© 2018 IJSRST | Volume 4 | Issue 3 | Print ISSN : 2395-6011 | Online ISSN: 2395-602X

National Conference on Advances in Engineering and Applied Science (NCAEAS)
29th January 2018
Organized by : Anjuman College of Engineering and Technology (ACET) Nagpur, Maharashtra, India, In association with
International Journal of Scientific Research in Science and Technology

A Non isolated Dual input Dual output DC-DC Boost Converter for Electric Vehicle

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ABSTRACT

A DC-DC converter is a power electronics device that accepts a DC input voltage and also provides a DC output voltage. The output voltage of DC to DC converter can be greater than the input voltage or vice versa. The converter output voltages are used to match the power supply required to the loads. The connection and disconnection of power supply to the load can be controlled using a switch in the simple DC to DC converter circuit. DC to DC converter circuits consists of a mosfet /IGBT or diode switch, energy storage devices like inductors or capacitors and these converters are generally used as linear voltage regulators or switched mode voltage regulators.

DC to DC Converter Operating Principle and Functionality

To understand the DC to DC converter operating principle and functionality, let us consider the working principle of DC to DC boost converter.

DC to DC Boost Converter

The low input DC voltage is converted into high output DC voltage using DC to DC boost converter. As the input voltage is stepped up compared to output voltage, hence, it is also called as a step up converter. Generally, DC to DC converters can be designed using power semiconductor switching devices and discrete electrical and electronics components.

In DC to DC converter, the converter operates in two modes:

Continuous Conduction Mode

Discontinuous Conduction Mode

Keywords: DC–DC converters, electric vehicle (EV), energy storage system (ESS), fuel cell (FC), hybrid power system, super capacitor (SC).

I. INTRODUCTION

The circuit of the DC to DC boost converter is shown in the figure that consists of an inductor, capacitor, switching device, diode, and input voltage source. This boost converter circuit switch is controlled using a pulse generator. If this switch is in ON state, then

energy will be developed in the inductor and thus more energy will be delivered to the output.

The discontinuous conduction mode circuit of the DC to DC boost converter is shown in the figure that consists of elements such as capacitor, inductor, voltage source, diode, and switching device. In this discontinuous conduction mode, if the switch is in ON state, then energy will be delivered to the power storage element, inductor. If the switch is in OFF state for some period, then the inductor current will reach zero until the next switching cycle is on. Thus, the capacitor gets charged and discharged with respect to the input voltage. But, here the output voltage in discontinuous conduction mode is less than the output voltage in continuous conduction mode.

II. MODIFIED DUAL INPUT DUAL OUTPUT DC-DC CONVERTER WITH PID CONTROLLER.

In a closed-loop system, a controller is used to compare the output of a system with the required condition and convert the error into a control action which is designed to reduce the error and bring the output of the system back to the desired response. Closed-loop control systems have many advantages over open-loop systems. Figure 2 shows block diagram of closed loop system with PID controller.

Open Loop Systems are simpler in their layout and hence are economical and stable too due to their simplicity. Since these are having a simple layout so are easier to construct. These systems do not have a feedback mechanism, so they are very inaccurate in terms of result output and hence they are unreliable too. Due to the absence of a feedback mechanism, they are unable to remove the disturbances occurring from external sources. Closed Loop Systems are more accurate than open loop systems due to their complex construction. They are equally accurate and are not disturbed in the presence of non-linearities. Since they are composed of a feedback mechanism, they clear out the errors between input and output signals, and hence remain unaffected to the external noise sources. They are relatively more complex in construction and hence it adds up to the cost making it costlier than open loop system. Since it consists of feedback loop, it may create oscillatory response of the system and it also reduces the overall gain of the system. It is less stable than open loop system but this disadvantage can be avoided, since we can make the sensitivity of the system very small so as to make the system as stable as possible.

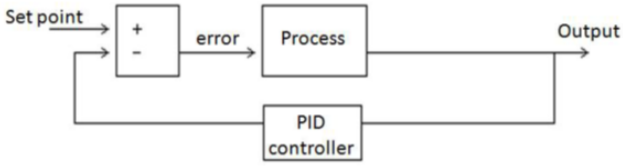

Figure 1

III. RESULTS AND DISCUSSION

For an input of 3 V and 8 V, switching frequency ***fc*** as 10kHz and a 100Ω resistive load, the proposed dual input dual output converter was simulated in battery discharging mode by using MATLAB R2014a. Following are the parameters used for MATLAB simulation of the converter.

