Title: Modelling of a five bus power system under three phase fault using OpenIPSL

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Abstract:

A five bus power system 1 generator of order iii at bus 4 and an infinite bus at bus 1. PQ loads are connected at all the five buses except at bus 1. Bus 1 is considered as a slack bus.

The system is subjected to following conditions

1. Introducing a three phase line to ground fault between bus5 and bus 3 starting from 1.5sec for duration of 0.5sec.
2. Opening and reclosing of line 6 between bus 3 and bus 5 starting from 20 sec for duration of 5 seconds.

The outputs under above condition are observed and explained

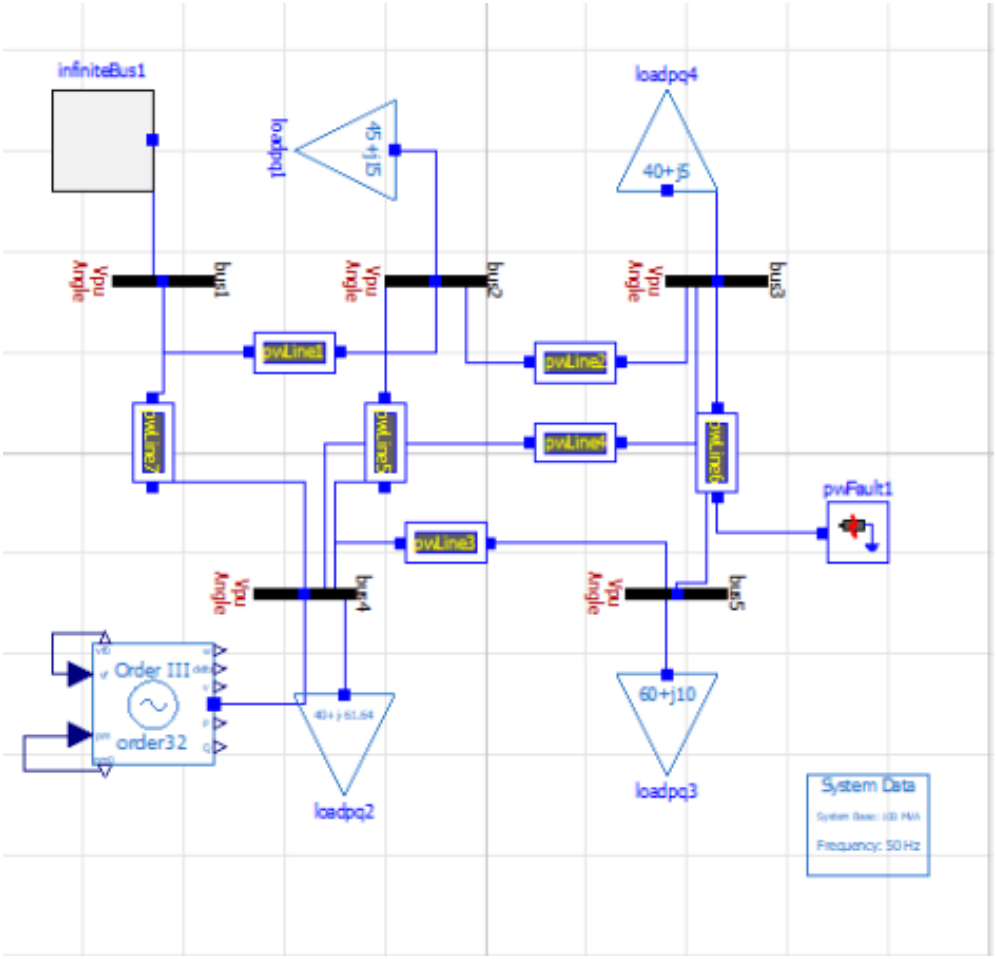

Fig 1. Modelling of a 5 bus power system for a three phase fault

Explanation:

The model uses the following components

Component name	Path	Quantity
Generator (order 3)	OpenIPSL.Electrical.Machines.PSAT.Order3	1
Bus	OpenIPSL.Electrical.Buses.Bus	5
Transmission Line	OpenIPSL.Electrical.Branches.PwLine	7
Load	OpenIPSL.Electrical.Loads.PSAT.LOADPQ	4
Three phase fault	OpenIPSL.Electrical.Events.PwFault	1
System block	OpenIPSL.Electrical.SystemBase	1
Infinite bus	OpenIPSL.Electrical.Buses.InfiniteBus	1

Case 1: Simulating the three phase fault at line 6.

