ISOLATED HIGH STEP-UP DC-DC CONVERTER WITH LOW VOLTAGE STRESS

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Abstract* - The main aim of this paper is to design the DC-DC converter for HVDC system with high step-up ratio and low voltage stress ac voltage. Therefore, high step-up ratio dc– dc converters are Nowadays DC-DC converter play a major role in photovoltaic panels Fuel cell stacks and photovoltaic panels generate rather low dc voltages and these voltages need to be boosted before converted to preferred in renewable energy systems. A new Z-source-based topology that can boost the input voltage to desired levels with low duty ratios is proposed in this paper.The topology utilizes coupled inductor. The leakage inductance energy can efficiently be discharged. Since the device stresses are low in this topology, low-voltage MOSFETs with small RDS (on) values can be selected to reduce the conduction loss. These features improve the converter efficiency. Also, the converter has a galvanic isolation between source and load. Finally, experimental results are given for a prototype converter that converts 25 V dc to 400 V dc at various power levels with over 90% efficiency to verify the effectiveness of the theoretical analysis.In case of HVDC system MOSFET is replaced by IGBT

1. GENERAL

The PV energy is considered as one of the most useful alternative energy sources because it is clean, unlimited, and cheap. However, the output voltage of the PV panels is low. So, a high voltage ratio converter is required to obtain high output voltage from low input voltage. Before connecting to the grid some DC-DC converter is used to boost the voltage. These kind of converters have some disadvantages like high voltage stress and switching loss and more duty cycle. To increase the output voltage various DC-DC converters are proposed. Existing system is based on boost converter, buck-boost converter and other step-up converters. These converters have more voltage stresses on the switches. Duty cycle of the system also very high. Energy stored in the leakage inductance of the transformer is very high and this creates the voltage stress on the power devices.

In this existing system we add the snubber circuit to overcome the switching losses or stress. Proposed system is used to get the high voltage gain value with low voltage stress and less duty cycle. Coupled inductor based z-source converter is proposed to obtain the maximum output voltage with minimum voltage stress. By using coupled inductor voltage boost is achieved it is mainly used in HVDC system.

2. OPERATION

There is one coupled inductor with four windings in the proposed converter. For the ease of understanding, it is shown in the figure as if there are two cores, T1 and T2. However, in real circuit, all coils are wound on the same core. Each coupled inductor has two windings. Turns ratios of these windings are N1 and N2. Primary and secondary inductances of the coupled inductors are L1 and L2.

The equivalent model of the coupled inductors includes the magnetizing inductors Lm, the primary leakage inductor Llk1, the summation secondary leakage inductor Llk2, and an ideal transformer. The circuit also employs five capacitors (Co, C1, C2, C3, and C4), four diodes (Do, D1, D2, and D3), and a power switch (S). When the power switch is turned ON, the diodes D1,D2, and D3 are OFF while the diode Do conducts.

The Capacitors C1, C2, C3, and C4 are discharged, while the load capacitor Co is charged. When the power switch is turned OFF, the diodes D1,D2, and D3 starts conducting and the diode Do is OFF.

The capacitors C1, C2, C3, and C4 are charged. The capacitor Co is discharged. While the primary leakage inductance energy is discharged through the capacitors C1 and C2 and the diodeD1, the secondary leakage inductance energy is discharged through the load. In the meantime, the switch and the diodes do not experience extra stress and the off-state voltage of the switch is Vin / (1 – 2D). Also, diode currents decay linearly during turn-off due to the leakage inductance. All these cause in higher efficiency.

