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Modeling Of Double Source Dc-Dc Converter

Rinkaj Singh Kushwah[1] Rameshwar Singh[2]
[1.2] NITM, Gwalior

Abstract: This is a two-switch converter belongs to fourth order family and performs bucking operation for one dc source while it allows both bucking as well as boosting feature with the second source. A new two-input DC-DC converter suitable to draw power from two different dc sources feeding a common dc-bus is presented in this paper. The salient feature of the proposed converter is that both the sources either individually or simultaneously supply power to the downstream load at reduced ripple current. This feature is particularly attractive for photovoltaic power processing applications. A digital voltage-mode controller is designed for downstream dc-bus regulation while the current controller regulates the power from the weak input power source. A 24 V, 96 Watt converter performance is analyzed and compared with the simulation observations.

I. INTRODUCTION

Reliability, accuracy and better load regulation are main issues of modern power supply .Demand of Switch-mode power converter is increasing day by day in various application such as hybrid vehicles and telecom power supply. .In order to utilize maximum energy from more than one energy source ,such as fuel cell., battery, solar array and wind energy various multi input converter has been proposed in the recent year. Depending upon the applications one could select a feasible topology by considering many features like reliability, cost and flexibility. Multi input converter has advantage of higher system efficiency high power density, light weight and small size. Several different types of switch-mode DC-DC converters, belongs to buck, boost and buck-boost topologies, have been developed to meet variety of applications. Major concern in the recent dc distribution systems, such as in automotive and telecom power supply systems, is to meet the increased power demand and reducing the load on the primary energy source, i.e. built-in battery. This is possible by adding additional power sources in parallel to the existing primary source. Power sources supplementing other resources are normally categorized as hybrid power source and the corresponding scheme is called hybrid distributed generation systems. Some of the applications of multi-input converters are discussed in the literature [1]-[2]. Several multiple-input (MI) DC-DC converters have recently been developed to interface more than one power source with a load. Basic two-input integrated type DC-DC converter is shown in Fig. 1

A DC-to-DC converter is an electronic circuit or electromechanical device which converts a source of direct current (DC) from one voltage level to another. It is a type of electric power converter. Power levels range from very low (small batteries) to very high (high-voltage power transmission). DC -DC converter is one of the most important and widely used devices of modern power applications. Power electronics field in the last decade has been the development of switching-mode converters with higher power density and low electromagnetic interference. Light weight, small size and high power density are also some of the key design parameters. Several different types of switch-mode dc-dc converters belong to buck, boost and buck-boost topologies, have been developed and reported in the literature to meet variety of applications. Major concern in the recent dc distribution systems, such as in automotive and telecom power supply systems, is to meet the increased power demand and reducing the load on the primary energy source, i.e. built-in battery. This is possible by adding additional power sources in parallel to the existing battery source. The additional power sources can be: (i) renewable energy sources such as photovoltaic (PV) or wind, (ii) fuel cell storage power

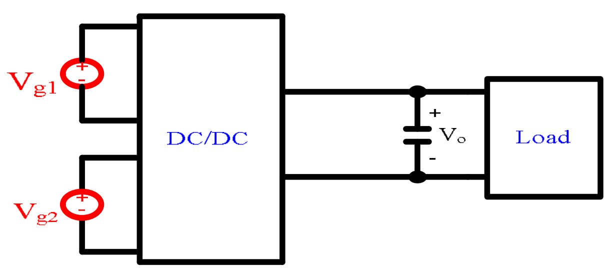

Fig. 1.. Block diagram of two-input integrated type DC-DC converter

The objective of this paper is to generate a two input topology by using pulsating source cell derived from six non isolated converter such as buck, boost buck-boost, Cuk, SEPIC and Zeta. The single-ended primary-inductor converter (SEPIC) is a type of

DC/DC converter allowing the electrical potential (voltage) at its output to be greater than, less than, or equal to that at its input. The output of the SEPIC is controlled by the duty cycle of the control transistor. A SEPIC is essentially a boost converter followed by a buck-boost converter, therefore it is similar to a traditional buck-boost converter, but has advantages of having non-inverted output (the output has the same voltage polarity as the input), using a series capacitor to couple energy from the input to the output (and thus can respond more gracefully to a short-circuit output), and being capable of true shutdown: when the switch is turned off, its output drops to 0 V. SEPICs are useful in applications in which a battery voltage can be above and below that of the regulator's intended output. For example, a single lithium ion battery typically discharges from 4.2 volts to 3 volts; if other components require 3.3 volts, then the SEPIC would be effective.

