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Research Paper

AN ADAPTIVE CONTROL AND IMPROVEMENT OF POWER QUALITY IN GRID CONNECTED SYSTEM USING POWER ELECTRONIC CONVERTERS

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This project presents a method to identify a modular approach to achieve harmonic cancellation using a Distribution Static Compensator (DSTATCOM). The DSTATCOM provides a continuous and smooth variation in the reactive power generation and can track the change in the VAR requirement very fast. The design of DSTATCOM parameters are considered an optimization problem according to the time domain-based objective function solved by a Honey Bee Mating Optimization (HBMO) algorithm that has a strong ability to find the most optimistic results associated with small disturbances that occur in the grid when connected to a non linear load. Objective of this project is to reduce harmonics level in the transmission line to reduce losses to increase efficiency.

Keywords: Harmonic compensation, Multilevel power converters, Power Quality (PQ), Distribution Static Compensator (DSTATCOM)

INTRODUCTION

In Recent years, electric grid regulations have become more demanding in terms of power quality indexes to meet the actual energy challenges. So that, concepts like active power filters and energy efficiency have gained relevance in order to improve the overall performance and reliability of the electric network. Due to these new requirements, active compensation schemes have received a lot of attention by the researchers in order to provide dynamic compensation capabilities to ensure high power quality indexes. Particularly, in order to

compensate highly inductive and/or nonlinear loads, the DSTATCOM configuration has reached as one of the most popular active power filter.

Several prior works have been published related with the DSTATCOM topology, where aspects like design, control and efficiency (just to name a few) have been deeply explored (Rahmani, 2012; Haibing, 2012). Actually, latest research efforts have been focused on multilevel DSTATCOMs because it is possible to reach higher power levels with standard rated semiconductors. Among the multilevel DSTATCOM topologies the most extended is the

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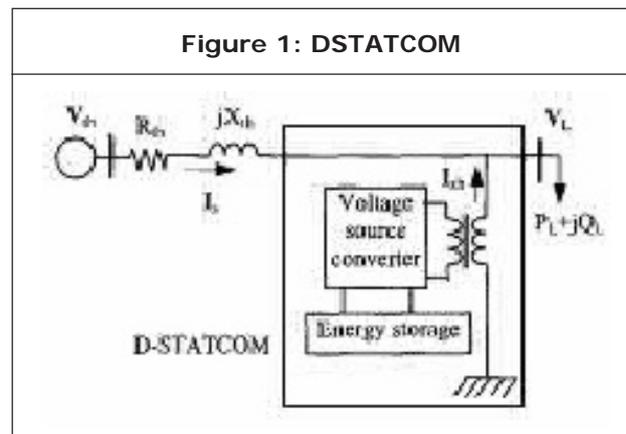
H-bridge based configuration, where several H-bridge modules are connected in cascade to generate a multilevel voltage (Yazdani, 2011). Some of the relevant features of this topology are that higher equivalent switching frequencies can be achieved and the total power is shared among all modules.

In a closed loop control and Delay compensation is provided. DSTATCOM along with SVPWM control technique provides reduction in THD, when an ac source is connected to a non linear load. BEE Algorithm has influencing in this system for compensate the Harmonics.

DSTATCOM AND SVPWM

Distribution Static Compensator which is schematically consists of a two-level Voltage Source Converter (VSC), a dc energy storage device, a coupling transformer connected in shunt to the distribution network through the coupling transformer. The voltage source converter converts the dc voltage across the storage device as a set of three-phase ac output voltages. These voltages are in phase and it is coupled with the ac system through the reactance of the coupling transformer. An adjustment of the phase and magnitude of the D-STATCOM output voltages allows effective control of active and reactive power exchanges between the D-STATCOM and the ac system. This type of configuration allows the device to absorb or generate controllable active and reactive power.

The VSC connected in shunt with the ac system provides a multifunctional topology which can be used for up to three quite distinct purposes: voltage regulation, compensation of reactive power, power factor correction and its elimination of current harmonics. Such a device is employed to provide continuous voltage regulation by using



an indirectly controlled Converter.

Space Vector Pulse Width Modulation (SVPWM) is an improved technique for generating a fundamental sine wave that provides a higher voltage, lower total harmonic distortion, and it controls the number of short pulses in the PWM waveform.

HARMONIC ANALYSIS

When a voltage and/or current waveform is distorted, it causes an abnormal operating conditions in the power system such as:

Voltage Harmonics can cause additional heating in induction and synchronous motors and generated Voltage Harmonics with high peak values can weaken insulation in cables, windings, and capacitors. Voltage Harmonics can cause malfunction of different electronic components and circuits that utilize the voltage waveform for synchronization or timing.

