Five Level Multiple Pole Space Vector PWM Converter

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***Abstract*– Good functioning of the electrical and electronic equipments depend on the supply voltage correctness.We have to represents the space vector pulse width modulation over than the simply PWM technical which will recovered the some drawbacks. Although the space vector modulation technique are general and applicable for n-level diode clamped converter. But now we have focus on five levels multiple pole system. In this paper proposed space vector PWM which is better than the PWM with reducing components. Another one focused is nothing but to reducing components which causes we can get light weighted of the circuitry design and ultimately reduced its cost and because of that we have to achieve better input current. This study explores the feasibility of five levels multiple pole space vector PWM techniques with reducing components and we have to getting better efficiency.**

Index Terms*— *Five level multiple pole of converter, space vector PWM, Reduced number of semiconductor devices.

I INTRODUCTION

Recently, multilevel converter is increasingly being used in high power medium voltage application due to their superior performance. Multilevel converter has been widely used in high power application. This ac to dc to ac converter are employed for widely in many industries .This configuration is favourable for many application such as heat ventilation, and air conditioning system, pumps blower traction drive and even permanent magnet synchronous generator wind turbine with grid connected .We have to used space vector modulation technique over the pulse width modulation technique .Although the (SVM) strategies are general and applicable for five level multilevel converter. The salient features of the proposed balancing strategy are minimization of switching frequency, minimization of total harmonic distortion, no requirement for the additional power circuitry .It also reduces switching losses. Multilevel converters can produce variable voltages and frequencies from discrete voltage by exploiting PWM method. The low harmonic distortion obtained due to multiple voltage levels at the output and reduced stresses on switching devices. Five level multiple pole ac to dc to ac drives based on the Proposed multiple pole multilevel diode clamped converter. It drastically reduces the number of power diodes and Semiconductor devices like rectifier, diodes, MOSFET, IGBT getting required. This rear end multilevel converter has one of the most promising technologies to be employed and front end diode rectifier with bidirectional switches are used to control the power factor near to unity and reduce the number of power semiconductor devices connected in series will have lower voltage stress for device .Hence lower rated voltage devices can be used .An increased number of voltage levels can be reduced filtering effort. Higher output voltage levels will yield a lower rate of change of voltage and lower total harmonic distortion and switching losses are achieved by utilizing low switching frequency. This can be explores that the feasibility of an ac to dc to ac drives with five levels multiple pole converter with reducing component with focus on achieving reducing the number of semiconductor devices and getting better input quality and gaining the efficiency. With the help of the ac source supply we can providing the ac supply to the whole given system then this ac supply we have to converted into the ac to dc source by using the rectifier by using the dc balancing circuit we can balancing the dc link circuitry side. That this all converted supply by using the space vector pulse width modulation we can getting better input current as compared to simply pulse width modulation technique. Medium-voltage drives have found applications in high-power industrial applications including oil and gas sectors, production plants, and process industries. Multilevel inverters are used rather than two-level inverters for driving medium-voltage drives for high-power application exceeding 1 MW while reducing the voltage rating of the semiconductor devices as well as conduction losses and for minimizing harmonic distortion. However, switching losses of devices at medium voltage still remain a concern. Power quality is the combination of voltage quality and current quality. Voltage quality is concerned with deviations of the actual voltage from the ideal voltage. Current quality is the equivalent definition for the current. A discussion on what is ideal voltage could take many pages, a similar discussion on the current even more. A simple and straight forward solution is to define the ideal voltage as a sinusoidal voltage waveform with constant amplitude and constant frequency, where both amplitude and frequency are equal to their nominal value. The ideal current is also of constant amplitude and frequency, but additionally the current frequency and phase are the same as the frequency and phase of the voltage. Any deviation of voltage or current from the ideal is a power quality disturbance. A disturbance can be a voltage disturbance or a current disturbance, but it is often not possible to distinguish between the two. Any change in current gives a change in voltage and the other way around. Where we use a distinction between voltage and current disturbances, we use the cause as a criterion to distinguish between them Voltage disturbances originate in the power network and potentially

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affect the customers, whereas current disturbances originate with a customer and potentially affect the network. Power quality is a simple term, yet it describes a multitude of issues that are found in any electrical power system and is a subjective term. The concept of good and bad power depends on the end user. If a piece of equipment functions satisfactorily Notch and noise produced at the converter section of an adjustable speed drive the user feels that the power is good. If the equipment does not function as intended or fails prematurely, there is a feeling that the power is bad. In between these limits, several grades or layers of power quality may exist, depending on system.

