Comparison of 5 level & 24 Level Cascaded H Bridge Multi Level Inverter

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Abstract. Nowadays inverters are playing a major role in electrical power system operation and control. The usage of the inverters starts from the domestic applications to aero-space applications. Basically, they convert DC electrical voltage to AC voltage of required amplitude and frequency. There are so many topologies available, but among all of them conventional H- bridge inverters serve the various needs of power system. In this paper 5 level inverter and 24 level inverter are modeled and their performance is compared. The simulation is done in Mat lab.

Keywords: multi level inverter , H bridge , Matlab

1 Introduction

Power system concerns are changing day to day, some of them are power quality and efficiency of the system. The output of conventional H-bridge inverter contains more THD and causing more power quality issues, so their usage is obsolete. New topologies are introduced with low THD output, they are multilevel inverters. They are also having well established topologies namely, “Diode clamped multilevel inverter,” “Flying capacitor multilevel inverter,” and “Cascaded multilevel inverter”. Recent research is done in cascaded multilevel inverters to explore higher performance converter with less cost. One of them is presented in this paper, which is Cascaded Multilevel Inverters with Reduced Number of Components Based on Developed H-Bridge. In this paper the proposed Three Phase Five Level cascaded H-Bridge Inverter is fed from renewable energy source of solar energy and the pulses generated for this inverter using phase shift SPWM switching Technique.

2 Multi Level Inverters

In this chapter a review of popular multilevel inverters with proposed Cascaded Multilevel Inverters with Reduced Number of Components Based on Developed H-Bridge is presented. A Multi level inverter takes DC as input and provides alternating current as output which consists multiple levels which is near to sinusoidal signal. This staircase wave will be more similar to sinusoidal as the number of steps increases which can reduce the harmonic distortion. However high number of levels increases the control complexity and introduces voltage imbalance problems.Apart from zero only two levels of voltages are possible by using full bridge conventional inverter. In multilevel inverters, an increased number of power switches are configured to provide several levels of voltage to the load. When compared to standard inverter, a multilevel inverter has many benefits. The topology used here is Modified Cascaded H-bridge due to various attractive features comparing with other two topologies.

3 Cascaded H-Bridge Multilevel Inverters (CHBMLI)

The inverter uses several H-bridge inverters connected in series to provide a sinusoidal output voltage. The cascaded H-Bridge multilevel inverter is to use capacitors and switches and requires less number of components in each level.

The multilevel inverter consists of various blocks each comprises of an H-bridge inverter which produces a DC voltage level. The sum of all these voltage levels will be the output of the H-bridge cascaded multilevel inverter. If the multi level inverter has k number of H-brides the output voltage levels will be equal to the (2k+1).

The number of each H-bridge cell consists of four switches and four diodes and gives the separate input DC voltage for each H-bridge. They comprises of H-bridge elements and each element which can provide the 3 voltages levels like zero, positive and negative DC voltages. The main advantage of this type of multilevel inverter is that it needs less number of components compared with diode clamped and flying capacitor inverters. The price and weight of the inverter are less than those of the two inverters. Soft switching is possible by the some of the new switching methods. Number of single phase H-bridges are cascaded to to form a multilevel inverter. If the magnitudes of all the H-bridges are equal then it is called symmetrical group and the if the magnitudes are different it is called as asymmetric group.

