POWER QUALITY IMPROVEMENT BY USING DSTATCOM

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ABSTRACT: Maximum AC loads consumes reactive power, it causes poor power quality in power system. The DSTATCOM is a compensating device which is used to control the flow of reactive power in the distribution systems. The complete background of the compensating devices and power electronic application in compensating devices is presented in this paper and also the compensation using the DSTATCOM modeling is also discussed. The detailed modeling and simulations of different control strategies are presented and implemented along with the necessary equations in the MATLAB simulink using the simpower systems tool boxes. The PI controllers are used for the implementation of the models and are discussed. Simulation results are we discussed and various case studies applied depending on the various loads like resistive, inductive and capacitive on the DSTATCOM simulink models and the simulation results are studied.

Keywords: Reactive power compensation, DSTATCOM, dq- model, power control and power quality.

INTRODUCTION

In the early days of power transmission in the late 19th century problems like voltage deviation during load changes and power transfer limitation were observed due to reactive power unbalances. Most of the AC loads are consuming reactive power due to presence of reactance. Heavy consumption of reactive power causes poor voltage quality. Today these Problems have even higher impact on reliable and secure power supply in the world of Globalization and Privatization of electrical systems and energy transfer. The development in fast and reliable semiconductors devices (GTO and IGBT) allowed new power electronic Configurations to be introduced to the tasks of power Transmission and load flow control. The FACTS devices offer a fast and reliable control over the transmission parameters, i.e. Voltage, line impedance, and phase angle between the sending end voltage and receiving end voltage. On the other hand the custom power is for low voltage distribution, and improving the poor quality and reliability of supply affecting sensitive loads. Custom power devices are very similar to the FACTS. Most widely known custom power devices are DSTATCOM, UPQC, DVR among them DSTATCOM is very well known and can provide cost effective solution for the compensation of reactive power and unbalance loading in distribution system.

The performance of the DSTATCOM depends on the control algorithm i.e. the extraction of the current components. For this purpose there are many control schemes which are reported in the literature and some of these are instantaneous reactive power (IRP) theory, instantaneous compensation, instantaneous symmetrical components, synchronous reference frame (SRF) theory, computation based on per phase basis, and scheme based on neural network. Among these control schemes instantaneous reactive power theory and synchronous rotating reference frame are most widely used. This paper focuses on the compensating the voltage sag, swells and momentary interruptions. The dynamic performance is analyzed and verified through simulation. It is a custom power device which is gaining a fast publicity during these days due to its exceptional features like it provides fast response, suitable for dynamic load response or voltage regulation and automation needs, Both leading and lagging VARS can be provided, to correct voltage surges or sags caused by reactive power demands DSTATCOM can be applied on wide range of distribution and transmission voltage, overload capability of this provides reserve energy for transients.

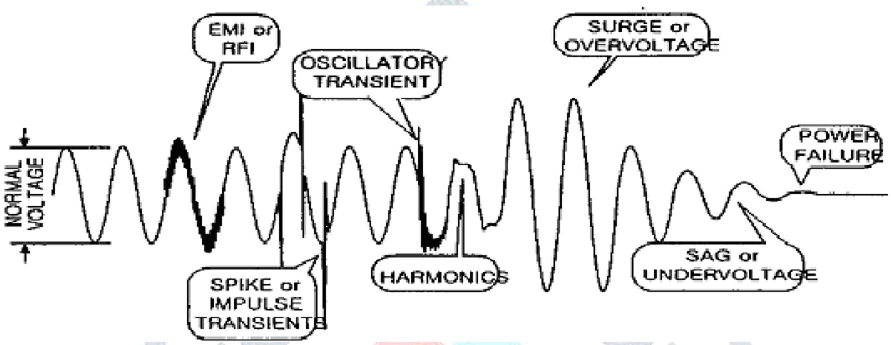
The causes of power quality problems are generally complex and difficult to detect. Technically speaking, the ideal AC line supply by the utility system should be a pure sine wave of fundamental frequency (50/60Hz).Different power quality problems, their characterization methods and possible causes are discussed above and which are responsible for the lack of quality power which affects the customer in many ways. We can therefore conclude that the lack of quality power can cause loss of production, damage of equipment or appliances or can even be detrimental to human health. It is therefore imperative that a high standard of power quality is maintained. This project demonstrates that the power electronic based power conditioning using custom power devices like DSTATCOM can be effectively utilized to improve the quality of power supplied to the customers.

The aim of the paper is shows to implement DSTATCOM with control strategies in the MATLAB, simulink using Simpower systems tool box and to verify the results through various case studies applying different loads and study them in detail.

