

Automatic Generation Control of Multi Area Power System Using PID Controller

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Abstract- This paper presents an Automatic Generation Control scheme for multi area power system using integrator and PID controller. The simulation results of four areas are compared using MATLAB/SIMULINK software. Automatic Generation Control is a very important process that operates constantly to balance the generation and load. PID controllers can be tuned by using many methods. In all methods an initial guess is made for PID controller parameter settings. Then these parameter settings are improved by fine tuning of the controller. Now a days various simulation software is widely used for this purpose of parameter settings. MATLAB Simulation software can also be used for fine tuning of the PID controller. So by using MATLAB Simulation tools a method is proposed for fine tuning of PID controller.

Keywords: Automatic Generation Control (AGC), Multi Area Power Systems (MAPS), Proportional- Integral- Derivative (PID) Controller

I. INTRODUCTION

The main objective of AGC is to establish a normal operating state and optimum scheduling of generation with good quality of power. To maintain desired megawatt output of a generator unit Automatic Generation Control is required. AGC also controls the

frequency of larger interconnected power system. AGC has made the operation of interconnected system possible. Automatic Generation Control equipments are installed for each generator in the power system. Automatic Generation Control also helps to maintain the net interchange of power between pool members at pre-specified values. In the conventional control design the integral of control error is taken as the control signal. By using integral controller zero steady state frequency deviation can be achieved but it gives poor dynamic response. Due to sudden load change in the system, there occurs fluctuations in the frequency which remains for a long time. One method to restore the frequency to its nominal value is to add integrator in the power system network. But PID controller is a powerful controller for improving transient and steady state responses. The goal of AGC is also to maintain zero steady state errors and to maintain transient stability in the system.

II. AUTOMATIC GENERATION CONTROL

Automatic Generation Control may be defined as the scheme used to restore frequency to the normal value by adjusting the generation automatically when there is continuous change in the system load. In an interconnected power system, active and reactive power demands are never steady and they keep on changing. So inputs to generators must be continuously

regulated in order to match the active power demand. In large interconnected power system networks regulation by using manual methods is not feasible. So automatic equipments for regulation are installed on each generator. In AGC controllers are set to operate for a particular operating condition and keep the frequency within the specified limits by taking care of small changes in load demand. If there is any variation in the load demand on a generating unit, it results in unbalance between real power input and output. The difference between real power input and output is supplied by the stored kinetic energy of the rotating parts of the unit.

The kinetic energy of the rotating part is given by:

$$\text{Kinetic Energy, K.E.} = \frac{1}{2} I \omega^2$$

Where, I= moment of inertia; ω = angular speed;

If K.E. decreases, angular speed decreases and hence frequency will decrease with the reduction in speed. Speed governor senses change in frequency, Δf and then Δf is feed back to change the input of prime mover. The signal Δf is fed to prime mover in order to keep balance between real power input and output.

The change of speed with change in load can be given as:

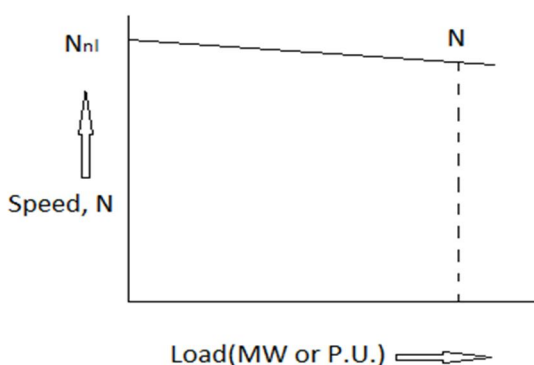


Fig. 1 change of speed with change in load

Power system comprises different control parts and these parts are connected to each other through tie lines. Interconnected multi area power system can be shown by using circles. A simplified four area interconnected power system is shown in fig. 2

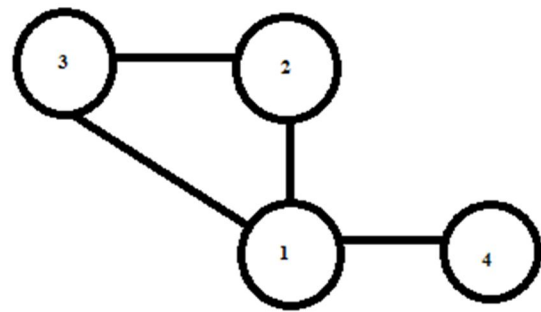


Fig. 2 Simplified four area interconnected power system

The transient response can be improved by using PID controller as compared to integral controller.

