Asian Journal of Science and Applied Technology (AJSAT)
Vol.3.No.1 2015 pp 29-33
available at: www.goniv.com
Paper Received :08-03-2015
Paper Accepted:20-03-2015
Paper Reviewed by: 1. R. Venkatakrishnan 2. R. Marimuthu
Editor : Prof. P.Muthukumar

HIGH BOOST HYBRID TRANSFORMER DC-DC CONVERTER FORPVAPPLICATIONS

SUGANTHI.M
M.E.-Final year,
Power Electronics & Drives, Department of Electrical and Electronics Engineering
Excel college of Engineering & Technology
Email: suganthisamy14@gmail.com

ABSTRACT

Now-a-days due to the shortage of electric power and rising cost of non-renewable energy resources generating electric power from the renewable energy sources such as PV modules are increasing day to day.A non-isolated, high step-up dc-dc converter with hybrid transformer for low-voltage renewable energy resources applications. The proposed converter utilizes a hybrid transformer to transfer the inductive and capacitive energy simultaneously &achieving high boost ratio with smaller sized magnetic component, the turn off loss of the switch is reduced, increasing the efficiency of the converter under all load conditions. The input current ripple and conduction losses are also reduced, because of the hybrid linear sinusoidal input current waveforms. By changing the input voltage the voltage stresses on the active switch and diodes are maintained at low level and are independent as a result of the resonant capacitor transferring energy to the output of the converter. Due to the high system efficiency as well as the ability to operate with wide variable input voltage, the proposed dc-dc converter is an attractive design for alternative low dc voltage energy sources, such as solar photovoltaic modules and fuel cells.

I.INTRODUCTION

Due to the rising costs and limited amount of non-renewable energy sources, there is an increasing demand for the utilization of renewable energy sources such as photovoltaic (PV) modules. Integrating the power from the PV module into the existing power distribution infrastructure can be achieved through power conditioning systems.

1.1 POWER CONDITIONING SYSTEMS

For low voltage dc energy sources, power conditioning system (PCS) is needed to convert the energy sources to a higher-voltage dc before making it to ac grid-tie applications. The double stage PCS consists of a dc-dc conversion stage that is connected to either a low power individual inverter or a high power centralized inverter that multiple converters could connect to. from the PV panel to a higher dc voltage. This voltage has to be higher than the peak output voltage of the dc-ac inverter, nominally in the 380-400V range. The double stage design can also suppress ac line double frequency by utilizing the active ripple cancellation technique.

The high boost ratio dc-dc converter for such systems can be isolated or non-isolated. For low input voltage energy sources, it is possible to float the source such that the converter circuit does not require isolation between input and output. To provide sufficiently high enough voltage for the inverter input, however it is nontrivial to design a cost effective high boost ratio without isolation transformer. So the transformer isolated circuits tend to be less efficient and more expensive due to the increased manufacturing costs.

A non-isolated dc-dc converter for with a high boost ratio would be advantageous for a two-stage PCS because it may be easily integrated with current PV systems with reducing the cost and high system efficiency. Due to the different output voltages from PV panel, it would be beneficial to have a system with a high efficiency over the entire PV voltage range to maximize the use of the PV during different operating conditions.

1.2 MPPT TECHNIQUE

The important function of the dc-dc converter for PV applications is being able to implement maximum power point tracking (MPPT). The ability to implement MPPT for an individual PV panel would ensure that a large cluster of PV could maintain maximum power output from each panel without interfering with other panels in the system. The major consideration for the main power stage of the converter is being able to implement an accurate MPPT is that the input current ripple of the converter has to be low.

MPPT is a technique that grid connected converters, solar battery chargers and similar devices use to get the maximum possible power from one or more photovoltaic devices use to get the maximum possible power from one or more photovoltaic devices, typical solar panels, though optical power transmission systems can benefit from similar technology. Solar cells have a complex relationship between solar irradiation, temperature and total resistances that produce a non-linear output efficiency which can be analyzed based on the I-V curve from the solar cell and apply the proper resistance (load) to obtain maximum power for any given environmental conditions. MPPT devices are typically integrated into an electric power converter system that provides voltage or current conversion, filtering, and regulation for driving various loads, including power grids, batteries, or motors.

- Solar inverters convert the DC power to AC power and may incorporate MPPT: such inverters sample the output power from the solar cell and apply the proper resistance, so as to obtain maximum power.
- MPP (Maximum power point) is the product of the MPP voltage (V mpp) and MPP current (I mpp): some solar panels have a higher maximum power than others.

