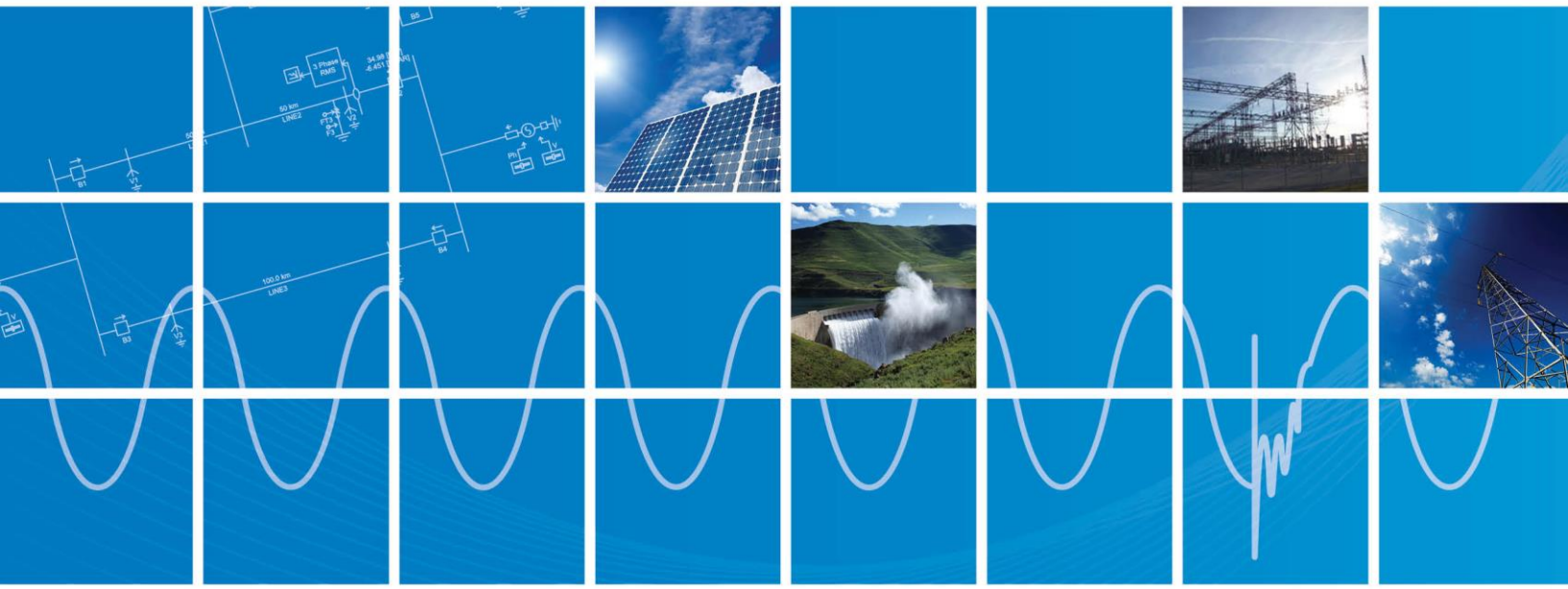
PSCAD™

IEEE 30 Bus System

May 22, 2018
Revision 1



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Contents

Objective 1
Validation 4
Set-up Instructions 5
Future updates to the system model 5
Technical References 5
Appendix 1 6

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 30-bus system [1]. The system consists of loads, capacitor banks, transmission lines, and generators. Figure 1 depicts a part of the PSCAD model of the IEEE 30-bus system.

