bidirectional converter. When there is no power to the load, that the boost converter to boost up the power from source to load via bi-directional converter. It will operate boost converter which supplies to the load when the solar generator output power is more than required load power. When output power is less to the load power, it will operate buck converter to the charges the battery.

Solar panel:

The solar panel devices principle is, to get the sun energy converted into an electrical energy. It is direct current generates from the solar panel. The dc power will convert in 230V to produce supplies to load and grid.

Bidirectional converter (BDC):

The bidirectional converter design in, Q1 and Q2 this two MOSFETS are used. It consist the resistors (R2 and R2), inductance L, High and Low voltage side capacitors can used. Either the battery charging mode (buck) or discharging mode (boost) thus type of operating modes can be used to this converter. That the T-off and T-on as shown in fig and that is symmetry gating signal waveform

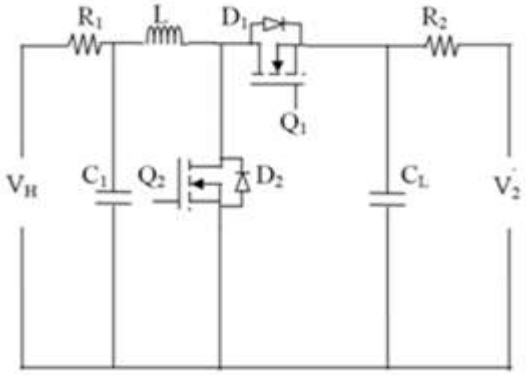

Fig 2: Bidirectional converter

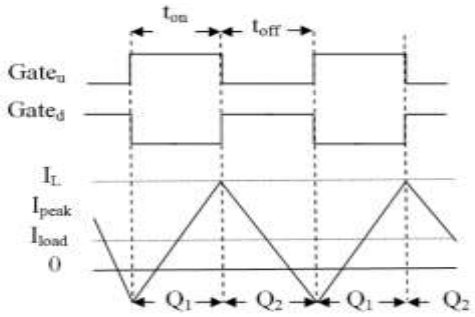

Fig 3: Complementary gating signal controls

Modes of operations

Mode condition	UDC	BDC	Inverter	Mode of operation
When the load is in ON condition				
Mode-1	Boost	OFF	OFF	Solar sourced battery mode
Mode-2	Boost	Boost	Stand-alone	Solar sourced battery-load mode
Mode-3	Boost	Boost	Stand-alone	Solar sourced load mode
Mode-4	OFF	Boost	Stand-alone	Battery sourced load mode
Mode-5	OFF	Buck	Grid-Rectifier	Grid sourced battery mode
When the load is in OFF condition				
Mode-1	Boost	OFF	OFF	Solar sourced battery mode
Mode-2	Boost	Boost	Grid-Inverter	Solar sourced battery-output mode
Mode-3	Boost	Boost	Grid-Inverter	Solar sourced output mode
Mode-4	OFF	OFF	OFF	-
Mode-5	OFF	Buck	Grid-Rectifier	Grid sourced battery mode

Simulation analysis and Results:

The DC-DC converter as controller with speed goat feedback drive and its operating input from the voltage, then power to load and drive converter. This system was developed in interfaced with speed goat and MATLAB/SIMULINK. In the simulation circuit, solar panel model is used for input to the PIMSG. Sunlight is produced to the solar panel model by constant block. Boost converter are implemented per design for DC-DC converter. Solar Panel voltage, boost voltage and rectified DC voltage is taken in simulation as shown in fig. PMSG voltage is sinusoidal waveform. It's generated from solar panel. Boost converter boost up the DC voltage into 24V and it is maintained the constant pi controller. Bidirectional output waveform is shown in fig. The direct current voltage 24V is boost up to 44V by the pulse controller. The 100ohm resistance has connected across the converter to the load.

Charging condition it will operated as buck mode and it output waveform is shown in figure. Sometimes the voltage level is less than 25V or climate changes, the solar voltage is very less so it will act as buck converter.

