International Journal of Science Engineering and Advance Technology

Fuel Cell Based Bridgeless Boost Rectifier For Low Voltage Energy Harvesting Applications.

[1]A.Suresh Krishna, [2]K.Dhana Raju
Dept. of EEE, Kiet College of Engineering & Tech., Thallarevu, Kakinada
East Godavari District,AP, India

Abstract:

In energy producing systems power electronic circuit figures the key boundary between transducer and electronic load which might embrace a battery. The electrical and physical description of the power conditioning interfaces establishes the functionality, competence and the size of the integrated systems. The power electronic circuits are engaged to legalize the power delivered to the load and vigorously direct the electrical humid of the transducers so that maximum power could be transferred to the load. The output voltage level of the micro scale and mesoscale energy return devices is more often than not in the order of a few hundred millivolts depending on the topology of device. To get voltage for medium order in volts we introduce Fuel cell. The output ac voltage should be rectified, boosted and synchronized by power converters to complete the voltage requirement of the loads. The proposed topology unites a boost converter and a buck-boost converter to condition the positive and negative half portions of the input ac voltage respectively. Only one inductor and capacitor are used in both circuitries to decrease the size of the converter. A fuel cell is a device that converts chemical reaction into electricity. For generation of electricity hydrogen plays major role. Fuel cell efficiencies can reach 80-90% and stay clean for the environment. Versatile fuel cells offer a promising way to generate electricity and on a infinitely decentralized basis.

Keywords: AC/DC conversion, boost, bridgeless, buck-boost,fuel cell, energy harvesting, low-voltage rectification.

Introduction:

A single-stage ac–dc power electronic converter is planned to powerfully manage the energy harvested from electrochemical fuel cell with low-voltage outputs.It changes from electrochemical to electricity. Conventional ac–dc converters for energy harvesting and conditioning typically consists of two stages. A diode bridge rectifier naturally forms the first stage while the second stage is a dc–dc converter to normalize the rectified ac voltage to a dc voltage. Though the diode bridge would acquire substantial voltage drop manufacture the low-voltage rectification infeasible. To conquer these drawbacks CMOS diodes with low voltage drops are investigated in the bridge rectifiers to alternative conventional p-n junction diodes. Another advance to make the most of the conversion competence in low-voltage rectification is to use bridgeless direct ac–dc converters

Related Work:

The boost converter is the ordinary power conditioning interface due to its simple structure, voltage step-up capability and high efficiency. The buck-boost converter has facility to step up the input voltage with a reverse polarity. Therefore it is an opposite applicant to condition the negative voltage cycle. Besides the boost and buck-boost topologies could share the same inductor and capacitor to meet the miniature size and weight requirements. The power electronics interface (PEI) is working to supply constant voltage and to deliver power to the load. In order to make easy and simplify analyses it is supposed that the input impedance of the PEI is considerably larger than the internal impedance of energy harvesting device.

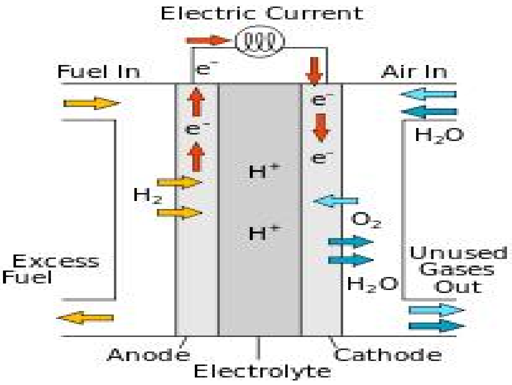
Existing Method:

Essentially the micro generator system consists of a spring, a proof mass, and an electrical damper. The extrinsic vibrations excite the internal oscillation between the proof mass (magnet) and electrical damper (coils). The internal oscillation produces a periodically variable magnetic flux which induces a corresponding alternating output voltage.

Disadvantages:

This system is only for very low applications and set to be vibrate all the time for generation of electricity.

