What is Power World?

Power World is a power system visualization, simulation, and analysis tool.

2. CREATING A NEW CASE

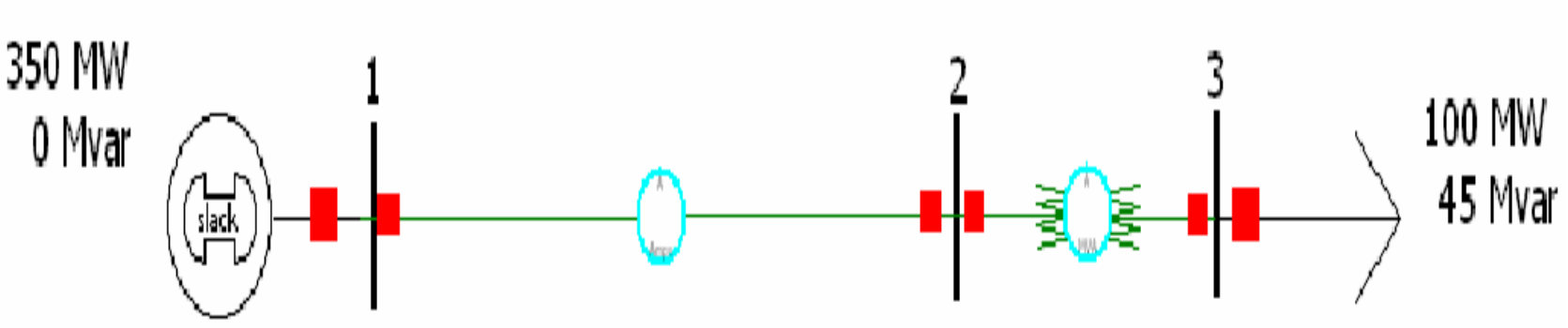
Generator: Rated voltage 66 kV maximum active power generation: 350 MW, reactive power limits ±90 MVAr

Transmission line: R = 0.01 p.u., X = 0.06 p.u, B = 0.10 p.u.

Transformer: 66/11 kV, X = 0.05 p.u.

