Product Service

TEST REPORT
EN 50549-1:2019
TUV SUD Test Report for *Requirements for generating plants to be connected in parallel with distribution networks - Part 1: Connection to a LV distribution network - Generating plants up to and including Type B*

Report No.:	64.290.23.30723.01
Date of issue:	2023-06-29
Project handler:	Jinjing Peng
Testing laboratory:	TÜV SÜD Certification and Testing (China) Co., Ltd. Guangzhou Branch
Address:	TÜV SÜD Testing Center, D1 building, No. 63 Chuangqi Road, Shilou Town, Panyu District, Guangzhou 511447, P.R. China
Testing location:	as above
Client:	EAST Group Co., Ltd.
Client number:	076644
Address:	No.6 Northern Industry Road, Songshan Lake Sci. & Tech. Industry Park, 523808 DongGuan City, Guangdong Province PEOPLE'S REPUBLIC OF CHINA
Contact person:	Haijian Pan
Standard:	This TUV SUD test report form is based on the following requirements: *EN 50549-1:2019/AC:2019 & Belgium Deviation C10/11 ed2.2, 2021*
TRF number and revision:	*TRF EN 50549-1:2019/AC:2019 rev.0/2019-04*
TRF originated by:	TUV SUD Product Service, Mr. Billy Qiu
Copyright blank test report:	This test report is based on the content of the standard (see above). The test report considered selected clauses of the a.m. standard(s) and experience gained with product testing. It was prepared by TUV SUD Product Service. TUV SUD Group takes no responsibility for and will not assume liability for damages resulting from the reader's interpretation of the reproduced material due to its placement and context.
General disclaimer:	This test report may only be quoted in full. Any use for advertising purposes must be granted in writing. This report is the result of a single examination of the object in question and is not generally applicable evaluation of the quality of other products in regular production.
Scheme:	☐ GS Mark ☐ NRTL Mark ☐ EU-Directive ☐ TUV Mark ☒ Type verification of conformity
Non-standard test method:	☒ No ☐ Yes, see details under Summary of testing
National deviations:	Belgium Deviation C10/11 ed2.2, 2021
Number of pages *(Report)*:	58
Number of pages *(Attachments)*:	N/A
Compiled by:	Jinjing Peng *(Printed Name and Signature)* Peng Jinjing
Approved by:	Yuneng Chen *(Printed Name and Signature)* Yuneng Chen

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Test sample: Type of test object: Trademark: Model and/or type reference:	Hybrid Inverter Type test EAST® EAHI-3000-SL, EAHI-3600-SL, EAHI-5000-SL, EAHI-6000-SL
Rating(s):	See page of 5-6
Manufacturer: Manufacturer number: Address:	EAST Group Co., Ltd. 076644 No.6 Northern Industry Road, Songshan Lake Sci. & Tech. Industry Park, 523808 DongGuan City, Guangdong Province PEOPLE'S REPUBLIC OF CHINA
Sub-contractors/ tests (clause): Name:	N/A N/A
Order description:	☒ Complete test according to TRF
	☐ Partial test according to manufacturer's specifications
	☐ Preliminary test
	☐ Spot check
	☐ Others:
Date of order: Date of receipt of test item: Date(s) of performance of test:	2023-04-07 2023-04-25 2023-04-25 to 2023-05-17

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Test item particulars:	
Equipment mobility ....:	☐ movable ☐ hand-held ☐ stationary ☒ fixed ☐ transportable ☐ for building-in
Connection to the mains......................:	☐ pluggable equipment ☐ direct plug-in ☒ permanent connection ☐ for building-in
Enviromental category.........................:	☒ outdoor ☐ indoor unconditional ☐ indoor conditional
Over voltage category Mains ....:	☐ OVC I ☐ OVC II ☒ OVC III ☐ OVC IV
Over voltage category PV ....:	☐ OVC I ☒ OVC II ☐ OVC III ☐ OVC IV
Mains supply tolerance (%).................:	+/- 10%
Tested for power systems ....:	TN system
IT testing, phase-phase voltage (V) ...:	N/A
Class of equipment.............................:	☒ Class I ☐ Class II ☐ Class III ☐ Not classified
Mass of equipment (kg)......................:	21.4kg (EAHI-3000-SL, EAHI-3600-SL), 24.8(EAHI-5000-SL, EAHI-6000-SL)
Pollution degree..................................:	PD 3 (External), PD 2 (Internal)
IP protection class ....:	IP 66