Proposed Method:



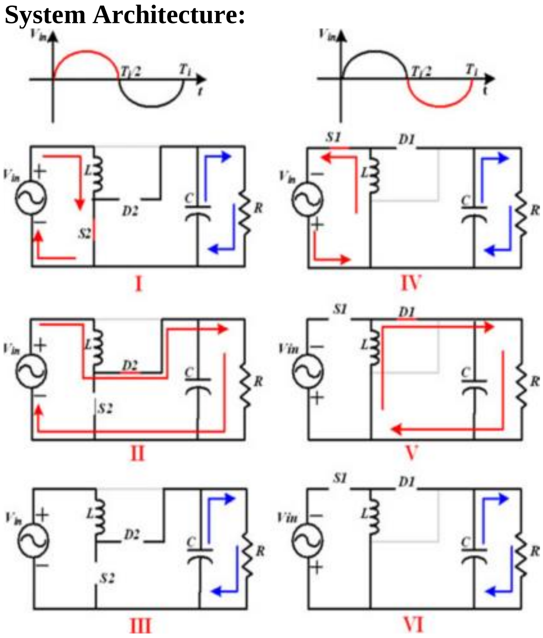
Fuel cell stack is mixture of cathode, anode and electrolyte. It is best to think of a fuel cell as a continuous battery that electrochemically changes a hydrogen rich fuel source into electricity. Fuel cell is usually classified according to the nature of the electrolyte they use.

Proton-Exchange-Membrane fuel cell. Its name describes what is going on inside the cell…an electrochemical reaction in which a hydrogen atom is split into proton and an electron. The proton travels directly across a membrane and combines with an oxygen atom to form water. Meanwhile, the free electron is routed through an external circuit as electricity.

Advantages:

The control scheme of DCM operation is comparatively simpler. Since the circuit size can be condensed and the competence can be improved. DCM operation is more appropriate than continuous conduction mode (CCM) operation.

System Architecture:



Each cycle of the input ac voltage can be alienated into six operation modes. Modes I–III exemplify the circuit operation during positive input cycle where *S*1 is turned ON while *D*1 is reverse biased. The converter activates as a boost circuit during Modes I–III while switching *S*2 and *D*2. The operation during negative input cycle is established in Modes IV–VI where *S*2 is turned ON while *D*2 is reverses biased. In these modes the converter operates comparable to a buck boost circuit.

Dc-Dc Converter:

In all of the applications we want to change the DC energy from one voltage level to another while wasting as little as achievable in the method. In other words we want to achieve the conversion with the maximum probable competence. An important point to remember about all DC-DC converters is that like a transformer they fundamentally just change the input energy into a different impedance level. So whatever the output voltage level the output power all comes from the input. There is no energy contrived inside the converter.

Buck Converter:

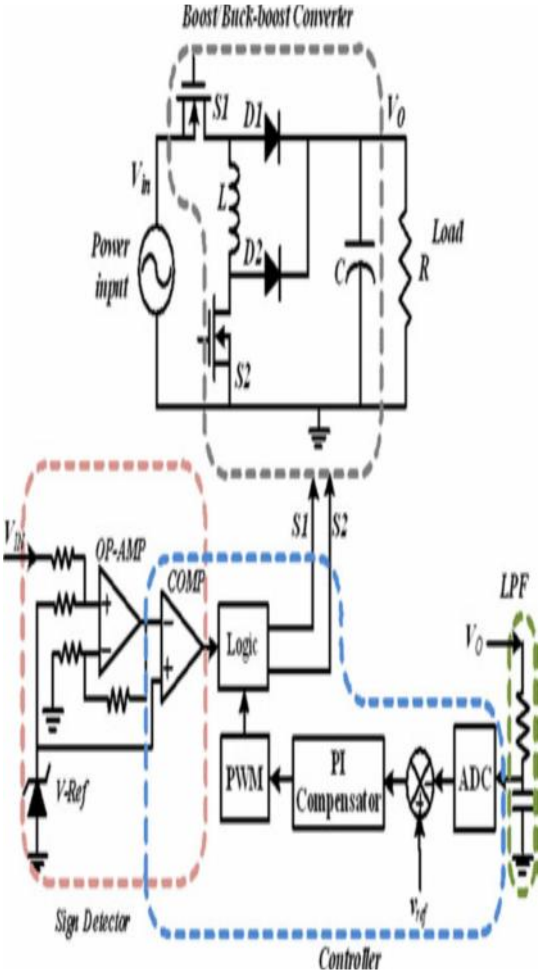
There are only four main components switching power MOSFET Q1, flywheel diode D1, inductor L and output filter capacitor C1. A control circuit often a single IC checks the output voltage and upholds it at the desired level by switching Q1 on and off at a fixed rate the converters operating frequency but with a varying duty cycle the proportion of each switching period that Q1 is turned on When Q1 is turned on, current starts flowing from the input source through Q1 and L and then into C1 and the load. The magnetic field in L therefore builds up store up energy in the inductor with the voltage drop across L opposing or bucking part of the input voltage. Then when Q1 is turned off the inductor be against any drop in current by abruptly reversing its EMF and now provisions current to the load itself via D1. Without going too profoundly into its operation, the DC output voltage which emerges across the load is a portion of the input voltage and this fraction turns out to be the same to the duty cycle.

