

ETAP TIP – No. 009

Transient Stability – Events & Actions

Applicable ETAP Versions: 5.5.0, 5.5.5, 5.5.6

(For lower versions, some of the descriptions and procedures below may differ in some ways)

Event is any occurrence (intentional or unintentional) in an electrical system that may affect the stability limit of the power system. We can simulate this phenomenon in the Transient Stability module of ETAP.

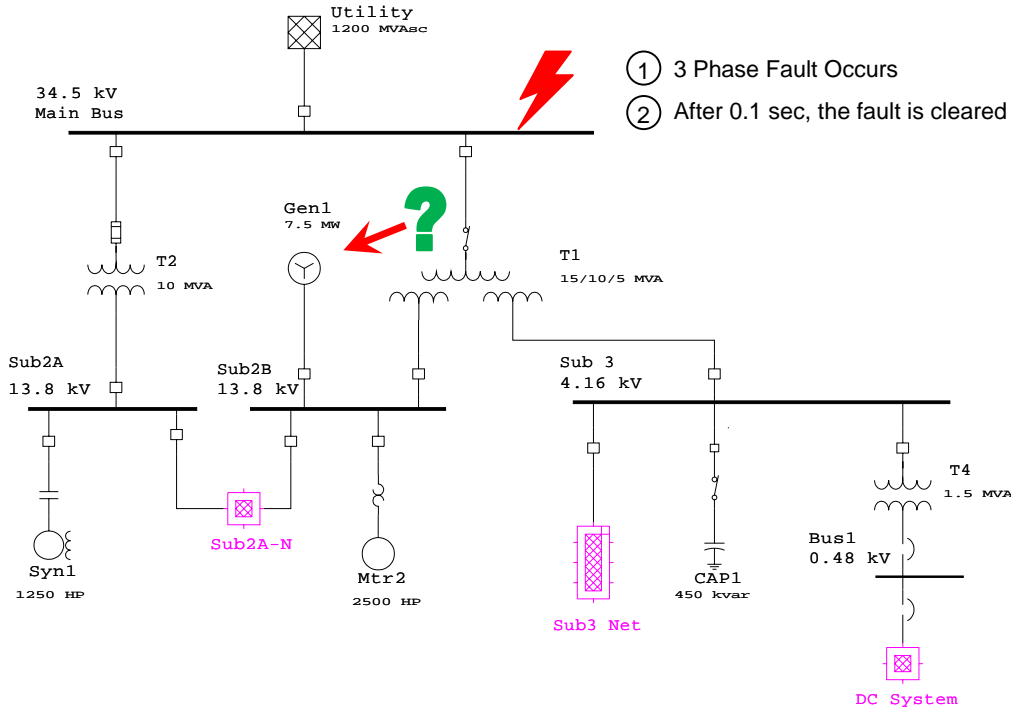
In Transient Stability simulation, we specify events with corresponding actions. The “Events” are the instances (time) the incidents in the electrical system occur while the “Actions” are the incidents that occur at a particular “Event”. One or more actions may be associated with one particular event.

The following actions can be simulated in ETAP:

