महापारेषण

MAHARASHTRA STATE ELECTRICITY TRANSMISSION COMPANY LIMITED
(CIN NO U40109MH2005SGC153646)

Name of Office	:	**Chief Engineer (State Transmission Utility)**
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MSETCL/CO/STU/Sys/SGC/ No - 1874 **Date:** 15 MAR 2022

NOTICE

Inviting Comments / Suggestions on the Draft Procedure formulated towards "STANDARD PLANNING DATA "

Hon'ble MERC has issued, the MERC (State Grid Code) Regulations, 2020, notified on dated 02.09.2020. The Regulation No. 14 of the said Regulations is reproduced below:

Transmission Licensees and Users shall supply the following types of data to the STU for the purpose of developing the transmission plan:

- Standard Planning Data
- Detailed Planning Data

➢ **Standard Planning Data**

Standard Planning Data shall consist of details which are expected to be normally sufficient for the STU to investigate the impact on the InSTS due to User/Transmission Licensee development.

Transmission Licensees and Users shall provide the following data to the STU from time to time in standard formats as provided by the STU:

- Preliminary project planning data;
- Committed project planning data; and
- Connected planning data.

Provided that the STU shall provide a date for submission of information in the said formats, after providing reasonable time to Transmission Licensees and Users:

Provided that the STU shall develop standard formats, for submission of above-mentioned data, within one month from notification of these Regulations and make the same available on its website:

Inviting Comments / Suggestions on the Draft Procedure formulated towards "STANDARD PLANNING DATA "

Provided also that the STU shall be guided by the formats, developed for submission of abovementioned data, under the pro visions of IEGC.

➢ **Detailed Planning Data**

Detailed Planning Data shall consist of additional, more detailed data not normally expected to be required by the STU to assess the impact of User/Transmission Licensee development on the InSTS.

Detailed Planning Data shall be furnished by the Users and Transmission Licensees as and when requested by the STU.

Based on the above directives, STU has formulated draft procedure in accordance with the said regulations and is hereby published on dated 15.03.2022 on MSETCL's Website (STU section): www.mahatransco.in, for seeking comments / suggestions, if any, from various Stake holders. In view of above, it is requested to offer valuable comments/suggestions if any on the said draft procedure to make this procedure more accurate and error free, for smooth implementation of the said regulations in the State. After receipt of the comments / suggestions from various stake holders, the same shall be scrutinized and final draft shall be submitted to the Hon'ble Commission.

The details for submission of comments / suggestions are as follows:

Last date of submission	:	**30.03.2022 by 18.00 Hrs.**
Mode of submission	:	**Soft copy in '.xls' form in the attached format along with 'PDF' copy through e-Mail. No hard copy is required.**
Mail Id	:	**sesys@mahatransco.in**

Please make a note that any submission after the mentioned date & time and comments/ submission on any other e-mail-ids' of MSETCL shall not be considered.

Encl: 1) Draft Procedure
2) Format for Comments

Place : Prakashganga, BKC,
Bandra (E), Mumbai: - 400051.

Date : 11.03.2022

Yours Sincerely,

(S.G Bhole)
Chief Engineer (STU)

Inviting Comments / Suggestions on the Draft Procedure formulated towards "STANDARD PLANNING DATA "

Format for submission of Comments/Suggestions

Name of Stake holder:			
Sr. No	Draft Procedure Clause No.	Comments of the Stakeholder	Suggestion of the Stakeholder

Note: Suggestions on any additional points which are not covered in the Draft Procedure shall be added separately with Clause No. as "Additional".

Above format is to be submitted in "excel" form through e-mail for ease of consolidation of comments of all the Stakeholders.

STANDARD PLANNING DATA

(Pursuant to Section 14.2.2 of the MEGC 2020)

In accordance with the

Maharashtra Electricity Regulatory Commission

(Electricity Grid Code) Regulations, 2020

MAHATRANSCO
Maharashtra State Electricity Transmission Co. Ltd.

Prepared by

STATE TRANSMISSION UTILITY

MAHARASHTRA STATE ELECTRICITY TRANSMISSION COMPANY LIMITED

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List Of Abbreviations

Abbreviation/Acronym	Expanded Form
BESS	Battery Energy Storage System
CEA	Central Electricity Authority
CHP	Combined Heat and Power
CPP	Captive Power Producer
CTU	Central Transmission Utility
EPS	Electric Power Survey
FACT	Flexible Alternating Current Transmission
IEEE	The Institute of Electrical and Electronics Engineers
InSTS	Intra-State Transmission System
IPP	Independent Power Producer
ISTS	Inter-State Transmission System
kV	Kilovolt
LTA	Long-term Access
MEGC	Maharashtra Electricity Grid Code, 2020
MERC	Maharashtra Electricity Regulatory Commission
MTOA	Medium-term Open Access
MVAr	Mega volt ampere (reactive)
MW	Megawatt
PSS/E	Power System Simulator for Engineering
QCA	Qualified Coordinating Agency
RE	Renewable Energy
SLDC/MSLDC	Maharashtra State Load Despatch Centre
STU	Maharashtra State Transmission Utility
WR	Western Region
RLDC	Regional load Dispatch Centre

Standard Planning Data

1. Introduction:

   To enable State Transmission Utility (STU) to discharge its responsibilities relating to planning of Intra-State Transmission System (InSTS) under Electricity Act, 2003, the Users are required to furnish data relating to their systems to STU. In accordance with clause 14.2.2 and other relevant clauses of MEGC 2020, the Transmission Licensee and Users shall supply planning data to the State Transmission Utility for purpose of developing the transmission plan.

   This document describes the procedure, format and periodicity of submission of data required by STU from the Transmission Licensees and Users for development of transmission plan on long term basis.

2. Definitions

   1. Connectivity: The state of getting connected to the InSTS by a generating station, including captive generating plant or User or an Intra-State Transmission Licensee.
   2. Flexible Alternating Current Transmission (FACT): A power electronics-based system and other static equipment that provide control of one or more AC transmission system parameters to enhance controllability and increase in power transfer capability;
   3. Intra State Transmission System (InSTS) means any system for conveyance of electricity by transmission lines within the area of the State and includes all transmission lines, sub-stations, and associated equipment of transmission licensees in the State excluding ISTS.
   4. Inter State Transmission System (ISTS):

      i) Any system for the conveyance of electricity by means of a main transmission line from the territory of one State to another State.

      ii) The conveyance of electricity across the territory of an intervening State as well as conveyance within the State which is incidental to such inter-State transmission of energy.

iii) The transmission of electricity within the territory of State on a system built, owned, operated, maintained, or controlled by CTU.

5. Licensee: A person who has been granted a licence or deemed licensee under Section 14 of the Act.
6. Maharashtra State Load Despatch Centre (MSLDC or SLDC): The Centre established under sub-section (1) of Section 31 of the Act.
7. Open Access: The non-discriminatory provision for the use of transmission lines or distribution system or associated facilities with such lines or system by any licensees or consumer or a person engaged in generation in accordance with Regulations of the appropriate Commission.
8. Qualified Coordinating Agency (QCA): The agency appointed by the Wind or Solar Energy Generators connected to a Pooling Sub-Station, or by an individual Generator connected directly to a Sub-Station, to perform the functions and discharge the obligations specified in the MERC (Forecasting, Scheduling and Deviation Settlement for Solar and Wind Generation) Regulations, 2018.
9. Regional Load Despatch Centre (RLDC): The Centre established under sub-section (1) of Section 27 of the Act.
10. Transmission Licence: A licence granted under Section 14 of the Act to transmit electricity.
11. User or InSTS User: A person such as State owned generator including, CPP, Renewable Energy Generators or Distribution Licensee or Consumers connected to the InSTS.

3. Objective and Scope

The objective of this procedure is to prescribe formats for submission of all the data required to be provided by the Transmission Licensees and the Users to STU in accordance with the provisions of MEGC 2020 and periodicity for submission of such data.

All existing grid users (including InSTS Transmission Licensees, Generators (State

owned Generators, IPPs, CPPs, RE generator), Distribution Licensees and Open Access consumers connected to InSTS and those Users seeking Connectivity, LTOA or MTOA to InSTS shall furnish the data.

4. Responsibility

4.1. All Users are responsible for submitting up-to-date data to STU as per Annexure-1 in accordance with the provisions of the MEGC 2020.

4.2. All Users shall provide STU with the name, designation, address and contact details of the nodal officer who will be responsible for sending the data.

4.3. STU shall inform all Users of the name, designation, address and contact details of the nodal officer who will be responsible for receiving data.

4.4. STU shall provide up to date data to Users as they may require for planning their system.

4.5. Responsibility for the correctness of data rests with concerned User providing the data.

5. Planning Philosophy and Cycle

5.1. A robust, strong and flexible InSTS network acts as an enabler for seamless transfer of power from any generator to load centres anywhere in the State in an efficient, reliable and economic manner. Such a network shall facilitate the ease of interconnection of generators to the InSTS and also the end consumers to purchase power at competitive rates along with promoting the development of vibrant power market. An adequate InSTS network is essential for ensuring continuity of power supply to state utilities and distribution companies under various emergency situations including disaster management.

5.2. The STU shall draw up plan for InSTS for up to next five years on rolling basis, every year identifying specific transmission projects which are required to be taken up

along with their implementation timelines, after considering the plans made by Central Electricity Authority (CEA) and studying the progress in generation capacity and demand in different parts of the State. The STU transmission plans shall consider the quarterly feedbacks provided by SLDC and RLDC to affect system strengthening, to remove transmission congestion. The STU plan shall be in accordance with perspective plan of CEA, planning of Inter-State Transmission System (ISTS) substation and transmission elements in the State by Central Transmission Utility (CTU), the decision taken in the Western Region (WR) standing committee so as to ensure building of evacuation system from ISTS substation in the State.

5.3. State Distribution Licensees shall furnish demand forecast for one year ahead and five years ahead. The long-term forecast for the state can also be taken from Electric Power Survey (EPS) of CEA.

6. Planning Data Requirement:

6.1. To enable STU to discharge its responsibilities relating to planning Intra-State Transmission System under Electricity Act, 2003. All the Users are required to furnish Planning Data to STU in the prescribed formats appended herewith and at prescribed time.

6.2. To enable the Users to co-ordinate planning, design and operation of their own plants and systems with InSTS they may seek certain salient data of the Transmission System as applicable to them. STU/ Transmission Licensee shall supply these data from time to time.

6.3. The data shall be submitted by concerned Users to STU as per standard formats given in Section -1 for General and Connection data, Section – 2 for Load flow data and Section – 3 for Dynamic data within three (3) months of uploading of the format on website of STU and as when changes occur in case of existing stations, however any

other data as required by STU for transmission planning shall be made available to STU by all the Users and InSTS Transmission Licensees as per the timelines and in a format provided by the STU.

6.4. Transmission Licensees and Users shall submit the Standard Planning Data to the State Transmission Utility for purpose of developing transmission plan.

7. Standard Planning Data

7.1. Standard Planning Data shall consist of details which are expected to be normally sufficient for the State Transmission Utility to investigate the impact on the InSTS due to User/Transmission Licensees development in their systems.

Standard Planning Data shall consist of following:

a) Preliminary project planning data

b) Committed project planning data

c) Connected planning data

7.2. Preliminary project planning data comprise location of Generating station, Pooling Substation, type of fuel and various stages approvals concerning land acquisition, fuel supply agreement, various clearances from statutory authorities, timelines for various activity including schedule date of commissioning, start-up power arrangement, etc.

7.3. Committed project planning data comprise connectivity details, power purchase agreements, LTA and MTOA details, No. of units, Size/Capacity of units, Rating of equipments, etc.

7.4. Connected planning data comprise of equipment details, Load Flow (Static) data and Dynamic data.

8. Format for Standard Planning Data

Standard Planning Data shall be provided by the Generating Companies including IPPs, CPPs, RE generators, Transmission Licensees, Distribution Licensees and Open Access

consumers connected to InSTS in the formats prescribed in Section -1, Section-2 and Section-3 of this document.

9. Changes to Users Data

9.1. Whenever any User becomes aware of a change to any items of data that is registered with STU, the User must promptly notify STU of the changes. STU on receipt of intimation of the changes shall promptly correct the database accordingly. This shall also apply to any data compiled by STU regarding to its own system.

9.2. In case of Distribution Licensees the load data (substation wise data - MW/ MVAr) need to be updated at least once in a year. Similarly, Transmission Licensees shall update the planning data base on quarterly basis to incorporate new transmission lines and new substation added in the network. As and when a generation unit/ station is added SLDC shall inform STU for updating the planning data base.

9.3. However, STU can create base cases using the planning data of the existing system and by incorporating data for those generators, transmission elements and load centers expected to be commissioned for planning horizon such as one year ahead and five year ahead.

10. Methods of Submitting Data

10.1. The data shall be furnished in the standard formats for data submission and such format must be used for the written submission of data to STU.

10.2. All data to be submitted under the Schedule(s) must be submitted to STU. The name of the Person who is submitting each schedule of data must be indicated.

10.3. In case the Users / Transmission Licensees of InSTS are using PSS/E software for system studies, they can submit the planning data in the PSS/E files as indicated below.

A. For load flow data ".sav", ".sld", ".raw" files need to be furnished

B. For dynamic model data can be furnished in ".dyre" file.

11. Preparation of Transmission Plan for new InSTS

11.1. Load-generation scenarios shall be worked out as per the requirements so as to reflect the daily and seasonal variations in load demand and generation availability (such as cases for peak, off-peak and other than peak / off-peak hours for different seasons considering low, moderate and high renewable/other generation capacity).

11.2. In addition to this, varying import / export requirements of load centers and scheduling of various generating stations under economic dispatch for which variable cost of existing and upcoming generating stations may also be considered.

11.3. While planning the transmission system, options of upgrading the existing InSTS in place of building new transmission lines (such as increasing line loading through use of compensation, reconductoring, etc.) shall be explored for optimally utilizing the existing assets.

11.4. To avoid bottling up of power, STUs shall also plan to strengthen their downstream networks based on the evolved Inter-State Transmission System in similar time-frame. Based on progress of implementation of generating stations and upstream/downstream systems, mid-course correction for transmission system to the extent possible should be made in terms of (i) Re-configuration of planned transmission system, (ii) Phasing of transmission elements and (iii) Rescheduling of some of the transmission elements.

11.5. STU shall carry out joint studies with CTU in order to avoid duplication of substation and transmission elements in the plans of CTU and STU and also to plan evacuation networks from CTU substations. The integration of CTU and STU plans shall be coordinated through WR standing committee meetings of CEA.

12. Data not supplied

Users are obliged to supply data as referred to in the individual formats. In case any data is missing and not supplied by any User, STU may, acting reasonably, if and when necessary, estimates such data depending upon the urgency of the situation preferably from Standard IEEE, PSS/E, etc. models shall be used in case of non-available data.

13. Special Considerations

STU and any other User may at any time make reasonable request for extra data as necessary.

Annexure-1

All existing grid users (including InSTS Transmission Licensees, Generators (State owned Generators, IPPs, CPPs, RE), Distribution Licensees and Open Access consumers connected to InSTS and those users seeking Connectivity, LTOA or MTOA to InSTS shall furnish the data as per formats given under sections 1, 2 and 3.

Details of State-owned Generator, IPPs and CPPs, RE generator and QCA on behalf of RE Generator, Transmission licensee and Distribution Licensee

Nodal Officer and Designation	
Contact Number and Email address	
Name of the data submitting Agency	
Whether State owned Generator, IPPs and CPPs, RE generator and QCA on behalf of RE Generator, Transmission licensee and Distribution Licensee	
User registration details with SLDC	
Address	

Detailed Planning Data shall be provided by the Generating Companies including IPPs, CPPs, RE generators, Transmission Licensees, Distribution Licensees, Open Access users connected to InSTS as and when requested by the State Transmission Utility in the formats prescribed hereunder:

Sr. No.	Formats No.	Data submission by	Data to be submitted to	Data relating to	Periodicity of data submission
	Section :1 - General Information and Connectivity Details Formats				
1	Format No. - General/Gen/thermal/1	Generating Company/ CPP	STU	Each thermal power station	Three month after uploading of the formats on the

Sr. No.	Formats No.	Data submission by	Data to be submitted to	Data relating to	Periodicity of data submission
2	Format No. - General/Gen/hydro/1	Generating Company/CPP/ Hydro Power generator	STU	Each Hydro power station	website of STU and as when changes occur in case of existing stations For upcoming generating station seeking connectivity, LTOA or MTOA along with application. If placement of orders for main and balance equipment is not done at the time of seeking connectivity, the balance data need to be furnished at the earliest or in within one month of placing order for equipments.
3	Format No. - General/Gen/Cogen/1	Cogeneration or CHP Company/ CPP	STU	Each Cogeneration station	
4	Format No. - General/Gen/RE/1	Wind / Solar Generating Company/CPP and QCA on behalf of RE Generators	STU	Each Wind / Solar station	
5	Format No. - General/Storage/BESS/1	BESS	STU	BESS	
6	Format No. - General/Transmission/1	Transmission Licensee/TSU	STU	Each line and sub-station	
7	Format No. - General//Distribution/1	Distribution Licensee/ Discom	STU	Entire Distribution system	
	Section: 2 - Load Flow Studies Formats				
8	Format No. - LF/Bus/1	Transmission licensee, Generating Company, CPPs, RE Generators and QCA on behalf of RE Generators	STU	Bus Data	As and when requested by STU
9	Format No. - LF/Transformer/1		STU	Transmission Line / Transformer	
10	Format No. - LF/Transformer/2		STU	Transmission Line / Transformer	

Sr. No.	Formats No.	Data submission by	Data to be submitted to	Data relating to	Periodicity of data submission
11	Format No. - LF/Transformer/ 3		STU	Transmission Line / Transformer	
12	Format No. - LF/HVDC/1	Transmission Licensee	STU	HVDC Lines	
13	Format No. - LF/FACT/1	Transmission Licensee	STU	FACT Devices	
14	Format No. - LF/FACT/2	Transmission Licensee	STU	FACT Devices	
15	Format No. - LF/STATCOM/1	Transmission Licensee	STU	STATCOM	
	Section: 3 - Dynamic Studies Formats				
16	Format No. - Dyn/Generation / Thermal-Coal Fired/1	Generating Company /CPP	STU	Coal Fired thermal Generation details	As and when requested by STU
17	Format No. - Dyn/Generation / Thermal-Gas/1	Generating Company /CPP	STU	Each Gas based thermal power station	
18	Format No. - Dyn/Generation /Hydro/1	Generating Company/CPP/ Hydro Power generator	STU	Each hydro station	
19	Format No. - Dyn/Generation /Wind/1	Wind Power Generator /CPP	STU	Wind Mill	
20	Format No. - Dyn/Generation /Solar/1	Solar Power Generator /CPP	STU	Solar Generation Plant	
21	Format No. - Dyn/Storage/BE SS/1	BESS	STU	BESS	
22	Format No. - Dyn/Transmissio n/HVDC/1	Transmission Licensee	STU	HVDC Link	

Section - 1
General information and Connectivity Details Formats

14. General Information and Connectivity Details Format

14.1.Generation: Thermal (Coal/Gas/Liquid Fuel)

Format No.:	General/Gen/thermal/1
Data Submission By:	Generating Company / CPP
Data related to:	Each thermal power station
Data to be submitted to:	State Transmission Utility
Periodicity & prescribed date for data submission:	Three months after uploading of the formats on the website of STU and as when changes occur in case of existing stations For upcoming generating station seeking connectivity, LTA or MTOA along with application. If placement of orders for main and balance equipment is not done at the time of seeking connectivity, the balance data need to be furnished at the earliest or in within one month of placing order for equipments.

GENERAL		
1	Name of Generating Company	
2	Name of Power Station	
3	Name of Pooling Station	
4	Site Map	Showing area required for Power Station coal linkage, coal yard, water pipe lines, ash disposal area, colony etc.
5	Approximate period of construction and Date of Commercial Operation date (COD)	
6	Proof of Land Acquisition	
7	Fuel Supply Arrangement	
8	Statutory clearance from various authority	
9	Startup power Arrangement details	
CONNECTION		
1	Point of Connection/ Interface Point	Furnish single line diagram of the proposed Connection with the Transmission system with clear indication of possibility for right of way for unobstructed outlet.
2	Step up voltage for Connection (kV)	
STATION CAPACITY		
1	Total Power Station capacity (MW)	Give details whether development will be carried out in phases and if so, furnish details.
2	No. of units & unit size (MW)	
GENERATING UNIT DATA FOR EACH TYPE		
1	Generator	

	(a) Make and Type	
	(b) Rating (MVA)	
	(c) Terminal Voltage (kV)	
	(d) Rated Power Factor	
	(e) Reactive Power capability (MVAr) in the range 0.95 leading and 0.85 lagging.	
	(f) Short Circuit Ratio	
	(g) Direct axis transient reactance (% on MVA rating)	
	(h) Direct axis sub-transient reactance (% on MVA rating)	
	(i) Auxiliary Power requirement	
2	Generator Transformer	
	(a) Type	
	(b) Rated Capacity (MVA)	
	(c) Voltage Ratio (HV/LV)	
	(d) Tap change range (+% to -%)	
	(e) Percentage Impedance (Positive Sequence at Full load).	
3	Steam Generating Unit	Give details of type, capacity, steam pressure, stream temperature etc.
4	Steam turbine	Give details of type, capacity.

14.2. Generation: Hydro

Format No. :	General/Gen/hydro/1
Data Submission By:	Generating Company / CPP / Hydro Power Generator
Data related to:	Each hydro station
Data to be submitted to:	State Transmission Utility
Periodicity & prescribed date for data submission	Three months after uploading of the formats on the website of STU and as when changes occur in case of existing stations For upcoming generating station seeking connectivity, LTA or MTOA along with application. If placement of orders for main and balance equipment is not done at the time of seeking connectivity, the balance data need to be furnished at the earliest or in within one month of placing order for equipments.

GENERAL		
1	Name of Generating Company	
2	Name of Power Station	
3	Name and location of Pooling Station	
4	Site	Give location map to scale showing roads, railway lines, and transmission lines.
5	Site map (To scale)	Showing proposed canal, reservoir area, water conductor system, fore-bay, power house etc.
6	Submerged Area	Give information on area submerged, villages submerged, submerged forest land, agricultural land etc
7	Whether storage type or run of river type or pumped storage	
8	Whether catchments receiving discharges from other reservoir or power plant.	
9	Full reservoir level	
10	Minimum draw down level.	
11	Tail race level	
12	Design Head	
13	Reservoir level v/s energy potential curve	
14	Restraint, if any, in water discharges	
15	Approximate period of construction.	
16	Proof of Land Acquisition	

17	Statutory clearance from various authorities	
18	Startup power arrangement details	
CONNECTION		
1	Point of Connection/ Interface Point	Furnish single line diagram of the proposed Connection with the Transmission system with clear indication of possibility for right of way for unobstructed outlet.
2	Step up voltage for Connection (kV)	
STATION CAPACITY		
1	Total Power Station capacity (MW)	Give details whether development will be carried out in phases and if so, furnish details.
2	No. of units & unit size (MW)	
GENERATING UNIT DATA FOR EACH TYPE		
1	Operating Head (in Metres)	a. Maximum b. Minimum c. Average.
2	Hydro Unit	
a	Capability to operate as synchronous condenser	
b	Water head versus discharges curve (at full and part load)	
c	Power requirement or water discharge while operating as synchronous condenser	
3	Turbine	State Type and capacity
4	Generator	
a	Type	
b	Rating (MVA)	
c	Speed (RPM)	
d	Terminal Voltage (kV)	
e	Rated Power Factor	
f	Reactive Power Capability (MVAr) in the range 0.95 of leading and 0.85 of lagging	
g	MW & MVAr capability curve of generating unit	
h	Short Circuit Ratio	
i	Direct axis transient (saturated) reactance (% on rated MVA)	

j	Direct axis sub-transient (saturated) reactance (% on rated MVA)	
k	Auxiliary Power Requirement (MW)	

14.3. Generation: Cogeneration or Combined Heat and Power (CHP)

Format No.:	General/Gen/Cogen/1
Data Submission By:	Generating Company / CPP
Data related to:	Each Cogeneration or Combined Heat and Power (CHP) power station
Data to be submitted to:	State Transmission Utility
Periodicity & prescribed date for data submission:	Three months after uploading of the formats on the website of STU and as when changes occur in case of existing stations For upcoming generating station seeking connectivity, LTA or MTOA along with application. If placement of orders for main and balance equipment is not done at the time of seeking connectivity, the balance data need to be furnished at the earliest or in within one month of placing order for equipments.

GENERAL	
Name of Generating Company	
Name of Power Station	
Name of Pooling Station	
Site Map	Showing area required for Power Station coal linkage, coal yard, water pipe lines, ash disposal area, colony etc.
Approximate period of construction and Date of Commercial Operation date (COD)	
Proof of Land Acquisition	
Type of Fuel and Fuel Supply Arrangement	
Statutory clearance from various authority	
Startup power Arrangement details	
Type of Cogeneration Power Plants	Combined Cycle CGP Plant / Steam Turbine CHP Plant / Internal Combustion / others (details to be added)
CONNECTION	
Point of Connection/ Interface Point	Furnish single line diagram of the proposed Connection with the Transmission system with clear indication of possibility for right of way for unobstructed outlet.
Step up voltage for Connection (kV)	
STATION CAPACITY	

1	Total Power Station capacity (MW)	Give details whether development will be carried out in phases and if so, furnish details.
2	No. of units & unit size (MW)	
GENERATING UNIT DATA FOR EACH TYPE		
1	Generator	
	(a) Make and Type	
	(b) Rating (MVA)	
	(c) Terminal Voltage (kV)	
	(d) Rated Power Factor	
	(e) Reactive Power capability (MVAr) in the range 0.95 leading and 0.85 lagging	
	(f) Short Circuit Ratio	
	(g) Direct axis transient reactance (% on MVA rating)	
	(h) Direct axis sub-transient reactance (% on MVA rating)	
	(i) Auxiliary Power requirement	
2	Generator Transformer	
	(a) Type	
	(b) Rated Capacity (MVA)	
	(c) Voltage Ratio (HV/LV)	
	(d) Tap change range (+% to -%)	
	(e) Percentage Impedance (Positive Sequence at Full load)	
3	Steam Generating Unit	Give details of type, capacity, steam pressure, stream temperature etc.
4	Steam turbine / Gas Turbine/ Reciprocating engine	Give details of type, capacity, equipment configuration (Back-pressure steam turbine, Extraction & condensing steam turbine, Extraction & back-pressure steam turbine, Single/double extraction & condensing, Gas turbine with unfired Waste Heat Recovery Boiler (WHRB), and etc.) details

14.4. Generation: Wind/Solar

Format No. :	General/Gen/RE/1
Data Submission By:	Wind / Solar Generating Company/CPP and QCA on behalf of RE Generators
Data related to:	Each Wind / Solar station
Data to be submitted to:	State Transmission Utility
Periodicity & prescribed date for data submission	Three months after uploading of the formats on the website of STU and as when changes occur in case of existing stations For upcoming generating station seeking connectivity, LTA or MTOA along with application. If placement of orders for main and balance equipment is not done at the time of seeking connectivity, the balance data need to be furnished at the earliest or in within one month of placing order for equipments.

