Order no. 208 of 14.12.2018

approving the technical norm on the technical requirements to connect power-generating modules, power plants modules and offshore power park modules to public electrical grids

In view of the provisions of Article 36 (7) letter n) of the Electricity and Natural Gas Act no. 123/2012, as subsequently amended and supplemented, of Article 7 (1) and (4) of the Commission Regulation (EU) 2016/631 of 14 April 2016 establishing a network code on requirements for grid connection of generators,

pursuant to the provisions of Article 5 (1) (c) and (d) and of Article 9 (1) (h) of the Emergency Government Ordinance no. 33/2007 on the organization and functioning of the National Energy Regulatory Authority, approved as subsequently amended and supplemented by Law no. 160/2012, as subsequently amended and supplemented,

the President of the National Energy Regulatory Authority hereby issues the present order:

Article 1. Approval is granted for the technical norm on the technical requirements to connect power-generating modules, power park modules and offshore power park modules to public electrical grids, provided in the annex which is an integral part of this order.

Article 2. Economic operators in the electricity sector fulfill the provisions of this order and the organizational entities within the National Energy Regulatory Authority supervise the compliance therewith.

Article 3. On the date of entry into force of this order, the following shall be abrogated:

a) Article 2 of the annex to the Order no. 51/2009 of the President of the National Energy Regulatory Authority approving the technical norm "Technical requirements to connect wind power plants to the public electrical grids", published in the Official Journal of Romania, Part I, no. 306 of 11 May 2009, as subsequently amended and supplemented;

b) Article 2 of the annex to the Order no. 30/2013 of the President of the National Energy Regulatory Authority approving the technical norm "Technical requirements to connect photovoltaic power plants to the public electrical grids", published in the Official Journal of Romania, Part I, no. 313 of 30 May 2013, as subsequently amended.

Article 4. This order shall be published in the Romanian Official Journal, Part I, and enters into force on 27 April 2019.

President,

Dumitru Chiriță

Annex

Technical norm on the technical requirements to connect power-generating modules, power park modules and offshore power park modules to public electrical grids

Chapter I

General provisions

Section 1. Purpose

Article 1. This technical norm sets out the minimum technical requirements for connecting the following to public electrical grids:

(a) power-generating modules;
(b) power park modules;
(c) offshore power park modules with one or more offshore connection points in alternating current (AC).

Section 2. Scope

Article 2.

(1) The technical requirements regarding connection provided in this technical norm shall apply to:
(a) new power-generating modules, according to the category to which they belong;
(b) new power park modules, according to the category to which they belong;
(c) offshore power park modules which are connected in alternating current (AC). The RSO shall set the AC offshore connection point of the offshore power park module.

(2) AC-connected offshore power park modules which fall within the scope of this technical norm shall be categorized in accordance with the following offshore grid connection system configurations:
(a) configuration 1: AC-connection via a single onshore connection point to the NPS, via which one or more offshore power park modules, interconnected via an offshore AC system, are connected to the onshore system;
(b) configuration 2: AC-connection to an onshore loop network, whereby a number of offshore power park modules are interconnected to form an offshore AC system and the offshore AC system is connected to the onshore system at two or more onshore network interconnection points.

(3) An AC-connected power-generating module located offshore which does not have an offshore connection point shall be considered as an onshore power-generating module and thus shall comply with the technical requirements governing power-generating modules situated onshore, provided in this technical norm.

(4) The transmission system operator (hereinafter referred to as "TSO") or distribution system operators (hereinafter referred to as "DSOs"), as the case may be, shall refuse to allow the connection of power-generating modules and power park modules which do not comply with the technical requirements set forth in this technical norm and which have not been granted a derogation.

(5) This technical norm shall not apply to:
(a) power-generating modules and power park modules connected to the power transmission grid and/or to the power distribution grid and which belong, in full

or in part, to islands of which the systems are not operated synchronously with the Continental Europe synchronous area;

(b) power-generating modules and power park modules which use emerging technology, provided in Article 66 of Commission Regulation (EU) 2016/631 of 14 April 2016 establishing a network code on requirements for network connection of generators (hereinafter referred to as the "Regulation"), except Article 30 of the Regulation;

(c) power-generating modules and power park modules which do not have a permanent connection point and are used by grid operators (TSO or DSO, as the case may be) to temporarily/occasionally provide power when the installed capacity of the power system is partly or completely unavailable;

(d) power-generating modules and power park modules installed for a determined time period, usually less than 2 years, which are operated in parallel with the system for less than five minutes in a given calendar month, with the system being operated in normal state. Parallel operation during maintenance or commissioning tests of that power-generating module shall not count towards the five-minute limit.

(e) storage devices except for pump-storage modules.

Article 3.

(1). The requirements of this technical norm shall not apply to existing power-generating modules and existing power park modules, except if:

(a) a type C or D power-generating module or power park module undergoes modernization/refitting which determines an update to the TCA/CnC according to the following procedure:

i. the power-generating module owner or the power park module owner who intends to perform modernization/refitting works shall give prior notice both to the RSO, and the TSO, as the case may be, of the project regarding the modernization/refitting of the power-generating module or the power park module;

ii. if the RSO considers that the modernization/refitting of the power-generating module/the power park module requires an update to the TCA/CnC, the RSO notifies the power-generating module owner or the power park module owner and NRA regarding the requirements that must be complied with according to the classification in the relevant categories for type C and type D power-generating modules/power park modules and according to the provisions of this technical norm, as well as regarding the necessity to update the TCA/CnC;

iii. NRA shall decide upon the obligation of the power-generating module/power park module to comply, in part or in full, with the requirements provided in this technical norm.

iv. the modernization/refitting works are the following:

- replacement/modernization of a component of a power-generating module, such as: the synchronous/asynchronous alternator which is operated asynchronously with the network to which it is connected through power electronics, conversion from the *stall control* generation type – class II or the *double feed* generation type – class III, to the *full convertor* generation type – class IV, replacement/modernization of photovoltaic panels or of component inverters, provided such modifications allow compliance with the provisions of this technical norm;

- modification of the generation capacity of the power-generating module/power park module (in part or in full), which leads to an increase in maximum active power of at least 10% for C type modules and of at least 5% for D type modules respectively;
- modification of the maximum active power of the power-generating module/power park module which leads to its conversion in the upper category;
- replacement of a number of power-generating modules or increase in the number of power-generating modules leading to the increase in approved power by at least 10% of the total power of the type C power park module and by at least 5% for type D modules, the modification of the P-Q-diagram by introducing new offset equipment or replacing the existing ones, the modification of the reactive/active power control systems, provided that such modifications allow compliance with the provisions of this technical norm.

Repair works for equipment mentioned in paragraph (iv) shall not be considered as modernization/refitting works (e.g. the modernization/replacement of control loops for active power, reactive power or voltage in the power park module).

(b) NRA shall decide to make a power-generating module/power park module subject to one or more requirements of this technical norm based on a proposal submitted by the TSO, according to the provisions of paragraphs (3) – (8).

(2). A power-generating module/power park module shall be considered as existing for the purposes of this technical norm when:

(a) it is connected to the network on the date of entry into force of this technical norm; or

(b) the power-generating module owner or the power park module owner concluded a firm contract for purchasing the main generating plant, within a maximum of two years from the date of entry into force of the Regulation, namely until 17.05.2018. The power-generating facility owner has the obligation to notify the RSO (TSO or DSO, as the case may be) regarding the conclusion of the contract no later than 30 months from the date of entry into force of the Regulation. The notification submitted by the power-generating facility owner to the RSO and to the relevant TSO shall at least indicate the contract title, its date of signature and date of entry into force and the specifications of the main generating plant to be constructed, assembled or purchased.

(3). The TSO may propose to NRA, following a public consultation with the stakeholders (DSO, power-generating module owners or power park module owners, etc.), to extend the application of the provisions set forth in this technical norm to existing power-generating modules/power park modules. The purpose of this extension is to address significant factual changes in the power system, including the integration of renewable energy sources, smart grids, distributed generation or demand response.

(4). In order to extend the application of the provisions set forth in this technical norm to existing power-generating modules/power park modules, the TSO shall perform a detailed and transparent quantitative cost-benefit analysis according to the provisions of Article 38 and Article 39 of the Regulation, which shall include:

(a) the assessment of costs associated with the compliance of power-generating modules/power park modules with the provisions of this technical norm;

(b) the socioeconomic benefit resulting from applying the requirements set out in this technical norm; and
(c) the possibility to apply alternative measures in order to reach the performances required by this technical norm.

(5). Before performing the quantitative cost-benefit analysis as described in paragraph (4), the TSO shall:
(a) carry out a preliminary qualitative comparison of costs and benefits;
(b) obtain NRA approval for carrying out the cost-benefit analysis.

(6). Within six months from receiving the report and the TSO proposal drafted in accordance with the provisions of Article 38 (4) of the Regulation, NRA shall decide upon the extension of the applicability of this technical norm to existing power-generating modules/existing power park modules. NRA's decision upon the extension of the applicability of this technical norm to existing power-generating modules/existing power park modules shall be published on NRA's website.

(7). The TSO shall take into consideration the results of the cost-benefit analysis and of the public consultation with the power-generating facilities owners in order to assess the application of the requirements set forth in this technical norm to existing power-generating modules/existing power park modules.

(8). The TSO may assess, every three years, the application of one or more requirements set forth by this technical norm to existing power-generating modules/existing power park modules, according to the criteria and procedures provided in paragraphs (4) – (7).

Section 3. Definitions and abbreviations

Article 4.

(1). For the purposes of this technical norm, the terms used bear the following meaning:

1. technical connection approval	means a written approval valid for a certain location only, to be issued by the grid operator upon request from a user about the possibilities and technical-economic conditions for network connection of demand facilities and/or generation facilities, while meeting the user's requirements as specified in the request;
2. pumped storage	means a hydro unit in which water can be raised by means of pumps and stored to be used for the generation of electrical energy;
3. frequency response deadband	means an interval used intentionally to make the frequency control unresponsive;
4. maximum capacity (Pmax)	means the maximum continuous active power which a generating unit can produce, less any load (demand), foreseen in the TCA/CnC or agreed upon between the relevant system operator and the power-generating facility owner;
5. black start capability	means the capability of recovery of a synchronous generating unit from a total shutdown through a dedicated auxiliary power source without any electrical energy supply external to the synchronous generating unit;

6. fault-ride-through capability (FRT or LVRT)	means the capability of electrical devices to be able to remain connected to the network and operate through periods of low voltage at the connection/interface point, as the case may be, caused by secured faults;
7. power park module	means one or more power-generating modules consisting of power generation plants (e.g.: inverters) or synchronous/asynchronous generators asynchronously connected to the network through power electronics, connected in a single point to the network;
8. equipment certificate	means a document issued by an authorized certifier for equipment used by a generating unit, demand unit, DSO, demand facility or high-voltage direct current system (HVDC system). The equipment certificate defines the scope of its validity at national or other level at which a specific value is selected from the range allowed at European level. For the purposes of replacing specific parts of the compliance process, the equipment certificate may include mathematical models that have been verified against actual test results;
9. connection certificate (CnC)	means the unique document issued by the grid operator for a demand facility and/or a generation facility, certifying the fulfillment of network connection requirements, namely the construction of the connection facility as well as the electrical facilities of the user, establishing the technical conditions for using the network after the final application of voltage to the facility;
10. fast fault current	means a current injected by a power-generating module/power park module or HVDC system during and after a voltage deviation caused by an electrical fault with the aim of identifying a fault by network protection systems at the initial stage of the fault, supporting system voltage retention at a later stage of the fault and system voltage restoration after fault clearance;
11. HVDC system maximum current	means the highest phase current, associated with an operating point inside the U-Q/P_{max}-profile of the direct current – alternating current converter station at maximum HVDC active power transmission capacity;
12. secured fault	means a fault which is successfully cleared according to the TSO's planning criteria;
13. P-Q-capability diagram	means a diagram describing the reactive power capability of a power-generating module/power park module in the context of varying active power at the connection/interface point, as the case may be;
14. U-Q/ P_{max}-profile	means a profile representing the reactive power capability of a power-generating module or a power park module in the context of varying voltage at the connection/interface point, as the case may be;
15. instruction	means any command, within its authority, given by a TSO or DSO to a power-generating facility owner, DSO, as the case may be, or HVDC system owner in order to perform an action;
16. main generating plant	means one or more of the items of equipment required to convert the primary source of energy into electricity;

17. frequency	means the frequency of the AC power system expressed in Hertz that can be measured in all parts of the synchronous area, considered as a quasi-constant value for the system in the time frame of seconds, with only minor differences between different measurement locations. Its nominal value is 50Hz;
18. houseload operation	means the operation which ensures that power-generating facilities are able to continue to supply their in-house loads in the event of network failures resulting in power-generating modules being disconnected from the network;
19. power-generating facility owner	means a natural or legal entity owning a power-generating facility;
20. inertia	means the capability of a rotating body, such as the rotor of an alternator, such that it maintains its state of uniform rotational motion and angular momentum unless an external torque is applied;
21. synthetic inertia	means the facility provided by the power park module or HVDC system to replace the effect of inertia of a synchronous generating unit to a prescribed level of performance;
22. frequency response insensitivity	means the inherent feature of a control system specified as the minimum magnitude of change in the frequency or input signal that results in a change of output power or output signal;
23. power-generating facility	means a facility that converts primary energy into electrical energy and which consists of one or more generating units connected to a network at one or more connection points;
24. power-generating module / power park module	means a unit or ensemble of units generating electricity (including synchronous or asynchronous generating units), which is either non-synchronously connected to the network or connected through power electronics, and that also has a single connection point to a transmission system, distribution system including closed distribution system or HVDC system;
25. offshore power park module	means a power park module located offshore with an offshore connection point;
26. relevant system operator	means the TSO or DSO to whose system a power-generating module, demand facility, distribution system or HVDC system is or will be connected;
27. slope	means the ratio of the change in voltage, based on reference 1 r.u. voltage, to a change in reactive power in- feed from zero to maximum reactive power, based on maximum reactive power;
28. connection point	means a physical point in the network to which a user is connected, representing the interface to which the power-generating module or the power park module or the HVDC system connects to a power transmission grid, to an offshore network;
29. interface point	means a point in which the user's facilities are interfaced in terms of ownership from the grid operator's facilities;
30. HVDC interface point	means a point at which the HVDC equipment is connected to an AC network, at which technical specifications affecting the performance of the equipment can be prescribed;

31. active power	means the real component of the apparent power at fundamental frequency, expressed in watts (W) or multiples thereof such as kilowatts ("kW") or megawatts ("MW");
32. apparent power	means the product of voltage and current at fundamental frequency, and the square root of three in the case of three-phase systems, usually expressed in kilovolt-amperes ("kVA") or megavolt-amperes ("MVA");
33. installed capacity	means the nominal (apparent) active power of a power-generating module, indicated in the technical documentation of the constructing manufacturer and registered on the nameplate or indicated by the manufacturer. For power park modules, the installed capacity results from the sum of installed capacities of all power-generating modules in the power park module. For photovoltaic power park modules, the installed capacity is the minimum between the sum of nominal powers of inverters and the sum of nominal powers of photovoltaic panels in the power park module;
34. reactive power	means the imaginary component of the apparent power at fundamental frequency, usually expressed in kilovar ("kVAr") or megavar ("MVAr");
35. island operation	means the independent operation of a whole network or part of a network that is isolated after being disconnected from the interconnected system, where at least one synchronous generating unit, one power-generating module, one power park module or one HVDC system supplies power to this network and controls the frequency and voltage;
36. frequency control	means the capability of a power-generating module or power park module to adjust its active power output in response to a measured deviation of system frequency from a setpoint, in order to maintain stable system frequency;
37. limited frequency sensitive mode – overfrequency (LFSM-O)	means a power-generating module or power park module operating mode which will result in active power output reduction in response to a change in system frequency above a certain value;
38. limited frequency sensitive mode – underfrequency (LFSM-U)	means a power-generating module or power park module operating mode which will result in active power output increase in response to a change in system frequency below a certain value;
39. frequency sensitive mode (FSM)	means the operating mode of a power-generating module or power park module in which the active power output changes in response to a change in system frequency, in such a way that it assists with the recovery to target frequency;
40. network	means the ensemble of lines, including their support and protection elements, substations and other interconnected electricity equipment by means of which electricity is transmitted from a power generating capacity to a user; the network can be a transmission grid or a distribution grid;
41. high-voltage direct current system (HVDC system)	means a power system which transmits/transfers energy in the form of direct current (DC) and at a nominal voltage that is higher than or equal to 110 kV, between two or more alternating current (AC) buses and which comprises at least two alternating current/direct current converter stations and the

	overhead power lines or direct current cables between such stations;
42. embedded high-voltage direct current system	means an HVDC system connected within a control area that is not installed for the purpose of connecting a DC-connected power park module at the time of installation, nor installed for the purpose of connecting a demand facility;
43. steady-state stability (stability at minor disturbances)	means the ability of a network or an ensemble of generating units (power system) to revert and maintain stable operation following a minor disturbance (equivalent to the ability of a power system to reach steady-state identical to the initial state or very close to it, following any minor disturbance);
44. dynamic (transient) stability	means the ability of a network or an ensemble of generating units (power system) to revert to a synchronous operational state following one or several major disturbances;
45. droop	means the ratio of a steady-state change of frequency to the resulting steady-state change in active power output, expressed in percentage terms. The change in frequency is expressed as a ratio to nominal frequency (50 Hz) and the change in active power expressed as a ratio to maximum power $s2\ [\%] = 100\times (\Delta f/ f_n)\times (P_{max} /\Delta P)$
46. stator	means the portion of a rotating machine which includes the stationary magnetic parts with their associated windings;
47. power-generating unit	means either a synchronous generating unit or a power park module;
48. setpoint	means the target value for any parameter typically used in control schemes;
49. synchronous area	means an area covered by synchronously interconnected TSOs, such as the synchronous areas of Continental Europe ("CE"), Great Britain ("GB"), Ireland-Northern Ireland ("IRE") and Nordic ("NE") and the power systems of Lithuania, Latvia and Estonia, together referred to as "Baltic" which are part of a wider synchronous area.

(2). In this technical norm, the following abbreviations are used:

NRA	National Energy Regulatory Authority
TCA	Technical connection approval
AC	Alternating current
PTG code	Technical Transmission Grid Code
CnC	Connection certificate
DMS-SCADA	SCADA system of the distribution operator (Distribution Management System – Supervisory Control and Data Acquisition)
EMS-SCADA	SCADA of the transmission operator (Energy Management System – Supervisory Control and Data Acquisition)

ENTSO-E	European Network of Transmission System Operators for Electricity
LV	Low voltage
LVRT	Low voltage ride-through
MV	Medium voltage
DSO	Distribution operator; can be the concessionaire distribution operator or another operator owning a power distribution grid
RSO	Relevant system operator
TSO	Transmission and system operator
Ci	Installed capacity
PIF	Commissioning
PSS	Cross-zonal power oscillations stabilizer
AR	Automatic reset
AVR	Automatic voltage regulator
ASC	Automatic speed controller
PTG	Power transmission grid
PDG	Power distribution grid
FSM	Frequency sensitive mode
LFSM-O	Limited frequency sensitive mode – overfrequency
LFSM-U	Limited frequency sensitive mode – underfrequency
HVDC	High-voltage direct current system
SCADA	Supervisory, Control And Data Acquisition System of a technological process or facility
NPS	National Power System
r.u.	relative unit
Un	Nominal voltage of the network (reference voltage)

CHAPTER II
REQUIREMENTS FOR POWER-GENERATING MODULES

Section 1. REQUIREMENTS FOR POWER-GENERATING MODULES CONNECTED TO INDUSTRIAL PLATFORMS

Article 5.

(1). Offshore power park modules connected to the interconnected power system shall meet the requirements for onshore power-generating modules (with onshore connection point), unless the requirements are modified for this purpose by the RSO or unless the connection of power park modules is performed via a high voltage direct current connection or via a network whose frequency is not synchronously coupled to that of the interconnected system (such as via a back-to-back convertor scheme).

(2). For power-generating modules and power park modules connected to networks related to industrial platforms, their owners, the power grid operators of industrial platforms and the RSO to whose network the industrial platform's network is connected, shall have the right to agree upon the conditions of disconnection from the RSO network of these power-generating modules. The exercise of this right shall be coordinated with the TSO.

(3). For power-generating modules/power park modules connected to networks related to the industrial platforms, their classification is based on the maximum power, irrespective of the voltage level to which they are connected.

(4). The owner of the industrial platform networks, in coordination with the DSO or the TSO, as the case may be, may request (via the tender specifications) additional connection requirements specific to the D type (if the voltage of the industrial platform's connection point is higher than or equal to 110 kV), accompanied by a technical justification clarifying that such requirements aim at ensuring the operational security of the industrial platform.

Section 2. GENERAL REQUIREMENTS FOR TYPE A POWER-GENERATING MODULES

Article 6. Type A power-generating modules shall fulfil the following requirements **in relation to frequency stability:**

(a) the power-generating module shall be capable of remaining connected to the network and operate within the **frequency ranges** and time periods specified in table 1A;

(b) the power-generating module must remain connected to the network and must operate at frequency variation rates of 2 Hz/s for a period of 500 ms, of 1.5 Hz/s for a period of 1000 ms and of 1.25 Hz/s for a period of 2000 ms, depending on the technology type and the short-circuit power of the system at the connection point (a value provided by the RSO in the TCA). The protection controls at the connection point must allow operation of the power-generating module for these frequency variation profiles.

Table 1A. *The minimum duration for which a type A power-generating module has to be capable to remain connected to the network and to operate on different frequencies, deviating from a nominal value*

Frequency range	Duration for operation
47.5 Hz – 48.5 Hz	Minimum 30 minutes
48.5 Hz – 49 Hz	Minimum 30 minutes
49 Hz – 51 Hz	Unlimited
51.0 Hz – 51.5 Hz	30 minutes

Article 7. Type A power-generating modules shall be capable to ensure a limited frequency response, namely to **frequency increases** above the nominal value of 50 Hz (**LFSM-O**), thus:

(a) at overfrequencies, the power-generating module shall decrease the active power output according to the frequency variation, in accordance with figure 1A and with the following parameters:

i. the frequency threshold from which the power-generating module ensures overfrequency response is 50.2 Hz;

ii. the droop settings shall be between 2% and 12% and shall be provided by the RSO via operational controls, at the power-generating module's commissioning. Usually, the droop value equals 5%;

iii. the power-generating module shall be capable of decreasing the active power related to the frequency variation with an initial delay that is lower than 500 ms. If this delay is greater than 500 ms, the power-generating module owner shall justify the delay, providing technical evidence to the TSO. The response time for the active power decrease in the event of overfrequency shall be lower than or equal to 2 seconds for a power variation of 50% from the maximum active power.

(b) when reaching the power related to the minimum control level, the power-generating module shall be capable of:

i. containing the activated power within a duration of no more than 20 seconds and continuing its operation at this level (within the limits of the admissible power given by the primary source); or

ii. continuing to reduce the active power output according to the operational controls and in accordance with its own technical feature submitted together with the technical data, which does not deviate from the functional features of power-generating modules of the same type; or

iii. maintaining the power level reached with a permitted deviation of ±5% P_{max}, so long the frequency deviation is maintained.

(c) the power-generating module shall be stable during operation in the LFSM-O mode during frequency increases over 50.2 Hz. So long LFSM-O is active, the LFSM-O setpoint shall prevail over any other active power setpoints.

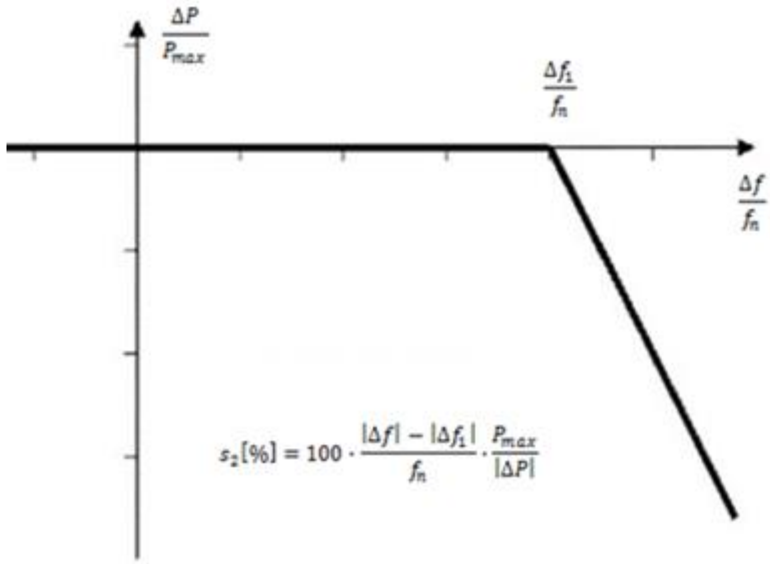


Figure 1A. *Active power frequency response capability of type A power-generating modules in LFSM-O*

where: ΔP is the change in active power output from the power-generating module; P_{max} *is the active power setpoint based on which ΔP is established – namely the maximum power of the power-generating module; Δf is the frequency deviation in the network;* f_n *is the nominal frequency (50 Hz) in the network. At overfrequencies where Δf is above + 200 mHz compared to the nominal value (50 Hz), the power-generating module has to decrease the active power according to the droop* s_2.

Article 8. The type A power-generating module shall be capable of maintaining constant output at its target active power value regardless of changes in frequency, within the limits of the power offered by the primary source, except where the power-generating module follows the frequency increases according to Article 7 or has acceptable power decreases at frequency decreases according to the provisions of Article 9 and Article 10.

Article 9. The TSO sets the active power output reduction of the power-generating module compared to the active power output (admissible power given by the primary source) following the frequency decrease, within the limits specified in figure 2A, hence:

(a) at underfrequencies below 49 Hz, an active power output decrease (admissible power given by the primary source) is admitted at a percentage of 2% from the maximum active power output at the frequency of 50 Hz, for every 1 Hz of frequency decrease. Any maximum active power output reduction curve situated above the dotted line is admitted depending on the frequency;

(b) at a frequency decrease under 49.5 Hz a maximum active power output decrease is admitted at a percentage of 10% from the maximum active power output at the frequency of 50 Hz, for every 1 Hz of frequency decrease, if the frequency is lower than 49.5 Hz for a duration of over 30 s. Any maximum active power reduction curve situated above the continuous line is admitted depending on the frequency.

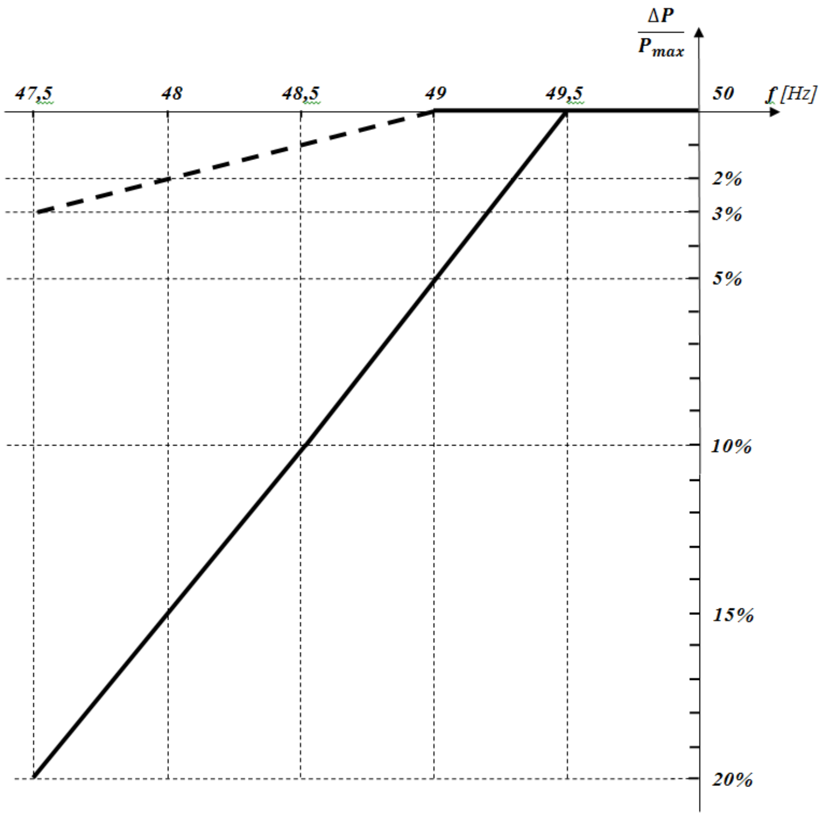


Figure 2A. *Admissible limits for power reduction established by the TSO in the event of underfrequency*

Article 10.

(1). The admissible active power reduction compared to the maximum active power output (admissible power, given by the primary source) in the event of frequency deviations under 49.5 Hz is established:

(a) under standard environmental conditions related to a temperature of 20 degrees Celsius. As the case may be, the owner submits to the RSO the dependency diagram of the active power in terms of temperature for at least one set of temperatures: -10^{0}C, 0^{0}C, 15^{0}C, 25^{0}C, 30^{0}C, 40^{0}C;

(b) depending on the technical capability of the power-generating modules.

(2). The power-generating module owner shall submit to the RSO and the TSO the dependency diagram of the active power in terms of environmental factors (temperature, pressure, solar irradiance, wind speed, as the case may be) and the technical data regarding the technical capability of the power-generating module, set forth in Annex 1 to this technical norm.

(3). The data provided in paragraph (2) shall be submitted during the commissioning stage within the connection process.

Article 11.

(1). The power-generating module shall be equipped with a logic interface in order to reduce the active power to the point of shut-down in a time period of no more than five seconds following a disconnection instruction being received at the input port. The RSO shall have the right to specify requirements for equipment to make this reduction controllable remotely.

(2). The technical requirements for the logic interface described in paragraph (1) are mandatory for type A power-generating modules connected in MV.

(3). For type A power-generating modules connected in LV, the RSO shall specify, in agreement with the power-generating module owner, the technical requirements and the mode of utilization of the logic interface.

Article 12.

(1). The RSO sets forth the requirements for the automatic connection of a power-generating module to the network, after these requirements have been agreed upon with the TSO.

(2). The requirements provided in paragraph (1) include:

(a) the frequency range in which the automatic connection is accepted, namely 47.5÷51 Hz, the voltage range (0.9-1.1 U_n), the observation/validation period (including the synchronization time) and the period for maintaining the metered parameters within the determined range, of maximum 300 seconds;

(b) the slope admitted for the active power increase after connection ($\leq$ 20 % P_{max}/min), usually 10% of the P_{max}/min (the setpoint is chosen within the range indicated by the power-generating module manufacturer)

Article 13. Under normal network operation, the power-generating module shall not produce fast voltage fluctuations at the connection/interface point, as the case may be, greater than ±5% of the nominal voltage of the network to which it is connected.

Article 14. Irrespective of the operational auxiliary installations and regardless of the power output, the power-generating module shall ensure, at the connection/interface point, as the case may be, the electricity quality according to applicable standards (European standards and the performance standard for providing the electricity transmission service and the system service, and the standard for providing the electricity distribution service respectively).

Article 15. The power-generating module is monitored in terms of electricity quality at the connection/interface point, as the case may be, during tests performed for verifying the compliance with the connection technical requirements. The RSO may require, as the case may be, a permanent monitoring of electricity quality at the connection/demarcation point, as the case may be, and the integration of the permanent monitoring equipment in its own electricity quality monitoring system.

Article 16. The connection solution of type A power-generating modules with installed capacities lower than 1 MW shall not allow their island operation, including via endowment with protections which trip the power-generating modules at the occurrence of such an operation state.

Section 3. GENERAL REQUIREMENTS FOR TYPE B POWER-GENERATING MODULES

Article 17. Type B power-generating modules shall fulfil the following requirements **in relation to frequency stability:**

(a) the power-generating module shall be capable of remaining connected to the network and operate within the frequency ranges and time periods specified in table 1B;

(b) (i) the power-generating module must remain connected to the network and must operate at frequency variation rates of 2 Hz/s for a period of 500 ms, of 1.5 Hz/s for a period of 1000 ms and of 1.25 Hz/s for a period of 2000 ms, depending on the technology type and the short-circuit power of the system at the connection point (a value provided by the RSO in the TCA), as well as the inertia available at synchronous area level.
(ii) the values provided in point (i) shall be notified to the power-generating module owner when issuing the TCA.
(iii) the protection controls at the connection point, coordinated by the RSO, must allow operation of the power-generating module for these frequency variation profiles.

Table 1B. *The minimum duration for which a type B power-generating module has to be capable to remain connected to the network and to operate on different frequencies, deviating from a nominal value*

Frequency range	Duration for operation
47.5 Hz – 48.5 Hz	Minimum 30 minutes
48.5 Hz – 49 Hz	Minimum 30 minutes
49 Hz – 51 Hz	Unlimited
51.0 Hz – 51.5 Hz	30 minutes

Article 18. Type B power-generating modules shall be capable to ensure a limited frequency response, namely to **frequency increases** above the nominal value of 50 Hz (**LFSM-O**), thus:

(a) at overfrequencies, the power-generating module shall decrease the active power output according to the frequency variation, in accordance with figure 1B and with the following parameters:
   i. the frequency threshold from which the power-generating module ensures overfrequency response is 50.2 Hz;
   ii. the droop settings shall be between 2% and 12% and shall be provided by the RSO via operational controls, at the power-generating module's commissioning. Usually, the droop value equals 5%;
   iii. the power-generating module shall be capable of decreasing the active power related to the frequency variation with an initial delay that is lower than 500 ms. If this delay is greater than 500 ms, the power-generating module owner shall justify the delay, providing technical evidence to the TSO. The response time for the power decrease in the event of overfrequency shall be lower than or equal to 2 seconds for a power variation of 50% from the maximum active power.

(b) when reaching the power related to the minimum control level, the power-generating module shall be capable of:
   i. containing the activated power within a duration of no more than 20 seconds and continuing its operation at this level (within the limits of the admissible power given by the primary source); or
   ii. continuing to reduce the active power output according to the operational controls and in accordance with the functional features of power-generating modules of the same type; or

iii. maintaining the power level reached with a permitted deviation of ±5% P_{max}, so long the frequency deviation is maintained.

(c) the power-generating module shall remain in stable operation during operation in the LFSM-O mode during frequency increases over 50.2 Hz. So long LFSM-O is active, the LFSM-O setpoint shall prevail over any other active power setpoints.

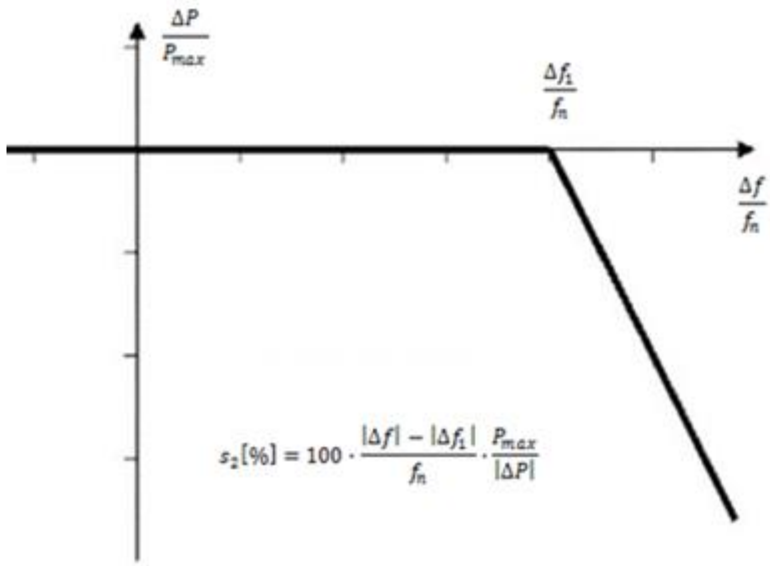


Figure 1B. *Active power frequency response capability of type B power-generating modules in LFSM-O*

where: ΔP is the change in active power output from the power-generating module; P_{max} is the active power setpoint based on which ΔP is established – namely the maximum power of the power-generating module; Δf is the frequency deviation in the network; f_n is the nominal frequency (50 Hz) in the network. At overfrequencies where Δf is above +200 mHz compared to the nominal value (50 Hz), the power-generating module has to decrease the active power according to the droop s_2.

Article 19. The type B power-generating module shall be capable of maintaining constant output at its target active power value regardless of changes in frequency, within the limits of the power offered by the primary source, except where the power-generating module follows the frequency increases according to Article 18 or has acceptable power decreases at frequency decreases according to the provisions of Article 20 and Article 21.

Article 20. The TSO sets the active power output reduction of the type B power-generating module compared to the maximum power output (admissible power given by the primary source) following the frequency decrease, within the admissible limits specified in figure 2B, hence:

(a) at a frequency decrease under 49 Hz an active power output decrease (admissible power given by the primary source) is admitted at a percentage of 2% from the maximum active power output at the frequency of 50 Hz, for every 1 Hz of frequency decrease. Any maximum active power output reduction curve situated above the dotted line is admitted depending on the frequency;

(b) at a frequency decrease under 49.5 Hz a maximum active power output decrease is admitted at a percentage of 10% from the maximum active power output at the frequency of 50 Hz, for every 1 Hz of frequency decrease, if the frequency is lower than 49.5 Hz for a duration of over 30 s. Any maximum active power reduction curve situated above the continuous line is admitted depending on the frequency.

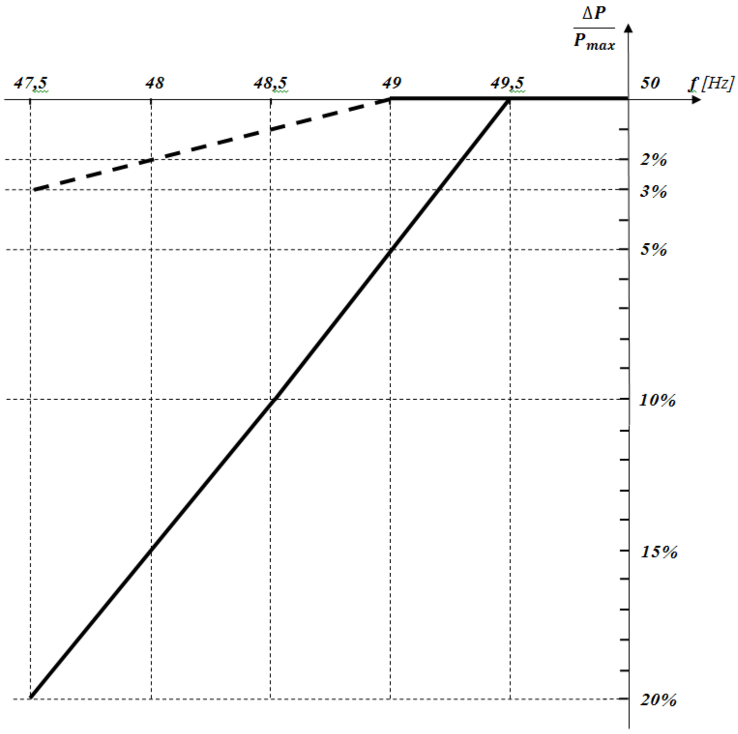


Figure 2B. *Admissible limits for power reduction established by the TSO in the event of underfrequency*

Article 21.

(1). The admissible active power reduction compared to the maximum power output (admissible power, given by the primary source) in the event of frequency deviations under 49.5 Hz is established:

(a) under standard environmental conditions related to a temperature of 20 degrees Celsius. As the case may be, the owner submits to the RSO the dependency diagram of the active power in terms of temperature for at least one set of temperatures: -10^{0}C, 0^{0}C, 15^{0}C, 25^{0}C, 30^{0}C, 40^{0}C;

(b) depending on the technical capability of the power-generating modules.

(2). The type B power-generating module owner shall submit to the RSO the dependency diagram of the active power in terms of environmental factors (temperature, pressure, solar irradiance, wind speed, as the case may be) and the technical data regarding the technical capability of the power-generating module, set forth in Annex 2 to this technical norm;

(3). The data provided in paragraph (2) shall be submitted during the solution study stage within the connection process.

Article 22.

(1). The type B power-generating module shall be equipped with a logic interface or corresponding protections in order to reduce the active power output to the point of shut-down in a time period of no more than five seconds following a disconnection instruction being received at the interface.

(2). The RSO is entitled to establish the technical requirements for the logic interface described in paragraph (1) and its connection method with its own SCADA system.

Article 23.

(1). The RSO sets forth the requirements for the automatic connection of a type B power-generating module to the network, after these requirements have been agreed upon with the TSO.

(2). The requirements provided in paragraph (1) include:

(a) the frequency ranges in which the automatic connection is accepted, namely 47.5÷51 Hz, the voltage range (0.9-1.1 U_n), the observation/validation period (including the synchronization time) and the period for maintaining the metered parameters within the determined range, of maximum 300 seconds;

(b) the slope admitted for the active power increase after connection ($\leq$ 20 % P_{max}/min), usually 10% of the P_{max}/min (value within the range indicated by the power-generating module manufacturer).

Article 24. Type B power-generating modules shall fulfil the following requirements in relation to load-frequency control in order to contain frequency:

(a) to control active power output, the power-generating module shall be equipped with an interface (input port) in order to be able to receive a downward power target;

(b) the power-generating module shall perform the power target within no more than 60 seconds, with a precision of ± 5% P_{max} and

(c) the RSO shall have the right to specify the requirements for further equipment to allow active power output to be remotely operated. These requirements shall be specified during the TCA issuance stage.

Article 25. Type B power-generating modules shall fulfil the following requirements in relation to **robustness, in terms of**:

(a) fault ride through capability:

i. the power-generating module must be capable to remain connected to the network, continuing its stable operation following a correctly secured fault in the network, according to the voltage-time dependency described in figure 3B, with respect to the connection/interface point, as the case may be;

ii. the voltage-against-time-profile represents a lower admissible limit of the actual course of the voltages at the connection/interface point during a symmetrical fault, as a function of time before, during and after the fault;

iii. the TSO shall specify and make publicly available the pre-fault and post-fault conditions for the fault-ride-through capability in terms of:

1. the pre-fault minimum short-circuit power calculation at the connection/interface point, as the case may be;
2. the pre-fault active and reactive power operating point of the power-generating module at the connection/interface point, as the case may be, and voltage at the connection/interface point, as the case may be; and
3. the post-fault minimum short-circuit power calculation at the connection/interface point, as the case may be;

iv. upon request by a power-generating module owner, the RSO shall provide the pre-fault and post-fault conditions to be considered for fault-ride-through capability as an outcome of the calculations at the connection/interface point, as the case may be, as specified in point (iii) regarding:

1. the pre-fault minimum short-circuit power at every connection/interface point, as the case may be, expressed in MVA;
2. the pre-fault operating point of the power-generating module, expressed in active power, reactive power and voltage at the connection/interface point, as the case may be; and

3. the post-fault minimum short-circuit power at the connection/interface point, as the case may be, expressed in MVA.

v. the power-generating module shall remain connected to the network and shall continue to operate stably when the actual course of the phase-to-phase voltages on the network voltage level at the connection/demarcation point, as the case may be, during a symmetrical fault, given the pre-fault and post-fault conditions described in points (iii) and (iv), remains above the lower limit specified in point (ii), except the triggering via the protections for internal electrical faults. The protection schemes and settings for internal electrical faults must not jeopardize fault-ride-through performance;

vi. considering the requirements provided in point (v), the power-generating module owner establishes the undervoltage protection (either the fault-ride-through capability, or the minimum voltage defined at the connection/interface point, as the case may be) according to the maximum voltage range corresponding to the power-generating module, except if the RSO requires a narrower range, according to Article 27 (b). The settings shall be justified by the power-generating module owner in accordance with the provisions set forth in point (v);

(b) fault-ride-through capability in case of asymmetrical faults which must comply with the requirements set forth in paragraph (a) point (i).

(c) post-fault active power recovery.

Figure 3B. *Fault-ride-through profile of a type B power-generating module*

Note: The diagram in figure 3B represents the lower limit of a voltage-against-time profile of the voltage at the connection/demarcation point, as the case may be, expressed in relative units as the ratio of its actual value and its reference value before, during and after a fault. U_{ret} is the retained voltage at the connection/demarcation point, as the case may be, during a fault, t_{clear} is the instant when the fault has been cleared. U_{rec1}, U_{rec2}, t_{rec1}, t_{rec2} and t_{rec3} specify certain points of lower limits of voltage recovery after fault clearance. The parameters related to the fault-ride-through are provided in table 2B.

Table 2B. *Parameters related to the fault-ride-through capability of type B power-generating modules*

Voltage parameters [r.u.]		**Time parameters [seconds]**	
U_{ret}:	0.15	t_{clear}:	0.25
U_{clear}:	0.15	t_{rec1}:	0.25

U_{rec1}:	0.15	t_{rec2}:	0.25
U_{rec2}:	0.85	t_{rec3}:	3

Article 26. Type B power-generating modules shall fulfil the following requirements in relation to **system restoration**:

(a) they shall be capable to reconnect to the network following an accidental disconnection caused by an event in the network, according to the operational controls and under the conditions defined by the TSO;

(b) installation of automatic reconnection systems shall be subject to prior authorization both by the RSO, and the TSO, in order to specify the automatic reconnection requirements. Usually, the automatic reconnection is performed within a (47.5÷50.5) Hz frequency range, a (0.85÷1.1) U_n voltage range and during a time period of (1÷10) minutes;

(c) the requirements and conditions for the automatic reconnection provided in letters (a) and (b) shall be notified to the power-generating module owner during the grid connection process, when issuing the TCA.

Article 27. Type B power-generating modules shall fulfil the following **general operational requirements in relation to**:

(a) control and automation schemes and related settings:

i. the control and automation schemes, as well as the related settings, including the control parameters, necessary for the network stability calculations and emergency measures analysis, shall be submitted by the power-generating module owner to the RSO or the TSO respectively, no later than 3 months prior to the application of voltage for the beginning of the testing period, in order for them to be coordinated and agreed upon between the TSO, RSO and the power-generating module owner;

ii. any changes to the control and automation schemes and settings, as referred to in point (i), of the different control devices of the power-generating module shall be coordinated and agreed upon between the TSO, the grid operator and the power-generating module owner.

(b) electrical protection schemes and related settings:

i. the protection systems needed for the power-generating module and the network, as well as the settings relevant to the power-generating module shall be coordinated and agreed upon between the RSO and the power-generating module owner, during the connection process. The functions of the protections shall be prescribed by the RSO who may request a different protection control than the one proposed by the owner. The protection systems and settings for internal electrical faults must not jeopardize the performance of the power-generating module. The protection and automation systems shall fulfill at least the following requirements:

1. they shall ensure protection against internal faults of the power-generating module and against abnormal operation states and faults from the network to which the module is connected;

2. they shall be efficient, highly reliable and organized in groups, selective, sensible, capable to detect internal and external faults, physically and galvanically separated from the power supplies with operative voltage, from voltage and current metering transformers to command execution devices. The protection systems shall be equipped with extended self-testing and self-diagnosis functions, as well as with events recording and oscillography

functions. The electrical protections system shall be equipped with standard communication interfaces aiming for the integration in a local system for data acquisition, supervision and control.

3. the internal faults electrical protections system shall be capable to detect at least the short-circuit currents in the power-generating module, the current asymmetry, stator and rotor electrical overloads, excitation loss of the power-generating module, maximum/minimum voltage in the power-generating module terminals, maximum/minimum frequency in the power-generating module terminals.

4. the external faults electrical protections system, as backup protections, shall be capable to detect at least the symmetrical and asymmetrical short-circuits from the network to which it is connected, the current asymmetry, the transition in the motor regime, the current and voltage electrical overloads.

ii. the electrical protection of the power-generating module shall take precedence over operational controls, taking into account the operational security of the system, the health and safety of staff and of the public, as well as mitigating any damage to the power-generating module.

iii. Together with the power-generating module owner, the RSO shall coordinate and commonly agree that the protection systems must cover at least the following faults:

A. power-generating module protections ensured by the power-generating module owner:

1. internal faults of the power-generating module (short-circuits or groundings);
2. short-circuits or groundings on the electrical line/connection cable;
3. short-circuits or groundings in the network, as backup protection;
4. maximum and minimum voltage at the power-generating module terminals.