Device Type	Actions	Setting 1	Setting 2
Bus	3 Phase Fault / Clear Fault	-	-
Cable	Fault / Clear Fault	% of total length	-
Line	Fault / Clear Fault	% of total length	-
Impedance	Fault / Clear Fault	% of total length	-
Circuit Breaker	Open / Close	-	-
SPST Switch	Open / Close	-	-
Fuse	Trip	-	-
Contactor	Open / Close	-	-
Generator	Ref. Machine / Droop / Isoch/	-	-
	Start / Loss Excitation /	-	-
	Generation Impact	% change in electrical power	-
	Generation Ramp	% change in electrical power	Time(sec) for % change
	Voltage Impact	% change in reference voltage	-
	Voltage Ramp	% change in reference voltage	Time(sec) for % change
Utility	Delete	-	-
	Ref. Machine	-	-
	Voltage Impact	% change in reference voltage	-
	Voltage Ramp	% change in reference voltage	Time(sec) for % change
Synchronous Motor	Delete	-	-
	Accelerate	-	-
	Load Impact	% change in loading	-
	Load Ramp	% change in loading	Time(sec) for % change
Induction Motor	Delete	-	-
	Accelerate	-	-
	Load Impact	% change in loading	-
	Load Ramp	% change in loading	Time(sec) for % change
Lumped Load	Delete	-	-
	Load Impact	% change in loading	-
	Load Ramp	% change in loading	Time(sec) for % change
MOV	Start	-	-
Wind Turbine	U-D Wind Disturbance	-	-
	Wind Gust / Wind Ramp	-	-
Wind Turbine (Zone)	U-D Wind Disturbance	-	-
	Wind Gust / Wind Ramp	-	-
None	Load Flow (no action)	-	-

Illustration:


Using the “Example-ANSI.oti” sample project, suppose that a 3-phase fault will occur at Utility, 34.5 kV “Main Bus” and will be cleared after 0.1 sec. After this disturbance, will the generator “Gen1” stay in synchrony with the Utility?

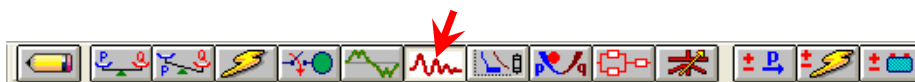



Illustration

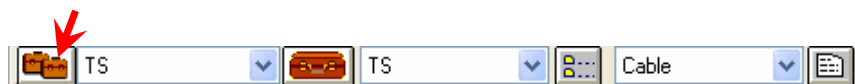
Refer to “Toolbars Map” on page 8 of ETAP TIP No. 003 to map out the toolbars that will be identified in the succeeding procedures.

Procedure:

1. Activate the “Study View” one line diagram presentation by clicking its window (or you can go to “project view” and double click “Study View” folder)
2. Switch to Transient Stability Analysis Mode by clicking the icon  on the “Mode” toolbar.



3. Create a new study case (by copying an existing one) by clicking the icon  on the “Study Case” toolbar



4. The “Duplicate Study Case” dialog box will be displayed as shown in Fig. 1.
 - a. Select the existing study case to be copied i.e. “TS”.
 - b. Enter a unique name for the new study case. Say “Case-1”
 - c. Click “Ok” button

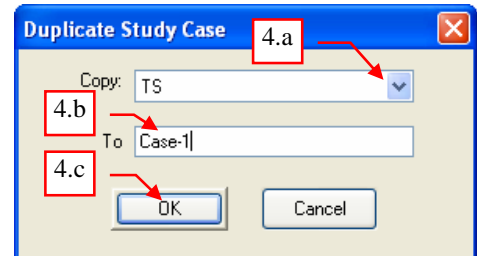


Fig. 1

5. Select the study case which was created in Step 4 on the “Study Case” pull down box. See Fig. 2.
6. Click on “Edit Study Case” button to specify the study conditions for “Case-1” study case. See Fig. 2

