TEST REPORT
C10/11
SPECIFIC TECHNICAL PRESCRIPTIONS REGARDING POWER-GENERATING PLANTS OPERATING IN PARALLEL TO THE DISTRIBUTION NETWORK

Report Reference No.....:	230401862SHA-002
Date of issue.....:	2023-07-26
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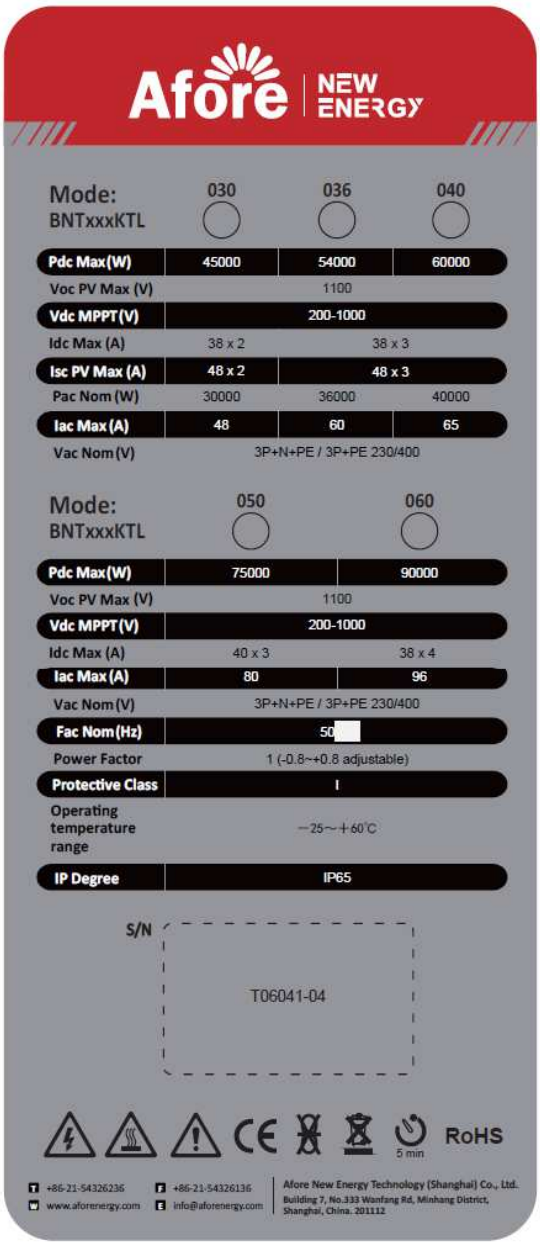
Applicant's name.....:	Afore New Energy Technology (Shanghai) Co., Ltd.
Address.....:	Building 7, No.333 Wanfang Rd, Minhang District, Shanghai. China. 201112
Test specification:	
Standard.....:	C10/11: ed.2.2, 15 Mar 2021
Test procedure.....:	Type approval for type A
Non-standard test method.....:	N/A
Test Report Form No.....:	C10/11_a
Test Report Form(s) Originator.....:	Intertek Guangzhou
Master TRF.....:	Dated 2019-10

Test item description.....:	Grid-connected PV inverter
Trade Mark.....:	Afore
Manufacturer.....:	Same as Applicant
Model/Type reference.....:	BNT030KTL, BNT036KTL, BNT040KTL, BNT050KTL, BNT060KTL
Rating.....:	See below Specifications table

Specifications table					
Model	BNT030KTL	BNT036KTL	BNT040KTL	BNT050KTL	BNT060KTL
PV input					
P pv Max(W)	45000	54000	60000	75000	90000
Vmax PV (Vdc) (absolute Max.)	1100	1100	1100	1100	1100
Isc PV (absolute Max.) (A)	48 x 2	48 x 3	48 x 3	48 x 3	48 x 4
Number MPP trackers	2	3	3	3	4
Number input strings	2/3	2/2/2	2/2/2	2/2/3	2/2/2/2
Max. PV input current / strings (A)	38 x 2	38 x 3	38 x 3	40 x 3	38 x 4
MPPT voltage range (Vdc)	200-1000	200-1000	200-1000	200-1000	200-1000
Vdc range @ full power (Vdc)	500-850	500-850	500-850	500-850	500-850
AC Grid (output)					
Normal AC Voltage (V_{AC})	3P+N+PE/3P+PE 230/400				
Frequency (Hz)	50				
Normal AC Current (A)	43.5	52.2	58	72.5	87
Max. cont. output current (A)	48	60	65	80	96
Normal Power (W)	30000	36000	40000	50000	60000
Rated Apparent Power (VA)	30000	36000	40000	50000	60000
Max. cont. Power (W)	30000	36000	40000	50000	60000
Max. cont. Apparent Power (VA)	30000	36000	40000	50000	60000
Power factor(adjustable)	1.0(-0.8~ +0.8)				
Others					
Protective class	Class I				
Ingress protection (IP)	IP65				
Temperature (℃)	-25℃ to +60℃				
Inverter Isolation	Non-isolated				
Overvoltage category	OVC III (AC Main), OVC II (PV)				
Software version	DSP:V06 CPLD:V06 HMI:V06				

Summary of testing:	
Tests performed (name of test and test clause): All applicable tests Remark: Other than special notice, for all clauses, the model BNT060KTL is type tested and valid for other models.	**Testing location:** Intertek Testing Services Shanghai. Building No.86, 1198 Qinzhou Road (North), Shanghai 200233, China.

Copy of marking plate



Note:

1. The above markings are the minimum requirements required by the safety standard. For the final production samples, the additional markings which do not give rise to misunderstanding may be added.
2. Label is attached on the side surface of enclosure and visible after installation
3. The model name: BNTxxxKTL, xxx means 030, 036, 040, 050, 060.
4. The information covered by ☐ on marking plate was irrelevant to this report.

Test item particulars:	
Temperature range:	-25˚C ~ 60˚C
AC Overvoltage category:	☐ OVC I ☐ OVC II ☒ OVC III ☐ OVC IV
DC Overvoltage category:	☐ OVC I ☒ OVC II ☐ OVC III ☐ OVC IV
IP protection class:	IP65
Possible test case verdicts:	
- test case does not apply to the test object:	N/A (Not applicable)
- test object does meet the requirement:	P (Pass)
- test object does not meet the requirement:	F (Fail)
Testing:	
Date of receipt of test item:	2023-04-27
Date (s) of performance of tests:	2023-04-27 to 2023-07-26

General remarks:

The test results presented in this report relate only to the object tested.
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"(see Enclosure #)" refers to additional information appended to the report.
"(see appended table)" refers to a table appended to the report.

When determining for test conclusion, measurement uncertainty of tests has been considered.
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The test report only allows to be revised only within the report defined retention period unless standard or regulation was withdrawn or invalid.

Throughout this report a point is used as the decimal separator.

General product information:

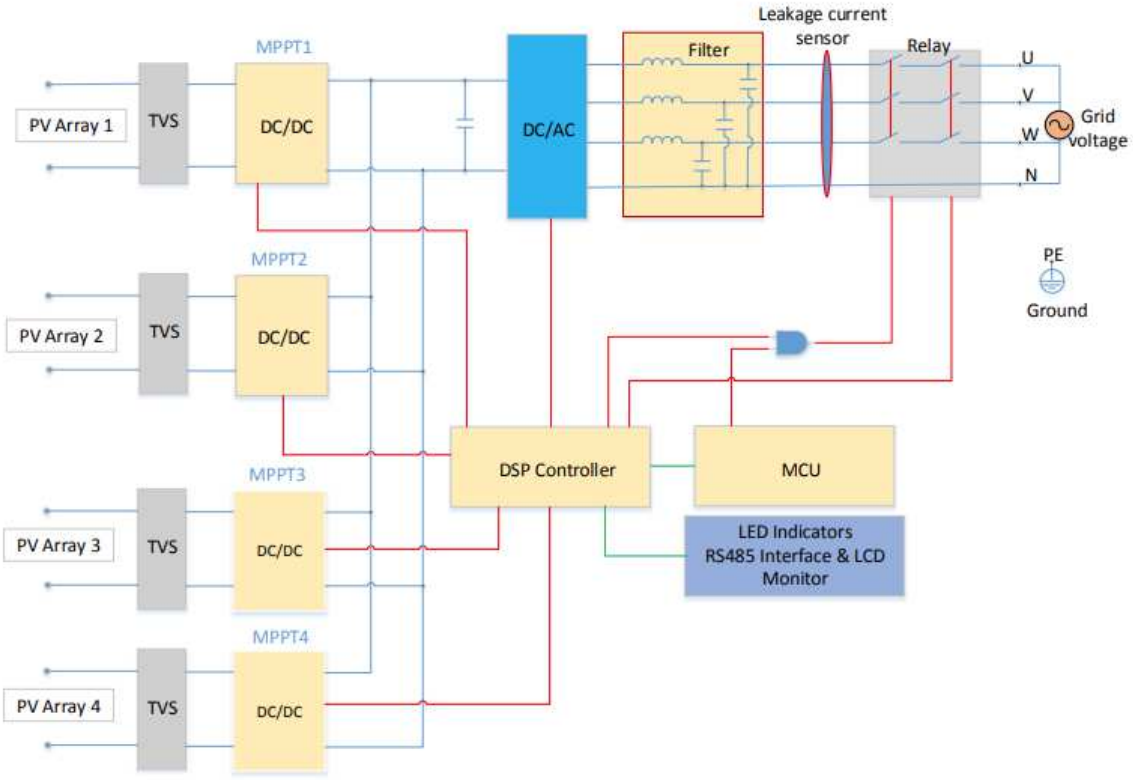
The testing item is a grid-connected type inverter for indoor or outdoor installation.

The Inverter is three-phase type and no isolation between PV input and AC output.

The relays are designed to redundant structure that controlled by separately.

The master controller and slave controller are used together to control relay open or close, if the single fault on one controller, the other controller can be capable to open the relay, so that still providing safety means.

The topology diagram as following:



Model differences:

All models are identical with hardware version and software version, the output power is derating by software.
Model BNT030KTL has 2 MPPT tracker with 5 input strings,
Model BNT036KTL and BNT040KTL has 3 MPPT trackers with 6 input strings,
Model BNT050KTL has 3 MPPT trackers with 7 input strings,
Model BNT060KTL has 4 MPPT trackers with 8 input strings,

Except as noted, the model BNT060KTL is as the representative test model in this report.

Factory information: Afore New Energy Technology (Shanghai) Co., Ltd.
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C10/11: ed.2.2, 15 Mar 2021			
Clause	Requirement - Test	Result - Remark	Verdict
ANNEXE D	**Technical basic requirements regarding the power-generating units**		P
D.1	**General**	This report is only evaluated and tested for generating unit; The generating plant incorporated with the generating unit shall further consider this clause and sub-clause.	P
	In line with the scope of these technical specifications as well as the CENELEC standards EN 50549-1 and EN 50549-2, these requirements are applicable to all kinds of generation of electrical energy, including energy storage systems.	In line with the scope of EN 50549-1	P
D.2	**Order of priorities**		P
	If different requirements on the power-generating unit interfere with each other, the hierarchy listed in EN 50549-1 or EN 50549-2 shall be respected		P
	In brief, the standard specifies following hierarchy: 1. Generating unit protection, including regarding the prime mover. 2. Interface protection and protection against fault within the power-generating plant; 3. Voltage support during faults and voltage steps; 4. The lower value of: remote control command on active power limitation setpoint from the DSO and local response to overfrequency; 5. Local response to underfrequency if applicable; 6. Reactive power and active power (P(U)) controls; 7. Other control commands on active power set point for e.g. market, economic reasons, self-consumption optimization.		P
D.3	**Integrated automatic separation system**		P
	This clause is applicable to power-generating units with a maximum power ≤ 30 kVA.		P
	An integrated automatic separation system is strongly recommended in order to facilitate the installation procedure. Indeed, if the power-generating unit is not equipped with such an integrated system, an external device must be used	Incorporating integrated automatic separation system	P
	For the integrated automatic separation system, the requirements of this clause apply.		P
	Following protection functions are required: • Overvoltage 10 min mean • Overvoltage • Undervoltage • Overfrequency • Underfrequency • A means to detect island situation (LoM) according to EN 62116.	(See appended table D.3)	P

<table>
<tr><td colspan="4">C10/11: ed.2.2, 15 Mar 2021</td></tr>
<tr><td>Clause</td><td>Requirement - Test</td><td>Result - Remark</td><td>Verdict</td></tr>
<tr><td></td><td>All of these protection functions must comply with the relevant requirements in EN 50549-1 (in edition 2019, section 4.9.3</td><td></td><td>P</td></tr>
<tr><td></td><td>The integrated automatic separation system must have single fault tolerance according to EN 50549-1.</td><td>Two series relays in each line and may independent operation for each relay.</td><td>P</td></tr>
<tr><td></td><td>The integrated automatic separation system must be set in accordance with the settings as specified in ANNEXE C</td><td></td><td>P</td></tr>
<tr><td>D.4</td><td>Operating ranges</td><td></td><td>P</td></tr>
<tr><td></td><td>Generating plants shall have the capability to operate in the operating ranges specified below regard-less of the topology and the settings of the interface protection.</td><td></td><td>P</td></tr>
<tr><td>D.4.1</td><td>Operating frequency range</td><td></td><td>P</td></tr>
<tr><td></td><td>This clause is not applicable to backup power systems as specified in § 2.2.1.</td><td>Not backup power system</td><td>N/A</td></tr>
<tr><td></td><td>The power-generating unit must comply with the minimum requirements of the applicable standard EN 50549 or EN 5055-2 on the operating frequency range (edition 2019, see clause 4.4.2 « Operating frequency range »)</td><td>Comply with EN 50549-1</td><td>P</td></tr>
<tr><td></td><td>In brief, the requirements in the standard are as follows:
<table>
<tr><td>Frequency domain</td><td>Duration</td></tr>
<tr><td>47,5 Hz – 49,0 Hz</td><td>30 minutes</td></tr>
<tr><td>49,0 Hz – 51,0 Hz</td><td>Permanent</td></tr>
<tr><td>51,0 Hz – 51,5 Hz</td><td>30 minutes</td></tr>
</table></td><td>(See appended table D.4.1)</td><td>P</td></tr>
<tr><td></td><td>Additionally, the DSO shall be informed about the capability of the power-generating unit to operate in the frequency range from 51,5 Hz and 52,5 Hz and, where appropriate, the maximum duration of operation in this frequency range.</td><td></td><td>P</td></tr>
<tr><td></td><td>The URD cannot without good reason refuse to apply wider frequency ranges or longer minimum operating periods than those specified above, provided that the technical and economic impact is limited.</td><td>Comply with above requirements</td><td>P</td></tr>
<tr><td>D.4.2</td><td>Maximum admissible power reduction in case of underfrequency</td><td></td><td>P</td></tr>
<tr><td></td><td>This clause is not applicable to backup power systems as specified in § 2.2.1.</td><td>Not backup power system</td><td>N/A</td></tr>
<tr><td></td><td>In general, a power-generating unit must continue to operate in case of a reduction of the frequency at the point of connection. This means that, in underfrequency, the power-generating unit should reduce the output power as little as possible and at least being capable of staying above the limit specified hereafter.</td><td></td><td>P</td></tr>
</table>

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Clause	Requirement - Test	Result - Remark	Verdict
	Where the technical capabilities of the power-generating unit are influenced by ambient conditions, these technical capabilities may be demonstrated using the following reference conditions: • Temperature: 0 °C • Altitude: between 400 and 500 m • Humidity: between 15 and 20 g H_2O/kg air		P
D.4.2.1	**Limit for non-synchronous power-generating technology (Power Park Modules)**	(See appended table D.4.2.1)	P
	The power-generating unit must comply with the most stringent requirement of EN 50549-1 or EN 50549-2 (edition 2019, see clause 4.4.3 « Minimal requirement for active power delivery at underfrequency »).	Comply with EN 50549-1	P
D.4.2.2	**Limits for synchronous power-generating technology**	Not synchronous power-generating	N/A
	In steady state (from t2 onwards), the power-generating unit must comply with the relevant default requirement of the applicable standard EN 50549-1 or EN 50549-2 (edition 2019, see section 4.4.3 « Minimal requirement for active power delivery at underfrequency »).		N/A
	Additionally, in the transient time (between t1 and t2), the power-generating unit must comply with the relevant most stringent requirement of EN 50549-1 or EN 50549-2. (In edition 2019 of the standard, the relevant requirements can be found in clause 4.4.3 « Minimal requirement for active power delivery at underfrequency »).		N/A
D.4.3	**Continuous operating voltage range**		P
	The power-generating unit must comply with the relevant requirement of EN 50549-1 or EN 50549-2 (edition 2019, see clause 4.4.4 « Continuous operating voltage range »).	Comply with EN 50549-1	P
	In brief, the requirement in the standard specifies the power-generating plant should be capable to operate continuously when he voltage at the point of connection is within the following range:	(See appended table D.4.3)	P
	• For a connection to the low voltage network: 85 % Un < U < 110 % Un where Un = 230 V		P
	• For a connection to the high voltage network: 90 % Uc < U < 110 % Uc where Uc is the declared voltage.		N/A
	It is also allowed to reduce apparent power in case of voltage is below respectively 95 % Un or 95 % Uc.		P
D.5	**Immunity to disturbances**		P
	Independent of the topology and the settings of the interface protection, a power-generating unit must have the following withstand capabilities.		P
D.5.1	**Rate of change of frequency (RoCoF) immunity**		P
	This clause does not apply to backup power systems as specified in § 2.2.1.	Not backup power system	N/A

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Clause	Requirement - Test	Result - Remark	Verdict
	The power-generating unit must comply with the relevant requirements of the applicable standard EN 50549-1 or EN 50549-2 (edition 2019, see section 4.5.2 « Rate of change of frequency (RoCoF) immunity ») taking the additional modifications and information specified hereunder into account.	(See appended table D.5.1)	P
	The power-generating unit shall have the capability to stay connected and operate when the frequen-cy at the point of connection changes with the frequency against time profiles as depicted in the fig-ures hereunder. When considering a sliding measurement window of 500ms, these profiles have a maximum RoCoF of 2 Hz/s.		P
	For synchronous generating technology, this requirement is more stringent than the default value in the applicable standard EN 50549-1 or EN 50549-2 (2 Hz/s instead of 1 Hz/s) as, in contrast with the standard, no distinction is made between power-generating technologies.	Not synchronous power-generating	N/A
D.5.2	**Under-voltage ride through UVRT**		P
	This section is not applicable to backup power systems as specified in § 2.2.1.	Not backup power system	N/A
	For a power-generating unit that is part of a power-generating module with a power ≥ 1 MW (type B in accordance with NC RfG) this paragraph is mandatory.		N/A
	For a power-generating unit that is part of a power-generating module with a power < 1 MW, this paragraph is non-mandatory and to be considered as a orienting capability, not as a hard requirement. However, the real withstand capability to voltage dips shall be provided during the homologation process.	Considered as an orienting capability	P
	The power-generating unit must comply with the relevant requirements of the applicable standard EN 50549-1 or EN 50549-2 (edition 2019, see clause 4.5.3 « Under-voltage ride through (UVRT) »), with the following change: • The voltage-time profiles are to be replaced by the profiles hereunder.	(See appended table D.5.2)	P
	As a consequence, for synchronous generating technology this profile is more stringent than the default requirement in EN 50549-1 or EN 50549-2.	Not synchronous power-generating	N/A
	For some power-generating technologies, the behaviour of the power-generating unit during and after voltage dips may be impacted by the short circuit power available at the point of connection.		N/A
	For such technologies different cases can be considered:		N/A
	• Compliance with this UVRT requirement can be demonstrated considering a ratio of 10 be-tween the available short circuit power at the connection point and the maximum power of the considered power-generating module. In this case, no further checks are needed.		N/A

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Clause	Requirement - Test	Result - Remark	Verdict
	• If not, the manufacturer must declare the minimum short-circuit power conditions for which the UVRT-requirement can be complied with. This value shall be considered during the installation process.		N/A
	In line with EN 50549-1 or EN 50549-2 at least 90% of the pre-fault power or 90% of the available power whichever is the smallest, shall be resumed as fast as possible, but at the latest within the following default time after the voltage returned to the continuous operating voltage range (85% Un < U < 110% Un for a connection to a low-voltage distribution network; 90% Uc < U < 110% Uc for a connection to a high-voltage distribution network):		P
	• 3 seconds for a power-generating unit with synchronous generating technology		N/A
	• 1 second for a power-generating unit with non-synchronous generating technology		P
	Another site specific maximum allowed time is to be agreed during the commissioning process. This decision must be taken with the DSO in coordination with the TSO.		N/A
	For a backup power system connected to the high voltage distribution network as specified in §2.2.1, the general requirement is this clause may be relaxed, replacing the voltage-time profile by the figure underneath.	Not backup power system	N/A
D.5.3	**Over-voltage ride through (OVRT)**		N/A
	Requirement under consideration for a future edition. No requirement in this edition.		N/A
D.6	**Active response to frequency deviations**		P
D.6.1	**Power response to overfrequency**		P
	This clause is not applicable to backup power system as specified in section §2.2.1	Not backup power system	N/A
	The power-generating unit must comply with the relevant requirements of the applicable standard EN 50549-1 or EN 50549-2 (edition 2019, see 4.6.1 « Power response to overfrequency ») taking into account the additional modifications and information specified hereunder.	Comply with EN 50549-1	P
	Instead of the default maximum step response time of 30s specified in the standards EN 50549-1 and EN 50549-2, the following dynamic step response characteristics are required:		P
	• For synchronous power-generating technologies For power-generating units base on a gas turbine or an internal combustion engine with technical specificities not allowing compliance with the prescriptions applied by default as de-scribed above, the following alternative prescription, relating to a minimum power gradient in increasing or decreasing frequency, is applicable:		N/A
	- If Pmax ≤2 MW at minimum 1,11 % Pmax per second		N/A

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Clause	Requirement - Test	Result - Remark	Verdict
	- If Pmax >2 MW at minimum 0,33 % Pmax per second		N/A
	• For non-synchronous power-generating technology	(See appended table D.6.1)	P
	The figure hereunder clarifies the terms « Step response time» and « Settling time». In this clause, the 'Value' is the active power and the tolerance is 10%.		P
	In line with the default requirement of the applicable standard EN 50549-1 :2019 or EN 50549-2: 2019, power-generating units reaching their minimum regulating level shall, in the event of further frequency increase, maintain this power level until a frequency decrease results in a power setpoint which is again above this level.	Comply with EN 50549-1	P
	The optional deactivation threshold f_{stop} is not required. In case f_{stop} is implemented, it shall be deactivated.		P
	At the time of deactivation of the active power frequency response (= frequency goes down below the threshold frequency f1), the active power can be increased to up to the level of the available power. Nevertheless this shall be done respecting a power limit with a gradient of 10% Pmax/min.		P
	For energy storage systems with a connection to the high-voltage distribution network, the DSU might, for justified technical or security reasons, agree with the DSO on applicable minimum state of charge limits in his connection agreement.		N/A
	The settings must be protected from unpermitted interference (e.g. by a password or seal).		P
	Automatic disconnection and reconnection as alternative for the droop function are not permitted by default as per the TSO provisions.		P
D.6.2	**Power response to underfrequency**	Not an energy store system	N/A
	The power-generating unit must comply with the relevant requirements of the applicable EN 50549-1 or EN 50549-2 (edition 2019, see clause 4.6.2 « Power response to underfrequency ») taking additional modifications and information as specified hereunder into account.		N/A
	This clause is applicable to energy storage systems. For justified technical or security reasons, the DSU might agree with the DSO (in his connection agreement is the power-generating plant is connected to the high-voltage distribution network) on applicable maximum state of charge limits in his connection agreement.		N/A
	This clause is optional for all other power-generating units. When, in such units, the capability of activating active power response to underfrequency is activated, the power-generating units must comply with the requirements of this clause.		N/A

