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Second Order Hbc Prototype for Front- End Photo voltaic systems

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ABSTRACT

Front-end PV system with a 200-W, 35 to 380 V second-orders HBC is designed and hybrid boosting converter (HBC) with collective advantages of regulation capability from its boost structure and gain enhancement from its voltage multiplier structure is proposed in this project. The new converter incorporates a bipolar voltage multiplier, featuring symmetrical configuration, single inductor and single switch, high gain capability with wide regulation range, low component stress, small output ripple and flexible extension. The operation principle, component stress, and voltage ripple are analyzed in this project.Performance, comparison and evaluation with a number of previous single-switch single-inductor converters are provided and the experimental result confirms the feasibility of the proposed converter.

INTRODUCTION:

In recent years, the rapid development of renewable energy system calls for new generation of high gain dc/dc converters with high efficiency and low cost. The front end of "Plug and Play" PV system usually demands step-up converter which is capable of boosting the voltage from 35 to 380Vwith regulation capability due to the low terminal voltage and the requirement of MPPT tracking function for single PV panel. Considering a wind farm with internal medium-voltage dc (MVDC)-grid system, a MVDC converter able to boost the voltage from 1−6 to 15−60 kV is required to link the output of generator-facing rectifier to the MVDC line. Some other energy storage systems such as fuel cell powered system also require high-gain dc/dc converter due to their low voltage level at storage side. In order to achieve high voltage conversion ratio with high efficiency, many high gain enhancement techniques were investigated in the previous publications. Among them, switched capacitor tapped/coupled inductor based technique transformer based technique voltage multiplier structure or combinations of them attracted significant attentions. Each technology has its unique advantages and limitations. The switched capacitor dc−dc converter can achieve high efficiency but has pulsating current and poor regulation capability. Introduction of resonant switched-capacitor converter can alleviate the pulsating current but does not solve the regulation issue. The tapped inductor and transformer facilitate gain boosting function but require snubber circuit to handle leakage problem. The combination of above technologies usually outputs promising circuit features but with excessive number of components. In this paper, gain enhancement technology based on modification of traditional boost converter while maintaining single inductor and single switch is investigated, targeting at

simplifying the circuit design, reducing the cost, satisfying the demands of normal high gain applications, and facilitating mass production.

BOOST CONVERTER

A boost converter (step-up converter) is a power converter with an output DC voltage greater than its input DC voltage. It is a class of switching mode power supply (SMPS) containing at least two semiconductors switches (a diode and a transistor) at least one energy storage element. Filters made of capacitor (sometimes in combination with inductor) are normally added to the output of the converter to reduce output voltage ripple.

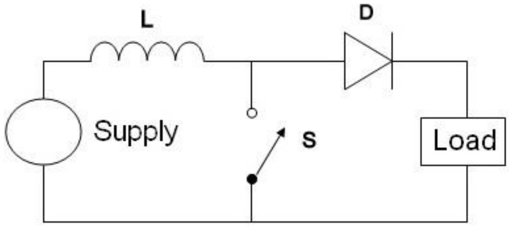


Fig 2.1: Circuit Diagram of Boost Converter

Power can also come from DC sources such as batteries, solar panels, rectifiers and DC generators. A process that changes one DC voltage to a different DC voltage is called DC to DC conversion. A boost converter is a DC to DC converter with an output voltage greater than the source voltage. A boost converter is sometimes called a step-up converter since it “steps up” the source voltage. Since power ($P = VI$ or $P = UI$ in Europe) must be conserved, the output current is lower than the source current.

A boost converter may also be referred to as a 'Joule thief'. This term is usually used only with very low power battery applications, and is aimed at the ability of a boost converter to 'steal' the remaining energy in a battery. This energy would otherwise be wasted since a normal load wouldn't be able to handle the battery's low voltage.
This energy would otherwise remain untapped because in most low-frequency applications, currents will not flow through a load without a significant difference of potential between the two poles of the source (voltage.)

BLOCK DIAGRAM:

The basic building blocks of a boost converter circuit are shown in Fig.2.2

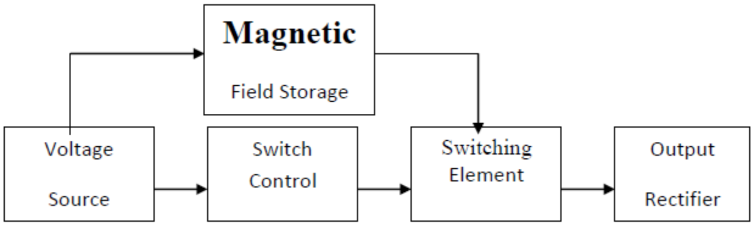


Fig 2.2: Block diagram of Boost Converter

Continuous mode:

When a boost converter operates in continuous mode, the current through the inductor (IL) never falls to zero. Figure2.3(c) shows the typical waveforms of currents andvoltages in a converter operating in this mode.

