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PERFORMANCE ANALYSIS OF PV BASED SERIES SEPIC CONVERTER FED BLDC MOTOR

K.Gokulraj asst prof Roever Engineering College, Elambalur, perambalur dist. k.Gokulraj14@gmail.com.

S.Arulmozhi Roever Engineering College Elambalur, perambalur dist. s.arulmozhi92@gmail.com.

ABSTRACT: ***This study deals with performance analysis of pv based series sepic converter fed bldc motor for variable speed applications. Extracting solar power from the solar cell with high efficiency is a challenge. A best boost converter can be employed to do the above mention process. compared with the prototype of the SEPIC converter this SERIES SEPIC converter can perform positive to positive DC-DC voltage increasing conversion with higher voltage transfer gains. They are different from other existing DC_DC step up converter and possess obivious advantages, mainly including fewer switches, clear conversion processes and a high voltage with simple ripples.The speed of the BLDC motor is controlled by varying the dc-link voltage source inverter (VSI). A low-frequency switching of the VSI is used for achieving the electronic commutation of BLDC motor for reduced switching losses. The voltage transformation is doubled. The simulations are done with MATLAB/SIMULINK and the results are exhibited,***

Index Terms—*pv panel, voltage source inverter, SERIES SEPIC converter, BLDC motor.*

1 INTRODUCTION

The Renewable energy is the only solution to meet the present energy crisis. Among them, solar energy is the best energy that can be employed without environmental contamination and maintenance free. Solar energy PV panel is a nonlinear device. In order to take out the maximum power from the PV panel a Boost converter can be employed between the PV panel and the load shown in Fig1. By adjusting the duty ratio of the converter, maximum power can be achieved from the PV panel. But, the energy generated by the system is very low. In order to overcome, the aforementioned disadvantage in the PV system the DC/DC boost converter is employed in between the power generation stage and the load to boost the voltage obtained. Power converters with high efficiency are required. The high efficiency can be achieved by reducing the switching losses, reducing input current and output voltage ripples. So, there is a high demand for finding out a best and suitable converter for every system depending on their load demands and requirements.

DC–DC step-up converters are widely used in computer hardware and industrial applications such as computer periphery power supplies, car auxiliary power supplies, servo-motor drives and medical equipment. The classical SEPIC converter has many industrial applications due to its good characteristics. This topology does not suffer from an output polarity inversion, and capacitor can prevent unwanted current flow from vin to vo. Under the different values of duty ratio D, it can perform step-down and step-up DC–DC conversion according to its voltage transfer function as The effect of parasitic elements occurs at high values of D, so the practical values of D have an upper limit. It is difficult to operate at higher duty ratios and hence achieve high-voltage transfer gains. With the fast development in technologies, this disadvantage limits the further applications of SEPIC converters in some areas that require higher voltage transfer gains such as in communication equipment, aerospace electronics, portable devices and IC chips. DC–DC converters may be developed by n-cell cascade connection or by adding transformers to obtain higher voltage transfer gains . However, the resulting problems, energy losses, multiple power switches and large switching surges in transformers significantly increase the control complexity and the cost of these converters. In recent years, advanced DC–DC conversion enhancement techniques such as switched-capacitor (SC) and voltage-lift (VL) techniques have been greatly explored . The main objective is to reach a high efficiency, high power density and simple structures. Since SEPIC converters are widely used in

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power electronics as a classical topology, the combination with the SEPIC prototype and the above-mentioned enhancement techniques could be a good solution for promoting its further application. It is well known that the main advantage of SC techniques is the absence of inductors, making very small size and high power density possible. However, more switches are required in SC-type converters than in magnetic-based converters. The VL technique is an effective method that is widely applied in electronic circuit design, especially in the radio engineering. It can also lead to improvement performance and characteristics of DC–DC converters; however, it differs from current SC techniques. Both inductors and
&capacitors play important roles in the VL technique, and all inner capacitors are fully charged by the power source.