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Clause	Requirement - Test	Result - Remark	Verdict
	Instead of the default maximum step response time of 30s in EN 50549-1 and EN 50549-2, the re-quired dynamic step response characteristics (step response time and settling time) are identical to those stipulated above regarding the power response to overfrequency, including the alternative approach for power-generating units based on a gas turbine or an internal combustion engine (see D.6.1).		N/A
	The settings must be protected from unpermitted interference (e.g. by a password or seal).		P
D.7	**Power response to voltage changes**		P
D.7.1	**Voltage support by reactive power**		P
	A backup power system as referred to in section §2.2.1, must not comply with the requirements of this clause. Instead, for such a system, the power factor must be as close to 1 as possible and may definitely not fall below the limit of 0.85 during in-parallel operation. No control mode at all for the reactive power is imposed by the DSO.	Not backup power system	N/A
	The power-generating plant must at least comply with the corresponding requirements of the applicable standard EN 50549-1 or EN 50549-233 (edition 2019, see clause 4.7.2 « Voltage support by reactive power ») taking the modifications and additional information specified hereunder into account. It is usually the power-generating unit itself that meets this requirement, which is assessed at the time of the homologation. In the other cases, if for example additional equipment such as a capacitor bank is necessary in combination with the power-generating unit, this will be evaluated by the DSO during the procedure for commissioning.	Comply with EN 50549-1	P
	For a power-generating plant with a maximum power ≤ 250 kVA connected to the high-voltage distribution network, the DSU may decide to comply to the equivalent requirements of EN 50549-1 rather than those of EN 50549-2.		N/A
	The reactive power capability shall be evaluated at the terminals of the power-generating unit (including, when applicable, the step-up transformer specific to the power-generating unit).	(See appended table D.7.1)	P
	The real reactive power capabilities of the power-generating unit at the terminals should be communicated to the DSO. This can be done during the process of homologation.		P
	If the capabilities exceed the minimum requirement, and as far as this has only limited technical and economic impact, the DSU is not allowed to refuse without justification the DSO to make use of the reactive power capability (this is not applicable to a small power-generating plant (as defined in chapter 4)).		P
	The settings of the control mode must be protected from unpermitted interference (e.g. by a password or seal).		P

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Clause	Requirement - Test	Result - Remark	Verdict
D.7.1.1	**Specific for a small power-generating plant**		P
	By default, the power generation unit must operate according to the following rules:		P
	• When the voltage ≤ 105 % Un: cos phi = 1 (Q=0)		P
	• When the voltage > 105 % Un: free operation with 1 ≥ cos phi > 0,9under-excited. (no over-excited operation allowed)		P
D.7.1.2	**Specific for another (not small) power-generating plant**		P
	If applicable, the details of the reactive power control mode to be activated in the power-generating unit shall be provided by the DSO during the installation procedure. This setting might be reviewed by the DSO during the lifetime of the power-generating module.		P
	If the power-generating plant is connected to the high voltage distribution network, it may be necessary to use additional resources such as, for example, a capacitor bank to meet the previous requirements related to the supply of reactive power. If the power-generating unit is disconnected, they must be disconnected as well.	Not connected to the high voltage distribution network	N/A
	For a synchronous power-generating unit that is part of a power-generating module with a maximum power of ≥ 1 MW (type B according to NC RfG), the following specific requirement is also applicable:	Not synchronous power-generating unit	N/A
	Alternatively to the Q(U) control mode specified above, a synchronous power-generating unit of type B (power ≥ 1 MW) shall be equipped with a permanent automatic excitation control system that can provide constant alternator terminal voltage at a selectable setpoint without instability over the entire operating range of the synchronous power-generating module. When the setpoint gives rise to a re-active power exchange beyond the capability requirements above, the reactive power exchange may be kept at the limits of the required capability.		N/A
	The setpoint must be selectable in the continuous operating voltage range (see section D.4.3) and is given by the DSO.		P
	The DSO can give the required instructions to make the selection of the setpoint possible remotely by the DSO's control center (see § 7.13), respecting the applicable regional legal framework.		P
D.7.2	**Voltage related active power reduction P(U)**	(See appended table D.7.2)	P

C10/11: ed.2.2, 15 Mar 2021			
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	Voltage relating active power reduction is allowed and even recommended in order to avoid disconnection due to the operation of the overvoltage protection. When implemented, the power-generating unit must comply with the relevant requirements of the applicable standard EN 50549-1 or EN50549-2 (edition 2019, see clause 4.7.3 « Voltage related active power reduction »).	Comply with EN 50549-1	P
D.7.3	**Provision of additional fast reactive current during faults and voltage steps**		P
	This Section is only applicable to non-synchronous power-generating units connected to a high volt-age distribution network and are not part of a small power-generating plant.		P
	For power-generating units that are part of a power-generating module with a maximum power <1 MW, there is no capability requirement. However, if such a generating module has the capability to provide additional fast reactive current during faults and voltage steps, this function must be deactivated by default.		P
	Power-generating units that are part of a power-generating module with a maximum power ≥ 1 MW must comply with the relevant requirements of the standard EN 50549-2 (edition 2019, see clause 4.7.4.2.1 « Voltage support during faults and voltage steps »), taking the additional information specified in this Section into account. By default, this function must be deactivated.		P
	A directly connected asynchronous machine cannot provide voltage support in a controlled manner with regard to short circuit currents as a consequence of faults or when there are sudden voltage variations. The DSO will include these elements in its assessment of the demand for connection.		N/A
D.8	**Connection and reconnection**		P
	The power-generating unit must comply with the relevant requirements of the applicable standard EN 50549-1 or EN 50549-2 (edition 2019, see clause 4.10 « Connection and starting to generate electrical power ») taking the additional information specified hereunder into account.	Comply with EN 50549-1	P
	Connection and reconnection after tripping of the interface protection relay is subject to the conditions listed in the table hereunder. These settings are different than the default settings of EN 50549-1 and EN 50549-2.	(See appended table D.8)	P
	The automatic connection and reconnection is allowed if the abovementioned conditions are met.		P

C10/11: ed.2.2, 15 Mar 2021			
Clause	Requirement - Test	Result - Remark	Verdict
	If, at the power-generating unit connected to the HV distribution network, no distinct sets of conditions can be applied, it is not possible to make a distinction between the two connection modes, the conditions must be chosen such as they meet both sets of conditions.	Not connected to the HV distribution network	N/A
D.9	**Ceasing and reduction of active power on set point**		P
	This clause is not applicable to the backup power systems specified in §2.2.1.	Not backup power system	N/A
D.9.1	**Ceasing active power**	(See appended table D.9)	P
	The power-generating unit must comply with the relevant requirements of the applicable standard EN 5054-1 or EN 50549-2 (edition 2019, see clause 4.11.1 « Ceasing active power ») taking into account the additional information specified hereunder.	Comply with EN 50549-1	P
	In brief, the requirements in the standards are the following:		P
	For modules with a power > 800 W, a logic interface to cease the production of active power within 5 seconds after receiving the instruction is required.		P
	Remote operation is optional		P
	Respecting the regional regulatory provisions, the DSO can request additional equipment for a remote operation of this logic interface.		P
	Unless defined otherwise by the DSO, this logic interface is based on a contact rather than using a communicated protocol.		P
D.9.2	**Reduction of active power on set point**	(See appended table D.9)	P
	The requirement of this Section is applicable only to the power-generating units that are part of:		P
	• a power-generating module with a maximum power of ≥ 1 MW		N/A
	• a power-generating plant with a maximum power of > 250 kVA, if the DSO so requires, in accordance with the regional regulations.		P
	The power-generating module must comply with the relevant requirements of the applicable standard EN 50549-1 or EN 50549-2 (edition 2019, see clause 4.11.2 « Reduction of active power on set point ») taking into account the additional information specified hereunder. Generally, the power-generating unit complies with this requirement, which is assessed when homologated. Otherwise, if, for example, additional equipment such as a capacitor bank is required in combination with the power-generating unit, this will be evaluated by the DSO during the commissioning procedure.	Comply with EN 50549-1	P

C10/11: ed.2.2, 15 Mar 2021			
Clause	Requirement - Test	Result - Remark	Verdict
	In brief, the requirements in the standard are the following: For type B modules: The settings of the limit must be possible with a maximum increment of 10%. Reduction of the power generation to the respective limit in a range of maximum 0,66 % Pn/ s and of minimum 0,33 % Pn/ s Deconnection of the network is allowed when below minimum regulating level Remote operation is optional		P
	Depending of the modalities specified in section D.10 hereafter, the DSO can request additional equipment for a remote operation of this reduction.		N/A
D.10	**Communication – Remote monitoring and control**		N/A

Appended Table - Testing Result

8.2.3	TABLE: Flicker	P

Flicker measurement

According to EN 61000-3-3/EN 61000-3-11

Model: BNT060KTL

Value		D_c (%)	D_{max} (%)	d(t) – 500ms	P_{st}	P_{lt}
Limit		3.30	4.00	3.30%	1.00	0.65
Test value	L1	0.030	0.365	0.0	0.119	0.116
	L2	0.042	0.290	0.0	0.128	0.123
	L3	0.758	1.296	0.0	0.179	0.151

	dc[%]		dmax[%]		d(t)[ms]		Pst		Plt	
Limit	3.30		4.00		500 3.30%		1.00		0.65 N:12	
No. 1	0.026	Pass	0.258	Pass	0.0	Pass	0.117	Pass		
2	0.030	Pass	0.287	Pass	0.0	Pass	0.114	Pass		
3	0.027	Pass	0.252	Pass	0.0	Pass	0.116	Pass		
4	0.011	Pass	0.214	Pass	0.0	Pass	0.115	Pass		
5	0.028	Pass	0.221	Pass	0.0	Pass	0.114	Pass		
6	0.024	Pass	0.365	Pass	0.0	Pass	0.116	Pass		
7	0.023	Pass	0.246	Pass	0.0	Pass	0.115	Pass		
8	0.025	Pass	0.266	Pass	0.0	Pass	0.116	Pass		
9	0.027	Pass	0.244	Pass	0.0	Pass	0.119	Pass		
10	0.026	Pass	0.224	Pass	0.0	Pass	0.117	Pass		
11	0.014	Pass	0.250	Pass	0.0	Pass	0.116	Pass		
12	0.029	Pass	0.256	Pass	0.0	Pass	0.116	Pass		
Result		Pass		Pass		Pass		Pass	0.116	Pass

L1 phase

	dc[%]		dmax[%]		d(t)[ms]		Pst		Plt	
Limit	3.30		4.00		500 3.30%		1.00		0.65 N:12	
No. 1	0.023	Pass	0.290	Pass	0.0	Pass	0.126	Pass		
2	0.020	Pass	0.269	Pass	0.0	Pass	0.123	Pass		
3	0.017	Pass	0.240	Pass	0.0	Pass	0.128	Pass		
4	0.015	Pass	0.234	Pass	0.0	Pass	0.122	Pass		
5	0.024	Pass	0.153	Pass	0.0	Pass	0.123	Pass		
6	0.012	Pass	0.181	Pass	0.0	Pass	0.123	Pass		
7	0.031	Pass	0.164	Pass	0.0	Pass	0.123	Pass		
8	0.042	Pass	0.190	Pass	0.0	Pass	0.124	Pass		
9	0.034	Pass	0.172	Pass	0.0	Pass	0.123	Pass		
10	0.033	Pass	0.187	Pass	0.0	Pass	0.121	Pass		
11	0.021	Pass	0.217	Pass	0.0	Pass	0.118	Pass		
12	0.031	Pass	0.204	Pass	0.0	Pass	0.122	Pass		
Result		Pass		Pass		Pass		Pass	0.123	Pass

L2 phase

	dc[%]		dmax[%]		d(t)[ms]		Pst		Plt	
Limit	3.30		4.00		500 3.30%		1.00		0.65 N:12	
No. 1	0.118	Pass	0.257	Pass	0.0	Pass	0.117	Pass		
2	0.156	Pass	0.209	Pass	0.0	Pass	0.163	Pass		
3	0.078	Pass	0.165	Pass	0.0	Pass	0.179	Pass		
4	0.580	Pass	1.168	Pass	0.0	Pass	0.142	Pass		
5	0.153	Pass	1.191	Pass	0.0	Pass	0.157	Pass		
6	0.106	Pass	0.303	Pass	0.0	Pass	0.118	Pass		
7	0.224	Pass	0.437	Pass	0.0	Pass	0.156	Pass		
8	0.115	Pass	0.219	Pass	0.0	Pass	0.146	Pass		
9	0.758	Pass	1.296	Pass	0.0	Pass	0.162	Pass		
10	0.693	Pass	1.189	Pass	0.0	Pass	0.153	Pass		
11	0.211	Pass	0.539	Pass	0.0	Pass	0.154	Pass		
12	0.071	Pass	0.275	Pass	0.0	Pass	0.148	Pass		
Result		Pass		Pass		Pass		Pass	0.151	Pass

L3 phase

8.2.3	TABLE: Flicker	P

Flicker measurement

According to EN 61000-3-3/EN 61000-3-11

Model: BNT030KTL

Value		D_c (%)	D_{max} (%)	d(t) – 500ms	P_{st}	P_{lt}
Limit		3.30	4.00	3.30%	1.00	0.65
Test value	L1	0.031	0.337	0.0	0.118	0.113
	L2	0.044	0.333	0.0	0.127	0.120
	L3	0.258	0.525	0.0	0.298	0.155

	dc[%]		dmax[%]		d(t)[ms]		Pst		Plt	
Limit	3.30		4.00		500 3.30%		1.00		0.65 N:12	
No. 1	0.023	Pass	0.305	Pass	0.0	Pass	0.118	Pass		
2	0.027	Pass	0.264	Pass	0.0	Pass	0.116	Pass		
3	0.029	Pass	0.291	Pass	0.0	Pass	0.115	Pass		
4	0.028	Pass	0.299	Pass	0.0	Pass	0.113	Pass		
5	0.028	Pass	0.230	Pass	0.0	Pass	0.112	Pass		
6	0.019	Pass	0.243	Pass	0.0	Pass	0.112	Pass		
7	0.028	Pass	0.337	Pass	0.0	Pass	0.111	Pass		
8	0.025	Pass	0.260	Pass	0.0	Pass	0.110	Pass		
9	0.023	Pass	0.238	Pass	0.0	Pass	0.112	Pass		
10	0.031	Pass	0.221	Pass	0.0	Pass	0.112	Pass		
11	0.022	Pass	0.289	Pass	0.0	Pass	0.113	Pass		
12	0.028	Pass	0.302	Pass	0.0	Pass	0.110	Pass		
Result		Pass		Pass		Pass		Pass	0.113	Pass

L1 phase

	dc[%]		dmax[%]		d(t)[ms]		Pst		Plt	
Limit	3.30		4.00		500 3.30%		1.00		0.65 N:12	
No. 1	0.007	Pass	0.222	Pass	0.0	Pass	0.107	Pass		
2	0.019	Pass	0.249	Pass	0.0	Pass	0.110	Pass		
3	0.017	Pass	0.307	Pass	0.0	Pass	0.119	Pass		
4	0.025	Pass	0.299	Pass	0.0	Pass	0.116	Pass		
5	0.033	Pass	0.274	Pass	0.0	Pass	0.119	Pass		
6	0.021	Pass	0.333	Pass	0.0	Pass	0.122	Pass		
7	0.044	Pass	0.243	Pass	0.0	Pass	0.120	Pass		
8	0.026	Pass	0.321	Pass	0.0	Pass	0.127	Pass		
9	0.024	Pass	0.277	Pass	0.0	Pass	0.123	Pass		
10	0.030	Pass	0.263	Pass	0.0	Pass	0.123	Pass		
11	0.028	Pass	0.295	Pass	0.0	Pass	0.125	Pass		
12	0.036	Pass	0.285	Pass	0.0	Pass	0.122	Pass		
Result		Pass		Pass		Pass		Pass	0.120	Pass

L2 phase

	dc[%]		dmax[%]		d(t)[ms]		Pst		Plt	
Limit	3.30		4.00		500 3.30%		1.00		0.65 N:12	
No. 1	0.258	Pass	0.334	Pass	0.0	Pass	0.159	Pass		
2	0.140	Pass	0.312	Pass	0.0	Pass	0.127	Pass		
3	0.027	Pass	0.525	Pass	0.0	Pass	0.130	Pass		
4	0.090	Pass	0.376	Pass	0.0	Pass	0.298	Pass		
5	0.058	Pass	0.324	Pass	0.0	Pass	0.119	Pass		
6	0.026	Pass	0.197	Pass	0.0	Pass	0.109	Pass		
7	0.035	Pass	0.217	Pass	0.0	Pass	0.111	Pass		
8	0.016	Pass	0.214	Pass	0.0	Pass	0.107	Pass		
9	0.016	Pass	0.211	Pass	0.0	Pass	0.103	Pass		
10	0.011	Pass	0.201	Pass	0.0	Pass	0.102	Pass		
11	0.024	Pass	0.244	Pass	0.0	Pass	0.103	Pass		
12	0.069	Pass	0.222	Pass	0.0	Pass	0.103	Pass		
Result		Pass		Pass		Pass		Pass	0.155	Pass

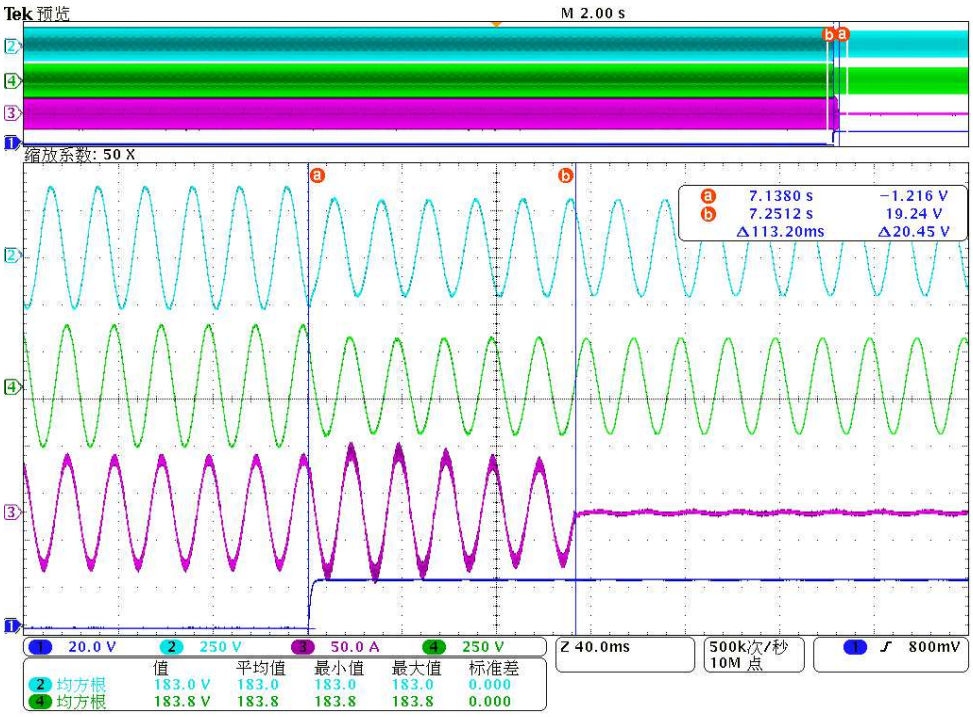
L3 phase

8.2.4	TABLE: Current harmonics emission test(EN 61000-3-12)						
Model	BNT060KTL						
Harmonic	L1		L2		L3		Limits (%)
	Magnitude (A)	% of Fundamental	Magnitude (A)	% of Fundamental	Magnitude (A)	% of Fundamental	
1	86.939	99.980	86.939	99.983	86.939	99.979	--
2	0.637	0.733	0.805	0.926	0.867	0.997	8
3	0.679	0.781	0.541	0.622	0.594	0.683	21.6%
4	0.228	0.262	0.150	0.173	0.281	0.323	4
5	0.893	1.027	1.012	1.164	0.945	1.087	10.7
6	0.109	0.125	0.084	0.097	0.108	0.124	2.7
7	0.936	1.077	0.398	0.458	0.803	0.924	7.2
8	0.161	0.185	0.169	0.194	0.170	0.196	2
9	0.118	0.136	0.123	0.142	0.093	0.107	N/A
10	0.072	0.083	0.097	0.111	0.087	0.100	1.6
11	0.301	0.346	0.416	0.478	0.402	0.462	3.1
12	0.091	0.105	0.104	0.120	0.083	0.096	1.3
13	0.297	0.342	0.146	0.168	0.203	0.234	2
14	0.075	0.086	0.088	0.101	0.095	0.109	N/A
15	0.062	0.071	0.127	0.146	0.150	0.172	N/A
16	0.063	0.072	0.090	0.104	0.095	0.109	N/A
17	0.137	0.158	0.144	0.166	0.075	0.086	N/A
18	0.058	0.067	0.060	0.069	0.073	0.084	N/A
19	0.077	0.089	0.063	0.072	0.077	0.089	N/A
20	0.030	0.035	0.049	0.056	0.051	0.059	N/A
21	0.043	0.050	0.040	0.046	0.044	0.051	N/A
22	0.028	0.032	0.044	0.051	0.050	0.057	N/A
23	0.060	0.069	0.053	0.061	0.070	0.081	N/A
24	0.026	0.030	0.034	0.039	0.042	0.048	N/A
25	0.041	0.047	0.050	0.058	0.030	0.035	N/A
26	0.019	0.022	0.030	0.034	0.032	0.037	N/A
27	0.022	0.025	0.029	0.033	0.036	0.041	N/A
28	0.016	0.018	0.028	0.032	0.030	0.035	N/A
29	0.023	0.026	0.031	0.036	0.030	0.034	N/A
30	0.012	0.014	0.019	0.022	0.025	0.029	N/A
31	0.023	0.026	0.030	0.034	0.030	0.035	N/A
32	0.012	0.014	0.020	0.023	0.025	0.029	N/A
33	0.017	0.019	0.018	0.021	0.028	0.032	N/A
34	0.010	0.012	0.017	0.020	0.026	0.030	N/A
35	0.017	0.019	0.011	0.013	0.023	0.026	N/A
36	0.010	0.011	0.016	0.018	0.024	0.028	N/A
37	0.016	0.018	0.012	0.014	0.020	0.023	N/A
38	0.009	0.010	0.013	0.015	0.022	0.025	N/A
39	0.014	0.016	0.016	0.018	0.021	0.024	N/A
40	0.010	0.012	0.012	0.014	0.020	0.023	N/A
THD	-	1.977	-	1.843	-	2.039	13
PWHD	-	1.166	-	1.390	-	1.442	22

8.2.4	TABLE: Current harmonics emission test(EN 61000-3-2)						
Model	BNT030KTL						
Harmonic	L1		L2		L3		Limits (%)
	Magnitude (A)	% of Fundamental	Magnitude (A)	% of Fundamental	Magnitude (A)	% of Fundamental	
1	43.478	100.000	43.478	100.000	43.478	100.000	--
2	0.009	0.021	0.009	0.021	0.018	0.041	8
3	0.036	0.082	0.039	0.090	0.037	0.086	21.6%
4	0.013	0.029	0.007	0.017	0.016	0.037	4
5	0.036	0.083	0.035	0.080	0.029	0.067	10.7
6	0.013	0.029	0.006	0.014	0.007	0.015	2.7
7	0.007	0.016	0.010	0.022	0.010	0.023	7.2
8	0.003	0.006	0.003	0.006	0.004	0.009	2
9	0.010	0.024	0.002	0.004	0.011	0.025	N/A
10	0.002	0.004	0.005	0.012	0.005	0.012	1.6
11	0.032	0.073	0.030	0.069	0.033	0.075	3.1
12	0.010	0.024	0.007	0.015	0.008	0.019	1.3
13	0.018	0.042	0.018	0.041	0.017	0.038	2
14	0.004	0.010	0.005	0.012	0.007	0.016	N/A
15	0.006	0.014	0.003	0.008	0.004	0.009	N/A
16	0.006	0.014	0.007	0.017	0.008	0.019	N/A
17	0.008	0.018	0.007	0.016	0.011	0.026	N/A
18	0.007	0.017	0.007	0.015	0.011	0.026	N/A
19	0.026	0.060	0.023	0.052	0.022	0.051	N/A
20	0.007	0.017	0.006	0.013	0.007	0.016	N/A
21	0.007	0.016	0.006	0.013	0.007	0.017	N/A
22	0.008	0.019	0.004	0.010	0.005	0.011	N/A
23	0.013	0.031	0.014	0.032	0.015	0.034	N/A
24	0.008	0.019	0.009	0.020	0.010	0.023	N/A
25	0.020	0.046	0.019	0.043	0.017	0.039	N/A
26	0.005	0.012	0.005	0.012	0.007	0.015	N/A
27	0.004	0.009	0.004	0.010	0.005	0.012	N/A
28	0.005	0.011	0.007	0.015	0.005	0.011	N/A
29	0.012	0.028	0.012	0.028	0.012	0.027	N/A
30	0.007	0.015	0.005	0.012	0.007	0.015	N/A
31	0.019	0.044	0.020	0.046	0.018	0.041	N/A
32	0.005	0.012	0.004	0.009	0.005	0.011	N/A
33	0.004	0.009	0.003	0.006	0.004	0.010	N/A
34	0.007	0.015	0.008	0.018	0.007	0.017	N/A
35	0.010	0.022	0.011	0.025	0.015	0.035	N/A
36	0.007	0.015	0.006	0.014	0.007	0.016	N/A
37	0.014	0.033	0.016	0.037	0.017	0.038	N/A
38	0.003	0.008	0.004	0.009	0.003	0.008	N/A
39	0.002	0.005	0.002	0.005	0.002	0.005	N/A
40	0.006	0.013	0.006	0.014	0.007	0.015	N/A
THD	-	0.849	-	0.842	-	0.853	13
PWHD	-	0.613	-	0.610	-	0.638	22