Boost Converter:

The procedure consists of using Q1 as a high speed switch with output voltage control by changing the switching duty cycle. When Q1 is switched on current flows from the input source through L and Q1 and energy is stored in the inductor's magnetic field. There is no current through D1 and the load current is completed by the charge in C1. Then when Q1 is turned off, L opposes any drop in current by immediately reversing its EMF. The output voltage is consequently higher than the input voltage and it turns out that the voltage step-up ratio.

ISSN 2321-6905
January-2015

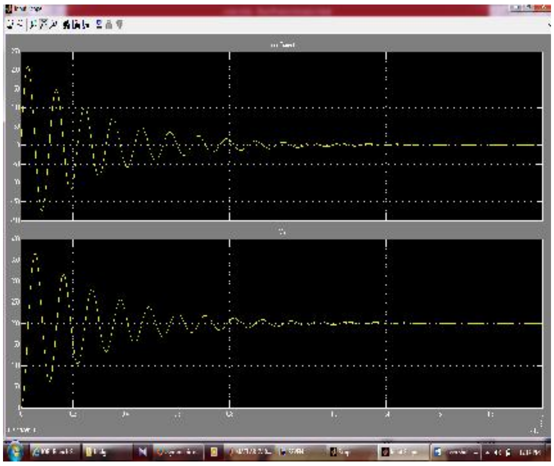
Control Circuit For Convertor:



The converter is considered to function in DCM. The output voltage is sieved by a passive low-pass filter and then fed to the analog-to-digital converter (ADC) of the controller. The dissimilarity between the ADC output and the desired voltage is intended and remunerated through the PI algorithm to produce an adaptable duty cycle signal. The switching signals of *S*1 and *S*2 are dependent relative on the division of the input voltage. A sign detector is used to decide the input voltage polarity.

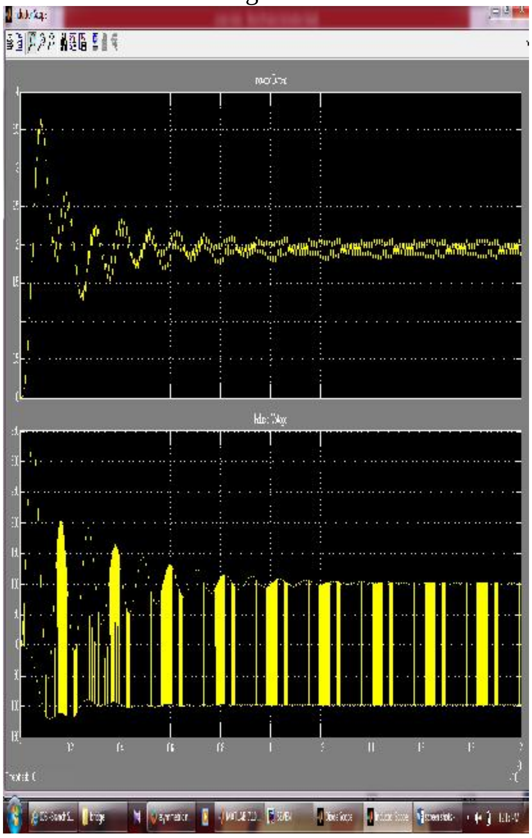
The Atmel Mega 16 A is selected as the controller in this paper, which has both on-chip analog comparator and integrated ADC and can be incorporated with the sign detector. The sign detector is collected of a voltage reference, an op amp and the on-chip analog comparator. The op-amp operates as an analog adder where a dc bias (voltage reference) is added to the input voltage. The signal summation is contrasted with the voltage reference to detect the polarity.

