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Comparison Performances of Asymmetric Multilevel Inverters in the Maximum Voltage Rating of Power Electronic Devices

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Abstract – *The paper presents comparison performances of Asymmetric Cascaded Multilevel Inverter (ACMLI) in the maximum voltage rating of power electronic devices, to find which the DC voltage progression that has the best performance. The performances have been investigated based upon in amplitude, Total Harmonic Distortions (THD), and frequency spectrum in the binary (order-2) DC voltage progression, trinary (order-3), equal interval and sine quantization. A single phase ACMLI in the five H-bridges structures simulated by Matlab has been used to verify these performances. The comparisons show that the performance of sine quantization DC voltage progression have highest output voltage, low total harmonics distortions, amplitude of DC voltage realistically and good frequency spectrum, making it possible to overcome the limitation of maximum voltage rating of power electronic devices.*

Keywords: *Asymmetric Multilevel Inverter, Voltage Rating, Sine Quantization, Amplitude, Frequency Spectrum, Total Harmonic Distortion*

Nomenclature

n	Number of voltage step in output voltages that called voltage levels
N	Number of H-Bridges inverter in CMLI and ACMLI
S_{1j}	Individual H-Bridge switch where j is series of H-Bridges and 1 (also 2,3 and 4) is the component switching on the inverter H-Bridges number 1
V_1	Amplitude of fundamental frequency
V_{DCj}	Amplitude of DC voltage in H-Bridge in j series
V_m	Maximum voltage of sine reference
V_n	Amplitude of harmonics distortion in order n
V_o	Output voltage of H-Bridge and multilevel inverter
V_{omax}	Maximum output voltage multilevel inverter
THD	Total Harmonic Distortions
V_{cn}	Voltage control for n voltage level in CPOVL
θ_n	Switching angle of voltage level n
θ_{an}	The upper angles of voltage level n
θ_{bn}	The upper angles of voltage level n

Abbreviations

AC	Alternating Current
ACMLI	Asymmetric Cascaded Multilevel Inverters
CMLI	Cascaded Multilevel Inverter
CPOVL	Center Point of Voltage Levels
DC	Direct Current
IGBT	Insulated Gated Bipolar Transistor
MCT	Metal Oxide Semiconductor-controlled Thyristor
MLI	Multilevel Inverter
p.u.	Power unit

I. Introduction

Static power converters of electric power are used in industry for variety of purposes. These devices convert AC to DC, DC to AC, DC to DC and AC to AC. But the using of these devices connect to electric power system can change the sinusoidal nature of AC power current (consequently the AC voltage drop), thereby resulting in the flow of harmonic currents in the AC power system that cause additional heating, interference with communication circuit, resonance in the system, increase power losses and other problems [1]-[6].

Inverter that converts DC to AC is the important static power converter for high voltage DC transmission, adjustable speed drives, uninterruptible power supplies and grid connected of renewable energy [7]. These devices have many topologies and control methods. Recently the multilevel inverter (MLI) is the most popular DC to AC converters topology for high voltage and high power. The general structure of MLI is to synthesize a sinusoidal voltage from several levels of voltages [2]-[5]. There are three well-known topologies; diode-clamps, flying capacitor, and cascaded multilevel inverter (CMLI) [5]-[9].

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