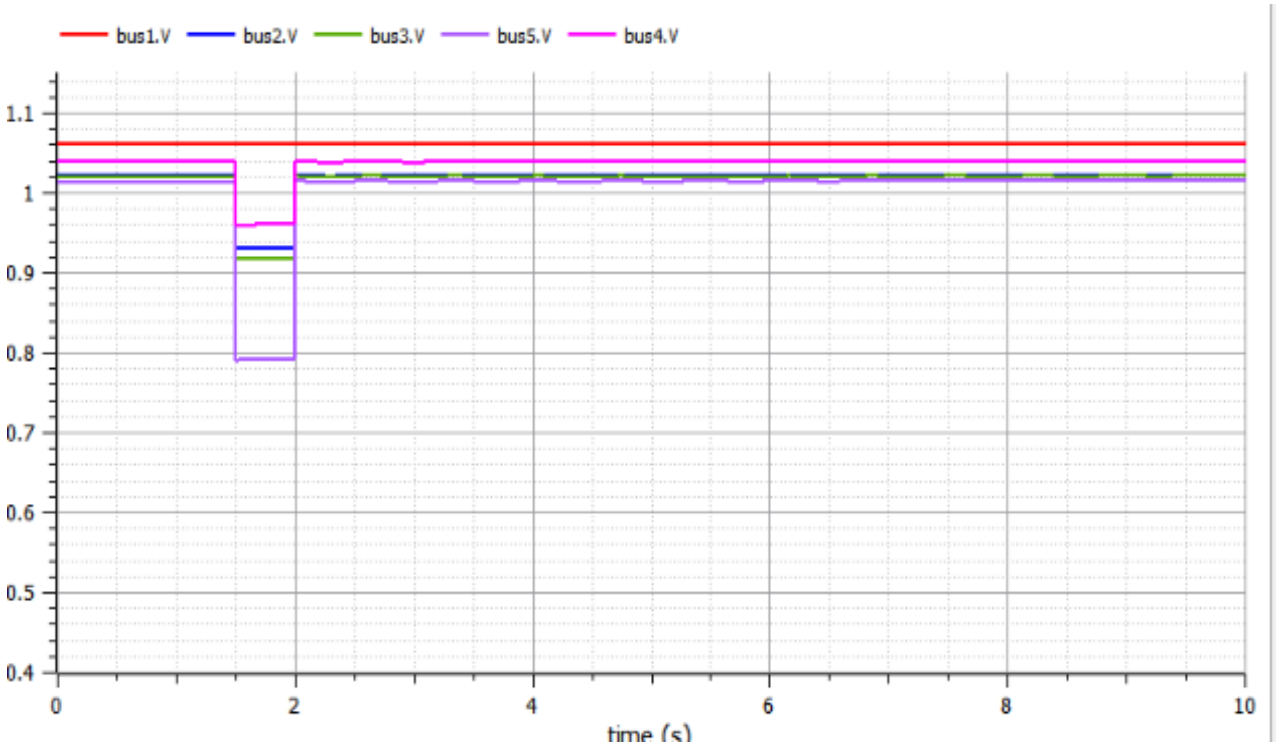

Fig 2. Voltage profile of the buses during three phase fault

In this model, the balanced three-phase ground fault is simulated at line 6 between bus 3 and bus 5 for a duration of 0.5 secs starting from 1.5 sec and cleared at 2 secs. The voltage profiles are plotted (refer to figure 2). The severity of the fault is more at fault bus and almost zero at the slack bus and minimum at the generator bus.. We can observe that the voltage is stabilised after the fault is cleared. This can be observed from the voltage profiles of bus 4 and bus 5.We can also observe that

even after the fault is cleared the system consists of persistent oscillations in its voltage profile. These oscillations can be damped by using additional controllers (Turbine governor (TG) and Power system stabilisers (PSS)) on the generator's side.

