BACK TO BACK CASCADED HORMONIC BRIDGE CONVERTER

S.ANANTHASAI
Asst.prof
Joginpally B.R Eng College,Hyderabad

G.SEKHAR BABU
Asst.prof
Joginpally B.R Eng College,hyderabad

M.KONDALU
Prof & HOD
Joginpally B.R Eng College,hyderabad

Abstract:

This paper presents an investigation high voltage direct current (HVDC) transmissions are used for bulk transmission of power over long distances. Major feature of HVDC over AC is its fast controllability of power which can be used effectively for improving the system security. The principal characteristics of VSC HVDC transmission is its ability to independently control the active and reactive power flow at each of ac systems to which it is connected , at point of common coupling ,can operate without communication between stations and no change of voltage polarity when power direction is changed. Main aim our project is to improve power quality such as reducing harmonics, eliminating voltage flickers, frequency deviations and phase angle jumps. Many kinds of power electronic equipments are widely applied in order to reduce power quality problems. Here we implementing a solution to power quality problems by using voltage source converter (VSC) based HVDC system. Case studies will be done using MATLAB.

Keywords: Cascaded Harmonic Bridge Converter, MATLAB software, Voltage source converter,

I INTRODUCTION

High-voltage direct current (HVDC) is used to transmit large amounts of power over long distances or for interconnections between asynchronous grids[1]. When electrical energy is required to be transmitted over very long distances, it is more economical to transmit using direct current instead of alternating current. For a long transmission line, the lower losses and reduced construction cost of a DC line can offset the additional cost of converter stations at each end[2]. Also, at high AC voltages, significant amounts of energy are lost due to corona discharge, the capacitance between phases or, in the case of buried cables, between phases and the soil or water in which the cable is buried. HVDC is also used for long submarine cables because over about 30 km length AC can no longer be applied[3].

A HVDC transmission line costs less than an AC line for the same transmission capacity. However, the terminal stations are more expensive in the HVDC case due to the fact that they must perform the conversion from AC to DC and vice versa. But above a certain distance, the so called "break-even distance", the HVDC alternative will always give the lowest cost[4]. The first commercially used HVDC link in the world was built in 1954 between the mainland of Sweden and island of Gotland. Since the technique of power transmission by HVDC has been continuously developed. In India, the first HVDC line in Rihand-Delhi in 1991 i.e.500 KV, 1000 KM. In Maharashtra in between Chandrapur & Padaghe at 1500 KV & 1000MV [5][6]. Global HVDC transmission capacity has increase from 20 MW in 1954 to 17.9 GW in 1984. Now the growth of DC transmission capacity has reached an average of 2500MW/year. In India there is one new HVDC link between kolar and talcher. In 2012, the longest HVDC link will be the Rio Madeira link connecting the Amazonas to the São Paulo area where the length of the DC line is over 2,500 km (1,600 mi).The first 25 years of HVDC transmission were sustained by converters having mercury arc valves till the mid-1970s. The next 25 years till the year 2000 were sustained by line-commutated converters using thyristor valves [7]. Now due to recent development in power electronic devices forced commutated converters are used in HVDC[8].

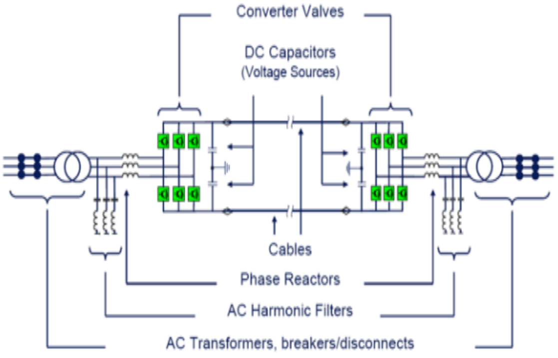

Fig.1.1.Block diagram of HVDC

All Rights Reserved © 2014 IJSETR

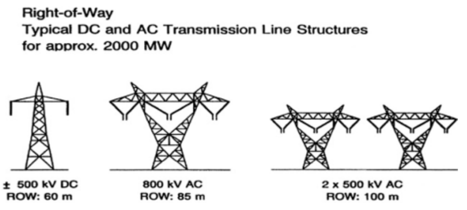

Fig .1.2. Variation of costs of transmission with distance for ac and dc transmission.