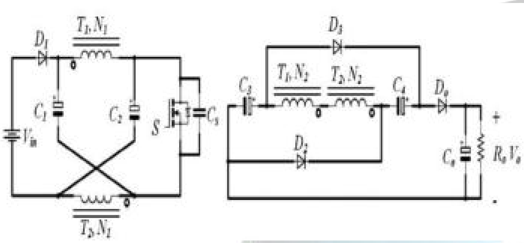
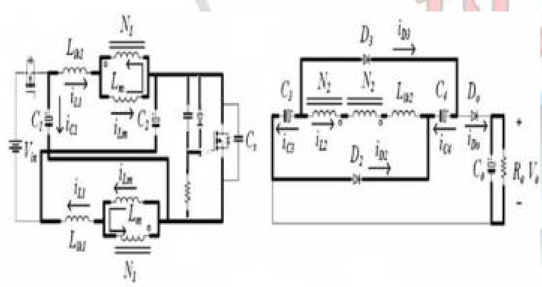


Figure1: Equivalent Circuit of the DC to DC Converter

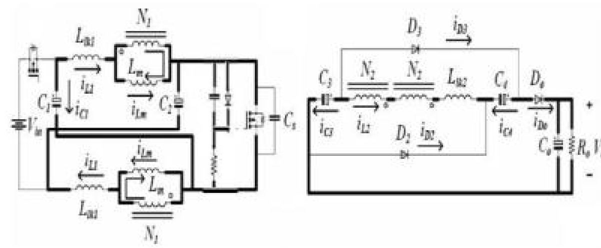
3.MODES OF OPERATION (CCM OPERATION)

MODE1



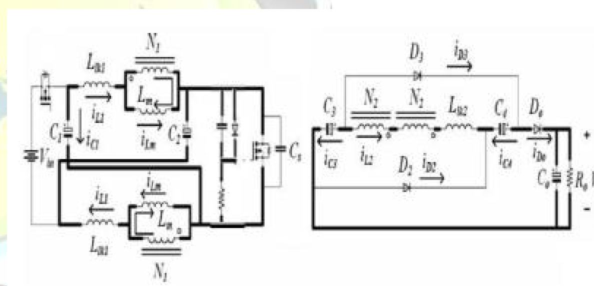
This short mode starts at t = t0 and the

MODE2

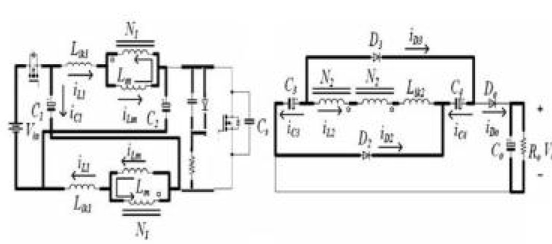


This is also a short mode. The switch is still conducting at t = t1 . The diode Do conducts while the diodes D1,D2 , and D3 are OFF. The capacitors C1 and C2 and the inductors Lm and Llk1 keep their states as in Mode I. The capacitors C3 and C4 are in series and discharged through the load. The capacitor Co is charged. This mode ends when vL2 = nvL1 at t = t2

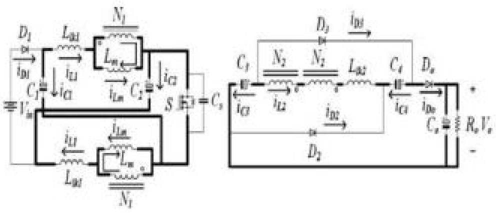
MODE3



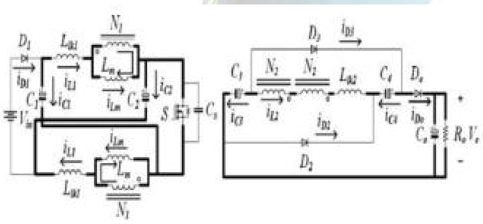
In this mode, the switch, diodes, capacitors, and inductors keep their states as in Mode II. The current flow path is shown in Fig. 3(b). The magnetizing inductor Lm transfers the stored energy to the secondary. The secondary side of the coupled inductors is in series with the capacitors C3 and C4 by charging them to a voltage level depending on the conversion ratio and passes the energy to the load. This mode ends at t = t3 when the switch is turned OFF.



switch is conducting in this mode. It is assumed that the stray capacitor Cs quickly discharges. The diodes Do andD1 are OFF while the diodes D2 and D3 conduct the current. The capacitorsC1 andC2 are discharged. The magnetizing and leakage inductors Lm and Llk1 are charged by VC voltage. The leakage inductor Llk2 discharges its energy through parallel the capacitors C3 and C4. The secondary current iL2 linearly decays, causing soft recovery of diodes. The capacitor Co is discharged through the load. This



mode ends at t = t1 when iD2 = iD3 = 0



This is also a short mode. When the switch is turned OFF, the stray capacitor Cs starts to charge quickly. The diodes, capacitors, and inductors keep their states as in Mode III. The current flow path is shown in Fig. 3(c). This mode ends at t = t4 when the diode D1 starts conducting and the voltage on the switch is equal to Vin /(1 – 2 D).

