Implementation of Multilevel Inverter with Svpwm Scheme for PV Grid

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ABSTRACT- This paper presents the implementation of space vector pulse width modulation (SVPWM) scheme for a multi level inverter to generate 3-$\emptyset$ wave form from the PV cell and connect it to the grid. Multiphase multilevel inverters are controlled by this method to provide multiphase variable voltage and variable frequency supply. PV cells are the DC voltage sources and they give the variable DC voltage at their terminals. By using space vector pulse width modulation method we control the inverters thereby we generate 3-$\emptyset$ wave form with required voltage magnitude and frequency in order to connect it to the grid. This technology very useful to the power producers in small amount in their plants (solar, fuel cell, vehicle to grid system) .we are getting the controlled pulses by the use of algorithm to give multilevel inverters .

KEY WORDS: Multilevel inverters, SVPWM, PV cells,

I.) INTRODUCTION

Recent development in the area of multiphase variable speed drives, initiated predominantly by potential applications in electric ship propulsion, more-electric aircraft, electric and hybrid-electric vehicles, and other high power industries, have led to a equivalent development of pulse width modulation (PWM) schemes for multiphase inverters used in these drives. The most generally used techniques for implementing the pulse width modulation (PWM) strategy for multilevel inverters are sine-triangle PWM (SPWM) and space vector PWM (SVPWM). Each method has its own advantages and disadvantages and is suitable for different occasions. SPWM is simple and easy to implement. This method can be divided into carrier disposition PWM and phase shift carrier PWM

The SVPWM is considered a better technique of PWM implementation as it has some advantage over SPWM in terms of good utilization of dc-bus voltage, reduced switching frequency and small current ripple. SVPWM presents the advantage of its extreme simplicity and its easy and direct hardware implementation in a digital signal processor (DSP). SVPWM can be efficiently executed in a few microseconds, achieving similar results compared with other PWM methods. The topology of a cascade multilevel inverter is shown in Fig. 1. In general, the SVPWM implementation involves the sector identification, determining the duration of each switching space vector voltage, determining the switching space vector and optimum switching sequence selection for the inverter voltage vectors. .

Multilevel converter technology is based on the synthesis of a voltage waveform from several DC voltage levels. As the number of levels increases, the synthesized output voltage gets more steps and produces a waveform which approaches the reference more accurately. The major advantages of using multilevel inverters are: high voltage capability with voltage limited devices; low harmonic distortion; reduced switching losses; increased efficiency

II.) The SVPWM modulator of a single-stage inverter

 The PWM waveform for the left bridge arm is obtained by comparing and the triangular carrier with amplitude of 1. Through uni-polar double frequency theory, the PWM waveform for the right bridge arm is obtained by comparing with the 180° phase shift and the triangular carrier.

In Phase A, the reference modulation waveform of the left and right bridge arms, the switching signals of the upper tube in the left and right bridge arms, and the output waveform of the H-bridge are shown in Figure -1. In the figure, the carrier frequency is $f_c = 1/T_s = 500$ Hz, and the reference modulation waveform frequency is f=50 Hz. The modulation method in Figure 4 is DPWM min. The generalized SVPWM modulator is shown
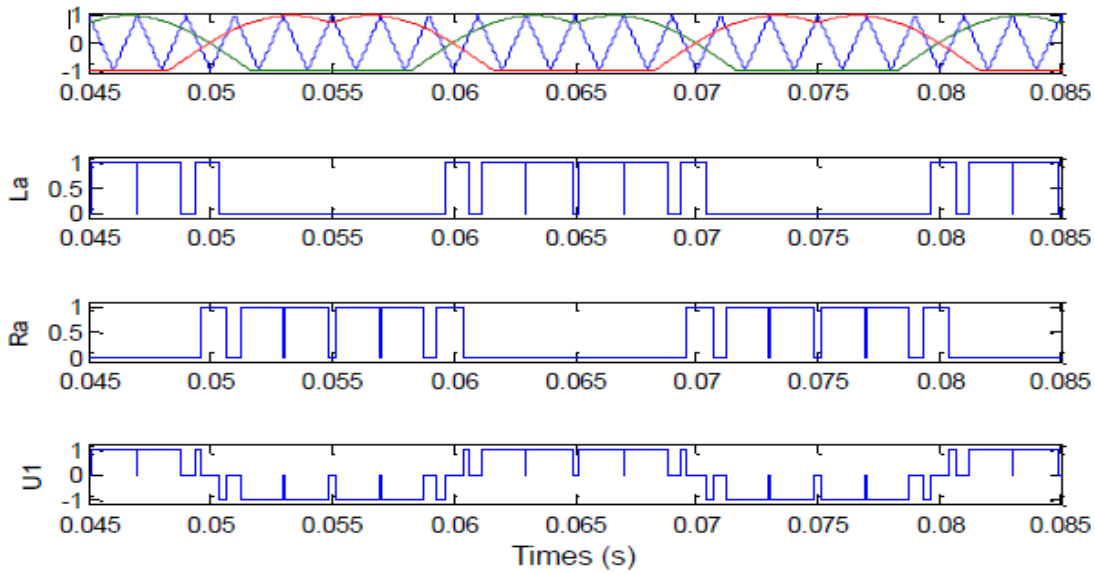
Figure 1. Phase A modulation and switching signals of DPWM min

