A SINGLE DC SOURCE CASCADED SEVEN-LEVEL INVERTER INTEGRATING SWITCHED CAPACITOR TECHNIQUES

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ABSTRACT:

In this project, a novel cascaded seven-level inverter topology with a single input source integrating switched capacitor techniques is presented. Compared with the traditional cascade multilevel inverter (CMI), the proposed topology replaces all the separate dc sources with capacitors, leaving only one H-bridge cell with a real dc voltage source and only adds two charging switches. The capacitor charging circuit contains only power switches, so that the capacitor charging time is independent of the load. The capacitor voltage can be controlled at a desired level without complex voltage control algorithm and only use the most common carrier phase-shifted sinusoidal pulse width modulation (CPS-SPWM) strategy. The operation principle and the charging-discharging characteristic analysis are discussed in detail. A 1kW experimental prototype is built and tested to verify the feasibility and effectiveness of the proposed topology.

Keywords: Multi level inverter, converter, NPC, PV system.

1. INTRODUCTION:

In general, multilevel converters are classified into diode-clamped, flying capacitor, and cascaded multilevel inverter topologies. A topology because of its modularity, particular attention has been given to cascaded multilevel symmetrical structure, and simplicity of control. A cascade inverter can be directly connected in series with the electrical system for static var compensation. Cascaded inverters are ideal for connecting renewable energy sources with an ac grid, because of the need for separate dc sources, which is the case in applications such as photovoltaic's or fuel cells. Photovoltaic panel, fuel cells batteries, and ultra capacitors are the most common independent sources. The most attractive features of multilevel inverters are as follows.

1) They can generate output voltages with extremely low distortion and lower dv/dt.

2) They draw input current with very low distortion.

3) They generate smaller common-mode (CM) voltage, thus reducing the stress in the motor bearings. In addition, using sophisticated modulation methods, CM voltages can be eliminated [8].

4) They can operate with a lower switching frequency. A five-level CMI for distributed energy applications is presented.

The CMI input ports are connected to a group of batteries, whose characteristics are large size, high cost, and the battery discharging speed limits the continuity of the system. Some solutions to reduce the number of isolated source in the CMI are proposed. Multilevel cascaded inverters have been proposed for such applications as static var generation, an interface with renewable energy sources, and for battery-based applications. An important improvement is the "asymmetrical CMI" (ACMI), which can generate the same number of levels with fewer power supplies [10].

ACMI increases the power quality, but they lose modularity and still need more than one isolated sources. To eliminate the dc sources of the auxiliary converters, the system uses a high-frequency link (HFL), based on a square-wave generator and a multi winding toroidal transformer. An alternative option without transformers is to replace all the separate dc sources feeding the H-bridge cells with capacitors, leaving only one H-bridge cell with a real dc voltage source. A simple capacitor voltage regulation constraint is derived which can be used in optimization

problems for harmonic minimization or harmonic mitigation to guarantee capacitor voltage regulation in all load condition [7]. A new control method, phase-shift modulation, is used to regulate the voltage of the capacitors replacing the independent dc source. The method is robust and does not incur much computational burden [8]. The proposed dc-voltage-ratio control [9] is based on a time-domain modulation strategy that avoids the use of inappropriate states to achieve any dc voltage ratio.

2. PREVIOUS STUDY:

The various strategies on deriving energy from renewables, the rapid advances in technology and the increasing environmental stress have made the renewable energy resources to meet the future energy needs. The availability of sources such as wind, solar, photovoltaic, biofuels, geothermal and hydel energy are important aspects of many nations' energy strategies. As many of these resources have attained economic viability, their adoption and integration into today's electricity networks is becoming increasingly widespread. The concern about the environment and the need of developing sustainable energy supplies will enhance the use of renewable energy resources in electric power generation [1]. However, the sustainability of the available resources is a major factor to be considered and hence, the use of these resources have to be in the most efficient way. The available sources in an area can be integrated for generating power, so that these resources can share the available load. When the load cannot be met by a single source, the sources can be used in cascade for efficient power generation. Among the renewable energy sources available, solar energy has been one of the most active research areas, both for grid connected and stand-alone applications. The rapid rate of growth in the solar energy generation is mainly due to different inverter topologies [2]. Inverters therefore play a crucial role in the power generation, distribution and transmission systems incorporating renewable sources. AC output voltage is created by switching the full bridge in an appropriate sequence. The inverter topologies can be mainly divided into two: single and multi-stage inverter. Though the single stage inverters are less complex, the efficiency is very less due to high rate of change of output voltage and increase in the

