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DESIGN AND ANALYSIS OF A SNUBBERLESS DC–DC CONVERTER INTEGRATED INVERTER TOPOLOGY

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ABSTRACT: The specified inverter does the DC-to-DC conversion in the absence of a snubber. When it comes to DC-DC converters, a snubber circuit is an industry standard for reducing voltage transients. When a standard DC-DC converter is turned off, voltage spikes are generated across all semiconductor components. In your stead. As the number of components and losses in the converter increase, its efficiency decreases. The problem can be fixed by using a converter that can handle soft-switching and secondary modulation. Therefore, a second snubber is superfluous. The zero-voltage switching (ZVS) and zero-current switching (ZCS) are employed in this configuration. In order to initiate and terminate the converter's operation, respectively, ZVS and ZCS use zero current circumstances. Our recommendation is that you use a voltage converter that has a high step-up voltage conversion ratio. A full bridge inverter and a DC-DC converter can collaborate by connecting their respective outputs. The inverter gets its juice from an AC power source. Snubberless DC/DC inverters are utilized in electric vehicles, residential solar PV systems, and energy storage systems. The MATLAB Simulink Model was used for both the development and verification of the system.

KeyWords: Snubberless dc-dc converter, Soft Switching, Zero Voltage Switching, Zero Current Switching, Secondary modulation Technique.

