Available online at www.elixirpublishers.com (Elixir International Journal)

Electrical Engineering

Elixir Elec. Engg. 38 (2011) 4380-4382

ISSN: 2229-712X

Simulation of custom power devices using PSCAD/EMTDC

Bhavya Kanchanapalli and S.Dileep Kumar Varma
Shri Vishnu Engineering College for Women, Bhimavaram.

ARTICLE INFO

Article history:
Received: 22 August 2011;
Received in revised form:
26 August 2011;
Accepted: 31 August 2011;

Keywords
Custom power,
D-STATCOM,
DVR,
PSCAD/EMTDC,
VSC.

ABSTRACT

For some decades, power quality did not cause any problem, because it had no effect on most of the loads connected to the electrical distribution system. Voltage sags is the most common type of power quality disturbance in the distribution. Recently various power electronic devices are proposed for this purpose. Among these devices special attention was given to the family based on the VSC technology for faster response. This project intends to investigate mitigation technique that is suitable for different type of voltage sags source with different type of loads. The mitigation techniques that will be studied are such as Dynamic Voltage Restorer (DVR), Distribution Static Compensator (DSTATCOM). The simulation is done using PSCAD/EMTDC software.

Introduction

Power quality is the one of the major concern at present. Voltage magnitude is one of the major factors that determine the quality of power. In the distribution level the load is subjected to voltage sags and voltage swells because of sudden switching of high inductive loads such as arc furnace & capacitive loads etc. At present most of the industries are using electronic devices which may cause the most of the power quality problems. Voltage swells can cause the over heating, tripping or even destruction of industrial drives. Voltage sag is the one of the severe power quality problem which may be defined as the reduction in voltage magnitude between 0.1pu-0.9pu with respect to the nominal voltage.

Many efforts have been made to remedy the situation. Indeed custom power technology and flexible AC transmission technology (FACTS) has been emerged as a best solution to solve the problem for the continuity of power to the consumer.

At present wide range of flexible controllers are designed for the power system applications. Among this distribution compensator (DSTATCOM) and dynamic voltage restorer (DVR) are based on the VSC technology. A DSTATCOM can inject a voltage in shunt with the system via a coupling transformer and a DVR can also inject the voltage into the system similar to the DSTATCOM but in series.

VSC Based Controllers

In this section VSC based controllers are discussed which are proposed in this paper.

DSTATCOM:

In the basic form, the DSTATCOM consists of a voltage source converter (VSC), dc storage device and a coupling transformer connected in shunt with the system. fig 1 represents the basic form of DSTATCOM.

The VSC converts the dc voltage across the storage device into the three phase AC voltage which is coupled with the system voltage through the reactance of coupling transformer. By the angle between system voltage and VSC voltage the active power flow is controlled and reactive power flow is controlled by the difference between the magnitudes of these voltages. The controller continuously monitors the load voltage and determines the amount of compensation required by the AC system for various disturbances.

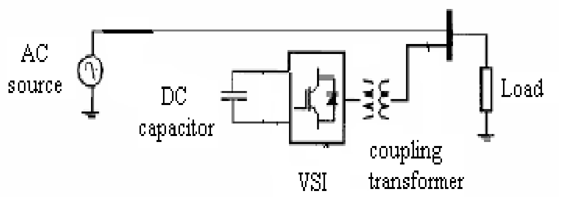

Fig1. Basic configuration of DSTATCOM

The control scheme is explained in the section III.

DVR:

It is a recently proposed series controlled solid state device which injects a voltage in series with the system. It is normally installed between supply system and the sensitive load. In its basic form it is similar to the DSTATCOM but it is connected in series with the system through coupling transformer. Its primary function is to boost up the voltage at the load end in the event of any disturbances. Fig 2 represents the basic form of DVR. The control scheme is explained in section III

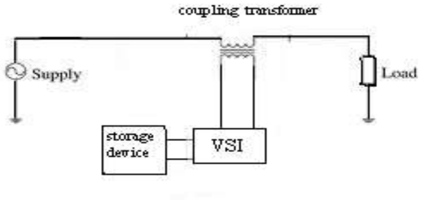

Fig2. Basic configuration of DVR

Control Scheme

This section describes the control scheme for the proposed custom power devices. The control scheme is based on the sinusoidal pulse width modulation (SPWM). The aim of this control scheme is to maintain a constant voltage at the point where a sensitive load is connected under any system

Tele:
E-mail addresses: sagiraju_dileep@yahoo.co.in

disturbances. This scheme is same for both the custom power devices. The control system exerts the voltage control as follows: the load rms voltage Vrms is continuously monitored and compared with the reference voltage magnitude V_{ref} and produces an error signal. This error signal is processed through the PI controller then the controller generates a delay angle which drives the error to zero. In the pwm generator the sinusoidal signal $V_{control}$ is phase modulated by the delay angle generated by the PI controller. This control voltage $v_{control}$ is compared with the triangular signal (carrier signal) and produces the switching signals required for the VSC.