B. protections covered by the power-generating module owner and/or the RSO, as the case may be:

1. short-circuits or groundings on the electrical line/evacuation cable of the power output;
2. maximum and minimum voltage at the connection/demarcation point, as the case may be;
3. maximum and minimum frequency at the connection/demarcation point, as the case may be;
4. short-circuits or groundings in the network, as backup protection.

iv. changes to the protection schemes, needed for the power-generating module and the network and to the settings relevant to the generation plant shall be agreed upon in advance between the RSO and the power-generating module owner;

(c) the organization by the power-generating module owner of the protection and control devices according to the following prioritization:

i. the network's and power-generating module's protection;
ii. frequency control (active power adjustment);
iii. power restrictions;
iv. limiting the ramping rate of power variations.

(d) **information exchange:**

i. power-generating modules shall be capable of exchanging information with the RSO in real time or periodically, as specified in the instructions issued by the RSO or the TSO;
ii. The RSO, in coordination with the TSO, sets the content of the information exchanges, which shall comprise at least: the active power at the connection/interface point, as the case may be, the state signals and commands regarding the breaker position and the separators position and the command to reduce active power following an instruction.

Article 28.

(1). The type B power-generating module owner shall ensure continuity in the submission of status and operation values provided in Article 27 (d) to the RSO.
(2). The data provided shall be integrated in the DMS-SCADA system of the RSO and shall ensure at least the active power signal. The RSO is entitled to request the integration of other values into DMS-SCADA.
(3). The communication path is specified by the RSO.
(4). The DMS-SCADA integration falls under the responsibility of the power-generating module owner.

Article 29. The type B power-generating module owner has the obligation to ensure compatibility of data exchange equipment at the RSO's DMS-SCADA system interface level, according to the features requested by it.

Article 30. Under normal network operation, the power-generating module shall not produce fast voltage fluctuations at the connection/interface point, as the case may be, greater than ±5% of the nominal voltage of the network to which it is connected.

Article 31. Irrespective of the number of operational auxiliary installations and regardless of the power output, the power-generating module shall ensure, at the connection point, the electricity quality according to applicable standards (European standards and the performance standard for providing the electricity transmission service and the system service, and the standard for providing the electricity distribution service respectively).

Article 32. The power-generating module is monitored in terms of electricity quality at the connection/interface point, as the case may be, during tests performed for verifying the compliance with the connection technical requirements. The RSO may require, as the case may be, a permanent monitoring of electricity quality at the connection/interface point, as the case may be, and the integration of the permanent monitoring equipment in its own electricity quality monitoring system.

Article 33. If several power-generating modules are connected in the same electrical node (bar), for which the sum of installed capacities of all power-generating modules exceeds the maximum power of type B, these must commonly provide reactive power control at the connection/interface point, as the case may be. If the sum of installed capacities of all generating units, together with the power generating module to be connected in the common electrical node, exceeds the maximum power of type C, these must commonly provide voltage control at the connection point.

Article 34. The connection solution of type B power-generating modules shall not allow their island operation and must foresee the endowment with protections which trip the power-generating module at the occurrence of such an operation state.

Section 4. GENERAL REQUIREMENTS FOR TYPE C POWER-GENERATING MODULES

Article 35. Type C power-generating modules shall fulfil the following requirements **in relation to frequency stability:**

(a) the power-generating module shall be capable of remaining connected to the network and operate within the **frequency ranges** and time periods specified in table 1C;

(b) (i) the power-generating module must remain connected to the network and must operate at frequency variation rates of 2 Hz/s for a period of 500 ms, of 1.5 Hz/s for a period of 1000 ms and of 1.25 Hz/s for a period of 2000 ms, depending on the technology type and the short-circuit power of the system at the connection point (a value provided by the RSO in the TCA), as well as the inertia available at synchronous area level.

(ii) the values provided in point (i) shall be notified to the synchronous power-generating module owner when issuing the TCA.

(iii) the protection controls at the connection point, coordinated by the RSO, must allow operation of the power-generating module for these frequency variation profiles.

Table 1C. *The minimum duration for which a type C power-generating module has to be capable to remain connected to the network and to operate on different frequencies, deviating from a nominal value*

Frequency range	**Duration for operation**
47.5 Hz – 48.5 Hz	Minimum 30 minutes
48.5 Hz – 49 Hz	Minimum 30 minutes
49 Hz – 51 Hz	Unlimited
51.0 Hz – 51.5 Hz	30 minutes

Article 36. Type C power-generating modules shall be capable to ensure a limited frequency response, namely to **frequency increases** above the nominal value of 50 Hz (**LFSM-O**), thus:

(a) at overfrequencies, the power-generating module shall decrease the active power output according to the frequency variation, in accordance with figure 1C and with the following parameters:

i. the frequency threshold from which the power-generating module ensures overfrequency response is 50.2 Hz;

ii. the droop settings shall be between 2% and 12% and shall be specified at the time of commissioning of the power-generating module and may be modified by the RSO via operational controls, at the time of commissioning of the power-generating module. Usually, the droop value equals 5%.

iii. the power-generating module shall be capable of decreasing the active power related to the frequency variation with an initial delay that is lower than 500 ms (called delay and marked with t_1 in figure 5C). If this delay is greater than 500 ms, the power-generating module owner shall justify the delay, providing technical evidence to the TSO. The response time for the power decrease in the event of overfrequency shall be lower than or equal to 2 seconds for a power variation of 50% from the maximum active power.

(b) when reaching the power related to the minimum control level, the power-generating module shall be capable of:

i. containing the activated power within a duration of no more than 20 seconds and continuing its operation at this level (within the limits of the admissible power given by the primary source); or

ii. continuing to reduce the active power output according to the operational controls and in accordance with the functional features of power-generating modules of the same type;

iii. maintaining the power level reached with a permitted deviation of ±5% P_{max}, so long the frequency deviation is maintained.

(c) the power-generating module shall remain in stable operation during operation in the LFSM-O mode during frequency increases over 50.2 Hz. So long LFSM-O is active, the LFSM-O setpoint shall prevail over any other active power setpoints.

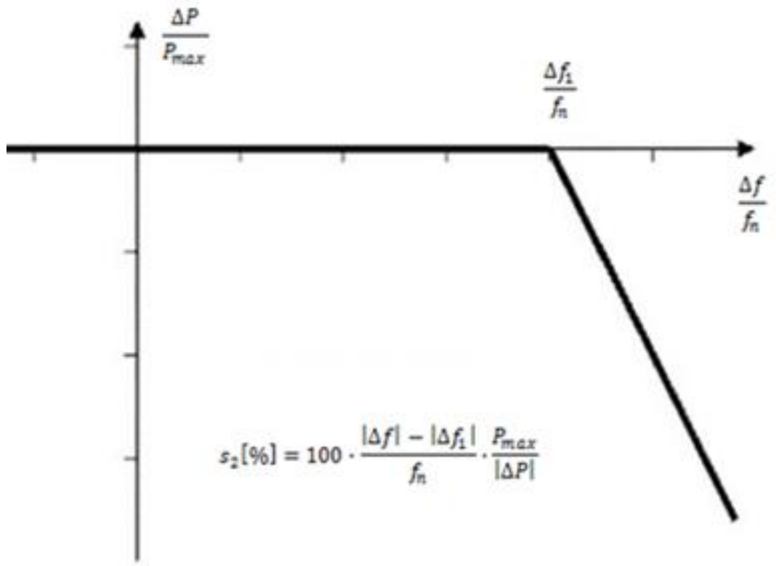


Figure 1C. *Active power frequency response capability of type C power-generating modules in LFSM-O*

where: ΔP is the change in active power output from a power-generating module; P_{max} is the active power setpoint based on which ΔP is established – namely the maximum power of the power-generating module; Δf is the frequency deviation in the network; f_n is the nominal frequency (50 Hz) in the network. At overfrequencies where Δf is above +200 mHz compared to the nominal value (50 Hz), the power-generating module has to decrease the active power according to the droop s_2.

Article 37. The type C power-generating module shall be capable of maintaining constant output at its target active power value regardless of changes in frequency, within the limits of the power offered by the primary source, except where the power-generating module follows the frequency increases according to Article 36 or has acceptable power decreases at frequency decreases according to the provisions of Article 36, Article 38 and Article 39.

Article 38. The TSO sets the active power output reduction of the type C power-generating module compared to the maximum active power output (admissible power given by the primary source) following the frequency decrease, within the admissible limits specified in figure 2C, hence:

(a) at a frequency decrease under 49 Hz a maximum active power output decrease (admissible power given by the primary source) is admitted at a percentage of 2% from the maximum active power output at the frequency of 50 Hz, for every 1 Hz of frequency decrease. Any maximum active power output reduction curve situated above the dotted line is admitted depending on the frequency;
(b) at a frequency decrease under 49.5 Hz a maximum active power output decrease is admitted at a percentage of 10% from the maximum active power output at the frequency of 50 Hz, for every 1 Hz of frequency decrease, if the frequency is lower than 49.5 Hz for a duration of over 30 s. Any maximum active power reduction curve situated above the continuous line is admitted depending on the frequency.

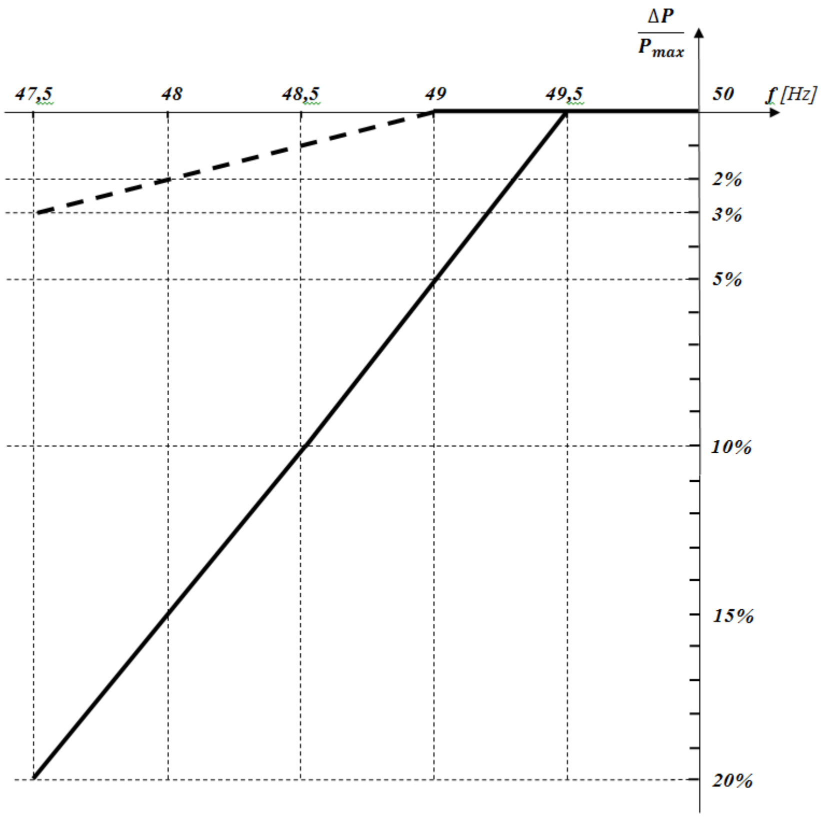


Figure 2C. *Admissible limits for power reduction established by the TSO in the event of underfrequency*

Article 39.

(1). The admissible active power reduction compared to the maximum active power output (admissible power, given by the primary source) in the event of frequency deviations under 49.5 Hz is established:
   (a) under standard environmental conditions related to a temperature of 20 degrees Celsius. As the case may be, the owner submits to the RSO and the TSO the dependency diagram of the active power in terms of temperature for at least one set of temperatures: -10^{0}C, 0^{0}C, 15^{0}C, 25^{0}C, 30^{0}C, 40^{0}C;
   (b) depending on the technical capability of the power-generating modules.

(2). The power-generating module owner shall submit to the RSO and the TSO the dependency diagram of the active power in terms of environmental factors (temperature, pressure, solar irradiance, wind speed, as the case may be) and the technical data regarding the technical capability of the power-generating module, set forth in Annex 3 to this technical norm.

(3). The data provided in paragraph (2) shall be submitted during the solution study stage within the connection process.

Article 40.

(1). The active power control system of the type C power-generating module shall be capable of adjusting an active power setpoint in line with the instructions given to the power-generating module owner by the RSO or the TSO.

(2). The time to reach the active power setpoint or the active power variation speed when adjusting the setpoint falls within the (10÷30)% P_{max}/min range depending on the technology, while the idle time (the time elapsed until the movement of the primary motor) shall not exceed 1 second and the setpoint fulfillment tolerance is of 5% P_{max}.

Article 41. Local control shall be allowed in cases where the automatic remote control devices are out of service.

Article 42.

(1). The RSO sets forth the conditions for the automatic connection of a type C power-generating module to the network, after these conditions have been agreed upon with the TSO.

(2). The requirements provided in paragraph (1) include:

(a) the frequency ranges in which the automatic connection is accepted, namely (47.5÷51) Hz, the voltage range (0.9-1.1) U_n, the observation/validation period and the period for maintaining the metered parameters within the determined range, of maximum 300 seconds;

(b) the slope admitted for the active power increase after connection ($\leq$ 20 % P_{max}/min), usually 10% of the P_{max}/min (the setpoint is chosen within the range indicated by the power-generating module manufacturer).

Article 43. Type C power-generating modules shall be capable to ensure a limited frequency response, namely to frequency decreases (LFSM-U), thus:

(a) it must be capable to mobilize active power response at underfrequencies below a 49.8 Hz frequency threshold and with a droop set by the TSO for every power-generating module, at the time of PIF or via operational controls within the (2÷12)% limits, usually at the 5% value, which corresponds to an active power mobilizied of 8% P_{max}, according to figure 3C;

(b) the delivery of active power in response to the frequency decrease (in LFSM-U mode) shall also take into account, as the case may be, the following:

i. the dependency diagram of active power output in terms of environmental conditions;

ii. the operating requirements of the power-generating module, in particular the limitations on operation near maximum active power at low frequencies and the respective impact of external operating requirements according to the provisions of Article 38 and Article 39 ;

(c) the activation of active power frequency response by the power-generating module shall not be unduly delayed. If this delay (called idle time and marked with t_1 in figure 5C) is greater than 500 ms, the power-generating module owner shall justify the delay towards the TSO;

(d) while operating in the LFSM-U mode, the power-generating module shall ensure a power increase up to the maximum/admissible power depending on the primary energy source. The response time for the power increase for power-generating modules, except for wind turbines, shall be lower than or equal to 10 seconds for a power variation of maximum 50% from the maximum power. For wind turbines, the response time shall be lower than or equal to 5 seconds for a power variation of 20% from the maximum power, if the starting operating point is higher than 50% from the maximum power. An active power increase time higher than 5 seconds can be accepted if the starting operating point is lower than 50% from the maximum power. This situation shall be justified by the owner. Reaching the setpoint shall take place in a time interval of maximum 30 seconds with a maximum tolerance of ±5% from P_{max};

(e) the power-generating module shall operate stably during the LFSM-U mode at frequencies lower than 49.8 Hz.

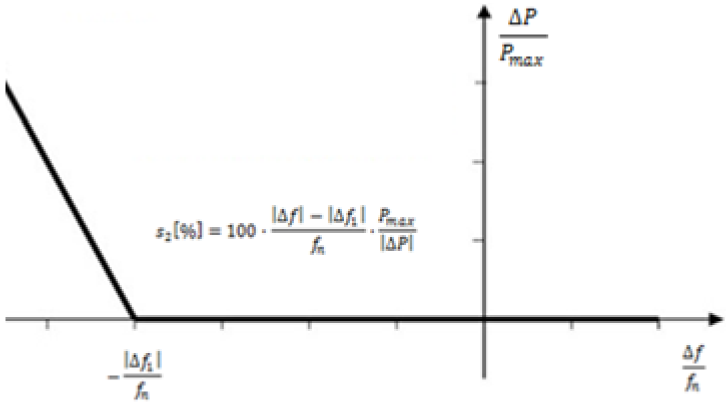


Figure 3C. *Active power frequency response capability of type C power-generating modules in LFSM-U*

where: P_{max} is the active power setpoint based on which ΔP is established – namely the maximum power of the power-generating module; ΔP is the change in active power output from the power-generating module; f_n is the nominal frequency (50 Hz) in the network and Δf is the frequency deviation in the network. At underfrequencies below 49.8 Hz where Δf is below -200 mHz, the power-generating module has to increase the active power according to the droop s_2.

Article 44. If the FSM mode is active, under the conditions offered by the primary source, the type C power-generating module shall fulfill all requirements described below, in addition to the requirements provided in Article 43 according to figure 4C:

(a) the module shall provide FSM, according to the parameters specified by the TSO, within the value ranges provided in table 2C, thus:

i. in case of overfrequency above the 50 Hz value, the active power frequency response is limited by the minimum regulating level;

ii. in case of underfrequency compared to the 50 Hz value, the active power frequency response is limited by the maximum active power available given by the primary source.

iii. the actual delivery of active power frequency response depends on the external and operating conditions of the power-generating module when this response is triggered, namely on the limitations given by the operation of the power-generating module, under the conditions of the primary source at low frequencies.

(b) the module shall be able to modify the frequency deadband and the droop following the TSO's instruction. Usually, the s_1 droop value equals 5%, which corresponds to an active power mobilized of 8% P_{max};

(c) in the event of a frequency step change, the power-generating module shall be capable of activating full active power frequency response, at or above the line shown in figure 5C, in accordance with the parameters specified in table 3C, in the absence of technological limitations, namely: with a delay (t_1) of 500 ms for power-generating modules without inertia, or above 2 seconds for power-generating modules with inertia and an activation time of maximum 10 seconds (t_2), within the power limit offered by the primary source;

(d) the initial activation of active power required shall not be unduly delayed. If the delay in initial activation of active power is greater than 500 ms for power-generating modules without inertia, or greater than 2 seconds for power-generating modules with inertia, the power-generating module owner shall provide technical evidence demonstrating why a longer time is needed;

(e) the module shall be capable to provide active power corresponding to the frequency deviation for a duration of 15-30 minutes specified by the TSO, depending on the availability of the primary source;

(f) the active power control shall not have any adverse impact on the active power frequency response.

(g) if participating to the frequency restoration process at the setpoint and/or exchange powers to the scheduled values, the power-generating module shall ensure specific functions for performing these services, established via procedures drafted by the TSO.

Table 2C. *Parameters for active power frequency response in FSM (see figure 5C)*

Parameters		Ranges
Active power range related to maximum power $\frac{\lvert\Delta P_1\rvert}{P_{\max}}$		(2÷10)%
Frequency response insensitivity	$\lvert\Delta f_i\rvert$	10 mHz
	$\frac{\lvert\Delta f_i\rvert}{f_n}$	0.02 – 0.06%
Frequency response deadband * After the qualification of groups for the provision of frequency containment reserves (FCR), this value is set at 0 mHz for FCR providing groups, and for other groups the TSO shall decide to set the value different to 0 mHz so that the impact on the frequency control is kept at a minimum		0 mHz
Droop s_1		(2÷12)%

Table 3C. *Parameters for full activation of active power frequency response resulting from frequency step change (see figure 5C)*

Parameters	Ranges or values
Active power range related to maximum power (frequency response range) $\frac{\lvert\Delta P_1\rvert}{P_{\max}}$	(1.5÷10)%
For power-generating modules with inertia, the maximum admissible initial delay t_1, except when the TSO admits longer activation periods, based on technical evidence provided by the power-generating module owner	2 seconds
For power-generating modules without inertia, the maximum admissible initial delay t_1, unless justified otherwise in line with Article 44 (d)	500 ms
Maximum admissible choice of full activation time t_2, unless longer activation times are allowed by the TSO for reasons of system stability	10 seconds

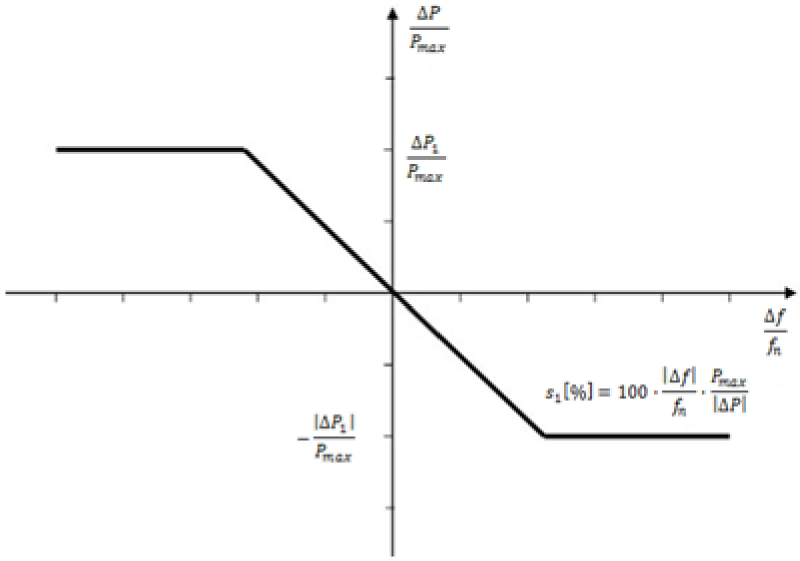


Figure 4C. *Active power frequency response capability of type C power-generating modules in FSM illustrating the case of zero deadband and insensitivity area*

where: ΔP is the change in active power output from the power-generating module; P_{max} is the active power setpoint based on which ΔP is established – namely the maximum power of the power-generating module; Δf is the frequency deviation in the network; f_n is the nominal frequency (50 Hz) in the network.

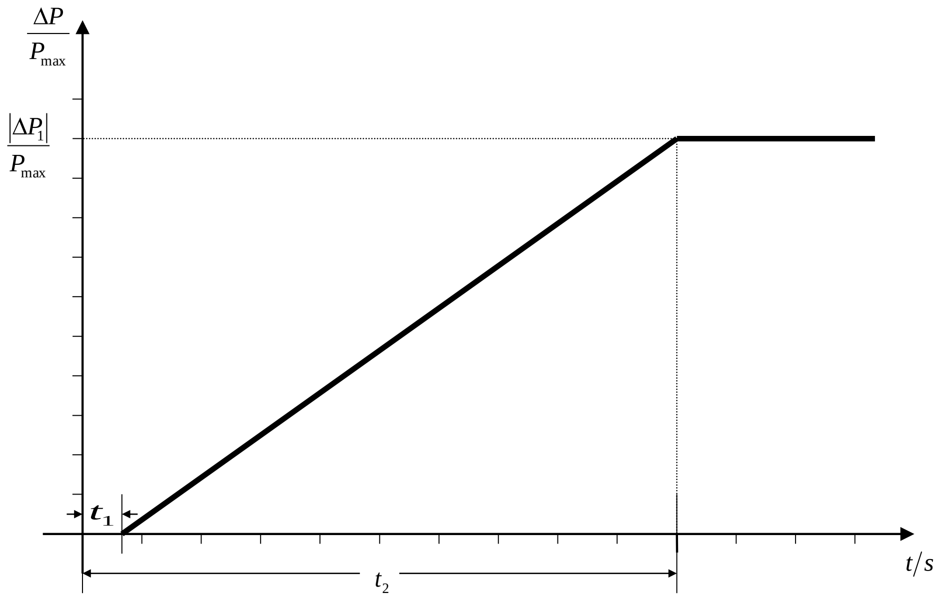


Figure 5C. *Frequency response capability*

where: P_{max} is the active power setpoint based on which ΔP is established – namely the maximum power of the power-generating module; ΔP is the change in active power of the power-generating module. The power-generating module shall activate an active power ΔP up to the point ΔP_1, according to the t_1 and t_2 times, while the ΔP_1, t_1 and t_2 values are specified by the TSO according to the provisions from table 3C; t_1 is the initial delay (idle time); t_2 is the duration until the full activation of active power.

Article 45.

(1). Real-time monitoring of the active power frequency automated response of the type C power-generating module shall be ensured by transmitting, in real-time and in a secured way, from an interface of the power-generating module to the dispatching center of the RSO, upon request by the RSO, of at least the following signals:

i. the operation condition signal with/without active power frequency automated response;
ii. setpoint (scheduled) active power;
iii. actual value of the active power output;
iv. load-frequency response deadband;
v. parameter settings for the active frequency control mode.

(2). i. the RSO shall specify additional signals to be provided by the power-generating module via monitoring and recording devices in order to verify the performance of the active power frequency response provision;

ii. The additional signals are: frequency at the connection/interface point, as the case may be, state signals and commands regarding the breaker position and the separators position;
iii. The power-generating module owner ensures the transmission of signals via one/two independent communication paths (set in the TCA); usually, the main path is ensured via optical fiber equipment.

(3). Parameter settings for active power frequency response and the droop are established via operational controls.

Article 46. Type C power-generating modules shall fulfil the following **requirements in relation to voltage stability**:

(a) they shall be capable to automatically disconnect when the voltage at the connection/demarcation point, as the case may be, exceeds the limits specified by the RSO in the (0.85÷1.1) U_n range.
(b) the requirements and settings for automatic disconnection of power-generating modules shall be specified by the RSO in coordination with the TSO.

Article 47. Type C power-generating modules shall fulfil the following requirements in relation to **robustness,** in terms of:

(a) the fault-ride-through capability in case of symmetrical faults:

i. the power-generating module must be capable to remain connected to the network, continuing its stable operation following a correctly secured fault in the network, according to the voltage-time dependency described in figure 6C, with respect to the connection/interface point, as the case may be, and described by the parameters in table 4C;

ii. the voltage-against-time-profile represents a lower admissible limit of the actual course of the voltages at the connection/interface point, as the case may be, during a symmetrical fault, as a function of time before, during and after the fault;

iii. the TSO shall specify and make publicly available the pre-fault and post-fault conditions for the fault-ride-through capability in terms of:

1. the pre-fault minimum short-circuit power calculation at the connection/demarcation point, as the case may be;
2. the pre-fault active and reactive power operating point of the power-generating module at the connection/demarcation point, as the case may be, and voltage at the connection/demarcation point, as the case may be; and
3. the post-fault minimum short-circuit power calculation at the connection/demarcation point, as the case may be.

iv. upon request by a power-generating module owner, the RSO shall provide the pre-fault and post-fault conditions (as relevant values resulted from typical cases) to be considered for fault-ride-through capability as an outcome of the calculations at the connection/demarcation point, as the case may be, as specified in point (iii) regarding:

1. the pre-fault minimum short-circuit power at the connection/demarcation point, as the case may be, expressed in MVA;
2. the pre-fault operating point of the power-generating module, expressed in active power, reactive power and voltage at the connection/demarcation point, as the case may be; and
3. the post-fault minimum short-circuit power at the connection/demarcation point, as the case may be, expressed in MVA.

v. the power-generating module shall remain connected to the network and shall continue to operate stably when the actual course of the phase-to-phase voltages on the network voltage level at the connection/interface point, as the case may be, during a symmetrical fault, given the existing pre-fault and post-fault conditions described in points (iii) and (iv), remains above the lower limit specified in point (ii), except the triggering via the protections for internal electrical faults. The protection schemes and settings for internal electrical faults must not jeopardize fault-ride-through performance;

vi. considering the requirements provided in point (v), the power-generating module owner establishes the undervoltage protection (either the fault-ride-through capability, or the minimum voltage defined at the connection/interface point, as the case may be) according to the maximum voltage range corresponding to the power-generating module, except if the RSO requires a narrower voltage range. The settings shall be justified by the power-generating module owner in accordance with this principle;

(b) fault-ride-through capability in case of asymmetrical faults shall comply with the provisions set forth in letter (a) point (i) for symmetrical faults;

(c) maintaining stable operation at every point within the P-Q-capability diagram in the event of power oscillations between the power plant and the connection/demarcation point, as the case may be;

(d) power-generating modules shall be capable of remaining connected to the network without reducing power (within the limits given by the primary source), so long the frequency and voltage fall within the limits provided in table 1C, namely ±10% U_n of the network to which they are connected;

(e) power-generating modules shall be capable of remaining connected to the network during single-phase or three-phase AR on loop network lines to which they are connected. The specific technical details shall be subject to coordination and instructions on protection schemes and settings agreed upon with the RSO.

Figure 6C. *Fault-ride-through profile of a type C power-generating module*

Note: The diagram in figure 6C represents the lower limit of a voltage-against-time profile of the voltage at the connection/demarcation point, as the case may be, expressed in relative units as the ratio of its actual value and its reference value before, during and after a fault. U_{ret} is the retained voltage during a fault at the connection/demarcation point, as the case may be, t_{clear} is the instant when the fault has been cleared. U_{rec1}, U_{rec2}, t_{rec1}, t_{rec2} and t_{rec3} represent certain points of lower limits of retained voltage after fault clearance.

Table 4C. *Parameters related to the fault-ride-through capability of type C power-generating modules*

Voltage parameters [r.u.]		Time parameters [seconds]	
U_{ret}:	0.15	t_{clear}:	0.25
U_{clear}:	0.15	t_{rec1}:	0.25
U_{rec1}:	0.15	t_{rec2}:	0.25
U_{rec2}:	0.85	t_{rec3}:	3

Article 48.

(1). Type C power-generating modules shall fulfil the following requirements in relation to **system restoration:**

(a) they shall be capable to reconnect to the network following an accidental disconnection caused by an event in the network, under the conditions defined by the TSO. Usually, the automatic reconnection is performed within a (47.5÷50.5) Hz frequency range, a (0.85÷1.1) U_n voltage range and during an observation/validation period of maximum 300 s;

(b) installation of automatic reconnection systems shall be subject to prior authorization both by the RSO, and the TSO, in order to specify the automatic reconnection conditions.

(c) they shall fulfil the requirements regarding the quick re-synchronization capability: in the event of disconnection from the network, the power-generating module shall be able to quickly re-synchronize, usually in less than 15 minutes, according to the protection plan agreed upon with the RSO, within the limits of the technical possibilities of power-generating modules;

(2). The requirements and conditions for the automatic reconnection provided in paragraph (1) letters (a) and (b) shall be notified to the power-generating module owner during the grid connection process.

Article 49. Type C power-generating modules shall fulfil the following **general operational requirements** in relation to:

(a) **control and automation schemes** and related settings:

i. the control and automation schemes, as well as the related settings, including the control parameters, necessary for the network stability calculations and emergency measures analysis, shall be submitted by the power-generating module owner to the RSO or the TSO respectively, no later than 3 months prior to the application of voltage for the beginning of the testing period, in order for them to be coordinated and agreed upon between the TSO, RSO and the power-generating module owner;

ii. any changes to the control and automation schemes and settings, as referred to in point (i), of the different control devices of the power-generating module shall be coordinated and agreed upon between the TSO, the RSO and the power-generating module owner.

(b) **electrical protection schemes and related settings**:

i. the protection systems needed for the power-generating module and the network, as well as the settings relevant to the power-generating module shall be coordinated and agreed upon between the RSO and the power-generating module owner, during the connection process. The functions of the protections shall be prescribed by the RSO who may request a different protection control than the one proposed by the owner. The protection systems and related settings for internal electrical faults must not jeopardize the performance of the power-generating module.

The protection and automation systems shall fulfill at least the following requirements:

- they shall ensure protection against internal faults of the power-generating module and against abnormal operation states and faults from the network to which the module is connected;
- they shall be efficient, highly reliable and organized in groups with redundant functionality; the protections shall be selective, sensible, capable to detect internal and external faults, physically and galvanically separated from the power supplies with operative voltage, from voltage and current

metering transformers to command execution devices. The electrical protection system shall be equipped with extended self-testing and self-diagnosis functions, as well as with events recording and oscillography functions. The electrical protections system shall be equipped with standard communication interfaces aiming for the integration to a local data acquisition, supervision and control system;

- the internal faults electrical protections system shall be capable to detect at least the short-circuit currents in the power-generating module, the current asymmetry, the maximum/minimum voltage in the power-generating module terminals, the maximum/minimum frequency in the power-generating module terminals;
- the external faults electrical protections system, as backup protections, shall be capable to detect at least the symmetrical and asymmetrical short-circuits from the network to which the power-generating module is connected, the power oscillations, the current asymmetry, the current and voltage electrical overloads.

ii. the electrical protection of the power-generating module shall take precedence over operational controls, taking into account the operational security of the system, the health and safety of staff and of the public, as well as mitigating any damage to the power-generating module.

iii. Together with the power-generating module owner, the RSO shall coordinate and commonly agree that the protection systems must cover at least the following faults:

A. the protections of the power-generating module and of the step-up transformer are covered by the power-generating module owner, for:

1. internal faults of the power-generating module (short-circuits and groundings);
2. internal faults of the step-up transformer;
3. short-circuits or groundings on the network connection evacuation line of the power output;
4. short-circuits or groundings in the network, as backup protection;
5. maximum and minimum voltage at the power-generating module terminals.

B. protections covered by the power-generating module owner and/or the RSO, as the case may be:

1. short-circuits or groundings on the connection line in the network of the power output;
2. maximum and minimum voltage at the connection/interface point, as the case may be;
3. maximum and minimum frequency at the connection/interface point, as the case may be;
4. short-circuits or groundings in the network, as backup protection.

iv. changes to the protections schemes, needed for the power-generating module and the network and to the settings relevant to the generation plant shall be agreed upon in advance between the RSO and the power-generating module owner;

(c) the protection and control devices shall be organized by the power-generating module owner, according to the following prioritization:

i. the network's and power-generating module's protection;

ii. frequency control (active power adjustment);
iii. power restrictions;
iv. limiting the ramping rate of power variations.

(d) **information exchange:**

i. power-generating modules shall be capable of exchanging information with the RSO in real time or periodically, as specified in the instructions issued by the RSO or the TSO;
ii. the RSO, in coordination with the TSO, shall specify the content of information exchanges including a precise list of data to be provided to the TSO by the RSO and by the power-generating module owner. The real-time submitted data are: active power, scheduled active power, as the case may be, reactive power, voltage and frequency at the connection/interface point, as the case may be, state signals and commands regarding the breaker position and the separators position and the operation condition signal with/without active power frequency automated response. The power-generating module owner ensures the transmission of signals via one/two independent communication paths (set in the TCA); usually, the main path is ensured via optical fiber equipment.

(e) the possibility of the power-generating module to automatically disconnect from the network when losing robustness. The disconnection criteria regarding the protection against current asymmetry, phase interruption and critical disconnection time, shall be agreed upon between the power-generating module owner, the RSO and the TSO.

(f) **instrumentation**:

i. power-generating modules shall be equipped with devices to provide fault recording and monitoring of dynamic system behavior; these devices are usually oscilloperturbographs or equipment that can replace functions covered by oscilloperturbographs. These devices shall record the following parameters:
   1. voltages in all three phases;
   2. current in each phase;
   3. active power in all three phases;
   4. reactive power in all three phases;
   5. frequency.

   The RSO shall have the right to specify quality of supply parameters to be complied with, provided via the aforementioned devices, on condition that they are previously agreed upon with the power-generating module owner.
ii. the settings of the fault recording equipment, including triggering criteria and the sampling rates shall be commonly agreed between the power-generating module owner and the RSO at the time of PIF and shall be documented via written arrangements. These shall also include a criterion for detecting oscillations established by the TSO;
iii. The RSO, TSO and the power-generating module owner commonly agree upon including a criterion for detecting oscillations in order to monitor the dynamic system behavior, specified by the TSO in order to detect poorly damped power oscillations (undamped);
iv. the dynamic system behavior monitoring system shall include arrangements for the power-generating module owner and the RSO to access the information. The communications protocols for registered data shall be commonly agreed between the power-generating module owner, the RSO and the TSO, prior to choosing the monitoring equipment.

(g) **power-generating module operation simulation models**:

i. upon request of the RSO or the TSO, the power-generating module owner shall provide the power-generating module operation simulation models that reflect the power-generating module behavior both in steady-state regime, as well as in dynamic regime (including for transient electromagnetic phenomena, if requested). The models provided shall be validated via the compliance test results. The power-generating module owner submits to the RSO or the TSO the results of these tests for the power-generating module, proven by means of check-up certificates recognized on European level, carried out by an authorized certifier;

ii. the models provided by the power-generating module owner shall contain the following sub-models, depending on the existence of individual components:

1. photovoltaic panel, wind turbine etc. and converter models;
2. active power control;
3. voltage control;
4. power-generating module protections models, as agreed by the RSO and the power-generating module owner;
5. inverter and wind generating unit models, as the case may be.

iii. upon request by the RSO as referred to in point (i), the TSO shall specify:

1. the format in which simulation models are to be provided, including the utilized calculation program;
2. the documentation on a mathematical model's structure and block diagrams;
3. the estimate of the minimum and maximum short-circuit power at the connection/interface point, as the case may be, expressed in MVA, as an equivalent of the network.

iv. the power-generating module owner provides the RSO, upon request, with recordings of the power-generating module's performance. The RSO or the TSO may make such a request, in order to compare the response of the models and model simulations performed with actual operational recordings.

(h) the installation of devices for system operation and devices for system operational security, if the RSO or the TSO considers that it is necessary to install additional devices in a power-generating module in order to preserve or restore system operation or system operational security. The RSO and the power-generating module owner, together with the TSO, analyze and agree upon the adequate solution;

(i) the minimum and maximum limits on rates of change of active power output (ramping limits) in both an up and down direction of change of active power output for a power-generating module are specified by the RSO, in coordination with the TSO, taking into consideration the specific characteristics of prime mover technology. Usually, the rate of change falls within the (10÷30)% P_{max}/minute range and is equal in both directions (up and down direction);

(j) earthing arrangement of the neutral-point at the network side of step-up transformers shall comply with the specifications of the RSO.

Article 50.

(1) The type C power-generating module owner shall ensure continuity in the submission of status and operation values provided in Article 49 (d) to the RSO.

(2) The type C power-generating module shall be integrated in the DMS-SCADA system of the RSO, ensuring at least the signal exchange: active power, reactive power, voltage and frequency at the connection/interface point, as the case may be, set values for active power and reactive power, state signals and commands regarding the breaker position and the separators position.

(3) The type C power-generating module owner ensures the transmission of signals via one/two independent communication paths (set in the TCA). Usually, the main path is ensured via optical fiber equipment.

Article 51. The type C power-generating module owner has the obligation to ensure the compatibility of data exchange equipment at the RSO's DMS-SCADA system interface level, according to the features requested by it.

Article 52. If several power-generating modules are connected in the same electrical node (bar), for which the sum of installed capacities of all energy sources exceeds the maximum power of type C, these must commonly provide voltage control at the connection/interface point, as the case may be.

Article 53. Under normal network operation, the power-generating module shall not produce fast voltage fluctuations at the connection/interface point, as the case may be, greater than ±5% of the nominal voltage of the network to which it is connected.

Article 54. Irrespective of the operational auxiliary installations and regardless of the power output, the power-generating module shall ensure, at the connection/interface point, as the case may be, the electricity quality according to applicable standards (European standards and the performance standard for providing the electricity transmission service and the system service, and the standard for providing the electricity distribution service respectively).

Article 55. The power-generating module is monitored in terms of electricity quality at the connection/interface point, as the case may be, during tests performed for verifying the compliance with the connection technical requirements. The RSO may require, as the case may be, a permanent monitoring of electricity quality at the connection/interface point, as the case may be, and the integration of the permanent monitoring equipment in its own electricity quality monitoring system.

Section 5. GENERAL REQUIREMENTS FOR TYPE D POWER-GENERATING MODULES

Article 56. Type D power-generating modules shall fulfil the following requirements **in relation to frequency stability:**

(a) the power-generating module shall be capable of remaining connected to the network and operate within the **frequency ranges** and time periods specified in table 1D;

(b) i. the power-generating module must remain connected to the network and must operate at frequency variation rates of 2 Hz/s for a period of 500 ms, of 1.5 Hz/s for a period of 1000 ms and of 1.25 Hz/s for a period of 2000 ms, depending on the technology type and the short-circuit power of the system at the connection point (a value provided by the RSO in the TCA), as well as the inertia available at synchronous area level.

ii. the values provided in point (i) shall notified to the power-generating module owner when issuing the TCA.

iii. the protection controls at the connection point, coordinated by the RSO, must allow operation of the power-generating module for these frequency variation profiles.

Table 1D. *The minimum duration for which a type D power-generating module has to be capable to remain connected to the network and to operate on different frequencies, deviating from a nominal value*

Frequency range	Duration for operation
47.5 Hz – 48.5 Hz	Minimum 30 minutes
48.5 Hz – 49 Hz	Minimum 30 minutes
49 Hz – 51 Hz	Unlimited
51.0 Hz – 51.5 Hz	30 minutes

Article 57. Type D power-generating modules shall be capable to ensure a limited frequency response, namely to **frequency increases** above the nominal value of 50 Hz (**LFSM-O**), thus:

(a) at overfrequencies, the power-generating module shall decrease the active power output according to the frequency variation, in accordance with figure 1D and with the following parameters:

i. the frequency threshold from which the power-generating module ensures overfrequency response is 50.2 Hz;

ii. the droop settings shall be between 2% and 12% and shall be provided by the RSO via operational controls, at the power-generating module's commissioning. Usually, the droop value equals 5%.

iii. the power-generating module shall be capable of decreasing the active power related to the frequency variation with an initial delay that is lower than 500 ms (marked with t_1 in figure 5D). If this delay is greater than 500 ms, the power-generating module owner shall justify the delay, providing technical evidence to the TSO. The response time for the power decrease in the event of overfrequency shall be lower than or equal to 2 seconds for a power variation of 50% from the maximum active power.

(b) when reaching the power related to the minimum control level, the power-generating module shall be capable of:

i. containing the activated power within a duration of no more than 20 seconds and continuing its operation at this level (within the limits of the admissible power given by the primary source); or

ii. continuing to reduce the active power output according to the operational controls and in accordance with the functional features of power-generating modules of the same type; or

iii. maintaining the power level reached with a permitted deviation of ±5% P_{max}, so long the frequency deviation is maintained.

(c) the power-generating module shall remain in stable operation during operation in the LFSM-O mode during frequency increases over 50.2 Hz. So long LFSM-O is active, the LFSM-O setpoint shall prevail over any other active power setpoints.

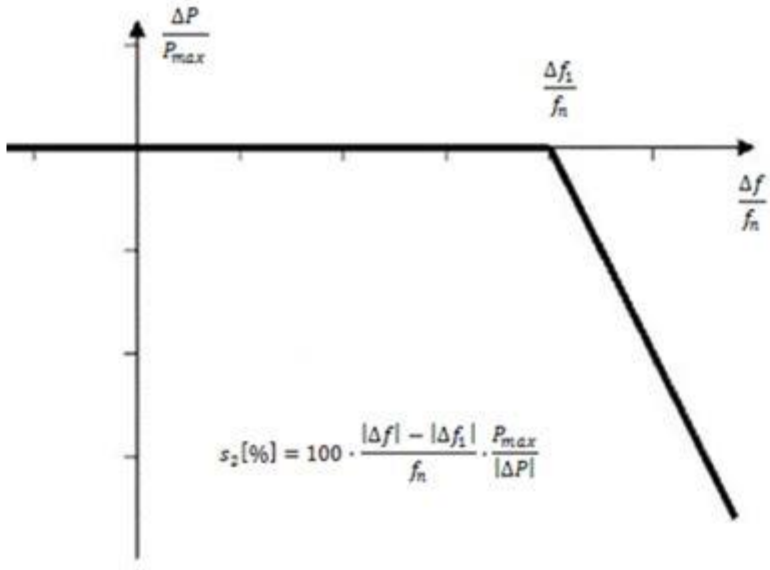


Figure 1D. *Active power frequency response capability of type D power-generating modules in LFSM-O*

where: ΔP is the change in active power output from the power-generating module; P_{max} is the active power setpoint based on which ΔP is established – namely the maximum power of the power-generating module; Δf is the frequency deviation in the network; f_n is the nominal frequency (50 Hz) in the network. At overfrequencies where Δf is above +200 mHz compared to the nominal value (50 Hz), the power-generating module has to decrease the active power according to the droop s_2.

Article 58. The type D power-generating module shall be capable of maintaining constant output at its target active power value regardless of changes in frequency, within the limits of the power offered by the primary source, except where the power-generating modules in the power park module follow the frequency increases according to Article 57 or have acceptable power decreases at frequency decreases according to the provisions of Article 59 and Article 60.

Article 59. The TSO sets the active power output reduction of the type D power-generating module compared to the maximum active power output following the frequency decrease, within the admissible limits specified in figure 2D, hence:

(a) at a frequency decrease under 49 Hz an active power output decrease (admissible power given by the primary source) is admitted at a percentage of 2% from the maximum active power output at the frequency of 50 Hz, for every 1 Hz of frequency decrease. Any maximum active power output reduction curve situated above the dotted line is admitted depending on the frequency;

(b) at a frequency decrease under 49.5 Hz a maximum active power output decrease is admitted at a percentage of 10% from the maximum active power output at the frequency of 50 Hz, for every 1 Hz of frequency decrease, if the frequency is lower than 49.5 Hz for a duration of over 30 s. Any maximum active power output reduction curve situated above the continuous line is admitted depending on the frequency.

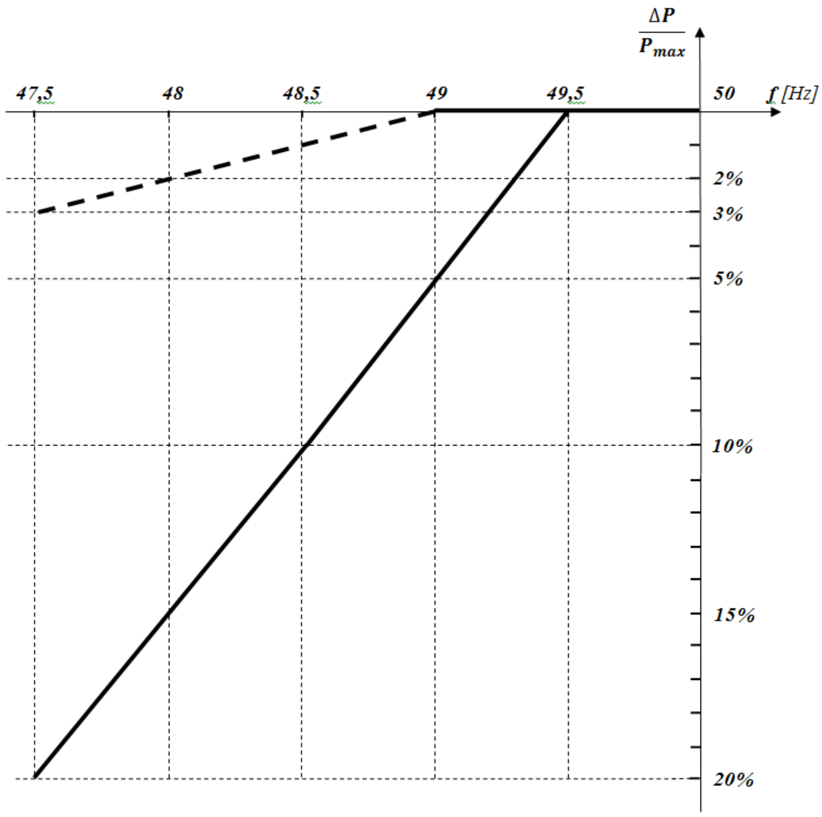


Figure 2D. *Admissible limits for power reduction established by the TSO in the event of underfrequency*

Article 60.

(1). The admissible active power reduction compared to the maximum active power output (admissible power, given by the primary source) in the event of frequency deviations under 49.5 Hz is established:

(a) under standard environmental conditions related to a temperature of 20 degrees Celsius. As the case may be, the owner submits to the RSO and the TSO the dependency diagram of the active power in terms of temperature for at least one set of temperatures: -10^0C, 0^0C, 15^0C, 25^0C, 30^0C, 40^0C;

(b) depending on the technical capability of the power-generating modules.

(2). The power-generating module owner shall submit to the RSO and the TSO the dependency diagram of the active power in terms of environmental factors (temperature, pressure, solar irradiance, wind speed, as the case may be) and the technical data regarding the technical capability of the power-generating module, set forth in Annex 4 to this technical norm;

(3). The data provided in paragraph (2) shall be submitted during the solution study stage within the connection process.

Article 61.

(1). The active power control system of the type D power-generating module shall be capable of adjusting an active power setpoint in line with the instructions given to the power-generating module owner by the RSO or the TSO.

