Title: Power system modeling of a 4-bus system using varying load and observing the effects of Static Var Compensator (SVC) due to line disturbances

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Abstract:

The simulation presents power system modelling of a 4-bus system consisting of 1 generator of order ii at bus 4 and an infinite bus at bus 1. A time varying load is connected at bus 3. Bus 1 is considered as a slack bus. The duration for varying load is 5 seconds. Opening and reclosing of line 2_4 between bus 2 and bus 4 starting from 70 sec for duration of 5 seconds is also provided. A Static Var Compensator (SVC) is provided to lower the line perturbation. The power system model is shown in Figure 1.

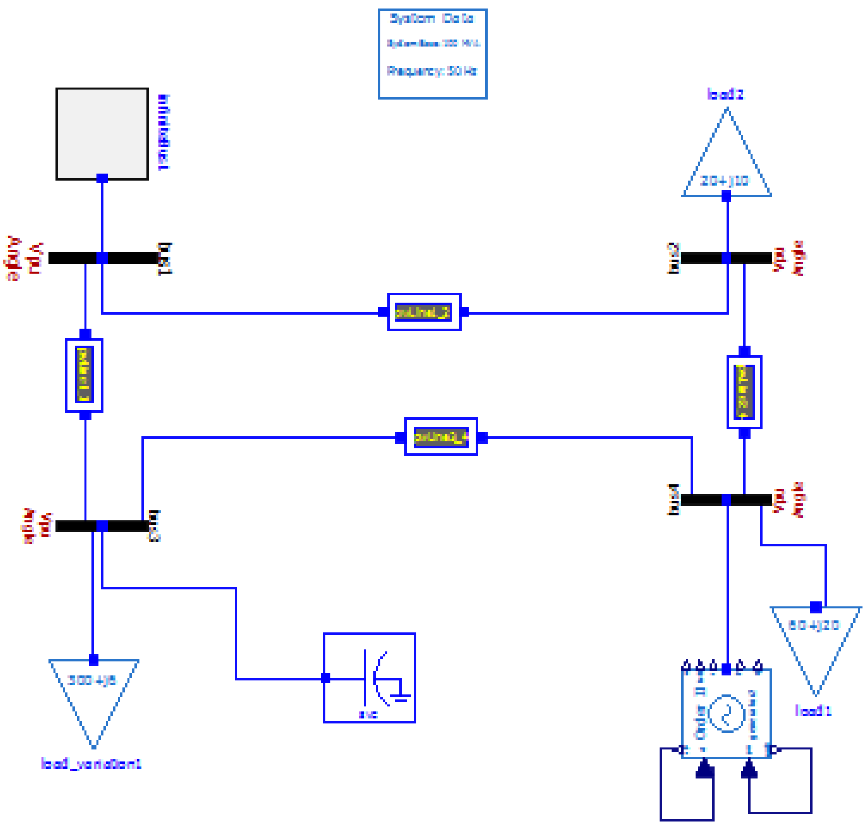

Figure 1: Power System Model

Explanation:

The model uses the following components

Component name	Path	Quantity
Generator (order 2)	OpenIPSL.Electrical.Machines.PSAT.Order2	1
Bus	OpenIPSL.Electrical.Buses.Bus	4
Transmission Line	OpenIPSL.Electrical.Branches.PwLine	4
Constant Load	OpenIPSL.Electrical.Loads.PSSE.Load	2
Varying Load	OpenIPSL.Electrical.Loads.PSSE.Load_variation	1
Static Var Compensator (SVC)	OpenIPSL.Electrical.Banks.PSSE.SVC.SVC	1
System block	OpenIPSL.Electrical.SystemBase	1
Infinite bus	OpenIPSL.Electrical.Buses.InfiniteBus	1

The above model is subjected to different conditions at different time periods in order to observe the voltage profiles at the buses. The conditions which it is subjected to are:

1. The load variation of bus 3 starts at 25 seconds.
2. Opening and reclosing of line 2_4 between bus 2 and bus 4 starting from 70 seconds.

Case 1: Simulating the voltage profile at bus 3 without the use of SVC

The voltage at the bus 3 is shown in the fig 2 and from this we can see that the voltage dips at the times mentioned above which indicates that the system decelerates. Thus, the system decelerates and when the load is cut off after 5 secs the voltage angle oscillates about its steady state value and settles after some time. The dipping occurs at time 25 secs. The voltage dips again at 70 sec due to line disturbances between bus 2 and bus 4 (pwline2_4) and reclosed after 5 secs. We can see that system is stable even after reclosure as there are parallel lines connected at bus 2 and bus 4 individually where the power can be redirected. In this case, even the generator bus voltage starts to oscillate.

