



International Journal for Innovative Engineering and Management Research

A Peer Reviewed Open Access International Journal

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IJIEMR Transactions, online available on 18th Dec 2020. Link

[:http://www.ijiemr.org/downloads.php?vol=Volume-09&issue=ISSUE-12](http://www.ijiemr.org/downloads.php?vol=Volume-09&issue=ISSUE-12)

DOI: 10.48047/IJIEMR/V09/I12/49

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Volume 09, Issue 12, Pages: 282-287

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SIMULATION OF SINGLE PHASE CASCADED H-BRIDGE MULTILEVEL INVERTERS & THD ANALYSIS

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ABSTRACT:

This paper present the different levels of cascaded H-bridge inverters and the minimization of total harmonic distortion by increasing levels. Selective Harmonic Elimination technique is used as a switching scheme. The analysis of three, five and seven level cascaded H-bridge inverter simulation work is done by using the MATLAB software and experimental results have been presented to validate the theory. The simulation results show the improvement of output voltage waveform and reduction of the THD by increasing the levels in inverter

Keywords: *Multi level inverter, THD, H bridge inverter.*

1. INTRODUCTION

Multilevel inverters have ability to generate low switching frequency high quality output waveforms with several high voltages and higher power applications. The general structure of the multilevel converter is to synthesize a sinusoidal voltage from several level of voltages [1][2]. The multilevel inverter has overcome the limitations of conventional two level voltage converters. The advantages of multilevel inverter are higher power quality, lower switching losses, low electromagnetic interference and higher voltage capability. There are mainly three types of multilevel inverter topologies used- (1) Diode clamp multilevel inverter (DCMI),(2) Flying capacitor multilevel inverter(FCMI) and (3) Cascade multilevel inverter (CHB)[3].Harmonic problems in multilevel inverter is the most important one with distress the output voltage and

increased level of switching strategy. There are numerous methods like (SPWM) Sinusoidal Pulse Width Modulation, (MCPWM) Multi-Carrier Pulse Width Modulation and (SHE-PWM) Selective Harmonic Elimination Pulse Width Modulation are implemented for harmonic elimination in multilevel inverter. (MCPWM)Multi-Carrier Pulse Width Modulation strategies is widely used, because it can be easily implemented to low voltage modules. Normally MCPWM can be categorized as Level Shifted PWM (LS-PWM) and Phase Shifted PWM (PS-PWM) methods.(LS-PWM) Level Shifted PWM is characterized into three i.e. Phase Disposition Technique (PD) ,Phase Opposition Disposition Technique (POD) and Alternative Phase Opposition Disposition Technique (APOD). For

systems where high switching efficiency is needed, it is desirable to keep the switching frequency much lower. In this state, another approach is to choose the switching angle in such a way that a desired fundamental output is generated and chosen harmonics of the fundamental voltage are suppressed, this is called as harmonic elimination or programmed harmonic elimination to eliminate specific harmonics[4]. The characteristic of the SHEPWM method is that the waveform analysis is performed by using Fourier theory. The sets of non-linear transcendental equations are derived, and the solution is obtained by using an iterative method.

comprehensive review of a recently proposed multilevel inverter is presented by KK Gupta. This paper presented the topology comprises of floating input dc sources connected in opposite polarities through power switches. The structure requires lesser active switches as compared with conventional cascaded H- bridge topology with much reduced switching losses. The topology is analyzed for both symmetric and asymmetric source configurations. Also, a new algorithm for asymmetric source configuration suitable for CCSMLI is proposed. (K.K. Gupta et al 2013).

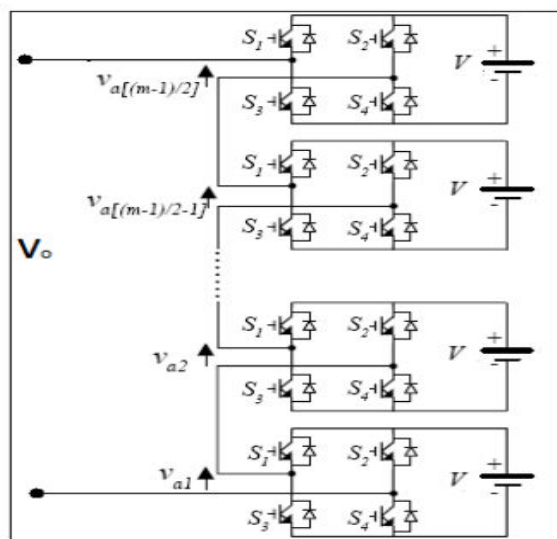


Fig.1.1 broad-spectrum diagram of cascaded H-bridge ML.