GENERAL		
1	Name of Generating Company	
2	Type Wind/Solar Generator	
3	Name and location of pooling station	
4	If applying on behalf of group of generators details of agreement to be attached	
5	Name of QCA/ Lead Generator	
6	Registered with SLDC	
7	Converter/Inverter details	
8	Details of dedicated lines (Including ownership)	
9	Total Installed Capacity of Generating Station	
10	Total Number of Units with details	
11	Physical Address of the RE Generating Station	
12	Whether any PPA has been signed: (Y/N)	If yes, then attach details
13	Name of Pooling substation /Connectivity Details	Location/Voltage Level
14	Metering Details	Meter No. 1. Main Meter No. 2. Check
15	Connectivity Diagram	(Please Enclose)
16	Proof of Land Acquisition	
17	Statutory clearance from various authority	

(a) General Data of Wind Generating Station

Sr. No	Particulars
1	Type (Type 1/Type 2/ Type 3/Type 4) *
2	Manufacturer
3	Make
4	Model
5	Capacity
6	Commission date
7	Hub height
8	Total height
9	RPM Range
10	Rated wind speed
11	Performance Parameter
12	Rated electrical power at Rated wind speed
13	Cut in speed
14	Cut out speed
15	Survival speed (Max wind speed)
16	Ambient temperature for out of operation
17	Ambient temperature for in operation
18	Survival temperature
19	Low Voltage Ride Through (LVRT) setting
20	High Voltage Ride Through (HVRT) setting
21	Lightning strength (kA & in coulombs)
22	Noise power level (db)
23	Rotor
24	Hub type
25	Rotor diameter
26	Number of blades
27	Area Swept by blades
28	Rated rotational speed
29	Rotational Direction
30	Coning angle
31	Tilting angle
32	Design tip speed ratio
33	Blade
34	Length
35	Diameter
36	Material
37	Twist angle
38	Generator
39	Generator Type
40	Generator No. of poles
41	Generator speed
42	Winding type
43	Rated Gen. Voltage
44	Rated Gen. Frequency
45	Generator current

46	Rated Temperature of generator
47	Generator cooling
48	Generator power factor
49	KW/MW at Rated Wind speed
50	KW/MW at Rated peak continuous
51	Frequency Converter
52	Filter generator side
53	Filter grid side
54	Transformer
55	Transformer Capacity
56	Transformer cooling type
57	Voltage
58	Winding configuration
59	Weight
60	Rotor Weight
61	Nacelle Weight
62	Tower weight
63	Over speed Protection
64	Design life
65	Design Standard
66	Latitude
67	Longitude
68	COD Details
69	Past Generation History from the COD to the date on which DAS facility provided at SLDC, if applicable
70	Distance above mean sea level

*Type 1 – Squirrel cage induction generator

Type 2 – Wound rotor induction generator

Type 3 – Doubly fed induction generator (DFID)

Type 4 – Full Converter type

(b) General Data of Solar Generating Station

1. Latitude
2. Longitude
3. Inverter Power Curve
4. Elevation and orientation angles of arrays or concentrators
5. The generator capacity of the Generating Facility
6. Distance above mean sea level etc.
7. COD details
8. Rated voltage
9. Details of type of Mounting: (Tracking Technology if used, single axis or dual axis, auto or manual)
10. Manufacturer and Model (of important Components, Concentrators, Inverter, Cable, PV Module, Transformer, Cables)
11. DC installed Capacity
12. Module Cell Technology
13. I-V Characteristics of the Module
14. Inverter Rating at different temperature

15. Inverter Efficiency Curve
16. Transformer Capacity & Rating, Evacuation voltage, distance from injection point

14.5. Storage: BESS

Format No.:	General/Storage/BESS/1
Data Submission By:	BESS
Data related to:	Each BESS
Data to be submitted to:	State Transmission Utility
Periodicity & prescribed date for data submission:	Three months after uploading of the formats on the website of STU and as when changes occur in case of existing stations. For upcoming generating station seeking connectivity, LTA or MTOA along with application. If placement of orders for main and balance equipment is not done at the time of seeking connectivity, the balance data need to be furnished at the earliest or in within one month of placing order for equipments.

GENERAL		
1	Name of BESS Utility	
2	Name and location of BESS Station	
3	Name and location of Pooling Station	
4	Approximate period of construction and Date of Commercial Operation date (COD)	
5	Registered with SLDC	
6	Statutory clearance from various authority	
7	Point of Connection / Interface Point	Furnish single line diagram of the proposed Connection with the Transmission system with clear indication of possibility for right of way for unobstructed outlet.
BASIC TECHNICAL DETAILS		
A	Battery	
1	Make/Manufacturer	
2	Type / Chemistry	
3	Design capacity of battery in terms of KWh	
4	Self-Discharge rate	
5	Depth of Discharge (DoD)	
	Life cycle of battery	

	Round trip efficiency	
	Dimensions and weight of battery	
	Test certificate available for battery cell/module (IEC Standards)	
	Number of series & parallel connected cells and modules	
	Power/energy rating cells and modules	
	BESS favourable operating temperature	
POWER CONDITIOINING UNIT		
	Make/manufacturer	
	Type of charge controller(DC-DC converter)	
	Inverter- power rating & efficiency	
	Inverter minimum response time	
	Test certificate available (IEC Standards)	

General Data of Battery Parameters:

Details	Technical Requirement
AC ratings	
Total rated output power to load @ nominal voltage (charge) MW to (discharge) MW	
Apparent power @ nominal voltage	
No of units	
Rate output power of each unit	
Real and reactive power control accuracy (%)	
Voltage range	
Type of output	
Frequency (Nominal Frequency and the tolerance band)	
VAR production (full MVAR production at rated Voltage)	
Harmonics (as per CEA standards)	
DC input ratings	
Voltage range	
Ripple voltage Ripple current (% of full current peak to Peak)	
Environmental ratings	
Operating temperature	
Humidity	
Functions/Features	

Power flow operation (, Support four - quadrant control)	Yes / No
Real power control (Positive and negative)	Yes / No
Reactive power control (capacitiveand inductive)	Yes / No
Combination of real and reactive power control(priority real power)	Yes / No
Load following (renewable smoothing)	Yes / No
Low-voltage ride through	Yes / No
Synchro-check function	Yes / No
Operation modes	
Black start (external command)	Yes / No
Commanded power (external command)	Yes / No
Commanded VAR (external command)	Yes / No
Frequency regulation	Yes / No
Frequency response (Automatic)	Yes / No
Islanding	Yes / No
Renewable smoothing (if applicable , automatic)	Yes / No
Scheduled power (preconfigured time/date of work power profiles	Yes / No
Voltage regulation	Yes / No
Response time of PCS to the command received (Milli seconds)	Yes / No
Communications	
Communications with SLDC (main /standby)	Yes / No
Battery technologies	
Battery technologies supported(Ex Li-Ion etc ..)	
Battery Cycle life	> 4,000 at 20-80% SOC
Voltage Regulation (%)	
Reactive Power Regulation (Var flow level Range +/- example +/- 5%)	
Frequency Regulation (+/_ cycle /second)	
Capacity (Ah)	
Power factor	
Battery temperature (average/extreme)	
Overload capability (%) and Switching frequency(in kHz) State of Charge (SOC)	
Protection system	
Under/over voltage (DC and AC)	
Under/over frequency	
Over current protection	
Ground fault protection	
Over heat protection	
Surge protection (DC and AC)	
Automatic AC & DC open circuit when fault detection	

14.6. Transmission: Transmission Licensee

Format No. :	General/Transmission/1
Data Submission By:	Transmission Licensee/TSU
Data related to:	Each line and sub-station
Data to be submitted to:	State Transmission Utility
Periodicity & prescribed date for data submission	Three months after uploading of the formats on the website of STU and as when changes occur in case of existing stations.

GENERAL		
1	Name of Transmission Licensee	
2	Name of line (indicating Generating Station and sub-stationsto be connected)	Proposed route showing existing power lines and telecommunication lines.
3	Voltage of Line	
4	Number of Circuit	
5	Route length(Ckt – KM)	
6	Conductor Size (Name and area insq mm)	
7	Line parameters (PU on 100 MVAbase or ohmic value)	
	(a) Resistance/KM	
	(b) Reactance /KM	
	(c) Susceptance/KM	
8	Approximate power flow	MW MVAr
9	Terrain of the route TopographicSheet	Give information regarding nature of terrain i.e. forest land, fallow land, agricultural and river basin, hill slope etc.
10	Route map (to scale)	Furnish topographical map showing the proposed route showing existing power lines and telecommunication lines
11	Purpose of connection	Reference to schemes
12	Approximate period of construction	

14.7. Distribution: Distribution Licensee

Format No. :	General//Distribution/1
Data Submission By:	Distribution Licensee/ Discom
Data related to:	Entire Distribution System
Data to be submitted to:	State Transmission Utility
Periodicity & prescribed date for data submission	Three months after uploading of the formats on the website of STU and as when changes occur in case of existing stations.

Format-1

GENERAL		
1	Name of Distributing Company	
2	Name of Divisions /sub-divisionpresently in charge of the Distribution.	
3	Area Map (to scale)	Marking the area in the map of area for which Distribution License is applicable
4	Consumer Data	Furnish categories of consumers, their numbers and connected loads.
CONNECTION		
1	Points of Connection	Furnish single line diagram showing points of connection
2	Voltage of supply at points of Connection / interface point	
3	Names of Grid Sub-Station feeding the Connection/ interface	
LINES AND SUBSTATIONS		
1	Line Data	Furnish lengths of line and voltages within the area
2	Sub-station Data	Furnish details of 33/11kV sub-station,11/0.4 kV sub-stations, capacitor installations
LOADS		
1	Loads drawn at connection/interface points.	If the Distribution Licensee receive power at a number of connection point in a compact area, which are interconnected in a ring, then such Distribution Licensee shall forward the overall load drawn for overall Area of Supply as well as at each connection point with variation or tolerance as mutually discussed and agreed upon with the STU

2	Details of loads fed at EHV, if any.	Give name of consumer, voltage of supply,contract demand and name of Grid Sub- station from which line is drawn, length of EHV line from Grid Sub-station to consumer's premises
3	Reactive Power compensation installed	Give details of capacitors and capacitor banks installed at various sub-station andconsumers' premises
DEMAND DATA (FOR ALL LOADS 1 MW AND ABOVE)		
1	Type of load	Give details of furnace loads, rolling mills,traction loads, other industrial loads, pumping loads etc.
2	Rated voltage and phase	
3	Electrical loading of equipment	Give number and size of motors, types ofdrive and control arrangements.
4	Power Factor	
5	Sensitivity of load to voltage and frequency of supply.	
6	Maximum Harmonic content of load	
7	Average and maximum phase unbalance of load.	
8	Nearest sub-station from whichload is to be fed.	
9	Location map to scale	Showing location of load with reference tolines and sub-stations in the vicinity.
LOAD FORECAST DATA		
1	Peak load and energy forecast for each category of loads for each of the succeeding 5 years.	
2	Details of methodology and assumptions on which forecasts are based.	
3	If supply is received from more than one substation, the sub-stationwise break up of peak load and energy projections for each category of loads for each of the succeeding 5 years along with estimated Daily load curve.	
4	Details of loads 1 MW and above. a. Name of prospective consumer. b. Location and nature of load/complex. c. Sub-Station from which to be fed. d. Voltage of supply. e. Phasing of load.	

Format - 2

Distribution licensee - To provide details information of Power Purchase from outside state through ISTS Network

Sr. No.	Name of Generating Station outside the state	Generating Station Situated State & Region	Name of Pooling ISTS Substation	Total installed capacity of Generating Station (in MW)	Maximum Contracted Capacity (in MW) using ISTS	Voltage level at POC (kV)	Type of Open Access (LTA / MTOA / STOA)
A	**Central Sector (Conventional)**						
1							
2							
3							
N							
B	**IPP (Conventional)**						
1							
2							
3							
N							
C	**Others (Conventional)**						
1							
2							
3							
N							
D	**Non-Conventional**						
1							
2							
3							
N							

Section – 2
Load Flow Studies Formats

Source-PSS/E Model Library

14. Load Flow Studies Format

Network data for Load Flow Studies

Data Submission By:	Transmission licensee, Generating Company, CPPs, RE Generators and QCA on behalf of RE Generators
Data related to:	Bus data / Transformer /HVDC Lines/ FACT Devices / STATCOM
Data to be submitted to:	State Transmission Utility
Periodicity & prescribed date for data submission	As and When requested by STU.

15.1.Format for Bus data

Format No. :	LF/Bus/1
Data Submission By:	Transmission licensee, Generating Company, CPPs, RE Generators and QCA on behalf of RE Generators

Date of Commercial Operation	Bus Name	Base Voltage (kV)	Bus Type *	Shunt Admittance		In service/ Out of service during Peak Block
				Conductance (MW)	Susceptance (MVAR)	

*Note – Bus Type

1. Load Bus
2. Generator Bus
3. Swing Bus

15.2.Format for Transformer-1

Format No.:	LF/Transformer/1
Data Submission By:	Transmission licensee, Generating Company, CPPs, RE Generators and QCA on behalf of RE Generators

Date of Commercial Operation	Bus Name	Machine Identifier (ID)	MW Output (PG)	Max MW (PT)	Min MW (PB)	MVAR Output (QG)	Max MVAR (QT)	Min MVAR (QB)	Voltage Set point (VS)	Remote Controlled Bus Index (IREG)	MVA Base (MBASE)	In service/ Out of service during peak block	Machine Impedance (PU on MBASE)		Step up Transformer Impedance (PU on MBASE)		Off Nominal Tap Ratio	RMPCT
													Resistance (ZR)	Reactance (ZX)	Resistance (R T)	Reactance (XT)		

15.3.Format for Transformer-2

Format No.:	LF/Transformer/2
Data Submission By:	Transmission licensee, Generating Company, CPPs, RE Generators and QCA on behalf of RE Generators

Date of Commercial Operation	From Bus Name	To Bus Name	Ckt ID	Length	Owner	Type of Line (InSTS)	Line configuration	Shunt Admittance				Operational Limits			Electrical Parameters (In Per Unit)			In service/ Out of service during peak block	Remarks
								From Bus		To Bus		SIL Limit	Thermal loading Limit	Emergency loading limit	R	X	B		
								G	B	G	B								

15.4. Format for Transformer-3

Format No.:	LF/Transformer/3
Data Submission By:	Transmission licensee, Generating Company, CPPs, RE Generators and QCA on behalf of RE Generators

Date of Commercial Operation	From Bus Name	To Bus Name	Ckt ID	In Service/ Out of service during Peak Block	Rate A	Rate B	Rate C	Nominal Tap Ratio	Transformer Phase shift angle	Resistance (R)	Reactance (X)	Controlled Bus	Max. Turns Ratio	Min. Turns Ratio	Max Controlled Volts	Min Controlled Volts	Turns Ration Step Increment	Table

15.5. Format for HVDC Lines

Format No.:	LF/HVDC/1
Data Submission By:	Transmission licensee

Date of Commerci-al Operation	DC Line Num-ber	Contro -l Mode	Resista-nce	Current or Power Demand	Scheduled Compounde -d DC Voltage	Mode Switch DC Voltag e	Compou -nding Resistan -ce	Curre -nt Marg -in	Meter - ed end Code	Rectifie- r convert -er Bus number	Num-ber of Bridg es	Max Rectif -ier firing angle	Minim -um Rectifi-er firing angle	Rectifier Commuta -ting Transfor-mer resistance per bridge	Rectifier Commuta -ting Transfor-mer reactance per bridge	Rectifier Primary Base AC Voltage	Recti-fier Trans-former ratio	Rectif -ier Tap settin g	Maxim um Rectifi-er Tap Setting	Minim um Rectifi-er Tap Setting	Rectif -ier Tap step	In Service / Out of Service during Peak Block

15.6. Format for FACT devices - 1

Format No.:	LF/FACT/1
Data Submission By:	Transmission Licensee

Date of Commercial Operation	Bus Name	Mode	In Service/ Out of service during Peak Block	Voltage Upper Limit	Voltage Lower Limit	Voltage Set point	N1	B1	N2	B2

N: Steps for Block N

B: Admittance Increment of Block 1 in MVAR at 1.0 pu

15.7. Format for FACT devices - 2

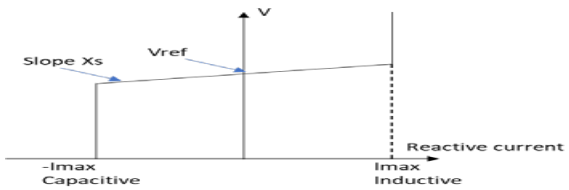
Format No.:	LF/FACT/2
Data Submission By:	Transmission Licensee

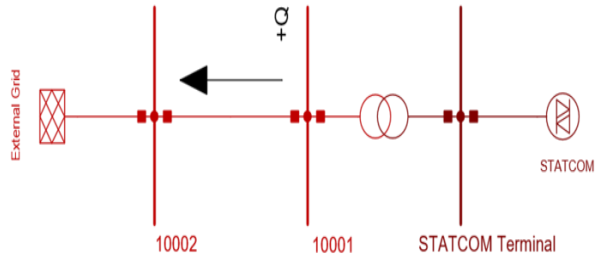
Voltage Level (kV)	Substation Name	FACT Device Type	Sub Device Name	Voltage level of Sub Device	Total Number of Sub Devices	MVAR/ MVA Rating	In Voltage	Out Voltage	Slope (%)	Impedance (%)	Connection Type (Star, Delta), Vector Group

15.8. Format for STATCOM

Format No.:	LF/STATCOM/1
Data Submission By:	Transmission Licensee

Steady State STATCOM model parameters with example value for voltage droop control

Parameter	Example value
STATCOM rating (MVA) This is the MVA base for all control parameters.	10 MVA
Continuous current limit (kA)	0.175 kA
Nominal voltage at the controlled remote bus (kV)	33 kV
Nominal voltage at the converter terminal (kV)	0.5 kV
Temperature and voltage dependence of STATCOM rating (e.g. 90% of MVA base when voltage is at 90%)	9 MVAr when terminal voltage is at 90% of nominal voltage.
Overload capacity	+25% of nominal current for 1second
Modulation limit	1
No-load loss (kW)	100 kW
Switching loss factor (kW/A)	5 kW/A
Resistive loss factor (ohm)	0 ohm
Negative sequence impedance r2, x2	998 + j1503 pu
Typical control mode (Voltage control, voltage droop, reactive power, or power factor)	Voltage droop
Typical setpoint (Voltage, reactive power, or power factor)	1.0 pu
Voltage droop (% of MVA base) or relevant V-I curve	4% Or V-I curve as shown below 
Voltage deviation dead band for reducing controller sensitivity (pu)	0.0 pu
Load flow single line diagram of the STATCOM	As shown

Parameter	Example value
	
Remote bus for voltage measurement	10001/Bus Name & Voltage Level
Remote bus for branch / line for reactive power measurement – sending end (where reactive current injection convention to this bus is positive)	10001/Bus Name & Voltage Level
Remote bus for branch / line for reactive power measurement – receiving end (where reactive current injection convention to this bus is negative	10002/Bus Name & Voltage Level

Section - 3
Dynamic Studies Format

Source-PSS/E Model Library

16. Dynamic Studies Format

16.1. Generation: Thermal (Coal Fired)

Format No.:	Dyn/Generation/ Thermal-Coal Fired/1
Data Submission By:	Generating Company / CPP
Data related to:	Coal Fired thermal Generator
Data to be submitted to:	State Transmission Utility
Periodicity & prescribed date for data submission:	As and when requested by STU

16.1.1. Details of models in PSS/E for modelling coal fired thermal generation:

(a) Synchronous Machine

Category	Parameter Description	Data
Generator Nameplate	Rated apparent power in MVA	
	Rated terminal voltage	
	Rated power factor	
	Rated frequency (in Hz)	
	Rated speed (in RPM)	
	Rated excitation (in Amperes and Volts)	
Type of synchronous machine	Round rotor or salient pole No. of Poles:	
Generator capability curve	The generator capability curve shows the reactive capability of the machine and should include any restrictions on the real or reactive power range like under/over excitation limits, stability limits, etc. Capability curve should have properly labelled axis and legible data	
Generator Open Circuit and Short Circuit Characteristic	Graph of excitation current versus terminal voltage and stator current	
	No load excitation current	
	Excitation current at rated stator current	
Generator v-curves	Otherwise referred to as "V-curve". A plot of the terminal (armature) current versus the generating unit field voltage.	
Resistance values	Resistance measurements of field winding and stator winding to a known temperature	
Generator Data sheet	Direct axis synchronous reactance Xd in p.u. (Unsaturated or saturated)	
	Direct axis transient synchronous reactance Xd' in p.u. (Unsaturated or saturated)	
	Direct axis sub-transient synchronous reactance Xd'' in p.u. (Unsaturated or saturated)	

Category	Parameter Description	Data
	Stator leakage reactance Xa in p.u. (Unsaturated or saturated)	
	Quadrature axis synchronous reactance Xq in p.u. (Unsaturated or saturated)	
	Quadrature axis transient synchronous reactance Xq' in p.u. (Unsaturated or saturated)	
	Quadrature axis sub-transient synchronous reactance Xq'' in p.u. (Unsaturated or saturated)	
	Direct axis open circuit transient time constant Tdo' in sec	
	Direct axis open circuit sub-transient time constant Tdo'' in sec	
	Quadrature axis open circuit transient time constant Tqo' in sec	
	Quadrature axis open circuit sub-transient time constant Tqo'' in sec	
	Inertia constant of total rotating mass (generator, AVR, turbo-governor set) H in MW.s/MVA	
	Speed Damping D	
	Saturation constant S (1.0) in p.u.	
	Saturation constant S (1.2) in p.u.	
Generator step up transformer (GSUT)	Nameplate Rating - Rated primary and secondary voltage - Vector group - Impedance - Tap changer details (Number of taps, tap position, tap ratio etc.)	

(b) Site Load

	Low Output			High Output		
	kW	kVAr	kVA	kW	kVAr	kVA
Auxiliary Load						

(c) Excitation System

Category	Parameter Description	Data
Type of Automatic Voltage Regulator (AVR)	Manufacturer and product details	
	Type of control system:- Analogue or digital	
	Year of commissioning / Year of manufacture	

Category	Parameter Description	Data
	As found settings (obtained either from HMI or downloaded from controller in digital systems)	
	Static excitation system OR	
Type of excitation system	Indirect excitation system (i.e. rotating exciter) - AC exciter, or - DC exciter	
Details of AVR converter	Rated excitation current (converter rating in Amperes)	
	Six pulse thyristor bridge or PWM converter	
Source of excitation supply	Excitation transformer or auxiliary supply (Details thereof)	
	If excitation transformer, nameplate information such as type of transformer, HV and HV winding ratings, positive and zero sequence impedance, tap positions, voltage step per tap is required.	
Schematics	Saturation curves of the exciter (if applicable – see Type AC and DC)	
	Drawings of excitation system, typically prepared and supplied by the OEM	
	Single line diagram (i.e. one-line diagram) for the excitation system	
Excitation limiters	What excitation limiters are commissioned?	
	Under Excitation Limiters settings	
	Over Excitation Limiters settings	
	Voltage/frequency limiter	
	Stator current limiter	
	Minimum excitation current limiter	
PSS	Is the AVR equipped with a PSS?	
	How many input Channels does the PSS have? (Speed, real power output or both	
	If the PSS uses speed, is this a derived speed signal (i.e. synthesized speed signal) or measured directly (i.e. actual rotor speed)?	
	Type of PSS Block Diagram of PSS and as commissioned parameters value (Gain, time constants, filter coefficients, output limits of the PSS)	

(d) Turbine Details

Category	Parameter Description	Data
Manufacturer of turbine	Manufacturer and name plate details Rating of turbine	
Type of Governor	Electro-mechanical governor	
	Digital electric governor	
	Block diagram of the speed governor	
Ramp rates	How fast can the turbine increase and/or decrease load, specified in MW/min	
	Stroke limits of speed changer (values of full stroke, full load and no-load in mm)	
Droop	Droop setting (% on machine base)	
	Frequency influence limiters - Maximum frequency deviation limiter (eg +/-2 Hz) - Maximum influence limiter (eg 10% of rating)	
Dead band	Details of frequency dead band (typically in Hz)	
Steam turbine	Tandem compound: all sections on one shaft with a single generator	
	Cross compound: consists of two shafts, each connected to a generator and driven by one or more turbine section	
	Turbine sections: High pressure (HP), intermediate pressure (IP) and low pressure (LP)	
	Reheat or non-reheat: In a reheat, steam upon leaving HP section returns to boiler where it passed through reheater before entering IP section	
Steam turbine (Continued)	Valves: - Main inlet stop valve (MSV) - Governor control valve (CV) - Reheater stop valve (RSV) - Intercept valves (IV)	
	Turbine control action:	
	- Boiler follow mode - Turbine follow mode - Coordinated control	
	Fast valving /bypass operation	
	Block diagram of the turbine load control	

Category	Parameter Description	Data
	Reheater volume (m^3), volume flow (kg/s), and average specific volume (m^3/kg)	

16.1.2. Generic Models for synchronous machine

There are two typical groups of synchronous machine models, depending upon the type of machine:

- Round rotor machine (2 poles):
  - GENROU – Round rotor machine model with quadratic saturation function
  - GENROE – Round rotor machine model with exponential saturation function
- Salient pole machine (more than two poles):
  - GENSAL – Salient pole machine with quadratic saturation function
  - GENSAE – Salient pole machine with exponential saturation function

Category	Parameter Description	Data
Generator Model		
GENROU OR GENROE	Direct axis open circuit transient time constant Tdo' in sec	
	Direct axis open circuit sub-transient time constant Tdo'' in sec	
	Quadrature axis open circuit transient time constant Tqo' in sec	
	Quadrature axis open circuit sub-transient time constant Tqo'' in sec	
	Inertia constant of total rotating mass H in MWs/MVA	
	Speed Damping D	
	Direct axis synchronous reactance Xd in p.u. (Unsaturated or saturated)	
	Quadrature axis synchronous reactance Xq in p.u. (Unsaturated or saturated)	
	Direct axis transient synchronous reactance Xd' in p.u. (Unsaturated or saturated)	
	Quadrature axis transient synchronous reactance Xq' in p.u. (Unsaturated or saturated)	
	Direct axis sub-transient synchronous reactance Xd'' in p.u. (Unsaturated or saturated) = Quadrature axis sub-transient synchronous reactance Xq'' in p.u. (Unsaturated or saturated)	
	Stator leakage reactance Xl in p.u.	
	Saturation constant S (1.0) in p.u.	
	Saturation constant S (1.2) in p.u.	
GENSAEOR GENSAL	Direct axis open circuit transient time constant Tdo' in sec	
	Direct axis open circuit sub-transient time constant Tdo'' in sec	
	Quadrature axis open circuit sub-transient time constant Tqo'' in sec	
	Inertia constant of total rotating mass H in MW/MVA	
	Speed Damping D	
	Direct axis synchronous reactance Xd in p.u. (Unsaturated or saturated)	
	Quadrature axis synchronous reactance Xq in p.u. (Unsaturated or saturated)	
	Direct axis transient synchronous reactance Xd' in p.u. (Unsaturated	

	or saturated)	
	Direct axis sub-transient synchronous reactance Xd'' in p.u. (Unsaturated or saturated) = Quadrature axis sub-transient synchronous reactance Xq'' in p.u. (Unsaturated or saturated)	
	Stator leakage reactance Xl in p.u.	
	Saturation constant S (1.0) in p.u.	
	Saturation constant S (1.2) in p.u.	

While entering the values in above table, following relationship must be kept:

$$Xd > Xq > Xq' \geq Xd' > Xq'' \geq Xd''$$

$$Tdo' > Td' > Tdo'' > Td''$$

$$Tqo'' > Tq' > Tqo'' > Tq''$$

16.1.3. Excitation system model:

If a generic model is used, the first step must be to identify what type of exciter is present in the excitation system. The IEEE Std 421.5 (IEEE Recommended Practice for Excitation System Models for Power System Stability Studies published on 26th Aug 2016) has published several generic models, which are classified into three groups:

- Type DC: for excitation systems with a DC exciter
- Type AC: for excitation systems with an AC exciter
- Type ST: for excitation systems with a static exciter

The following table shows the types of models separated into their respective groups.

