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Review of Full-Bridge DC−DC Converter by using of Flying Capacitors

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ABSTRACT: DC-DC converters are high-frequency power conversion circuits that use high-frequency switching and inductors, transformers, and capacitors to smooth out switching noise into regulated DC voltages. Closed feedback loops maintain constant voltage output even when changing input voltages and output currents. Some of the converter which used DC/DC for power applications is developed with the battery charger for photovoltaic system, vehicle charger, power supply. It consists of using a Full-Bridge DC/DC converter which is controlled by a new analog control, designed and analyzed during this work. The control has been dimensioned so that it ensures a smooth switching of the transistors, which makes it possible to reduce the losses of power, and consequently increases the efficiency of the overall system. It allows also to increase the current and to lower the voltage to the desired value; a large generated current. This paper reviews about various full-bridge DC−DC converters for home and industrial applications.

KEYWORDS: Converter, DC, Full Bridge, frequency, Transistors, Analog.

I. INTRODUCTION

DC to DC converters are used in portable electronic devices such as cellular phones and laptop computers, which are supplied with power from batteries primarily. Such electronic devices often contain several sub-circuits, each with its own voltage level requirement different from that supplied by the battery or an external supply (sometimes higher or lower than the supply voltage). Additionally, the battery voltage declines as its stored energy is drained. Switched DC to DC converters offer a method to increase voltage from a partially lowered battery voltage thereby saving space instead of using multiple batteries to accomplish the same thing.

Most DC to DC converter circuits also regulate the output voltage. Some exceptions include high-efficiency LED power sources, which are a kind of DC to DC converter that regulates the current through the LEDs, and simple charge pumps which double or triple the output voltage.

DC to DC converters which are developed to maximize the energy harvest for photovoltaic systems and for wind turbines are called power optimizers.

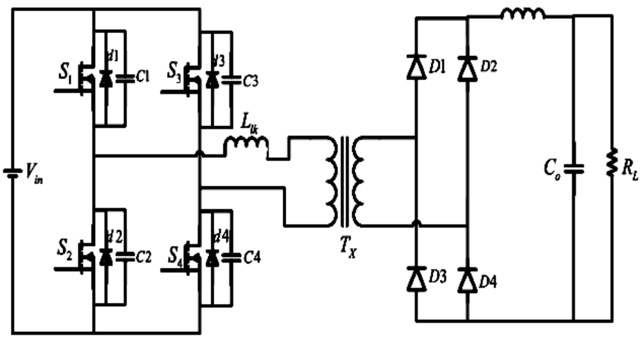

Figure 1: Full bridge DC-DC converter

Transformers used for voltage conversion at mains frequencies of 50–60 Hz must be large and heavy for powers exceeding a few watts. This makes them expensive, and they are subject to energy losses in their windings and due to eddy currents in their cores. DC-to-DC techniques that use transformers or inductors work at much higher frequencies,

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requiring only much smaller, lighter, and cheaper wound components. Consequently these techniques are used even where a mains transformer could be used; for example, for domestic electronic appliances it is preferable to rectify mains voltage to DC, use switch-mode techniques to convert it to high-frequency AC at the desired voltage, then, usually, rectify to DC. The entire complex circuit is cheaper and more efficient than a simple mains transformer circuit of the same output. DC-DC converter is widely used in the DC microgrid applications for different voltage level applications.

II. BACKGROUND

P. Liu et al.,[1] provides the detailed mode operation analysis of the TLFB converter and reveals the cause of the imbalance. In addition, the mechanism of the self-balance ability provided by the flying capacitors is explained in detail, which gives a deep insight into the converter. At last, the influence factor of the voltage error in steady state has been analyzed, and the specific expression of the voltage error is also derived. The feasibility of the theoretical analysis is verified by the simulation and experimental results.

K. Raj et al.,[2] induction motor drive scheme generating a highly dense multilevel 24-sided polygonal voltage space vector structure using a single dc source, which can eliminate harmonics till 23rd order from phase voltages, is presented. Cascaded power circuit topology with a flying capacitor inverter fed with a dc source and two low voltage floating capacitor fed H-bridge inverters is used. Detailed experimentally validated results, under scalar as well as indirect rotor field oriented control of induction motor are provided. Studies on voltage ripple and reactive energy in various floating capacitors, harmonic performance of output voltage for wide range of speed operation, are also included.

