

# To Analysis the performance of two area power system in Automatic Generation Control based on MATLAB

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**Abstract** - The main objective of this paper is to study the load frequency control problem associated in single and Two-area electrical power systems. At first uncontrolled system is studied and then improvement of its response is learnt on the application of integral controller. All the study is done using MATLAB software both in SIMULINK and Workspace windows. By comparing the simulation of controller and workspace controller results obtained. By using Matlab Software, a good agreement between these results is obtained. Thus the response of Two area power system with integral controller is suitable than response of other controllers available

**Key Words:** Power system control, AGC, Parameter calculations, Load frequency control, Integral Controller, SIMULINK and Workspace, MATLAB

## 1. INTRODUCTION

The main purpose of operating the load frequency control is to keep uniform the frequency changes during the load changes. During the power system operation rotor angle, frequency and active power are the main parameters to change. In multi area system a change of power in one area is met by the increase in generation in all areas associated with a change in the tie-line power and a reduction in frequency. In the normal operating state the power system demands of areas are satisfied at the nominal frequency. A simple Control strategy for the normal mode is to operate in such a way that to keep frequency approximately at nominal value, Maintain the tie-line flow at about schedule, each area should absorb its own load changes. Controller must be sensitive against changes in frequency and load. To analyze the control system mathematical model must be established. There are two models which are widely used, 1. Transfer function model 2. State variable approach. The most applied controller is Conventional Integral (PI), So that the power system operations, the load is changing continuously and randomly. As a result the real and reactive power demands on the power system are never steady, but continuously vary with the rising or falling

trend. The real and reactive power generations must change accordingly to match the load perturbations. Load frequency control is essential for successful operation of power systems, especially interconnected power systems [13]. Without it the frequency of power supply may not be able to be controlled within the required limit band. To accomplish this, it becomes necessary to automatically regulate the operations of main steam valves or hydro gates in accordance with a suitable control strategy, which in turn controls the real power output of electric generators. The problem of controlling the output of electric generators in this way is termed as Automatic Generation Control (AGC) [14]. Automatic generation control is the regulation of power output of controllable generators within a prescribed area in response to change in system frequency, tie-line loading, or a relation of these to each other, so as to maintain the schedule system frequency and/or the established interchange with other areas within predetermined limits [13]. Automatic Generation Control can be sub divided into fast (primary) and slow (secondary) control modes. The loop dynamics following immediately upon the onset of the load disturbance is decided by fast primary mode of AGC. This fast primary mode of AGC is also known as "Uncontrolled mode" since the speed changer position is unchanged. The secondary control acting through speed changer and initiated by suitable controller constitutes the slow secondary or the "Controlled modes" of AGC. The overall performance of AGC in any power system depends on the proper design of both primary and secondary control loops. So the overall performance of AGC in any power system depends on the proper design of both primary control loop (selection of R) and secondary control loops (selection of gain for supplementary controller). Among the various types of load frequency controllers, the most widely employed are integral (I), their use is not only for their simplicity, but also due their success in large industrial applications

## 2 Model Derivation of Isolated Power System

To understand the load frequency control problem, let us consider a single turbo-generator system supplying an isolated load.

For LFC scheme of single generating unit has basically three parts:

- Turbine speed governing system
- Turbine Generator and
- load

In the next section, mathematical transfer function model of single area thermal system is developed.

### 2.1 Turbine Speed Governing System Model

Fig. 2.1 shows schematically the speed governing system of a steam turbine. The system consists of the following components:

- (1) Fly ball speed governor: This is the heart of the system which senses the change in speed (frequency). As the speed increases the fly balls move outwards and the point B on linkage mechanism moves downwards. The reverse happens when the speed decreases.
- (2) Hydraulic amplifier: It comprises a pilot valve and main piston arrangement. Low power level valve movement is converted into high power level piston movement. This is necessary in order to open or close the steam valve against high pressure steam.

