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Solar PV Based Multi Level Inverter For BLDC Motor Drive

[1]K. Durga Prasad, [2]T.Srinu, [2]CH.B.R.Srikanth

[1]PGScholar, [2]Assistant Professor, [2] Assistant Professor
[1,2,3]Department of Electrical and Electronics Engineering,
[1,2,3]Visakha institute of Engineering and technology, Narava, Visakhapatnam, India

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ABSTRACT: Because of the BLDC motor's straightforward construction, high efficiency, low maintenance requirements, and low cost, it is commonly used in high power and low voltage applications. Also, they produce a lot of power and have a lot of torque for their size. Although being a DC motor in this instance, the BLDC motor functions on an alternating current source and is driven directly from the AC supply port. The main drawback is that any disruptions in the source will have an impact on the applications that use BLDC motors in the industrial context. So, to avoid this, there should be a converter and an inverter intermediary between the motor and the source. . The BLDC motor can be driven using one of three different techniques. 1.Pulse width modulation-based two-level inverters (PWM). 2. An inverter with many operating levels. 3. A neutral clamping multilevel inverter. The recommended inverter may reduce the harmonic content of the output signal by employing a multicarrier PWM method. It has the ability to produce excellent motor currents. In this case, it is possible to precisely control the speed of a BLDC by using a three-level diode clamped multilevel inverter.

The main objective of this study is to show how to use an inverter to operate a BLDC drive, where the harmonics can be reduced. A device that changes voltage into current is called a diode clamped multi-level inverter. This research gives a more effective alternative to this approach. It is possible to evaluate the overall effectiveness of the system by modelling the operation of the neutral clamp multilevel inverter-based drive system using the MATLAB Simulink software package. The entire application will stop working and producing output in the event of a power outage. So, under these conditions, it is necessary to turn to renewable energies in order to strengthen the reliability of electricity supply and output. Several renewable energy sources are accessible, but due to their advantages, solar PV systems should be chosen over conventional power supplies. A diode clamped multi-level inverter was used to drive the BLDC.

Keywords:BLDC, Multi-level Inverter, Neutral Point Clamped Diode, THD, Multicarrier PWM, firing circuit.

I. INTRODUCTION

Using a BLDC motor has many benefits, including great efficiency, little maintenance needs, lighter weight, and a significantly more compact design. BLDC motors have been widely used in a range of industrial applications for many years due to their inherent advantages. These are the most suitable motors for applications requiring rapid dynamic response in speed response due to their high efficiency and ease of regulation across a wide speed range. The motor drive industry is seeing an increase in the use of motor drive topologies based on Multi-Level Inverter (MLI) technology. The ability to construct multilayer voltage waveforms with equipment with a lower voltage rating is one advantage of three-level topologies, which would be a significant benefit.Whereas Pulse Width Modulation (PWM) techniques aim to produce sinusoids with varying voltage and frequency, multilevel inverters' goal is to generate sine values utilising discrete voltage levels. Sinus voltages are produced from discrete voltage levels using multilevel inverters. It is feasible to create three-phase sinusoids for a range of voltages by giving the MOSFETs various gate signals. PWM has been implemented for inverters in a number of different ways that have been created. The two most popular methods for creating PWM for multilevel inverters are Sine-Triangle PWM (SPWM) and Space Vector PWM (SVPWM) (SVPWM). A type of pulse width modulation called multilevel sine triangle PW comparingvalues.The speed control of different motors using multilayer inverter systems has been the subject of several earlier investigations, all of which have been published. Some of them have memberships in this group. Yousif Ismail Al

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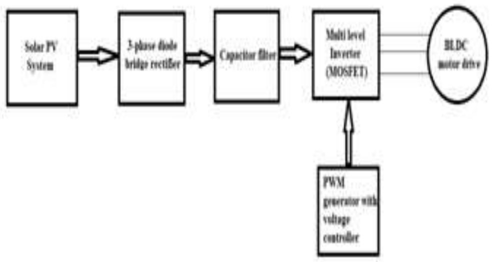
Mashhad and associates [1] proposed that the brushless direct current (BLDC) motor has a wide range of applications in high-power systems. It is simple to construct, affordable, requires less maintenance, is more efficient, and generates a sizable amount of electricity in the output unit. The BLDC motor, a direct current motor, is powered by an inverter. A 3-phase, 3-level inverter's design and modelling. In this work, methods for driving a brushless DC motor are provided. It provides a three-phase voltage source with amplitude, phase, and frequency controls. In this study, MATLAB Simulink is used to model the system and show how it works. Devi Kiran and colleagues [2] give a thorough explanation of the modular three-phase multilevel inverter system for controlling brushless dc motors. During operation, if both switches in a single leg conduct happen at precisely the same time, the power supply has been shorted out and needs to be rectified. Currently, each switch is dispersing half of the electricity, which reduces the intensity of the power cell explosion by 50%. This lowers system costs and increases system reliability while also being cost-effective.

