Chapter 6
Power Flow Modeling in Power System With Multiple FACTS Controller

ABSTRACT

Flexible AC transmission systems (FACTS) devices are integrated into power system networks to control power flow, increase transmission line capability to its thermal limit, and improve the security of transmission systems. Power flow is an important mathematical calculation for planning, operation, and control of power systems network. The focus of the chapter is to explore how to modify Newton-Raphson power flow method to include various FACTS devices such as static VAR compensator (SVC), static synchronous compensator (STATCOM), static synchronous series compensator (SSSC), thyristor-controlled series capacitor (TCSC), thyristor-controlled phase shifter (TCPS), unified power flow controller (UPFC) controllers. This chapter briefly describes the power flow equations of the aforesaid FACTS-based power system network, and how the conventional power flow calculation is systematically extended to include these controllers is also been discussed.

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INTRODUCTION

Load flow (or Power flow) calculations are an important mathematical calculation in power systems network for planning, operational planning, and control (Scott, 1974; Tamimi et al., 2017) Power flow programs are the most frequently used computer routines for power systems calculations. Appropriate steady state model of the power system is needed for writing the computer programs. The model includes nonlinear algebraic equations, which must be solved iteratively. Power flow calculation is needed for both steady state power flow analysis and initializations for different dynamic analyses.

Flexible AC transmission system (FACTS) controllers are able to change the network parameters in a fast and effective way in order to achieve better system performance (Hingorani & Gyugyi, 2000; Peng, 2017) These controllers are used for enhancing dynamic performance of power systems in terms of voltage/angle stability while improving the power transfer capability and voltage profile in steady state. Different FACTS controllers are considered in this chapter which is connected either in series or shunt with the bus bar. These controllers are: Static synchronous Compensator (STATCOM), static synchronous series compensator (SSSC), and unified power flow controller (UPFC), Thyrister control series capacitor (TCSC), Static VAR Compensator (SVC) and Thyrister control phase shifter (TCPS).

MODELING OF POWER SYSTEM WITH MULTIPLE FACTS CONTROLLER

Power System With Static VAR Compensator (SVC)

The SVC is the most widely used employed FACTS controller. It is a shunt-connected static VAR generator or absorber whose output is adjusted to exchange capacitive or inductive current so as to maintain or control specific parameters of the electrical power system (typically bus voltage).

The SVC in general, may be a Thyristor Controlled Reactor (TCR) or Thyristor Switched Capacitor (TSC) or a combination of both. Some other configuration of SVC is Fixed Capacitor-TCR(FC-TCR) or TCR-Mechanically Switched Capacitor(TCR-MSC). The high voltage side system bus voltage is measured and filtered and compared with the reference voltage. The error