2005년도 대한전기학회 하계학술대회 논문집 2005. 7. 18 - 20

직렬 및 병렬 Sin+Cos 전력계통안정화장치

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Series and Parallel Sin+Cos PSS

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Abstract - This paper proposes new series and parallel Sin+Cos PSS(power system stabilizer) for the purpose to improve the existing PSS1A's performance. The purpose of PSS is used to enhance damping of power system oscillations through injection of auxiliary signal for an excitation control terminal. The proposed series and parallel Sin+Cos PSS is connected adding the Sin+Cos terms additionally with serial and with parallel connection in a conventional PSS1A. The proposed controller is aim to considering of a damping of oscillation when it changes parameter fluctuations or operational load variations in a power system. The object of electric power system is KEPCO system and the voltage of power transmission line is a 154kV and a 345kV. The PSCAD/EMTDC package is used to authorize the effect of the proposed controller. Simulations were shown by and compared with the waveforms for frequency, voltage and electric power.

Index Terms-New series and parallel Sin+Cos PSS, PSS1A Type PSS, KEPCO system, PSCAD/EMTDC, damping

1. Introduction

Unfortunately, power outages and exceptional events may occur in unexpected ways [1-2]. In the case of a blackout occurring throughout all the areas in South Korea, the restorative procedure had been assigned by the KPX (Korea Power Exchange). Black-start generators assigned by these rules are usually used hydro type to energize the remote generators such as nuclear type and thermal type through primary restorative transmission (PRT) in the case of wide area blackout. KEPCO power systems adopt the "all open"switching strategy except the circuit breakers which are closed in PRT lines to make procedure simple after wide area blackout, which is the same strategy that is used in all of the world's power systems. PRT lines can be supplied by two cases of energization [3]. The first line involves the main energized transmission line. The second line deals with the subsidiary energized transmission.

In South Korea, power system can be divided into 7 geographical areas that take geographical boundaries into account, which are the Gyeongin northern area, the Gyeongin southern area, the Yeongdong area, the Jungbu area, the Yeongnam area, the Honam area, and the Jeju Island area. Power system on Jeju Island is currently connected to the mainland via a 100km-long submarine transmission system, comprised of HVDC (High Voltage Direct Current) cables between Haenam in Honam and North-Jeju on Jeju Island [4].

The power after blackout is reenergized to power restoration line (PRL) from a black-start generator and during these periods, power, angle and terminal voltage, etc for the fluctuation of waveforms. To relive with these oscillations, a new series and parallel Sin+Cos PSS(power system stabilizer) for damping of power system during power restoration after a blackout in South Korea is presented.

This PSS structure has the parallel addition of series and parallel Sin+Cos term with conventional Lead-Lag PSS. Conventionally, power system stabilizer (PSS) is used to enhance damping of power system oscillations through excitation control.

Here the only used input to the stabilizers is the shaft speed. Conventional PSS1A PSS is to enhance damping of power system oscillations through excitation control, and to use inputs to the stabilizers as a shaft speed [5].

The main objectives of this paper are to demonstrate that the setting of the proposed series and parallel Sin+Cos PSS module can be effectively damped. The resulting power systems simulated will be shown the results by using a PSCAD/EMTDC tool.

2. Power system stabilizer

2.1 Power System Stabilizer (PSS)

PSS is used to enhance damping of power system oscillations through excitation control [6-9]. Here the only used input to the stabilizers is the shaft speed. Conventional PSS1A PSS used in Fig. 1 is to enhance damping of power system oscillations through excitation control, and to use inputs to the stabilizers

as a shaft speed.

$$u_{pss}(s) = K_s \frac{sT_5}{1+sT_5} \frac{1+sT_1}{1+sT_2} \frac{1+sT_3}{1+sT_4} \frac{1}{1+sT_6} \omega(s) \quad (1)$$

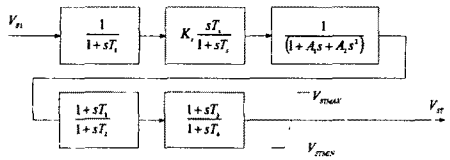
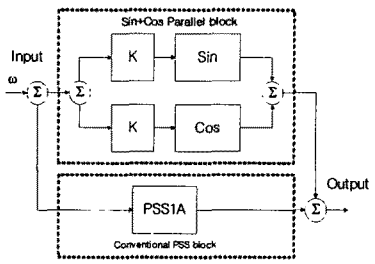
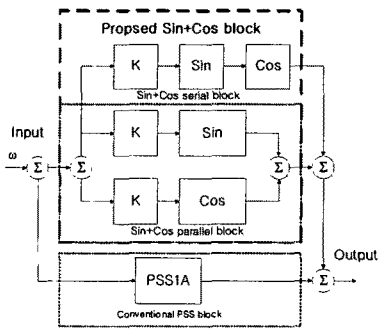


Fig. 1. Conventional PSS1A PSS block diagram

In Fig. 2, the proposed series and parallel Sin+Cos PSS is composed of the additional structure both a Sine+Cosine term and a conventional Lead-Lag PSS.