(2). The time to reach the active power setpoint or the active power variation speed when adjusting the setpoint falls within the (10÷30)% P_{max}/min range depending on the technology, while the idle time shall not exceed 1 second and the setpoint fulfillment tolerance is of 1% P_{max}.

Article 62. Local control shall be allowed in cases where the automatic remote control devices are out of service.

Article 63. Type D power-generating modules shall be capable to ensure a limited frequency response, namely to frequency decreases (LFSM-U), thus:

(a) it must be capable to mobilize active power response at underfrequencies below a 49.8 Hz frequency threshold and with a droop set by the TSO for every power-generating module, at the time of PIF or via operational controls within the (2÷12)% limits, usually at the 5% value, which corresponds to an active power mobilized of 8% P_{max}, according to figure 3D;

(b) the delivery of active power in response to the frequency decrease (in LFSM-U mode) shall also take into account, as the case may be, the following:

i. the dependency diagram of active power output in terms of environmental conditions (primary source);

ii. the operating requirements of the power-generating module, in particular the limitations on operation near maximum active power at low frequencies and the respective impact of external operating requirements according to the provisions of Article 59 and Article 60;

(c) the activation of active power frequency response by the power-generating module shall not be unduly delayed. If this delay (called idle time and marked with t_1 in figure 5D) is greater than 500 ms, the power-generating module owner shall justify the delay towards the TSO;

(d) while operating in the LFSM-U mode, the power-generating module shall ensure a power increase up to the maximum admissible power given by the primary source. The response time for the power increase for power-generating modules, except for wind turbines, shall be lower than or equal to 10 seconds for a power variation of maximum 50% from the maximum power. For wind turbines, the response time shall be lower than or equal to 5 seconds for a power variation of 20% from the maximum power, if the starting operating point is higher than 50% from the maximum power. An active power increase time higher than 5 seconds can be accepted if the starting operating point is greater than 50% from the maximum power. This situation shall be justified by the owner. Reaching the setpoint shall take place in a time interval of maximum 30 seconds with a maximum tolerance of ±5% from P_{max};

(e) the power-generating module shall operate stably during the LFSM-U mode at frequencies lower than 49.8 Hz.

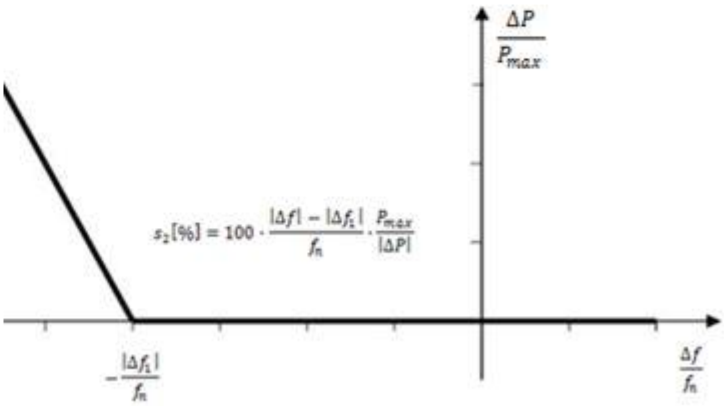


Figure 3D. *Active power frequency response capability of type D power-generating modules in LFSM-U* *where: P_{max} is the active power setpoint based on which ΔP is established – namely the maximum power of the power-generating module; ΔP is the change in active power output from a power-generating module; P_{ref} is the active power setpoint based on which ΔP is established; Δf is the frequency deviation in the network; f_n is the nominal frequency (50 Hz). At underfrequencies under 49.8 Hz where Δf exceeds -200 mHz, the power-generating module has to increase the active power according to the droop s_2.*

Article 64. If the FSM mode is active, under the conditions offered by the primary source, the type D power-generating module shall fulfill all requirements described below, in addition to the requirements provided in Article 63 according to figure 4D:

(a) the module shall provide FSM, according to the parameters specified by the TSO, within the value ranges provided in table 2D, thus:
   i. in case of overfrequency above the 50 Hz value, the active power frequency response is limited by the minimum regulating level;
   ii. in case of underfrequency compared to the 50 Hz value, the active power frequency response is limited by maximum active power available given by the primary source;
   iii. the actual delivery of active power frequency response depends on the external and operating conditions of the power-generating module when this response is triggered, particularly on the limitations given by the operation of the power-generating module, under the conditions of the primary source at low frequencies.

(b) the module shall be able to modify the frequency deadband and the droop following the TSO's instruction. Usually, the s_1 droop value equals 5%, which corresponds to an active power mobilized of 8% P_{max};

(c) in the event of a frequency step change, the power-generating module shall be capable of activating full active power frequency response, at or above the line shown in figure 5D, in accordance with the parameters specified in table 3D, in the absence of technological limitations, namely: with a delay (t_1) of 500 ms for power-generating modules without inertia, or above 2 seconds for power-generating modules with inertia and an activation time of maximum 10 seconds (t_2), within the power limit offered by the primary source;

(d) the initial activation of active power required shall not be unduly delayed. If the delay in initial activation of active power is greater than 500 ms for power-generating modules without inertia, or greater than 2 seconds for power-generating modules with inertia, the power-generating module owner shall provide technical evidence demonstrating why a longer time is needed;

(e) the module shall be capable to provide active power corresponding to the frequency deviation for a duration of 15-30 minutes specified by the TSO, depending on the power offered by the primary source;

(f) the active power control shall not have any adverse impact on the active power frequency response.

(g) if participating to the frequency restoration process at the setpoint and/or exchange powers to the scheduled values, the power-generating module shall ensure specific functions for performing these services, established via qualification procedures drafted by the TSO.

(h) with regard to disconnection due to underfrequency, the power-generating facility that includes both power-generating modules and loads, shall be capable of disconnecting its load in case of underfrequency.

Table 2D. *Parameters for active power frequency response in FSM (see figure 5D) (Article 15 (2) (d) (i), table 4)*

Parameters		Ranges
Active power range related to maximum power $\frac{\lvert\Delta P_1\rvert}{P_{\max}}$		(1.5÷10)%
Frequency response insensitivity	$\lvert\Delta f_i\rvert$	10 mHz
	$\frac{\lvert\Delta f_i\rvert}{f_n}$	(0.02 – 0.06)%
Frequency response deadband * After the qualification of groups for the provision of frequency containment reserves (FCR), this value is set at 0 mHz for FCR providing groups, and for other groups the TSO shall decide to set the value different to 0 mHz so that the impact on the frequency control is kept at a minimum		0 mHz
Droop s_1		(2÷12)%

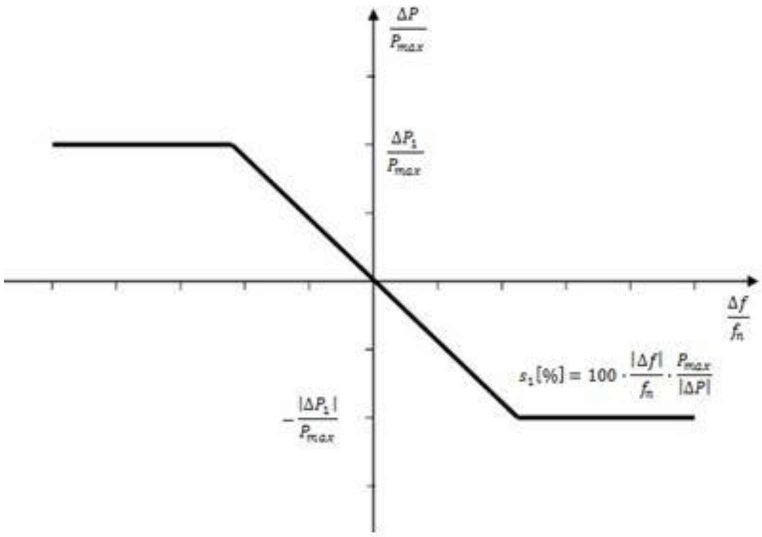


Figure 4D. *Active power frequency response capability of power-generating modules in FSM illustrating the case of zero deadband and insensitivity area.*

where: ΔP is the change in active power output from the power-generating module; P_{max} is the active power setpoint based on which the change in active power ΔP is established – namely the maximum power of the power-generating module; Δf is the frequency deviation in the network; f_n is the nominal frequency (50 Hz) in the network.

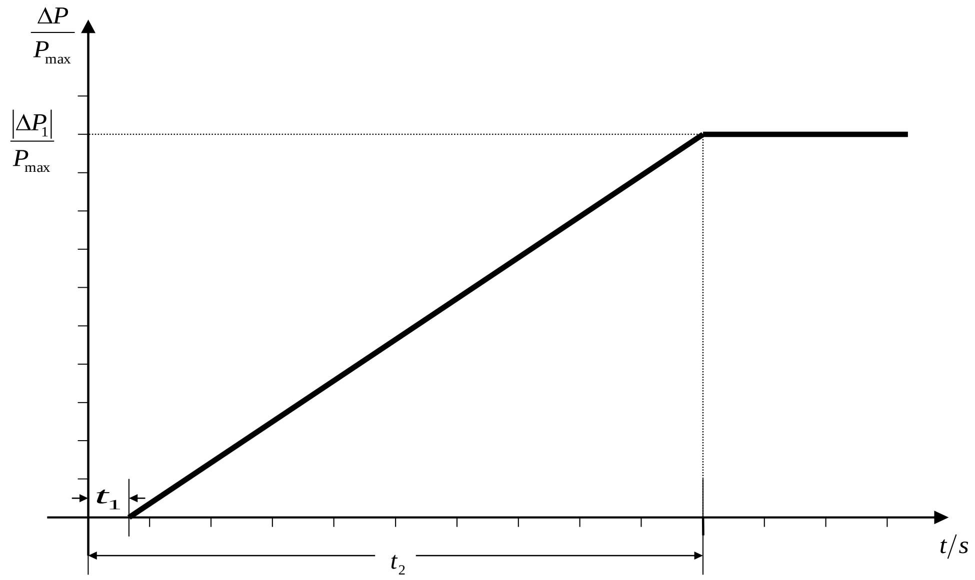


Figure 5D. *Frequency response capability*

where: P_{max} is the maximum (nominal) power based on which the active power range ΔP is established; ΔP is the change in active power of the power-generating module. The power-generating module shall activate an active power ΔP up to the point ΔP_1, according to the t_1 and t_2 times, while the ΔP_1, t_1 and t_2 values are specified by the TSO according to the provisions from table 3D; t_1 is the initial delay (idle time); t_2 is the duration until the full activation of active power.

Table 3D. *Parameters for full activation of active power frequency response resulting from frequency step change (explanation for figure 5D)*

Parameters	Ranges or values
Active power range related to maximum power (frequency response range) $\frac{\lvert\Delta P_1\rvert}{P_{max}}$	(1.5÷10)%
For power-generating modules with inertia, the maximum admissible initial delay t_1, except when the TSO admits longer activation periods, based on technical evidence provided by the power-generating module owner	2 seconds
For power-generating modules without inertia, the maximum admissible initial delay t_1, unless justified otherwise in line with Article 64 (d)	500 ms
Maximum admissible choice of full activation time t_2, unless longer activation times are allowed by the TSO for reasons of system stability	10 seconds

Article 65.

(1). Real-time monitoring of the active power automated frequency response of the type D power-generating module shall be ensured by transmitting, in real-time and in a secured way, from an interface of the power-generating module to the dispatching center of the RSO, upon request by the RSO, of at least the following signals:

i. the operation condition signal with/without active power frequency automated response;
ii. setpoint (scheduled) active power;
iii. actual value of the active power output;
iv. load-frequency response deadband;
v. parameter settings for active power frequency response (not provided in real-time, they are only monitored from the dispatching center).

(2). i. the RSO shall specify additional signals to be provided by the power-generating module via monitoring and recording devices in order to verify the performance of the active power frequency response provision;
ii. The additional signals are: frequency at the connection/interface point, as the case may be, state signals and commands regarding the breaker position and the separators position;
iii. The power-generating module owner ensures the transmission of signals via two independent communication paths with EMS-SCADA; usually, the main path is ensured via optical fiber equipment.
(3). Parameter settings for active power frequency response and the droop are established via operational controls.

Article 66. Type D power-generating modules shall fulfil the following requirements in relation to **robustness, in terms of**:
(a) the fault-ride-through capability in case of symmetrical faults:
i. the power-generating module must be capable to remain connected to the network, continuing its stable operation following a correctly secured fault in the network, according to the voltage-time dependency described in figure 6D, with respect to the connection/interface point, as the case may be, and described by the parameters in table 4D;
ii. the voltage-against-time-profile represents a lower admissible limit of the actual course of the voltages at the connection/interface point, as the case may be, during a symmetrical fault, as a function of time before, during and after the fault;
iii. the TSO shall specify and make publicly available the pre-fault and post-fault conditions for the fault-ride-through capability in terms of:
- the pre-fault minimum short-circuit power calculation at the connection/demarcation point, as the case may be;
- the pre-fault active and reactive power operating point of the power-generating module at the connection/interface point, as the case may be, and voltage at the connection/interface point, as the case may be; and
- the post-fault minimum short-circuit power calculation at the connection/interface point, as the case may be.
iv. upon request by a power-generating module owner, the RSO shall provide the pre-fault and post-fault conditions (as relevant values resulted from typical cases) to be considered for fault-ride-through capability as an outcome of the calculations at the connection/interface point, as the case may be, as specified in point (iii) regarding:
- the pre-fault minimum short-circuit power at every connection/demarcation point, as the case may be, expressed in MVA;
- the pre-fault operating point of the power-generating module, expressed in active power, reactive power and voltage at the connection/interface point, as the case may be; and

- the post-fault minimum short-circuit power at the connection/interface point, as the case may be, expressed in MVA.

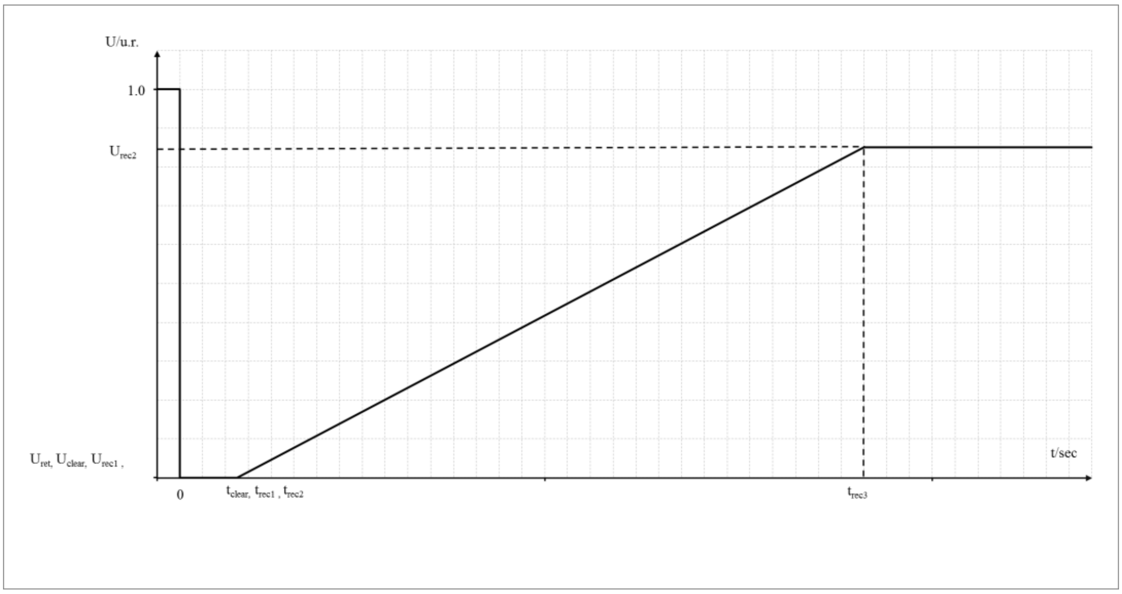


Figure 6D. *Fault-ride-through profile of a type D power-generating module*

Note: The diagram in figure 6D represents the lower limit of a voltage-against-time profile of the voltage at the connection/demarcation point, as the case may be, expressed as the ratio of its actual value and its reference value before, during and after a fault. U_{ret} is the retained voltage during a fault at the connection/demarcation point, as the case may be, and t_{clear} is the instant when the fault has been cleared. U_{rec1}, U_{rec2}, t_{rec1}, t_{rec2} and t_{rec3} represent certain points of lower limits of retained voltage after fault clearance. The parameters related to the fault-ride-through are provided in table 4D.

Table 4D. *Parameters related to the fault-ride-through capability of type D power-generating modules*

Voltage parameters [r.u.]		Time parameters [seconds]	
U_{ret}:	0	t_{clear}:	0.25
U_{clear}:	0	t_{rec1}:	0.25
U_{rec1}:	0	t_{rec2}:	0.25
U_{rec2}:	0.85	t_{rec3}:	3

v. the power-generating module shall remain connected to the network and shall continue to operate stably when the actual course of the phase-to-phase voltages on the network voltage level at the connection/interface point, as the case may be, during a symmetrical fault, given the existing pre-fault and post-fault conditions described in points (iii) and (iv), remains above the lower limit specified in point (ii), except the triggering via the protections for internal electrical faults. The protection schemes and settings for internal electrical faults must not jeopardize fault-ride-through performance;

vi. considering the requirements provided in point (v), the power-generating module owner establishes the undervoltage protection (either the fault-ride-through capability, or the minimum voltage defined at the connection/interface point, as the case may be) according to the maximum voltage range corresponding to the power-generating module, except if the RSO requires a narrower voltage range. The settings shall be justified by the power-generating module owner in accordance with the provisions set forth in point (vi);

(b) fault-ride-through capability in case of asymmetrical faults shall comply with the provisions set forth in letter (a) point (i) for faults;

(c) post-fault active power recovery at the pre-fault value, depending on the primary source. The TSO shall specify the post-fault active power recovery level, usually equal to the pre-fault power output, if the primary source is capable of providing and shall specify:

i) when the post-fault active power recovery begins, immediately after the moment when the voltage is higher than or equal to 0.85 U_{ret};

ii) the maximum period allowed for post-fault active power recovery is equal to maximum 50 ms; after the fault is cleared and the voltage recovers to a value greater than 0.85 U_{ret}, active power shall be restored, depending on the technology and the availability of the primary source, within a time interval of (1/0.5÷10) seconds for a value of (80÷90)% from the pre-fault power value;

iii) the magnitude and accuracy of active power recovery depending on the technology used by the power park module and on the availability of the primary source equals to (80÷90)% of the pre-fault power value with an accuracy of 10% from the pre-fault active power value.

(d) maintaining stable operation at every point within the P-Q-capability diagram in the event of power oscillations between the power plant and the connection/demarcation point, as the case may be;

(e) power-generating modules shall be capable of remaining connected to the network without reducing power (within the limits given by the primary source), so long the frequency and voltage fall within the limits provided in table 1D and the limits provided in tables 5D and 6D respectively;

(f) power-generating modules shall be capable of remaining connected to the network during single-phase or three-phase AR on loop network lines to which they are connected. The specific technical details shall be subject to coordination and instructions on protection schemes and settings agreed upon with the RSO.

Article 67.

(1). Type D power-generating modules shall fulfil the following requirements in relation to **system restoration:**

(a) they shall be capable to reconnect to the network following an accidental disconnection caused by an event in the network, under the conditions defined by the TSO;

(b) installation of automatic reconnection systems shall be subject to prior authorization both by the RSO, and the TSO, in order to specify the automatic reconnection requirements. Usually, the reconnection is performed with the agreement of the TSO and in the cases defined in letter (a), the automatic reconnection is performed within a (47.5÷50.5) Hz frequency range, a (0.85÷1.1) U_n voltage range and during a time period of (1÷5) minutes;

(c) they shall fulfil the requirements regarding the quick re-synchronization capability: in the event of disconnection from the network, the power-generating module shall be able to quickly re-synchronize according to the protection plan agreed upon with the RSO, within the limits of the technical possibilities of power-generating modules;

(2). The requirements for the automatic reconnection provided in paragraph (1) letters (a) and (b) shall be notified to the power-generating module owner during the grid connection process.

Article 68. Type D power-generating modules shall fulfil the following **general requirements related to system operation**:

(a) synchronizing the power-generating module with the system following an incident is performed by the power-generating module owner following approval by the RSO only;

(b) the power-generating module shall be equipped with the necessary synchronization facilities;

(c) synchronization shall be performed at frequencies within the ranges set out in table 1D;

(d) the RSO and the power-generating module owner shall agree upon and specify, prior to operation of the power-generating module, the settings of synchronization devices in order to allow the synchronization of the power-generating module, as follows:

i) voltage range, ±10% U_n (at terminals);

ii) frequency range, (47.5÷51) Hz;

iii) phase angle range, smaller than 10º;

iv) phase sequence;

v) deviation of voltage smaller than 10% U_n and deviation of frequency smaller than 50 mHz;

vi) verification time of metered values of 60 seconds.

(e) the following requirements with regard to **control and automation schemes** and their related settings shall be complied with:

i) the control and automation schemes, as well as the related settings, including the control parameters, necessary for the network stability calculations and emergency measures analysis, shall be submitted by the power-generating module owner to the RSO or the TSO respectively, no later than 6 months prior to the application of voltage for the beginning of the testing period, in order for them to be coordinated and agreed upon between the TSO, RSO and the power-generating module owner;

ii) any changes to the control and automation schemes and settings, as mentioned in point (i), of the different control devices of the power-generating module shall be coordinated and agreed upon between the TSO, the grid operator and the power-generating module owner.

(f) the following requirements with regard to **electrical protection schemes and settings** shall be complied with:

i. the protection systems needed for the power-generating module and the network, as well as the settings relevant to the power-generating module shall be coordinated and agreed upon between the RSO and the power-generating module owner, during the connection process. The protection systems and related settings for internal electrical faults must not jeopardize the performance of the power-generating module. The protection and automation systems shall fulfill at least the following requirements:

1. they shall ensure protection against internal faults of the power-generating module and against abnormal operation states and faults from the network to which the module is connected;

2. they shall be efficient, highly reliable and organized in groups with redundant functionality; the protections shall be selective, sensible, capable to detect internal and external faults, physically and galvanically separated from the power supplies with operative voltage, from voltage and current metering transformers to command execution devices. The electrical protection system shall be equipped with extended self-testing and self-diagnosis functions, as well as with events recording and

oscillography functions. The electrical protections system shall be equipped with standard communication interfaces aiming for the integration in a local system for data acquisition, supervision and control.

3. the electrical protections system may be organized in two groups of independent and redundant protections, both for the power-generating module as well as for the connection, as the case may be.
4. the internal faults electrical protections system shall be capable to detect at least the short-circuit currents in the power-generating module, the current asymmetry, the maximum/minimum voltage in the power-generating module terminals, the maximum/minimum frequency in the power-generating module terminals;
5. the external faults electrical protections system, as backup protections, shall be capable to detect at least the symmetrical and asymmetrical short-circuits from the network which the power-generating module is connected to, the power oscillations, the current asymmetry, the current and voltage electrical overloads.

ii. the electrical protection of the power-generating module shall take precedence over operational controls, taking into account the operational security of the system, the health and safety of staff and of the public, as well as mitigating any damage to the power-generating module.

iii. Together with the power-generating module owner, the RSO shall coordinate and commonly agree that the protection systems must cover at least the following faults:

A. the protections of the power-generating module and of the step-up transformer are covered by the power-generating module owner, for:
1. internal faults of the power-generating module (short-circuits or groundings);
2. internal faults of the power-generating module's step-up transformer;
3. short-circuits or groundings on the evacuation line in the network of the power output;
4. short-circuits or groundings in the network, as backup protection;
5. maximum and minimum voltage at the power-generating module terminals.

B. protections covered by the power-generating module owner and/or the RSO, as the case may be:
1. short-circuits or groundings on the evacuation line in the network of the power output;
2. maximum and minimum voltage at the connection/interface point, as the case may be;
3. maximum and minimum frequency at the connection/interface point, as the case may be;
4. short-circuits or groundings in the network, as backup protection.

iv. changes to the protection schemes, needed for the power-generating module and the network and to the settings relevant to the generation plant shall be agreed upon between the RSO and the power-generating module owner;

(g) the protection and control devices shall be organized by the power-generating module owner, according to the following prioritization:

i. the network's and power-generating module's protection;
ii. frequency control (active power adjustment);
iii. power restrictions;
iv. limiting the ramping rate of power variations.

(h) with regard to **information exchange**:

i. protection/control and automation systems of the power-generating modules shall be capable of exchanging information with the RSO in real time or periodically with time stamping;

ii. the RSO, in coordination with the TSO, shall specify the content of information exchanges including a precise list of data to be provided to the TSO by the RSO and by the power-generating module owner. The real-time submitted data are: active power, scheduled active power, reactive power, voltage and frequency at the connection/interface point, as the case may be, state signals and commands regarding the breaker position and the separators position and the operation condition signal with/without active power frequency automated response. The power-generating module owner ensures the transmission of signals via two independent communication paths (set in the TCA); usually, the main path is ensured via optical fiber equipment.

(i) the possibility of the power-generating module to automatically disconnect from the network when losing robustness. The disconnection criteria regarding the protection against current asymmetry, phase interruption and critical disconnection time, shall be agreed upon between the power-generating module owner, the grid operator and the TSO.

(j) regarding **instrumentation**:

i. power-generating modules shall be equipped with devices to provide fault recording and monitoring of dynamic system behavior; these devices are usually oscilloperturbographs or equipment that can replace functions covered by oscilloperturbographs. These devices shall record the following parameters:
   1. voltages in all three phases;
   2. current in each phase;
   3. active power in all three phases;
   4. reactive power in all three phases;
   5. frequency.

   The RSO shall have the right to specify quality of supply parameters to be complied with, provided via the aforementioned devices, on condition that they are previously agreed upon with the power-generating module owner.

ii. the settings of the fault recording equipment, including triggering criteria and the sampling rates shall be commonly agreed between the power-generating module owner and the RSO at the time of PIF and shall be documented via written arrangements. These shall also include a criterion for detecting oscillations established by the TSO;

iii. The RSO, TSO and the power-generating module owner commonly agree upon the need to include a criterion for detecting the dynamic system behavior, specified by the TSO in order to detect poorly damped power oscillations (undamped);

iv. the dynamic system behavior monitoring system shall include arrangements for the power-generating module owner and the RSO to access the information. The communications protocols for registered data shall be commonly agreed between the power-generating module owner, the RSO and the TSO, prior to choosing the monitoring equipment.

(k) regarding **power-generating module operation simulation models**:

i. upon request of the RSO or the TSO, the power-generating module owner shall provide the power-generating module operation simulation models that reflect the power-generating module behavior both in steady-state regime, as well as in dynamic regime (including for transient electromagnetic phenomena, if requested). The models provided shall be validated via the compliance test results. The power-generating module owner submits to the RSO or the TSO the results of these tests for the power-generating module, proven by means of check-up certificates recognized on European level, carried out by an authorized certifier;

ii. the models provided by the power-generating module owner shall contain the following sub-models, depending on the existence of individual components:
   - photovoltaic panel, wind turbine etc. and converter models;
   - active power control, as the case may be;
   - voltage control;
   - power-generating module protections models, as agreed by the RSO and the power-generating module owner;
   - inverter, wind generating unit models, as the case may be.

iii. upon request by the RSO as referred to in letter (k), the TSO shall specify:
   - the format in which simulation models are to be provided, including the utilized calculation program;
   - the documentation on a mathematical model's structure and block diagrams;
   - the estimate of the minimum and maximum short-circuit power at the connection/interface point, as the case may be, expressed in MVA, as an equivalent of the network.

iv. the power-generating module owner provides the RSO, upon request, with recordings of the power-generating module's performance. The RSO or the TSO may make such a request, in order to compare the response of the models and model simulations performed with actual operational recordings.

(l) the installation of devices for system operation and devices for system operational security, if the RSO or the TSO considers that it is necessary to install additional devices in a power-generating module in order to preserve or restore system operation or system operational security. The RSO and the power-generating module owner, together with the TSO, analyze and agree upon the adequate solution;

(m) the minimum and maximum limits on rates of change of active power output (ramping limits) in both an up and down direction of change of active power output for a power-generating module are specified by the RSO, in coordination with the TSO, taking into consideration the specific characteristics of prime mover technology. Usually, the rate of change falls within the (10÷30)% P_{max}/min range and is equal in both directions (up and down direction);

(n) earthing arrangement of the neutral-point at the network side of step-up transformers shall comply with the specifications of the RSO.

Article 69. Type D power-generating modules shall fulfil the following **requirements in relation to voltage stability**:

(a) With regard to voltage ranges:

i. Notwithstanding the provisions of Article 66 (a) regarding the fault-ride-through capability, a power-generating module shall be capable to remain connected to the network and to operate within the voltage range at the connection/interface point, as the case may be. The voltage range values are expressed in relative units as ratio between the voltage at the connection/interface point, as the case may be, and the reference 1 r.u. voltage related to the durations specified in tables 5D and 6D;

ii. the TSO may specify shorter periods of time during which power-generating modules shall be capable of remaining connected to the network in the event of simultaneous overvoltage and underfrequency or simultaneous undervoltage and overfrequency;

(b) The RSO and the power-generating module owner, in coordination with the TSO, may agree upon wider voltage ranges or longer minimum time periods for operation. If wider voltage ranges or longer minimum times for operation are economically and technically feasible, the power-generating module owner shall not unduly withhold consent for these proposals;

(c) without prejudice to the provisions of letter (a), the RSO, in coordination with the TSO, shall have the right to specify voltages at the connection/interface point, as the case may be, at which a power-generating module is capable of automatic disconnection. Requirements and settings for automatic disconnection shall be agreed between the RSO and the power-generating module owner;

(d) The RSO shall specify in the TCA the need to implement the power containment function aiming to damp active power oscillations, specified depending on system conditions, installed capacity of the power-generating module and its position in the network. The settings of the power containment systems shall be specified by the TSO and implemented according to the TSO's instruction.

Table 5D. *Minimum time for operation of a power-generating module connected at the 110 kV and 220 kV voltage level respectively*

Voltage range	Time period for operation
0.85 r.u. – 0.90 r.u.	60 minutes
0.90 r.u. – 1.118 r.u.	Unlimited
1.118 r.u. – 1.15 r.u.	20 minutes

Note: Table 5D shows the minimum time periods during which a power-generating module must be capable of operating without disconnection, for voltages deviating from the reference 1 r.u. value at the connection/interface point, as the case may be. Usually, the unlimited maximum value for operation for a nominal voltage of 110 kV equals to 123 kV and for a nominal voltage of 220 kV it equals 245 kV, as absolute values. For network areas where time periods for operation longer than 20 minutes are agreed, for voltage values in the 1.118 r.u. – 1.15 r.u. range, the maximum duration cannot exceed 60 minutes. The values are specified based on operational agreements between users and the RSO.

Table 6D. *Minimum time for operation of a power-generating module connected at the 400 kV voltage level*

Voltage range	Time period for operation
0.85 r.u. – 0.90 r.u.	60 minutes
0.90 r.u. – 1.05 r.u.	Unlimited
1.05 r.u. – 1.10 r.u.	20 minutes

Note: Table 6D shows the minimum time periods during which a power-generating module must be capable of operating without disconnection, for voltages deviating from the reference 1 r.u. value at the connection/interface point, as the case may be, in the case where the setpoint equals to 400 kV. For network areas where time periods for operation longer than 20 minutes are agreed, for voltage values in the 1.05 r.u. – 1.1 r.u. range, the maximum duration cannot exceed 60 minutes. The values are specified based on operational agreements between users and the RSO.

Article 70. The type D power-generating module shall be able to set the rate of change of active power output to the value required by the TSO (MW/minute) of minimum 10% P_{max}/min.

Article 71. The type D power-generating module owner must ensure protection of facilities and components of the power-generating module and of auxiliary installations against faults generated from its own facilities or from the network impact over them when the power-generating module activation protections are operated properly or upon network incidents (short-circuits with or without grounding, network protections tripping, transient over-voltages etc.), as well as upon exceptional/abnormal technical operational conditions.

Article 72. The type D power-generating module owner shall ensure power supply to the monitoring, control and data transmission facilities provided in Article 68, so that they are available for at least three hours after the loss of power supply.

Article 73.

(1) The type D power-generating module owner shall ensure two communication paths with reservation from the monitoring facilities or control facilities of the power-generating module to the interface with the RSO located in a location accepted by it, under quality parameters required by the RSO and according to the provisions of Article 68.

(2) Ensuring and maintenance of the communication path between the power-generating module and the data interface (belonging to the RSO) falls under the responsibility of the power-generating module owner.

Article 74.

(1) The integration in the DMS-SCADA and EMS-SCADA systems, as the case may be, as well as in the electricity monitoring system, falls under the responsibility of the power-generating module owner.

(2) The control and data acquisition facilities, as interface systems between the power-generating module and the power transmission/distribution grid, are specified in the TCA.

Article 75. The type D power-generating module owner has the obligation to ensure compatibility of data exchange equipment at interface level with the DMS-SCADA and EMS-SCADA system, as the case may be, according to the features requested by it.

Article 76. The type D power-generating module owner has the obligation to allow access to the RSO and the TSO to the outputs of its own metering systems for voltage, current, frequency, active and reactive power and to information regarding switching equipment indicating the status of facilities and alarm signals, in order to transfer this information to the interface with the control and data acquisition system – DMS-SCADA or EMS-SCADA respectively, as well as with the remote metering system.

Article 77. Under normal network operation, the power-generating module shall not produce fast voltage fluctuations at the connection/interface point, as the case may be, greater than ±5% of the nominal voltage of the network to which it is connected.

Article 78. Irrespective of the operational auxiliary installations and regardless of the power output, the power-generating module shall ensure, at the connection/demarcation point, as the case may be, the electricity quality according to applicable standards (European standards and the performance standard for providing the electricity transmission service and the system service, and the performance standard for providing the electricity distribution service respectively).

Article 79. The power-generating module is monitored in terms of electricity quality at the connection/interface point, as the case may be, during tests performed for verifying the compliance with the connection technical requirements. The RSO may require, as the case may be, a permanent monitoring of electricity quality at the connection/interface point, as the case may be, and the integration of the permanent monitoring equipment in its own electricity quality monitoring system.

CHAPTER III

Section 1. GENERAL REQUIREMENTS FOR TYPE B POWER PARK MODULES

Article 80. Type B power park modules shall fulfil the following requirements **in relation to frequency stability:**

(a) the power park module shall be capable of remaining connected to the network and operate within the **frequency ranges** and time periods specified in table 1B;

(b) i. the power park module must remain connected to the network and must operate at frequency variation rates of 2 Hz/s for a time period of 500 ms, of 1.5 Hz/s for a time period of 1000 ms and of 1.25 Hz/s for a time period of 2000 ms, depending on the technology type and the short-circuit power of the system at the connection point (a value provided by the RSO in the TCA).
ii. the values provided in point (i) shall be notified to the power park module owner when issuing the TCA.
iii. the protection controls at the connection point, coordinated by the RSO, must allow operation of the power park module for these frequency variation profiles.

Table 1B. *The minimum duration for which a type B power park module has to be capable to remain connected to the network and to operate on different frequencies, deviating from a nominal value*

Frequency range	Duration for operation
47.5 Hz – 48.5 Hz	Minimum 30 minutes
48.5 Hz – 49 Hz	Minimum 30 minutes
49 Hz – 51 Hz	Unlimited
51.0 Hz – 51.5 Hz	30 minutes

Article 81. Type B power park modules shall be capable to ensure a limited response to frequency deviations, namely to **frequency increases** above the nominal value of 50 Hz (**LFSM-O**), thus:

(a) at overfrequencies, the power park module shall decrease the active power output according to the frequency variation, in accordance with figure 1B and with the following parameters:

i. the frequency threshold from which the power park module ensures overfrequency response is 50.2 Hz;

ii. the droop settings shall be between 2% and 12% and shall be provided by the RSO via operational controls, at the power park module's commissioning, but may be changed whenever it is requested. Usually, the droop value equals 5%.

iii. the power park module shall be capable of decreasing the active power related to the frequency variation with an initial delay that is lower than 500 ms. If this delay is greater than 500 ms, the power park module owner shall justify the delay, providing technical evidence to the TSO. The response time for the power decrease in the event of overfrequency shall be lower than or equal to 2 seconds for a power variation of 50% from the maximum active power. For wind power plants, a longer response time (t_2) shall be accepted, of maximum 10 seconds for a power variation of 50% from the maximum active power.

(b) when reaching the power related to the minimum control level, the power park module shall be capable of:

   i. containing the activated power within a duration of no more than 20 seconds and continuing its operation at this level (within the limits of the admissible power given by the primary source); or
   ii. continuing to reduce the active power output according to the operational controls and in accordance with the functional features of power-generating modules of the same type; or
   iii. maintaining the power level reached with a permitted tolerance of ±5% P_{max}, so long the frequency deviation is maintained.

(c) the power park module shall be stable during operation in the LFSM-O mode during frequency increases over 50.2 Hz. So long LFSM-O is active, the LFSM-O setpoint shall prevail over any other active power setpoints.

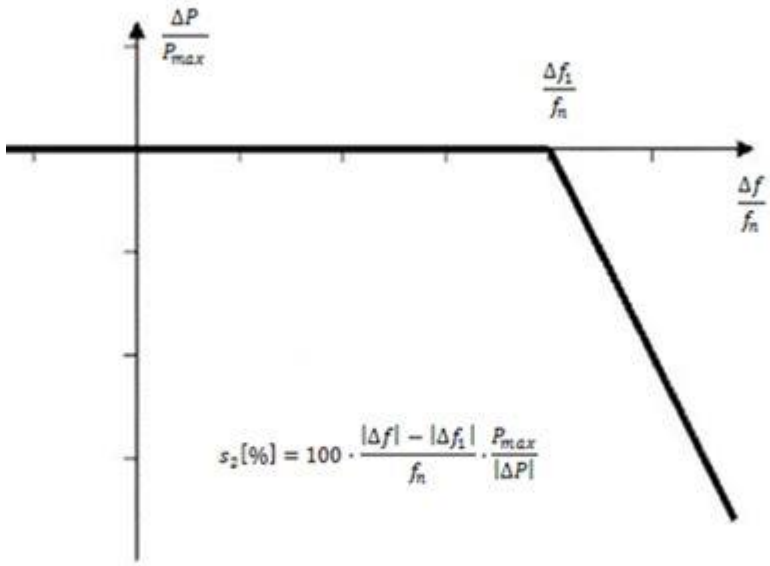


Figure 1B. *Active power frequency response capability of type B power park modules in LFSM-O*

where: P_{max} is the active power setpoint based on which ΔP is established – namely the maximum power of the power park module; ΔP is the change in active power output from the power park module; Δf is the frequency deviation in the network; f_n is the nominal frequency (50 Hz) in the network. At overfrequencies where Δf is above +200 mHz compared to the nominal value (50 Hz), the power park module has to decrease the active power according to the droop s_2.

Article 82. The type B power park module shall be capable of maintaining constant output at its target active power value regardless of changes in frequency, within the limits of the power offered by the primary source, except where the power-generating modules in the power park module follow the frequency increases according to Article 81 or have power decreases at frequency decreases accepted by the RSO and according to the provisions of Article 83 and Article 84.

Article 83. The TSO sets the active power output reduction of the type B power park module compared to the maximum power output (admissible power given by the primary source) following the frequency decrease, within the admissible limits specified in figure 2B, hence:

(a) at underfrequencies below 49 Hz, the decrease of maximum active power (admissible power given by the primary source) is admitted at a percentage of 2% from the maximum active power output at the frequency of 50 Hz, for every 1 Hz of frequency decrease. Any maximum active power output reduction curve situated above the dotted line is admitted depending on the frequency;

(b) at a frequency decrease under 49.5 Hz a maximum active power output decrease is admitted at a percentage of 10% from the maximum active power output at the frequency of 50 Hz, for every 1 Hz of frequency decrease, if the frequency is lower than 49.5 Hz for a duration of over 30 s. Any maximum active power reduction curve situated above the continuous line is admitted depending on the frequency.

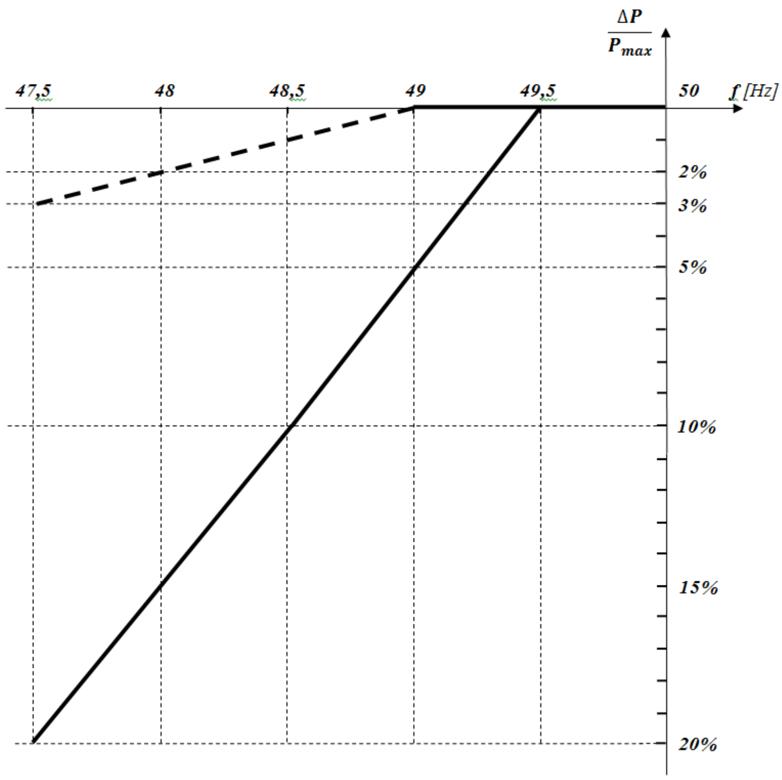


Figure 2B. *Admissible limits for power reduction established by the TSO in the event of underfrequency*

Article 84.

(1)The admissible active power reduction compared to the maximum power output (admissible power, given by the primary source) in the event of frequency deviations under 49.5 Hz is established:

(a) under standard environmental conditions related to a temperature of 20 degrees Celsius. As the case may be, the owner submits to the RSO the dependency diagram of the active power in terms of temperature for at least one set of temperatures: -10^{0}C, 0^{0}C, 15^{0}C, 25^{0}C, 30^{0}C, 40^{0}C;

(b) depending on the technical capability of the power-generating modules in the power park module.

(2) The power park module owner shall submit to the RSO the dependency diagram of the active power in terms of environmental factors (temperature, pressure, solar irradiance, wind speed, as the case may be) and the technical data regarding the technical capability of power-generating modules in the power park module, set forth in Annex 5 to this technical norm;

(3) The data provided in paragraph (2) shall be submitted during the solution study stage within the connection process.

Article 85.

(1) The type B power park module shall be equipped with a logic interface or corresponding protections in order to reduce the active power output to the point of shut-down in a time period of no more than five seconds following a disconnection instruction being received at the interface.

(2) The RSO is entitled to establish the technical requirements for the logic interface described in paragraph (1) and its connection method with the RSO's own SCADA system.

Article 86.

(1)The RSO sets forth the requirements for the automatic connection of a type B power park module to the network, after these requirements have been agreed upon with the TSO.

(2)The requirements provided in paragraph (1) include:

(a) the frequency ranges in which the automatic connection is accepted (namely (47.5÷51) Hz, the voltage range ((0.9-1.1) U_n), the observation/validation period (including the synchronization time) and the period for maintaining the metered parameters within the determined range, of maximum 300 seconds;

(b) the slope admitted for the active power increase after connection ($\leq$ 20 % P_{max}/min), usually 10% of the P_{max}/min (the setpoint is chosen within the range indicated by the power-generating modules manufacturer).

Article 87. Type B power park modules shall fulfil the following requirements in relation to active load-frequency control:

(a) to control active power output, the power park module shall be equipped with an interface (input port) in order to be able to receive a downward power target;

(b) the power-generating module shall perform the power target within no more than 60 seconds, with a precision of ± 5% P_{max} and

(c) the RSO shall have the right to specify the requirements for further equipment to allow active power output to be remotely operated. These requirements shall be specified in the TCA.

Article 88. Type B power park modules shall fulfil the following requirements in relation to **robustness, in terms of**:

(a) fault ride through capability:

i. the power park module must be capable to remain connected to the network, continuing its stable operation following a correctly secured fault in the network, according to the voltage-time dependency described in figure 3B, with respect to the connection/interface point, as the case may be;

ii. the voltage-against-time-profile represents a lower admissible limit of the actual course of the voltages at the connection/interface point during a symmetrical fault, as a function of time before, during and after the fault;

iii. the TSO shall specify and make publicly available the pre-fault and post-fault conditions for the fault-ride-through capability in terms of:

1. the pre-fault minimum short-circuit power calculation at the connection/interface point, as the case may be;

2. the pre-fault active and reactive power operating point of the power park module at the connection/interface point, as the case may be, and the voltage at the connection/interface point, as the case may be; and

3. the post-fault minimum short-circuit power calculation at the connection/interface point, as the case may be.

iv. upon request by a power park module owner, the RSO shall provide the pre-fault and post-fault conditions to be considered for fault-ride-through capability as an outcome of the calculations at the connection/interface point, as the case may be, as specified in point (iii) regarding:

1. the pre-fault minimum short-circuit power at every connection/interface point, as the case may be, expressed in MVA;
2. the pre-fault operating point of the power park module, expressed in active power, reactive power and voltage at the connection/interface point, as the case may be; and
3. the post-fault minimum short-circuit power at the connection/interface point, as the case may be, expressed in MVA.

v. the power park module shall remain connected to the network and shall continue to operate stably when the actual course of the phase-to-phase voltages on the network voltage level at the connection/interface point, as the case may be, during a symmetrical fault, remains above the lower limit for the voltage profile described in the fault-ride-through-profile specified in point (ii), except the triggering via the protections for internal electrical faults. The protection schemes and settings for internal electrical faults must not jeopardize fault-ride-through performance;

vi. considering the requirements provided in point (v), the power park module owner establishes the undervoltage protection (either the fault-ride-through capability, or the minimum voltage defined at the connection/interface point, as the case may be) according to the maximum voltage range corresponding to the power park module, except if the RSO requires a narrower range. The settings shall be justified by the power park module owner in accordance with the provisions set forth in point (vi);

Figure 3B. *Fault-ride-through profile of a type B power park module*

Note: The diagram in figure 3B represents the lower limit of a voltage-against-time profile of the voltage at the connection/demarcation point, as the case may be, expressed in relative units as the ratio of its actual value and its reference value before, during and after a fault. U_{ret} *is the retained voltage at the connection/demarcation point, as the case may be, during a fault,* t_{clear} *is* *the instant when the fault has been cleared. U_{rec1}, U_{rec2}, t_{rec1}, t_{rec2} and t_{rec3} specify certain points of lower limits of voltage recovery after fault clearance. The parameters related to the fault-ride-through are provided in table 2B.*

Table 2B. *Parameters related to the fault-ride-through capability of power park modules*

Voltage parameters [PU]		Time parameters [seconds]	
U_{ret}:	0.15	t_{clear}:	0.25
U_{clear}:	0.15	t_{rec1}:	0.25
U_{rec1}:	0.15	t_{rec2}:	0.25
U_{rec2}:	0.85	t_{rec3}:	3.0

(b) fault-ride-through capability in case of asymmetrical faults which must comply with the requirements set forth in letter (a) point (i).

(c) the TSO shall specify the post-fault active power recovery that the type B power park module shall be capable of providing and shall specify:

  i. when the post-fault active power recovery begins, immediately after the moment when the voltage is higher than or equal to 85% U_{ret};

  ii. the maximum period allowed for post-fault active power recovery is equal to maximum 50 ms; after the fault is cleared and the voltage recovers to a value greater than 0.85 U_{ret}, active power shall be restored, depending on the technology and the availability of the primary source, within a time interval of (1÷10) seconds for a value of (80÷90)% from the pre-fault power value; and

  iii. the magnitude and accuracy of active power recovery depending on the technology used by the power park module and on the availability of the primary source equals to (80÷90)% of the pre-fault power value with an accuracy of 10% from the pre-fault active power value.