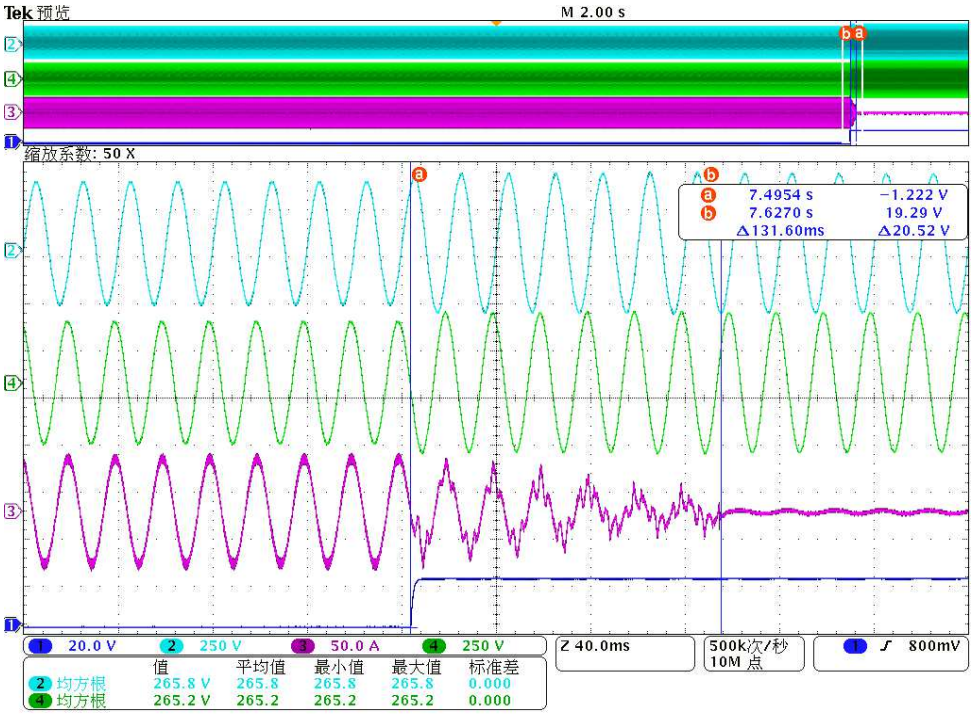
D.3	Table: Undervoltage threshold stage				P
Parameter	**Settings**	**Test 1**	**Test 2**	**Test 3**	**Limits**
Trip value L1[V]	184	183.8	183.4	183.7	184±2.3
Trip time [ms]	150	98.8	82.4	96.6	<200
L2[V]	184	183.1	183.7	183.3	184±2.3
Trip time [ms]	150	114.4	119.6	122.4	<200
L3[V]	184	183.8	183.5	183.4	184±2.3
Trip time [ms]	150	96.4	115.2	121.6	<200
L1L2L3[V]	184	183.0	183.2	183.6	184±2.3
Trip time [ms]	150	113.2	112.0	112.7	<200

Trip time

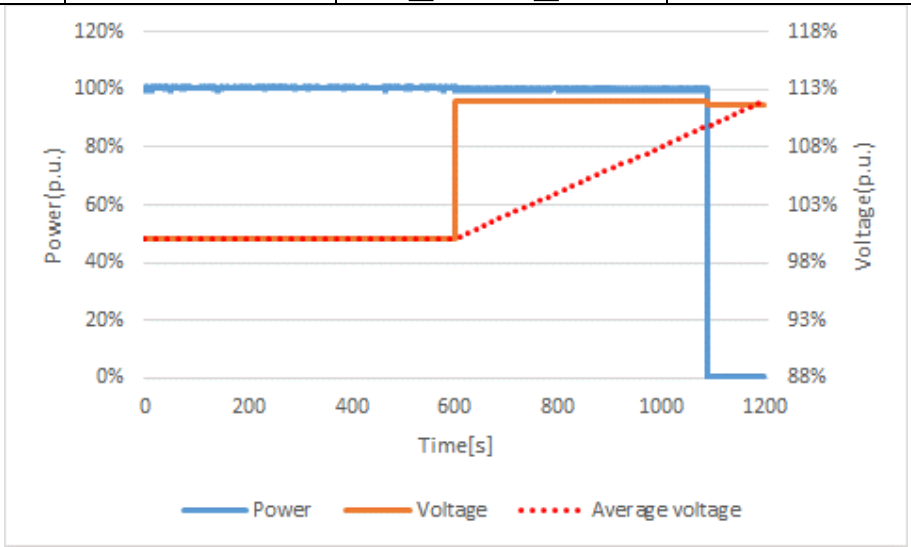


D.3	Table: Overvoltage threshold stage				P
Parameter	**Settings**	**Test 1**	**Test 2**	**Test 3**	**Limits**
Trip value L1 [V]	264.5	265.9	265.8	265.7	264.5±2.3
Trip time [ms]	100	114.4	104.0	111.6	<200
L2 [V]	264.5	265.0	265.8	265.3	264.5±2.3
Trip time [ms]	100	118.0	126.4	129.6	<200
L3 [V]	264.5	265.3	265.4	265.5	264.5±2.3
Trip time [ms]	100	131.2	99.2	133.2	<200
L1L2L3 [V]	264.5	265.8	265.7	265.4	264.5±2.3
Trip time [ms]	100	131.6	130.8	112.4	<200

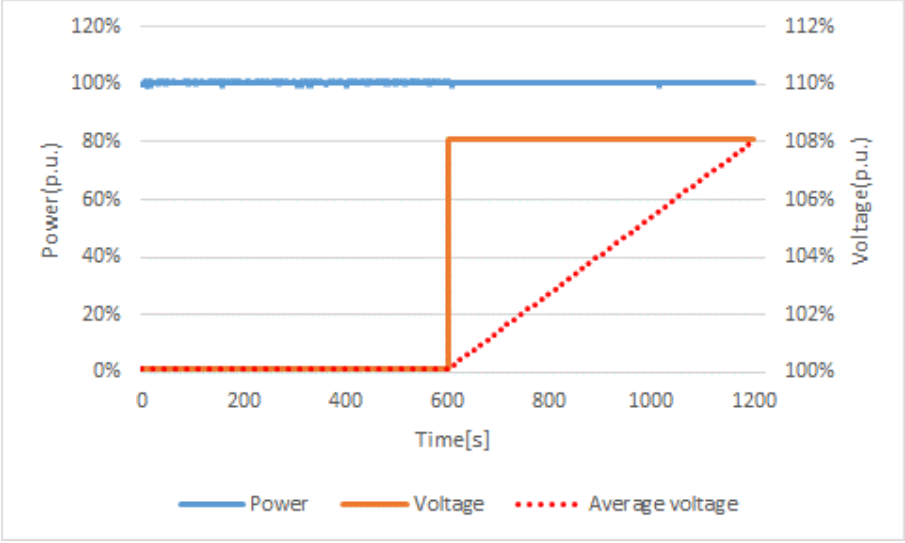
Trip time



D.3	Overvoltage 10 min mean Protection		P
	Output Voltage (V)	Switch	
		On/Off state Finally	Time until switch off (s)
100% Un	230.24	☒On ☐Off	--
112% Un	257.55	☐On ☒Off	489.0
100% Un	230.24	☒On ☐Off	--
108% Un	248.55	☒On ☐Off	--
106% Un	243.97	☒On ☐Off	--
114% Un	261.84	☐On ☒Off	289.5

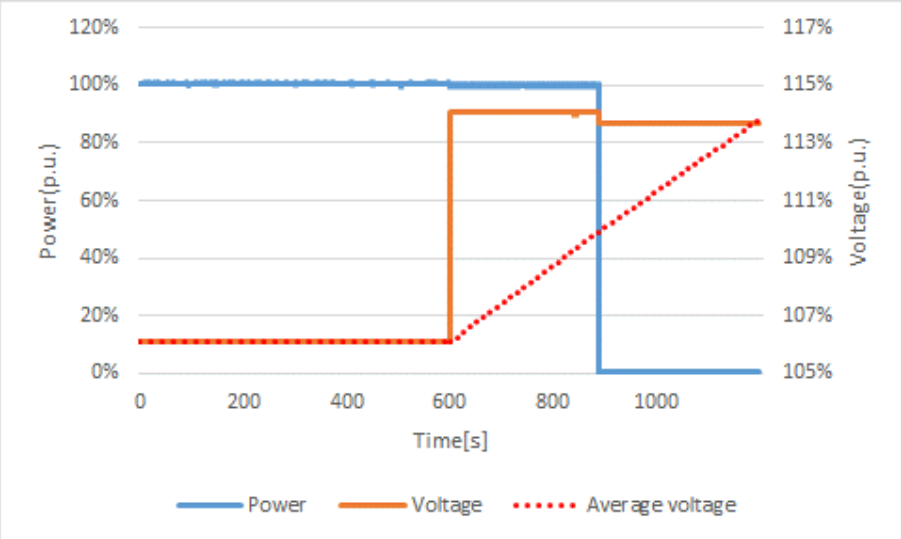


Un to 1.12Un



Un to 1.08Un

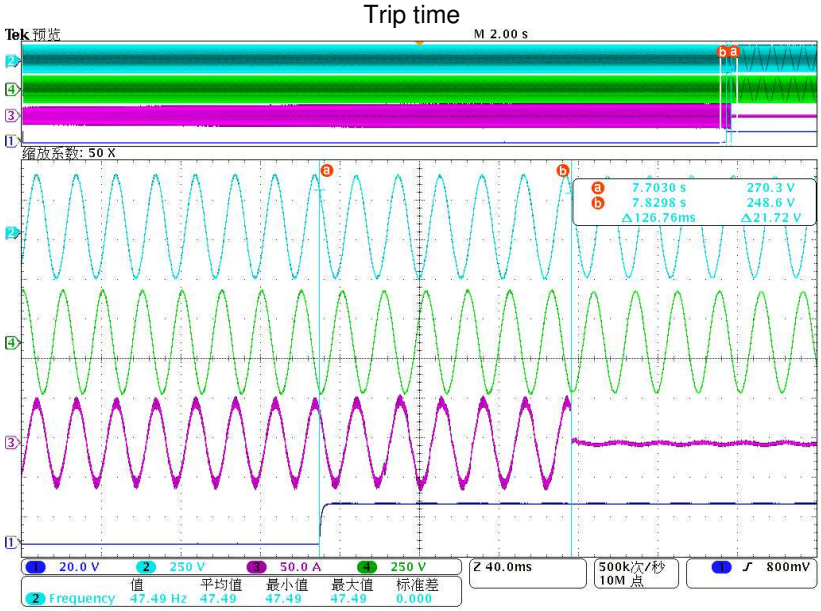
D.3	Overvoltage 10 min mean Protection	P



1.06 Un to 1.14Un

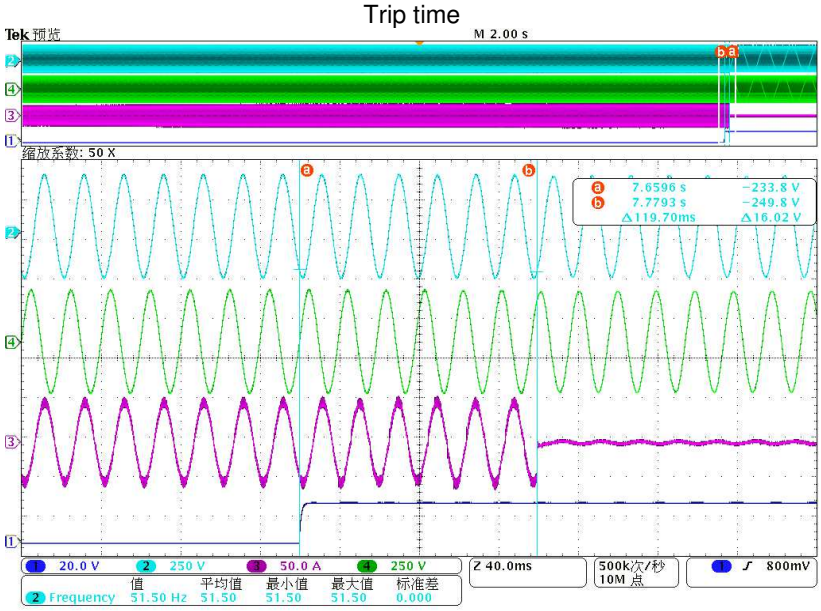
D.3	Table: Underfrequency threshold stage				P
Parameter	**Settings**	**Test 1**	**Test 2**	**Test 3**	**Limits**
Trip value [Hz]	47.5	47.49	47.49	47.49	47.5±0.05
Trip time [ms]	100	126.76	120.36	137.00	<200

Trip time



D.3	Table: Overfrequency threshold stage				P
Parameter	**Settings**	**Test 1**	**Test 2**	**Test 3**	**Limits**
Trip value [Hz]	51.50	51.50	51.50	51.50	51.5±0.05
Trip time [ms]	100	119.70	135.10	132.00	<200

Trip time

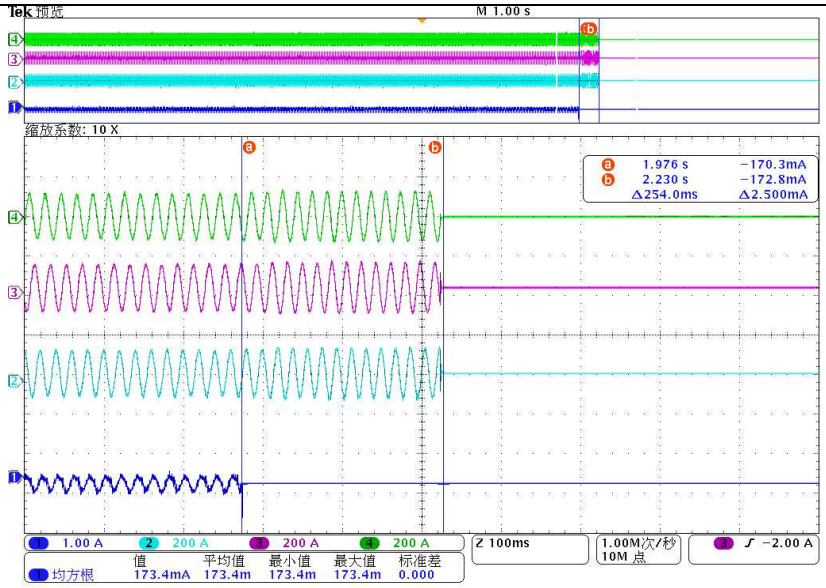


D.3	Table: Islanding								P
No.	P_{EUT}[1] (%of EUT rating)	Reactive load (% of Q_L in 6.1.d)[1]	P_{AC}[2] (% of nominal)	Q_{AC}[3] (% of nominal)	Run on time (ms)	P_{EUT} (W)	Actual Q_f	V_{DC}	Remarks[4]
1	100	100	0	0	254.0	60000	1.00	785	Test A at BL
2	66	66	0	0	559.0	39600	1.00	690	Test B at BL
3	33	33	0	0	532.0	19800	1.00	576	Test C at BL
4	100	100	-5	-5	181.0	60000	0.98	785	Test A at IB
5	100	100	-5	0	201.0	60000	1.00	785	Test A at IB
6	100	100	-5	5	210.0	60000	1.02	785	Test A at IB
7	100	100	0	-5	243.0	60000	0.98	785	Test A at IB
8	100	100	0	5	230.0	60000	1.00	785	Test A at IB
9	100	100	5	-5	202.0	60000	0.96	785	Test A at IB
10	100	100	5	0	192.0	60000	0.97	785	Test A at IB
11	100	100	5	5	171.0	60000	1.00	785	Test A at IB
12	66	66	0	-5	207.6	39600	0.97	690	Test B at IB
13	66	66	0	-4	212.8	39600	0.98	690	Test B at IB
14	66	66	0	-3	220.4	39600	0.98	690	Test B at IB
15	66	66	0	-2	246.0	39600	0.99	690	Test B at IB
16	66	66	0	-1	331.0	39600	0.99	690	Test B at IB
17	66	66	0	1	371.0	39600	0.99	690	Test B at IB
18	66	66	0	2	297.6	39600	1.00	690	Test B at IB
19	66	66	0	3	227.6	39600	0.99	690	Test B at IB
20	66	66	0	4	213.6	39600	1.02	690	Test B at IB
21	66	66	0	5	199.2	39600	1.01	690	Test B at IB
22	33	33	0	-5	205.6	19800	0.96	576	Test C at IB
23	33	33	0	-4	207.2	19800	0.97	576	Test C at IB
24	33	33	0	-3	226.0	19800	0.98	576	Test C at IB
25	33	33	0	-2	290.4	19800	0.99	576	Test C at IB
26	33	33	0	-1	359.0	19800	0.98	576	Test C at IB
27	33	33	0	1	308.0	19800	0.99	576	Test C at IB
28	33	33	0	2	242.4	19800	0.99	576	Test C at IB
29	33	33	0	3	216.0	19800	1.00	576	Test C at IB
30	33	33	0	4	206.0	19800	1.01	576	Test C at IB
31	33	33	0	5	190.8	19800	1.02	576	Test C at IB

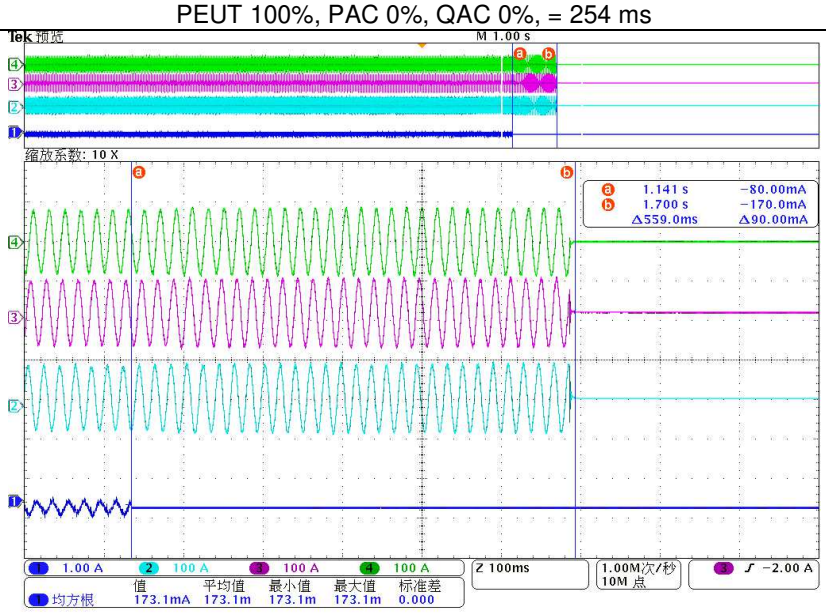
Remark:

1) P_{EUT}: EUT output power
2) P_{AC}: Real power flow at S1 in Figure 1. Positive means power from EUT to utility. Nominal is the 0% test condition value.
3) Q_{AC}: Reactive power flow at S1 in Figure 1. Positive means power from EUT to utility. Nominal is the 0% test condition value.
4) BL: Balance condition, IB: Imbalance condition.
5) *Note: test condition A (100%): If any of the recorded run-on times are longer than the one recorded for the rated balance condition, i.e. test procedure 6.1 f), then the non-shaded parameter combinations (no.32~47) also require testing.

D.3	Table: Islanding	P

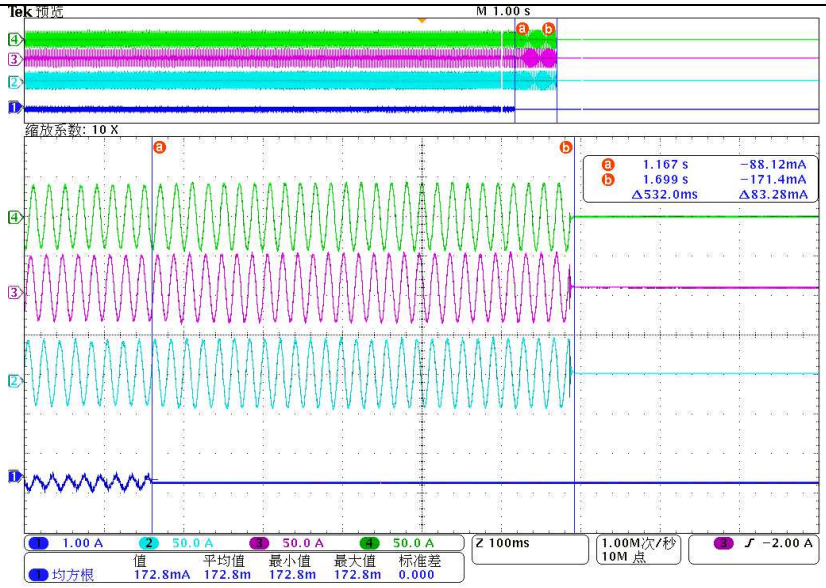


PEUT 100%, PAC 0%, QAC 0%, = 254 ms



PEUT 66%, PAC 0%, QAC 0%, = 559 ms

D.3	Table: Islanding	P



PEUT 33%, PAC 0%, QAC 0%, = 532 ms

4.4.4		TABLE: Single fault tolerance				P
No.	Component name	Component No.	Fault point	Duration	Result	
1.	ISO Relay	K1	Short circuit before start up inverter	3min	Unit can't operating, error massage: Iso Fault. No danger ,no hazard ,no fires	
2.	Monitoring Relay - L1	RL3	Pin1 to Pin2 short circuit before start up inverter	3min	Unit can't operating, error massage: Grid Relay Fault. No danger ,no hazard ,no fires	
3.	Monitoring Relay - L1	RL3	Pin3 to Pin4 short circuit before start up inverter	3min	Unit can't operating, error massage: Grid Relay Fault. No danger ,no hazard ,no fires	
4.	Monitoring Relay - L1	RL9	Pin1 to Pin2 short circuit before start up inverter	3min	Unit can't operating, error massage: Grid Relay Fault. No danger ,no hazard ,no fires	
5.	Monitoring Relay - L1	RL9	Pin3 to Pin4 short circuit before start up inverter	3min	Unit can't operating, error massage: Grid Relay Fault. No danger ,no hazard ,no fires	
6.	Monitoring Relay - L2	RL2	Pin1 to Pin2 short circuit before start up inverter	3min	Unit can't operating, error massage: Grid Relay Fault. No danger ,no hazard ,no fires	
7.	Monitoring Relay - L2	RL2	Pin3 to Pin4 short circuit before start up inverter	3min	Unit can't operating, error massage: Grid Relay Fault. No danger ,no hazard ,no fires	
8.	Monitoring Relay - L2	RL8	Pin1 to Pin2 short circuit before start up inverter	3min	Unit can't operating, error massage: Grid Relay Fault. No danger ,no hazard ,no fires	
9.	Monitoring Relay - L2	RL8	Pin3 to Pin4 short circuit before start up inverter	3min	Unit can't operating, error massage: Grid Relay Fault. No danger ,no hazard ,no fires	
10.	Monitoring Relay - L3	RL1	Pin1 to Pin2 short circuit before start up inverter	3min	Unit can't operating, error massage: Grid Relay Fault. No danger ,no hazard ,no fires	
11.	Monitoring Relay - L3	RL1	Pin3 to Pin4 short circuit before start up inverter	3min	Unit can't operating, error massage: Grid Relay Fault. No danger ,no hazard ,no fires	
12.	Monitoring Relay - L3	RL7	Pin1 to Pin2 short circuit before start up inverter	3min	Unit can't operating, error massage: Grid Relay Fault. No danger ,no hazard ,no fires	
13.	Monitoring Relay - L3	RL7	Pin3 to Pin4 short circuit before start up inverter	3min	Unit can't operating, error massage: Grid Relay Fault. No danger ,no hazard ,no fires	
14.	AC voltage measure1	R777	Pin1-Pin2 Short circuit	3min	Unit shut down, Error message: Grid Volt Fault. no danger ,no hazard ,no fires	
15.	AC voltage measure1	R783	Pin1-Pin2 Open circuit	3min	Unit shut down, Error message: Grid Volt Fault. no danger ,no hazard ,no fires	
16.	AC voltage measure2	R784	Pin1-Pin2 Short circuit	3min	Unit shut down, Error message: Grid Volt Fault. no danger ,no hazard ,no fires	
17.	AC voltage measure2	R790	Pin1-Pin2 Open circuit	3min	Unit shut down, Error message: Grid Volt Fault. no danger ,no hazard ,no fires	

