

SIMULATING ACTIVE AND PASSIVE SNUBBERS IN A SOFT-SWITCHING BIDIRECTIONAL ISOLATED HALF-BRIDGE CONVERTER

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ABSTRACT: A bidirectional isolated half-bridge dc-dc converter is compared to a whole bridge dc-dc converter in this study. It has a ninefold gentle start-up ratio and soft-switching qualities for charging and discharging batteries. Two passive capacitor-diode snubbers and an active flyback are included in the Half Bridge DC-DC converter. This can provide near-zero-voltage and zero-current soft-switching properties, as well as lower voltage, switching losses, and current stresses. This paper first outlines the suggested converter's operational principle before giving its analysis and design. MATLAB/Simulink can be used to implement the recommended bidirectional isolated dc-dc converter with active and passive snubbers.

Keywords: Bidirectional Half Bridge DC-DC Converter, Zero Current Switching, Zero-Voltage Switching.

1. INTRODUCTION

Batteries often power devices in renewable DC-supply systems. Their voltages are usually much lower than the DC bus. Therefore, bidirectional adapters are needed to charge and discharge batteries. Over the past decade, bridge-type bidirectional converters for highpower applications have garnered attention. Power levels are often increased with a dual full-bridge design. Its low and high sides usually have boost and buck topologies. These efforts aim to decrease switching loss, voltage and current stressors, and circulation currentinduced conduction loss. The isolation transformer's leakage inductance creates a higher voltage surge when switching, which is worse. The leakage inductance allows the current to run freely, increasing conduction loss and decreasing duty cycle. Another alternative is to precharge the defective inductance to match the current-fed inductance. This reduces the voltage surge by minimizing their current differences. However, the resistor melted, decreasing efficiency. A passive RCD snubber was replaced by a buck converter, but intricate tightening circuits remain.A simple active

holding circuit may work for two-way converters. However, its resonance current strains switches more. This design allows softstarting but not step-down operation. This study recycles restricting capacitor energy with a flyback snubber. The flyback snubber capacitor controls constrained voltage independently. This means it can sustain a voltage only slightly higher than the low-side transformer winding. When the system is under tremendous stress, full-bridge switches reduce current strains because current does not pass through them. This dramatically boosts system reliability. The flyback snubber can also precharge the high-side capacitor at starting, making it more practical.



Fig.1. A bidirectional full-bridge dc–dc

converter with an active clamp snubber.

Passive and active clamp circuits were suggested to reduce the voltage surge induced by the current-fed inductor and leakage inductance current differential. Resistor, capacitor, and diode snubbers are used to passively clamp voltage. The buffer capacitor's energy is lost to the resistor, reducing efficiency. The second idea was a basic active clipping circuit (Fig. 1). Harmonic current through primary switches will dramatically increase current stress. In Fig. 2, a discrete twoway converter with a flyback snubber was proposed. As long as the primary switch is not current-driven, the flyback snubber can reuse its energy in the clamping capacitor CC. The voltage can also be kept just above the low side coils. When loads are high, snubber current does not go through the main switches, reducing current stress. The flyback snubber can precharge the high-side capacitor to eliminate start-up surge current. High-voltage spikes come from the low- and high-side switches being off.



Fig.2. Full-bridge dc–dc converter with bidirectional flyback snubber.



Fig.3. A bidirectional full-bridge dc–dc converter with type B paralleled snubber capacitors Cb1 and Cb2 and a flyback snubber.



Fig.4. A two-way, isolated soft-switching fullbridge converter featuring an active flyback and two passive capacitor–diode snubbers.

Fig. 3 shows how to address the problem by adding two parallel buffer capacitors (Cb1 and Cb2) to the voltage-fed bridge's top legs. Due to these two buffer capacitors, the low and high side switches can work with practically zerovoltage and zero-current switching. EMI noise and switching loss will grow when these capacitors react with the transformer's leakage inductance during step-down conversion. Figure 4 suggests using two inactive capacitordiode snubbers with the active flyback snubber. The suggested snubber configuration can reduce the voltage spike caused by the leakage inductance not matching the current-fed inductor currents and help the main switches handle high current and voltage stresses when turning on and off. Both transformer sides include switches that can reach the ZVS and ZCS terminals.

