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An Advanced Two-Way DC–DC Converter

Punit Kumar Chandra[1], Tikeshwar Gajpal[2]

Raipur Institute of Technology Raipur, India [1]

Raipur Institute of Technology Raipur, India [2]

ABSTRACT: In recent years, global concerns regarding future fossil fuel shortages have spurred efforts to reduce the reliance on oil, coal, and gas to generate electricity. Consequently, electricity is increasingly generated from solar, wind, or tidal energy sources. These sources are renewable in nature, but highly variable, leading to the possibility of significant dynamic mismatches between electricity supply and demand levels.The dual active bridge (DAB) converter in has been given considerable interest in recent years for its favourable characteristics, including zero-voltage switching (ZVS) of all devices, near-minimum voltage and current stresses, and integrated transformer turns ratio. This paper, therefore, proposes a novel DAB topology, which utilizes a resonant network to minimize the reactive power requirement of the converter over the entire load range. The proposed converter employs a tuned inductor–capacitor–inductor (LCL) network, which includes the leakage inductance of the isolation transformer, to significantly reduce the magnitude of bridge currents and therefore to switch and copper losses.

KEYWORDS: Converter, Dual Active Bridge (DAB), Converter, DC-DC converter.

I. INTRODUCTION

Power Electronics is the art of converting electrical energy from one form to another in an efficient, clean, compact, and robust manner for convenient utilisation. A passenger lift in a modern building equipped with a Variable-Voltage-Variable-Speed induction-machine drive offers a comfortable ride and stops exactly at the floor level. Behind the scene it consumes less power with reduced stresses on the motor and corruption of the utility mains. Power Electronics involves the study of power semiconductor devices including their physics, characteristics, drive requirements and their protection for optimum utilisation of their capacities ,power converter topologies involving them, control strategies of the converters, digital, analogue and microelectronics involved, capacitive and magnetic energy storage elements, rotating and static electrical devices, quality of waveforms generated, electro Magnetic and Radio Frequency Interference.

Power electronic converters modify the form of electrical energy (voltage, current or frequency).Power ranges from some milli watts (mobile phone) to hundreds of megawatts (HVDC transmission system). With "classical" electronics, electrical currents and voltage are used to carry information, whereas with power electronics, they carry power. Thus, the main metric of power electronics becomes the efficiency. The first very high power electronic devices were mercury arc valves. In modern systems the conversion is performed with semiconductor switching devices such as diodes, thyristor and transistors. In contrast to electronic systems concerned with transmission and processing of signals and data, in power electronics substantial amounts of electrical energy are processed. An AC/DC converter (rectifier) is the most typical power electronics device found in many consumer electronic devices, e.g., television sets, personal computers, battery chargers, etc. The power range is typically from tens of watts to several hundred watts. In industry the most common application is the variable speed drive that is used to control an induction motor. The power range of VSDs starts from a few hundred watts and end at tens of megawatts.

The power conversion systems can be classified according to the type of the input and output power

- AC to DC (rectification)
- DC to AC (inversion)
- DC to DC (chopping)
- AC to AC (transformation)

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A. The working principle

The instantaneous dissipated power of a device P = V.I. Thus, losses of a power device are at a minimum when the voltage across it is zero (the device is in the On-State) or when no current flows through it (Off-State). Therefore, a power electronic converter is built around one (or more) device operating in switching mode (either on or off).

B.Applications

Power electronic systems are found in virtually every electronic device. For example:

- DC/DC converters are used in most mobile devices (mobile phones, PDA etc.) to maintain the voltage at a fixed value whatever the voltage level of the battery is. These converters are also used for electronic isolation and power factor correction.
- AC/DC converters (rectifiers) are used every time an electronic device is connected to the mains (computer, television etc.). These may simply change AC to DC or can also change the voltage level as part of their operation.
- AC/AC converters are used to change either the voltage level or the frequency (international power adapters, light dimmer). In power distribution networks AC/AC converters may be used to exchange power between utility frequency50 Hz and 60 Hz power grids.
- DC/AC converters (inverters) are used primarily in UPS or emergency lighting systems. When mains power is available, it will charge the DC battery. If the mains fails, an inverter will be used to produce AC electricity at mains voltage from the DC battery.

