International Journal of Advance Research in Science and Engineering
Volume No. 11, Issue No. 07, July 2022
www.ijarse.com

IJARSE
ISSN 2319 - 8354

Power quality improvement using a five-level Cascade H-Bridge multilevel inverter based on D-STATCOM

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Abstract

To lessen harmonics in the distribution system, a bespoke power device called a Distribution Static Compensator (D-STATCOM) is utilised.The multi-level cascade active power filter of the shunt type is created by the VSC.A cascaded multilevel inverter called an H-Bridge inverter is made up of a number of single phase full bridge inverter components.This multilayer inverter's primary purpose is to create a desired voltage from a number of different DC sources, such as batteries, fuel cells, or solar cells.A full bridge inverter is linked to each individual DC source.Contrary to the other two topologies, the cascaded multilevel inverter does not require either voltage clamping diodes or voltage balancing capacitors.

***Key words**: Cascade H-Bridge, power quali*

I .INTRODUCTION

In electronic-based systems, the power quality problems are more severe[1].Popular criteria that describe the level of distortion and reactive power demand at a certain utility bus include the level of harmonics and reactive power demand [2].One of the most prevalent issues in low- and medium-level distribution networks is harmonic resonance.Custom power devices (CPDs) based on power converters are helpful for reducing power quality issues.The control technique utilised for the reference current estimate and gating pulse generation scheme greatly affects the performance of any custom power device.The linear load and nonlinear loads are fed by a three phase ac source.A three phase ac mains feeding is linked to a D-STATCOM powered by a voltage source converter (VSC).

II. CASCADE H-BRIDGE MULTILEVEL INVERTER

A three-phase structure of a five-level cascaded inverter is illustrated in Figure 2. The multilevel inverter using cascaded-inverter with separate dc sources (SDCSs) synthesize a favorable voltage from several independent sources of dc voltages, which may be achieved from batteries, solar cellsand fuel cells [6]. This structure recently has become very widespread in ac power supply and adjustable speed drive applications the output of each cell will have three levels +Vdc , 0 and −Vdc that obtained by connecting the dc source to the ac output by different

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ISSN 2319 - 8354

combinations of the four switches S1 , S2 , S3 and S4 . To obtain +Vdc , switches S1 and S4 are turned on, whereas −Vdc can be obtained by turning on switches S2 and S4 . By turning on S1 and S2 or S3 and S4 , the output voltage is 0. The output voltage is the sum of the voltage that is generated by each cell. The numbers of output voltage levels are 2(1) m + where m is the number of cells.

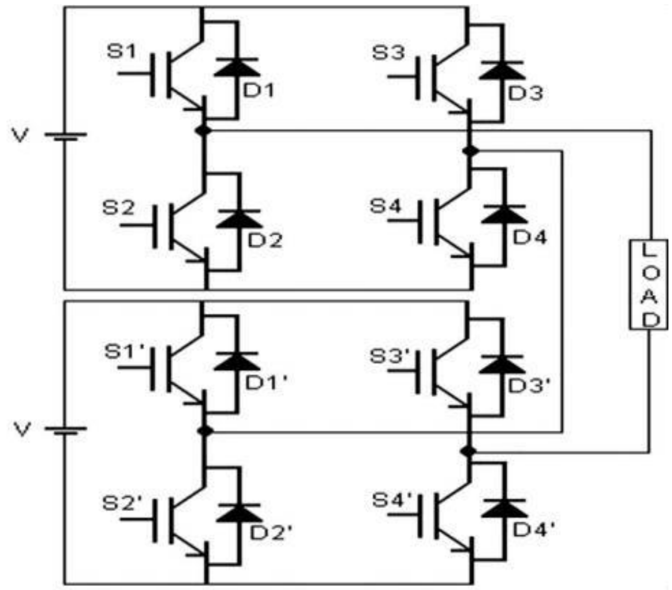

Fig.1. Five level cascade H-bridge inverter structure

Fig.1. shows cascaded multilevel inverter consists of a series of three phase full bridge inverter units[8]. The general function of this multilevel inverter is to synthesize a desired voltage from several separate DC sources, which may beobtained from batteries, fuel cells or solar cells. Each separate DC source is connected to a full bridge inverter [9][10]. The cascaded multilevel inverter does not require any voltage clamping diodes or voltage balancing capacitors like other two topologies.

III. MODULATION STRATEGY

The modulation schemes for the multilevel CHB inverters can be generally assortment into carrier based modulation, space vector modulation and staircase modulation with selective harmonic elimination [9]. The carrier-based modulation schemes for multilevel inverters are classified to phase-shifted and level shifted modulations. In this paper, the inverter switches are controlled by pulse width modulation strategy employing phase shifted carriers (PSPWM). Multilevel inverter with m voltage levels needs m−1 triangular carriers. In the phase-shifted multicarrier modulation, all the triangular carriers have the equal frequency and the peak-peak amplitude with the phase shift between any two adjacent carrier waves given by: 360 1 cr m ϕ = − D (2) The frequency modulation index mf is given by: m f /m f = cr m (3) where cr f and mf respectively mention to carrier signal frequency and fundamental signal frequency. The frequency of prevalent harmonic in the inverter output voltage is given by [10] , (1) swinvsw

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ISSN 2319 - 8354

dev f mf = − × (4) where sw, dev f represents the device switching frequency. The modulated signal V-control is compared with a phase shifted triangular signals in order to generate the switching signals. Figure 3 shows waveforms of carrier, modulating andcommand signals using phase shifted PWM method. The main parameters of the phase shifted PWM scheme are the amplitude modulation index of signal, and the frequency modulation index of the triangular signal [11].