DC exciter	AC exciter	Static excitation system
Type DC1A	Type AC1A	Type ST1A
Type DC2A	Type AC2A	Type ST2A
Type DC3A	Type AC4A	Type ST3A
Type DC4B	Type AC5A	Type ST4B
	Type AC6A	Type ST5B
	Type AC7B	Type ST6B
	Type AC8B	Type ST7B

DC Exciter, AC Exciter and Static Excitation System

Category	Parameter Description	Data
DC Exciter		
ESDC1A OR ESDC2A	TR regulator input filter time constant (sec)	
	KA (> 0) (pu) voltage regulator gain	
	TA (s), voltage regulator time constant	
	TB (s), lag time constant	
	TC (s), lead time constant	
	VRMAX (pu) regulator output maximum limit or Zero	
	VRMIN (pu) regulator output minimum limit	
	KE (pu) exciter constant related to self-excited field	

Category	Parameter Description	Data
	TE (> 0) rotating exciter time constant (sec)	
	KF (pu) rate feedback gain	
	TF1 (> 0) rate feedback time constant (sec)	
	Switch	
	E1, exciter flux at knee of curve (pu)	
	SE(E1), saturation factor at knee of curve	
	E2, maximum exciter flux (pu)	
	SE(E2), saturation factor at maximum exciter flux (pu)	
ESDC3A	TR regulator input filter time constant (sec)	
	KV (pu) limit on fast raise/lower contact setting	
	VRMAX (pu) regulator output maximum limit or Zero	
	VRMIN (pu) regulator output minimum limit	
	TRH (> 0) Rheostat motor travel time (sec)	
	TE (> 0) exciter time-constant (sec)	
	KE (pu) exciter constant related to self-excited field	
	VEMIN (pu) exciter minimum limit	
	E1, exciter flux at knee of curve (pu)	
	SE(E1), saturation factor at knee of curve	
	E2, maximum exciter flux (pu)	
	SE(E2), saturation factor at maximum exciter flux (pu)	
ESDC4B	TR regulator input filter time constant (sec)	
	KP (pu) (> 0) voltage regulator proportional gain	
	KI (pu) voltage regulator integral gain	
	KD (pu) voltage regulator derivative gain	
	TD voltage regulator derivative channel time constant (sec)	
	VRMAX (pu) regulator output maximum limit	
	VRMIN (pu) regulator output minimum limit	
	KA (> 0) (pu) voltage regulator gain	
	TA voltage regulator time constant (sec)	
	KE (pu) exciter constant related to self-excited field	
	TE (> 0) rotating exciter time constant (sec)	
	KF (pu) rate feedback gain	
	TF (> 0) rate feedback time constant (sec)	
	VEMIN (pu) minimum exciter voltage output	
	E1, exciter flux at knee of curve (pu)	
	SE(E1), saturation factor at knee of curve	
	E2, maximum exciter flux (pu)	
	SE(E2), saturation factor at maximum exciter flux (pu)	

Category	Parameter Description	Data
AC Exciter		
ESAC1A	TR regulator input filter time constant (sec)	
	TB (s), lag time constant	
	TC (s), lead time constant	
	KA (> 0) (pu) voltage regulator gain	
	TA (s), voltage regulator time constant	
	VAMAX (pu) regulator output maximum limit	
	VAMIN (pu) regulator output minimum limit	
	TE (> 0) rotating exciter time constant (sec)	
	KF (pu) rate feedback gain	
	TF (> 0) rate feedback time constant (sec)	
	KC (pu) rectifier loading factor proportional to commutating reactance	
	KD (pu) demagnetizing factor, function of AC exciter reactances	
	KE (pu) exciter constant related to self-excited field	
	E1, exciter flux at knee of curve (pu)	
	SE(E1), saturation factor at knee of curve	
	E2, maximum exciter flux (pu)	
	SE(E2), saturation factor at maximum exciter flux (pu)	
	VRMAX (pu) regulator output maximum limit	
	VRMIN (pu) regulator output minimum limit	
ESAC2A	TR regulator input filter time constant (sec)	
	TB (s), lag time constant	
	TC (s), lead time constant	
	KA (> 0) (pu) voltage regulator gain	
	TA (s), voltage regulator time constant	
	VAMAX (pu) regulator output maximum limit	
	VAMIN (pu) regulator output minimum limit	
	KB, Second stage regulator gain	
	VRMAX (pu) regulator output maximum limit	
	VRMIN (pu) regulator output minimum limit	
	TE (> 0) rotating exciter time constant (sec)	
	VFEMAX, parameter of VEMAX, exciter field maximum output	
	KH, Exciter field current feedback gain	
	KF (pu) rate feedback gain	
	TF (> 0) rate feedback time constant (sec)	

Category	Parameter Description	Data
	KC (pu) rectifier loading factor proportional to commutating reactance	
	KD (pu) demagnetizing factor, function of AC exciter reactances	
	KE (pu) exciter constant related to self-excited field	
	E1, exciter flux at knee of curve (pu)	
	SE(E1), saturation factor at knee of curve	
	E2, maximum exciter flux (pu)	
	SE(E2), saturation factor at maximum exciter flux (pu)	
ESAC3A	TR regulator input filter time constant (sec)	
	TB (s), lag time constant	
	TC (s), lead time constant	
	KA (> 0) (pu) voltage regulator gain	
	TA (s), voltage regulator time constant	
	VAMAX (pu) regulator output maximum limit	
	VAMIN (pu) regulator output minimum limit	
	TE (> 0) rotating exciter time constant (sec)	
	VEMIN (pu) minimum exciter voltage output	
	KR (>0), Constant associated with regulator and alternator field power supply	
	KF (pu) rate feedback gain	
	TF (> 0) rate feedback time constant (sec)	
	KN, Exciter feedback gain	
	EFDN, A parameter defining for which value of UF the feedback gain shall change from KF to KN	
	KC, rectifier regulation factor (pu)	
	KD, exciter regulation factor (pu)	
	KE (pu) exciter constant related to self-excited field	
	VFEMAX, parameter of VEMAX, exciter field maximum output	
	E1, exciter flux at knee of curve (pu)	
	SE(E1), saturation factor at knee of curve	
	E2, maximum exciter flux (pu)	
	SE(E2), saturation factor at maximum exciter flux (pu)	
ESAC4A	TR regulator input filter time constant (sec)	
	VIMAX, Maximum value of limitation of the integrator signal VI in p.u	
	VIMIN, Minimum value of limitation of the signal VI in p.u.	
	TB (s), lag time constant	
	TC (s), lead time constant	

Category	Parameter Description	Data
	KA (> 0) (pu) voltage regulator gain	
	TA (s), voltage regulator time constant	
	VRMAX (pu) regulator output maximum limit	
	VRMIN (pu) regulator output minimum limit	
	KC, rectifier regulation factor (pu)	
ESAC5A	TR regulator input filter time constant (sec)	
	KA (> 0) (pu) voltage regulator gain	
	TA (s), voltage regulator time constant	
	VRMAX (pu) regulator output maximum limit	
	VRMIN (pu) regulator output minimum limit	
	KE (pu) exciter constant related to self-excited field	
	TE (> 0) rotating exciter time constant (sec)	
	KF (pu) rate feedback gain	
	TF1 (sec), Regulator stabilizing circuit time constant in seconds	
	TF2 (sec), Regulator stabilizing circuit time constant in seconds	
	TF3 (sec), Regulator stabilizing circuit time constant in seconds	
	E1, exciter flux at knee of curve (pu)	
	SE(E1), saturation factor at knee of curve	
	E2, maximum exciter flux (pu)	
	SE(E2), saturation factor at maximum exciter flux (pu)	
AC6A	TR regulator input filter time constant (sec)	
	KA (> 0) (pu) voltage regulator gain	
	TA (s), voltage regulator time constant	
	TK (sec), Lead time constant	
	TB (s), lag time constant	
	TC (s), lead time constant	
	VAMAX (pu) regulator output maximum limit	
	VAMIN (pu) regulator output minimum limit	
	VRMAX (pu) regulator output maximum limit	
	VRMIN (pu) regulator output minimum limit	
	TE (> 0) rotating exciter time constant (sec)	
	VFELIM, Exciter field current limit reference	
	KH, Damping module gain	
	VHMAX, damping module limiter	
	TH (sec), damping module lag time constant	
	TJ (sec), damping module lead time constant	

Category	Parameter Description	Data
	KC, rectifier regulation factor (pu)	
	KD, exciter regulation factor (pu)	
	KE (pu) exciter constant related to self-excited field	
	E1, exciter flux at knee of curve (pu)	
	SE(E1), saturation factor at knee of curve	
	E2, maximum exciter flux (pu)	
	SE(E2), saturation factor at maximum exciter flux (pu)	
AC7B	TR (sec) regulator input filter time constant	
	KPR (pu) regulator proportional gain	
	KIR (pu) regulator integral gain	
	KDR (pu) regulator derivative gain	
	TDR (sec) regulator derivative block time constant	
	VRMAX (pu) regulator output maximum limit	
	VRMIN (pu) regulator output minimum limit	
	KPA (pu) voltage regulator proportional gain	
	KIA (pu) voltage regulator integral gain	
	VAMAX (pu) regulator output maximum limit	
	VAMIN (pu) regulator output minimum limit	
	KP (pu)	
	KL (pu)	
	KF1 (pu)	
	KF2 (pu)	
	KF3 (pu)	
	TF3 (sec) time constant (> 0)	
	KC (pu) rectifier loading factor proportional to commutating reactance	
	KD (pu) demagnetizing factor, function of AC exciter reactance	
	KE (pu) exciter constant related for self-excited field	
	TE (pu) exciter time constant (>0)	
	VFEMAX (pu) exciter field current limit (> 0)	
	VEMIN (pu)	
	E1, exciter flux at knee of curve (pu)	
	SE(E1), saturation factor at knee of curve	
	E2, maximum exciter flux (pu)	
	SE(E2), saturation factor at maximum exciter flux (pu)	
AC8B	TR (sec) regulator input filter time constant	
	KPR (pu) regulator proportional gain	

Category	Parameter Description	Data
	KIR (pu) regulator integral gain	
	KDR (pu) regulator derivative gain	
	TDR (sec) regulator derivative block time constant	
	VPIDMAX (pu) PID maximum limit	
	VPIDMIN (pu) PID minimum limit	
	KA (pu) voltage regulator proportional gain	
	TA (sec) voltage regulator time constant	
	VRMAX (pu) regulator output maximum limit	
	VRMIN (pu) regulator output minimum limit	
	KC (pu) rectifier loading factor proportional to commutating reactance	
	KD (pu) demagnetizing factor, function of AC exciter reactances	
	KE (pu) exciter constant related fo self-excited field	
	TE (pu) exciter time constant (>0)	
	VFEMAX (pu) max exciter field current limit (> 0)	
	VEMIN (pu),	
	E1, exciter flux at knee of curve (pu)	
	SE(E1), saturation factor at knee of curve	
	E2, maximum exciter flux (pu)	
	SE(E2), saturation factor at maximum exciter flux (pu)	
Static Exciter		
ST1A	TR (sec) regulator input filter time constant	
	VIMAX, Controller Input Maximum	
	VIMIN, Controller Input Minimum	
	TC (s), Filter 1st Derivative Time Constant	
	TB (s), l Filter 1st Delay Time Constant	
	TC1 (s), Filter 2nd Derivative Time Constant	
	TB1 (s), Filter 2nd Delay Time Constant	
	KA (pu) voltage regulator proportional gain	
	TA (sec) voltage regulator time constant	
	VAMAX (pu) regulator output maximum limit	
	VAMIN (pu) regulator output minimum limit	
	VRMAX (pu) regulator output maximum limit	
	VRMIN (pu) regulator output minimum limit	
	KC (pu) rectifier loading factor proportional to commutating reactance	
	KF (pu) rate feedback gain	

Category	Parameter Description	Data
	TF (> 0) rate feedback time constant (sec)	
	KLR, Current Input Factor	
	ILR, Current Input Reference	
ST2A	TR (sec) regulator input filter time constant	
	KA (pu) voltage regulator proportional gain	
	TA (sec) voltage regulator time constant	
	VRMAX (pu) regulator output maximum limit	
	VRMIN (pu) regulator output minimum limit	
	KE (pu) exciter constant related fo self-excited field	
	TE (pu) exciter time constant (>0)	
	KF (pu) rate feedback gain	
	TF (> 0) rate feedback time constant (sec)	
	KP (pu) voltage regulator proportional gain	
	KI (pu) voltage regulator integral gain	
	KC (pu) rectifier loading factor proportional to commutating reactance	
	EFDMAX	
ST3A	TR (sec) regulator input filter time constant	
	VIMAX, Maximum value of limitation of the signal VI in p.u.	
	VIMIN, Minimum value of limitation of the signal VI in p.u.	
	KM, Forward gain constant of the inner loop field regulator	
	TC (s), lag time constant	
	TB (s), lead time constant	
	KA (pu) voltage regulator proportional gain	
	TA (sec) voltage regulator time constant	
	VRMAX (pu) regulator output maximum limit	
	VRMIN (pu) regulator output minimum limit	
	KG, Feedback gain constant of the inner loop field regulator	
	KP (pu) voltage regulator proportional gain	
	KI (pu) voltage regulator integral gain	
	VBMAX, Maximum value of limitation of the signal VB in p.u.	
	KC (pu) rectifier loading factor proportional to commutating reactance	
	XL, Reactance associated with potential source	
	VGMAX, Maximum value of limitation of the signal VG in p.u	
	Θ_P (degrees)	
	TM (sec), Forward time constant of the inner loop field regulator	

Category	Parameter Description	Data
	VMMAX, Maximum value of limitation of the signal VM in p.u	
	VMMIN, Minimum value of limitation of the signal VM in p.u.	
ST4B	TR (sec) regulator input filter time constant	
	KPR (pu) regulator proportional gain	
	KIR (pu) regulator integral gain	
	VRMAX (pu) regulator output maximum limit	
	VRMIN (pu) regulator output minimum limit	
	TA (sec) voltage regulator time constant	
	KPM, Regulator gain	
	KIM, Regulator gain	
	VMMAX, Maximum value of limitation of the signal in p.u.	
	VMMIN, Minimum value of limitation of the signal in p.u.	
	KG	
	KP (pu) voltage regulator proportional gain	
	KI (pu) voltage regulator integral gain	
	VBMAX	
	KC (pu) rectifier loading factor proportional to commutating reactance	
	XL	
	Θ_P (degrees)	
ST5B	TR regulator input filter time constant (sec)	
	TC1 lead time constant of first lead-lag block (voltage regulator channel) (sec)	
	TB1 lag time constant of first lead-lag block (voltage regulator channel) (sec)	
	TC2 lead time constant of second lead-lag block (voltage regulator channel) (sec)	
	TB2 lag time constant of second lead-lag block (voltage regulator channel) (sec)	
	KR (>0) (pu) voltage regulator gain	
	VRMAX (pu) voltage regulator maximum limit	
	VRMIN (pu) voltage regulator minimum limit	
	T1 voltage regulator time constant (sec)	
	KC (pu)	
	TUC1 lead time constant of first lead-lag block (under-excitation channel) (sec)	
	TUB1 lag time constant of first lead-lag block (under-excitation channel) (sec)	
	TUC2 lead time constant of second lead-lag block (under-excitation channel) (sec)	
	TUB2 lag time constant of second lead-lag block (under-excitation channel) (sec)	

Category	Parameter Description	Data
	TOC1 lead time constant of first lead-lag block (over-excitation channel) (sec)	
	TOB1 lag time constant of first lead-lag block (over-excitation channel) (sec)	
	TOC2 lead time constant of second lead-lag block (over-excitation channel) (sec)	
	TOB2 lag time constant of second lead-lag block (over-excitation channel) (sec)	
ST6B	TR regulator input filter time constant (sec)	
	KPA (pu) (> 0) voltage regulator proportional gain	
	KIA (pu) voltage regulator integral gain	
	KDA (pu) voltage regulator derivative gain	
	TDA voltage regulator derivative channel time constant (sec)	
	VAMAX (pu) regulator output maximum limit	
	VAMIN (pu) regulator output minimum limit	
	KFF (pu) pre-control gain of the inner loop field regulator	
	KM (pu) forward gain of the inner loop field regulator	
	KCI (pu) exciter output current limit adjustment gain	
	KLR (pu) exciter output current limiter gain	
	ILR (pu) exciter current limit reference	
	VRMAX (pu) voltage regulator output maximum limit	
	VRMIN (pu) voltage regulator output minimum limit	
	KG (pu) feedback gain of the inner loop field voltage regulator	
	TG (> 0) feedback time constant of the inner loop field voltage regulator (sec)	
ST7B	TR regulator input filter time constant (sec)	
	TG lead time constant of voltage input (sec)	
	TF lag time constant of voltage input (sec)	
	Vmax (pu) voltage reference maximum limit	
	Vmin (pu) voltage reference minimum limit	
	KPA (pu) (>0) voltage regulator gain	
	VRMAX (pu) voltage regulator output maximum limit	
	VRMIN (pu) voltage regulator output minimum limit	
	KH (pu) feedback gain	
	KL (pu) feedback gain	
	TC lead time constant of voltage regulator (sec)	
	TB lag time constant of voltage regulator (sec)	
	KIA (pu) (>0) gain of the first order feedback block	
	TIA (>0) time constant of the first order feedback block (sec)	

16.1.4. Power system stabilizer:

The function of the PSS is to add to the unit's characteristic electromechanical oscillations. This is achieved by modulating excitation to develop a component in electrical torque in phase with rotor speed deviations.

The most important aspect when considering a PSS model is the number of inputs. The following table shows the type of models separated based on the inputs:

Type	Inputs	Remarks
PSS1A	Single input	Two lead-lags Input can either be speed, frequency or power
PSS2B	Dual input	Integral of accelerating power Speed and Power Most common type Supersedes PSS2A (three versus two lead lags)
PSS3B	Dual input	Power and rotor angular frequency deviation Stabilizing signal is a vector sum of processed signals Not very common

Category	Parameter Description	Data
Stabilizer Models		
PSS1A	A1, Filter coefficient	
	A2, Filter coefficient	
	TR, transducer time constant	
	0	
	0	
	0	
	T1, 1st Lead-Lag Derivative Time Constant	
	T2, 1st Lead-Lag Delay Time Constant	
	T3, 2nd Lead-Lag Derivative Time Constant	
	T4, 2nd Lead-Lag Delay Time Constant	
	Tw, Washout Time Constant	
	Tw, Washout Time Constant	
	Ks, input channel gain	
	VSTMAX, Controller maximum output	
	VSTMAX, Controller minimum output	
	0	
	0	
	TW1, 1st Washout 1th Time Constant	
	TW2, 1st Washout 2th Time Constant	
	T6, 1st Signal Transducer Time Constant	
	TW3, 2nd Washout 1th Time Constant	
	TW4, 2nd Washout 2th Time Constant	
	T7, 2nd Signal Transducer Time Constant	
	KS2, 2nd Signal Transducer Factor	

PSS2B	KS3, Washouts Coupling Factor	
	T8, Ramp Tracking Filter Deriv. Time Constant	
	T9, Ramp Tracking Filter Delay Time Constant	
	KS1, PSS Gain	
	T1, 1st Lead-Lag Derivative Time Constant	
	T2, 1st Lead-Lag Delay Time Constant	
	T3, 2nd Lead-Lag Derivative Time Constant	
	T4, 2nd Lead-Lag Delay Time Constant	
	T10, 3rd Lead-Lag Derivative Time Constant	
	T11, 3rd Lead-Lag Delay Time Constant	
	VS1MAX, Input 1 Maximum limit	
	VS1MIN, Input 1 Minimum limit	
	VS2MAX, Input 2 Maximum limit	
	VS2MIN, Input 2 Minimum limit	
	VSTMAX, Controller Maximum Output	
	VSTMIN, Controller Minimum Output	
PSS3B	KS1 (pu) (≠0), input channel #1 gain	
	T1 input channel #1 transducer time constant (sec)	
	Tw1 input channel #1 washout time constant (sec)	
	KS2 (pu) (≠0), input channel #2 gain	
	T2 input channel #2 transducer time constant (sec)	
	Tw2 input channel #2 washout time constant (sec)	
	Tw3 (0), main washout time constant (sec)	
	A1, Filter coefficient	
	A2, Filter coefficient	
	A3, Filter coefficient	
	A4, Filter coefficient	
	A5, Filter coefficient	
	A6, Filter coefficient	
	A7, Filter coefficient	
	A8, Filter coefficient	
	VSTMAX, Controller maximum output	
	VSTMAX, Controller minimum output	

16.1.5. Generic models for turbine-governor

The following table is a list for generic models of steam turbines:

Type	Name	Remarks
BBGOV1	Brown-Boveri turbine governor model	Mainly used for steam turbine with electrical damping feedback
TGOV1	Steam-turbine governor	Mainly used for steam turbine with reheater
CRCMGV	Cross-compound turbine	-

Type	Name	Remarks
IEEEG1	IEEE type 1 Speed-Governor Model	Used to represent non-reheat, tandem compound, and cross compound types.
IEEEG2	IEEE Type 2 Speed-Governing Model	Linearized model for representing a hydro turbine-governor and penstock dynamics
IEEEG3	IEEE type 3 turbine-governor model	Includes a more complex representation of the governor controls than IEEEG2 does
IEESGO	IEEE Standard Model	Simple model of reheat steam turbine
TGOV2	Steam –turbine governor with fast valving	Fast valving model of steam turbine
TGOV3	Modified IEEE Type 1 Speed-Governing Model with fast valving	Modification of IEEEG! For fast valving studies
TGOV4	Modified IEEE Type 1 Speed-GoverningModel with PLU and EVA	Model of steam turbine and boiler, explicit action for both control valve (CV) and inlet valve (IV), main reheat and LP steam effects,and boiler
TGOV5	IEEE Type 1 Speed-Governor Model Modified to Include Boiler Controls	Most common type of governor model, based on TGOV1 with boiler controls
TURCZT	Czech hydro or steam turbine governormodel	General-purpose hydro and thermal turbine-governor model. Penstock dynamic is notincluded in the model

Category	Parameter Description	Data
Turbine Governor Model		
BBGOV1	fcut (>=0) (pu), cut off frequency	
	KS, frequency gain	
	KLS (> 0)	
	KG	
	KP, power regulator gain	
	TN (sec) (> 0)	
	KD, damping gain	
	TD (sec) (> 0), damping time constant	
	T4 (sec), high pressure time constant	
	K2, intermediate pressure time constant	
	T5 (sec), intermediate re-heater time constant	
	K3, high pressure time constant	
	T6 (sec), re-heater time constant	
	T1 (sec), measuring transducer time constant	
	SWITCH	
	PMAX, maximum power output limiter	
	PMIN, minimum power output limiter	
	R, Permanent Droop	
	T1 (>0) (sec), Steam bowl time constant	

Category	Parameter Description	Data
TGOV1	VMAX, Maximum valve position	
	VMIN, Minimum valve position	
	T2 (sec), Time constant	
	T3 (>0) (sec), reheater time constant	
	Dt, Turbine damping coefficient	
	VMAX, VMIN, Dt and R are in per unit on generator MVA base.T2/T3 = high-pressure fraction.	
CRCMGV	PMAX (HP)1, maximum HP value position (on generator base)	
	R (HP), HP governor droop	
	T1 (HP) (>0), HP governor time constant	
	T3 (HP) (>0), HP turbine time constant	
	T4 (HP) (>0), HP turbine time constant	
	T5 (HP) (>0), HP reheater time constant	
	F (HP), fraction of HP power ahead of reheater	
	DH (HP), HP damping factor (on generator base)	
	PMAX (LP), maximum LP value position (on generator base)	
	R (LP), LP governor droop	
	T1 (LP) (>0), LP governor time constant	
	T3 (LP) (>0), LP turbine time constant	
	T4 (LP) (>0), LP turbine time constant	
	T5 (LP) (>0), LP turbine time constant	
	F (LP), fraction of LP power ahead of reheater	
	DH (LP), LP damping factor (on generator base)	
IEEEG1	K, Governor gain, (1/droop) pu	
	T1 (sec), Lag time constant (sec)	
	T2 (sec), Lead time constant (sec)	
	T3 (> 0) (sec), valve position time constant	
	Uo (pu/sec), maximum valve opening rate	
	Uc (< 0) (pu/sec), maximum valve closing rate	
	PMAX (pu on machine MVA rating)	
	PMIN (pu on machine MVA rating)	
	T4 (sec), time constant for steam inlet	
	K1, HP fraction	
	K2, LP fraction	
	T5 (sec), Time Constant for Second Boiler Pass [s]	
	K3, HP Fraction	
	K4, LP fraction	
	T6 (sec), Time Constant for Third Boiler Pass [s]	
	K5, HP Fraction	
	K6, LP fraction	
	T7 (sec), Time Constant for Fourth Boiler Pass [s]	
	K7, HP Fraction	
	K8, LP fraction	
	K, Governor gain	
	T1 (sec), Governor lag time constant	
	T2 (sec), Governor lead time constant	

Category	Parameter Description	Data
IEEEG2	T3 (>0) (sec), Gate actuator time constant	
	PMAX (pu on machine MVA rating), gate maximum	
	PMIN (pu on machine MVA rating), gate minimum	
	T4 (>0) (sec), water starting time	
IEEEG3	TG, (>0) (sec), gate servomotor time constant	
	TP (>0) (sec), pilot value time constant	
	Uo (pu per sec), opening gate rate limit	
	Uc (pu per sec), closing gate rate limit (< 0)	
	PMAX maximum gate position (pu on machine MVA rating)	
	PMIN minimum gate position (pu on machine MVA rating)	
	σ, permanent speed droop coefficient	
	δ, transient speed droop coefficient	
	TR, (>0) (sec), Dashpot time constant	
	TW (>0) (sec), water starting time	
	a11 (>0), Turbine coefficient	
	a13, Turbine coefficient	
	a21, Turbine coefficient	
	a23 (>0), Turbine coefficient	
IEESGO	T1, Controller Lag	
	T2, Controller Lead Compensation	
	T3, Governor Lag (> 0)	
	T4, Delay Due To Steam Inlet Volumes	
	T5, Reheater Delay	
	T6, Turbine, pipe, hood Delay	
	K1, 1/Per Unit Regulation	
	K2, Fraction	
	K3, fraction	
	PMAX, Upper Power Limit	
	PMIN, Lower Power Limit	
TGOV2	R (pu), permanent droop	
	T1 (>0) (sec), Steam bowl time constant	
	VMAX (pu), Maximum valve position	
	VMIN (pu), Minimum valve position	
	K (pu), Governor gain	
	T3 (>0) (sec), Time constant	
	Dt (pu), Turbine damping coefficient	
	Tt (>0) (sec), Valve time constant	
	TA, Valve position at time 2 (fully closed after fast valving initialization)	
	TB, Valve position at time 3 (start to reopen after fast valving initialization)	
	TC, Valve position at time 4 (again fully open after fast valving initializations)	
	K, Governor gain	

Category	Parameter Description	Data
TGOV3	T1 (sec), Governor lead time constant	
	T2 (sec), Governor lag time constant	
	T3 (>0) (sec), Valve positioner time constant	
	Uo, Maximum valve opening velocity	
	Uc (< 0), Maximum valve closing velocity	
	PMAX, Maximum valve opening	
	PMIN, Minimum valve opening	
	T4 (sec), Inlet piping/steam bowl time constant	
	K1, Fraction of turbine power developed after first boiler pass	
	T5 (> 0) (sec), Time constant of second boiler pass	
	K2, Fraction of turbine power developed after second boiler pass	
	T6 (sec), Time constant of crossover or third boiler pass	
	K3, Fraction of hp turbine power developed after crossover or third boiler pass	
	TA (sec), Valve position at time 2 (fully closed after fast valving initializations)	
	TB (sec), Valve position at time 3 (start to reopen after fast valving initializations)	
	TC (sec), Valve position at time 4 (again fully open after fast valving initializations)	
	PRMAX (pu), Max. pressure in reheater	
TGOV4	K, The inverse of the governor speed droop	
	T1 (sec), The governor controller lag time constant	
	T2 (sec), The governor controller lead time constant	
	T3 (>0) (sec), The valve servomotor time constant for the control valves	
	Uo, The control valve open rate limit	
	Uc (<0), The control valve close rate limit	
	KCAL	
	T4 (sec), The steam flow time constant	
	K1	
	T5 (> 0) (sec)	
	K2	
	T6 (sec)	
	PRMAX	
	KP	
	KI	
	TFuel (sec)	
	TFD1 (sec)	
	TFD2 (sec)	
	Kb	
	Cb (> 0) (sec)	
	TIV (> 0) (sec)	
	UOIV	

Category	Parameter Description	Data
	UCIV	
	R (>0)	
	Offset	
	CV position demand characteristic	
	CV #2 offset	
	CV #3 offset	
	CV #4 offset	
	IV position demand characteristic	
	IV #2 offset	
	CV valve characteristic	
	IV valve characteristic	
	CV starting time for valve closing (sec)	
	CV closing rate (pu/sec)	
	Time closed for CV #1 (sec)	
	Time closed for CV #2	
	Time closed for CV #3	
	Time closed for CV #4	
	IV starting time for valve closing (sec)	
	IV closing rate (pu/sec)	
	Time closed for IV #1 (sec)	
	Time closed for IV #2 (sec)	
	TRPLU (>0) (sec)	
	PLU rate level	
	Timer	
	PLU unbalance level	
	TREVA (>0) (sec)	
	EVA rate level	
	EVA unbalance level	
	Minimum load reference (pu)	
	Load reference ramp rate (pu/sec)	
	K, The inverse of the governor speed droop	
	T1 (sec), The governor controller lag time constant	
	T2 (sec), The governor controller lead time constant	
	T3 (>0) (sec), The valve servomotor time constant for the control valves	
	Uo, The control valve open rate limit	
	Uc (<0), The control valve close rate limit	
	VMAX, The maximum valve area	
	VMIN, The minimum valve area	
	T4 (sec), The steam flow time constant	
	K1, The fractions of the HP	
	K2, fractions of the LP	
	T5 (sec), The first reheater time constant	
	K3, The fractions of the HP	
	K4, fractions of the LP	