AC tends to be more economical than dc for distances less than the "breakeven distance" but is more expensive for longer distances[9]. The breakeven distances can vary between 400 to 700 km in overhead lines depending on the per unit line costs. With a cable system, this breakeven distance lies between 25 to 50 km.

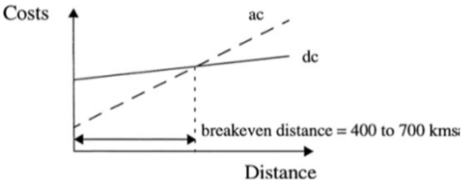

Fig.1.3. Cost of ac and dc vs distance

Evaluations of Technical Considerations:

Due to its fast controllability, a dc transmission has full control over transmitted power, an ability to enhance transient and dynamic stability in associated ac networks and can limit fault currents in the dc lines. Furthermore, dc transmission overcomes some of the following problems associated with ac transmission:

II SYNCHRONIZATION TECHNIQUES FOR POWER CONVERTERS

The firing pulse generation unit of a static converter has a significant impact on the transient performance of the converter. For HVDC applications, a Voltage Controlled Oscillator (VCO) in conjunction with a Phase Locked Loop is used to generate equi-distant firing pulses so that a satisfactory transient performance can be achieved even with relatively weak ac systems. One common type of GFU, referred as the Conventional type, is based on a VCO in conjunction with a PLL. In the circuit, the synchronizing voltage Vsync is compared with the commutation voltage Vcom from the ac system bus. The error between these two signals is then fed to a VCO to alter the frequency and phase angle of the synchronizing voltage such that this error is reduced to zero[10][11].

Another type of GFU, referred to as the Transvektor type or DQO type has a DQO transformation stage in the circuit. This DQO-type has been used in motor drives applications. The primary objective of a GFU is to provide firing pulses to the converter valves in the correct phasor relationship to the relevant fundamental component of the commutation voltage. There are two types of GFUs that have been widely used; one based on Individual Phase Control (IPC) and the other on Equi-Distant Pulse Control (EPC)[13].

2.1 Individual Phase Control (IPC) Unit

In this type of GFU (now obsolete), the firing pulses are directly derived from the zero crossover points of the commutation voltage. Consequently, the firing pulses are vulnerable to harmonic pollution on the waveform. Developments in tracking band-pass filters which derive the fundamental frequency component of the commutation voltage with no phase shift may be useful in operation with weak ac systems [14].

2.2. Equi-Distant Pulse Control (EPC) Unit

EPC systems generate only characteristic harmonics during steady state operation. Two GFUs of this type are:

Pulse Frequency Control (PFC) Type: To decouple the direct dependence of the pulse firing from the zero crossover points of the commutation voltage, a VCO followed by a ring counter is used. The characteristic feature of this method is that a dc input control signal to the VCO results in a change in the frequency of the VCO. For this reason, this type of GFU is referred to as of the PFC type[15].

Pulse Phase Control (PPC) Type: In a GFU of this type, the dc control voltage resulted in a change to the phase of the VCO output rather than its frequency. The transfer function of this type of unit is therefore proportional rather than integral. To ensure the synchronism of the VCO output frequency with the ac supply frequency, a slower acting frequency error feedback loop is used[16].

2.3. CONVENTIONAL GFU

The block diagram of a conventional GFU is shown in Figure 3.1.

