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Design of Shunt Active Filter Based Solar PV System Based on P-Q Theory to Enhance Power Quality

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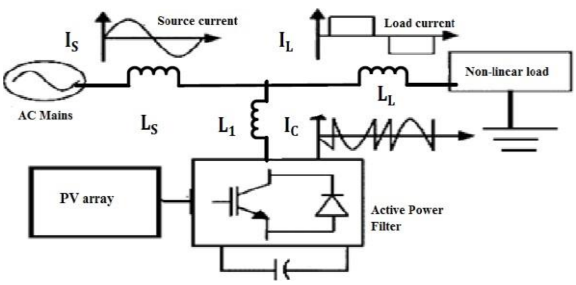
Abstract

There are numerous alternatives, but there is no accepted method for rating the active filters. Basic SAPF principles and theoretical ideas are used to define the filter and circuit design. The PWM filter controller (p-q) is designed using the power theory. The shunt active filters were validated using a Simulink model. According to studies, the grid's electricity quality can be confirmed.

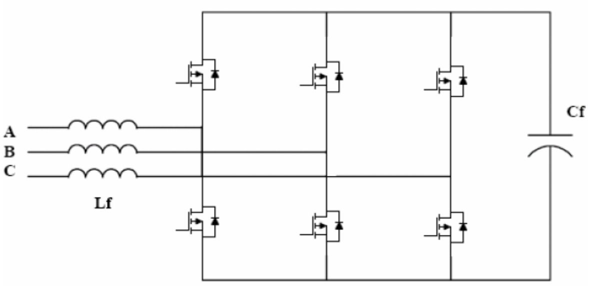
Introduction

Although the consequences of power quality (PQ) issuesare just now becoming apparent, the problems themselves have long been recognized [1]. Over the past decade, there havebeen major advancements in semiconductor technology, which have resulted in a revolution in the field of power electronic technology [2]. Accommodating DC motors, motor drives, and chargers, in addition to adjustable-speed (ASD) drives, are responsible for the rise in difficulties associated with PQ[3].

Principle of shunt APF



SHUNT ACTIVE POWER FILTER



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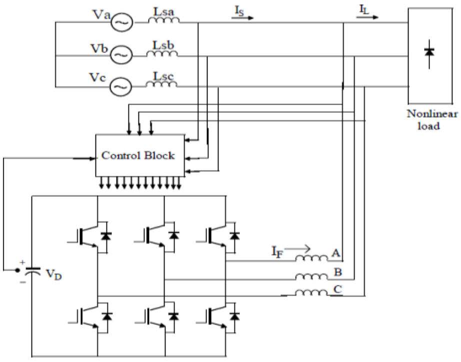
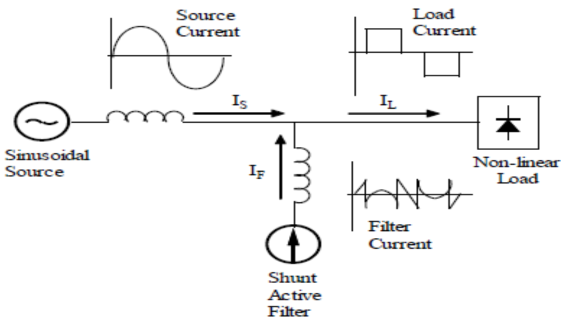
Basic compensation principle of STATCOM

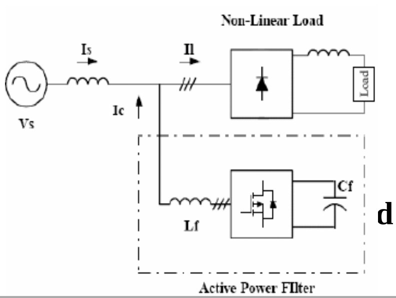
Shunt power filter topology



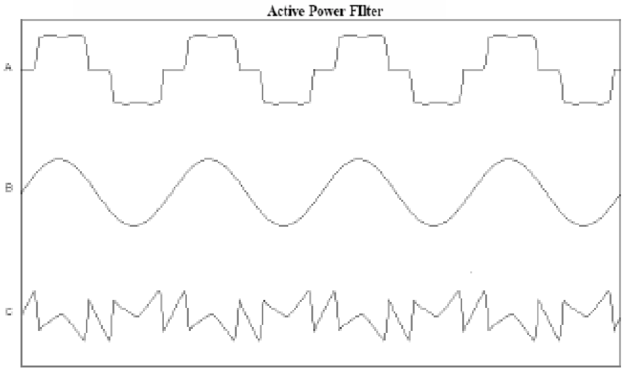
Filter current IF generated to compensate load current harmonics