(d) The RSO shall specify in the TCA or at the time of commissioning, as the case may be:

  i. the interdependency between fast fault current requirements according to points (b) and (c) and voltage (the K-factor value shall be specified);

  ii. the dependence between active power recovery times and duration of voltage variations. The RSO shall specify, at the moment of commissioning, the maximum active power recovery time depending on the maximum duration of the fault, usually equal to (1÷10) s for faults secured within a time period greater than 140 ms;

  iii. the limit of the maximum allowed time for active power recovery, usually less than 10 seconds. A smaller value shall be requested if the solution studies and the time for fault clearance require it;

  iv. the adequacy between the level of voltage recovery and the minimum magnitude for active power recovery. Usually, for a voltage recovery value higher than 85% U_{ret}, the minimum value of post-fault recovered active power shall reach at least 85% of the pre-fault value within a time period of maximum 1 second, according to the availability of the primary source; and

  v. the requirements regarding active power oscillations damping between the power plant and the connection/demarcation point, as the case may be, if dynamic studies show that equipment is necessary in order to secure the damping of these active power oscillations.

Article 89. Type B power park modules shall fulfil the following requirements in relation to the contribution to **system restoration**:

(a) they shall be capable to reconnect to the network following an accidental disconnection caused by an event in the network, according to the operational controls and under the conditions defined by the TSO. Usually, the automatic reconnection is performed within a (47.5÷50.5) Hz frequency range, a (0.85÷1.1) U_n voltage range and during a time period of maximum 5 minutes;

(b) installation of automatic reconnection systems shall be subject to prior authorization both by the RSO, and the TSO, in order to specify the automatic reconnection requirements. These requirements shall be specified in the TCA and shall be detailed in the technical project;

(c) the requirements and conditions for the automatic reconnection provided in letters (a) and (b) shall be notified to the power park module owner when issuing the TCA.

Article 90. Type B power park modules shall fulfil the following **operational requirements** in relation to:

(a) control and automation schemes and related settings:

i. the control and automation schemes, as well as the related settings, including the control parameters, necessary for the network stability calculations and emergency measures analysis, shall be submitted by the power park module owner to the RSO or the TSO respectively, no later than 3 months prior to the application of voltage for the beginning of the testing period, in order for them to be coordinated and agreed upon between the TSO, RSO and the power park module owner;

ii. any changes to the control and automation schemes and settings, as mentioned in point (i), of the different control devices of the power park module shall be coordinated and agreed upon between the TSO, the grid operator and the power park module owner.

(b) electrical protection schemes and related settings:

i. the protection systems needed for the power park module and the network, as well as the settings relevant to the power park module shall be coordinated and agreed upon between the RSO and the power park module owner, during the connection process. The functions of the protections shall be prescribed by the RSO who may request a different protection control than the one proposed by the owner. The protection systems and settings for internal electrical faults must not jeopardize the performance of the power park module. The TSO coordinates with the DSO and the power park module owner in order to coordinate protections, taking into account the frequency variation value resulted from periodical studies on the inertia of the Continental Europe synchronous system to which the NPS belongs. The protection and automation systems shall fulfill at least the following requirements:

1. they shall ensure protection against internal faults of the **power-generating modules in the power park module**, as well as backup protection against abnormal operation states and faults from the network to which they are connected;

2. they shall be efficient, highly reliable and organized in groups, selective, sensible, capable to detect internal and external faults, physically and galvanically separated from the power supplies with operative voltage, from voltage and current metering transformers to command execution devices.

The protection systems shall be equipped with extended self-testing and self-diagnosis functions, as well as with events recording and oscillography functions. The electrical protections system shall be equipped with standard communication interfaces aiming for the integration to a local data acquisition, supervision and control system;

3. the internal faults electrical protections system shall be capable to detect at least the short-circuit currents, the current asymmetry, the maximum/minimum voltage at the connection/interface point, as the case may be, the maximum/minimum frequency at the connection/interface point, as the case may be;

4. the external faults electrical protections system, as backup protections, shall be capable to detect at least the symmetrical and asymmetrical short-circuits from the network to which the power-generating module in the power park module is connected, the power oscillations, the current asymmetry, the current and voltage electrical overloads.

ii. the electrical protection of the power-generating modules in the power park module shall take precedence over operational controls, taking into account the operational security of the system, the health and safety of staff and of the public, as well as mitigating any damage to the power-generating modules in the power park module.

iii. Together with the power park module owner, the RSO shall coordinate and commonly agree that the protection systems must cover at least the following faults:

A. protections of power-generating modules in the power park module, of the step-up transformer and of the houseload or ancillary services transformer, covered by the power park owner:

1. internal faults of power-generating modules in the power park module, of the step-up transformer and potentially of the houseload transformer (short-circuits or groundings);
2. internal faults of the step-up transformer of the power-generating module in the power park module;
3. short-circuits or groundings on the connection power line;
4. short-circuits or groundings in the network, as backup protection;
5. maximum and minimum voltage at the terminals of the power-generating module in the power park module.

B. protections covered by the power park module owner and/or the RSO, as the case may be:

1. short-circuits or groundings on the power output evacuation line;
2. maximum and minimum voltage at the connection/interface point, as the case may be;
3. maximum and minimum frequency at the connection/interface point, as the case may be;
4. short-circuits or groundings in the network, as backup protection.

iv. changes to the protection schemes, needed for the power park module and the network and to the settings relevant to the generation plant shall be agreed upon in advance between the RSO and the power park module owner;

(c) the organization by the power park module owner of the protection and control devices according to the following prioritization:

i. the network's and power park module's protection;

ii. synthetic inertia, if applicable;

iii. frequency control (active power adjustment);
iv. power restrictions;
v. limiting the ramping rate of power variations.

(d) **information exchange:**

i. protection/control and automation systems of power-generating modules in the power park module shall be capable of exchanging information with the RSO in real-time or periodically with time stamping; In the event of aggregations, according to the functions agreed to be aggregated, the exchanged information is communicated to the RSO and the TSO;

ii. The RSO, in coordination with the TSO, sets the content of the exchanges of information provided by the power park module owner, which shall comprise at least the following data transmitted in real-time: the active power at the connection/interface point, as the case may be, the state signals and commands regarding the breaker position and the separators position and the command to reduce active power following an instruction from the RSO/TSO, as the case may be. The power park module owner ensures the transmission of signals via one/two independent communication paths (set in the TCA); usually, the main path is ensured via optical fiber equipment.

Article 91. Type B power park modules shall fulfil the following requirements in relation to **voltage stability**:

(a) with regard to reactive power capability, the RSO shall have the right to specify the capability of the type B power park module to provide reactive power. Usually, the reactive power output at maximum active power shall ensure a 0.9 inductive and capacitive power factor (as maximum value).

(b) the type B power park module shall be capable of providing fast fault current at the connection/demarcation point, as the case may be, in case of symmetrical (three-phase) faults, under the following conditions:

i. the type B power park module shall be capable of activating the supply of fast fault current either by:

1. ensuring the supply of the fast fault current at the connection/interface point, as the case may be, corresponding to the voltage variation with a proportionality factor (k) between 2 and 10 according to the formula: $\Delta I = k * \Delta U$; or

2. measuring voltage variations at the terminals of the power park module and providing fast fault current at the terminals of these modules (reactive current component);

ii. The RSO, in coordination with the TSO, shall specify:

1. how and when a voltage variation is to be determined as well as the duration of the voltage variation. The voltage variation shall be determined when the metered voltage, either at the connection/interface point, as the case may be, or at the terminals of the generating unit, is lower than 0.85 r.u. The duration of the variation is considered up to the point when the voltage recovers to a value greater than 0.85 r.u.

2. the characteristics of the fast fault current, including the time domain for measuring the voltage deviation and fast fault current, for which current and voltage may be measured differently from the method specified in Article 91 (b) (i), are: increase time of the fault current, lower than or equal to 30 ms and the clearance time of the fault current, lower than or equal to 60 ms;

3. the timing and accuracy of the fast fault current, which may include several stages during a fault and after its clearance. The power-generating module shall inject, immediately after the fault (when low voltage is detected,

according to the provisions set forth in the point above) in a time period no longer than 50 ms, a reactive current depending on the magnitude of the low voltage (retained voltage) with a proportionality factor between 2 and 10. The injected reactive current shall be maintained all throughout the low voltage duration according to the voltage profile defined by the fault-ride-through in figure 3B and shall be cancelled immediately after fault clearance (according to IGD Fault current contribution from PPMS & HVDC).

(c) with regard to the supply of fast fault current in case of asymmetrical (one-phase or two-phase) faults, the RSO, in coordination with the TSO, shall have the right to specify the requirements for asymmetrical current injection. Usually, the requirements regarding the asymmetrical current injection are similar to the requirements regarding the symmetrical current injection set forth in letter (b). These requirements shall be notified to the owner by the RSO.

Article 92.

(1). The type B power park module owner shall ensure continuity in the submission of status and operation values provided in Article 90 (d) to the RSO.

(2). The RSO-connected power park module shall be integrated in the SCADA system of the RSO and shall ensure at least the active power signal. The RSO is entitled to request the integration of other values into DMS-SCADA.

(3). The communication path is specified by the RSO.

(4). The integration in the RSO's SCADA system falls under the responsibility of the power park module owner.

Article 93. The type B power park module owner has the obligation to ensure compatibility of data exchange equipment at the RSO's SCADA system interface level, according to the features requested by it.

Article 94. Under normal network operation, the power park module shall not produce fast voltage fluctuations at the connection/interface point, as the case may be, greater than ±5% of the nominal voltage of the network to which it is connected.

Article 95. Irrespective of the number of operational auxiliary installations and regardless of the power output, the power park module shall ensure, at the connection/interface point, as the case may be, the electricity quality according to applicable standards (European standards and the performance standard for providing the electricity transmission service and the system service, and the standard for providing the electricity distribution service respectively).

Article 96. The power park module shall be monitored in terms of electricity quality at the connection/interface point, as the case may be, during tests performed for verifying the compliance with the connection technical requirements. The RSO may require, as the case may be, a permanent monitoring of electricity quality at the connection/demarcation point, as the case may be, and the integration of the permanent monitoring equipment in its own electricity quality monitoring system.

Article 97. If several power park modules are connected in the same electrical node (bar), for which the sum of installed capacities of all generation sources exceeds the maximum power of type B, these must provide reactive power control at the connection/interface point, as the case may be. If the sum of installed capacities of all generation sources in the common electrical node, including the power park module, exceeds the maximum power of type C, these must commonly provide voltage control at the connection point.

Article 98. The connection solution of type B power park modules shall not allow their island operation and must foresee the endowment with protections which trip the power park module at the occurrence of such an operation state.

Section 2. GENERAL REQUIREMENTS FOR TYPE C POWER PARK MODULES

Article 99. Type C power park modules shall fulfil the following requirements **in relation to frequency stability:**

(a) the power park module shall be capable of remaining connected to the network and operate within the **frequency ranges** and time periods specified in table 1C;

(b) i. the power park module must remain connected to the network and must operate at frequency variation rates of 2 Hz/sec for a time period of 500 ms, of 1.5 Hz/s for a time period of 1000 ms and of 1.25 Hz/s for a time period of 2000 ms, depending on the technology type and the short-circuit power of the system at the connection/demarcation point, as the case may be (a value provided by the RSO in the TCA), and the inertia available at synchronous area level.
ii. the values provided in point (i) shall be notified to the power park module owner.
iii. the protection controls at the connection/interface point, as the case may be, coordinated by the RSO, must allow operation of the power park module for these frequency variation profiles.

Table 1C. *The minimum duration for which a power park module has to be capable to remain connected to the network and to operate at different frequencies, deviating from a nominal value*

Frequency range	Duration for operation
47.5 Hz – 48.5 Hz	Minimum 30 minutes
48.5 Hz – 49 Hz	Minimum 30 minutes
49 Hz – 51 Hz	Unlimited
51.0 Hz – 51.5 Hz	30 minutes

Article 100. Type C power park modules shall be capable to ensure a limited frequency response at the connection point, namely to **frequency increases** above the nominal value of 50 Hz (**LFSM-O**), thus:

(a) at overfrequencies, the power park module shall decrease the active power output according to the frequency variation, in accordance with figure 1C and with the following parameters:

i. the frequency threshold from which the power park module ensures overfrequency response is 50.2 Hz;

ii. the droop settings shall be between 2% and 12% and shall be specified at the time of commissioning of the power park module and may be modified by the RSO via operational controls, at the time of commissioning of the power park module. Usually, the droop value equals 5%.

iii. the power park module shall be capable of decreasing the active power related to the frequency variation with an initial delay that is lower than 500 ms (marked with t_1 in figure 5C). If this delay is greater than 500 ms, the power park module owner shall justify the delay, providing technical evidence to the TSO. The response time for the power decrease in the event of overfrequency shall be lower than or equal to 2 seconds for a power variation of 50% from the maximum active power.

(b) when reaching the power related to the minimum control level, the power park module shall be capable of:

   i. containing the activated power within a duration of no more than 20 seconds and continuing its operation at this level (within the limits of the admissible power given by the primary source); or

   ii. continuing to reduce the active power output according to the operational controls and in accordance with the functional features of power-generating modules of the same type in the power park module;

   iii. maintaining the power level reached with a permitted deviation of ±5% P_{max}, so long the frequency deviation is maintained.

(c) the power park module shall be stable during operation in the LFSM-O mode during frequency increases over 50.2 Hz. So long LFSM-O is active, the LFSM-O setpoint shall prevail over any other active power setpoints.

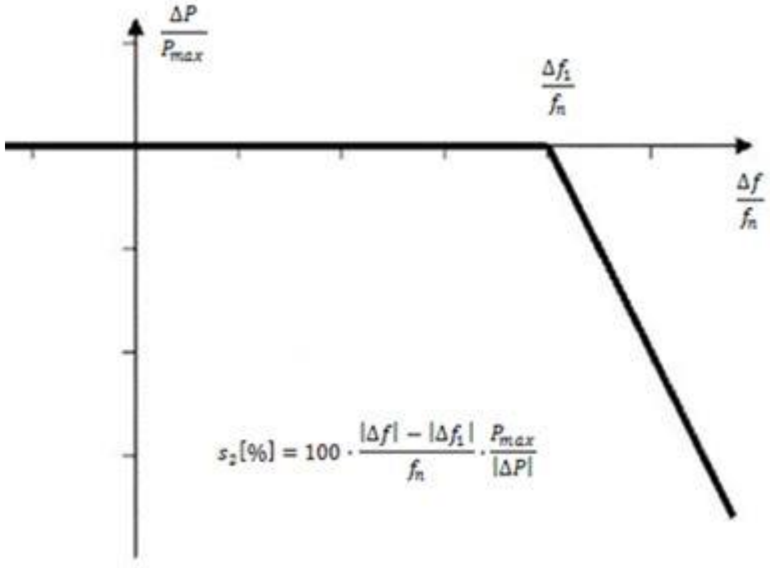


Figure 1C. *Active power frequency response capability of type C power park modules in LFSM-O*

where: ΔP is the change in active power output from the power park module; P_{max} is the active power setpoint based on which ΔP is established – namely the maximum power of the power park module; Δf is the frequency deviation in the network; f_n is the nominal frequency (50 Hz) in the network. At overfrequencies where Δf is above +200 mHz compared to the nominal value (50 Hz), the power park module has to decrease the active power according to the droop s_2.

Article 101. The type C power park module shall be capable of maintaining constant output at its target active power value regardless of changes in frequency, within the limits of the power offered by the primary source, except where the power park module follows the frequency increases according to Article 100 or has power decreases at frequency decreases accepted by the RSO, according to the provisions of Article 102 and Article 103.

Article 102. The TSO sets the active power output reduction of the type C power park module compared to the maximum active power output (admissible power given by the primary source) following the frequency decrease, within the admissible limits specified in figure 2C, hence:

(a) at a frequency decrease under 49 Hz a maximum active power output decrease is admitted at a percentage of 2% from the maximum active power output at the frequency of 50 Hz, for every 1 Hz of frequency decrease. Any maximum active power output reduction curve situated above the dotted line is admitted depending on the frequency;

(b) at a frequency decrease under 49.5 Hz a maximum active power output decrease is admitted at a percentage of 10% from the maximum active power output at the frequency of 50 Hz, for every 1 Hz of frequency decrease, if the frequency is lower than 49.5 Hz for a duration of over 30 s. Any maximum active power reduction curve situated above the continuous line is admitted depending on the frequency.

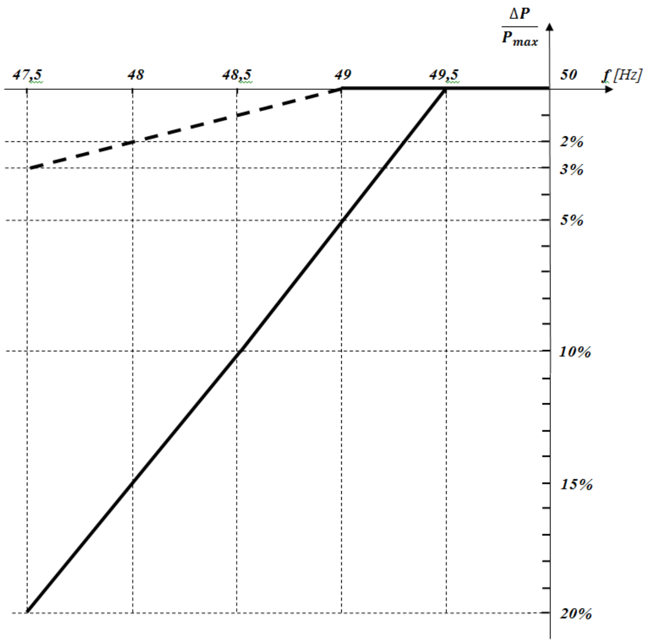


Figure 2C. *Admissible limits for power reduction established by the TSO in the event of underfrequency*

Article 103.

(1) The admissible active power reduction compared to the maximum active power output (admissible power, given by the primary source) in the event of frequency deviations under 49.5 Hz is established:

(a) under standard environmental conditions related to a temperature of 20 degrees Celsius. As the case may be, the owner submits to the RSO and the TSO the dependency diagram of the active power in terms of temperature for at least one set of temperatures: -10^{0}C, 0^{0}C, 15^{0}C, 25^{0}C, 30^{0}C, 40^{0}C;

(b) depending on the technical capability of the power-generating modules in the power park module.

(2) The power park module owner shall submit to the RSO and the TSO the dependency diagram of the active power in terms of environmental factors (temperature, pressure, solar irradiance, wind speed, as the case may be) and the

technical data regarding the technical capability of power-generating modules in the power park module, set forth in Annex 3;

(3) The data provided in paragraph (2) shall be submitted during the solution study stage within the connection process.

Article 104.

(1) The active power control system of the type C power park module shall be capable of adjusting an active power setpoint in line with the instructions given to the power park module owner by the RSO or the TSO.

(2) The time to reach the active power setpoint or the rate of change of active power output when adjusting the setpoint falls within the (10÷30)% P_{max}/min range depending on the technology, while the idle time equals to 1 second and the setpoint fulfillment tolerance equals to 5% P_{max}.

Article 105. Local control shall be allowed in cases where the automatic remote control devices are out of service.

Article 106.

(1) The RSO sets forth the conditions for the automatic connection of a type C power park module to the network, after these conditions have been agreed upon with the TSO.

(2) The requirements provided in paragraph (1) include:

(a) the frequency ranges in which the automatic connection is accepted (namely (47.5÷51) Hz, the voltage range ((0.9-1.1) U_n), the observation/validation period (including the synchronization time) and the period for maintaining the metered parameters within the determined range, of maximum 300 seconds;

(b) the slope admitted for the active power increase after connection (≤ 20 % P_{max}/min), usually 10% of the P_{max}/min (the setpoint is chosen within the range indicated by the manufacturer of power-generating modules in the power park).

Article 107. Type C power park modules shall be capable to ensure a limited frequency response, namely to frequency decreases (LFSM-U), thus:

(a) it must be capable to mobilize active power response at underfrequencies below a 49.8 Hz threshold and with a droop set by the TSO for every power-generating module in the power park, at the time of PIF or via operational controls within the (2÷12)% limits, usually at the 5% value, which corresponds to an active power mobilized of 8% P_{max}, according to figure 3C;

(b) the delivery of active power in response to the frequency decrease (in LFSM-U mode) shall also take into account, as the case may be, the following:

i. the dependency diagram of active power output in terms of environmental conditions (given by the primary source);

ii. the operating requirements of the power park module, in particular the limitations on operation near maximum active power at low frequencies and the respective impact of external operating requirements according to the provisions of Article 102 and Article 103 ;

(c) the activation of active power frequency response by the power-generating module shall not be unduly delayed. If this delay (called idle time and marked with t_1 in figure 5C) is greater than 500 ms, the power park module owner shall justify the delay towards the TSO;

(d) while operating in the LFSM-U mode, the power park module shall ensure a power increase up to the maximum/admissible power depending on the primary energy source. The response time for the power increase for power-generating modules, except for wind turbines, shall be lower than or equal to 10 seconds for a power variation of maximum 50% from the maximum power. For wind turbines, the response time shall be lower than or equal to 5 seconds for a power variation of 20% from the maximum power, if the starting operating point is higher than 50% from the maximum power. Higher active power increase times can be accepted if the starting operating point is lower than 50% from the maximum power. Reaching the setpoint shall take place in a time interval of maximum 30 seconds with a maximum tolerance of ±5% from P_{max};

(e) the power park module shall operate stably during the LFSM-U mode at frequencies lower than 49.8 Hz.

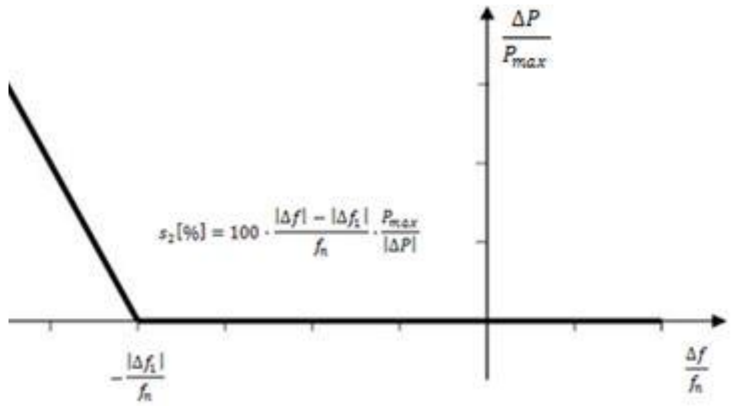


Figure 3C. *Low frequency response capability of type C power park modules (LFSM-U)*

where: P_{max} is the active power setpoint based on which ΔP is established – namely the maximum (nominal) power of the power park module; ΔP is the change in active power output from the power park module; f_n is the nominal frequency (50 Hz) in the network and Δf is the frequency deviation in the network. At underfrequencies below 49.8 Hz where Δf is below -200 mHz, the power park module has to increase the active power according to the droop s_2.

Article 108. If the FSM mode is active, under the conditions offered by the primary source, the type C power park module shall fulfill all requirements described below, in addition to the requirements provided in Article 107 according to figure 4C:

(a) the module shall provide FSM, according to the parameters specified by the TSO, within the value ranges provided in table 2C, thus:

i. in case of overfrequency above the 50 Hz value, the active power frequency response is limited by the minimum regulating level;

ii. in case of underfrequency compared to the 50 Hz value, the active power frequency response is limited by the maximum active power available given by the primary source.

iii. the actual delivery of active power frequency response depends on the external and operating conditions of the power park module when this response is triggered, particularly on the limitations given by the operation of the power park module, under the conditions of the primary source at low frequencies.

(b) the module shall be able to modify the frequency deadband and the droop following the TSO's instruction. Usually, the s_1 droop value equals 5%, which corresponds to an active power mobilized of 8% P_{max};

(c) in the event of a frequency step change, the module shall be capable of activating full active power frequency response, at or above the line shown in figure 5C, in accordance with the parameters specified in table 3C, in the absence of technological limitations, namely for power-generating modules in the power park with inertia, with a delay (t_1) of two seconds and an activation time of maximum 30 seconds (t_2), within the power limit offered by the primary source;

(d) for power-generating modules in the power park without inertia, the initial activation of active power required shall not be unduly delayed. If the delay in initial activation of active power is greater than 500 ms for modules without inertia, or greater than two seconds for modules with inertia, the power park module owner shall provide technical evidence demonstrating why a longer time is needed;

(e) the module shall be capable to provide active power corresponding to the frequency deviation for a duration of maximum 15-30 minutes specified by the TSO, within the limits of the power offered by the primary source;

(f) the active power control shall not have any adverse impact on the active power frequency response.

(g) if participating to the frequency restoration process at the setpoint and/or exchange powers to the scheduled values, the power park module shall ensure specific functions for performing these services, established via procedures drafted by the TSO;

(h) with regard to disconnection due to underfrequency, power park modules capable of acting as a load shall be capable of disconnecting their load in case of underfrequency. The requirement referred to in this point does not extend to auxiliary supply.

Table 2C. *Parameters for active power frequency response in FSM (see figure 5C)*

<table>
<tr><th colspan="2">Parameters</th><th>Ranges</th></tr>
<tr><td colspan="2">Active power range related to maximum power $\frac{|\Delta P_1|}{P_{\max}}$</td><td>(1.5÷10)%</td></tr>
<tr><td rowspan="2">Frequency response insensitivity</td><td>$|\Delta f_i|$</td><td>10 mHz</td></tr>
<tr><td>$\frac{|\Delta f_i|}{f_n}$</td><td>(0.02 – 0.06)%</td></tr>
<tr><td colspan="2">Frequency response deadband *

After the qualification of groups for the provision of frequency containment reserves (FCR), this value is set at 0 mHz for FCR providing groups, and for other groups the TSO shall decide to set the value different to 0 mHz so that the impact on the frequency control is kept at a minimum</td><td>0 mHz</td></tr>
<tr><td colspan="2">Droop s_1</td><td>(2÷12)%</td></tr>
</table>

Table 3C. *Parameters for full activation of active power frequency response resulting from frequency step change (explanation for figure 5C)**

Parameters	**Ranges or values**
Active power range related to maximum power (frequency response range) $\frac{\lvert\Delta P_1\rvert}{P_{\max}}$	(1.5÷10)%
For power park modules with inertia, the maximum admissible initial delay t_1, except when the TSO admits longer activation periods, based on technical evidence provided by the power park module owner	2 seconds
For power park modules without inertia, the maximum admissible initial delay t_1, except when the TSO admits longer activation periods, based on technical evidence provided by the power park module owner	500 ms
Maximum admissible choice of full activation time t_2, unless longer activation times are allowed by the TSO for reasons of system stability	10 seconds

*Parameters shall be complied with insofar as no technological limitations occur

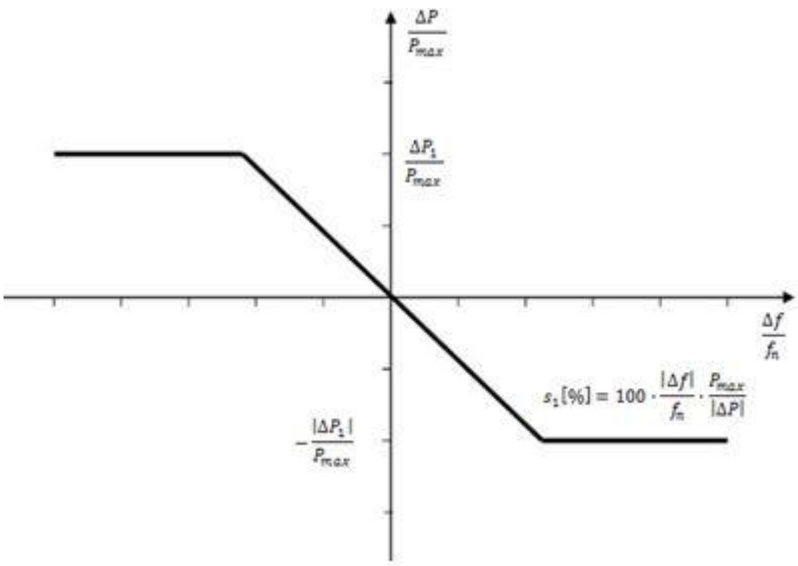


Figure 4C. *Active power frequency response capability of type C power park modules in FSM illustrating the case of zero deadband and insensitivity area.*

where: ΔP is the change in active power output from the power park module; P_{max} is the active power setpoint based on which the change in active power ΔP is established – namely the maximum (nominal) power of the power park module; Δf is the frequency deviation in the network; f_n is the nominal frequency (50 Hz) in the network.

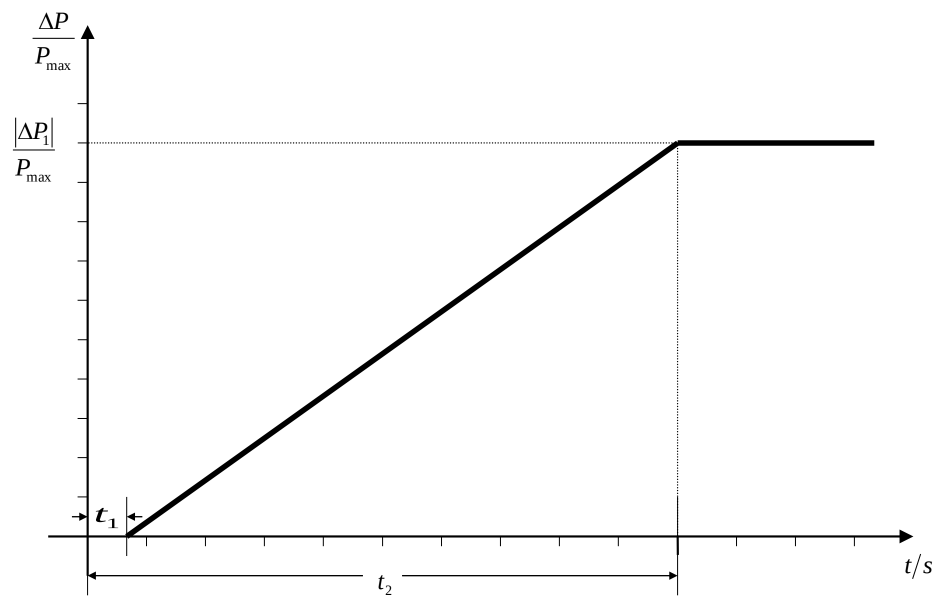


Figure 5C. *Frequency response capability*

where: P_{max} is the maximum power based on which the active power range ΔP is established; ΔP is the change in active power of the power park module. The power park module shall activate an active power ΔP up to the point ΔP_1, according to the t_1 and t_2 times, while the ΔP_1, t_1 and t_2 values are specified by the TSO according to the provisions from table 3C; t_1 is the initial delay (idle time); t_2 is the duration until the full activation.

Article 109.

(1). Real-time monitoring of the active power frequency automated response of the type C power park module shall be ensured by transmitting, in real-time and in a secured way, from an interface of the power park module to the dispatching center of the RSO, upon request by the RSO, of at least the following signals:

i. the operation condition signal with/without active power frequency automated response;
ii. setpoint (scheduled) active power;
iii. actual value of the active power output;
iv. load-frequency response deadband;
v. parameter settings for active power frequency response (not provided in real-time, they are only monitored from the dispatching center of the RSO).

(2). i. the RSO shall specify additional signals to be provided by the power park module via monitoring and recording devices in order to verify the performance of the active power frequency response provision;

ii. The additional signals are: frequency at the connection/interface point, as the case may be, state signals and commands regarding the breaker position and the separators position;

iii. The power park module owner ensures the transmission of signals at power park level via one/two independent communication paths, as referred to in the TCA.

(3). Parameter settings for active power frequency response and the droop are established via operational controls.

Article 110. The TSO shall have the right to request the power park module to provide synthetic inertia during very fast frequency deviations. The power park module should recommendably provide a minimum contribution with an inertia constant of 3 s (H= 3s).

Article 111. The operating principle of the installed control schemes shall be analyzed by the TSO in order to verify the possibility to provide synthetic inertia. The corresponding performance parameters shall be specified by the TSO and shall be requested via the TCA.

Article 112. Type C power park modules shall fulfil the following requirements in relation to **robustness,** in terms of:

(a) the fault-ride-through capability in case of symmetrical faults:

i. the power park module must be capable to remain connected to the network, continuing its stable operation following a correctly secured fault in the network, according to the voltage-time dependency described in figure 6C, with respect to the connection/interface point, as the case may be, and described by the parameters in table 4C;

ii. the voltage-against-time-profile represents a lower admissible limit of the actual course of the voltages at the connection/interface point, as the case may be, during a symmetrical fault, as a function of time before, during and after the fault;

iii. the TSO shall specify and make publicly available the pre-fault and post-fault conditions for the fault-ride-through capability in terms of:

- the pre-fault minimum short-circuit power calculation at the connection/interface point, as the case may be;
- the pre-fault active and reactive power operating point of the power park module at the connection/interface point, as the case may be, and voltage at the connection/demarcation point, as the case may be; and
- the post-fault minimum short-circuit power calculation at the connection/interface point, as the case may be.

iv. upon request by a power park module owner, the RSO shall provide the pre-fault and post-fault conditions (as relevant values resulted from typical cases) to be considered for fault-ride-through capability as an outcome of the calculations at the connection/interface point, as the case may be, as specified in point (iii) regarding:

- the pre-fault minimum short-circuit power at every connection/interface point, as the case may be, expressed in MVA;
- the pre-fault operating point of the power park module, expressed in active power, reactive power and voltage at the connection/interface point, as the case may be; and
- the post-fault minimum short-circuit power at the connection/interface point, as the case may be, expressed in MVA.

v. the power park module shall remain connected to the network and shall continue to operate stably when the actual course of the phase-to-phase voltages on the network voltage level at the connection/demarcation point, as the case may be, during a symmetrical fault, remains above the lower limit for the voltage profile described in the fault-ride-through-profile specified in letter (a) point (ii), except the triggering via the protections for internal electrical faults. The protection schemes and settings for internal electrical faults must not jeopardize fault-ride-through performance;

vi. considering the requirements provided in point (v), the power park module owner establishes the undervoltage protection (either the fault-ride-through capability, or the minimum voltage defined at the connection/interface point, as the case may be) according to the maximum voltage range corresponding to the power park module, except if the RSO requires a narrower voltage range. The settings shall be justified by the power park module owner in accordance with this principle;

(b) fault-ride-through capability in case of asymmetrical faults shall comply with the provisions set forth in letter (a) point (i) for symmetrical faults;

(c) post-fault active power recovery at the pre-fault value, depending on the primary source;

(d) maintaining stable operation at every point within the P-Q-capability diagram in the event of power oscillations between the power plant and the connection/interface point, as the case may be;

(e) power park modules shall be capable of remaining connected to the network without reducing power (within the limits given by the primary source), so long the frequency and voltage fall within the limits provided in table 1C, namely ±10% U_n of the network to which the park is connected;

(f) power park modules shall be capable of remaining connected to the network during single-phase or three-phase AR on loop network lines to which they are connected. The specific technical details shall be subject to coordination and instructions on protection schemes and settings agreed upon with the RSO.

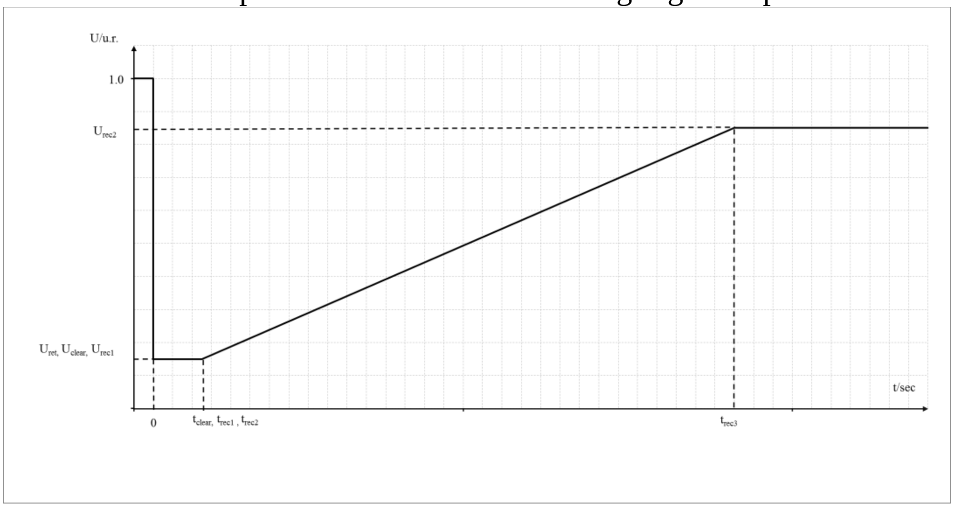


Figure 6C. *Fault-ride-through profile of a type C power park module*

Note: The diagram in figure 6C represents the lower limit of a voltage-against-time profile of the voltage at the connection/interface point, as the case may be, expressed in relative units as the ratio of its actual value and its reference value before, during and after a fault. U_{ret} is the retained voltage at the connection/demarcation point, as the case may be, during a fault, t_{clear} is the instant when the fault has been cleared. U_{rec1}, U_{rec2}, t_{rec1}, t_{rec2} and t_{rec3} specify certain points of lower limits of voltage recovery after fault clearance.

Table 4C. *Parameters related to the fault-ride-through capability of power park modules*

Voltage parameters [r.u.]		Time parameters [seconds]	
U_{ret}:	0.15	t_{clear}:	0.25
U_{clear}:	0.15	t_{rec1}:	0.25

U_{rec1}:	0.15	t_{rec2}:	0.25
U_{rec2}:	0.85	t_{rec3}:	3.0

(g) the TSO shall specify the post-fault active power recovery if the primary source maintained its capability from the moment when the fault occurred, that the type C power park module shall be capable of providing and shall specify:
  i. when the post-fault active power recovery begins, immediately after the moment when the voltage is higher than or equal to 85% U_{ret};
  ii. the maximum period allowed for post-fault active power recovery is equal to maximum 50 ms; after the fault is cleared and the voltage recovers to a value greater than 0.85 U_{ret}, active power shall be restored, depending on the technology and the availability of the primary source, within a time interval of (1÷10) seconds for a value of (80÷90)% from the pre-fault power value; and
  iii. the magnitude and precision (tolerance) of active power recovery depending on the technology used by the power-generating modules in the power park and on the availability of the primary source equals to (80÷90)% of the pre-fault active power value with a precision of 10% from the pre-fault active power value;

(h) The RSO shall specify in the TCA or at the time of commissioning, as the case may be:
  i. the interdependency between fast fault current requirements according to the provisions of Article 115 (1) points (b) and (c) and active power recovery;
  ii. the dependence between active power recovery times and duration of voltage variations. The RSO shall specify, at the moment of commissioning, the maximum active power recovery time for the maximum duration of the fault, usually equal to (1÷10) s for faults secured within a time period greater than 140 ms;
  iii. the limit of the maximum allowed time for active power recovery, usually less than 10 seconds. A smaller value shall be requested if the solution studies require it;
  iv. the adequacy between the level of voltage recovery and the minimum magnitude for active power recovery. Usually, for a voltage recovery value higher than 85% U_{ret}, the minimum value of post-fault recovered active power shall reach at least 85% of the pre-fault value within a time period of maximum 1 second, according to the availability of the primary source; and
  v. the requirements regarding active power oscillations damping between the power plant and the connection/interface point, as the case may be (for power plants with long OHLs/UPLs), if dynamic studies show that equipment is necessary in order to secure the damping of these active power oscillations.

Article 113.

(1) Type C power park modules shall fulfil the following requirements in relation to the contribution to **system restoration**:

(a) they shall be capable to reconnect to the network following an accidental disconnection caused by an event in the network, under the conditions defined by the TSO. Usually, the time to reconnect to the network following an accidental disconnection equals to maximum 10 minutes; and

(b) installation of automatic reconnection systems shall be subject to prior authorization both by the RSO, and the TSO, in order to specify the automatic reconnection conditions. These conditions shall be specified in the TCA and shall be detailed in the technical project.

(2) The requirements and conditions for the automatic reconnection provided in paragraph (1) letters (a) and (b) shall be notified to the power park module owner when issuing the TCA.

(3) With regard to black start capability or to the participation to the black start process:

i) the black start capability or the capability to participate to the black start process is not mandatory, but may be requested by the TSO during the grid connection stage in order to ensure the system's operational security;

ii) power park module owners shall, upon request by the TSO, provide a quotation for providing black start capability. The TSO may request the provision of black start capability if it considers system security to be at risk due to a lack of black start capability in its control area where the power park is located;

iii) a power park module with black start capability shall be capable of starting or participating to the start-up process, in full or via several pieces of equipment, from the shutdown state, without any external electrical energy supply within a time frame specified by the TSO, usually 15÷30 minutes from the instant the instruction is received;

iv) a power park module with black start capability shall be capable to reconnect within the (47.5÷50) Hz frequency range and within the (0.9÷1.1) U_n voltage range specified by the RSO, within a time period of maximum 300 s;

v) a power park module with black start capability or participating to the restoration process, shall be capable to automatically control voltage, including voltage variations which may occur during the restoration process;

vi) a power park module with black start capability or participating to the restoration process, shall:

1. be capable of regulating active power output for load connections at the connection/interface point, as the case may be;
2. be capable of participating to frequency variations, both for an increase over 50.2 Hz (in the LFSM-O mode) and for a decrease below 49.8 Hz (in the LFSM-U mode);
3. participate to frequency containment in case of overfrequency or underfrequency within the whole active power output range between minimum active power and maximum active power, as well as at houseload operation level;
4. be capable of parallel operation with other power park modules within one island;
5. control voltage automatically during system restoration within the ±10% U_n range.

(4) With regard to the capability to take part in island operation:

i) power park modules contributing to system restoration shall be capable of operating in island operation or taking part in island operation if required by the RSO in coordination with the TSO and

1. the frequency range in island operation is 47.5÷51.5 Hz;
2. the voltage range in island operation is U_n ±4% for LV and U_n ±5% for LV, for voltages < 110 kV.

ii) power park modules shall be able to operate with active frequency control mode during island operation. In the event of a power surplus, power park modules shall be capable of reducing the active power output from a previous operating point to any new operating point within the P-Q-capability diagram, depending on the availability of the primary source;
iii) the method for detecting a change from interconnected system operation to island operation shall be commonly agreed between the power park module owner and the RSO, in coordination with the TSO. The agreed method of detection must not rely solely on the TSO's switchgear position signals;
iv) power park modules shall be capable of operating in LFSM-O and LFSM-U during island operation, as commonly agreed with the TSO.

(5) With respect to the quick re-synchronization capability in the event of disconnection from the network, the power park module shall be able to quickly re-synchronize, usually within 15 minutes, according to the protection plan agreed upon with the RSO, within the limits of the technical possibilities of power-generating modules.

Article 114. Type C power park modules shall fulfil the following **operational requirements** in relation to:

(a) control and automation schemes and related settings:

i. the control and automation schemes, as well as the related settings, including the control parameters, necessary for the network stability calculations and emergency measures analysis, shall be submitted by the power park module owner to the RSO or the TSO respectively, no later than 3 months prior to the application of voltage for the beginning of the testing period, in order for them to be coordinated and agreed upon between the TSO, RSO and the power park module owner;

ii. any changes to the control and automation schemes and settings, as mentioned in point (i), of the different control devices of the power park module shall be coordinated and agreed upon between the TSO, the RSO and the power park module owner, in particular if they apply in the situations described in point (i).

(b) electrical protection schemes and related settings:

i. the protection systems needed for the power park module and the network, as well as the settings relevant to the power park module shall be coordinated and agreed upon between the RSO and the power park module owner, during the connection process. The TSO coordinates with the DSO and the power park module owner in order to coordinate protections, taking into account the frequency variation value resulted from periodical studies on the inertia of the Continental Europe synchronous system to which the NPS belongs. The protection systems and related settings for internal electrical faults must not jeopardize the performance of the power park module.

The protection and automation systems shall fulfill at least the following requirements:

1. they shall ensure protection against internal faults of the power-generating modules in the power park module, as well as backup protection against abnormal operation states and faults from the network to which they are connected;

2. they shall be efficient, highly reliable and organized in groups with redundant functionality; the protections shall be selective, sensible, capable

to detect internal and external faults, physically and galvanically separated from the power supplies with operative voltage, from voltage and current metering transformers to command execution devices. The electrical protection system shall be equipped with extended self-testing and self-diagnosis functions, as well as with events recording and oscillography functions. The electrical protections system shall be equipped with standard communication interfaces aiming for the integration to a local data acquisition, supervision and control system;

3. the internal faults electrical protections system shall be capable to detect at least the short-circuit currents, the current asymmetry, the maximum/minimum voltage, the maximum/minimum frequency at the terminals of the power-generating module in the power park module;

4. the external faults electrical protections system, as backup protections, shall be capable to detect at least the symmetrical and asymmetrical short-circuits from the network to which the power-generating module in the power park module is connected, the power oscillations, the current asymmetry, the current and voltage electrical overloads.

ii. the electrical protection of the power park module shall take precedence over operational controls, taking into account the operational security of the system, the health and safety of staff and of the public, as well as mitigating any damage to the power-generating modules in the power park module.

iii. Together with the power park module owner, the RSO shall coordinate and commonly agree that the protection systems must cover at least the following faults:

A. protections of power-generating modules in the power park module, of the step-up transformer and of the houseload or ancillary services transformer, covered by the power park owner, for:

1. internal faults of power-generating modules in the power park module, of the step-up transformer and potentially of the houseload transformer (short-circuits and groundings);
2. internal faults of the step-up transformer of the power-generating module in the power park module;
3. short-circuits or groundings on the network evacuation line of the power output;
4. short-circuits or groundings in the network, as backup protection;
5. maximum and minimum voltage at the terminals of the power-generating module in the power park module.

B. protections covered by the power park module owner and/or the RSO, as the case may be:

1. short-circuits or groundings on the network evacuation line of the power output;
2. maximum and minimum voltage at the connection/interface point, as the case may be;
3. maximum and minimum frequency at the connection/interface point, as the case may be;
4. short-circuits or groundings in the network, as backup protection.

iv. changes to the protections schemes, needed for the power park module and the network and to the settings relevant to the generation plant shall be agreed upon in advance between the RSO and the power park module owner;

(c) the organization by the power park module owner of the protection and control devices according to the following prioritization:
   i. the network's and power park module's protection;
   ii. synthetic inertia, if applicable;
   iii. frequency control (active power adjustment);
   iv. power restrictions;
   v. limiting the ramping rate of power variations.

(d) The RSO may request, within the technical connection approval, the additional installation in the power park module of automation systems aiming to quickly reduce power, namely until shutdown, in justified cases, in order to protect facilities, persons and the environment.

(e) **information exchange:**
   i. protection/control and automation systems of the power park module shall be capable of exchanging information with the RSO in real-time or periodically with time stamping. In the event of aggregations, according to the functions agreed to be aggregated, the exchanged information is communicated to the RSO and the TSO;
   ii. The RSO, in coordination with the TSO, sets the content of the exchanges of information provided by the power park module owner, which shall comprise at least the following data transmitted in real-time: active power, scheduled active power, as the case may be, reactive power, voltage and frequency at the connection/interface point, as the case may be, state signals and commands regarding the breaker position and the separators position and the operation condition signal with/without active power frequency automated response. The power park module owner ensures the transmission of signals via one/two independent communication paths (set in the TCA); usually, the main path is ensured via optical fiber equipment.

(f) Power park modules shall be capable to automatically disconnect from the network when losing robustness. The disconnection criteria regarding the protection against current asymmetry, phase interruption and critical disconnection time, shall be agreed upon between the power park module owner, the RSO and the TSO.

(g) instrumentation:
   i. power park modules shall be equipped with devices to provide fault recording and monitoring of dynamic system behavior; these devices are usually oscilloperturbographs or equipment that can replace functions covered by oscilloperturbographs. These devices shall record the following parameters:
      1. voltages in all three phases;
      2. current in each phase;
      3. active power in all three phases;
      4. reactive power in all three phases;
      5. frequency.