III.) **PWM of a multilevel inverter**

The carrier phase shift technique, the carriers of adjacent single-stage inverters deviated by Ts/2N, where N is the series of cascaded inverters, and Ts is the carrier cycle. The PWM waveforms of all single-stage inverters are obtained by comparing the carriers and the reference modulation waveforms. The output voltage of each single-stage inverter and the total output voltage of Phase A are shown in bellow, where N=3, U_{DC} =750 V, f_c=500 Hz, and f=50 Hz.
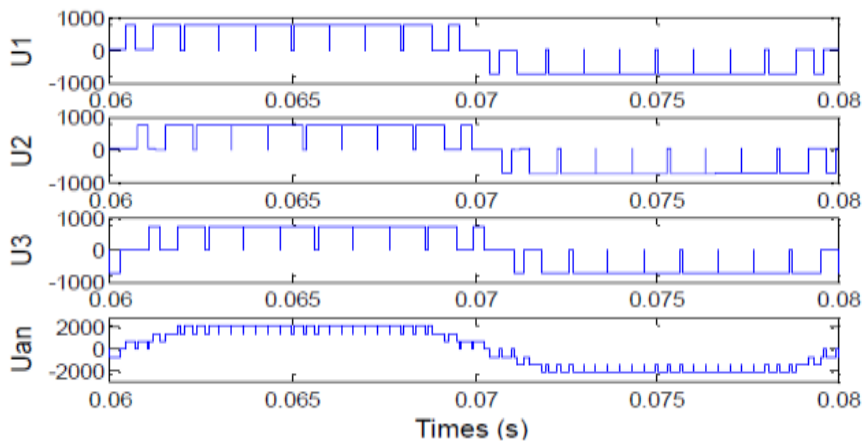

Figure -2 Output waveform for PWM Inverter

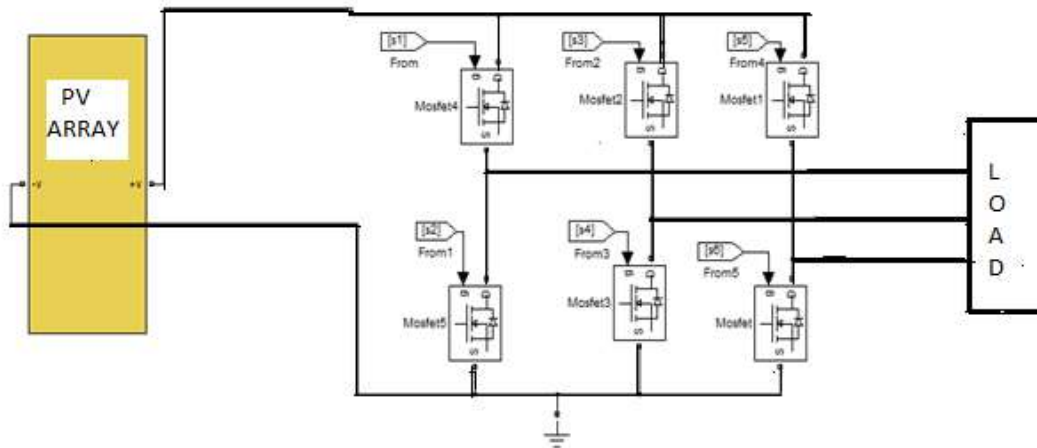## IV.) IMPLEMENTATION OF SVPWM TECHNIQUE FOR PV GRID:

Figure 3 Simulation of PV Grid with SVPWM inverter

we use 6 bidirectional switches, here we connect the A, B, here we will connect C such that the load three phase load when it is represented; let us take this is ABC such that i_A plus i_b plus i_B is equal to 0 that means for a three phase system.

