A CUK Converter Based High Gain Input-Parallel Output-Series Dc/Dc Converter

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ABSTRACT

Due to the decade of fossil fuels at present renewable energy plays an important role in generating power to meet the load requirements. Power produced from the renewable energy is very low. So chopper circuit is required to boost the voltage level of renewable energy sources. Chopper is a circuit in which fixed DC voltage is converted into variable voltage. There are many types of chopper circuit in which buck converter, boost converter and buck boost converter plays an important role in renewable based energy applications due to its simplicity. But it has many disadvantages like energy conversion is limited by duty cycle, more switching stress and conduction losses. To overcome the disadvantages of conventional choppers cuk converter is used in this project as a chopper circuit to boost the voltage to meet the load requirements and the proposed work is implemented by using MATLAB software.
Keywords: Voltage Converter, voltage doubler, PWM switching and CUK converter

I. INTRODUCTION

High voltage gain dc–dc converters are required in many industrial applications such as photovoltaic and fuel cell energy systems, high-intensity discharge lamp (HID), dc backup energy systems, and electric vehicles. In existing system interleaved boost converter is used to improve the voltage gain. But major disadvantage of using interleaved boost converter is more no of switches so switching losses will be more and switching stress also high. size of the system is also increased. To overcome the drawbacks of interleaved converter in proposed system cuk converter is used to improve the voltage gain. Many single switch topologies based on the conventional boost converter had been presented for high step-up voltage gain [1]–[2]. The cascaded boost converter is also capable of providing high voltage gain without the penalty of extreme duty cycle [3]. However, the voltage stress of the main switch is equal to the output voltage. In [4] and [5], several switching capacitor/ switching-inductor structures are proposed, and transformer less hybrid dc–dc converters with high voltage gain are derived by the use of structures integrated with classical single switch non-isolated PWM converters. They present the following advantage: the energy in the magnetic elements is low, which leads to weight, size, and cost saving for the inductor, and less

conduction losses. Another method for achieving high step-up gain is the use of the voltage-lift technique [6], showing the advantage that the voltage stress across the switch is low. However, several diode–capacitor stages are required when the conversion ratio is very large, which makes the circuit complex. In addition, the single switch may suffer high current for high power applications, which risks reducing its efficiency.

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Another alternative single switch converters including forward, fly-back and tapped-inductor boost can achieve high conversion ratio by adjusting the turns ratio of the transformer, but these converters require large transformer turns ratio to achieve high voltage gain. In an integrated boost flyback converter is proposed to achieve high voltage gain, and the energy of a leakage inductor is recycled into the output during the switch-off period. Unfortunately, the input current is pulsed from the experimental results. In addition, it should be noticed that the low-level input voltages usually cause large input currents and current ripples to flow through the single switch for high step up and high power dc–dc conversion, which also leads to increasing conduction losses. Therefore, the single-switch topologies are not perfect candidates for high step up dc–dc conversion.

In order to handle high input currents and reduce current ripples, the three-state switching cell based on interleaved control is introduced in boost converters [7]. However, the voltage gain of the conventional three-state switching boost converter is only determined by the duty ratio [8]. Moreover, the voltage stresses of the power devices are still equivalent to output voltage. Thus, the large duty ratios, high switch voltage stresses, and serious output diode reverse recovery problem are still major challenges for high step up and high power conversion with satisfactory efficiency. To solve aforementioned drawbacks, some three-state switching converters with high static gain employing diode–capacitor cells were presented [9]. However, several diode–capacitor cells are required to meet a very high step-up gain. Thus, other topologies using three-state switching cell and coupled inductors are investigated in [10]–[11]. The authors in [12] proposed an interleaved boost converter with coupled inductors and a voltage doubler rectifier in order to satisfy the high step-up applications and low input current ripple, in which the secondary sides of two coupled inductors are connected in series. The winding-cross-coupled inductors and output diode reverse-recovery alleviation techniques are also introduced in interleaved three-state switching dc–dc converters, which can get a considerably high voltage

conversion ratio and improve the performance of the converter.

II. METHODS AND MATERIAL

Existing System

A high frequency metal–oxide–semiconductor field-effect transistor (MOSFET) is used in the Cuk converter for PFC and voltage control, whereas insulated-gate bipolar transistors (IGBTs) are used in the VSI for its low frequency operation. The BLDC motor is commutated electronically to operate the IGBTs of VSI in fundamental frequency switching mode to reduce its switching losses.

