TEST REPORT
C10/11: ed.2.1
SPECIFIC TECHNICAL PRESCRIPTIONS REGARDING POWER-GENERATING PLANTS OPERATING IN PARALLEL TO THE DISTRIBUTION NETWORK

Report Reference No……:	210916007GZU -001
Date of issue……:	18 Oct 2021
Total number of pages. ……:	76 pages
Testing Laboratory……:	Intertek Testing Services Shenzhen Ltd. Guangzhou Branch
Address……:	Room 02, & 101/E201/E301/E401/E501/E601/E701/E801 of Room 01 1-8/F., No. 7-2. Caipin Road, Science City, GETDD, Guangzhou, Guangdong, China
Testing location/ address……:	Same as above
Tested by (name + signature) ……:	Gaison Li Engineer
Approved by (name + signature)..	Jason Fu Supervisor
Applicant's name	Afore New Energy Technology (Shanghai) Co., Ltd.
Address	Build No.7, 333 Wanfang Road, Minhang District, Shanghai. China. 201112
Test specification:	
Standard	C10/11: ed.2.1, 01 Sep. 2019
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.....	BNT003KTL, BNT004KTL, BNT005KTL, BNT006KTL, BNT008KTL, BNT010KTL, BNT012KTL, BNT013KTL, BNT015KTL, BNT017KTL, BNT020KTL, BNT025KTL

Rating……: See below Specifications table

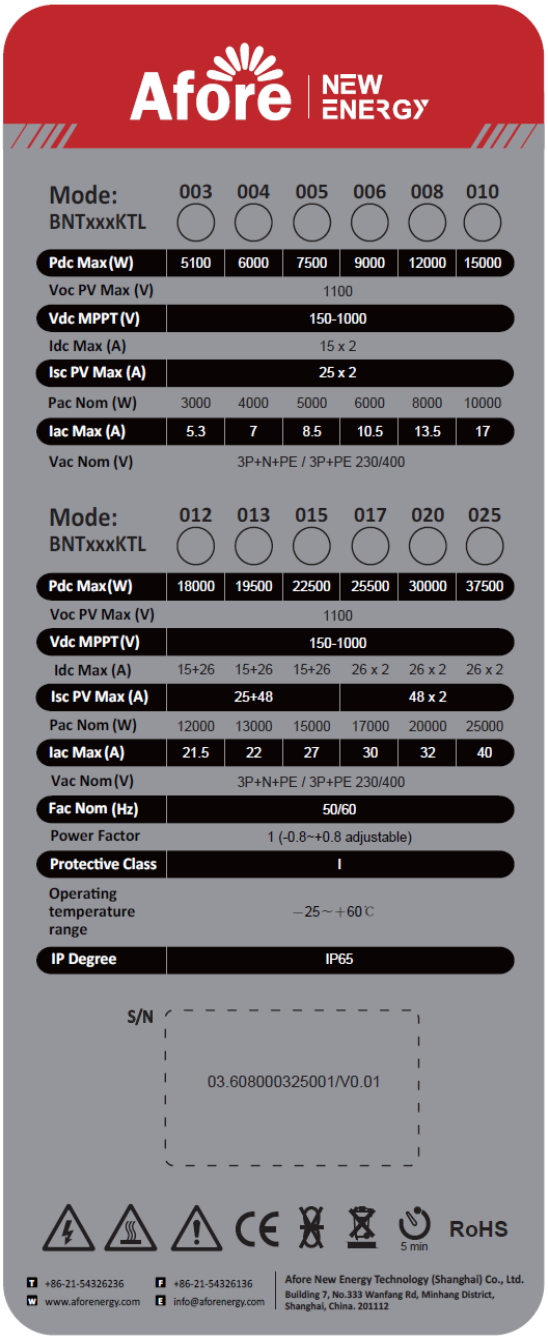
Specifications table				
Model	BNT003KTL	BNT004KTL	BNT005KTL	BNT006KTL
Input:				
Vmax PV (Vdc)	1100	1100	1100	1100
Isc PV (absolute Max.) (A)	25 x 2	25 x 2	25 x 2	25 x 2
Number MPP trackers	2	2	2	2
Number input strings	1/1	1/1	1/1	1/1
Max. PV input current(A)	15 x 2	15 x 2	15 x 2	15 x 2
MPPT voltage range (Vdc)	150-1000	150-1000	150-1000	150-1000
Vdc range @ full power (Vdc)	200-850	200-850	200-850	250-850
Output				
Normal Voltage(V)	3P+N+PE/3P+PE 230/400			
Frequency (Hz)	50 / 60			
Current (normal) (A)	4.4	5.8	7.3	8.7
Current (Max. continuous) (A)	5.3	7	8.5	10.5
Power rating (W)	3000	4000	5000	6000
Power Rating (VA)	3000	4000	5000	6000
Power factor /rated	1 (-0.8~+0.8 adjustable)	1 (-0.8~+0.8 adjustable)	1 (-0.8~+0.8 adjustable)	1 (-0.8~+0.8 adjustable)
others				
Protective class	Class I			
Ingress protection (IP)	IP 65			
Temperature (°C)	-25°C to +60°C (up 45°C derating)			
Inverter Isolation	Non-isolated			
Overvoltage category	OVC III (AC Main), OVC II (PV)			
Weight (kg)	17			
Dimensions (WxHxD) (mm)	510 x 370 x 196			
Software version:	DSP: V06 CPLD: V06 HMI: V06			

Specifications table				
Model	BNT008KTL	BNT010KTL	BNT012KTL	BNT013KTL
Input:				
Vmax PV (Vdc)	1100	1100	1100	1100
Isc PV (absolute Max.) (A)	25 x 2	25 x 2	25 + 48	25 + 48
Number MPP trackers	2	2	2	2
Number input strings	1/1	1/1	1/2	1/2
Max. PV input current(A)	15 x 2	15 x 2	15 + 26	15 + 26
MPPT voltage range (Vdc)	150-1000	150-1000	150-1000	150-1000
Vdc range @ full power (Vdc)	300-850	500-850	500-850	500-850
Output				
Normal Voltage(V)	3P+N+PE/3P+PE 230/400			
Frequency (Hz)	50 / 60			
Current (normal) (A)	11.6	14.5	17.4	18.9
Current (Max. continuous) (A)	13.5	17	21.5	22
Power rating (W)	8000	10000	12000	13000
Power Rating (VA)	8000	10000	12000	13000
Power factor /rated	1 (-0.8~+0.8 adjustable)	1 (-0.8~+0.8 adjustable)	1 (-0.8~+0.8 adjustable)	1 (-0.8~+0.8 adjustable)
others				
Protective class	Class I			
Ingress protection (IP)	IP 65			
Temperature (°C)	-25°C to +60°C (up 45°C derating)			
Inverter Isolation	Non-isolated			
Overvoltage category	OVC III (AC Main), OVC II (PV)			
Weight (kg)	17		19	
Dimensions (WxHxD) (mm)	510 x 370 x 196			
Software version:	DSP: V06 CPLD: V06 HMI: V06			

Specifications table				
Model	BNT015KTL	BNT017KTL	BNT020KTL	BNT025KTL
Input:				
Vmax PV (Vdc)	1100	1100	1100	1100
Isc PV (absolute Max.) (A)	25 + 48	48 x 2	48 x 2	48 x 2
Number MPP trackers	2	2	2	2
Number input strings	1/2	2/2	2/2	2/2
Max. PV input current(A)	15 + 26	26 x 2	26 x 2	26 x 2
MPPT voltage range (Vdc)	150-1000	150-1000	150-1000	150-1000
Vdc range @ full power (Vdc)	500-850	500-850	500-850	500-850
Output				
Normal Voltage(V)	3P+N+PE/3P+PE 230/400			
Frequency (Hz)	50 / 60			
Current (normal) (A)	21.8	24.7	29	36.3
Current (Max. continuous) (A)	27	30	32	40
Power rating (W)	15000	17000	20000	25000
Power Rating (VA)	15000	17000	20000	25000
Power factor /rated	1 (-0.8~+0.8 adjustable)	1 (-0.8~+0.8 adjustable)	1 (-0.8~+0.8 adjustable)	1 (-0.8~+0.8 adjustable)
others				
Protective class	Class I			
Ingress protection (IP)	IP 65			
Temperature (°C)	-25°C to +60°C (up 45°C derating)			
Inverter Isolation	Non-isolated			
Overvoltage category	OVC III (AC Main), OVC II (PV)			
Weight (kg)	19		21	
Dimensions (WxHxD) (mm)	510 x 370 x 196			
Software version:	DSP: V06 CPLD: V06 HMI: V06			

Summary of testing:	
Tests performed (name of test and test clause):	**Testing location:**
All applicable tests Remark: Other than special notice, for all clauses, the model BNT025KTL is type tested and valid for other models.	Intertek Testing Services Shenzhen Ltd. Guangzhou Branch Room 02, & 101/E201/E301/E401/E501/E601/E701/E801 of Room 01 1-8/F., No. 7-2. Caipin Road, Science City, GETDD, Guangzhou, Guangdong, 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 003, 004, 005, 006, 008, 010, 012, 013, 015, 017, 020, 025.

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.....:	16 Sep2021
Date (s) of performance of tests.....:	17 Sep 2021 to 15 Oct 2021

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:

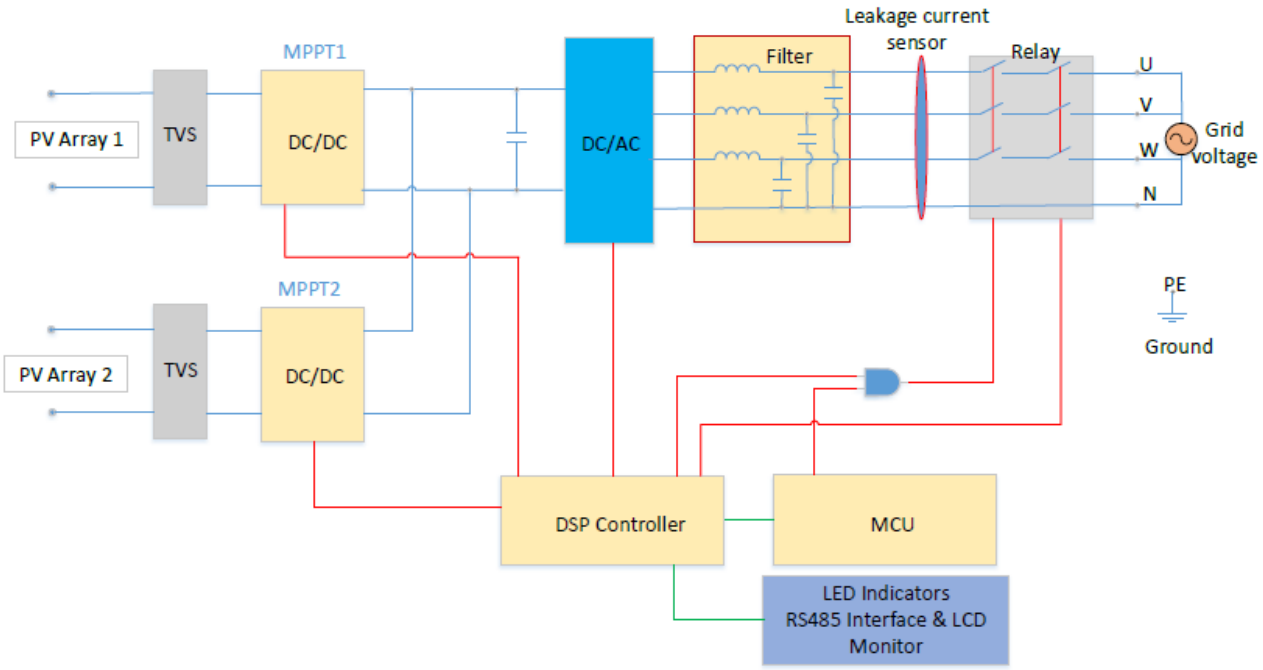
The testing item is a grid-connected type inverter for indoor or outdoor installation.

The Inverter is three-phase type and non-isolated between input and 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 completely identical, also, the output power is derating in software.

Factory information:

Afore New Energy Technology (Shanghai) Co., Ltd.

Build No.7, 333 Wanfang Road, Minhang District, Shanghai. China. 201112

C10/11: ed.2.1, 01 Sep 2019			
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

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Clause	Requirement - Test	Result - Remark	Verdict
	All of these protection functions must comply with the relevant requirements in EN 50549-1 (in edition 2019, section 4.9.3		P
	The integrated automatic separation system must have single fault tolerance according to EN 50549-1.	Two series relays in each line and may independent operation for each relay.	P
	The integrated automatic separation system must be set in accordance with the settings as specified in ANNEXE C		P
D.4	**Operating ranges**		P
	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.		P
D.4.1	**Operating frequency range**		P
	This clause is not applicable to backup power systems as specified in § 2.2.1.	Not backup power system	N/A
	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 »)	Comply with EN 50549-1	P
	In brief, the requirements in the standard are as follows: 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	(See appended table D.4.1)	P
	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.		P
	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.	Comply with above requirements	P
D.4.2	**Maximum admissible power reduction in case of underfrequency**		P
	This clause is not applicable to backup power systems as specified in § 2.2.1.	Not backup power system	N/A
	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.		P

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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

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Clause	Requirement - Test	Result - Remark	Verdict
	• 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
	• 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

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Clause	Requirement - Test	Result - Remark	Verdict
	• 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

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Clause	Requirement - Test	Result - Remark	Verdict
	- If Pmax ≤2 MW at minimum 1,11 % Pmax per second		N/A
	- 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

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Clause	Requirement - Test	Result - Remark	Verdict
	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
	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

C10/11: ed.2.1, 01 Sep 2019			
Clause	Requirement - Test	Result - Remark	Verdict
	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
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

C10/11: ed.2.1, 01 Sep 2019			
Clause	Requirement - Test	Result - Remark	Verdict
	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
	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

C10/11: ed.2.1, 01 Sep 2019			
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 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
	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

C10/11: ed.2.1, 01 Sep 2019			
Clause	Requirement - Test	Result - Remark	Verdict
	• 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
	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

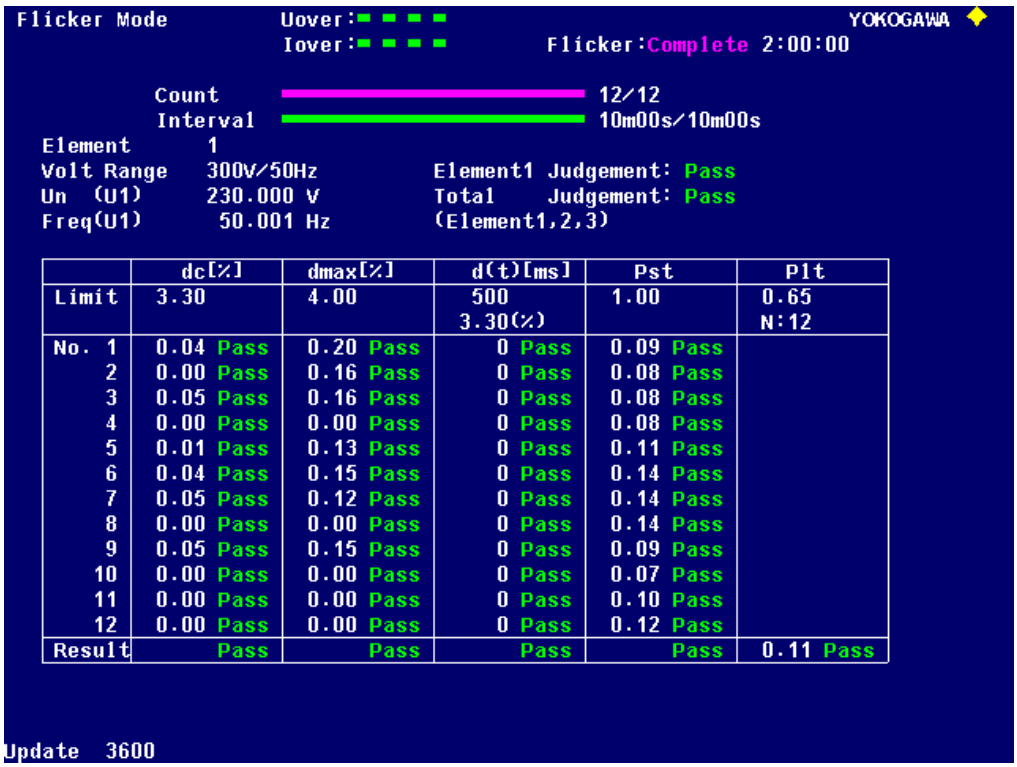
8.2.3	TABLE: Flicker	P

Flicker measurement

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

Model: BNT003KTL

Value		Dc (%)	D_{max} (%)	d(t) – 500ms	P_{st}	P_{lt}
Limit		3.30	4.00	3.30%	1.00	0.65
Test value	L1	0.05	0.20	0.00	0.14	0.11
	L2	0.06	0.28	0.00	0.12	0.10
	L3	0.05	0.23	0.00	0.12	0.09



	dc[%]	dmax[%]	d(t)[ms]	Pst	P1t
Limit	3.30	4.00	500 3.30(%)	1.00	0.65 N:12
No. 1	0.04 Pass	0.20 Pass	0 Pass	0.09 Pass	
2	0.00 Pass	0.16 Pass	0 Pass	0.08 Pass	
3	0.05 Pass	0.16 Pass	0 Pass	0.08 Pass	
4	0.00 Pass	0.00 Pass	0 Pass	0.08 Pass	
5	0.01 Pass	0.13 Pass	0 Pass	0.11 Pass	
6	0.04 Pass	0.15 Pass	0 Pass	0.14 Pass	
7	0.05 Pass	0.12 Pass	0 Pass	0.14 Pass	
8	0.00 Pass	0.00 Pass	0 Pass	0.14 Pass	
9	0.05 Pass	0.15 Pass	0 Pass	0.09 Pass	
10	0.00 Pass	0.00 Pass	0 Pass	0.07 Pass	
11	0.00 Pass	0.00 Pass	0 Pass	0.10 Pass	
12	0.00 Pass	0.00 Pass	0 Pass	0.12 Pass	
Result	Pass	Pass	Pass	Pass	0.11 Pass

L1 phase

8.2.3	TABLE: Flicker	P

Flicker Mode Uover: Iover: YOKOGAWA
Flicker:Complete 2:00:00

Count 12/12
Interval 10m00s/10m00s
Element 2
Volt Range 300V/50Hz Element2 Judgement: Pass
Un (U2) 230.003 V Total Judgement: Pass
Freq(U2) 50.001 Hz (Element1,2,3)

	dc[%]	dmax[%]	d(t)[ms]	Pst	Plt
Limit	3.30	4.00	500 3.30(%)	1.00	0.65 N:12
No. 1	0.06 Pass	0.26 Pass	0 Pass	0.10 Pass	
2	0.03 Pass	0.28 Pass	0 Pass	0.09 Pass	
3	0.03 Pass	0.22 Pass	0 Pass	0.09 Pass	
4	0.03 Pass	0.24 Pass	0 Pass	0.09 Pass	
5	0.03 Pass	0.24 Pass	0 Pass	0.11 Pass	
6	0.03 Pass	0.19 Pass	0 Pass	0.12 Pass	
7	0.03 Pass	0.19 Pass	0 Pass	0.11 Pass	
8	0.03 Pass	0.17 Pass	0 Pass	0.10 Pass	
9	0.05 Pass	0.28 Pass	0 Pass	0.07 Pass	
10	0.04 Pass	0.21 Pass	0 Pass	0.07 Pass	
11	0.03 Pass	0.18 Pass	0 Pass	0.07 Pass	
12	0.04 Pass	0.17 Pass	0 Pass	0.08 Pass	
Result	Pass	Pass	Pass	Pass	0.10 Pass

Update 3600

L2 phase

Flicker Mode Uover: Iover: YOKOGAWA
Flicker:Complete 2:00:00

Count 12/12
Interval 10m00s/10m00s
Element 3
Volt Range 300V/50Hz Element3 Judgement: Pass
Un (U3) 230.015 V Total Judgement: Pass
Freq(U3) --------- (Element1,2,3)

	dc[%]	dmax[%]	d(t)[ms]	Pst	Plt
Limit	3.30	4.00	500 3.30(%)	1.00	0.65 N:12
No. 1	0.04 Pass	0.18 Pass	0 Pass	0.07 Pass	
2	0.03 Pass	0.18 Pass	0 Pass	0.07 Pass	
3	0.01 Pass	0.14 Pass	0 Pass	0.07 Pass	
4	0.02 Pass	0.16 Pass	0 Pass	0.07 Pass	
5	0.04 Pass	0.18 Pass	0 Pass	0.08 Pass	
6	0.04 Pass	0.16 Pass	0 Pass	0.11 Pass	
7	0.04 Pass	0.23 Pass	0 Pass	0.12 Pass	
8	0.03 Pass	0.16 Pass	0 Pass	0.11 Pass	
9	0.05 Pass	0.17 Pass	0 Pass	0.09 Pass	
10	0.03 Pass	0.15 Pass	0 Pass	0.07 Pass	
11	0.02 Pass	0.15 Pass	0 Pass	0.10 Pass	
12	0.03 Pass	0.17 Pass	0 Pass	0.11 Pass	
Result	Pass	Pass	Pass	Pass	0.09 Pass