Moreover, fewer power switches (usually single switch or two synchronous switches) are included in VL-type structures and avoid those complex multiple switches control schemes. Therefore we apply the VL technique to the SEPIC prototype in this paper and develop a new series SEPIC implementing VL technique fig 3.1 shows circuit diagram if series SEPIC. Consequently, a set of positive output VL-type DC–DC converters have been successfully created. The proposed VL-type DC–DC converters are different from any other existing DC–DC step-up converters and possess the above-mentioned advantages as well as the primary advantages in the SEPIC prototype. It perform positive to positive DC–DC voltage increasing conversion with higher voltage transfer gains, small ripples and high efficiency in simple structures. Therefore they will be used in computer peripheral equipment and industrial applications, especially for high output voltage projects. The detailed analysis will be performed in the following sections.

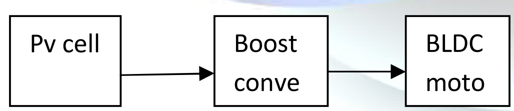

Fig 1. Block Diagram.

VOLTAGE SOURCE INVERTER

The word ‘inverter’ in the context of power-electronics denotes a class of power conversion (or power conditioning) circuits that operates from a dc voltage source or a dc current source and converts it into ac voltage or current. The ‘inverter’ does reverse of what AC-to-DC ‘converter’ does (refer to AC to DC converters). Even though input to an inverter circuit is a dc source, it is not uncommon to have this DC derived from an AC source such as utility ac supply. Thus, for example, the primary source of input power may be utility AC voltage supply that is ‘converted’ to DC by an AC to DC converter and then ‘inverted’ back to ac using an inverter. Here, the final AC output may be of a different frequency and magnitude than the input AC of the utility supply In the beginning of the modeling process, a designer must define some conventions related to the nature of the signal flowing through the model, and some standards about a module’s graphical and functional designs. In this work, these conventions are:
1)The signals on the terminals of detailed and average models in stationary coordinates, connected to the main power circuit have electrical characteristics, i.e. they are described through their voltage and current vectors. 2) The signals on the terminals of average models designed in dq (or dq0) coordinates have unit less, single vector properties and they will be called control signals. They can come either from the other dq modules or from the interface blocks between electrical signals in stationary coordinates and control signals in dq coordinates. These terminals are defined to have unidirectional signal flow property (could be either inputs or outputs). 3) The signals on the stationary average model terminals connected to the control circuits, like the terminals for the average phase duty cycle inputs of the VSI average model, have the control signal properties. 4) The signals on the detailed model terminals connected to the control circuits, like the terminals for the switching signals of the VSI detailed model, can be both, electrical or control signals, depending on a desired level of detail. Using the same example, the VSI switches can be modeled with the control switching signals, coming directly from the PWM modulator, or with the electrical switching signals coming from a D/A converter and a driver circuit

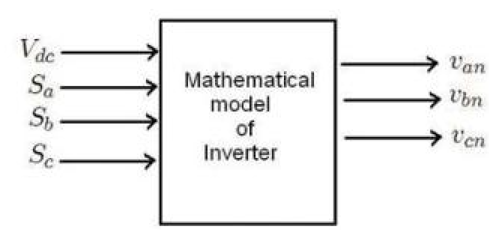

Fig 2.1. Mathematical model of the 3 phase voltage source inverter

Fig 2.1 shows the mathematical model of the 3 phase VSI. To derive the mathematical model of such an inverter, three Boolean variables Sa , Sb and Sc are conceived here; each denoting the state of conducting device (switch) of a particular leg (i.e. a or b or c

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accordingly). The Boolean variable Sa can assume a value of either `0' or `1'. The state Sa =0 will mean that bottom device (T4) for inverter leg `a' would be conducting, and, Sa =1 will mean that top device (T1 ) for the same leg `a' would be conducting. Same logic holds good for the Boolean variables `S b ', and `Sc ' denoting the switching states of inverter legs `b' and `c' respectively. The mathematical model of the 3 phase VSI, as shown in Fig 2.1 as a block, should have the DC link voltage (Vdc), the 3 switching functions (Boolean variables) Sa , Sb and Sc as input variables and should have the 3 phase voltages van , vbn and vcn as output variables. The output variables of the inverter will form as the input phase voltages to be fed to the PMSM armature winding (Star connected).

