

Survey Study on Hybrid Transformer Integrated with High Boost Ratio DC-DC Converter for PV Array Applications

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Abstract - Analysis and Detailed study are important parts for future research on any topic and design of modified electrical circuits. This Paper presents the study and survey made on high boost- ratio hybrid transformer dc-dc converter low-voltage applications with renewable energy sources like PV array. The DC-DC boost converter is modeled using small signal analysis where the duty cycle and the voltage are the control & Output variable respectively. As a result of incorporating the resonant mode of operation into the outmoded high boost ratio pulse-width modulation (PMW) converter, we further modify the circuits to obtain the new result. A transfer function of the converter is derived where the duty cycle and the voltage are the control and output variables respectively. Hence to improve the output we have to modify the circuit to boost the gain to next level.

Key Words: Hybrid transformer, High boost ratio DC-DC converter IGBT, Full-Bridge Voltage Source Inverter, PV array.

1. INTRODUCTION

DC-Dc converters are used as switching circuits to convert as pulsating Dc voltage into a regulated and smooth DC voltage.

For higher power applications more numbers of modules can be paralleled to increase the power rating and the dynamic performance of the high step-up converter is proposed for a frontend photovoltaic system. But at lower voltage level we have to boost it to optimum voltage.

With increasing concern about non-renewable sources of energy, the steady increase in fossil fuel prices, global warming, environmental degradation and the ecosystem. Renewable energy is becoming increasingly popular and attracting more attention as an alternative to non-renewable energy sources. Among the renewable sources of energy, energy is considered to be the most important, most reliable and most sustainable energy source compared to other types of energy sources such as wind, tides, etc., by photovoltaic effects. Basically, there are different types of DC-DC regulators, i.e, buck converter, boost converter and buck- boost converter. For integration with PV array, those converters output need to be regulated irrespective of load variation.

2. SYSTEM DESCRIPTION AND CONVERTER TOPOLOGY

2.1 Bidirectional dc-dc converters

Bidirectional converters have a simple structure, better Efficiency, high reliability at low cost. The basic converter consists of a single switch and a single diode and can have an inductor and a capacitor as storage elements. Another converters with two switches, two diodes and additional energy storage elements.

Bidirectional converters can transmit electricity in both directions. When Source1 actively transmits power, the other side is turned off The converter consumes energy acting as a load and vice versa.

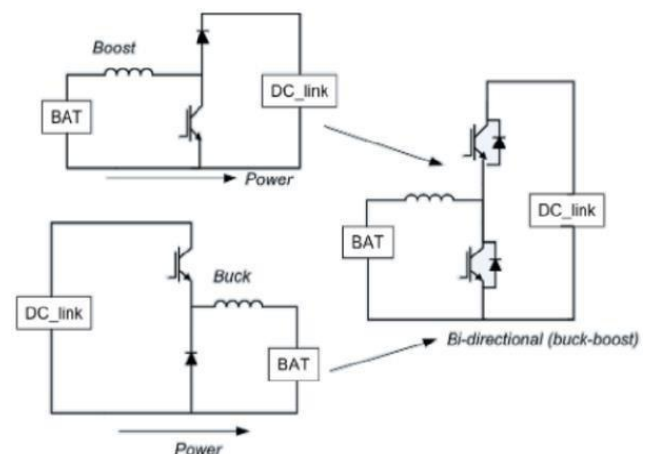


Fig.1 - Bidirectional DC-DC converters

2.2 Multiport dc-dc converters

Multiport converters, a promising concept for alternative energy systems, have attracted increasing research interest recently. The Single input topology 1 can also be used in the V2G mode with the battery pack and ultra-capacitor bank serving as multiple input sources, and a DC external load connected across C4 at Vout in the circuit shown in Fig2.

