ETAP Transient Stability
Validation Cases and Comparison Results

Case No. 2
Synchronous Generator Response to a Fault

ETAP TS V&V Case Number TCS-TS-238

Comparison with I.E.E. Japan (IEEJ) Benchmark

Highlights:

- Comparison between ETAP Transient Stability Simulation Results and I.E.E. Japan (IEEJ) Electrical Power System Standard Benchmark
- A 100 MW generator oscillation and stability with respect to a power grid
- Long transmission line network with large charging capacitance
- 3-phase fault in the middle of a transmission line
- ETAP built-in salient-pole subtransient synchronous machine model
- ETAP User-Defined Dynamic Model (UDM) for the IEEJ thermal and nuclear LPT-1 type turbine/governor model
- ETAP User-Defined Dynamic Model (UDM) for the IEEJ LAT-1 type excitation/AVR model
- Very close correlation between ETAP results and the benchmark
- Accepted and published results by IEEJ

1. System Description

The system to be modeled is an IEEJ Electrical Power System Standard Model (reference: *2001 National Convention Record I.E.E. Japan*). This system includes a generator connected to a power system through transmission lines, as shown in Figure 1. The generator is rated in 100 MW and modeled in ETAP as a subtransient salient-pole type. IEEJ Thermal and Nuclear LPT-1 type Turbine/Governor model and IEEJ LAT-1 type Exciter/AVR model are used, and modeled using ETAP User-Defined Dynamic Model (UDM) module, as shown in Figures 2 and 3.

