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Comparison of PWM and Nearest Level Modulation technique for Modular Multilevel Converter

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ABSTRACT

Modular multilevel converters (MMC) have recently received a lot of attention for their exceptional features. Three critical features of HVDC MMCs are power quality, converter cost, and system performance, all of which are closely linked to the converter modulation and switching schemes. The two modulation technique studied in this thesis are the Nearest Level Modulation and Level – Shifted type Alternate Opposition Phase Disposition Pulse Width modulation technique. On compairing the output of the two modulation technique we observe that , the percentage of total harmonics distortion present in Pulse width Modulation technique is 22% and that of another method i.e Nearest level modulation is 14.82 %.

Keywords: HVDC, Modular Multilevel Converters

I. INTRODUCTION

Electrical converters are well known in industry and higher education institutions as one of the preferred options for high-performance power conversion systems. Over the past few years, a few power converters have been developed and marketed in the form of standard and customized products. These converters enable a wide range of industrial testing applications such as pumps, compressors, fans, mills, conveyors, transport (e.g., electric vehicles and, rail), production, petrochemical, high-voltage direct current (HVDC) transmission, reactive energy compensation, and wind energy conversion programs. These power conversion topology require a high voltage transformer or semiconductor devices with high voltage to operate in high voltage. The previous solution is expensive and increases the size and volume of the conversion system. The new solution does not increase the size and volume of the converter. The main limitation of this solution is the availability of HV semiconductors devices.

A **modular** method has been developed to overcome device parameters of semiconductors and their series connections to achieve maximum thermal power.

II. METHODS AND MATERIAL

MODULAR MULTILEVEL CONVERTER

The modular multilevel converter has a modular construction , high reliability, and cost-effectiveness because it uses low voltage – Insulated gate bipolar transistor (LV-IGBT) , high-voltage (HV) access technology performance.MMC is directly connected

to medium-voltage (MV) and high-voltage(HV) grids without any mounting transformer. These features may be helpful with many different programs.

This topology is commercially used in medium-voltage motor drive, HVDC transmission, multi-terminal HVDC systems, offshore wind farms and complaint fixed compensation (STATCOM). MMC too requires a management scheme with a complex requires a management scheme with a complex structure and a few administrative functions manage objectives simultaneously. In addition, it requires high performance control panel to process a large number of login signals.

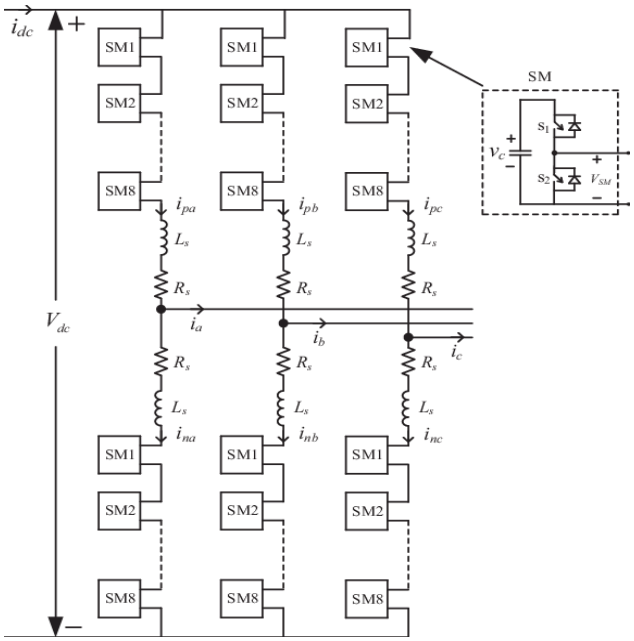


Figure (1) Schematic diagram of MMC

MODULATION SCHEME USE

Pulse width Modulation (PWM)

PWM systems are intended to reduce output voltage harmonic distortion while increasing output voltage magnitude at a given switching frequency. The PWM schemes for a modular multilevel converter are divided into three categories based on the switching frequency: high switching frequency, low switching frequency, and fundamental switching frequency modulation schemes.

