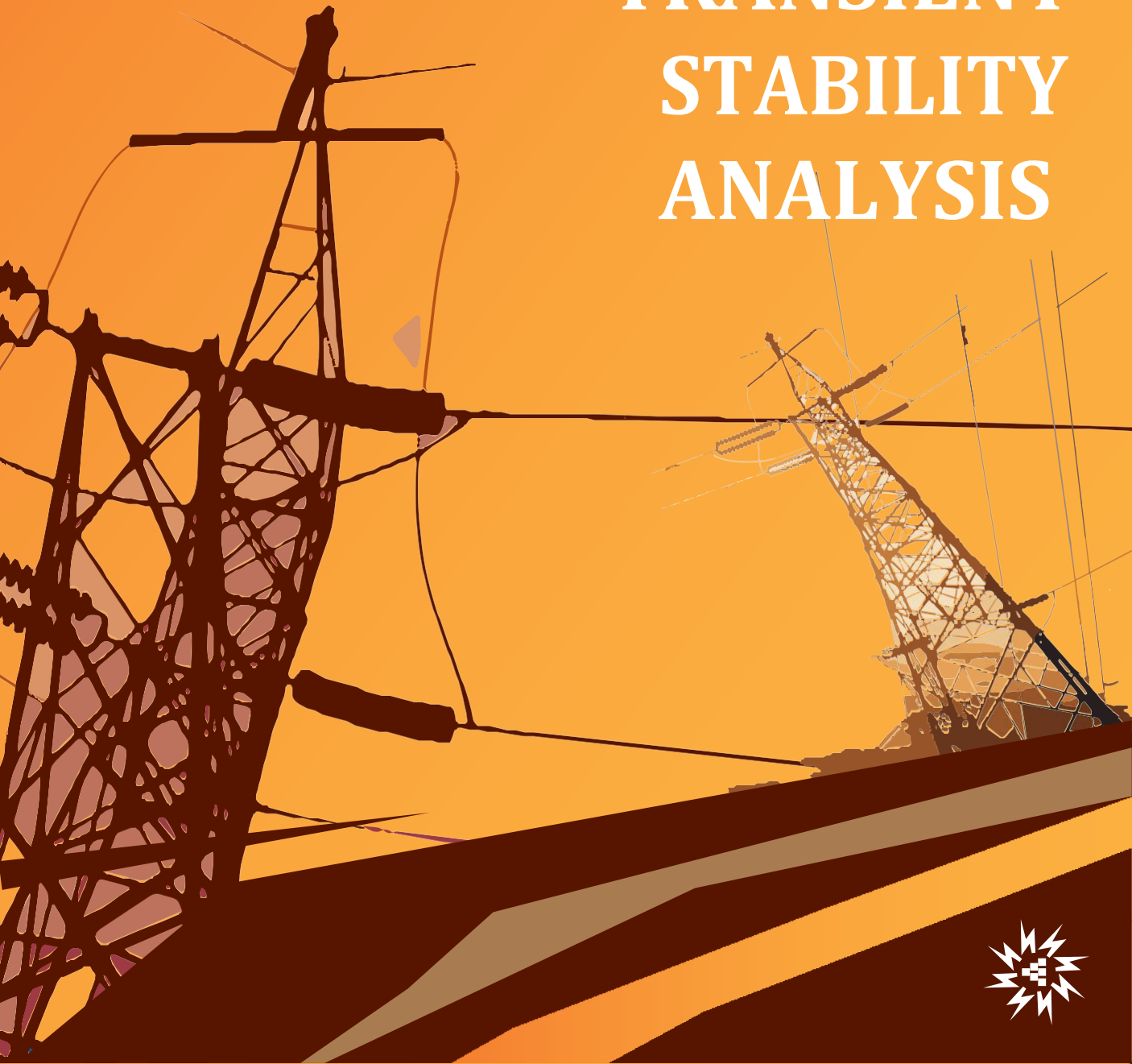
User Manual

PSCT | Protection Analytic tool

TRANSIENT STABILITY ANALYSIS



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1. Introduction

POWERTRS is designed to perform the transient stability analysis for the given power system. The transient behavior of a power system, resulting from major disturbances such as a fault followed by switching operations, sudden rejection of load or generation, etc., is referred to as Transient Stability. Transient stability solution is obtained in time domain. Transient stability simulation studies are carried out to study these phenomena and the results enable to plan and coordinate the protection and control schemes efficiently. Critical clearing times of circuit breakers can be computed and protection zones of distance relays during transient swings can be adjusted. Proper restoration/islanding schemes can be suitably designed. Compared to load flow and short circuit studies, transient stability studies are more complex since they involve the electromechanical dynamics of rotating machines and their associated controls viz., excitation and governor systems. The period of investigation varies from fraction of a second when first swing stability is being determined, to over several seconds when multiple swing stability is to be examined.

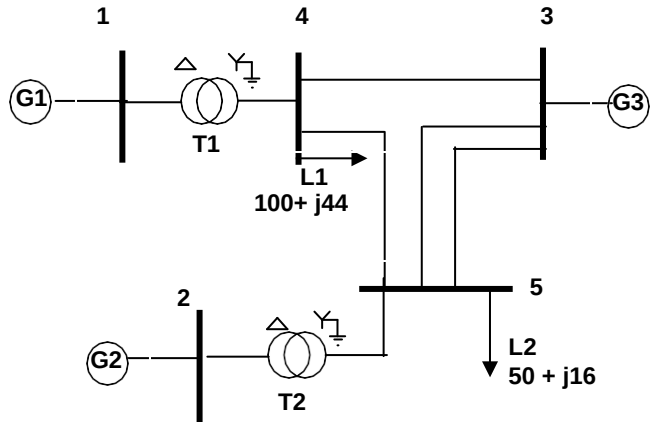
The program requires the base case load flow solution to establish the initial conditions. The program uses fast decoupled load flow method for the network solution, and implicit trapezoidal rule of integration method for the solution of differential equation representing the dynamics of machines, controllers, etc.

The program input data is through an ASCII file, the format of which is described in chapter 3. In chapter 5, case studies are given, wherein the data file preparation for typical transient stability studies are discussed along with the analysis of the results.

2. HOW TO SOLVE TRANSIENT STABILITY

Example: Transient Stability Studies

Figure shows a single line diagram of a 5-bus system with three generating units, four lines and two transformers and two loads. Per-unit transmission line series impedances and shunt susceptances are given on 100 MVA base, generator's transient impedance and transformer leakage reactances are given in the accompanying table.



Values given are on 100 MVA Base. Frequency = 60 Hz.

If a 3 - phase fault occurs on line 4 - 5 near bus 4 and the fault is cleared by simultaneously opening the circuit breaker at the ends of the line 4-5 at 0.225 seconds (fault clearing time), plot the swing curve and comment on stability of machine 1 and machine 2

Transmission Line Details		
Bus - code	**Impedance**	**Line charging**
p-q	**Zpq**	**Y'pq/2**
3 - 4	0.007 + j0.04	j0.041
3 -5(1)	0.008 + j0.047	j0.049
3 -5 (2)	0.008 + j0.047	j0.049
4 - 5	0.018 + j0.110	j0.113

Transformer Details:

T1 = 20/230 kV 400 MVA with Leakage reactance = 0.022
p.u T2 = 18/230 kV 250 MVA with Leakage reactance =
0.040 p.u

Generator Details:

G1 = 400 MVA, 20 kV, X'd = 0.067 pu, H = 11.2 MJ / MVA
G2 = 250 MVA, 18 kV, X'd = 0.10 pu, H = 8.0 MJ / MVA
G3 = 1000 MVA, 230 kV, X'd = 0.00001 p.u, H = 1000 MJ / MVA (Infinite Bus Modeling)

Generation and Load Details					
Bus Code 'p'	Generation		Load		Specified Voltage
	MW	Mvar	MW	Mvar	
1	350	71.2	0	0	1.03
2	185	29.8	0	0	1.02
3	800	0	0	0	1.0
4	0	0	100	44	Unknown
5	0	0	50	16	Unknown

Interpretation according to MiP-PSCT:

- Observe transmission line details. You will find lines connected to nodes 3 and 5 have common parameters.
- No of transmission line libraries = 3
- No of generator libraries = 3 (Three different generators)
- No. of transformer libraries = 2 (two different transformers)

Procedure to enter the data for performing studies, using MiP-

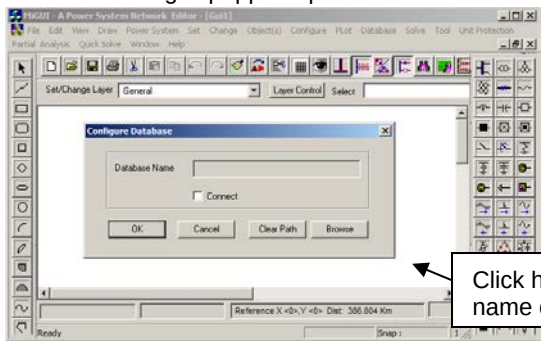
PSCT. Following are the two methods.

1. Drawing single line diagram and entering corresponding data in database manager separately.
2. Drawing single line diagram and entering the data simultaneously.

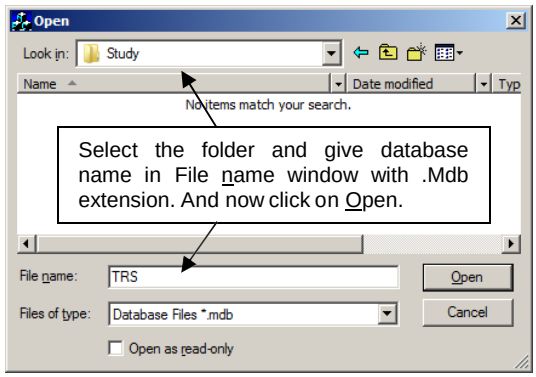
Method 2 follows:

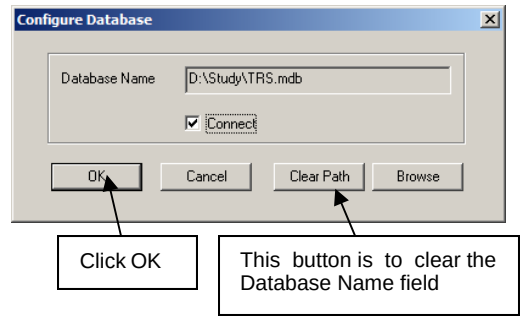
MiP-PSCT - Database Configuration

Open power system network editor. Select menu option **Database → Configure**. Configure Database dialog is popped up as shown below. Click **Browse** button.

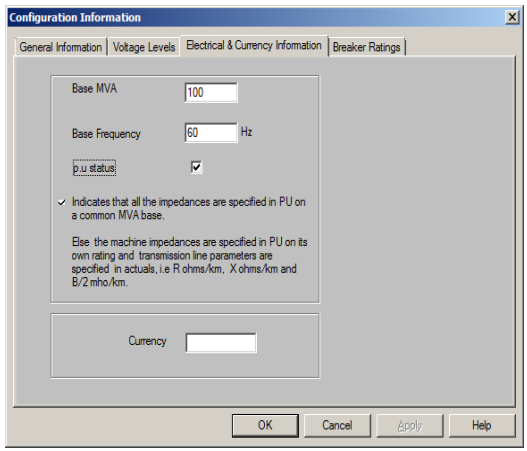


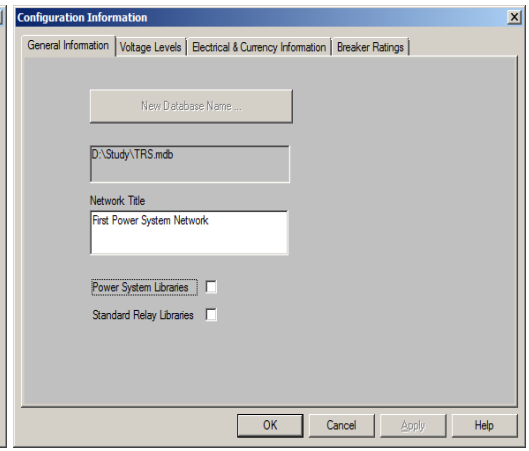
Open dialog box is popped up as shown below, where you are going to browse the desired directory and specify the name of the database to be associated with the single line diagram. Click **Open** button after entering the desired database name. **Configure Database** dialog will appear with path chosen.





Click **OK** button on the **Configure Database** dialog. The dialog shown below appears.



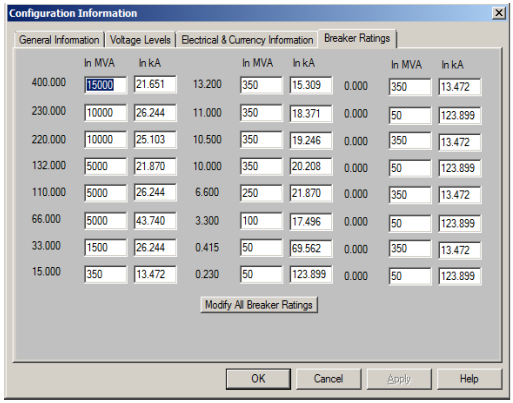


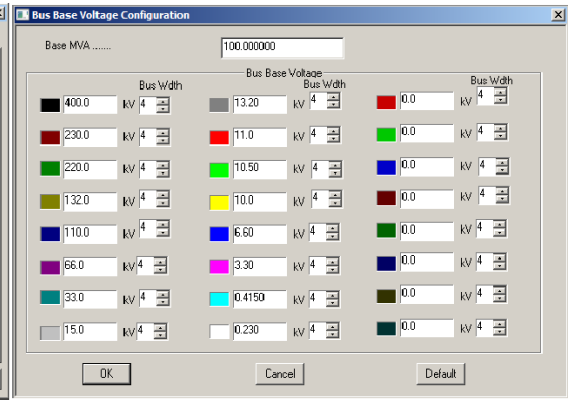
Uncheck the Power System Libraries and Standard Relay Libraries. For this example these standard libraries are not needed, because all the data is given on pu for power system libraries (like transformer, line\cable, generator), and relay libraries are required only for relay co-ordination studies. If Libraries are selected, standard libraries will be loaded into the database. Click **Electrical Information** tab. Since the impedances are given on 100 MVA base check the

pu status as shown. Enter the Base MVA and Base frequency as shown above. Click on Breaker Ratings button to give breaker ratings. Click **OK** button to create the database to return to Network Editor.

Bus Base Voltage Configuration

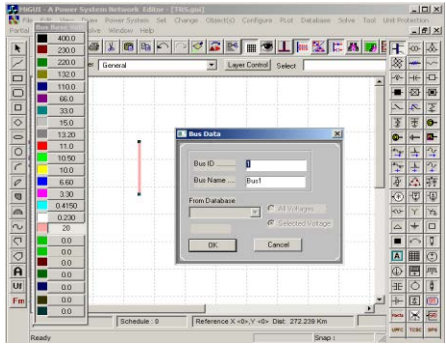
In the network editor, configure the base voltages for the single line diagram. Select menu option **Configure→Base voltage**. The dialog shown below appears. If necessary change the **Base-voltages, color, Bus width** and click **OK.**

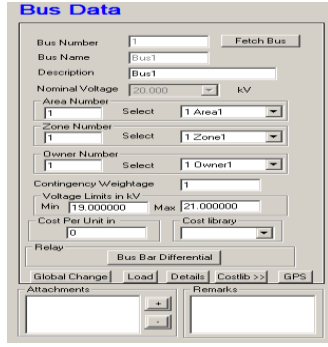




Procedure to Draw First Element - Bus

Click on **Bus** icon provided on power system tool bar. Draw a bus and a dialog appears prompting to give the Bus ID and Bus Name. Click OK. Database manager with corresponding **Bus Data** form will appear. Modify the area number, zone number and contingency weightage data if it is other than the default values. If this data is not furnished, keep the default values. Usually the minimum and maximum voltage ratings are ± 5% of the rated voltage. If these ratings are different, modify these fields. Otherwise keep the default values.



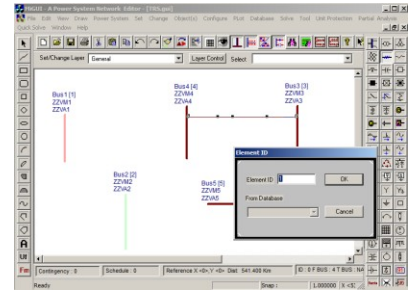


Bus description field can be effectively used if the bus name is more than 8 characters. If bus name is more than 8 characters, then a short name is given in the bus name field and the bus description field can be used to abbreviate the bus name. For example let us say the bus name is **Northeast**, then bus name can be given as **NE** and the bus description field can be **North East.** After entering data click **Save** 🖫**,** which invokes **Network Editor**. Follow the same procedure for remaining buses. Following table gives the data for other buses.

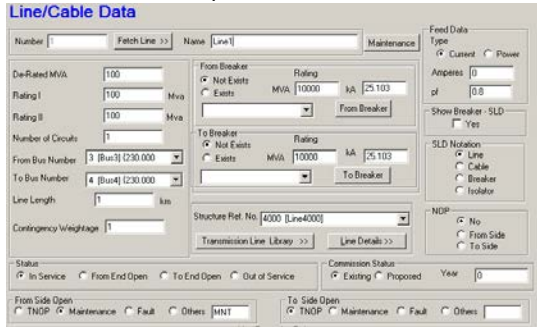
Bus Data					
Bus Number	1	2	3	4	5
Bus Name	Bus-1	Bus-2	Bus-3	Bus-4	Bus-5
Nominal voltage	20	18	230	230	230
Area number	1	1	1	1	1
Zone number	1	1	1	1	1
Contingency weightage	1	1	1	1	1

Procedure to Draw Transmission Line

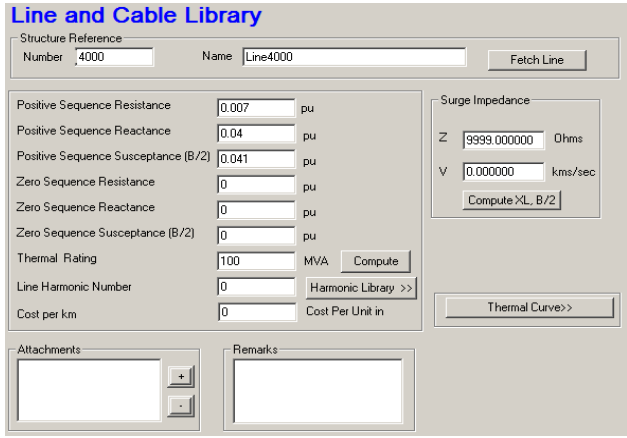
Click on **Transmission Line** icon provided on power system tool bar. To draw the line click in between two buses and to connect to the from bus double clicking LMB (Left Mouse Button) on the **From Bus** and join it to another bus by double clicking the mouse button on the **To Bus**. **Element ID** dialog will appear.



Enter **Element ID** number and click OK. Database manager with corresponding **Line\Cable Data** form will be open. Enter the details of that line as shown below.



Enter **Structure Ref No.** as **4000** and click on **Transmission Line Library >>** button. **Line & Cable Library** form will appear. Enter transmission line library data in the form as shown below for Line3-4.



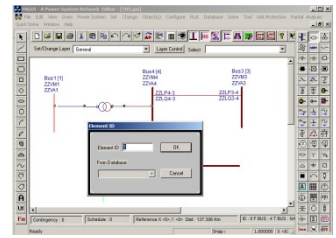
Enter other line libraries and element data details as per the following tables:

Transmission Line Libraries			
Structure Ref. No.	4000	4001	4002
Structure Ref. Name	Line-3-4	Line-3-5	Line-4-5
Positive Sequence Resistance	0.007	0.008	0.018
Positive Sequence Reactance	0.040	0.047	0.110
Positive Sequence Susceptance	0.041	0.049	0.113
Thermal Rating	100	100	100

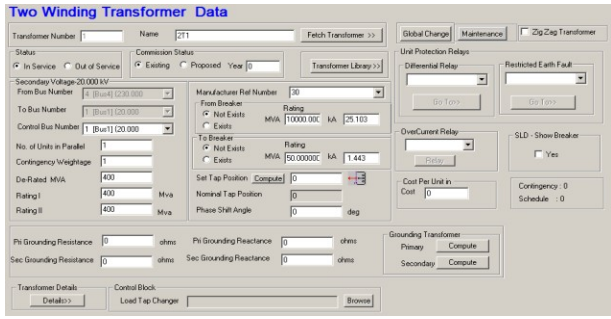
Transmission Line Element Data Details				
Line Number	1	2	3	4
Line Name	Line3-4	Line3-5	Line4-5	Line3-5
De-Rated MVA	100	100	100	100
No. Of Circuits	1	1	1	1
From Bus No.	4	3	4	3
To Bus No.	3	5	5	5
Line Length	1	1	1	1
From Breaker Rating	5000	5000	5000	5000
To Breaker Rating	5000	5000	5000	5000
Structure Reference No.	4000	4001	4002	4001

Procedure to Draw Transformer

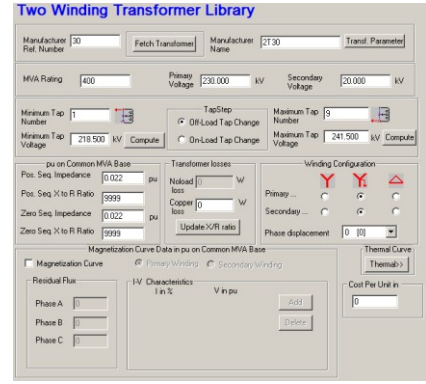
Click on **Two Winding Transformer** icon provided on power system tool bar. To draw the transformer click in between two buses and to connect to the from bus double clicking LMB (Left Mouse Button) on the **From Bus** and join it to another bus by double clicking the mouse button on the **To Bus**. The **Element ID** dialog will appear. Click OK.



Two Winding Transformer Data form will be open. Enter the **Manufacturer Ref. Number** as **30.** Enter transformer data in the form as shown below. Click on **Transformer Library >>** button.



Enter transformer library details as shown below. Click **Save** 🖫 button and close the screen. Transformer element data form will appear. Click **Save** 🖫 button, which invokes Network Editor. In the similar way enter other transformer details.

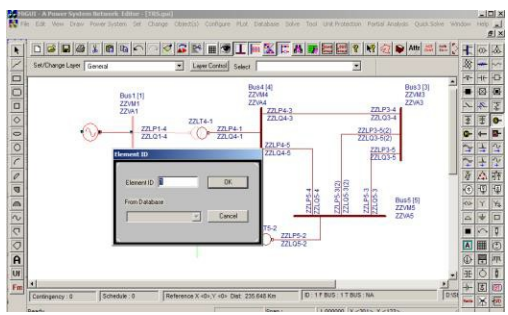


Transformer Library Detail		
Manufacturer ref. No.	30	31
Manufacturer Name	2T30	2T31
MVA Rating	400	250
Primary Voltage	230	230
Secondary Voltage	20	18
Minimum Tap	1	1
Maximum Tap	9	9
Minimum Tap Voltage	218.5 (230 * 0.95)	218.5 (230 * 0.95)
Maximum Tap Voltage	241.5 (230 * 1.05)	241.5 (230 * 1.05)
Positive Sequence Impedance	0.022	0.040
R/X Ratio	9999 (R is Negligible)	9999 (R is Negligible)

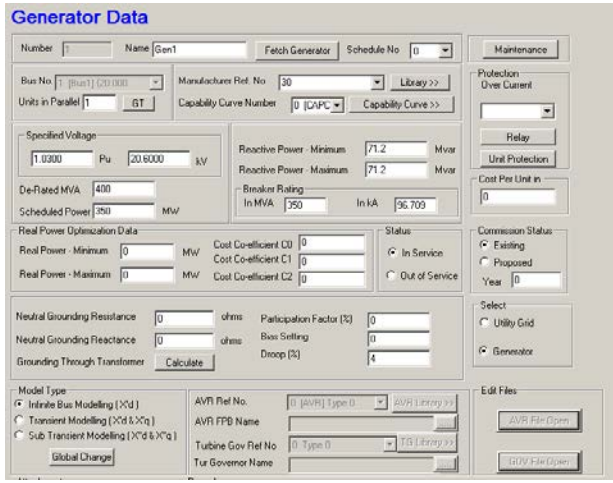
Transformer Element Detail		
Transformer Number	1	2
Transformer Name	2T1	2T2
From Bus Number	4	5
To Bus Number	1	2
Control Bus Number	1	2
Number of Units in Parallel	1	1
Manufacturer ref. Number	2T30	2T31
De Rated MVA	400	250
From Breaker Rating	5000	5000
To Breaker Rating	350	350
Nominal Tap Position	5	5

Procedure to Draw Generator

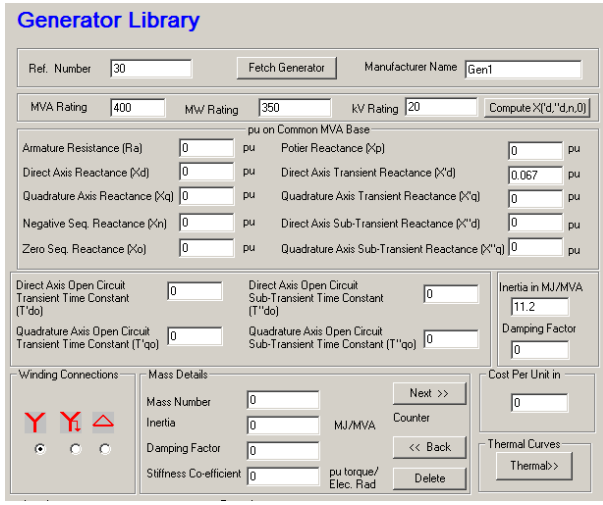
Click on **Generator** icon provided on power system tool bar. Draw the generator by clicking LMB (Left Mouse Button) on the **Bus1**. The **Element ID** dialog will appear. Click OK.



Generator Data form will be opened. Enter the **Manufacturer Reference No** as **30.** Enter generator data in the form as shown below.



Click on **Generator Library >>** button. Enter generator library details as shown below.



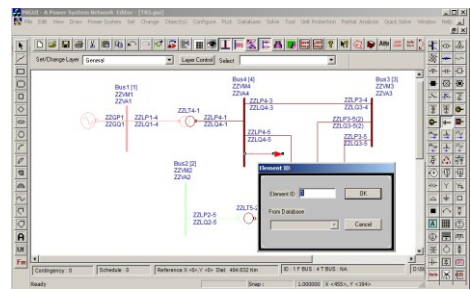
Enter other generator library and element details as per the following table.

Generator Library Details			
Reference Number	30	31	32
Manufacturer Name	BHEL-1	BHEL-2	BHEL-3
MVA Rating	400	250	1000
MW Rating	350	185	800
kV Rating	20	18	230
Ra	0	0	0
Xd	0	0	0
Xq	0	0	0
Xn	0	0	0
Xo	0	0	0
Xp	0	0	0
X'd	0.067	0.10	0.00001
X'q	0	0	0
X d	0	0	0
X q	0	0	0
Inertia MJ/MVA	11.2	8.0	1000

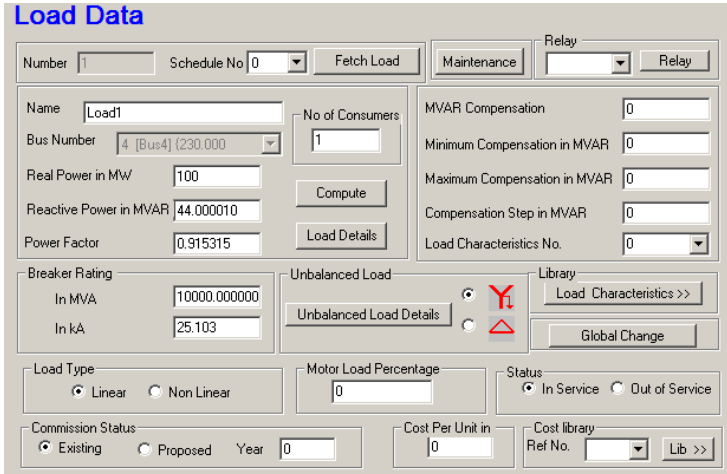
Generator Element Details			
Name	GEN-1	GEN-2	GEN-3
Bus Number	1	2	3
Manufacturer Ref. Number	30	31	32
Number of Generators in Parallel	1	1	1
Capability Curve Number	0	0	0
De-Rated MVA	400	250	1000
Specified Voltage	20.6	18.36	230
Scheduled Power	350	185	800
Reactive Power Minimum	71.2	29.8	0
Reactive Power Maximum	71.2	29.8	600
Breaker Rating	350	350	10000
Type of Modeling	Infinite	Infinite	Infinite

Procedure To Draw Load

Click on **Load** icon provided on power system tool bar. Draw the load by clicking LMB (Left Mouse Button) on the **Bus4**. The **Element ID** dialog will appear. Click **OK**.

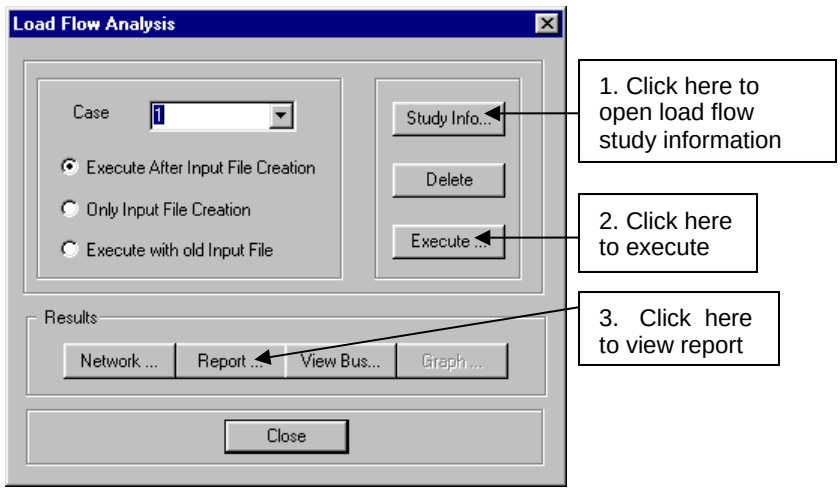


Load Data form will be opened. Enter the load details as shown below.



Connect other load (50 + j16) to bus 5.

To solve load flow studies choose menu option **Solve → Load Flow Analysis** or click **LFA** button on the toolbar, which is on the right side of the screen. Load flow analysis screen appears.



The results of load flow are shown below:

```
--------------------------------------------------------------------------------
ITERATION    MAX P BUS     MAX P    MAX Q BUS     MAX Q
    COUNT       NUMBER  PER UNIT       NUMBER  PER UNIT
---------    ---------  --------    ---------  --------
        1            1     3.500           4     1.263
        2            4     0.087           4     0.016
        3            4     0.002           4     0.000
        4            4     0.000           4     0.000
        5            4     0.000           1     0.000
        6            1     0.000           1     0.000
Number of p iterations :   3 and Number of q iterations :   5
--------------------------------------------------------------------------------
BUS VOLTAGES AND POWERS

NODE FROM       V-MAG   ANGLE        MW      MVAR        MW      MVAR      MVAR
NO.  NAME        P.U. DEGREE       GEN       GEN      LOAD      LOAD      COMP
---- --------   ------ ------   -------- --------   -------- -------- --------
   1     Bus1   1.0300   8.90    350.000    71.200      0.000    0.000    0.000
   2     Bus2   1.0200   6.39    185.000    29.800      0.000    0.000    0.000
   3     Bus3   1.0000   0.00   -380.503   -26.497      0.000    0.000    0.000  <
   4     Bus4  1.0175   4.68      0.000     0.000    100.000   44.000    0.000
   5     Bus5   1.0109   2.27      0.000     0.000     50.000   16.000    0.000
--------------------------------------------------------------------------------
NUMBER OF BUSES EXCEEDING MINIMUM VOLTAGE LIMIT (@ mark) :     0
NUMBER OF BUSES EXCEEDING MAXIMUM VOLTAGE LIMIT (# mark) :     0
NUMBER OF GENERATORS EXCEEDING MINIMUM Q LIMIT (< mark)  :     1
NUMBER OF GENERATORS EXCEEDING MAXIMUM Q LIMIT (> mark)  :     0
--------------------------------------------------------------------------------
LINE FLOWS AND LINE LOSSES

SLNO CS FROM FROM        TO TO              FORWARD             LOSS          %
        NODE NAME      NODE NAME           MW      MVAR        MW      MVAR LOADING
---- -- ---- -------- ---- -------- -------- -------- -------- -------- -------
   1  1     4       Bus4     1       Bus1  -349.988   -44.745    0.0026   26.4537
86.7#
   2  1     5       Bus5     2       Bus2  -184.999   -16.301    0.0013   13.4999
73.5$
   3  1     4       Bus4     3       Bus3   210.573    11.960    3.0157    8.8876
207.3!
   4  1     4       Bus4     5       Bus5    39.418   -11.215    0.2702  -21.5963
40.3^
   5  1     3       Bus3     5       Bus5   -86.473   -11.712    0.6019   -6.3713
87.3#
   6  1     3       Bus3     5       Bus5   -86.473   -11.712    0.6019   -6.3713
87.3#
```

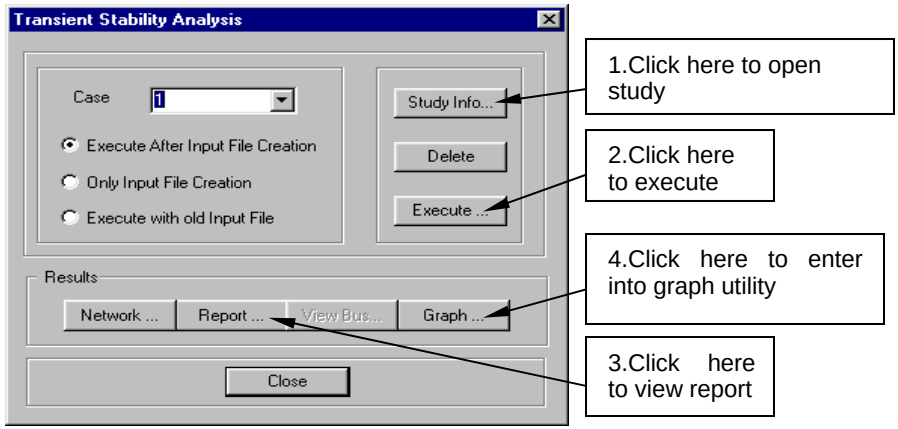
```
! NUMBER OF LINES LOADED BEYOND  125%          :     1
@ NUMBER OF LINES LOADED BETWEEN 100% AND 125% :     0
# NUMBER OF LINES LOADED BETWEEN  75% AND 100% :     3
$ NUMBER OF LINES LOADED BETWEEN  50% AND  75% :     1
^ NUMBER OF LINES LOADED BETWEEN  25% AND  50% :     1
& NUMBER OF LINES LOADED BETWEEN   1% AND  25% :     0
* NUMBER OF LINES LOADED BETWEEN   0% AND   1% :     0
--------------------------------------------------------------------------------
```

This will become the initial condition for transient stability analysis

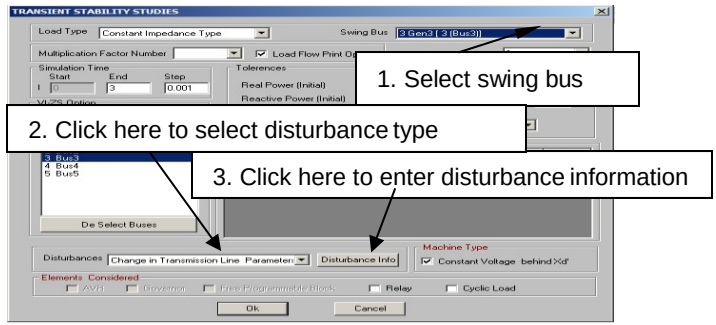
Note: You have to get the same results to conduct transient stability study.

Executing transient stability study:

Click on **Solve →Transient stability analysis**.

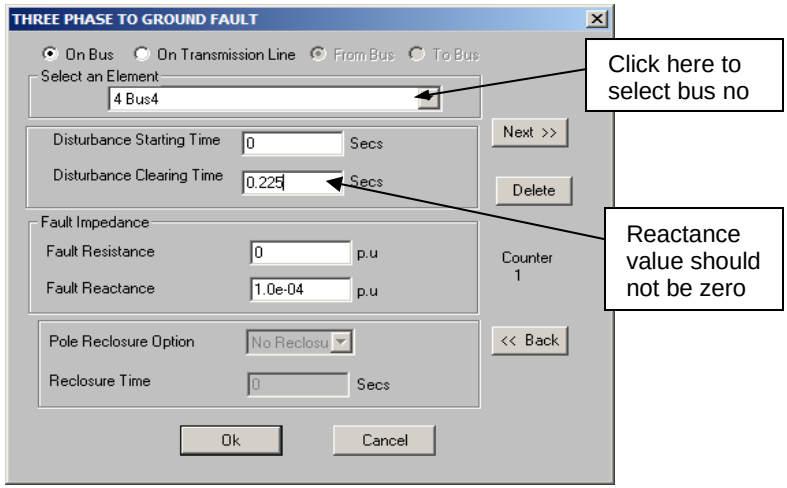


On **Transient Stability Studies** screen click on **Study Info**….button.



Enter all the details as shown:

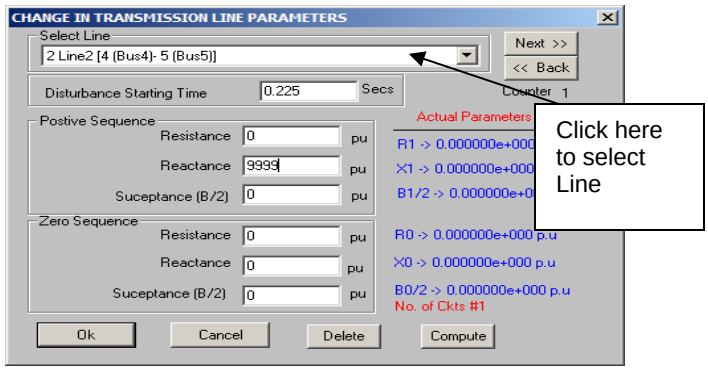
To simulate 3 phase to ground fault, select the **Disturbances** as *Three Phase To Ground Fault* from the disturbance list and click on **Disturbance Info** button to enter the fault data.



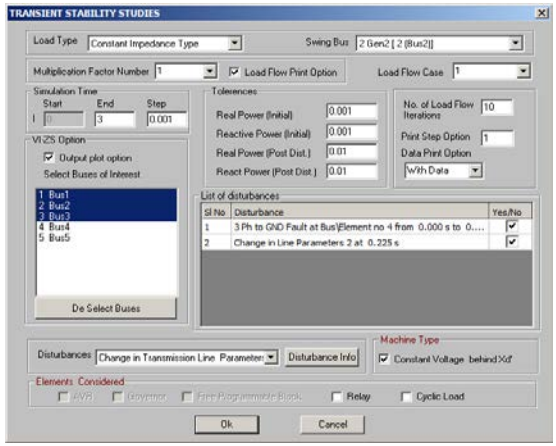
Fault is on bus 4 so select bus 4 from the Bus number list box.
Click **OK** to return to previous form.

To account the effect of opening of breaker, in the disturbance list select *Change in transmission Line Parameters* and click on **Disturbance Info** button.

In this, select line between bus 4 and bus 5. Give disturbance starting time as 0.225 secs and make positive sequence resistance as zero and reactance very high accounting for opening of the line (let us say 9999).



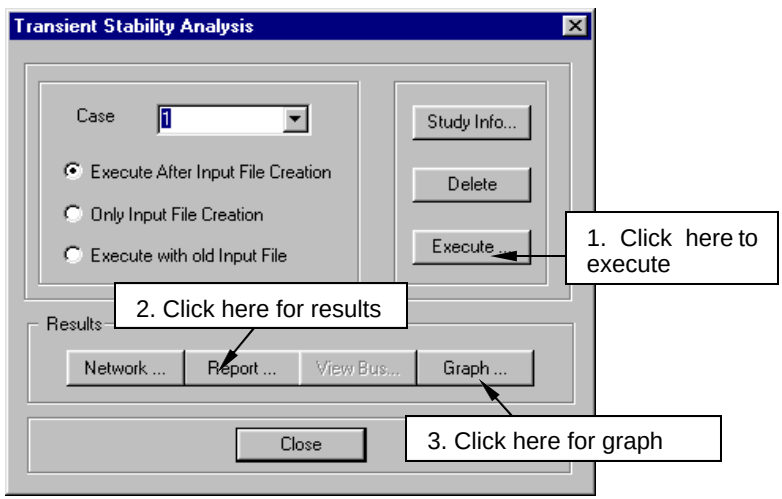
Finally you will return to the previous dialog. Here list of disturbances applied on the network are listed as shown below. Click **OK** button to return to **Solve** dialog.



On the **Solve** dialog box, click Execute button to execute transient stability study.

Results Observation:

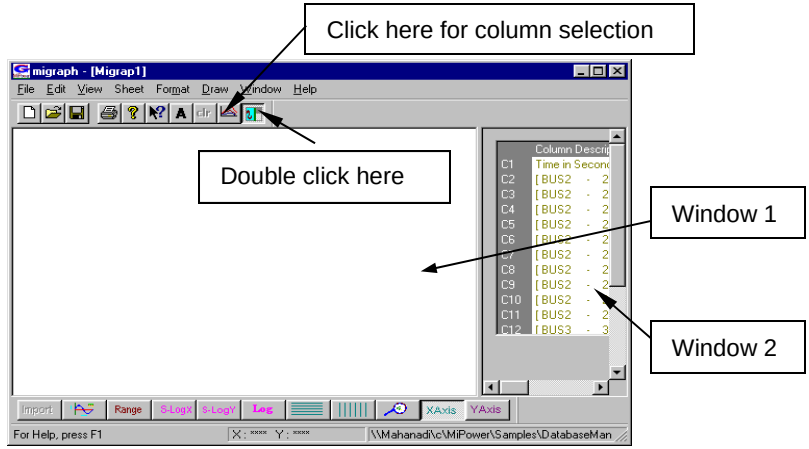
The results can be observed by clicking **Report** button. The results can be best analyzed using graph. For this click on **Graph** button.



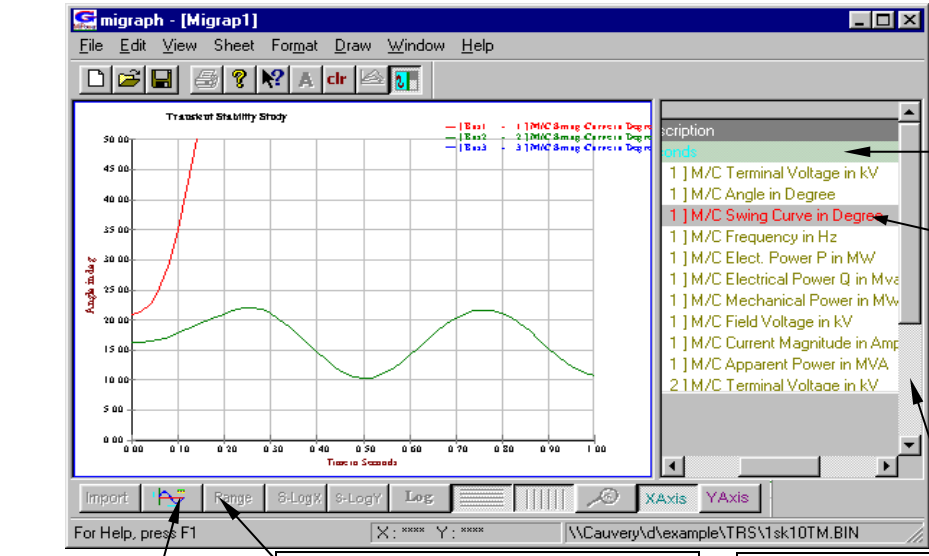
Part of Report is shown below:

```
--------------------------------------------------------------------------------
Time =   0.00000 Seconds
Intermediate results for Machines
GNo Name     Voltage Angle    Delta    Freq    Pgen    Qgen    Pmech   Efd/Slip
             pu      Degree   Degree   Hzs.    MW      MVAR    MW      pu/PU
--- -------- ------- -------- -------- ------- ------- ------- ------- --------
  1     Bus1    1.03      8.9     20.8      60     350    71.2     350      1.1
  2     Bus2    1.02     6.39     16.2      60     185    29.8     185     1.06
  3     Bus3       1        0 -0.00218      60    -381   -26.2    -381        1
--------------------------------------------------------------------------------
Maximum rotor angle difference :   20.84351 b/w buses : 3 and 1
--------------------------------------------------------------------------------
3 phase fault  0.00000    4     Bus4
--------------------------------------------------------------------------------
Time =   0.00100 Seconds
Intermediate results for Machines
GNo Name     Voltage Angle    Delta    Freq    Pgen    Qgen    Pmech   Efd/Slip
             pu      Degree   Degree   Hzs.    MW      MVAR    MW      pu/P.U.
--- -------- ------- -------- -------- ------- ------- ------- ------- --------
  1     Bus1   0.275     20.1     20.8      60    5.93     339     350      1.1
  2     Bus2   0.908     6.55     16.2      60     162     129     185     1.06
  3     Bus3       1 -0.00455  -0.0022      60     414 3.02e+003  -381        1
--------------------------------------------------------------------------------
Maximum rotor angle difference :   20.84437 b/w buses : 1 and 3
--------------------------------------------------------------------------------
```

Click Graph button on **Solve** dialog box , Graph Utility screen will open as shown below.



Graph editor will open the corresponding plot file of the study. Window 1 is used for displaying the graphs and window 2 holds the plot variables like time in seconds, swing curve of machines, machine internal angle, machine voltage, machine current etc. User has to choose plot variables in the 2nd window.



1. Double click here

2. Double click here

3. To select machine 2 swing curve scroll the window

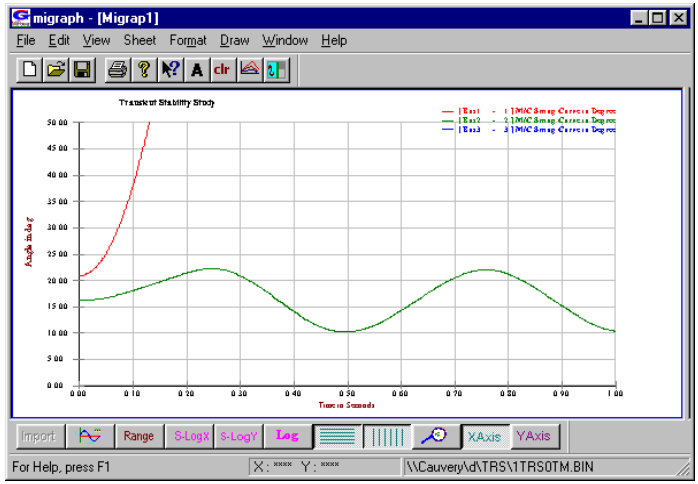
4. Click here to plot

5. Click here or click RMB for selecting proper range. Select X axis (0 to 1) and Y axis (0 to 50)

Final output is shown below

Comment: As seen from the graph

- Machine 1 turns out to be unstable and machine 2 is stable.



Exercise: For different clearing times conduct studies and observe the swing curves

Hint: Take clearing time = 0.05sec and execute transient stability.

3. INPUT FILE FORMAT

This chapter gives the input file format, which helps, in creating an input file or manipulating the input file created by integrated mode.

Input data to **POWERTRS** is through an ASCII file. If **POWERTRS** is run in the MiP-PSCT integrated environment, input file is automatically generated using the centralized database, whenever execution of **POWERTRS** is selected. The Input file format is "**1Grid0T.dat0**", where **1** represents Case Number, **Grid** – Database Name, **0** – Contingency Number, **T** – Study Code - Transient Stability, **dat** – File type – Input, **0** – Schedule Number. Results are written to file "1Grid0T.out0". Graphs files generated by the **POWERTRS** are 1Grid0TM.bin, 1Grid0TL.bin & 1Grid0TF.bin(if any FPB is present in the network). 1Grid0TM.bin, which contains plot information regarding machines at the selected V-I-Z-S buses present in the network. 1Grid0TL.bin, which contains plot information regarding lines and other elements present in the network. 1Grid0TF.bin, which contains plot information regarding free programmable blocks present in the network.

If the input file is prepared by the user according to the format provided in this chapter, there is no restriction on the file name, it is user-defined name. The output files are generated with user-defined filename plus default extensions. About file extensions it has been explained in the table 4.1.

The input data is read in free format. Input data is divided into different heads called streams for explanation purposes. `*int'* is used to indicate that the data type is an integer. `*float'* is used to reference the floating point (real) variable. Character streams (string) are indicated by `*char'* type.

Stream 1: System Description

This consists of 3 lines of data for the description of the power system for which the study is done. Each line data is of char type, and maximum number of alphanumeric characters (including blanks) in a line should not exceed 80. Any useful information, which has to appear in the report file ("TRSOUT") can be given in this stream.

The comment lines can be given in the data file by entering '%' sign in the first column. Comment line is not written in the output file. These lines are simply read and skipped. However, if the comment line has to appear in the output file also, then one more '%' sign should appear in the second column. In the two statements appearing below, the first line does not appear in the output file, while the second line appears in the output file.

% This comment line does not appear in the output file.
%% This comment line appears in the output file.

Stream 2: System Size Specification

This consists of a line of data, which specifies the system size. Data types/specifications are separated by blanks. Since the data is read in free format, data appearing in a line can be given in successive lines also. Table 3.1 gives the data appearing under different columns of this stream.

Table 3.1 : System Size Definition

Col No.	Description	Type	Min	Max
1.	Maximum Bus Number	Int	1	99999999
2.	Actual number of buses	Int	1	99999
3.	Number of 2 winding transformers	Int	0	5000
4.	Number of 3 winding transformers	Int	0	1000
5.	Number of transmission lines	Int	0	5000
6.	Number of series reactors (inductors)	Int	0	5000
7.	Number of series capacitors	Int	0	5000
8.	Number of bus couplers	Int	0	5000
9.	Number of shunt reactors (inductors)	Int	0	5000
10.	Number of shunt capacitors	Int	0	5000
11.	Number of shunt impedances	Int	0	5000
12.	Number of generators	Int	1	5000
13.	Number of motors	Int	0	5000
14.	Number of loads	Int	0	5000
15.	Number of load characteristics	Int	0	5000
16.	Number of under frequency relays	int	0	1000
17.	Number of voltage relays	int	0	1000
18.	Number of over current relays	int	0	1000
19.	Number of Distance relays	int	0	20
20.	Number of filters	int	0	20
21.	Number of cyclic loads	int	0	5
22.	Number of voltage regulators	int	0	1000
23.	Number of governors	int	0	1000
24.	Number of static var compensators	int	0	100
25.	Number of HVDC converters	int	0	20
26.	Number of DC links	int	0	10
27.	Number of free programmable blocks	int	0	100
28.	Number of Wind Turbines	Int	0	5000
29.	Number of Curves in wind turbine	Int	0	5000
30.	Number of Detailed curves in wind turbine	Int	0	100

Explanations for the entries in table 3.1 are as follows -

- In **POWERTRS** bus numbers need not be assigned continuously and there can be cases wherein some buses are deleted. Maximum bus number in column 1 is the largest bus number used.

- Actual number of buses refers to total buses that are physically present in the system.
- Two winding transformers, three winding transformers, lines, series reactors (inductor), series capacitors and bus couplers are together referred as series elements (branches). Maximum number of series elements should not exceed 2500. Each three winding transformer results in three series elements, since equivalent Star connection data is considered. Sum of total number of two winding transformers and 3 times the number of 3 winding transformers should not exceed 1000. Even though the terminology bus coupler is used in column 8 of table 3.1, it can refer to switches, isolators and disconnecting switches, and are modeled as low impedance paths.
- Shunt reactors (inductor), shunt capacitors and shunt impedances are together referred as shunt elements. Maximum number of shunt elements should not exceed 1000. In **POWERTRS** transformer positive and zero sequence impedances are modeled depending on the winding connection. Zero sequence modeling will have connection to ground from primary or secondary of the transformer, if the transformer winding is delta connected on one side and star-grounded on the other side. Numbers of shunt impedances are equal to the sum of number of actual shunt connections (whose data are given in impedance form) that exist in the system and the shunt impedances that result due to the modeling of the transformer.
- In **POWERTRS** loads can be modeled as constant power load or constant current load or constant impedance load or a combination of all the three, along with frequency correction. Different loads can refer to the same load characteristic. Number of load characteristics is equal to the different characteristics referenced in the load data.
- **POWERTRS** computes the frequency at each time interval at the selected buses other than the generator bus. Also, if the frequency goes below the specified limit, it is possible to trip the series element or shunt element. In case of loads, loads can be tripped partly or completely. Under frequency relays monitor the bus frequency and are set to open the desired breaker. Hence in **POWERTRS** different series and shunt elements can refer to same relay characteristics. Number of frequency relays is equal to different relays referenced in the series element data and shunt element data (including generator and load).
- **POWERTRS** computes the bus voltage magnitude at each time interval at all the buses. Also, if the voltage goes below the specified limit, it is possible to trip the series element or shunt element. In case of loads, loads can be tripped partly or completely. Under voltage relays monitor the bus voltage and are set to open the desired breaker. Hence in **POWERTRS** different series and shunt elements can refer to it under voltage relay characteristics. Number of voltage relays is equal to different relays referenced in the series element data and shunt element data (including generator and load).
- Over current relays are used in the power system to safeguard the equipments from overloading and from severe disturbances arising from faults. In **POWERTRS** 3 seconds and 1.3 seconds over current relays are modeled. Number of over current relays for which the data is provided is entered in column 18.

- Distance relays are modeled in **POWERTRS** using various characteristics. Number of distance relays for which the data is provided is given in column 19.
- An unique feature of specifying the user defined filter is provided in **POWERTRS**. Total number of filters in the system is given in column 20 and should not exceed 20.
- Rolling mill loads are cyclic in nature. Number of cyclic loads in the system is given in column 21.
- **POWERTRS** supports standard IEEE representations for voltage regulators and prime movers and speed governors. In addition, free programmable blocks are supported to model any other
  type of controllers. Total number of free programmable blocks in the system is given in column 27. For more information on free programmable block representation refer the manual – **PowerFPB**.
- Change in wind speed disturbance is only for WT3 type model.
- Change in Wind Turbine Generator generation disturbance is only for WT1, WT2 and WT4 type models.
- Wind Turbine Generator starting disturbance is applicable only for WT1 & WT2.

Stream 3: Program Control Inputs

Different control inputs are read by **POWERTRS** to control the program flow, results printing and model selection. These inputs are specified under this stream. Data appearing in different columns of line 1 of this stream are given in table 3.2

Table 3.2 : Program Control Inputs - Line 1

Col No.	Description	Type	Min	Max
1.	Number of zones	int	0	351
2.	Number of disturbances	int	0	100
3.	Number of nodes for V-I-Z-S output	int	0	20
4.	Number of iterations in load flow analysis	int	5	200
5.	Number of time steps for print	int	1	10000
6.	Index for Load type during post disturbances	int	0	1
7.	Index for load flow print	int	0	1
8.	Index for Voltage impedance print	int	0	1
9.	Index for data details print	int	0	1
10.	Reference bus for relative swing computation	int	0	99999999

Explanations to entries given in table 3.2 are as follows -

- In power system, the equipments are owned by different utilities, and in a same utility, equipments belong to different zones. Hence each bus is associated with a number called zone. All the equipment (shunt elements) connected to the bus are attributed to the zone of the bus. In case of series elements, the line belongs to the zone of the from bus (sending bus). Number of zones in the given power system data are given in column 1.

- It is possible to specify a number of disturbances at different time intervals. Total numbers of disturbances are given in column 2.
- For series elements connected between specified numbers of buses, it is possible to get the voltage, current, impedance and power at the desired time interval. Total number of such buses is given in column 3. If the graph of generator variables is to be plotted, then corresponding generator buses should be included in this list.
- Maximum numbers of iterations refer to the iteration number after which the fast-decoupled power flow iteration used in **POWERTRS** is terminated. This number is usually in the range 10-20.
- Time step for transient stability study is usually in the range 0.01 to 0.025 seconds. While conducting the study for larger duration, it is not necessary to print or plot the values at each time interval. Hence facility is given in terms of print interval time step to control the printing. If the simulation time step is 0.02 seconds, and the print interval time step is 10, then at every 0.1 seconds the printing of results is done.
- Load type during post disturbance is interpreted as -
  0: Impedance type of load.
  1: As per the load model specified in the load characteristic.
- Index for load flow print is interpreted as - 0 or 1 where
  0: No printing of load flow results.
  1: Printing of load flow results
- Index for voltage impedance print is interpreted as -
  0: No print of voltage at bus, current in a line, and impedance seen by the distance relay.
  1: Print of above quantities.
- Index for data details print is interpreted as -
  0: No printing of data
  1: Data read is printed

If the swing bus is zero absolute swing of each generator is given. If the bus is other than zero, swing relative to this bus angle is given.

Stream 3: Line 2: V-I-Z-S Bus Data

This line data is to be provided, only if the number of V-I-Z-S print buses are greater than 0. Bus numbers corresponding to V-I-Z-S print are given in this line. Hence total number of columns of data is equal to the number of V-I-Z-S buses. All the fields are of integer type, separated by one or more blanks.

Stream 3: Line 3 - Model Selection Parameters

In this line, 9 fields are given to select the model for transformer resistance, circuit breaker impedance etc. Table 3.3 gives the values that appear in different columns of this line.

Table 3.3 : Model selection parameters				
Col No.	**Description**	**Type**	**Min**	**Max**
1.	Base MVA	float	0.0	1.0e6
2.	Base Frequency	float	0.1	100.00
3.	Transformer R/X ratio	float	0.0	1.0
4.	Circuit breaker resistance in pu	float	0.0	1.0e2
5.	Circuit breaker reactance in pu	float	0.0001	1.0e2
6.	Initial real power tolerance in pu	float	1.0e-4	0.1
7.	Initial reactive power tolerance in pu	float	1.0e-4	0.1
8.	Post disturbance real power tolerance in pu	float	1.0e-4	0.1
9.	Post disturbance reactive power tolerance in pu	float	1.0e-4	0.1

Explanations to entries in table 3.3 are as follows -

- Load and generation data are accepted in actual values i.e., MW for real power and Mvar for reactive power etc. Series and shunt elements' parameters given in the data file are in pu system. Base MVA is the power base considered to compute the pu quantities.
- Transformer R/X ratio (ratio of resistance to reactance) is usually 0.05. In certain cases, the resistance value is unknown and hence R/X ratio is used to compute the resistance value, when the reactance value is given. If the transformer resistance is 0.0, then the resistance is computed as the product of R/X ratio and the transformer reactance. R/X ratio should be given as zero to neglect the transformer resistance in the computation. Entry in column 2 of table 3.3 corresponds to transformer R/X ratio.
- Two techniques are used to model the circuit breaker or switches in closed position. One technique is to merge buses connected between the circuit breakers and treat the buses as single bus for all computation purposes. Other technique is to consider the circuit breaker as a low impedance path. Later is used in the modeling of circuit breakers in **POWERTRS**. In this model the resistance value of circuit breaker is zero and reactance value is 0.0001 p.u. But if the impedances of other elements are relatively large, then the circuit breaker impedance can also be of higher value. Resistance and reactance values of circuit breaker in p.u are given in columns 3 and 4 of table 3.3, respectively. In some applications (especially for distribution systems), higher values are to be used for these two quantities. Since **POWERTRS** requires the solved base case load flow, circuit breaker resistance and reactance used while solving the load flow should be given here also.
- Real and reactive power tolerances are in p.u on the given base. These values are used to check the convergence of fast-decoupled load flow. During each iteration, maximum real and reactive power mismatch at all buses are computed. When maximum real power mismatch is less than the real power tolerance and the maximum reactive power mismatch is less than the reactive power tolerance, convergence is achieved. On hundred MVA base 0.001 p.u is generally an acceptable value for tolerance, which results in 0.1 MW real power error. If all the load values are relatively large, then tolerance value can be as high as 0.1 p.u on 100 MVA base. Tolerance values for pre-disturbance and post disturbance is given separately. The values can be same for both the cases.

Stream 3: Line 4 - Variable Time Step Data

POWERTRS has the facility to consider different time steps for different intervals of study time. Table 3.4 gives the values that appear in different columns of this line.

Table 3.4 : Variable Time Step Data

Col No.	Description	Type	Min	Max
1.	End time for interval 1 in seconds	float	0.025	1.0e3
2.	Time step for interval 1 in seconds	float	0.001	0.1
3.	End time for interval 2 in seconds	float	0.025	1.0e3
4.	Time step for interval 2 in seconds	float	0.001	0.1
5.	End time for interval 3 in seconds	float	0.025	1.0e3
6.	Time step for interval 3 in seconds	float	0.001	0.1
7.	Maximum simulation time in seconds	float	0.025	1.0e3
8.	Time step for interval 4 in seconds	float	0.001	0.1

Explanations to entries given in table 3.4 are as follows –

Starting time is always at t = 0.0 seconds.
End of each time interval is measured from the starting time i.e., t = 0.0 seconds.
It is assumed that the end of each time intervals is in the increasing order.
Maximum simulation time is the duration for which **POWERTRS** should run.
Normal value for maximum simulation time is 3 seconds, and the time step is 0.025 seconds.

Stream 3.1 New Stream: Zone wise Multiplication Factor

In this stream, for each zone, (a) Zone number, (b) Print option, (c) real power multiplication factor and (d) reactive power multiplication factor are read. Zone zero corresponds to global change.

Stream 4: Disturbance Data

In this stream, disturbance data is given. Numbers of lines in this stream are equal to the number of disturbances as specified earlier. Each line consists of 12 fields. Fields are separated by a blank. Exact value that appears under each column depends on the disturbance type. Table 3.5 gives the values that appear under different columns.

Table 3.5 - System Specification – Line 6 : Multiplication factors				
Col	**Description**	**Type**	**Min**	**Max**
1.	Circuit breaker resistance in pu	float	0.0	1.0
2.	Circuit breaker reactance in pu	float	1.0e-5	1.0
3.	Transformer R/X ratio	float	0.0	1.0
4.	Transformer zero sequence impedance multiplication factor	float	0.5	1.0
5.	Number of transmission voltage levels	int	1	20
6.	Transmission line voltage in kV	float	0.001	1.0e4
7.	Transmission line zero sequence resistance multiplication factor	float	0.0	10.0
8.	Transmission line zero sequence reactance multiplication factor	float	1.0	10.0
9.	Transmission line zero sequence admittance multiplication factor	float	0.5	1.0
10.	Generator negative sequence resistance multiplication factor	float	0.0	2.0
11.	Generator negative sequence reactance multiplication factor	float	0.5	2.0
12.	Generator zero sequence resistance multiplication factor	float	0.0	2.0
13.	Generator zero sequence reactance multiplication factor	float	0.5	2.0
14.	Load negative sequence impedance multiplication factor	float	0.1	2.0
15.	Load zero sequence impedance multiplication factor	float	0.1	2.0
16.	Series reactor zero sequence impedance multiplication factor	float	0.5	2.0
17.	Shunt reactor zero sequence impedance multiplication factor	float	0.5	2.0

Explanations to entries given in table 3.5 are as follows -

- Disturbance number is the serial number of the disturbance. It should be given in the increasing order, with no numbers missing in between.
- Disturbance type in column 2 is interpreted as –
    1. Change in transformer/line parameters
    2. Change in shunt impedance load
    3. Change in real and reactive power of loads
    4. 3 Phase fault creation at a bus
    5. 3 Phase fault removal at a bus
    6. Change in number of generator sets at a bus
    7. Complete generation outage at a bus
    8. Simulation of single line to ground fault
    9. Clearing of single line to ground fault
    10. Reclosing of line with SLG fault cleared
    11. Loss of excitation at a generator
    12. Change in Shunt Impedance
    13. Change in Load Model
    14. Motor Start
    21. Wind Turbine Generator Starting
- Disturbance time is the time at which the disturbance is applied. The time is measured from the start of the simulation time i.e., 0.0 seconds. If no disturbance is to be considered, then this time should be larger than the maximum simulation time.

- Disturbance buses are interpreted depending on type of disturbance. For disturbance type 1, 9 and 10 the disturbance buses are from and to bus numbers of the series elements. For all other disturbances, both the numbers should be same and they refer to the bus number at which the disturbance is considered.
- New value fields are interpreted depending on the type of disturbance. The interpretation is -
  - For change in transformer/line parameters, the positive sequence resistance, reactance and susceptance (B/2) in p.u are given in new value 1 fields respectively. In case of transformer, this field is the new transformer tap. Zero sequence resistance, reactance and susceptance (B/2) in p.u are given in new value 2 fields respectively. The values are for the new configuration. Hence to consider the opening of a line, resistance of the line is given as 0.0 p.u, reactance as 999.9 p.u and susceptance as 0.0 p.u for both positive and zero sequence values.
  - For change in shunt impedance load, positive sequence resistance and reactance values in p.u are given in new value 1, field 1 and 2 respectively. Zero sequence values are given in new value 2 fields.
  - For change in PQ load, new real power load in MW, new reactive power load in M VAr and new compensating MVAr at the bus are given in new value 1 fields. New value 2 fields are ignored.
  - For three phase fault, the fault impedance resistance and reactance in p.u are given in new value 1, fields 1 and 2 respectively. Other fields are ignored.
  - For three phase fault removal, the fault impedance resistance and reactance in p.u that are to be removed are given in new value 1, fields 1 and 2 respectively. Other fields are ignored. Normally this value is same as the one given in case of application of 3 - phase fault.
  - For change in number of generator sets at a bus, the old and new real generator ratings in MW are given in new value 1 field 1 and 2 respectively. Other fields are ignored. Since the ratio of old value to new value is of interest, old number of units and new number of units can also be given in new value 1 field 1 and 2 respectively.
  - For complete generation outage at a bus, the new value fields are ignored.
  - For fault types 8 to 9, new value fields are ignored.

- If the disturbance type is 9, then the SLG fault clearing type is interpreted as -
  - 0: Clearing of SLG fault applied at a bus.
  - 1: Single pole opening on from bus side.

- Disturbance type 10 is applicable, only if disturbance 9 is considered with clearing type as 1.
- For a line outage disturbance the line impedance will be changed. Till the line impedance is 999 the line is not physically open. Means if the network gets islanded with that line outage then to see that effect the line impedance should be given a value more than 999.
- Disturbance Wind turbine generator starting, is applicable only for WT1 and WT2 type wind generators

Stream 5: Generator Bus Numbers

In this stream all the bus numbers of synchronous and asynchronous machines connected to the system are given. The fields are of integer type and generator/motor bus numbers are separated by one or more blanks.

Stream 6: Bus Data

In this stream of data, bus details are given. Total number of lines of data is equal to actual number of buses as given under system size specification stream. The data in columns of each line are given in table 3.6.

Table 3.7 - Bus

Col No.	Description	Type	Min	Max
1.	Bus number	int	1	9999
2.	Bus status	int	0	1
3.	Zone number	int	1	20
4.	Bus voltage in kV	float	0.001	1.0e5
5.	Bus name	char	1	8
6.	Voltage magnitude in pu	float	0.5	2.0
7.	Voltage angle in degrees	float	-360.0	360.0
8.	Real power generation at bus in MW	float	-1.0e6	1.0e6
9.	Reactive power generation at bus in Mvar	float	-1.0e6	1.0e6
10.	Real power load at bus in MW	float	-1.0e6	1.0e6
11.	Reactive power load at bus in Mvar	float	-1.0e6	1.0e6
12.	Reactive compensation provided at bus in Mvar	float	-1.0e6	1.0e6

Explanations to entries given in table 3.6 are as follows –

- Bus number refers to the number by which the buses are identified. Bus numbers need not be continuous and buses belonging to different zones can be referenced by having different starting numbers (i.e., buses in zone 1 can have the bus numbers from 1 to 200, buses in zone2 can have the numbers from 201 to 300 and so on. When input file is created through MiP-PSCT's integrated environment, the buses are numbered automatically and the numbers are transparent to the user.
- Island number is the island to which the bus belongs. This number is obtained from the load flow study. If there are no islands in the system, then this field is unity.
- As explained earlier, zone field refers to the zone number to which the bus belongs.
- Bus voltage entry given in column 4 of table 3.6 is in kilovolts and it is also the base voltage for the bus.
- Buses are more commonly referred by names rather than numbers. Bus name is a string of maximum 9 characters. Any alphanumeric characters can constitute the bus name. Bus name should be unique.
- Base case load flow solution's bus voltage magnitude in p.u, voltage angle in degrees, power generation at the bus (MW and MVAr), load at the bus (MW, MVAr and

- Compensation in MVAr) are obtained from the initial load flow run on the system under consideration.

Stream 7: Transformer Data

In this stream of data, transformer details are given. Figure 3.1 shows the modeling of the transformer with off nominal turn's ratio. Figure 3.2 shows the modeling of phase shifting transformer. Three winding transformers are modeled using equivalent star connection between the windings. Figure 3.3 shows the modeling of three-winding transformer. Total number of lines of data in this stream are equal to sum of number of 2-winding transformers and three times the number of three winding transformers. The data that appear in different columns of each line are given in table 3.7.

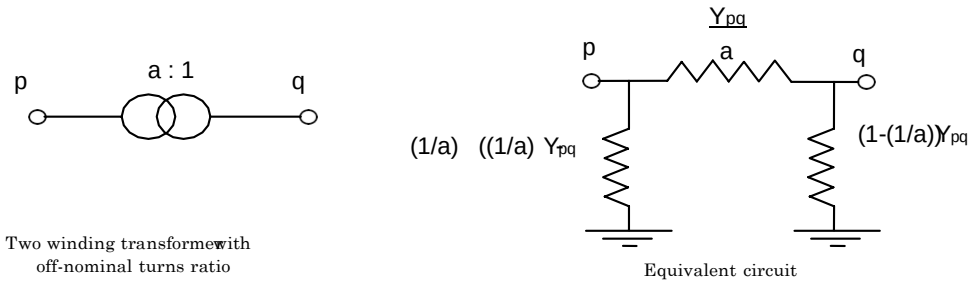


Figure 3.1 - Two winding transformer representation

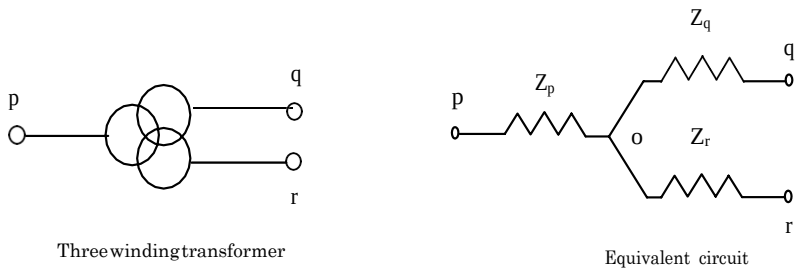
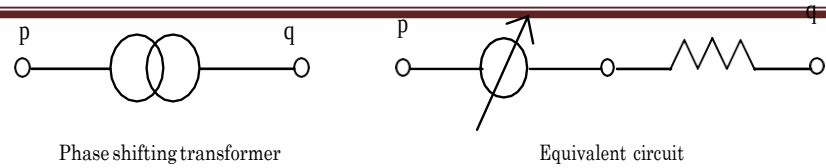


Figure 3.2 - Three winding transformer representation

$(a_s + Jb_s) : 1$ $(a_s + jb_s) : 1$ Y_{pq}



3.3 Phase shifting Transformer Representation

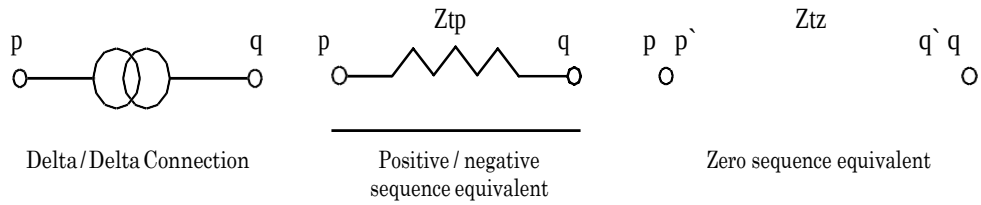
Table 3.7: Transformer Data				
Col.No.	**Description**	**Type**	**Min**	**Max**
1.	Connection status	int	0	3
2.	Numbers in parallel	int	1	10
3.	From bus number	int	1	99999999
4.	To bus number	int	1	99999999
5.	Positive sequence resistance in pu.	float	0.0	1.0e2
6.	Positive sequence reactance in pu.	float	1.0e-4	1.0e2
7.	Zero sequence resistance in pu.	float	0.0	1.0e2
8.	Zero sequence reactance in pu.	float	0.0	1.0e2
9.	Nominal tap setting in pu.	float	0.5	1.5
10.	Phase shift	float	0.0	360.0
11.	From side frequency relay number	int	0	20
12.	From side voltage relay number	int	0	20
13.	To side frequency relay number	int	0	20
14.	To side voltage relay number	int	0	20
15.	Transformer phase shift	float	0.0	360.0
16.	Primary winding configuration	Char		
17.	Secondary winding configuration	Char		

Explanations to entries given in table 3.7 are as follows -

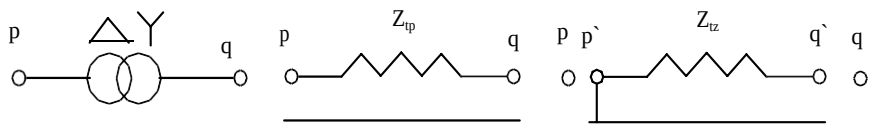
- Connection status is interpreted as
  - 0: Transformer is open on either ends.
  - 1: Transformer is open on from end.
  - 2: Transformer is open on to end.
  - 3: Transformer is closed on either ends.

  Values 0 and 3 are of significant. If the status value is 3, then only the transformer is modeled in the analysis. Numbers in parallel is used for information purpose only.
- From bus number and To bus number are the buses on either side to which the transformer is connected. The numbers must be present in the bus data stream.
- Transformer impedance values are in p.u on a common base for the equivalent circuit. i.e., if there are n transformers in parallel, then impedance value per transformer on its own rating is divided by n and then converted to a common base. If the resistance value is zero, effective resistance is computed by multiplying the transformer reactance by the r/x ratio.

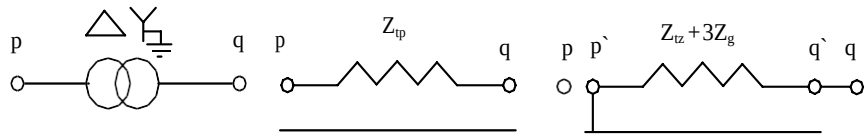
- Nominal tap setting is the tap setting at which the study is to be carried out. It is assumed that the transformer tap is provided on the from bus side. Hence, since the transformer taps are usually provided on the high voltage winding, it is always preferred to specify the from bus side as the high voltage bus number. In case of three-winding transformer, tap is specified from the HT winding to additional node arising because of the equivalent star connection representation. For branches from other two windings, the nominal tap is unity. At unity tap setting, one p.u voltage applied at the from bus produces one p.u voltage at the to bus on no load. In case of phase shifting transformers, the phase shift is represented in polar form. The phase shift magnitude is entered in the nominal tap position, while phase shift angle is provided in the phase shift position. Phase shift angle is in degrees.
- The 10th field is phase shift of phase shift transformer.
- The 15th field is phase shift due to the winding configuration.
- Zero sequence transformer connection exists in the branch information only if the transformer winding is grounded on either side. Otherwise transformer zero sequence reactance should be of high value (usually 999.99 PU). If the transformer is grounded through any impedance, times the ground impedance value should be added to the zero sequence impedance. Figures 3.4 and 3.5 shows the transformer positive and zero sequence network connections.



Delta / Delta Connection | Positive / negative sequence equivalent | Zero sequence equivalent



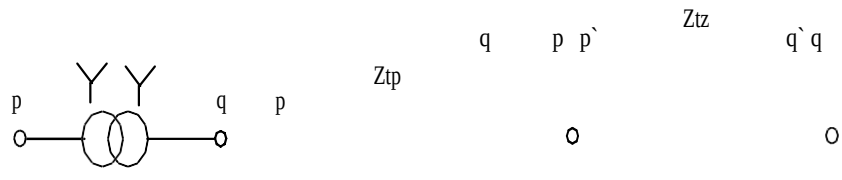
Delta/ Star Connection | Positive / negative Sequence equivalent | zero sequence equivalent



Delta / Star-ground Connection

Positive / negative sequence equivalent

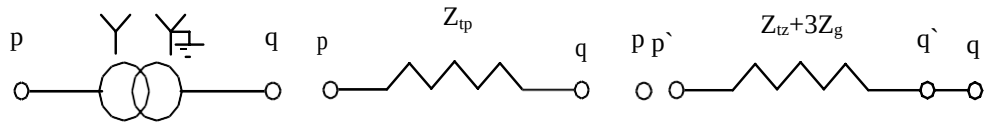
zero sequence equivalent



Star /Star Connection

Positive / negative sequence equivalent

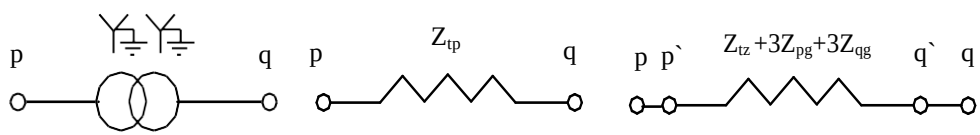
Zero sequence equivalent



Star / Star-ground Connection

Positive / negative Sequence equivalent

zero sequence equivalent



Star-ground / Star-ground Connection

Positive / negative sequence equivalent

zero sequence equivalent

Figure 3.4 - Positive, negative and zero sequence representation of two winding transformer for different connection.

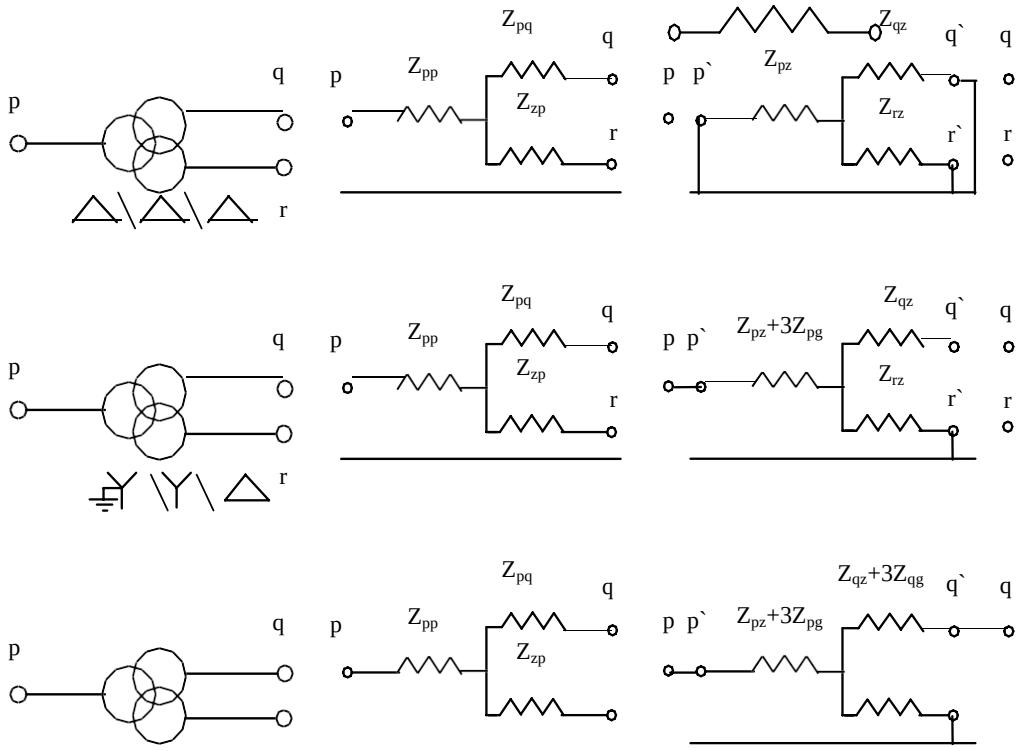


Figure 3.5 positive, negative and zero sequence representation of three-phase transformer

Frequency and voltage dependent tripping of transformer is possible in **POWERTRS**. Relay number to be referred for the transformer from and to side to isolate the transformer is given in columns 11 to 14.

Stream 8: Transmission Line Data

In this stream of data, transmission line details are given. Lines/Cables are modeled using equivalent circuit as shown in figure 3.6.

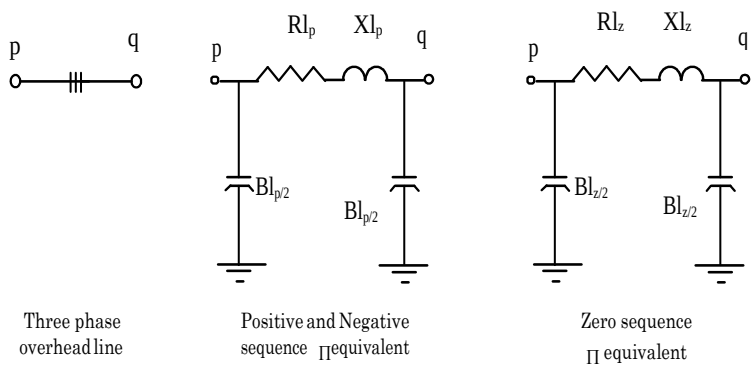


Figure 3.6 - Three phase over head line modeling

Total number of lines of data in this stream is equal to number of transmission lines as given in specification stream. The data that appears in different columns of each line are given in table 3.8.

Table 3.8 : Transmission Line Data

Col No.	Description	Type	Min	Max
1.	Connection status	int	0	3
2.	Numbers of circuits	int	1	10
3.	From bus number	int	1	9999
4.	To bus number	int	1	9999
5.	Positive sequence resistance in p.u.	float	-1.0e3	1.0e3
6.	Positive sequence reactance in p.u.	float	-1.0e3	1.0e3
7.	Positive sequence susceptance (B/2) in p.u.	float	0.0	1.0e3
8.	Zero sequence resistance in p.u.	float	-1.0e3	1.0e3
9.	Zero sequence reactance in p.u.	float	-1.0e3	1.0e3
10.	Zero sequence susceptance (B/2) in p.u.	float	0.0	1.0e3
11.	From side frequency relay number	int	0	20
12.	From side voltage relay number	int	0	20
13.	To side frequency relay number	int	0	20
14.	To side voltage relay number	int	0	20

Explanations to entries given in table 3.8 are as follows -

- Connection status is interpreted as
  - 0: Line is open on either ends.
  - 1: Line is open on from end.
  - 2: Line is open on to end.
  - 3: Line is closed on either ends.

  Values 0 and 3 are of significant. If the status value is 3, then only the line is modeled in the analysis.
- Number of circuits in parallel is used to modify the line impedance in the case of single pole opening.
- From bus number and to bus number are the buses on either side to which the line is connected. The numbers must be present in the bus data stream.
- Line impedance values are in p.u on a common base for the equivalent circuit. i.e., if there are n lines in parallel, then impedance value per line is divided by n and then converted to a common base.
- Frequency and voltage dependent tripping of line is possible in **POWERTRS**. Relay number to be referred for the line from and to side to isolate the line is given in columns 11 to 14.

Stream 9: Series Reactor and Capacitor Data

In this stream, data for series reactor and capacitor are given. Series reactor and capacitor are modeled as series element consisting of resistance (usually zero or negligible value) in series with inductive or capacitive reactance. Figure 3.7 and 3.8 show the modeling of series inductor and capacitor respectively.

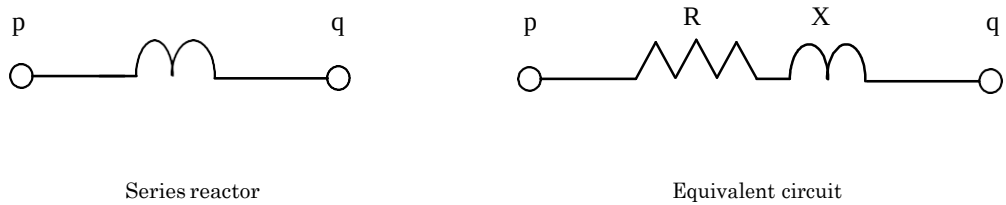


Figure 3.7: Series reactor (inductor) representation

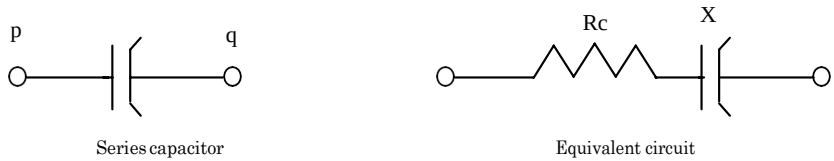


Figure 3.8: Series capacitor representation

Total number of lines of data in this stream is equal to the sum of number of series reactors and capacitors as given in specification stream. The data that appears in different columns of each line are given in table 3.9.

Table 3.9: Series Reactor/Capacitor Data

Col No.	Description	Type	Min	Max
1.	Connection status	int	0	3
2.	From bus number	int	1	9999
3.	To bus number	int	1	9999
4.	Positive sequence resistance in p.u.	float	0.0	1.0e3
5.	Positive sequence reactance in p.u.	float	1.0e-4	1.0e3
6.	Zero sequence resistance in p.u.	float	0.0	1.0e3
7.	Zero sequence reactance in p.u.	float	0.0	1.0e3
8.	From side frequency relay number	int	0	20
9.	From side voltage relay number	int	0	20
10.	To side frequency relay number	int	0	20
11.	To side voltage relay number	int	0	20

Explanations to entries given in table 3.9 are as follows -

- Connection status is interpreted as
  - 0: Series reactor/capacitor is open on either ends.
  - 1: Series reactor/capacitor is open on from end.
  - 2: Series reactor/capacitor is open on to end.
  - 3: Series reactor/capacitor is closed on either ends.

  Values 0 and 3 are of significant. If the status value is 3, then only the reactor/capacitor is modeled in the analysis.
- From bus number and to bus number are the buses on either side to which the reactor/capacitor is connected. The numbers must be present in the bus data stream. Reactor/capacitor impedance values are in p.u on a common base.
- Resistance value of the reactor/capacitor is usually zero or of negligible value.
- Frequency and voltage dependent tripping of series reactor/capacitor is possible in **POWERTRS**. Relay number to be referred for the reactor/capacitor from and to side to isolate the reactor/capacitor is given in columns 8 to 11.

Stream 10: Circuit Breaker Data

In this stream, data for circuit breakers and isolating switches are given. Switches are modeled as series element consisting of resistance (usually zero or of negligible value) and reactance (small non zero value) whose values are given in system specifications. Figure 3.9 shows the circuit breaker in closed position.

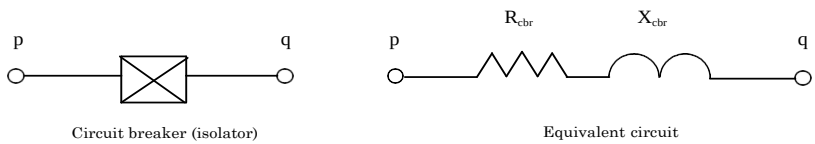


Figure 3.9 - Circuit breaker representation in closed position

Total number of lines of data in this stream is equal to the number of circuit breakers. The data that appears in different columns of each line are given in table 3.10.

Table 3.10: Circuit Breaker Data

Col No.	Description	Type	Min	Max
1.	Connection status	int	0	3
2.	From bus number	int	1	9999
3.	To bus number	int	1	9999
4.	Frequency relay number	int	0	20
5.	Voltage relay number	int	0	20

Explanations to entries given in table 3.10 are as follows -

- Connection status is interpreted as
  - 0: Circuit breaker is opened.
  - 3: Circuit breaker is closed.
- Frequency and voltage dependent tripping of circuit breaker is possible in **POWERTRS**. Relay number to be referred to isolate the breaker is given in columns 4 and 5.

Stream 11: Shunt Connection (Admittance) Data

In this stream, data for shunt reactors and capacitors in admittance form is given. Admittance value in pu consists of conductance and susceptance. For shunt inductive reactor, susceptance is negative and for shunt capacitor, susceptance value is positive. Conductance value is zero or of negligible value. Total number of lines of data in this stream is equal to the sum of shunt reactors and capacitors, whose values are given in admittance form. The data that appears in different columns of each line are given in table 3.11.

Table 3.11 : Shunt Reactor/Capacitor (Admittance form) Data

Col No.	Description	Type	Min	Max
1.	From bus number	int	1	9999
2.	Positive sequence conductance in p.u.	float	-1.0e-4	1.0e4
3.	Positive sequence susceptance in p.u.	float	-1.0e4	1.0e4
4.	Zero sequence conductance in p.u.	float	-1.0e-4	1.0e4
5.	Zero sequence susceptance in p.u.	float	-1.0e4	1.0e4
6.	Frequency relay number	int	0	20
7.	Voltage relay number	int	0	20

Explanations to entries given in table 3.11 are as follows -

- `From bus number' is the bus number to which the shunt inductor/capacitor is connected.
- Usually the reactor/capacitor value will be specified in Mvar at the rated voltage. If the rated voltage is the base voltage at the bus, then the magnitude of susceptance value in p.u is equal to the specified Mvar value in p.u. The sign is positive for capacitive reactor and negative for inductive reactor. Thus the susceptance value of 63 Mvar inductor at 420 kV is -0.57143 p.u on 100 MVA base at 400 kV. Similarly, susceptance value of 50 MVAR capacitor at 420 kV is 0.45351 p.u on 100 MVA base at 400 kV.
- Frequency and voltage dependent tripping of reactor/capacitor is possible in **POWERTRS**. Relay number to be referred to isolate the breaker is given in columns 6 and 7.

Stream 12: Shunt Connection (Impedance) Data

In this stream, data for shunt reactors and capacitors in impedance form is given. Impedance value in p.u consists of resistance and reactance. For shunt inductive reactor, reactance is positive and for shunt capacitor, reactance value is negative. Resistance is zero or of negligible value. In some particular system studies, shunt element data is readily available in impedance

form. Also, in some studies loads are represented in impedance form. When a network is reduced, all the loads can be lumped at a bus as impedance load. In these cases this stream of data is used. Because of the transformer winding connection, if there results any ground connection for zero sequence network, then that information is also given in this stream. Since corresponding positive sequence network has no ground connection, a high value is given for positive sequence reactance (usually 999.99 p.u.).