Load:100 MW, 45 MVAr

ONE LINE DIAGRAM OF SAMPLE POWER SYSTEM

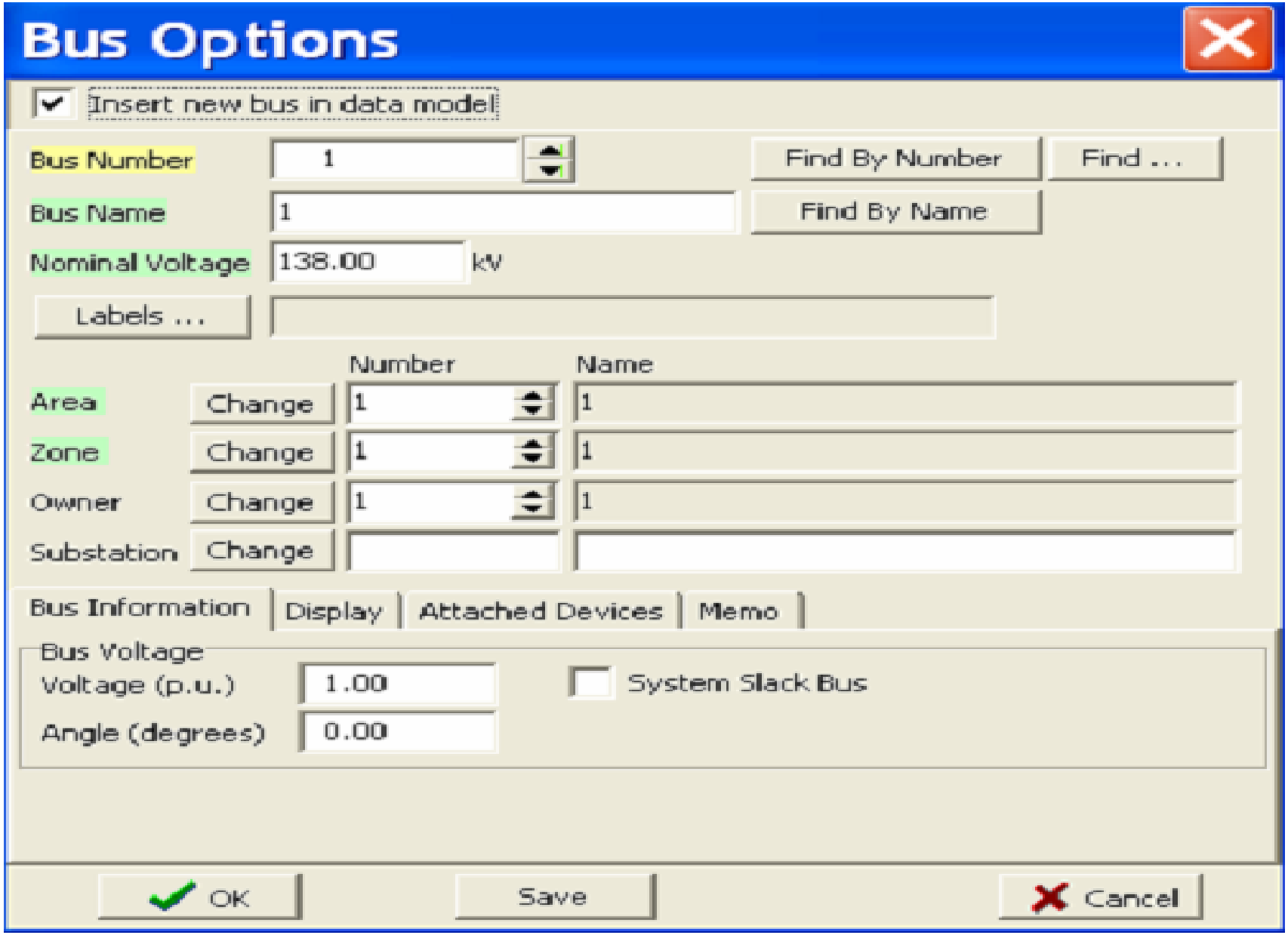


FROM THE FILE MENU SELECT NEW CASE

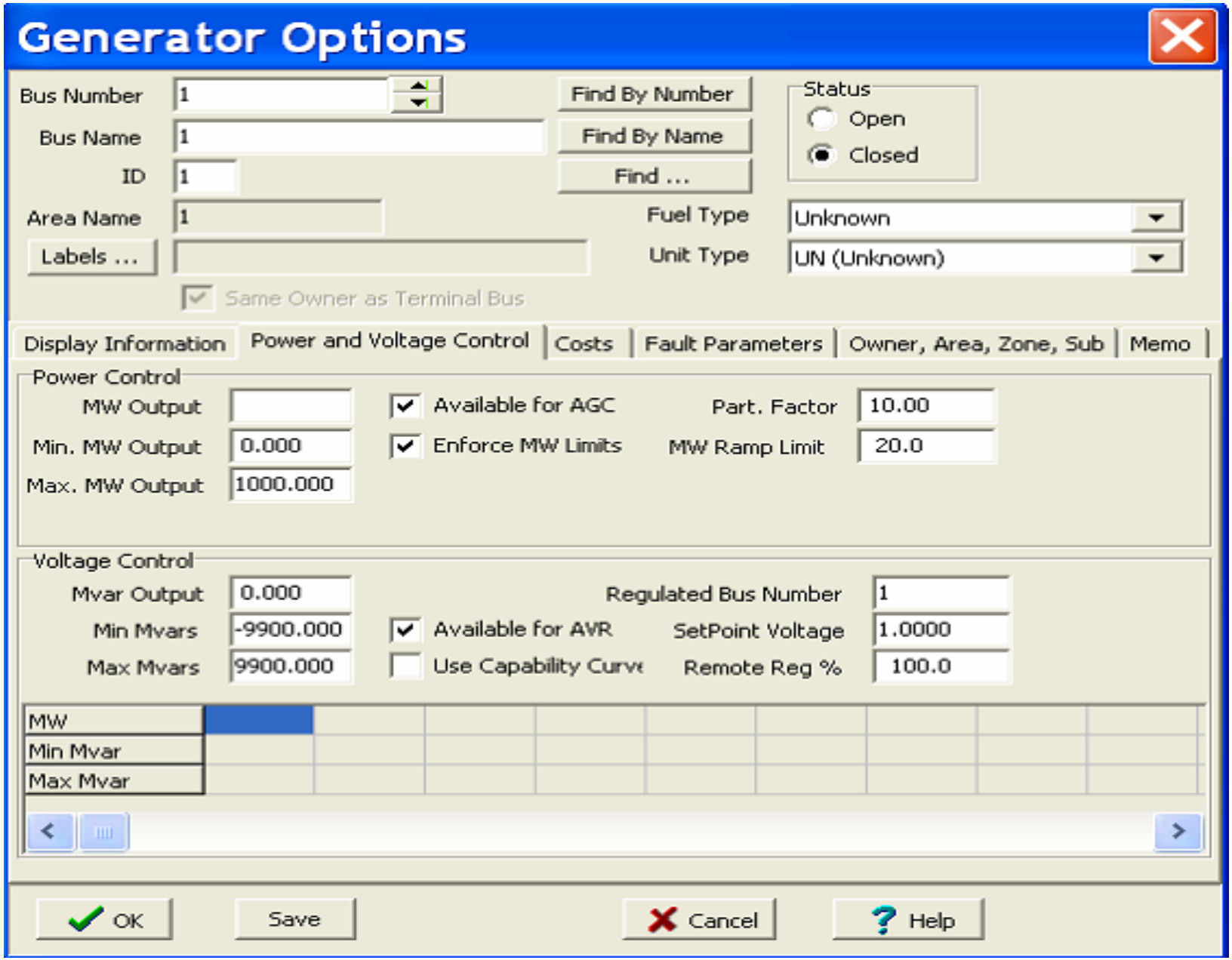
(a)Inserting a bus

From the Insert menu select Bus or click on the button in the “Insert” toolbar.

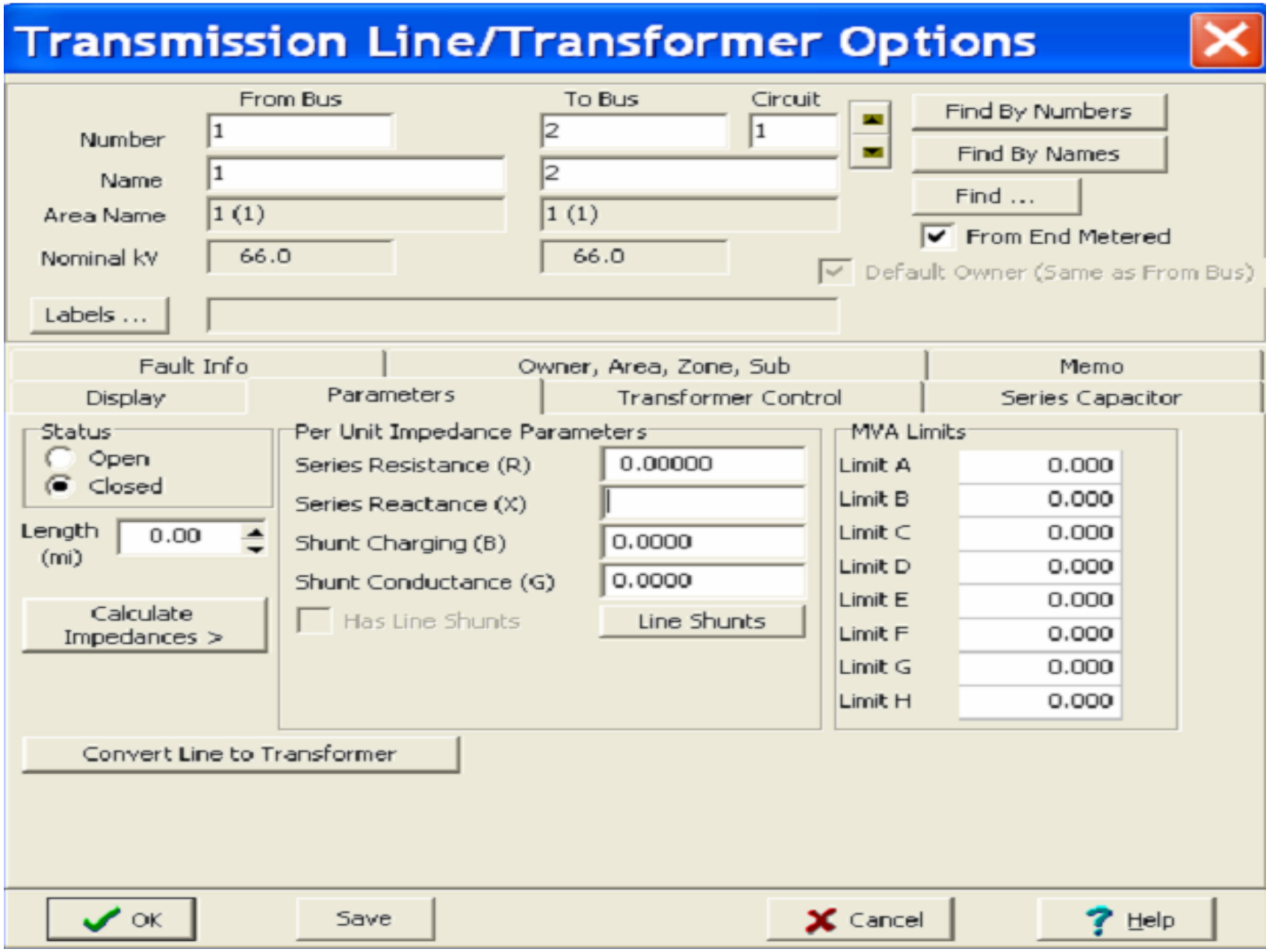
BUS OPTION


Bus Options
Insert new bus in data model
Bus Number
1
Find By Number
Find ...
Bus Name
1
Find By Name
Nominal Voltage
138.00
kV
Labels ...
Number
Name
Area
Change
1
1
Zone
Change
1
1
Owner
Change
1
1
Substation
Change
Bus Information
Display
Attached Devices
Memo
Bus Voltage
Voltage (p.u.)
1.00
System Slack Bus
Angle (degrees)
0.00
OK
Save
Cancel

