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Multicarrier Based Pulse Width Modulated Cascaded H-Bridge Multilevel Inverter

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Abstract: This paper presents a cascaded H-bridge multilevel inverter that can be implemented using symmetrical topology. A multi level inverter is a power electronic device built to synthesize a desired AC voltage from several levels of DC voltages. Multi-level inverters have been an important development in recent years. Owing to their capability to increase the voltage and power delivered to the motor.

Key words: DC · AC · To the motor.

INTRODUCTION

Multi level inverters are most advanced and latest type of power electronic converters that synthesize a desired output voltage from several levels of dc voltages as inputs. By taking sufficient number of dc sources, a nearly sinusoidal voltage waveform can be synthesized. The unique structure of the multi level voltage source inverters allows them to reach high voltage with low harmonics with out the use of transformers. To synthesize multi level output ac voltage using different levels of dc inputs, semiconductors devices must be switched on and off in such a way that desired fundamental is obtained with minimum harmonic distortion. There are different types of approaches for the selection of switching techniques for the multi level inverters.

In the Cascaded H-bridge MLI we are having two types of MLI. They are Symmetrical Cascade H-bridge MLI and Asymmetrical Cascade H-bridge MLI. In the Symmetrical Cascaded MLI the Source voltage of all the bridges are equal. In the asymmetrical cascaded MLI the Source voltage of all the bridges are not equal.

Three Phase 5-level Symmetrical Cascaded H-bridge Inverter in Figure1 represents the structure of a single phase cascaded type converter with separate dc sources. Each bridge of converter generates two levels of voltages v and -v.

Principle of Operation: Let us consider names of the switches of each bridge as S11, S12, S13, S14 for first bridge and S21, S22, S23, S24 for second bridge. Consider the two voltage sources are equal to V1=V2=V. Possible output voltage levels of this inverter are

- Level 1 0
- Level 2 V
- Level 3 2V
- Level 4 -V
- Level 5 -2V

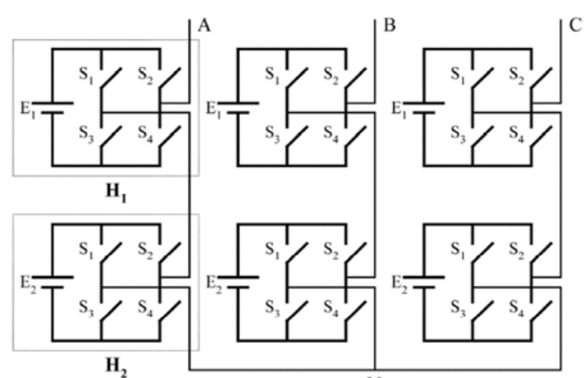

Fig. 2.1:Threephasefivelevelcascadedinverter

Controltechniques: AC loads may require constant or adjustable voltage at the irinput terminals.When such loads are fed by inverters, it is essential that output

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voltageof the inverters is so controlled as to fulfil the requirements of ac loads. Examples of such requirements are as under:

- An ac load may require a constan tinput voltage through at different levels. For such a load, any variations in the dc input voltage must be suitably compensated in order to maintain a constant voltage at the ac load terminals at desired level [1].
- In case inverter supplies power to a magnetic circuit, such as an induction motor, the voltage to frequency ratio at the inverter output terminals must be kept constant. This avoids saturation in the magnetic circuit of the device fed by the inverter.

Thevarious methods for the control of output voltage of inverters are as under:

- External control of ac output voltage: There are two possible methods of external control of ac output voltage obtained from inverter output terminals. These methods are:

AC voltage control: In this method, an ac voltage controller is inserted between the output terminals of inverter and load terminals as shown below

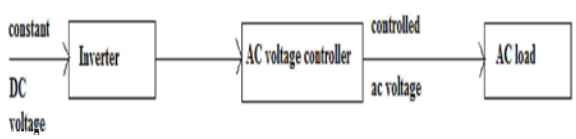


Fig. 3.1: A.C voltage controller

The output voltage input to the ac load is regulated through thefiring angle control of ac voltagecontroller. Practically this method gives rise to higher harmonic content in the output voltage [2].