1. INTRODUCTION

Lizhi Zhu demonstrated this dc-dc converter in 2006. Soft-commutated two-way ZVS-PWM isolated boost full-bridge converter. The researchers used soft-commutating control to create a two-mode boost full-bridge converter like a popular soft-switching full-bridge DC/DC buck converter. The complex logic of the commutation mechanism ensures that the current-fed inductor compensates for the transformer's leaky inductance. Thus, passively regulated voltage snubbers can replace weaker active ones. The strategy and control plan maintain a reasonable mismatch with a resonant tank and voltage-fed full bridge inverter freewheeling circuit. Transformer inductance leaks provide a precise current reading. A voltage-fed inverter in boost mode may have zero voltage settings. An isolated three-kilowatt full-bridge DC/DC converter for fuel cell electric vehicles uses soft-commuting. Alexander Isurin and colleagues studied a dormant snubber circuit with soft switching and energy recovery in 2008. Reclaiming is how this circuit recovers energy. The discharge line returns 70%–80% of electricity to the power source. This snubber circuit makes leg power changes simple and straightforward. Wu and pals. The flyback snubber prevents voltage spikes induced by the current-carrying inductor's short-term variations and the isolation transformer's residual inductance. Look for a device that converts well, has a large output capacity, and starts softly. Current-driven active switches halves current. Full-bridge switches are less stressed because they don't handle high-magnitude current. This boosts system trustworthiness. Flyback snubbers can be made advance initiators. Tsai-Fu Wu, Jeng-Gung Yang, and Chia-Ling Kuo suggested a soft-switching bidirectional isolated full-bridge converter using active and passive snubbers. This layout's two-way, segregated soft-switching full-bridge converter can charge and discharge 42V to 54V batteries. The best alternating current module inverter uses a current-fed half-bridge front end with soft-switching. The converter design is innovative for photovoltaic (PV) applications. In addition to being reliable, low-cost, and efficient, it is straightforward to incorporate, galvanically separated, and requires no external power. Converters can adjust secondary voltage to protect device voltage without active clamp circuits or snubbers. This method simplifies soft-switching's benefits and implementation. Rong-Jong Wai and colleagues created an efficient, adaptable two-way converter. This research suggests that circuit designers should use transformers and soft switching methods like ZVS and ZCS to reduce switching losses. Transformer-based systems with more than four switches degrade conversion efficiency and increase production costs. This project aims to develop coupled-inductor bidirectional converter technology that regulates current flow with three power switches. DC buses are suitable for low-voltage battery cells because to their quick voltage changes. To efficiently transform power, use coordinated production, voltage control, and seamless transitions between voltage sources. This design used zero-voltage-shift pulse-width modulation (PWM) boost converters. Good news: active soft switching circuits only need one additional switch. This arrangement eliminates boost diode reverse recovery losses and lets the main switches work without the power supply. The ZCS reading of the auxiliary switch indicates converter operation. I wrote it myself. A self-contained DC-DC converter and an active-clamping PWM current-fed half-bridge converter with zero-voltage switching are explored by Gopinath et al. By eliminating voltage spikes across switches, an active-clamp device lowers choppy switching during power outages. This reduces functional clamp power by 1%. As component voltage rises, switch root mean square (rms) current increases, increasing current flow. Two more working valves, a huge high-frequency capacitor, and two snubber capacitors are needed. The conversion becomes more complicated as components are added. When the clamp and snubber circuits are off, switch voltage is constant. This makes equipment smaller and cheaper. Try cycling the secondary and body diodes without powering them to improve converter performance. Primary components must also have ZCS. Numerous motions are kept at low cost. In 2010, Wei Chen, Ping Rong, and Zhengyu Lu created a snubberless, two-way DC-DC converter with lower switching losses. The team built a bidirectional DC-DC converter using a novel CLLC resonant tank. Input inverter is ZVS, output rectifier is ZCS; BDC used. The converter's switching process will be simplified by using MOSFETs as primary switches. Because of its seamless switching, the recommended adaptor does not need snubbers. It gives broad planning ideas and specific directions. One-way dc-dc converters that use Zero Voltage Switching (ZVS) and Zero Current Switching (ZCS) solve the frequency modulation-PWM converter problem. The fuel cell car-specific snubberless, naturally clamped, bidirectional ZCS/ZVS current-fed half-bridge DC/DC converter was extensively studied by Akshay K. Rathore and colleagues in 2013 [10]. This paper shows a fuel cell vehicle DC/DC converter using a half-bridge with bidirectional current flow instead of a snubber. Because active semiconductors are integrated into both the main and secondary stages, the proposed converter may switch between ZVS and ZCS. Energy storage, fuel cell converters to convert alternating current to direct current, and fuel cell vehicle power are shown via this method. Zero current switching (ZCS) reduces voltage across connected devices to the mains and prevents voltage spikes while the switch is off without an additional circuit. The consequence is lower costs. Primary-side current-fed converters change duty cycle rather than mirroring output voltage, unlike other modern converters. Choose devices with low ON-state resistance and voltage to save energy. It reduces conduction losses. Pan Xuewei and colleagues constructed a bidirectional, current-fed, isolated, and interleaved FCV device. Also used is soft-switching. Even with huge output power changes, this ZCS current-fed full-bridge dc/dc converter maintains the semiconductor devices' ZCS and ZVS, assuring their stability. Turn-on loss been decreased for critical items. This requires soft-switching methods. Reducing switching power losses while raising converter frequency is typical. This makes better, user-friendly goods easier to make. This modulation approach uses zero-current commutation to separately adjust mains side device voltage. Thus, active clamps or idle snubber are optional in current-fed systems to prevent device shutdown voltage surges. Integrated architecture improves electricity efficiency. Downsizing may minimize voltage, current, inactive sections, heat dissipation, and incoming current ripple. In 2014, Pant Xuewei and colleagues published "Soft-switching Snubberless Naturally Clamped Current-Fed Full-Bridge Front-End Converters". The isolated DC/DC converter's full-bridge construction limits capacity and feeds current in both directions while transitioning to zero-current. Through zero-current switching, this secondary modulation method limits the voltage between primary side components. This makes passive snubber and active-clamp circuits unnecessary. Negligible switching losses come from turning off primary and secondary devices. Advantages include smooth transitions and load-independent voltage stability. The device's main side voltage is constant regardless of power input or output duty cycle. Low voltage semiconductor devices are widely used because they can operate within a restricted output voltage range. Due to its versatility, fuel cell cars, generators, and storage systems use the converter. Akshay K. Rathore and Udupi R. Prasanna developed a current-fed half-bridge front-end converter solar inverter without snubber in 2013. A current-fed half-bridge front-end with a separated dc/dc converter is the core of a revolutionary solar power inverter design. It can work with and without the power grid. The converter regulates device voltage via secondary modulation instead of an active-clamp or snubber. Primary devices can use natural commutation, whereas secondary devices need zero-voltage switching. Batteries in computers, phones, and electric cars are charged via DC/DC converters. When full, the converter should smoothly switch from no-load to full-load, charging the batteries. A conventional full-bridge DC/DC converter may not achieve zero-voltage switching when the load changes. The transformer's parasitic inductance causes output diode voltage jumps. Current-fed full-bridge DC-to-DC converters without snubber have smooth on/off switching and low voltage stress.