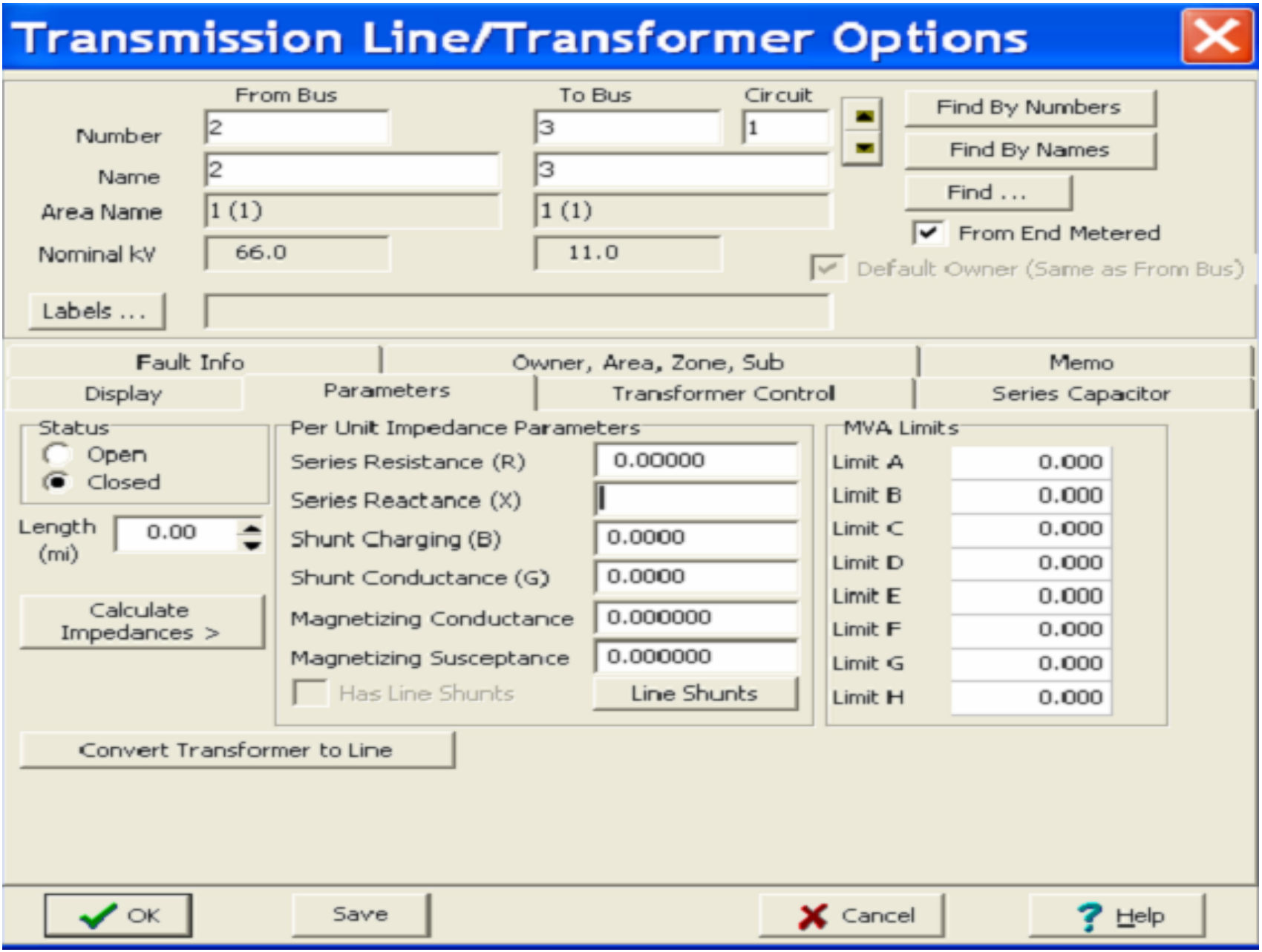
(B) INSERTING A GENERATOR



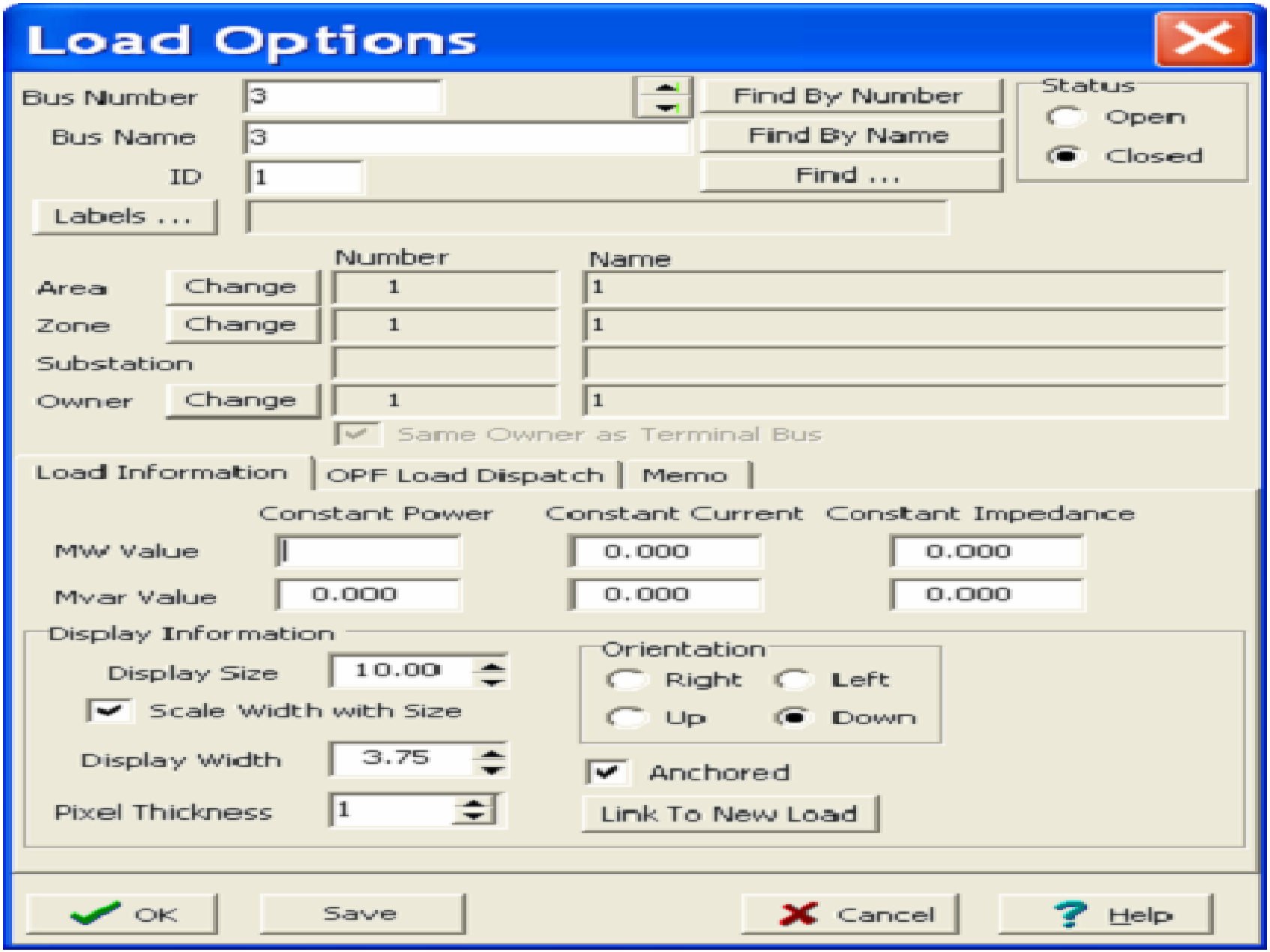
(C) INSERTING A TRANSMISSION LINE



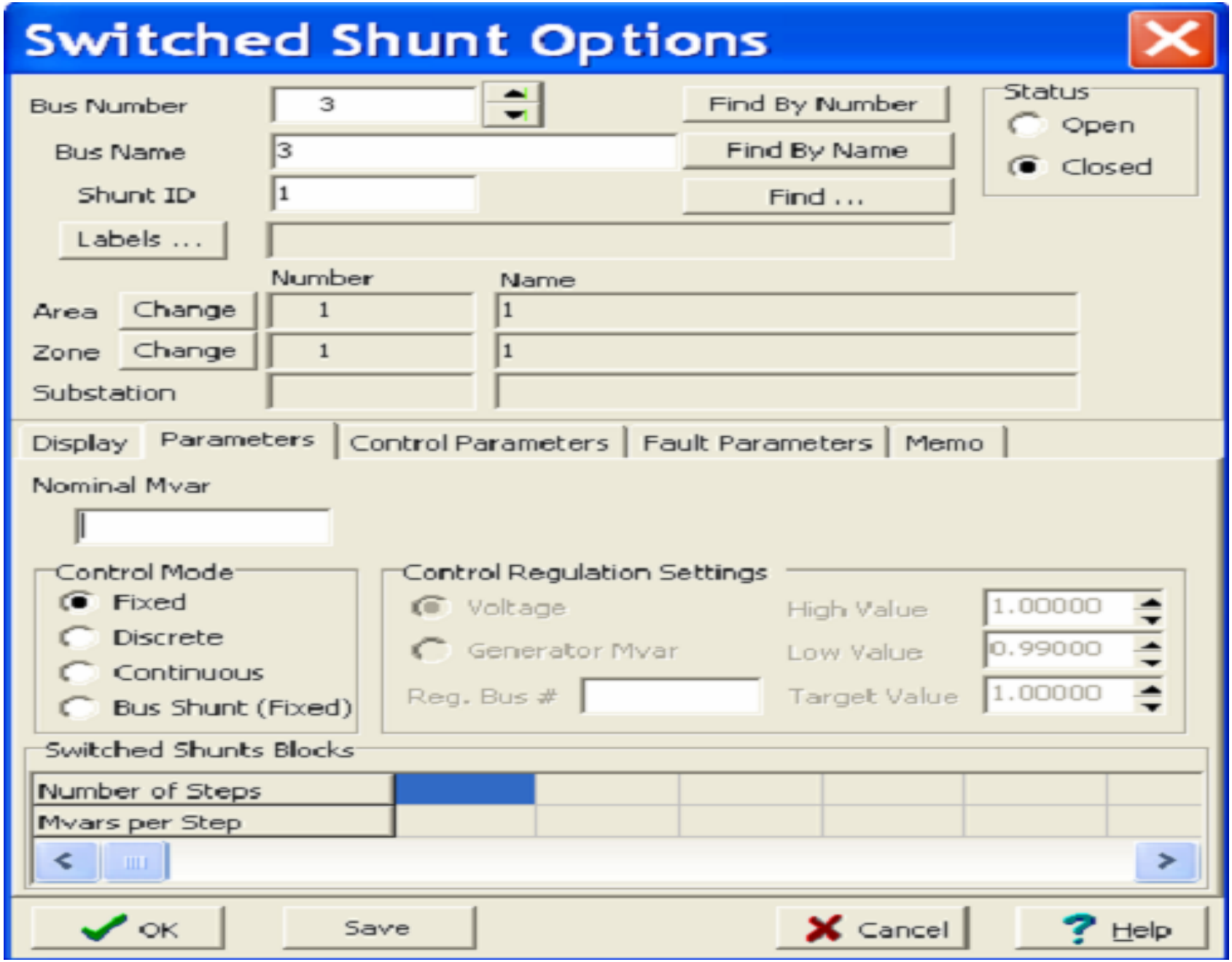
(D) INSERTING A TRANSFORMER



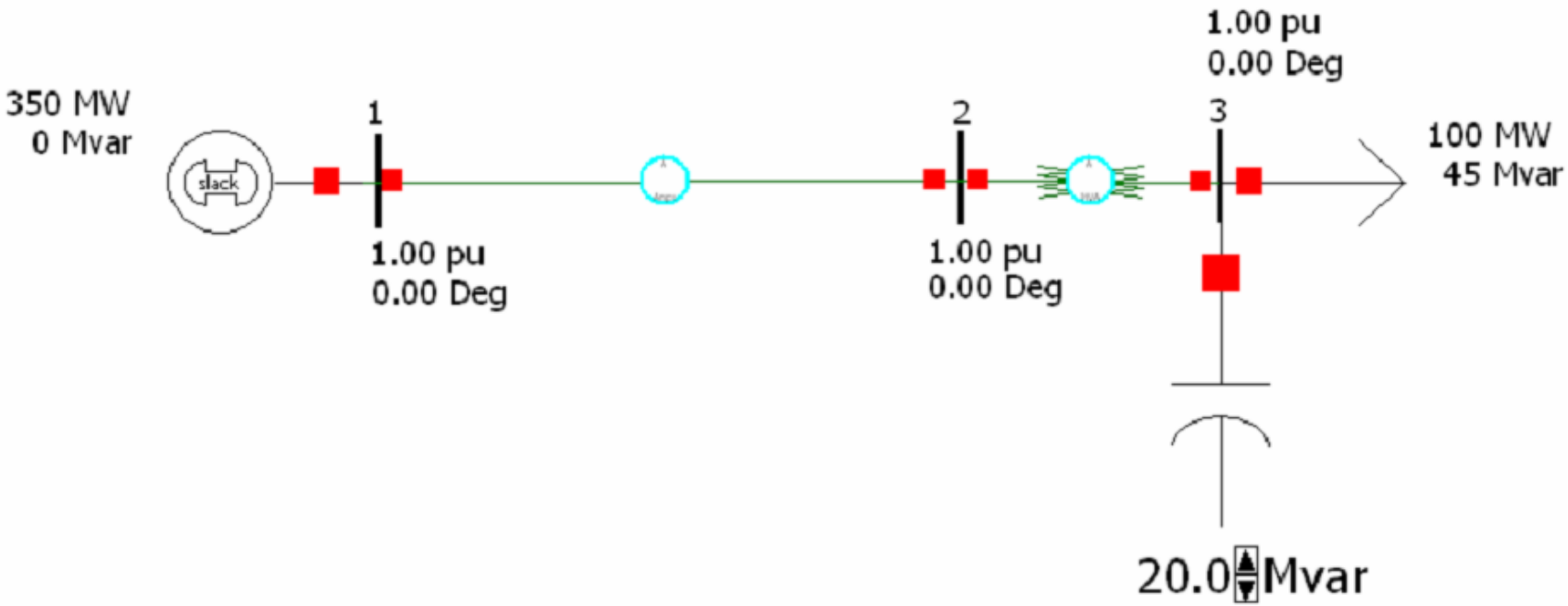
(E) INSERTING A LOAD



