Title: Modeling of Single Machine distribution network using Modelica and Open IPSL

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Abstract:

The nine bus power system model uses a single machine which is a generator model with salient pole (GENSAL) to meet the power demand at various loads. The model contains nine buses, four two-winding transformers, four voltage dependent loads and four transmission lines (PwLine). The system base is 100 MVA. A three-phase balanced fault is simulated in one of the buses (8th bus) for the duration of 0.4 seconds (from 4.6 seconds to 5 seconds). The purpose of this power system simulation is to study the voltage stability at multiple buses.

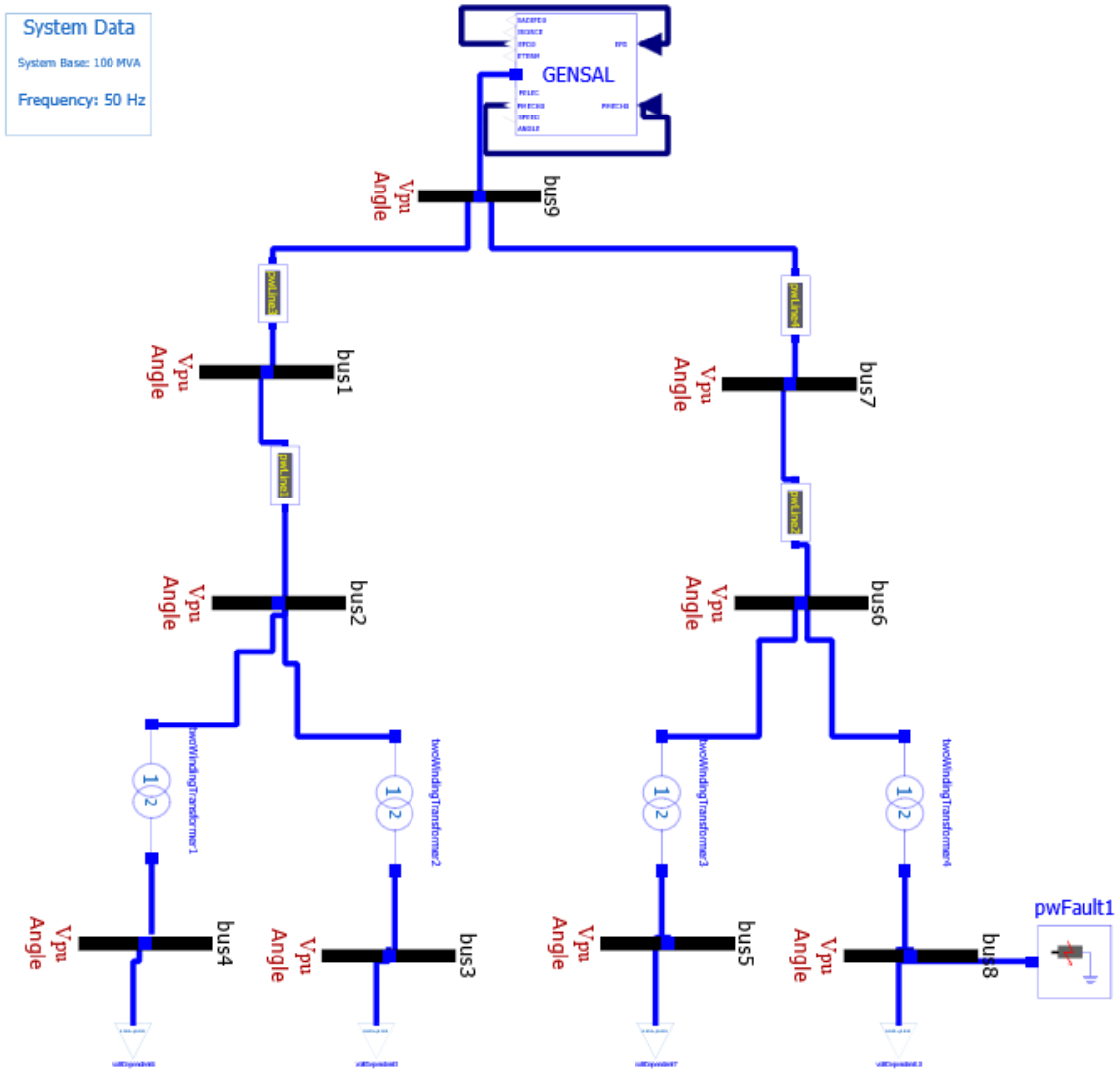

Figure 1: single machine distribution network using Modelica and OpenIPSL

Explanation:

This model uses the following components:

Component Name	Class Path	Number
Two Winding	OpenIPSL.Electrical.Branches.PSAT.TwoWindingTransformer	4
Three phase fault	OpenIPSL.Electrical.Events.PwFault	1
Voltage Dependent	OpenIPSL.Electrical.Loads.PSAT.VoltDependant	4
Generators	OpenIPSL.Electrical.Machines.PSSE.GENSAL	1
Buses	OpenIPSL.Electrical.Buses.Bus	9
PwLine	OpenIPSL.Electrical.Branches.PwLine	4
Sysdata block	OpenIPSL.Electrical.SystemBase	1

Table 1: Components used in system

The single machine distribution network model implemented in Modelica language using OpenIPSL package, is used to study the voltage stability at different buses. Model reference has been taken from EHV-AC, HVDC by S.Rao from page number 926 shown in figure 3, however many modifications has been made to system. More buses have been added, generator transformer and intermediate transformers has been removed, series capacitors has not been used and the system base is 100 MVA. The generator model implemented network has no controller. Hence during fault, voltage at fault bus abruptly falls near to zero as there is fault impedance of value 1e-3. Since system is highly damped, after fault voltage rises as curve and attains normal voltage level. Type of generator used is salient pole (GENSAL). A fault is simulated for the duration of 4.6 to 5 seconds at the 8th bus. Simulation obtained shows voltage profiles at various buses and waveforms obtained are observed

The simulation result of the all 9 Bus voltages shown below.