Level-Shifted Carrier Modulation

This system likewise requires an n-number of triangular carriers that are identical. Carrier waves are placed one on top of the other in this arrangement. Each carrier is assigned a separate sub-module. When compared to a reference signal, the module must either be applied or bypassed. When the number of modules is large enough, a comparatively low switching frequency with low harmonic output is created.

The LSC-PWM has three versions depending on the phase relationship between nearby carriers: I phase-disposition (PD), in which the triangular carrier signals are vertically aligned in phase, as shown in Figure (a); (ii) phase-opposition-disposition (POD), in which triangular carrier signals above the sinusoidal reference zero are in phase and those below the sinusoidal reference zero are out of phase, as shown in Figure (b); and (iii) alternate phase-opposition-disposition (APOD), in which all triangular carrier signals are disposed alternately in phase-opposition, as shown in Figure (c)

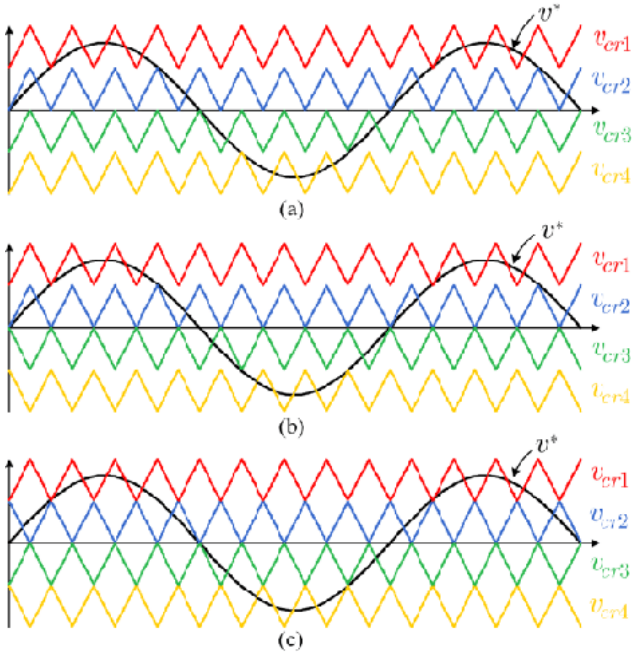


Figure (2) (a)PD, (b)POD, (c)APOD

Nearest Level Modulation

The number of sub-modules inserted is determined by the amplitude of the reference modulating signal. This approach generates the desired reference phase voltage by using the nearest voltage level; thus, it is also known as near-est level modulation (NLM). The NLM is a fundamental switching frequency modulation that avoids the usage of triangular carrier signals, unlike the sine-triangle PWM approach. This modulation technique is suitable for modular multilevel converter systems with a large number of sub-modules because output voltage quality is less likely to deteriorate with small voltage steps. Furthermore, nearest-level modulation is simple to implement in large modular multilevel converter systems.