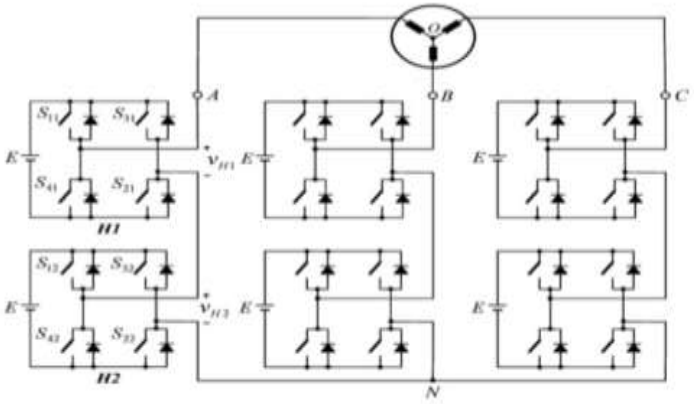

Fig.1. Three Phase 5 Level Cascaded H-Bridge Inverter

Output Voltage	Switching State					
v_{AN}	S_{11}	S_{31}	S_{12}	S_{32}	v_{H1}	v_{H2}
$2E$	1	0	1	0	E	E
E	1	0	1	1	E	0
	1	0	0	0	E	0
	1	1	1	0	0	E
	0	0	1	0	0	E
0	0	0	0	0	0	0
	0	0	1	1	0	0
	1	1	0	0	0	0
	1	1	1	1	0	0
	1	0	0	1	E	$-E$
	0	1	1	0	$-E$	E
$-E$	0	1	1	1	$-E$	0
	0	1	0	0	$-E$	0
	1	1	0	1	0	$-E$
	0	0	0	1	0	$-E$
$-2E$	0	1	0	1	$-E$	$-E$

Fig.2. Switching Sequence For 5 Level CHBMI

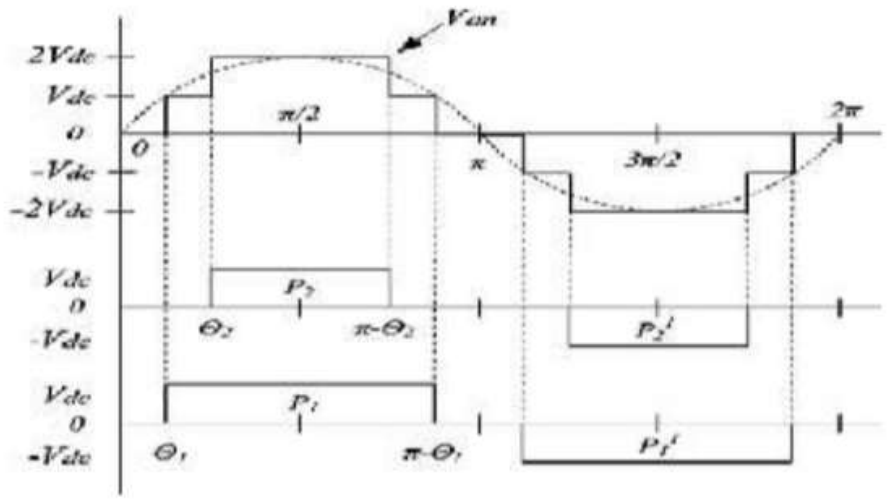

Fig.3. Waveforms of 5 Level CHBMI

4 Carrier Based Pwm Techniques

There are different types of inverter and these inverters are used in there respective applications. To control switching pattern of these inverters, different PWM techniques are used such as SPWM, SVPWM, Selective Harmonic Elimination (SHE). SPWM is simplest method that can be implemented for inverters. The principle of SPWM is illustrated as follow, where sinusoidal modulating wave is compared with triangular carrier wave to give two state (high or low). The modulating wave is compared with triangular carrier wave, if the modulating wave amplitude is greater than amplitude of carrier wave results in high state otherwise remains at low state. At high state switch become on and at low state it will be turn off. SPWM technique is used to control the switching pattern of inverter which results in reduction of THD for output voltage. Any change in modulating waveform, results in load current harmonics and causes EMI (electromagnetic interference), power loss, etc. PWM technique is effective modulation technique and it does not require any additional components and eliminates lower harmonics easily.

For multi carrier SPWM technique, (m-1) carrier waves are required for m-level CHB inverter. The amplitude and frequency for all carrier waves must be same. The frequency modulation index is given by mf = fcr/fm where fcr is carrier wave frequency and fm is modulating wave frequency. Whereas the amplitude modulation index is defined asma = Vm/Vcr Where Vm is the peak value of modulating wave and Vcr is peak value of each carrier wave. Multi carrier PWM technique is used to control switching pattern of multilevel inverters. For MLIs carrier based PWM techniques are classified as

1. Single-Carrier SPWM

2. Multi-Carrier

4.1 The Multi-Carrier SPWM control techniques:

A. Phase Shifted SPWM
B. Level Shifted SPWM
C. Hybrid(Combination of level shifted and Phase shifted)

4.2 Phase Shifted SPWM

In the phase shifted SPWM technique, all carrier wave have same peak-peak amplitude and same frequency, but there is phase shift between adjacent carrier signals, phase shift between two carrier wave is given by phase shift between adjacent carrier signals = 360/(m − 1)

In phase shifted SPWM technique for five level CHB inverter number of carrier wave required is (m-1)=4, which are shifted by 90 degrees. Shows the comparison of carrier wave and sinusoidal modulating wave and gate pulse for lower and upper switches.

