International Journal of Innovative Research in Scientific Engineering and Technology-IJIRSET
VOLUME 1 ISSUE 1, MAY 2018 ISSN: 2XXX-XXXX
WWW.IJIRSET.ORG

Implementation of Space Vector Pulse Width Modulation Technique to reduce stress in Three Phase to Single Phase Cycloconverter

R.Meenakshi,
Assistant Professor Department of computer science,
Nazareth college of arts and science, Chennai.

Abstract- Cycloconverters are used for generating variable frequency and variable voltage. The switches generally used in cycloconverters are thyristors which requires external commutation circuit and also switching frequency is less. Among the transistor switches IGBT is used because it has low on state loss switching losses when compared to MOSFET and also it has high switching frequency when compared to BJT. Due to high switching frequency used, the stress across switches will be high and this can be reduced by PWM techniques. Among various PWM techniques, SVPWM is used because it prevents unnecessary switching which is caused by voltage stress.

Keywords- Cycloconverter; Voltage stress; MOSFET; IGBT;PWM techniques;SVPWM

1 INTRODUCTION

Cycloconverter is a device which can generate variable frequency and variable voltage output directly from an AC input. Matrix converter is also a device which can also provide variable frequency along with voltage output. But there are several disadvantages over the working matrix converters as these matrix converters performance depends on the modulation strategies and the complex topology of the matrix converters make the application of these modulation strategies a difficult task. Some more disadvantages like lower voltage modulation index, higher sensitivity to power supply disturbances, complexity control, switching losses, dv/dt stresses on the load and switches, higher harmonic components and output voltage with high total harmonic distortion.

Three phase to single phase forced commutated cycloconverters is one type of direct AC-AC matrix converters. These type of forced commutated cycloconverters can be made compact and they are highly reliable and this type of forced commutated cycloconverters are widely used for controlling speed (or drive the) of the synchronous motor as well as the induction motor.

In this paper, the output of the forced commutated cycloconverters has been compared by changing the switching device in them. The effect of the dv/dt stress of the switches on the load was discussed and also for limiting the high voltage transient among the several available pulse width modulation technique was used to control the gate signals given to the switches.

2 VOLTAGE STRESS

Change in the voltage with respect to time is known as dv/dt. There are several types of switching devices from thyristor (SCR) to Transistors(like BJT,MOSFET,IGBT).In these switches there will be alternate layers of P type and N type semiconductors and these switches conducts when they are forward biased and remains in off-state when they are reverse biased. Between these layers due to accumulation on the positive ions on one side and the negative ions on the other side the internal capacitor which is known as the parasitic capacitor is formed. The capacitance of a capacitor is given as C=£A/d. So when the distance between the positive layer and the negative layer is reduced the capacitance will increase. And also when the input voltage has a high transient the value of the parasitic capacitance formed inside the switches will also increase (i.e) the value of the capacitance will get increased along with the increased input voltage.

3 FAULT SWITCHING

The transistors like MOSFET and IGBT are controlled by the gate voltage signals. When the gate signals are given the switch conducts and when the gate signals are not given, the switches get turned off. But the capacitor formed inside, discharges when the gate signals are not given and hence these discharges from the capacitor acts as the gate voltage which results in the fault switching that will affect the output of the cycloconverter.

4 SELECTION OF SWITCHES

Among the various switches available, the switch that is generally used is thyristor or BJT. But, the SCR cannot be

controlled once the gate pulses are given and also the switching frequency of BJT is very very less. So, MOSFET was selected as the switch. Whose switching frequency was very very high [But it also has the high on state losses which is almost more than twice that of the BJT]. Even though IGBT has less on state losses when compared to MOSFET the switching frequency is less when compared to MOSFET. Hence the switch that is used in the cycloconverter is MOSFET.

5 CYCLOCONVERTER

Cycloconverter is a type of power controller, where an alternating voltage at supply frequency is converted directly to an alternating voltage at load frequency, without any intermediate dc stage. The output frequency of the cycloconverter is limited to about one-third of the supply frequency of 50H. There are different types in cycloconverter like three phase to single phase cycloconverter, single phase to single phase cycloconverter, three phase to three phase cycloconverter. Among these the three phase to single phase cycloconverter is discussed in this paper. The switches used in the cycloconverter may be a thyristor or a transistor family. In earlier days the thyristors were used as the power semiconducting switch in the cycloconverter, but due to the presence of various advantages in the transistor family, the switches like BJT, MOSFET, IGBT were used.

