International Journal of Pure and Applied Mathematics
Volume 119 No. 14 2018, 1755-1759
ISSN: 1314-3395 (on-line version)
url: http://www.ijpam.eu
Special Issue

ijpam.eu

BIDIRECTIONAL BUCK CONVERTER FOR PARALLELED POWER SUPPLIES

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ABSTRACT: This project uses two power supplies for power conversion. Snubber capacitor is used to neutralize the mutual capacitance that is produced in the solar panel. Snubber capacitor voltage is used by the secondary voltage source i.e. the battery from which bidirectional buck converter provides power to the load even under a very light load condition. A buck converter is used between the bidirectional converter and the secondary voltage source to charge the secondary voltage source at a faster rate. The energy storage is of vital importance in applications such as hybrid electric vehicle, space vehicle, etc. A bidirectional converter is used between the source and the secondary voltage source i.e. the battery to match the voltage level. This project mainly deals with building the hardware for bidirectional power flow between source and load or battery and load. In this project, Bidirectional non-Isolated DC-DC converter is designed to operate with a battery.

Index Terms: Variable Frequency Drive, Maximum Power Point Tracker, MOSFET, phase-shift full-bridge converter, photovoltaic cell.

INTRODUCTION

In this current scenario and environment promoting and using of energy saving, high efficiency instruments and devices are valued so that the power consumption is minimal. Especially under the light load condition since the power systems operate mostly under the light load condition. For example, the 80PLUS performance specification requires power supplies in computers and servers to be high efficient. The efficiency must be satisfied mostly to be greater than 90% at 10% load to achieve Titanium certification, as well as under a full-load condition. Furthermore, many manufacturers of computer, telecommunication, and network equipment require high light-load efficiency even below 5% load condition, which exceeds the latest Energy Star specifications. This means that very light-load efficiency will become more important in the future.

In this project 'N' power supplies can be connected in parallel and provide the output power with an equally shared load current. It helps to increase overall efficiency and the power handling capability. In our prototype we are using two dc sources. Redundant power supplies are also being used in this structure. This helps in power to be continuously supplied even when the source is turned off due to some faults, which improves the reliability of the structure. Each power supply works on two power conversion stages. Each power supply has two power conversion stages. The first one is the input filter and the power-factor-correction (PFC) circuit, which creates low EMI, surge protection, and a high power factor. The PFC circuit, which uses a boost converter , converts the AC voltage to DC link voltage Vs of about 400V. The second power conversion stage is the DC/DC power conversion circuits, which use an isolation transformer and regulate the output voltage at about 12V. A phase-shift full-bridge (PSFB)converter is generally used to meet the high step-down voltage, low output voltage and high output current. In DC/DC conversion, many switches and magnetic components are used, therefore it is very difficult to improve the overall efficiency of the circuit, especially under a light-load condition due to switching and core-losses. Hot-swap circuits using a switch QHS and load-share control circuits are additionally required to connect and drive the paralleled power supplies. Arduino UNO is used in the circuit to provide gate pulse to the switches. TLP driver unit is used to increase the amplitude of pulses required by the switches.

1. PROPOSED SYSTEM

In this circuit we use Luo converter instead of CUK converter. Luo converters have low output current stress achieved by using an output inductor, which results in low overall conduction loss that is why these are widely used in low-voltage, high-current and high-power applications. A power conversion scheme considering paralleled modules is proposed. Under a light-load condition, the redundant power supply enters standby mode as in the CR concept. A non-isolated buck converter in the secondary side of the remaining

power supply provides the output power, which is different from the CR concept under a very light-load condition.

Thus, the operating components and the related power losses are more minimized. Also, to achieve high power density, the buck converter is integrated with the rectifier circuits in the secondary side of the Luo converter.The main advantage of the proposed scheme is that high efficiency can be achieved especially under light-load as well as heavy-load condition because of the low switching and core loss achieved by using the buck converter instead of the conventional structure composed of a primary inverter, a transformer, and a secondary rectifier.