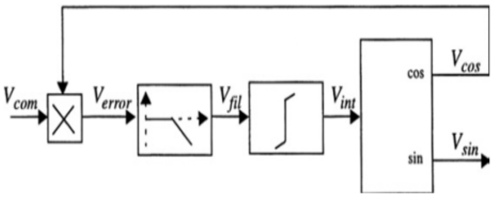

Fig. 2.1. Block diagram of conventional GFU

In this circuit the commutation voltage assumed to $= 1\sin(w1t + \theta1)$, is multiplied by a feedback signal , $Vcos = 1\cos(w2t + \theta2)$. The output voltage $Verror$ is obtained according to equation.

$$Verror = 1\sin(w1t + \theta1).1\cos(w2t+\theta2)$$

$$Verror = 0.5\sin([(w1-w2)t+(\theta1-\theta2)]+0.5\sin[(w1+w2)t+(\theta1+\theta2)])$$

The first term of eq. represents the error between the synchronizing voltage and the commutation voltage due to the frequency and phase difference. Under steady state, the synchronizing voltage will be locked to the commutation voltage. In this case, w1=w2 and θ1=θ2 and the first term of eq. is zero. The second term is an unwanted ac component which has a frequency of 2w1 under steady state. In order to extract the dc error signal and filter out the unwanted ac component, a low-pass filter having the transfer function wc/(s+wc) is used. Under steady state conditions, the feedback signal Vsync will be in phase and at the same frequency as the commutation voltage, Vcom. Thus Vsync can be used as a stable pollution-free signal to derive the zero-crossover points to provide the timing reference points for the GFU [17].

2.4. DQO GFU

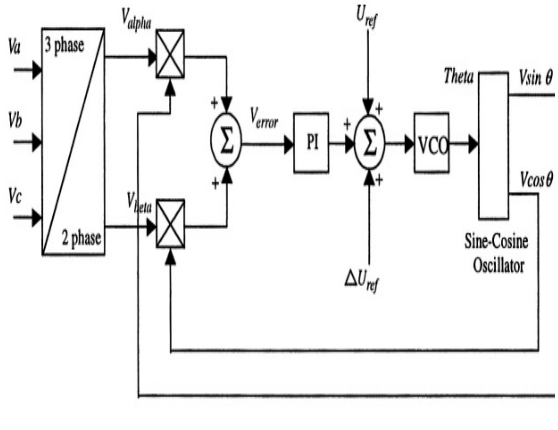

Fig.2.2. Block diagram of the DQO GRID FIRING UNIT

The following signals from the DQO GFU are shown in Figure shown below

- The three phase voltages Va , Vb and Vc,
- The voltage Verror,
- The voltage Theta and
- The commutation voltage Vcom and the synchronizing voltage Vsync.

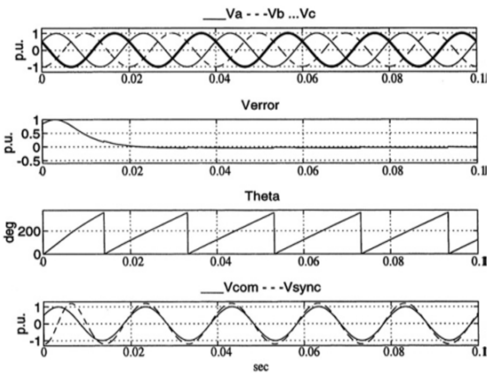

Fig.no.2.3. The DQO GRID FIRING UNIT

The three phase commutation voltages Va ,Vb and Vc are transformed into DQO axis voltages Valpha and Vbeta

$$Valpha = (2/3)Va-(1/3)Vb-(1/3)Vc$$
$$Vbeta = (1/\sqrt{3})(Vb-Vc)$$
$$Verror = ValphaVsin\theta+VbetaVcos\theta$$

An error signal, Verror derived using eq., is fed through a PI controller to generate a reference value for the VCO. This reference value can be modulated by a signal ΔUref , and it has a fixed voltage bias Uref which sets the center frequency of the VCO. The output of the VCO is a signal proportional to a sawtooth waveform (an angle *Theta*). This waveform is used to generate the Sine-Cosine waveforms which are fed back to the multipliers to generate the error signal. The major difference between the operational behaviors of the conventional and DQO GFUs is the presence of the ac harmonic component in the signal under normal operating conditions.