The three phase to single phase cycloconverters consists of two three phase full wave bridge converters connected back to back, with six thyristors for each bridge. In this paper, the non-circulating current mode of operation is used, where only one converter either bridge 1 or bridge 2 conducts at a time, but both the converter do not conduct at the same time. Each thyristors conducts for about 120°, (i.e) one third of one complete cycle, whereas a particular thyristor pair , say 1 and 2 conducts for about 60°, (i.e) one – sixth of a cycle. The thyristor conducts in pairs as stated, one thyristor in the top half and the other in the bottom half in two different legs. Two thyristors in one leg are not allowed to conduct at a time, which will result in a short circuit.

The control principle used in cycloconverter is to continuously modulate the firing angles of the individual switches so that each produces the same sinusoidal voltage at its output terminals.

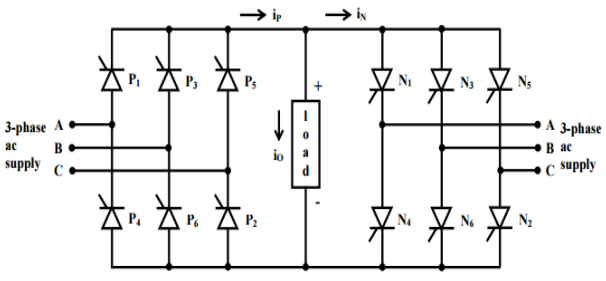

Fig.1 Three phase to Single phase converter

6 FORCED COMMUTATED CYCLOCONVERTERS

The 3ϕ to 1ϕ cycloconverters consists of six switches which are divided into two groups. To prevent creation of a short circuit path, the switches that are in the same group should not be turned on simultaneously. At any time only one switch from each group should be turned on. The three phase source is given as the input. The gate pulses given to each switch in the cycloconverter is controlled by using space vector pulse width modulation technique.

The table given below gives the switching sequence and the value of voltage that develops on the converters output terminal according to each position. With suitable switching approach it is possible to handle flexible output voltage in terms of magnitude, phase angle and frequency from n phase input voltage. The switches which are used in forced commutated cycloconverters structures are bidirectional with capability of blocking voltage and conducting current in both the directions.

As mentioned in the table, each time by choosing one of the seven switching patterns, it is possible to develop seven voltage values on the converter output. In each given time seven waveforms around the reference voltage waveform can be considered, which makes it possible to select suitable voltage waveforms or voltage value according to switching pattern.

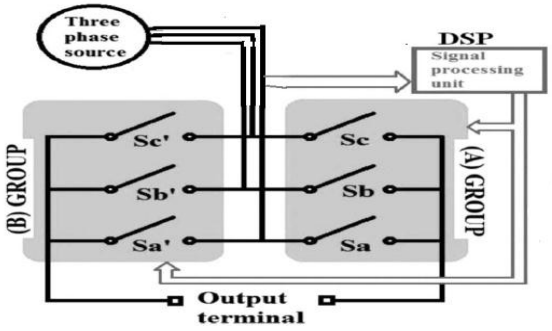

Fig.2 Forced commutated cycloconverter

Table 1 Switching values.

Stat	Switches position [1=on	Output voltage

e	and 0=off]						
	Sa	Sb	Sc	S'_a	S'_b	S'_c	
1	1	0	0	0	1	0	Vab = √3Vmsin(ωt+30)
2	1	0	0	0	0	1	Vac = √3Vmsin(ωt−30)
3	0	1	0	0	0	1	Vbc = √3Vmsin(ωt−30)
4	0	1	0	1	0	0	V'_{ab} = √3Vmsin(ωt+30)
5	0	0	1	1	0	0	V'_{ac} =√3Vmsin(ωt+30)
6	0	0	1	0	1	0	V'_{ac} = √3Vmsin(ωt+30)
7	1	0	0	1	0	0	0

7 SIMULATION RESULT

In a cycloconverter, ac power at one frequency is converted directly to a lower frequency in a single conversion stage and also the power circuit is more compact, eliminating the circuit losses associated with forced commutation.