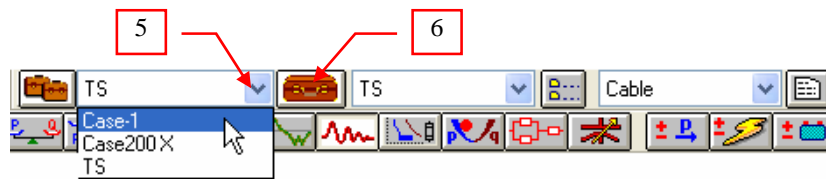


Fig. 2

7. The “Transient Stability Study Case” dialog box will be displayed as shown in Fig. 3. Click the “Events” Tab.

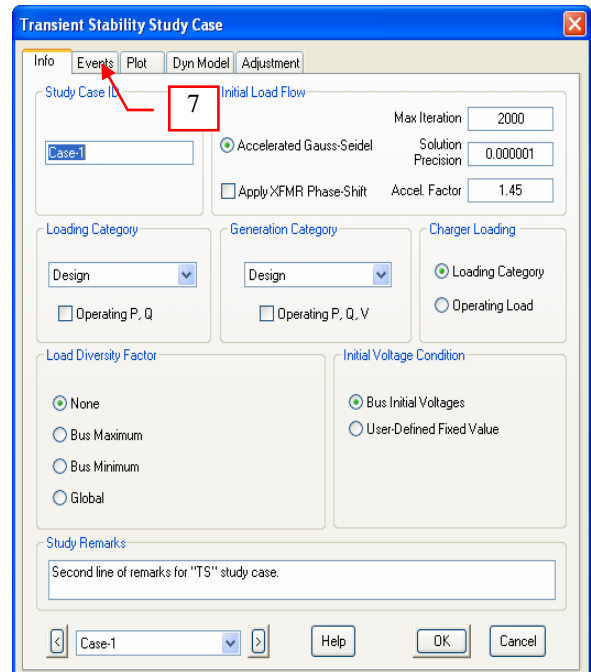


Fig. 3

8. On the “Events” tab, existing events and actions will be seen that were inherited from the “TS” study case copied in Step 4. Delete these and create new events and actions based on the illustration on page 2. See Fig. 4

a. Select “Event1” ID

Note: Notice that a “*” symbol is prefixed with the ID. The presence of the “*” denotes that the event is active which means that it will be considered during the simulation.

b. Click “Delete” button

c. Do similar actions to delete “Event2”

d. Click “Add..” button. The “Event Editor” dialog box will be displayed.

9. On the “Event Editor” dialog box shown in Fig. 5, do the following:

a. Type “E1” on the “Event ID” text box

b. Type “0.5” on the “Time” text box

Note: 0.5 is the time in second at which the event occurs.

c. Click the “OK” button

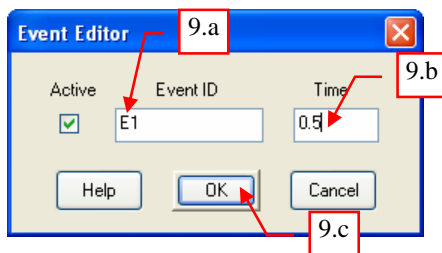


Fig. 5

10. With the Event ID “E1” active (selected) on the “Events” Frame of the “Events” dialog box, click the “Add” button at the “Actions” frame (See Fig. 6). The “Action Editor” dialog box will be displayed.

