Performance Analysis of BLDC Motor Using Interleaved Boost Converter Cum Solar PV

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Abstract **- BLDC motor has been progressively replacing conventional DC drives in various applications such as electrical vehicles and industrial automation. The SPV array is designed such that the power at rated DC voltage is supplied to the BLDC motor under standard test condition and maximum switch utilization of interleaved boost converter is achieved which results in efficiency improvement of the converter. A Photovoltaic (PV) array under uniform irradiance exhibits a current voltage characteristic with a unique point called the maximum power point (MPP) where the array produces maximum output power.The interleaved boost topology provides superior performance with low voltage and current stress and low individual component losses. The electronically commutated BLDC motor is used with a voltage source inverter (VSI) operated at fundamental frequency switching thus avoiding the high frequency switching losses resulting in a high efficiency of the system. Finally, in Matlab/Simulink environment, Performances of the proposed drive are simulated, which improved the efficiency and power factor.**

Keywords: solar pv(photo voltaic), MPPT(Maximum Power Point tracking) ,interleaved boost converter ,bldc (Brushless DC Motor)

INTRODUCTION

Today ,solar PV is served as a major source of electricity. PV panels produce more energy than that of their installation .PV power generation is more expensive than other resources however governments are promoting it with subsidies or feed –in tarrifs ,expecting the development of the technology so that in he near future it will become competitive. Increasing the efficiency in plants so the power generated increases is a key aspect as it will increase the incomes reducing consequently the cost of the power generated so it will approach the cost of the power produced from other sources. BLDC motor are more efficient compared to induction motor because of its good performance with longer life [1], low commutation and low copper loss. A motor controller converts DC to AC this design is simpler than that of brushed motors because it eliminates the complication of transferring power from outside motor to the spinning rotor.

In existing system boost converter, buck boost converter has been designed. The system have low performance when compared to interleaved boost converter. Power leakage and high harmonics are considered as the major drawback of this system. These drawbacks are overcome by interleaved boost converters. When the power demands increases, a single power stage in converter is insufficient. When compared to the single-boost converter, the interleaved boost converter approach provides efficiency, size and cost advantages in both analytically and empirically. A conventional Boost converter is a type of DC-DC converter which is used to step up the input DC voltage. A desired output DC voltage can be obtained by varying the duty ratio of switching of the transistor. An Interleaved Boost converter is the parallel connection of two or more conventional Boost converters. The number of parallel connections determines the number of phases of the Interleaved Boost converter. An Interleaved Boost converter offers better current and voltage ripple reduction, improved power factor, etc. Also it reduces the component size, improves the transient stability of the system. Hence it is widely used in applications which require ripple reduction and power factor improvement. It is very important to track the MPP accurately under all possible conditions so that the maximum available power is always obtained.

The merits of the interleaved converter are as follows:I)The converter is characterized by a low input current ripple and low conduction lossesII)It is suitable for high power applications.III)The converter achieves the high step up voltage gain that renewable energy systems require.IV)The main switch voltage stress of the converter is lower than that of the output voltage.V)Low cost and high efficiency are achieved by the low voltage rating of the power switching device.

PROPOSED SYSTEM

1. SOLAR PHOTO VOLTAIC

Global warming and energy policies have become a hot topic on the international agenda in the last years. Developed countries are trying to reduce their greenhouse gas emissions. Photo voltaic (PV) power generation has an

important role to play due to the fact that it is a green source. The only emissions associated with power generation are those from the production of its components. After their installation they generate electricity from the solar irradiation without emitting greenhouse gases in their lifetime which is around 25 years .PV panels produce more energy than that for their manufacturing .Also they can be installed in places with no other use such as roofs and deserts or they can produce electricity for remote locations where there is no electricity network. The latter type of installations is known as off grid facilities and sometimes they are the most economical alternative to provide electricity in isolated areas .PV power generation is more expensive than other resources. Governments are promoting it with subsidies or feed in tariffs expecting the development of the technology so that in the near future it MPPT algorithms are necessary in PV applications because the MPP of a solar panel varies with the irradiation and temperature so the use of MPPT algorithms is required in order to obtain the maximum power from a solar array [2].Over the past decades many methods to find the MPPT have been developed and published. These techniques differ in many aspects such as required sensors, complexity , cost ,range of effectiveness, convergence speed , correct tracking when irradiation or temperature change hardware needed for the implementation or popularity among others .A Complete review of 19 different MPPT algorithms can be found .Among these techniques the P&O algorithms are the most common[3] . These techniques have the advantage of an easy implementation and also have low cost.