Total number of lines of data in this stream is equal to the shunt impedance number as given in specification stream. The data that appears in different columns of each line are given in table 3.12.

Table 3.12 : Shunt Impedance Data

Col No.	Description	Type	Min	Max
1.	From bus number	int	1	9999
2.	Positive sequence resistance in p.u.	float	0.00	1.0e3
3.	Positive sequence reactance in p.u.	float	-1.0e3	1.0e4
4.	Zero sequence resistance in p.u.	float	0.00	1.0e3
5.	Zero sequence reactance in p.u.	float	-1.0e3	1.0e4

Explanations to entries given in table 3.12 are as follows -

- From bus number' is the bus number to which the shunt impedance is connected.
- If the load power at the nominal voltage (base voltage) is known, then the impedance value in p.u is computed as the reciprocal of the conjugate of the complex power in p.u. Thus the p.u resistance and reactance values of 80 MW and 60 Mvar load are 0.8 and 0.6 respectively on 100 MVA base.
- If the transformer is delta connected on primary and star grounded on secondary, then zero sequence shunt connection exists from the transformer secondary bus to ground. Also if the transformer is star grounded on primary and delta connected on secondary, then zero sequence shunt connection exists from the transformer primary to ground. In either case positive sequence reactance value is high i.e., approximately 999.0 p.u.

Stream 13: Filter Data

In this stream of data, filter details are given. For each filter, the bus numbers to which the filter is connected and the number of branch elements (Resistor, Inductor, and Capacitor) that constitute the filter are given followed by the actual filter data. Hence total number of lines of data in this stream is equal to sum of number of filters as given in the specification stream and sum of number of filter branches of each filter. The data that appears in different columns of each line for a filer branch are given in table 3.13.

Table 3.13: Filter Data				
Col No.	**Description**	**Type**	**Min**	**Max**
1.	Filter branch number	int	0	20
2.	From node	int	0	9999
3.	To node	int	0	9999
4.	Filter element type	int	1	3
5.	Element value	float	0.0	1.0e4

Explanation to entries in the table 3.13 is as follows -

- Branch number is the serial number of the filter branch. Total number of branches per filter should be less than 20.
- Filter nodes are numbered in order considering the reference node (ground) as 0 and the bus to which the filter is connected as 1. From and to filter nodes refer to the node numbers of the filter, between which the basic filter element is connected.
- Filter element type is interpreted as -
    1. Resistor, element value unit is in Ohm.
    2. Inductor, element value unit is in Henry.
    3. Capacitor, element value unit is in Farad.

In the transient stability study, the equivalent shunt admittance in p.u, from the filter bus to the ground is computed at the specified system frequency, bus voltage and base MVA. If a filter at bus say 8, consists of resistor, inductor and capacitor connected as shown in figure 3.10, then the data appearing for the filter is as follows -

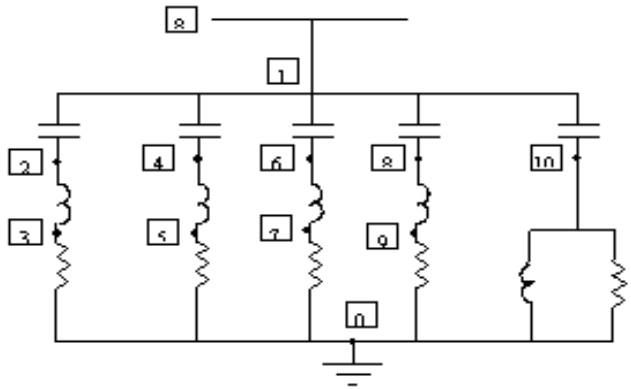


Figure 3.10: Example of a Filter Data

Bus = 8		Filter Branch Elements = 15		
Branch	**From Node**	**To Node**	**Branch Element Type**	**Active Value**
1	1	2	3	000.417e-6
2	2	3	2	000.974
3	3	0	1	037.000
4	1	4	3	000.417e-6
5	4	5	2	000.497
6	5	0	1	026.600
7	1	6	3	000.417e-6
8	6	7	2	000.201
9	7	0	1	016.900
10	1	8	3	000.417e-6
11	8	9	2	000.145
12	9	0	1	014.400
13	1	10	3	000.417e-6
14	10	0	2	0.085
15	10	0	1	452.00
Only values need to be entered				

Stream 14: Load Data

In this stream of data, load details are given. Total number of lines of data in this stream is equal to number of loads as given in specification stream. The data that appears in different columns of each line are given in table 3.14.

Table 3.14: Load Data

Col No.	Description	Type	Min	Max
1.	Load bus number	Int	1	9999
2.	Real power load in MW	Float	-1.0e6	1.0e6
3.	Reactive power load in Mvar	Float	-1.0e6	1.0e6
4.	Compensating Mvar	Float	-1.0e6	1.0e6
5.	Load characteristic number	int	0	20
6.	Load frequency relay number	int	0	20
7.	Load voltage relay number	int	0	20

Explanations to entries given in table 3.14 are as follows -

- Load bus number is the bus number to which the load is connected. This number should be provided in the bus data stream.
- Real power and reactive power load values are the scheduled values at the scheduled frequency and nominal voltage. Nominal voltage is equal to the base voltage at the bus. Scheduled frequency is read under system specification stream. This is normally either 50 Hz or 60 Hz.
- Loads are modeled as constant power load or constant current load or constant impedance load or as a combination of all, including the frequency dependency. Modeling of the load is determined by the load characteristic number. If the load characteristic number is zero, then the loads are modeled as constant power type. At any bus i, the expressions for loads are given by

For Load char. Number Less than or Equal to 50

$$P_L^i = P_{LO}^i (1 + cp_f^i \Delta f) \quad (cp_p^i + cp_i^i V^i + cp_z^i V^i V^i)$$

$$Q_L^i = Q_{LO}^i (1 + cq_f^i \Delta f)(cq_p^i + cq_i^i V^i + cq_z^i V^i V^i)$$

For Const. P Load - Cp = 1, Ci = 0, Cz = 0

For Const. I Load - Cp = 0, Ci = 1, Cz = 0

For Const. Z Load - Cp = 0, Ci = 0, Cz = 1

For Load char. Number greater than 50

$$P_L^i = P_{LO}^i (1 + cp_f^i * \Delta f) (cp_p^i (V_i)^{cp_i^i})$$

$$Q_L^i = Q_{LO}^i (1 + cq_f^i * \Delta f) (cq_p^i (V_i)^{cq_i^i})$$

For Const. P Load - Cp = 1, Ci = 0, Cz = Not Used

For Const. I Load - Cp = 1, Ci = 1, Cz = Not Used

For Const. Z Load - Cp = 1, Ci = 2, Cz = Not Used

where,

P_L^i : Actual real power at the bus i in pu.

f = f - f_o

P_{LO}^i : Scheduled real power at the bus i in pu.

cp_f^i : Coeff. of frequency dependence for P at bus I

cp_p^i : Constant power fraction for P at bus i.

cp_i^i : Constant current fraction for P at bus i.

cp_z^i : Constant impedance fraction for P at bus i.

V^i : Magnitude of the voltage at bus i in pu.

NOTE : $\sum (cp_p^i + cp_i^i + cp_z^i) = 1.0$

Q_L^i : Actual reactive power at the bus i in pu.

Q_{LO}^i : Scheduled reactive power at the bus i in pu.

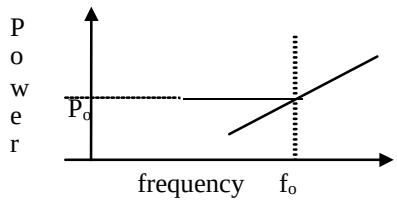
cq_f^i : Coeff. of frequency dependence for Q at bus i.

cq_p^i : Constant power fraction for Q at bus i.

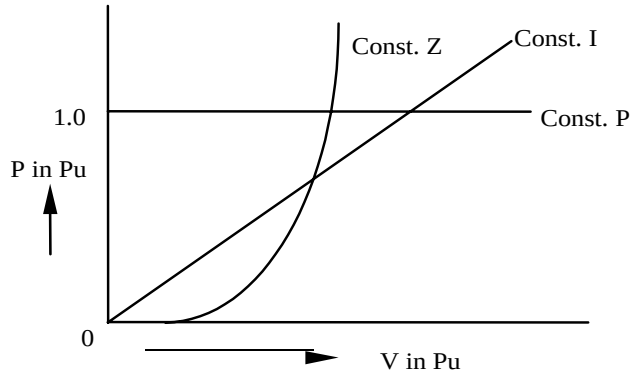
cq_i^i : Constant current fraction for Q at bus i.

cq_z^i : Constant impedance fraction for Q at bus i.

$$\sum (cq_p^i + cq_i^i + cq_z^i) = 1.0$$



Variation of P with Frequency



Variation of Real Power with Voltage

where,

cp_f = 2.5, cp_p = 0.5, cp_i = 0.3, cp_z = 0.2, implies real power changes by 5% for 1 Hz. change in frequency, 50% of the load is constant power type, 30% of the load is constant current type and 20% of load is constant impedance type. If the voltage at a bus goes below the specified value, then the load model for that bus is switched from the given model to constant impedance model as explained in the "system specification stream".

- Compensating Mvar is the fixed compensation provided at the bus. It is assumed that irrespective of the bus voltage, compensating Mvar remains constant. If at a bus fixed capacitor or inductor is present, it is advisable to provide the compensation data as shunt impedance/admittance at the bus.
- Load characteristic number is the number given in the load characteristi c data to be referred for the modeling of the load at the bus. Load characteristic is detailed under "load characteristic stream".
- Frequency and voltage dependent tripping of loads is possible in **POWERTRS**. Relay number to be referred to isolate the breaker is given in columns 4 and 5.

Stream 15: Load Characteristic Data

In this stream of data, load characteristic details are given. Total number of lines of data in this stream is equal to number of load characteristics as given in specification stream. The data that appears in different columns of each line are given in table 3.15.

Table 3.15: Load Characteristic Data				
Col.No.	**Description**	**Type**	**Min**	**Max**
1.	Load characteristic number	int	1	9999
2.	Real power - constant power factor	float	0.0	1.0
3.	Real power - constant current factor	float	1.0	10.0
4.	Real power - constant impedance factor	float	0.0	1.0
5.	Reactive power - constant power factor	float	0.0	1.0
6.	Reactive power - constant current factor	float	0.0	1.0
7.	Reactive power - constant impedance factor	float	0.0	1.0
8.	Real power - frequency factor	float	0	20
9.	Reactive power - frequency factor	float	0	20

Explanations to entries given in table 3.15 are as follows -

- Loads are modeled as explained in load data. The Load characteristic number given here should match the one given under load data.
- Frequency factor of 0.05 implies the load changes by 5 percent for 1 p.u. change in frequency.

Stream 16: Island Data

When base case load flow is done taking the generator and load regulation characteristics, the solution obtained may not be at the nominal system frequency for flat tie line power control. Hence **POWERTRS** accepts frequency of each island as additional input. This stream consists of two lines of data. In first line the total number of islands in the solved base case system is given. In the subsequent line, the frequency of each island is given. Fields are of float type and are separated by one or more blanks.

Stream 17: Machine Data

In this stream of data, Machine details are given. Total number of lines of data in this stream is equal to the sum of number of synchronous and asynchronous machines as given under system specification field. For each synchronous machine (generator) 22 fields are read. Order of data input for each generator is given in table 3.16.

Table 3.16 : Generator Parameter Data				
Sl No.	**Description**	**Type**	**Min**	**Max**
1.	Generator bus number	int	1	9999
2.	Type of modeling	int	1	3
3.	Number of units	int	1	20
4.	Machine MVA rating	Float	0.0	1.0e6
5.	Inertia constant (H)	Float	1.0e-3	1.0e4
6.	Steady state resistance in p.u (r_a)	Float	0.0	1.0e2
7.	Direct axis transient reactance in p.u (x_d')	Float	1.0e-4	1.0e2
8.	Quadrature axis transient reactance in pu (x_q')	Float	1.0e-4	1.0e2
9.	Steady state negative sequence reactance in p.u (x_n)	Float	1.0e-4	1.0e2
10.	Steady state zero sequence resistance in p.u (R_0)	Float	1.0e-4	1.0e2
11.	Steady state zero sequence reactance in p.u (x_0)	Float	1.0e-4	1.0e2
12.	Damping factor (df)	Float	0.0	1.0e2
13.	Steady state direct axis reactance in p.u (x_d)	Float	1.0e-4	1.0e2
14.	Steady state quadrature axis reactance in p.u (x_q)	Float	1.0e-4	1.0e2
15.	Potier reactance in p.u (x_p)	Float	1.0e-4	1.0e2
16.	Sub-transient direct axis reactance in p.u (x_d'')	Float	1.0e-4	1.0e2
17.	Sub-transient quadrature axis reactance in p.u (x_q'')	Float	1.0e-4	1.0e3
18.	Transient direct axis open circuit time constant in seconds (t_{do}') Transient quadrature axis open circuit	Float Float	1.0e-4 1.0e-4	1.0e3 1.0e3
19.	time constant in seconds (t_{qo}')			
20.	Sub-transient direct axis open circuit time constant in seconds (t_{d0}'')	float	1.0e-4	1.0e3
21.	Sub-transient quadrature axis open circuit time constant in seconds (t_{q0}'')	float	1.0e-4	1.0e3
22.	Frequency relay number	int	0	20
23.	Voltage relay number	int	0	20

Explanation for the entries in the table 3.16 is as follows -

- Generator bus number is the bus number to which the generator is connected. This number should match with the bus number present in the `Generator Bus Data' stream.
- Type of modeling is interpreted as -
    1. Simple representation of voltage behind transient direct axis reactance.
    2. Representation with transient reactance and time constants.
    3. Representation with transient and sub-transient reactances and time constants.
- The machine data used for modeling depends on the type of model. But irrespective of the model, all the data values should be given as input. But the values not considered in the model are ignored.
- All the machine parameters are given in p.u on the machine rating for individual machines. Machine rating in MVA and number of units are used to convert the parameters to a common base.
- Since the machine parameters are per machine, number of units is read to convert the machine parameters to a common base.

- If the machine parameters are already available in common base for the equivalent system (considering number of machines in parallel), then machine rating is given as common base MVA and number of units in parallel as 1.
- Frequency and voltage dependent tripping of generator is possible in **POWERTRS**. Under frequency and under voltage relay numbers to be referred to isolate the generator is given in columns 21 and 22 respectively.

For asynchronous motors (induction motors), 14 fields are read for each motor. Figure 3.11 gives the modeling of Induction motor.

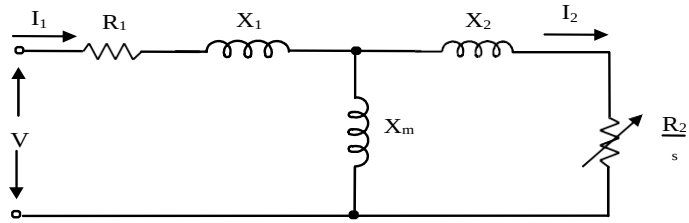


Figure 3.11 - Equivalent Circuit Diagram of Induction Motor

Table 3.17 gives the fields read for each induction motor.

Table 3.17 : Induction Motor Parameter Data

Sl No.	Description	Type	Min	Max
1.	Motor bus number	int	1	9999
2.	Type of modeling	int	4	6
3.	Number of units	int	0	999
4.	Motor MVA rating	float	1.0e-3	1.0e6
5.	Inertia constant (H- MJ/ MVA) in seconds	float	1.0e-3	1.0e4
6.	Stator resistance in pu. (r_1)	float	0.0	1.0e2
7.	Stator reactance in pu (x_1)	float	1.0e-4	1.0e2
8.	Rotor resistance in pu (r_2) at Slip = 1	float	1.0e-4	1.0e2
9.	Rotor reactance in pu (x_2) at Slip = 1	float	1.0e-4	1.0e2
10.	Rotor resistance in pu (r_2) at Slip = 0	float	1.0e-4	1.0e2
11.	Rotor reactance in pu (x_2) at Slip = 0	float	1.0e-4	1.0e2
12.	Magnetizing reactance in pu (x_m)	float	1.0e-4	1.0e3
13.	Initial motor slip (s) in pu	float	0.0	1.0
14.	C1	float	0.0	1.0
15.	C2	float	0.0	1.0
16.	C3	float	0.0	1.0
17.	Motor rated power in MW	float	1.0e-4	1.0e2
18.	Mode	int	0	2
19.	Slip set (tap-cutoff-slip for sync. Motor)	float	0.10000	1.0
20.	Time Cut-off	float	0.0	1.0e2
21.	Auto tap	float	0.0	1.000

22.	Resistance-Start	float	1.0e-4	1.0e2
23.	Resistance-end	float	1.0e-4	1.0e2
24.	Frequency relay number	int	0	20
25.	Voltage relay number	int	0	20

Explanations for the entries in the table 3.17 are as follows -

- Motor bus number is the bus number to which the motor is connected.
- Model type is usually 4 for induction motor. Type 1 to 3 is reserved for generators. Model type 10 refers to Characteristic modeling of motor.

For Model type 4 –

- Motor parameters should be given in pu on a common base, selected for the study.
- During Motor starting on load the torque of the motor is given by,

$T = Tc (C_1 + C_2N + C_3N^2)$

where,

T_c : No-load torque,
C_1 : Constant independent of Speed,
C_2 : Constant proportional to speed and
C_3 : Constant proportional to square of the speed.

Sum of these constants is 1(C1+ C2+ C3 =1.0).

If the sum of these constants is greater than 1.0, then the load modeling is considered from speed vs torque characteristics.

- If the initial slip is 1.0, motor is at stand still and the study is equivalent to starting of the motor. If the motor is already running, then corresponding slip value should be given.
- Mode is interpreted as
  0 – Auto-transformer /DOL start
  1 – Resistance start, the starting resistance and the ending resistance should be given
  2 – Star delta start
- Slip set is the steady state slip of the motor in pu.
- Time cut-off in seconds
- The auto tap implies the auto transformer tap setting during starting in pu.
- Frequency and voltage dependent tripping of motor is possible in **POWERTRS**. Under frequency and under voltage relay numbers to be referred to isolate the motor are given in columns 24 and 25 respectively.

In case of synchronous motor starting-

- Synchronous motor is considered as a generator of model type 3 with negative MW power. In initial stages of starting the motor is considered as induction motor and at the slip equal to tap-cutoff-slip the modeling is considered as synchronous motor.

- The input data is same as generator input data with the model type 6 in case of auto-transformer starting otherwise detailed model of generator (type 3) is to be considered. In addition to this data additional motor specific data has to be given. The sample form at is as follows.

Motor bus no	:	15	Bus name	:	BUS15
Model type	:	6	units	:	1
MVA	:	3.75	H	:	7.73000
Ra	:	0.00372	xd'	:	0.01013
xq'	:	0.02743	xn	:	0.16087
x0	:	2.24962	df	:	1.00000
xd	:	1.00000	xq	:	0.00000
xp	:	0.00000	xd''	:	0.00000
xq''	:	0.10000	tdo'	:	1.00000
tqo'	:	0.00000	tdo''	:	0.00000
tqo''	:	1.00000	Frequency Relay No	:	5
Voltage Relay No	:	0	c1	:	1.00000
c2	:	0.00000	c3	:	0.00000
p	:	1.00000	slip	:	0.00000
tap-cutoff-slip	:	0.06000	auto-tap	:	0.02400
Vfld	:	0.00000	rf-ext	:	0.0000

Here Vfld and rf-ext are not used at present.

If the sum of the constants C1+C2+C3 is greater than 1.0, then the load modeling is considered from speed vs torque characteristics. The motor data from column 1 to 25 is read. This is followed by number of characteristic points. For each point the Table 3.17 – a gives the fields read

Table 3.17-a : Induction Motor Load Characteristic data

Sl No.	Description	Type	Min	Max
1.	Speed in pu	float	.1	1
2.	Power in pu	float	0.0	6

For Model Type 10 -
Column number 1 to 4 are read. This is followed by number of characteristic data. Table 3.17-b gives the fields read for each characteristic data. Number of lines of data is equal to number of characteristic data.

Table 3.17-b : Induction Motor Characteristic data

Sl No.	Description	Type	Min	Max
3.	Time in seconds	float	1	9999
4.	Real power in pu	float	0	6
5.	Reactive power in pu	float	0	6

Stream 18: Voltage Regulator Data

In this stream, voltage regulator details are given. Figures 3.11 to 3.16 give different IEEE types of regulators that are modeled in **POWERTRS**. Voltage regulators given under this stream should not include the regulators realized using the free programmable blocks.

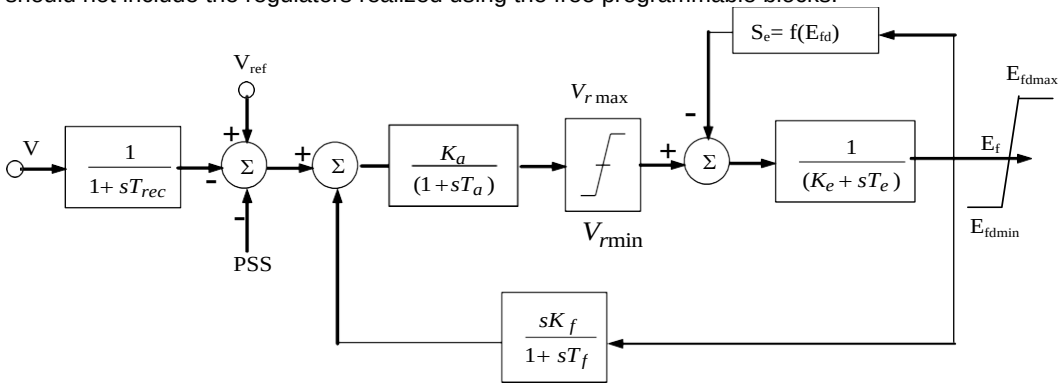


Figure 3.11 - Excitation System Type 1

Typical Parameters

Parameter Value	Parameter Value
T_{rec} 0.01 -- 0.10	T_a 0.025 -- 0.2
T_s T_c 0.5 -- 1.0	T_f 0.5 -- 1.0
K_a 25 -- 200	K_e -0.5 -- 1.0
k_f 0.01 -- 0.1	

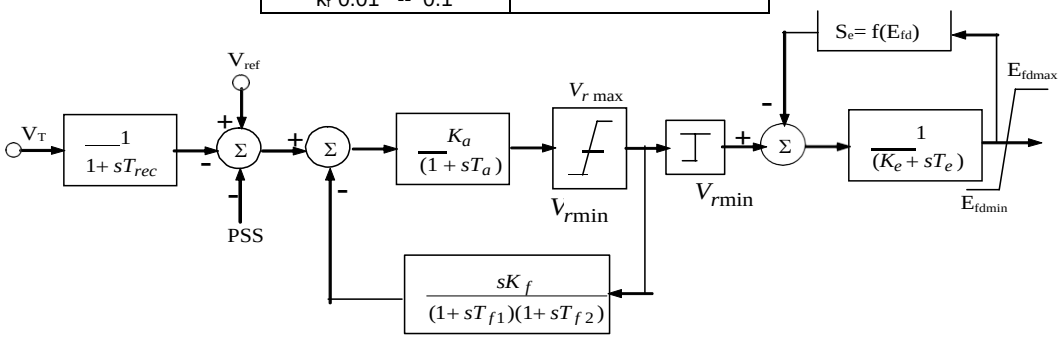


Figure 3.12- Excitation System Type - 2

Typical Parameters

Parameter Value	Parameter Value
T_{rec} 0.01 --- 0.05	T_a 0.01 --- 0.05
T_e 0.5 --- 1.0	$T_{f1} \cong$ 1.0
$T_{f2} \cong$ 0.1	K_a 50--200-400-600
$K_e \cong$ 1.0	K_f 0.01 - 0.05

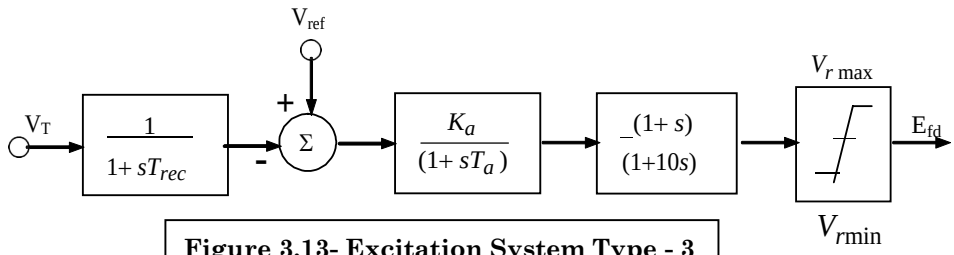


Figure 3.13- Excitation System Type - 3

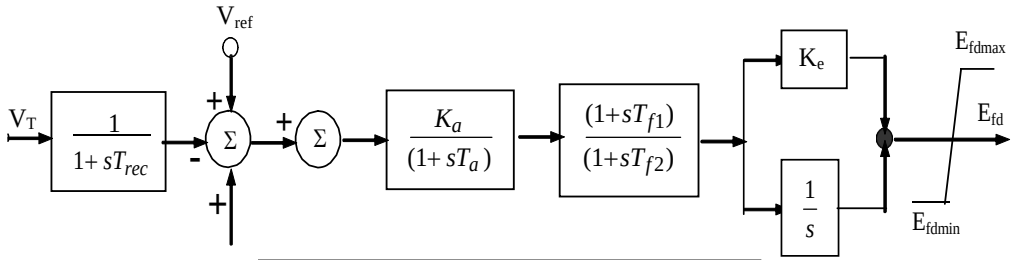


Figure 3.14- Excitation System Type-4

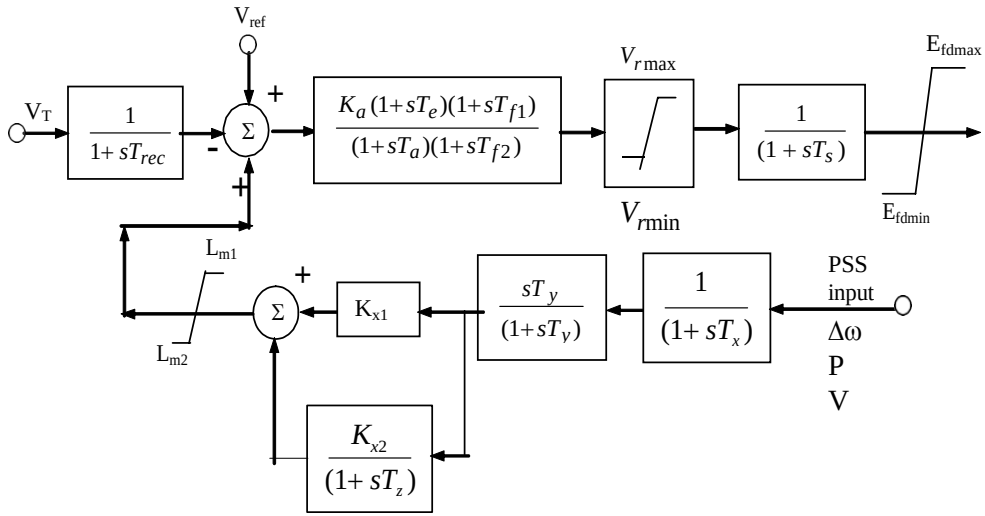


Figure 3.15 - Excitation System Type - 5

Typical Parameters

Parameter Value	Parameter Value
T_{rec} 0.01 -- 0.025	T_s 0.025
$T_e \cong$ 1.0	$T_{f1} \cong$ 0.06
T_a 40.0	$T_{f2} \cong$ 0.024
$k_a \cong$ 200.0	

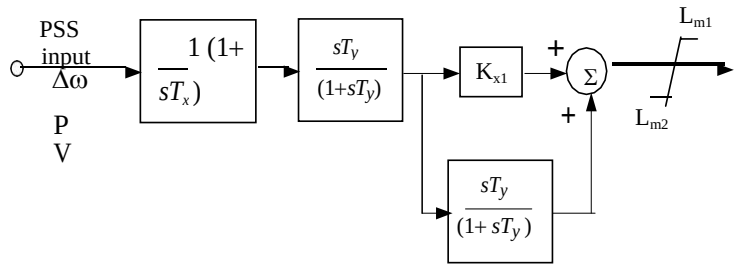


Figure 3.16 - Power System Stabilizer Type - 1

For each regulator 18 fields are read. Data appearing under different fields for each regulator is given in table 3.18.

Table 3.18 : Voltage Regulator Details

Sl No.	Description	Type	Min	Max
1.	Bus number	int	1	9999
2.	Type of AVR	int	0	10
3.	PSS status	int	0	10
4.	Gain of amplifier (K_a)	float	0.0	100.0
5.	Time constant of amplifier (T_a)	float	0.0	10.0
6.	Gain of exciter (K_e)	float	-100.0	100.0
7.	Exciter time constant (T_e)	float	0.0	10.0
8.	(V_k f)	float	0.0	10.0
9.	(T_{f1})	float	0.0	10.0
10.	(T_{f2})	float	0.0	100.0
11.	Input filter time constant (T_{rec})	float	0.0	10.0
12.	(V_{ts})	float	0.0	100.0
13.	Saturation function value (V_{se1}) at 0.75 times E_{fdmax},	float	0.0	10.0
14.	Saturation function value (V_{se2}) at E_{fdmax},	float	0.0	10.0
15.	Maximum regulator output (V_{rmax})	float	0.0	10.0
16.	Minimum regulator output (V_{rmin})	float	-10.0	0.0
17.	Maximum excitor output (E_{fdmax})	float	0.0	10.0
18.	Minimum excitor output (E_{fdmin})	float	-10.0	0.0

Explanations for the entries in table 3.18 are as follows -

- Figures 3.11 to 3.16 can be referred to know the significance of each value.
- Bus number refers to the generator bus number to which the regulator is associated.
- Type field is interpreted as 1 for IEEE type 1, ..., 5 for IEEE type 5.
- Even though in some block schematics, values indicated are not present, 18 fields should be given for each regulator. Gain value is given as 0.0 and time constant as 99.9 whenever the block or constant is not referred in the figure.
- PSS (power system stabilizer) status is interpreted as -
  - 0 : PSS is not present.
  - 1 : PSS is present.

If the PSS is present, then 7 additional fields are read for each PSS. Referring to the PSS figure 3.16, the float fields read in order are K_{x1},, K_{x2},, T_x,, T_y,, Tz, lm_1, and lm_2.. All the fields are separated by one or more blanks.

Stream 19: Governor Data

In this stream of data, governor details are given. Figures 3.17 and 3.18 give modeling of governor for steam and hydro turbines respectively.

Speed Governor Systems:

The prime source of electrical energy supplied by utilities is the kinetic energy of water and the thermal energy derived from fossil fuels and nuclear fission. The prime movers convert these sources of energy into mechanical energy that is in turn converted to electrical energy by synchronous generators. The prime movers governing systems provide a means of controlling power and frequency -a function commonly referred to as load - frequency control or automatic - generation control (AGC).

During increase or decrease of load, the governor system provides a means for controlling power and frequency.

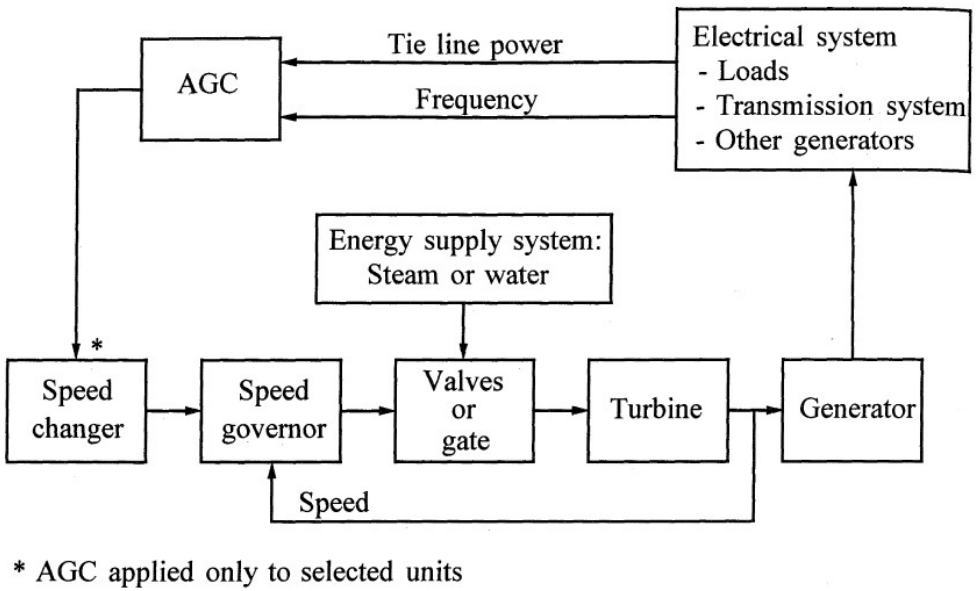


Figure 3.17: Speed Governing System

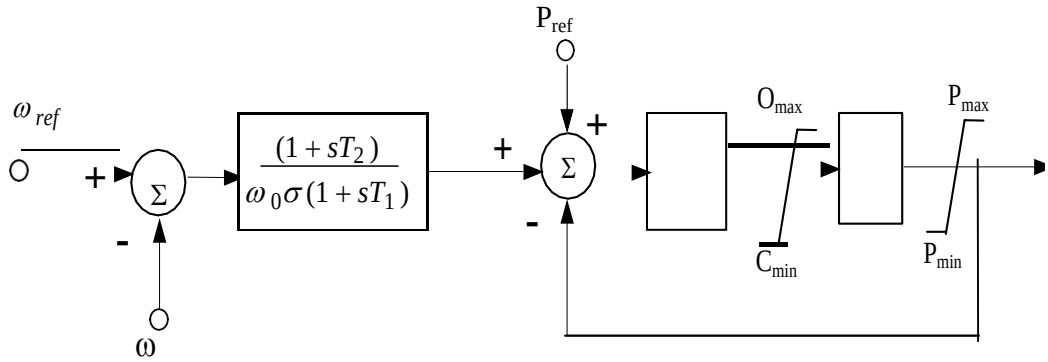


Figure 3.18 (a) : Block schematic of Steam Governor System

Typical Parameters

Parameter	Value	Parameter	Value
σ	0.04 - 0.05	P_{max}	1.00
T_1	0.10	P_{min}	0.00
T_2	0.03	O_{max}	0.10
T_3	0.40	C_{min}	-1.00

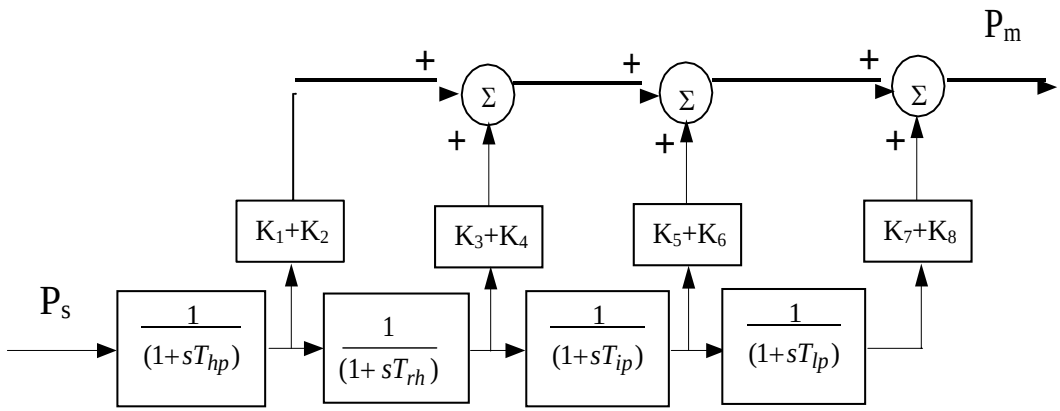


Figure 3.18 (b) : Turbine System Model for Steam Turbines (Type - 1) Governor

Typical Parameters

Parameter	Value	Parameter	Value	Parameter	Value
T_{hp}	0.26	k_1	0.2760	$k_1 + k_2$	VHP
T_{rh}	10.0	k_3	0.324	$k_3 + k_4$	HP
T_{lp}	0.5	k_5	0.4	$k_5 + k_6$	IP
T_{ip}	99.9	k_7	0.0	$k_7 + k_8$	LP

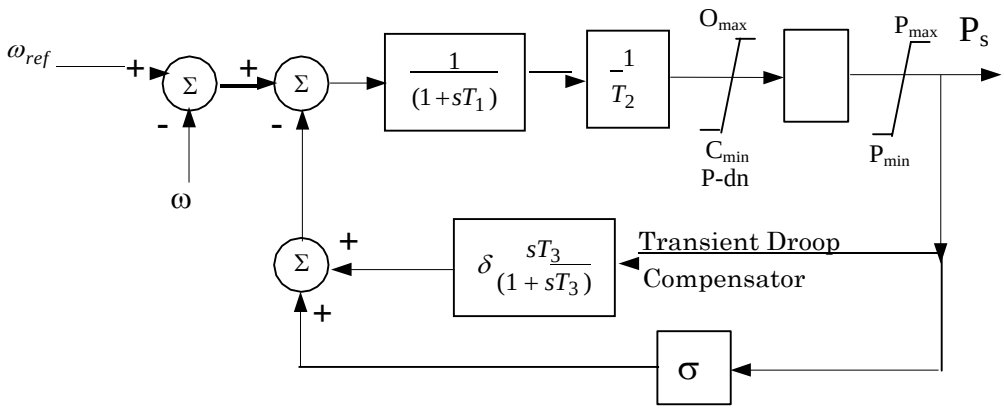


Figure 3.19 (a) : Hydro Speed Governing System (Type - 2)

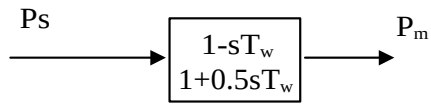


Figure 3.19 (b): Block Schematic of Hydro Turbine

Typical Parameters

Parameter	Value	Parameter	Value
δ	0.36	Pmax	1.10
σ	0.04	Pmin	0.00
T1	0.05	Pup	0.10
T2	0.20	Pdown	-1.00
T3	5.00	T_w	1.00

For steam turbine unit, 19 fields are read. Data appearing under different columns are given in table 3.19.

Table 3.19 : Steam turbine - governor Data				
Sl No.	**Description**	**Type**	**Min**	**Max**
1.	Bus number	int	0	9999
2.	Governor type	int	0	10
3.	Number of units	int	1	10
4.	Governor droop	float	0.0	1.0
5.	Maximum power output of governor in pu	float	0.0	10.0
6.	Minimum power output of governor in pu	float	0.0	10.0

Table 3.19 : Steam turbine - governor Data (Continued)				
Sl No.	**Description**	**Type**	**Min**	**Max**
7.	Power up in pu	float	0.0	10.0
8.	Power down in pu	float	-10.0	10.0
9.	Gain constants of turbine ($K_1 + K_2$)	float	0.0	10.0
10.	Gain constants of turbine ($K_3 + K_4$)	float	0.0	10.0
11.	Gain constants of turbine ($K_5 + K_6$)	float	0.0	10.0
12.	Gain constants of turbine ($K_7 + K_8$)	float	0.0	10.0
13.	Governor time constants T_1	float	0.0	1.0e3
14.	Governor time constants T_2	float	0.0	1.0e3
15.	Governor time constants T_3	float	0.0	1.0e3
16.	High pressure turbine time constant T_{hp}	float	0.0	1.0e3
17.	Reheat time constant T_{rh}	float	0.0	1.0e3
18.	Intermediate pressure turbine time constant T_{ip}	float	0.0	1.0e3
19.	Low pressure turbine time constant T_{lp}	float	0.0	1.0e3

Explanations for the entries in table 3.19 are as follows -

- Bus number is the generator bus to which the governor is connected.
- Governor type field should be 1 for steam turbine governor model.
- Number of units refers to number of generating units in parallel.
- Governor droop should be given as 0.04 if the droop is 4 percent. The droop is for per machine on its rating.
- Maximum and minimum power outputs of turbine are in p.u on machine rating.
- Rate of opening and closing of valve is per machine and the unit is p.u per second.
- Sum of gain constants K_1 to K_8 should be unity.

For hydro turbine unit, 13 fields are read. Data appearing under different columns are given in table 3.20.

Table 3.20 : Hydro turbine - governor Data				
Sl No.	**Description**	**Type**	**Min**	**Max**
1.	Bus number	int	0	9999
2.	Governor type	int	0	10

4.	Governor droop	float	0.0	1.0
5.	Transient droop	float	0.0	1.0
6.	Maximum power output of governor in pu	float	0.0	10.0
7.	Minimum power output of governor in pu	float	0.0	10.0
8.	Rate of valve opening in pu power/sec	float	0.0	10.0
9.	Rate of valve closing in pu power/sec	float	-10.0	10.0
10.	Governor time constants T_1	float	1.0e-4	1.0e3
11.	Governor time constants T_2	float	1.0e-4	1.0e3
12.	Governor time constants T_3	float	1.0e-4	1.0e3
13.	Water time constant T_w	float	1.0e-4	1.0e3

Explanations for the entries in table 3.20 are as follows –

- Bus number is the generator bus to which the governor is connected.
- Governor type field should be 2 for hydro turbine governor model.
- Number of units refers to number of generating units in parallel.
- Governor droop should be given as 0.04 if the droop is 4 percent. The droop is for per machine on its rating. Hydro governor systems have both permanent droop setting and transient droop setting.
- Maximum and minimum power outputs of turbine are in p.u on machine rating.
- Rate of opening and closing of valve is per machine and the unit is p.u per second.

Stream 20: Wind Turbine Generator Data

In this stream of data, wind generator details are given. There are basically four IEEE standard models. They are as shown below.

Wind Turbine Model	Description
WT1	Squirrel cage induction generator type wind turbine
WT2	Variable rotor resistance induction generator type wind turbine (WT2)
WT3	Doubly fed induction generator type wind turbine (WT3) generally called as DFIG type model
WT4	Full converter type wind turbine (WT4)

WT1 Model: The mechanical power output of the wind turbine will come from pseudo governor model. The mechanical power output is given as input to the squirrel cage induction machine model. The electrical machine model will compute the real, reactive power generation, operating slip and other steady state operating parameters. Control flow block diagram is given below.

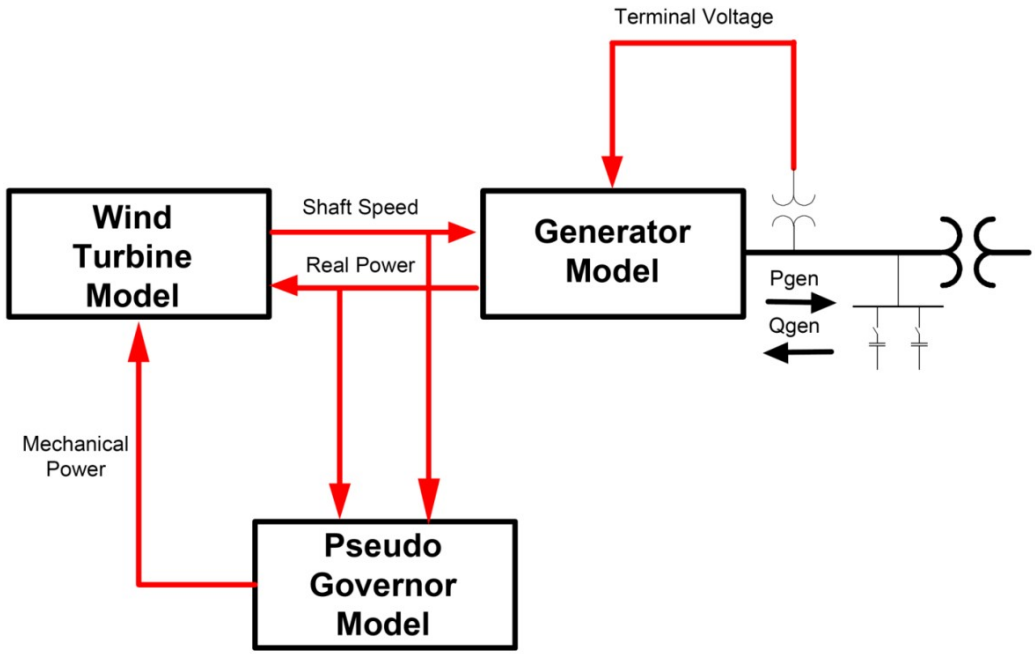


Figure 3.17: WT1 type Wind Turbine

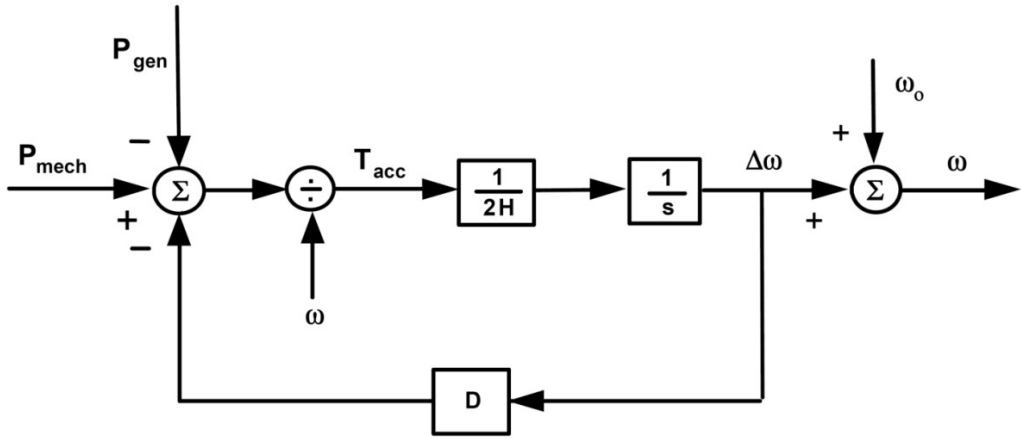


Figure 3.17: One mass model drive train system

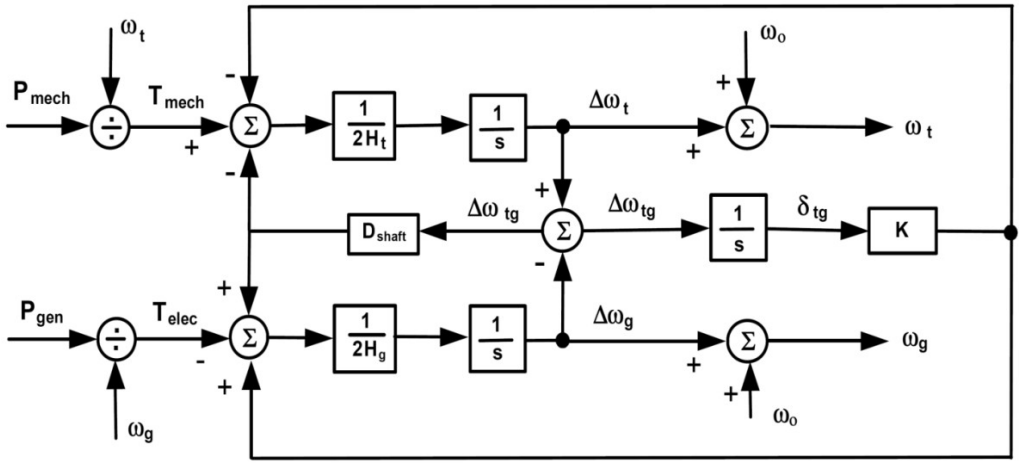


Figure 3.17: Two mass model drive train system

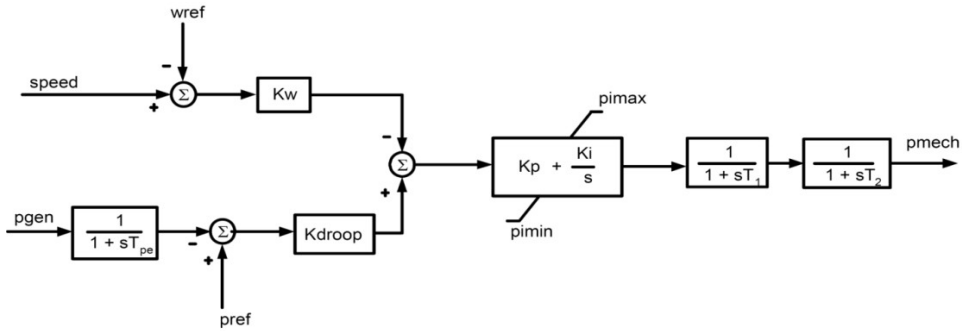


Figure 3.17: Pseudo Governor Model

WT2 Model: The mechanical power output of the wind turbine will come from pseudo governor model. The same is given as input to the induction machine model with rotor resistance controllable. The electrical machine model will compute the real, reactive power generation, operating slip and other steady state operating parameters. Control flow block diagram is given below.

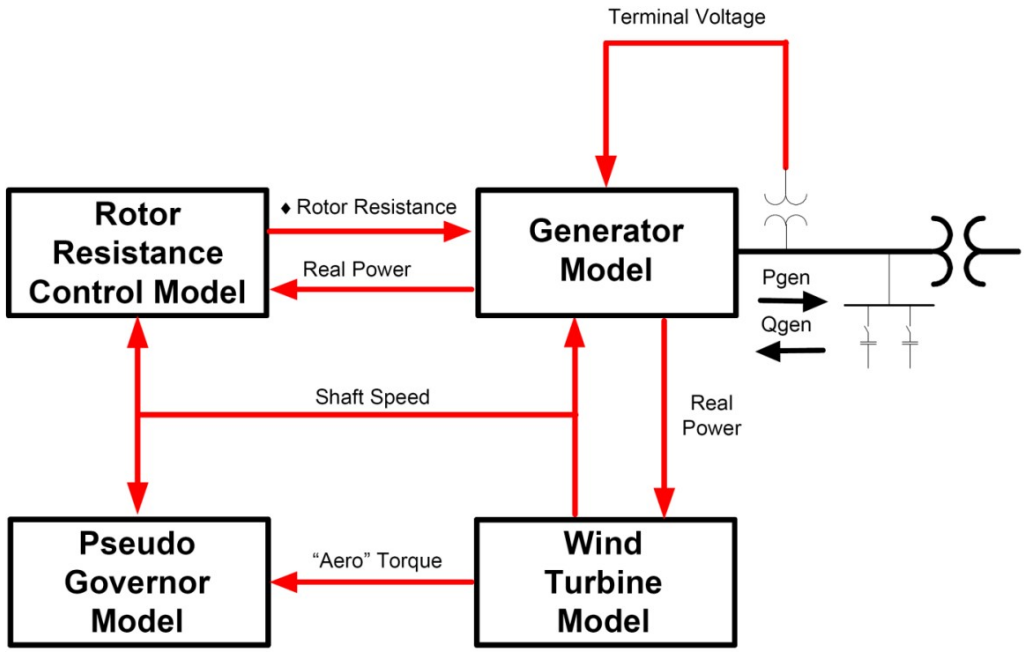


Figure 3.17: WT2 type Wind Turbine

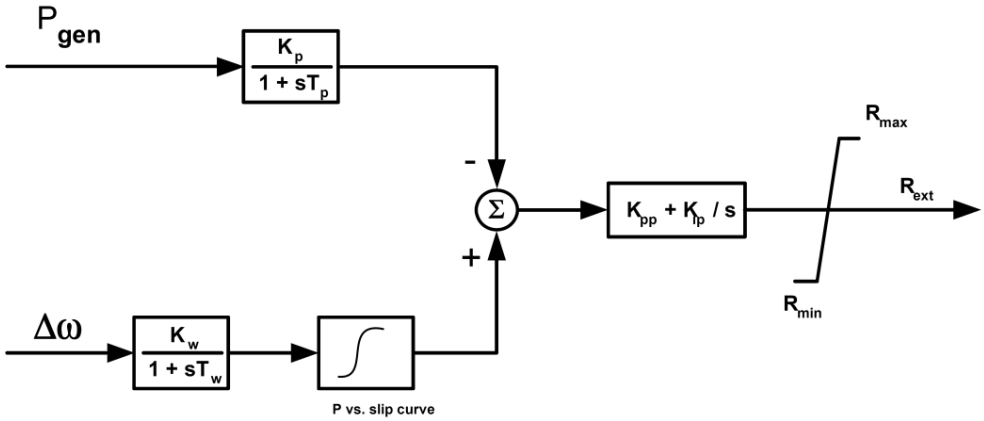


Figure 3.17: External Rotor Resistance Control model

WT3 Model: The mechanical power output of the wind turbine is calculated based on the power curve (Mechanical power to wind speed). Pitch regulation will be given by pitch control model. Power electronic converter block set & machine behavior will be replicated through converter control model and generator/converter model. Control flow block diagram is given below.

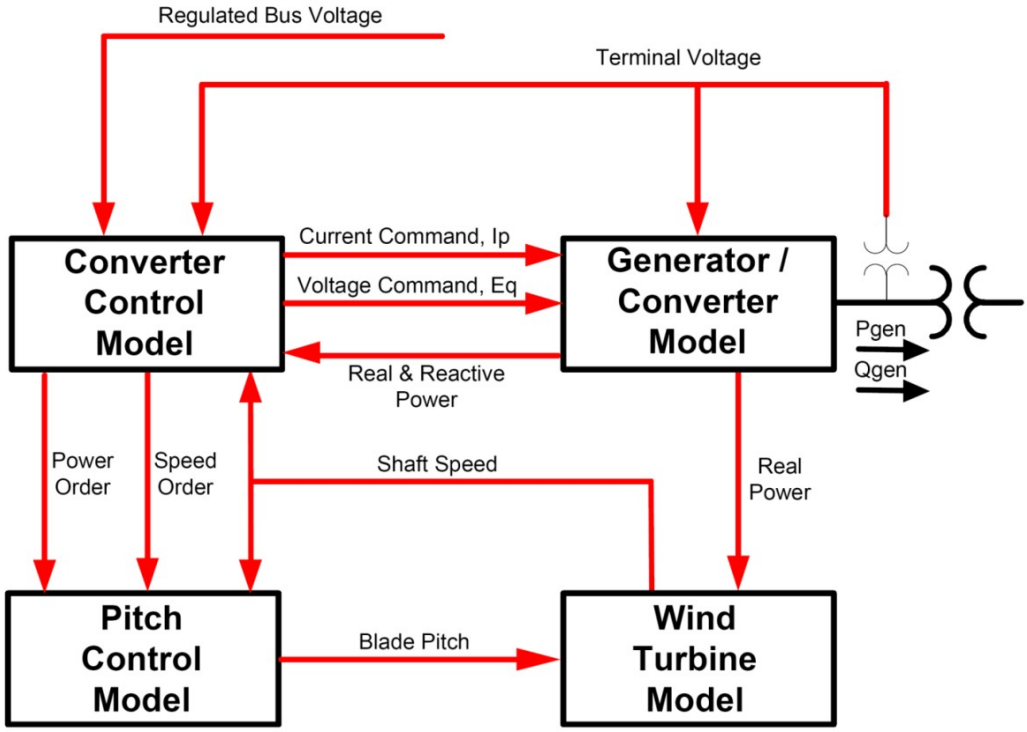


Figure 3.17: WT3 type Wind Turbine

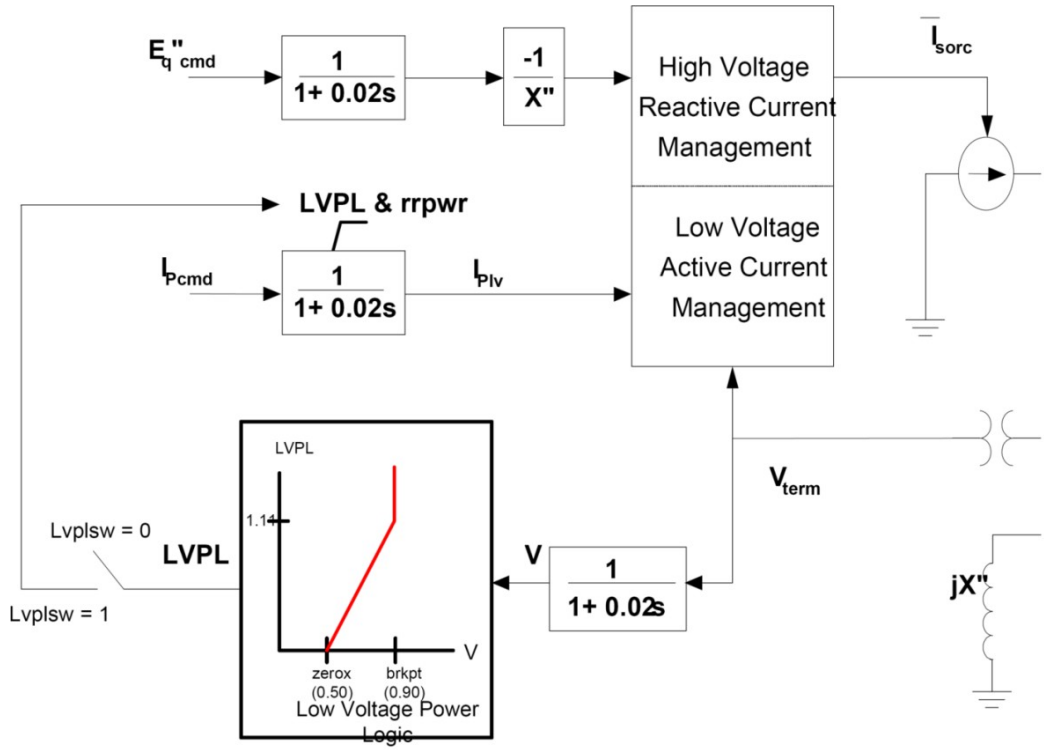


Figure 3.17: DFIG/Full Converter Generator Model

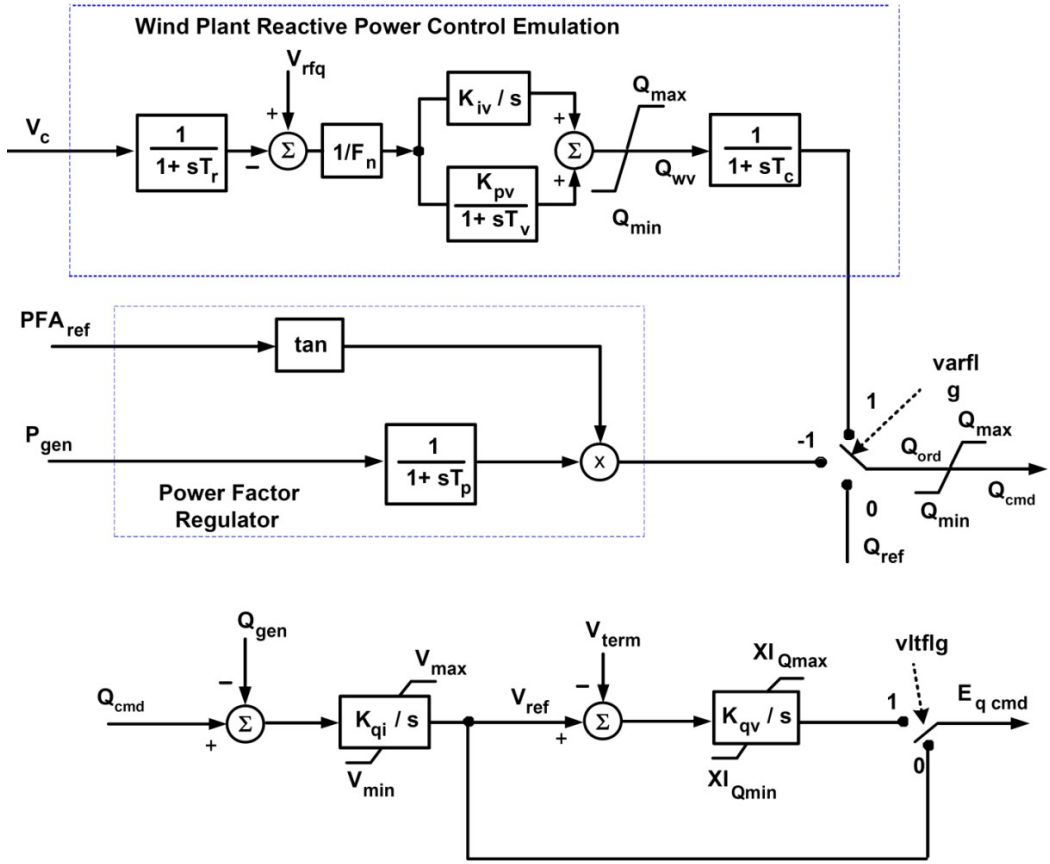


Figure 3.17: DFIG Reactive Power Control Model

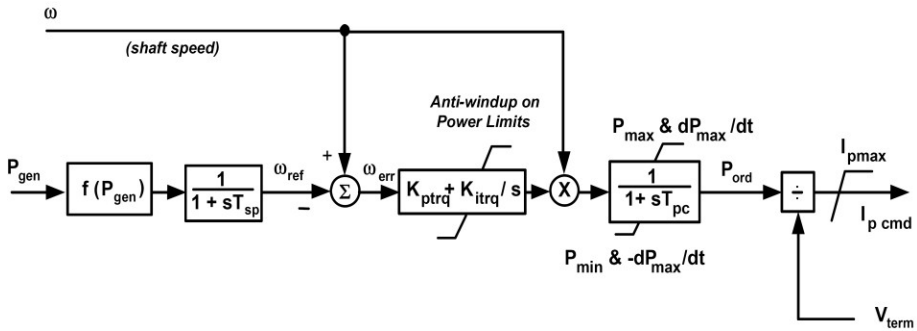


Figure 3.17: Active Power Control Model

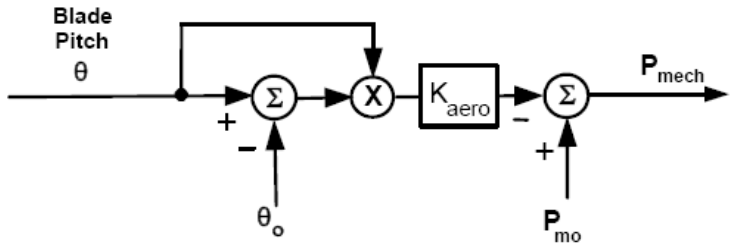


Figure 3.17: Aerodynamic Control Model

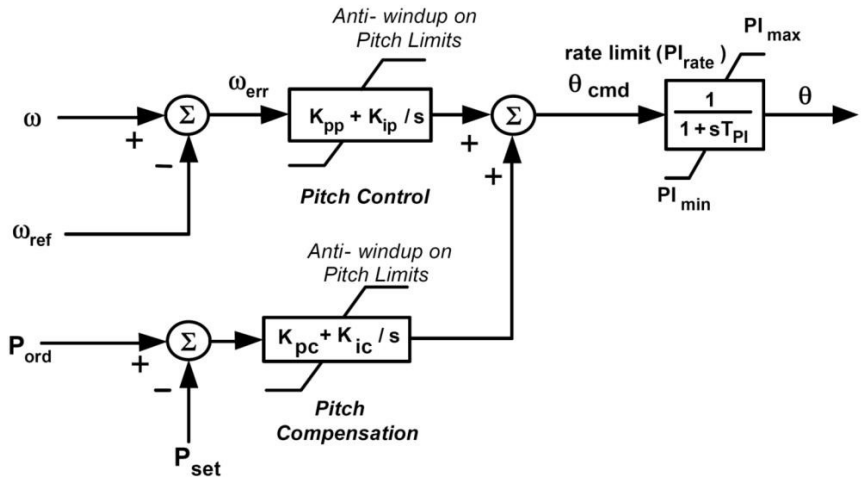


Figure 3.17: Pitch Control Model

WT4 Model: The mechanical power output of the wind turbine is calculated based on the power curve (Mechanical power to wind speed). Power electronic converter block set & machine behavior will be replicated through converter control model and generator/converter model. Control flow block diagram is given below.

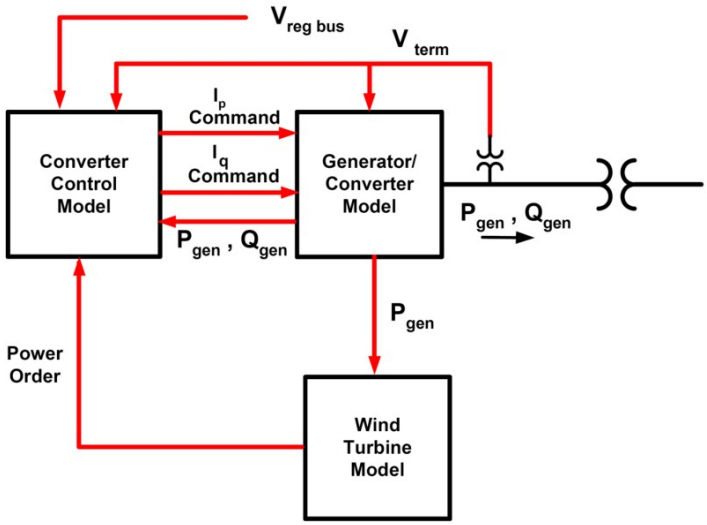


Figure 3.17: WT4 type Wind Turbine

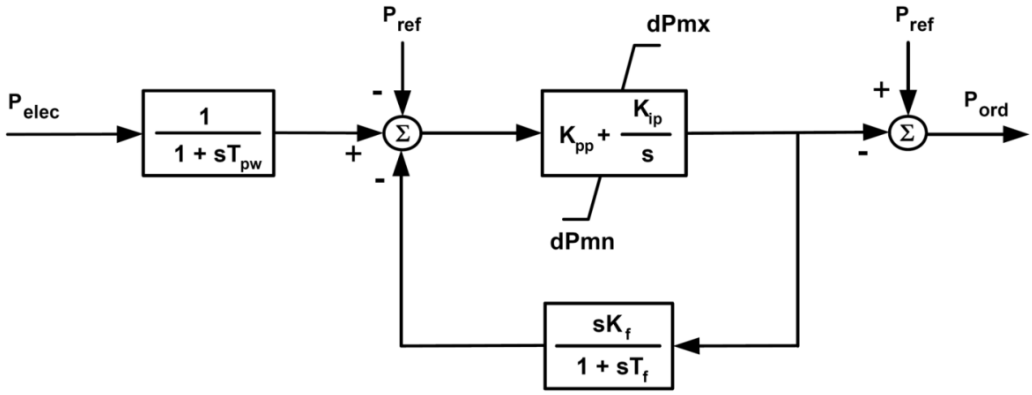


Figure 3.17: Turbine Model

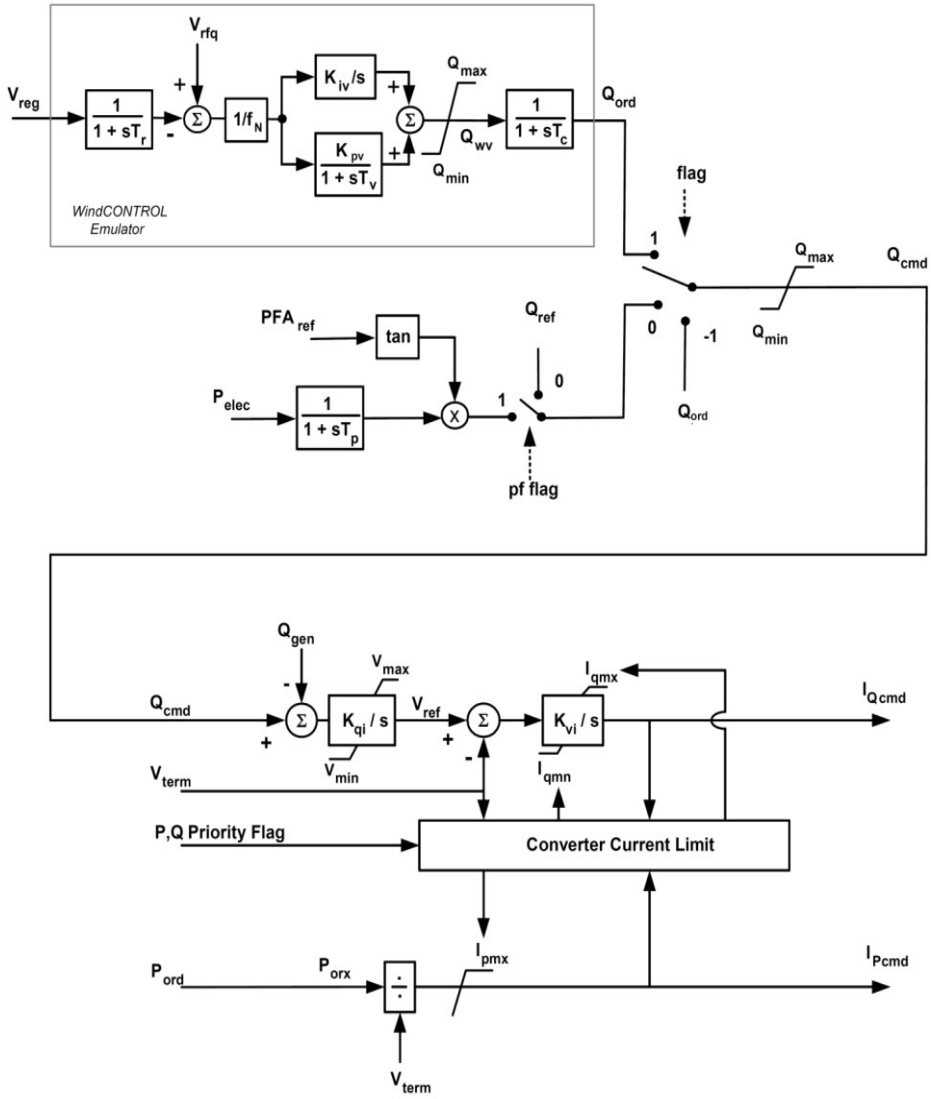


Figure 3.17: Converter Control Model

The data entry format for each model is different. The data that appears in different columns of each line for each model are given in Table 3.12, Table 3.13, Table 3.14, and Table 3.15 respectively.

Table 3.12 – Wind Generator Data for WT1

Col No.	Description	Type	Min	Max
1	Status	Int	0	3
2	WT Generator bus number	Int	1	9999
3	WT Generator model number	Int	1	4
4	No. of Turbines in the wind farm	Int	1	9999
5	MVA rating	Double	0.0	1.0e6
6	Drive Train model	Int	1	2
7	Shunt impedance of reactive power injection	Double	-1.0e6	1.0e6
8	No. of poles (only even numbers)	Int	2	9999
9	Gearbox ratio	Double	0.001	1.0e6
10	Turbine diameter in m	Double	-1.0e6	1.0e6
11	Stator resistance (Rs)	Double	0	1.0e6
12	Stator reactance (Xs)	Double	0	1.0e6
13	Rotor resistance (Rr)	Double	0	1.0e6
14	Rotor reactance (Xr)	Double	0	1.0e6
15	Magnetizing reactance (Xm)	Double	0	1.0e6
16	Turbine shaft inertia (Hw)	Double	0	1.0e6
17	Generator shaft inertia (Hg)	Double	0	1.0e6
18	Shaft stiffness constant (K)	Double	0	1.0e6
19	Turbine damping constant (Dw)	Double	0	1.0e6
20	Machine damping constant (Dg)	Double	0	1.0e6
21	Shaft damping constant (Ds)	Double	0	1.0e6
22	Wind Speed (m/s)	Double	0	50
23	Air Density (kg/m^3)	Double	0	3
24	Pitch Angle	Double	0	180
25	Shaft Angle	Double	0	180
26	Operating slip	Double	0	2
27	Operating real power	Double	0	1.0e6
28	Tpe	Double	-1.0e6	1.0e6
29	Kw	Double	-1.0e6	1.0e6
30	Kdroop	Double	-1.0e6	1.0e6
31	Kp	Double	-1.0e6	1.0e6
32	Ki	Double	-1.0e6	1.0e6
33	Pimax	Double	-1.0e6	1.0e6
34	Pimin	Double	-1.0e6	1.0e6
35	T1	Double	-1.0e6	1.0e6
36	T2	Double	-1.0e6	1.0e6

Table 3.13 – Wind Generator Data for WT2				
Col No.	**Description**	**Type**	**Min**	**Max**
1	Status	Int	0	3
2	WT Generator bus number	Int	1	9999
3	WT Generator model number	Int	1	4
4	No. of Turbines in the wind farm	Int	1	9999
5	MVA rating	Double	0.0	1.0e6
6	Drive Train model	Int	1	2
7	Shunt impedance of reactive power injection	Double	-1.0e6	1.0e6
8	No. of poles (only even numbers)	Int	2	9999
9	Gearbox ratio	Double	0.001	1.0e6
10	Turbine diameter in m	Double	-1.0e6	1.0e6
11	Optimum real power to operating slip curve	Int	1	9999
12	Stator resistance (Rs)	Double	0	1.0e6
13	Stator reactance (Xs)	Double	0	1.0e6
14	Rotor resistance (Rr)	Double	0	1.0e6
15	Rotor reactance (Xr)	Double	0	1.0e6
16	Magnetizing reactance (Xm)	Double	0	1.0e6
17	Turbine shaft inertia (Hw)	Double	0	1.0e6
18	Generator shaft inertia (Hg)	Double	0	1.0e6
19	Shaft stiffness constant (K)	Double	0	1.0e6
20	Turbine damping constant (Dw)	Double	0	1.0e6
21	Machine damping constant (Dg)	Double	0	1.0e6
22	Shaft damping constant (Ds)	Double	0	1.0e6
23	Wind Speed (m/s)	Double	0	50
24	Air Density (kg/m^3)	Double	0	3
25	Pitch Angle	Double	0	180
26	Shaft Angle	Double	0	180
27	Operating slip	Double	0	2
28	Operating real power	Double	0	1.0e6
29	Tpe	Double	-1.0e6	1.0e6
30	Kw	Double	-1.0e6	1.0e6
31	Kdroop	Double	-1.0e6	1.0e6
32	Kp	Double	-1.0e6	1.0e6
33	Ki	Double	-1.0e6	1.0e6
34	Pimax	Double	-1.0e6	1.0e6
35	Pimin	Double	-1.0e6	1.0e6
36	T1	Double	-1.0e6	1.0e6
37	T2	Double	-1.0e6	1.0e6
38	Kp	Double	-1.0e6	1.0e6
39	Tp	Double	-1.0e6	1.0e6
40	Kw	Double	-1.0e6	1.0e6
41	Tw	Double	-1.0e6	1.0e6
42	Kpp	Double	-1.0e6	1.0e6

43	Kip	Double	-1.0e6	1.0e6
44	Rmin	Double	-1.0e6	1.0e6
45	Rmax	Double	-1.0e6	1.0e6

Table 3.14 – Wind Generator Data for WT3

Col No.	Description	Type	Min	Max
1	Status	Int	0	3
2	WT Generator bus number	Int	1	9999
3	WT Generator model number	Int	1	4
4	No. of Turbines in the wind farm	Int	1	9999
5	MVA rating	Double	0.0	1.0e6
6	Drive Train model	Int	1	2
7	Shunt impedance of reactive power injection	Double	-1.0e6	1.0e6
8	No. of poles (only even numbers)	Int	2	9999
9	Gearbox ratio	Double	0.001	1.0e6
10	Turbine diameter in m	Double	-1.0e6	1.0e6
11	Power curve	Int	1	9999
12	Operating mechanical power Vs operating slip	Int	1	9999
13	Power curve type	Int	1	9999
14	Stator resistance (Rs)	Double	0	1.0e6
15	Stator reactance (Xs)	Double	0	1.0e6
16	Rotor resistance (Rr)	Double	0	1.0e6
17	Rotor reactance (Xr)	Double	0	1.0e6
18	Magnetizing reactance (Xm)	Double	0	1.0e6
19	Turbine shaft inertia (Hw)	Double	0	1.0e6
20	Generator shaft inertia (Hg)	Double	0	1.0e6
21	Shaft stiffness constant (K)	Double	0	1.0e6
22	Turbine damping constant (Dw)	Double	0	1.0e6
23	Machine damping constant (Dg)	Double	0	1.0e6
24	Shaft damping constant (Ds)	Double	0	1.0e6
25	Wind Speed (m/s)	Double	0	50
26	Air Density (kg/m^3)	Double	0	3
27	Pitch Angle	Double	0	180
28	Shaft Angle	Double	0	180
29	Operating slip	Double	0	2
30	Operating real power	Double	0	1.0e6
31	Operating reactive power	Double	0	1.0e6
32	varflg – VAR control flag	Int	0	1
33	pfaflg – Power factor control flag	Int	0	1
34	vltflg – Voltage control flag	Int	0	1
35	apcflg – Active power control flag	Int	0	1
36	wfflg – Turbine control flag	Int	0	1
37	fcflg – Frequency control flag	Int	0	1

38	Voltage control bus	Int	1	9999
39	Real power reference	Double	0	1.0e6
40	Reactive power reference	Double	0	1.0e6
41	kptrq	Double	0	1.0e6
42	kitrq	Double	0	1.0e6
43	Pwrat	Double	0	1.0e6
44	Pwmin	Double	0	1.0e6
45	Pwmax	Double	0	1.0e6
46	tp	Double	0	1.0e6
47	tpc	Double	0	1.0e6
48	kpp	Double	0	1.0e6
49	kip	Double	0	1.0e6
50	kpc	Double	0	1.0e6
51	kic	Double	0	1.0e6
52	Pimax	Double	0	1.0e6
53	Pimin	Double	0	1.0e6
54	Pirat	Double	0	1.0e6
55	tr	Double	0	1.0e6
56	Fn	Double	0	1.0e6
57	kiv	Double	0	1.0e6
58	tv	Double	0	1.0e6
59	kpv	Double	0	1.0e6
60	Qmin	Double	0	1.0e6
61	Qmax	Double	0	1.0e6
62	tc	Double	0	1.0e6
63	tpwr	Double	0	1.0e6
64	kqi	Double	0	1.0e6
65	Vmin	Double	0	1.0e6
66	Vmax	Double	0	1.0e6
67	kqv	Double	0	1.0e6
68	ipmax	Double	0	1.0e6
69	zerox	Double	0	1.0e6
70	brkpt	Double	0	1.0e6
71	Xdd	Double	0	1.0e6
72	XiQmax	Double	0	1.0e6
73	XiQmin	Double	0	1.0e6
74	Vl1	Double	0	1.0e6
75	Vh1	Double	0	1.0e6
76	Tl1	Double	0	1.0e6
77	Tl2	Double	0	1.0e6
78	Th1	Double	0	1.0e6
79	Th2	Double	0	1.0e6
80	Ql1	Double	0	1.0e6
81	Ql2	Double	0	1.0e6
82	Ql3	Double	0	1.0e6
83	Qh1	Double	0	1.0e6

84	Qh2	Double	0	1.0e6
85	Qh3	Double	0	1.0e6
86	dvtrp1	Double	0	1.0e6
87	dvtrp2	Double	0	1.0e6
88	dvtrp3	Double	0	1.0e6
89	dvtrp4	Double	0	1.0e6
90	dvtrp5	Double	0	1.0e6
91	dvtrp6	Double	0	1.0e6
92	dttrp1	Double	0	1.0e6
93	dttrp2	Double	0	1.0e6
94	dttrp3	Double	0	1.0e6
95	dttrp4	Double	0	1.0e6
96	dttrp5	Double	0	1.0e6
97	dttrp6	Double	0	1.0e6
98	Ipp	Double	0	1.0e6
99	rrpwr	Double	0	1.0e6
100	Xc	Double	0	1.0e6
101	kqd	Double	0	1.0e6
102	tlpqd	Double	0	1.0e6
103	Xqd	Double	0	1.0e6
104	vermn	Double	0	1.0e6
105	vermx	Double	0	1.0e6
106	vfrz	Double	0	1.0e6
107	tw	Double	0	1.0e6
108	tpav	Double	0	1.0e6
109	Pa	Double	0	1.0e6
110	Pbc	Double	0	1.0e6
111	Pd	Double	0	1.0e6
112	fa	Double	0	1.0e6
113	fb	Double	0	1.0e6
114	fc	Double	0	1.0e6
115	fd	Double	0	1.0e6
116	Pmax	Double	0	1.0e6
117	Pmin	Double	0	1.0e6
118	kwi	Double	0	1.0e6
119	dbwi	Double	0	1.0e6
120	tlpwi	Double	0	1.0e6
121	twowi	Double	0	1.0e6
122	urlwi	Double	0	1.0e6
123	drlwi	Double	0	1.0e6
124	pmxwi	Double	0	1.0e6
125	pmnwi	Double	0	1.0e6

Table 3.15 – Wind Generator Data for WT4

Col No.	Description	Type	Min	Max
1	Status	Int	0	3
2	WT Generator bus number	Int	1	9999
3	WT Generator model number	Int	1	4
4	No. of Turbines in the wind farm	Int	1	9999
5	MVA rating	Double	0.0	1.0e6
6	Drive Train model	Int	1	2
7	Shunt impedance of reactive power injection	Double	-1.0e6	1.0e6
8	No. of poles (only even numbers)	Int	2	9999
9	Gearbox ratio	Double	0.001	1.0e6
10	Turbine diameter in m	Double	-1.0e6	1.0e6
11	Power curve	Int	1	9999
12	Operating mechanical power Vs operating slip	Int	1	9999
13	Power curve type	Int	1	9999
14	Stator resistance (Rs)	Double	0	1.0e6
15	Stator reactance (Xs)	Double	0	1.0e6
16	Rotor resistance (Rr)	Double	0	1.0e6
17	Rotor reactance (Xr)	Double	0	1.0e6
18	Magnetizing reactance (Xm)	Double	0	1.0e6
19	Turbine shaft inertia (Hw)	Double	0	1.0e6
20	Generator shaft inertia (Hg)	Double	0	1.0e6
21	Shaft stiffness constant (K)	Double	0	1.0e6
22	Turbine damping constant (Dw)	Double	0	1.0e6
23	Machine damping constant (Dg)	Double	0	1.0e6
24	Shaft damping constant (Ds)	Double	0	1.0e6
25	Wind Speed (m/s)	Double	0	50
26	Air Density (kg/m^3)	Double	0	3
27	Pitch Angle	Double	0	180
28	Shaft Angle	Double	0	180
29	Operating slip	Double	0	2
30	Operating real power	Double	0	1.0e6
31	Operating reactive power	Double	0	1.0e6
32	varflg – VAR control flag	Int	0	1
33	pfaflg – Power factor control flag	Int	0	1
34	vltflg – Voltage control flag	Int	0	1
35	apcflg – Active power control flag	Int	0	1
36	wfflg – Turbine control flag	Int	0	1
37	fcflg – Frequency control flag	Int	0	1
38	Voltage control bus	Int	1	9999
39	Real power reference	Double	0	1.0e6
40	Reactive power reference	Double	0	1.0e6
41	kptrq	Double	0	1.0e6
42	kitrq	Double	0	1.0e6
43	Pwrat	Double	0	1.0e6
44	Pwmin	Double	0	1.0e6

45	Pwmax	Double	0	1.0e6
46	tp	Double	0	1.0e6
47	tpc	Double	0	1.0e6
48	kpp	Double	0	1.0e6
49	kip	Double	0	1.0e6
50	kpc	Double	0	1.0e6
51	kic	Double	0	1.0e6
52	Pimax	Double	0	1.0e6
53	Pimin	Double	0	1.0e6
54	Pirat	Double	0	1.0e6
55	tr	Double	0	1.0e6
56	Fn	Double	0	1.0e6
57	kiv	Double	0	1.0e6
58	tv	Double	0	1.0e6
59	kpv	Double	0	1.0e6
60	Qmin	Double	0	1.0e6
61	Qmax	Double	0	1.0e6
62	tc	Double	0	1.0e6
63	tpwr	Double	0	1.0e6
64	kqi	Double	0	1.0e6
65	Vmin	Double	0	1.0e6
66	Vmax	Double	0	1.0e6
67	kqv	Double	0	1.0e6
68	ipmax	Double	0	1.0e6
69	zerox	Double	0	1.0e6
70	brkpt	Double	0	1.0e6
71	dvtrp1	Double	0	1.0e6
72	dvtrp2	Double	0	1.0e6
73	dvtrp3	Double	0	1.0e6
74	dvtrp4	Double	0	1.0e6
75	dvtrp5	Double	0	1.0e6
76	dvtrp6	Double	0	1.0e6
77	dttrp1	Double	0	1.0e6
78	dttrp2	Double	0	1.0e6
79	dttrp3	Double	0	1.0e6
80	dttrp4	Double	0	1.0e6
81	dttrp5	Double	0	1.0e6
82	dttrp6	Double	0	1.0e6
83	Ipp	Double	0	1.0e6
84	rrpwr	Double	0	1.0e6
85	Xc	Double	0	1.0e6
86	kqd	Double	0	1.0e6
87	tlpqd	Double	0	1.0e6
88	Xqd	Double	0	1.0e6
89	vermn	Double	0	1.0e6
90	vermx	Double	0	1.0e6

91	vfrz	Double	0	1.0e6
92	tw	Double	0	1.0e6
93	tpav	Double	0	1.0e6
94	Pa	Double	0	1.0e6
95	Pbc	Double	0	1.0e6
96	Pd	Double	0	1.0e6
97	fa	Double	0	1.0e6
98	fb	Double	0	1.0e6
99	fc	Double	0	1.0e6
100	fd	Double	0	1.0e6
101	Pmax	Double	0	1.0e6
102	Pmin	Double	0	1.0e6
103	kwi	Double	0	1.0e6
104	dbwi	Double	0	1.0e6
105	tlpwi	Double	0	1.0e6
106	twowi	Double	0	1.0e6
107	urlwi	Double	0	1.0e6
108	drlwi	Double	0	1.0e6
109	pmxwi	Double	0	1.0e6
110	pmnwi	Double	0	1.0e6
111	Iphl	Double	0	1.0e6
112	Iqhl	Double	0	1.0e6
113	kbdr	Double	0	1.0e6
114	ebst	Double	0	1.0e6
115	spdw1	Double	0	1.0e6

Explanations to entries given in table 3.12 are as follows -

- Generator bus number refers to the bus number at which the generator is connected. The bus number should exist in the bus data stream.
- MVA rating will be specifying rating of one individual turbine. Number of units specifies the number of similar wind turbine available in the farm.
- Real power specified will be significant only in the case of WT4 model. Because thi s model can generate the power as specified by the operator, with in the limit of available power generation.
- The wind farm/turbine tends to maintain the specified operating power factor within the reactive power limits. Negative operating power factor indicates lagging power factor and positive power factor indicates leading power factor.
- The reactive power compensation for WT1, WT2 will be through switchable capacitors at its terminal. So the compensation will be in terms of steps of capacitor bank.
- The No. of steps field is for WT1, WT2 models only. This field specifies No. of reactive power steps.
- The reactive power compensation for WT3, WT4 will be continuous control.
- In case of wind farm the reactive power limits are specified for the entire wind farm.

- System operating frequency should be less than the product of synchronous speed (rips), number of poles, gear box ratio/120. If this validation is not checked the program will give error.
- A general power curve can be represented as below.

$$P_m = \frac{1}{2}. C_p(\lambda, \beta). \rho. A. R^2 V_w^3$$

$$\lambda = \frac{\omega_R R}{V_w}$$

$$\omega_R = \frac{2\pi n}{60}$$

Where, Pm is the total power absorbed by the aerodynamic system
ρ is air density (kg/m3)
R is radius of the turbine blade (m)
Vm is wind speed (m/s)
λ is tip speed ratio, i.e. ratio between speed of tip of the blade to the wind speed
β is the pitch angle
Cp is coefficient of power
ωR is mechanical angular velocity of the turbine rotor (rad/s)
n is rotational speed of wind turbine (RPM)

- Power curve can be represented in four ways. They are
  1. Power curve is represented in formula 1
  2. Power curve is represented in formula 2
  3. Power curve is represented in power curve data
  4. Power curve is represented in detailed power curve data

  First three types of power curve representations will be in curve data library. Fourth type of representation will be in detailed curve data library.

The generalized formula 1 is as below:

$$C_p = C_0\{\frac{C_1}{\lambda_i} + C_2\lambda_i + C_3\beta^{C_4} + C_5\}e^{(\frac{C_6}{\lambda_i} + C_7\beta)}$$

$$\frac{1}{\lambda_i} = \frac{1}{\lambda + a_0\beta} - \frac{a_1}{\beta^3 + 1}$$

Where C_p is the coefficient of power
λ is tip speed ratio
β is pitch angle
All other coefficients in the equation are constant values and to be entered by the user.

The generalized formula 2 is as below:

$$P_w = \sum_{i=0}^{4}\sum_{j=0}^{4}(\alpha_{ij}\beta^i\lambda^j)$$

Where P_w is mechanical power generation
αij coefficients for i = 0 to 4 and j = 0 to 4 need to be given in the input data
β is the pitch angle
λ is the tip speed ratio

- Variable number 20 specifies the format of power curve.

Value of variable 20	Respective power curve format
1	Formula 1
2	Formula 2
3	Power curve
4	Detailed power curve

- Variable number 21, 22 and 23 specify the three curves reference numbers to curve libraries. First is Power curve(wind speed(m/s) vs mechanical power generation(p.u.)), second is operating mechanical power(p.u.) vs operating rotor speed(p.u.) and third is operating wind speed(m/s) vs operating rotor speed(p.u.).
- When the variable 20 is 1-3 the power curve represented is of curve library. When the variable 20 is 4 the power curve represented is of detailed curve library.

Stream 21: Static Var Compensator Details

In this section Static var compensator details are given. Figure 3.20 gives the static VAR compensator model.