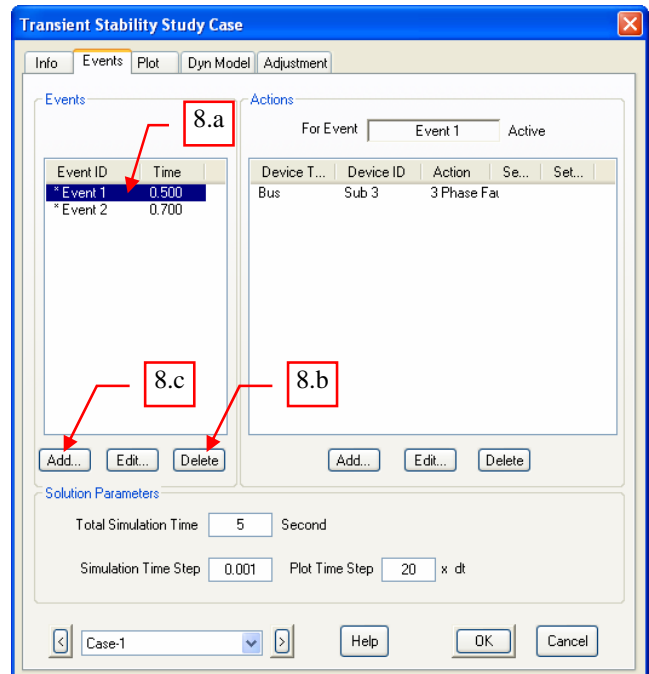


Fig. 4

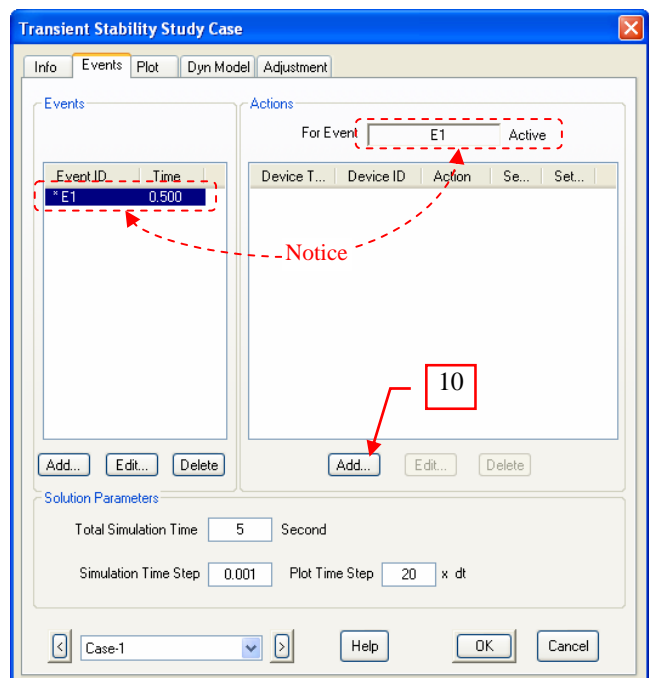


Fig. 6

11. As per the Illustration on page 2, do the following on the “Action Editor” dialog box shown in Fig. 7:

- Select “Bus” on the “Device Type”.
- Select “Main Bus” on the “Device ID”.
- Select “3PhaseFault” on the “Action”.
- Click “OK” button.

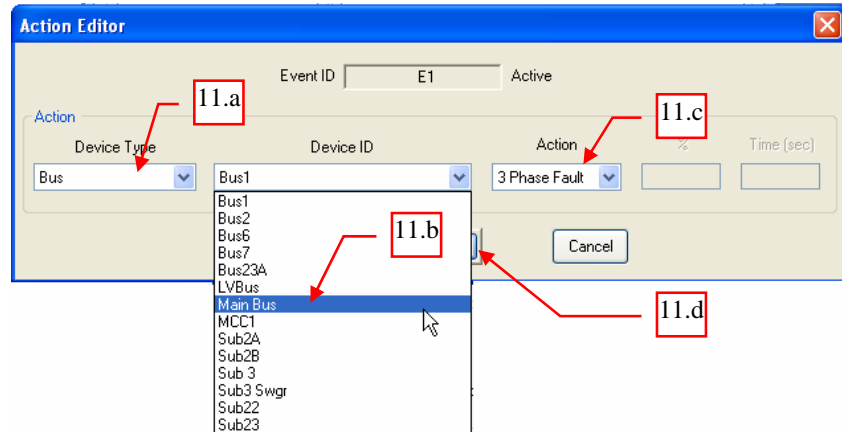


Fig. 7

12. Follow Step 9 to add the second event with the following data:

Event ID → E2
Time → 0.6 sec

Note: For the time, we specified 0.6 second since as per the Illustration on page 2; the fault will be cleared after 0.1 sec. Since E1 will occur at 0.5 sec, E2 must occur at 0.6 sec to get a difference of 0.1 sec fault clearing time.

13. Associate an action to event “E2” by following Steps 10 and 11. At the “Action Editor” dialog box, select the following:

Device Type → Bus
Device ID → Main Bus
Action → Clear Fault

The end result should look like Fig. 8

14. For this particular exercise, maintain the existing setting on the “Solution Parameters” frame.

Explanation of the parameters:

Total Simulation Time – The period in second to be considered in the simulation. This time should be greater than the time of the last event.