III. AUTOMATIC GENERATION CONTROL MODEL

The first step in the design of a control system is mathematical modelling of the power system. The most common methods are the transfer function method and state variable approach. The state variable approach can be used for linear as well as non linear systems. In order to use linear state equations, the system first must be linearized. The dynamic models in state- space form is given as:

$$\begin{aligned} \dot{X} &= AX + BU, \quad Y = CX \\ X &= [\Delta f \quad \Delta P_t \quad \Delta P_g \quad \Delta P_{ref}]^T; \quad U = [\Delta P_L]^T \\ Y &= [\Delta f] \end{aligned}$$

Where X= state vector, U= control vector, Y= output variables.

Automatic Generation Control model of four area power system using integrator and PID controller is given in the fig. 3 and fig. 4. Area 1 and Area 2 of four area power system is given by using integrator and PID controller.

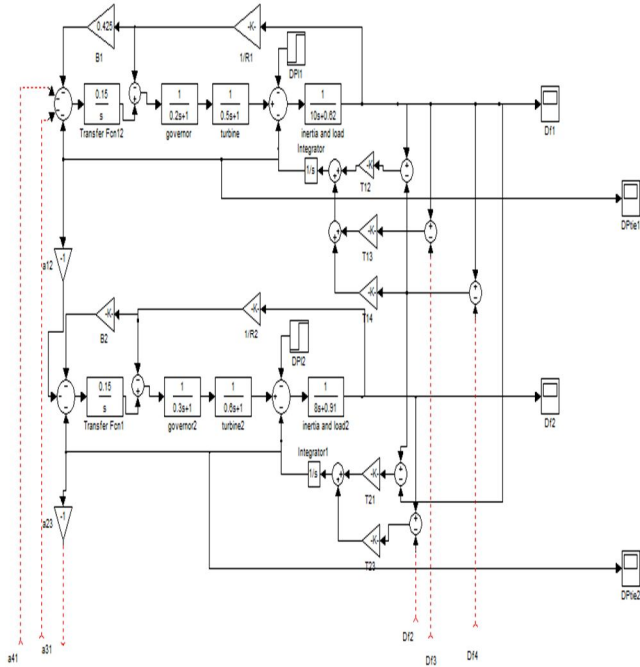


Fig3: Area 1 and Area 2 (with AGC) of four area power system using integral Controller

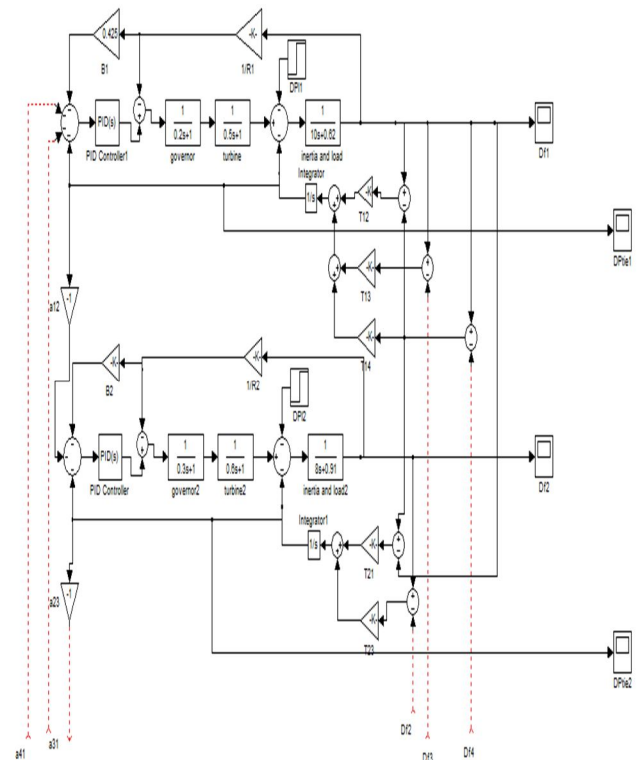


Fig4: Area 1 and Area 2 (with AGC) of four area power system using PID Controller

In this scheme PID controller and integral controller are used and the results of both controllers are compared, then it is found that PID controller gives better results as compared to integral controller.

IV.SIMULATION RESULTS AND DISCUSSIONS:

PID controllers of the form (1) are used in AGC modelling. These PID controllers are tuned by making an initial guess. Later the parameters settings are improved by using MATLAB Simulink. Figs 5-10 show the resulting responses of the simulation model. Fig 5, 6, 7, 8 shows the frequency responses of the four area power system using PID controller and integrator. Fig 9, 10 shows the variation of the tie line power with integrator and PID controller.

From all these figures we obtain that the results with PID controller are better as compared to integrator. The results obtained with PID controller has less overshoot/undershoot and less settling time as compared to integrator.

