International Journal of Engineering Research and Reviews ISSN 2348-697X (Online)
Vol. 3, Issue 1, pp: (55-59), Month: January - March 2015, Available at: www.researchpublish.com

Improvement in Power Quality of Distribution System Using STATCOM

[1]Pushpa Chakravarty, [2]Dr. A.K. Sharma

[1]M.E. Scholar, Depart. of Electrical Engineering, Jabalpur Engineering College, Jabalpur, India.
[2]HOD, Depart. of Electrical Engineering, Jabalpur Engineering College, Jabalpur, India.

Abstract: **This project proposes the power quality problems such as voltage sags and swell. Compensation techniques of custom power electronic device D-STATCOM was presented. Power quality issues are gaining significant attention due to the increase in the number of sensitive loads. Many of these loads use equipment that is sensitive to distortions or dips in supply voltages. Almost all power quality problems originate from disturbances in the distribution networks. The present loads are sensitive and need to be protected by suitable compensating devices; owing to this power quality and its study have gained much attention of the researchers especially in developing countries like India. D-STATCOM is one such power conditioner used for improving PQ.**

Keywords: **Power Quality, STATCOM, D-STATCOM.**

1. INTRODUCTION

In power distribution networks, reactive power is the main cause of increasing Distribution system losses and various power quality problems. Regulations apply in many places, which limit the distortion and unbalance that a customer can inject to a distribution system. These regulations may require the installation of compensators (filters) on customer premises. It is also expected that a utility will supply a low distortion balanced voltage to its customers, especially those with sensitive loads. Conventionally, Static Var Compensators (SVCs) have been used in conjunction with passive filters at the distribution level for reactive power compensation and mitigation of power quality problems. Though SVCs are very effective system controllers used to provide reactive power compensation at the transmission level, their limited bandwidth, higher passive element count that increases size and losses, and slower response make them inapt for the modern day distribution requirement. Another compensating system has been proposed by, employing a combination of SVC and active power filter, which can compensate three phase loads in a minimum of two cycles. Thus, a controller which continuously monitors the load voltages and currents to determine the right amount of compensation required by the system and the less response time should e a viable alternative. Distribution Static Compensator (DSTATCOM) has the capacity to overcome the above mentioned drawbacks by providing precise control and fast response during transient and steady state, with reduced foot print and weight. However, strict requirements of STATCOM losses and total system loss penalty preclude the use of high frequency PWM for VSC based STATCOM applications. This constraint of implementing VSC either without PWM or with low switching frequency PWM functionality causes DC bus voltage variations, resulting in over-currents and trips of the STATCOM during and after system disturbances and faults - when its VAR support functionality is most required [1]. This project proposes the power quality problems such as voltage sags and swell. Compensation techniques of custom power electronic device D-STATCOM was presented. The Design and applications of D-STATCOM for voltage sags, swells and comprehensive results were presented. The Voltage Source Convert (VSC) was implemented with the help of Sinusoidal Pulse Width Modulation (SPWM).

2. POWER QUALITY

Power quality determines the fitness of electrical power to consumer devices. Synchronization of the voltage frequency and phase allows electrical systems to function in their intended manner without significant loss of performance or life. The electric industry comprises electricity generation (AC power), electric power transmission and ultimately electricity distribution to an electricity meter located at the premises of the end user of the electric power [2]&[3].The electricity then moves through the wiring system of the end user until it reaches the load[4]&[5]. While "power quality" is a convenient term for many, it is the quality of the voltage—rather than power or electric current—that is actually described by the term. Power is simply the flow of energy and the current demanded by a load is largely uncontrollable. IN today's highly complex and interconnected power systems, there is a great need to improve electric power utilization while still maintaining reliability and security. While power flows in some of the transmission lines are well below their normal limits, other lines are overloaded, which has an overall effect on deteriorating voltage profiles and decreasing system stability and security. Because of all that, it becomes more important to control the power flow along the transmission lines to meet the needs of power transfer. On the other hand, the fast development of solid-state technology has introduced a series of power electronic devices that made FACTS a promising pattern of future power systems.

3. FACTS

Flexible AC Transmission Systems, called FACTS, got in the recent years a well known term for higher controllability in power systems by means of power electronic devices. Several FACTS-devices have been introduced for various applications worldwide. The main idea of FACTS can be explained by the basic equation for AC power transmission.

