A New Multi Carrier Based PWM for Multilevel Converter

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Abstract - Multi-level converters (MLC) are emerging as a new breed of power converter options for power system applications. This project addresses a new multi-carrier modulation technique called wave shift multi-carrier modulation (WSHM), which is used to control the Cascade Multilevel Converter (CMC). The proposed switching technique generates lower voltage Total Harmonic Distortion (THD) in comparison with multi carrier based pulse width modulation (PWM) techniques such as Phase –Shift Modulation (PSHM) and Level-Shift Modulation (LSHM). Simulink software is tightly integrated with the MATLAB environment. The main objective of this project is to increase number of levels with a low number of switches and sources at the output without adding any complexity to the power circuit. The main merit of the new topology is to reduce the lower total harmonic distortion and lower electromagnetic interference generation and high output voltage. In this various carrier pulse width modulation techniques are proposed, which can minimize the total harmonic distortion and enhances the output voltages.

Keywords - Converter, Harmonic Distortion, electromagnetic, Simulink, voltage.

I. INTRODUCTION

Multi-level converters (MLC) are emerging as a new breed of power converter options for power system applications. Recently the "multilevel converter" has drawn tremendous interest in the power industry. The general structure of the multilevel converter is to synthesize a sinusoidal voltage from several levels of voltages, typically obtained from capacitor voltage sources. In general multilevel converters are classified into three types, there are three types of capacitor voltage synthesis based multilevel converters.

- Diode-Clamped Multilevel Converter (DCMC).
- Flying-Capacitor Multilevel Converter (FCMC).
- Cascaded Multilevel Converters (CMC).

As Compared DCMC and FCMC converters, a CMC is easy to design and assemble because of the uniform circuit structure of the converter units and modularized circuit layout. Easy packaging is also possible in CMC topology as each level has the same structure, and there are no extra clamping diodes or voltage-balancing capacitors, which are required in the DCMC and the FCMC. The number of output voltage levels can be easily adjusted by changing the number of full-bridge converters. The CMC synthesizes a desired voltage from several independent sources of DC voltages, which may be obtained from batteries, fuel cells or solar cells. FFS modulation can be easily implemented for the CMC due to its unique structure. All switching angles can be calculated off-line and then stored in a look-up table for digital implementation. Compared with the carrier-based PWM schemes, FFS features low switching losses since all the IGBT* switches operate at fundamental frequency. Various PWM techniques applied to the multilevel converters. The PWM techniques can be classified into two categories: the triangle intersection technique and the direct digital technique (space vector modulation). With the development of digital technology, the space vector modulation is widely used, due to not only relatively easy hardware implementation, but also its features of good dc link voltage utilization and low current ripple. But this method has a very significant drawback that if the voltage level is more than five, the control algorithm becomes too complex to implement. Thus it is reasonable to adapt in this paper the triangle intersection techniques in the high level application.

II. OVER VIEW OF VARIOUS MULTILEVEL CONVERTERS

A. Diode-Clamped Multilevel Converter (DCMC)

In diode clamped multilevel converter is to analyze its basic principle and circuit diagram operation, and its merits and demerits are to be discussed below.

B. Basic Principle

An m-level diode-clamped converter typically consists of m-1 capacitors on the dc bus and produces m levels of the phase voltage. Fig.2.1shows a single-phase full bridge five level diode-clamp converter in which the dc bus consists of four capacitors, C1, C2, C3, and C4,. For a dc bus voltage Vdc, the voltage across each capacitor is Vdc/4, and each device voltage stress will be limited to one capacitor voltage level. Vdc/4, through clamping diodes.

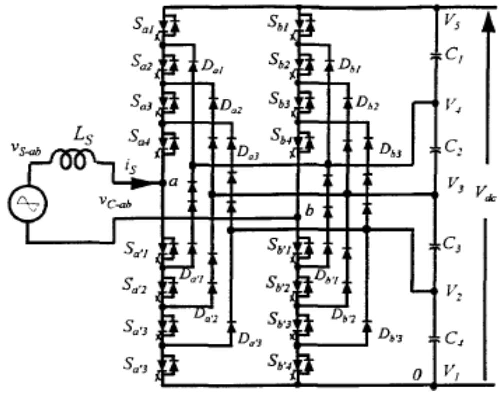

Fig. 2.1. A Diode-Clamped 5 Level Converter

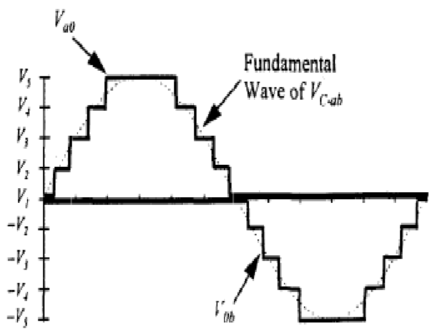

Fig. 2.2. Phase and Line Voltage Waveform of A 5-Level Diode Clamped Voltage Source Converter

To explain how the staircase voltage is synthesized, the negative dc rail, 0, is considered as the output phase voltage reference point.