The block schematic of a multilevel inverter-powered 3-phase induction. The system's parts will be divided into two groups, the control circuit and the power supply circuit, respectively. The power portion consists of a three-phase inverter and a power rectifier. The power section is finished with a filter capacitor and a multilayer inverter with three phases of diode clamps. The motor is connected to the multilevel inverter by a servo motor drive, allowing it to function separately from the inverter. A three-phase diode bridge rectifier receives an alternating current (AC) input voltage to produce direct current (DC) output voltage via a capacitor filter. output voltage in dc A device called a capacitor filter lowers the amount of ripple content that is actually present in the alternate current output voltage. The three-phase multilevel inverter receives pure dc electricity and uses it to run after applying the capacitor filter. By using 12 MOSFET switches that are operated in parallel, a direct current (DC) input voltage is converted into an alternating current (AC) output voltage (DC). The control circuit of the proposed system is composed, respectively, of a microcontroller, an opto-coupler, and a gate driver circuit. The microcontroller is specifically responsible for producing the gating signals needed to turn on the power MOSFET switches built into the multilevel inverter system.



Block diagram of BLDC Motor

II. II.MODELLING OF SYSTEM MODEL

A. Multi-LevelInverterTypeBLDCDrive

The Simulink model for a BLDC drive with a multi-level inverter is displayed in Figure 2. The model of a BLDC drive with a multi-level inverter consists of a source, a multi-level inverter with 12 mosfet-based power electronics control valves, and a BLDC drive with an induction motor driver circuit. The inverter output voltages and currents are represented by this Vabc and Iabc.

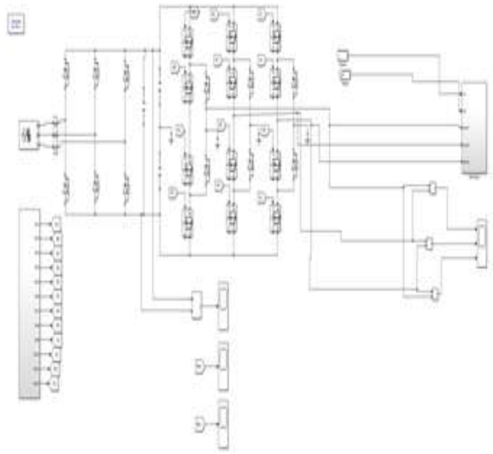


Fig.2.Simulink model for multi-level inverter type BLDC drive

A. BLDC drive circuit

In this circuit, the AC7 block from the Specialized Power Systems library is modified. This model displays a sensor-free DC motor drive with brake chopper for a single 3HP motor. The AC7 no longer needs speed or hall sensors. The voltages and currents at the motor's terminals are used by a back-emf observer to calculate the motor's speed and location. The rotor position creates commutations signals every 60 electrical degrees (equal to hall effect signals).

A trapezoidal back-EMF synchronous motor is driven by a PWM voltage source inverter

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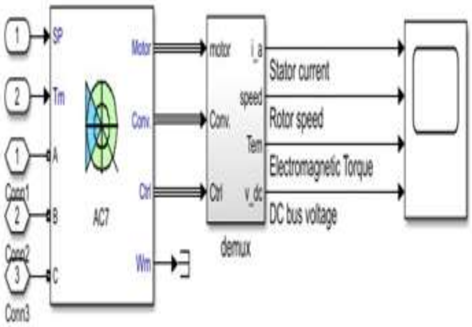
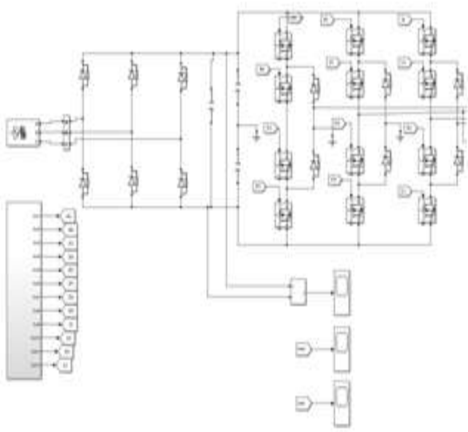
via a Universal Bridge Block. A PI regulator in the speed control loop produces the torque benchmark for the present control block. A three-phase current regulator is used to supply the motor with the three reference motor line currents in cycle with the back electromotive forces when the torque reference is determined. The output terminals of the block provide access to the motor current, speed (actual and anticipated), and torque signals.



