Available online at www.sciencedirect.com
SCIENCE DIRECT®
Electric Power Systems Research 76 (2006) 701–708
ELECTRIC POWER SYSTEMS RESEARCH
www.elsevier.com/locate/epsr

Reactive current control through SVC for load power factor correction

Sameh K.M. Kodsi, Claudio A. Cañizares *, Mehrdad Kazerani

University of Waterloo, Department of Electrical & Computer Engineering, Waterloo, Ont., Canada N2L 3G1

Received 6 October 2005; accepted 10 October 2005
Available online 13 December 2005

Abstract

This paper discusses a new technique for controlling SVCs (Fixed Capacitor–Thyristor Controlled Reactor) in power systems with the aim of canceling the reactive current component of the load. A complete model of the SVC with its control circuit is set up and simulated in the EMTDC program. The generated harmonics from the proposed SVC controller are considered to design simple tuned filters to cancel the undesirable harmonic components. The effect of these filters is considered as well in the SVC control design, so that the reactive current component absorbed by the combination of the load, SVC, and filters is eliminated. The proposed control technique is compared with respect to a standard PI-based SVC controller.

Keywords: FACTS; SVC; Reactive power compensation; Control design; Tuned filters

1. Introduction

Reactive power consumption has a significant effect on the operation of a power system. FACTS controllers nowadays are able to achieve reliable, economic and stable compensation of reactive power to improve power factor at all conditions of loading. To achieve this requirement, FACTS have basically branched out into two main application levels, i.e. transmission systems (e.g., control the power transmitted through a line), and distribution networks (e.g., power factor correction). The latter is commonly concerned with load behavior, and hence load voltage regulation [1,2]. Thus, the design of FACTS controllers in distribution systems should include the control of the reactive power injected by the SVC to attain unity power factor [2–5]. FACTS controllers for distribution systems are typically defined by the type of feedback signal; i.e., load voltage or reactive current signal to either improve power factor or load voltage profile [6–9].

FACTS controllers can be modeled using different computer tools depending on the user objectives and level of model detail and performance [10,11]. The main problem with simulations is how to simulate the controller so that the user can properly model the power factor correction or load voltage control. Hence, in this paper, the SVC controller is modeled in detail, including all electronic switches, using the EMTDC.

One of the main drawbacks of using FACTS is the undesirable injection of harmonics into the system. There are many solutions to overcome this problem; however, the simplest one is the insertion of tuned filters. The issue in this case is the injection of excessive reactive power by these filters at fundamental frequency. Therefore, the proper compensation of reactive power controllers through SVC should consider this phenomenon, as discussed in this paper.

The main objective of the present paper is to discuss a new control method for SVC (Fixed Capacitor–Thyristor Controlled Reactor) controllers for distribution system applications, to achieve maximum power factor correction. The need for tuned filters to filter out the harmonics generated by the SVC, and their effect on SVC controller design, are also discussed. Comparisons of the proposed control with a standard PI-based voltage control are presented, to highlight the benefits of the proposed control technique.

This paper is organized as follows: Section 2 introduces some basic concepts in SVC controller design and characteristics. The design of the proposed control circuit and the corresponding modeling in EMTDC are discussed in Section 3. Section 4

* Corresponding author.
E-mail addresses: skamelme@engmail.uwaterloo.ca (S.K.M. Kodsi), ccanizar@uwaterloo.ca (C.A. Cañizares), M.Kazerani@ece.uwaterloo.ca (M. Kazerani).

0378-7796/$ – see front matter
doi:10.1016/j.epsr.2005.10.002

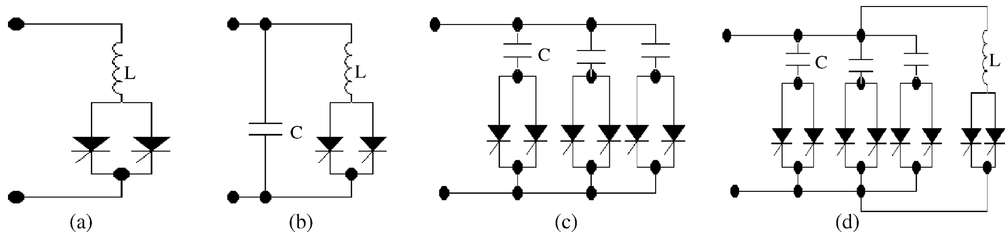

Fig. 1. Types of SVC.