R. Chakrabarty et al.,[3] presents the performance of distribution static compensator (DSTATCOM) for load compensation in a weak distribution system. The DSTATCOM topology is realized using a single DC source based cascaded H-bridge multilevel inverter (SDCHBMLI). In SDCHBMLI, the multilevel waveform is generated by cascading the output of the transformers connected to individual full-bridge cells. The use of single DC source eliminates the requirement for capacitor voltage balancing, which is one of the limitations of diode-clamped and flying-capacitor based multilevel inverters. Also, the transformers in SDCHBMLI provide inbuilt isolation between the DSTATCOM and the distribution system. In a weak distribution system, feeder impedances make the voltages at point of common coupling (PCC) susceptible to distortions.

A. K. Anand et al.,[4] describes a real time simulator of non-grid-connected wind energy conversion system suitable for controller design and test. Also digital components are gaining higher and higher performance while their cost is constantly decreasing. The various control strategies of current source converter and its topologies has also been studied. With the fast development of wind power technology, the need for rapid prototyping and testing of wind power apparatus is also increasing. The traditional way of testing, integration and validation of complex controlled consists on systematic analysis of the behavior of individual components, mostly by simulation, before complete integration on real apparatus. A more advanced testing/integration approach is needed to diminish the probability of damage, personal injuries and time to market.

B. Lin et al.,[5] presents a soft-switching converter for direct current microgrid applications. The studied converter includes n cells of the hybrid full-bridge converter with primary-series-secondary-parallel connection for high-voltage input and large current output applications. Thus, the voltage stress of power switches and the current stress of rectifier diodes are decreased. Therefore, the low-voltage stress and low conduction resistance of power metal-oxide-semiconductor field-effect transistors are utilised in the studied converter to reduce conduction losses on power switches.

Z. Guo et al.,[6] proposes a three-level bidirectional dc-dc converter with an auxiliary inductor for full-operation zero-voltage switching (ZVS) in high-output voltage applications. The auxiliary inductor is connected across the middle node of the split flying capacitors and the center tap of the secondary winding in the transformer. In this topology, the outer and inner switches in the three-level stage can generate two independent 50% duty-cycle square waveforms, which are used to control the current in the auxiliary inductor to extend the ZVS from no loads to full loads. Considering the phase-shift angle in three-level stage, the ZVS range of the converter is analyzed, and the modulation trajectory to maintain the full-operation ZVS range with low condition loss is proposed. A flowchart implementation can guarantee the seamless transfer in different working modes.

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P. Liu et al.,[7] In high-voltage output applications, the rectifier diodes in the conventional full-bridge converter have to bear the whole secondary voltage of a transformer. In this paper, a three-level rectifier structure with flying capacitors is proposed for the dc-dc converter. Compared with the conventional dc-dc converter, the converter with the proposed rectifier structure has the following advantages: low-voltage diodes could be used for high-voltage output applications; due to the secondary flying capacitors, there are no voltage spikes on the rectifier diodes even if no snubber circuits are attached; not only can the leading switches realize zero voltage switching (ZVS) as the same as the conventional converters, but also the lagging switches can realize zero current switching in discontinuous-conduction mode and ZVS in continuous-conduction mode.

S. Kennedy et al.,[8] presents a novel fully integrated step-up dc/dc converter containing circuits to improve electromagnetic emissions. This design utilizes current sources to limit the impulsive current flow into the integrated flying capacitors. This reduces the discontinuous pulse currents normally associated with capacitive converters causing electromagnetic interference (EMI). A variable reference current enables the converter to operate with the lowest possible emissions through the entire operating range and is used to regulate the output voltage. The inclusion of low EMI techniques enables fully integrated power converters to be implemented in systems where noise produced by converters currently restricts or prohibits their use. The proposed 3.2 mW voltage doubler was fabricated in a 0.18 µm CMOS process.

W. Hang, et al.,[9] A novel five-level (5L) full-scale converter is proposed for large direct-drive wind turbines. In this scheme, a 5L-Vienna rectifier is used as a robust generator-side converter and a 5L neutral-point-clamped inverter as a grid-side converter, a flying-capacitor auxiliary bridge leg is proposed to maintain the voltage balance of the dc capacitors. This study first discusses the neutral-point balancing method based on the flying-capacitor auxiliary bridge leg and modulation. Furthermore, it presents the control strategies for the proposed 5L converter. Finally, simulation and small-scale experiments are carried out to verify the analysis.