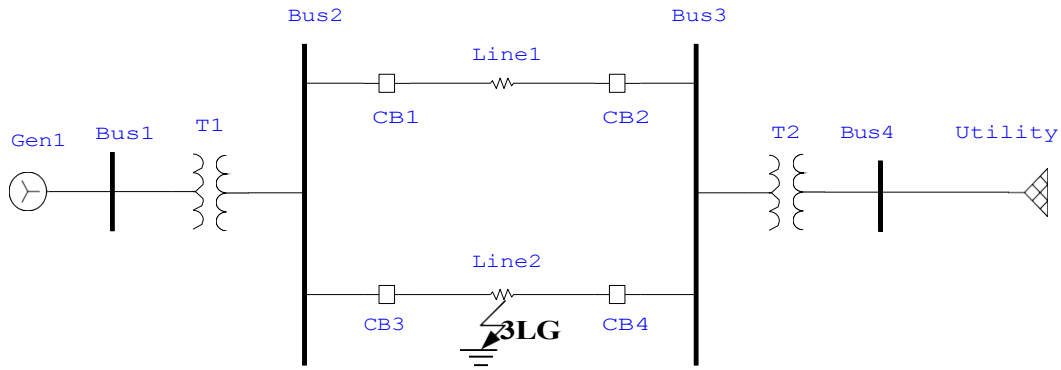


Fig. 1. IEEJ Electrical Power System Standard Benchmark

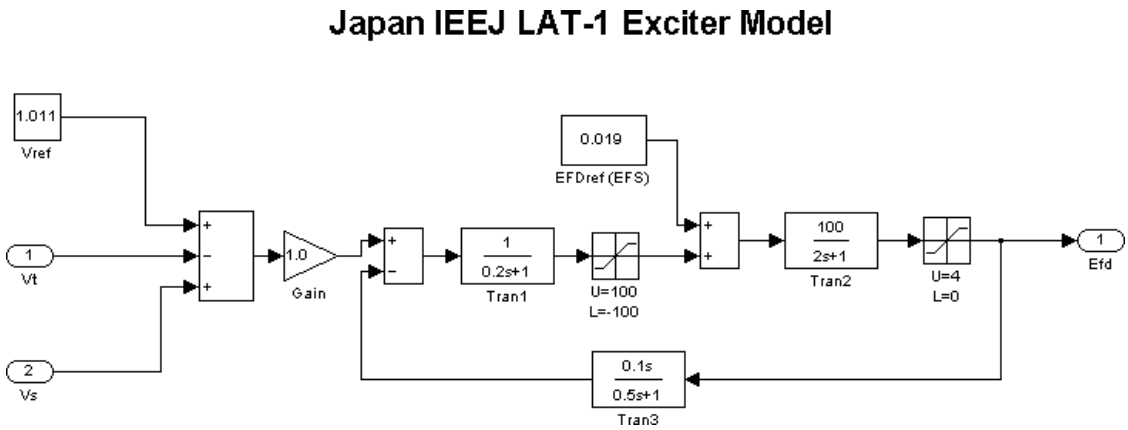


Fig. 2. ETAP UDM Model for IEEJ LAT-1 Type Exciter/AVR

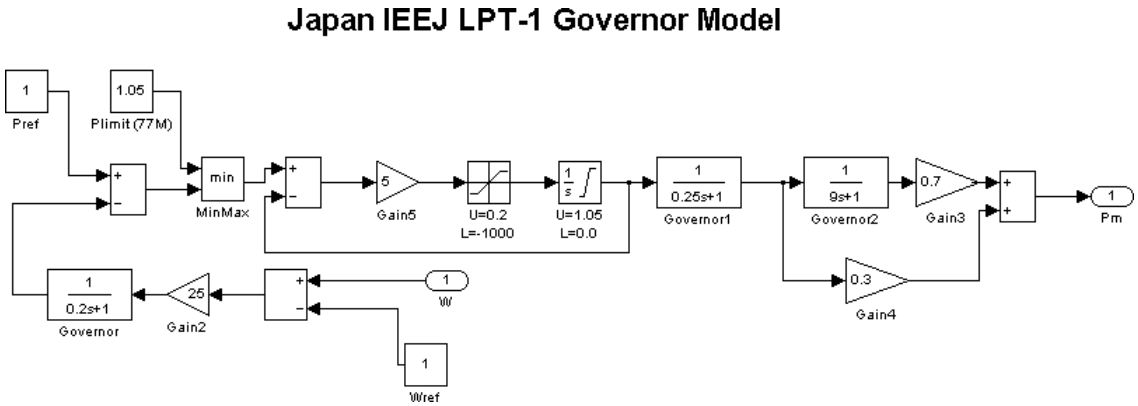


Fig. 3. ETAP UDM Model for IEEJ LPT-1 Type Turbine/Governor

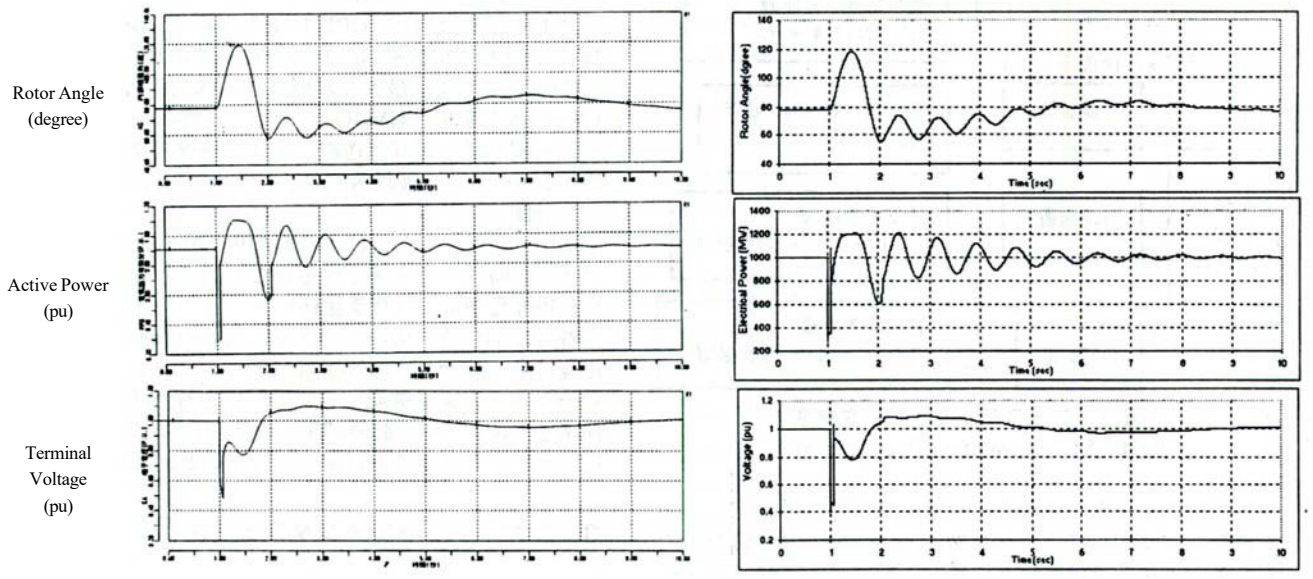
2. Simulation Events

The simulation events on this system are set up as follows:

- 3-phase fault on the middle of Line2 @ t = 1.00 second
- Clear fault and open CB3 and CB4 @ t = 1.07 second
- Re-close CB3 and CB4@ t = 2.07 second

3. Simulation Result Comparisons with IEEJ Y-Method

In this study, the generator rotor angle, electrical power, and terminal voltage response behaviors by ETAP simulation will be checked against those by IEEJ Y-Method. Comparison of the results is shown in Figure 4.



(a) IEEJ Y-Method **(b) ETAP**

Fig. 4. Result Comparison between IEEJ Y-Method and ETAP

As shown in the above figures, peak values, settle down time, final stable values, oscillation frequency, and general response curve shapes are sufficiently equal between the two programs for the generator rotor angle, active power, and terminal voltage. It is noted that the ETAP results show a slightly larger sub-oscillations than IEEJ Y-Method during the settle down time for the rotor angle and active power. This is due to the generator-damping coefficient used in the IEEJ Y-Method, which is not available and a typical value is used in the ETAP simulation.

4. Conclusions

As shown from the generator output response comparison curves, simulation results produced by Y-Method and ETAP are sufficiently equal to each other.

Reference:

1. Hiroyuki Iki, et al, "Activities of ETAP PowerStation (User Group Japan) – Analysis and Simulation by ETAP PowerStation," *2001 National Convention Record I.E.E. Japan (IEEJ)*, 2001.

2. *IEEJ: Electrical Power System Standard Models*, Technical Report No. 754, 1999.

3. ETAP Transient Stability V&V Documents, Test Case Number TCS-TS-238, 2023.