INSULATED GATE BIPOLAR TRANSISTOR

A modern power transistor is Insulated Gate Bipolar Transistor (IGBT).It operates as a transistor with high-voltage and high-current capability and a moderate forward voltage drop during conduction. The IGBT is a device that is part way to being a thyristor, but is designed to not latch into full conduction equivalent to a voltage drop of one junction, but instead IGBT part way to latching stays as a transistor. In addition it also has an integrated MOS structure with insulated gate, like a MOSFET. Its structural cross section and equivalent circuit are shown in Figure Like the thyristor and the GTO, it has a two-transistor structure. But the turn-on and turn-off are carried out by a MOSFET structure across its npn transistor instead of the gate emitter of the upper npn transistor. With turn-on, there is a current flow through the base and the emitter of the npn transistor as in a thyristor, but not enough for the device to avalanche into a latched conduction.

As shown in Figure, the base emitter junction is shunted by a resistance, which is built into the device structure. This resistance bypasses part of the cathode current rather than all of it. In the structural cross section shown, the upper n' is the MOS source of n carriers, p is the base, n' layer is the drift region, lower p+ is the buffer layer, and finally p+ is the substrate. Like a MOSFET, when the gate is made positive with respect to the emitter for turn-on, n carriers are drawn into the p channel near the gate region, which forward biases the base of the npn transistor, which thereby turns on. The IGBT is turned on by just applying a positive base voltage to open the channel for n carriers and is turned off by removing the base voltage to close the channel, which results in a very simple driver circuit. This study explores the feasibility of an AC/DC/AC drive with near unity power factor front-end rectifier and five-level rear-end multilevel inverter topology with a focus on achieving lower voltage total harmonic distortion and higher energy efficiency. The unity PF front-end rectifier in this AC/DC/AC drive may cause unbalanced voltage in the DC bus capacitors leading to high voltage distortion on the output AC voltage of a rear-end multilevel inverter.

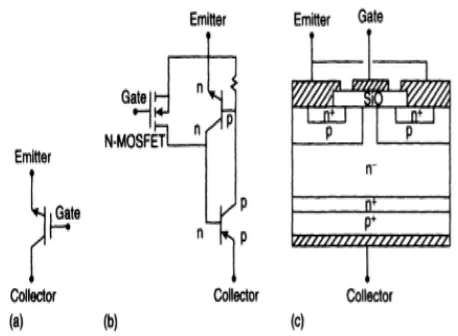

Fig1.IGBT

a) Symbol
b) Equivalent circuit
c) Basic structure

The advantage of the IGBT is its fast turn-on and turn-off because it is more like a majority carrier (electrons) device. It can be therefore used in Pulse Width Modulation (PWM) Converters operating at high frequency. On the other hand being a transistor device, it has higher forward voltage drop compared to thyristor type devices such as GTOs. Nevertheless the IGBT has become a workhorse for industrial applications, and has reached sizes capable of applications in the range of 10 MW or more .The transistor devices, such as MOSFETs and IGBTs; potentially have current- limiting capability by controlling the gate voltage. During this current-limiting mode, the device losses are very high, and in high-power applications, current-limiting action can only be used for very short periods of a few microseconds. Yet this time can be enough to allow other protective actions to be taken for safe turn-off of the devices. This feature is extremely valuable in voltage-sourced converters, in which fault current can rise to high levels very rapidly due to the presence of a large dc capacitor across the converter. On the other hand, with fast sensing, combined with the fast turn-off of the advanced GTOs, an effective turn-off can be achieved within 2-3microseconds. A generalized optimal pulse width modulation (PWM) technique applicable to multilevel inverters for low-switching-frequency control of medium-voltage high-power industrial ac drives is presented. Proposed synchronous optimal PWM method allows setting the maximum switching frequency to a low value without compromising the harmonic distortion of machine currents. Low switching frequency reduces the switching losses of the power semiconductor devices, resulting in higher inverter power output and efficiency. The proposed optimization results in low harmonic distortion at low switching frequency. Experimental results of a five-level inverter drive using optimal PWM are presented. Additional degree of freedom associated with multilevel inverters (higher than three levels) allows them to acquire multiple potential levels.