Experimental Results:

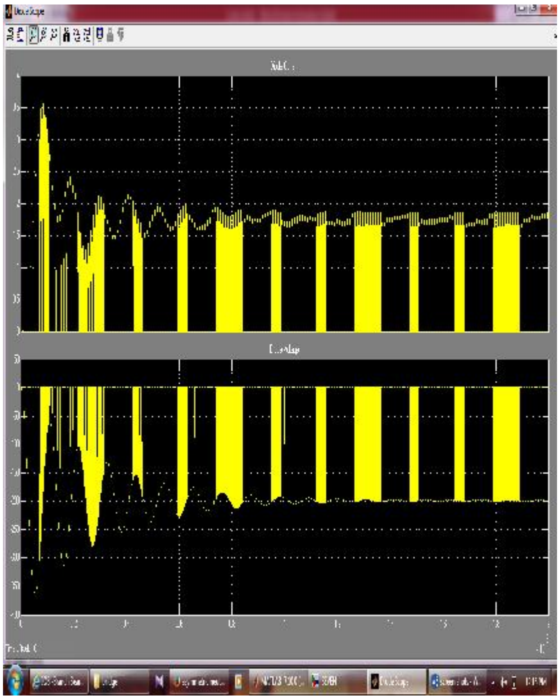


Input voltage and currents

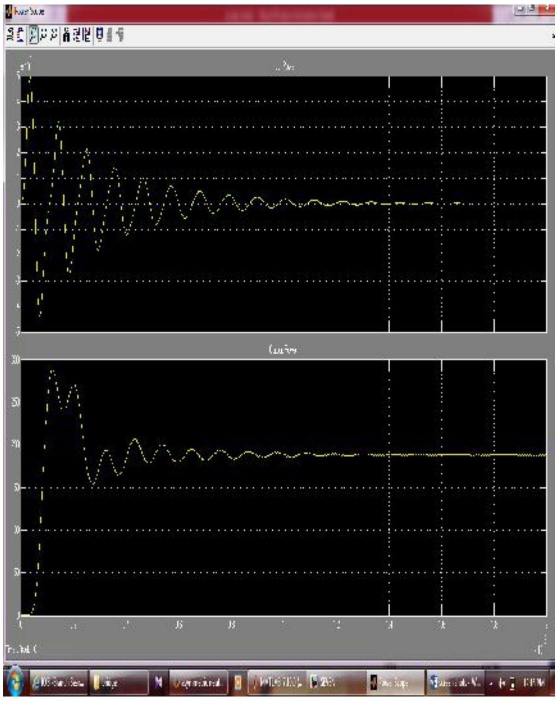
Load current and voltage



Inductor Current and voltage



Diode currents Id_1 and Id_2



Input and output power

Conclusion:

The topology exclusively merges a boost converter and a buck-boost converter to Simulate the positive input cycles and negative input cycles respectively. Only one inductor and one filter capacitor are necessary in this topology. This prototype productively boosts the 14V, 100-Hz ac to 150V dc. Output voltage is firmly regulated at 150V dc through closed-loop voltage control. The measured renovation competence at approximately of 80% efficiency of 300w. In comparison to state-of-the-art low-voltage bridgeless rectifiers this revise utilizes the minimum number of unreceptive energy storage components and realizes the greatest conversion competence. A single stage ac–dc topology for low-voltage low-power energy harvesting applications is proposed and lastly we will get approximately 150v in the result.

References:

[1] S. Roundy, P. K. Wright, and J. Rabaey, "A study of low level vibrations as a power source for wireless sensor nodes," *Comput. Commun.*, vol. 26, no. 11, pp. 1131–1144, Jul. 2003.

[2] M. El-hami, P. Glynne-Jones, N. M. White, M. Hill, S. Beeby, E. James, A. D. Brown, and J. N. Ross, "Design and fabrication of a new vibrationbased electromechanical power generator," *Sens. Actuators A: Phys.*, vol. 92, no. 1–3, pp. 335–342, Aug. 2001.

