Priya R. Sonone et al. 2016, Volume 4 Issue 2
ISSN (Online): 2348-4098
ISSN (Print): 2395-4752

International Journal of Science, Engineering and Technology
An Open Access Journal

A Review Paper on Mitigation of Power Quality Issues in Distribution System by Using D-Statcom

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Abstract

In this paper there is mitigation of power quality issue by using fact devices like D-STATCOM, DVR, SVC. The D-STATCOM is used for solving power quality problem in distribution system. This D-STATCOM is connected as a shunt to the transmission line at the load side. It injects the current after that generates and absorbs the reactive power as per requirement. This work on the VSC(voltage source converter)principle, by use these principle they reduce the voltage sag problem and by using LCL passive filter harmonic distortion get reduce and improve power factor. The simulations were performed using MATLAB SIMULINK version R2010b.

Keywords: D-STATCOM, VSC (voltage source converter), Controller, LCL passive filter.

Introduction

Now a day there is increases the need of electric energy. Due to these there is an increasing the generation and distribution. so that there is required high quality of electric power it means that the disturbances occur in case of generation and distribution get less. The disturbances in power quality are voltage sag, voltage swell, harmonic distortion, low power factor. Due to these disturbances the working ability of the equipment get reduces. So that we must awareness about power quality at the customer side and utility.

Compared to other power quality problems affecting industrial and commercial end users, voltage sags occur most frequently. They reduce the energy being delivered to the end user and cause computers to fail, adjustable-speed drives to shut down, and motors to stall and overheat. The voltage sag means voltage dips. The duration of voltage sag is less than 1min but more than 8milisecond.The magnitude of reduction is between 10 percent and 90 percent of the normal root mean square (rms) voltage at 50Hz.

There is a harmonic current in the system produced the harmonic distortion. The harmonic distortion is the major source of sine waveform distortion. Harmonics is integral multiples of the fundamental frequency of the sine wave. The cause's harmonic currents are usually caused by nonlinear loads, like adjustable speed drives, solid-state heating controls, electronic ballasts for fluorescent lighting, switched-mode power supplies in computers, static UPS systems, electronic and medical test equipment, rectifiers, filters, and electronic office machines. Nonlinear loads cause harmonic currents to change from a sinusoidal current to a non sinusoidal current by drawing short bursts of current each cycle or interrupting the current during a cycle. Due to this power factor get decreases.

In some of the electric power consumers, such as the telecommunications industry, power-electronics drive applications, etc., there is a constraint for ac as well as dc loads. The telecommunication industry uses several parallel-connected switch-mode rectifiers to support dc bus voltage. Such an arrangement draws nonlinear load currents from the utility. This causes reduced power factor, more losses and less efficiency. Obviously, there are Power Quality issues, such as unbalance, poor power factor, and harmonics produced by telecom equipment in power distribution networks. Therefore, the functionalities of the conventional DSTATCOM should be increased to mitigate the abovementioned PQ problems and to supply the dc loads from its DC Link as well.

For reducing these issues the development of power electronic device such as FACTS (Flexible AC Transmission system). In that case the D-STATCOM is used at the distribution level. It connects at load side and by injecting the current it can reduce the power

quality problem. The D-STATCOM has additional properties to sustain reactive current at low voltage and can be developed as a voltage and frequency support by replacing capacitor with batteries as energy storage.

In this paper, there is the study of D-STATCOM with LCL passive filter and enhancement of the power quality such as voltage sags, harmonic distortion and low power factor in distribution system.

Basic Concepts of D-Statcom

A distribution static compensator is a voltage source converter based power electronic device. Usually, this device is supported by short term energy stored in a dc capacitor. The DSTATCOM filters load current such that it meets the specifications for utility connection. The DSTATCOM can fulfill the following points.

1. The result of poor load power factor such that the current drawn from the supply has a near unity power factor.

2. The result of harmonic contents in loads such that current drawn from the supply is sinusoidal.

3. The result of unbalanced loads such that the current drawn from the supply is balanced.

4. The dc offset in loads such that the current drawn from the supply has no offset.

One of the main features of DSTATCOM is the generation of the reference compensator currents. The compensator, when it tracks these reference currents, injects three-phase currents in the ac system to cancel out disturbances caused by the load. Therefore, the generation of reference currents from the measurements of local variables has fascinated wide attention. These methods carry an inherent assumption that the source is stiff (i.e., the voltage at the point of common coupling is tightly regulated and cannot be influenced by the currents injected by the shunt device). This however is not a valid assumption and the concert of the compensator will reduce considerably with high impedance ac supplies. The operation of VSC is supported by a dc storage capacitor with appropriate dc the transient response of the voltage across it. The transient response of the DSTATCOM is very significant while compensating AC and DC loads.

