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A Review Article to Voltage Sag and Swell Power Compensation with Power Stabilization Using SAF

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Abstract- The parameters of electrical energy, such as supply voltage amplitude, are very important, especially from the viewpoint of the final consumer with respect to sensitive loads connected to the grid. Dynamic states in the power grid?voltage sags and swells?might cause faults and defects to develop in sensitive loads. To mitigate unwanted effects, many topologies of ac/ac converters are implemented as voltage compensators. This article presents a review of hybrid ac/ac converters designed to compensate voltage sags and swells with the aim of protecting sensitive loads against sudden and severe changes in supply voltage amplitude. In this article, only solutions without galvanic separation between source and load are described. To assess the properties and to compare different topologies of voltage compensators, some common parameters, such as range of voltage sag and swell compensation, reliability, quantity of switches and transformers, and required power ratings of power electronic units in relation to power of load, are introduced. In addition, we discuss possibilities for compensation of voltage interruption, time of compensation, the efficiency, and the effect on the supply network of the described circuits. The results of the analysis have been collected and compared in tabular form and represented in graphical form. Furthermore, we show potential areas of application for particular solutions of ac voltage compensators.

Keywords- Dynamic Voltage Restorer (DVR), voltage sags, voltage swells, sensitive load.

I. INTRODUCTION

Thanks to industrial automation, in recent years electronic facilities are increasingly demanding with respect to the quality of their electricity, such as sudden voltage sags/swells, and demand for an output voltage with low harmonic distortion. Sudden voltage sags (caused mainly by the starting of high-power motors or by short circuit) are normally the most common disruptions for electrical systems. They account for more than 90% of power quality issues. Voltage swell, on the other hand, occurs when switching large capacity devices, removing heavy loads, and when uni-directional ground connection malfunctions occur. Sudden voltage sags affect systems tremendously.

Modern semiconductor facilities, such as computer communications systems, measurement instruments and production machineries, are all very sensitive to voltage changes. Even a mere three to five cycles of voltage change can hang systems and affect factory production.

It follows, then, that since all of the high-tech industries use computerized, automated systems that are highly voltage sensitive, investment in stable voltage output and power quality is a required necessity. As dynamic voltage restorers (DVRs) need to be highly efficient and highly reliable, their deployment requires both electrical and electronic techniques.

There are two types of DVR systems: one uses the energy storage element to supply the compensated power source, as shown in Figure 1a, and the other uses the utility power source with AC/DC converter to supply the compensated power, as shown in Figure 1b. Figure 1c shows the proposed novel AC/AC converter used in this paper to compensate the power source for the DVR system without a bulk capacitor, in order to improve system efficiency and reduce the cost of the proposed DVR system with the proposed single-stage AC/AC converter.

II. LITERATURE REVIEW

1. Mitigation of Voltage Sags/Swells Unbalanced in Low Voltage Distribution Systems:
From this Paper we referThe main problems of the power quality like voltagesags/swells in low voltage distribution systems and on the transmission side due to sensitive loads, the terminology used forthe compensation devices is different. Dynamic Voltage Restorer (DVR) is one of the equipment's for voltage disturbancemitigation in power systems. It is installed between the incomingsupply and the sensitive loads to maintain the voltage at thesensitive load from balance. This paper proposes a mitigation ofvoltage sags/swells in low voltage distribution system using aneffective series compensator (DVR). The compensator shouldprotect sensitive loads against of voltage sags/swells. Performanceof the proposed method is investigated under different types

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offault in both single phase and three phases for various sensitiveload conditions. The simulation was carried out with the help ofSIMULINK & MATLAB and the results show appropriateoperation of the proposed control system.

2. Optimal Placement of Dstatcom for Voltage Sag Mitigation Using an Anfis Based Approach:
FOR POWER QUALITY ENHANCEMENT From this Paper we referDSTATCOM is one of the equipment's for voltage sag mitigation in power systems. Voltage sag has been considered as one of the most harmful power quality problem as it may significantly affect industrial production. This paper presents an Artificial Neuro fuzzy inference system (ANFIS) based approach for optimal placement of Distribution Static Compensator (DSTATCOM) to mitigate voltage sag under faults. Voltage sag under different type of short circuits has been estimated using MATLAB/SIMULINK software. Optimal location of DSTATCOM has been obtained using a feed forward neural network trained by post-fault voltage magnitude of three phases at different buses. Case studies have been performed on IEEE 30-bus system and effectiveness of proposed approach of DSTATCOM placement has been established.