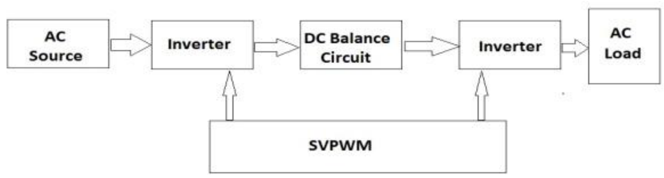

Fig.2 Basic block diagram of converter

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In electrical engineering, the power factor of an AC electrical power system is defined as the ratio of the real power flowing to the load, to the apparent power . Real power is the capacity of the circuit for performing work in a particular time. Apparent power is the product of the current and voltage of the circuit. Due to energy stored in the load and returned to the source, or due to a non-linear load that distorts the wave shape of the current drawn from the source, the apparent power will be greater than the real power. A negative power factor occurs when the device which is normally the load generates power which then flows back towards the device which is normally considered the generator. In an electric power system, a load with a low power factor draws more current than a load with a high power factor for the same amount of useful power transferred. The higher currents increase the energy lost in the distribution system, and require larger wires and other equipment. Because of the costs of larger equipment and wasted energy, electrical utilities will usually charge a higher cost to industrial or commercial customers where there is a low power factor. The voltage and current stress expressions for the respective front-end rectifiers are derived with the switching function in and based on the following factors, high power factor operation current and voltage ripple free, constant switching frequency, balanced dc-link capacitors voltage.

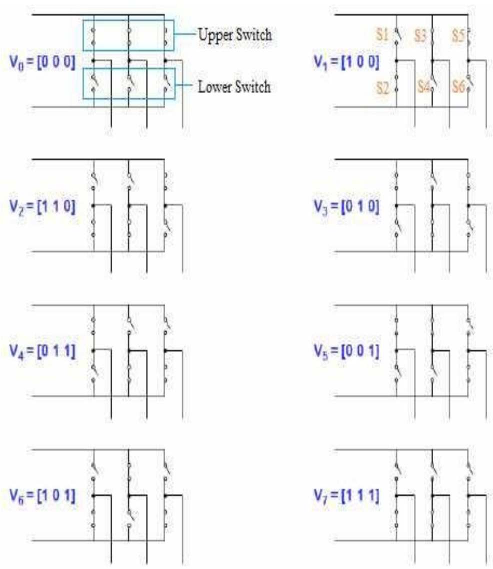

Fig. 3 Eight switching state of inverter voltage vector

All SVM schemes and most of the other PWM for the output voltage synthesis. The modulation algorithms that use non-adjacent have been shown to produce higher THD and/or switching losses and are not analyzed here, although some of them, e.g. hysteresis, can be very simple to implement and can provide faster transient response. The duty cycles are uniquely determined the only difference between PWM schemes that adjacent vector is the choice of the zero vector and the sequence in which the vectors are applied within the switching cycle.

Voltage Vectors	Switching Vectors			Line to neutral voltage			Line to line voltage		
	a	b	c	V_{an}	V_{bn}	V_{cn}	V_{ab}	V_{bc}	V_{ca}
V_0	0	0	0	0	0	0	0	0	0
V_1	1	0	0	2/3	-1/3	-1/3	1	0	-1
V_2	1	1	0	1/3	1/3	-2/3	0	1	-1
V_3	0	1	0	-1/3	2/3	-1/3	-1	1	0
V_4	0	1	1	-2/3	1/3	1/3	-1	0	1
V_5	0	0	1	-1/3	-1/3	2/3	0	-1	1
V_6	1	0	1	1/3	-2/3	1/3	1	-1	0
V_7	1	1	1	0	0	0	0	0	0

Table 4 switching vectors, line to neutral voltage, line to line voltages

SPACE VECTOR PULSE WIDTH MODULATION TECHNIQUE

Space Vector Modulation became a standard for the switching power converters and important research effort has been dedicated to this topic. Tens of papers, research reports and patents were developed in the last ten years and the theory of Space Vector Modulation is already well- established. Diverse implementation methods were tried and some dedicated hardware pieces were developed based on this principle. The initial use of Space Vector Modulation at three-phase voltage-source inverters has been expanded by application to novel three-phase topologies as AC/DC Voltage Source Converter, AC/DC or DC/AC Current Source Converters, Resonant Three-Phase Converters, B4-inverter, Multilevel Converters, AC/AC Matrix Converters, and so on.