J. B. Banu et al.,[10] A phase shift PWM topology with an active fly back snubber in the primary side and passive auxiliary circuit on the secondary side of the isolation transformer is presented in this paper. The use of a flyback snubber suppress the voltage oscillations produced due to current mismatch between the input current-fed inductor and primary side leakage inductance of the isolation transformer. Thus, minimize the current entering through the power switches at the input side. The passive auxiliary circuit consists of passive components to reduce the conduction losses. The proposed topology obtains soft switching over a wide load range with maximum conversion ratio. The principle of operation of the proposed topology features is first described, and then converter analysis and simulation results of the proposed technique are presented.

III. CONVERTER

Switched-mode DC-to-DC converters convert one DC voltage level to another, which may be higher or lower, by storing the input energy temporarily and then releasing that energy to the output at a different voltage. The storage may be in either magnetic field storage components (inductors, transformers) or electric field storage components (capacitors). This conversion method can increase or decrease voltage. Switching conversion is often more power-efficient (typical efficiency is 75% to 98%) than linear voltage regulation, which dissipates unwanted power as heat. Fast semiconductor device rise and fall times are required for efficiency; however, these fast transitions combine with layout parasitic effects to make circuit design challenging.[5] The higher efficiency of a switched-mode converter reduces the heat sinking needed, and increases battery endurance of portable equipment. Efficiency has improved since the late 1980s due to the use of power FETs, which are able to switch more efficiently with lower switching losses at higher frequencies than power bipolar transistors, and use less complex drive circuitry. Another important improvement in DC-DC converters is replacing the flywheel diode by synchronous rectification [6] using a power FET, whose "on resistance" is much lower, reducing switching losses. Before the wide availability of power semiconductors, low-power DC-to-DC synchronous converters consisted of an electro-mechanical vibrator followed by a voltage step-up transformer feeding a vacuum tube or semiconductor rectifier, or synchronous rectifier contacts on the vibrator.

Most DC-to-DC converters are designed to move power in only one direction, from dedicated input to output. However, all switching regulator topologies can be made bidirectional and able to move power in either direction by replacing all diodes with independently controlled active rectification. A bidirectional converter is useful, for example, in applications requiring regenerative braking of vehicles, where power is supplied to the wheels while driving, but supplied by the wheels when braking.

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Although they require few components, switching converters are electronically complex. Like all high-frequency circuits, their components must be carefully specified and physically arranged to achieve stable operation and to keep switching noise (EMI / RFI) at acceptable levels.[7] Their cost is higher than linear regulators in voltage-dropping applications, but their cost has been decreasing with advances in chip design.

DC-to-DC converters are available as integrated circuits (ICs) requiring few additional components. Converters are also available as complete hybrid circuit modules, ready for use within an electronic assembly.

Linear regulators which are used to output a stable DC independent of input voltage and output load from a higher but less stable input by dissipating excess volt-amperes as heat, could be described literally as DC-to-DC converters, but this is not usual usage. (The same could be said of a simple voltage dropper resistor, whether or not stabilised by a following voltage regulator or Zener diode.)

There are also simple capacitive voltage doubler and Dickson multiplier circuits using diodes and capacitors to multiply a DC voltage by an integer value, typically delivering only a small current.

IV. BENEFITS AND CHALLENGES

Following are the benefits of DC-DC converter:

- It provides technique to extend potential from partly reduced cell potential.
- It is available as whole hybrid circuit element and requires very few additional components.
- DC to DC choppers are used to regulate the voltage.
- It is constructed to make best usage of the energy yield for photo-voltaic systems.
- Isolated DC-DC converter has more energy transformer on condition of the barrier.
- The output of isolated converter is organized as positive or negative.

Following are the drawbacks or challenges of DC-DC converter:

- Switching converters are prone to noise.
- They are expensive.
- Choppers are inadequate due to unsteady voltage and current supply.
- Disadvantages of fly-back type: More EMI due to gap, more ripple current, more input/output capacitance, higher losses etc.

