Requirements for WECC Model Submission

Version 1.0 – 10 June 2022

Disclaimer

Revision History

Ver.	Date	Notes	Prepared by	Checked by	Approved by
1.0	10 June 2024	Initial Release	Mark Rafferty	Sarah Foster	

Table of Contents

List of Tables

List of Figures

Acronyms

AVR	Automatic Voltage Regulation
BESS	Battery Energy Storage System
DC	Distribution Code
DSO	Distribution System Operator
ESPS	Energy Storage Power Station
FRT	Fault Ride Through
GC	Grid Code
GCC	Grid Code Compliance
HV	High Voltage
HVDC	High Voltage Direct Current
LV	Low Voltage
MEC	Maximum Export Capacity
MIC	Maximum Import Capacity
MV	Medium Voltage
MVAr	Mega Volt Ampere Reactive
PoC	Point of Connection
PPM	Power Park Module
PV	Photovoltaic
RfG	Requirements for Generators
RMS	Root Mean Square
SONI	System Operator for Northern Ireland
SPGM	Synchronous Power Generating Module
TSO	Transmission System Operator
WECC	Western Electricity Coordinating Council

Table 1 - Demarcation of Requirements

Symbol	Applicable To
○	RfG Generation Units
⊖	Non-RfG Generation Units

1. Introduction

The purpose of this document is to provide a guideline for the submission and validation requirements for the Western Electricity Coordinating Council [1] (WECC) 2nd generation dynamic RMS model parameters of the connecting Power Park Modules (PPMs) to the Northern Irish electrical network covering the following types of generators:

- Wind Farms;
- Solar Photovoltaic Plants; and
- Battery Energy Storage Power Stations.

The Synchronous Power Generating Modules (SPGM) and HVDC are out of the scope of this document as full detailed models are required for those connections. Similarly, EMT model requirements are not described in this document as they will be covered in a separate document.

Presently, SONI requests detailed dynamic models of the connecting facilities for Fault Ride-Through (FRT) studies. Information on the requirements of the FRT studies and FRT dynamic models can be found in the Simulation Studies and Modelling Requirements for Compliance Demonstration [2].

Besides the FRT dynamic models which require vendor-specific libraries (e.g. PSSE UDM librares), the WECC generic models of the facilities are also required because, for computational efficiency purposes, the control centres in Ireland and Northern Ireland use 2nd generation WECC generic models with site-specific parameters to assess the impact and performance of the facilities on the transmission system in real time operations.

The FRT dynamic model is expected to be a detailed Root-Mean-Square (RMS) representation of the facility using vendor-specific libraries which are hard-coded and may not be disclosed to users for confidentiality reasons. The vendor libraries are regarded as a “black box” with essentially unknown characteristics. On the other hand, generic models provide a medium for the manufacturers to represent their equipment without revealing any proprietary data to other users. The detailed RMS-based dynamic models are of great importance for future planning studies of the network, but generic models are used in real-time operations due to the limitations and complexities presented by the vendor specific libraries.

The 2nd generation generic models developed by WECC are RMS-based positive sequence reduced order models reflecting normal operation controls as well as the dynamic controls managed by the generation units. They are non-proprietary and accessible to all users without the need for non-disclosure agreements. Further information on WECC generic models can be found in [1] and [3].

It should be noted that the WECC 2nd generation models are required for PPM models to be used in Operational studies **only** and they should be provided alongside those listed in [2] with regards RMS, EMT and Harmonic modelling requirements to demonstrate FRT capability of the plant.

SONI also provides a spreadsheet titled "WECC-Model-Submission-Spreadsheet-v1.0.xlsx" to the customers to be used in the parameter submissions. Check up-to-date version in SONI's Library. The current version (v1.0) of the spreadsheet is available on the SONI website.

Note that for a realistic assessment, the submitted models must reflect site-specific parameters, therefore generic values for the parameters will not be accepted by SONI. This should be demonstrated via an accompanying model validation report, which is expected to be delivered post-grid code compliance testing, comparing the submitted models response to on-site measurements recorded during the grid code compliance testing.

All the TSO PPM customers are requested to submit WECC 2nd generation models of their facility to SONI. For the DSO PPM customers, it depends on the Registered Capacity of the facility as given in the following table.