2. LITERATURE SURVEY

A brief overview of earlier investigation carried out on cascaded multilevel H- bridge inverter employing transformer is presented in this paper. a) A

The need for the step up transformer can be surpassed by using multilevel inverter. MI also reduces harmonics produced by inverter. The key features of multilevel inverters are as follows [7]: 1. The output voltage and power increases with numbers of level. 2. The harmonic proportion is inversely proportional to number of level and hence requirement of filter decreases. 3. The harmonic can be formerly selected for elimination as higher voltage levels have more free switching-angles. . 4. Switching devices are having capacity of Static and dynamic voltage sharing. Clamping diodes or capacitors structures are helping for same. 5. Voltage-sharing problems is not faced by the switching device. In present scenario, Modern electronics sensitive equipments used in power systems are prominent reason for emerging severe power quality issues. Low system efficiency and poor power factor are due non-linearity issues of power

system, so the power quality researchers are attracted to the concept of multilevel inverter. Multilevel Inverters are having some advantages which are helpful to deal with harmonic distortion issue. The "multilevel" terms starts from 3 levels and as per requirement no. of voltage levels can be retrieve as shown in fig (1). [8] This paper mainly focuses on Simulation results of threelevel, five-level and seven-level Single Phase Cascaded HBridge Multilevel Inverters and their THD values.

3. RELATED STUDY

In power electronics and drive industries, inverters have established as key component and its different topologies are playing important role for motor controlling and power systems [1]. Reduced harmonic contents and high power are necessity of AC drives, so multi-inverters system is capable for AC drives [4]. Multilevel inverters have been mostly used in medium or high power system applications, such as static reactive power compensation and adjustable-speed drives [7]. A multilevel inverter has benefit of achieving high power ratings. It also facilitates the use of renewable energy sources. Multilevel inverter system can be combined with non- conventional energy sources such as photovoltaic, wind, and fuel cells for a high power application [8]. The output voltage or a current waveform obtained through modern converters should be quality waveform with minimum of ripple content. Switching losses and constraints of the power device ratings are two main reasons for limitations of use of

traditional Two level inverters in high power applications.[6].The combination of power switches like IGBT MOSFET in series or parallel can be used to obtain the power handling voltages and currents. Under normal operating conditions also THD levels produce by The conventional two level inverters is around 60%. Harmonics created by it has undesirable effects 978-1-5386-5743-0/18/\$31.00©2018 IEEE .It leads to further losses and other power quality issues too on the AC drives and utilities. Enhanced power aspect, Minimum switching losses, improved electro-magnetic compatibility and elevated voltage capability are gained from power conversion achieved through multilevel voltage steps. The multilevel inverters study is fascinating research area due to these benefits.

4. CASCADED H-BRIDGE MULTILEVEL INVERTER

The multilevel inverter topologies for high power – medium voltage energy control is proposed by Jose Rodriguez. This paper presented the most important topologies like diode – clamped inverter (neutral point clamped), capacitor clamped (flying capacitor) and cascaded multi cell with separate DC sources. Emerging topologies like asymmetric hybrid cells, soft – switched multi level inverters, control and modulation methods for the family of converters, namely multi level sinusoidal pulse width modulation, multilevel selective harmonic elimination, and space- vector modulation were analyzed.

A new modified hybrid H – bridge multilevel inverter with lesser number of switches compared to conventional multilevel inverter is proposed. Reduction in number of switches reduces the switching losses and improve the efficiency. 3-level configuration will give three stairs in output waveform of voltage of single phase inverter. Each part comprises single H bridge unit. They are connected to each other in series combination. The voltage levels are obtained as per switching of IGBTs. Three level arrangement comprises of one H-bridge one DC source. With help of simulation carried in Matlab; we are trying to obtain stair case waveform of 3 steps.

