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PV BASED POWER CONVERSTION USING PWM AND SOFTSWITCHING TECHNIQUES FOR FULL BRIDGE DC-DC CONVERTER

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Abstract

Novel soft-switching techniques to increase the power conversion efficiency in systems using a full-bridge topology hardware kit. For this purpose, a special right-aligned modulation sequence is developed to minimize conduction losses while maintaining soft-switching characteristics. The techniques successfully reduce conduction losses and ensure low stress in all the switches. A detailed analysis of the techniques for efficiency gains are presented and a phase-shift zero-voltage switching topology explained as a reference topology to highlight the mechanisms for performance enhancement and the advantages in the use of the special modulation.

So as to create the PV generation system additional flexible and expandable, the backstage power circuit consists of a high change of magnitude device and PWM electrical converter. Within the DC-DC power conversion, the high change of magnitude device is introduced to enhance the conversion potency of standard boost converters and to permit the operation of low-tension PV modules. Moreover, associate degree adaptative total sliding-mode system is meant for this management of the PWM electrical converter to take care of the output current with the next power issue and fewer variations below load changes.

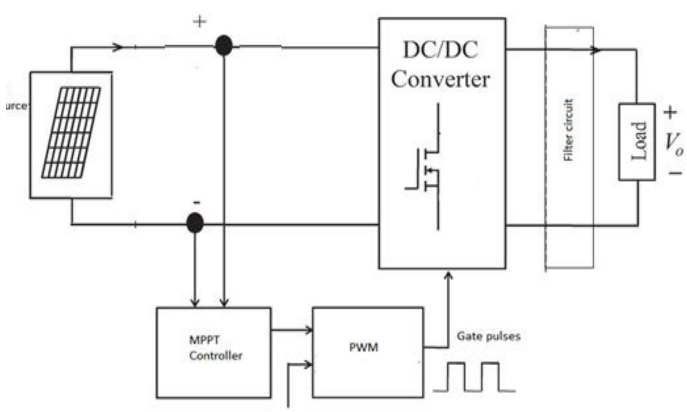

Fig 1: DC-DC converter circuit Block Diagram

The DC-DC converter shown in figure 1.2 gives the complete idea of present work where the input source in the circuit is taken from PV system. To maintain the maximum power in different conditions, a MPPT has been connected as shown in figure 1.2. The PWM modulation techniques

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are used to maintain gate pulses properly and are sent to the circuit. A DC-DC converter along with filters converts the voltage, steps up the voltage and removes the ripples from the DC-DC converter output. The different components of DC-DC converter circuit are explained in detail in this chapter.The circuit shown converts an unregulated input DC voltage and steps up the output voltage, with a different magnitude from input voltage. The converter includes one or many transistors regulate the output voltage with the help of regulated signal. The converters were with very low loss as a result, transistors will not operate in linear time intervals. Instead of this, it operates as a switch. The transistor operation in DC- DC converter is as follows. When the transistor is ON, the power wastage in the transistor is very little because of its low transistor voltage.

The current and power dissipation across the transistor is low when it is in non-conduct. The converters resistors avoided in this, to get low losses. For lossless operation capacitors and inductors are used. High power quality is needed for medical, industries and research. Many techniques have been applied to achieve power quality by reducing the distortions in the converter output voltage/current waveforms. It is commonly performed by employing suitable ZVS, ZCS soft switching, step up DC-DC converter, coupled inductor structures DC-DC converter techniques with PV input that increases the output voltage. Studied different types of DC-DC converter topologies to develop proposed circuit in this thesis work.

DIFFERENT TYPES OF DC-DC CONVERTER TOPOLOGIES USED IN DEVELOPING THE PROPOSED CIRCUIT

This converter operation technique can have low input current ripple and switch current stress. Converter with voltage multiplier cells has been proposed to provide higher voltage gain.

Boost converter: The boost converter is a basic step-up converter topology. The voltage gain can be increased by increasing the duty cycle which in turn increases the switch stress.