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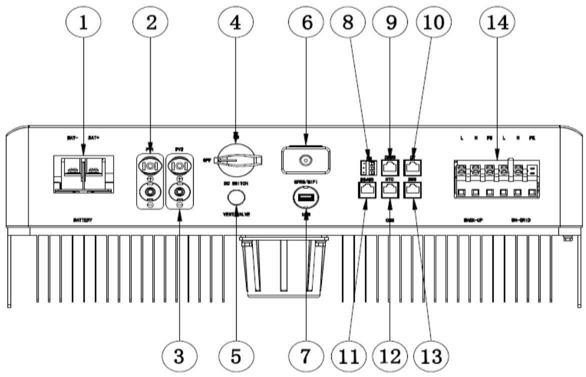
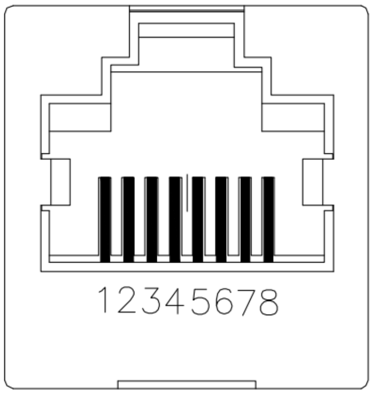
General product information:

1. The unit is non-isolated (transformerless) hybrid inverter for connection with public low voltage grid, for outdoor use.
2. The unit may be connected single-phase, a storage unit and a balancing device must be used to ensure that the requirements of maximum permissible unbalance ≤ 5 kVA according to 7.6.7 of Belgium Deviation C10/11 ed2.2, 2021 are met and a registration with the grid operators the finally installation.
3. If certain functions are not permitted by local regulation, the function shall be disabled by hardware or software setting (if applicable) by the manufacturer before putting into the market. For example, it's not permissible to draw electricity from the grid and then feed it back in order to claim statutory reimbursement in some nations.
4. Low voltage electrical installations shall comply with national and local regulation. Only qualified electricians are allowed to install and maintain the converter.
5. The scheme of remote control as below: data-logger receives the command from central computer and transfers it to the signal to PGU's RS-485 port, after receiving the signal, the inverter will decrease output active power to zero in 5 seconds. The RS-485 port and the connection schematic are as below:





S/N	Mark	Purpose
1	Battery terminal	Connect the battery
2	Positive PV terminal	Connect the PV positive electrode
3	Negative PV terminal	Connect the PV negative electrode
4	PV input switch	Connect/ disconnect the PV switch
5	Vent valve	Discharge the growing air from housing
6	GPRS/WIFI	The inverter uploads the data/ connects with the upper computer by GPRS/WIFI
7	USB	USB upgrade interface
8	Dry contact input	Connect the user's dry contact circuit
9	Safety communication	Reserved according to Australia safety regulation
10	CT or kilo-watt-hour meter signal input	CT or kilo-watt-hour meter signal input provided externally on the inverter
11	RS485	RS485 communication with the upper computer
12	NTC temperature sampling	Reserved
13	BMS communication	Battery communication input
14	AC wiring terminal	Load and grid input

Pin	1	2	3	4	5	6	7	8
Definition	RS3_485-	RS3_485-	RS3_485-	RS3_485-	RS3_485+	RS3_485+	RS3_485+	RS3_485+

6. Software version: V1002, DSP: V1002, MCU: V1005, Firmware version: V1.0.

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Model differences:
Model EAHI-6000-SL is the basic model, other models have same electric circuits topology design, same enclosure structure design, same main control circuits and firmware. The output power and current are limited by software, All model have LCD and LED appearance. Other differences are as follows:

Component	Model	
	EAHI-3000-SL, EAHI-3600-SL	EAHI-5000-SL, EAHI-6000-SL
MPPT Tracker number	1	2
Inverter inductor	Single magnetic ring NPF22060 2.0*68Ts, 597.8uH±10%	Triple magnetic ring NPS22060*3P 1.7*2P 38Ts, 597.8uH±10%
DC switch	PEDS150R-HM25-2	PEDS150R-HM25-4
INV IGBT tube	JT050N065WED(650V, 50A, -55°C-175°C)	JT075N065WED(650V, 75A,-40°C-175°C) CRG75T65AK5SD(650V, 75A, -55°C-150°C)

Characteristic data *(not shown on the marking plate)*:

Model	EAHI-3000-SL	EAHI-3600-SL	EAHI-5000-SL	EAHI-6000-SL
PV input rating				
Rated input voltage	360 V d.c.			
Maximum input voltage	550 V d.c.			
MPPT voltage range	100 V d.c. – 540 V d.c.			
Full-load voltage range	250 V d.c. – 450 V d.c.			
Maximum input current	15 A d.c.		15 A d.c.*2	
Maximum short circuit current	20 A d.c.		20 A d.c.*2	
Maximum input power	4680 W	4680 W	6500 W	7800 W
Battery input / output rating				
Battery type	Lead-acid / Li-ion battery			
Rated voltage	48.0 V d.c. / 51.2 V d.c.			
Battery voltage range	42.0 V d.c. – 58.0 V d.c.			
Maximum charging current	66 A d.c.	75 A d.c.	100 A d.c.	100 A d.c.
Maximum charging power	3000 W	3600 W	5000 W	5000 W
Maximum discharging current	66 A d.c.	75 A d.c.	100 A d.c.	120 A d.c.
Maximum discharging power	3000 W	3600 W	5000 W	6000 W
Grid input rating				
Rated input voltage	230 V a.c.			
Rated output current	13.05 A a.c.	15.70 A a.c.	21.80 A a.c.	26.09 A a.c.
Maximum input current	13.05 A a.c.	15.70 A a.c.	21.80 A a.c.	26.09 A a.c.
Maximum input power from grid to battery	3000 W	3600 W	5000 W	6000 W
Maximum input power from grid	3000 W	3600 W	5000 W	6000 W
Rated input frequency	50 Hz			
Grid output rating				
Rated output voltage	230 V a.c.			
Rated output current	13.05 A a.c.	15.7 A a.c.	21.8 A a.c.	26.09 A a.c.