In Fig 1, existing system DC supply is given to interleaved converter and output of interleaved converter is fed as an input to voltage doubler which is used to improve the voltage gain. The secondary windings of two coupled inductors are connected in series for a voltage multiplier module, which is stacked on the output of the modified converter to get higher voltage gain.
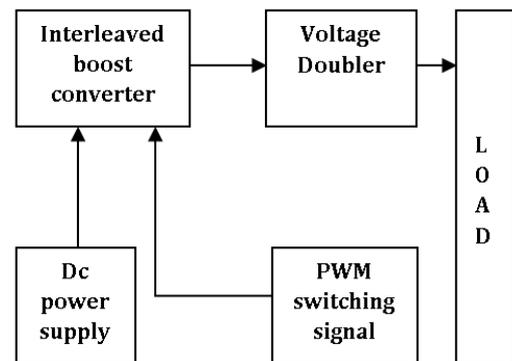
Figure 1. Block Diagram of Existing System

In existing system SEPIC converter is used as a power factor correction circuit. Ac supply is converted into DC supply by using diode bridge rectifier. Output of diode rectifier is given as an input to the cuk converter. Output of cuk converter is given as an input to the inverter. Inverter converts DC supply into AC supply which drives the BLDC motor. Pulse width modulation technique is used to trigger the switches the switches used in the cuk converter and inverter circuit. The main drawback of existing system is usage of diode bridge rectifier introduces power loss in the circuit and reduces the efficiency of the system.

Proposed System
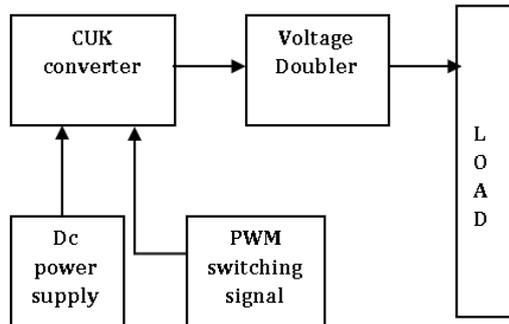
Figure 2: Block Diagram of Proposed System.

In fig 2 , proposed system cuk converter is used instead of interleaved boost converter to improve the voltage gain. The main advantage of using cuk converter is less switching stress compare to interleaved boost converter and system complexity is less. Output of cuk converter is given to voltage multiplier module to increase the voltage gain and output of voltage multiplier module is given to load. sinusoidal pulse width modulation technique is used to generate the gate pulse for switches in the cuk converter.

A. Pulse Width Modulation

The method of Pulse Width Modulation (PWM) has established broad acceptance for controlling electronic switching power inverters. PWM control signals were initially generated with the assist of electronic hardware, although recently microcontrollers have begun to play an vital role in the design and control of signal generators for power inverters, regularly assuming additional functions. In previous systems, a microcomputer was used to generate the orientation signal, whilst the timing signal and the actual PWM signals were produced by electronic hardware. Afterward, systems were improved with a microcomputer, used to compute switching points for PWM patterns with preferred harmonic removal and to recover recomputed patterns from look-up tables. In a velocity control systems, with a large range of generated frequencies a microprocessor was used to generate PWM or a six-step unmodulated signal and to maintain a constant voltage/ frequency ratio. Because of computation speed limitations found in many of the available microcomputers previously, it was concluded that the on-line computation of switching patterns was not practical. However the latest advances in microelectronics produced new microcomputers with faster speeds so that the switching pattern can be computed on line.

The AC/DC converters consist of power electronics devices like Insulated Gate Bipolar Transistors (IGBT) or Gate Turn-Off thyristors (GTO) that are characterized by switch mode operation. The capability of forming sinusoidal currents is provided by the introduction of the sophisticated technique called Pulse-Width Modulation (PWM). This technique provides the sequences of width-modulated pulses to control power switches. Many PWM techniques have been developed according to special requirements and optimization criteria. The choice of the particular PWM technique arises from the de-sired performance of the synchronous rectifiers. Generally pulse-width modulation techniques for frequency converters may be classified as follows: Carrier-Based Sinusoidal PWM, Hysteresis-Band PWM, Space Vector PWM, Selected Harmonic Elimination PWM, Minimum Current Ripple PWM, Sinusoidal PWM with Instantaneous Current Control and Random PWM.