Category	Parameter Description	Data
TGOV5	T6 (sec), second reheater time constant	
	K5, The fractions of the HP	
	K6, fractions of the LP	
	T7 (sec), crossover time constant	
	K7, The fractions of the HP	
	K8, fractions of the LP	
	K9, The adjustment to the pressure drop coefficient as a function of drum pressure	
	K10, The gain of anticipation signal from main stream flow	
	K11, The gain of anticipation signal from load demand	
	K12, The gain for pressure error bias	
	K13, The gain between MW demand and pressure set point	
	K14, Inverse of load reference servomotor time constant (= 0.0 if load reference does not change).	
	RMAX, The load reference positive rate of change limit	
	RMIN, The load reference negative rate of change limit	
	LMAX, The maximum load reference	
	LMIN, The minimum load reference	
	C1, The pressure drop coefficient	
	C2, The gain for the pressure error bias	
	C3, The adjustment to the pressure set point	
	B, The frequency bias for load reference control	
	CB (>0) (sec), The boiler storage time constant	
	KI, The controller integral gain	
	TI (sec), The controller proportional lead time constant	
	TR (sec), The controller rate lead time constant	
	TR1 (sec), The inherent lag associated with lead TR (usually about TR/10)	
	CMAX, The maximum controller output	
	CMIN, The minimum controller output	
	TD (sec), The time delay in the fuel supply system	
	TF (sec), The fuel and air system time constant	
	TW (sec), The water wall time constant	
	Psp (initial) (>0), The initial throttle pressure set point	
	TMW (sec), The MW transducer time constant	
	KL (0.0 or 1.0), The feedback gain from the load reference	
	KMW (0.0 or 1.0), The gain of the MW transducer	
	DPE (pu pressure), The dead band in the pressure error signal for load reference control	
	• *The fractions of the HP unit's mechanical power developed by the various turbine stages.The sum of K1,*	

Category	Parameter Description	Data
	K3, K5 andK7 constants should be one for a non-cross-compound unit. • *Similarly fractions of the LP unit's mechanical power should be zero for a non-cross- compound unit. For a cross-compound unit, the sum of K1 through K8 should equal one.*	
TURCZT	fDEAD (pu), Frequency Dead Band	
	fMIN (pu), Frequency Minimum Deviation	
	fMAX (pu), Frequency Maximum Deviation	
	KKOR (pu), Frequency Gain	
	KM > 0 (pu), Power Measurement Gain	
	KP (pu), Regulator Proportional Gain	
	SDEAD (pu), Speed Dead Band	
	KSTAT (pu), Speed Gain	
	KHP (pu), High Pressure Constant	
	TC (sec), Measuring transducer time constant	
	T 1 (sec), Regulator Integrator Time Constant	
	TEHP (sec), Hydro Converter Time Constant	
	TV > 0 (sec), Regulation Valve Time Constant	
	THP (sec), High Pressure Time Constant	
	TR (sec), Reheater time constant	
	TW (sec), Water Time Constant	
	NTMAX (pu), Power Regulator-Integrator Maximum Limiter	
	NTMIN (pu), Power Regulator-Integrator Minimum Limiter	
	GMAX (pu), Valve Maximum Open	
	GMIN (pu), Valve Minimum Open	
	VMIN (pu/sec), Valve Maximum Speed Close	
	VMAX (pu/sec), Valve Maximum Speed Open	

16.2. Generation: Thermal (Gas)

Format No.	Dyn/Generation/ Thermal-Gas/1
Data Submission By:	Generating Company / CPP
Data related to:	Each Gas based thermal power station
Data to be submitted to:	State Transmission Utility
Periodicity & prescribed date for data submission:	As and when required by STU

16.2.1. Details of models in PSS/E for modelling Gas power generation:

(a) Synchronous Machine – To be filled separately for Gas turbine (GT) and steam turbine (ST)

Category	Parameter Description	Data
Generator Nameplate	Rated apparent power in MVA	

Category	Parameter Description	Data
	Rated terminal voltage	
	Rated power factor	
	Rated speed (in RPM)	
	Rated frequency (in Hz)	
	Rated excitation (in Amperes and Volts)	
Type of Synchronous Machine	Round rotor or salient pole No. of poles	
Generator capability curve	The generator capability curve shows the reactive capability of the machine and should include any restrictions on the real or reactive power range like under/over excitation limits, stability limits, etc. Capability curve should have properly labelled axis and legible data	
Generator Open Circuit and Short Circuit Characteristic	Graph of excitation current versus terminal voltage and stator current	
	No load excitation current – used to derive per unit values	
	Excitation current at rated stator current	
Generator vee-curves	Otherwise referred to as "V-curve". A plot of the terminal (armature) current versus the generating unit field voltage.	
Resistance values	Resistance measurements of field winding and stator winding to a known temperature	
Generator Data sheet	Direct axis synchronous reactance Xd in p.u. (Unsaturated or saturated)	
	Direct axis transient synchronous reactance Xd' in p.u. (Unsaturated or saturated)	
	Direct axis sub-transient synchronous reactance Xd'' in p.u. (Unsaturated or saturated)	
	Stator leakage reactance Xa in p.u. (Unsaturated or saturated)	
	Quadrature axis synchronous reactance Xq in p.u. (Unsaturated or saturated)	
	Quadrature axis transient synchronous reactance Xq' in p.u. (Unsaturated or saturated)	
	Quadrature axis sub-transient synchronous reactance Xq'' in p.u. (Unsaturated or saturated)	
	Direct axis open circuit transient time constant Tdo' in sec	
	Direct axis open circuit sub-transient time constant Tdo'' in sec	
	Quadrature axis open circuit transient time constant Tqo' in sec	

Category	Parameter Description	Data
	Quadrature axis open circuit sub-transient time constant Tqo'' in sec	
	Inertia constant of total rotating mass (generator, AVR, turbo-governor set) H in MW/MVA	
	Speed Damping D	
	Saturation constant S (1.0) in p.u.	
	Saturation constant S (1.2) in p.u.	
Generator step up transformer (GSUT)	Nameplate Rating - Rated primary and secondary voltage - Vector group - Impedance - Tap changer details (Number of taps, tap position, tap ratio etc.)	
Auxiliary power (i.e., active and reactive auxiliary load)	Value of auxiliary load (MW and MVAr) at rated power of the generating unit.	
	Whether or not the load trips if the generating unit trips.	
Test Reports	Factory acceptance test (FAT) reports	

(b) Site Load

	Low Output			High Output		
	kW	kvar	kVA	kW	kvar	kVA
Auxiliary Load						

(c) Excitation System

Category	Parameter Description	Data
Type of Automatic Voltage Regulator (AVR)	Manufacturer and product details (for example ABB UNITROL or GE EX2100e)	
	Type of control system :- Analogue or digital	
	Year of commissioning / Year of manufacture	
	As found settings (obtained either from HMI or downloaded from controller in digital systems)	
Type of excitation system	Static excitation system OR	
	Indirect excitation system (i.e. rotating exciter)	
	- AC exciter, or	
	- DC exciter	
Details of AVR converter	Rated excitation current (converter rating in Amperes)	
	Six pulse thyristor bridge or PWM converter	
Source of excitation supply	Excitation transformer or auxiliary supply (Details thereof)	
	If excitation transformer, nameplate information required	
Schematics	Saturation curves of the exciter (if applicable – see Type AC and DC)	

Category	Parameter Description	Data
	Drawings of excitation system, typically prepared and supplied by the OEM	
	Single line diagram (i.e. one-line diagram) for the excitation system	
Excitation limiters	What excitation limiters are commissioned?	
	Under Excitation Limiters settings	
	Over Excitation Limiters settings	
	Voltage/frequency limiter	
	Stator current limiter	
	Minimum excitation current limiter	

(d) Excitation System

Category	Parameter Description	Data
Type of prime mover	- Open cycle gas turbine - Aero-derivative (twin shaft) gas turbine - Combined cycle plant (closed cycle gas turbine)	
Manufacturer of turbine	Manufacturer and name plate details	
Governor	Electro-mechanical governor (including settings and drawings)	
	Digital electric governor (including settings and drawings)	
Ramp rates	How fast can the turbine increase and/or decrease load, specified in MW/min Guide vane/wicket gate characteristic, including opening, closing rates/times and limits	
Droop	Droop setting (% on machine base)	
	Frequency influence limiters - Maximum frequency deviation limiter (eg +/-2 Hz) - Maximum influence limiter (eg 10% of rating)	
Dead band	Details of frequency dead band (typically in Hz or RPM)	
Technology	- Open cycle	
	- Close cycle	
Gas turbine	Does turbine operate in dual fuel (gas and liquid fuel)	
	Inlet guide vane (IGV) characteristic	
	Limit for exhaust gas temperature (EGT)	
	Base load/frequency control	
	Power output versus ambient temperature	
	No load fuel flow and turbine gain (determined by relationship of active power versus fuel valve position or fuel stroke reference)	
Combine cycle plant	Details on heat recovery steam generator (HRSG) - Block diagram - GT output vs heat relationship (look up table) - Drum time constant - Pressure loss due to friction in boiler tubes	
	Size of steam turbine	
	Frequency control of ST	
	Time lag and relationship of GT and ST	
	Is the combined cycle plant a single shaft plant – i.e. the gas and steam turbine are on same shaft and drive same generator	

16.2.2. Generic Models for synchronous machine

Gas turbine (GT) or steam turbines (ST) are generally round rotor machines however, salient pole Gas turbine (aero-derivative) with synchronous machine having four poles has also been installed at some of the places. Depending upon the saturation characteristic of the machine they are classified further:

- Round rotor machine (2 poles):
  - GENROU – Round rotor machine model with quadratic saturation function
  - GENROE – Round rotor machine model with exponential saturation function
- Salient pole machine (more than two poles):
  - GENSAL – Salient pole machine with quadratic saturation function
  - GENSAE – Salient pole machine with exponential saturation function

Category	Parameter Description	Data
Generator Model		
GENROU OR GENROE	Direct axis open circuit transient time constant Tdo' in sec	
	Direct axis open circuit sub-transient time constant Tdo'' in sec	
	Quadrature axis open circuit transient time constant Tqo' in sec	
	Quadrature axis open circuit sub-transient time constant Tqo'' in sec	
	Inertia constant of total rotating mass H in MW.s/MVA	
	Speed Damping D	
	Direct axis synchronous reactance Xd in p.u. (Unsaturated or saturated)	
	Quadrature axis synchronous reactance Xq in p.u. (Unsaturated or saturated)	
	Direct axis transient synchronous reactance Xd' in p.u. (Unsaturated or saturated)	
	Quadrature axis transient synchronous reactance Xq' in p.u. (Unsaturated or saturated)	
	Direct axis sub-transient synchronous reactance Xd'' in p.u. (Unsaturated or saturated) = Quadrature axis sub-transient synchronous reactance Xq'' in p.u. (Unsaturated or saturated)	
	Stator leakage reactance Xl in p.u.	
	Saturation constant S (1.0) in p.u.	
	Saturation constant S (1.2) in p.u.	
GENSAE OR GENSAL	Direct axis open circuit transient time constant Tdo' in sec	
	Direct axis open circuit sub-transient time constant Tdo'' in sec	
	Quadrature axis open circuit sub-transient time constant Tqo'' in sec	
	Inertia constant of total rotating mass H in MW.s/MVA	
	Speed Damping D	
	Direct axis synchronous reactance Xd in p.u. (Unsaturated or saturated)	
	Quadrature axis synchronous reactance Xq in p.u. (Unsaturated or saturated)	
	Direct axis transient synchronous reactance Xd' in p.u. (Unsaturated or saturated)	
	Direct axis sub-transient synchronous reactance Xd'' in p.u. (Unsaturated or saturated) = Quadrature axis sub-transient synchronous reactance Xq'' in p.u.	

	(Unsaturated or saturated)	
	Stator leakage reactance Xl in p.u.	
	Saturation constant S (1.0) in p.u.	
	Saturation constant S (1.2) in p.u.	

16.2.3. Excitation system model:

If a generic model is used, the first step must be to identify what type of exciter is present in the excitation system. The IEEE Std 421.5 (IEEE Recommended Practice for Excitation System Models for Power System Stability Studies published on 26th Aug 2016) has published several generic models, which are classified into three groups:

- Type DC: for excitation systems with a DC exciter
- Type AC: for excitation systems with an AC exciter
- Type ST: for excitation systems with a static exciter

The following table shows the types of models separated into their respective groups.

DC exciter	AC exciter	Static excitation system
Type DC1A	Type AC1A	Type ST1A
Type DC2A	Type AC2A	Type ST2A
Type DC3A	Type AC4A	Type ST3A
Type DC4B	Type AC5A	Type ST4B
	Type AC6A	Type ST5B
	Type AC7B	Type ST6B
	Type AC8B	Type ST7B

Category	Parameter Description	Data
DC Exciter		
ESDC1A OR ESDC2A	TR regulator input filter time constant (sec)	
	KA (> 0) (pu) voltage regulator gain	
	TA (s), voltage regulator time constant	
	TB (s), lag time constant	
	TC (s), lead time constant	
	VRMAX (pu) regulator output maximum limit or Zero	
	VRMIN (pu) regulator output minimum limit	
	KE (pu) exciter constant related to self-excited field	
	TE (> 0) rotating exciter time constant (sec)	
	KF (pu) rate feedback gain	
	TF1 (> 0) rate feedback time constant (sec)	
	Switch	
	E1, exciter flux at knee of curve (pu)	
	SE(E1), saturation factor at knee of curve	

Category	Parameter Description	Data
	E2, maximum exciter flux (pu)	
	SE(E2), saturation factor at maximum exciter flux (pu)	
ESDC3A	TR regulator input filter time constant (sec)	
	KV (pu) limit on fast raise/lower contact setting	
	VRMAX (pu) regulator output maximum limit or Zero	
	VRMIN (pu) regulator output minimum limit	
	TRH (> 0) Rheostat motor travel time (sec)	
	TE (> 0) exciter time-constant (sec)	
	KE (pu) exciter constant related to self-excited field	
	VEMIN (pu) exciter minimum limit	
	E1, exciter flux at knee of curve (pu)	
	SE(E1), saturation factor at knee of curve	
	E2, maximum exciter flux (pu)	
	SE(E2), saturation factor at maximum exciter flux (pu)	
ESDC4B	TR regulator input filter time constant (sec)	
	KP (pu) (> 0) voltage regulator proportional gain	
	KI (pu) voltage regulator integral gain	
	KD (pu) voltage regulator derivative gain	
	TD voltage regulator derivative channel time constant (sec)	
	VRMAX (pu) regulator output maximum limit	
	VRMIN (pu) regulator output minimum limit	
	KA (> 0) (pu) voltage regulator gain	
	TA voltage regulator time constant (sec)	
	KE (pu) exciter constant related to self-excited field	
	TE (> 0) rotating exciter time constant (sec)	
	KF (pu) rate feedback gain	
	TF (> 0) rate feedback time constant (sec)	
	VEMIN (pu) minimum exciter voltage output	
	E1, exciter flux at knee of curve (pu)	
	SE(E1), saturation factor at knee of curve	
	E2, maximum exciter flux (pu)	
	SE(E2), saturation factor at maximum exciter flux (pu)	
	TR regulator input filter time constant (sec)	
	TB (s), lag time constant	
	TC (s), lead time constant	
	KA (> 0) (pu) voltage regulator gain	
	TA (s), voltage regulator time constant	
	VAMAX (pu) regulator output maximum limit	

Category	Parameter Description	Data
ESAC1A	VAMIN (pu) regulator output minimum limit	
	TE (> 0) rotating exciter time constant (sec)	
	KF (pu) rate feedback gain	
	TF (> 0) rate feedback time constant (sec)	
	KC (pu) rectifier loading factor proportional to commutating reactance	
	KD (pu) demagnetizing factor, function of AC exciter reactances	
	KE (pu) exciter constant related to self-excited field	
	E1, exciter flux at knee of curve (pu)	
	SE(E1), saturation factor at knee of curve	
	E2, maximum exciter flux (pu)	
	SE(E2), saturation factor at maximum exciter flux (pu)	
	VRMAX (pu) regulator output maximum limit	
	VRMIN (pu) regulator output minimum limit	
ESAC2A	TR regulator input filter time constant (sec)	
	TB (s), lag time constant	
	TC (s), lead time constant	
	KA (> 0) (pu) voltage regulator gain	
	TA (s), voltage regulator time constant	
	VAMAX (pu) regulator output maximum limit	
	VAMIN (pu) regulator output minimum limit	
	KB, Second stage regulator gain	
	VRMAX (pu) regulator output maximum limit	
	VRMIN (pu) regulator output minimum limit	
	TE (> 0) rotating exciter time constant (sec)	
	VFEMAX, parameter of VEMAX, exciter field maximum output	
	KH, Exciter field current feedback gain	
	KF (pu) rate feedback gain	
	TF (> 0) rate feedback time constant (sec)	
	KC (pu) rectifier loading factor proportional to commutating reactance	
	KD (pu) demagnetizing factor, function of AC exciter reactances	
	KE (pu) exciter constant related to self-excited field	
	E1, exciter flux at knee of curve (pu)	
	SE(E1), saturation factor at knee of curve	
	E2, maximum exciter flux (pu)	
	SE(E2), saturation factor at maximum exciter flux (pu)	
AC Exciter		
	TR regulator input filter time constant (sec)	
	TB (s), lag time constant	

Category	Parameter Description	Data
ESAC3A	TC (s), lead time constant	
	KA (> 0) (pu) voltage regulator gain	
	TA (s), voltage regulator time constant	
	VAMAX (pu) regulator output maximum limit	
	VAMIN (pu) regulator output minimum limit	
	TE (> 0) rotating exciter time constant (sec)	
	VEMIN (pu) minimum exciter voltage output	
	KR (>0), Constant associated with regulator and alternator field power supply	
	KF (pu) rate feedback gain	
	TF (> 0) rate feedback time constant (sec)	
	KN, Exciter feedback gain	
	EFDN, A parameter defining for which value of UF the feedback gain shall change from KF to KN	
	KC, rectifier regulation factor (pu)	
	KD, exciter regulation factor (pu)	
	KE (pu) exciter constant related to self-excited field	
	VFEMAX, parameter of VEMAX, exciter field maximum output	
	E1, exciter flux at knee of curve (pu)	
	SE(E1), saturation factor at knee of curve	
	E2, maximum exciter flux (pu)	
	SE(E2), saturation factor at maximum exciter flux (pu)	
ESAC4A	TR regulator input filter time constant (sec)	
	VIMAX, Maximum value of limitation of the integrator signal VI in p.u	
	VIMIN, Minimum value of limitation of the signal VI in p.u.	
	TB (s), lag time constant	
	TC (s), lead time constant	
	KA (> 0) (pu) voltage regulator gain	
	TA (s), voltage regulator time constant	
	VRMAX (pu) regulator output maximum limit	
	VRMIN (pu) regulator output minimum limit	
	KC, rectifier regulation factor (pu)	
	TR regulator input filter time constant (sec)	
	KA (> 0) (pu) voltage regulator gain	
	TA (s), voltage regulator time constant	
	VRMAX (pu) regulator output maximum limit	
	VRMIN (pu) regulator output minimum limit	
	KE (pu) exciter constant related to self-excited field	
	TE (> 0) rotating exciter time constant (sec)	

Category	Parameter Description	Data
ESAC5A	KF (pu) rate feedback gain	
	TF1 (sec), Regulator stabilizing circuit time constant in seconds	
	TF2 (sec), Regulator stabilizing circuit time constant in seconds	
	TF3 (sec), Regulator stabilizing circuit time constant in seconds	
	E1, exciter flux at knee of curve (pu)	
	SE(E1), saturation factor at knee of curve	
	E2, maximum exciter flux (pu)	
	SE(E2), saturation factor at maximum exciter flux (pu)	
AC6A	TR regulator input filter time constant (sec)	
	KA (> 0) (pu) voltage regulator gain	
	TA (s), voltage regulator time constant	
	TK (sec), Lead time constant	
	TB (s), lag time constant	
	TC (s), lead time constant	
	VAMAX (pu) regulator output maximum limit	
	VAMIN (pu) regulator output minimum limit	
	VRMAX (pu) regulator output maximum limit	
	VRMIN (pu) regulator output minimum limit	
	TE (> 0) rotating exciter time constant (sec)	
	VFELIM, Exciter field current limit reference	
	KH, Damping module gain	
	VHMAX, damping module limiter	
	TH (sec), damping module lag time constant	
	TJ (sec), damping module lead time constant	
	KC, rectifier regulation factor (pu)	
	KD, exciter regulation factor (pu)	
	KE (pu) exciter constant related to self-excited field	
	E1, exciter flux at knee of curve (pu)	
	SE(E1), saturation factor at knee of curve	
	E2, maximum exciter flux (pu)	
	SE(E2), saturation factor at maximum exciter flux (pu)	
	TR (sec) regulator input filter time constant	
	KPR (pu) regulator proportional gain	
	KIR (pu) regulator integral gain	
	KDR (pu) regulator derivative gain	
	TDR (sec) regulator derivative block time constant	
	VRMAX (pu) regulator output maximum limit	
	VRMIN (pu) regulator output minimum limit	

Category	Parameter Description	Data
AC7B	KPA (pu) voltage regulator proportional gain	
	KIA (pu) voltage regulator integral gain	
	VAMAX (pu) regulator output maximum limit	
	VAMIN (pu) regulator output minimum limit	
	KP (pu)	
	KL (pu)	
	KF1 (pu)	
	KF2 (pu)	
	KF3 (pu)	
	TF3 (sec) time constant (> 0)	
	KC (pu) rectifier loading factor proportional to commutating reactance	
	KD (pu) demagnetizing factor, function of AC exciter reactances	
	KE (pu) exciter constant related fo self-excited field	
	TE (pu) exciter time constant (>0)	
	VFEMAX (pu) exciter field current limit (> 0)	
	VEMIN (pu)	
	E1, exciter flux at knee of curve (pu)	
	SE(E1), saturation factor at knee of curve	
	E2, maximum exciter flux (pu)	
	SE(E2), saturation factor at maximum exciter flux (pu)	
AC8B	TR (sec) regulator input filter time constant	
	KPR (pu) regulator proportional gain	
	KIR (pu) regulator integral gain	
	KDR (pu) regulator derivative gain	
	TDR (sec) regulator derivative block time constant	
	VPIDMAX (pu) PID maximum limit	
	VPIDMIN (pu) PID minimum limit	
	KA (pu) voltage regulator proportional gain	
	TA (sec) voltage regulator time constant	
	VRMAX (pu) regulator output maximum limit	
	VRMIN (pu) regulator output minimum limit	
	KC (pu) rectifier loading factor proportional to commutating reactance	
	KD (pu) demagnetizing factor, function of AC exciter reactances	
	KE (pu) exciter constant related fo self-excited field	
	TE (pu) exciter time constant (>0)	
	VFEMAX (pu) max exciter field current limit (> 0)	
	VEMIN (pu),	
	E1, exciter flux at knee of curve (pu)	

Category	Parameter Description	Data
	SE(E1), saturation factor at knee of curve	
	E2, maximum exciter flux (pu)	
	SE(E2), saturation factor at maximum exciter flux (pu)	
Static Exciter		
ST1A	Static Exciter	
	TR (sec) regulator input filter time constant	
	VIMAX, Controller Input Maximum	
	VIMIN, Controller Input Minimum	
	TC (s), Filter 1st Derivative Time Constant	
	TB (s), l Filter 1st Delay Time Constant	
	TC1 (s), Filter 2nd Derivative Time Constant	
	TB1 (s), Filter 2nd Delay Time Constant	
	KA (pu) voltage regulator proportional gain	
	TA (sec) voltage regulator time constant	
	VAMAX (pu) regulator output maximum limit	
	VAMIN (pu) regulator output minimum limit	
	VRMAX (pu) regulator output maximum limit	
	VRMIN (pu) regulator output minimum limit	
	KC (pu) rectifier loading factor proportional to commutating reactance	
	KF (pu) rate feedback gain	
	TF (> 0) rate feedback time constant (sec)	
	KLR, Current Input Factor	
ST2A	TR (sec) regulator input filter time constant	
	KA (pu) voltage regulator proportional gain	
	TA (sec) voltage regulator time constant	
	VRMAX (pu) regulator output maximum limit	
	VRMIN (pu) regulator output minimum limit	
	KE (pu) exciter constant related fo self-excited field	
	TE (pu) exciter time constant (>0)	
	KF (pu) rate feedback gain	
	TF (> 0) rate feedback time constant (sec)	
	KP (pu) voltage regulator proportional gain	
	KI (pu) voltage regulator integral gain	
	KC (pu) rectifier loading factor proportional to commutating reactance	
	EFDMAX	
ST3A	TR (sec) regulator input filter time constant	
	VIMAX, Maximum value of limitation of the signal VI in p.u.	
	VIMIN, Minimum value of limitation of the signal VI in p.u.	

Category	Parameter Description	Data
	KM, Forward gain constant of the inner loop field regulator	
	TC (s), lag time constant	
	TB (s), lead time constant	
	KA (pu) voltage regulator proportional gain	
	TA (sec) voltage regulator time constant	
	VRMAX (pu) regulator output maximum limit	
	VRMIN (pu) regulator output minimum limit	
	KG, Feedback gain constant of the inner loop field regulator	
	KP (pu) voltage regulator proportional gain	
	KI (pu) voltage regulator integral gain	
	VBMAX, Maximum value of limitation of the signal VB in p.u.	
	KC (pu) rectifier loading factor proportional to commutating reactance	
	XL, Reactance associated with potential source	
	VGMAX, Maximum value of limitation of the signal VG in p.u	
	Θ_P (degrees)	
	TM (sec), Forward time constant of the inner loop field regulator	
	VMMAX, Maximum value of limitation of the signal VM in p.u	
	VMMIN, Minimum value of limitation of the signal VM in p.u.	
ST4B	TR (sec) regulator input filter time constant	
	KPR (pu) regulator proportional gain	
	KIR (pu) regulator integral gain	
	VRMAX (pu) regulator output maximum limit	
	VRMIN (pu) regulator output minimum limit	
	TA (sec) voltage regulator time constant	
	KPM, Regulator gain	
	KIM, Regulator gain	
	VMMAX, Maximum value of limitation of the signal in p.u.	
	VMMIN, Minimum value of limitation of the signal in p.u.	
	KG	
	KP (pu) voltage regulator proportional gain	
	KI (pu) voltage regulator integral gain	
	VBMAX	
	KC (pu) rectifier loading factor proportional to commutating reactance	
	XL	
	Θ_P (degrees)	
ST5B	TR regulator input filter time constant (sec)	
	TC1 lead time constant of first lead-lag block (voltage regulator channel) (sec)	

Category	Parameter Description	Data
	TB1 lag time constant of first lead-lag block (voltage regulator channel) (sec)	
	TC2 lead time constant of second lead-lag block (voltage regulator channel) (sec)	
	TB2 lag time constant of second lead-lag block (voltage regulator channel) (sec)	
	KR (>0) (pu) voltage regulator gain	
	VRMAX (pu) voltage regulator maximum limit	
	VRMIN (pu) voltage regulator minimum limit	
	T1 voltage regulator time constant (sec)	
	KC (pu)	
	TUC1 lead time constant of first lead-lag block (under-excitation channel) (sec)	
	TUB1 lag time constant of first lead-lag block (under-excitation channel) (sec)	
	TUC2 lead time constant of second lead-lag block (under-excitation channel) (sec)	
	TUB2 lag time constant of second lead-lag block (under-excitation channel) (sec)	
	TOC1 lead time constant of first lead-lag block (over-excitation channel) (sec)	
	TOB1 lag time constant of first lead-lag block (over-excitation channel) (sec)	
	TOC2 lead time constant of second lead-lag block (over-excitation channel) (sec)	
	TOB2 lag time constant of second lead-lag block (over-excitation channel) (sec)	
ST6B	TR regulator input filter time constant (sec)	
	KPA (pu) (> 0) voltage regulator proportional gain	
	KIA (pu) voltage regulator integral gain	
	KDA (pu) voltage regulator derivative gain	
	TDA voltage regulator derivative channel time constant (sec)	
	VAMAX (pu) regulator output maximum limit	
	VAMIN (pu) regulator output minimum limit	
	KFF (pu) pre-control gain of the inner loop field regulator	
	KM (pu) forward gain of the inner loop field regulator	
	KCI (pu) exciter output current limit adjustment gain	
	KLR (pu) exciter output current limiter gain	
	ILR (pu) exciter current limit reference	
	VRMAX (pu) voltage regulator output maximum limit	
	VRMIN (pu) voltage regulator output minimum limit	
	KG (pu) feedback gain of the inner loop field voltage regulator	
	TG (> 0) feedback time constant of the inner loop field voltage regulator (sec)	
ST7B	TR regulator input filter time constant (sec)	

Category	Parameter Description	Data
	TG lead time constant of voltage input (sec)	
	TF lag time constant of voltage input (sec)	
	Vmax (pu) voltage reference maximum limit	
	Vmin (pu) voltage reference minimum limit	
	KPA (pu) (>0) voltage regulator gain	
	VRMAX (pu) voltage regulator output maximum limit	
	VRMIN (pu) voltage regulator output minimum limit	
	KH (pu) feedback gain	
	KL (pu) feedback gain	
	TC lead time constant of voltage regulator (sec)	
	TB lag time constant of voltage regulator (sec)	
	KIA (pu) (>0) gain of the first order feedback block	
	TIA (>0) time constant of the first order feedback block (sec)	

16.2.4. Power system stabilizer:

The function of the PSS is to add to the unit's characteristic electromechanical oscillations. This is achieved by modulating excitation to develop a component in electrical torque in phase with rotorspeed deviations.