Series-inverter control: This method of voltage control involves the useof two are more inverters in series. It is essential that the frequency of output voltages from thetwo inverters is the same. The series connection of inverters,called multi converter control, does not augment the harmonic content even at low outputvalue levels [3].

- External control of dc input voltage:In case the available voltage source is ac, then dc voltage input to the inverter is controlled through the fully controlled rectifiers [4].

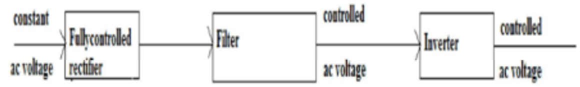


Fig. 3.2: External control of dc input voltage

Internal Control of Inverter: Output voltage from an inverter can also be adjusted by exercising acontrol with in the inverter it self.themostefficient method of doing this is by pulse width modulation control used with in the inverter.

PWM: In this method, affixed dc input voltage is given to the inverter and a controlled ac output voltage is obtained by adjusting the on and off periods of the inverter components.

Advantages: The output voltage control with this method can be obtained with out any additional components.

Control Techniques of Multilevel Inverter: To synthesize multilevel voltages of magnitude and spectralquality required by the specific application.

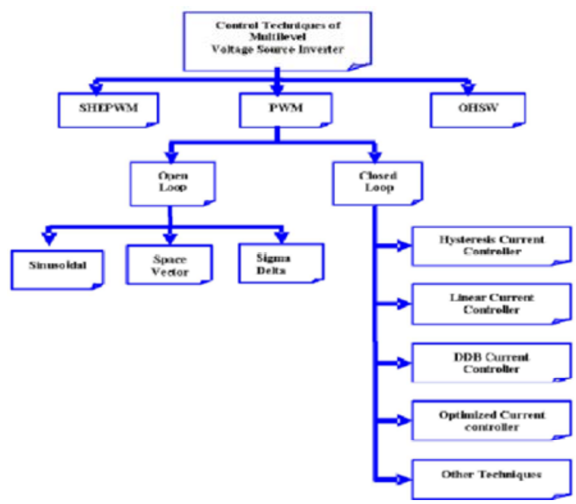


Fig. 4.1: Control techniques of multi level inverter

All space vector modulation and nonlinear current control strategies incorporate voltage imbalances in over all current regulation strategy.The most widely accepted PWM technique is sinusoidal PWM.The main modulation strategies can be classified as:

Multicarrier PWM Techniques: Multicarrier PWM Techniques entail the natural sampling of single modulating reference waveform typically being sinusoidal, through several carrier signals typically being triangular waveforms.

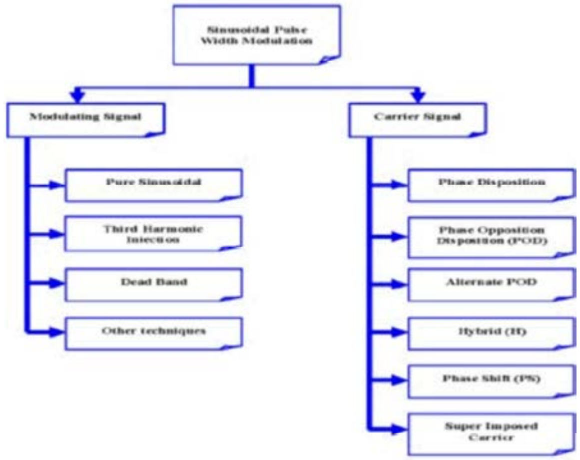


Fig. 4.2: Classification of SPWM

Phasedisposition (PD):

- This technique employs a number of carriers which are all inphase accordingly [5].
- In5-level converter all the four carrier waves are inphase with each other.
- Two types of PD technique are shown below.