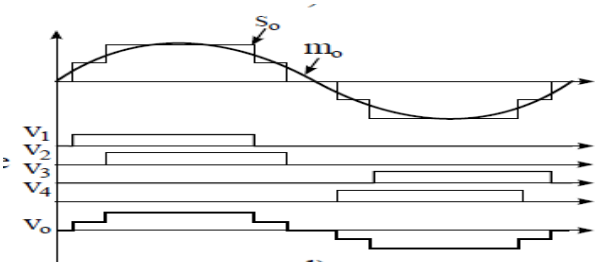


Figure (3) nearest level modulation

III. RESULTS AND DISCUSSION

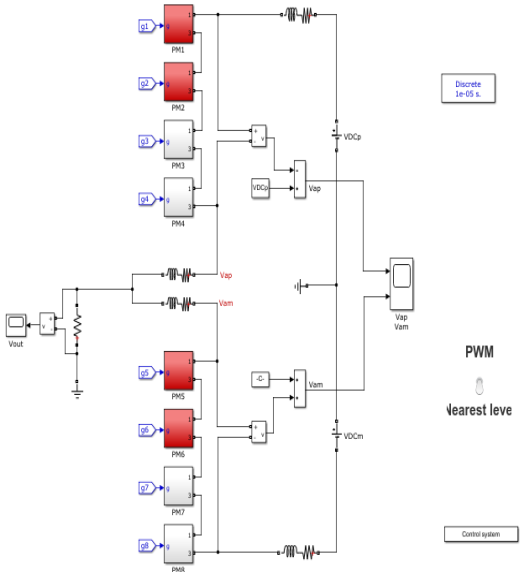


Figure (4) Simulation model of mmc using PWM and Nearest level modulation performed in MATLAB

This model consist of 4 submodule in each arm ie. Upper and lower arm , and the submodules implements the half-bridge modular multilevel converter.Each submodule consist of one half- bridge and one capacitor on the dc side.

