A REVIEW ON Hybrid-type Full-bridge DC/DC Converter with High Efficiency

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Abstract - This thesis presents a hybrid-type full-bridge dc/dc converter with high efficiency. Using a hybrid control techniques with a simple circuit structure, the proposed dc/dc converter has a hybrid operation mode. Under a normal input limit, the proposed converter operate as a phase-shift full-bridge series resonant converter that provide high efficiency by applying soft switching on all switches and rectifier diodes and reducing conduction lose. When the input is lower than the normal input limit, the converter operates as an active-clamp step-up converter that enhances an operation range. Due to the hybrid operation, the proposed converter operates with larger phase shift value than the conventional converter under the normal input range. So due to this, the proposed converter is capable of being designed to give high power conversion efficiency and its operation range is extended. A 1kw prototype is implemented to confirm the theoretical analysis and validity of the proposed converter.

***Key Words*:** Full-bridge circuit, phase-shift control, active clamp circuit.

1. INTRODUCTION

Nowadays, demands on dc/dc converters with a high power density, high efficiency, and low electromagnetic interference (EMI) have been increased in various industrial fields. As the switching frequency increase to obtain the high power density, switching loses related to the turn-on and turn-off of the switching devices increase. Because these losses limit the increase of the switching frequency, soft switching techniques are indispensable.

Among previous dc to dc converter, a phase-shift full-bridge (PSFB) converter is attractive because all the primary switches were turned on with zero-voltage switching (ZVS) without additional auxiliary circuit. The PSFB converters has some serious problems such as narrow ZVS range of lagging-leg switches, high power losses by the circulation of current, and voltage ringing across rectifier diodes. With the requirement of wide input range, the PSFB converter is designed to operate with small phase-shift value under the normal input range; the design of the PSFB converter lengthens the freewheeling interval and causes the excessive circulating current which increases conduction lose.

In the present time, the various PSFB converters using auxiliary circuits have been introduced. The PSFB converter extends ZVS range or reduces the circulating current by utilizing additional passive or active auxiliary circuits. The additional circuit results in the form of complicated circuit configuration, complex control strategy, and extra power losse. In the addition, of some PSFB converters still require the extra snobbier to prevent serious voltage ringing problem across rectifier diodes. In the PSFB converters employing a series resonant converter have been introduced, namely, the PSFB series-resonant converters; they have many advantages such as the soft switching technique of all the primary switches and rectifier diodes, elimination of circulating current, reduction of voltage stress on rectifier diodes, and a simple circuit view.

When all the PSFB converters are required to guarantee a wide operation range, they still operate with the small phase-shift value under the normal input range. The operation with the small phase-shift values of the circuit generally gives high conduction losses by high peak current; it results in low power efficiency.

To achieve high efficiency in the normal input range and cover the wide input range, the different techniques are suggested. The converters in change the turn ratio of the transformer by using additional switching devices. Although the approach achieves high efficiency and ensures the wide input range, these techniques give circuit complexity and reduction of the transformer utilization.

Active-clamp circuit has been specificaly used to absorb surge energy stored in leakage inductance of a transformer. the circuits provide a soft switching technique. Some studies have introduced dc to dc converters combining the active-clamp circuit and voltage doubler or multiplier rectifier. The circuit configuration allows achieving a step-up function like a boost converter. The voltage stresses of rectifier diodes are also clamped at the output voltage and no extra snubber circuit is required.

2. Literature Review

Among previous dc/dc converters, a phase-shift full-bridge (PSFB) converter is attractive because all primary switches are turned on with zero-voltage switching (ZVS) without additional auxiliary circuits [1]. However, the PSFB converter has some serious problems such as narrow ZVS range of lagging-leg switches, high power losses by circulating current, and voltage ringing across rectifier diodes. Especially, with a requirement of wide input range, the PSFB converter is designed to operate with small phase-shift value under the normal input range; the design of the PSFB converter lengthens the freewheeling interval and causes the excessive circulating current which increases conduction losses [2], [3]. Recently, the various PSFB converters using auxiliary circuits have been introduced [4]-[12]. The PSFB converters extend

ZVS range or reduce the circulating current by utilizing additional passive or active auxiliary circuits. However, the additional circuits result in complicated circuit configuration, complex control strategy, and extra power losses [13]. In addition, some PSFB converters still require the extra snubber to prevent serious voltage ringing problem across rectifier diodes. In [14], [15], the PSFB converters employing a series resonant converter have been introduced, namely, the PSFB series-resonant converters; they have many advantages such as soft switching techniques of all primary switches and rectifier diodes, elimination of circulating current, reduction of voltage stress on rectifier diodes, and a simple circuit structure. However, when all aforementioned PSFB converters are required to guarantee a wide operation range, they still operate with the small phase-shift value under the normal input range. The operation with the small phase-shift value generally gives high conduction losses by high peak current; it results in low power efficiency. To achieve high efficiency under the normal input range and cover the wide input range, the different techniques are suggested. The converters in [16], [17] change the turn ratio of the transformer by using additional switching devices. Although the approach achieves high efficiency and ensures the wide input range, these techniques give circuit complexity and reduction of the transformer utilization. Active-clamp circuits have been commonly used to absorb surge energy stored in leakage inductance of a transformer. Moreover, the circuits provide a soft switching technique [18], [19]. Some studies have introduced dc/dc converters combining the active-clamp circuit and voltage doubler or multiplier rectifier [20], [21]. The circuit configuration allows achieving a step-up function like a boost converter. The voltage stresses of rectifier diodes are also clamped at the output voltage and no extra snubber circuit is required.

