Chapter 3

Power Quality Improvement in Distribution System Using Dynamic Voltage Restorer

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ABSTRACT

With the advancement of technology, the dependency on the electrical energy has been increased greatly. Computer and telecommunication networks, railway network banking, post offices, and life support systems are a few applications that cannot function without electricity. At the same time, these applications demand qualitative energy. However, the quality of power supplied is affected by various internal and external factors of the power system. Harmonics, voltage, and frequency variations deteriorate the performance of the system. Voltage sag/dip is the most frequent problem and there are many methods to overcome this problem. The use of FACT devices is an efficient one. This chapter discusses an overview of the FACT device known as dynamic voltage restorer (DVR) in mitigating voltage sag. The strategy to control this device is also presented. The proposed control strategies are simulated in MATLAB SIMULINK environment and analyzed. The method is utilized and discussed briefly.

INTRODUCTION

Modern society is fully dependent on the Power generated by generating station. Traditional power system comprises of three parts i.e. generation, transmission and distribution of electrical power in the form of AC. The generated power should have good quality so that it can energize all equipments or appliances equally and satisfactorily (Papic, 2000). Due to heavy loads or any abnormal conditions or faults on the line reduces the quality of the power, becomes less suitable for further applications.

The power provided by generating station must be improved for delivering pure and clean power to the end users. For delivering a good quality of power, Flexible AC Transmission System (FACTS) devices like static synchronous series compensator (SSSC), static synchronous compensator (STATCOM), interline power flow controller (IPFC), unified power flow controller (UPFC) etc. were used.

DOI: 10.4018/978-1-7998-1230-2.ch003
Generally, FACTS devices are modified to be used in electrical distribution system known as Custom Power Devices. Some of the widely used custom power devices are Distribution Static Synchronous Compensator (DSTATCOM), Dynamic Voltage Restorer (DVR), Active filter (AF) and Unified power quality conditioner (UPQC) (Pal and Gupta, 2015; Khan et al., 2019; Khan et al., 2018; Khan et al., 2017; Banteywalu et al., 2019; Anteneh et al., 2019; Molla et al., 2019, Molla et al., 2018, Jariso et al. 2018). These devices are used to reduce power quality problems. DVR is one of the most efficient and effective custom power devices due to its fast response, lower cost and smaller size. Power electronics technology had played an important role in power flow control and utilization of electrical energy. Consumers need constant sine wave, constant frequency and symmetrical voltage with a constant root mean square (RMS) value to continue the production (Alhelou et al., 2019; Makdisie et al., 2018; Alhelou et al., 2016; Haes Alhelou et al., 2019; Njenda et al., 2018). So to satisfy these demands, of course the disturbances must be eliminated from the system. Some of the typical Power quality issues in the system such as sags, swells, these disturbances change the shape of the sine waveform of the supply voltage and adversely affect the performance of equipment connected to the system (Ansal et al. 2016). The voltage sag’s magnitude mainly ranged from 10% to 90% of nominal voltage and with duration from half a cycle to 1 min and swell is defined as an increase in RMS voltage or current at the power frequency for durations from 0.5 cycles to 1 min. (Singh et al. 2016).

There are two general approaches to mitigate power quality disturbances. One approach is to ensure that the process equipment is less responsive to disturbances, allowing it to ride-through the disturbances (Pal and Gupta, 2015; Khan et al. 2014; Khan et al. 2013; Khan et al. 2012; Negash et al., 2017; Negash et al., 2016; Jariso et al. 2017; Kifle et al. 2018; Yeshalem et al. 2017; Singh et al. 2017; Gupta et al., 2015). The other approach to suppress or neutralize the disturbance at the customer end is installing custom power devices. The DVR is one of most effective and efficient power electronic custom power device, which is used to inject voltage in series with distribution feeder in order to compensate for voltage sag/swell. In order to restore the load voltage, active and/or reactive power should be injected into the distribution feeder.

**Literature Review**

Voltage quality is the most important portion of power quality. The quality of voltage can be affected by several events including voltage sags and voltage swells. These events can cause malfunction of voltage sensitive loads and automated process disruption. As a result, the voltage sags and swells can lead to huge financial and technical losses. Therefore, the voltage sags and swells should be avoided as far as possible. One of the solutions is to install a proper device at sensitive load location to mitigate the voltage sags and swells (Alhelou et al., 2019; Makdisie et al., 2018; Alhelou et al., 2018; Alhelou et al., 2016; Haes Alhelou et al., 2019; Njenda et al., 2018). Power electronic based solutions have been widely applied for solving the problems (Babaei and Kangarlu, 2015). There are varieties of custom power devices available each with its own benefits and boundaries: Active Power Filters (APF), Battery Energy Storage Systems (BESS), Distribution Series Capacitors (DSC), Solid-State Transfer Switches (SSTS), Surge Arresters (SA), Super conducting Magnetic Energy Systems (SMES), Uninterruptible Power Supply (UPS), Static Electronic Tap Changers (SETC), Solid State Fault Current Limiter (SSFCL), Static VAR Compensator (SVC) and Thyristor Switched Capacitors (TSC), unified power-quality conditioner (UPQC), Distribution-STATCOM (DSTATCOM) and dynamic voltage restorer (DVR).
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