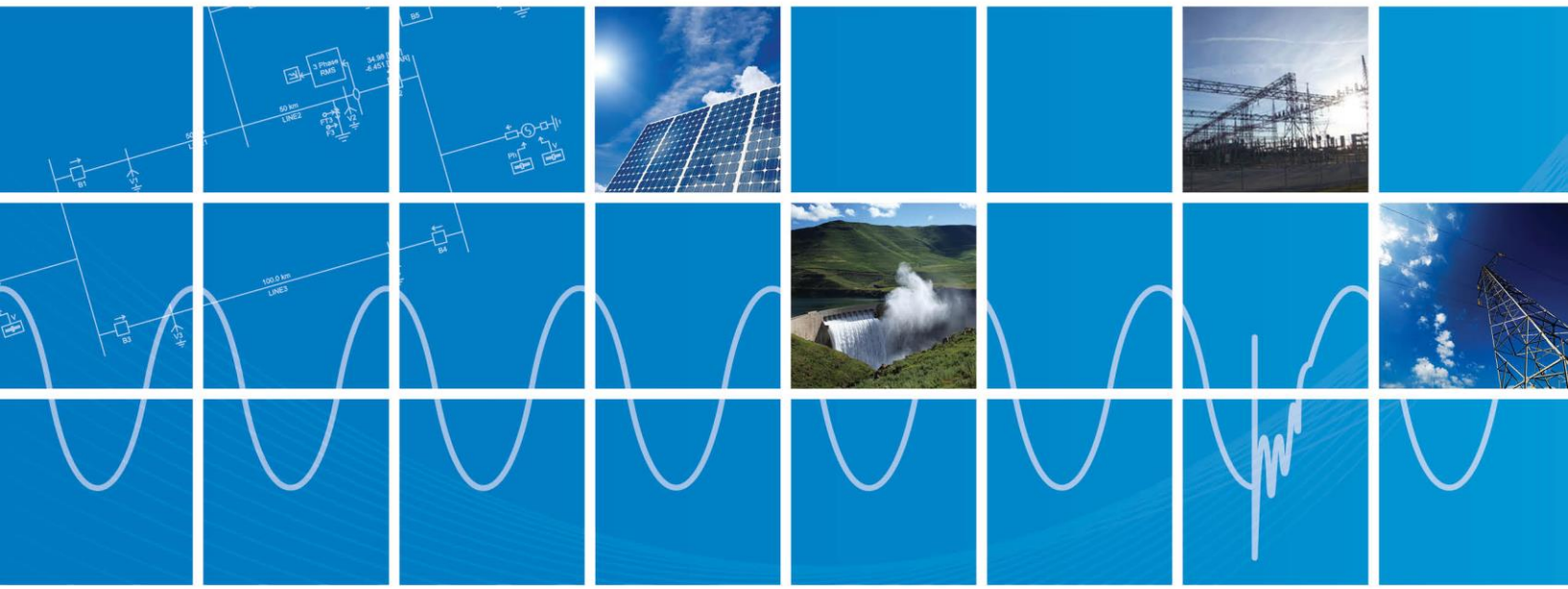
PSCAD™

IEEE 09 Bus System

May 22, 2018
Revision 1



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1.0 Objective

IEEE bus systems are used by researchers to implement new ideas and concepts. This technical note describes the details of the IEEE 9-bus system [1]. The system consists of loads, transmission lines, and generators as shown in Figure 1.

