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Compensation of balanced and unbalanced voltage disturbance by SRF controlled DVR

Ms. Priyanka Niroti Nimje
Department of Electrical Engineering (IPS)
Abha Gaikwad Patil College of Engineering
Mohgaon, Nagpur-09, India
8237960881
priyankanimje007@gmail.com

Prof. Bushra Khan
Department of Electrical Engineering (IPS)
Abha Gaikwad Patil College of Engineering
Mohgaon, Nagpur-09, India
8888822367
bushra.electrical@agpce.com

Abstract— **The growth of power electronic technology in the field of electric power sector has caused a greater awareness on the power quality of distribution systems. With the re-structuring of power systems and with shifting trend towards distributed and dispersed generation, the issue of power quality is going to take newer dimensions. The present research is to identify the prominent concerns in this area and hence the measures that can enhance the quality of power. The research work is going to be investigates the problems of voltage sag, swell and its severe impact on nonlinear loads, sensitive loads. Protection of the sensitive unbalanced nonlinear loads from sag/swell, distortion, and unbalance in supply voltage is achieved economically using the dynamic voltage restorer (DVR).DVR is installed between supply and load which will inject voltage and active power to the distribution system during balanced/unbalanced voltage sag and swell disturbances. The control technique used to operate the DVR is SRF Theory with Proportional Integral (PI) controller. The performance of DVR based Synchronous reference frame theory (SRF) for the mitigation of voltage sag, swell for balanced and unbalanced voltages is going to be tested and Simulation results are going to be carried out by MATLAB with its Simu-link to analyze the proposed method .**

Keywords— Synchronous Reference Frame Theory (SRF), Balanced and Un-Balanced Voltage, Dynamic Voltage Restorer (DVR).

I. Introduction

In power distribution systems the advent of a large numbers of sophisticated electrical and electronic equipment such as computers, programmable logic Controllers and variable speed drives causes various power quality problems like voltage sag, voltage swell and harmonics. These are the major concern of the industrial and commercial electrical consumers due to enormous loss in terms of time and money, in which voltage sag and swell are major power quality problems. Voltage sags and swells are the most common power quality problems in electrical distribution systems. Voltage sag is defined as decrease in the rms value of voltage magnitude. Voltage swell is defined as increment in the rms value of voltage magnitude. There are two types of voltage sag and swell which can occur on any transmission lines; balanced and unbalanced voltage sag and swell which are also known as symmetrical and asymmetrical voltage sag and swell respectively. Most of these faults that occur on power systems are not the balanced three-phase faults, but the unbalanced faults. In the analysis of power system under fault conditions, it is necessary to make a distinction between the types of fault to ensure the best results possible in the analysis. In balanced voltage sag & swell, voltage decreases and increase in all three phases simultaneously. In unbalanced voltage sag & swell voltage decrease and increases in only one phase or two phases at a time.

Custom power devices are used to compensate these power quality problems in the systems. There are different types of Custom power devices used in electrical network to improve power quality problems. Each of the devices has its own benefits and limitations. A few of these reasons are as follows. The SVC (Static Var Compensator) pre-dates the DVR, but the DVR is still preferred because the SVC has no ability to control active power flow. Another reason include that the DVR has a higher energy capacity compared to the SMES (Super Conducting Magnetic Energy Storage) and UPS devices. Furthermore, the DVR is smaller in size and cost is less compared to the DSTATCOM (Distributed Static Compensator) and other custom power devices. Based on these reasons, it is no surprise that the DVR is widely considered as an effective custom power device in mitigating voltage sags. In addition to voltage sags and swells compensation, DVR can also add other features such as harmonics and power factor correction. Compared to the other devices, the DVR is clearly considered to be one of the best economic solutions for its size and capabilities .Dynamic Voltage Restorer is located between grid and sensitive load. It injects controlled voltage to keep dc link voltage constant at load-side.

The proposed DVR is connected to the system through the three single phase injection transformers. DVR is designed

according to the voltage needed in the secondary side of transformer. The DVR consists of three single phase VSI units. Each unit is connected to system through the injection transformer. It provides the isolation to the converter. The performance of DVR depends up on control strategy used. In this paper SRF Theory with Proportional Integral (PI) controller technique is used for compensation of balanced/unbalanced voltage sag and swell.

II. problem defination

Power quality is very important issue recently due to the impact on electricity suppliers, equipment manufacture and customers. Power quality is described as the variation of voltage, current and frequency in a power system. It refers to a wide variety of electromagnetic phenomena that characterize the voltage and current at a given time and at a given location in the power system. Nowadays, there are so many industries using high technology for manufacturing and process unit. This technology requires high quality and high reliability of power supply. The industries like semiconductor, computer, and the equipments of manufacturing unit are very sensitive to the changes of quality in power supply.

Power Quality problems encompass a wide range of disturbances such as voltage sags/swells, flicker, harmonics distortion, impulse transient, and interruptions. Voltage sags/swells can occurs more frequently than other Power quality phenomenon. These sags/swells are the most important power quality problems in the power distribution system. Maintaining the Integrity of the Specifications

III. objectives

One of the best solutions to improve power quality is the dynamic voltage restorer (DVR). DVR is a kind of custom power devices that can inject active/reactive power to the power grids. This can protect loads from disturbances such as sag and swell. Usually DVR installed between sensitive loads feeder and source in distribution system.

