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Review Paper on SVPWM Technique based D-STATCOM to Improve Power Quality in Distribution System

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Abstract- *In this paper, the operation of D-STATCOM is presented and the control technique used for voltage is Space vector PWM. From project work voltage sag, voltage swell and Harmonics in the system will improved. D-STATCOM modelled and simulated using MATLAB/SIMULINK software.*

Keywords- D-STATCOM, SVPWM, voltage sag and swell, Harmonics, MATLAB/ SIMULINK, VSC

1. INTRODUCTION

D-STATCOM is a custom power device which capable to inject a current into the system to correct the power factor and reactive power compensation and harmonics reduction. Space vector pulse width modulation technique is an advanced, computation–intensive PWM method and is best among all the PWM techniques. D-STATCOM based on VSC improves quality of power by removing voltage sag and voltage swell by using SVPWM technique. Three winding transformer is used to bear excess current when power quality problems occur. Space Vector Pulse width modulation (SVPWM) provide triggering pulse to D-STATCOM circuit through gate terminal using single circuit of D-ATATCOM. LCL passive filter circuit added with D-STATCOM to improve harmonics in distribution system. Three phase VI measurement block is used to measure instantaneous three-phase voltages and currents in a circuit.

1.1 D-STATCOM

It is a compensating device which is used to control the flow of reactive power in distribution system. It is based on voltage source converter (VSC). It absorbs or generates controllable active and reactive power. It consists of a two-level Voltage Source Converter (VSC), a dc energy storage device, a coupling transformer connected in shunt to the distribution network through a coupling transformer. Proper adjustment of magnitude and phase of the DSTATCOM output voltages allows effective control of active and reactive power exchanges between the D-STATCOM and the ac system. In this paper, the D-STATCOM will be used to regulate the voltage at the point of connection. The control will based on space vector PWM and only requires the measurement of the rms voltage at the load point. The DC side of the converter is connected to a DC capacitor, which carries the input ripple current of the converter and is the main reactive energy storage element. This capacitor could be charged by a battery source, or could be recharged by the converter itself. If the output voltage of the VSC is equal to the AC terminal voltage, no reactive power is delivered to the system. If the output voltage is greater than the AC terminal voltage, the D-STATCOM is in the capacitive mode of operation and vice versa.

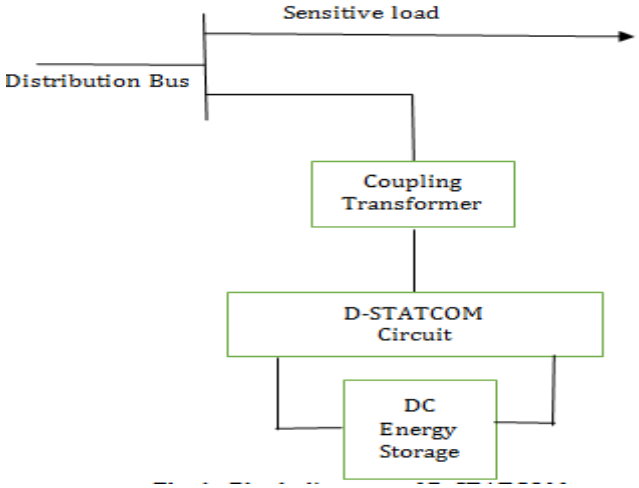

Fig-1: Block diagram of D-STATCOM

1.2 SVPWM

Space vector pulse width modulation technique is an advanced, computation–intensive PWM method and is possibly the best among all the PWM techniques for variable-frequency drive applications. In this paper, Space vector pulse width modulation will control D-STATCOM by providing gate triggering and with potential of supplying reactive power, harmonics and unbalanced load compensation and it is used to provide real component of load current, positive sequence and fundamental frequency.

The circuit model of a three-phase voltage source PWM inverter is shown in figure 2. S_1 to S_6 are the six power switches which are controlled by the switching variables a, a′, b, b′, c and c′. When an upper transistor S_1, S_3 and S_5 are switched on, i.e., when a, b or c is 1, the corresponding lower transistor S_2, S_4 and S_6 are switched off, i.e., the corresponding a′, b′ or c′ is 0. Therefore, the on and off states of the upper transistors S_1, S_3 and S_5 can be used to determine the output voltage. The objective of space vector PWM technique is to approximate the reference voltage vector Vref using the eight switching patterns. One simple method of approximation is to generate the average output of the inverter in a small period T to be the same as that of Vref in the same period.