The most important aspect when considering a PSS model is the number of inputs. The following tableshows the type of models separated based on the inputs:

Type	Inputs	Remarks
PSS1A	Single input	Two lead-lags Input can either be speed, frequency or power
PSS2B	Dual input	Integral of accelerating power type stabilizer Speed and Power Most common type Supersedes PSS2A (three versus two lead lags)
PSS3B	Dual input	Power and rotor angular frequency deviation Stabilizing signal is a vector sum of processed signalsNot very common

Category	Parameter Description	Data
Stabilizer Models		
PSS1A	A1, Filter coefficient	
	A2, Filter coefficient	
	TR, transducer time constant	
	0	
	0	
	0	
	T1, 1st Lead-Lag Derivative Time Constant	
	T2, 1st Lead-Lag Delay Time Constant	

Category	Parameter Description	Data
	T3, 2nd Lead-Lag Derivative Time Constant	
	T4, 2nd Lead-Lag Delay Time Constant	
	Tw, Washout Time Constant	
	Tw, Washout Time Constant	
	Ks, input channel gain	
	VSTMAX, Controller maximum output	
	VSTMAX, Controller minimum output	
	0	
	0	
PSS2B	TW1, 1st Washout 1th Time Constant	
	TW2, 1st Washout 2th Time Constant	
	T6, 1st Signal Transducer Time Constant	
	TW3, 2nd Washout 1th Time Constant	
	TW4, 2nd Washout 2th Time Constant	
	T7, 2nd Signal Transducer Time Constant	
	KS2, 2nd Signal Transducer Factor	
	KS3, Washouts Coupling Factor	
	T8, Ramp Tracking Filter Deriv. Time Constant	
	T9, Ramp Tracking Filter Delay Time Constant	
	KS1, PSS Gain	
	T1, 1st Lead-Lag Derivative Time Constant	
	T2, 1st Lead-Lag Delay Time Constant	
	T3, 2nd Lead-Lag Derivative Time Constant	
	T4, 2nd Lead-Lag Delay Time Constant	
	T10, 3rd Lead-Lag Derivative Time Constant	
	T11, 3rd Lead-Lag Delay Time Constant	
	VS1MAX, Input 1 Maximum limit	
	VS1MIN, Input 1 Minimum limit	
	VS2MAX, Input 2 Maximum limit	
	VS2MIN, Input 2 Minimum limit	
	VSTMAX, Controller Maximum Output	
	VSTMIN, Controller Minimum Output	
PSS3B	KS1 (pu) (≠0), input channel #1 gain	
	T1 input channel #1 transducer time constant (sec)	
	Tw1 input channel #1 washout time constant (sec)	
	KS2 (pu) (^{1}0), input channel #2 gain	
	T2 input channel #2 transducer time constant (sec)	
	Tw2 input channel #2 washout time constant (sec)	

Category	Parameter Description	Data
	Tw3 (0), main washout time constant (sec)	
	A1, Filter coefficient	
	A2, Filter coefficient	
	A3, Filter coefficient	
	A4, Filter coefficient	
	A5, Filter coefficient	
	A6, Filter coefficient	
	A7, Filter coefficient	
	A8, Filter coefficient	
	VSTMAX, Controller maximum output	
	VSTMAX, Controller minimum output	

16.2.5. Generic models for gas turbine-governor:

The following table is a list for common generic models of gas turbines:

Type	Name	Remarks
GAST	Gas turbine governor	Simplified model for industrial gas turbine (i.e. OCGT)
GAST2A	Gas turbine governor	More detailed GT from GAST. Governor can be configured for droop or isochronous control. Includes temperature control
GASTWD	Woodward Gas Turbine-Governor model	Same detail of turbine dynamics as GAST2A but with a Woodward governor controls
WESGOV	Westinghouse Digital governor for GasTurbine	Westinghouse 501 combination turbine governor
GGOV1	GE General Governor/Turbine model	General purpose GE GT model (neglects ICV control)
PWTBD1	Pratt & Whitney Turboden turbine-governor	Turbine load PI control with valve and look-up table
URCSCT	Combined cycle, single shaft turbine-governor model	
URGS3T	WECC gas turbine governor	

Category	Parameter Description	Data
Turbine Governor Model		
GAST	R, permanent droop	
	T1 (>0) (sec), Governor mechanism time constant	
	T2 (>0) (sec), Turbine power time constant	
	T3 (>0) (sec), Turbine exhaust temperature time constant	
	Ambient temperature load limit, AT	
	KT, Temperature limiter gain	
	VMAX, Maximum turbine power	
	VMIN, Minimum turbine power	
	Dturb, Turbine damping factor	

Category	Parameter Description	Data
GAST2A	W, governor gain (1/droop) (on turbine rating)	
	X (sec) governor lead time constant	
	Y (sec) (> 0) governor lag time constant	
	Z, governor mode:1 Droop or 0 ISO	
	ETD (sec), Turbine exhausts time constant	
	TCD (sec), Gas turbine dynamic time constant	
	TRATE turbine rating (MW)	
	T (sec), Fuel control time constant	
	MAX (pu) limit (on turbine rating)	
	MIN (pu) limit (on turbine rating)	
	ECR (sec), Combustor time constant	
	K3, Fuel control gain	
	a (> 0) valve positioner	
	b (sec) (> 0) valve positioner	
	c valve positioner	
	Tf (sec) (> 0), Fuel system time constant	
	Kf, feedback gain	
	K5, Radiation shield	
	K4, Radiation shield	
	T3 (sec) (> 0), Radiation shield time constant	
	T4 (sec) (> 0), Thermocouple time constant, seconds	
	Tt (> 0), Temperature control time constant	
	T5 (sec) (> 0), Temperature control time constant	
	af1, describes the turbine characteristic	
	bf1, describes the turbine characteristic	
	af2, describes the turbine characteristic	
	bf2, describes the turbine characteristic	
	cf2, describes the turbine characteristic	
	TR (degree), Rated temperature	
	K6 (pu), Minimum fuel flow	
	TC (degree), Temperature control	
	KDROOP (on turbine rating)	
	KP, Proportional gain	
	KI, Integral gain	
	KD, Derivative gain	
	ETD (sec), Turbine exhaust time constant	
	TCD (sec), Gas turbine dynamic time constant	
	TRATE turbine rating (MW)	
	T (sec), Fuel control time constant	
	MAX (pu) limit (on turbine rating)	
	MIN (pu) limit (on turbine rating)	
	ECR (sec), Combustor time constant	
	K3, Fuel control gain	
	a (> 0) valve positioner	
	b (sec) (> 0) valve positioner	
	c valve positioner	

Category	Parameter Description	Data
GASTWD	tf (sec) (> 0), Fuel system time constant	
	Kf, feedback gain	
	K5, Radiation shield	
	K4, Radiation shield	
	T3 (sec) (> 0), Radiation shield time constant	
	T4 (sec) (> 0), Thermocouple time constant, seconds	
	tt (> 0), Temperature control time constant	
	T5 (sec) (> 0), Temperature control time constant	
	af1, describes the turbine characteristic	
	bf1, describes the turbine characteristic	
	af2, describes the turbine characteristic	
	bf2 (>0), describes the turbine characteristic	
	cf2, describes the turbine characteristic	
	TR(degree), Rated temperature1	
	K6 (pu), Minimum fuel flow	
	TC (degree), Temperature control1	
	TD (sec) (> 0), Power transducer	
WESGOV	ΔTC (sec), Δt sample for controls	
	ΔTP (sec), Δt sample for PE	
	Power Droop	
	Kp, Trubine proportional gain	
	TI (> 0) (sec), Integral time constant	
	T1 (sec), Constant time	
	T2 (sec), Constant time	
	ALIM	
	Tpe (sec), Power time constant	
	R, Permanent droop, pu	
	Tpelec, Electrical power transducer time constant, sec	
	maxerr, Maximum value for speed error signal	
	minerr, Minimum value for speed error signal	
	Kpgov, Governor proportional gain	
	Kigov, Governor integral gain	
	Kdgov, Governor derivative gain	
	Tdgov, Governor derivative controller time constant, sec	
	vmax, Maximum valve position limit	
	vmin, Minimum valve position limit	
	Tact, Actuator time constant, sec	
	Kturb, Turbine gain	
	Wfnl, No load fuel flow, pu	
	Tb, Turbine lag time constant, sec	
	Tc, Turbine lead time constant, sec	
	Teng, Transport lag time constant for diesel engine, sec	
	Tfload, Load Limiter time constant, sec	
	Kpload, Load limiter proportional gain for PI controller	

Category	Parameter Description	Data
GGOV1	Kiload, Load limiter integral gain for PI controller	
	Ldref, Load limiter reference value pu	
	Dm, Mechanical damping coefficient, pu	
	Ropen, Maximum valve opening rate, pu/sec	
	Rclose, Maximum valve closing rate, pu/sec	
	Kimw, Power controller (reset) gain	
	Aset, Acceleration limiter setpoint, pu/sec	
	Ka, Acceleration limiter gain	
	Ta, Acceleration limiter time constant, sec (> 0)	
	Trate, Turbine rating (MW)1	
	db, Speed governor deadband	
	Tsa, Temperature detection lead time constant, sec	
	Tsb, Temperature detection lag time constant, sec	
	Rup, Maximum rate of load limit increase	
	Rdown, Maximum rate of load limit decrease	
PWTBD1	Trate (MW), Turbine rating (MW)	
	K (pu), Proportional gain	
	Ki (pu), Integral gain	
	Vrmax (pu), Upper Limit of PI controller	
	Vrmin (pu), Lower Limit of PI controller	
	Tv (s) (>0), Control valve Time Constant	
	Lo (pu/sec) (>0), Control valve open rate limit	
	Lc (pu/sec) (>0), Control valve close rate limit	
	Vmax (pu), Maximum valve position	
	Vmin (pu), Minimum valve position	
	Tb1 (s), steam buffer time constant	
	Tb2 (s), steam buffer time constant	
	v1 (pu), valve position 1	
	p1 (pu), power output for valve position v1	
	v2 (pu), valve position 2	
	p2 (pu), power output for valve position v2	
	v3 (pu), valve position 3	
	p3 (pu), power output for valve position v3	
	v4 (pu), valve position 4	
	p4 (pu), power output for valve position v4	
	v5 (pu), valve position 5	
	p5 (pu), power output for valve position v5	
	v6 (pu), valve position 6	
	p6 (pu), power output for valve position v6	
	v7 (pu), valve position 7	
	p7 (pu), power output for valve position v7	
	v8 (pu), valve position 8	
	p8 (pu), power output for valve position v8	

Category	Parameter Description	Data
	v9 (pu), valve position 9	
	p9 (pu), power output for valve position v9	
	v10 (pu), valve position 10	
	p11 (pu), power output for valve position v11	
	v11 (pu), valve position 11	
	p11 (pu), power output for valve position v11	
URCSCT	W, governor gain (1/droop) (on turbine rating)	
	X (sec) governor lead time constant	
	Y (sec) (> 0) governor lag time constant	
	Z, governor mode:1 Droop or 0 ISO	
	ETD (sec), Turbine exhausts time constant	
	TCD (sec), Gas turbine dynamic time constant	
	TRATE turbine rating (MW)	
	T (sec), Fuel control time constant	
	MAX (pu) limit (on turbine rating)	
	MIN (pu) limit (on turbine rating)	
	ECR (sec), Combustor time constant	
	K3, Fuel control gain	
	a (> 0) valve positioner	
	b (sec) (> 0) valve positioner	
	c valve positioner	
	Tf (sec) (> 0), Fuel system time constant	
	Kf, feedback gain	
	K5, Radiation shield	
	K4, Radiation shield	
	T3 (sec) (> 0), Radiation shield time constant	
	T4 (sec) (> 0), Thermocouple time constant, seconds	
	Tt (> 0), Temperature control time constant	
	T5 (sec) (> 0), Temperature control time constant	
	af1, describes the turbine characteristic	
	bf1, describes the turbine characteristic	
	af2, describes the turbine characteristic	
	bf2, describes the turbine characteristic	
	cf2, describes the turbine characteristic	
	TR (degree), Rated temperature	
	K6 (pu), Minimum fuel flow	
	TC (degree), Temperature control	
	K, Governor gain, (1/droop) pu	
	T1 (sec), Lag time constant (sec)	
	T2 (sec), Lead time constant (sec)	
	T3 (> 0) (sec), valve position time constant	
	Uo (pu/sec), maximum valve opening rate	
	Uc (< 0) (pu/sec), maximum valve closing rate	
	PMAX (pu on machine MVA rating)	

Category	Parameter Description	Data
	PMIN (pu on machine MVA rating)	
	T4 (sec), time constant for steam inlet	
	K1, HP fraction	
	K2, LP fraction	
	T5 (sec), Time Constant for Second Boiler Pass [s]	
	K3, HP Fraction	
	K4, LP fraction	
	T6 (sec), Time Constant for Third Boiler Pass [s]	
	K5, HP Fraction	
	K6, LP fraction	
	T7 (sec), Time Constant for Fourth Boiler Pass [s]	
	K7, HP Fraction	
	K8, LP fraction	
	ST Rating, Steam turbine rating (MW)	
	POUT A, Plant total, point A (MW)	
	STOUT A, Steam turbine output, point A (MW)	
	POUT B, Plant total, point B (MW)	
	STOUT B, Steam turbine output, point B (MW)	
	POUT C, Plant total, point C (MW)	
	STOUT C, Steam turbine output, point C (MW)	
URGS3T	R	
	T1 (> 0) (sec)	
	T2 (> 0) (sec)	
	T3 (> 0) (sec)	
	Lmax	
	Kt	
	Vmax	
	Vmin	
	Dturb	
	Fidle	
	Rmax	
	Linc (> 0)	
	Tltr (>0) (sec)	
	Ltrat	
	a	
	b (> 0)	
	db1, dead band width (p.u.)	
	Err, deadband hysteresis (p.u.)	
	db2, dead band width (p.u.)	
	GV1, coordinate of power-gate look-up table (p.u. gate)	
	PGV1, coordinate of power-gate look-up table (p.u. power)	
	GV2, coordinate of power-gate look-up table (p.u. gate)	
	PGV2, coordinate of power-gate look-up table (p.u. power)	

Category	Parameter Description	Data
	GV3, coordinate of power-gate look-up table (p.u. gate)	
	PGV3, coordinate of power-gate look-up table (p.u. power)	
	GV4, coordinate of power-gate look-up table (p.u. gate)	
	PGV4, coordinate of power-gate look-up table (p.u. power)	
	GV5, coordinate of power-gate look-up table (p.u. gate)	
	PGV5, coordinate of power-gate look-up table (p.u. power)	
	Ka	
	T4	
	T5	
	MWCAP	

16.3. Generation: Hydro

Format No.:	Dyn/Generation/Hydro/1
Data Submission By:	Generating Company/CPP/Hydro Power generator
Data related to:	Each hydro station
Data to be submitted to:	State Transmission Utility
Periodicity & prescribed date for data submission:	As and when requested by STU.

16.3.1. Details of models in PSS/E for modelling hydro power generator:

(a) Synchronous Machine – HPP and PSP types

Category	Parameter Description	Data
Generator Nameplate	Rated apparent power in MVA	
	Rated terminal voltage	
	Rated power factor	
	Rated speed (in RPM)	
	Rated frequency (in Hz)	
	Rated excitation (in Amperes and Volts)	
Type of Synchronous Machine	Round rotor or salient pole No. of poles	
Generator capability curve	The generator capability curve shows the reactive capability of the machine and should include any restrictions on the real or reactive power range like under/over excitation limits, stability limits, etc. Capability curve should have properly labelled axis and legible data Graph of excitation current versus terminal voltage and stator current	
Generator Open Circuit and Short Circuit Characteristic	No load excitation current – used to derive per unit values	
	Excitation current at rated stator current	

Category	Parameter Description	Data
Generator vee-curves	Otherwise referred to as "V-curve". A plot of the terminal (armature) current versus the generating unit field voltage.	
Resistance values	Resistance measurements of field winding and stator winding to a known temperature	
Generator Data sheet	Direct axis synchronous reactance Xd in p.u. (Unsaturated or saturated)	
	Direct axis transient synchronous reactance Xd' in p.u. (Unsaturated or saturated)	
	Direct axis sub-transient synchronous reactance Xd'' in p.u. (Unsaturated or saturated)	
	Stator leakage reactance Xa in p.u. (Unsaturated or saturated)	
	Quadrature axis synchronous reactance Xq in p.u. (Unsaturated or saturated)	
	Quadrature axis transient synchronous reactance Xq' in p.u. (Unsaturated or saturated)	
	Quadrature axis sub-transient synchronous reactance Xq'' in p.u. (Unsaturated or saturated)	
	Direct axis open circuit transient time constant Tdo' in sec	
	Direct axis open circuit sub-transient time constant Tdo'' in sec	
	Quadrature axis open circuit transient time constant Tqo' in sec	
	Quadrature axis open circuit sub-transient time constant Tqo'' in sec	
	Inertia constant of total rotating mass (generator, AVR, turbo-governor set) H in MW/MVA	
	Speed Damping D	
	Saturation constant S (1.0) in p.u.	
	Saturation constant S (1.2) in p.u.	
Generator step up transformer (GSUT)	Nameplate Rating - Rated primary and secondary voltage - Vector group - Impedance - Tap changer details (Number of taps, tap position, tap ratio etc.)	
Auxiliary power (i.e. active and reactive auxiliary load)	Value of auxiliary load (MW and Mvar) at rated power of the generating unit.	
	Whether or not the load trips if the generating unit trips.	
Test Reports	Factory acceptance test (FAT) reports	

(b) Site Load

	Low Output			High Output		
	kW	kVAr	kVA	kW	kVAr	kVA
Auxiliary Load						

(c) Excitation System

Category	Parameter Description	Data
Type of Automatic Voltage Regulator (AVR)	Manufacturer and product details (for example ABB UNITROL)	
	Type of control system :- Analogue or digital	
	Year of commissioning / Year of manufacture	
	As found settings (obtained either from HMI or downloaded from controller in digital systems)	
Type of excitation system	Static excitation system OR	
	Indirect excitation system (i.e. rotating exciter) - AC exciter, or - DC exciter	
Details of AVR converter	Rated excitation current (converter rating in Amperes)	
	Six pulse thyristor bridge or PWM converter	
Source of excitation supply	Excitation transformer or auxiliary supply (Details thereof)	
	If excitation transformer, nameplate information required	
Schematics	Saturation curves of the exciter (if applicable – see Type AC and DC)	
	Drawings of excitation system, typically prepared and supplied by the OEM	
	Single line diagram (i.e. one-line diagram) for the excitation system	
Excitation limiters	What excitation limiters are commissioned?	
	Under Excitation Limiters settings	
	Over Excitation Limiters settings	
	Voltage/frequency limiter	
	Stator current limiter	
	Minimum excitation current limiter	
PSS	Is the AVR equipped with a PSS?	
	How many input Channels does the PSS have? (speed, real power output or both	
	If the PSS uses speed, is this a derived speed signal (i.e. synthesized speed signal) or measured directly (i.e. actual rotor speed)?	
	Type of PSS Block Diagram of PSS and as commissioned parameters value (Gain, time constants, filter coefficients, output limits of the PSS)	
Test Reports	Factory acceptance test (FAT) reports	

(d) Turbine Details (to be filled in for the HPP and PSP separately)

Category	Parameter Description	Data
Type of prime mover	Hydro-electric turbine Other (Pumped storage)	

Category	Parameter Description	Data
Manufacturer of turbine	Manufacturer and name plate details	
Modes of operation	Type of modes of operation capable: - Generator - Pump storage - Synchronous condenser	
Governor	- Electro-mechanical governor (including settings and drawings) - Digital electric governor (including settings and drawings) - PID governor details and settings - Transient droop (dashpot) governor details and settings - Tacho-accelerometric governor details and settings - Input transducer details - Transfer function data	
	Digital electric governor	
Ramp rates	How fast can the turbine increase and/or decrease load, specified in MW/min Guide vane/wicket gate characteristic, including opening, closing rates/times and limits	
Droop	Droop setting (% on machine base)	
	Frequency influence limiters - Maximum frequency deviation limiter (eg +/-2 Hz) - Maximum influence limiter (eg 10% of rating)	
Dead band	Details of frequency dead band (typically in Hz or RPM)	
Hydro-electric turbine	Type of hydro turbine	
	- Impulse turbines: typical with high head plants (Pelton wheel)	
	- Reaction turbine: typical with low and medium head plants (such as Francis and Kaplan turbine	
	Head, water flow, velocity and pressure (e.g. intake and outtake/draft tube)	
Penstock	Length (m)	
	Area (m^2)	
	Internal penstock diameter	
	Pipe thickness, material or other characteristics (such as tapering)	
	Non-elastic or elastic	
	Linear or non-linear model (with or without relief valve) or Kaplan model	
	Flow of water through turbine (m^3/s) – with gates fully open	
	Number of penstocks supplied from common tunnel	

Category	Parameter Description	Data
Pressure relief valve	Drawings/schematics	
	Settings	
	Operational descriptions	
Surge tank, reservoir and tail water (i.e. head)	Vertical distance between the upper reservoir and level of turbine (in meters)	
	Head at turbine admission (lake head minus tailrace head) – (in meters)	
	Head loss due to friction in conduit (in meters)	
	Surge tank height, diameter and other characteristics (e.g. restricted inlet orifice)	
Pump characteristics	Active power draw vs head (table)	
	PSS status when pumping (on/off/not used)	
Synchronous condenser	Dewatered when operating as Syncon (yes/no)	
	Losses when operating as Sync on: · Mechanical loss (0 Mvar) : …… MW · Copper loss (table) MW loss as a function of MVar output	
Other	Details of protection schemes that could influence dynamics (if any)	
	Details of resonance chamber for pipes (if any)	
	Temperature (e.g. water , ambient , unit)	
	Characteristic curve of blade versus gate (from 0MW to maximum MW)	

16.3.2. Generic Models for synchronous machine

Hydro machines are multi-pole machines and depending upon the saturation characteristic of the machine they are classified in two groups:

- GENSAL – Salient pole machine with quadratic saturation function
- GENSAE – Salient pole machine with exponential saturation function

Category	Parameter Description	Data
Generator Model		
GENSAE OR GENSAL	Direct axis open circuit transient time constant Tdo' in sec	
	Direct axis open circuit sub-transient time constant Tdo'' in sec	
	Quadrature axis open circuit sub-transient time constant Tqo'' in sec	
	Inertia constant of total rotating mass H in MW/MVA	
	Speed Damping D	
	Direct axis synchronous reactance Xd in p.u. (Unsaturated or saturated)	
	Quadrature axis synchronous reactance Xq in p.u. (Unsaturated or saturated)	

	Direct axis transient synchronous reactance Xd' in p.u. (Unsaturated or saturated)	
	Direct axis sub-transient synchronous reactance Xd'' in p.u. (Unsaturated or saturated) = Quadrature axis sub-transient synchronous reactance Xq'' in p.u. (Unsaturated orsaturated)	
	Stator leakage reactance Xl	
	Saturation constant S (1.0) in p.u.	
	Saturation constant S (1.2) in p.u.	

16.3.3. Excitation system model:

If a generic model is used, the first step must be to identify what type of exciter is present in the excitation system. The IEEE Std 421.5 (IEEE Recommended Practice for Excitation System Models for Power System Stability Studies published on 26th Aug 2016) has published several generic models, which are classified into three groups:

- Type DC: for excitation systems with a DC exciter
- Type AC: for excitation systems with an AC exciter
- Type ST: for excitation systems with a static exciter

The following table shows the types of models separated into their respective groups.

DC exciter	AC exciter	Static excitation system
Type DC1A	Type AC1A	Type ST1A
Type DC2A	Type AC2A	Type ST2A
Type DC3A	Type AC4A	Type ST3A
Type DC4B	Type AC5A	Type ST4B
	Type AC6A	Type ST5B
	Type AC7B	Type ST6B
	Type AC8B	Type ST7B

Category	Parameter Description	Data
DC Exciter		
ESDC1A OR ESDC2A	TR regulator input filter time constant (sec)	
	KA (> 0) (pu) voltage regulator gain	
	TA (s), voltage regulator time constant	
	TB (s), lag time constant	
	TC (s), lead time constant	
	VRMAX (pu) regulator output maximum limit or Zero	
	VRMIN (pu) regulator output minimum limit	
	KE (pu) exciter constant related to self-excited field	
	TE (> 0) rotating exciter time constant (sec)	
	KF (pu) rate feedback gain	
	TF1 (> 0) rate feedback time constant (sec)	
	Switch	
	E1, exciter flux at knee of curve (pu)	

Category	Parameter Description	Data
	SE(E1), saturation factor at knee of curve	
	E2, maximum exciter flux (pu)	
	SE(E2), saturation factor at maximum exciter flux (pu)	
ESDC3A	TR regulator input filter time constant (sec)	
	KV (pu) limit on fast raise/lower contact setting	
	VRMAX (pu) regulator output maximum limit or Zero	
	VRMIN (pu) regulator output minimum limit	
	TRH (> 0) Rheostat motor travel time (sec)	
	TE (> 0) exciter time-constant (sec)	
	KE (pu) exciter constant related to self-excited field	
	VEMIN (pu) exciter minimum limit	
	E1, exciter flux at knee of curve (pu)	
	SE(E1), saturation factor at knee of curve	
	E2, maximum exciter flux (pu)	
	SE(E2), saturation factor at maximum exciter flux (pu)	
ESDC4B	TR regulator input filter time constant (sec)	
	KP (pu) (> 0) voltage regulator proportional gain	
	KI (pu) voltage regulator integral gain	
	KD (pu) voltage regulator derivative gain	
	TD voltage regulator derivative channel time constant (sec)	
	VRMAX (pu) regulator output maximum limit	
	VRMIN (pu) regulator output minimum limit	
	KA (> 0) (pu) voltage regulator gain	
	TA voltage regulator time constant (sec)	
	KE (pu) exciter constant related to self-excited field	
	TE (> 0) rotating exciter time constant (sec)	
	KF (pu) rate feedback gain	
	TF (> 0) rate feedback time constant (sec)	
	VEMIN (pu) minimum exciter voltage output	
	E1, exciter flux at knee of curve (pu)	
	SE(E1), saturation factor at knee of curve	
	E2, maximum exciter flux (pu)	
	SE(E2), saturation factor at maximum exciter flux (pu)	
AC Exciter		
	TR regulator input filter time constant (sec)	
	TB (s), lag time constant	
	TC (s), lead time constant	
	KA (> 0) (pu) voltage regulator gain	
	TA (s), voltage regulator time constant	
	VAMAX (pu) regulator output maximum limit	
	VAMIN (pu) regulator output minimum limit	
	TE (> 0) rotating exciter time constant (sec)	
	KF (pu) rate feedback gain	
	TF (> 0) rate feedback time constant (sec)	

Category	Parameter Description	Data
ESAC1A	KC (pu) rectifier loading factor proportional to commutating reactance	
	KD (pu) demagnetizing factor, function of AC exciter reactances	
	KE (pu) exciter constant related to self-excited field	
	E1, exciter flux at knee of curve (pu)	
	SE(E1), saturation factor at knee of curve	
	E2, maximum exciter flux (pu)	
	SE(E2), saturation factor at maximum exciter flux (pu)	
	VRMAX (pu) regulator output maximum limit	
	VRMIN (pu) regulator output minimum limit	
ESAC2A	TR regulator input filter time constant (sec)	
	TB (s), lag time constant	
	TC (s), lead time constant	
	KA (> 0) (pu) voltage regulator gain	
	TA (s), voltage regulator time constant	
	VAMAX (pu) regulator output maximum limit	
	VAMIN (pu) regulator output minimum limit	
	KB, Second stage regulator gain	
	VRMAX (pu) regulator output maximum limit	
	VRMIN (pu) regulator output minimum limit	
	TE (> 0) rotating exciter time constant (sec)	
	VFEMAX, parameter of VEMAX, exciter field maximum output	
	KH, Exciter field current feedback gain	
	KF (pu) rate feedback gain	
	TF (> 0) rate feedback time constant (sec)	
	KC (pu) rectifier loading factor proportional to commutating reactance	
	KD (pu) demagnetizing factor, function of AC exciter reactances	
	KE (pu) exciter constant related to self-excited field	
	E1, exciter flux at knee of curve (pu)	
	SE(E1), saturation factor at knee of curve	
	E2, maximum exciter flux (pu)	
	SE(E2), saturation factor at maximum exciter flux (pu)	
ESAC3A	TR regulator input filter time constant (sec)	
	TB (s), lag time constant	
	TC (s), lead time constant	
	KA (> 0) (pu) voltage regulator gain	
	TA (s), voltage regulator time constant	
	VAMAX (pu) regulator output maximum limit	
	VAMIN (pu) regulator output minimum limit	
	TE (> 0) rotating exciter time constant (sec)	
	VEMIN (pu) minimum exciter voltage output	
	KR (>0), Constant associated with regulator and alternator field power supply	
	KF (pu) rate feedback gain	
	TF (> 0) rate feedback time constant (sec)	
	KN, Exciter feedback gain	