(F) INSERTING A SHUNT COMPONENT

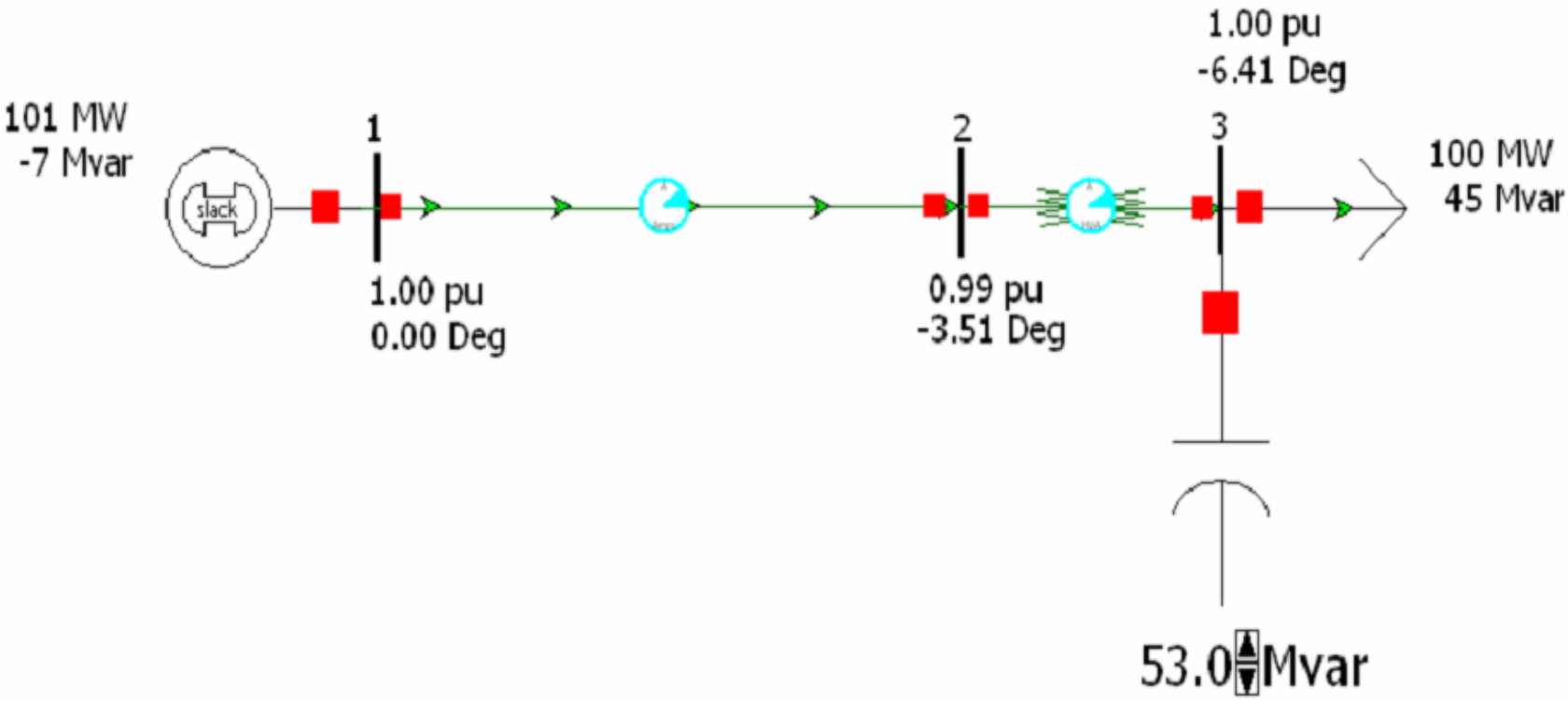


THE FINAL ONE LINE DIAGRAM SHOULD LOOK LIKE THE DIAGRAM BELOW:



3-RUNNING A CASE

In order to simulate the case that we have designed, we select the Run Mode from the toolbar below the menu. Select Simulation - Solve and Animate.