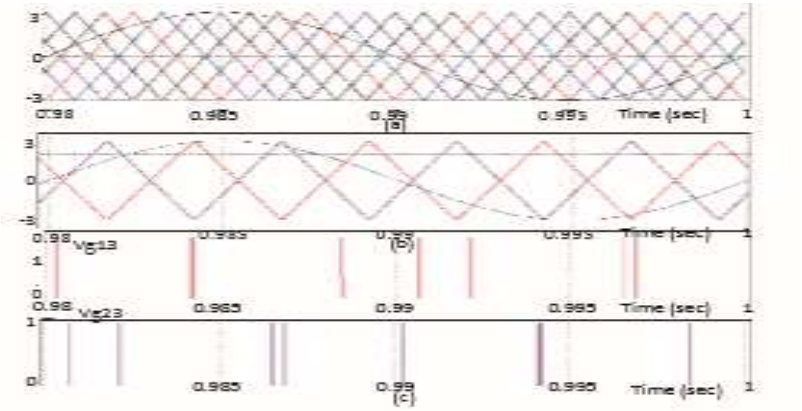

Fig 4 Phase Shift SPWM

5 Results

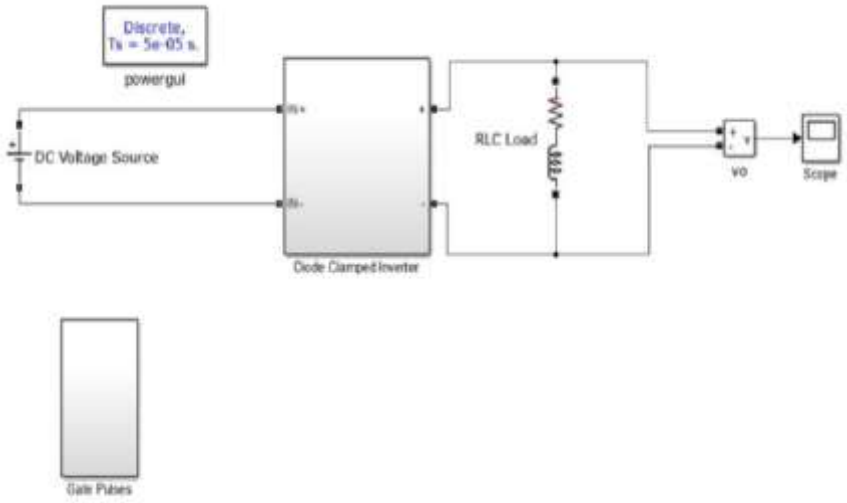

Fig .5. simulation block for 5 level inverter

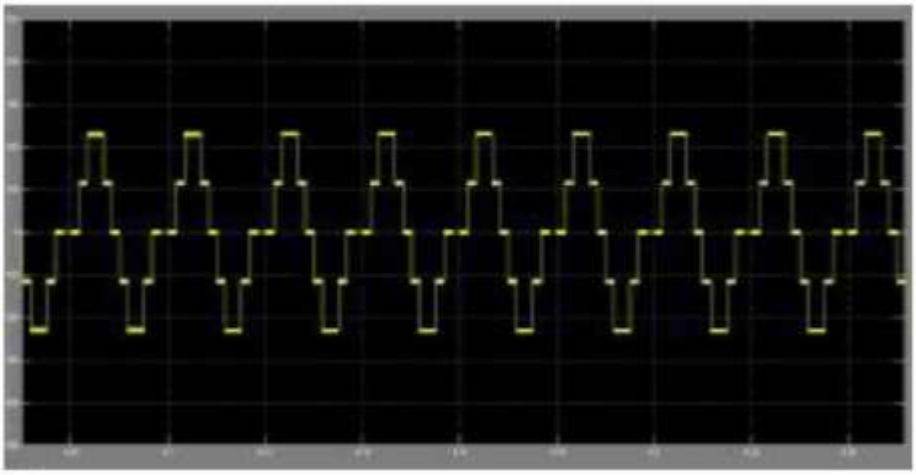

Fig. 6. simulation result for 5 level inverter output voltage

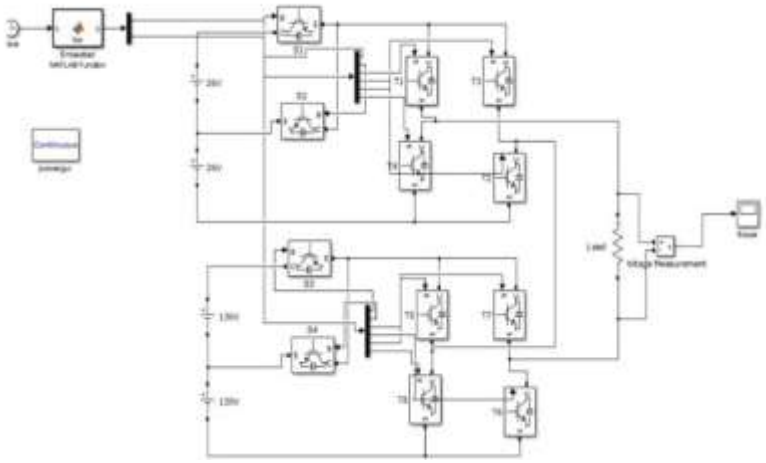

Fig. 7. simulation block for 24 level H bridge cascaded inverter

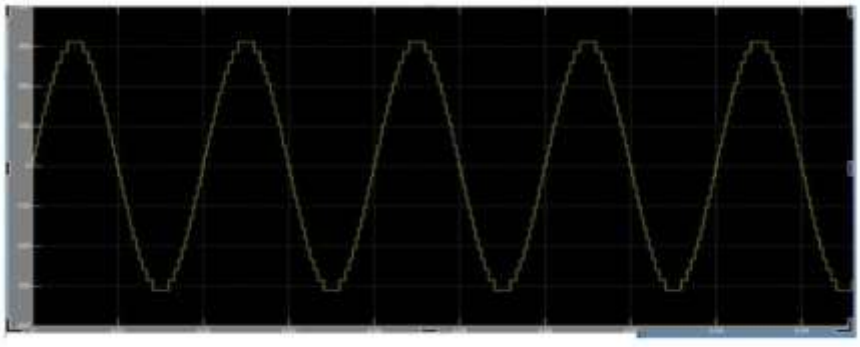

Fig.8. simulation result for 24 level H bridge cascaded multilevel inverter

6 conclusion

The out put waveform from 24 level cascaded H bridge multilevel inverter is waveform is more sinusoidal in nature compared to the 5 level inverter. The total harmonic distortion levels are also better in 24 level compared to 5 level inverters.

References

1.Chen Junling(April 2008), Capacitor Voltage Balancing Control of Cascaded Multilevel Inverter for High-power Active lower Filters, IEEE Transaction on Industrial Electronics volume.24 no: 06 pp-15-25.

