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The Role Of Dstatcom For Power Quality Improvement In Distribution Networks

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ABSTRACT

At present, a wide range of very flexible controllers, which capitalize on newly available power electronics components, are emerging for custom power applications . Among these, the distribution static compensator is use in the present work. The fast response of the Distribution Static Compensator (DSTATCOM) makes it the efficient solution for improving power quality in distribution systems. DSTATCOM can use with different types of controllers. The device consider in this work is Distribution Static Synchronous Compensator (DSTATCOM) with PI controller to improve the of power quality under different abnormal conditions like single line to ground fault, double line to ground fault in distribution networks with static linear and static non-linear loads.

I. INTRODUCTION

Increasing automation in modem industry and deregulation has changed the requirements on Power Quality. Computer and process control equipment as well as drive converters are sensitive to deviations of the line voltage from the ideal sinusoidal. Voltage sags, harmonic distortion, flicker and interruption of power supply are the most common problems. In an increasing number of cases, where conventional equipment cannot solve these problems, PWM converter-based shunt connected Power Conditioners named DSTATCOM (Distribution Static Compensator) have been introduced. With energy storage added to the Power Conditioner even more flexibility in system operation and planning is provided for utilities and industry. In this paper, Simulink model of test system is analyzed. In this test model two similar loads with different feeders are considered. One of the feeder is connected to DSTATCOM and the other is kept as it is. This test system is analyzed under different fault conditions. System is also analyzed with non linear load under same fault conditions. The control technique implements a PI controller which starts from the difference between the injected current (DSTATCOM current) and reference current (identified current) that determines the reference voltage of the inverter (modulating reference signal).

II. PARAMETERS OF THE TEST SYSTEM

The modeled system has been tested an different fault conditions with linear as well non linear load. The system is employed with three phase generation source with configuration of 11 KV, 50 Hz. The source is feeding two transmission lines through a three phase, three winding transformer with power rating 250 MVA, 50 Hz.

Winding 1: V1rms (ph-ph) = 11 KV, R1 = .0021 (pu), L1 = .080012 (pu).

Winding 2: V2rms (ph-ph) = 11 KV, R2 = .0022 (pu), L2 = .080022 (pu).

Winding 3: V3rms (ph-ph) = 11 KV, R3 = .0021 (pu), L3 = .080012 (pu).

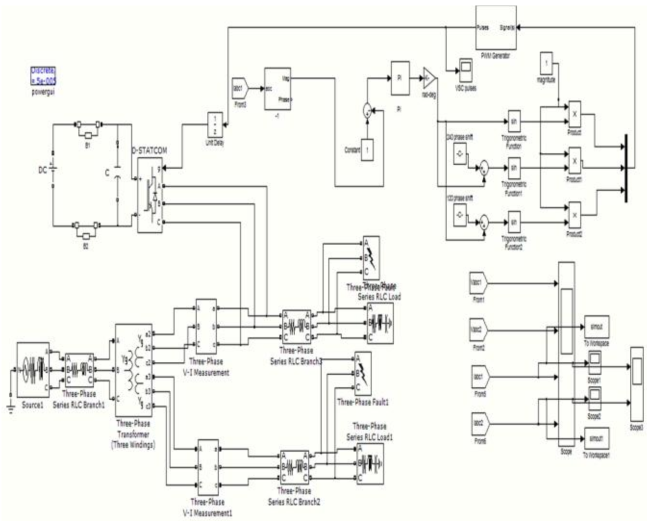
III. SIMULINK MODEL OF THE TEST SYSTEM WITH STATIC LINEAR LOAD

Simulink model of the test system is given in Figure-1. The system consists of two parallel feeders with similar loads of same rating. One of the line is connected to DSTATCOM and the other line is kept as it is. This system is analyzed under different fault conditions.

Figure-1: Simulink model of test system

IV. RESULTS UNDER DIFFERENT FAULT CONDITIONS

Three different fault conditions are considered for the test system as shown in Figure-1 The three different fault conditions are single line to ground, double line to ground and three phase line to ground fault. The results for each fault condition are given one by one.