harmonic contents. The multi-level inverters have replace the single stage inverter circuits due to their high voltage capability, low switching frequency, and low power losses. The conventional multilevel topologies include the diode clamped, flying capacitor, and cascaded H-bridge converters. In the past, multilevel switching was achieved by phase shifting of multiple single level converter output voltage waveforms which are added together vectorically using series connected transformer windings [3]. As the number of levels increased it became difficult to realize the approach due to requirement of multiple transformer windings. The alternative solution was to replace the multi-winding transformers with multilevel dc bus. This was achieved by connecting several controllable cells in series on the base of a single device connection to get a multilevel source [4]. The result of this approach was the conventional neutral point clamped, flying capacitor and cascaded H bridge topologies. The main drawbacks were the increase in the number of switches and hence the switching losses as the levels increase. Hence newer topologies were developed in the literature to reduce the number of components and the losses associated with it.

3. PROPOSED SYSTEM:

Although those cup as well as enhancements not instantly lead the COMPUTER are the secrets supplies to run a valuable deadly, you experience not fail to remember the culture on that particular we generate. Power problem is the adhesive that attaches base blocks. Power quality likewise impacts business of raising workout, utilize stability, our standing, and also initial acquisition in stamina transportation systems to alleviation brand-new swell installments. "Using DC sensibly is an excellent ambience and also financial technique that conserves you funding lowers discharges from regulation blossoms and also saves our instinctive sources." All understanding, get to look demands Continues to establish at an astonishing price. Next-generation sack swell, whichever was previously in the advancement motion, will certainly require a regular eminence obligate meat of in the joint 1500 as well as 2000 kWh - two times the mean thorough anticipate for three-way life-span. The fast advancement in electrical energy demand, the advancement in the society of box extend, the advanced

updates of the hidden generator, and also the significant SSDs obliged to accomplish as well as rule the create will certainly sustain understanding of the release of electrical power ability in the really future.

The proposed structure can be used for a photovoltaic-battery three-input inverter application, as shown in Fig. 1(b). When the photovoltaic ports are available, the converter is used as a traditional cascaded seven-level inverter with three independent isolated sources. However, in the case PV ports powering off in the night, all the separate PV sources are separated from the converter and are replaced by capacitors, so that the operation principle is the same as the converter in Fig. 1(a). With the switched capacitor techniques, the different H-bridges can share the input source; thus, the redundancy of the topology is enhanced. This paper is organized as follows. After the Introduction, the CPS-SPWM strategy in the proposed single-supply cascaded seven-level inverter is explained in Section II. The capacitor charging and discharging characteristic are presented in Sections III. Section IV analyzes the charging current and loss and the charging-switch pair voltage. Section V presents the simulation and experimental results. Section VI provides the conclusions.
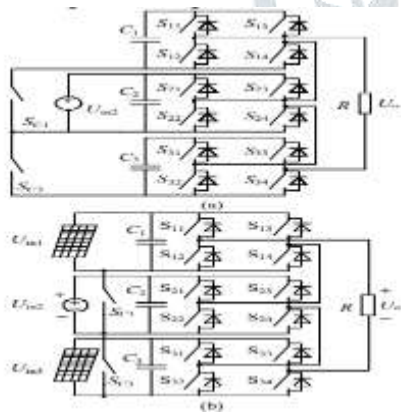

Fig.3.1. Topologies of the proposed inverter.