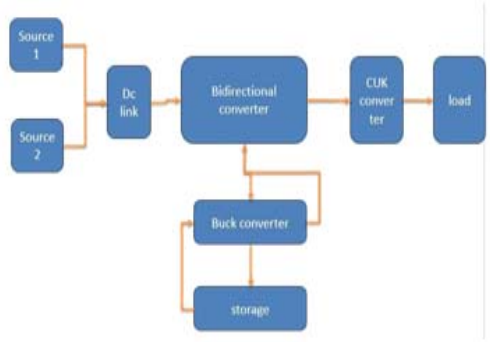

Fig 1: Block diagram of the entire circuit

2. HARDWARE DETAILS

The system consists of three types of converters, Boost Converter, LUO converter and Buck Converter.Another converter known as Bidirectional converter is used as a two way switch .i.e. (a) to provide input power supply directly to the load (b) to give power to the storage unit. A 12V,1.3AH Lead –acid battery is used as the storage unit. which later can be used to run the load constantly even when there is fault occured in the supply side.Arduino which is an open-source , is an easy to utilize equipment for coding and hardware . Arduino provides Gate pulses to switches present in the converters. The other part which is used is TLP 250 Driver Circuit. In the electrical systems, a driver is an electric part used to control a segments such as transistors, LCD, here TLP 250 is used to turn on the converters. Theterm Driver is frequently utilized, for instance , for a particular incorporated circuit that controls high- control switches in exchanged mode control converters . A speaker can likewise be viewed as a driver for amplifiers,or a voltage controller that keeps an appended segment working inside an expansive scope of info voltages. A 12V,20W ,750 mA DC motor is used as a load in the hardware circuit

3. LUO CONVERTER

Mode 1: When switch S is ON, the inductor is charged by a supply voltage E. At the same time, the inductor L1 retains vitality from both source and capacitor C1. The heap is provided by capacitor C2.

$$V = \frac{Ldi}{dt}$$

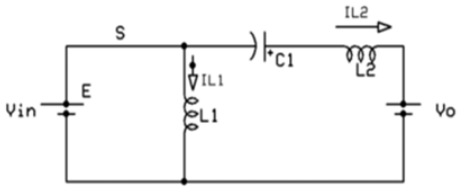

Fig. 2: When switch S is ON

Mode 2: When Switch S is OFF, the current drawn from source winds up zero. Current iL1 moves through a freewheeling diode to charge capacitor C1. The current iL2 streams from L2, C2, and freewheeling diode D to keep itself ceaseless.

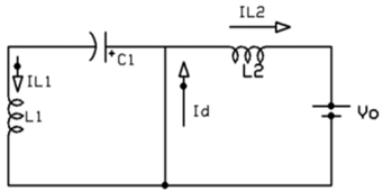

Fig 3: When switch S is off

In discontinuous conduction mode, the output should be in discontinuous form. In this case diode is in reverse bias and hence cannot conduct, hence the inductor L1 discharges through L2 and V0. The output stage of a Luo converter consists of an inductor and a capacitor. It stores and delivers the energy to the load and smooths out the switch node voltage to produce a constant output voltage.