V. CONCLUSION

A DC-DC converter is electronic circuit. The main function of this circuit is to modify one potential difference(i.e. voltage) level to the another potential difference level. It is basically a voltage regulator consisting of switches, inductor and capacitor for power conversion. There are numerous applications of DC-DC converter. It's major application is steady switch mode dc power supply. Therefore the main reasons for its wide spread use in electronic circuits is to simplify power supply systems, to isolate primary circuit and secondary circuit, to match the loads to the power supply. In future we designed a DC-DC converter efficient model for various applications.

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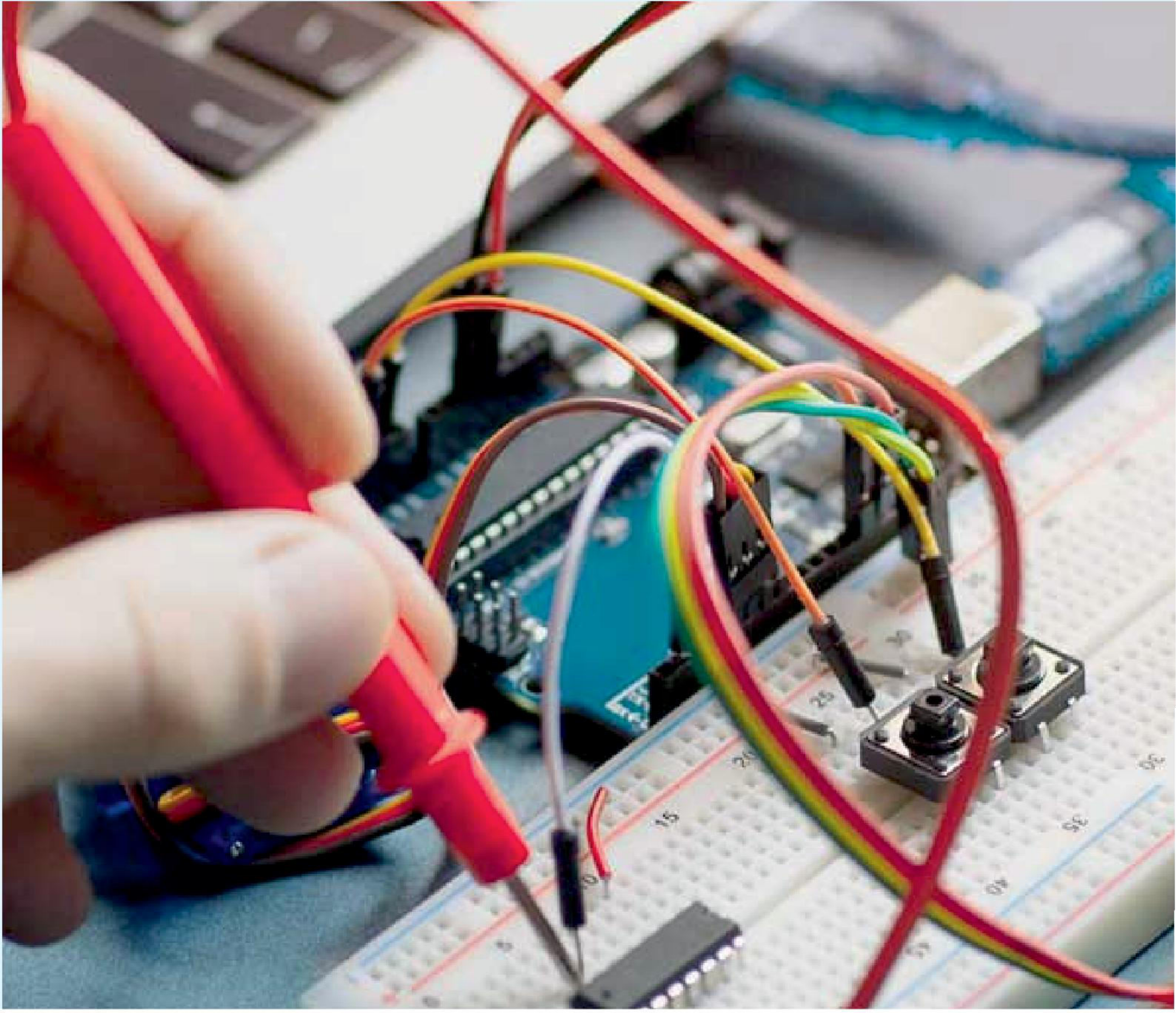

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