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Power Quality Improvement under Different Fault Conditions

K Ramakrishna Pandu

Department of Electrical and Electronics Engineering, Ramachandra College of Engineering, Eluru, Andhra Pradesh, India.

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ABSTRACT

The improvement of power flow in a distributed system can be achieved by the FACTS compensator that is D-STATCOM (DISTRIBUTION_STATIC_COMPENSATOR) also known as which is shunt connected, is explained in this paper.To reduced the Sag-in-voltageissues(power quality issue), a Distribution-STATCOM is used which is connected at PCC (Point of Common Coupling).The advantage of quick operation of Distribution-STATCOM makes the it more efficient and hence power flow is improved.Varied controllers are utilzed to operate the Distribution-STATCOM. To enhance the power flow, we are simulating and designing it with PI Controller. In distribution networks with linear balanced loads, thierpower flow can be increases atvaried fault conditions such as L-L Faults (Line to Line),L-G Faults (Line to Ground), L-L-G Faults, L-L-L-G Faults. These faults are studied and simulated output waveforms are presented also calculating THD (Total Harmonic Distortion) with and withoutDistribution-STATCOM Compensator. The harmonics and Sag-in-voltages due to LG, LLG & LLLG faults in this proposed system are reduced and we can achieve enhanced power flow. The reduction of faults and trhe value of THD (Total-Harmonic-Distortion) can be simulated and studied in MATLAB.

Keywords: DSTATCOM, PI, FAULTS, PWM.

I. INTRODUCTION

In power system, loadsare dynamically keeps changing with time and customer which make it even more difficult for forecasting. This leads to a great need of improving power utilization methods now-a-days. By maintaining accurate balance in both generated capacity and its demand, we can have optimized power flow..

Due to increased usage of inductive and capacitive loadscontaining power electronics in recent years, this is causing power flow concerns (power pollution) in powersystems.Power flowissue is caused because of using IGBT based loads and non-linear loads in most of the power utilities. Swells and sags in voltage are the major power flow issue problems in utility distribution networks, which affects the sensitive loads connected with it. The usual compensatingdeviceslike capacitor bank parallel feeder, UPS are used to clear the Sag-in-voltages, however the usual compensating devices cannot resolve the power flow issues completely.Hencecustom power device is initiated, to solve the problem related to the power flow.

CPD's solve the most of the power flow issues. D-STATCOM and DVR are the efficient compensators which belonging to FACTS family. These FACTS devices which use the IGBT switches, are reliable and quick. We can have the control in the power flow in transmission line and parameters such as phase angle, line impedence and line voltage. Also FACTS devices improves the power transfer capability, we can mitigate Sag-in-voltages and Swells. The compensation of reactive power in the distributed system..By implementing the Pulse-Width modulation based control scheme, the electronic values of D-STATCOM are controlled to enhance the power flow during varied cases, which causes the power transmissionisses.

II. Literature Survey

Varied methods are used to mitigate the Sag-in-voltages problems, but a Custom Power Device (CPD) is the most efficient method. There are several types of CPD. CPDconcept was introduced by Hingorani. N.G. CPDmeans the utilization of IGBT's and controllers for the distribupotion systems. D-STATCOM is used forregulation of voltage, elimination of neutral current, correction of power factor and balancing of load in three-phase distribution system feeding domestic and commercial consumers. D-STATCOM will inject the reactive in distribution systemand mitigate theSag-in-voltages.

III. D-STATCOM

A D-STATCOM is a VSC based power electronic device. DSTATCOM are always shunted with electrical distribution system. Generally DSTATCOM can be connected to capacitor for back up and the energy is stored in capacitor in the form of DC. In Distribution system when D-STATCOM is connected before load, it injects the compensating currents into the line, so that to meet the total load demand requirements for utility supply. DSTATCOM generates reactive power internally in the capacitor and inductor. Its control operation is quick and capable to provide enoughpower tocompensate reactive power in the test system.

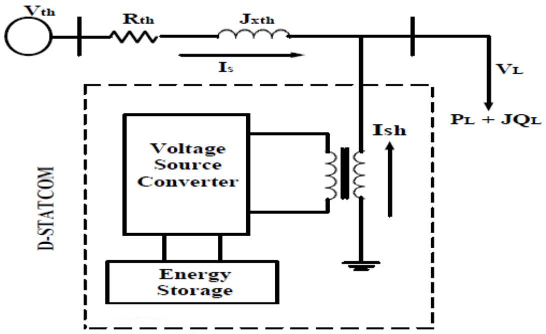

Figure 1: D-STATCOM

IV. CONTROLLER

The error in the desired set point and output can be controlled using the PI(Proportional Integral) controller which drives the test system to get the controlled output and the integral of that value. Figure 2shows PI-SPWM controller. The PI-SPWM controller is a part of electrical distribution system.