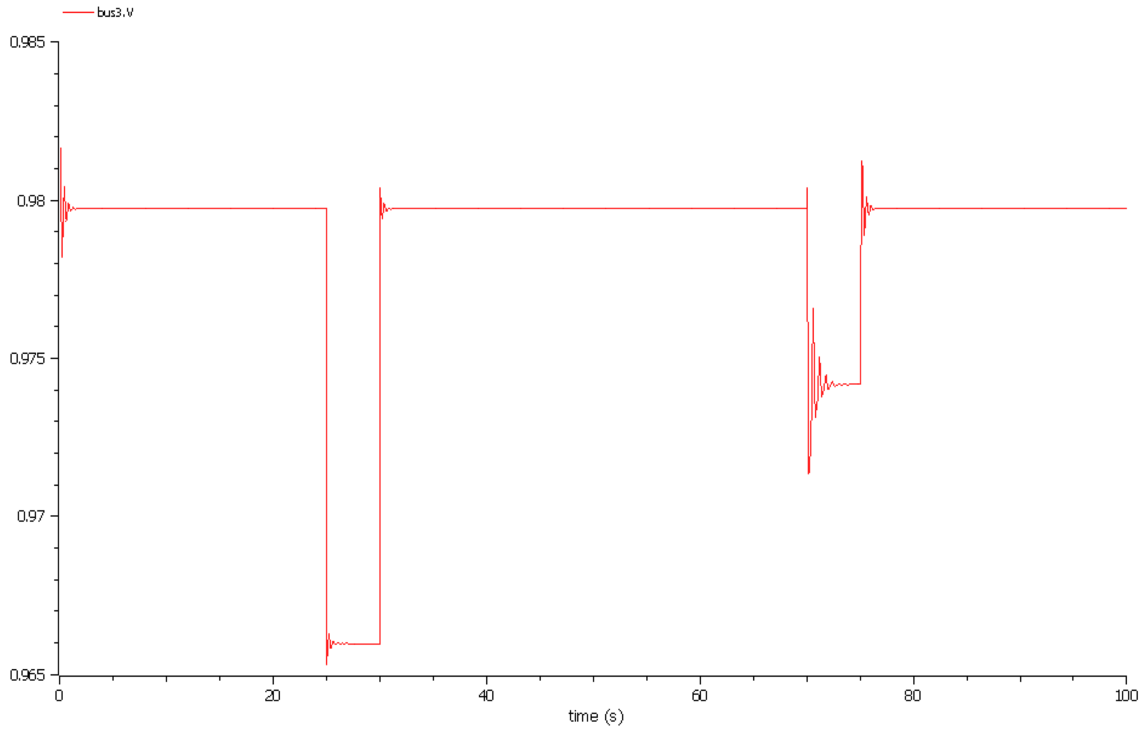

Figure 2: Voltage profile of bus 3 without use of SVC

Case 2: Simulating the voltage profile at bus 3 with SVC

In this case the voltage value is slightly increased. The effect due to line disturbances is reduced thus accelerating the system. The simulation is shown in figure 3. The line Voltage stability is concerned with the ability of a power system to maintain acceptable voltages at all buses of the system under normal conditions and after the occurrence of a disturbance. A system enters a state of voltage instability when a disturbance, increase in load demand or change in system conditions. Figure 4 shows the comparison for bus3 voltage profile with and without using SVC, the blue colored graph shows the voltage profile of bus3 after using SVC and the red colored graph shows the voltage profile of bus3 without using SVC.