Classification:

1. Perturb and observe.
2. Incremental conductance.
3. Current sweep method.
4. Constant voltage.

1.3 HYBRID TRANSFORMER

Hybrid transformer can be used as a power splitter. Hybrids are symmetrical and bidirectional. A **hybrid coil** (or **bridge transformer**, or sometimes **hybrid**) is a transformer that has three windings, and which is designed to be configured as a circuit having four branches, (i.e. ports) that are conjugate in pairs. A signal arriving on one branch is divided between the two adjacent branches but does not appear at the opposite branch. In the schematic diagram, the signal into W splits between X and Z, and no signal passes to Y. Similarly, signals into X split to W and Y with none to Z, etc. Correct operation requires matched characteristic impedance at all four ports.

Uses:

1. It provides dc isolation
2. It changes the unbalanced signals to the balanced one.

A high boost ratio dc-dc converter with hybrid transformer is presented to achieve high system level efficiency over a wide input voltage and output power ranges. By adding small resonant inductor and reducing the capacitance of the switched capacitor in the energy transfer path, a hybrid operation mode, which combines pulse width modulation and resonant power conversions, is introduced in the proposed high boost ratio dc-dc converter. The inductive and capacitive energy can be transferred simultaneously to a high voltage dc bus increasing the total power delivered decreasing the losses in the circuit. As a result of energy transferred through the hybrid transformer that combines the modes where the transformer operates under normal conditions and where it operates as a coupled inductor, magnetic core can be used effectively and smaller magnetic can be used.

The lower input current ripple is useful in capacitance can be reduced and it is easier to implement a more accurate MPPT for PV modules. The conduction losses in the transformer are greatly reduced because of the input voltages. Due to the introduction of the resonant portion of the current, the turn off current of the active switch is reduced. As a result of the decreased RMS current value and smaller turn off current of the active switch, high efficiency can be maintained at light output power level and low input voltage operation. Because of the resonant capacitor transferring energy to the output of the converter, all the voltage stresses of the diodes are kept under the output dc bus voltage and independent of the input voltage.

1.4 PHOTOVOLTAIC (PV) MODULE

A solar panel is a set of solar photovoltaic modules electrically connected and mounted on a supporting structure. A photovoltaic module is a packaged, connected assembly of solar cells. The solar panel can be used as a component of a larger photovoltaic system to generate and supply electricity in commercial and residential applications. Each module is rated by its DC output power under standard test conditions (STC), and typically ranges from 100 to 320 watts. The efficiency of a module determines the area of a module given the same rated output an 8% efficient 230 watt module will have twice the area of a 16% efficient 230 watt module. A single solar module can produce only a limited amount of power; most installations contain multiple modules. A photovoltaic system typically includes a panel or an array of solar modules, an inverter, and sometimes a battery and/or solar tracker and interconnection wiring.

1.5 EXISTING SYSTEM

The converter utilizes a hybridtransformer to transfer the inductive and capacitive energy simultaneously, achieving a high boost ratio with a smaller sized magnetic component. As a result of incorporating the resonant operation mode into the traditional high boost ratio pulse width modulation converter, the turn-off loss of the switc is reduced, increasing the efficiency of the converter under all load conditions. The input current ripple and conduction losses are also reduced because of the hybrid linear-sinusoidal input current waveforms. The voltage stresses on the active switch and diodes are maintained at a low level and are independent of the changing input voltage over a wide range as a result of the resonant capacitor transferring energy to the output of the converter.

The switching losses for a dc–dc converter are directly proportional to the switching current given by the fixed conversion voltages.

1.6 PROPOSED SYSTEM

In order for the proposed converter to be used in higher power level conversion applications, the interleaving method applicable to the traditional high boost ratio PWM dc–dc converter can be employed. The difference between standard interleaved converters and the proposed interleaved converter is that the clamping capacitor *Cc* can also be shared by the interleaved units reducing the total number of components in the system.

Using the phase-shift method of control, the current ripple through the clamping capacitor *Cc* is reduced as a result the capacitance needed for *Cc* is also reduced.

This gives the advantages of standard interleaved converter systems such as low-input current ripple, reduced output voltage ripple, and lower conduction losses.