BLDC drive circuit

C. Multi-level inverter

In this study, multilevel inverter-fed BLDC motors are introduced. The diode clamped inverter, which produces a variety of voltage levels, is powered by a sequential bank of capacitors. Across the switches, only 50% of the dc bus voltage may be observed. These characteristics almost quadruple the power rating of the voltage source inverter. The recommended inverter may reduce harmonic content by using multicarrier PWM. It generates superior motor currents. The speed of a BLDC is precisely controlled using a three-level diode clamp multilevel inverter.



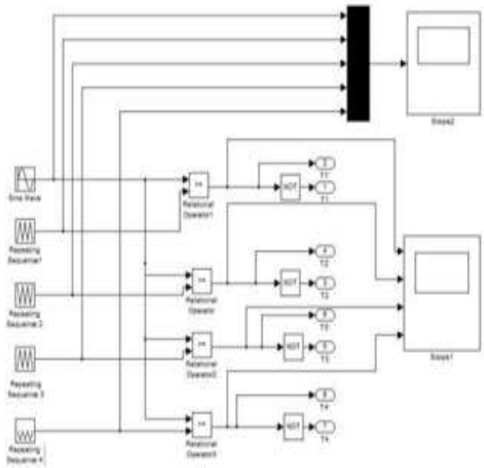
Multi-level inverter simulation

The voltage inverter's three-level neutral point-clamped source is shown in above Figure . There are 6 neutral point clamp diodes and a total of 12 active unidirectional switches on it. The neutrality point between the two capacitors in this illustration, denoted by "n," could be specified. This configuration has many benefits because each switch just needs to block half of the voltage (Vdc/2). Two switches from each phase leg must be switched on simultaneously at all times in order to create three levels. Two bulk capacitors, Ca and Cb, are coupled in series to divide the dc bus voltage into three levels. They both have the same ratings. Similar-type diodes are used to share the voltage fairly or to clamp the same reference voltage across the switch when it is not in use. As a result, the switch is subjected to substantially less voltage stress.

The process of creating three-level voltages from an inverter leg involves three steps. In order to produce an output voltage level of Vao=Vdc/2, turn on the top switches A1 and A2. To set the output voltage Vao to 0 volts, turn on upper switch A2 and bottom switch A1'. On all lower half switches A1' and A2' as shown in figure 5, with an output voltage level Vao=-Vdc/2. The suggested BLC SC converter uses a single voltage sensor to reduce the power variable of the AC framework to 1 and operates in group inductor current mode. By altering the DC transport voltage of the voltage source inverter (VSI), which controls the BLDC engine through the PFC converter, the speed of the BLDC engine is limited. Thus, the BLDC engine is electronically switched so that the VSI can work with frequent switching and reduce switching tragedy. Moreover, the unbridged configuration of the CSC converter has a lower conduction unfortunate because to the relatively neglected front diode span rectifier.

D) Firing circuit

Firing circuit designed for multi-level inverted is based on the pulse width modulation technic where PWM is amodulation technique that generates variable-width pulses to represent the amplitude of an analog input signal. The output switching transistorison more of the time for a high-amplitude signal and off more of the time for alow-amplitude signal.