(a) Parallel Sin+Cos PSS block diagram



(b) Serial Parallel Sin+Cos PSS

Fig. 3. Proposed Sin+Cos PSS block diagram

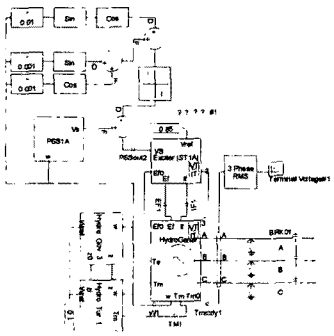


Fig. 4. EMTDC/PSCAD block diagram of the proposed Sin+Cos PSS

3. Power flow considering seasonal load pattern

3.1 PSCAD/EMTDC diagram for 7 regions in Korea

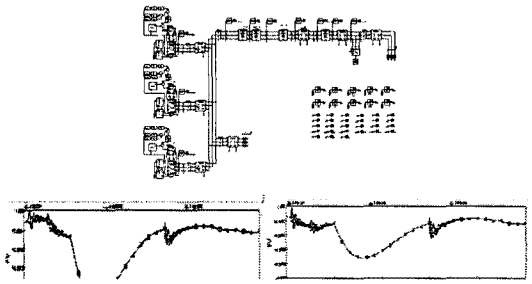


Fig. 5. PSCAD/EMTDC line diagram and waveforms for main transmission line of Northern Gyeongin Area

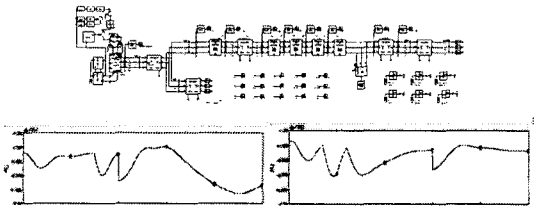


Fig. 6. PSCAD/EMTDC diagram and waveforms for main transmission line of Southern Kyung-In Area

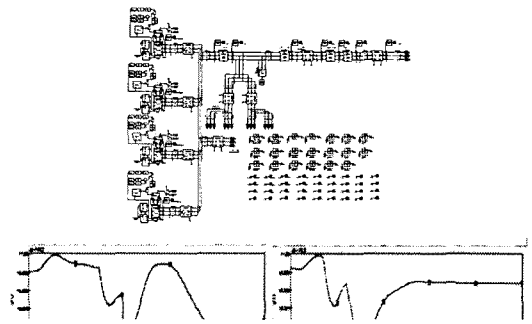


Fig. 7. PSCAD/EMTDC diagram and waveforms for subsidiary transmission line of Young-Dong area

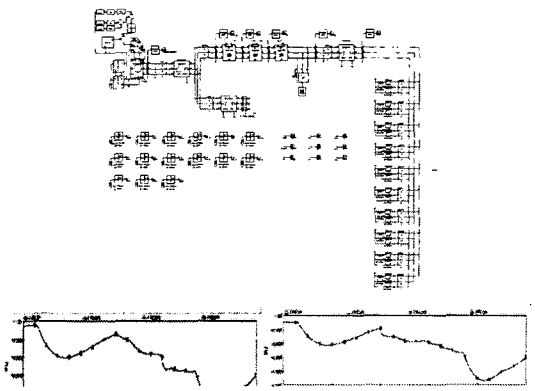


Fig. 8. PSCAD/EMTDC diagram and waveforms for main transmission line of Jung-Bu Area

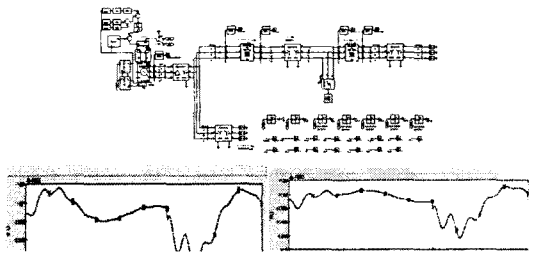


Fig. 9. PSCAD/EMTDC diagram and waveforms for main transmission line of Yeongnam area

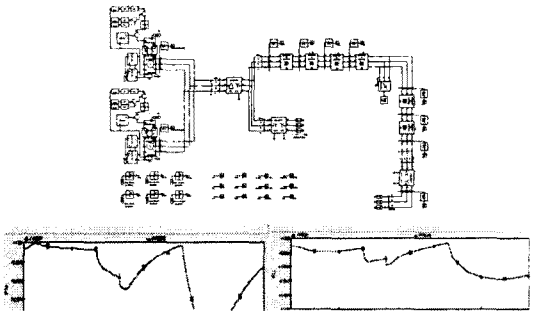


Fig. 10. PSCAD/EMTDC diagram and waveforms for main transmission line of Honam area

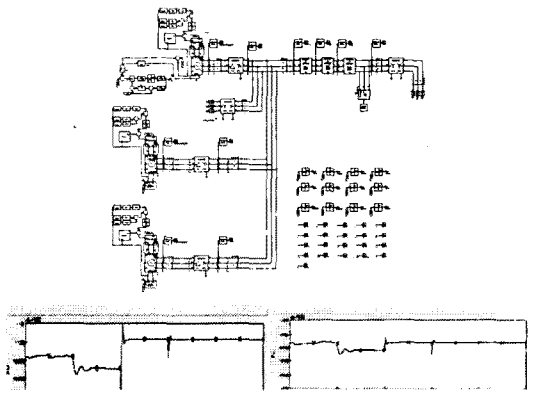


Fig. 11. PSCAD/EMTDC diagram and waveforms for main transmission line of Jeju Island

4. Conclusions

New series and parallel Sin+Cos PSS (power system stabilizer) was proposed. This was composed of parallel structures. The proposed PSS strategy for damping of power system during restoration in the cases of dividing into 7 geographical areas in South Korea was applied. The damping characteristics of a PSS (power system stabilizer) were presented by using a PSCAD/EMTDC in electric power grids including black-start generators in South Korea. The tested power system was Korea's power system, and was simulated by a PSCAD/EMTDC tool. The oscillation for seven cases can be considerably damped or marginally reduced by the setting of the proposed model with a PSCAD/EMTDC package.

Acknowledgment

This work has been supported by KESRI, which is funded by MOCIE (Ministry of commerce, industry and energy)

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