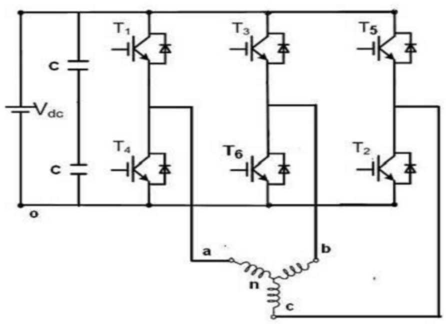

Fig 2.2: Three-Phase Sine- Inverter with three phase load

Fig 2.2 shows the 3 phase sine inverter with three phase load

Voltages vao , vbo and v co may be represented in terms of the switching functions as,

$$v_{ao} = v_{dc} s_a$$

$$v_{bo} = v_{dc} s_b$$

$$v_{co} = v_{dc} s_c \quad (2.1)$$

Where, vao is the voltage of point `a' with respect to -ve DC link bus. Similar nomenclature is also applicable for other two phases. The 3 phase voltage impressed on the star connected armature winding of PMSM (these are output voltage of the inverter) can be represent as,

$$v_{an} = v_{ao} - v_{no}$$

$$v_{bn} = v_{bo} - v_{no}$$

$$v_{cn} = v_{co} - v_{no} \quad (2.2)$$

Where v no = The voltage of the neutral point `n' with respect to the point `o' of the DC bus. v an + vbn + vcn = vao + vbo + vco - 3v no assuming that the machine being balanced, van + vbn + vcn = 0 Hence inverter phase voltages can be expressed as,

$$v_{an} = v_{ao} - \frac{v_{ao}+v_{bo}+v_{co}}{3} = \frac{2v_{ao}-v_{bo}-v_{co}}{3} = \frac{2s_a-(s_b+s_c)}{3} \quad (2.3)$$

Similarly,

$$v_{bn} = \frac{2s_b-(s_c+s_a)}{3} \quad (2.4)$$

And

$$v_{cn} = \frac{2s_c-(s_a+s_b)}{3} \quad (2.5)$$

3 THE PROPOSED SCHEMES

The converter operating in CICM using a current multiplier approach requires sensing of dc-link voltage (V_{dc}), supply voltage (v_s) and input current (i_{in}). An inherent PFC is achieved in converter operating in DICM using a voltage follower approach; and it requires sensing of dc-link voltage (Vdc), hence requiring a single voltage sensor. Proper selection of a converter is required for achieving a wide range of speed control of BLDC motor by varying the dc-link voltage. A widely used boost converter is not suitable for this application because of its limitation of boosting the voltage higher than input voltage. Hence the operation of BLDC motor cannot be performed at lower speeds. A series Sepic converter is used for this application because of its capability of bucking and boosting the voltage and its operation as an excellent PF corrector. Christo Ananth et al.[3] presented a brief outline on Electronic Devices and Circuits which forms the basis of the project.