ABC phases or the poles, A can have two positions, either to the top or to the bottom. So, this will represent as if top switch is on, top on, we will mark as one; for the bottom switch is on, we will mark as 0. So, for each pole, there are two states possible either 1 or 0. So, there are three poles. So, you will have 2^3 sets, 8.

Generation of three phase wave is only possible Using these combinations of, alternatively using these 8 states, we have to generate the PWM wave from such that the average variation in the phase will be sinusoidal. now this is our A, B, C. **So**, let us take the conditions 000, 001, 010, 011, then 100, 101, 110, 111. these two(111,000) are zero states that means all the top switches are on, all the ABC phases will be shorted to the positively and all lower switches are on will be shorted negatively**.**

(1) let us start with 100. 100 means this A phase will be connected to top switch. B and C will be connected to the bottom switch that means bottom device is on; this is 100.

(2) Now, let us take, next is let us take, 110. So, 110 will be A B C; this is A, this is B, C. So, 110 means both A and B is connected to the top.

(3) Now, let us take three, the three, let us take 010. so A will be connected to 0, bottom. B will be connected to the top, C pole will be connected to the bottom; so this is 010.

(4) let us take the **fourth state**, fourth state we will take as 011. So here, the inverter poles are connected, so from this pole states 011 it clear clearly indicates where we have to connect the inverter poles that is ABC poles. A will be connected to zero that is bottom side, B will be connected to the positive, so top switch is on in the B leg; this is 011, this is our fourth state.

(5)let us take **our fifth state**; fifth is 001. Here, it will be like this; A phase will be connected to 0, B phase also connected to 0, B phase also connected to 0, C phase connected to A B C. A phase is connected to 0; by connecting means bottom switch is turned on, B is also connected here, C is connected to top; these are fifth

(6) Let us take our **sixth one**; sixth one is 101. This ABC, see A phase is all A is connected to the top rail and B is connected to the bottom rail that means the bottom switch is on and C is again connected to bottom top here. This is 101, sixth.

the next are the zero states that is 7 and 8. 7 and 8 let us take that is 111, seven is 111 that means all the legs or the pole ABC are shorted to the positive top rail that means ABC

Now, one more is there; that is 000 that will term as the number 8. So here, ABC, here all the three poles ABC is connected to the bottom rails that is bottom switch is on. This is also called a zero state.

we can only have one out of this 8. So, how do you use these states such that the average variation in phase is sinusoidal or the voltage space vector will tip of the voltage space vector, the average voltage space vector will trace a circle
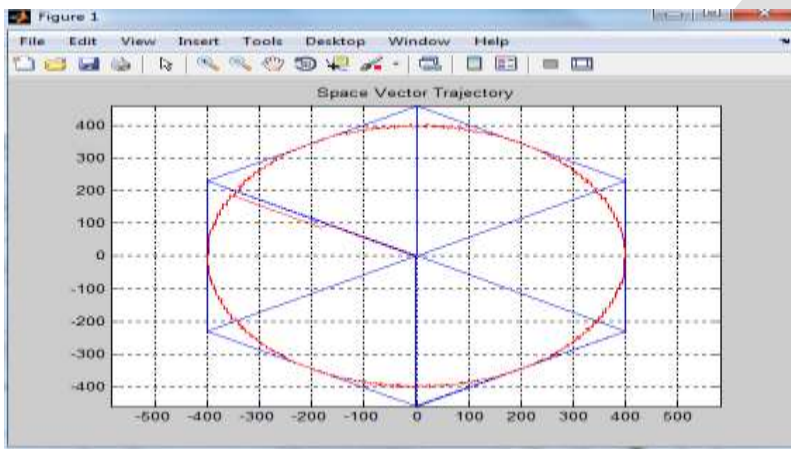