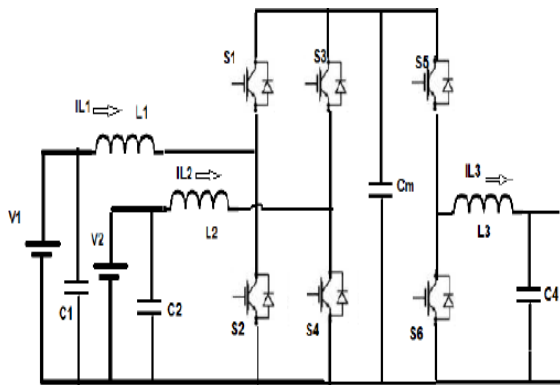


Fig.2- Multiport DC-DC converter

The multiport DC-DC converter has been proposed to efficient power management and grid integration for the multiple origins and development in a new era in a demand quality power in remote communities. The isolated dc-dc converter has multiple input ports for connecting different sources, such as photovoltaic (PV) panels, wind turbine generators (WTGs), fuel cells, etc., The multiport dc-dc converter not only regulates the low level dc voltages of the sources to a constant high level required by the inverter but also provides other important control functions, such as maximum power point tracking (MPPT).

3. OPERATING PRINCIPLE OF SYSTEM COMPONENTS

3.1 High boost ratio DC to DC Converter

It is a combination of flyback and boost converters. Flyback converter consists of $L1=L2$, C_r , D_r & L_r and a boost converter, which consists of $L1$, $S1$, $D1$ & C_c . Hence the flyback output is $nD/(1-D)$ and boost output is $1/(1-D)$, the total output voltage is $(1+nD)/(1-D)$.

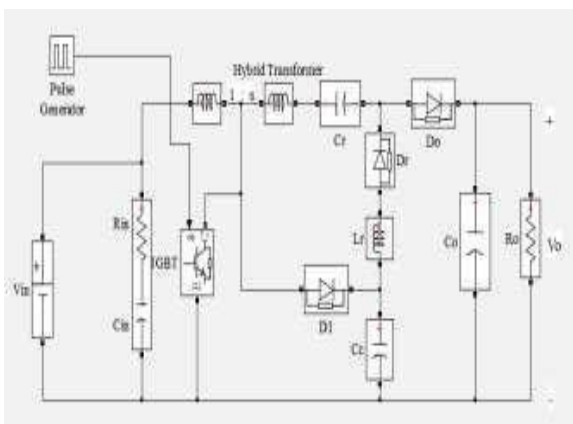


Fig. 3. High boost ratio DC to DC Converter

(i) Boost Converter

DC to DC Converters are used for converting one level of DC voltage (usually unregulated) to another level of DC voltage (regulated). This transformation is done with the help of a network consisting of storage elements like inductor and capacitor.

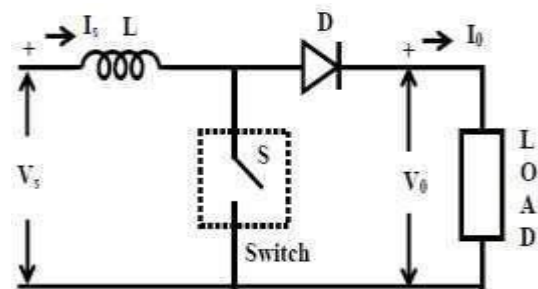


Fig. 4. Boost converter

The boost converter is the tendency of an inductor to oppose sudden changes in current. In a boost converter, the output voltage is always higher than the input voltage. A schematic of a boost converter is shown in Fig. 2. Here, IGBT is used as a switch. When the switch is turn-on, the current flows through the inductor (L) and hence energy is well as magnetic flux increases and storing energy in the transformer. The voltage induced in the secondary winding is negative.

(ii) Flyback Converter

It is suitable for both AC to DC and DC to DC conversion with galvanic isolation between the input and outputs. This is a type of buck-boost converter with the inductor split to form a transformer. Hence the voltage ratios are multiplied with an additional advantage of isolation.

The working principle of Flyback converter, when the switch is turned-ON, Transformer primary is directly connected to the input voltage source. So primary current as well as magnetic flux increases and storing energy in the transformer. The voltage induced in the secondary winding is negative.

So the diode is reverse-biased i.e. blocked. The output capacitor supplies energy to the load. When the switch is turned-OFF, the primary current and magnetic flux drops, Then the secondary voltage is positive i.e. forward-biasing the diode, allowing current to flow from the transformer.