Bipolar PD

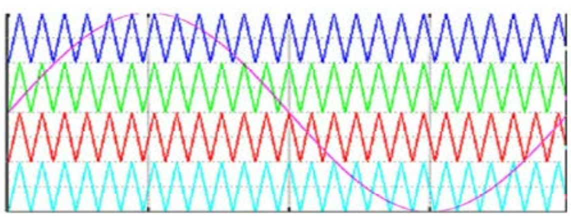


Fig. 4.3: BipolarPhase Disposition

Unipolar PS

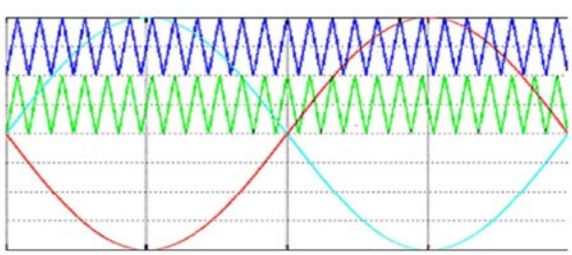


Fig. 4.4: UnipolarPhase Disposition

Phaseshift (PS):

- This technique employs a number of carriers are all phase shifted by 90 degree accordingly.
- In 5 -level converter all the four carrier waves are inphase with each other.
- Two types of PS technique are shown below.

Bipolar PS1

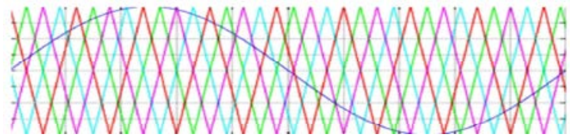


Fig. 4.5: BipolarPhase shift

Unipolar PS

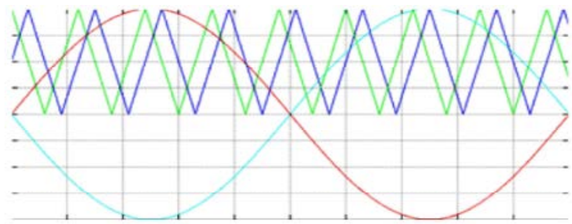


Fig. 4.6: UnipolarPhaseShift

MATLAB/ SIMULINK model: The figure (4) shows the overall MATLAB/SIMULINK MODEL for 5-level cascaded multilevel inverter with sub systems. In this model, the two H bridge is connected in series in order to form 5-level cascaded multi level inverter.