This tutorial presents the base theory of SVM when applied to a 3-phase voltage source inverter. The roots of vectorial representation of three-phase systems are presented in the research contributions of Park and Kron, but the decisive step on systematically using the Space Vectors was done by Kovacs and Racz. They provided both mathematical treatment and a physical description and understanding of the drive transients even in the cases when machines are fed through electronic converters. In early seventies, Space Vector theory was already widely used by industry and presented in numerous books. Stepina and Serrano-Iribarnegaray suggested that the correct designation for the analytical tool to analyzing electrical machines has to be “Space Phasor” instead of “Space Vector”. “Space Phasor” concept is now a day mainly used for current and flux in analysis of electrical machines. One of the major issues faced in power electronic design is the reduction of harmonic content in inverter circuits. All PWM schemes generate inverter voltage load losses in three phase machine. One of the solutions to enhance the harmonic free environment in high power converters is to use PWM control techniques. Several techniques of modulation have to the purpose. divided into analog and digital techniques. In the former technique, the switching angles occur at the crossing of two waves, thus giving to the PWM wave. In the latter technique the switching angles are chosen so as to directly affect the harmonic content. This is done by eliminating some harmonics and by minimizing a figure of current distortion in the load. The commonly available technique is Selective Harmonic Elimination method at fundamental frequency, for which transcendental equations

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characterizing harmonics are solved to compute switching angles.

Waveforms which contain a rich harmonic spectrum. This spectrum ordinarily contains the desired fundamental component and clusters of sidebands about integer multiples of

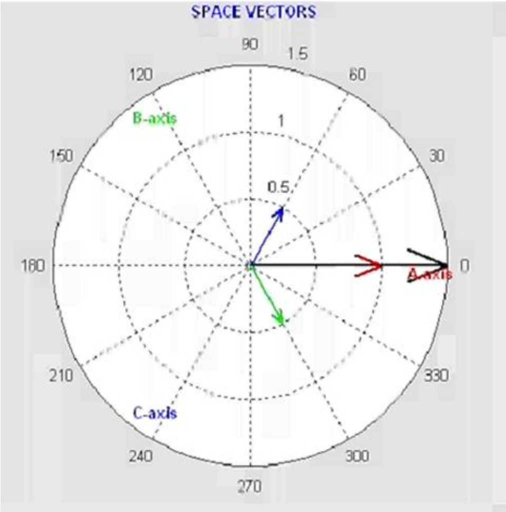

Fig.4 Space vector three phase quantities

The eight vectors are for low power applications, switching losses are acceptable for specific range but for high power applications, switching losses become more significant. Because of switching losses, high frequencies are less efficient than lower frequencies due to efficiency of system reduces as switching losses increased, since for reducing filtering requirements we have to increase switching frequency which results in greater switching losses. Although switching losses can be reduced by modifying carrier signal in SPWM or using zero switching technique or shifting to multilevel inverters but on the other hand it results in greater harmonic distortion or poor power factor. SVPMW has greater flexibility to reduce switching losses. In SVPWM reduced switching losses are because of the changing of any one switching state which results in one single phase voltage change every time.

II SIMULATION DESIGN

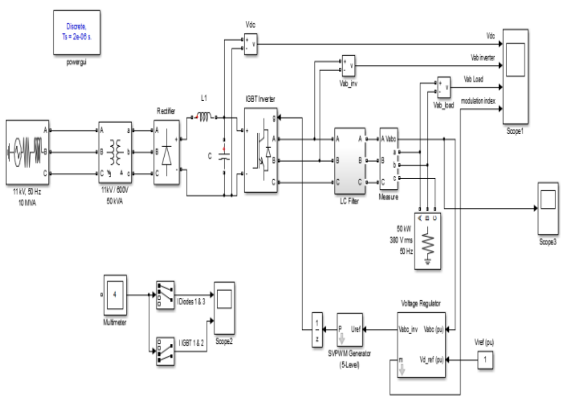
Fig.5 Simulation design

the switching frequency. As the switching frequency is usually limited only by the maximum permissible level of inverter switching losses, the harmonic voltages are at reasonably high frequencies in modern inverters and do not affect the fundamental system behaviour. This has shown in figure5.