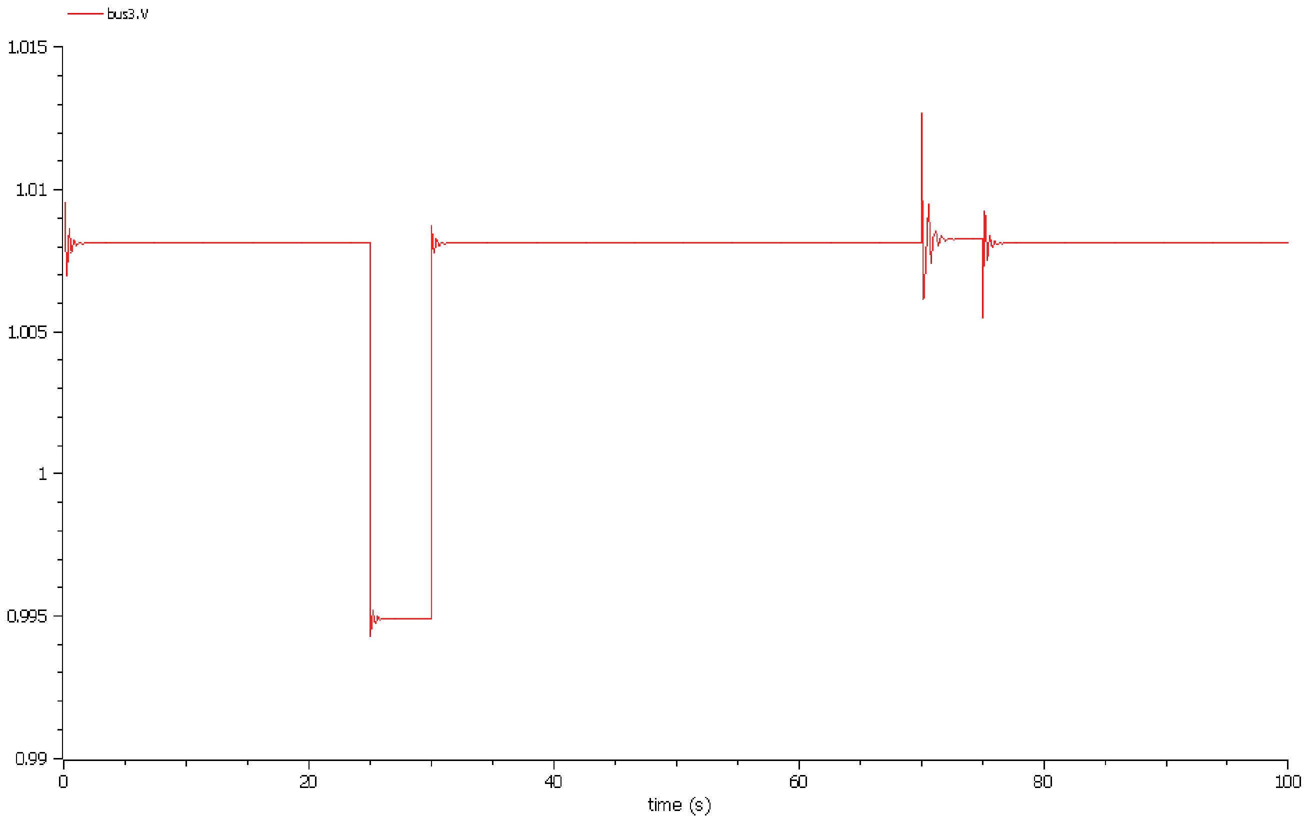

Figure 3: Voltage profile of bus3 after using SVC

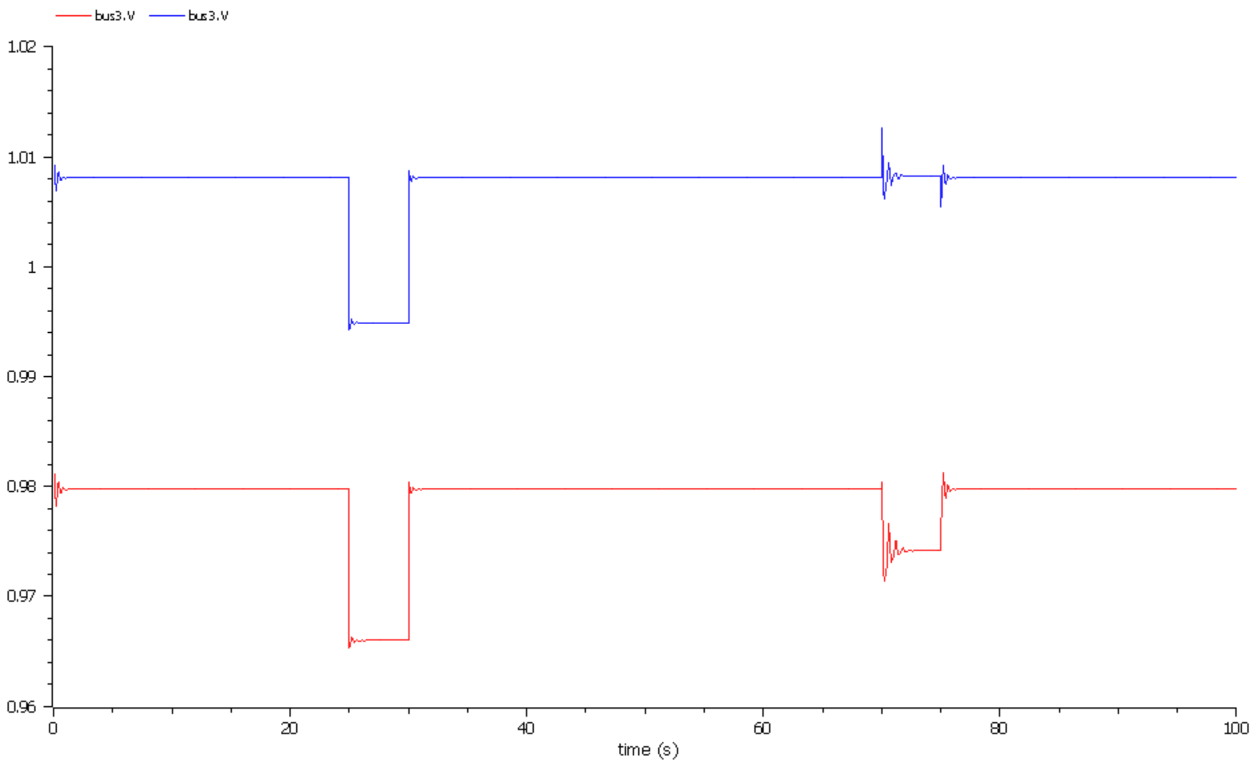

Figure 4: Comparison of bus3 voltage profile due to use of SVC

Conclusion:

The model represents the behavior of the system under time varying load and line disturbances and the effect of SVC. In the case of reclosure of the power line, the system oscillates and after reclosure it comes back to stable condition. But during the load variation although the magnitude of oscillation is small but the voltage dipping is considerably large. The SVC accelerates the system and reduces the line disturbances.