A. CASE 1. Single Line to Ground Fault Condition

In first case a single line to ground fault is considered for both the feeders. Here the fault resistance is 0.001 ohm and the ground resistance is 0.001 ohm. The fault is created for the duration of 0.3s to 0.5s. The output wave for the load current with compensation and without compensation is shown in Figure-2, Figure-3 respectively

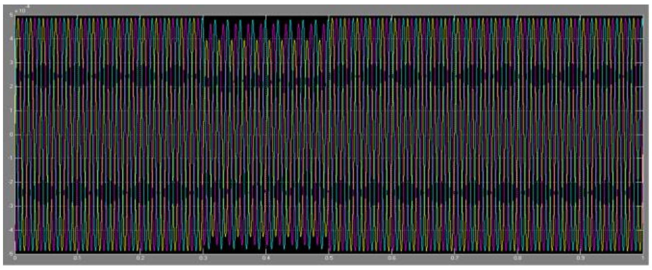
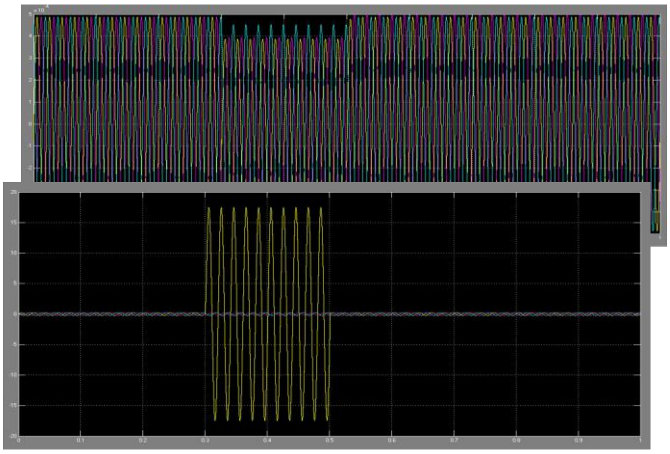


Figure-2: Load current (with compensation)

Figure-3: Load current (without compensation)



Here it is clear from the output wave shapes that the current in the phase where fault is created is increasing during the fault duration in the uncompensated feeder. So, here the unbalancing in the system where DSTATCOM is connected is reduced clearly.

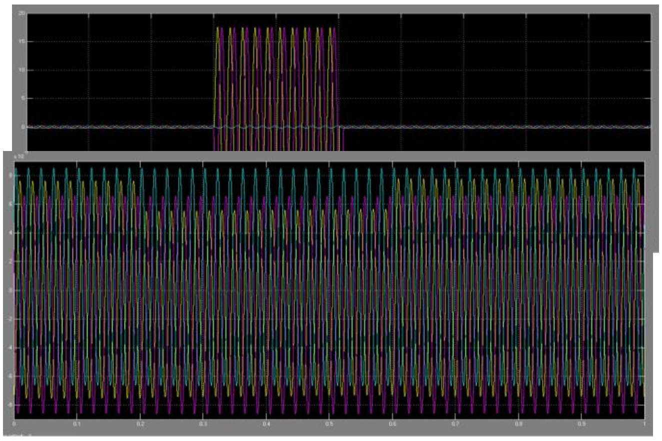
B. CASE 2. Double Line to Ground Fault Condition

In second case considered fault for both the feeders is double line to ground fault. For this fault resistance and ground resistance is 0.001ohm and 0.001ohm respectively. And the time duration for this fault is 0.3seconds to 0.5seconds. The output wave for the load current with compensation and without compensation is shown in figure-4 and Figure-5 respectively.

Figure-4 Load current (with compensation)

Figure-5 Load current (without compensation)

The output wave shapes clear that the current in the phase where fault is created is increasing durin g the fault duration in the uncompensated feeder, but in system where the DSTATCOM is connected unbalancing is reduced clearly.



C. CASE 3. Three Phase Line to Ground Fault Condition

In third case a considered fault for both the feeders is three phase to line fault. The fault is created for the duration of 0.3s to 0.5s. And fault resistance and ground resistance is 0.001ohm and 0.0 01ohm respectively. The output wave for the load current with compensation and without compensation is shown in Figure-6 and Figure-7 respectively.

Figure-6: Load current (with compensation)

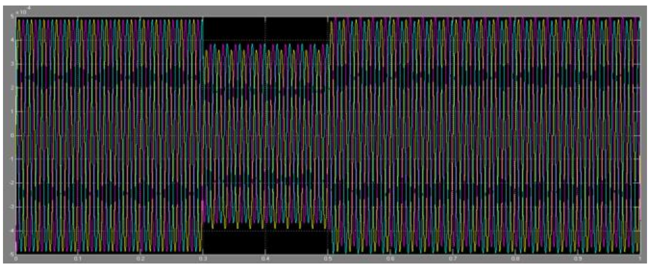
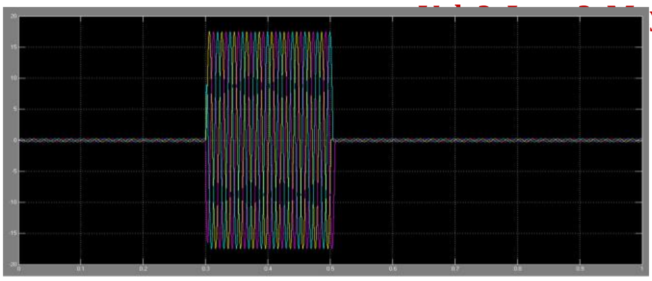
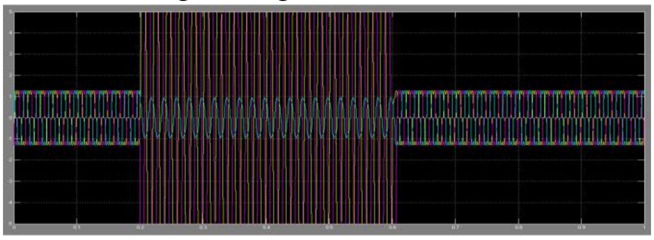