[3] S. P. Beeby, R. N. Torah, M. J. Tudor, P. Glynne-Jones, T. O'Donnell, C. R. Saha, and S. Roy, "A micro electromagnetic generator for vibration energy harvesting," *J. Micromech. Microeng.*, vol. 17, no. 7, pp. 1257– 1265, Jul. 2007.

[4] R. Vullers, R. van Schaijk, and I. Doms, "Micropower energy harvesting," *Solid-State Electron.*, vol. 53, no. 7, pp. 684–693, Jul. 2009.

[5] C. B.Williams, C. Shearwood, M. A. Harradine, P. H.Mellor, T. S. Birch, and R. B. Yates, "Development of an electromagnetic micro-generator," *IEE Proc. Circuits Devices Syst.*, vol. 148, no. 6, pp. 337–342, Jun. 2001.

[6] G. D. Szarka, B. H. Stark, and S. G. Burrow, "Review of power conditioning for kinetic energy harvesting systems," *IEEE Trans. Power Electron.*, vol. 27, no. 2, pp. 803–815, Feb. 2012.

[7] S. G. Burrow and L. R. Clare, "Open-loop power conditioning for vibration energy harvesters," *Electron. Lett.*, vol. 45, no. 19, pp. 999–1000, Sep. 2009.

[8] A. Cammarano, S. G. Burrow, D. A. W. Barton, A. Carrella, and L. R. Clare, "Tuning a resonant energy harvester using a generalized electrical load," *Smart Mater. Structures*, vol. 19, no. 5, pp. 1–7, May 2010.

[9] S. Cheng, N. Wang, and D. P. Arnold, "Modeling of magnetic vibrational energy harvesters using equivalent circuit representations," *J. Micromech. Microeng.*, vol. 17, no. 11, pp. 2328–2335, Nov. 2007.

[10] R. Dayal and L. Parsa, "A new single stage AC-DC converter for low voltage electromagnetic energy harvesting," in *Proc. IEEE Energy Convers. Congr. Expo.*, Atlanta, GA, USA, Sep. 2010, pp. 4447–4452.

[11] P. D. Mitcheson, T. C. Green, and E. M. Yeatman, "Power processing circuits for electromagnetic, electrostatic and piezoelectric inertial energy scavengers," *Microsyst. Technol.*, vol. 13, no. 11–12, pp. 1629–1635, Jan. 2007.
[12] X. Cao, W.-J. Chiang, Y.-C. King, and Y.-K. Lee, "Electromagnetic energy harvesting circuit with feedforward and feedback DC–DC PWM boost converter for vibration power generator system," *IEEE Trans. Power Electron.*, vol. 22, no. 2, pp. 679–685, Mar. 2007.
[13] E. Lefeuvre, D. Audigier, C. Richard, and D. Guyomar, "Buck-boost converter for sensorless power optimization of piezoelectric energy harvester," *IEEE Trans. Power Electron.*, vol. 22, no. 5, pp. 2018–2025, Sep. 2007.
[14] A. Harb, "Energy harvesting: State-of-the-art," *RenewableEnergy*, vol. 36, no. 10, pp. 2641–2654, Oct. 2011.
[15] T. Umeda, H. Yoshida, S. Sekine, Y. Fujita, T. Suzuki, and S. Otaka, "A 950MHzrectifier circuit for sensor networks with 10 m-distance," in *Proc. IEEE Int. Solid-State Circuits Conf., Digest Tech. Papers*, San Francisco, CA, USA, Feb. 2005, pp. 35–4

Mr.A.Suresh Krishna is a student of KIET College of Engineering & Technology,Kakinada. Presently he is pursuing his M.Tech [Power Electronics] from this college and he received his B.Tech from Sri chundi Ranganayakulu Engineering college, affiliated to JNT University, Kakinada in the year 2011. His area of interest includes power quality, object oriented subjects in all current trends and techniques in power electronics.

Mr.K.Dhanaraju was an excellent teacher Received M.tech degree from sree nidhi institute of science & technology, Ghatkesar and persuing Ph.D in Jawaharlal nehru university, kakinada is working as Associate Professor and HOD, Department of EEE, and professor for M.Tech power electronics engineering , Kiet college of Engineering and Technology.He has 7 years of teaching experience in various engineering colleges. To his credit couple of publications both national and international conferences /journals. His area of Interest includes power electronics, power systems, facts, machines in electrical engineering.