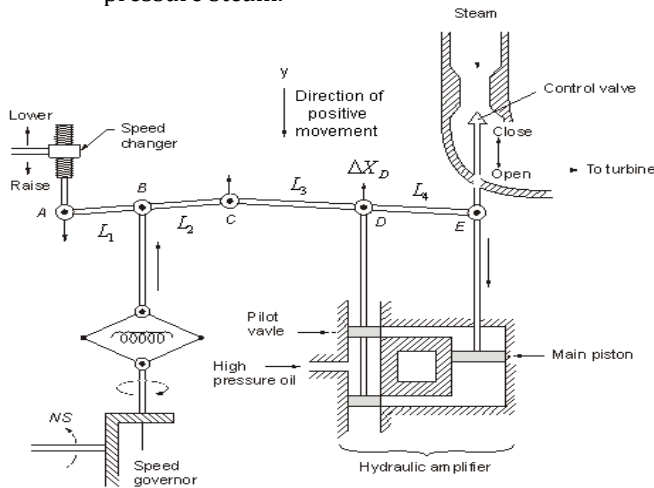


Fig. 2.1 Model of Turbine speed governing system

- (3) Linkage mechanism: ABC is a rigid link pivoted at B and CDE is another rigid link pivoted at D. This link mechanism provides a movement to the control valve in proportion to change in speed. It also provides a feedback from the steam valve movement.
- (4) Speed changer: It provides a steady state power output setting for the turbine. Its downward

movement opens the upper pilot valve so that more steam is admitted to the turbine under steady conditions (hence more steady power output). The reverse happens for upward movement of speed changer.

Let the point A on the linkage mechanism be moved downwards by a small amount  $\Delta y_A$ . It is a command which causes the turbine power output to change and can therefore be written as

$$\Delta y_A = K_C \Delta P_C \quad (2.1)$$

Where  $\Delta P_C$  is the commanded increase in power:

The command signal  $\Delta P_C$  (i.e.  $\Delta y_E$ ) sets into motion a sequence of events - The pilot valve moves upwards, high pressure oil flows on to the top of the main piston moving it downwards; the steam valve opening consequently increases, the turbine generator speed increases, i.e. the frequency goes up. Let us model these events mathematically.

Two factors contribute to the movement of C:

$$(1) \Delta y_A \text{ contributes - } \left( \frac{L_2}{L_1} \right) \Delta y_A \text{ or } -K_1 \Delta y_A \text{ (i.e.}$$

upwards) of  $-K_1 K_C \Delta P_C$

$$(2) \text{ Increase in frequency } \Delta f \text{ causes the fly balls to move outwards so that B moves downwards by a proportional amount } K'_2 \Delta f. \text{ The consequent movement of C with A remaining fixed at } \Delta y_A \text{ is}$$

$$+ \left( \frac{L_2 + L_2}{L_1} \right) K'_2 \Delta f = +K_2 \Delta f \text{ (i.e. downwards)}$$

The net movement of C is therefore

$$\Delta y_C = -K_1 K_C \Delta P_C + K_2 \Delta f \quad (2.2)$$

The movement of D,  $\Delta y_D$ , is the amount by which the pilot valve opens. It is contributed by  $\Delta y_C$  and  $\Delta y_E$  and can be written as

$$\Delta y_D = \left( \frac{L_4}{L_3 + L_4} \right) \Delta y_C + \left( \frac{L_3}{L_3 + L_4} \right) \Delta y_E$$

$$= K_3 \Delta y_C + K_4 \Delta y_E \quad (2.3)$$

The movement  $\Delta y_D$  depending upon its sign opens one of the ports of the pilot valve admitting high pressure oil into the cylinder thereby moving the main piston and opening the steam valve by  $\Delta y_E$ .

The volume of oil admitted to the cylinder is proportional to the time integral of  $\Delta y_D$ . The movement  $\Delta y_E$  is obtained by dividing the oil volume by the area of the cross section of the piston. Thus

$$\Delta y_E = k_5 \int_0^t (-\Delta y_D) dt \quad (2.4)$$

Take Laplace transform of Eqs. (2.2), (2.3) and (2.4),

$$\Delta Y_C(s) = -K_1 K_C \Delta P_C(s) + K_2 \Delta F(s)$$

$$\Delta Y_D(s) = -K_3 \Delta Y_C(s) + K_4 \Delta Y_E(s)$$

$$\Delta Y_E(s) = -K_5 \left( \frac{1}{s} \right) \Delta Y_D(s)$$

Eliminating  $\Delta Y_C(s)$  and  $\Delta Y_D(s)$ , we can write

$$\begin{aligned} \Delta Y_E(s) &= \frac{K_1 K_3 K_C \Delta P_C(s) - K_2 K_3 \Delta F(s)}{\left( K_4 + \frac{s}{K_5} \right)} \\ &= \left[ \Delta P_C(s) - \frac{1}{R} \Delta F(s) \right] \times \left( \frac{K_{sg}}{1 + T_{sg} s} \right) \end{aligned} \quad (2.5)$$

Where  $R = \frac{K_1 K_C}{K_2}$  = speed regulation of the governor

$$K_{sg} = \frac{K_1 K_3 K_C}{K_4} = \text{gain of speed governor}$$

$$T_{sg} = \frac{1}{K_4 K_5} = \text{time constant of speed governor}$$

The equation can be represented in the form of a block diagram in Fig. 2.2.