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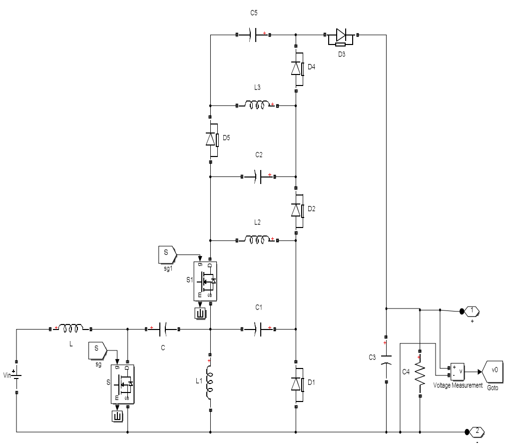

Fig.3.1 Circuit diagram of series SEPIC converter

In order to extract the maximum power from the PV panel a Boost converter can be employed between the PV panel and the load . pv voltage is buck or boost by the SERIES SEPIC converter. Fig 3.1 shows the circuit diagram of SERIES sepic converter. Assuming that there are n VL cells depend on the voltage gain. All future active switches can be replaced by passive diodes. According to this principle, only two synchronous switches S and S1 are required for each complex multiple-lift circuit, which simplify the control scheme and decrease the cost significantly. Hence, each circuit has two switches, inductors, capacitors and diodes. When switches S and S1 turn on, D1, D2, . . ., D2n21 are on and Do is off. When S and S1 turn off,D1, D2, . . . D2n21 are off and Do is on. Capacitors C1, C2, . . . ,Cn lift VCo by n times of VCs. Inductors L2, L3, . . , Ln perform the same function of a ladder joint to link the adjacent capacitors.

Fig 3.2 shows the block diagram representation of proposed system. In this pv panel is extract power from solar. This DC voltage is convert to AC by using three phase sinusoidal voltage source inverter. The output of VSI is a sine wave with very low HD and clean power like utility supplied electricity. It gives the transformer less operation so we get the ripple free AC.VSI give the sinusoidal input to the BLDC motor to run . Before giving the input to the BLDC sinusoidal current is given to current controller. Ref speed and feedback speed from BLDC is compared by speed controller. These two controller used for gate pulse control. This signal is given to the gate pulse generation produce the pulse for three phase VSI operation.

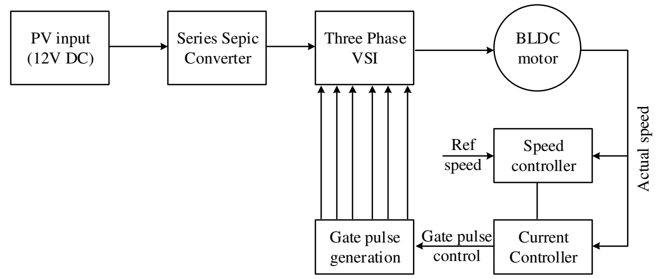

Fig.3.2 Block diagram representation of proposed system

4. SIMULATION RESULTS

This chapter illustrates the results obtained using the computer programs. The proposed system is simulated using MATLAB/Simulink. MATLAB is one of the most successful software packages currently available. It is a powerful, comprehensive and user friendly software package for simulation studies. A very nice feature of Simulink is that it visually represents the simulation process by using simulation block diagram. Especially, functions are then interconnected to form a Simulink block diagram that defines the system structure. Once the system structure is defined, parameters are entered in the individual subsystem blocks that correspond to the given system data. Some additional simulation parameter must also be set to govern how the computation is carried out and the output data will be displayed.

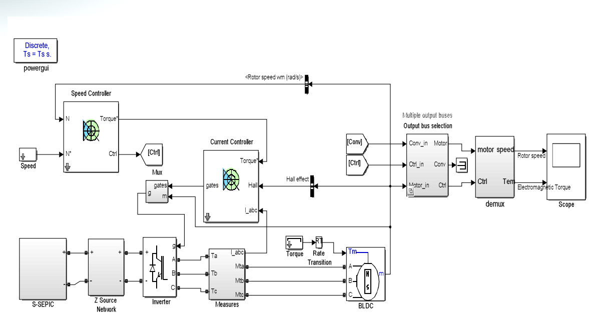

Fig 4.1 Matlab Simulink model for proposed system

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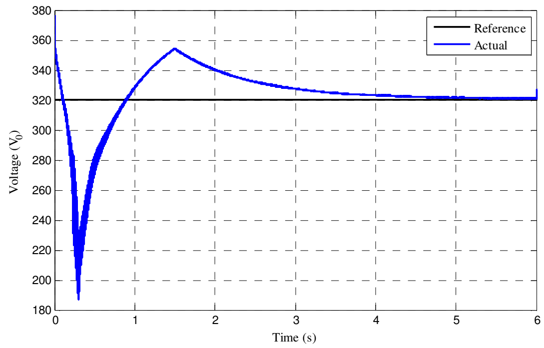

