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RESEARCH ON MODULATION STRATEGY OF CASCADED STATCOM BASED ON CPD-SPWM

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ABSTRACT

For multi-level structure , PWM technology is one very critical aspect, it relates to the quality and efficiency of the system output voltage cascaded STATCOM. Based on the principle of multiple modulation strategies analyzed and compared, including vertical carrier phase shift modulation, the carrier level phase shift modulation technique, the unipolar vertical multiplier carrier phase shifting CPD-SPWM technique as Cascaded STATCOM modulation techniques. Vertical carrier modulation technique can make STATCOM relatively low switching frequency to achieve a relatively high equivalent switching frequency, thereby to reduce the harmonic content of the output current.

KEYWORDS: Cascaded STATCOM,Vertical Carrier Phase Shift Modulation,Level Carrier Phase Shift Modulation,CPD-SPWM

INTRODUCTION

There are many ways about Multi-level modulation of the inverter. FIG. 1 is a classification diagram.Broadly speaking,There are multiple-carrier PWM technique [1] and space loss PWM technology [2]; Space vector PWM modulation method is easy to implement in hardware, but when the output level is more than five, the control method will be too complicated. Therefore, in practice, we mainly use multi-carrier PWM modulation method according to the distribution of the carrier, multi-carrier PWM method can be divided into a carrier-based PWM phase shift method [3] and carrier-based lamination PWM method [4].

The work in this paper: analysis and comparison of several stacked PWM method and the horizontal phase shift PWM method of harmonic components of its spectrum using MATLAB software.

PD MODULATION

The principle of Carrier lamination phase shift method [6] is: For an N-level inverter, the vertical phase shift method requires N-1 carriers, and they have the same amplitude and frequency. Using these carriers as zero reference horizontal center axis, these carriers are used jointly modulated wave, so that they mutually corresponding switching signal obtained after comparison. Carrier-based laminated PWM modulation can be divided into PD modulation (Phase Disposition), APOD modulation [7] (Alternative Phase Opposition Disposition), POD modulation [8] (Phase Opposition Disposition) three.

Features of PD modulation is all carrier phases are identical. Its carrier distribution shown in Figure 1 (a) is its carrier distribution, (b) being a five-level output phase voltage waveform, (c) being their five-level phase voltage spectrum.

From the spectrum we can know, when adapting PD modulation strategy, the most serious harmonics is in the first carrier frequency.Spectrum contains not only the carrier harmonic but also the band harmonics [9].