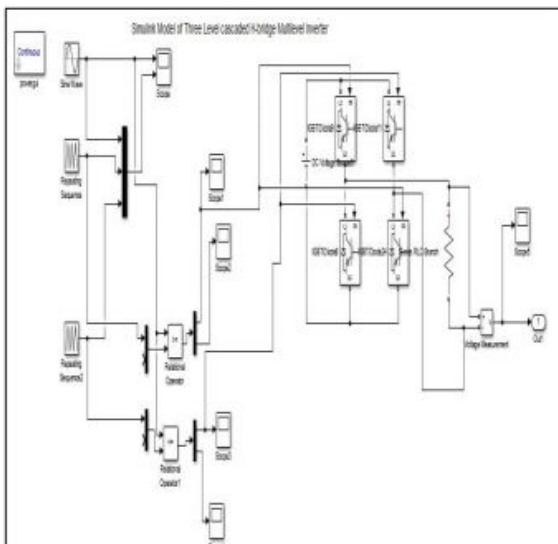


Fig.4.1. Simulink Model of Three Level cascaded H-bridge Multilevel Inverter.

SIMULATION RESULTS:

A-Single phase Three level H Bridge Multilevel Inverter Voltages of different levels are analyzed and for calculation of harmonics, help of FFT analysis is taken and

THD is determined and presented in figures below:

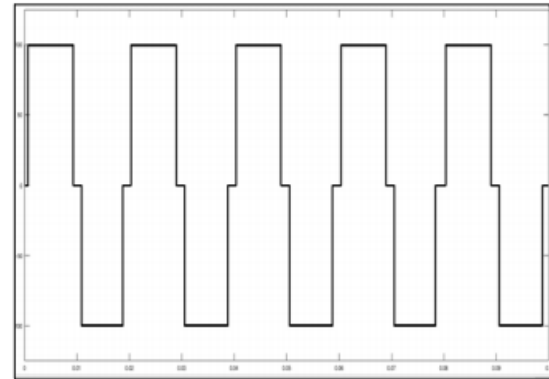


Fig.4.2. 3LEVEL Output.

Stair case waveform is achieved with 3 different voltage values as +Vd, 0,-Vd. It is examined from waveforms that it is giving outcome of voltage values of 100V, 0V,-100V. FFT analysis of 3-level cascaded H-bridge inverter is as below

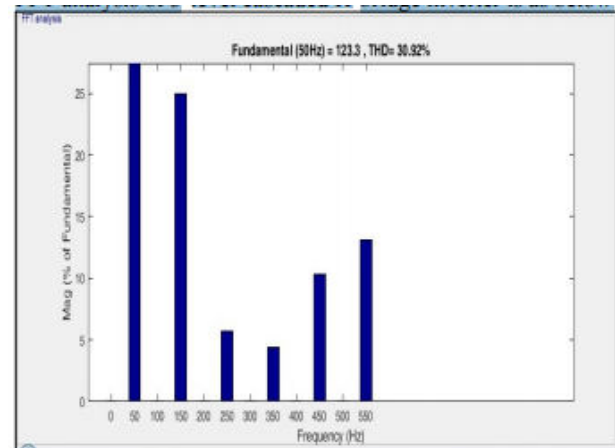


Fig.4.3. Fast Fourier Transform analysis of Three level H-Bridge MI.

Similarly for Five level H-bridge MI, output waveform is obtained in form of Stair case as shown in simulation results of fig.4. It is examined from waveforms that it is giving outcome of voltage values of 200V, 100V, 0V,-100V,-200V.

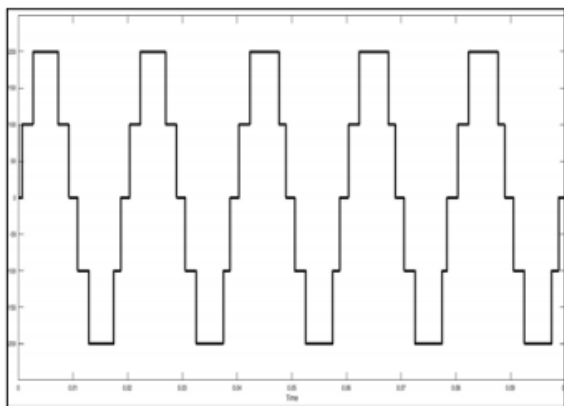


Fig.4.4. 5 LEVEL output voltages.