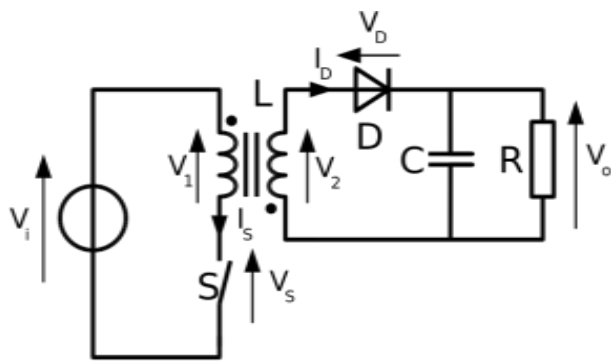


Fig. 5. Fly-back converter

The energy from the transformer charges the Capacitor and supplies the load.

3.2 Control of DC to DC converter

The output voltage of DC to DC converter is controlled or regulated by switching ON and OFF the switch, in a periodic manner. The regulation is normally achieved by Pulse Width Modulation (PWM) technique at a fixed frequency.

Where T is the time period of switching device and it is nothing but the addition of ON and OFF time of a switching device which is given by: $T = T_{ON} + T_{OFF}$

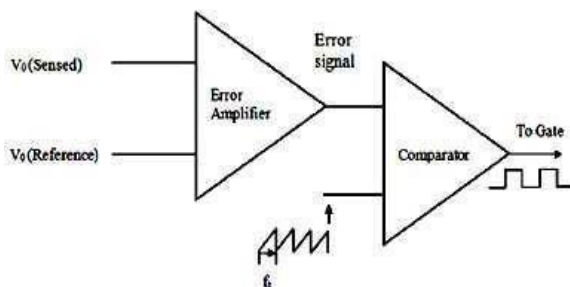


Fig. 6. Control circuit

As the ratio T_{ON}/T is duty ratio and as this duty ratio varies, the output voltage also varies. This is called constant frequency, variable duty ratio control.

Control circuit of boost converter is shown in Fig.5 for regulation purpose, output voltage is continuously sensed V_o (sensed) and compared with a reference voltage V_o (reference). The resulting error signal is compared with a sawtooth waveform having frequency f_t . The output of a comparator is fed to the switch or fed into the gate of a power IGBT. Usually, frequency in kilohertz is selected so as to maximize the efficiency of a converter.

A full-bridge voltage source inverter (VSI) is used here, which consists of four switches. The function of the VSI is

to convert DC voltage supplied by the DC-DC converter into an AC.

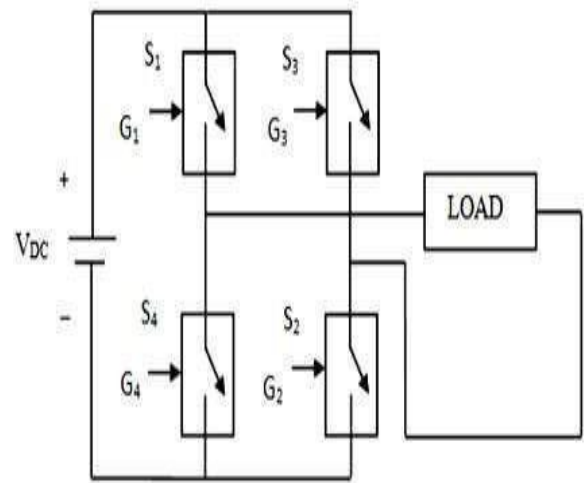


Fig. 7. Full-Bridge Voltage Source Inverter

The output signal from this full-bridge VSI is a square waveform which contains the desired output waveform along with frequency components at or around harmonics of the switching frequency. A low-pass filter is utilized here to extract the desired output voltage (50 Hz fundamental frequency) by separating it from the switching frequency.

4. INTEGRATION WITH PV MODULE

PV array is composed of number of PV panels; While PV panel is a series as well as parallel combination of PV cells. A solar cell is basically a semiconductor diode whose p-n junction is exposed to light. A single solar cell can produce only up to 3 to 5 W output power and to increase the output power number of such cells is connected in series.

