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Power Quality Improvement Using DSTATCOM in Simulink

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Abstract: *By power quality, we mean the power supplied to the consumer should be free from any short of disturbances. The main power quality deviations are caused by short-circuits, harmonic distortions, notching, voltage sags and swells, as well as transients due to load switching. One of the most common power quality disturbance is voltage sag. In this paper, a simulink model is developed to study voltage sag and a D'statcom is used to mitigate voltage deviation and improve power quality. The quality of power is also analysed by wavelet .*

1. INTRODUCTION

The quality of electrical power may be described as a set of values of parameters, such as:

- Continuity of service
- Variation in voltage magnitude (see below)
- Transient voltages and currents
- Harmonic content in the waveforms for AC power

Recently, power quality(PQ) has become a significant issue for both power suppliers and customers. In the past, it was sufficient for utilities to provide electric power without outage. However, customers have come to require high quality electricity because there have been some important changes in power systems with respect to power quality. First, power electronic devices are currently widespread. Since these devices have non-linear voltage and current characteristics, they deteriorate power quality. Second, electric loads have become more vulnerable to power quality. They may suffer failure, disoperation, or hardware damage even during small power quality events. Several other techniques have been proposed in the literature for power quality detection[1-6].

One of the most common power quality problems today is voltage sag/swell. It is often set only by two parameters, depth/magnitude and duration. The voltage sag/swell magnitude is ranged from 10% to 90% of nominal voltage and with duration from half a cycle to 1 min. Voltage sag is caused by a fault in the utility system, a fault within the customer's facility or a large increase of the load current, like starting a motor or transformer energizing. Typical faults are single -phase or multiple -phase short circuits, which leads to high currents. The high current results in a voltage drop over the network impedance. At the fault location the voltage in the faulted phases drops close to zero, whereas in the non-faulted phases it remains more or less unchanged.

Voltage sags are one of the most occurring power quality problems. For an industry voltage sags occur more often and cause severe problems and economical losses. Utilities often focus on disturbances from end-user equipment as the main power quality problems. There are different ways to enhance power quality problems in transmission and distribution systems. Among these, the D-STATCOM is one of the most effective devices. A PWM -based control scheme has been implemented to control the electronic valves in the D-STATCOM.

2. BASIC THEORY OF DSTATCOM

DSTATCOM is a voltage source converter (VSC) that is connected in shunt with the distribution system by means of a tie reactance connected to compensate the load current. In general, a coupling transformer is installed between the distribution system and the DSTATCOM for isolating the DSTATCOM from the distribution system. In addition, the device needs to be installed as close to the sensitive load as possible to maximize the compensating capability. Being a shunt connected device, the DSTATCOM mainly injects reactive power to the system.

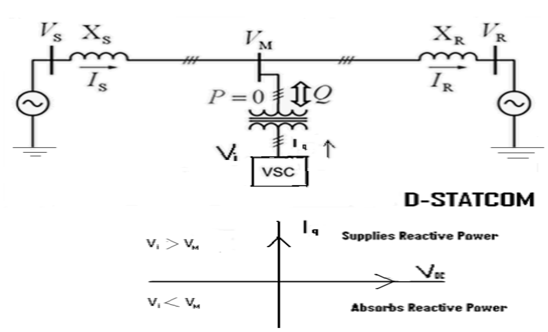

Fig. 1: Structure of DSATCOM along with its operational mode

The structure of DSTATCOM along with its operating modes is shown in Fig. 1.The main components of DSATCOM are:

1. VSC (voltage source converter)
2. Controller
3. Filter
4. Energy storage device
5. Isolation transformer
6. DC charging unit

The main parts of DSTATCOM and its simulink model are shown in fig.2 and fig.3.

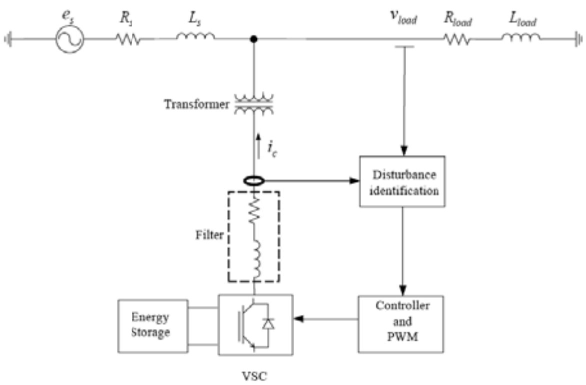

Fig. 2: Main parts of DSATCOM

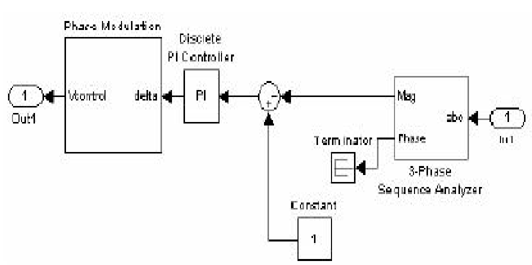

Fig. 3:Simulink Model of D-STATCOM Controller

3. SIMULINK MODEL WITH DSTATCOM

Fig. 4 shows the simulink model of power system with DSTATCOM. The series RLC load is constant and load is varied by RLC load1. The parameters of other blocks in the model are shown in Table I and II.

