21-LEVEL INVERTER FORMED BY CASCADING FLYING CAPACITOR AND FLOATING CAPACITOR H-BRIDGES
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ABSTRACT

Multilevel inverter is a power electronic device and that is develop into more or more popularize over the years in high-voltage high-power applications. Multilevel inverters have unique structure which makes it possible to reach high voltages by means of less harmonic content and lower EMI. The harmonic satisfied of the output voltage waveform decreases as the number of output voltage increases. This paper present a 21-level multi-level inverter with Asymmetrical cascaded MLI topology. A multilevel inverter for generating 21 voltage levels using a three-level flying capacitor inverter and cascaded H-bridge module with floating capacitors has been proposed. Various aspects of the planned inverter like capacitor voltage balancing have been accessible in the present paper. Experimental results are obtainable to study the performance of the proposed converter. The solidity of the capacitor balancing algorithm has been established both during transients and steady-state process. All the capacitors in this circuit can be balanced instantaneously by using one of the pole power combinations. A different advantage of this topology is its aptitude to generate all the voltages from a single dc-link power supply which enables back-to-back operation of converter. Also, the planned inverter can be operated at all load power factors plus modulation indices. Additional advantage is, if one of the H-bridges fail, the inverter can still be operate at full load with reduced number of levels. This configuration has very low dv/dt and common-mode voltage variation.

Keywords: Cascaded H-bridge, flying capacitor, multilevel inverter, 21-level inverter

1. INTRODUCTION

Multilevel inverters have become additional attractive for their employ in high-voltage and high-power applications. In multilevel inverters, the desired output voltage is achieved by appropriate mixture of multiple low dc voltage sources used at the input side. As the number of dc sources is augmented, the output voltage becomes closer to a pure sinusoidal waveform. The necessary dc power can be chosen from different sources such as battery, photovoltaic, fuel cells, capacitors, the rectified production voltage of wind turbines, and other similar dc power sources. Some advantages of multilevel inverters are good power quality, low switch wounded and electromagnetic compatibility due to the low dv/dt transitions. The voltage source inverters produce a voltage or a current with levels either 0 otherwise ±V dc they are known as two level inverters. To obtain a quality output voltage or a present waveform with a minimum amount of ripple content, they require high switch frequency along with various pulse width modulation (PWM) strategies. In high authority and high voltage applications, these two level inverters, however, have some limitations in operating at elevated frequency mainly due to switching devices should be used in such a manner as to avoid troubles associated with their series-parallel combinations that are essential to obtain capability of handling high voltages and currents. It may be easier to produce a elevated
power, high voltage inverter with the multi-level structure because of the way in which device voltage stresses are controlled in the structure. Increasing the numeral of voltage levels in the inverters without requiring higher ratings on the individual plans can increase the power rating. The unique arrangement of Multi-level voltages sources inverters allow them to reach high voltages by means of low harmonics without the use of transformer or series connected synchronized switching devices. As the number of voltage levels increases, the harmonic content of output electrical energy waveform decreases significantly.

2. RELATED WORKS

In [1] José Rodríguez, Jih-Sheng Lai, Fang Zheng Peng et al presents Multilevel inverter technology has emerged recently as a very vital alternative in the area of high-power medium-voltage energy control. This paper present the most significant topologies like diode-clamped inverter (neutral-point clamped), capacitor-clamped (flying capacitor), plus cascaded Multicell with separate dc sources. Emerging topologies like asymmetric hybrid cells and soft-switched multilevel inverters are also discuss. This paper also presents the most relevant control and intonation methods developed for this family of converters: multilevel sinusoidal pulse width modulation, multilevel selective harmonic removal, and space-vector intonation. Special attention is dedicated to the latest and more relevant applications of these converters such as laminators, conveyor belts, and unified power-flow controller. The need of an active front end at the input surface for those inverters supplying regenerative loads is too discussed, and the circuit topology options are also presented. Finally, the peripherally developing areas such as high-voltage high-power devices plus optical sensors and other opportunities for future development are addressed.

In [2] Samar Koura, Marias Malinowski, K. Gopakumar et al presents Multilevel converters contain been under research and development for more than three decades and have found successful industrial application. However, this is immobile a technology under development, and a lot of new contributions and new commercial topologies have been reported in the last few years. The aim of this paper be to group and review these recent help, in order to establish the current state of the art and trends of the technology, to provide readers by means of a comprehensive and insightful review of where multilevel converter technology stands and is title. This paper first presents a brief overview of well-established multilevel converters strongly oriented to the ir present state in industrial applications to then center the conversation on the new converters that have made their way into the industry. In addition, new promising topologies are discuss. Recent advances made in modulation and control of multilevel converters is also address. A great part of this paper is devoted to show nontraditional applications powered by multilevel converters and how multilevel converters are flatter an enabling technology in many industrial sectors.

