CURRENT SOURCE CONVERTER BASED UPQC FOR UNBALANCED LOAD CONDITION

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ABSTRACT: In recent days, the quality of power has become more important to the most of the customer load. The unified power quality conditioner (UPQC) is the ultimate solution to provide the quality of power irrespective of the type of power quality problems. Current source converter based UPQC find application for the mitigation harmonic. We introduce a Unit Vector Template to derive fundamental voltage signal from an unbalanced source. Simple PI controller andPWM is used for the derivation of reference signal and switching signal respectively. Extensive simulation results obtained using MATLAB/SIMULINK under R-L non- linear loading conditions are presented and discussed.

I. INTRODUCTION

The modern power distribution system is facing the different power quality problems. The extensive use of non-linear loads is further contributing to increased current and voltage harmonics issues. Furthermore, the penetration level of small/large-scale renewable energy systems based on wind energy, solar energy, fuel cell, etc., installed at distribution as well as transmission levels is increasing significantly. Unified power quality control was widely studied by many researchers as an eventual method to improve power quality of electrical distribution system. The function of unified power quality conditioner is to compensate supply voltage flicker/imbalance, reactive power, negative sequence current, and harmonics [1]. With the availability of new IGBT with reverse blocking capability, the use of current source active filters is increasing due to its inbuilt short circuit protection capability, higher efficiency at low power loads, simple open loop current control and effective filtering of harmonics. A configuration and control aspect of current source active power filter is discussed in references [2]. The UPQC is expected to be one of the most powerful solutions to large capacity loads sensitive to supply voltage flicker/imbalance. The UPQC consisting of the combination of a series active power filter (APF) and shunt APF can also compensate the voltage interruption if it has some energy storage or battery in the dc link. The shunt APF is usually connected across the loads to compensate for all current-related problems such as the reactive power compensation, power factor improvement, current harmonic, compensation, and load unbalance compensation whereas the series APF is connected in a series with the line through series transformers. It acts as controlled voltage source and can compensate all voltage related problems, such as voltage harmonics, voltage sag, voltage swell, flicker, etc. The proposed control technique has been evaluated and tested under unbalanced load conditions using Matlab/Simulink software.

II. CSC BASED UPQC

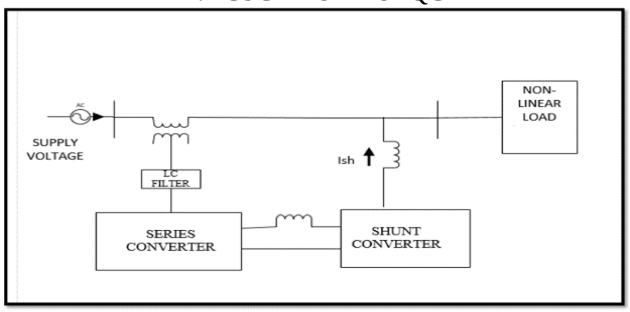

Figure 1. CSC based UPQC

A Current source converter based UPQC is built with two bridges of IGBT switches connected back to back through an inductor of sufficiently large value as shown in figure 1. The series filter is connected to AC mains supply through a series transformer of suitable rating. Series filter are mitigate the voltage related issue and shunt filter are mitigate the current related issue.In current source based UPQC a large inductor is used as a DC link. This dc link will function as DC sources and hence does not demand any external power source. However in order to maintain constant DC current/ voltage in the energy storage element a small fundamental current is drawn to compensate active filter losses.

SERIES CONTROLLER

The series filter is controlled by PWM control. A series active filter acts as controlled voltage source by imposing high impedance for the harmonic currents, blocking their flow from both loads to source and source to load directions. The source voltage may contain zero, negative sequence as well as harmonic component, which need to be eliminated by series compensator. In order for the load voltage to perfectly sinusoidal and balanced, the series filter should produce a voltage that makes the load voltage sinusoidal. The reference load voltages are obtained by multiplying a PLL based unit vector templates with a constant equal to peak amplitude of fundamental input voltage. Now reference voltage are compared with the measured value and output is given to the PWM for series controller pulse generation.

SHUNT CONTROLLER

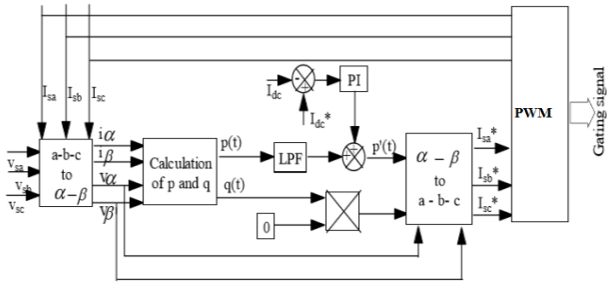

Figure.2 shunt controller

In case of CSC based UPQC, the dc link current is sensed and compared with reference dc link current. A PI controller then processes the error. The output signal from PI controller is regarded as switching power losses of shunt active filter, and is added to real power loss component to derive reference source current. These reference currents are then compared with actual source current and error given to PWM controller to derive the switching signals of shunt inverter. The schematic block diagram of shunt filter controller is shown in figure.2