Update 3600

L3 phase

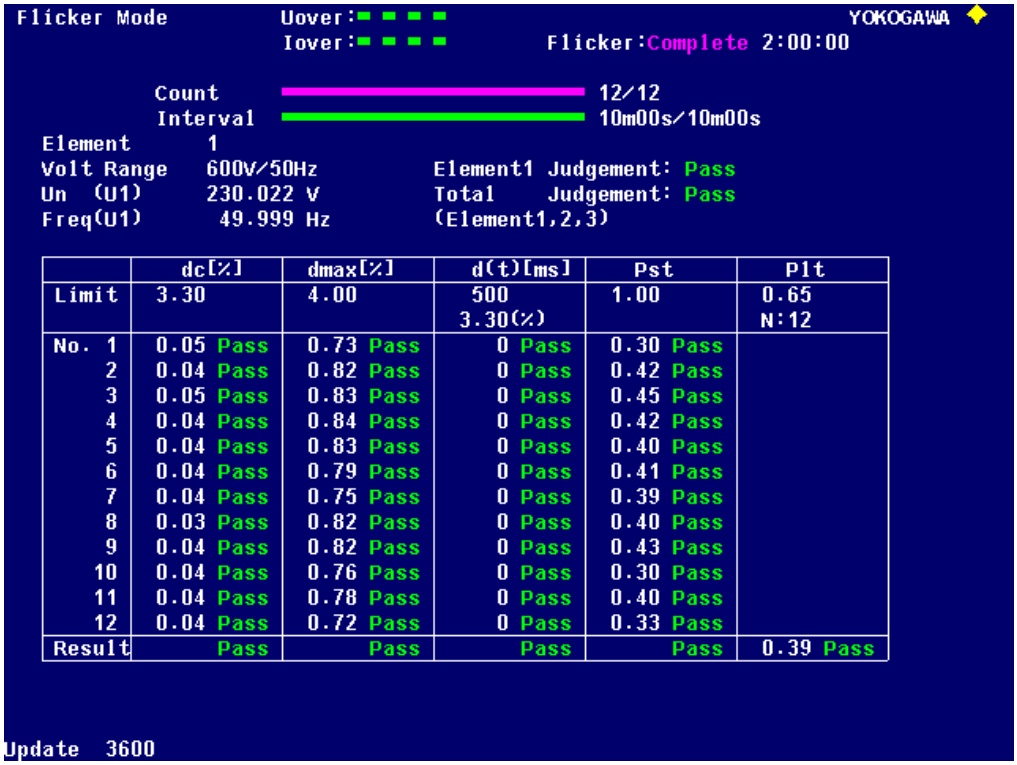
8.2.3	TABLE: Flicker	P

Flicker measurement

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

Model: BNT025KTL

Value		Dc (%)	D_{max} (%)	d(t) – 500ms	P_{st}	P_{lt}
Limit		3.30	4.00	3.30%	1.00	0.65
Test value	L1	0.05	0.84	0.00	0.45	0.39
	L2	0.05	0.81	0.00	0.43	0.38
	L3	0.06	0.80	0.00	0.48	0.44



	dc[%]	dmax[%]	d(t)[ms]	Pst	Plt
Limit	3.30	4.00	500 3.30(%)	1.00	0.65 N:12
No. 1	0.05 Pass	0.73 Pass	0 Pass	0.30 Pass	
2	0.04 Pass	0.82 Pass	0 Pass	0.42 Pass	
3	0.05 Pass	0.83 Pass	0 Pass	0.45 Pass	
4	0.04 Pass	0.84 Pass	0 Pass	0.42 Pass	
5	0.04 Pass	0.83 Pass	0 Pass	0.40 Pass	
6	0.04 Pass	0.79 Pass	0 Pass	0.41 Pass	
7	0.04 Pass	0.75 Pass	0 Pass	0.39 Pass	
8	0.03 Pass	0.82 Pass	0 Pass	0.40 Pass	
9	0.04 Pass	0.82 Pass	0 Pass	0.43 Pass	
10	0.04 Pass	0.76 Pass	0 Pass	0.30 Pass	
11	0.04 Pass	0.78 Pass	0 Pass	0.40 Pass	
12	0.04 Pass	0.72 Pass	0 Pass	0.33 Pass	
Result	Pass	Pass	Pass	Pass	0.39 Pass

L1 phase

8.2.3	TABLE: Flicker	P

Flicker Mode Uover: Iover: YOKOGAWA
Flicker:Complete 2:00:00

Count 12/12
Interval 10m00s/10m00s
Element 2
Volt Range 600V/50Hz
Un (U2) 229.860 V
Freq(U2) ---------
Element2 Judgement: Pass
Total Judgement: Pass
(Element1,2,3)

	dc[%]	dmax[%]	d(t)[ms]	Pst	Plt
Limit	3.30	4.00	500 3.30(%)	1.00	0.65 N:12
No. 1	0.04 Pass	0.75 Pass	0 Pass	0.29 Pass	
2	0.04 Pass	0.77 Pass	0 Pass	0.40 Pass	
3	0.05 Pass	0.77 Pass	0 Pass	0.43 Pass	
4	0.04 Pass	0.74 Pass	0 Pass	0.41 Pass	
5	0.05 Pass	0.76 Pass	0 Pass	0.38 Pass	
6	0.03 Pass	0.78 Pass	0 Pass	0.39 Pass	
7	0.03 Pass	0.78 Pass	0 Pass	0.37 Pass	
8	0.04 Pass	0.79 Pass	0 Pass	0.37 Pass	
9	0.05 Pass	0.77 Pass	0 Pass	0.41 Pass	
10	0.04 Pass	0.71 Pass	0 Pass	0.29 Pass	
11	0.05 Pass	0.81 Pass	0 Pass	0.39 Pass	
12	0.02 Pass	0.76 Pass	0 Pass	0.31 Pass	
Result	Pass	Pass	Pass	Pass	0.38 Pass

Update 3600

L2 phase

Flicker Mode Uover: Iover: YOKOGAWA
Flicker:Complete 2:00:00

Count 12/12
Interval 10m00s/10m00s
Element 3
Volt Range 600V/50Hz
Un (U3) 229.599 V
Freq(U3) ---------
Element3 Judgement: Pass
Total Judgement: Pass
(Element1,2,3)

	dc[%]	dmax[%]	d(t)[ms]	Pst	Plt
Limit	3.30	4.00	500 3.30(%)	1.00	0.65 N:12
No. 1	0.06 Pass	0.61 Pass	0 Pass	0.37 Pass	
2	0.05 Pass	0.80 Pass	0 Pass	0.47 Pass	
3	0.05 Pass	0.79 Pass	0 Pass	0.48 Pass	
4	0.05 Pass	0.70 Pass	0 Pass	0.47 Pass	
5	0.06 Pass	0.79 Pass	0 Pass	0.45 Pass	
6	0.06 Pass	0.67 Pass	0 Pass	0.45 Pass	
7	0.06 Pass	0.75 Pass	0 Pass	0.44 Pass	
8	0.05 Pass	0.72 Pass	0 Pass	0.44 Pass	
9	0.06 Pass	0.72 Pass	0 Pass	0.48 Pass	
10	0.06 Pass	0.63 Pass	0 Pass	0.37 Pass	
11	0.06 Pass	0.71 Pass	0 Pass	0.43 Pass	
12	0.05 Pass	0.62 Pass	0 Pass	0.38 Pass	
Result	Pass	Pass	Pass	Pass	0.44 Pass

Update 3600

L3 phase

8.2.4	TABLE: Current harmonics emission test			P
Model: BNT003KTL		Rating: 100%Pn		
Harmonics order n	Measured Value (A)			Limit in BS EN 61000-3-2 in Amps
	R	S	T	
2	0.042	0.052	0.027	1.080
3	0.026	0.010	0.022	2.300
4	0.012	0.017	0.019	0.430
5	0.074	0.074	0.089	1.140
6	0.004	0.006	0.005	0.300
7	0.059	0.061	0.073	0.770
8	0.004	0.005	0.006	0.230
9	0.012	0.005	0.010	0.400
10	0.003	0.004	0.005	0.184
11	0.026	0.021	0.024	0.330
12	0.004	0.004	0.005	0.153
13	0.017	0.022	0.015	0.210
14	0.005	0.004	0.005	0.131
15	0.008	0.006	0.005	0.150
16	0.005	0.005	0.005	0.115
17	0.043	0.047	0.055	0.132
18	0.005	0.005	0.006	0.102
19	0.047	0.046	0.050	0.118
20	0.002	0.003	0.003	0.092
21	0.005	0.003	0.006	0.107
22	0.002	0.003	0.003	0.084
23	0.045	0.045	0.043	0.098
24	0.003	0.003	0.003	0.077
25	0.022	0.019	0.019	0.090
26	0.002	0.002	0.003	0.071
27	0.004	0.003	0.005	0.083
28	0.003	0.003	0.004	0.066
29	0.010	0.006	0.008	0.078
30	0.004	0.003	0.004	0.061
31	0.007	0.009	0.010	0.073
32	0.003	0.004	0.004	0.058
33	0.003	0.003	0.003	0.068
34	0.002	0.002	0.002	0.054
35	0.018	0.021	0.019	0.064
36	0.008	0.002	0.002	0.051
37	0.021	0.018	0.021	0.061
38	0.003	0.002	0.003	0.048
39	0.003	0.002	0.003	0.058
40	0.002	0.002	0.002	0.046

8.2.4	TABLE: Current harmonics emission test			P
Model: BNT003KTL		Rating: 66%Pn		

Harmonics order n	Measured Value (A)			Limit in BS EN 61000-3-2 in Amps
	R	S	T	
2	0.031	0.048	0.028	1.080
3	0.006	0.010	0.013	2.300
4	0.005	0.010	0.013	0.430
5	0.083	0.081	0.102	1.140
6	0.006	0.007	0.008	0.300
7	0.048	0.055	0.070	0.770
8	0.008	0.009	0.005	0.230
9	0.008	0.006	0.011	0.400
10	0.007	0.007	0.004	0.184
11	0.033	0.022	0.043	0.330
12	0.008	0.004	0.010	0.153
13	0.006	0.017	0.019	0.210
14	0.004	0.005	0.005	0.131
15	0.007	0.004	0.008	0.150
16	0.005	0.007	0.007	0.115
17	0.059	0.056	0.055	0.132
18	0.006	0.005	0.005	0.102
19	0.028	0.021	0.024	0.118
20	0.003	0.004	0.004	0.092
21	0.005	0.003	0.006	0.107
22	0.003	0.004	0.004	0.084
23	0.007	0.006	0.009	0.098
24	0.004	0.003	0.003	0.077
25	0.025	0.027	0.028	0.090
26	0.003	0.003	0.003	0.071
27	0.004	0.003	0.005	0.083
28	0.003	0.003	0.004	0.066
29	0.036	0.037	0.034	0.078
30	0.003	0.004	0.005	0.061
31	0.021	0.018	0.016	0.073
32	0.003	0.003	0.004	0.058
33	0.004	0.003	0.004	0.068
34	0.002	0.003	0.003	0.054
35	0.014	0.016	0.015	0.064
36	0.008	0.003	0.003	0.051
37	0.024	0.020	0.023	0.061
38	0.003	0.003	0.003	0.048
39	0.004	0.003	0.005	0.058
40	0.002	0.002	0.002	0.046

8.2.4	TABLE: Current harmonics emission test			P
Model: BNT003KTL		Rating: 33%Pn		
Harmonics order n	Measured Value (A)			Limit in BS EN 61000-3-2 in Amps
	R	S	T	
2	0.056	0.040	0.035	1.080
3	0.005	0.007	0.015	2.300
4	0.006	0.012	0.008	0.430
5	0.160	0.160	0.167	1.140
6	0.012	0.012	0.003	0.300
7	0.040	0.048	0.044	0.770
8	0.007	0.004	0.006	0.230
9	0.012	0.009	0.006	0.400
10	0.006	0.004	0.006	0.184
11	0.009	0.007	0.007	0.330
12	0.003	0.007	0.007	0.153
13	0.062	0.056	0.067	0.210
14	0.004	0.004	0.004	0.131
15	0.005	0.006	0.008	0.150
16	0.008	0.009	0.007	0.115
17	0.050	0.059	0.065	0.132
18	0.012	0.009	0.006	0.102
19	0.070	0.072	0.072	0.118
20	0.009	0.005	0.005	0.092
21	0.012	0.003	0.012	0.107
22	0.006	0.004	0.004	0.084
23	0.032	0.032	0.034	0.098
24	0.004	0.005	0.004	0.077
25	0.016	0.014	0.014	0.090
26	0.003	0.003	0.003	0.071
27	0.005	0.003	0.006	0.083
28	0.003	0.004	0.005	0.066
29	0.021	0.018	0.019	0.078
30	0.004	0.004	0.004	0.061
31	0.025	0.027	0.024	0.073
32	0.005	0.004	0.005	0.058
33	0.005	0.003	0.005	0.068
34	0.004	0.003	0.004	0.054
35	0.022	0.021	0.019	0.064
36	0.011	0.005	0.003	0.051
37	0.019	0.018	0.015	0.061
38	0.004	0.004	0.004	0.048
39	0.004	0.003	0.005	0.058
40	0.003	0.003	0.003	0.046

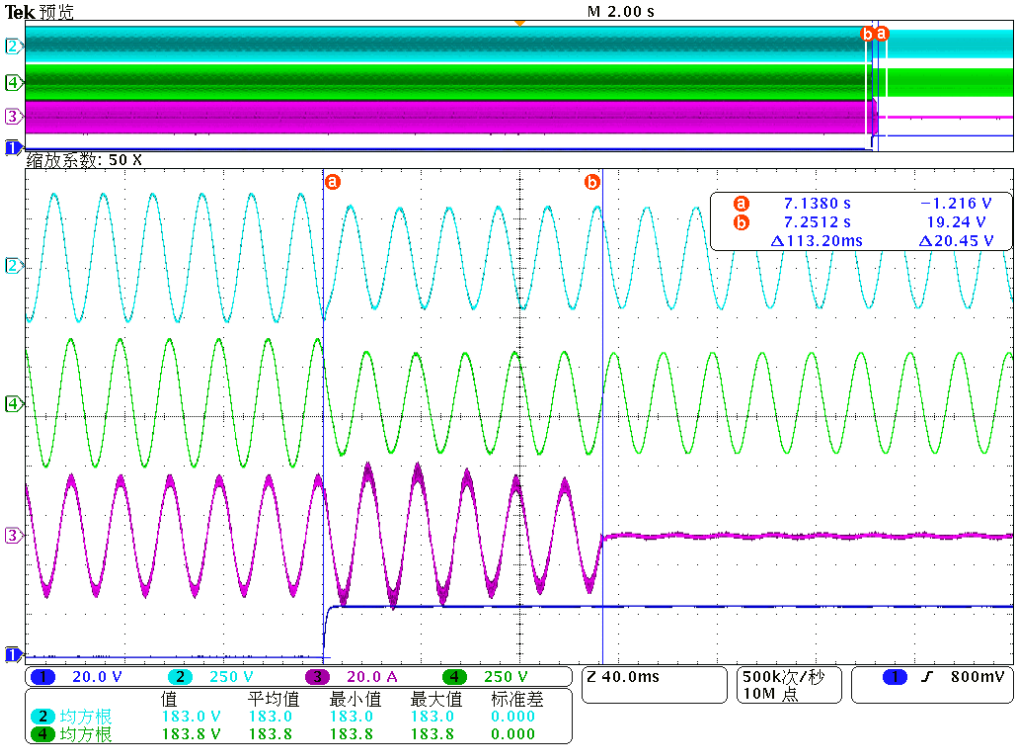
8.2.4	TABLE: Current harmonics emission test			P
Model: BNT025KTL		Rating: 100%Pn		
Harmonics order n	Measured Value (%)			Limit in EN 61000-3-12 in %
	R	S	T	
2	0.381	0.416	0.403	8%
3	0.343	0.271	0.225	21.6%
4	0.098	0.139	0.121	4%
5	0.375	0.331	0.259	10.7%
6	0.061	0.101	0.106	2.67%
7	0.364	0.392	0.333	7.2%
8	0.055	0.089	0.070	2%
9	0.307	0.145	0.183	3.8%
10	0.048	0.064	0.055	1.6%
11	0.098	0.096	0.118	3.1%
12	0.044	0.057	0.052	1.33%
13	0.088	0.113	0.128	2%
THD	2.466	2.266	2.400	13%
PWHD	0.899	1.105	0.967	22%

8.2.4	TABLE: Current harmonics emission test			P
Model: BNT025KTL		Rating: 66%Pn		
Harmonics order n	Measured Value (%)			Limit in EN 61000-3-12 in %
	R	S	T	
2	0.378	0.325	0.339	8%
3	0.147	0.064	0.230	21.6%
4	0.068	0.045	0.053	4%
5	0.570	0.447	0.470	10.7%
6	0.044	0.054	0.045	2.67%
7	0.317	0.425	0.391	7.2%
8	0.029	0.043	0.044	2%
9	0.067	0.052	0.081	3.8%
10	0.029	0.038	0.039	1.6%
11	0.139	0.108	0.100	3.1%
12	0.032	0.032	0.029	1.33%
13	0.087	0.090	0.092	2%
THD	1.630	1.527	1.636	13%
PWHD	1.284	1.197	1.202	22%

8.2.4	TABLE: Current harmonics emission test			P
Model: BNT025KTL		Rating: 33%Pn		
Harmonics order n	Measured Value (%)			Limit in EN 61000-3-12 in %
	R	S	T	
2	0.257	0.228	0.261	8%
3	0.352	0.075	0.416	21.6%
4	0.081	0.077	0.070	4%
5	0.978	0.865	0.948	10.7%
6	0.109	0.066	0.056	2.67%
7	0.726	0.808	0.775	7.2%
8	0.061	0.075	0.069	2%
9	0.096	0.090	0.132	3.8%
10	0.037	0.051	0.048	1.6%
11	0.268	0.187	0.267	3.1%
12	0.059	0.052	0.045	1.33%
13	0.173	0.182	0.164	2%
THD	1.857	1.690	1.771	13%
PWHD	2.928	2.825	2.988	22%

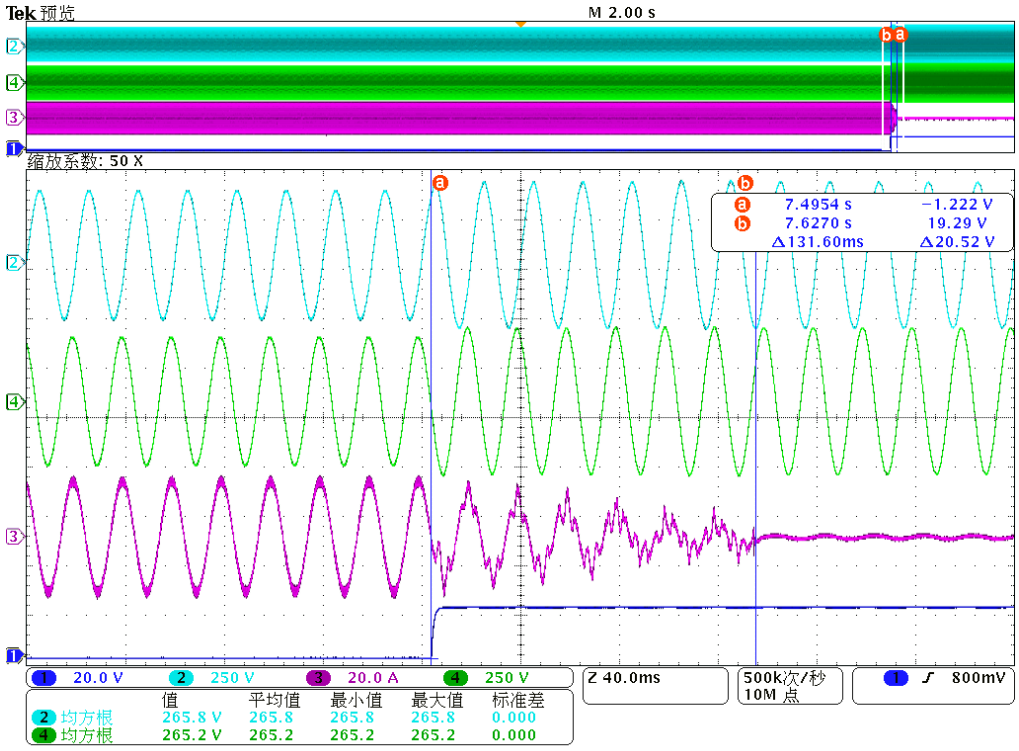
D.3	Table: Undervoltage threshold stage				P
Parameter	**Settings**	**Test 1**	**Test 2**	**Test 3**	**Limits**
Trip value L1 [V]	184	183.8	183.4	183.7	184±2.3
Trip time [ms]	100	98.8	82.4	122.4	<200
Trip value L2 [V]	184	183.1	183.7	183.3	184±2.3
Trip time [ms]	100	114.4	119.6	122.4	<200
Trip value L3 [V]	184	183.8	183.5	183.4	184±2.3
Trip time [ms]	100	96.4	115.2	121.6	<200
Trip value L1L2L3[V]	184	183.8	183.1	183.0	184±2.3
Trip time [ms]	100	113.2	112.0	118.0	<200

Trip time

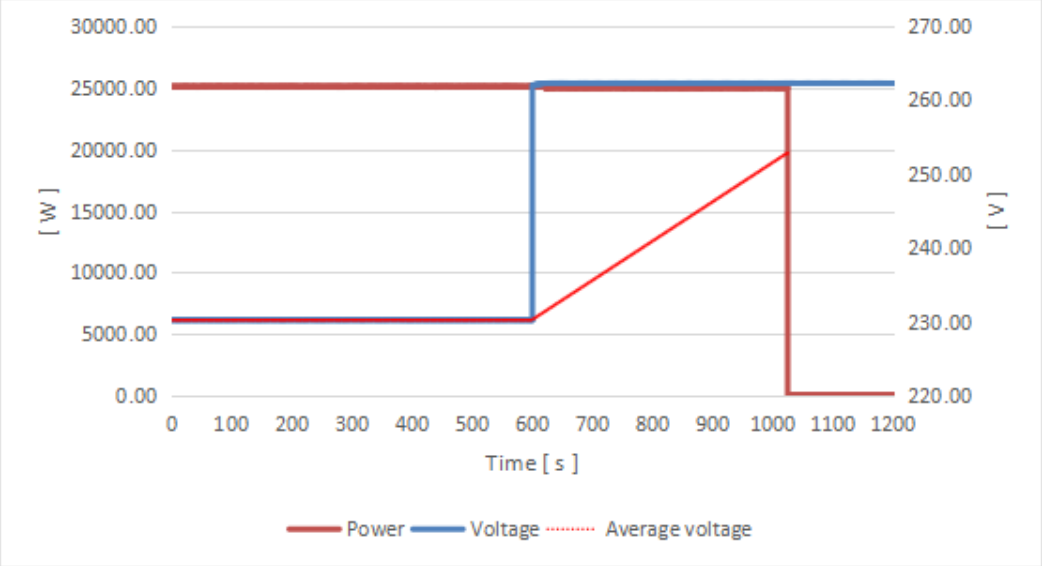


D.3	Table: Overvoltage threshold stage				P
Parameter	**Settings**	**Test 1**	**Test 2**	**Test 3**	**Limits**
Trip value L1 [V]	264.5	265.9	265.8	265.7	264.5±2.3
Trip time [ms]	100.0	114.4	104.0	111.6	<200
Trip value L2 [V]	264.5	265.0	265.8	265.3	264.5±2.3
Trip time [ms]	100.0	118.0	126.4	129.6	<200
Trip value L3 [V]	264.5	265.3	265.4	265.5	264.5±2.3
Trip time [ms]	100.0	131.2	99.2	133.2	<200
Trip value L1L2L3[V]	264.5	265.2	265.0	265.5	264.5±2.3
Trip time [ms]	100.0	131.6	132.8	112.4	<200

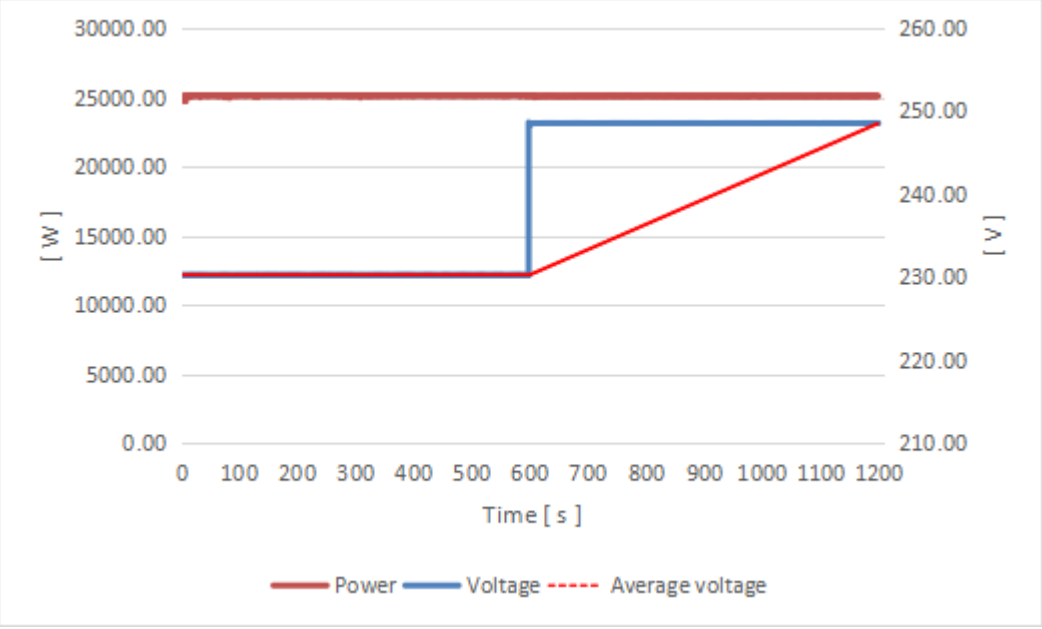
Trip time



D.3	Overvoltage 10 min mean Protection		P
	Output Voltage (V)	Switch	
		On/Off state Finally	Time until Switch off (s)
100% Un	230.23	☒On ☐Off	--
112% Un	257.72	☐On ☒Off	489.5
100% Un	230.23	☒On ☐Off	--
108% Un	248.55	☒On ☐Off	--
106% Un	243.97	☒On ☐Off	--
114% Un	262.30	☐On ☒Off	289.5