      The RSO shall have the right to specify quality of supply parameters to be complied with, provided via the aforementioned devices, on condition that they are previously agreed upon with the power park module owner.
   ii. the settings of the fault recording equipment, including triggering criteria and the sampling rates shall be commonly agreed between the power park module owner and the RSO at the time of PIF and shall be documented via written arrangements. These shall also include a criterion for detecting oscillations between the power park and the connection/interface point, as the case may be, established by the TSO;

iii. The RSO, TSO and the power park module owner shall commonly agree upon the need to include a criterion for detecting oscillations between the power park and the connection/interface point, as the case may be, in order to monitor the dynamic system behavior, specified by the TSO in order to detect poorly damped power oscillations (undamped);

iv. the dynamic system behavior monitoring system shall include arrangements for the power park module owner and the RSO to access the information. The communications protocols for registered data shall be commonly agreed between the power park module owner, the RSO and the TSO, prior to choosing the monitoring equipment.

(h) power park module operation simulation models:

i. upon request of the RSO or the TSO, the power park module owner shall provide the power park module operation simulation models that reflect the power park module behavior both in steady-state regime, as well as in dynamic regime (including for transient electromagnetic phenomena, if requested). The models provided shall be validated via the results of compliance tests for verifying compliance with technical connection requirements. The power park module owner submits to the RSO or the TSO the results of these tests for the power-generating modules in the power park module or for heat engines that gear the power-generating modules in the power park module, proven by means of check-up certificates recognized on European level, carried out by an authorized certifier;

ii. the models provided by the power park module owner shall contain the following sub-models, depending on the existence of individual components:

1. models for the photovoltaic panel, wind turbine etc. and converters in the power park;
2. frequency and active power control;
3. voltage control;
4. power park module protections models, as agreed by the RSO and the power park module owner;
5. inverter and wind generating unit models, as the case may be.

iii. upon request by the RSO as referred to in point (i), the TSO shall specify:

1. the format in which simulation models are to be provided, including the utilized calculation program;
2. the documentation on the mathematical model's structure and block diagrams;
3. the estimate of the minimum and maximum short-circuit power at the connection/interface point, as the case may be, expressed in MVA, as an equivalent of the network.

iv. the power park module owner provides the RSO, upon request, with recordings of the power park module's performance. The RSO or the TSO may make such a request, in order to compare the response of the models and model simulations performed with actual operational recordings.

(i) the installation of devices for system operation and devices for system operational security, if the RSO or the TSO considers that it is necessary to install additional devices in a power park module in order to preserve or restore system operation or system operational security. The RSO and the power park module owner, together with the TSO, shall analyze and agree upon the adequate solution;

(j) the minimum and maximum limits on rates of change of active power output (ramping limits) in both an up and down direction of change of active power output for a power park module are specified by the RSO, in coordination with the TSO, taking into consideration the specific characteristics of prime mover technology. Usually, the rate of change falls within the (10÷30)% P_{max}/minute range and is equal in both directions (up and down direction);

(k) earthing arrangement of the neutral-point at the network side of step-up transformers shall comply with the specifications of the RSO.

Article 115.

(1). Type C power park modules shall fulfil the following requirements in relation to voltage stability:

(a) they shall be capable to automatically disconnect when the voltage at the connection/interface point, as the case may be, exceeds the levels specified by the RSO. The conditions and settings for automatic disconnection of power park modules shall be specified by the RSO in coordination with the TSO.

(b) they shall be capable of providing fast fault current at the connection/demarcation point, as the case may be, in case of symmetrical (three-phase) faults, under the following conditions:

i. the type C power park module shall be capable of activating the supply of fast fault current either by:

1. ensuring the supply of the fast fault current at the connection/interface point, as the case may be, corresponding to the voltage variation with a proportionality factor (k) between 2 and 10 according to the formula: $\Delta I = k * \Delta U$

2. measuring voltage variations at the type C connection/interface point and providing a fast fault current at the respective terminals (reactive current component);

ii. The RSO, in coordination with the TSO, shall specify:

1. how and when a voltage deviation is to be determined as well as the duration of the voltage deviation. The voltage deviation shall be determined when the metered voltage, either at the connection/interface point, as the case may be, or at the terminals of the power-generating module is lower than 0.85 U_{ref}. The duration of the deviation is considered up to the point when the voltage recovers to a value greater than 0.85 U_{ref};

2. the characteristics of the fast fault current, including the time domain for measuring the voltage deviation and fast fault current, for which current and voltage may be measured differently from the method specified in letter (b) point (i), are: increase time of the fault current, lower than or equal to 30 ms and the clearance time of the fault current, lower than or equal to 60 ms;

3. the timing and accuracy of the fast fault current, which may include several stages during a fault and after its clearance. Thus, the power-generating module shall inject, immediately after the fault (when low voltage is detected, according to the provisions set forth in the point above) in a time period of usually 50 ms, a reactive current depending on the magnitude of the low voltage (retained voltage) with a (2÷10) proportionality factor. The injected reactive current shall be maintained all throughout the low voltage duration according to the voltage profile defined by the fault-ride-through according to figure 6C and shall be cancelled immediately after fault clearance (according to IGD Fault current contribution from PPMS & HVDC).

(c) with regard to the supply of fast fault current in case of asymmetrical (one-phase or two-phase) faults, the RSO, in coordination with the TSO, shall have the right to specify the requirements for asymmetrical current injection. Usually, the requirements regarding the asymmetrical current injection are similar to the requirements regarding the symmetrical current injection set forth in letter (b). These requirements shall be notified to the owner.

(d) they shall be capable of providing additional reactive power, specified by the RSO, which shall be provided at the connection/interface point, as the case may be, of the power park module, if it is not located at the high-voltage terminals of the step-up transformer. The additional reactive power shall compensate the reactive power exchange of the high-voltage line or cable between the high-voltage terminals of the step-up transformer of the power park module and the connection point. The additional reactive power shall be covered via dedicated equipment provided by the power park module owner. This additional reactive power is specified via a reactive power offset study at the connection/interface point, as the case may be, and shall provide, at the connection/interface point, as the case may be, null reactive power exchange at zero active power, with the following tolerance: maximum 0.5 MVAr if voltage at the connection/interface point, as the case may be, is ≥110 kV or if the connection/interface point, as the case may be, is located at the substations' bars, and maximum 0.1 MVAr respectively for power park modules connected to lines or at the end of a long MV line.

(e) they shall be capable to generate reactive power at the connection/interface point, as the case may be, at full capacity, whilst complying with the following requirements:

   i. the power park module owner shall provide an envelope of the U-Q/P_{max}-profile, which may take any shape within the limits of which the power park module is capable to provide/absorb reactive power at voltage variations and full capacity operation; the envelope shall be analyzed and approved by the TSO in coordination with the RSO;

   ii. the U-Q/P_{max}-profile shall be specified by the RSO in coordination with the TSO in line with the following principles:

      1. the U-Q/P_{max}-envelope shall not exceed the U-Q/P_{max}-profile represented by the inner envelope in figure 7C;
      2. the dimensions of the U-Q/P_{max}-profile envelope (Q/P_{max} range and voltage range) shall be within the maximum values specified in table 5C;
      3. the position of the U-Q/P_{max}-profile envelope shall be within the limits of the fixed outer envelope in figure 7C; and
      4. the U-Q/P_{max}-profile specified for power park modules may take any shape, having regard to the potential costs of delivering the capability to provide reactive power production at high voltages and reactive power consumption at low voltages;

   iii. the reactive power provision capability requirement applies at the connection/interface point, as the case may be. For envelope shapes other than rectangular, the voltage range represents the highest and lowest values. The full reactive power range is therefore not expected to be available across the range of steady-state voltages.

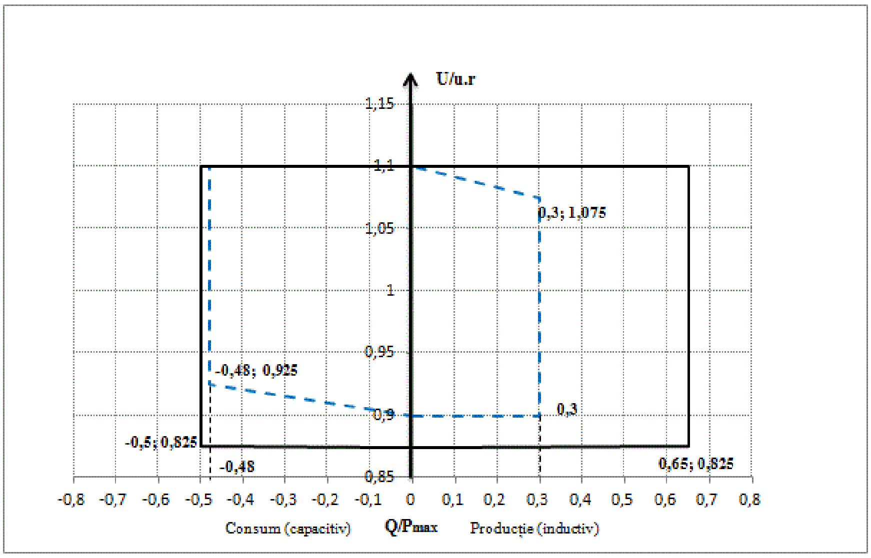


Figure 7C. *U-Q/P_{max}-profile of a power park module*

Figure 7C represents the typical boundaries of a U-Q/P_{max}-profile by the voltage at the connection/interface point, as the case may be, expressed in relative units by the ratio of its actual value and the reference value, against the ratio of the reactive power (Q) and the maximum capacity (P_{max}). The position, size and shape of the envelope are indicative and the TSO may also request, depending on system conditions at the connection/interface point, as the case may be, other shapes of the U-Q/P_{max}-profile within the maximum Q/P_{max} range of 0.75.

Maximum Q/P_{max} range	Maximum range of steady-state voltage level, expressed in relative units
0.75	0.200

Table 5C: *Parameters for the inner envelope in figure 7C*

(f) with regard to reactive power capability below maximum power (below P_{max}):

i. The RSO, in coordination with the TSO, shall specify the requirements regarding reactive power provision capability, as well as a P-Q/P_{max}-envelope of any shape within the limits of which the power park module shall provide reactive power under its maximum power given by the P-Q-profile;

ii. the limits of the P-Q/P_{max}-capability diagram shall be specified by the RSO in coordination with the TSO in line with the following principles:

1. the P-Q/P_{max}-envelope shall not exceed the P-Q/P_{max}-profile envelope, represented by the inner envelope in figure 8C;
2. the Q/P_{max}-range on the P-Q/P_{max}-profile envelope is specified in table 5;
3. the active power range of the P-Q/P_{max}-profile envelope at zero reactive power shall be 1 r.u. P_{max};
4. the P-Q/P_{max}-profile envelope can be of any shape and shall include conditions for reactive power capability at zero active power; and
5. the position of the P-Q/P_{max}-profile envelope shall be within the limits of the fixed outer envelope set out in figure 8C;

iii. when operating at an active power output below maximum power ($P < P_{max}$), the power park module shall be capable of providing reactive power at any operating point inside its P-Q/P_{max}-profile, if all units of that power park module which generate power are technically available, that is to say they are not out of service due to maintenance or failure, otherwise there may be less reactive power capability, taking into consideration the technical availabilities.

iv. the power park module shall be capable of moving to any operating point within its P-Q/P_{max} profile in appropriate timescales to target values requested by the RSO.

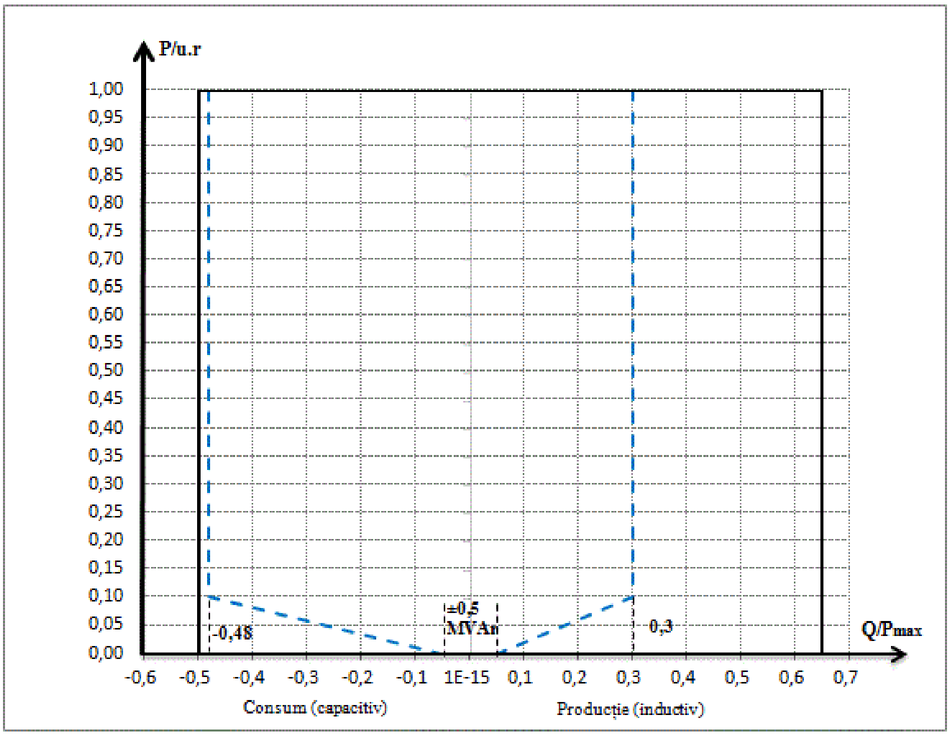


Figure 8C. *P-Q/P_{max}-profile of a power park module*

Figure 8C represents the typical boundaries of a P-Q/P_{max}-profile by the active power at the connection/interface point, as the case may be, expressed in relative units by the ratio of its actual value and the maximum capacity, against the ratio of the reactive power (Q) and the maximum capacity (P_{max}). The position, size and shape of the inner envelope are indicative and the TSO may also request, depending on system conditions at the connection/interface point, as the case may be, other shapes of the U-Q/P_{max}-profile within the maximum Q/P_{max} range of 0.75.

(g) with regard to reactive power control modes:

i. the power park module shall be capable of providing reactive power automatically by either voltage control mode, reactive power control mode or power factor control mode;

ii. for the purposes of voltage control mode, the power park module shall be capable of contributing to voltage control at the connection/interface point, as the case may be, by providing the necessary reactive power exchange with the network with a setpoint voltage covering at least the (0.95÷1.05) r.u. range, in steps no greater than 0.01 r.u., with a slope having a range of at least (2÷7)% in steps no greater than 0.5%. The voltage control deadband is specified in table 5C1.

Voltage variation range	(90÷110)%, for Un=110 kV and Un=220 kV respectively (95÷105)%, for Un=400 kV
Voltage variation steps	< = 1% Un, and < = 0.01 r.u, respectively
Maximum slope	< = 2% Un/min
Maximum voltage shift step	< = 1% Un, and < = 0.01 r.u, respectively
Increase time to 90% t1	1 – 5 s
Containment time – t2	60 s
Voltage control deadband – z	±0.5% – for 110 kV representing ±0.55 kV ±0.25% – for 220 kV representing ±0.55 kV ±0.15% – for 400 kV representing ±0.6 kV
Steady-state stability	= 5% of the maximum reactive power but no more than 5 MVAr

Table 5C1. Parameters of the voltage control mode

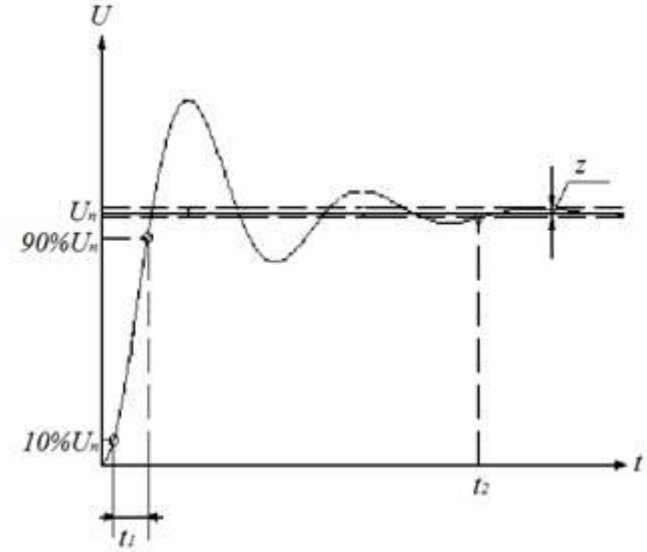


Figure 8C1. Parameters of the voltage control mode

iii. the setpoint may be operated with or without a deadband selectable in a range from 0 to ±5% U_{ref}, where $U_{ref} = U_n$, in steps no greater than 0.5% U_{ref};

iv. following a voltage step change, a power park module shall be capable to reach 90% of the step value in the t_1 instant, specified by the RSO, of maximum 30 seconds, and shall stabilize at the value requested within a t_2 time period, specified by the RSO and usually of 60 seconds;

v. for the purpose of reactive power control mode, the power park module shall be capable of setting the reactive power setpoint anywhere in the reactive power range, specified in letters (d) and (e), with setting steps of 5% of full reactive power but no greater than 5 MW, controlling the reactive power at the connection/interface point, as the case may be, to an accuracy within plus or minus 1 MVAr or plus or minus 1% (whichever is smaller) of the full reactive power;

vi. with respect to power factor control mode, the power park module shall be capable of controlling the power factor at the connection/interface point, as the case may be, within the P-Q/P_{max}-profile envelope required for reactive power range, specified by the RSO according to letters (d) and (e), with a target power factor in steps no greater than 0.01. The RSO shall specify the target power factor value, its tolerance and the period of time to achieve the target power factor following a sudden change of active power output. The tolerance of the target power factor shall be expressed through the tolerance of its corresponding reactive power, but shall not exceed 1% of the maximum reactive power of power park modules.

vii. the RSO, in coordination with the TSO and with the power park module owner, shall specify which of the three reactive power control mode options (voltage control, reactive power control or power factor control) and associated setpoints is to apply, and what further equipment is needed to make the adjustment of the relevant setpoint operable remotely;

(h) with regard to prioritizing active or reactive power contribution, the TSO shall specify whether active power contribution or reactive power contribution has priority during faults for which fault-ride-through capability is required. If priority is given to active power contribution, its provision has to be established no later than 150 ms from the fault inception;

(i) with regard to power oscillations damping control, if specified by the RSO when issuing the TCA, the power park module shall be capable of contributing to damping power oscillations between the power park module and the connection/interface point, as the case may be. The voltage and reactive power control system characteristics of power park modules must not adversely affect the damping of power oscillations.

Article 116.

(1). The type C power park module owner shall ensure continuity in the submission of status and operation values provided in Article 114 to the RSO.

(2). The PTG connected type C power park module shall be integrated in the SCADA system of the RSO, ensuring at least the following signal exchange: active power, reactive power, voltage and frequency at the connection/interface point, as the case may be, set values for active power and reactive power, state signals and commands regarding the breaker position and the separators position.

(3). The PTG connected type C power park module shall be integrated both in the EMS-SCADA and in the DMS-SCADA system. The EMS-SCADA integration shall be ensured at least for the following exchange of signals: active power, reactive power, voltage and frequency at the connection/interface point, as the case may be, set values for active power and reactive power, state signals and commands regarding the breaker position. The EMS-SCADA integration shall be ensured via two independent communication paths, of which at least one shall be via optical fiber equipment (set in the TCA). The DMS-SCADA integration shall be ensured at least for the following exchange of signals: active power, reactive power, voltage and frequency at the connection/interface point, as the case may be, state signals and commands regarding the breaker position and the separators position. The DMS-SCADA integration shall be ensured via at least one communication path, usually via optical fiber equipment (set in the TCA).

Article 117. The type C power park module owner has the obligation to ensure compatibility of data exchange equipment at the RSO's SCADA system interface level, according to the features requested by it.

Article 118. If several power park modules are connected in the same electrical node (busbar), these must commonly provide voltage control at the connection/interface point, as the case may be.

Article 119. Under normal network operation, the power park module shall not produce fast voltage fluctuations at the connection/interface point, as the case may be, greater than ±5% of the nominal voltage of the network to which it is connected.

Article 120. Irrespective of the operational auxiliary installations and regardless of the power output, the power park module shall ensure, at the connection point/interface point, as the case may be, the electricity quality according to applicable standards (European standards and the performance standard for providing the electricity transmission service and the system service, and the standard for providing the electricity distribution service respectively).

Article 121. The type C power park module shall be monitored in terms of electricity quality at the connection/interface point, as the case may be, during tests performed for verifying the compliance with the connection technical requirements. The RSO may require, as the case may be, a permanent monitoring of electricity quality at the connection/interface point, as the case may be, and the integration of the permanent monitoring equipment in its own electricity quality monitoring system.

Article 122. The connection solution of type C power park modules shall not allow their island operation and must foresee the endowment with protections which trip the power park module at the occurrence of such an operation state.

Section 3. GENERAL REQUIREMENTS FOR TYPE D POWER PARK MODULES

Article 123. Type D power park modules shall fulfil the following requirements **in relation to frequency stability:**

(a) the power park module shall be capable of remaining connected to the network and operate within the **frequency ranges** and time periods specified in table 1D;

(b) i. the power park module must remain connected to the network and must operate at frequency variation rates of 2 Hz/s for a time period of 500 ms, of 1.5 Hz/s for a time period of 1000 ms and of 1.25 Hz/s for a time period of 2000 ms, depending on the technology type and the short-circuit power of the system at the connection/demarcation point, as the case may be (a value provided by the RSO in the TCA), and the inertia available at synchronous area level.

ii. the values provided in point (i) shall be notified to the power park module owner.

iii. the protection controls at the connection/interface point, as the case may be, coordinated by the RSO, must allow operation of the power park module for these frequency variation profiles.

Table 1D. *The minimum duration for which a type D power park module has to be capable to remain connected to the network and to operate at different frequencies, deviating from a nominal value*

Frequency range	Duration for operation
47.5 Hz – 48.5 Hz	Minimum 30 minutes
48.5 Hz – 49 Hz	Minimum 30 minutes
49 Hz – 51 Hz	Unlimited
51.0 Hz – 51.5 Hz	30 minutes

Article 124. Type D power park modules shall be capable to ensure a limited frequency response, namely to **frequency increases** above the nominal value of 50 Hz (**LFSM-O**), thus:

(a) at overfrequencies, the power park module shall decrease the active power output according to the frequency variation, in accordance with figure 1D and with the following parameters:

i. the frequency threshold from which the power park module ensures overfrequency response is 50.2 Hz;

ii. the droop settings shall be between 2% and 12% and shall be provided by the RSO via operational controls, at the power park module's commissioning. Usually, the droop value equals 5%;

iii. the power park module shall be capable of decreasing the active power related to the frequency variation with an initial delay that is lower than 500 ms (marked with t_1 in figure 5D). If this delay is greater than 500 ms, the power park module owner shall justify the delay, providing technical evidence to the TSO. The response time for the power decrease in the event of overfrequency shall be lower than or equal to 2 seconds for a power variation of 50% from the maximum active power.

(b) when reaching the power related to the minimum control level, the power park module shall be capable of:

i. containing the activated power within a duration of no more than 20 seconds and continuing its operation at this level (within the limits of the admissible power given by the primary source); or

ii. continuing to reduce the active power output according to the operational controls and in accordance with the functional features of power-generating modules of the same type in the power park module;

iii. maintaining the power level reached with a permitted deviation of ±5% P_{max}, so long the frequency deviation is maintained.

(c) the power park module shall be stable during operation in the LFSM-O mode during frequency increases over 50.2 Hz. So long LFSM-O is active, the LFSM-O setpoint shall prevail over any other active power setpoints.

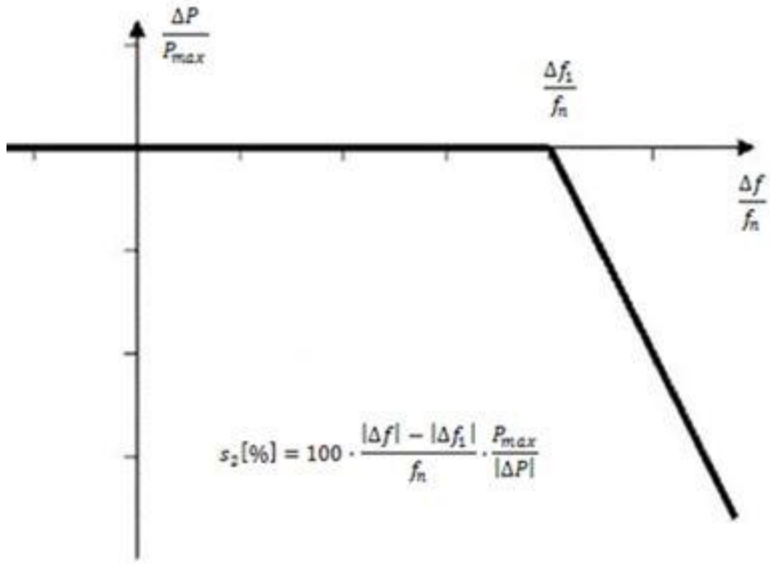


Figure 1D. *Active power frequency response capability of type D power park modules in LFSM-O*

where: P_{max} is the active power setpoint based on which ΔP is established – namely the maximum power of the power park module; Δf is the frequency deviation in the network; f_n is the nominal frequency (50 Hz) in the network. At overfrequencies where Δf is above +200 mHz compared to the nominal value (50 Hz), the power park module has to decrease the active power according to the droop s_2.

Article 125. The type D power park module shall be capable of maintaining constant output at its target active power value regardless of changes in frequency, within the limits of the power offered by the primary source, except where the power-generating modules in the power park module follow the frequency increases according to Article 124 or have power decreases at frequency decreases accepted by the RSO and according to the provisions of Article 126 and Article 127.

Article 126. The TSO sets the active power output reduction of the type D power park module compared to the maximum active power output (admissible power given by the primary source) following the frequency decrease, within the admissible limits specified in figure 2D, hence:

(a) at underfrequencies below 49 Hz, a maximum power output decrease is admitted at a percentage of 2% from the maximum active power output at the frequency of 50 Hz, for every 1 Hz of frequency decrease. Any maximum active power output reduction curve situated above the dotted line is admitted depending on the frequency;

(b) at a frequency decrease under 49.5 Hz a maximum active power output decrease is admitted at a percentage of 10% from the maximum active power output at the frequency of 50 Hz, for every 1 Hz of frequency decrease, if the frequency is lower than 49.5 Hz for a duration of over 30 s. Any maximum active power output reduction curve situated above the continuous line is admitted depending on the frequency.

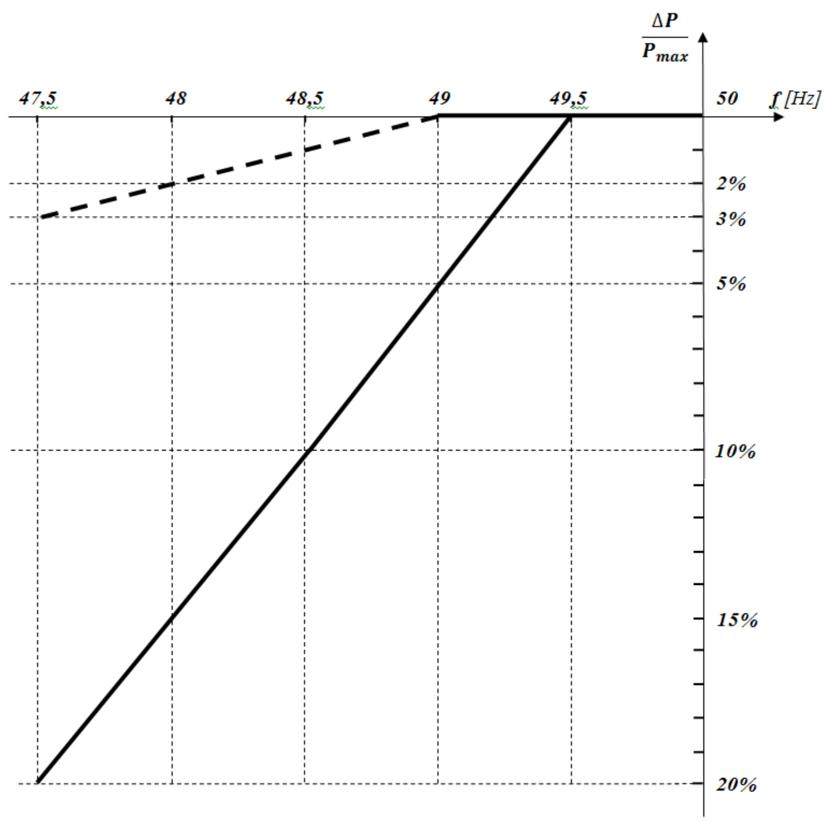


Figure 2D. *Admissible limits for power reduction established by the TSO in the event of underfrequency*

Article 127.

(1). The admissible active power reduction compared to the maximum active power output (admissible power, given by the primary source) in the event of frequency deviations under 49.5 Hz is established:

(a) under standard environmental conditions related to a temperature of 20 degrees Celsius. As the case may be, the owner submits to the RSO and the TSO the dependency diagram of the active power in terms of temperature for at least one set of temperatures: -10^{0}C, 0^{0}C, 15^{0}C, 25^{0}C, 30^{0}C, 40^{0}C;

(b) depending on the technical capability of the power-generating modules in the power park module.

(2). The power park module owner shall submit to the RSO and the TSO the dependency diagram of the active power in terms of environmental factors (temperature, pressure, solar irradiance, wind speed, as the case may be) and the technical data regarding the technical capability of power-generating modules in the power park module, set forth in Annex 4;

(3). The data provided in paragraph (2) shall be submitted during the solution study stage within the connection process.

Article 128.

(1). The active power control system of the type D power park module shall be capable of adjusting an active power setpoint in line with the instructions given to the power park module owner by the RSO or the TSO.

(2). The time to reach the active power setpoint or the rate of change of active power output when adjusting the setpoint falls within the (10÷30)% P_{max}/min range depending on the technology, while the idle time equals to 1 second and the setpoint fulfillment tolerance equals to 1% P_{max}.

Article 129. Local control shall be allowed in cases where the automatic remote control devices are out of service.

Article 130.

(1). The RSO sets forth the conditions for the automatic connection of a type D power park module to the network, after these conditions have been agreed upon with the TSO.

(2). The requirements provided in paragraph (1) include:

(a) the frequency ranges in which the automatic connection is accepted (namely (47.5÷51) Hz, the voltage range ((0.9-1.1) U_n), the observation/validation period (including the synchronization time) and the period for maintaining the metered parameters within the determined range, of maximum 300 seconds;

(b) the slope admitted for the active power increase after connection (≤ 20 % P_{max}/min), usually 10% of the P_{max}/min (the setpoint is chosen within the range indicated by the manufacturer of power-generating modules in the power park).

Article 131. Type D power park modules shall be capable to ensure a limited frequency response, namely to frequency decreases (LFSM-U), thus:

(a) it must be capable to mobilize active power response at underfrequencies below a 49.8 Hz frequency threshold and with a droop set by the TSO for every power-generating module in the power park, at the time of PIF or via operational controls within the (2÷12)% limits, usually at the 5% value, which corresponds to an active power mobilized of 8% P_{max}, according to figure 3D;

(b) the delivery of active power in response to the frequency decrease (in LFSM-U mode) shall also take into account, as the case may be, the following:

i. the dependency diagram of active power output in terms of environmental conditions (primary source);

ii. the operating requirements of the power park module, in particular the limitations on operation near maximum active power at low frequencies and the respective impact of external operating requirements according to the provisions of Article 126 and Article 127;

(c) the activation of active power frequency response by the power-generating module shall not be unduly delayed. If this delay (called idle time and marked with t_1 in figure 5D) is greater than 500 ms, the power park module owner shall justify the delay towards the TSO;

(d) while operating in the LFSM-U mode, the power park module shall ensure a power increase up to the maximum/admissible power depending on the primary energy source. The response time for the power increase for power-generating modules, except for wind turbines, shall be lower than or equal to 10 seconds for a power variation of maximum 50% from the maximum power. For wind turbines, the response time shall be lower than or equal to 5 seconds for a power variation of 20% from the maximum power, if the starting operating point is higher than 50% from the maximum power. Higher active power increase times can be accepted if the starting operating point is lower than 50% from the maximum power. Reaching the setpoint shall take place in a time interval of maximum 30 seconds with a maximum tolerance of ±5% from P_{max};

(e) the power park module shall operate stably during the LFSM-U mode at frequencies lower than 49.8 Hz.

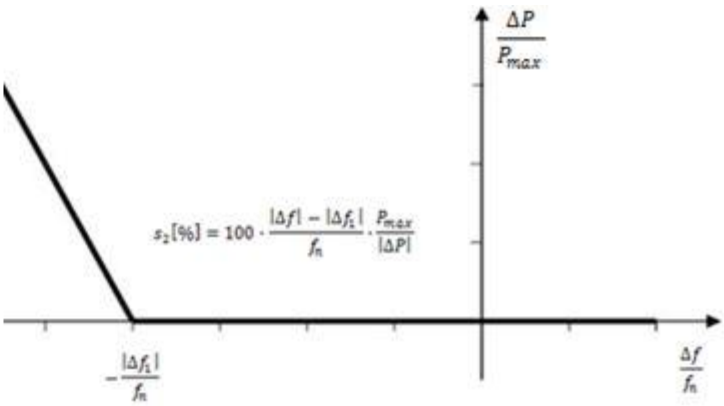


Figure 3D. *Active power frequency response capability of type D power park modules in LFSM-U*

where: P_{max} is the active power setpoint based on which ΔP is established – namely the maximum power of the power park module; ΔP is the change in active power output from the power park module; Δf is the frequency deviation in the network; f_n is the nominal frequency (50 Hz) in the network. At underfrequencies below 49.8 Hz where Δf is below -200 Hz, the power park module has to increase the active power according to the droop s_2.

Article 132. If the FSM mode is active, under the conditions offered by the primary source, the type D power park module shall fulfill all requirements described below, in addition to the requirements provided in Article 131 according to figure 4D:

(a) the module shall provide FSM, according to the parameters specified by the TSO, within the value ranges provided in table 2D, thus:

i. in case of overfrequency above the 50 Hz value, the active power frequency response is limited by the minimum regulating level;

ii. in case of underfrequency compared to the 50 Hz value, the active power frequency response is limited by the maximum active power available given by the primary source.

iii. the actual delivery of active power frequency response depends on the external and operating conditions of the power park module when this response is triggered, particularly on the limitations given by the operation of the power park module, under the conditions of the primary source at low frequencies.

(b) the module shall be able to modify the frequency deadband and the droop following the TSO's instruction. Usually, the s_1 droop value equals 5%, which corresponds to an active power mobilized of 8% P_{max};

(c) in the event of a frequency step change, the power park module shall be capable of activating full active power frequency response, at or above the line shown in figure 5D, in accordance with the parameters specified in table 3D, in the absence of technological limitations, namely for power-generating modules in the power park with inertia, with a delay (t_1) of two seconds and an activation time of maximum 30 seconds (t_2), within the power limit offered by the primary source;

(d) for power-generating modules in the power park without inertia, the initial activation of active power required shall not be unduly delayed. If the delay in initial activation of active power is greater than 500 ms for modules without inertia, or greater than two seconds for modules with inertia, the power park module owner shall provide technical evidence demonstrating why a longer time is needed;

(e) the power park module shall be capable of providing active power corresponding to the frequency deviation for a duration of maximum 15-30 minutes specified by the TSO, within the limits of the power offered by the primary source;
(f) the active power control shall not have any adverse impact on the active power frequency response;
(g) if participating to the frequency restoration process at the setpoint and/or exchange powers to the scheduled values, the power park module shall ensure specific functions for performing these services, established via procedures drafted by the TSO;
(h) with regard to disconnection due to underfrequency, power park modules that also include loads shall be capable of disconnecting their load in case of underfrequency.

Table 2D. *Parameters for active power frequency response in FSM (see figure 5D)*

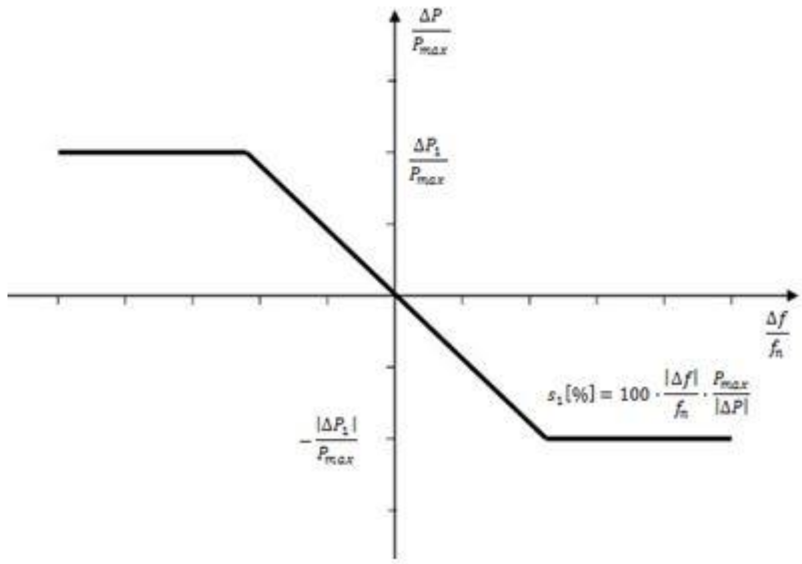
Parameters		Ranges
Active power range related to maximum power $\frac{\lvert\Delta P_1\rvert}{P_{max}}$		(1.5÷10)%
Frequency response insensitivity	$\lvert\Delta f_i\rvert$	10 mHz
	$\frac{\lvert\Delta f_i\rvert}{f_n}$	(0.02 – 0.06)%
Frequency response deadband * After the qualification of groups for the provision of frequency containment reserves (FCR), this value is set at 0 mHz for FCR providing groups, and for other groups the TSO shall decide to set the value different to 0 mHz so that the impact on the frequency control is kept at a minimum		0 mHz
Droop s_1		(2÷12)%

Table 3D. *Parameters for full activation of active power frequency response resulting from frequency step change (explanation for figure 5D)**

Parameters	Ranges or values
Active power range related to maximum power (frequency response range) $\frac{\lvert\Delta P_1\rvert}{P_{max}}$	(1.5÷10)%
For power park modules with inertia, the maximum admissible initial delay t_1, except when the TSO admits longer activation periods, based on technical evidence provided by the power park module owner	2 seconds
For power park modules without inertia, the maximum admissible initial delay t_1, unless justified otherwise	500 ms
For power park modules, the maximum admissible choice of full activation time t_2, unless longer activation times are allowed by the TSO for reasons of system stability	10 seconds

*Parameters shall be complied with insofar as no technological limitations occur

Figure 4D. *Active power frequency response capability of type D power park modules in FSM illustrating the case of zero deadband and insensitivity area.*



where: ΔP is the change in active power output from the power park module; P_{max} is the active power setpoint based on which the change in active power ΔP is established – namely the maximum power of the power park module; Δf is the frequency deviation in the network; f_n is the nominal frequency (50 Hz) in the network.

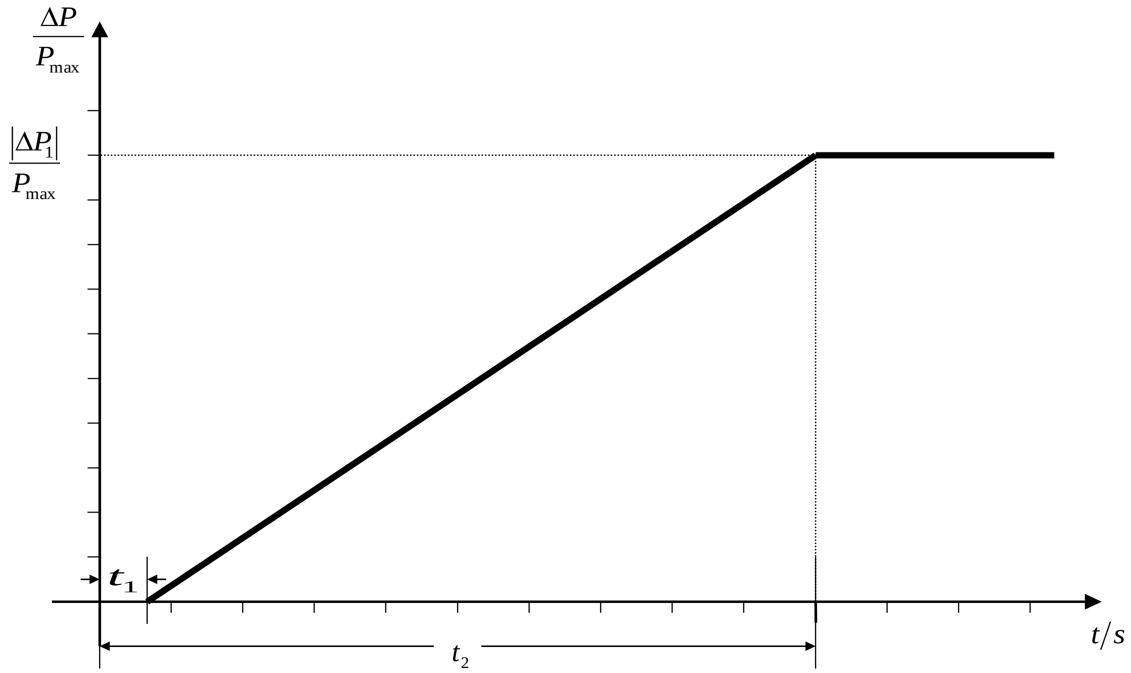


Figure 5D. *Frequency response capability*

where: P_{max} is the active power setpoint based on which the change in active power ΔP is established – namely the maximum power of the power park module; ΔP is the change in active power output from the power park module. The power park module shall activate an active power ΔP up to the point ΔP_1, according to the t_1 and t_2 times, while the ΔP_1, t_1 and t_2 values are specified by the TSO according to the *provisions from table 3D; t_1 is the initial delay (idle time); t_2 is the duration until the full activation of active power.*

Article 133.

(1). Real-time monitoring of the active power frequency automated response of the type D power park module shall be ensured by transmitting, in real-time and in a secured way, from an interface of the power park module to the dispatching center of the RSO, upon request by the RSO, of at least the following signals:

i. the operation condition signal with/without active power frequency automated response;

ii. setpoint (scheduled) active power;

iii. actual value of the active power output;

iv. load-frequency response deadband;

v. parameter settings for active power frequency response (not provided in real-time, they are only monitored from the dispatching center of the RSO).

(2). i. the RSO shall specify additional signals to be provided by the power park module via monitoring and recording devices in order to verify the performance of the active power frequency response provision;

ii. The additional signals are: frequency at the connection/interface point, as the case may be, state signals and commands regarding the breaker position and the separators position;

iii. The power park module owner ensures the transmission of signals via two independent communication paths (set in the TCA); usually, the main path is ensured via optical fiber equipment.

(3). Parameter settings for active power frequency response and the droop are established via operational controls.

Article 134. The TSO shall have the right to request the power park module to provide synthetic inertia during very fast frequency deviations. The power park module should recommendably provide a minimum contribution with an inertia constant of 3 s (H= 3s).

Article 135. The operating principle of the installed control schemes shall be analyzed by the TSO in order to verify the possibility to provide synthetic inertia. The corresponding performance parameters shall be specified by the TSO and shall be requested via the TCA.

Article 136. Type D power park modules shall fulfil the following requirements in relation to **robustness**, in terms of:

(a) the fault-ride-through capability in case of symmetrical faults:

i. the power park module must be capable to remain connected to the network, continuing its stable operation following a correctly secured fault in the network, according to the voltage-time dependency described in figure 6D, with respect to the connection/interface point, as the case may be, and described by the parameters in table 4D;

ii. the voltage-against-time-profile represents a lower admissible limit of the actual course of the voltages at the connection/interface point, as the case may be, during a symmetrical fault, as a function of time before, during and after the fault;

The lower limit shall be specified by the TSO, using the parameters set out in figure 6D and within the limits set out in table 4D for power park modules connected at or above the 110 kV level.
The lower limit shall also be specified by the RSO, using the parameters set out in figure 6D and within the limits set out in table 4D.

iii. the TSO shall specify and make publicly available the pre-fault and post-fault conditions for the fault-ride-through capability in terms of:
   1. the pre-fault minimum short-circuit power calculation at the connection/demarcation point, as the case may be;
   2. the pre-fault active and reactive power operating point of the power park module at the connection/interface point, as the case may be, and the voltage at the connection/interface point, as the case may be; and
   3. the post-fault minimum short-circuit power calculation at the connection/interface point, as the case may be.

iv. upon request by a power park module owner, the RSO shall provide the pre-fault and post-fault conditions (as relevant values resulted from typical cases) to be considered for fault-ride-through capability as an outcome of the calculations at the connection/interface point, as the case may be, as specified in letter (a) point (iii) regarding:
   1. the pre-fault minimum short-circuit power at every connection/interface point, as the case may be, expressed in MVA;
   2. the pre-fault operating point of the power park module, expressed in active power, reactive power and voltage at the connection/interface point, as the case may be; and
   3. the post-fault minimum short-circuit power at the connection/demarcation point, as the case may be, expressed in MVA.

Figure 6D. *Fault-ride-through profile of a type D power park module*

Note: The diagram in figure 6D represents the lower limit of a voltage-against-time profile of the voltage at the connection/interface point, as the case may be, expressed in relative units as the ratio of its actual value and its reference value before, during and after a fault. U_{ret} is the retained voltage during a fault at the connection/interface point, as the case may be, and t_{clear} is the instant when the fault has been cleared. U_{rec1}, U_{rec2}, t_{rec1}, t_{rec2} and t_{rec3} represent certain points of lower limits of retained voltage after fault clearance. The parameters related to the fault-ride-through are provided in table 4D.

Table 4D. *Parameters related to the fault-ride-through capability of type D power park modules*

Voltage parameters [r.u.]		**Time parameters [seconds]**	
U_{ret}:	0	t_{clear}:	0.25
U_{clear}:	0	t_{rec1}:	0.25
U_{rec1}:	0	t_{rec2}:	0.25
U_{rec2}:	0.85	t_{rec3}:	3.0

v. the power park module shall remain connected to the network and shall continue to operate stably when the actual course of the phase-to-phase voltages on the network voltage level at the connection/interface point, as the case may be, during a symmetrical fault, remains above the lower limit for the voltage profile described in the fault-ride-through-profile specified in letter (a) point (ii), except the triggering via the protections for internal electrical faults. The protection schemes and settings for internal electrical faults must not jeopardize fault-ride-through performance;

vi. considering the requirements provided in point (v), the power park module owner establishes the undervoltage protection (either the fault-ride-through capability, or the minimum voltage defined at the connection/interface point, as the case may be) according to the maximum voltage range corresponding to the power park module, except if the RSO requires a narrower voltage range. The settings shall be justified by the power park module owner in accordance with this principle;

(b) fault-ride-through capability in case of asymmetrical faults shall comply with the provisions set forth in letter (a) point (i) for symmetrical faults;

(c) maintaining stable operation at every point within the P-Q-capability diagram in the event of power oscillations between the power plant and the connection/interface point, as the case may be;

(d) power park modules shall be capable of remaining connected to the network without reducing power (within the limits given by the primary source), so long the frequency and voltage fall within the limits provided in table 1D, namely ±10% U_n of the network to which the park is connected;

(e) power park modules shall be capable of remaining connected to the network during single-phase or three-phase AR on loop network lines to which they are connected. The specific technical details shall be subject to coordination and instructions on protection schemes and settings agreed upon with the RSO.

(f) the TSO shall specify the post-fault active power recovery that the type D power park module shall be capable of providing and shall specify:

i. when the post-fault active power recovery begins, immediately after the moment when the voltage is higher than or equal to 85% U_{ret};

ii. the maximum period allowed for post-fault active power recovery is equal to maximum 50 ms; after the fault is cleared and the voltage recovers to a value greater than 0.85 U_{ret}, active power shall be restored, depending on the technology and the availability of the primary source, within a time interval of (1÷10) seconds for a value of (80÷90)% from the pre-fault power value; and

iii. the magnitude and precision (tolerance) of active power recovery depending on the technology used by the power park module and on the availability of the primary source equals to (80÷90)% of the pre-fault power value with an accuracy of 10% from the pre-fault active power value.

