

Harmonic Elimination in Solar Fed Cascaded Multilevel Inverter Using Optimization Techniques

Loganathan. G¹, Prabhakaran. B², Indhumathy. K³

Assistant Professor, Excel College of Engineering and Technology, Komarapalayam, Namakkal, Tamilnadu, India^{1,2,3}

ABSTRACT: In this paper, total harmonic distortion (THD) minimization of the output voltage of multilevel inverters is discussed. Minimum Total Harmonic Distortion is one of the most important requirements from multilevel inverter concerning good Power Quality. This paper presents the optimization of THD in 15 levels Cascaded Multilevel Inverter with equal dc source using Genetic Algorithm (GA). THD minimization is taken as an optimization problem derived. Results give all. Switching strategy, FFT analysis possible solutions at each modulation index and computational time has been analyzed using MATLAB simulation environment.

KEYWORDS: Genetic algorithm (GA), line-voltage total harmonic distortion (THD), multilevel inverter, optimal minimization of THD (OMTHD), THD minimization.

I. INTRODUCTION

Photo voltaic sources are used today in many applications as they have the advantages of being maintenance and pollution free. The solar fed cascaded multilevel inverter produces AC output voltage of desired magnitude and frequency. The output waveform of the inverter can be improved by reducing its respective harmonic content. Since the inverter is used in a PV system, a optimization technique is used to obtain the switching angles to reduce the harmonic content.

II. POWER QUALITY

The growing power quality concern is harmonics distortion. The ideal quality of power supply is characterized by electric power energy with perfect sinusoidal waveform at a constant frequency of specified constant voltage with least amount of interruptions. Harmonics is defined as the content of the signal whose frequency is an integer multiple of the system's fundamental frequency.

The presence of harmonics distorts the wave form shape of the voltage and current, increases the current level, and changes power factor, which in turn creates many disturbances. Electricity is produced and delivered in its fundamental form as a 50 cycles/sec (Hz) sine wave in India. Harmonics are multiples of 50 Hz waves. For e.g., the second harmonic is at 100 Hz, the third is 150 Hz and soon. As harmonics are super imposed on the fundamental waveform, frequency of the electricity does not follow a smooth sine. Most electrical equipment is designed to handle smooth frequencies. Hence, distortions created by harmonics can cause a variety of problems. There are two major categories of harmonics effects on equipment:

- Heating effects in power handling equipment such as motors, capacitors, and transformers that most often reduce the equipment's operating life.
- Disruption of operation that in the most part of the electronically controlled equipment.

III. INVERTERS

The electrical power converter that converts DC to AC is inverter. DC to AC conversion is needed in many fields such as power conditioning, harmonic compensation, motor drives, and renewable energy grid-integration. In power systems it is required to eliminate the harmonic contents present in the output of inverter. Inverters plays vital role in many renewable energy applications.

In photo voltaic applications, the inverter gets the input of DC electrical energy from the output of a photovoltaic module or array. The inverter then converts into an AC voltage which is to be interfaced with either a load or the utility grid. Inverters may also get employed in order renewable systems, such as wind turbines etc. In Inverters output voltage contain harmonics.

IV. MULTILEVEL INVERTER

Multilevel inverters generate a stair case wave form. By increasing the number of output levels, the output voltages have more steps and harmonic content on the output voltage and the THD values are reduced. Therefore, they produce high quality output voltage by increasing the number of levels. In Cascaded H-Bridge Multi Level Inverter topology, the H-bridges are cascade in every phase. With the increase in H-bridges in a phase, the output voltage waveform tends to be more sinusoidal. In n-level topology $(n-1)/2$ identical DC bus of every individual H-bridge. Hence, this topology is useful for collecting energy from renewable energy resources e.g., solar panels and fuel cell. Cascaded H-bridge inverter topology offers better performance compared to other topologies. This high resolution multilevel waveforms can be achieved relatively low number of components. These waveforms can be achieved with relatively low number of components.