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Maximum continuous output current	13.05 A a.c.	15.7 A a.c.	21.8 A a.c.	26.09 A a.c.
Rated output power	3000 W	3600 W	5000 W	6000 W
Maximum output active power	3000 W	3600 W	5000 W	6000 W
Maximum output apparent power	3000 VA	3600 VA	5000 VA	6000 VA
Rated output frequency	50 Hz			
Power factor	0.8 under-excited to 0.8 over-excited			

Attachments:

N/A

General remarks:

"(see remark #)" refers to a remark appended to the report.
"(see appended table)" refers to a table appended to the report.
*Throughout this report **a point** is used as the decimal separator.*
The test results presented in this report relate only to the object tested.
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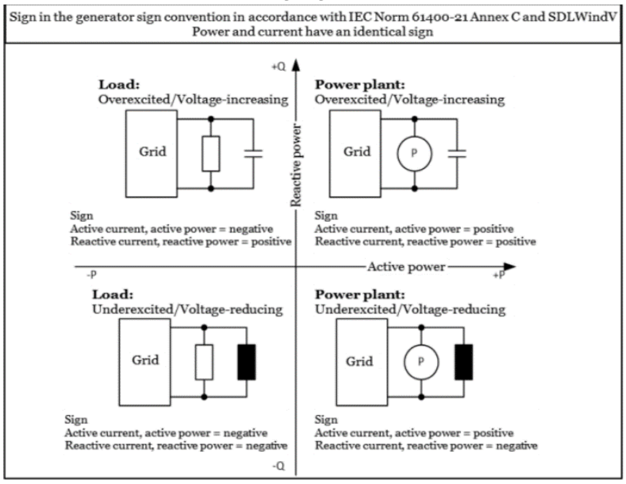
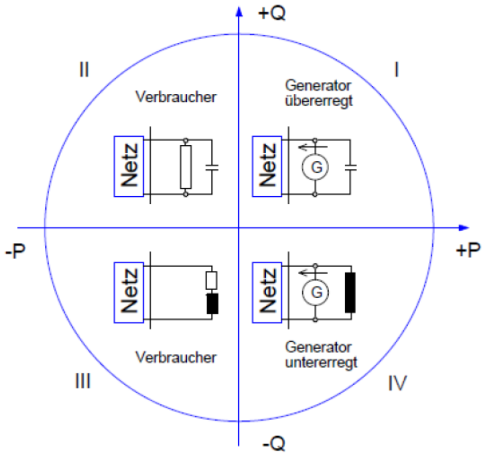
Summary of testing:

Full tests method is based on draft standard EN 50549-1:2019/AC:2019 and Belgium Deviation C10/11 ed2.2, 2021 as a reference, test voltage is on nominal voltage 230 Va.c., and nominal frequency 50Hz.

Generator sign convention has been applied for all measurements and results given in this report. This is described in the following figure and table.





	Inductive (under-excited)	Capacitive(over-excited)
Generator (Discharge mode)	IV. Quadrant P > 0, the equipment supplies active power from the mains (Discharge mode) Q < 0, the equipment draws reactive power from the mains (inductive behaviour)	I. Quadrant P > 0, the equipment supplies active power from the mains (Discharge mode) Q > 0, the equipment supplies reactive power to the mains (capacitive behaviour)
Consumer (Charge mode)	III. Quadrant P < 0, the equipment draw active power from the mains (Charge mode) Q < 0, the equipment draws reactive power from the mains (inductive behaviour)	II. Quadrant P < 0, the equipment draw active power from the mains (Charge mode) Q > 0, the equipment supplies reactive power to the mains (capacitive behaviour)

Tests performed (name of test and test clause):

Clause of Belguim	Requirement	Clause of EN 50549-1 for type A	EN 50549-1 requirement
Annex D.3	Integrated automatic separation system	4.9.3	Requirements on voltage and frequency protection
Annex D.4.1 & Annex D.4.3	Operating frequency range Continuous operating voltage range	4.4.2 & 4.4.4	Operating frequency range& Continuous operating voltage range
Annex D.4.2	Maximum admissible power reduction in case of underfrequency	4.4.3	Minimal requirement for active power delivery at under-frequencies
Annex D.5.1	Rate of change of frequency (RoCoF) immunity	4.5.2	Rate of change of frequency (ROCOF) immunity
Annex D.6.1	Power response to overfrequency	4.6.1	Power response to over frequency