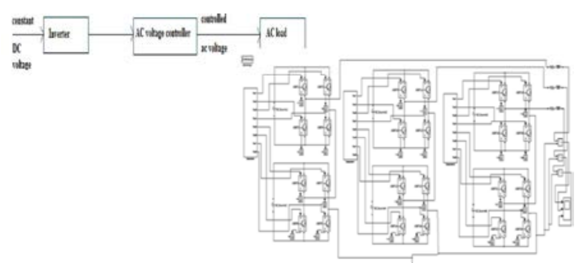


Fig. 5.1: Simulation circuit of 3-phase 5-level MLI

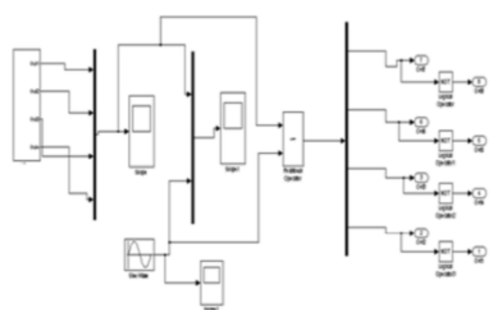


Fig. 5.2: Multi carriers in EPWM signal generation for bipolar mode of PD and PS

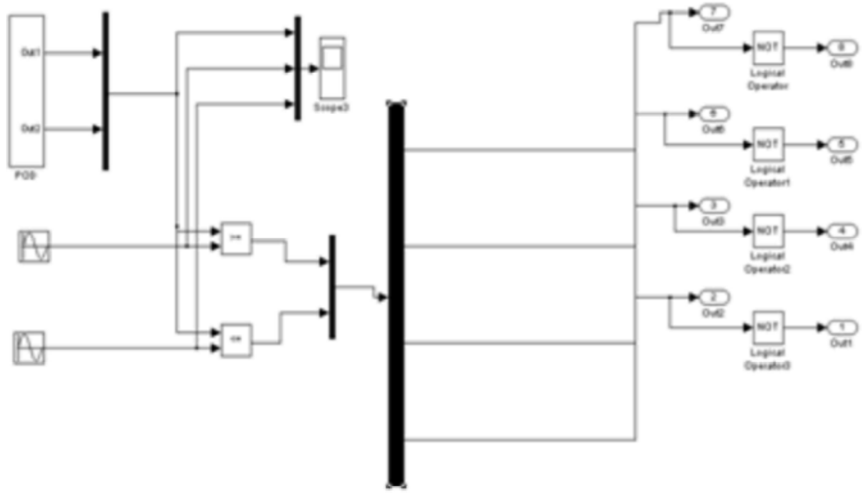


Fig. 5.3: Multi carrier sine PWM signal generation for unipolar mode of PD and PS

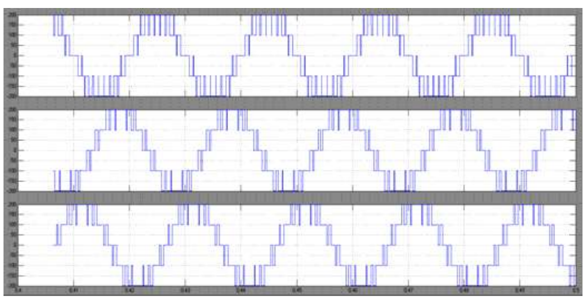


Fig. 5.4: For modulation index 0.8 inverter output voltage in pd bipolar mode.

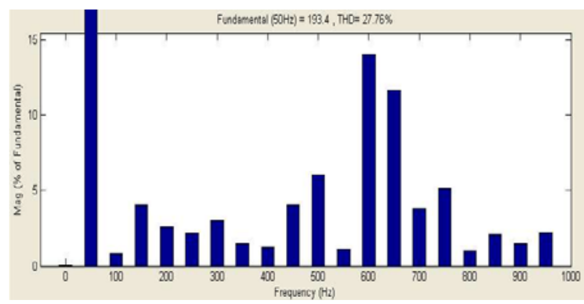


Fig. 5.7: For modulation index 0.8 frequency spectrum in pd unipolar mode.

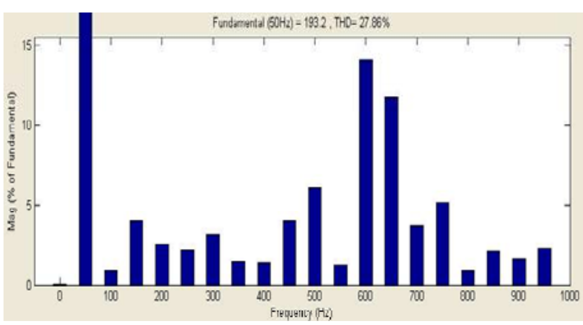


Fig. 5.5: For modulation index 0.8 frequency spectrum in pd bipolar mode.

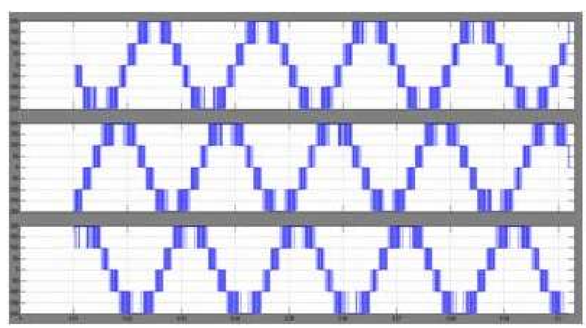


Fig. 5.8: For modulation index 0.8 inverter output voltage in ps bipolar mode.

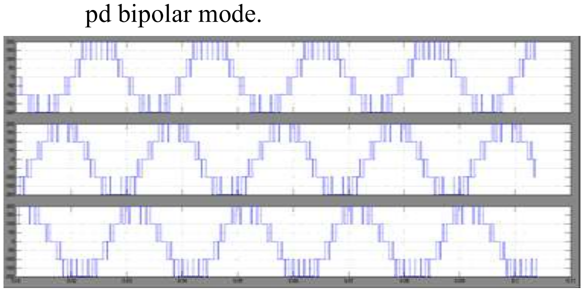


Fig. 5.6: For modulation index 0.8 inverter output voltage in pd unipolar mode.