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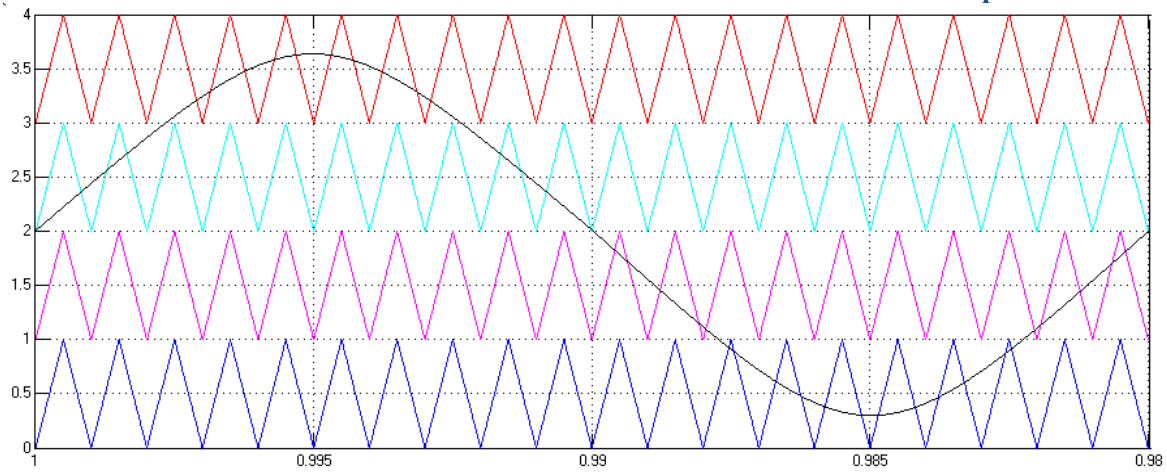
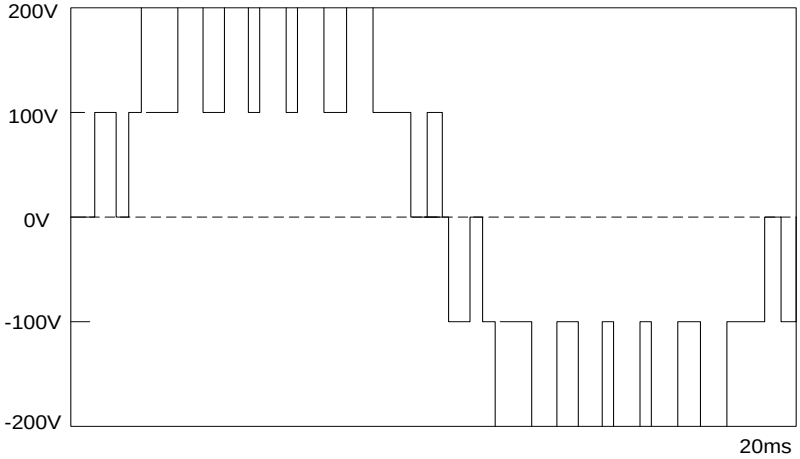
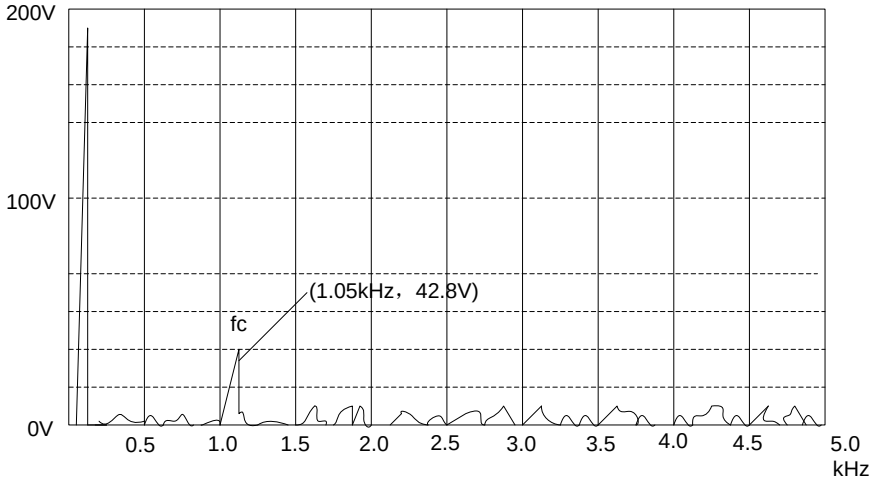


(a) PD Modulation Strategy



(b) Five-level phase voltage



(c) Five-level phase voltage spectrum

Fig. 1 The simulation of PD modulation strategy

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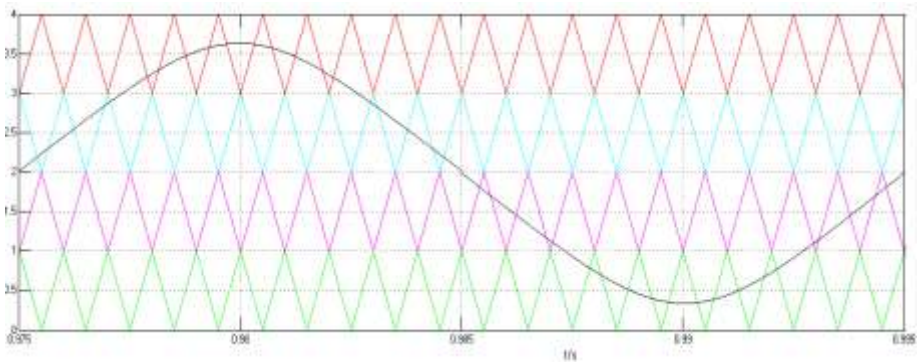
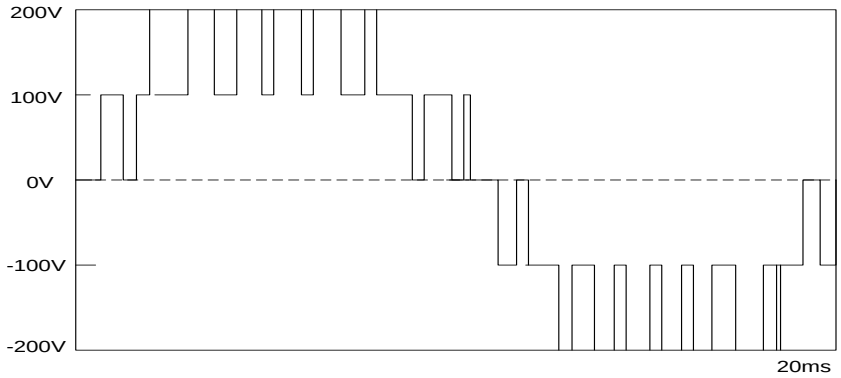
APOD MODULATION[10]