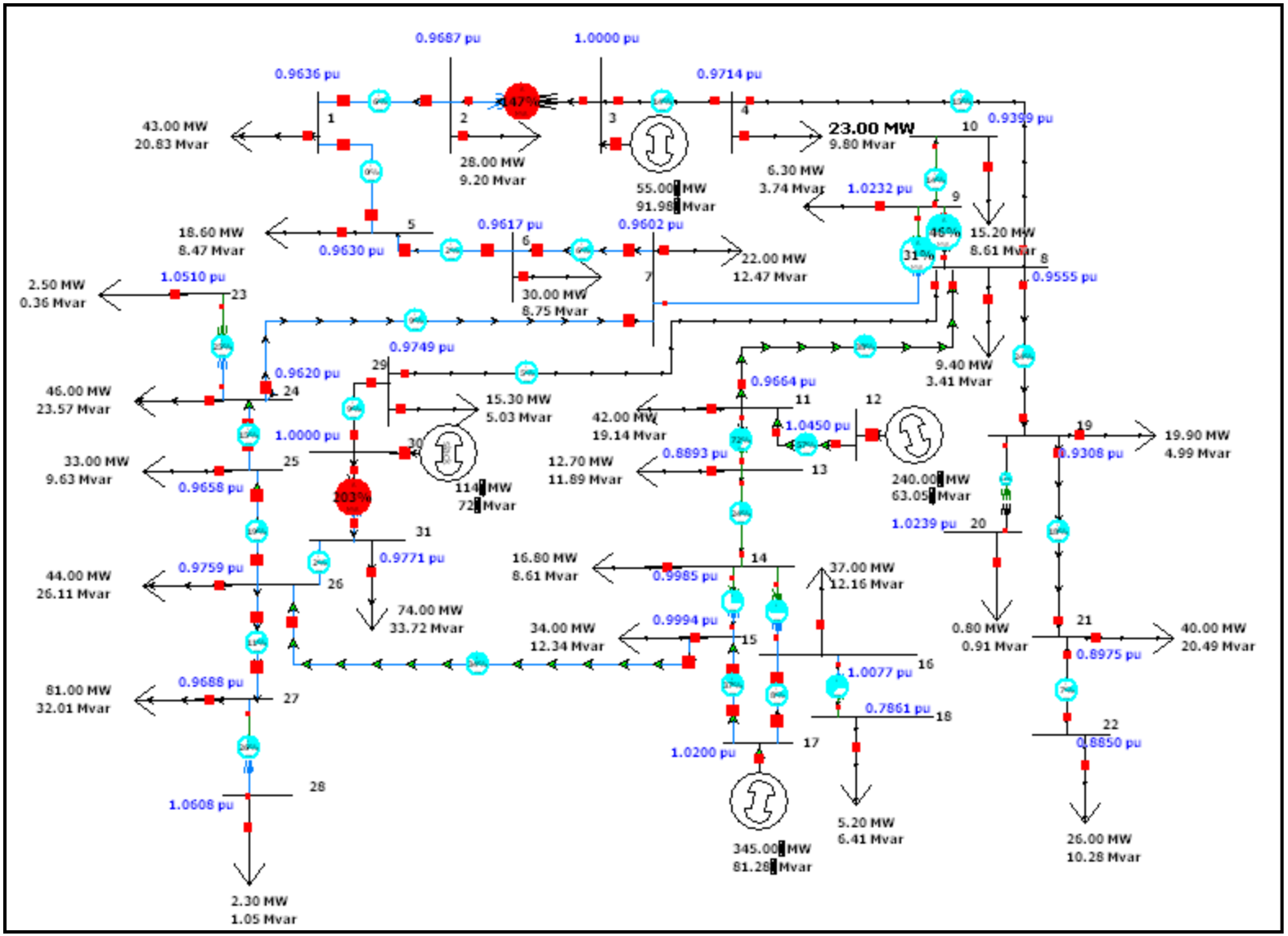
CALCULATED LINE PARAMETERS (PER UNIT SYSTEM)

NO	FROM	TO	KV Rating	Total MVA Rating	Tower Type	Length (km)	ZB (ohm)	B base	XL (pu)	Xc (pu)	R Line (pu)
1	**13**	**14**	69	120.707	69 Kv Single circuit Steel Tower	70	47.61	0.021004	0.60034	0.01332	0.103011
2	**9**	**10**	69			80	47.61	0.021004	0.60134	0.01543	0.117727
3	**3**	**4**	115	402.356	115 Kv Double circuit Steel Tower	35	132.25	0.007561	0.5555	0.036458	0.009271
4	**4**	**8**	115			25	132.25	0.007561	0.039457	0.026041	0.006622
5	**11**	**12**	115			65	132.25	0.007561	0.102589	0.067707	0.017218
6	**19**	**21**	115			50	132.25	0.007561	0.078915	0.052082	0.013244
7	**21**	**22**	115			55	132.25	0.007561	0.086806	0.057291	0.014569
8	**8**	**11**	115			60	132.25	0.007561	0.094698	0.062499	0.015893
9	**8**	**19**	115			30	132.25	0.007561	0.047349	0.031249	0.007947
10	**8**	**29**	115			55	132.25	0.007561	0.086806	0.057291	0.014569
11	**29**	**30**	115			65	132.25	0.007561	0.102589	0.067707	0.017218
12	**1**	**2**	230	804.71	230 Kv Double circuit Steel Tower	50	529	0.00189	0.021977	0.18619	0.003311
13	**1**	**5**	230			20	529	0.00189	0.008791	0.074476	0.001324
14	**5**	**6**	230			45	529	0.00189	0.01978	0.167571	0.00298
15	**6**	**7**	230			40	529	0.00189	0.017582	0.148952	0.002649
16	**7**	**24**	230			35	529	0.00189	0.015384	0.130333	0.002318
17	**24**	**25**	230			25	529	0.00189	0.010989	0.093095	0.001656
18	**25**	**26**	230			60	529	0.00189	0.026373	0.223429	0.003973
19	**26**	**27**	230			40	529	0.00189	0.017582	0.148952	0.002649
20	**26**	**15**	230			65	529	0.00189	0.028571	0.242048	0.004304
21	**15**	**17**	230			45	529	0.00189	0.01978	0.167571	0.00298
22	**17**	**16**	230			70	529	0.00189	0.030768	0.260667	0.004635
23	**26**	**31**	230			55	529	0.00189	0.024175	0.20481	0.003642

TRANSFORMER SELECTION

FROM BUS	TO BUS	FROM (KV)	TO (KV)	MVA RATING	X (pu)	X (pu new)
2	3	230	115	50	0.17	0.34
8	9	115	69	50	0.115	0.23
7	9	230	69	50	0.1525	0.305
19	20	115	69	10	0.115	1.15
16	18	230	69	15	0.1525	1.016666667
11	13	115	69	50	0.115	0.23
27	28	230	69	10	0.1525	1.525
23	24	69	230	10	0.1525	1.525
30	31	115	230	50	0.17	0.34
14	15	69	230	50	0.1525	0.305
14	16	69	230	50	0.1525	0.305

POWER FLOW SIMULATION



HIGH/LOW BUS VOLTAGES

Number	Name	Area Name	Nom kV	PU Volt	Volt (kV)	Angle (Deg)	Load MW	Load Mvar
1	1	1	230	0.96364	221.637	-110.7	43	20.83
2	2	1	230	0.96869	222.798	-110.14	28	9.2
3	3	1	115	1	115	-94.45		
4	4	1	115	0.97138	111.709	-93.6	23	9.8
5	5	1	230	0.96302	221.495	-110.69	18.6	8.47
6	6	1	230	0.96166	221.182	-110.46	30	8.75
7	7	1	230	0.96025	220.857	-109.91	22	12.47
8	8	1	115	0.95553	109.886	-92.44	9.4	3.41
9	9	1	69	1.02322	70.602	-109.73	6.3	3.74
10	10	1	69	0.93992	64.854	-115.51	15.2	8.61
11	11	1	115	0.96639	111.135	-83.43	42	19.14
12	12	1	115	1.045	120.175	-69.99		
13	13	1	69	0.88925	61.358	-89.52	12.7	11.89
14	14	1	69	0.99845	68.893	-99.92	16.8	8.61
15	15	1	230	0.99936	229.853	-101.64	34	12.34
16	16	1	230	1.00767	231.764	-99.14	37	12.16
17	17	1	230	1.02	234.6	-98.43		
18	18	1	69	0.78615	54.244	-105.46	5.2	6.41
19	19	1	115	0.93078	107.039	-94.95	19.9	4.99
20	20	1	69	1.02394	70.652	-95.45	0.8	0.91
21	21	1	115	0.8975	103.212	-98.3	40	20.49
22	22	1	115	0.88501	101.776	-99.85	26	10.28
23	23	1	69	1.05098	72.517	-111.63	2.5	0.36
24	24	1	230	0.96201	221.262	-109.25	46	23.57
25	25	1	230	0.96581	222.136	-108.47	33	9.63
26	26	1	230	0.97593	224.464	-106.07	44	26.11
27	27	1	230	0.96879	222.822	-106.92	81	32.01
28	28	1	69	1.06083	73.198	-108.68	2.3	1.05
29	29	1	115	0.97493	112.117	-91.93	15.3	5.03
30	30	1	115	1	115	-90.42		
31	31	1	230	0.97708	224.729	-105.91	74	33.72

