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IMPLEMENTATION OF MULTILEVEL INVERTER USING SINUSOIDAL PULSE WIDTH MODULATION TECHNIQUE

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Abstract: In general Multilevel inverter used to control various parameters of load. This paper has included about seven Level Inverter and cascaded seven Level Inverter which is used to convert uncontrolled D.C. into controlled A.C. For pulse generation we are using Sinusoidal Pulse Width Modulation (SPWM) technique by comparing carrier and reference signal which is widely used in industrial applications like speed control of Induction Motor, Brushless D.C. Motor and large power applications. By using this technique, we can reduce the Total Harmonic Distortion (THD) and improves voltage magnitude of load. All output result of inverter with R load, and FFT analysis has discussed in this paper.

Key words: seven Level Inverter, cascaded seven Level Inverter, SPWM, Simulation Results.

I. INTRODUCTION

For getting controlled A.C output an inverter to be used. Inverter is converting uncontrolled D.C. in to controlled A.C. There are so many types of inverter like two level ,three level and five level etc. In this paper seven level inverter has discussed and it' results. Seven level inverter has made up of D.C. source, 12 power electronic devices (ideal switches), star connected resistive load, (with 180 deg.conduction mode).Sinusoidal Pulse Width Modulation (SPWM) technique is used to generate the gate pulses. SPWM technique is widely used in industries. Cascaded seven Level Inverter is discussed in this paper. FFT is used for harmonic analysis of output of Seven Level Inverter.

The paper is organized as follows: Section 2 explains the cascaded H- bridges. Section 3 discusses the sinusoidal pulse width modulation technique. Section 4 explains the the circuit description of seven level onverter. Test cases and simulation results for single and seven levelsare given and discussed in Section 5 ,6. In section 7 **discusses** comparison of power component requirements per phase leg among three multilevel inverters
and conclusions in Section 8.

II. CASCADED H-BRIDGES

A single-phase structure of an m-level cascaded inverter is illustrated in Figure1. Each separate dc source (SDCS) is connected to a single-phase full-bridge, or H-bridge, inverter. Each inverter level can generate three different voltage outputs, $+V_{dc}$, 0, and $-V_{dc}$ by connecting the dc source to the ac output by different combinations of the four switches, S_1, S_2, S_3, and S_4. To obtain $+V_{dc}$, switches S_1 and S_4 are turned on, whereas $-V_{dc}$ can be obtained by turning on switches S_2 and S_3. By turning on S_1 and S_2 or S_3 and S_4, the output voltage is 0. The ac outputs of each of the different full-bridge inverter levels are connected in series such that the synthesized voltage waveform is the sum of the inverter outputs. The number of output phase voltage levels m in a cascade inverter is defined by m = 2s+1, where s is the number of separate dc sources[5]

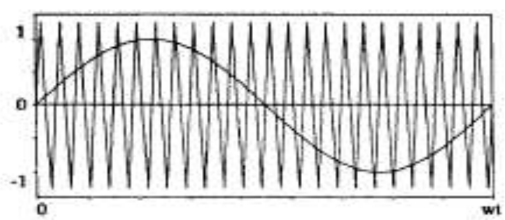
III.SINUSOIDAL PULSE WIDTH MODULATION TECHNIQUE

This is a very simple technique for harmonic reduction. In this technique pulse magnitude will be constant and only pulse time (width) can be changed. In this pure sine wave is compared with carrier (triangular) wave and producing gate pulses. Sine wave has fundamental frequency and carrier wave can be taken more than fundamental frequency.

Sinusoidal pulse width modulation is one of the primitive techniques, which are used to suppress harmonics presented in the quasi-square wave. In the modulation techniques, there are two important defined parameters: 1) the ratio P = ωc/ωm known as frequency ratio, 2) the ratio Ma = Am/Ac known as modulation index, where ωc is the reference frequency, ωm is the carrier frequency, Am is reference signal amplitude and AC is carrier signal amplitude.

