

## **A REVIEW OF Power Quality Improvement by D-STATCOM in Distribution under Various Fault Conditions**

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*Abstract:-In this paper we see that D-STATCOM (distribution static compensator ) is used for improving power quality of distribution network during different type of fault occur in system. In this paper we used PI controller and sinusoidal PWM based control scheme. D-STATCOM connected as shunt load with distribution network at load end. This work on VSC(voltage source convertor ) based technique , using this concept maintain constant voltage at load end and by using LCL passive filter eliminate harmonic from system and also improve power factor of system.*

**Keyword:-D-STATCOM , VSC(voltage source convertor) , controller , LCL passive filter.**

### **INTRODUCTION:**

Now a day demand of electrical energy increases so increases the generation and distribution so we need high quality of electrical energy means voltage ,current , frequency must lies in permissible range and less distortion means less THD. If power quality is not good than working capacity of equipment get reduced . so we need good power quality at customer side as well as utility side. Due to poor power quality mainly contain voltage sag problem at customer side, due to voltage sag , reduced energy transfer to load side due to this compute fail , adjustable speed driver motor shut down etc.Harmonic current produced harmonic distortion in system . harmonic distortion means deviation from sinusoidal wave. Harmonic is integral multiple of fundamental frequency. Harmonic current occur due to non linear load like motor, solid state heating device , fluorescent lamp , SMPS (switching mode power supply ) in computer , electronics and medical test equipment , filter etc.

Now a day ,most of connected load as non- linear load so, there is large chances of occurring harmonic distortion and low power factor. Now due to increase demand of electrical energy complexity of electrical network is very complex. So there is always chances of occurring different type of fault like single line to ground fault (L-G) , double line fault (L-L) , double line to ground fault (L-L-G), triple line fault (L-L-L) , triple line to ground fault (L-L-L-G) . during this fault voltage dip , very high current flow through distribution network and variation in THD is also very large so power quality become poor during fault duration, so we used FACT device like D-STATCOM for improving power quality of electrical system during fault duration. Here D-STATCOM connected at load side as shunt connected device , so it inject current at load side and improve power quality of distribution network.

### **Basic Concept Of D-STATCON :**

D-STATCON is VSC based power electronics device , by controlling switching angle of we can controlled the amount of reactive power feed to distribution network or amount of reactive power compensation.

Benefits of D-STATCON in distribution network

- (1) Improve power factor of load .
- (2) Reduced harmonic distortion at load side of distribution network.
- (3) Result of unbalanced load such that the current drawn from the supply is balanced.
- (4) Reduced dc offset at load side.

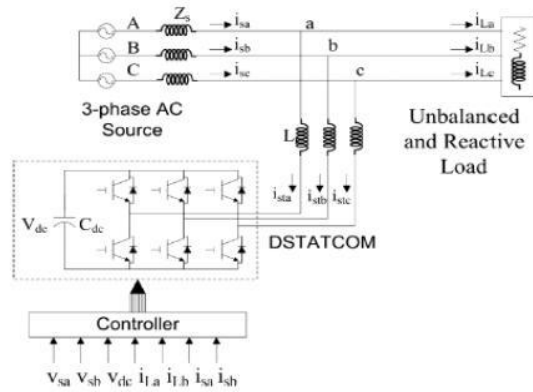


Fig1:Basic Circuit Diagram of the DSTATCOM System.

Actually , D-STATCON contain voltage source convertor this may be behave like convertor or inverter during operation according to requirement for maintain good power quality . when short circuit occur in the network than voltage dip occur in the network than VSC behave like inverter it convert D.C energy to A.C energy and maintain good power quality. When voltage swell occur in system than VSC behave like convertor and it convert A.C energy to D.C energy for maintain voltage in permissible region. During whole operation charging and discharging of capacitor take place. During voltage swell charging of capacitor take place and during voltage dip discharging of capacitor take place.

Component of D-STATCON :

Following are component of D-STATCON

- (1) Voltage source convertor (VSC)
- (2) Energy storage circuit
- (3) LCL passive filter
- (4) Controller

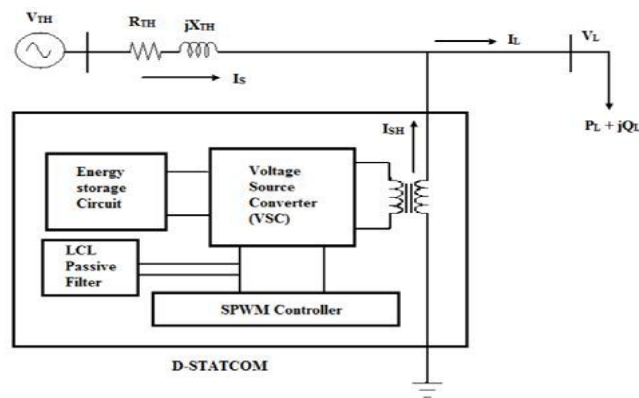


Fig 2 : Schematic diagram of a D-STATCOM

(1) Voltage Source Converter (VSC)

Voltage source either convert d.c capacitor voltage to a.c voltage or a.c voltage to d.c capacitor voltage depending on voltage dip or swell occur in network .

