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The Use of Multiband PSS to Improve Transient Stability of Multimachine Power System

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ABSTRACT

With the increase in demand for electrical energy, electrical networks must constantly work near their stability limits faster and more flexible. These grids are often subject to disturbances such as short circuits which cause the loss of stability of generators and the entire network. In this work we present two different approaches to PSS (power system stabilizer), the conventional PSS and multiband PSS in order to improve transient stability of multimachine network. The latter is subjected to a short-circuit current with a duration of 200ms just 350km from the first generator. Multiband PSS offers an additional advantage since it produces a signal stabilizing not only from the variation of the angular velocity of the rotor as well as electrical power. Instead of one, it uses three filters (Lead/Lag) independent, each optimized for vibration damping local oscillations between interconnected networks and global oscillations. Different simulations were performed using the software matlab sympower system.

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1. INTRODUCTION

Disturbances that occur in electrical networks cause electromechanical oscillations. These power oscillations must be damped effectively to maintain the stability of generators and preserve the integrity of the entire system [1]. Transient stability is the most important problems in the reliability and proper functioning of electrical networks. The generators are equipped with power stabilizer (PSS) as control devices for damping power oscillations and provide dynamic performance. These PSS are mainly used to absorb low frequency oscillations from 0.2Hz to 2.5Hz.

Literature review that has been done author used in the chapter "Introduction" to explain the difference of the manuscript with other papers, that it is innovative, it are used in the chapter "Research Method" to describe the step of research and used in the chapter "Results and Discussion" to support the analysis of the results [2].

2. DESCRIPTION AND BASIC PRINCIPLE OF CONVENTIONAL PSS

The PSS is designed to introduce an electric torque in line with the variations in the speed of the rotor, this is achieved by an additional stabilization ΔVs applied to the automatic voltage regulator (AVR) of the generator as shown in Figure 1 this figure illustrates the basic structure of the conventional PSS [3].

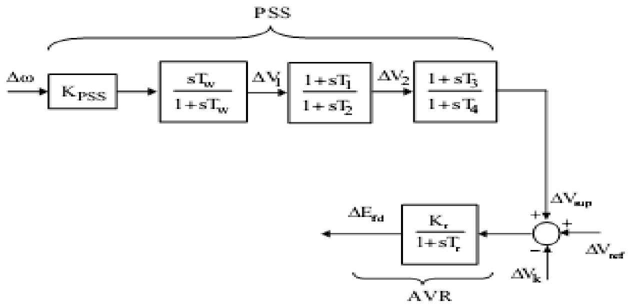

Figure 1. Basic Structure of Conventional PSS

The controller consists of an amplifier block K_{PSS} is adjusted to obtain the desired damping, block checker which is defined by the time constant Tw, it functions as a filter for the low frequencies (0.8 to 2 , 0 Hz), the time constants T1, T2, T3 and T4 define two lead-lag compensator blocks of the input signal.

With: T_w=10 secondes, K_{PSS}=30, T_1=50e-3, T_2=20e-3, T3=3 and T4=5.4 sec [4 5]. Figure 2 below shows a production unit consists of a synchronous generator, excitation system of AVR and a PSS.

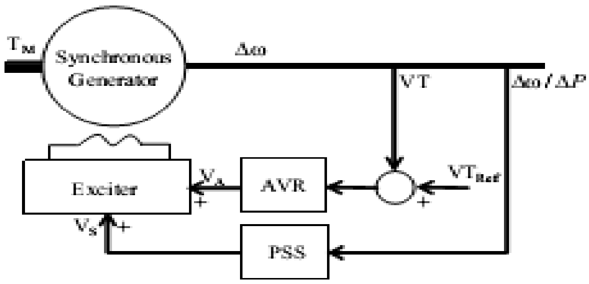

Figure 2. Diagram of Production Unit

3. DESCRIPTION AND BASIC PRINCIPLE OF MB-PSS

Multiband PSS is designed to absorb all the disturbances that occur in electrical networks, these disturbances induce electromechanical oscillations in power systems. Multiband PSS provides cushioning through three separate bands, a band of high-frequency mode, a mode for intermediate frequencies and mode for lower frequencies. The low band (KL, TL) acts on the slow oscillations in isolated systems.