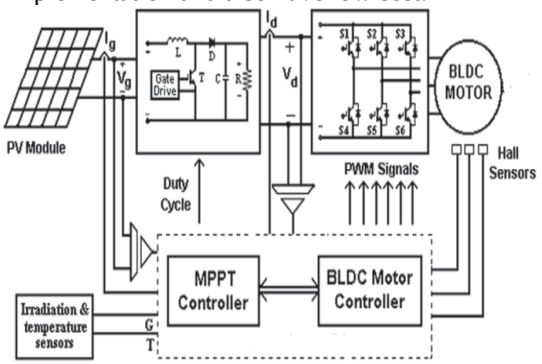


Fig.1 proposed block diaram

The Perturb & Observe algorithm states that when the operating voltage of the PV panel is perturbed by a small increment, if the resulting change in power P is positive, then we are going in the direction of MPP and we keep on perturbing in the same direction. If P is negative, we are going away from the direction of MPP and the sign of perturbation supplied has to be changed.

will become competitive .Increasing the efficiency in PV plants so the power generated increases is a key aspect as it will increase the incomes reducing consequently the cost of the power generated so it will approach the cost of the power produced from other sources Photovoltaic PV sources are used today in many applications as they have the advantages of maintenance free and pollution free .Solar electric energy demand has grown consistently by 20% to 25% per annum over the past 20 years which is mainly due to its decreasing costs and prices .A Photovoltaic (PV) array under uniform irradiance exhibits a current voltage characteristic with a unique point called the maximum power point (MPP) where the array produces maximum output power.

2.Maximum Power Point Tracking (Mppt)

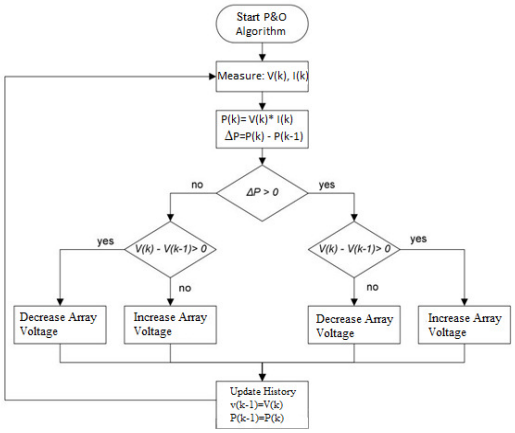


Fig 2. Flowchart of P&O algorithm

3.Inter Leaved Boost Converter

In the case of conventional Boost converter, ripple is present in the input current due to rise and fall of the inductor current. This problem can be eliminated by using Interleaved Boost converter. An Interleaved Boost converter is the parallel connection of 2 or more Boost converters [4], called the phases. Interleaved control In the case of conventional Boost converter, ripple is present in the input current due to rise and fall of the inductor current. This problem can be eliminated by using Interleaved Boost converter. An Interleaved Boost converter is the parallel connection of 2 or more Boost converters [5], also called the phases. Interleaved control of such a topology with n number of phases has phase shifting by $2\pi/n$ or T/n where T is the switching time period. The advantages of Interleaved Boost converter compared to the Boost converter are reduced current and voltage ripple, improved power factor, increased efficiency, reduction in the power rating of the inductor and the switch.

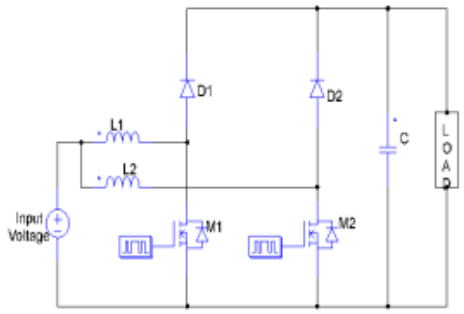


Fig 3.Circuit diagram of IBC Converter

WORKING PRINCIPLE

There are two modes of operation of a Interleaved Boost converter.