II.BACKGROUND AND RELATED WORK

In vehicle-to-grid (V2G) systems [1], electric vehicles interact with the grid as distributed energy storage systems that offer many potential benefits. As an energy interface between a vehicle and the grid, the bidirectional converter plays a crucial role in their interaction. Its reliability, safety, cost, efficiency, weight, size, harmonics, and other factors are of essential importance for V2G realization, especially for on-board operations. Beyond the common existing topologies for bidirectional chargers, this paper introduces a novel high-power-factor bidirectional single-stage full-bridge (BSS-FBC) topology, which offers advantages in power density, size, weight, cost, efficiency, power quality, dynamic characteristic, reliability, and complexity. According to [2] power conversion is one of the major requirement in various industries and in daily life. Among various types of power conversion, DC- DC conversion has greater importance. DC - DC conversion can be reliably performed using luo converter. It employs voltage lift technique so that output voltage is increased stage by stage, in arithmetic progression. Luo converter can be incorporated with the z network or impedance network so as to ensure simple start up and smooth power conversion. In [3] A new dual active-clamping dc-dc converter is proposed to obtain high efficiency. The proposed converter employs a dual active-clamping technique, while a resonant voltage doubler rectifier scheme controls the output voltage with the pulse width modulation technique. The dual active-clamping circuit serves to recycle the energy stored in the leakage inductor or the magnetizing inductor and provides zero-current turn-off switching. The voltage stresses of the main switches are clamped. The voltage transient spikes across the dual active-clamping circuit and the current stress of the current-fed side switches are limited by auxiliary dual active-clamping circuits on both sides, and zero-current switching is achieved. Also, to reduce the output voltage variation, a modified PI controller is suggested. The method in [4] proposes an improved Transformer less high step-up dc-dc converter using stacked Cockcroft Walton voltage multiplier. The multiplying of voltage is done using stacked cascaded voltage multiplier; the low DC voltage has been multiplied to obtain high DC voltage. The Stacked cascaded voltage multiplier is a 3 stage voltage multiplier which is designed and implemented based upon the Cockcroft Walton voltage multiplier. Two independent frequencies are used for the control strategy, one high frequency is used to minimize the size of the inductor and one low frequency is used according to the desired output voltage. The high voltage is obtained from a very low DC voltage. The obtained output is given to a DC motor. The voltage ripples produced during the motor operation is reduced in this proposed method. A new technique called PWM converter in [5] is proposed enabling the use of high- value snubber capacitors with the lagging leg of the PSFB As advantages of the proposed technique, high-capacitive discharge current through IGBT is prevented at light loads, the turn-off switching losses of the IGBTs are decreased, and the performance of the converter is improved at high currents. The proposed PSFB PWM converter includes an auxiliary circuit, and it has a simple structure, low cost, and ease of control as well.

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III.PROBLEM IDENTIFICATION

The dual active bridge (DAB) converter in below given figure has been given considerable interest in recent years for its favourable characteristics, including zero-voltage switching (ZVS) of all devices, near-minimum voltage and current stresses, and integrated transformer turns ratio. The major drawbacks in current methodology include:

- The currents flowing in dc buses contain high ripple content; therefore appropriate filtering circuits are necessary.
- Proper control is required to prevent dc saturation on both sides as there is no inherent dc current blocking capability for transformer windings.
- Similar to many other topologies, the converter may lose soft switching in light load conditions.
- Another disadvantage is relatively high component count that leads to larger driver size, higher gate losses and increased cost compared to low switch count topologies

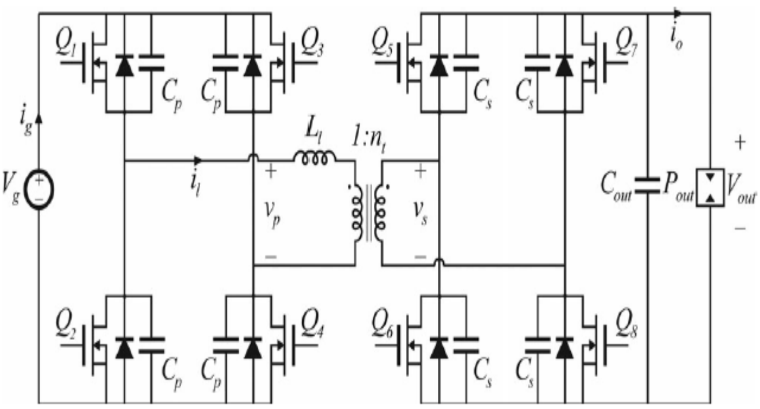

Fig 1: DAB converter

IV.RESULTS AND DISCUSSION

This paper presents a new resonant dual active bridge (DAB) topology, which uses a tuned inductor–capacitor–inductor (LCL) network. In comparison to conventional DAB topologies, the proposed topology significantly reduces the bridge currents, lowering both conduction and switching losses and the VA rating associated with the bridges. The performance of the DAB is investigated using a mathematical model under various operating conditions. This paper, therefore, proposes a novel DAB topology, which utilizes a resonant network to minimize the reactive power requirement of the converter over the entire load range. The proposed converter employs a tuned inductor–capacitor–inductor (LCL) network, which includes the leakage inductance of the isolation transformer, to significantly reduce the magnitude of bridge currents and therefore to switch and copper losses.

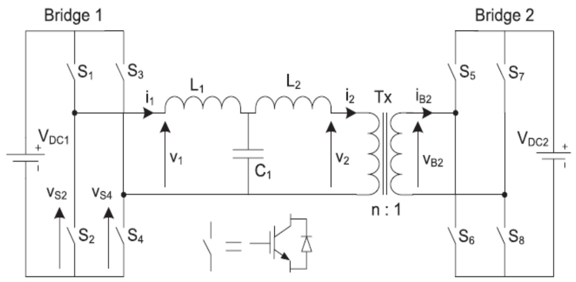

Fig 2: Resonant dual active bridge (DAB) topology

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The advantages of the proposed technique include:

- Low bridge currents.
- Both conduction and switching losses are reduced.
- Reactive power requirement is minimized.
- High efficiency can be achieved.
- Low eddy current losses in the transformer winding.

The major application areas of new technique are:-

- Renewable energy systems,
- Fuel cell energy systems,
- Hybrid electric vehicles(HEV) and
- Uninterruptible power supplies (UPS).

V.CONCLUSION

An improved two way DC-DC converter that can provide high output has been successfully created. The current approach proposes a new resonant dual active bridge (DAB) topology, which uses a tuned inductor–capacitor–inductor (LCL) network. In comparison to conventional DAB topologies, the proposed topology significantly reduces the bridge currents, lowering both conduction and switching losses and the VA rating associated with the bridges. The performance is investigated under various operating conditions. The proposed approach has various applications like renewable energy systems, fuel cell energy systems, hybrid electric vehicles (HEV) and Uninterruptible power supplies (UPS).

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