An Analysis of Two Area Load Frequency Control with Different Types of Feedback Controllers

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Abstract: This paper deals with the classical method of reducing transients of load frequency of a two area power system. The load frequency of a two area power system is studied with and without Controllers. The model is compared in terms of its uncontrolled response obtained earlier.. A new model is represented in this paper where an advance PID Controller is used compared to Integral Control . For a practical two area power system the change in frequency response is studied for different change in load condition with both types of controllers. The PID controller is properly tuned in such a way that it proved to be a more better controller in comparison to Integral Controller for change in frequency response. With PID Controller applied to two area power Systems the frequency transients are quenched at much faster rates without oscillations.

Key words: Two area frequency power system, PI controller, PID controller

I. INTRODUCTION

The modern power systems with industrial and commercial loads need to operate at constant frequency with reliable power. The load frequency control of an interconnected power system is being improved over the last few years. The goals of the LFC are to maintain zero steady state errors in a multi area interconnected power system [1], [2]. Studies on two area interconnected power system networks were presented based on conventional techniques. Recently many researchers are applying different advance Controllers to improve the dynamic performance of the system by damping the oscillations resulted from load perturbations faster. Subsequently a robust load frequency control for uncertain non linear power systems using fuzzy logic approach to quench the transients in frequency deviations and tie line power deviations is presented [7]. In all these works the basic dynamic model representation of a two area power system given in the reference [2] is considered and the responses of two area power systems are evaluated. These studies using different conventional and fuzzy control methods show that the frequency deviations are oscillatory and the total time to reach final steady state is more. After a sudden load change in area 1 or in area 2 or in both the areas the frequency deviations are oscillatory without any control method. With integral controller in the feedback of the system the steady state frequency error finally reaches Zero. But there are transient present in the change in Frequency response. The behaviour of the two – area power system for different load changes to predict the variations is a major study with and without the application of the fuzzy controller. With this aim an attempt is made to improve the transient behavior of the two – area power system. The first part of the study is concentrated on the transient behaviour of the uncontrolled system for a range of step load changes for the dynamic model considered here.. The system frequency deviations are zero before any disturbance in the power system. Assuming a step load change in area 1 if the fuzzy controller is incorporated in area 1 the system behaviour is observed. Studies are also conducted to find the response of the system by placing the fuzzy controller in area 2. Studies are also performed to load changes in both areas with fuzzy controllers. The behaviour of the interconnected power system for different load changes are also obtained in all these cases.

II. TWO AREA SYSTEM

A two area system consists of two single area systems, connected through a power line called tie-line, is shown in the Figure 1. Each area feeds its user pool, and the tie line allows electric power to flow between the areas. Information about the local area is found in the tie line power fluctuations. Therefore, the tie-line power is sensed, and the resulting tie-line power is fed back into both areas. It is conveniently assumed that each control area can be represented by and equivalent turbine, generator and governor system. Figure1 shows the block diagram representing the two area power system . This model includes the conventional integral controller gains (K1 , K2) and the two auxiliary (stabilizing) signals($\Delta u1$, $\Delta u2$). The stabilizing signals will be generated by the proposed fuzzy logic load frequency controller (FLFC). Each power area has a number of generators which are closely coupled together so as to form a coherent group, i.e. all the generators respond in unison to changes in the load. Such a coherent area is called a control area in which the frequency is assumed to be the same throughout in static as well as dynamic situation

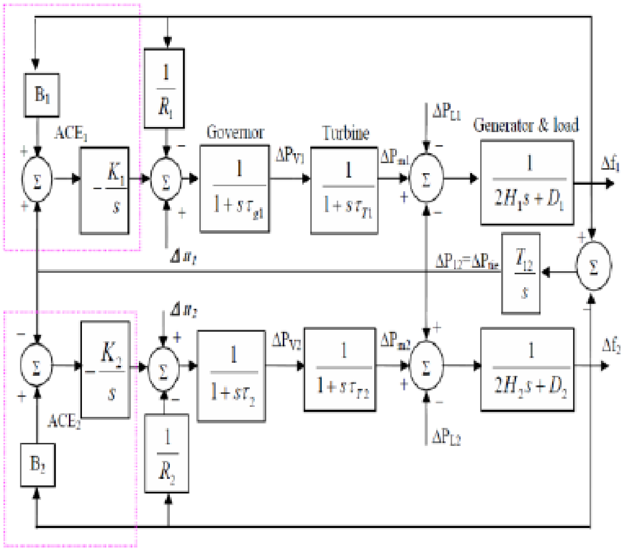

Figure 1

Power transported out of area 1 is given by-

$Ptie,1 = \frac{|V_1||V_2|}{X_{12}} sin(\delta_1\text{-}\delta_2)$

δ_1, δ_2 is power angles of equivalent machine of the two areas

For incremental changes in δ_1, δ_2 the incremental tie line power can be expressed as-