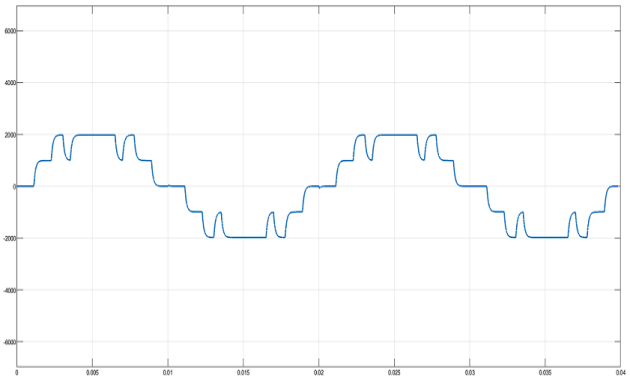


Figure (5) Output voltage waveform of PWM technique

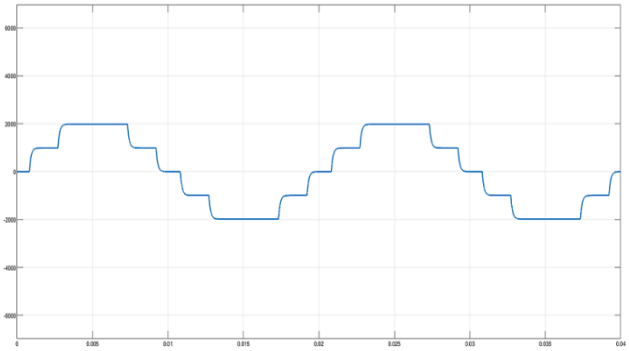


Figure (6) Output Voltage waveform of NLM technique

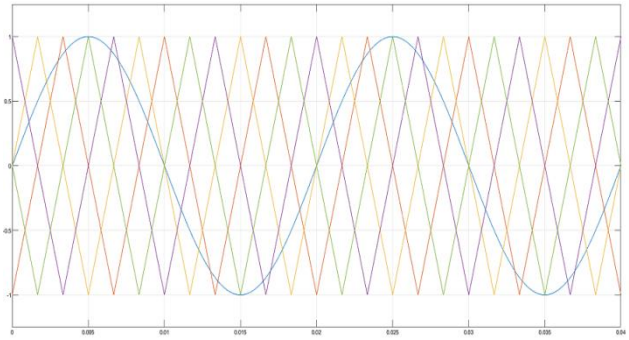


Figure (7) Waveform of carrier and reference voltage

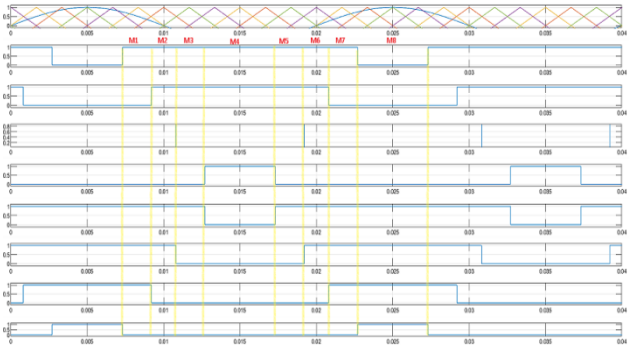


Figure (8) Formation of gate pulses

Table 1 Modes of Operation

Modes	S1	S2	S3	S4	S5	S6	S7	S8
M1	ON	ON	ON	ON	ON	ON	ON	OFF
M2	OFF	ON	ON	ON	ON	ON	OFF	OFF
M3	OFF	OFF	ON	ON	ON	OFF	OFF	OFF
M4	OFF	OFF	OFF	ON	OFF	OFF	OFF	OFF
M5	ON	ON	ON	OFF	ON	ON	ON	ON
M6	ON	ON	OFF	OFF	OFF	ON	ON	ON
M7	ON	OFF	OFF	OFF	OFF	OFF	ON	ON
M8	OFF	OFF	OFF	OFF	OFF	OFF	OFF	ON

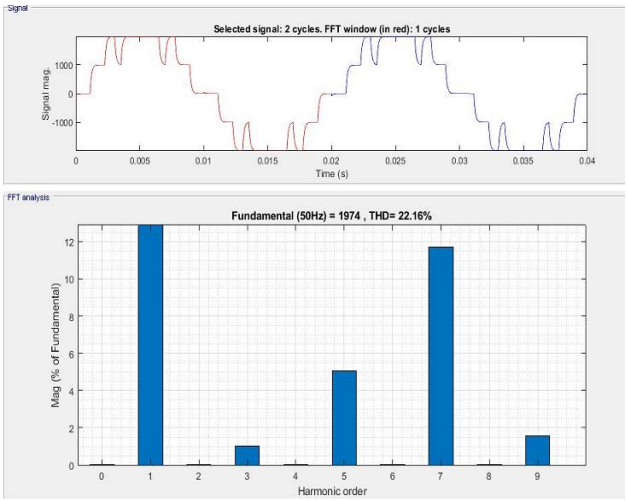
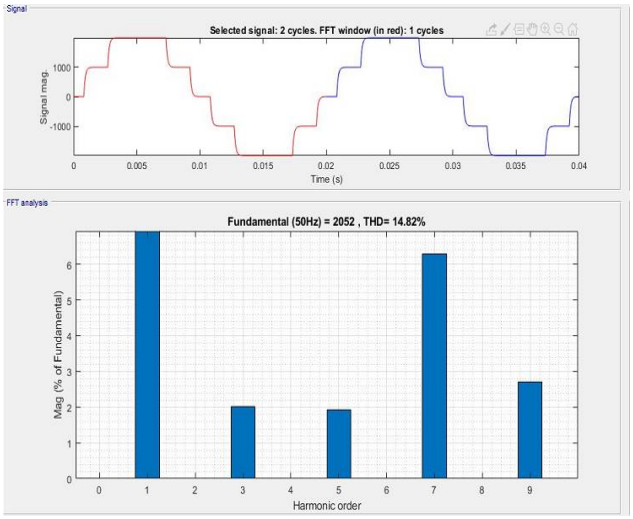


Figure (9) THD analysis of AOPD-PWM technique



Figure(10) THD analysis of Nearest Level Modulation

IV. CONCLUSION

This paper mainly focuses on how different modulation technique is used to decrease the total harmonic disturbance (THD) present in the output voltage of Modular Multilevel Converter (MMC). Several modulation technique is in use we majorly working on APOD-PWM modulation and Nearest Level modulation technique.

After observing the output of APOD-PWM we found that for 4 set of submodule we are getting the 5 level output, but the output is little distorted due to present of 22.16% of THD which is much high and not good for our system.

So to reduce the harmonics present in output we perform the same procedure with another modulation technique ie nearest level modulation , here we found 5 level output for 4 set of submodules and we obser the flat levels with low harmonics. In NLM method the THD is reduce to 14.82%.

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