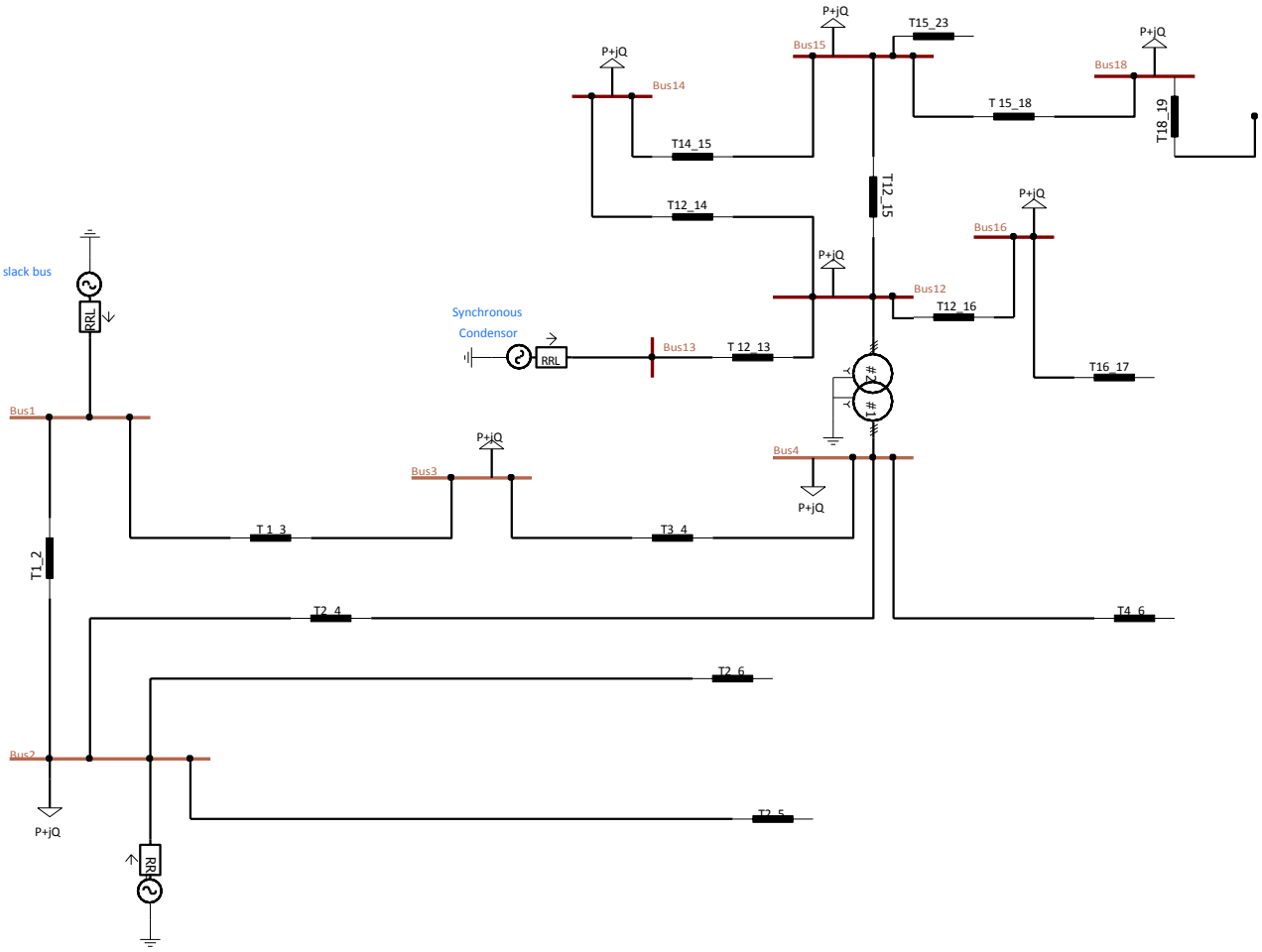

Figure 1 - PSCAD Model of IEEE 30-bus system

Each machine (generator) is represented as a voltage source where its source impedance is set arbitrarily as 10 Ohms. Table 1 summarizes the characteristics of each source, with a base of 100 [MVA] for per unitizing.