IV SIMULATION RESULT

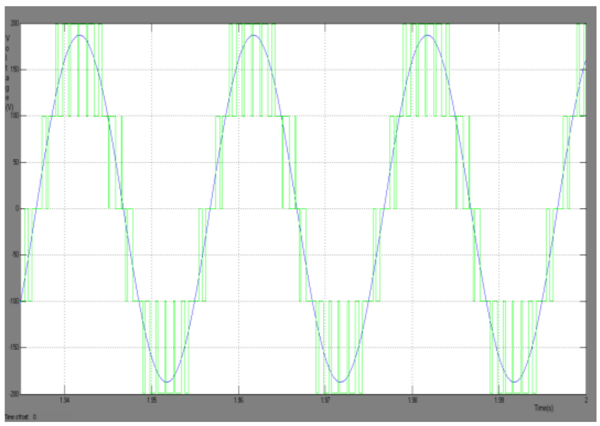

Fig.2. Voltage and current waveform for MLI.

The simulink model for compensated system with 415V, 50 Hz three phase source is connected to a three phase load. The BP control algorithm is used here for injecting the current for compensating the voltage by which the reactive power compensation is done. The load voltage is 520V and load current is 25A.

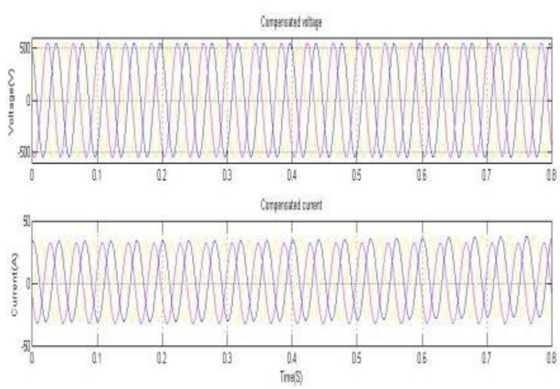

Fig.3. Voltage and current waveform for compensated system.

The Fig.3.shows the results of three phase source voltage and current waveform for compensated system. The source voltage is 415V and 50Hz and the waveforms here is shown. The Fig.4(a). shows the total harmonic voltage distortion display at the output side for compensated system.The load voltage is taken as the input. It displays the one cycle of load current in which the distortions obtained is as 0.56% at the fundamental frequency.Fig.4(b) shows

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ISSN 2319 - 8354

the total harmonic current distortion display at the output side for compensated system. It displays the one cycle of load current in which the distortions obtained is as 0.28% at the fundamental frequency. The power factor for compensated system using the BP control algorithm at the source side is 0.956. Fig.6 shows the wave form of real and reactive power.

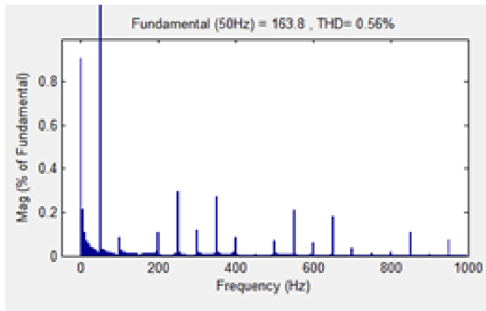

Fig 4(a) Harmonic analysis voltage order for compensated system

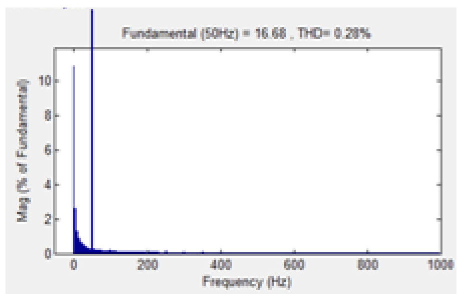

Fig 4(b) Harmonic analysis current order for compensated system

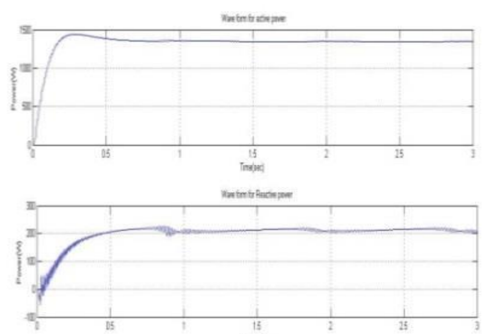

Fig.5. Wave form for real and reactive power

IV.CONCLUSION

The most popular option for enhancing power quality has been recognised as a VSC-based D-STATCOM.For switching purposes, the D-STATCOM with multilayer architecture is employed.When the load conditions change, it may still extract the reference source currents.Additionally, the DSTATCOM's dc bus voltage has been maintained at the rated level during the load variation without any overshoots or undershoots.Compared to the compensated system, the uncompensated system has higher THD values.Consequently, the supply current's THD is below the limits set forth by the IEEE-519 standard.The efficiency of this method has been confirmed by simulation and test results.

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