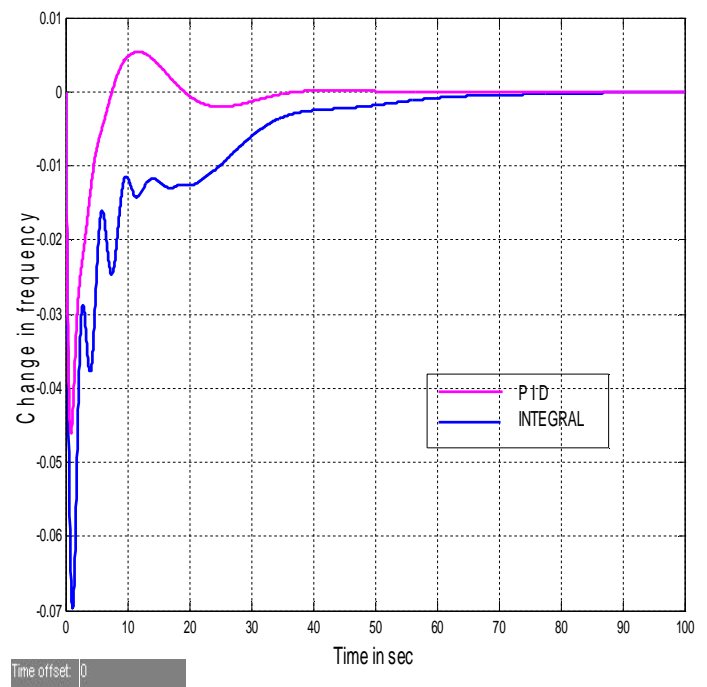


Fig. 5: Frequency response of area-1

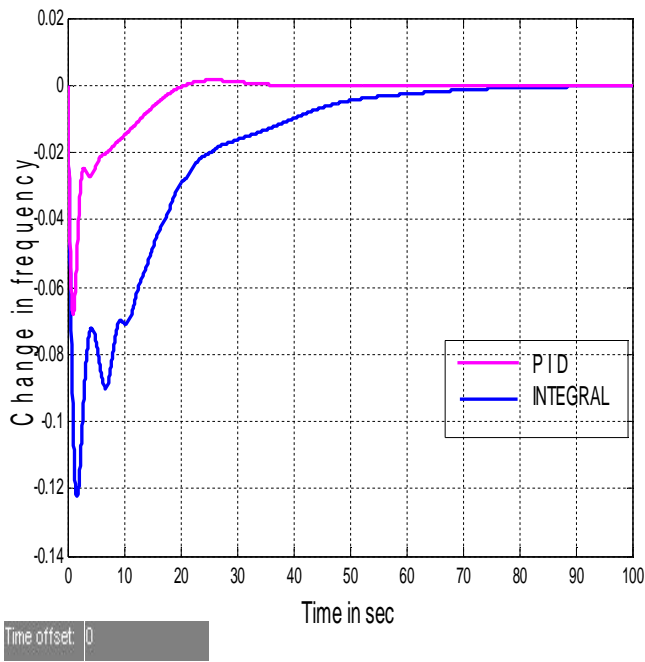


Fig. 6: Frequency response of area-2

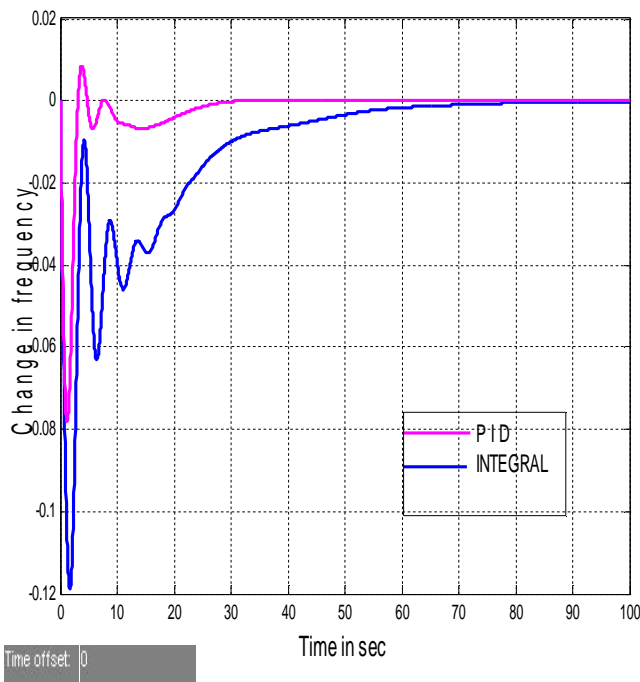


Fig. 7: Frequency response of area-3

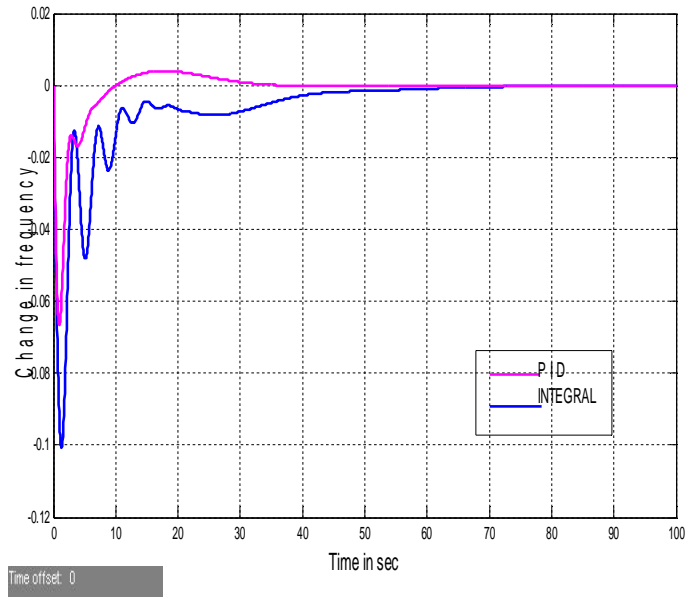


Fig. 8: Frequency response of area-4

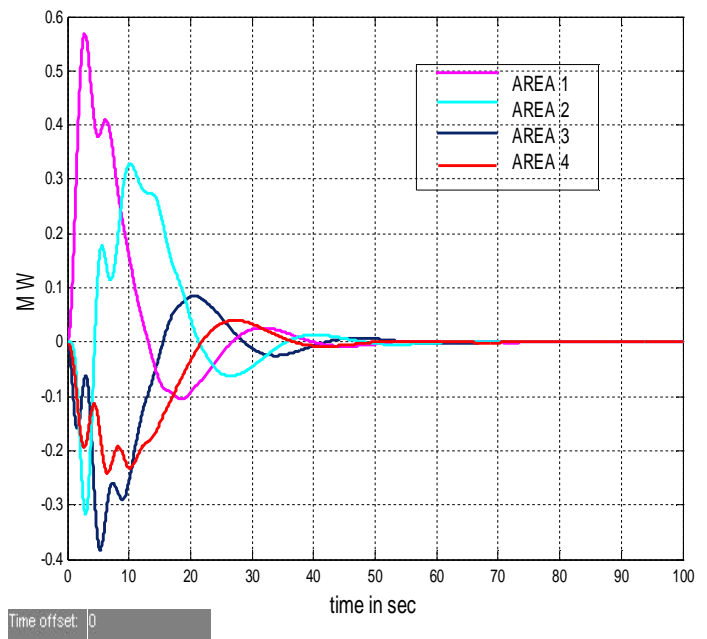


Fig. 9: Tie- line power of four areas with Integral control

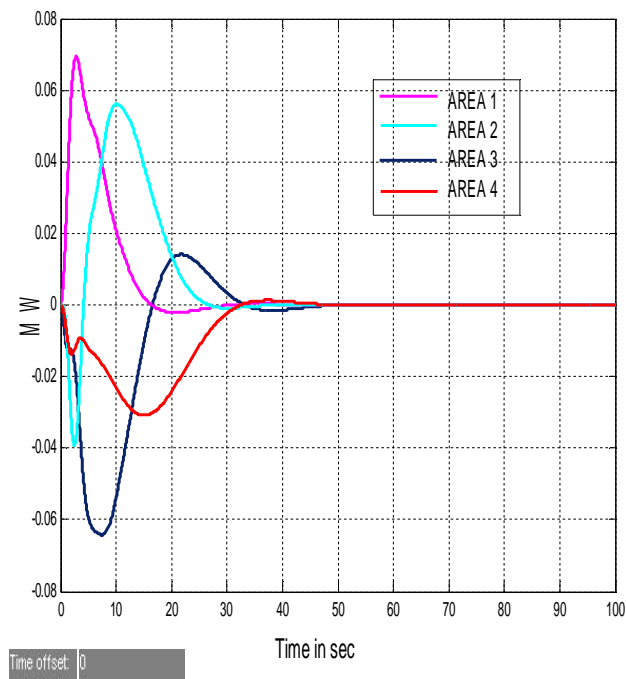


Fig. 10: Tie- line power of four areas with PID controller

V. CONCLUSIONS

In this paper, a PID controller has been investigated for automatic generation control of multi area power system in order to improve the performance of the system. For this purpose, PID controller is tuned by using a new simple tuning method. Performance comparison of the proposed paper shows that PID controller has a shorter settling time as compared to integral controller. In order to improve transient response of the system fine tuned PID controller can be used.

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