2.Grain P. Adam(Aug 2008), Capacitor Balance Issues of the Diode-Clamped Multilevel Inverter Operated in a Quasi Two-State Mode ,IEEE Transaction on Industrial Electronicsvolume.55 no:08 pp-3088-3099.

3.Sirisukprasert. S(Aug 2002), Optimum harmonic reductionwith a widerange of modulation indexes for multilevel converters IEEE Trans. Ind. Electron., vol. 49, no. 4, pp. 875–881.

4.Yu Liu(Feb 2008), Real-Time Calculation of Switching Angles Minimizing THD for Multilevel Inverters with Step Modulation, IEEE Transaction on Industrial Electronicsvolume.56 no: 02 pp-285-292.

5.S.Busquets-Monge, J. Rocabert, P. Rodriguez, S. Alepuz, J. BordonauJuly 2008 (), Multilevel Diode-clamped Converter for Photovoltaic Generators with Independent Voltage Control of Each Solar Array, IEEE Transactions on Industrial Electronics, vol. 55, pp. 2713-2723.

6.E. Ozdemir, S. Ozdemir, L. M. Tolbert, B. Ozpineci(Feb 2008), Fundamental Frequency Modulated Multilevel Inverter for Three-phase Stand-alone Photovoltaic Application, IEEE Applied Power ElectronicsConference and Exposition, Feb. 24-28,pp. 148-153.