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# A Seven Level Cascaded MLI with Single-DC-Source Using PWM Based Modulation

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## Abstract:

This paper presents a new control technique to regulate the capacitor voltage in cascaded multilevel inverters. Without requiring transformers, the scheme proposed here allows the use of a single dc power source with there maining n−1 dc sources being capacitors. This paper focuses mainly to achieve an effective capacitor voltage regulation with the Phase shift modulation and energy storage using Ultra capacitors as they have higher power density, higher efficiency, longer life and greater cycling capability in cascaded multilevel inverters. It shows hope to reduce the voltage ripple of the capacitors, which leads to higher power conversion efficiency with equal power distribution, reduces the initial cost, and complexity hence it is apt for industrial applications. 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.

## INDEX TERMS:

multi level inverter, pwm ontrol,Ultracapacitor.

## I.INTRODUCTION:

Numerous industrial applications have begun to require high power apparatus in recent years. Multilevel inverters have become more popular over the years in industrial propel applications and high power applications with the promise of less disturbances, smaller common-mode voltage, the possibility to function at lower switching frequencies, and good potential for further developments than ordinary two Level inverters.

In multilevel inverters the Cascaded H-Bridge(CHB) configuration has recently become very popular in high-power AC supplies and adjustable-speed drive applications. A cascade multilevel inverter consists of a series of H-bridge (single-phase full bridge) inverter units ineach of its three phases. The cascaded multilevel inverter was invented for use in medium to high power applications. The traditional cascaded multilevel inverter interfaces DC energy sources.

The advantages of cascaded multilevel inverters are:

- Requires less number of components per level.
- Modularizedstructure without clamping components.
- Simple voltage balancing modulation.

Hybrid cascaded multilevel converters provide an attractive option for high power and high performance motor drive applications. Traditional H-bridge HCMC use multiple dc sources, but recently, energy storage elements have beenused to replace some of the dc sources, mainly to providereactive power compensation. Most of the research that hasbeen conducted on the use of energy storage for motordriveapplications is based on the use of converter for interfacebetween the ultra-capacitors (UC) and the induction motor.In most applications, a power converter needs to transfer real power from ac to dc (rectifier operation) or dc to ac(inverter operation). When operating at unity power factor,the charging time for rectifier operation (or dischargingtime for inverter operation) for each capacitor is different. Such a capacitor charging profile repeats every halfcycle,and the result is unbalanced capacitor voltages between different levels.

The voltage unbalance problem in a multilevel converter can be solved by several approaches, such as replacing capacitors by a controlled constant dc voltage sourcesuch as pulse-width modulation (PWM) voltage regulators or batteries. The use of a controlled dc voltage will result insystem complexity and cost penalties. With the high power nature of utility power systems, the converter switching frequency must be kept to a minimum to avoid switching losses and electromagnetic interference (EMI) problems .When operating at zero power factors, however, the capacitor voltages can be balanced by equal charge and dischargein onehalf cycle. This indicates that the converter cantransfer pure reactive power without the voltage unbalance problem.

In early implementations each H-bridge cell wassupplied by an independent dc source. Later, research showedthat only one cell needs to be supplied by a dc power source;the remaining cells can be fed by capacitors .The method proposed in usesthe switching state redundancy for capacitor voltage regulation,where the voltage level of the auxiliary cell usually is selectedto be half that of the main H-bridge cell. However, studies haveshown that regulating the capacitor voltage is not as easy asinitially predicted. The existence of redundantswitching states has been assumed to be adequate for capacitorvoltage regulation. However, the output current of the inverterand the time duration of the redundant switching states greatlyimpact the charging or discharging patterns of the replacementcapacitors.

In multilevel power electronic converters, the desired output can be synthesized by combining several DC sources .solar panels, fuel cells, batteries, and ultra capacitors are the most common independent sources used. These converters are having single phase and three phase applications. The first topology introduces was the series H-Bridge converter which utilized a bank of series capacitors. Later flying capacitor design. In general multilevel converters are categorized into diode-clamped, flying capacitor, and cascaded H-bridge. The diode-clamped inverter provides multiple voltage levels through connection of the phases to a series bank of capacitors. Applications of diode clamped multilevel converters include high-power ac motor drives in conveyors, pump, fans, and mills. But due to capacitor voltage balancing issue diode-clamped inverter has been mostly limited to 3-level.

Flying capacitor involves series connection of capacitor clamped switching cells. This can be used in high-bandwidth, high-switching frequency applications such as medium voltage traction drives. Drawback of this topology is large number of capacitors are more expensive and bulky. Finally cascaded H-bridge inverter consists of series power conversion cells. Voltage and power levels may be easily scaled. Cascaded H-bridge multilevel converter has been applied to high-power and high-quality applications such as static volt-ampere reactive generation, active filters, reactive power compensators, photovoltaic power conversion, uninterruptible power supplies, and magnetic resonance imaging.