It is often used in order to simplify the analysis of three-phase synchronous machines or to simplify calculations for the control of three-phase inverters. In dq analysis, the time varying inductances that occur due to an electric circuit in relative motion and electric circuits with varying magnetic reluctances can be varied. The DQ transformation is a transformation of coordinates from the three-phase stationary coordinate system to the dq rotatingcoordinate system. This transformation is made in two steps:

1) a transformation from the three-phase stationary coordinate system to the two-phase, so-called αβ stationary coordinate system (clarke's transformation)and

2) a transformation from the alpha , beta stationary coordinate system to the dq rotating coordinate system.(park's transformation)

The transformations used here are called 'Clarke Transformation' and 'Park

ISSN: 2278 – 7798

All Rights Reserved © 2014 IJSETR

Transformation’. This is an important tool used in the controllers.

III RESULTS AND ANALYSIS

3.1. THREE PHASE RECTIFIER WITH CLOSED LOOP OPERATION

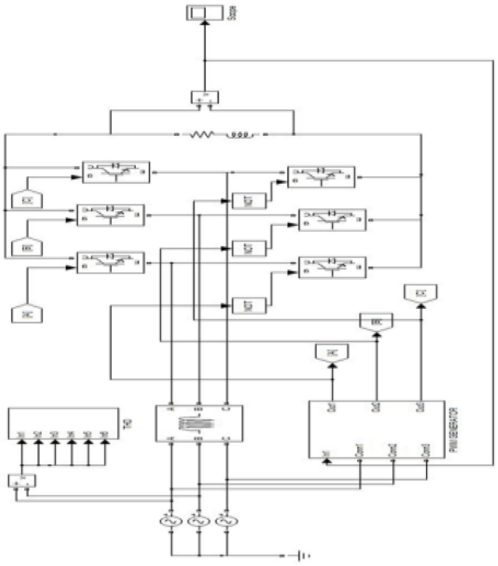

Fig.no.3.1 The three phase rectifier with closed loop operation

3.2. PWM GENERATION UNIT

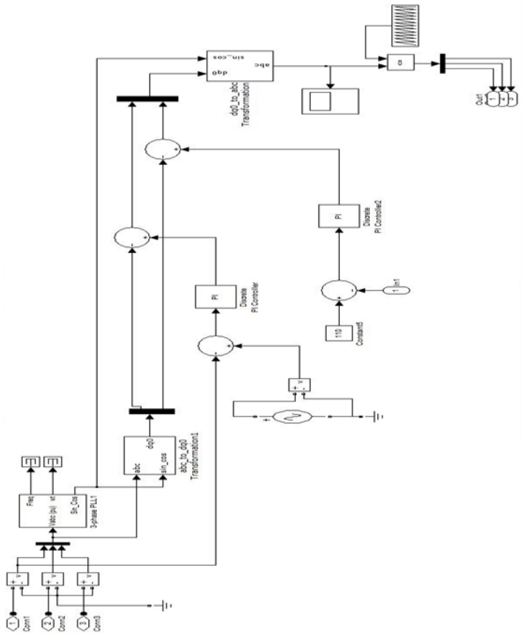

Fig.no.3.2 The PWM GENERATION UNIT

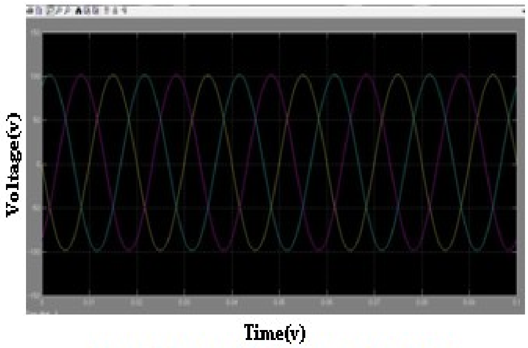

Fig.no.3.3 output waveform of dqo to abc

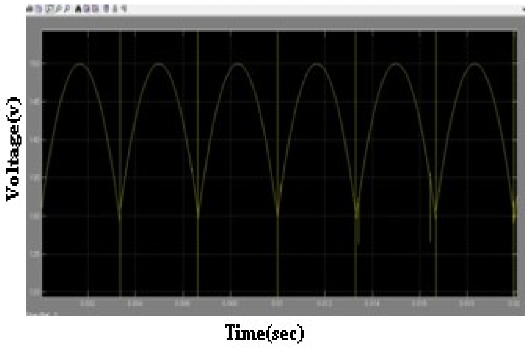

Fig.no.3.4 The PHASE RECTIFIER OUTPUT

3.5. THREE PHASE RECTIFIER WITH CLOSED LOOP OPERATION

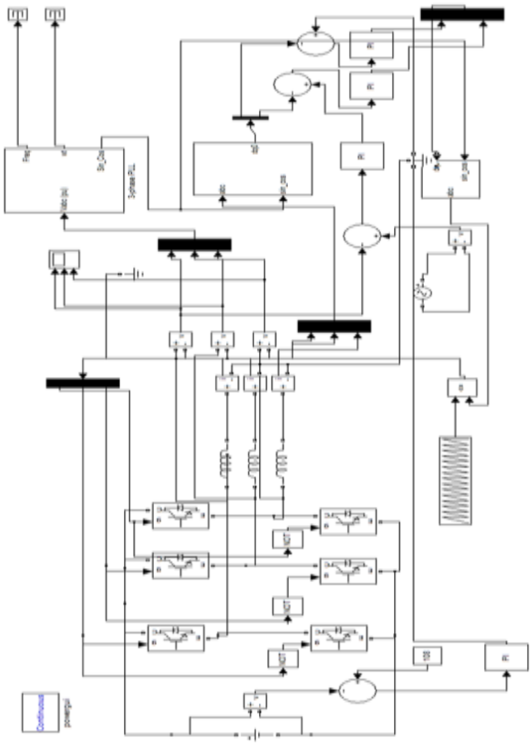

Fig.no.3.5 The three phase rectifier with closed loop operation

ISSN: 2278 – 7798

All Rights Reserved © 2014 IJSETR

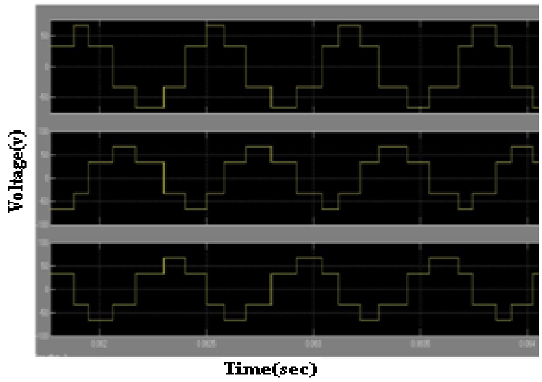

Fig. no. 3.6 inverter output

3.7. Combination of rectifier and inverter

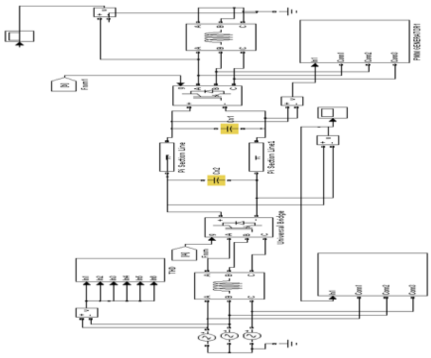

Fig.no.3.7 The Combination of rectifier and inverter

IV CONCLUSION