IV.SAMPLING TECHNIQUE

In this method of modulation, several pulses per half-cycle are used. Instead of maintaining the width of all pulses, the width of each pulse is varied proportional to the amplitude of a sin-wave evaluated at the centre of the same pulse. By comparing a sinusoidal reference signal with a triangular carrier wave, the gating signals are generated. The frequency of reference signal determine the inverter output frequency and its peak amplitude, controls the modulation index, M, and then in turn the RMS output voltage in Fig3 shows the more common carrier technique, the conventional sinusoidal pulse width Modulation (SPWM) technique, which is based on the principle of comparing a triangular carrier signal with a sinusoidal reference waveform (natural sampling).The figure below gives the sinusoidal pulse width modulation.



V.CIRCUIT DIAGRAM AND DESCRIPTION

The circuit which is used in this system seven level inverter is shown in following fig.

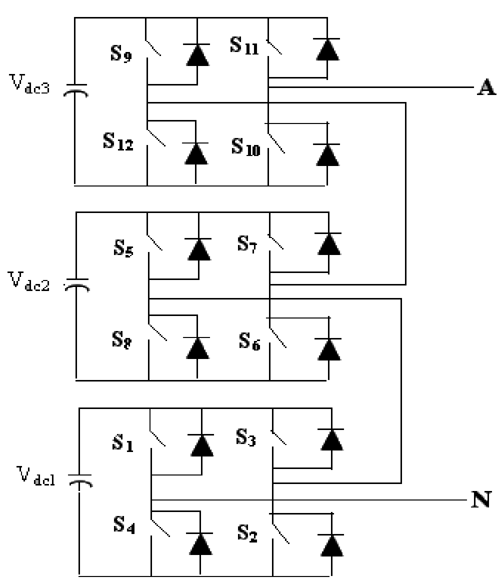


Fig 1. Circuit diagram of seven level inverter

In this circuit six switching devices are connected with D.C. source, and star connected load. Here all thyristors are conducted for 180 degree, at a time three Tthyristors upper side and three lower side will be conducted. At mode-1 the switches Q1 and Q2 will operate. At that time other two switches turned off. Vo and Io will be the output voltage and current respectively. At mode-2 the switches Q3 and Q4 will be turned-on and other two switches are omitted. Its main function is to convert uncontrolled D.C. in to three phases controlled A.C. using 12 power electronic devices like SCRs, ideal switches etc.

The modularity of this structure allows easier maintenance and provides a very convenient way to add redundancy into the system. The multilevel inverter using cascaded-inverter with separate DC sources synthesizes a desired voltage from several independent sources of dc voltages, which may be obtained from batteries, fuel cells, or solar cells.

This configuration recently becomes very popular in ac power supply and adjustable speed drivapplications. This new inverter can avoid extra clamping diodes or voltage balancing capacitors. One major advantage of this hybrid approach is that the number of output can be further increased without addition of any new components, requiring only the dc sources with different voltage levels.