Furthermore one of the growing applications for multilevel power electronic converters is electric drive vehicles in which the traction motor is driven by batteries. The main disadvantage of this cascaded H-Bridge topology is that large number of isolated voltage requires supplying each cell. This paper has given an alternate method to overcome the disadvantage of cascaded H-Bridge multilevel inverter.This project proposes a control method applicable to singledc-source cascaded H-bridge multilevel inverters to improvetheir capacitor voltage regulation. The proposed method, phaseshiftmodulation, is robust and does not incur much computational burden.In this method, the main inverter switches atthe fundamental frequency, and the auxiliary inverter switchesat the PWM frequency.

## II PROPOSED TOPOLOGY:

In this paper, the proposed multilevel inverter not only has the modularity feature of cascaded topologies but also consists of single dc source and the remaining are of capacitors. Proposed topology is not only used to regulate the voltage across the capacitors and also used for energy storage purpose with the use of ultra capacitors.

### General Switching Methods used for Cascaded h-bridge Inverter :

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.

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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.

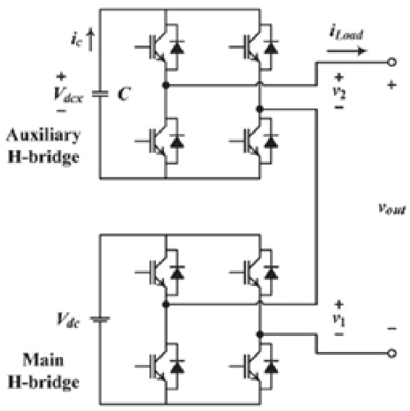


Fig. 1. Block diagram of a cascaded H-bridge inverter.

## III CONTROL STRATEGY:

Here we use the Phase Shift Modulation control strategy .it has explained below briefly

### Phase Shift Modulation

Regulating the capacitor voltage in the auxiliary bridge is a challenging one. The capacitor voltage balancing is achieved by adjusting the active power that the main H-bridge cell injects into the system. By shifting the voltage waveform (Figure 5) generated by the main H-bridge cell to the left or right, one can inject more or less active power, which can be used to charge or discharge the capacitor on the auxiliary cell. Some assumptions are made to simplify the analytical description of the principle of the operation of phase shift modulation.

## IV.SIMULATION RESULTS:

### Simulation circuit:

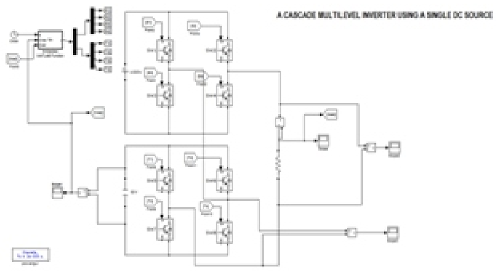


Fig.2. Matlab Simulation Circuit

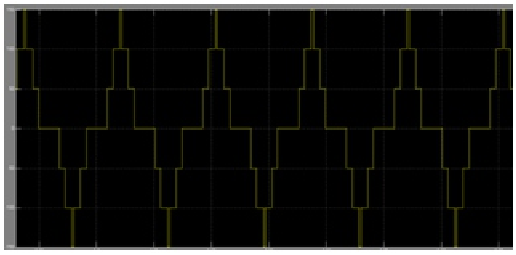

Fig.3. Output voltage 7 levels

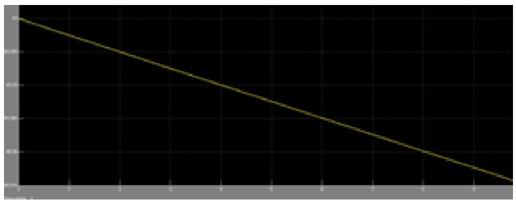

Fig.4. DC Capacitor Voltage.

## V. CONCLUSION:

A single-dc-source cascaded H-bridge multilevel converter has been analyzed. A new control method, phase-shiftmodulation, is used to regulate the voltage of the capacitors replacing the independent dc sources by capacitors. Theproposed method offers an effective regulation of the capacitor voltage and the energy storageusing ultra-capacitors asthey have higher power density, higher efficiency, longer life and greater cycling capability with hybrid cascadedmultilevel inverter topologies for high performance motor drive applications.

Thsimulatiobn results show the effectiveness of this method of regulating the capacitor and reduce the voltage ripple of the capacitors, which leads to higher power conversion efficiency with equal power distribution, reduces the initial cost, and complexity hence it isapt for industrial applications.

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