$\Delta Ptie,1(pu) = T_{12}(\Delta\delta_1 - \Delta\delta_2)$

Where,

$T_{12} = \frac{|V_1||V_2|}{P_{r1}X_{12}} \cos(\delta_1\text{-}\delta_2)$=Synchronizing Co-efficient

Since incremental power angles are integrals of incremental frequencies we can write-

ΔPtie,1=2∏$T_{12}(\int \Delta f_1$ dt-$\int \Delta f_2\, dt)$

Where Δf_1 *and* Δf_2 are incremental frequency changes of area1 and area2 respectively.

Similarly incremental tie power out of area 2 is given by

ΔPtie, 2=2∏$T_{21}(\int \Delta f_2$ dt-$\int \Delta f_1\, dt)$

Where, $C = \frac{|V_1||V_2|}{P_{r2}X_{21}} \cos(\delta_2\text{-}\delta_1) = (\frac{P_{r1}}{P_{r2}})\, T_{12} = a_{12}T_{12}$ the incremental power balance equation for area1 can be written as-

$\Delta P_{G1} - \Delta P_{D1} = \frac{2H_1}{f_1}\frac{d\Delta f_1}{dt} + B_1\Delta f_1 + \Delta Ptie, 1$

Taking Laplace transform we get-

$\Delta F_1(s) = [\Delta P_{G1}(s) - \Delta P_{D1}(s) - \Delta P_{tie1}(s)] * \frac{K_{ps,1}}{1+T_{ps1}(s)}$

$K_{ps,1} = 1/B_1$

$T_{ps1}(s) = 2H_1/B_1 f$

Similarly,

ΔPtie, 1(s) = $\frac{2\prod T_{12}}{S}[\Delta F_1(s) - [\Delta F_2(s)]$

ΔPtie, 2(s) =- $\frac{2\prod T_{12}}{S}[\Delta F_1(s) - [\Delta F_2(s)]$

Area Control Error (ACE) for two areas are

$ACE1 = \Delta Ptie, 1 + b_1\Delta f_1$

b_1 is called frequency bias

$ACE1(s) = \Delta Ptie, 1 + b_1\Delta F_1$ (s)

$ACE2(s) = \Delta Ptie, 2 + b_2\Delta F_2$ (s)

III. INTEGRAL CONTROL

The integral control composed of a frequency sensor and an integrator. The frequency sensor measures the frequency error Δf and this error signal is fed into the integrator The input to the integrator is called the Area Control Error (ACE). The ACE is the change in area frequency , which when used in an integral-control loop, forces the s steady-state frequency error to zero. The integrator produces a real-power command signal ΔPc and is given by-

$\Delta Pc = -Ki\int \Delta f dt = -Ki\int ACE\, dt$

ΔPc = input of speed –changer Ki = integral gain constant.

PID Controller

In place of Integral controller PID controller is placed to reduce the transients in tie line Power

$$\Delta Pc = K_p.\Delta f + Ki\int \Delta f dt + K_d\frac{d\Delta f}{dt}$$

$$\Delta Pc = K_p.ACE + Ki\int ACE\, dt + K_d\frac{d\, ACE}{dt}$$

IV. SIMULATION AND RESULTS

The following simulations were performed in order to investigate the performance of PID controller over the conventional integral controller with 1%, 3% and 5% change in load of each area.

Simulation is carried out of two area system as per following systems for response of Δf1,

1. With PI controller
2. With PID Controller

Simulation is carried out of two area system as per following systems for response of Δf2,