18.	AC voltage measure3	R791	Pin1-Pin2 Short circuit	3min	Unit shut down, Error message: Grid Volt Fault. no danger ,no hazard ,no fires
19.	AC voltage measure3	R797	Pin1-Pin2 Open circuit	3min	Unit shut down, Error message: Grid Volt Fault. no danger ,no hazard ,no fires
20.	AC current measure1	R571	Pin1-Pin2 Short circuit	3min	Unit can't operating, error message: Inv Over Current. No damage ,no hazard ,no fire.
21.	AC current measure2	R581	Pin1-Pin2 Short circuit	3min	Unit can't operating, error message: Inv Over Current. No damage ,no hazard ,no fire.
22.	AC current measure3	R593	Pin1-Pin2 Short circuit	3min	Unit can't operating, error message: Inv Over Current. No damage ,no hazard ,no fire.
23.	AC frequency measure	R555	Pin1-Pin2 Open circuit	3min	Unit shut down, error message: Grid Freq Fault. No damage ,no hazard ,no fire
24.	V-bus measure	R492	Pin1-Pin2 Short circuit	3min	Unit shut down ,error massage: BusAllVoltHwOveFault. No damage ,no hazard ,no fire
25.	V-bus measure	R100	Pin1-Pin2 Short circuit	3min	Unit can't start up No damage ,no hazard ,no fire
26.	DC current measure	U26	Pin1-Pin2 Short circuit	3min	Unit shut down,error message: PV1HwoVerCurrFault. no danger ,no hazard ,no fires
27.	Bus cap	C41	Pin1-Pin2 Short circuit before start up	3min	Unit can not start up, No damage, no hazard, no fire.
28.	COM-of CPU1-CPU2	C258	Pin 172 Open circuit	3min	Unit shut down. error message: Slave Com Waring. No damage, no hazard, no fire.
29.	CPU1 Failure -Power	R159	Pin 1-Pin2 Short circuit	3min	Unit shut down. No damage ,no hazard ,no fire
30.	T measure	U7	Pin1-Pin2 Short circuit	3min	Unit can't operating,Error massage: CoolingTemAdChanWarning. No damage, no hazard, no fire.
31.	Insulation impedance measure	Q2	Pin1-Pin2 Short circuit	3min	Unit can't operating,Error massage: Iso Err. No damage, no hazard, no fire.
32.	Drive optocoupler	Q2	Pin1-Pin2 Short circuit before start up	~~3min~~	Unit can not start up, No damage, no hazard, no fire.
33.	power tube Boost	Q2	Pin1-Pin2 Short circuit before start up	3min	Unit can not start up, No damage, no hazard, no fire.
34.	power tube Boost	D20	Pin1-Pin3 Short circuit before start up	3min	Unit can not start up, No damage, no hazard, no fire.
35.	power tube Boost	TQ6	Pin2-Pin3 Short circuit before start up	3min	Unit can not start up, No damage, no hazard, no fire.
36.	Diode	U26	Short circuit	3min	Unit normal operation, No danger ,no hazard ,no fires
37.	power tube IGBT - inverter	C41	Pin1-Pin2 Short circuit before start up	3min	Unit can't start ,error message: Hardware Fault, No damage ,no hazard ,no fire

38.	power tube IGBT - inverter	TQ6	Pin1-Pin3 Short circuit before start up	3min	Unit can't start ,error message: Hardware Fault, No damage ,no hazard ,no fire
39.	GFCI check	R553	Short circuit	3min	Unit shut down, error message: GFCI Fault. No damage ,no hazard ,no fire
40.	Power supply +20V	T1	Pin10-Pin11 Short circuit before start up	3min	Unit can not start up, No damage, no hazard, no fire.
41.	Power supply +8V	T1	Pin25-Pin26 Short circuit before start up	3min	Unit can not start up, No damage, no hazard, no fire.
42.	Power supply +12V	T1	Pin27-Pin29 Short circuit before start up	3min	Unit can not start up, No damage, no hazard, no fire.
43.	Power supply +12V	T1	Pin132-Pin34 Short circuit before start up	3min	Unit can not start up, No damage, no hazard, no fire.
44.	power tube MOS-SPS	Q3	G-D Short circuit	3min	SPS no output, no danger ,no hazard ,no fires
45.	Output L1 to N	--	short circuit	3min	Unit shut down ,error message: Grid Volt Fault. No damage ,no hazard ,no fire
46.	Output L1 to L2	--	short circuit	3min	Unit shut down ,error message: Grid Volt Fault. No damage ,no hazard ,no fire
47.	Output L to PE	--	short circuit	3min	Unit shut down ,error message: Grid Volt Fault. No damage ,no hazard ,no fire
48.	Output N to PE	--	short circuit	3min	Unit shut down ,error message: Grid Volt Fault. No damage ,no hazard ,no fire
49.	Overload	--	Output overload (110%)	30 min	Unit normal operation, No damage ,no hazard ,no fire
50.	Cooling system failure – Blanketing test	--	Put the unit to box	2Hour	1 hour power run at 80%
51.	PV+ to PV-	--	Reverse polarity	3min	Unit can not start up, no danger ,no hazard ,no fires
52.	Output L - N	--	Reverse polarity before start up	3min	Unit normal operation. No damage, no hazard, no fire.
53.	Output L1 - N	--	Reverse polarity before start up	3min	Unit can't operating, error message: Grid Volt Fault. No damage ,no hazard ,no fire
54.	Output L1 - L2	--	Reverse polarity before start up	3min	Unit normal operation. No damage, no hazard, no fire.

Remarks:

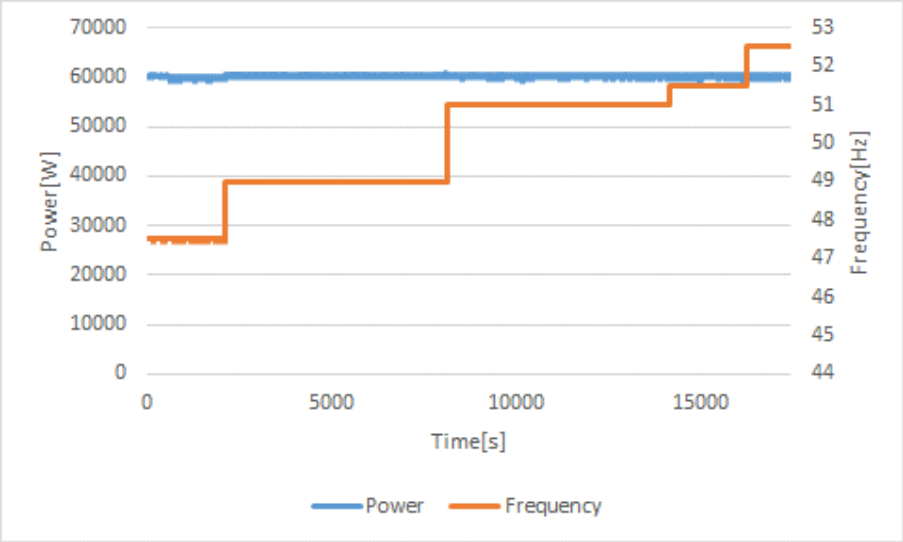
Abbreviations APS:auxiliary power supply, EM: error message
, EUT: equipment under test, SC short circuit, OP: open circuit, O/L: Overloaded
EUT shut down: EUT not connect to Grid ,cease to export power to Grid, the relay is opened.
EUT standby: EUT connect to Grid ,cease to export power to Grid, the relay is closed.

During the test:
Fire can not propagates beyond the EUT;
Equipment shall not emitt molten metal;
Enclosures shall not deform to cause non-compliance with the standard.
Dielectric test is made on RI and BI between Pri. circuit and protective earthing terminal after the test.
No Backfeed voltage on the test

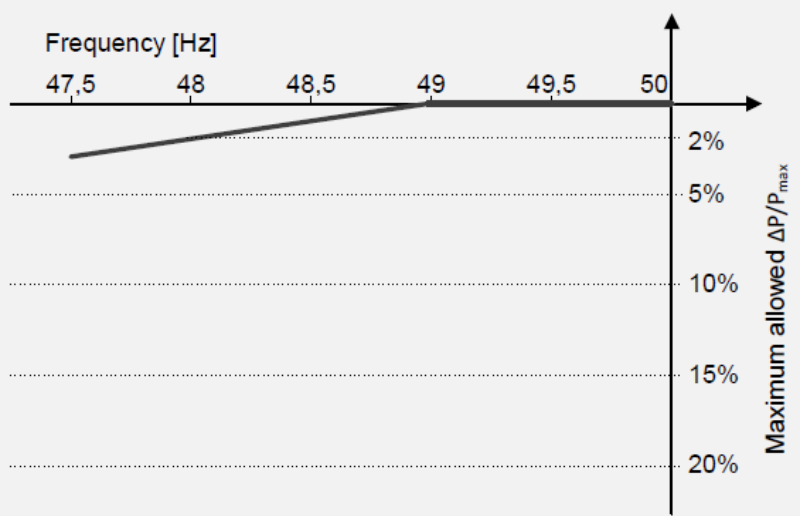
D.4.1	Table: Operating frequency range	P

Frequency domain	Duration
47,5 Hz – 49,0 Hz	30 minutes
49,0 Hz – 51,0 Hz	Permanent
51,0 Hz – 51,5 Hz	30 minutes

Steps	f (Hz)	f (Hz) Measured	Time	Time measured	Comments
1	47.5 Hz	47.50	>30 min	35min	Operated normally.
2	49.0 Hz	49.00	Permanent	100min	Operated normally.
3	51.0 Hz	51.00	Permanent	100min	Operated normally.
4	51.5 Hz	51.50	>30 min	35min	Operated normally.
5	52.5 Hz	52.50	>15 min	20min	Operated normally.

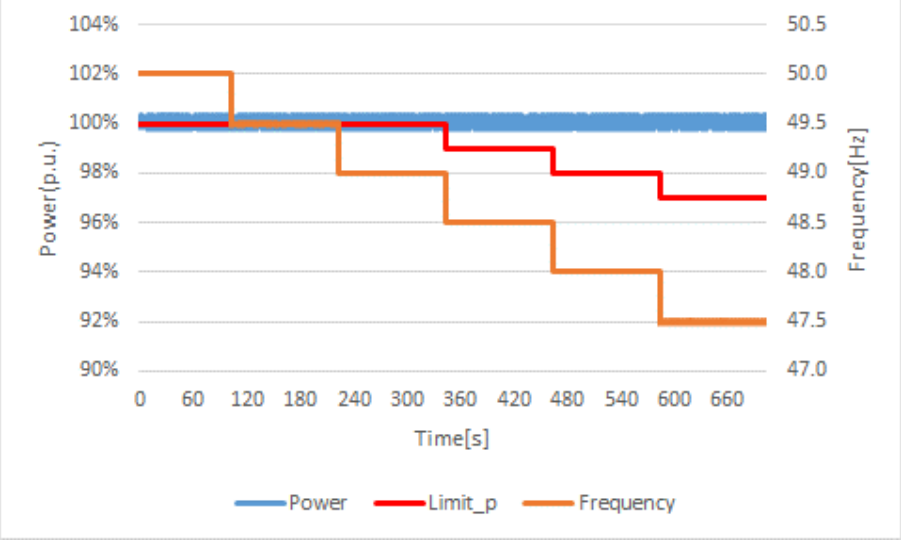


D.4.2	Table: Minimal requirements for active power delivery at underfrequency	P



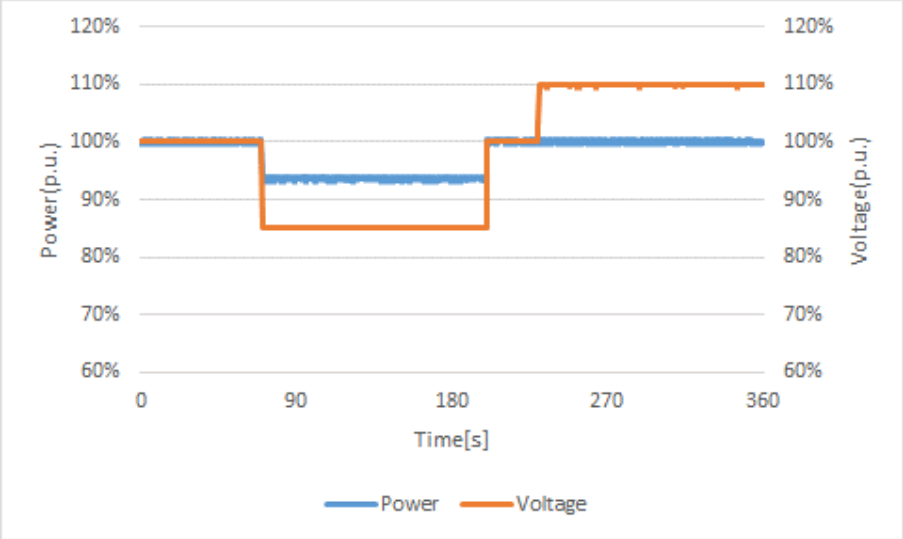
Step	f (Hz)	fmea. (Hz)	T (s)	T meas. (s)	P (%) - max	P (%) - min	P meas. (%)
1	50.00 ± 0.05	50.00	>60	103	100%	100%	100.09%
2	49.50 ± 0.05	49.50	>60	120	100%	100%	100.09%
3	49.00 ± 0.05	49.00	>60	120	100%	100%	100.09%
4	48.50 ± 0.05	48.50	>60	120	100%	99%	100.09%
5	48.00 ± 0.05	48.00	>60	120	100%	98%	100.10%
6	47.50 ± 0.05	47.50	>60	120	100%	97%	100.09%

Supplementary information:



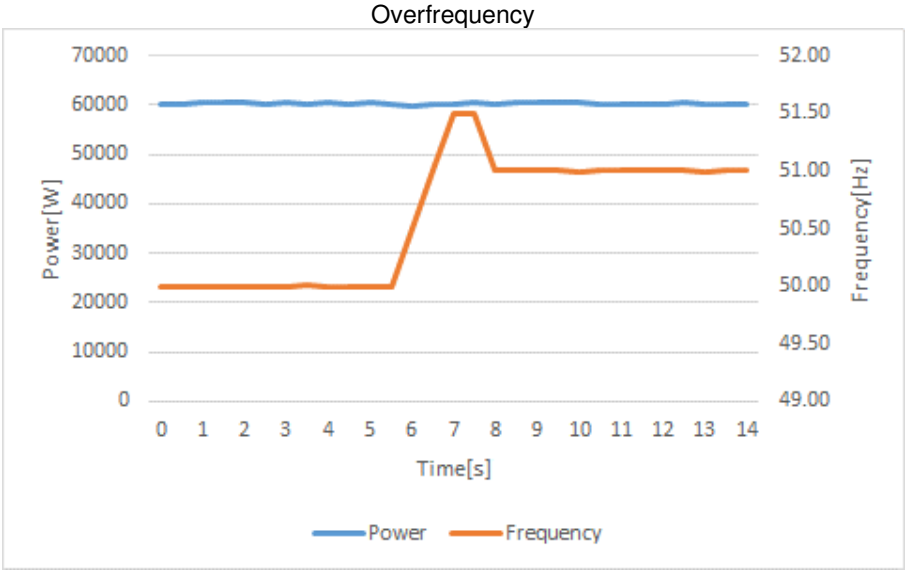
D.4.3	Table: Continuous voltage operation range				P
Step	Voltage (%)	P (%)	P meas. (%)	Time (s)	T meas (s)
1	100	100	100.07%	>60	70
2	85	100 (*)	93.70%	>120	130
3	100	100	100.08%	>5	30
4	110	100	100.08%	>120	130

(*) Active power reduction is allowed due to current limitation.

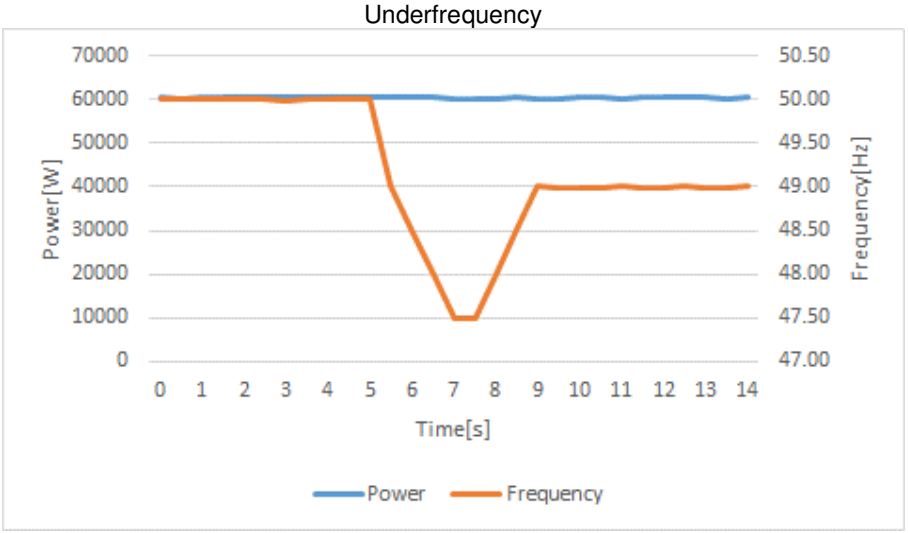


D.5.1	Table: Rate of change of frequency (ROCOF)					P
Steps	Overfrequency			Underfrequency		
	f (Hz)	Step time (s)	Output power (W)	f (Hz)	Step time (s)	Output power (W)
1	50.0 to 51.0	0.5	59966	50.0 to 49.0	0.5	60211
2	51.0 to 51.5	0.5	60259	49.0 to 47.5	1.5	60197
3	51.5	1	60143	47.5	1	59970
4	51.5 to 51.0	0.5 s	60124	47.5 to 49.0	1.5	60075
5	51.0	3.0 s	60115	49.0	0.5	60157

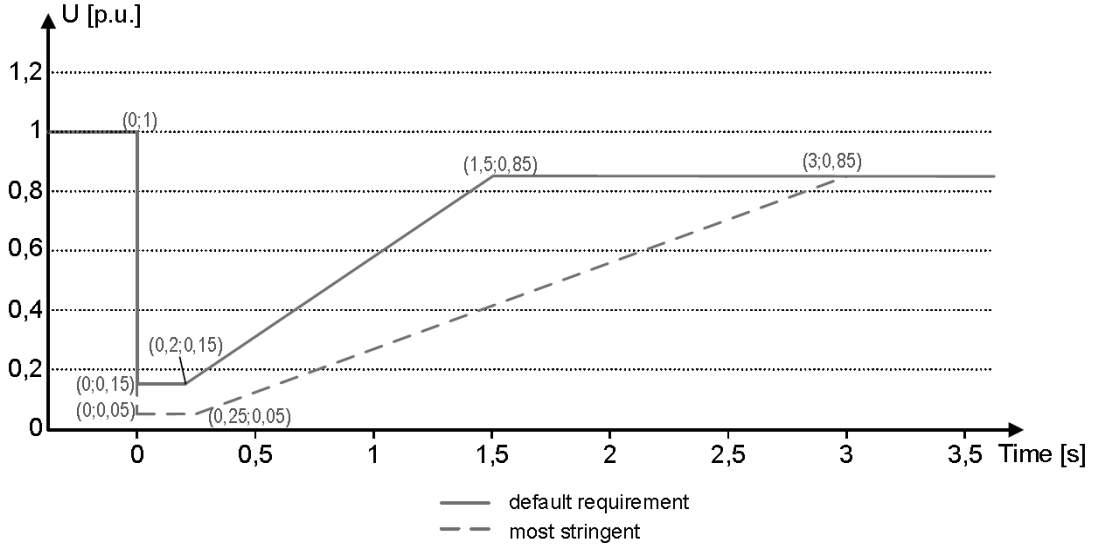
Overfrequency



Underfrequency



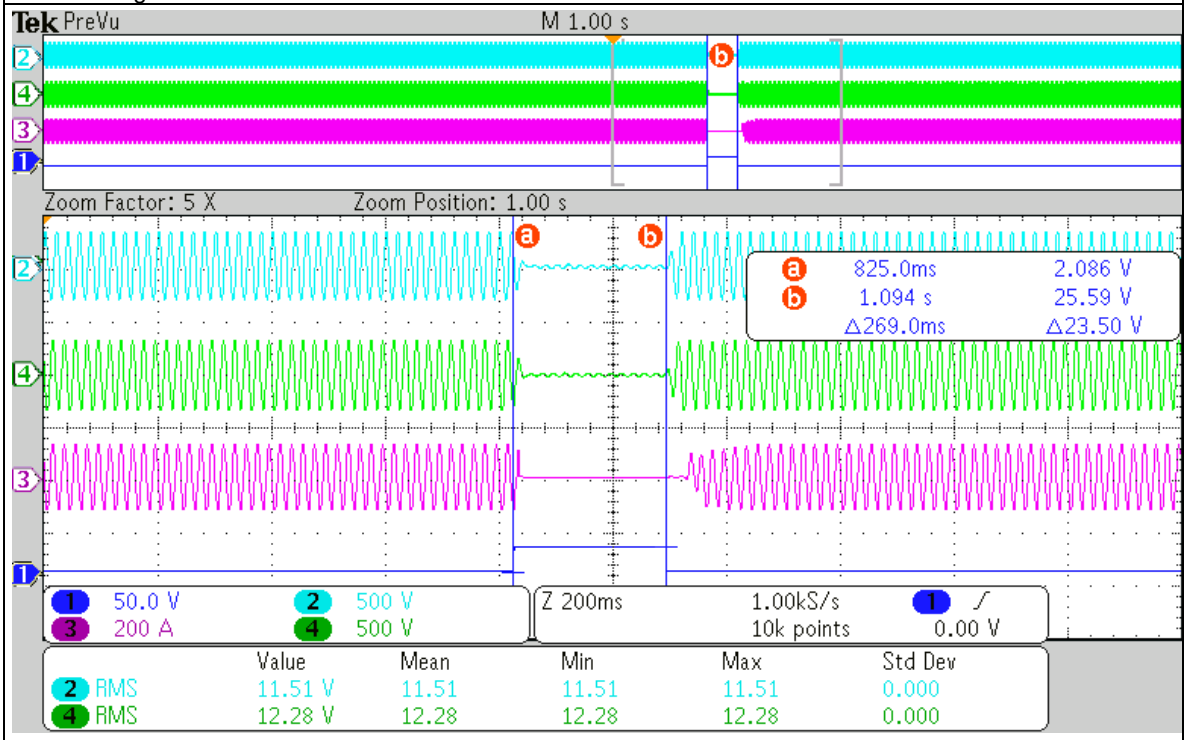
D.5.2	Table: UVRT	P



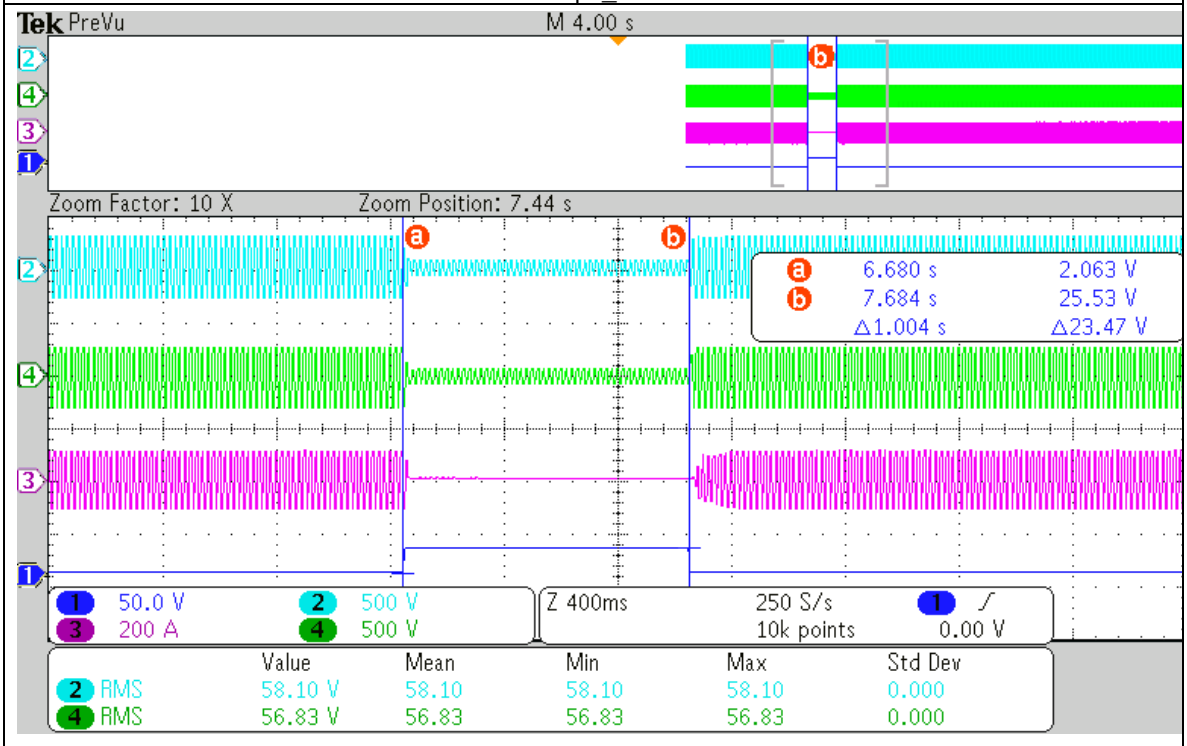
Test at full load (>90%)