The intermediate strip (KI, IT) is used for the oscillations between regional networks oscillation frequency is in the range [0.2Hz, 1.0Hz]. High band (KH, TH) is used for local oscillations or inter-machine (between alternator and other machines in the same plant) with a frequency range of 0.8Hz to 4.0Hz, the pattern [6] Multiband PSS is given in Figure 3 below:

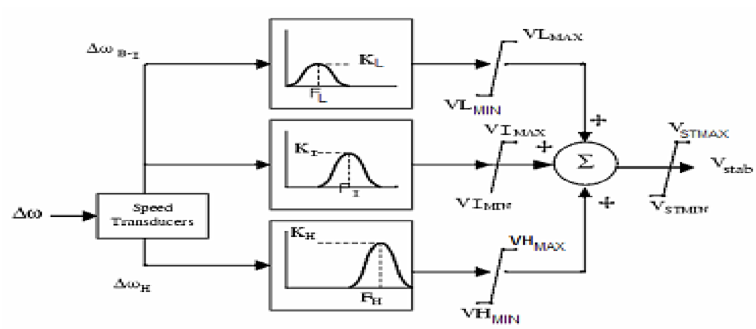

Figure 3. Basic Structure of Multiband PSS

The detailed structure of Multiband PSS is given in Figure 4 below [7]:

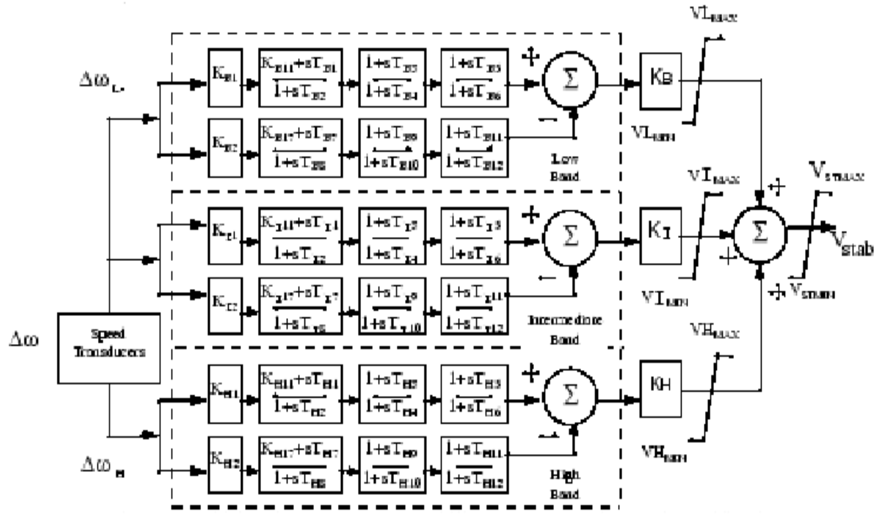

Figure 4. Detailed Structure of Multibans PSS

Each band is made of a band-pass filter, a gain and a limiter. Multiband PSS parameters are given as follows:

F_L=0.2Hz, K_L=30, F_I=1.25Hz, K_I=40, F_H=12Hz, K_H=160.
V_{LMAX}= 0.0175.
V_{IMAX}= 0.15
V_{HMAX}=0.15
V_{STMAX}= 0.15

4. DESCRIPTION OF THE NETWORK STUDIED

The power system is consisting of two machines and a power of respectively 1000 and 5000MVA interconnected via two transformers and two line of a length of 350km. Resistive load of 5000 MW is applied to node B3. The network is subjected to a short-circuit current with a duration of 200ms. The network is shown in Figure 5 below [8]:

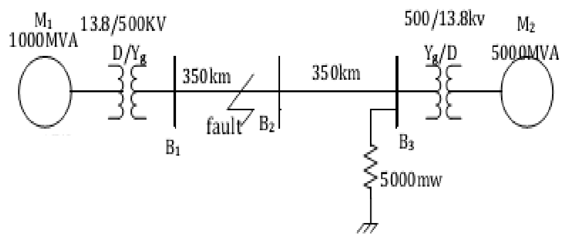

Figure 5. Simplified Diagram of the System Studied

5. SIMULATION RESULTS

The results shows the different characteristic parameters of machines on the power system (the voltage, the rotor speed, the electrical power and the rotor speed between two area) for three different cases, the first case power system being without control (Figure 6) ,the results show that the power system loose its stability at time 0.2s, power oscillations appear and the rotor speed between two area is increasing to reach 0.2 pu By equipping this power system with a conventional regulation (AVR + generic PSS) (Figure 7), the oscillations are damped gradually and their amplitude is less important. Using Multiband PSS (Figure

8) instead of conventional PSS, these power oscillations are damped completely and the power system returns to its stability from the third second, with a modern multiband PSS, we get a better response time.

