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Literature Survey: Multilevel Voltage Source Inverter With Optimized Convention Of Bidirectional Switches

P.Bhagya[1], M.Thangadurai[2], V.Mohamed Ibrahim[3]
PG Scholar [1], Assistant Professor[2], Head of Department[3]
Department of Electrical and Electronics Engineering
Mahakavi Bharathiyar College of Engineering & Technology

ABSTRACT

Multilevel inverters helps in producing stepped output waveform which results in higher output waveform quality and lower distortion. The first ever introduced topology is the series H-bridge design. This H-bridge topology was followed by the Case-Cade inverter which utilizes a bank of series capacitors to split the dc bus voltage. Hybrid multilevel converters have been presented. In the hybrid topologies, the magnitude of dc voltage sources are unequal or changed dynamically depending upon the need. These converters are very efficient in the size and cost and improve the reliability since less number of semiconductors and capacitors are used in this topology. Multilevel inverter technology has emerged recently as a very important alternative in the area of high-power medium-voltage applications. Researchers are going on to improve their capabilities further through optimized control techniques, and to minimize both component count and manufacturing cost.

Keywords:

1. INTRODUCTION

Multilevel inverter technology has emerged recently as a very important alternative in the area of high-power medium-voltage applications. Researchers are going on to improve their capabilities further through optimized control techniques, and to minimize both component count and manufacturing cost. The multilevel inverter has been implemented in various applications, such as motor drives, power conditioning devices, renewable energy generation and distribution. PWM inverters can simultaneously control output voltage, frequency and it can reduce the amount of harmonics in output current which results in better THD content. Several multilevel topologies have been developed, but as the output voltage levels increases, it also increases the number of switches, number of independent dc sources, switching stresses, losses, voltage unbalancing across capacitors etc. Half and Full bridge inverters requires large input and output filters, lower voltage operating capability, harmonic distortion is high, high Electro Magnetic Interference (EMI). The mainly used MLI topologies are flying capacitor, diode clamped and H-bridge converter with separate DC sources. Diode clamped MLI requires large number of diodes as no: of level increases. Flying capacitor MLI uses a large no: of capacitors to hold voltages. Cascaded H bridge MLI requires least no: of components but needs separate dc voltage sources for each H bridges. Among conventional multilevel inverters, cascaded H-bridge multilevel inverter (CHB) is one of the best approaches to increase the number of output voltage levels.

2. A LITERATURE SURVEY ON TOPOLOGIES AND CONTROL STRATEGIES

Multilevel inverters have been attracting in favor of academia as well as industry in the recent decade for high - power and medium - voltage energy control. In addition, they can synthesize switched waveforms with lower levels of harmonic distortion than an equivalently rated two - level converter. The multilevel concept is used to decrease the harmonic distortion in the output waveform without decreasing the inverter power output. This paper presents the most important topologies like diode - clamped inverter (neutral - point clamped), capacitor -clamped (flying capacitor), and cascaded multilevel with separate dc sources. This paper also presents the most relevant modulation methods developed for this family of converters: multilevel sinusoidal pulsewidth modulation, multilevel selective harmonic elimination, and space - vector modulation. Authors strongly believe that this survey article will be very much useful to the researchers for finding out the relevant references in the field of topologies and modulation strategies of multilevel inverter.

Researchers try to enhance the efficiency and quality of the output power of multilevel inverters by use of new topologies or enhanced switching algorithms. But it should be noted that, it is not easy to change the inverter switching algorithm and doing this will increases the costs. Also these algorithms are not usually extensible to all inverter types. By considering these limitations, in this paper the THD equation of the output voltage of an asymmetric single phase cascaded multilevel inverter capable of generating 9 output voltage levels is extracted. This equation will be a function of switching angles and input voltage source values. Now, with the use of genetic algorithm which is one of the strongest optimization tools, the voltage THD is minimized and the optimized switching angles are obtained. By applying these angles in the conventional switching algorithm with fundamental frequency, the quality of the output voltage reaches its highest level. The method used in this paper is simpler than the switching algorithm changing method and can be generalized to different types of multilevel inverters. Also the use of fundamental switching frequency, will reduce switching losses. The simulation results obtained by MATLAB/SIMULINK software, confirm the performance accuracy of the proposed method. A novel three phase multilevel inverter with a small number of switching devices is proposed. Large electrical drives and utility application require advanced power electronics converter to meet the high power demands. As a result, multilevel power converter structure has been introduced as an alternative in high power and medium voltage situations. A multilevel converter not only achieves high power rating but also improves the performance of the whole system in terms of harmonics. In this paper the proposed inverter can output more numbers of voltage levels with reduced number of switches as compared to cascade H-bridge inverter, which results in reduction of installation cost and have simplicity of control system. Finally, the simulation and experimental results validate the concept of this new topology.

