International Journal of Engineering and Advanced Technology (IJEAT)
ISSN: 2249 – 8958, Volume-4 Issue-4, April 2015

DC-DC Boost and Buck/Boot Converter with Electrolyser and Fuel Cell

T. Sivackani

Abstract— ***Now a day's Electrical energy is the most important and powerful one used as large energy level. Fuel cell energy is used as alternate and non harmful energy source used in many applications. For this generation an Electrolyser is used to produce hydrogen through Electrolysis. Due to this Electrolysis H2 gas is produced and stored. This H2 gas is send to fuel cell and produce electricity whenever it is needed. This electrolyser is connected to an DC bus via a DC-DC boost converter.This boost converter give a constant voltage to Electrolyser even if there is any variation in DC bus voltage. A Buck/Boost converter is used in between fuel cell and DC bus.This will Boost when the bus voltage is reduced and Buck the voltage if the bus votage is high.This type generation will not produce any harmful gases and hazard's***

Index Terms— ***Electrolyser, Electrolysis, DC_DC boost converter, Buck/Boost s.***

I. INTRODUCTION

Electrolyser use with the concept of electrochemical process. An electrochemical process is in which electrical energy is the driving force of current through them. H2 gas is produced from water and sent to a fuel cell which convert this gas into electrical energy. Fuel cell is connected with a Buck/Boost converter.

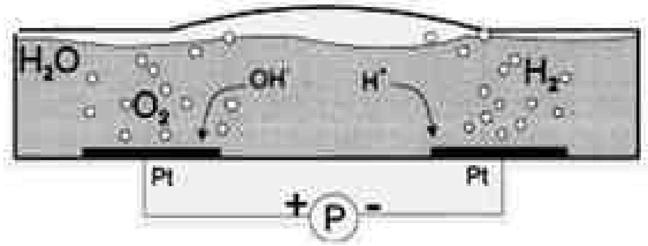

Figure 1. H_2 seperation from water through electro chemical process

The separation of hydrogen from water equation is shown here:

H2O (l)↔ H+ (aq) + OH- (aq) -----(1)

Oxygen and hydrogen gas can be generated at noble metal electrodes by the electrolysis of water:

+ electrode (anode):

4OH- ↔ 2H2O + O2 + 4e ------ (2a)

- electrode (cathode):

2H+ (aq) + 2e- ↔ H2 (g) -----(2b)

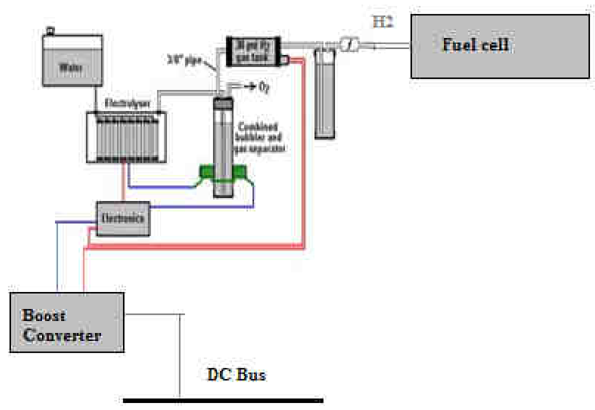

Figure 2. Electrolyser with Boost converter

II. DC-DC BOOST TOPOLOGY

A conventional DC-DC Boost converter is used .The boost converter is operated in by-pass mode. If we want to produce more gas for the fuel cell the Electrolyser need more electric supply to the electrode. When the bus voltage is lower than the load voltage or requirement due to the shutdown of other sources are overload. The boost converter will boost the supply voltage to the Electrolyser.Here a full bridge converter is used. The full bridge converter applies a square wave of voltage to a resonant network. The resonant network has the effect of filtering the higher harmonic voltages so that, essentially, a sine wave of current appears at the input to the resonant circuit. This fact allows classical ac analysis techniques to be used. The fundamental component of the square wave input voltage is applied to the resonant network, and the resulting sine waves of current and voltage in the resonant circuit are computed using classical AC analysis. For a rectifier with an inductor output filter, the sine wave voltage at the input to the rectifier is rectified, and the average value takes to arrive at the resulting dc output voltage. For a capacitive output filter, a square wave of voltage appears at the input to the rectifier while a sine wave of current is injected into the rectifier. For this case the fundamental component of the square wave voltage is used in the ac analysis. The even harmonics in the output of the rectifier are filtered using LC filter. Driving pulses are applied to the MOSFET in such a way that the pulse width coincides with the resonant period.

Manuscript Received on March 2015.
T. Sivackani, Department of Electrical and Electronic Engineering, Sri Shakthi Institute of Engineering and Technology, Coimbatore, India.