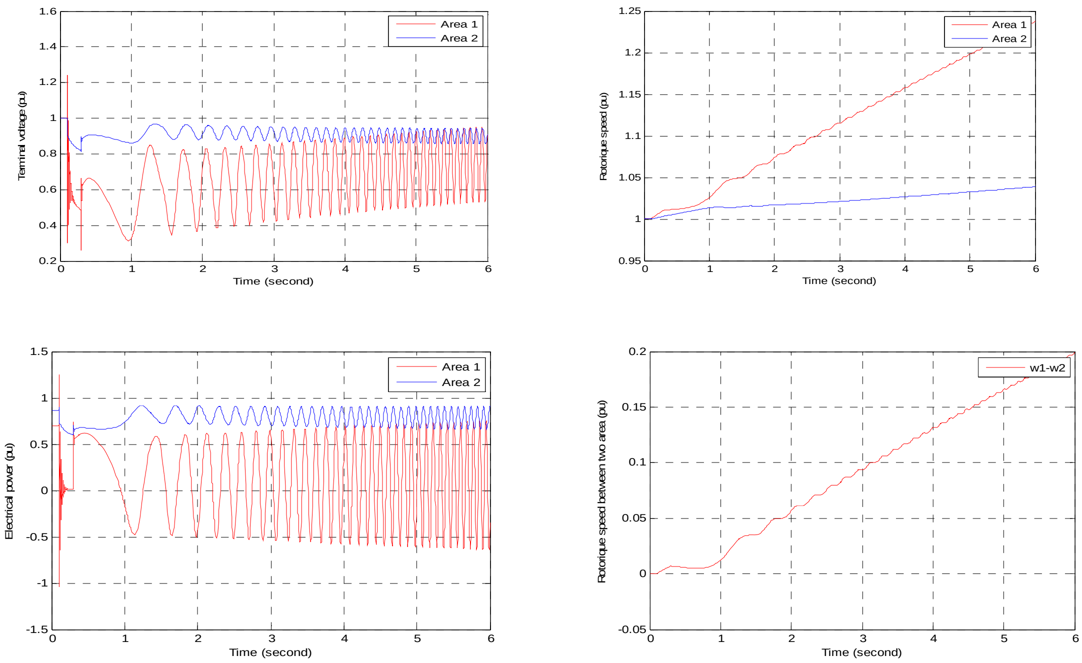

Figure 6. Power System without Regulation

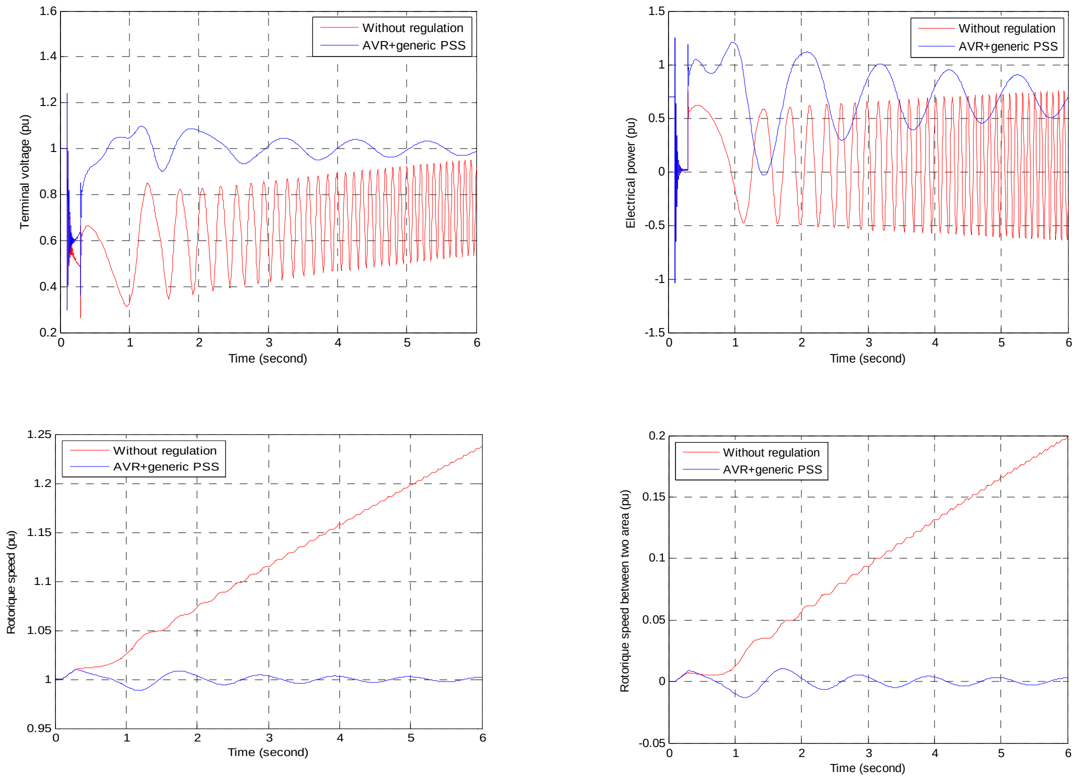

Figure 7. Power System Equipped with AVR+generic PSS

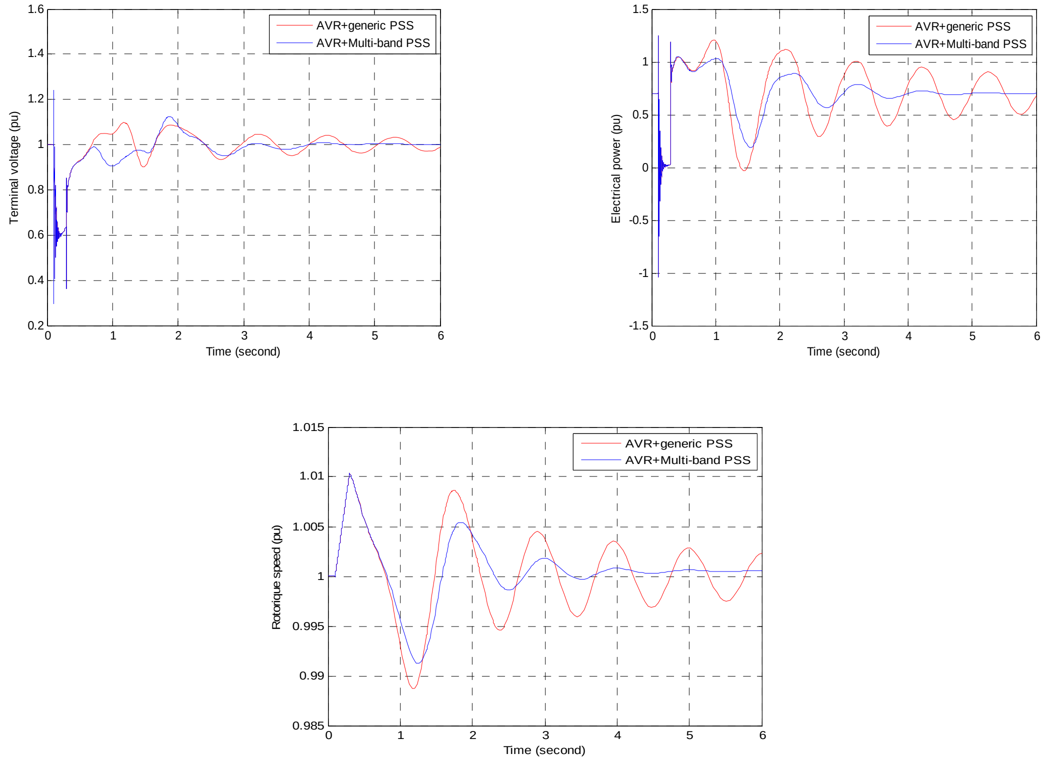

Figure 8. Power System Equipped with AVR+multiband PSS

6. CONCLUSION

In this paper we made a comparative study between conventional PSS and multiband PSS for transient stability of multimachine network. For this, we simulated a short-circuit current with a duration of 200ms, the simulation results have shown that the system without control loses its stability, power oscillations appear and we observed an increase of the two machines rotor speeds that caused the loss of synchronism and consequently the loss of stability of power system. By equipping power system with conventional PSS and associating it with automatic voltage regulator AVR, we saw a slight damping power oscillations after the extinction of the fault at 0.3s, the power system returned to its stability long after, in the last series of our simulation we used the multiband**.**

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