Title: Fault Analysis of 33 Bus distribution system using OpenModelica and OpenIPSL

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Abstract: Fault analysis of power system is required in order to analyze the performance of the system during occurrence of fault. The system had been analyzed based on its pre-fault, during fault and post-fault parameters. In this project, 33-bus radial distribution system is selected to perform fault analysis. In radial distribution system, electric power flows along a single path. It is an effective distribution network which links bulk power consumers. In case of any failure in the distribution system, the supply power beyond the fault gets isolated. The system was simulated using Modelica and Open-IPSL, assuming fault at bus 10 between 1 to 1.2 sec and the waveforms was analyzed.

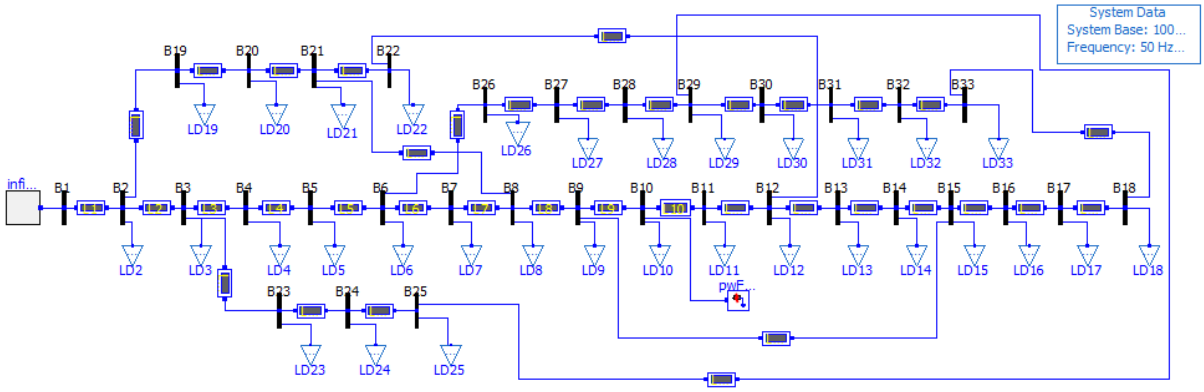

Figure 1: Implementation of IEEE 33 bus test system in OpenModelica and OpenIPSL

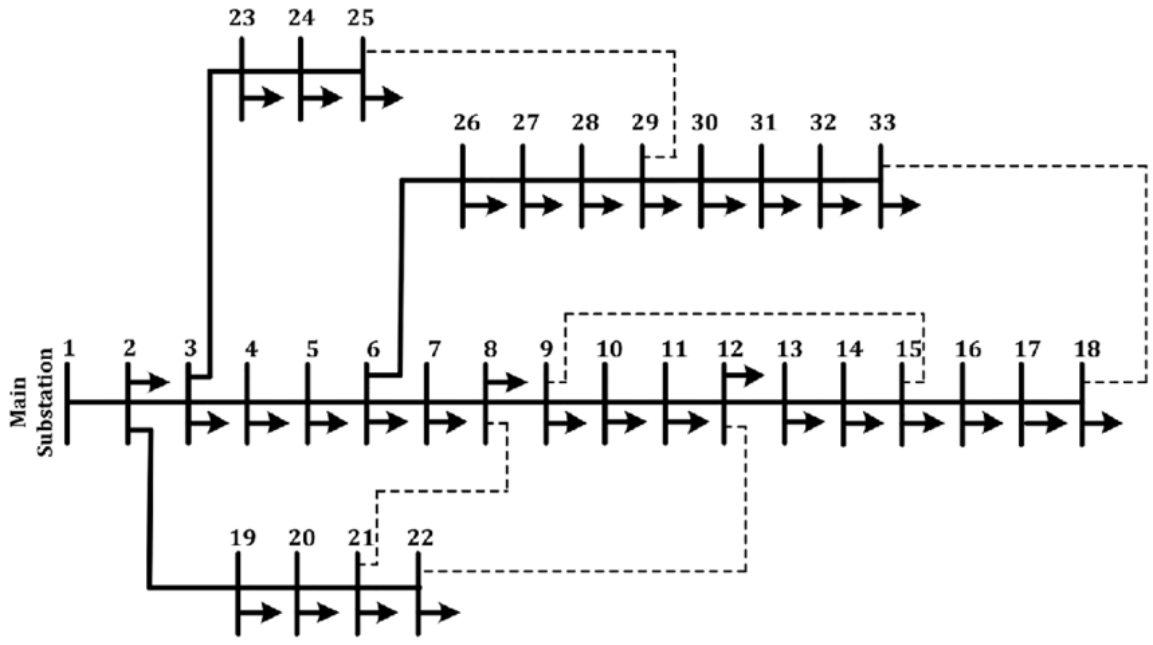

Figure 2: Singe Line Diagram of IEEE 33 bus radial distribution system

Explanation:

A radial distribution system is one which supplies power to the consumers through a single source. IEEE 33 bus radial distribution system is considered for the analysis in this project. The system consists of 33 buses with a total real power load of 3.72 MW and total reactive power load of 2.30 MVar supplied by source at bus 1(infinite bus). There are 37 transmission lines (including 5 tie lines) in the system to transfer the power to the consumers. The base value for the system is 100 MVA. The minimum and maximum bus voltage limits are considered as 0.9 pu and 1.1 pu respectively. The base voltage for all the buses is 12.66 kV.

The load flow solution for the test system is obtained using MATPOWER. Then, the model is created in OpenModelica and OpenIPSL. The components used in the model are given in Table 1.