2. PROPOSEDSYSTEM

DC/DC Snubberless converters are energy efficient and have a high step-up conversion ratio despite their greater cost. Boost converters were originally considered the best option due to their simple circuitry and rapid voltage increase. Unmovable switches limit energy consumption. This will increase financial losses, lowering transfer success. Multiple power sources in parallel may increase current. This method fails with input and output current holes. Interleaved design increases thermal management, output power, transient reactivity, passive component size, and current stability. Power tools require mechanical switching, making them impractical. Research focuses on trouble-free semiconductor device interoperability. Innovative secondary modulation eliminates the need for snubber to adjust voltage. Zero-current and zero-voltage switching reduce switching losses significantly. The natural seamless switching ability remains regardless of load. Variations in input power or energy do not influence it. All depends on photovoltaics, or solar cells. Power is increased by boost converters and high-frequency transformers. Additionally, the boost converter separates input and output stages. High duty cycles and switch voltages stress a normal boost converter, but the suggested converter is cheaper and has a higher step-up conversion ratio.

Operationoftheproposedsystem

The primary focus of this research is the steady-state analysis and operation of the proposed high step-up DC-DC converter. Current thinking suggests the following assumptions should increase the suggested method's performance. Due to the huge boost inductor L, current remains constant. No component is like it. Series-connected inductors Llk1 and Llk2 have parasitic inductances that imitate torque. Total Llk1 and Llk2 is Llk_T. Transformer magnetizing inductance is crucial. Gating signals 180 degrees out of phase turn the primary switches S1 and S2 on and off, as demonstrated in steady-state operational waveforms. Duty cycles above 50% are ideal. More ideal waveforms for the proposed system are shown in Figure 3.

MODE 1(to<t<t1)

Its main mechanism. D3 and S2 are on opposite sides of the conducting body diodes. The system's high-frequency transformer meets demand. Secondary device S4 cannot receive the reflected output voltage VDC/n from primary device S1. Thus, every subchapter has correct iS1, iS2, iLlk1, and iD3 values. VDC/n shows S1 switch current. S4 switch VS4 and VDC are equivalent.

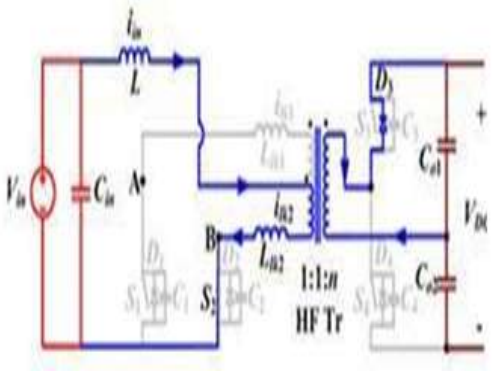

Fig-1: Mode1

MODE 2(t1<t<t2)

S1, the main switch, activates at t1. The C1 capacitor drains. Since all S1 connections are made, C1 is accessible from anywhere.

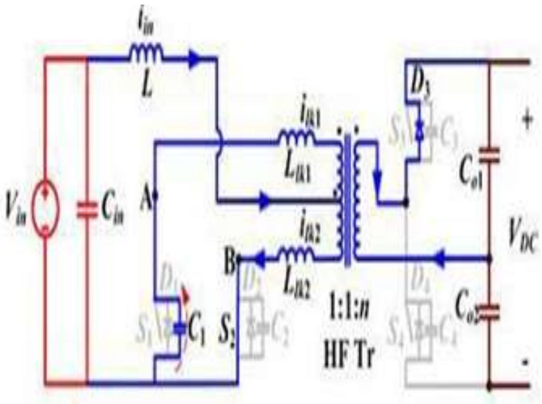

Fig-2: Mode2

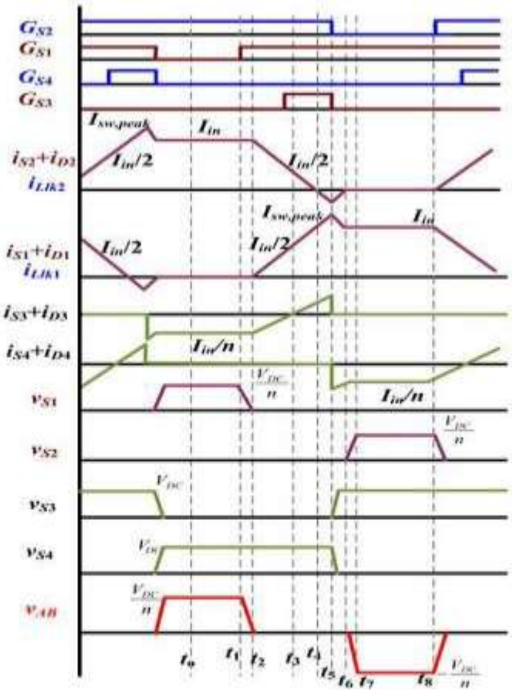

Fig-3:Waveforms of the proposed system

MODE 3(t2<t<t3)

