ISSN (Online) 2395-2717

International Journal of Engineering Research in Electrical and Electronic Engineering (IJEREEE)
Vol 3, Issue 5, May 2017

SIMO DC-DC Converter With Both Buck Converter And Boost Converter For Different Levels Of DC Output For Multiple Applications

[1] Usha S ,[2]Rashmi Pattan, [3]Nadhia, [4]Kiran R
[1][2][3][4]Assistant Professor,Department of Electrical Engineering
Dayananda Sagar Academy Of Technology And Management
Bangalore, Karnataka

Abstract-— **The Multi-port DC-DC converter topologies can be used to generate multiple DC outputs from a single DC input source. This paper proposes a multi-port DC-DC converter topology which generates multiple outputs of different DC levels, from a single DC input. Operating modes and steady state behaviour of the proposed converter has been studied in this paper. Using MATLAB/SIMULINK (R2010a) the proposed converter topology is simulated to generate two outputs and four outputs from a single DC input.**

Keywords- Different DC Levels as Output, Single Input Multiple Output Converter (SIMO).

I. INTRODUCTION

Present day power electronic systems require multiple dc outputs at different voltage levels. Auxiliary circuits are often present in addition to the main power stage, and they should be powered at low voltages, e.g., fuel cell system. Power converter architectures having multiple dc ports (input/output) are used in a wide variety of applications . Typical examples include hybrid electric vehicles, dc-based nanogrids, LED drivers, stand-by power supplies, bias supplies, etc. Single-input-multi-output (SIMO) dc-dc converter stages have been utilized in many of these applications.

Fig.1. shows a representative system, where four distinct outputs vo1 , vo2 , vo3 , vo4 are obtained from a single dc input using four separate power converters. In general, an N- output system requires 2N number of switches for a high efficiency synchronous implementation. For efficient operation of systems using multiple outputs, there should be proper coordination of control between each of the converters for power flow management. Fig.2. shows the system where a single stage architecture is used to generate the different outputs. These converters, denoted as single input multi-output converter (SIMO) in this paper, utilizes reduced number of switches ((N + 1) switches for N outputs) compared to separate converters. The use of lower number of switches reduces the cost of the switch and its associated drivers. Also, due to this kind of architecture, all the outputs of the system are regulated using the same set of switches, and hence, the coordination control is easier.

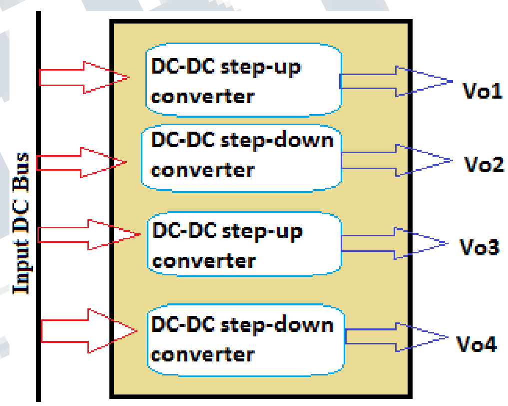


Fig.1. Schematic of power converter architecture having four separate dc-dc converters and its outputs

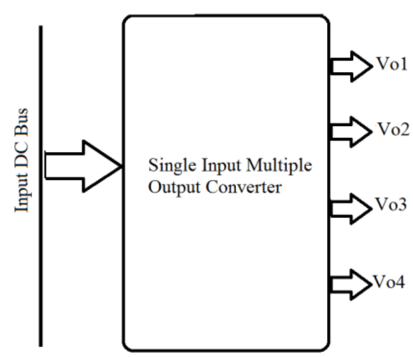


Fig.2. Schematic of the proposed single stage architecture used to provide four dc Outputs.

ISSN (Online) 2395-2717

International Journal of Engineering Research in Electrical and Electronic Engineering (IJEREEE)
Vol 3, Issue 5, May 2017

II. PROPOSED CONVERTER TOPOLOGY

The schematic of the converter, proposed in this paper, is shown in Fig.3. From a single DC input (Vin), this three-port converter provides outputs at two different levels terminals vo1 and vo2, respectively. The converter architecture has been derived by replacing the controllable switch of a conventional converter by the two bidirectional switches Q1 and Q2, along with the low pass filter comprising of inductor L2 and capacitor C2, which provides the additional low level output port.