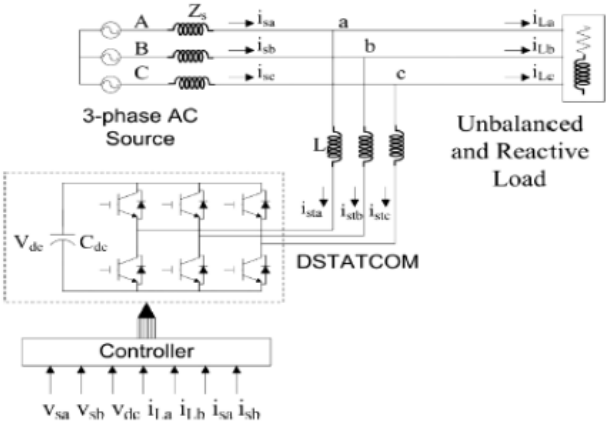

Figure 1.1: Basic Circuit Diagram of the DSTATCOM System.

A static synchronous compensator (STATCOM) is one of the most operative solutions to regulate the line voltage. The STATCOM consists of a voltage source converter connected in shunt with the power system and permits to control a leading or lagging reactive power by means of correcting its ac voltage. A STATCOM for installation on a distribution power system called DSTATCOM, has been researched to clear voltage fluctuations and voltage flickers. A shunt active filter intended for installation on a power distribution system, with emphasis on voltage regulation capability. The harmonic damping has the capability to improve the stability of voltage regulation. Thus, modification of the feedback gains makes it possible to decrease voltage fluctuation in transient states, when the active filter has the function of combined harmonic damping and voltage regulation.

D-STATCOM (Distribution Static Compensator)

It is a FACTS device which is installed for the support of electricity networks which have poor power factor and voltage regulation also, commonly it is use for the stabilization of voltage and to improve power factor of that network. It is a voltage source converter based device, which can work as reactive power source. The D-STATCOM, in which the dc storage battery also connected with the device to charge in case of over voltage and to discharge in case of under voltage in this way by withdrawing and supplying the reactive power it can compensate the reactive power. Therefore it can improve the power factor and reduce the harmonics in the system. The D-STATCOM proposed here maintains the voltage

magnitude within the limits by eliminating the voltage sags and swells in the system.

Operation of D-STATCOM

D-STATCOM consists of following component:

A. Voltage source converter

B. Energy storage circuit

C. LCL passive filter

D. Controller

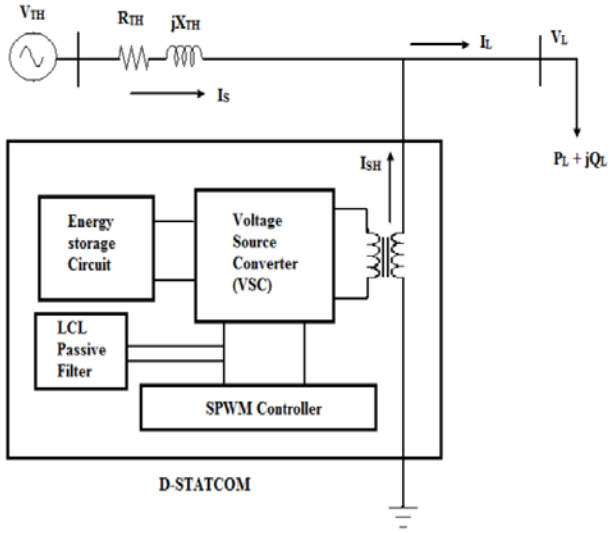

Figure 2.1.1: Schematic diagram of a D-STATCOM

Voltage Source Converter

The voltage source converter have a dc input voltage source provided by capacitor C_s, the converter

produce set of controllable three phase output voltages with the frequency of the ac power system. Each output voltage in phase with, and coupled to the corresponding ac system voltage via relatively small the per phase leakage inductance of the coupling transformer. By varying the amplitude of a output voltage produced, the reactive power exchange between converter and ac system .If the amplitude of a output voltage is increases above the ac system voltage then the current flows through the leakage inductance from the converter to ac system, and the converter generates reactive power (capacitive) power for the ac system. If the amplitude of a output voltage is decreases above the ac system voltage then the current flows through the leakage inductance from the ac system to converter, and the converter absorb reactive power (inductive). If the amplitude of a output voltage is equal to the ac system voltage, the reactive power exchange is zero. VSC-based unit utilizes several important Technological developments:

i. High voltage valves with series-connected MOSFETs
ii. Compact, dry, high-voltage dc capacitors
iii. High capacity control system