Choose this to engage both major switches, S1 and S2. Both series inductors Llk1 and Llk2 show output voltage. A current travels between the S1 and S2 shifters. S2, previously conductive, now turns non-conductive. Switch S1 conducts no current, reducing turn-on losses. Before stopping, body diode D3 will be modified. Simply press S3 to activate ZVS. D3 will then relocate. All needed devices receive Iin/2 current. Correct equation: 0 = iLlk1 + iLlk2 + Iin/2 + iS1 + iS2 + Iin/2 + iD3. All these numbers add up to this.

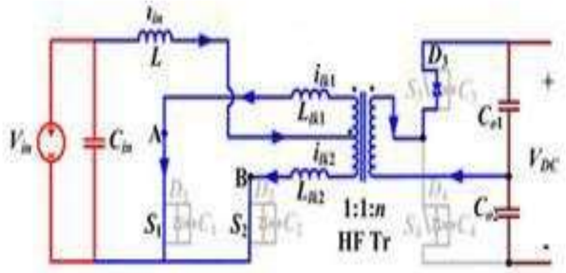

Fig-4: Mode3

MODE 4(t3<t<t4)

Mode 4 maintains a constant voltage with the secondary side switch S3 open. All switching devices increase or decrease current by the third iteration. ZCS automatically adjusts the primary side switch S2 after this time. Zero-current switching (ZCS) happens as iS2 approaches zero. S1 uses incoming current. Finally, iLlk2 = iS2 = 0, iS3 = Iin/n, and iLlk1 = Iin.

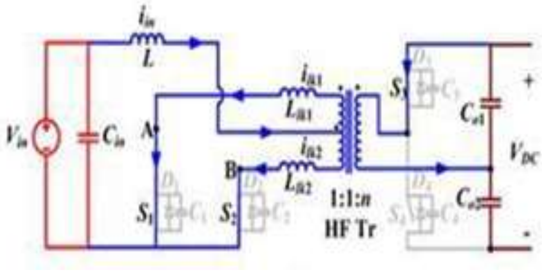

Fig-5: Mode4

MODE 5(t4<t<t5)

Mode 4 stays powered with S3 on. All

switching devices increase or decrease current by the third iteration. Zero Current Commutation quickly resets the main side switch S2 after the timer expires. A ZCS arises when iS2 = 0. Another power-using device is S1. Finally, iLlk2 = iS2 = 0, iS3 = Iin/n, and iLlk1 = Iin.

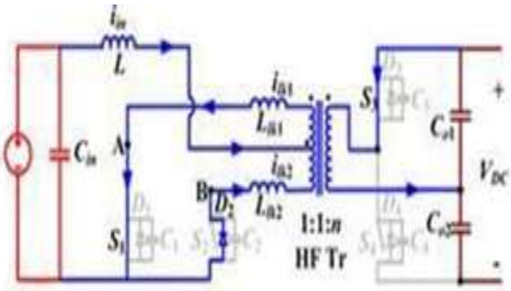

Fig-6: Mode5

MODE 6(t5<t<t6)

Activating the anti-parallel body diode D2 accelerates leakage inductance current iLlk1. The ZCS stops working when the voltage across the switched S2 is zero. Disable S3 backup now. When all five sessions are over, switch S1 has the latest data.

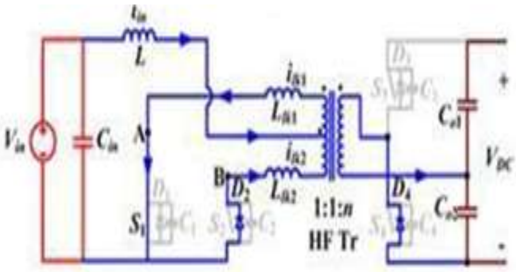

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Fig-7: Mode6

MODE 7(t6<t<t7)

Under these conditions, capacitor C2 charges quickly and maintains its voltage across its ends. The S2 switch sends data elsewhere.