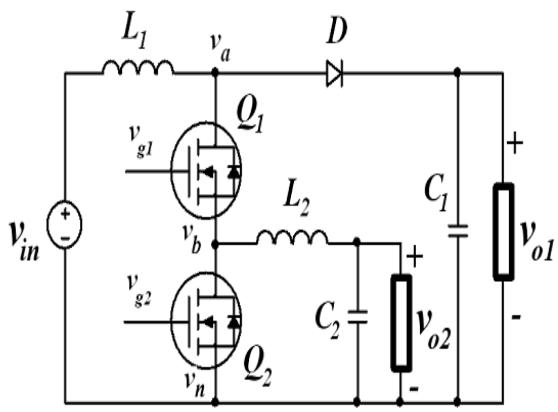


Fig.3. Schematic of the proposed integrated single input dual output converter

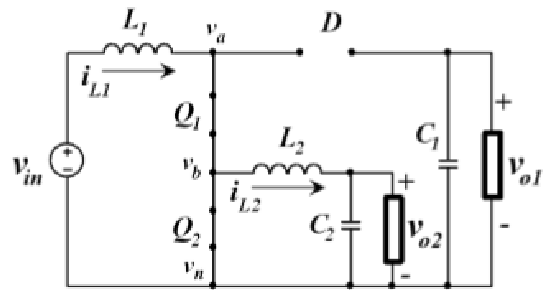
III. STEADY STATE OPERATION

A. Operating modes

The proposed converter assumes four modes of operation out of which three are distinct depending upon the status of the two bidirectional switches Q1 and Q2, either it is turned-on or turned-off. These different operating modes have been discussed in the following subsections.

1) Mode I : Both S1 and S2 are ON:

Mode I occurs when both the switches S1 and S2 are in the ON condition. The diode D is reverse biased during this interval. The inductor current i_l1 builds up during this interval, while the inductor current i_(l2)freewheels through the switch S2. With respect to the waveforms shown in Fig.5. and considering the DC loads R_o1 and R_o2 at the two different terminals, for a time D1.Ts, (where Ts = switching period).



(a)

Fig.4(a). The equivalent circuit of the converter at mode I.

The time duration for mode I operation is defined by duty ratio D1. The equations governing this mode of operation are shown below:
During this interval

$$V_{l1}= V_{in} - V_{o1}$$

$$V_{l2}= V_{o1} - V_{o2}$$

$$i_{c1}= i_{l1} - i_{l2} - \frac{Vo1}{Ro1}$$

$$i_{c2}= i_{l2} - \frac{Vo2}{Ro2}$$

3) Mode III : S1 is OFF and S2 is ON:

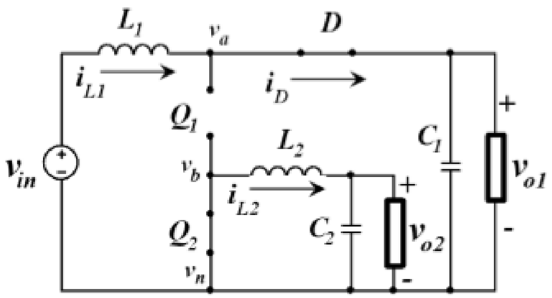
During this mode the inductor current i_(l2) freewheels through the anti-parallel diode of the bidirectional switch S2 (if S2 is not being gated). This interval is thus analogous to freewheel period associated with conventional converters, either the lower switch conducts in synchronous switching scheme or the diode conducts. The diode D conducts the inductor current〖 i〗_l1. Hence, both the inductors give out their energy to their respective outputs.
During this interval

$$V_{L1}= V_{in}\text{-}V_{o1}$$

$$V_{L2}= V_{o2}$$

$$i_{c1}=i_{l1} - \frac{Vo1}{Ro1}$$

$$i_{c2}=i_{l2} - \frac{Vo2}{Ro2}$$



(c)

Fig.4(c). The equivalent circuit of the converter at mode III.

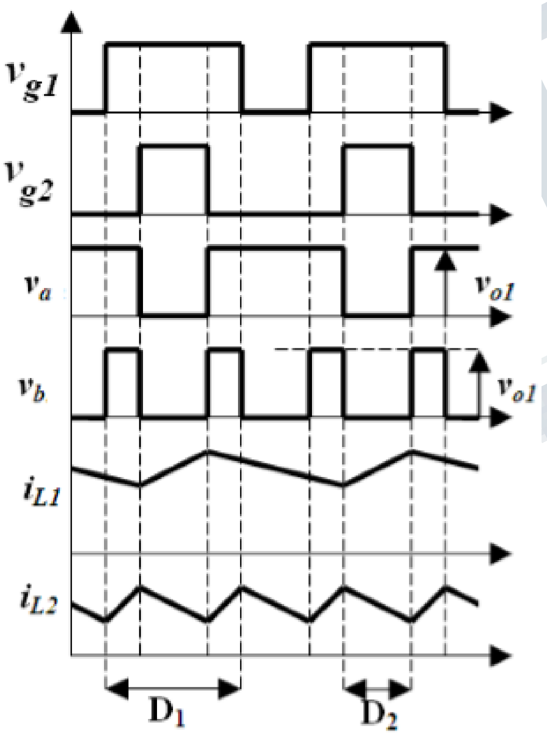


Fig.5. shows typical waveforms of the inductor currents i_l1, i_l2 and the switch node voltages V_a and V_b at different operating modes..