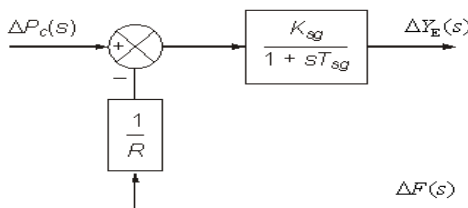


Fig. 2.2 Block diagram representation of speed governor system

### 2.2 Turbine Model

The dynamic response is largely influenced by two factors, (i) entrained steam between the inlet steam valve and first stage of the turbine, (ii) the storage action in the reheater which causes the output of the low pressure stage to lag behind that of the high pressure stage. Thus, the turbine transfer function is characterized by two time constants. For ease of analysis it will be assumed here that the turbine can be modeled to have a single equivalent time constant as given in Fig. 2.3

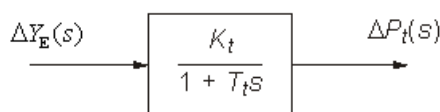


Fig. 2.3 Turbine transfer function model

Where,  $K_t$  = Gain of turbine,  $T_t$  = Time constant of turbine

### 2.3 Generator Load Model

The increment in power input to the generator-load system is

$$\Delta P_G - \Delta P_D$$

Where  $\Delta P_G = \Delta P_t$ , incremental turbine power output (assuming generator incremental loss to be negligible) and  $\Delta P_D$  is the load increment.

This increment in power input to the system is accounted for in two ways:

(1) Rate of increase of stored kinetic energy in the generator rotor. At scheduled frequency ( $f^0$ ), the stored energy is

$$W_{ke}^0 \approx H \times P_r \text{ kW} = \text{sec (kilojoules)}$$

Where  $P_r$  is the kW rating of the turbo-generator and  $H$  is defined as its inertia constant.

The kinetic energy being proportional to square of speed (frequency), the kinetic energy at a frequency of ( $f^0 + \Delta f$ ) is given by

$$\begin{aligned} W_{ke} &= W_{ke}^0 \left( \frac{f^0 + \Delta f}{f^0} \right)^2 \\ &\approx H P_r \left( 1 + \frac{2\Delta f}{f^0} \right) \end{aligned} \quad (2.6)$$

Rate of change of kinetic energy is therefore

$$\frac{d}{dt}(W_{ke}) = \frac{2H P_r}{f^0} \frac{d}{dt}(\Delta f) \quad (2.7)$$

(ii) As the frequency changes, the motor load changes being sensitive to speed, the rate of change of load with respect to frequency, i.e.  $\partial P_D / \partial f$  can be regarded as nearly constant for small changes in frequency  $\Delta f$  and can be expressed as

$$\left( \frac{\partial P_D}{\partial f} \right) \Delta f = B \Delta f \quad (2.8)$$

Where, the constant  $B$  can be determined empirically.  $B$  is positive for a predominantly motor load.

Writing the power balance equation, we have

$$\Delta P_G - \Delta P_D = \frac{2H P_r}{f^0} \frac{d}{dt}(\Delta f) + B \Delta f$$

Dividing throughout by  $P_r$  and rearranging, we get

$$\Delta P_G(pu) - \Delta P_D(pu) = \frac{2H}{f^0} \frac{d}{dt}(\Delta f) + B(pu) \Delta f \quad (2.9)$$

Taking the Laplace transform, we can write  $\Delta F(s)$  as

$$\begin{aligned} \Delta F(s) &= \frac{\Delta P_G(s) - \Delta P_D(s)}{B + \frac{2H}{f^0} s} \\ &= [\Delta P_G(s) - \Delta P_D(s)] \times \left( \frac{K_p s}{1 + T_p s} \right) \end{aligned} \quad (2.10)$$

Where

$$T_{ps} = \frac{2H}{Bf^0} = \text{power system time constant}$$

$$K_{ps} = \frac{1}{B} = \text{power system gain}$$

The equation can be represented in block diagram form as in Fig. 2.4.