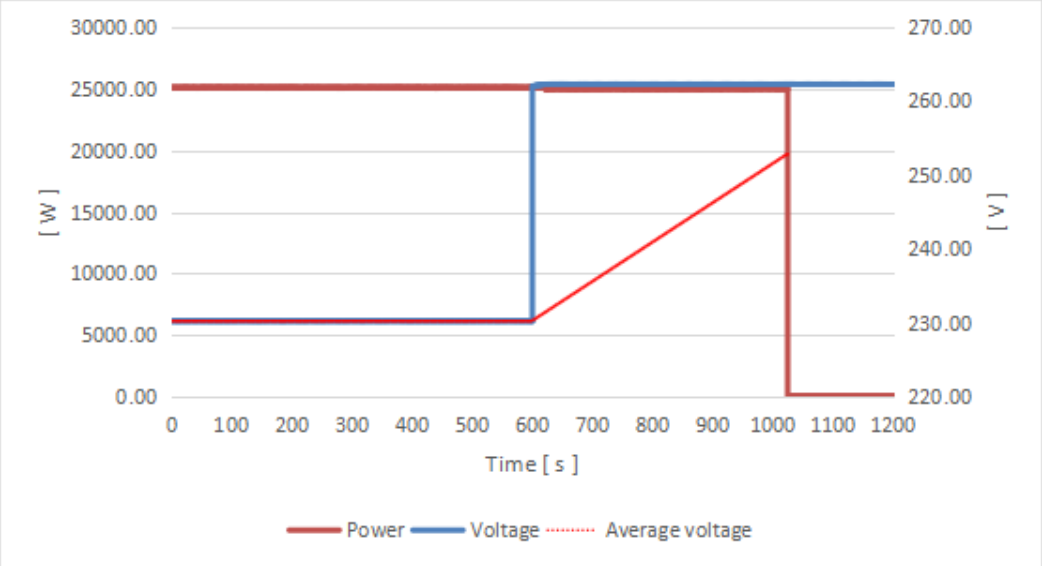


Un to 1.12Un



Un to 1.08Un

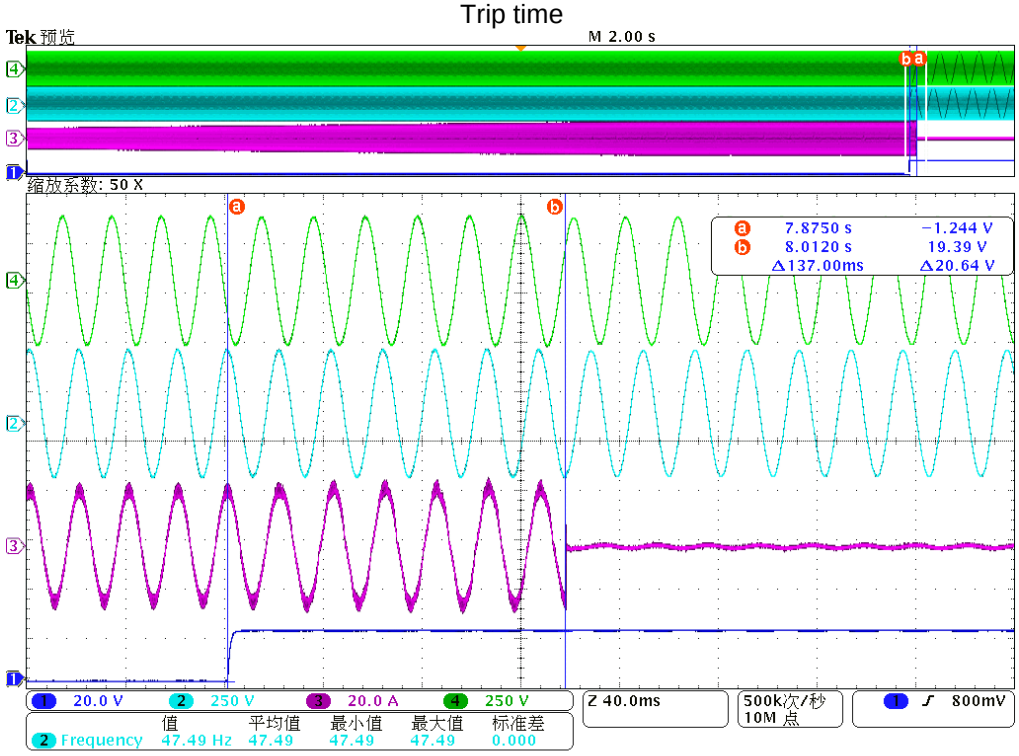
D.3	Overvoltage 10 min mean Protection	P



1.06 Un to 1.14Un

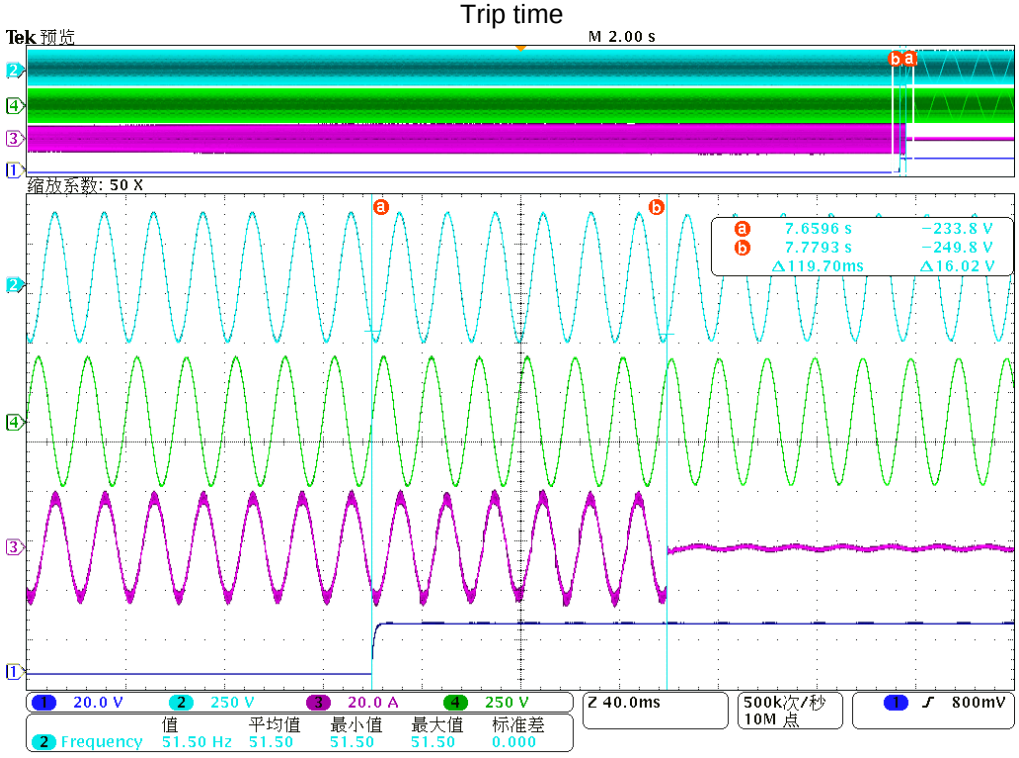
D.3	Table: Underfrequency threshold stage				P
Parameter	**Settings**	**Test 1**	**Test 2**	**Test 3**	**Limits**
Trip value [Hz]	47.5	47.49	47.49	47.49	47.5±0.05
Trip time [ms]	100	137.0	126.7	120.36	<200

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	119.7	135.1	132.0	<200

Trip time

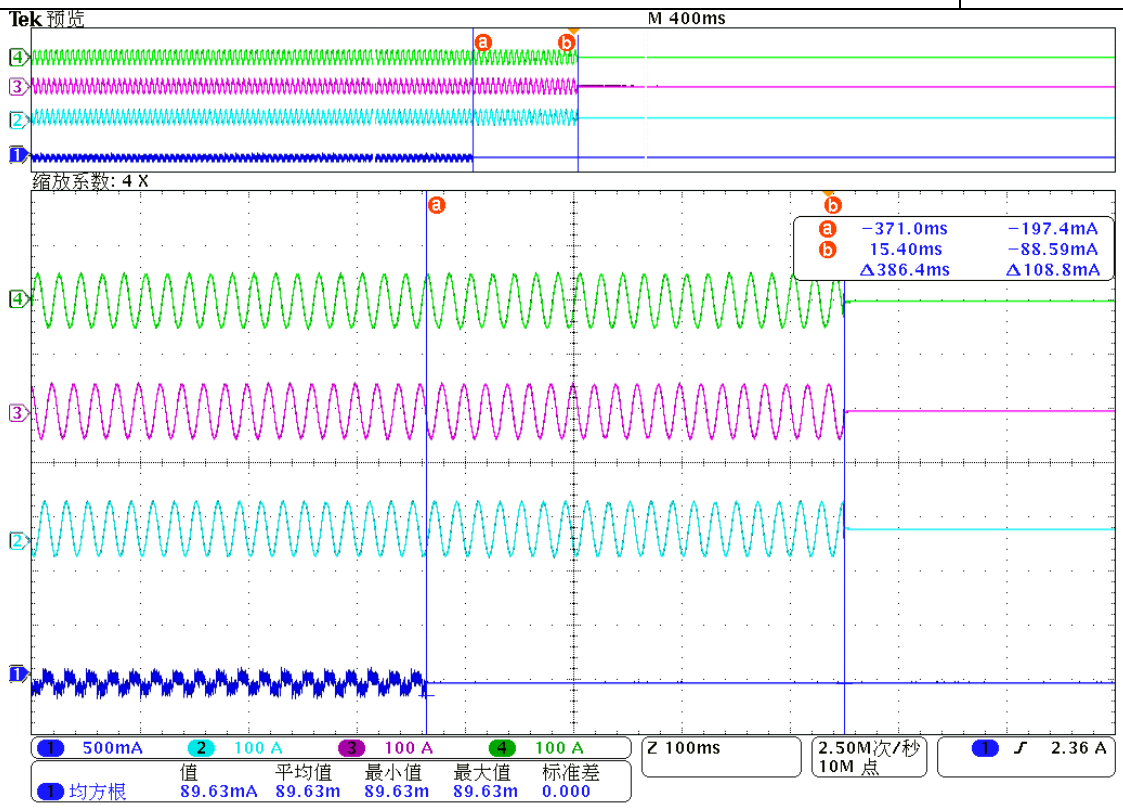


D.3	Table: Islanding								P			
No.	P_{EUT}[1] (%of EUT rating)	Reactive load (% of Q_L in 6.1.d)[1]	P_{AC}[2] (% of nominal)	Q_{AC}[3] (% of nominal)	Run on time (ms)	P_{EUT} (W)	Actual Q_f	V_{DC}	Remarks[4]			
1	100	100	0	0	386.4	25000	0.98	763	Test	A	at	BL
2	66	66	0	0	350.4	16500	1.01	675	Test	B	at	BL
3	33	33	0	0	340.6	8330	0.99	570	Test	C	at	BL
4	100	100	-5	-5	329.4	25000	1.01	763	Test	A	at	IB
5	100	100	-5	0	225.4	25000	1.02	763	Test	A	at	IB
6	100	100	-5	5	311.6	25000	1.02	763	Test	A	at	IB
7	100	100	0	-5	281.6	25000	0.97	763	Test	A	at	IB
8	100	100	0	5	213.6	25000	1.01	763	Test	A	at	IB
9	100	100	5	-5	213.6	25000	0.91	763	Test	A	at	IB
10	100	100	5	0	265.4	25000	0.93	763	Test	A	at	IB
11	100	100	5	5	310.4	25000	0.96	763	Test	A	at	IB
12	66	66	0	-5	209.4	16500	0.99	675	Test	B	at	IB
13	66	66	0	-4	228.4	16500	0.99	675	Test	B	at	IB
14	66	66	0	-3	247.4	16500	0.99	675	Test	B	at	IB
15	66	66	0	-2	267.4	16500	0.99	675	Test	B	at	IB
16	66	66	0	-1	280.4	16500	1.00	675	Test	B	at	IB
17	66	66	0	1	330.4	16500	1.01	675	Test	B	at	IB
18	66	66	0	2	285.4	16500	1.01	675	Test	B	at	IB
19	66	66	0	3	259.4	16500	1.02	675	Test	B	at	IB
20	66	66	0	4	238.4	16500	1.02	675	Test	B	at	IB
21	66	66	0	5	214.4	16500	1.03	675	Test	B	at	IB
22	33	33	0	-5	103.4	8330	0.98	570	Test	C	at	IB
23	33	33	0	-4	233.6	8330	0.95	570	Test	C	at	IB
24	33	33	0	-3	280.6	8330	0.96	570	Test	C	at	IB
25	33	33	0	-2	283.6	8330	0.97	570	Test	C	at	IB
26	33	33	0	-1	328.6	8330	0.97	570	Test	C	at	IB
27	33	33	0	1	291.6	8330	0.98	570	Test	C	at	IB
28	33	33	0	2	284.6	8330	0.98	570	Test	C	at	IB
29	33	33	0	3	254.6	8330	0.98	570	Test	C	at	IB
30	33	33	0	4	237.6	8330	0.99	570	Test	C	at	IB
31	33	33	0	5	115.4	8330	0.99	570	Test	C	at	IB

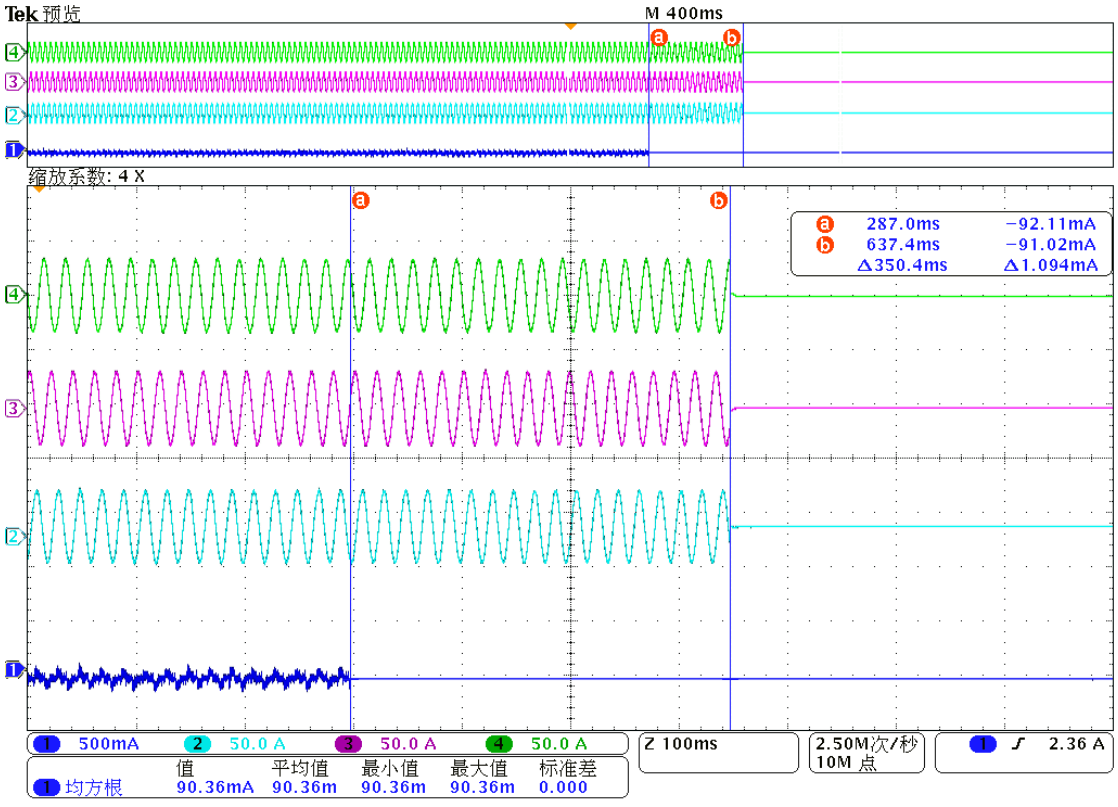
Remark:

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

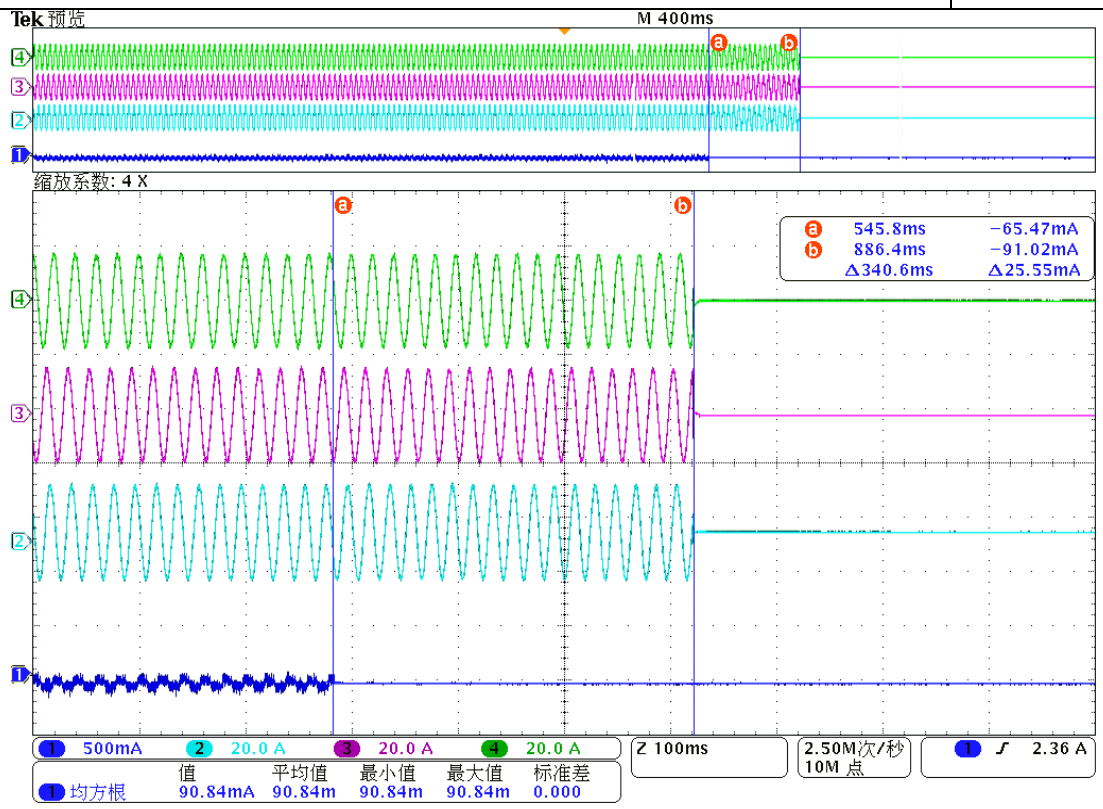


P_{EUT} 100%. P_{AC} 0%. Q_{AC} 0%. = 386.4 ms



P_{EUT} 66%. P_{AC} 0%. Q_{AC} 0%. = 350.4 ms

D.3	Table: Islanding	P



P_{EUT} 33%. P_{AC} 0%. Q_{AC} 0%. = 340.6 ms

Note: CH4 voltage of EUT; CH3 current of EUT; CH1 current of signal (the signal from Grid)

4.4.4	TABLE: Single fault tolerance				P
No.	Component name	Component No.	Fault point	Duration	Result
1.	ISO Relay	K2	Short circuit before start up inverter	3min	Unit can't operate, error message: Iso Fault. No fire. no danger. no hazard.
2.	Monitoring Relay - L1	K3	Pin1 to Pin2 short circuit before start up inverter	3min	Unit can't operate, error message: Grid Relay Fault. No fire. no danger. no hazard.
3.	Monitoring Relay - L1	K3	Pin3 to Pin4 short circuit before start up inverter	3min	Unit can't operate, error message: Grid Relay Fault. No fire. no danger. no hazard.
4.	Monitoring Relay - L1	K6	Pin1 to Pin2 short circuit before start up inverter	3min	Unit can't operate, error message: Grid Relay Fault. No fire. no danger. no hazard.
5.	Monitoring Relay - L1	K6	Pin3 to Pin4 short circuit before start up inverter	3min	Unit can't operate, error message: Grid Relay Fault. No fire. no danger. no hazard.
6.	Monitoring Relay - L2	K7	Pin1 to Pin2 short circuit before start up inverter	3min	Unit can't operate, error message: Grid Relay Fault. No fire. no danger. no hazard.
7.	Monitoring Relay - L2	K7	Pin3 to Pin4 short circuit before start up inverter	3min	Unit can't operate, error message: Grid Relay Fault. No fire. no danger. no hazard.
8.	Monitoring Relay - L2	K10	Pin1 to Pin2 short circuit before start up inverter	3min	Unit can't operate, error message: Grid Relay Fault. No fire. no danger. no hazard.
9.	Monitoring Relay - L2	K10	Pin3 to Pin4 short circuit before start up inverter	3min	Unit can't operate, error message: Grid Relay Fault. No fire. no danger. no hazard.
10.	Monitoring Relay - L3	K7	Pin1 to Pin2 short circuit before start up inverter	3min	Unit can't operate, error message: Grid Relay Fault. No fire. no danger. no hazard.
11.	Monitoring Relay - L3	K7	Pin3 to Pin4 short circuit before start up inverter	3min	Unit can't operate, error message: Grid Relay Fault. No fire. no danger. no hazard.
12.	Monitoring Relay - L3	K10	Pin1 to Pin2 short circuit before start up inverter	3min	Unit can't operate, error message: Grid Relay Fault. No fire. no danger. no hazard.
13.	Monitoring Relay - L3	K10	Pin3 to Pin4 short circuit before start up inverter	3min	Unit can't operate, error message: Grid Relay Fault. No fire. no danger. no hazard.
14.	AC voltage measure1	R413	Pin1-Pin2 Short circuit	3min	Unit shut down, Error message: Grid Volt Fault. No fire. no danger. no hazard.
15.	AC voltage measure1	R547	Pin1-Pin2 Open circuit	3min	Unit shut down, Error message: Grid Volt Fault. No fire. no danger. no hazard.
16.	AC voltage measure2	R425	Pin1-Pin2 Short circuit	3min	Unit shut down, Error message: Grid Volt Fault. No fire. no danger. no hazard.
17.	AC voltage measure2	R548	Pin1-Pin2 Open circuit	3min	Unit shut down, Error message: Grid Volt Fault. No fire. no danger. no hazard.