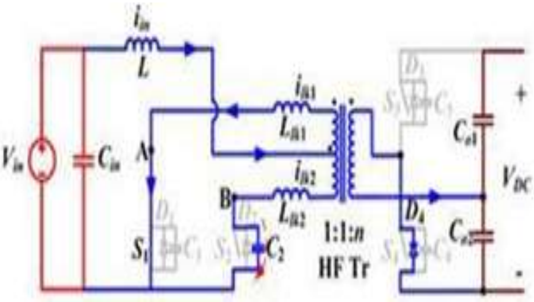

Fig-8: Mode7

MODE8(t7<t<t8)

At Iin, transformer and S1 currents remain unchanged. It goes through secondary switch D4's antiparallel body diode to reach Iin/n. Finally, iLlk2 = iS2 = 0, iD4 = Iin/n, and iS1 = Iin. The voltage across SP2 is VS2, calculated by dividing VDC by n. Electricity from switch S2 to S1 changed the transformer current direction.

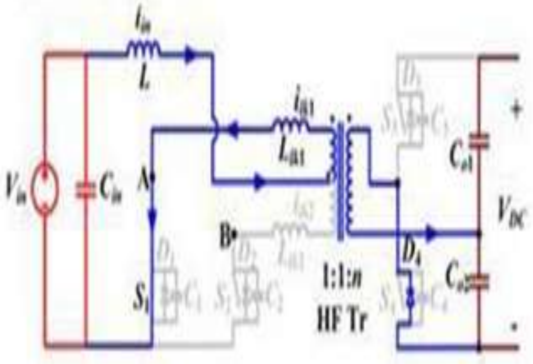

Fig-9: Mode8

3. SIMULATIONRESULTS

The recommended configuration is in these Simulink files. It generates pulses and operates a full-bridge converter. Additionally, it converts AC to DC power.

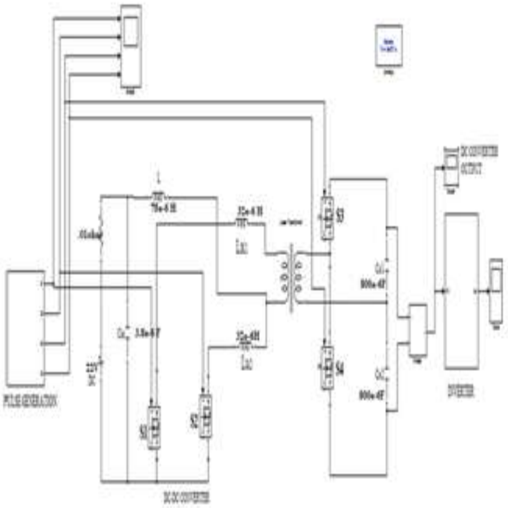

Fig-10:Simulink Model of Suggested System

Waveforms are generated by pulse-width

modulation on switches S1–S4. Triangle carrier patterns provide pulse width modulation (PWM) signals by combining their duty cycle ratios and switch open durations. Changes the fundamental frequency at 10 kHz.

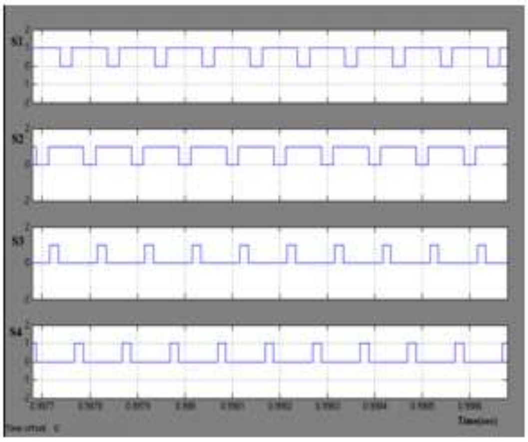

Fig-11:DC-DC converter switching pulses

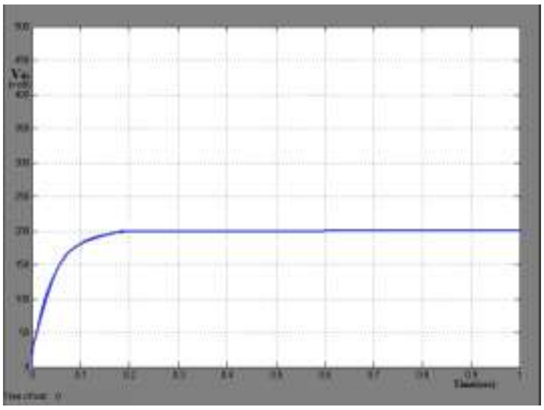

Fig-12:Snubberless DC-DC converter output for 12V input.