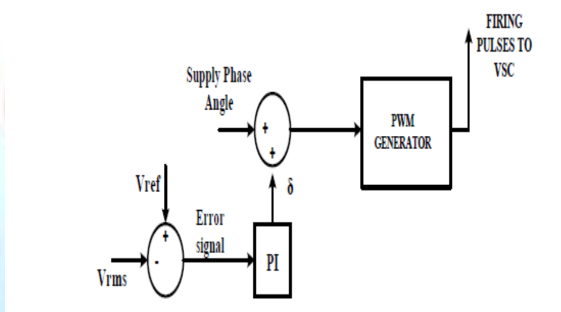

Figure 2: block diagram of PI-SPWM controller

PWM generator gives the Sine PWM waveform. To operate it, the PWM sine wave angle and the phase angle of the balanced supply voltage areaddedexactly separated by 120 degrees. Therefore, the required synced signal is obtained. The obtained error is given to the PI controller and the modulated signal is compared with a carrier signal , which gives pulses for the IGBT's in the VSC.

V. SIMULATION RESULTS

The simulation diagram of test system of D-STATCOM is shown in fig.8.Thestated test system has two feeders connected with anideal three winding transformer and loaded with balanced linear loads. Thisstated test system is analyzed under varied fault conditions. The D-STATCOM invaried fault cases are testedwith both un-balanced and balanced faults are simulated. In LG fault analysis, 'A' phase is subjected to fault, while in LLG fault analysis, the A phase and B phase are subjected to fault. In addition, in three phase fault, the A phase, B phase, and C phase are subjected to fault. In LL fault analysis, phase A and phase B are subjected to fault without ground terminal