II. PROPOSED CONVERTER

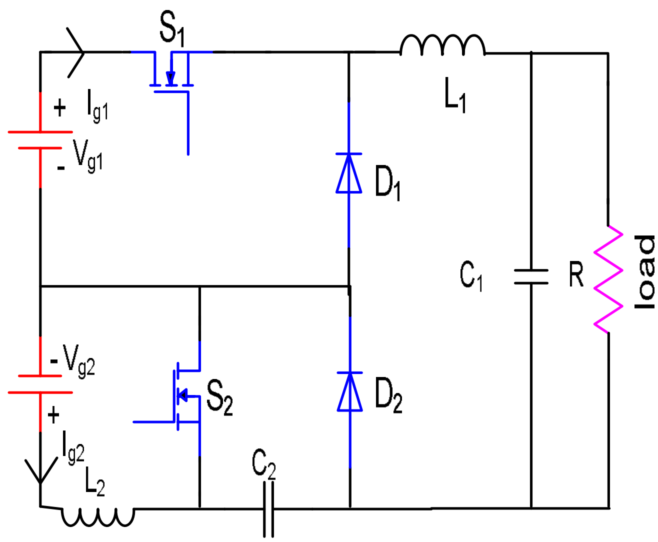

Fig. 2. DC-DC CONVERTER CIRCUIT DIAGRAM

The proposed two-input integrated converter, shown in the Fig. 2. For this converter three different cases may be possible: (1) source-1 delivers more power than source-2. (2) source-2 delivers more power than source-1 (3). Both the sources delivers same amount of power. The modelling of the converter has been carried out by taking the first case i.e. source-1 can deliver more power than source-2. So source-1 has to be operated for more time. Because of the limited power supply capacity of source 2, the duty cycle of the switch S_2 (d_2) is assumed to be less than the duty cycle of the switch S_1 (d_1). With this assumption the PWM gating signals are shown in the below Fig.3.

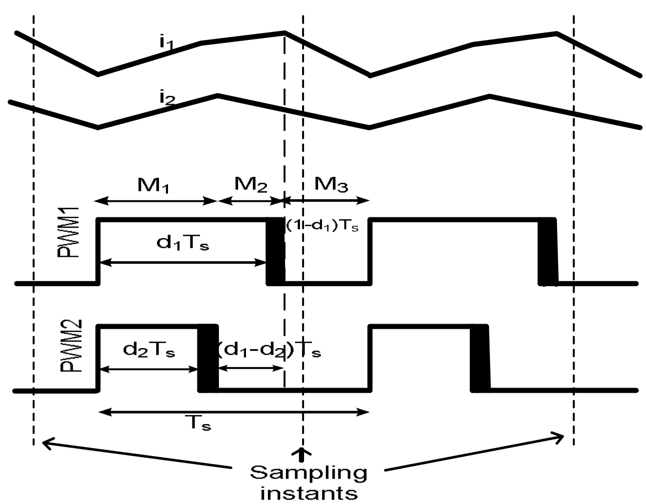

Fig.3 Sampling Process

A. Modeling of Two-Input DC-DC Converter

. In each mode of operation the power stage dynamics can easily be described by a set of state equations given by:

$$\dot{x} = A_K x + B_K u$$
$$y = C_k x + F_k u \qquad (1)$$

Where $[x]=[i_{L1} \quad i_{L2} \quad v_{c1} \quad v_{c2}]^T$, $[u]=[V_{g1} \quad V_{g2}]^T$, and k=1,2,3 for mode-1, mode-2 and 3, respectively.