Simulation Time Step – The integration time step in the simulation. The program performs calculation at every interval of this time step.

Plot Time Step – This is the interval in multiple of the Simulation Time Step at which ETAP records the results of the calculation. This determines the resolution of the output Plots (graphs).

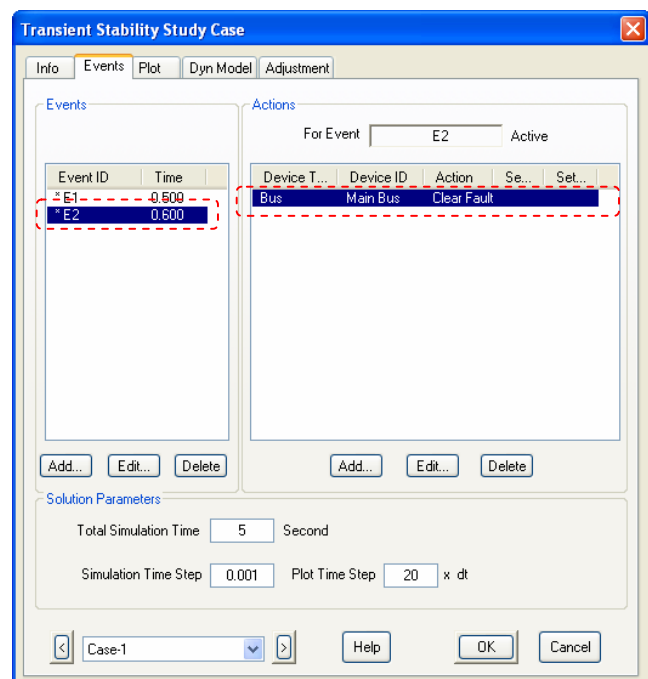


Fig. 8

15. Since the concern is to verify the response of the Gen1 due to the disturbance, instruct the program to create plot profiles for the Gen1. See Fig. 9.

- a. Click the “Plot” tab.
- b. On the “Device Type”, select “Syn Generator”.
- c. On the “Plot Options” select “Gen1”.
- d. Click the “Plot & Tabulate” check box to leave a check mark, or just click directly at the “Plot/Tabulate” column adjacent to “Gen1”
- e. Click “OK” button to close the study case.

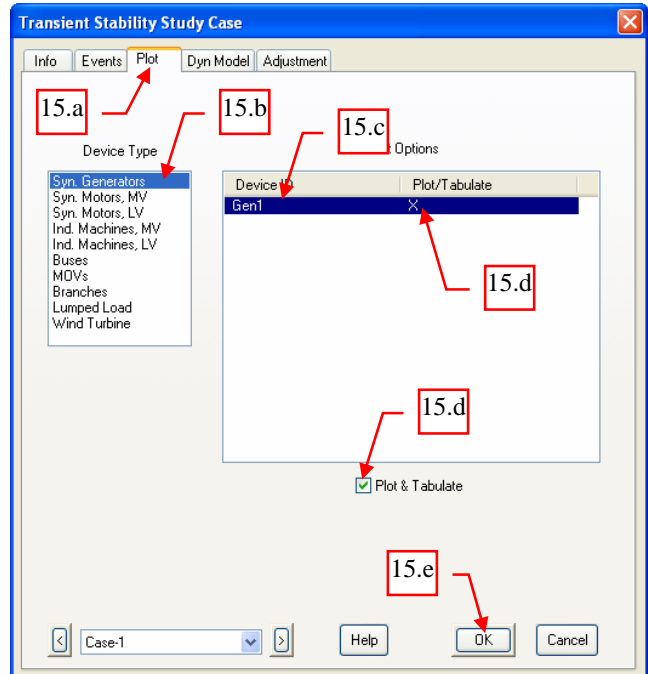


Fig. 9

16. Now, run the simulation. On the “Study Case” toolbar, select “Prompt” from the “Output Report” pull down box. The program will prompt for a filename of the output report for the study case “Case-1” when the simulation is ran. See Fig. 10.