CASE I: WITHOUT DSTATCOM

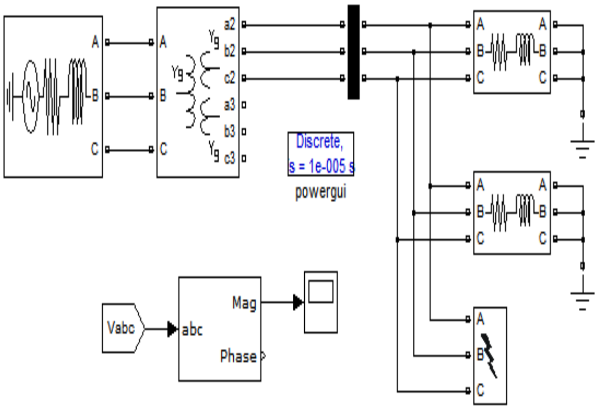

Figure 3: test system of proposed system without DSTATCOM

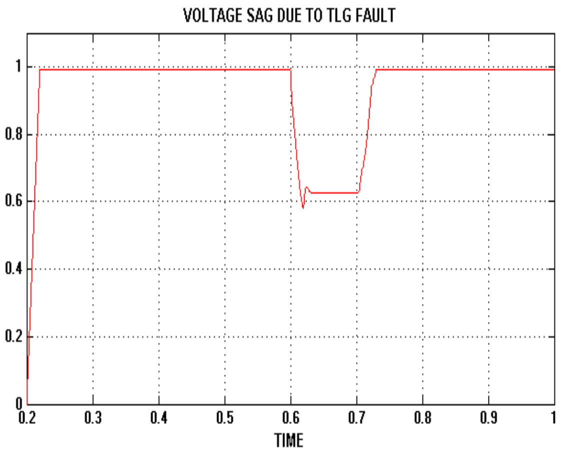

Figure 4: Sag-in-voltage inLLLG fault

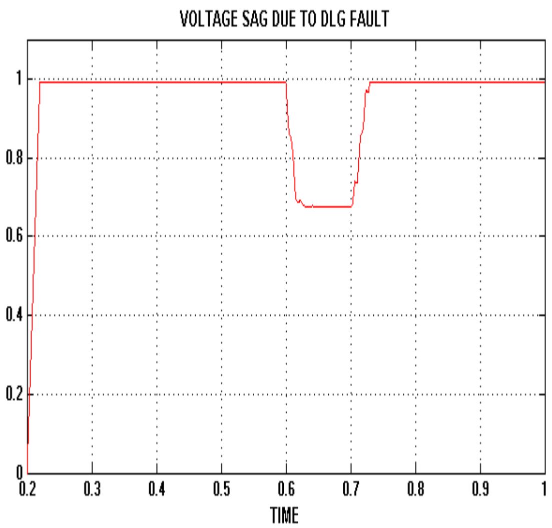

Figure 5: Sag-in-voltage inLLG fault

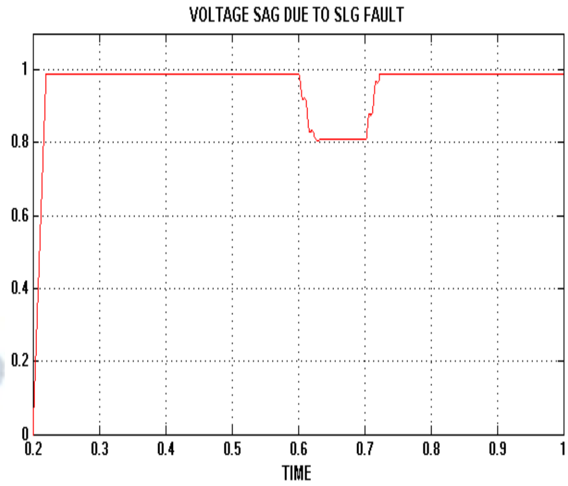

Figure 6: Sag-in-voltage inLG fault

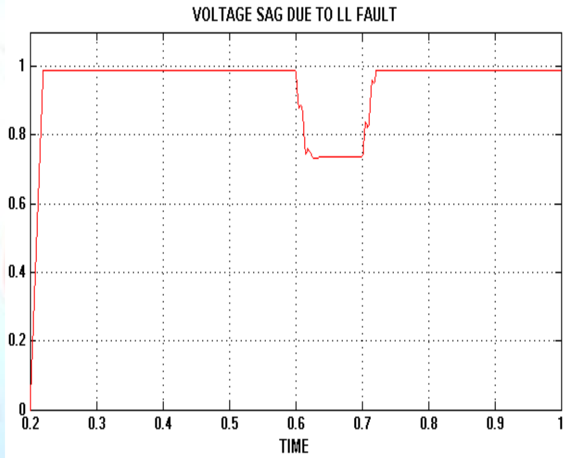

Figure 7: Sag-in-voltage in LL fault

Figure 4 to 7 show the simulation results of thetest system of proposed system for varied types of fault conditions. The fault create during(0.6sec to 0.7sec) when the resistance of the fault, Rf =0.6 Ω.

Table 1: Sag-in-voltage of varied types of faults with varied fault resistances

Fault resistance In ohms	Sag-in-voltage inLLLG fault	Sag-in-voltage inLLG fault	Sag-in-voltage inLG fault	Sag-in-voltage in LL fault
0.6	0.626	0.677	0.809	0.735
0.7	0.681	0.723	0.834	0.771
0.8	0.727	0.762	0.855	0.802

From the table 1, itgives the Sag-in-voltage is reduced for increase of fault resistance value for varied types of fault.