2. OPERATING PRINCIPLES OF THE PROPOSED CONVERTER

The circuit configuration of the proposed converter is shown in the figure 2.1.$C_{in}$is the input capacitor; HT is the hybrid transformer; S_1 is the active MOSFET switch; D_1 id the clamping diode ; which provides current path for the leakage inductance of the hybrid transformer when the switch S_1 is OFF, C_c captures the leakage energy from the hybrid transformer and transfers it to the resonant capacitor C_r by means of the resonant circuit composed of C_c, C_r, L_r, and D_r; L_r is the resonant inductor, which operates in the resonant mode; and D_r is used to provide the unidirectional current flow path for the operation of the resonant portion of the circuit. C_r is the resonant capacitor, which operates in the hybrid mode by having a resonant charge and linear discharge.

The turn-on of D_r is determined by the active switch S_1. D_0 is the output diode similar to the traditional coupled-inductor boost converter and C_o is the output capacitor. R_0 is the equivalent resistive load.

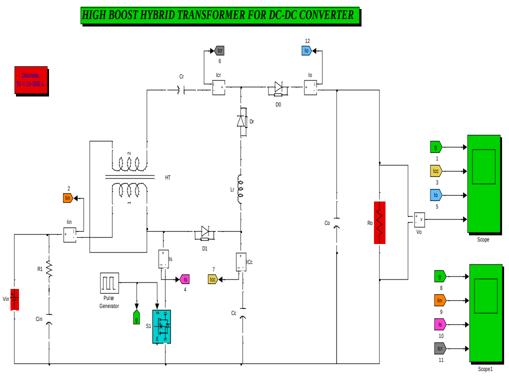

Fig 2.1 Simulation Diagram

The operation modes are briefly described as follows.In this period, MOSFET S1 is ON, the magnetizing inductor of the hybrid transformer is charged by input voltage, Cr is charged by Cc, and the secondary-reflected input voltage nVinof the hybrid transformer together by the resonant circuit composed of secondary side of the hybrid transformer, Cr,Cc,Lr, and Dr. The energy captured by Cc is transferred to Cr, which in turn is transferred to the load during the off-time of the MOSFET.

The current in MOSFET S1 is the sum of the resonant current and linear magnetizing inductor current as shown in Figure. There are two distinctive benefits that can be achieved by the linear and resonant hybrid mode operation. The first benefit is that the energy is delivered from source during the capacitive mode and inductive mode simultaneously. Compared to previous coupled-inductor high boost ratio dc–dc converters with only inductive energy delivery, the dc current bias is greatly reduced, decreasing the size of the magnetics. Second, the turnoff current is decreased, which causes a reduction in the turn-off switching losses. At time t1, MOSFET S1 is turned OFF, the clamping diode D1 is turned ON by the leakage energy stored in the hybrid transformer during the time period that the MOSFET is ON and the capacitor Cc is charged which causes the voltage on the MOSFET to be clamped.

At time t2, the capacitor Cc is charged to the point that the output diode Do is forwarded biased. The energy stored in the magnetizing inductor and capacitor Cr is being transferred to the load and the clamp diode D1 continues to conduct while Cc remains charged. At time t3, diode D1 is reversed biased and as a result, the energy stored in magnetizing inductor of the hybrid transformer and in capacitor Cris simultaneously transferred to the load. During the steady-state operation, the charge through capacitor Cr must satisfy charge balance. The key waveform of the capacitor Crcurrent shows that the capacitor operates at a hybrid-switching mode, i.e., charged in resonant style and discharged in linear style.

TheMOSFET S1 is turned ON at time t4. Due to the leakage effect of the hybrid transformer, the output diode current i0will continue to flow for a short time and the output diode Do will be reversed biased at time t0; then the next switching cycle starts.

2.2 SIMULATION OUTPUT

The figure 2.2a shows the voltage and current waveforms of the proposed converter. Gate represents the driver signal of the active MOSFET switch S_1; icc is the current of clsmping capacitor C_c; i_o is the current through the output diode; and V_o is the output voltage of the circuit.

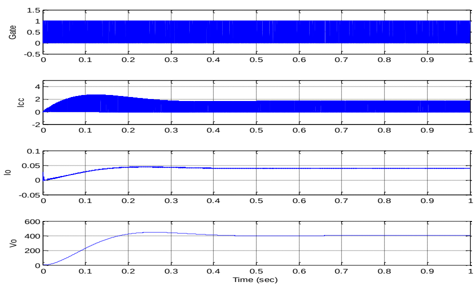

Fig 2.2a Simulation Output

Figure 2.2b shows the study state output voltage of the gate pulse, icc, i_o and V_o. For simplicity , we assume that the dc input voltage is a stiff voltage source with a constant voltage Vin, the load is a resistor and all the switch and diodes are ideal devices.