Advantages:

- It very much useful to the researchers for finding out the relevant references as well as the previous work done in the field of multilevel inverter topologies and their modulation technique.

Disadvantages:

- It does not satisfy the condition, this scheme no longer exists.

3. Performance Improvement of Multilevel Inverter through Trapezoidal Triangular Carrier based PWM

From this document a new SPWM technique using a trapezoidal triangular multicarrier for a 17 level cascaded H bridge multilevel inverter is simulated and compared with other types of carrier based PWM technique for performance evaluation. Different triangular carrier modulation techniques such as constant switching frequency level shift (LS) PWM technique viz, phase disposition (PD), phase opposition disposition (POD), alternative phase disposition (APOD), phase shift carrier (PSC) PWM, and variable switching frequency (VSF PWM) are compared with proposed technique for symmetric and asymmetric structure of cascaded H bridge MLI. Simulation for 17 level CHB inverter has been carried out in MATLAB/Simulink and simulation results for voltage waveform and harmonic spectrum are presented and compared. The variation of THD with modulation index for output voltages are analyzed.

From this, constant switching frequency and variable switching frequency based on carrier pulse width modulation methods are presented and compared. A new modulation method called trapezoidal triangular multi carrier (TTMC) SPWM is implemented and compared with other methods. This new modulation method gives advantages in multilevel inverter to minimize the percentage of total harmonic distortion (THD) and to increase the output voltage.

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Advantages:

- The proposed output voltage is higher in asymmetric MLI.

Disadvantages:

- It has major disadvantage of highest THD.

4. Recent Advances and Industrial Applications of Multilevel Converters

Multilevel converters have been under research and development for more than three decades and have found successful industrial application. However, this is still a technology under development, and many new contributions and new commercial topologies have been reported in the last few years. The aim of this paper is to group and review these recent contributions, in order to establish the current state of the art and trends of the technology, to provide readers with a comprehensive and insightful review of where multilevel converter technology stands and is heading. This paper first presents a brief overview of well-established multilevel converters strongly oriented to their current state in industrial applications to then center the discussion on the new converters that have made their way into the industry. In addition, new promising topologies are discussed. Recent advances made in modulation and controls of multilevel converters are also addressed. A great part of this paper is devoted to show nontraditional applications powered by multilevel converters and how multilevel converters are becoming an enabling technology in many industrial sectors. Finally, some future trends and challenges in the further development of this technology are discussed to motivate future contributions that address open problems and explore new possibilities.

Recently, many publications have addressed multilevel converter technology and stressed the growing importance of multilevel converters for high-power applications. These works have a survey and tutorial nature and cover in depth traditional and well-established multilevel converter topologies, such as the neutral point clamped (NPC), cascaded H-bridge (CHB), and flying capacitor (FC), as well as the most used modulation methods. Instead, this paper presents a technology review, which is focused mainly on the most recent advances made in this field in the past few years, covering new promising topologies, modulations, controls, and operational issues. In addition, one of the most interesting topics in multilevel converter technology is the rapidly increasing and diverse application field, which is addressed in this work as well. In addition, emerging trends, challenges, and possible future directions of the development in multilevel converter technology are outlined to motivate further work in this field.

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Advantages:

- It is clear that the development of power electronic devices, the changes and evolution of the industrial processes.

Disadvantages:

- It will not be covered in this paper devoted to the present research topics.

5. Cascaded H-Bridge with Single DC Source and Regulated Capacitor Voltage

Multilevel power electronic converter has wide range of applications. In multilevel power electronic converters the output can be synthesized by combining several DC voltage sources. Cascade H-Bridge multilevel inverter generally requires more number of DC sources. An alternative option is to replace all the DC sources feeding H-Bridge cells with capacitors, leaving only one H-Bridge cell with a real DC sources. But balancing the capacitor voltage is challenging. In this paper a new control method for cascade H-bridge multi-level inverter fed with only one independent DC source is presented. Simulation results support the proposed control method.

