THYRISTOR CONTROLLED PHASE SHIFTER BASED STABILIZER DESIGN USING SIMULATED ANNEALING ALGORITHM

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ABSTRACT - This paper presents a thyristor controlled phase shifter (TCPS) based stabilizer design using simulated annealing (SA) algorithm. An eigenvalue based objective function to increase the system damping is proposed. Then, SA algorithm is employed to search for optimal setting of stabilizer parameters. Two different control schemes have been proposed and tested on a weakly connected power system with different disturbances and loading conditions. It was also observed that the TCPS controller provides efficient damping of low frequency oscillations and improves greatly the voltage profile of the system under severe disturbances.

Keywords: thyristor controlled phase shifter, power system stabilizer, simulated annealing algorithm.

1 INTRODUCTION

The recent advances in power electronics have led to the development of the flexible alternating current transmission systems (FACTS). One of the promising FACTS devices is the thyristor controlled phase shifter (TCPS). Despite the potential of modern control techniques with different structures reported in the literature, power system utilities still prefer a conventional lead-lag controller structure. In this paper, SA algorithm is proposed to TCPS based stabilizer design problem.

2 PROBLEM FORMULATION

Power systems experience low frequency oscillations due to disturbances. To enhance system damping to these oscillations, a widely used conventional lead-lag stabilizer is considered in this study. It can be described as

$$u = \frac{sT_w}{1+sT_w}\frac{K(1+sT_1)(1+sT_3)}{(1+sT_2)(1+sT_4)}\Delta\omega$$

In this structure, T_W, T_2, and T_4 are usually prespecified. The parameters K, T_1, and T_3 are remained to be determined. The following control schemes are proposed.

- **Scheme (a)** where TCPS based stabilizer only is considered.
- **Scheme (b)** where coordinated design of both TCPS based stabilizer and PSS is considered.

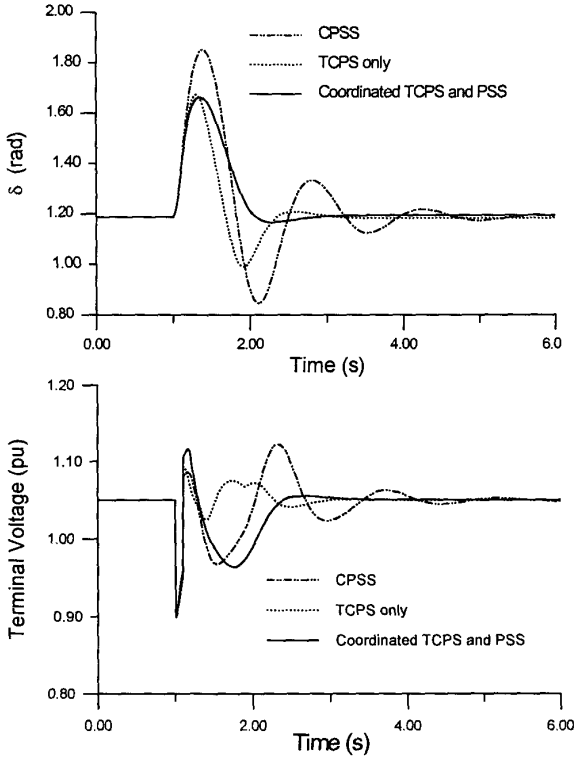
The proposed objective function is given as

$J=\zeta$ of electromechanical mode

The design problem can be formulated as *Maximize J* with the optimized parameter bounds as the problem constraints. SA algorithm has been applied to search for optimal settings of the optimized parameters.

3 SIMULATION RESULTS

To assess the effectiveness of the proposed control schemes, different loading conditions were considered. The behavior of the proposed control schemes under transient conditions was verified by applying a 6-cycle three phase fault at the infinite bus. The system response is shown in figures below. It can be seen that the first swing in the torque angle is significantly suppressed and the terminal voltage profile is greatly improved with the proposed control schemes.



4 CONCLUSIONS

In this study, the effects TCPS based stabilizer when applied independently and also through coordination with PSS have been investigated. The proposed control schemes have been tested on a weakly connected power system under different disturbances and loading conditions. The results show that

(a) the potential of SA algorithm to solve the problem of TCPS based stabilizer design;

(b) the TCPS based stabilizer provides good damping of low frequency oscillations and improves greatly the voltage profile;