Table 2 - Customers Required to Submit WECC Models

Generator Type	Customer Type	Registered Capacity
Wind Farms Solar PV Plants Battery ESPS	TSO Customers	All Customers
	DSO Customers	Reg. Cap. ≥ 5 MW*

* SONI doesn't require any WECC model submission from the DSO customers < 5MW

The indicative timeline for the submission of the WECC model parameters is given in Figure 1. Customers are required to submit an initial version of the parameters at least 6 months before the scheduled energisation of the facility. After the completion of Grid Code Compliance Tests including approval of the pertaining test reports by SONI, a validation report should be submitted no later than 2 months post grid code compliance test completion, demonstrating that the provided set of values reflect the site-specific configuration of the generation units or providing an alternative set of parameters that are reflective of the as-built tuned controls of the facility as demonstrated during the grid code testing.

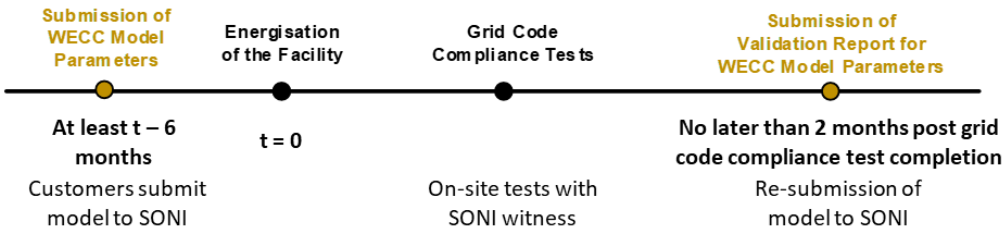

Figure 1 - Timeline for the WECC Model Parameters Submission [4]

2. Grid Code Requirements

In the Grid Code, a PPM is defined as a generation unit or ensemble of generation units generating electricity which is connected to the network non-synchronously or through power electronics, and has a single connection point onshore to a transmission system, distribution system, or HVDC system.

Note that Battery Energy Storage Power Stations (ESPS) can also be called Battery Energy Storage Systems (BESS) and are classified as PPMs.

The active Grid Code and Distribution Code at the time of preparation of this document are as follows:

- The SONI Grid Code: dated 09/02/2023. The most up-to-date version is available on the SONI website [5].
- The NIE Networks Distribution Code: Issue 5, 26/04/2019. The most up to-to-date version is available on the NIE website [6].

The WECC modelling requirements fall under SONI Grid Code Appendix D and Distribution Code DCC4.7. See the following excerpts from the Grid Code related to Modelling Requirements:

- **Grid Code PC.D2.2: General**
    - All Users shall provide the TSO with suitable and accurate Models in order for the TSO to assess the impact of the connection on the transient performance, security and stability of the System.
    - The Models submitted by the User shall be representative of the Users Plant and Apparatus at the Connection Point. All Models must take into account all communication, controller and processing delays of the Users Plant and Apparatus. If all Generating Units contained within the Users Plant and Apparatus are not identical, the Model shall account for this by accurately representing the overall performance of the Users Plant and Apparatus at the Connection Point.
- **Grid Code PC.D4: Model Documentation and Source Code**
    - Users shall provide the TSO with an appropriate balanced, root mean-squared positive-phase sequence time domain Model and a three-phase electromagnetic transient Model in accordance with this Grid Code. The TSO requires that sufficient information be provided by the User to allow for Models to be redeveloped in the event of future software environment changes or version updates. All Models shall be accompanied with appropriate documentation with sufficient detail as specified and deemed complete by the TSO (such agreement not to be unreasonably withheld or delayed). The User shall provide information including, but not limited to, a full description of the Model structure, inputs/outputs and functionality, Laplace diagrams or other suitably understandable information. The User shall provide a description of the controller's functionality of all levels of control on the Users Plant and Apparatus, along with manufacturer details,

version and operation manual. The User may also choose to provide the TSO with Model source code. The Models shall be provided in a software format as specified by the TSO. Alternatively, the User may provide an unambiguous reference to a standard open-source Model, such as a standard IEEE Model, or to a Model previously submitted to the TSO provided this Model accurately reflects the Users Plant and Apparatus at the Connection Point.

- The TSO may, when necessary to ensure the proper operation of its complete system representation or to facilitate its understanding of the results of a dynamic simulation, request additional information concerning the Model, which may include Model documentation or source code of one or more routines in the Model. The User shall comply with such request without undue delay.

