SIEMENS

Ingenuity for life

Controller and machine studies

Measurements, modeling and analysis

At a glance

Dynamic computer simulations of electrical power systems are playing an important role in electrical network planning. The dynamic representation of the power system typically includes power plants, induction machines, load characteristics, high-voltage direct current (HVDC) connections and flexible AC transmission systems (FACTS), such as static VAr compensators (SVC). The controllers of these units influence the performance of the power system and therefore are modeled based on standard or user-defined models.

Siemens PTI's powerful PSS® Software Suite (PSS®E, PSS®SINCAL and PSS®-NETOMAC) conducts modeling of dynamic representation of machines and controllers.

Objectives of dynamic simulations are:

- grid interconnection studies
- control of system voltage and frequency
- damping of oscillations
- design, optimization and location of power system stabilizer and power oscillation damping devices
- assessment of grid code compliance of power plants

The challenges

One challenge is to meet the required accuracy of the dynamic models for a certain investigation. Another challenge is the simplification and standardization of the models to enable sophisticated simulations with limited available data, especially at the development phase of a project.

Validation and improvement of individual dynamic models is a challenging and permanent task to enhance dynamic simulations. The model validation can be done after commissioning of a unit by means of the commissioning records or with individual field tests at the units in service.

Due to the fact that power systems are operated more and more closely to their dynamic limits, accurate dynamic investigations are essential to assess the dynamic limits and countermeasures.

Our solution

With respect to detailed and accurate dynamic simulation of electrical power systems, measurements, analysis, modeling and validation of control systems Automatic voltage regulator (AVR), are conducted for particular projects or entire power systems.

These control systems include:

- power system stabilizer
- governors and turbine performance
- power plant performance
- FACTS, such as SVC and SVC PLUS
- HVDC and HVDC PLUS
- power oscillation damping devices

Development, coding and validation of standard or user-defined models for controllers are performed. Depending on the PSS® software used, the controller structure can be coded in Siemens PTI's graphical model builder (GMB), FORTRAN or BOSL code.

Machine parameters of synchronous generators and induction machines are determined based on factory tests and measurements. Therefore, intensive data collection sets the basis for building dynamic models. Parameter identification is used for optimizing model parameters.

Application examples

Tuning of a power system stabilizer
A power system stabilizer at a generator has to damp the inherent frequency of the generating unit. Tuning of a power system stabilizer to this specific inherent frequency of the generating unit is essential for proper operation of a power plant. The Bode diagram (

Figure 1) shows that the power system stabilizer has a high damping in the range between 0.2 Hz and 2.0 Hz.

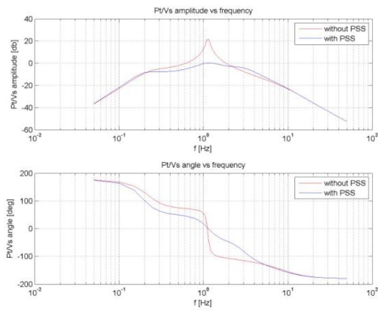

Figure 1: Bode plot with and without a power system stabilizer (PSS)

Parameter identification of an induction machine

To determine the machine parameters of an induction machine, the electrical torque characteristic vs. speed given by the manufacturer is used to identify the machine parameters. As an example, the results of a parameter identification process with PSS®NETOMAC is depicted in Figure 2, where the original values are shown in black and the system with the identified parameters are plotted in red.

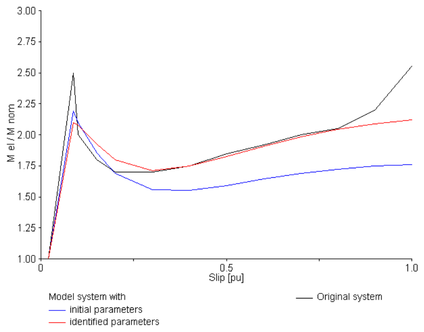

Figure 2: Results of a parameter identification of an induction machine

Modeling and validation of an automatic voltage controller (AVR)

After commissioning of a gas turbine the dynamic simulation models were optimized and validated with the field test records of the commissioning.

Figure 3 shows a measured 5 percent voltage step change of an AVR at no-load (red chart) and the simulation in PSS®E with the optimized parameters of an AVR model (blue chart).

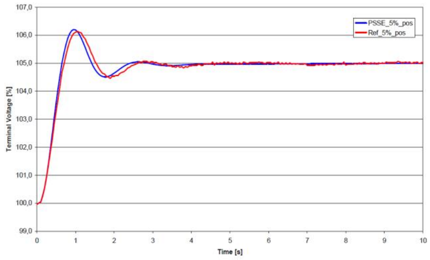

Figure 3: Graphical comparison of +5.0% voltage step change to AVR inertia (simulation and measurement

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