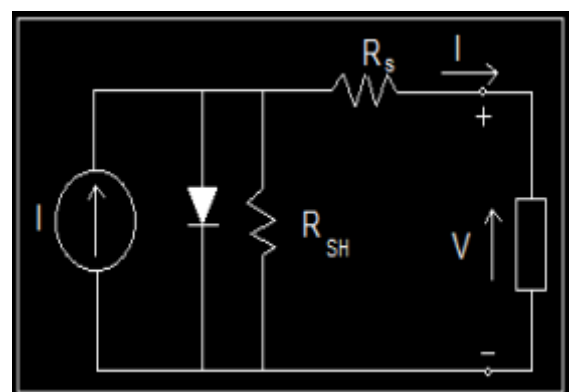


Fig.8 -Single Diode model of PV cell

The review on multiport dc-dc converter for simultaneous power management of multiple renewable energy sources uses only one power electronic switch in each input port connected to a source. Typically a solar cell can be modeled

by a current source and an inverted diode connected in parallel to it. It has its own series and parallel resistance. Series resistance is due to hindrance in the path of flow of electrons from n to p junction and parallel resistance is due to the leakage current.

5. NEED OF MODIFICATION

As per the present scenario, utilization of renewable energy sources such as PV modules need power conditioning systems (PCS) to improve the stable output. Current study shows it is not that much effective to boost the power to meet the requirements in peak load duration. To overcome these limitations, we need a high efficient and high boost ratio dc-dc converter to increase the low dc input voltage from the PV panel to a higher dc voltage.

6. CONCLUSION

After review these previously published paper, we conclude that a DC-DC boost converter with small power application have several limitations and it was the topic of further investigation. A transfer function of the converter is derived where the duty cycle and the voltage are the control and output variables respectively. Hence to improve the output we have to modify the circuit to boost the gain to next level.

To overcome the limitation of the previous research works, it was needed to modify in current circuit to boost the characteristics of the hybrid transformer so that to we can get optimum output from the PV array when integrated into the high boost DC-DC converter.

REFERENCES

- [1] Myada Shadoul, Rashid Al Abri, Hassan yousef, Mahmoud Masoud, "DC- DC Boost Converter Controller Design for PV Applications" 978-1-5386-2756-3/17/\$31.00 9th IEEE-GCC Conference and Exhibition (GCCCE) ©2017 IEEE
- [2] A. Lavanya, J. Divya Navamani and K. Vijayakumar, "Multiport Dc-Dc Converter for Renewable Energy Applications", International Journal of Pure and Applied Mathematics, ISSN: 1311-8080 Vol 118 No. 17 2018.
- [3] Ruchika Sharma, Kuldeep Thakur "A Review on Multiport DC-DC Converter for Different Renewable Energy Sources", IRJET, ISSN 2395-0072, Vol. 3, Issue 8, 2016.
- [4] Challa Srinivas Reddy, Rosaiash Mudigondla, "Optimized Magnetics and Improved Power Devices Utilization for PV Modules by Using Hybrid Transformer ZVS/ZCS DC-DC Converter", IJMETMR, ISSN 2348-4845, Vol. 3, Issue. 6, 2016.
- [5] T. Ravi Kumar, V. Lavanya, "High Efficiency PV based Interleaved DC-DC Converter for AC Load Applications", IJASTEMS, ISSN 2454-356X, Vol. 2, Issue 8, 2016.

- [6] Chaithanya Kumar, Narasimhaiah Achari, "High Boost Ratio Hybrid Transformer DC-DC Converter for Photovoltaic Module Applications", IJATIR, ISSN 2348-2370, Vol. 8, Issue.02, 2016.
- [7] S. Priya, "Design of High Step-Up DC-DC Converter with Single Switch and SPWM Inverter for Micro source Application", IJEDR, ISSN 2321-9939, Vol. 4, Issue 4, 2016
- [8] K. Suvarna Kumary, B. Revathi, "High Boost Ratio Hybrid Transformer DC-DC Converter for PV Grid Applications", IJSR, ISSN 2319-7064, Vol. 4, Issue 3, 2015.
- [9] Muthukrishnan and R. Dhanasekaran, "Design and Simulation of Voltage Booster Circuit Using Coupled Inductor", ARPN, ISSN 1819- 6608, Vol. 10, Issue 6, 2015.
- [10] Bukya Rajesh, "Design of Modified Single Input Multiple Output Dc- Dc Converter", IJCSMC, ISSN 2320-088X, Vol. 3, Issue 10, 2014.

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