Category	Parameter Description	Data
	EFDN, A parameter defining for which value of UF the feedback gain shall change from KF to KN	
	KC, rectifier regulation factor (pu)	
	KD, exciter regulation factor (pu)	
	KE (pu) exciter constant related to self-excited field	
	VFEMAX, parameter of VEMAX, exciter field maximum output	
	E1, exciter flux at knee of curve (pu)	
	SE(E1), saturation factor at knee of curve	
	E2, maximum exciter flux (pu)	
	SE(E2), saturation factor at maximum exciter flux (pu)	
ESAC4A	TR regulator input filter time constant (sec)	
	VIMAX, Maximum value of limitation of the integrator signal VI in p.u	
	VIMIN, Minimum value of limitation of the signal VI in p.u.	
	TB (s), lag time constant	
	TC (s), lead time constant	
	KA (> 0) (pu) voltage regulator gain	
	TA (s), voltage regulator time constant	
	VRMAX (pu) regulator output maximum limit	
	VRMIN (pu) regulator output minimum limit	
	KC, rectifier regulation factor (pu)	
ESAC5A	TR regulator input filter time constant (sec)	
	KA (> 0) (pu) voltage regulator gain	
	TA (s), voltage regulator time constant	
	VRMAX (pu) regulator output maximum limit	
	VRMIN (pu) regulator output minimum limit	
	KE (pu) exciter constant related to self-excited field	
	TE (> 0) rotating exciter time constant (sec)	
	KF (pu) rate feedback gain	
	TF1 (sec), Regulator stabilizing circuit time constant in seconds	
	TF2 (sec), Regulator stabilizing circuit time constant in seconds	
	TF3 (sec), Regulator stabilizing circuit time constant in seconds	
	E1, exciter flux at knee of curve (pu)	
	SE(E1), saturation factor at knee of curve	
	E2, maximum exciter flux (pu)	
	SE(E2), saturation factor at maximum exciter flux (pu)	
	TR regulator input filter time constant (sec)	
	KA (> 0) (pu) voltage regulator gain	
	TA (s), voltage regulator time constant	
	TK (sec), Lead time constant	
	TB (s), lag time constant	
	TC (s), lead time constant	

Category	Parameter Description	Data
AC6A	VAMAX (pu) regulator output maximum limit	
	VAMIN (pu) regulator output minimum limit	
	VRMAX (pu) regulator output maximum limit	
	VRMIN (pu) regulator output minimum limit	
	TE (> 0) rotating exciter time constant (sec)	
	VFELIM, Exciter field current limit reference	
	KH, Damping module gain	
	VHMAX, damping module limiter	
	TH (sec), damping module lag time constant	
	TJ (sec), damping module lead time constant	
	KC, rectifier regulation factor (pu)	
	KD, exciter regulation factor (pu)	
	KE (pu) exciter constant related to self-excited field	
	E1, exciter flux at knee of curve (pu)	
	SE(E1), saturation factor at knee of curve	
	E2, maximum exciter flux (pu)	
	SE(E2), saturation factor at maximum exciter flux (pu)	
AC7B	TR (sec) regulator input filter time constant	
	KPR (pu) regulator proportional gain	
	KIR (pu) regulator integral gain	
	KDR (pu) regulator derivative gain	
	TDR (sec) regulator derivative block time constant	
	VRMAX (pu) regulator output maximum limit	
	VRMIN (pu) regulator output minimum limit	
	KPA (pu) voltage regulator proportional gain	
	KIA (pu) voltage regulator integral gain	
	VAMAX (pu) regulator output maximum limit	
	VAMIN (pu) regulator output minimum limit	
	KP (pu)	
	KL (pu)	
	KF1 (pu)	
	KF2 (pu)	
	KF3 (pu)	
	TF3 (sec) time constant (> 0)	
	KC (pu) rectifier loading factor proportional to commutating reactance	
	KD (pu) demagnetizing factor, function of AC exciter reactances	
	KE (pu) exciter constant related fo self-excited field	
	TE (pu) exciter time constant (>0)	
	VFEMAX (pu) exciter field current limit (> 0)	
	VEMIN (pu)	
	E1, exciter flux at knee of curve (pu)	
	SE(E1), saturation factor at knee of curve	
	E2, maximum exciter flux (pu)	
	SE(E2), saturation factor at maximum exciter flux (pu)	

Category	Parameter Description	Data
AC8B	TR (sec) regulator input filter time constant	
	KPR (pu) regulator proportional gain	
	KIR (pu) regulator integral gain	
	KDR (pu) regulator derivative gain	
	TDR (sec) regulator derivative block time constant	
	VPIDMAX (pu) PID maximum limit	
	VPIDMIN (pu) PID minimum limit	
	KA (pu) voltage regulator proportional gain	
	TA (sec) voltage regulator time constant	
	VRMAX (pu) regulator output maximum limit	
	VRMIN (pu) regulator output minimum limit	
	KC (pu) rectifier loading factor proportional to commutating reactance	
	KD (pu) demagnetizing factor, function of AC exciter reactances	
	KE (pu) exciter constant related fo self-excited field	
	TE (pu) exciter time constant (>0)	
	VFEMAX (pu) max exciter field current limit (> 0)	
	VEMIN (pu),	
	E1, exciter flux at knee of curve (pu)	
	SE(E1), saturation factor at knee of curve	
	E2, maximum exciter flux (pu)	
	SE(E2), saturation factor at maximum exciter flux (pu)	
Static Exciter		
ST1A	TR (sec) regulator input filter time constant	
	VIMAX, Controller Input Maximum	
	VIMIN, Controller Input Minimum	
	TC (s), Filter 1st Derivative Time Constant	
	TB (s), l Filter 1st Delay Time Constant	
	TC1 (s), Filter 2nd Derivative Time Constant	
	TB1 (s), Filter 2nd Delay Time Constant	
	KA (pu) voltage regulator proportional gain	
	TA (sec) voltage regulator time constant	
	VAMAX (pu) regulator output maximum limit	
	VAMIN (pu) regulator output minimum limit	
	VRMAX (pu) regulator output maximum limit	
	VRMIN (pu) regulator output minimum limit	
	KC (pu) rectifier loading factor proportional to commutating reactance	
	KF (pu) rate feedback gain	
	TF (> 0) rate feedback time constant (sec)	
	KLR, Current Input Factor	
	ILR, Current Input Reference	
	TR (sec) regulator input filter time constant	
	KA (pu) voltage regulator proportional gain	
	TA (sec) voltage regulator time constant	
	VRMAX (pu) regulator output maximum limit	
	VRMIN (pu) regulator output minimum limit	

Category	Parameter Description	Data
ST2A	KE (pu) exciter constant related fo self-excited field	
	TE (pu) exciter time constant (>0)	
	KF (pu) rate feedback gain	
	TF (> 0) rate feedback time constant (sec)	
	KP (pu) voltage regulator proportional gain	
	KI (pu) voltage regulator integral gain	
	KC (pu) rectifier loading factor proportional to commutating reactance	
	EFDMAX	
ST3A	TR (sec) regulator input filter time constant	
	VIMAX, Maximum value of limitation of the signal VI in p.u.	
	VIMIN, Minimum value of limitation of the signal VI in p.u.	
	KM, Forward gain constant of the inner loop field regulator	
	TC (s), lag time constant	
	TB (s), lead time constant	
	KA (pu) voltage regulator proportional gain	
	TA (sec) voltage regulator time constant	
	VRMAX (pu) regulator output maximum limit	
	VRMIN (pu) regulator output minimum limit	
	KG, Feedback gain constant of the inner loop field regulator	
	KP (pu) voltage regulator proportional gain	
	KI (pu) voltage regulator integral gain	
	VBMAX, Maximum value of limitation of the signal VB in p.u.	
	KC (pu) rectifier loading factor proportional to commutating reactance	
	XL, Reactance associated with potential source	
	VGMAX, Maximum value of limitation of the signal VG in p.u	
	Θ_P (degrees)	
	TM (sec), Forward time constant of the inner loop field regulator	
	VMMAX, Maximum value of limitation of the signal VM in p.u	
	VMMIN, Minimum value of limitation of the signal VM in p.u.	
ST4B	TR (sec) regulator input filter time constant	
	KPR (pu) regulator proportional gain	
	KIR (pu) regulator integral gain	
	VRMAX (pu) regulator output maximum limit	
	VRMIN (pu) regulator output minimum limit	
	TA (sec) voltage regulator time constant	
	KPM, Regulator gain	
	KIM, Regulator gain	
	VMMAX, Maximum value of limitation of the signal in p.u.	
	VMMIN, Minimum value of limitation of the signal in p.u.	
	KG	
	KP (pu) voltage regulator proportional gain	
	KI (pu) voltage regulator integral gain	
	VBMAX	

Category	Parameter Description	Data
	KC (pu) rectifier loading factor proportional to commutating reactance	
	XL	
	Θ_P (degrees)	
ST5B	TR regulator input filter time constant (sec)	
	TC1 lead time constant of first lead-lag block (voltage regulator channel) (sec)	
	TB1 lag time constant of first lead-lag block (voltage regulator channel) (sec)	
	TC2 lead time constant of second lead-lag block (voltage regulator channel) (sec)	
	TB2 lag time constant of second lead-lag block (voltage regulator channel) (sec)	
	KR (>0) (pu) voltage regulator gain	
	VRMAX (pu) voltage regulator maximum limit	
	VRMIN (pu) voltage regulator minimum limit	
	T1 voltage regulator time constant (sec)	
	KC (pu)	
	TUC1 lead time constant of first lead-lag block (under-excitation channel) (sec)	
	TUB1 lag time constant of first lead-lag block (under-excitation channel) (sec)	
	TUC2 lead time constant of second lead-lag block (under-excitation channel) (sec)	
	TUB2 lag time constant of second lead-lag block (under-excitation channel) (sec)	
	TOC1 lead time constant of first lead-lag block (over-excitation channel) (sec)	
	TOB1 lag time constant of first lead-lag block (over-excitation channel) (sec)	
	TOC2 lead time constant of second lead-lag block (over-excitation channel) (sec)	
	TOB2 lag time constant of second lead-lag block (over-excitation channel) (sec)	
ST6B	TR regulator input filter time constant (sec)	
	KPA (pu) (> 0) voltage regulator proportional gain	
	KIA (pu) voltage regulator integral gain	
	KDA (pu) voltage regulator derivative gain	
	TDA voltage regulator derivative channel time constant (sec)	
	VAMAX (pu) regulator output maximum limit	
	VAMIN (pu) regulator output minimum limit	
	KFF (pu) pre-control gain of the inner loop field regulator	
	KM (pu) forward gain of the inner loop field regulator	
	KCI (pu) exciter output current limit adjustment gain	
	KLR (pu) exciter output current limiter gain	
	ILR (pu) exciter current limit reference	
	VRMAX (pu) voltage regulator output maximum limit	
	VRMIN (pu) voltage regulator output minimum limit	

Category	Parameter Description	Data
	KG (pu) feedback gain of the inner loop field voltage regulator	
	TG (> 0) feedback time constant of the inner loop field voltage regulator (sec)	
ST7B	TR regulator input filter time constant (sec)	
	TG lead time constant of voltage input (sec)	
	TF lag time constant of voltage input (sec)	
	Vmax (pu) voltage reference maximum limit	
	Vmin (pu) voltage reference minimum limit	
	KPA (pu) (>0) voltage regulator gain	
	VRMAX (pu) voltage regulator output maximum limit	
	VRMIN (pu) voltage regulator output minimum limit	
	KH (pu) feedback gain	
	KL (pu) feedback gain	
	TC lead time constant of voltage regulator (sec)	
	TB lag time constant of voltage regulator (sec)	
	KIA (pu) (>0) gain of the first order feedback block	
	TIA (>0) time constant of the first order feedback block (sec)	

16.3.4. Power system stabilizer:

The function of the PSS is to add to the unit's characteristic electromechanical oscillations. This is achieved by modulating excitation to develop a component in electrical torque in phase with rotor speed deviations.

The most important aspect when considering a PSS model is the number of inputs. The following tableshows the type of models separated based on the inputs:

Type	Inputs	Remarks
PSS1A	Single input	Two lead-lags Input can either be speed, frequency or power
PSS2B	Dual input	Integral of accelerating power Speed and Power Most common type Supersedes PSS2A (three versus two lead lags)
PSS3B	Dual input	Power and rotor angular frequency deviation Stabilizing signal is a vector sum of processed signals Not very common

Category	Parameter Description	Data
Stabilizer Models		
	A1, Filter coefficient	
	A2, Filter coefficient	
	TR, transducer time constant	
	0	
	0	
	0	
	T1, 1st Lead-Lag Derivative Time Constant	

Category	Parameter Description	Data
PSS1A	T2, 1st Lead-Lag Delay Time Constant	
	T3, 2nd Lead-Lag Derivative Time Constant	
	T4, 2nd Lead-Lag Delay Time Constant	
	Tw, Washout Time Constant	
	Tw, Washout Time Constant	
	Ks, input channel gain	
	VSTMAX, Controller maximum output	
	VSTMAX, Controller minimum output	
	0	
	0	
PSS2B	TW1, 1st Washout 1th Time Constant	
	TW2, 1st Washout 2th Time Constant	
	T6, 1st Signal Transducer Time Constant	
	TW3, 2nd Washout 1th Time Constant	
	TW4, 2nd Washout 2th Time Constant	
	T7, 2nd Signal Transducer Time Constant	
	KS2, 2nd Signal Transducer Factor	
	KS3, Washouts Coupling Factor	
	T8, Ramp Tracking Filter Deriv. Time Constant	
	T9, Ramp Tracking Filter Delay Time Constant	
	KS1, PSS Gain	
	T1, 1st Lead-Lag Derivative Time Constant	
	T2, 1st Lead-Lag Delay Time Constant	
	T3, 2nd Lead-Lag Derivative Time Constant	
	T4, 2nd Lead-Lag Delay Time Constant	
	T10, 3rd Lead-Lag Derivative Time Constant	
	T11, 3rd Lead-Lag Delay Time Constant	
	VS1MAX, Input 1 Maximum limit	
	VS1MIN, Input 1 Minimum limit	
	VS2MAX, Input 2 Maximum limit	
	VS2MIN, Input 2 Minimum limit	
	VSTMAX, Controller Maximum Output	
	VSTMIN, Controller Minimum Output	
PSS3B	KS1 (pu) (≠0), input channel #1 gain	
	T1 input channel #1 transducer time constant (sec)	
	Tw1 input channel #1 washout time constant (sec)	
	KS2 (pu) (≠0), input channel #2 gain	
	T2 input channel #2 transducer time constant (sec)	
	Tw2 input channel #2 washout time constant (sec)	
	Tw3 (0), main washout time constant (sec)	
	A1, Filter coefficient	
	A2, Filter coefficient	
	A3, Filter coefficient	
	A4, Filter coefficient	

Category	Parameter Description	Data
	A5, Filter coefficient	
	A6, Filter coefficient	
	A7, Filter coefficient	
	A8, Filter coefficient	
	VSTMAX, Controller maximum output	
	VSTMAX, Controller minimum output	

16.3.5. Generic models for turbine-governor:

The following table is a list for generic models of steam turbines:

Type	Name	Remarks
BBGOV1	Brown-Boveri turbine governor model	Mainly used for steam turbine with electrical damping feedback
TGOV1	Steam-turbine governor	Mainly used for steam turbine with reheater
CRCMGV	Cross-compound turbine	-
IEEEG1	IEEE type 1 Speed-Governor Model	Used to represent non-reheat, tandem compound, and cross compound types.
IEEEG2	IEEE Type 2 Speed-Governing Model	Linearized model for representing a hydro turbine-governor and penstock dynamics
IEEEG3	IEEE type 3 turbine-governor model	Includes a more complex representation of the governor controls than IEEEG2 does
IEESGO	IEEE Standard Model	Simple model of reheat steam turbine
TGOV2	Steam –turbine governor with fast valving	Fast valving model of steam turbine
TGOV3	Modified IEEE Type 1 Speed-Governing Model with fast valving	Modification of IEEEG! For fast valving studies
TGOV4	Modified IEEE Type 1 Speed-GoverningModel with PLU and EVA	Model of steam turbine and boiler, explicit action for both control valve (CV) and inlet valve (IV), main reheat and LP steam effects,and boiler
TGOV5	IEEE Type 1 Speed-Governor Model Modified to Include Boiler Controls	Most common type of governor model, based on TGOV1 with boiler controls
TURCZT	Czech hydro or steam turbine governormodel	General-purpose hydro and thermal turbine-governor model. Penstock dynamic is notincluded in the model

Category	Parameter Description	Data
Turbine Governor Model		
HYGOV	R, permanent droop	
	r, temporary droop	
	Tr (>0) governor time constant	
	Tf (>0) filter time constant	
	Tg (>0) servo time constant	
	+ VELM, gate velocity limit	
	GMAX, maximum gate limit	
	GMIN, minimum gate limit	
	TW (>0) water time constant	
	At, turbine gain	
	Dturb, turbine damping	
	qNL, no power flow	
HYGOVDU	R, permanent droop	
	r, temporary droop	
	Tr (>0) governor time constant	
	Tf (>0) filter time constant	
	Tg (>0) servo time constant	
	+ VELM, gate velocity limit	
	GMAX, maximum gate limit	
	GMIN, minimum gate limit	
	TW (>0) water time constant	
	At, turbine gain	
	Dturb, turbine damping	
	qNL, no power flow	
	DBH (pu), droop for over-speed, (> 0)	
	DBL (pu), droop for under-speed, (< 0)	
	TRate (MW), turbine rating, if zero, then MBASE used	
	Prated, rated turbine power (MW	
	Qrated, rated turbine flow (cfs or cms)	
	Hrated, rated turbine head (ft or m)	
	Grated, gate position at rated conditions (pu)	
	QNL, no power flow (pu of Qrated)	
	R, permanent droop (pu)	
	r, temporary droop (pu)	
	Tr, governor time constant (> 0) (sec)	
	Tf, filter time constant (> 0) (sec)	
	Tg, servo time constant (> 0) (sec)	
	MXGTOR, maximum gate opening rate (pu/sec)	
	MXGTCR, maximum gate closing rate (< 0) (pu/sec)	
	MXBGOR, maximum buffered gate opening rate (pu/sec)	
	MXBGCR, maximum buffered gate closing rate (< 0) (pu/sec)	

Category	Parameter Description	Data
HYGOVM	BUFLIM, buffer upper limit (pu)	
	GMAX, maximum gate limit (pu)	
	GMIN, minimum gate limit (pu)	
	RVLVCR, relief valve closing rate (< 0) (pu/sec) or MXJDOR, maximum jet deflector opening rate (pu/sec)	
	RVLMAX, maximum relief valve limit (pu) or MXJDCR, maximum jet deflector closing rate (< 0) (pu/sec)	
	HLAKE, lake head (ft or m)	
	HTAIL, tail head (ft or m)	
	PENL/A, summation of penstock, scroll case and draft tube lengths/ cross sections (> 0) (1/ft or 1/m)	
	PENLOS, penstock head loss coefficient (ft/cfs2 or m/cms2)	
	TUNL/A, summation of tunnel lengths/cross sections (>0) (1/ft or 1/m)	
	TUNLOS, tunnel head loss coefficient (ft/cfs^2 or m/cms^2)	
	SCHARE, surge chamber effective cross section (>0) (ft^2 or m^2)	
	SCHMAX, maximum water level in surge chamber (ft or m)	
	SCHMIN, minimum water level in surge chamber (ft or m)	
	SCHLOS, surge chamber orifice head loss coefficient (ft/cfs^2 or m/cms^2)	
	DAMP1, turbine damping under RPM1	
	RPM1, over speed (pu)	
	DAMP2, turbine damping above RPM2	
	RPM2, over speed (pu)	
	R-PERM-GATE (Feedback settings)	
	R-PERM-PE (Feedback settings)	
	TPE (sec), Power time constant	
	Kp, Proportional gain	
	KI, Integral gain	
	KD, Derivative gain	
	TD (sec), Derivative time constant	
	TP (sec), Gate servo time constant	
	TDV (sec), Time constant	
	Tg (sec), Gate servo time constant	
	GTMXOP (>0), Max gate opening velocity	
	GTMXCL (<0), Max gate closing velocity	
	GMAX, Maximum governor output	
	GMIN, Minimum governor output	
	DTURB, Turbine damping factor	
	TW (sec), Water inertia time constant	
	Speed Dead Band (DBAND)	
	DPV, Governor limit factor	
	DICN, Gate limiter modifier	
	GATE 1	
	GATE 2	
	GATE 3	
	GATE 4	

Category	Parameter Description	Data
WEHGOV	GATE 5	
	FLOW G1	
	FLOW G2	
	FLOW G3	
	FLOW G4	
	FLOW G5	
	FLOW P1	
	FLOW P2	
	FLOW P3	
	FLOW P4	
	FLOW P5	
	FLOW P6	
	FLOW P7	
	FLOW P8	
	FLOW P9	
	FLOW P10	
	PMECH1	
WEHGOV	PMECH2	
	PMECH3	
	PMECH4	
	PMECH5	
	PMECH6	
	PMECH7	
	PMECH8	
	PMECH9	
	PMECH10	
HYGOVT	Prated, rated turbine power (MW)	
	Qrated, rated turbine flow (cfs or cms)	
	Hrated, rated turbine head (ft or m)	
	Grated, gate position at rated conditions (pu)	
	QNL, no power flow (pu of Qrated)	
	R, permanent droop	
	r, temporary droop (pu)	
	Tr, governor time constant (> 0) (sec)	
	Tf, filter time constant (> 0) (sec)	
	Tg, servo time constant (> 0) (sec)	
	MXGTOR, maximum gate opening rate (pu/sec)	
	MXGTCR, maximum gate closing rate (< 0) (pu/sec)	
	MXBGOR, maximum buffered gate opening rate (pu/sec)	
	MXBGCR, maximum buffered gate closing rate (< 0) (pu/sec)	
	BUFLIM, buffer upper limit (pu)	
	GMAX, maximum gate limit (pu)	
	GMIN, minimum gate limit (pu)	
	RVLVCR, relief valve closing rate (< 0) (pu/sec) or MXJDOR, maximum jet deflector opening rate (pu/sec)	

Category	Parameter Description	Data
	RVLMAX, maximum relief valve limit (pu) or MXJDCR, maximum jet deflector closing rate (< 0) (pu/sec)	
	HLAKE, lake head (ft or m)	
	HTAIL, tail head (ft or m)	
	PENLGTH, penstock length (ft or m)	
	PENLOS, penstock head loss coefficient (ft/cfs2 or m/cms2)	
	TUNLGTH, tunnel length (ft or m)	
	TUNLOS, tunnel head loss coefficient (ft/cfs2 or m/cms2)	
	SCHARE, surge chamber effective cross section (>0) (ft2 or m2)	
	SCHMAX, maximum water level in surge chamber (ft or m)	
	SCHMIN, minimum water level in surge chamber (ft or m)	
	SCHLOS, surge chamber orifice head loss coefficient (ft/cfs2 or m/cms2)	
	DAMP1, turbine damping under RPM1	
	RPM1, overspeed (pu)	
HYGOVT	DAMP2, turbine damping above RPM2	
	RPM2, overspeed (pu)	
	PENSPD, penstock wave velocity (>0) (ft/sec or m/sec)	
	PENARE, penstock cross section (>0) (ft2 or m2)	
	TUNSPD, tunnel wave velocity (>0) (ft/sec or m/sec)	
	TUNARE, tunnel cross section (>0) (ft2 or m2)	
PIDGOV	Rperm, permanent drop, pu	
	Treg (sec), speed detector time constant	
	Kp, proportional gain, pu/sec	
	Ki, reset gain, pu/sec	
	Kd, derivative gain, pu	
	Ta (sec) > 0, controller time constant	
	Tb (sec) > 0, gate servo time constant	
	Dturb, turbine damping factor, pu	
	G0, gate opening at speed no load, pu	
	G1, intermediate gate opening, pu	
	P1, power at gate opening G1, pu	
	G2, intermediate gate opening, pu	
	P2, power at gate opening G2, pu	
	P3, power at full opened gate, pu	
	Gmax, maximum gate opening, pu	
	Gmin, minimum gate opening, pu	
	Atw > 0, factor multiplying Tw, pu	
	Tw (sec) > 0, water inertia time constant	
	Velmax, minimum gate opening velocity, pu/sec	
	Velmin < 0, minimum gate closing velocity, pu/sec	
	db1, Intentional dead band width, Hz	
	Err, deadband hysteresis (p.u.)	
	Td (sec), Input filter time constant, s	
	T1 (sec), Lead time constant 1, s	
	T2 (sec) q, Lag time constant 1, s	

Category	Parameter Description	Data
HYGOVR1	T3 (sec), Lead time constant 2, s	
	T4 (sec), Lag time constant 2, s	
	T5 (sec), Lead time constant 3, s	
	T6 (sec), Lag time constant 3, s	
	T7 (sec), Lead time constant 4, s	
	T8 (sec), Lag time constant 4, s	
	KP, proportional gain	
	R, Steady-state droop, p.u.	
	Tt, Power feedback time constant, s	
HYGOVR1	KG, Gate servo gain, p.u.	
	TP (sec), Gate servo time constant, s	
	VELOPEN, Maximum gate opening velocity, p.u./s	
	VELCLOSE, Maximum gate closing velocity, p.u./s (<0)	
	PMAX, Maximum gate opening, p.u. of mwcap	
	PMIN, Minimum gate opening, p.u. of mwcap	
	db2, Unintentional deadband, MW	
	TW (>0) water time constant	
	At, turbine gain	
	Dturb, turbine damping	
	qNL, no power flow	
	Trate (Turbine MW rating)	
TURCZT	fDEAD (pu), Frequency Dead Band	
	fMIN (pu), Frequency Minimum Deviation	
	fMAX (pu), Frequency Maximum Deviation	
	KKOR (pu), Frequency Gain	
	KM > 0 (pu), Power Measurement Gain	
	KP (pu), Regulator Proportional Gain	
	SDEAD (pu), Speed Dead Band	
	KSTAT (pu), Speed Gain	
	KHP (pu), High Pressure Constant	
	TC (sec), Measuring transducer time constant	
	T 1 (sec), Regulator Integrator Time Constant	
	TEHP (sec), Hydro Converter Time Constant	
	TV > 0 (sec), Regulation Valve Time Constant	
	THP (sec), High Pressure Time Constant	
	TR (sec), Reheater time constant	
	TW (sec), Water Time Constant	
	NTMAX (pu), Power Regulator-Integrator Maximum Limiter	
	NTMIN (pu), Power Regulator-Integrator Minimum Limiter	
	GMAX (pu), Valve Maximum Open	
	GMIN (pu), Valve Minimum Open	
	VMIN (pu/sec), Valve Maximum Speed Close	
	VMAX (pu/sec), Valve Maximum Speed Open	
	R, permanent droop	
	r, temporary droop	

Category	Parameter Description	Data
TWDM1T	Tr, governor time constant (>0)	
	Tf, filter time constant (>0)	
	Tg, servo time constant (>0)	
	VELMX, open gate velocity limit (pu/sec)	
TWDM1	VELMN, close gate velocity limit (pu/sec) (<0)	
	GMAX, maximum gate limit	
	GMIN, minimum gate limit	
	TW, water time constant (sec) (>0)	
	At, turbine gain	
	Dturb, turbine damping	
	qNL, no power flow	
	F1, frequency deviation (pu)	
	TF1, time delay (sec)	
	F2, frequency deviation (pu)	
	sF2, frequency (pu/sec)	
	TF2, time delay (sec)	
	GMXRT, rate with which GMAX changes when TWD is tripped (pu/sec)	
	NREF, setpoint frequency deviation (pu)	
	Tft, frequency filter time constant (>0	
TWDM2	TREG (sec), governor time constant (s)	
	Reg, permanent droop (p.u. on generator MVA rating)	
	KP, controller proportional gain (p.u.)	
	KI, controller integral gain (p.u./s)	
	KD, controller derivative gain (p.u.-s)	
	TA (sec) (> 0), controller time constant (s)	
	TB (sec) (> 0), controller time constant (s)	
	VELMX (pu/sec), open gate velocity limit (p.u./s)	
	VELMN (pu/sec) (> 0), close gate velocity limit (p.u./s)	
	GATMX (pu), maximum gate limit (p.u.)	
	GATMN (pu), minimum gate limit (p.u.)	
	TW (sec) (> 0), water time constant (s)	
	At, turbine gain	
	qNL, flow rate at no load (p.u.)	
	Dturb, turbine damping factor	
	F1, frequency deviation (pu)	
	TF1, time delay (sec)	
	F2, frequency deviation (pu)	
	sF2, frequency (pu/sec)	
	TF2, time delay (sec)	
	PREF, power reference (pu)	
	Tft, frequency filter time constant (sec) (>0)	
	TREG (sec), governor time constant (s)	
	REG1, permanent droop (p.u. on generator MVA base)	
	KP, controller proportional gain (p.u.)	