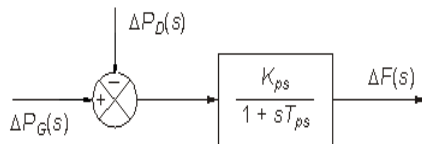


Fig. 2.4 Block diagram representation of generator-load model

### 3. Block Diagram Representation of Load Frequency Control of an Isolated Area

A block diagram representation of an isolated power system by combining the block diagrams of turbine, generator, governor and load with feedback loop as shown in Fig. 3.1

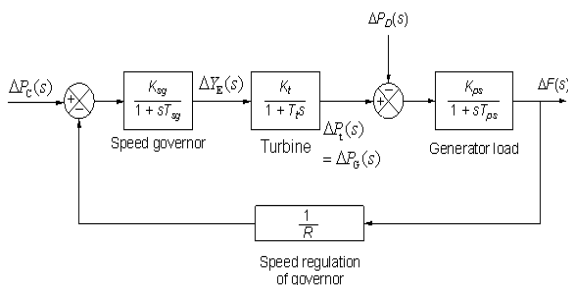


Fig. 3.1 Block Diagram Model of Load Frequency Control (isolated power system)

#### 3.1 Steady States Analysis

The model of Fig. 3.1 shows that there are two important incremental inputs to the load frequency control system i.e.  $-\Delta P_C$ , the change in speed changer setting; and  $\Delta P_D$ , the change in load demand. Let us consider the speed changer has a fixed setting (i.e.  $\Delta P_C = 0$ ) and load demand changes. This is known as free governor operation. For such an operation the steady change in system frequency for a sudden change in load demand by an amount  $\Delta P_D$  (i.e.  $\Delta P_D(s) = \Delta P_D/s$ ) is obtained as follows

$$\Delta F(s) \Big|_{\Delta P_C(s)=0} = - \frac{K_{ps}}{(1 + T_{ps}s) + \frac{K_{sg} K_t K_{ps}}{R}} \times \frac{\Delta P_D(s)}{s} \quad (3.1)$$

$$\Delta f \text{ steady state} = s\Delta F(s) \Big|_{s \rightarrow 0} = - \left( \frac{K_{ps}}{1 + (K_{sg} K_t K_{ps} / R)} \right) \Delta P_D \quad (3.2)$$

$$\Delta P_C = 0 \quad s \rightarrow 0 \quad \Delta P_C(s) = 0$$

Let it be assumed for simplicity that  $K_{sg}$  is so adjusted that  $K_{sg} K_t \approx 1$

It also recognized that  $K_{ps} = 1/B$ , where  $B = (\partial P_D / \partial f) / P_r$  (in pu MW/unit change in frequency). Now

$$\Delta f = - \left( \frac{1}{B + \frac{1}{R}} \right) \Delta P_D \quad (3.3)$$

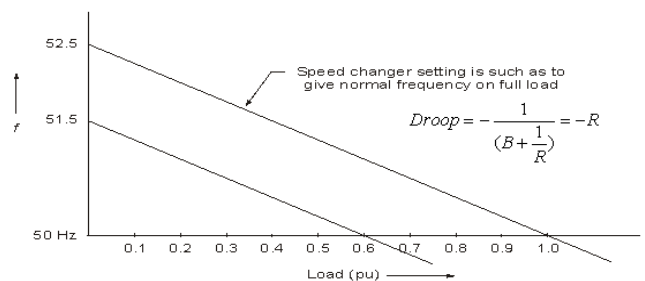


Fig. 3.2 Steady State LFC characteristics of a speed governor system

Fig. 3.2 shows the linear relationship between frequency and load for free governor operation with speed changer set to give a scheduled frequency of 100% at full load. It depicts two load frequency plots – one to give scheduled frequency at 100% rated load and the other to give the same frequency at 60% rated load

The 'droop' or slope of this relationship is  $-\left( \frac{1}{B + \frac{1}{R}} \right)$ .