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Annex D.6.2	Power response to underfrequency	4.6.2	Power response to under frequency
Annex D.7.1	Voltage support by reactive power	4.7.2	Voltage support by reactive power
Annex D.7.2	Voltage related active power reduction P(U)	4.7.3	Voltage related active power reduction
Annex D.8	Connection and reconnection	4.10	Connection and starting to generate electrical power
Annex D.9.1	Ceasing active power	4.11.1	Ceasing active power

☐ deviation(s) found

☒ no deviations found

Additional information on Non-standard test method(s)

Sub clause: N/A
Page: N/A
Rational: N/A

If additional information is necessary, please provide

N/A

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Copy of marking plate:

Hybrid Inverter
MODEL : EAHI-3000-SL

PV input

Max. input power	4680 W
Rated input voltage	360 Vd.c.
Max. input voltage	550 Vd.c.
MPPT voltage range	100 Vd.c. ~ 540 Vd.c.
PV max input current	15 Ad.c.
Max. short circuit current	20 Ad.c.

Battery

Rated voltage	48 Vd.c.(Lead-acid)/51.2 Vd.c.(Li-ion)
Max.charge current	66 Ad.c.
Max.discharge current	66 Ad.c.

AC grid

Rated output voltage	230 Va.c.
Rated grid frequency	50 Hz
Rated input/output current	13.05 Aa.c.
Rated input/output power	3000W
Max. apparent power	3000VA
Power factor range	0.8 leading ~ 0.8 lagging
Input voltage range	207 Va.c. ~ 253 Va.c.

Load output

Rated output power	3000VA/3000W
Rated output voltage	230 Va.c.
Rated output current	13.05 Aa.c.
Rated output frequency	50 Hz

General data

Dimensions(W×H×D)	548x440x197 mm
Weight	21.4 kg
Protection rating	IP66
Operating temperature	-25 ~ 60°C
Protection class:	I

HI03C2211300001

5 min

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Hybrid Inverter
MODEL : EAHI-3600-SL

PV input

Max. input power	4680 W
Rated input voltage	360 Vd.c.
Max. input voltage	550 Vd.c.
MPPT voltage range	100 Vd.c. ~ 540 Vd.c.
PV max input current	15 Ad.c.
Max. short circuit current	20 Ad.c.

Battery

Rated voltage	48 Vd.c.(Lead-acid)/51.2 Vd.c.(Li-ion)
Max.charge current	75 Ad.c.
Max.discharge current	75 Ad.c.

AC grid

Rated output voltage	230 Va.c.
Rated grid frequency	50 Hz
Rated input/output current	15.7 Aa.c.
Rated input/output power	3600W
Max. apparent power	3600VA
Power factor range	0.8 leading ~ 0.8 lagging
Input voltage range	207 Va.c. ~ 253 Va.c.

Load output

Rated output power	3600VA/3600W
Rated output voltage	230 Va.c.
Rated output current	15.7 Aa.c.
Rated output frequency	50 Hz

General data

Dimensions(W×H×D)	548x440x197 mm
Weight	21.4 kg
Protection rating	IP66
Operating temperature	-25 ~ 60°C
Protection class:	I

HI36B2211300001

5 min

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Hybrid Inverter
MODEL : EAHI-5000-SL

PV input

Max. input power	6500 W
Rated input voltage	360 Vd.c.
Max. input voltage	550 Vd.c.
MPPT voltage range	100 Vd.c. ~ 540 Vd.c.
PV max input current	15 Ad.c.+15 Ad. c.
Max. short circuit current	20 Ad.c.+20 Ad. c.

Battery

Rated voltage	48 Vd.c.(Lead-acid)/51.2 Vd.c.(Li-ion)
Max.charge current	100 Ad.c.
Max.discharge current	100 Ad.c.

AC grid

Rated output voltage	230 Va.c.
Rated grid frequency	50 Hz
Rated input/output current	21.8 Aa.c.
Rated input/output power	5000W
Max. apparent power	5000VA
Power factor range	0.8 leading ~ 0.8 lagging
Input voltage range	207 Va.c. ~ 253 Va.c.

Load output

Rated output power	5000VA/5000W
Rated output voltage	230 Va.c.
Rated output current	21.8 Aa.c.
Rated output frequency	50 Hz

General data

Dimensions(W×H×D)	548x440x197 mm
Weight	24.8 kg
Protection rating	IP66
Operating temperature	-25 ~ 60°C
Protection class:	I

HI05C2211300001

5 min

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Hybrid Inverter
MODEL : EAHI-6000-SL

PV input

Max. input power	7800 W
Rated input voltage	360 Vd.c.
Max. input voltage	550 Vd.c.
MPPT voltage range	100 Vd.c. ~ 540 Vd.c.
PV max input current	15 Ad. c. +15 Ad. c.
Max. short circuit current	20 Ad. c. +20 Ad. c.

Battery

Rated voltage	48 Vd.c.(Lead-acid)/51.2 Vd.c.(Li-ion)
Max.charge current	100 Ad.c.
Max.discharge current	120 Ad.c.