The method used to switch cascaded H-Bridge cells can be based either on the fundamental switching frequency that is staircase modulation, or the pulse width modulation technique. In the fundamental switching frequency approach, the switching losses are less, but the harmonic in the output voltage waveform appear at lower frequencies. Several methods are proposed in the literature to selectively eliminate harmonics in the output waveforms of multilevel converters. In the pulse width modulation switching method, the harmonic in the output waveform appear at high frequencies, but due to a higher switching frequency, the switching losses are greater.

However, regulating the capacitor voltage is not easy. This paper proposes a control method to single dc source H-bridge inverter to improve their capacitor voltage regulation. The proposed method phase shift modulation is robust and does not incur much computational burden. In this method the main inverter switches at the fundamental frequency, and the auxiliary inverter switches at the PWM frequency. The working theory of the cascaded H-bridge multilevel inverter is briefly introduced following sections.

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Advantages:

- The proposed method offers a robust regulation of the capacitor voltage when the inverters load is inductive.

Disadvantages:

- It does not incur much computational burden.

6. Comparison of Asymmetrical Cascaded Multilevel Inverter Control Techniques

From this dissertation presents asymmetrical cascaded multilevel inverter

(ACMLI) approach for high voltage and high power output applications. It is based on the cascade connection of the H-bridge inverter cells. Now ever by the supplies which are in GP with different ratios like 2, 3, etc. The proposed configuration is shown for 27 level inverters with symmetrical step control, optimization angle control and. Structural and operational characteristics are discussed and their inherent advantages are shown. Simulation using Matlab Simulink is done to verify the performance. Simulation shown in this paper and result for this proposed scheme are present in this paper.

The multilevel inverter [MLI] is a promising inverter topology for high voltage and high power applications. This inverter synthesizes several different levels of DC voltages to produce a staircase (stepped) that approaches the pure sine waveform. It has high power quality waveforms, lower voltage ratings of devices, lower harmonic distortion, lower switching frequency and switching losses, higher efficiency, and reduction of dv/dt stresses. It gives the possibility of working with low speed semiconductors if its comparison with the two-level inverter. Numerous of MLI topologies and modulation techniques have been introduced and studied extensively. But most popular MLI topologies are Diode Clamp, Flying Capacitor and Cascaded Multilevel Inverter (CMLI). In this paper we use a CMLI that consist of some H-Bridge inverters and with un-equal DC named as Asymmetric Cascaded Multilevel Inverter (ACMLI). It is implemented because these inverters are more modular and simple in construction and have other advantages than Diode clamp and flying capacitor. There are many modulation techniques to control this inverter, such as Selected Harmonics Elimination or Optimized Harmonic Stepped-Waveform (OHSW), Space Vector PWM (SVPWM) and Carrier-Based PWM (CBPWM), Symmetrical step control, Optimization angle control, Comparison control technique, etc. Having shown the simulation result of the 27 level for Symmetrical step control has the highest total harmonic distortion than another technique. But symmetrical step control method is simplest among the all three technique and also easy to implement in hardware. However it has more THD hence the losses are more in the system. Optimization angle control technique is more reliable and also easy to implement in hardware.

Advantages:

- Comparison control technique is the best among the all three technique.

Disadvantages:

- It has very less THD compared to other techniques hence losses are very less. Also it is simple method and easy to implement in hardware.

7. CONCLUSION

For verifying the validity of the proposed multilevel inverter in the generation of the desired output voltagewaveform, prototype is simulated based on the proposed topology. All the DC voltage sourceis same because the proposed multilevel is symmetrical type. The multilevel inverter is adjusted to produce a 50-Hz, 5-level staircase waveform. The output waveform of a single phase is with their corresponding Fourier spectrum. The total harmonic distortion (THD) is one of the measure harmonics in waveform we have the THD in voltage waveform of phase A is 9.9% which is better the phase voltage of all the three phase. The output is reduce the harmonic is 1^{st}, 3^{rd} and 5^{th} order is very low compare to the overall harmonic distortion. The output voltage is 200v with five levels.

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