Consider now the steady effect of changing speed changer setting  $\left( \Delta P_C(s) = \frac{\Delta P_C}{s} \right)$  with load demand remaining fixed (i.e.  $\Delta P_D = 0$ ). The steady state change in frequency is obtained as follows.

$$\Delta F(s) \Big|_{\Delta P_D(s)=0} = \frac{K_{sg} K_t K_{ps}}{(1 + T_{sg}s)(1 + T_t s)(1 + T_{ps}s) + \frac{K_{sg} K_t K_{ps}}{R}} \times \frac{\Delta P_C}{s} \quad (3.4)$$

$$\Delta f \Big|_{\Delta P_D=0}^{steady\ state} = \left( \frac{K_{sg} K_t K_{ps}}{1 + \frac{K_{sg} K_t K_{ps}}{R}} \right) \Delta P_C$$

If,  $K_{sg} K_t \approx 1$

$$\Delta f = \left( \frac{1}{B + \frac{1}{R}} \right) \Delta P_c \tag{3.5}$$

If the speed changer setting is changed by  $\Delta P_c$  while the load demand changes by  $\Delta P_d$  the steady frequency change is obtained by superposition, i.e.

$$\Delta f = \left( \frac{1}{B + \frac{1}{R}} \right) (\Delta P_c - \Delta P_d) \tag{3.6}$$

From Eq. (3.6) the frequency change caused by load demand can be compensated by changing the setting of the speed changer, i.e.  $\Delta P_c = \Delta P_d$ , for  $\Delta f = 0$

### 3.2 Dynamic Response

To obtain the dynamic response giving the change in frequency as function of the time for a step change in load, we must obtain the Laplace inverse of Eq. (3.1). The characteristic equation can be approximated as first order by examining the relative magnitudes of the time constants involved. Typical values of the time constants of load frequency control system are related as

$$T_{sg} \ll T_t \ll T_{ps}$$

Consider  $T_{sg}=0.08$  sec,  $T_t=0.3$  sec., and  $T_{ps}=20$  sec

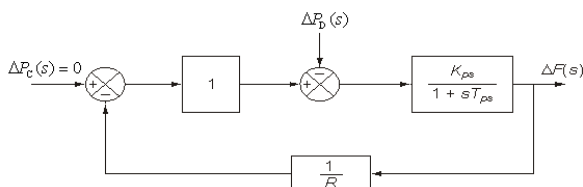


Fig. 3.3 first order approximate block diagram of load frequency control of an isolated area

Letting  $T_{sg} = T_t = 0$ , (and  $K_{sg}K_t \approx 1$ ), the block diagram of Fig. 3.1 is reduced to that of Fig.3.3, from which we can write

$$\begin{aligned} \Delta F(s) \Big|_{\Delta P_c(s) = 0} &= - \left( \frac{K_{ps}}{1 + \frac{K_{ps}}{R} + T_{ps}s} \right) \times \frac{\Delta P_d}{s} \\ &= - \frac{K_{ps} / T_{ps}}{s \left[ s + \frac{R + K_{ps}}{RT_{ps}} \right]} \times \Delta P_d \end{aligned}$$

$$\Delta f(t) = - \frac{RK_{ps}}{R + K_{ps}} \left\{ 1 - \exp \left[ - \frac{t}{T_{ps}} \left( \frac{R + K_{ps}}{R} \right) \right] \right\} \Delta P_d \tag{3.7}$$

Taking  $R=2.4$ ,  $K_{ps}=120$ ,  $T_{ps}=20$  sec.,  $\Delta P_d=0.01$  pu

$$\Delta f(t) = -0.0235(1 - e^{-2.55t}) \tag{3.8}$$

$$\Delta f_{\text{steady state}} = -0.0235 \text{ Hz}$$

### 4 SIMULINK Model

A SIMULINK model named **sm\_A1\_wc** is constructed for isolated uncontrolled power system as shown in Fig. 4.1

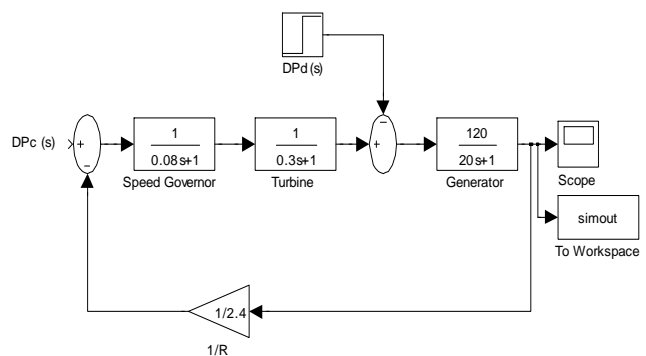


Fig. 4.1 SIMULINK model for uncontrolled isolated area

### 4.1 Control Area Concept

It is possible to divide an extended power system (say, national grid) into sub areas (may be, state electricity boards) in which the generators are tightly coupled together so as to form a *coherent group*, i.e. all the generators respond in unison to changes in load or speed changer settings. 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 conditions. For purposes of developing a suitable control strategy, a control area can be reduced to single speed governor, turbo-generator and load system.