AC grid

Rated output voltage	230 Va.c.
Rated grid frequency	50 Hz
Rated input/output current	26.09 Aa.c.
Rated input/output power	6000W
Max. apparent power	6000VA
Power factor range	0.8 leading ~ 0.8 lagging
Input voltage range	207 Va.c. ~ 253 Va.c.

Load output

Rated output power	6000VA/6000W
Rated output voltage	230 Va.c.
Rated output current	26.09 Aa.c.
Rated output frequency	50 Hz

General data

Dimensions(W×H×D)	548x440x197 mm
Weight	24.8 kg
Protection rating	IP66
Operating temperature	-25 ~ 60°C
Protection class:	I

HI06C2211300001

5 min

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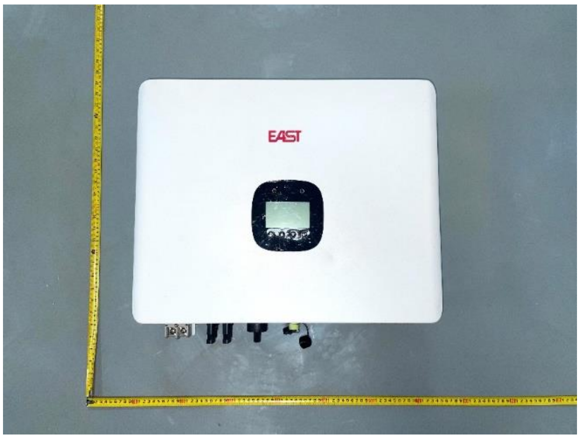
Remark: For application of this standard, the nominal voltage is 230 Va.c., nominal frequency is 50 Hz, and the power factor range: 0.8 under-excited … 0.8 over-excited.

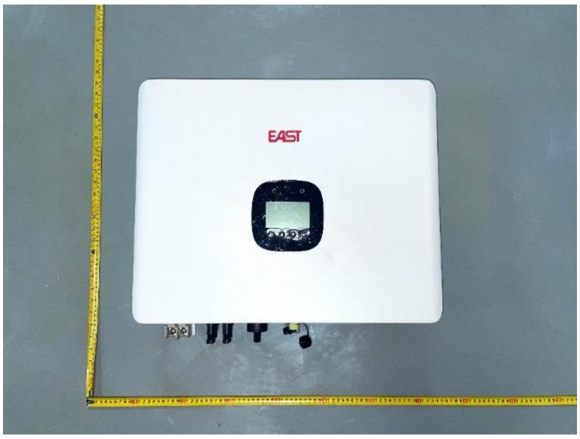
Pictures of the product:

Inverter front view (LED)

Inverter front view (LCD)



Inverter right view



Overall view

Inverter terminal view
(EAHI-3000-SL, EAHI-3600-SL)

Inverter terminal view
(EAHI-5000-SL, EAHI-6000-SL)

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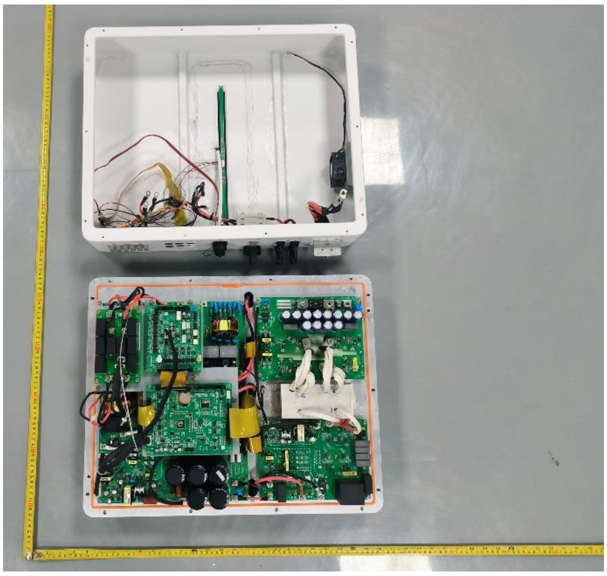
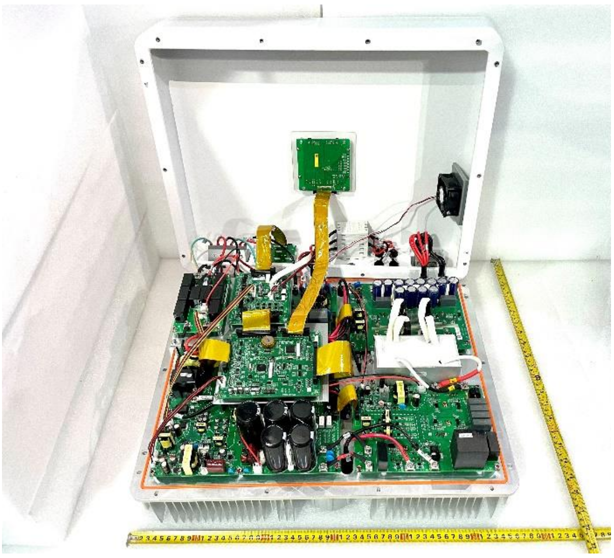
Inverter terminal view (With Terminal Cover) (EAHI-3000-SL, EAHI-3600-SL)	Inverter terminal view (With Terminal Cover) (EAHI-5000-SL, EAHI-6000-SL)
	
Internal view after opening the LED cover	Internal view after opening the LCD cover
	

Name and address of factory (ies) *(only if certification is provided)*:

Factory name: EAST Group Co., Ltd.