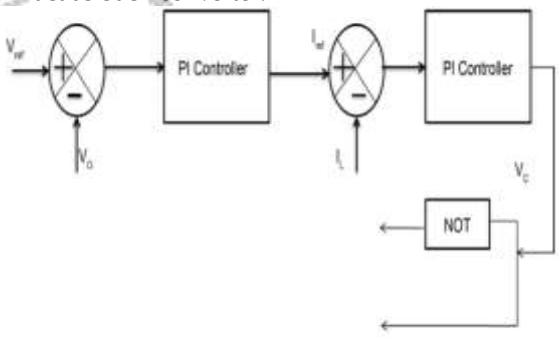

Fig 4: Block diagram of the controller

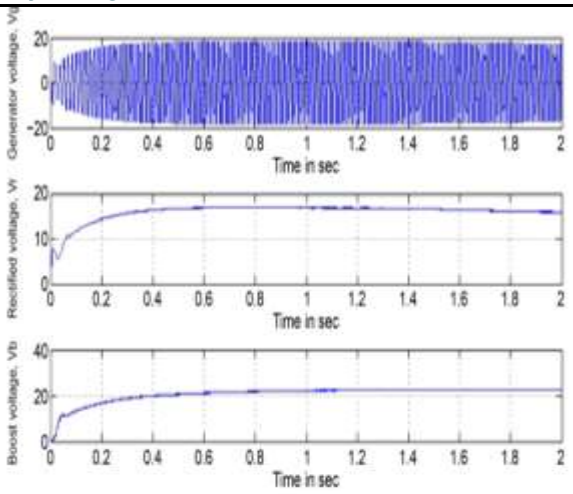

Fig 5: Boost converter output waveform

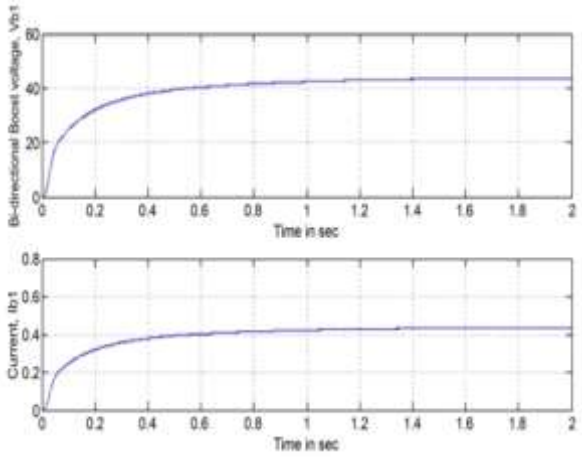

Fig 6: Bidirectional converter output waveform

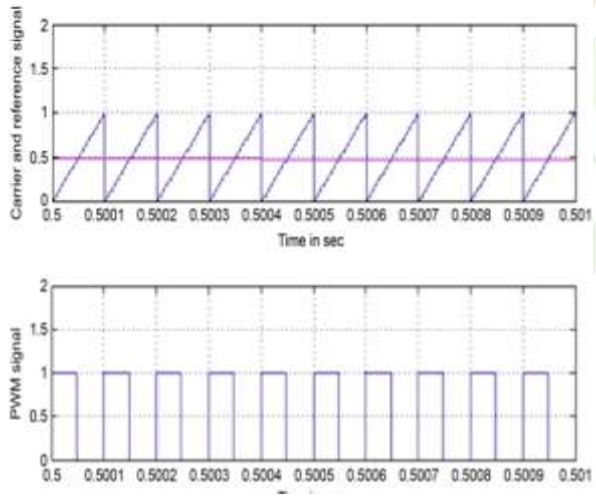

Fig 7: Controller PWM signal

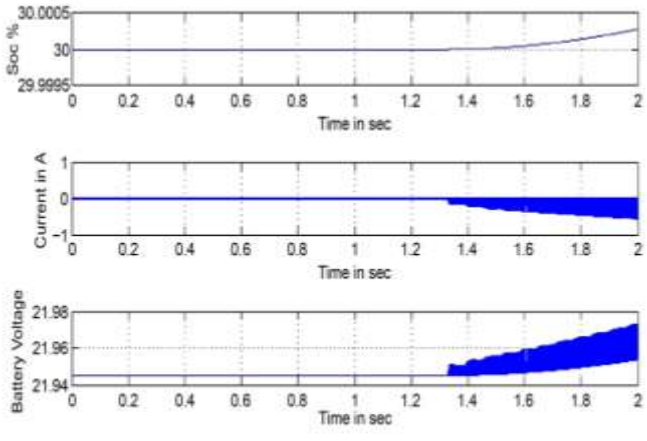

Fig 8: Battery during charging mode

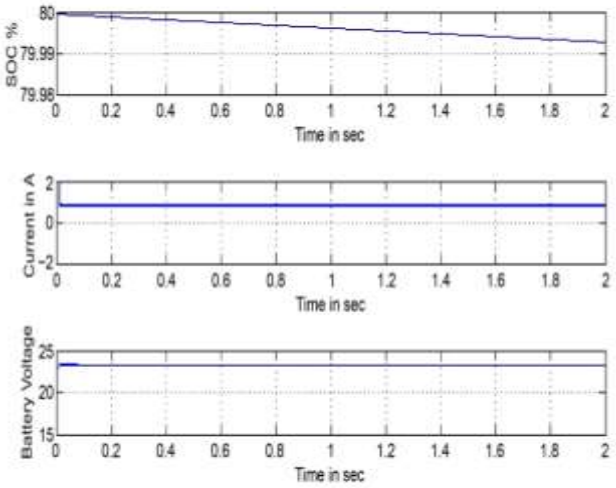

Fig 9: Battery during discharging mode

Output voltage and current values:

Sl. NO.	COMPONENTS	VALUES
1.	Source DC voltage	12 V
2.	Boost converter output Voltage	24 V
3.	Bi-directional converter boost mode voltage	44 V
4.	Battery charging mode current	0.35 A
5.	Battery discharging mode current	0.15 A
6.	Lamp load	100 W
7.	Bi-directional converter boost mode load current	0.12 A

Conclusion:

DC-DC bi-directional converter is developed for solar energy generation and it is simulated in MATLAB/SIMULINK. The multilevel power changing method is used to store the batteries. At solar panel power, this type of system can use the battery to store the energy to have the load current stable and load voltage. The system design and control strategy can be very simply implemented and access to improve the efficiency of solar panel system. Further, filter circuit can be design for harmonic elimination.

References:

[1] H. Liu, M. Dahidah, R. T. Naayagi, M. Armstrong and Yu, "A novel modular multilevel step-up DC/DC converter for offshore systems," 2017 IEEE 26th International Symposium on Industrial Electronics (ISIE), Edinburgh, 2017, pp. 576-581.

[2] L. Yang, J. Peng, F. Yang, Y. Zhang and H. Wu, "Single-Phase High-gain Bidirectional DC/AC Converter Based on High Step-up/step-down DC/DC Converter and Dual-input DC/AC Converter," 2019 IEEE 10th International Symposium on Power Electronics for Distributed Generation Systems (PEDG), Xi'an, China, 2019, pp. 554-559.

[3] J. Ning, J. Zeng and X. Du, "A Four-port Bidirectional DC-DC Converter for Renewable Energy-Battery-DC Microgrid System," 2019 IEEE Energy Conversion Congress and Exposition (ECCE), Baltimore, MD, USA, 2019, pp. 6722-6727.

[4] S. Lu, L. Wang, T. Lo and A. V. Prokhorov, "Integration of Wind Power and Wave Power Generation Systems Using a DC Microgrid," in IEEE Transactions on Industry Applications, vol. 51, no. 4, pp. 2753-2761, July-Aug. 2015.

[5] A. C. Hua and B. C. Cheng, "Design and implementation of power converters for wind energy conversion system," The 2010 International Power Electronics Conference - ECCE ASIA -, Sapporo, 2010, pp. 323-328.

[6] P. J. dos Santos Neto, T. A. dos Santos Barros, M. V. de Paula, E. R. Filho, J. C. Vasquez and J. M. Guerrero, "Wind Distributed System Based on Switched Reluctance Generator Using a Bidirectional DC-DC Converter with Sliding Mode Control," IECON 2019 - 45th Annual Conference of the IEEE Industrial Electronics Society, Lisbon, Portugal, 2019, pp. 4469-4474

[7] S.Sahu, G. Panda and S. P. Yadav, "Dynamic Modelling and Control of PMSG based Stand-alone Wind Energy Conversion System," 2018 Recent Advances on Engineering, Technology and Computational Sciences (RAETCS), Allahabad, 2018, pp. 1-6

[8] B.. Mangu, S. Akshatha, D. Suryanarayana and B. G. Fernandes, "Grid-Connected PV-Wind-Battery-Based Multi-Input Transformer-Coupled Bidirectional DC-DC Converter for Household Applications," in IEEE Journal of Emerging and Selected Topics in Power Electronics, vol. 4, no. 3, pp. 1086-1095, Sept. 2016.

[9] V. B. Thurai Raaj and K. Suresh, "An Intelligent Controller based Power Grid Interconnected System for Reliable Operation," 2019 3rd International Conference on Computing Methodologies and Communication (ICCMC), Erode, India, 2019, pp. 608-613.

[10] Y. Wei, I. Jayawardene and G. Kumar Venayagamoorthy, "Optimal automatic generation controllers in a multi-area interconnected power system with utility-scale PV plants," in IET Smart Grid, vol. 2, no. 4, pp. 581-593, 12 2019.