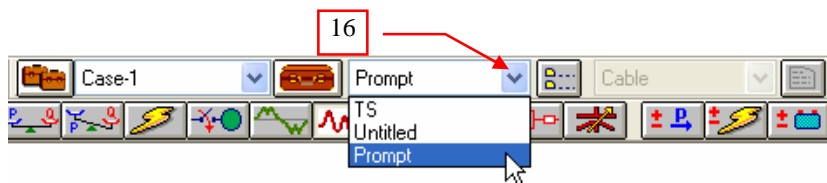


Fig. 10

17. On the “Transient Stability” toolbar, click “Run Transient Stability” button, see Fig. 11.

18. The “Output Report Filename” dialog box will be displayed (due to Step 16) as shown below. Type “R-Case1” and click “OK” button. The program will proceed with the calculation.

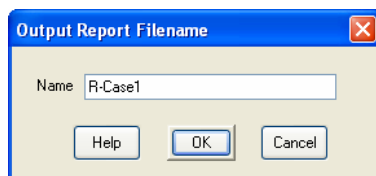


Fig. 11

19. When the calculation is completed, a “Transient Stability Time-Slider” dialog box will be displayed. This slider allows for animation of the result of simulation at different points in time. See Fig. 12.

- Click the “Toggle Action List” button to show the “Action List”
- Click and drag the “Slide Pointer” towards right.
- Notice the “Action List” is populated with the events, associated devices, and the corresponding actions in chronological order.
- Notice also how the One Line Diagram presentation animates while moving the “Slide Pointer”.

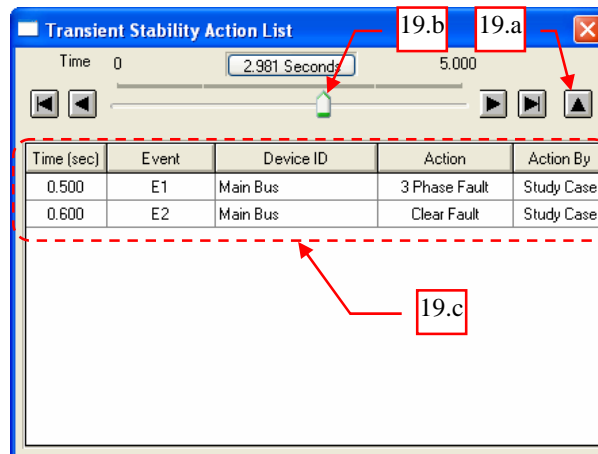


Fig. 12

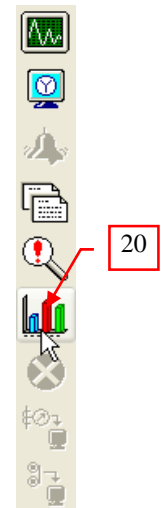


Fig. 13

20. To view the performance of Gen1, on the “Transient Stability” toolbar, click the “Transient Stability Plots” button. See Fig. 13.

21. On the “Transient Stability Plot Selection” dialog box, do the following (See Fig. 14):

- On the “Device Type”, select “Syn Generators”
- On the “Device ID”, select “Gen1”.
- There are 11 Plots available for the Syn. Generator device. But in this exercise, view only the “Power Angle (Relative)”. Click the “Uncheck All” button.
- Check the “Power Angle (Relative)”
- Click “OK” button.