Address: No.6 Northern Industry Road, Songshan Lake Sci. & Tech. Industry Park, 523808 DongGuan City, Guangdong Province PEOPLE'S REPUBLIC OF CHINA

Possible test case verdicts:

test case does not apply to the test object:	N/A (not applicable / not included in the order)
test object does meet the requirement:	P (Pass)
test object does not meet the requirement:	F (Fail)

Possible suffixes to the verdicts:

suffix for detailed information for the client:	C (Comment)
suffix for important information for factory inspection:	M (Manufacturing)

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EN 50549-1:2019/AC:2019			
Clause	Requirement + Test	Result – Remark	Verdict
4	**Requirements on generating plants**		P
4.1	**General**		P
4.2	**Connection scheme**		P
4.3	**Choice of switchgear**		P
4.3.1	General		P
4.3.2	Interface switch		P
4.4	**Normal operating range**		P
4.4.1	General		P
4.4.2	Operating frequency range	Amended to 47.5 to 51.5 Hz according to C10/11:2021	P
4.4.3	Minimal requirement for active power delivery at underfrequencies		P
4.4.4	Continuous operating voltage range		P
4.5	**Immunity to disturbances**		P
4.5.1	General		P
4.5.2	Rate of change of frequency (ROCOF) immunity	See appendix table	P
4.5.3	Under-voltage ride through (UVRT)	Not suitable for Type A unit	N/A
4.5.4	Over-voltage ride through (OVRT)	Not suitable for Type A unit	N/A
4.6	**Active response to frequency deviation**		P
4.6.1	Power response to overfrequency	Amended step response time and settling time according to C10/11:2021	P
4.6.2	Power response to underfrequency	Amended default droop to 2% and step response time and settling time according to C10/11:2021	N/A
4.7	**Power response to voltage changes**		P
4.7.1	General	Set according to C10/11:2021	P
4.7.2	Voltage support by reactive power	See appendix table	P
4.7.2.1	General		P
4.7.2.2	Capabilities	Set according to C10/11:2021	P

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EN 50549-1:2019/AC:2019			
Clause	Requirement + Test	Result – Remark	Verdict
4.7.2.3	Control modes	Set according to C10/11:2021	P
4.7.2.3.1	General		P
4.7.2.3.2	Setpoint control modes		P
4.7.2.3.3	Voltage related control modes		P
4.7.2.3.4	Power related Control mode		P
4.7.3	Voltage related active power reduction	Set according to C10/11:2021	P
4.7.4	Short circuit current requirements on generating plants		N/A
4.7.4.1	General		N/A
4.7.4.2	Generating plant with non-synchronous generating technology		N/A
4.7.4.2.1	Voltage support during faults and voltage steps		N/A
4.7.4.2.2	Zero current mode for converter connected generating technology		N/A
4.7.4.2.3	Induction generator based units		N/A
4.7.4.3	Generating plant with synchronous generating technology - Synchronous generator based units		N/A
4.8	EMC and power quality		N/A
4.9	**Interface protection**		P
4.9.1	General	Set according to C10/11:2021	P
4.9.2	Void		P
4.9.3	Requirements on voltage and frequency protection		P
4.9.3.1	General	Set according to C10/11:2021	P
4.9.3.2	Undervoltage protection [27]		P
4.9.3.3	Overvoltage protection [59]		P
4.9.3.4	Overvoltage 10 min mean protection		P
4.9.3.5	Underfrequency protection [81<]		P
4.9.3.6	Overfrequency protection [81>]		P
4.9.4	Means to detect island situation		P
4.9.4.1	General		P
4.9.4.2	Active methods tested with a resonant circuit		N/A
4.9.4.3	Switch to narrow frequency band (see Annex E and Annex F)		N/A
4.9.5	Digital input to the interface protection	Set according to C10/11:2021	N/A
4.10	**Connection and starting to generate electrical power**		P

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EN 50549-1:2019/AC:2019			
Clause	Requirement + Test	Result – Remark	Verdict
4.10.1	General	Set according to C10/11:2021	P
4.10.2	Automatic reconnection after tripping		P
4.10.3	Starting to generate electrical power		P
4.10.4	Synchronization		P
4.11	**Active power reduction on set point**		P
4.11.1	Ceasing active power		P
4.11.2	Reduction of active power on set point		P
4.12	**Remote information exchange**		N/A
4.13	**Requirements regarding single fault tolerance of interface protection system and interface switch**		P