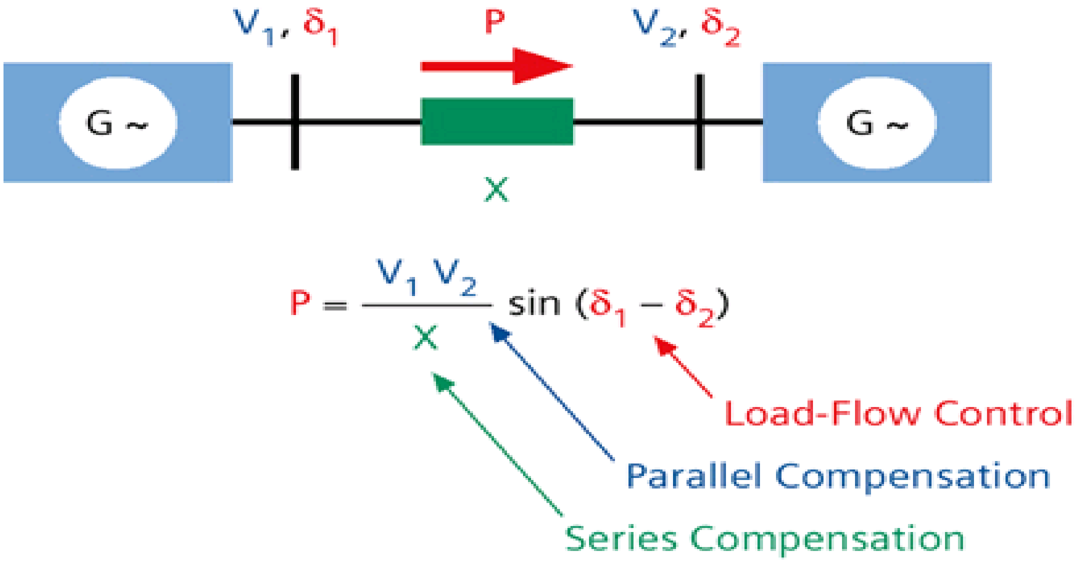

Fig.1. Power transmitted between two nodes

Power transmitted between two nodes of the system depends on the voltages at both ends of the interconnection, the impedance of the line and the phase angle difference between both systems. Different FACTS devices can actively influence one or more of these parameters for power flow control and for improvement of voltage stability at the node of interconnection. The history of FACTS controllers can be traced back to 1970s when Hingorani presented the idea of power electronic applications in power system compensation. From then on, various researches were conducted on the application of high power semiconductors in transmission systems. The shunt-connected Static VAR compensator (SVC) using solid state switches and the series-connected controllers were proposed in AC transmission system application. In 1988, Hingorani defined the FACTS concept and described the wide prospects of the application. Nowadays, FACTS technology has shown strong potential. FACTS controllers are defined in IEEE Terms and Definitions as:

- Flexible AC Transmission System (FACTS): Alternating current transmission systems incorporating power electronic-based and other static controllers to enhance controllability and increase power transfer capability.
- FACTS Controller: A power electronic-based system and other static equipment that provide control of one or more AC transmission system parameters.

3.1 Static VAR Compensator (SVC):

Static Var Compensator is "a shunt-connected static Var generator or absorber whose output is adjusted to exchange capacitive or inductive current so as to maintain or control specific parameters of the electrical power system (typically bus voltage)". SVC is based on thyristors without gate turn-off capability. The operating principal and characteristics of thyristors realize SVC variable reactive impedance.