MODES OF OPERATION (DCM OPERATION)

MODE1

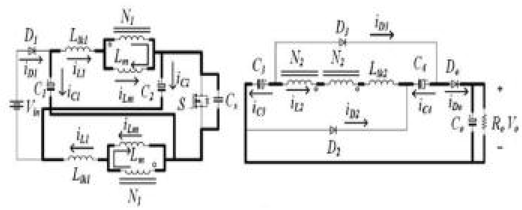
This shortmode starts at t = t0 and the switch is conducting in this mode. It is assumed that the stray capacitor Cs quickly discharges. The diode Do conducts while the diodes D1,D2 , and D3 are OFF. The current flow The capacitors C1 and C2 are discharged. and leakage inductors Lm and Llk1 are charged by VCvoltage. The capacitors C3 and C4 are in series and discharged through the load. The capacitor Co is charged. This mode ends when vL2 = nvL1 at t = t1

MODE2

In this mode, the switch and diodes keep their states as in Mode I. The magnetizing and leakage inductors Lm and Llk1 are still charged by VC voltage. The magnetizing inductor Lm transfersthe stored energy to the secondary. The secondary side of thecoupled inductors is in series with the capacitors C3 and C4 by charging them to a voltage level depending on the conversion ratio and passes the energy to the load. The capacitor Co is still charged. This mode ends at t = t2 when the switch is turned OFF.

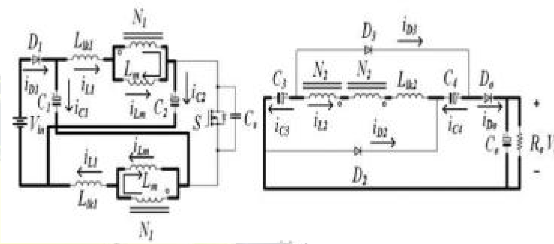
MODE3

This is also a short mode. The diodes keeptheir states as in Mode I. When the switch is turned OFF, strayCapacitor Cs starts to charge quickly. The diodes, capacitors, and inductors keep their states as in Mode II. This mode ends at t = t3 when D1diode starts conducting and the voltage across the switch is equal to Vin /(1 – 2D).



MODE4

This is also a short mode. The switch andthe diodes D2 and D3 are OFF while the diodes Do and D1 Conduct the current. The current flow path is shown in Fig. 6(c). The capacitors Co, C1, and C2 are charged. The energy stored in Lm and Llk1 is discharged through C1, C2 capacitors and the source. The leakage inductor Llk2 discharges its energy through the series capacitors C3 and C4 and the load. This mode ends diodeD4.



4. SIMULATION OUTPUT

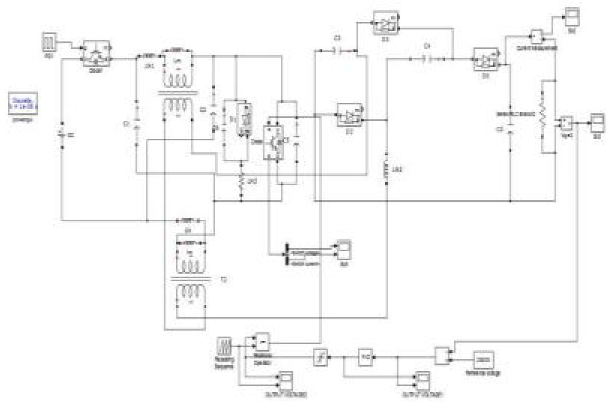
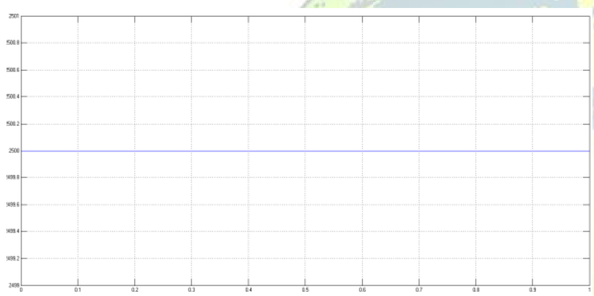
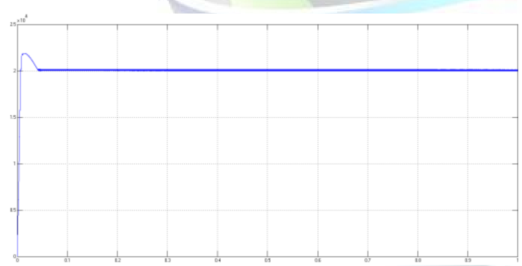