CASE II: WITH DSTATCOM

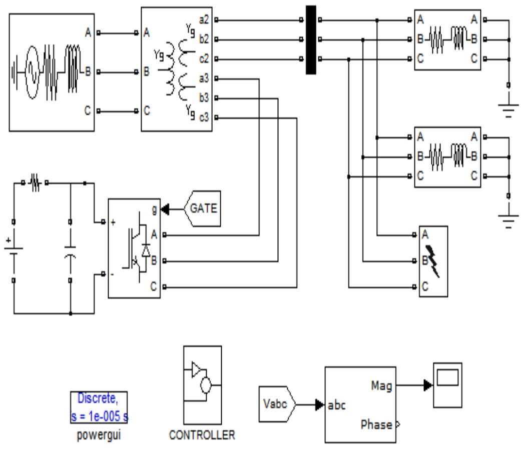

Figure 8: test system of proposed system

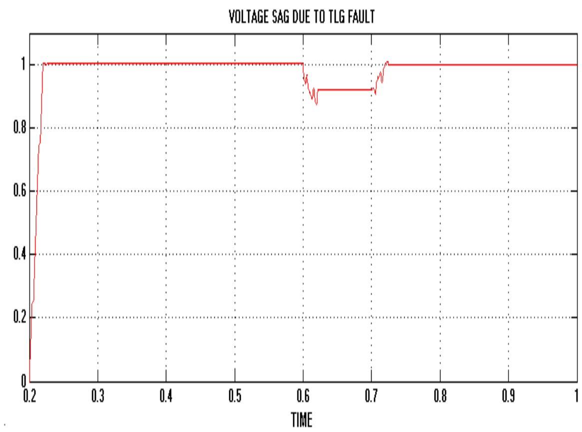

Figure 9: Sag-in-voltage(SAG)due to LLLG fault

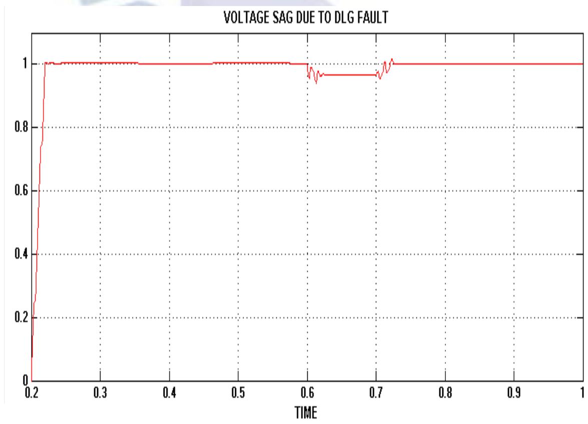

Figure 10: Sag-in-voltage(SAG) due to LLG fault

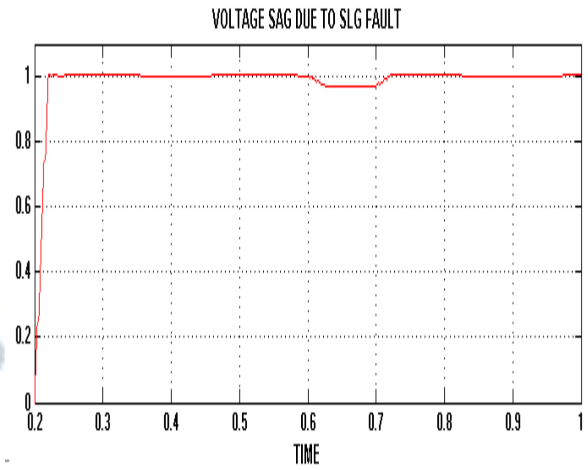

Figure 11: Sag-in-voltage(SAG) due to LG fault

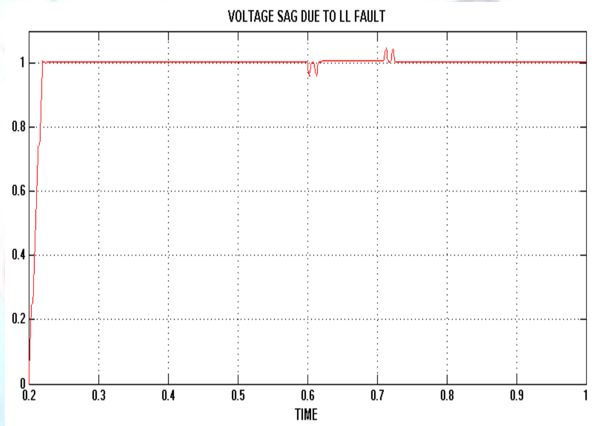

Figure 12: Sag-in-voltage (SAG) due to LL fault

Figure 9 to 12display the simulated outpuys of the test system of proposed system at varied fault conditions. The fault create during (0.6sec to 0.7sec) when the resistance of the fault, Rf =0.6 Ω.

Table 2: Sag-in-voltageat varied faults with varied fault resistances

Fault resistance In ohms	Sag-in-voltage**inLLLG fault**	Sag-in-voltage**in LLG fault**	Sag-in-voltage**in LG fault**	Sag-in-voltage**in LL fault**
0.6	0.920	0.967	0.972	1.000
0.7	0.940	0.975	0.980	1.010
0.8	0.948	0.980	0.983	1.014

From the table 2, Sag-in-voltages improved with combination of D-STATCOM in varied types fault conditions.The range of Sag-in-voltages in between (0.9pu to 1.014p.u.)

Table 3: overall improvement of Sag-in-voltage with and without DSTATCOM

TYPES OF FAULT	WITHOUT DSTATCOM (p.u)	WITHOUT DSTATCOM (p.u)	PERSENTAGE OF IMPROVEMEN
LLLG	0.626	0.920	29.4%
LLG	0.677	0.967	29%
LG	0.809	0.972	16.3%
LL	0.735	1.00	26.5%

From table 3 it observed that D-STATCOM improves the Sag-in-voltageatvaried fault cases with varied resistance values

VI. CONCLUSION

The DSTATCOM is in shunt with distribution system for improvement of the power flow problems.The VSC based shunt connected DSTATCOM successfully mitigates the one of the power transmission problems is Sag-in-voltage with the help of the sinusoidal Pulse Width Modulation control technique. The entire controlling action of DSTATCOM is performed by employing the PI controller in the controller circuit. TheSimulation/MATLAB results shows the overall performance of shunt connected distributed static compensator (DSTATCOM) for mitigation of Sag-in-voltage under varied faults conditions.

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