Tabel 1

Simulation parameters	Values
Switching frequency	10kHz
DC Source (V_{in1})	3 V
Battery (V_{in2})	8 V
Inductor	3.2mH
Capacitors (C_1 , C_2)	22μF
Load resistance	100 Ω

Simulink Model:

Simulink model of a dual input dual output DC-DC Boost converter with PID controller is shown in fig below MOSFET'sare used as switches. Output voltage and output currents are analyzed from the simulation results.

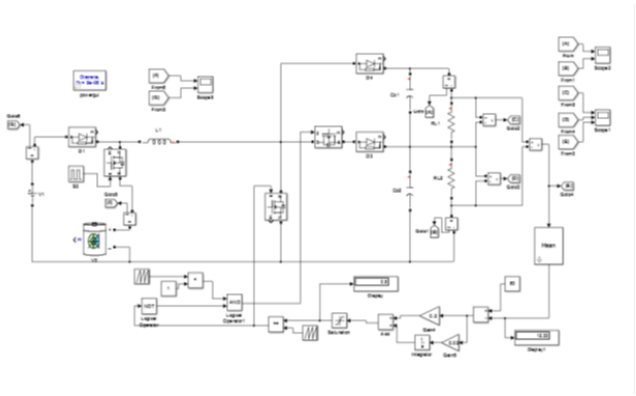

Figure 2

Simulation Results:

Fig. shows the simulation results at the input voltages Vin1 = 3 V and Vin2 (Battery) = 8 V . output voltages thus obtained are VO1 = 3.9 V and VO2 = 8.5 V. Total Voltage VT = 12.4 V

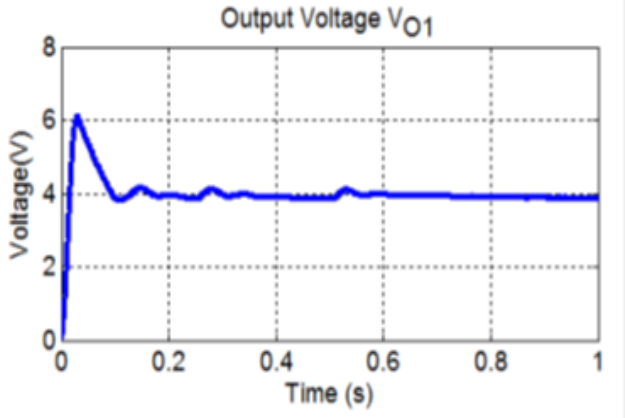

Figure 3

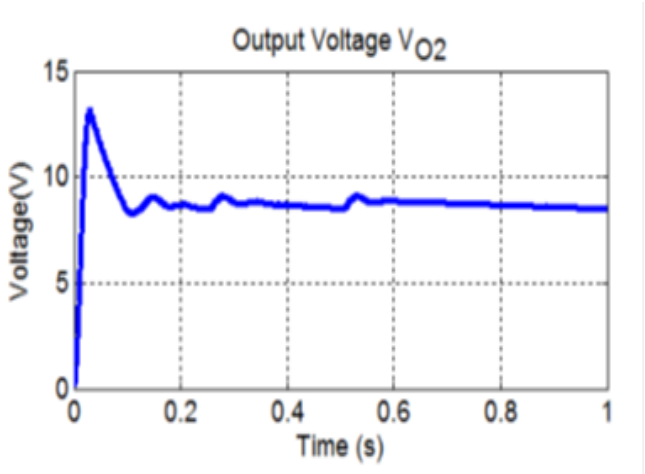

Figure 4

IV. CONCLUSIONS

A new dual input dual output dc - dc boost converter with unified structure for hybridizing of power sources in electric vehicles is presented in this paper. The presented converter has just one inductor. This can be used for transferring energy between different energy resources such as FC, PV, and ESSs like battery and SC. In this paper, FC and battery are considered as power source and ESS, respectively. The converter has two main operation modes in which battery discharging mode both of input sources deliver power to output and in battery charging mode one of the input sources not only supplies loads but also delivers power to the other source (battery). It is seen that under various conditions such as rapid rise of the loads power and sudden change of the battery reference current, output voltages and battery current are regulated to desired values with PID controller. Outputs with different dc voltage levels are appropriate for connection to multilevel inverters. In electric vehicles, using of multilevel inverters leads to torque ripple reduction of induction motors. Also, electric vehicles which use dc motors have at least two different dc voltage levels, one for ventilation system and cabin lightening and other for supplying electric motor. Simulation results verify the operation principle of this converter.

V. REFERENCES

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