### 4.2 Application of Integral Controller

To remove the steady state frequency error (see Eq. 3.8) the speed changer setting should be adjusted automatically by monitoring the frequency changes. For this purpose, a signal from  $\Delta f$  is fed through an integrator to the speed changer resulting in the block diagram configuration shown in Fig. 4.2

### 4.3 Two-Area Load Frequency Control

#### 4.3.1 Introduction

The large-scale power systems are normally composed of control areas (i.e. multi-area) or regions representing coherent groups of generators. The various areas are interconnected through tie-lines. The tie-lines are utilized for contractual energy exchange between areas and provide inter-area support in case of abnormal conditions. Without loss of generality we shall consider a two-area case connected by a single line as illustrated in Fig. 4.4. The concepts and theory of two-area power system is also applicable to other multi-area power systems i.e. three-area, four-area, five-area etc.

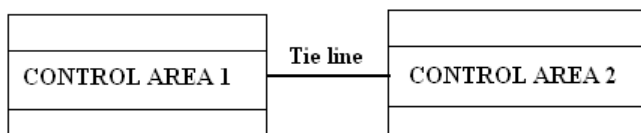


Fig. 4.3 Two interconnected control areas (single tie line)

Power transported out of area 1 is given by

$$P_{tie, 1} = \frac{|V_1| |V_2|}{X_{12}} \sin(\delta_1^0 - \delta_2^0) \quad (4.1)$$

Where

$\delta_1^0, \delta_2^0$  = power angles (angle between rotating magnetic flux & rotor) of equivalent machines of the two areas.

For incremental changes in  $\Delta f_1$  and  $\Delta f_2$ , the incremental tie line power can be expressed as

$$\Delta P_{tie,1}(pu) = T_{12}(\Delta\delta_1 - \Delta\delta_2) \quad (4.2)$$

Where

$$T_{12} = \frac{|V_1| |V_2|}{P_{r1} X_{12}} \cos(\delta_1^0 - \delta_2^0) = \text{synchronizing coefficient}$$

Since incremental power angles are integrals of incremental frequencies, we can write above Eq. (4.2) as

$$\Delta P_{tie, 1} = 2\pi T_{12} \left( \int \Delta f_1 dt - \int \Delta f_2 dt \right) \quad (4.3)$$

Where,  $\Delta f_1$  and  $\Delta f_2$  are incremental frequency change of areas 1 and 2 respectively.

Similarly the incremental tie line power out of area 2 is given by

$$\Delta P_{tie, 2} = 2\pi T_{21} \left( \int \Delta f_2 dt - \int \Delta f_1 dt \right) \quad (4.3)$$

Where

$$T_{21} = \frac{|V_2| |V_1|}{P_{r2} X_{21}} \cos(\delta_2^0 - \delta_1^0) = \left( \frac{P_{r1}}{P_{r2}} \right) T_{12} = a_{12} T_{12} \quad (4.4)$$

With ref. to Eq. (2.9), the incremental power balance equation for area1 can be written as

$$\Delta P_{G1} - \Delta P_{D1} = \frac{2H_1}{f_1^0} \frac{d}{dt} (\Delta f_1) + B_1 \Delta f_1 + \Delta P_{tie, 1} \quad (4.5)$$

It may be noted that all quantities other than frequency are in per unit in Eq. (4.5).

Taking the Laplace transform of Eq. (4.5) and reorganizing, we get and show the block diagram in fig 4.4

$$\Delta F_1(s) = [\Delta P_{G1}(s) - \Delta P_{D1}(s) - \Delta P_{tie, 1}(s)] \times \frac{Kps_1}{1 + Tps_1} \quad (4.6)$$

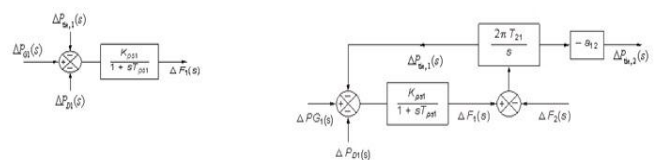


Fig.4.4 Turbine-Load Model for Two-Area LFC & Model Corresponding to Tie line Power Change

Taking the Laplace transform of Eq. (4.6), the signal  $\Delta P_{tie,1}(s)$  is obtained as

$$\Delta P_{tie, 1}(s) = \frac{2\pi T_{12}}{s} [\Delta F_1(s) - \Delta F_2(s)] \quad (4.7)$$

The corresponding block diagram is shown in Fig. 4.4.