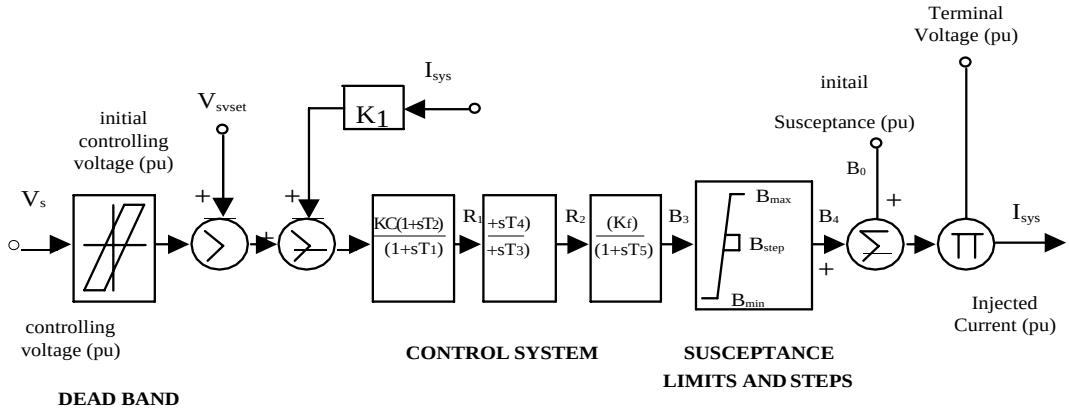


Figure 3.20: Composite Static Var Compensation System (SVS) Model

Number of lines of data is equal to number of static var compensators as given under system specification stream. Data that appear under different columns for each SVS is given in table 3.21

Explanations for the entries in table 3.21 are as follows –

- Bus number refers to the bus number to which the SVC is connected. This number should exist in the bus data stream.
- If the current stabilizer loop is open, then K_i value should be given as 0.0
- Initial control angled α_0 in radians is computed from the expression -

$$B_0 = B_{am}(1 - 2\alpha_0/\Pi - \sin(2\alpha/\Pi) \quad (3.5)$$

- Minimum capacitance value is assumed as zero. For 50 Mvar capacitor bank control, B_{max} value is 0.5 pu on a 100 MVA base.

Table 3.21: SVC Details

Col No.	Description	Type	Min	Max
1.	Bus number	int	0	9999
2.	Current stabilizer gain K_i	float	0.0	10.0
3.	K_c as per figure 3.20	float	1.0	10.0
4.	K_f as per figure 3.20	float	1.0	100.0
5.	Time constant T_1	float	1.0e-3	100.0

6.	Time constant T_2	float	1.0e-3	100.0
7.	Time constant T_3	float	1.0e-3	100.0
8.	Time constant T_4	float	1.0e-3	100.0
9.	Time constant T_5	float	1.0e-3	100.0
10.	Initial control angle in radians	float	1.0e-3	100.0
11.	Maximum capacitance value B_{max} in pu	float	0.0	100.0
12.	Initial value of capacitance B_0 in pu	float	0.0	100.0

- It is assumed that there is no other fixed compensation (Q-Mvar), specified along with the load data at the SVS bus.
- If the initial capacitance value is other than zero, then corresponding compensating Mvar should be provided at that bus in the load flow analysis data to establish the proper initial condition.

Stream 22: HVDC Converters Data

In this stream of data, HVDC converter details are given. The schematic diagram of a 12 pulse converter station and its equivalent representation are given in figures 3.21 and 3.22 respectively.

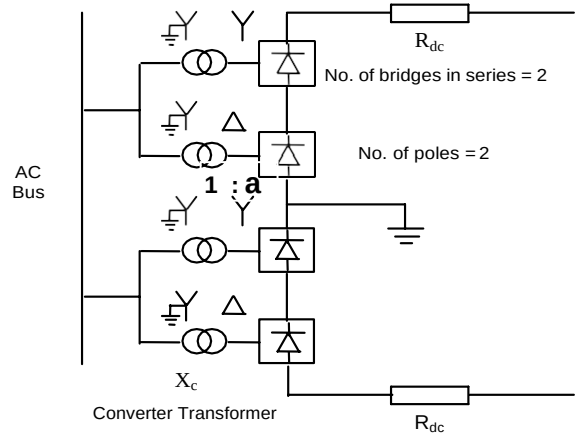


Figure 3.21: Schematic of 12 Pulse Bipolar Converter Station

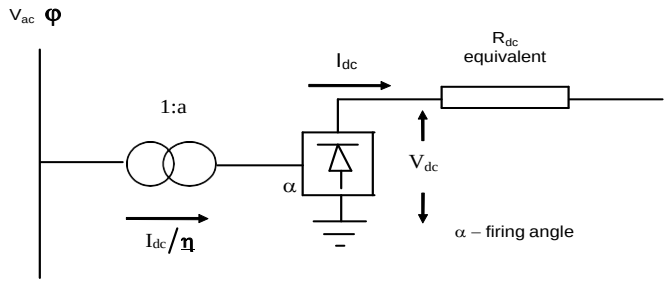


Figure 3.22: Equivalent representation

Total number of lines of data in this stream is equal to number of HVDC converters as given in specification stream. The data that appears in different columns of each line is given in table 3.22. Explanations to entries given in table 3.22 are as follows –

- Converter number is the serial number of the converter, which is also the dc bus number.
- AC bus number is the bus number to which the converter is connected. This number should exist in the "bus data stream".

Table 3.22 - HVDC Converter Data

Col No.	Description	Type	Min	Max
1.	Converter number	int	1	20
2.	AC bus number	int	1	9999
3.	Converter transformer X in pu	float	1.0e-5	1.0e2
4.	Control tag	int	1	3
5.	Voltage order in kV	float	-1.0e05	1.0e05
6.	Current order in Amps	float	-1.0e05	1.0e05
7.	Power order in MW	float	-1.0e05	1.0e05
8.	Current margin in Amps	float	-1.0e03	1.0e03
9.	Number of bridges in series	int	1	10
10.	Number of poles	int	1	2
11.	Converter transformer secondary kV	float	0.1	1.0e4
12.	Converter transformer MVA rating	float	0.1	1.0e4
13.	Minimum control angle in degrees	float	0.0	180.0
14.	Operating voltage in kV	float	-1.0e05	1.0e05
15.	Operating power in MW	float	-1.0e05	1.0e05
16.	Operating reactive power in Mvar	float	-1.0e05	1.0e05
17.	Control angle in degrees	float	0.0	180.0
18.	Transformer tap in pu	float	0.5	1.5
19.	Smoothening reactance in pu	float	0.0	1.0e05

- Converter transformer reactance is in p.u on transformer MVA rating. Commutation resistance R_c is related to the transformer reactance X_c by the expression -

$$R_c = \frac{3X_c}{\pi} \quad (3.6)$$

- Control tag is interpreted as -
  1. Constant voltage control
  2. Constant current control
  3. Constant power control.

  In a two terminal or multi terminal converter group, at least one converter in the group should have control tag as 1.
- Depending on the control tag, voltage order or current order or power order is selected for the converter.
- Current margin is maintained between the rectifier and the inverter in order to avoid the mode changes.
- Number of bridges is interpreted as -
  1. Six pulse converter
  2. Twelve pulse converter.
- Number of poles is interpreted as -
  3. Monopolar
  4. Bipolar.

Minimum control angle in degrees is the minimum firing angle (α_{min}) for converter and minimum extinction angle (α_{min} = 180.0 - α-μ) for the inverter. μ Is the overlap angle. Minimum firing angle ranges from 5 degrees to 7 degrees. Minimum extinction angle ranges from 15 degrees to 20 degrees.

Prior to transient stability study, load flow analysis is performed to establish the initial conditions. Columns 14 to 18 are obtained from the initial load flow study. During transient stability study converter transformer tap is held constant at the value given in column 18.

- In ac system, the base quantities are -
  P_{ac} base = 3 phase power
  V_{ac} base = line to line rms value.

  $$I_{ac}\,base = P_{ac}\,base \,/\, \sqrt{3}\; V_{ac}\,base$$
- In dc system, the base quantities are -
  P_{dc} base = P_{ac} base
  V_{dc} base = K_b V_{ac} base.

  $$I_{dc}\,base = (3\sqrt{2}/\pi) I_{ac} base$$

  where,

  $$K_b = (3\sqrt{2}/\pi) n_b$$

n_b number of series connected bridges in a hvdc terminal.

- The dc voltage and power at the converter are given by -

$$V_{dc} = a\, V_{ac}\, \text{Cos}\alpha - R_c\, I_{dc} \quad (3.7)$$

$$P_{dc} = V_{dc} I_{dc} \quad (3.8)$$

where,
a : transformer tap setting
α : firing angle.

Neglecting the losses in the converter and its transformer, the equation for power factor angle (ϕ-η) is given by $V_{dc} = a V_{ac} \cos(\phi-\eta)$ (3.9)

Expression for reactive power flowing from the AC bus into the converter terminal is given by

$$Q_{dc} = P_{dc} \tan(\phi-\eta) \quad (3.10)$$

where,
ϕ : AC voltage angle. η : AC current angle.

Stream 23: DC Link Data

In this stream of data, DC link details are given. Total number of lines of data in this stream is equal to number of DC links as given in specification stream. The data that appears in different columns of each line is given in table 3.23.

Table 3.23 - DC Link Data

Col No.	Description	Type	Min	Max
1.	From convertor number	int	1	20
2.	To convertor number	int	1	20
3.	DC link resistance in ohms	float	1.0e-5	1.0e2
4.	DC link inductance in henry	float	1.0e-5	1.0e2
5.	DC link shunt capacitance in farads	float	1.0e-08	1.0

Explanations to entries given in table 3.23 are as follows -

- From convertor number is the convertor number to which one end of dc link is connected. This number should exist in the convertor data stream.
- To convertor number is the convertor number to which the other end of dc link is connected. This number should exist in the convertor data stream.
- DC link resistance is in ohms for one pole. For bipolar operation, equivalent resistance is computed internally.
- DC link inductance is in henry for one pole. For bipolar operation, equivalent inductance is computed internally.

- DC link capacitance is in farads for one pole. For bipolar operation, equivalent capacitance is computed internally.
-

Stream 24: Free Programmable Block (FPB) Data

In this stream, data needed for the free programmable blocks are given. Number of data sets corresponds to number of FPBs as specified under system specification stream. For more details, chapter on Free programmable Block should be referred. For each FPB unit, following data are read.

- FPB bus, i.e., the bus to which the FPB is connected. In case of HVDC this is the convertor ac bus number. In case of ULTC this is transformer number
- FPB type which is interpreted as -
  1. Automatic voltage regulator
  2. Turbine governing system
  3. Static var system
  4. HVDC system
  5. Under Load Tap Changer
  6. Controller for load

In case of AVR and turbine governing system, FPB bus should be a generating bus. Also there should not be any standard AVR or turbine-governor control blocks associated with that generator, if the FPB type is for AVR or for turbine governing system respectively.

Total number of state variables (i.e., number of FPB nodes) in the FPB unit.

- Total number of basic free programmable blocks in the FPB unit.
- Total number of tables referred by the FPB.
- Initial value for nodes.
- Maximum number of iteration.
- Convergence tolerance
- Node data
- Block data

In **POWERTRS**, while establishing the initial condition and also while solving the system dynamic equations, node type field are used to establish the relation between the FPB state variable and the generator state variable. Node type field is explained in the chapter on Free Programmable Blocks.

Stream 25: Frequency Relay Data

In this stream of data, frequency relay characteristic details are given. Total number of lines of data in this stream is equal to number of relay characteristics as given in specification stream. The data that appears in different columns of each line are given in table 3.24.

Table 3.24: Frequency Relay Characteristic Data

Col No.	Description	Type	Min	Max
1.	Frequency relay characteristic number	int	1	20
2.	Relay type	int	0	2
3.	Frequency setting 1 in Hz.	float	0.0	1.0
4.	Time setting 1 in seconds.	float	0.0	5.0
5.	Load shedding factor 1	float	0.0	1.0
6.	Frequency setting 2 in Hz.	float	0.0	1.0
7.	Time setting 2 in seconds.	float	0.0	5.0
8.	Load shedding factor 2	float	0.0	1.0
9.	Frequency setting 3 in Hz.	float	0.0	1.0
10.	Time setting 3 in seconds.	float	0.0	5.0
11.	Load shedding factor 3	float	0.0	1.0

Explanations to entries given in table 3.24 are as follows -

- The frequency relay number given here should match the one given under series element and shunt element data.
- Relay type is interpreted as -
  0: Under frequency relay.
  1: Over frequency relay.
  2: df/dt relay.
- In case of relay associated with a load, it is possible to shed the load partly or completely, depending on the load shedding factor. For elements other than loads, load shedding factor is not applicable.
- The relays are modeled to have 3 frequency settings. If the frequency (or df/dt) goes below the setting 3 (df/dt setting in case of rate of change of frequency relay), a timer is started. If the frequency deviation persists till the time setting 3, then the series or shunt element is disconnected from the system. In case of loads, load is curtailed by the amount given by factor 3. Thus if the specified load is 100 MW, frequency setting 3 is 47 Hz., time setting is 2 seconds, and the load shedding factor is 0.5, then if the bus frequency goes below 47 Hz, and persists for duration greater than 2 seconds, the actual load considered for the remaining duration is 50 MW. Same explanation holds for other two settings also.
- It is assumed that frequency setting 3 is less than frequency setting 2 and frequency setting 2 is less than frequency setting 1 for under frequency relay. In case of over frequency relay, frequency setting 3 is greater than frequency setting 2 and frequency setting 2 is greater than frequency setting 1.

- Load shedding factor is the amount of load to be shed from the specified value. At the end of each transient stability time step, the bus frequency at desired buses is computed.

  Frequency relay logic is introduced to determine the starting of the timer. A proper co-ordination of relays are required in terms of frequency settings and time delay to avoid the shedding (tripping) of loads (other series elements or shunt elements) at all the places simultaneously.

Stream 26: Voltage Relay Data

In this stream of data, voltage relay characteristic details are given. Total number of lines of data in this stream is equal to number of voltage characteristics as given in specification stream. The data that appears in different columns of each line are given in table 3.25.

Table 3.25: Voltage Relay Characteristic Data

Col No.	Description	Type	Min	Max
1.	Voltage relay characteristic number	int	1	20
2.	Relay type	int	0	1
3.	Voltage setting 1 in pu.	float	0.0	1.0
4.	Time setting 1 in seconds.	float	0.0	5.0
5.	Load shedding factor 1	float	0.0	1.0
6.	Voltage setting 2 in pu.	float	0.0	1.0
7.	Time setting 2 in seconds.	float	0.0	5.0
8.	Load shedding factor 2	float	0.0	1.0
9.	Voltage setting 3 in pu.	float	0.0	1.0
10.	Time setting 3 in seconds.	float	0.0	5.0
11.	Load shedding factor 3	float	0.0	1.0

Explanations to entries given in table 3.25 are as follows -

- The voltage relay number given here should match the one given under series element and shunt element data.
- Relay type is interpreted as -
  0: Under voltage relay.
  1: Over voltage relay.
- In case of relay associated with a load, it is possible to shed the load partly or completely, depending on the load shedding factor.
- For elements other than loads, load shedding factor is not applicable.
- The relays are modeled to have 3 voltage settings. If the bus voltage goes below the setting 3, a timer is started. If the voltage deviation persists till the time setting 3, then the series or shunt element is disconnected from the system. In case of loads, load is curtailed by the amount given by factor 3. Thus if the specified load is 100 MW, under voltage setting 3 is 0.75 pu, time setting is 5 seconds, and the load shedding factor is 0.5, then if the bus voltage goes below 0.75 pu, and persists for duration greater than 5 seconds, the actual load considered for the remaining duration is 50 MW. Same explanation holds for other two settings also.

- It is assumed that voltage setting 3 is less than voltage setting 2 and voltage setting 2 is less than voltage setting 1 for under voltage relays. For over voltage relays, it is assumed that voltage setting 3 is greater than voltage setting 2 and voltage setting 2 is greater than voltage setting 1.
- Load shedding factor is the amount of load to be shed from the specified value. At the end of each transient stability time step, the bus frequency at desired buses is computed. Frequency relay logic is introduced to determine the starting of the timer. A proper co-ordination of relays are required in terms of frequency settings and time delay to avoid the shedding (tripping) of loads (other series elements or shunt elements) at all the places simultaneously.

Stream 27: Over Current Relay Data

In this stream of data, over current relay characteristics data are given. Total number of lines of data under this stream is equal to number of **relays specified** under system size specification field. Data that appears under different columns of each line are given in table 3.26.

Table 3.26: Over current relay details

Col No.	Description	Type	Min	Max
1.	Element number	int	1	1000
2.	Relay location	int	1	2
3.	Relay type	int	1	10
4.	Time dial setting (TDS or TMS)	float	0.05	10.0
5.	Relay plug setting	float	1.0	1.0e5
6.	Relay instantaneous setting	float	1.0	1.0e5

Explanations for the entries in table 3.26 are as follows -

- Element number refers to the series/shunt element number for which the relay is provided. Element number is assigned by counting the series elements in the system first and then the shunt elements as specified in the data. In series elements, transformers are counted first (2 winding transformers first and then 3 winding transformers, each 3 winding transformer results in 3 series elements), then the lines, followed by series reactors, capacitors, and bus couplers in the order the data is presented. For shunt elements, machines (generators and motors) are counted first, followed by shunt reactors and capacitors in admittance form and shunt reactors and capacitors in impedance form.
- Relay location is always 1 for shunt elements. For series elements, relay location is interpreted as -
  - 1: Relay is on the from bus side.
  - 2: Relay is on the to bus side.

  But in the model, for series elements, tripping of any one side results in the isolation of other end also.

Relay type is interpreted as -

- 1 : 3 seconds relay i.e., relay operates in 3 seconds for 10 times the plug setting multiplier at unity time dial setting. The curve at unity TDS is implemented by t = 3.0/log (M) where t is the operating time in seconds, and M is the multiple of plug setting.
- 2 : 1.3 seconds relay i.e., relay operates in 1.3 seconds for 10 times the plug setting multiplier at unity time dial setting.
- The curve at unity TDS is implemented by t = 1.3/log (M) where t is the operating time in seconds, and M is the multiple of plug setting.
- 3 - 10: User defined relay characteristics.
  Operating time at any other time dial setting is given by multiplying the above operating time by the time dial setting.

- Time dial setting (TDS) is sometimes referred to as time multiplier setting (TMS). The usual range is 0.05 - 1.0. But some manufacturers give the TDS value from 1 to 10 also. Relay TDS setting actually done after co-ordination is entered in column 4.
- Plug setting is given in amperes referred to CT primary side. If the relay CT is 300/5 amps, and the relay plug setting is 150% (plug setting for phase fault relay is in the range 50% to 200%) then the value to be given in column 5 is 450 amperes.
- Over current relays are provided with instantaneous elements to isolate the faulted line for close in faults. The instantaneous setting in amps, referred to CT primary side is given in column 6.
- Whenever the current sensed by the relay exceeds the plug setting, a timer is started. If the timer count exceeds the actual relay operation time, the trip signal is given.

Stream 28: Distance Relay Data

In this stream, distance relay characteristics data are given. Total number of lines of data in this stream is equal to the number of distance relays as given under system size specification stream. Data fields that appear under different columns are given in table 3.27.

Table 3.27: Distance relay data

Col No.	Description	Type	Min	Max
1.	Line number	Int	1	1000
2.	Relay location	Int	1	2

For each relay the following data are considered as per table 3.28.

Table 3.28: Distance relay data

Col No.	Description	Type	Min	Max
1.	Relay number	Int	1	1000
2.	Relay name	char	1	10
3.	Relay type	Int	0	8
4.	Relay parameters for each zone (Zone1 Zone2, Zone3, PS1, PS2 and starter setting as per table 3.29)	-	-	-
5.	Power swing set time.	Float	0	1000
6.	Blocking time.	Float	0	1000

Table 3.29: Distance relay parameter for each zone

Relay type.	Relay type	Data required	Type	Min	Max
0	Mho	1.Impedence 2. Theta 3.Displacement 4.TimeSetting	Float Float Float Float	0 0 0 0	10 00 360 1000 1000
1	Ohm	1.Impedence 2. Theta 3.Phi 4.TimeSetting	Float Float Float Float	0 0 0 0	1000 360 360 1000
2	Quadrilateral	1.RF 2.RB 3.XT 4.XB 5.Theta 6.Phi 7.TimeSetting	Float Float Float Float Float Float Float	0 0 0 0 0 0 0	1000 1000 1000 1000 1000 1000 1000
3	Quadra Mho	1.Impedence 2. Theta 3.TimeSetting	Float Float Float	0 0 0	1000 360 1000
4	Elliptical	1.Impedence 2. Theta 3.Displacement 4.TimeSetting	Float Float Float Float	0 0 0 0	1000 360 1000 1000
5	Lentical	1.Impedence 2. Theta 3.Displacement 4.TimeSetting	Float Float Float Float	0 0 0 0	1000 360 1000 1000

6	Circular	1.Impedence 2.TimeSetting	Float Float	0 0	1000 1000
7	Oval	1.Impedence 2. Theta 3.TimeSetting	Float Float Float	0 0 0	1000 360 1000

Note: Relay Type number 8 corresponds to that no relays settings are present for that zone.

Explanations for the entries in table 3.27 to 3.29 are as follows –

- Distance relays are provided for transmission lines. Line number refers to the transmission line number to which the relay should refer to. Since transmission line data follows the transformer data, number of transformer elements is subtracted from series element number to find the transmission line number.
- Relay location field is interpreted as -

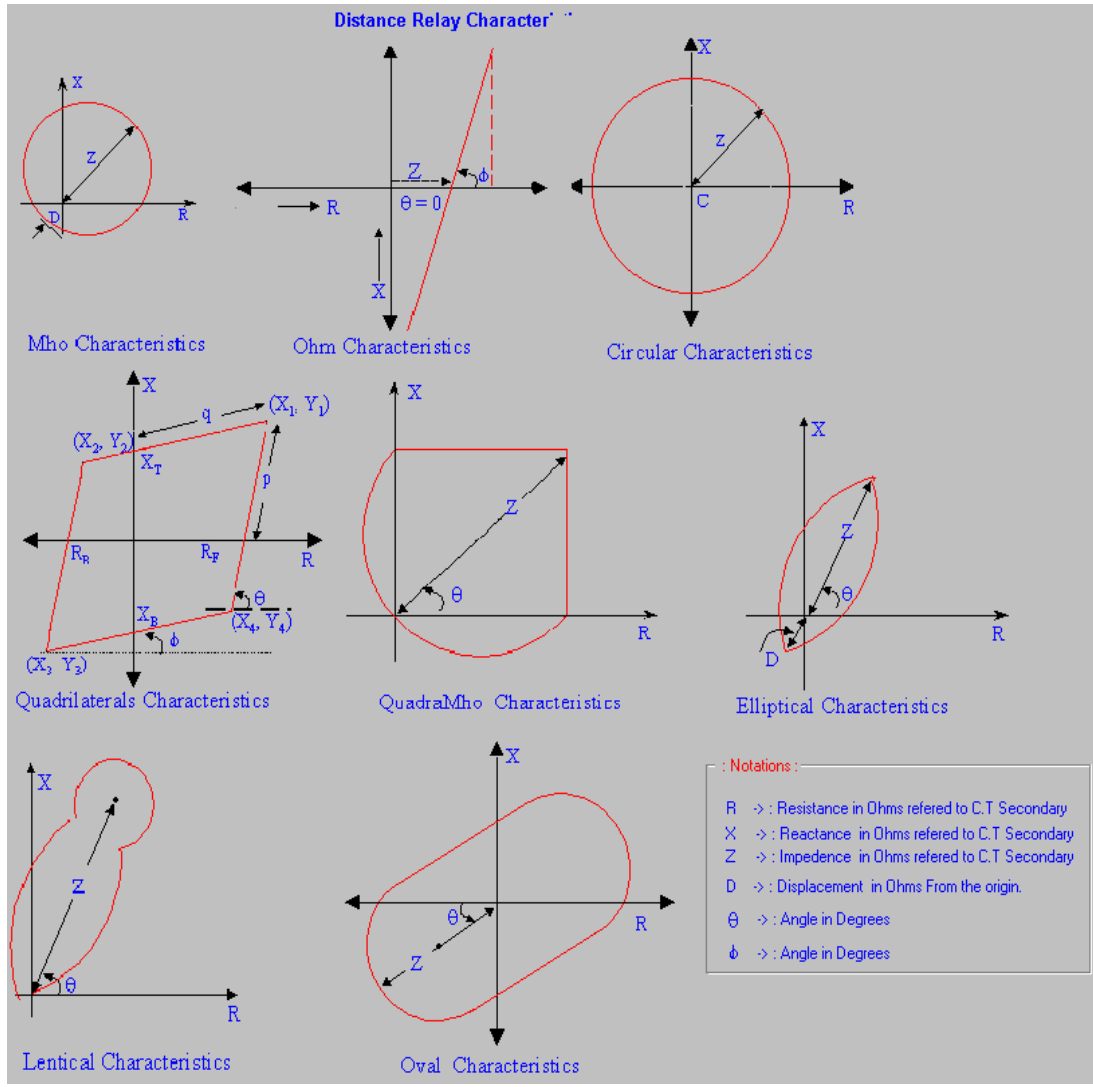
  1: Relay is provided on from bus side of the line.

  2: Relay is provided on to bus side of the line.

  Even if anyone relay operates, the line is completely isolated from the system.
- Impedance, Displacement, RF, RB, XT, and XB referred in relay parameters are in ohms referred to primary (HT) side of instruments transformers (CT and PT).
- Theta and Phi referred in relay parameters are in angle in degrees.
- Power swing set time and blocking time referred in relay settings are time in sacs.
- At each simulation time step, the impedance seen by the distance relay is computed. If the impedance falls within zone 1 characteristic, line is tripped instantaneously (after a preset time interval corresponding to circuit breaker time delay). If the impedance falls within zone 2 or zone 3, respective timers are started. If the fault persists, the line is tripped after the zone 2 or zone 3-time delay.

Different set of characteristics are provided for phase and earth loop.

The ideal characteristic plots are as shown


Distance Relay Characteristics
X
Z
D
R
Mho Characteristics
Z
θ = 0
ϕ
R
X
Ohm Characteristics
X
Z
C
R
Circular Characteristics
X
(X1, Y1)
q
(X2, Y2)
XT
p
RR
RF
R
XR
θ
(X4, Y4)
ϕ
(X3, Y3)
Quadrilaterals Characteristics
X
Z
θ
R
QuadraMho Characteristics
X
Z
θ
D
R
Elliptical Characteristics
X
Z
θ
R
Lentical Characteristics
X
θ
R
Z
Oval Characteristics
: Notations :
R -> : Resistance in Ohms refered to C.T Secondary
X -> : Reactance in Ohms refered to C.T Secondary
Z -> : Impedence in Ohms refered to C.T Secondary
D -> : Displacement in Ohms From the origin.
θ -> : Angle in Degrees
ϕ -> : Angle in Degrees

Stream 29: Cyclic Load Data

1. Cyclic load bus number (int field): This is the bus number to which the cyclic load is connected.
2. Number of data points for cyclic load (int field): Total number of data points per cyclic load should not exceed 50.
3. Time period of cyclic load: Time period is in seconds, afterwhich the load pattern repeats.
4. For each data points following fields are read in order
   (a) Serial number of the data point.
   (b) Time in seconds for the sample from zero instant of time.
   (c) Real power load in MW.
   (d) Reactive power load in Mvar.

Load points need not be given in equal time intervals. Between two data points, the stra ight line relation is used to compute the load at inter-mediate points. Consider a cyclic load at bus say 15, which repeats after 10 seconds. The load remains constant at 10 MW in the interval 0.0-4.0 seconds. It remains constant at 20 MW in the interval 4.0-7.0 seconds. It is again 16 MW in the interval 7.0-10.0 seconds. Reactive power demand is 50% of real power demand. The cyclic variation of real power load is given in figure 3.23. For this case, the data is prepared as follows –

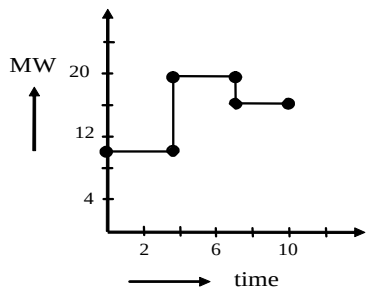


Figure 3.23 - Typical Cyclic Load Curve

15	6	10.0	
1	0.00	10.0	5.0
2	4.00	10.0	5.0
3	4.00	20.0	10.0
4	7.00	20.0	10.0
5	7.00	16.0	8.0
6	0.00	16.0	8.0

Stream 30: Wind Turbine Generator Curve Data

In this stream of data, wind turbine related curves details are given. For each curve, the data given are -

1. Curve number.
2. Curve type.
3. Number of curve points.
4. Real power in pu, corresponding minimum and maximum reactive powers in pu on its own rating for each data point.

Curve number is the generator capability curve number referred by the generator under "generator data stream". Minimum number of curve points required is two. Maximum number of curve points should not exceed ten. For a generator MVA rating 265, figure 3.8 shows a sample generator capability curve for minimum and maximum reactive power limits as shown in the table 3.17.

In this stream, Wind Turbine related curves library is printed. Basically there are five types of curves. They are

1. Power curve represented in formula 1 format.
2. Power curve represented in formula 2 format.
3. Power curve represented in curve data format.
4. Operating mechanical power(p.u.) vs operating rotor speed(p.u.)
5. Operating wind speed(m/s) vs operating rotor speed(p.u.)

Curve type 1-3 will represent for power curve. Curve type 4 represent for operating mechanical power vs operating rotor speed and curve type 5 for operating wind speed vs operating rotor speed. The format for the curve type 3-5 is same but for curve type 1 and 2 are different. Various streams present for each type of curve are listed in tables for each curve type separately.

Data streams for curve type 1

Table 3.12 – Curve data for curve type 1

Col No.	Description	Type	Min	Max
1	C0	Double	-1.0e6	1.0e6
2	C1	Double	-1.0e6	1.0e6
3	C2	Double	-1.0e6	1.0e6
4	C3	Double	-1.0e6	1.0e6
5	C4	Double	-1.0e6	1.0e6
6	C5	Double	-1.0e6	1.0e6
7	a	Double	-1.0e6	1.0e6
8	b	Double	-1.0e6	1.0e6
9	c	Double	-1.0e6	1.0e6
10	d	Double	-1.0e6	1.0e6
11	a0	Double	-1.0e6	1.0e6
12	a1	Double	-1.0e6	1.0e6

The generalized formula for curve type 1 is as below:

$$C_p = C_0\{\frac{C_1}{\lambda_\diamond} + C_2\lambda_\diamond + C_3\diamond^\diamond + C_4\diamond^\diamond + C_5\}e^{(\diamond\lambda_i + \frac{\diamond}{\lambda_i})}$$

$$\lambda_\diamond = \frac{1}{\frac{1}{\lambda + a_0\diamond} - \frac{a_1}{\diamond^3 + 1}}$$

Where C_p is the coefficient of power

λ is tip speed ratio

β is pitch angle

All other coefficients in the equation are constant values and to be entered by the user.

Data streams for curve type 2

Table 3.12 – Curve data for curve type 2

Col No.	Description	Type	Min	Max
1	α_{00}	Double	-1.0e6	1.0e6
2	α_{01}	Double	-1.0e6	1.0e6
3	α_{02}	Double	-1.0e6	1.0e6
4	α_{03}	Double	-1.0e6	1.0e6
5	α_{04}	Double	-1.0e6	1.0e6
6	α_{10}	Double	-1.0e6	1.0e6
7	α_{11}	Double	-1.0e6	1.0e6
8	α_{12}	Double	-1.0e6	1.0e6
9	α_{13}	Double	-1.0e6	1.0e6
10	α_{14}	Double	-1.0e6	1.0e6
11	α_{20}	Double	-1.0e6	1.0e6
12	α_{21}	Double	-1.0e6	1.0e6
13	α_{22}	Double	-1.0e6	1.0e6
14	α_{23}	Double	-1.0e6	1.0e6
15	α_{24}	Double	-1.0e6	1.0e6
16	α_{30}	Double	-1.0e6	1.0e6
17	α_{31}	Double	-1.0e6	1.0e6
18	α_{32}	Double	-1.0e6	1.0e6
19	α_{33}	Double	-1.0e6	1.0e6
20	α_{34}	Double	-1.0e6	1.0e6
21	α_{40}	Double	-1.0e6	1.0e6
22	α_{41}	Double	-1.0e6	1.0e6
23	α_{42}	Double	-1.0e6	1.0e6
24	α_{43}	Double	-1.0e6	1.0e6
25	α_{44}	Double	-1.0e6	1.0e6

The generalized formula for curve type 2 is as below:

$$P_w = \sum_{i=0}^{4} \sum_{j=0}^{4} (\alpha_{ij} \beta^i \lambda^j)$$

Where P_w is mechanical power generation

αij coefficients for i = 0 to 4 and j = 0 to 4 need to be given in the input data

β is the pitch angle

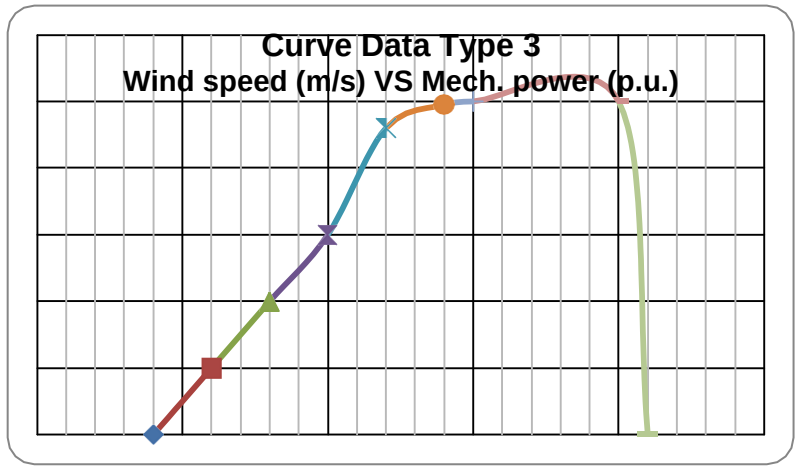
λ is the tip speed ratio

Data streams for curve type 3

Table 3.12 – Curve data for curve type 3

Col No.	Wind Speed (m/s)	Mechanical Power Generation (p.u.)
1	4	0
2	6	0.2
3	8	0.4
4	10	0.6
5	12	0.92
6	14	0.99
7	15	1.0
8	20	1.0
9	21	0.0

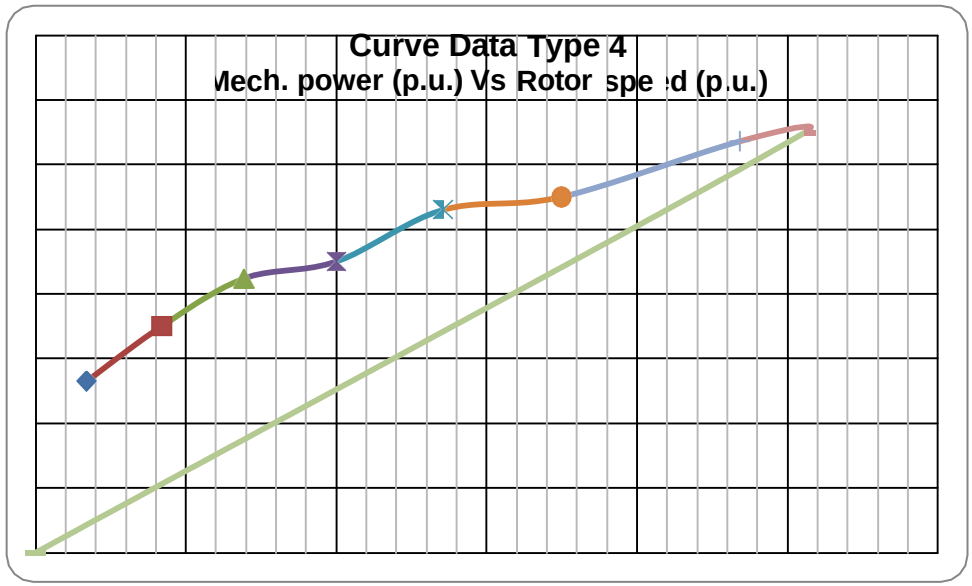
The maximum allowed number of points is 20. A typical power curve diagram is shown below.



Data streams for curve type 4

Table 3.12 – Curve data for curve type 4		
Col No.	**Operating Mechanical Power Generation (p.u.)**	**Operating Rotor Speed (p.u.)**
1	0.0678	0.53
2	0.1678	0.7
3	0.2775	0.848
4	0.4	0.9
5	0.5421	1.06
6	0.7	1.1
7	0.9367	1.272
8	1.0238	1.3

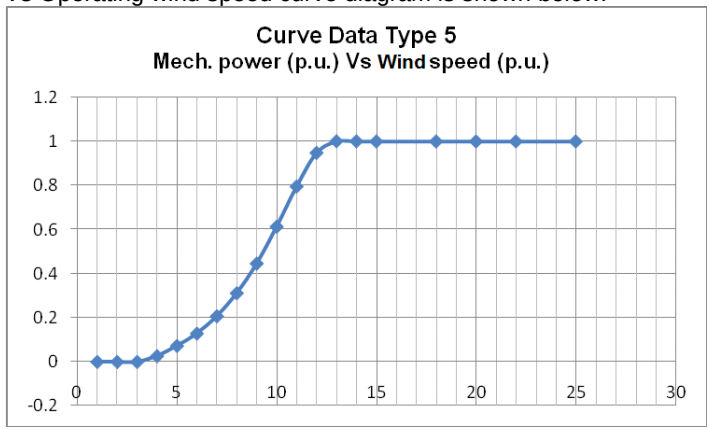
The maximum allowed number of points is 20. A typical operating mechanical power generation Vs Operating rotor speed curve diagram is shown below.



Data streams for curve type 5

Table 3.12 – Curve data for curve type 5		
Col No.	**Operating Wind Speed (m/s)**	**Mechanical Power Generation (p.u.)**
1	1	0
2	2	0
3	3	0
4	4	0.026403
5	5	0.072607
6	6	0.128383
7	7	0.206931
8	8	0.311551
9	9	0.445875
10	10	0.613201
11	11	0.79538
12	12	0.948185
13	13	1.00066
14	14	1.00066
15	15	1
16	18	1
17	20	1
18	22	1
19	25	1

The maximum allowed number of points is 20. A typical operating mechanical power generation Vs Operating wind speed curve diagram is shown below.



4. INPUT/OUTPUT FILES

Table 4.1 gives extensions of different input and output files used by **POWERTRS**.

Table 4.1: Input and Output Files of POWERTRS

Sl. No.	File Extension	Mode	Description
1.	"**.datX**"	Input	Program input file
2.	"**.outX**"	Output	Program output (general report) file
3.	"T**M.BIN**" Machine Binary file "**TL.BIN**" Line, Other Shunt Elements Binary file "**TF.BIN**" FPB Binary file and "**TW.TXT**" for Wind Turbine graph.	Output	Binary files having the information for plotting using MiP-PSCT graph module - MIGRAPH

".outX" file contains -

- Input data to the program, in the order the data is read.
- Computed values for machines, like terminal voltage, internal angle, frequency, mechanical power, electrical power etc.
- Flows, impedances in selected lines.
- Tripping information
- Negative and zero sequence flows for SLG fault.
- SVC output.

".BIN" files refer to graphic output files, whose format is compatible to MiP-PSCT's graphic utility. All the variables of the machines and the lines connected to the machine buses selected for plotting are written to two different binary files. For machines the binary plot file is "TM.BIN" and for lines it is "TL.BIN" where M of and L of TRSPLOT are distinct for machines and lines respectively. The variables written to the plot files are listed in table 4.2 and 4.3 for machines and lines respectively.

Table 4.2 : Machine variables written to the binary ("TM.BIN") files

Sl.No.	Description
1.	Time in Seconds
2.	Machine terminal voltage in pu
3.	Machine terminal angle in degrees
4.	Machine internal angle for swing curve in degrees
5.	Machine frequency in Hz.
6.	Machine electrical power in MW
7.	Machine reactive power in Mvar
8.	Machine Mechanical power in MW

9	Machine field voltage in pu
10	Machine current magnitude in A
11	Machine Apparent Power in MVA
12	Motor slip in p.u *
13	Motor electrical torque in pu *
14	Motor mechanical torque in pu *

** Plotted only for motors*

In case of line flow plots, the variables written to the binary file (TRSPLOTL.BIN) are given in table 4.3.

Table 4.3: Machine variables written to the binary ("TL.BIN") files

Sl.No.	Description
1.	Time in s
2.	Bus voltage in pu
3.	Bus frequency in Hz
4.	Current in A
5.	Real power in MW
6.	Reactive power in MVAr
7.	Resistance in pu
8.	Reactance in pu

In case of line flow plots, the variables written to the binary file (TRSPLOTL.BIN) are given in table 4.4.

Table 4.4: Wind Turbine Generator variables written to the ("TW.TXT") files

Sl.No.	Description
1.	Time in Seconds
2.	WTG terminal voltage in pu
3.	WTG terminal angle in degrees
4.	WTG wind speed in m/s
5.	WTG turbine shaft speed in pu
6.	WTG generator shaft speed in pu
7.	WTG electrical power in MW
8.	WTG reactive power in Mvar
9.	WTG mechanical power in MW
10.	WTG current magnitude in A
11.	Time in Seconds

For viewing the results by graph, graph module - Migraph has to be invoked. While importing the file, anyone of the binary file can be selected at a time. The variables list will be displayed in the screen which user can select according to the requirement.

Error Messages

If the program while execution traces any error, an error message is written to the report file and further execution of the program is terminated. The error messages, which are traced by the program, are printed in the following format -

Error Number Error Message Error Description

Error number is a number by which the error is identified. The nature of error is given in the error message. An error description specific to user/application is also given. The errors identified by the program are -

- [Error No. 0] Parameter passing error: If there is an error in passing parameters to the program, then an error is reported. In the description, the missing parameter is named.
- [Error No. 1] Input file opening error: If the input data file name specified by the user is not found or if an error occurs while the input file is opened, this message is generated. If there is more than one input file for the program then, the description specifies missing input file.
- [Error No. 2] Output file opening error: If an error occurs while opening the output file, this message is generated.
- [Error No. 3] Too less parameters to read: If the data provided is insufficient then, this error is displayed. The input data 'stream' for which data is insufficient is also described in the error message.
- [Error No. 4] Memory allocation error : If memory is not allocated for a variable for which dynamic memory allocation is done, this error message is given. The variable for which memory allocation is not successfully done is mentioned in the error description.
- [Error No. 5] Invalid character : If an invalid character data is present in the input data file then this message is generated. The data item for which invalid character is entered is also mentioned in the error message.
- [Error No. 6] Invalid number : If an invalid integer data is present in the input data file then this message is displayed. The data item for which invalid integer data is given is also mentioned in the error message.
- [Error No. 7] Invalid value : If the data given exceeds the limits mentioned for each item mentioned under different streams, an error message is given along with a description of the data item.

- [Error No. 8] Division by zero : During a mathematical operation, if division by zero occurs, then this error is generated. The variable, which may have caused this condition, is mentioned in the error description.

- [Error No. 9] Diverging error : This message is generated if no convergence is observed after a specified number of iterations.

- [Error No. 10] Error in data, Results not okay : If an erroneous input data is present which doesn't come under any of the above mentioned categories as a result of which wrong results are obtained, then this message is generated.

These errors are displayed in the output file mentioned by the user. Some of the common error messages and their probable reason for occurrence are -

ERROR [1] : Input file opening error - Input file not opened for reading. is written to the report file. If the program expects data to be read from input file, but has not provided data and end of file is reached, then this error message.

ERROR [3] : Too less parameters to read - Insufficient data provided for Stream is written to the report file. If the from/to bus of a transformer specified by the user doesn't exist in the bus data stream, then an error message

ERROR [6] : Invalid number - Invalid bus id specified is written to the report file.

5. Case Study

In this section, a sample IEEE power system network (Reference : J. Duncan Glover, "A Personal Computer Software package for Power Engineering Education, IEEE Transactions on Power System, Vol. 3, No. 4, November 1988, PP. 1864 - 1871) is considered to explain the execution and analysis of results of **POWERTRS**. The single line diagram of the sample network considered is given in figure 5.1. Tables 5.1 gives input data file and Table 5.2 gives output results file respectively.

A three phase fault is applied at the generating bus 1 at time t = 0.10 seconds, and removed after 0.1second duration. A graphical representation of the swing curve for generator 1 is given in figure 5.2.

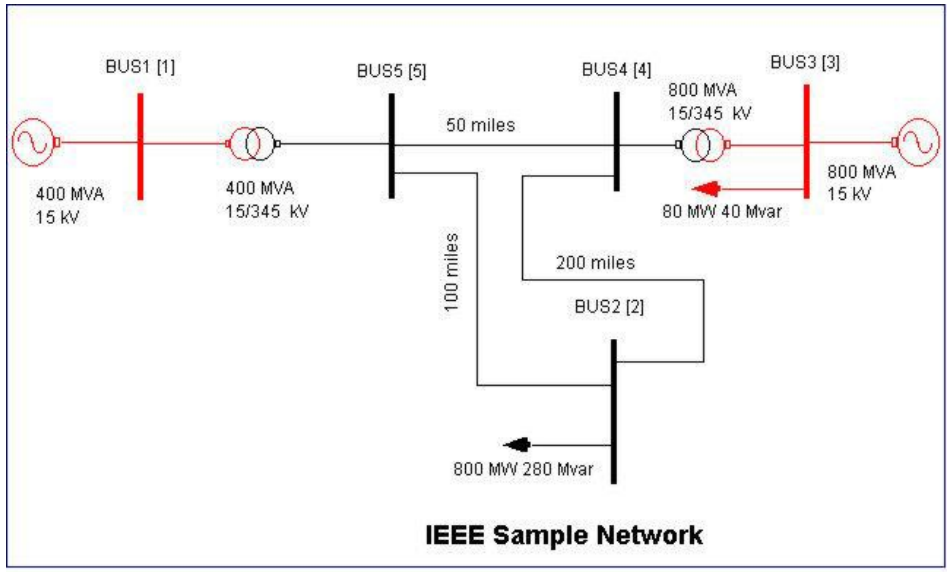


Figure 5.1

Load Flow Results

```
--------------------------------------------------------------------------------
BUS VOLTAGES AND POWERS

    NODE      FROM    V-MAG   ANGLE         MW      MVAR         MW      MVAR      MVAR
     NO.      NAME     P.U.  DEGREE        GEN       GEN       LOAD      LOAD      COMP
-------- --------  ------  ------   --------  --------  --------  -------- --------
       1      Bus1  1.0000    0.00    388.983   295.503     0.000     0.000     0.000
>
       2      Bus2  0.9227  -19.53      0.000     0.000   800.000   280.000     0.000
@
       3      Bus3  1.0500   -0.29    520.000    55.566    80.000    40.000     0.000
       4      Bus4  1.0462   -2.57      0.000     0.000     0.000     0.000     0.000
       5      Bus5  1.0505   -4.49      0.000     0.000     0.000     0.000     0.000
#
--------------------------------------------------------------------------------
--------------------------------------------------------------------------------
TRANSFORMER FLOWS AND TRANSFORMER LOSSES

SLNO CS  FROM    FROM      TO      TO        FORWARD            LOSS             %
         NODE     NAME      NODE     NAME      MW       MVAR          MW       MVAR
LOADING
   1   1    5       Bus5         1       Bus1 -385.403 -247.777    3.5794   47.7255
81.4#
   2   1   4       Bus4          3       Bus3 -438.684     2.011    1.3183   17.5768
41.9^
--------------------------------------------------------------------------------
--------------------------------------------------------------------------------
LINE FLOWS AND LINE LOSSES

SLNO CS  FROM     FROM     TO       TO          FORWARD        LOSS              %
         NODE      NAME     NODE       NAME         MW     MVAR          MW      MVAR
LOADING
---- -- -------- -------- -------- -------- -------- -------- -------- --------
--
   3   1    5       Bus5         4       Bus4 -143.670     9.088    0.4436 -43.4296
12.2&
   4   1   4       Bus4          2       Bus2   294.554    50.506    8.8542 -68.9760
28.0^
   5   1   5       Bus5          2       Bus2   529.045   238.689   14.7779   78.1802
552.5!
--------------------------------------------------------------------------------

Table 5.1: Transient Stability Study Input file - 1Glove0t.dat0

       TRANSIENT STABILITY STUDIES
CASE NO :  1     CONTINGENCY  : 0  SCHEDULE NO : 0
CONTINGENCY NAME : Base Case
VERSION  8.1
```

```
%% First Power System Network
% COMMON SYSTEM SPECIFICATIONS

%  (1)Maximum Bus Id (2) No of Buses  (3) No of 2WdgTr
%  (4) NUMBER OF 3 WIND. TRANSFORMERS    (5) NUMBER OF TRANSMISSION LINES
%  (6) NUMBER OF SERIES REACTORS         (7) NUMBER OF SERIES CAPACITORS
%  (8) NUMBER OF CIRCUIT BREAKERS        (9) NUMBER OF SHUNT REACTORS
% (10) NUMBER OF SHUNT CAPACITORS        (11) NUMBER OF SHUNT IMPEDANCES
% (12) NUMBER OF GENERATORS              (13) NUMBER OF MOTORS
% (14) NUMBER OF LOADS(+WIND GENERATORS)(15) NUMBER OF LOAD CHARACTERISTICS
% (16) NUMBER OF UNDER FREQUENCY RELAYS (17) NUMBER OF VOLTAGE RELAYS
% (18) NUMBER OF OVER CURRENT RELAYS    (19) NUMBER OF DISTANCE RELAYS
% (20) NUMBER OF FILTERS                (21) NUMBER OF CYCLIC LOADS
% (22) NUMBER OF VOLTAGE REGULATORS     (23) NUMBER OF GOVERNORS
% (24) NUMBER OF STATIC VAR COMPENSATORS(25) NUMBER OF HVDC CONV. TERMINALS
% (26) NUMBER OF HVDC LINKS
% (27) NUMBER OF FREE PROGRAMMABLE BLOCKS
% (28) NUMBER OF WIND TURBINES(DETAILED)% (29) NUMBER OF WT CURVES
% (30) NUMBER OF DETAILED WT CURVES
   5     5     2     0     3     0     0     0     0     0
   0     2     0     2     0     0     0     0     0     0
   0     0     0     0     0     0     0    0    0    0

% CONTROL INPUTS
% (1) No of Zones   (2) No of Disturb    (3) No of VIZS Out  (4) No of LF iter
% (5) No of Time Steps

   1     2     5    10     10

% (6) Load Type during Post. Dist. (7) LF Print opt (8) VI print opt
% (9) Data Print opt (10) Swing Ref Bus
   0     1     1     1      0

% V_I_Z BUS DATA
   1    2    3    4    5

% MODEL SELECTION PARAMETERS
% (1) Base MVA   (2)Base Frequency (3) R/X Ratio   (4) CB R  (5) CB X

4.0000e+002  50.0000   0.0500 0.0000e+000  1.0000e-004

% (5) Init P Tol  (6) Init Q Tol (7) Post P Tol (8) Post Q Tol

1.0000e-004  1.0000e-004  1.0000e-004  1.0000e-004

% VARIABLE TIME STEP DATA
% End Time       TimeStep

5.0000e-001  2.0000e-003  1.0000e+000  2.0000e-002
2.0000e+000  2.0000e-002  3.0000e+000  2.0000e-002
```

```
%Zonal Multiplication Factors
% 1.Zone Numbers  2.PLoad   3.QLoad    4.PGen  5.QGen      6.ShRea    7.ShCap  8
Compensation
   0   1.0000   1.0000   1.0000   1.0000   1.0000   1.0000  1.0000
   1   1.0000   1.0000   1.0000   1.0000   1.0000   1.0000  1.0000

% DISTURBANCE DATA
% SlNo   DistType  DistTime  FromBus     ToBus
% New1F1 New1F2    New1F3    PoleRecType
% New2F1 New2F2    New2F3

   1      4     0.1000      1     1 0.000000e+000   1.000000e-005   0.000000e+000
0
0.000000e+000  0.000000e+000  0.000000e+000
   2      5     0.2000      1     1 0.000000e+000   1.000000e-005   0.000000e+000
0
0.000000e+000  0.000000e+000  0.000000e+000

% GENERATOR AND MOTOR BUS NUMBERS
   1     3

% BUS DATA
% BusId  Islnd No  Zone No  Base Volt  BusName
% VMag   VAng      PGen     QGen    PLd     QLd  QComp

   1  1   1  15.000     Bus1
      1.000000000000e+000    0.000000000000e+000    3.889830e+002    2.955030e+002
0.000000e+000 0.000000e+000   0.00
   2  1   1 345.000     Bus2
      9.227341992785e-001   -1.952998891308e+001   0.000000e+000   0.000000e+000
8.000000e+002 2.800000e+002   0.00
   3  1   1  15.000     Bus3
      1.050000000000e+000   -2.854108260466e-001   5.200000e+002   5.556600e+001
8.000000e+001 4.000000e+001   0.00
   4  1   1 345.000     Bus4
      1.046210697168e+000   -2.574152239005e+000   0.000000e+000   0.000000e+000
0.000000e+000 0.000000e+000   0.00
   5  1   1 345.000     Bus5
      1.050491445376e+000   -4.486125141903e+000   0.000000e+000   0.000000e+000
0.000000e+000 0.000000e+000   0.00

% 2 WDG TRANSFORMER DATA
% Status  Units   FromBus  ToBus  +veR  +veX  ZeroR  ZeroX
% NomTap  PhShift FromFreq ToFreq  FromVoltRel  ToVoltRel

3   1     5    1  5.999949e-003 7.999932e-002    5.999949e-003 7.999932e-002
   1.120000e+000 0.000000e+000 0  0  0  0
 0.00000e+000  G  D

3   1     4    3  2.999077e-003 3.998769e-002    2.999077e-003 3.998769e-002
```

```
   1.000000e+000 0.000000e+000 0  0  0  0
 0.00000e+000  G  D

% Transmission Line Data
% Status  Units   FromBus  ToBus  +veR  +veX  +ve B/2  ZeroR  ZeroX ZeroB/2
%         FromFreq ToFreq  FromVoltRel  ToVoltRel

3   1       5      4 9.000000e-003  1.000000e-001  5.500000e-002   0.000000e+000
0.000000e+000 0.000000e+000
    0  0  0  0
3   1       4      2 3.600000e-002  4.000000e-001  2.150000e-001   0.000000e+000
0.000000e+000 0.000000e+000
    0  0  0  0
3   1       5      2 1.800000e-002  2.000000e-001  1.100000e-001   0.000000e+000
0.000000e+000 0.000000e+000
    0  0  0  0

% LOAD DATA
% FromBus MWLoad MVARLoad  CompMVAR  LoadCharNo FreqRelId VoltRelId

   2 8.000000e+002 2.800000e+002 0.000000e+000    0    0    0
   3 8.000000e+001 4.000004e+001 0.000000e+000    0    0    0

% Island Information
1
50.000000

% GENERATOR DATA
%FromBus ModelType Units  MVA  H     +veR  xd`  xq`  Xn
%     Ro   Xo        DampFact    Xd    Xq    Xp   Xd'' xq''
%        Tdo'      Tqo'        Tdo'' Tqo'' FreqRel VoltRel

   1  1 1 4.000000e+002  5.000000e+001  0.000000e+000  8.000000e-003 1.200000e-
002  4.000000e-002
    0.000000e+000   4.000000e-002   1.500000e+000   4.000000e-001   4.000000e-002
2.000000e-002 4.000000e-003 4.000000e-002
    1.000000e-003 2.000000e-003 0.000000e+000 1.000000e-004    0     0
   3  1 1 4.000000e+002  5.000000e+001  0.000000e+000  8.000000e-003 1.200000e-
002  4.000000e-002
    0.000000e+000   4.000000e-002   1.500000e+000   4.000000e-001   4.000000e-002
8.000000e-002 4.000000e-003 4.000000e-002
    1.000000e-003 1.000000e-003 0.000000e+000 1.000000e-004    0     0

% Wind Turbine Data
--------------------------------------------------------------------------------
---
```

Table 5.2: Transient Stability Study Outut file - 1Glove0t.out0

```
--------------------------------------------------------------------------------
Date and Time : Wed Apr 30 10:59:48 2014
--------------------------------------------------------------------------------
        TRANSIENT STABILITY STUDIES
CASE NO :  1     CONTINGENCY  : 0  SCHEDULE NO : 0
CONTINGENCY NAME : Base Case
--------------------------------------------------------------------------------
VERSION NUMBER :  8.1
%% First Power System Network
LARGEST BUS NUMBER                 :    5
ACTUAL NUMBER OF BUSES             :    5
NUMBER OF 2 WIND. TRANSFORMERS     :    2
NUMBER OF 3 WIND. TRANSFORMERS     :    0
NUMBER OF TRANSMISSION LINES       :    3
NUMBER OF SERIES REACTORS          :    0
NUMBER OF SERIES CAPACITORS        :    0
NUMBER OF CIRCUIT BREAKERS         :    0
NUMBER OF SHUNT REACTORS           :    0
NUMBER OF SHUNT CAPACITORS         :    0
NUMBER OF LINE REACTORS            :    0
NUMBER OF GENERATORS               :    2
NUMBER OF MOTORS                   :    0
NUMBER OF LOADS                    :    2
NUMBER OF LOAD CHARACTERISTICS     :    0
NUMBER OF UNDER FREQUENCY RELAYS   :    0
NUMBER OF VOLTAGE RELAYS           :    0
NUMBER OF OVER CURRENT RELAYS      :    0
NUMBER OF DISTANCE RELAYS          :    0
NUMBER OF FILTERS                  :    0
NUMBER OF CYCLIC LOADS             :    0
NUMBER OF VOLTAGE REGULATORS       :    0
NUMBER OF GOVERNORS                :    0
NUMBER OF SHUNT FACT DEVICES       :    0
NUMBER OF HVDC CONV. TERMINALS     :    0
NUMBER OF HVDC LINKS               :    0
NUMBER OF FREE PROGRAMMABLE BLOCKS :    0
NUMBER OF WIND TURBINES            :    0
--------------------------------------------------------------------------------
No. of Zones                                :    1
No. of Disturbances                         :    2
No. of Nodes for V-I-Z-S output             :    5
No. of Iterations in Load Flow Analysis     :   10
No. of Time Steps for Print                 :   10
Index for Load type during post-disturbance :    0
Index for Load Flow Print                   :    1
Index for Voltage Impedance Print           :    1
Index for Data details Print                :    1
Reference swing bus                         :    0
--------------------------------------------------------------------------------
Voltage - Current - Impedance Print Bus Numbers :
--------------------------------------------------------------------------------
   1    2    3    4    5
```

```
--------------------------------------------------------------------------------
Base MVA                                      : 400.0000
Rated system frequency                        :  50.0000
Transformer R/X                               :   0.0500
Circuit breaker resistance                    :   0.0000
Circuit breaker reactance                     :   0.0001
Tolerance  -  Real  Power  (pu)  -  initial  :  0.0001
Tolerance  -  Reactive  Power  (pu)  -  initial  :  0.0001
Tolerance  -  Real  Power  (pu)  -  post-distb  :  0.0001
Tolerance - Reactive Power (pu) - post-distb :   0.0001
--------------------------------------------------------------------------------
Variable Time Step (Seconds)
From Time    To Time  Time Step
---------- ---------- ----------
  0.00000*    0.50000     0.00200
  0.50000*    1.00000     0.02000
  1.00000*    2.00000     0.02000
  2.00000*    3.00000*    0.02000
--------------------------------------------------------------------------------
--------------------------------------------------------------------------------
Zonal Wise Demand Multiplication Factors :
Zone Number    P-DM    Q-DM    P-GM    Q-GM    SR_M    SC-M    C-DM
----------- ------- ------- ------- ------- ------- ------- -------
          0  1.0000  1.0000  1.0000  1.0000  1.0000  1.0000  1.0000
          1  1.0000  1.0000  1.0000  1.0000  1.0000  1.0000  1.0000
--------------------------------------------------------------------------------
--------------------------------------------------------------------------------
Disturbance Description
Dist. Type  Description
---------- -----------------------------------------------------
        1.  Change in transformer/line parameters
        2.  Change in shunt impedance load
        3.  Change in load P and Q values
        4.  Fault creation at a bus
        5.  Fault clearing at a bus
        6.  Change in number of generator sets a a bus
        7.  Complete generation outage at a bus
        8.  Simulation of single line to ground falut
        9.  Clearing of single-line-to-ground fault and single pole opening
       10.  SLG fault clearing or recloser of the line
       11.  Loss of excitation at a generator
       12.  Change in load model data
       13. Starting of the motor
       14. Stopping of the motor
       15. Change in motor torque T0
       16. Series faults
       17. Clearing of series faults
       18. Change in generation
       19. Asymmetrical faults like LL and LLG
       20. Clearing asymmetrical faults like LL and LLG
```

```
Dist. Dist. Time      From To   New Z.re New Z.im New  B/2 Rec.
No.   Type  Sec.      No.  No.  New P.MW New MVAR New Comp Type
----- ----- -------- ---- ---- -------- -------- -------- ----
    1     4   0.1000    1    1  0.00000  0.00001  0.00000    0
                                0.00000  0.00000  0.00000
    2     5   0.2000    1    1  0.00000  0.00001  0.00000    0
                                0.00000  0.00000  0.00000
--------------------------------------------------------------------------------
Generator Bus Numbers :    1    3
--------------------------------------------------------------------------------
--------------------------------------------------------------------------------
--------------------------------------------------------------------------------
Bus No. Island Zone Rated-Kv Name     Vmag-pu  Vang-Deg Pgen-MW  Qgen-MR
                                               Pl-MW    Ql-MVAR  Comp-MR
------- ------ ---- -------- -------- -------- -------- -------- --------
      1      1    1   15.000      Bus1  1.00000    0.000  388.983  295.503
                                           0.000    0.000    0.000
      2      1    1  345.000      Bus2  0.92273  -19.530    0.000    0.000
                                         800.000  280.000    0.000
      3      1    1   15.000      Bus3  1.05000   -0.285  520.000   55.566
                                          80.000   40.000    0.000
      4      1    1  345.000      Bus4  1.04621   -2.574    0.000    0.000
                                           0.000    0.000    0.000
      5      1    1  345.000      Bus5  1.05049   -4.486    0.000    0.000
                                           0.000    0.000    0.000
--------------------------------------------------------------------------------
--------------------------------------------------------------------------------
TRANSFORMER DATA ON 400.000 MVA BASE
SLNO* STAT #CKT FROM FROMNAME TO   TO  NAME    RP-PU    XP-PU    RZ-PU    XZ-PU
                                              TAP PHASE-SH F-FREQ-V T-FREQ-V
----- ---- ---- ---- -------- ---- -------- -------- -------- -------- --------
    1    3    1    5     Bus5    1     Bus1  0.00600  0.08000  0.00600  0.08000
                                             1.120  0.00000    0-  0     0-  0
0 G D
    2    3    1    4     Bus4    3     Bus3  0.00300  0.03999  0.00300  0.03999
                                             1.000  0.00000    0-  0     0-  0
0 G D
```

```
--------------------------------------------------------------------------------
TRANSMISSION LINE DATA ON 400.000 MVA BASE
SLNO* STAT #CKT FROM FROMNAME TO   TO  NAME    RP-PU    XP-PU  BP/2-PU
                                      R0-PU    X0-PU  B0/2-PU F-FREQ-V T-FREQ-V
----- ---- ---- ---- -------- ---- -------- -------- -------- -------- --------
    1    3    1    5     Bus5    4     Bus4  0.00900  0.10000  0.05500
                                    0.00000  0.00000  0.00000    0-  0    0-  0
    2    3    1    4     Bus4    2     Bus2  0.03600  0.40000  0.21500
                                    0.00000  0.00000  0.00000    0-  0    0-  0
    3    3    1    5     Bus5    2     Bus2  0.01800  0.20000  0.11000
                                    0.00000  0.00000  0.00000    0-  0    0-  0
--------------------------------------------------------------------------------
LOAD DATA
SLNO NODE BUS NAME     P-MW   Q-MVAR COMPMVAR LOADCHAR L-FREQ-V
---- ---- -------- -------- -------- -------- -------- --------
   1    2     Bus2  800.000  280.000    0.000        0    0-  0
   2    3     Bus3   80.000   40.000    0.000        0    0-  0
--------------------------------------------------------------------------------
Total islands in the system :    1
Frequency :  50.00
--------------------------------------------------------------------------------
Machine Data on its own MVA rating
Notation used in the generator data print
H   : Inertia constant in seconds.
Ra  : Generator resistance in pu.
xd' : Direct axis transient reactance in pu.
xq' : Quadrature axis transient reactance in pu.
xn  : Negative sequence reactance in pu.
R0 : Zero sequence resistance in pu.
x0  : Zero sequence reactance in pu.
df  : Damping factor in pu.
xd  : Direct axis reactance in pu.
xq : Quadrature axis reactance in pu.
xp  : Potier reactance in pu.
xd" : Direct axis sub-transient reactance in pu.
xq" : Quadrature axis  sub-transient reactance in pu.
tdo': Direct axis transient open circuit time constant in seconds.
tqo': Quadrature axis transient open circuit time constant in seconds.
tdo": Direct axis sub-transient time constant in seconds.
tqo": Quadrature axis sub-transient time constant in seconds.

Notation used in the motor data print
H   : Inertia constant in seconds.
r1 : Stator resistance in pu.
x1  : Stator reactance in pu.
r2  : Rotor resistance in pu.
x2  : Rotor reactance in pu.
xm : Magnetizing reactance in pu.
Slip: Initial motor slip in pu.
```

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pm  : Motor rated power in  in pu.
------------------------------------------------------------------------------
Generator bus no. :    1  Bus name :     Bus1 Model type :    1 Units :    1
MVA   :   400.000 H      : 50.00000,  Ra    :   0.00000 xd'   :   0.00800 xq'   :
0.01200
xn    :  0.04000 Ro   :  0.00000, x0   :  0.04000 df   :  1.50000
xd    :   0.40000 xq    :   0.04000   xp    :   0.02000 xd"   :   0.00400 xq"   :
0.04000
tdo' :  0.00100 tqo' :  0.00200 tdo" :  0.00000 tqo" :  0.00010
Frequency Relay No :    0 Voltage Relay NO :    0

Generator bus no. :    3  Bus name :     Bus3 Model type :    1 Units :    1
MVA   :   400.000 H      : 50.00000,  Ra    :   0.00000 xd'   :   0.00800 xq'   :
0.01200
xn    :  0.04000 Ro   :  0.00000, x0   :  0.04000 df   :  1.50000
xd    :   0.40000 xq    :   0.04000   xp    :   0.08000 xd"   :   0.00400 xq"   :
0.04000
tdo' :  0.00100 tqo' :  0.00100 tdo" :  0.00000 tqo" :  0.00010
Frequency Relay No :    0 Voltage Relay NO :    0

------------------------------------------------------------------------------
------------------------------------------------------------------------------
------------------------------------------------------------------------------
kp 0 kq 0 Iterations 1 dpmax 0.000084 dqmax 0.000024
------------------------------------------------------------------------------
Iter # Pmax     Pmax-bus Qmax     Qmax-bus Vmax     Vmax-bus
------ -------- -------- -------- -------- -------- --------
     1  0.00008        2  0.00002        2  0.00000        0
------------------------------------------------------------------------------
Results of load flow study
No.  Name     Island Zone Rated KV Vact-KV  V-mag    Ang-Deg  Pgen     Qgen
                                                    Pload    Qload    Q-comp
---- -------- ------ ---- -------- -------- -------- -------- -------- --------
   1     Bus1     1    1   15.000   15.000  1.00000    0.000  388.983  295.503
                                                      0.000    0.000    0.000
   2     Bus2     1    1  345.000  318.343  0.92273  -19.530    0.000    0.000
                                                    800.000  280.000    0.000
   3     Bus3     1    1   15.000   15.750  1.05000   -0.285  520.000   55.566
                                                     80.000   40.000    0.000
   4     Bus4     1    1  345.000  360.943  1.04621   -2.574    0.000    0.000
                                                      0.000    0.000    0.000
   5     Bus5     1    1  345.000  362.420  1.05049   -4.486    0.000    0.000
                                                      0.000    0.000    0.000
```

```
--------------------------------------------------------------------------------
Line flow and line losses
From From     To   To       Ckts Forward  Forward  MWLoss   MVARLoss
Node Name     Node Name     No.  FlowMW   FlowMVAR MW
---- -------- ---- -------- ---- -------- -------- -------- --------
   1     Bus1    5     Bus5    1   388.98   295.50    3.579   47.726

   2     Bus2    4     Bus4    1  -285.70  -119.48    8.854  -68.976
   2     Bus2    5     Bus5    1  -514.27  -160.51   14.778   78.180

   3     Bus3    4     Bus4    1   440.00    15.57    1.318   17.577

   4     Bus4    3     Bus3    1  -438.68     2.01    1.318   17.577
   4     Bus4    5     Bus5    1   144.11   -52.52    0.444  -43.430
   4     Bus4    2     Bus2    1   294.55    50.51    8.854  -68.976

   5     Bus5    1     Bus1    1  -385.40  -247.78    3.579   47.726
   5     Bus5    4     Bus4    1  -143.67     9.09    0.444  -43.430
   5     Bus5    2     Bus2    1   529.04   238.69   14.778   78.180