- **Grid Code PC.D7: Validation**

  - The Models provided to the TSO must be validated. The TSO must be satisfied that behaviour shown by the Model under simulation conditions is representative of the Users Plant and Apparatus under equivalent conditions.

  - Prior to energisation of the Users Plant and Apparatus, and where appropriate, the User shall provide type test results to show that the responses shown by the Models are representative of the Users Plant and Apparatus under laboratory test conditions.

  - Post Commissioning/Acceptance Testing the User shall complete dynamic simulations using the Models such that responses shown by the Models can be compared against measurements from Commissioning/Acceptance Testing to ensure the Model responses are representative of the Users Plant and Apparatus. Tests may include but are not limited to steady state reactive capability, Voltage control & Reactive Power stability, low Voltage ride through, high Voltage ride through, low Frequency response and high Frequency response. If these tests show the Models are not representative of the Users Plant and Apparatus, the User shall provide updated Models, supporting documentation and associated data to ensure the responses shown by the Models is representative of the responses shown by Users Plant and Apparatus during Commissioning/Acceptance Testing.

  - Through Monitoring, the TSO shall ensure that Models submitted by the User remain representative of the Users Plant and Apparatus throughout the operational lifetime of the Users Plant and Apparatus.

  - In the event the TSO identifies that the response of the Models are not representative of the Users Plant and Apparatus, the TSO shall notify the User. The User shall provide the revised Models, supporting documentation and associated data whose response is representative of the Users Plant and Apparatus as soon as reasonably practicable, but in any case no longer than 30 Business Days after notification of the noncompliance by the TSO, or as otherwise agreed with the TSO.

- In the event of the User modifying hardware/software which affects the control and/or operation of the Users Plant and Apparatus, the User shall provide the TSO with updated Models, supporting documentation and associated data to enable the TSO to assess the impact of the modification of the Users Plant and Apparatus on the System. The User shall not implement any hardware/software modifications to the Users Plant and Apparatus without prior agreement with the TSO.

The RfG and Non-RfG Generation Units are described in the Grid Code as follows:

1. **RfG Generation Unit:**

   Indicated with the symbol of ◯. A Generation Unit that is <u>not</u> a Non-RfG Generation Unit.

2. **Non-RfG Generation Unit:**

   Indicated with the symbol of ⊖. A Generation Unit with a signed Connection Agreement:

   a. Connected to the Network on or before the 27th April 2019; or

   b. Whose owner has concluded a final and binding contract for the purchase of the main Plant on or before 17th May 2018 and provides evidence of same, as acknowledged by the TSO, on or before the 11th November 2018. Such evidence shall at least contain the contract title, its date of signature and date of entry into force, and the specifications of the main Plant to be constructed, assembled or purchased; or

   c. Is one of the exceptions to the applicability of the RfG Generation Unit requirements and is a Generating Unit as follows:

      i. Installed to provide back-up power and operate in parallel with the Network for less than five minutes per calendar month while the system is in normal state; or

      ii. No permanent Connection Point and is used by the TSO to temporarily provide power when normal system capacity is partly or completely unavailable; or

      iii. Energy Storage Units except for Pumped Storage Plant.

   A Non-RfG Generating Unit that undergoes modernisation, refurbishment or replacement of equipment which drives a modification to its Connection Agreement and had concluded a final and binding contract for the purchase of the Plant being modified after 27th April 2019 will be deemed an RfG Generating Unit, unless the Plant being modified is one of the exceptions listed in (c) above.

3. WECC Models

The required 2nd generation WECC generic models for each type of generator are listed in the table below. The model parameters are expected to be site-specific, generic model parameters will not be accepted.

If a 2nd generation WECC model is not available for a plant, and for the generator types not listed in the table below, please contact SONI.

The model names are given in the PSS/E v34 format just for information purposes only. The set values of the parameters are required to be submitted through the provided spreadsheet by SONI.

Table 3 - The 2nd Generation WECC Models in PSS/E V33 Format

Model Name	Generator Type			
	Wind Type 3	**Wind Type 4**	**Solar Photovoltaic**	**Energy Storage**
Generator/Converter[1]	REGCA1	REGCA1	REGCA1	REGCA1
Electrical Controller	REECA1	REECA1	REECD1	REECC1
Plant Controller	REPCTA1	REPCA1	REPCA1	REPCA1
Drive-Train	WTDTA1	WTDTA1*	-	-
Pitch Control	WTPTA1	-	-	-
Aerodynamic	WTARA1	-	-	-
Torque Control	WTTQA1	-	-	-

* Optional

The WECC models for the protection systems are shown in the following table. The submission of the site-specific parameters for the protection systems is also required.