Category	Parameter Description	Data
WPIDHY	KI, controller integral gain (p.u./s)	
	KD, controller derivative gain (p.u./s)	
	TA (>0) (sec), controller time constant (s)	
	TB (>0) (sec), controller time constant (s)	
	VELMX (>0), open gate velocity limit (p.u./s)	
	VELMN (<0), close gate velocity limit (p.u./s)	
	GATMX, maximum gate limit (p.u.)	
	GATMN, minimum gate limit (p.u.)	
	TW (>0) (sec), water time constant (s)	
	PMAX, maximum gate position (p.u.)	
	PMIN, minimum gate position (p.u.)	
	D	
	G0, gate position at no load (p.u.)	
	G1, first gate intermediate position (p.u.)	
	P1, power at gate position G1 (p.u. on generator MVA rating)	
	G2, second gate intermediate position (p.u.)	
	P2, power at gate position G2 (p.u. on generator MVA rating)	
	P3, power at fully open gate (p.u. on generator MVA rating)	
WSHYDD	db1, deadband width (p.u.)	
	Err, deadband hysteresis (p.u.)	
	Td (sec), input filter time constant (s)	
	K1, derivative gain (p.u.)	
	Tf (sec), derivative time constant (s)	
	KD, double derivative gain (p.u.)	
	KP, integral gain (p.u.)	
	R, droop (p.u. on Trate)	
	Tt, power feedback time constant (s)	
	KG, gate servo gain (p.u.)	
	TP (sec), gate servo time constant (s)	
	VELOPEN (>0), maximum gate opening rate (p.u./s)	
	VELCLOSE (>0), maximum gate closing rate (p.u./s)	
	PMAX, maximum gate opening (p.u.)	
	PMIN, minimum gate opening (p.u.)	
	db2, deadband (p.u.)	
	GV1, coordinate of power-gate look-up table (p.u. gate)	
	PGV1, coordinate of power-gate look-up table (p.u. power)	
	GV2, coordinate of power-gate look-up table (p.u. gate)	
WSHYDD	PGV2, coordinate of power-gate look-up table (p.u. power)	
	GV3, coordinate of power-gate look-up table (p.u. gate)	
	PGV3, coordinate of power-gate look-up table (p.u. power)	
	GV4, coordinate of power-gate look-up table (p.u. gate)	
	PGV4, coordinate of power-gate look-up table (p.u. power)	
	GV5, coordinate of power-gate look-up table (p.u. gate)	
	PGV5, coordinate of power-gate look-up table (p.u. power)	
	Aturb, turbine lead time constant multiplier	
	Bturb (> 0), turbine lag time constant multiplier	

Category	Parameter Description	Data
	Tturb (> 0) (sec), turbine time constant (s)	
	Trate, turbine rating (MW)	
WSHYGP	db1, deadband width (p.u.)	
	Err, deadband hysteresis (p.u.)	
	Td (sec), input filter time constant (s)	
	K1, derivative gain (p.u.)	
	Tf (sec), derivative time constant (s)	
	KD, double derivative gain (p.u.)	
	KP, integral gain (p.u.)	
	R, droop (p.u. on Trate)	
	Tt, power feedback time constant (s)	
	KG, gate servo gain (p.u.)	
	TP (sec), gate servo time constant (s)	
	VELOPEN (>0), maximum gate opening rate (p.u./s)	
	VELCLOSE (>0), maximum gate closing rate (p.u./s)	
	PMAX, maximum gate opening (p.u.)	
	PMIN, minimum gate opening (p.u.)	
	db2, deadband (p.u.)	
	GV1, coordinate of power-gate look-up table (p.u. gate)	
	PGV1, coordinate of power-gate look-up table (p.u. power)	
	GV2, coordinate of power-gate look-up table (p.u. gate)	
	PGV2, coordinate of power-gate look-up table (p.u. power)	
	GV3, coordinate of power-gate look-up table (p.u. gate)	
	PGV3, coordinate of power-gate look-up table (p.u. power)	
	GV4, coordinate of power-gate look-up table (p.u. gate)	
	PGV4, coordinate of power-gate look-up table (p.u. power)	
	GV5, coordinate of power-gate look-up table (p.u. gate)	
	PGV5, coordinate of power-gate look-up table (p.u. power)	
	Aturb, turbine lead time constant multiplier	
	Bturb (> 0), turbine lag time constant multiplier	
	Tturb (> 0) (sec), turbine time constant (s)	
	Trate, turbine rating (MW)	

16.4. Generation: Wind

Format No.	Dyn/Generation/Wind/1
Data Submission By:	Wind Power Generator / CPP
Data related to:	Wind Mills
Data to be submitted to:	State Transmission Utility
Periodicity & prescribed date for data submission:	As and when requested by STU.

16.4.1. Details of models in PSS/E for modelling Wind plants/ farms/ parks:

Category	Parameter Description	Data
Generator Nameplate	Connection point voltage (kV)	
	Terminal voltage (kV)	
	Wind Farm - Rated active power (sent out) in MW	
	Turbine - Rated MVA	
	Turbine - Rated active power (PMAX) in MW	
	Number of wind turbines (Type wise)	
Reactive power capability	Capability chart at connection point [If not available, then for each	
	individual wind turbine, and mode of operation of Power Plant Controller)	
	QMAX	
	QMIN	
Single Line Diagram	Single line diagram of the wind farm/park showing number and location of turbines, cable run, transformers, feeders (including type of cables and electrical R,X,B parameters), and connection to transmission system Preferable : Electrical Single Line Diagram including details between individual WTGs and b/w WTGs and aggregation points	
Wind Turbine Details	Manufacturer and product details (include Year of Manufacture)	
	Year of commissioning	
	Fixed speed or variable speed	
	Type of turbine: stall control, pitch control , active stall control , limited variable speed, variable speed with partial or full-scale frequency	
	converter	

Category	Parameter Description	Data
	Hub height (in metre)	
	Rotor diameter (in metre)	
	Number of blades	
	Rotor speed (in rpm)	
	Gearbox ratio	
Generator	Type of generator: Type 1/ Type 2 / Type 3 / Type 4	
	Number of pole pairs	
	Stator resistance (in Ohms)	
	Rotor resistance (in Ohms)	
Speed control	Details of speed controller in wind turbine	
	Efficiency (Cp) curves	
	Cut-in wind speed	
	Wind speed at which full power is attained Cut-out wind speed	
	Pitch angle at low wind speed	
Reticulation System	Voltage of the reticulation system	
	Number of feeders	
	Cable schedules (lengths, cable size, conductor material, rating info)	
Turbine Transformer	Details of the turbine transformer, including vector group, impedance, and number of taps, tap position, tap ratio	
	Nameplate details	
Wind-farm Step-up transformer	Details of the main wind farm step up transformer, including vector	
	group, impedance, and tap position	
	Nameplate ; OLTC?	
	Controlled bus	
	Voltage setpoint	
	Dead band	
	Number of taps	
	Tap ratio range	
Connection Details	Voltage influence (maximum change etc)	
	Short circuit ratio (SCR)	
	Min	
	Max	
	Harmonic filters	
	STATCOM	
	Synchronous condensers	
	Battery Energy Storage System (if applicable)	
Power Plant Controller (PPC) Details	Does the wind farm have a PPC? If yes, whether PPC controls all or part of the WTGs in wind farm	

Category	Parameter Description	Data
	What is the method of control -voltage regulation, power factor	
	control, reactive power control?	
	Voltage control strategy (operating mode)	
	- Controls MV Bus	
	- Controls HV Bus	
	- PF control	
	- Q control	
	- Voltage control	
	Is there a droop setting?	
	- Voltage control	
	- Frequency Control	
	- Is there line drop compensation?	
	Is reactive power limited?	
	Temperature dependency	
	Active power ramp rate limiters	
	FRT protocols and setpoints	
	- LVRT	
	- HVRT	
	Provide settings from controller.	

16.4.2. Generic Models for Type-1 and Type-2 Wind turbine generators:

Category	Parameter Description	Data
Generator Model		
Generator:Type-1 (WTIGI)	Synchronous reactance (ohms or pu) Xs	
	Transient reactance (ohms or pu) X'	
	Wound rotor induction generator (WRIG) with a variable resistor in the rotor circuit, and typically employs pitch control	
	Leakage reactance , XL	
	Saturation curve (El, S(El), E2, S(E2)	
Generator: Type-2 (WT2GI)	XA, stator reactance (pu)	
	Doubly fed induction generator (DFIG) wind turbines ; Variable speed with rotor side converter	
	Xl rotor reactance (put)	
	R_Rot_Mach, rotor resistance (pu)	
	R_Rot_Max (sum of R_Rot_Mach + total external resistance) in pu	
	Saturation curve (El, S (El), E2, S(E2)	
	Power - slip curve (Top 5 points in the T-s curve)	
Electrical Control Model		
	TsP, rotor speed filter time constant, sec.	

Rotor Resistance Control: Type-2 (WT2EI)	Tpe, power filter time constant, sec.	
	Ti, PI-contro ller integrator time constant, sec.	
	Kp, PI-controller proportional gain, pu	
	ROTRV_MAX, Output MAX limit	
	ROTRV_MIN, Output MIN limit	
Drive Train Model		
Two -Mass Turbine Model for Type 1 and Type 2 Wind Generators: (WT12TI)	H, Total inertia constant, sec	
	DAMP, Machine damping factor, pu P/pu speed	
	Htfrac , Turbine inertia fraction (Hturb/H)I	
	Freq1, First shaft torsional resonant frequency, Hz	
	Dshaft, Shaft damping factor (pu)	

16.4.3. Generic Models for Type-3 and Type-4 Wind turbine generators:

Category	Parameter Description	Data
Generator Model		
Type-3 or Type-4 (REGCAI)	Tg, Converter time constant (s)	
	Rrpwr, Low Voltage Power Logic (LVPL) ramp rate limit (pu/s)	
	Wound rotor induction generator (WRIG) with a variable resistor inthe rotor circuit, and typically employs pitch control	
	Zerox, LVPL characteristic voltage 1 (pu)	
	Lvpll, LVPL gain (pu)	
	Volim, Voltage limit (pu) for high voltage reactive current manage-	
	Doubly fed induction generator (DFIG) wind turbines; Variable speed with rotor side converter	
	Lvpntl, High voltage point for low voltage active current manage-	
	ment (pu)	
	LvpntO, Low voltage point for low voltage active current manage-	
	ment (pu)	
	lolim, Current limit (pu) for high voltage reactive current manage-	
	ment (specified as a negative value)	
	Tfltr , Voltage filter time constant for low voltage active current man-	
	agement (s)	
	Khv, Overvoltage compensation gain used in the high voltage reac-	
	tive current management	
	Iqrmax, Upper limit on rate of change for reactive current (pu)	
	Iqrmin, Lower limit on rate of change for reactive current (pu)	
	Accel, acceleration factor (O < Accel <= 1)	
Electrical Control Model		

Category	Parameter Description	Data
Type-3 and Type-4Wind turbines: (REECAl)	Vdip (pu), low voltage threshold to activate reactive current injection logic	
	Vup (pu), Voltage above which reactive current injection logic is activated	
	Trv (s), Voltage filter time constant	
	dbdl (pu), Voltage error dead band lower threshold (:50)	
	dbd2 (pu), Voltage error dead band upper threshold (2::0)	
	Kqv (pu), Reactive current injection gain during over and undervoltage conditions	
	lqhl (pu), Upper limit on reactive current injection lqinj	
	lqll (pu), Lower limit on reactive current injection lqinj	
	VrefO (pu), User defined reference (if 0, model initializes it to initial terminal voltage)	
	lqfrz (pu), Value at which lqinj is held for Thld seconds following a voltage dip if Thld > 0	
	Thld (s), Time for which lqinj is held at lqfrz after voltage dip returns to zero (see Note 1)	
	Thld2 (s) (2::0), Time for which the active current limit (IPMAX) is held at the faulted value after voltage dip returns to zero	
	Tp (s), Filter time constant for electrical power	
	QMax (pu), limit for reactive power regulator	
	QMin (pu) limit for reactive power regulator	
	VMAX (pu), Max. limit for voltage control	
	VMIN (pu), Min. limit for voltage control	
	Kqp (pu), Reactive power regulator proportional gain	
	Kqi (pu), Reactive power regulator integral gain	
	Kvp (pu), Voltage regulator proportional gain	
	Kvi (pu), Voltage regulator integral gain	
	Vbias (pu), User-defined bias (normally O)	
	Tiq (s), Time constant on delay s4	
	dPmax (pu/s) (>O) Power reference max. ramp rate	
	dPmin (pu/s) (<O) Power reference min. ramp rate	
	PMAX (pu), Max. power limit	
	PMIN (pu), Min. power limit	
	lmax (pu), Maximum limit on total converter current	
	Tpord (s), Power filter time constant	
	VQ-IQ characteristic (at least two pairs, up to 4 pairs of voltage and current in pu)	
	VP-IP characteristic (at least two pairs, up to 4 pairs, of voltage and current in pu)	

Category	Parameter Description	Data
	Is turbine in PF control or Q control (including controlled by external signal)?	
	Is the turbine controlling voltage (directly, not than through PPC)?	
	If controlling voltage directly what bus does it control?	
	Is the turbine in P or Q priority mode?	
Drive Train Model		
	H, Total inertia constant, sec	
	DAM P, Machine damping factor, pu P/pu speed	
	Ht frac, Turbine inertia fraction (Hturb/H)l	
	Freq1, First shaft torsional resonant frequency, Hz	
	Dshaft, Shaft damping factor (pu)	
Pitch Control Model [for Type-3 only]		
Generic Pitch Control model forType-3: (WTPAl)	Kiw, Pitch-control Integral Gain (pu)	
	Kpw, Pitch-control proportional gain (pu)	
	Kie, Pitch-compensation integral gain (pu)	
	Kpc, Pitch-compensation proportional gain (pu)	
	Kee, Gain (pu)	
	Tp, Blade response time constant (s)	
	TetaMax, Maximum pitch angle (degrees)	
	TetaMin, Minimum pitch angle (degrees)	
	RTetaMax, Maximum pitch angle rate (degrees/s)	
	RTetaMin, Minimum pitch angle rate (degrees/s) (< O)	
Aerodynamic Model [For Type-3 only]		
(WTARAl)	Ka, Aerodynamic gain factor (pu/degrees)	
	Theta O Initial pitch angle (degrees)	
Torque Controller Model [For Type-3 only]		
Generic Torque Controller for Type-3wind machines : (WTTQAl)	Kpp, Proportional gain in torque regulator (pu)	
	KIP, Integrator gain in torque regulator (pu)	
	Tp, Electrical power filter time constant (s)	
	Twref, Speed-reference time constant (s)	
	Temax, Max limit in torque regulator (pu)	
	Temin, Min limit in torque regulator (pu)	
	pl, power (pu)	
	spdl, shaft speed for power pl (pu)	
	p2, power (pu)	
	spd2, shaft speed for power p2 (pu)	
	p3, power (pu)	
	spd3, shaft speed for power p3 (pu)	
	p4, power (pu)	
	spd4, shaft speed for power p3 (pu)	
	TRATE, Total turbine rating (MW)	

Category	Parameter Description	Data
Power Plant Controller (PPC) Model		
Generic Power PlantController (PPC) model for Type-3 and Type-4 wind turbines: REPCTAl for type 3, and REPCAl for type 4 turbines	Tfltr, Voltage or reactive power measurement filter time constant (s)	
	Kp, Reactive power Pl control proportional gain (pu)	
	Ki, Reactive power Pl control integral gain (pu)	
	Tft, Lead time constant (s)	
	Tfv, Lag time constant (s)	
	Vfrz, Voltage below which State s2 is frozen (pu)	
	Re, Line drop compensation resistance (pu)	
	Xe, Line drop compensation reactance (pu)	
	Kc, Reactive current compensation gain (pu)	
	emax, upper limit on deadband output (pu)	
	emin, lower limit on deadband output (pu)	
	dbdl, lower threshold for reactive power control deadband (<=O)	
	dbd2, upper threshold for reactive power control deadband (>=O)	
	Qmax, Upper limit on output of V/Q control (pu)	
	Qmin, Lower limit on output of V/Q control (pu)	
	Kpg, Proportional gain for power control (pu)	
	Kig, Proportional gain for power control (pu)	
	Tp, Real power measurement filter time constant (s)	
	fdbdl, Deadband for frequency control, lower threshold (<=O)	
	Fdbd2, Deadband for frequency control, upper threshold (>=O)	
	femax, frequency error upper limit (pu)	
	femin, frequency error lower limit (pu)	
	Pmax, upper limit on power reference (pu)	
	Pmin, lower limit on power reference (pu)	
	Tg, Power Controller lag time constant (s)	
	Ddn, droop for over-fr equency conditions (pu)	
	Dup, droop for under-frequency conditions (pu)	

16.5. Generation: Solar

Format No.	Dyn/Generation/Solar/1
Data Submission By:	Solar Generating Company / CPP
Data related to:	Solar Generation Plant
Data to be submitted to:	State Transmission Utility
Periodicity & prescribed date for data submission:	As and When requested by STU

16.5.1. Details of models in PSS/E for modelling Solar plants / farms/ parks:

Category	Parameter Description	Data
Inverter Details	Manufacturer, model number and product details	
	Year of commissioning	
	As found settings (obtained either from HMI or downloaded from controller in digital systems)	
Technology	• Grid following • Grid forming (viz. Assist in regulation of Voltage and Frequency) • Reactive power priority (Controls Pf or Voltage? Point of control?)	
Single Line Diagram	Single line diagram of the solar farm showing number and location of inverters and PV arrays behind each inverter, cable run, transformers, feeders (including type of cables and electrical R,X,B parameters), and connection to transmission system Preferable: Electrical Single Line Diagram including details between PV array to Inverters, Inverters to MV reticulation system, MV reticulation system till Point of Interconnection (POI) at EHV level (220 kV/400 kV)	
Capability	DC/AC ratio	
	Number of inverters	
	Panel type	
	Number of modules per string	
	Tracking in 0/1/2 axes	
	Capability diagram at nominal (STC) and typical temperature	
Controls	Does the solar farm have a PPC? If yes, whether PPC controls all or part of the inverters in Solar farm	
	What is the method of control -voltage regulation, power factor control, reactive power control?	
	Voltage control strategy (operating mode) • Controls MV bus • Controls HV bus • PF control • Q control	
	Is there a droop setting? • Voltage control • Frequency control	
	Is reactive power limited? Details thereof	
	Is active power limited below MPPT at high output? Details thereof	
	Temperature dependency details	

Category	Parameter Description	Data
	Active power ramp rate limiters	
	Fault Ride Through (FRT) protocols and setpoints • LVRT • HVRT	
	Provide settings from controller	
Reticulation System	Voltage of the reticulation system	
	Number of feeders	
	Cable schedules (lengths, cable size, conductor material, rating info)	
Inverter station transformer	Details of the turbine transformer, including vector group, impedance, and number of taps, tap position, tap ratio	
	Nameplate details	
Solar Farm step-up transformer	Details of the main solar farm step up transformer, including vector group, impedance, and tap position	
	Nameplate ; OLTC?	
	Controlled bus	
	Voltage setpoint	
	Dead band	
	Number of taps	
	Tap ratio range	
Connection Details	Voltage influence (maximum change etc)	
	Short circuit ratio (SCR)	
	Min	
	Max	
	Harmonic filters	
	STATCOM	
	Synchronous condensers	
	Battery Energy Storage System (if applicable)	
Power Plant Controller (PPC) Details	Does the solar farm have a PPC? If yes, whether PPC controls all or part of the inverters in solar farm	
	What is the method of control -voltage regulation, power factor control , reactive power control?	
	Voltage control strategy (operating mode)	
	- Controls MV Bus - Controls HV Bus - PF control - Q control	

Category	Parameter Description	Data
	- Voltage control	
	Is there a droop setting? - Voltage control - Frequency Control - Is there line drop compensation?	
	Is reactive power limited?	
	Temperature dependency	
	Active power ramp rate limiters	
	FRT protocols and setpoints - LVRT - HVRT	
	Provide settings from controller.	

16.5.2. Generic Models for utility Scale Solar – PV generation:

Category	Parameter Description	Data
Generator Model		
Solar PV (REGCAl)	Tg, Converter time constant (s)	
	Rrpwr, Low Voltage Power Logic (LVPL) ramp rate limit (pu/s)	
	Brkpt, LVPL characteristic voltage 2 (pu)	
	Zerox, LVPL characteristic voltage 1 (pu)	
	Lvpll, LVPL gain (pu)	
	Volim, Voltage limit (pu) for high voltage reactive current manage-	
	Lvpntl, High voltage point for low voltage active current management (pu)	
	LvpntO, Low voltage point for low voltage active current management (pu)	
	Iolim, Current limit (pu) for high voltage reactive current management (specified as a negative value)	
	Tfltr, Voltage filter time constant for low voltage active current management (s)-	
	Khv, Overvoltage compensation gain used in the high voltage reactive current management	
	Iqrmax, Upper limit on rate of change for reactive current (pu)	
	Iqrmin, Lower limit on rate of change for reactive current (pu)	
	Accel, acceleration factor (0 < Accel <= 1)	
Electrical Control Model		
Large Solar PV :	Vdip (pu), low voltage threshold to activate reactive current injection logic	
	Vup (pu), Voltage above which reactive current injection logic isactivated	
	Trv (s), Voltage filter time constant	
	dbdI (pu), Voltage error dead band lower threshold (0)	
	dbd2 (pu), Voltage error dead band upper threshold (;::0)	

Category	Parameter Description	Data
(REECBl)	Kqv (pu), Reactive current injection gain during over and undervoltage conditions	
	lqhl (pu), Upper limit on reactive current injection lqinj	
	lqll (pu), Lower limit on reactive current injection lqinj	
	Vref0 (pu), User defined reference (if 0, model initializes it toinitial terminal voltage)	
	Tp (s), Filter time constant for electrical power	
Large Solar PV: (REECBl)	QMax (pu), limit for reactive power regulator	
	QMin (pu) limit for reactive power regulator	
	VMAX (pu) , M ax. limit for voltage control	
	VMIN (pu) , Min. limit for voltage control	
	Kqp (pu), Reactive power regulator proportional gain	
	Kqi (pu), Reactive power regulator integral gain	
	Kvp (pu) , Voltage regulator proportional gain	
	Kvi (pu), Voltage regulator integral gain	
	Tiq (s), Time constant on delay s4	
	dPmax (pu/s) (>O) Power reference max. ramp rate	
	dPmin (pu/s) (<O) Power reference min. ramp rate	
	PMAX (pu), Max. power limit	
	PMIN (pu), Min. power limit	
	Imax (pu), Maximum limit on total converter current	
	Tpord (s), Power filter time constant	
Generic Power PlantController (PPC) model: (REPCAl)	Tfltr, Voltage or reactive power measurement filter time constant (s)	
	Kp, Reactive power Pl control proportional gain (pu)	
	Ki, Reactive power Pl control integral gain (pu)	
	Tft, Lead time constant (s)	
	Tfv, Lag time constant (s)	
	Vfrz, Voltage below which State s2 is frozen (pu)	
	Re, Line drop compensation resistance (pu)	
	Xe, Line drop compensation reactance (pu)	
	Kc, Reactive current compensation gain (pu)	
	emax, upper limit on deadband output (pu)	
	emin, lower limit on deadband output (pu)	
	dbdl, lower threshold for reactive power control deadband (<=O)	
	dbd2, upper threshold for reactive power control deadband (>=O)	
	Qmax, Upper limit on output of V/Q control (pu)	
	Qmin, Lower limit on output of V/Q control (pu)	
	Kpg, Proportional gain for power control (pu)	
	Kig, Proportional gain for power control (pu)	
	Tp, Real power measurement filter time constant (s)	

Category	Parameter Description	Data
	fdbdl , Deadband for frequency control, lower threshold (<=O)	
	Fdbd2, Deadband for frequency control, upper threshold (>=O)	
	femax, frequency error upper limit (pu)	
	femin, frequency error lower limit (pu)	
	Pmax, upper limit on power reference (pu)	
	Pmin, lower limit on power reference (pu)	
	Tg, Power Controller lag time constant (s)	
	Ddn, droop for over-frequency conditions (pu)	
	Dup, droop for under-frequency conditions (pu)	

16.6. Storage: BESS

Format No.	Dyn/Storage/BESS/1
Data Submission By:	BESS
Data related to:	BESS
Data to be submitted to:	State Transmission Utility
Periodicity & prescribed date for data submission:	As and when requested by STU.

Details of PSS/E model for modelling BESS:

Category	Parameter Description	Data
Electrical Control Model: BESS		
Generic Electrical Control model for Utility Scale BESS: (REECCU1)	Vdip (pu), low voltage threshold to activate reactive current injection logic	
	Vup (pu),Voltage above which reactive current injection logic is activated	
	Trv 9s), Voltage filter time constant	
	Dbd1 (pu), Voltage error dead band lower threshold (<= 0)	
	Dbd1 (pu), Voltage error dead band upper threshold (>= 0)	
	Kqv (pu), Reactive current injection gain during over and undervoltage conditions	
	Iqh1 (pu), upper limit in reactive current injection Iqinj	
	Iqh1 (pu), lower limit in reactive current injection Iqinj	
	Vref0 (pu), user defined reference (if , model initialized it to initial terminal voltage)	
	Tp (s), Filter time constant for electrical power	
	Qmax (pu), limit for reactive power regulator	
	Qmin (pu), limit for reactive power regulator	
	VMAX (pu), Max. limit for voltage control	

	VMIN(pu), Min. limit for voltage control	
	Kqp (pu), Reactive power regulator proportional gain	
	Kqi (pu), Reactive power regulator integral gain	
	Kvp (pu), Voltage regulator proportional gain	
	Kvi (pu), Voltage regulator integral gain	
	Tiq (s), Time constant on delay s4	
	dPmax (pu/s) (>0) power reference max. ramp rate	
	dPmin (pu/s) (>0) power reference min. ramp rate	
	PMAX (pu), Max. power limit	
	PMIN (pu), Min. power limit	
	Imax (pu), Maximum limit on total converter current	
	Tpord (s), Power filter time constant	
	Vq and Iq curve (Reactive Power V-I pair in p.u): 4 points	
	Vq and Iq curve (Active Power V-I pair in p.u): 4 points	
	T, battery discharge time (s) (<0)	
	SOCini (pu), initial state of charge	
	SOCmax(pu), Maximum allowable state of charge	
	SOCmin(pu), Minimum allowable state of charge	

Note: 1) SOCini represents the initial state of charge on the battery and is a user entered value. This is entered in pu; with 1 pu meaning that the battery is fully charged and 0 means the battery is completely discharged.

2) If BESS have other PSS/E model / user model, same can be shared with STU.