Fig 4.2Simulated voltage response of Series SEPIC DC-DC Converter for the set speed value of 300 rpm

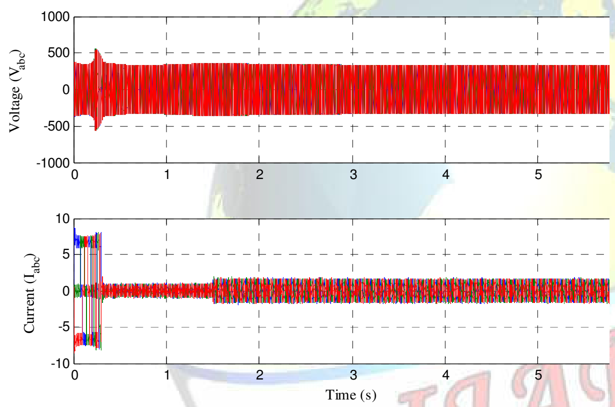

Fig 4.2. Simulated stator voltage and current response of BLDC for the set speed value of 300 rpm

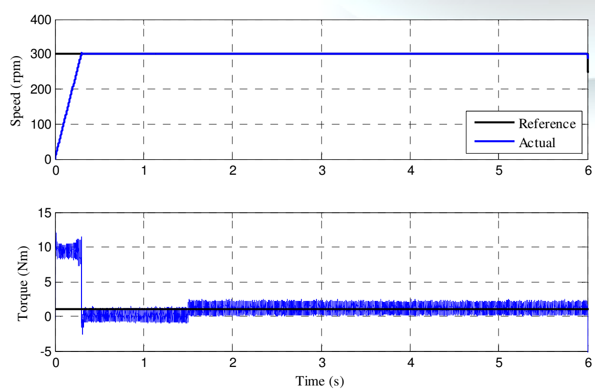

Fig 4.3 Simulated speed and torque response of BLDC for the set speed value of 300 rpm

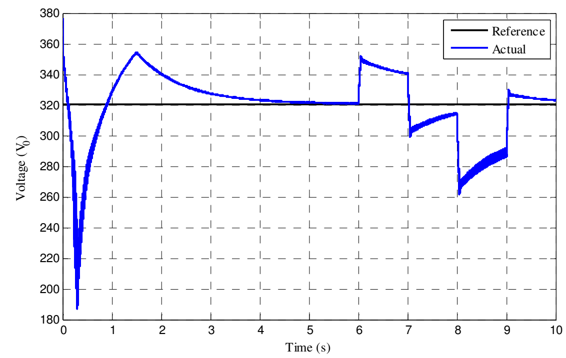

Fig 4.4 Simulated voltage response of Series SEPIC DC-DC Converter for change in reference speed of BLDC

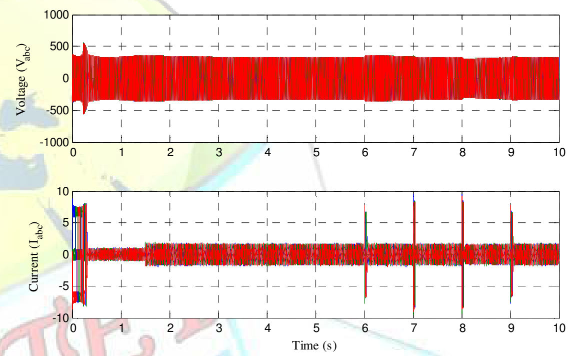

Fig 4.5 Simulated stator voltage and current response of BLDC for change in reference speed

