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Actuator unified power flow damping by using PID controller for power system

ER Kailash Chand Chittora
Assistant Professor, Department of Electronics and Communication Engineering, Vedant College of Engineering, Bundi, Rajasthan, India

Abstract
This paper developed a technical approach for control designing of UPFC for damping low frequency oscillation in a power system. We select the best input control signal of the UPFC and design optimal UPFC based damping controller in order to enhance the damping of power system. The developed UPFC based damping controller with PID controller provides an efficient damping when compared to conventional controller.

Keywords: FACTS, damping controller, PID controller, SMIB, UPFC

1. Introduction

The Flexible AC Transmission System (FACTS) Technology, introduced in 1988 by Hingorani in an enabling technology and provides added flexibility and can enable a line to transfer power to the thermal rating. Unified Power Flow Controller .is one of the FACTS devices which can control three power system parameters like terminal voltage, phase angle, line impedance etc.

A comprehensive and analytical approach for mathematical modeling of UPFC for steady state and linearised dynamic stability has been proposed. Several years the power system stabilizer act as a common control approach to damp the system oscillations [3].

2. Single machine infinite bus system without considering fault

A single machine infinite bus system installed without UPFC is considered.

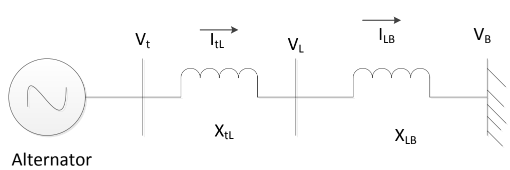

Fig 1: A single machine infinite bus system

$$\Delta \dot{\delta} = \omega_b \Delta\omega$$

$$\Delta \dot{E}_{fd} = \left(-\frac{k_5 k_a}{T_a}\right)\Delta\delta + \frac{k_a}{T_a}\Delta\omega + \left(-\frac{k_6 k_a}{T_a}\right)\Delta E'_q + \left(-\frac{1}{T_a}\right)\Delta E_{fd} + \left(\frac{k_a}{T_a}\right)\Delta V_{ref}$$

With the help of these linearised equation of SMIB, we obtained a simulation model of SMIB without UPFC considering fault.

The output of this simulation is taken as angle deviation, electrical power and terminal voltage .Simulation process is carried out for duration of 30 seconds.

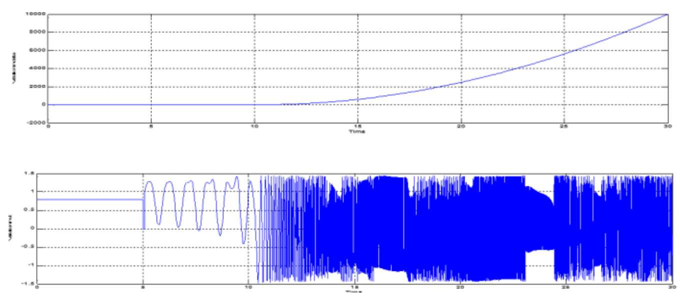

Fig 2: Response of Variation of load angle, electrical power

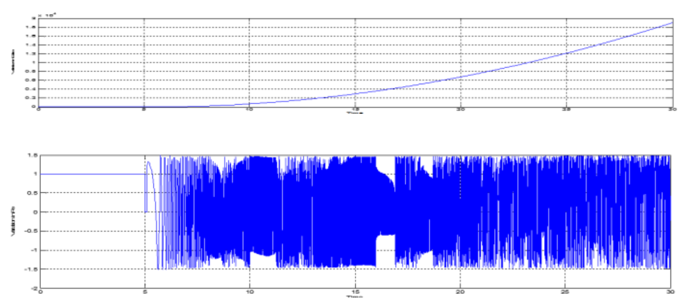

Fig 3: Electrical power, terminal voltage at 100 % loading considering fault

3. Single machine infinite bus system

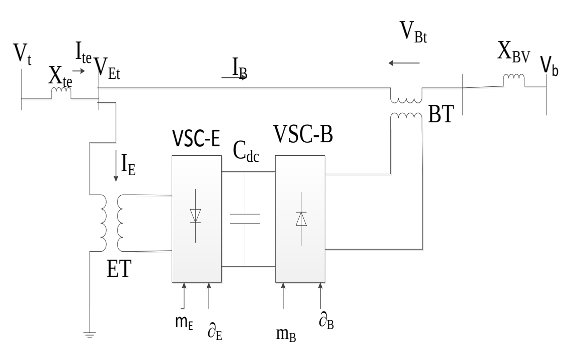

Fig 4: power system installed with UPFC

A single machine infinite bus system (SMIB) installed with UPFC as shown in fig.4. Shunt converter is connected in shunt with the power system through an exciting transformer(ET) and series converter is connected in series with the power system through a boosting transformer(BT).Both transformers are connected via a dc link.
The structure of UPFC based damping controller is shown in figure