1. With PI controller
2. with PID Controller

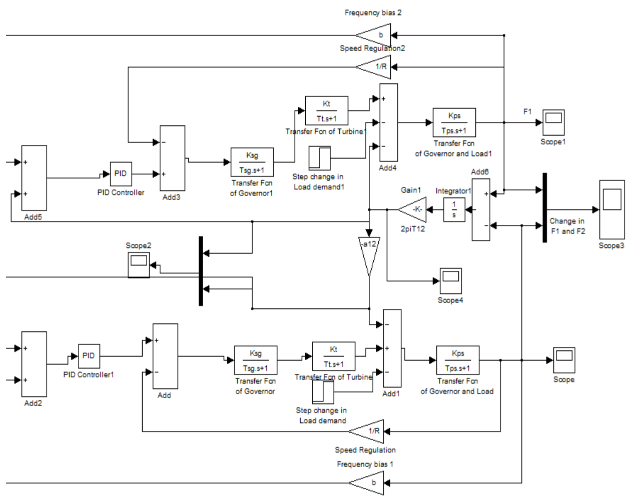

Figure-1:Simulation of a Two Area Load frequency System

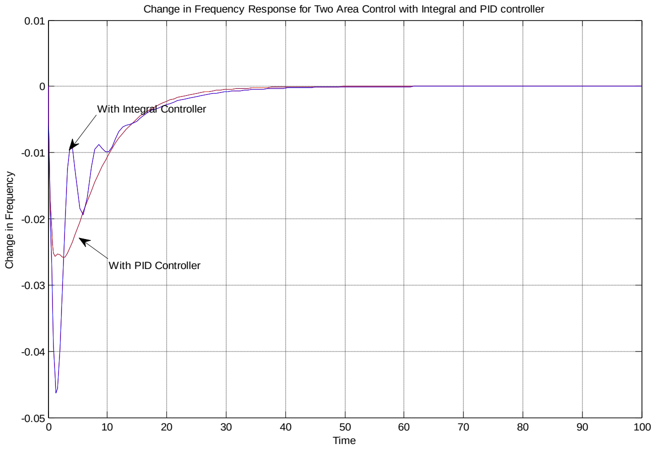

Figure-2: Change in frequency response for integral & PID Controller for 1% change in Load

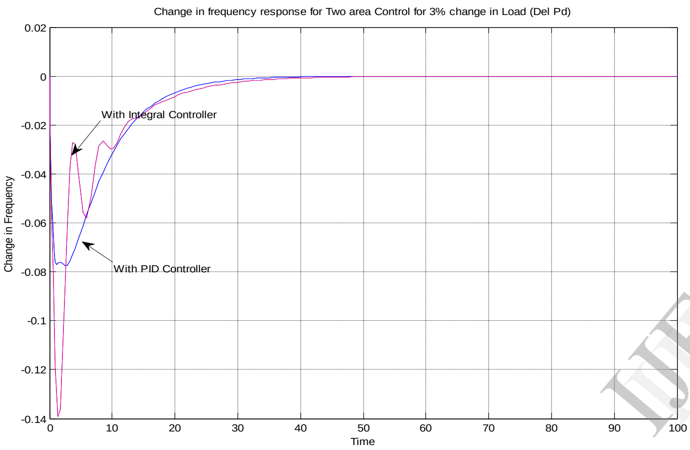

Figure-3: Change in frequency response for integral & PID Controller for 3% change in Load

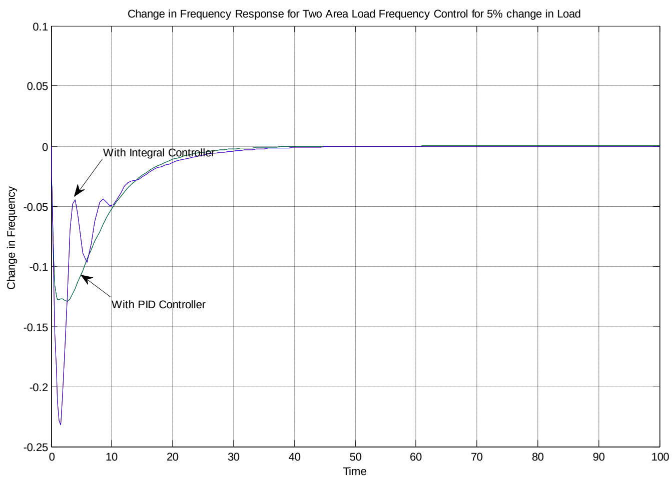

Figure-3: Change in frequency response for integral & PID Controller for 3% change in Load

V. CONCLUSION

In this study an approach of PID controller has been investigated for two area frequency control of power system. Results have been compared for step load change against PI controller technique for different change in load conditions. The result shows the PID controller is having more improved dynamic response. With the aid of PID controller the transients in the frequency response reduced to A great extend.

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APPENDIX

Parameters	Values
Tsg	0.4 sec
Tt	0.5sec
Tps	20 sec
Kps	100
R	3
b	0.425
K_I	0.09
$2\prod T_{12}$	0.05

Bibliography:

Debirupa Hore was born in Guwahati Assam India on April 19th 1983.She received her B.E Degree in Electrical Engineering. from Assam Engineering College Guwahati in 2006 and M.Tech in Energy and Power Systems in 2010 from NIT Silchar. She worked in GIMT Guwahati for 5 years as Assistant Professor. Currently she is working as an Assistant Professor in Electrical Engineering Department in KJ Educational Institutes, KJCOEMR, Pune (Maharashtra).Her research areas of interest includes Power Systems, AI Techniques, Power Electronics and Drives etc