One of the most important advantage of the proposed method is its capability of high quality voltage conversion independent of input voltage waveform whether it is in the unbalanced condition or in the balanced condition. It is also possible to convert the voltage along with the boosted magnitude. Reduction of voltage stress over the switches also reduces the energy losses, that is , a great effect on converter longevity.

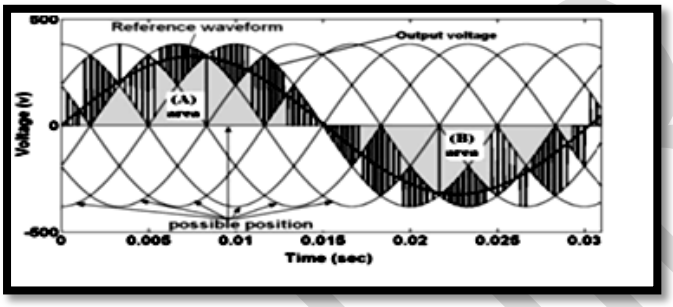

Fig: 3 Single phase output voltage from three phase Sinusoidal input voltage

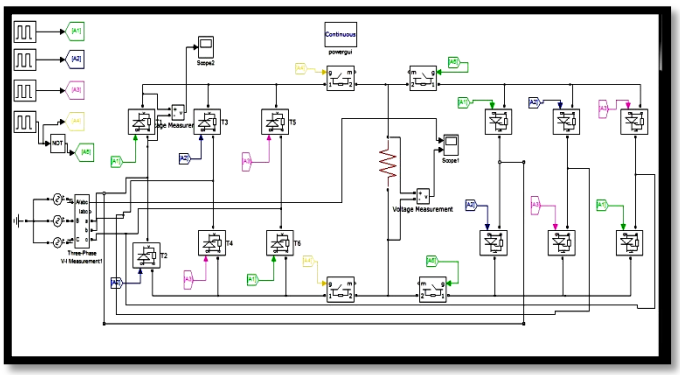

Fig: 4 Simulink diagram of three phase to single phase cycloconverter using IGBT

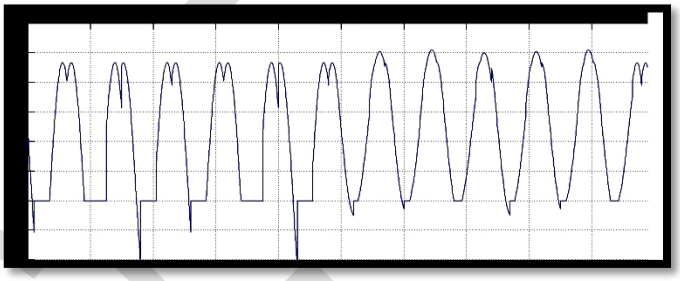

Fig: 5 Voltage across switches

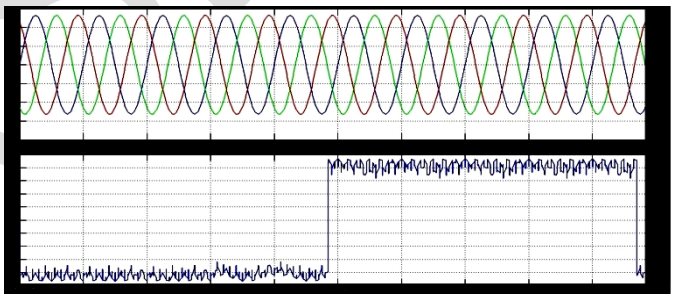

Fig 6.Voltage across the load using MOSFET

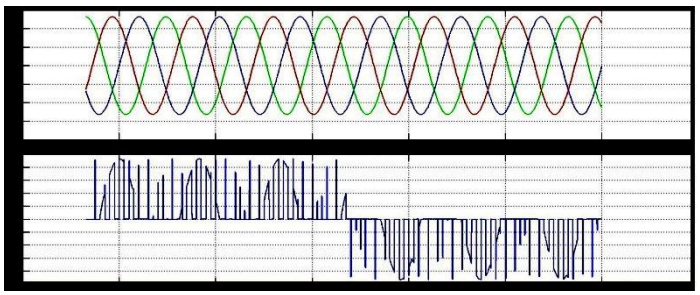

Fig 7.Voltage across the load using IGBT

8 ADVANTAGES

In a cycloconverter, ac power at one frequency is converted directly to a lower frequency in a single conversion stage and also the power circuit is more compact, eliminating the circuit losses associated with forced commutation.