The switching strategy makes the converter to operate in the interval sequence (III), (II), (I), (II), (III) during each period. It is important to note that Mode III in Fig.5. shows GS1 and GS2 being turned off. The waveforms would be same if during Mode III; GS2 is switched on, thus resulting in synchronous switching operation. Fig.5. shows typical waveforms of the switch node voltages, the inductor and the diode currents. The duty cycles are D1 and D2.

IV. SIMULATION RESULTS

The first section describes about the software implementation of the basic topology - with two outputs. The simulation results include simulation model and its corresponding waveforms of the basic converter topology. The second section gives the simulation results of the four output converter topology.

1) Simulation Models and Waveforms :

The proposed single input multiple output converters has been simulated using the MATLAB/SIMULINK R2010a. The simulated results justifies the behaviour of the converter. The results shows that the proposed converter can generate two levels of output with the respective duty cycles.

This single input multiple output converter works for an input voltage of 12 V DC and generates two output voltages simultaneously. One output with a step-up voltage in the range of 80 to 90 V and other with a step-down voltage in the range of 8 to 10 V.

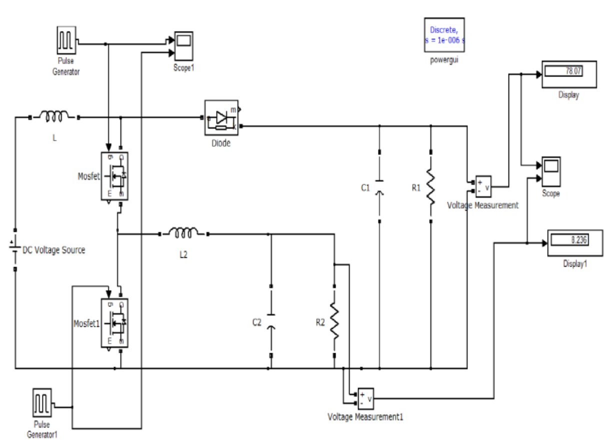


Fig.6(a). Simulink Model of the two output Converter

ISSN (Online) 2395-2717

International Journal of Engineering Research in Electrical and Electronic Engineering (IJEREEE)
Vol 3, Issue 5, May 2017

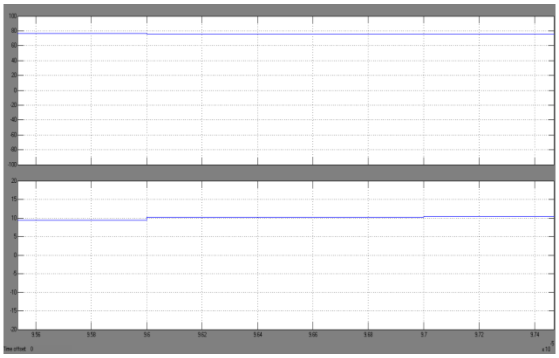


Fig.6(b). Output Voltage

The design parameters and specifications are shown below:

Input voltage Vin	12 V
output voltage Vo1	Range : 80- 90 V
output voltage Vo2	Range : 8 – 9 V
Switching frequency	100 KHz
Inductors L1	61.2 µH
Inductors L2	2.334816 µH
Capacitors C1	1.0625µF
Capacitors C2	8.375µF

2) Simulation Model and Waveform for four outputs

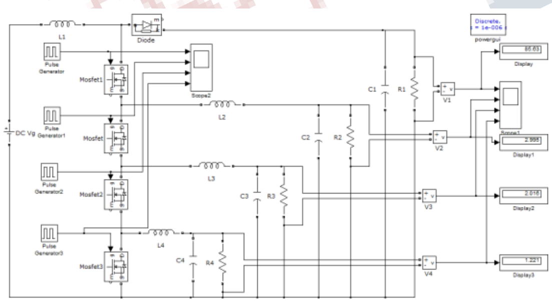


Fig.7(a). Simulink Model of the four output Converter

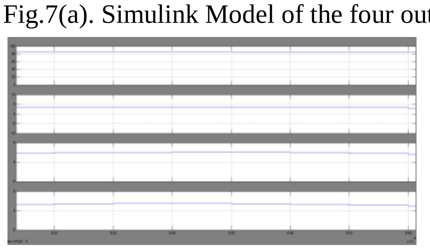


Fig.7(b). Output Voltage

VI. CONCLUSION

This paper proposed an Single Input multi-output dc-dc converter topology with different levels of outputs. Analysis and characterization of the different modes of operation of the converter is done. The merits of the converter with respect to shoot-through protection, lesser Bill-of-Material and wider output ranges have been discussed. The converter behaviour has been verified using a simulation as well as experimental prototype.

VII. REFERENCES

[1]. Olive Ray, Anil Prasad J., and Santanu Mishra, "A Multi-port DC-DC Converter topology with simultaneous Buck and Boost outputs" IEEE, DOI 10.1109/PESTSE.2014.6805284

[2]. Chinnu V V, Daisykutty Abraham and Ninu Joy, "An Integrated Single Input Multi-Output DC DC Converter with Simultaneous Buck and Boost Outputs" IJAREEIE Vol. 3, Special Issue 5, December 2014