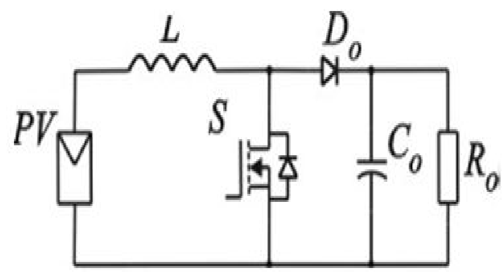

Fig 2. Boost converter

The conduction losses increase with increase in duty cycle. The power rating of switch also increases. The boost converters are usually cascaded in order to obtain higher gain but at the cost of efficiency.The power rating of switches and diodes can be decreased with the use of smaller inductors. When switches are switched ON and OFF or driven sequentially one by one voltage ripples of the output are reduced. The main disadvantage is that Electromagnetic Interference (EMI) arises due to flow of diode reverse recovery current when the

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diodes are switched off. To overcome that problem, the converter must be driven or in particular inductor current must be driven in discontinuous mode. If operated in continuous inductor current mode, it will give rise to lower input current ripples as well as lower switching losses. The main disadvantage of that topology is relatively low voltage gain which is only two times the input voltage. The transformers are combined with interleaved boost converter to get high voltage gain. Soft switching boost converters: This topology has high voltage gain relatively higher than boost converter as it uses zero voltage switching which reduces the switching losses. The switching sequence is slightly complicated in this topology. Separation at driver side is not required as both switches operate at the same ground potential. The disadvantage of that topology is the complexity of the circuit, because of five more components addition including a switch and an extra inductor shown fig.3.

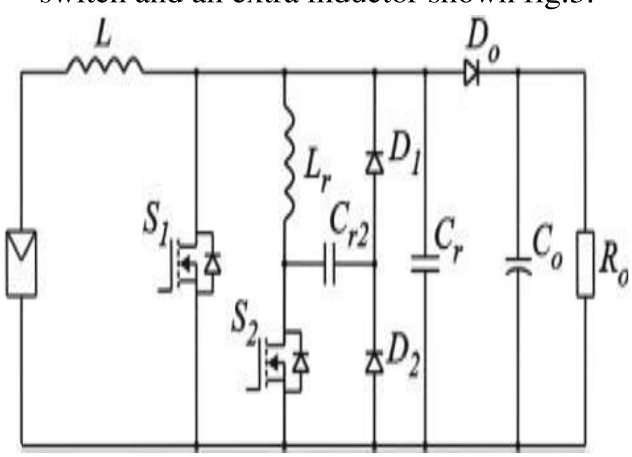

Fig. 3 Soft switching boost converter

In this topology (Fig. 4) the high voltage gain can be achieved by adjusting the turn's ratio of two same coupled inductors without increasing the duty cycle. In this case, the current is shared at the input hence the rating of the switches reduces. The main drawback is that this topology uses two diodes, two capacitors and secondary winding of coupled inductors with interleaved boost converter acting as a voltage multiplier, thereby increasing the number of components.

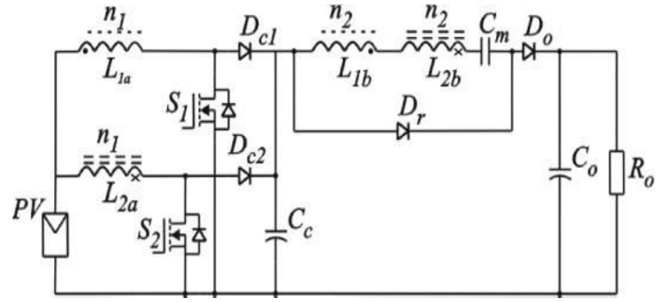

Fig. 4 Interleaved step up converter with voltage multiplier

Non inductive solutions: The transformer less topology has advantage over the above topologies as it reduces the size, cost and weight, hence the overall complexity of the converter. The other advantage is the possibility to work at higher temperatures than inductor based counterparts. Recently the new converter developed which meet the requirements of high efficiency and ability to work in high temperatures. Again in this case voltage multiplier cells are included that operate based on switching capacitor principle to get high voltage gain.The main drawback is use of relatively large number of switches, which are 12 in this case. The current stress is high due to use of capacitive load.Many DC-DC converters with isolation are found in literature which

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provides the platform for further research and development of more advanced systems. As topologies such as fly back, forward or push-pull, and their combinations is described. In these topologies the voltage gain is high but the efficiency is poor. Here ZVS and ZCS soft switching techniques are applied to improve the efficiency.