For the control area 2,  $\Delta P_{tie,2}(s)$  is given as

$$\Delta P_{tie, 2}(s) = \frac{-2\pi a_{12} T_{12}}{s} [\Delta F_1(s) - \Delta F_2(s)] \quad (4.8)$$

This is also indicated by the block diagram of Fig. 4.5.

In the case of an isolated control area, ACE is the change in area frequency which when used in integral control loop forced the steady state frequency error to zero. In order that the steady state tie line power error in a two-area control be made zero another control loop (one for each area) must be introduced to integrate the incremental tie line power signal and feed it back to speed changer. For the control area 2,  $ACE_2$  is expressed as

$$ACE_2(s) = \Delta P_{tie,2}(s) + b_2 \Delta F_2(s) \tag{4.9}$$

Where b constant

#### 4.4 Block Diagram of Uncontrolled Two-Area LFC

Block diagram of uncontrolled two-area power system is given in Fig. 4.5.

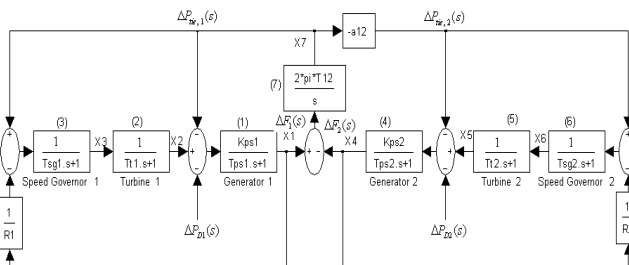


Fig. 4.5. Block diagram of two-area load frequency control without controller

#### 4.4.1 SIMULINK Model for Uncontrolled Two-Area LFC

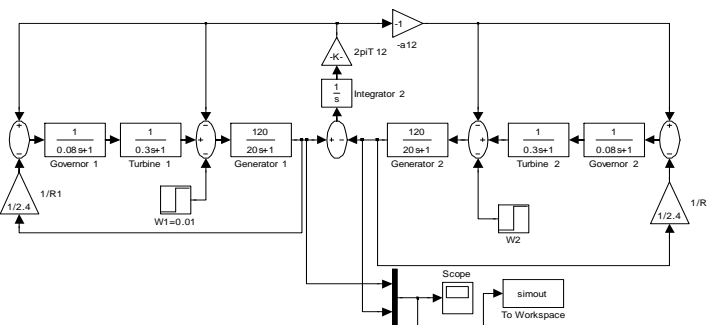


Fig. 4.6 SIMULINK model for two-area LFC without using controller

#### 4.5 Block Diagram of Two-Area LFC with Integral Controller

Block diagram model and its corresponding diagram to derive state space model of two-area LFC with integral controller are given in Fig. 4.7 (a) and (b) respectively.