In [3] Sebastian Rivera, Salvador Alepuz, Samir Kouro, Mariusz Malinowski et al presents A generalized multilevel direct power control (ML-DPC) scheme for grid-connected multilevel authority converters. The proposed method extends the original DPC operating principle by considering simply the closest subset of two level voltage vectors to the present switch state. The implementation of this principle requires the power derivatives for feedback, which be able to present numerical problems when practical experimentally, mainly due to high dimension noise sensitivity. Therefore, a derivative estimator is proposed based on the converter–grid model inside the synchronous reference frame. In addition, a virtual flux spectator is developed to achieve synchronization and improve robustness in the presence of network voltage harmonics. The proposed method is applicable to any multilevel converter topology of any number of levels. In this paper, simulations and new results are presented for a seven-level cascaded H-bridge converter. The permanent magnet synchronous
generator-based wind energy conversion system (WECS) using fully rated power converter has become the state-of-the-art solution for large size multimegawatt wind turbines.

In [4] Toufann Chaudhuri, Alfred Rufer, and Peter K. Steimer et al presents Rising interest in multilevel applications has triggered new investigate activities. This paper proposes a novel multilevel power electronics building block (PEBB) for the five-level active neutral point clamp (ANPC) multilevel voltage source inverter. The PEBB is composed of six switches in a crossed configuration and one capacitor. It is ordinary to the three phases of a five-level ANPC topology, enabling a large number of levels to be generated. This PEBB is meant to be a reliable upgrade to the 5L topology, rising production signal quality and reducing the size of the output filter in medium voltage applications. The number of levels generated by the common cross-connected stage (C3S) PEBB plus the ANPC depends on the electrical energy ratios chosen between the phase capacitors of the ANPC and the PEBB capacitor(s). The exchange stands between the ability to balance the capacitors, the rated blocking voltage of the devices, and the number of levels produced. The analysis of the general topology, the account of the nine-level case, and simulation results are first presented. Prototyping results are then shown, and they validate the bring in comaritalcept and topology.

In [5] Baljit S. Riar, and Udaya K. Madawala et al presents Cascaded H-bridge, capacitor clamp and neutral point clamped topologies have been used for medium to high-voltage application but Modular multilevel converter (M2LC) is becoming a popular alternative. However, in comparison to other topologies, manage of load current, which is inherently coupled with circulating currents, is more difficult in the M2LC topology. This document proposes a modified M2LC topology that allows for decoupled control of circulating currents from load current. Each arm of the modified topology comprise a plurality of half-bridge modules and one full-bridge module. The full-bridge module minimize harmonic currents within the converter without affecting the load current. A state-space model, which is generalized per arm with an N number of half-bridge module and one full-bridge module, is presented to accurately predict the behavior of the proposed topology. Theoretical as well as experimental consequences of a single-phase three level 800-VA prototype converter are presented with a discussion to show the viability of both the proposed mathematical model and modified topology.

3. BLOCK DIAGRAM

![Block Diagram](image)

Fig-1: Block diagram.

4. CASCADED H-BRIDGE INVERTER

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

5. HYBRID MULTILEVEL TOPOLOGY

A cascaded H-bridge converter with equal dc voltage is widely used for STATCOM request. The cascaded single-phase H-bridge converter saves a large amount of clamped diodes and flying capacitors compare with diode clamped converter and flying capacitor converter. In high-power request further improvement of power efficiency and waveform quality is expected of cascade Hbridge topology. Either by rising switching frequency or figure of cascaded modules, a low distorted ac voltage waveform can be achieve but which may results in high power loss or high cost to the STATCOM system. A high-quality tradeoff between waveform quality and switching loss can be obtained by hybrid multilevel skill. Increased voltage levels of output waveform, better ac current quality, reduced switching frequency resulting in low switching loss and also enhanced converter competence are the main advantages of cross multilevel converters.

