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Single Area Load Frequency Control Using Traditional Conventional Tuning Method

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Abstract—This paper studies control of load frequency in single area power system with PI controller, PID controller and Ziegler–Nichols controller. In this study, PID parameters are improved using the Ziegler–Nichols controller. The Proposed controller compared with a conventional PI Controller, PID controllers tuned by Ziegler-Nicholas technique. The settling times with the proposed Ziegler–Nichols controller is better than the outputs of the conventional PI and PID controllers.

Keywords— Single area Load Frequency Control, PI Controller, PID controller, PSOPID, ZNPID.

I. INTRODUCTION

The modern power systems with industrial and commercial loads need to operate at constant frequency with reliable power. Load Frequency Control (LFC) is a very important issue in power system operation and control for supplying sufficient and reliable electric power with good quality. The main goal of the LFC is to maintain zero steady state errors for frequency deviation and good tracking load demands in a multi-area restructured power system [1]. Load frequency control is the basis of many advanced concepts of the large. The dynamic behavior of many industrial Plants is heavily influenced by disturbances and, in particular, by changes in the operating point. This is typically the case for power systems [2].Frequency is an explanation of stability criterion in power systems. To provide the stability, active power balance and steady frequency are required. Frequency depends on active power balance. If any change occurs in active power demand/generation in power systems, frequency cannot be hold in its rated value. So oscillations increase in both power and frequency. Thus, system subjects to a serious instability problem. In electric power generation, system disturbances caused by load fluctuations result in changes to the desired frequency value. Load Frequency Control (LFC) is a very important issue in power system operation and control for supplying sufficient and both good quality and reliable power [3].Changes that happens in load power system, can affect the frequency and in addition it will make the power quality crisis on the customer super sensitive equipment's to evade. So, this frequency must be regulating inside the limit. In the power system the load changes are arbitrary without control and there is unbalance in real and reactive power. For controlling frequency in power system a load frequency control (LFC) is needed and it plays an essential task in power system control [4].The conventional controllers such as proportional integral and proportional integral derivative are utilized for Load Frequency Control. However, these methods have the capacity to control the single area, performed well under load variation, and good robustness. It also has some crisis such as damping oscillation, long settling time and maximum overshoot of frequency. As the load varies constantly the control is actually difficult due to the gain value of the controller is fixed of these controller. The conventional controller plus Ziegler Nichols Method (PIDZN) use for LFC to control single area power system and also it enhances the system dynamic performance, reduces the oscillation & settling time. The results of the three controllers are compared using MATLAB/Simulink software package. Comparison results of conventional PI controller, PID Tuning controller and conventional controller plus Ziegler Nichols Method (PIDZN) System are presented.

II. SINGLE AREA LOAD FREQUENCY CONTROL MODELING

The aim of LFC is to maintain real power balance in the system through control of system frequency. Whenever the real power demand changes, a frequency change occurs. This frequency error is amplified, mixed and changed to a command signal which is sent to turbine governor. The governor operates to restore the balance between the input and output by changing the turbine output. This method is also referred as Megawatt frequency or Power frequency (P-f) control [5].An one generating unit or bunch of generating units is placed in close vicinity to distribute the electricity in the same area is called single area system. More than one control area power systems with a single control zone is actually a combination of power systems and the problems of each region, combining a control structure. Figure 1 is a single zone with a power system block diagrams. Here, the system, a regulator regulating the speed of synchronous generator, synchronous generator and the load is composed [6]. Only the generating unit present in that area is responsible to maintain the desired frequency in normal and abnormal conditions.

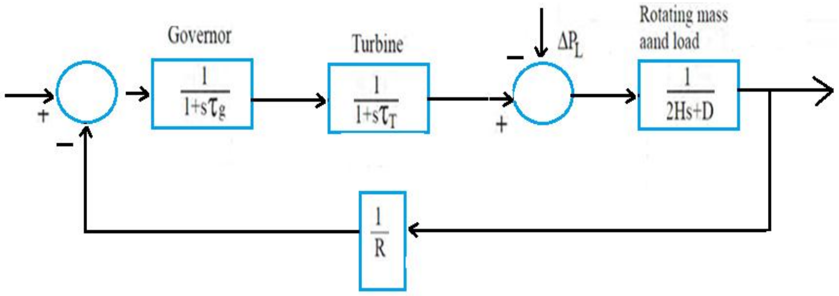

Fig1. Single-zone power system block diagram

III. DESIGN OF CONVENTIONAL CONTROLLER

A. Conventional PI Controller: PI controllers are very often used in industry, especially when speed of the response is not an issue Among various types of load frequency controller, the PI controller are most widely used to speed-governing system for LFC scheme [7].

