The International Journal Of Engineering And Science (IJES)
||Volume||3 ||Issue|| 2||Pages|| 35-38||2014||
ISSN(e): 2319 – 1813 ISSN(p): 2319 – 1805

Three Phase Current Source Inverter Using Space Vector Pwm For Grid Connected Applications

[1,] V.Sureshkumar, [2,] S.Arun
[1] P.G Scholar, Dept. of PGES, P.A.College of Engineering & Technology Pollachi, India
[2] Asst. Professor, Dept. of EEE, P.A.College of Engineering & Technology Pollachi, India

--ABSTRACT---
This paper presents the implementation of the space vector pulse width modulation for the current source inverter for the grid connected applications. The space vector pwm provides the digital control by producing the gate pulses to the power electronic switches thereby, reducing the switching loss across the devices and with very less Total Harmonic Distortion (THD).

KEYWORDS: *space vector pulse width modulation, grid interconnection, switching losses.*

Date of Submission: 04 February 2014 ⟺ Date of Acceptance: 20 February 2014

I. INTRODUCTION

The shift from large centralized energy resources to small distributed energy resources (DERs) located at the point of consumption (DERs) is one of the emerging trends in the electricity industry with having the multiple advantages over the traditional energy technologies, like improved asset utilization, better power quality, and enhanced power system reliability and capacity. The renewable energy sources, like solar cells and fuel cells, usually generate dc power. The application of the inverters for the grid inter-connection has become much more popular because of increasing use of the renewable energy resources, mostly the solar PV cells and fuel cells as the distributed energy resources (DERs).

Thus, a grid-connected inverter is usually needed to convert this dc power into the ac power, which is then fed into the electric grid for utilization. The two major types of inverters are voltage source inverters (VSIs) and current-source inverters (CSIs). The control of current source inverter is much more easier than the voltage source inverter, because CSI can balance the grid voltage fluctuations and it produces a predetermined value of current to the grid, thereby achieving a high power factor at the output voltage.The major advantage of CSI is it has inherent short-circuit protection and rapidness in system control. Hence the current source inverter is found to be more advantageous than the voltage source inverter for the grid connected applications.The space vector pulse width modulation is found to be better switching scheme among the various available switching schemes for the grid connected applications since, it has inherent advantages like less current waveform distortion, lower THD, easier digital implementation and very low switching losses.

II. INVERTER

The inverter is used to convert the dc power to ac power at the required output voltage and frequency. The solar PV cell, fuel cell, which produces the DC is supplied as the input to the current source inverter. The large value of inductance is placed in series with the input source for providing the constant current to the inverter.The inverter therefore is an adjustable-frequency voltage source. The configuration of ac to dc converter and dc to ac inverter is called a dc-link converter. Inverters are broadly classified into two types, voltage source inverter and current source inverters. A voltage–fed inverter (VFI) or more generally a voltage–source inverter (VSI) is one in which the dc source has small or negligible impedance. The voltage at the input terminals is constant. A current–source inverter (CSI) is fed with adjustable current from the dc source of high impedance that is from a constant dc source. i.e...The current across the input terminals is maintained constant.

III. CURRENT SOURCE INVERTER

In current source inverter, the input behaves as a current source. The output current is maintained constant irrespective of load on the inverter and the output voltage is forced to change. The circuit diagram of a single phase inverter is shown in Figure 1.

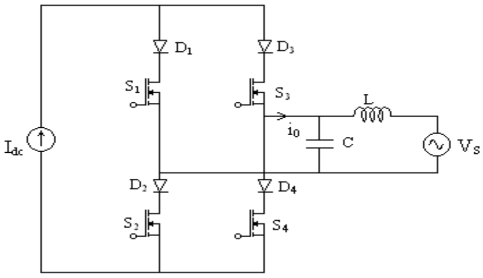

Fig 1. Current Source Inverter

There must be continuous current flows from the source, two switches must always conduct one from the upper and one from the lower switches. The conduction sequence is 14, 43, 32 and 21.Diodes in series with the switches is required to block the reverse voltages.

IV. PWM TECHNIQUES

PWM is the most commonly used method of producing the gate signals for controlling power to inertial electrical devices, made practical by modern electronic power switches. The average value of voltage and current which is fed to the load is controlled by switching on and off the device. The device turn on time determines the power output to the load.The duty cycle is a term which describes the proportion of 'on' time to the 'period' of time; a low duty cycle corresponds to low power, because the power is off for most of the time. Duty cycle is expressed as 100% if fully on. The various PWM techniques are used with various duty cycles for each period. The width of the produced gate pulses are modulated to obtain inverter output voltage control and to reduce its harmonic content. The various techniques are used to generate the PWM signals. The PWM techniques essentially vary in the harmonic content of their respective output voltages to the load.Thus the choice of a selecting a PWM technique depends on the allowable harmonic content in the inverter output voltage and the type of application.