--------------------------------------------------------------------------------
Total power generation        :   908.98 MW       351.07 MVAR
Total reactive compensation   :                     0.00 MVAR
Total capacitivei copensation :                     0.00 MVAR
Total inductive compensation  :                     0.00 MVAR
Total power losses            :    28.97 MW        31.08 MVAR
Over all P mismatch           :    0.010 MW
Percentage P losses           :    3.188
--------------------------------------------------------------------------------
kp 0 kq 0 Iterations 1 dpmax 0.000084 dqmax 0.000024
Notation used for generator graph files
Vbname.grp : Voltage Magnitude
Abname.grp : Voltage Angle
Dbname.grp : Swing curve
Fbname.grp : Frequency plot
Pbname.grp : Electrical Power P - MW
Qbname.grp : Electrical Power Q - MVAR
Mbname.grp : Mechanical Power - MW
Ebname.grp : Field Voltage - kV
Sbname.grp : Motor Slip - PU
Ibname.grp : Current Magnitude - Amps
Tbname.grp : Apparent power - MVA
wherein bname is the bus name.
--------------------------------------------------------------------------------
Notation used for line flow graph files
LPxFV.grp : Voltage Magnitude From Bus
LPxTV.grp : Voltage Magnitude To Bus
LPxFI.grp : Forward flow current magnitude
LPxFF.grp : Frequency in Hz. From Bus
LPxFP.grp : Forward real power flow
```

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LPxFR.grp : Forward reactive power flow
LPxFZ.grp : Forward impedance loci (r-x plot)
wherein x is the line number in the plot list as follows
   1     Bus1     5     Bus5 x : 1
   2     Bus2     4     Bus4 x : 2
                  5     Bus5 x : 3
   3     Bus3     4     Bus4 x : 4
   4     Bus4     3     Bus3 x : 5
                  5     Bus5 x : 6
                  2     Bus2 x : 7
   5     Bus5     1     Bus1 x : 8
                  4     Bus4 x : 9
                  2     Bus2 x : 10
-------------------------------------------------------------------------------
Time =   0.00000 Seconds
Intermediate results for Machines
GNo Name       Voltage Angle    Delta    Freq     Pgen     Qgen     Pmech    Efd/Slip
               pu      Degree   Degree   Hzs.     MW       MVAR     MW       pu/PU
--- -------- ------- -------- -------- -------- -------- -------- -------- --------
  1     Bus1       1        0    0.443       50      389      296      389     1.01
  3     Bus3    1.05   -0.285    0.255       50      520     55.6      520     1.05
---------------------------------------------------------------------------
Maximum rotor angle difference :    0.18861 b/w buses : 1 and 3
kp 0 kq 0 Iterations 1 dpmax 0.000084 dqmax 0.000024
kp 0 kq 0 Iterations 1 dpmax 0.000084 dqmax 0.000024
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kp 0 kq 0 Iterations 1 dpmax 0.000084 dqmax 0.000024
kp 0 kq 0 Iterations 1 dpmax 0.000084 dqmax 0.000024
kp 0 kq 0 Iterations 1 dpmax 0.000084 dqmax 0.000024
------------------------------------------------------------------------------
Time =   0.02000 Seconds
Intermediate results for Machines
GNo Name       Voltage Angle    Delta    Freq     Pgen     Qgen     Pmech    Efd/Slip
               pu      Degree   Degree   Hzs.     MW       MVAR     MW       pu/P.U.
--- -------- ------- -------- -------- -------- -------- -------- ------- --------
  1     Bus1       1        0    0.443       50      389      296      389     1.01
  3     Bus3    1.05   -0.285    0.255       50      520     55.6      520     1.05
-------------------------------------------------------------------------------
Maximum rotor angle difference :    0.18861 b/w buses : 1 and 3
Island    1 Common system frequency 50.000
```

```
--------------------------------------------------------------------------------
Voltage (pu), Current (AMPS), impedance (PU) and power (MW-MVAR) for lines
From Name     Voltage Angle   To   Name     Voltage  Angle    Current  Angle
                                              Zl-real  Zl-im    P        Q
---- -------- ------- ------- ---- -------- -------- -------- -------- --------
   1     Bus1   1.000    0.00    5     Bus5     1.05     -4.5 1.9e+004      -37
                                              0.65      0.5 3.9e+002   3e+002
   2     Bus2   0.923  -19.53    4     Bus4     1.05     -2.6 5.6e+002 1.4e+002
                                                -1         -0.42  -2.9e+002  -
1.2e+002
                                5     Bus5     1.05     -4.5 9.8e+002 1.4e+002
                                              -0.6         -0.19  -5.1e+002  -
1.6e+002
   3     Bus3   1.050   -0.29    4     Bus4     1.05     -2.6 1.6e+004     -2.3
                                                 1    0.035 4.4e+002       16
   4     Bus4   1.046   -2.57    3     Bus3     1.05    -0.29   7e+002 1.8e+002
                                                -1          0.0046   -4.4e+002
2
                                5     Bus5     1.05     -4.5 2.5e+002       17
                                               2.7    -0.98 1.4e+002      -53
                                2     Bus2    0.923      -20 4.8e+002      -12
                                               1.4     0.25 2.9e+002       51
   5     Bus5   1.050   -4.49    1     Bus1        1        0 7.3e+002 1.4e+002
                                             -0.81         -0.52  -3.9e+002  -
2.5e+002
                                4     Bus4     1.05     -2.6 2.3e+002 1.8e+002
                                              -3.1            0.19   -1.4e+002
9.1
                                2     Bus2    0.923      -20 9.2e+002      -29
                                              0.69     0.31 5.3e+002 2.4e+002
kp 0 kq 0 Iterations 1 dpmax 0.000084 dqmax 0.000024
```

```
kp 0 kq 0 Iterations 1 dpmax 0.000084 dqmax 0.000024
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kp 0 kq 0 Iterations 1 dpmax 0.000084 dqmax 0.000024
kp 0 kq 0 Iterations 1 dpmax 0.000084 dqmax 0.000024
kp 0 kq 0 Iterations 1 dpmax 0.000084 dqmax 0.000024
-------------------------------------------------------------------------------
Time =   0.04000 Seconds
Intermediate results for Machines
GNo Name     Voltage Angle    Delta    Freq    Pgen    Qgen    Pmech   Efd/Slip
             pu      Degree   Degree   Hzs.    MW      MVAR    MW      pu/P.U.
--- -------- ------- -------- -------- ------- ------- ------- ------- --------
  1     Bus1       1        0    0.443      50     389     296     389     1.01
  3     Bus3    1.05   -0.285    0.255      50     520    55.6     520     1.05
--------------------------------------------------------------------------------
Maximum rotor angle difference :    0.18861 b/w buses : 1 and 3
Island    1 Common system frequency 50.000
-------------------------------------------------------------------------------
Voltage (pu), Current (AMPS), impedance (PU) and power (MW-MVAR) for lines
From Name      Voltage Angle   To    Name      Voltage  Angle    Current  Angle
                                               Zl-real  Zl-im    P        Q
---- -------- ------- ------- ---- -------- -------- -------- -------- --------
   1     Bus1   1.000    0.00    5     Bus5     1.05     -4.5 1.9e+004      -37
                                                0.65      0.5 3.9e+002   3e+002
   2     Bus2   0.923  -19.53    4     Bus4     1.05     -2.6 5.6e+002 1.4e+002
                                                  -1        -0.42  -2.9e+002   -
1.2e+002
                                   5     Bus5     1.05     -4.5 9.8e+002 1.4e+002
                                                -0.6        -0.19  -5.1e+002   -
1.6e+002
   3     Bus3   1.050   -0.29    4     Bus4     1.05     -2.6 1.6e+004     -2.3
                                                   1    0.035 4.4e+002       16
   4     Bus4   1.046   -2.57    3     Bus3     1.05    -0.29   7e+002 1.8e+002
                                                  -1          0.0046    -4.4e+002
2
                                   5     Bus5     1.05     -4.5 2.5e+002       17
                                                 2.7    -0.98 1.4e+002      -53
                                   2     Bus2    0.923      -20 4.8e+002      -12
                                                 1.4     0.25 2.9e+002       51
   5     Bus5   1.050   -4.49    1     Bus1        1        0 7.3e+002 1.4e+002
                                               -0.81        -0.52  -3.9e+002   -
2.5e+002
                                   4     Bus4     1.05     -2.6 2.3e+002 1.8e+002
                                                -3.1             0.19   -1.4e+002
9.1
                                   2     Bus2    0.923      -20 9.2e+002      -29
                                                0.69     0.31 5.3e+002 2.4e+002
```

```
kp 0 kq 0 Iterations 1 dpmax 0.000084 dqmax 0.000024
kp 0 kq 0 Iterations 1 dpmax 0.000084 dqmax 0.000024
kp 0 kq 0 Iterations 1 dpmax 0.000084 dqmax 0.000024
kp 0 kq 0 Iterations 1 dpmax 0.000084 dqmax 0.000024
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kp 0 kq 0 Iterations 1 dpmax 0.000084 dqmax 0.000024
kp 0 kq 0 Iterations 1 dpmax 0.000084 dqmax 0.000024
------------------------------------------------------------------------------
Time =   0.06000 Seconds
Intermediate results for Machines
GNo Name     Voltage Angle    Delta    Freq    Pgen    Qgen    Pmech   Efd/Slip
             pu      Degree   Degree   Hzs.    MW      MVAR    MW      pu/P.U.
--- -------- ------- -------- -------- ------- ------- ------- ------- --------
  1     Bus1       1        0    0.443      50     389     296     389     1.01
  3     Bus3    1.05   -0.285    0.255      50     520    55.6     520     1.05
------------------------------------------------------------------------------
Maximum rotor angle difference :    0.18861 b/w buses : 1 and 3
Island    1 Common system frequency   50.000
------------------------------------------------------------------------------
Voltage (pu), Current (AMPS), impedance (PU) and power (MW-MVAR) for lines
From Name     Voltage Angle   To   Name     Voltage  Angle    Current  Angle
                                            Zl-real  Zl-im    P        Q
---- -------- ------- ------- ---- -------- -------- -------- -------- --------
   1     Bus1   1.000    0.00    5     Bus5     1.05     -4.5 1.9e+004      -37
                                                0.65      0.5 3.9e+002   3e+002
   2     Bus2   0.923  -19.53    4     Bus4     1.05     -2.6 5.6e+002 1.4e+002
                                                  -1        -0.42  -2.9e+002  -
1.2e+002
                                   5     Bus5     1.05     -4.5 9.8e+002 1.4e+002
                                                -0.6        -0.19  -5.1e+002  -
1.6e+002
   3     Bus3   1.050   -0.29    4     Bus4     1.05     -2.6 1.6e+004     -2.3
                                                   1    0.035 4.4e+002       16
   4     Bus4   1.046   -2.57    3     Bus3     1.05    -0.29   7e+002 1.8e+002
                                                  -1         0.0046   -4.4e+002
2
                                   5     Bus5     1.05     -4.5 2.5e+002       17
                                                 2.7    -0.98 1.4e+002      -53
                                   2     Bus2    0.923      -20 4.8e+002      -12
                                                 1.4     0.25 2.9e+002       51
```

```
   5      Bus5    1.050    -4.49     1      Bus1         1         0 7.3e+002 1.4e+002
                                                    -0.81          -0.52  -3.9e+002  -
2.5e+002
                                      4      Bus4      1.05      -2.6 2.3e+002 1.8e+002
                                                      -3.1             0.19  -1.4e+002
9.1
                                      2      Bus2     0.923       -20 9.2e+002       -29
                                                      0.69      0.31 5.3e+002 2.4e+002
```

```
kp 0 kq 0 Iterations 1 dpmax 0.000084 dqmax 0.000024
kp 0 kq 0 Iterations 1 dpmax 0.000084 dqmax 0.000024
kp 0 kq 0 Iterations 1 dpmax 0.000084 dqmax 0.000024
kp 0 kq 0 Iterations 1 dpmax 0.000084 dqmax 0.000024
kp 0 kq 0 Iterations 1 dpmax 0.000084 dqmax 0.000024
kp 0 kq 0 Iterations 1 dpmax 0.000084 dqmax 0.000024
kp 0 kq 0 Iterations 1 dpmax 0.000084 dqmax 0.000024
kp 0 kq 0 Iterations 1 dpmax 0.000084 dqmax 0.000024
kp 0 kq 0 Iterations 1 dpmax 0.000084 dqmax 0.000024
kp 0 kq 0 Iterations 1 dpmax 0.000084 dqmax 0.000024
------------------------------------------------------------------------------
Time =   0.08000 Seconds
Intermediate results for Machines
GNo Name     Voltage Angle    Delta    Freq     Pgen     Qgen     Pmech    Efd/Slip
             pu      Degree   Degree   Hzs.     MW       MVAR     MW       pu/P.U.
--- -------- ------- -------- -------- -------- -------- -------- -------- --------
  1     Bus1       1        0    0.443      50     389      296      389     1.01
  3     Bus3    1.05   -0.285    0.255      50     520     55.6      520     1.05
-------------------------------------------------------------------------------
Maximum rotor angle difference :    0.18861 b/w buses : 1 and 3
Island    1 Common system frequency 50.000
------------------------------------------------------------------------------
Voltage (pu), Current (AMPS), impedance (PU) and power (MW-MVAR) for lines
From Name     Voltage Angle   To   Name     Voltage  Angle    Current  Angle
                                            Zl-real  Zl-im    P        Q
---- -------- ------- ------- ---- -------- -------- -------- -------- --------
   1     Bus1   1.000    0.00    5     Bus5     1.05     -4.5 1.9e+004      -37
                                                0.65      0.5 3.9e+002   3e+002
   2     Bus2   0.923  -19.53    4     Bus4     1.05     -2.6 5.6e+002 1.4e+002
                                                  -1        -0.42  -2.9e+002  -
1.2e+002
                                   5     Bus5     1.05     -4.5 9.8e+002 1.4e+002
                                                -0.6        -0.19  -5.1e+002  -
1.6e+002
   3     Bus3   1.050   -0.29    4     Bus4     1.05     -2.6 1.6e+004     -2.3
                                                   1    0.035 4.4e+002       16
   4     Bus4   1.046   -2.57    3     Bus3     1.05    -0.29   7e+002 1.8e+002
                                                  -1         0.0046   -4.4e+002
2
                                   5     Bus5     1.05     -4.5 2.5e+002       17
                                                 2.7    -0.98 1.4e+002      -53
                                   2     Bus2    0.923      -20 4.8e+002      -12
                                                 1.4     0.25 2.9e+002       51
   5     Bus5   1.050   -4.49    1     Bus1        1        0 7.3e+002 1.4e+002
                                               -0.81        -0.52  -3.9e+002  -
2.5e+002
                                   4     Bus4     1.05     -2.6 2.3e+002 1.8e+002
                                                -3.1           0.19   -1.4e+002
9.1
                                   2     Bus2    0.923      -20 9.2e+002      -29
                                                0.69     0.31 5.3e+002 2.4e+002
kp 0 kq 0 Iterations 1 dpmax 0.000084 dqmax 0.000024
```

```
kp 0 kq 0 Iterations 1 dpmax 0.000084 dqmax 0.000024
kp 0 kq 0 Iterations 1 dpmax 0.000084 dqmax 0.000024
kp 0 kq 0 Iterations 1 dpmax 0.000084 dqmax 0.000024
kp 0 kq 0 Iterations 1 dpmax 0.000084 dqmax 0.000024
kp 0 kq 0 Iterations 1 dpmax 0.000084 dqmax 0.000024
kp 0 kq 0 Iterations 1 dpmax 0.000084 dqmax 0.000024
kp 0 kq 0 Iterations 1 dpmax 0.000084 dqmax 0.000024
kp 0 kq 0 Iterations 1 dpmax 0.000084 dqmax 0.000024
kp 0 kq 0 Iterations 1 dpmax 0.000084 dqmax 0.000024
------------------------------------------------------------------------------
Time =   0.10000 Seconds
Intermediate results for Machines
GNo Name     Voltage Angle    Delta    Freq    Pgen    Qgen    Pmech   Efd/Slip
             pu      Degree   Degree   Hzs.    MW      MVAR    MW      pu/P.U.
--- -------- ------- -------- -------- ------- ------- ------- ------- --------
  1    Bus1       1        0    0.443      50     389     296     389     1.01
  3    Bus3    1.05   -0.285    0.255      50     520    55.6     520     1.05
-------------------------------------------------------------------------------
Maximum rotor angle difference :    0.18861 b/w buses : 1 and 3
Island    1 Common system frequency 50.000
------------------------------------------------------------------------------
Voltage (pu), Current (AMPS), impedance (PU) and power (MW-MVAR) for lines
From Name     Voltage Angle   To   Name     Voltage  Angle    Current  Angle
                                            Zl-real  Zl-im    P        Q
---- -------- ------- ------- ---- -------- -------- -------- -------- --------
   1    Bus1   1.000    0.00    5    Bus5      1.05     -4.5 1.9e+004      -37
                                               0.65      0.5 3.9e+002   3e+002
   2    Bus2   0.923  -19.53    4    Bus4      1.05     -2.6 5.6e+002 1.4e+002
                                                 -1        -0.42  -2.9e+002   -
1.2e+002
                                    5    Bus5      1.05     -4.5 9.8e+002 1.4e+002
                                               -0.6        -0.19  -5.1e+002   -
1.6e+002
   3    Bus3   1.050   -0.29    4    Bus4      1.05     -2.6 1.6e+004     -2.3
                                                  1    0.035 4.4e+002       16
   4    Bus4   1.046   -2.57    3    Bus3      1.05    -0.29   7e+002 1.8e+002
                                                 -1         0.0046    -4.4e+002
2
                                    5    Bus5      1.05     -4.5 2.5e+002       17
                                                2.7    -0.98 1.4e+002      -53
                                    2    Bus2     0.923      -20 4.8e+002      -12
                                                1.4     0.25 2.9e+002       51
   5    Bus5   1.050   -4.49    1    Bus1         1        0 7.3e+002 1.4e+002
                                              -0.81        -0.52  -3.9e+002   -
2.5e+002
                                    4    Bus4      1.05     -2.6 2.3e+002 1.8e+002
                                               -3.1            0.19   -1.4e+002
9.1
                                    2    Bus2     0.923      -20 9.2e+002      -29
                                               0.69     0.31 5.3e+002 2.4e+002
------------------------------------------------------------------------------
```

```
3 phase fault  0.10000    1     Bus1
kp 1 kq 0  Iterations 10 dpmax 0.002596 dqmax 0.000095
kp 1 kq 0  Iterations 10 dpmax 0.001096 dqmax 0.000096
kp 1 kq 0  Iterations 10 dpmax 0.001084 dqmax 0.000097
kp 1 kq 0  Iterations 10 dpmax 0.001074 dqmax 0.000097
kp 1 kq 0  Iterations 10 dpmax 0.001066 dqmax 0.000097
kp 1 kq 0  Iterations 10 dpmax 0.001060 dqmax 0.000097
kp 1 kq 0  Iterations 10 dpmax 0.001056 dqmax 0.000097
kp 1 kq 0  Iterations 10 dpmax 0.001055 dqmax 0.000097
kp 1 kq 0  Iterations 10 dpmax 0.001055 dqmax 0.000003
kp 1 kq 0  Iterations 10 dpmax 0.001057 dqmax 0.000004
--------------------------------------------------------------------------------
Time =   0.12000 Seconds
Intermediate results for Machines
GNo Name     Voltage Angle    Delta    Freq    Pgen    Qgen    Pmech   Efd/Slip
             pu      Degree   Degree   Hzs.    MW      MVAR    MW      pu/P.U.
--- -------- ------- -------- -------- ------- ------- ------- ------- --------
  1     Bus1  0.0013   0.0469    0.475      50   0.482    65.5     389     1.01
  3      Bus3     1.01    -0.235     0.259        50      459 1.9e+003       520
1.05
--------------------------------------------------------------------------------
Maximum rotor angle difference :    0.21526 b/w buses : 1 and 3
Island    1 Common system frequency   50.005
--------------------------------------------------------------------------------
Voltage (pu), Current (AMPS), impedance (PU) and power (MW-MVAR) for lines
From Name     Voltage Angle   To   Name     Voltage  Angle    Current  Angle
                                            Zl-real  Zl-im    P        Q
---- -------- ------- ------- ---- -------- -------- -------- -------- --------
   1     Bus1   0.001    0.05    5     Bus5     0.43     -5.6 7.4e+004       89
                                           6.6e-006 -0.00027     0.06     -2.5
   2     Bus2   0.495  -19.47    4     Bus4    0.828     -1.9   7e+002 1.1e+002
                                             -0.31         -0.36  -1.4e+002  -
1.5e+002
                                5        Bus5        0.43        -5.6 4.1e+002  -
1.6e+002
                                              -0.64      0.5      -94       74
   3     Bus3   1.014   -0.23    4     Bus4    0.828     -1.9 7.2e+004      -79
                                              0.044     0.21 3.8e+002 1.9e+003
   4     Bus4   0.828   -1.91    3     Bus3     1.01    -0.23 3.1e+003   1e+002
                                            -0.041         -0.17  -3.6e+002  -
1.5e+003
                                5     Bus5     0.43     -5.6 2.6e+003      -83
                                              0.034     0.21 2.1e+002 1.3e+003
                                2     Bus2    0.495      -19 5.4e+002      -58
                                              0.57     0.85 1.5e+002 2.2e+002
   5     Bus5   0.430   -5.61    1     Bus1   0.0013    0.047 2.9e+003      -91
                                             0.0075      0.1       55 7.3e+002
                                4     Bus4    0.828     -1.9 2.7e+003       97
                                             -0.024          -0.1  -1.5e+002  -
6.7e+002
                                2     Bus2    0.495      -19 4.4e+002       26
```

```
                                                    0.55    -0.34       97      -60
kp 1 kq 0  Iterations 10 dpmax 0.001061 dqmax 0.000004
kp 1 kq 0  Iterations 10 dpmax 0.001068 dqmax 0.000004
kp 1 kq 0  Iterations 10 dpmax 0.001076 dqmax 0.000004
kp 1 kq 0  Iterations 10 dpmax 0.001086 dqmax 0.000004
kp 1 kq 0  Iterations 10 dpmax 0.001097 dqmax 0.000004
kp 1 kq 0  Iterations 10 dpmax 0.001111 dqmax 0.000004
kp 1 kq 0  Iterations 10 dpmax 0.001126 dqmax 0.000004
kp 1 kq 0  Iterations 10 dpmax 0.001144 dqmax 0.000004
kp 1 kq 0  Iterations 10 dpmax 0.001163 dqmax 0.000004
kp 1 kq 0  Iterations 10 dpmax 0.001183 dqmax 0.000005
--------------------------------------------------------------------------------
Time =   0.14000 Seconds
Intermediate results for Machines
GNo Name     Voltage Angle    Delta    Freq    Pgen    Qgen    Pmech   Efd/Slip
             pu      Degree   Degree   Hzs.    MW      MVAR    MW      pu/P.U.
--- -------- ------- -------- -------- ------- ------- ------- ------- --------
  1     Bus1  0.0013   0.0959    0.576      50   0.534    65.5     389     1.01
  3      Bus3     1.01     -0.22     0.275        50      459 1.9e+003       520
1.05
--------------------------------------------------------------------------------
Maximum rotor angle difference :    0.30068 b/w buses : 1 and 3
Island    1 Common system frequency   50.011
--------------------------------------------------------------------------------
Voltage (pu), Current (AMPS), impedance (PU) and power (MW-MVAR) for lines
From Name     Voltage Angle   To   Name     Voltage  Angle    Current  Angle
                                            Zl-real  Zl-im    P        Q
---- -------- ------- ------- ---- -------- -------- -------- -------- --------
   1     Bus1   0.001    0.10    5     Bus5     0.43     -5.6 7.4e+004       89
                                             6.8e-006 -0.00027    0.062     -2.5
   2     Bus2   0.495  -19.46    4     Bus4    0.828     -1.9   7e+002 1.1e+002
                                            -0.31         -0.36  -1.4e+002  -
1.5e+002
                                5        Bus5        0.43        -5.6 4.1e+002  -
1.6e+002
                                           -0.64      0.5      -94       74
   3     Bus3   1.014   -0.22    4     Bus4    0.828     -1.9 7.2e+004       -79
                                            0.044     0.21 3.8e+002 1.9e+003
   4     Bus4   0.828   -1.89    3     Bus3     1.01    -0.22 3.1e+003   1e+002
                                           -0.041         -0.17  -3.6e+002  -
1.5e+003
                                5     Bus5     0.43     -5.6 2.6e+003      -83
                                           0.034     0.21 2.1e+002 1.3e+003
                                2     Bus2    0.495      -19 5.4e+002       -58
                                            0.57     0.85 1.5e+002 2.2e+002
   5     Bus5   0.430   -5.59    1     Bus1   0.0013    0.096 2.9e+003       -91
                                           0.0075      0.1       55 7.3e+002
                                4     Bus4    0.828     -1.9 2.7e+003       97
                                           -0.024          -0.1  -1.5e+002  -
6.7e+002
                                2     Bus2    0.495      -19 4.4e+002       26
```

```
                                                    0.55    -0.34       97      -60
kp 1 kq 0  Iterations 10 dpmax 0.001206 dqmax 0.000005
kp 1 kq 0  Iterations 10 dpmax 0.001230 dqmax 0.000005
kp 1 kq 0  Iterations 10 dpmax 0.001256 dqmax 0.000005
kp 1 kq 0  Iterations 10 dpmax 0.001283 dqmax 0.000005
kp 1 kq 0  Iterations 10 dpmax 0.001312 dqmax 0.000005
kp 1 kq 0  Iterations 10 dpmax 0.001343 dqmax 0.000005
kp 1 kq 0  Iterations 10 dpmax 0.001375 dqmax 0.000006
kp 1 kq 0  Iterations 10 dpmax 0.001409 dqmax 0.000006
kp 1 kq 0  Iterations 10 dpmax 0.001445 dqmax 0.000006
kp 1 kq 0  Iterations 10 dpmax 0.001482 dqmax 0.000006
------------------------------------------------------------------------------
Time =   0.16000 Seconds
Intermediate results for Machines
GNo Name     Voltage Angle    Delta    Freq    Pgen    Qgen    Pmech   Efd/Slip
             pu      Degree   Degree   Hzs.    MW      MVAR    MW      pu/P.U.
--- -------- ------- -------- -------- ------- ------- ------- ------- --------
  1     Bus1  0.0013    0.155    0.747      50   0.655    65.5     389     1.01
  3      Bus3     1.01    -0.194     0.302        50      459 1.9e+003       520
1.05
------------------------------------------------------------------------------
Maximum rotor angle difference :    0.44496 b/w buses : 1 and 3
Island    1 Common system frequency 50.017
------------------------------------------------------------------------------
Voltage (pu), Current (AMPS), impedance (PU) and power (MW-MVAR) for lines
From Name     Voltage Angle   To   Name     Voltage  Angle    Current  Angle
                                            Zl-real  Zl-im    P        Q
---- -------- ------- ------- ---- -------- -------- -------- -------- --------
   1     Bus1   0.001    0.15    5     Bus5     0.43     -5.6 7.4e+004       89
                                           6.9e-006 -0.00027    0.063     -2.5
   2     Bus2   0.495  -19.43    4     Bus4    0.828     -1.9   7e+002 1.1e+002
                                            -0.31         -0.36  -1.4e+002  -
1.5e+002
                                5        Bus5        0.43        -5.6 4.1e+002  -
1.6e+002
                                             -0.64      0.5      -94       74
   3     Bus3   1.014   -0.19    4     Bus4    0.828     -1.9 7.2e+004      -79
                                             0.044     0.21 3.8e+002 1.9e+003
   4     Bus4   0.828   -1.87    3     Bus3     1.01    -0.19 3.1e+003   1e+002
                                            -0.041         -0.17  -3.6e+002  -
1.5e+003
                                5     Bus5     0.43     -5.6 2.6e+003      -83
                                             0.034     0.21 2.1e+002 1.3e+003
                                2     Bus2    0.495      -19 5.4e+002      -58
                                             0.57     0.85 1.5e+002 2.2e+002
   5     Bus5   0.430   -5.56    1     Bus1   0.0013     0.15 2.9e+003      -91
                                            0.0075      0.1       55 7.3e+002
                                4     Bus4    0.828     -1.9 2.7e+003       97
                                            -0.024          -0.1  -1.5e+002  -
6.7e+002
                                2     Bus2    0.495      -19 4.4e+002       26
```

```
                                                    0.55    -0.34       97      -60
kp 1 kq 0  Iterations 10 dpmax 0.001520 dqmax 0.000006
kp 1 kq 0  Iterations 10 dpmax 0.001560 dqmax 0.000007
kp 1 kq 0  Iterations 10 dpmax 0.001601 dqmax 0.000007
kp 1 kq 0  Iterations 10 dpmax 0.001644 dqmax 0.000007
kp 1 kq 0  Iterations 10 dpmax 0.001688 dqmax 0.000007
kp 1 kq 0  Iterations 10 dpmax 0.001734 dqmax 0.000008
kp 1 kq 0  Iterations 10 dpmax 0.001781 dqmax 0.000008
kp 1 kq 0  Iterations 10 dpmax 0.001830 dqmax 0.000008
kp 1 kq 0  Iterations 10 dpmax 0.001880 dqmax 0.000009
kp 1 kq 0  Iterations 10 dpmax 0.001931 dqmax 0.000009
--------------------------------------------------------------------------------
Time =   0.18000 Seconds
Intermediate results for Machines
GNo Name     Voltage Angle    Delta    Freq    Pgen    Qgen    Pmech   Efd/Slip
             pu      Degree   Degree   Hzs.    MW      MVAR    MW      pu/P.U.
--- -------- ------- -------- -------- ------- ------- ------- ------- --------
  1     Bus1  0.0013    0.231    0.988      50   0.836    65.5     389     1.01
  3      Bus3     1.01    -0.157      0.34        50      459 1.9e+003      520
1.05
--------------------------------------------------------------------------------
Maximum rotor angle difference :    0.64808 b/w buses : 1 and 3
Island    1 Common system frequency 50.022
--------------------------------------------------------------------------------
Voltage (pu), Current (AMPS), impedance (PU) and power (MW-MVAR) for lines
From Name     Voltage Angle   To   Name     Voltage  Angle    Current  Angle
                                            Zl-real  Zl-im    P        Q
---- -------- ------- ------- ---- -------- -------- -------- -------- --------
   1     Bus1   0.001    0.23    5     Bus5     0.43     -5.5 7.4e+004       89
                                           7.1e-006 -0.00027    0.065     -2.5
   2     Bus2   0.495  -19.39    4     Bus4    0.828     -1.8   7e+002 1.1e+002
                                            -0.31        -0.36  -1.4e+002  -
1.5e+002
                                5        Bus5       0.43        -5.5 4.1e+002  -
1.6e+002
                                             -0.64      0.5      -94       74
   3     Bus3   1.014   -0.16    4     Bus4    0.828     -1.8 7.2e+004       -78
                                             0.044     0.21 3.8e+002 1.9e+003
   4     Bus4   0.828   -1.83    3     Bus3     1.01    -0.16 3.1e+003   1e+002
                                            -0.041        -0.17  -3.6e+002  -
1.5e+003
                                5     Bus5     0.43     -5.5 2.6e+003      -83
                                             0.034     0.21 2.1e+002 1.3e+003
                                2     Bus2    0.495      -19 5.4e+002      -58
                                              0.57     0.85 1.5e+002 2.2e+002
   5     Bus5   0.430   -5.53    1     Bus1   0.0013     0.23 2.9e+003      -91
                                            0.0075      0.1       55 7.3e+002
                                4     Bus4    0.828     -1.8 2.7e+003       97
                                            -0.024         -0.1  -1.5e+002  -
6.7e+002
                                2     Bus2    0.495      -19 4.4e+002       26
```

```
                                                    0.55    -0.34       97      -60
kp 1 kq 0  Iterations 10 dpmax 0.001983 dqmax 0.000010
kp 1 kq 0  Iterations 10 dpmax 0.002037 dqmax 0.000011
kp 1 kq 0  Iterations 10 dpmax 0.002092 dqmax 0.000011
kp 1 kq 0  Iterations 10 dpmax 0.002148 dqmax 0.000012
kp 1 kq 0  Iterations 10 dpmax 0.002206 dqmax 0.000013
kp 1 kq 0  Iterations 10 dpmax 0.002265 dqmax 0.000014
kp 1 kq 0  Iterations 10 dpmax 0.002325 dqmax 0.000015
kp 1 kq 0  Iterations 10 dpmax 0.002386 dqmax 0.000016
kp 1 kq 0  Iterations 10 dpmax 0.002449 dqmax 0.000017
kp 1 kq 0  Iterations 10 dpmax 0.002512 dqmax 0.000018
--------------------------------------------------------------------------------
Time =   0.20000 Seconds
Intermediate results for Machines
GNo Name     Voltage Angle    Delta    Freq    Pgen    Qgen    Pmech   Efd/Slip
             pu      Degree   Degree   Hzs.    MW      MVAR    MW      pu/P.U.
--- -------- ------- -------- -------- ------- ------- ------- ------- --------
  1     Bus1  0.0013     0.33      1.3      50    1.07    65.5     389     1.01
  3      Bus3     1.01    -0.109     0.389        50      459 1.9e+003       520
1.05
--------------------------------------------------------------------------------
Maximum rotor angle difference :    0.90999 b/w buses : 1 and 3
Island    1 Common system frequency   50.028
--------------------------------------------------------------------------------
Voltage (pu), Current (AMPS), impedance (PU) and power (MW-MVAR) for lines
From Name     Voltage Angle   To   Name     Voltage  Angle    Current  Angle
                                              Zl-real  Zl-im    P        Q
---- -------- ------- ------- ---- -------- -------- -------- -------- --------
   1     Bus1   0.001    0.33    5     Bus5     0.43     -5.5 7.4e+004       89
                                             7.3e-006 -0.00027    0.067     -2.5
   2     Bus2   0.495  -19.35    4     Bus4    0.828     -1.8   7e+002 1.1e+002
                                              -0.31         -0.36  -1.4e+002  -
1.5e+002
                                  5        Bus5        0.43        -5.5 4.1e+002  -
1.6e+002
                                               -0.64      0.5      -94       74
   3     Bus3   1.014   -0.11    4     Bus4    0.828     -1.8 7.2e+004      -78
                                               0.044     0.21 3.8e+002 1.9e+003
   4     Bus4   0.828   -1.78    3     Bus3     1.01    -0.11 3.1e+003   1e+002
                                             -0.041         -0.17  -3.6e+002  -
1.5e+003
                                  5     Bus5     0.43     -5.5 2.6e+003      -83
                                               0.034     0.21 2.1e+002 1.3e+003
                                  2     Bus2    0.495      -19 5.4e+002      -58
                                               0.57     0.85 1.5e+002 2.2e+002
   5     Bus5   0.430   -5.48    1     Bus1   0.0013     0.33 2.9e+003      -91
                                              0.0075      0.1       55 7.3e+002
                                  4     Bus4    0.828     -1.8 2.7e+003       97
                                              -0.024          -0.1  -1.5e+002  -
6.7e+002
                                  2     Bus2    0.495      -19 4.4e+002       26
```

```
                                                    0.55    -0.34       97      -60
--------------------------------------------------------------------------------
Fault removal  0.20000    1     Bus1
kp 0 kq 0  Iterations 7 dpmax 0.000014 dqmax 0.000000
kp 0 kq 0  Iterations 3 dpmax 0.000037 dqmax 0.000000
kp 0 kq 0  Iterations 3 dpmax 0.000037 dqmax 0.000000
kp 0 kq 0  Iterations 3 dpmax 0.000037 dqmax 0.000000
kp 0 kq 0  Iterations 3 dpmax 0.000038 dqmax 0.000000
kp 0 kq 0  Iterations 3 dpmax 0.000038 dqmax 0.000000
kp 0 kq 0  Iterations 3 dpmax 0.000038 dqmax 0.000000
kp 0 kq 0  Iterations 3 dpmax 0.000038 dqmax 0.000000
kp 0 kq 0  Iterations 3 dpmax 0.000039 dqmax 0.000000
kp 0 kq 0  Iterations 3 dpmax 0.000039 dqmax 0.000000
--------------------------------------------------------------------------------
Time =   0.22000 Seconds
Intermediate results for Machines
GNo Name     Voltage Angle    Delta    Freq    Pgen    Qgen    Pmech   Efd/Slip
             pu      Degree   Degree   Hzs.    MW      MVAR    MW      pu/P.U.
--- -------- ------- -------- -------- ------- ------- ------- ------- --------
  1     Bus1       1     1.13     1.65      50     421     296     389      1.01
  3     Bus3    1.05  -0.0666    0.446      50     488    55.4     520      1.05
--------------------------------------------------------------------------------
Maximum rotor angle difference :    1.19982 b/w buses : 1 and 3
Island    1 Common system frequency   50.028
--------------------------------------------------------------------------------
Voltage (pu), Current (AMPS), impedance (PU) and power (MW-MVAR) for lines
From Name     Voltage Angle   To   Name     Voltage  Angle    Current  Angle
                                              Zl-real  Zl-im    P        Q
---- -------- ------- ------- ---- -------- -------- -------- -------- --------
   1     Bus1   1.000    1.13    5     Bus5     1.05     -3.7   2e+004      -34
                                              0.64     0.45 4.2e+002   3e+002
   2     Bus2   0.923  -18.90    4     Bus4     1.05     -2.2 5.6e+002 1.4e+002
                                                -1         -0.44  -2.8e+002  -
1.2e+002
                                5     Bus5     1.05     -3.7 9.8e+002 1.4e+002
                                              -0.6         -0.18  -5.2e+002  -
1.6e+002
   3     Bus3   1.050   -0.07    4     Bus4     1.05     -2.2 1.5e+004     -2.2
                                               1.1    0.041 4.1e+002       15
   4     Bus4   1.046   -2.19    3     Bus3     1.05   -0.067 6.5e+002 1.8e+002
                                              -1.1  -0.00078  -4.1e+002       -
0.29
                                5     Bus5     1.05     -3.7   2e+002       21
                                               3.2     -1.4 1.2e+002      -50
                                2     Bus2    0.923      -19 4.7e+002      -12
                                               1.5     0.25 2.9e+002       50
   5     Bus5   1.050   -3.74    1     Bus1        1      1.1 7.7e+002 1.5e+002
                                             -0.79         -0.46  -4.2e+002  -
2.4e+002
                                4     Bus4     1.05     -2.2 1.9e+002 1.8e+002
```

```
                                                    -3.8            0.15   -1.2e+002
4.5
                                 2     Bus2    0.923      -19 9.3e+002      -28
                                                  0.69     0.31 5.3e+002 2.4e+002
kp 0 kq 0  Iterations 3 dpmax 0.000039 dqmax 0.000000
kp 0 kq 0  Iterations 3 dpmax 0.000040 dqmax 0.000000
kp 0 kq 0  Iterations 3 dpmax 0.000040 dqmax 0.000000
kp 0 kq 0  Iterations 3 dpmax 0.000041 dqmax 0.000000
kp 0 kq 0  Iterations 3 dpmax 0.000041 dqmax 0.000000
kp 0 kq 0  Iterations 3 dpmax 0.000041 dqmax 0.000000
kp 0 kq 0  Iterations 3 dpmax 0.000042 dqmax 0.000000
kp 0 kq 0  Iterations 3 dpmax 0.000042 dqmax 0.000000
kp 0 kq 0  Iterations 3 dpmax 0.000043 dqmax 0.000000
kp 0 kq 0  Iterations 3 dpmax 0.000043 dqmax 0.000000
--------------------------------------------------------------------------------
Time =   0.24000 Seconds
Intermediate results for Machines
GNo Name     Voltage Angle    Delta    Freq    Pgen    Qgen    Pmech   Efd/Slip
             pu      Degree   Degree   Hzs.    MW      MVAR    MW      pu/P.U.
--- -------- ------- -------- -------- ------- ------- ------- ------- --------
  1     Bus1       1     1.46     1.99      50     430     297     389     1.01
  3     Bus3    1.05  0.00485    0.509      50     479    55.5     520     1.05
--------------------------------------------------------------------------------
Maximum rotor angle difference :    1.47838 b/w buses : 1 and 3
Island    1 Common system frequency   50.028
--------------------------------------------------------------------------------
Voltage (pu), Current (AMPS), impedance (PU) and power (MW-MVAR) for lines
From Name     Voltage Angle   To   Name     Voltage  Angle    Current  Angle
                                              Zl-real  Zl-im    P        Q
---- -------- ------- ------- ---- -------- -------- -------- -------- --------
   1     Bus1   1.000    1.46    5     Bus5     1.05     -3.5   2e+004      -33
                                               0.63     0.44 4.3e+002   3e+002
   2     Bus2   0.923  -18.72    4     Bus4     1.05     -2.1 5.6e+002 1.4e+002
                                                 -1        -0.44  -2.8e+002  -
1.2e+002
                                 5     Bus5     1.05     -3.5 9.8e+002 1.4e+002
                                               -0.6        -0.18  -5.2e+002  -
1.6e+002
   3     Bus3   1.050    0.00    4     Bus4     1.05     -2.1 1.5e+004     -2.2
                                                1.1    0.043   4e+002       15
   4     Bus4   1.046   -2.07    3     Bus3     1.05   0.0048 6.4e+002 1.8e+002
                                               -1.1  -0.0028  -4e+002        -1
                                 5     Bus5     1.05     -3.5 1.9e+002       22
                                                3.4     -1.5 1.1e+002      -49
                                 2     Bus2    0.923      -19 4.7e+002      -12
                                                1.5     0.25 2.9e+002       50
   5     Bus5   1.050   -3.52    1     Bus1        1      1.5 7.8e+002 1.5e+002
                                              -0.78        -0.45  -4.3e+002  -
2.4e+002
                                 4     Bus4     1.05     -2.1 1.7e+002 1.8e+002
```

```
                                                    -4.1             0.12   -1.1e+002
3.1
                                  2     Bus2    0.923      -19 9.3e+002      -28
                                                 0.69     0.31 5.3e+002 2.4e+002
kp 0 kq 0  Iterations 3 dpmax 0.000043 dqmax  0.000000
kp 0 kq 0  Iterations 3 dpmax 0.000044 dqmax  0.000000
kp 0 kq 0  Iterations 3 dpmax 0.000044 dqmax  0.000000
kp 0 kq 0  Iterations 3 dpmax 0.000045 dqmax  0.000000
kp 0 kq 0  Iterations 3 dpmax 0.000045 dqmax  0.000000
kp 0 kq 0  Iterations 3 dpmax 0.000046 dqmax  0.000000
kp 0 kq 0  Iterations 3 dpmax 0.000046 dqmax  0.000000
kp 0 kq 0  Iterations 3 dpmax 0.000047 dqmax  0.000000
kp 0 kq 0  Iterations 3 dpmax 0.000047 dqmax  0.000000
kp 0 kq 0  Iterations 3 dpmax 0.000048 dqmax  0.000000
--------------------------------------------------------------------------------
Time =   0.26000 Seconds
Intermediate results for Machines
GNo Name     Voltage Angle    Delta    Freq    Pgen    Qgen    Pmech   Efd/Slip
             pu      Degree   Degree   Hzs.    MW      MVAR    MW      pu/P.U.
--- -------- ------- -------- -------- ------- ------- ------- ------- --------
  1     Bus1       1     1.79     2.32      50     438     297     389     1.01
  3     Bus3    1.05   0.0829    0.579      50     471    55.6     520     1.05
--------------------------------------------------------------------------------
Maximum rotor angle difference :    1.74227 b/w buses : 1 and 3
Island    1 Common system frequency   50.028
--------------------------------------------------------------------------------
Voltage (pu), Current (AMPS), impedance (PU) and power (MW-MVAR) for lines
From Name     Voltage Angle   To   Name     Voltage  Angle    Current  Angle
                                              Zl-real  Zl-im    P        Q
---- -------- ------- ------- ---- -------- -------- -------- -------- --------
   1     Bus1   1.000    1.79    5     Bus5     1.05     -3.3   2e+004      -32
                                               0.63     0.42 4.4e+002   3e+002
   2     Bus2   0.923  -18.53    4     Bus4     1.05     -1.9 5.5e+002 1.4e+002
                                                 -1        -0.45  -2.8e+002  -
1.2e+002
                                  5     Bus5     1.05     -3.3 9.9e+002 1.4e+002
                                               -0.6        -0.18  -5.2e+002  -
1.6e+002
   3     Bus3   1.050    0.08    4     Bus4     1.05     -1.9 1.4e+004     -2.2
                                                1.1    0.045 3.9e+002       16
   4     Bus4   1.046   -1.95    3     Bus3     1.05    0.083 6.2e+002 1.8e+002
                                               -1.1   -0.0049 -3.9e+002       -
1.7
                                  5     Bus5     1.05     -3.3 1.8e+002       23
                                                3.5     -1.7   1e+002      -48
                                  2     Bus2    0.923      -19 4.7e+002      -12
                                                3.5     0.25 2.9e+002       50
   5     Bus5   1.050   -3.30    1     Bus1        1      1.8 7.9e+002 1.5e+002
                                              -0.78        -0.43  -4.3e+002  -
2.4e+002
                                  4     Bus4     1.05     -1.9 1.6e+002 1.8e+002
```

```
                                                  -4.4    0.082  -1e+002      1.9
                                  2     Bus2     0.923      -19 9.3e+002      -27
                                                  0.69     0.31 5.4e+002 2.4e+002
kp 0 kq 0  Iterations 3 dpmax 0.000048 dqmax  0.000000
kp 0 kq 0  Iterations 3 dpmax 0.000049 dqmax  0.000000
kp 0 kq 0  Iterations 3 dpmax 0.000049 dqmax  0.000000
kp 0 kq 0  Iterations 3 dpmax 0.000050 dqmax  0.000000
kp 0 kq 0  Iterations 3 dpmax 0.000050 dqmax  0.000000
kp 0 kq 0  Iterations 3 dpmax 0.000051 dqmax  0.000000
kp 0 kq 0  Iterations 3 dpmax 0.000052 dqmax  0.000000
kp 0 kq 0  Iterations 3 dpmax 0.000052 dqmax  0.000000
kp 0 kq 0  Iterations 3 dpmax 0.000053 dqmax  0.000000
kp 0 kq 0  Iterations 3 dpmax 0.000053 dqmax  0.000000
--------------------------------------------------------------------------------
Time =   0.28000 Seconds
Intermediate results for Machines
GNo Name     Voltage Angle    Delta    Freq    Pgen    Qgen    Pmech   Efd/Slip
             pu      Degree   Degree   Hzs.    MW      MVAR    MW      pu/P.U.
--- -------- ------- -------- -------- ------- ------- ------- ------- --------
  1     Bus1       1     2.11     2.65      50     446     298     389      1.01
  3     Bus3    1.05    0.169    0.658      50     463    55.7     520      1.05
--------------------------------------------------------------------------------
Maximum rotor angle difference :    1.98843 b/w buses : 1 and 3
Island    1 Common system frequency   50.028
--------------------------------------------------------------------------------
Voltage (pu), Current (AMPS), impedance (PU) and power (MW-MVAR) for lines
From Name     Voltage Angle   To   Name     Voltage  Angle    Current  Angle
                                              Zl-real  Zl-im    P        Q
---- -------- ------- ------- ---- -------- -------- -------- -------- --------
   1     Bus1   1.000    2.11    5     Bus5     1.05     -3.1 2.1e+004      -32
                                              0.62     0.41 4.5e+002   3e+002
   2     Bus2   0.923  -18.34    4     Bus4     1.05     -1.8 5.5e+002 1.4e+002
                                                -1        -0.45  -2.8e+002  -
1.2e+002
                                  5     Bus5     1.05     -3.1 9.9e+002 1.4e+002
                                              -0.6        -0.18  -5.2e+002  -
1.6e+002
   3     Bus3   1.050    0.17    4     Bus4     1.05     -1.8 1.4e+004     -2.2
                                               1.1    0.047 3.8e+002       16
   4     Bus4   1.046   -1.82    3     Bus3     1.05     0.17 6.1e+002 1.8e+002
                                              -1.1   -0.0072 -3.8e+002       -
2.4
                                  5     Bus5     1.05     -3.1 1.7e+002       25
                                               3.7     -1.8       94      -47
                                  2     Bus2    0.923      -18 4.7e+002      -12
                                               1.5     0.25 2.9e+002       49
   5     Bus5   1.050   -3.08    1     Bus1        1      2.1   8e+002 1.5e+002
                                             -0.77        -0.42  -4.4e+002  -
2.4e+002
                                  4     Bus4     1.05     -1.8 1.5e+002 1.8e+002
                                              -4.7    0.038      -94     0.76
```

```
                                    2     Bus2    0.923      -18 9.4e+002      -27
                                                  0.69     0.31 5.4e+002 2.4e+002
kp 0 kq 0  Iterations 3 dpmax 0.000054 dqmax  0.000000
kp 0 kq 0  Iterations 3 dpmax 0.000055 dqmax  0.000000
kp 0 kq 0  Iterations 3 dpmax 0.000055 dqmax  0.000000
kp 0 kq 0  Iterations 3 dpmax 0.000056 dqmax  0.000000
kp 0 kq 0  Iterations 3 dpmax 0.000057 dqmax  0.000000
kp 0 kq 0  Iterations 3 dpmax 0.000057 dqmax  0.000000
kp 0 kq 0  Iterations 3 dpmax 0.000058 dqmax  0.000000
kp 0 kq 0  Iterations 3 dpmax 0.000059 dqmax  0.000000
kp 0 kq 0  Iterations 3 dpmax 0.000059 dqmax  0.000000
kp 0 kq 0  Iterations 3 dpmax 0.000060 dqmax  0.000000
--------------------------------------------------------------------------------
Time =   0.30000 Seconds
Intermediate results for Machines
GNo Name     Voltage Angle    Delta    Freq    Pgen    Qgen    Pmech   Efd/Slip
             pu      Degree   Degree   Hzs.    MW      MVAR    MW      pu/P.U.
--- -------- ------- -------- -------- ------- ------- ------- ------- --------
  1     Bus1       1     2.41     2.96      50     453     298     389      1.01
  3     Bus3    1.05    0.265    0.747      50     456    55.8     520      1.05
--------------------------------------------------------------------------------
Maximum rotor angle difference :    2.21399 b/w buses : 1 and 3
Island    1 Common system frequency   50.028
--------------------------------------------------------------------------------
Voltage (pu), Current (AMPS), impedance (PU) and power (MW-MVAR) for lines
From Name     Voltage Angle   To   Name     Voltage  Angle    Current  Angle
                                            Zl-real  Zl-im    P        Q
---- -------- ------- ------- ---- -------- -------- -------- -------- --------
   1     Bus1   1.000    2.41    5     Bus5     1.05     -2.9 2.1e+004      -31
                                              0.62      0.4 4.5e+002   3e+002
   2     Bus2   0.923  -18.15    4     Bus4     1.05     -1.7 5.5e+002 1.4e+002
                                                -1        -0.45  -2.8e+002  -
1.2e+002
                                    5     Bus5     1.05     -2.9 9.9e+002 1.5e+002
                                              -0.6        -0.18  -5.2e+002  -
1.6e+002
   3     Bus3   1.050    0.26    4     Bus4     1.05     -1.7 1.4e+004     -2.2
                                               1.2    0.049 3.8e+002       16
   4     Bus4   1.046   -1.69    3     Bus3     1.05     0.26   6e+002 1.8e+002
                                              -1.2  -0.0095 -3.7e+002       -
3
                                    5     Bus5     1.05     -2.9 1.6e+002       26
                                               3.9       -2       88      -46
                                    2     Bus2    0.923      -18 4.6e+002      -11
                                               1.5     0.26 2.9e+002       49
   5     Bus5   1.050   -2.86    1     Bus1        1      2.4 8.1e+002 1.5e+002
                                             -0.77        -0.41  -4.5e+002  -
2.4e+002
                                    4     Bus4     1.05     -1.7 1.4e+002 1.8e+002
                                                -5   -0.017      -88    -0.29
                                    2     Bus2    0.923      -18 9.4e+002      -27
```

```
                                                          0.69     0.31 5.4e+002 2.4e+002
kp 0 kq 0  Iterations 3 dpmax 0.000061 dqmax  0.000000
kp 0 kq 0  Iterations 3 dpmax 0.000061 dqmax  0.000000
kp 0 kq 0  Iterations 3 dpmax 0.000062 dqmax  0.000000
kp 0 kq 0  Iterations 3 dpmax 0.000063 dqmax  0.000000
kp 0 kq 0  Iterations 3 dpmax 0.000064 dqmax  0.000000
kp 0 kq 0  Iterations 3 dpmax 0.000064 dqmax  0.000000
kp 0 kq 0  Iterations 3 dpmax 0.000065 dqmax  0.000000
kp 0 kq 0  Iterations 3 dpmax 0.000066 dqmax  0.000000
kp 0 kq 0  Iterations 3 dpmax 0.000067 dqmax  0.000000
kp 0 kq 0  Iterations 3 dpmax 0.000067 dqmax  0.000000
--------------------------------------------------------------------------------
Time =   0.32000 Seconds
Intermediate results for Machines
GNo Name     Voltage Angle    Delta    Freq    Pgen    Qgen    Pmech   Efd/Slip
             pu      Degree   Degree   Hzs.    MW      MVAR    MW      pu/P.U.
--- -------- ------- -------- -------- ------- ------- ------- ------- --------
  1     Bus1       1     2.71     3.26      50     460     298     389     1.01
  3     Bus3    1.05    0.371    0.848      50     449      56     520     1.05
--------------------------------------------------------------------------------
Maximum rotor angle difference :    2.41634 b/w buses : 1 and 3
Island    1 Common system frequency   50.028
--------------------------------------------------------------------------------
Voltage (pu), Current (AMPS), impedance (PU) and power (MW-MVAR) for lines
From Name     Voltage Angle   To   Name     Voltage  Angle    Current  Angle
                                            Zl-real  Zl-im    P        Q
---- -------- ------- ------- ---- -------- -------- -------- -------- --------
   1     Bus1   1.000    2.71    5     Bus5     1.05     -2.6 2.1e+004      -30
                                              0.61      0.4 4.6e+002   3e+002
   2     Bus2   0.923  -17.96    4     Bus4     1.05     -1.5 5.5e+002 1.4e+002
                                                -1         -0.46  -2.8e+002  -
1.2e+002
                                5     Bus5     1.05     -2.6 9.9e+002 1.5e+002
                                              -0.6         -0.18  -5.2e+002  -
1.6e+002
   3     Bus3   1.050    0.37    4     Bus4     1.05     -1.5 1.4e+004     -2.1
                                               1.2    0.052 3.7e+002       16
   4     Bus4   1.046   -1.55    3     Bus3     1.05     0.37 5.9e+002 1.8e+002
                                              -1.2    -0.012 -3.7e+002       -
3.6
                                5     Bus5     1.05     -2.6 1.5e+002       27
                                               4.1     -2.2       82      -45
                                2     Bus2    0.923      -18 4.6e+002      -11
                                               1.5     0.26 2.9e+002       49
   5     Bus5   1.050   -2.65    1     Bus1        1      2.7 8.2e+002 1.5e+002
                                             -0.76          -0.4  -4.6e+002  -
2.4e+002
                                4     Bus4     1.05     -1.5 1.3e+002 1.8e+002
                                              -5.4    -0.08       -82     -1.2
                                2     Bus2    0.923      -18 9.4e+002      -27
                                              0.68       0.3 5.4e+002 2.4e+002
```

```
kp 0 kq 0  Iterations 3 dpmax 0.000068 dqmax 0.000000
kp 0 kq 0  Iterations 3 dpmax 0.000069 dqmax 0.000000
kp 0 kq 0  Iterations 3 dpmax 0.000070 dqmax 0.000000
kp 0 kq 0  Iterations 3 dpmax 0.000070 dqmax 0.000000
kp 0 kq 0  Iterations 3 dpmax 0.000071 dqmax 0.000000
kp 0 kq 0  Iterations 3 dpmax 0.000072 dqmax 0.000000
kp 0 kq 0  Iterations 3 dpmax 0.000073 dqmax 0.000000
kp 0 kq 0  Iterations 3 dpmax 0.000074 dqmax 0.000000
kp 0 kq 0  Iterations 3 dpmax 0.000074 dqmax 0.000000
kp 0 kq 0  Iterations 3 dpmax 0.000075 dqmax 0.000000
------------------------------------------------------------------------------
Time =   0.34000 Seconds
Intermediate results for Machines
GNo Name     Voltage Angle    Delta    Freq    Pgen    Qgen    Pmech   Efd/Slip
             pu      Degree   Degree   Hzs.    MW      MVAR    MW      pu/P.U.
--- -------- ------- -------- -------- ------- ------- ------- ------- --------
  1     Bus1       1        3     3.55      50     466     299     389     1.01
  3     Bus3    1.05    0.489    0.961      50     443    56.1     520     1.05
------------------------------------------------------------------------------
Maximum rotor angle difference :    2.59312 b/w buses : 1 and 3
Island    1 Common system frequency   50.028
------------------------------------------------------------------------------
Voltage (pu), Current (AMPS), impedance (PU) and power (MW-MVAR) for lines
From Name     Voltage Angle   To   Name     Voltage  Angle    Current  Angle
                                              Zl-real  Zl-im    P        Q
---- -------- ------- ------- ---- -------- -------- -------- -------- --------
   1     Bus1   1.000    3.00    5     Bus5     1.05     -2.4 2.1e+004       -30
                                               0.61     0.39 4.7e+002   3e+002
   2     Bus2   0.923  -17.77    4     Bus4     1.05     -1.4 5.5e+002 1.4e+002
                                                 -1        -0.46  -2.8e+002  -
1.2e+002
                                 5     Bus5     1.05     -2.4 9.9e+002 1.5e+002
                                               -0.6        -0.18  -5.2e+002  -
1.6e+002
   3     Bus3   1.050    0.49    4     Bus4     1.05     -1.4 1.3e+004     -2.1
                                                1.2    0.054 3.6e+002       16
   4     Bus4   1.046   -1.40    3     Bus3     1.05     0.49 5.8e+002 1.8e+002
                                               -1.2    -0.014 -3.6e+002       -
4.2
                                 5     Bus5     1.05     -2.4 1.4e+002       29
                                                4.2     -2.5       77       -45
                                 2     Bus2    0.923      -18 4.6e+002       -11
                                                1.5     0.26 2.8e+002       49
   5     Bus5   1.050   -2.43    1     Bus1        1        3 8.3e+002 1.5e+002
                                              -0.76        -0.39  -4.6e+002  -
2.4e+002
                                 4     Bus4     1.05     -1.4 1.2e+002 1.8e+002
                                               -5.7    -0.15       -77     -2.1
                                 2     Bus2    0.923      -18 9.4e+002       -26
                                               0.68      0.3 5.4e+002 2.4e+002
kp 0 kq 0 Iterations 3 dpmax 0.000076 dqmax 0.000000
```

```
kp 0 kq 0 Iterations 3 dpmax 0.000077 dqmax 0.000000
kp 0 kq 0 Iterations 3 dpmax 0.000078 dqmax 0.000000
kp 0 kq 0 Iterations 3 dpmax 0.000079 dqmax 0.000000
kp 0 kq 0 Iterations 3 dpmax 0.000080 dqmax 0.000000
kp 0 kq 0 Iterations 3 dpmax 0.000080 dqmax 0.000000
kp 0 kq 0 Iterations 3 dpmax 0.000081 dqmax 0.000000
kp 0 kq 0 Iterations 3 dpmax 0.000082 dqmax 0.000000
kp 0 kq 0 Iterations 3 dpmax 0.000083 dqmax 0.000000
kp 0 kq 0 Iterations 3 dpmax 0.000084 dqmax 0.000000
--------------------------------------------------------------------------------
Time =   0.36000 Seconds
Intermediate results for Machines
GNo Name     Voltage Angle    Delta    Freq    Pgen    Qgen    Pmech   Efd/Slip
             pu      Degree   Degree   Hzs.    MW      MVAR    MW      pu/P.U.
--- -------- ------- -------- -------- ------- ------- ------- ------- --------
  1     Bus1       1     3.27     3.83      50     471     299     389      1.01
  3     Bus3    1.05     0.62     1.09      50     438    56.3     520      1.05
--------------------------------------------------------------------------------
Maximum rotor angle difference :    2.74226 b/w buses : 1 and 3
Island    1 Common system frequency   50.028
--------------------------------------------------------------------------------
Voltage (pu), Current (AMPS), impedance (PU) and power (MW-MVAR) for lines
From Name     Voltage Angle   To   Name     Voltage  Angle    Current  Angle
                                              Zl-real  Zl-im    P        Q
---- -------- ------- ------- ---- -------- -------- -------- -------- --------
   1     Bus1   1.000    3.27    5     Bus5     1.05     -2.2 2.1e+004      -29
                                              0.61     0.38 4.7e+002   3e+002
   2     Bus2   0.923  -17.57    4     Bus4     1.05     -1.2 5.5e+002 1.4e+002
                                                -1        -0.46  -2.8e+002  -
1.2e+002
                                5     Bus5     1.05     -2.2 9.9e+002 1.5e+002
                                              -0.6        -0.18  -5.2e+002  -
1.6e+002
   3     Bus3   1.050    0.62    4     Bus4     1.05     -1.2 1.3e+004       -2
                                               1.2    0.056 3.6e+002       16
   4     Bus4   1.046   -1.24    3     Bus3     1.05     0.62 5.7e+002 1.8e+002
                                              -1.2    -0.016 -3.6e+002       -
4.6
                                5     Bus5     1.05     -2.2 1.4e+002       30
                                               4.4     -2.7       73      -44
                                2     Bus2    0.923      -18 4.6e+002      -11
                                               1.5     0.26 2.8e+002       49
   5     Bus5   1.050   -2.22    1     Bus1       1      3.3 8.3e+002 1.5e+002
                                             -0.75        -0.38  -4.7e+002  -
2.4e+002
                                4     Bus4     1.05     -1.2 1.2e+002 1.8e+002
                                               -6    -0.23      -73     -2.8
                                2     Bus2    0.923      -18 9.4e+002      -26
                                               0.68      0.3 5.4e+002 2.4e+002
kp 0 kq 0 Iterations 3 dpmax 0.000085 dqmax 0.000000
kp 0 kq 0 Iterations 3 dpmax 0.000086 dqmax 0.000000
```

```
kp 0 kq 0 Iterations 3 dpmax 0.000087 dqmax 0.000000
kp 0 kq 0 Iterations 3 dpmax 0.000087 dqmax 0.000000
kp 0 kq 0 Iterations 3 dpmax 0.000089 dqmax 0.000002
kp 0 kq 0 Iterations 3 dpmax 0.000089 dqmax 0.000000
kp 0 kq 0 Iterations 3 dpmax 0.000090 dqmax 0.000000
kp 0 kq 0 Iterations 3 dpmax 0.000092 dqmax 0.000001
kp 0 kq 0 Iterations 3 dpmax 0.000092 dqmax 0.000000
kp 0 kq 0 Iterations 3 dpmax 0.000093 dqmax 0.000000
--------------------------------------------------------------------------------
Time =   0.38000 Seconds
Intermediate results for Machines
GNo Name     Voltage Angle    Delta    Freq    Pgen    Qgen    Pmech   Efd/Slip
             pu      Degree   Degree   Hzs.    MW      MVAR    MW      pu/P.U.
--- -------- ------- -------- -------- ------- ------- ------- ------- --------
  1     Bus1       1     3.53     4.09      50     474     299     389     1.01
  3     Bus3    1.05    0.764     1.23      50     434    56.4     520     1.05
--------------------------------------------------------------------------------
Maximum rotor angle difference :    2.86201 b/w buses : 1 and 3
Island    1 Common system frequency   50.028
--------------------------------------------------------------------------------
Voltage (pu), Current (AMPS), impedance (PU) and power (MW-MVAR) for lines
From Name     Voltage Angle   To   Name     Voltage  Angle    Current  Angle
                                              Zl-real  Zl-im    P        Q
---- -------- ------- ------- ---- -------- -------- -------- -------- --------
   1     Bus1   1.000    3.53    5     Bus5     1.05       -2 2.2e+004      -29
                                               0.6     0.38 4.7e+002   3e+002
   2     Bus2   0.922  -17.38    4     Bus4     1.05     -1.1 5.5e+002 1.4e+002
                                                 -1        -0.46  -2.8e+002  -
1.2e+002
                                 5     Bus5     1.05       -2 9.9e+002 1.5e+002
                                              -0.6        -0.18  -5.2e+002  -
1.6e+002
   3     Bus3   1.050    0.76    4     Bus4     1.05     -1.1 1.3e+004     -1.9
                                               1.2    0.057 3.5e+002       16
   4     Bus4   1.046   -1.08    3     Bus3     1.05     0.76 5.7e+002 1.8e+002
                                              -1.2   -0.017 -3.5e+002        -
5
                                 5     Bus5     1.05       -2 1.3e+002       31
                                               4.5     -2.8       70      -44
                                 2     Bus2    0.922      -17 4.6e+002      -11
                                               1.5     0.26 2.8e+002       49
   5     Bus5   1.050   -2.01    1     Bus1       1      3.5 8.4e+002 1.5e+002
                                             -0.75        -0.38  -4.7e+002  -
2.4e+002
                                 4     Bus4     1.05     -1.1 1.1e+002 1.8e+002
                                              -6.3     -0.3      -70     -3.3
                                 2     Bus2    0.922      -17 9.4e+002      -26
                                              0.68      0.3 5.4e+002 2.4e+002
kp 0 kq 0 Iterations 3 dpmax 0.000094 dqmax 0.000001
kp 0 kq 0 Iterations 3 dpmax 0.000095 dqmax 0.000000
kp 0 kq 0 Iterations 3 dpmax 0.000096 dqmax 0.000000
```

```
kp 0 kq 0 Iterations 3 dpmax 0.000097 dqmax 0.000000
kp 0 kq 0 Iterations 3 dpmax 0.000098 dqmax 0.000000
kp 0 kq 0 Iterations 3 dpmax 0.000099 dqmax 0.000000
kp 0 kq 0 Iterations 3 dpmax 0.000100 dqmax 0.000000
kp 0 kq 0 Iterations 4 dpmax 0.000005 dqmax 0.000000
kp 0 kq 0 Iterations 4 dpmax 0.000005 dqmax 0.000000
kp 0 kq 0 Iterations 4 dpmax 0.000005 dqmax 0.000000
--------------------------------------------------------------------------------
Time =   0.40000 Seconds
Intermediate results for Machines
GNo Name     Voltage Angle    Delta    Freq    Pgen    Qgen    Pmech   Efd/Slip
             pu      Degree   Degree   Hzs.    MW      MVAR    MW      pu/P.U.
--- -------- ------- -------- -------- ------- ------- ------- ------- --------
  1     Bus1       1     3.77     4.34      50     477     299     389     1.01
  3     Bus3    1.05    0.923     1.39      50     431    56.5     520     1.05
--------------------------------------------------------------------------------
Maximum rotor angle difference :    2.95098 b/w buses : 1 and 3
Island    1 Common system frequency   50.028
--------------------------------------------------------------------------------
Voltage (pu), Current (AMPS), impedance (PU) and power (MW-MVAR) for lines
From Name     Voltage Angle   To   Name     Voltage  Angle    Current  Angle
                                            Zl-real  Zl-im    P        Q
---- -------- ------- ------- ---- -------- -------- -------- -------- --------
   1     Bus1   1.000    3.77    5     Bus5     1.05     -1.8 2.2e+004      -28
                                              0.6     0.38 4.8e+002   3e+002
   2     Bus2   0.922  -17.18    4     Bus4     1.05     -0.9 5.5e+002 1.4e+002
                                                -1        -0.46  -2.8e+002  -
1.2e+002
                                 5     Bus5     1.05     -1.8 9.9e+002 1.5e+002
                                             -0.6         -0.18  -5.2e+002  -
1.6e+002
   3     Bus3   1.050    0.92    4     Bus4     1.05     -0.9 1.3e+004     -1.8
                                              1.3    0.059 3.5e+002       16
   4     Bus4   1.046   -0.90    3     Bus3     1.05     0.92 5.6e+002 1.8e+002
                                             -1.2    -0.019 -3.5e+002       -
5.3
                                 5     Bus5     1.05     -1.8 1.3e+002       32
                                              4.6       -3       67      -43
                                 2     Bus2    0.922      -17 4.6e+002      -11
                                              1.5     0.26 2.8e+002       49
   5     Bus5   1.050   -1.80    1     Bus1        1      3.8 8.4e+002 1.5e+002
                                            -0.75         -0.37  -4.7e+002  -
2.4e+002
                                 4     Bus4     1.05     -0.9 1.1e+002 1.8e+002
                                             -6.6    -0.36      -67     -3.7
                                 2     Bus2    0.922      -17 9.4e+002      -26
                                             0.68      0.3 5.4e+002 2.4e+002
kp 0 kq 0 Iterations 4 dpmax 0.000005 dqmax 0.000000
kp 0 kq 0 Iterations 4 dpmax 0.000005 dqmax 0.000000
kp 0 kq 0 Iterations 4 dpmax 0.000005 dqmax 0.000000
kp 0 kq 0 Iterations 4 dpmax 0.000005 dqmax 0.000000
```

```
kp 0 kq 0 Iterations 4 dpmax 0.000005 dqmax 0.000000
kp 0 kq 0 Iterations 4 dpmax 0.000005 dqmax 0.000000
kp 0 kq 0 Iterations 4 dpmax 0.000006 dqmax 0.000000
kp 0 kq 0 Iterations 4 dpmax 0.000006 dqmax 0.000000
kp 0 kq 0 Iterations 4 dpmax 0.000006 dqmax 0.000000
kp 0 kq 0 Iterations 4 dpmax 0.000006 dqmax 0.000000
--------------------------------------------------------------------------------
Time =   0.42000 Seconds
Intermediate results for Machines
GNo Name     Voltage Angle    Delta    Freq    Pgen    Qgen    Pmech   Efd/Slip
             pu      Degree   Degree   Hzs.    MW      MVAR    MW      pu/P.U.
--- -------- ------- -------- -------- ------- ------- ------- ------- --------
  1     Bus1       1        4     4.57      50     479     300     389     1.01
  3     Bus3    1.05      1.1     1.56      50     429    56.6     520     1.05
--------------------------------------------------------------------------------
Maximum rotor angle difference :    3.00809 b/w buses : 1 and 3
Island    1 Common system frequency   50.028
--------------------------------------------------------------------------------
Voltage (pu), Current (AMPS), impedance (PU) and power (MW-MVAR) for lines
From Name     Voltage Angle   To   Name     Voltage  Angle    Current  Angle
                                              Zl-real  Zl-im    P        Q
---- -------- ------- ------- ---- -------- -------- -------- -------- --------
   1     Bus1   1.000    4.00    5     Bus5     1.05     -1.6 2.2e+004      -28
                                               0.6     0.37 4.8e+002   3e+002
   2     Bus2   0.922  -16.98    4     Bus4     1.05    -0.72 5.5e+002 1.4e+002
                                                -1        -0.46  -2.7e+002  -
1.2e+002
                                 5     Bus5     1.05     -1.6 9.9e+002 1.5e+002
                                              -0.6        -0.18  -5.2e+002  -
1.6e+002
   3     Bus3   1.050    1.10    4     Bus4     1.05    -0.72 1.3e+004     -1.6
                                               1.3     0.06 3.5e+002       17
   4     Bus4   1.046   -0.72    3     Bus3     1.05      1.1 5.6e+002 1.8e+002
                                              -1.3     -0.02 -3.5e+002       -
5.5
                                 5     Bus5     1.05     -1.6 1.3e+002       33
                                               4.7     -3.1       65      -43
                                 2     Bus2    0.922      -17 4.6e+002      -10
                                               1.5     0.26 2.8e+002       49
   5     Bus5   1.050   -1.59    1     Bus1       1        4 8.4e+002 1.5e+002
                                            -0.75        -0.37  -4.7e+002  -
2.4e+002
                                 4     Bus4     1.05    -0.72   1e+002 1.7e+002
                                              -6.7    -0.41      -65       -4
                                 2     Bus2    0.922      -17 9.4e+002      -26
                                               0.68      0.3 5.4e+002 2.4e+002
kp 0 kq 0 Iterations 4 dpmax 0.000006 dqmax 0.000000
kp 0 kq 0 Iterations 4 dpmax 0.000006 dqmax 0.000000
kp 0 kq 0 Iterations 4 dpmax 0.000006 dqmax 0.000000
kp 0 kq 0 Iterations 4 dpmax 0.000006 dqmax 0.000000
kp 0 kq 0 Iterations 4 dpmax 0.000006 dqmax 0.000000
```

```
kp 0 kq 0 Iterations 4 dpmax 0.000006 dqmax 0.000000
kp 0 kq 0 Iterations 4 dpmax 0.000006 dqmax 0.000000
kp 0 kq 0 Iterations 4 dpmax 0.000006 dqmax 0.000000
kp 0 kq 0 Iterations 4 dpmax 0.000006 dqmax 0.000000
kp 0 kq 0 Iterations 4 dpmax 0.000006 dqmax 0.000000
--------------------------------------------------------------------------------
Time =   0.44000 Seconds
Intermediate results for Machines
GNo Name     Voltage Angle    Delta    Freq    Pgen    Qgen    Pmech   Efd/Slip
             pu      Degree   Degree   Hzs.    MW      MVAR    MW      pu/P.U.
--- -------- ------- -------- -------- ------- ------- ------- ------- --------
  1     Bus1       1     4.21     4.78      50     480     300     389     1.01
  3     Bus3    1.05     1.28     1.75      50     429    56.6     520     1.05
--------------------------------------------------------------------------------
Maximum rotor angle difference :    3.03267 b/w buses : 1 and 3
Island    1 Common system frequency   50.028
--------------------------------------------------------------------------------
Voltage (pu), Current (AMPS), impedance (PU) and power (MW-MVAR) for lines
From Name     Voltage Angle   To   Name     Voltage  Angle    Current  Angle
                                              Zl-real  Zl-im    P        Q
---- -------- ------- ------- ---- -------- -------- -------- -------- --------
   1     Bus1   1.000    4.21    5     Bus5     1.05     -1.4 2.2e+004      -28
                                               0.6     0.37 4.8e+002   3e+002
   2     Bus2   0.922  -16.78    4     Bus4     1.05    -0.53 5.5e+002 1.4e+002
                                                -1        -0.46  -2.7e+002  -
1.2e+002
                                   5     Bus5     1.05     -1.4 9.9e+002 1.5e+002
                                              -0.6        -0.18  -5.2e+002  -
1.6e+002
   3     Bus3   1.050    1.28    4     Bus4     1.05    -0.53 1.3e+004     -1.4
                                               1.3     0.06 3.5e+002       17
   4     Bus4   1.046   -0.53    3     Bus3     1.05      1.3 5.6e+002 1.8e+002
                                              -1.3     -0.02 -3.5e+002       -
5.6
                                   5     Bus5     1.05     -1.4 1.2e+002       33
                                               4.7     -3.1       65      -43
                                   2     Bus2    0.922      -17 4.6e+002      -10
                                               1.5     0.26 2.8e+002       49
   5     Bus5   1.050   -1.39    1     Bus1        1      4.2 8.5e+002 1.5e+002
                                             -0.74        -0.37  -4.8e+002  -
2.4e+002
                                   4     Bus4     1.05    -0.53   1e+002 1.7e+002
                                              -6.8    -0.44      -65     -4.1
                                   2     Bus2    0.922      -17 9.4e+002      -25
                                              0.68      0.3 5.4e+002 2.4e+002
kp 0 kq 0 Iterations 4 dpmax 0.000006 dqmax 0.000000
kp 0 kq 0 Iterations 4 dpmax 0.000006 dqmax 0.000000
kp 0 kq 0 Iterations 4 dpmax 0.000006 dqmax 0.000000
kp 0 kq 0 Iterations 4 dpmax 0.000006 dqmax 0.000000
kp 0 kq 0 Iterations 4 dpmax 0.000006 dqmax 0.000000
kp 0 kq 0 Iterations 4 dpmax 0.000006 dqmax 0.000000
```

```
kp 0 kq 0 Iterations 4 dpmax 0.000006 dqmax 0.000000
kp 0 kq 0 Iterations 4 dpmax 0.000007 dqmax 0.000000
kp 0 kq 0 Iterations 4 dpmax 0.000007 dqmax 0.000000
kp 0 kq 0 Iterations 4 dpmax 0.000007 dqmax 0.000000
--------------------------------------------------------------------------------
Time =   0.46000 Seconds
Intermediate results for Machines
GNo Name     Voltage Angle    Delta    Freq    Pgen    Qgen    Pmech   Efd/Slip
             pu      Degree   Degree   Hzs.    MW      MVAR    MW      pu/P.U.
--- -------- ------- -------- -------- ------- ------- ------- ------- --------
  1     Bus1       1     4.41     4.98      50     480     300     389     1.01
  3     Bus3    1.05     1.49     1.96      50     429    56.6     520     1.05
--------------------------------------------------------------------------------
Maximum rotor angle difference :    3.02440 b/w buses : 1 and 3
Island    1 Common system frequency   50.028
--------------------------------------------------------------------------------
Voltage (pu), Current (AMPS), impedance (PU) and power (MW-MVAR) for lines
From Name     Voltage Angle   To   Name     Voltage  Angle    Current  Angle
                                            Zl-real  Zl-im    P        Q
---- -------- ------- ------- ---- -------- -------- -------- -------- --------
   1     Bus1   1.000    4.41    5     Bus5     1.05     -1.2 2.2e+004      -28
                                              0.6     0.37 4.8e+002   3e+002
   2     Bus2   0.922  -16.58    4     Bus4     1.05    -0.32 5.5e+002 1.4e+002
                                                -1         -0.46  -2.7e+002  -
1.2e+002
                                5     Bus5     1.05     -1.2 9.9e+002 1.5e+002
                                             -0.6         -0.18  -5.2e+002  -
1.6e+002
   3     Bus3   1.050    1.49    4     Bus4     1.05    -0.32 1.3e+004     -1.2
                                              1.3     0.06 3.5e+002       17
   4     Bus4   1.046   -0.32    3     Bus3     1.05      1.5 5.6e+002 1.8e+002
                                             -1.3     -0.02 -3.5e+002      -
5.5
                                5     Bus5     1.05     -1.2 1.2e+002       33
                                              4.7     -3.1       65      -43
                                2     Bus2    0.922      -17 4.6e+002      -10
                                              1.5     0.26 2.8e+002       49
   5     Bus5   1.050   -1.19    1     Bus1        1      4.4 8.5e+002 1.5e+002
                                            -0.74         -0.37  -4.8e+002  -
2.4e+002
                                4     Bus4     1.05    -0.32   1e+002 1.8e+002
                                             -6.8    -0.43      -65     -4.1
                                2     Bus2    0.922      -17 9.4e+002      -25
                                             0.68      0.3 5.4e+002 2.4e+002
kp 0 kq 0 Iterations 4 dpmax 0.000007 dqmax 0.000000
kp 0 kq 0 Iterations 4 dpmax 0.000007 dqmax 0.000000
kp 0 kq 0 Iterations 4 dpmax 0.000007 dqmax 0.000000
kp 0 kq 0 Iterations 4 dpmax 0.000007 dqmax 0.000000
kp 0 kq 0 Iterations 4 dpmax 0.000007 dqmax 0.000000
kp 0 kq 0 Iterations 4 dpmax 0.000007 dqmax 0.000000
kp 0 kq 0 Iterations 4 dpmax 0.000007 dqmax 0.000000
```

```
kp 0 kq 0 Iterations 4 dpmax 0.000007 dqmax 0.000000
kp 0 kq 0 Iterations 4 dpmax 0.000007 dqmax 0.000000
kp 0 kq 0 Iterations 4 dpmax 0.000007 dqmax 0.000000
--------------------------------------------------------------------------------
Time =   0.48000 Seconds
Intermediate results for Machines
GNo Name     Voltage Angle    Delta    Freq    Pgen    Qgen    Pmech   Efd/Slip
             pu      Degree   Degree   Hzs.    MW      MVAR    MW      pu/P.U.
--- -------- ------- -------- -------- ------- ------- ------- ------- --------
  1     Bus1       1      4.6     5.16      50     479     299     389     1.01
  3     Bus3    1.05     1.71     2.18      50     430    56.5     520     1.05
--------------------------------------------------------------------------------
Maximum rotor angle difference :    2.98335 b/w buses : 1 and 3
Island    1 Common system frequency   50.028
--------------------------------------------------------------------------------
Voltage (pu), Current (AMPS), impedance (PU) and power (MW-MVAR) for lines
From Name     Voltage Angle   To   Name     Voltage  Angle    Current  Angle
                                              Zl-real  Zl-im    P        Q
---- -------- ------- ------- ---- -------- -------- -------- -------- --------
   1     Bus1   1.000    4.60    5     Bus5     1.05    -0.99 2.2e+004      -27
                                               0.6     0.38 4.8e+002   3e+002
   2     Bus2   0.922  -16.38    4     Bus4     1.05    -0.11 5.5e+002 1.4e+002
                                                 -1        -0.46  -2.7e+002  -
1.2e+002
                                 5     Bus5     1.05    -0.99 9.9e+002 1.5e+002
                                              -0.6        -0.18  -5.2e+002  -
1.6e+002
   3     Bus3   1.050    1.71    4     Bus4     1.05    -0.11 1.3e+004       -1
                                               1.3    0.059 3.5e+002       17
   4     Bus4   1.046   -0.11    3     Bus3     1.05      1.7 5.6e+002 1.8e+002
                                              -1.3    -0.019 -3.5e+002       -
5.4
                                 5     Bus5     1.05    -0.99 1.3e+002       33
                                               4.6     -3.1       66       -43
                                 2     Bus2    0.922      -16 4.6e+002     -9.9
                                               1.5     0.26 2.8e+002       49
   5     Bus5   1.050   -0.99    1     Bus1       1      4.6 8.4e+002 1.5e+002
                                             -0.75        -0.37  -4.7e+002  -
2.4e+002
                                 4     Bus4     1.05    -0.11   1e+002 1.8e+002
                                              -6.7     -0.4      -66       -4
                                 2     Bus2    0.922      -16 9.4e+002      -25
                                               0.68      0.3 5.4e+002 2.4e+002
kp 0 kq 0 Iterations 4 dpmax 0.000007 dqmax 0.000000
kp 0 kq 0 Iterations 4 dpmax 0.000007 dqmax 0.000000
kp 0 kq 0 Iterations 4 dpmax 0.000007 dqmax 0.000000
kp 0 kq 0 Iterations 4 dpmax 0.000007 dqmax 0.000000
kp 0 kq 0 Iterations 4 dpmax 0.000007 dqmax 0.000000
kp 0 kq 0 Iterations 4 dpmax 0.000007 dqmax 0.000000
kp 0 kq 0 Iterations 4 dpmax 0.000007 dqmax 0.000000
kp 0 kq 0 Iterations 4 dpmax 0.000008 dqmax 0.000000
```

```
kp 0 kq 0 Iterations 4 dpmax 0.000008 dqmax 0.000000
kp 0 kq 0 Iterations 4 dpmax 0.000008 dqmax 0.000000
------------------------------------------------------------------------------
Time =   0.50000 Seconds
Intermediate results for Machines
GNo Name     Voltage Angle    Delta    Freq    Pgen    Qgen    Pmech   Efd/Slip
             pu      Degree   Degree   Hzs.    MW      MVAR    MW      pu/P.U.
--- -------- ------- -------- -------- ------- ------- ------- ------- --------
  1     Bus1       1     4.77     5.33      50     477     299     389     1.01
  3     Bus3    1.05     1.94     2.42      50     432    56.5     520     1.05
-------------------------------------------------------------------------------
Maximum rotor angle difference :     2.90997 b/w buses : 1 and 3
Island    1 Common system frequency   50.028
------------------------------------------------------------------------------
Voltage (pu), Current (AMPS), impedance (PU) and power (MW-MVAR) for lines
From Name     Voltage Angle   To   Name     Voltage  Angle    Current  Angle
                                            Zl-real  Zl-im    P        Q
---- -------- ------- ------- ---- -------- -------- -------- ------- --------
   1     Bus1   1.000    4.77    5     Bus5     1.05    -0.79 2.2e+004      -27
                                                 0.6     0.38 4.8e+002   3e+002
   2     Bus2   0.922  -16.17    4     Bus4     1.05     0.11 5.5e+002 1.4e+002
                                                  -1        -0.46  -2.8e+002  -
1.2e+002
                                 5     Bus5     1.05    -0.79 9.9e+002 1.5e+002
                                                -0.6        -0.18  -5.2e+002  -
1.6e+002
   3     Bus3   1.050    1.94    4     Bus4     1.05     0.11 1.3e+004    -0.74
                                                 1.2    0.058 3.5e+002       16
   4     Bus4   1.046    0.11    3     Bus3     1.05      1.9 5.6e+002 1.8e+002
                                                -1.2    -0.018 -3.5e+002      -
5.2
                                 5     Bus5     1.05    -0.79 1.3e+002       33
                                                 4.6     -2.9       68      -44
                                 2     Bus2    0.922      -16 4.6e+002     -9.6
                                                 1.5     0.26 2.8e+002       49
   5     Bus5   1.050   -0.79    1     Bus1        1      4.8 8.4e+002 1.5e+002
                                               -0.75        -0.37  -4.7e+002  -
2.4e+002
                                 4     Bus4     1.05     0.11 1.1e+002 1.8e+002
                                                -6.5    -0.35      -68     -3.6
                                 2     Bus2    0.922      -16 9.4e+002      -25
                                                0.68      0.3 5.4e+002 2.4e+002
kp 0 kq 0 Iterations 4 dpmax 0.000008 dqmax 0.000000
kp 0 kq 0 Iterations 4 dpmax 0.000008 dqmax 0.000000
kp 0 kq 0 Iterations 4 dpmax 0.000008 dqmax 0.000000
kp 0 kq 0 Iterations 4 dpmax 0.000008 dqmax 0.000000
kp 0 kq 0 Iterations 4 dpmax 0.000008 dqmax 0.000000
kp 0 kq 0 Iterations 4 dpmax 0.000008 dqmax 0.000000
kp 0 kq 0 Iterations 4 dpmax 0.000008 dqmax 0.000000
kp 0 kq 0 Iterations 4 dpmax 0.000008 dqmax 0.000000
kp 0 kq 0 Iterations 4 dpmax 0.000008 dqmax 0.000000
```

```
kp 0 kq 0 Iterations 4 dpmax 0.000008 dqmax 0.000000
--------------------------------------------------------------------------------
Time =   0.52000 Seconds
Intermediate results for Machines
GNo Name     Voltage Angle    Delta    Freq    Pgen    Qgen    Pmech   Efd/Slip
             pu      Degree   Degree   Hzs.    MW      MVAR    MW      pu/P.U.
--- -------- ------- -------- -------- ------- ------- ------- ------- --------
  1     Bus1       1     4.92     5.47      50     473     299     389     1.01
  3     Bus3    1.05     2.19     2.67      50     435    56.4     520     1.05
--------------------------------------------------------------------------------
Maximum rotor angle difference :    2.80507 b/w buses : 1 and 3
Island    1 Common system frequency   50.028
--------------------------------------------------------------------------------
Voltage (pu), Current (AMPS), impedance (PU) and power (MW-MVAR) for lines
From Name     Voltage Angle   To   Name     Voltage  Angle    Current  Angle
                                              Zl-real  Zl-im    P        Q
---- -------- ------- ------- ---- -------- -------- -------- -------- --------
   1     Bus1   1.000    4.92    5     Bus5     1.05     -0.6 2.2e+004      -27
                                               0.6     0.38 4.7e+002   3e+002
   2     Bus2   0.922  -15.97    4     Bus4     1.05     0.34 5.5e+002 1.4e+002
                                                 -1        -0.46  -2.8e+002  -
1.2e+002
                                 5     Bus5     1.05     -0.6 9.9e+002 1.5e+002
                                              -0.6        -0.18  -5.2e+002  -
1.6e+002
   3     Bus3   1.050    2.19    4     Bus4     1.05     0.34 1.3e+004    -0.45
                                               1.2    0.057 3.6e+002       16
   4     Bus4   1.046    0.34    3     Bus3     1.05      2.2 5.7e+002 1.8e+002
                                              -1.2    -0.017 -3.5e+002       -
4.9
                                 5     Bus5     1.05     -0.6 1.3e+002       32
                                               4.5     -2.8       71      -44
                                 2     Bus2    0.922      -16 4.6e+002     -9.4
                                               1.5     0.26 2.8e+002       49
   5     Bus5   1.050   -0.60    1     Bus1        1      4.9 8.4e+002 1.5e+002
                                             -0.75        -0.38  -4.7e+002  -
2.4e+002
                                 4     Bus4     1.05     0.34 1.1e+002 1.8e+002
                                              -6.2    -0.28      -71     -3.2
                                 2     Bus2    0.922      -16 9.4e+002      -25
                                              0.68      0.3 5.4e+002 2.4e+002
kp 0 kq 0  Iterations 4 dpmax 0.000008 dqmax 0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000008 dqmax 0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000008 dqmax 0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000008 dqmax 0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000008 dqmax 0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000008 dqmax 0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000008 dqmax 0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000008 dqmax 0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000009 dqmax 0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000009 dqmax 0.000000
```

```
------------------------------------------------------------------------------
Time =   0.54000 Seconds
Intermediate results for Machines
GNo Name     Voltage Angle    Delta    Freq    Pgen    Qgen    Pmech   Efd/Slip
             pu      Degree   Degree   Hzs.    MW      MVAR    MW      pu/P.U.
--- -------- ------- -------- -------- ------- ------- ------- ------- --------
  1     Bus1       1     5.06     5.61      50     469     299     389     1.01
  3     Bus3    1.05     2.45     2.94      50     440    56.2     520     1.05
-------------------------------------------------------------------------------
Maximum rotor angle difference :    2.66984 b/w buses : 1 and 3
Island    1 Common system frequency   50.028
------------------------------------------------------------------------------
Voltage (pu), Current (AMPS), impedance (PU) and power (MW-MVAR) for lines
From Name     Voltage Angle   To   Name     Voltage  Angle    Current  Angle
                                            Zl-real  Zl-im    P        Q
---- -------- ------- ------- ---- -------- -------- -------- -------- --------
   1     Bus1   1.000    5.06    5     Bus5     1.05    -0.41 2.1e+004      -27
                                                0.61     0.39 4.7e+002   3e+002
   2     Bus2   0.923  -15.76    4     Bus4     1.05     0.58 5.5e+002 1.4e+002
                                                  -1        -0.46  -2.8e+002   -
1.2e+002
                                   5     Bus5     1.05    -0.41 9.9e+002 1.5e+002
                                                -0.6        -0.18  -5.2e+002   -
1.6e+002
   3     Bus3   1.050    2.45    4     Bus4     1.05     0.58 1.3e+004    -0.13
                                                 1.2    0.055 3.6e+002       16
   4     Bus4   1.046    0.58    3     Bus3     1.05      2.5 5.7e+002 1.8e+002
                                                -1.2    -0.015  -3.6e+002      -
4.5
                                   5     Bus5     1.05    -0.41 1.4e+002       31
                                                 4.3     -2.6       74      -44
                                   2     Bus2    0.923      -16 4.6e+002     -9.2
                                                 1.5     0.26 2.8e+002       49
   5     Bus5   1.050   -0.41    1     Bus1        1      5.1 8.3e+002 1.5e+002
                                               -0.75        -0.38  -4.6e+002   -
2.4e+002
                                   4     Bus4     1.05     0.58 1.2e+002 1.8e+002
                                                -5.9     -0.2      -74     -2.6
                                   2     Bus2    0.923      -16 9.4e+002      -24
                                                0.68      0.3 5.4e+002 2.4e+002
kp 0 kq 0  Iterations 4 dpmax 0.000009 dqmax  0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000009 dqmax  0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000009 dqmax  0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000009 dqmax  0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000009 dqmax  0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000009 dqmax  0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000009 dqmax  0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000009 dqmax  0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000009 dqmax  0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000009 dqmax  0.000000
```

```
Time =   0.56000 Seconds
Intermediate results for Machines
GNo Name     Voltage Angle    Delta    Freq    Pgen    Qgen    Pmech   Efd/Slip
             pu      Degree   Degree   Hzs.    MW      MVAR    MW      pu/P.U.
--- -------- ------- -------- -------- ------- ------- ------- ------- --------
  1     Bus1       1     5.19     5.73      50     464     299     389     1.01
  3     Bus3    1.05     2.73     3.22      50     445    56.1     520     1.05
-------------------------------------------------------------------------------
Maximum rotor angle difference :    2.50581 b/w buses : 1 and 3
Island    1 Common system frequency   50.028
------------------------------------------------------------------------------
Voltage (pu), Current (AMPS), impedance (PU) and power (MW-MVAR) for lines
From Name     Voltage Angle   To   Name     Voltage  Angle    Current  Angle
                                            Zl-real  Zl-im    P        Q
---- -------- ------- ------- ---- -------- -------- -------- ------- --------
   1     Bus1   1.000    5.19    5     Bus5     1.05    -0.22 2.1e+004      -28
                                                0.61     0.39 4.6e+002   3e+002
   2     Bus2   0.923  -15.55    4     Bus4     1.05     0.83 5.5e+002 1.4e+002
                                                  -1        -0.46  -2.8e+002  -
1.2e+002
                                   5     Bus5     1.05    -0.22 9.9e+002 1.5e+002
                                                -0.6        -0.18  -5.2e+002  -
1.6e+002
   3     Bus3   1.050    2.73    4     Bus4     1.05     0.83 1.3e+004      0.2
                                                 1.2    0.053 3.6e+002       16
   4      Bus4    1.046     0.83     3      Bus3      1.05       2.7 5.8e+002  -
1.8e+002
                                                -1.2   -0.013 -3.6e+002        -
4
                                   5     Bus5     1.05    -0.22 1.5e+002       31
                                                 4.2     -2.4       79      -45
                                   2     Bus2    0.923      -16 4.6e+002     -8.9
                                                 1.5     0.26 2.9e+002       49
   5     Bus5   1.050   -0.22    1     Bus1        1      5.2 8.2e+002 1.5e+002
                                               -0.76        -0.39  -4.6e+002  -
2.4e+002
                                   4     Bus4     1.05     0.83 1.3e+002 1.8e+002
                                                -5.6    -0.13      -79     -1.8
                                   2     Bus2    0.923      -16 9.4e+002      -24
                                                0.68      0.3 5.4e+002 2.4e+002
kp 0 kq 0  Iterations 4 dpmax 0.000009 dqmax 0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000009 dqmax 0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000009 dqmax 0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000009 dqmax 0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000009 dqmax 0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000009 dqmax 0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000009 dqmax 0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000009 dqmax 0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000009 dqmax 0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000009 dqmax 0.000000
------------------------------------------------------------------------------
```

```
Time =   0.58000 Seconds
Intermediate results for Machines
GNo Name     Voltage Angle    Delta    Freq    Pgen    Qgen    Pmech   Efd/Slip
             pu      Degree   Degree   Hzs.    MW      MVAR    MW      pu/P.U.
--- -------- ------- -------- -------- ------- ------- ------- ------- --------
  1     Bus1       1      5.3     5.83      50     458     298     389      1.01
  3     Bus3    1.05      3.02     3.52      50     451    55.9     520      1.05
--------------------------------------------------------------------------------
Maximum rotor angle difference :    2.31486 b/w buses : 1 and 3
Island    1 Common system frequency   50.028
--------------------------------------------------------------------------------
Voltage (pu), Current (AMPS), impedance (PU) and power (MW-MVAR) for lines
From Name     Voltage Angle   To   Name     Voltage  Angle    Current  Angle
                                             Zl-real  Zl-im    P        Q
---- -------- ------- ------- ---- -------- -------- -------- -------- --------
   1     Bus1   1.000    5.30    5     Bus5     1.05    -0.03 2.1e+004       -28
                                             0.61      0.4 4.6e+002   3e+002
   2     Bus2   0.923  -15.34    4     Bus4     1.05      1.1 5.5e+002 1.4e+002
                                               -1         -0.45  -2.8e+002  -
1.2e+002
                                  5     Bus5     1.05    -0.03 9.9e+002 1.5e+002
                                             -0.6         -0.18  -5.2e+002  -
1.6e+002
   3     Bus3   1.050    3.02    4     Bus4     1.05      1.1 1.4e+004     0.56
                                              1.2    0.051 3.7e+002       16
   4      Bus4    1.046     1.09     3      Bus3      1.05          3 5.9e+002  -
1.8e+002
                                             -1.2    -0.011 -3.7e+002       -
3.5
                                  5     Bus5     1.05    -0.03 1.5e+002       30
                                                4     -2.2       84       -46
                                  2     Bus2    0.923      -15 4.6e+002     -8.7
                                              1.5      0.26 2.9e+002       49
   5     Bus5   1.050   -0.03    1     Bus1        1       5.3 8.2e+002 1.5e+002
                                            -0.76          -0.4  -4.5e+002  -
2.4e+002
                                  4     Bus4     1.05      1.1 1.3e+002 1.8e+002
                                             -5.3    -0.06      -84    -0.95
                                  2     Bus2    0.923      -15 9.4e+002      -24
                                              0.68     0.31 5.4e+002 2.4e+002
kp 0 kq 0  Iterations 4 dpmax 0.000009 dqmax 0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000010 dqmax 0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000010 dqmax 0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000010 dqmax 0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000010 dqmax 0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000010 dqmax 0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000010 dqmax 0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000010 dqmax 0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000010 dqmax 0.000000
```

```
Time =   0.60000 Seconds
Intermediate results for Machines
GNo Name      Voltage Angle    Delta    Freq    Pgen    Qgen    Pmech   Efd/Slip
              pu      Degree   Degree   Hzs.    MW      MVAR    MW      pu/P.U.
--- -------- ------- -------- -------- ------- ------- ------- ------- --------
  1     Bus1       1      5.4     5.93      50     451     298     389     1.01
  3     Bus3    1.05     3.32     3.83      50     458    55.8     520     1.05
---------------------------------------------------------------------------------
Maximum rotor angle difference :    2.09916 b/w buses : 1 and 3
Island    1 Common system frequency   50.028
--------------------------------------------------------------------------------
Voltage (pu), Current (AMPS), impedance (PU) and power (MW-MVAR) for lines
From Name      Voltage Angle   To   Name      Voltage  Angle    Current  Angle
                                              Zl-real  Zl-im    P        Q
---- -------- ------- ------- ---- -------- -------- -------- ------- --------
   1     Bus1   1.000    5.40    5     Bus5     1.05     0.16 2.1e+004      -28
                                                0.62     0.41 4.5e+002   3e+002
   2     Bus2   0.923  -15.12    4     Bus4     1.05      1.4 5.5e+002 1.4e+002
                                                  -1        -0.45  -2.8e+002  -
1.2e+002
                                   5     Bus5     1.05     0.16 9.9e+002 1.5e+002
                                                -0.6        -0.18  -5.2e+002  -
1.6e+002
   3     Bus3   1.050    3.32    4     Bus4     1.05      1.4 1.4e+004     0.92
                                                 1.2    0.049 3.8e+002       16
   4      Bus4    1.046     1.36     3      Bus3      1.05        3.3    6e+002  -
1.8e+002
                                                -1.2   -0.0088  -3.8e+002       -
2.9
                                   5     Bus5     1.05     0.16 1.6e+002       29
                                                 3.8       -2       90      -46
                                   2     Bus2    0.923      -15 4.7e+002     -8.4
                                                 1.5     0.25 2.9e+002       49
   5     Bus5   1.050    0.16    1     Bus1        1      5.4 8.1e+002 1.5e+002
                                               -0.77        -0.41  -4.5e+002  -
2.4e+002
                                   4       Bus4       1.05         1.4 1.4e+002  -
1.8e+002
                                                -4.9   0.0016      -90     0.03
                                   2     Bus2    0.923      -15 9.4e+002      -24
                                                0.69     0.31 5.4e+002 2.4e+002
kp 0 kq 0  Iterations 4 dpmax 0.000010 dqmax 0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000010 dqmax 0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000010 dqmax 0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000010 dqmax 0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000010 dqmax 0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000010 dqmax 0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000010 dqmax 0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000010 dqmax 0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000010 dqmax 0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000010 dqmax 0.000000
```

```
------------------------------------------------------------------------------
Time =   0.62000 Seconds
Intermediate results for Machines
GNo Name     Voltage Angle    Delta    Freq    Pgen    Qgen    Pmech   Efd/Slip
             pu      Degree   Degree   Hzs.    MW      MVAR    MW      pu/P.U.
--- -------- ------- -------- -------- ------- ------- ------- ------- --------
  1     Bus1       1      5.5     6.01      50     443     297     389     1.01
  3     Bus3    1.05     3.63     4.15      50     465    55.7     520     1.05
-------------------------------------------------------------------------------
Maximum rotor angle difference :    1.86120 b/w buses : 1 and 3
Island    1 Common system frequency   50.028
------------------------------------------------------------------------------
Voltage (pu), Current (AMPS), impedance (PU) and power (MW-MVAR) for lines
From Name     Voltage Angle   To   Name     Voltage  Angle    Current  Angle
                                            Zl-real  Zl-im    P        Q
---- -------- ------- ------- ---- -------- -------- -------- ------- --------
   1     Bus1   1.000    5.50    5     Bus5     1.05     0.34 2.1e+004      -28
                                                0.62     0.42 4.4e+002   3e+002
   2     Bus2   0.923  -14.91    4     Bus4     1.05      1.6 5.5e+002 1.4e+002
                                                  -1        -0.45  -2.8e+002  -
1.2e+002
                                   5     Bus5     1.05     0.34 9.9e+002 1.5e+002
                                                -0.6        -0.18  -5.2e+002  -
1.6e+002
   3     Bus3   1.050    3.63    4     Bus4     1.05      1.6 1.4e+004      1.3
                                                 1.1    0.046 3.9e+002       16
   4      Bus4    1.046     1.63     3      Bus3      1.05        3.6 6.1e+002  -
1.8e+002
                                                -1.1   -0.0065  -3.8e+002       -
2.2
                                   5     Bus5     1.05     0.34 1.7e+002       28
                                                 3.7     -1.8       97      -47
                                   2     Bus2    0.923      -15 4.7e+002     -8.1
                                                 1.5     0.25 2.9e+002       49
   5     Bus5   1.050    0.34    1     Bus1        1      5.5   8e+002 1.5e+002
                                               -0.77        -0.42  -4.4e+002  -
2.4e+002
                                   4       Bus4       1.05         1.6 1.5e+002  -
1.8e+002
                                                -4.6    0.053      -96      1.1
                                   2     Bus2    0.923      -15 9.3e+002      -24
                                                0.69     0.31 5.4e+002 2.4e+002
kp 0 kq 0 Iterations 4 dpmax 0.000010 dqmax 0.000000
kp 0 kq 0 Iterations 4 dpmax 0.000010 dqmax 0.000000
kp 0 kq 0 Iterations 4 dpmax 0.000010 dqmax 0.000000
kp 0 kq 0 Iterations 4 dpmax 0.000010 dqmax 0.000000
kp 0 kq 0 Iterations 4 dpmax 0.000010 dqmax 0.000000
kp 0 kq 0 Iterations 4 dpmax 0.000010 dqmax 0.000000
kp 0 kq 0 Iterations 4 dpmax 0.000010 dqmax 0.000000
kp 0 kq 0 Iterations 4 dpmax 0.000010 dqmax 0.000000
kp 0 kq 0 Iterations 4 dpmax 0.000010 dqmax 0.000000
```

```
kp 0 kq 0 Iterations 4 dpmax 0.000010 dqmax 0.000000
--------------------------------------------------------------------------------
Time =   0.64000 Seconds
Intermediate results for Machines
GNo Name     Voltage Angle    Delta    Freq    Pgen    Qgen    Pmech   Efd/Slip
             pu      Degree   Degree   Hzs.    MW      MVAR    MW      pu/P.U.
--- -------- ------- -------- -------- ------- ------- ------- ------- --------
  1     Bus1       1     5.58     6.08      50     435     297     389     1.01
  3     Bus3    1.05     3.95     4.48      50     474    55.6     520     1.05
--------------------------------------------------------------------------------
Maximum rotor angle difference :    1.60369 b/w buses : 1 and 3
Island    1 Common system frequency   50.028
--------------------------------------------------------------------------------
Voltage (pu), Current (AMPS), impedance (PU) and power (MW-MVAR) for lines
From Name     Voltage Angle   To   Name     Voltage  Angle    Current  Angle
                                              Zl-real  Zl-im    P        Q
---- -------- ------- ------- ---- -------- -------- -------- -------- --------
   1     Bus1   1.000    5.58    5     Bus5     1.05     0.52   2e+004      -29
                                              0.63     0.43 4.4e+002   3e+002
   2     Bus2   0.923  -14.70    4     Bus4     1.05      1.9 5.5e+002 1.4e+002
                                                -1         -0.44  -2.8e+002  -
1.2e+002
                                5     Bus5     1.05     0.52 9.9e+002 1.5e+002
                                              -0.6         -0.18  -5.2e+002  -
1.6e+002
   3     Bus3   1.050    3.95    4     Bus4     1.05      1.9 1.4e+004      1.7
                                               1.1    0.044 3.9e+002       16
   4      Bus4    1.046     1.91     3      Bus3      1.05          4 6.3e+002  -
1.8e+002
                                              -1.1   -0.0043 -3.9e+002       -
1.5
                                5     Bus5     1.05     0.52 1.8e+002       27
                                               3.5     -1.6   1e+002      -48
                                2     Bus2    0.923      -15 4.7e+002     -7.8
                                               1.5     0.25 2.9e+002       50
   5     Bus5   1.050    0.52    1     Bus1        1      5.6 7.9e+002 1.5e+002
                                             -0.78         -0.44  -4.3e+002  -
2.4e+002
                                4       Bus4       1.05         1.9 1.7e+002  -
1.8e+002
                                              -4.3    0.095  -1e+002      2.3
                                2     Bus2    0.923      -15 9.3e+002      -24
                                               0.69     0.31 5.3e+002 2.4e+002
kp 0 kq 0 Iterations 4 dpmax 0.000010 dqmax 0.000000
kp 0 kq 0 Iterations 4 dpmax 0.000010 dqmax 0.000000
kp 0 kq 0 Iterations 4 dpmax 0.000010 dqmax 0.000000
kp 0 kq 0 Iterations 4 dpmax 0.000011 dqmax 0.000000
kp 0 kq 0 Iterations 4 dpmax 0.000011 dqmax 0.000000
kp 0 kq 0 Iterations 4 dpmax 0.000011 dqmax 0.000000
kp 0 kq 0 Iterations 4 dpmax 0.000011 dqmax 0.000000
```

```
kp 0 kq 0 Iterations 4 dpmax 0.000011 dqmax 0.000000
kp 0 kq 0 Iterations 4 dpmax 0.000011 dqmax 0.000000
--------------------------------------------------------------------------------
Time =   0.66000 Seconds
Intermediate results for Machines
GNo Name     Voltage Angle    Delta    Freq    Pgen    Qgen    Pmech   Efd/Slip
             pu      Degree   Degree   Hzs.    MW      MVAR    MW      pu/P.U.
--- -------- ------- -------- -------- ------- ------- ------- ------- --------
  1     Bus1       1     5.65     6.14      50     427     297     389     1.01
  3     Bus3    1.05     4.28     4.82      50     482    55.5     520     1.05
--------------------------------------------------------------------------------
Maximum rotor angle difference :    1.32961 b/w buses : 1 and 3
Island    1 Common system frequency   50.028
--------------------------------------------------------------------------------
Voltage (pu), Current (AMPS), impedance (PU) and power (MW-MVAR) for lines
From Name     Voltage Angle   To   Name     Voltage  Angle    Current  Angle
                                              Zl-real  Zl-im    P        Q
---- -------- ------- ------- ---- -------- -------- -------- -------- --------
   1     Bus1   1.000    5.65    5     Bus5     1.05     0.71   2e+004      -29
                                             0.63     0.44 4.3e+002   3e+002
   2     Bus2   0.923  -14.48    4     Bus4     1.05      2.2 5.6e+002 1.4e+002
                                               -1         -0.44  -2.8e+002  -
1.2e+002
                                5     Bus5     1.05     0.71 9.8e+002 1.5e+002
                                             -0.6         -0.18  -5.2e+002  -
1.6e+002
   3     Bus3   1.050    4.28    4     Bus4     1.05      2.2 1.5e+004      2.1
                                              1.1    0.042   4e+002       15
   4      Bus4    1.046     2.19     3      Bus3      1.05       4.3 6.4e+002  -
1.8e+002
                                             -1.1  -0.0022  -4e+002    -0.79
                                5     Bus5     1.05     0.71 1.9e+002       26
                                              3.3     -1.4 1.1e+002      -49
                                2     Bus2    0.923      -14 4.7e+002     -7.5
                                              1.5     0.25 2.9e+002       50
   5     Bus5   1.050    0.71    1     Bus1        1      5.7 7.8e+002 1.5e+002
                                            -0.79         -0.45  -4.2e+002  -
2.4e+002
                                4       Bus4       1.05         2.2 1.8e+002  -
1.8e+002
                                               -4            0.13   -1.1e+002
3.6
                                2     Bus2    0.923      -14 9.3e+002      -23
                                             0.69     0.31 5.3e+002 2.4e+002
kp 0 kq 0 Iterations 4 dpmax 0.000011 dqmax 0.000000
kp 0 kq 0 Iterations 4 dpmax 0.000011 dqmax 0.000000
kp 0 kq 0 Iterations 4 dpmax 0.000011 dqmax 0.000000
kp 0 kq 0 Iterations 4 dpmax 0.000011 dqmax 0.000000
kp 0 kq 0 Iterations 4 dpmax 0.000011 dqmax 0.000000
kp 0 kq 0 Iterations 4 dpmax 0.000011 dqmax 0.000000
kp 0 kq 0 Iterations 4 dpmax 0.000011 dqmax 0.000000
```

```
kp 0 kq 0 Iterations 4 dpmax 0.000011 dqmax 0.000000
kp 0 kq 0 Iterations 4 dpmax 0.000011 dqmax 0.000000
kp 0 kq 0 Iterations 4 dpmax 0.000011 dqmax 0.000000
--------------------------------------------------------------------------------
Time =   0.68000 Seconds
Intermediate results for Machines
GNo Name     Voltage Angle    Delta    Freq    Pgen    Qgen    Pmech   Efd/Slip
             pu      Degree   Degree   Hzs.    MW      MVAR    MW      pu/P.U.
--- -------- ------- -------- -------- ------- ------- ------- ------- --------
  1     Bus1       1     5.72      6.2      50     417     296     389     1.01
  3     Bus3    1.05     4.61     5.16      50     492    55.4     520     1.05
--------------------------------------------------------------------------------
Maximum rotor angle difference :    1.04209 b/w buses : 1 and 3
Island    1 Common system frequency 50.028
--------------------------------------------------------------------------------
Voltage (pu), Current (AMPS), impedance (PU) and power (MW-MVAR) for lines
From Name     Voltage Angle   To   Name     Voltage  Angle    Current  Angle
                                              Zl-real  Zl-im    P        Q
---- -------- ------- ------- ---- -------- -------- -------- -------- --------
   1     Bus1   1.000    5.72    5     Bus5     1.05     0.89   2e+004      -30
                                              0.64     0.45 4.2e+002   3e+002
   2     Bus2   0.923  -14.27    4     Bus4     1.05      2.5 5.6e+002 1.4e+002
                                                -1         -0.44  -2.8e+002  -
1.2e+002
                                   5     Bus5     1.05     0.89 9.8e+002 1.5e+002
                                              -0.6         -0.18  -5.2e+002  -
1.6e+002
   3     Bus3   1.050    4.61    4     Bus4     1.05      2.5 1.5e+004      2.5
                                               1.1     0.04 4.1e+002       15
   4      Bus4    1.046     2.47     3      Bus3      1.05        4.6 6.6e+002  -
1.8e+002
                                             -1.1  -0.00019  -4.1e+002      -
0.072
                                   5     Bus5     1.05     0.89 2.1e+002       25
                                               3.1     -1.3 1.2e+002      -50
                                   2     Bus2    0.923      -14 4.7e+002     -7.3
                                               1.5     0.25 2.9e+002       50
   5     Bus5   1.050    0.89    1     Bus1        1      5.7 7.6e+002 1.5e+002
                                            -0.79         -0.47  -4.1e+002  -
2.4e+002
                                   4        Bus4       1.05         2.5 1.9e+002  -
1.8e+002
                                             -3.7            0.15   -1.2e+002
4.9
                                   2     Bus2    0.923      -14 9.3e+002      -23
                                              0.69     0.31 5.3e+002 2.4e+002
kp 0 kq 0 Iterations 4 dpmax 0.000011 dqmax 0.000000
kp 0 kq 0 Iterations 4 dpmax 0.000011 dqmax 0.000000
kp 0 kq 0 Iterations 4 dpmax 0.000011 dqmax 0.000000
kp 0 kq 0 Iterations 4 dpmax 0.000011 dqmax 0.000000
kp 0 kq 0 Iterations 4 dpmax 0.000011 dqmax 0.000000
```