Udip	Type		t min (ms)	U meas. (%)	T meas.(ms)	P recover (s)
5%	1 ph	Phase A	250	5.27/99.96/100.00	260	0.076
		Phase B		99.48/5.15/100.00	264	0.087
		Phase C		100.00/99.04/5.17	262	0.092
	2 ph	Phase A & B		5.23/4.82/100.00	261	0.071
		Phase B & C		100.00/5.18/4.82	262	0.070
		Phase C & A		5.32/100.00/5.12	265	0.087
	3 ph			5.00/5.34/5.00	269	0.084
25%	1 ph	Phase A	938	100.57/25.13/100.00	1002	0.078
		Phase B		25.25/99.26/100.00	1001	0.072
		Phase C		100.00/100.09/24.90	998	0.075
	2 ph	Phase A & B		24.77/25.07/100.00	1010	0.089
		Phase B & C		100.00/25.12/24.62	1013	0.085
		Phase C & A		24.96/100.00/24.82	999	0.076
	3 ph			25.26/24.71/5.00	1004	0.089
50%	1 ph	Phase A	1797	99.96/50.17/100.00	1851	0.086
		Phase B		50.52/98.96/100.00	1851	0.084
		Phase C		100.00/99.13/49.52	1852	0.087
	2 ph	Phase A & B		50.39/49.87/100.00	1851	0.086
		Phase B & C		100.00/50.35/49.74	1846	0.086
		Phase C & A		50.22/100.00/49.52	1856	0.082
	3 ph			50.78/49.87/50.00	1846	0.087
75%	1 ph	Phase A	2656	100.78/74.26/100.00	2706	0.063
		Phase B		75.78/99.39/100.00	2701	0.096
		Phase C		100.00/101.13/75.79	2697	0.084
	2 ph	Phase A & B		75.30/76.00/100.00	2716	0.083
		Phase B & C		100.00/76.17/75.61	2705	0.091
		Phase C & A		74.61/100.00/75.87	2709	0.095
	3 ph			75.35/75.83/75.00	2701	0.095

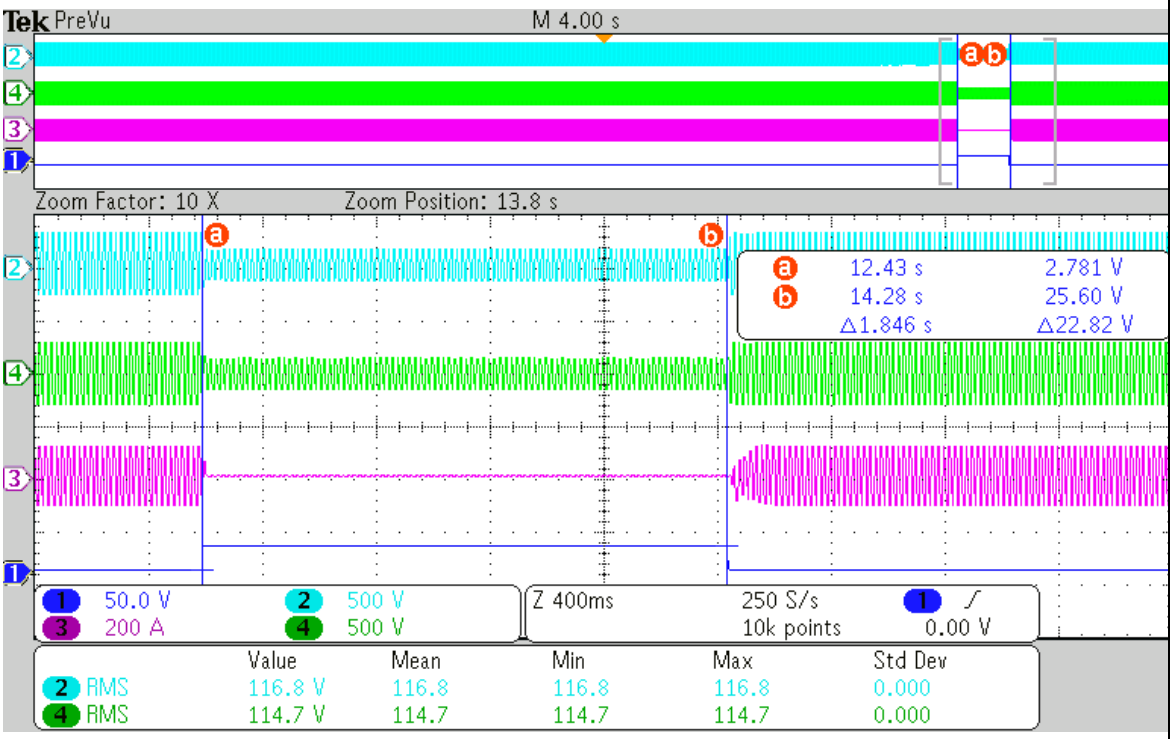
Remark:
The tests are performed together with clause 4.7.4.2.2 Zero current mode and enabling of default setting:
Undervoltage of 70%Un.



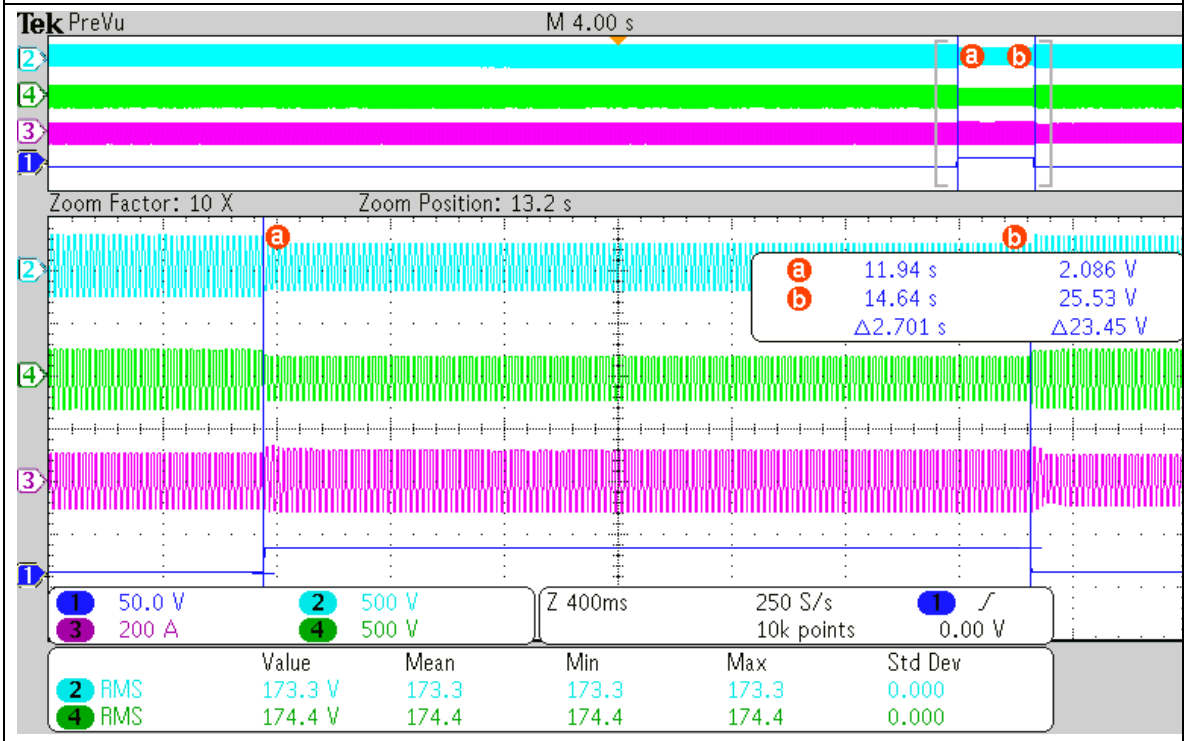
Graph_5%



Graph_25%



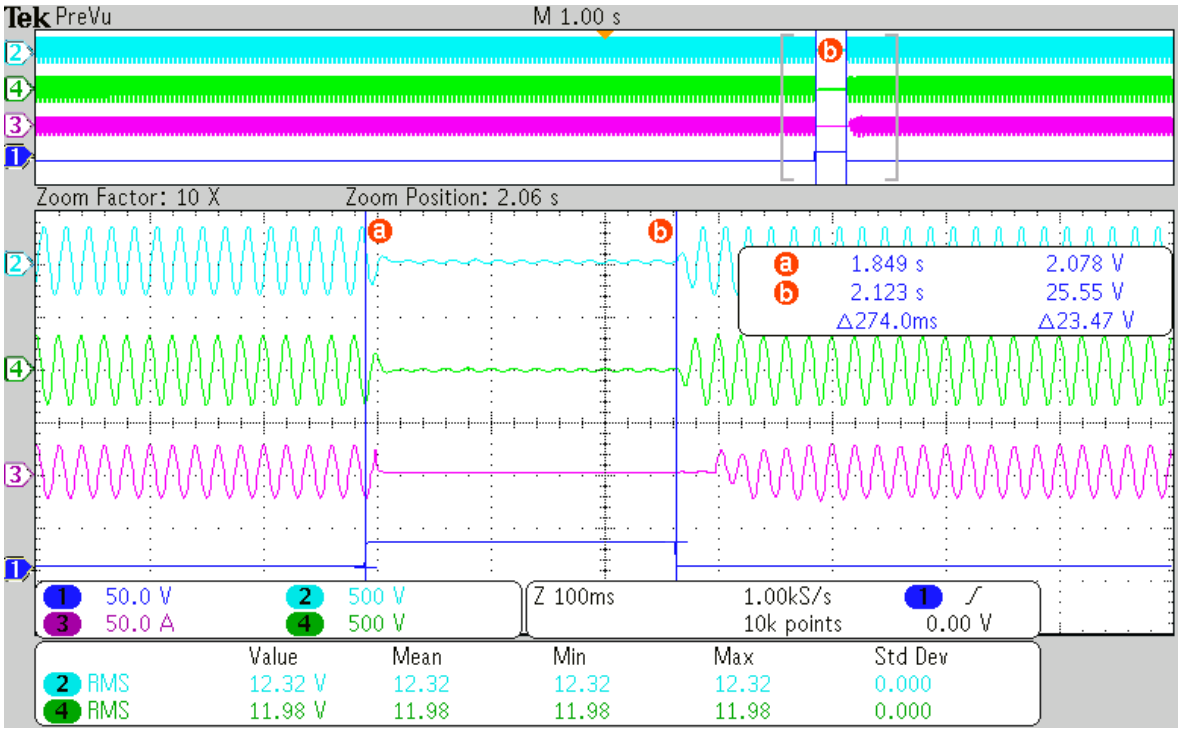
Graph_50%



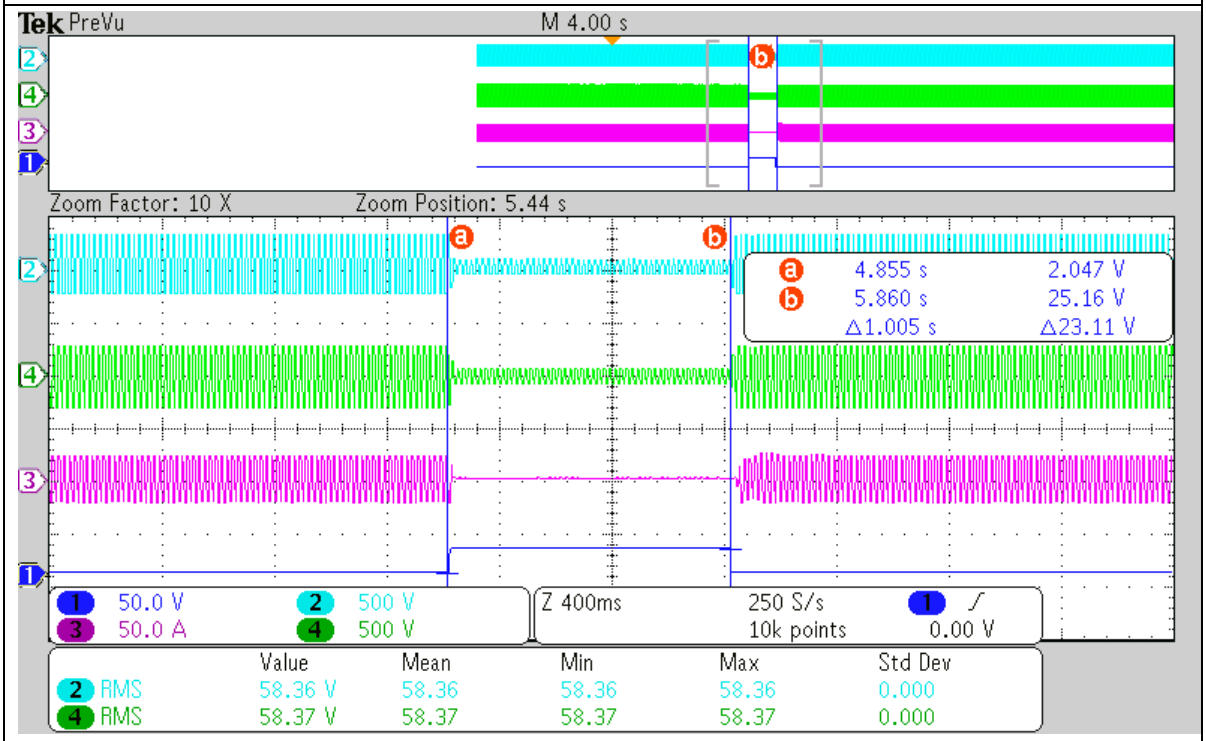
Graph_75%

D.5.2	Table: UVRT					P
Test at partial load (30%Pn)						
Udip	Type		t min (ms)	U meas. (%)	T meas.(ms)	P recover (s)
5%	1 ph	Phase A	250	100.87/4.75/100.00	264	0.070
		Phase B		4.79/100.17/100.00	279	0.091
		Phase C		100.00/99.65/5.02	272	0.081
	2 ph	Phase A & B		5.24/5.26/100.00	271	0.079
		Phase B & C		100.00/5.31/4.88	268	0.082
		Phase C & A		5.12/100.00/5.36	272	0.081
	3 ph			5.36/5.21/5.00	274	0.096
25%	1 ph	Phase A	938	100.09/24.75/100.00	1004	0.073
		Phase B		24.77/100.26/100.00	1000	0.077
		Phase C		100.00/100.17/24.70	1005	0.072
	2 ph	Phase A & B		24.71/24.97/100.00	1000	0.077
		Phase B & C		100.00/24.98/24.69	1003	0.072
		Phase C & A		25.07/100.00/25.03	1002	0.075
	3 ph			25.37/25.38/25.00	1005	0.074
50%	1 ph	Phase A	1797	100.70/49.61/100.00	1843	0.093
		Phase B		50.70/99.61/100.00	1852	0.083
		Phase C		100.83/50.83/100.00	1853	0.087
	2 ph	Phase A & B		49.48/50.09/100.00	1851	0.083
		Phase B & C		100.00/49.91/49.96	1847	0.084
		Phase C & A		50.78/100.00/49.13	1853	0.083
	3 ph			50.78/50.09/50.00	1849	0.084
75%	1 ph	Phase A	2656	99.22/75.83/100.00	2702	0.094
		Phase B		75.70/99.09/100.00	2695	0.076
		Phase C		100.00/100.30/74.22	2704	0.074
	2 ph	Phase A & B		75.35/75.91/100.00	2706	0.090
		Phase B & C		100.00/74.83/76.22	2704	0.092
		Phase C & A		75.04/100.00/76.00	2688	0.088
	3 ph			75.96/76.35/75.00	2702	0.075

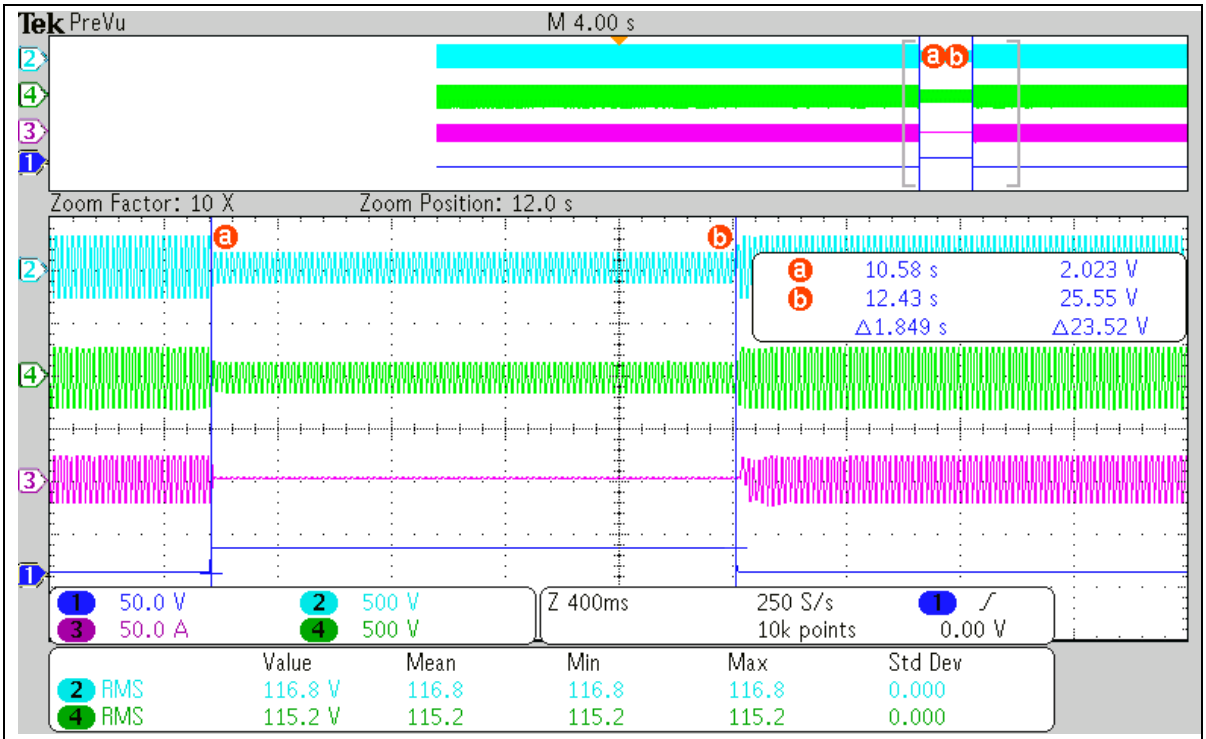
Remark:
The tests are performed together with clause 4.7.4.2.2 Zero current mode and enabling of default setting: undervoltage of 70%Un.



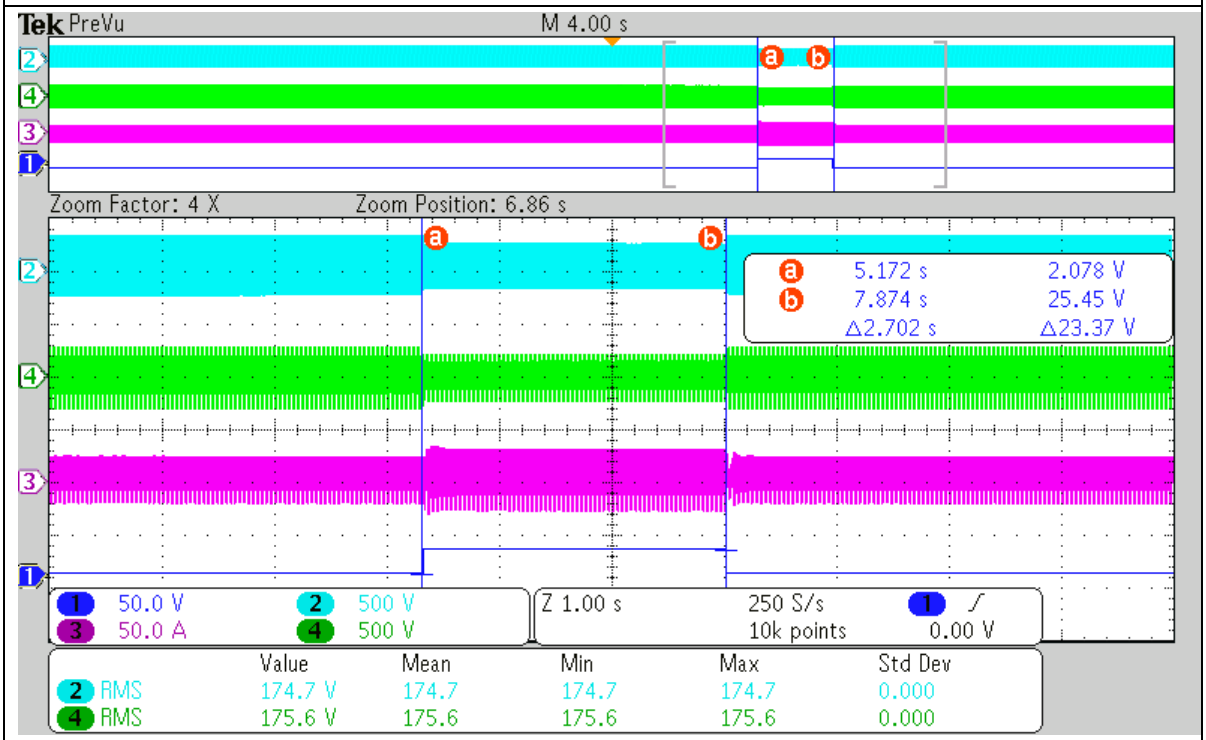
Graph_5%



Graph_25%



Graph_50%



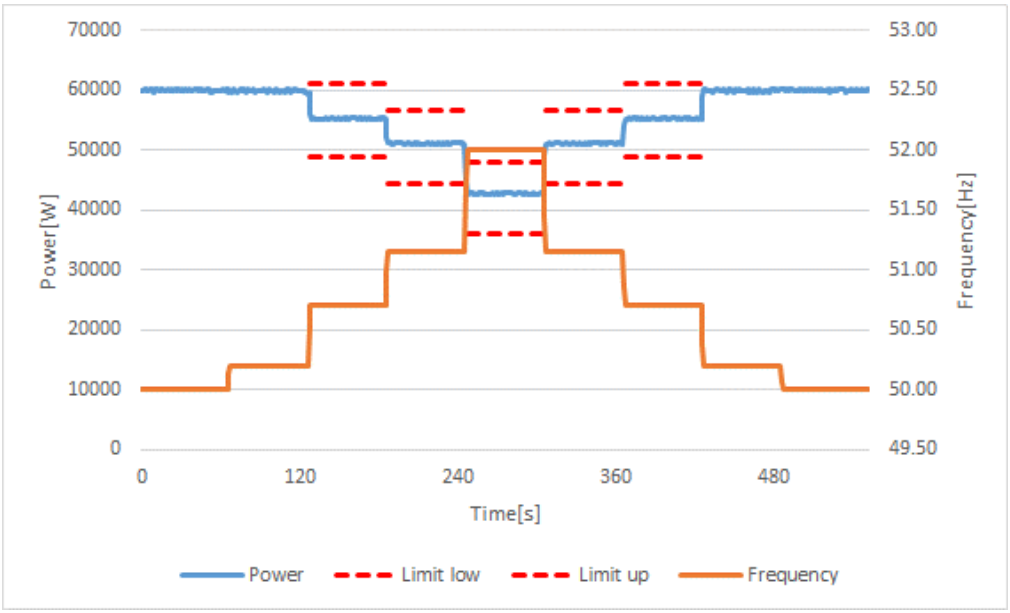
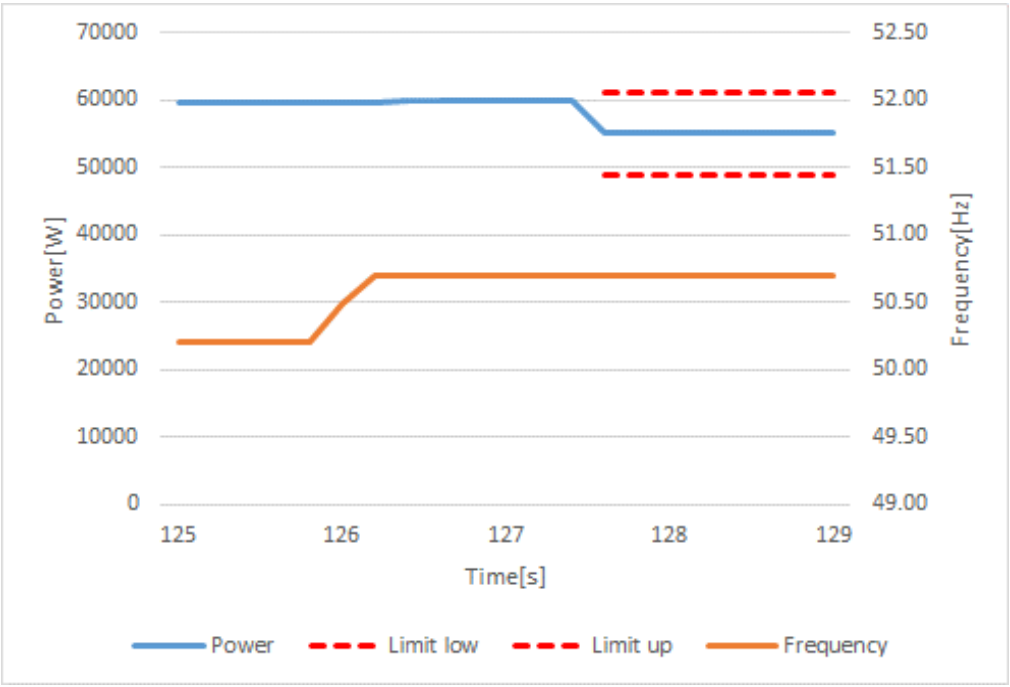
Graph_75%