Basic compensation principle



d source and the compensating current



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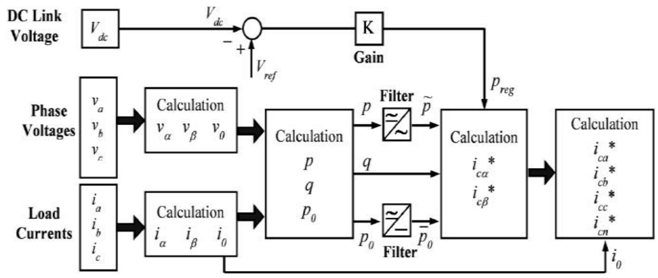
p–q theory Based Control



$$\begin{bmatrix} V_\alpha \\ V_\beta \end{bmatrix} = \sqrt{\frac{2}{3}} \begin{bmatrix} 1 & \frac{-1}{2} & \frac{-1}{2} \\ 0 & \frac{\sqrt{3}}{2} & \frac{-\sqrt{3}}{2} \end{bmatrix} \begin{bmatrix} V_a \\ V_b \\ V_c \end{bmatrix}$$

$$\begin{bmatrix} p_L \\ q_L \end{bmatrix} = \begin{bmatrix} V_\alpha & V_\beta \\ V_\beta & -V_\alpha \end{bmatrix} \begin{bmatrix} i_{L\alpha} \\ i_{L\beta} \end{bmatrix}$$

$$\begin{bmatrix} i_{L\alpha} \\ i_{L\beta} \end{bmatrix} = \sqrt{\frac{2}{3}} \begin{bmatrix} 1 & \frac{-1}{2} & \frac{-1}{2} \\ 0 & \frac{\sqrt{3}}{2} & \frac{-\sqrt{3}}{2} \end{bmatrix} \begin{bmatrix} i_{La} \\ i_{Lb} \\ i_{Lc} \end{bmatrix}$$

p-q theory power components

$pc = -p + p_{loss}$

$qc = -q_L$

$$\begin{bmatrix} i_{c\alpha} \\ i_{c\beta} \end{bmatrix} = \frac{1}{{V_\alpha}^2 + {V_\beta}^2} \begin{bmatrix} V_\alpha & V_\beta \\ V_\beta & -V_\alpha \end{bmatrix} \begin{bmatrix} -p + p_{loss} \\ -q_L \end{bmatrix}$$

$$\begin{bmatrix} i_{ca}* \\ i_{cb}* \\ i_{cc}* \end{bmatrix} = \sqrt{\frac{2}{3}} \begin{bmatrix} 1 & 0 \\ \frac{-1}{2} & \frac{\sqrt{3}}{2} \\ \frac{-1}{2} & \frac{-\sqrt{3}}{2} \end{bmatrix} \begin{bmatrix} i_{c\alpha} \\ i_{c\beta} \end{bmatrix}$$

SIMULATION RESULTS

Input and Output Voltage for the Grid, Load and Filter

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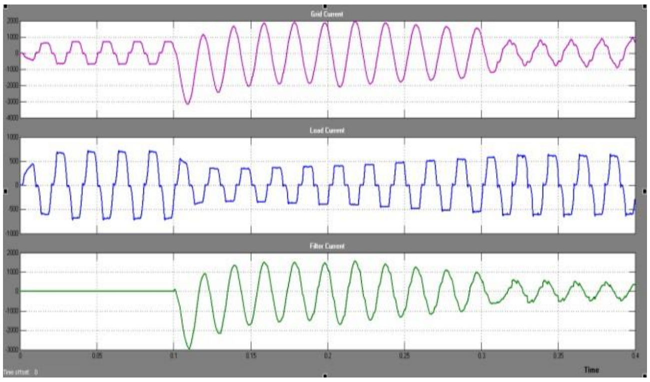
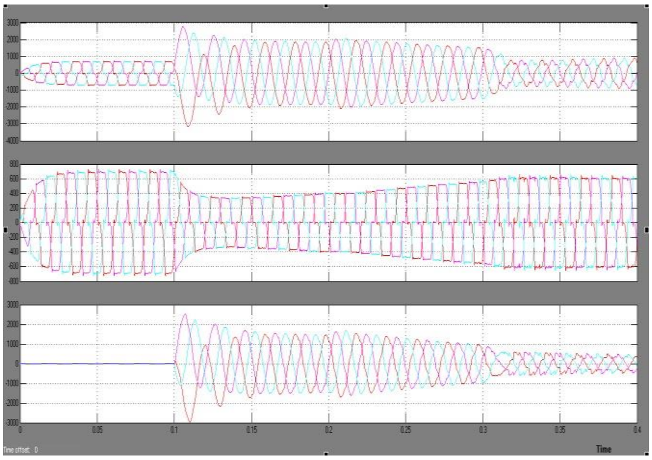
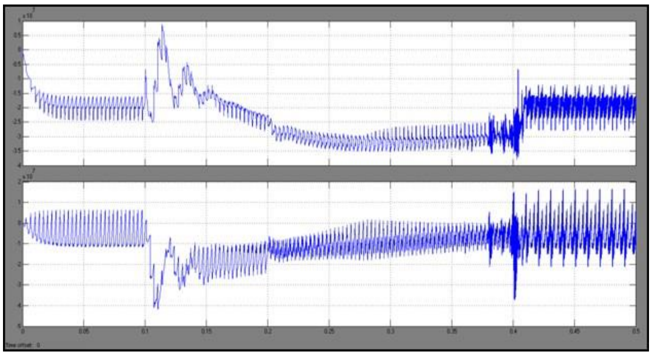