Current Harmonics in the windings can create Electromagnetic Interference (EMI). Current Harmonics flowing through cables can cause higher heating over and above the heating that is created from the fundamental component. Current Harmonics flowing through a transformer can cause higher heating over and above the heating that is created by the fundamental

component, Current Harmonics flowing through circuit breakers and switch-gear can increase their heating losses.

Resonant currents are created by current harmonics and the different filtering topologies of the power system can cause capacitor failures and/or fuse failures in the capacitor or other electrical equipment. False tripping of circuit breakers is done by protective relays.

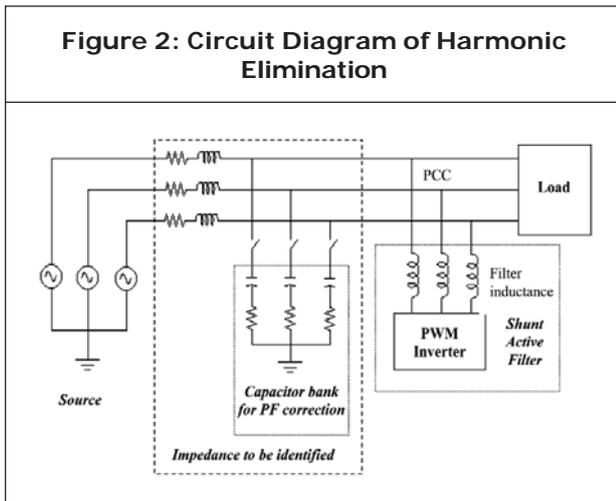


Figure 2: Circuit Diagram of Harmonic Elimination

MULTILEVEL DSTATCOM

The classic multilevel DSTATCOM configuration consists in the cascaded interconnection of single phase H-bridge. Traditionally, power cell is modulated such that all of them inject a similar AC voltage to generate the necessary current to compensate harmonics and/or reactive power.

Proposed Approach

Figure 4.1 shows the approach, where it can be seen that the same multilevel traditional configuration is used but including two different types of power cells. This proposal allows compensation for harmonic components generated by nonlinear loads and also provides compensation of reactive power at fundamental frequency. It is stated that, there are two types of cells, first one compensates the disturbances at

fundamental frequency and the other compensates harmonic currents Figure 4.1 indicates the level DSTATCOM. The fundamental cells are intended in the multilevel DSTATCOM to compensate fundamental input power factor. Cascaded assembling of converters allows the reduction of the components rating and thus overcome the power limitations of this kind of structures. The “harmonic cells” are also connected in series and the number of cells depends upon what harmonics are needed to be compensated. In this paper, each harmonic cell will compensate a specific harmonic; so many cells are connected as harmonics are required to be compensated. In practical implementations, it is not expected to compensate more than the 5th, 7th, 11th, and 13th harmonics. This work shows that the series assembling of the harmonics cells allows the cancellation of any nonlinear current thanks to the superposition principle.

The main advantage of this approach is that the fundamental cells are switched at lower frequencies than the harmonic cells. This feature allows the use of slow semiconductors and slow control loops for the first type of cells and faster semiconductors and faster control loops for the second ones. The value of the dc voltage of each harmonic cell can be selected based on the current harmonics and the cell is intended to compensate, so it can be adjusted according to the load conditions. It can be seen from the topology, as the harmonic frequency increases, the harmonic cells must have higher dc voltages due to the inductive output filter. However, nonlinear loads, such as diode bridge rectifiers, and harmonics amplitude decreases with the frequency. Also, for this kind of loads, the harmonics amplitude is considerably smaller than the fundamental component.

