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Implementation of Automatic Generation Control with Automatic Voltage Regulator and Power System Stabilizer of an Isolated Power System

Harsh S. Dhiman
Electrical Engineering Department, Faculty of Technology & Engineering
The Maharaja Sayajirao University of Baroda, Vadodara, India

ABSTRACT: The paper presents a simulink model of Automatic Generation Control of Synchronous Generator interfaced with AVR (Automatic Voltage Regulator) and PSS (Power System Stabilizer). The terminal voltage and frequency deviation to a step change in the load were analyzed and various results were plotted for different gains. The load frequency controller maintains the steady state error to zero, while the AVR loop maintains the terminal voltage to be constant. Also the simulation was carried out with and without PSS in the exciter circuit of the alternator.

Keywords: Automatic Voltage Regulator, Proportional Integral Control, Power System Stabilizer, Step Response

I. INTRODUCTION

Current trend of power system is such that it requires high on both real and reactive power, also the control and balancing of both real and reactive power becomes an essential part in an interconnected grid. This paper presents a methodology along with a comparative study of implementing Power System Stabilizer in the AVR loop of the Alternator. Apart from maintaining the synchronism in the grid it is also essential to monitor the power quality based on the nature of receiving end voltage and frequency. Thus a balance between real power generation and demand must be met. Any change taking place on the load reflects on the real power generation of the alternator connected by suitable changes in the tie line frequency. However a frequency deviation of about ±3% does not lead to any abnormal operation but certainly damages the turbine blades and leads to a less efficient speed governing system. However the problem is even worse in case of interconnected networks where the tie line power flows and torque get suitably affected due to frequency perturbations and ultimately cause swinging of rotor often known as hunting in synchronous generators. In order to avoid the problem of swinging of rotor about its mean equilibrium position which is primarily caused by sudden changes in load, the AVR loop comes into action and maintains the right amount of reactive power in the power system. The main function of the AVR loop is to maintain the terminal voltage of the generator within the acceptable limits after being subjected to sudden load rejection on the demand side. Here we have incorporated power system stabilizer that servers as an aid in filtering out the low frequency oscillations during a three phase fault or load rejection. The Demand Side Management often deals with such situations where the voltage and frequency profile of the power system are being studied and preventive measures are taken so as to minimize voltage collapse.

II. METHODOLOGY AND ROLE OF PSS

The role of Power System Stabilizer in an exciter circuit is basically to damp the low frequency oscillations that cause significant heating of the stator core of the alternator. In order to remove these oscillations the PSS is modeled according with all the blocks and their parameters set to optimum value. Typical PSS contains a wash out circuit which removes the dc offset from the low frequency oscillations, a cascaded lead-lad compensation network in order to improve the frequency response also to suppress the noise signal present if any, and a limiter in order to limit the output of the PSS in order to avoid saturation. There are two types of PSS available, one is the generic PSS that can accept inputs like rotor speed deviation, accelerating power and change in angular frequency, other one is the Multiband PSS.

III. MATLAB SIMULATION AND OBSERVATIONS

The Matlab simulation circuit along with all the measuring scopes is shown below. The ALFC loop consists of PI controller. The parameters of the ALFC loop along with their values are mentioned in the table given below. Similarly the AVR loop is coupled with PSS whose input is rotor speed deviation. However it is possible to have two or more blocks of lead-lag compensator in cascade connection for a much better frequency response. Here the circuit configuration is tested for Step response of terminal voltage with and without PSS in the exciter circuit.