(i) Mode 1 :

At t =0, the gate pulse is given to the switch

- 'S1' of the first phase. Then the switch 'S1' is turned on, the current across the inductor L1 rises linearly.
- At the same time, the switch 'S2' in the second phase is turned off and the energy stored in the inductor L2 is transferred to the load through the output diode D2 [6].
- In this time interval, the diode D1 in the first phase is i**n reverse bias condition.**
- **At time t0, S1 is closed. The current in the inductor L1 starts to rise while L2 continues to discharge.**

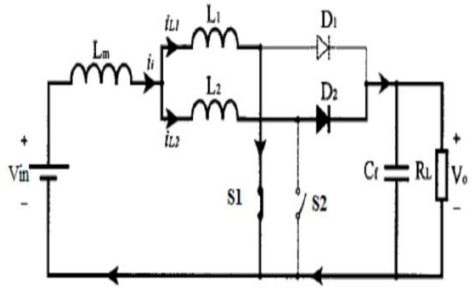


Fig 4.IBC mode 1 operation

(ii) Mode 2:

- At t = t1, the gate pulse is given to the switch 'S2' of the first phase.
- Then the switch 'S2' is turned on, the current across the inductor L2 rises linearly.
- At the same time, the switch 'S1' in the first phase is turned off and the energy stored in the inductor L1 is transferred to the load through the output diode D1.
- In this time interval, the diode D2 in the second phase is in reverse bias condition [7].
- At time t1, S2 is closed. The current in the inductor L2 starts to rise while L1 continues to discharge.

The rate of change of iL1 is approximately given

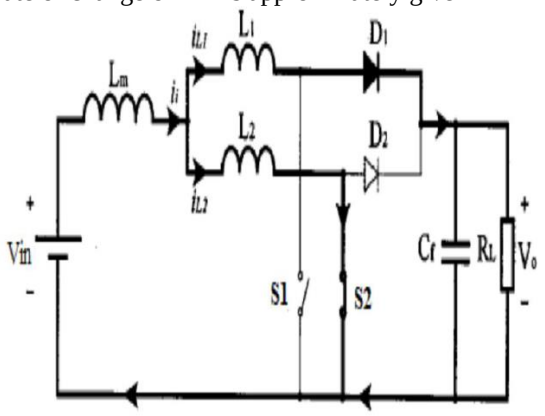


Fig 5.IBC mode 2 operation

The waveforms for voltages and currents are shown in Fig. 6 for continuous load current, assuming that the current rises or falls linearly.

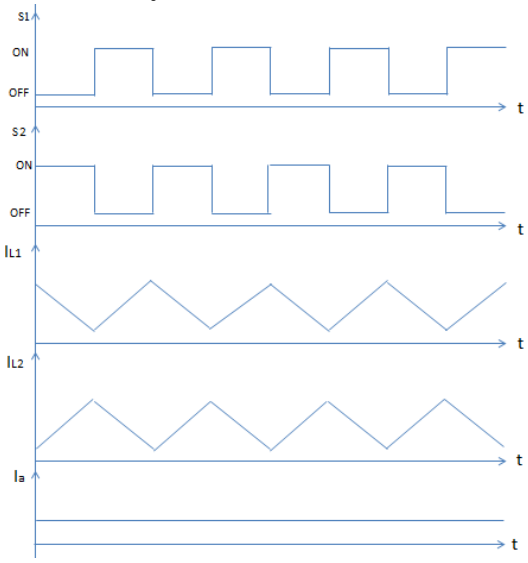


Fig 6.Voltage and current waveforms of IBC

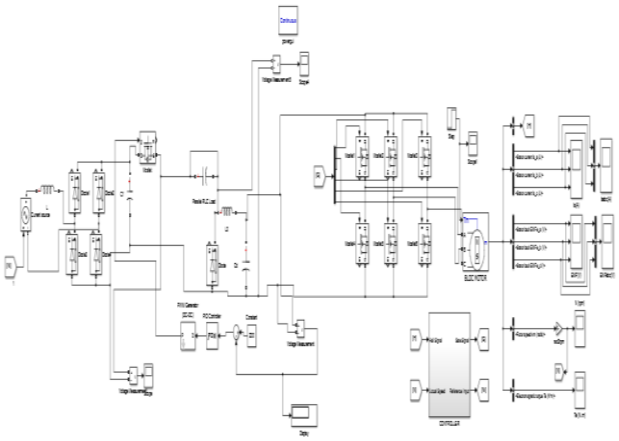
4. THREE PHASE VOLTAGE SOURCE INVERTER

The full-bridge inverter is only responsible for unfolding the sinusoidally modulated dc current packs into ac at the right moment of the grid voltage. Since the switches of the inverter are operated at the grid frequency, the switching losses are insignificant. Only conduction losses are concerned. For this reason, the bridge can use thyristor or even transistor switches for lower cost. However, for easy control also the availability in the laboratory for fast prototyping, we prefer using insulated-gate bipolar transistor (IGBT) switches for this design[10]. But, the final prototype will not use IGBTs. The low-pass filter after the IGBT inverter is responsible for supplying a current to the grid with low THD by removing the high frequency harmonics of the pulsed current waveforms.