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Clause	Requirement + Test	Result – Remark	Verdict
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 (see section § 7.5). 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. All of these protection functions must comply with the relevant requirements in EN 50549-1 (in edition 2019, section 4.9.3 « Requirements on voltage and frequency protection »).	See appendix table	P
	The integrated automatic separation system must have single fault tolerance according to EN 50549-1. (edition 2019, see clause 4.13 « Requirements regarding single fault tolerance of interface protection system and interface switch »). The integrated automatic separation system must be set in accordance with the settings as specified in ANNEXE C (C.1).	See appendix table	P
D.4	Operating ranges	See appendix table	P
	Generating plants shall have the capability to operate in the operating ranges specified below regardless of the topology and the settings of the interface protection.		P
D.4.1	Operating frequency range [NC RfG Art 13 1.]	See appendix table	P
	This clause in not applicable to backup power systems as specified in § 2.2.1.		P
	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 »)		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

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Clause	Requirement + Test	Result – Remark	Verdict
	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 limited31		
D.4.2	Maximum admissible power reduction in case of underfrequency [NC RfG Art 13 4. + Art 13 5.]	See appendix table	P
	This clause is not applicable to backup power systems as specified in §2.2.1.		P
	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
	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 H2O/kg air Remark: If the power-generating unit has the capability to raise the output in underfrequency situations, this is not forbidden but subject to specific requirements (see Section D.6.2 « Power response to underfrequency »).		P
D.4.2.1	Limit for non-synchronous power-generating technology (Power Park Modules)		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 »). The characteristics of the limiting curve are given in the Table 10. Table 10 – characteristics of the limiting curve for the non-synchronous power-generating technologies		P
D.4.2.2	Limits for synchronous power-generating technology		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 »). t1, t2 and t3 are given in the following table, together with the characteristics of the limiting curves.		N/A

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Clause	Requirement + Test	Result – Remark	Verdict
	Table 11 – Characteristics of the limiting curves for the synchronous power-generating technologies		
D.4.3	Continuous operating voltage range	See appendix table	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 »).		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 : • For a connection to the low voltage network: 85 % Un < U < 110 % Un where Un = 230 V • For a connection to the high voltage network: 90 % Uc < U < 110 % Uc where Uc is the declared voltage. It is also allowed to reduce apparent power in case of voltage is below respectively 95 % Un or 95 % Uc.	Connect to low voltage network	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 [NC RfG Art. 13 1.(b)]		P
	This clause does not apply to the backup power systems as specified in §2.2.1.		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 section 4.5.2 « Rate of change of frequency (RoCoF) immunity ») taking the additional modifications and information specified hereunder into account.		P
	The power-generating unit shall have the capability to stay connected and operate when the frequency at the point of connection changes with the frequency against time profiles as depicted in the figures hereunder. When considering a sliding measurement window of 500ms, these profiles have a maximum RoCoF of 2 Hz/s. Figure 10 – Frequency against time profiles for rate of change of frequency immunity		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.		P
D.5.2	Under-voltage ride through UVRT [NC RfG Art. 14 3.(a) + Art. 17 3. + Art. 20 3.(a)]		N/A
	This section is not applicable to backup power systems as specified in §2.2.1.		N/A

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Clause	Requirement + Test	Result – Remark	Verdict
	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		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 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.		N/A
	As a consequence, for synchronous generating technology this profile is more stringent than the default requirement in EN 50549-1 or EN 50549-2.		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. For such technologies different cases can be considered: • Compliance with this UVRT requirement can be demonstrated considering a ratio of 10 between 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. • 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): • 3 seconds for a power-generating unit with synchronous generating technology • 1 second for a power-generating unit with non-synchronous generating technology		N/A
	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		N/A

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Clause	Requirement + Test	Result – Remark	Verdict
	requirement is this clause may be relaxed, replacing the voltage-time profile by the figure underneath. Figure 13 – Voltage-time profile for packup power systems		
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 [NC RfG Art 13 2.]	See appendix table	P
	This clause is not applicable to backup power system as specified in section §2.2.1		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 4.6.1 « Power response to overfrequency ») taking into account the additional modifications and information specified hereunder.		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 Table 12 – Dynamic step response time characteristics (synchronous power-generating technologies)		N/A
	• For non-synchronous power-generating technology Tableau 13 - Dynamic step reponse time characteristics (non-synchronous power-generating technologies)		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%. Figure 14 – Timing data for step response behaviour		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.		P
	The optional deactivation threshold fstop is not required. In case fstop 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. The parameter setting shall be as follows: Table 14 – Parameter settings for power response to overfrequency	Frequency threshold can be set 50.2 Hz to 50.5 Hz, default setting 50.2 Hz is selected and tested	P
	For energy storage systems with a connection to the high-voltage distribution network, the DSU might, for justified		N/A