The various PWM schemes that are used commonly are:

- Single pulse width modulation
- Multiple pulse width modulation
- Sinusoidal pulse width modulation
- Space vector pulse width modulation

In PWM inverters, forced commutation is essential. The PWM techniques furnished above differ from one another based on the harmonic content in their respective output voltages. Thus the selection of a particular PWM technique depends upon the allowable harmonic content in the inverter output voltage. Here the space vector pulse width modulation technique is used, since the space vector pulse width modulation has the inherent advantages when it is applied for the grid connected applications.

A. Space vectorPulse Width Modulation

The space vector pulse width width modulation is one of the promising and mostly used switching scheme for the

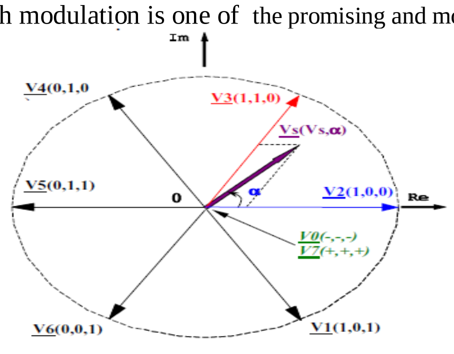

Fig 2. Switching Vectors Corresponding to Inverter Operation

inverters and for the industrial applications.The space vector modulation combines all the modulating voltages (vector summation) into one reference voltage or into a single unit. The svpwm generates a reference voltage vector (V_{ref}) whose angular speed calculate the desired vaue of synchronous speed (ω_s) of the motor and its magnitude determines the required voltage (v_s) for the industrial applications.The vector representation of the 3 phase systems is first used by Park and Kron by providing the mathematical model for the power electronic switching pulses. Nowadays, the most analysis in the field of Electrical machines are done by using the space vector concept.

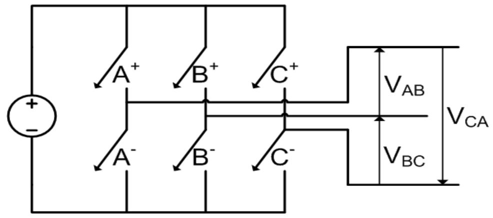

Fig 3. Topology of Basic 3 Phase Inverter

The power electronic switches are controlled such that only one switch of the same leg is made ON at a time otherwise the DC supply will be short-circuited. This can be done by operating the switches of the same leg in the complementary basis with A^+ is on and A^- is off and vice versa which lead to the production of 8 switching patterns from v_0 to v_7 with two zero vectors and six active switching vectors. The concept of space vector is derived from the rotating field of AC machines which is used for modulating the inverter output voltage. In this modulating technique, the 3 phase quantities can be transformed to their equivalent two phase quantity either in synchronously rotating reference frame or stationary reference frame. From this two phase component, the reference vector (V_{ref}) magnitude can be found and used for modulating the inverter output.

$$u_a = \sqrt{2}U\cos(\omega t)$$
$$u_b = \sqrt{2}U\cos(\omega t - 2\pi/3) \quad (1)$$
$$u_c = \sqrt{2}U\cos(\omega t - 4\pi/3)$$

A reference signal with a frequency of v_{ref} is sampled with the nominal frequency, f_s ($T_s = 1/f_s$) to produce the space vector modulation.

$$u_\alpha = \left(\frac{2}{3}\right)(u_a - 0.5u_b - 0.5u_c) = \sqrt{2}U\cos(\omega t) \quad (2)$$
$$u_\beta = \left(-\frac{2}{3}\right)\left(\frac{\sqrt{3}}{2}u_b - \frac{\sqrt{3}}{2}u_c\right) = \sqrt{2}U\sin(\omega t)$$

The αβγ transform is used to produce the reference signal from the three phase references. This reference vector is then synthesized by using the combination of the two adjacent switching vectors and zero vectors. When this 3-phase voltage is applied to the AC machine, it produces the rotating flux in the airgap of the machine whose magnitude and phase angle can be found by using Clark's transformation. The space vector representation of the three phase quantity is

$$V_{ref} = V_\alpha + jV_\beta = \frac{2}{3}[V_a + aV_b + a^2V_c] \quad (3)$$

Where $a=e^{j2\pi/3}$

As there are three switches, corresponding to the three phases, there are eight possible switching states for the inverter at any instant of time which are shown in the figure 2. The space phasor of voltage stays in each of the positions 1 to 6 for a time interval corresponding to 60° of the fundamental period and jumps to the next position at the end of every sixty degree.

V. RESULTS AND DISCUSSIONS

The input for the inverter is assumed to be the constant DC voltage to be supplied by the battery. The figure 4 shows the.