Similarly for Seven level H-bridges MI, output waveform is obtained in form of Stair case as shown in simulation results of fig. It can be seen from waveform that it is giving results of voltage values of 300V,200V, 100V, 0V,-100V,-200V,- 300V

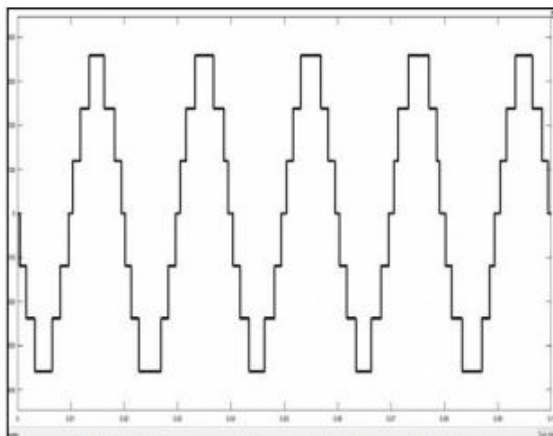


Fig.4.5. Voltage waveform of 7-level cascaded H-bridge MI.

5. CONCLUSION

Single Phase Three level, Five level and Seven level Cascaded H-bridge Multilevel Inverter are simulated in Matlab R2016 Version 9.0.0. In Cascaded H-Bridge MI, Higher levels of voltages be capable of obtaining with less number of components and with better results as compared to other types of multilevel inverter. Stair case

waveforms results are obtained as per expectation. FFT results of three-level, five-level & seven-level Multilevel Inverter gives Total Harmonic Distortion of three configuration mentioned in fig 10. As number of levels of configuration increases, THD decreases with big percentage difference as displayed in fig 2. Advanced levels of structures can be preferred which gives good power quality with less THD.

REFERENCES

- 1) K. K. Gupta, Shailendra Jain “Comprehensive review of a recently proposed multilevel inverter”, IET Power Electron 2012.
- 2) Jose Rodriguez et al “The multilevel topologies for high power medium – voltage energy control 2007
- 3) C. R. Balamurugan , S.P. Natarajan , V. Vidhya “ A new modified hybrid H – bridge multilevel inverter Using lesser number of switches”, International Conference on computation of Power, Energy, Information and Communication, 2013.
- 4) Bindeshwar Singh, Nupur Mittal , S.P.Singh , “ Multilevel Inverters: A literature survey on topologies and Control strategies.” 2nd International Conference on Power, Control and Embedded Systems 2012.
- 5) H. Khounjahan , M.R. Banaei , Amir Farakhor , “ A new low cost cascaded transformer multilevel inverter Topology using minimum number of components with modified selective harmonic elimination modulation. Ain Shams Engineering Journal 2015.



- 6) Javad Ebrahimi , Ebrahim Babaei , Gevorg B Gharehpetian , “ A new Multilevel Converter Topology with Reduced Number of Power Electronic Components”. IEEE TRANSACTION ON INDUSTRIAL ELECTRONICS, VOL-59, 2012.
- 7) J. Rodriguez , L.G. Franquelo, S. Kouro et al.: ‘Multilevel converters: an enabling technology for high-power applications’ Proc. IEEE, 2009, 97(11), pp. 1786-1817.
- 8) M. Malinowski, K. Gopakumar, J. Rodriguez, & M. A. Perez, - A survey on cascaded multilevel inverters, IEEE Trans. Ind. Electron. , vol 57, no.7, pp. 2197-2206, July 2010.
- 9) J. Rodriguez, J-S. Lai, & F.Z. Peng,- “ Multilevel inverters: A survey of topologies, controls, & applications, ” IEEE Trans. Ind. Electron, vol.49, no.4, pp.724-738 Aug.2002.