Figure- with snubber circuit

INPUT VOLTAGE



OUTPUT VOLTAGE



5. CONCLUSION

Switches used in the HVDC application need to protect properly. If any problems occurs in the switch will create big blast in the system. So snubber circuit is added in this project to protect the switch. Voltage and current across the switch is controlled to some limited value. This will increase the system efficiency, life time of the switch and also cost factor.

REFERENCES:

T-F. Wu, Y.-S.lai,J.-C.Hung, and Y.- .Chen(2008)

Proposed a boost converter with coupled inductors and buck boost type of active clamp.Many boost converters based on a coupled inductor or tapped inductor provide solutions to achieve a high voltage gain,and low voltage stress on the active switch without the penalty of high duty ratio,however the input current is not continuos.particularly as the turn ratio ot the coupled inductor or tapped inductor is increased to extend the voltage conversion ratio,the input current ripple becomes larger.

G.Spiazzi,P.Mattavlli,j.R Gazoli,R.magalhacs and G.Frattani(2010)

proposed an improved integrated boost-flyback high step up converter,The conventional flyback converter is usually adopted for achieving high voltage gain by adjusting the turns ratio of the transformer.However the leakage inductor of the transformer may not only cause high voltage spikes on the power device,but also induce energy losses.In order to improve afore mentioned problems,a resistor –capacitor-diode snubber can be used,but the leakage inductor is dissipated

E.S.dasilva, L.dos Reis Barbosa,J.B.Vieira,L.C.de Freitas and V.J.farias(2011)

Proposed an improved boost PWM soft-single-switched converter with low voltage and current stresses.The conventional boost converter would not be acceptable for realizing high step up voltage gain along with high efficiency.Many non sinusoidal topologies have been researched to achieve a high conversion ratio and avoid operating at extremely high duty cycle.These converters include the switched capacitor types,switched-inductor types and the voltage-doubler circuits

T.Zhou and B.Francois (2011)

Proposed an energy management and power control of a hybrid active wind generator for distributed power generation and grid integration,Classical wind energy conversion systemsare usually passive generators.The generated power does not depend on the grid requirement but entirely on the fluctuant wind condition.A dc coupled wind/hydrogen/super capacitor hybrid power system is studied in this paper.The purpose of the control system is to coordinate these different sources,particularly their power exchange,in order to make controllable the generated power

Y.P,Hsieh. J.F.Chen. T.J.Liang, and L.S.Yang (2011)

proposed a novel high step-up dc-cd converter with coupled inductor and switched capacitor techniques for a sustainable energy system.This paper has proposed a novel high step up DC-DC converter with the coupled inductor and switched capacitors.The converter adds passive components without extra winding stage,and uses capacitors charged in parallel and discharged in series with a coupled-inductor to achieve high step up voltage gain and high efficiency

T.Kefalas and A.Kladas (2012)

proposed an analysis of transformers working under heavily saturated conditions in grid-connected renewable energy systems. Researches have proposed transformer less solutions for connecting renewable energy power plants to the grid.the purpose of this paper is the development of a finite element computational tool that is going to aid transformer manufacturers in designing distribution transformers specifically for the renewable energy market