Test Cases and Simulation Results

This section is divided into two parts. In the first part DSTATCOM simulation model is designed and simulations results are explained which is followed by the simulation design of DVR and its results.

DSTATCOM simulations & results

Fig4. Shows the test system implementation for the DSTATCOM using PSCAD/EMTDC. The test system consists of 230KV transmission system which is represented by thevinen equivalent circuit which is feeding the primary of the 3-phase transformer 3 winding transformer. The varying load is connected to 400V the secondary winding of the transformer. The DSTATCOM is connected at the 400V tertiary winding of the transformer. A capacitor is connected is connected on the DC side of the DSTATCOM to provide energy storage capability.

A set of simulations are carried out for the test system shown in fig. 4. the control scheme implemented is shown in fig.3 The simulation relates to two main operating conditions.

1. In the simulation period 300ms-600ms the load is increased by closing the switch B. In this case the voltage is dropped to almost 25% with respect to the reference voltage.

2. At 600ms the switch B is opened and remains same throughout the rest of the simulation then the load voltage is same as the reference voltage i.e. 1PU.

Fig 5(a) shows the RMS voltage at the load point when the DSTATCOM is not connected to the system. Similarly a set of simulations are carried out but now with DSTATCOM. The results are shown in the fig. 5(b), where the effective voltage regulation is achieved.

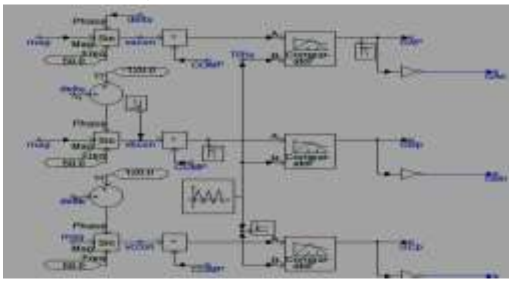

Fig3 control scheme for DSTATCOM

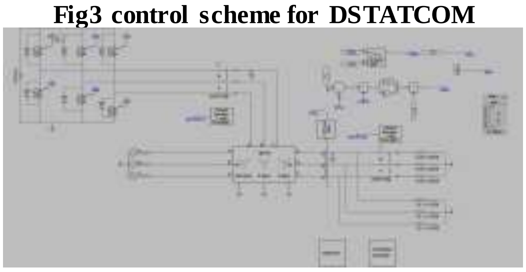

Fig 4. Test system implemented in PSCAD/EMTDC for DSTATCOM simulations

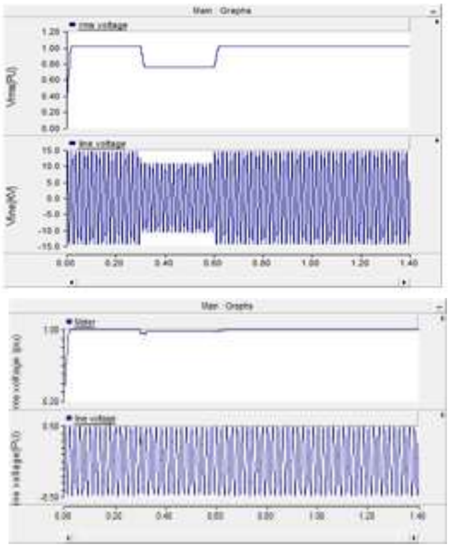

Fig 5) voltage at the load point a) with no DSTATCOM b) with DSTATCOM

DVR simulations & results

Fig7. Shows the test system implementation for the DSTATCOM using PSCAD/EMTDC. The coupling transformer is connected in delta on DVR side with a leakage reactance of 10%. The control scheme implemented is shown in fig.6 .In these two simulations are carried out as follows:

1. At 300-600ms a three phase short circuit fault is applied with a short circuit resistance of 1 Ω. Then the voltage sag is 50% with respect to the reference voltage.

2. The second simulation is carried out with the same fault condition same as above, but now with DVR in operation.

The total simulation period is 1.4ms. The simulation results are as shown in fig 8.