Active clamp step up converter

Like the topologies mentioned earlier, the active clamp step-up DC-DC converter, Fig. 5 uses an active clamp circuit. Like fly back and forward converter the output voltage is regulated. By the use of active clamp circuit the output power is transferred to the output during both the switching states.

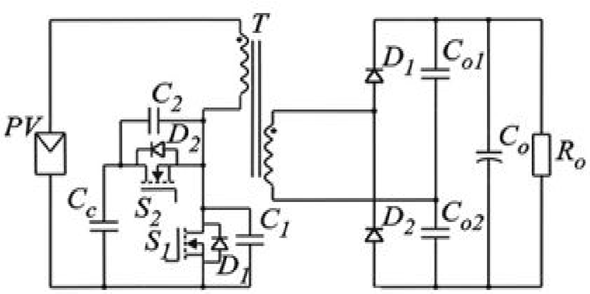

Fig. 5 Active clamp step up converter

The high voltage gain is obtained by the voltage doubler circuit and also the conduction losses of the switches are also reduced. The resonant circuit ensures commutation of diodes without any reverse recovery problem. This converter can be used in photovoltaic systems. But again the circuit is complex and number of part count is more.The half-bridge and full-bridge isolated converter topologies have high efficiencies and also use soft switching principles.

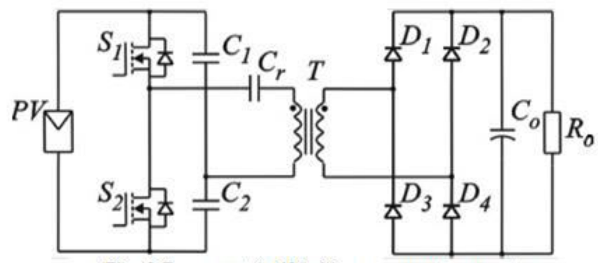

Fig. 6 Resonant half bridge resonant converter

In this case, the leakage inductance along with the capacitor properly selected forms a resonant converter to achieve ZCS condition. Also the capacitors are connected in parallel with the switches to achieve high efficiency so that they can be turned-on at zero voltage and zero current. The main drawback is that the conduction losses are more in this type of converter seen in Fig. 6.

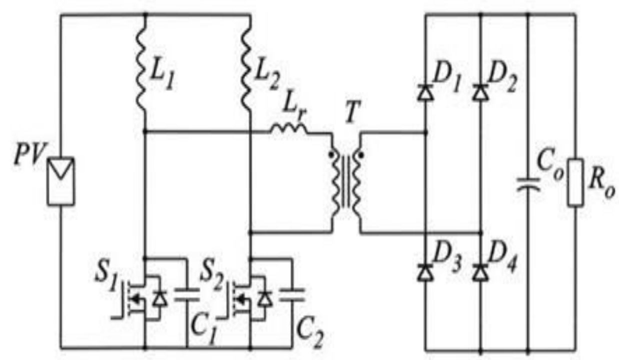

Fig. 7 Resonant half bridge dual converter

In topology like ZVS two-inductor boost converter two parallel capacitors are used with the resonant inductor to get the ZVS turn off of the switches. So the turning- on of the switches happens when voltage of the capacitor becomes zero.

The continuous and discontinuous mode of resonant half bridge dual converter depends on the current of a boost circuit. The advantage of this circuit is the high

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voltage gain and high efficiency. The main drawback of this topology is occurrence of multiple resonances with the use of voltage doubler circuit.