This has presented a VSC based HVDC system which can supply ac voltage of good quality to sensitive loads. HVDC system has the ability to provide a solution to power quality. In this paper we faced the problem in designing the filters to improve power quality. So, in this paper we are showing the result of rectifier and inverter. In this cascaded H-bridge multilevel inverter based APF is implemented in distribution system. This eliminates need of high cost transformer with MLI in high voltage systems. Cascade type inverter has certain advantages as compared with other types. Positive sequence voltage detector and instantaneous real-power theory is used to generate reference currents of APF. The Phase Shifted Carrier PWM method reduces individual device switching frequency despite high frequency output of the converter. Simulated results validate that the cascaded multi-level inverter based APF can compensate harmonics without use of transformer in high voltage system. It can be concluded that the proposed technique is best suited for load compensation under unbalanced load, distorted and unbalanced supply voltage conditions. Total Harmonic Distortion of the source current has been reduced from a high value to an allowable limit to meet IEEE 519 and IEC 61000-3 harmonic standard**.**

V REFERENCES

[1] Vijay K. Sood, HVDC and Facts Controllers - Applications of Static Converters in Power Systems.Kluwer Academic Publishers, 2004.ISBN 1-4020-7891-9.

[2] Muhammad H. Rashid "Power Electronics Handbook Devices, Circuits and applications".

[3] Bimal K. Bose, "Modern Power Electronics and AC Drives",

[4] C. Du, The control of VSC-HVDC and its use for large industrial power systems. PhD thesis, Department of Electric Power Engineering, Chalmers University of Technology, Goteborg, Sweden, 2003.

[5] M. P. Bahrman, \Overview of hvdc transmission," PSCE, pp. 18-23, 2006.

[6] M. P. Bahrman, \Hvdc transmission overview," IEEE, pp. 1-7, 2008.