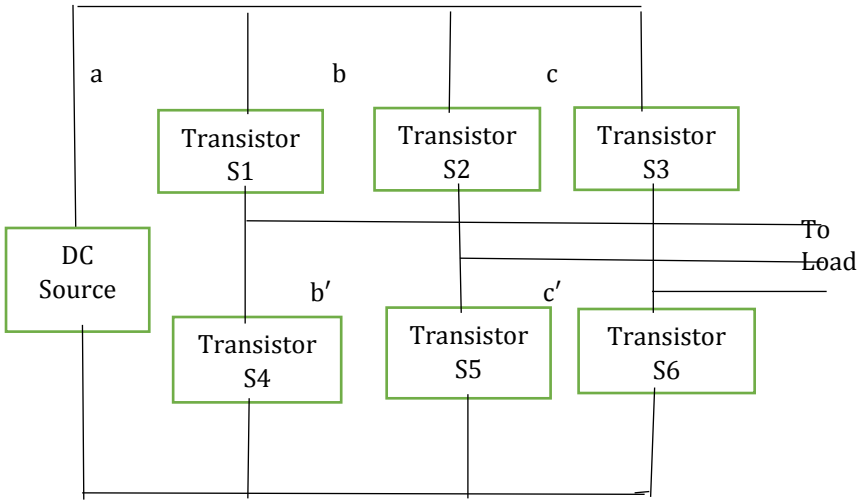

Fig-2: STATCOM Inverter

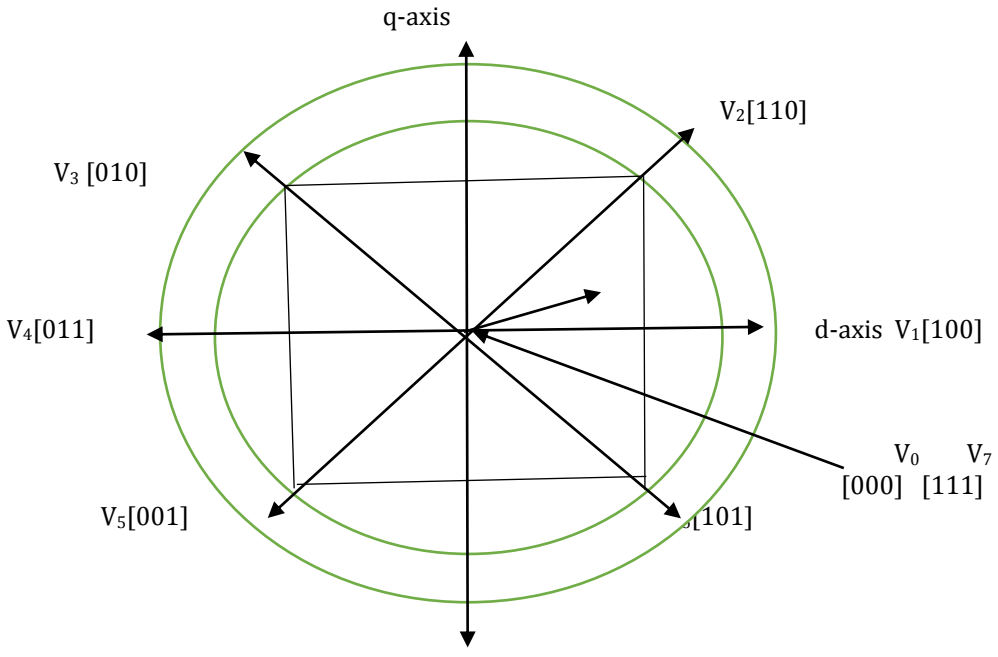

Fig-3: Vector Representations of the Switching Gates

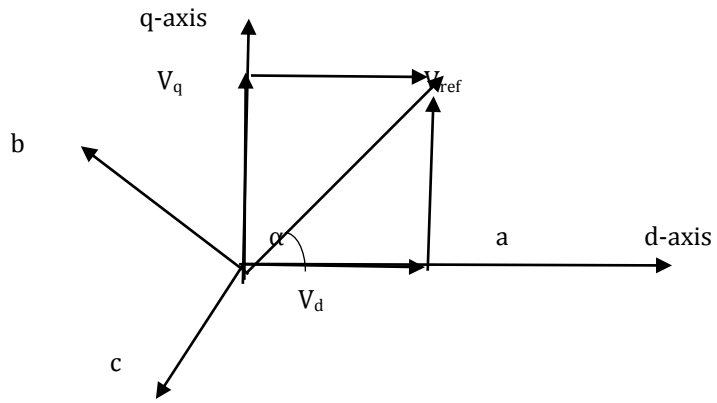

Fig-4: Voltage Space Vector and its Components

From fig.4, The Vd, Vq, Vref, and angle (α) can be determined as follows:

$$Vd = Van.Cos0 - Vbn.Cos60 - Vcn.cos60 \dots\dots\dots\dots (1)$$

$$Vd = Van - 1/2\ Vbn - 1/2\ Vcn$$

$$Vq = Van.Cos90 + Vbn.Cos30 - Vcn.Cos30 \dots\dots\dots. (2)$$

$$Vq = \sqrt{3}/2\ Vbn - \sqrt{3}/2\ Vcn$$

$$\alpha = \tan^{-1}(Vd/Vq) \dots\dots\dots\dots (3)$$

$$|Vref| = \sqrt{(Vd^2+Vq^2)} \dots\dots\dots\dots (4)$$

2. LITERATURE REVIEW

[1] O. Anaya-Lara suggested that fault detection technique by simulation of custom power devices using PSCAD/EMTDC graphics technique. The newly invented power electronics controllers have high reliability and higher enhancing power capability in case low power supply. Modelling of these controllers can be done with mathematical and graphical model to improve quality of power. In this paper, modelling of these controllers done by graphical method with the help of PSCAD/EMTDC graphics technique. PSCAD/EMTDC is used to conduct all aspects of model implementation and to carry out extensive simulation studies. Models based on these graphics suitable for electromagnetic transient studies are presented for the following three custom power controllers: the distribution static compensator (D-STATCOM), the dynamic voltage restorer (DVR), and the solid-state transfer switch (SSTS). Modelling and simulation of D-STATCOM,DVR and SSTS is done with PSCAD/EMTDC graphics technique and showed results of each custom device and applied them to study of power quality. The difference in PWM and PSCAD/EMTDC technique is that PWM technique suitable for voltage measurement only and PSCAD/EMTDC suitable for low voltage custom power application. In simulation of D-STATCOM, main role is of capacitor. Capacitor size is inversely proportional power quality improve problem like total harmonic distortion that is,as size of capacitor goes on increased, power quality issues goes on increasing.

In simulation of DVR, the main role is DC storage device and coupling transformer, it provides excellent voltage regulation and capacity of power compensation. From this mitigation of power quality problem like voltage sag (maximum value). Simulation results of SSTS proved that it is suitable for screening selected load points against faulted conditions. The transfer of load from a faulted feeder to a healthy one can be achieved in a short period of time.

[2] S.V.Ravi Kumar suggested the techniques of correcting the supply voltage sag, swell and interruption in a distributed system. To remove these power quality problem custom power devices like D-STATCOM, DVR is used. These both devices work on same principle VSC. A DVR injects a voltage in series with the system voltage while D-STATCOM injects a current into the system to correct the voltage sag, swell and interruption. Simulation of custom power devices is done and results observed that the capacity for power compensation and voltage regulation of DVR and D-STATCOM depends on the rating of the dc storage device. Modelling in this paper based on PI controller. The aim of this control scheme is to maintain constant voltage magnitude at the point where a sensitive load is connected, under system disturbances. Paper includes simulation results of with D- STATCOM and without D-STATCOM also and same with Dynamic voltage restorer.

[3] Noramin Ismail suggested that suggested that enhancement of voltage sags, harmonic distortion and low power factor using Distribution Static Compensator (D-STATCOM) with LCL Passive Filter in distribution system. D-STATCOM injects current in the system to mitigate voltage sag and to improve harmonics in system LCL passive filter added with D-STATCOM circuit. D-STATCOM model based on voltage source converter (VSC). Enhancement of power quality is explained using D-STATCOM based on VSC with the help sinusoidal pulse width modulation (SVPWM) technique. Model based on PI controller.

In this paper, to create distortion in the distribution system different types of fault such as three phase to ground, double line to ground, line to line and single line to ground are injected. Paper includes simulation results of with D-STATCOM and without D-STATCOM. Overall this paper explained that power quality is improved to mitigate voltage sag by using D-STATCOM with LCL passive filter circuit.