Published By:
Blue Eyes Intelligence Engineering
& Sciences Publication Pvt. Ltd.

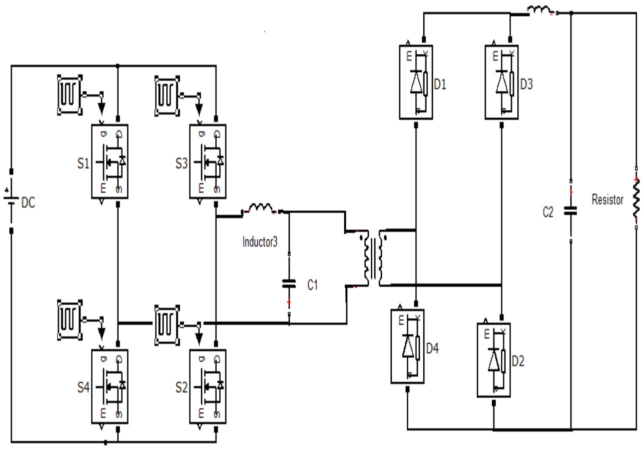

Figure 3. Full bridge DC-DC converter

III. OPERATING PRINCIPLE

In the given figure a Dc bus is connected to many loads as well as to the electrolyser. Electrolyser should not be connected to the DC bus directly. To control the power to the electrolyser a DC-DC converter is used. When the load demand is varied to high the Dc bus should satisfy the demand. In order to supply heavy load the supply to electrolyser will drop to certain voltage level. The DC-DC boost rectifier would increase the voltage and send to the Electrolyser. The H2 gas produced by the electrolyser may directly send to the fuel cell and converted to DC voltage with a Buck/Boost converter. This converter will adjust the produced DC voltage with the DC bus voltage.