16.7. Transmission: HVDC Links

Format No.	Dyn/Transmission/HVDC/1
Data Submission By:	Transmission Licensee
Data related to:	HVDC Link
Data to be submitted to:	State Transmission Utility
Periodicity & prescribed date for data submission:	As and when requested by STU

16.6.1. Details of models in PSS/E for modelling HVDC Links:

Category	Parameter Description	Data
Link OEM and rating	Manufacturer and product details (for example Siemens, Areva, ABB, etc)	
	Year of commissioning	
	Rated DC voltage	
	Length of the link	
	Conductor Type (of DC lines)	
	Number of Poles	
	Rating of Each Pole (Power-MW, and Current-Amperes)	

Category	Parameter Description	Data
	Minimum Power flow on DC link (per pole) in MW	
	Overload capability of DC link (per pole) in MW and no. of hours	
	LCC, Rectifier controls maintain - constant DC power or DC current?	
	LCC, Inverter controls maintain - constant DC voltage or extinction angle?	
	LCC, For DC voltage control, whether any compensation is utilized?	
	LCC, Inverter current margin	
	VSC, converter controls DC voltage or DC power?	
	VSC, converter controls AC voltage or power factor?	
Technology	Converters: - LCC (Conventional) - Voltage Source Converter (VSC) - Multi-terminal	
DC Components	Smoothing Reactors	
	DC Line resistance (Rdc) in Ohms	
	Minimum inverter dc voltage for power control mode (in kV)	
Converter transformer	Make	
	MVA rating	
	Two winding transformer or three winding transformer?	
	If three winding, any auxiliary equipment connected to tertiary winding?	
	AC side base voltage	
	DC side base voltage	
	Impedance (in Ohms, in % on 100 MVA base and mention Voltage reference side)	
	Converter transformer secondary commutating reactance in ohms per bridge[Star point to Secondary]	
	Converter transformer secondary commutating resistance in ohms per bridge [Star point to Secondary]	
	Primary to Star-point impedance of Converter transformer (R+jX)	
	Tertiary to Star-point impedance of Converter transformer (R+jX)	
	Maximum value of converter transformer tap ratio (in p.u. of Voltage)	

Category	Parameter Description	Data
	Minimum value of converter transformer tap ratio (in p.u. of Voltage)	
	Converter transformer tap-step (in pu of voltage)	
Converter Details	Minimum firing (delay) angle of rectifier in degrees (Alpha-min)	
	Maximum firing (delay) angle objective for rectifier in degrees (Alpha-max)	
	Minimum margin angle of inverter in degrees (Gamma-min)	
	Maximum margin angle objective for inverter in degrees (Gamma-max)	
	Number of Pulses (Ex. 12 pulse bridge, with 2 nos. 6 pulse bridge in series)	
	Alpha-min, actual absolute minimum firing angle during transients	
	Gamma-min, actual absolute minimum extinction angle during transients	
Additional information for VSC HVDC	AC side MVA rating	
	Q limits	
	Converter Losses	
	Voltage Control Settings	
AC Filters	Details of AC filters (Switching sequence w.r.t. Power order, MVAR values at nominal voltage and fundamental frequency	

16.6.2. Transient simulation model (Dynamics):

For representation of the electromechanical transient behavior of HVDC links, standard models areavailable in PSS/E library. A list of standard models are listed below:

Generic Models for HVDC links

Category	Type	Model Description
CDC4T	LCC	Two-terminal dc line model
CDC7T	LCC	DC line model
HVDCPL1	VSC	Siemens HVDC plus model
VSCDCT	VSC	Two-terminal VSC dc line model
MTDC1T	MTDC	Multiterminal (five converter) dc line model
MTDC2T	MTDC	Multiterminal (five converter) dc line model

Category	Parameters	Data
LCC based HVDC		
	ALFDY, minimum alpha for dynamics (degrees)	

Category	Parameters	Data
CDC4T	GAMDY, minimum gamma for dynamics (degrees)	
	TVDC, dc voltage transducer time constant (sec)	
	TIDC, dc current transducer time constant (sec)	
	VBLOCK, rectifier ac blocking voltage (pu)	
	VUNBL, rectifier ac unblocking voltage (pu)	
	TBLOCK, minimum blocking time (sec)	
	VBYPAS, inverter dc bypassing voltage (kV)	
	VUNBY, inverter ac unbypassing voltage (pu)	
	TBYPAS, minimum bypassing time (sec)	
	RSVOLT, minimum dc voltage following block (kV)	
	RSCUR, minimum dc current following block (amps	
	VRAMP, voltage recovery rate (pu/sec)	
	CRAMP, current recovery rate (pu/sec)	
	C0, minimum current demand (amps)	
	V1, voltage limit point 1 (kV)	
	C1, Current limit point 1 (amps); >C0	
	V2, voltage limit point 2 (kV)	
	C2, current limit point 2 (amps)	
	V3, voltage limit point 3 (kV)	
	C3, current limit point 3 (amps)	
	TCMODE, minimum time stays in switched mode (sec)	
CDC7T	dc voltage sensor time constant, sec.	
	dc current sensor time constant, sec.	
	Rectifier smoothing reactor inductance, mH	
	Rectifier smoothing reactor resistance, ohm	
	Inverter smoothing reactor inductance, mH	
	Inverter smoothing reactor resistance, ohm	
	Inductance of O/H dc line from rectifier side, mH	
	Resistance of O/H dc line from rectifier side, ohm	
	Inductance of O/H dc line from inverter side, mH	
	Resistance of O/H dc line from inverter side, ohm	
	Inductance of dc cable line, mH	
	Damping resistance of dc cable line, ohm	
	dc line capacitance, μF	
	dc fault shunt inductance, rectifier side, mH	
	dc fault shunt resistance, rectifier side, ohm	
	dc fault shunt inductance, mid-line, mH	
	dc fault shunt resistance, mid-line, ohm	
	dc fault shunt inductance, inverter side, mH	
	dc fault shunt resistance, inverter side, ohm	
	dc cable damping resistor	
	Rated dc current, A	
	Rated dc voltage, kV	
	VDComp down time constant for VDCL, rectifier, sec	

Category	Parameters	Data
CDC7T	VDComp up time constant for VDCL, rectifier, sec	
	VDComp down time constant for VDCL, inverter, sec	
	VDComp up time constant for VDCL, inverter, sec	
	Current margin, rectifier, pu	
	Current margin, inverter, pu	
	Voltage margin, rectifier, pu	
	Voltage margin, inverter, pu	
	Gamma margin, rectifier, pu	
	Gamma margin, inverter, pu	
	IDC error to V-control gain, rectifier	
	IDC error to V-control gain, inverter	
	IDC error to Gamma-control gain, inverter	
	VDComp filter gain, rectifier, pu	
	VDComp filter gain, inverter, pu	
	VDComp filter time constant, rectifier, sec.	
	VDComp filter time constant, inverter, sec.	
	Selected controller output gain, rectifier	
	Selected controller output gain, inverter	
	PI-controller proportional gain, rectifier	
	PI-controller integrator time constant, rectifier, sec.	
	PI-controller proportional gain, inverter	
	PI-controller integrator time constant, inverter, sec.	
	Max Alfa limit, rectifier	
	Min Alfa limit, rectifier	
	Max Alfa limit, inverter	
	Min Alfa limit, inverter	
	Control configuration 1	
	Control configuration 3	
	Min GAMA in dynamics	
	Rate of current order change when blocking, A/sec	
	Rate of current order change when unblocking, A/sec	
	VDC filter time constant for Pordr calculation, sec.	
	5 pairs of rectifier VDCL coordinates (Vd1, Id1) … (Vd5, Id5)1	
	5 pairs of inverter VDCL coordinates (Vd1, Id1) … (Vd5, Id5)1	
	Rated AC voltage on DC side of converter Xfmr [kV]	
	Rectifier transformer impedance [pu of SBASE]	
	Inverter transformer impedance [pu of SBASE]	
	DC line total inductance [H]	
	DC line total capacitance [F]	
	Gain GQr of the rectifier reactive power controller	
	Lead time constant TLeadQr of the rectifier reactive power controller [s]	
	Lag time constant TLagQr of the rectifier reactive power controller [s]	
	Gain GQi of the inverter reactive power controller	
	Lead time constant TLeadQi of the inverter reactive power controller [s]	
	Lag time constant TLagQi of the inverter reactive power controller [s]	
	Gain G1Ud of the DC voltage controller	
	Lead time constant TLead1Ud of the DC voltage controller [s]	
	Lag time constant TLag1Ud of the DC voltage controller [s]	

Category	Parameters	Data
HVDCPL1	Gain G2Ud of the DC voltage controller	
	Lead time constant TLead2Ud of the DC voltage controller [s]	
	Lag time constant TLag2Ud of the DC voltage controller [s]	
	Ramp rate of the inverter active power setting value [p.u./s] (used for interconnected application)	
	Gain G1P of the inverter active power controller (interconnected application)	
	Lead time constant TLead1P of the inverter active power controller [s] (interconnected application)	
	Lag time constant TLag1P of the inverter active power controller [s] (interconnected application)	
	Gain G2P of the inverter active power controller (interconnected application)	
	Lead time constant TLead2P of the inverter active power controller [s] (interconnected application)	
	Lag time constant TLag2P of the inverter active power controller [s] (interconnected application)	
	TIntQr (s); Rectifier Q controller integrator time constant	
	LMXQr (pu); Rectifier Q controller integrator upper limit	
	LMNQr (pu); Rectifier Q controller integrator lower limit	
	TIntQi (s); Inverter Q controller integrator time constant	
	LMXQi (pu); Inverter Q controller integrator upper limit	
	LMNQi (pu); Inverter Q controller integrator lower limit	
	TIntUd (s); Inverter dc voltage controller integrator time constant	
	LMXIUd (pu); Inverter dc voltage controller integrator upper limit	
	LMNIUd(pu); Inverter dc voltage controller integrator lower limit	
	TIntP (s); Inverter P controller integrator time constant	
	LMXP (pu); Inverter P controller integrator upper limit	
	LMNP (pu); Inverter P controller integrator lower limit	
	Tsync (s); Inverter POI Angle measurement delay	
	LMX1Ud (deg.); Rectifier dc voltage controller first lead-lag upper limit	
HVDCPL1	Power-Voltage characteristics, X6	
	Power-Voltage characteristics, Y6	
	DC Chopper characteristics, X1 (Direct voltage in pu)	
	DC Chopper V-I characteristics, Y1 (chopper current in kA)	
	DC Chopper characteristics, X2	
	DC Chopper characteristics, Y2	
	DC Chopper characteristics, X3	
	DC Chopper characteristics, Y3	
	DC Chopper characteristics, X4	
	DC Chopper characteristics, Y4	
	DC Chopper characteristics, X5	
	DC Chopper characteristics, Y5	
	DC Chopper characteristics, X6	
	DC Chopper characteristics, Y6	
	DC Chopper characteristics, X7	
	DC Chopper characteristics, X7	
	DC Chopper characteristics, X8	
	DC Chopper characteristics, X8	

Category	Parameters	Data
	DC Chopper characteristics, X9	
	DC Chopper characteristics, X9	
	DC Chopper characteristics, X10	
	DC Chopper characteristics, X10	
VSCDCT	Tpo_1, Time constant of active power order controller, sec (For VSC # 1).	
	AC_VC_Limits_1, Reactive power limit for ac voltage control, pu on converter MVA rating. When 0, it is not used and Qmax/Qmin pair is used instead (For VSC # 1).	
	AC_Vctrl_kp_1, AC Voltage control proportional gain, converter MVA rating/BASEKV (For VSC # 1).	
	Tac_1 > 0.0, Time constant for AC voltage PI integral, sec (For VSC # 1). When 0, VSC#1 is ignored.	
	Tacm_1, Time constant of the ac voltage transducer, sec (For VSC # 1).	
	Iacmax_1, Current Limit, pu on converter MVA rating (For VSC # 1).	
	Droop_1, AC Voltage control droop, converter MVA rating/BASEKV (For VSC # 1).	
	VCMX_1, Maximum VSC Bridge Internal Voltage (For VSC # 1).	
	XREACT_1 > 0.0, Pu reactance of the ac series reactor on converter MVA rating (For VSC # 1). When 0.0, default value 0.17 is used.	
	QMAX_1, Maximum system reactive limits in Mvars (For VSC # 1). When AC- VC_Limits_1 >0, QMAX_1 is not used.	
	QMIN_1, Minimum system reactive limits in MVARs (For VSC # 1). When AC- VC_Limits_1 >0, QMIN_1 is not used.	
	AC_VC_KT_1, Adjustment Parameter for the feedback from reactive power limiter to ac voltage controller (For VSC #1).	
	AC_VC_KTP_1, Adjustment Parameter for the feedback from current order limiter to ac voltage controller (For VSC #1).	
	Tpo_2, Time constant of active power order controller, sec (For VSC # 2).	
VSC based HVDC		
VSCDCT	AC_VC_Limits_2, Reactive power limit for ac voltage control, pu on converter MVA rating. When 0, it is not used and Qmax/Qmin pair is used instead (For VSC # 2).	
	AC_Vctrl_kp_2, AC Voltage control proportional gain, converter MVA rating/BASEKV (For VSC # 2).	
	Tac_2 > 0.0, Time constant for AC voltage PI integral, sec (For VSC # 2). When 0, VSC#2 is ignored.	
	Tacm_2, Time constant of the ac voltage transducer, sec (For VSC # 2).	
	Iacmax_2, Current Limit, pu on converter MVA rating (For VSC # 2).	
	Droop_2, AC Voltage control droop, converter MVA rating/BASEKV (For VSC # 2).	
	VCMX_2, Maximum VSC Bridge Internal Voltage (For VSC # 2).	
	XREACT_2 > 0.0, Pu reactance of the ac series reactor on converter MVA rating (For VSC # 2). When 0.0, default value 0.17 is used.	

Category	Parameters	Data
	QMAX_2, Maximum system reactive limits in MVARs (For VSC # 2). When AC-VC_Limits_2 >0, QMAX_2 is not used.	
	QMIN_2, Minimum system reactive limits in MVARs (For VSC # 2). When AC- VC_Limits_2 >0, QMIN_2 is not used.	
	AC_VC_KT_2, Adjustment Parameter for the feedback from reactive power limiter to ac voltage controller (For VSC #2).	
	AC_VC_KTP_2, Adjustment Parameter for the feedback from current order limiter to ac voltage controller (For VSC #2).	
	Tpo_DCL, Time constant of the power order controller, sec (For DC Line).	
	Tpo_lim, Time constant of the power order limit controller, sec (For DC Line).	
MTDC		
MTDC1T	DY1, minimum angle converter 1 (degrees)	
	TVAC1, ac voltage transducer converter 1 (sec)	
	TVDC1, dc voltage transducer converter 1 (sec)	
	TIDC1, current transducer converter 1 (sec)	
	RSVLT1, minimum dc voltage following block, converter 1 (kV)1	
	RSCUR1, minimum dc current following block, converter 1 (amps)2	
	VRMP1, voltage recovery rate, converter 1 (pu/sec)1	
	CRMP1, current recovery rate, converter 1 (pu/sec)2	
	C0-1, minimum current demand converter 1 (amps)3	
	V1-1, voltage limit point 1, converter 1 (kV)2	
	C1-1, current limit point 1, converter 1 (amps)2	
	V2-1, voltage limit point 2, converter 1 (kV)2	
	C2-1, current limit point 2, converter 1 (amps)2	
	V3-1, voltage limit point 3, converter 1 (kV)2	
	C3-1, current limit point 3, converter 1 (amps)2	
	DY2, minimum angle converter 2 (degrees)	
	TVAC2, ac voltage transducer converter 2 (sec)	
	TVDC2, dc voltage transducer converter 2 (sec)	
	TIDC2, current transducer converter 2 (sec)	
	RSVLT2, minimum dc voltage following block, converter 2 (kV)1	
	RSCUR2, minimum dc current following block, converter 2 (amps)2	
	VRMP2, voltage recovery rate, converter 2 (pu/sec)1	
	CRMP2, current recovery rate, converter 2 (pu/sec)2	
	C0-2, minimum current demand converter 2 (amps)3	
	V1-2, voltage limit point 1, converter 2 (kV)2	
	C1-2, current limit point 1, converter 2 (amps)2	
	V2-2, voltage limit point 2, converter 2 (kV)2	
	C2-2, current limit point 2, converter 2 (amps)2	
	V3-2, voltage limit point 3, converter 2 (kV)2	
	C3-2, current limit point 3, converter 2 (amps)2	
	DY3, minimum angle converter 3 (degrees)	
	TVAC3, ac voltage transducer converter 3 (sec)	
	TVDC3, dc voltage transducer converter 3 (sec)	
	TIDC3, current transducer converter 3 (sec)	

Category	Parameters	Data
MTDC1T	RSVLT3, minimum dc voltage following block, converter 3 (kV)1	
	RSCUR3, minimum dc current following block, converter 3 (amps)2	
	VRMP3, voltage recovery rate, converter 3 (pu/sec)1	
	CRMP3, current recovery rate, converter 3 (pu/sec)2	
	C0-3, minimum current demand converter 3 (amps)3	
	V1-3, current limit point 1, converter 3 (kV)2	
	C1-3, current limit point 1, converter 3 (amps)2	
	V2-3, voltage limit point 2, converter 3 (kV)2	
	C2-3, current limit point 2, converter 3 (amps)2	
	V3-3, voltage limit point 3, converter 3 (kV)2	
	C3-3, current limit point 3, converter 3 (amps)2	
	DY4, minimum angle converter 4 (degrees)	
	TVAC4, ac voltage transducer converter 4 (sec)	
	TVDC4, dc voltage transducer converter 4 (sec)	
	TIDC4, current transducer converter 4 (sec)	
	RSVLT4, minimum dc voltage following block, converter 4 (kV)1	
	RSCUR4, minimum dc current following block, converter 4 (amps)2	
	VRMP4, voltage recovery rate, converter 4 (pu/sec)1	
	CRMP4, current recovery rate, converter 4 (pu/sec)2	
	C0-4, minimum current demand converter 4 (amps)3	
	V1-4, voltage limit point 1, converter 4 (kV)2	
	C1-4, current limit point 1, converter 4 (amps)2	
	V2-4, voltage limit point 2, converter 4 (kV)2	
	C2-4, current limit point 2, converter 4 (amps)2	
	V3-4, voltage limit point 3, converter 4 (kV)2	
	C3-4, current limit point 3, converter 4 (amps)2	
	DY5, minimum angle converter 5 (degrees)	
	TVAC5, ac voltage transducer converter 5 (sec)	
	TVDC5, dc voltage transducer converter 5 (sec)	
MTDC1T	TIDC5, current transducer converter 5 (sec)	
	RSVLT5, minimum dc voltage following block, converter 5 (kV)1	
	RSCUR5, minimum dc current following block, converter 5 (amps)2	
	VRMP5, Voltage recovery rate, converter 5 (pu/sec)1	
	CRMP5, current recovery rate, converter 5 (pu/sec)2	
	C0-5, minimum current demand converter 5 (amps)3	
	V1-5, voltage limit point 1, converter 5 (kV)2	
	C1-5, current limit point 1, converter 5 (amps)2	
	V2-5, voltage limit point 2, converter 5 (kV)2	
	C2-5, current limit point 2, converter 5 (amps)2	
	V3-5, voltage limit point 3, converter 5 (kV)2	
	C3-5, current limit point 3, converter 5 (amps)2	
	TCMODE (sec)	
	DY1, minimum angle converter 1 (degrees)	
	TVAC1, ac voltage transducer converter 1 (sec)	
	TVDC1, dc voltage transducer converter 1 (sec)	
	TIDC1, current transducer converter 1 (sec)	
	RSVLT1, minimum dc voltage following block, converter 1 (kV)1	
	RSCUR1, minimum dc current following block, converter 1 (amps)	

Category	Parameters	Data
MTDC2T	VRMP1, voltage recovery rate, converter 1 (pu/sec)1	
	CRMP1, current recover rate, converter 1 (pu/sec)	
	C0-1, minimum current demand converter 1 (amps)	
	V1-1, minimum current demand converter 1	
	C1-1, minimum current demand converter 1 (amps)	
	V2-1, minimum current demand converter 1	
	C2-1, minimum current demand converter 1 (amps)	
	V3-1, minimum current demand converter 1	
	C3-1, minimum current demand converter 1 (amps)	
	DY2, minimum angle converter 2 (degrees)	
	TVAC2, ac voltage transducer converter 2 (sec)	
	TVDC2, dc voltage transducer converter 2 (sec)	
	TIDC2, current transducer converter 2 (sec)	
	RSVLT2, minimum dc voltage following block, converter 2 (kV)1	
	RSCUR2, minimum dc current following block, converter 2 (amps)	
	VRMP2, voltage recovery rate, converter 2 (pu/sec)1	
	CRMP2, current recover rate, converter 2 (pu/sec)	
	C0-2, minimum current demand converter 2 (amps)	
	V1-2, minimum current demand converter 2	
	C1-2, minimum current demand converter 2 (amps)	
	V2-2, minimum current demand converter 2	
	C2-2, minimum current demand converter 2 (amps)	
	V3-2, minimum current demand converter 2	
MTDC2T	C3-2, minimum current demand converter 2 (amps)	
	DY3, minimum angle converter 3 (degrees)	
	TVAC3, ac voltage transducer converter 3 (sec)	
	TVDC3, dc voltage transducer converter 3 (sec)	
	TIDC3, current transducer converter 3 (sec)	
	RSVLT3, minimum dc voltage following block, converter 3 (kV)1	
	RSCUR3, minimum dc current following block, converter 3 (amps)	
	VRMP3, voltage recovery rate, converter 3 (pu/sec)1	
	CRMP3, current recover rate, converter 3 (pu/sec)	
	C0-3, minimum current demand converter 3 (amps)	
	V1-3, minimum current demand converter 3	
	C1-3, minimum current demand converter 3 (amps)	
	V2-3, minimum current demand converter 3	
	C2-3, minimum current demand converter 3 (amps)	
	V3-3, minimum current demand converter 3	
	C3-3, minimum current demand converter 3 (amps)	
	DY4, minimum angle converter 4 (degrees)	
	TVAC4, ac voltage transducer converter 4 (sec)	
	TVDC4, dc voltage transducer converter 4 (sec)	
	TIDC4, current transducer converter 4 (sec)	
	RSVLT4, minimum dc voltage following block, converter 4 (kV)1	
	RSCUR4, minimum dc current following block, converter 4 (amps)	
	VRMP4, voltage recovery rate, converter 4 (pu/sec)1	
	CRMP4, current recovery rate, converter 4 (pu/sec)	
	C0-4, minimum current demand converter 4 (amps)	

Category	Parameters	Data
	V1-4, minimum current demand converter 4	
	C1-4, minimum current demand converter 4 (amps)	
	V2-4, minimum current demand converter 4	
	C2-4, minimum current demand converter 4 (amps)	
	V3-4, minimum current demand converter 4	
	C3-4, minimum current demand converter 4 (amps)	
	DY5, minimum angle converter 5 (degrees)	
	TVAC5, ac voltage transducer converter 5 (seconds)	
	TVDC5, dc voltage transducer converter 5 (seconds)	
	TIDC5, current transducer converter 5 (seconds)	
	RSVLT5, minimum dc voltage following block, converter 5 (kV)1	
	RSCUR5, minimum dc current following block, converter 5 (amps)	
	VRMP5, voltage recovery rate, converter 5 (pu/sec)1	
	CRMP5, current recovery rate, converter 5 (pu/sec)	
	C0-5, minimum current demand converter 5 (amps)	
	V1-5, minimum current demand converter 5	
	C1-5, minimum current demand converter 5 (amps)	
MTDC2T	V2-5, minimum current demand converter 5	
	C2-5, minimum current demand converter 5 (amps)	
	V3-5, minimum current demand converter 5	
	C3-5, minimum current demand converter 5 (amps)	
	TVF, power control VDC transducer time constant (sec)	
	VDCOLUP, voltage transducer time constants (sec)	
	VDCOLON, voltage transducer time constants (sec)	
	Current margin (amps)	
	Converter 1 DV/DI multiplier (pu)2	
	Converter 2 DV/DI multiplier (pu)2	
	Converter 3 DV/DI multiplier (pu)2	
	Converter 4 DV/DI multiplier (pu)2	
	Converter 5 DV/DI multiplier (pu)2	

16.8. Transmission: STATCOM

Format No.:	Dyn/Transmission/STATCOM/1
Data Submission By:	Transmission Licensee
Data related to:	STATCOM
Data to be submitted to:	State Transmission Utility
Periodicity & prescribed date for data submission:	As and when requested by STU

16.7.1. Details of models in PSS/E for modelling HVDC Links:

(a) Transient simulation model (Dynamics):

For representation of the RMS behaviour of STATCOMs, two standard models are available in the PSS/E library, namely SVSMO3T2 and CSTCNT. Details for SVSMO3T2 are given in Table 1 and Table 2 and the CSTCNT model are given in Table 3 and Table 4. The SVSMO3T2 has been described as STATCOM based

SVC with logic to trip mechanically switched shunts (MSS). In comparison, the CSTCNT is a simpler representation of STATCOM with no dependence on shunt devices.

Table 1: Parameters of SVSMO3T2 generic STATCOM model

Parameter (Controller parameters or PSS/E CON)	Value
Xc0, linear droop	
Tc1, voltage measurement lead time constant (sec)	
Tb1, voltage measurement lag time constant (sec)	
Kp, proportional gain	
Ki, integral gain	
Vemax, voltage error max. (pu)	
Vemin, voltage error min. (pu)	
T0, firing sequence control delay (sec)	
Imax1, max. continuous current rating (pu on STBASE)	
dbd, deadband range for voltage control (pu)	
Kdbd, ratio of outer to inner deadband	
Tdbd, deadband time (sec)	
Kpr, proportional gain for slow-reset control	
Kir, integral gain for slow-reset control	
Idbd, deadband range for slow-reset control (pu on STBASE)	
Vrmax, max. limit on slow-reset control output (pu)	
Vrmin, min. limit on slow-reset control output (pu)	
Ishrt, max. short-term current rating as a multiplier of max. cont. current rating (pu)	
UV1, voltage at which STATCOM limit starts to be reduced linearly (pu)	
UV2, voltage below which STATCOM is blocked (pu)	
OV1, voltage above which STATCOM limit linearly drops (pu)	
OV2, voltage above which STATCOM blocks (pu)	
Vtrip, voltage above which STATCOM trips after time delay Tdelay2 (pu)	
Tdelay1, short-term rating time(sec)	
Tdelay2, trip time for V .GT. Vtrip(sec)	
Vrefmax, max. limit on voltage reference (pu)	
Vrefmin, min. limit on voltage reference (pu)	
Tc2, lead time constant(sec)	
Tb2, lag time constant(sec)	
I2t, short-term limit	
Reset, reset rate for I2t limit	
hyst, width of hysteresis loop for I2t limit	
Xc1, non-linear droop slope 1	
Xc2, non-linear droop slope 2	
Xc3, non-linear droop slope 3	
V1, non-linear droop upper voltage (pu)	
V2, non-linear droop lower voltage (pu)	
Tmssbrk, time for MSS breaker to operate (sec)	

Parameter (Controller parameters or PSS/E CON)	Value
Tout, time MSC should be out before switching back in (sec)	
TdelLC, Time delay for switching in a MSS (sec)	
Iupr, Upper threshold for switching MSS (pu on STBASE)	
Ilwr, Lower threshold for switching MSS (pu on STBASE)	
Sdelay, time STATCOM should remain blocked before being unblocked	
STBASE (>0), STATCOM BASE MVA	

Table 2: Parameters of SVSMO3T2 generic STATCOM model – additional information

Parameter (Other relevant information or PSS/E ICON)	Value
Remote bus number for voltage regulation	Bus Name & Voltage Level
Disable or enable coordinated MSS switching, 0 - no MSS switching, 1 - MSS switching based on STATCOM current	
flag1, slow-reset off/on, flag1 (0/1)	
flag2, non-linear droop off/on, flag2 (0/1)	
1st MSS bus #	
1st MSS Id (to be entered within single quotes)	
2nd MSS bus #	
2nd MSS Id (to be entered within single quotes)	
3rd MSS bus #	
3rd MSS Id (to be entered within single quotes)	
4th MSS bus #	
4th MSS Id (to be entered within single quotes)	
5th MSS bus #	
5th MSS Id (to be entered within single quotes)	
6th MSS bus #	
6th MSS Id (to be entered within single quotes)	
7th MSS bus #	
7th MSS Id (to be entered within single quotes)	
8th MSS bus #	
8th MSS Id (to be entered within single quotes)	

Table 3: Parameters of CSTCNT generic STATCON model

Parameter (Controller parameters or PSS/E CON)	Value
T1 (>0)	
T2 (>0)	
T3 (>0)	
T4 (>0)	
K(Typical = 25/(dv/dei))	
Droop (typical = 0.03)	
VMAX (typical = 999)	
VMIN (typical = -999)	
ICMAX (typical = 1.25) Max capacitive current	
ILMAX (typical = 1.25) Max inductive current	
Vcutout (typical = 0.2)	

Elimit (typical = 1.2)	
Xt (>0) (transformer reactance, typical = 0.1)	
Acc (acceleration factor, typical = 0.5)	
STBASE (>0) STATCON base MVA	

Table 4: Parameters of CSTCNT generic STATCOM model – additional information

Parameter (Other relevant information or PSS/E ICON)	Value
IB, remotely regulated bus	Bus Name & Voltage Level