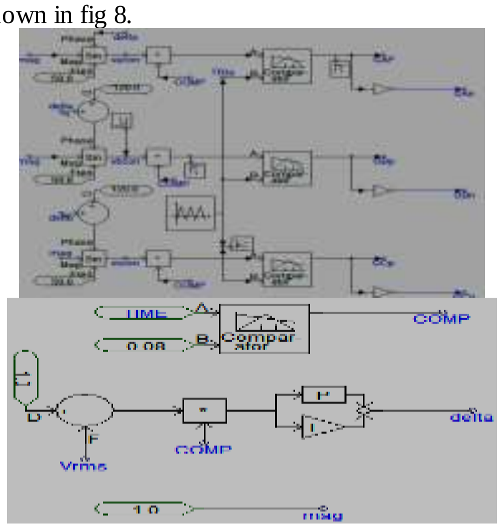

Fig 6. Control scheme for DVR

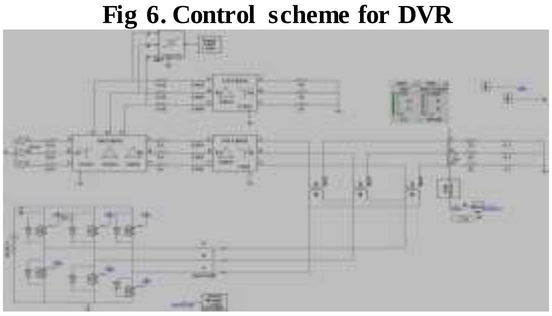

Fig7. Test system implemented in PSCAD/EMTDC for DVR simulations

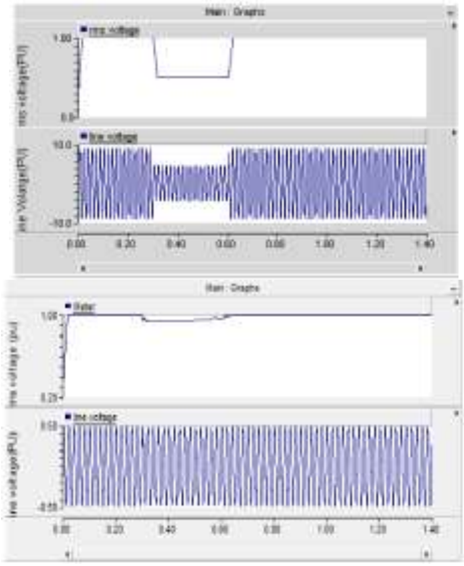

Fig 8) voltage at the load point a) with no DSTATCOM b) with DVR

Conclusion

In this study modeling and simulation of DVR & DSTATCOM with necessary control strategy is implemented. The simulation results showed clearly the performance of the DVR & DSTATCOM in mitigating the voltage sag. The load has been maintained at the constant voltage magnitude. A new PWM based control scheme is implemented to control the operation of the power electronic switches in VSC which is used in the DSTATCOM & DVR. The control scheme will measure only the voltage magnitude but not the reactive power. It is observed that their regulating capability depends on the two factors. They are the capacity of DC storage capacitor and the characteristics of the coupling transformer.

Acknowledgement

I wish to thank our department staff for their constant support to complete my project.

References

[1] Aswin Kumar Sahoo , T.Thyagarajan "Transient studies of FACTS and Custom Power Devices " International Journal Of Recent Trends in Engineering,vol.1 , NO.3, May 2009.

[2] N. Hingorani, "FACTS—Flexible ac transmission systems," in Proc. IEE 5th Int. Conf. AC DC Transmission, London, U.K., 1991, Conf. Pub.345, pp 1–7.

[3]. Hojat Hatami, Farhad Shahnia, Afshin Pashaei, S.H. Hosseini " Investigation on DVR and DSTATCOM operation for voltage control in Distribution networks with new control strategy" .

[4] O. Anaya-Lara, E. Acha, "Modeling and analysis of custom power systems by PSCAD/EMTDC", IEEE Trans. on Power Delivery, Vol. 17, No. 1, pp.266-272, January 2002.

[5]. Introduction to PSCAD/EMTDC, Manitoba HVDC Research Centre, March 2000.

[6]. T.DEVARAJU, DR. V.C. VEERA REDDY "MODELING AND SIMULATION OF CUSTOM POWER DEVICES TO MITIGATE POWER QUALITY PROBLEMS" INTERNATIONAL JOURNAL OF ENGINEERING SCIENCE AND TECHNOLOGY, VOL.2 (6), 2010.