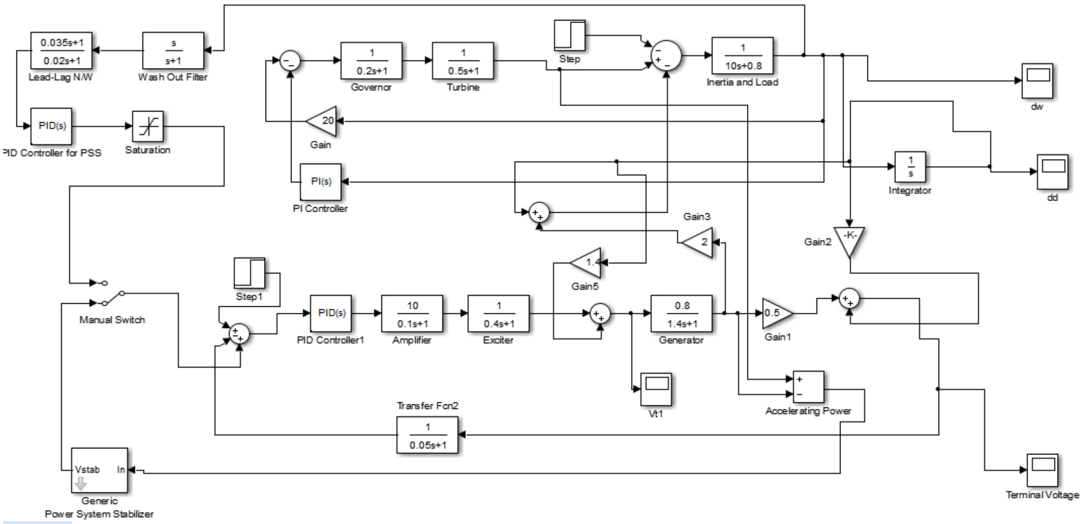

Fig 1: AGC and AVR of an Isolated System with PSS

Sr no	Parameter	Value
1	Amplifier Gain (K_A)	10
2	Exciter Gain (K_E)	1
3	Sensor Gain (K_F)	1
4	Generator Gain	0.8
5	Exciter Time Constant (T_E)	0.4 seconds
6	Generator Time Constant (T_G)	1.4 seconds
7	Amplifier Time Constant (T_A)	0.1 seconds

Table 1: Assumptions for Automatic Voltage Regulator (AVR)

Sr No	Parameter	Value
1	Governor Time Constant	0.2 seconds
2	Turbine Time Constant	0.5 seconds
3	Inertia Constant (H)	5 seconds
4	Load Change (ΔP_L)	0.2 pu
5	Proportional Gain (K_P)	1
6	Integral Gain (K_I)	6

Table 2: Assumptions for Automatic Generation Control Block (AGC)

Sr No	Parameters	Value
1	Washout Time Constant	1
2	Lead Lag Time Constant (T1, T2)	0.035 sec, 0.020 sec
3	Proportional Gain	1
4	Integral Gain	0.25
5	Derivative Gain	3
6	Upper limit	0.5
7	Lower limit	-0.5

Table 3: Assumptions for Power System Stabilizer (PSS)