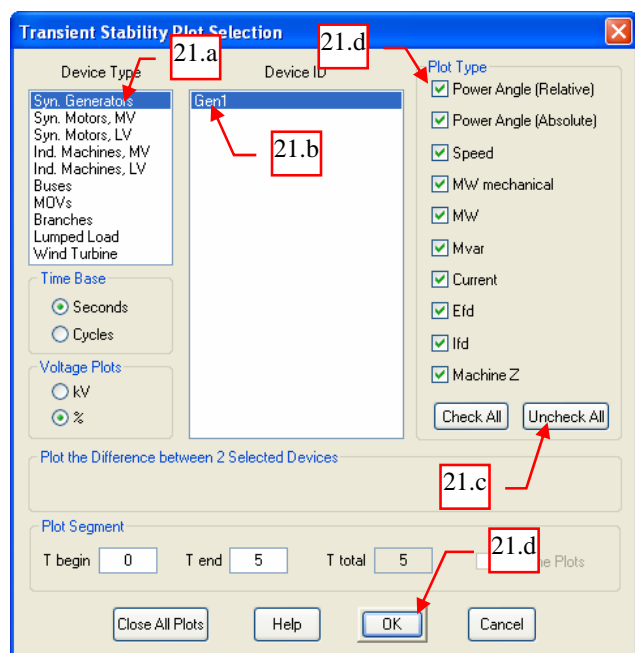


Fig. 14

22. The output plot is displayed in Fig. 15. Looking at the profile, when the fault occurred, the generator power angle swing to 80 deg (approx). After the fault was cleared, it oscillated and was damped gradually approaching closely to its initial position . Based on this behavior, Gen1 stays in synchrony with the utility.

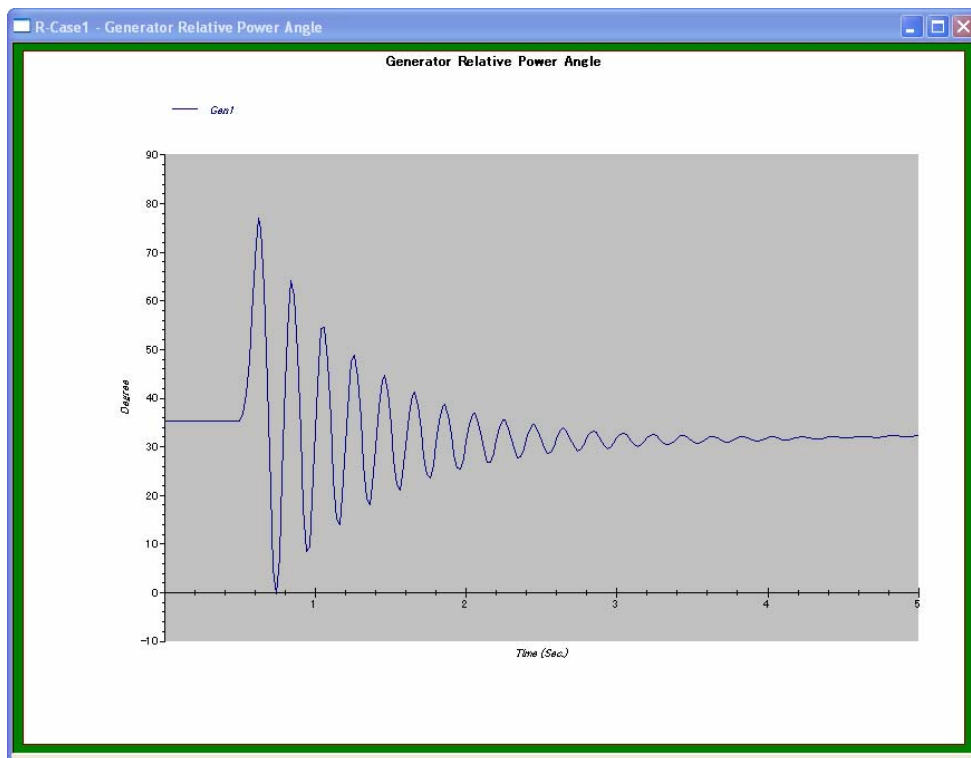


Fig. 15