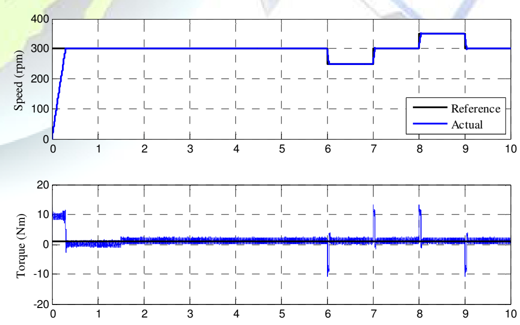

Fig 4.6 Simulated speed and torque response of BLDC for change in reference from 300 t0 250 rpm at time t=6s & from 300rpm to 350 rpm at time t=8s

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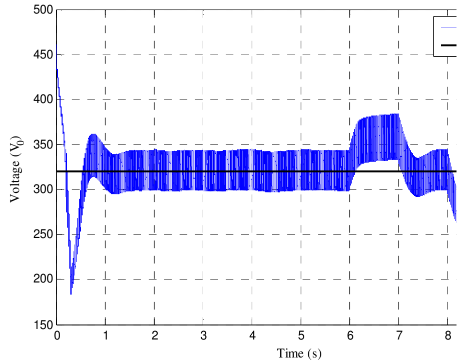

Fig 4.7 Simulated voltage response of Series SEPIC DC-DC Converter for change in load of BLDC

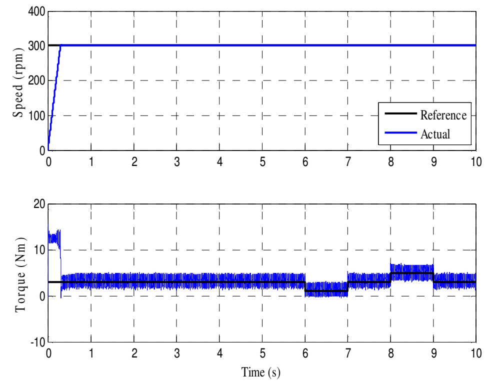

Fig 4.8 Simulated speed and torque response of BLDC for change in load from 3 to 1 N-m at time t=6s & 3 to 5 N-m at time t=8s

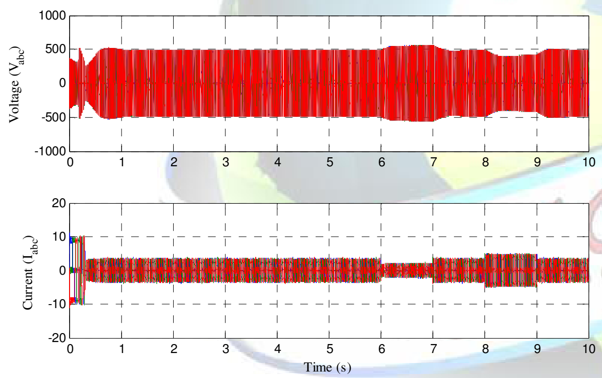

Fig 4.8 Simulated stator voltage and current response of BLDC for change in load from 3 to 1 N-m at time t=6s & 3 to 5 N-m at time t=8s

5. CONCLUSION

In this project the VL technique in the design of DC–DC power conversion circuits is developed. Several DC–DC converters have been proposed using a series SEPIC DC converters implementing VL technique, which can greatly increase the output voltage transfer gains without resorting to higher values of duty ratio D. IN this paper the source is pv panel and closed loop control technique is used.. Even though the torque is vary due to any reason but the speed of the motor is not changed. Sine wave VSI give the transformer less operation .It should replace the transformer so 60-70% of ripples will be less. this is used to maintain the speed level and improve the voltage transfer gain.

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