Table 4 - WECC Models for the Protection Systems

Model Name for Generator Protection	For All Facilities
Low/High Frequency Ride-Through	FRQTPAT, FRQDCAT
Low/High Voltage Ride-Through	VTGTPAT, VTGDCAT

[1] The REGCA1model is the default generator model which is required to be submitted, however this will be decided on a cases and sometimes a REGCB or REGCC model may be required (e.g. when PPM is connecting at locations of low system strength as determined by SONI)

If the parameters change in different operating modes, this should be clearly indicated along with the associated values. For Battery ESPS connections, the WECC model parameters for the operating modes outlined in Table 6 are required to be submitted.

A list of parameters for the generic model should be provided for the generator when in reactive power (Q) and voltage (V) control mode, for the reactive power control tests outlined in Table 7.

4. Validation Report

Dynamic models play a crucial role in the real-time stability analysis of the transmission network. Generic parameters are not acceptable and submitted models should reflect site-specific behaviour of the generation plant. Therefore, validation of the submitted parameters against on-site Grid Code Compliance tests is required. SONI require that the WECC 2nd generation models are validated against site specific Grid Code Compliance tests.

Information on the Grid Code Compliance & Testing procedures is available on SONI's website [5]

The required Grid Code Compliance tests for WECC model validation purposes are as follows:

- Fault Ride Through (FRT) and Active Power Recovery
- Frequency Control Tests
- Reactive Power Control Tests

The validation report should demonstrate that the WECC models provided prior to energisation can reproduce with reasonable accuracy the Grid Code Compliance tests for that specific site, and also a comparison of the WECC 2nd generation generic model with site specific parameters to the submitted detailed user defined model with site specific parameters for FRT and active power recovery purposes. Alternatively, updated model parameters must be provided.

The actual set points and measurements taken during the Grid Code Compliance tests should be considered for the purpose of validating the WECC model for the Frequency and Reactive Power Control Tests. For the FRT and Active Power Recovery validation, a comparison between the generic model and detailed user defined model should be presented using the fault simulations detailed in [2].

If any control parameters have been re-tuned during commissioning tests, these should be highlighted in the report and the updated parameters and set values should be submitted to SONI.

Any software capable of running dynamic studies can be used for the validation of WECC model parameters e.g. PSSE, Digsilent Powerfactory, DSA Tools TSAT.

The simulation outputs of the submitted model should be compared against recorded results of the compliance tests conducted at the physical site. The comparison can be done by plotting the outputs of the model simulations and the compliance tests on graphs. Evaluation on the obtained results is required. The validation test data must be submitted to SONI in the format of a time series record and Microsoft Excel Plot.

Note that there might be updates in the Grid Code Compliance templates and different procedures might be followed for older connections. Also, there might be differences in the specified test parameters and on-site measurements due to generator specifications or other conditions. Use the on-site setpoint values, measurements and the test procedures for reference in the validation studies.

SONI is primarily interested in the verification of the dynamic aspects of the Grid Code tests. For the tests with extensive duration, it is possible to split the simulations and focus only on the time periods where the dynamic response is provided.

Note that a sufficient state-of-charge level should be assumed for the studies of Battery ESPS units.

4.1. Fault Ride Through (FRT) and Active Power Recovery

The purpose of this validation is to confirm the accuracy of the generic model to the detailed user defined model with respect to FRT and active power recovery post fault. The user defined model (and acoompanying FRT studies) should be submitted as part of the pre-energisation phase of the connections process.

This study should confirm that the generator remains connected and stable post the occurrence of a fault on the network whilst meeting the capability requirements CC.S2.1.4 and CC.S2.2.3.4 for transmission and distribution connected PPMs respectively.

The FRT and Active Power Recovery tests for the validation studies required for WECC modelling are listed in the following table. Please refer to [2] and [5] for more information on the required simulations to demonstrate FRT capability of the unit and the FRT requirements for units.

Table 5 – FRT and Active Power Recovery Validation

Generator Type	Fault Type	Retained Voltage (p.u.)	Duration (ms)
RfG and Non-RfG PPM (Wind and Solar)	Three-phase fault	0	150
Battery ESPS		0.85	2900

To simulate the validation of the generic model to the detailed user defined model, the powerflow model presented in Figure 2 is sufficient for the purpose of this study. System impedance, shown in Figure 2, needs to be taken from the Minimum System Strength Report.