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kp 0 kq 0 Iterations 4 dpmax 0.000011 dqmax 0.000000
kp 0 kq 0 Iterations 4 dpmax 0.000011 dqmax 0.000000
kp 0 kq 0 Iterations 4 dpmax 0.000011 dqmax 0.000000
kp 0 kq 0 Iterations 4 dpmax 0.000011 dqmax 0.000000
kp 0 kq 0 Iterations 4 dpmax 0.000011 dqmax 0.000000
--------------------------------------------------------------------------------
Time =   0.70000 Seconds
Intermediate results for Machines
GNo Name     Voltage Angle    Delta    Freq    Pgen    Qgen    Pmech   Efd/Slip
             pu      Degree   Degree   Hzs.    MW      MVAR    MW      pu/P.U.
--- -------- ------- -------- -------- ------- ------- ------- ------- --------
  1     Bus1       1     5.78     6.25      50     408     296     389     1.01
  3     Bus3    1.05     4.95     5.51      50     501    55.4     520     1.05
--------------------------------------------------------------------------------
Maximum rotor angle difference :    0.74446 b/w buses : 1 and 3
Island    1 Common system frequency 50.028
--------------------------------------------------------------------------------
Voltage (pu), Current (AMPS), impedance (PU) and power (MW-MVAR) for lines
From Name     Voltage Angle   To   Name     Voltage  Angle    Current  Angle
                                              Zl-real  Zl-im    P        Q
---- -------- ------- ------- ---- -------- -------- -------- -------- --------
   1     Bus1   1.000    5.78    5     Bus5     1.05      1.1 1.9e+004      -30
                                              0.64     0.47 4.1e+002   3e+002
   2     Bus2   0.923  -14.05    4     Bus4     1.05      2.8 5.6e+002 1.4e+002
                                                -1         -0.43  -2.8e+002  -
1.2e+002
                                   5     Bus5     1.05      1.1 9.8e+002 1.5e+002
                                              -0.6         -0.19  -5.2e+002  -
1.6e+002
   3     Bus3   1.050    4.95    4     Bus4     1.05      2.8 1.5e+004      2.9
                                                 1    0.038 4.2e+002       15
   4      Bus4    1.046     2.76     3      Bus3      1.05          5 6.7e+002  -
1.8e+002
                                                -1          0.0016   -4.2e+002
0.65
                                   5     Bus5     1.05      1.1 2.2e+002       24
                                                 3     -1.2 1.3e+002      -51
                                   2     Bus2    0.923      -14 4.7e+002       -7
                                                1.5     0.25 2.9e+002       50
   5     Bus5   1.050    1.07    1     Bus1        1      5.8 7.5e+002 1.5e+002
                                              -0.8         -0.48    -4e+002  -
2.5e+002
                                   4       Bus4       1.05         2.8    2e+002 -
1.8e+002
                                              -3.5             0.17   -1.3e+002
6.3
                                   2     Bus2    0.923      -14 9.3e+002      -23
                                               0.69     0.31 5.3e+002 2.4e+002
kp 0 kq 0 Iterations 4 dpmax 0.000011 dqmax 0.000000
kp 0 kq 0 Iterations 4 dpmax 0.000011 dqmax 0.000000
kp 0 kq 0 Iterations 4 dpmax 0.000011 dqmax 0.000000
```

```
kp 0 kq 0 Iterations 4 dpmax 0.000011 dqmax 0.000000
kp 0 kq 0 Iterations 4 dpmax 0.000011 dqmax 0.000000
kp 0 kq 0 Iterations 4 dpmax 0.000011 dqmax 0.000000
kp 0 kq 0 Iterations 4 dpmax 0.000011 dqmax 0.000000
kp 0 kq 0 Iterations 4 dpmax 0.000011 dqmax 0.000000
kp 0 kq 0 Iterations 4 dpmax 0.000011 dqmax 0.000000
kp 0 kq 0 Iterations 4 dpmax 0.000011 dqmax 0.000000
--------------------------------------------------------------------------------
Time =   0.72000 Seconds
Intermediate results for Machines
GNo Name     Voltage Angle    Delta    Freq    Pgen    Qgen    Pmech   Efd/Slip
             pu      Degree   Degree   Hzs.    MW      MVAR    MW      pu/P.U.
--- -------- ------- -------- -------- ------- ------- ------- ------- --------
  1     Bus1       1     5.84      6.3      50     398     296     389     1.01
  3     Bus3    1.05      5.3     5.86      50     511    55.5     520     1.05
--------------------------------------------------------------------------------
Maximum rotor angle difference :    0.44015 b/w buses : 1 and 3
Island    1 Common system frequency 50.028
--------------------------------------------------------------------------------
Voltage (pu), Current (AMPS), impedance (PU) and power (MW-MVAR) for lines
From Name     Voltage Angle   To   Name     Voltage  Angle    Current  Angle
                                            Zl-real  Zl-im    P        Q
---- -------- ------- ------- ---- -------- -------- -------- -------- --------
   1     Bus1   1.000    5.84    5     Bus5     1.05      1.2 1.9e+004       -31
                                             0.65     0.48   4e+002   3e+002
   2     Bus2   0.923  -13.83    4     Bus4     1.05      3.1 5.6e+002 1.4e+002
                                               -1        -0.43  -2.8e+002  -
1.2e+002
                                5     Bus5     1.05      1.2 9.8e+002 1.5e+002
                                             -0.6        -0.19  -5.2e+002  -
1.6e+002
   3     Bus3   1.050    5.30    4     Bus4     1.05      3.1 1.6e+004       3.2
                                                1    0.037 4.3e+002        16
   4      Bus4    1.046     3.06     3      Bus3      1.05        5.3 6.9e+002  -
1.8e+002
                                             -1          0.0032   -4.3e+002
1.4
                                5     Bus5     1.05      1.2 2.3e+002        24
                                              2.8     -1.1 1.4e+002       -52
                                2     Bus2    0.923      -14 4.8e+002      -6.7
                                              1.4     0.25 2.9e+002        50
   5     Bus5   1.050    1.25    1     Bus1        1      5.8 7.4e+002 1.5e+002
                                             -0.8          -0.5  -3.9e+002  -
2.5e+002
                                4       Bus4       1.05         3.1 2.2e+002  -
1.8e+002
                                             -3.2             0.18   -1.4e+002
7.7
                                2     Bus2    0.923      -14 9.3e+002       -23
                                              0.69     0.31 5.3e+002 2.4e+002
kp 0 kq 0 Iterations 4 dpmax 0.000011 dqmax 0.000000
```

```
kp 0 kq 0 Iterations 4 dpmax 0.000011 dqmax 0.000000
kp 0 kq 0 Iterations 4 dpmax 0.000011 dqmax 0.000000
kp 0 kq 0 Iterations 4 dpmax 0.000011 dqmax 0.000000
kp 0 kq 0 Iterations 4 dpmax 0.000011 dqmax 0.000000
kp 0 kq 0 Iterations 4 dpmax 0.000011 dqmax 0.000000
kp 0 kq 0 Iterations 4 dpmax 0.000011 dqmax 0.000000
kp 0 kq 0 Iterations 4 dpmax 0.000011 dqmax 0.000000
kp 0 kq 0 Iterations 4 dpmax 0.000011 dqmax 0.000000
kp 0 kq 0 Iterations 4 dpmax 0.000011 dqmax 0.000000
------------------------------------------------------------------------------
Time =   0.74000 Seconds
Intermediate results for Machines
GNo Name     Voltage Angle    Delta    Freq    Pgen    Qgen    Pmech   Efd/Slip
             pu      Degree   Degree   Hzs.    MW      MVAR    MW      pu/P.U.
--- -------- ------- -------- -------- ------- ------- ------- ------- --------
  1     Bus1       1      5.9     6.35      50     388     296     389     1.01
  3     Bus3    1.05     5.64     6.22      50     521    55.6     520     1.05
-------------------------------------------------------------------------------
Maximum rotor angle difference :    0.13267 b/w buses : 1 and 3
Island    1 Common system frequency 50.028
------------------------------------------------------------------------------
Voltage (pu), Current (AMPS), impedance (PU) and power (MW-MVAR) for lines
From Name     Voltage Angle   To   Name     Voltage  Angle    Current  Angle
                                            Zl-real  Zl-im    P        Q
---- -------- ------- ------- ---- -------- -------- -------- -------- --------
   1     Bus1   1.000    5.90    5     Bus5     1.05      1.4 1.9e+004      -31
                                                0.65      0.5 3.9e+002   3e+002
   2     Bus2   0.923  -13.61    4     Bus4     1.05      3.3 5.6e+002 1.4e+002
                                                  -1    -0.42  -2.9e+002   -
1.2e+002
                                   5     Bus5     1.05      1.4 9.8e+002 1.5e+002
                                                -0.6    -0.19  -5.1e+002   -
1.6e+002
   3     Bus3   1.050    5.64    4     Bus4     1.05      3.3 1.6e+004      3.6
                                                   1    0.035 4.4e+002       16
   4      Bus4    1.046     3.35     3      Bus3      1.05        5.6    7e+002 -
1.8e+002
                                                  -1          0.0046    -4.4e+002
2
                                   5     Bus5     1.05      1.4 2.5e+002       23
                                                 2.7    -0.97 1.4e+002      -53
                                   2     Bus2    0.923      -14 4.8e+002     -6.4
                                                 1.4     0.25 2.9e+002       51
   5     Bus5   1.050    1.43    1     Bus1        1      5.9 7.3e+002 1.5e+002
                                               -0.81    -0.52  -3.8e+002   -
2.5e+002
                                   4       Bus4       1.05         3.3 2.3e+002  -
1.7e+002
                                                  -3            0.19   -1.4e+002
9.2
                                   2     Bus2    0.923      -14 9.2e+002      -23
```

```
                                                         0.69      0.31 5.3e+002 2.4e+002
kp 0 kq 0  Iterations 4 dpmax 0.000011 dqmax  0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000011 dqmax  0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000011 dqmax  0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000011 dqmax  0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000011 dqmax  0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000011 dqmax  0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000011 dqmax  0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000011 dqmax  0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000011 dqmax  0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000011 dqmax  0.000000
------------------------------------------------------------------------------
Time =   0.76000 Seconds
Intermediate results for Machines
GNo Name      Voltage Angle    Delta    Freq     Pgen     Qgen     Pmech    Efd/Slip
              pu      Degree   Degree   Hzs.     MW       MVAR     MW       pu/P.U.
--- -------- ------- -------- -------- ------- ------- ------- ------- --------
  1     Bus1       1     5.96      6.4      50     378     295     389     1.01
  3     Bus3    1.05     5.98     6.57      50     531    55.7     520     1.05
---------------------------------------------------------------------------
Maximum rotor angle difference :    0.17444 b/w buses : 1 and 3
Island    1 Common system frequency   50.028
------------------------------------------------------------------------------
Voltage (pu), Current (AMPS), impedance (PU) and power (MW-MVAR) for lines
From Name      Voltage Angle   To   Name      Voltage  Angle    Current  Angle
                                              Zl-real  Zl-im    P        Q
---- -------- ------- ------- ---- -------- -------- -------- -------- --------
   1     Bus1   1.000    5.96    5     Bus5     1.05      1.6 1.8e+004      -32
                                                0.66     0.51 3.8e+002   3e+002
   2     Bus2   0.923  -13.40    4     Bus4     1.05      3.6 5.6e+002 1.4e+002
                                                  -1        -0.42  -2.9e+002  -
1.2e+002
                                   5     Bus5     1.05      1.6 9.8e+002 1.5e+002
                                                -0.6        -0.19  -5.1e+002  -
1.6e+002
   3     Bus3   1.050    5.98    4     Bus4     1.05      3.6 1.7e+004        4
                                                0.98    0.034 4.5e+002       16
   4      Bus4    1.046     3.64     3      Bus3      1.05          6 7.2e+002  -
1.8e+002
                                               -0.97          0.0058   -4.5e+002
2.7
                                   5     Bus5     1.05      1.6 2.6e+002       23
                                                 2.5    -0.89 1.5e+002      -53
                                   2     Bus2    0.923      -13 4.8e+002     -6.1
                                                 1.4     0.25   3e+002       51
   5     Bus5   1.051    1.61    1     Bus1        1        6 7.2e+002 1.5e+002
                                               -0.82        -0.54  -3.7e+002  -
2.5e+002
                                   4      Bus4      1.05        3.6 2.4e+002  -
1.7e+002
```

```
                                                    -2.9              0.2  -1.5e+002
11
                                     2     Bus2    0.923      -13 9.2e+002      -23
                                                    0.69     0.31 5.3e+002 2.4e+002
kp 0 kq 0  Iterations 4 dpmax 0.000011 dqmax 0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000011 dqmax 0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000011 dqmax 0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000011 dqmax 0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000011 dqmax 0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000011 dqmax 0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000011 dqmax 0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000011 dqmax 0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000011 dqmax 0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000011 dqmax 0.000000
------------------------------------------------------------------------------
Time =   0.78000 Seconds
Intermediate results for Machines
GNo Name      Voltage Angle    Delta    Freq     Pgen     Qgen     Pmech    Efd/Slip
              pu      Degree   Degree   Hzs.     MW       MVAR     MW       pu/P.U.
--- -------- ------- -------- -------- ------- ------- ------- ------- --------
  1     Bus1       1     6.02     6.45      50     369     295     389     1.01
  3     Bus3    1.05     6.33     6.92      50     540    55.9     520     1.05
---------------------------------------------------------------------------
Maximum rotor angle difference :    0.47760 b/w buses : 1 and 3
Island    1 Common system frequency   50.028
------------------------------------------------------------------------------
Voltage (pu), Current (AMPS), impedance (PU) and power (MW-MVAR) for lines
From Name      Voltage Angle   To   Name      Voltage  Angle    Current  Angle
                                              Zl-real  Zl-im    P        Q
---- -------- ------- ------- ---- -------- -------- -------- -------- --------
   1     Bus1   1.000    6.02    5     Bus5     1.05      1.8 1.8e+004      -33
                                                0.66     0.53 3.7e+002   3e+002
   2     Bus2   0.923  -13.18    4     Bus4     1.05      3.9 5.6e+002 1.4e+002
                                                  -1        -0.42  -2.9e+002  -
1.2e+002
                                 5     Bus5     1.05      1.8 9.7e+002 1.5e+002
                                               -0.61        -0.19  -5.1e+002  -
1.6e+002
   3     Bus3   1.050    6.33    4     Bus4     1.05      3.9 1.7e+004      4.3
                                                0.96    0.033 4.6e+002       16
   4      Bus4    1.046     3.93     3      Bus3      1.05       6.3 7.3e+002  -
1.8e+002
                                               -0.95          0.0069   -4.6e+002
3.3
                                 5     Bus5     1.05      1.8 2.7e+002       22
                                                 2.4    -0.81 1.6e+002      -54
                                 2     Bus2    0.923      -13 4.8e+002     -5.8
                                                 1.4     0.25   3e+002       51
   5     Bus5   1.051    1.79    1     Bus1        1        6 7.1e+002 1.5e+002
                                               -0.82        -0.56  -3.7e+002  -
2.5e+002
```

```
                                    4       Bus4       1.05         3.9 2.6e+002  -
1.7e+002
                                                      -2.7              0.2  -1.6e+002
12
                                    2     Bus2    0.923       -13 9.2e+002       -23
                                                       0.7     0.32 5.3e+002 2.4e+002
kp 0 kq 0  Iterations 4 dpmax 0.000011 dqmax  0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000011 dqmax  0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000011 dqmax  0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000011 dqmax  0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000011 dqmax  0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000011 dqmax  0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000011 dqmax  0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000011 dqmax  0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000011 dqmax  0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000011 dqmax  0.000000
------------------------------------------------------------------------------
Time =   0.80000 Seconds
Intermediate results for Machines
GNo Name     Voltage Angle    Delta    Freq    Pgen    Qgen    Pmech    Efd/Slip
             pu      Degree   Degree   Hzs.    MW      MVAR    MW       pu/P.U.
--- -------- ------- -------- -------- ------- ------- ------- ------- --------
  1     Bus1       1     6.08      6.5      50     359     295     389     1.01
  3     Bus3    1.05     6.67     7.27      50     550    56.2     520     1.05
---------------------------------------------------------------------------
Maximum rotor angle difference :    0.77333 b/w buses : 1 and 3
Island    1 Common system frequency   50.028
------------------------------------------------------------------------------
Voltage (pu), Current (AMPS), impedance (PU) and power (MW-MVAR) for lines
From Name     Voltage Angle   To   Name     Voltage  Angle    Current  Angle
                                            Zl-real  Zl-im    P        Q
---- -------- ------- ------- ---- -------- -------- -------- -------- --------
   1     Bus1   1.000    6.08    5     Bus5     1.05        2 1.8e+004      -33
                                                0.66     0.55 3.6e+002   3e+002
   2     Bus2   0.923  -12.96    4     Bus4     1.05      4.2 5.7e+002 1.4e+002
                                                  -1    -0.41  -2.9e+002  -
1.2e+002
                                   5     Bus5     1.05        2 9.7e+002 1.5e+002
                                               -0.61    -0.19  -5.1e+002  -
1.6e+002
   3     Bus3   1.050    6.67    4     Bus4     1.05      4.2 1.7e+004      4.7
                                                0.94    0.032 4.7e+002       16
   4      Bus4    1.046     4.22     3      Bus3      1.05        6.7 7.5e+002  -
1.8e+002
                                               -0.93         0.0077   -4.7e+002
3.9
                                   5     Bus5     1.05        2 2.9e+002       22
                                                 2.3    -0.75 1.7e+002      -55
                                   2     Bus2    0.923      -13 4.8e+002     -5.5
                                                 1.4     0.24   3e+002       51
   5     Bus5   1.051    1.97    1     Bus1        1      6.1 6.9e+002 1.5e+002
```

```
                                                                 -0.83         -0.59  -3.6e+002   -
2.5e+002
                                 4        Bus4       1.05         4.2 2.7e+002  -
1.7e+002
                                                                  -2.6            0.21   -1.7e+002
14
                                 2      Bus2    0.923      -13 9.2e+002       -22
                                                   0.7      0.32 5.3e+002 2.4e+002
kp 0 kq 0  Iterations 4 dpmax 0.000011 dqmax 0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000011 dqmax 0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000011 dqmax 0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000011 dqmax 0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000011 dqmax 0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000011 dqmax 0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000011 dqmax 0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000011 dqmax 0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000011 dqmax 0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000011 dqmax 0.000000
------------------------------------------------------------------------------
Time =   0.82000 Seconds
Intermediate results for Machines
GNo Name     Voltage Angle    Delta    Freq    Pgen    Qgen    Pmech   Efd/Slip
             pu      Degree   Degree   Hzs.    MW      MVAR    MW      pu/P.U.
--- -------- ------- -------- -------- ------- ------- ------- ------- --------
  1     Bus1       1     6.15     6.56      50     350     295     389     1.01
  3     Bus3    1.05        7     7.62      50     559    56.4     520     1.05
---------------------------------------------------------------------------
Maximum rotor angle difference :    1.05819 b/w buses : 1 and 3
Island    1 Common system frequency   50.028
------------------------------------------------------------------------------
Voltage (pu), Current (AMPS), impedance (PU) and power (MW-MVAR) for lines
From Name     Voltage Angle   To   Name     Voltage  Angle    Current  Angle
                                            Zl-real  Zl-im    P        Q
---- -------- ------- ------- ---- -------- -------- -------- -------- --------
   1     Bus1   1.000    6.15    5     Bus5     1.05      2.1 1.8e+004      -34
                                                0.67     0.56 3.5e+002   3e+002
   2     Bus2   0.923  -12.75    4     Bus4     1.05      4.5 5.7e+002 1.5e+002
                                                  -1        -0.41  -2.9e+002   -
1.2e+002
                                 5     Bus5     1.05      2.1 9.7e+002 1.5e+002
                                               -0.61        -0.19  -5.1e+002   -
1.6e+002
   3     Bus3   1.050    7.00    4     Bus4     1.05      4.5 1.8e+004        5
                                                0.92    0.032 4.8e+002       16
   4      Bus4   1.046     4.51     3      Bus3      1.05          7 7.6e+002  -
1.7e+002

4.4
```

```
                                                          1.4     0.24   3e+002       51
   5     Bus5   1.051    2.15    1     Bus1         1      6.2 6.8e+002 1.5e+002
                                                   -0.83         -0.61  -3.5e+002  -
2.5e+002
                                  4       Bus4       1.05         4.5 2.8e+002  -
1.7e+002
                                                    -2.5             0.21   -1.8e+002
15
                                  2     Bus2    0.923      -13 9.2e+002      -22
                                                      0.7     0.32 5.2e+002 2.4e+002
kp 0 kq 0 Iterations 4 dpmax 0.000011 dqmax 0.000000
kp 0 kq 0 Iterations 4 dpmax 0.000011 dqmax 0.000000
kp 0 kq 0 Iterations 4 dpmax 0.000011 dqmax 0.000000
kp 0 kq 0 Iterations 4 dpmax 0.000011 dqmax 0.000000
kp 0 kq 0 Iterations 4 dpmax 0.000011 dqmax 0.000000
kp 0 kq 0 Iterations 4 dpmax 0.000011 dqmax 0.000000
kp 0 kq 0 Iterations 4 dpmax 0.000010 dqmax 0.000000
kp 0 kq 0 Iterations 4 dpmax 0.000010 dqmax 0.000000
kp 0 kq 0 Iterations 4 dpmax 0.000010 dqmax 0.000000
kp 0 kq 0 Iterations 4 dpmax 0.000010 dqmax 0.000000
--------------------------------------------------------------------------------
Time =   0.84000 Seconds
Intermediate results for Machines
GNo Name     Voltage Angle    Delta    Freq    Pgen    Qgen    Pmech   Efd/Slip
             pu      Degree   Degree   Hzs.    MW      MVAR    MW      pu/P.U.
--- -------- ------- -------- -------- ------- ------- ------- ------- --------
  1     Bus1       1     6.23     6.62      50     341     295     389      1.01
  3     Bus3    1.05     7.33     7.95      50     568    56.7     520      1.05
--------------------------------------------------------------------------------
Maximum rotor angle difference :    1.32887 b/w buses : 1 and 3
Island    1 Common system frequency   50.028
--------------------------------------------------------------------------------
Voltage (pu), Current (AMPS), impedance (PU) and power (MW-MVAR) for lines
From Name     Voltage Angle   To   Name     Voltage  Angle    Current  Angle
                                              Zl-real  Zl-im    P        Q
---- -------- ------- ------- ---- -------- -------- -------- -------- --------
   1     Bus1   1.000    6.23    5     Bus5     1.05      2.3 1.7e+004      -35
                                                 0.67     0.58 3.4e+002   3e+002
   2     Bus2   0.923  -12.53    4     Bus4     1.05      4.8 5.7e+002 1.5e+002
                                                   -1         -0.4  -2.9e+002  -
1.2e+002
                                  5     Bus5     1.05      2.3 9.7e+002 1.5e+002
                                                -0.61        -0.19  -5.1e+002  -
1.6e+002
   3     Bus3   1.050    7.33    4     Bus4     1.05      4.8 1.8e+004      5.4
                                                  0.9    0.031 4.9e+002       17
   4      Bus4    1.046     4.79     3      Bus3      1.05        7.3 7.8e+002  -
1.7e+002
                                                 -0.9           0.009   -4.9e+002
4.9
                                  5     Bus5     1.05      2.3 3.1e+002       22
```

```
                                                    2.2     -0.65 1.9e+002       -56
                                 2     Bus2     0.923       -13 4.9e+002        -5
                                                    1.4      0.24   3e+002        52
   5     Bus5   1.051    2.33    1     Bus1         1       6.2 6.7e+002 1.5e+002
                                                -0.83         -0.63  -3.4e+002  -
2.5e+002
                                 4       Bus4       1.05         4.8    3e+002  -
1.7e+002
                                                   -2.4            0.21   -1.9e+002
16
                                 2     Bus2     0.923       -13 9.2e+002       -22
                                                    0.7      0.32 5.2e+002 2.4e+002
kp 0 kq 0  Iterations 4 dpmax 0.000010 dqmax  0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000010 dqmax  0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000010 dqmax  0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000010 dqmax  0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000010 dqmax  0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000010 dqmax  0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000010 dqmax  0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000010 dqmax  0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000010 dqmax  0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000010 dqmax  0.000000
------------------------------------------------------------------------------
Time =   0.86000 Seconds
Intermediate results for Machines
GNo Name     Voltage Angle    Delta    Freq     Pgen     Qgen     Pmech    Efd/Slip
             pu      Degree   Degree   Hzs.     MW       MVAR     MW       pu/P.U.
--- -------- ------- -------- -------- -------- -------- -------- -------- --------
  1     Bus1       1     6.31      6.7       50      333      295      389     1.01
  3     Bus3    1.05     7.65     8.28       50      576       57      520     1.05
---------------------------------------------------------------------------
Maximum rotor angle difference :    1.58225 b/w buses : 1 and 3
Island    1 Common system frequency   50.028
------------------------------------------------------------------------------
Voltage (pu), Current (AMPS), impedance (PU) and power (MW-MVAR) for lines
From Name     Voltage Angle   To   Name     Voltage  Angle    Current  Angle
                                            Zl-real  Zl-im    P        Q
---- -------- ------- ------- ---- -------- -------- -------- -------- --------
   1     Bus1   1.000    6.31    5     Bus5     1.05      2.5 1.7e+004       -35
                                                    0.67      0.6 3.3e+002   3e+002
   2     Bus2   0.923  -12.32    4     Bus4     1.05      5.1 5.7e+002 1.5e+002
                                                     -1          -0.4  -2.9e+002  -
1.2e+002
                                 5     Bus5     1.05      2.5 9.7e+002 1.5e+002
                                                -0.61          -0.2  -5.1e+002  -
1.6e+002
   3     Bus3   1.050    7.65    4     Bus4     1.05      5.1 1.8e+004       5.7
                                                    0.89    0.031   5e+002        17
   4      Bus4    1.046     5.07     3      Bus3      1.05       7.6 7.9e+002  -
1.7e+002
```

```
                                                      -0.88           0.0094   -4.9e+002
5.3
                                 5      Bus5      1.05       2.5 3.2e+002        22
                                                   2.1     -0.62 1.9e+002       -57
                                 2      Bus2     0.923       -12 4.9e+002      -4.7
                                                   1.4      0.24   3e+002        52
   5      Bus5   1.051     2.51  1      Bus1         1       6.3 6.6e+002 1.4e+002
                                                 -0.84          -0.65  -3.3e+002   -
2.6e+002
                                 4        Bus4        1.05          5.1 3.1e+002  -
1.7e+002
                                                  -2.3              0.21   -1.9e+002
17
                                 2      Bus2     0.923       -12 9.1e+002       -22
                                                   0.7      0.32 5.2e+002 2.4e+002
kp 0 kq 0 Iterations 4 dpmax 0.000010 dqmax 0.000000
kp 0 kq 0 Iterations 4 dpmax 0.000010 dqmax 0.000000
kp 0 kq 0 Iterations 4 dpmax 0.000010 dqmax 0.000000
kp 0 kq 0 Iterations 4 dpmax 0.000010 dqmax 0.000000
kp 0 kq 0 Iterations 4 dpmax 0.000010 dqmax 0.000000
kp 0 kq 0 Iterations 4 dpmax 0.000010 dqmax 0.000000
kp 0 kq 0 Iterations 4 dpmax 0.000010 dqmax 0.000000
kp 0 kq 0 Iterations 4 dpmax 0.000010 dqmax 0.000000
kp 0 kq 0 Iterations 4 dpmax 0.000010 dqmax 0.000000
kp 0 kq 0 Iterations 4 dpmax 0.000010 dqmax 0.000000
------------------------------------------------------------------------------
Time =   0.88000 Seconds
Intermediate results for Machines
GNo Name     Voltage Angle    Delta    Freq    Pgen    Qgen    Pmech   Efd/Slip
             pu      Degree   Degree   Hzs.    MW      MVAR    MW      pu/P.U.
--- -------- ------- -------- -------- ------- ------- ------- ------- --------
  1     Bus1       1      6.4     6.78      50     325     295     389     1.01
  3     Bus3    1.05     7.96      8.6      50     584    57.4     520     1.05
---------------------------------------------------------------------------
Maximum rotor angle difference :    1.81537 b/w buses : 1 and 3
Island    1 Common system frequency   50.028
------------------------------------------------------------------------------
Voltage (pu), Current (AMPS), impedance (PU) and power (MW-MVAR) for lines
From Name     Voltage Angle   To   Name     Voltage  Angle    Current  Angle
                                            Zl-real  Zl-im    P        Q
---- -------- ------- ------- ---- -------- -------- -------- -------- --------
   1     Bus1   1.000     6.40   5      Bus5      1.05       2.7 1.7e+004       -36
                                                   0.67      0.61 3.3e+002   3e+002
   2     Bus2   0.923   -12.11   4      Bus4      1.05       5.3 5.7e+002 1.5e+002
                                                     -1          -0.4  -2.9e+002  -
1.2e+002
                                 5      Bus5      1.05       2.7 9.7e+002 1.5e+002
                                                  -0.61          -0.2  -5.1e+002  -
1.6e+002
   3     Bus3   1.050     7.96   4      Bus4      1.05       5.3 1.8e+004         6
                                                   0.87      0.03   5e+002        17
```

```
   4      Bus4    1.046     5.34     3      Bus3      1.05         8    8e+002 -
1.7e+002
                                                  -0.87   0.0098  -5e+002      5.6
                                5     Bus5     1.05      2.7 3.3e+002       21
                                                     2    -0.58   2e+002      -58
                                2     Bus2    0.923      -12 4.9e+002     -4.4
                                                   1.4     0.24   3e+002       52
   5     Bus5   1.051    2.69    1     Bus1        1      6.4 6.6e+002 1.4e+002
                                                  -0.84        -0.67  -3.2e+002  -
2.6e+002
                                4       Bus4       1.05         5.3 3.2e+002  -
1.7e+002
                                                  -2.2     0.21  -2e+002       19
                                2     Bus2    0.923      -12 9.1e+002      -22
                                                   0.7     0.32 5.2e+002 2.4e+002
kp 0 kq 0  Iterations 4 dpmax 0.000010 dqmax  0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000010 dqmax  0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000010 dqmax  0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000010 dqmax  0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000010 dqmax  0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000010 dqmax  0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000010 dqmax  0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000009 dqmax  0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000009 dqmax  0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000009 dqmax  0.000000
--------------------------------------------------------------------------------
Time =   0.90000 Seconds
Intermediate results for Machines
GNo Name     Voltage Angle    Delta    Freq    Pgen    Qgen    Pmech   Efd/Slip
             pu      Degree   Degree   Hzs.    MW      MVAR    MW      pu/P.U.
--- -------- ------- -------- -------- ------- ------- ------- ------- --------
  1     Bus1       1      6.5     6.88      50     318     295     389     1.01
  3     Bus3    1.05     8.26      8.9      50     590    57.7     520     1.05
--------------------------------------------------------------------------------
Maximum rotor angle difference :    2.02552 b/w buses : 1 and 3
Island    1 Common system frequency   50.028
--------------------------------------------------------------------------------
Voltage (pu), Current (AMPS), impedance (PU) and power (MW-MVAR) for lines
From Name     Voltage Angle   To   Name     Voltage  Angle    Current  Angle
                                              Zl-real  Zl-im    P        Q
---- -------- ------- ------- ---- -------- -------- -------- -------- --------
   1     Bus1   1.000    6.50    5     Bus5     1.05      2.9 1.7e+004      -36
                                                 0.68     0.63 3.2e+002   3e+002
   2     Bus2   0.923  -11.90    4     Bus4     1.05      5.6 5.7e+002 1.5e+002
                                                   -1          -0.4  -2.9e+002  -
1.2e+002
                                5     Bus5     1.05      2.9 9.6e+002 1.5e+002
                                                -0.61          -0.2  -5.1e+002  -
1.6e+002
   3     Bus3   1.050    8.26    4     Bus4     1.05      5.6 1.9e+004      6.3
                                                 0.86     0.03 5.1e+002       18
```

```
   4      Bus4    1.046     5.60     3      Bus3      1.05       8.3 8.1e+002  -
1.7e+002
                                                -0.86            0.01   -5.1e+002
6
                                 5     Bus5      1.05      2.9 3.4e+002       21
                                                    2    -0.56 2.1e+002      -58
                                 2     Bus2     0.923      -12 4.9e+002     -4.2
                                                  1.4     0.24   3e+002       52
   5     Bus5   1.051    2.88    1     Bus1         1      6.5 6.5e+002 1.4e+002
                                                -0.84        -0.69  -3.2e+002  -
2.6e+002
                                 4       Bus4       1.05        5.6 3.3e+002  -
1.7e+002
                                                 -2.1     0.21  -2e+002       20
                                 2     Bus2     0.923      -12 9.1e+002      -22
                                                  0.7     0.32 5.2e+002 2.4e+002
kp 0 kq 0 Iterations 4 dpmax 0.000009 dqmax 0.000000
kp 0 kq 0 Iterations 4 dpmax 0.000009 dqmax 0.000000
kp 0 kq 0 Iterations 4 dpmax 0.000009 dqmax 0.000000
kp 0 kq 0 Iterations 4 dpmax 0.000009 dqmax 0.000000
kp 0 kq 0 Iterations 4 dpmax 0.000009 dqmax 0.000000
kp 0 kq 0 Iterations 4 dpmax 0.000009 dqmax 0.000000
kp 0 kq 0 Iterations 4 dpmax 0.000009 dqmax 0.000000
kp 0 kq 0 Iterations 4 dpmax 0.000009 dqmax 0.000000
kp 0 kq 0 Iterations 4 dpmax 0.000009 dqmax 0.000000
kp 0 kq 0 Iterations 4 dpmax 0.000009 dqmax 0.000000
------------------------------------------------------------------------------
Time =   0.92000 Seconds
Intermediate results for Machines
GNo Name     Voltage Angle    Delta    Freq    Pgen    Qgen    Pmech   Efd/Slip
             pu      Degree   Degree   Hzs.    MW      MVAR    MW      pu/P.U.
--- -------- ------- -------- -------- ------- ------- ------- ------- --------
  1     Bus1       1     6.62     6.98      50     312     295     389     1.01
  3     Bus3    1.05     8.55     9.19      50     596      58     520     1.05
-------------------------------------------------------------------------------
Maximum rotor angle difference :    2.21026 b/w buses : 1 and 3
Island    1 Common system frequency   50.028
------------------------------------------------------------------------------
Voltage (pu), Current (AMPS), impedance (PU) and power (MW-MVAR) for lines
From Name     Voltage Angle   To   Name     Voltage  Angle    Current  Angle
                                            Zl-real  Zl-im    P        Q
---- -------- ------- ------- ---- -------- -------- -------- ------- --------
   1     Bus1   1.000    6.62    5     Bus5      1.05      3.1 1.7e+004      -37
                                                 0.68     0.64 3.1e+002   3e+002
   2     Bus2   0.923  -11.69    4     Bus4      1.05      5.9 5.7e+002 1.5e+002
                                                   -1        -0.39  -2.9e+002  -
1.2e+002
                                 5     Bus5      1.05      3.1 9.6e+002 1.5e+002
                                                -0.61         -0.2  -5.1e+002  -
1.6e+002
   3     Bus3   1.050    8.55    4     Bus4      1.05      5.9 1.9e+004      6.5
```

```
                                                    0.85     0.03 5.2e+002       18
   4      Bus4    1.046      5.86     3      Bus3      1.05        8.5 8.2e+002  -
1.7e+002
                                                   -0.85            0.01   -5.1e+002
6.2
                                 5     Bus5      1.05      3.1 3.5e+002       21
                                                    1.9    -0.53 2.1e+002      -58
                                 2     Bus2     0.923      -12 4.9e+002     -3.9
                                                    1.4     0.24   3e+002       52
   5     Bus5   1.051    3.07     1     Bus1        1      6.6 6.4e+002 1.4e+002
                                                   -0.84          -0.7  -3.1e+002  -
2.6e+002
                                 4       Bus4       1.05         5.9 3.4e+002  -
1.7e+002
                                                    -2.1             0.2  -2.1e+002
21
                                 2     Bus2     0.923      -12 9.1e+002      -22
                                                    0.7     0.32 5.2e+002 2.4e+002
kp 0 kq 0  Iterations 4 dpmax 0.000009 dqmax  0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000009 dqmax  0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000009 dqmax  0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000009 dqmax  0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000009 dqmax  0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000009 dqmax  0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000009 dqmax  0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000009 dqmax  0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000009 dqmax  0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000009 dqmax  0.000000
------------------------------------------------------------------------------
Time =   0.94000 Seconds
Intermediate results for Machines
GNo Name      Voltage Angle    Delta    Freq    Pgen    Qgen    Pmech   Efd/Slip
              pu      Degree   Degree   Hzs.    MW      MVAR    MW      pu/P.U.
--- -------- ------- -------- -------- ------- ------- ------- ------- --------
  1     Bus1       1     6.74      7.1      50     307     295     389     1.01
  3     Bus3    1.05     8.82     9.47      50     602    58.2     520     1.05
-------------------------------------------------------------------------------
Maximum rotor angle difference :    2.36742 b/w buses : 1 and 3
Island    1 Common system frequency   50.028
------------------------------------------------------------------------------
Voltage (pu), Current (AMPS), impedance (PU) and power (MW-MVAR) for lines
From Name      Voltage Angle   To   Name      Voltage  Angle    Current  Angle
                                              Zl-real  Zl-im    P        Q
---- -------- ------- ------- ---- -------- -------- -------- ------- --------
   1     Bus1   1.000    6.74    5     Bus5      1.05      3.3 1.6e+004      -37
                                                 0.68     0.65 3.1e+002   3e+002
   2     Bus2   0.923  -11.48    4     Bus4      1.05      6.1 5.7e+002 1.5e+002
                                                   -1        -0.39    -3e+002  -
1.2e+002
```

```
                                                -0.61          -0.2    -5e+002  -
1.6e+002
   3     Bus3   1.050    8.82    4     Bus4     1.05      6.1 1.9e+004      6.8
                                                0.84     0.03 5.2e+002       18
   4      Bus4    1.046     6.10     3      Bus3      1.05       8.8 8.3e+002  -
1.7e+002
                                                -0.84            0.01   -5.2e+002
6.4
                                 5     Bus5     1.05      3.3 3.6e+002       21
                                                 1.9    -0.52 2.2e+002      -59
                                 2     Bus2    0.923      -11 4.9e+002     -3.7
                                                 1.4     0.24   3e+002       52
   5     Bus5   1.051    3.26    1     Bus1        1      6.7 6.4e+002 1.4e+002
                                                -0.84         -0.72     -3e+002  -
2.6e+002
                                 4       Bus4       1.05         6.1 3.4e+002  -
1.7e+002
                                                   -2             0.2   -2.1e+002
21
                                 2     Bus2    0.923      -11 9.1e+002      -21
                                                 0.7     0.32 5.2e+002 2.4e+002
kp 0 kq 0  Iterations 4 dpmax 0.000009 dqmax 0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000008 dqmax 0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000008 dqmax 0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000008 dqmax 0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000008 dqmax 0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000008 dqmax 0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000008 dqmax 0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000008 dqmax 0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000008 dqmax 0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000008 dqmax 0.000000
------------------------------------------------------------------------------
Time =   0.96000 Seconds
Intermediate results for Machines
GNo Name      Voltage Angle    Delta    Freq     Pgen     Qgen     Pmech    Efd/Slip
              pu      Degree   Degree   Hzs.     MW       MVAR     MW       pu/P.U.
--- -------- ------- -------- -------- ------- ------- ------- ------- --------
  1     Bus1       1     6.88     7.24      50     303     295     389     1.01
  3     Bus3    1.05     9.08     9.74      50     606    58.5     520     1.05
---------------------------------------------------------------------------
Maximum rotor angle difference :    2.49518 b/w buses : 1 and 3
Island    1 Common system frequency   50.028
------------------------------------------------------------------------------
Voltage (pu), Current (AMPS), impedance (PU) and power (MW-MVAR) for lines
From Name      Voltage Angle   To   Name      Voltage  Angle    Current  Angle
                                              Zl-real  Zl-im    P        Q
---- -------- ------- ------- ---- -------- -------- -------- ------- --------
   1     Bus1   1.000    6.88    5     Bus5     1.05      3.4 1.6e+004      -37
                                                0.68     0.66   3e+002   3e+002
   2     Bus2   0.922  -11.27    4     Bus4     1.05      6.3 5.8e+002 1.5e+002
```

```
                                                   -1          -0.39     -3e+002   -
1.1e+002
                                 5      Bus5      1.05       3.4 9.6e+002 1.5e+002
                                                 -0.61           -0.2     -5e+002   -
1.6e+002
   3      Bus3    1.050     9.08     4      Bus4      1.05       6.3 1.9e+004       7.1
                                                  0.84     0.029 5.3e+002        18
   4       Bus4    1.046      6.34      3       Bus3       1.05        9.1 8.4e+002  -
1.7e+002
                                                 -0.83           0.011   -5.2e+002
6.6
                                 5      Bus5      1.05       3.4 3.6e+002        21
                                                   1.9      -0.5 2.2e+002       -59
                                 2      Bus2     0.922       -11   5e+002      -3.4
                                                   1.4      0.24 3.1e+002        52
   5      Bus5    1.051     3.45     1      Bus1         1       6.9 6.3e+002 1.4e+002
                                                 -0.84          -0.73     -3e+002   -
2.6e+002
                                 4       Bus4       1.05         6.3 3.5e+002  -
1.7e+002
                                                    -2              0.2   -2.2e+002
22
                                 2      Bus2     0.922       -11 9.1e+002       -21
                                                   0.7      0.32 5.2e+002 2.4e+002
kp 0 kq 0  Iterations 4 dpmax 0.000008 dqmax  0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000008 dqmax  0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000008 dqmax  0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000008 dqmax  0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000008 dqmax  0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000008 dqmax  0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000008 dqmax  0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000008 dqmax  0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000008 dqmax  0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000008 dqmax  0.000000
------------------------------------------------------------------------------
Time =   0.98000 Seconds
Intermediate results for Machines
GNo Name      Voltage Angle    Delta    Freq     Pgen     Qgen     Pmech    Efd/Slip
              pu      Degree   Degree   Hzs.     MW       MVAR     MW       pu/P.U.
--- -------- ------- -------- -------- ------- ------- ------- ------- --------
  1     Bus1        1     7.04     7.39      50     300     296     389     1.01
  3     Bus3     1.05     9.33     9.98      50     609    58.6     520     1.05
-------------------------------------------------------------------------------
Maximum rotor angle difference :    2.59202 b/w buses : 1 and 3
Island    1 Common system frequency   50.028
------------------------------------------------------------------------------
Voltage (pu), Current (AMPS), impedance (PU) and power (MW-MVAR) for lines
From Name      Voltage Angle   To   Name      Voltage  Angle    Current  Angle
                                              Zl-real  Zl-im    P        Q
---- -------- ------- ------- ---- -------- -------- -------- -------- --------
   1      Bus1    1.000     7.04     5      Bus5      1.05       3.6 1.6e+004       38
```

```
                                                    0.68     0.67   3e+002   3e+002
   2     Bus2   0.922  -11.06    4     Bus4      1.05      6.6 5.8e+002 1.5e+002
                                                    -1        -0.39    -3e+002  -
1.1e+002
                                  5     Bus5      1.05      3.6 9.6e+002 1.5e+002
                                                 -0.61          -0.2    -5e+002  -
1.7e+002
   3     Bus3   1.050    9.33    4     Bus4      1.05      6.6 1.9e+004      7.3
                                                 0.83    0.029 5.3e+002       19
   4      Bus4    1.046     6.57     3      Bus3      1.05        9.3 8.4e+002  -
1.7e+002
                                                -0.83           0.011   -5.3e+002
6.7
                                  5     Bus5      1.05      3.6 3.7e+002       22
                                                  1.8    -0.49 2.2e+002      -59
                                  2     Bus2     0.922      -11   5e+002     -3.2
                                                  1.4     0.24 3.1e+002       53
   5     Bus5   1.051    3.64    1     Bus1         1        7 6.3e+002 1.4e+002
                                                -0.84         -0.74    -3e+002  -
2.6e+002
                                  4       Bus4       1.05         6.6 3.5e+002  -
1.7e+002
                                                    -2             0.2  -2.2e+002
22
                                  2     Bus2     0.922      -11 9.1e+002      -21
                                                    0.7     0.32 5.2e+002 2.4e+002
kp 0 kq 0  Iterations 4 dpmax 0.000008 dqmax  0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000008 dqmax  0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000007 dqmax  0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000007 dqmax  0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000007 dqmax  0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000007 dqmax  0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000007 dqmax  0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000007 dqmax  0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000007 dqmax  0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000007 dqmax  0.000000
--------------------------------------------------------------------------------
Time =   1.00000 Seconds
Intermediate results for Machines
GNo Name     Voltage Angle    Delta    Freq    Pgen    Qgen    Pmech   Efd/Slip
             pu      Degree   Degree   Hzs.    MW      MVAR    MW      pu/P.U.
--- -------- ------- -------- -------- ------- ------- ------- ------- --------
  1     Bus1       1      7.2     7.56      50     298     296     389      1.01
  3     Bus3    1.05     9.56     10.2      50     611    58.8     520      1.05
--------------------------------------------------------------------------------
Maximum rotor angle difference :    2.65680 b/w buses : 1 and 3
Island    1 Common system frequency   50.028
--------------------------------------------------------------------------------
Voltage (pu), Current (AMPS), impedance (PU) and power (MW-MVAR) for lines
From Name      Voltage Angle   To   Name      Voltage  Angle    Current  Angle
                                                Zl-real  Zl-im    P        Q
```

```
---- -------- ------- ------- ---- -------- -------- -------- -------- --------
   1     Bus1   1.000     7.20    5     Bus5     1.05      3.8 1.6e+004      -38
                                                 0.68     0.67   3e+002   3e+002
   2     Bus2   0.922   -10.86    4     Bus4     1.05      6.8 5.8e+002 1.5e+002
                                                   -1        -0.39    -3e+002  -
1.1e+002
                                  5     Bus5     1.05      3.8 9.6e+002 1.5e+002
                                                -0.61          -0.2    -5e+002  -
1.7e+002
   3     Bus3   1.050     9.56    4     Bus4     1.05      6.8 1.9e+004      7.5
                                                 0.83    0.029 5.3e+002       19
   4      Bus4    1.046     6.79     3      Bus3      1.05        9.6 8.5e+002  -
1.7e+002
                                                -0.83           0.011   -5.3e+002
6.8
                                  5     Bus5     1.05      3.8 3.7e+002       22
                                                  1.8    -0.49 2.2e+002      -59
                                  2     Bus2    0.922      -11   5e+002       -3
                                                  1.4     0.24 3.1e+002       53
   5     Bus5   1.051     3.84    1     Bus1        1      7.2 6.3e+002 1.4e+002
                                                -0.84        -0.74    -3e+002  -
2.6e+002
                                  4      Bus4      1.05         6.8 3.6e+002  -
1.7e+002
                                                   -2             0.2  -2.2e+002
23
                                  2     Bus2    0.922      -11 9.1e+002      -21
                                                  0.7     0.32 5.2e+002 2.4e+002
kp 0 kq 0  Iterations 4 dpmax 0.000007 dqmax 0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000007 dqmax 0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000007 dqmax 0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000007 dqmax 0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000007 dqmax 0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000007 dqmax 0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000007 dqmax 0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000007 dqmax 0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000007 dqmax 0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000007 dqmax 0.000000
------------------------------------------------------------------------------
Time =   1.02000 Seconds
Intermediate results for Machines
GNo Name      Voltage Angle    Delta    Freq     Pgen     Qgen     Pmech    Efd/Slip
              pu      Degree   Degree   Hzs.     MW       MVAR     MW       pu/P.U.
--- -------- ------- -------- -------- ------- ------- ------- ------- --------
  1     Bus1       1     7.39     7.74      50     297     296     389     1.01
  3     Bus3    1.05     9.78     10.4      50     612    58.8     520     1.05
---------------------------------------------------------------------------
Maximum rotor angle difference :    2.68875 b/w buses : 1 and 3
Island     1 Common system frequency   50.028
------------------------------------------------------------------------------
Voltage (pu), Current (AMPS), impedance (PU) and power (MW-MVAR) for lines
```

```
From Name     Voltage Angle   To   Name     Voltage  Angle    Current  Angle
                                            Zl-real  Zl-im    P        Q
---- -------- ------- ------- ---- -------- -------- -------- -------- --------
   1     Bus1   1.000    7.39    5     Bus5     1.05        4 1.6e+004      -38
                                                0.68     0.67   3e+002   3e+002
   2     Bus2   0.922  -10.66    4     Bus4     1.05        7 5.8e+002 1.5e+002
                                                  -1        -0.39    -3e+002  -
1.1e+002
                                   5     Bus5     1.05        4 9.6e+002 1.5e+002
                                               -0.61         -0.2    -5e+002  -
1.7e+002
   3     Bus3   1.050    9.78    4     Bus4     1.05        7   2e+004      7.8
                                                0.83    0.029 5.3e+002       19
   4      Bus4    1.046      7.01     3      Bus3      1.05        9.8 8.5e+002  -
1.7e+002
                                               -0.82           0.011   -5.3e+002
6.9
                                   5     Bus5     1.05        4 3.7e+002       22
                                                 1.8    -0.48 2.2e+002      -60
                                   2     Bus2    0.922      -11   5e+002     -2.8
                                                 1.4     0.24 3.1e+002       53
   5     Bus5   1.051    4.03    1     Bus1        1      7.4 6.3e+002 1.4e+002
                                               -0.84        -0.75  -2.9e+002   -
2.6e+002
                                   4       Bus4       1.05           7 3.6e+002  -
1.7e+002
                                                  -2             0.2  -2.2e+002
23
                                   2     Bus2    0.922      -11 9.1e+002      -21
                                                 0.7     0.32 5.2e+002 2.4e+002
kp 0 kq 0  Iterations 4 dpmax 0.000007 dqmax  0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000006 dqmax  0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000006 dqmax  0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000006 dqmax  0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000006 dqmax  0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000006 dqmax  0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000006 dqmax  0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000006 dqmax  0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000006 dqmax  0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000006 dqmax  0.000000
------------------------------------------------------------------------------
Time =   1.04000 Seconds
Intermediate results for Machines
GNo Name     Voltage Angle    Delta    Freq     Pgen     Qgen     Pmech    Efd/Slip
             pu      Degree   Degree   Hzs.     MW       MVAR     MW       pu/P.U.
--- -------- ------- -------- -------- -------- -------- -------- -------- --------
  1     Bus1       1     7.59     7.95       50      296      296      389     1.01
  3     Bus3    1.05     9.98     10.6       50      612     58.8      520     1.05
------------------------------------------------------------------------------
Maximum rotor angle difference :    2.68747 b/w buses : 1 and 3
Island    1 Common system frequency   50.028
```

```
--------------------------------------------------------------------------------
Voltage (pu), Current (AMPS), impedance (PU) and power (MW-MVAR) for lines
From Name     Voltage Angle   To   Name     Voltage  Angle    Current  Angle
                                            Zl-real  Zl-im    P        Q
---- -------- ------- ------- ---- -------- -------- -------- -------- --------
   1     Bus1   1.000    7.59    5     Bus5     1.05      4.2 1.6e+004      -37
                                                0.68     0.67   3e+002   3e+002
   2     Bus2   0.922  -10.46    4     Bus4     1.05      7.2 5.8e+002 1.5e+002
                                                  -1        -0.39    -3e+002  -
1.1e+002
                                 5     Bus5     1.05      4.2 9.6e+002 1.5e+002
                                               -0.61         -0.2    -5e+002  -
1.7e+002
   3     Bus3   1.050    9.98    4     Bus4     1.05      7.2   2e+004      7.9
                                                0.83    0.029 5.3e+002       19
   4      Bus4    1.046     7.21     3      Bus3      1.05         10 8.5e+002  -
1.7e+002
                                               -0.82           0.011   -5.3e+002
6.9
                                 5     Bus5     1.05      4.2 3.7e+002       22
                                                 1.8    -0.48 2.2e+002      -60
                                 2     Bus2    0.922      -10   5e+002     -2.6
                                                 1.4     0.24 3.1e+002       53
   5     Bus5   1.051    4.23    1     Bus1        1      7.6 6.3e+002 1.4e+002
                                               -0.84        -0.75  -2.9e+002  -
2.6e+002
                                 4       Bus4       1.05         7.2 3.6e+002  -
1.7e+002
                                                  -2             0.2  -2.2e+002
23
                                 2     Bus2    0.922      -10 9.1e+002      -20
                                                 0.7     0.32 5.2e+002 2.4e+002
kp 0 kq 0  Iterations 4 dpmax 0.000006 dqmax 0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000006 dqmax 0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000006 dqmax 0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000006 dqmax 0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000006 dqmax 0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000006 dqmax 0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000006 dqmax 0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000006 dqmax 0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000006 dqmax 0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000006 dqmax 0.000000
--------------------------------------------------------------------------------
Time =   1.06000 Seconds
Intermediate results for Machines
GNo Name      Voltage Angle    Delta    Freq    Pgen    Qgen    Pmech   Efd/Slip
              pu      Degree   Degree   Hzs.    MW      MVAR    MW      pu/P.U.
--- -------- ------- -------- -------- ------- ------- ------- ------- --------
  1     Bus1        1      7.8     8.16      50     297     296     389     1.01
  3     Bus3     1.05     10.2     10.8      50     611    58.8     520     1.05
-----------------------------------------------------------------------------
```

```
Maximum rotor angle difference :    2.65295 b/w buses : 1 and 3
Island    1 Common system frequency   50.028
-------------------------------------------------------------------------------
Voltage (pu), Current (AMPS), impedance (PU) and power (MW-MVAR) for lines
From Name     Voltage Angle   To   Name     Voltage  Angle    Current  Angle
                                            Zl-real  Zl-im    P        Q
---- -------- ------- ------- ---- -------- -------- -------- ------- --------
   1     Bus1   1.000    7.80    5     Bus5     1.05      4.4 1.6e+004      -37
                                                0.68     0.67   3e+002   3e+002
   2     Bus2   0.922  -10.26    4     Bus4     1.05      7.4 5.8e+002 1.5e+002
                                                  -1        -0.39    -3e+002  -
1.1e+002
                                   5     Bus5     1.05      4.4 9.6e+002 1.5e+002
                                               -0.61          -0.2    -5e+002  -
1.7e+002
   3     Bus3   1.050   10.16    4     Bus4     1.05      7.4 1.9e+004      8.1
                                                0.83    0.029 5.3e+002       19
   4      Bus4    1.046     7.40     3      Bus3      1.05         10 8.5e+002  -
1.7e+002
                                               -0.83           0.011   -5.3e+002
6.8
                                   5     Bus5     1.05      4.4 3.7e+002       22
                                                 1.8    -0.49 2.2e+002      -59
                                   2     Bus2    0.922      -10   5e+002     -2.4
                                                 1.4     0.24 3.1e+002       53
   5     Bus5   1.051    4.44    1     Bus1        1      7.8 6.3e+002 1.4e+002
                                               -0.84        -0.74  -2.9e+002  -
2.6e+002
                                   4       Bus4       1.05         7.4 3.6e+002  -
1.7e+002
                                                  -2             0.2  -2.2e+002
23
                                   2     Bus2    0.922      -10 9.1e+002      -20
                                                 0.7     0.32 5.2e+002 2.4e+002
kp 0 kq 0  Iterations 4 dpmax 0.000006 dqmax  0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000005 dqmax  0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000005 dqmax  0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000005 dqmax  0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000005 dqmax  0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000005 dqmax  0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000005 dqmax  0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000005 dqmax  0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000005 dqmax  0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000005 dqmax  0.000000
-------------------------------------------------------------------------------
Time =   1.08000 Seconds
Intermediate results for Machines
GNo Name      Voltage Angle    Delta    Freq    Pgen    Qgen    Pmech   Efd/Slip
              pu      Degree   Degree   Hzs.    MW      MVAR    MW      pu/P.U.
--- -------- ------- -------- -------- ------- ------- ------- ------- --------
  1     Bus1       1     8.03      8.4      50     300     296     389     1.01
```

```
  3     Bus3    1.05     10.3       11      50     609    58.7     520     1.05
------------------------------------------------------------------------------
Maximum rotor angle difference :    2.58555 b/w buses : 1 and 3
Island    1 Common system frequency 50.028
------------------------------------------------------------------------------
Voltage (pu), Current (AMPS), impedance (PU) and power (MW-MVAR) for lines
From Name     Voltage Angle   To   Name     Voltage  Angle    Current  Angle
                                             Zl-real  Zl-im    P        Q
---- -------- ------- ------- ---- -------- -------- -------- -------- --------
   1     Bus1   1.000    8.03    5     Bus5     1.05      4.6 1.6e+004      -37
                                              0.68     0.67   3e+002   3e+002
   2     Bus2   0.922  -10.06    4     Bus4     1.05      7.6 5.8e+002 1.5e+002
                                                -1        -0.39    -3e+002  -
1.1e+002
                                   5     Bus5     1.05      4.6 9.6e+002 1.5e+002
                                             -0.61          -0.2    -5e+002  -
1.7e+002
   3     Bus3   1.050   10.33    4     Bus4     1.05      7.6 1.9e+004      8.3
                                              0.83    0.029 5.3e+002       19
   4      Bus4    1.046     7.58     3       Bus3      1.05         10 8.4e+002  -
1.7e+002
                                             -0.83           0.011   -5.3e+002
6.7
                                   5     Bus5     1.05      4.6 3.7e+002       23
                                                1.8    -0.49 2.2e+002      -59
                                   2     Bus2    0.922      -10   5e+002     -2.2
                                                1.4     0.24 3.1e+002       53
   5     Bus5   1.051    4.64    1     Bus1        1        8 6.3e+002 1.4e+002
                                             -0.84         -0.74    -3e+002  -
2.6e+002
                                   4        Bus4       1.05         7.6 3.5e+002  -
1.7e+002
                                                -2             0.2   -2.2e+002
23
                                   2     Bus2    0.922      -10 9.1e+002      -20
                                                0.7     0.32 5.2e+002 2.4e+002
kp 0 kq 0  Iterations 3 dpmax 0.000100 dqmax  0.000000
kp 0 kq 0  Iterations 3 dpmax 0.000099 dqmax  0.000000
kp 0 kq 0  Iterations 3 dpmax 0.000098 dqmax  0.000000
kp 0 kq 0  Iterations 3 dpmax 0.000097 dqmax  0.000000
kp 0 kq 0  Iterations 3 dpmax 0.000096 dqmax  0.000000
kp 0 kq 0  Iterations 3 dpmax 0.000095 dqmax  0.000000
kp 0 kq 0  Iterations 3 dpmax 0.000094 dqmax  0.000000
kp 0 kq 0  Iterations 3 dpmax 0.000093 dqmax  0.000000
kp 0 kq 0  Iterations 3 dpmax 0.000092 dqmax  0.000000
kp 0 kq 0  Iterations 3 dpmax 0.000091 dqmax  0.000000
------------------------------------------------------------------------------
Time =   1.10000 Seconds
Intermediate results for Machines
GNo Name     Voltage Angle    Delta    Freq    Pgen    Qgen    Pmech    Efd/Slip
             pu      Degree   Degree   Hzs.    MW      MVAR    MW       pu/P.U.
```

```
--- -------- ------- -------- -------- ------- ------- ------- ------- --------
  1     Bus1       1     8.28     8.65      50     303     295     389     1.01
  3     Bus3    1.05     10.5     11.1      50     606    58.5     520     1.05
------------------------------------------------------------------------------
Maximum rotor angle difference :    2.48602 b/w buses : 1 and 3
Island    1 Common system frequency   50.028
------------------------------------------------------------------------------
Voltage (pu), Current (AMPS), impedance (PU) and power (MW-MVAR) for lines
From Name     Voltage Angle   To   Name     Voltage  Angle    Current  Angle
                                              Zl-real  Zl-im    P        Q
---- -------- ------- ------- ---- -------- -------- -------- -------- --------
   1     Bus1   1.000    8.28    5     Bus5     1.05      4.8 1.6e+004      -36
                                              0.68     0.66   3e+002   3e+002
   2     Bus2   0.922   -9.87    4     Bus4     1.05      7.7 5.8e+002 1.5e+002
                                                -1        -0.39    -3e+002  -
1.1e+002
                                   5     Bus5     1.05      4.8 9.6e+002 1.5e+002
                                             -0.61          -0.2    -5e+002  -
1.6e+002
   3     Bus3   1.050   10.49    4     Bus4     1.05      7.7 1.9e+004      8.5
                                              0.84    0.029 5.3e+002       19
   4      Bus4    1.046     7.75     3      Bus3      1.05         10 8.4e+002  -
1.7e+002
                                            -0.83           0.011   -5.2e+002
6.6
                                   5     Bus5     1.05      4.8 3.6e+002       23
                                                1.9     -0.5 2.2e+002      -59
                                   2     Bus2    0.922     -9.9   5e+002       -2
                                                1.4     0.24 3.1e+002       52
   5     Bus5   1.051    4.85    1     Bus1        1      8.3 6.3e+002 1.4e+002
                                            -0.84         -0.73    -3e+002  -
2.6e+002
                                   4       Bus4       1.05         7.7 3.5e+002  -
1.7e+002
                                                -2             0.2   -2.2e+002
22
                                   2     Bus2    0.922     -9.9 9.1e+002      -20
                                                0.7     0.32 5.2e+002 2.4e+002
kp 0 kq 0  Iterations 3 dpmax 0.000090 dqmax 0.000000
kp 0 kq 0  Iterations 3 dpmax 0.000089 dqmax 0.000000
kp 0 kq 0  Iterations 3 dpmax 0.000088 dqmax 0.000000
kp 0 kq 0  Iterations 3 dpmax 0.000088 dqmax 0.000000
kp 0 kq 0  Iterations 3 dpmax 0.000087 dqmax 0.000000
kp 0 kq 0  Iterations 3 dpmax 0.000086 dqmax 0.000000
kp 0 kq 0  Iterations 3 dpmax 0.000085 dqmax 0.000000
kp 0 kq 0  Iterations 3 dpmax 0.000084 dqmax 0.000000
kp 0 kq 0  Iterations 3 dpmax 0.000083 dqmax 0.000000
kp 0 kq 0  Iterations 3 dpmax 0.000082 dqmax 0.000000
------------------------------------------------------------------------------
Time =    1.12000 Seconds
Intermediate results for Machines
```

```
GNo Name     Voltage Angle    Delta    Freq    Pgen    Qgen    Pmech   Efd/Slip
             pu      Degree   Degree   Hzs.    MW      MVAR    MW      pu/P.U.
--- -------- ------- -------- -------- ------- ------- ------- ------- --------
  1     Bus1       1     8.53     8.91      50     307     295     389      1.01
  3     Bus3    1.05     10.6     11.3      50     602    58.3     520      1.05
------------------------------------------------------------------------------
Maximum rotor angle difference :    2.35549 b/w buses : 1 and 3
Island    1 Common system frequency   50.028
------------------------------------------------------------------------------
Voltage (pu), Current (AMPS), impedance (PU) and power (MW-MVAR) for lines
From Name     Voltage Angle   To   Name     Voltage  Angle    Current  Angle
                                             Zl-real  Zl-im    P        Q
---- -------- ------- ------- ---- -------- -------- -------- -------- --------
   1     Bus1   1.000    8.53    5     Bus5     1.05      5.1 1.6e+004       -35
                                              0.68     0.65 3.1e+002   3e+002
   2     Bus2   0.923   -9.68    4     Bus4     1.05      7.9 5.7e+002 1.5e+002
                                                -1        -0.39    -3e+002  -
1.2e+002
                                   5     Bus5     1.05      5.1 9.6e+002 1.5e+002
                                             -0.61          -0.2    -5e+002  -
1.6e+002
   3     Bus3   1.050   10.63    4     Bus4     1.05      7.9 1.9e+004       8.6
                                              0.84     0.03 5.2e+002        18
   4      Bus4    1.046     7.91     3       Bus3      1.05         11 8.3e+002  -
1.7e+002
                                             -0.84            0.01   -5.2e+002
6.5
                                   5     Bus5     1.05      5.1 3.6e+002        23
                                               1.9    -0.52 2.2e+002       -59
                                   2     Bus2    0.923     -9.7 4.9e+002     -1.8
                                               1.4     0.24   3e+002        52
   5     Bus5   1.051    5.06    1     Bus1        1      8.5 6.4e+002 1.4e+002
                                             -0.84         -0.72    -3e+002  -
2.6e+002
                                   4        Bus4       1.05         7.9 3.4e+002  -
1.7e+002
                                                -2             0.2   -2.1e+002
21
                                   2     Bus2    0.923     -9.7 9.1e+002       -20
                                                0.7     0.32 5.2e+002 2.4e+002
kp 0 kq 0  Iterations 3 dpmax 0.000081 dqmax  0.000000
kp 0 kq 0  Iterations 3 dpmax 0.000080 dqmax  0.000000
kp 0 kq 0  Iterations 3 dpmax 0.000079 dqmax  0.000000
kp 0 kq 0  Iterations 3 dpmax 0.000078 dqmax  0.000000
kp 0 kq 0  Iterations 3 dpmax 0.000077 dqmax  0.000000
kp 0 kq 0  Iterations 3 dpmax 0.000077 dqmax  0.000000
kp 0 kq 0  Iterations 3 dpmax 0.000076 dqmax  0.000000
kp 0 kq 0  Iterations 3 dpmax 0.000075 dqmax  0.000000
kp 0 kq 0  Iterations 3 dpmax 0.000074 dqmax  0.000000
kp 0 kq 0  Iterations 3 dpmax 0.000073 dqmax  0.000000
------------------------------------------------------------------------------
```

```
Time =   1.14000 Seconds
Intermediate results for Machines
GNo Name     Voltage Angle    Delta    Freq    Pgen    Qgen    Pmech   Efd/Slip
             pu      Degree   Degree   Hzs.    MW      MVAR    MW      pu/P.U.
--- -------- ------- -------- -------- ------- ------- ------- ------- --------
  1     Bus1       1     8.81     9.19      50     312     295     389     1.01
  3     Bus3    1.05     10.8     11.4      50     597      58     520     1.05
------------------------------------------------------------------------------
Maximum rotor angle difference :    2.19543 b/w buses : 1 and 3
Island    1 Common system frequency   50.028
------------------------------------------------------------------------------
Voltage (pu), Current (AMPS), impedance (PU) and power (MW-MVAR) for lines
From Name     Voltage Angle   To   Name     Voltage  Angle    Current  Angle
                                              Zl-real  Zl-im    P        Q
---- -------- ------- ------- ---- -------- -------- -------- -------- --------
   1     Bus1   1.000    8.81    5     Bus5     1.05      5.3 1.7e+004       -35
                                              0.68     0.64 3.1e+002   3e+002
   2     Bus2   0.923   -9.48    4     Bus4     1.05      8.1 5.7e+002 1.5e+002
                                                -1         -0.39  -2.9e+002  -
1.2e+002
                                   5     Bus5     1.05      5.3 9.6e+002 1.5e+002
                                             -0.61          -0.2  -5.1e+002  -
1.6e+002
   3     Bus3   1.050   10.75    4     Bus4     1.05      8.1 1.9e+004       8.8
                                              0.85     0.03 5.2e+002        18
   4      Bus4    1.046     8.06     3      Bus3      1.05         11 8.2e+002  -
1.7e+002
                                             -0.85            0.01   -5.2e+002
6.3
                                   5     Bus5     1.05      5.3 3.5e+002        24
                                               1.9    -0.53 2.1e+002       -59
                                   2     Bus2    0.923     -9.5 4.9e+002     -1.7
                                               1.4     0.24   3e+002        52
   5     Bus5   1.051    5.27    1     Bus1        1      8.8 6.4e+002 1.5e+002
                                             -0.84          -0.7  -3.1e+002  -
2.6e+002
                                   4       Bus4       1.05         8.1 3.4e+002  -
1.7e+002
                                              -2.1             0.2  -2.1e+002
21
                                   2     Bus2    0.923     -9.5 9.1e+002       -19
                                                0.7     0.32 5.2e+002 2.4e+002
kp 0 kq 0 Iterations 3 dpmax 0.000072 dqmax 0.000000
kp 0 kq 0 Iterations 3 dpmax 0.000071 dqmax 0.000000
kp 0 kq 0 Iterations 3 dpmax 0.000071 dqmax 0.000000
kp 0 kq 0 Iterations 3 dpmax 0.000070 dqmax 0.000000
kp 0 kq 0 Iterations 3 dpmax 0.000069 dqmax 0.000000
kp 0 kq 0 Iterations 3 dpmax 0.000068 dqmax 0.000000
kp 0 kq 0 Iterations 3 dpmax 0.000067 dqmax 0.000000
kp 0 kq 0 Iterations 3 dpmax 0.000066 dqmax 0.000000
kp 0 kq 0 Iterations 3 dpmax 0.000066 dqmax 0.000000
```

```
kp 0 kq 0 Iterations 3 dpmax 0.000065 dqmax 0.000000
--------------------------------------------------------------------------------
Time =   1.16000 Seconds
Intermediate results for Machines
GNo Name     Voltage Angle    Delta    Freq    Pgen    Qgen    Pmech   Efd/Slip
             pu      Degree   Degree   Hzs.    MW      MVAR    MW      pu/P.U.
--- -------- ------- -------- -------- ------- ------- ------- ------- --------
  1     Bus1       1     9.09     9.48      50     318     295     389     1.01
  3     Bus3    1.05     10.9     11.5      50     591    57.7     520     1.05
--------------------------------------------------------------------------------
Maximum rotor angle difference :    2.00767 b/w buses : 1 and 3
Island    1 Common system frequency   50.028
--------------------------------------------------------------------------------
Voltage (pu), Current (AMPS), impedance (PU) and power (MW-MVAR) for lines
From Name     Voltage Angle   To   Name     Voltage  Angle    Current  Angle
                                              Zl-real  Zl-im    P        Q
---- -------- ------- ------- ---- -------- -------- -------- -------- --------
   1     Bus1   1.000    9.09    5     Bus5     1.05      5.5 1.7e+004       -34
                                              0.68     0.63 3.2e+002   3e+002
   2     Bus2   0.923   -9.29    4     Bus4     1.05      8.2 5.7e+002 1.5e+002
                                                -1         -0.39  -2.9e+002  -
1.2e+002
                                5     Bus5     1.05      5.5 9.6e+002 1.5e+002
                                             -0.61          -0.2  -5.1e+002  -
1.6e+002
   3     Bus3   1.050   10.87    4     Bus4     1.05      8.2 1.9e+004       8.9
                                              0.86     0.03 5.1e+002        18
   4      Bus4    1.046     8.21     3      Bus3      1.05         11 8.2e+002  -
1.7e+002
                                             -0.86             0.01   -5.1e+002
6
                                5     Bus5     1.05      5.5 3.4e+002        24
                                                2    -0.55 2.1e+002       -58
                                2     Bus2    0.923     -9.3 4.9e+002      -1.5
                                              1.4     0.24   3e+002        52
   5     Bus5   1.051    5.48    1     Bus1        1      9.1 6.5e+002 1.5e+002
                                             -0.84         -0.69  -3.1e+002  -
2.6e+002
                                4       Bus4       1.05         8.2 3.3e+002  -
1.7e+002
                                             -2.1              0.21   -2.1e+002
20
                                2     Bus2    0.923     -9.3 9.1e+002       -19
                                              0.7     0.32 5.2e+002 2.4e+002
kp 0 kq 0 Iterations 3 dpmax 0.000064 dqmax 0.000000
kp 0 kq 0 Iterations 3 dpmax 0.000063 dqmax 0.000000
kp 0 kq 0 Iterations 3 dpmax 0.000063 dqmax 0.000000
kp 0 kq 0 Iterations 3 dpmax 0.000062 dqmax 0.000000
kp 0 kq 0 Iterations 3 dpmax 0.000061 dqmax 0.000000
kp 0 kq 0 Iterations 3 dpmax 0.000060 dqmax 0.000000
kp 0 kq 0 Iterations 3 dpmax 0.000060 dqmax 0.000000
```

```
kp 0 kq 0 Iterations 3 dpmax 0.000059 dqmax 0.000000
kp 0 kq 0 Iterations 3 dpmax 0.000058 dqmax 0.000000
kp 0 kq 0 Iterations 3 dpmax 0.000057 dqmax 0.000000
--------------------------------------------------------------------------------
Time =   1.18000 Seconds
Intermediate results for Machines
GNo Name     Voltage Angle    Delta    Freq    Pgen    Qgen    Pmech   Efd/Slip
             pu      Degree   Degree   Hzs.    MW      MVAR    MW      pu/P.U.
--- -------- ------- -------- -------- ------- ------- ------- ------- --------
  1     Bus1       1     9.39     9.79      50     325     295     389     1.01
  3     Bus3    1.05       11     11.6      50     584    57.4     520     1.05
--------------------------------------------------------------------------------
Maximum rotor angle difference :    1.79436 b/w buses : 1 and 3
Island    1 Common system frequency   50.028
--------------------------------------------------------------------------------
Voltage (pu), Current (AMPS), impedance (PU) and power (MW-MVAR) for lines
From Name     Voltage Angle   To   Name     Voltage  Angle    Current  Angle
                                              Zl-real  Zl-im    P        Q
---- -------- ------- ------- ---- -------- -------- -------- -------- --------
   1     Bus1   1.000    9.39    5     Bus5     1.05      5.7 1.7e+004       -33
                                              0.67     0.61 3.2e+002   3e+002
   2     Bus2   0.923   -9.11    4     Bus4     1.05      8.3 5.7e+002 1.5e+002
                                                -1          -0.4  -2.9e+002  -
1.2e+002
                                   5     Bus5     1.05      5.7 9.7e+002 1.5e+002
                                             -0.61          -0.2  -5.1e+002  -
1.6e+002
   3     Bus3   1.050   10.97    4     Bus4     1.05      8.3 1.9e+004        9
                                              0.87     0.03   5e+002       17
   4      Bus4    1.046     8.34     3      Bus3      1.05         11    8e+002 -
1.7e+002
                                             -0.87   0.0099  -5e+002      5.7
                                   5     Bus5     1.05      5.7 3.3e+002       24
                                                 2    -0.58   2e+002       -58
                                   2     Bus2    0.923     -9.1 4.9e+002     -1.4
                                                 1.4     0.24   3e+002       52
   5     Bus5   1.051    5.69    1     Bus1        1      9.4 6.6e+002 1.5e+002
                                             -0.84         -0.67  -3.2e+002  -
2.6e+002
                                   4       Bus4       1.05         8.3 3.2e+002  -
1.7e+002
                                             -2.2     0.21  -2e+002       19
                                   2     Bus2    0.923     -9.1 9.1e+002      -19
                                                 0.7     0.32 5.2e+002 2.4e+002
kp 0 kq 0 Iterations 3 dpmax 0.000057 dqmax 0.000000
kp 0 kq 0 Iterations 3 dpmax 0.000056 dqmax 0.000000
kp 0 kq 0 Iterations 3 dpmax 0.000055 dqmax 0.000000
kp 0 kq 0 Iterations 3 dpmax 0.000055 dqmax 0.000000
kp 0 kq 0 Iterations 3 dpmax 0.000054 dqmax 0.000000
kp 0 kq 0 Iterations 3 dpmax 0.000053 dqmax 0.000000
kp 0 kq 0 Iterations 3 dpmax 0.000052 dqmax 0.000000
```

```
kp 0 kq 0 Iterations 3 dpmax 0.000052 dqmax 0.000000
kp 0 kq 0 Iterations 3 dpmax 0.000051 dqmax 0.000000
kp 0 kq 0 Iterations 3 dpmax 0.000051 dqmax 0.000000
--------------------------------------------------------------------------------
Time =   1.20000 Seconds
Intermediate results for Machines
GNo Name     Voltage Angle    Delta    Freq    Pgen    Qgen    Pmech   Efd/Slip
             pu      Degree   Degree   Hzs.    MW      MVAR    MW      pu/P.U.
--- -------- ------- -------- -------- ------- ------- ------- ------- --------
  1     Bus1       1      9.7     10.1      50     332     295     389     1.01
  3     Bus3    1.05     11.1     11.7      50     577    57.1     520     1.05
--------------------------------------------------------------------------------
Maximum rotor angle difference :    1.55793 b/w buses : 1 and 3
Island    1 Common system frequency   50.028
--------------------------------------------------------------------------------
Voltage (pu), Current (AMPS), impedance (PU) and power (MW-MVAR) for lines
From Name     Voltage Angle   To   Name     Voltage  Angle    Current  Angle
                                             Zl-real  Zl-im    P        Q
---- -------- ------- ------- ---- -------- -------- -------- -------- --------
   1     Bus1   1.000    9.70    5     Bus5     1.05      5.9 1.7e+004       -32
                                             0.67      0.6 3.3e+002   3e+002
   2     Bus2   0.923   -8.92    4     Bus4     1.05      8.5 5.7e+002 1.5e+002
                                               -1          -0.4  -2.9e+002  -
1.2e+002
                                  5     Bus5     1.05      5.9 9.7e+002 1.5e+002
                                            -0.61          -0.2  -5.1e+002  -
1.6e+002
   3     Bus3   1.050   11.06    4     Bus4     1.05      8.5 1.8e+004       9.1
                                             0.89     0.03   5e+002        17
   4      Bus4    1.046     8.47     3       Bus3      1.05         11 7.9e+002  -
1.7e+002
                                            -0.88   0.0095  -5e+002       5.3
                                  5     Bus5     1.05      5.9 3.2e+002        25
                                              2.1    -0.61 1.9e+002       -57
                                  2     Bus2    0.923     -8.9 4.9e+002      -1.3
                                              1.4     0.24   3e+002        52
   5     Bus5   1.051    5.91    1     Bus1        1      9.7 6.6e+002 1.5e+002
                                            -0.84         -0.65  -3.3e+002  -
2.6e+002
                                  4       Bus4       1.05         8.5 3.1e+002  -
1.7e+002
                                            -2.3             0.21   -1.9e+002
18
                                  2     Bus2    0.923     -8.9 9.1e+002       -19
                                              0.7     0.32 5.2e+002 2.4e+002
kp 0 kq 0 Iterations 3 dpmax 0.000050 dqmax 0.000000
kp 0 kq 0 Iterations 3 dpmax 0.000049 dqmax 0.000000
kp 0 kq 0 Iterations 3 dpmax 0.000049 dqmax 0.000000
kp 0 kq 0 Iterations 3 dpmax 0.000048 dqmax 0.000000
kp 0 kq 0 Iterations 3 dpmax 0.000047 dqmax 0.000000
kp 0 kq 0 Iterations 3 dpmax 0.000047 dqmax 0.000000
```

```
kp 0 kq 0 Iterations 3 dpmax 0.000046 dqmax 0.000000
kp 0 kq 0 Iterations 3 dpmax 0.000046 dqmax 0.000000
kp 0 kq 0 Iterations 3 dpmax 0.000045 dqmax 0.000000
kp 0 kq 0 Iterations 3 dpmax 0.000045 dqmax 0.000000
--------------------------------------------------------------------------------
Time =   1.22000 Seconds
Intermediate results for Machines
GNo Name     Voltage Angle    Delta    Freq    Pgen    Qgen    Pmech   Efd/Slip
             pu      Degree   Degree   Hzs.    MW      MVAR    MW      pu/P.U.
--- -------- ------- -------- -------- ------- ------- ------- ------- --------
  1     Bus1       1       10     10.4      50     340     295     389     1.01
  3     Bus3    1.05     11.1     11.7      50     569    56.7     520     1.05
--------------------------------------------------------------------------------
Maximum rotor angle difference :    1.30111 b/w buses : 1 and 3
Island    1 Common system frequency   50.028
--------------------------------------------------------------------------------
Voltage (pu), Current (AMPS), impedance (PU) and power (MW-MVAR) for lines
From Name     Voltage Angle   To   Name     Voltage  Angle    Current  Angle
                                              Zl-real  Zl-im    P        Q
---- -------- ------- ------- ---- -------- -------- -------- -------- --------
   1     Bus1   1.000   10.02    5     Bus5     1.05      6.1 1.7e+004       -31
                                              0.67     0.58 3.4e+002   3e+002
   2     Bus2   0.923   -8.73    4     Bus4     1.05      8.6 5.7e+002 1.5e+002
                                                -1          -0.4  -2.9e+002  -
1.2e+002
                                5     Bus5     1.05      6.1 9.7e+002 1.5e+002
                                             -0.61         -0.19  -5.1e+002  -
1.6e+002
   3     Bus3   1.050   11.14    4     Bus4     1.05      8.6 1.8e+004       9.2
                                               0.9    0.031 4.9e+002        17
   4      Bus4    1.046     8.60     3       Bus3      1.05         11 7.8e+002  -
1.7e+002
                                             -0.9          0.0091   -4.9e+002
4.9
                                5     Bus5     1.05      6.1 3.1e+002        25
                                               2.1    -0.65 1.9e+002       -57
                                2     Bus2    0.923     -8.7 4.9e+002     -1.1
                                               1.4     0.24   3e+002        52
   5     Bus5   1.051    6.13    1     Bus1        1       10 6.7e+002 1.5e+002
                                             -0.83         -0.63  -3.4e+002  -
2.5e+002
                                4       Bus4       1.05         8.6    3e+002 -
1.7e+002
                                             -2.4             0.21   -1.9e+002
16
                                2     Bus2    0.923     -8.7 9.2e+002       -18
                                               0.7     0.32 5.2e+002 2.4e+002
kp 0 kq 0 Iterations 3 dpmax 0.000044 dqmax 0.000000
kp 0 kq 0 Iterations 3 dpmax 0.000044 dqmax 0.000000
kp 0 kq 0 Iterations 3 dpmax 0.000043 dqmax 0.000000
kp 0 kq 0 Iterations 3 dpmax 0.000042 dqmax 0.000000
```

```
kp 0 kq 0 Iterations 3 dpmax 0.000042 dqmax 0.000000
kp 0 kq 0 Iterations 3 dpmax 0.000041 dqmax 0.000000
kp 0 kq 0 Iterations 3 dpmax 0.000041 dqmax 0.000000
kp 0 kq 0 Iterations 3 dpmax 0.000040 dqmax 0.000000
kp 0 kq 0 Iterations 3 dpmax 0.000040 dqmax 0.000000
kp 0 kq 0 Iterations 3 dpmax 0.000040 dqmax 0.000000
--------------------------------------------------------------------------------
Time =   1.24000 Seconds
Intermediate results for Machines
GNo Name     Voltage Angle    Delta    Freq    Pgen    Qgen    Pmech   Efd/Slip
             pu      Degree   Degree   Hzs.    MW      MVAR    MW      pu/P.U.
--- -------- ------- -------- -------- ------- ------- ------- ------- --------
  1     Bus1       1     10.3     10.8      50     349     295     389     1.01
  3     Bus3    1.05     11.2     11.8      50     560    56.4     520     1.05
--------------------------------------------------------------------------------
Maximum rotor angle difference :    1.02684 b/w buses : 1 and 3
Island    1 Common system frequency   50.028
--------------------------------------------------------------------------------
Voltage (pu), Current (AMPS), impedance (PU) and power (MW-MVAR) for lines
From Name     Voltage Angle   To   Name     Voltage  Angle    Current  Angle
                                              Zl-real  Zl-im    P        Q
---- -------- ------- ------- ---- -------- -------- -------- -------- --------
   1     Bus1   1.000   10.34    5     Bus5     1.05      6.3 1.8e+004      -30
                                              0.67     0.57 3.5e+002   3e+002
   2     Bus2   0.923   -8.55    4     Bus4     1.05      8.7 5.7e+002 1.5e+002
                                                -1        -0.41  -2.9e+002  -
1.2e+002
                                   5     Bus5     1.05      6.3 9.7e+002 1.5e+002
                                             -0.61        -0.19  -5.1e+002  -
1.6e+002
   3     Bus3   1.050   11.21    4     Bus4     1.05      8.7 1.8e+004      9.2
                                              0.92    0.031 4.8e+002       16
   4      Bus4    1.046     8.72     3      Bus3      1.05         11 7.7e+002  -
1.7e+002
                                            -0.91          0.0085   -4.8e+002
4.5
                                   5     Bus5     1.05      6.3   3e+002       26
                                               2.2     -0.7 1.8e+002      -56
                                   2     Bus2    0.923     -8.5 4.9e+002       -1
                                               1.4     0.24   3e+002       51
   5     Bus5   1.051    6.35    1     Bus1        1       10 6.8e+002 1.5e+002
                                             -0.83        -0.61  -3.5e+002  -
2.5e+002
                                   4       Bus4       1.05         8.7 2.8e+002  -
1.7e+002
                                            -2.5             0.21   -1.8e+002
15
                                   2     Bus2    0.923     -8.5 9.2e+002      -18
                                               0.7     0.32 5.2e+002 2.4e+002
kp 0 kq 0 Iterations 3 dpmax 0.000039 dqmax 0.000000
kp 0 kq 0 Iterations 3 dpmax 0.000039 dqmax 0.000000
```

```
kp 0 kq 0 Iterations 3 dpmax 0.000038 dqmax 0.000000
kp 0 kq 0 Iterations 3 dpmax 0.000038 dqmax 0.000000
kp 0 kq 0 Iterations 3 dpmax 0.000037 dqmax 0.000000
kp 0 kq 0 Iterations 3 dpmax 0.000037 dqmax 0.000000
kp 0 kq 0 Iterations 3 dpmax 0.000037 dqmax 0.000000
kp 0 kq 0 Iterations 3 dpmax 0.000036 dqmax 0.000000
kp 0 kq 0 Iterations 3 dpmax 0.000036 dqmax 0.000000
kp 0 kq 0 Iterations 3 dpmax 0.000036 dqmax 0.000000
--------------------------------------------------------------------------------
Time =   1.26000 Seconds
Intermediate results for Machines
GNo Name     Voltage Angle    Delta    Freq    Pgen    Qgen    Pmech   Efd/Slip
             pu      Degree   Degree   Hzs.    MW      MVAR    MW      pu/P.U.
--- -------- ------- -------- -------- ------- ------- ------- ------- --------
  1     Bus1       1     10.7     11.1      50     358     295     389     1.01
  3     Bus3    1.05     11.3     11.9      50     551    56.2     520     1.05
--------------------------------------------------------------------------------
Maximum rotor angle difference :    0.73828 b/w buses : 1 and 3
Island    1 Common system frequency   50.028
--------------------------------------------------------------------------------
Voltage (pu), Current (AMPS), impedance (PU) and power (MW-MVAR) for lines
From Name     Voltage Angle   To   Name     Voltage  Angle    Current  Angle
                                            Zl-real  Zl-im    P        Q
---- -------- ------- ------- ---- -------- -------- -------- -------- -------
   1     Bus1   1.000   10.67    5     Bus5     1.05      6.6 1.8e+004      -29
                                             0.67     0.55 3.6e+002   3e+002
   2     Bus2   0.923   -8.36    4     Bus4     1.05      8.8 5.7e+002 1.5e+002
                                               -1        -0.41  -2.9e+002  -
1.2e+002
                                5     Bus5     1.05      6.6 9.7e+002 1.5e+002
                                            -0.61        -0.19  -5.1e+002  -
1.6e+002
   3     Bus3   1.050   11.28    4     Bus4     1.05      8.8 1.7e+004      9.3
                                             0.94    0.032 4.7e+002       16
   4      Bus4    1.046     8.83     3      Bus3      1.05         11 7.5e+002  -
1.7e+002
                                            -0.93         0.0078   -4.7e+002
3.9
                                5     Bus5     1.05      6.6 2.9e+002       27
                                              2.3    -0.75 1.7e+002      -55
                                2     Bus2    0.923     -8.4 4.8e+002    -0.91
                                              1.4     0.24   3e+002       51
   5     Bus5   1.051    6.56    1     Bus1        1       11 6.9e+002 1.5e+002
                                            -0.83        -0.59  -3.5e+002  -
2.5e+002
                                4       Bus4       1.05         8.8 2.7e+002  -
1.7e+002
                                            -2.6            0.21   -1.7e+002
14
                                2     Bus2    0.923     -8.4 9.2e+002      -18
                                              0.7     0.32 5.3e+002 2.4e+002
```