Table 1: Components used in system

Component Name	Class Path	Number
PSAT Infinite Bus	OpenIPSL.Electrical.Buses.InfiniteBus	1
Buses	Open IPSL.Electrical.Buses.Bus	33
Constant PQ load	Open IPSL.Electrical.Loads.PSAT.LOADPQ	32
PwLine	Open IPSL.Electrical.Branches.PwLine	37
Three Phase fault	Open IPSL.Electrical.Events.PwFault	1
Sysdata Block	Open IPSL.Electrical.SystemBase	1

The model implemented in OpenModelica and OpenIPSL is used to study the study the voltage at different buses. A fault with fault impedance of j0.1Ω is simulated at bus 10 for duration of 1 to 1.2 seconds. The bus voltage profiles for all buses are shown in figure 3.

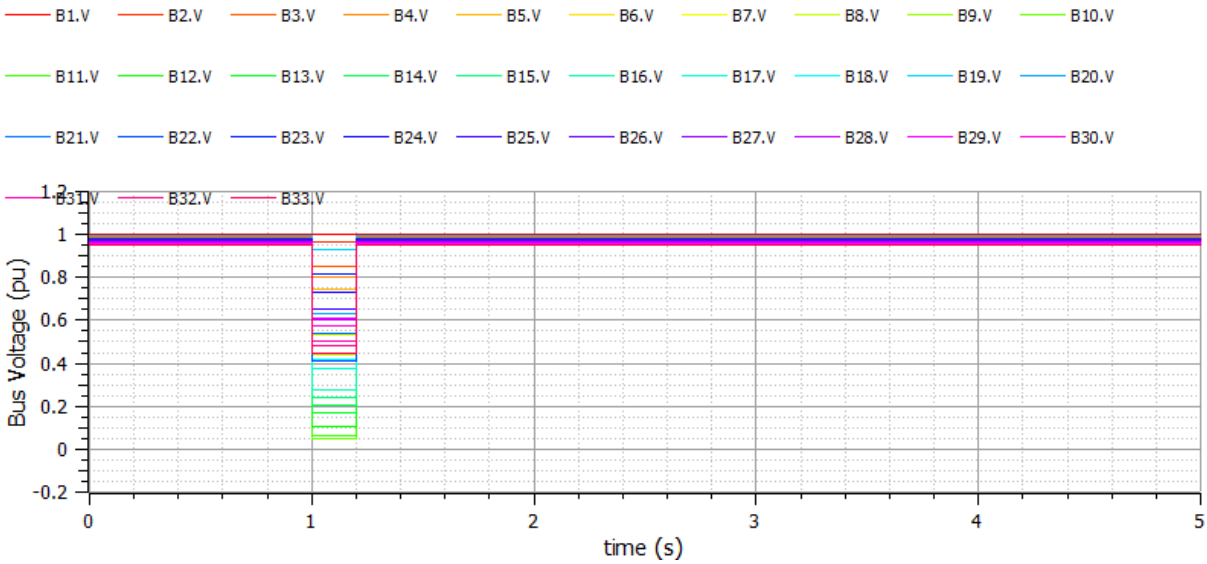

Figure 3: The voltage profiles of simulated IEEE 33 bus Test System

From the results, we can observe that the faulted bus (Bus 10) and the buses which are nearer to bus 10 are highly affected due to the fault. The severity reduces as the buses move away from the faulted bus. All the bus voltages under pre-fault and post-fault conditions are maintained between 0.9 pu and 1.1 pu.

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

Bus Number	Pre Fault Voltage(pu)	During Fault Voltage(pu)	Post Fault Voltage(pu)
Bus 1	1	1	1
Bus 2	0.99709	0.96435	0.99709
Bus 3	0.98622	0.85242	0.98622
Bus 4	0.98252	0.79879	0.98252
Bus 5	0.97906	0.74358	0.97906
Bus 6	0.97098	0.60164	0.97098
Bus 7	0.97000	0.53330	0.97000
Bus 8	0.96888	0.44096	0.96888
Bus 9	0.96558	0.23715	0.96558
Bus 10	0.96515	0.04674	0.96515
Bus 11	0.96515	0.06102	0.96515
Bus 12	0.96528	0.10668	0.96528
Bus 13	0.96185	0.17232	0.96185
Bus 14	0.96066	0.20512	0.96066
Bus 15	0.96031	0.23842	0.96031
Bus 16	0.95850	0.27853	0.95850
Bus 17	0.95499	0.37416	0.95499
Bus 18	0.95388	0.41672	0.95388
Bus 19	0.99533	0.93086	0.99533
Bus 20	0.98071	0.63330	0.98071
Bus 21	0.97661	0.54132	0.97661
Bus 22	0.97286	0.41333	0.97286
Bus 23	0.98071	0.81307	0.98071
Bus 24	0.96997	0.73113	0.96997
Bus 25	0.96260	0.65413	0.96260
Bus 26	0.96997	0.60186	0.96997
Bus 27	0.96870	0.60239	0.96870
Bus 28	0.96356	0.60584	0.96356
Bus 29	0.96008	0.60908	0.96008
Bus 30	0.95688	0.57706	0.95688
Bus 31	0.95376	0.50419	0.95376
Bus 32	0.95321	0.47989	0.95321
Bus 33	0.95342	0.45024	0.95342

Conclusion:

The implemented IEEE-33 bus model in OpenModelica and OpenIPSL represents the system behavior before and after the occurrence of fault at bus 10. The results also help us to understand the behavior of a radial distribution system under faulty conditions.