(g) The RSO shall specify in the TCA or at the time of commissioning, as the case may be:

i. the interdependency between fast fault current requirements according to the provisions of Article 140 (a) and (b) and active power recovery;

ii. the dependence between active power recovery times and duration of voltage variations. The RSO shall specify, at the moment of commissioning, the maximum active power recovery time for the maximum duration of the fault, usually equal to (1÷10) s for faults secured within a time period greater than 140 ms;

iii. the limit of the maximum allowed time for active power recovery, usually less than 10 seconds. A smaller value shall be requested if the solution studies require it;

iv. the adequacy between the level of voltage recovery and the minimum magnitude for active power recovery. Usually, for a voltage recovery value higher than 85% U_{ret}, the minimum value of post-fault recovered active power shall reach at least 85% of the pre-fault value within a time period of maximum 1 second, according to the availability of the primary source; and

v. the requirements regarding active power oscillations damping between the power plant and the connection/demarcation point, as the case may be (for power plants with long OHLs/UPLs), if dynamic studies show that equipment is necessary in order to secure the damping of these active power oscillations.

Article 137.

(1) Type D power park modules shall fulfil the following requirements in relation to the contribution to **system restoration**:

(a) they shall be capable to reconnect to the network following an accidental disconnection caused by an event in the network, under the conditions defined by the TSO. Usually, the time to reconnect to the network following an accidental disconnection equals to maximum 10 minutes;

(b) installation of automatic reconnection systems shall be subject to prior authorization both by the RSO, and the TSO, in order to specify the automatic reconnection requirements. These conditions shall be specified in the TCA and shall be detailed in the technical project.

(2)The requirements for the automatic reconnection provided in paragraph (1) letters (a) and (b) shall be notified to the power park module owner when issuing the TCA.

Article 138.

(1) Type D power park modules shall fulfil the following requirements in relation to:

(a) the black start capability or to the participation to the black start process:

i. the black start capability or the capability to participate to the black start process is not mandatory, but may be requested by the TSO during the grid connection stage in order to ensure the system's operational security;

ii. power park module owners shall, upon request by the TSO, provide a quotation for providing black start capability. The TSO may request the provision of black start capability if it considers system security to be at risk due to a lack of black start capability in its control area where the power park is located;

iii. a power park module with black start capability shall be capable of starting or participating to the start-up process, in full or via several pieces of equipment, from the shutdown state, without any external electrical energy supply within a time frame specified by the TSO, usually (15÷30) minutes from the instant the instruction is received;

iv. a power park module with black start capability shall be capable to reconnect within the (47.5÷50) Hz frequency range and within the (0.9÷1.1) U_n voltage range specified by the RSO, within a time period of maximum 300 s, for nominal voltages lower than 110 kV, and for voltages higher than or equal to 110 kV, within the voltage range specified in tables 6D and 7D;

v. a power park module with black start capability or participating to the restoration process, shall be capable to automatically control voltage, including voltage variations which may occur during the restoration process;

vi. a power park module with black start capability or participating to the restoration process, shall:

1. be capable of regulating power output for load connections at the connection/interface point, as the case may be;
2. be capable of participating to frequency variations, both for an increase over 50.2 Hz (in the LFSM-O mode) and for a decrease below 49.8 Hz (in the LFSM-U mode);
3. participate to frequency containment in case of overfrequency or underfrequency within the whole active power output range between minimum active power and maximum active power, as well as at houseload operation level;
4. be capable of parallel operation with other power park modules within one island;
5. control voltage automatically during system restoration within the ±10% U_n voltage range.

(b) with regard to the capability to take part in island operation:

i. when separating from the NPS, power park modules shall be capable of switching to island operation (houseload operation) from any operating point on the P-Q-profile and to operate with auxiliary supply for at least 1 hour, in order to contribute to the NPS restoration. When switching to island operation, power park modules shall be capable of operating above the minimum stable power value and to control voltage and frequency within the standardized range (according to the data provided in table 2D and 6D) for at least 3 hours, until the NPS is resynchronized.

ii. power park modules contributing to system restoration shall be capable of operating in island operation or taking part in island operation if required by the RSO in coordination with the TSO. The request shall be made when issuing the TCA and

1. the frequency range in island operation is (47.5÷51.5) Hz;
2. the voltage range in island operation is:

- $U_n \pm 4\%$ for LV and U_n ± 5% for MV (for voltages < 110 kV);
- $U_n \pm 10\%$ for voltages of 110 kV and 220 kV;
- $U_n \pm 5\%$ for voltages of 400 kV.

iii. power park modules shall be able to operate with active frequency control in FSM mode during island operation. In the event of a power surplus, power park modules shall be capable of reducing the active power output from a previous operating point to any new operating point within the P-Q-capability diagram, depending on the availability of the primary source;

iv. the method for detecting a change from interconnected system operation to island operation shall be commonly agreed between the power park module owner and the RSO, in coordination with the TSO. The agreed method of detection must not rely solely on the TSO's switchgear position signals;

v. power park modules shall be capable of operating in LFSM-O and LFSM-U during island operation, as commonly agreed with the TSO.

(c) With respect to the quick re-synchronization capability in the event of disconnection from the network, the power park module shall be able to quickly re-synchronize, usually within 15 minutes, according to the protection plan agreed upon with the RSO, within the limits of the technical possibilities of power-generating modules.

Article 139. Type D power park modules shall fulfil the following **requirements related to system operation**:

(a) the start-up of a power park module and the synchronization are performed by the power park module owner after the RSO's approval only;

(b) the power-generating module shall be equipped with the necessary synchronization facilities;

(c) synchronization shall be performed at frequencies within the ranges set out in table 1D and at voltages within the ranges set out in tables 6D and 7D;

(d) the RSO and the power park module owner shall agree upon and specify, prior to commissioning, the settings of synchronization devices in order to allow the synchronization of the power park module, as follows:

i. voltage range, ±10% U_n (at terminals);

ii. frequency range, (47.5-51) Hz;

iii) phase angle range, smaller than 10º;

iv) phase sequence;

ii) deviation of voltage smaller than 10% U_n and deviation of frequency smaller than 50 mHz;

iii. verification time of metered values of 60 seconds.

(e) control and automation schemes and related settings:

i. the control and automation schemes, as well as the related settings, including the control parameters, necessary for the network stability calculations and emergency measures analysis, shall be submitted by the power park module owner to the RSO or the TSO respectively, no later than 6 months prior to the application of voltage for the beginning of the testing period, in order for them to be coordinated and agreed upon between the TSO, RSO and the power park module owner;

ii. any changes to the control and automation schemes and settings, as mentioned in point (i), of the different control devices of the power park module shall be coordinated and agreed upon between the TSO, the grid operator and the power park module owner, in particular if they apply in the situations described in point (i).

(f) electrical protection schemes and related settings:

i. the protection systems needed for the power park module and the network, as well as the settings relevant to the power park module shall be coordinated and agreed upon between the RSO and the power park module owner, during the connection process. The TSO coordinates with the RSO and with the power park module owner in order to coordinate protections, taking into account the frequency variation value resulted from periodical studies on the inertia of the Continental Europe synchronous system to which the NPS belongs. The protection systems and related settings for internal electrical faults must not jeopardize the performance of the power park module. The protection and automation systems shall fulfill at least the following requirements:

1. they shall ensure protection against internal faults of the power-generating modules in the power park module, as well as backup protection against abnormal operation states and faults from the network to which they are connected;
2. they shall be efficient, highly reliable and organized in groups with redundant functionality; the protections shall be selective, sensible, capable to detect internal and external faults, physically and galvanically separated from the power supplies with operative voltage, from voltage and current metering transformers to command execution devices. The electrical protection system shall be equipped with extended self-testing and self-diagnosis functions, as well as with events recording and oscillography functions. The electrical protections system shall be equipped with standard communication interfaces aiming for the integration in a local system for data acquisition, supervision and control.
3. the electrical protections system may be organized in two groups of independent and redundant protections, both for the power park module as well as for the connection, as the case may be.
4. the internal faults electrical protections system shall be capable to detect at least the short-circuit currents, the current asymmetry, the maximum/minimum voltage, the maximum/minimum frequency at the terminals of the power-generating module in the power park module;
5. the external faults electrical protections system, as backup protections, shall be capable to detect at least the symmetrical and asymmetrical short-circuits from the network to which the power-generating modules in the power park module are connected, the power oscillations, the current asymmetry, the current and voltage electrical overloads.

ii. the electrical protection of the power park module shall take precedence over operational controls, taking into account the operational security of the system, the health and safety of staff and of the public, as well as mitigating any damage to the power-generating modules in the power park module.

iii. Together with the power park module owner, the RSO shall coordinate and commonly agree that the protection systems must cover at least the following faults:

A. protections of power-generating modules in the power park module, of the step-up transformer and of the houseload or ancillary services transformer, covered by the power park owner, for:

1. internal faults of power-generating modules in the power park module, of the step-up transformer and potentially of the houseload transformer (short-circuits or groundings);
2. internal faults of the step-up transformer of the power-generating module in the power park module;
3. short-circuits or groundings on the network evacuation line of the power output;
4. short-circuits or groundings in the network, as backup protection;
5. maximum and minimum voltage at the terminals of power-generating modules in the power park module.

B. protections covered by the power park module owner and/or the RSO, as the case may be, for:

1. short-circuits or groundings on the network evacuation line of the power output;
2. maximum and minimum voltage at the connection/interface point, as the case may be;
3. maximum and minimum frequency at the connection/interface point, as the case may be;
4. short-circuits or groundings in the network, as backup protection;

iv. changes to the protection schemes, needed for the power park module and the network and to the settings relevant to the generation plant shall be agreed upon in advance between the RSO and the power park module owner;

(g) the organization by the power park module owner of the protection and control devices according to the following prioritization:

i. the network's and power park module's protection;
ii. synthetic inertia, if applicable;
iii. frequency control (active power adjustment);
iv. power restrictions;
v. limiting the ramping rate of power variations.

(h) information exchange:

i. protection/control and automation systems of power-generating modules in the power park module shall be capable of exchanging information with the RSO and TSO in real-time or periodically;
ii. The RSO, in coordination with the TSO, sets the content of the exchanges of information provided by the power park module owner, which shall comprise at least the following data transmitted in real-time: active power, scheduled active power, as the case may be, reactive power, voltage and frequency at the connection/interface point, as the case may be, state signals and commands regarding the breaker position and the separators position and the operation condition signal with/without active power frequency automated response. The power park module owner ensures the transmission of signals via two independent communication paths (set in the TCA); usually, the main path is ensured via optical fiber equipment.

(i) The power park module shall be capable to automatically disconnect from the network when losing robustness. The disconnection criteria regarding the protection against current asymmetry, phase interruption and critical disconnection time, shall be agreed upon between the power park module owner, the RSO and the TSO.

(j) instrumentation:

i. power park modules shall be equipped with devices to provide fault recording and monitoring of dynamic system behavior; these devices are usually oscilloperturbographs or equipment that can replace functions covered by oscilloperturbographs. These devices shall record the following parameters:

1. voltages in all three phases;
2. current in each phase;
3. active power in all three phases;
4. reactive power in all three phases;
5. frequency.

The RSO shall have the right to specify quality of supply parameters to be complied with, provided via the aforementioned devices, on condition that they are previously agreed upon with the power park module owner.

ii. the settings of the fault recording equipment, including triggering criteria and the sampling rates shall be commonly agreed between the power park module owner and the RSO at the time of PIF and shall be documented via written arrangements. These shall also include a criterion for detecting oscillations between the power park and the connection/interface point, as the case may be, established by the TSO;

iii. The RSO, TSO and the power park module owner shall commonly agree upon the need to include a criterion for detecting oscillations between the power park and the connection/interface point, as the case may be, in order to monitor the dynamic system behavior, specified by the TSO in order to detect poorly damped power oscillations (undamped);

iv. the dynamic system behavior monitoring system shall include arrangements for the power park module owner and the RSO to access the information. The communications protocols for registered data shall be commonly agreed between the power park module owner, the RSO and the TSO, prior to choosing the monitoring equipment.

(k) power park module operation simulation models:

i. upon request of the RSO or the TSO, the power park module owner shall provide the power park module operation simulation models that reflect its behavior both in steady-state regime, as well as in dynamic regime (including for transient electromagnetic phenomena, if requested). The models provided shall be validated via the compliance test results. The power park module owner submits to the RSO or the TSO the results of these tests for the power park module or for heat engines that gear the power-generating modules in the power park module, proven by means of check-up certificates recognized on European level, carried out by an authorized certifier;

ii. the models of the photovoltaic panel, wind turbine etc. and converters, provided by the power park module owner shall contain the following sub-models, depending on the existence of individual components:

1. the power-generating module in the power park module;
2. speed, frequency and active power control, as the case may be;
3. voltage control;
4. power park module protections models, as agreed by the RSO and the power park module owner;
5. inverter and wind generating unit models, as the case may be.

iii. upon request by the RSO, the TSO shall specify:

1. the format in which simulation models are to be provided, including the utilized calculation program;
2. the documentation on the mathematical model's structure and block diagrams;
3. the estimate of the minimum and maximum short-circuit power at the connection/interface point, as the case may be, expressed in MVA, as an equivalent of the network.

iv. the power park module owner provides the RSO, upon request, with recordings of the power park module's performance. The RSO or the TSO may make such a request, in order to compare the response of the models and model simulations performed with actual operational recordings.

(l) regarding the installation of devices for system operation and devices for system operational security, if the RSO or the TSO considers that it is necessary to install additional devices in order to preserve or restore system operation or system operational security. The RSO and the power park module owner, together with the TSO, shall analyze and agree upon the adequate solution;

(m) the RSO shall specify, in coordination with the TSO, the minimum and maximum limits on rates of change of active power output from the power park module (ramping limits) in both an up and down direction of change, taking into consideration the specific characteristics of prime mover technology. Usually, the rate of change falls within the (10÷30)% P_{max}/min range and is equal in both directions (up and down direction);

(n) earthing arrangement of the neutral-point at the network side of step-up transformers shall comply with the specifications of the RSO.

Article 140. Type D power park modules shall fulfil the following requirements in relation to voltage stability:

(a) they shall be capable of providing fast fault current at the connection/interface point, as the case may be, in case of symmetrical (three-phase) faults, under the following conditions:

i. the power park module shall be capable of activating the supply of fast fault current either by:

1. ensuring the supply of the fast fault current at the connection/demarcation point, as the case may be, corresponding to the voltage variation with a proportionality factor (k) between 2 and 10 according to the formula: $\Delta I = k * \Delta U$; or

2. measuring voltage variations at the terminals of the power park module and providing fast fault current at the terminals of these modules (reactive current component).

ii. The RSO, in coordination with the TSO, shall specify:

1. how and when a voltage deviation is to be determined as well as the duration of the voltage deviation. The voltage deviation shall be determined when the metered voltage, either at the connection/interface point, as the case may be, or at the terminals of the power-generating module is lower than 0.85 U_{ref}. The duration of the deviation is considered up to the point when the voltage recovers to a value greater than 0.85 U_{ref};

2. the characteristics of the fast fault current, including the time domain for measuring the voltage deviation and fast fault current, for which current and voltage may be measured differently from the method specified in paragraph (a) point (i), are: increase time of the fault current, lower than or equal to 30 ms and the clearance time of the fault current, lower than or equal to 60 ms;

3. the timing and accuracy of the fast fault current, which may include several stages during a fault and after its clearance. Thus, the power-generating module shall inject, immediately after the fault (when low voltage is detected, according to the provisions set forth in the point above) in a time period of usually 50 ms, a reactive current depending on the magnitude of the low voltage (retained voltage) with a (2÷10) proportionality factor. The injected reactive current shall be maintained all throughout the low voltage duration according to the voltage profile defined by the fault-ride-through in figure 6D and shall be cancelled immediately after fault clearance (according to IGD Fault current contribution from PPMS & HVDC).

(b) with regard to the supply of fast fault current in case of asymmetrical (one-phase or two-phase) faults, the RSO, in coordination with the TSO, shall have the right to specify the requirements for asymmetrical current injection. Usually, the requirements regarding the asymmetrical current injection are similar to the requirements regarding the symmetrical current injection set forth in letter (a). These requirements shall be notified to the owner.

(c) they shall be capable of providing additional reactive power, specified by the RSO, which shall be provided at the connection/interface point, as the case may be, of the power park module, if it is not located at the high-voltage terminals of the step-up transformer. The additional reactive power shall compensate the reactive power exchange of the high-voltage line or cable between the high-voltage terminals of the step-up transformer of the power park module and the connection/demarcation point, as the case may be. The additional reactive power shall be covered via dedicated equipment provided by the power park module owner. This additional reactive power is specified via a reactive power offset study at the connection/interface point, as the case may be, and shall provide null reactive power exchange at zero active power, with the following tolerance: maximum 0.5 MVAr if voltage at the connection/demarcation point, as the case may be, is ≥110 kV or if the connection/interface point, as the case may be, is located at the substations' bars, and maximum 0.1 MVAr respectively for power park modules connected to lines or at the end of a long MV line;

(d) they shall be capable to generate reactive power at full capacity, whilst complying with the following requirements:

   i. the power park module owner shall provide an envelope of the U-Q/P_{max}-profile, which may take any shape within the limits of which the power park module is capable to provide/absorb reactive power at voltage variations and full capacity operation; the envelope shall be analyzed and approved by the TSO in coordination with the RSO;

   ii. the U-Q/P_{max}-profile shall be specified by the RSO in coordination with the TSO in line with the following principles:

      1. the U-Q/P_{max}-envelope shall not exceed the U-Q/P_{max}-profile represented by the inner envelope in figure 7D;
      2. the dimensions of the U-Q/P_{max}-profile envelope (Q/P_{max} range and voltage range) shall be within the maximum values specified in table 5D;
      3. the position of the U-Q/P_{max}-profile envelope shall be within the limits of the fixed outer envelope in figure 7D; and
      4. the U-Q/P_{max}-profile specified for power park modules may take any shape, having regard to the potential costs of delivering the capability to provide reactive power production at high voltages and reactive power consumption at low voltages.

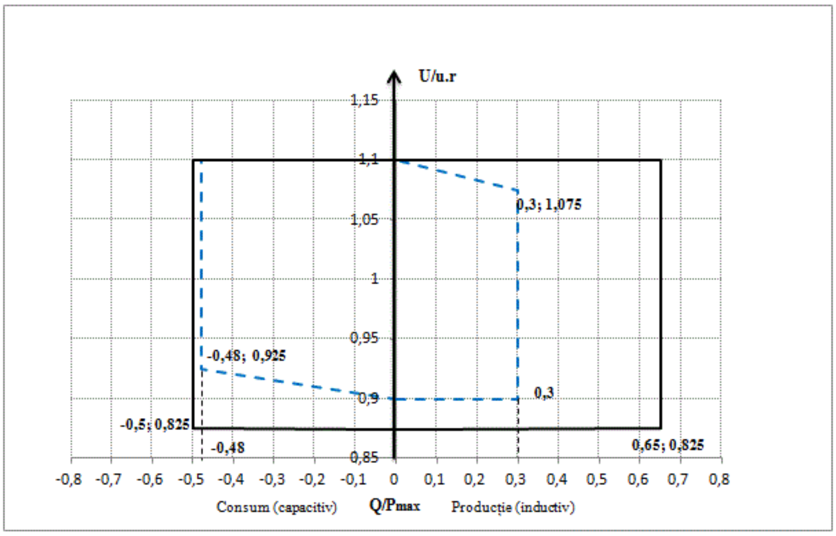


Figure 7D. *U-Q/P_{max}-profile of a power park module*

Figure 7D represents the typical boundaries of a U-Q/P_{max}-profile by the voltage at the connection/interface point, as the case may be, expressed in relative units by the ratio of its actual value and the reference value, against the ratio of the reactive power (Q) and the maximum capacity (P_{max}). The position, size and shape of the envelope are indicative and the TSO may also request, depending on system conditions at the connection/interface point, as the case may be, other shapes of the U-Q/P_{max}-profile within the maximum Q/P_{max} range of 0.75.

Maximum Q/P_{max} range	**Maximum range of steady-state voltage level, expressed in relative units (r.u.)**
0.75	0.200

Table 5D. *Parameters for the inner envelope in figure 7D*

iii. the reactive power provision capability requirement applies at the connection/interface point, as the case may be. For envelope shapes other than rectangular, the voltage range represents the highest and lowest values. The full reactive power range is therefore not expected to be available across the range of steady-state voltages.

(e) with regard to reactive power capability below maximum power (below P_{max}):

i. The RSO, in coordination with the TSO, shall specify the requirements regarding reactive power provision capability, as well as a P-Q/P_{max}-envelope of any shape within the limits of which the power park module shall provide reactive power under its maximum power given by the P-Q-profile;

ii. the limits of the P-Q/P_{max}-capability diagram shall be specified by the RSO in coordination with the TSO in line with the following principles:

1. the P-Q/P_{max}-envelope shall not exceed the P-Q/P_{max}-profile envelope, represented by the inner envelope in figure 8D;
2. the Q/P_{max}-range on the P-Q/P_{max}-profile envelope is specified in table 5D;
3. the active power range of the P-Q/P_{max}-profile envelope at zero reactive power shall be 1 r.u. P_{max};
4. the P-Q/P_{max}-profile envelope can be of any shape and shall include conditions for reactive power capability at zero active power; and
5. the position of the P-Q/P_{max}-profile envelope shall be within the limits of the fixed outer envelope set out in figure 8D;

iii. when operating at an active power output below maximum power ($P < P_{max}$), the power park module shall be capable of providing reactive power at any operating point inside its P-Q/P_{max}-profile, if all units of that power park module which generate power are technically available, that is to say they are not out of service due to maintenance or failure, otherwise there may be less reactive power capability, taking into consideration the technical availabilities.

iv. the power park module shall be capable of moving to any operating point within its P-Q/P_{max} profile in appropriate timescales to target values requested by the RSO.

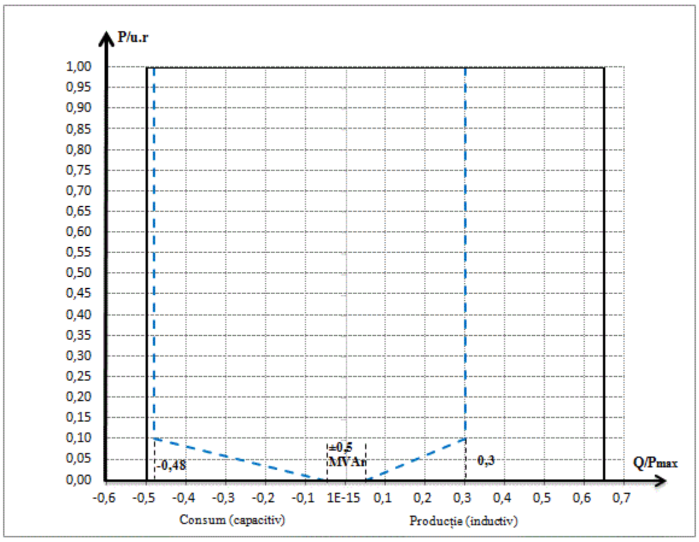


Figure 8D. *P-Q/P_{max}-profile of a power park module*

Figure 8D represents the typical boundaries of a P-Q/P_{max}-profile by the active power at the connection/interface point, as the case may be, expressed in relative units by the ratio of its actual value and the maximum active power considered, against the ratio of the reactive power (Q) and the maximum power (P_{max}). The position, size and shape of the inner envelope are indicative and the TSO may also request, depending on system conditions at the connection/interface point, as the case may be, other shapes of the U-Q/P_{max}-profile within the maximum Q/P_{max} range of 0.75.

(f) with regard to reactive power control modes:

i. the power park module shall be capable of providing reactive power automatically by either voltage control mode, reactive power control mode or power factor control mode;

ii. for the purposes of voltage control mode, the power park module shall be capable of contributing to voltage control at the connection/interface point, as the case may be, by providing the necessary reactive power exchange with the network with a setpoint voltage covering at least the (0.95÷1.05) r.u. range, in steps no greater than 0.01 r.u., with a slope having a range of at least (2÷7)% in steps no greater than 0.5%. The reactive power output shall be zero when the grid voltage value at the connection/interface point, as the case may be, equals the voltage setpoint;

iii. the setpoint may be operated with or without a deadband selectable in a range from 0 to ±5% U_{ref}, where $U_{ref} = U_n$, in steps no greater than 0.5% U_{ref};

iv. following a voltage step change, a power park module shall be capable to reach 90% of the step value in the t_1 instant, specified by the RSO within the (1÷5)-second range, usually of 1 second, and shall stabilize at the value requested within a t_2 time period, specified by the RSO within the (5÷60)-second range, usually of 10 seconds. The voltage change performed by the power park module shall follow a variation slope given by the t_1 and t_2 instants, and the requested value shall be performed with a steady-state reactive power tolerance no greater than 5% of the maximum reactive power. The RSO shall specify the time specifications for t_1 and t_2;

v. for the purpose of reactive power control mode, the power park module shall be capable of setting the reactive power setpoint anywhere in the reactive power range, specified in letters (c) and (d), with setting steps no greater than 5 MVAr or 5% (whichever is smaller) of full reactive power, controlling the reactive power at the connection/interface point, as the case may be, to an accuracy within plus or minus 5 MVAr or plus or minus 5% (whichever is smaller) of the full reactive power;

vi. with respect to power factor control mode, the power park module shall be capable of controlling the power factor at the connection/interface point, as the case may be, within the P-Q/P_{max}-profile envelope required for reactive power range, specified by the RSO according to letters (c) and (d), with a target power factor in steps no greater than 0.01. The RSO shall specify the target power factor value, its tolerance and the period of time to achieve the target power factor following a sudden change of active power output. The tolerance of the target power factor shall be expressed through the tolerance of its corresponding reactive power, but shall not exceed 1% of the maximum reactive power of power park modules;

vii. the RSO, in coordination with the TSO and with the power park module owner, shall specify which of the three reactive power control mode options (voltage control, reactive power control or power factor control) and associated setpoints is to apply, and what further equipment is needed to make the adjustment of the relevant setpoint operable remotely;

(g) with regard to prioritizing active or reactive power contribution, the TSO shall specify whether active power contribution or reactive power contribution has priority during faults for which fault-ride-through capability is required. If priority is given to active power contribution, its provision has to be established no later than 150 ms from the fault inception;

(h) with regard to power oscillations damping control, if specified by the TSO when issuing the TCA, the power park module shall be capable of contributing to the power oscillations damping between the power park module and the connection/demarcation point, as the case may be. The voltage and reactive power control system characteristics of power park modules must not adversely affect the damping of power oscillations.

(i) with regard to voltage ranges:

i. notwithstanding the provisions of Article 136 (a) regarding the fault-ride-through capability, a power park module shall be capable to remain connected to the network and to operate within the voltage range at the connection/interface point, as the case may be, related to the reference 1 r.u. voltage, and for the time periods specified tables 6D and 7D;

ii. the TSO may specify shorter periods of time during which power park modules shall be capable of remaining connected to the network in the event of simultaneous overvoltage and underfrequency or simultaneous undervoltage and overfrequency;

iii. for the 400 kV grid voltage level (or alternatively commonly referred to as 380 kV level), the reference 1 r.u. value is 400 kV; for other grid voltage levels, the reference 1 r.u. voltage shall be agreed upon with the TSO.

Table 6D. *Minimum time for operation of a power park module connected at the 110 kV and 220 kV voltage level respectively*

Voltage range	Time period for operation
0.85 r.u. – 0.90 r.u.	60 minutes
0.90 r.u. – 1.118 r.u.	Unlimited
1.118 r.u. – 1.15 r.u.	20 minutes

**Table 6D shows the minimum time periods during which a power park module must be capable of operating for voltages deviating from the nominal value, expressed in relative units, at the connection/interface point, as the case may be, without disconnecting from the network, where the voltage base for the setpoint is 110 kV and 220 kV. Usually, the unlimited maximum value for operation for a nominal voltage of 110 kV equals to 123 kV and for a nominal voltage of 220 kV it equals 245 kV, as absolute values. For network areas where time periods for operation longer than 20 minutes are agreed, for voltage values in the 1.118 r.u. – 1.15 r.u. range, the maximum duration cannot exceed 60 minutes. The values are specified based on operational agreements between users and the RSO.*

Table 7D. *Minimum time for operation of a power park module connected at the 400 kV voltage level*

Voltage range	Time period for operation
0.85 r.u. – 0.90 r.u.	60 minutes
0.90 r.u. – 1.05 r.u.	Unlimited
1.05 r.u. – 1.10 r.u.	20 minutes

**Table 7D shows the minimum time periods during which a power park module must be capable of operating for voltages deviating from the nominal value, expressed in relative units, at the connection/interface point, as the case may be, without disconnecting from the network, where the voltage base for the setpoint is 400 kV. For network areas where time periods for operation longer than 20 minutes are agreed, for voltage values in the 1.05 r.u. – 1.1 r.u. range, the maximum duration cannot exceed 60 minutes. The values are specified based on operational agreements between users and the RSO.*

(j) The RSO and the power park module owner, in coordination with the TSO, may agree upon wider voltage ranges or longer minimum time periods for operation. If wider voltage ranges or longer minimum times for operation are economically and technically feasible, the power park module owner shall not unduly withhold consent for these proposals;

(k) without prejudice to the provisions of letter (i), the RSO, in coordination with the TSO, shall have the right to specify voltages at the connection/interface point, as the case may be, at which a power park module is capable of automatic disconnection. Requirements and settings for automatic disconnection shall be agreed between the RSO and the power park module owner.

(l) The TSO shall specify in the TCA the need to implement the power containment function aiming to damp active power oscillations, specified depending on system conditions, installed capacity of the power park module and its position in the network. The settings of the power containment systems shall be specified by the TSO and implemented according to the TSO's instruction.

Article 141. The type D power park module shall be able to set the rate of change of active power output to the value required by the TSO (MW/minute) of minimum 10% P_{max}/min, depending on the technology used.

Article 142. The grid operator may request, within the TCA, the additional installation in the power park module of automation systems aiming to quickly reduce power, namely until shutdown, in justified cases, in order to protect facilities, persons and the environment.

Article 143. The power park module shall be equipped with reliable and secure protections systems, both against faults from its own network, as well as against faults from the NPS.

Article 144. The type D power park module owner must ensure protection of facilities and components of the power park module and of auxiliary installations against faults generated from its own facilities or from the network impact over them when the power park module activation protections are operated properly or upon network incidents (short-circuits with or without grounding, network protections tripping, transient over-voltages, etc.), as well as upon exceptional/abnormal technical operational conditions.

Article 145. The power park module owner shall provide the grid operator with the protections type, the connection method to the voltage circuits, electric current circuits and trip circuits, the actuation matrix for protection functions specified in the project, at the interface between the power park module and the connection/interface point, as the case may be, belonging to the NPS.

Article 146. Under normal network operation, the power park module shall not produce fast voltage fluctuations at the connection/interface point, as the case may be, greater than ±5% of the nominal voltage of the network to which it is connected.

Article 147. Irrespective of the operational auxiliary installations and regardless of the power output, the power park module shall ensure, at the connection/interface point, as the case may be, the electricity quality according to applicable standards (European standards and the performance standard for providing the electricity transmission service and the system service, and the standard for providing the electricity distribution service respectively).

Article 148. The type D power park module shall be monitored in terms of electricity quality at the connection/interface point, as the case may be, during tests performed for verifying the compliance with the connection technical requirements. The RSO may require, as the case may be, a permanent monitoring of electricity quality at the connection/interface point, as the case may be, and the integration of the permanent monitoring equipment in its own electricity quality monitoring system.

Article 149. The RSO shall take all necessary measures so that the conditions set forth in this technical norm are complied with, without jeopardizing the system's operational security.

Article 150.

(1). The type D power park module owner shall ensure continuity in the submission of status and operation values to the RSO and the TSO.

(2). The power park module shall be integrated in the DMS-SCADA/EMS-SCADA systems of the RSO, ensuring at least the following signal exchange: active power, reactive power, voltage and frequency at the connection/interface point, as the case may be, set values for active power and reactive power, state signals and commands regarding the breaker position and the separators position.

(3). The power park module owner ensures the transmission of signals via two independent communication paths (set in the TCA).

Article 151. The type D power park module owner shall ensure power supply to the monitoring, control and data transmission facilities provided in Article 150, so that they are available for at least three hours after the loss of power supply.

Article 152.

(1). The type D power park module owner shall ensure the communication paths from the monitoring facilities or control facilities of the power park module to the interface with the RSO located in a location accepted by it, under quality parameters required by the RSO (Article 177 of the PTG code).

(2). Constructing and maintaining the communication path between the power park module and the RSO's interface falls under the responsibility of the power park module owner or the RSO.

Article 153.

(1). The integration in the EMS-SCADA/DMS-SCADA systems, as the case may be, as well as in the electricity monitoring system, falls under the responsibility of the power park module owner.

(2). The control and data acquisition facilities, as interface systems between the power park module and the power transmission/distribution grid, are specified in the TCA.

Article 154. The type D power park module owner has the obligation to ensure compatibility of data exchange equipment at the RSO's DMS-SCADA/EMS-SCADA systems interface level, according to the features requested by it.

Article 155. The type D power park module owner has the obligation to allow access to the RSO and the TSO to the outputs of its own metering systems for voltage, current, frequency, active and reactive power and to information regarding switching equipment indicating the status of facilities and alarm signals, in order to transfer this information to the interface with the control and data acquisition system – DMS-SCADA or EMS-SCADA respectively, as well as with the remote metering system.

CHAPTER IV

TECHNICAL REQUIREMENTS APPLICABLE TO OFFSHORE POWER PARK MODULES WHICH ARE CONNECTED IN ALTERNATING CURRENT (AC)

Article 156.

(1). Offshore power park modules shall fulfil the following requirements in relation to frequency stability:

(a) they shall be capable of remaining connected to the network and operate within the frequency ranges and time periods specified in table 1;

(b) they shall remain connected to the network and must operate at frequency variation rates of 2 Hz/sec for a time period of 500 ms, of 1.5 Hz/s for a time period of 1000 ms and of 1.25 Hz/s for a time period of 2000 ms, depending on the technology type and the short-circuit power of the system at the connection/demarcation point, as the case may be (a value provided by the RSO in the TCA);The protection controls at the connection/interface point, as the case may be, coordinated by the RSO, must allow operation of the power park module for these frequency variation profiles.

Table 1. *The minimum duration for which an offshore power park module has to be capable to remain connected to the network and to operate at different frequencies, deviating from a nominal value (Article 13 (1) (a) (i) and (ii))*

Frequency range	Duration for operation
47.5 Hz – 48.5 Hz	Minimum 30 minutes
48.5 Hz – 49 Hz	Minimum 30 minutes
49 Hz – 51 Hz	Unlimited
51.0 Hz – 51.5 Hz	30 minutes

Article 157. Offshore power park modules shall be capable to ensure a limited frequency response, namely to frequency increases above the nominal value of 50 Hz (LFSM-O), thus:

(a) at overfrequencies, the offshore power park module shall decrease the active power output according to the frequency variation, in accordance with figure 1 and with the following parameters:

i. the frequency threshold from which the offshore power park module ensures overfrequency response is 50.2 Hz;

ii. the droop settings shall be between 2% and 12% and shall be provided by the RSO via operational controls, at the offshore power park module's commissioning.

iii. the offshore power park module shall be capable of decreasing the active power related to the frequency variation with an initial delay that is lower than 500 ms (marked with t_1 in figure 5). If this delay is greater than 500 ms, the offshore power park module owner shall justify the delay, providing technical evidence to the TSO. The response time for the power decrease in the event of overfrequency shall be lower than or equal to 2 seconds for a power variation of 50% from the maximum active power.

(b) when reaching the power related to the minimum control level, the offshore power park module shall be capable of:

i. containing the activated power within a duration of no more than 20 seconds and continuing its operation at this level (within the limits of the admissible power given by the primary source); or

ii. continuing to reduce the active power output according to the operational controls and in accordance with its own technical feature submitted together with the technical data, which does not deviate from the functional features of offshore power park modules of the same type;

iii. maintaining the power level reached with a permitted deviation of ± 5% P_{max}, so long the frequency deviation is maintained.

(c) the offshore power park module shall be stable during operation in the LFSM-O mode during frequency increases over 50.2 Hz. So long LFSM-O is active, the LFSM-O setpoint shall prevail over any other active power setpoints.

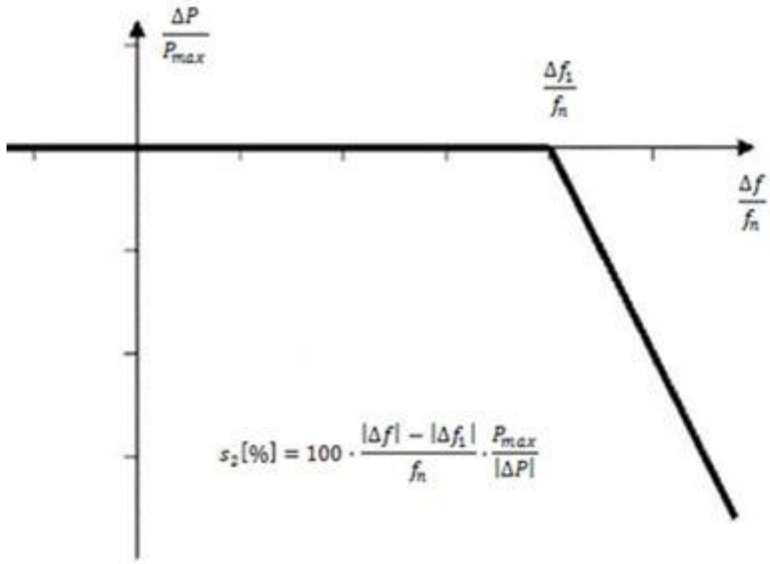


Figure 1. *Active power frequency response capability of offshore power park modules in LFSM-O*

where: P_{max} is the active power setpoint based on which ΔP is established – namely the maximum (nominal) power of the power park module; f_n is the nominal frequency (50 Hz) in the network and Δf is the frequency deviation in the network. At overfrequencies where Δf is above +200 mHz compared to the nominal value (50 Hz), the offshore power park module has to decrease the active power according to the droop s_2.

Article 158. The offshore power park module shall be capable of maintaining constant output at its target active power value regardless of changes in frequency, within the limits of the power offered by the primary source, except where the power-generating modules in the power park module follow the frequency increases according to Article 157 or have acceptable power decreases at frequency decreases accepted by the RSO and according to the provisions of Article 159 and Article 160.

Article 159. The TSO sets the active power output reduction of the offshore power park module compared to the maximum active power output (admissible power given by the primary source) following the frequency decrease, within the limits specified in figure 2, hence:

(a) at underfrequencies below 49 Hz, a maximum active power output decrease is admitted at a percentage of 2% from the maximum active power output at the frequency of 50 Hz, for every 1 Hz of frequency decrease. Any maximum active power output reduction curve situated above the dotted line is admitted depending on the frequency;

(b) at a frequency decrease under 49.5 Hz a maximum active power output decrease is admitted at a percentage of 10% from the maximum active power output at the frequency of 50 Hz, for every 1 Hz of frequency decrease, if the frequency is lower than 49.5 Hz for a duration of over 30 s. Any maximum active power reduction curve situated above the continuous line is admitted depending on the frequency.

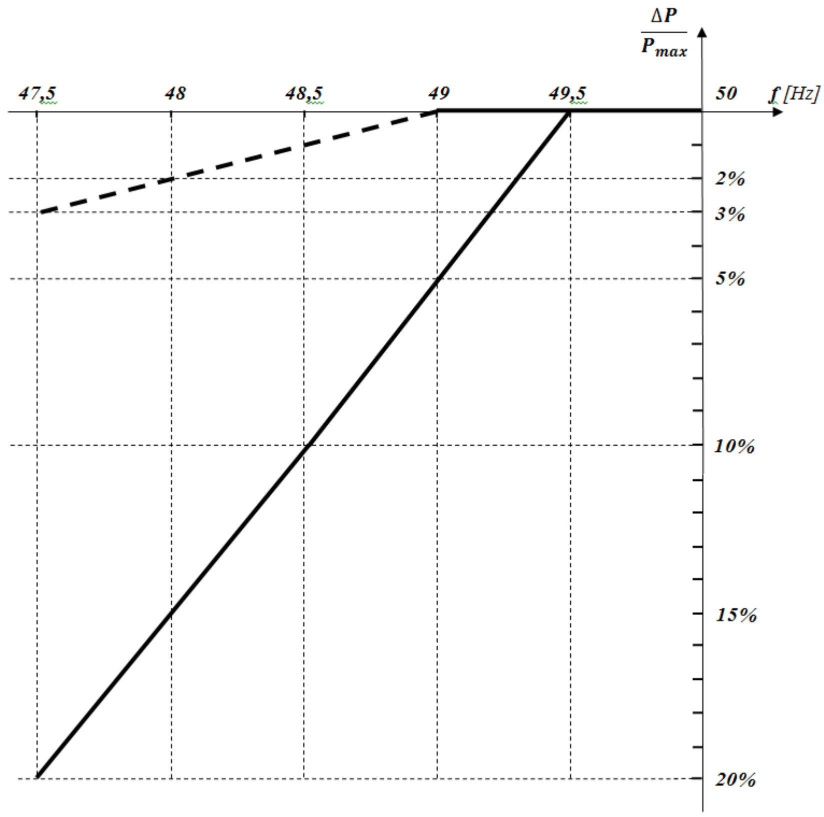


Figure 2. *Admissible limits for power reduction established by the TSO in the event of underfrequency*

Article 160.

(1). The admissible active power reduction compared to the maximum active power output (admissible power, given by the primary source) in the event of frequency deviations under 49.5 Hz is established:

(a) under standard environmental conditions related to a temperature of 20 degrees Celsius. As the case may be, the owner submits to the RSO and the TSO the dependency diagram of the active power in terms of temperature for at least one set of temperatures: -10^{0}C, 0^{0}C, 15^{0}C, 25^{0}C, 30^{0}C, 40^{0}C;

(b) depending on the technical capability of the offshore power park modules.

(2). The offshore power park module owner shall submit to the RSO and the TSO the dependency diagram of the active power in terms of environmental factors (temperature, pressure, solar irradiance, wind speed, as the case may be) and the technical data regarding the technical frequency response capability of the offshore power park module, set forth in paragraph (1), as well as the technical data set forth in Annex 8 to this technical norm.

(3). The data provided in paragraph (2) shall be submitted during the commissioning stage within the connection process.

Article 161.

(1). The active power control system of the offshore power park module shall be capable of adjusting an active power setpoint in line with the instructions given to the power park module owner by the RSO or the TSO.

(2). The time to reach the active power setpoint or the rate of change of active power output when adjusting the setpoint falls within the (10÷30)% P_{max}/min range depending on the technology used, while the idle time equals to 1 second and the setpoint fulfillment tolerance equals to 1% P_{max}.

Article 162. Local control shall be allowed in cases where the automatic remote control devices are out of service.

Article 163. Offshore power park modules shall be capable to ensure a limited frequency response, namely to frequency decreases (LFSM-U), thus:

(a) it must be capable to mobilize active power response at underfrequencies below a 49.8 Hz frequency threshold and with a droop set by the TSO for every offshore power park module, at the time of PIF or via operational controls within the (2÷12)% limits, usually at the 5% value, which corresponds to an active power mobilized of 8% P_{max}, according to figure 3;

(b) the delivery of active power in response to the frequency decrease (in LFSM-U mode) shall also take into account, as the case may be, the following:

  i. the dependency diagram of active power output in terms of environmental conditions;

  ii. the operating requirements of the offshore power park module, in particular the limitations on operation near maximum active power at low frequencies and the respective impact of external operating requirements according to the provisions of Article 159 and Article 160;

  iii. the availability of the primary energy sources.

(c) the activation of active power frequency response by the power-generating module shall not be unduly delayed. If this delay (called idle time and marked with t_1 in figure 5) is greater than 500 ms for power-generating modules without inertia, or greater than 2 seconds for power-generating modules with inertia, the offshore power park module owner shall justify the delay towards the TSO;

(d) while operating in the LFSM-U mode, the offshore power park module shall ensure a power increase up to the maximum/admissible power depending on the primary energy source. The response time for the power increase for offshore power-generating modules, except for offshore wind turbines, shall be lower than or equal to 10 seconds for a power variation of maximum 50% from the maximum power. For offshore wind turbines, the response time shall be lower than or equal to 5 seconds for a power variation of 20% from the maximum power, if the starting operating point is higher than 50% from the maximum power. Higher active power increase times can be accepted if the starting operating point is lower than 50% from the maximum power. Reaching the setpoint shall take place in a time interval of maximum 30 seconds with a maximum tolerance of ±5% from P_{max};

(e) the offshore power park module shall operate stably during the LFSM-U mode at frequencies lower than 49.8 Hz.

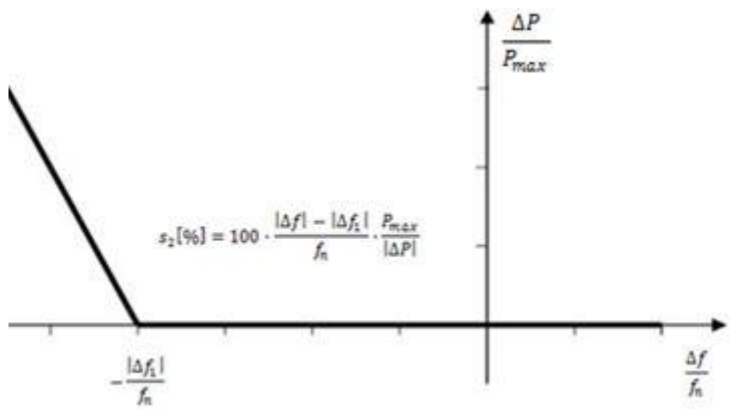


Figure 3 *Low frequency response capability of offshore power park modules (LFSM-U)*

where: P_{max} is the active power setpoint based on which ΔP is established – namely the maximum (nominal) power of the power park module; f_n is the nominal frequency (50 Hz) in the network and Δf is the frequency deviation in the network. At underfrequencies below 49.8 Hz where Δf is below -200 mHz, the offshore power park module has to increase the active power according to the droop s_2.

Article 164. If the FSM mode is active, under the conditions offered by the primary source, the offshore power park module shall fulfill all requirements described below, in addition to the requirements provided in Article 163 according to figure 4:

(a) the module shall provide FSM, according to the parameters specified by the TSO, within the value ranges provided in table 2, thus:
  i. in case of overfrequency above the 50 Hz value, the active power frequency response is limited by the minimum regulating level;
  ii. in case of underfrequency compared to the 50 Hz value, the active power frequency response is limited by the maximum active power available given by the primary source.
  iii. the actual delivery of active power frequency response depends on the external and operating conditions of the offshore power park module when this response is triggered, particularly on the limitations given by the operation of the offshore power park module, under the conditions of the primary source at low frequencies.

(b) the module shall be able to modify the frequency deadband and the droop following the TSO's instruction. Usually, the s_1 droop value equals 5%, which corresponds to an active power mobilized of 8% P_{max};

(c) in the event of a frequency step change, the power park module shall be capable of activating full active power frequency response, at or above the line shown in figure 5, in accordance with the parameters specified in table 3, in the absence of technological limitations, namely for offshore power-generating modules with inertia, with a delay (t_1) of two seconds and an activation time of maximum 30 seconds (t_2), within the power limit offered by the primary source;

(d) for offshore power-generating modules without inertia, the initial activation of active power required shall not be unduly delayed. If the delay in initial activation of active power is greater than 500 ms for modules without inertia, or two seconds (for modules with inertia), the offshore power park module owner shall provide technical evidence demonstrating why a longer time is needed;

(e) the module shall be capable to provide active power corresponding to the frequency deviation for a duration of maximum 15-30 minutes specified by the TSO, within the limits of the power offered by the primary source;

(f) the active power control shall not have any adverse impact on the active power frequency response.

(g) if participating to the frequency restoration process at the setpoint and/or exchange powers to the scheduled values, the offshore power park module shall ensure specific functions for performing these services, established via procedures drafted by the TSO. These shall request at least covering the LFSM-O, the LFSM-U, the FSM and the active power control with a control accuracy of 1% and a rate of change of active power output of at least 10% P_{max}/min, as well as the connection to the frequency restoration controller.