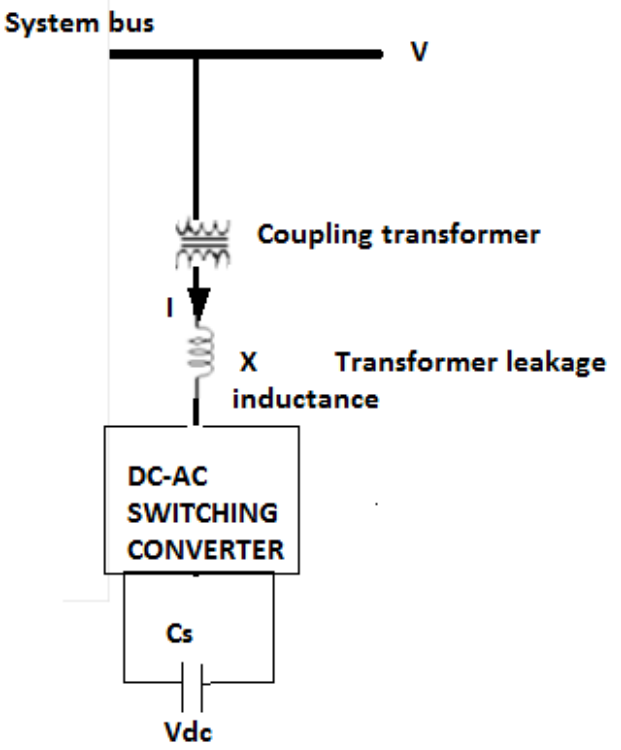

Figure 2.1.2**:** Operation mode of Voltage Source Converter

Energy storage circuit

This connected to the VSC(voltage source converter),energy storage circuit consists of capacitor which is parallel to the DC source. The capacitor is charged by battery and discharged by converter.

Controller

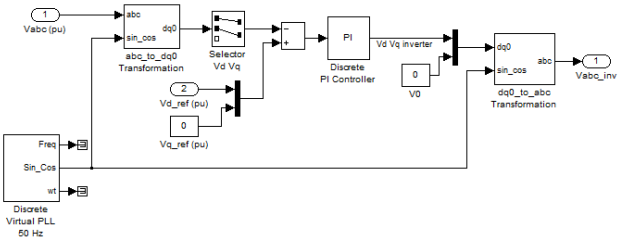

Fig.2.1.3: Block Diagram of Controller System

Above figure shows the block diagram of controller system. The controller system is important part of distribution system. Here use a PI controller for minimizing the error in the system. PI controller is a feedback controller. In this case, PI controller will process the error signal to zero. Transmission line voltage or load r.m.s. voltage is given to the abc_to_dq0 transformation. Function of this transformation block is to convert abc phases to dq0 for simplification of the system.

Transmission line voltage is brought back to the reference voltage with the r.m.s. voltages that measured at the load voltages. In controller block also maintain the angle of three phases. PI controller output is given to the dq0_to_abc transformation. These block convert the dq0 to abc phases and it is given to PWM generator.

LCL passive filter

In passive filter inductor and capacitor are used. The high order LCL filter using space of conventional L-filter for smoothing the output current. It's saves large amount of cost and reduce the rate and size as the reduce in component. It has been used in grid connected inverter and pulse width modulated rectifier, because the minimize the current distortion injected to utility grid. Also it is used in reduction of harmonic distortion.

This LCL filter will introduce resonance frequency into the system. The harmonic resonance current is reducing by adding passive damping circuit to the filter. This damping circuit can be purely resistive causing relatively high losses or a more complex solution consisting of combination of resistor, capacitor and inductor.