HIGH TRANSFORMER RATING

From Number	To Number	MW From	Mvar From	MVA From	Lim MVA	% of MVA Limit (Max)	MW Loss	Mvar Loss
1	2	-43.6	-24	49.8	805	6.2	0.08	-16.87
1	5	0.6	3.2	3.2	805	1.3	0	-6.91
2	3	-71.7	-16.3	73.5	50	163.2	0	22.63
3	4	-16.7	53	55.6	402	14.3	0.3	-1.73
4	8	-40	44.9	60.2	402	15.2	0.26	-0.86
5	6	-18	1.6	18.1	805	3.1	0.01	-15.43
6	7	-48	8.3	48.7	805	6.5	0.07	-13.27
7	9	-1.1	15.3	15.3	50	30.7	0	0.63
7	24	-69	-6.2	69.3	805	8.6	0.12	-11.24
9	8	-23	1.4	23	50	47.3	0	7.04
11	8	152.2	-5.4	152.3	402	37.9	3.94	17.73
8	19	88.5	35.5	95.3	402	23.7	0.8	1.98
29	8	12.9	16.9	21.3	402	6.3	0.08	-4.83
10	9	-15.2	-8.6	17.5	121	15.1	0.39	0.87
11	12	-230.2	-11.6	230.5	402	61.7	9.79	51.44
11	13	36	-2.2	36.1	50	73	0	3.87
13	14	23.3	-17.9	29.4	121	26.6	1.1	5.36
14	15	9.6	-7.9	12.4	50	25.5	0	0.5
14	16	-4.2	-24	24.4	50	52.8	0	2.1
15	17	-295.8	-60	301.8	805	37.8	2.69	0.79
26	15	-268.1	-41	271.2	805	34.1	3.28	-1.78
16	17	-46.4	-46.3	65.6	805	8.1	0.15	-25.81
16	18	5.2	8.1	9.6	15	64.1	0	1.68
19	20	0.8	0.9	1.2	10	12.2	0	0.02
19	21	67	27.6	72.4	402	18	0.82	0.54
21	22	26.1	6.5	26.9	402	7	0.14	-3.73
23	24	-2.5	-0.4	2.5	10	25.4	0	0.11
24	25	-117.6	-19	119.1	805	14.8	0.25	-6.98
25	26	-150.9	-21.6	152.4	805	18.9	0.97	-14.58
26	27	83.5	20.5	86	805	11.1	0.22	-12.65
31	26	11.3	-6.8	13.2	805	2.1	0.01	-19.5
27	28	2.3	1.1	2.6	10	25.7	0	0.09
29	30	-28.2	-22	35.7	402	8.9	0.21	-5.37
30	31	85.3	55.4	101.7	50	203.4	0	28.49

CORRECTION TO POWER FLOW

- Installation of shunt capacitor – to increase the bus voltage
- Installation of shunt reactor – to decrease the bus voltage
- Addition of transformer to increase the total MVA rating

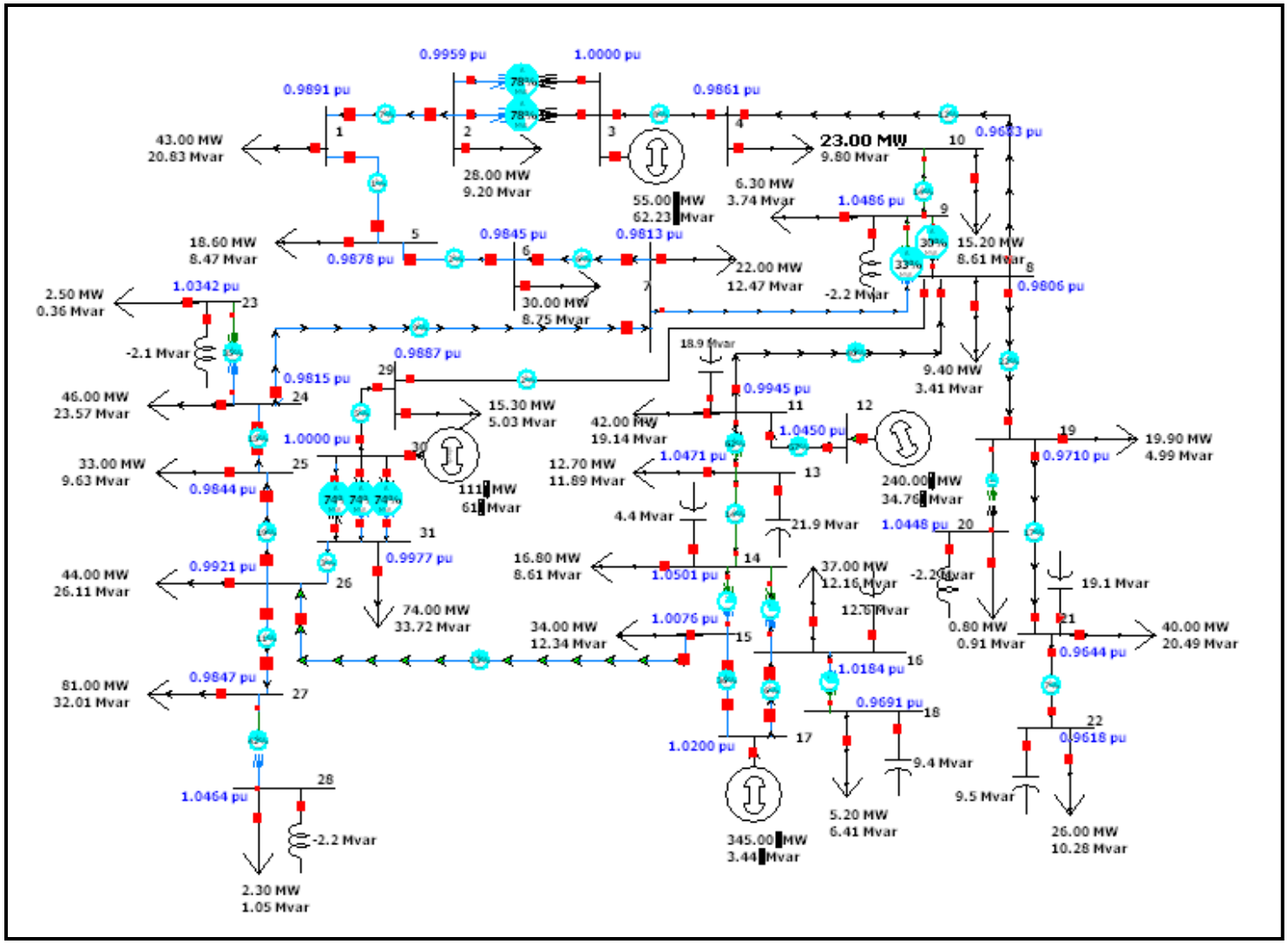
CORRECTION DETAILS

Compensation Made

Bus	Nominal Voltage (kV)	Compensation Type	Value (MVAr)
9	69	Reactor	2.20
11	115	Capbank	18.90
13	69	Capbank	21.90
14	69	Capbank	4.40
16	230	Capbank	12.60
18	69	Capbank	9.40
20	69	Reactor	2.20
21	115	Capbank	19.10
22	115	Capbank	9.50
23	69	Reactor	2.10
26	230	Reactor	2.20