The output voltage can be calculated asfollows, in the case of an ideal converter (i.e. fig 2.3 (c)using components with an ideal behavior)operating in steady conditions:

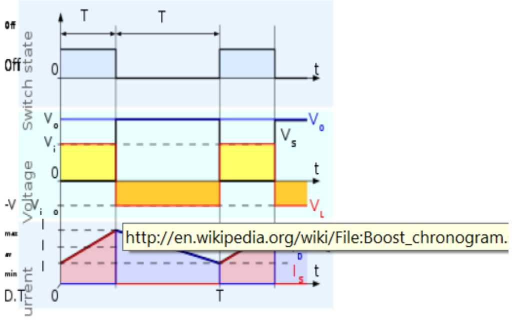


Fig 2.3 c): Waveforms of Current and Voltage in a Boost Converter Operating In Continuous Mode

During the On-state, the switch S is closed, which makes the input voltage (Vi) appear across the inductor, which causes a change in current (IL) flowing through the inductor during a time period (t) by the formula:

$$\frac{\Delta I_L}{\Delta t} = \frac{V_i}{L}$$

At the end of the On-state, the increase of IL is therefore:

$$\Delta I_{L_{On}} = \frac{1}{L}\int_0^{DT} V_i dt = \frac{DT}{L} V_i$$

D is the duty cycle. It represents the fraction of the commutation period T during which the switch is on. Therefore D ranges between 0 (S is never on) and 1 (S is always on).

During the Off-state, the switch S is open, so the inductor current flows through the load. If we consider zero voltage drops in the diode, and a capacitor large enough for its voltage to remain constant, the evolution of IL is:

$$V_i - V_o = L\frac{dI_L}{dt}$$

Therefore, the variation of IL during the Off-period is:

$$\Delta I_{L_{Off}} = \int_0^{(1-D)T} \frac{(V_i - V_o)\, dt}{L} = \frac{(V_i - V_o)\,(1-D)\,T}{L}$$

As we consider that the converter operates in steady-state conditions, the amount of energy stored in each of its components has to be the same at the beginning and at the end of a commutation cycle. In particular, the energy stored in the inductor is given by:

$$E = \frac{1}{2} L I_L^2$$

So, the inductor current has to be the same at the start and end of the commutation cycle. This means the overall change in the current (the sum of the changes) is zero:

$$\Delta I_{L_{On}} + \Delta I_{L_{Off}} = 0$$

Substituting $\Delta I_{L_{On}}$and $\Delta I_{L_{Off}}$ by their expressions yields:

$$\Delta I_{L_{On}} + \Delta I_{L_{Off}} = \frac{V_i DT}{L} + \frac{(V_i - V_o)\,(1-D)\,T}{L} = 0$$

This can be written as:

$$\frac{V_o}{V_i} = \frac{1}{1-D}$$

Which in turns reveals the duty cycle to be?

$$D = 1 - \frac{V_i}{V_o}$$

From the above expression it can be seen that the output voltage is always higher than the input voltage (as the duty cycle goes from 0 to 1), and that it increases with D, theoretically to infinity as D approaches 1. This is why this converter is sometimes referred to as a *step-up* converter

Discontinuous mode:

In some cases, the amount of energy required by the load is small enough to be transferred in a time smaller than the whole commutation period. In this case, the current through the inductor falls to zero during part of the period. The only difference in the principle described above is that the inductor is completely discharged at the end of the commutation cycle (see waveforms in figure). Although slight, the difference has a strong effect on the output voltage equation. It can be calculated as follows:

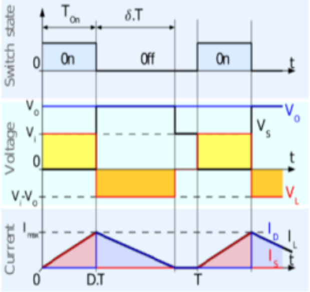


Fig 2.3 (d): Waveforms of Current and Voltage In A Boost Converter Operating In Discontinuous Mode