III. SIMULATION AND RESULTS

Supply	3 Phase 50Hz 415V
Nonlinear load	10+j7.85
Line resistance	.01
Line inductance	50µH
DC link inductance	450mH

Table-1. Parameter of the system

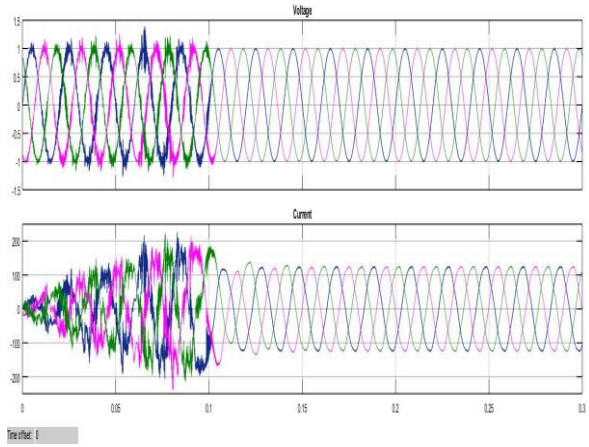

Figure 3. Supply voltage and current

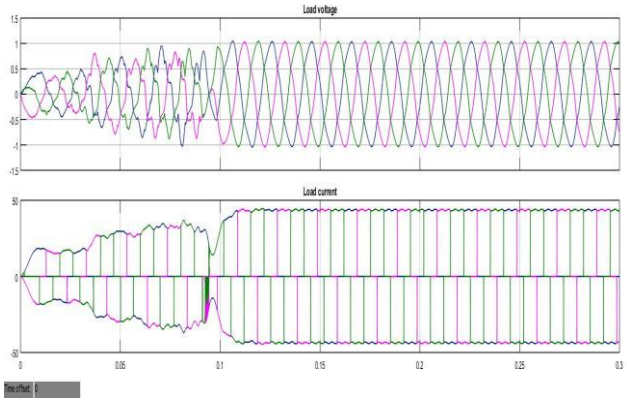

Figure 4. Load voltage and current

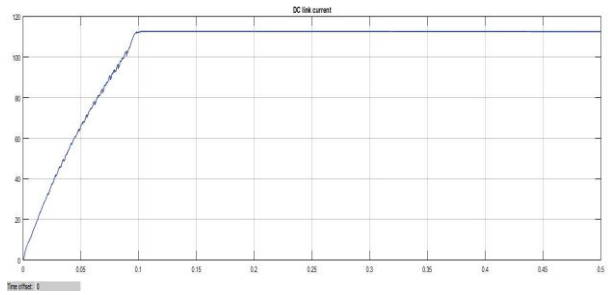

Figure 5. DC link current

Figure 3 shows the supply voltage and current waveform. At 0.1 sec supply current became sinusoidal and contain some harmonics. Figure 5. Shows the DC link current that are maintain to the rated value. THD analysis of the source current is done in CSC based UPQC. THD of the supply current reduced from the 28.78% to 2.37%. Figure 6. Show the THD of the supply current.

CSC based UPQC effectively reduced harmonic from the source current under the nonlinear load condition.

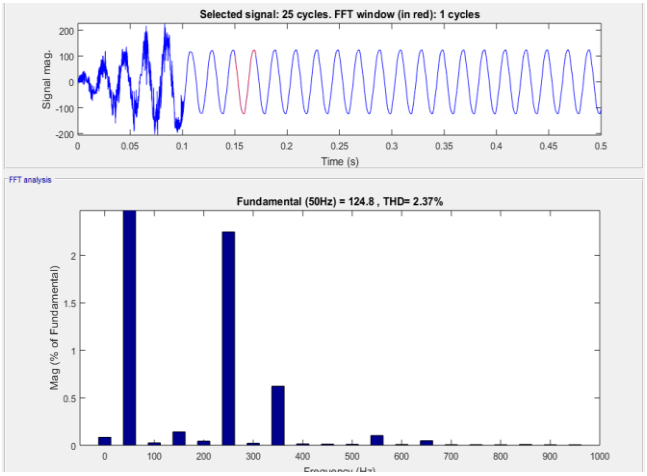

Figure 6. THD of supply current

IV. CONCLUSION

In recent days, the quality of power has become more important to the most of the customer load. The CSC based UPQC is the solution for the power quality related problem. In this paper simulation is done under the nonlinear load condition. CSC based UPQC effectively reduced the harmonic on the supply side current. CSC based UPQC has advantage of inbuilt short capability due to use of IGBT. But CSC based UPQC is not extended to multilevel. CSC based UPQC reduced the THD of supply side current from 28.78% to 2.37%. Hence, CSC based UPQC effectively enhance the power quality of the system.

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