APOD modulation characteristics across carriers are successively by 180 °. The phase of each carrier are sequentially by 180 °.Fig 2 (a) is its carrier distribution , (b) being a five-level output phase voltage waveform of it, (c) being their five-level phase voltage spectrum .

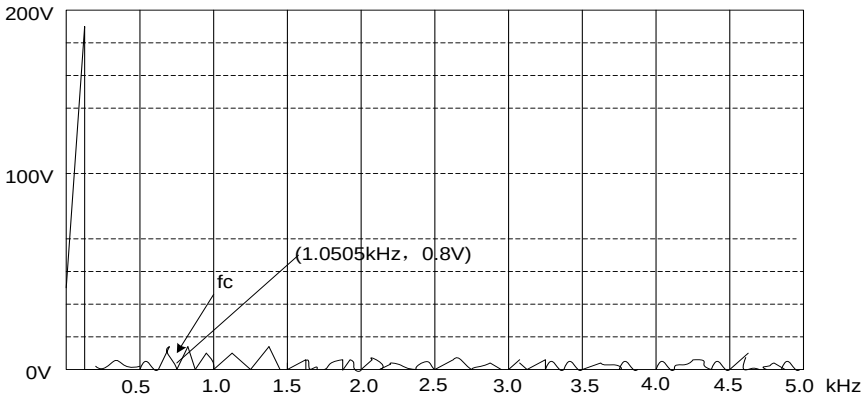
From the output phase voltage spectrum we know, after using APOD modulation strategy, The most serious harmonic appears near to the band harmonics which the first carrier frequency f_c being its center. Spectrum contains multiple carrier band harmonics, not multiple carrier harmonic .



(a)APOD modulation waveform



(b) APOD five-level output phase voltage waveform



(c) Five-level phase voltage spectrum

Fig. 2 The simulation of APOD modulation strategy

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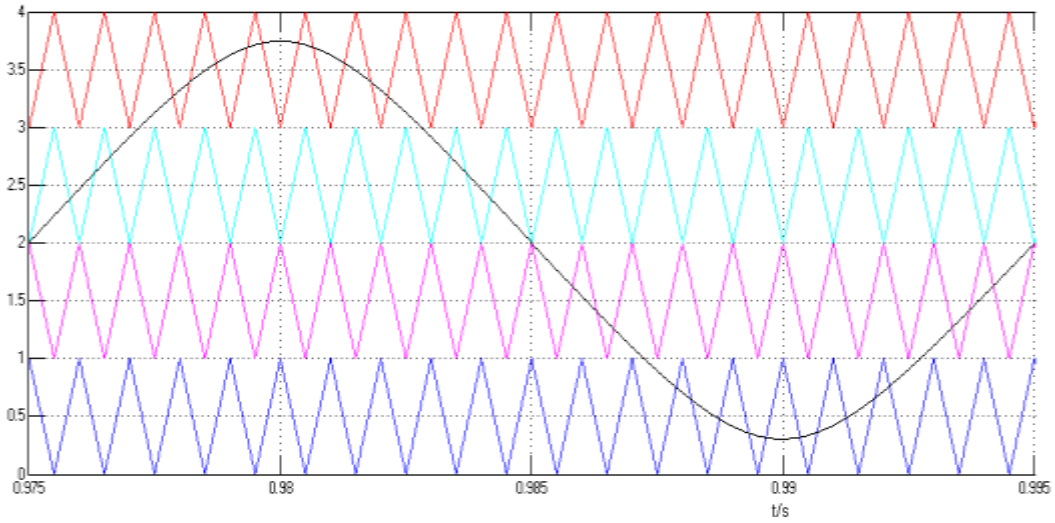
POD MODULATION