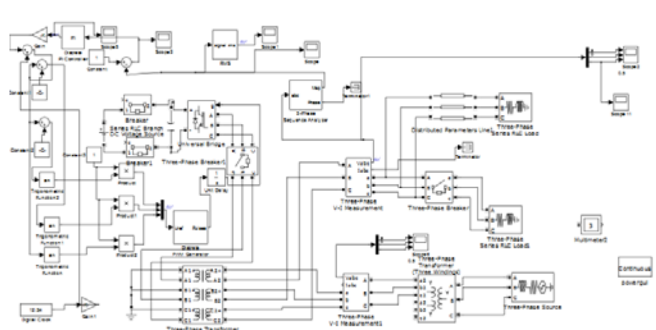

Fig. 4: Simulink model of power system with DSTATCOM

Table 1: Parameters for different parts of test system

Block	Parameter
3 phase source	Ph to ph rms voltage=25000V,frequency=50 Hz source resistance=.8929 Ω, inductance=.01656H
3 phase transformer (3 winding)	Measurement-winding voltage
3 phase series RLC load 1	Nominal ph to ph voltage=11000V,Nominal frequency=50 Hz, Active power=1000kW,reactive power=20 VAR
3 phase breaker	Resistance=.001Ω ,snubber resistance=1MΩ
3 phase series RLC load	Nominal ph to ph voltage=11000V,Nominal frequency=50 Hertz, active power=10 kW,reactive power=100VAR

Table 2: Parameters for DSATCOM

Blocks	Parameter
3 phase transformer(12 terminal)	3 ph rated power=11kW,frequency=50 Hz, magnetizing branch Rm=10 Ω ,Xm=10 Ω
PI controller	Proportional gain=5,Integral gain=120
Capacitance	C=750µF
DC voltage source	Amplitude=2400 V
Universal bridge	Number of bridge arms=3,Snubber resistance=50000 Ω
PWM generator	Carrier frequency=375 HZ

4. RESULTS AND CONCLUSION

Voltage sag is generated by adding an extra load RLC load1.RLC load is added for the period 0.1to 0.3 second. The voltage waveform of three phases and the rms voltage without DSTATCOM are shown in Fig. 5 and Fig. 6

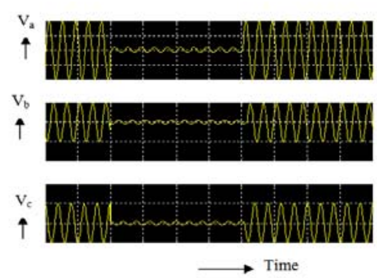

Fig. 5: Phase Voltages without DSTATCOM

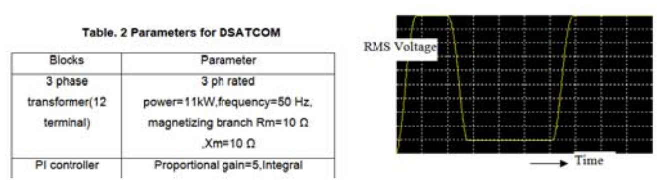

Fig. 6: RMS Voltages without DSTATCOM

Waveform of phase a is decomposed by discrete wavelet transform(DWT) DB4 of level 10. The detail coefficients of DWT are shown in fig.7 which clearly shows the beginning and end point of the sag.

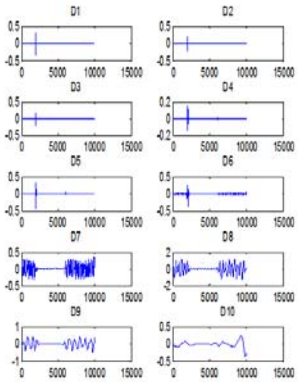

Fig. 7: Plot for Detail Coefficients

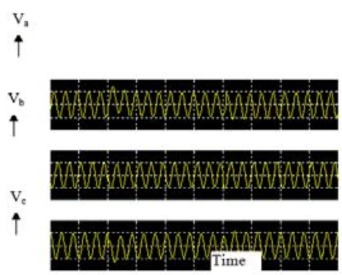

Fig. 8: Phase Voltages with DSTATCOM

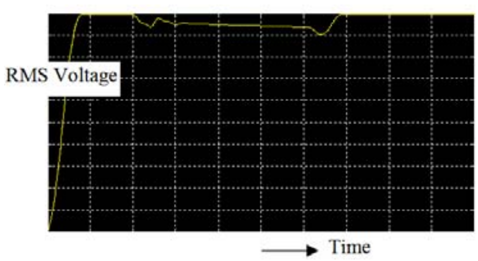

Fig. 9: RMS Voltages with DSTATCOM

Fig.9 and Fig.10 shows the phase voltages and the RMS voltage respectively when the DSTATCOM is introduced in the system. The Fig. s show the improvement in the voltages.

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