Title: Modeling of single machine infinite bus (SMIB) using Modelica and the OpenIPSL

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Abstract:

Modelica implementation of the single machine infinite bus (SMIB) using the OpenIPSL library is shown in Figure 1. The generator model uses a PSAT synchronous machine of order VI, with no additional controls but an AVR of order III. A three phase balanced fault is simulated in the Bus 2 from 0.5 to 0.57 seconds. The simulation result shown in Figure 2, represents the voltage at Bus 2 before and after the fault occurs.

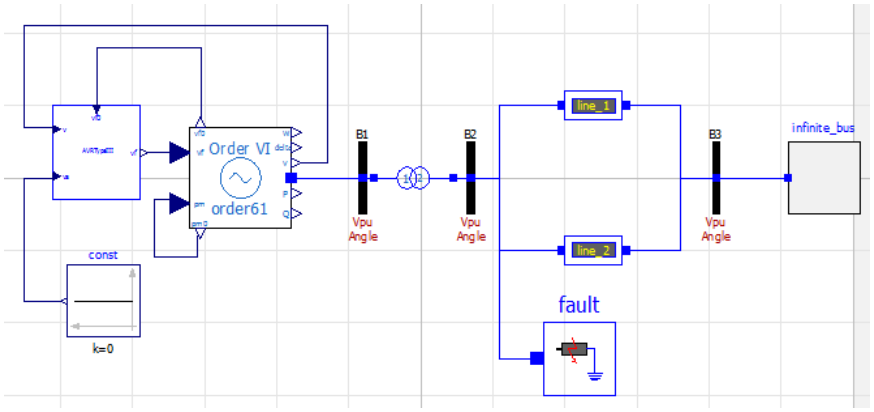

Figure 1: Implementation of SMIB using OpenIPSL

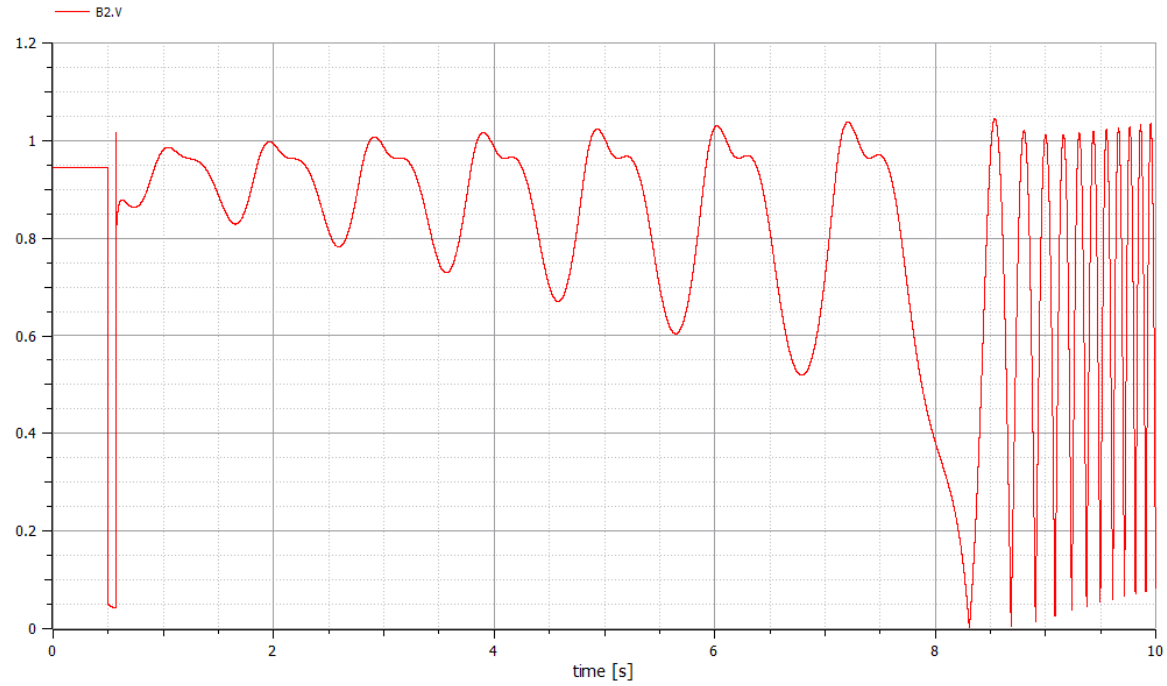

Figure 2: Voltage profile at the fault bus

Explanation:

This model uses following components

Component Name	Path	Number
AVR typeIII	OpenIPSL.Electrical.Controls.PSAT.AVR.AVRtypeIII	4
Two Winding Transformer	OpenIPSL.Electrical.Branches.PSAT.TwoWindingTransformer	1
Constant block	Modelica.Blocks.Sources.Constant	1
Three phase fault	OpenIPSL.Electrical.Events.PwFault	4
Infinite Bus	OpenIPSL.Electrical.Buses.InfiniteBus	4
Generator (Order VI)	OpenIPSL.Electrical.Machines.PSAT.Order6	1
Bus	OpenIPSL.Electrical.Buses.Bus	3
PwLine	OpenIPSL.Electrical.Branches.PwLine	2
Sysdata block	OpenIPSL.Electrical.SystemBase	1

In this model the stability of a single generator connected to an infinite bus is analyzed. Here we use a classic case of a single synchronous machine connected to an infinite bus. The machine is modelled in OpenModelica as a 6th-order machine and has a simple AVR connected. The AVR controls the field voltage of the generator by taking initial field voltage and the terminal voltage of the generator as feedback. The AVR parameters are set and the model is simulated. At t=0.5s, a three-phase fault is applied to the Bus 2 and at t=0.57s, the fault is cleared. From the voltage profile of bus 2 (fault bus), during the fault we can see there is huge dip in the voltage profile but the voltage doesn't drop to zero as there is fault reactance involved. The fault is cleared and the system becomes unstable. This can be brought back to stable by adding necessary controls like PSS(Power System Stabilizer), TG(Turbine Governor) etc. to the generator.

Conclusion:

The model represents the behavior of the system both before and after the fault has occurred. The generator(order VI) is an uncontrolled one and hence the system becomes unstable even after the fault is being cleared. This can be clearly seen from the voltage profile at the fault bus. The system can be brought back to stable condition by adding more controls such as Power System Stabilizers (PSS) and Turbine governor (TG).