Table 2.1 lists the voltage levels and their crresponding switch states. State condition 1 means the switch is on, and 0 means the switch is off. Notice that each switch is only switched once per cycle. There exist four complimentary switch pairs in each phase. The complimentary switch pair is defined such that turning on one of the pair switches will exclude the other from being turned on. Using phase-leg a as the example. The four complementary pairs are (Sa1, Sa’1), (sa2,sa’2), (sa3,sa’3), and (sa4,sa’4).

TABLE 1. A DIODE-CLAMPED 5 LEVEL CONVERTER VOLTAGE LEVELS AND THEIR CORRESPONDING SWITCHING STATES

Output Va0	Switch states							
	Sa1	Sa2	Sa3	Sa4	Sa’1	Sa’2	Sa’3	Sa’4
V5=Vdc	1	1	1	1	0	0	0	0
V4=3Vdc/4	0	1	1	1	1	0	0	0
V3=Vdc/2	0	0	1	1	1	1	0	0
V2=Vdc/4	0	0	0	1	1	1	1	0
V1=0	0	0	0	0	1	1	1	1

Fig. 2.2 shows phase and line voltage waveform of 5-level converter. The line voltage consists of a positive phase-leg a voltage and a negative phase-leg b voltage. Each phase voltage tracks one-half of the sinusoidal waves. The: resulting line voltage is a 9- levelstaircase wave. This implies that an m-level converter has an m-level output phase voltage and a (2m-l) level output line voltage.

III. ADVANTAGESAND DISADVANTAGES

In summary advantages and disadvantages of a diode clamped multilevel voltage source converter are as follows.

A. Advantages

When the number of levels is high enough, harmonic content will be low enough to avoid the need for filters.
Efficiency is high because all devices are switched at the fundamental frequency.
Reactive power flow can be controlled.
The control method is simple for a back-to-back intertie system.

B. Disadvantages

Excessive clamping diodes are required when the number of levels is high.
It is difficult to do real power flow control for the individual converter.

IV. FLYING–CAPACITOR MULTI-LEVEL CONVERTER (FCMC)

In flying capacitors multilevel converter is to analyze its basic principle and circuit diagram operation, and its merits and demerits are to be discussed below.

Basic Principle:

Flying - Capacitors Multilevel Converter illustrates the fundamental building block of a single-phase full-bridge flying-capacitor based 5-level converter. Each phase-leg has an identical structure. Assuming that each capacitor has the same voltage rating, the series connection of capacitors in Fig. 2.3is to indicate the voltage level between the clamping points. Three inner-loop balancing capacitors for phase leg a, Ca1, Ca2, and Ca3 are independent from those for phase leg b. All phase legs share the same dc link capacitors, C1- C4.

V. CONCLUSION

This project presents simulation of seven , nine level CMC and also three phase nine level CMC connected to three phase RLC load . Three types of multicarrier based PMW techniques were considered to control the output voltage of CMC. Among those three modulation techniques, it has been found and proved that the Wave shift is better than others in terms of THD reduction. The simulation results have demonstrated excellent control capabilities of the seven and nine level CMC and also three phase nine level connected to three phase RLC loadusing the proposed multi-carrier based PWM technique. Finally the cascade multilevel converters (CMC) are emerging a key role in industrial and power system applications and very popular converter topologies used in high power Medium Voltage (MV) drives. In the entire circuit configuration number of H-bridges is connected on their ac side to achieve medium voltage operation and low harmonic distortion.Ultimately, a zero harmonic distortion of the output wave can be obtained by an infinite number of levels.

VI. FUTURE SCOPE

These cascaded multilevel converters lead an enormous performance in the various fields such as power systems and industrial power sectors and to serve as a distortion less power quality and maintain the sinusoidal voltages and sinusoidal currents. Not only in power and industrial sectors, but also these multilevel converters are capable of serving low, medium and high power drives to be running. As it is a very reliable circuit structure and low cost of equipment compared to other multilevel converters.

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