3. PROPOSED SYSTEM

Power electronics is the application of the solid-state electronics for the control and conversion of electric power. It also refer to the subject of research in electronic and electrical engineering which deals with design, control, computation and integration of nonlinear, time varying energy processing electronic systems with fast dynamic.
The first high power electronic device were mercury-arc valve. In modern system the conversion is performed with the semiconductor switching devices such as diodes, thyristors and transistors, pioneered by R. D. Middlebrooks and the other beginning in the 1950s. In contrast to the electronic systems concerned with transmission and processing of signals and data, in power electronics substantial amounts of electrical energy are process. An AC to DC converter (rectifier) is the most typical power electronics device found in many consumer electronic devices, e.g. the television sets, personal computers, battery chargers, etc. The power limit is typically from tens of watts to several hundred watts. In the industry a common application is the variable speed drive (VSD) that is used to control an induction motor. The power limits of the 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 (rectifier)
- DC to AC (inverter)
- DC to DC (DC-to-DC converter)
- AC to AC (AC-to-AC converter)

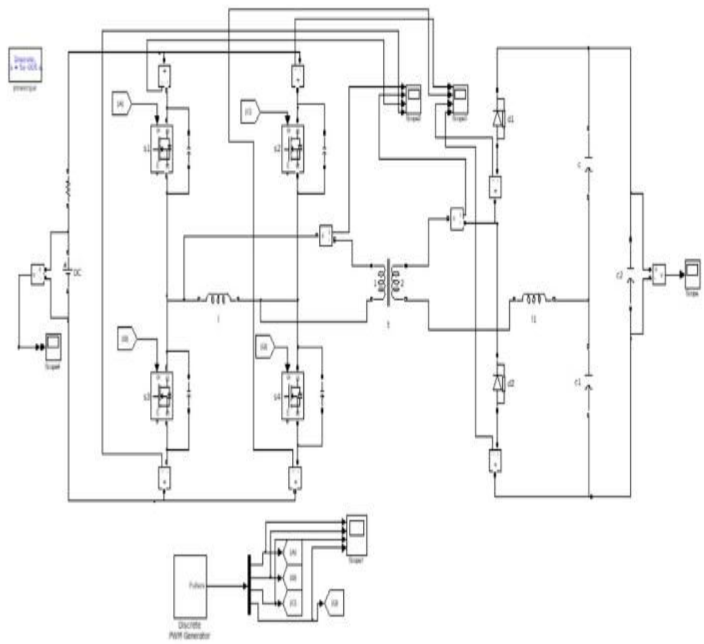

Fig -1: Circuit of the System

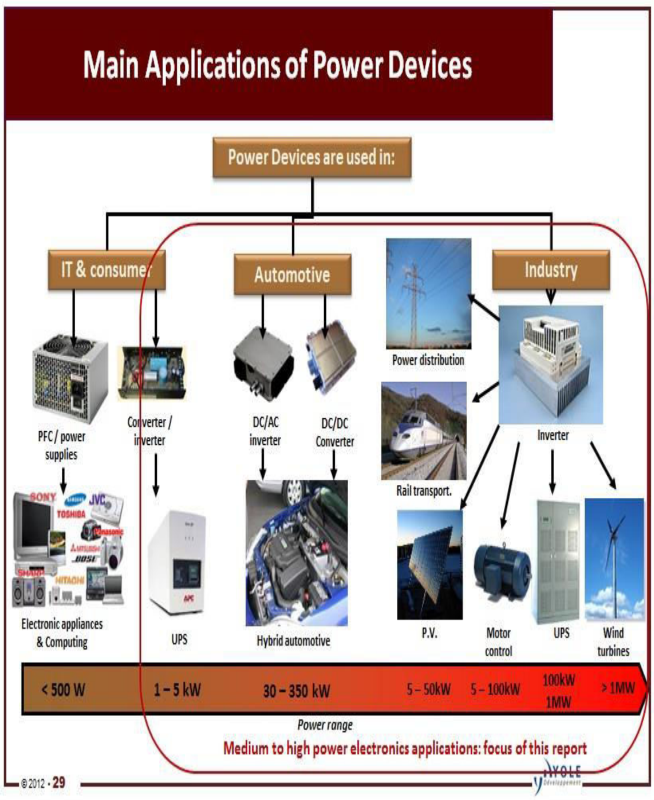

Fig -2: Main Applications of Power Device

4. CONCLUSION

The novel hybrid-type full-bridge dc to dc converter with the high efficiency has been introduced and verified by the analysis and experimental result. By using the hybrid control scheme with the simple circuit structure, the proposed converter has both the step-down and the step-up function, from which ensure the cover of wide input limit. Under the normal input limit, the proposed converter achieve high efficiency by providing the soft switching technique to all the switches and rectifier diode, and reducing the current stress. When the input is lower than the normal input limit, the proposed converter provide the step-up function by using the active-clamp circuit and the voltage doubler, which extends the operation limit. To confirm the validity of the proposed converter, 1 kW prototype was built and tested. Under the normal input limit, the conversion efficiency is over 96% at full-load condition, and the input range from 250 to 350 V is guaranteed. Thus, the proposed converter has many advantages such as high efficiency and wide input limit.

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