Chapter 10
Application of Novel Techniques in Active Power Filter

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ABSTRACT

Traditionally, the major part of the electrical power is generally consumed by the non-linear loads due to frequent application of the semiconductor devices in the form of domestic and industrial loads. This results from distortion in the actual supply voltage waveform at the source end due to the interference of the multiple harmonics generated out of semiconductor devices used at load end and excessive absorption of the reactive power. The insufficiency of these compensation techniques leads to the advent of the phase multiplication techniques as well as the most reliable and economic active power filtering scheme. A deep analysis showing tedious waveforms using the ORCAD simulation package for the various kind of loads in conjunction with the single-phase active power filter shunted to the single-phase line at the load end for the two current control techniques (i.e., hysteresis band current control, triangularization of current control) has been done. The results are analyzed and tested to lead the optimistic approach for APF (active power filters).

INTRODUCTION

Over the years, there has been a continuous proliferation of a non-linear type of loads due to the intensive use of electronic power control in all branches of industry as well as by the general consumers of electric energy. This solid-state control of ac power using thyristors and other semiconductor switches is widely employed to feed controlled electric power to electrical loads, such as adjustable speed drives

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(ASD's) furnaces, computer power supplies, etc. Such controllers are also used in HVDC systems and renewable electrical power generation. Nowadays, the power electronic converters are capable of processing a massive amount of power, and due to their advantages such as increased efficiency and ease of control, they have caused a dramatic increase in the number of power electronic loads in the industry/system. Unluckily, power electronic loads have an inherently nonlinear nature, and they, therefore, draw a distorted current from the mains supply. That is, they draw non-sinusoidal current, which is not in proportion to the sinusoidal voltage. As a result, the utility supplying these loads has to provide large reactive volt-amperes. Also, the harmonics generated by the load pollute it. As nonlinear loads, these solid-state converters draw harmonic and reactive power component of current from ac mains. The injected harmonics, reactive power burden, unbalance and excessive neutral current cause low system efficiency and reduced power factor. They also cause disturbance to other consumers and interference in nearby communication networks, excessive heating in transmission and distribution equipment, errors in metering, and malfunctioning of utility relays. The inflatable tariffs levied by utilities against excessive VARS and the threat of stricter harmonics standards have led to extensive surveys to quantify the problems associated with electric power networks having nonlinear loads. i.e., the load compensation techniques for power quality improvement.

This work's objective is to study the effect of different current control techniques on the performance of a single-phase shunt active power filter. Among the different control techniques, the two, i.e., Hysteresis-band control and Triangularization of error control, have been employed here for the analysis and simulation point of view of the APF. The active filter selected for the study is capable of supplying reactive power and generating the harmonics so that the current drawn from the supply is sinusoidal and in phase with the supply voltage. The study contains a brief discussions of the numerous kind of active power filters and reactive power compensators, and further study involves the design of the single-phase active power filter and detailed simulation to show typical waveforms and to compare the performance of the active filter under each one of the current control techniques noted above in the same paragraph.

The chapter is divided into six sections. Sections 1 deals with the introduction of active power filters for power quality improvement, and the objective of the present work. Section 2 contains literature survey; Sections 3 is an ideal evolution for the basic principle, unique features and elements of the active power filter chosen for study in the chapter in accordance with the modeling of the power-converter as an active filter, the current control law, the generation of the reference current, and designing of the power circuit. Section 4 discusses the two current control techniques employed for generating the gating pulses of an active filter. Section 5 has the simulation circuits & results and evaluation with their typical waveforms. Section 6 includes a conclusion and future prospects.

BACKGROUND

The recent advances in several key areas of power electronics technology, such as power semiconductor devices, power converter circuits, and control of power electronics. The structure and characteristics of IGBT, SIT, SITH, and MCT devices provide a better understanding before switching over to the active power filtering scheme. The control technique of the power converter is one of the prominent parts of the converter operation. As the evolution of the high power self commutated switches (GTO 4500V, 3000A, 1KHz; BJT 1200V, 800A, 10KHz; IGBT 1200V, 400A, 20KHz. the interest has increased in the study of active power line conditioners for reactive power and harmonic compensation. There are a number

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