Figure - 4 voltage space vector rotation diagram

The figure-4 shown the voltage space vector rotation diagram, which is implement for PV grid. The inverter control Signals are shown in Figure-5. The figure-6 is shown the 3-phase Multilevel inverter output from the PV grid and Figure-7 is a Space vector voltage for two phase control.
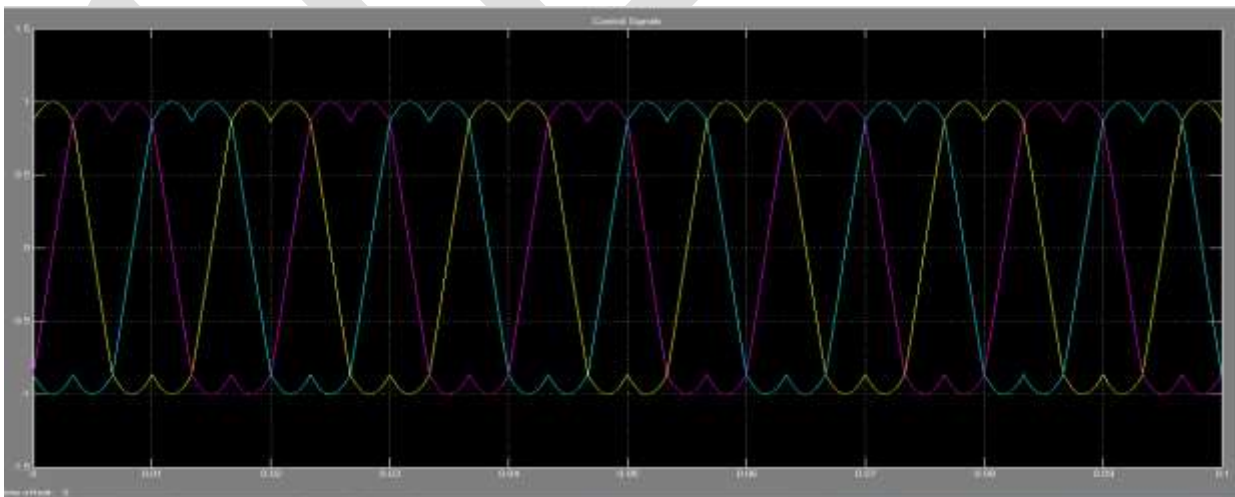

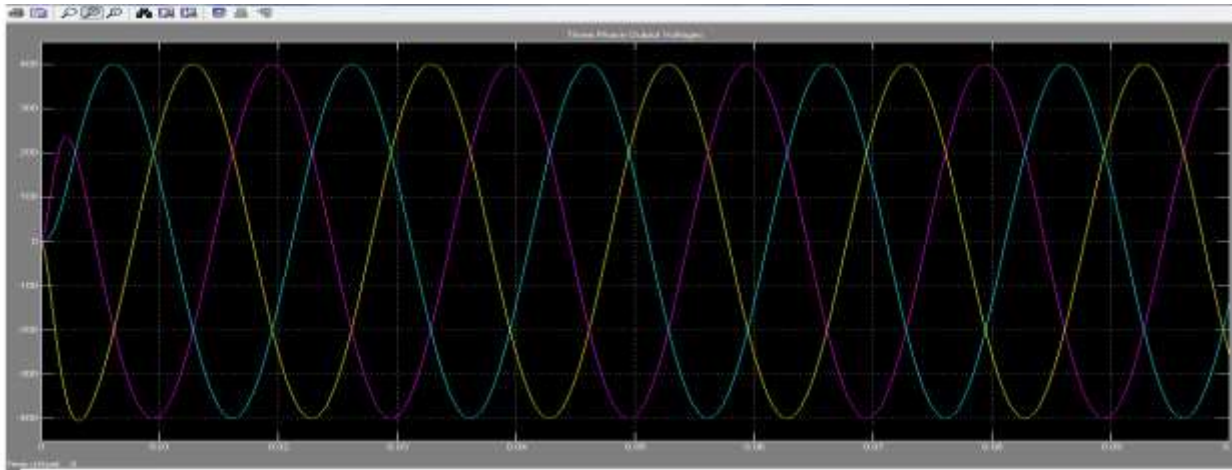**Figure-5 Inverter control signals.**

Figure-6output waveform of the inverter

Figure-7 Space Vector two phase voltage

V.) CONCLUSION

This paper proposes a SVPWM based scheme to perform over modulation for a multilevel inverter, and its implementation. The position of the vector is identified using an integer parameter, called a triangle number. The switching sequences are mapped with respect to the triangle number. The on-times calculation is based on on-time calculation for two-level SVPWM. The on-time calculation equations do not change with the triangle. A simple method of calculating on-times in the over modulation range is used, hence, a solution to complex equations and lookup tables are not required. This leads to ease of implementation. There are no significant changes in computation with the increase in level. The proposed implementation is general in nature and can be applied to a variety of modulation schemes. The implementation is shown for a five-level and seven-level cascaded inverter. The experimental results are provided. The proposed method can be easily implemented using a commercially available motion control DSP or micro-controller, which normally supports only two-level modulation.

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