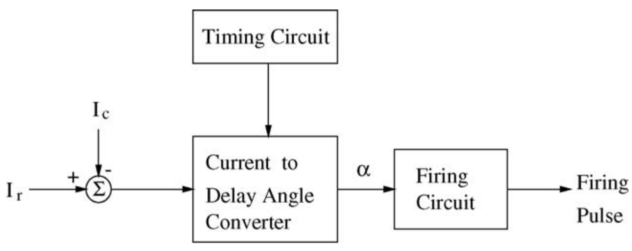

Fig. 2. Control scheme for the FC–TCR SVC.

presents the simulation data used and the results obtained for the new SVC controller; these results are then compared with a standard PI-based SVC controller. The main contributions of this paper are summarized in Section 5.

2. Basic background

Most of the current thyristor-controlled SVCs are based on controls whose main aim is to provide variable shunt impedance by synchronously switching shunt capacitors and/or reactors to control the reactive power injected to the network. Using appropriate switching controls, the var output can be controlled continuously from maximum capacitive to maximum inductive output at a given network voltage. The main types of SVC controllers presently used can be identified as follows (see Fig. 1):

1. Thyristor Controlled Reactor (TCR) (see Fig. 1(a)): a reactor with thyristor valves is incorporated in each phase. Reactive power is varied by controlling the current through the reactor

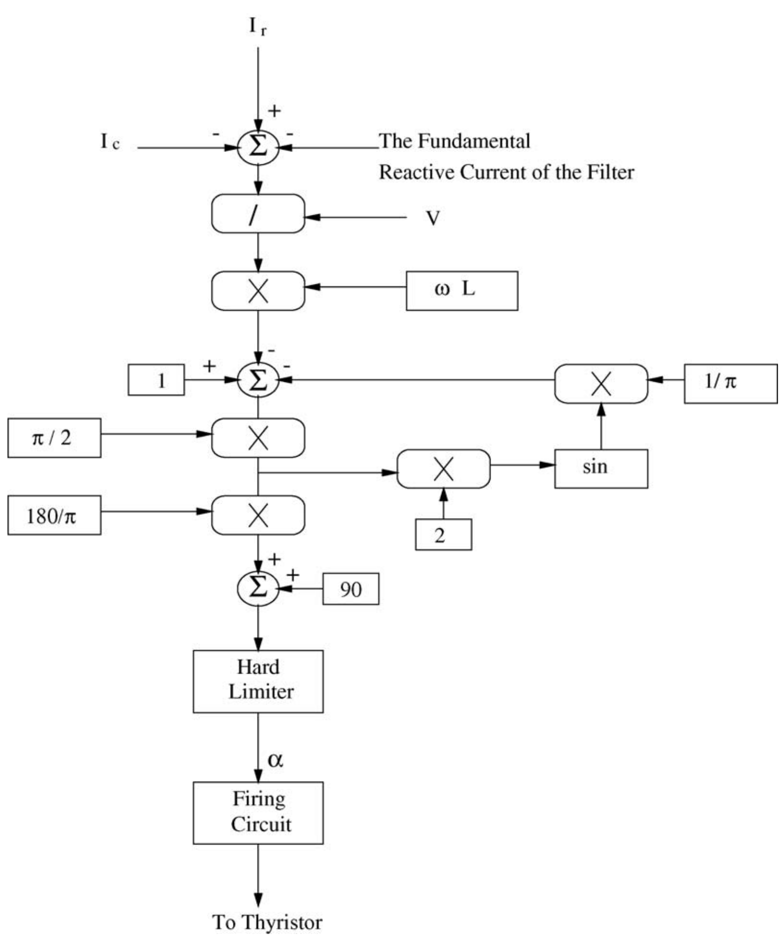

Fig. 3. Modeling of control system in EMTDC.