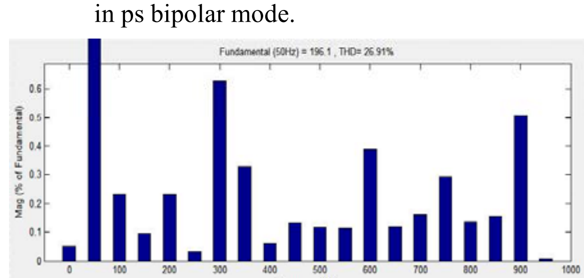


Fig. 5.9: For modulation index 0.8 frequency spectrum in ps bipolar mode.

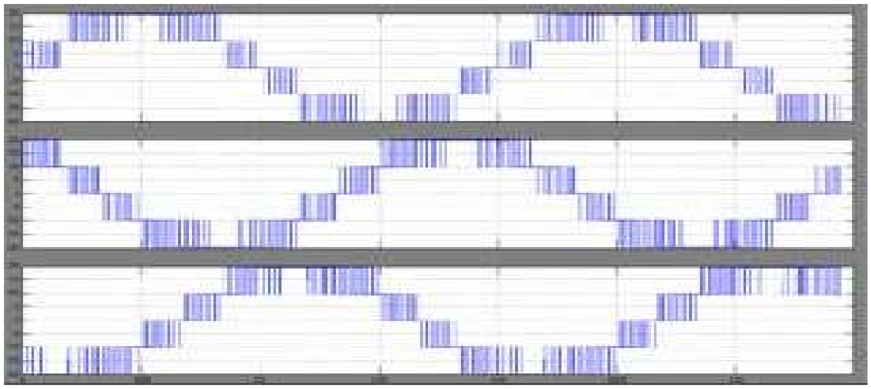


Fig. 5.10: For modulation index 0.8 inverter output voltage in ps unipolar mode.

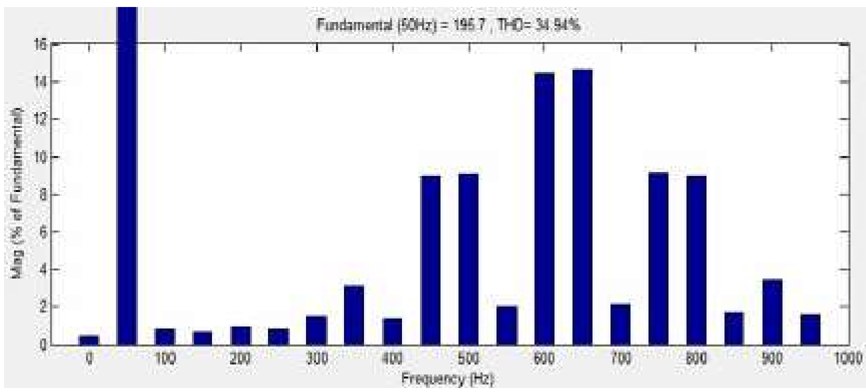


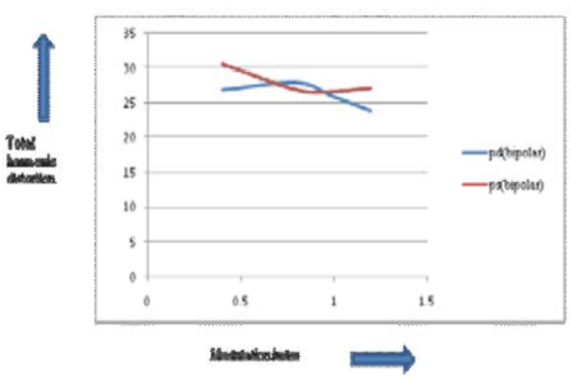
Fig. 5.11: For modulation index 0.8 frequency spectrum in ps unipolar mode.

s.no	modulation index	pd(bipolar)	ps(bipolar)
1	0.4	26.81	30.63
2	0.8	27.86	26.91
3	1	25.85	26.69
4	1.2	23.86	27.16