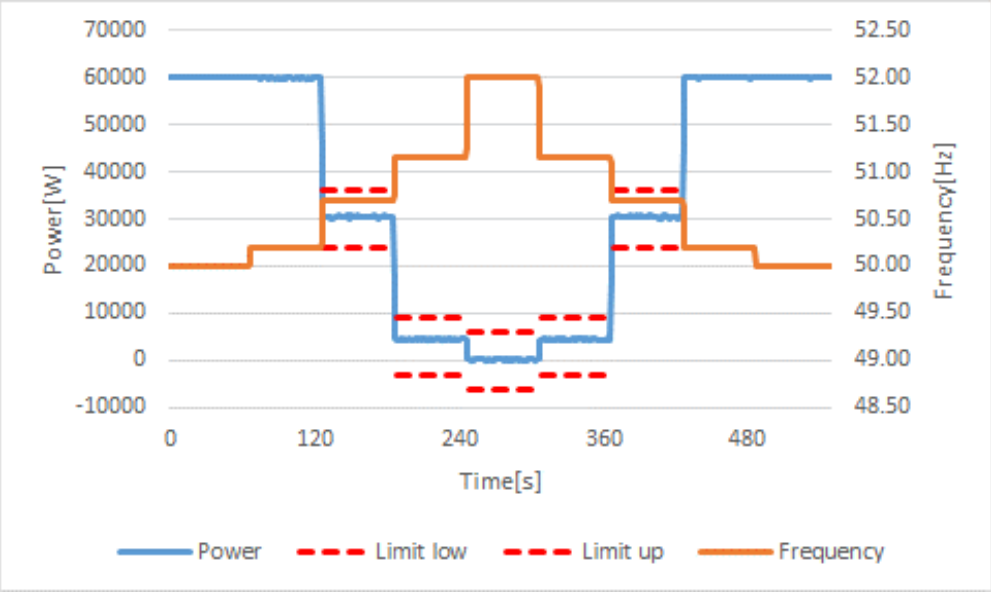
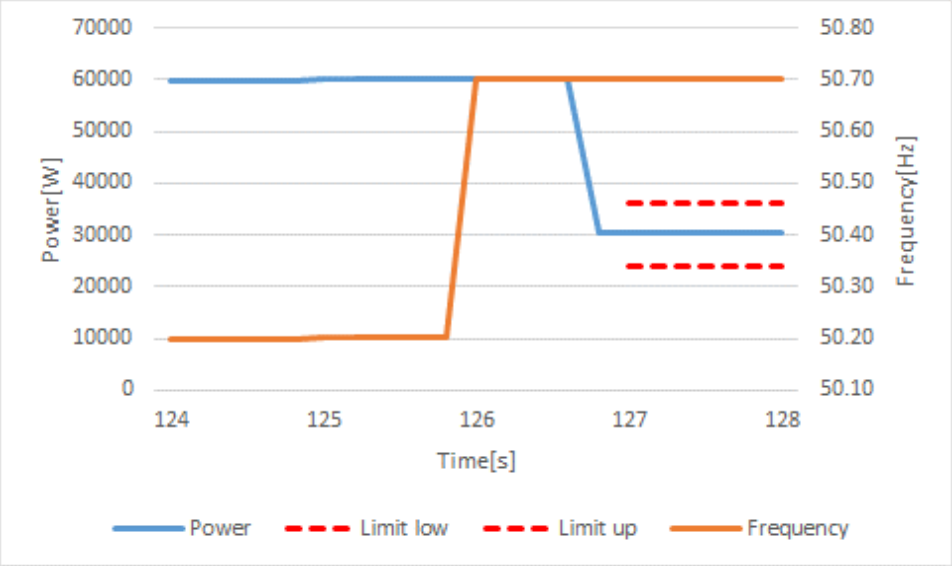
D.6.1	Table: Power response to over frequency	P

Grid tied mode

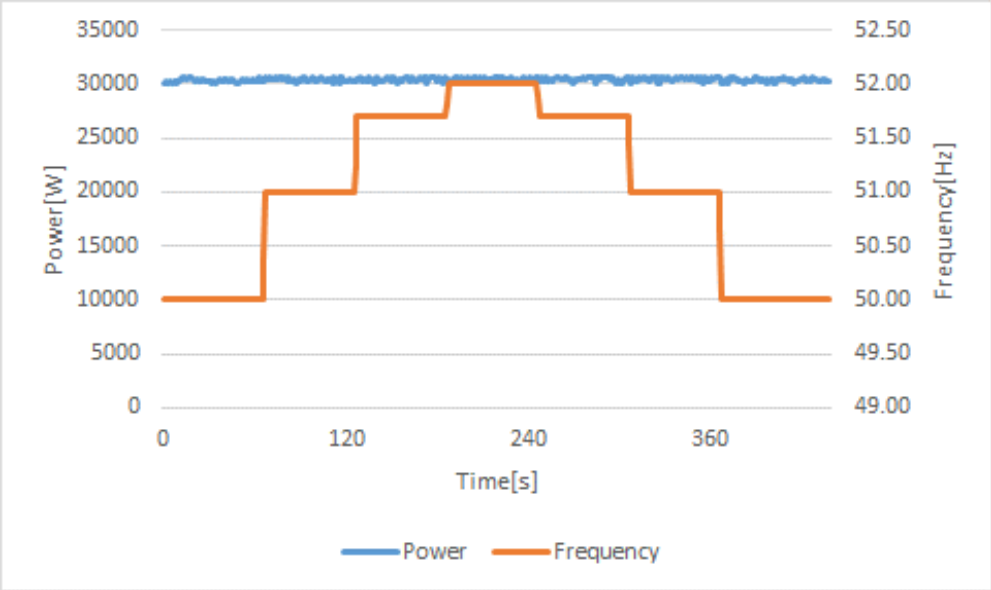
Test 1	100% P_n, f1 =50.2Hz; droop=12%; f-stop deactivated, with delay of 2 s						
	f (Hz)	Measured output Power (W)	Calculated from standard characteristic curve P (W)	Tolerance between measured P and calculated P (W)	Tolerance Limit (W)	For a reduction of active power of 50% Pmax T≤2s	For a reduction of active power T≤20s
50Hz ± 0.01Hz	50.00	60035.32	60000	--	--	--	--
50.2Hz ± 0.01Hz	50.20	59925.85	60000	--	--	--	--
50.70Hz ± 0.01Hz	50.70	55341.27	55000	341.27	± 6000	0.4s	0.8s
51.15Hz ± 0.01Hz	51.15	51175.90	50500	675.90	± 6000	0.4s	0.6s
52.0Hz ± 0.01Hz	52.00	42800.48	42000	800.48	± 6000	0.4s	0.8s
51.15Hz ± 0.01Hz	51.15	51130.15	50500	630.15	± 6000	0.2s	0.4s
50.70Hz ± 0.01Hz	50.70	55241.98	55000	241.98	± 6000	0.2s	0.4s
50.2Hz ± 0.01Hz	50.20	59958.92	60000	-41.08	± 6000	0.4s	0.6s
50Hz ± 0.01Hz	50.00	60017.04	60000	--	--	--	--
Test 2	100% P_n, f1 =50.2Hz; droop=2%; f-stop deactivated, no delay						
	f (Hz)	Measured output Power (W)	Calculated from standard characteristic curve P (W)	Tolerance between measured P and calculated P (W)	Tolerance Limit (W)	For a reduction of active power of 50% Pmax T≤2s	For a reduction of active power T≤20s
50Hz ± 0.01Hz	50.00	60063.43	--	--	--	--	--
50.2Hz ± 0.01Hz	50.20	59939.68	--	--	--	--	--
50.70Hz ± 0.01Hz	50.70	30692.77	30000	692.77	± 6000	0.4s	0.6s
51.15Hz ± 0.01Hz	51.15	4709.79	3000	1709.79	± 6000	0.4s	0.8s
52.0Hz ± 0.01Hz	52.00	223.28	0	223.28	± 6000	0.4s	0.6s
51.15Hz ± 0.01Hz	51.15	4456.75	3000	1456.75	± 6000	0.6s	0.8s
50.70Hz ± 0.01Hz	50.70	30252.40	30000	252.40	± 6000	0.4s	0.4s
50.2Hz ± 0.01Hz	50.20	59777.62	--	--	--	0.4s	0.6s
50Hz ± 0.01Hz	50.00	60029.74	--	--	--	--	--

Test 3	50% P_n, f1 =52.0Hz; droop=5%; f-stop deactivated, no delay						
	f (Hz)	Measured output Power (W)	Calculated from standard characteristic curve P (W)	Tolerance between measured P and calculated P (W)	Tolerance Limit (W)	For a reduction of active power of 50% Pmax T≤2s	For a reduction of active power T≤20s
50Hz ± 0.01Hz	50.00	30326.33	--	--	--	--	--
51.0Hz ± 0.01Hz	51.00	30420.18	30000.00	420.18	± 6000	--	--
51.70Hz ± 0.01Hz	51.70	30451.13	30000.00	451.13	± 6000	--	--
52.0Hz ± 0.01Hz	52.00	30451.52	30000.00	451.52	± 6000	--	--
51.70Hz ± 0.01Hz	51.70	30476.67	30000.00	476.67	± 6000	--	--
51.00Hz ± 0.01Hz	51.00	30485.38	30000.00	485.38	± 6000	--	--
50Hz ± 0.01Hz	50.00	30365.14	--	--	--	--	--
Test 4	100% P_n, f1 =50.2Hz; droop=5%; f-stop =50.1, no delay, Deactivation time t**stop** 30s						
	f (Hz)	Measured output Power (W)	Calculated from standard characteristic curve P (W)	Tolerance between measured P and calculated P (W)	Tolerance Limit (W)	For a reduction of active power of 50% Pmax T≤2s	For a reduction of active power T≤20s
50Hz ± 0.01Hz	50.00	59969.24	60000	--	--	--	--
50.2Hz ± 0.01Hz	50.20	59800.58	60000	--	--	--	--
50.70Hz ± 0.01Hz	50.70	47055.03	48000	-944.97	± 6000	0.4s	0.6s
51.15Hz ± 0.01Hz	51.15	36650.15	37200	-549.85	± 6000	0.2s	0.4s
52.0Hz ± 0.01Hz	52.00	17070.00	16800	270.00	± 6000	0.4s	0.6s
51.15Hz ± 0.01Hz	51.15	16962.45	16800	162.45	± 6000	--	--
50.70Hz ± 0.01Hz	50.70	16958.87	16800	158.87	± 6000	--	--
50.2Hz ± 0.01Hz	50.20	16949.80	16800	--	--	--	--
50Hz ± 0.01Hz	50.00	60057.88	60000	--	--	--	--

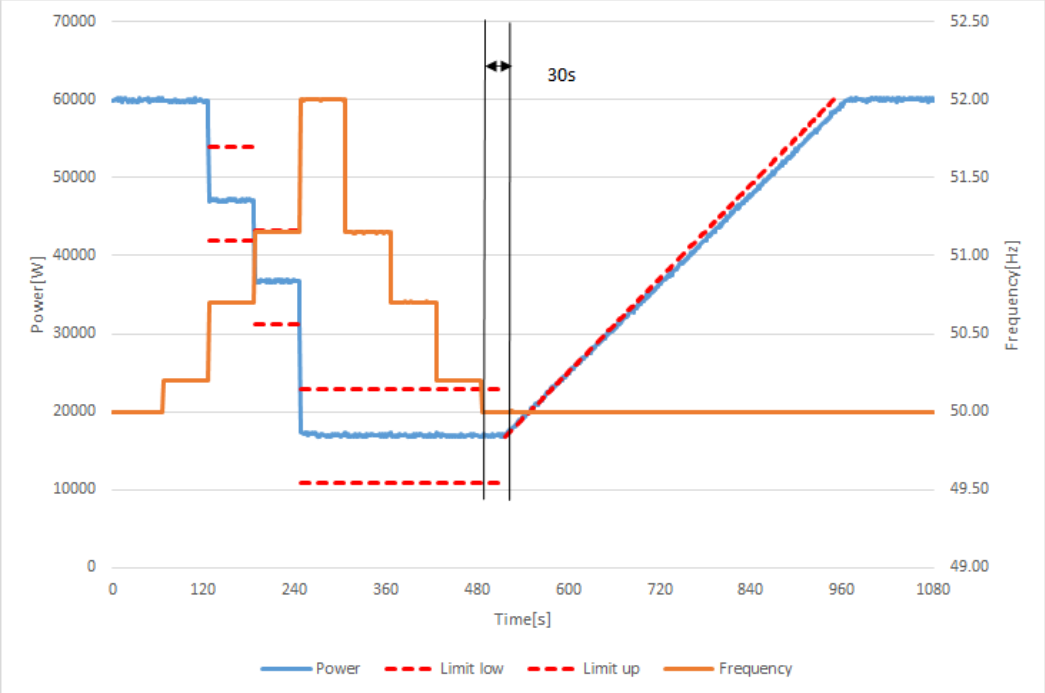
Test 1_Graph

Intentional delay time (2s)


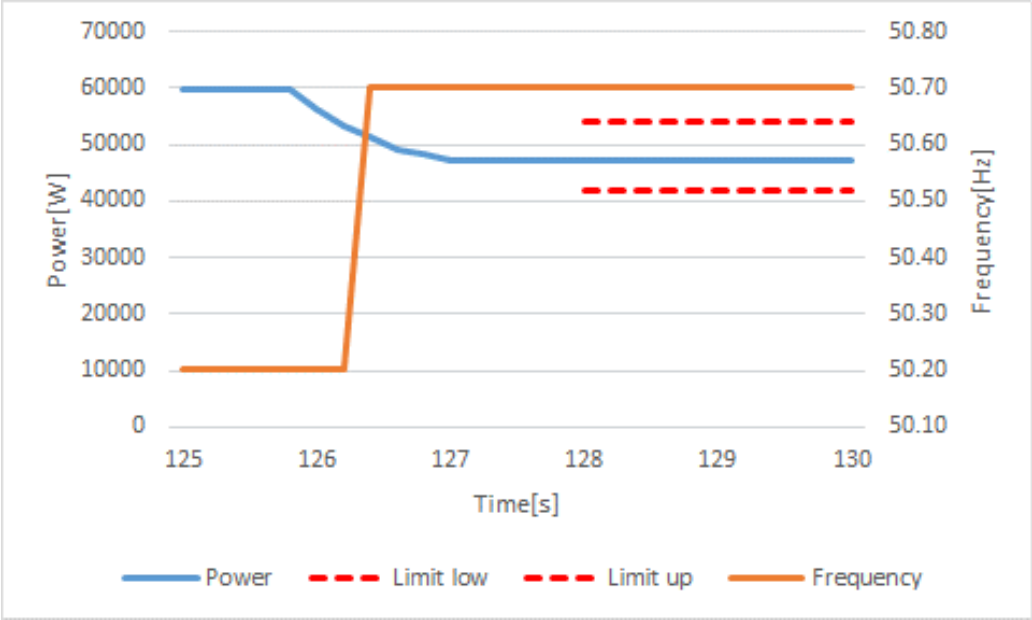
Test 2_Graph

Step response time (T≤2s)


Test 3_Graph



Test 4_Graph



Step response time (T≤2s)


D.7.1	Table: Q Capabilities (Power Factor)	P

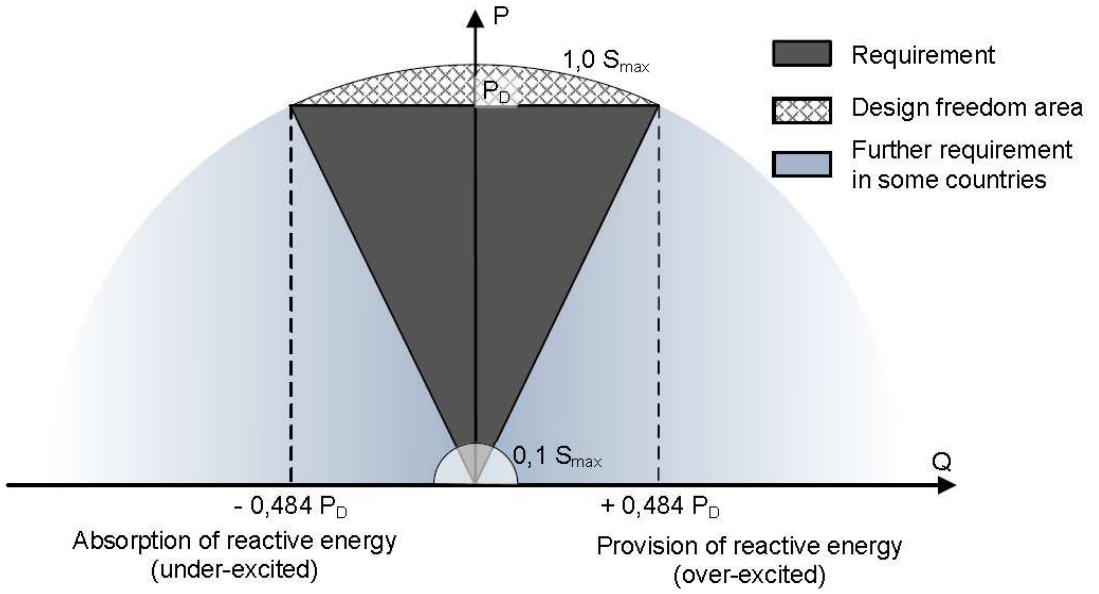


Figure 12 — Reactive power capability at nominal voltage

Leading PF=0.9:

P/Pn[%] setpoint	P[W]	Q[Var]	Cosφ	Cosφ setpoint	Δcosφ	Q[Var] setpoint	ΔQ/Smax [%]	LIMITE [%]
10	6178.82	3498.70	0.8697	0.9	-0.0434	2905.93	0.10	± 2
20	12263.42	5967.68	0.8992	0.9	0.0000	5811.87	0.05	± 2
30	18329.55	8918.56	0.8992	0.9	-0.0005	8717.80	0.10	± 2
40	24370.35	11832.58	0.8996	0.9	-0.0014	11623.73	0.14	± 2
50	30381.24	14775.86	0.8993	0.9	-0.0002	14529.66	0.21	± 2
60	36356.64	17648.90	0.8996	0.9	-0.0004	17435.60	0.21	± 2
70	42326.99	20531.96	0.8997	0.9	-0.0004	20341.53	0.22	± 2
80	48298.74	23437.19	0.8997	0.9	-0.0006	23247.46	0.25	± 2
90	54258.43	26356.55	0.8995	0.9	-0.0008	26153.39	0.30	± 2
100*	54429.89	26306.34	0.9004	0.9	0.0015	--	--	--

* Remark: Due to the max current limit, the active power can't get to 100%.

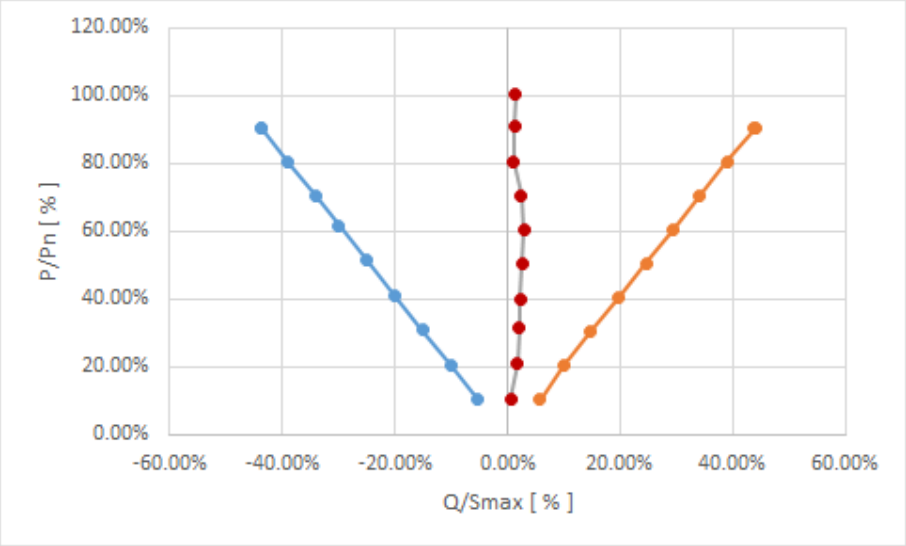
Lagging PF=-0.9:

P/Pn[%] setpoint	P[W]	Q[Var]	Cosφ	Cosφ setpoint	Δcosφ	Q[Var] setpoint	ΔQ/Smax [%]	LIMITE [%]
10	6249.76	-3143.37	0.8931	0.9	-0.0437	-2905.93	-0.04	± 2
20	12391.62	-6035.21	0.8990	0.9	-0.0011	-5811.87	-0.07	± 2
30	18585.03	-9031.70	0.8994	0.9	0.0029	-8717.80	-0.16	± 2
40	24761.87	-12009.62	0.8998	0.9	0.0017	-11623.73	-0.26	± 2
50	30894.44	-14941.95	0.9002	0.9	0.0020	-14529.66	-0.34	± 2
60	37049.66	-17957.15	0.8999	0.9	0.0017	-17435.60	-0.52	± 2
70	42230.55	-20395.59	0.9005	0.9	0.0013	-20341.53	-0.06	± 2
80	48227.72	-23351.84	0.9001	0.9	0.0012	-23247.46	-0.14	± 2
90	54220.76	-26205.25	0.9004	0.9	0.0010	-26153.39	-0.08	± 2
100*	54407.73	-26227.27	0.9008	0.9	0.0013	--	--	--

* Remark: Due to the max current limit, the active power can't get to 100%.