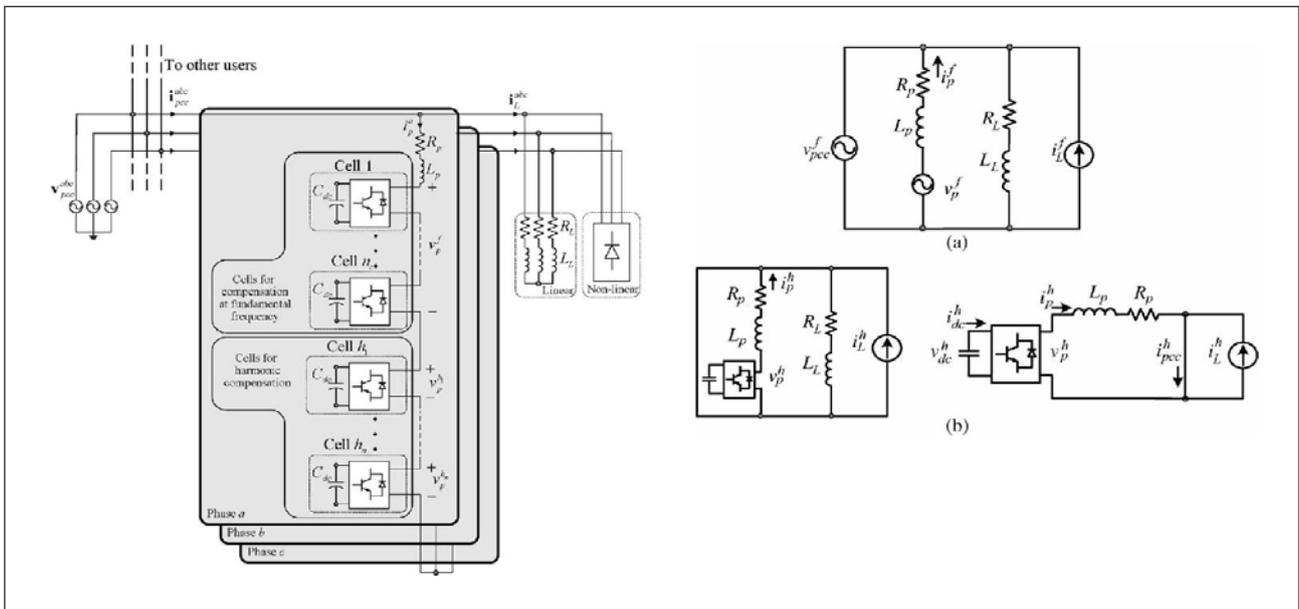


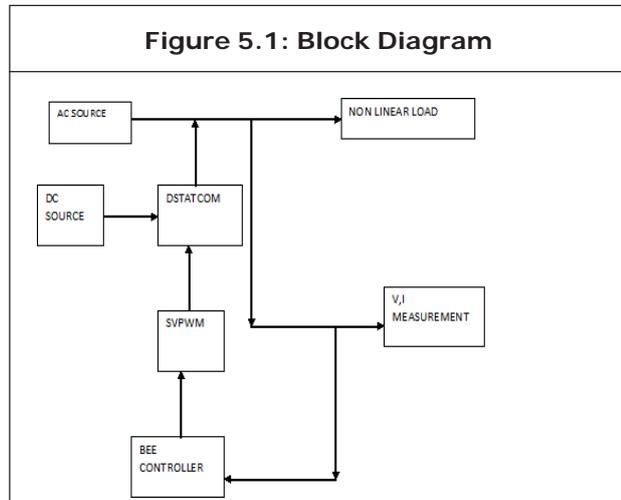
Figure. 4.1(a), Multilevel STATCOM equivalent circuit (a) for fundamental frequency, (b) for harmonic frequency. harmonic frequency h and at any arbitrary Figure4.1. Multilevel STATCOM equivalent circuit (a) for fundamental frequency, (b) for harmonic frequency. harmonic frequency h , Figure 4.1(b),

Taking into account, the considerations, the harmonic cells can work with a reduced dc voltage, in terms of nominal and operational values.

The multilevel STATCOM equivalent circuit can be obtained at fundamental frequency f , in order to understand how the superposition principle applies for this approach. Thus, the fundamental voltage injected by the STATCOM is represented by v_p^f and the harmonic voltage generated in any arbitrary harmonic cell corresponds to v_p^h . The nonlinear load current is considered as a perturbation for modeling and control purposes. It can be noticed, in Figure 4.1(a), that the topology can inject a current at fundamental frequency in order to compensate the fundamental power factor.

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BLOCKDIAGRAM



Delay compensator has include advancing angle of the current regulator output voltage as well as discrete current regulator design. BEE Algorithm has influencing in this system for compensate the Harmonics. Earlier the system has the following problems it can't eliminate 3rd and 9th harmonics in active power filters and Delay compensation is not considered. By using the proposed system these disadvantages can be overcome.

The utility of Bee algorithm is as follows:

The icosq controller belongs to the family of the predictive controllers. They are based on a common principle: to foresee the evolution of the controlled quantity (the current) and on the basis of this prediction. to choose the state of the converter (ON-OFF predictive) or the average voltage produced by the converter (predictive with pulse width modulator). The starting point is to calculate its derivative to predict the effect of the control action. The controller is developed on the basis of the model of the filter and of the grid, which is used to predict the system dynamic behavior: the controller is inherently sensitive to model and parameter mismatches.