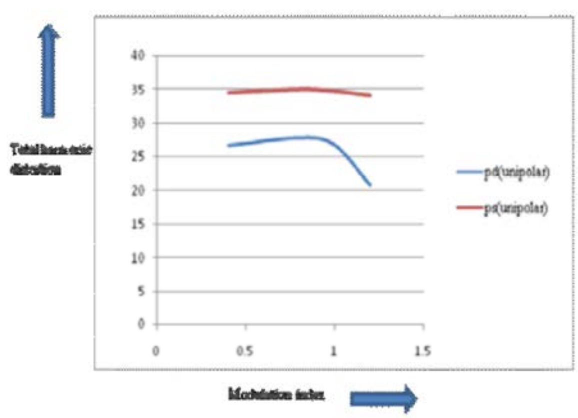
THD Values for PD&PS BIPOLAR Control technique for different M.I's

s.no	modulation index	pd(unipolar)	ps(unipolar)
1	0.4	26.59	34.41
2	0.8	27.76	34.94
3	1	26.69	34.66
4	1.2	20.78	34.01

THD Values for PD&PS UNIPOLAR Control technique for different M.I's



M.I (Vs) T.H.D graph for PD&PS bipolar mode



M.I (Vs) T.H.D graph for PD&PS unipolar mode

CONCLUSION

This paper presents a three phase 5-level cascaded H- bridge multi level inverter that can be implemented using symmetrical topology. The total harmonic distortion analysis has been done for different modulation indices. From the T analysis it is observed that the THD for phase disposition technique is less when compared with phase shift carrier control technique. In the phase disposition, unipolar mode of operation is the best technique which got less THD values compared to bipolar [6-10].

REFERENCES

1. International conference on "control, automation, communication and energy conservation-2009, 4th-6th June 2009 comparative Study on unipolar multi carrier PWM strategies for five level flying capacitor inverter by B. Shanthi and S.P.Natarajan
2. Anshumanshukla, Arindamghosh and Avinashjoshi, 2007. Hysteresis currentcontrol operation of flying capacitor multi level inverter and its application in shunt compensation of distribution systems, ieee trans. Power Delivery, 22(1): 396-405.
3. Jeevananthan, S., R. Madhavan, T. Suresh padmanabhan and P. Dananjayan, 2006. State-of-the-art of multi carrier modulation techniques for seven level inverter: a critical evaluation and novel submissions based on control degree of freedom, in IEEE Conf. Rec.:1-4244-0726-5/06, pp: 1269-1274.
4. Samirkouro, Student Member, Ieee, Pablolezana, Member, Ieee, Mauricioangulo,and Josérodríguez, Senior Member, IEEE Multi Carrier PWM with Dc-link Ripple Feed Forward Compensation for Multi Level Inverters Ieee Transactionson Power.
5. Novel multi level inverter carrier-based PWM methods ieeeias 1998 annual meeting, st.Louis, missouri, October 10-15, 1998, pp: 1424-1431. byleonm.Tolbert,thomas g. Habetler.
6. Sibghatullah Nasir, 2013. Microfinance in India Contemporary Issues and Challenges. Middle-East Journal of Scientific Research, 15(2): 191-199.
7. Mueen Uddin, Asadullah Shah, Raed Alsaqour and Jamshed Memon, 2013. Measuring Efficiency of Tier Level Data Centers to Implement Green Energy Efficient Data Centers, Middle-East Journal of Scientific Research, 15(2): 200-207.
8. Hossein Berenjeian Tabrizi, Ali Abbasi and Hajar Jahadian Sarvestani, 2013. Comparing the Static and Dynamic Balances and Their Relationship with the Anthropometrical Characteristics in the Athletes of Selected Sports, Middle-East Journal of Scientific Research, 15(2): 216-221.
9. Anatoliy Viktorovich Molodchik, 2013. Leadership Development. A Case of a Russian Business School, Middle-East Journal of Scientific Research, 15(2): 222-228.
10. Meruert Kylyshbaevna Bissenova and Ermek Talantuly Nurmaganbet. The Notion of Guilt and Problems of Legislative Regulations of its Forms. The Notion of Guilt in the Criminal Law of Kazakstan, Middle-East Journal of Scientific Research, 15(2): 229-236.