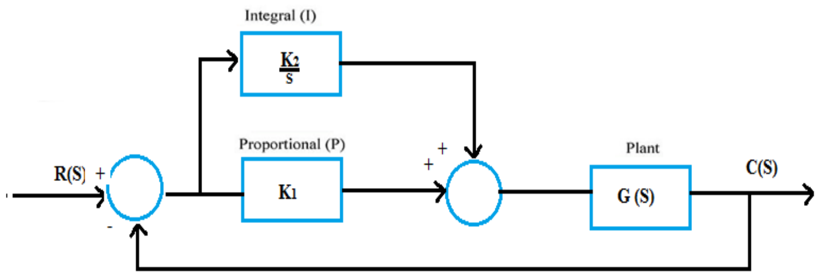

Fig 2 PI controller

The proportional plus integral controller (PI controller) produces an output signal consisting of two terms-one proportional to error signal and the other proportional to the integral of error signal An advantage of the PI control technique is to reduce the steady-state error to zero by feeding the errors in the past forward to the plant .P-I controller is mainly used to eliminate the steady state error resulting from P controller. However, in terms of the speed of the response and overall stability of the system, it has a negative impact. This controller is mostly used in areas where speed of the system is not an issue [8]. Since P-I controller has no ability to predict the future errors of the system it cannot decrease the rise time and eliminate the oscillations.

B. Conventional PID Controller: The PID controller improved the transient response so as to reduced the error amplitude with oscillation [9] One of the main advantages of the P-I-D controller is that it can be used with higher order processes including more than single energy storage. In order to observe the basic impacts, described above, of the proportional, integrative and derivative gain to the system response.

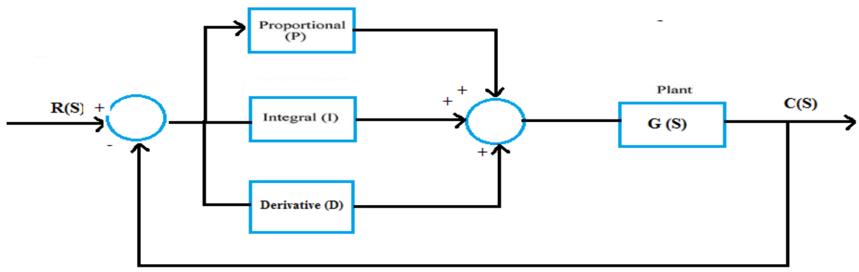

Fig 3 PID Controller

PID parameter values directly from the transfer function model of the process, without doing any experiment. Still, you should verify that the PID tuning is proper by simulating.

C. Conventional Z-N-PID Controller: The Ziegler–Nichols tuning method is a heuristic method of tuning a PID controller. It was developed by John G. Ziegler and Nathaniel B. Nichols. A very useful empirical tuning formula was proposed by Ziegler and Nichols in early 1942. The tuning formula is obtained when the plant model is given by a first-order plus dead time (FOPDT) which can be expressed by The Ziegler-Nichols step response and frequency response methods are the classical tuning methods for PID controllers. The step response method is based on an open-loop step response test of the process, hence requiring the process to be stable. The unit step response of the process is characterized by two parameters, L and T. The frequency response method is also based on describing the process with two parameters that are the crossover gain, Kc, and the crossover period, Tc. For determining these parameters, the plant is controlled with a P-controller, and its gain is increased until the system oscillates critically [10-11].

IV. MATLAB SIMULINK RESULTS

The MATLAB simulation has been conducted in MATLAB (R2010a) for single area power system with conventional PI controller, PID Tuning controller and conventional controller plus Ziegler Nichols Method (PIDZN) tuning controller is design for Power plant model using MATLAB Simulink. The frequency deviations in POWER area studied under PI controller, PID controller and Ziegler Nichols Method (PIDZN) actions. The parameter of proposed single area power system given in Appendix section [12].

TEST CASE 4.1 CONVENTIONAL PI CONTROLLER BASED LOAD FREQUENCY CONTROL

The SIMULINK model is constructed for PI Controller system as shown in Fig 4. In this case tuning of PI controller value of K for system, MATLAB Diagram of PI Controller for single Area Load Frequency Control show in the fig 4 for system KI is 1.9710.frequency response of conventional PI controller show in the fig 5.