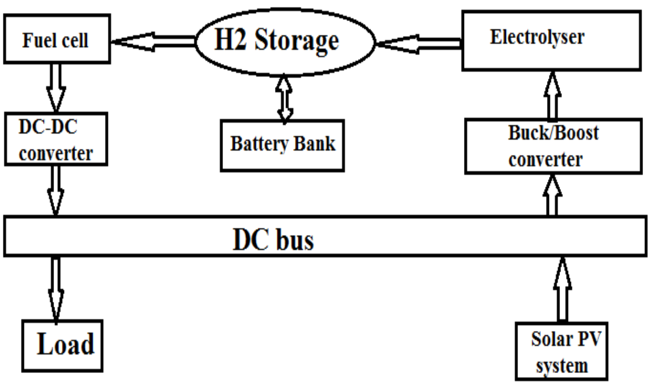

Figure 4. Block Diagram

IV. BUCK/BOOST TOPOLOGY

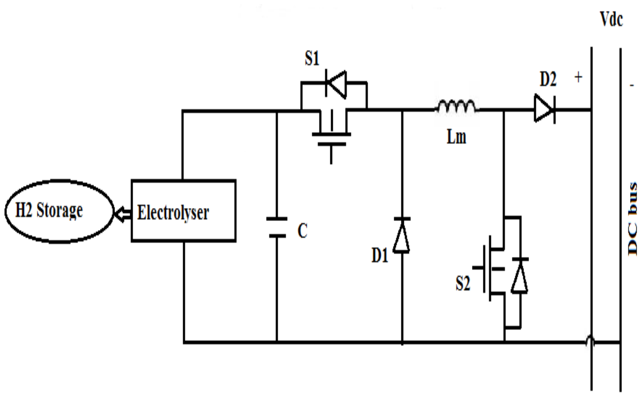

Figure 5. Buck/Boost converter

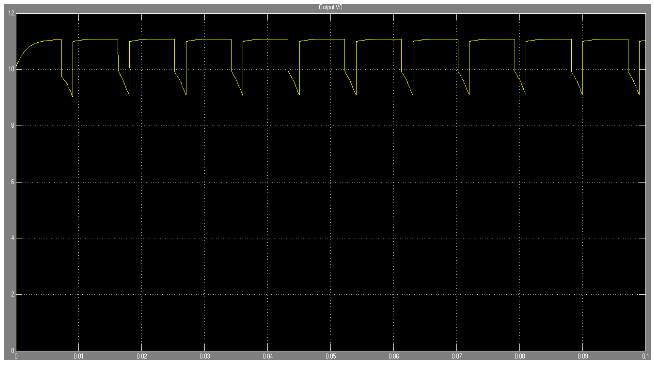

Figure 6. Buck/Boost Output waveform

The Buck/Boost topology is formed by a buck converter and a boost converter. The output of the fuel cell voltage is V_{fc} and dc-bus voltage $V_{dc.}$ Inductor current is i_{Lm} into the single chip microcontroller to determine operational mode and duty ratio for the switch. When voltage $V_{fc\ is}$ higher than V_{dc} the converter operated in the buck mode and switch S_1 is turned ON to magnetize inductor Lm and the inductor current is increased. When switch S_1 turned OFF the stored energy in the inductor flow through D_1 and D_2. If the dc bus voltage V_{dc} is higher than V_{fc} the converter operated in a Boost mode. In this mode both switches S1 and S2 are turned ON. The inductor L_m is magnetized. When S2 is turned OFF the inductor releases the stored energy through D2.

$$. \, d_{buck} = \frac{V_{dc}}{V_{fc}} \quad \text{for buck mode}$$

$$d_{boost} = \underline{V_{dc}-V_{fc}} \quad \text{for boost mode}$$

V. CONCLUSSION

Electrolyser is used to produce H2 gas using DC voltage The Buck/Boost topology is used to give constant input to the electrolyser to produce constant H2 gas to the fuel cel. This topology will give constant output voltage to the DC bus if bus voltage is affected by any voltage fluctuations.

REFERENCES

[1] Tsai-Fu Wu, Senior Member, IEEE, Chia-Ling Kuo, Kun-Han Sun, Yu-Kai Chen, Yung-Ruei Chang, Member, IEEE, and Yih-Der Lee, Member, IEEE "Integration and Operation of a Single-Phase Bidirectional Inverter With Two Buck/Boost MPPTs for DC-Distribution Applications", *IEEE TRANSACTIONS ON POWER ELECTRONICS*, VOL. 28, NO. 11, NOVEMBER 2013

[2] Application Deepak S. Gautam, and Ashoka K.S. Bhat, Fellow, IEEE "A Two-Stage Soft-Switched Converter for Electrolyser", *Fifteenth National Power Systems Conference (NPSC)*, IIT Bombay, December 2008

[3] Emmanuel Zoulias1, Elli Varkaraki1, Nicolaos Lymberopoulos1, Christodoulos N. Christodoulou2 and George N. Karagiorgis2 1 Centre for Renewable Energy Sources (CRES), Pikermi, Greece 2 Frederick Research Center (FRC), Nicosia, Cyprus "A review on water electrolysis"

[4] R. Samuel Rajesh Babu, Joseph Henry "A Comparison of Half Bridge & Full Bridge Isolated DC-DC Converters for Electrolysis Application" *International Journal of Soft Computing and Engineering (IJSCE) ISSN*: 2231-2307, Volume-1, Issue-4, September 2011

[5] J. A. Sabate, V. Vlatkovic, R.B. Ridley, F.C. Lee and B.H. Cho, "Design considerations for high voltage, high power, full-bridge ZVS PWM converters," IEEE Applied Power Electronics Conf., 1990, pp. 275-284.

[6] D.J. Shortt, W.T. Michael, R.L. Avert, and R.E. Palma, "A 600 W four stage phase-shifted parallel DC to DC converter,", *IEEE Power Electronics Specialists Conf.*, 1985, pp. 136-143.

Published By:
Blue Eyes Intelligence Engineering & Sciences Publication Pvt. Ltd.

[7] V. Nguyen, J. Dhayanchand, and P. Thollot, “A multiphase topology series-resonant DC-DC converter,” in Proceedings of Power conversion International, 1985, pp. 45-53.

[8] D.S. Gautam and A.K.S. Bhat, “A comparison of soft-switched DC-to-DC converters for Electrolyser application”, *IEEE IICPE Conf. Record CD*, Chennai, 2006.

[9] D. S. Gautam, “Soft-Switched DC-to-DC Converters for Power Conditioning of Electrolyser in a Renewable Energy System,” *M.A.Sc Thesis, Dept. of ECE, University of Victoria*, 2006.

[10] H. Bodur and A. F. Bakan, “A new ZVT-PWM DC-DC converter,”*IEEE Trans. on Power Electr*., vol. 17, no. 1, Jan. 2002, pp. 40-47.

[11] R. Streit and D. Tollik, “High efficiency telecom rectifier using a novel soft-switched boost based input current shaper”, *IEEE INTELC Conf. Record*, 1991, pp.720-726.

T. Sivackani Born at udumalpet,BE : Studied at K.S.Rangasamy College of Technology, Thiruchengode ME : Studiying in Sri Shakthi College of Engineering and Technology

Published By:
Blue Eyes Intelligence Engineering
& Sciences Publication Pvt. Ltd.