One of the most important advantage of the proposed method is its capability of high quality voltage conversion independent of input voltage waveform whether it is in the unbalanced condition or in the balanced condition. It is also possible to convert the voltage along with the boosted magnitude. Reduction of voltage stress over the switches also reduces the energy losses, that is, a great effect on converter longevity.

9 CONCLUSION

The purpose of the project is to present several advantages of using the IGBT as the power semiconducting switches in the cycloconverter over the other switches in the transistor family and also to propose a pwm based switching strategy for the six switches in the cycloconverter whose gate pulses are been controlled by using the space vector pulse width modulation technique. This causes the decrease in the voltage stress across the switches because of which the fault switching can be avoided. Voltage boosting character and perfect performance in unbalance and non-sinusoidal input voltage conditions are the other advantages in this system. According to the listed advantages , the suggested system can be used to drive both the synchronous as well as induction motors , including steel role mills, cement kilns, mine winders, and ship propulsion drives.

10 REFERENCES

[1] Hossein Khoun Jahan, Mohamad Reza Banaei, "Switching strategy for six switches forced commutated cycloconverter with several advantages" published in IET power electronics, 2013.

[2] Mei,Y.huang "Improved switching function modulation strategy for 3ϕ to 1ϕ matrix converter", 2009.

[3] Casadei, D. Serra, G. Tani, "Matrix converter modulation strategy: a general approach on svpwm of switch state", 2002.

[4]. R. Gupta, K. Mohapatra, A. Somani "Direct matrix converter-based drive for three-phase open-endwinding ac machine with a advanced features," IEEE Trans. Ind. Electron., vol. 57, no. 12, pp. 4032– 4042, Dec. 2014.

[5]. H. Keyhani and H. A. Toliyat, "A soft-switched three-phase ac-ac converter with a high-frequency ac link," IEEE Trans. Ind. Appl., vol. 50, no. 4, pp. 2637–2647, Jul. /Aug. 2014.

[6]. o tas, G. 'A novel direct AC–AC converter for single and two-phase asynchronous motors'. MSc thesis, Firat University, 2016.

[7]. J. Lei, . Zhou, X. Qin, J. Wei, and J. ian, "Active damping control strategy of matrix converter via modifying input reference currents," IEEE Trans. Power Electron., vol. 30, no. 9, pp. 5260–5271, Sep. 2016.

[8]. L. Empringham, J. Kolar, J. Rodrigue , P. W. Wheeler, and J. C. Clare, "Technological issues and industrial application of matrix converters A review," IEEE Trans. Ind. Electron., vol. 60, no. 10, pp. 4260–4271, Oct. 2013.

[9]. J. Rodrigue , M. Rivera, J. W. Kolar, and P. W. Wheeler, "A review of control and modulation methods for matrix converters," IEEE Trans. Ind. Electron., vol. 59, no. 1, pp. 58–70, Jan. 2012.

[10]. R. Palanisamy, K. Vijayakumar, Aishwarya Bagchi, Vachika Gupta, Swapnil Sinha, "Implementation of Coupled Inductor Based 7-Level Inverter with Reduced Switches", International Journal of Power Electronics and Drive Systems, Vol 8, No 3, September 2017.

[11]. . McGrath, D. Holmes, and T. Lipo, "Optimi ed space vector switching sequences for multilevel inverters," IEEE Trans. Power Electron., vol. 18, no. 6, pp. 1293–1301, Nov. 2013.

[12]. K. Gupta and A. Khambadkone.: A Space Vector PWM Scheme for Multilevel Inverters Based on the Two-Level Space Vector PWM. In: IEEE Transactions on Industrial Electronics, Vol. 53, No. 5 (2013).