Fig 2.3 (d): Waveforms of Current and Voltage In A Boost Converter Operating InDiscontinuous Mode

As the inductor current at the beginning of the cycle is zero, its maximum value $I_{L_{Max}}$ (at $t = DT$) is

$$I_{L_{Max}} = \frac{V_i DT}{L}$$

During the off-period, IL falls to zero after δT:

$$I_{L_{Max}} + \frac{(V_i - V_o)\,\delta T}{L} = 0$$

Using the two previous equations, δ is:

$$\delta = \frac{V_i D}{V_o - V_i}$$

The load current Io is equal to the average diode current (ID). As can be seen on figure 4, the diode current is equal to the inductor current during the off-state. Therefore the output current can be written as

$$I_o = \bar{I_D} = \frac{I_{L_{max}}}{2}\delta$$

Replacing ILmaxand δ by their respective expressions yields:

$$I_o = \frac{V_i DT}{2L} \cdot \frac{V_i D}{V_o - V_i} = \frac{V_i^2 D^2 T}{2L\,(V_o - V_i)}$$

Therefore, the output voltage gain can be written as flow:

$$\frac{V_o}{V_i} = 1 + \frac{V_i D^2 T}{2 L I_o}$$

Compared to the expression of the output voltage for the continuous mode, thisexpression is much more complicated. Furthermore, in discontinuous operation, theoutput voltage gain not only depends on the duty cycle, but also on the inductor value,the input voltage, the switching frequency, and the output current.

SIMULATION CIRCUITS & RESULTS

MAIN CIRCUIT DIAGRAM:

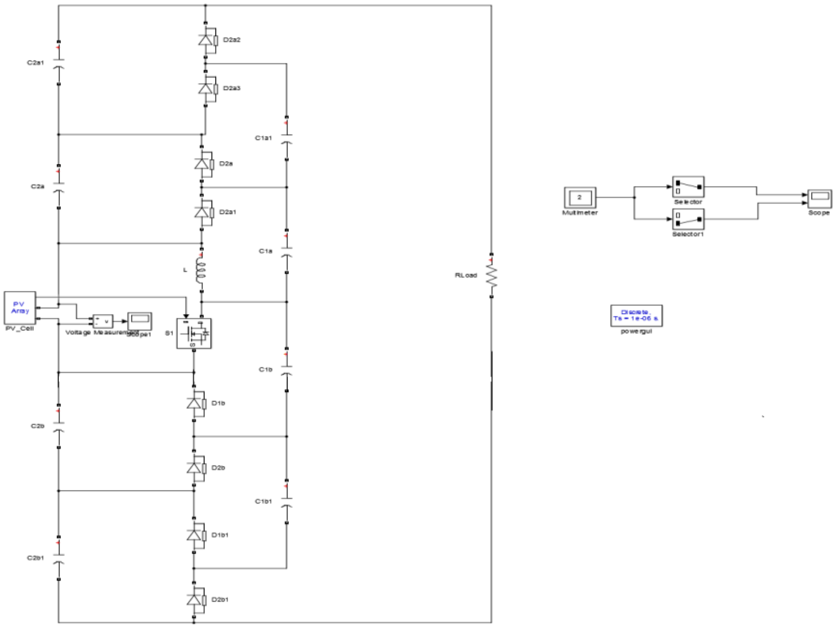


Figure 3. Main Circuit Diagram

In this figure the input voltage is taken from PV cell (i.e. Renewable Energy Source). The voltage measurement is connected across the output terminal of the PV array the main purpose voltage measurement is how much of voltage is generated in PV cell. Same output voltage of PV cell is connected to the bridge network, this bridge network will act as two half-cycles i.e. one for positive half cycle and another for negative half cycle. In this, positive half-cycle the upper side of converter will act into operation and in negative half-cycle the down side of the converterwill act into operation. The main purpose of the IGBT is, it acts as a switch. The switch isoperated depending upon the clock pulse. The clock pulse is generated within the Boostconverter and the control strategy of MPPT. The inductor is connected in series to the IGBTand finally RL load

PV Array:

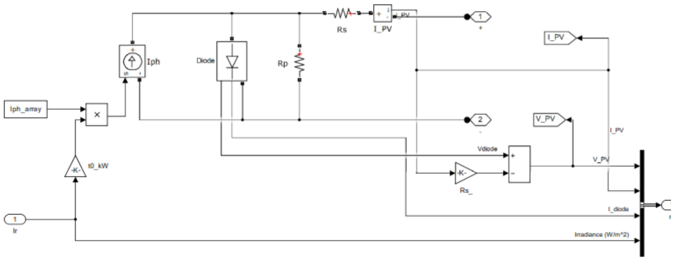


Figure (a) PV Array The above figure shows the PV ARRAY

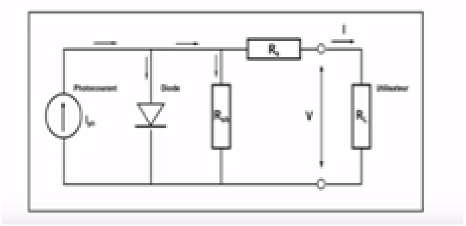


Figure (b) Basic Symblol

Where Iph=Photocurrent

Irs=Reverse diode current

Is= current in Rs resistance

I= The total output current(Io)

PV CELL:

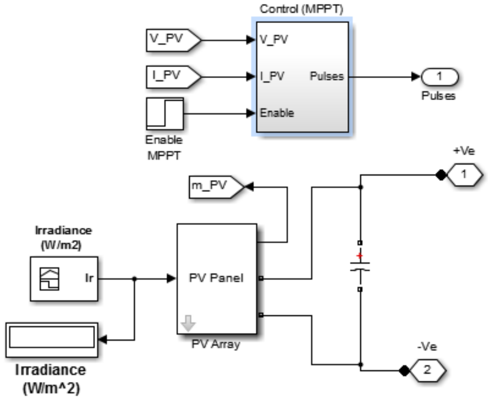
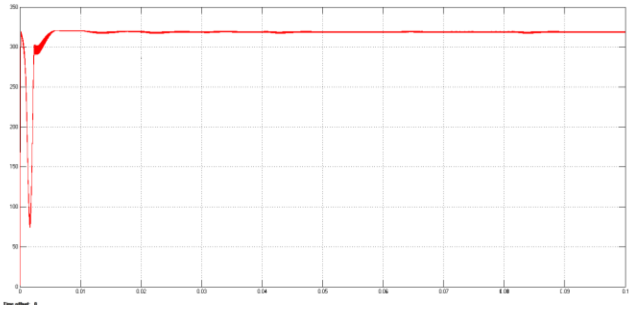


Figure (c) PV cell

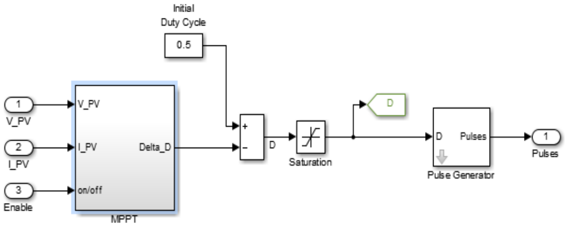
The above Fig(c) shows the solar PV cell, in this figure the solar irradiance is connected to the PV panel or PV array as shown in fig. if suppose the solar irradiance increases the output voltage of the PV panel also increases. The output voltage depends on the solar irradiance. The PV array is designed internally by connecting number of PV cells which are connected in series manner and it produces the required output voltage.



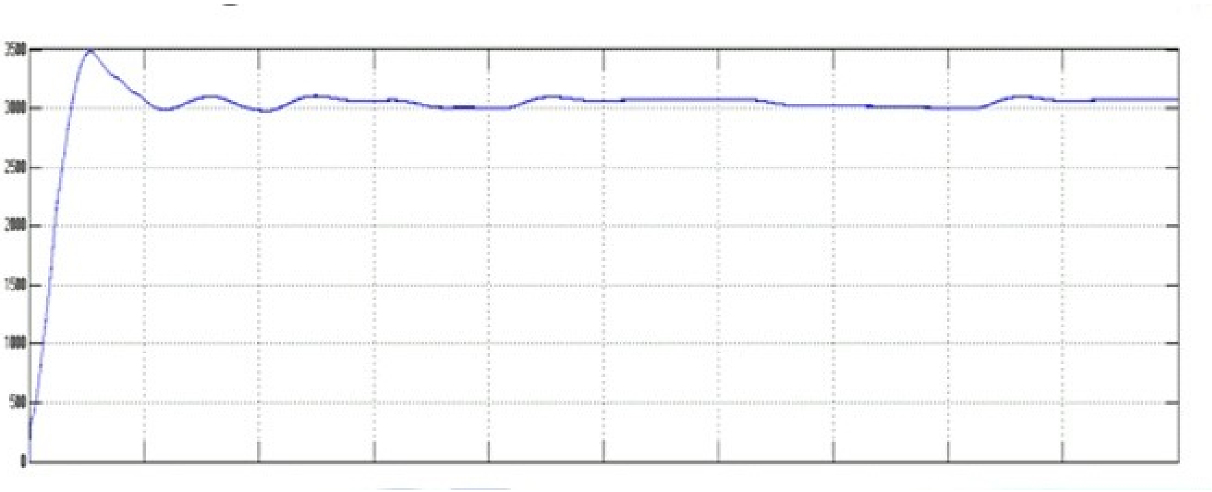
LOAD VOLTAGE AND LOAD CURRENT:

Figure (d) PV Cell output

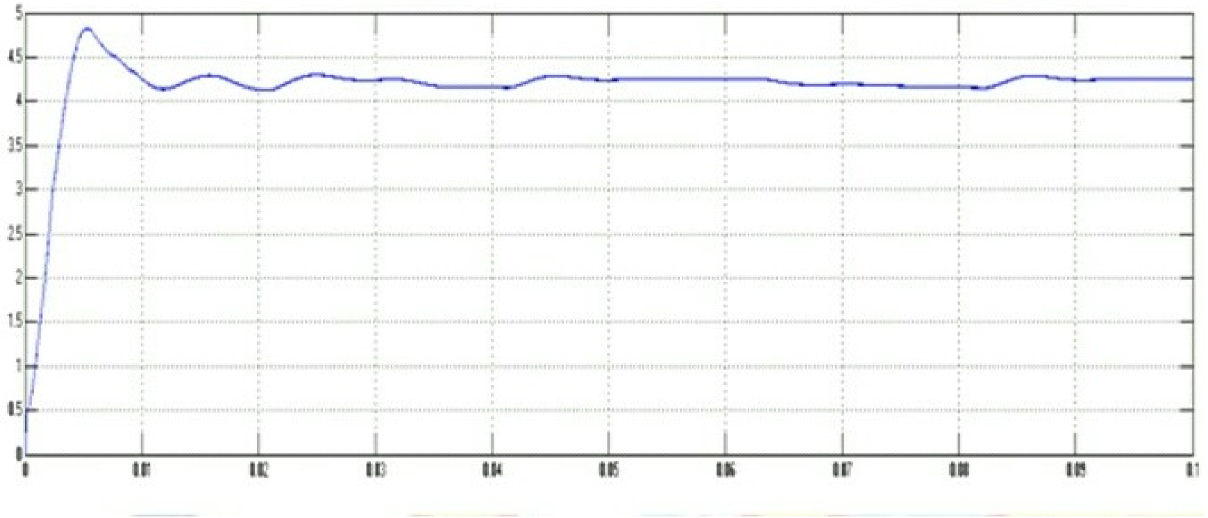
MPPT CONTROL:



The above figure (e) shows the Maximum Power Point Technique control, where we have three input parameters those are V_ PV, I_PV and Enable. The enable is used to control the MPPT it works as a switch when ENABLE is ON the MPPT generate the signal and the ENABLE is DISABLE then the MPPT is TURN OFF and finally output of MPPT."D" is connected to the input of the logical operator and other input is taken form dutycycle. In duty cycle, the modulation index is set to 0.5. The logical operator perform thelogical operation and it produces an output D. thus the output D is connected to the input ofthe Pulse Generator the PG generates pulses and it is connected to the input of the gain Kand also connected to the multiplexer.



Output Voltage



Output current

In the main circuit diagram the output side of the converter is connected to loadresistance R . The input voltage is taken in to the solar PV i.e.converter input voltage is applied to HB converter and then the generated output

CONCLUSION

Front-end PV system with a 200-W, 35 to 380 V second-order HBC is designed andhybrid boosting converter (HBC) with collective advantages of regulation capability andgain enhancement from its boost structure and voltage multiplier structure were proposedin this project. A Bipolar voltage multiplier (BVM) was included in a new converter,featuring symmetrical configuration, single inductor and single switch, high gaincapability with wide regulation range, low component stress, small output ripple andflexible extension. The various processes of component stress, voltage ripple andoperation principle were analyzed in this project. The results confirms thefeasibility of the proposed converter by their performance, comparison and evaluationwith a number of previous single-switch, single-inductor convertors provided.

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