[7] R. Song, C. Zheng, R. Li, and X. Zhou, \Vscs based hvdc and its control strategy," IEEE/PES Transmission and Distribution, pp. 1{6, 2005.

[8] R. Arnold, "Solution to Power Quality Problem", Power Engineering Journal, pp.65-73, April 2001.

[9] W.E.Reid, "Power Quality Issues – Standards and Guidelines", IEEE Transactions on Industry Applications, Vol.32, No.3, pp625-632, May/June 1996.

[10] Weixing Lu, "Control and Application of Multi-Terminal HVDC based on Voltage Source Converter". Ph.D. dissertation, Dept.Elec.Eng., Univ. McGill., Canada, 2003.

[11] A.Yazdani and R.Iravani, Voltage Source Converters in Power Systems. John Wiley & Sons, March 2010. ISBN: 978-0-470-52156-4.

[12] R. Song, C. Zheng, R. Li, and X. Zhou, VSC based hvdc and its control strategy, IEEE/PES Transmission and Distribution, pp. 1-6, 2005.

[13] Bhim Singh, Kamal Al-Haddad &Ambrish Chandra, "A New Control Approach to 3-phase Active Filter for Harmonics and Reactive Power Compensation"-IEEE Trans. on Power Systems, Vol. 46, NO. 5, pp.133 – 138, Oct- 1999.

[14] W. K. Chang, W. M. Grady, Austin, M. J. Samotyj "Meeting IEEE- 519 Harmonic Voltage and Voltage Distortion Constraints with an Active Power Line Conditioner"- IEEE Trans on Power Delivery, Vol.9, No.3, pp.1531-1537, 1994.

[15] Hirofumi Akagi, "Trends in Active Power Line Conditioners"- IEEE Trans on Power Electronics, Vol.9, No.3, May-1994.

[16] ZhilingQiu; Wenqiang Zhao; Guozhu Chen "Study on shunt active power filter with high quality grid current waveform", Applied Power Electronics Conference and Exposition, 2008. APEC 2008.Twenty-Third Annual IEEE.

[17] Hirofumi Akagi. Active harmonic filters. Proceedings of the IEEE, 2005, 93 (12): 2128~2141.

[18] Basu, M.; Das, S.P.; Dubey, G.K., "Parallel converter scheme for high-power active power filters", Electric PowerApplications,IEE

All Rights Reserved © 2014 IJSETR