VI.SIMULATION RESULTS

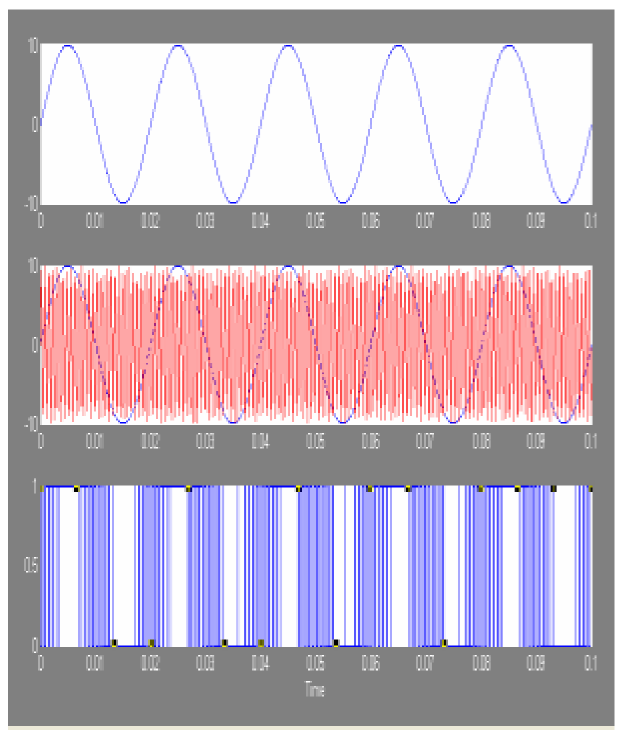
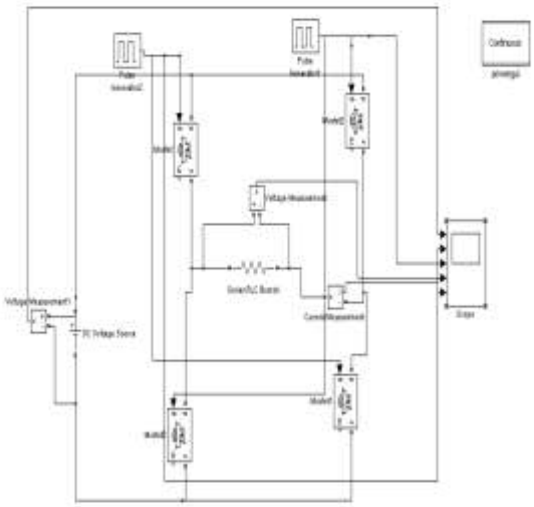
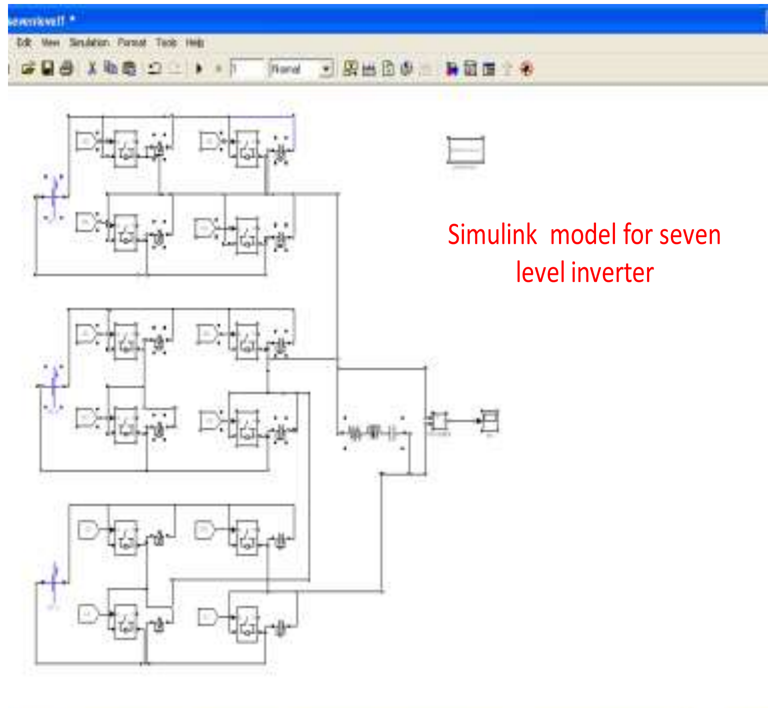


Fig.2 Output waveform of SPWM

Simulink model for single level inverter :