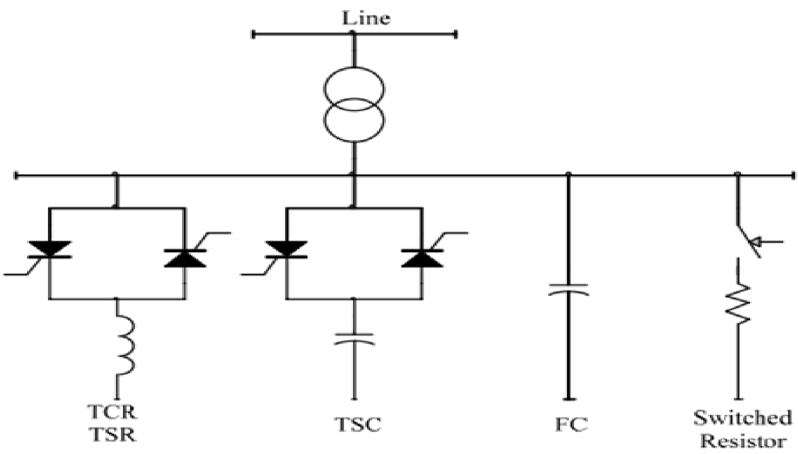

Fig.2. Static VAR compensator: TCR/TSC FC and mechanically switched resistor

3.2 Series-connected controllers:

Series-connected FACTS controllers can also be divided into either impedance type or converter type. The former includes Thyristor-Switched Series Capacitor (TSSC), Thyristor-Controlled Series Capacitor (TCSC), Thyristor Switched Series Reactor, and Thyristor-Controlled Series Reactor.

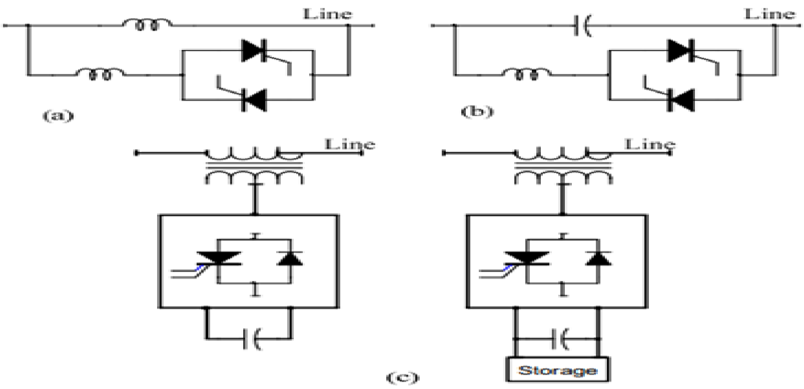

Fig.3. Series connected facts controller: (a) TCSR and TSSR; (b) TSSC; (c) SSSC

3.3 Converter-based Compensator:

Static Synchronous Compensator (STATCOM) is one of the key Converter-based Compensators which are usually based on the voltage source inverter (VSI) or current source inverter (CSI). . Unlike SVC, STATCOM controls the output current independently of the AC system voltage, while the DC side voltage is automatically maintained to serve as a voltage source. Mostly, STATCOM is designed based on the VSI. Compared with SVC, the topology of a STATCOM is more complicated.

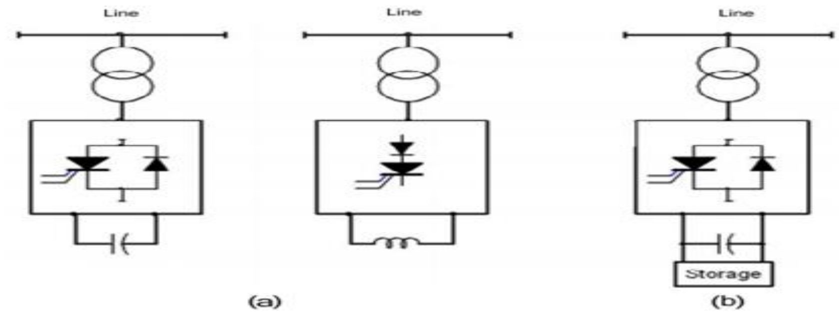

Fig.4. STATCOM topologies: (a) STATCOM based on VSI and CSI (b) STATCOM with storage.

4. DSTATCOM

A DSTATCOM is basically a converter based distribution flexible AC transmission controller, sharing many similar concepts with that of a Static Compensator (STATCOM) used at the transmission level. At the transmission level, STATCOM handles only fundamental reactive power and provides voltage support, while a DSTATCOM is employed at the distribution level or at the load end for dynamic compensation .The latter, DSTATCOM, can be one of the viable alternatives to SVC in a distribution network. Additionally, a DSTATCOM can also behave as a shunt active filter, to eliminate unbalance or distortions in the source current or the supply voltage, as per the IEEE-519 standard limits. Since a DSTATCOM is such a multifunctional device, the main objective of any control algorithm should be to make it flexible and easy to implement, in addition to exploiting its multi functionality to the maximum. Prior to the type of control algorithm incorporated, the choice of converter configuration is an important criterion. . Such a device is employed to provide continuous voltage regulation using an indirectly controlled converter.