B. Buck converter

The buck converter is step down converter and produces a lower average output voltage than the dc input voltage. Fig 1 shows the basic configuration of buck converter. The two modes in steady state operations are
Mode 1 Operation

In this mode the switch is turned on and the diode is reversed biased, the current flows through the load. The load current for mode 1 and circuit diagram is shown below.
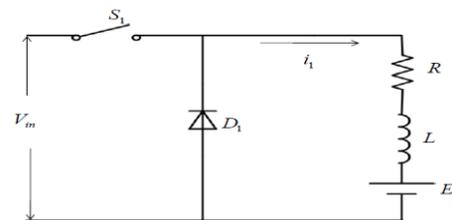

Figure 3: Basic configuration of buck converter.

III. RESULTS AND DISCUSSION
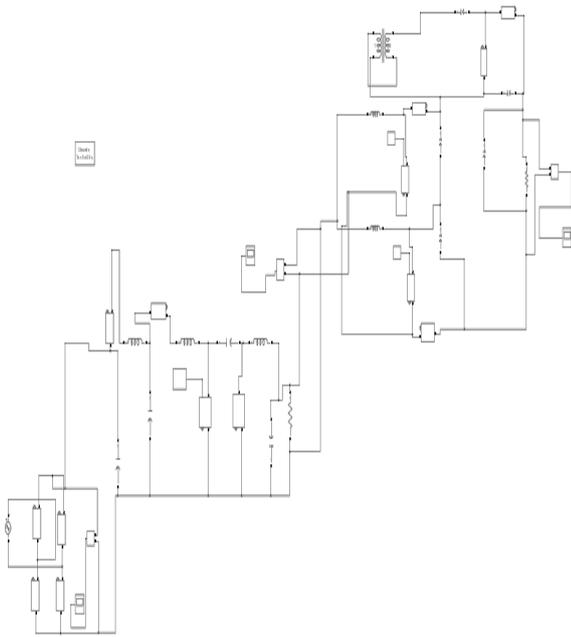
Figure 4: Simulation Model of Proposed System

Figure 4 shows the simulation model of proposed system. The fundamental principle behind the operation of BDHC is based upon the fact that the inverter bridge input must be connected to a positive voltage during the power interval only.This means that the inverter output has to be modulated when vsn ?= 0 andboost operation occurs when vab = 0. The inverter output voltage assumes three different values, and hence, the PWMmodulation strategy used is based upon unipolar sine-PWMscheme, which provides three voltage levels for output. The PWM control scheme for the BDHC is based upon the switching scheme proposed. In this scheme, shown in Fig. 4 the shoot-through is realized by gating-on both the switches of a single leg at the same time. The switching strategy involves turning on only one leg at a time in order to achieve shoot-through. Another alternative is to turn on all the switches during shoot-through. As shown in the figure, turning on all the switches for shoot-through involves more switching during each switching period with their associated losses. The reliability of the circuit also reduces since the time between two successive switching is dependent on tz which can be close to zero. This may be impractical considering minimum switching times for the devices used.
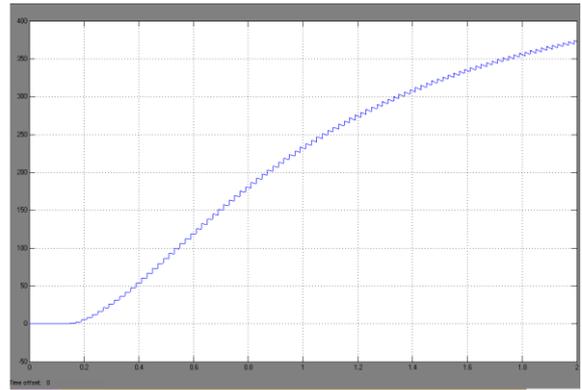
Figure 5 : Simulation Output waveform of proposed converter

Above figure shows the converter output waveform for proposed system with the 230V input AC supply.

IV. CONCLUSION

The proposed system can achieve a much higher voltage gain and avoid operating at extreme duty cycle and numerous turn ratios 2) the voltage stresses of the main switches are very low, which are one fourth of the output voltage under N = 1; 3) the input current can be automatically shared by each phase and low ripple currents are obtained at input, the current falling rates of the diodes are controlled by the leakage inductance so that the diode reverse-recovery problem is alleviated.

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