When load voltage greater than output of VSC than power flow from A.C to D.C capacitor ,under this condition behave like convertor and charging of capacitor take place. When load voltage less than output of VSC than power flow from convertor to load or we can say that D.C to A.C conversion take place under this condition this behave like inverter and discharging of capacitor take place.

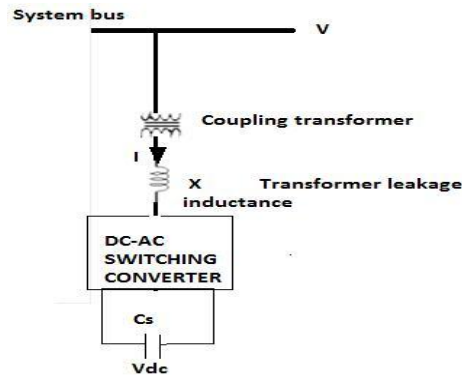


Fig 3: Operation mode of Voltage Source converter .

(2) Energy Storage Circuit :

Here capacitor is used for energy storage , this connected with VSC (voltage source converter ). Charging of capacitor take place when voltage swell occur in network and discharging of capacitor take place when voltage dip occur at load end.

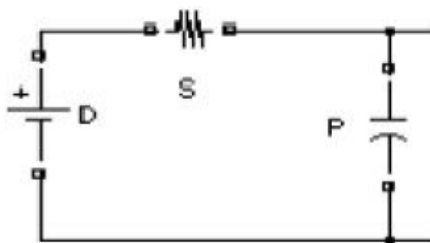


Fig 4 : Energy Storage Circuit

(3) Controller :

Here compare load voltage with normal voltage and the difference of this voltage act as error signal for PI controller and output of PI controller send into PWM , then PWM generate gate pulse which feed into VSC. Than VSC generate reactive power according to requirement for controlling voltage in normal range.

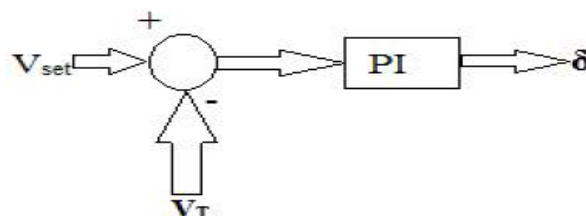


Fig 5:PI Controller

(4)LCL passive filter:

Filter Is Connected At Output Of VSC. Harmonic Filter Is Used For Filterout The Unwanted Signal At Output Of Converter. LCL Passive Filter Is Most Effective Filter For Isolate The Harmonic.To Design It, Equation (1), (2) And (3)Are Used.

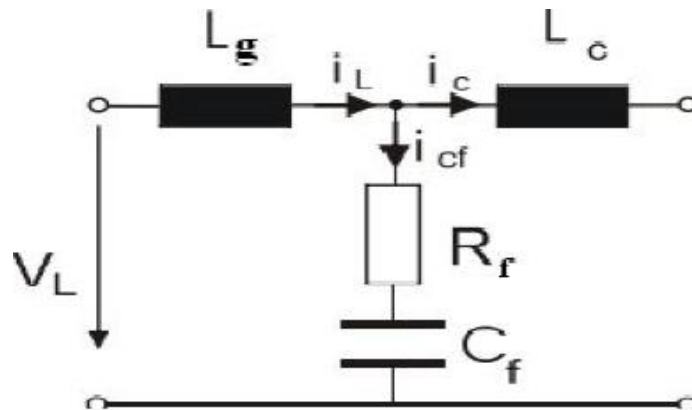


Fig 6 : LCL passive filter.

$$L_g = \frac{E_n}{2\sqrt{6}i_{rpm}f_{sw}}$$

(1)

$$C_f = \frac{L + L_g}{LL_g (2\pi f_{res})^2}$$

(2)

Most effective LCL passive filter when

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

(3)

Literature review:

Sr.no	Author / Title	Description
1.	Simulation of d-statcom under fault condition and non linear load. By p.verranjeyulu ,Associate professor ,EEE dept. MRIET India	In this paper we see that how we can design and simulate the D-STATCOM with PI controller for improving power quality Of distribution network under different type fault . in this paper we also see that what is effect of LCL passive filter on power quality improvement.
2.	Power quality enhancement under different fault condition by mithilesh kumar ,associate professor of MMM. Gorakhpur india	In this paper we study that improvement of power quality during fault with the help of D-STATCOM .
3.	Power Quality Improvement Using D-STATCOM In Distribution System At Various Faults by INTERNATIONAL JOURNAL OF INNOVATIVE RESEARCH IN ELECTRICAL, ELECTRONICS, INSTRUMENTATIO AND CONTROL ENGINEERING Vol. 2, Issue 6, June 2014	This paper deal with power quality problem such as voltage swell and dip . used FACT device for improving power quality . we know during fault voltage dip occure and when load is suddenly off then voltage swell occure so for maintain voltage in permissible region use D-STATCOM.
4.	Anaya-Lara, E. Acha, "Modeling and analysis of custom power systems. by PSCAD/EMTDC," IEEE Trans. Power Delivery, vol. 17, no I, pp. 266-272, January 2002	In this paper we study electromagnetic transient model of different type of FACT device like D-STATCOM, DVR ,SVC etc.  In this paper we also see that maximum amount of voltage sag/swell can be mitigate by FACT device.
5.	S. Ravi Kumar, S. Sivanagaraju, "Simualgion of D-STATCOM and DVR in power system," ARPN journal of engineering and applied science, vol. 2, no. 3, pp. 7-13, June 2007	In this paper we study different type control scheme of D-STATCOM and different simulation method of designing D-STATCOM .
6.	N. Hingorani, "FACTS-Flexible ac transmission systems," in Proc. IEE 5th IntConf AC DCTransmission, London, U.K., 1991, Conf Pub. 345, pp. 1-7.	In this paper we study that D-STATCOM with 12 pulse inverter ,which connected at load end in shunt mode and used sinusoidal pulse width modulation (SPWM) technique for controlling D-STATCOM and simulation of STATCOM done on power system computer aided design (PSCAD) system.
7.	Mahesh Singh, VaibhavTiwari, "Modeling analysis and solution to power quality problems,"unpublished	In this paper we study different control scheme of D-STATCOM and also design simulation model of D-STATCOM in MATLAB.

8.	Xiaomeng Li and Ganesh K. Venayagamoorthy, "A Neural Network Based Wide Area Monitor for a Power System", IEEE Power Engineering Society General Meeting, Vol. 2, pp: 1455-1460, 2005	In this paper we design of system based on ARM microcontroller that used for maintain voltage, current and temperature under permissible region.
9.	Nielsen, J.G.; Newman, M.; Nielsen, H.; Blaabjerg, F., "Control and testing of a dynamic voltage restorer (DVR) at medium voltage level," Power Electronics, IEEE Transactions on , vol.19, no.3, pp.806,813, May 2004	In this paper we study power quality improvement of system during fault by using DVR. Under linear and non linear load . we observe that very small effect on power quality occure due to used DVR.
10.	Hideaki Fujita and Hirofumi Akagi, "The Unified Power Quality Conditioner: The Integration of Series- and Shunt Active Filters", IEEE Transactions on Power Electronics, Vol.13, No.2, March 1998	In this paper we see improvement of power quality in distribution network under different type of fault by UPQC. We see that UPQC is able to improve power quality as well as power factor of system.
11.	N. Srinivasa Rao and Dr G.V. Siva Krishna Rao, "Modeling and Simulation of D-STATCOM for Power Quality Improvement", International journal of Engineering Research and Development, ISSN: 2278-067X, Volume 1, Issue 12(July 2012), PP.33-40.	In this paper we study , D-STATCOM is flexible device which can operate in current control mode for compensating voltage variation , unbalanced and reactive power and in voltage control mode as voltage stabilizer. We also see , simulation model of D-STATCOM give satisfactory performance for improving power quality means voltage , current , Thd lies in permissible region .
12.	NPTEL course on power quality in power distribution system. By DR. Mahesh kumar , IIT madras.	In this paper book we study that , what is power , what is power quality , fundamental theory of load compensation , series compensation using DVR and D-STATCOM.
13.	Design and control of a D-STATCOM for power quality improvement using cross-correlation function approach by BHIM SINGH , PROFF IIT DELHI.	In this paper we study that design and control of a D-STATCOM for power quality improvement using cross-correlation function approach.

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- [12]NPTEL course on power quality in power distribution system. By DR. Mahesh kumar , IIT madras.
- [13] Design and control of a D-STATCOM for power quality improvement using cross-correlation function approach by BHIM SINGH , PROFF IIT DELHI .