The 11kv 50 hertz AC supply is taken from grid. Three phase ac is taken from the power grid. That three phase ac supply is basic need of our system. Then this supply is passed to the transformer for step down the supply system. According to the need of our consumer supply getting step down it. That supply is getting step down at 11kv/600v. Transformer is a static device used to transfer electrical energy from one circuit to another with increase or decrease the value of current or voltage without change in frequency. In this project three transformer used which is step down. Step down transformer means the transformer which reduces the supply voltage to the desired value. Rectifiers are normally used in circuits that require a steady voltage to be supplied. To provide a steady DC output. The raw rectified DC requires a smoothing capacitor circuit to enable the rectified DC to be smoothed so that it can be used to power electronics circuits without large levels of voltage variation. Would not function because the power would be removed every half cycle. To smooth the output of the rectifier a reservoir capacitor is used - placed across the output of the rectifier and in parallel with the load. This capacitor charges up when the voltage from the rectifier rises above that of the capacitor and then as the rectifier voltage falls, the capacitor provides the required current from its stored charge. The Powergui block is necessary for simulation of any Simulink model containing Sim Power Systems blocks. It is used to store the equivalent Simulink circuit that represents the state-space equations of the model. The Powergui block allows you to choose one of the following methods to solve your circuit Continuous method, which uses a variable step Simulink solver. Ideal Switching continuous method. Discretization of the electrical system for a solution at fixed time steps. Phasor solution method

Components	Numbers of parameter
MOSFET	18
Capacitor	4
Isolated gate drive	18
Diode	24

Table 2.List of parameter before design of simulation

Components	Value of parameter
Three phase source	11 Kv 10 MVA
Frequency	50 Hz
Transformer	11Kv/10 MVA
Winding 1 connection	Star – Ground
Winding 2 connection	Delta
Inductor	200 micro henry
Capacitor	5000 micro farad
V rms	380 V
Active power	50 kw

Table 3. List of parameter after designing of simulation

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III EXPERIMENTAL OUTPUT

Excellent performance and low input current distortion with high power factor is achieved with low operational switching frequency. In addition to that, the reduction of component counts allows the proposed converters to achieve low voltage/current stress and low switching losses. As a result, the overall converter efficiency is also improved. The size of input reactors is greatly reduced as well because of the incremental voltage stepped waveforms synthesized at low switching frequency.

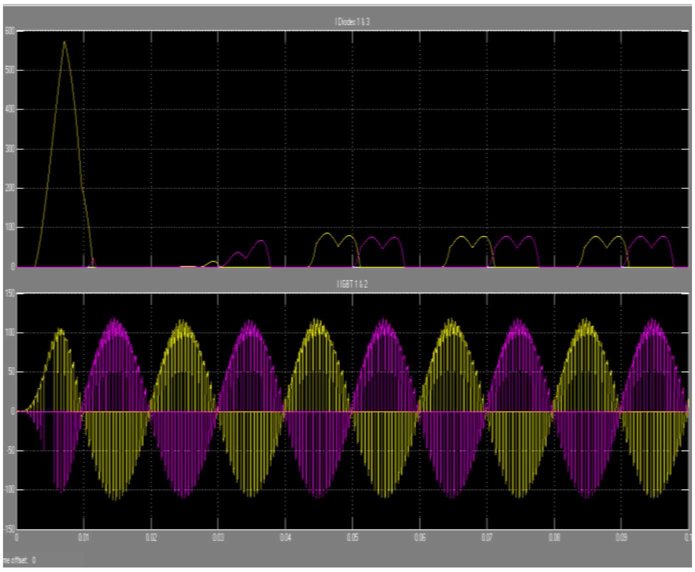

Fig.6 Output waveforms of Diode and IGBT

However, the dc-link voltage balancing circuit is restricted to certain power applications. For the case of medium-voltage drives, the size of the in the balancing circuit must be extremely large to meet such required power ratings. Thus, alternative dc-link balancing strategies such as modulation schemes or control algorithms can be implemented to replace the additional balancing circuit. These will provide a more cost-effective and energy efficient solution for a higher level ac/dc/ac drive and can particularly is suitable for renewable energy conversion where high efficiency is paramount.