The above equation describes the small-signal dynamics of the proposed converter, with the converter state variables depending on the two control variables, d_1 and d_2. In order to design suitable control strategies based on d_1 and d_2, it is essential to know the degree of interaction between the control loops.

Table I. Parameter values of the converter

Parameter	Value
L_1	300 µH
L_2	250 µH
C_1	200 µF
C_2	120

B. Digital Controller Design

Several different types of control strategies are reported in literature, and they are broadly classified into: (i) single-loop voltage-mode, (ii) single-loop current-mode, (iii) two-loop current mode control, and (iv) multi-loop schemes. Although the single-loop strategies are simple to implement, but their dynamic response times are slightly higher side. Although two-loop current-mode schemes are popular in the power supply applications, but their compensator design presents complexity. In this paper two decoupled control scheme are proposed, of which one for dc-bus voltage regulation and the other for load division on second dc source. This structure is capable of maintaining the load voltage regulation while feeding available power from the weak dc source. The control schemes can be interchangeable from one to other depending on the source power supply capacity. However, use of current-control loop for heavier source limits the load supplying capacity and hence it is not recommended. In view of this difficulty it is always recommended to use current-control loop for the weaker source and connected to the circuit portion that gives buck-boost feature. DC-bus voltage regulation loop should be closed together with the heavier source. Detailed mathematical treatment will be presented in the final paper to support above discussion. For decoupled digital controllers design two different loopgains have been defined here, one for current-control loop while the second one for the dc-bus voltage regulation loop. In any case the digital compensator is designed using sisotool of the MATLAB in the frequency domain. Pole-zero placement technique is used and then final design is arrived. Fine tuning of the compensator is performed to ensure relative stability margins, i.e. gain margin> 6 dB, 35^0<phase margin<75^0 and reasonable crossover frequency, which normally depends on the order of the converter under consideration.

III. SIMULATION STUDIES AND RESULTS

To extract the salient features of the proposed converter and to verify the load distribution together with dc-bus regulation capability a 24 V, 96 *Watt* two-input dc-dc converter system was considered in this studies and its parameters are listed in Table I. PSIM is used for simulation purpose. In these studies DC source-1 considered as heavier source having sufficient power supplying capacity, more than load demand, while DC source-2 considered as weaker source with its power supplying capacity less than the load demand.

In order to confirm the developed theoretical analysis established. In this paper, firstly the simulation results are carried out on two-input integrated DC-DC converter with decentralized controllers followed by centralized controllers.. Initially the two voltage sources are set to V_{g1}=36 V, V_{g2}=12 V and duty ratio of switch S_1 and S_2 are adjusted to 0.5 and 0.3 respectively and observed the converter steady-state performance.

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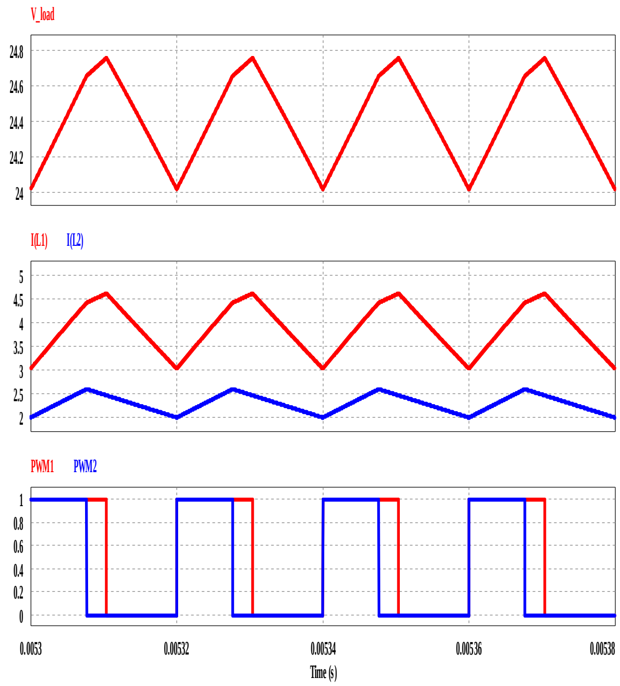