Grid, load, and filter currents in a three-phase system



Active Power and Reactive Powers



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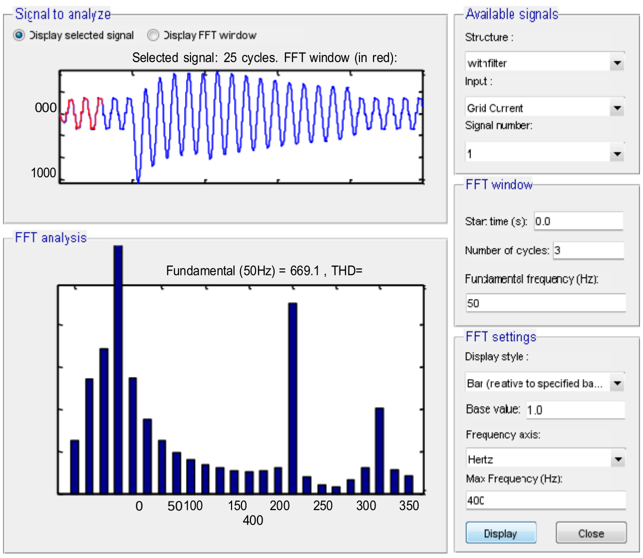
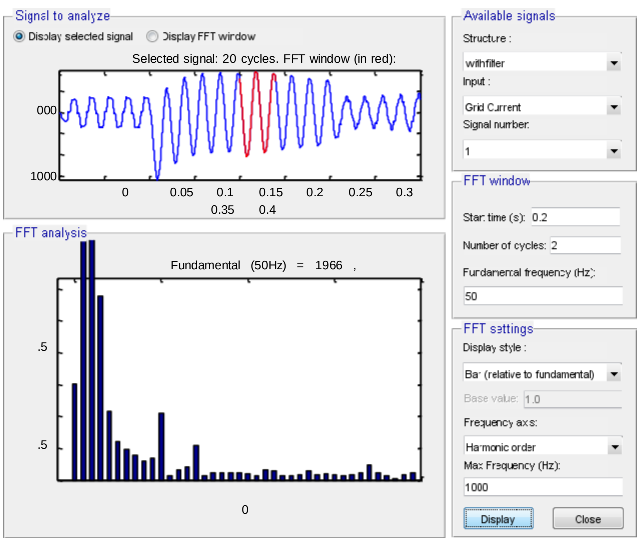
THD Without Filter



THD WITH FILTER



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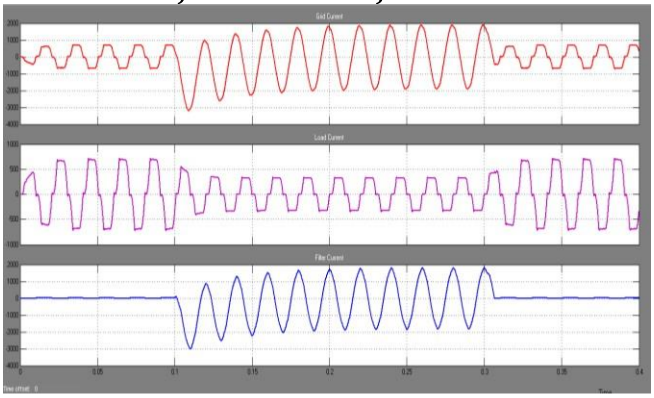
Grid current, Load current, and Filter current are all examples ofcurrents.



GRID CURRENT THD FOR THE PROPOSED SYSTEM

TABLE I. THD FOR TRADITIONAL AND SUGGESTED APPROACHES IS COMPARED TO EACH OTHER.

Typical circuit without a filter	15.82%
Typical circuit with a filter	1.77%
Filter circuit proposed	1.63%

Conclusion

The study uses simulations to apply the P-Q theory to the issue. The graphs of active and reactive power are shown both before and after the filter has been enabled.

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