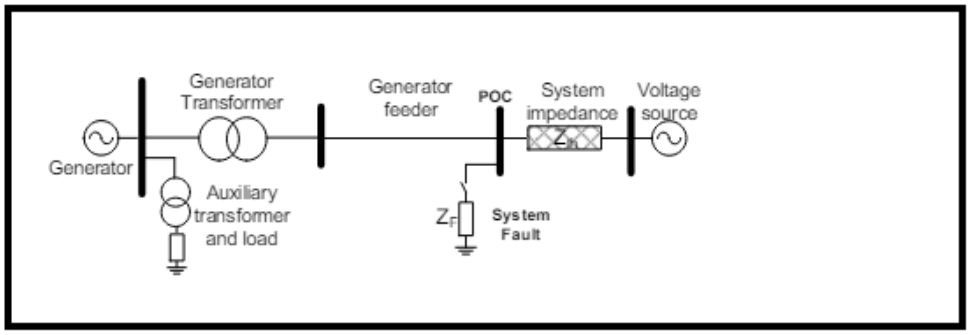

Figure 2 - General model SLD for FRT validation

More information on the required FRT and active power recovery capabilities iis provided in the SONI grid code [5], and the simulations requirements are presented in the SONI modelling requirements document [2].

4.2. Frequency Control Tests

The purpose of the Grid Code Compliance Frequency Control Tests is to confirm the ability of the PPM to respond to changes in system frequency. The unit shall be capable of operating with a "MW/Hz" slope – e.g. able to continuously adjust its active power output in response to changes in frequency.

The frequency response tests for the validation studies required for WECC modelling are listed in the following table. Please refer [4] - [7] for more information on the required Grid Code Compliance testing procedures.

Table 6 - GCC Frequency Response Tests

Generator Type	Required Procedures for Validation
RfG and Non-RfG PPM (Wind and Solar) [4] [8]	Injection Tests at Maximum Instantaneous Output (**MIO)**
	Injection Tests at 50% of **MIO**
	Injection Tests at Designed Minimum Operating Level (**DMOL)**
Battery ESPS [7]	Frequency Response ON, Mode 1
	Frequency Response ON, Mode 2
	Frequency Response ON, Mode 5

Information on the test procedures are available online, for:

- Power Park Module Settings Schedule (RfG) [4];
- Wind Farm Settings Schedule (non RfG) [7]; and
- Batteries ESPS Compliance Procedure [8]

4.3. Reactive Power Control Tests

The purpose of the Grid Code Compliance Reactive Power Control Tests is to confirm correct operation of Automatic Voltage Regulation (AVR) system of the facilities in Voltage Regulation (kV) and Reactive Power (Q) modes and Power Factor (PF) modes, and also changing between these modes.

The reactive power control tests for the validation studies required for WECC modelling are listed in the following table. Please refer [4] - [8] for more information on the required Grid Code Compliance testing procedures.

Table 7 - GCC Reactive Power Control Tests

Generator Type	Required Procedures for Validation
RfG/Non-RfG PPM (Wind and Solar) [4] [7]	Voltage Control Mode
	Automatic Voltage Control Mode
	Reactive Power Dispatch
Battery ESPS [8]	Automatic Voltage Regulation Mode
	Automatic Voltage Regulation Response Rate
	MVAr Control Mode
	Power Factor Control Mode

Information on the test procedures are available online, for:

- Power Park Module Settings Schedule (RfG) [4];
- Wind Farm Settings Schedule (non RfG) [7]; and
- Batteries ESPS Compliance Procedure [8]

4.4. Accuracy Requirements

The limitations of using generic models to emulate the behaviour of actual systems are acknowledged by SONI. The responses of the facilities should be simulated in a reasonable manner and as accurately as the generic models allow. Therefore, the accuracy requirements should be considered as target values to reach. There could be deviations out of the given limits. In such cases, the results should be analysed and discussed if it is possible to obtain more accurate responses while adjusting the parameters of the WECC models.