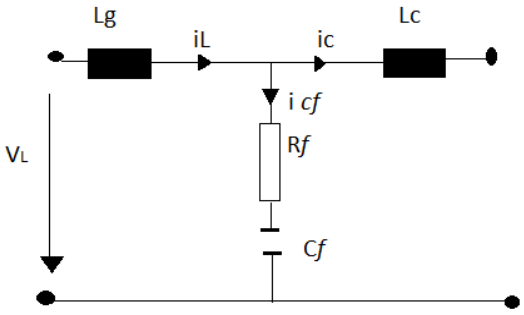

Figure 2.1.4: LCL Passive Filter

LCL filter is more effective on reducing harmonic distortion. To design it, these equation are used

$$L_g = \frac{E_n}{2\pi\sqrt{6} i_{rpm} f_{sw}} \quad \text{.....(1)}$$

$$L_c = \frac{L_g}{2} \quad \text{..... (2)}$$

$$C_f = \frac{L+L_g}{L L_g (2\pi f_{res})} \quad \text{.....(3)}$$

To design a LCL passive filter make sure that,

$$10 f_n \leq f_{res} \leq 0.5 f_{sw}$$

Where;

E_n = RMS value of grid voltage,

L_g = Grid side filter inductance,

L_c = Converter side filter inductance,

C_f = Filter capacitance,

i_{rpm}=Peak value fundamental harmonic current,

f_{sw} = Switching frequency,

f_{res} = Resonance frequency

Application

1. It is used in wind energy.
2. It is used in solar energy.
3. It is used in ship.

Conclusion

1. D-STATCOM in system the power quality and voltage profile is improved. The power factors also increase close to unity. Thus by adding D-STATCOM with LCL filter the harmonic distortion get reduced. , it can be concluded that by adding D-STATCOM the voltage and current are improved that in addition to complete reactive power compensation, power factor correction and voltage regulation and harmonics are

also checked, and for achieving improved power quality levels at the distribution end.

References

[1] Archana M. Kadam, SatyenDhamdhere, D.S.Bankar, "DSTATCOM for Improvement of Power Quality using MATLAB Simulation" International Journal of Science and Modern Engineering (IJISME), ISSN: 2319-6386, Volume-1, Issue-1, December 2012.

[2] Bhattacharya Sourabh, "Applications of DSTATCOM Using MATLAB Simulation in Power System", Research Journal of Recent Sciences,ISSN 2277 – 2502, Vol. 1(ISC-2011), 430-433 (2012).

[3] Darji Dhaval, D. Patel, Sumit R., Prof.Hardik H. Raval, "Improving Voltage Profile of Distribution System using DSTATCOM", IJEDR Volume 2, Issue 1, ISSN: 2321-9939(2014).

[4] Firas Marwan Flaih, Jyoti Shrivastava " DSTATCOM with LCL Filter to Improve Voltage Sags and Current Harmonics in Power Distribution System" Vol. 3, ISSN: 2249-6645, Nov - Dec. 2013

[5] Mithilesh Kumar Kanaujia, Dr. S.K. Srivastava, "Power Quality Enhancement With D-Statcom Under Different Fault Conditions",IJERA(International Journal of Engineering Research and Application),ISSN: 2248-9622,Vol. 3, Issue 2, March -April 2013.

[6] M.Prashanth, Dr.Himani, "Reduction Of Reactive Power In A Distribution System Using D-Statcom", JREEE(Journal of Research in Electrical and Electronics Engineering),ISSN: 2321-2667,Volume 2, Issue 4, July 2013.

[7] Narain G. Hingorani, LaszloGyugyi, "Understanding FACTS", Standard Publisher Distributers,pp167-168.

[8] NoraminIsmail, WanNorainin Wan Abdullah, "Enhancement of Power Quality in Distribution System Using D-STATCOM", IEEE, 978-4244-7128, 23-24 June 2010.

[9] Priyanka Rani, Ashish Sharma,"Power Quality Enhancement By Improving Voltage Stability Using Dstatcom", IJRET(International Journal of Research in Engineering and Technology),ISSN: 2319-1163,volume:03,issue:04,apr-2014.

[10] Shaik Khaja Gareeb Nawaz, Shaik Hameed,"Mitigation Of Power Quality Problems By Using D-Statcom", IJRAET(International Journal of Recent Advances in Engineering & Technology),ISSN : 2347-2812, Volume-1, Issue -3, 2013.

[11] Varsha Vishwakarma, NitinSaxena, "Application Of D-Statcom For Power Quality Improvement", Global Journal of Multidisciplinary StudiesISSN:2348-0459 ,Volume 3, Issue 6, May 2014.

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Copy for Cite this Article- Priya R. Sonone, Pratiksha A. Shende, Shubhangi R. Thakre, Mangesh J. Nemade, "A Review Paper On Mitigation Of Power Quality Issues In Distribution System By Using D-Statcom", *International Journal of Science, Engineering and Technology,* Volume 4 Issue 2: 2016, pp. 441- 445.