Case 2: Introducing disturbance in line 6 starting from 20 sec for 5 secs

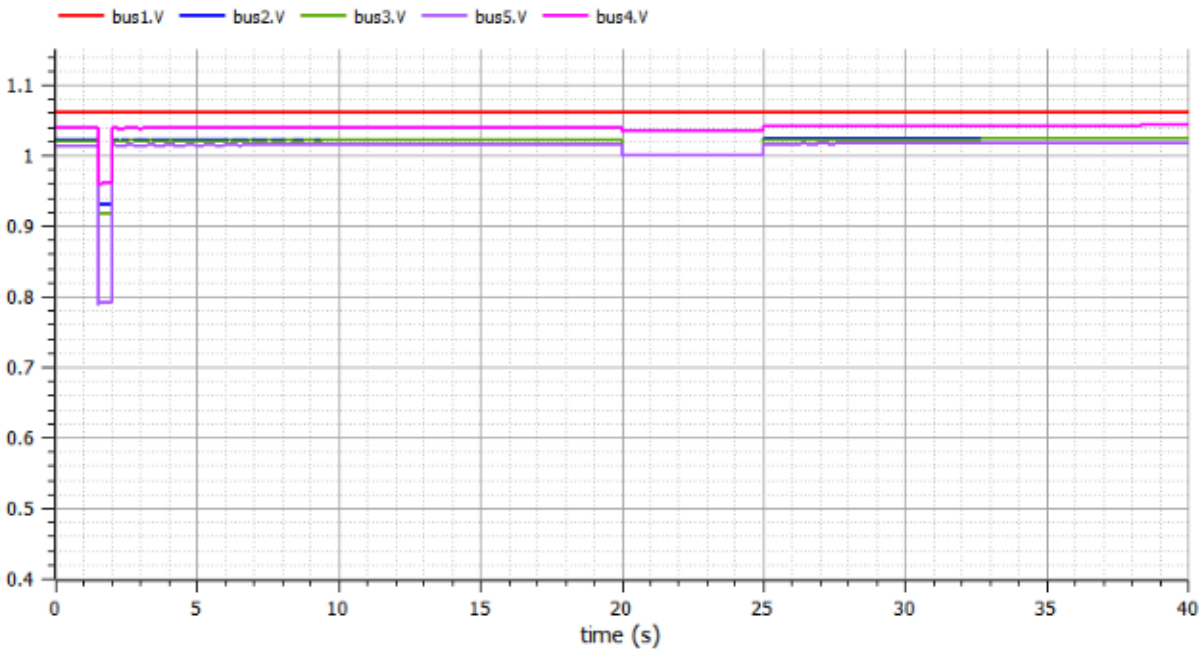

Fig 3: Voltage profiles in case of reclosing the power line

In this model, the line between bus 3 and bus 5 (pwline6) is opened at 20 secs and reclosed at 25 secs. The voltage profiles for the same are shown in figure 3. We can see that system is stable even after reclosure as there are parallel lines connected at bus 3 and bus 5 individually where the power can be redirected. In this case, even the generator bus voltage starts to oscillate but relatively these oscillations are of less magnitude. 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.

Conclusion:

The model represents the behaviour of the system under a three-phase ground fault condition and Opening and reclosing of the power line. In the case of reclosure of the power line, the system remains as there are other lines connected at bus 3 and bus 5 where the power could be redirected.. In the case of a three-phase ground fault, the generator buses are slightly affected and this can be taken care of by using Automatic Voltage Regulator (AVR) in the generator. Voltages remain stable at all the buses after the fault is cleared.