Table 1 - Terminal Conditions of IEEE 30-bus system

Bus	V [kV]	δ [deg]	P [pu]	Q [pu]
1	139.9200	98.4316	2.6095	-0.1679
2	137.6932	93.0798	0.4000	0.5000
5	133.4520	84.2658	0.0000	0.3685
8	133.3200	86.6183	0.0000	0.3714
11	35.7060	84.3227	0.0000	0.1617
13	35.3430	83.4883	0.0000	0.1062

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

Table 2 - Transmission line characteristics of IEEE 30-bus system

Line		R [pu/m]	X [pu/m]	B [pu/m]
From Bus	To Bus			
1	2	1.92E-07	5.75E-07	5.28E-07
1	3	4.52E-07	1.65E-06	4.08E-07
2	4	5.70E-07	1.74E-06	3.68E-07
2	5	4.72E-07	1.98E-06	4.18E-07
2	6	5.81E-07	1.76E-06	3.74E-07
3	4	1.32E-07	3.79E-07	8.40E-08
4	6	1.19E-07	4.14E-07	9.00E-08
5	7	4.60E-07	1.16E-06	2.04E-07
6	7	2.67E-07	8.20E-07	1.70E-07
6	8	1.20E-07	4.20E-07	9.00E-08
6	28	1.69E-07	5.99E-07	1.30E-07
8	28	6.36E-07	2.00E-06	4.28E-07
9	10	1.00E-09	1.10E-06	1.00E-09
9	11	1.00E-09	2.08E-06	1.00E-09
10	17	3.24E-07	8.45E-07	1.00E-09
10	20	9.36E-07	2.09E-06	1.00E-09
10	21	3.48E-07	7.49E-07	1.00E-09
10	22	7.27E-07	1.50E-06	1.00E-09
12	13	1.00E-09	1.40E-06	1.00E-09
12	14	1.23E-06	2.56E-06	1.00E-09
12	15	6.62E-07	1.30E-06	1.00E-09
12	16	9.45E-07	1.99E-06	1.00E-09

14	15	2.21E-06	2.00E-06	1.00E-09
15	18	1.07E-06	2.19E-06	1.00E-09
15	23	1.00E-06	2.02E-06	1.00E-09
16	17	5.24E-07	1.92E-06	1.00E-09
18	19	6.39E-07	1.29E-06	1.00E-09
19	20	3.40E-07	6.80E-07	1.00E-09
21	22	1.16E-07	2.36E-07	1.00E-09
22	24	1.15E-06	1.79E-06	1.00E-09
23	24	1.32E-06	2.70E-06	1.00E-09
24	25	1.89E-06	3.29E-06	1.00E-09
25	26	2.54E-06	3.80E-06	1.00E-09
25	27	1.09E-06	2.09E-06	1.00E-09
27	29	2.20E-06	4.15E-06	1.00E-09
27	30	3.20E-06	6.03E-06	1.00E-09
29	30	2.40E-06	4.53E-06	1.00E-09

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

Table 3 - Load characteristics of IEEE 30-bus system

Bus	P [pu]	Q [pu]
2	0.217	0.127
3	0.024	0.012
4	0.076	0.016
5	0.942	0.190
7	0.228	0.109
8	0.300	0.300
10	0.058	0.020
12	0.112	0.075
14	0.062	0.016
15	0.082	0.025
16	0.035	0.018
17	0.090	0.058
18	0.032	0.009
19	0.095	0.034
20	0.022	0.007
21	0.175	0.112
23	0.032	0.016
24	0.087	0.067
26	0.035	0.023
29	0.024	0.009
30	0.106	0.019