```
kp 0 kq 0  Iterations 3 dpmax 0.000035 dqmax 0.000000
kp 0 kq 0  Iterations 3 dpmax 0.000035 dqmax 0.000000
kp 0 kq 0  Iterations 3 dpmax 0.000034 dqmax 0.000000
kp 0 kq 0  Iterations 3 dpmax 0.000034 dqmax 0.000000
kp 0 kq 0  Iterations 3 dpmax 0.000034 dqmax 0.000000
kp 0 kq 0  Iterations 3 dpmax 0.000034 dqmax 0.000000
kp 0 kq 0  Iterations 3 dpmax 0.000033 dqmax 0.000000
kp 0 kq 0  Iterations 3 dpmax 0.000033 dqmax 0.000000
kp 0 kq 0  Iterations 3 dpmax 0.000033 dqmax 0.000000
kp 0 kq 0  Iterations 3 dpmax 0.000032 dqmax 0.000000
--------------------------------------------------------------------------------
Time =   1.28000 Seconds
Intermediate results for Machines
GNo Name     Voltage Angle    Delta    Freq    Pgen    Qgen    Pmech   Efd/Slip
             pu      Degree   Degree   Hzs.    MW      MVAR    MW      pu/P.U.
--- -------- ------- -------- -------- ------- ------- ------- ------- --------
  1     Bus1       1       11     11.5      50     368     295     389     1.01
  3     Bus3    1.05     11.3     11.9      50     541    55.9     520     1.05
--------------------------------------------------------------------------------
Maximum rotor angle difference :    0.43876 b/w buses : 1 and 3
Island    1 Common system frequency   50.028
--------------------------------------------------------------------------------
Voltage (pu), Current (AMPS), impedance (PU) and power (MW-MVAR) for lines
From Name     Voltage Angle   To   Name     Voltage  Angle    Current  Angle
                                              Zl-real  Zl-im    P        Q
---- -------- ------- ------- ---- -------- -------- -------- -------- --------
   1     Bus1   1.000   11.01    5     Bus5     1.05      6.8 1.8e+004      -28
                                              0.66     0.53 3.7e+002   3e+002
   2     Bus2   0.923   -8.18    4     Bus4     1.05      8.9 5.7e+002 1.5e+002
                                                -1        -0.42  -2.9e+002  -
1.2e+002
                                5     Bus5     1.05      6.8 9.7e+002 1.5e+002
                                             -0.61        -0.19  -5.1e+002  -
1.6e+002
   3     Bus3   1.050   11.34    4     Bus4     1.05      8.9 1.7e+004      9.4
                                              0.96    0.033 4.6e+002       16
   4      Bus4    1.046     8.94     3      Bus3      1.05         11 7.4e+002  -
1.7e+002
                                             -0.95           0.007   -4.6e+002
3.4
                                5     Bus5     1.05      6.8 2.7e+002       27
                                               2.4    -0.81 1.6e+002      -54
                                2     Bus2    0.923     -8.2 4.8e+002    -0.79
                                               1.4     0.25   3e+002       51
   5     Bus5   1.051    6.78    1     Bus1        1       11   7e+002 1.5e+002
                                             -0.82        -0.57  -3.6e+002  -
2.5e+002
                                4       Bus4       1.05         8.9 2.6e+002  -
1.7e+002
                                             -2.7             0.2  -1.6e+002
12
```

```
                                    2     Bus2    0.923     -8.2 9.2e+002      -18
                                                  0.7     0.32 5.3e+002 2.4e+002
kp 0 kq 0  Iterations 3 dpmax 0.000032 dqmax 0.000000
kp 0 kq 0  Iterations 3 dpmax 0.000032 dqmax 0.000000
kp 0 kq 0  Iterations 3 dpmax 0.000032 dqmax 0.000000
kp 0 kq 0  Iterations 3 dpmax 0.000032 dqmax 0.000000
kp 0 kq 0  Iterations 3 dpmax 0.000031 dqmax 0.000000
kp 0 kq 0  Iterations 3 dpmax 0.000031 dqmax 0.000000
kp 0 kq 0  Iterations 3 dpmax 0.000031 dqmax 0.000000
kp 0 kq 0  Iterations 3 dpmax 0.000031 dqmax 0.000000
kp 0 kq 0  Iterations 3 dpmax 0.000031 dqmax 0.000000
kp 0 kq 0  Iterations 3 dpmax 0.000031 dqmax 0.000000
--------------------------------------------------------------------------------
Time =   1.30000 Seconds
Intermediate results for Machines
GNo Name     Voltage Angle    Delta    Freq    Pgen    Qgen    Pmech   Efd/Slip
             pu      Degree   Degree   Hzs.    MW      MVAR    MW      pu/P.U.
--- -------- ------- -------- -------- ------- ------- ------- ------- --------
  1     Bus1       1     11.4     11.8      50     378     295     389      1.01
  3     Bus3    1.05     11.4       12      50     531    55.7     520      1.05
--------------------------------------------------------------------------------
Maximum rotor angle difference :    0.13172 b/w buses : 1 and 3
Island    1 Common system frequency   50.028
--------------------------------------------------------------------------------
Voltage (pu), Current (AMPS), impedance (PU) and power (MW-MVAR) for lines
From Name     Voltage Angle   To   Name     Voltage  Angle    Current  Angle
                                              Zl-real  Zl-im    P        Q
---- -------- ------- ------- ---- -------- -------- -------- -------- --------
   1     Bus1   1.000   11.35    5     Bus5     1.05        7 1.8e+004      -27
                                              0.66     0.51 3.8e+002   3e+002
   2     Bus2   0.923   -8.00    4     Bus4     1.05        9 5.6e+002 1.5e+002
                                                -1        -0.42  -2.9e+002  -
1.2e+002
                                    5     Bus5     1.05        7 9.8e+002 1.5e+002
                                              -0.6        -0.19  -5.1e+002  -
1.6e+002
   3     Bus3   1.050   11.39    4     Bus4     1.05        9 1.7e+004      9.4
                                              0.98    0.034 4.5e+002       16
   4      Bus4    1.046     9.05     3      Bus3      1.05         11 7.2e+002  -
1.7e+002
                                             -0.97           0.006   -4.5e+002
2.8
                                    5     Bus5     1.05        7 2.6e+002       28
                                                2.5    -0.88 1.5e+002      -54
                                    2     Bus2    0.923       -8 4.8e+002    -0.69
                                                1.4     0.25   3e+002       51
   5     Bus5   1.051    7.01    1     Bus1        1       11 7.2e+002 1.5e+002
                                             -0.82        -0.54  -3.7e+002  -
2.5e+002
                                    4       Bus4       1.05           9 2.5e+002  -
1.7e+002
```

```
                                                 -2.9              0.2  -1.5e+002
11
                                2     Bus2    0.923       -8 9.2e+002      -17
                                                 0.69     0.31 5.3e+002 2.4e+002
kp 0 kq 0  Iterations 3 dpmax 0.000030 dqmax  0.000000
kp 0 kq 0  Iterations 3 dpmax 0.000030 dqmax  0.000000
kp 0 kq 0  Iterations 3 dpmax 0.000030 dqmax  0.000000
kp 0 kq 0  Iterations 3 dpmax 0.000030 dqmax  0.000000
kp 0 kq 0  Iterations 3 dpmax 0.000030 dqmax  0.000000
kp 0 kq 0  Iterations 3 dpmax 0.000030 dqmax  0.000000
kp 0 kq 0  Iterations 3 dpmax 0.000030 dqmax  0.000000
kp 0 kq 0  Iterations 3 dpmax 0.000030 dqmax  0.000000
kp 0 kq 0  Iterations 3 dpmax 0.000030 dqmax  0.000000
kp 0 kq 0  Iterations 3 dpmax 0.000030 dqmax  0.000000
------------------------------------------------------------------------------
Time =   1.32000 Seconds
Intermediate results for Machines
GNo Name     Voltage Angle    Delta    Freq     Pgen     Qgen     Pmech    Efd/Slip
             pu      Degree   Degree   Hzs.     MW       MVAR     MW       pu/P.U.
--- -------- ------- -------- -------- ------- ------- ------- ------- --------
  1     Bus1       1      11.7     12.2      50     388     295     389     1.01
  3     Bus3    1.05      11.4       12      50     521    55.6     520     1.05
---------------------------------------------------------------------------
Maximum rotor angle difference :    0.17928 b/w buses : 1 and 3
Island    1 Common system frequency   50.028
------------------------------------------------------------------------------
Voltage (pu), Current (AMPS), impedance (PU) and power (MW-MVAR) for lines
From Name     Voltage Angle   To   Name     Voltage  Angle    Current  Angle
                                            Zl-real  Zl-im    P        Q
---- -------- ------- ------- ---- -------- -------- -------- -------- --------
   1     Bus1   1.000   11.70    5     Bus5     1.05      7.2 1.9e+004      -26
                                                0.65      0.5 3.9e+002   3e+002
   2     Bus2   0.923   -7.81    4     Bus4     1.05      9.2 5.6e+002 1.5e+002
                                                  -1        -0.42  -2.9e+002   -
1.2e+002
                                 5     Bus5     1.05      7.2 9.8e+002 1.5e+002
                                                -0.6        -0.19  -5.1e+002   -
1.6e+002
   3     Bus3   1.050   11.45    4     Bus4     1.05      9.2 1.6e+004      9.4
                                                   1    0.035 4.4e+002       16
   4      Bus4    1.046     9.15     3      Bus3     1.05        11   7e+002 -
1.7e+002
                                                  -1         0.0047   -4.4e+002
2.1
                                 5     Bus5     1.05      7.2 2.5e+002       29
                                                 2.7    -0.97 1.5e+002      -53
                                 2     Bus2    0.923     -7.8 4.8e+002    -0.58
                                                 1.4     0.25 2.9e+002       51
   5     Bus5   1.050    7.23    1     Bus1        1       12 7.3e+002 1.5e+002
                                               -0.81        -0.52  -3.8e+002   -
2.5e+002
```

```
                                    4        Bus4        1.05          9.2 2.3e+002  -
1.7e+002
                                                           -3             0.19   -1.4e+002
9.3
                                    2      Bus2     0.923      -7.8 9.2e+002       -17
                                                      0.69      0.31 5.3e+002 2.4e+002
kp 0 kq 0  Iterations 3 dpmax 0.000030 dqmax  0.000000
kp 0 kq 0  Iterations 3 dpmax 0.000030 dqmax  0.000000
kp 0 kq 0  Iterations 3 dpmax 0.000030 dqmax  0.000000
kp 0 kq 0  Iterations 3 dpmax 0.000030 dqmax  0.000000
kp 0 kq 0  Iterations 3 dpmax 0.000030 dqmax  0.000000
kp 0 kq 0  Iterations 3 dpmax 0.000030 dqmax  0.000000
kp 0 kq 0  Iterations 3 dpmax 0.000030 dqmax  0.000000
kp 0 kq 0  Iterations 3 dpmax 0.000030 dqmax  0.000000
kp 0 kq 0  Iterations 3 dpmax 0.000030 dqmax  0.000000
kp 0 kq 0  Iterations 3 dpmax 0.000030 dqmax  0.000000
------------------------------------------------------------------------------
Time =   1.34000 Seconds
Intermediate results for Machines
GNo Name     Voltage Angle    Delta    Freq     Pgen     Qgen     Pmech    Efd/Slip
             pu      Degree   Degree   Hzs.     MW       MVAR     MW       pu/P.U.
--- -------- ------- -------- -------- ------- ------- ------- ------- --------
  1     Bus1       1       12     12.5      50     398     296     389     1.01
  3     Bus3    1.05     11.5       12      50     511    55.5     520     1.05
---------------------------------------------------------------------------
Maximum rotor angle difference :    0.49066 b/w buses : 1 and 3
Island    1 Common system frequency   50.028
------------------------------------------------------------------------------
Voltage (pu), Current (AMPS), impedance (PU) and power (MW-MVAR) for lines
From Name     Voltage Angle   To   Name     Voltage  Angle    Current  Angle
                                            Zl-real  Zl-im    P        Q
---- -------- ------- ------- ---- -------- -------- -------- -------- --------
   1     Bus1   1.000   12.04    5     Bus5     1.05      7.4 1.9e+004      -25
                                                0.65     0.48   4e+002   3e+002
   2     Bus2   0.923   -7.63    4     Bus4     1.05      9.3 5.6e+002 1.5e+002
                                                  -1        -0.43  -2.8e+002  -
1.2e+002
                                 5     Bus5     1.05      7.4 9.8e+002 1.6e+002
                                                -0.6        -0.19  -5.2e+002  -
1.6e+002
   3     Bus3   1.050   11.50    4     Bus4     1.05      9.3 1.6e+004      9.4
                                                   1    0.037 4.3e+002       15
   4      Bus4    1.046     9.26     3      Bus3      1.05        12 6.9e+002  -
1.7e+002
                                                  -1         0.0033   -4.3e+002
1.4
                                 5     Bus5     1.05      7.4 2.3e+002       30
                                                 2.8     -1.1 1.4e+002      -52
                                 2     Bus2    0.923     -7.6 4.8e+002    -0.47
                                                 1.4     0.25 2.9e+002       50
   5     Bus5   1.050    7.45    1     Bus1        1       12 7.4e+002 1.6e+002
```

```
                                                    -0.8          -0.5  -3.9e+002  -
2.5e+002
                                  4       Bus4       1.05         9.3 2.2e+002  -
1.7e+002
                                                    -3.2            0.19  -1.4e+002
7.8
                                  2     Bus2    0.923     -7.6 9.3e+002      -17
                                                     0.69     0.31 5.3e+002 2.4e+002
kp 0 kq 0  Iterations 3 dpmax 0.000030 dqmax 0.000000
kp 0 kq 0  Iterations 3 dpmax 0.000030 dqmax 0.000000
kp 0 kq 0  Iterations 3 dpmax 0.000030 dqmax 0.000000
kp 0 kq 0  Iterations 3 dpmax 0.000030 dqmax 0.000000
kp 0 kq 0  Iterations 3 dpmax 0.000030 dqmax 0.000000
kp 0 kq 0  Iterations 3 dpmax 0.000031 dqmax 0.000000
kp 0 kq 0  Iterations 3 dpmax 0.000031 dqmax 0.000000
kp 0 kq 0  Iterations 3 dpmax 0.000031 dqmax 0.000000
kp 0 kq 0  Iterations 3 dpmax 0.000031 dqmax 0.000000
kp 0 kq 0  Iterations 3 dpmax 0.000031 dqmax 0.000000
--------------------------------------------------------------------------------
Time =   1.36000 Seconds
Intermediate results for Machines
GNo Name     Voltage Angle    Delta    Freq    Pgen    Qgen    Pmech   Efd/Slip
             pu      Degree   Degree   Hzs.    MW      MVAR    MW      pu/P.U.
--- -------- ------- -------- -------- ------- ------- ------- ------- --------
  1     Bus1       1     12.4     12.9      50     408     296     389     1.01
  3     Bus3    1.05     11.6     12.1      50     501    55.4     520     1.05
--------------------------------------------------------------------------------
Maximum rotor angle difference :    0.79882 b/w buses : 1 and 3
Island    1 Common system frequency   50.028
--------------------------------------------------------------------------------
Voltage (pu), Current (AMPS), impedance (PU) and power (MW-MVAR) for lines
From Name     Voltage Angle   To   Name     Voltage  Angle    Current  Angle
                                              Zl-real  Zl-im    P        Q
---- -------- ------- ------- ---- -------- -------- -------- -------- --------
   1     Bus1   1.000   12.38    5     Bus5     1.05      7.7 1.9e+004       -24
                                                 0.64     0.47 4.1e+002    3e+002
   2     Bus2   0.923   -7.45    4     Bus4     1.05      9.4 5.6e+002 1.5e+002
                                                   -1         -0.43  -2.8e+002  -
1.2e+002
                                  5     Bus5     1.05      7.7 9.8e+002 1.6e+002
                                                 -0.6         -0.19  -5.2e+002  -
1.6e+002
   3     Bus3   1.050   11.56    4     Bus4     1.05      9.4 1.5e+004       9.5
                                                    1    0.038 4.2e+002        15
   4      Bus4    1.046     9.37     3      Bus3      1.05         12 6.7e+002  -
1.7e+002
                                                   -1          0.0017   -4.2e+002
0.69
                                  5     Bus5     1.05      7.7 2.2e+002        31
                                                    3     -1.2 1.3e+002       -51
                                  2     Bus2    0.923     -7.4 4.7e+002      0.37
```

```
                                                    1.5     0.25 2.9e+002       50
   5     Bus5   1.050    7.67    1     Bus1         1       12 7.5e+002 1.6e+002
                                                   -0.8      -0.48    -4e+002  -
2.5e+002
                                   4       Bus4       1.05         9.4    2e+002 -
1.7e+002
                                                   -3.5             0.17   -1.3e+002
6.3
                                   2     Bus2    0.923     -7.4 9.3e+002      -17
                                                    0.69     0.31 5.3e+002 2.4e+002
kp 0 kq 0 Iterations 3 dpmax 0.000031 dqmax 0.000000
kp 0 kq 0 Iterations 3 dpmax 0.000032 dqmax 0.000000
kp 0 kq 0 Iterations 3 dpmax 0.000032 dqmax 0.000000
kp 0 kq 0 Iterations 3 dpmax 0.000032 dqmax 0.000000
kp 0 kq 0 Iterations 3 dpmax 0.000032 dqmax 0.000000
kp 0 kq 0 Iterations 3 dpmax 0.000033 dqmax 0.000000
kp 0 kq 0 Iterations 3 dpmax 0.000033 dqmax 0.000000
kp 0 kq 0 Iterations 3 dpmax 0.000033 dqmax 0.000000
kp 0 kq 0 Iterations 3 dpmax 0.000033 dqmax 0.000000
kp 0 kq 0 Iterations 3 dpmax 0.000034 dqmax 0.000000
--------------------------------------------------------------------------------
Time =   1.38000 Seconds
Intermediate results for Machines
GNo Name     Voltage Angle    Delta    Freq    Pgen    Qgen    Pmech   Efd/Slip
             pu      Degree   Degree   Hzs.    MW      MVAR    MW      pu/P.U.
--- -------- ------- -------- -------- ------- ------- ------- ------- --------
  1     Bus1       1     12.7     13.2      50     417     296     389      1.01
  3     Bus3    1.05     11.6     12.1      50     492    55.4     520      1.05
--------------------------------------------------------------------------------
Maximum rotor angle difference :    1.10018 b/w buses : 1 and 3
Island    1 Common system frequency   50.028
--------------------------------------------------------------------------------
Voltage (pu), Current (AMPS), impedance (PU) and power (MW-MVAR) for lines
From Name     Voltage Angle   To   Name     Voltage  Angle    Current  Angle
                                              Zl-real  Zl-im    P        Q
---- -------- ------- ------- ---- -------- -------- -------- -------- --------
   1     Bus1   1.000   12.72    5     Bus5     1.05      7.9   2e+004      -23
                                                 0.64     0.45 4.2e+002   3e+002
   2     Bus2   0.923   -7.26    4     Bus4     1.05      9.5 5.6e+002 1.5e+002
                                                   -1        -0.44  -2.8e+002  -
1.2e+002
                                   5     Bus5     1.05      7.9 9.8e+002 1.6e+002
                                                 -0.6        -0.18  -5.2e+002  -
1.6e+002
   3     Bus3   1.050   11.62    4     Bus4     1.05      9.5 1.5e+004      9.5
                                                  1.1     0.04 4.1e+002       15
   4      Bus4    1.046     9.48     3      Bus3      1.05         12 6.6e+002 -
1.7e+002
                                                 -1.1  -0.00011  -4.1e+002      -
0.048
                                   5     Bus5     1.05      7.9 2.1e+002       32
```

```
                                                    3.1     -1.3 1.2e+002      -50
                                  2     Bus2    0.923     -7.3 4.7e+002    -0.26
                                                    1.5     0.25 2.9e+002       50
   5     Bus5   1.050    7.89    1     Bus1        1       13 7.6e+002 1.6e+002
                                                  -0.79        -0.47  -4.1e+002  -
2.4e+002
                                  4       Bus4       1.05         9.5 1.9e+002  -
1.7e+002
                                                   -3.7            0.15   -1.2e+002
4.9
                                  2     Bus2    0.923     -7.3 9.3e+002      -16
                                                   0.69     0.31 5.3e+002 2.4e+002
kp 0 kq 0  Iterations 3 dpmax 0.000034 dqmax 0.000000
kp 0 kq 0  Iterations 3 dpmax 0.000034 dqmax 0.000000
kp 0 kq 0  Iterations 3 dpmax 0.000035 dqmax 0.000000
kp 0 kq 0  Iterations 3 dpmax 0.000035 dqmax 0.000000
kp 0 kq 0  Iterations 3 dpmax 0.000035 dqmax 0.000000
kp 0 kq 0  Iterations 3 dpmax 0.000036 dqmax 0.000000
kp 0 kq 0  Iterations 3 dpmax 0.000036 dqmax 0.000000
kp 0 kq 0  Iterations 3 dpmax 0.000036 dqmax 0.000000
kp 0 kq 0  Iterations 3 dpmax 0.000037 dqmax 0.000000
kp 0 kq 0  Iterations 3 dpmax 0.000037 dqmax 0.000000
--------------------------------------------------------------------------------
Time =   1.40000 Seconds
Intermediate results for Machines
GNo Name     Voltage Angle    Delta    Freq    Pgen    Qgen    Pmech   Efd/Slip
             pu      Degree   Degree   Hzs.    MW      MVAR    MW      pu/P.U.
--- -------- ------- -------- -------- ------- ------- ------- ------- --------
  1     Bus1       1     13.1     13.6      50     427     297     389      1.01
  3     Bus3    1.05     11.7     12.2      50     482    55.5     520      1.05
--------------------------------------------------------------------------------
Maximum rotor angle difference :    1.39127 b/w buses : 1 and 3
Island    1 Common system frequency   50.028
--------------------------------------------------------------------------------
Voltage (pu), Current (AMPS), impedance (PU) and power (MW-MVAR) for lines
From Name     Voltage Angle   To   Name     Voltage  Angle    Current  Angle
                                              Zl-real  Zl-im    P        Q
---- -------- ------- ------- ---- -------- -------- -------- -------- --------
   1     Bus1   1.000   13.06    5     Bus5     1.05      8.1   2e+004      -22
                                                 0.63     0.44 4.3e+002   3e+002
   2     Bus2   0.923   -7.08    4     Bus4     1.05      9.6 5.6e+002 1.5e+002
                                                   -1        -0.44  -2.8e+002  -
1.2e+002
                                  5     Bus5     1.05      8.1 9.8e+002 1.6e+002
                                                 -0.6        -0.18  -5.2e+002  -
1.6e+002
   3     Bus3   1.050   11.68    4     Bus4     1.05      9.6 1.5e+004      9.5
                                                  1.1    0.042   4e+002       15
   4      Bus4    1.046     9.59     3      Bus3      1.05         12 6.4e+002  -
1.7e+002
                                                 -1.1  -0.0021  -4e+002    -0.78
```

```
                                   5      Bus5     1.05      8.1 1.9e+002       33
                                                    3.3     -1.5 1.1e+002      -49
                                   2      Bus2    0.923     -7.1 4.7e+002    -0.15
                                                    1.5     0.25 2.9e+002       50
   5      Bus5    1.050    8.11    1      Bus1        1       13 7.8e+002 1.6e+002
                                                  -0.79         -0.45  -4.2e+002  -
2.4e+002
                                   4        Bus4        1.05         9.6 1.8e+002  -
1.7e+002
                                                     -4             0.13   -1.1e+002
3.6
                                   2      Bus2    0.923     -7.1 9.3e+002      -16
                                                   0.69     0.31 5.3e+002 2.4e+002
kp 0 kq 0  Iterations 3 dpmax 0.000038 dqmax  0.000000
kp 0 kq 0  Iterations 3 dpmax 0.000038 dqmax  0.000000
kp 0 kq 0  Iterations 3 dpmax 0.000038 dqmax  0.000000
kp 0 kq 0  Iterations 3 dpmax 0.000039 dqmax  0.000000
kp 0 kq 0  Iterations 3 dpmax 0.000039 dqmax  0.000000
kp 0 kq 0  Iterations 3 dpmax 0.000040 dqmax  0.000000
kp 0 kq 0  Iterations 3 dpmax 0.000040 dqmax  0.000000
kp 0 kq 0  Iterations 3 dpmax 0.000041 dqmax  0.000000
kp 0 kq 0  Iterations 3 dpmax 0.000041 dqmax  0.000000
kp 0 kq 0  Iterations 3 dpmax 0.000042 dqmax  0.000000
------------------------------------------------------------------------------
Time =   1.42000 Seconds
Intermediate results for Machines
GNo Name     Voltage Angle    Delta    Freq    Pgen    Qgen    Pmech   Efd/Slip
             pu      Degree   Degree   Hzs.    MW      MVAR    MW      pu/P.U.
--- -------- ------- -------- -------- ------- ------- ------- ------- --------
  1     Bus1       1     13.4     13.9      50     436     297     389     1.01
  3     Bus3    1.05     11.7     12.2      50     473    55.6     520     1.05
------------------------------------------------------------------------------
Maximum rotor angle difference :    1.66870 b/w buses : 1 and 3
Island    1 Common system frequency   50.028
------------------------------------------------------------------------------
Voltage (pu), Current (AMPS), impedance (PU) and power (MW-MVAR) for lines
From Name     Voltage Angle   To   Name     Voltage  Angle    Current  Angle
                                              Zl-real  Zl-im    P        Q
---- -------- ------- ------- ---- -------- -------- -------- -------- -------
   1     Bus1   1.000   13.38    5     Bus5     1.05      8.3   2e+004      -21
                                              0.63     0.43 4.4e+002   3e+002
   2     Bus2   0.923   -6.90    4     Bus4     1.05      9.7 5.5e+002 1.5e+002
                                                -1         -0.44  -2.8e+002  -
1.2e+002
                                   5     Bus5     1.05      8.3 9.9e+002 1.6e+002
                                              -0.6         -0.18  -5.2e+002  -
1.6e+002
   3     Bus3   1.050   11.75    4     Bus4     1.05      9.7 1.4e+004      9.5
                                               1.1    0.044 3.9e+002       16
   4      Bus4    1.046     9.70     3      Bus3      1.05         12 6.3e+002  -
1.7e+002
```

```
                                                    -1.1   -0.0043 -3.9e+002       -
1.5
                                5     Bus5     1.05      8.3 1.8e+002       35
                                                 3.5     -1.6   1e+002       -48
                                2     Bus2    0.923     -6.9 4.7e+002   -0.036
                                                 1.5     0.25 2.9e+002       50
   5     Bus5   1.050    8.33    1     Bus1        1       13 7.9e+002 1.6e+002
                                                -0.78         -0.44  -4.3e+002  -
2.4e+002
                                4        Bus4       1.05         9.7 1.6e+002  -
1.7e+002
                                                -4.3    0.094  -1e+002      2.3
                                2     Bus2    0.923     -6.9 9.3e+002      -16
                                                0.69     0.31 5.3e+002 2.4e+002
kp 0 kq 0  Iterations 3 dpmax 0.000042 dqmax  0.000000
kp 0 kq 0  Iterations 3 dpmax 0.000043 dqmax  0.000000
kp 0 kq 0  Iterations 3 dpmax 0.000043 dqmax  0.000000
kp 0 kq 0  Iterations 3 dpmax 0.000044 dqmax  0.000000
kp 0 kq 0  Iterations 3 dpmax 0.000044 dqmax  0.000000
kp 0 kq 0  Iterations 3 dpmax 0.000045 dqmax  0.000000
kp 0 kq 0  Iterations 3 dpmax 0.000045 dqmax  0.000000
kp 0 kq 0  Iterations 3 dpmax 0.000046 dqmax  0.000000
kp 0 kq 0  Iterations 3 dpmax 0.000046 dqmax  0.000000
kp 0 kq 0  Iterations 3 dpmax 0.000047 dqmax  0.000000
------------------------------------------------------------------------------
Time =   1.44000 Seconds
Intermediate results for Machines
GNo Name     Voltage Angle    Delta    Freq    Pgen    Qgen    Pmech   Efd/Slip
             pu      Degree   Degree   Hzs.    MW      MVAR    MW      pu/P.U.
--- -------- ------- -------- -------- ------- ------- ------- ------- --------
  1     Bus1       1     13.7     14.2      50     444     297     389     1.01
  3     Bus3    1.05     11.8     12.3      50     465    55.7     520     1.05
------------------------------------------------------------------------------
Maximum rotor angle difference :    1.92926 b/w buses : 1 and 3
Island    1 Common system frequency   50.028
------------------------------------------------------------------------------
Voltage (pu), Current (AMPS), impedance (PU) and power (MW-MVAR) for lines
From Name     Voltage Angle   To   Name     Voltage  Angle    Current  Angle
                                              Zl-real  Zl-im    P        Q
---- -------- ------- ------- ---- -------- -------- -------- -------- --------
   1     Bus1   1.000   13.70    5     Bus5     1.05      8.5 2.1e+004       -20
                                              0.62     0.42 4.4e+002   3e+002
   2     Bus2   0.923   -6.71    4     Bus4     1.05      9.8 5.5e+002 1.5e+002
                                                -1         -0.45  -2.8e+002  -
1.2e+002
                                5     Bus5     1.05      8.5 9.9e+002 1.6e+002
                                                -0.6         -0.18  -5.2e+002  -
1.6e+002
   3     Bus3   1.050   11.82    4     Bus4     1.05      9.8 1.4e+004       9.5
                                               1.1    0.047 3.8e+002        16
```

```
   4      Bus4    1.046     9.82     3       Bus3      1.05         12 6.1e+002  -
1.7e+002
                                                 -1.1   -0.0066 -3.8e+002       -
2.2
                                5     Bus5     1.05      8.5 1.7e+002       36
                                                3.7     -1.8       96      -47
                                2     Bus2    0.923     -6.7 4.7e+002    0.082
                                                1.5     0.25 2.9e+002       49
   5     Bus5   1.050    8.54    1     Bus1        1       14   8e+002 1.6e+002
                                               -0.77        -0.42  -4.4e+002  -
2.4e+002
                                4       Bus4       1.05         9.8 1.5e+002  -
1.7e+002
                                                -4.6     0.05      -96        1
                                2     Bus2    0.923     -6.7 9.4e+002      -16
                                                0.69     0.31 5.4e+002 2.4e+002
kp 0 kq 0  Iterations 3 dpmax 0.000048 dqmax  0.000000
kp 0 kq 0  Iterations 3 dpmax 0.000048 dqmax  0.000000
kp 0 kq 0  Iterations 3 dpmax 0.000049 dqmax  0.000000
kp 0 kq 0  Iterations 3 dpmax 0.000050 dqmax  0.000000
kp 0 kq 0  Iterations 3 dpmax 0.000050 dqmax  0.000000
kp 0 kq 0  Iterations 3 dpmax 0.000051 dqmax  0.000000
kp 0 kq 0  Iterations 3 dpmax 0.000051 dqmax  0.000000
kp 0 kq 0  Iterations 3 dpmax 0.000052 dqmax  0.000000
kp 0 kq 0  Iterations 3 dpmax 0.000053 dqmax  0.000000
kp 0 kq 0  Iterations 3 dpmax 0.000053 dqmax  0.000000
--------------------------------------------------------------------------------
Time =   1.46000 Seconds
Intermediate results for Machines
GNo Name     Voltage Angle    Delta    Freq    Pgen    Qgen    Pmech   Efd/Slip
             pu      Degree   Degree   Hzs.    MW      MVAR    MW      pu/P.U.
--- -------- ------- -------- -------- ------- ------- ------- ------- --------
  1     Bus1       1        14     14.6      50     452     298     389     1.01
  3     Bus3    1.05      11.9     12.4      50     457    55.8     520     1.05
--------------------------------------------------------------------------------
Maximum rotor angle difference :    2.16992 b/w buses : 1 and 3
Island    1 Common system frequency   50.028
--------------------------------------------------------------------------------
Voltage (pu), Current (AMPS), impedance (PU) and power (MW-MVAR) for lines
From Name     Voltage Angle   To   Name     Voltage  Angle    Current  Angle
                                              Zl-real  Zl-im    P        Q
---- -------- ------- ------- ---- -------- -------- -------- -------- --------
   1     Bus1   1.000   14.02    5     Bus5     1.05      8.8 2.1e+004      -19
                                               0.62     0.41 4.5e+002   3e+002
   2     Bus2   0.923   -6.53    4     Bus4     1.05      9.9 5.5e+002 1.5e+002
                                                 -1        -0.45  -2.8e+002  -
1.2e+002
                                5     Bus5     1.05      8.8 9.9e+002 1.6e+002
                                               -0.6        -0.18  -5.2e+002  -
1.6e+002
   3     Bus3   1.050   11.91    4     Bus4     1.05      9.9 1.4e+004      9.5
```

```
                                                    1.2    0.049 3.8e+002       16
   4      Bus4    1.046     9.95     3      Bus3      1.05        12    6e+002 -
1.7e+002
                                                   -1.2    -0.009 -3.8e+002       -
2.9
                                5     Bus5     1.05      8.8 1.6e+002       37
                                                    3.9       -2       89       -46
                                2     Bus2    0.923     -6.5 4.7e+002       0.2
                                                    1.5     0.25 2.9e+002       49
   5     Bus5   1.050    8.76    1     Bus1        1       14 8.1e+002 1.6e+002
                                                  -0.77        -0.41  -4.5e+002  -
2.4e+002
                                4       Bus4       1.05         9.9 1.4e+002  -
1.7e+002
                                                   -4.9  -0.0044      -89   -0.079
                                2     Bus2    0.923     -6.5 9.4e+002       -15
                                                    0.69     0.31 5.4e+002 2.4e+002
kp 0 kq 0  Iterations 3 dpmax 0.000054 dqmax  0.000000
kp 0 kq 0  Iterations 3 dpmax 0.000055 dqmax  0.000000
kp 0 kq 0  Iterations 3 dpmax 0.000055 dqmax  0.000000
kp 0 kq 0  Iterations 3 dpmax 0.000056 dqmax  0.000000
kp 0 kq 0  Iterations 3 dpmax 0.000057 dqmax  0.000000
kp 0 kq 0  Iterations 3 dpmax 0.000058 dqmax  0.000000
kp 0 kq 0  Iterations 3 dpmax 0.000058 dqmax  0.000000
kp 0 kq 0  Iterations 3 dpmax 0.000059 dqmax  0.000000
kp 0 kq 0  Iterations 3 dpmax 0.000060 dqmax  0.000000
kp 0 kq 0  Iterations 3 dpmax 0.000061 dqmax  0.000000
--------------------------------------------------------------------------------
Time =   1.48000 Seconds
Intermediate results for Machines
GNo Name     Voltage Angle    Delta    Freq    Pgen    Qgen    Pmech   Efd/Slip
             pu      Degree   Degree   Hzs.    MW      MVAR    MW      pu/P.U.
--- -------- ------- -------- -------- ------- ------- ------- ------- --------
  1     Bus1       1     14.3     14.9      50     459     298     389      1.01
  3     Bus3    1.05       12     12.5      50     450      56     520      1.05
--------------------------------------------------------------------------------
Maximum rotor angle difference :    2.38789 b/w buses : 1 and 3
Island    1 Common system frequency   50.028
--------------------------------------------------------------------------------
Voltage (pu), Current (AMPS), impedance (PU) and power (MW-MVAR) for lines
From Name     Voltage Angle   To   Name     Voltage  Angle    Current  Angle
                                              Zl-real  Zl-im    P        Q
---- -------- ------- ------- ---- -------- -------- -------- -------- --------
   1     Bus1   1.000   14.32    5     Bus5     1.05        9 2.1e+004       -19
                                                    0.61      0.4 4.6e+002   3e+002
   2     Bus2   0.923   -6.34    4     Bus4     1.05       10 5.5e+002 1.5e+002
                                                      -1        -0.46  -2.8e+002  -
1.2e+002
                                5     Bus5     1.05        9 9.9e+002 1.6e+002
                                                    -0.6         -0.18  -5.2e+002
 1.6e+002
```

```
   3     Bus3   1.050   12.01    4     Bus4     1.05       10 1.4e+004      9.5
                                                 1.2    0.051 3.7e+002       16
   4      Bus4    1.046    10.08     3      Bus3      1.05         12 5.9e+002  -
1.7e+002
                                               -1.2    -0.011 -3.7e+002       -
3.5
                                5     Bus5     1.05        9 1.5e+002       39
                                                 4     -2.2       83      -46
                                2     Bus2    0.923     -6.3 4.6e+002     0.33
                                               1.5     0.26 2.9e+002       49
   5     Bus5   1.050    8.97    1     Bus1        1       14 8.2e+002 1.6e+002
                                            -0.76          -0.4  -4.5e+002  -
2.4e+002
                                4       Bus4       1.05          10 1.3e+002  -
1.7e+002
                                               -5.3    -0.07      -83     -1.1
                                2     Bus2    0.923     -6.3 9.4e+002      -15
                                               0.68      0.3 5.4e+002 2.4e+002
kp 0 kq 0  Iterations 3 dpmax 0.000061 dqmax 0.000000
kp 0 kq 0  Iterations 3 dpmax 0.000062 dqmax 0.000000
kp 0 kq 0  Iterations 3 dpmax 0.000063 dqmax 0.000000
kp 0 kq 0  Iterations 3 dpmax 0.000064 dqmax 0.000000
kp 0 kq 0  Iterations 3 dpmax 0.000064 dqmax 0.000000
kp 0 kq 0  Iterations 3 dpmax 0.000065 dqmax 0.000000
kp 0 kq 0  Iterations 3 dpmax 0.000066 dqmax 0.000000
kp 0 kq 0  Iterations 3 dpmax 0.000067 dqmax 0.000000
kp 0 kq 0  Iterations 3 dpmax 0.000068 dqmax 0.000000
kp 0 kq 0  Iterations 3 dpmax 0.000069 dqmax 0.000000
--------------------------------------------------------------------------------
Time =   1.50000 Seconds
Intermediate results for Machines
GNo Name     Voltage Angle    Delta    Freq    Pgen    Qgen    Pmech   Efd/Slip
             pu      Degree   Degree   Hzs.    MW      MVAR    MW      pu/P.U.
--- -------- ------- -------- -------- ------- ------- ------- ------- --------
  1     Bus1       1     14.6     15.2      50     465     299     389      1.01
  3     Bus3    1.05     12.1     12.6      50     444    56.1     520      1.05
--------------------------------------------------------------------------------
Maximum rotor angle difference :    2.58063 b/w buses : 1 and 3
Island    1 Common system frequency   50.028
--------------------------------------------------------------------------------
Voltage (pu), Current (AMPS), impedance (PU) and power (MW-MVAR) for lines
From Name     Voltage Angle   To   Name     Voltage  Angle    Current  Angle
                                              Zl-real  Zl-im    P        Q
---- -------- ------- ------- ---- -------- -------- -------- -------- --------
   1     Bus1   1.000   14.61    5     Bus5     1.05      9.2 2.1e+004      -18
                                               0.61     0.39 4.7e+002   3e+002
   2     Bus2   0.923   -6.15    4     Bus4     1.05       10 5.5e+002 1.5e+002
                                                 -1        -0.46  -2.8e+002  -
1.2e+002
                                5     Bus5     1.05      9.2 9.9e+002 1.6e+002
```

```
                                                    -0.6         -0.18  -5.2e+002  -
1.6e+002
   3     Bus3   1.050   12.11    4     Bus4     1.05       10 1.3e+004       9.6
                                                   1.2    0.054 3.6e+002        16
   4      Bus4    1.046    10.22     3       Bus3      1.05         12 5.8e+002  -
1.7e+002
                                                    -1.2    -0.014 -3.6e+002       -
4.1
                                  5     Bus5     1.05      9.2 1.4e+002        40
                                                   4.2     -2.4       78       -45
                                  2     Bus2    0.923     -6.1 4.6e+002      0.47
                                                   1.5     0.26 2.9e+002        49
   5     Bus5   1.050    9.19    1     Bus1        1       15 8.3e+002 1.6e+002
                                                 -0.76         -0.39  -4.6e+002  -
2.4e+002
                                  4       Bus4       1.05          10 1.2e+002  -
1.7e+002
                                                    -5.7    -0.15      -78       -2
                                  2     Bus2    0.923     -6.1 9.4e+002      -15
                                                   0.68      0.3 5.4e+002 2.4e+002
kp 0 kq 0  Iterations 3 dpmax 0.000069 dqmax  0.000000
kp 0 kq 0  Iterations 3 dpmax 0.000070 dqmax  0.000000
kp 0 kq 0  Iterations 3 dpmax 0.000071 dqmax  0.000000
kp 0 kq 0  Iterations 3 dpmax 0.000072 dqmax  0.000000
kp 0 kq 0  Iterations 3 dpmax 0.000073 dqmax  0.000000
kp 0 kq 0  Iterations 3 dpmax 0.000074 dqmax  0.000000
kp 0 kq 0  Iterations 3 dpmax 0.000074 dqmax  0.000000
kp 0 kq 0  Iterations 3 dpmax 0.000075 dqmax  0.000000
kp 0 kq 0  Iterations 3 dpmax 0.000076 dqmax  0.000000
kp 0 kq 0  Iterations 3 dpmax 0.000077 dqmax  0.000000
------------------------------------------------------------------------------
Time =   1.52000 Seconds
Intermediate results for Machines
GNo Name     Voltage Angle    Delta    Freq    Pgen    Qgen    Pmech   Efd/Slip
             pu      Degree   Degree   Hzs.    MW      MVAR    MW      pu/P.U.
--- -------- ------- -------- -------- ------- ------- ------- ------- --------
  1     Bus1       1     14.9     15.4      50     471     299     389     1.01
  3     Bus3    1.05     12.2     12.7      50     438    56.3     520     1.05
------------------------------------------------------------------------------
Maximum rotor angle difference :    2.74589 b/w buses : 1 and 3
Island    1 Common system frequency   50.028
------------------------------------------------------------------------------
Voltage (pu), Current (AMPS), impedance (PU) and power (MW-MVAR) for lines
From Name     Voltage Angle   To   Name     Voltage  Angle    Current  Angle
                                              Zl-real  Zl-im    P        Q
---- -------- ------- ------- ---- -------- -------- -------- -------- --------
   1     Bus1   1.000   14.88    5     Bus5     1.05      9.4 2.1e+004       -18
                                                   0.61     0.38 4.7e+002   3e+002
   2     Bus2   0.923   -5.96    4     Bus4     1.05       10 5.5e+002 1.5e+002
                                                     -1        -0.46  -2.8e+002  -
1.2e+002
```

```
                                  5     Bus5     1.05      9.4 9.9e+002 1.6e+002
                                                -0.6        -0.18  -5.2e+002  -
1.6e+002
   3     Bus3   1.050   12.23    4     Bus4     1.05       10 1.3e+004      9.6
                                                 1.2    0.056 3.6e+002       16
   4      Bus4    1.046    10.37     3       Bus3       1.05         12 5.7e+002  -
1.7e+002
                                                -1.2    -0.016 -3.6e+002       -
4.6
                                  5     Bus5     1.05      9.4 1.4e+002       42
                                                 4.4     -2.7       73      -44
                                  2     Bus2    0.923       -6 4.6e+002     0.62
                                                 1.5     0.26 2.8e+002       49
   5     Bus5   1.050    9.40    1     Bus1        1        15 8.3e+002 1.6e+002
                                               -0.75        -0.38  -4.7e+002  -
2.4e+002
                                  4       Bus4       1.05          10 1.2e+002  -
1.7e+002
                                                   -6    -0.23      -73     -2.8
                                  2     Bus2    0.923       -6 9.4e+002      -15
                                                0.68       0.3 5.4e+002 2.4e+002
kp 0 kq 0  Iterations 3 dpmax 0.000078 dqmax 0.000000
kp 0 kq 0  Iterations 3 dpmax 0.000079 dqmax 0.000000
kp 0 kq 0  Iterations 3 dpmax 0.000080 dqmax 0.000000
kp 0 kq 0  Iterations 3 dpmax 0.000081 dqmax 0.000000
kp 0 kq 0  Iterations 3 dpmax 0.000082 dqmax 0.000000
kp 0 kq 0  Iterations 3 dpmax 0.000083 dqmax 0.000000
kp 0 kq 0  Iterations 3 dpmax 0.000083 dqmax 0.000000
kp 0 kq 0  Iterations 3 dpmax 0.000084 dqmax 0.000000
kp 0 kq 0  Iterations 3 dpmax 0.000085 dqmax 0.000000
kp 0 kq 0  Iterations 3 dpmax 0.000086 dqmax 0.000000
--------------------------------------------------------------------------------
Time =   1.54000 Seconds
Intermediate results for Machines
GNo Name     Voltage Angle    Delta    Freq    Pgen    Qgen    Pmech   Efd/Slip
             pu      Degree   Degree   Hzs.    MW      MVAR    MW      pu/P.U.
--- -------- ------- -------- -------- ------- ------- ------- ------- --------
  1     Bus1       1     15.1     15.7      50     475     299     389     1.01
  3     Bus3    1.05     12.4     12.8      50     434    56.4     520     1.05
--------------------------------------------------------------------------------
Maximum rotor angle difference :    2.88173 b/w buses : 1 and 3
Island    1 Common system frequency   50.028
--------------------------------------------------------------------------------
Voltage (pu), Current (AMPS), impedance (PU) and power (MW-MVAR) for lines
From Name     Voltage Angle   To   Name     Voltage  Angle    Current  Angle
                                              Zl-real  Zl-im    P        Q
---- -------- ------- ------- ---- -------- -------- -------- -------- --------
   1     Bus1   1.000   15.15    5     Bus5     1.05      9.6 2.2e+004      -17
                                                 0.6     0.38 4.8e+002   3e+002
   2     Bus2   0.922   -5.77    4     Bus4     1.05       11 5.5e+002 1.5e+002
```

```
                                                    -1         -0.46  -2.8e+002  -
1.2e+002
                                5     Bus5     1.05      9.6 9.9e+002 1.6e+002
                                                  -0.6         -0.18  -5.2e+002  -
1.6e+002
   3     Bus3   1.050   12.37    4     Bus4     1.05       11 1.3e+004      9.7
                                                   1.2    0.058 3.5e+002       16
   4      Bus4    1.046    10.53     3      Bus3      1.05         12 5.6e+002  -
1.7e+002
                                                  -1.2   -0.018 -3.5e+002        -
5
                                5     Bus5     1.05      9.6 1.3e+002       43
                                                   4.5     -2.9       69      -44
                                2     Bus2    0.922     -5.8 4.6e+002     0.77
                                                   1.5     0.26 2.8e+002       49
   5     Bus5   1.050    9.60    1     Bus1        1       15 8.4e+002 1.6e+002
                                                 -0.75         -0.38  -4.7e+002  -
2.4e+002
                                4       Bus4       1.05          11 1.1e+002  -
1.7e+002
                                                  -6.4    -0.31      -69     -3.4
                                2     Bus2    0.922     -5.8 9.4e+002      -14
                                                  0.68      0.3 5.4e+002 2.4e+002
kp 0 kq 0  Iterations 3 dpmax 0.000088 dqmax  0.000002
kp 0 kq 0  Iterations 3 dpmax 0.000088 dqmax  0.000000
kp 0 kq 0  Iterations 3 dpmax 0.000089 dqmax  0.000000
kp 0 kq 0  Iterations 3 dpmax 0.000090 dqmax  0.000001
kp 0 kq 0  Iterations 3 dpmax 0.000091 dqmax  0.000000
kp 0 kq 0  Iterations 3 dpmax 0.000092 dqmax  0.000000
kp 0 kq 0  Iterations 3 dpmax 0.000093 dqmax  0.000001
kp 0 kq 0  Iterations 3 dpmax 0.000094 dqmax  0.000000
kp 0 kq 0  Iterations 3 dpmax 0.000095 dqmax  0.000000
kp 0 kq 0  Iterations 3 dpmax 0.000096 dqmax  0.000000
------------------------------------------------------------------------------
Time =   1.56000 Seconds
Intermediate results for Machines
GNo Name     Voltage Angle    Delta    Freq    Pgen    Qgen    Pmech   Efd/Slip
             pu      Degree   Degree   Hzs.    MW      MVAR    MW      pu/P.U.
--- -------- ------- -------- -------- ------- ------- ------- ------- --------
  1     Bus1       1     15.4       16      50     478     299     389      1.01
  3     Bus3    1.05     12.5       13      50     430    56.5     520      1.05
------------------------------------------------------------------------------
Maximum rotor angle difference :    2.98657 b/w buses : 1 and 3
Island    1 Common system frequency   50.028
------------------------------------------------------------------------------
Voltage (pu), Current (AMPS), impedance (PU) and power (MW-MVAR) for lines
From Name     Voltage Angle   To   Name     Voltage  Angle    Current  Angle
                                              Zl-real  Zl-im    P        Q
---- -------- ------- ------- ---- -------- -------- -------- -------- --------
  1     Bus1   1.000   15.39    5     Bus5     1.05      9.8 2.2e+004      -17
                                                   0.6     0.38 4.8e+002 3e+002
```

```
   2     Bus2   0.922   -5.58    4     Bus4     1.05       11 5.5e+002 1.5e+002
                                                 -1        -0.46  -2.8e+002  -
1.2e+002
                                  5     Bus5     1.05      9.8 9.9e+002 1.6e+002
                                                -0.6        -0.18  -5.2e+002  -
1.6e+002
   3     Bus3   1.050   12.52    4     Bus4     1.05       11 1.3e+004      9.8
                                                 1.3    0.059 3.5e+002       17
   4      Bus4    1.046    10.70     3      Bus3      1.05         13 5.6e+002 -
1.7e+002
                                                -1.3    -0.019 -3.5e+002       -
5.4
                                  5     Bus5     1.05      9.8 1.3e+002       44
                                                 4.6       -3       66      -43
                                  2     Bus2    0.922     -5.6 4.6e+002     0.93
                                                 1.5     0.26 2.8e+002       49
   5     Bus5   1.050    9.81    1     Bus1        1       15 8.4e+002 1.6e+002
                                               -0.75        -0.37  -4.7e+002  -
2.4e+002
                                  4       Bus4       1.05          11 1.1e+002  -
1.7e+002
                                                -6.6    -0.39      -66     -3.9
                                  2     Bus2    0.922     -5.6 9.4e+002      -14
                                                0.68      0.3 5.4e+002 2.4e+002
kp 0 kq 0  Iterations 3 dpmax 0.000097 dqmax  0.000000
kp 0 kq 0  Iterations 3 dpmax 0.000098 dqmax  0.000000
kp 0 kq 0  Iterations 3 dpmax 0.000099 dqmax  0.000000
kp 0 kq 0  Iterations 3 dpmax 0.000100 dqmax  0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000005 dqmax  0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000005 dqmax  0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000005 dqmax  0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000005 dqmax  0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000005 dqmax  0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000005 dqmax  0.000000
--------------------------------------------------------------------------------
Time =   1.58000 Seconds
Intermediate results for Machines
GNo Name     Voltage Angle    Delta    Freq    Pgen    Qgen    Pmech   Efd/Slip
             pu      Degree   Degree   Hzs.    MW      MVAR    MW      pu/P.U.
--- -------- ------- -------- -------- ------- ------- ------- ------- --------
  1     Bus1       1     15.6     16.2      50     481     300     389     1.01
  3     Bus3    1.05     12.7     13.1      50     428    56.6     520     1.05
--------------------------------------------------------------------------------
Maximum rotor angle difference :    3.05917 b/w buses : 1 and 3
Island    1 Common system frequency   50.028
--------------------------------------------------------------------------------
Voltage (pu), Current (AMPS), impedance (PU) and power (MW-MVAR) for lines
From Name     Voltage Angle   To   Name     Voltage  Angle    Current  Angle
                                              Zl-real  Zl-im    P        Q
---- -------- ------- ------- ---- -------- -------- -------- -------- --------
  1     Bus1   1.000   15.63    5     Bus5     1.05       10 2.2e+004      -16
```

```
                                                    0.6     0.37 4.8e+002   3e+002
   2     Bus2   0.922   -5.38    4     Bus4     1.05       11 5.5e+002 1.5e+002
                                                   -1        -0.47  -2.7e+002  -
1.2e+002
                                  5     Bus5     1.05       10 9.9e+002 1.6e+002
                                                 -0.6        -0.18  -5.2e+002  -
1.6e+002
   3     Bus3   1.050   12.68    4     Bus4     1.05       11 1.3e+004      9.9
                                                  1.3     0.06 3.5e+002       17
   4      Bus4    1.046    10.87     3      Bus3      1.05         13 5.6e+002  -
1.7e+002
                                                 -1.3     -0.02 -3.5e+002       -
5.6
                                  5     Bus5     1.05       10 1.2e+002       45
                                                  4.7     -3.2       64      -43
                                  2     Bus2    0.922     -5.4 4.6e+002      1.1
                                                  1.5     0.26 2.8e+002       49
   5     Bus5   1.050   10.01    1     Bus1        1       16 8.5e+002 1.6e+002
                                                -0.74        -0.37  -4.8e+002  -
2.4e+002
                                  4       Bus4       1.05          11    1e+002  -
1.7e+002
                                                 -6.9    -0.45      -64     -4.2
                                  2     Bus2    0.922     -5.4 9.4e+002      -14
                                                 0.68      0.3 5.4e+002 2.4e+002
kp 0 kq 0 Iterations 4 dpmax 0.000005 dqmax 0.000000
kp 0 kq 0 Iterations 4 dpmax 0.000005 dqmax 0.000000
kp 0 kq 0 Iterations 4 dpmax 0.000005 dqmax 0.000000
kp 0 kq 0 Iterations 4 dpmax 0.000006 dqmax 0.000000
kp 0 kq 0 Iterations 4 dpmax 0.000006 dqmax 0.000000
kp 0 kq 0 Iterations 4 dpmax 0.000006 dqmax 0.000000
kp 0 kq 0 Iterations 4 dpmax 0.000006 dqmax 0.000000
kp 0 kq 0 Iterations 4 dpmax 0.000006 dqmax 0.000000
kp 0 kq 0 Iterations 4 dpmax 0.000006 dqmax 0.000000
kp 0 kq 0 Iterations 4 dpmax 0.000006 dqmax 0.000000
--------------------------------------------------------------------------------
Time =   1.60000 Seconds
Intermediate results for Machines
GNo Name     Voltage Angle    Delta    Freq    Pgen    Qgen    Pmech   Efd/Slip
             pu      Degree   Degree   Hzs.    MW      MVAR    MW      pu/P.U.
--- -------- ------- -------- -------- ------- ------- ------- ------- --------
  1     Bus1       1     15.8     16.4      50     482     300     389      1.01
  3     Bus3    1.05     12.9     13.3      50     426    56.6     520      1.05
--------------------------------------------------------------------------------
Maximum rotor angle difference :    3.09866 b/w buses : 1 and 3
Island    1 Common system frequency   50.028
--------------------------------------------------------------------------------
Voltage (pu), Current (AMPS), impedance (PU) and power (MW-MVAR) for lines
From Name     Voltage Angle   To   Name     Voltage  Angle    Current  Angle
                                             Zl-real  Zl-im    P        Q
---- -------- ------- ------- ---- -------- -------- -------- -------- --------
```

```
   1     Bus1   1.000   15.85    5     Bus5     1.05       10 2.2e+004      -16
                                                 0.6     0.37 4.8e+002   3e+002
   2     Bus2   0.922   -5.18    4     Bus4     1.05       11 5.5e+002 1.5e+002
                                                  -1        -0.47  -2.7e+002  -
1.2e+002
                                 5     Bus5     1.05       10 9.9e+002 1.6e+002
                                                -0.6        -0.18  -5.2e+002  -
1.6e+002
   3     Bus3   1.050   12.86    4     Bus4     1.05       11 1.3e+004       10
                                                 1.3    0.061 3.5e+002       17
   4      Bus4    1.046    11.06     3      Bus3      1.05        13 5.5e+002  -
1.7e+002
                                                -1.3    -0.021 -3.5e+002       -
5.8
                                 5     Bus5     1.05       10 1.2e+002       45
                                                 4.8     -3.2       63      -43
                                 2     Bus2    0.922     -5.2 4.6e+002      1.3
                                                 1.5     0.26 2.8e+002       49
   5     Bus5   1.050   10.22    1     Bus1        1       16 8.5e+002 1.6e+002
                                               -0.74        -0.37  -4.8e+002  -
2.4e+002
                                 4       Bus4       1.05          11    1e+002  -
1.7e+002
                                                  -7    -0.49      -63     -4.4
                                 2     Bus2    0.922     -5.2 9.4e+002      -14
                                                0.68      0.3 5.4e+002 2.4e+002
kp 0 kq 0  Iterations 4 dpmax 0.000006  dqmax  0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000006  dqmax  0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000006  dqmax  0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000006  dqmax  0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000006  dqmax  0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000006  dqmax  0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000006  dqmax  0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000006  dqmax  0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000006  dqmax  0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000006  dqmax  0.000000
-------------------------------------------------------------------------------
Time =   1.62000 Seconds
Intermediate results for Machines
GNo Name     Voltage Angle    Delta    Freq     Pgen     Qgen     Pmech    Efd/Slip
             pu      Degree   Degree   Hzs.     MW       MVAR     MW       pu/P.U.
--- -------- ------- -------- -------- -------- -------- -------- -------- --------
  1     Bus1       1       16     16.6       50      483      300      389     1.01
  3     Bus3    1.05     13.1     13.5       50      426     56.7      520     1.05
--------------------------------------------------------------------------------
Maximum rotor angle difference :    3.10455 b/w buses : 1 and 3
Island    1 Common system frequency   50.028
-------------------------------------------------------------------------------
Voltage (pu), Current (AMPS), impedance (PU) and power (MW-MVAR) for lines
From Name      Voltage Angle   To   Name      Voltage  Angle    Current  Angle
                                              Zl-real  Zl-im    P        Q
```

```
---- -------- ------- ------- ---- -------- -------- -------- -------- --------
   1     Bus1   1.000   16.05    5     Bus5     1.05       10 2.2e+004       -16
                                               0.6     0.37 4.8e+002   3e+002
   2     Bus2   0.922   -4.99    4     Bus4     1.05       11 5.5e+002 1.5e+002
                                                 -1        -0.47  -2.7e+002  -
1.2e+002
                                  5     Bus5     1.05       10 9.9e+002 1.6e+002
                                               -0.6        -0.18  -5.2e+002  -
1.6e+002
   3     Bus3   1.050   13.05    4     Bus4     1.05       11 1.3e+004       10
                                               1.3    0.061 3.5e+002       17
   4      Bus4    1.046    11.25     3      Bus3      1.05         13 5.5e+002  -
1.7e+002
                                              -1.3    -0.021 -3.5e+002       -
5.8
                                  5     Bus5     1.05       10 1.2e+002       46
                                               4.8     -3.3       63      -43
                                  2     Bus2    0.922       -5 4.6e+002      1.5
                                               1.5     0.26 2.8e+002       49
   5     Bus5   1.050   10.41    1     Bus1        1       16 8.5e+002 1.6e+002
                                             -0.74        -0.37  -4.8e+002  -
2.4e+002
                                  4       Bus4       1.05          11    1e+002  -
1.7e+002
                                                -7     -0.5      -63     -4.5
                                  2     Bus2    0.922       -5 9.4e+002      -14
                                              0.68      0.3 5.4e+002 2.4e+002
kp 0 kq 0 Iterations 4 dpmax 0.000006 dqmax 0.000000
kp 0 kq 0 Iterations 4 dpmax 0.000006 dqmax 0.000000
kp 0 kq 0 Iterations 4 dpmax 0.000006 dqmax 0.000000
kp 0 kq 0 Iterations 4 dpmax 0.000007 dqmax 0.000000
kp 0 kq 0 Iterations 4 dpmax 0.000007 dqmax 0.000000
kp 0 kq 0 Iterations 4 dpmax 0.000007 dqmax 0.000000
kp 0 kq 0 Iterations 4 dpmax 0.000007 dqmax 0.000000
kp 0 kq 0 Iterations 4 dpmax 0.000007 dqmax 0.000000
kp 0 kq 0 Iterations 4 dpmax 0.000007 dqmax 0.000000
kp 0 kq 0 Iterations 4 dpmax 0.000007 dqmax 0.000000
--------------------------------------------------------------------------------
Time =   1.64000 Seconds
Intermediate results for Machines
GNo Name     Voltage Angle    Delta    Freq    Pgen    Qgen    Pmech   Efd/Slip
             pu      Degree   Degree   Hzs.    MW      MVAR    MW      pu/P.U.
--- -------- ------- -------- -------- ------- ------- ------- ------- --------
  1     Bus1       1     16.2     16.8      50     482     300     389     1.01
  3     Bus3    1.05     13.3     13.7      50     427    56.6     520     1.05
--------------------------------------------------------------------------------
Maximum rotor angle difference :    3.07674 b/w buses : 1 and 3
Island    1 Common system frequency   50.028
--------------------------------------------------------------------------------
Voltage (pu), Current (AMPS), impedance (PU) and power (MW-MVAR) for lines
From Name     Voltage Angle   To   Name     Voltage  Angle    Current  Angle
```

```
                                             Zl-real  Zl-im    P        Q
---- -------- ------- ------- ---- -------- -------- -------- -------- --------
   1     Bus1   1.000   16.24    5     Bus5     1.05       11 2.2e+004      -16
                                                 0.6     0.37 4.8e+002   3e+002
   2     Bus2   0.922   -4.79    4     Bus4     1.05       11 5.5e+002 1.5e+002
                                                  -1       -0.47  -2.7e+002  -
1.2e+002
                                   5     Bus5     1.05       11 9.9e+002 1.6e+002
                                                -0.6       -0.18  -5.2e+002  -
1.6e+002
   3     Bus3   1.050   13.26    4     Bus4     1.05       11 1.3e+004       11
                                                 1.3    0.061 3.5e+002       17
   4      Bus4    1.046    11.46     3      Bus3      1.05        13 5.5e+002  -
1.7e+002
                                                -1.3    -0.021  -3.5e+002      -
5.7
                                   5     Bus5     1.05       11 1.2e+002       46
                                                 4.7     -3.2       63      -43
                                   2     Bus2    0.922     -4.8 4.6e+002      1.7
                                                 1.5     0.26 2.8e+002       49
   5     Bus5   1.050   10.61    1     Bus1        1       16 8.5e+002 1.6e+002
                                               -0.74       -0.37  -4.8e+002  -
2.4e+002
                                   4      Bus4      1.05         11    1e+002  -
1.7e+002
                                                -6.9    -0.48      -63     -4.4
                                   2     Bus2    0.922     -4.8 9.4e+002      -13
                                                0.68      0.3 5.4e+002 2.4e+002
kp 0 kq 0  Iterations 4 dpmax 0.000007 dqmax  0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000007 dqmax  0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000007 dqmax  0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000007 dqmax  0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000007 dqmax  0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000007 dqmax  0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000007 dqmax  0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000007 dqmax  0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000007 dqmax  0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000007 dqmax  0.000000
------------------------------------------------------------------------------
Time =   1.66000 Seconds
Intermediate results for Machines
GNo Name     Voltage Angle    Delta    Freq     Pgen     Qgen     Pmech    Efd/Slip
             pu      Degree   Degree   Hzs.     MW       MVAR     MW       pu/P.U.
--- -------- ------- -------- -------- -------- -------- -------- -------- --------
  1     Bus1       1     16.4       17       50      480      300      389     1.01
  3     Bus3    1.05     13.5       14       50      429     56.6      520     1.05
---------------------------------------------------------------------------
Maximum rotor angle difference :    3.01554 b/w buses : 1 and 3
Island    1 Common system frequency   50.028
------------------------------------------------------------------------------
Voltage (pu), Current (AMPS), impedance (PU) and power (MW-MVAR) for lines
```

```
From Name     Voltage Angle   To   Name     Voltage  Angle    Current  Angle
                                              Zl-real  Zl-im    P        Q
---- -------- ------- ------- ---- -------- -------- -------- -------- --------
   1     Bus1   1.000   16.41    5     Bus5     1.05       11 2.2e+004       -16
                                               0.6     0.37 4.8e+002   3e+002
   2     Bus2   0.922   -4.59    4     Bus4     1.05       12 5.5e+002 1.5e+002
                                                -1         -0.46  -2.7e+002  -
1.2e+002
                                    5     Bus5     1.05       11 9.9e+002 1.6e+002
                                              -0.6         -0.18  -5.2e+002  -
1.6e+002
   3     Bus3   1.050   13.49    4     Bus4     1.05       12 1.3e+004        11
                                               1.3     0.06 3.5e+002        17
   4      Bus4    1.046    11.67     3      Bus3      1.05         13 5.6e+002  -
1.7e+002
                                              -1.3     -0.02 -3.5e+002       -
5.5
                                    5     Bus5     1.05       11 1.2e+002        45
                                               4.7     -3.1        65       -43
                                    2     Bus2    0.922     -4.6 4.6e+002       1.9
                                               1.5     0.26 2.8e+002        49
   5     Bus5   1.050   10.81    1     Bus1        1       16 8.5e+002 1.6e+002
                                             -0.74         -0.37  -4.8e+002  -
2.4e+002
                                    4       Bus4       1.05          12    1e+002  -
1.7e+002
                                              -6.8    -0.43       -65     -4.1
                                    2     Bus2    0.922     -4.6 9.4e+002       -13
                                               0.68      0.3 5.4e+002  2.4e+002
kp 0 kq 0  Iterations 4 dpmax 0.000007 dqmax  0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000007 dqmax  0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000008 dqmax  0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000008 dqmax  0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000008 dqmax  0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000008 dqmax  0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000008 dqmax  0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000008 dqmax  0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000008 dqmax  0.000000
--------------------------------------------------------------------------------
Time =   1.68000 Seconds
Intermediate results for Machines
GNo Name     Voltage Angle    Delta    Freq    Pgen    Qgen    Pmech   Efd/Slip
             pu      Degree   Degree   Hzs.    MW      MVAR    MW      pu/P.U.
--- -------- ------- -------- -------- ------- ------- ------- ------- --------
  1     Bus1       1     16.6     17.1      50     477     299     389      1.01
  3     Bus3    1.05     13.7     14.2      50     432    56.5     520      1.05
--------------------------------------------------------------------------------
Maximum rotor angle difference :    2.92160 b/w buses : 1 and 3
Island    1 Common system frequency   50.028
--------------------------------------------------------------------------------
```

```
Voltage (pu), Current (AMPS), impedance (PU) and power (MW-MVAR) for lines
From Name     Voltage Angle   To   Name     Voltage  Angle    Current  Angle
                                            Zl-real  Zl-im    P        Q
---- -------- ------- ------- ---- -------- -------- -------- -------- --------
   1     Bus1   1.000   16.56    5     Bus5     1.05       11 2.2e+004      -16
                                                 0.6     0.38 4.8e+002   3e+002
   2     Bus2   0.922   -4.38    4     Bus4     1.05       12 5.5e+002 1.5e+002
                                                  -1        -0.46  -2.8e+002  -
1.2e+002
                                   5     Bus5     1.05       11 9.9e+002 1.6e+002
                                                -0.6        -0.18  -5.2e+002  -
1.6e+002
   3     Bus3   1.050   13.73    4     Bus4     1.05       12 1.3e+004       11
                                                 1.3    0.059 3.5e+002       16
   4      Bus4    1.046    11.90     3      Bus3      1.05         14 5.6e+002  -
1.7e+002
                                                -1.2    -0.019  -3.5e+002       -
5.2
                                   5     Bus5     1.05       11 1.3e+002       45
                                                 4.6       -3       67      -44
                                   2     Bus2    0.922     -4.4 4.6e+002      2.1
                                                 1.5     0.26 2.8e+002       49
   5     Bus5   1.050   11.00    1     Bus1        1       17 8.4e+002 1.6e+002
                                               -0.75        -0.37  -4.7e+002  -
2.4e+002
                                   4       Bus4       1.05          12 1.1e+002  -
1.7e+002
                                                -6.5    -0.36      -67     -3.7
                                   2     Bus2    0.922     -4.4 9.4e+002      -13
                                                0.68      0.3 5.4e+002 2.4e+002
kp 0 kq 0  Iterations 4 dpmax 0.000008 dqmax 0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000008 dqmax 0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000008 dqmax 0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000008 dqmax 0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000008 dqmax 0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000008 dqmax 0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000008 dqmax 0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000008 dqmax 0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000008 dqmax 0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000008 dqmax 0.000000
-------------------------------------------------------------------------------
Time =   1.70000 Seconds
Intermediate results for Machines
GNo Name      Voltage Angle    Delta    Freq    Pgen    Qgen    Pmech   Efd/Slip
              pu      Degree   Degree   Hzs.    MW      MVAR    MW      pu/P.U.
--- -------- ------- -------- -------- ------- ------- ------- ------- --------
  1     Bus1       1     16.7     17.3      50     473     299     389     1.01
  3     Bus3    1.05       14     14.5      50     436    56.4     520     1.05
--------------------------------------------------------------------------------
Maximum rotor angle difference :    2.79600 b/w buses : 1 and 3
Island    1 Common system frequency   50.028
```

```
--------------------------------------------------------------------------------
Voltage (pu), Current (AMPS), impedance (PU) and power (MW-MVAR) for lines
From Name     Voltage Angle   To   Name     Voltage  Angle    Current  Angle
                                              Zl-real  Zl-im    P        Q
---- -------- ------- ------- ---- -------- -------- -------- -------- --------
   1     Bus1   1.000   16.71    5     Bus5     1.05       11 2.2e+004       -16
                                               0.6     0.38 4.7e+002   3e+002
   2     Bus2   0.922   -4.18    4     Bus4     1.05       12 5.5e+002 1.5e+002
                                                -1        -0.46  -2.8e+002  -
1.2e+002
                                5     Bus5     1.05       11 9.9e+002 1.6e+002
                                              -0.6        -0.18  -5.2e+002  -
1.6e+002
   3     Bus3   1.050   13.98    4     Bus4     1.05       12 1.3e+004       11
                                               1.2    0.057 3.6e+002       16
   4      Bus4    1.046    12.13     3       Bus3      1.05         14 5.7e+002  -
1.7e+002
                                              -1.2    -0.017 -3.5e+002       -
4.9
                                5     Bus5     1.05       11 1.3e+002       44
                                               4.5     -2.8       71      -44
                                2     Bus2    0.922     -4.2 4.6e+002      2.4
                                               1.5     0.26 2.8e+002       49
   5     Bus5   1.050   11.19    1     Bus1        1       17 8.4e+002 1.6e+002
                                             -0.75        -0.38  -4.7e+002  -
2.4e+002
                                4       Bus4       1.05          12 1.1e+002  -
1.7e+002
                                              -6.2    -0.28      -71     -3.1
                                2     Bus2    0.922     -4.2 9.4e+002      -13
                                               0.68      0.3 5.4e+002 2.4e+002
kp 0 kq 0  Iterations 4 dpmax 0.000008 dqmax  0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000008 dqmax  0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000008 dqmax  0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000009 dqmax  0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000009 dqmax  0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000009 dqmax  0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000009 dqmax  0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000009 dqmax  0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000009 dqmax  0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000009 dqmax  0.000000
--------------------------------------------------------------------------------
Time =   1.72000 Seconds
Intermediate results for Machines
GNo Name     Voltage Angle    Delta    Freq    Pgen    Qgen    Pmech   Efd/Slip
             pu      Degree   Degree   Hzs.    MW      MVAR    MW      pu/P.U.
--- -------- ------- -------- -------- ------- ------- ------- ------- --------
  1     Bus1       1     16.8     17.4      50     468     299     389      1.01
  3     Bus3    1.05     14.3     14.7      50     441    56.2     520      1.05
--------------------------------------------------------------------------------
Maximum rotor angle difference :    2.64016 b/w buses : 1 and 3
```

```
Island    1 Common system frequency   50.028
-------------------------------------------------------------------------------
Voltage (pu), Current (AMPS), impedance (PU) and power (MW-MVAR) for lines
From Name      Voltage Angle   To   Name      Voltage  Angle    Current  Angle
                                              Zl-real  Zl-im    P        Q
---- -------- ------- ------- ---- -------- -------- -------- -------- --------
   1     Bus1   1.000   16.83    5     Bus5     1.05       11 2.1e+004      -16
                                                0.61     0.39 4.7e+002   3e+002
   2     Bus2   0.923   -3.97    4     Bus4     1.05       12 5.5e+002 1.5e+002
                                                  -1        -0.46  -2.8e+002  -
1.2e+002
                                 5     Bus5     1.05       11 9.9e+002 1.6e+002
                                                -0.6        -0.18  -5.2e+002  -
1.6e+002
   3     Bus3   1.050   14.25    4     Bus4     1.05       12 1.3e+004       12
                                                 1.2    0.055 3.6e+002       16
   4      Bus4    1.046    12.38     3      Bus3      1.05         14 5.8e+002  -
1.7e+002
                                                -1.2    -0.015  -3.6e+002       -
4.4
                                 5     Bus5     1.05       11 1.4e+002       43
                                                 4.3     -2.6       75      -45
                                 2     Bus2    0.923       -4 4.6e+002      2.6
                                                 1.5     0.26 2.8e+002       49
   5     Bus5   1.050   11.38    1     Bus1        1       17 8.3e+002 1.6e+002
                                               -0.75        -0.39  -4.6e+002  -
2.4e+002
                                 4      Bus4      1.05         12 1.2e+002  -
1.7e+002
                                                -5.9    -0.19      -75     -2.4
                                 2     Bus2    0.923       -4 9.4e+002      -13
                                                0.68      0.3 5.4e+002 2.4e+002
kp 0 kq 0  Iterations 4 dpmax 0.000009 dqmax 0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000009 dqmax 0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000009 dqmax 0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000009 dqmax 0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000009 dqmax 0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000009 dqmax 0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000009 dqmax 0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000009 dqmax 0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000009 dqmax 0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000009 dqmax 0.000000
-------------------------------------------------------------------------------
Time =   1.74000 Seconds
Intermediate results for Machines
GNo Name      Voltage Angle    Delta    Freq     Pgen     Qgen     Pmech    Efd/Slip
              pu      Degree   Degree   Hzs.     MW       MVAR     MW       pu/P.U.
--- -------- ------- -------- -------- ------- ------- ------- ------- --------
  1     Bus1       1     16.9     17.5      50     462     298     389     1.01
  3     Bus3    1.05     14.5       15      50     446    56.1     520     1.05
-------------------------------------------------------------------------------
```

```
Maximum rotor angle difference :    2.45585 b/w buses : 1 and 3
Island    1 Common system frequency   50.028
------------------------------------------------------------------------------
Voltage (pu), Current (AMPS), impedance (PU) and power (MW-MVAR) for lines
From Name     Voltage Angle   To   Name     Voltage  Angle    Current  Angle
                                              Zl-real  Zl-im    P        Q
---- -------- ------- ------- ---- -------- -------- -------- -------- --------
   1     Bus1   1.000   16.95    5     Bus5     1.05       12 2.1e+004       -16
                                              0.61     0.39 4.6e+002   3e+002
   2     Bus2   0.923   -3.76    4     Bus4     1.05       13 5.5e+002 1.5e+002
                                                -1        -0.46  -2.8e+002  -
1.2e+002
                                   5     Bus5     1.05       12 9.9e+002 1.6e+002
                                              -0.6        -0.18  -5.2e+002  -
1.6e+002
   3     Bus3   1.050   14.54    4     Bus4     1.05       13 1.3e+004       12
                                               1.2    0.053 3.7e+002       16
   4      Bus4    1.046    12.63     3      Bus3      1.05         15 5.8e+002  -
1.7e+002
                                              -1.2    -0.013 -3.7e+002       -
3.9
                                   5     Bus5     1.05       12 1.5e+002       42
                                               4.1     -2.3       80      -45
                                   2     Bus2    0.923     -3.8 4.6e+002      2.9
                                               1.5     0.26 2.9e+002       49
   5     Bus5   1.050   11.56    1     Bus1        1       17 8.2e+002 1.6e+002
                                            -0.76        -0.39  -4.6e+002  -
2.4e+002
                                   4       Bus4       1.05          13 1.3e+002  -
1.7e+002
                                              -5.5    -0.11      -80     -1.6
                                   2     Bus2    0.923     -3.8 9.4e+002      -12
                                               0.68      0.3 5.4e+002 2.4e+002
kp 0 kq 0  Iterations 4 dpmax 0.000009 dqmax  0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000009 dqmax  0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000009 dqmax  0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000009 dqmax  0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000009 dqmax  0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000009 dqmax  0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000010 dqmax  0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000010 dqmax  0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000010 dqmax  0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000010 dqmax  0.000000
------------------------------------------------------------------------------
Time =   1.76000 Seconds
Intermediate results for Machines
GNo Name      Voltage Angle    Delta    Freq    Pgen    Qgen    Pmech   Efd/Slip
              pu      Degree   Degree   Hzs.    MW      MVAR    MW      pu/P.U.
--- -------- ------- -------- -------- ------- ------- ------- ------- --------
  1     Bus1       1       17     17.6      50     456     298     389     1.01
  3     Bus3    1.05     14.8     15.3      50     453    55.9     520     1.05
```

```
---------------------------------------------------------------------------------
Maximum rotor angle difference :    2.24517 b/w buses : 1 and 3
Island    1 Common system frequency   50.028
--------------------------------------------------------------------------------
Voltage (pu), Current (AMPS), impedance (PU) and power (MW-MVAR) for lines
From Name      Voltage Angle    To   Name      Voltage  Angle    Current  Angle
                                             Zl-real  Zl-im    P        Q
---- -------- ------- ------- ---- -------- -------- -------- -------- --------
   1     Bus1   1.000   17.05    5     Bus5     1.05       12 2.1e+004      -16
                                                0.61      0.4 4.6e+002   3e+002
   2     Bus2   0.923   -3.55    4     Bus4     1.05       13 5.5e+002 1.5e+002
                                                  -1        -0.45  -2.8e+002  -
1.2e+002
                                 5     Bus5     1.05       12 9.9e+002 1.6e+002
                                                -0.6        -0.18  -5.2e+002  -
1.6e+002
   3     Bus3   1.050   14.83    4     Bus4     1.05       13 1.4e+004       12
                                                 1.2     0.05 3.7e+002       16
   4      Bus4    1.046    12.89     3      Bus3      1.05        15    6e+002  -
1.7e+002
                                                -1.2     -0.01  -3.7e+002       -
3.3
                                 5     Bus5     1.05       12 1.6e+002       41
                                                   4     -2.1       86      -46
                                 2     Bus2    0.923     -3.6 4.6e+002      3.1
                                                 1.5     0.26 2.9e+002       49
   5     Bus5   1.050   11.74    1     Bus1        1       17 8.1e+002 1.6e+002
                                               -0.76          -0.4  -4.5e+002  -
2.4e+002
                                 4       Bus4       1.05          13 1.4e+002  -
1.7e+002
                                                -5.1   -0.038      -86    -0.64
                                 2     Bus2    0.923     -3.6 9.4e+002      -12
                                                0.68     0.31 5.4e+002 2.4e+002
kp 0 kq 0  Iterations 4 dpmax 0.000010 dqmax 0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000010 dqmax 0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000010 dqmax 0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000010 dqmax 0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000010 dqmax 0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000010 dqmax 0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000010 dqmax 0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000010 dqmax 0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000010 dqmax 0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000010 dqmax 0.000000
--------------------------------------------------------------------------------
Time =   1.78000 Seconds
Intermediate results for Machines
GNo Name      Voltage Angle    Delta    Freq    Pgen    Qgen    Pmech   Efd/Slip
              pu      Degree   Degree   Hzs.    MW      MVAR    MW      pu/P.U.
--- -------- ------- -------- -------- ------- ------- ------- ------- --------
  1     Bus1       1     17.1     17.7      50     448     298     389     1.01
```

```
  3     Bus3    1.05     15.1     15.6      50     461    55.8     520     1.05
-------------------------------------------------------------------------------
Maximum rotor angle difference :    2.01054 b/w buses : 1 and 3
Island    1 Common system frequency 50.028
------------------------------------------------------------------------------
Voltage (pu), Current (AMPS), impedance (PU) and power (MW-MVAR) for lines
From Name      Voltage Angle   To   Name     Voltage  Angle    Current  Angle
                                             Zl-real  Zl-im    P        Q
---- -------- ------- ------- ---- -------- -------- -------- ------- --------
   1     Bus1   1.000   17.14    5     Bus5     1.05       12 2.1e+004      -16
                                                0.62     0.41 4.5e+002   3e+002
   2     Bus2   0.923   -3.34    4     Bus4     1.05       13 5.5e+002 1.5e+002
                                                  -1         -0.45  -2.8e+002  -
1.2e+002
                                 5     Bus5     1.05       12 9.9e+002 1.6e+002
                                                -0.6         -0.18  -5.2e+002  -
1.6e+002
   3     Bus3   1.050   15.14    4     Bus4     1.05       13 1.4e+004       13
                                                 1.2    0.048 3.8e+002       16
   4      Bus4    1.046    13.16     3      Bus3      1.05         15 6.1e+002  -
1.7e+002
                                                -1.2   -0.0079  -3.8e+002       -
2.6
                                 5     Bus5     1.05       12 1.7e+002       40
                                                 3.8     -1.9       92      -47
                                 2     Bus2    0.923     -3.3 4.7e+002      3.4
                                                 1.5     0.25 2.9e+002       49
   5     Bus5   1.050   11.93    1     Bus1        1       17   8e+002 1.6e+002
                                               -0.77         -0.42  -4.4e+002  -
2.4e+002
                                 4       Bus4       1.05          13 1.5e+002  -
1.7e+002
                                                -4.8    0.022      -92     0.43
                                 2     Bus2    0.923     -3.3 9.4e+002      -12
                                                0.69     0.31 5.4e+002 2.4e+002
kp 0 kq 0  Iterations 4 dpmax 0.000010 dqmax  0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000010 dqmax  0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000010 dqmax  0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000010 dqmax  0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000010 dqmax  0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000010 dqmax  0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000010 dqmax  0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000010 dqmax  0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000010 dqmax  0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000010 dqmax  0.000000
------------------------------------------------------------------------------
Time =   1.80000 Seconds
Intermediate results for Machines
GNo Name      Voltage Angle    Delta    Freq     Pgen     Qgen     Pmech    Efd/Slip
              pu      Degree   Degree   Hzs.     MW       MVAR     MW       pu/P.U.
--- -------- ------- -------- -------- ------- ------- ------- ------- --------
```

```
  1      Bus1       1     17.2     17.7      50     440     297     389     1.01
  3      Bus3    1.05     15.5       16      50     469    55.6     520     1.05
------------------------------------------------------------------------------
Maximum rotor angle difference :    1.75464 b/w buses : 1 and 3
Island    1 Common system frequency   50.028
------------------------------------------------------------------------------
Voltage (pu), Current (AMPS), impedance (PU) and power (MW-MVAR) for lines
From Name     Voltage Angle   To   Name     Voltage  Angle    Current  Angle
                                              Zl-real  Zl-im    P        Q
---- -------- ------- ------- ---- -------- -------- -------- -------- -------
   1     Bus1   1.000   17.22    5     Bus5     1.05       12   2e+004      -17
                                              0.62     0.42 4.4e+002   3e+002
   2     Bus2   0.923   -3.13    4     Bus4     1.05       13 5.5e+002 1.5e+002
                                                -1        -0.45  -2.8e+002  -
1.2e+002
                                   5     Bus5     1.05       12 9.9e+002 1.6e+002
                                              -0.6         -0.18  -5.2e+002  -
1.6e+002
   3     Bus3   1.050   15.45    4     Bus4     1.05       13 1.4e+004       13
                                               1.1    0.046 3.9e+002       16
   4      Bus4    1.046    13.43     3      Bus3      1.05         15 6.2e+002  -
1.7e+002
                                             -1.1   -0.0056 -3.9e+002       -
1.9
                                   5     Bus5     1.05       12 1.8e+002       39
                                               3.6     -1.7   1e+002       -48
                                   2     Bus2    0.923     -3.1 4.7e+002      3.7
                                               1.5     0.25 2.9e+002       49
   5     Bus5   1.050   12.11    1     Bus1        1       17 7.9e+002 1.6e+002
                                            -0.78         -0.43  -4.4e+002  -
2.4e+002
                                   4       Bus4       1.05          13 1.6e+002  -
1.7e+002
                                             -4.4    0.072      -99      1.6
                                   2     Bus2    0.923     -3.1 9.3e+002      -12
                                              0.69     0.31 5.4e+002 2.4e+002
kp 0 kq 0  Iterations 4 dpmax 0.000010 dqmax  0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000010 dqmax  0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000010 dqmax  0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000010 dqmax  0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000010 dqmax  0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000010 dqmax  0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000010 dqmax  0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000011 dqmax  0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000011 dqmax  0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000011 dqmax  0.000000
------------------------------------------------------------------------------
Time =   1.82000 Seconds
Intermediate results for Machines
GNo Name     Voltage Angle    Delta    Freq    Pgen    Qgen    Pmech   Efd/Slip
             pu      Degree   Degree   Hzs.    MW      MVAR    MW      pu/P.U.
```

```
--- -------- ------- -------- -------- ------- ------- ------- ------- --------
  1     Bus1       1     17.3     17.8      50     431     297     389     1.01
  3     Bus3    1.05     15.8     16.3      50     478    55.5     520     1.05
-------------------------------------------------------------------------------
Maximum rotor angle difference :    1.48042 b/w buses : 1 and 3
Island    1 Common system frequency   50.028
------------------------------------------------------------------------------
Voltage (pu), Current (AMPS), impedance (PU) and power (MW-MVAR) for lines
From Name     Voltage Angle   To   Name     Voltage  Angle    Current  Angle
                                            Zl-real  Zl-im    P        Q
---- -------- ------- ------- ---- -------- -------- -------- -------- --------
   1     Bus1   1.000   17.29    5     Bus5     1.05       12   2e+004      -17
                                                0.63     0.43 4.3e+002   3e+002
   2     Bus2   0.923   -2.92    4     Bus4     1.05       14 5.5e+002 1.5e+002
                                                  -1       -0.44  -2.8e+002   -
1.2e+002
                                 5     Bus5     1.05       12 9.8e+002 1.6e+002
                                                -0.6       -0.18  -5.2e+002   -
1.6e+002
   3     Bus3   1.050   15.78    4     Bus4     1.05       14 1.5e+004       14
                                                 1.1    0.043   4e+002       16
   4      Bus4    1.046    13.71     3      Bus3      1.05        16 6.3e+002  -
1.7e+002
                                                -1.1  -0.0033  -4e+002     -1.2
                                 5     Bus5     1.05       12 1.9e+002       38
                                                 3.4     -1.5 1.1e+002      -48
                                 2     Bus2    0.923     -2.9 4.7e+002        4
                                                 1.5     0.25 2.9e+002       50
   5     Bus5   1.050   12.29    1     Bus1        1       17 7.8e+002 1.6e+002
                                               -0.78       -0.44  -4.3e+002   -
2.4e+002
                                 4       Bus4       1.05          14 1.7e+002  -
1.7e+002
                                                -4.1            0.11   -1.1e+002
2.9
                                 2     Bus2    0.923     -2.9 9.3e+002      -12
                                                0.69     0.31 5.3e+002 2.4e+002
kp 0 kq 0  Iterations 4 dpmax 0.000011 dqmax 0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000011 dqmax 0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000011 dqmax 0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000011 dqmax 0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000011 dqmax 0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000011 dqmax 0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000011 dqmax 0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000011 dqmax 0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000011 dqmax 0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000011 dqmax 0.000000
------------------------------------------------------------------------------
Time =    1.84000 Seconds
Intermediate results for Machines
GNo Name      Voltage Angle    Delta     Freq     Pgen     Qgen     Pmech    Efd/Slip
```

```
             pu      Degree   Degree   Hzs.    MW      MVAR    MW      pu/P.U.
--- -------- ------- -------- -------- ------- ------- ------- ------- --------
  1     Bus1       1     17.4     17.8      50     422     297     389     1.01
  3     Bus3    1.05     16.1     16.7      50     487    55.5     520     1.05
--------------------------------------------------------------------------------
Maximum rotor angle difference :    1.19103 b/w buses : 1 and 3
Island    1 Common system frequency   50.027
-------------------------------------------------------------------------------
Voltage (pu), Current (AMPS), impedance (PU) and power (MW-MVAR) for lines
From Name     Voltage Angle   To   Name     Voltage  Angle    Current  Angle
                                            Zl-real  Zl-im    P        Q
---- -------- ------- ------- ---- -------- -------- -------- -------- --------
   1     Bus1   1.000   17.36    5     Bus5     1.05       12   2e+004      -18
                                                0.63     0.45 4.2e+002   3e+002
   2     Bus2   0.923   -2.71    4     Bus4     1.05       14 5.6e+002 1.5e+002
                                                  -1        -0.44  -2.8e+002   -
1.2e+002
                                   5     Bus5     1.05       12 9.8e+002 1.6e+002
                                                -0.6        -0.18  -5.2e+002   -
1.6e+002
   3     Bus3   1.050   16.11    4     Bus4     1.05       14 1.5e+004       14
                                                 1.1    0.041 4.1e+002       15
   4      Bus4    1.046    14.00     3      Bus3      1.05        16 6.5e+002  -
1.7e+002
                                                -1.1   -0.0012  -4.1e+002      -
0.44
                                   5     Bus5     1.05       12   2e+002       37
                                                 3.2     -1.4 1.2e+002      -49
                                   2     Bus2    0.923     -2.7 4.7e+002      4.3
                                                 1.5     0.25 2.9e+002       50
   5     Bus5   1.050   12.46    1     Bus1        1       17 7.7e+002 1.6e+002
                                               -0.79        -0.46  -4.2e+002   -
2.4e+002
                                   4       Bus4       1.05          14 1.8e+002  -
1.7e+002
                                                -3.8            0.14   -1.1e+002
4.2
                                   2     Bus2    0.923     -2.7 9.3e+002      -12
                                                0.69     0.31 5.3e+002 2.4e+002
kp 0 kq 0  Iterations 4 dpmax 0.000011 dqmax  0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000011 dqmax  0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000011 dqmax  0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000011 dqmax  0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000011 dqmax  0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000011 dqmax  0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000011 dqmax  0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000011 dqmax  0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000011 dqmax  0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000011 dqmax  0.000000
-------------------------------------------------------------------------------
Time =   1.86000 Seconds
```