18.	AC voltage measure3	R435	Pin1-Pin2 Short circuit	3min	Unit shut down, Error message: Grid Volt Fault. No fire. no danger. no hazard.
19.	AC voltage measure3	R551	Pin1-Pin2 Open circuit	3min	Unit shut down, Error message: Grid Volt Fault. No fire. no danger. no hazard.
20.	AC current measure1	R564	Pin1-Pin2 Short circuit	3min	Unit can't operate, error message: Inv Over Current. No fire. no danger. no hazard.
21.	AC current measure2	R574	Pin1-Pin2 Short circuit	3min	Unit can't operate, error message: Inv Over Current. No fire. no danger. no hazard.
22.	AC current measure3	R587	Pin1-Pin2 Short circuit	3min	Unit can't operate, error message: Inv Over Current. No fire. no danger. no hazard.
23.	AC frequency measure	R555	Pin1-Pin2 Open circuit	3min	Unit shut down, error message: Grid Freq Fault. No fire. no danger. no hazard.
24.	V-bus measure	C315	Pin1-Pin2 Short circuit	3min	Unit shut down, error message: BusAllVoltHwOveFault. No fire. no danger. no hazard.
25.	V-bus measure	R492	Pin1-Pin2 Short circuit	3min	Unit can't start up, No fire. no danger. no hazard.
26.	DC current measure	R536	Pin1-Pin2 Short circuit	3min	Unit shut down, error message: PV1HwoVerCurrFault. No fire. no danger. no hazard.
27.	Bus cap	C32	Pin1-Pin2 Short circuit before start up	3min	Unit can not start up, No fire. no danger. no hazard.
28.	COM-of CPU1-CPU2	U26	Pin 172 Open circuit	3min	Unit shut down. error message: Slave Com Waring. No fire. no danger. no hazard.
29.	CPU1 Failure -Power	C41	Pin 1-Pin2 Short circuit	3min	Unit shut down. No fire. no danger. no hazard.
30.	T measure	C258	Pin1-Pin2 Short circuit	3min	Unit can't operate, Error message: CoolingTemAdChanWarning. No fire. no danger. no hazard.
31.	Insulation impedance measure	R15	Pin1-Pin2 Short circuit	3min	Unit can't operate, Error message: Iso Err. No fire. no danger. no hazard.
32.	Drive optocoupler	U18	Pin1-Pin2 Short circuit before start up	~~3min~~	Unit can not start up, No fire. no danger. no hazard.
33.	power tube Boost	QA2	Pin1-Pin2 Short circuit before start up	3min	Unit can not start up, No fire. no danger. no hazard.
34.	power tube Boost	QA2	Pin1-Pin3 Short circuit before start up	3min	Unit can not start up, No fire. no danger. no hazard.
35.	power tube Boost	QA2	Pin2-Pin3 Short circuit before start up	3min	Unit can not start up, No fire. no danger. no hazard.
36.	Diode	D54	Short circuit	3min	Unit normal operation, No fire. no danger. no hazard.
37.	power tube IGBT - inverter	TQ1A	Pin1-Pin2 Short circuit before start up	3min	Unit can't start, error message:Hardware Fault, No fire. no danger. no hazard.
38.	power tube IGBT - inverter	TQ1A	Pin1-Pin3 Short circuit before start up	3min	Unit can't start, error message:Hardware Fault, No fire. no danger. no hazard.
39.	GFCI check	R869	Short circuit	3min	Unit shut down, error message: GFCI Fault. No fire. no danger. no hazard.

4.4.4.4 Transformer short circuit tests					
40.	Power supply +20V	T1	Pin10-Pin11 Short circuit before start up	3min	Unit can not start up, No fire. no danger. no hazard.
41.	Power supply +8V	T1	Pin25-Pin26 Short circuit before start up	3min	Unit can not start up, No fire. no danger. no hazard.
42.	Power supply +12V	T1	Pin27-Pin29 Short circuit before start up	3min	Unit can not start up, No fire. no danger. no hazard.
43.	Power supply +12V	T1	Pin132-Pin34 Short circuit before start up	3min	Unit can not start up, No fire. no danger. no hazard.
44.	power tube MOS-SPS	Q2	G-D Short circuit	3min	SPS no output,No fire. no danger. no hazard.
4.4.4.5 Output short circuit					
45.	Output L1 to N	--	short circuit	3min	Unit shut down, error message: Grid Volt Fault. No fire. no danger. no hazard.
46.	Output L1 to L2	--	short circuit	3min	Unit shut down, error message: Grid Volt Fault. No fire. no danger. no hazard.
47.	Output L to PE	--	short circuit	3min	Unit shut down, error message: Grid Volt Fault. No fire. no danger. no hazard.
48.	Output N to PE	--	short circuit	3min	Unit shut down, error message: Grid Volt Fault. No fire. no danger. no hazard.
4.4.4.7 Output overload					
49.	Overload	--	Output overload (110%)	30 min	Unit normal operation, No fire. no danger. no hazard.
4.4.4.8 cooling system failure test					
50.	Cooling system failure – Blanketing test	--	Put the unit to box	2Hour	1 hour power run at 80%
4.4.4.11 Reverse d.c. connections					
51.	PV+ to PV-	--	Reverse polarity	3min	Unit can not start up, No fire. no danger. no hazard.
4.4.4.13 Mis-wiring with incorrect phase sequence or polarity					
52.	Output L - N	--	Reverse polarity before start up	3min	Unit normal operation. No fire. no danger. no hazard.
53.	Output L1 - N	--	Reverse polarity before start up	3min	Unit can't operate, error message: Grid Volt Fault. No fire. no danger. no hazard.
54.	Output L1 - L2	--	Reverse polarity before start up	3min	Unit normal operation. No fire. no danger. no hazard.

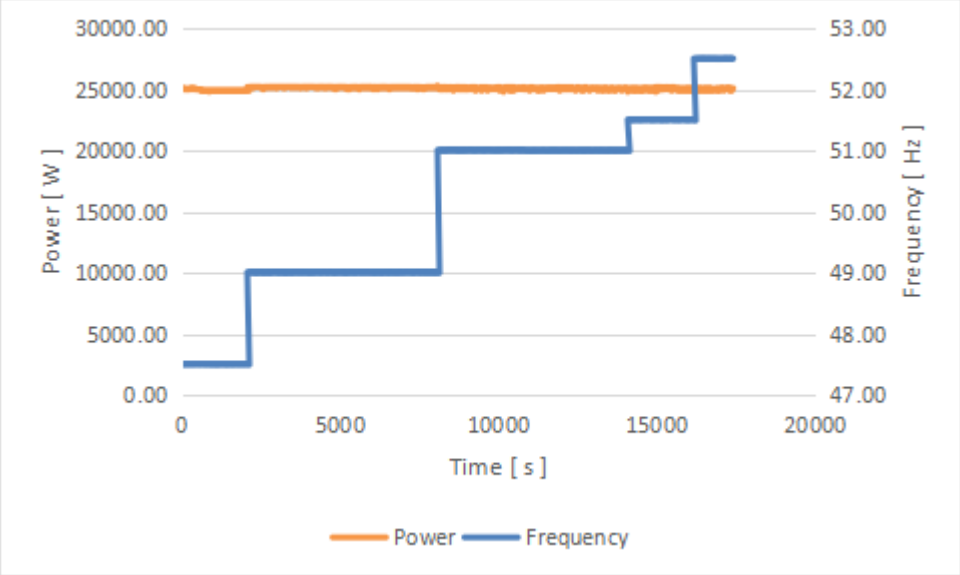
Remarks:

During the test:
Fire can not propagate beyond the EUT.
Equipment shall not emit 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

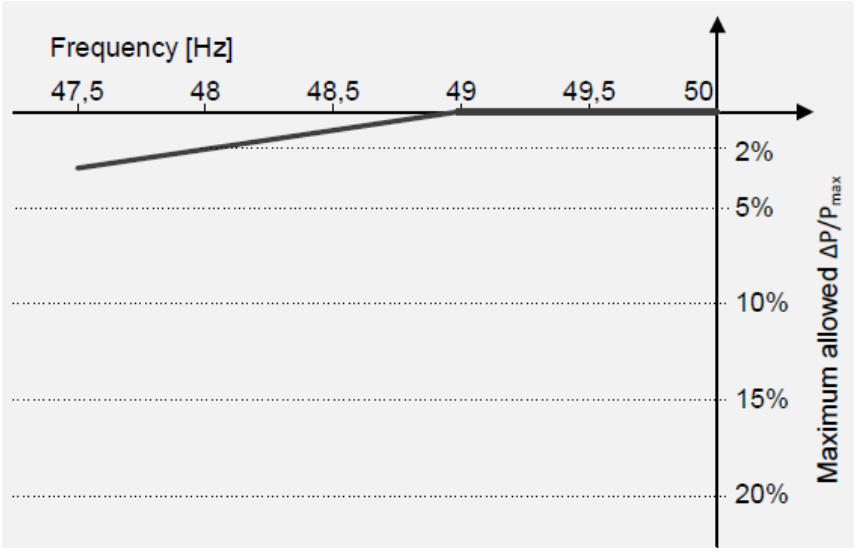
D.4.1	Table: Operating frequency range	P

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

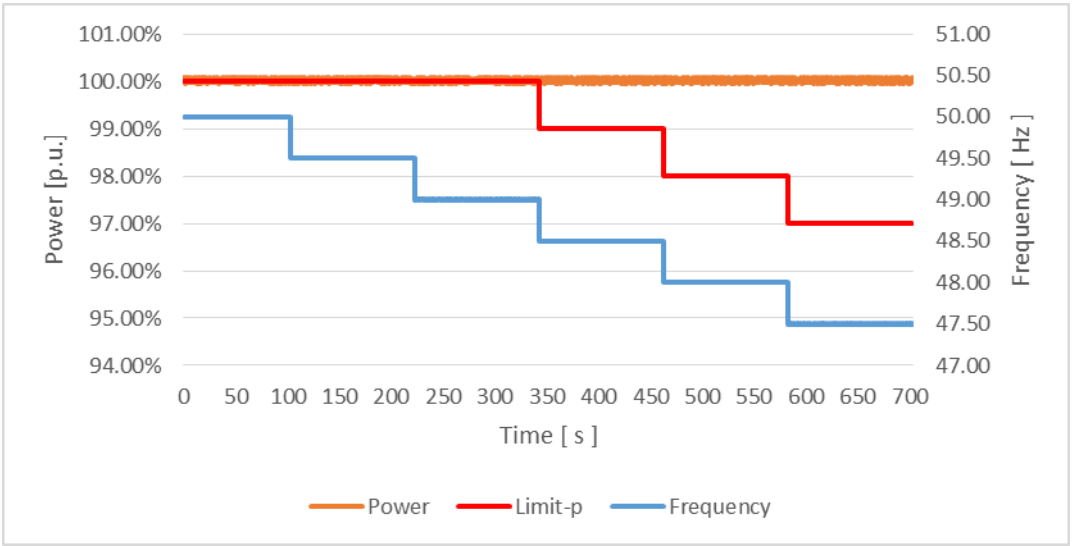
Steps	f (Hz)	f (Hz) Measured	Time	Time measured	Comments
1	47.5 Hz	47.499	>30 min	35 min	Operated normally.
2	49.0 Hz	49.001	Permanent	100 min	Operated normally.
3	51.0 Hz	51.000	Permanent	100 min	Operated normally.
4	51.5 Hz	51.500	>30 min	35 min	Operated normally.
5	52.5 Hz	52.500	>15 min*	20 min	Operated normally.



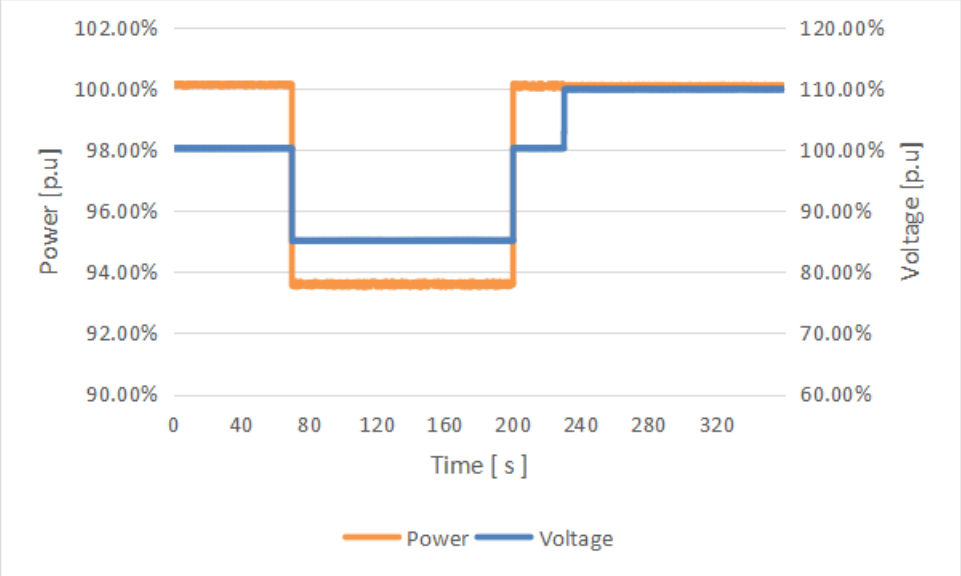
D.4.2	Table: Minimal requirements for active power delivery at underfrequency	P



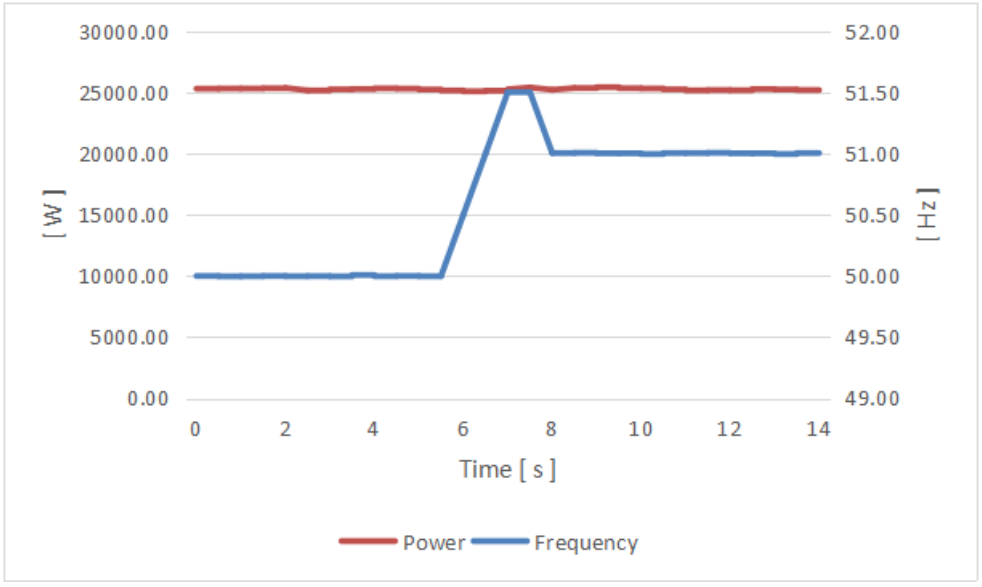
Step	f (Hz)	fmea. (Hz)	T (s)	T meas. (s)	P (%) - max	P (%) - min	P meas. (%)
1	50.00 ± 0.05	50.001	>60	70	100%	100%	100.03%
2	49.50 ± 0.05	49.501	>60	70	100%	100%	100.03%
3	49.00 ± 0.05	49.001	>60	70	100%	100%	100.02%
4	48.50 ± 0.05	48.501	>60	70	100%	99%	100.03%
5	48.00 ± 0.05	48.001	>60	70	100%	98%	100.03%
6	47.50 ± 0.05	47.501	>60	70	100%	97%	100.03%



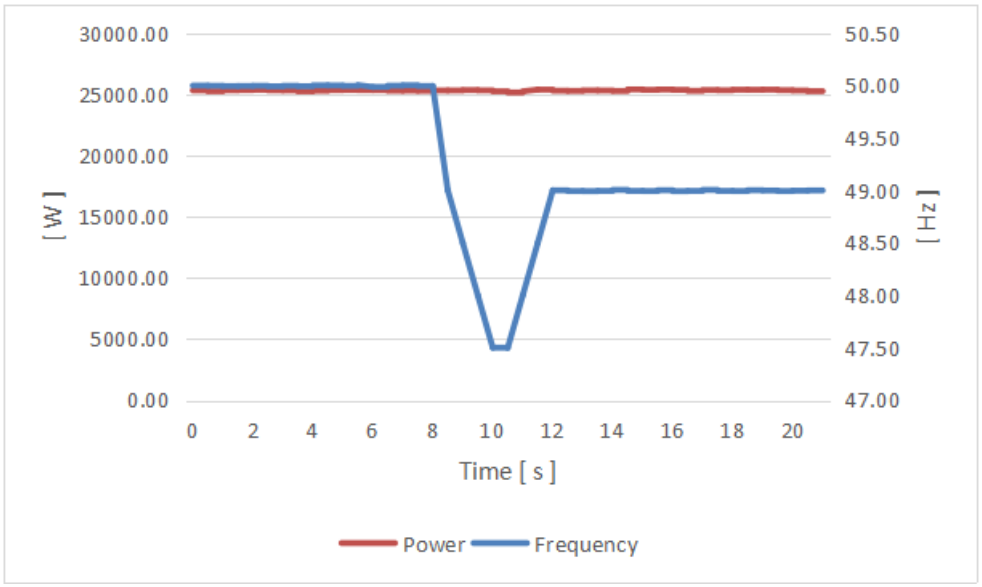
D.4.3	Table: Continuous voltage operation range				P
Step	Voltage (%)	P (%)	P meas. (%)	Time (s)	T meas (s)
1	100	100	100.12	>60	70
2	85	100 (*)	93.60	>120	130
3	100	100	100.08	>5	30
4	110	100	100.12	>120	130
(*) Active power reduction is allowed due to current limitation.					



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	25024.82	50.0 to 49.0	0.5	25087.76
2	51.0 to 51.5	0.5	25024.83	49.0 to 47.5	1.5	25083.56
3	51.5	1	25048.51	47.5	1	25049.22
4	51.5 to 51.0	0.5 s	25073.71	47.5 to 49.0	1.5	25002.91
5	51.0	3.0 s	25071.62	49.0	0.5	25055.25

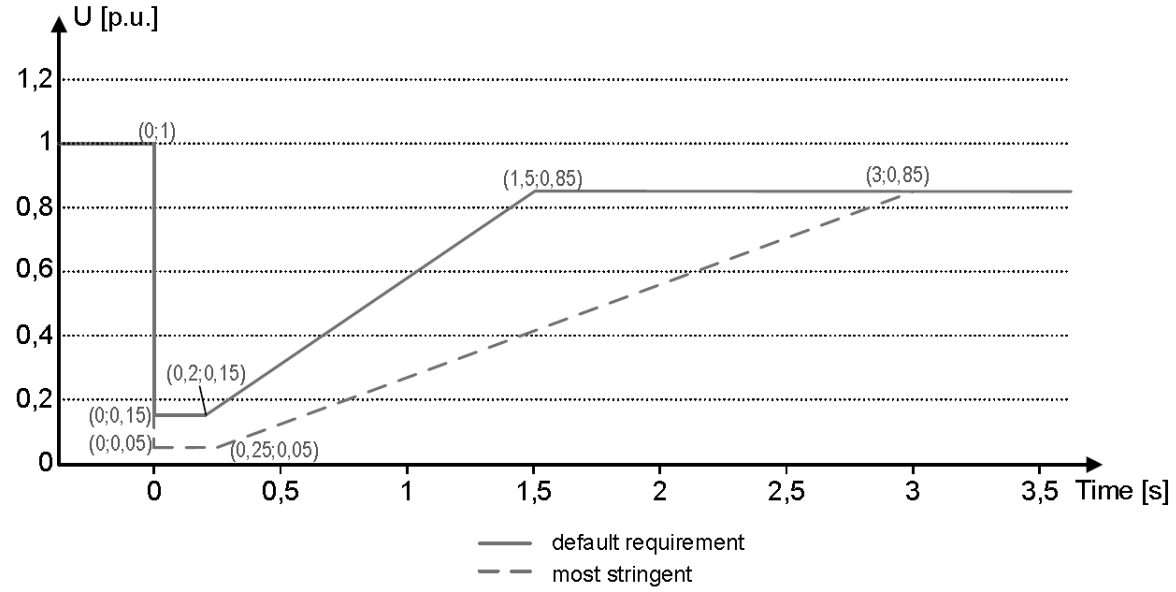


Overfrequency



Underfrequency

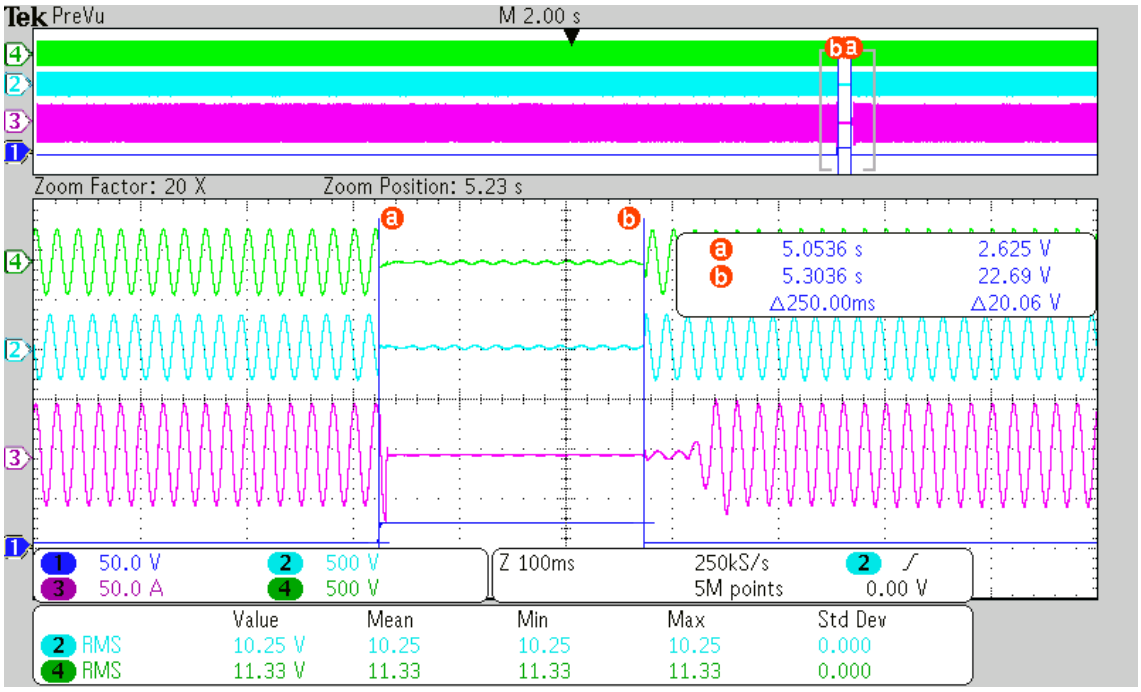
D.5.2	Table: UVRT	P



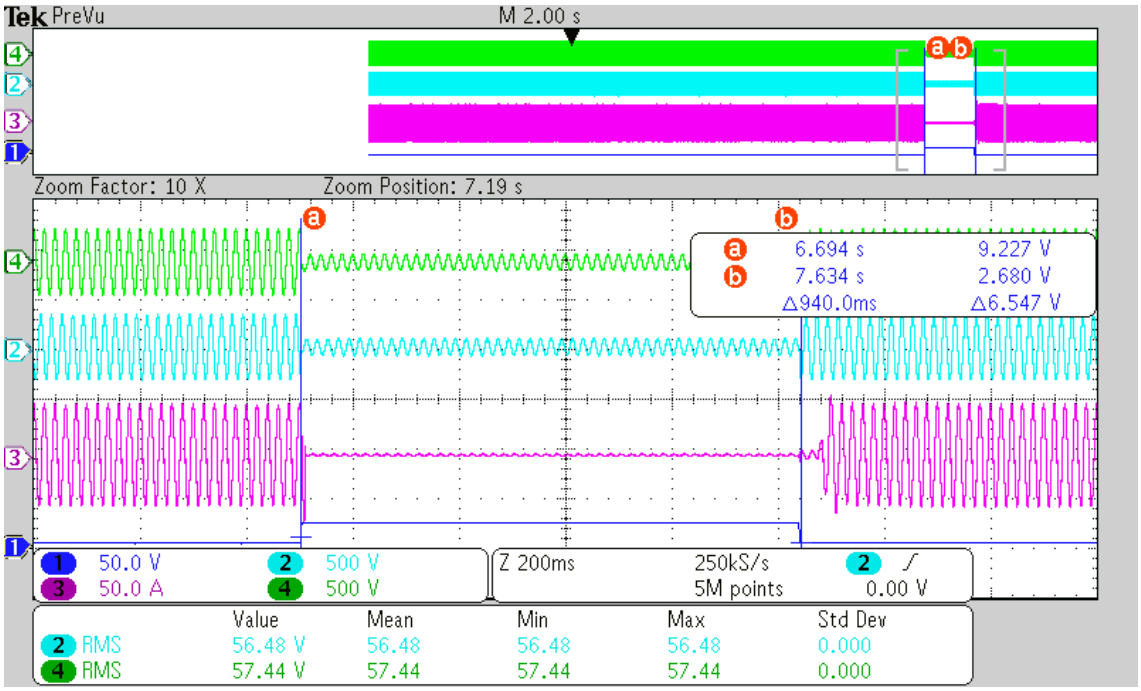
Test at full load (>90%)