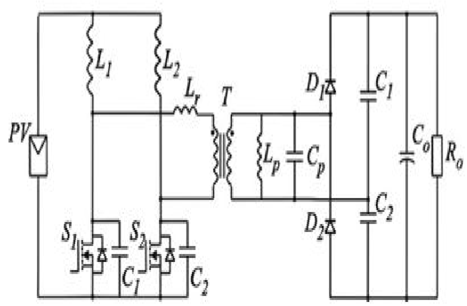

Fig. 8 Current fed multi-resonant converter

A transformer is combined with two inductor half bridge structures and also with a resonant tank circuit to form Current Fed Multi-Resonant Converter (CFMRC). However, the efficiency is limited due to high turns ratio of the transformer which gives rise to secondary winding losses. This topology has advantages such as high voltage gain, low input ripple current. An improved CFMRC topology is developed which overcome the limitation of this converter with reduced cost.A resonance between leakage inductor Lr and resonant capacitor Cp occurs. There is overlapping of the gate signals of both the switches. In this case, the voltage spikes within converters are reduced and also switches are switched using ZCS condition. Due to this the power loss of the voltage doubler diodes as well as switches becomes less.Also during full load as well at light load condition, the primary current is limited. Another advantage of half bridge current-fed converters is common ground gate signal provided to the switches.

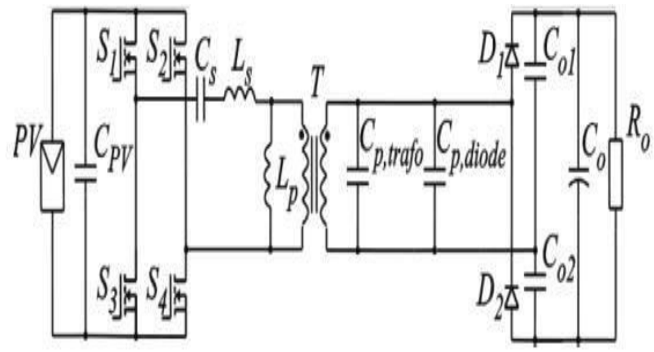

Fig. 9 Series parallel resonant converter

The LLCC Series-Parallel Resonant Converter (SPRC) is depicted in Fig. 9. A full bridge inverter is combined with half bridge rectifier and high step-up high-frequency transformer in this topology. As in the previous case switches are turned on by ZVS and diodes are turned off by ZCS. In this case, the snubber circuits also contribute to high efficiency of the system along with the above features. Because of the presence of transformer as well number of components is more, the size and cost increases, but two important characteristics, high voltage gain and high efficiency is achieved.

ZERO-CURRENT SWITCHING

When current becomes zero, the transistor switches off. The effect of current on the MOSFET causes loss and this loss can be eliminated by zero current switching.

ZERO-VOLTAGE SWITCHING

When voltage is zero transistors turns on. One of the semiconductor devices used for zero voltage scheme is diode. When diode is charged there are some voltages drops happen on diode.

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This will increase the switching loss. By utilizing zero-voltage switching, the loss in the diode can be reduced. This zero voltage scheme is mostly preferable for resonant converter which uses MOSFET as a switch.

RESONANT SWITCH CONVERTERS

Resonant switch converters have inductor and capacitor (L-C) networks and whose current (I) and voltage (V) waveforms vary during every switching. There are various resonant switch converters.

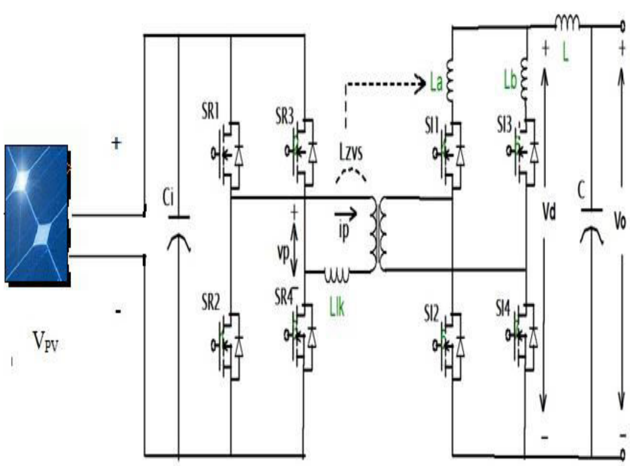

Fig. 10 DC-DC full bridge converter circuit

"Modulation is a process of message signal and modulating is varied according to the carrier signal for transmission purpose. The message signal can varied in accordance to the carrier signal that is in terms of angular or amplitude. So modulating the signal."High quality power is needed for important equipment like medical and research. Many techniques have been applied to achieve quality power by reducing the distortions in the converter output voltage/current waveforms. It is commonly performed by employing suitable pulse width modulation techniques and increasing the level in the output voltage.