```
Intermediate results for Machines
GNo Name      Voltage Angle    Delta    Freq    Pgen    Qgen    Pmech   Efd/Slip
              pu      Degree   Degree   Hzs.    MW      MVAR    MW      pu/P.U.
--- -------- ------- -------- -------- ------- ------- ------- ------- --------
  1     Bus1       1     17.4     17.9      50     412     296     389     1.01
  3     Bus3    1.05     16.4       17      50     496    55.4     520     1.05
--------------------------------------------------------------------------------
Maximum rotor angle difference :    0.88980 b/w buses : 1 and 3
Island    1 Common system frequency   50.027
-------------------------------------------------------------------------------
Voltage (pu), Current (AMPS), impedance (PU) and power (MW-MVAR) for lines
From Name      Voltage Angle   To   Name      Voltage  Angle    Current  Angle
                                              Zl-real  Zl-im    P        Q
---- -------- ------- ------- ---- -------- -------- -------- -------- --------
   1     Bus1   1.000   17.42    5     Bus5     1.05       13   2e+004      -18
                                                0.64     0.46 4.1e+002   3e+002
   2     Bus2   0.923   -2.49    4     Bus4     1.05       14 5.6e+002 1.5e+002
                                                  -1        -0.43  -2.8e+002  -
1.2e+002
                                 5     Bus5     1.05       13 9.8e+002 1.6e+002
                                                -0.6        -0.19  -5.2e+002  -
1.6e+002
   3     Bus3   1.050   16.45    4     Bus4     1.05       14 1.5e+004       14
                                                 1.1    0.039 4.2e+002       15
   4      Bus4    1.046    14.28     3      Bus3      1.05        16 6.6e+002  -
1.7e+002
                                                -1.1        0.00076    -4.2e+002
0.3
                                 5     Bus5     1.05       13 2.1e+002       36
                                                   3     -1.2 1.2e+002      -50
                                 2     Bus2    0.923     -2.5 4.7e+002      4.6
                                                 1.5     0.25 2.9e+002       50
   5     Bus5   1.050   12.64    1     Bus1        1       17 7.6e+002 1.6e+002
                                                -0.8        -0.48  -4.1e+002  -
2.4e+002
                                 4       Bus4       1.05          14    2e+002  -
1.6e+002
                                                 -3.6            0.16   -1.2e+002
5.6
                                 2     Bus2    0.923     -2.5 9.3e+002      -12
                                                0.69     0.31 5.3e+002 2.4e+002
kp 0 kq 0  Iterations 4 dpmax 0.000011 dqmax 0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000011 dqmax 0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000011 dqmax 0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000011 dqmax 0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000011 dqmax 0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000011 dqmax 0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000011 dqmax 0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000011 dqmax 0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000011 dqmax 0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000011 dqmax 0.000000
```

```
--------------------------------------------------------------------------------
Time =   1.88000 Seconds
Intermediate results for Machines
GNo Name     Voltage Angle    Delta    Freq    Pgen    Qgen    Pmech   Efd/Slip
             pu      Degree   Degree   Hzs.    MW      MVAR    MW      pu/P.U.
--- -------- ------- -------- -------- ------- ------- ------- ------- --------
  1     Bus1       1     17.5     17.9      50     403     296     389      1.01
  3     Bus3    1.05     16.8     17.4      50     506    55.5     520      1.05
--------------------------------------------------------------------------------
Maximum rotor angle difference :    0.58020 b/w buses : 1 and 3
Island    1 Common system frequency   50.027
--------------------------------------------------------------------------------
Voltage (pu), Current (AMPS), impedance (PU) and power (MW-MVAR) for lines
From Name     Voltage Angle   To   Name     Voltage  Angle    Current  Angle
                                              Zl-real  Zl-im    P        Q
---- -------- ------- ------- ---- -------- -------- -------- -------- --------
   1     Bus1   1.000   17.47    5     Bus5     1.05       13 1.9e+004       -19
                                              0.65     0.47   4e+002   3e+002
   2     Bus2   0.923   -2.28    4     Bus4     1.05       15 5.6e+002 1.5e+002
                                                -1        -0.43  -2.8e+002  -
1.2e+002
                                   5     Bus5     1.05       13 9.8e+002 1.6e+002
                                              -0.6        -0.19  -5.2e+002  -
1.6e+002
   3     Bus3   1.050   16.79    4     Bus4     1.05       15 1.6e+004       15
                                                 1    0.037 4.3e+002       15
   4      Bus4    1.046    14.57     3      Bus3      1.05         17 6.8e+002  -
1.7e+002
                                                -1         0.0025   -4.3e+002
1
                                   5     Bus5     1.05       13 2.3e+002       36
                                               2.9     -1.1 1.3e+002      -51
                                   2     Bus2    0.923     -2.3 4.8e+002      4.8
                                               1.5     0.25 2.9e+002       50
   5     Bus5   1.050   12.82    1     Bus1        1       17 7.5e+002 1.6e+002
                                              -0.8        -0.49    -4e+002  -
2.5e+002
                                   4       Bus4       1.05          15 2.1e+002  -
1.6e+002
                                              -3.3            0.18   -1.3e+002
7.1
                                   2     Bus2    0.923     -2.3 9.3e+002      -11
                                               0.69     0.31 5.3e+002 2.4e+002
kp 0 kq 0 Iterations 4 dpmax 0.000011 dqmax 0.000000
kp 0 kq 0 Iterations 4 dpmax 0.000011 dqmax 0.000000
kp 0 kq 0 Iterations 4 dpmax 0.000011 dqmax 0.000000
kp 0 kq 0 Iterations 4 dpmax 0.000011 dqmax 0.000000
kp 0 kq 0 Iterations 4 dpmax 0.000011 dqmax 0.000000
kp 0 kq 0 Iterations 4 dpmax 0.000011 dqmax 0.000000
kp 0 kq 0 Iterations 4 dpmax 0.000011 dqmax 0.000000
```

```
kp 0 kq 0 Iterations 4 dpmax 0.000011 dqmax 0.000000
kp 0 kq 0 Iterations 4 dpmax 0.000011 dqmax 0.000000
--------------------------------------------------------------------------------
Time =   1.90000 Seconds
Intermediate results for Machines
GNo Name     Voltage Angle    Delta    Freq    Pgen    Qgen    Pmech   Efd/Slip
             pu      Degree   Degree   Hzs.    MW      MVAR    MW      pu/P.U.
--- -------- ------- -------- -------- ------- ------- ------- ------- --------
  1     Bus1       1     17.5       18      50     392     296     389     1.01
  3     Bus3    1.05     17.1     17.7      50     516    55.5     520     1.05
--------------------------------------------------------------------------------
Maximum rotor angle difference :    0.26581 b/w buses : 1 and 3
Island    1 Common system frequency 50.027
--------------------------------------------------------------------------------
Voltage (pu), Current (AMPS), impedance (PU) and power (MW-MVAR) for lines
From Name     Voltage Angle   To   Name     Voltage  Angle    Current  Angle
                                              Zl-real  Zl-im    P        Q
---- -------- ------- ------- ---- -------- -------- -------- -------- --------
   1     Bus1   1.000   17.52    5     Bus5     1.05       13 1.9e+004       -19
                                              0.65     0.49 3.9e+002   3e+002
   2     Bus2   0.923   -2.06    4     Bus4     1.05       15 5.6e+002 1.6e+002
                                                -1         -0.43  -2.9e+002  -
1.2e+002
                                5     Bus5     1.05       13 9.8e+002 1.6e+002
                                              -0.6         -0.19  -5.1e+002  -
1.6e+002
   3     Bus3   1.050   17.14    4     Bus4     1.05       15 1.6e+004       15
                                                 1    0.036 4.4e+002       16
   4      Bus4    1.046    14.87     3      Bus3      1.05         17    7e+002 -
1.6e+002
                                               -1           0.004   -4.4e+002
1.7
                                5     Bus5     1.05       13 2.4e+002       35
                                               2.7       -1 1.4e+002      -52
                                2     Bus2    0.923     -2.1 4.8e+002      5.1
                                               1.4     0.25 2.9e+002       50
   5     Bus5   1.050   12.99    1     Bus1        1       18 7.3e+002 1.6e+002
                                             -0.81         -0.51  -3.9e+002  -
2.5e+002
                                4       Bus4       1.05          15 2.2e+002  -
1.6e+002
                                              -3.1             0.19   -1.4e+002
8.6
                                2     Bus2    0.923     -2.1 9.3e+002      -11
                                              0.69     0.31 5.3e+002 2.4e+002
kp 0 kq 0 Iterations 4 dpmax 0.000011 dqmax 0.000000
kp 0 kq 0 Iterations 4 dpmax 0.000011 dqmax 0.000000
kp 0 kq 0 Iterations 4 dpmax 0.000011 dqmax 0.000000
kp 0 kq 0 Iterations 4 dpmax 0.000011 dqmax 0.000000
kp 0 kq 0 Iterations 4 dpmax 0.000011 dqmax 0.000000
kp 0 kq 0 Iterations 4 dpmax 0.000011 dqmax 0.000000
```

```
kp 0 kq 0 Iterations 4 dpmax 0.000011 dqmax 0.000000
kp 0 kq 0 Iterations 4 dpmax 0.000011 dqmax 0.000000
kp 0 kq 0 Iterations 4 dpmax 0.000011 dqmax 0.000000
kp 0 kq 0 Iterations 4 dpmax 0.000011 dqmax 0.000000
--------------------------------------------------------------------------------
Time =   1.92000 Seconds
Intermediate results for Machines
GNo Name     Voltage Angle    Delta    Freq    Pgen    Qgen    Pmech   Efd/Slip
             pu      Degree   Degree   Hzs.    MW      MVAR    MW      pu/P.U.
--- -------- ------- -------- -------- ------- ------- ------- ------- --------
  1     Bus1       1     17.6       18      50     382     295     389     1.01
  3     Bus3    1.05     17.5     18.1      50     527    55.7     520     1.05
--------------------------------------------------------------------------------
Maximum rotor angle difference :    0.04974 b/w buses : 1 and 3
Island    1 Common system frequency   50.027
--------------------------------------------------------------------------------
Voltage (pu), Current (AMPS), impedance (PU) and power (MW-MVAR) for lines
From Name     Voltage Angle   To   Name     Voltage  Angle    Current  Angle
                                              Zl-real  Zl-im    P        Q
---- -------- ------- ------- ---- -------- -------- -------- -------- --------
   1     Bus1   1.000   17.57    5     Bus5     1.05       13 1.9e+004       -20
                                              0.66     0.51 3.8e+002   3e+002
   2     Bus2   0.923   -1.85    4     Bus4     1.05       15 5.6e+002 1.6e+002
                                                -1        -0.42  -2.9e+002  -
1.2e+002
                                5     Bus5     1.05       13 9.8e+002 1.6e+002
                                              -0.6        -0.19  -5.1e+002  -
1.6e+002
   3     Bus3   1.050   17.48    4     Bus4     1.05       15 1.6e+004       15
                                              0.99    0.035 4.5e+002       16
   4      Bus4    1.046    15.16     3       Bus3      1.05         17 7.1e+002  -
1.6e+002
                                            -0.98          0.0054   -4.5e+002
2.4
                                5     Bus5     1.05       13 2.5e+002       35
                                               2.6    -0.92 1.5e+002      -53
                                2     Bus2    0.923     -1.8 4.8e+002      5.4
                                               1.4     0.25   3e+002       51
   5     Bus5   1.051   13.17    1     Bus1        1       18 7.2e+002 1.6e+002
                                            -0.81         -0.53  -3.8e+002  -
2.5e+002
                                4       Bus4       1.05          15 2.4e+002  -
1.6e+002
                                             -2.9             0.2  -1.5e+002
10
                                2     Bus2    0.923     -1.8 9.2e+002      -11
                                              0.69     0.31 5.3e+002 2.4e+002
kp 0 kq 0 Iterations 4 dpmax 0.000011 dqmax 0.000000
kp 0 kq 0 Iterations 4 dpmax 0.000011 dqmax 0.000000
kp 0 kq 0 Iterations 4 dpmax 0.000011 dqmax 0.000000
kp 0 kq 0 Iterations 4 dpmax 0.000011 dqmax 0.000000
```

```
kp 0 kq 0 Iterations 4 dpmax 0.000011 dqmax 0.000000
kp 0 kq 0 Iterations 4 dpmax 0.000011 dqmax 0.000000
kp 0 kq 0 Iterations 4 dpmax 0.000011 dqmax 0.000000
kp 0 kq 0 Iterations 4 dpmax 0.000011 dqmax 0.000000
kp 0 kq 0 Iterations 4 dpmax 0.000011 dqmax 0.000000
kp 0 kq 0 Iterations 4 dpmax 0.000011 dqmax 0.000000
--------------------------------------------------------------------------------
Time =   1.94000 Seconds
Intermediate results for Machines
GNo Name     Voltage Angle    Delta    Freq    Pgen    Qgen    Pmech   Efd/Slip
             pu      Degree   Degree   Hzs.    MW      MVAR    MW      pu/P.U.
--- -------- ------- -------- -------- ------- ------- ------- ------- --------
  1     Bus1       1     17.6     18.1      50     372     295     389     1.01
  3     Bus3    1.05     17.8     18.4      50     537    55.8     520     1.05
--------------------------------------------------------------------------------
Maximum rotor angle difference :    0.36281 b/w buses : 1 and 3
Island    1 Common system frequency   50.027
--------------------------------------------------------------------------------
Voltage (pu), Current (AMPS), impedance (PU) and power (MW-MVAR) for lines
From Name     Voltage Angle   To   Name     Voltage  Angle    Current  Angle
                                              Zl-real  Zl-im    P        Q
---- -------- ------- ------- ---- -------- -------- -------- -------- --------
   1     Bus1   1.000   17.63    5     Bus5     1.05       13 1.8e+004       -21
                                              0.66     0.52 3.7e+002   3e+002
   2     Bus2   0.923   -1.64    4     Bus4     1.05       15 5.6e+002 1.6e+002
                                                -1         -0.42  -2.9e+002  -
1.2e+002
                                   5     Bus5     1.05       13 9.7e+002 1.6e+002
                                              -0.6         -0.19  -5.1e+002  -
1.6e+002
   3     Bus3   1.050   17.83    4     Bus4     1.05       15 1.7e+004       16
                                              0.96    0.034 4.6e+002       16
   4      Bus4    1.046    15.45     3      Bus3      1.05         18 7.3e+002  -
1.6e+002
                                             -0.96          0.0065   -4.6e+002
3.1
                                   5     Bus5     1.05       13 2.7e+002       34
                                                2.5    -0.84 1.6e+002       -54
                                   2     Bus2    0.923     -1.6 4.8e+002      5.7
                                                1.4     0.25   3e+002       51
   5     Bus5   1.051   13.35    1     Bus1        1       18 7.1e+002 1.6e+002
                                             -0.82         -0.56  -3.7e+002  -
2.5e+002
                                   4       Bus4       1.05          15 2.5e+002  -
1.6e+002
                                             -2.8              0.2  -1.6e+002
12
                                   2     Bus2    0.923     -1.6 9.2e+002      -11
                                                0.7     0.31 5.3e+002 2.4e+002
kp 0 kq 0 Iterations 4 dpmax 0.000011 dqmax 0.000000
kp 0 kq 0 Iterations 4 dpmax 0.000011 dqmax 0.000000
```

```
kp 0 kq 0 Iterations 4 dpmax 0.000011 dqmax 0.000000
kp 0 kq 0 Iterations 4 dpmax 0.000011 dqmax 0.000000
kp 0 kq 0 Iterations 4 dpmax 0.000011 dqmax 0.000000
kp 0 kq 0 Iterations 4 dpmax 0.000011 dqmax 0.000000
kp 0 kq 0 Iterations 4 dpmax 0.000011 dqmax 0.000000
kp 0 kq 0 Iterations 4 dpmax 0.000011 dqmax 0.000000
kp 0 kq 0 Iterations 4 dpmax 0.000011 dqmax 0.000000
kp 0 kq 0 Iterations 4 dpmax 0.000011 dqmax 0.000000
--------------------------------------------------------------------------------
Time =   1.96000 Seconds
Intermediate results for Machines
GNo Name     Voltage Angle    Delta    Freq    Pgen    Qgen    Pmech   Efd/Slip
             pu      Degree   Degree   Hzs.    MW      MVAR    MW      pu/P.U.
--- -------- ------- -------- -------- ------- ------- ------- ------- --------
  1     Bus1       1     17.7     18.1      50     362     295     389     1.01
  3     Bus3    1.05     18.2     18.8      50     547    56.1     520     1.05
--------------------------------------------------------------------------------
Maximum rotor angle difference :    0.66977 b/w buses : 1 and 3
Island    1 Common system frequency   50.027
--------------------------------------------------------------------------------
Voltage (pu), Current (AMPS), impedance (PU) and power (MW-MVAR) for lines
From Name     Voltage Angle   To   Name     Voltage  Angle    Current  Angle
                                              Zl-real  Zl-im    P        Q
---- -------- ------- ------- ---- -------- -------- -------- -------- -------
   1     Bus1   1.000   17.68    5     Bus5     1.05       14 1.8e+004      -21
                                              0.66     0.54 3.6e+002   3e+002
   2     Bus2   0.923   -1.42    4     Bus4     1.05       16 5.7e+002 1.6e+002
                                                -1        -0.41  -2.9e+002  -
1.2e+002
                                5     Bus5     1.05       14 9.7e+002 1.6e+002
                                             -0.61        -0.19  -5.1e+002  -
1.6e+002
   3     Bus3   1.050   18.17    4     Bus4     1.05       16 1.7e+004       16
                                              0.94    0.033 4.7e+002       16
   4      Bus4    1.046    15.74     3      Bus3      1.05         18 7.4e+002  -
1.6e+002
                                             -0.94         0.0074   -4.7e+002
3.7
                                5     Bus5     1.05       14 2.8e+002       34
                                               2.4    -0.77 1.7e+002      -55
                                2     Bus2    0.923     -1.4 4.8e+002        6
                                               1.4     0.24   3e+002       51
   5     Bus5   1.051   13.52    1     Bus1       1       18   7e+002 1.6e+002
                                             -0.82        -0.58  -3.6e+002  -
2.5e+002
                                4       Bus4       1.05          16 2.7e+002  -
1.6e+002
                                             -2.6            0.21   -1.7e+002
13
                                2     Bus2    0.923     -1.4 9.2e+002      -11
                                                0.7     0.32 5.3e+002 2.4e+002
```

```
kp 0 kq 0  Iterations 4 dpmax 0.000011 dqmax 0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000011 dqmax 0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000011 dqmax 0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000011 dqmax 0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000011 dqmax 0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000011 dqmax 0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000011 dqmax 0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000011 dqmax 0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000011 dqmax 0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000011 dqmax 0.000000
-----------------------------------------------------------------------------
Time =   1.98000 Seconds
Intermediate results for Machines
GNo Name      Voltage Angle    Delta    Freq     Pgen     Qgen     Pmech    Efd/Slip
              pu      Degree   Degree   Hzs.     MW       MVAR     MW       pu/P.U.
--- -------- ------- -------- -------- -------- -------- -------- -------- --------
  1     Bus1       1     17.7     18.1       50      353      295      389     1.01
  3     Bus3    1.05     18.5     19.1       50      556     56.3      520     1.05
--------------------------------------------------------------------------
Maximum rotor angle difference :    0.96707 b/w buses : 1 and 3
Island    1 Common system frequency   50.027
-----------------------------------------------------------------------------
Voltage (pu), Current (AMPS), impedance (PU) and power (MW-MVAR) for lines
From Name      Voltage Angle   To   Name      Voltage  Angle    Current  Angle
                                              Zl-real  Zl-im    P        Q
---- -------- ------- ------- ---- -------- -------- -------- -------- --------
   1     Bus1   1.000   17.74    5     Bus5     1.05       14 1.8e+004      -22
                                                0.67     0.56 3.5e+002   3e+002
   2     Bus2   0.923   -1.21    4     Bus4     1.05       16 5.7e+002 1.6e+002
                                                  -1      -0.41  -2.9e+002  -
1.2e+002
                                   5     Bus5     1.05       14 9.7e+002 1.6e+002
                                               -0.61      -0.19  -5.1e+002  -
1.6e+002
   3     Bus3   1.050   18.50    4     Bus4     1.05       16 1.7e+004       17
                                                0.92    0.032 4.8e+002       16
   4      Bus4    1.046    16.03     3      Bus3      1.05        19 7.6e+002  -
1.6e+002
                                               -0.92         0.0082    -4.7e+002
4.2
                                   5     Bus5     1.05       14 2.9e+002       34
                                                 2.3    -0.72 1.8e+002      -56
                                   2     Bus2    0.923     -1.2 4.9e+002      6.3
                                                 1.4     0.24   3e+002       51
   5     Bus5   1.051   13.70    1     Bus1        1       18 6.9e+002 1.6e+002
                                               -0.83         -0.6  -3.5e+002  -
2.5e+002
                                   4       Bus4      1.05        16 2.8e+002  -
1.6e+002
                                                -2.5            0.21   -1.7e+002
14
```

```
                                     2      Bus2     0.923      -1.2 9.2e+002       -11
                                                       0.7      0.32 5.2e+002 2.4e+002
kp 0 kq 0  Iterations 4 dpmax 0.000011 dqmax  0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000011 dqmax  0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000011 dqmax  0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000011 dqmax  0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000011 dqmax  0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000011 dqmax  0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000011 dqmax  0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000011 dqmax  0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000011 dqmax  0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000011 dqmax  0.000000
------------------------------------------------------------------------------
Time =   2.00000 Seconds
Intermediate results for Machines
GNo Name      Voltage Angle    Delta    Freq     Pgen     Qgen     Pmech    Efd/Slip
             pu      Degree   Degree   Hzs.     MW       MVAR     MW       pu/P.U.
--- -------- ------- -------- -------- -------- ------- -------- ------- --------
  1     Bus1        1     17.8     18.2       50      344      295      389     1.01
  3     Bus3     1.05     18.8     19.5       50      565     56.6      520     1.05
---------------------------------------------------------------------------
Maximum rotor angle difference :    1.25127 b/w buses : 1 and 3
Island    1 Common system frequency   50.027
------------------------------------------------------------------------------
Voltage (pu), Current (AMPS), impedance (PU) and power (MW-MVAR) for lines
From Name      Voltage Angle   To   Name      Voltage  Angle     Current  Angle
                                              Zl-real  Zl-im     P        Q
---- -------- ------- ------- ---- -------- -------- -------- -------- --------
   1     Bus1   1.000   17.81    5     Bus5     1.05       14 1.7e+004       -23
                                                0.67     0.58 3.4e+002   3e+002
   2     Bus2   0.923   -1.00    4     Bus4     1.05       16 5.7e+002 1.6e+002
                                                  -1        -0.41  -2.9e+002  -
1.2e+002
                                     5     Bus5     1.05       14 9.7e+002 1.6e+002
                                               -0.61        -0.19  -5.1e+002  -
1.6e+002
   3     Bus3   1.050   18.83    4     Bus4     1.05       16 1.8e+004        17
                                                0.91    0.031 4.9e+002        17
   4      Bus4    1.046    16.31     3      Bus3      1.05        19 7.7e+002  -
1.6e+002
                                                -0.9          0.0088   -4.8e+002
4.7
                                     5     Bus5     1.05       14 3.1e+002        33
                                                 2.2    -0.67 1.8e+002       -56
                                     2     Bus2    0.923       -1 4.9e+002       6.6
                                                 1.4     0.24   3e+002        52
   5     Bus5   1.051   13.88    1     Bus1        1       18 6.8e+002 1.6e+002
                                               -0.83        -0.62  -3.4e+002  -
2.5e+002
                                     4      Bus4       1.05          16 2.9e+002  -
1.6e+002
```

```
                                                    -2.4             0.21   -1.8e+002
16
                                       2     Bus2    0.923       -1 9.2e+002      -11
                                                      0.7     0.32 5.2e+002 2.4e+002
kp 0 kq 0  Iterations 4 dpmax 0.000010 dqmax  0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000010 dqmax  0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000010 dqmax  0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000010 dqmax  0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000010 dqmax  0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000010 dqmax  0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000010 dqmax  0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000010 dqmax  0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000010 dqmax  0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000010 dqmax  0.000000
------------------------------------------------------------------------------
Time =   2.02000 Seconds
Intermediate results for Machines
GNo Name      Voltage Angle    Delta    Freq     Pgen     Qgen     Pmech    Efd/Slip
              pu      Degree   Degree   Hzs.     MW       MVAR     MW       pu/P.U.
--- -------- ------- -------- -------- ------- ------- ------- ------- --------
  1     Bus1       1     17.9     18.3      50     335     295     389     1.01
  3     Bus3    1.05     19.2     19.8      50     574      57     520     1.05
------------------------------------------------------------------------------
Maximum rotor angle difference :    1.51906 b/w buses : 1 and 3
Island    1 Common system frequency   50.027
------------------------------------------------------------------------------
Voltage (pu), Current (AMPS), impedance (PU) and power (MW-MVAR) for lines
From Name      Voltage Angle   To   Name     Voltage  Angle    Current  Angle
                                             Zl-real  Zl-im    P        Q
---- -------- ------- ------- ---- -------- -------- -------- -------- --------
   1     Bus1   1.000   17.88    5     Bus5     1.05       14 1.7e+004      -24
                                                0.67     0.59 3.3e+002   3e+002
   2     Bus2   0.923   -0.78    4     Bus4     1.05       17 5.7e+002 1.6e+002
                                                  -1         -0.4  -2.9e+002  -
1.2e+002
                                   5     Bus5     1.05       14 9.7e+002 1.6e+002
                                                -0.61        -0.2  -5.1e+002  -
1.6e+002
   3     Bus3   1.050   19.16    4     Bus4     1.05       17 1.8e+004       17
                                                0.89    0.031 4.9e+002       17
   4      Bus4    1.046    16.59     3      Bus3      1.05        19 7.9e+002  -
1.6e+002
                                                -0.89         0.0093   -4.9e+002
5.2
                                   5     Bus5     1.05       14 3.2e+002       33
                                                 2.1    -0.63 1.9e+002      -57
                                   2     Bus2    0.923    -0.78 4.9e+002      6.8
                                                 1.4     0.24   3e+002       52
   5     Bus5   1.051   14.06    1     Bus1        1       18 6.7e+002 1.6e+002
                                                -0.84        -0.64  -3.3e+002  -
2.6e+002
```

```
                                     4       Bus4       1.05          17    3e+002  -
1.6e+002
                                                      -2.3            0.21   -1.9e+002
17
                                     2     Bus2    0.923    -0.78 9.1e+002       -10
                                                       0.7     0.32 5.2e+002 2.4e+002
kp 0 kq 0  Iterations 4 dpmax 0.000010 dqmax  0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000010 dqmax  0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000010 dqmax  0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000010 dqmax  0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000010 dqmax  0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000010 dqmax  0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000010 dqmax  0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000010 dqmax  0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000010 dqmax  0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000010 dqmax  0.000000
------------------------------------------------------------------------------
Time =   2.04000 Seconds
Intermediate results for Machines
GNo Name     Voltage Angle    Delta    Freq    Pgen    Qgen    Pmech   Efd/Slip
             pu      Degree   Degree   Hzs.    MW      MVAR    MW      pu/P.U.
--- -------- ------- -------- -------- ------- ------- ------- ------- --------
  1     Bus1       1       18     18.3      50     327     295     389     1.01
  3     Bus3    1.05     19.5     20.1      50     582    57.3     520     1.05
-------------------------------------------------------------------------------
Maximum rotor angle difference :    1.76734 b/w buses : 1 and 3
Island    1 Common system frequency   50.027
------------------------------------------------------------------------------
Voltage (pu), Current (AMPS), impedance (PU) and power (MW-MVAR) for lines
From Name     Voltage Angle   To   Name     Voltage  Angle    Current  Angle
                                            Zl-real  Zl-im    P        Q
---- -------- ------- ------- ---- -------- -------- -------- -------- --------
   1     Bus1   1.000   17.96    5     Bus5     1.05       14 1.7e+004      -24
                                                0.67     0.61 3.3e+002   3e+002
   2     Bus2   0.923   -0.57    4     Bus4     1.05       17 5.7e+002 1.6e+002
                                                  -1          -0.4  -2.9e+002  -
1.2e+002
                                     5     Bus5     1.05       14 9.7e+002 1.6e+002
                                                 -0.61          -0.2  -5.1e+002  -
1.6e+002
   3     Bus3   1.050   19.47    4     Bus4     1.05       17 1.8e+004       17
                                                0.88     0.03   5e+002       17
   4      Bus4    1.046    16.86     3      Bus3      1.05         19    8e+002  -
1.6e+002
                                               -0.87   0.0097  -5e+002      5.6
                                     5     Bus5     1.05       14 3.3e+002       33
                                                   2    -0.59   2e+002      -57
                                     2     Bus2    0.923    -0.57 4.9e+002      7.1
                                                 1.4     0.24   3e+002       52
   5     Bus5   1.051   14.24    1     Bus1        1       18 6.6e+002 1.6e+002
```

```
                                                 -0.84         -0.66  -3.2e+002   -
2.6e+002
                                  4       Bus4       1.05          17 3.2e+002  -
1.6e+002
                                                  -2.2      0.21  -2e+002        18
                                  2     Bus2     0.923     -0.57 9.1e+002       -10
                                                   0.7      0.32 5.2e+002 2.4e+002
kp 0 kq 0  Iterations 4 dpmax 0.000010 dqmax  0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000010 dqmax  0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000010 dqmax  0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000010 dqmax  0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000010 dqmax  0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000010 dqmax  0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000010 dqmax  0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000010 dqmax  0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000010 dqmax  0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000010 dqmax  0.000000
------------------------------------------------------------------------------
Time =   2.06000 Seconds
Intermediate results for Machines
GNo Name     Voltage Angle    Delta    Freq    Pgen    Qgen    Pmech   Efd/Slip
             pu      Degree   Degree   Hzs.    MW      MVAR    MW      pu/P.U.
--- -------- ------- -------- -------- ------- ------- ------- ------- --------
  1     Bus1       1     18.1     18.4      50     320     295     389     1.01
  3     Bus3    1.05     19.8     20.4      50     589    57.6     520     1.05
------------------------------------------------------------------------------
Maximum rotor angle difference :    1.99322 b/w buses : 1 and 3
Island    1 Common system frequency   50.027
------------------------------------------------------------------------------
Voltage (pu), Current (AMPS), impedance (PU) and power (MW-MVAR) for lines
From Name     Voltage Angle   To   Name     Voltage  Angle    Current  Angle
                                            Zl-real  Zl-im    P        Q
---- -------- ------- ------- ---- -------- -------- -------- -------- --------
   1     Bus1   1.000   18.05    5     Bus5     1.05       14 1.7e+004      -25
                                                0.68     0.62 3.2e+002   3e+002
   2     Bus2   0.923   -0.36    4     Bus4     1.05       17 5.7e+002 1.6e+002
                                                  -1        -0.4  -2.9e+002  -
1.2e+002
                                 5     Bus5     1.05       14 9.6e+002 1.6e+002
                                               -0.61        -0.2  -5.1e+002  -
1.6e+002
   3     Bus3   1.050   19.78    4     Bus4     1.05       17 1.9e+004       18
                                                0.86     0.03 5.1e+002       18
   4      Bus4    1.046    17.12     3      Bus3      1.05         20 8.1e+002 -
1.6e+002
                                               -0.86           0.01   -5.1e+002
5.9
                                 5     Bus5     1.05       14 3.4e+002       33
                                                   2    -0.56   2e+002      -58
                                 2     Bus2    0.923    -0.36 4.9e+002      7.4
                                                 1.4     0.24   3e+002       52
```

```
   5     Bus5   1.051   14.42    1     Bus1        1       18 6.5e+002 1.6e+002
                                                -0.84         -0.68  -3.2e+002  -
2.6e+002
                                 4       Bus4       1.05          17 3.3e+002  -
1.6e+002
                                                 -2.1      0.21  -2e+002       19
                                 2     Bus2    0.923     -0.36 9.1e+002      -10
                                                  0.7      0.32 5.2e+002 2.4e+002
kp 0 kq 0  Iterations 4 dpmax 0.000010 dqmax 0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000009 dqmax 0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000009 dqmax 0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000009 dqmax 0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000009 dqmax 0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000009 dqmax 0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000009 dqmax 0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000009 dqmax 0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000009 dqmax 0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000009 dqmax 0.000000
------------------------------------------------------------------------------
Time =   2.08000 Seconds
Intermediate results for Machines
GNo Name     Voltage Angle    Delta    Freq    Pgen    Qgen    Pmech   Efd/Slip
             pu      Degree   Degree   Hzs.    MW      MVAR    MW      pu/P.U.
--- -------- ------- -------- -------- ------- ------- ------- ------- --------
  1     Bus1       1     18.2     18.5      50     313     295     389     1.01
  3     Bus3    1.05     20.1     20.7      50     596    57.9     520     1.05
-------------------------------------------------------------------------------
Maximum rotor angle difference :    2.19407 b/w buses : 1 and 3
Island    1 Common system frequency   50.027
------------------------------------------------------------------------------
Voltage (pu), Current (AMPS), impedance (PU) and power (MW-MVAR) for lines
From Name     Voltage Angle   To   Name     Voltage  Angle    Current  Angle
                                            Zl-real  Zl-im    P        Q
---- -------- ------- ------- ---- -------- -------- -------- -------- --------
   1     Bus1   1.000   18.16    5     Bus5     1.05       15 1.7e+004      -25
                                                0.68     0.64 3.1e+002   3e+002
   2     Bus2   0.923   -0.16    4     Bus4     1.05       17 5.7e+002 1.6e+002
                                                  -1        -0.39  -2.9e+002  -
1.2e+002
                                 5     Bus5     1.05       15 9.6e+002 1.6e+002
                                               -0.61         -0.2  -5.1e+002  -
1.6e+002
   3     Bus3   1.050   20.07    4     Bus4     1.05       17 1.9e+004       18
                                                0.85     0.03 5.2e+002       18
   4      Bus4    1.046    17.38     3      Bus3      1.05        20 8.2e+002  -
1.6e+002
                                               -0.85            0.01   -5.1e+002
6.2
                                 5     Bus5     1.05       15 3.5e+002       33
                                                 1.9    -0.54 2.1e+002      -58
                                 2     Bus2    0.923    -0.16 4.9e+002      7.6
```

```
                                                      1.4       0.24   3e+002        52
   5     Bus5   1.051   14.60    1      Bus1          1         18 6.4e+002 1.5e+002
                                                    -0.84           -0.7  -3.1e+002  -
2.6e+002
                                 4       Bus4       1.05           17 3.3e+002  -
1.6e+002
                                                     -2.1               0.2  -2.1e+002
20
                                 2      Bus2      0.923    -0.16 9.1e+002       -10
                                                      0.7     0.32 5.2e+002 2.4e+002
kp 0 kq 0 Iterations 4 dpmax 0.000009 dqmax 0.000000
kp 0 kq 0 Iterations 4 dpmax 0.000009 dqmax 0.000000
kp 0 kq 0 Iterations 4 dpmax 0.000009 dqmax 0.000000
kp 0 kq 0 Iterations 4 dpmax 0.000009 dqmax 0.000000
kp 0 kq 0 Iterations 4 dpmax 0.000009 dqmax 0.000000
kp 0 kq 0 Iterations 4 dpmax 0.000009 dqmax 0.000000
kp 0 kq 0 Iterations 4 dpmax 0.000009 dqmax 0.000000
kp 0 kq 0 Iterations 4 dpmax 0.000009 dqmax 0.000000
kp 0 kq 0 Iterations 4 dpmax 0.000009 dqmax 0.000000
kp 0 kq 0 Iterations 4 dpmax 0.000009 dqmax 0.000000
------------------------------------------------------------------------------
Time =   2.10000 Seconds
Intermediate results for Machines
GNo Name      Voltage Angle    Delta    Freq     Pgen     Qgen     Pmech    Efd/Slip
              pu      Degree   Degree   Hzs.     MW       MVAR     MW       pu/P.U.
--- -------- ------- -------- -------- -------- -------- -------- -------- --------
  1     Bus1        1      18.3     18.6       50      307      295      389     1.01
  3     Bus3     1.05      20.3       21       50      602     58.2      520     1.05
-------------------------------------------------------------------------------
Maximum rotor angle difference :    2.36756 b/w buses : 1 and 3
Island    1 Common system frequency   50.027
------------------------------------------------------------------------------
Voltage (pu), Current (AMPS), impedance (PU) and power (MW-MVAR) for lines
From Name      Voltage Angle   To   Name      Voltage  Angle    Current  Angle
                                              Zl-real  Zl-im    P        Q
---- -------- ------- ------- ---- --------- -------- -------- -------- --------
   1     Bus1   1.000   18.27    5      Bus5      1.05        15 1.6e+004       -26
                                                  0.68      0.65 3.1e+002   3e+002
   2     Bus2   0.923    0.05    4      Bus4      1.05        18 5.7e+002 1.6e+002
                                                    -1        -0.39    -3e+002  -
1.2e+002
                                 5      Bus5      1.05        15 9.6e+002 1.6e+002
                                                 -0.61           -0.2    -5e+002  -
1.6e+002
   3     Bus3   1.050   20.35    4      Bus4      1.05        18 1.9e+004        18
                                                  0.84      0.03 5.2e+002        18
   4      Bus4    1.046    17.63     3      Bus3      1.05          20 8.3e+002  -
1.6e+002
                                                 -0.84            0.01   -5.2e+002
6.4
                                 5      Bus5      1.05        15 3.6e+002        33
```

```
                                                  1.9    -0.52 2.2e+002       -59
                                  2     Bus2    0.923    0.051 4.9e+002       7.9
                                                  1.4     0.24   3e+002        52
   5     Bus5   1.051   14.79    1     Bus1        1       18 6.4e+002 1.5e+002
                                               -0.84        -0.72    -3e+002  -
2.6e+002
                                  4       Bus4       1.05          18 3.4e+002  -
1.6e+002
                                                    -2             0.2  -2.1e+002
21
                                  2     Bus2    0.923    0.051 9.1e+002      -9.8
                                                  0.7     0.32 5.2e+002 2.4e+002
kp 0 kq 0  Iterations 4 dpmax 0.000009 dqmax 0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000009 dqmax 0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000009 dqmax 0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000009 dqmax 0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000008 dqmax 0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000008 dqmax 0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000008 dqmax 0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000008 dqmax 0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000008 dqmax 0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000008 dqmax 0.000000
--------------------------------------------------------------------------------
Time =   2.12000 Seconds
Intermediate results for Machines
GNo Name     Voltage Angle    Delta    Freq    Pgen    Qgen    Pmech   Efd/Slip
             pu      Degree   Degree   Hzs.    MW      MVAR    MW      pu/P.U.
--- -------- ------- -------- -------- ------- ------- ------- ------- --------
  1     Bus1       1     18.4     18.8      50     303     296     389     1.01
  3     Bus3    1.05     20.6     21.3      50     606    58.5     520     1.05
--------------------------------------------------------------------------------
Maximum rotor angle difference :    2.51164 b/w buses : 1 and 3
Island    1 Common system frequency   50.027
--------------------------------------------------------------------------------
Voltage (pu), Current (AMPS), impedance (PU) and power (MW-MVAR) for lines
From Name     Voltage Angle   To   Name     Voltage  Angle    Current  Angle
                                              Zl-real  Zl-im    P        Q
---- -------- ------- ------- ---- -------- -------- -------- -------- --------
   1     Bus1   1.000   18.40    5     Bus5     1.05       15 1.6e+004       -26
                                               0.68     0.66   3e+002   3e+002
   2     Bus2   0.922    0.26    4     Bus4     1.05       18 5.8e+002 1.6e+002
                                                 -1        -0.39    -3e+002  -
1.1e+002
                                  5     Bus5     1.05       15 9.6e+002 1.6e+002
                                               -0.61          -0.2    -5e+002  -
1.6e+002
   3     Bus3   1.050   20.61    4     Bus4     1.05       18 1.9e+004        19
                                               0.84    0.029 5.3e+002        19
   4     Bus4   1.046   17.87    3     Bus3     1.05       21 8.4e+002 -
1.6e+002
```

```
                                                        -0.83            0.011   -5.2e+002
6.6
                                    5      Bus5      1.05         15 3.6e+002        33
                                                      1.9       -0.5 2.2e+002       -59
                                    2      Bus2     0.922       0.26   5e+002       8.1
                                                      1.4       0.24 3.1e+002        52
   5      Bus5    1.051    14.97    1      Bus1         1         18 6.3e+002 1.5e+002
                                                    -0.84          -0.73    -3e+002   -
2.6e+002
                                    4        Bus4        1.05           18 3.5e+002   -
1.6e+002
                                                       -2               0.2   -2.2e+002
22
                                    2      Bus2     0.922       0.26 9.1e+002      -9.7
                                                      0.7       0.32 5.2e+002 2.4e+002
kp 0 kq 0 Iterations 4 dpmax 0.000008 dqmax 0.000000
kp 0 kq 0 Iterations 4 dpmax 0.000008 dqmax 0.000000
kp 0 kq 0 Iterations 4 dpmax 0.000008 dqmax 0.000000
kp 0 kq 0 Iterations 4 dpmax 0.000008 dqmax 0.000000
kp 0 kq 0 Iterations 4 dpmax 0.000008 dqmax 0.000000
kp 0 kq 0 Iterations 4 dpmax 0.000008 dqmax 0.000000
kp 0 kq 0 Iterations 4 dpmax 0.000008 dqmax 0.000000
kp 0 kq 0 Iterations 4 dpmax 0.000008 dqmax 0.000000
kp 0 kq 0 Iterations 4 dpmax 0.000008 dqmax 0.000000
kp 0 kq 0 Iterations 4 dpmax 0.000008 dqmax 0.000000
------------------------------------------------------------------------------
Time =   2.14000 Seconds
Intermediate results for Machines
GNo Name     Voltage Angle    Delta    Freq    Pgen    Qgen    Pmech   Efd/Slip
             pu      Degree   Degree   Hzs.    MW      MVAR    MW      pu/P.U.
--- -------- ------- -------- -------- ------- ------- ------- ------- --------
  1     Bus1       1     18.5     18.9      50     299     296     389     1.01
  3     Bus3    1.05     20.9     21.5      50     610    58.7     520     1.05
-------------------------------------------------------------------------------
Maximum rotor angle difference :    2.62463 b/w buses : 1 and 3
Island    1 Common system frequency   50.027
------------------------------------------------------------------------------
Voltage (pu), Current (AMPS), impedance (PU) and power (MW-MVAR) for lines
From Name     Voltage Angle   To   Name     Voltage  Angle    Current  Angle
                                            Zl-real  Zl-im    P        Q
---- -------- ------- ------- ---- -------- -------- -------- -------- --------
   1     Bus1   1.000   18.54    5     Bus5     1.05        15 1.6e+004       -26
                                                0.68      0.67   3e+002   3e+002
   2     Bus2   0.922    0.46    4     Bus4     1.05        18 5.8e+002 1.6e+002
                                                  -1        -0.39    -3e+002   -
1.1e+002
                                   5     Bus5     1.05        15 9.6e+002 1.6e+002
                                               -0.61          -0.2    -5e+002   -
1.7e+002
   3     Bus3   1.050   20.87    4     Bus4     1.05        18 1.9e+004        19
                                                0.83     0.029 5.3e+002        19
```

```
   4      Bus4    1.046    18.11     3      Bus3      1.05         21 8.5e+002  -
1.6e+002
                                                    -0.83           0.011   -5.3e+002
6.8
                                  5     Bus5     1.05       15 3.7e+002       33
                                                   1.8    -0.49 2.2e+002      -59
                                  2     Bus2    0.922     0.46   5e+002      8.3
                                                   1.4     0.24 3.1e+002       53
   5     Bus5   1.051   15.16    1     Bus1        1       19 6.3e+002 1.5e+002
                                                  -0.84        -0.74    -3e+002  -
2.6e+002
                                  4       Bus4       1.05          18 3.5e+002  -
1.6e+002
                                                     -2             0.2  -2.2e+002
23
                                  2     Bus2    0.922     0.46 9.1e+002     -9.5
                                                   0.7     0.32 5.2e+002 2.4e+002
kp 0 kq 0  Iterations 4 dpmax 0.000008 dqmax  0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000008 dqmax  0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000008 dqmax  0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000008 dqmax  0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000008 dqmax  0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000007 dqmax  0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000007 dqmax  0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000007 dqmax  0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000007 dqmax  0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000007 dqmax  0.000000
--------------------------------------------------------------------------------
Time =   2.16000 Seconds
Intermediate results for Machines
GNo Name     Voltage Angle    Delta    Freq    Pgen    Qgen    Pmech   Efd/Slip
             pu      Degree   Degree   Hzs.    MW      MVAR    MW      pu/P.U.
--- -------- ------- -------- -------- ------- ------- ------- ------- --------
  1     Bus1       1     18.7     19.1      50     296     296     389     1.01
  3     Bus3    1.05     21.1     21.8      50     613    58.9     520     1.05
--------------------------------------------------------------------------------
Maximum rotor angle difference :    2.70520 b/w buses : 1 and 3
Island    1 Common system frequency   50.027
--------------------------------------------------------------------------------
Voltage (pu), Current (AMPS), impedance (PU) and power (MW-MVAR) for lines
From Name     Voltage Angle   To   Name     Voltage  Angle    Current  Angle
                                              Zl-real  Zl-im    P        Q
---- -------- ------- ------- ---- -------- -------- -------- -------- -------
   1     Bus1   1.000   18.70    5     Bus5     1.05       15 1.6e+004       -26
                                                 0.68     0.68   3e+002   3e+002
   2     Bus2   0.922    0.66    4     Bus4     1.05       18 5.8e+002 1.6e+002
                                                   -1        -0.39    -3e+002  -
1.1e+002
                                  5     Bus5     1.05       15 9.6e+002 1.6e+002
                                                -0.61          -0.2    -5e+002  -
1.7e+002
```

```
   3     Bus3   1.050   21.10    4     Bus4     1.05       18   2e+004       19
                                                 0.83    0.029 5.3e+002       19
   4      Bus4    1.046    18.33     3      Bus3      1.05         21 8.5e+002  -
1.6e+002
                                                -0.82           0.011   -5.3e+002
6.9
                                 5     Bus5     1.05       15 3.7e+002       33
                                                 1.8    -0.48 2.2e+002      -60
                                 2     Bus2    0.922     0.66   5e+002      8.6
                                                 1.4     0.24 3.1e+002       53
   5     Bus5   1.051   15.35    1     Bus1        1       19 6.3e+002 1.5e+002
                                                -0.84        -0.75   -2.9e+002   -
2.6e+002
                                 4       Bus4      1.05          18 3.6e+002  -
1.6e+002
                                                   -2              0.2  -2.2e+002
23
                                 2     Bus2    0.922     0.66 9.1e+002     -9.3
                                                 0.7     0.32 5.2e+002 2.4e+002
kp 0 kq 0  Iterations 4 dpmax 0.000007 dqmax 0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000007 dqmax 0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000007 dqmax 0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000007 dqmax 0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000007 dqmax 0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000007 dqmax 0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000007 dqmax 0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000007 dqmax 0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000007 dqmax 0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000007 dqmax 0.000000
------------------------------------------------------------------------------
Time =   2.18000 Seconds
Intermediate results for Machines
GNo Name        Voltage Angle    Delta    Freq     Pgen     Qgen     Pmech    Efd/Slip
                pu      Degree   Degree   Hzs.     MW       MVAR     MW       pu/P.U.
--- -------- ------- -------- -------- ------- ------- ------- ------- --------
  1     Bus1        1     18.9     19.2      50     295     296     389     1.01
  3     Bus3     1.05     21.3       22      50     614      59     520     1.05
---------------------------------------------------------------------------
Maximum rotor angle difference :    2.75240 b/w buses : 1 and 3
Island    1 Common system frequency   50.027
------------------------------------------------------------------------------
Voltage (pu), Current (AMPS), impedance (PU) and power (MW-MVAR) for lines
From Name      Voltage Angle   To   Name     Voltage  Angle    Current  Angle
                                             Zl-real  Zl-im    P        Q
---- -------- ------- ------- ---- -------- -------- -------- -------- --------
   1     Bus1   1.000   18.88    5     Bus5     1.05       16 1.6e+004      -26
                                                 0.68     0.68 2.9e+002   3e+002
   2     Bus2   0.922    0.86    4     Bus4     1.05       19 5.8e+002 1.6e+002
                                                   -1       -0.39    -3e+002   -
1.1e+002
                                 5     Bus5     1.05       16 9.6e+002 1.6e+002
```

```
                                                  -0.61          -0.2    -5e+002  -
1.7e+002
   3     Bus3   1.050   21.32    4     Bus4     1.05       19   2e+004       19
                                                  0.82    0.029 5.3e+002       19
   4      Bus4    1.046    18.54     3       Bus3      1.05         21 8.5e+002  -
1.6e+002
                                                  -0.82           0.011   -5.3e+002
6.9
                                  5     Bus5     1.05       16 3.7e+002       33
                                                   1.8    -0.48 2.3e+002      -60
                                  2     Bus2    0.922     0.86   5e+002      8.8
                                                   1.4     0.24 3.1e+002       53
   5     Bus5   1.051   15.55    1     Bus1        1       19 6.2e+002 1.5e+002
                                                  -0.84         -0.75  -2.9e+002  -
2.6e+002
                                  4       Bus4       1.05          19 3.6e+002  -
1.6e+002
                                                  -1.9             0.2  -2.3e+002
23
                                  2     Bus2    0.922     0.86 9.1e+002     -9.1
                                                  0.71     0.32 5.2e+002 2.4e+002
kp 0 kq 0  Iterations 4 dpmax 0.000007 dqmax  0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000007 dqmax  0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000007 dqmax  0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000007 dqmax  0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000006 dqmax  0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000006 dqmax  0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000006 dqmax  0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000006 dqmax  0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000006 dqmax  0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000006 dqmax  0.000000
--------------------------------------------------------------------------------
Time =   2.20000 Seconds
Intermediate results for Machines
GNo Name     Voltage Angle    Delta    Freq    Pgen    Qgen    Pmech   Efd/Slip
             pu      Degree   Degree   Hzs.    MW      MVAR    MW      pu/P.U.
--- -------- ------- -------- -------- ------- ------- ------- ------- --------
  1     Bus1       1     19.1     19.4      50     294     296     389      1.01
  3     Bus3    1.05     21.5     22.2      50     615      59     520      1.05
--------------------------------------------------------------------------------
Maximum rotor angle difference :    2.76564 b/w buses : 1 and 3
Island    1 Common system frequency   50.027
--------------------------------------------------------------------------------
Voltage (pu), Current (AMPS), impedance (PU) and power (MW-MVAR) for lines
From Name     Voltage Angle   To   Name     Voltage  Angle    Current  Angle
                                              Zl-real  Zl-im    P        Q
---- -------- ------- ------- ---- -------- -------- -------- -------- --------
   1     Bus1    1.000   19.06    5     Bus5     1.05       16 1.6e+004       -26
                                                  0.68     0.68 2.9e+002   3e+002
   2     Bus2    0.922    1.06    4     Bus4     1.05       19 5.8e+002 1.6e+002
```

```
                                                    -1         -0.39    -3e+002   -
1.1e+002
                                 5     Bus5     1.05       16 9.6e+002 1.6e+002
                                               -0.61          -0.2    -5e+002   -
1.7e+002
   3     Bus3   1.050   21.53    4     Bus4     1.05       19   2e+004       19
                                                0.82    0.029 5.3e+002       19
   4      Bus4    1.046    18.74     3      Bus3      1.05         22 8 .5e+002 -
1.6e+002
                                               -0.82           0.011   -5.3e+002
7
                                 5     Bus5     1.05       16 3.8e+002       33
                                                 1.8    -0.47 2.3e+002      -60
                                 2     Bus2    0.922      1.1   5e+002        9
                                                 1.4     0.24 3.1e+002       53
   5     Bus5   1.051   15.74    1     Bus1        1       19 6.2e+002 1.5e+002
                                               -0.84         -0.75  -2.9e+002   -
2.6e+002
                                 4       Bus4       1.05          19 3.6e+002  -
1.6e+002
                                                -1.9              0.2  -2.3e+002
23
                                 2     Bus2    0.922      1.1 9.1e+002     -8.9
                                                0.71     0.32 5.2e+002 2.4e+002
kp 0 kq 0  Iterations 4 dpmax 0.000006 dqmax 0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000006 dqmax 0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000006 dqmax 0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000006 dqmax 0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000006 dqmax 0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000006 dqmax 0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000006 dqmax 0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000006 dqmax 0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000006 dqmax 0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000006 dqmax 0.000000
------------------------------------------------------------------------------
Time =   2.22000 Seconds
Intermediate results for Machines
GNo Name     Voltage Angle    Delta    Freq     Pgen     Qgen     Pmech    Efd/Slip
             pu      Degree   Degree   Hzs.     MW       MVAR     MW       pu/P.U.
--- -------- ------- -------- -------- ------- ------- ------- ------- --------
  1     Bus1       1     19.3     19.6      50     295     296     389     1.01
  3     Bus3    1.05     21.7     22.4      50     614      59     520     1.05
---------------------------------------------------------------------------
Maximum rotor angle difference :    2.74474 b/w buses : 1 and 3
Island    1 Common system frequency   50.027
------------------------------------------------------------------------------
Voltage (pu), Current (AMPS), impedance (PU) and power (MW-MVAR) for lines
From Name      Voltage Angle   To   Name     Voltage  Angle    Current  Angle
                                             Zl-real  Zl-im    P        Q
---- -------- ------- ------- ---- -------- -------- -------- -------- --------
   1     Bus1   1.000   19.27    5     Bus5     1.05       16 1.6e+004       26
```

```
                                                    0.68     0.68 2.9e+002   3e+002
   2     Bus2   0.922    1.26    4     Bus4      1.05       19 5.8e+002 1.6e+002
                                                      -1        -0.39    -3e+002  -
1.1e+002
                                   5     Bus5      1.05       16 9.6e+002 1.6e+002
                                                   -0.61          -0.2    -5e+002  -
1.7e+002
   3     Bus3   1.050   21.72    4     Bus4      1.05       19   2e+004       20
                                                    0.82    0.029 5.3e+002       19
   4      Bus4    1.046    18.93     3       Bus3       1.05         22 8.5e+002  -
1.6e+002
                                                   -0.82           0.011   -5.3e+002
7
                                   5     Bus5      1.05       16 3.7e+002       34
                                                     1.8    -0.48 2.3e+002      -60
                                   2     Bus2     0.922      1.3   5e+002      9.2
                                                     1.4     0.24 3.1e+002       53
   5     Bus5   1.051   15.94    1     Bus1         1       19 6.2e+002 1.5e+002
                                                   -0.84         -0.75  -2.9e+002  -
2.6e+002
                                   4        Bus4        1.05          19 3.6e+002  -
1.6e+002
                                                    -1.9              0.2  -2.3e+002
23
                                   2     Bus2     0.922      1.3 9.1e+002     -8.7
                                                    0.71     0.32 5.2e+002 2.4e+002
kp 0 kq 0 Iterations 4 dpmax 0.000006 dqmax 0.000000
kp 0 kq 0 Iterations 4 dpmax 0.000006 dqmax 0.000000
kp 0 kq 0 Iterations 4 dpmax 0.000006 dqmax 0.000000
kp 0 kq 0 Iterations 4 dpmax 0.000005 dqmax 0.000000
kp 0 kq 0 Iterations 4 dpmax 0.000005 dqmax 0.000000
kp 0 kq 0 Iterations 4 dpmax 0.000005 dqmax 0.000000
kp 0 kq 0 Iterations 4 dpmax 0.000005 dqmax 0.000000
kp 0 kq 0 Iterations 4 dpmax 0.000005 dqmax 0.000000
kp 0 kq 0 Iterations 4 dpmax 0.000005 dqmax 0.000000
kp 0 kq 0 Iterations 4 dpmax 0.000005 dqmax 0.000000
--------------------------------------------------------------------------------
Time =   2.24000 Seconds
Intermediate results for Machines
GNo Name     Voltage Angle    Delta    Freq    Pgen    Qgen    Pmech   Efd/Slip
             pu      Degree   Degree   Hzs.    MW      MVAR    MW      pu/P.U.
--- -------- ------- -------- -------- ------- ------- ------- ------- --------
  1     Bus1       1     19.5     19.9      50     296     296     389     1.01
  3     Bus3    1.05     21.9     22.5      50     613    58.9     520     1.05
--------------------------------------------------------------------------------
Maximum rotor angle difference :    2.68993 b/w buses : 1 and 3
Island    1 Common system frequency   50.027
--------------------------------------------------------------------------------
Voltage (pu), Current (AMPS), impedance (PU) and power (MW-MVAR) for lines
From Name     Voltage Angle   To   Name     Voltage  Angle    Current  Angle
                                              Zl-real  Zl-im    P        Q
```

```
---- -------- ------- ------- ---- -------- -------- -------- -------- --------
   1     Bus1   1.000   19.49     5     Bus5     1.05       16 1.6e+004       -25
                                                 0.68     0.68   3e+002   3e+002
   2     Bus2   0.922    1.45     4     Bus4     1.05       19 5.8e+002 1.6e+002
                                                   -1        -0.39    -3e+002  -
1.1e+002
                                   5     Bus5     1.05       16 9.6e+002 1.6e+002
1.7e+002                                        -0.61          -0.2    -5e+002  -
   3     Bus3   1.050   21.89     4     Bus4     1.05       19   2e+004       20
                                                 0.83    0.029 5.3e+002       19
   4      Bus4    1.046    19.12     3      Bus3      1.05         22 8.5e+002 -
1.6e+002
                                                -0.82           0.011   -5.3e+002
6.9
                                   5     Bus5     1.05       16 3.7e+002       34
                                                  1.8    -0.48 2.2e+002      -60
                                   2     Bus2    0.922      1.4   5e+002      9.3
                                                  1.4     0.24 3.1e+002       53
   5     Bus5   1.051   16.14     1     Bus1        1       19 6.3e+002 1.5e+002
                                                -0.84         -0.75  -2.9e+002  -
2.6e+002
                                   4       Bus4       1.05          19 3.6e+002  -
1.6e+002
                                                   -2              0.2  -2.2e+002
23
                                   2     Bus2    0.922      1.4 9.1e+002     -8.5
                                                  0.7     0.32 5.2e+002 2.4e+002
kp 0 kq 0  Iterations 4 dpmax 0.000005 dqmax  0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000005 dqmax  0.000000
kp 0 kq 0  Iterations 3 dpmax 0.000100 dqmax  0.000000
kp 0 kq 0  Iterations 3 dpmax 0.000099 dqmax  0.000000
kp 0 kq 0  Iterations 3 dpmax 0.000098 dqmax  0.000000
kp 0 kq 0  Iterations 3 dpmax 0.000097 dqmax  0.000000
kp 0 kq 0  Iterations 3 dpmax 0.000096 dqmax  0.000000
kp 0 kq 0  Iterations 3 dpmax 0.000095 dqmax  0.000000
kp 0 kq 0  Iterations 3 dpmax 0.000094 dqmax  0.000000
kp 0 kq 0  Iterations 3 dpmax 0.000093 dqmax  0.000000
------------------------------------------------------------------------------
Time =   2.26000 Seconds
Intermediate results for Machines
GNo Name     Voltage Angle    Delta    Freq    Pgen    Qgen    Pmech   Efd/Slip
             pu      Degree   Degree   Hzs.    MW      MVAR    MW      pu/P.U.
--- -------- ------- -------- -------- ------- ------- ------- ------- --------
  1     Bus1       1     19.7     20.1      50     299     296     389     1.01
  3     Bus3    1.05       22     22.7      50     610    58.7     520     1.05
------------------------------------------------------------------------------
Maximum rotor angle difference :    2.60179 b/w buses : 1 and 3
Island    1 Common system frequency   50.027
------------------------------------------------------------------------------
Voltage (pu), Current (AMPS), Impedance (PU) and power (MW-MVAR) for lines
```

```
From Name     Voltage Angle   To   Name     Voltage  Angle    Current  Angle
                                              Zl-real  Zl-im    P        Q
---- -------- ------- ------- ---- -------- -------- -------- -------- --------
   1     Bus1   1.000   19.73    5     Bus5     1.05       16 1.6e+004      -25
                                              0.68     0.67   3e+002   3e+002
   2     Bus2   0.922    1.64    4     Bus4     1.05       19 5.8e+002 1.6e+002
                                                -1        -0.39    -3e+002  -
1.1e+002
                                5     Bus5     1.05       16 9.6e+002 1.6e+002
                                             -0.61          -0.2    -5e+002  -
1.7e+002
   3     Bus3   1.050   22.05    4     Bus4     1.05       19 1.9e+004       20
                                              0.83    0.029 5.3e+002       19
   4      Bus4    1.046    19.29     3      Bus3      1.05         22 8.5e+002  -
1.6e+002
                                             -0.83           0.011   -5.3e+002
6.8
                                5     Bus5     1.05       16 3.7e+002       34
                                               1.8    -0.49 2.2e+002      -59
                                2     Bus2    0.922      1.6   5e+002      9.5
                                               1.4     0.24 3.1e+002       53
   5     Bus5   1.051   16.34    1     Bus1        1       20 6.3e+002 1.6e+002
                                             -0.84         -0.74    -3e+002  -
2.6e+002
                                4       Bus4       1.05          19 3.5e+002  -
1.6e+002
                                               -2             0.2   -2.2e+002
23
                                2     Bus2    0.922      1.6 9.1e+002     -8.3
                                               0.7     0.32 5.2e+002 2.4e+002
kp 0 kq 0  Iterations 3 dpmax 0.000092 dqmax 0.000000
kp 0 kq 0  Iterations 3 dpmax 0.000091 dqmax 0.000000
kp 0 kq 0  Iterations 3 dpmax 0.000090 dqmax 0.000000
kp 0 kq 0  Iterations 3 dpmax 0.000089 dqmax 0.000000
kp 0 kq 0  Iterations 3 dpmax 0.000088 dqmax 0.000000
kp 0 kq 0  Iterations 3 dpmax 0.000087 dqmax 0.000000
kp 0 kq 0  Iterations 3 dpmax 0.000086 dqmax 0.000000
kp 0 kq 0  Iterations 3 dpmax 0.000085 dqmax 0.000000
kp 0 kq 0  Iterations 3 dpmax 0.000084 dqmax 0.000000
kp 0 kq 0  Iterations 3 dpmax 0.000083 dqmax 0.000000
------------------------------------------------------------------------------
Time =   2.28000 Seconds
Intermediate results for Machines
GNo Name     Voltage Angle    Delta    Freq    Pgen    Qgen    Pmech   Efd/Slip
             pu      Degree   Degree   Hzs.    MW      MVAR    MW      pu/P.U.
--- -------- ------- -------- -------- ------- ------- ------- ------- --------
  1     Bus1       1       20     20.3      50     303     295     389     1.01
  3     Bus3    1.05     22.2     22.8      50     606    58.5     520     1.05
------------------------------------------------------------------------------
Maximum rotor angle difference :    2.40182 b/w buses : 1 and 3
Island   1 Common system frequency :   50.027
```

```
------------------------------------------------------------------------------
Voltage (pu), Current (AMPS), impedance (PU) and power (MW-MVAR) for lines
From Name     Voltage Angle   To   Name     Voltage  Angle    Current  Angle
                                              Zl-real  Zl-im    P        Q
---- -------- ------- ------- ---- -------- -------- -------- -------- --------
   1     Bus1   1.000   19.98    5     Bus5     1.05       17 1.6e+004       -24
                                              0.68     0.66   3e+002   3e+002
   2     Bus2   0.922    1.83    4     Bus4     1.05       19 5.8e+002 1.6e+002
                                                -1        -0.39    -3e+002  -
1.1e+002
                                5     Bus5     1.05       17 9.6e+002 1.6e+002
                                              -0.61          -0.2    -5e+002  -
1.6e+002
   3     Bus3   1.050   22.19    4     Bus4     1.05       19 1.9e+004       20
                                              0.84    0.029 5.3e+002       18
   4      Bus4    1.046    19.45     3       Bus3      1.05         22 8.4e+002  -
1.6e+002
                                             -0.83           0.011   -5.2e+002
6.6
                                5     Bus5     1.05       17 3.6e+002       35
                                               1.9     -0.5 2.2e+002      -59
                                2     Bus2    0.922      1.8   5e+002      9.7
                                               1.4     0.24 3.1e+002       52
   5     Bus5   1.051   16.55    1     Bus1        1       20 6.3e+002 1.6e+002
                                             -0.84         -0.73    -3e+002  -
2.6e+002
                                4       Bus4       1.05          19 3.5e+002  -
1.6e+002
                                               -2             0.2   -2.2e+002
22
                                2     Bus2    0.922      1.8 9.1e+002     -8.1
                                                0.7     0.32 5.2e+002 2.4e+002
kp 0 kq 0  Iterations 3 dpmax 0.000082 dqmax  0.000000
kp 0 kq 0  Iterations 3 dpmax 0.000081 dqmax  0.000000
kp 0 kq 0  Iterations 3 dpmax 0.000080 dqmax  0.000000
kp 0 kq 0  Iterations 3 dpmax 0.000079 dqmax  0.000000
kp 0 kq 0  Iterations 3 dpmax 0.000078 dqmax  0.000000
kp 0 kq 0  Iterations 3 dpmax 0.000077 dqmax  0.000000
kp 0 kq 0  Iterations 3 dpmax 0.000077 dqmax  0.000000
kp 0 kq 0  Iterations 3 dpmax 0.000076 dqmax  0.000000
kp 0 kq 0  Iterations 3 dpmax 0.000075 dqmax  0.000000
kp 0 kq 0  Iterations 3 dpmax 0.000074 dqmax  0.000000
------------------------------------------------------------------------------
Time =   2.30000 Seconds
Intermediate results for Machines
GNo Name     Voltage Angle    Delta    Freq    Pgen    Qgen    Pmech   Efd/Slip
             pu      Degree   Degree   Hzs.    MW      MVAR    MW      pu/P.U.
--- -------- ------- -------- -------- ------- ------- ------- ------- --------
  1     Bus1       1     20.2     20.6      50     307     295     389      1.01
  3     Bus3    1.05     22.3       23      50     601    58.2     520      1.05
------------------------------------------------------------------------------
```

```
Maximum rotor angle difference :    2.32988 b/w buses : 1 and 3
Island    1 Common system frequency   50.027
------------------------------------------------------------------------------
Voltage (pu), Current (AMPS), impedance (PU) and power (MW-MVAR) for lines
From Name     Voltage Angle   To   Name     Voltage  Angle    Current  Angle
                                              Zl-real  Zl-im    P        Q
---- -------- ------- ------- ---- -------- -------- -------- -------- --------
   1     Bus1   1.000   20.24    5     Bus5     1.05       17 1.6e+004       -24
                                               0.68     0.65 3.1e+002   3e+002
   2     Bus2   0.923    2.02    4     Bus4     1.05       20 5.7e+002 1.6e+002
                                                 -1        -0.39    -3e+002  -
1.2e+002
                                5     Bus5     1.05       17 9.6e+002 1.6e+002
                                              -0.61          -0.2    -5e+002  -
1.6e+002
   3     Bus3   1.050   22.32    4     Bus4     1.05       20 1.9e+004       20
                                               0.84     0.03 5.2e+002       18
   4      Bus4    1.046    19.60     3      Bus3      1.05         22 8.3e+002  -
1.6e+002
                                             -0.84            0.01   -5.2e+002
6.5
                                5     Bus5     1.05       17 3.6e+002       35
                                                1.9    -0.52 2.2e+002      -59
                                2     Bus2    0.923        2 4.9e+002      9.8
                                                1.4     0.24   3e+002       52
   5     Bus5   1.051   16.76    1     Bus1        1       20 6.4e+002 1.6e+002
                                             -0.84         -0.71    -3e+002  -
2.6e+002
                                4       Bus4       1.05          20 3.4e+002  -
1.6e+002
                                                -2             0.2   -2.1e+002
21
                                2     Bus2    0.923        2 9.1e+002     -7.9
                                                0.7     0.32 5.2e+002 2.4e+002
kp 0 kq 0  Iterations 3 dpmax 0.000073 dqmax 0.000000
kp 0 kq 0  Iterations 3 dpmax 0.000072 dqmax 0.000000
kp 0 kq 0  Iterations 3 dpmax 0.000071 dqmax 0.000000
kp 0 kq 0  Iterations 3 dpmax 0.000070 dqmax 0.000000
kp 0 kq 0  Iterations 3 dpmax 0.000069 dqmax 0.000000
kp 0 kq 0  Iterations 3 dpmax 0.000068 dqmax 0.000000
kp 0 kq 0  Iterations 3 dpmax 0.000068 dqmax 0.000000
kp 0 kq 0  Iterations 3 dpmax 0.000067 dqmax 0.000000
kp 0 kq 0  Iterations 3 dpmax 0.000066 dqmax 0.000000
kp 0 kq 0  Iterations 3 dpmax 0.000065 dqmax 0.000000
------------------------------------------------------------------------------
Time =   2.32000 Seconds
Intermediate results for Machines
GNo Name     Voltage Angle    Delta    Freq    Pgen    Qgen    Pmech   Efd/Slip
             pu      Degree   Degree   Hzs.    MW      MVAR    MW      pu/P.U.
--- -------- ------- -------- -------- ------- ------- ------- ------- --------
  1     Bus1       1    20.5     20.9      50     313     295     389    1.01
```

```
  3     Bus3    1.05     22.4     23.1      50     596    57.9     520     1.05
--------------------------------------------------------------------------------
Maximum rotor angle difference :    2.14919 b/w buses : 1 and 3
Island    1 Common system frequency 50.027
--------------------------------------------------------------------------------
Voltage (pu), Current (AMPS), impedance (PU) and power (MW-MVAR) for lines
From Name     Voltage Angle   To   Name     Voltage  Angle    Current  Angle
                                              Zl-real  Zl-im    P        Q
---- -------- ------- ------- ---- -------- -------- -------- -------- --------
   1     Bus1   1.000   20.52    5     Bus5     1.05       17 1.7e+004       -23
                                              0.68     0.64 3.1e+002   3e+002
   2     Bus2   0.923    2.21    4     Bus4     1.05       20 5.7e+002 1.6e+002
                                                -1        -0.39  -2.9e+002  -
1.2e+002
                                   5     Bus5     1.05       17 9.6e+002 1.6e+002
                                             -0.61          -0.2  -5.1e+002  -
1.6e+002
   3     Bus3   1.050   22.43    4     Bus4     1.05       20 1.9e+004       20
                                              0.85     0.03 5.2e+002       18
   4      Bus4    1.046    19.75     3       Bus3      1.05         22 8.2e+002  -
1.6e+002
                                             -0.85            0.01   -5.1e+002
6.2
                                   5     Bus5     1.05       17 3.5e+002       35
                                               1.9    -0.54 2.1e+002      -58
                                   2     Bus2    0.923      2.2 4.9e+002       10
                                               1.4     0.24   3e+002       52
   5     Bus5   1.051   16.97    1     Bus1        1       21 6.4e+002 1.6e+002
                                             -0.84          -0.7  -3.1e+002  -
2.6e+002
                                   4        Bus4       1.05          20 3.3e+002  -
1.6e+002
                                             -2.1             0.2   -2.1e+002
20
                                   2     Bus2    0.923      2.2 9.1e+002     -7.6
                                                 0.7     0.32 5.2e+002 2.4e+002
kp 0 kq 0  Iterations 3 dpmax 0.000064 dqmax  0.000000
kp 0 kq 0  Iterations 3 dpmax 0.000063 dqmax  0.000000
kp 0 kq 0  Iterations 3 dpmax 0.000063 dqmax  0.000000
kp 0 kq 0  Iterations 3 dpmax 0.000062 dqmax  0.000000
kp 0 kq 0  Iterations 3 dpmax 0.000061 dqmax  0.000000
kp 0 kq 0  Iterations 3 dpmax 0.000060 dqmax  0.000000
kp 0 kq 0  Iterations 3 dpmax 0.000059 dqmax  0.000000
kp 0 kq 0  Iterations 3 dpmax 0.000059 dqmax  0.000000
kp 0 kq 0  Iterations 3 dpmax 0.000058 dqmax  0.000000
kp 0 kq 0  Iterations 3 dpmax 0.000057 dqmax  0.000000
--------------------------------------------------------------------------------
Time =   2.34000 Seconds
Intermediate results for Machines
GNo Name      Voltage Angle    Delta    Freq     Pgen     Qgen     Pmech    Efd/Slip
                  pu   Degree   Degree   Hzs.     MW       MVAR     MW       pu/P.U
```

```
--- -------- ------- -------- -------- ------- ------- ------- ------- --------
  1     Bus1       1     20.8     21.2      50     320     295     389     1.01
  3     Bus3    1.05     22.5     23.2      50     589    57.6     520     1.05
------------------------------------------------------------------------------
Maximum rotor angle difference :    1.94131 b/w buses : 1 and 3
Island    1 Common system frequency   50.027
------------------------------------------------------------------------------
Voltage (pu), Current (AMPS), impedance (PU) and power (MW-MVAR) for lines
From Name     Voltage Angle   To   Name     Voltage  Angle    Current  Angle
                                              Zl-real  Zl-im    P        Q
---- -------- ------- ------- ---- -------- -------- -------- -------- --------
   1     Bus1   1.000   20.81    5     Bus5     1.05       17 1.7e+004       -22
                                              0.68     0.62 3.2e+002   3e+002
   2     Bus2   0.923    2.40    4     Bus4     1.05       20 5.7e+002 1.6e+002
                                                -1          -0.4  -2.9e+002  -
1.2e+002
                                5     Bus5     1.05       17 9.6e+002 1.6e+002
                                             -0.61          -0.2  -5.1e+002  -
1.6e+002
   3     Bus3   1.050   22.53    4     Bus4     1.05       20 1.9e+004       21
                                              0.87     0.03 5.1e+002       18
   4      Bus4    1.046    19.88     3      Bus3      1.05         23 8.1e+002 -
1.6e+002
                                            -0.86            0.01   -5.1e+002
5.9
                                5     Bus5     1.05       17 3.4e+002       36
                                                2    -0.56   2e+002      -58
                                2     Bus2    0.923      2.4 4.9e+002       10
                                              1.4     0.24   3e+002       52
   5     Bus5   1.051   17.18    1     Bus1        1       21 6.5e+002 1.6e+002
                                             -0.84         -0.68  -3.2e+002  -
2.6e+002
                                4       Bus4       1.05          20 3.3e+002  -
1.6e+002
                                             -2.2     0.21  -2e+002       19
                                2     Bus2    0.923      2.4 9.1e+002     -7.4
                                              0.7     0.32 5.2e+002 2.4e+002
kp 0 kq 0  Iterations 3 dpmax 0.000056 dqmax 0.000000
kp 0 kq 0  Iterations 3 dpmax 0.000055 dqmax 0.000000
kp 0 kq 0  Iterations 3 dpmax 0.000055 dqmax 0.000000
kp 0 kq 0  Iterations 3 dpmax 0.000054 dqmax 0.000000
kp 0 kq 0  Iterations 3 dpmax 0.000053 dqmax 0.000000
kp 0 kq 0  Iterations 3 dpmax 0.000052 dqmax 0.000000
kp 0 kq 0  Iterations 3 dpmax 0.000052 dqmax 0.000000
kp 0 kq 0  Iterations 3 dpmax 0.000051 dqmax 0.000000
kp 0 kq 0  Iterations 3 dpmax 0.000050 dqmax 0.000000
kp 0 kq 0  Iterations 3 dpmax 0.000050 dqmax 0.000000
------------------------------------------------------------------------------
Time =   2.36000 Seconds
Intermediate results for Machines
GNo Name     Voltage Angle    Delta    Freq    Pgen    Qgen    Pmech   Efd/Slip
```

```
             pu       Degree   Degree   Hzs.     MW       MVAR     MW       pu/P.U.
--- -------- ------- -------- -------- ------- ------- ------- ------- --------
  1     Bus1       1     21.1     21.5      50     327     295     389      1.01
  3     Bus3    1.05     22.6     23.2      50     582    57.3     520      1.05
--------------------------------------------------------------------------------
Maximum rotor angle difference :    1.70864 b/w buses : 1 and 3
Island    1 Common system frequency   50.027
--------------------------------------------------------------------------------
Voltage (pu), Current (AMPS), impedance (PU) and power (MW-MVAR) for lines
From Name     Voltage Angle   To   Name     Voltage  Angle    Current  Angle
                                              Zl-real  Zl-im    P        Q
---- -------- ------- ------- ---- -------- -------- -------- -------- --------
   1     Bus1   1.000   21.12    5     Bus5     1.05       17 1.7e+004       -21
                                              0.67     0.61 3.3e+002   3e+002
   2     Bus2   0.923    2.58    4     Bus4     1.05       20 5.7e+002 1.6e+002
                                                -1          -0.4  -2.9e+002  -
1.2e+002
                                5     Bus5     1.05       17 9.7e+002 1.6e+002
                                             -0.61          -0.2  -5.1e+002  -
1.6e+002
   3     Bus3   1.050   22.62    4     Bus4     1.05       20 1.8e+004       21
                                              0.88     0.03   5e+002       17
   4      Bus4    1.046    20.01     3      Bus3      1.05         23    8e+002  -
1.6e+002
                                             -0.87   0.0098  -5e+002      5.6
                                5     Bus5     1.05       17 3.3e+002       36
                                                2    -0.59   2e+002      -57
                                2     Bus2    0.923      2.6 4.9e+002       10
                                              1.4     0.24   3e+002       52
   5     Bus5   1.051   17.39    1     Bus1        1       21 6.6e+002 1.6e+002
                                             -0.84         -0.66  -3.2e+002  -
2.6e+002
                                4       Bus4       1.05          20 3.2e+002  -
1.6e+002
                                             -2.2     0.21  -2e+002       18
                                2     Bus2    0.923      2.6 9.1e+002     -7.1
                                              0.7     0.32 5.2e+002 2.4e+002
kp 0 kq 0  Iterations 3 dpmax 0.000049 dqmax  0.000000
kp 0 kq 0  Iterations 3 dpmax 0.000048 dqmax  0.000000
kp 0 kq 0  Iterations 3 dpmax 0.000048 dqmax  0.000000
kp 0 kq 0  Iterations 3 dpmax 0.000047 dqmax  0.000000
kp 0 kq 0  Iterations 3 dpmax 0.000046 dqmax  0.000000
kp 0 kq 0  Iterations 3 dpmax 0.000046 dqmax  0.000000
kp 0 kq 0  Iterations 3 dpmax 0.000045 dqmax  0.000000
kp 0 kq 0  Iterations 3 dpmax 0.000044 dqmax  0.000000
kp 0 kq 0  Iterations 3 dpmax 0.000044 dqmax  0.000000
kp 0 kq 0  Iterations 3 dpmax 0.000043 dqmax  0.000000
--------------------------------------------------------------------------------
Time =   2.38000 Seconds
Intermediate results for Machines
GNo Name     Voltage Angle    Delta    Freq    Pgen    Qgen    Pmech   Efd/Slip
```

```
             pu       Degree   Degree   Hzs.     MW       MVAR     MW       pu/P.U.
--- -------- ------- -------- -------- ------- ------- ------- ------- --------
  1     Bus1       1     21.4     21.8      50     335     295     389     1.01
  3     Bus3    1.05     22.7     23.3      50     574    56.9     520     1.05
------------------------------------------------------------------------------
Maximum rotor angle difference :    1.45382 b/w buses : 1 and 3
Island    1 Common system frequency 50.027
------------------------------------------------------------------------------
Voltage (pu), Current (AMPS), impedance (PU) and power (MW-MVAR) for lines
From Name     Voltage Angle   To   Name     Voltage  Angle    Current  Angle
                                              Zl-real  Zl-im    P        Q
---- -------- ------- ------- ---- -------- -------- -------- -------- --------
   1     Bus1   1.000   21.43    5     Bus5     1.05       18 1.7e+004       -20
                                              0.67     0.59 3.4e+002   3e+002
   2     Bus2   0.923    2.76    4     Bus4     1.05       20 5.7e+002 1.6e+002
                                                -1          -0.4  -2.9e+002  -
1.2e+002
                                5     Bus5     1.05       18 9.7e+002 1.6e+002
                                             -0.61          -0.2  -5.1e+002  -
1.6e+002
   3     Bus3   1.050   22.70    4     Bus4     1.05       20 1.8e+004       21
                                              0.89    0.031 4.9e+002       17
   4      Bus4    1.046    20.13     3       Bus3      1.05         23 7.9e+002  -
1.6e+002
                                             -0.89          0.0094   -4.9e+002
5.2
                                5     Bus5     1.05       18 3.2e+002       37
                                              2.1    -0.63 1.9e+002      -57
                                2     Bus2    0.923      2.8 4.9e+002       10
                                              1.4     0.24   3e+002       52
   5     Bus5   1.051   17.60    1     Bus1        1       21 6.7e+002 1.6e+002
                                             -0.84         -0.64  -3.3e+002  -
2.6e+002
                                4       Bus4       1.05          20    3e+002  -
1.6e+002
                                             -2.3             0.21   -1.9e+002
17
                                2     Bus2    0.923      2.8 9.1e+002     -6.9
                                                0.7     0.32 5.2e+002 2.4e+002
kp 0 kq 0  Iterations 3 dpmax 0.000043 dqmax  0.000000
kp 0 kq 0  Iterations 3 dpmax 0.000042 dqmax  0.000000
kp 0 kq 0  Iterations 3 dpmax 0.000041 dqmax  0.000000
kp 0 kq 0  Iterations 3 dpmax 0.000041 dqmax  0.000000
kp 0 kq 0  Iterations 3 dpmax 0.000040 dqmax  0.000000
kp 0 kq 0  Iterations 3 dpmax 0.000040 dqmax  0.000000
kp 0 kq 0  Iterations 3 dpmax 0.000039 dqmax  0.000000
kp 0 kq 0  Iterations 3 dpmax 0.000039 dqmax  0.000000
kp 0 kq 0  Iterations 3 dpmax 0.000038 dqmax  0.000000
kp 0 kq 0  Iterations 3 dpmax 0.000038 dqmax  0.000000
------------------------------------------------------------------------------
Time =   2.40000 Seconds
```

```
Intermediate results for Machines
GNo Name     Voltage Angle    Delta    Freq    Pgen    Qgen    Pmech   Efd/Slip
             pu      Degree   Degree   Hzs.    MW      MVAR    MW      pu/P.U.
--- -------- ------- -------- -------- ------- ------- ------- ------- --------
  1     Bus1       1     21.8     22.2      50     344     295     389      1.01
  3     Bus3    1.05     22.8     23.4      50     565    56.6     520      1.05
------------------------------------------------------------------------------
Maximum rotor angle difference :    1.17980 b/w buses : 1 and 3
Island    1 Common system frequency   50.027
------------------------------------------------------------------------------
Voltage (pu), Current (AMPS), impedance (PU) and power (MW-MVAR) for lines
From Name     Voltage Angle   To   Name     Voltage  Angle    Current  Angle
                                             Zl-real  Zl-im    P        Q
---- -------- ------- ------- ---- -------- -------- -------- -------- --------
   1     Bus1   1.000   21.75    5     Bus5     1.05       18 1.7e+004       -19
                                              0.67     0.57 3.4e+002   3e+002
   2     Bus2   0.923    2.95    4     Bus4     1.05       20 5.7e+002 1.6e+002
                                                -1        -0.41  -2.9e+002  -
1.2e+002
                                   5     Bus5     1.05       18 9.7e+002 1.7e+002
                                             -0.61        -0.19  -5.1e+002  -
1.6e+002
   3     Bus3   1.050   22.77    4     Bus4     1.05       20 1.8e+004       21
                                              0.91    0.031 4.8e+002       17
   4      Bus4    1.046    20.25     3      Bus3      1.05         23 7.7e+002  -
1.6e+002
                                             -0.91          0.0089   -4.8e+002
4.7
                                   5     Bus5     1.05       18 3.1e+002       37
                                               2.2    -0.67 1.8e+002      -56
                                   2     Bus2    0.923      2.9 4.9e+002       11
                                               1.4     0.24   3e+002       52
   5     Bus5   1.051   17.82    1     Bus1        1       22 6.8e+002 1.6e+002
                                             -0.83        -0.62  -3.4e+002  -
2.5e+002
                                   4       Bus4       1.05          20 2.9e+002  -
1.6e+002
                                              -2.4            0.21   -1.8e+002
16
                                   2     Bus2    0.923      2.9 9.2e+002     -6.6
                                                0.7     0.32 5.2e+002 2.4e+002
kp 0 kq 0  Iterations 3 dpmax 0.000037 dqmax 0.000000
kp 0 kq 0  Iterations 3 dpmax 0.000037 dqmax 0.000000
kp 0 kq 0  Iterations 3 dpmax 0.000036 dqmax 0.000000
kp 0 kq 0  Iterations 3 dpmax 0.000036 dqmax 0.000000
kp 0 kq 0  Iterations 3 dpmax 0.000035 dqmax 0.000000
kp 0 kq 0  Iterations 3 dpmax 0.000035 dqmax 0.000000
kp 0 kq 0  Iterations 3 dpmax 0.000034 dqmax 0.000000
kp 0 kq 0  Iterations 3 dpmax 0.000034 dqmax 0.000000
kp 0 kq 0  Iterations 3 dpmax 0.000033 dqmax 0.000000
kp 0 kq 0  Iterations 3 dpmax 0.000033 dqmax 0.000000
```

```
--------------------------------------------------------------------------------
Time =   2.42000 Seconds
Intermediate results for Machines
GNo Name     Voltage Angle    Delta    Freq    Pgen    Qgen    Pmech   Efd/Slip
             pu      Degree   Degree   Hzs.    MW      MVAR    MW      pu/P.U.
--- -------- ------- -------- -------- ------- ------- ------- ------- --------
  1     Bus1       1     22.1     22.5      50     353     295     389     1.01
  3     Bus3    1.05     22.8     23.4      50     556    56.3     520     1.05
--------------------------------------------------------------------------------
Maximum rotor angle difference :    0.88972 b/w buses : 1 and 3
Island    1 Common system frequency   50.027
--------------------------------------------------------------------------------
Voltage (pu), Current (AMPS), impedance (PU) and power (MW-MVAR) for lines
From Name     Voltage Angle   To   Name     Voltage  Angle    Current  Angle
                                              Zl-real  Zl-im    P        Q
---- -------- ------- ------- ---- -------- -------- -------- -------- --------
   1     Bus1   1.000   22.09    5     Bus5     1.05       18 1.8e+004       -18
                                              0.67     0.56 3.5e+002    3e+002
   2     Bus2   0.923    3.13    4     Bus4     1.05       20 5.7e+002 1.6e+002
                                                -1        -0.41  -2.9e+002  -
1.2e+002
                                5     Bus5     1.05       18 9.7e+002 1.7e+002
                                             -0.61        -0.19  -5.1e+002  -
1.6e+002
   3     Bus3   1.050   22.83    4     Bus4     1.05       20 1.7e+004       21
                                              0.93    0.032 4.8e+002       16
   4      Bus4    1.046    20.36     3      Bus3      1.05         23 7.6e+002  -
1.6e+002
                                             -0.92          0.0082   -4.7e+002
4.2
                                5     Bus5     1.05       18 2.9e+002       38
                                               2.3    -0.72 1.8e+002      -56
                                2     Bus2    0.923      3.1 4.9e+002       11
                                               1.4     0.24   3e+002       51
   5     Bus5   1.051   18.04    1     Bus1       1       22 6.9e+002 1.6e+002
                                             -0.83          -0.6  -3.5e+002  -
2.5e+002
                                4       Bus4       1.05          20 2.8e+002  -
1.6e+002
                                             -2.5             0.21   -1.7e+002
14
                                2     Bus2    0.923      3.1 9.2e+002     -6.4
                                               0.7     0.32 5.2e+002 2.4e+002
kp 0 kq 0 Iterations 3 dpmax 0.000033 dqmax 0.000000
kp 0 kq 0 Iterations 3 dpmax 0.000032 dqmax 0.000000
kp 0 kq 0 Iterations 3 dpmax 0.000032 dqmax 0.000000
kp 0 kq 0 Iterations 3 dpmax 0.000031 dqmax 0.000000
kp 0 kq 0 Iterations 3 dpmax 0.000031 dqmax 0.000000
kp 0 kq 0 Iterations 3 dpmax 0.000031 dqmax 0.000000
kp 0 kq 0 Iterations 3 dpmax 0.000030 dqmax 0.000000
kp 0 kq 0 Iterations 3 dpmax 0.000030 dqmax 0.000000
```

```
kp 0 kq 0 Iterations 3 dpmax 0.000030 dqmax 0.000000
kp 0 kq 0 Iterations 3 dpmax 0.000029 dqmax 0.000000
--------------------------------------------------------------------------------
Time =   2.44000 Seconds
Intermediate results for Machines
GNo Name     Voltage Angle    Delta    Freq    Pgen    Qgen    Pmech   Efd/Slip
             pu      Degree   Degree   Hzs.    MW      MVAR    MW      pu/P.U.
--- -------- ------- -------- -------- ------- ------- ------- ------- --------
  1     Bus1       1     22.4     22.9      50     363     295     389     1.01
  3     Bus3    1.05     22.9     23.5      50     546      56     520     1.05
--------------------------------------------------------------------------------
Maximum rotor angle difference :    0.58692 b/w buses : 1 and 3
Island    1 Common system frequency   50.027
--------------------------------------------------------------------------------
Voltage (pu), Current (AMPS), impedance (PU) and power (MW-MVAR) for lines
From Name     Voltage Angle   To   Name     Voltage  Angle    Current  Angle
                                              Zl-real  Zl-im    P        Q
---- -------- ------- ------- ---- -------- -------- -------- -------- --------
   1     Bus1   1.000   22.42    5     Bus5     1.05       18 1.8e+004       -17
                                              0.66     0.54 3.6e+002   3e+002
   2     Bus2   0.923    3.31    4     Bus4     1.05       20 5.7e+002 1.6e+002
                                                -1        -0.41  -2.9e+002  -
1.2e+002
                                5     Bus5     1.05       18 9.7e+002 1.7e+002
                                             -0.61        -0.19  -5.1e+002  -
1.6e+002
   3     Bus3   1.050   22.89    4     Bus4     1.05       20 1.7e+004       21
                                              0.95    0.033 4.7e+002       16
   4      Bus4    1.046    20.46     3      Bus3      1.05         23 7.4e+002  -
1.6e+002
                                            -0.94          0.0074   -4.6e+002
3.7
                                5     Bus5     1.05       18 2.8e+002       39
                                               2.4    -0.78 1.7e+002      -55
                                2     Bus2    0.923      3.3 4.8e+002       11
                                               1.4     0.24   3e+002       51
   5     Bus5   1.051   18.25    1     Bus1        1       22   7e+002 1.6e+002
                                            -0.82         -0.58  -3.6e+002  -
2.5e+002
                                4       Bus4       1.05          20 2.7e+002  -
1.6e+002
                                             -2.6             0.21   -1.7e+002
13
                                2     Bus2    0.923      3.3 9.2e+002     -6.1
                                               0.7     0.32 5.3e+002 2.4e+002
kp 0 kq 0 Iterations 3 dpmax 0.000029 dqmax 0.000000
kp 0 kq 0 Iterations 3 dpmax 0.000029 dqmax 0.000000
kp 0 kq 0 Iterations 3 dpmax 0.000029 dqmax 0.000000
kp 0 kq 0 Iterations 3 dpmax 0.000028 dqmax 0.000000
kp 0 kq 0 Iterations 3 dpmax 0.000028 dqmax 0.000000
kp 0 kq 0 Iterations 3 dpmax 0.000028 dqmax 0.000000
```