Udip	Type		t min (ms)	U meas. (V)	T meas. (ms)	P recover (s)
5%	1 ph	Phase A	250	11.01/230.4/229.8	250	0.088
		Phase B		229.9/11.31/229.7	251	0.087
		Phase C		229.8/230.2/11.98	250	0.088
	2 ph	Phase A & B		11.1/10.64/230	250	0.087
		Phase B & C		230/10.79/11.1	250	0.087
		Phase C & A		10.53/230/11	250	0.086
	3 ph			11.33/10.25/11.3	250	0.088
25%	1 ph	Phase A	938	57.46/229.7/230	939	0.079
		Phase B		229.1/56.13/229.2	939	0.079
		Phase C		230.1/229.8/56.74	939	0.081
	2 ph	Phase A & B		57/56.9/230	939	0.080
		Phase B & C		230/56.67/56.95	938	0.080
		Phase C & A		56.25/229.8/56.94	938	0.080
	3 ph			57.44/56.48/56.72	940	0.080
50%	1 ph	Phase A	1797	113.3/230/229.8	1799	0.081
		Phase B		229.9/113.5/230	1798	0.082
		Phase C		229.9/230/113.3	1798	0.081
	2 ph	Phase A & B		113.3/115/229.8	1799	0.081
		Phase B & C		230/115/113.5	1798	0.082
		Phase C & A		113/230/115	1799	0.082
	3 ph			113.9/115/114.8	1798	0.042
75%	1 ph	Phase A	2656	172.1/229/229.9	2658	0.044
		Phase B		230/170.9/229.8	2659	0.046
		Phase C		230/229.1/170.9	2658	0.036
	2 ph	Phase A & B		170.2/172/229.8	2658	0.040
		Phase B & C		229.9/172/170	2656	0.034
		Phase C & A		172/229.8/170.9	2658	0.036
	3 ph			172.1/170.9/170.3	2658	0.034

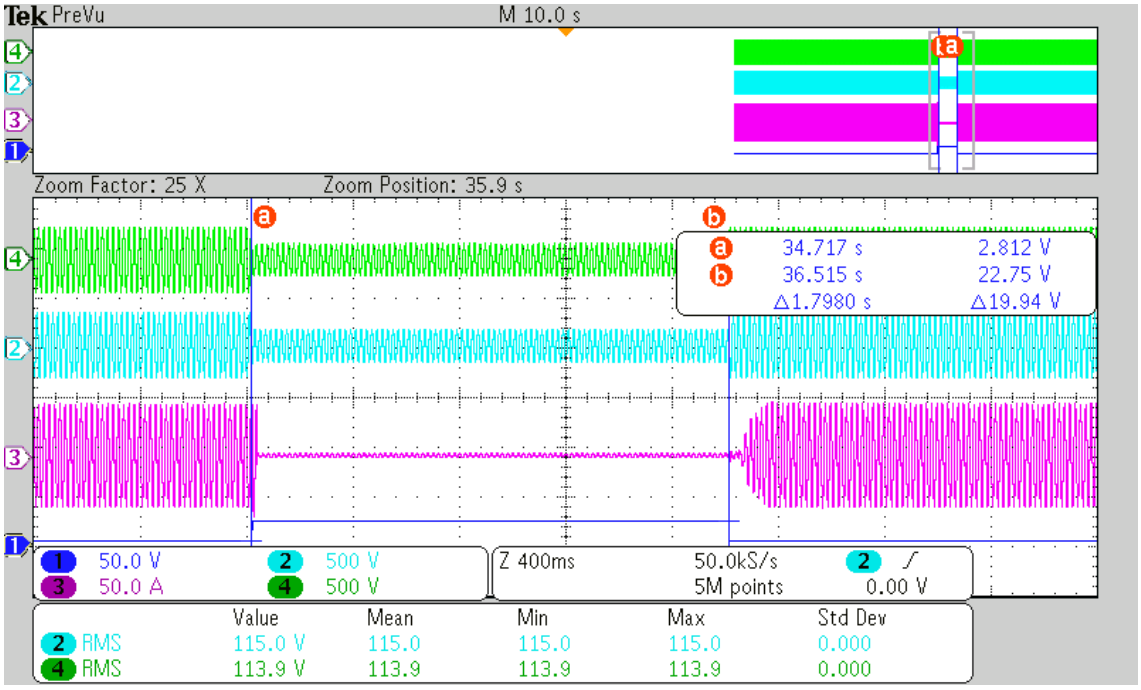
Remark:
The tests are performed together with clause 4.7.4.2.2 Zero current mode and enabling of default setting: Undervoltage of 50%Un.



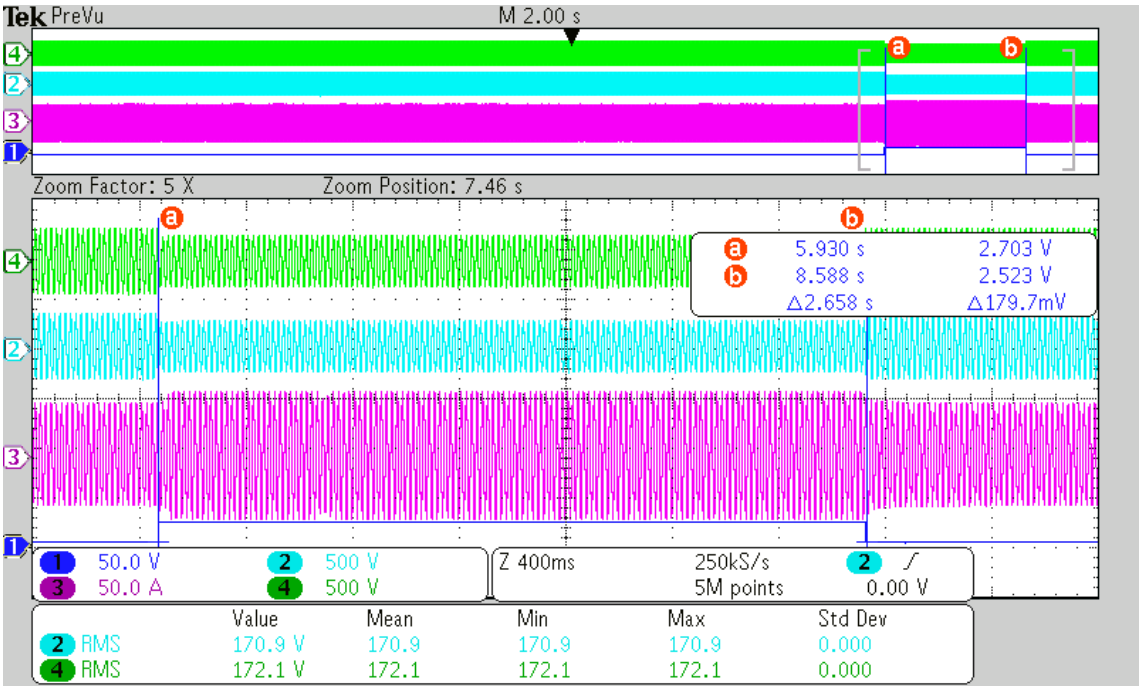
Graph_5%



Graph_25%

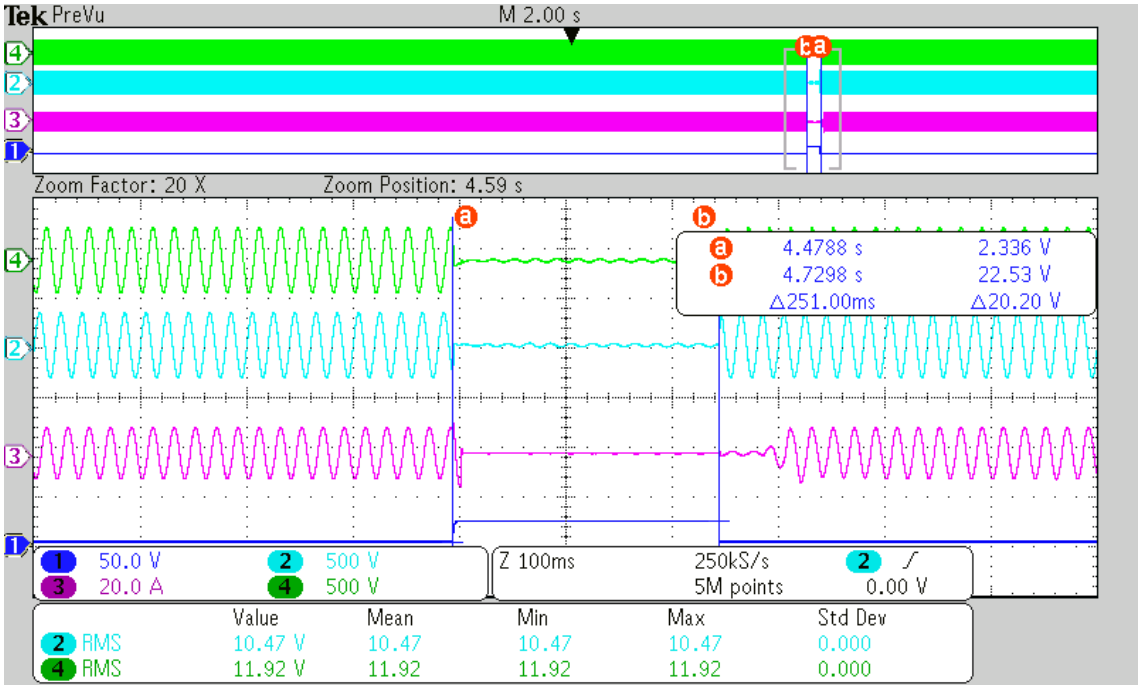


Graph_50%

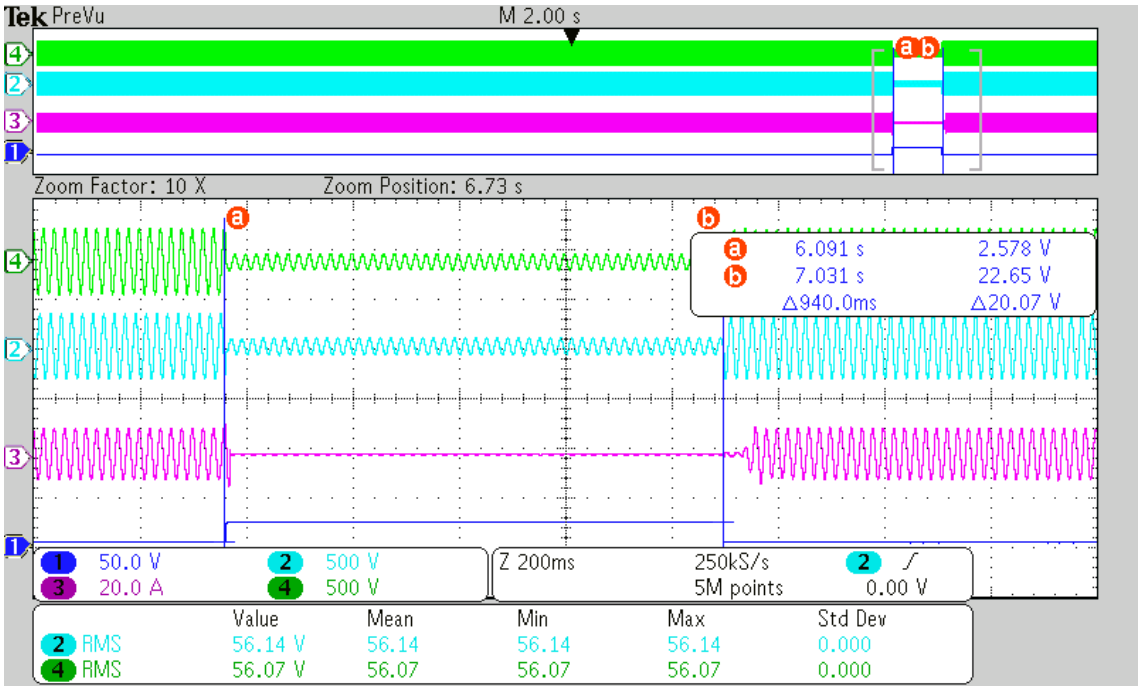


Graph_75%

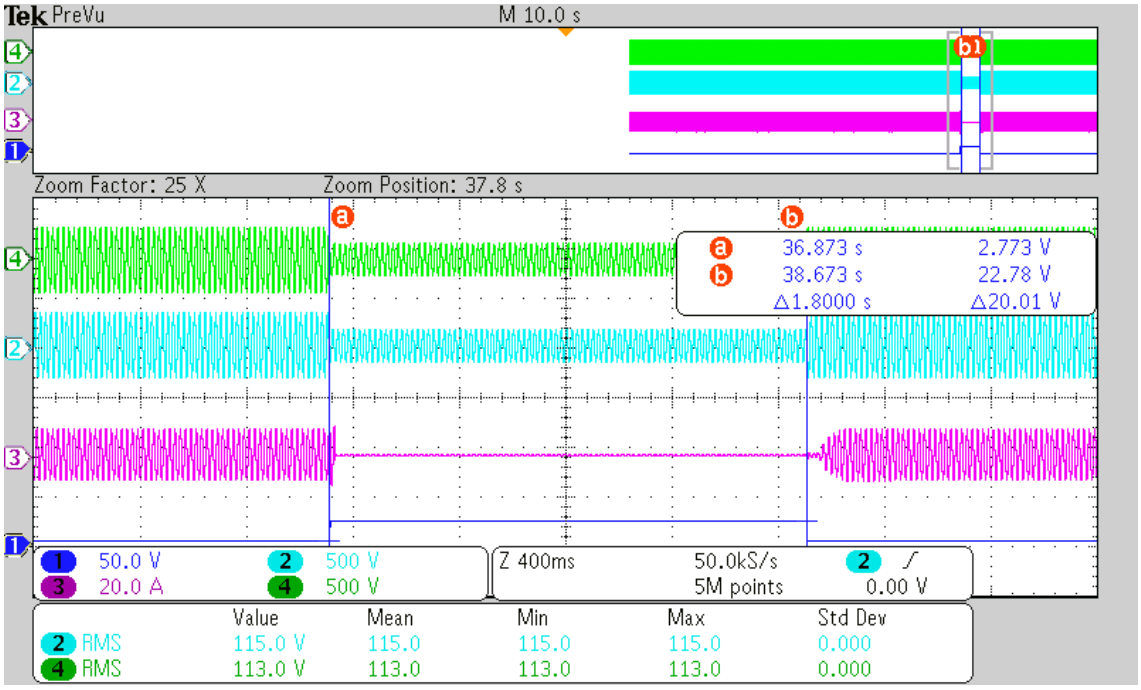
D.5.2	Table: UVRT					P
Test at partial load (>30%Pn)						
Udip	Type		t min (ms)	U meas. (%)	T meas. (ms)	P recover (s)
5%	1 ph	Phase A	250	11.14/229.8/229.6	251	0.085
		Phase B		229.8/11.2/229.9	251	0.087
		Phase C		230/229.9/11.41	250	0.087
	2 ph	Phase A & B		11.21/10.57/229.8	251	0.088
		Phase B & C		230/10.02/11.78	251	0.087
		Phase C & A		10.76/229.8/11.97	250	0.087
	3 ph			11.92/10.47/11.56	251	0.087
25%	1 ph	Phase A	938	56.36/230/229.8	939	0.080
		Phase B		229.4/56.08/230	940	0.080
		Phase C		229.9/230/56.52	938	0.081
	2 ph	Phase A & B		56.68/56.57/230	939	0.080
		Phase B & C		229.8/56.59/56.7	940	0.080
		Phase C & A		56.61/229.9/56.1	938	0.080
	3 ph			56.07/56.14/56.12	940	0.080
50%	1 ph	Phase A	1797	115.7/230.3/229.9	1800	0.082
		Phase B		229.8/113.9/229.8	1798	0.081
		Phase C		229.9/230.3/113.8	1797	0.081
	2 ph	Phase A & B		115.3/113.1/230	1798	0.083
		Phase B & C		229.9/115/113.1	1799	0.080
		Phase C & A		113.8/229.8/115	1797	0.081
	3 ph			113/115/114	1800	0.082
75%	1 ph	Phase A	2656	172.1/229.1/229.8	2658	0.035
		Phase B		228.4/172.4/230	2656	0.036
		Phase C		230/229.2/172.1	2656	0.024
	2 ph	Phase A & B		172.5/172.2/230	2659	0.042
		Phase B & C		230/170.3/170.1	2659	0.038
		Phase C & A		170.3/229.8/170.2	2658	0.038
	3 ph			172.5/172.2/172.3	2658	0.036
Remark: The tests are performed together with clause 4.7.4.2.2 Zero current mode and enabling of default setting: undervoltage of 50%Un.						



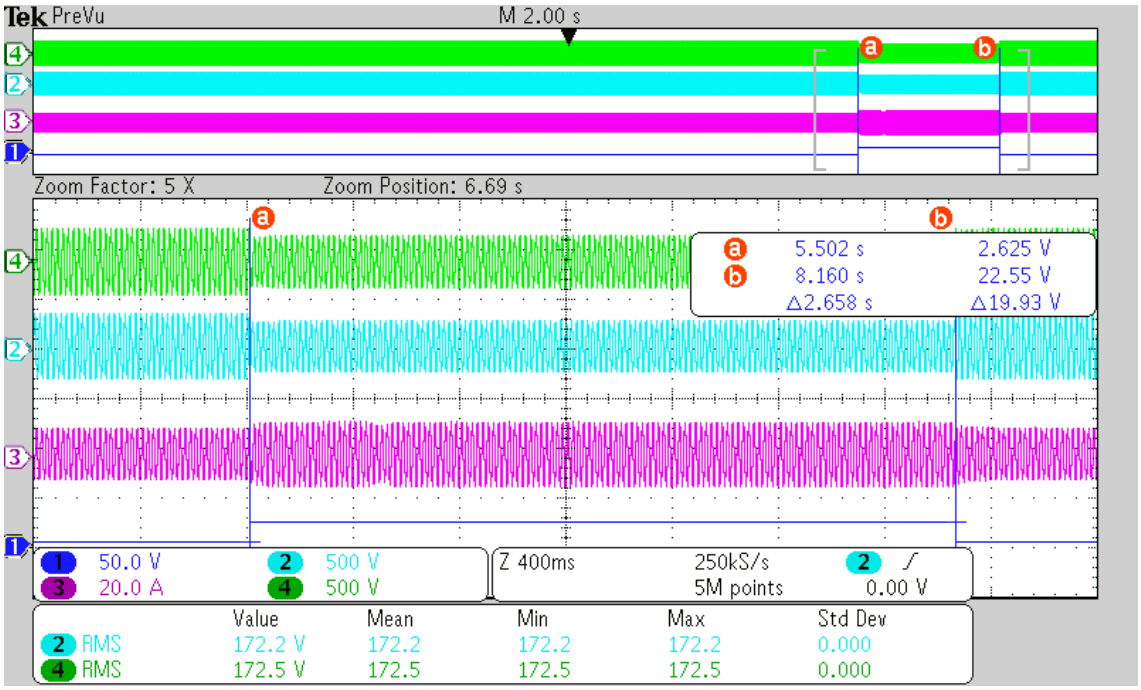
Graph_5%



Graph_25%



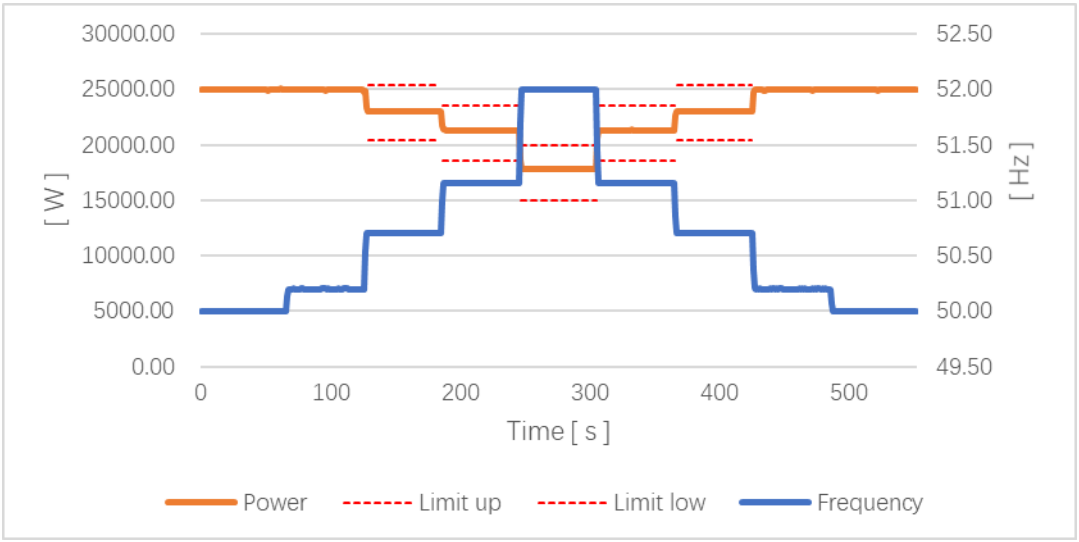
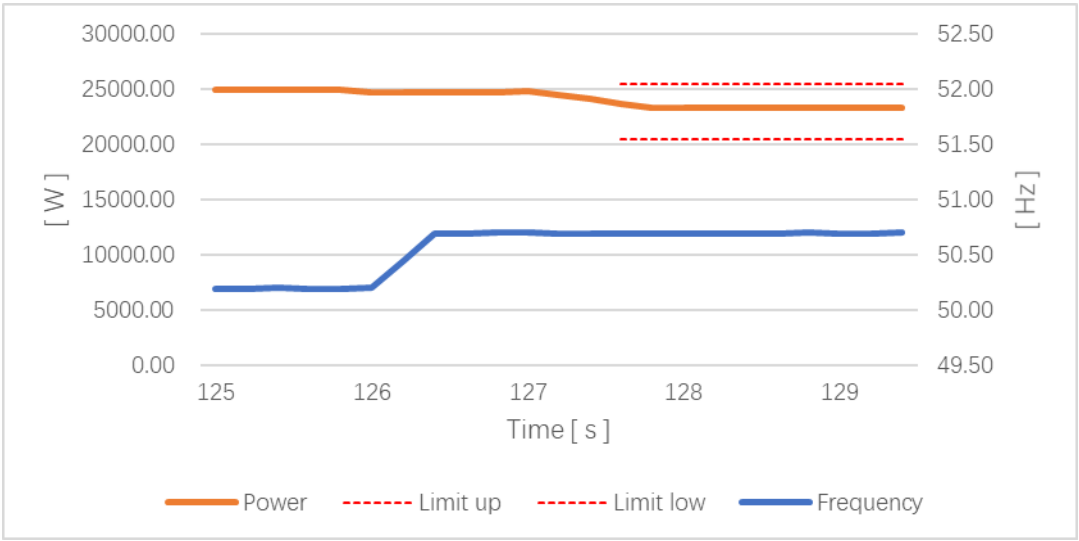
Graph_50%