Table 2. *Parameters for active power frequency response in FSM (see figure 5)*

Parameters		Ranges
Active power range related to maximum power $\frac{\lvert \Delta P_1 \rvert}{P_{\max}}$		(1.5÷10)%
Frequency response insensitivity	$\lvert \Delta f_i \rvert$	10 mHz
	$\frac{\lvert \Delta f_i \rvert}{f_n}$	(0.02 – 0.06)%
Frequency response deadband * After the qualification of groups for the provision of frequency containment reserves (FCR), this value is set at 0 mHz for FCR providing groups, and for other groups the TSO shall decide to set the value different to 0 mHz so that the impact on the frequency control is kept at a minimum		0 mHz
Droop s_1		(2÷12)%

Table 3. *Parameters for full activation of active power frequency response resulting from frequency step change (explanation for figure 5)**

Parameters	Ranges or values
Active power range related to maximum power (frequency response range) $\frac{\lvert \Delta P_1 \rvert}{P_{\max}}$	(1.5÷10)%
For offshore power park modules with inertia, the maximum admissible initial delay t_1, except when the TSO admits longer activation periods, based on technical evidence provided by the offshore power park module owner	2 seconds
For offshore power park modules without inertia, the maximum admissible initial delay t_1, except when the TSO admits longer activation periods, based on technical evidence provided by the offshore power park module owner	500 ms
For offshore power park modules, the maximum admissible choice of full activation time t_2, unless longer activation times are allowed by the TSO for reasons of system stability	30 seconds

*Parameters shall be complied with insofar as no technological limitations occur

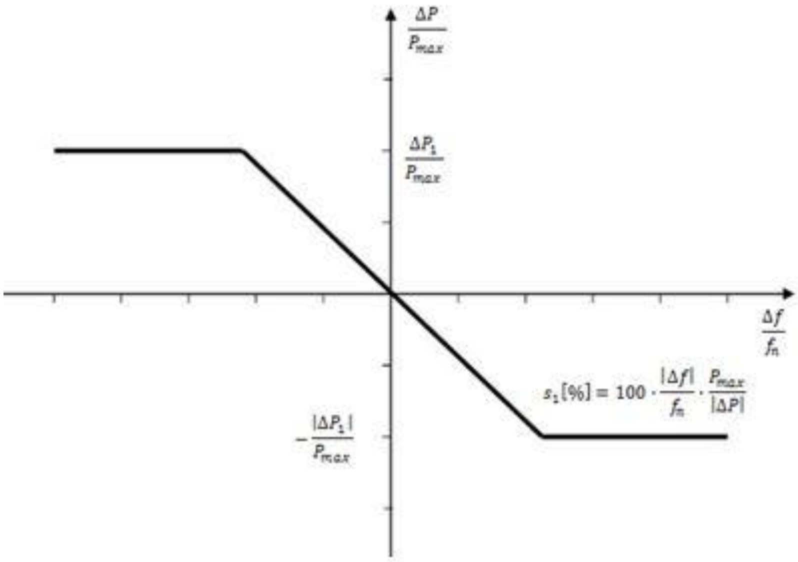


Figure 4 *Active power frequency response capability of offshore power park modules in FSM illustrating the case of zero deadband and insensitivity area.*

where: P_{max} is the active power setpoint based on which ΔP is established – namely the maximum power of the power park module; ΔP is the change in active power output from the offshore power park module; f_n is the nominal frequency (50 Hz) in the network and Δf is the frequency deviation in the network.

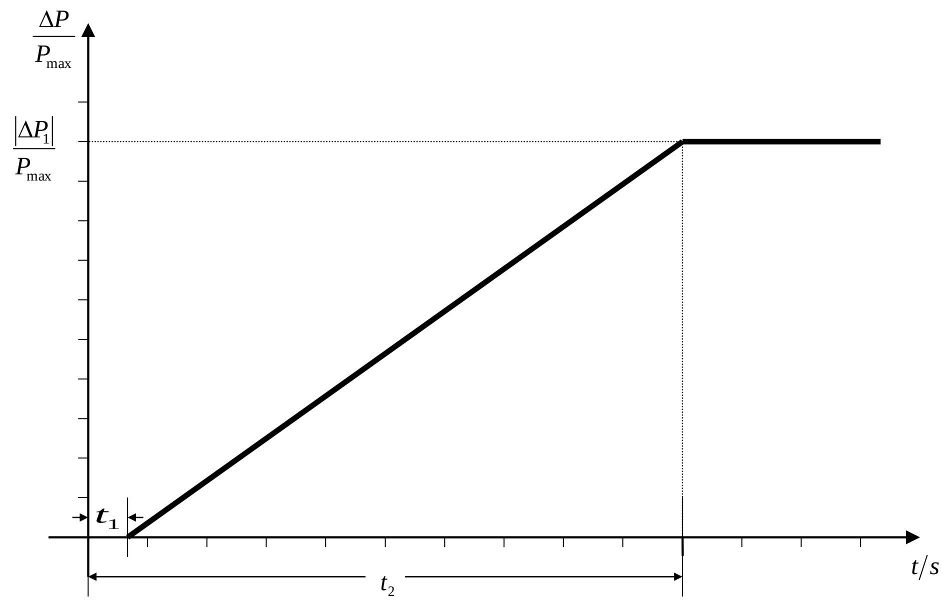


Figure 5 *Frequency response capability*

where: P_{max} is the active power setpoint based on which ΔP is established – namely the maximum power of the power park module; ΔP is the change in active power output from the offshore power park module. The offshore power park module shall activate an active power ΔP up to the point ΔP_1, according to the t_1 and t_2 times, while the ΔP_1, t_1 and t_2 values are specified by the TSO according to the provisions from table 3; t_1 is the initial delay (idle time); t_2 is the duration until the full activation of active power.

Article 165.

(1). Real-time monitoring of the active power frequency automated response of the offshore power park module shall be ensured by transmitting, in real-time and in a secured way, from an interface of the offshore power park module to the dispatching center of the RSO, upon request by the RSO, of at least the following signals:

i. the operation condition signal with/without active power frequency automated response;
ii. setpoint (scheduled) active power;
iii. actual value of the active power output;
iv. load-frequency response deadband;
v. parameter settings for active power frequency response – FSM (not provided in real-time, they are only monitored).

(2). i. the RSO shall specify additional signals to be provided by the offshore power park module via monitoring and recording devices in order to verify the performance of the active power frequency response provision.

ii. The additional signals are: frequency at the connection/interface point, as the case may be, state signals and commands regarding the breaker position and the separators position.

iii. The offshore power park module owner ensures the transmission of signals via one or two independent communication paths (as set forth in the TCA); usually, the main path is ensured via optical fiber equipment.

(3). Parameter settings for active power frequency response and the droop are established via operational controls.

Article 166. The TSO shall have the right to request the offshore power park module to provide synthetic inertia during very fast frequency deviations. The power park module should recommendably provide a minimum contribution with an inertia constant of 3 s (H= 3s).

Article 167. The operating principle of control systems installed to provide synthetic inertia and the associated performance parameters shall be specified by the TSO and shall be requested during the TCA issuance stage. Usually, a frequency response is requested with a (t_1) activation time lower than or equal to 500 ms.

Article 168. AC-connected offshore power park modules shall fulfil the following requirements in relation to **robustness,** in terms of:

(a) the fault-ride-through capability in case of symmetrical faults:

i. the offshore power park module must be capable to remain connected to the network, continuing its stable operation following a correctly secured fault in the network, according to the voltage-time dependency described in figure 6.1, with respect to the offshore connection/interface point, as the case may be, and described by the parameters in tables 4.1C and 4.1D;

ii. the voltage-against-time-profile represents a lower admissible limit of the actual course of the voltages at the offshore connection/interface point, as the case may be, during a symmetrical fault, as a function of time before, during and after the fault;

The lower limit shall be specified by the TSO, using the parameters set out in figure 6.1 and within the limits set out in table 4.1C for offshore power park modules connected at a voltage level lower than 110 kV, and in table 4.1D for type D offshore power park modules connected at or above the 110 kV level;

The lower limit shall also be specified by the RSO, using the parameters set out in figure 6.1 and within the limits set out in table 4.1;

iii. the TSO shall specify and make publicly available the pre-fault and post-fault operational conditions for the fault-ride-through capability in terms of:
   1. the pre-fault minimum short-circuit power calculation at the offshore connection/interface point, as the case may be;
   2. the pre-fault active and reactive power operating point of the offshore power park module at the offshore connection/interface point, as the case may be, and the voltage at the offshore connection/interface point, as the case may be; and
   3. the post-fault minimum short-circuit power calculation at the offshore connection/interface point, as the case may be.

iv. upon request by an offshore power park module owner, the RSO shall provide the pre-fault and post-fault conditions (as relevant values resulted from typical cases) to be considered for fault-ride-through capability as an outcome of the calculations at the offshore connection/demarcation point, as the case may be, regarding:
   - the pre-fault minimum short-circuit power at every offshore connection/interface point, expressed in MVA;
   - the pre-fault operating point of the offshore power park module, expressed in active power, reactive power and voltage at the offshore connection/interface point, as the case may be; and
   - the post-fault minimum short-circuit power at the offshore connection/interface point, as the case may be, expressed in MVA.

Figure 6.1. *Fault-ride-through profile of an offshore power park module*

Note: *The diagram in figure 6.1 represents the lower limit of a voltage-against-time profile of the voltage at the offshore connection point, expressed in relative units as the ratio of its actual value and its reference value before, during and after a fault. U_{ret} is the retained voltage during a fault at the offshore connection/interface point, as the case may be, and t_{clear} is the instant when the fault has been cleared. U_{rec1}, U_{rec2}, t_{rec1}, t_{rec2} and t_{rec3} represent certain points of lower limits of retained voltage after fault clearance. The parameters related to the fault-ride-through are provided in tables 4.1C and 4.1D.*

Table 4.1C. *Parameters related to the fault-ride-through capability of type C offshore power park modules connected at a voltage level lower than 110 kV*

Voltage parameters [r.u.]		**Time parameters [seconds]**	
U_{ret}:	0.15	t_{clear}:	0.25

U_{clear}:	0.15	t_{rec1}:	0.25
U_{rec1}:	0.15	t_{rec2}:	0.25
U_{rec2}:	0.85	t_{rec3}:	3

Table 4.1D. *Parameters related to the fault-ride-through capability of type D offshore power park modules connected at a voltage level higher than or equal to 110 kV*

Voltage parameters [r.u.]		Time parameters [seconds]	
U_{ret}:	0	t_{clear}:	0.25
U_{clear}:	0	t_{rec1}:	0.25
U_{rec1}:	0	t_{rec2}:	0.25
U_{rec2}:	0.85	t_{rec3}:	3

v. the offshore power park module shall remain connected to the network and shall continue to operate stably when the actual course of the phase-to-phase voltages on the network voltage level at the offshore connection/interface point, during a symmetrical fault, remains above the lower limit for the voltage profile described in the fault-ride-through-profile specified in letter (a) point (ii), except the triggering via the protections for internal electrical faults. The protection schemes and settings for internal electrical faults must not jeopardize fault-ride-through performance;

vi. considering the requirements provided in point (v), the offshore power park module owner establishes the undervoltage protection (either the fault-ride-through capability, or the minimum voltage defined at the offshore connection/interface point) according to the maximum voltage range corresponding to the offshore power park module, except if the RSO requires a narrower voltage range. The settings shall be justified by the offshore power park module owner in accordance with the provisions set forth in point (vi);

(b) the TSO shall specify the post-fault active power recovery that the offshore power park module shall be capable of providing and shall specify:

i. when the post-fault active power recovery begins, immediately after the moment when the voltage is higher than or equal to 85% U_{ret};

ii. the maximum period allowed for post-fault active power recovery is equal to maximum 50 ms; after the fault is cleared and the voltage recovers to a value greater than 0.85 U_{ret}, active power shall be restored, depending on the technology and the availability of the primary source, within a time interval of (1÷10) seconds for a value of (80÷90)% from the pre-fault power value; and

iii. the magnitude and accuracy of active power recovery depending on the technology used by the offshore power park modules and on the availability of the primary source equals to (80÷90)% of the pre-fault power value with a precision of 10% from the pre-fault active power value;

(c) The RSO shall specify in the TCA or at the time of commissioning, as the case may be:

i. the interdependency between fast fault current requirements according to the provisions of Article 170 (a) and (b) and active power recovery (including the specification of the current injection factor – K, usually equal to 10);

ii. the dependence between active power recovery times and duration of voltage deviations. The RSO shall specify, at the moment of commissioning, the maximum active power recovery time for the maximum duration of the fault, usually equal to (1÷10) s for faults secured within a time period greater than 140 ms;

iii. the limit of the maximum allowed time for active power recovery, usually less than 10 seconds. A smaller value shall be requested if the solution studies require it. The possible values are within the (0.5÷1) s range;
iv. the adequacy between the level of voltage recovery and the minimum magnitude for active power recovery. Usually, for a voltage recovery value higher than 85% U_{ret}, the minimum value of post-fault recovered active power shall reach at least 85% of the pre-fault value within a time period of maximum 1 second, according to the availability of the primary source; and
v. the requirements regarding active power oscillations damping between the power plant and the connection point of the cable connecting the offshore connection point and the onshore network, if dynamic studies show that equipment is necessary in order to secure the damping of these active power oscillations.

(d) maintaining stable operation of the offshore power park module at every point within the P-Q-capability diagram in the event of power oscillations between the power plant and the connection point to the onshore network;
(e) offshore power park modules shall be capable of remaining connected to the network without reducing power (within the limits given by the primary source), so long the frequency and voltage at the offshore connection point fall within the limits provided in table 1, namely ±10% U_n;
(f) offshore power park modules shall be capable of remaining connected to the network during single-phase or three-phase AR on loop AC-network lines to which they are connected. The specific technical details shall be subject to coordination and instructions on protection schemes and settings agreed upon with the RSO.

Article 169.

(1). Offshore power park modules shall fulfil the following requirements in relation to the contribution to **system restoration**:
(a) they shall be capable to reconnect to the network following an accidental disconnection caused by an event in the network, under the conditions defined by the TSO. Usually, the time to reconnect to the network following an accidental disconnection equals to maximum 10 minutes;
(b) installation of automatic reconnection systems shall be subject to prior authorization both by the RSO, and the TSO, in order to specify the automatic reconnection requirements. These conditions shall be specified in the TCA and shall be detailed in the technical project. Automatic reconnection shall be carried out in the (47.5÷51) Hz frequency range, the (0.9÷1.1) U_n voltage range and within the (0÷300) s observation/validation time (including synchronization time), and the slope admitted for the active power increase after connection is usually (10÷20)% of the P_{max}/min.

(2). The requirements for the automatic reconnection provided in paragraph (1) shall be notified to the offshore power park module owner during the grid connection process (when issuing the TCA/CnC).

Article 170.

(1). Offshore power park modules shall fulfil the following requirements in relation to:
(a) the black start capability or the participation to the black start process:
i. the black start capability or the capability to participate to the black start process is not mandatory, but may be requested by the TSO in the TCA in order to ensure the system's operational security;

ii. the offshore power park module owners shall, upon request by the TSO, provide a quotation for providing black start capability. The TSO may request the provision of black start capability if it considers system security to be at risk due to a lack of black start capability in its control area where the power park is located;

iii. an offshore power park module with black start capability shall be capable of starting or participating to the start-up process, in full or via several pieces of equipment, from the shutdown state, without any external electrical energy supply within a time frame specified by the TSO, usually (15÷30) minutes from the instant the instruction is received;

iv. an offshore power park module with black start capability shall be capable to synchronize within the (47.5÷51.5) Hz frequency range and within the (0.85÷1.1) U_n voltage range specified by the RSO, within a time period of maximum 10 minutes, for nominal voltages lower than 110 kV, and according to the provisions of Article 173 for voltages higher than or equal to 110 kV;

v. an offshore power park module with black start capability or participating to the restoration process, shall be capable to automatically control voltage, including voltage variations which may occur during the restoration process;

vi. an offshore power park module with black start capability or participating to the restoration process, shall:

1. be capable of regulating power output for load connections at the offshore connection/interface point, as the case may be;
2. be capable of participating to frequency variations, both for an increase over 50.2 Hz (in the LFSM-O mode) and for a decrease below 49.8 Hz (in the LFSM-U mode);
3. participate to frequency containment in case of overfrequency or underfrequency within the whole active power output range between minimum active power and maximum active power, as well as at houseload operation level;
4. be capable of parallel operation with other offshore power park modules within one island;
5. control voltage automatically during system restoration within the ±10% U_n voltage range.

(b) with regard to the capability to take part in island operation:

i. offshore power park modules contributing to system restoration shall be capable of operating in island operation or taking part in island operation if required by the RSO in coordination with the TSO. The request shall be made when issuing the TCA and:

1. the frequency range in island operation is (47.5÷51.5) Hz;
2. the voltage range in island operation is:
$U_n \pm$ 4%for voltages <110 kV; U_n ±10% (for voltages of 110 kV and 220 kV; U_n ±5% (for voltages of 400 kV)

ii. offshore power park modules shall be able to operate with active frequency control in FSM mode during island operation. In the event of a power surplus, offshore power park modules shall be capable of reducing the active power output from a previous operating point to any new operating point within the P-Q-capability diagram, depending on the availability of the primary source;

iii. the method for detecting a change from interconnected system operation to island operation shall be commonly agreed between the offshore power park module owner and the RSO, in coordination with the TSO. The agreed method of detection must not rely solely on the TSO's switchgear position signals;

iv. offshore power park modules shall be capable of operating in LFSM-O and LFSM-U during island operation, as commonly agreed with the TSO.

(c) with respect to the quick re-synchronization capability in the event of disconnection from the network, the offshore power park module shall be able to quickly re-synchronize, usually within 15 minutes, according to the protection plan agreed upon with the RSO, within the limits of the technical possibilities of offshore power-generating modules.

Article 171. Offshore power park modules shall fulfil the following **general requirements in relation to system operation**:

(a) the start-up of an offshore power park module and the synchronization are performed by the power park owner after the RSO's approval only;

(b) the power park module shall be equipped with the necessary synchronization facilities;

(c) synchronization shall be performed at frequencies within the ranges set out in table 1 and at voltages within the ranges set out in tables 6.1 and 6.2;

(d) the RSO and the offshore power park module owner shall agree upon and specify, prior to commissioning, the settings of synchronization devices in order to allow the synchronization of the offshore power park module, as follows:

i) voltage range, ±10% U_n;
ii) frequency range, (47.5-51.5) Hz;
iii) phase angle range, smaller than 10º;
iv) phase sequence;
v) deviation of voltage smaller than 10% U_n and deviation of frequency smaller than 50 mHz.

(e) the following requirements with regard to **control and automation schemes** and their related settings shall be complied with:

i. the control and automation schemes, as well as the related settings, including the control parameters of active and reactive power control loops, namely the voltages of power-generating modules in the power park and the modules in the offshore power park module, necessary for the network stability calculations and emergency measures analysis, shall be submitted by the offshore power park module owner to the RSO or the TSO respectively, no later than 6 months prior to the application of voltage for the beginning of the testing period, in order for them to be coordinated and agreed upon between the TSO, RSO and the offshore power park module owner;

ii. any changes to the control and automation schemes and related settings, as mentioned in point (i), of the different control devices of the offshore power park module shall be coordinated and agreed upon between the TSO, the RSO and the offshore power park module owner, in particular if they apply in the situations described in point (i).

(f) the following requirements with regard to **electrical protection schemes and settings** shall be complied with:

i. the protection systems needed for the offshore power park module and the network, as well as the settings relevant to the offshore power park module shall be coordinated and agreed upon between the RSO and the offshore power park module owner, during the connection process. The TSO coordinates with the DSO and the power park module owner in order to coordinate protections, taking into account the frequency variation value resulted from periodical studies on the inertia of the Continental Europe synchronous system to which it belongs. The protection systems and related settings for internal electrical faults must not jeopardize the performance of the offshore power park module. The protection and automation systems shall fulfill at least the following requirements:

1. the electrical protection system shall ensure protection against internal faults of the power-generating modules in the power park module, as well as backup protection against abnormal operation states and faults from the network to which they are connected;
2. the electrical protection system shall be efficient, highly reliable and organized in groups with redundant functionality (if the choice for two protection groups has been made); the protections shall be selective, sensible, capable to detect internal and external faults, physically and galvanically separated from the power supplies with operative voltage, from voltage and current metering transformers to command execution devices. The electrical protection system shall be equipped with extended self-testing and self-diagnosis functions, as well as with events recording and oscillography functions. The electrical protections system shall be equipped with standard communication interfaces aiming for the integration to a local data acquisition, supervision and control system;
3. where necessary, the electrical protections system may be organized in two groups of independent and redundant protections (usually when the offshore connection point has a voltage of ≥110 kV), both for the offshore power park module as well as for the connection, as the case may be.

ii. the electrical protection of the offshore power park module shall take precedence over operational controls, taking into account the operational security of the system, the health and safety of staff and of the public, as well as mitigating any damage to the offshore power park module.

iii. Together with the offshore power park module owner, the RSO shall coordinate and commonly agree that the protection systems must cover at least the following faults:

A. protections of offshore power park modules, of the step-up transformer and of the houseload or ancillary services transformer, covered by the offshore power park owner, for:

1. internal faults of offshore power-generating modules in the power park module, of the step-up transformer and potentially of the houseload transformer (short-circuits or groundings);
2. internal faults of the step-up transformer of the offshore power-generating module in the power park module;
3. short-circuits or groundings on the network evacuation cable of the power output;
4. short-circuits or groundings in the network, as backup protection;
5. maximum and minimum voltage at the offshore power park module terminals.

B. protections covered by the offshore power park module owner and/or the RSO, as the case may be, for:

1. short-circuits or groundings on the network evacuation cable of the power output;
2. maximum and minimum voltage at the offshore connection/interface point, as the case may be;
3. maximum and minimum frequency at the offshore connection/interface point, as the case may be;
4. short-circuits or groundings in the network, as backup protection;

iv. changes to the protection schemes, needed for the offshore power park module and the network and to the settings relevant to the generation plant shall be agreed upon in advance between the RSO and the offshore power park module owner;

(g) the protection and control devices shall be organized by the offshore power park module owner, according to the following prioritization:

i. the cable network's and offshore power park module's protection;

ii. synthetic inertia, if applicable;

iii. frequency control (active power adjustment);

iv. power restrictions;

v. limiting the ramping rate of power variations.

(h) with regard to **information exchange**:

i. protection/control and automation systems of the offshore power park module shall be capable of exchanging information with the RSO in real-time or periodically with time stamping.

ii. The RSO, in coordination with the TSO, sets the content of the exchanges of information provided by the offshore power park module owner, which shall comprise at least the following data transmitted in real-time: active power, scheduled active power, as the case may be, reactive power, voltage and frequency at the offshore AC-connection point, state signals and commands regarding the breaker position and the separators position and the operation condition signal with/without active power frequency automated response. The offshore power park module owner ensures the transmission of signals via one or two independent communication paths (set in the TCA); usually, the main path is ensured via optical fiber equipment.

(i) offshore power park modules shall be capable to automatically disconnect from the network when losing robustness. The disconnection criteria regarding the protection against current asymmetry, phase interruption and critical disconnection time, shall be agreed upon between the offshore power park module owner, the RSO and the TSO.

(j) regarding **instrumentation**:

i. offshore power park modules shall be equipped with devices to provide fault recording and monitoring of dynamic system behavior; these devices are usually oscilloperturbographs or equipment that can replace functions covered by oscilloperturbographs. These devices shall record the following parameters:

1. voltages in all three phases;
2. current in each phase;
3. active power in all three phases;
4. reactive power in all three phases;
5. frequency.

The RSO shall have the right to specify quality of supply parameters to be complied with, provided via the aforementioned devices, on condition that they are previously agreed upon with the offshore power park module owner.

ii. the settings of the fault recording equipment, including triggering criteria and the sampling rates shall be commonly agreed between the offshore power park module owner and the RSO at the time of PIF and shall be documented via written arrangements. These shall also include a criterion for detecting oscillations between the power park and the onshore connection point of the evacuation cable, set by the TSO;

iii. The RSO, TSO and the offshore power park module owner shall commonly agree upon the need to include a criterion for detecting oscillations between the power park and the connection point of the electricity output evacuation cable, in order to monitor the dynamic system behavior and to detect poorly damped power oscillations (undamped);

iv. the dynamic system behavior monitoring system shall include arrangements for the offshore power park module owner and the RSO to access the information. The communications protocols for registered data shall be commonly agreed between the offshore power park module owner, the RSO and the TSO, prior to choosing the monitoring equipment.

(k) offshore power park module operation simulation models:

i. upon request of the RSO or the TSO, the offshore power park module owner shall provide the offshore power park module operation simulation models that reflect the offshore power park module behavior both in steady-state regime, as well as in dynamic regime (including for transient electromagnetic phenomena, if requested). The models provided shall be validated via the results of compliance tests for verifying compliance with technical connection requirements. The offshore power park module owner submits to the RSO or the TSO the results of these tests, proven by means of check-up certificates recognized on European level, carried out by an authorized certifier;

ii. the models provided by the offshore power park module owner shall contain the following sub-models, depending on the existence of individual components:

1. the offshore power-generating module in the power park module;
2. frequency and active power control;
3. voltage control;
4. offshore power park module protections models, as agreed by the RSO and the offshore power park module owner;

iii. upon request by the RSO, the TSO shall specify:

1. the format in which simulation models are to be provided, including the utilized calculation program;
2. the documentation on a mathematical model's structure and block diagrams;
3. the estimate of the minimum and maximum short-circuit power at the offshore connection point, expressed in MVA, as an equivalent of the network.

iv. the offshore power park module owner provides the RSO, upon request, with recordings of the offshore power park module's performance. The RSO or the TSO may make such a request, in order to compare the response of the models and model simulations performed with actual operational recordings.

(l) regarding the installation of devices for system operation and devices for system operational security, if the RSO or the TSO considers that it is necessary to install additional devices in an offshore power park module in order to preserve or restore system operation or system operational security. The RSO and the offshore power park module owner, together with the TSO, shall analyze and agree upon the adequate solution;

(m) the RSO shall specify, in coordination with the TSO, the minimum and maximum limits on rates of change of active power output from the offshore power park module (ramping limits) in both an up and down direction of change, taking into consideration the specific characteristics of prime mover technology. Usually, this rate of change falls within the (10÷30)% P_{max}/min range and is equal in both directions (up and down direction);

(n) earthing arrangement of the neutral-point at the network side of step-up transformers shall comply with the specifications of the RSO.

Article 172. AC-connected offshore power park modules shall fulfil the following **requirements in relation to voltage stability**:

(a) they shall be capable of providing fast fault current at the AC-offshore connection/interface point, as the case may be, in case of symmetrical (three-phase) faults, under the following conditions:

i. the offshore power park module shall be capable of activating the supply of fast fault current either by:

1. ensuring the supply of the fast fault current at the offshore connection/interface point, as the case may be, corresponding to the voltage variation with a proportionality factor (k) between 2 and 10 according to the formula: $\Delta I = k * \Delta U$; or

2. measuring voltage variations at the terminals of offshore power park modules and providing a fast fault current at the terminals of these modules (reactive current component).

ii. The RSO, in coordination with the TSO, shall specify:

1. how and when a voltage deviation is to be determined as well as the duration of the voltage deviation. The voltage deviation shall be determined when the metered voltage, either at the offshore connection point, or at the terminals of the power-generating module is lower than 0.85 U_{ref} (0.85 r.u.). The duration of the deviation is considered up to the point when the voltage recovers to a value greater than 0.85 U_{ref} (0.85 r.u.);

2. the characteristics of the fast fault current, including the time domain for measuring the voltage deviation and fast fault current, for which current and voltage may be measured differently from the method specified in Article 172 (a) (i);

3. the timing and accuracy of the fast fault current, which may include several stages during a fault and after its clearance. Thus, the power-generating module shall inject, immediately after the fault (when low voltage is detected, according to the provisions set forth in the point above) in a time period no longer than 50 ms, a reactive current depending on the magnitude of the low voltage (retained voltage) with a (2÷10) proportionality factor. The injected reactive current shall be maintained all throughout the low voltage duration according to the voltage profile defined by the fault-ride-through in figure 6.1 and shall be cancelled immediately after fault clearance (according to IGD Fault current contribution from PPMS & HVDC).

(b) with regard to the supply of fast fault current in case of asymmetrical (one-phase or two-phase) faults, the RSO, in coordination with the TSO, shall have the right to specify the requirements for asymmetrical current injection. Usually, the requirements regarding the asymmetrical current injection are similar to the requirements regarding the symmetrical current injection described above (figure 6.1). These requirements shall be notified to the owner.

(c) they shall be capable of providing additional reactive power, specified by the RSO, which shall be provided at the offshore connection/interface point, as the case may be, of the offshore power park module, if it is not located neither at the high-voltage terminals of the step-up transformer, nor at the terminals of the offshore power-generating modules in the power park, if there is no step-up transformer. The additional reactive power shall compensate the reactive power exchange of the high-voltage cables between the terminals of the generating units and the offshore connection point. The additional reactive power shall be covered via dedicated equipment provided by the offshore power park module owner. This additional reactive power is specified via a reactive power offset study at the offshore connection point;

(d) they shall be capable to generate reactive power at full capacity, whilst complying with the following requirements:

i. the offshore power park module owner shall provide an envelope of the U-Q/P_{max}-profile, which may take any shape within the limits of which the offshore power park module is capable to provide/absorb reactive power at voltage variations and full capacity operation; the envelope shall be analyzed and approved by the TSO in coordination with the RSO;

ii. the U-Q/P_{max}-profile shall be specified by the RSO in coordination with the TSO in line with the following principles:

1. the U-Q/P_{max}-envelope shall not exceed the U-Q/P_{max}-profile represented by the inner envelope in figure 7;
2. the dimensions of the U-Q/P_{max}-profile envelope (Q/P_{max} range and voltage range) shall be within the maximum values specified in table 5;
3. the position of the U-Q/P_{max}-profile envelope shall be within the limits of the fixed outer envelope in figure 7; and
4. the U-Q/P_{max}-profile specified for offshore power park modules may take any shape, having regard to the potential costs of delivering the capability to provide reactive power production at low voltages and reactive power consumption at high voltages.

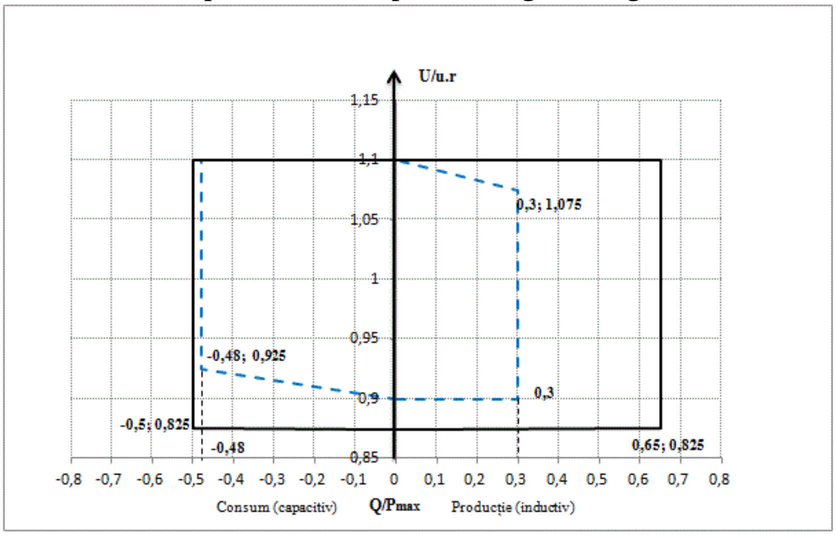


Figure 7. *U-Q/P_{max}-profile of an offshore power park module*

Figure 7 represents the typical boundaries of a U-Q/P_{max}-profile by the voltage (in relative units) at the offshore connection point, expressed by the ratio of its actual value and the reference value (110 kV, 220 kV and 400 kV), against the ratio of the reactive power (Q) and the maximum active power (P_{max}). The position, size and shape of the envelope are indicative and the TSO may also request, depending on system conditions at the connection/demarcation point, as the case may be, other shapes of the U-Q/P_{max}-profile within the maximum Q/P_{max} range of 0.75.

Maximum Q/P_{max} range	**Maximum range of steady-state voltage level, expressed in relative units (r.u.)**
0.75	0.200

Table 5: *Parameters for the inner envelope in figure 7*

iii. the reactive power provision capability requirement applies at the offshore AC-connection/interface point, as the case may be. For envelope shapes other than rectangular, the voltage range represents the highest and lowest values. The full reactive power range is therefore not expected to be available across the range of steady-state voltages.

(e) with regard to reactive power capability below maximum power (below P_{max}):

i. The RSO, in coordination with the TSO, shall specify the requirements regarding reactive power provision capability, as well as a P-Q/P_{max}-envelope of any shape within the limits of which the offshore power park module shall provide reactive power under its maximum power given by the P-Q-profile;

ii. the limits of the P-Q/P_{max}-capability diagram shall be specified by the RSO in coordination with the TSO in line with the following principles:

1. the P-Q/P_{max}-envelope shall not exceed the P-Q/P_{max}-profile envelope, represented by the inner envelope in figure 8;
2. the Q/P_{max}-range on the P-Q/P_{max}-profile envelope is specified in table 5;
3. the active power range of the P-Q/P_{max}-profile envelope at zero reactive power shall be 1 r.u. P_{max};
4. the P-Q/P_{max}-profile envelope can be of any shape and shall include conditions for reactive power capability at zero active power; and
5. the position of the P-Q/P_{max}-profile envelope shall be within the limits of the fixed outer envelope set out in figure 8;

iii. when operating at an active power output below maximum power ($P < P_{max}$), the offshore power park module shall be capable of providing reactive power at any operating point inside its P-Q/P_{max}-capability diagram, if all units of that offshore power park module which generate power are technically available, that is to say they are not out of service due to maintenance or failure, otherwise there may be less reactive power capability, taking into consideration the technical availabilities.

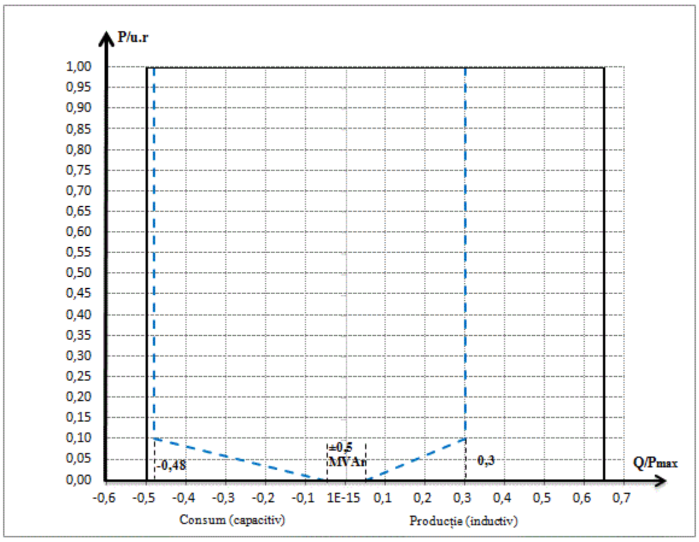


Figure 8. *P-Q/P_{max}-profile of an offshore power park module*

Figure 8 represents the typical boundaries of a P-Q/P_{max}-profile by the active power at the connection point, expressed in relative units by the ratio of its actual value and the maximum active power considered, against the ratio of the reactive power (Q) and the maximum power (P_{max}). The position, size and shape of the inner envelope are indicative and the TSO may also request, depending on system *conditions at the connection/demarcation point, as the case may be, other shapes of the U-Q/P_{max}-profile within the maximum Q/P_{max} range of 0.75.*

iv. the offshore power park module shall be capable of moving to any operating point within its P-Q/P_{max} profile in appropriate timescales to target values requested by the RSO.

(f) with regard to reactive power control modes:

i. the offshore power park module shall be capable of providing reactive power automatically by either voltage control mode, reactive power control mode or power factor control mode;

ii. for the purposes of voltage control mode, the offshore power park module shall be capable of contributing to voltage control at the onshore connection point, by providing the necessary reactive power exchange with the network with a setpoint voltage covering at least the (0.95÷1.05) range, in steps no greater than 0.01 r.u., with a slope having a range of at least (2÷7)% in steps no greater than 0.5%. The reactive power output shall be zero when the grid voltage value at the offshore connection point equals the voltage setpoint;

iii. the setpoint may be operated with or without a deadband selectable in a range from 0 to ±5% U_{ref}, where $U_{ref} = U_n$, in steps no greater than 0.5% U_{ref};

iv. following a voltage step change, an offshore power park module shall be capable to reach 90% of the step value in the t_1 instant, specified by the RSO within the (1÷5)-second range, usually of 1 second, and shall stabilize at the value requested within a t_2 time period, specified by the RSO within the (5÷60)-second range, usually of 10 seconds. The voltage change performed by the offshore power park module shall follow a variation slope given by the t_1 and t_2 instants, and the requested value shall be performed with a steady-state reactive power tolerance no greater than 5% of the maximum reactive power. The RSO shall specify the time specifications for t_1 and t_2;

v. for the purpose of reactive power control mode, the offshore power park module shall be capable of setting the reactive power setpoint anywhere in the reactive power range, specified in Article 172 (c) and (d), with setting steps no greater than 5 MVAr or 5% (whichever is smaller) of full reactive power, controlling the reactive power at the offshore connection point, to an accuracy within plus or minus 5 MVAr or plus or minus 5% (whichever is smaller) of the full reactive power;

vi. with respect to power factor control mode, the offshore power park module shall be capable of controlling the power factor at the offshore connection point, within the P-Q/P_{max}-profile envelope required for reactive power range, specified by the RSO according to Article 172 (c) and (d), with a target power factor in steps no greater than 0.01. The RSO shall specify the target power factor value, its tolerance and the period of time to achieve the target power factor following a sudden change of active power output. The tolerance of the target power factor shall be expressed through the reactive power tolerance corresponding to the active power output, but shall not exceed 1% of the maximum reactive power of the offshore power park module;

vii. the RSO, in coordination with the TSO and with the offshore power park module owner, shall specify which of the three reactive power control mode options (voltage control, reactive power control or power factor control) and associated setpoints is to apply, and what further equipment is needed to make the adjustment of the relevant setpoint operable remotely;

(g) with regard to prioritizing active or reactive power contribution, the TSO shall specify whether active power contribution or reactive power contribution has priority during faults for which fault-ride-through capability is required. If priority is given to active power contribution, its provision has to be established no later than 150 ms from the fault inception;

(h) with regard to power oscillations damping control, if specified by the TSO when issuing the TCA, the offshore power park module shall be capable of contributing to the power oscillations damping between the power park and the offshore connection point. The voltage and reactive power control system characteristics of offshore power park modules must not adversely affect the damping of power oscillations.

Article 173. Notwithstanding the provisions of Article 168 (a), an AC-connected offshore power park module shall be capable to remain connected to the network and to operate within the network voltage range at the offshore connection point related to the reference 1 r.u. voltage, and for the time periods specified tables **6.1** and **6.2.**

Table 6.1. Minimum time for operation of an offshore power park module connected at the 110 kV and 220 kV voltage level respectively

Voltage range	**Time period for operation**
0.85 r.u. – 0.90 r.u.	60 minutes
0.90 r.u. – 1.118 r.u.	Unlimited
1.118 r.u. – 1.15 r.u.	20 minutes

Note: *Table* ***6.1*** *shows the minimum time periods during which an AC-connected offshore power park module must be capable of operating without disconnection, for voltages deviating from the reference 1 r.u. value at the offshore connection point, in the case where the setpoint equals to 110 kV and 220 kV. Usually, the unlimited maximum value for operation for a nominal voltage of 110 kV equals to 123 kV and for a nominal voltage of 220 kV it equals 245 kV, as absolute values. For network areas where time periods for operation longer than 20 minutes are agreed, for voltage values in the 1.118 r.u. – 1.15 r.u. range, the maximum duration cannot exceed 60 minutes. The values are specified based on operational agreements between users and the RSO.*

Table 6.2. Minimum time for operation of an offshore power park module connected at the 400 kV voltage level

Voltage range	**Time period for operation**
0.85 r.u. – 0.90 r.u.	60 minutes
0.90 r.u. – 1.05 r.u.	Unlimited
1.05 r.u. – 1.10 r.u.	20 minutes

Note: *Table* ***6.2*** *shows the minimum time periods during which an AC-connected offshore power park module must be capable of operating without disconnection, for voltages* *deviating from the reference 1 r.u. value at the offshore connection point, in the case where the setpoint equals to 400 kV. For network areas where time periods for operation longer than 20 minutes are agreed, for voltage values in the 1.05 r.u. – 1.1 r.u. range, the maximum duration cannot exceed 60 minutes. The values are specified based on operational agreements between users and the RSO.*

Article 174. The grid operator may request, within the TCA, the additional installation in the offshore power park module of automation systems aiming to quickly reduce power, namely until shutdown, in justified cases, in order to protect facilities, persons and the environment.

Article 175. The offshore power park module owner has the obligation to ensure protection of facilities and components of the offshore power park module and of auxiliary installations against faults generated from its own facilities or from the network impact over them when the offshore power park module activation protections are operated properly or upon network incidents (short-circuits with or without grounding, network protections tripping, transient over-voltages etc.), as well as upon exceptional/abnormal technical operational conditions.

Article 176. The offshore power park module owner shall provide the grid operator with the protections type, the connection method to the voltage circuits, electric current circuits and trip circuits, the actuation matrix for protection functions specified in the project, at the interface between the offshore power park module and the offshore connection point belonging to the NPS.

Article 177. Under normal network operation, the offshore power park module shall not produce fast voltage fluctuations at the offshore connection point, as the case may be, greater than ±5% of the nominal voltage of the network to which it is connected.

Article 178. Irrespective of the number of generation plants and the number of operational auxiliary installations and regardless of the power output, the offshore power park module shall ensure, at the offshore connection point, the requirements of applicable technical norms regarding electricity quality.

Article 179. The RSO may require, as the case may be, a permanent monitoring of electricity quality at the offshore connection point of the offshore power park module and the integration of the permanent monitoring equipment in its own electricity quality monitoring system.

Article 180. The RSO shall take all necessary measures so that the conditions specified in this technical norm are complied with, without jeopardizing the system's operational security.

Article 181.

(1). The offshore power park module owner shall ensure continuity in the submission of status and operation values to the RSO and the TSO.

(2). The offshore power park module shall be integrated in the DMS-SCADA/EMS-SCADA systems of the RSO, ensuring at least the following signal exchange: active power, reactive power, voltage and frequency at the offshore connection point, set values for active power and reactive power, state signals and commands regarding the breaker position and the separators position.

(3). The offshore power park module owner ensures the transmission of signals via two independent communication paths, of which at least one shall be ensured via optical fiber equipment (set in the TCA).

Article 182. The offshore power park module owner shall ensure power supply to the monitoring, control and data transmission facilities provided in Article 181, so that they are available for at least three hours after the loss of power supply.

Article 183.

(1). The offshore power-generating module owner shall ensure communication paths with reservation from the monitoring facilities or control facilities of the offshore power park module to the interface with the RSO located in a location accepted by it, under quality parameters required by the RSO and according to the provisions of Article 181.

(2). Maintaining the communication path between the offshore power park module and the RSO's interface falls under the responsibility of the offshore power park module owner.

Article 184.

(1). The integration in the EMS-SCADA/DMS-SCADA systems, as the case may be, as well as in the electricity monitoring system, falls under the responsibility of the offshore power park module owner.

(2). The control and data acquisition facilities, as interface systems between the offshore power park module and the power transmission/distribution grid, are specified in the TCA.

Article 185. The offshore power park module owner has the obligation to ensure compatibility of data exchange equipment at the RSO's DMS-SCADA/EMS-SCADA systems interface level, according to the features requested by it.

Article 186. The offshore power park module owner has the obligation to allow access to the RSO and the TSO to the outputs of its own metering systems for voltage, current, frequency, active and reactive power and to information regarding switching equipment indicating the status of facilities and alarm signals, in order to transfer this information to the interface with the control and data acquisition system – DMS-SCADA or EMS-SCADA respectively, as well as with the remote metering system.

CHAPTER V

TRANSITIONAL AND FINAL PROVISIONS

Article 187. This technical norm may be revised following the completion of the European harmonization of general requirements set forth in the Regulation or due to the entry into force of other pan-European codes.

Article 188. Type A power park modules shall fulfill, at the connection/interface point, as the case may be, the technical connection conditions specified in Articles 6 – 16 relating to type A power-generating modules.

Article 189. Annexes no. 1 – 8 form an integral part of this technical norm.

ANNEX 1 to the technical norm

Technical data for type A power-generating modules

1. The power-generating module owner shall provide the RSO with technical data specified in table 1A, in accordance with the provisions of this technical norm.
2. Within the notification procedure for the connection of power-generating modules and verifying their compliance with the technical requirements regarding the connection to public electricity grids, the RSO may request additional data for each stage of the notification and compliance verification process.
3. Standard planning data (S), shared via the connection request and used in the solution studies (forms), represent the entirety of the general technical data that characterize the type A power-generating module.
4. Detailed planning data (D) are technical data which allow special steady-state and transient stability analyses, dimensioning of automation facilities and protections control, as well as other data necessary for operational scheduling; detailed planning data (D) are shared with the RSO at least 1 month prior to PIF.
5. The data, validated and completed by the date of PIF, shall be confirmed during the verification process of compliance with technical requirements regarding the connection to public electricity grids (R).

Table 1A. Data for type A power-generating modules

Description of data	Measuring unit	Data category
Connection/interface point, as the case may be	Text, diagram	S, D, R
Nominal voltage at the connection/interface point, as the case may be	kV	S, D, R
Apparent nominal power	MVA	S, D, R
Net power	MW	S, D, R
Nominal active power output at the terminals	MW	S, D, R
Maximum active power output at the terminals	MW	S, D, R

Description of data	Measuring unit	Data category
Nominal voltage	kV	S, D, R
Maximum/minimum operational frequency under nominal parameters	Hz	S, D, R
Maximum reactive power at the terminals	MVAr	S, D, R
Minimum reactive power at the terminals	MVAr	S, D, R
P-Q-capability diagram*	Graphical data	D, R
Variation diagram of technical data depending on the deviations from standard environmental conditions*		R
LVRT fault-ride-through capability*	Diagram	S, D, R
Contained internal protection functions	Text	D
Data for wind power-generating modules (as the case may be)		
Wind unit type (with horizontal/vertical axis)	Description	S, R
Rotor diameter	m	S, R
Rotor axis height	m	S, R
Blades control system (pitch/stall)	Text	S, R
Speed control system (fixed/with two gears/variable)	Text	S, R
Type of alternator	Description	S, R
Type certificates accompanied by test results carried out by laboratory recognized on European level for frequency variations, voltage variations and fault-ride-through	certificates	D
Frequency converter type and nominal parameters	kW	S, R
Rate of change of active power output	MW/min	S, R
Nominal current	A	S, R
Nominal voltage	V	S, R
Start-up wind speed	m/s	S, R
Wind speed (corresponding to the nominal power)	m/s	S, R
Disconnection wind speed	m/s	S, R
Change in power output depending on wind speed	Table	S, R
Electricity quality parameters		

Description of data	Measuring unit	Data category
Flicker coefficient for continuous operation		S
Flicker step factor for switch operations		S
Voltage variation factor		S
Maximum number of switch operations in a 10-minute time period		S
Maximum number of switch operations in a 2-hour time period		S
Data for photovoltaic power-generating modules		
Number of photovoltaic panels	Number	S
Type of photovoltaic panels	Description	D
Nominal power of the photovoltaic panel (DC)	kW	S
Maximum power of the photovoltaic panel (DC)	kW	S
Data for inverters used		
Number of inverters	Number	S
Inverter type	Description	S
Type certificates for inverters accompanied by test results carried out by laboratory recognized on European level for frequency variations, voltage variations and fault-ride-through	certificates	D
Nominal input power (DC)	kW	S
Recommended maximum input power (DC)	kW	S
Input voltage range (DC)	V	S
Maximum input voltage (DC)	V	S
Maximum input current (DC)	A	S
Nominal output active power (AC)	kW	S
Maximum output active power (AC)	kW	S
Nominal output reactive power (AC)	kVAr	S
Nominal output voltage (AC)	V, kV	S
Nominal output current (AC)	A	S
Frequency range	Hz	S

Description of data	Measuring unit	Data category
Power factor control range		D
Maximum own consumption (AC)	W	D
Night-time consumption (AC)	W	D
Electricity quality parameters		
Maximum number of power variations ($\Delta S/S_{sc}$) per minute		S
Maximum value for quick voltage variations	V, kV	S
Total electric current distortion factor		S
Electric current harmonics (up to the 50^{th} order harmonics)		S
Total voltage distortion factor		S
Voltage harmonics (up to the 50^{th} order harmonics)		S
Negative sequence voltage non-symmetry factor		S

* Optional data, depending on the power-generating module's equipment

Note: Depending on the needs regarding the NPS operational security, the relevant system operator and the TSO may request the power-generating module owner to provide other information in addition to the ones set forth in table 1A.