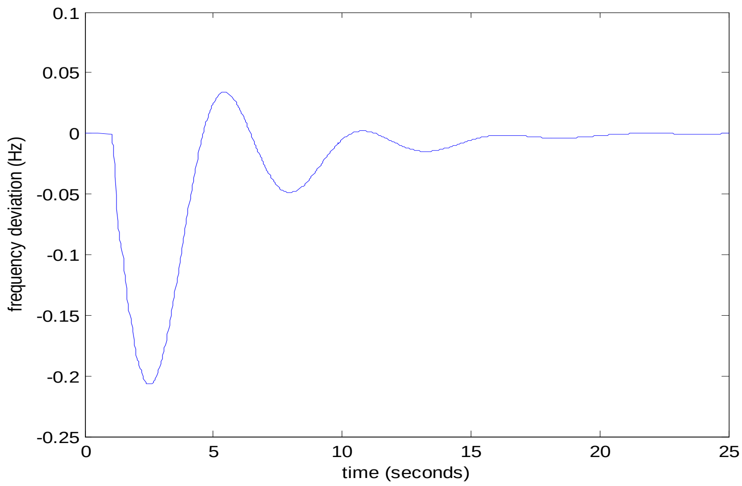

Fig 2: Frequency Response of AGC without PSS in Exciter Circuit

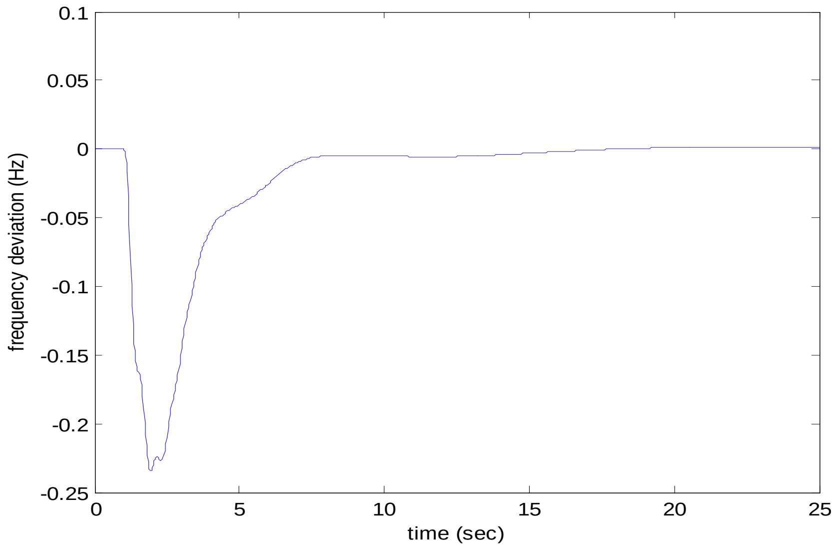

Fig 3: Frequency Response of AGC with PSS in Exciter Circuit

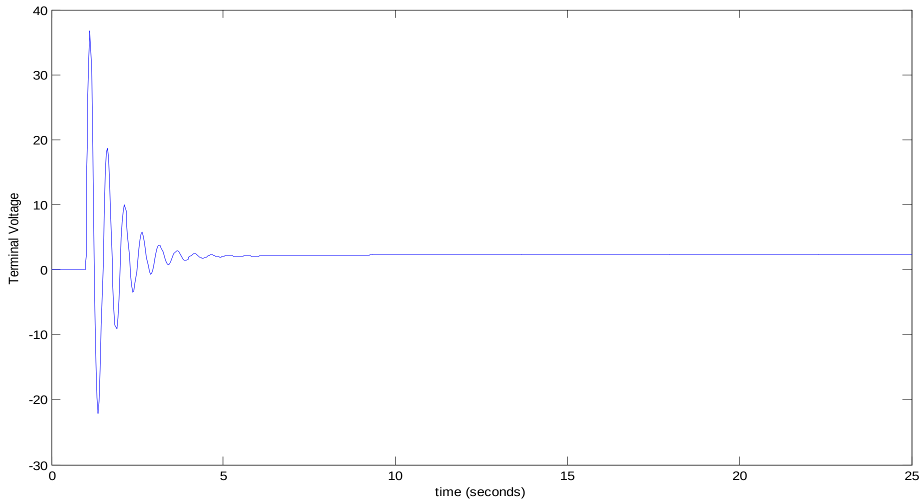

Fig 4: Terminal Voltage Response of Alternator **without PSS**

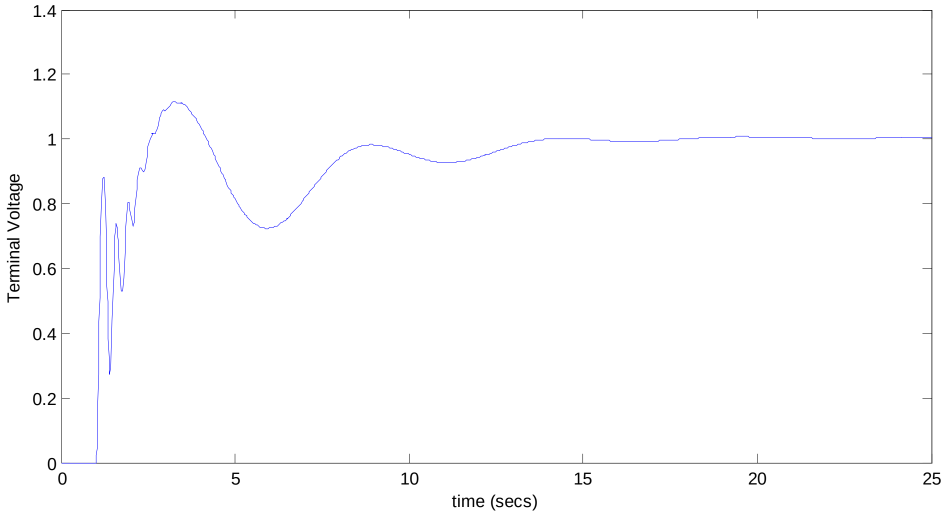

Fig 5: Terminal Voltage Response of Alternator **with PSS** in Exciter Circuit

IV. CONCLUSION

From the above results we can say that the step response of the terminal voltage with PSS in the exciter circuit is much better than without PSS. The peak overshoot in the terminal voltage of the single area system was found to be less when PSS is connected in the circuit. However there is no suitable change in the nature of the frequency response of ALFC loop. Thus the overall performance of the single area system is better with PSS connected in the exciter circuit. Also the PID controller used in the PSS serves the purpose of improving the steady state stability and improving the time response of the system.

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