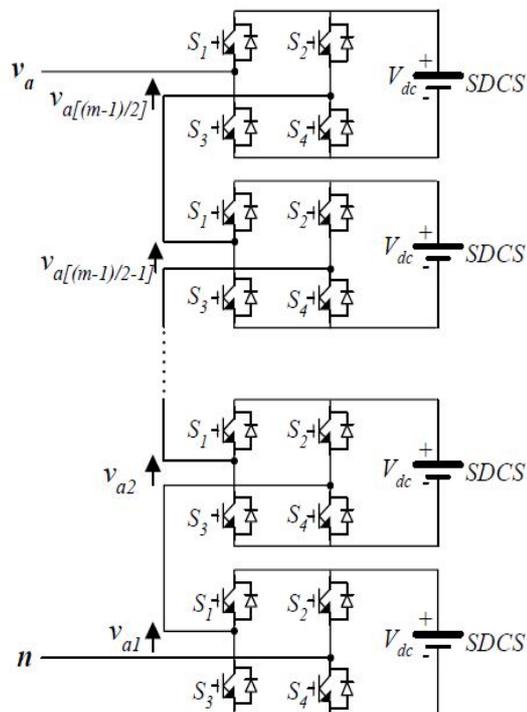


Fig.1. Multi-Level Inverter

REFERENCES

- [1] Nima Yousefpoor, Seyyed Hamid Fathi(2012) "THD Minimization applied Directly on the Line-to-Line Voltage of Multilevel Inverter" in IEEE TRANSACTIONS ON INDUSTRIAL ELECTRONICS, VOL. 59, NO. 1, JANUARY 2012
- [2] Aghdam M. G. H., Fathi S. H., and Gharehpetian G. B. (2007), "Elimination of harmonics in a multi-level inverter with unequal DC sources using the homotopy algorithm," in Proc. IEEE Int. Symp. Ind. Electron., pp. 578–583.
- [3] Du Z., Tolbert L. M. and Chiasson J. N. (2006), "Active harmonic elimination for multilevel converters," IEEE Trans. Power Electron., Vol. 21, No. 2, pp. 459–469
- Y. Sahali and M. K. Fellah, "Comparison between optimal minimization of total harmonic distortion and harmonic elimination with voltage control candidates for multilevel inverters," J. Elect. Syst., vol. 1, no. 3, pp. 32–46, Sep. 2005.
- Du Z., Tolbert L. M., Chiasson J. N., and Li H. (2005), "Low switching frequency active harmonic elimination in multilevel converters with unequal DC voltages," in Conf. Rec. IEEE IAS Annu. Meeting, pp. 92–98.
- Du Z., Tolbert L. M. and Chiasson J. N. (2006), "Active harmonic elimination for multilevel converters," IEEE Trans. Power Electron., Vol. 21, No. 2, pp. 459–469.
- Filho F. J. T., Tolbert L. M., Cao Y., and Ozpineci B. (2010), "Real time selective harmonic minimization for multilevel inverters connected to solar panels using artificial neural network angle generation," in Proc. IEEE Energy Convers. Congr. Expo., pp. 594–598.
- Gil-Arias O. and Ortiz-Rivera E. I. (2008), "A general purpose tool for simulating the behavior of PV solar cells, modules and arrays," in Proc. 11th Workshop Control Model. Power Electron., pp. 1–5.
- Kang D. W., Kim H. C., Kim T. J. and Hyun D. S. (2005), "A simple method for acquiring the conducting angle in a multilevel cascaded inverter using step pulse waves," Proc. Inst. Elect. Eng.—Elect. Power Appl., Vol. 152, No. 1, pp. 103–111.
- Liu Y., Hong H., and Huang A. Q. (2009), "Real-time calculation of switching angles minimizing THD for multilevel inverters with step modulation," IEEE Trans. Ind. Electron., Vol. 56, No. 2, pp. 285–293.
- Ozpineci B, Tolbert L. M, and Chiasson J. N. (2005), "Harmonic optimization of multilevel converters using genetic algorithms," IEEE Power Electron. Lett., Vol. 3, No. 3, pp. 92–95.
- L.M Tolbert, F. Z. Peng, T.G. Habetler, "Multilevel PWM methods at low modulation indices," IEEE Transactions on Power Electronics, 15(4), July 2000, pp. 719 – 725.
- J. N. Chiasson, L. M. Tolbert, K. J. McKenzie, Z. Du, "A Unified Approach to Solving the Harmonic Elimination Equations in Multilevel Converters," IEEE Transactions on Power Electronics, 19(2), March 2004, pp. 478 – 490.
- Y. Sahali and M. K. Fellah, "Application of the optimal minimization of the THD technique to the multilevel symmetrical inverters and study of its performance in comparison with the selective harmonic elimination technique," in Proc. IEEE Int. SPEEDAM, May 23–26, 2006,
- N. Yousefpoor, N. Farokhnia, S. H. Fathi, and J. Moghani, "Developed single-phase OMTD technique for cascaded multi-level inverter by considering adjustable DC sources," in Proc. IEEE Int. Conf. EPECS, 2009,