SIEMENS

Ingenuity for life

Controller and machine measurements, modeling and analysis

At a glance

Dynamic computer simulations of electrical power systems play 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 are therefore modeled as well, based on standard or user-defined models.

Modeling the dynamic representation of machines and controllers is conducted in Siemens PTI's PSS® software suite, i.e. PSS®E, PSS®SINCAL and PSS®NETOMAC.

Dynamic simulations are performed for:

- Grid interconnection studies,
- Control of system voltage and frequency,
- Damping of oscillations,
- Design, optimization and location of power system stabilizers and power oscillation damping devices
- Assessment of grid code compliance of power plants.

The challenges

One of the main challenges is to meet the required accuracy of the dynamic model for the planned investigation. In other cases models need to be simplified and standardized to enable sophisticated simulations with limited available data, especially during the development phase of a project.

Validation and improvement of individual dynamic models to enhance dynamic simulations is also a challenging and ongoing task. 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 increasingly closer to their dynamic limits, accurate dynamic investigations are essential to assess the dynamic limits and countermeasures.

Our solution

In order to perform a detailed and accurate dynamic simulation of an electrical power system, measurements, analyses, modeling and validation of control systems are conducted for particular projects or entire power systems. Some examples of control systems are:

- Automatic voltage regulator (AVR),
- Power System Stabilizer (PSS),
- Governor 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 for analysis, the controller structure can be coded in Siemens PTI's graphical model builder (GMB), in FORTRAN or using the BOSL code.

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

Application examples

Tuning of a PSS

A PSS has to damp the inherent frequency of a generating unit, which is essential for proper operation of the power plant. Tuning of a PSS to this specific frequency is achieved and the resulting improvement is shown in the Bode diagram (Figure 1). It shows that the correct tuning of the PSS ensures a high damping in the range between 0.2 Hz and 2.0 Hz.

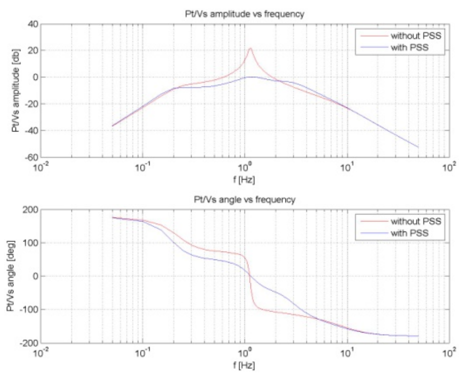

Figure 1: Bode plot with and without a PSS

Parameter identification of an induction machine

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

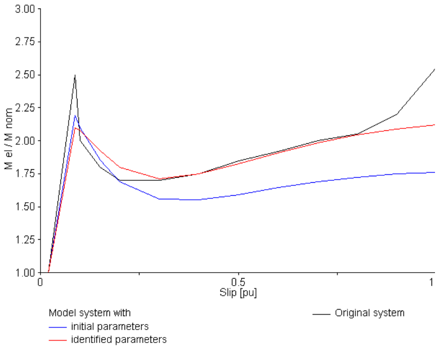

Figure 2: Results of a parameter identification of an induction machine

Modeling and validation of an Automatic Voltage Controller (AVR)

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

Figure 3 shows a measured 5% voltage step change of an AVR (red chart) and the simulation in PSS®E with the optimized parameters of an AVR model (blue chart).

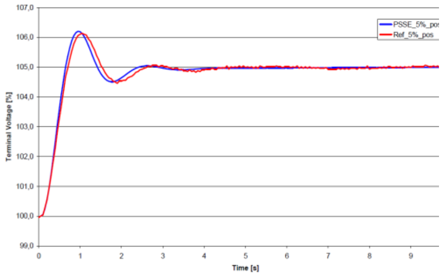

Figure 3: Graphical comparison of +5.0% voltage step change at AVR (simulation and measurement)

Published by
Siemens AG 2017

Energy Management Division
Freyeslebenstrasse 1
91058 Erlangen, Germany

For more information, please contact:
power-technologies.energy@siemens.com

AL=N, ECCN=EAR99