3. Performance Evaluation of D-Statcom for Voltage Fluctuations in Power Distribution System:
From this Paper we referAs demand of quality and reliability of electric power is continuously increasing, Power Quality has now become a important aspect in the current power scenario. Power quality determines quality and ability of electric power available at the consumer end. Maintaining voltage, frequency and phase to desired level allows electrical systems to provide quality and reliability of power without considerable loss of performance or life. poor power quality can be caused due to failure of loads and sudden switching of heavy electrical loads in the network, which mainly result in voltage sag and swell , disturbances in loads may also results in voltage fluctuation. However voltage flicker and interruptions are the most common problem which effects power quality.

4. Mitigation of Voltage Sag and Voltage Swell by Using D-Statcom and Pwm Switched Autotransformer:
From this Paper we refer This paper proposes a novel distribution-level voltage control scheme that can compensate voltage Sag and Swellconditions in three-phase power systems. Faults occurring in power distribution systems or facilities in plants generally cause the voltage sag or swell. Sensitivity to voltage sags and swells varies within different applications. For sensitive loads, even the slightest voltage sag for short duration can cause serious problems. Normally, a voltage interruption trigger protection device, which causes shut down the entire load. In order to mitigate power interruptions, this paper proposes a voltage sag support based on a pulse width modulatedautotransformer and D-STATCOM. The proposed devicesquickly recognize the voltage sag and voltage swell conditions and correct the voltage by either boosting the input voltage during voltage sag events or reducing the voltage during swell events. Simulation analysis of these devices is performed in PSCAD/EMTDC and performance analysis of the system is presented for various levels of sag and swell. Simulation results are presented for various conditions of sag and swell disturbances in the supply voltage to show the compensation effectiveness.

5. Comparative Study on Voltage Sag/Swell Mitigation by Modelling and Simulation of DVR and DSTATCOM:
From this Paper we referThe electrical energy is one of the easily used forms of energy. It can be easily converted to other forms of energy. With the advancement of technology, the dependency on the electrical energy has been increased greatly. Computer and telecommunication networks, railway network banking, post office, life support system are few application that just 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. The presence of harmonics, voltage and frequency variations deteriorate the performance of the system. In this paper the frequently occurring power quality problem- voltage variation is discussed. The voltage sag/dip is the most frequently occurring problem. There are many methods to overcome this problem. Among them the use of FACT devices is an efficient one. This paper presents an overview of the FACT devices like- DVR, D-STATCOM, in mitigating voltage sag. Each one of the above device is studied and analyzed. And also the control strategies to control these devices are presented in this project. The proposed control strategies are simulated in MATLABSIMULINK environment and the results are presented in this paper. A comparative study based on the performance of these devices in mitigating voltage sag is also presented.

6. Design and Simulation Studies of D-Statcom for Voltage Sag, Swell Mitigation:
From this Paper we referThis paper presents the design of a prototype distribution static compensator (D-STATCOM) for voltage sag mitigation in an unbalanced distribution system. The D-STATCOM is intended to replace the widely used static Varcompensator (SVC). The model is based on the Voltage Source Converter (VSC) principle. A new PWM based control scheme has been implemented to control the electronic valves in two level of VSC. The D-STATCOM injects a current into the system to mitigate the voltage sags. In this work, the 6-pulse D-STATCOM configuration with IGBT has been designed using MATLAB SIMULINK. Accordingly, simulations are first carried out to illustrate the use of DSTATCOM in mitigating voltage sag in a distribution

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system. Simulation results prove that the D-STATCOM is capable of mitigating voltage sag as well as improving power quality of a system.

The integration of distributed generation (DG) involving windmills, solar plants, fuel cells, etc., is growing considerably. The application of DG has numerous technical, environmental, and economical advantages. However, the integration of DG imposes many challenges on the electric utilities [13]. The controlling of DG mainly depends upon reactive power compensation. Frequent changes to the reactive power consumption of bulk loads can introduce voltage sag and swell into the system. This causes a change in the real power demand of the system, resulting in power fluctuations [14].

Uncompensated reactive power also affects the efficiency of DG system, power factor (PF), and active power capability. The use of a power electronic converter (PEC) for the interconnection of DG to the utility grid ensures the safe functioning of equipment and switching between sources. However, it introduces a wide range of PQ problems such as current and voltage harmonics, voltage sag/swell, voltage and current unbalance, voltage flicker, load reactive power, neutral current, impulse transients, and interruptions [15].