[4] G.Venkataramana suggested that Sensitive load centres like semiconductor processing plant requires high quality of power. To supply this high quality of power, power line conditioning techniques are used. Recently, a pulse width modulated power converter suitable for three phase power line conditioning. In this paper the development of a control strategy for the application of the pulse width modulated power Custom Power device capable of fast regulation converter for power conditioning is presented. To provide high power quality with sensitive load, operation of three phase power conditioning system is suitable. Simulation of detailed model of the power conditioning system, including the pulse width modulation and control systems is used. From this model, got better output voltage regulation, mitigate voltage sag and swell, unbalanced load and input voltages. In this paper, converter has been fabricated and tested using an open loop control scheme.

[5] N. Raveendra included removal of power quality problem like total harmonic distortion (THD) using D-STATCOM based VSC. The control of the Voltage Source Converter (VSC) is done with the help of SPWM, SVPWM, sub-harmonic PWM and Triangular PWM. Simulation results with modelling based on D-STATCOM of all the techniques are presented in this paper. D-STATCOM based on voltage source converter. Voltage sag and swell is improved by using D-STATCOM and THD (total harmonic distortion) is improved using D-STATCOM with LCL passive filter circuit added with it.

3. PROPOSED WORK

Power quality problems will be improved by modelling and simulation of D-STATCOM based on VSC using Space vector pulse width modulation (SVPWM) technique. Voltage sag and voltage swell will remove using D-STATCOM and harmonics will removed by adding LCL passive filter circuit with D-STATCOM using SVPWM. To mitigate Voltage sag, voltage swell and harmonics in distribution system. Proposed model of D-STATCOM with SVPWM showed as follows,

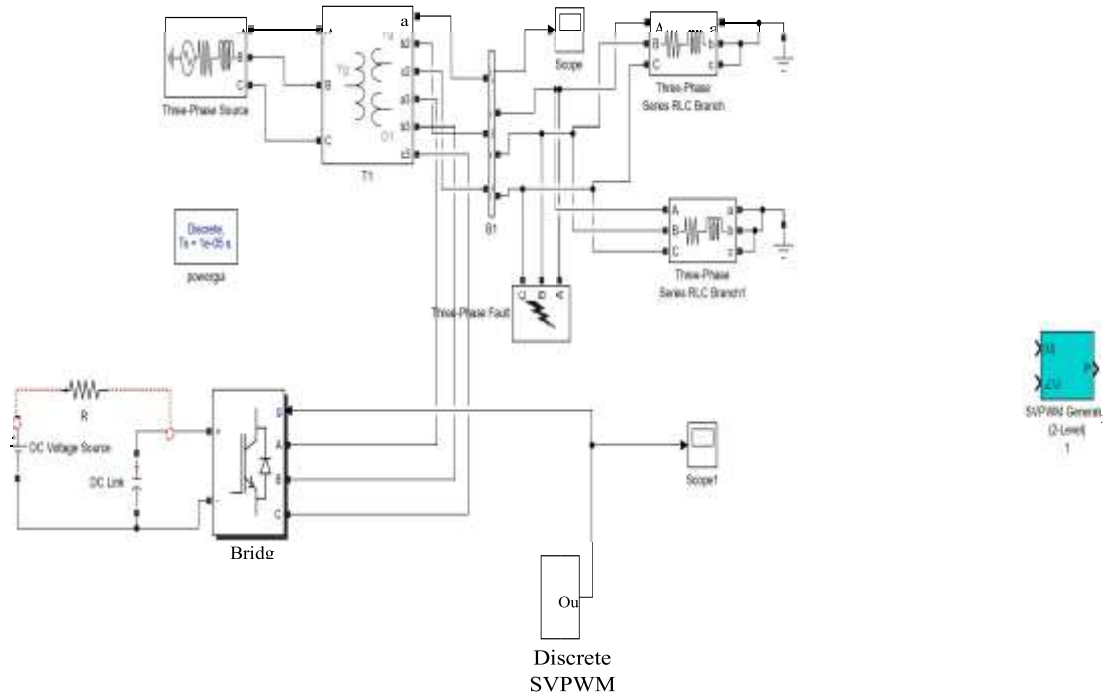

Fig-5: Proposed model of D-STATCOM using SVPWM technique

4. CONCLUSION

D-STATCOM is a best custom power device to improve power quality problem in distribution system among all power devices. SVPWM technique is an advanced technique among all techniques for variable drive application. Discrete SVPWM generator will provide gate pulse to thyristor used in D-STATCOM circuit to improve quality of power. To reduce harmonics in system passive LCL filter circuit added with D-STATCOM.

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