The validation studies shall have the following accuracy requirements:

- For a linear response over a frequency range of 0.1 to 5 Hz, deviations between simulated and measured waveforms of the control system must be less than 10% for amplitude and less than 5 degrees for the phase angle. Discrete waveform changes (amplitude spikes) on the simulated waveform should be less than 10% in relation to measured quantity and in the case of where this level is exceeded due to numerical integration issues, this should be documented in the report.
- For dynamic time domain simulations where non-linear response is included to replicate set point changes or response to disturbances on the wider network, the following requirements apply for deviations between simulated and measured responses:
    - Oscillation in active power, reactive power, voltage and frequency in the 0.1-5Hz range must have damping and the deviation in the frequency of oscillation must be less than 10% for 95% of the recorded samples;
    - Considering possible difference in the voltage at the connection point, deviation in generator response (active power, reactive power, etc.) must be less than 10% for 95% of the samples;
    - Considering possible difference in the final settled value of voltage at the connection point, the final value of generator response (active power, reactive power, etc.) must settle to within 2% of the plants rated capacity.
- All studies should be capable of running under with a user defined integration time step in the range of 1 to 10 ms, 5 ms is the preferred time step.;

The remainder of the RMS model simulation requirements are outlined in Section 2.2.2. in [2].

References

[1] “Western Electricity Coordinating Council (WECC),” [Online]. Available: https://www.wecc.org.

[2] SONI, “Simulation Studies and Modelling Requirements for Compliance Demonstration,” 29 June 2021. [Online]. Available: https://www.soni.ltd.uk/media/documents/1.-SONI_RfG_Simulation-Requirements_290621.pdf.

[3] Western Electricity Coordinating Council (WECC), “WECC Approved Dynamic Model Library,” WECC, May 2022. [Online]. Available: https://www.wecc.org/Reliability/Approved%20Dynamic%20Models%20May%202022.pdf.

[4] SONI, “Power Park Module Setting Schedule,” October 2020. [Online]. Available: https://www.soni.ltd.uk/media/documents/PPM-Setting-Schedule-October-2020.pdf.

[5] SONI, “Grid Code,” [Online]. Available: https://www.soni.ltd.uk/how-the-grid-works/grid-codes/.

[6] NIE, “Distribution Code,” [Online]. Available: https://www.nienetworks.co.uk/about-us/distribution-code.

[7] SONI, “WFPS Settings Schedule - Version 6,” 31 July 2015. [Online]. Available: https://www.soni.ltd.uk/media/documents/Operations/Grid-Code/SONI-GridCodeWFPS-SettingsScheduleVersion6-31-07-2015.pdf.

[8] SONI, “SONI Battery ESPS Compliance Test Procedures,” [Online]. Available: https://www.soni.ltd.uk/media/documents/Battery-ESPS-Compliance-Procedures.pdf.

Appendix - Model Parameters

Please refer to Table 3 for required WECC models to be submitted for each technology type.

B.1. Generator/Converter - REGCA1

Table 8 - Parameters of Generator/Converter – REGCA1

Generator/Converter	
REGCA1	
Parameter	**Value**
Lvplsw	
Tg	
Rrpwr	
Brkpt	
Zerox	
Lvpl1	
Volim	
Lvpnt1	
Lvpnt0	
Iolim	
Tfltr	
Khv	
Iqrmax	
Iqrmin	
Accel	

B.2. Plant Controllers - REPCTA1/REPCA1

Table 9 - Parameters of Plant Controllers

Plant Controller			
REPCTA1		**REPCA1**	
Parameter	**Value**	**Parameter**	**Value**
VCFlag		VCFlag	
RefFlag		RefFlag	
Fflag		Fflag	
Tfltr		Tfltr	
Kp		Kp	
Ki		Ki	
Tft		Tft	
Tfv		Tfv	
Vfrz		Vfrz	
Rc		Rc	
Xc		Xc	
Kc		Kc	
emax		emax	
emin		emin	
dbd1		dbd1	
dbd2		dbd2	
Qmax		Qmax	
Qmin		Qmin	
Kpg		Kpg	
Kig		Kig	
Tp		Tp	
fdbd1		fdbd1	

fdbd2		fdbd2	
femax		femax	
femin		femin	
Pmax		Pmax	
Pmin		Pmin	
Tg		Tg	
Ddn		Ddn	
Dup		Dup	