5.BLDC MOTOR

BLDC motor are most popularly used in industrial application due to its reliability, low maintenance and low susceptibility. It has been progressively replacing conventional DC drives in various applications such as electrical vehicles and industrial automation. The BL30 EB is an extremely compact brushless DC motor with integrated drive electronics. This motor is an outer rotor motor providing a robust bearing system capable of handling high side loads. High quality components ensure an operating life of min. 20000 hours [8]. The output torque of 30 mNm at a constant speed of 3500 RPM makes this motor ideal for small membrane and peristaltic pumps, laser scanners, high-end fan and medical applications. The BLDC motor is selected because of its merits useful for the development of suitable water pumping system. This electronically commutated BLDC motor is supplied by a voltage source inverter (VSI) which is operated by fundamental frequency switching resulting in low switching losses [9].

SIMULATION RESULT



7.SIMULATION FIGURE OF BLDC MOTOR USING IBC

BLDC MOTOR OUTPUT

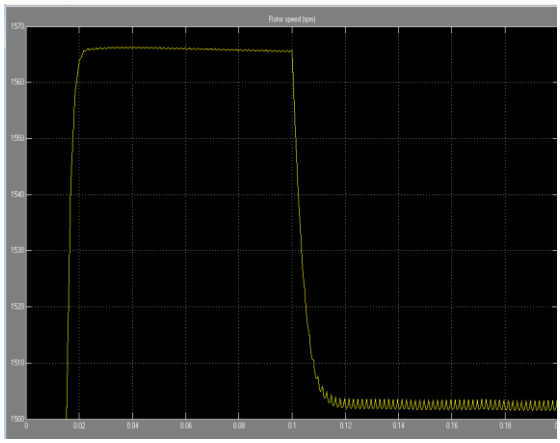


Fig 8.Bldc motor output

ROTOR SPEED

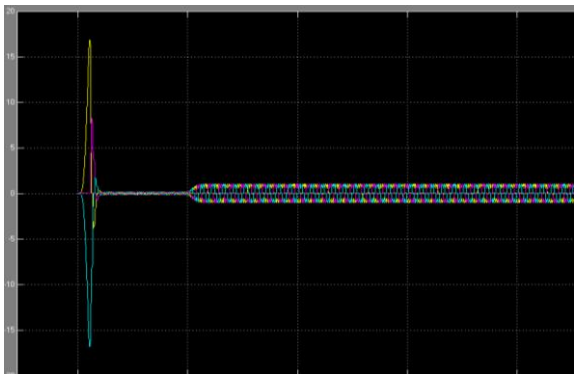


Fig 9.Rotor speed of Bldc motor

ELECTROMAGNETIC TORQUE

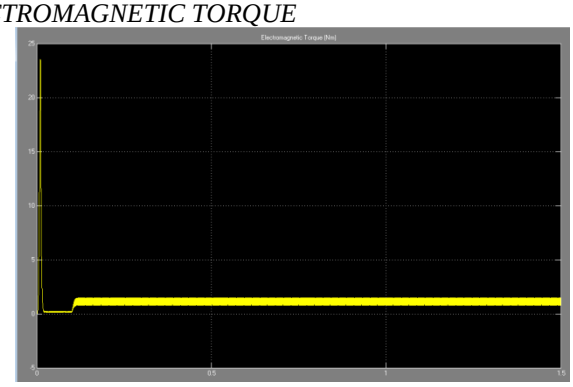


Fig10.Simulation of Electomagnetic Torque

CONCLUSION

This paper presents the simulation of interleaved boost converter feeding a BLDC motor drive in low power applications. With this proposed converter the power quality can be improved at the AC mains. The speed control of the BLDC motor can be carried out by varying the DC bus voltage level. Electronic commutation will leads to the reduction of switching stress in the inverter. Speed can be controlled by the variation in DC link voltage. The interleaved boost converter performed importantly among the system because the system required a sufficiently high step-up conversion. The interleaved boost converter magnetically coupled to a voltage doubled circuit which provides a voltage gain higher than that of conventional boost topology this converter has low voltage stress across the switches neutral voltage balancing between output capacitors, low input current ripple, and magnetic components operating with the double with the double of switching frequency .

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