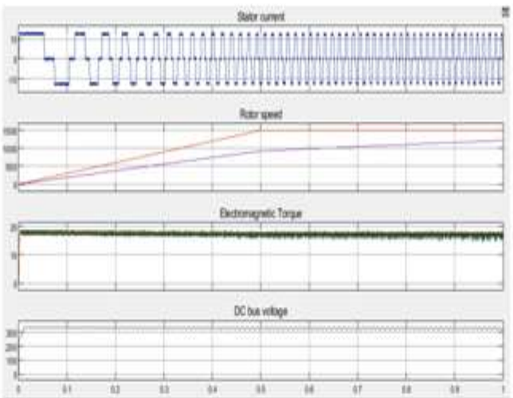


Firing circuit

III. SIMULATION RESULTS

A. BLDC drive results:

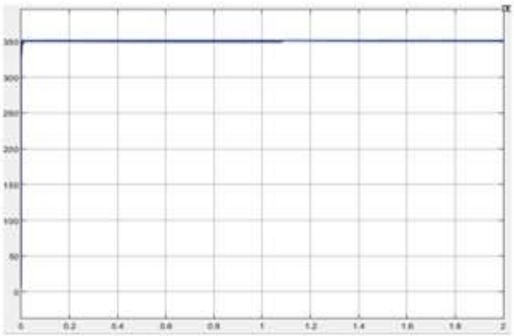
As the input supply source magnitude having 250-line voltage with 50 Hz frequency, the output from the multilevel inverter thatis input stator current to BLDC motor is having 10A.and with that magnitude the stator speed will be 1500 rpm and the torque that the motor have is20 N-M and the output DC-bus voltage is330v as shown in fig7.(BLDC drive characteristics)



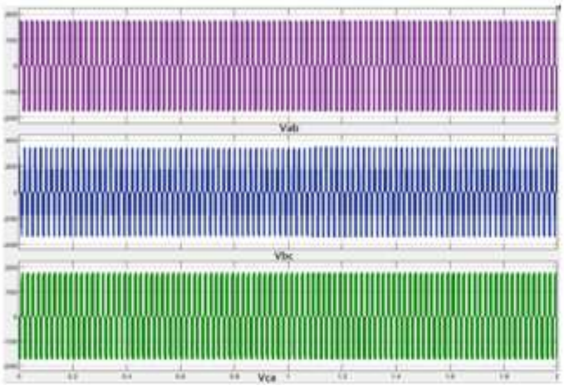
BLDC drive characteristics

A. Inverter results

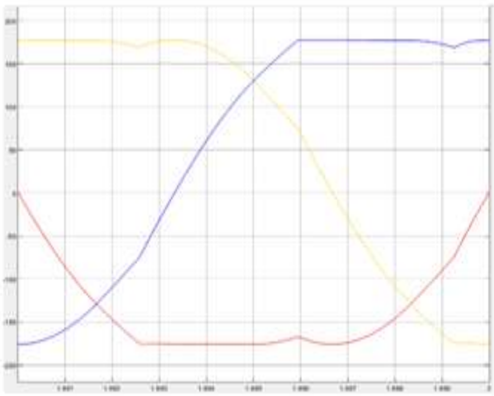
These are the inverter output voltages shown in fig8.of line to line voltagesVab, Vbc, Vca. Fig.9.depicts the voltage of the output DC bus, where as Fig.9.depicts the voltage of the output converter



DC bus voltage



Inverter output voltages of line-to-line voltages Vab, Vbc, Vca.



Converter output voltage

A. Results with solar PV system based multi-level inverter

Solar PV system model shown in fig.11, having two inputs one is solar irradiance (1000) and second one is solar temperature(25degree centigrade) as constant values which are given to solar panel having 10 parallel strings and each string having seriesconnected modules of 1000 which will give approximately 800v output voltage and 80 amperes of current that is given to BLDCmotordrive.

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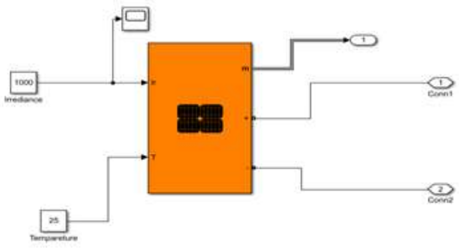
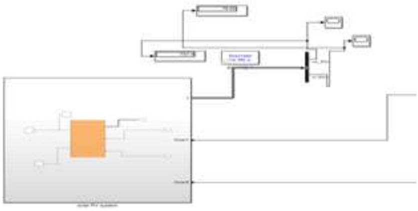
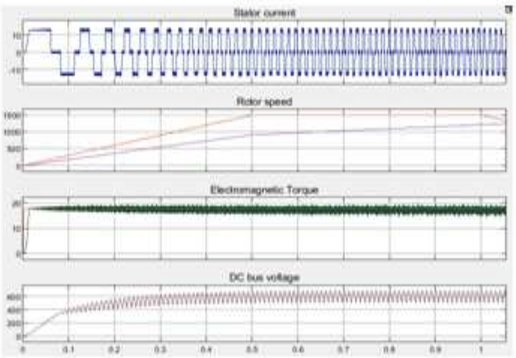