POWER QUALITY AND RELIABILITY:

Power quality and reliability cost the industry large amounts due to mainly sags and short-term interruptions. Distorted and unwanted voltage wave forms, too. And the main concern for the consumers of electricity was the reliability of supply. Here we define the reliability as the continuity of supply. As shown in Fig.1, the problem of distribution lines is divided into two major categories. First group is power quality, second is power reliability. First group consists of harmonic distortions, impulses and swells. Second group consists of voltage sags and outages. Voltage sags is much more serious and can cause a large amount of damage. If exceeds a few cycle, motors, robots, servo drives and machine tools cannot maintain control of process

Fig.1. power quality and reliability



Both the reliability and quality of supply are equally important. For example, a consumer that is connected to the same bus that supplies a large motor load may have to face a severe dip in his supply voltage every time the motor load is switched on. In some extreme cases even we have to bear the black outs which is not acceptable to the consumers. There are also sensitive loads such as hospitals (life support, operation theatre, and patient database system), processing plants, air traffic control, financial institutions and numerous other data processing and service providers that require clean and uninterrupted power. In processing plants, a batch of product can be ruined by voltage dip of very short duration. Such customers are very wary of such dips since each dip can cost them a substantial amount of money. Even short dips are sufficient to cause contactors on motor drives to drop out. Stoppage in a portion of process can destroy the conditions for quality control of product and require restarting of production. Thus in this scenario in which consumers increasingly demand the quality power, the term power quality (PQ) attains increased significance

Transmission lines are exposed to the forces of nature. Furthermore, each transmission line has its load ability limit that is often determined by either stability constraints or by thermal limits or by the dielectric limits. Even though the power quality problem is distribution side problem, transmission lines are often having an impact on the quality of the power supplied. It is however to be noted that while most problems associated with the transmission systems arise due to the forces of nature or due to the interconnection of power systems, individual customers are responsible for more substantial fraction of the problems of power distribution systems.

DISTRIBUTED STATIC COMPENSATOR

The Distribution Static Compensator (DSTATCOM) is a voltage source inverter based static compensator (similar in many respects to the DVR) that is used for the correction of bus voltage sags. Connection (shunt) to the distribution network is via a standard power distribution transformer. The DSTATCOM is capable of generating continuously variable inductive or capacitive shunt compensation at a level up its maximum MVA rating. The DSTATCOM continuously checks the line waveform with respect to a reference ac signal, and therefore, it can provide the correct amount of leading or lagging reactive current compensation to reduce the amount of voltage fluctuations. The major components of a DSTATCOM are shown in Fig. 2. It consists of a dc capacitor, one or more inverter modules, an ac filter, a transformer to match the inverter output to the line voltage, and a PWM control strategy. In this DSTATCOM implementation, a voltage-source inverter converts a dc voltage into a three-phase ac voltage that is synchronized with, and connected to, the ac line through a small tie reactor and capacitor (ac filter).

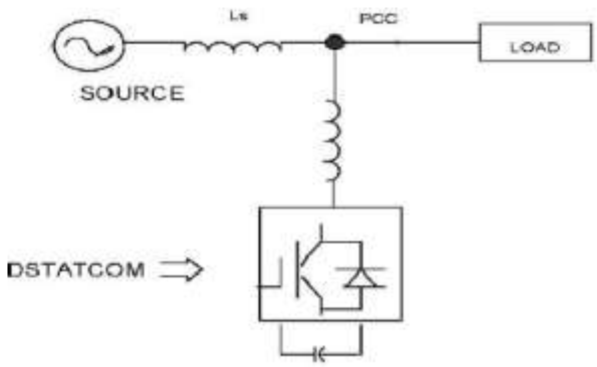


Fig.2.block diagram of DSTATCOM circuit

DSTATCOM COMPONENTS: DSTATCOM involves mainly three parts

IGBT or GTO based dc-to-ac inverters:

These inverters are used which create an output voltage wave that's controlled in magnitude and phase angle to produce either leading or lagging reactive current, depending on the compensation required

L-C filter:

The LC filter is used which reduces harmonics and matches inverter output impedance to enable multiple parallel inverters to share current. The LC filter is chosen in accordance with the type of the system and the harmonics present at the output of the inverter.

Control block:

Control block is used which switch Pure Wave DSTATCOM modules as required. They can control external devices such as mechanically switched capacitor banks too. These control blocks are designed based on the various control theories and algorithms like instantaneous PQ theory, synchronous frame theory etc.. All these different algorithms are discussed in the next chapter

Conclusion:

Custom Power (CP) devices can be used, at reasonable cost, to provide high power quality and improved power service. Detailed modeling is presented and results are discussed with different case studies. These Custom Power devices provide solutions to power quality at the medium voltage distribution network level. This project presents the detailed modeling of one of the custom power products, DSTATCOM is presented using instantaneous PQ theory, used for the control of DSTATCOM are discussed. These control algorithms are described with the help of simulation results under linear loads. The control scheme maintains the power balance at the PCC to regulate the dc capacitor voltages. PW control scheme only requires voltage measurements. This characteristic makes it ideally suitable for low-voltage custom power applications. The control scheme was tested under a wide range of operating conditions, and it was observed to be very robust in every case. Extensive simulations were conducted to gain insight into the impact of capacitor size on DSTATCOM harmonic generation, speed of response of the PWM control and transient overshooting. It was observed that an undersized capacitor degrades all three aspects. On the other hand, an oversized capacitor may also lead to a PWM control with a sluggish response but it will reduce DSTATCOM harmonic generation and transient overshooting. It is concluded that a DSTATCOM though is conceptually similar to a STATCOM at the transmission level; its control scheme should be such that in addition to complete reactive power compensation, power factor correction and voltage regulation the harmonics are also checked, and for achieving improved power quality levels at the distribution end.

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