

PSCAD

# IEEE 09 Bus System

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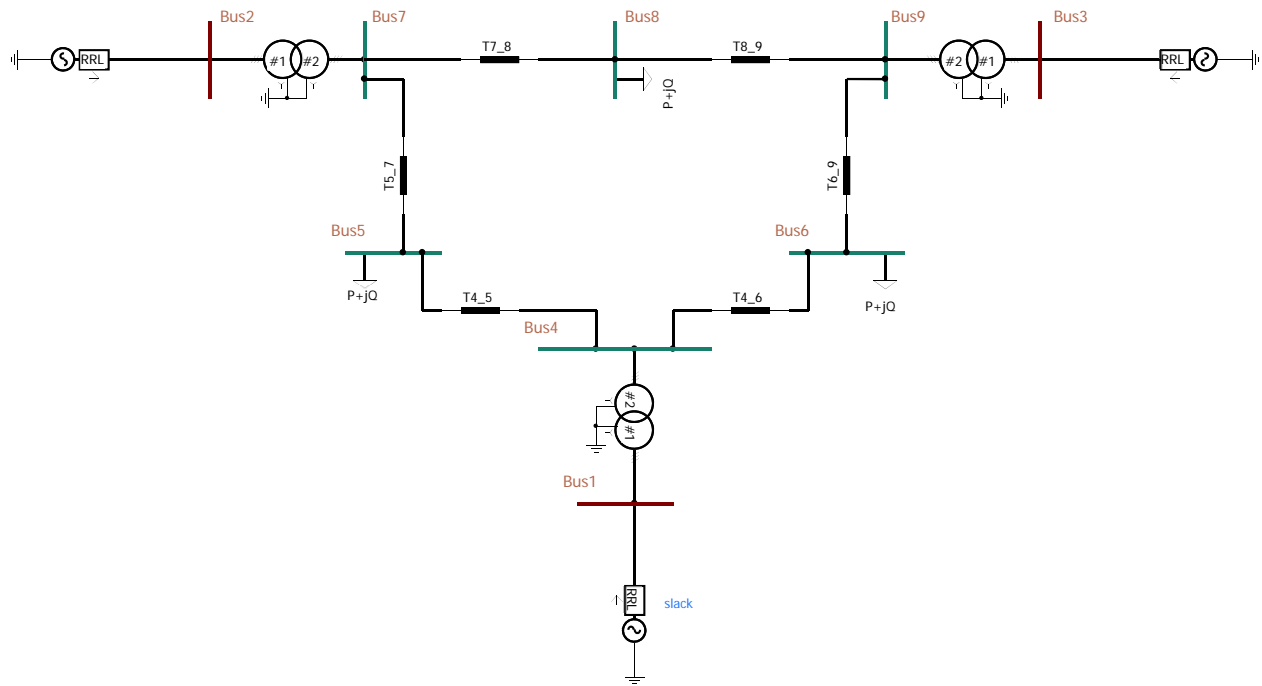
Revision: 0.00



**PSCAD**

## 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 arbitrarily 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]	$\delta$ [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

## 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

## 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

## 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.

## 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](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**

<b>From Bus</b>	<b>To Bus</b>	<b>Total Reactance (<math>\Omega</math>)</b>	<b>Approximate length of the line based on typical line reactance values (km)</b>
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**

<b>Voltage (kV)</b>	<b>R(<math>\Omega</math>/km)</b>	<b>X(<math>\Omega</math>/km)</b>
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