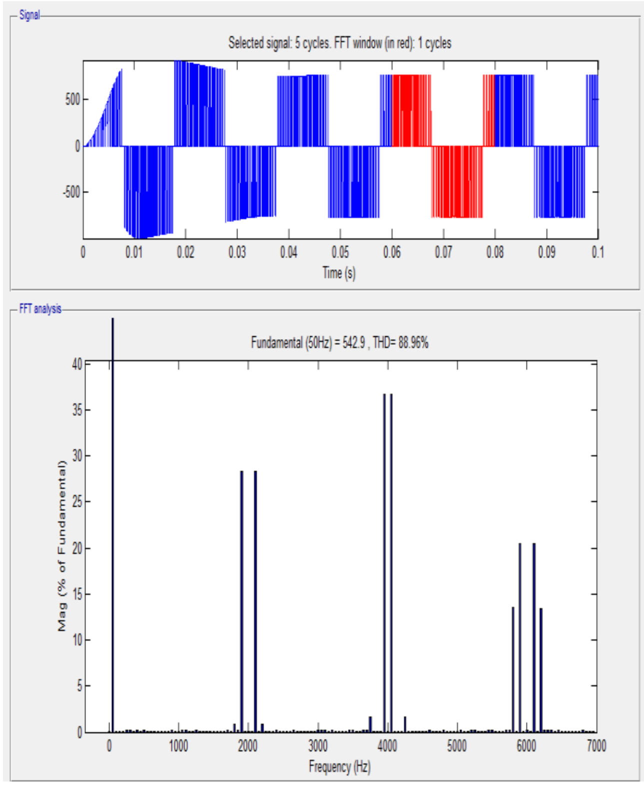

Fig. 7 FFT Analysis

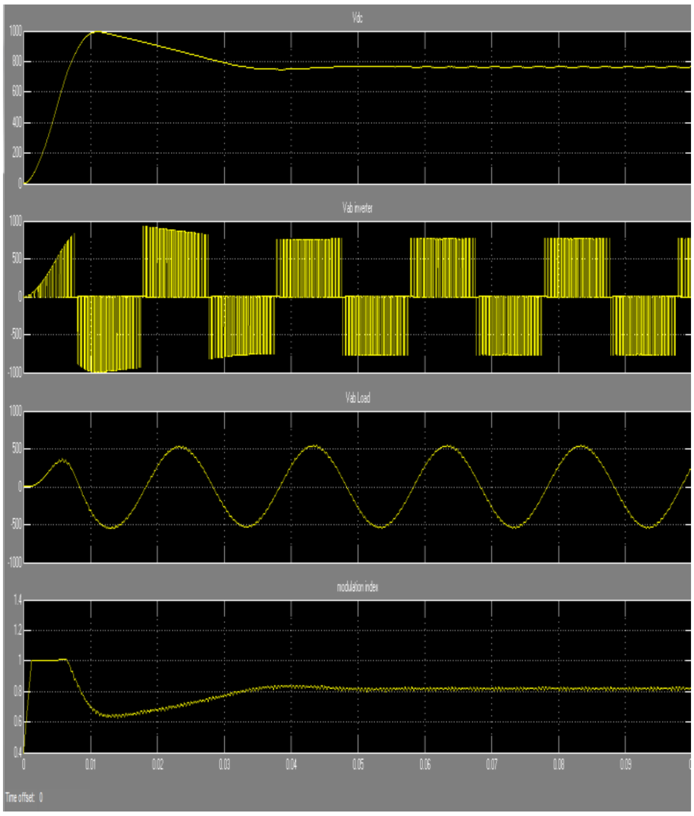

Fig.9 Output waveforms of Vdc,Vab inverter, Vab Load,Modulation index

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One of the major issues faced in power electronic design is the reduction of harmonic content in inverter circuits. As the switching frequency is usually limited only by the maximum permissible level of inverter switching losses, the harmonic voltages are at reasonably high frequencies in modern inverters and do not affect the fundamental system behaviour.