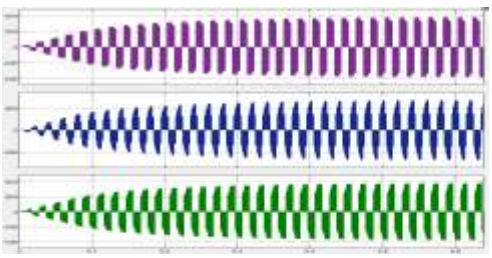


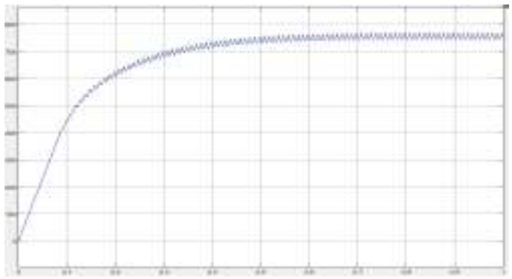
Solar PV system

BLDC drive characteristics with solar PV system as input source having same characteristics without any deviation so from thiswe can conclude that the solar PV system can be used as conventional energy source instead of available AC source as shown infig.12andfig13.



Inverter output voltage with Solar PV system as energy source





DC Voltage output with solar PV system.

IV. CONCLUSION

The implementation of a diode clamp with a multilayer inverter for BLDC motor controlling applications is demonstrated in this research. The lowest harmonic distortion in the outputs can be achieved by using the multicarrier PWM approach, which also produces a high output power with minimal harmonic distortion. A 3-level BLDC motor drive was designed and simulated using Simulink. The overall harmonic distortion is quite minimal when compared to a traditional inverter. It was discovered that the BLDC motor was capable of reaching speeds between 600 and 900 rpm at various points during the trial. An inverter system can be used in businesses that require variable speed drives, and because of its lower harmonic losses, it could result in significant energy savings. To further limit the quantity of harmonic distortion created, the number of levels may also be increased. We can deduce that the solar PV system can be used as a conventional energy source instead of the available AC source based on the fact that BLDC drive characteristics with solar PV system as input source have the same characteristics without any variation. The simulated implementations circuit was made using MATLAB. Between 600-900rpm were determined to be the most common speeds. There was also a simulation of the PWM wave for maswell as outputs of the three-level multilevel inverters system.

To implement the BLDC engine regulator plan using a PWM-based inverter with a variation of power factor revision techniques that will improve handling, location, and recognition activities to further develop the closed-loop operation of the entire system. Furthermore, by precisely coordinating the pulses produced by the spatial vector-adjustment of the pulse width and the Hall Effect sensors, the wave of the speed bend of the brushless DC motor may be reduced.

REFERENCES

[1]. Yousif Ismail Al Mashhadany , “High-

performance multilevel inverter drive of brushless DC motor", International Journal of Sustainable and Green Energy, Vol. 4, pp 1-7, October 2014

[2]. P. Devi Kiran, M. RamachandraRao, "Two Level and Five Level Fed BLDC Motor Drive", International Journal of Electrical and Electronics, Vol. 3, Issue 3, pp 71-82, August 2013

[3]. Purna Chandra Rao,Y.P. Obulesh, Ch. SaiBabu, "High Performance Cascaded Multilevel Inverter fed BLDC Motor Drive", International Journal of Engineering Sciences and Emerging Technologies, Vol. 5, Issue 2, pp: 88-96, June 2013

[4]. S.FloraViji Rose1, Mr.B.V.Manikandan , "Simulation and Implementation of Multilevel Inverter Based Induction Motor Drive", International conference on control automation and energy conservation, Chennai 4-6 June 2009

[5]. Jose, Steff en Sernet, Bin Wu, Jorge and Samir Kouro, " Multilevel Voltage Source - Converter Topologies for Industrial Medium - Voltage Drives" , IEEE Trans on Industrial Electronics, Vol.54, Issue 6, December 2007t

[6]. P.Thirumuraugan, R.Preethi, " Closed Loop Control of Multilevel InverterUsing SVPWM", International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering, Vol. 2, Issue 4,pp 1561-1572, April 2013

[7]. Yadav, J. Kumar, "Harmonic Reduction in Cascaded Multilevel Inverter", International Journal of Recent Technology and Engineering, Vol.2, Iss. 2, pp 147-149, May 2013

[8]. G. Real, E. V. Sánchez, J. G. Gil, "Position and Speed Control of Brushless DC Motors Using Sensorless Techniques and Application Trends", Sensors, pp 6901- 6964, 2010

[9]. M.Rajshekar,V.G.Swamy,T.A.Kumar,"" Modelingand\simulationofdiscontinuescurrentmodeinverterfeepermanentmagnetsynchronous motorderive",JournalofTheoreticaland Apply.