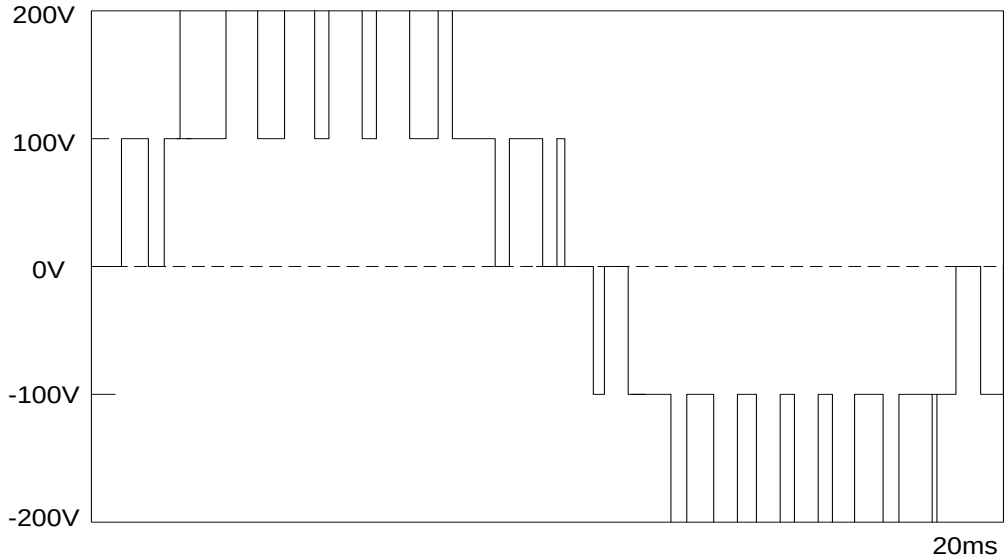
Characteristic of POD modulation is when the carriers are both located above or down the reference axis 0 they are in the same phase ,otherwise their phase differ from 180 °. Figure 3 (a) is its carrier distribution, (b) being a five-level output phase voltage waveform, (c) being their five-level phase voltage spectrum .

From the POD Output phase voltage spectrum we can know,when adapting APOD modulation strategy the most serious harmonic appears near to the band harmonics which the first carrier frequency being its center. Spectrum contains multiple carrier band harmonics, not multiple carrier harmonic .

Several of these methods by Fourier analysis shows that: in improving the waveform, PD modulation is the best, APOD modulation following the PD and the POD modulation is the worst From the above analysis, From the above analysis, CPD-SPWM(carrier Phase Disposition Sinusoidal pulse width modulation) method works well. Figure 4 is its modulation waveform and FIG. 5 is the output voltage waveform.



(a) POD modulation waveform



(b) POD Output voltage waveform

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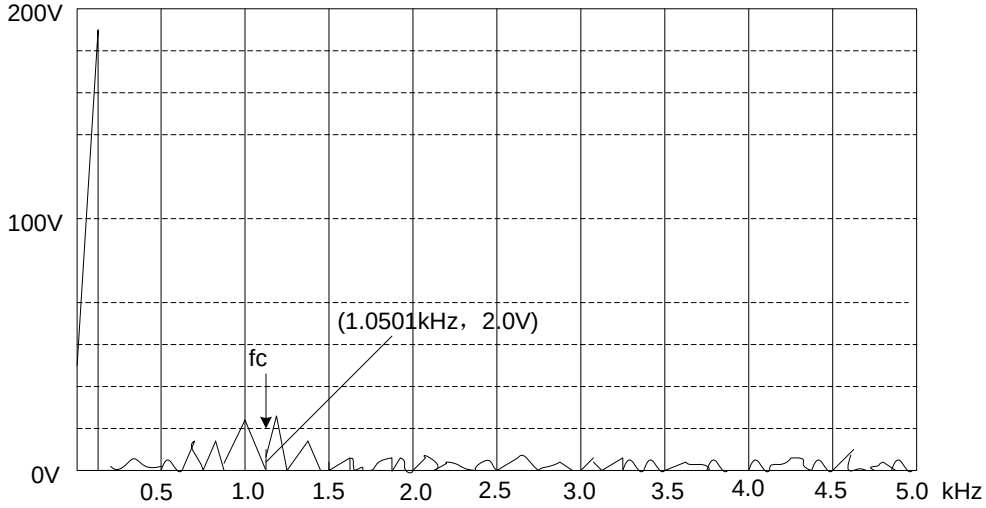