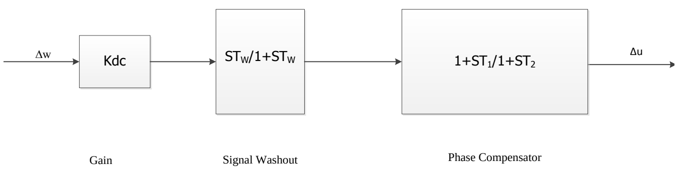

Fig 5: UPFC based damping controller

A linear dynamic model is obtained by linearizing the nonlinear model

$$\Delta\dot{\delta} = w_0 \Delta w$$

$$\Delta\dot{E}_{fd} = -\frac{\Delta E_{fd}}{T_a} + \frac{K_a}{T_a}(\Delta V_{ref} - \Delta V_t)$$

$$\Delta E_q^{'} = K_4 \Delta\delta + K_3 \Delta E_q^{'} + K_{vd} \Delta V_{dc} + K_{qe} \Delta m_E + K_{q\delta e} \Delta\delta_E + K_{qb} \Delta m_B + K_{q\delta b} \Delta\delta_B$$

$$\Delta V_t = K_5 \Delta\delta + K_6 \Delta E_q^{'} + K_{vd} \Delta V_{dc} + K_{ve} \Delta m_E + K_{v\delta e} \Delta\delta_E + K_{vb} \Delta m_B + K_{v\delta b} \Delta\delta_B$$

$$\Delta V_{dc}^{\cdot} = K_7 \Delta\delta + K_8 \Delta E_q^{'} - K_9 \Delta V_{dc} + K_{ce} \Delta m_E + K_{c\delta e} \Delta\delta_E + K_{cb} \Delta m_B + K_{c\delta b} \Delta\delta_B$$

With the help of these linearised equation of SMIB with UPFC, we obtained a simulation model of SMIB with UPFC considering fault.
The output of this simulation is taken as angle deviation, electrical power and terminal voltage .Simulation process is carried out for duration of 30 seconds

4. Scope of work
As we can see that using UPFC the oscillation of SMIB is reduced. But still the system is having oscillations which should be damped. So we install a PID controller on UPFC. The input is given to PID controller is dw and output is formed from PID controller is given as input to UPFC.

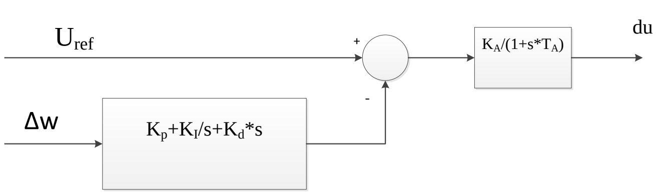

Fig 6: UPFC based damping controller with PID

The output of this simulation is taken as angle deviation, electrical power and terminal voltage .Simulation process is carried out for duration of 30 seconds.

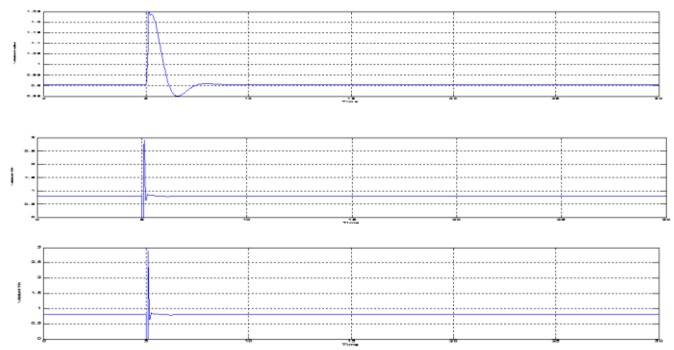

Fig 7: Response of proposed UPFC with PID controller in Variation of load angle

5. Conclusion
In this paper, MATLAB/SIMULINK model of a single machine infinite bus (SMIB) system with a UPFC based damping controller presented. With the help of this controller power system oscillation will damped out. But still system having the oscillation. Then we will incorporate PID controller with UPFC based damping controller.

6. References

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