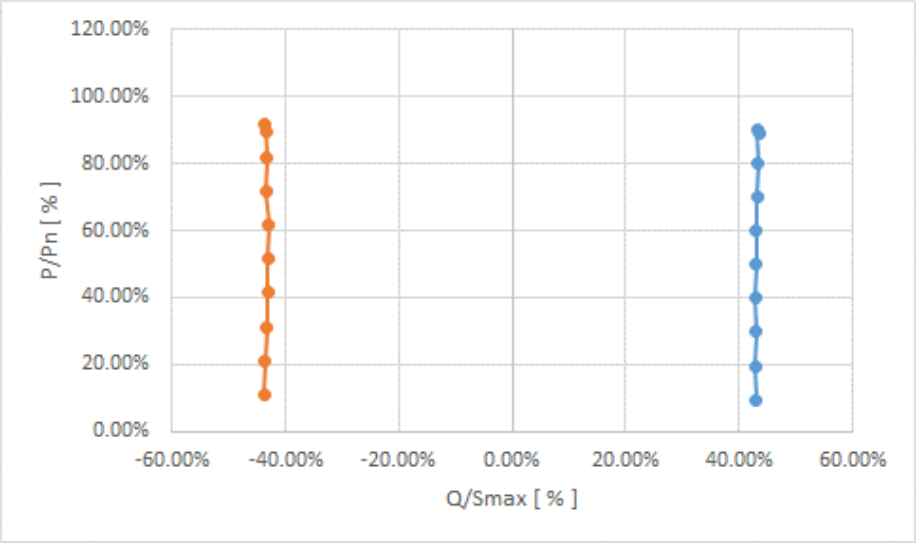
Q=0:

D.7.1	Table: Q Capabilities (Power Factor)							P
P/Pn[%] setpoint	P[W]	Q[Var]	Cosφ	Cosφ Set-point	Δcosφ	Q[Var] setpoint	ΔQ/S_{max} [%]	LIMITE [%]
10	6353.05	391.82	0.9980	1.0	-0.0061	0.00	0.07	± 2
20	12668.69	1109.56	0.9962	1.0	-0.0011	0.00	0.37	± 2
30	19011.69	1260.33	0.9978	1.0	-0.0005	0.00	0.63	± 2
40	24085.73	1367.08	0.9984	1.0	-0.0004	0.00	0.91	± 2
50	30133.86	1533.97	0.9987	1.0	-0.0003	0.00	1.28	± 2
60	36145.32	1739.59	0.9988	1.0	-0.0002	0.00	1.74	± 2
70	42375.97	1513.50	0.9994	1.0	-0.0001	0.00	1.77	± 2
80	48264.05	708.43	0.9999	1.0	-0.0001	0.00	0.94	± 2
90	54479.76	738.15	0.9999	1.0	-0.0001	0.00	1.11	± 2
100	60293.54	904.02	0.9999	1.0	-0.0001	0.00	1.51	± 2



Graph

D.7.1	Table: Q Capabilities (Power Factor)					P
Q=43.58%P_D						
P/Pn[%] setpoint	P[W]	Q[Var]	Cosφ	Q[Var] setpoint	$\Delta Q/S_{max}$ [%]	LIMITE [%]
10	5689.93	25798.22	0.22	26148.00	-0.58	± 2
20	11778.10	25718.93	0.42	26148.00	-0.72	± 2
30	17857.51	25819.79	0.57	26148.00	-0.55	± 2
40	23911.83	25711.11	0.68	26148.00	-0.73	± 2
50	29952.58	25824.22	0.76	26148.00	-0.54	± 2
60	35972.69	25726.75	0.81	26148.00	-0.70	± 2
70	42003.19	25849.13	0.85	26148.00	-0.50	± 2
80	47996.61	25951.36	0.88	26148.00	-0.33	± 2
90	54090.77	25913.66	0.90	26148.00	-0.39	± 2
100*	53446.79	26045.88	0.90	26148.00	-0.17	± 2
Q=-43.58%P_D						
P/Pn[%] setpoint	P[W]	Q[Var]	Cosφ	Q[Var] setpoint	$\Delta Q/S_{max}$ [%]	LIMITE [%]
10	6634.49	-26207.66	0.25	-26148.00	-0.10	± 2
20	12726.72	-26083.34	0.44	-26148.00	0.11	± 2
30	18793.79	-25936.72	0.59	-26148.00	0.35	± 2
40	24864.78	-25818.44	0.69	-26148.00	0.55	± 2
50	31065.74	-25820.57	0.77	-26148.00	0.55	± 2
60	37116.20	-25670.94	0.82	-26148.00	0.80	± 2
70	42960.65	-26030.07	0.86	-26148.00	0.20	± 2
80	48948.86	-25911.83	0.88	-26148.00	0.39	± 2
90	54887.58	-26151.11	0.90	-26148.00	-0.01	± 2
100*	53536.14	-26033.75	0.90	-26148.00	0.19	± 2
* Remark: Due to the max current limit, the active power can't get to 100%.						
Graph						



D.7.1	Table: Q(U) Capabilities	P

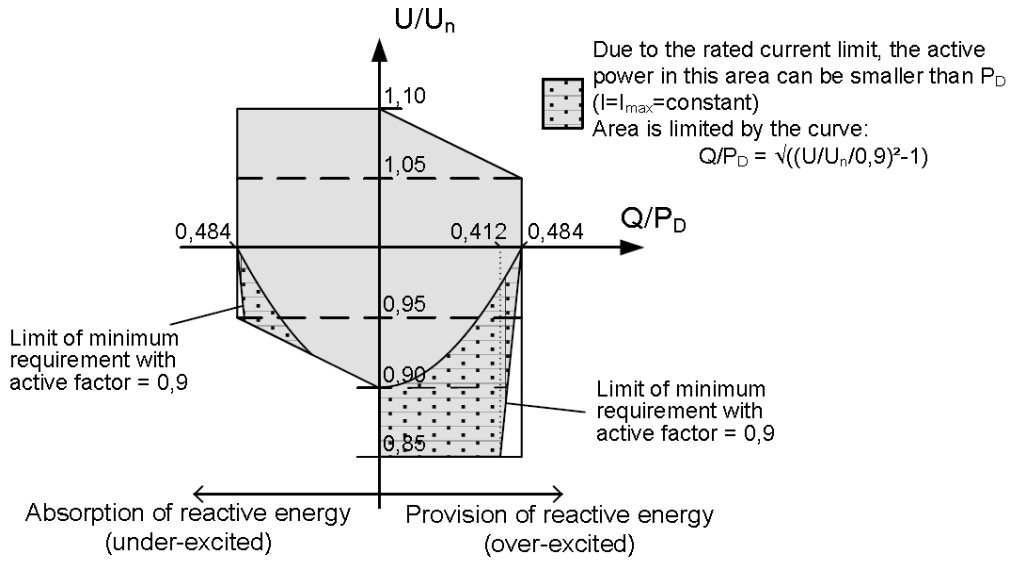


Figure 13 — Reactive power capability at active power P_D in the voltage range (positive sequence component of the fundamental)

Over-excited:

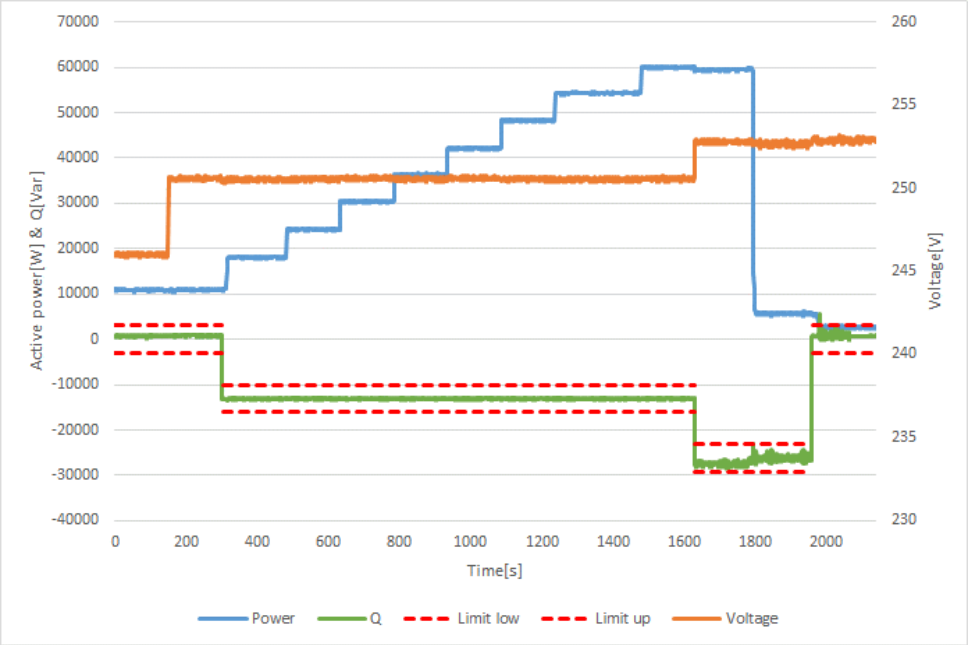
AC output				Reactive power measured		
Voltage setting [V/Vn]	Measured			Reactive power [Var]	Value [Q/PD]	Limits
	Voltage [V]	[V/Vn]	Active power [W]			
1.10	252.79	1.10	60858.60	790.48	0.0130	±0.02
1.08	248.33	1.08	60865.41	11506.02	0.1890	0.194±0.02
1.05	241.53	1.05	59231.70	28726.06	0.4850	0.484±0.02
1.00	230.10	1.00	59163.80	28656.55	0.4844	0.484±0.02
0.95	218.40	0.95	56528.01	27300.99	0.4830	--
0.92	211.38	0.92	54320.92	26315.06	0.4844	--
0.90	207.01	0.90	53297.69	25803.14	0.4841	--
0.85	195.49	0.85	50512.87	24424.90	0.4835	--

Under-excited:

AC output				Reactive power measured		
Voltage setting [V/Vn]	Measured			Reactive power [Var]	Value [Q/PD]	Limits
	Voltage [V]	[V/Vn]	Active power [W]			
1.10	252.49	1.10	59486.55	-28815.69	-0.4844	-0.484±0.02
1.08	247.89	1.08	59487.94	-28793.05	-0.4840	-0.484±0.02
1.05	240.89	1.05	59065.14	-28637.26	-0.4848	-0.484±0.02
1.00	229.91	1.00	59260.63	-28408.52	-0.4794	-0.484±0.02
0.95	217.99	0.95	55736.73	-26429.59	-0.4742	--
0.92	211.24	0.92	59266.46	-11437.08	-0.1930	-0.194±0.02
0.90	206.63	0.90	59240.87	-819.21	-0.0138	±0.02

D.7.1	Table: Q Control. Voltage related control mode					P
P/Pn [%] Setpoint	Vac [V] Setpoint	P/Pn [%] measured	Vac [V] Measured	Q [VAr] measured	Q [Var] expected	Δ Q [Var] (≤ ± 5 %Pn)
< 20 %	1.07 Vn	18.11	246.03	777.96	≈0 (< ± 5 % Pn)	1.30
< 20 %	1.09 Vn	18.13	250.59	861.36	≈0 (< ± 5 % Pn)	1.44
<20 % to 30 %	1.09 Vn	30.15	250.54	-13075.21	-13074.00 (Within 10sec)	0.00
40 %	1.09 Vn	40.44	250.58	-13123.17	-13074.00	-0.08
50 %	1.09 Vn	50.68	250.61	-13095.04	-13074.00	-0.04
60 %	1.09 Vn	60.63	250.57	-13145.26	-13074.00	-0.12
70 %	1.09 Vn	70.34	250.61	-13053.40	-13074.00	0.03
80 %	1.09 Vn	80.54	250.57	-13050.78	-13074.00	0.04
90 %	1.09 Vn	90.53	250.54	-13080.81	-13074.00	-0.01
100 %	1.09 Vn	100.00	250.58	-13041.11	-13074.00	0.05
100 %	1.1 Vn	99.23	252.80	-27388.80	-26148.00	-2.07
100 % to10 %	1.1 Vn	9.72	252.69	-26225.83	-26148.00	-0.13
10 % to ≤ 5 %	1.1 Vn	4.52	252.88	845.92	≈0 (< ± 5 % Pn)	1.41
P/Pn [%] Set-point	Vac [V] Set-point	P/Pn [%] measured	Vac [V] Measured	Q [VAr] measured	Q [Var] expected	Δ Q [Var] (≤ ± 5 %Pn)
< 20 %	0.93 Vn	18.11	213.77	440.07	≈0 (< ± 5 % Pn)	0.73
< 20 %	0.91 Vn	18.10	209.18	394.84	≈0 (< ± 5 % Pn)	0.66
<20 % to 30 %	0.91 Vn	29.77	209.14	13230.93	13074.00 (Within 10sec)	0.26
40 %	0.91 Vn	39.86	209.21	13212.92	13074.00	0.23
50 %	0.91 Vn	49.97	209.16	13132.22	13074.00	0.10
60 %	0.91 Vn	60.20	209.23	13123.89	13074.00	0.08
70 %	0.91 Vn	70.23	209.19	13157.47	13074.00	0.14
80 %	0.91 Vn	80.67	209.15	13187.11	13074.00	0.19
90 %	0.91 Vn	90.28	209.20	13148.32	13074.00	0.12
100 %	0.91 Vn	96.84	209.24	13435.32	13074.00	0.60
100 %	0.90 Vn	89.05	206.94	25322.93	26148.80	-1.38
100 % to 10 %	0.90 Vn	9.50	206.65	25195.07	26148.80	-1.59
10 % to ≤ 5 %	0.91 Vn	4.31	209.15	364.77	≈0 (< ± 5 % Pn)	0.61

D.7.1	Table: Q Control. Voltage related control mode	P



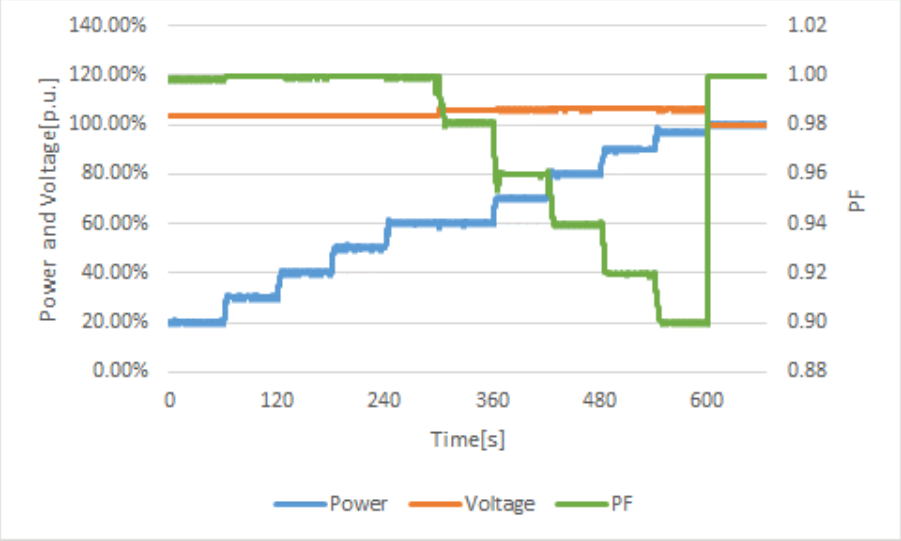
Graph: Lock-in at 1.08Vn

Graph: Lock-in at 0.92Vn

D.7.1	Table: Q Control Power related control modes							P
P Desired (%Sn)	**P measured (%Sn)**	**Q measured (Var)**	**Voltage Desired (%Un)**	**Voltage Measured (%Un)**	**Power Factor desired (cos φ)**	**Power Factor measured (cos φ)**	**△Q (%S_{Max})**	**Limit (%S_{Max})**
20%	20.25	685.54	<105%	103.49	1.0000	0.9984	1.04	±2
30%	30.28	639.10	<105%	103.54	1.0000	0.9994	0.97	±2
40%	40.33	850.55	<105%	103.60	1.0000	0.9994	1.29	±2
50%	50.36	749.19	<105%	103.66	1.0000	0.9997	1.14	±2
60%	60.34	1090.72	<105%	103.78	1.0000	0.9995	1.65	±2
60%	60.32	6972.61	>105%	106.09	0.9800	0.9817	0.51	±2
70%	70.21	12330.02	>105%	106.17	0.9600	0.9597	-0.12	±2
80%	80.16	17451.23	>105%	106.25	0.9400	0.9400	-0.04	±2
90%	89.98	23053.69	>105%	106.34	0.9200	0.9197	-0.08	±2
100%	97.10	28199.36	>105%	106.25	0.9000	0.9001	1.30	±2
100%	100.06	1154.50	<100%	99.83	1.0000	0.9997	1.75	±2

Remark: Tested at lock-in voltage 1.05 Vn and lock-out voltage Vn.
The Lock-in value is adjustable between Vn and 1.1Vn in 0.01V steps, the Lock-out value is adjustable between 0.9Vn and Vn in 0.01V steps

Graph



D.7.2	Table: Voltage related active power reduction P(U)	P

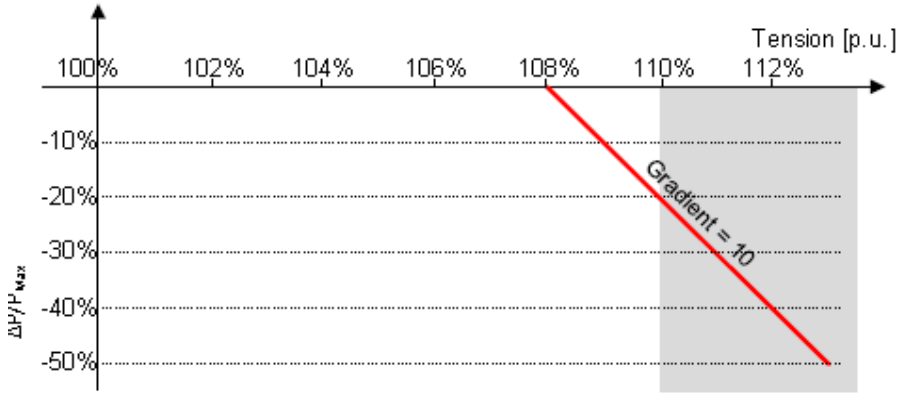
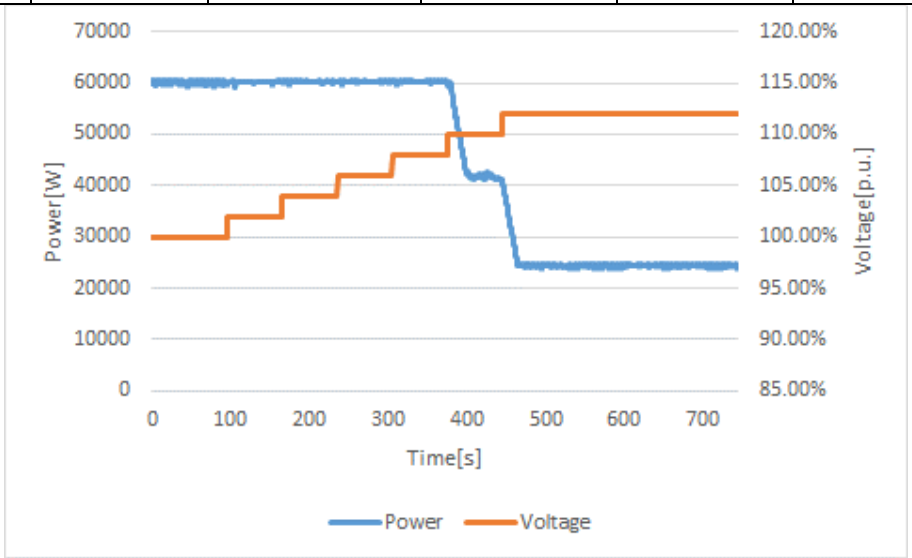


Figure 15 - Example curve for P(U)

Step#	Set voltage vaule V/Vn [%]	Measured voltage vaule V/Vn[%]	Measured power values[W]	Measured power bin[%]	Limit[%]	RESULT
1	100	100.00	60156	100.26	--	P
2	102	101.98	60203	100.34	--	
3	104	104.00	60233	100.39	--	
4	106	106.00	60256	100.43	--	
5	108	108.00	60266	100.44	--	
6	110	110.02	45501	75.84	<80	
7	112	112.00	25001	41.67	<60	

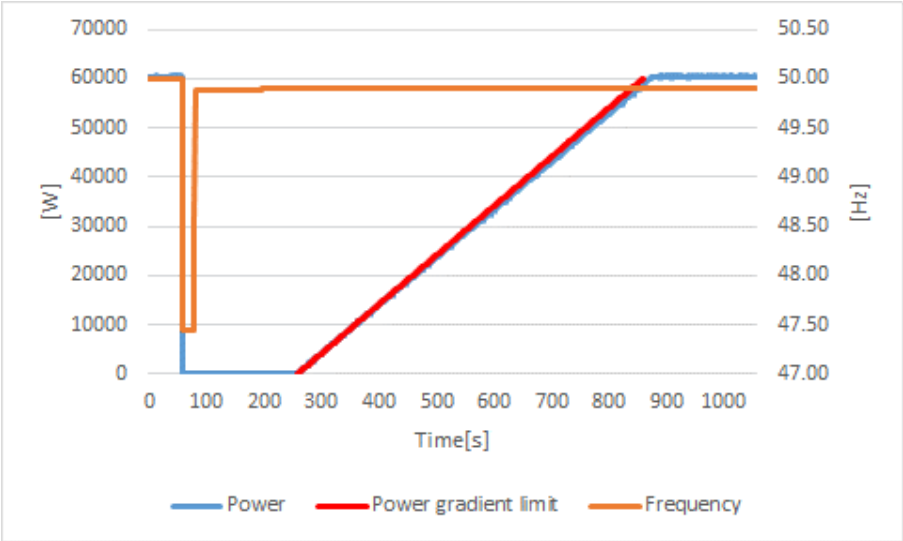


D.8	Table: Connection and reconnection	P

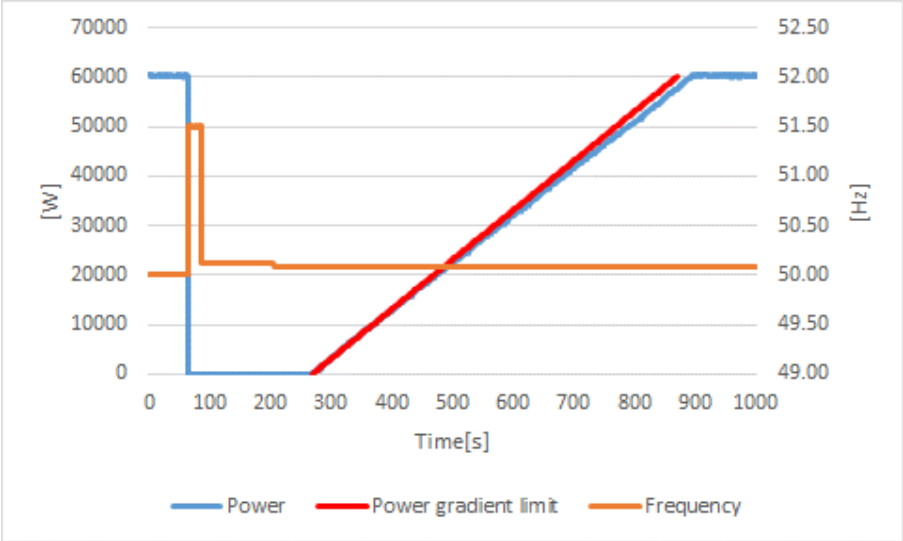
Parameter	Reconnection after tripping of the interface protection relay	Normal operation starting
Lower frequency	49,9 Hz	49,9 Hz
Upper frequency	50,1 Hz	50,1 Hz
Lower voltage	If connection to the LV distribution network: 85% U_n	If connection to the LV distribution network: 85% U_n
	If connection to the HV distribution network: 90 % U_c	If connection to the HV distribution network: 90 % U_c
Upper voltage	If connection to the LV distribution network: 110 % U_n	If connection to the LV distribution network: 110 % U_n
	If connection to the HV distribution network: 110 % U_c	If connection to the HV distribution network: 110 % U_c
Observation time	60 s	60 s
Maximum active power increase gradient	10 %/min*	20 %/min
** Power-generating units that have not the ability to apply a certain gradient shall take into account an additional delay.*		

Test sequence after trip	connection	connection allowed	Observation time (s)	Power gradient after connection (%/min)
Step a)	<49.9Hz	No	--	--
Step b)	≥49.9Hz	Yes	60.0	9.79
Step c)	>50.1Hz	No	--	--
Step d)	≤50.1Hz	Yes	63.0	9.62
Step e)	<195.5V	No	--	--
Step f)	≥195.5V	Yes	64.5	9.56
Step g)	>253V	No	--	--
Step h)	≤253V	Yes	65.0	9.33
Remark: Maximum active power increase gradient 10 %/min.				