6. HYBRID MODULATION

Hybrid modulation is shown in Fig which includes two parts: fundamental lilt and pulse width modulation. Fundamental modulation is defined as: when the sinusoidal voltage command is greater than a positive threshold worth of Vcmp high voltage converter outputs positive electrical energy; when the sinusoidal voltage command is lower than the negative threshold value of -Vcmp high electrical energy converter outputs negative voltage and if sinusoidal command is in range between –Vcmp and Vcmp high voltage converter outputs zero. residual part of sinusoidal authority and quasi square waveform voltage is command voltage for low voltage converter. It be modulated by single-polar PWM modulation technology with the carrier frequency of 5 kHz. Based on this lilt strategy, an ac waveform with higher electrical energy levels is produced. It brings the advantages of improving output quality, keeping high equal switching frequency, and reducing power loss.

7. MULTILEVEL INVERTER CONFIGURATION

A lot of multilevel inverter topologies have been proposed during the last three decades. Modern research has engaged novel inverter topologies and unique lilt schemes. Three dissimilar major multilevel inverter structures have been reported in the literature: cascaded H-bridges inverter with separate DC sources, diode clamp (neutral clamped) and flying capacitors (capacitor clamped). The first topology introduced was the series H-bridge design. This was follow by the diode-clamped multilevel inverter which utilizes a bank of series capacitors to split the DC bus voltage. After few existence the flying-capacitor (or capacitor clamped) topology was introduced in which instead of series connected capacitors floating capacitors be used to clamp the voltage levels. Another multilevel design, slightly different from the preceding ones, involves parallel connection of inverter outputs through inter-phase reactors. In this plan the switches must block the entire reverse voltage, but share the load current.
8. WORKING PRINCIPLE OF MULTILEVEL INVERTER

General concept of multilevel inverter be able to be explained in this piece which is very popular. In this explanation operation of semiconductors be shown by an ideal switch with several states. The switching pattern of switches and commutation of them allow the addition of the capacitor voltages as provisional DC voltage sources whereas the switches should withstand the voltages of capacitors.

Fig-2: working principle of multilevel inverter.

9. 21-LEVEL INVERTER

Multilevel voltage basis inverter is recognized as an important alternative to the normal two level voltage source inverter especially in high voltage application. Using multilevel method, the amplitude of the voltage is increased, stress in the switch devices is reduced and the overall harmonics profile is improved. Among the familiar topologies, the most well-liked one is cascaded multilevel inverter. It exhibits several attractive features such as easy circuit layout, less components counts, modular in structure and avoid unbalance capacitor voltage problem. However as the number of output level increases, the circuit becomes bulky due to the add to in the number of power devices. In this project, it is proposed to employ a new technique to obtain a multilevel production using less number of power semiconductor switches when compared to ordinary cascade multilevel inverter. The proposed converter consists of less number of switches when compared to the other familiar topologies. The initial cost reduces since of the switch reduction. So, it looks attractive and an apt one for industrial applications. In another give, it can restrain harmonics and get better power quality according to customers’ needs. STATCOM has superior performance in lots of
aspect such as responding pace, stabilize voltage of power grid, reduce system power loss and harmonics, add to both transmission capacity and limit for transient voltage. It also have advantage of smaller in dimension.

The switches are set in the manner as shown in the figure. For the planned topology, we just need to add only one switch for every increase in levels, so initial cost gets abridged.

10. OPERATION

A Three Phase Twenty one level inverter by seven switches with a new Pulse Width-Modulated (PWM) control method. In this multi transporter pulse width modulation technique is used to generate the 21 level output voltage. Seven equal amplitude carrier triangular signals with counterbalance are compared with the sinusoidal reference signal. These PWM signals are given to the switches S1, S2, S3. Then the two sinusoidal signals having 180 amount displacement signals are compared with the carrier triangular signal, these PWM pulses are having dead band, it will avoid the shoot through problem flanked by two devices. These PWM pulses are known to the single phase inverter circuit switches H1, H2, H3, and H4.

11. SWITCHING MODE FUNCTION

![Fig-4: Switching mode function.](image)

12. SIMULATION CIRCUIT

![Fig-5: simulation output](image)
13. OUTPUT

Fig-6: Output.

14. CONCLUSION

A 21-level multi-level inverter by Asymmetrical cascaded MLI topology is proposed with different PWM techniques and planned MLI topology with different PWM techniques is used to generate 21-level output phase voltage. It is prove that, the proposed work of Single phase 21-level MLI output voltage total harmonics distortion is reduced and improve the efficiency of system contrast with different conventional topologies of single phase and three-phase 21-level MLI. Harmonic analysis carried out using Mat Lab R2013a version software. This planned MLI topology requires less number of components as compared to conformist MLI inverters. Simulation results show the performance of single-phase MLI with different PWMs technique.

REFERENCES