SIMULATION DIAGRAM AND RESULTS

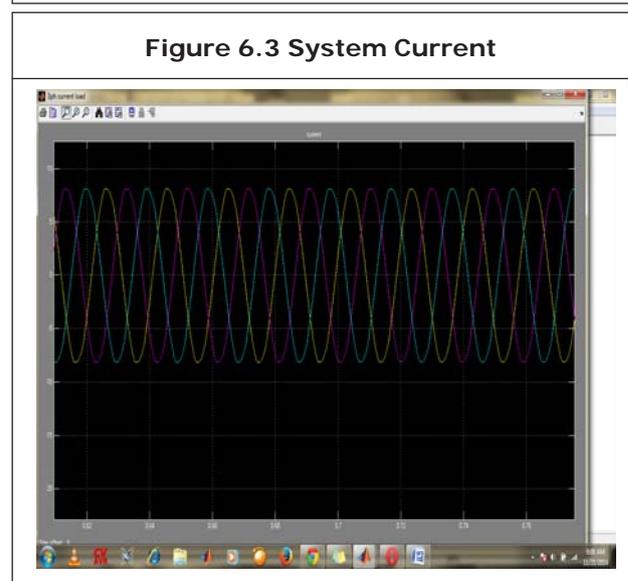
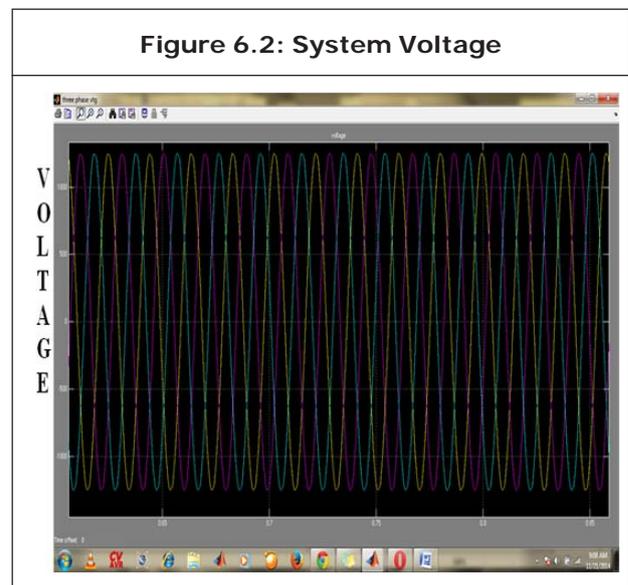
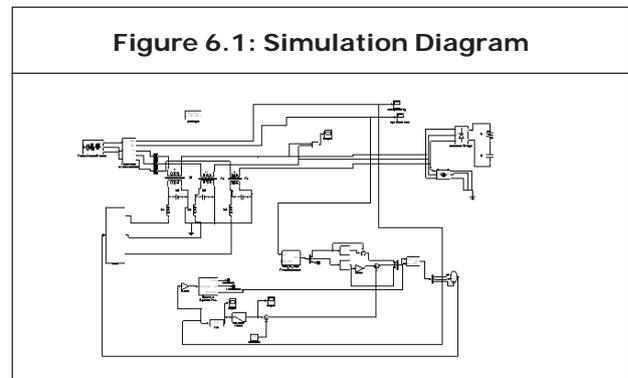
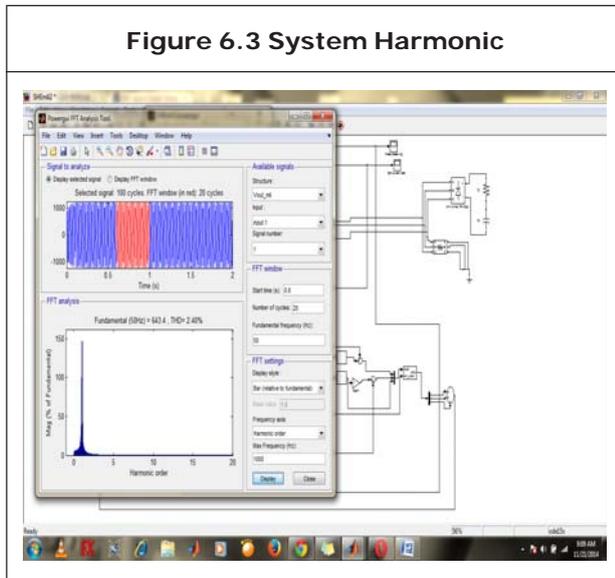


Figure 6.3 System Harmonic



CONCLUSION

This paper has presented the Design of VSI DSTATCOM to improve the power quality in Grid system with and without a battery. VSI based DSTATCOM compensator is one of the flexible device, which can operate in the current control mode for compensating voltage variation its unbalance and reactive power and in voltage control mode as a voltage stabilizer, and the latter feature enables its application for compensation of dips coming from the supplying network. The simulation results shows exactly the performance of DSTATCOM system and it is found to be satisfactory for improving the power quality in the consumer premises. The Rectifier-based non-linear loads generated harmonics are eliminated by the DSTATCOM. When the rectifier loads are connected, the DSTATCOM currents tries to balance these unbalanced load currents created. Finally Matlab/Simulink based model is developed and simulation results are presented.

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