(c) Five-level phase voltage spectrum

Fig. 3 The simulation of POD modulation strategy

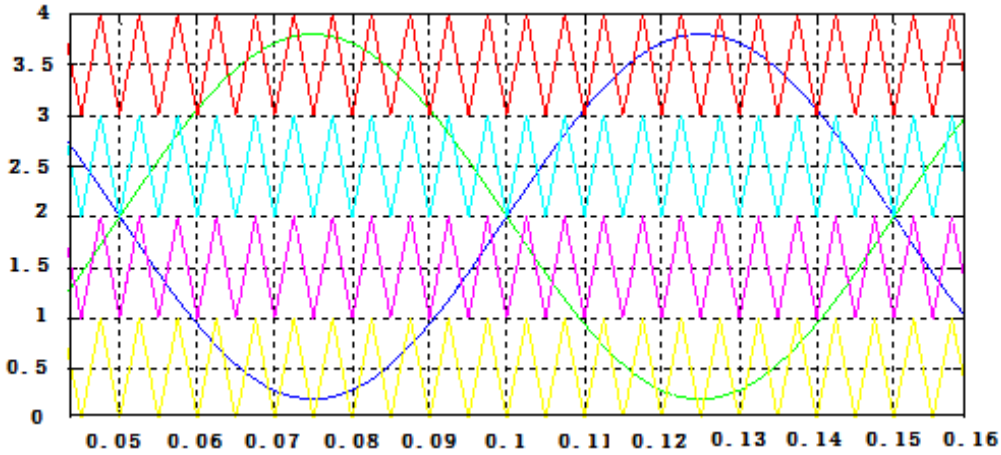

Fig.4 modulation waveform of CPD-SPWM

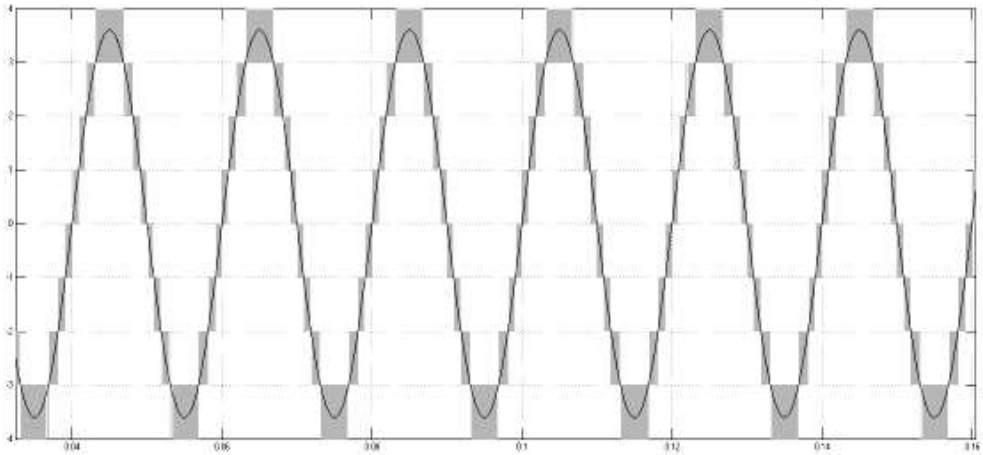

Fig. 5 Output voltage waveform of CPD-SPWM

CONCLUSION

Through a variety of modulation strategy simulation analysis, the following conclusions are: CPD-SPWM modulation strategy switching frequency can be increased to 2N times, and can effectively reduce the harmonic content of the Cascade STATCOM output voltage. Therefore, the use of H-bridge unit phase modulation with a carrier moved vertically can improve the cascade STATCOM power level, but also reduces power device switching frequency requirements, we can more easily introduce advanced control strategies to optimize the performance of the entire system index.

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