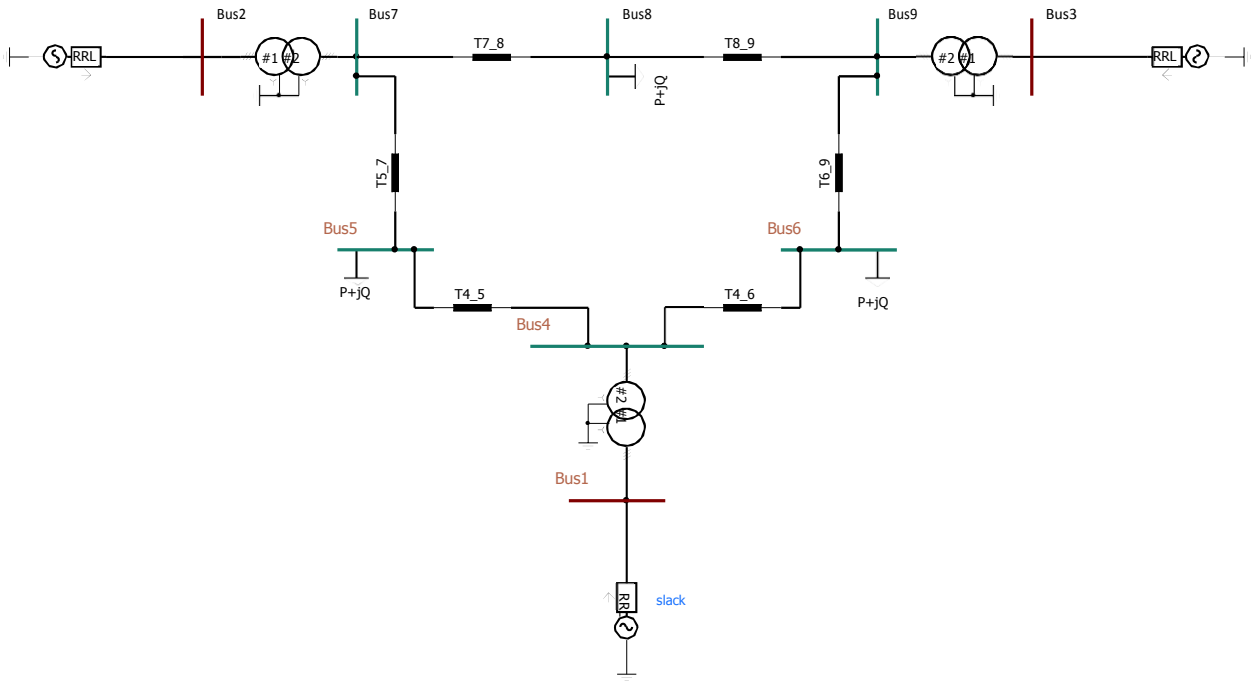

Figure 1 - PSACD model of IEEE 9-bus system

Each machine (generator) is represented as a voltage source where its source impedance is set arbitarily as 1 Ohm. Table 1 summarizes the perunitized terminal conditions of each source, with 100 [MVA] base.

Table 1 - Terminal conditions of IEEE 9-bus system

Bus	V [kV]	δ [deg]	P [pu]	Q [pu]
1	17.1600	0.0000	0.7163	0.2791
2	18.4500	9.3507	1.6300	0.0490
3	14.1450	5.1420	0.8500	-0.1145

Transmission lines are modelled using the Bergeron model. Table 2 summarizes the transmission line parameters.

Table 2 - Transmission line characteristics of IEEE 9-bus system

Line		R [pu/m]	X [pu/m]	B [pu/m]
From Bus	To Bus			
4	5	0.0100	0.0680	0.1760
4	6	0.0170	0.0920	0.1580
5	7	0.0320	0.1610	0.3060
6	9	0.0390	0.1738	0.3580
7	8	0.0085	0.0576	0.1490
8	9	0.0119	0.1008	0.2090

Loads are modelled as a constant PQ load with parameters as shown in Table 3.

Table 3 - Load characteristics of IEEE 9-bus system

Bus	P [pu]	Q [pu]
5	1.25	0.50
6	0.90	0.30
8	1.00	0.35

2.0 Validation

The PSCAD model was validated against the PSS/E power flow values from [1]. Table 4 depicts the line and source power flow comparison.

Table 4 - Source and line power flow comparison of IEEE 9-bus system

Bus		PSS/E		PSCAD	
		P [pu]	Q [pu]	P [pu]	Q [pu]
1		0.716	0.279	0.7152	0.2761
2		1.630	0.049	1.6320	0.0454
3		0.850	-0.114	0.8512	-0.1170
From Bus	To Bus				
4	5	0.433	0.235	0.4322	0.2334
4	6	0.283	0.013	0.2830	0.0115
5	7	0.842	-0.104	0.8430	-0.1041
6	9	0.633	-0.178	0.6340	-0.1810
7	8	0.788	-0.008	0.7892	-0.0089
8	9	0.217	0.023	0.2172	0.0229

3.0 Set-up Instructions

Dependencies

This example is compatible with PSCAD v4.5.3 and beyond. The file

required to run the tutorial is given below:

- New_IEEE_09_CT.pscx

4.0 Future updates to the system model

- Replace the voltage sources with detailed machine models for dynamic analysis.
- Update short circuit levels of each source to represent specific system strengths.

5.0 Technical References

[1] Illinois Center for a Smarter Electric Grid. (2013). [Online]. Available FTP: http://publish.illinois.edu/smartergrid/

[2] http://sas.ieee.ca/pesias/seminar_slides/IEEE_PES-IAS_Chapter_24_01_13.pdf

Appendix 1

The line resistances and reactances are provided in [1] for each line segment of the test system. The following table lists the approximate line length of each segment, based on typical line data (as listed in Table A-2).

Table A-1 Approximate line lengths based on typical line reactance values as shown in Table A-2

From Bus	To Bus	Total Reactance (Ω)	Approximate length of the line based on typical line reactance values (km)
4	5	2645	5290
4	6	3174	6348
5	7	3703	7406
6	9	4761	9522
7	8	4232	8464
8	9	4761	9522

Table A-2- Typical line reactance values

Voltage (kV)	R(Ω/km)	X(Ω/km)
72	0.41	0.5
138	0.14	0.5
230 (single)	0.09	0.5
230 (bundled)	0.04	0.4
345 (bundled)	0.03	0.3
500 (bundled)	0.02	0.3

DOCUMENT TRACKING

Rev.	Description	Date
0	Initial	30/Dec/2014
1	Update to new brand guidelines	22/May/2018