Fig.2 Simulation Results (open loop)

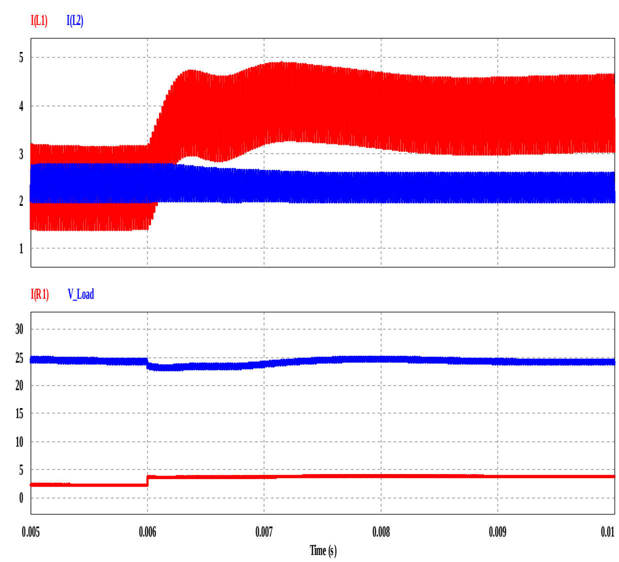


Fig.2 Simulation Results (closed loop)

IV. CONCLUSION

A new two-input DC-DC converter suitable for drawing power from two different dc sources and feeding to common dc bus was proposed in this paper. Modes of operations have been analyzed and then decoupled control-loops were designed to distribute the load demand on both the input sources. Voltage-mode control strategy was used to ensure dc bus voltage regulation, while current-control loop was implemented to restrict the load division on the second source. Simulation and experimental results were in agreement with the theoretical predictions. Detailed comparison of simulation results for different conditions will be given in the final paper.

REFERENCES

[1] Hirofumi Matsuo, Wenzhong Lin, Fujio Kurokawa, Tetsuro Shigemizu, Nobuya Watanabe, “Characteristics of the Multiple-Input DC–DC Converter,” IEEE Trans. on Ind. Electron, vol. 51, no. 3, pp.625-631, Jun. 2004.

[2] Jian Liu, Zhiming Chen, Zhong Du, “A new design of power supplies for pocket computer system”, IEEE Trans. on Ind. Electronics, 1998, Vol. 45(2), pp. 228-234.

[3] K. P. Yalamanchili, M. Ferdowsi, Keith Corzine, “New Double input dc-dc converters for automotive applications", IEEE Applied Power Electronics Conference (APEC), 2006, CD-ROM proceddings.

[4] R. D. Middlebrook, Cuk. S, “A general unified approach to modelling switching converter power stage”, IEEE Power electronics specialists conference, 1976, pp. 13-34.

[5] D. Maksimovic and R. Zane, “Small-Signal Discrete Time Modeling of Digitally Controlled PWM Converters”, IEEE Trans. on Power Electronics, vol. 22, no. 6, pp. 2552-2556, Jun. 2007.

[6] Krishna Mohan. B, “Robust Digital Voltage Mode Controller for Fifth-Order Boost Converter,” IEEE Trans. Industrial Electron., vol. 58, no. 1, pp. 263-277, Jan.2010.