Bus	Nominal Voltage (kV)	Existing (MVA)	Correction (MVA)
2 - 3	115/230	1 x 50	2 x 50
30-31	115/230	1 x 50	3 x 50

POWER FLOW CORRECTION



BUS VOLTAGE AFTER CORRECTION

Number	Name	Area Name	Nom kV	PU Volt	Volt (kV)	Angle (Deg)	Load MW	Load Mvar
1	1	1	230	0.98914	227.502	-101.25	43	20.83
2	2	1	230	0.99589	229.056	-100.7	28	9.2
3	3	1	115	1	115	-93.01		
4	4	1	115	0.98606	113.397	-92.23	23	9.8
5	5	1	230	0.98775	227.183	-101.26	18.6	8.47
6	6	1	230	0.98452	226.44	-101.05	30	8.75
7	7	1	230	0.98133	225.706	-100.54	22	12.47
8	8	1	115	0.98058	112.766	-91.14	9.4	3.41
9	9	1	69	1.04859	72.353	-101.62	6.3	3.74
10	10	1	69	0.96829	66.812	-107.1	15.2	8.61
11	11	1	115	0.99449	114.367	-82.23	42	19.14
12	12	1	115	1.045	120.175	-68.9		
13	13	1	69	1.04709	72.249	-85.84	12.7	11.89
14	14	1	69	1.05008	72.455	-91.23	16.8	8.61
15	15	1	230	1.00764	231.756	-92.34	34	12.34
16	16	1	230	1.01837	234.225	-89.97	37	12.16
17	17	1	230	1.02	234.6	-89.12		
18	18	1	69	0.96908	66.867	-95.04	5.2	6.41
19	19	1	115	0.97099	111.664	-93.62	19.9	4.99
20	20	1	69	1.0448	72.091	-94.09	0.8	0.91
21	21	1	115	0.96437	110.903	-96.85	40	20.49
22	22	1	115	0.96184	110.612	-98.26	26	10.28
23	23	1	69	1.03417	71.358	-102.21	2.5	0.36
24	24	1	230	0.98153	225.752	-99.85	46	23.57
25	25	1	230	0.98438	226.407	-99.05	33	9.63
26	26	1	230	0.99211	228.186	-96.64	44	26.11
27	27	1	230	0.98472	226.486	-97.45	81	32.01
28	28	1	69	1.0464	72.202	-99.21	2.3	1.05
29	29	1	115	0.98872	113.703	-91.23	15.3	5.03
30	30	1	115	1	115	-90.42		
31	31	1	230	0.99772	229.474	-96.37	74	33.72

LINE & TRANSFORMER RATING

From Number	To Number	Circuit	MW From	Mvar From	MVA From	Lim MVA	% of MVA	MW Loss	Mvar Loss
1	2	2	-46.6	-32.3	56.6	805	7	0.09	-17.73
1	5	2	3.6	11.4	12	805	2.4	0	-7.25
2	**3**	**1**	**-37.3**	**-11.9**	**39.2**	**50**	**82.6**	**0**	**5.8**
2	**3**	**2**	**-37.3**	**-11.9**	**39.2**	**50**	**82.6**	**0**	**5.8**
3	4	2	-19.7	26.9	33.3	402	8.9	0.11	-2.93
4	8	2	-42.8	20	47.2	402	12	0.16	-1.59
5	6	2	-15	10.2	18.2	805	3.8	0.02	-16.18
6	7	2	-45.1	17.7	48.4	805	6.8	0.07	-13.91
7	9	1	7.1	15	16.6	50	33.2	0	0.71
7	24	2	-74.2	4.1	74.3	805	9.4	0.14	-11.66
9	8	1	-14.8	-0.9	14.8	50	30.5	0	2.78
11	8	2	159.5	-2.8	159.5	402	39.7	4.09	18.27
8	19	2	88.1	5.4	88.2	402	22	0.65	0.87
29	8	2	-0.2	6.5	6.5	402	3	0.01	-5.48
10	9	1	-15.2	-8.6	17.5	121	15	0.37	0.65
11	12	2	-230.7	13.7	231.1	402	60.3	9.32	48.46
11	13	1	29.2	-11.1	31.2	50	64.1	0	2.15
13	14	1	16.5	-3.2	16.8	121	13.9	0.26	0.1
14	15	1	6.6	5.7	8.7	50	17.4	0	0.22
14	16	1	-7.2	-13.2	15	50	31.4	0	0.72
15	17	2	-293	-19.1	293.6	805	36.8	2.52	-0.46
26	15	2	-262.6	-16.5	263.1	805	33	3.01	-4.16
16	17	2	-49.4	-11.1	50.6	805	6.4	0.11	-26.35
16	18	1	5.2	-2.4	5.7	15	40	0	0.58
19	20	1	0.8	3.2	3.3	10	33	0	0.11
19	21	2	66.7	-3.6	66.8	402	16.6	0.63	-1.15
21	22	2	26.1	-3.9	26.4	402	6.6	0.11	-4.68
23	24	1	-2.5	-2.5	3.5	10	36.9	0	0.22
24	25	2	-122.8	-10.5	123.3	805	15.3	0.26	-7.27
25	26	2	-156.1	-12.9	156.6	805	19.5	1	-15.18
26	27	2	83.5	22.3	86.4	805	11.2	0.21	-13.15
31	26	2	22.1	9.6	24.1	805	4.6	0.03	-20.06
27	28	1	2.3	3.5	4.2	10	41.5	0	0.22
29	30	2	-15.1	-11.5	19	402	4.7	0.05	-6.38
30	**31**	**1**	**32**	**18.7**	**37.1**	**50**	**74.1**	**0**	**4.22**
30	**31**	**2**	**32**	**18.7**	**37.1**	**50**	**74.1**	**0**	**4.22**
30	**31**	**3**	**32**	**18.7**	**37.1**	**50**	**74.1**	**0**	**4.22**

CONCLUSION

- Power world software is able to simulate the unstable condition of the power flow for designed networks.
- The approach by adding shunt capacitor and shunt reactor, the low/high bus voltage can be maintained to nominal bus voltage hence the designed networks is stable.
- The fundamental concept of power system analysis and design give the better understanding of the concept by modeling the actual system.