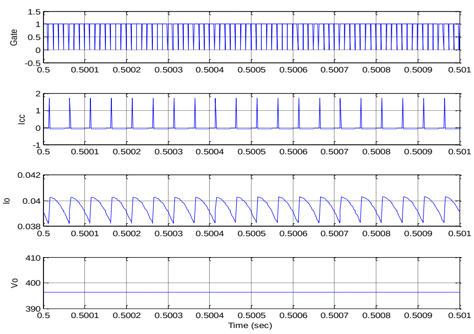

Fig 2.2b Simulation Output

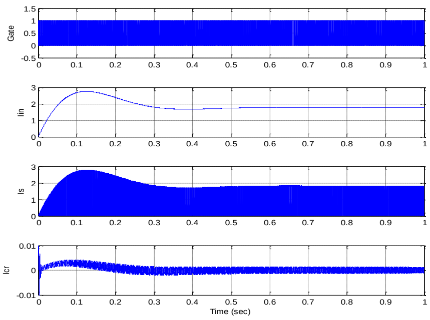

Fig 2.2c Simulation Output

The figure 4.2c shows the output of the proposed converter. Gate pulse represents the driver signal of the active MOSFET switch S_1; Iin is the primary side current of hybrid transformer; I_s is the surrent of the MOSFET S_1; Icr is the current of the resonant capacitor C_r.

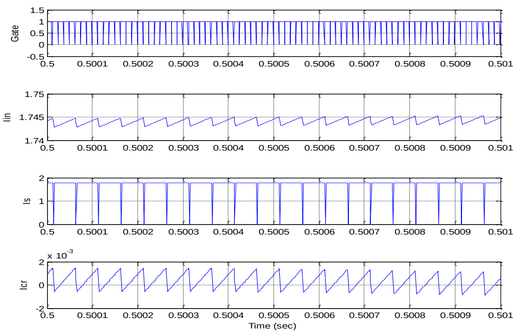

Fig 2.2d Simulation Output

The figure 2.2d shows the study state output of the proposed converter. The current in MOSFET S_1 is the sum of the resonant current and linear magnetizing inductor current. There are two distinctive benefits that can be schieved by the linear and resonant hybrid mode operation.the first benefit is that the energy delievered from source during the capacitive mode and inductive mode simultaneously. Also the dc current bias is greatly reduced, decreasing the size of the magnetics. Second, the turn-off current is decreased, which causes a reduction in the turn-off switching losses.

3.CONCLUSION& FUTURE ENHANCEMENTS

3.1 CONCLUSION

Thus it proposes a highly efficient high boost ratio dc-dc converter for photovoltaic module applications with the following features and benefits:

- This converter transfers the capacitive and inductive energy simultaneously to increase the total power delivery and reducing losses in the system.
- The conduction loss in MOSFET is reduced as a result of the low input

RMS current and switching loss is reduced with a lower turn off current.

- With these improved performances, the converter can maintain high efficiency under low output power and low-input voltage conditions.

3.2 FUTURE ENHANCEMENTS

For higher power level applications, the interleaving method is applicable to the traditional high boost ratio PWM dc-dc converter. So that, the circuit offers lower conduction losses, low input current ripple, reduced output voltage ripple.

4.REFERENCES

[1] J.S.Lai, "Power conditioning circuit topologies," IEEE Ind. Electron. Mag., vol.3, no.2, pp. 24-34, Jun. 2009.

[2] Y.P.Hsieh, J.F. Chen, T. J. Liang, and L. S. Yang, "Novel high step-up DC–DC converter with coupled-inductor and switched-capacitor techniques," IEEE Trans. Power Electron., vol. 59, no. 2, pp. 998–1007, Feb.2012.

[3] F.Blaabjerg, Z. Chen, and S.B. Kjaer, "Power electronics as efficient interface in dispersed power generation systems," IEEE Trans. Power Electron., vol. 19, no. 5, pp. 1184-1194, Sep. 2004.

[4] W. H. Li and X. N. He, "Review of non- isolated high step-up dc-dc converters," IEEE trans. Ind. Electron., vol. 58, no.4, pp. 1239-1250, Apr. 2011.