Figure-7: Load current (without compensation)



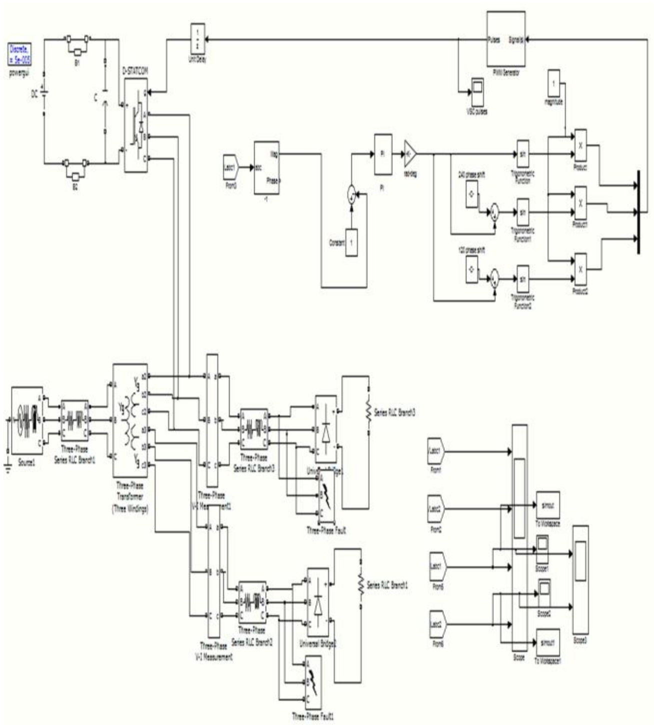
The Figure-6 and Figure-7 respectively shows the wave shapes that the current in the phase where fault is created is increasing during the fault duration in the



uncompensated feeder. And the system where DSTATCOM is connected unbalancing is reduced.

V. SIMULINK MODEL OF TEST SYSTEM WITH STATIC NON LINEAR LOAD

Simulink model of the test system is given in Figure-8. The system consists of two parallel feeders with similar loads of same rating. Here static non linear load is taken. One of the line is connected to DSTATCOM and the other line is kept as it is. This system is analyzed under different



fault conditions.

Figure-8: Simulink model of test system with non linear load.

VI. RESULTS UNDER DIFFERENT FAULT CONDITIONS

Three different fault conditions are considered for the test system as shown in Figure-8. The three different fault conditions are single line to ground, double line to ground and three phase line to ground fault. The results for each fault condition are given one by one.

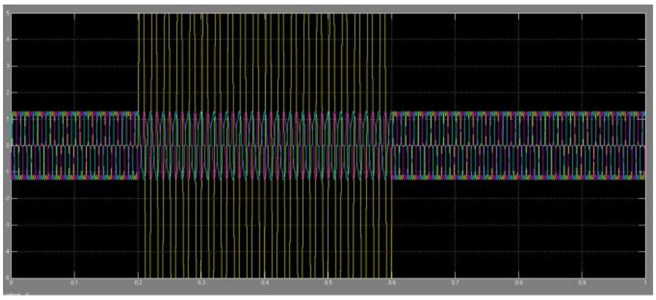
A. CASE 1. Single Line to Ground Fault Condition

In this case a single line to ground fault is considered for both the feeders. Here the fault resistance is 0.001 ohm and the ground resistance is 0.001 ohm. The fault is created for the duration of 0.2s to 0.6s. The output wave for the load current with compensation and without compensation is shown in Figure-9 and Figure-10 respectively.

Figure-9: Load current (with compensation)

Figure-10: Load current (without compensation)

The output wave shapes clear that the current in the phase where fault is created is increasing during the fault duration in the uncompensated feeder, but in system where the DSTATCOM is connected unbalancing is



reduced clearly.