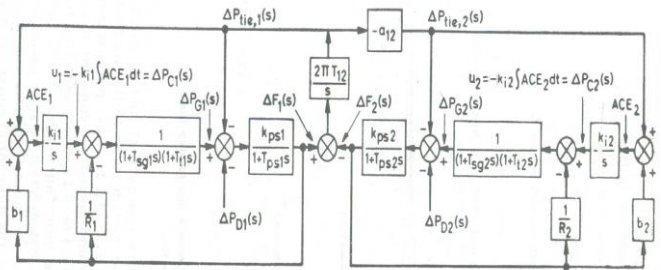


Fig. 4.7 (a) Block diagram of two-area LFC with Integral controller

#### 4.5.1 SIMULINK Model for Two-Area LFC with Integral Controller

A SIMULINK model named **sm\_A2\_I** is constructed as shown in Fig. 4.8

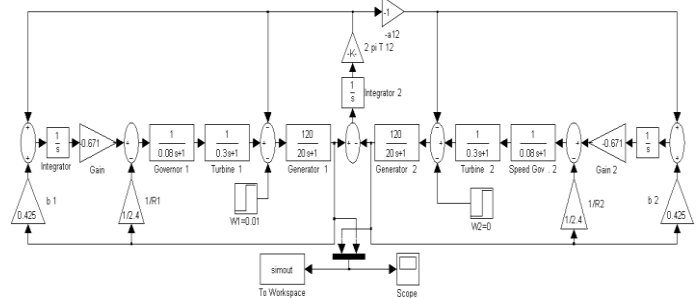


Fig. 4.8 SIMULINK model of two-area LFC with Integral controller

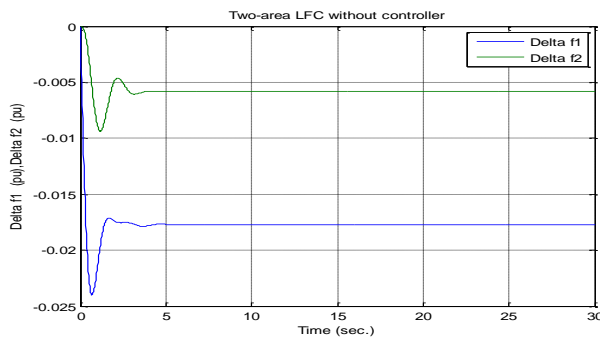
### 5 Results and Discussion

#### 5.1 Two-Area Power System

Simulations Models were performed with uncontroller and with integral controller is applied to two-area electrical power system by applying 0.01 p.u. MW step load disturbance to area 1

#### 5.2 Two-Area Power System without controller

From the Fig.4.6 and Fig. 4.8, we observe that both responses match with each other, also the steady-state frequency deviation,  $\Delta f$  (steady state) is -0.0178 Hz and frequency returns to its steady state value in 4.7 seconds. Results are shown in Table-1.

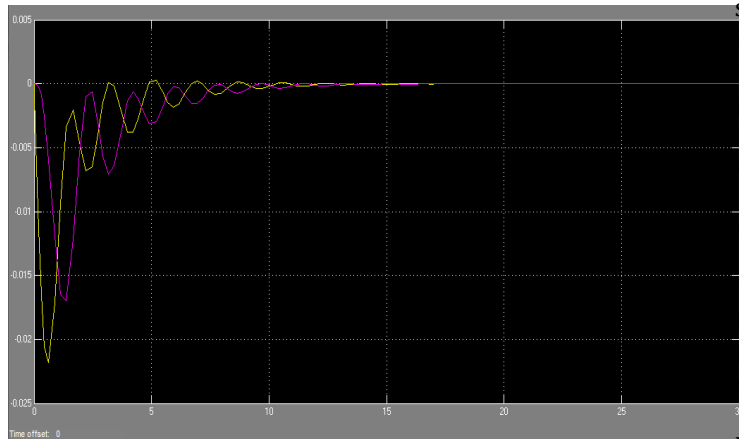


**Fig.5.1.**Result of Two Area LFC without Integral controller

This fig. 5.1 shows Controlled Two Area power system without Integral controller, It shows the relationship between power unit and frequency( 1/time) for two power system .The Power Unit is high at time zero second, oscillation will produce till time five second after that it damped out i.e. become study state, It mean frequency of load controlled

### 5.2 Two-Area Power System with Integral Controller

From the responses of the Figs. 4.1 and 4.3 we observe that both responses match with each other and steady state frequency deviation is zero, and the frequency returns to its nominal value in approximately 13.5 seconds. Results are shown in Table-1



**Fig.5.2.**Result of Two area LFC with Integral controller

The overall results without controller and with integral used to two-area power system are summarized in Table-1. Table-1 shows that the peak overshoot and settling time in case of optimal integral controller is better/less than the integral controller.

Table-1 Comparisons of settling time, peak overshoot & Frequency error of controller of two area Power System

**Table -1:** Comparisons of settling time, peak overshoot & Frequency error of controller of two area Power System

For $\Delta f_1$	Without Controller		With Controller	
	Simulink	Worksp ace	Simulin k	Workspa ce
Settling Time (s)	4.7	4.7	13.5	13.5
Peak overshoots (pu)	-0.0236	-0.0236	-0.0216	-0.0216
Freq. Error $\Delta f_{ss}$ (pu)	-0.0178	-0.0178	0	0

### 6. CONCLUSIONS

In this paper LFC problem related to two-area power systems is studied for uncontrolled case and then with the application of the integral controller using MATLAB SIMULINK/Workspace software.

In two-area power system, integral controller is used in both the areas to overcome system's steady state frequency errors and thereby enhancing system's dynamic performance.

Table-1 shows that the with integral controller developed better than the without controllers with respect to the settling time, peak overshoots, integral absolute error and integral of time multiplied absolute error of the frequency deviation ( $\Delta f_1$ ). The simulation results also show that proposed controller for load frequency control of Two-area system provide a reduction in settling time and peak overshoots when compared with other controllers

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