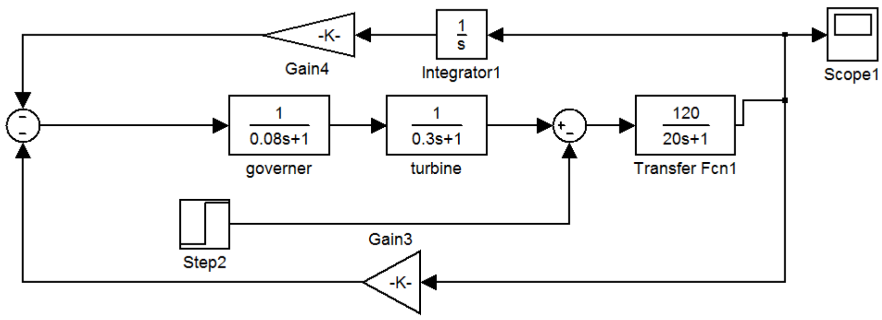

Fig 4 MATLAB Diagram of PI Controller for single Area Load Frequency Control

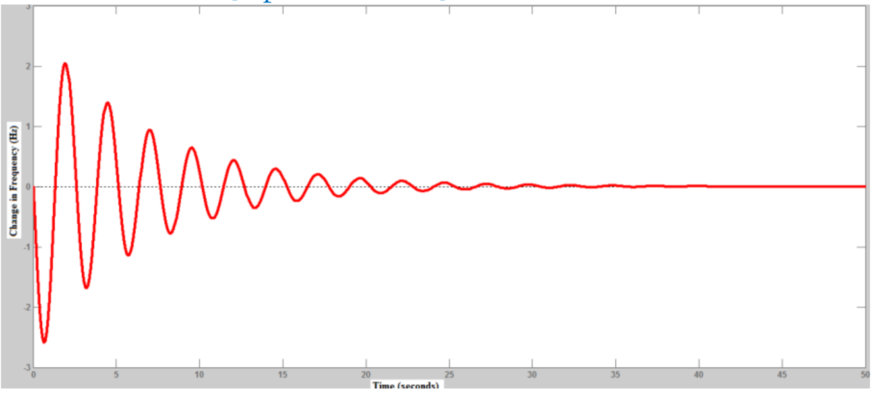

Fig 5 frequency response of conventional PI controller

TEST CASE 4.2: CONVENTIONAL PID CONTROLLER BASED LOAD FREQUENCY CONTROL

A SIMULINK model is constructed for PID Controller system as shown in Fig 6. In this case tuning MATLAB Diagram of PID Controller for single Area Load Frequency Control shown in Fig 6. In this case Use of PID parameter are Kp= 1.001,Ki= 2.261,Kd= 0.953.the Frequency response of conventional most effective PID controller is show in fig 7

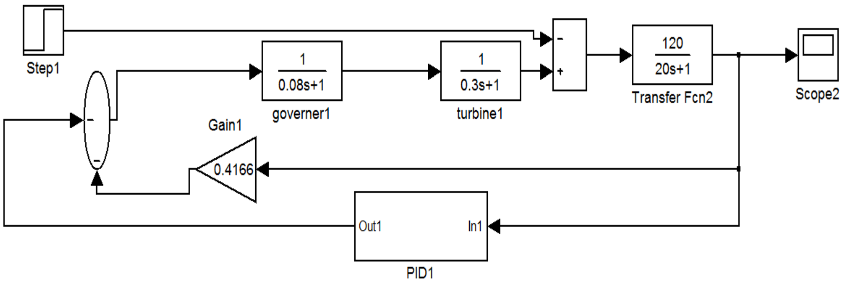

Fig 6 MATLAB Diagram of PID Controller for single Area Load Frequency Control

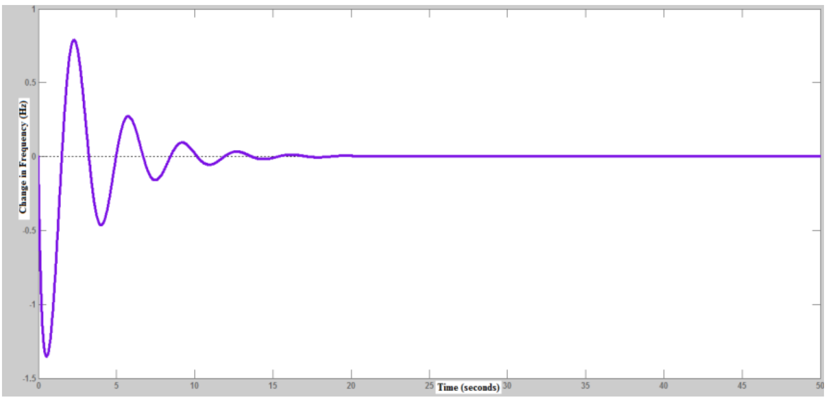

Fig 7 frequency response of conventional PID controller

TEST CASE 4.3: CONVENTIONAL ZN-PID CONTROLLER BASED LOAD FREQUENCY CONTROL

A SIMULINK model is constructed for ZN-PID Controller system as shown in Fig 8. In this case tuning MATLAB Diagram of PID Controller for single Area Load Frequency Control shown in Fig 8. In this case Use of PID parameters are Kp= 1.9818,Ki= 2.8701.Kd= 0.9143.the Frequency response of conventional effective ZN- PID controller is show in fig 9. , in this case it can be observed, that minimum settling time then other Conventional controller.