B. CASE 2. Double Line to Ground Fault Condition

In this case a Double line to ground fault is considered for both the feeders. Here the fault resistance is 0.001 ohm and the ground resistance is 0.001 ohm. The fault is created for the duration of 0.2s to 0.6s. The output wave for the load current with compensation and without compensation is shown in Figure-11 and Figure-12 respectively.

Figure-11: Load current (with compensation)

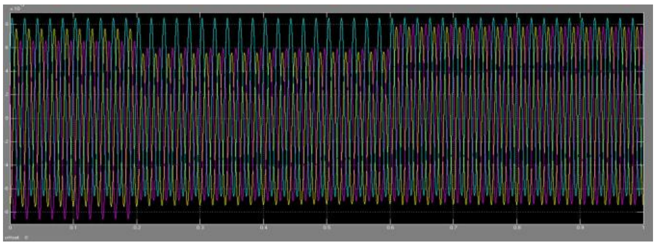


Figure-12: Load current (without compensation)

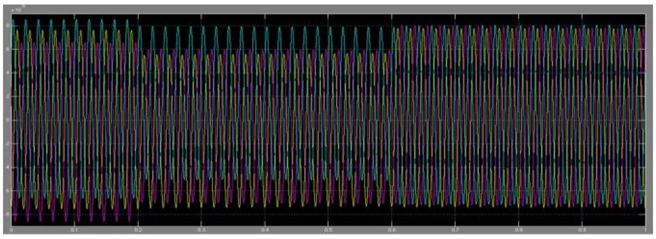
C. CASE 3. Three Phase Line to Ground Fault Condition

In this case a three phase line to ground fault is considered for both the feeders. Here the fault resistance is 0.001 ohm and the ground resistance is 0.001 ohm. The fault is created for the duration of 0.2s to 0.6s. The output wave for the load current with compensation and without compensation is shown in Figure-13 and Figure-14 respectively.

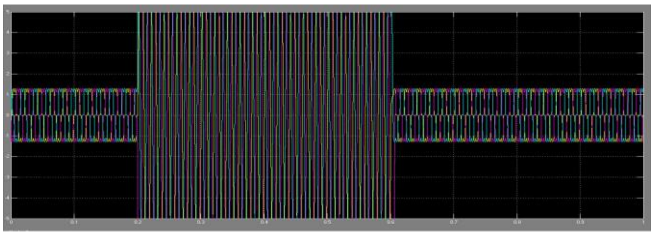
Figure-13: Load current (with compensation)

Figure-14: Load current (without compensation)

Here it is clear from the output wave shapes that the current in the phase where fault is created is increasing during the fault duration in the uncompensated feeder. So here the unbalancing in the



system where DSTATCOM is connected is reduced clearly. These results become clear from the total harmonic distortion graphs, which are taken one by one for compensated and non compensated feeders with

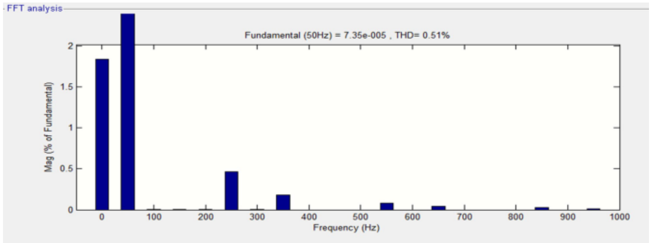


non linear loads.

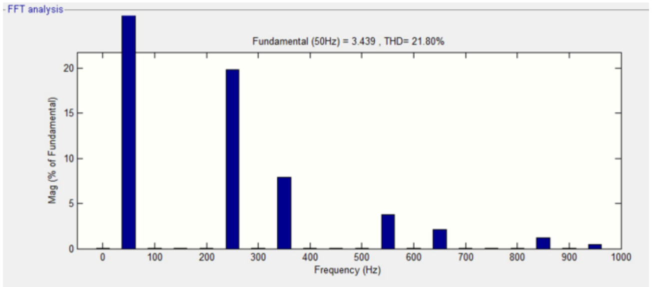
Figure-15: THD (with compensation)

Figure-16: THD (without compensation)

The THD graphs with compensation and without compensation are given in Figure-15 and Figure-16.



The total harmonic distortion without compensation is 21.80%, which is reduced to 0.50% where DSTATCOM is connected.



VII. Conclusion

In this work, the investigation on the role of DSTATCOM is carried out to improve the power quality in distribution networks with static linear and non linear loads. PI controller is used with the device to enhance its performance. Test system is analyzed and results are presented in the previous chapter. The results give the satisfactory applications of DSTATCOM in the distribution networks under different fault conditions and it can be concluded that DSTATCOM effectively improves the power quality in distribution networks with static linear.

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