[6].The two converter configurations are voltage source converter or current source converter, in addition to passive storage elements, either a capacitor or an inductor respectively. Normally, voltage source converters are preferred due to their smaller size, less heat dissipation and less cost of the capacitor, as compared to an inductor for the same rating. The control of the Voltage Source Converter (VSC) is done with the help of SPWM.

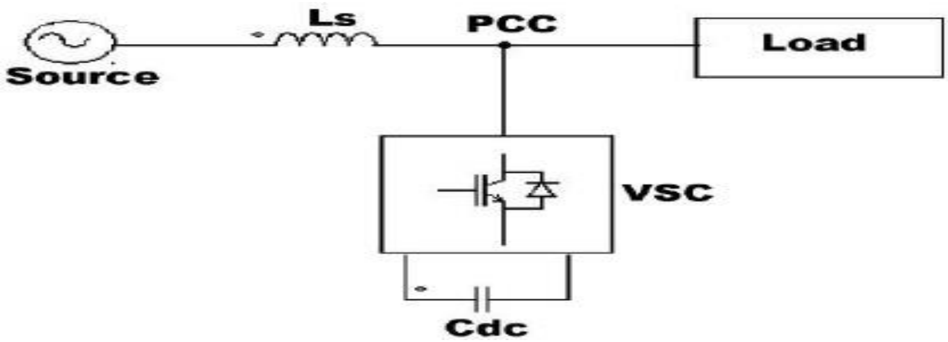

Fig.5. Block diagram of D-STATCOM.

PWM TECHNIQUE:

We use sinusoidal PWM technique to control the fundamental line to-line converter voltage. By comparing the three sinusoidal voltage waveforms with the triangular voltage waveform, the three phase converter voltages can be obtained.

The fundamental frequency of the converter voltage i.e. f1, modulation frequency, is determined by the frequency of the control voltages, whereas the converter switching frequency is determined by the frequency of the triangular voltage i.e. fs, carrier frequency. Thus, the modulating frequency f1 is equal to the supply frequency in STATCOM.

The Amplitude modulation ratio, ma is defined as:

$$m_a = \frac{V_{control}}{V_{tri}}$$

Where Vcontrol is the peak amplitude of the control voltage waveform and Vtri is the peak amplitude of the triangular voltage waveform. The magnitude of triangular voltage is maintained constant and the Vcontrol is allowed to vary.

5. CONCLUSION

This project presents the systematic procedure of the modeling and simulation of a Distribution STATCOM (DSTATCOM) for power quality problems, based on Sinusoidal Pulse Width Modulation (SPWM) technique. Power quality is an occurrence manifested as a nonstandard voltage, current or frequency that results in a failure of end use equipments.

To solve this problem, custom power devices are used. One of those devices is the Distribution STATCOM (D-STATCOM), which is the most efficient and effective modern custom power device used in power distribution networks. D-STATCOM injects a current in to the system to correct the voltage sag and swell. The control of the Voltage Source Converter (VSC) is done with the help of SPWM.

REFERENCES

[1] S. Bhattacharya, Z. Xi, "A Practical operation strategy for STATCOM under single line to ground faults in power system," *PSCE-06*, 2006.

[2] N. G. Hingorani and L. Gyugyi, Understanding FACTS. New York: IEEE Press, 1996.

[3] [R. M. Mathur and R. K.Varma, Thyristor-Based FACTS Controllers for Electrical Transmission Systems. Piscataway, NJ: IEEE Press, Feb.2002.

[4] Barker. P. P and de Mello R.W, "Determining the impact of distributed generation on power systems: Part1-Radial Distribution systems," in Proc. IEEE Power Engineering Soc. Summer Meeting, vol. 3, 2000, pp. 1645-1656.

[5] Beacon Power website, www.beaconpower.com/.

[6] W. Freitas, A. Morelato, "Comparative study between power system blackest and PSCAD/EMTDC for transient analysis of custom power devices based on voltage source converter," /PST, New Orleans, USA, 2003, pp. 1-6.