Different multilevel modulation techniques have been presented in the literature. For the CMI, carrier phase-shifted sinusoidal pulse width modulation (CPS-SPWM) is the most common strategy, with an improved harmonic performance. The CPS-SPWM associates a pair of carriers to each cell of the CMI, and a phase shift among the carriers of the different cells is introduced. In this way, a stepped

multilevel waveform is originated. There are some interesting features and advantages:

1) The output voltage has a switching pattern with 2N times the switching frequency (where N is the number of cells). Hence, better total harmonic distortion (THD) is obtained at the output, using 2N times lower frequency carriers.

2) Since all the cells are controlled with the same reference and same carrier frequency, the power is evenly distributed among the cells across the entire modulation index .

3) For the single-supply CMI using capacitors, the advantage is that the capacitors are properly charged without complex voltage balancing control algorithm.
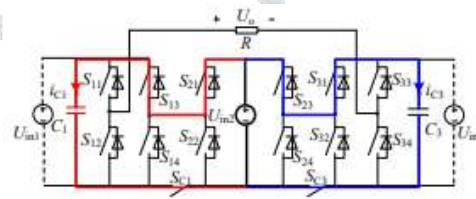

Fig.3.2. **Equivalent charging circuit for C1 and C3.**

By introducing the charging-switch pairs, the proposed cascaded seven-level inverter can operate well with only a single DC input source. It is necessary to analyze the charging-switch pair's voltage stress and SC1 was taken as an example for the voltage analysis. There are four voltage states for SC1 in a modulation cycle, which are described as follows. State I: S13, S21, and SC1 are turned on. The positive sides of C1 and Uin2 are connected directly. Input source Uin2 can charge C1 by introducing SC1.
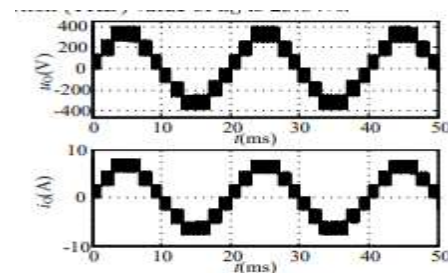

Fig.3.3. Output results.

The positive sides of C1 and Uin2 are connected directly. Input source Uin2 can charge C1 by introducing SC1, as shown in Fig. The voltage of SC1 is zero. State II: S13 and S22 are turned on, and SC1 is turned off. The voltage of SC1

is –UC1, as shown in Fig. State III: In Above Fig, S14 and S21 are turned on, and the voltage of SC1 is Uin2. State IV: In Fig. Below S14 and S22 are turned on and the voltage of SC1 is zero. States I to IV indicate that the voltage of SC1 is 0, the capacitor voltage UC1 or source voltage Uin2. Therefore, the proposed converter has low voltage stress on each switch, which resulted in low cost.
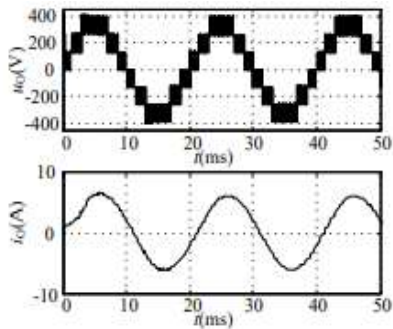

Fig.3.5. Multilevel inverter results.

5. CONCLUSION:

A novel single DC source cascaded seven-level inverter integrating switched capacitor techniques is developed in this paper. In the proposed topology, the transformerless charging circuit only contains power switches and capacitors, and the charging time is independent of the load. The operation principle and the charging-discharging characteristic analysis are investigated in depth. With the common CPS-SPWM strategy, the sinusoidal output voltage can be well obtained. Moreover, the capacitors are properly charged without complex voltage balancing control algorithm. The peak charging current and the charging loss can be reduced with appropriate circuit parameters. The proposed topology has the features of modularity, low cost and simplicity of control and makes it attractive in DC-AC power applications. A 1kW experimental prototype verifies the feasibility of the proposed inverter. The proposed inverter is also suitable for photovoltaic-battery multi-input application with high redundancy.

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