PROPOSED SYSTEM CONFIGURATION Figure 4 shows a soft-switching bidirectional isolated fullbridge converter with an active flyback and two passive capacitor-diode snubbers. It supports step-up and step-down conversions. A voltage-fed switch bridge, active flyback snubber, and passive pair are shown in Figure 4. Low-voltage side has a current-fed switch bridge. When power steps down from high to low voltage, inductor Lm filters the output. However, step-up translation is correct. In addition, a snubber capacitor (CC) and diode (DC) absorb the current difference between the inductor (iL) and the isolation transformer (TP) current drop. This happens with alternating commutation. When triggered, the flyback snubber transfers energy from CC to Cb1 and Cb2. The voltage VC drops to zero. Thus, switches M1 and M4 can have low voltage demands, leading in a ZCS-close



Fig. 5. Proposed soft-switching bidirectional isolated half-bridge converter with an active flyback and two passive capacitor-diode snubbers.

The recommended snubber prevents spike currents and allows soft switching, its best qualities. Charge migration, high current density, and magnetic force can occur from large surge currents. These factors reduce MOSFET carrier density, channel width, and wire bonding, increasing conduction resistance. A soft-switching, bidirectional, isolated halfbridge converter with an active flyback and two passive capacitor diode snubbers is used in this system. As seen in figure 5, this system has fewer switches to reduce switching losses.

PROPOSED PULSE WIDTH MODULATIONTECHNIQUE

Communication systems use pulse width modulation (PWM) to modify a signal before transmission and demodulate it during reception. Consistent thought can influence. The on/off network of switches in a powerful power converter is not linear. The intended constant wave shape is adjusted and turned into switch network-controlling digital signals. The switch network's AC connections' modulated signals are subsequently converted into a continuous voltage or current waveform by the AC filter. A power converter's control goal is usually constant voltage or current. The first PWM technique since 1964 was sinusoidal PWM (SPWM). Power electronics researchers are interested in the modulator because it affects voltage and current mistakes, switching losses, and electromagnetic interference. This topic has been extensively researched and written about. All proposed PWM designs fall categories: into four **SPWM** and its modifications, Optimal PWM, and Others. The remaining five are: Random PWM; Hysteresis and Bang-Bang modulation. All PWM approaches can be tested with a switching

frequency, reference signal frequency ratio, input-to-output voltage ratio, and modulation index M. Explanation of modulation number M $M = \frac{V_{II_pk}}{V_{II_pk}}$

(1)

Vll_pk is the line-to-line voltage maximum and Vg is the DC link voltage. Modulation technique performance can be assessed using five factors:

Variations in output voltage or current, power losses, harmonic spectrum and electromagnetic interference, motion range, and complexity. The output voltage or current should be stable whenever possible. If the curve is nonlinear, modulation number may affect its shape.

The number of cycles the switch is used in and the current flowing at the transition determine power losses. Different modulation methods may have different effects. PWM with low switching losses is best for high-power applications. Acoustic pollution and electromagnetic interference are connected to output voltage or current harmonics. Reduce EMI and sound pollution as much as feasible. What is dynamic range? It provides the most control in steady-state and changing conditions. It is also the input-to-maximum output ratio. A larger ratio is beneficial. It means a voltage source inverter may use DC link voltage more efficiently, which is important for high voltage applications. As demonstrated in Fig.6, a basic analog or digital PWM design is best.



SIMULATION RESULTS

A simulation circuit diagram of the proposed system is shown in figures 7–12. Simulation schematic waves are shown in these photographs.







Fig.8. Standard converter output voltage.







0+0

Fig.10. Proposed DC-DC isolated half-bridge converter simulation model.



Fig.11. Recommended converter output voltage.



Fig.12. Proposed converter output current. 4. CONCLUSION

This study describes a soft-switching, bidirectional, isolated half-bridge converter that can accept input voltage and charge and discharge batteries better than a full bridge converter. The suggested converter reduces voltage spikes generated by diode reverse recovery, switching losses, current and voltage stressors, and the difference in currents between the leakage inductance and the inductor's currents. Soft-switching near ZVS and ZCS is possible. Maintaining voltage Vb1 or Vb2 and improving diP/dt slew rate reduces duty losses. Step-down conversion cannot achieve a near-ZVS turn-on transition at low loads. Based on simulations of isolated bidirectional full-bridge dc-dc converters and the half bridge DC-DC converter, the suggested converter can reduce voltage and current spikes, increase efficiency, reduce ringing, and lessen switching losses. With galvanic isolation, it can handle high power. REFERENCES

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