4. SIMULATION DIAGRAM

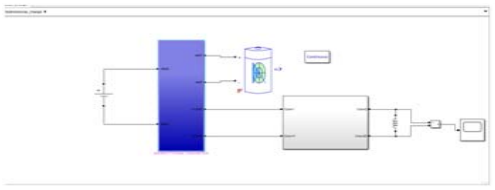

Fig. 4 Overall Simulation Diagram

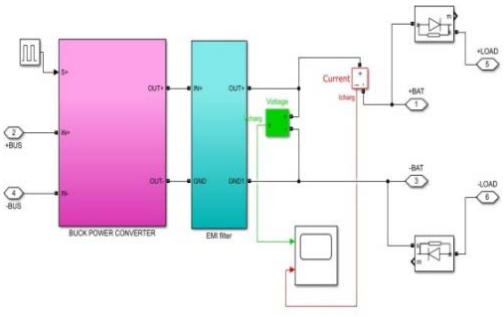

Fig. 5 Simulation Diagram

5. SIMULATION RESULTS

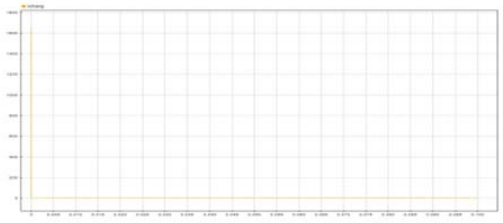

Fig. 6: Current vs time of Buck converter

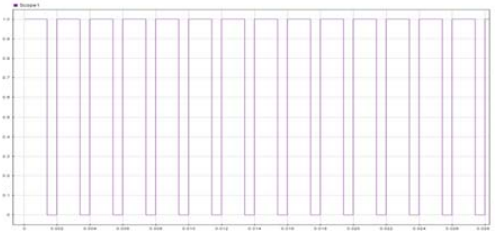

Fig. 7: Duty cycle

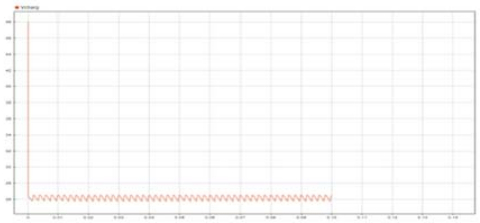

Fig. 8: Voltage vs time of Buck converter

6. HARDWARE OUTPUT

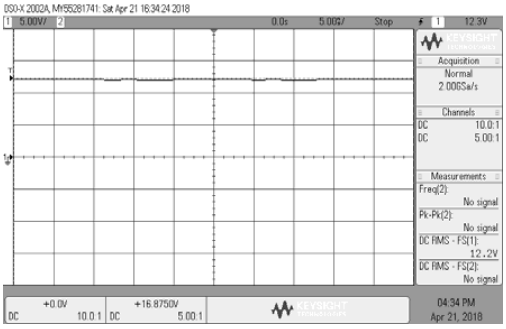

Fig 9 Input voltage

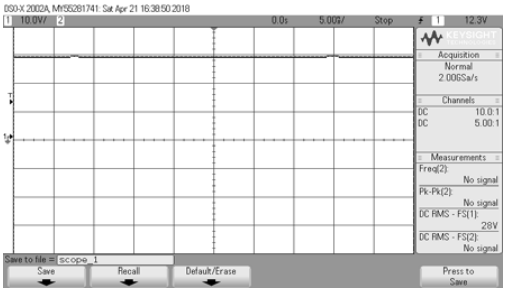

Fig. 10 Output voltage of Luo Converter

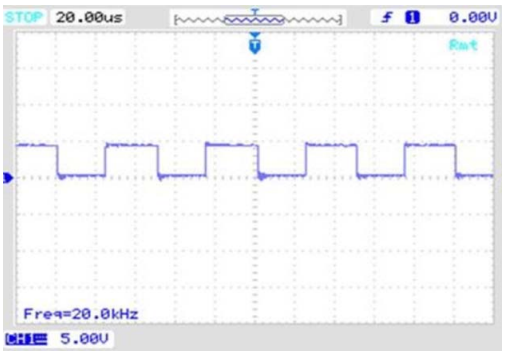

Fig. 11: Switching pulse of MOSFET

7. CONCLUSIONS

A new power conversion scheme is presented using paralleled modules. The proposed converter has high efficiency, in any voltage condition, achieved by using an integrated bidirectional buck converter.The circuit operation and design considerations are illustrated in this paper. The validity of the basic operational principles is confirmed by the experiment with two 12V/750W prototype modules. The initial experimental result is observed using MATLAB/SIMULINK.

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