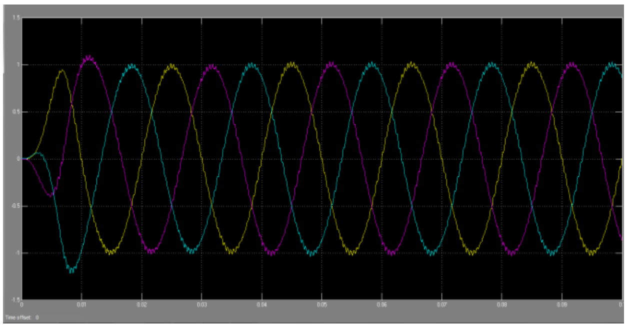

Fig.8 Three phase source of converter

The presence of the DC voltage allows compensating for the ripple of the DC bus voltage. This ripple can be caused by the insufficient filtering of the input rectifier power stage. Measuring the DC voltage at each sampling or with a larger sampling period will appropriately compensate for the effect of this ripple in the output voltage. Will keep account of a variable length of the active vectors (2/3Vd). However, this method reduces the maximum available voltage at the inverter output due to minimum Vdc voltage within ripple. Equivalent compensation would also result with good current control loops but it is preferable to eliminate all the nonlinearities and parameter variations before closing the loop. However, the dc-link voltage balancing circuit is restricted to certain power applications. For the case of medium-voltage drives, the size of the inductors in the balancing circuit must be extremely large to meet such required power ratings. Thus, alternative dc-link balancing strategies such as modulation schemes control algorithms can be implemented to replace the additional balancing circuit. These will provide a more cost-effective and energy efficient solution for a higher level ac/dc/ac drive and can particularly be suitable for renewable energy conversion where high efficiency is paramount. Five level multiple pole space vector pulse width modulation technique has very easy rather than the simple pulse width modulation technique for getting that balancing output.

The unbalanced dc-link capacitor voltages may disrupt the smooth operating system and affect the global reliability if the power converter is not adequately designed. This disastrous condition will damage the converter by overstressing the limited blocking voltage capability of the semiconductor devices. Although this undesirable condition can be typically resolved by disabling the rectifier/inverter operation when any fault condition occurs, the overall efficiency of the system may be greatly affected. The alternative solution to overcome this issue is to ensure that the power device ratings are properly selected during the design according to the worst case scenarios. This is at the small cost of having an additional voltage balancing circuitry in the dc link to balance the capacitor voltages.

RESULT

The agreement between the theoretical analysis and the experimental results is validated and has proven the feasibility of the two proposed ac/dc/ac topologies. Excellent performance and low input current distortion with high power factor is achieved with low total harmonic distortion 2.2%. In addition to that, the reduction of component counts allows the proposed converters to achieve low voltage/current stress and low switching losses. However, the dc-link voltage balancing circuit is restricted to certain power applications. For the case of medium-voltage drives, the size of the inductors in the balancing circuit must be extremely large to meet such required power ratings. Thus, alternative dc-link balancing strategies such as modulation schemes or control algorithms can be implemented to replace the additional balancing circuit. These will provide a more cost-effective and energy-efficient solution for a higher level ac/dc/ac drive and can particularly be suitable for renewable energy conversion where high efficiency is paramount.

CONCLUSION

In this paper we have to study that space vector modulation technique is more better than the pulse width modulation technician the five level multilevel converter there is getting many semiconductor components are used it but due to using that technique there will be reducing the number of components which will caused increasing the efficiency also getting light weighted model because of that there cost will be directly decreases that five level multilevel converter widely used it. That's why we have to use it given technique for removing there some drawbacks. Thus five level multiple pole space vector pulse width modulation converter with reduced components converter is the better choice for low cost and improved performance. This paper has presented the design and implementation of five levels multiple pole space vector PWM technique. The key idea of the proposed work is to reducing the harmonic distortion and getting the effective output. The advantages of the developed system are to have a continuous monitoring over industrial applications and also control them if going beyond their threshold conditions. Future work will focus on improvement of above proposed work and adding features to make a reliable smart Industrial monitoring and controlling system

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