B.3. Electrical Controller - REECA1

Table 10 - Parameters of Electrical Controller - REECA1

Electrical Controller			
REECA1			
Parameter	**Value**	**Parameter**	**Value**
PFFLAG		Kvi	
VFLAG		Vbias	
QFLAG		Tiq	
PFLAG		dPmax	
PQFLAG		dPmin	
Vdip		PMAX	
Vup		PMIN	
Trv		Imax	
dbd1		Tpord	
dbd2		Vq1	
Kqv		Iq1	
Iqh1		Vq2	
Iql1		Iq2	
Vref0		Vq3	
Iqfrz		Iq3	
Thld		Vq4	
Thld2		Iq4	
Tp		Vp1	
Qmax		Ip1	
Qmin		Vp2	
VMAX		Ip2	
VMIN		Vp3	

Kqp		Ip3	
Kqi		Vp4	
Kvp		Ip4	

B.4. Electrical Controller - REECCU1

Table 11 - Parameters of Electrical Controller - REECCU1

Electrical Controller			
REECCU1			
Parameter	**Value**	**Parameter**	**Value**
PFFlag		Pmax	
VFlag		Pmin	
QFlag		Imax	
PQFlag		Tpord	
Vdip		Vq1	
Vup		Iq1	
Trv		Vq2	
dbd1		Iq2	
dbd2		Vq3	
Kqv		Iq3	
Iqh1		Vq4	
Iql1		Iq4	
Vref0		Vp1	
Tp		Ip1	
Qmax		Vp2	
Qmin		Ip2	
Vmax		Vp3	
Vmin		Ip3	
Kqp		Vp4	
Kqi		Ip4	
Kvp		T	
Kvi		SOCini	

Tiq		SOCmax	
dPmax		SOCmin	
dPmin			

B.5. Electrical Controller - REECDU1

Table 12 - Parameters of Electrical Controller - REECDU1

Electrical Controller					
REECDU1					
Parameter	**Value**	**Parameter**	**Value**	**Parameter**	**Value**
PFFLAG		Tiq		Ip1	
VFLAG		dPmax		Vp2	
QFLAG		dPmin		Ip2	
PFLAG		PMAX		Vp3	
PQFLAG		PMIN		Ip3	
VcmpFlag		Imax		Vp4	
Vdip		Tpord		Ip4	
Vup		Vq1		Vp5	
Trv		Iq1		Ip5	
dbd1		Vq2		Vp6	
dbd2		Iq2		Ip6	
Kqv		Vq3		Vp7	
Iqh1		Iq3		Ip7	
Iql1		Vq4		Vp8	
Vref0		Iq4		Ip8	
Iqfrz		Vq5		Vp9	
Thld		Iq5		Ip9	
Thld2		Vq6		Vp10	
Tp		Iq6		Ip10	
Qmax		Vq7		rc	
Qmin		Iq7		Xc	
VMAX		Vq8		Tr1	

VMIN		Iq8		Kc	
Kqp		Vq9		Ke	
Kqi		Iq9		Vblkl	
Kvp		Vq10		Vblkh	
Kvi		Iq10		Tblk	
Vbias		Vp1			

B.6. Other Controllers

Table 13 - Parameters of Drive Train & Pitch Control

Drive-Train		Pitch Control	
WTDTA1		**WTPTA1**	
Parameter	**Value**	**Parameter**	**Value**
H		Kiw	
DAMP		Kpw	
Htfrac		Kic	
Freq1		Kpc	
DSHAFT		Kcc	
		Tp	
		TetaMax	
		TetaMin	
		RTetaMax	
		RTetaMin	

Table 14 - Parameters of Aerodynamic & Torque Control

Aerodynamic		Torque Control	
WTARA1		**WTTQA1**	
Parameter	**Value**	**Parameter**	**Value**
Ka		Tflag	
Theta0		Kpp	
		KIP	
		Tp	
		Twref	
		TeMax	
		TeMin	

p1	
spd1	
p2	
spd2	
p3	
spd3	
p4	
spd4	
TRATE	

B.7. Protection Systems

Table 15 - Parameters of Low/High Frequency Ride-Through

Low/High Frequency Ride-Through			
FRQTPAT		**FRQDCAT**	
Parameter	**Value**	**Parameter**	**Value**
FL		FL	
FU		FU	
TP		TP	
TB		TB	

Table 16 - Parameters of Low/High Voltage Ride-Through

Low/High Voltage Ride-Through			
VTGTPAT		**VTGDCAT**	
Parameter	**Value**	**Parameter**	**Value**
VL		VL	
VU		VU	
TP		TP	
TB		TB	