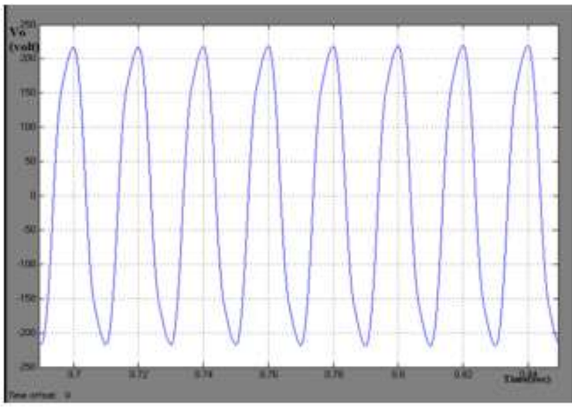

Fig-13:Full bridge 12V output

4. CONCLUSION

Despite lacking snubber, this DC/DC converter inverter can switch gently. Many DC-DC converter inverters have snubber. When too much current passes through a device, it loses power and performs poorly. As parts increase, equipment becomes more expensive and space-consuming. The suggested system needs secondary modulation. Secondary modulation permits gradual switching—from zero current and zero voltage to zero current and zero voltage again—making Snubberless DC-DC converters practicable. One end of the bridge inverter connects to the DC-DC converter. Inverters transform DC power into AC power for usage or grid feed. This technology improves efficiency, step-up conversion ratio, and switching/transmission losses. Some energy storage, fuel cell, and residential solar systems use inverters with Snubberless DC/DC converters. The suggested system was modeled in Simulink (Matlab).

REFERENCES

1. L. Zhu, “A novel soft-commutating isolated boost full-bridge ZVS-PWM DC–DC converter for bi-directional high-power applications,” IEEE Trans. Power Electron., vol. 21, no. 2, pp. 422–429, Mar. 2006.
2. Alexander Isurin and Alexander Cook, “Soft switching passive snubber circuit with energy recovery,” IEEE Trans. Power Electron., vol. 23, no. 8, pp. 465–468, Feb. 2008.
3. Tsai-Fu Wu, Yung-Chu Chen, and Jeng-Gung Yang, “Isolated bidirectional full-bridge DC–DC converter with a fly back snubber,” IEEE Trans. Ind. Electron., vol. 25, no.

7, pp. 555–560, Sept. 2010.

4. Tsai-Fu Wu, Jeng-Gung Yang, and Chia-Ling Kuo, “Soft-switching bidirectional isolated full-bridge converter with active & passive snubber,” IEEE Trans. Power Electron., vol. 16, no. 3, pp. 293–300, Mar. 2014.
5. S. J. Young, S. C. Shin, J. H. Lee, Y. C. Jung, and C. Y. Lee, “Isolated voltage doubler for fuel cell vehicle (FCV) application,” IEEE Trans. Power Electron., vol. 28, no. 12, Dec. 2013.
6. Udupi R. Prasanna, Akshay K. Rathore, and Sudip K. Mazumder, “Novel zero-current-switching current-fed half-bridge isolated DC–DC converter for fuel-cell-based applications,” IEEE Trans. Power Electron., vol. 49, no. 4, pp. xxx–xxx, Jul./Aug. 2013.(Page number was unclear—please verify if needed)
7. Udupi R. Prasanna and Akshay K. Rathore, “Analysis, design, and experimental results of a novel soft-switching Snubberless current-fed half-bridge front-end converter-based PV inverter,” IEEE Trans. Power Electron., vol. 28, no. 7, pp. xxx–xxx, Jul. 2013.(Page numbers missing—please confirm)
8. Pan Xuewei and Akshay K. Rathore, “Novel bidirectional Snubberless naturally commutated soft-switching current-fed full-bridge isolated DC–DC converter for fuel cell vehicles,” IEEE Trans. Power Electron., vol. 61, no. 5, pp. 920–925, May 2014.
9. Pan Xuewei, Udupi R. Prasanna, and Akshay K. Rathore, “Novel soft-switching Snubberless naturally clamped current-fed full-bridge front-end converter-based bidirectional inverter for renewables, microgrid, and UPS applications,” IEEE Trans. Power Electron., vol. 50, no. 6, pp. 945–951, Nov./Dec. 2014.