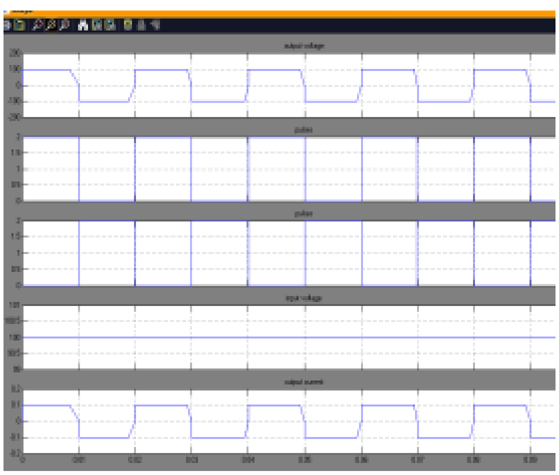


Fig.3 Output voltage and current wavefrom of R-load

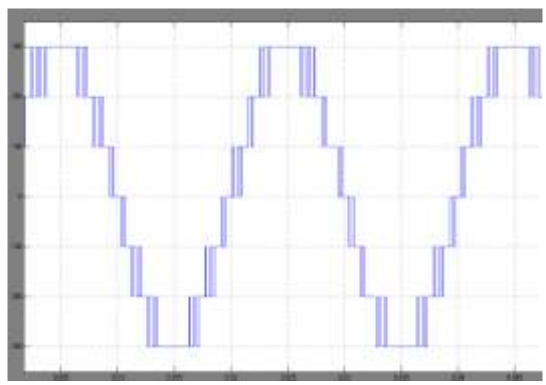


Fig.4 Simulation output of Multilevel Inverter

VII. RESUTLS OF FFT ANALYSIS

Such a technique is used for analysis of harmonic of output of Three Level Inverter. Here in this analysis has included with resistive load and with RL load Inverter.FFT analysis gives Magnitude of Output Voltage and % Total Harmonic Distortion.

$$\mathrm{THD} = \frac{\sqrt{V_2^2 + V_3^2 + V_4^2 + \cdots + V_n^2}}{V_1}$$

THD value for single level inverter:

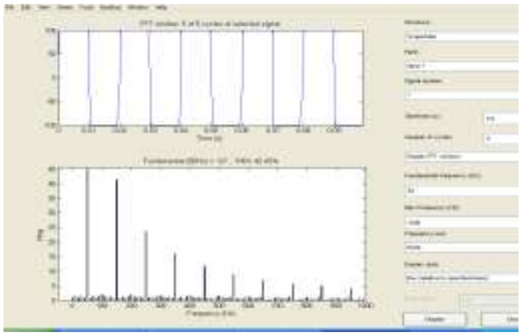


Fig 5 FFT analysis of single level inverter

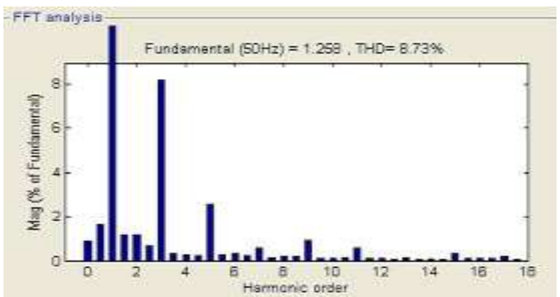


Fig 6 FFT analysis of seven level inverter

VIII. COMPARISON OF POWER COMPONENT REQUIREMENTS PER PHASE LEG AMONG THREE MULTILEVEL INVERTERS.

Inverter Configuration	**Diode – Clamped**	**Flying – Capacitors**	**Cascaded – inverters**
Main switching devices	**2(M-1)**	**2(M-1)**	**2(M-1)**
Main diodes	**2(M-1)**	**2(M-1)**	**2(M-1)**
Clamping diodes	**(M-1)(M-2)**	**0**	**0**
DC bus capacitors	**(M-1)**	**(M-1)**	**(M-1/2)**
Balancing Capacitors	**0**	(m – 1)(m – 2)/2	**0**

IX.CONCLUSION

H – bridge inverter has been analysised and simulated with reduced harmonics. Finally the harmonics in multilevel inverter at different stages were compared. From that comparison, it can be seen that the seven level inverter has least value of THD. . To keep the dc voltage balanced between the capacitors of each inverter, the rotated switching scheme using fundamental frequency switching is used, where the switching patterns are rotated every cycle. The use of reactive loads and power electronics converter based AC/DC drives in industry has drawn non-sinusoidal and non-periodic current from the distribution power system.

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