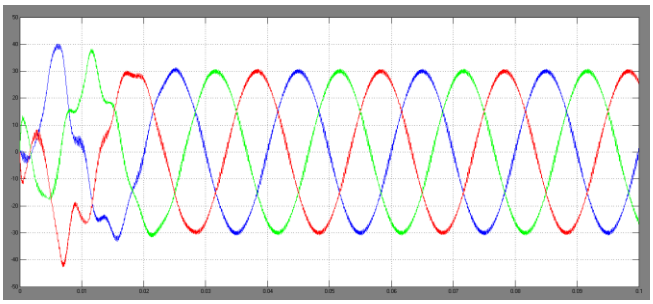

Fig 5. Simulation result for output current

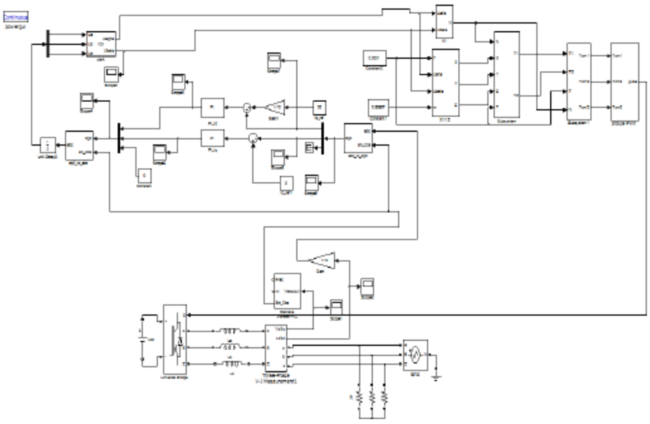

Fig 4. Simulation circuit for SVPWM based CSI

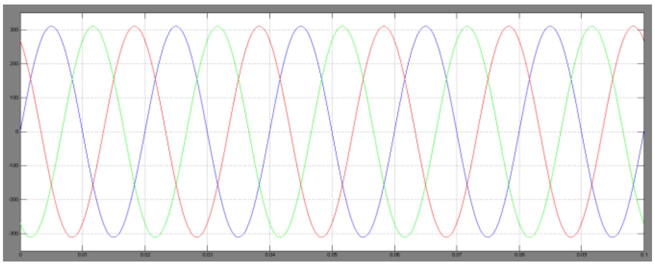

Fig 6. Simulation result for output voltage

simulation mode of the current source inverter using the space vector pulse width modulation for producing the gate signals. The figure 4 and figure 5 shows the simulation results for the output current and output voltages respectively. The results clearly shows the output has very less THD and produces much lower switching losses.

VI. CONCLUSION

In this paper, the importance of the space vector pulse width modulation has been explained. The proposed method, however has nine switching states, with three charging and six discharging states and only two switches are made on at a time.

REFERENCES

[1] Bader N.Alajmi, Khaled H.Ahmed and Barry W.Williams (2013),"single phase single stage transformer less grid connected PV system", *IEEE Trans.Power electron*.,vol. 28, no. 6.

[2] H. Nakamura, Y. Murai, and T. Lipo (1994), "Quasi current resonant DC link AC/AC converter," IEEE Trans. Power Electron., vol. 9, no. 6, pp. 594– 600.

[3] J. S. Sivaprasad and G.Narayan (2014), "Minimization of grid current distortion in parallel connected converter through carrier interleaving" IEEE Trans. Ind. Electron., vol. 61, no. 1.

[4] Prajna Paramita Dash and Mehrdad Kazerani (2011),"Dynamic modeling and performance analysis of a grid connected current source inverter-based PV system",IEEE Trans.on Power Electron., vol. 2, no.4.

[5] R. Li, H. Chung, and T. Chan (2007), "An active modulation technique for single phase grid-connected CSI," IEEE Trans. Power Electron., vol. 22, no. 4, pp. 1373–1382.

[6] S. B. Kjaer, J. Pedersen, and F. Blaabjerg (2005), "A review of single-phase grid connected inverters for photovoltaic modules," IEEE Trans. Ind. Appl., vol. 41, no. 5, pp. 1292–1306.

[7] Li Zhang, Kai Sun, Yan Xing, Lanlan Feng and Hongjuan Ge (2011),"A modular Grid connected photovoltaic generation system based on DC bus", IEEE Trans. Power Electron., vol. 26, no. 2.

[8] Behrooz Mirafzal, Mahdi Saghaleini and Ali Kaviani (2011),"An SVPWM based switching pattern for stand alone and grid connected three phase singe stage boost inverters," IEEE Trans. Power Electron., vol. 26, no. 4.

[9] Jung-Min Kwon, Bong-Hwan Kwon and Kwang-Hee Nam (2008),"Three-phase photovoltaic system with three-level boosting MPPT control", IEEE trans. On power Electron, vol.23, no.5.

[10] B.Yang, W.Li, Y.Zhao and X.He (2010),"Design and analysis of a grid connected photovoltaic power system," IEEE Trans. Power Electron., vol.25, no.4,pp.992-1000.

[11] A.Koran, K.Sano, R-Y.Kim and J.S.Lai,"Design of a photovoltaic simuator with a novel reference signal generator and two stage LC output filter," IEEE Trans. Power Electron., vol.25, no.5 ,pp.1331-1338.