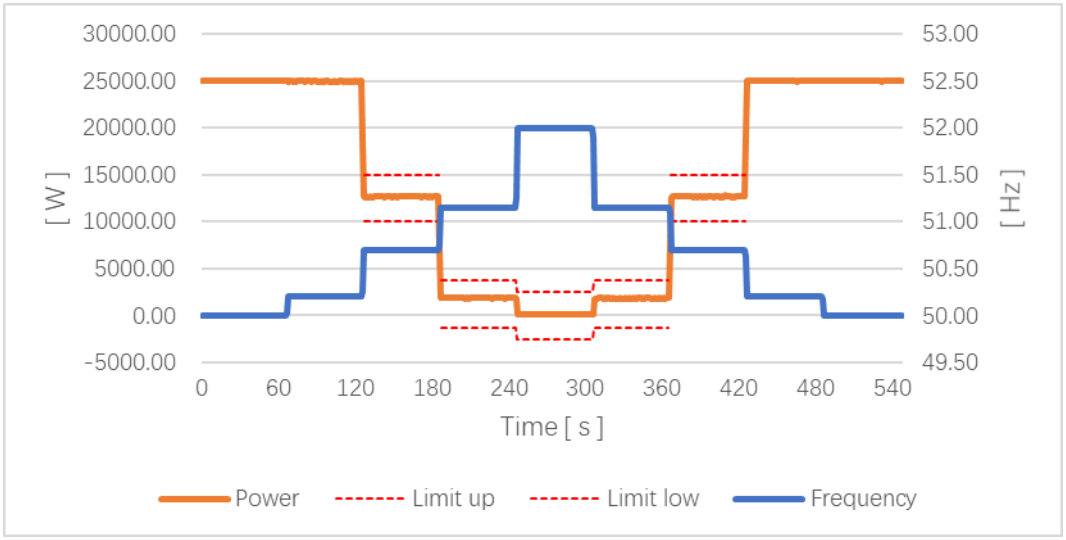
Graph_75%

D.6.1	Table: Power response to over frequency						P
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	24984.88	25000.00	--	--	--	--
50.2Hz ± 0.01Hz	50.20	24945.95	25000.00	--	--	--	--
50.70Hz ± 0.01Hz	50.70	23060.73	22916.67	144.06	± 2500	1.2s	1.4s
51.15Hz ± 0.01Hz	51.15	21322.88	21041.67	281.22	± 2500	0.2s	0.4s
52.0Hz ± 0.01Hz	52.00	17802.40	17500.00	302.40	± 2500	0.2s	0.4s
51.15Hz ± 0.01Hz	51.15	21305.72	21041.67	264.05	± 2500	0.2s	0.4s
50.70Hz ± 0.01Hz	50.70	23013.58	22916.67	96.92	± 2500	0.2s	0.4s
50.2Hz ± 0.01Hz	50.20	24943.93	25000.00	--	--	0.4s	0.6s
50Hz ± 0.01Hz	50.00	24989.25	25000.00	--	--	--	--
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	25013.66	25000.00	--	--	--	--
50.2Hz ± 0.01Hz	50.20	24835.90	25000.00	--	--	--	--
50.70Hz ± 0.01Hz	50.70	12560.47	12500.00	60.47	± 2500	0.4s	0.4s
51.15Hz ± 0.01Hz	51.15	1861.50	1250.00	611.50	± 2500	0.4s	0.6s
52.0Hz ± 0.01Hz	52.00	83.20	0.00	83.20	± 2500	0.4s	0.4s
51.15Hz ± 0.01Hz	51.15	1835.83	1250.00	585.83	± 2500	0.4s	0.4s
50.70Hz ± 0.01Hz	50.70	12679.54	12500.00	179.54	± 2500	0.4s	0.4s
50.2Hz ± 0.01Hz	50.20	24982.87	25000.00	--	--	0.4s	0.4s
50Hz ± 0.01Hz	50.00	25003.97	25000.00	--	--	--	--

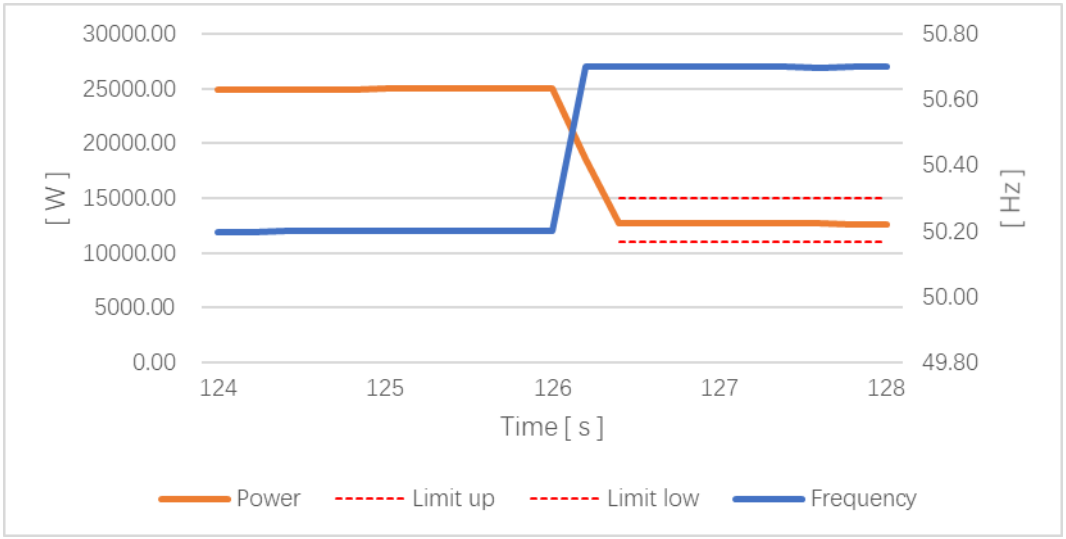
Test 3	50% P_n. f1 =52.0Hz; droop=5%; f-stop deactivated. no delay						
	f (Hz)	Measured output Power (W)	Calculated from standard characteristic curve P (W)	Tolerance between measured P and calculated P (W)	Tolerance Limit (W)	For a reduction of active power of 50% Pmax T≤2s	For a reduction of active power T≤20s
50Hz ± 0.01Hz	50.00	12616.49	12500.00	--	--	--	--
51.0Hz ± 0.01Hz	51.05	12641.50	12500.00	141.50	± 2500	--	--
51.70Hz ± 0.01Hz	51.70	12643.36	12500.00	143.36	± 2500	--	--
52.0Hz ± 0.01Hz	52.00	12648.43	12500.00	148.43	± 2500	--	--
51.70Hz ± 0.01Hz	51.70	12651.85	12500.00	151.85	± 2500	--	--
51.00Hz ± 0.01Hz	51.00	12641.50	12500.00	141.50	± 2500	--	--
50Hz ± 0.01Hz	50.00	12629.16	12500.00	--	--	--	--
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	24950.13	25000.00	--	--	--	--
50.2Hz ± 0.01Hz	50.20	24906.05	25000.00	--	--	--	--
50.70Hz ± 0.01Hz	50.70	19550.62	20000.00	-449.38	± 2500	0.4s	0.4s
51.15Hz ± 0.01Hz	51.15	15237.88	15500.00	-262.12	± 2500	0.4s	0.4s
52.0Hz ± 0.01Hz	52.00	7085.05	7000.00	85.05	± 2500	0.4s	0.4s
51.15Hz ± 0.01Hz	51.15	7046.60	7000.00	46.60	± 2500	--	--
50.70Hz ± 0.01Hz	50.70	7046.38	7000.00	46.38	± 2500	--	--
50.2Hz ± 0.01Hz	50.20	7044.34	7000.00	44.34	± 2500	--	--
50Hz ± 0.01Hz	50.00	17265.22	25000.00	--	--	--	--

Test 1_Graph

Intentional delay time (2s)


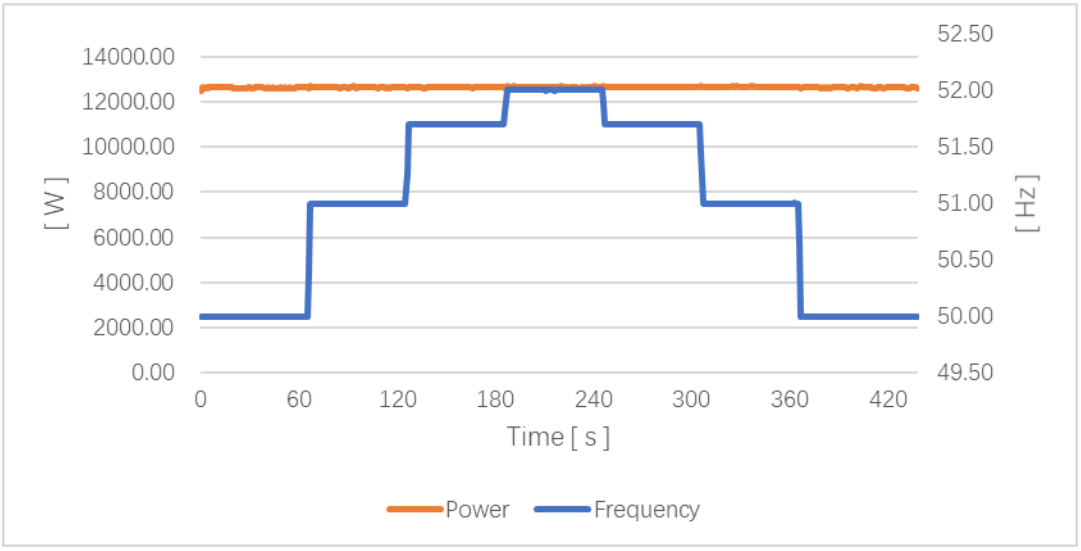
Test 2_Graph



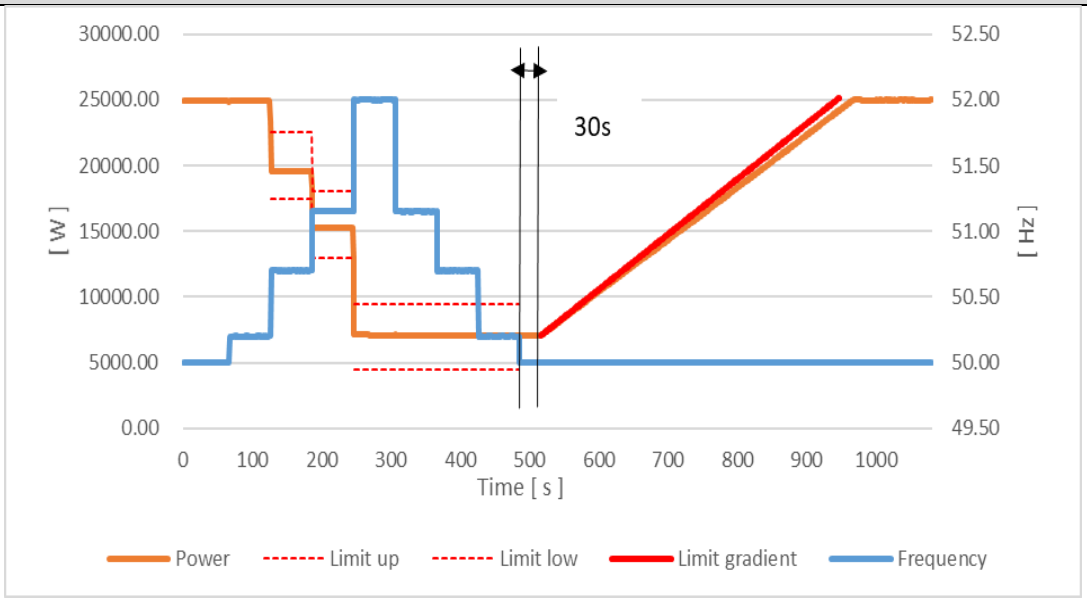
Step response time (T≤2s)



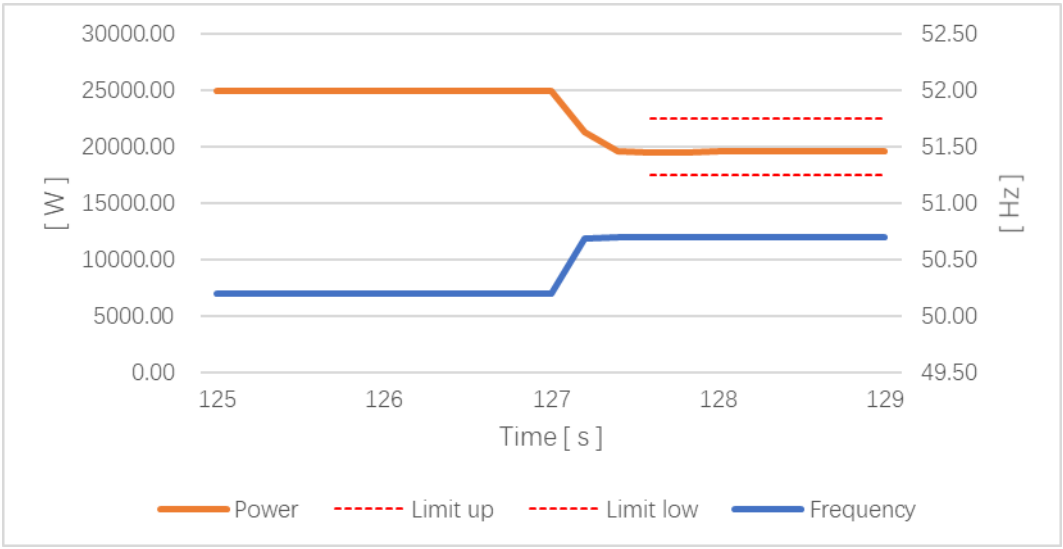
Test 3_Graph



Test 4_Graph



Step response time (T≤2s)



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

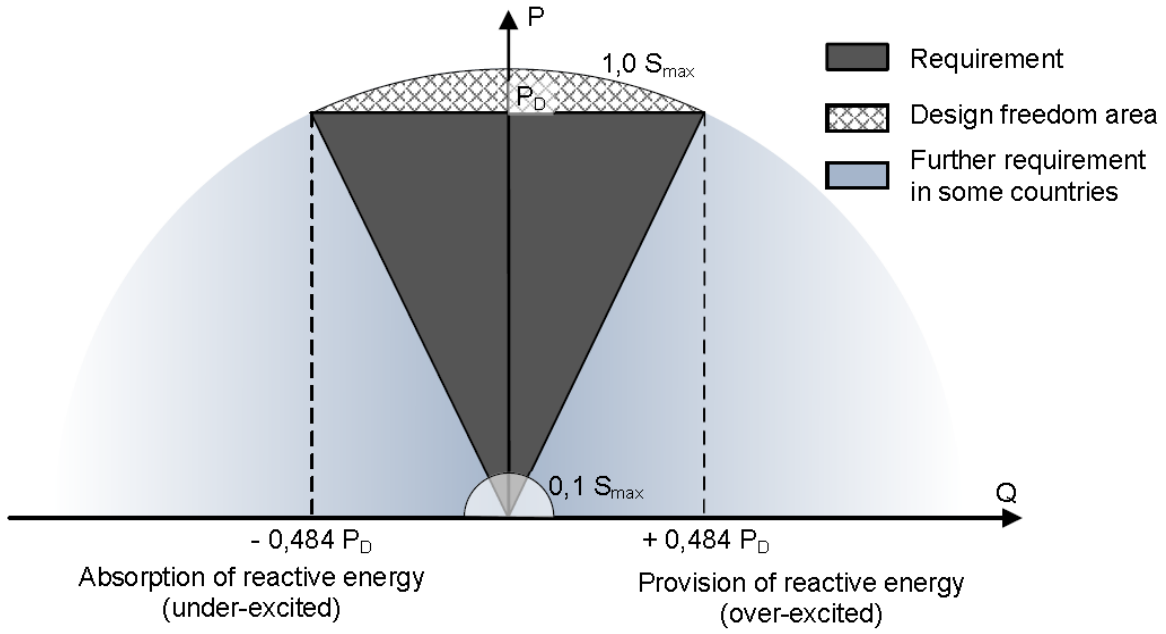


Figure 12 — Reactive power capability at nominal voltage

Leading PF=0.9:

P/Pn[%] setpoint	P[W]	Q[Var]	Cosφ	Cosφ setpoint	Δcosφ	Q[Var] setpoint	ΔQ/S_{max} [%]	LIMITE [%]
10	816.52	488.02	0.8581	0.9	-0.0419	387.46	0.13	± 2
20	1636.44	784.12	0.9017	0.9	0.0017	774.92	0.02	± 2
30	2432.97	1169.71	0.9012	0.9	0.0012	1162.37	0.03	± 2
40	3248.52	1571.04	0.9002	0.9	0.0002	1549.83	0.11	± 2
50	4064.54	1951.70	0.9014	0.9	0.0014	1937.29	0.09	± 2
60	4879.81	2346.80	0.9012	0.9	0.0012	2324.75	0.17	± 2
70	5680.22	2732.52	0.9011	0.9	0.0011	2712.20	0.18	± 2
80	6449.88	3106.38	0.9009	0.9	0.0009	3099.66	0.07	± 2
90	7279.97	3509.67	0.9008	0.9	0.0008	3487.12	0.25	± 2
100*	7273.12	3458.15	0.9031	0.9	0.0031	--	--	--

* 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/S_{max} [%]	LIMITE [%]
10	2568.72	-1548.82	0.8561	0.9	-0.0439	-1210.81	-1.35	± 2
20	5010.92	-2440.47	0.8989	0.9	-0.0011	-2421.61	-0.08	± 2
30	7604.34	-3618.81	0.9029	0.9	0.0029	-3632.42	0.05	± 2
40	10138.90	-4861.34	0.9017	0.9	0.0017	-4843.22	-0.07	± 2
50	12673.09	-6063.43	0.9020	0.9	0.0020	-6054.03	-0.04	± 2
60	15224.48	-7300.03	0.9017	0.9	0.0017	-7264.83	-0.14	± 2
70	17701.92	-8504.13	0.9013	0.9	0.0013	-8475.64	-0.11	± 2
80	20163.90	-9695.19	0.9012	0.9	0.0012	-9686.44	-0.03	± 2
90	22720.37	-10939.15	0.9010	0.9	0.0010	-10897.25	-0.17	± 2
100*	22628.50	-10875.87	0.9013	0.9	0.0013	--	--	--

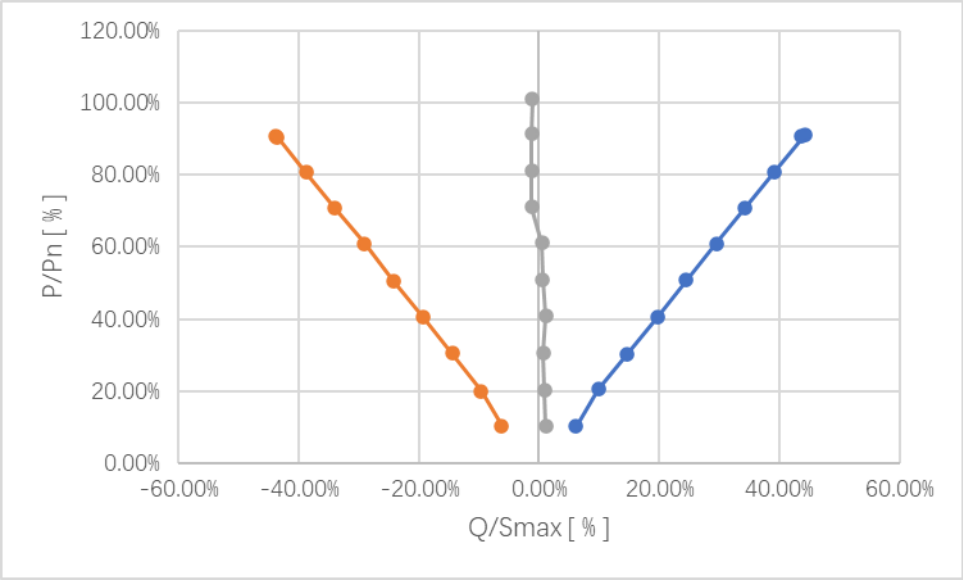
D.7.1	Table: Q Capabilities (Power Factor)	P

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

Q=0:

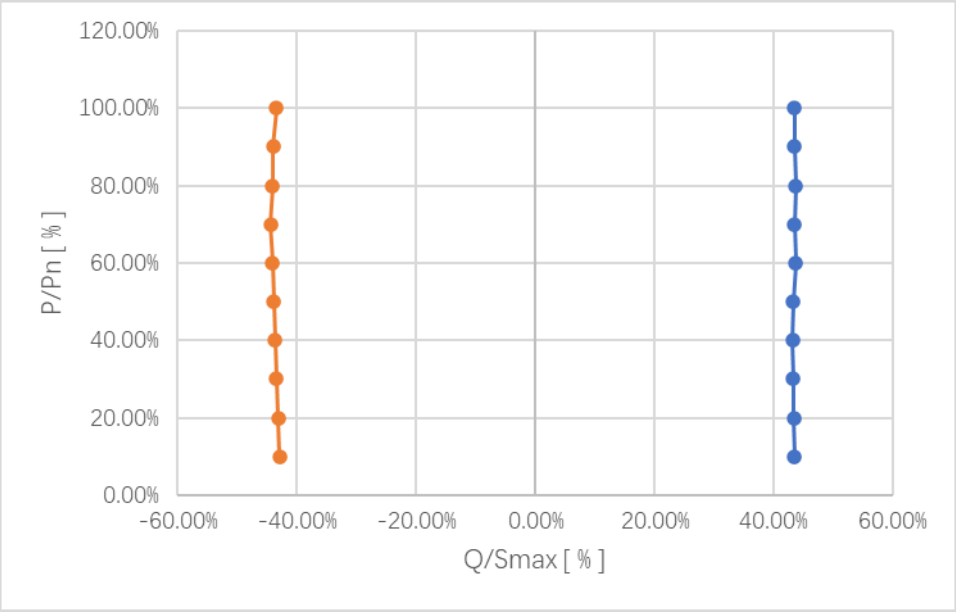
P/Pn[%] setpoint	P[W]	Q[Var]	Cosφ	Cosφ Set-point	Δcosφ	Q[Var] setpoint	ΔQ/S_{max} [%]	LIMITE [%]
10	2549.68	275.77	0.9939	1.0	-0.0061	0	1.10	± 2
20	5023.14	222.48	0.9989	1.0	-0.0011	0	0.89	± 2
30	7620.65	213.87	0.9995	1.0	-0.0005	0	0.86	± 2
40	10179.23	297.26	0.9996	1.0	-0.0004	0	1.19	± 2
50	12736.34	279.51	0.9997	1.0	-0.0003	0	1.12	± 2
60	15291.67	302.12	0.9998	1.0	-0.0002	0	1.21	± 2
70	17789.22	187.99	0.9999	1.0	-0.0001	0	0.75	± 2
80	20250.52	-283.99	0.9999	1.0	-0.0001	0	-1.14	± 2
90	22832.45	-301.98	0.9999	1.0	-0.0001	0	-1.21	± 2
100	25233.60	-317.01	0.9999	1.0	-0.0001	0	-1.27	± 2

Graph



D.7.1	Table: Q Capabilities (Power Factor)					P
Q=48.43%P_D						
P/Pn[%] setpoint	P[W]	Q[Var]	Cosφ	Q[Var] setpoint	$\Delta Q/S_{max}$ [%]	LIMITE [%]
10	2584.00	10865.12	0.2314	10895	-0.12	± 2
20	5080.67	10850.42	0.4240	10895	-0.18	± 2
30	7542.02	10810.32	0.5721	10895	-0.34	± 2
40	10041.00	10800.13	0.6809	10895	-0.38	± 2
50	12543.71	10821.53	0.7571	10895	-0.29	± 2
60	15041.00	10921.57	0.8091	10895	0.11	± 2
70	17530.50	10868.26	0.8499	10895	-0.11	± 2
80	20078.33	10935.67	0.8782	10895	0.16	± 2
90	22578.00	10878.87	0.9009	10895	-0.06	± 2
100*	22578.00	10878.87	0.9009	10895	-0.06	± 2
Q=-48.43%P_D						
P/Pn[%] setpoint	P[W]	Q[Var]	Cosφ	Q[Var] setpoint	$\Delta Q/S_{max}$ [%]	LIMITE [%]
10	2611.02	-10722.54	0.2366	-10895	0.69	± 2
20	5027.08	-10783.56	0.4225	-10895	0.45	± 2
30	7530.43	-10846.32	0.5703	-10895	0.19	± 2
40	10020.73	-10905.77	0.6766	-10895	-0.04	± 2
50	12553.48	-10976.04	0.7528	-10895	-0.32	± 2
60	15059.56	-11025.97	0.8068	-10895	-0.52	± 2
70	17544.55	-11087.03	0.8453	-10895	-0.77	± 2
80	20000.33	-11012.95	0.8760	-10895	-0.47	± 2
90	22503.58	-10980.25	0.8987	-10895	-0.34	± 2
100*	22505.81	-10855.26	0.9007	-10895	0.16	± 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

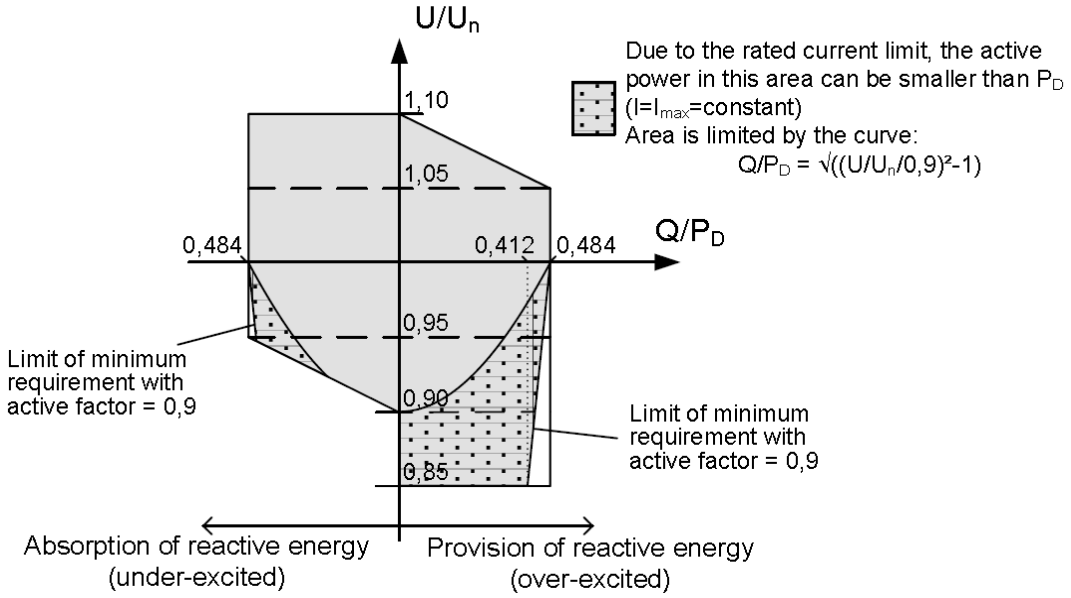


Figure 13 — Reactive power capability at active power P_D in the voltage range (positive sequence component of the fundamental)

Over-excited:

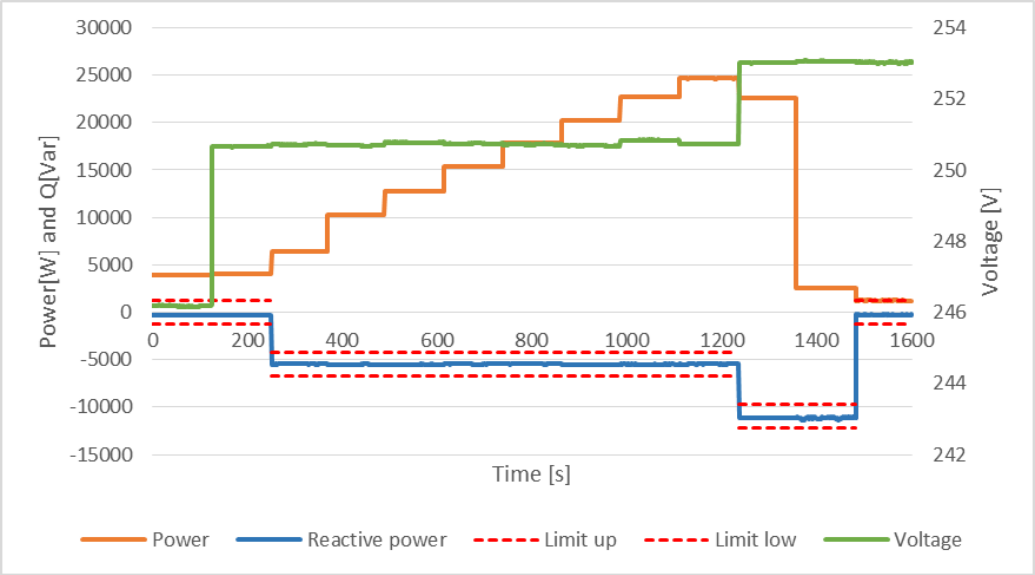
AC output				Reactive power measured		
Voltage setting [V/Vn]	Measured			Reactive power [Var]	Value [Q/PD]	Limits
	Voltage [V]	[V/Vn]	Active power [W]			
1.10	252.99	1.10	25048.00	-316.00	-0.0126	±0.02
1.08	248.61	1.08	24587.37	4753.39	0.1933	0.194±0.02
1.05	241.59	1.05	22552.33	10844.55	0.4809	0.484±0.02
1.00	230.25	1.00	22540.35	10857.46	0.4817	0.484±0.02
0.95	218.63	0.95	22707.67	10937.64	0.4817	--
0.92	211.42	0.92	22713.15	10912.94	0.4805	--
0.90	207.10	0.90	22708.00	10964.22	0.4828	--
0.85	195.41	0.85	21772.13	10512.38	0.4828	--

Under-excited:

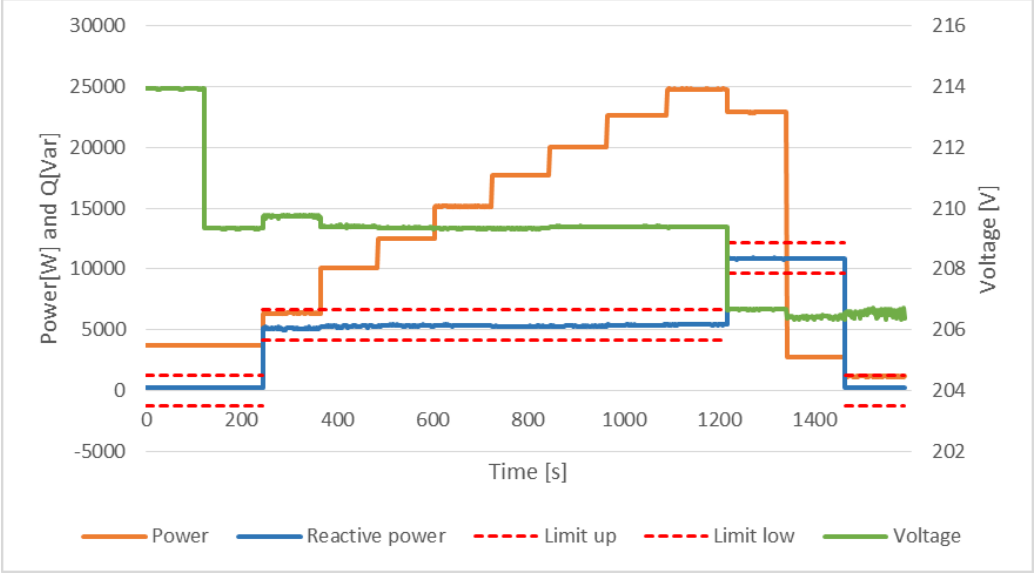
AC output				Reactive power measured		
Voltage setting [V/Vn]	Measured			Reactive power [Var]	Value [Q/PD]	Limits
	Voltage [V]	[V/Vn]	Active power [W]			
1.10	253.06	1.10	22704.33	-10982.43	-0.4837	-0.484±0.02
1.08	248.46	1.08	22653.63	-10973.12	-0.4844	-0.484±0.02
1.05	241.58	1.05	22500.32	-10864.39	-0.4829	-0.484±0.02
1.00	230.06	1.00	22583.00	-10832.83	-0.4797	-0.484±0.02
0.95	218.49	0.95	22708.00	-10751.08	-0.4734	--
0.92	210.59	0.92	24759.51	-4759.52	-0.1922	-0.194±0.02
0.90	207.01	0.90	25041.00	-316.00	-0.0126	±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	15.89	246.18	-326.36	≈0 (< ± 5 % Pn)	-1.31
< 20 %	1.09 Vn	16.40	250.66	-313.21	≈0 (< ± 5 % Pn)	-1.25
<20 % to 30 %	1.09 Vn	25.80	250.72	-5457.05	-5447.50 (within 10sec)	-0.04
40 %	1.09 Vn	40.88	250.69	-5497.00	-5447.50	-0.20
50 %	1.09 Vn	51.16	250.77	-5501.10	-5447.50	-0.21
60 %	1.09 Vn	61.34	250.74	-5453.73	-5447.50	-0.02
70 %	1.09 Vn	71.49	250.72	-5440.64	-5447.50	0.03
80 %	1.09 Vn	80.66	250.69	-5527.54	-5447.50	-0.32
90 %	1.09 Vn	90.83	250.84	-5482.92	-5447.50	-0.14
100 %	1.09 Vn	98.66	250.73	-5459.65	-5447.50	-0.05
100 %	1.1 Vn	90.16	253.01	-11188.35	-10895.00	-1.17
100 % to10 %	1.1 Vn	10.36	253.05	-11142.47	-10895.00	-0.99
10 % to ≤ 5 %	1.1 Vn	4.98	253.03	-257.43	≈0 (< ± 5 % Pn)	-1.03
P/Pn [%] Setpoint	Vac [V] Setpoint	P/Pn [%] measured	Vac [V] Measured	Q [VAr] measured	Q [Var] expected	Δ Q [Var] (≤ ± 5 %Pn)
< 20 %	0.93 Vn	14.99	213.92	248.50	≈0 (< ± 5 % Pn)	0.99
< 20 %	0.91 Vn	14.98	209.34	244.34	≈0 (< ± 5 % Pn)	0.98
<20 % to 30 %	0.91 Vn	25.57	209.74	5124.30	5447.50 (within 10sec)	-1.29
40 %	0.91 Vn	40.50	209.39	5305.23	5447.50	-0.57
50 %	0.91 Vn	49.99	209.35	5359.22	5447.50	-0.35
60 %	0.91 Vn	60.57	209.33	5380.52	5447.50	-0.27
70 %	0.91 Vn	70.95	209.33	5287.07	5447.50	-0.64
80 %	0.91 Vn	80.02	209.39	5317.54	5447.50	-0.52
90 %	0.91 Vn	90.46	209.40	5394.56	5447.50	-0.21
100 %	0.91 Vn	99.03	209.38	5430.09	5447.50	-0.07
100 %	0.90 Vn	91.50	206.67	10872.83	10895.00	-0.09
100 % to 10 %	0.90 Vn	11.13	206.42	10859.42	10895.00	-0.14
10 % to ≤ 5 %	0.91 Vn	4.71	206.56	262.46	≈0 (< ± 5 % Pn)	1.05

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



Graph: Lock-in at 1.08Vn

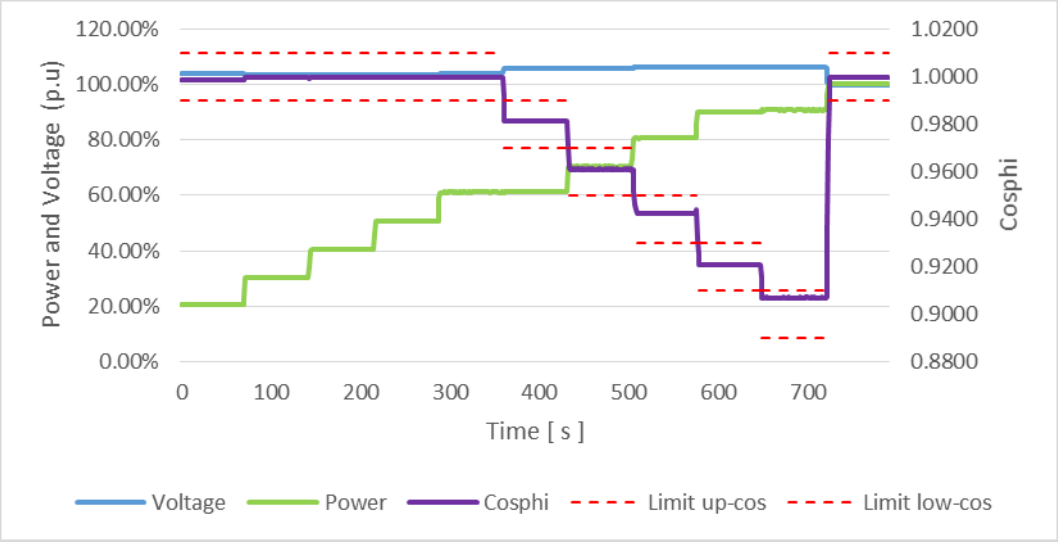


Graph: Lock-in at 0.92Vn

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%	20.55	-286.21	<105%	103.79	1.0000	0.9984	-1.11%	±2
30%	30.48	-215.14	<105%	103.74	1.0000	0.9995	-0.83%	±2
40%	40.50	-283.99	<105%	103.65	1.0000	0.9996	-1.10%	±2
50%	50.72	-275.40	<105%	103.70	1.0000	0.9997	-1.07%	±2
60%	61.09	-371.49	<105%	104.93	1.0000	0.9996	-1.44%	±2
60%	61.15	-2999.14	>105%	105.92	0.9800	0.9812	0.18%	±2
70%	70.42	-5059.74	>105%	106.04	0.9600	0.9611	0.17%	±2
80%	80.69	-7117.55	>105%	106.14	0.9400	0.9429	0.55%	±2
90%	90.57	-9516.18	>105%	106.25	0.9200	0.9212	0.27%	±2
100%	90.92	-10567.82	>105%	106.33	0.9000	0.9068	1.71%	±2
100%	100.19	-354.66	<100%	100.01	1.0000	0.9998	-1.38%	±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

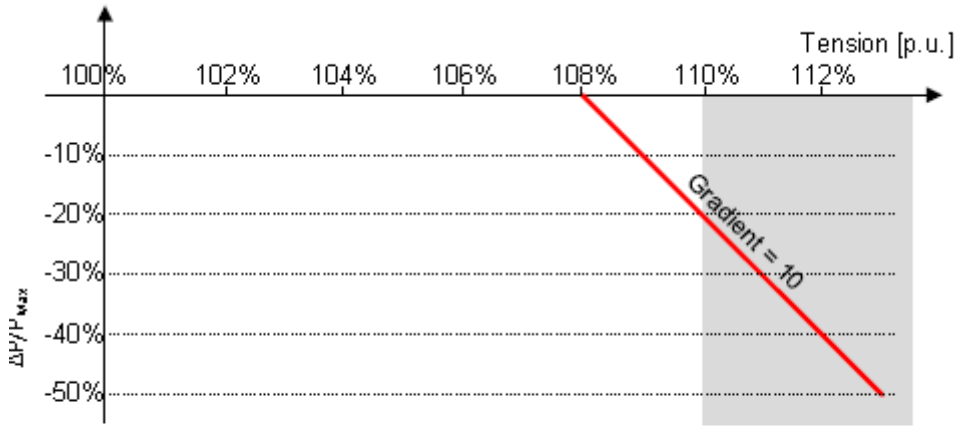
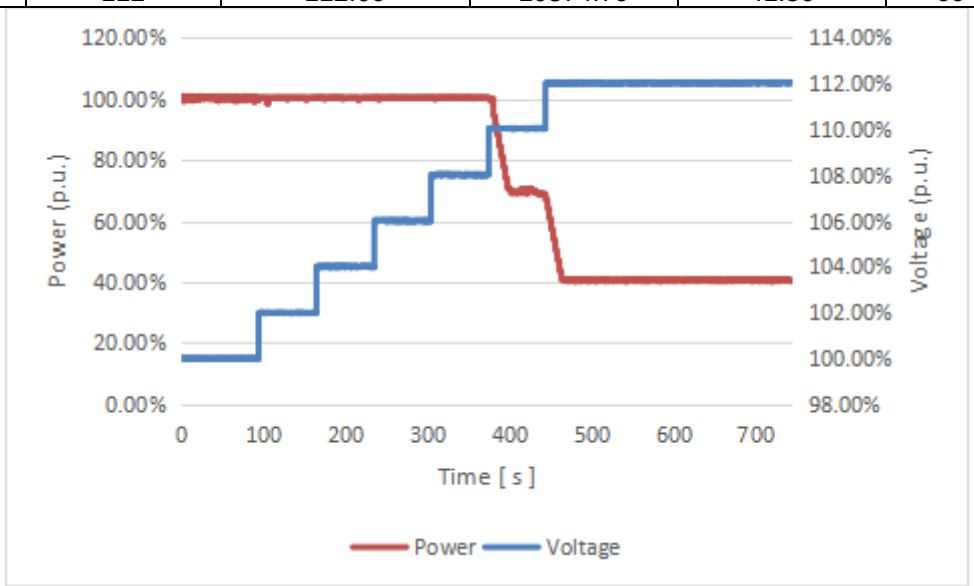


Figure 15 - Example curve for P(U)

Step #	Set voltage vaule V/Vn [%]	Measured voltage vaule V/Vn [%]	Measured power values [W]	Measured power bin [%]	Limit [%]	RESULT
1	100	100.00	25020.15	100.08	--	P
2	102	101.98	25042.74	100.17	--	
3	104	104.00	25055.41	100.22	--	
4	106	106.00	25063.28	100.25	--	
5	108	108.00	25068.49	100.27	--	
6	110	110.02	18916.54	75.67	<80	
7	112	112.00	10374.79	41.50	<60	

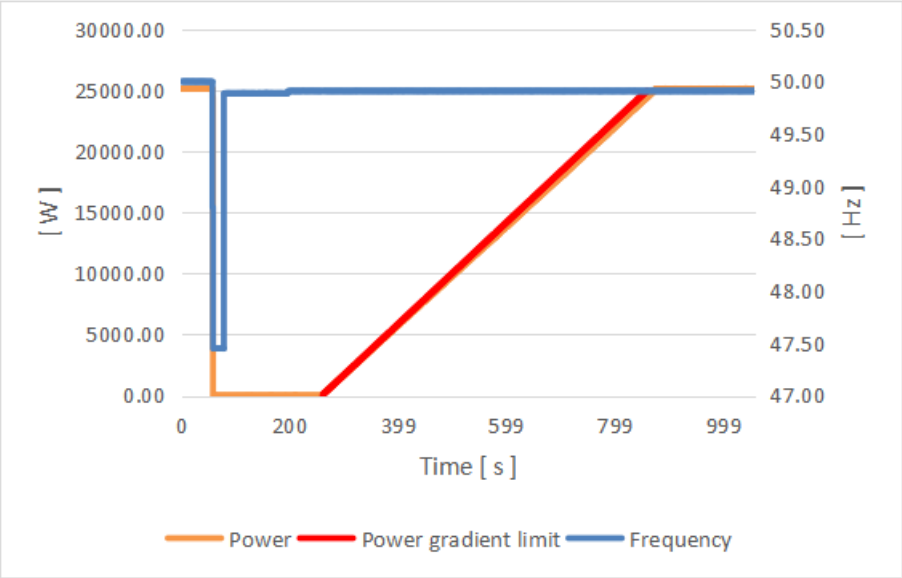


D.8	Table: Connection and reconnection	P

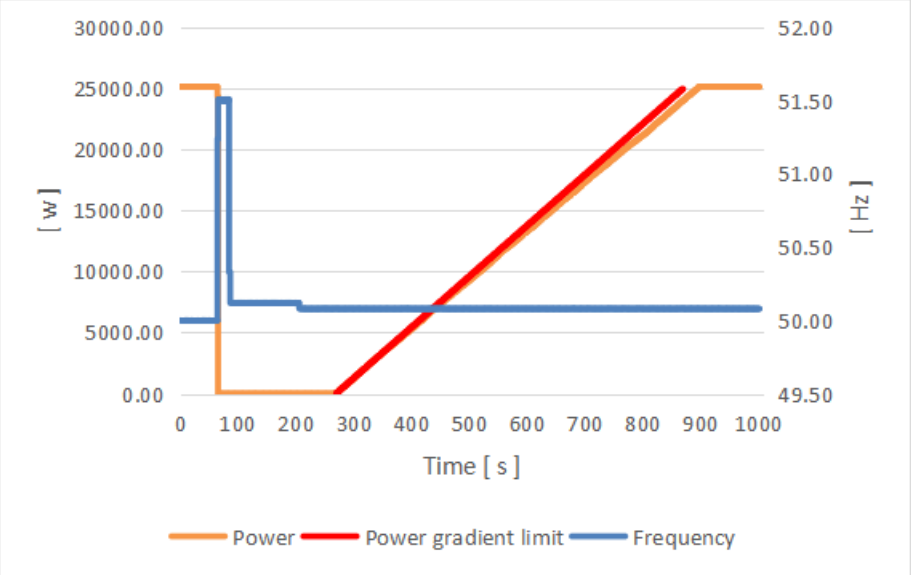
Parameter	Reconnection after tripping of the interface protection relay	Normal operation starting
Lower frequency	49,9 Hz	49,9 Hz
Upper frequency	50,1 Hz	50,1 Hz
Lower voltage	If connection to the LV distribution network: 85% U_n	If connection to the LV distribution network: 85% U_n
	If connection to 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**	61.0	9.69
Step c)	**>50.1Hz**	**No**	--	--
Step d)	**≤50.1Hz**	**Yes**	62.0	9.60
Step e)	**<195.5V**	**No**	--	--
Step f)	**≥195.5V**	**Yes**	61.0	9.63
Step g)	**>253V**	**No**	--	--
Step h)	**≤253V**	**Yes**	61.0	9.58
Remark: Maximum active power increase gradient 10 %/min.				