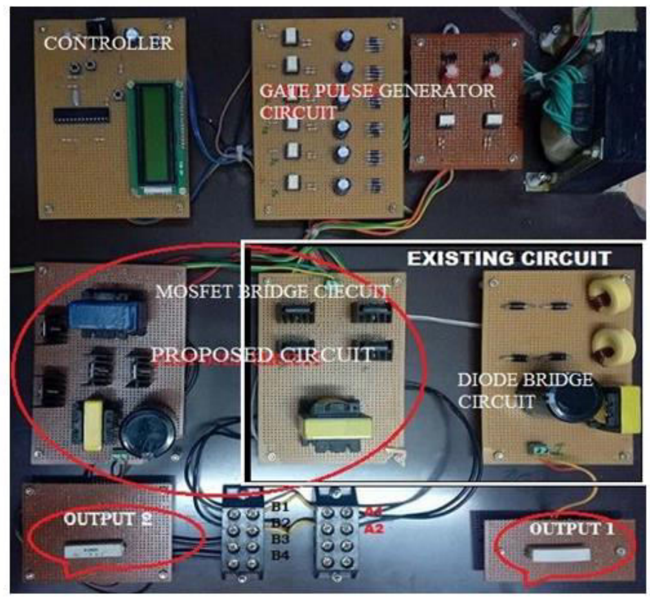

Figure 11 Experimental hardware setup

Figure 11. shows the Experimental hardware setup, it contains the existing system circuit and also proposed system circuit. In this existing circuit uses 4 MOSFETS and 4 diodes used as switches and converter respectively, in this proposed circuit uses 4 MOSFETS (IRFP250N) in the primary side in the circuit as a switches and 4 MOSFETS used in the secondary side after the transformer as a converter . In both the circuits 1.1KVA transformer is used for gate pulse generator circuit in present work. This gate circuit uses the gate drivers TLP250, that is controlled by a controllers dsPIC30F2010 in the controller circuit for PWM and these gate pulses are sent to the gates of the MOSFET in the

existing and the proposed circuit . In the existing circuit Fuel cell is used as the input supply. output 1 belong to the existing circuit (diode bridge circuit). In the proposed circuit PV cell is used as the input supply output 2 belong to the proposed circuit (MOSFET bridge circuit) and the resistive load is used for both existing circuit and proposed circuit shown in figure 11 .

Results of DC-DC full bridge converter circuit output voltage.

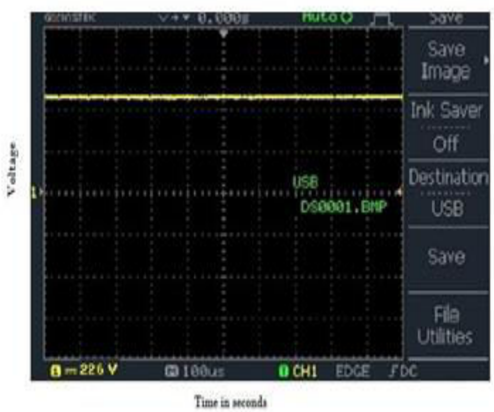

Fig 12 Proposed circuit output voltage waveform

Fuel cell in the existing circuit is replaced by PV cell in the proposed circuit because to reduce the cost. And on the secondary side of the transformer, the diode bridge circuit is replaced by MOSFET in the proposed circuit to reduce the reverse recovery losses.

For the proposed circuit 20V input taken from PV cell. Here it gives 226V output voltage (seen at output2 in the circuit 11) with less switching losses (MOSFET bridge circuit) and the output voltage are shown in figure 12.

CONCLUSION

The results of hardware studies have been presented for circuits. The remarkable improvements in efficiency, minimization of the switching losses and minimization of the reverse recovery have been witnessed with the proposed circuit. The booster DC-DC converter Output voltage finally concludes that proposed circuit is superior one than the existing ones.

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