ANNEX 2 to the technical norm

Technical data for type B power-generating modules

1. The power-generating module owner shall provide the RSO with technical data specified in table 1B, in accordance with the provisions of this technical norm.
2. Within the notification procedure for the connection of power-generating modules and verifying their compliance with the technical requirements regarding the connection to public electricity grids, the RSO may request additional data for each stage of the notification and compliance verification process.
3. Standard planning data (S), shared via the connection request and used in the solution studies, represent the entirety of the general technical data that characterize the type B power-generating module.
4. Detailed planning data (D) are technical data which allow special steady-state and transient stability analyses, dimensioning of automation facilities and protections control, as well as other data necessary for operational scheduling; detailed planning data (D) are shared with the RSO at least 3 months prior to PIF.
5. The data, validated and completed by the date of application of voltage to the facility for beginning the testing period, shall be confirmed during the verification process of compliance with technical requirements regarding the connection to public electricity grids (R).

Table 1B. Data for type B power-generating modules

Description of data	Measuring unit	Data category
Connection/interface point, as the case may be	Text, diagram	S, D, R
Nominal voltage at the connection/interface point, as the case may be	kV	S, D, R
Maximum short-circuit current at the connection/demarcation point, as the case may be, provided by the power-generating module (before the power electronics equipment/after the power electronics equipment) for a fault which is:		
– Symmetrical (three-phase)	kA	D
– Asymmetrical (two-phase, two-phase with earth connection and single-phase)	kA	D
Minimum short-circuit current at the connection/interface point, as the case may be, provided by the power-generating module (before the power electronics equipment/after the power electronics equipment) for a fault which is:		
– Symmetrical (three-phase)	kA	D
– Asymmetrical (two-phase, two-phase with earth connection and single-phase)	KA	D
Apparent nominal power	MVA	S, D, R
Net power	MW	S, D, R
Nominal active power output at the terminals	MW	S, D, R
Maximum active power output at the terminals	MW	S, D, R
Nominal voltage	kV	S, D, R
Maximum/minimum operational frequency under nominal parameters	Hz	S, D, R
P-Q-capability diagram	Graphical data	D, R
Variation diagram of technical data depending on the deviations from standard environmental conditions		R
LVRT fault-ride-through capability	Diagram	S, D, R
Contained internal protection functions	Text	D
Transformation units:		
Number of windings	Text	S, D, R

Description of data	Measuring unit	Data category
Nominal power on each winding	MVA	S, D, R
Nominal transformation ratio	kV/kV	S, D, R
Short-circuit voltage for each pair of windings (u_{12} for a transformer with two windings, u_{12},u_{13},u_{23} for a transformer with three windings)	% of U_{nom}, at S_{nom}	S, D, R
Idle run losses	kW	S, D, R
Load losses	kW	S, D, R
Magnetizing current	%	S, D, R
Connections group	Text	S, D, R
Control range	kV-kV	S, D, R
Size of control step and number of outlets	%	S, D, R
On load control	Yes/No	D, R
Neutral treatment	Text, diagram	S, D, R
Saturation curve	Diagram	R
Data for wind power-generating modules (as the case may be)		
Wind unit type (with horizontal/vertical axis)	Description	S, R
Rotor diameter	m	S, R
Rotor axis height	m	S, R
Blades control system (pitch/stall)	Text	S, R
Speed control system (fixed/with two gears/variable)	Text	S, R
Type of alternator	Description	S, R
Type certificates accompanied by test results carried out by laboratory recognized on European level for frequency variations, voltage variations and fault-ride-through	certificates	D
Frequency converter type and nominal parameters	kW	S, R
Rate of change of active power output	MW/min	S, R
Nominal current	A	S, R
Nominal voltage	V	S, R

Description of data	Measuring unit	Data category
Start-up wind speed	m/s	S, R
Wind speed (corresponding to the nominal power)	m/s	S, R
Disconnection wind speed	m/s	S, R
Change in power output depending on wind speed	Table	S, R
Electricity quality parameters		
Flicker coefficient for continuous operation		S
Flicker step factor for switch operations		S
Voltage variation factor		S
Maximum number of switch operations in a 10-minute time period		S
Maximum number of switch operations in a 2-hour time period		S
Data for photovoltaic power-generating modules		
Number of photovoltaic panels	Number	S
Type of photovoltaic panels	Description	D
Nominal power of the photovoltaic panel (DC)	kW	S
Maximum power of the photovoltaic panel (DC)	kW	S
Data for inverters used		
Number of inverters	Number	S
Inverter type	Description	S
Type certificates for inverters accompanied by test results carried out by laboratory recognized on European level for frequency variations, voltage variations and fault-ride-through	certificates	D
Nominal input power (DC)	kW	S
Recommended maximum input power (DC)	kW	S
Input voltage range (DC)	V	S
Maximum input voltage (DC)	V	S
Maximum input current (DC)	A	S
Nominal output active power (AC)	kW	S

Description of data	Measuring unit	Data category
Maximum output active power (AC)	kW	S
Nominal output reactive power (AC)	kVAr	S
Nominal output voltage (AC)	V, kV	S
Nominal output current (AC)	A	S
Frequency range	Hz	S
Power factor control range		D
Maximum own consumption (AC)	W	D
Night-time consumption (AC)	W	D
Electricity quality parameters		
Maximum number of power variations ($\Delta S/S_{sc}$) per minute		S
Maximum value for quick voltage variations	V, kV	S
Total electric current distortion factor		S
Electric current harmonics (up to the 50th order harmonics)		S
Total voltage distortion factor		S
Voltage harmonics (up to the 50th order harmonics)		S
Negative sequence voltage non-symmetry factor		S

Note: Depending on the needs regarding the NPS operational security, the relevant system operator and the TSO may request the power-generating module owner to provide other information in addition to the ones set forth in table 1B.

The owner shall provide the RSO with the protections type, the connection method to the voltage circuits, electric current circuits and trip circuits, the actuation matrix for protection functions specified in the project, at the connection point.

Note: Depending on the needs regarding the NPS operational security, the relevant system operator and the TSO may request the power-generating module owner to provide other information in addition to the ones set forth in table 1B.

ANNEX 3 to the technical norm

Technical data for type C power-generating modules

1. The power-generating module owner shall provide the RSO with technical data specified in table 1C, in accordance with the provisions of this technical norm.
2. Within the notification procedure for the connection of power-generating modules and verifying their compliance with the technical requirements regarding the connection to public

electricity grids, the RSO may request additional data for each stage of the notification and compliance verification process.

3. Standard planning data (S), shared via the connection request and used in the solution studies, represent the entirety of the general technical data that characterize the type C power-generating module.
4. Detailed planning data (D) are technical data which allow special steady-state and transient stability analyses, dimensioning of automation facilities and protections control, as well as other data necessary for operational scheduling; detailed planning data shall be provided at least 3 months prior to PIF.
5. The data, validated and completed by the date of application of voltage to the facility for beginning the testing period, shall be confirmed during the verification process of compliance with technical requirements regarding the connection to public electricity grids (R).

Table 1C. Data for type C power-generating modules

Description of data	Measuring unit	Data category
Connection/interface point, as the case may be	Text, diagram	S, D, R
Nominal voltage at the connection/interface point, as the case may be	kV	S, D, R
Maximum short-circuit current at the connection/demarcation point, as the case may be, provided by the power-generating module (before the power electronics equipment/after the power electronics equipment) for a fault which is:		
– Symmetrical (three-phase)	kA	R, D
– Asymmetrical (two-phase, two-phase with earth connection and single-phase)	kA	R, D
Minimum short-circuit current at the connection/interface point, as the case may be, provided by the power-generating module (before the power electronics equipment/after the power electronics equipment) for a fault which is:		
– Symmetrical (three-phase)	kA	R, D
– Asymmetrical (two-phase, two-phase with earth connection and single-phase)	kA	R, D
Apparent nominal power	MVA	S, D, R
Nominal power factor (cos φ_n)	-	S, D, R
Net power	MW	S, D, R
Nominal active power output at the terminals	MW	S, D, R
Maximum active power output at the terminals	MW	S, D, R
Nominal voltage	kV	S, D, R

Maximum/minimum operational frequency under nominal parameters	Hz	S, D, R
Consumption of auxiliary services at maximum power output at the terminals (as the case may be)	MW	S, D, R
Maximum reactive power at the terminals	MVAr	S, D, R
Minimum reactive power at the terminals	MVAr	S, D, R
Minimum active power output	MW	S, D, R
LVRT fault-ride-through capability	diagram	S, D, R
Internal protection functions	Text	D
Diagrams		
P-Q-capability diagram	Graphical data	S, D, R
Variation diagram of technical data depending on the deviations from standard environmental conditions		R
Power underfrequency response	diagram	R
Power overfrequency response	diagram	R
Droop setting range	%	R
s_1 droop value	%	R
Frequency response deadband	mHz	R
Delay time (idle time, t_1)	s	R
Response time (t_2)	s	R
Insensitivity area	mHz	R
Island operation capability	YES/ NO	S, D, R
Transformation units:		
Number of windings	Text	S, D, R
Nominal power on each winding	MVA	S, D, R
Nominal transformation ratio	kV/kV	S, D, R
Short-circuit voltage for each pair of windings (u_{12} for a transformer with two windings, u_{12},u_{13},u_{23} for a transformer with three windings)	% of U_{nom}, at S_{nom}	S, D, R
Idle run losses	kW	S, D, R

Load losses	kW	S, D, R
Magnetizing current	%	S, D, R
Connections group	Text	S, D, R
Control range	kV-kV	S, D, R
Control scheme (longitudinal or transversal)	Text, diagram	D, R
Size of control step and number of outlets	%	S, D, R
On load control	Yes/No	D, R
Neutral treatment	Text, diagram	S, D, R
Saturation curve	Diagram	R
Data for wind power-generating modules (as the case may be)		
Wind unit type (with horizontal/vertical axis)	Description	S, R
Rotor diameter	m	S, R
Rotor axis height	m	S, R
Blades control system (pitch/stall)	Text	S, R
Speed control system (fixed/with two gears/variable)	Text	S, R
Type of alternator	Description	S, R
Type certificates accompanied by test results carried out by laboratory recognized on European level for frequency variations, voltage variations and fault-ride-through	certificates	D
Frequency converter type and nominal parameters	kW	S, R
Rate of change of active power output	MW/min	S, R
Nominal current	A	S, R
Nominal voltage	V	S, R
Start-up wind speed	m/s	S, R
Wind speed (corresponding to the nominal power)	m/s	S, R
Disconnection wind speed	m/s	S, R
Change in power output depending on wind speed	Table	S, R
Electricity quality parameters		

Flicker coefficient for continuous operation		S
Flicker step factor for switch operations		S
Voltage variation factor		S
Maximum number of switch operations in a 10-minute time period		S
Maximum number of switch operations in a 2-hour time period		S
Data for photovoltaic power-generating modules		
Number of photovoltaic panels	Number	S
Type of photovoltaic panels	Description	D
Nominal power of the photovoltaic panel (DC)	kW	S
Maximum power of the photovoltaic panel (DC)	kW	S
Data for inverters used		
Number of inverters	Number	S
Inverter type	Description	S
Type certificates for inverters accompanied by test results carried out by laboratory recognized on European level for frequency variations, voltage variations and fault-ride-through	certificates	D
Nominal input power (DC)	kW	S
Recommended maximum input power (DC)	kW	S
Input voltage range (DC)	V	S
Maximum input voltage (DC)	V	S
Maximum input current (DC)	A	S
Nominal output active power (AC)	kW	S
Maximum output active power (AC)	kW	S
Nominal output reactive power (AC)	kVAr	S
Nominal output voltage (AC)	V, kV	S
Nominal output current (AC)	A	S
Frequency range	Hz	S
Power factor control range		D

Maximum own consumption (AC)	W	D
Night-time consumption (AC)	W	D
Electricity quality parameters		
Maximum number of power variations ($\Delta S/S_{sc}$) per minute		S
Maximum value for quick voltage variations	V, kV	S
Total electric current distortion factor		S
Electric current harmonics (up to the 50^{th} order harmonics)		S
Total voltage distortion factor		S
Voltage harmonics (up to the 50^{th} order harmonics)		S
Negative sequence voltage non-symmetry factor		S

The power-generating module owner shall provide the RSO with the protections type, the connection method to the voltage circuits, electric current circuits and trip circuits, the actuation matrix for protection functions specified in the project, at the connection point.

Note: Depending on the needs regarding the NPS operational security and the type of primary energy used by the power-generating module, the relevant system operator and the TSO may request the power-generating module owner to provide other information in addition to the ones set forth in table 1C.

ANNEX 4 to the technical norm

Technical data for type D power-generating modules

1. The power-generating module owner shall provide the RSO with technical data specified in table 1D, in accordance with the provisions of this technical norm.
2. Within the notification procedure for the connection of power-generating modules and verifying their compliance with the technical requirements regarding the connection to public electricity grids, the RSO may request additional data for each stage of the notification and compliance verification process.
3. Standard planning data (S), shared via the connection request and used in the solution studies, represent the entirety of the general technical data that characterize the type D power-generating module.
4. Detailed planning data (D) are technical data which allow special steady-state and transient stability analyses, dimensioning of automation facilities and protections control, as well as other data necessary for operational scheduling; detailed planning data (D) are shared with the RSO at least 6 months prior to PIF.
5. The data, validated and completed by the date of application of voltage to the facility for beginning the testing period, shall be confirmed during the verification process of compliance with technical requirements regarding the connection to public electricity grids (R).

Table 1D. Data for type D power-generating modules

Description of data	Measuring unit	Data category
Connection/interface point, as the case may be	Text, diagram	S, D, R
Standard environmental conditions for which the technical data has been determined	Text	D, R
Nominal voltage at the connection/interface point, as the case may be	kV	S, D, R
Maximum short-circuit current at the connection/interface point, as the case may be, provided by the power-generating module (before the power electronics equipment/after the power electronics equipment) for a fault which is:		
– Symmetrical (three-phase)	kA	D, R
– Asymmetrical (two-phase, two-phase with earth connection and single-phase)	kA	D, R
Minimum short-circuit current at the connection/interface point, as the case may be, provided by the power-generating module (before the power electronics equipment/after the power electronics equipment) for a fault which is:		
– Symmetrical (three-phase)	kA	D, R
– Asymmetrical (two-phase, two-phase with earth connection and single-phase)	kA	D, R
Apparent nominal power	MVA	S, D, R
Nominal power factor (cos φ_n)	-	S, D, R
Net power	MW	S, D, R
Nominal active power output at the terminals	MW	S, D, R
Maximum active power output at the terminals	MW	S, D, R
Nominal voltage	kV	S, D, R
Maximum/minimum operational frequency under nominal parameters	Hz	S, D, R
Consumption of auxiliary services at maximum power output at the terminals (as the case may be)	MW	S, D, R
Maximum reactive power at the terminals	MVAr	S, D, R
Minimum reactive power at the terminals	MVAr	S, D, R

Minimum active power output	MW	S, D, R
LVRT fault-ride-through capability	Diagram	S, D, R
Contained internal protection functions	Text	D
Diagrams		
P-Q-capability diagram	Graphical data	S, D, R
Variation diagram of technical data depending on the deviations from standard environmental conditions		R
Power underfrequency response	Diagram	R
Power overfrequency response	Diagram	R
Droop setting range	%	R
s_1 droop value	%	R
Frequency response deadband	mHz	R
Delay time (idle time, t_1)	s	R
Response time (t_2)	s	R
Insensitivity area	mHz	R
Islanding capability	Yes/No	S, D, R
Details regarding the speed control presented in the block diagram pertaining to transfer functions related to individual elements and measurement units	Scheme	R
Equivalent transfer function, potentially standardized, of the voltage control, values and measurement units	Text	S
Transformation units:		
Number of windings	Text	S, D, R
Nominal power on each winding	MVA	S, D, R
Nominal transformation ratio	kV/kV	S, D, R
Short-circuit voltage for each pair of windings (u_{12} for a transformer with two windings, u_{12},u_{13},u_{23} for a transformer with three windings)	% of U_{nom}, at S_{nom}	S, D, R
Idle run losses	kW	S, D, R
Load losses	kW	S, D, R
Magnetizing current	%	S, D, R
Connections group	Text	S, D, R

Control range	kV-kV	S, D, R
Control scheme (longitudinal or transversal)	Text, diagram	D, R
Size of control step and number of outlets	%	S, D, R
On load control	YES/ NO	D, R
Neutral treatment	Text, diagram	S, D, R
Saturation curve	Diagram	R
Data for wind power-generating modules (as the case may be)		
Wind unit type (with horizontal/vertical axis)	Description	S, R
Rotor diameter	m	S, R
Rotor axis height	m	S, R
Blades control system (pitch/stall)	Text	S, R
Speed control system (fixed/with two gears/variable)	Text	S, R
Type of alternator	Description	S, R
Type certificates accompanied by test results carried out by laboratory recognized on European level for frequency variations, voltage variations and fault-ride-through	certificates	D
Frequency converter type and nominal parameters	kW	S, R
Rate of change of active power output	MW/min	S, R
Nominal current	A	S, R
Nominal voltage	V	S, R
Start-up wind speed	m/s	S, R
Wind speed (corresponding to the nominal power)	m/s	S, R
Disconnection wind speed	m/s	S, R
Change in power output depending on wind speed	Table	S, R
Electricity quality parameters		
Flicker coefficient for continuous operation		S
Flicker step factor for switch operations		S
Voltage variation factor		S
Maximum number of switch operations in a 10-minute time period		S

Maximum number of switch operations in a 2-hour time period		S
Data for photovoltaic power-generating modules		
Number of photovoltaic panels	Number	S
Type of photovoltaic panels	Description	D
Nominal power of the photovoltaic panel (DC)	kW	S
Maximum power of the photovoltaic panel (DC)	kW	S
Data for inverters used		
Number of inverters	Number	S
Inverter type	Description	S
Type certificates for inverters accompanied by test results carried out by laboratory recognized on European level for frequency variations, voltage variations and fault-ride-through	certificates	D
Nominal input power (DC)	kW	S
Recommended maximum input power (DC)	kW	S
Input voltage range (DC)	V	S
Maximum input voltage (DC)	V	S
Maximum input current (DC)	A	S
Nominal output active power (AC)	kW	S
Maximum output active power (AC)	kW	S
Nominal output reactive power (AC)	kVAr	S
Nominal output voltage (AC)	V, kV	S
Nominal output current (AC)	A	S
Frequency range	Hz	S
Power factor control range		D
Maximum own consumption (AC)	W	D
Night-time consumption (AC)	W	D
Electricity quality parameters		
Maximum number of power variations ($\Delta S/S_{sc}$) per minute		S
Maximum value for quick voltage variations	V, kV	S

Total electric current distortion factor		S
Electric current harmonics (up to the 50^{th} order harmonics)		S
Total voltage distortion factor		S
Voltage harmonics (up to the 50^{th} order harmonics)		S
Negative sequence voltage non-symmetry factor		S

Note: Depending on the needs regarding the NPS operational security, the relevant system operator and the TSO may request the power-generating module owner to provide other information in addition to the ones set forth in table 1D.

The power-generating module owner shall provide the RSO with the protections type, the connection method to the voltage circuits, electric current circuits and trip circuits, the actuation matrix for protection functions specified in the project, at the connection point.

Note: Depending on the needs regarding the NPS operational security, the relevant system operator and the TSO may request the power-generating module owner to provide other information in addition to the ones set forth in table 1D.

ANNEX 5 to the technical norm

Technical data for type B power park modules

1. The power park module owner shall provide the RSO with technical data specified in table 1B-power parks, in accordance with the provisions of this technical norm.
2. Within the notification procedure for the connection of power park modules and verifying their compliance with the technical requirements regarding the connection to public electricity grids, the RSO may request additional data for each stage of the notification and compliance verification process.
3. Standard planning data (S), shared via the connection request and used in the solution studies, represent the entirety of the general technical data that characterize the type B power park module.
4. Detailed planning data (D) are technical data which allow special steady-state and transient stability analyses, dimensioning of automation facilities and protections control, as well as other data necessary for operational scheduling; detailed planning data (D) are shared with the RSO at least 3 months prior to PIF.
5. The data, validated and completed by the date of application of voltage to the facility for beginning the testing period, shall be confirmed during the verification process of compliance with technical requirements regarding the connection to public electricity grids (R).

Table 1B. Power park modules. Data for type B power park modules

Description of data	Measuring unit	Data category
Connection/interface point, as the case may be	Text, diagram	S, D, R
Nominal voltage at the connection/interface point, as the case may be	kV	S, D, R
Maximum short-circuit current at the connection/interface point, as the case may be, provided by the power park for a fault which is:		
- Symmetrical (three-phase)	kA	D, R
– Asymmetrical (two-phase, two-phase with earth connection and single-phase)	kA	D, R
Minimum short-circuit current at the connection/interface point, as the case may be, provided by the power park for a fault which is:		
- Symmetrical (three-phase)	kA	D, R
– Asymmetrical (two-phase, two-phase with earth connection and single-phase)	kA	D, R
Apparent nominal power (at the connection/demarcation point, as the case may be)	MVA	S, D, R
Nominal power factor (cos φ_n) (at the connection/demarcation point, as the case may be)	-	S, D, R
Data at the connection/interface point, as the case may be		
Net power	MW	S, D, R
Nominal active power output	MW	S, D, R
Maximum active power output	MW	S, D, R
Nominal voltage	kV	S, D, R
Maximum/minimum operational frequency under nominal parameters	Hz	S, D, R
Maximum reactive power in inductive regime	MVAr	S, D, R
Maximum reactive power in capacitive regime	MVAr	S, D, R

Description of data	Measuring unit	Data category
LVRT fault-ride-through capability	diagram	S, D, R
Protection functions	Text	D
General data for power-generating modules in the power park module		
Apparent nominal power	MVA	S, D, R
Nominal power factor (cos φ_n)	-	S, D, R
Net power	MW	S, D, R
Nominal active power output at the terminals	MW	S, D, R
Maximum active power output at the terminals	MW	S, D, R
Nominal voltage	kV	S, D, R
Maximum/minimum operational frequency under nominal parameters	Hz	S, D, R
Maximum reactive power in inductive regime at the terminals	MVAr	S, D, R
Maximum reactive power in capacitive regime at the terminals	MVAr	S, D, R
LVRT fault-ride-through capability	diagram	S, D, R
Contained internal protection functions	Text	D
Short-circuit ratio		D, R

Data for wind power-generating modules, connected via power electronics/asynchronously, in a power park module		
Wind unit type (with horizontal/vertical axis)	Description	S, R
Rotor diameter	m	S, R
Rotor axis height	m	S, R
Blades control system (pitch/stall)	Text	S, R
Speed control system (fixed/with two gears/variable)	Text	S, R
Type of alternator	Description	S, R
Type certificates accompanied by test results carried out by laboratory recognized on European level for frequency variations, voltage variations and fault-ride-through	certificates	D
Frequency converter type and nominal parameters	kW	S, R

Description of data	Measuring unit	Data category
Rate of change of active power output	MW/min	S, R
Reactive power	kVAr	S,
Nominal current	A	S, R
Nominal voltage	V	S, R
Start-up wind speed	m/s	S, R
Wind speed (corresponding to the nominal power)	m/s	S, R
Disconnection wind speed	m/s	S, R
Change in power output depending on wind speed	Table	S, R
P-Q-profile	Graphical data	S, R
Electricity quality parameters for each power-generating module in the power park module		
Flicker coefficient for continuous operation		S
Flicker step factor for switch operations		S
Voltage variation factor		S
Maximum number of switch operations in a 10-minute time period		S
Maximum number of switch operations in a 2-hour time period		S
At the connection/interface point		
Total electric current distortion factor THD_i		S
Harmonics (up to the 50^{th} order harmonics)		S
Negative sequence non-symmetry factor		S
Data for photovoltaic power-generating modules		
Number of photovoltaic panels in the power park	Number	S
Photovoltaic panels manufacturer	Name	D
Type of photovoltaic panels	Description	D
Photoelectric panel surface area	m^2	S
Nominal power of the photovoltaic panel (DC)	kW	S
Maximum power of the photovoltaic panel (DC)	kW	S

Description of data	Measuring unit	Data category
Nominal electric current of the photovoltaic panel (DC)	A	S
Nominal voltage of the photovoltaic panel (DC)	V	S
Data for inverters used by the photovoltaic power park module		
Number of inverters	Number	S
Inverter type	Description	S
Type certificates for inverters accompanied by test results carried out by laboratory recognized on European level for frequency variations, voltage variations and fault-ride-through	certificates	D
Nominal input power (DC)	kW	S
Recommended maximum input power (DC)	kW	S
Input voltage range (DC)	V	S
Maximum input voltage (DC)	V	S
Maximum input current (DC)	A	S
Nominal output active power (AC)	kW	S
Maximum output active power (AC)	kW	S
Nominal output reactive power (AC)	kVAr	S
Nominal output voltage (AC)	V, kV	S
Nominal output current (AC)	A	S
Working frequency range	Hz	S
Power factor control range		D
Maximum output	%	D
Maximum own consumption (AC)	W	D
Night-time consumption (AC)	W	D
Electricity quality parameters for the photovoltaic power park module		
Maximum number of power variations ($\Delta S/S_{sc}$) per minute		S
Maximum value for quick voltage variations	V, kV	S
Total electric current distortion factor		S

Description of data	Measuring unit	Data category
Electric current harmonics (up to the 50th order harmonics)		S
Total voltage distortion factor		S
Voltage harmonics (up to the 50th order harmonics)		S
Negative sequence voltage non-symmetry factor		S
Maximum number of power variations ($\Delta S/S_{sc}$) per minute		S
Data regarding protections:		
Differential protection	Text	D, R
Transformation units:		
Number of windings	Text	S, D, R
Nominal power on each winding	MVA	S, D, R
Nominal transformation ratio	kV/kV	S, D, R
Short-circuit voltage for each pair of windings (u_{12} for a transformer with two windings, u_{12},u_{13},u_{23} for a transformer with three windings)	% of U_{nom}, at S_{nom}	S, D, R
Idle run losses	kW	S, D, R
Load losses	kW	S, D, R
Magnetizing current	%	S, D, R
Connections group	Text	S, D, R
Control range	kV-kV	S, D, R
Control scheme (longitudinal or transversal)	Text, diagram	D, R
Size of control step and number of outlets	%	S, D, R
On load control	YES/ NO	D, R
Neutral treatment	Text, diagram	S, D, R
Saturation curve	Diagram	R

The power park module owner shall provide the RSO with the protections type, the connection method to the voltage circuits, electric current circuits and trip circuits, the actuation matrix for protection functions specified in the project, at the connection point.

Note: Depending on the needs regarding the NPS operational security and the type of primary energy used by the power park module, the RSO and the TSO may request the power park module owner to provide other information in addition to the ones set forth in table 1B-power parks.

ANNEX 6 to the technical norm

Technical data for type C power park modules

1. The power park module owner shall provide the RSO with technical data specified in table 1C-power parks, in accordance with the provisions of this technical norm.
2. Within the notification procedure for the connection of power park modules and verifying their compliance with the technical requirements regarding the connection to public electricity grids, the RSO may request additional data for each stage of the notification and compliance verification process.
3. Standard planning data (S), shared via the connection request and used in the solution studies, represent the entirety of the general technical data that characterize the type C power park module.
4. Detailed planning data (D) are technical data which allow special steady-state and transient stability analyses, dimensioning of automation facilities and protections control, as well as other data necessary for operational scheduling; detailed planning data shall be provided at least 3 months prior to PIF.
5. The data, validated and completed by the date of application of voltage to the facility for beginning the testing period, shall be confirmed during the verification process of compliance with technical requirements regarding the connection to public electricity grids (R).

Table 1C. Power park modules. Data for type C power park modules

Description of data	Measuring unit	Data category
Connection/interface point, as the case may be	Text, diagram	S, D, R
Nominal voltage at the connection/interface point, as the case may be	kV	S, D, R
Maximum short-circuit current at the connection/interface point, as the case may be, provided by the power park for a fault which is:		
– Symmetrical (three-phase)	kA	D, R
– Asymmetrical (two-phase, two-phase with earth connection, single-phase)	kA	D, R
Minimum short-circuit current at the connection/interface point, as the case may be, provided by the power park for a fault which is:		
– Symmetrical (three-phase)	kA	D, R
– Asymmetrical (two-phase, two-phase with earth connection, single-phase)	kA	D, R

Data at the connection/interface point, as the case may be		
Net power	MW	S, D, R
Nominal active power output	MW	S, D, R
Maximum active power output	MW	S, D, R
Nominal voltage	kV	S, D, R
Maximum/minimum operational frequency under nominal parameters	Hz	S, D, R
Maximum reactive power in inductive regime	MVAr	S, D, R
Maximum reactive power in capacitive regime	MVAr	S, D, R
LVRT fault-ride-through capability	diagram	S, D, R
Protection functions	Text	D
Diagrams		
P-Q-capability diagram	Graphical data	S, D, R
P-Q-profile depending on U at the connection/interface point	Graphical data	S, D, R
Variation diagram of technical data depending on the deviations from standard environmental conditions		R
Power underfrequency response	Diagram	R
Power overfrequency response	Diagram	R
Droop setting range	%	R
s_1 droop value	%	R
Frequency response deadband	mHz	R
Delay time (idle time, t_1)	s	R
Response time (t_2)	s	R
Insensitivity area	mHz	R
Islanding capability	Yes/No	S, D, R
Details regarding the speed control presented in the block diagram pertaining to transfer functions related to individual elements and measurement units	Scheme	R
Equivalent transfer function, potentially standardized, of the voltage control, values and measurement units	Text	S
General data for power-generating modules in the power park:		
Apparent nominal power	MVA	S, D, R

Nominal power factor (cos φ_n)		S, D, R
Net power	MW	S, D, R
Nominal active power output at the terminals	MW	S, D, R
Maximum active power output at the terminals	MW	S, D, R
Nominal voltage	kV	S, D, R
Maximum/minimum operational frequency under nominal parameters	Hz	S, D, R
Maximum reactive power in inductive regime at the terminals	MVAr	S, D, R
Maximum reactive power in capacitive regime at the terminals	MVAr	S, D, R
LVRT fault-ride-through capability	Diagram	S, D, R
Contained internal protection functions	Text	D
Data for wind power-generating modules, connected via power electronics/asynchronously, in a power park module		
Wind unit type (with horizontal/vertical axis)	Description	S, R
Rotor diameter	m	S, R
Rotor axis height	m	S, R
Blades control system (pitch/stall)	Text	S, R
Speed control system (fixed/with two gears/variable)	Text	S, R
Type of alternator	Description	S, R
Type certificates for inverters accompanied by test results carried out by laboratories recognized on European level for frequency variations, voltage variations and fault-ride-through	certificates	D
Frequency converter type and nominal parameters	MW	S, R
Rate of change of active power output	MW/min	S, R
Reactive power	MVAr	S
Nominal current	A	S, R
Nominal voltage	V	S, R
Start-up wind speed	m/s	S, R
Wind speed (corresponding to the nominal power)	m/s	S, R

Disconnection wind speed	m/s	S, R
Change in power output depending on wind speed	Table	S, R
P-Q-profile	Graphical data	S, R
Electricity quality parameters for each power-generating module in the power park module		
Flicker coefficient for continuous operation		S
Flicker step factor for switch operations		S
Voltage variation factor		S
Maximum number of switch operations in a 10-minute time period		S
Maximum number of switch operations in a 2-hour time period		S
At the connection point		
Total electric current distortion factor THD_i		S
Harmonics (up to the 50^{th} order harmonics)		S
Negative sequence non-symmetry factor		S
Data for photovoltaic power-generating modules		
Number of photovoltaic panels in the power park	Number	S
Photovoltaic panels manufacturer	Name	D
Type of photovoltaic panels	Description	D
Photovoltaic panel surface area	m^2	S
Nominal power of the photovoltaic panel (DC)	kW	S
Maximum power of the photovoltaic panel (DC)	kW	S
Nominal electric current of the photovoltaic panel (DC)	A	S
Nominal voltage of the photovoltaic panel (DC)	V	S
Data for inverters used by the photovoltaic power park module		
Number of inverters	Number	S
Inverter type	Description	S
Type certificates for inverters accompanied by test results carried out by laboratories recognized on European level for frequency variations, voltage variations and fault-ride-through	certificates	D

Nominal input power (DC)	kW	S
Recommended maximum input power (DC)	kW	S
Input voltage range (DC)	V	S
Maximum input voltage (DC)	V	S
Maximum input current (DC)	A	S
Nominal output active power (AC)	kW	S
Maximum output active power (AC)	kW	S
Nominal output reactive power (AC)	kVAr	S
Nominal output voltage (AC)	V, kV	S
Nominal output current (AC)	A	S
Working frequency range	Hz	S
Power factor control range	-	D
Night-time consumption (AC)	W	D
Electricity quality parameters for the photovoltaic power park module		
Maximum number of power variations ($\Delta S/S_{sc}$) per minute		S
Maximum value for quick voltage variations	kV/s	S
Total electric current distortion factor		S
Electric current harmonics (up to the 50th order harmonics)		S
Total voltage distortion factor		S
Voltage harmonics (up to the 50th order harmonics)		S
Negative sequence voltage non-symmetry factor		S
Differential protection	Text	D, R
Transformation units:		
Number of windings	Text	S, D, R
Nominal power on each winding	MVA	S, D, R
Nominal transformation ratio	kV/kV	S, D, R
Short-circuit voltage for each pair of windings (u_{12} for a transformer with two windings, u_{12},u_{13},u_{23} for a	% of U_{nom}, at S_{nom}	S, D, R

transformer with three windings)		
Idle run losses	kW	S, D, R
Load losses	kW	S, D, R
Magnetizing current	%	S, D, R
Connections group	Text	S, D, R
Control range	kV-kV	S, D, R
Control scheme (longitudinal or transversal)	Text, diagram	D, R
Size of control step and number of outlets	%	S, D, R
On load control	YES/ NO	D, R
Neutral treatment	Text, diagram	S, D, R
Saturation curve	Diagram	R

The power park module owner shall provide the RSO with the protections type, the connection method to the voltage circuits, electric current circuits and trip circuits, the actuation matrix for protection functions specified in the project, at the connection point.

Note: Depending on the needs regarding the NPS operational security and the type of primary energy used by the power-generating module, the RSO and the TSO may request the power park module owner to provide other information in addition to the ones set forth in table 1C-power parks.

ANNEX 7 to the technical norm

Technical data for type D power park modules

1. The power park module owner shall provide the RSO with technical data specified in table 1D-power parks, in accordance with the provisions of this technical norm.
2. Within the notification procedure for the connection of power park modules and verifying their compliance with the technical requirements regarding the connection to public electricity grids, the RSO may request additional data for each stage of the notification and compliance verification process.
3. Standard planning data (S), shared via the connection request and used in the solution studies, represent the entirety of the general technical data that characterize the type D power park module.
4. Detailed planning data (D) are technical data which allow special steady-state and transient stability analyses, dimensioning of automation facilities and protections control, as well as other data necessary for operational scheduling; detailed planning data (D) are shared with the RSO at least 6 months prior to PIF.

5. The data, validated and completed by the date of application of voltage to the facility for beginning the testing period, shall be confirmed during the verification process of compliance with technical requirements regarding the connection to public electricity grids (R).

Table 1D. Power park modules. Data for type D power park modules

Description of data	Measuring unit	Data category
Connection/interface point, as the case may be	Text, diagram	S, D, R
Standard environmental conditions for which the technical data has been determined	Text	D, R
Nominal voltage at the connection/interface point, as the case may be	kV	S, D, R
Maximum short-circuit current at the connection/interface point, as the case may be, provided by the power park for a fault which is:		
– Symmetrical (three-phase)	kA	D, R
– Asymmetrical (two-phase, two-phase with earth connection, single-phase)	kA	D, R
Minimum short-circuit current at the connection/interface point, as the case may be, provided by the power park for a fault which is:		
– Symmetrical (three-phase)	kA	D, R
– Asymmetrical (two-phase, two-phase with earth connection, single-phase)	kA	D, R
Data at the connection/interface point, as the case may be		
Net power	MW	S, D, R
Nominal active power output	MW	S, D, R
Maximum active power output	MW	S, D, R
Nominal voltage	kV	S, D, R
Maximum/minimum operational frequency under nominal parameters	Hz	S, D, R
Maximum reactive power in inductive regime	MVAr	S, D, R
Maximum reactive power in capacitive regime	MVAr	S, D, R
LVRT fault-ride-through capability	diagram	S, D, R
Protection functions	Text	D
P-Q-profile depending on U	Graphical data	S, D, R
Data at the connection/interface point, as the case may be		

Net power	MW	S, D, R
Nominal active power output	MW	S, D, R
Maximum active power output	MW	S, D, R
Nominal voltage	kV	S, D, R
Maximum/minimum operational frequency under nominal parameters	Hz	S, D, R
Maximum reactive power in inductive regime	MVAr	S, D, R
Maximum reactive power in capacitive regime	MVAr	S, D, R
LVRT fault-ride-through capability	diagram	S, D, R
Protection functions	Text	D
Diagrams		
P-Q-capability diagram	Graphical data	S, D, R
P-Q-profile depending on U at the connection/interface point	Graphical data	S, D, R
Variation diagram of technical data depending on the deviations from standard environmental conditions		R
Power underfrequency response	Diagram	R
Power overfrequency response	Diagram	R
Droop setting range	%	R
s_1 droop value	%	R
Frequency response deadband	mHz	R
Delay time (idle time, t_1)	s	R
Response time (t_2)	s	R
Insensitivity area	mHz	R
Islanding capability	Yes/No	S, D, R
Details regarding the speed control presented in the block diagram pertaining to transfer functions related to individual elements and measurement units	Scheme	R
Equivalent transfer function, potentially standardized, of the voltage control, values and measurement units	Text	S
General data for power-generating modules in the power park:		
Apparent nominal power	MVA	S, D, R
Nominal power factor ($\cos \varphi_n$)	-	S, D, R

Net power	MW	S, D, R
Nominal active power output at the terminals	MW	S, D, R
Maximum active power output at the terminals	MW	S, D, R
Nominal voltage	kV	S, D, R
Maximum/minimum operational frequency under nominal parameters	Hz	S, D, R
Maximum reactive power in inductive regime at the terminals	MVAr	S, D, R
Maximum reactive power in capacitive regime at the terminals	MVAr	S, D, R
LVRT fault-ride-through capability	Diagram	S, D, R
Contained internal protection functions	Text	D
Data for wind power-generating modules, connected via power electronics/asynchronously, in a power park module		
Wind unit type (with horizontal/vertical axis)	Description	S, R
Rotor diameter	m	S, R
Rotor axis height	m	S, R
Blades control system (pitch/stall)	Text	S, R
Speed control system (fixed/with two gears/variable)	Text	S, R
Type of alternator	Description	S, R
Type certificates for inverters accompanied by test results carried out by laboratories recognized on European level for frequency variations, voltage variations and fault-ride-through	certificates	D
Frequency converter type and nominal parameters	MW	S, R
Rate of change of active power output	MW/min	S
Reactive power	kVAr	S,
Nominal current	A	S, R
Nominal voltage	V	S, R
Start-up wind speed	m/s	S, R
Wind speed (corresponding to the nominal power)	m/s	S, R
Disconnection wind speed	m/s	S, R

Change in power output depending on wind speed	Table	S, R
P-Q-profile	Graphical data	S, R
Electricity quality parameters for each power-generating module in the power park module		
Flicker coefficient for continuous operation		S
Flicker step factor for switch operations		S
Voltage variation factor		S
Maximum number of switch operations in a 10-minute time period		S
Maximum number of switch operations in a 2-hour time period		S
Total electric current distortion factor THD_i		S
Harmonics (up to the 50^{th} order harmonics)		S
Negative sequence non-symmetry factor		S
Data for photovoltaic power-generating modules		
Number of photovoltaic panels in the power park	Number	S
Photovoltaic panels manufacturer	Name	D
Type of photovoltaic panels	Description	D
Photovoltaic panel surface area	m^2	S
Nominal power of the photovoltaic panel (DC)	kW	S
Maximum power of the photovoltaic panel (DC)	kW	S
Nominal electric current of the photovoltaic panel (DC)	A	S
Nominal voltage of the photovoltaic panel (DC)	V	S
Data for inverters used by the photovoltaic power park module		
Number of inverters	Number	S
Inverter type	Description	S
Type certificates for inverters accompanied by test results carried out by laboratories recognized on European level for frequency variations, voltage variations and fault-ride-through	certificates	D
Nominal input power (DC)	kW	S
Recommended maximum input power (DC)	kW	S

Input voltage range (DC)	V	S
Maximum input voltage (DC)	V	S
Maximum input current (DC)	A	S
Nominal output active power (AC)	kW	S
Maximum output active power (AC)	kW	S
Nominal output reactive power (AC)	kVAr	S
Nominal output voltage (AC)	V, kV	S
Nominal output current (AC)	A	S
Working frequency range	Hz	S
Power factor control range	-	D
Night-time consumption (AC)	W	D
Electricity quality parameters for the photovoltaic power park module		
Maximum number of power variations ($\Delta S/S_{sc}$) per minute		S
Maximum value for quick voltage variations	kV/s	S
Total electric current distortion factor		S
Electric current harmonics (up to the 50^{th} order harmonics)		S
Total voltage distortion factor		S
Voltage harmonics (up to the 50^{th} order harmonics)		S
Negative sequence voltage non-symmetry factor		S
Data regarding protections:		
Differential protection	Text	D, R
Transformation units:		
Number of windings	Text	S, D, R
Nominal power on each winding	MVA	S, D, R
Nominal transformation ratio	kV/kV	S, D, R
Short-circuit voltage for each pair of windings (u_{12} for a transformer with two windings, u_{12},u_{13},u_{23} for a transformer with three windings)	% of U_{nom}, at S_{nom}	S, D, R
Idle run losses	kW	S, D, R

Load losses	kW	S, D, R
Magnetizing current	%	S, D, R
Connections group	Text	S, D, R
Control range	kV-kV	S, D, R
Control scheme (longitudinal or transversal)	Text, diagram	D, R
Size of control step and number of outlets	%	S, D, R
On load control	YES/ NO	D, R
Neutral treatment	Text, diagram	S, D, R
Saturation curve	Diagram	R

The power park module owner shall provide the RSO with the protections type, the connection method to the voltage circuits, electric current circuits and trip circuits, the actuation matrix for protection functions specified in the project, at the connection point.

Note: Depending on the needs regarding the NPS operational security and the type of primary energy used, the RSO and the TSO may request the power park module owner to provide other information in addition to the ones set forth in table 1D-power parks.

ANNEX 8 to the technical norm

Technical data for offshore power park modules

1. The offshore power park module owner shall provide the RSO with technical data specified in table 1L, in accordance with the provisions of this technical norm.
2. Within the notification procedure for the connection of offshore power park modules and verifying their compliance with the technical requirements regarding the connection to public electricity grids, the RSO may request additional data for each stage of the notification and compliance verification process.
3. Standard planning data (S), shared via the connection request and used in the solution studies, represent the entirety of the general technical data that characterize the offshore power park module.
4. Detailed planning data (D) are technical data which allow special steady-state and transient stability analyses, dimensioning of automation facilities and protections control, as well as other data necessary for operational scheduling; detailed planning data (D) are shared with the RSO at least 6 months prior to PIF.
5. The data, validated and completed by the date of application of voltage to the facility for beginning the testing period, shall be confirmed during the verification process of compliance with technical requirements regarding the connection to public electricity grids (R).

Table 1L: Data for offshore power park modules

Description of data	Measuring unit	Data category
Offshore connection/interface point, as the case may be	Text, diagram	S, D, R
Standard environmental conditions for which the technical data has been determined	Text	D, R
Nominal voltage at the offshore connection/interface point	kV	S, D, R
Maximum short-circuit current at the offshore connection/interface point, provided by the power park for a fault which is:		
– Symmetrical (three-phase)	kA	D, R
– Asymmetrical (two-phase, two-phase with earth connection, single-phase)	kA	D, R
Minimum short-circuit current at the offshore connection/interface point, provided by the power park for a fault which is:		
– Symmetrical (three-phase)	kA	D, R
– Asymmetrical (two-phase, two-phase with earth connection, single-phase)	kA	D, R
Power-generating module in the offshore power park module:		
Apparent nominal power	MVA	S, D, R
Nominal power factor (cos φ_n)	-	S, D, R
Net power	MW	S, D, R
Nominal active power output at the terminals	MW	S, D, R
Maximum active power output at the terminals	MW	S, D, R
Nominal voltage	kV	S, D, R
Maximum/minimum operational frequency under nominal parameters	Hz	S, D, R
Consumption of internal/auxiliary services at maximum power output at the terminals	MW	S, D, R
Maximum reactive power in inductive regime at the terminals	MVAr	S, D, R
Maximum reactive power in capacitive regime at the terminals	MVAr	S, D, R
LVRT fault-ride-through capability	Diagram	S, D, R
Contained internal protection functions	Text	D

Short-circuit ratio		D, R
Data for the synchronous wind power-generating module, connected via power electronics/asynchronously, in an offshore power park module		
Wind unit type (with horizontal/vertical axis)	Description	S, R
Rotor diameter	m	S, R
Rotor axis height	m	S, R
Blades control system (pitch/stall)	Text	S, R
Speed control system (fixed/with two gears/variable)	Text	S, R
Type of alternator	Description	S, R
Type certificates for inverters accompanied by test results carried out by laboratories recognized on European level for frequency variations, voltage variations and fault-ride-through	certificates	D
Frequency converter type and nominal parameters (kW)		S, R
Rate of change of active power output	MW/min	S
Reactive power	kVAr	S
Nominal current	A	S, R
Nominal voltage	V	S, R
Start-up wind speed	m/s	S, R
Nominal wind speed (corresponding to the nominal power)	m/s	S, R
Disconnection wind speed	m/s	S, R
Change in power output depending on wind speed	Table	S, R
P-Q-profile	Graphical data	S, R
Electricity quality parameters for each offshore power-generating module in the power park module		
Flicker coefficient for continuous operation		S
Flicker step factor for switch operations		S
Voltage variation factor		S
Maximum number of switch operations in a 10-minute time period		S
Maximum number of switch operations in a 2-hour time		S

period		
At the busbar		
Total electric current distortion factor THD_i		S
Harmonics (up to the 50^{th} order harmonics)		S
Negative sequence non-symmetry factor		S
Capability in terms of reactive power:		
Reactive power in inductive/capacitive regime at maximum power output	MVAr output	S, D, R
Reactive power in inductive/capacitive regime at minimum power output	MVAr output	S, D, R
Reactive power in inductive/capacitive regime at zero power output	MVAr output	S, D, R
P-Q-profile depending on U	Graphical data	S, D, R
Data regarding protections:		
Differential protection	Text	D, R
Transformation units:		
Number of windings	Text	S, D, R
Nominal power on each winding	MVA	S, D, R
Nominal transformation ratio	kV/kV	S, D, R
Short-circuit voltage for each pair of windings (u_{12} for a transformer with two windings, u_{12},u_{13},u_{23} for a transformer with three windings)	% of U_{nom}, at S_{nom}	S, D, R
Idle run losses	kW	S, D, R
Load losses	kW	S, D, R
Magnetizing current	%	S, D, R
Connections group	Text	S, D, R
Control range	kV-kV	S, D, R
Control scheme (longitudinal or transversal)	Text, diagram	D, R
Size of control step and number of outlets	%	S, D, R
On load control	YES/ NO	D, R
Neutral treatment	Text, diagram	S, D, R
Saturation curve	Diagram	R

Note: Depending on the needs regarding the NPS operational security, the RSO and the TSO may request the offshore power park module owner to provide other information in addition to the ones set forth in table 1L.