III. RESEARCH MOTIVATION

Electrical Energy is invisible; a universal commodity that is immediately available in most of the world, and it has now been recognized as everyday consumer need [1]. Renewable Energy Systems (RESs) is used to aid the primary energy demand in solar, solar thermal, wind energy, etc. The intermittent nature of RESs, harmonics, and reactive power problems halt the power system's performance by originating stability concerns in the power system [2], [3]. The Flexible AC Transmission Systems (FACTS) devices are widely adapted for reactive power compensation, voltage stability, and power quality in distribution grids around the world [4], [5]. However, FACT devices also alter different parameters on the transmission and distribution system [6].

This work presents a study of the power quality and aims at identifying the causes of poor power quality and provides the solutions to these power quality problems. Some equipment like computers, laptops, relays, solid-state devices, adjustable speed drives, and optical devices are known as sensitive equipment. These devices are susceptible to input voltage variations created by interference with other parts of the system.

The power system is divided into the following parts as generation, transmission, distribution, and by using other transmission line power systems is fed to different loads on the distribution side. Power quality plays a vital role in the power system when variable power is supplied to the load. Subsequently, the domestic and industrial customers with delicate loads are affected by the poor quality of power. Even there is various type of load on the distribution side, but poor power quality affects the sensitive loads more than others.

Nowadays, most of the equipments based on power electronic devices used by the industry, lead to power quality problems. These devices not only need high-quality energy to work properly but also are the major cause for decreasing of power quality. In these conditions, both electric utilities and customers are increasingly affected from the quality of electric power. Between the different technical approaches available for compensation of power quality problems, Active Power Filters (APFs) have an important alternative to compensate the power quality problems [1].

Different configurations of APFs can be found in [2] and [3]. One of the comprehensive systems for many of power quality problems, such as current harmonics, reactive power, and source voltage distortions, is Unified Power Quality Conditioner (UPQC) [4]. It consists of two back to back connected series and shunt Voltage Source Inverters (VSIs) with a common dc link [5-9].

In all of the previous contributions of series and shunt inverters DC link capacitor is a major part of compensator. Custom power devices such as UPQC by a DC link capacitor need to an external control circuit for arranging up the DC capacitor stored energy. Although limit stored energy in DC capacitor causes inability of deep voltage sags and interruptions [10].

In the last decade, Distributed Generation systems (DGs) which use Clean Energy Sources (CESs) such as wind power [10], fuel cells [11] and photo voltaic are integrated at distribution level increasingly and will have major role in future sustainable energy systems [4]. Also they can be as an active power source which affects in stability, voltage regulation and Power Quality (PQ) issues of the network. With the advancement in power electronics, the custom power devices with DG systems can now be actively controlled to enhance the system operation for improving PQ at Point of common Coupling (PCC) [12].

In this area converters not only are considered as an essential part of custom power devices such as UPQC but also have a key role in connecting of different types of DGs to the grid. So, further studying and developing of them can be an essential problem.

A high frequency link direct boost DC-AC converter accompanied by a dc link capacitor has been proposed in [3]. Existence of DC link capacitor in this converter can lead to increase in circuit degree and difficulty in dynamic analysis. In some of related schemes, converters with a galvanic isolation high frequency link can be used for

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elimination of the DC link capacitor and big volume power transformer [4, 5].

The previous configurations of UPQC, based on limit DC link capacitor energy storage are unable to compensation of deep and long voltage sags, and interruptions [10]. This problem could be solved by using of DG as an active source in DC side of custom power devices such as UPQC. In [4] a series of photovoltaic arrays as a DC DG, have been connected to the DC side of UPQC via a boost DCDC converter.

In [10] a wind turbine as an AC DG has been connected to the DC side of UPQC via a DC-AC converter. Also because of variable nature of wind a battery has been connected directly to the DC side of UPQC. The battery is used in low power generation condition by the wind turbine. In [6] a small AC generator has been connected to the DC side of UPQC via a rectifier which could be as an active power source for load supply and compensation of voltage interruptions. In [7] a single phase combination of photovoltaic systems with UPQC for power quality compensation has been investigated too.

IV. CONCLUSION

In this paper, we are showing the solution for the Voltage Sags and Swells. We can use many types of methodology. DVR is the main method by which we can reduce the problem of voltage Sags and Swells. Voltage Sags and Swells are giving the main problem to the sensitive load in the distribution network.

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