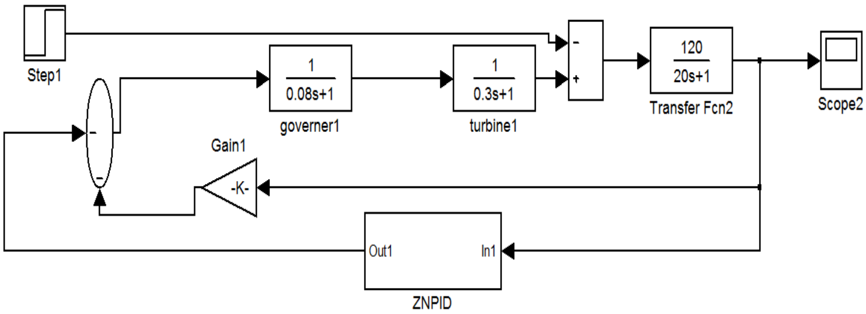

Fig 8 MATLAB Diagram of PID Controller for single Area Load Frequency Control

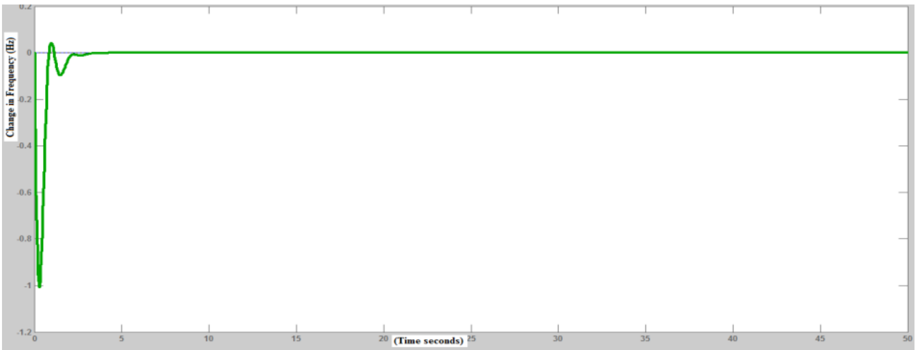

Fig 9 frequency response of conventional ZN-PID controller

Test Case 4.4 Comparison of different Conventional controller

The tuning of PI controller, PID Tuning controller and ZN-PID Controller proposed to solve the load frequency control problem of single area power system. Simulation results show that ZN-PID Tuning controller is frequency deviations of power system has a better performance than the PI controller and PID controller, because reduced the settling time and minimize overshoot, response of PI, PID,ZN-PID controller show in the fig 10. The settling time with the Tuning controller ZN-PID Tuning controller is much shorter than that of with the conventional PI controller and PID controller, the ZN-PID controller provides better performance and better results than other controller, its show in the comparative table 1 and fig 10.

Table 1compare of all controller

S.NO	Tuning methods	Settling time
1	PI Controller	26 [12]
2	PID controller	13 [12]
3	PSOPID Controller	4.5 [12]
4	**ZNPID controller**	**1.99**

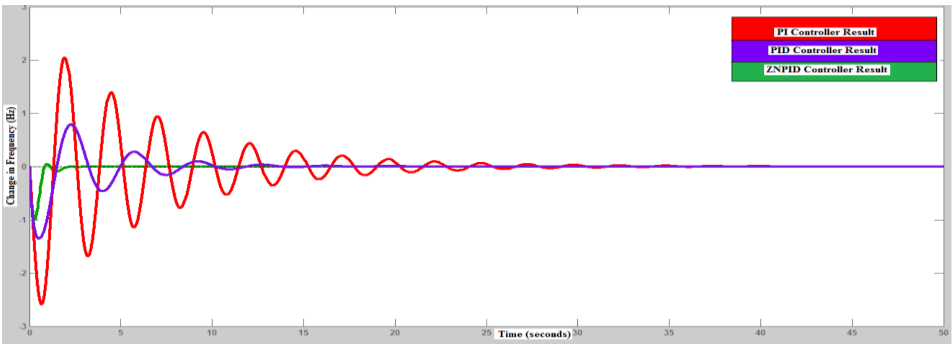

Fig 10 frequency response of conventional PI, PID and ZN-PID controller

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V. CONCLUSION

Conclusion of load frequency controller comparison with conventional PI, PID, and Ziegler-Nichols controller. Ziegler-Nichols controller defined as the effect of tunable parameters of ZNPID technique present single area system is better. The system response, settling time of improve when prefer Conventional Ziegler-Nichols controller. Overall Ziegler-Nichols controller is better response then PI controller and PID controller.

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APPENDIX

The parameter of proposed single area power system

Gain	Time constants
K_G=1	T_G=0.08
K_T=1	T_T=0.3
K_P=120	T_P=20
R=2.4	