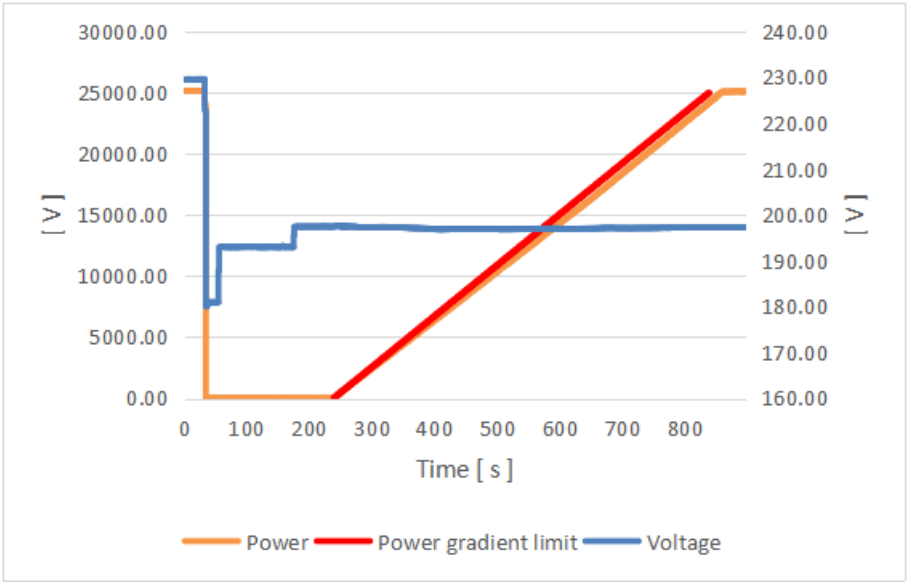
D.8	Table: Connection and reconnection	P



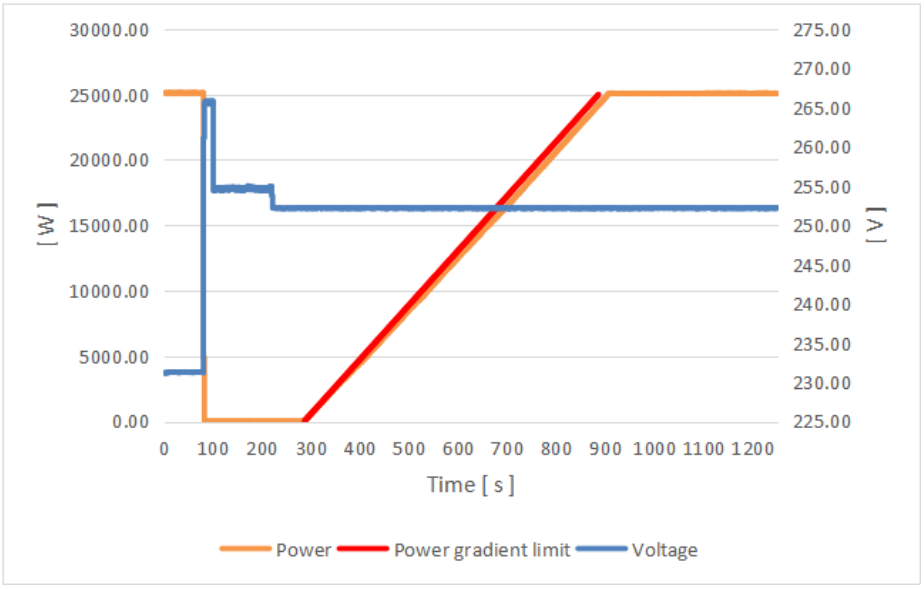
Graph_49.9Hz



Graph_50.1Hz

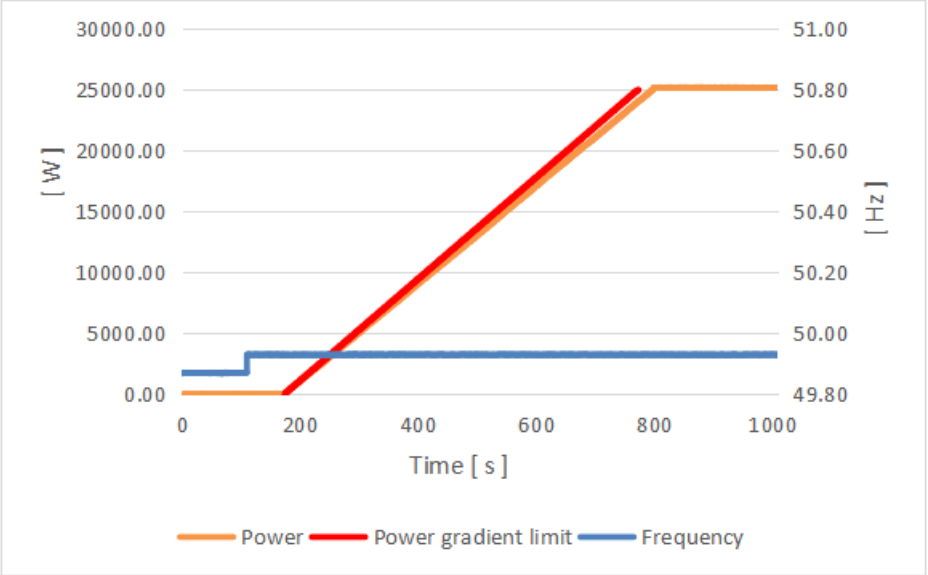


Graph_195.5V



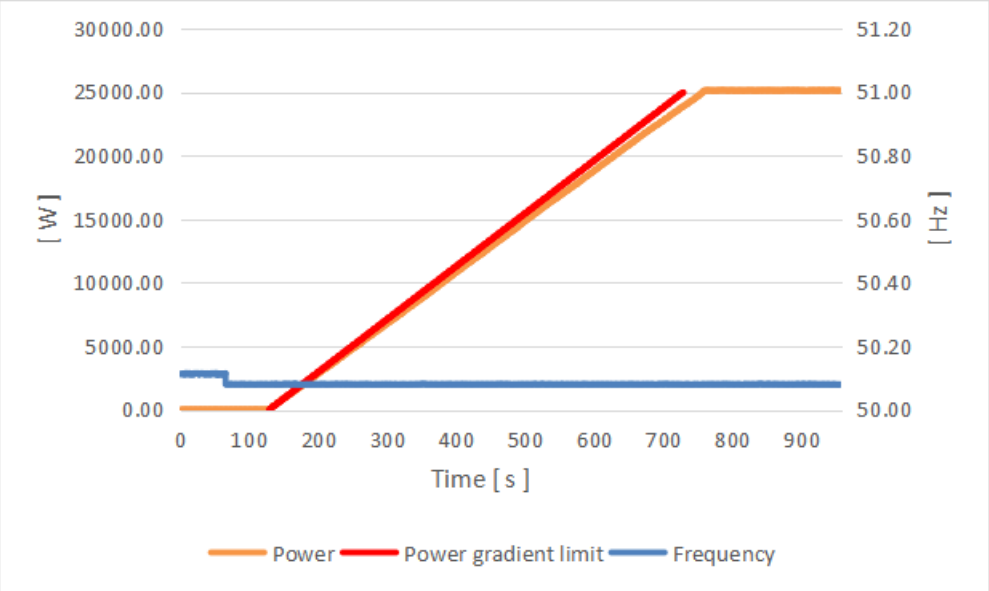
Graph_253V

D.8	Table: Connection and reconnection			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	9.56
Step c)	**>50.1Hz**	**No**	--	--
Step d)	**≤50.1Hz**	**Yes**	62.0	9.62
Step e)	**<195.5V**	**No**	--	--
Step f)	**≥195.5V**	**Yes**	63.0	9.76
Step g)	**>253V**	**No**	--	--
Step h)	**≤253V**	**Yes**	62.0	9.56
Remark: Maximum active power increase gradient 20 %/min.				

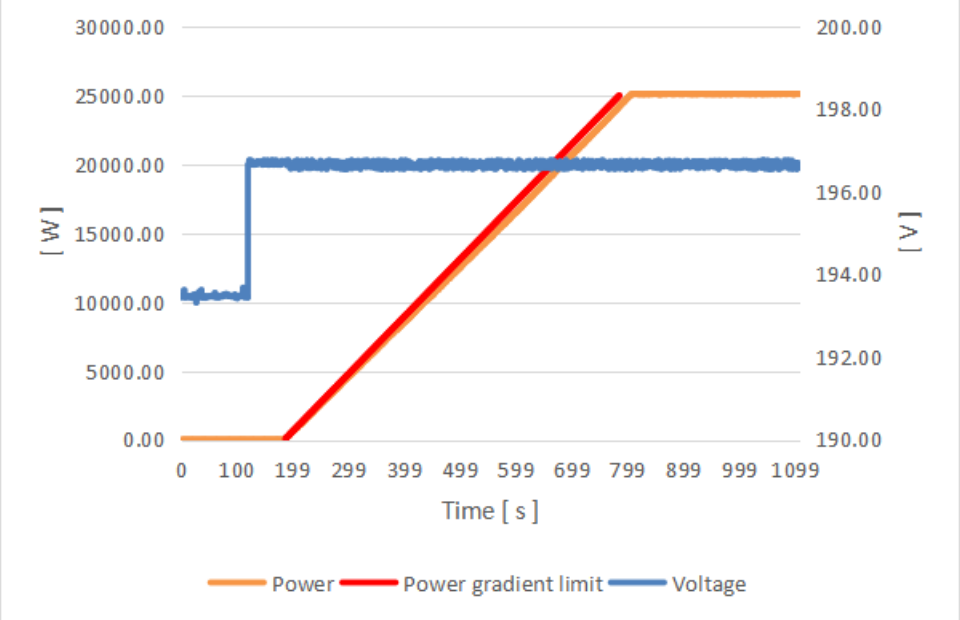


Graph_49.9Hz

D.8	Table: Connection and reconnection	P

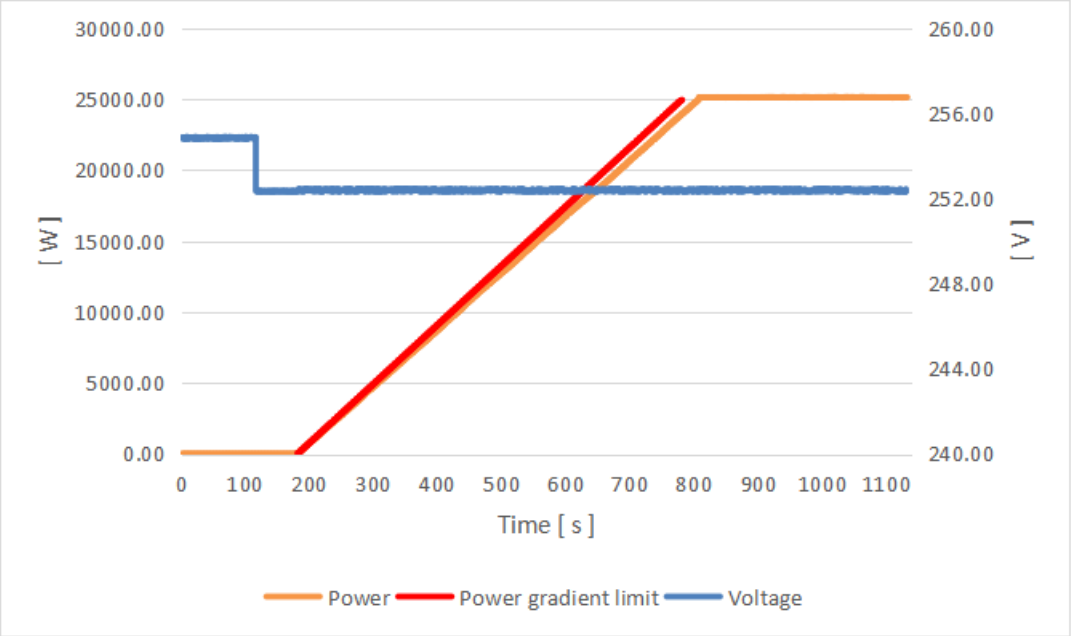


Graph_50.1Hz



Graph_195.5V

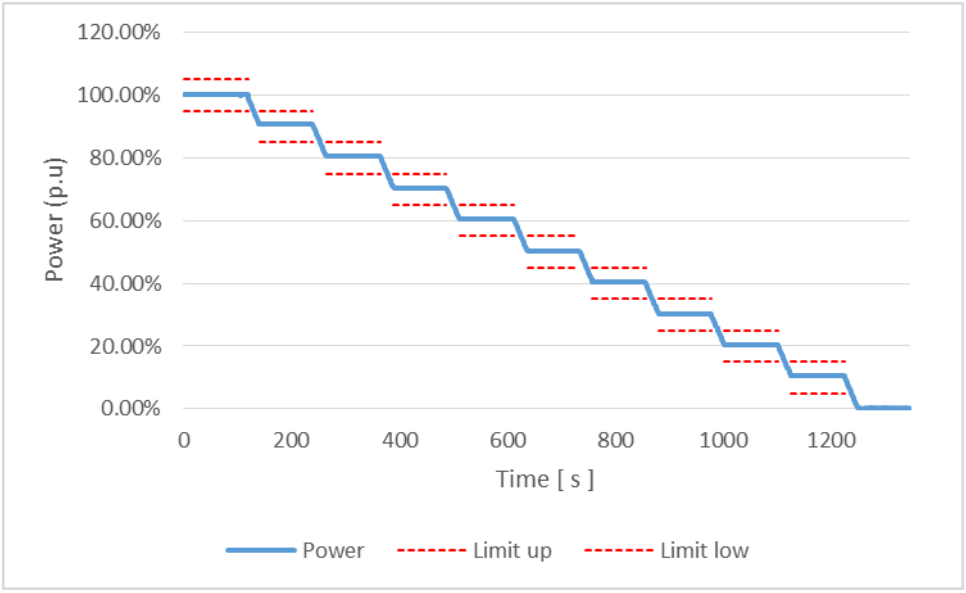
D.8	Table: Connection and reconnection	P

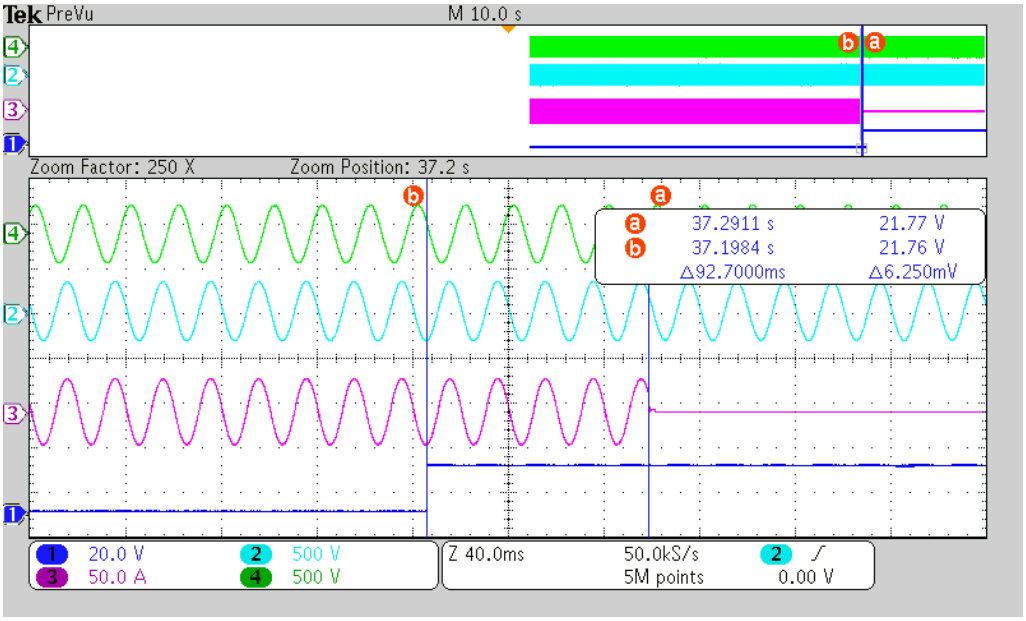


Graph_253V

D.9	Table: Ceasing and reduction of active power on set point (Logic interface)					P
String	1	U_{DC} =	620 Vdc	Uac = Un	230 Vac	P_{Emax} (kW)	25.0

1 min mean value P/Pn Psetpoint (%)	Pmeasured (%)	△Pmeasured (%)	Limit [%]
100%	100.05	0.05	±5%
90%	90.61	0.61	±5%
80%	80.53	0.53	±5%
70%	70.45	0.45	±5%
60%	60.39	0.39	±5%
50%	50.34	0.34	±5%
40%	40.35	0.35	±5%
30%	30.39	0.39	±5%
20%	20.47	0.47	±5%
10%	10.58	0.58	±5%
The power gradient for increasing and reducing (%P_n/s)			0.45%P_n/s
Time for Logic interface (at input port) activated			0.092





Waveform for logic interface

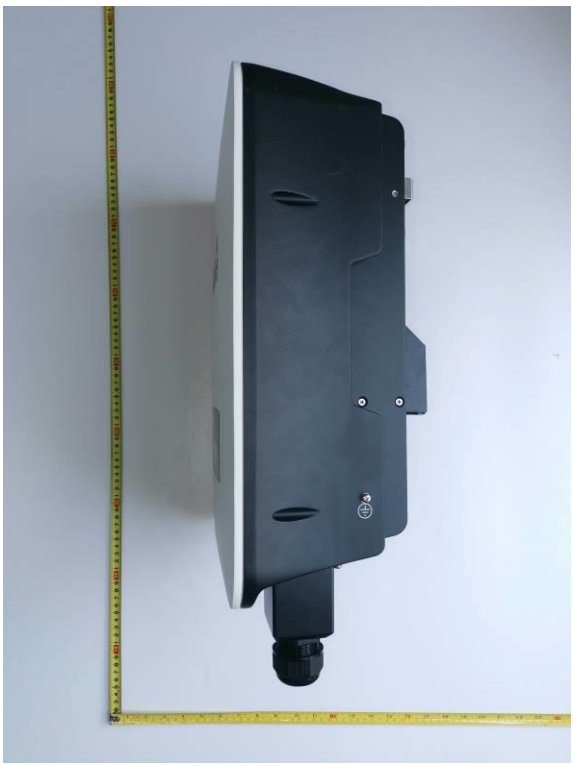
Annex 1: Photo document

Front

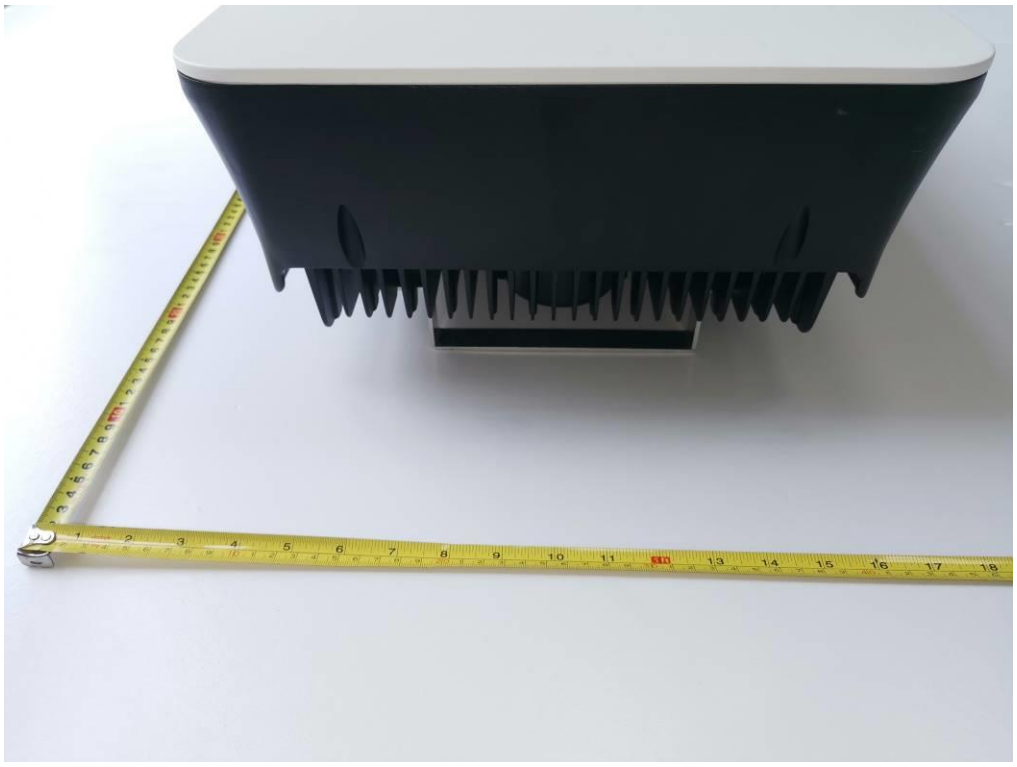
Back


Annex 1: Photo document

Left

Right


Annex 1: Photo document

Top

Bottom


Annex 1: Photo document

Internal