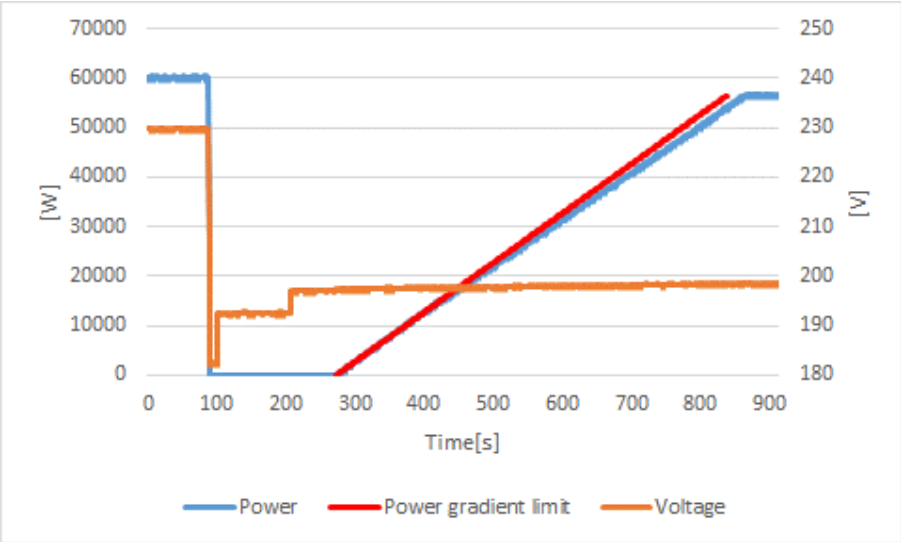
D.8	Table: Connection and reconnection	P



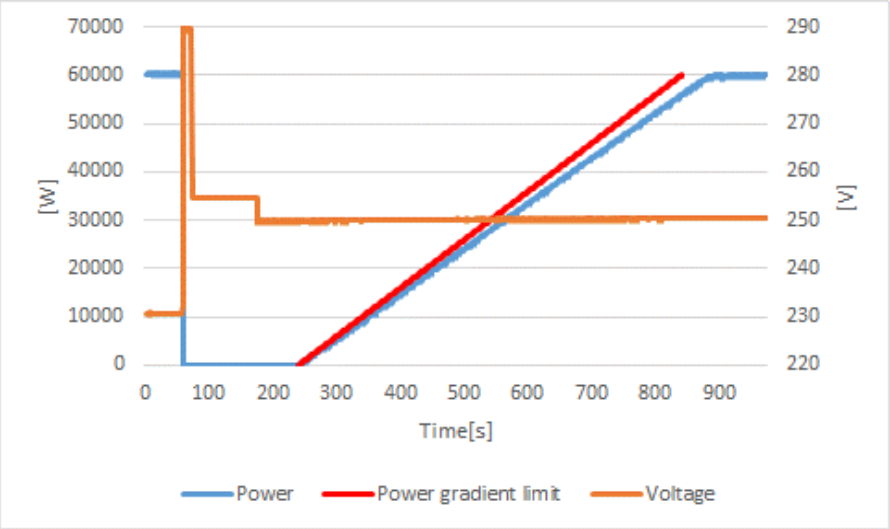
Graph_49.9Hz



Graph_50.1Hz

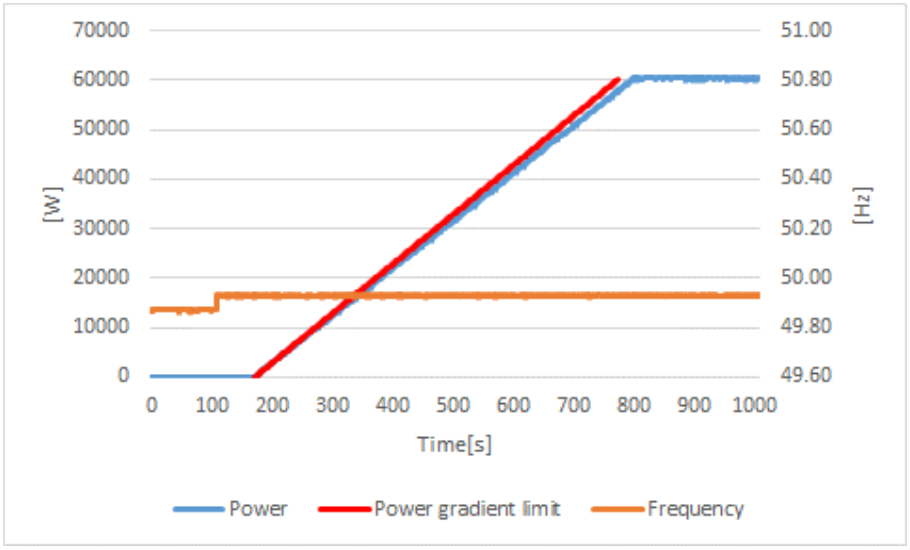


Graph_195.5V

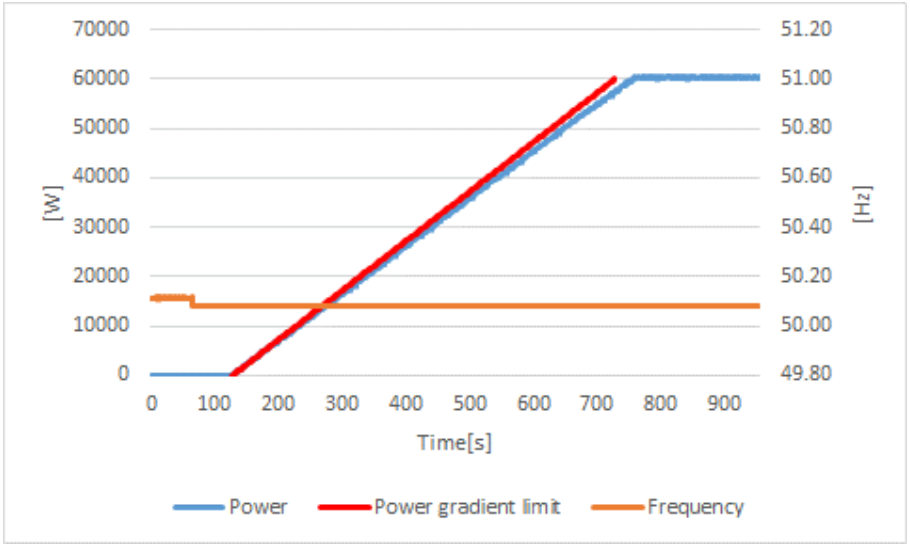


Graph_253V

D.8	Starting to generate electrical power			P
Test sequence at normal operation starting	**connection**	**connection allowed**	**Observation time (s)**	**Power gradient after connection (%/min)**
Step a)	<49.9Hz	No	--	--
Step b)	≥49.9Hz	Yes	61.0	9.62
Step c)	>50.1Hz	No	--	--
Step d)	≤50.1Hz	Yes	62.0	9.55
Step e)	<195.5V	No	--	--
Step f)	≥195.5V	Yes	60.0	9.74
Step g)	>253V	No	--	--
Step h)	≤253V	Yes	71.5	9.73

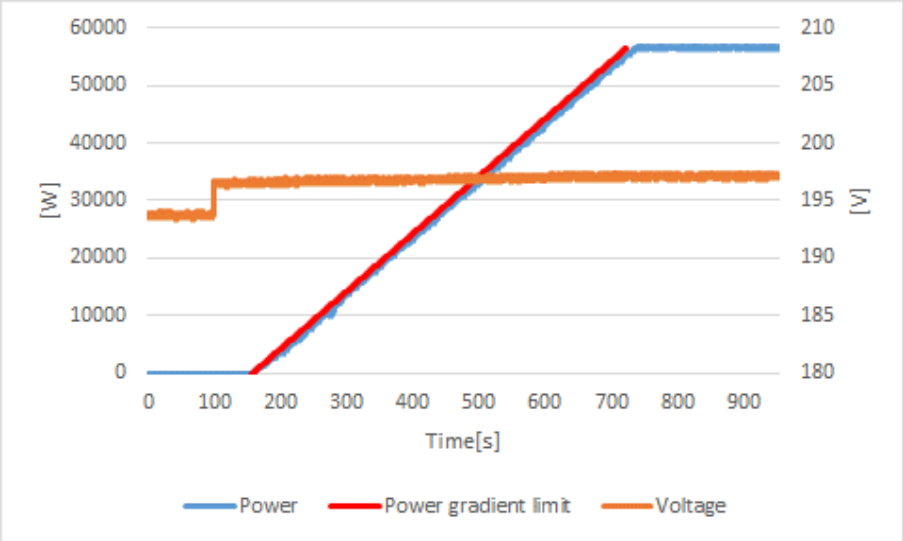


Graph_49.9Hz

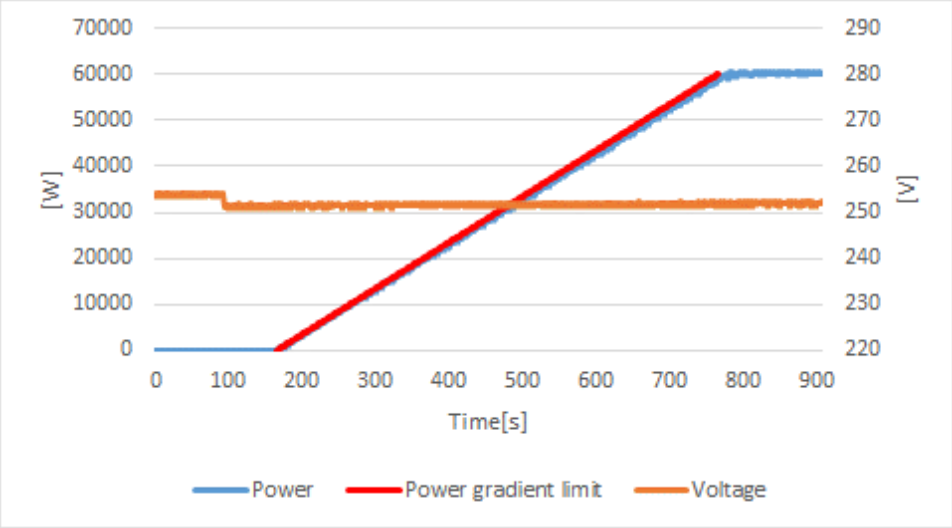


Graph_50.1Hz

D.8	Starting to generate electrical power	P



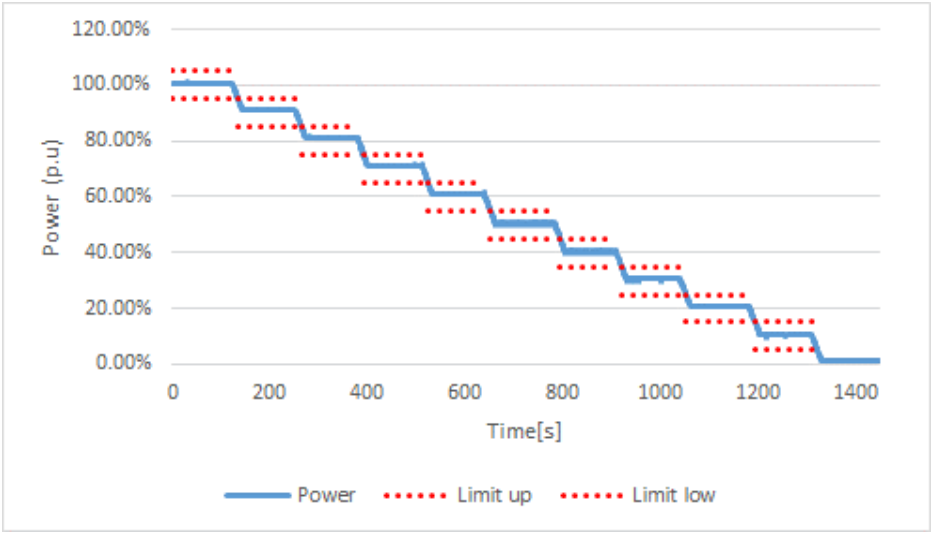
Graph_195.5V

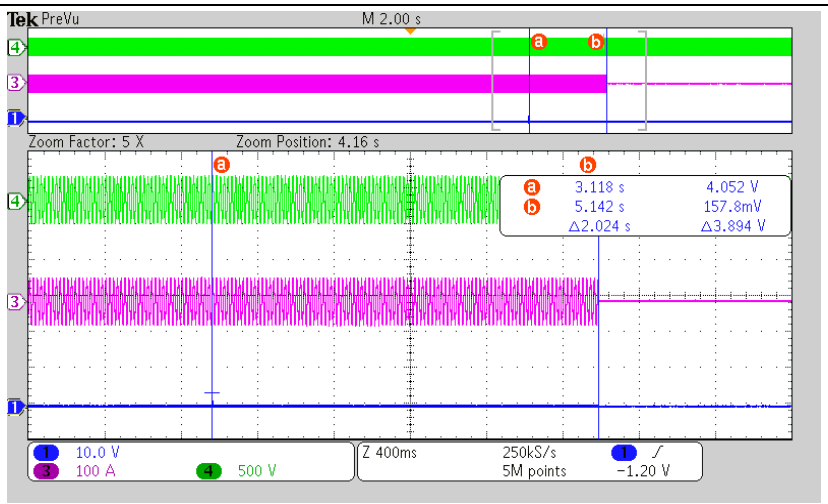


Graph_253V

D.9	Table: Ceasing and reduction of active power on set point (Logic interface)					P
String	4	U_{DC} =	620 Vdc	Uac = Un	230 Vac	P_{Emax} (KW)	60

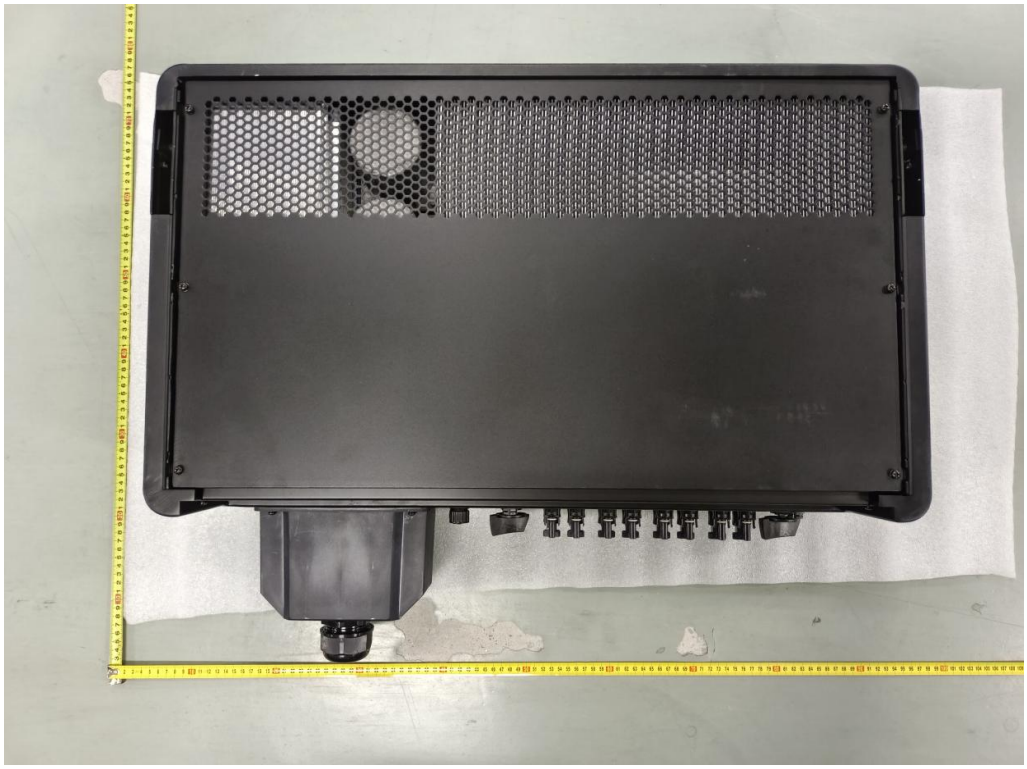
1 min mean value P/Pn Psetpoint (%)	Pmeasured (%)	△Pmeasured (%)	Limit [%]
100%	100.71%	0.71%	±5%
90%	91.38%	1.38%	±5%
80%	81.36%	1.36%	±5%
70%	71.23%	1.23%	±5%
60%	61.18%	1.18%	±5%
50%	50.84%	0.84%	±5%
40%	40.76%	0.76%	±5%
30%	30.84%	0.84%	±5%
20%	20.92%	0.92%	±5%
10%	10.79%	0.79%	±5%
The power gradient for increasing and reducing (%P_n/s)			0.48%P_n/s
Time for Logic interface (at input port) activated			2.024s





Annex 1: Photo document

Front

Back


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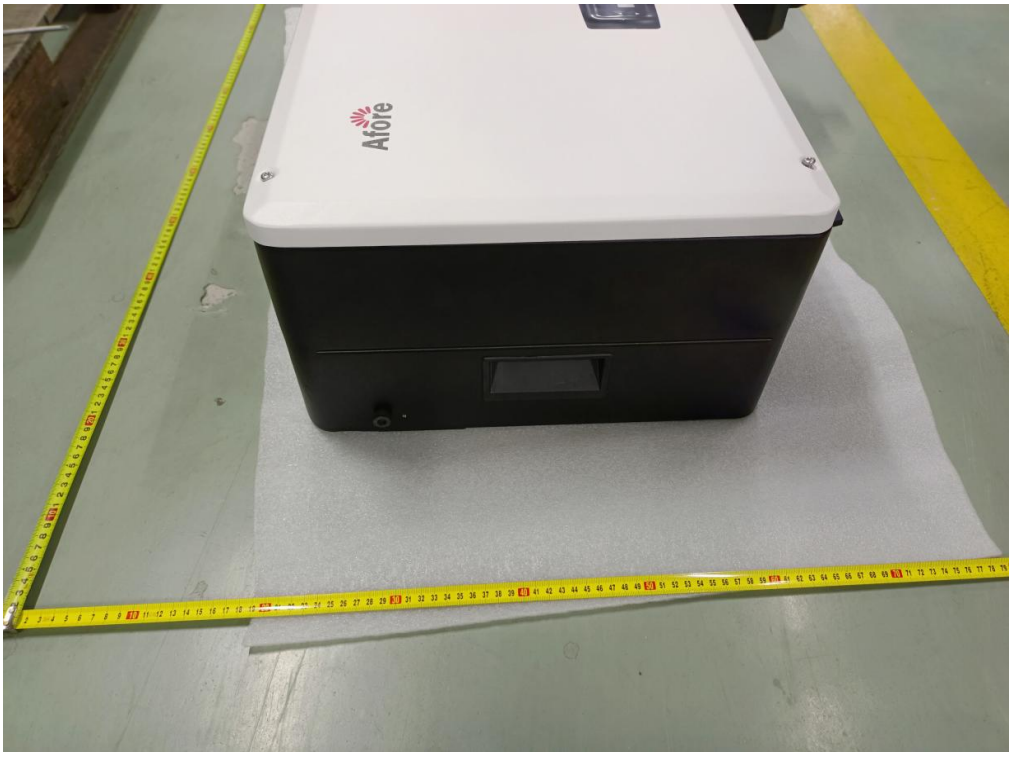
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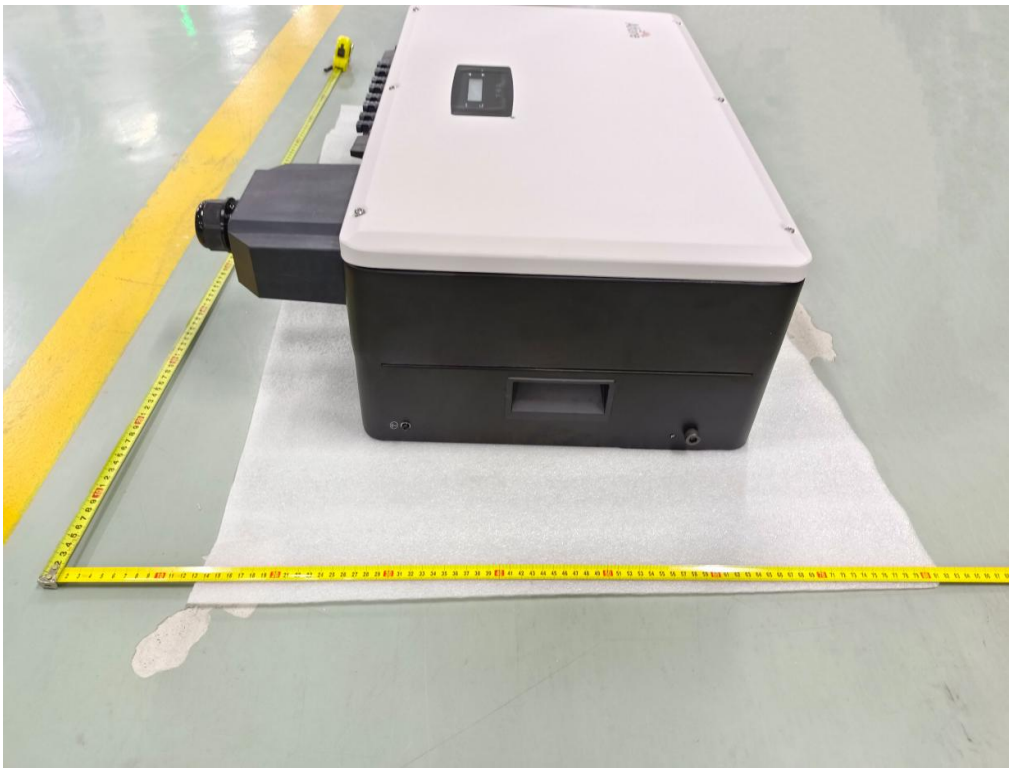

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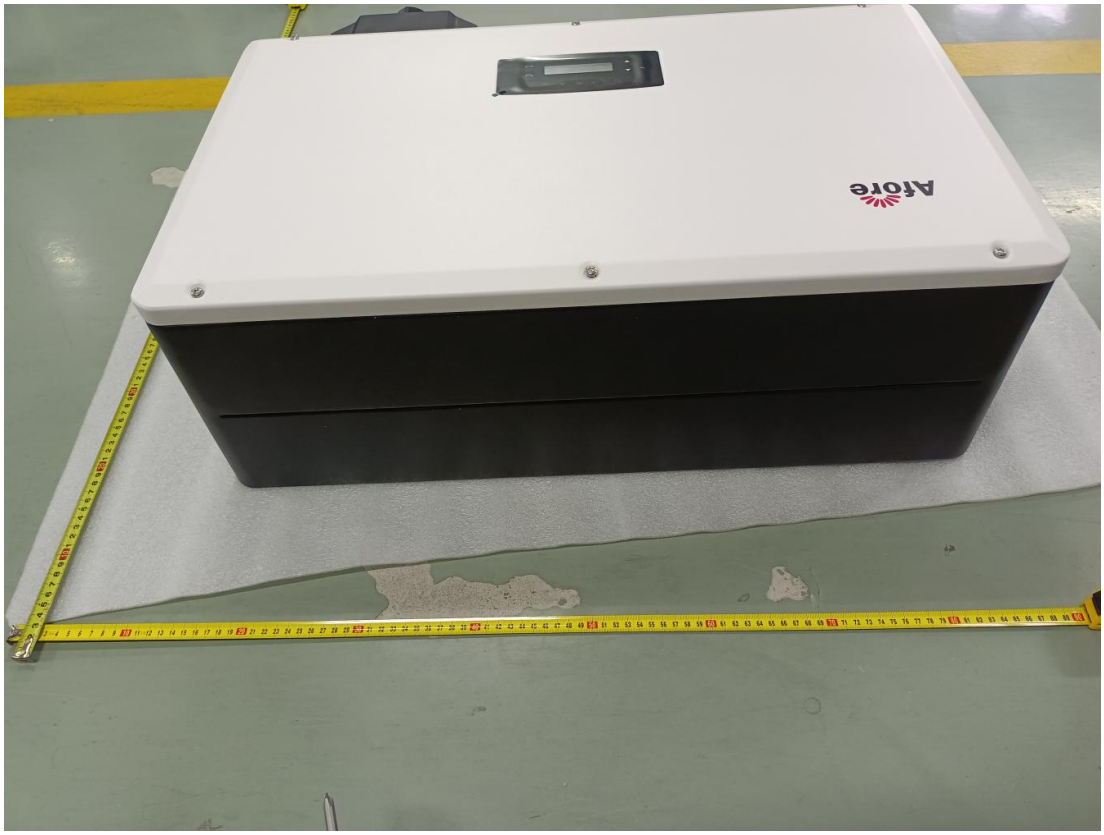
Bottom


Annex 1: Photo document

Internal