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Location of static var compensator in a multi-bus power system using unique network equivalent

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Abstract. This paper presents a new approach to identify the suitable location for static var compensator in a multi-bus power system for voltage stability enhancement using a unique two-bus π-network equivalent derived with optimal power flow solution of the actual system at different operating conditions. An index named equivalent network based index (ENBI), derived from the parameters of two-bus equivalent of the multi-bus power system is used for positioning the static var compensator. The proposed approach has been tested under simulated condition on a practical power system (203-bus Indian Eastern Grid) for illustration purpose. Simulation results obtained with the proposed approach are compared with the results of well-established *L*-index method. Improvement in voltage stability margin using static var compensator is also investigated for the test system considered.

Keywords: two-bus π-network equivalent; optimal power flow; static var compensator; L-index; equivalent network based index; global voltage stability indicator

1. Introduction

Modern power system operations are exposed to highly stressed conditions due to increased system complexity, changes in network topology and continued growth of load demand with limited transmission and/or generation enhancement. This makes the system vulnerable to stability and security problems. Voltage stability problem is the main issue with stressed power systems and is the major concern for researchers and power system engineers over the past few decades because of several events of the voltage collapse occurred all over the globe (Kundur 1994, Van Custem 1991, Mala De and Goswami 2011, Nourizadeh *et al.* 2012). The main factor for causing voltage instability is the reactive power mismatch in the power system and it is the cause for system collapse in which the system voltage decays to a level from which it is unable to recover. So, a power system needs to be sufficient reactive power capability to remain voltage secured even under highly stressed conditions (Yamashita *et al.* 2008, Ritwik Majumder 2014, Mala De and Goswami 2014, Chebbo *et al.* 1992, Juan *et al.* 2011).

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Appendix

SVC parameters adopted are:
1) Transformer reactance X_t=0.334 p.u.,
2) Transformer resistance R_t =0 p.u.,
3) Inductor reactance for the TCR, X_L=0.8741 p.u. and
4) Capacitive reactance, X_C=3.2484 p.u.

The maximum capacitive susceptance obtained is B_{SVC_max} = 0.3431 p.u. i.e., 34.31 MVar is the maximum reactive power that the SVC can inject at 1.00 p.u. terminal voltage. Fig. 7 depicts the variation in equivalent susceptance B_{t_svc} and equivalent reactance X_{eq} with variation in firing angle α. From the figure it is observed that resonance for the values adopted for the SVC model occurs at about 128°. Thus an initial value of 140° has been adopted for the firing angle α and has been adopted for the test system considered.

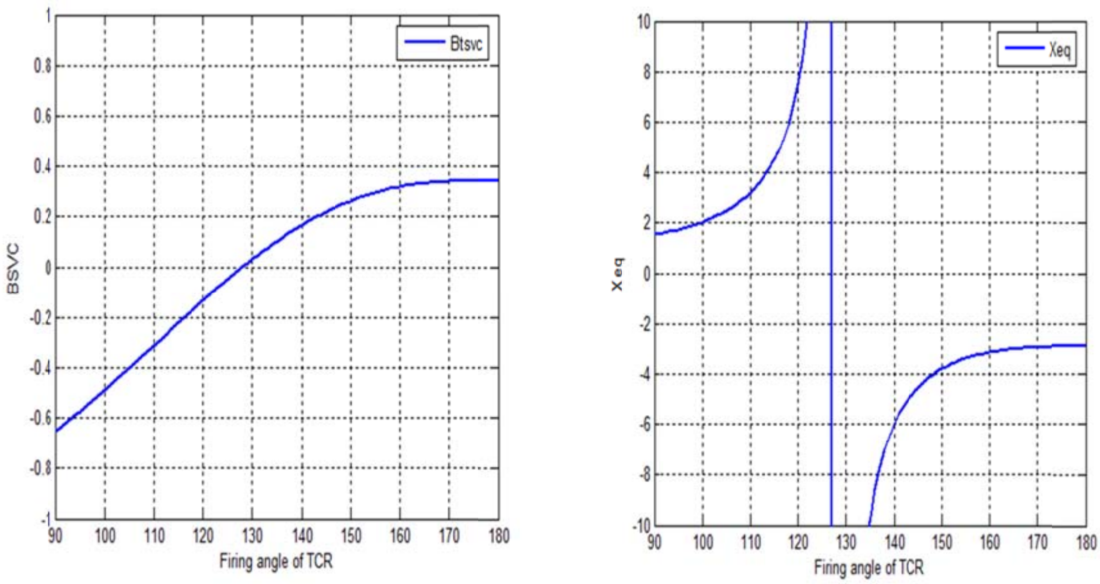

Fig. 7 Equivalent Susceptance ($B_{t\ svc}$) &Total equivalent Reactance (X_{eq}) of SVC