```
kp 0 kq 0 Iterations 3 dpmax 0.000028 dqmax 0.000000
kp 0 kq 0 Iterations 3 dpmax 0.000027 dqmax 0.000000
kp 0 kq 0 Iterations 3 dpmax 0.000027 dqmax 0.000000
kp 0 kq 0 Iterations 3 dpmax 0.000027 dqmax 0.000000
--------------------------------------------------------------------------------
Time =   2.46000 Seconds
Intermediate results for Machines
GNo Name     Voltage Angle    Delta    Freq    Pgen    Qgen    Pmech   Efd/Slip
             pu      Degree   Degree   Hzs.    MW      MVAR    MW      pu/P.U.
--- -------- ------- -------- -------- ------- ------- ------- ------- --------
  1     Bus1       1     22.8     23.2      50     373     295     389     1.01
  3     Bus3    1.05     22.9     23.5      50     536    55.8     520     1.05
--------------------------------------------------------------------------------
Maximum rotor angle difference :    0.27489 b/w buses : 1 and 3
Island    1 Common system frequency   50.027
--------------------------------------------------------------------------------
Voltage (pu), Current (AMPS), impedance (PU) and power (MW-MVAR) for lines
From Name     Voltage Angle   To   Name     Voltage  Angle    Current  Angle
                                              Zl-real  Zl-im    P        Q
---- -------- ------- ------- ---- -------- -------- -------- -------- --------
   1     Bus1   1.000   22.76    5     Bus5     1.05       18 1.8e+004       -16
                                              0.66     0.52 3.7e+002   3e+002
   2     Bus2   0.923    3.49    4     Bus4     1.05       21 5.6e+002 1.6e+002
                                                -1        -0.42  -2.9e+002  -
1.2e+002
                                5     Bus5     1.05       18 9.7e+002 1.7e+002
                                              -0.6        -0.19  -5.1e+002  -
1.6e+002
   3     Bus3   1.050   22.94    4     Bus4     1.05       21 1.7e+004       21
                                              0.97    0.034 4.6e+002       16
   4      Bus4    1.046    20.57     3       Bus3      1.05         23 7.3e+002  -
1.6e+002
                                            -0.96          0.0065   -4.5e+002
3
                                5     Bus5     1.05       18 2.7e+002       39
                                               2.5    -0.85 1.6e+002      -54
                                2     Bus2    0.923      3.5 4.8e+002       11
                                               1.4     0.25   3e+002       51
   5     Bus5   1.051   18.47    1     Bus1        1       23 7.1e+002 1.6e+002
                                            -0.82         -0.55  -3.7e+002  -
2.5e+002
                                4       Bus4       1.05          21 2.5e+002  -
1.6e+002
                                              -2.8             0.2  -1.6e+002
11
                                2     Bus2    0.923      3.5 9.2e+002     -5.9
                                               0.7     0.31 5.3e+002 2.4e+002
kp 0 kq 0 Iterations 3 dpmax 0.000027 dqmax 0.000000
kp 0 kq 0 Iterations 3 dpmax 0.000027 dqmax 0.000000
kp 0 kq 0 Iterations 3 dpmax 0.000026 dqmax 0.000000
kp 0 kq 0 Iterations 3 dpmax 0.000026 dqmax 0.000000
```

```
kp 0 kq 0 Iterations 3 dpmax 0.000026 dqmax 0.000000
kp 0 kq 0 Iterations 3 dpmax 0.000026 dqmax 0.000000
kp 0 kq 0 Iterations 3 dpmax 0.000026 dqmax 0.000000
kp 0 kq 0 Iterations 3 dpmax 0.000026 dqmax 0.000000
kp 0 kq 0 Iterations 3 dpmax 0.000026 dqmax 0.000000
kp 0 kq 0 Iterations 3 dpmax 0.000026 dqmax 0.000000
--------------------------------------------------------------------------------
Time =   2.48000 Seconds
Intermediate results for Machines
GNo Name     Voltage Angle    Delta    Freq    Pgen    Qgen    Pmech   Efd/Slip
             pu      Degree   Degree   Hzs.    MW      MVAR    MW      pu/P.U.
--- -------- ------- -------- -------- ------- ------- ------- ------- --------
  1     Bus1       1     23.1     23.6      50     383     295     389      1.01
  3     Bus3    1.05       23     23.5      50     526    55.6     520      1.05
--------------------------------------------------------------------------------
Maximum rotor angle difference :    0.04276 b/w buses : 1 and 3
Island    1 Common system frequency   50.027
--------------------------------------------------------------------------------
Voltage (pu), Current (AMPS), impedance (PU) and power (MW-MVAR) for lines
From Name     Voltage Angle   To   Name     Voltage  Angle    Current  Angle
                                              Zl-real  Zl-im    P        Q
---- -------- ------- ------- ---- -------- -------- -------- -------- --------
   1     Bus1   1.000   23.11    5     Bus5     1.05       19 1.9e+004       -15
                                              0.65      0.5 3.8e+002   3e+002
   2     Bus2   0.923    3.67    4     Bus4     1.05       21 5.6e+002 1.6e+002
                                                -1        -0.42  -2.9e+002  -
1.2e+002
                                    5     Bus5     1.05       19 9.8e+002 1.7e+002
                                              -0.6        -0.19  -5.1e+002  -
1.6e+002
   3     Bus3   1.050   22.99    4     Bus4     1.05       21 1.6e+004        21
                                              0.99    0.035 4.5e+002        16
   4      Bus4    1.046    20.67     3      Bus3      1.05         23 7.1e+002 -
1.6e+002
                                             -0.99          0.0053   -4.4e+002
2.4
                                    5     Bus5     1.05       19 2.5e+002        40
                                               2.6    -0.93 1.5e+002       -53
                                    2     Bus2    0.923      3.7 4.8e+002        11
                                               1.4     0.25   3e+002        51
   5     Bus5   1.051   18.69    1     Bus1        1       23 7.2e+002 1.7e+002
                                             -0.81         -0.53  -3.8e+002  -
2.5e+002
                                    4       Bus4       1.05          21 2.4e+002  -
1.6e+002
                                                -3             0.2  -1.5e+002
9.9
                                    2     Bus2    0.923      3.7 9.2e+002     -5.6
                                               0.69     0.31 5.3e+002 2.4e+002
kp 0 kq 0 Iterations 3 dpmax 0.000026 dqmax 0.000000
kp 0 kq 0 Iterations 3 dpmax 0.000026 dqmax 0.000000
```

```
kp 0 kq 0 Iterations 3 dpmax 0.000025 dqmax 0.000000
kp 0 kq 0 Iterations 3 dpmax 0.000025 dqmax 0.000000
kp 0 kq 0 Iterations 3 dpmax 0.000025 dqmax 0.000000
kp 0 kq 0 Iterations 3 dpmax 0.000025 dqmax 0.000000
kp 0 kq 0 Iterations 3 dpmax 0.000025 dqmax 0.000000
kp 0 kq 0 Iterations 3 dpmax 0.000025 dqmax 0.000000
kp 0 kq 0 Iterations 3 dpmax 0.000025 dqmax 0.000000
kp 0 kq 0 Iterations 3 dpmax 0.000025 dqmax 0.000000
--------------------------------------------------------------------------------
Time =   2.50000 Seconds
Intermediate results for Machines
GNo Name     Voltage Angle    Delta    Freq    Pgen    Qgen    Pmech   Efd/Slip
             pu      Degree   Degree   Hzs.    MW      MVAR    MW      pu/P.U.
--- -------- ------- -------- -------- ------- ------- ------- ------- --------
  1     Bus1       1     23.4     23.9      50     394     296     389     1.01
  3     Bus3    1.05       23     23.6      50     515    55.5     520     1.05
--------------------------------------------------------------------------------
Maximum rotor angle difference :    0.36237 b/w buses : 1 and 3
Island    1 Common system frequency 50.027
--------------------------------------------------------------------------------
Voltage (pu), Current (AMPS), impedance (PU) and power (MW-MVAR) for lines
From Name     Voltage Angle   To   Name     Voltage  Angle    Current  Angle
                                             Zl-real  Zl-im    P        Q
---- -------- ------- ------- ---- -------- -------- -------- -------- --------
   1     Bus1   1.000   23.45    5     Bus5     1.05       19 1.9e+004      -13
                                              0.65     0.49 3.9e+002   3e+002
   2     Bus2   0.923    3.85    4     Bus4     1.05       21 5.6e+002 1.6e+002
                                                -1        -0.43  -2.9e+002  -
1.2e+002
                                5     Bus5     1.05       19 9.8e+002 1.7e+002
                                              -0.6        -0.19  -5.1e+002  -
1.6e+002
   3     Bus3   1.050   23.03    4     Bus4     1.05       21 1.6e+004       21
                                                 1    0.036 4.4e+002       16
   4      Bus4    1.046    20.77     3      Bus3      1.05         23 6.9e+002  -
1.6e+002
                                               -1          0.0039   -4.3e+002
1.7
                                5     Bus5     1.05       19 2.4e+002       41
                                               2.7       -1 1.4e+002      -52
                                2     Bus2    0.923      3.8 4.8e+002       11
                                               1.4     0.25 2.9e+002       50
   5     Bus5   1.050   18.91    1     Bus1        1       23 7.4e+002 1.7e+002
                                            -0.81        -0.51  -3.9e+002  -
2.5e+002
                                4       Bus4       1.05          21 2.2e+002  -
1.6e+002
                                              -3.1            0.19   -1.4e+002
8.4
                                2     Bus2    0.923      3.8 9.3e+002     -5.4
                                              0.69     0.31 5.3e+002 2.4e+002
```

```
kp 0 kq 0  Iterations 3 dpmax 0.000025 dqmax 0.000000
kp 0 kq 0  Iterations 3 dpmax 0.000025 dqmax 0.000000
kp 0 kq 0  Iterations 3 dpmax 0.000026 dqmax 0.000000
kp 0 kq 0  Iterations 3 dpmax 0.000026 dqmax 0.000000
kp 0 kq 0  Iterations 3 dpmax 0.000026 dqmax 0.000000
kp 0 kq 0  Iterations 3 dpmax 0.000026 dqmax 0.000000
kp 0 kq 0  Iterations 3 dpmax 0.000026 dqmax 0.000000
kp 0 kq 0  Iterations 3 dpmax 0.000026 dqmax 0.000000
kp 0 kq 0  Iterations 3 dpmax 0.000026 dqmax 0.000000
--------------------------------------------------------------------------------
Time =   2.52000 Seconds
Intermediate results for Machines
GNo Name     Voltage Angle    Delta    Freq    Pgen    Qgen    Pmech   Efd/Slip
             pu      Degree   Degree   Hzs.    MW      MVAR    MW      pu/P.U.
--- -------- ------- -------- -------- ------- ------- ------- ------- --------
  1     Bus1       1     23.8     24.3      50     404     296     389     1.01
  3     Bus3    1.05     23.1     23.6      50     505    55.4     520     1.05
--------------------------------------------------------------------------------
Maximum rotor angle difference :    0.68025 b/w buses : 1 and 3
Island    1 Common system frequency   50.027
--------------------------------------------------------------------------------
Voltage (pu), Current (AMPS), impedance (PU) and power (MW-MVAR) for lines
From Name     Voltage Angle   To   Name     Voltage  Angle    Current  Angle
                                              Zl-real  Zl-im    P        Q
---- -------- ------- ------- ---- -------- -------- -------- -------- --------
   1     Bus1   1.000   23.79    5     Bus5     1.05       19 1.9e+004       -12
                                              0.64     0.47   4e+002   3e+002
   2     Bus2   0.923    4.03    4     Bus4     1.05       21 5.6e+002 1.6e+002
                                                -1         -0.43  -2.8e+002  -
1.2e+002
                                5     Bus5     1.05       19 9.8e+002 1.7e+002
                                              -0.6         -0.19  -5.2e+002  -
1.6e+002
   3     Bus3   1.050   23.08    4     Bus4     1.05       21 1.6e+004       21
                                                 1    0.038 4.3e+002       15
   4      Bus4    1.046    20.87     3      Bus3      1.05         23 6.8e+002  -
1.6e+002
                                               -1          0.0024   -4.2e+002
0.97
                                5     Bus5     1.05       19 2.3e+002       42
                                               2.9     -1.1 1.3e+002      -51
                                2     Bus2    0.923        4 4.8e+002       11
                                               1.5     0.25 2.9e+002       50
   5     Bus5   1.050   19.13    1     Bus1        1       24 7.5e+002 1.7e+002
                                              -0.8         -0.49    -4e+002  -
2.5e+002
                                4       Bus4       1.05          21 2.1e+002  -
1.6e+002
                                              -3.4             0.18   -1.3e+002
6.9
```

```
                                    2     Bus2    0.923        4 9.3e+002     -5.1
                                                  0.69     0.31 5.3e+002 2.4e+002
kp 0 kq 0  Iterations 3 dpmax 0.000026 dqmax  0.000000
kp 0 kq 0  Iterations 3 dpmax 0.000027 dqmax  0.000000
kp 0 kq 0  Iterations 3 dpmax 0.000027 dqmax  0.000000
kp 0 kq 0  Iterations 3 dpmax 0.000027 dqmax  0.000000
kp 0 kq 0  Iterations 3 dpmax 0.000027 dqmax  0.000000
kp 0 kq 0  Iterations 3 dpmax 0.000027 dqmax  0.000000
kp 0 kq 0  Iterations 3 dpmax 0.000028 dqmax  0.000000
kp 0 kq 0  Iterations 3 dpmax 0.000028 dqmax  0.000000
kp 0 kq 0  Iterations 3 dpmax 0.000028 dqmax  0.000000
kp 0 kq 0  Iterations 3 dpmax 0.000028 dqmax  0.000000
--------------------------------------------------------------------------------
Time =   2.54000 Seconds
Intermediate results for Machines
GNo Name     Voltage Angle    Delta    Freq    Pgen    Qgen    Pmech   Efd/Slip
             pu      Degree   Degree   Hzs.    MW      MVAR    MW      pu/P.U.
--- -------- ------- -------- -------- ------- ------- ------- ------- --------
  1     Bus1       1     24.1     24.6      50     414     296     389      1.01
  3     Bus3    1.05     23.1     23.6      50     495    55.4     520      1.05
--------------------------------------------------------------------------------
Maximum rotor angle difference :    0.99272 b/w buses : 1 and 3
Island    1 Common system frequency   50.027
--------------------------------------------------------------------------------
Voltage (pu), Current (AMPS), impedance (PU) and power (MW-MVAR) for lines
From Name     Voltage Angle   To   Name     Voltage  Angle    Current  Angle
                                              Zl-real  Zl-im    P        Q
---- -------- ------- ------- ---- -------- -------- -------- -------- --------
   1     Bus1   1.000   24.13    5     Bus5     1.05       19   2e+004      -11
                                              0.64     0.46 4.1e+002   3e+002
   2     Bus2   0.923    4.21    4     Bus4     1.05       21 5.6e+002 1.6e+002
                                                -1        -0.44  -2.8e+002  -
1.2e+002
                                    5     Bus5     1.05       19 9.8e+002 1.7e+002
                                              -0.6        -0.19  -5.2e+002  -
1.6e+002
   3     Bus3   1.050   23.13    4     Bus4     1.05       21 1.5e+004       21
                                               1.1    0.039 4.2e+002       15
   4      Bus4    1.046    20.97     3      Bus3      1.05         23 6.6e+002 -
1.6e+002
                                              -1.1        0.00057    -4.1e+002
0.22
                                    5     Bus5     1.05       19 2.1e+002       43
                                               3.1     -1.3 1.2e+002      -50
                                    2     Bus2    0.923      4.2 4.7e+002       11
                                               1.5     0.25 2.9e+002       50
   5     Bus5   1.050   19.34    1     Bus1        1       24 7.6e+002 1.7e+002
                                             -0.79        -0.47  -4.1e+002  -
2.4e+002
                                    4       Bus4       1.05          21 1.9e+002  -
1.6e+002
```

```
                                                    -3.6             0.16   -1.2e+002
5.4
                                  2     Bus2    0.923      4.2 9.3e+002     -4.8
                                                 0.69     0.31 5.3e+002 2.4e+002
kp 0 kq 0  Iterations 3 dpmax 0.000029 dqmax 0.000000
kp 0 kq 0  Iterations 3 dpmax 0.000029 dqmax 0.000000
kp 0 kq 0  Iterations 3 dpmax 0.000029 dqmax 0.000000
kp 0 kq 0  Iterations 3 dpmax 0.000029 dqmax 0.000000
kp 0 kq 0  Iterations 3 dpmax 0.000030 dqmax 0.000000
kp 0 kq 0  Iterations 3 dpmax 0.000030 dqmax 0.000000
kp 0 kq 0  Iterations 3 dpmax 0.000030 dqmax 0.000000
kp 0 kq 0  Iterations 3 dpmax 0.000031 dqmax 0.000000
kp 0 kq 0  Iterations 3 dpmax 0.000031 dqmax 0.000000
kp 0 kq 0  Iterations 3 dpmax 0.000031 dqmax 0.000000
--------------------------------------------------------------------------------
Time =   2.56000 Seconds
Intermediate results for Machines
GNo Name     Voltage Angle    Delta    Freq    Pgen    Qgen    Pmech   Efd/Slip
             pu      Degree   Degree   Hzs.    MW      MVAR    MW      pu/P.U.
--- -------- ------- -------- -------- ------- ------- ------- ------- --------
  1     Bus1       1     24.5       25      50     424     297     389     1.01
  3     Bus3    1.05     23.2     23.7      50     485    55.5     520     1.05
--------------------------------------------------------------------------------
Maximum rotor angle difference :    1.29616 b/w buses : 1 and 3
Island    1 Common system frequency   50.027
--------------------------------------------------------------------------------
Voltage (pu), Current (AMPS), impedance (PU) and power (MW-MVAR) for lines
From Name     Voltage Angle   To   Name     Voltage  Angle    Current  Angle
                                              Zl-real  Zl-im    P        Q
---- -------- ------- ------- ---- -------- -------- -------- -------- --------
   1     Bus1   1.000   24.47    5     Bus5     1.05       20   2e+004      -11
                                               0.63     0.44 4.2e+002   3e+002
   2     Bus2   0.923    4.39    4     Bus4     1.05       21 5.6e+002 1.6e+002
                                                 -1        -0.44  -2.8e+002  -
1.2e+002
                                  5     Bus5     1.05       20 9.8e+002 1.7e+002
                                               -0.6        -0.18  -5.2e+002  -
1.6e+002
   3     Bus3   1.050   23.18    4     Bus4     1.05       21 1.5e+004       21
                                                1.1    0.041 4.1e+002       15
   4      Bus4    1.046    21.08     3      Bus3      1.05         23 6.5e+002  -
1.6e+002
                                               -1.1  -0.0014  -4e+002    -0.53
                                  5     Bus5     1.05       20   2e+002       44
                                                3.2     -1.4 1.1e+002      -49
                                  2     Bus2    0.923      4.4 4.7e+002       11
                                                1.5     0.25 2.9e+002       50
   5     Bus5   1.050   19.56    1     Bus1        1       24 7.7e+002 1.7e+002
                                              -0.79        -0.46  -4.2e+002  -
2.4e+002
```

```
                                   4       Bus4       1.05          21 1.8e+002  -
1.6e+002
                                                     -3.9            0.14  -1.1e+002
4
                                   2     Bus2    0.923      4.4 9.3e+002     -4.6
                                                      0.69     0.31 5.3e+002 2.4e+002
kp 0 kq 0  Iterations 3 dpmax 0.000032 dqmax  0.000000
kp 0 kq 0  Iterations 3 dpmax 0.000032 dqmax  0.000000
kp 0 kq 0  Iterations 3 dpmax 0.000033 dqmax  0.000000
kp 0 kq 0  Iterations 3 dpmax 0.000033 dqmax  0.000000
kp 0 kq 0  Iterations 3 dpmax 0.000033 dqmax  0.000000
kp 0 kq 0  Iterations 3 dpmax 0.000034 dqmax  0.000000
kp 0 kq 0  Iterations 3 dpmax 0.000034 dqmax  0.000000
kp 0 kq 0  Iterations 3 dpmax 0.000035 dqmax  0.000000
kp 0 kq 0  Iterations 3 dpmax 0.000035 dqmax  0.000000
kp 0 kq 0  Iterations 3 dpmax 0.000036 dqmax  0.000000
--------------------------------------------------------------------------------
Time =   2.58000 Seconds
Intermediate results for Machines
GNo Name     Voltage Angle    Delta    Freq    Pgen    Qgen    Pmech   Efd/Slip
             pu      Degree   Degree   Hzs.    MW      MVAR    MW      pu/P.U.
--- -------- ------- -------- -------- ------- ------- ------- ------- --------
  1     Bus1       1     24.8     25.3      50     433     297     389      1.01
  3     Bus3    1.05     23.2     23.7      50     476    55.5     520      1.05
--------------------------------------------------------------------------------
Maximum rotor angle difference :    1.58706 b/w buses : 1 and 3
Island    1 Common system frequency   50.027
--------------------------------------------------------------------------------
Voltage (pu), Current (AMPS), impedance (PU) and power (MW-MVAR) for lines
From Name     Voltage Angle   To   Name     Voltage  Angle    Current  Angle
                                              Zl-real  Zl-im    P        Q
---- -------- ------- ------- ---- -------- -------- -------- -------- --------
   1     Bus1   1.000   24.80    5     Bus5     1.05       20   2e+004     -9.6
                                                 0.63     0.43 4.3e+002   3e+002
   2     Bus2   0.923    4.57    4     Bus4     1.05       21 5.5e+002 1.6e+002
                                                   -1        -0.44  -2.8e+002  -
1.2e+002
                                   5     Bus5     1.05       20 9.8e+002 1.7e+002
                                                 -0.6        -0.18  -5.2e+002  -
1.6e+002
   3     Bus3   1.050   23.24    4     Bus4     1.05       21 1.5e+004       21
                                                  1.1    0.044   4e+002       16
   4      Bus4    1.046    21.19     3      Bus3      1.05         23 6.3e+002  -
1.6e+002
                                                 -1.1   -0.0036 -3.9e+002       -
1.3
                                   5     Bus5     1.05       20 1.9e+002       46
                                                  3.4     -1.6 1.1e+002      -48
                                   2     Bus2    0.923      4.6 4.7e+002       11
                                                  1.5     0.25 2.9e+002       50
   5     Bus5   1.050   19.78    1     Bus1        1       25 7.8e+002 1.7e+002
```

```
                                                    -0.78         -0.44  -4.3e+002  -
2.4e+002
                                  4       Bus4       1.05          21 1.7e+002  -
1.6e+002
                                                    -4.2             0.1  -1.1e+002
2.6
                                  2     Bus2    0.923      4.6 9.3e+002     -4.3
                                                     0.69     0.31 5.3e+002 2.4e+002
kp 0 kq 0  Iterations 3 dpmax 0.000036 dqmax  0.000000
kp 0 kq 0  Iterations 3 dpmax 0.000037 dqmax  0.000000
kp 0 kq 0  Iterations 3 dpmax 0.000037 dqmax  0.000000
kp 0 kq 0  Iterations 3 dpmax 0.000038 dqmax  0.000000
kp 0 kq 0  Iterations 3 dpmax 0.000038 dqmax  0.000000
kp 0 kq 0  Iterations 3 dpmax 0.000039 dqmax  0.000000
kp 0 kq 0  Iterations 3 dpmax 0.000039 dqmax  0.000000
kp 0 kq 0  Iterations 3 dpmax 0.000040 dqmax  0.000000
kp 0 kq 0  Iterations 3 dpmax 0.000040 dqmax  0.000000
kp 0 kq 0  Iterations 3 dpmax 0.000041 dqmax  0.000000
--------------------------------------------------------------------------------
Time =   2.60000 Seconds
Intermediate results for Machines
GNo Name     Voltage Angle    Delta    Freq    Pgen    Qgen    Pmech   Efd/Slip
             pu      Degree   Degree   Hzs.    MW      MVAR    MW      pu/P.U.
--- -------- ------- -------- -------- ------- ------- ------- ------- --------
  1     Bus1       1     25.1     25.7      50     442     297     389     1.01
  3     Bus3    1.05     23.3     23.8      50     467    55.6     520     1.05
--------------------------------------------------------------------------------
Maximum rotor angle difference :    1.86203 b/w buses : 1 and 3
Island    1 Common system frequency   50.027
--------------------------------------------------------------------------------
Voltage (pu), Current (AMPS), impedance (PU) and power (MW-MVAR) for lines
From Name     Voltage Angle   To   Name     Voltage  Angle    Current  Angle
                                              Zl-real  Zl-im    P        Q
---- -------- ------- ------- ---- -------- -------- -------- -------- --------
   1     Bus1   1.000   25.13    5     Bus5     1.05       20 2.1e+004     -8.8
                                              0.62     0.42 4.4e+002   3e+002
   2     Bus2   0.923    4.75    4     Bus4     1.05       21 5.5e+002 1.6e+002
                                                -1        -0.45  -2.8e+002  -
1.2e+002
                                  5     Bus5     1.05       20 9.9e+002 1.7e+002
                                              -0.6         -0.18  -5.2e+002  -
1.6e+002
   3     Bus3   1.050   23.31    4     Bus4     1.05       21 1.4e+004       21
                                               1.1    0.046 3.9e+002       16
   4      Bus4    1.046    21.30     3       Bus3      1.05         23 6.2e+002  -
1.6e+002
                                              -1.1   -0.006 -3.9e+002        -
2
                                  5     Bus5     1.05       20 1.7e+002       47
                                              3.6     -1.7       98       -47
                                  2     Bus2    0.923      4.7 4.7e+002       12
```

```
                                                    1.5     0.25 2.9e+002       49
   5     Bus5   1.050   19.99    1     Bus1         1       25   8e+002 1.7e+002
                                                 -0.77        -0.43  -4.4e+002  -
2.4e+002
                                  4       Bus4       1.05          21 1.6e+002  -
1.6e+002
                                                   -4.5    0.063      -98      1.4
                                  2     Bus2     0.923      4.7 9.3e+002     -4.1
                                                   0.69     0.31 5.4e+002 2.4e+002
kp 0 kq 0 Iterations 3 dpmax 0.000041 dqmax 0.000000
kp 0 kq 0 Iterations 3 dpmax 0.000042 dqmax 0.000000
kp 0 kq 0 Iterations 3 dpmax 0.000042 dqmax 0.000000
kp 0 kq 0 Iterations 3 dpmax 0.000043 dqmax 0.000000
kp 0 kq 0 Iterations 3 dpmax 0.000044 dqmax 0.000000
kp 0 kq 0 Iterations 3 dpmax 0.000044 dqmax 0.000000
kp 0 kq 0 Iterations 3 dpmax 0.000045 dqmax 0.000000
kp 0 kq 0 Iterations 3 dpmax 0.000046 dqmax 0.000000
kp 0 kq 0 Iterations 3 dpmax 0.000046 dqmax 0.000000
kp 0 kq 0 Iterations 3 dpmax 0.000047 dqmax 0.000000
--------------------------------------------------------------------------------
Time =   2.62000 Seconds
Intermediate results for Machines
GNo Name     Voltage Angle    Delta    Freq    Pgen    Qgen    Pmech   Efd/Slip
             pu      Degree   Degree   Hzs.    MW      MVAR    MW      pu/P.U.
--- -------- ------- -------- -------- ------- ------- ------- ------- --------
  1     Bus1       1     25.4       26      50     450     298     389      1.01
  3     Bus3    1.05     23.4     23.9      50     459    55.8     520      1.05
--------------------------------------------------------------------------------
Maximum rotor angle difference :    2.11791 b/w buses : 1 and 3
Island    1 Common system frequency   50.027
--------------------------------------------------------------------------------
Voltage (pu), Current (AMPS), impedance (PU) and power (MW-MVAR) for lines
From Name     Voltage Angle   To   Name     Voltage  Angle    Current  Angle
                                              Zl-real  Zl-im    P        Q
---- -------- ------- ------- ---- -------- -------- -------- -------- --------
   1     Bus1   1.000   25.44    5     Bus5     1.05       20 2.1e+004       -8
                                                 0.62     0.41 4.5e+002   3e+002
   2     Bus2   0.923    4.93    4     Bus4     1.05       21 5.5e+002 1.6e+002
                                                   -1        -0.45  -2.8e+002  -
1.2e+002
                                  5     Bus5     1.05       20 9.9e+002 1.7e+002
                                                 -0.6        -0.18  -5.2e+002  -
1.6e+002
   3     Bus3   1.050   23.39    4     Bus4     1.05       21 1.4e+004       21
                                                  1.2    0.048 3.8e+002       16
   4      Bus4    1.046    21.42     3      Bus3      1.05         23    6e+002 -
1.6e+002
                                                 -1.2   -0.0084 -3.8e+002       -
2.8
                                  5     Bus5     1.05       20 1.6e+002       49
                                                  3.8       -2       91      -47
```

```
                                  2     Bus2    0.923      4.9 4.7e+002       12
                                                1.5     0.25 2.9e+002       49
   5     Bus5   1.050   20.21    1     Bus1        1       25 8.1e+002 1.7e+002
                                               -0.77        -0.41  -4.5e+002  -
2.4e+002
                                  4       Bus4       1.05          21 1.4e+002  -
1.6e+002
                                                -4.9    0.009      -91     0.17
                                  2     Bus2    0.923      4.9 9.4e+002     -3.8
                                                0.69     0.31 5.4e+002 2.4e+002
kp 0 kq 0  Iterations 3 dpmax 0.000048 dqmax  0.000000
kp 0 kq 0  Iterations 3 dpmax 0.000048 dqmax  0.000000
kp 0 kq 0  Iterations 3 dpmax 0.000049 dqmax  0.000000
kp 0 kq 0  Iterations 3 dpmax 0.000050 dqmax  0.000000
kp 0 kq 0  Iterations 3 dpmax 0.000050 dqmax  0.000000
kp 0 kq 0  Iterations 3 dpmax 0.000051 dqmax  0.000000
kp 0 kq 0  Iterations 3 dpmax 0.000052 dqmax  0.000000
kp 0 kq 0  Iterations 3 dpmax 0.000052 dqmax  0.000000
kp 0 kq 0  Iterations 3 dpmax 0.000053 dqmax  0.000000
kp 0 kq 0  Iterations 3 dpmax 0.000054 dqmax  0.000000
--------------------------------------------------------------------------------
Time =   2.64000 Seconds
Intermediate results for Machines
GNo Name     Voltage Angle    Delta    Freq    Pgen    Qgen    Pmech   Efd/Slip
             pu      Degree   Degree   Hzs.    MW      MVAR    MW      pu/P.U.
--- -------- ------- -------- -------- ------- ------- ------- ------- --------
  1     Bus1       1     25.7     26.3      50     458     298     389      1.01
  3     Bus3    1.05     23.5     23.9      50     451    55.9     520      1.05
--------------------------------------------------------------------------------
Maximum rotor angle difference :    2.35169 b/w buses : 1 and 3
Island    1 Common system frequency   50.027
--------------------------------------------------------------------------------
Voltage (pu), Current (AMPS), impedance (PU) and power (MW-MVAR) for lines
From Name     Voltage Angle   To   Name     Voltage  Angle    Current  Angle
                                              Zl-real  Zl-im    P        Q
---- -------- ------- ------- ---- -------- -------- -------- -------- -------
   1     Bus1   1.000   25.75    5     Bus5     1.05       20 2.1e+004     -7.3
                                               0.61      0.4 4.6e+002   3e+002
   2     Bus2   0.923    5.11    4     Bus4     1.05       22 5.5e+002 1.6e+002
                                                 -1        -0.45  -2.8e+002  -
1.2e+002
                                  5     Bus5     1.05       20 9.9e+002 1.7e+002
                                               -0.6        -0.18  -5.2e+002  -
1.6e+002
   3     Bus3   1.050   23.47    4     Bus4     1.05       22 1.4e+004       21
                                                1.2    0.051 3.7e+002       16
   4      Bus4    1.046    21.54     3      Bus3      1.05         23 5.9e+002  -
1.6e+002
                                               -1.2    -0.011 -3.7e+002       -
3.4
                                  5     Bus5     1.05       20 1.5e+002       50
```

```
                                                    4     -2.2       84       -46
                                  2     Bus2    0.923      5.1 4.6e+002       12
                                                  1.5     0.26 2.9e+002       49
   5     Bus5   1.050   20.42    1     Bus1        1       26 8.2e+002 1.7e+002
                                               -0.76         -0.4  -4.5e+002  -
2.4e+002
                                  4       Bus4       1.05          22 1.3e+002  -
1.6e+002
                                                 -5.2   -0.057      -84    -0.92
                                  2     Bus2    0.923      5.1 9.4e+002      -3.6
                                                 0.68     0.31 5.4e+002 2.4e+002
kp 0 kq 0 Iterations 3 dpmax 0.000055 dqmax 0.000000
kp 0 kq 0 Iterations 3 dpmax 0.000055 dqmax 0.000000
kp 0 kq 0 Iterations 3 dpmax 0.000056 dqmax 0.000000
kp 0 kq 0 Iterations 3 dpmax 0.000057 dqmax 0.000000
kp 0 kq 0 Iterations 3 dpmax 0.000058 dqmax 0.000000
kp 0 kq 0 Iterations 3 dpmax 0.000058 dqmax 0.000000
kp 0 kq 0 Iterations 3 dpmax 0.000059 dqmax 0.000000
kp 0 kq 0 Iterations 3 dpmax 0.000060 dqmax 0.000000
kp 0 kq 0 Iterations 3 dpmax 0.000061 dqmax 0.000000
kp 0 kq 0 Iterations 3 dpmax 0.000062 dqmax 0.000000
--------------------------------------------------------------------------------
Time =   2.66000 Seconds
Intermediate results for Machines
GNo Name     Voltage Angle    Delta    Freq    Pgen    Qgen    Pmech   Efd/Slip
             pu      Degree   Degree   Hzs.    MW      MVAR    MW      pu/P.U.
--- -------- ------- -------- -------- ------- ------- ------- ------- --------
  1     Bus1       1       26     26.6      50     464     299     389      1.01
  3     Bus3    1.05     23.6       24      50     444    56.1     520      1.05
--------------------------------------------------------------------------------
Maximum rotor angle difference :    2.56068 b/w buses : 1 and 3
Island    1 Common system frequency   50.027
--------------------------------------------------------------------------------
Voltage (pu), Current (AMPS), impedance (PU) and power (MW-MVAR) for lines
From Name     Voltage Angle   To   Name     Voltage  Angle    Current  Angle
                                              Zl-real  Zl-im    P        Q
---- -------- ------- ------- ---- -------- -------- -------- -------- --------
   1     Bus1   1.000   26.04    5     Bus5     1.05       21 2.1e+004     -6.7
                                               0.61     0.39 4.6e+002   3e+002
   2     Bus2   0.923    5.30    4     Bus4     1.05       22 5.5e+002 1.6e+002
                                                 -1        -0.46  -2.8e+002  -
1.2e+002
                                  5     Bus5     1.05       21 9.9e+002 1.7e+002
                                               -0.6         -0.18  -5.2e+002  -
1.6e+002
   3     Bus3   1.050   23.57    4     Bus4     1.05       22 1.3e+004       21
                                                1.2    0.053 3.6e+002       16
   4      Bus4    1.046    21.68     3      Bus3      1.05         24 5.8e+002  -
1.6e+002
                                               -1.2   -0.013 -3.6e+002       -
4
```

```
                                  5     Bus5     1.05       21 1.4e+002       52
                                                4.2     -2.4       78       -45
                                  2     Bus2    0.923      5.3 4.6e+002       12
                                                1.5     0.26 2.9e+002       49
   5     Bus5   1.050   20.63    1     Bus1        1       26 8.3e+002 1.7e+002
                                               -0.76         -0.39  -4.6e+002  -
2.4e+002
                                  4       Bus4       1.05          22 1.2e+002  -
1.6e+002
                                               -5.6    -0.14      -78     -1.9
                                  2     Bus2    0.923      5.3 9.4e+002     -3.4
                                                0.68      0.3 5.4e+002 2.4e+002
kp 0 kq 0  Iterations 3 dpmax 0.000063 dqmax  0.000000
kp 0 kq 0  Iterations 3 dpmax 0.000063 dqmax  0.000000
kp 0 kq 0  Iterations 3 dpmax 0.000064 dqmax  0.000000
kp 0 kq 0  Iterations 3 dpmax 0.000065 dqmax  0.000000
kp 0 kq 0  Iterations 3 dpmax 0.000066 dqmax  0.000000
kp 0 kq 0  Iterations 3 dpmax 0.000067 dqmax  0.000000
kp 0 kq 0  Iterations 3 dpmax 0.000068 dqmax  0.000000
kp 0 kq 0  Iterations 3 dpmax 0.000068 dqmax  0.000000
kp 0 kq 0  Iterations 3 dpmax 0.000069 dqmax  0.000000
kp 0 kq 0  Iterations 3 dpmax 0.000070 dqmax  0.000000
--------------------------------------------------------------------------------
Time =   2.68000 Seconds
Intermediate results for Machines
GNo Name     Voltage Angle    Delta    Freq    Pgen    Qgen    Pmech   Efd/Slip
             pu      Degree   Degree   Hzs.    MW      MVAR    MW      pu/P.U.
--- -------- ------- -------- -------- ------- ------- ------- ------- --------
  1     Bus1       1     26.3     26.9      50     470     299     389      1.01
  3     Bus3    1.05     23.7     24.1      50     438    56.3     520      1.05
--------------------------------------------------------------------------------
Maximum rotor angle difference :    2.74244 b/w buses : 1 and 3
Island    1 Common system frequency   50.027
--------------------------------------------------------------------------------
Voltage (pu), Current (AMPS), impedance (PU) and power (MW-MVAR) for lines
From Name     Voltage Angle   To   Name     Voltage  Angle    Current  Angle
                                              Zl-real  Zl-im    P        Q
---- -------- ------- ------- ---- -------- -------- -------- -------- --------
   1     Bus1   1.000   26.32    5     Bus5     1.05       21 2.1e+004     -6.1
                                               0.61     0.38 4.7e+002   3e+002
   2     Bus2   0.923    5.48    4     Bus4     1.05       22 5.5e+002 1.6e+002
                                                 -1        -0.46  -2.8e+002  -
1.2e+002
                                  5     Bus5     1.05       21 9.9e+002 1.7e+002
                                               -0.6         -0.18  -5.2e+002  -
1.6e+002
   3     Bus3   1.050   23.68    4     Bus4     1.05       22 1.3e+004       21
                                                1.2    0.056 3.6e+002       16
   4      Bus4    1.046    21.82     3      Bus3      1.05         24 5.7e+002  -
1.6e+002
```

```
                                                    -1.2    -0.016 -3.6e+002       -
4.6
                                 5     Bus5      1.05       21 1.4e+002       53
                                                   4.4     -2.7       73       -44
                                 2     Bus2     0.923      5.5 4.6e+002       12
                                                   1.5     0.26 2.8e+002       49
   5     Bus5   1.050   20.84    1     Bus1        1       26 8.3e+002 1.7e+002
                                                -0.75         -0.38  -4.7e+002  -
2.4e+002
                                 4       Bus4       1.05          22 1.2e+002  -
1.6e+002
                                                    -6    -0.23      -73     -2.7
                                 2     Bus2     0.923      5.5 9.4e+002     -3.1
                                                  0.68      0.3 5.4e+002 2.4e+002
kp 0 kq 0  Iterations 3 dpmax 0.000071 dqmax 0.000000
kp 0 kq 0  Iterations 3 dpmax 0.000072 dqmax 0.000000
kp 0 kq 0  Iterations 3 dpmax 0.000073 dqmax 0.000000
kp 0 kq 0  Iterations 3 dpmax 0.000074 dqmax 0.000000
kp 0 kq 0  Iterations 3 dpmax 0.000075 dqmax 0.000000
kp 0 kq 0  Iterations 3 dpmax 0.000076 dqmax 0.000000
kp 0 kq 0  Iterations 3 dpmax 0.000077 dqmax 0.000000
kp 0 kq 0  Iterations 3 dpmax 0.000077 dqmax 0.000000
kp 0 kq 0  Iterations 3 dpmax 0.000078 dqmax 0.000000
kp 0 kq 0  Iterations 3 dpmax 0.000079 dqmax 0.000000
------------------------------------------------------------------------------
Time =   2.70000 Seconds
Intermediate results for Machines
GNo Name     Voltage Angle    Delta    Freq    Pgen    Qgen    Pmech   Efd/Slip
             pu      Degree   Degree   Hzs.    MW      MVAR    MW      pu/P.U.
--- -------- ------- -------- -------- ------- ------- ------- ------- --------
  1     Bus1       1     26.6     27.2      50     475     299     389      1.01
  3     Bus3    1.05     23.8     24.3      50     433    56.4     520      1.05
------------------------------------------------------------------------------
Maximum rotor angle difference :    2.89483 b/w buses : 1 and 3
Island    1 Common system frequency   50.027
------------------------------------------------------------------------------
Voltage (pu), Current (AMPS), impedance (PU) and power (MW-MVAR) for lines
From Name     Voltage Angle   To   Name     Voltage  Angle    Current  Angle
                                              Zl-real  Zl-im    P        Q
---- -------- ------- ------- ---- -------- -------- -------- -------- --------
   1     Bus1   1.000   26.59    5     Bus5     1.05       21 2.2e+004     -5.6
                                                 0.6     0.38 4.8e+002   3e+002
   2     Bus2   0.922    5.67    4     Bus4     1.05       22 5.5e+002 1.6e+002
                                                  -1        -0.46  -2.8e+002  -
1.2e+002
                                 5     Bus5     1.05       21 9.9e+002 1.7e+002
                                                -0.6         -0.18  -5.2e+002  -
1.6e+002
   3     Bus3   1.050   23.80    4     Bus4     1.05       22 1.3e+004       21
                                                 1.2    0.058 3.5e+002       16
```

```
   4      Bus4    1.046    21.97     3       Bus3      1.05         24 5.6e+002  -
1.6e+002
                                                 -1.2    -0.018 -3.5e+002       -
5.1
                                5     Bus5     1.05        21 1.3e+002       54
                                                4.5     -2.9        69      -44
                                2     Bus2    0.922       5.7 4.6e+002       12
                                                1.5     0.26 2.8e+002       49
   5     Bus5   1.050   21.05    1     Bus1        1        27 8.4e+002 1.7e+002
                                               -0.75         -0.38  -4.7e+002  -
2.4e+002
                                4       Bus4       1.05          22 1.1e+002  -
1.6e+002
                                               -6.4    -0.32      -69     -3.4
                                2     Bus2    0.922       5.7 9.4e+002     -2.9
                                               0.68       0.3 5.4e+002 2.4e+002
kp 0 kq 0  Iterations 3 dpmax 0.000080 dqmax  0.000000
kp 0 kq 0  Iterations 3 dpmax 0.000081 dqmax  0.000000
kp 0 kq 0  Iterations 3 dpmax 0.000082 dqmax  0.000000
kp 0 kq 0  Iterations 3 dpmax 0.000083 dqmax  0.000000
kp 0 kq 0  Iterations 3 dpmax 0.000084 dqmax  0.000000
kp 0 kq 0  Iterations 3 dpmax 0.000085 dqmax  0.000000
kp 0 kq 0  Iterations 3 dpmax 0.000086 dqmax  0.000002
kp 0 kq 0  Iterations 3 dpmax 0.000087 dqmax  0.000000
kp 0 kq 0  Iterations 3 dpmax 0.000088 dqmax  0.000000
kp 0 kq 0  Iterations 3 dpmax 0.000089 dqmax  0.000001
------------------------------------------------------------------------------
Time =   2.72000 Seconds
Intermediate results for Machines
GNo Name     Voltage Angle    Delta    Freq    Pgen    Qgen    Pmech   Efd/Slip
             pu      Degree   Degree   Hzs.    MW      MVAR    MW      pu/P.U.
--- -------- ------- -------- -------- ------- ------- ------- ------- --------
  1     Bus1       1     26.8     27.4      50     479     300     389      1.01
  3     Bus3    1.05     23.9     24.4      50     429    56.6     520      1.05
------------------------------------------------------------------------------
Maximum rotor angle difference :    3.01609 b/w buses : 1 and 3
Island    1 Common system frequency   50.027
------------------------------------------------------------------------------
Voltage (pu), Current (AMPS), impedance (PU) and power (MW-MVAR) for lines
From Name     Voltage Angle   To   Name     Voltage  Angle    Current  Angle
                                              Zl-real  Zl-im    P        Q
---- -------- ------- ------- ---- -------- -------- -------- -------- --------
   1     Bus1   1.000   26.85    5     Bus5     1.05       21 2.2e+004     -5.2
                                                0.6     0.37 4.8e+002   3e+002
   2     Bus2   0.922    5.86    4     Bus4     1.05       22 5.5e+002 1.6e+002
                                                 -1        -0.46  -2.7e+002  -
1.2e+002
                                5     Bus5     1.05       21 9.9e+002 1.7e+002
                                               -0.6        -0.18  -5.2e+002  -
1.6e+002
   3     Bus3   1.050   23.94    4     Bus4     1.05       22 1.3e+004       21
```

```
                                                    1.3     0.06 3.5e+002       17
   4      Bus4    1.046    22.12     3      Bus3      1.05         24 5.6e+002  -
1.6e+002
                                                   -1.3     -0.02 -3.5e+002       -
5.5
                                5     Bus5     1.05       21 1.3e+002       56
                                                    4.7     -3.1       65      -43
                                2     Bus2    0.922      5.9 4.6e+002       12
                                                    1.5     0.26 2.8e+002       49
   5     Bus5   1.050   21.25    1     Bus1        1       27 8.4e+002 1.7e+002
                                                  -0.75         -0.37  -4.7e+002  -
2.4e+002
                                4       Bus4       1.05          22    1e+002  -
1.6e+002
                                                   -6.7    -0.41      -65       -4
                                2     Bus2    0.922      5.9 9.4e+002     -2.7
                                                    0.68      0.3 5.4e+002 2.4e+002
kp 0 kq 0  Iterations 3 dpmax 0.000090 dqmax  0.000000
kp 0 kq 0  Iterations 3 dpmax 0.000091 dqmax  0.000000
kp 0 kq 0  Iterations 3 dpmax 0.000092 dqmax  0.000001
kp 0 kq 0  Iterations 3 dpmax 0.000093 dqmax  0.000000
kp 0 kq 0  Iterations 3 dpmax 0.000094 dqmax  0.000000
kp 0 kq 0  Iterations 3 dpmax 0.000095 dqmax  0.000000
kp 0 kq 0  Iterations 3 dpmax 0.000096 dqmax  0.000000
kp 0 kq 0  Iterations 3 dpmax 0.000097 dqmax  0.000000
kp 0 kq 0  Iterations 3 dpmax 0.000098 dqmax  0.000000
kp 0 kq 0  Iterations 3 dpmax 0.000099 dqmax  0.000000
--------------------------------------------------------------------------------
Time =   2.74000 Seconds
Intermediate results for Machines
GNo Name     Voltage Angle    Delta    Freq    Pgen    Qgen    Pmech   Efd/Slip
             pu      Degree   Degree   Hzs.    MW      MVAR    MW      pu/P.U.
--- -------- ------- -------- -------- ------- ------- ------- ------- --------
  1     Bus1       1     27.1     27.7      50     482     300     389      1.01
  3     Bus3    1.05     24.1     24.6      50     426    56.7     520      1.05
--------------------------------------------------------------------------------
Maximum rotor angle difference :    3.10477 b/w buses : 1 and 3
Island    1 Common system frequency   50.027
--------------------------------------------------------------------------------
Voltage (pu), Current (AMPS), impedance (PU) and power (MW-MVAR) for lines
From Name     Voltage Angle   To   Name     Voltage  Angle    Current  Angle
                                              Zl-real  Zl-im    P        Q
---- -------- ------- ------- ---- -------- -------- -------- -------- --------
   1     Bus1   1.000   27.08    5     Bus5     1.05       21 2.2e+004     -4.8
                                                   0.6     0.37 4.8e+002   3e+002
   2     Bus2   0.922    6.05    4     Bus4     1.05       22 5.5e+002 1.6e+002
                                                    -1        -0.47  -2.7e+002  -
1.2e+002
                                5     Bus5     1.05       21 9.9e+002 1.7e+002
                                                  -0.6         -0.18  -5.2e+002  -
1.6e+002
```

```
   3     Bus3   1.050   24.09    4     Bus4     1.05       22 1.3e+004       21
                                                 1.3    0.061 3.5e+002       17
   4      Bus4    1.046    22.29     3      Bus3      1.05         24 5.5e+002  -
1.6e+002
                                               -1.3    -0.021 -3.5e+002       -
5.8
                                5     Bus5     1.05       21 1.2e+002       57
                                                 4.8     -3.2       63      -43
                                2     Bus2    0.922      6.1 4.6e+002       13
                                                 1.5     0.26 2.8e+002       49
   5     Bus5   1.050   21.45    1     Bus1        1       27 8.5e+002 1.8e+002
                                              -0.74         -0.37  -4.8e+002  -
2.4e+002
                                4       Bus4       1.05          22    1e+002  -
1.6e+002
                                                 -7    -0.49      -63     -4.4
                                2     Bus2    0.922      6.1 9.4e+002     -2.5
                                               0.68      0.3 5.4e+002 2.4e+002
kp 0 kq 0 Iterations 3 dpmax 0.000100 dqmax 0.000000
kp 0 kq 0 Iterations 4 dpmax 0.000005 dqmax 0.000000
kp 0 kq 0 Iterations 4 dpmax 0.000005 dqmax 0.000000
kp 0 kq 0 Iterations 4 dpmax 0.000005 dqmax 0.000000
kp 0 kq 0 Iterations 4 dpmax 0.000005 dqmax 0.000000
kp 0 kq 0 Iterations 4 dpmax 0.000005 dqmax 0.000000
kp 0 kq 0 Iterations 4 dpmax 0.000005 dqmax 0.000000
kp 0 kq 0 Iterations 4 dpmax 0.000005 dqmax 0.000000
kp 0 kq 0 Iterations 4 dpmax 0.000005 dqmax 0.000000
--------------------------------------------------------------------------------
Time =   2.76000 Seconds
Intermediate results for Machines
GNo Name     Voltage Angle    Delta    Freq    Pgen    Qgen    Pmech   Efd/Slip
             pu      Degree   Degree   Hzs.    MW      MVAR    MW      pu/P.U.
--- -------- ------- -------- -------- ------- ------- ------- ------- --------
  1     Bus1       1     27.3     27.9      50     484     300     389      1.01
  3     Bus3    1.05     24.3     24.7      50     425    56.7     520      1.05
--------------------------------------------------------------------------------
Maximum rotor angle difference :    3.15983 b/w buses : 1 and 3
Island    1 Common system frequency   50.027
--------------------------------------------------------------------------------
Voltage (pu), Current (AMPS), impedance (PU) and power (MW-MVAR) for lines
From Name     Voltage Angle   To   Name     Voltage  Angle    Current  Angle
                                              Zl-real  Zl-im    P        Q
---- -------- ------- ------- ---- -------- -------- -------- -------- --------
   1     Bus1   1.000   27.31    5     Bus5     1.05       22 2.2e+004     -4.5
                                                 0.6     0.37 4.8e+002   3e+002
   2     Bus2   0.922    6.24    4     Bus4     1.05       22 5.5e+002 1.6e+002
                                                  -1        -0.47  -2.7e+002  -
1.2e+002
                                5     Bus5     1.05       22 9.9e+002 1.7e+002
```

```
                                                  -0.6         -0.18  -5.3e+002   -
1.6e+002
   3     Bus3   1.050   24.26    4     Bus4     1.05        22 1.3e+004        21
                                                   1.3    0.062 3.4e+002        17
   4      Bus4    1.046    22.47     3      Bus3      1.05         24 5.5e+002  -
1.6e+002
                                                  -1.3    -0.022  -3.4e+002       -
5.9
                                 5     Bus5     1.05        22 1.2e+002        57
                                                   4.8      -3.4        61       -43
                                 2     Bus2    0.922       6.2 4.6e+002        13
                                                   1.5      0.26 2.8e+002        49
   5     Bus5   1.050   21.65    1     Bus1        1        27 8.5e+002 1.8e+002
                                                 -0.74         -0.36  -4.8e+002   -
2.3e+002
                                 4       Bus4       1.05          22          98  -
1.6e+002
                                                  -7.2    -0.55       -61      -4.7
                                 2     Bus2    0.922       6.2 9.4e+002      -2.3
                                                  0.68       0.3 5.4e+002 2.4e+002
kp 0 kq 0 Iterations 4 dpmax 0.000006  dqmax 0.000000
kp 0 kq 0 Iterations 4 dpmax 0.000006  dqmax 0.000000
kp 0 kq 0 Iterations 4 dpmax 0.000006  dqmax 0.000000
kp 0 kq 0 Iterations 4 dpmax 0.000006  dqmax 0.000000
kp 0 kq 0 Iterations 4 dpmax 0.000006  dqmax 0.000000
kp 0 kq 0 Iterations 4 dpmax 0.000006  dqmax 0.000000
kp 0 kq 0 Iterations 4 dpmax 0.000006  dqmax 0.000000
kp 0 kq 0 Iterations 4 dpmax 0.000006  dqmax 0.000000
kp 0 kq 0 Iterations 4 dpmax 0.000006  dqmax 0.000000
kp 0 kq 0 Iterations 4 dpmax 0.000006  dqmax 0.000000
-------------------------------------------------------------------------------
Time =   2.78000 Seconds
Intermediate results for Machines
GNo Name      Voltage Angle    Delta    Freq     Pgen     Qgen     Pmech    Efd/Slip
             pu      Degree   Degree   Hzs.     MW       MVAR     MW       pu/P.U.
--- -------- ------- -------- -------- ------- ------- ------- ------- --------
  1     Bus1       1      27.5     28.1      50     485      300     389      1.01
  3     Bus3    1.05      24.4     24.9      50     424     56.8     520      1.05
--------------------------------------------------------------------------------
Maximum rotor angle difference :    3.18061 b/w buses : 1 and 3
Island    1 Common system frequency   50.027
-------------------------------------------------------------------------------
Voltage (pu), Current (AMPS), impedance (PU) and power (MW-MVAR) for lines
From Name      Voltage Angle   To   Name      Voltage  Angle    Current  Angle
                                              Zl-real  Zl-im    P        Q
---- -------- ------- ------- ---- -------- -------- -------- ------- --------
   1     Bus1   1.000   27.51    5     Bus5     1.05        22 2.2e+004      -4.2
                                                   0.6      0.37 4.8e+002   3e+002
   2     Bus2   0.922    6.44    4     Bus4     1.05        23 5.5e+002 1.6e+002
                                                    -1         -0.47  -2.7e+002   -
1.2e+002
```

```
                                  5     Bus5     1.05       22 9.9e+002 1.7e+002
                                           -0.6         -0.18  -5.3e+002  -
1.6e+002
   3     Bus3   1.050   24.45    4     Bus4     1.05       23 1.3e+004       22
                                            1.3    0.062 3.4e+002       17
   4      Bus4    1.046    22.66     3      Bus3      1.05         24 5.5e+002  -
1.6e+002
                                           -1.3   -0.022 -3.4e+002        -
6
                                  5     Bus5     1.05       22 1.2e+002       58
                                            4.8     -3.4       61      -43
                                  2     Bus2    0.922      6.4 4.6e+002       13
                                            1.5     0.26 2.8e+002       49
   5     Bus5   1.050   21.85    1     Bus1        1       28 8.5e+002 1.8e+002
                                          -0.74         -0.36  -4.8e+002  -
2.3e+002
                                  4       Bus4       1.05          23          97 -
1.6e+002
                                           -7.2    -0.58      -60     -4.8
                                  2     Bus2    0.922      6.4 9.4e+002     -2.1
                                            0.68      0.3 5.4e+002 2.4e+002
kp 0 kq 0  Iterations 4 dpmax 0.000006 dqmax 0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000006 dqmax 0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000006 dqmax 0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000006 dqmax 0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000006 dqmax 0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000006 dqmax 0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000006 dqmax 0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000006 dqmax 0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000007 dqmax 0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000007 dqmax 0.000000
--------------------------------------------------------------------------------
Time =   2.80000 Seconds
Intermediate results for Machines
GNo Name     Voltage Angle    Delta    Freq    Pgen    Qgen    Pmech   Efd/Slip
             pu      Degree   Degree   Hzs.    MW      MVAR    MW      pu/P.U.
--- -------- ------- -------- -------- ------- ------- ------- ------- --------
  1     Bus1       1     27.7     28.3      50     485     300     389     1.01
  3     Bus3    1.05     24.6     25.1      50     424    56.8     520     1.05
--------------------------------------------------------------------------------
Maximum rotor angle difference :    3.16682 b/w buses : 1 and 3
Island    1 Common system frequency   50.027
--------------------------------------------------------------------------------
Voltage (pu), Current (AMPS), impedance (PU) and power (MW-MVAR) for lines
From Name     Voltage Angle   To   Name     Voltage  Angle    Current  Angle
                                              Zl-real  Zl-im    P        Q
---- -------- ------- ------- ---- -------- -------- -------- -------- --------
   1     Bus1   1.000   27.70    5     Bus5     1.05       22 2.2e+004       -4
                                              0.6     0.37 4.8e+002   3e+002
   2     Bus2   0.922    6.63    4     Bus4     1.05       23 5.5e+002 1.6e+002
```

```
                                                              -1          -0.47  -2.7e+002   -
1.2e+002
                                 5      Bus5      1.05         22 9.9e+002 1.7e+002
                                                  -0.6          -0.18  -5.3e+002   -
1.6e+002
   3     Bus3   1.050   24.65    4      Bus4      1.05         23 1.3e+004        22
                                                   1.3     0.062 3.4e+002        17
   4      Bus4    1.046    22.86     3       Bus3      1.05         25 5.5e+002  -
1.6e+002
                                                  -1.3    -0.022 -3.4e+002         -
6
                                 5      Bus5      1.05         22 1.2e+002        58
                                                   4.8      -3.4        61       -43
                                 2      Bus2     0.922        6.6 4.6e+002        13
                                                   1.5      0.26 2.8e+002        49
   5     Bus5   1.050   22.04    1      Bus1         1         28 8.5e+002 1.8e+002
                                                 -0.74          -0.36  -4.8e+002   -
2.3e+002
                                 4       Bus4       1.05          23          97  -
1.6e+002
                                                  -7.2     -0.57       -61      -4.8
                                 2      Bus2     0.922        6.6 9.4e+002      -1.9
                                                  0.68       0.3 5.4e+002 2.4e+002
kp 0 kq 0 Iterations 4 dpmax 0.000007  dqmax 0.000000
kp 0 kq 0 Iterations 4 dpmax 0.000007  dqmax 0.000000
kp 0 kq 0 Iterations 4 dpmax 0.000007  dqmax 0.000000
kp 0 kq 0 Iterations 4 dpmax 0.000007  dqmax 0.000000
kp 0 kq 0 Iterations 4 dpmax 0.000007  dqmax 0.000000
kp 0 kq 0 Iterations 4 dpmax 0.000007  dqmax 0.000000
kp 0 kq 0 Iterations 4 dpmax 0.000007  dqmax 0.000000
kp 0 kq 0 Iterations 4 dpmax 0.000007  dqmax 0.000000
kp 0 kq 0 Iterations 4 dpmax 0.000007  dqmax 0.000000
kp 0 kq 0 Iterations 4 dpmax 0.000007  dqmax 0.000000
-----------------------------------------------------------------------------
Time =   2.82000 Seconds
Intermediate results for Machines
GNo Name      Voltage Angle    Delta    Freq     Pgen     Qgen     Pmech    Efd/Slip
              pu      Degree   Degree   Hzs.     MW       MVAR     MW       pu/P.U.
--- -------- ------- -------- -------- ------- ------- ------- ------- --------
  1     Bus1        1      27.9      28.4      50      483      300      389      1.01
  3     Bus3     1.05      24.9      25.3      50      426     56.7      520      1.05
------------------------------------------------------------------------------
Maximum rotor angle difference :    3.11860 b/w buses : 1 and 3
Island    1 Common system frequency   50.027
-----------------------------------------------------------------------------
Voltage (pu), Current (AMPS), impedance (PU) and power (MW-MVAR) for lines
From Name      Voltage Angle    To   Name      Voltage  Angle    Current  Angle
                                               Zl-real  Zl-im    P        Q
---- -------- ------- ------- ---- -------- -------- -------- -------- --------
   1     Bus1   1.000   27.88    5      Bus5      1.05         22 2.2e+004      -3.9
                                                   0.6      0.37 4.8e+002    3e+002
```

```
   2     Bus2   0.922    6.83    4     Bus4     1.05       23 5.5e+002 1.6e+002
                                             -1         -0.47  -2.7e+002  -
1.2e+002
                                 5     Bus5     1.05       22 9.9e+002 1.7e+002
                                            -0.6         -0.18  -5.2e+002  -
1.6e+002
   3     Bus3   1.050   24.86    4     Bus4     1.05       23 1.3e+004        22
                                            1.3    0.062 3.5e+002        17
   4      Bus4    1.046    23.07     3      Bus3      1.05         25 5.5e+002 -
1.6e+002
                                            -1.3    -0.022 -3.4e+002       -
5.8
                                 5     Bus5     1.05       22 1.2e+002        58
                                             4.8     -3.3       62       -43
                                 2     Bus2    0.922      6.8 4.6e+002        13
                                             1.5     0.26 2.8e+002        49
   5     Bus5   1.050   22.24    1     Bus1        1       28 8.5e+002 1.8e+002
                                           -0.74         -0.36  -4.8e+002  -
2.4e+002
                                 4       Bus4       1.05          23          99 -
1.6e+002
                                            -7.1    -0.52      -62     -4.6
                                 2     Bus2    0.922      6.8 9.4e+002     -1.7
                                            0.68      0.3 5.4e+002 2.4e+002
kp 0 kq 0  Iterations 4 dpmax 0.000007 dqmax  0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000007 dqmax  0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000007 dqmax  0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000007 dqmax  0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000007 dqmax  0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000007 dqmax  0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000007 dqmax  0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000007 dqmax  0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000008 dqmax  0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000008 dqmax  0.000000
--------------------------------------------------------------------------------
Time =   2.84000 Seconds
Intermediate results for Machines
GNo Name     Voltage Angle    Delta    Freq    Pgen    Qgen    Pmech   Efd/Slip
             pu      Degree   Degree   Hzs.    MW      MVAR    MW      pu/P.U.
--- -------- ------- -------- -------- ------- ------- ------- ------- --------
  1     Bus1       1       28     28.6      50     481     300     389      1.01
  3     Bus3    1.05     25.1     25.6      50     428    56.6     520      1.05
--------------------------------------------------------------------------------
Maximum rotor angle difference :    3.03648 b/w buses : 1 and 3
Island    1 Common system frequency   50.027
--------------------------------------------------------------------------------
Voltage (pu), Current (AMPS), impedance (PU) and power (MW-MVAR) for lines
From Name     Voltage Angle   To   Name     Voltage  Angle    Current  Angle
                                              Zl-real  Zl-im    P        Q
---- -------- ------- ------- ---- -------- -------- -------- -------- --------
   1     Bus1   1.000    28.04    5     Bus5     1.05       22 2.2e+004        -9
```

```
                                                    0.6      0.37 4.8e+002   3e+002
   2     Bus2   0.922    7.03    4      Bus4      1.05        23 5.5e+002 1.6e+002
                                                     -1        -0.47  -2.7e+002  -
1.2e+002
                                 5      Bus5      1.05        22 9.9e+002 1.7e+002
                                                   -0.6        -0.18  -5.2e+002  -
1.6e+002
   3     Bus3   1.050   25.09    4      Bus4      1.05        23 1.3e+004       22
                                                    1.3      0.06 3.5e+002       17
   4      Bus4    1.046    23.29     3       Bus3      1.05         25 5.6e+002  -
1.6e+002
                                                   -1.3     -0.02  -3.5e+002       -
5.6
                                 5      Bus5      1.05        22 1.2e+002       57
                                                    4.7     -3.2        64      -43
                                 2      Bus2     0.922         7 4.6e+002       14
                                                    1.5      0.26 2.8e+002       49
   5     Bus5   1.050   22.43    1      Bus1         1        28 8.5e+002 1.8e+002
                                                  -0.74        -0.37  -4.8e+002  -
2.4e+002
                                 4       Bus4       1.05          23    1e+002  -
1.6e+002
                                                   -6.8    -0.45       -64     -4.2
                                 2      Bus2     0.922         7 9.4e+002     -1.5
                                                   0.68      0.3 5.4e+002 2.4e+002
kp 0 kq 0 Iterations 4 dpmax 0.000008 dqmax 0.000000
kp 0 kq 0 Iterations 4 dpmax 0.000008 dqmax 0.000000
kp 0 kq 0 Iterations 4 dpmax 0.000008 dqmax 0.000000
kp 0 kq 0 Iterations 4 dpmax 0.000008 dqmax 0.000000
kp 0 kq 0 Iterations 4 dpmax 0.000008 dqmax 0.000000
kp 0 kq 0 Iterations 4 dpmax 0.000008 dqmax 0.000000
kp 0 kq 0 Iterations 4 dpmax 0.000008 dqmax 0.000000
kp 0 kq 0 Iterations 4 dpmax 0.000008 dqmax 0.000000
kp 0 kq 0 Iterations 4 dpmax 0.000008 dqmax 0.000000
kp 0 kq 0 Iterations 4 dpmax 0.000008 dqmax 0.000000
------------------------------------------------------------------------------
Time =   2.86000 Seconds
Intermediate results for Machines
GNo Name      Voltage Angle    Delta    Freq     Pgen     Qgen     Pmech    Efd/Slip
              pu      Degree   Degree   Hzs.     MW       MVAR     MW       pu/P.U.
--- -------- ------- -------- -------- ------- ------- ------- ------- --------
  1     Bus1        1     28.2     28.7      50     477     299     389     1.01
  3     Bus3     1.05     25.3     25.8      50     432    56.5     520     1.05
-------------------------------------------------------------------------------
Maximum rotor angle difference :    2.92138 b/w buses : 1 and 3
Island    1 Common system frequency   50.027
------------------------------------------------------------------------------
Voltage (pu), Current (AMPS), impedance (PU) and power (MW-MVAR) for lines
From Name      Voltage Angle   To   Name     Voltage  Angle    Current  Angle
                                             Zl-real  Zl-im    P        Q
---- -------- ------- ------- ---- -------- -------- -------- -------- --------
```

```
   1     Bus1   1.000   28.18    5     Bus5     1.05       23 2.2e+004     -3.9
                                              0.6     0.38 4.8e+002   3e+002
   2     Bus2   0.922    7.23    4     Bus4     1.05       24 5.5e+002 1.6e+002
                                             -1         -0.46  -2.8e+002  -
1.2e+002
                                 5     Bus5     1.05       23 9.9e+002 1.7e+002
                                            -0.6         -0.18  -5.2e+002  -
1.6e+002
   3     Bus3   1.050   25.34    4     Bus4     1.05       24 1.3e+004       23
                                              1.3    0.059 3.5e+002       16
   4      Bus4    1.046    23.51     3       Bus3       1.05         25 5.6e+002 -
1.6e+002
                                            -1.2    -0.019 -3.5e+002       -
5.2
                                 5     Bus5     1.05       23 1.3e+002       56
                                            4.6       -3       67       -44
                                 2     Bus2    0.922      7.2 4.6e+002       14
                                            1.5     0.26 2.8e+002       49
   5     Bus5   1.050   22.61    1     Bus1        1       28 8.4e+002 1.8e+002
                                           -0.75         -0.37  -4.7e+002  -
2.4e+002
                                 4        Bus4       1.05          24 1.1e+002  -
1.6e+002
                                            -6.5    -0.36      -67     -3.7
                                 2     Bus2    0.922      7.2 9.4e+002     -1.3
                                            0.68      0.3 5.4e+002 2.4e+002
kp 0 kq 0  Iterations 4 dpmax 0.000008 dqmax  0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000008 dqmax  0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000008 dqmax  0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000008 dqmax  0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000008 dqmax  0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000008 dqmax  0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000008 dqmax  0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000008 dqmax  0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000009 dqmax  0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000009 dqmax  0.000000
--------------------------------------------------------------------------------
Time =   2.88000 Seconds
Intermediate results for Machines
GNo Name     Voltage Angle    Delta    Freq    Pgen    Qgen    Pmech   Efd/Slip
             pu      Degree   Degree   Hzs.    MW      MVAR    MW      pu/P.U.
--- -------- ------- -------- -------- ------- ------- ------- ------- --------
  1     Bus1       1     28.3     28.9      50     472     299     389      1.01
  3     Bus3    1.05     25.6     26.1      50     436    56.3     520      1.05
--------------------------------------------------------------------------------
Maximum rotor angle difference :    2.77459 b/w buses : 1 and 3
Island    1 Common system frequency   50.027
--------------------------------------------------------------------------------
Voltage (pu), Current (AMPS), impedance (PU) and power (MW-MVAR) for lines
From Name     Voltage Angle   To   Name     Voltage  Angle    Current  Angle
                                              Zl-real  Zl-im    P        Q
```

```
---- -------- ------- ------- ---- -------- -------- -------- ------- --------
   1     Bus1   1.000   28.31    5     Bus5     1.05       23 2.2e+004       -4
                                                 0.6     0.38 4.7e+002   3e+002
   2     Bus2   0.922    7.44    4     Bus4     1.05       24 5.5e+002 1.6e+002
                                                  -1        -0.46  -2.8e+002  -
1.2e+002
                                 5     Bus5     1.05       23 9.9e+002 1.7e+002
                                                -0.6        -0.18  -5.2e+002  -
1.6e+002
   3     Bus3   1.050   25.60    4     Bus4     1.05       24 1.3e+004       23
                                                 1.2    0.057 3.6e+002       16
   4      Bus4    1.046    23.75     3      Bus3      1.05        26 5.7e+002  -
1.6e+002
                                                -1.2    -0.017  -3.6e+002       -
4.8
                                 5     Bus5     1.05       23 1.3e+002       55
                                                 4.4     -2.7       71      -44
                                 2     Bus2    0.922      7.4 4.6e+002       14
                                                 1.5     0.26 2.8e+002       49
   5     Bus5   1.050   22.80    1     Bus1        1       28 8.4e+002 1.8e+002
                                               -0.75        -0.38  -4.7e+002  -
2.4e+002
                                 4       Bus4       1.05          24 1.1e+002  -
1.6e+002
                                                -6.2    -0.26      -71       -3
                                 2     Bus2    0.922      7.4 9.4e+002     -1.2
                                                0.68      0.3 5.4e+002 2.4e+002
kp 0 kq 0  Iterations 4 dpmax 0.000009 dqmax 0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000009 dqmax 0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000009 dqmax 0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000009 dqmax 0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000009 dqmax 0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000009 dqmax 0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000009 dqmax 0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000009 dqmax 0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000009 dqmax 0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000009 dqmax 0.000000
-------------------------------------------------------------------------------
Time =   2.90000 Seconds
Intermediate results for Machines
GNo Name     Voltage Angle    Delta    Freq    Pgen    Qgen    Pmech   Efd/Slip
             pu      Degree   Degree   Hzs.    MW      MVAR    MW      pu/P.U.
--- -------- ------- -------- -------- ------- ------- ------- ------- --------
  1     Bus1       1     28.4       29      50     467     299     389     1.01
  3     Bus3    1.05     25.9     26.4      50     442    56.2     520     1.05
--------------------------------------------------------------------------------
Maximum rotor angle difference :    2.59779 b/w buses : 1 and 3
Island    1 Common system frequency   50.027
-------------------------------------------------------------------------------
Voltage (pu), Current (AMPS), impedance (PU) and power (MW-MVAR) for lines
From Name      Voltage Angle   To   Name     Voltage  Angle    Current  Angle
```

```
                                                  Zl-real  Zl-im    P        Q
---- -------- ------- ------- ---- -------- -------- -------- -------- --------
   1     Bus1   1.000   28.42    5     Bus5     1.05       23 2.1e+004     -4.2
                                                0.61     0.39 4.7e+002   3e+002
   2     Bus2   0.923    7.64    4     Bus4     1.05       24 5.5e+002 1.6e+002
                                                  -1        -0.46  -2.8e+002   -
1.2e+002
                                 5     Bus5     1.05       23 9.9e+002 1.7e+002
                                                -0.6        -0.18  -5.2e+002   -
1.6e+002
   3     Bus3   1.050   25.88    4     Bus4     1.05       24 1.3e+004       23
                                                 1.2    0.054 3.6e+002       16
   4      Bus4    1.046    24.00     3      Bus3      1.05        26 5.8e+002  -
1.6e+002
                                                -1.2    -0.014  -3.6e+002       -
4.3
                                 5     Bus5     1.05       23 1.4e+002       54
                                                 4.3     -2.5       76      -45
                                 2     Bus2    0.923      7.6 4.6e+002       14
                                                 1.5     0.26 2.8e+002       49
   5     Bus5   1.050   22.98    1     Bus1        1       28 8.3e+002 1.8e+002
                                               -0.75        -0.39  -4.6e+002   -
2.4e+002
                                 4       Bus4       1.05          24 1.2e+002  -
1.6e+002
                                                -5.8    -0.17      -76     -2.2
                                 2     Bus2    0.923      7.6 9.4e+002       -1
                                                0.68      0.3 5.4e+002 2.4e+002
kp 0 kq 0  Iterations 4 dpmax 0.000009 dqmax  0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000009 dqmax  0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000009 dqmax  0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000009 dqmax  0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000009 dqmax  0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000009 dqmax  0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000009 dqmax  0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000009 dqmax  0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000009 dqmax  0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000009 dqmax  0.000000
------------------------------------------------------------------------------
Time =   2.92000 Seconds
Intermediate results for Machines
GNo Name     Voltage Angle    Delta    Freq     Pgen     Qgen     Pmech    Efd/Slip
             pu      Degree   Degree   Hzs.     MW       MVAR     MW       pu/P.U.
--- -------- ------- -------- -------- ------- ------- ------- ------- --------
  1     Bus1       1     28.5     29.1      50     460     298     389     1.01
  3     Bus3    1.05     26.2     26.7      50     448      56     520     1.05
---------------------------------------------------------------------------
Maximum rotor angle difference :    2.39299 b/w buses : 1 and 3
Island    1 Common system frequency   50.027
------------------------------------------------------------------------------
Voltage (pu), Current (AMPS), impedance (PU) and power (MW-MVAR) for lines
```

```
From Name      Voltage Angle   To   Name      Voltage  Angle    Current  Angle
                                              Zl-real  Zl-im    P        Q
---- -------- ------- ------- ---- -------- -------- -------- -------- --------
   1     Bus1   1.000   28.53    5     Bus5      1.05       23 2.1e+004     -4.4
                                                 0.61      0.4 4.6e+002   3e+002
   2     Bus2   0.923    7.85    4     Bus4      1.05       24 5.5e+002 1.6e+002
                                                   -1       -0.46  -2.8e+002  -
1.2e+002
                                 5     Bus5      1.05       23 9.9e+002 1.7e+002
                                                 -0.6       -0.18  -5.2e+002  -
1.6e+002
   3     Bus3   1.050   26.17    4     Bus4      1.05       24 1.4e+004       24
                                                  1.2    0.052 3.7e+002       16
   4      Bus4    1.046    24.26     3      Bus3      1.05        26 5.9e+002  -
1.6e+002
                                                 -1.2    -0.012  -3.7e+002      -
3.7
                                 5     Bus5      1.05       23 1.5e+002       53
                                                  4.1     -2.3       82      -45
                                 2     Bus2     0.923      7.8 4.6e+002       15
                                                  1.5     0.26 2.9e+002       49
   5     Bus5   1.050   23.16    1     Bus1         1       29 8.2e+002 1.8e+002
                                                -0.76        -0.4  -4.6e+002  -
2.4e+002
                                 4       Bus4       1.05        24 1.3e+002  -
1.6e+002
                                                 -5.4   -0.087      -82     -1.3
                                 2     Bus2     0.923      7.8 9.4e+002    -0.84
                                                 0.68      0.3 5.4e+002 2.4e+002
kp 0 kq 0  Iterations 4 dpmax 0.000009 dqmax 0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000010 dqmax 0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000010 dqmax 0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000010 dqmax 0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000010 dqmax 0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000010 dqmax 0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000010 dqmax 0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000010 dqmax 0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000010 dqmax 0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000010 dqmax 0.000000
------------------------------------------------------------------------------
Time =   2.94000 Seconds
Intermediate results for Machines
GNo Name      Voltage Angle    Delta    Freq    Pgen    Qgen    Pmech   Efd/Slip
              pu      Degree   Degree   Hzs.    MW      MVAR    MW      pu/P.U.
--- -------- ------- -------- -------- ------- ------- ------- ------- --------
  1     Bus1       1     28.6     29.1      50     453     298     389     1.01
  3     Bus3    1.05     26.5       27      50     456    55.8     520     1.05
---------------------------------------------------------------------------
Maximum rotor angle difference :    2.16253 b/w buses : 1 and 3
Island    1 Common system frequency   50.027
------------------------------------------------------------------------------
```

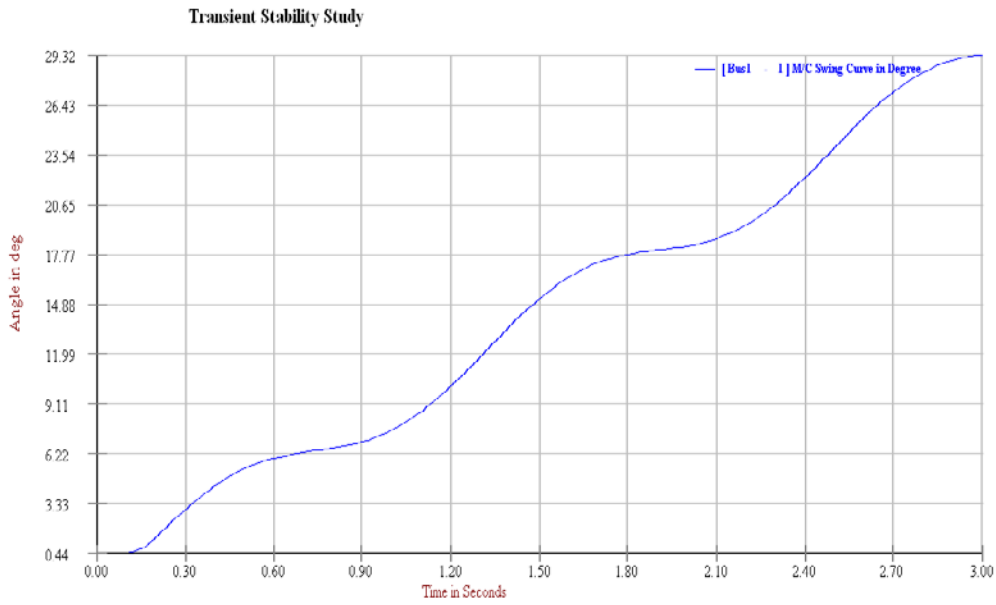
```
Voltage (pu), Current (AMPS), impedance (PU) and power (MW-MVAR) for lines
From Name     Voltage Angle   To   Name     Voltage  Angle    Current  Angle
                                            Zl-real  Zl-im    P        Q
---- -------- ------- ------- ---- -------- -------- -------- -------- --------
   1     Bus1   1.000   28.62    5     Bus5     1.05       23 2.1e+004     -4.7
                                                0.62     0.41 4.5e+002   3e+002
   2     Bus2   0.923    8.05    4     Bus4     1.05       25 5.5e+002 1.6e+002
                                                  -1        -0.45  -2.8e+002  -
1.2e+002
                                 5     Bus5     1.05       23 9.9e+002 1.7e+002
                                                -0.6        -0.18  -5.2e+002  -
1.6e+002
   3     Bus3   1.050   26.47    4     Bus4     1.05       25 1.4e+004       24
                                                 1.2    0.049 3.8e+002       16
   4      Bus4    1.046    24.52     3      Bus3      1.05         26    6e+002 -
1.6e+002
                                                -1.2   -0.0095 -3.7e+002        -
3
                                 5     Bus5     1.05       23 1.6e+002       52
                                                 3.9       -2       88      -46
                                 2     Bus2    0.923      8.1 4.6e+002       15
                                                 1.5     0.26 2.9e+002       49
   5     Bus5   1.050   23.34    1     Bus1        1       29 8.1e+002 1.8e+002
                                               -0.77        -0.41  -4.5e+002  -
2.4e+002
                                 4       Bus4       1.05          25 1.4e+002  -
1.6e+002
                                                  -5   -0.015      -88    -0.27
                                 2     Bus2    0.923      8.1 9.4e+002    -0.69
                                                0.69     0.31 5.4e+002 2.4e+002
kp 0 kq 0  Iterations 4 dpmax 0.000010 dqmax  0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000010 dqmax  0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000010 dqmax  0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000010 dqmax  0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000010 dqmax  0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000010 dqmax  0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000010 dqmax  0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000010 dqmax  0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000010 dqmax  0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000010 dqmax  0.000000
------------------------------------------------------------------------------
Time =   2.96000 Seconds
Intermediate results for Machines
GNo Name      Voltage Angle    Delta    Freq     Pgen     Qgen     Pmech    Efd/Slip
              pu      Degree   Degree   Hzs.     MW       MVAR     MW       pu/P.U.
--- -------- ------- -------- -------- ------- ------- ------- ------- --------
  1     Bus1       1     28.7     29.2      50     445     298     389     1.01
  3     Bus3    1.05     26.8     27.3      50     464    55.7     520     1.05
-------------------------------------------------------------------------------
Maximum rotor angle difference :    1.90906 b/w buses : 1 and 3
Island    1 Common system frequency   50.027
```

```
---------------------------------------------------------------------------------
Voltage (pu), Current (AMPS), impedance (PU) and power (MW-MVAR) for lines
From Name     Voltage Angle   To   Name     Voltage  Angle    Current  Angle
                                            Zl-real  Zl-im    P        Q
---- -------- ------- ------- ---- -------- -------- -------- ------- --------
   1     Bus1   1.000   28.69    5     Bus5     1.05       24 2.1e+004     -5.1
                                                0.62     0.42 4.5e+002   3e+002
   2     Bus2   0.923    8.26    4     Bus4     1.05       25 5.5e+002 1.6e+002
                                                  -1        -0.45  -2.8e+002   -
1.2e+002
                                 5     Bus5     1.05       24 9.9e+002 1.7e+002
                                                -0.6        -0.18  -5.2e+002   -
1.6e+002
   3     Bus3   1.050   26.78    4     Bus4     1.05       25 1.4e+004       24
                                                 1.1    0.047 3.8e+002       16
   4      Bus4    1.046    24.79     3      Bus3      1.05         27 6.1e+002  -
1.6e+002
                                                -1.1    -0.007  -3.8e+002       -
2.3
                                 5     Bus5     1.05       24 1.7e+002       51
                                                 3.7     -1.8        95      -47
                                 2     Bus2    0.923      8.3 4.7e+002       15
                                                 1.5     0.25 2.9e+002       49
   5     Bus5   1.050   23.52    1     Bus1        1       29   8e+002 1.7e+002
                                               -0.77        -0.42  -4.4e+002   -
2.4e+002
                                 4      Bus4      1.05         25 1.5e+002  -
1.6e+002
                                                -4.6    0.043       -95     0.89
                                 2     Bus2    0.923      8.3 9.4e+002    -0.54
                                                0.69     0.31 5.4e+002 2.4e+002
kp 0 kq 0  Iterations 4 dpmax 0.000010 dqmax  0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000010 dqmax  0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000010 dqmax  0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000010 dqmax  0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000010 dqmax  0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000010 dqmax  0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000010 dqmax  0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000010 dqmax  0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000010 dqmax  0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000010 dqmax  0.000000
---------------------------------------------------------------------------------
Time =   2.98000 Seconds
Intermediate results for Machines
GNo Name      Voltage Angle    Delta    Freq    Pgen    Qgen    Pmech   Efd/Slip
              pu      Degree   Degree   Hzs.    MW      MVAR    MW      pu/P.U.
--- -------- ------- -------- -------- ------- ------- ------- ------- --------
  1     Bus1       1     28.8     29.3      50     436     297     389     1.01
  3     Bus3    1.05     27.1     27.6      50     473    55.6     520     1.05
------------------------------------------------------------------------------
Maximum rotor angle difference :    1.63548 b/w buses : 1 and 3
```

```
Island     1 Common system frequency    50.027
-----------------------------------------------------------------------------
Voltage (pu), Current (AMPS), impedance (PU) and power (MW-MVAR) for lines
From Name      Voltage Angle    To    Name      Voltage  Angle    Current  Angle
                                                Zl-real  Zl-im    P        Q
---- -------- ------- ------- ---- -------- -------- -------- -------- --------
   1     Bus1   1.000   28.76    5     Bus5      1.05       24   2e+004     -5.5
                                                  0.63     0.43 4.4e+002   3e+002
   2     Bus2   0.923    8.47    4     Bus4      1.05       25 5.5e+002 1.6e+002
                                                    -1       -0.44  -2.8e+002   -
1.2e+002
                                 5     Bus5      1.05       24 9.9e+002 1.7e+002
                                                  -0.6       -0.18  -5.2e+002   -
1.6e+002
   3     Bus3   1.050   27.11    4     Bus4      1.05       25 1.4e+004       25
                                                   1.1    0.045 3.9e+002       16
   4      Bus4    1.046    25.07     3      Bus3      1.05        27 6.3e+002  -
1.6e+002
                                                  -1.1   -0.0046  -3.9e+002       -
1.6
                                 5     Bus5      1.05       24 1.8e+002       50
                                                   3.5     -1.6   1e+002      -48
                                 2     Bus2     0.923      8.5 4.7e+002       15
                                                   1.5     0.25 2.9e+002       50
   5     Bus5   1.050   23.70    1     Bus1         1       29 7.9e+002 1.7e+002
                                                 -0.78       -0.43  -4.3e+002   -
2.4e+002
                                 4       Bus4       1.05         25 1.6e+002  -
1.6e+002
                                                  -4.3     0.09  -1e+002      2.2
                                 2     Bus2     0.923      8.5 9.3e+002     -0.4
                                                  0.69     0.31 5.3e+002 2.4e+002
kp 0 kq 0  Iterations 4 dpmax 0.000010 dqmax 0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000011 dqmax 0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000011 dqmax 0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000011 dqmax 0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000011 dqmax 0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000011 dqmax 0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000011 dqmax 0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000011 dqmax 0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000011 dqmax 0.000000
kp 0 kq 0  Iterations 4 dpmax 0.000011 dqmax 0.000000
-----------------------------------------------------------------------------
Time =    3.00000 Seconds
Intermediate results for Machines
GNo Name      Voltage Angle     Delta     Freq     Pgen     Qgen     Pmech    Efd/Slip
              pu      Degree    Degree    Hzs.     MW       MVAR     MW       pu/P.U.
--- -------- ------- -------- -------- ------- ------- ------- ------- --------
  1     Bus1        1      28.8      29.3       50      427      297      389     1.01
  3     Bus3     1.05      27.4        28       50      482     55.5      520     1.05
--------------------------------------------------------------------------
```

```
Maximum rotor angle difference :    1.34494 b/w buses : 1 and 3
Island    1 Common system frequency   50.027
------------------------------------------------------------------------------
Voltage (pu), Current (AMPS), impedance (PU) and power (MW-MVAR) for lines
From Name     Voltage Angle   To   Name     Voltage  Angle    Current  Angle
                                              Zl-real  Zl-im    P        Q
---- -------- ------- ------- ---- -------- -------- -------- -------- --------
   1     Bus1   1.000   28.83    5     Bus5     1.05       24   2e+004       -6
                                              0.63     0.44 4.3e+002   3e+002
   2     Bus2   0.923    8.68    4     Bus4     1.05       25 5.6e+002 1.7e+002
                                                -1         -0.44  -2.8e+002  -
1.2e+002
                                   5     Bus5     1.05       24 9.8e+002 1.7e+002
                                              -0.6         -0.18  -5.2e+002  -
1.6e+002
   3     Bus3   1.050   27.44    4     Bus4     1.05       25 1.5e+004       25
                                               1.1    0.042   4e+002       16
   4      Bus4    1.046    25.35     3       Bus3      1.05         27 6.4e+002  -
1.5e+002
                                              -1.1  -0.0023  -4e+002    -0.84
                                   5     Bus5     1.05       24 1.9e+002       49
                                               3.3     -1.5 1.1e+002      -49
                                   2     Bus2    0.923      8.7 4.7e+002       16
                                               1.5     0.25 2.9e+002       50
   5     Bus5   1.050   23.87    1     Bus1        1       29 7.8e+002 1.7e+002
                                             -0.78         -0.45  -4.2e+002  -
2.4e+002
                                   4       Bus4       1.05          25 1.8e+002  -
1.5e+002
                                                -4            0.13   -1.1e+002
3.5
                                   2     Bus2    0.923      8.7 9.3e+002    -0.26
                                              0.69     0.31 5.3e+002 2.4e+002
------------------------------------------------------------------------------
Date and Time : Wed Apr 30 10:59:49 2014
```

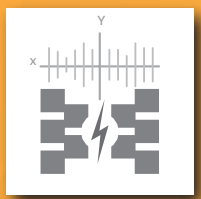
Transient Stability Sample output - Swing – Curve



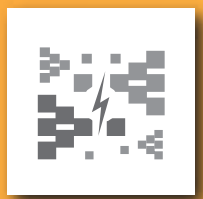
Protection Suite

PSCT | *Protection Analytic tool*

Power System Network Editor

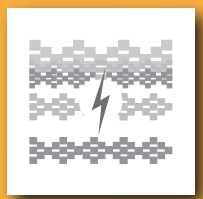


Graph Utility



Free Programmable Block

Database Manager



COMTRADE Viewer

LPC/CPC

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