2.0 Validation

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

Table 4 - Source and line power comparison of IEEE 30-bus system

Bus		PSS/E		PSCAD	
		P [pu]	Q [pu]	P [pu]	Q [pu]
1		2.609	-0.168	2.6070	-0.1530
2		0.400	0.500	0.3992	0.5167
5		0.000	0.369	0.0025	0.3868
8		0.000	0.371	-0.0000	0.4047
11		0.000	0.162	0.0004	0.1662
13		0.000	0.106	0.0009	0.1111
From Bus	To Bus				
1	2	1.732	-0.2130	1.7320	-0.2098
1	3	0.846	-0.0240	0.8442	-0.0128
2	4	0.426	0.0470	0.4253	0.0589
2	5	0.824	0.0180	0.8239	0.0142
2	6	0.603	0.0050	0.6026	0.0169
3	4	0.813	-0.0360	0.8116	-0.0408
4	6	0.715	-0.1760	0.7128	-0.1745
5	7	0.148	-0.1330	0.1469	-0.1465
6	7	0.377	-0.0300	0.3749	-0.0375
6	8	0.296	-0.0810	0.2947	-0.0990
6	28	0.186	0.0110	0.1861	0.0112
8	28	0.005	-0.0040	0.0052	-0.0045
9	10	0.277	0.0590	0.2776	0.0567
9	11	0.000	0.1620	0.0004	0.1662
10	17	0.053	0.0440	0.0531	0.0428
10	20	0.090	0.0370	0.0900	0.0362
10	21	0.157	0.0980	0.1574	0.0980
10	22	0.076	0.0450	0.0754	0.0450
12	13	0.000	0.1060	0.0009	0.1111
12	14	0.078	0.0220	0.0779	0.0227
12	15	0.177	0.0640	0.1771	0.0648
12	16	0.072	0.0340	0.0721	0.0335
14	15	0.016	0.0060	0.0159	0.0067
15	18	0.060	0.0160	0.0590	0.0157
15	23	0.050	0.0290	0.0503	0.0296

16	17	0.037	0.0140	0.0370	0.0154
18	19	0.028	0.0060	0.0279	0.0067
19	20	0.067	0.0280	0.0671	0.0273
21	22	0.018	0.0140	0.0176	0.0138
22	24	0.057	0.0310	0.0573	0.0306
23	24	0.018	0.0120	0.0183	0.0136
24	25	0.012	-0.0200	0.0116	-0.0214
25	26	0.035	0.0230	0.0350	0.0230
25	27	0.048	0.0040	0.0473	0.0025
27	29	0.061	0.0150	0.0610	0.0150
27	30	0.071	0.0170	0.0709	0.0175
29	30	0.037	0.0050	0.0367	0.0054

3.0 Set-up Instructions

Dependencies

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

required to run the tutorial are as follows:

- New_IEEE_30_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)
1	2	10.0188	2.00E+01
1	3	28.7496	5.75E+01
2	4	30.3177	6.06E+01
2	5	34.4995	6.90E+01
2	6	30.6662	6.13E+01
3	4	6.6037	1.32E+01
4	6	7.2135	1.44E+01
5	7	20.2118	4.04E+01
6	7	14.2877	2.86E+01
6	8	7.3181	1.46E+01
6	28	10.4369	2.09E+01
8	28	34.8480	6.97E+01
9	10	19.1664	3.83E+01
9	11	36.2419	7.25E+01
10	17	14.7233	2.94E+01
10	20	36.4162	7.28E+01
10	21	13.0506	2.61E+01
10	22	26.1360	5.23E+01
12	13	24.3936	4.88E+01
12	14	44.6054	8.92E+01
12	15	22.6512	4.53E+01
12	16	34.6738	6.93E+01
14	15	34.8480	6.97E+01
15	18	38.1586	7.63E+01
15	23	35.1965	7.04E+01
16	17	33.4541	6.69E+01
18	19	22.4769	4.50E+01
19	20	11.8483	2.37E+01
21	22	4.1121	8.22E+00
22	24	31.1889	6.24E+01
23	24	47.0448	9.41E+01

24	25	57.3249	1.15E+02
25	26	66.2112	1.32E+02
25	27	36.4162	7.28E+01
27	29	72.3096	1.45E+02
27	30	105.0667	2.10E+02
29	30	78.9307	1.58E+02

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