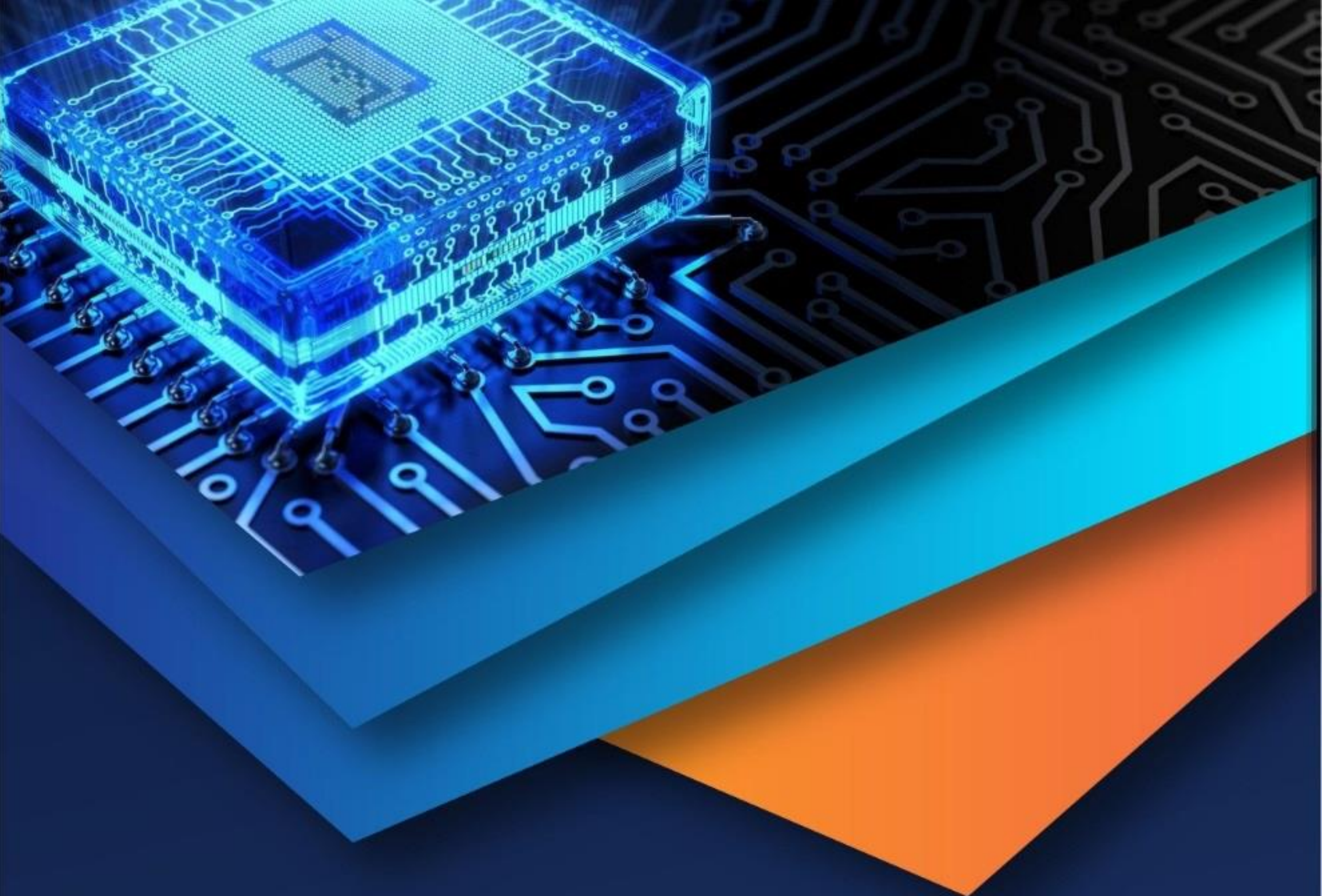
[7] M. Veerachary, “Two-loop controlled buck-SEPIC converter for input source power management,” IEEE Trans. On Industrial Electronics, Vol. 59(11), pp. 4075-4087, 2012.

[8] Veerachary. Mummadi, Ramakanth Naidu Gowra, and Dileep Ganta. "Discrete-time modeling of multi-state DC-DC converters."Proc. of IEEE conference on Power Electronics, Drives and Energy Systems (PEDES) & Power India, 2010, pp. 1-6.

[9] Maksimovic Dragan, and Regan Zane. "Small-signal discrete-time modeling of digitally controlled PWM converters.", IEEE Trans. on Power Electronics., vol.22(6), pp. 2552-2556, 2007

[10] MATLAB user manual, 2000.

[11] PSIM, user manual, 2004.



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