Its features include lower cost, smaller size, and its fast dynamic response to the disturbance. In this project SRF technique is used for conversion of voltage from rotating vectors to the stationary frame. SRF technique is also referred as park's transformation. In this the reference load voltage is estimated using the unit vectors.

IV. description of praposed work

A. Dynamic voltage restorer (DVR)

The DVR consists of the following major parts:-

1) Voltage source inverter (VSI)

PWM inverter using IGBT switches is used in the model. IGBT switches are commonly used in series connected circuits. The insulated gate bipolar transistor or IGBT is a three-terminal power semiconductor device, noted for high efficiency and fast switching. Pulse-width modulation (PWM) is a very efficient way of providing intermediate amounts of electrical power between fully on and fully off. The voltage source converter is used to convert the DC to AC and then supply the voltage to distribution feeder through an injection transformer.

2) Injection transformer

The injection transformers connect the DVR to the distribution network via the high voltage windings. They transform and couple the injected compensating voltages generated by the VSI to the incoming supply voltage. Basically injection transformers used in the model presented in this paper are three single phase transformers. The high voltage side of the injection transformer is connected in series to the distribution line, while the low voltage side is connected to the DVR power circuit. For a three-phase DVR, three single-phase or three-phase voltage injection transformers can be connected to the distribution line, and for single phase DVR one single-phase transformer is connected. The transformers not only reduce the voltage requirement of the inverters, but also provide isolation between the inverters.

3) Passive filter

Passive filters are placed at the high voltage side of the DVR to filter the harmonics. These filters are placed at the high voltage side as placing the filters at the inverter side introduces phase angle shift which can disrupt the control algorithm.

4) Energy storage

The energy storage unit supplies the required power for compensation of load voltage during voltage sag. A dc battery is used for this purpose. Batteries, flywheels or SMEs can be used to provide real power for compensation. Compensation using real power is essential when large voltage sag occurs.

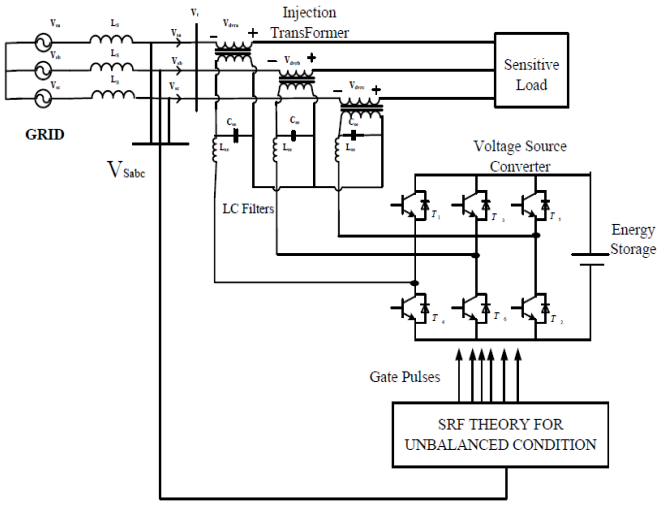

Fig 1 .Dynamic voltage restorer.

B. DVR based on synchronous reference frame theory

The following figure shows the Control Block Diagram of the DVR .In this control, Source Voltage is sensed and is given as an input to the abc/dq transformation block .The same source voltage is given as an input to the PLL block , this PLL block gives the information of sin, cos .This is given as an input to the abc/dq block, with these two inputs this transformation block gives Vd, Vq, and Vo information .

This information is compared with Vdact, Vqact and Voact which are the actual parameters .The quadrature and Vo axis is compared with 0 p.u .The error generated is given as an input to the pi controller ,the pi controller output is again given as an input to dq/abc block , and PLL information is also given as an input to dq/abc block. This block gives us the pulse information which is given as an input to pwm generator and from that gate pulses are generated, those gate pulses are for inverter.

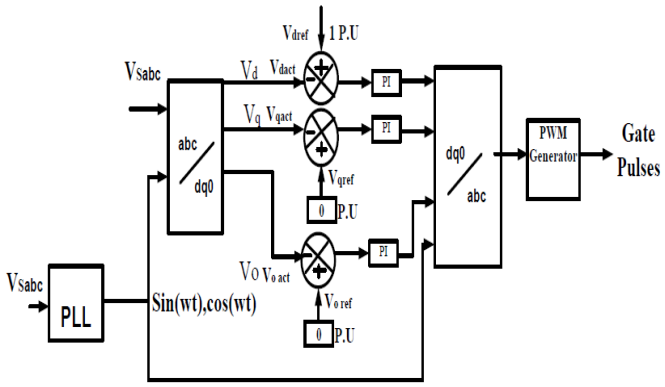

Fig 2. DVR controlled SRF theory.

conclusion

DVR is capable of compensating the various voltage disturbances like single phase and two phase sag and swell in unbalanced condition as well as sag and swell in unbalanced condition in three phases. Various conditions are tested for the performance capability of DVR through extensive simulation and results are verified.DVR is tested for balanced sag, swell, multiple sag and multiple swell and sag and swell cases, and in unbalanced condition sag and swell in single and two phases as well as unbalanced three phase condition.

In this research work we are going to improve the compensation of device by implementing the hardware model using facts device and MatLab -Simulation result using DVR based SRF controlled. The DVR is the best solution for mitigating the various voltage disturbances in a distribution system.

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