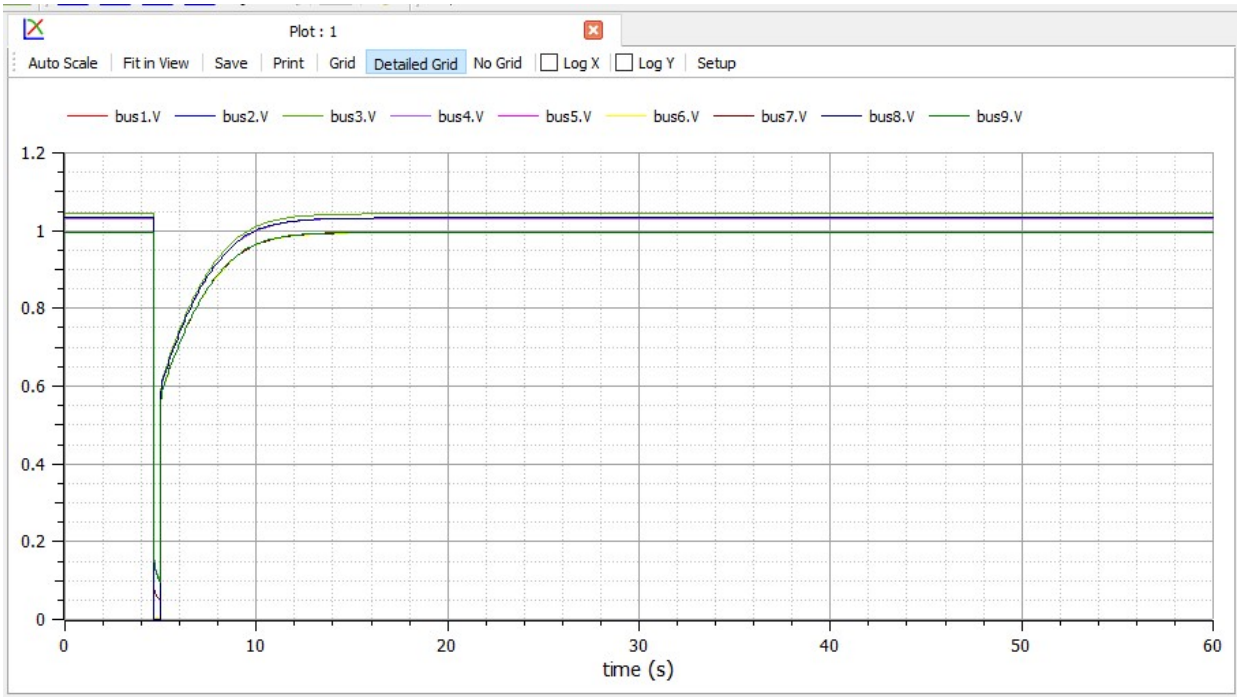

Figure 2: Voltage profiles of 9 buses

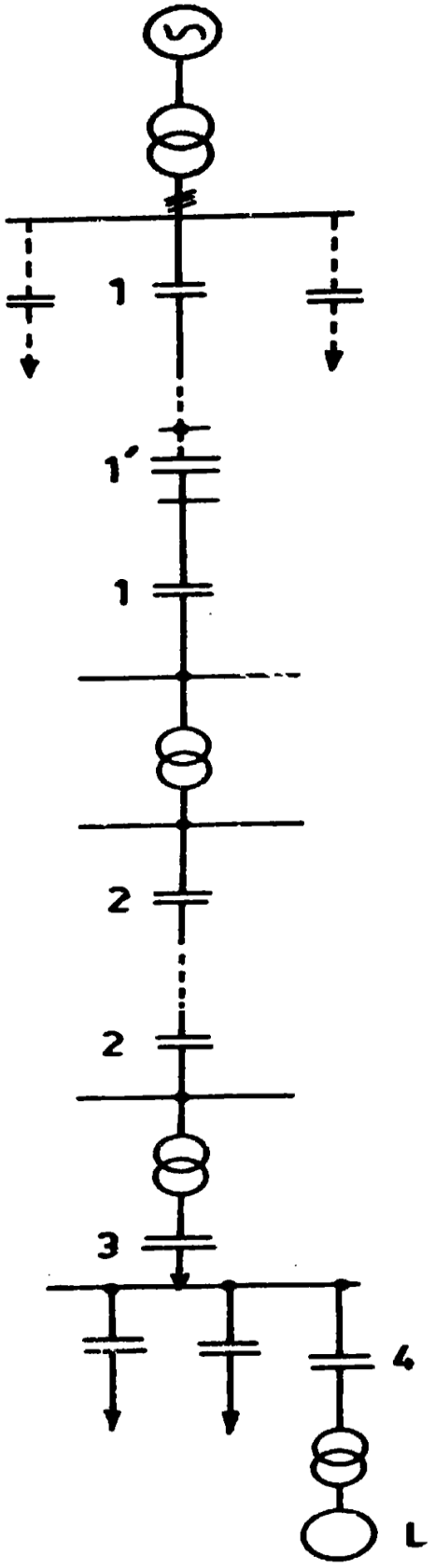

Figure 3: Reference single line diagram of system

Bus no.	Bus Voltage magnitude (p.u.)
1	0.995359
2	0.994593
3	1.04363
4	1.03183
5	1.03281
6	0.994607
7	0.995366
8	1.03281
9	0.996125

Table 2: Bus voltage magnitude (p.u.) of all 9 buses obtained.

Conclusion:

The implementation of the single machine distribution network model in Modelica represents the system behavior before and after the fault occurs at the 8^{th} bus. The relation between line impedance and fault severity is also observed. However controls along with Turbine governor (TG) in the generator model can be added for better voltage profiles.