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Clause	Requirement + Test	Result – Remark	Verdict
	technical or security reasons, agree with the DSO on applicable minimum state of charge limits in his connection agreement.		
	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 [NC RfG Art. 13 2.(b)] are not permitted by default as per the TSO provisions.		P
D.6.2	Power response to underfrequency		P
	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.	See appendix table	P
	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.		P
	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.		P
	Instead of the default maximum step response time of 30s in EN 50549-1 and EN 50549-2, the required 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).	Frequency threshold 49.8 Hz is set and tested respectively	P
	If the function is enabled, the parameters shall be set as following: Table 15 – Parameters settings for power response to underfrequency		P
	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 [NC RfG Art 17 2.(a) + Art 20 2.(a)]		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.		P
	The power-generating plant must at least comply with the corresponding requirements of the applicable standard EN	Q(U) control mode, voltage	P

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Clause	Requirement + Test	Result – Remark	Verdict
	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.	setting is 0.93Un ~ 0.97Un, 0.93Un for Qmax, 1.03Un ~ 1.07Un, 1.07Un for Qmin	
	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.		P
	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).		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.		N/A
	If the capabilities exceed the minimum requirement, and as far as this has only limited technical and economic impact 34, 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)).		N/A
	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		N/A
	By default, the power generation unit must operate according to the following rules: • When the voltage ≤ 105 % Un : cos phi = 1 (Q=0) • When the voltage > 105 % Un : free operation with 1 ≥ cos phi > 0,9 under-excited. (no overexcited operation allowed)		N/A
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.	The power factor set to 0.8 under-excited~0.8 over-excited	P
	If the power-generating plant is connected to the high voltage distribution network, it may be necesary 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.	Considered in final installation	N/A
	For a synchronous power-generating unit that is part of a power-generating module with a maximum power of ≥ 1 MW		N/A

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Clause	Requirement + Test	Result – Remark	Verdict
	(type B according to NC RfG), the following specific requirement is also applicable [NC RfG Art 17 2 (b)] :		
	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 reactive 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.		N/A
	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.		N/A
D.7.2	Voltage related active power reduction P(U)	See appendix table	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 »).	The overvoltage derating setting and response time setting: 1.10 Un	P
	The figure below shows an example of the implementation of this function. Figure 15 - Example curve for P(U)		P
D.7.3	Provision of additional fast reactive current during faults and voltage steps [NC RfG Art 20 2.(b)]		N/A
	This Section is only applicable to non-synchronous power-generating units connected to a high voltage distribution network and are not part of a small power-generating plant.		N/A
	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.		N/A
	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.		N/A
	A directly connected asynchronous machine cannot provide voltage support in a controlled manner with regard to short		N/A

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Clause	Requirement + Test	Result – Remark	Verdict
	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.		
D.8	Connection and reconnection [NC RfG Art 13 7 + Art 14 4]		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.		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. Table 16 – Conditions for automatic connection and reconnection	The connection and reconnection default time is set to 60 s The maximum active power increase gradient of reconnection and connection is selected to 10 %/min and tested	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.		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.		P
D.9.1	Ceasing active power [NC RfG Art 13 6]	See appendix table	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.		P
	In brief, the requirements in the standards are the following : 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. 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

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Clause	Requirement + Test	Result – Remark	Verdict
	Unless defined otherwise by the DSO, this logic interface is based on a contact rather than using a communicated protocol.		
D.9.2	Reduction of active power on set point [NC RfG Art 14 2.]		N/A
	The requirement of this Section is applicable only to the power-generating units that are part of: • a power-generating module with a maximum power of ≥ 1 MW • a power-generating plant with a maximum power of > 250 kVA, if the DSO so requires, in accordance with the regional regulations.		N/A
	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.		N/A
	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 Disconnection of the network is allowed when below minimum regulating level Remote operation is optional		N/A
	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 [NC RfG Art 14 5.d)]		N/A
	The requirements of this Section are applicable only to the power-generating units that are part of: • a power-generating module with a maximum power ≥ 1 MW • a power-generating plant with a maximum power > 250 kVA, if so required by the DSO, respecting the regional regulatory provisions.		N/A
	This paragraph is not applicable to backup power systems as defined in §2.2.1. However, special attention must be paid to § 7.12 Special supplemental requirement regarding backup power systems		N/A
	The power-generating unit must have the necessary functionalities to meet the requirements of § 7.13 concerning the communication (remote control and monitoring).		N/A

Annex D.3	Integrated automatic separation system	P

Function	Trip setting
Overvoltage 10 min mean	230 V + 10 % no delay*
Overvoltage	230 V +15 % no delay*
Undervoltage	230 V -20 % no delay*
Overfrequency	51,5 Hz no delay*
Underfrequency	47,5 Hz no delay*
LoM	according to EN 62116

« No delay » means that no time delay is added to the intrinsic technical duration required to initiate the disconnection. The operate time may not exceed 200ms.

Annexe C.1: Settings of the automatic separation system

		1		2		3	
		Value (V)	Time (ms)	Value (V)	Time (ms)	Value (V)	Time (ms)
L1-N voltage	UV level 0.80Un	182.80	50.70	183.15	42.40	182.95	50.60
	OV level 2 1.15un	264.25	64.80	264.82	67.05	264.40	67.80

Voltage monitoring for 10-min-mean-value: OV Level 1

Test procedure (for U>)	a) The voltage is maintained at 100% Un for 600s, afterwards the voltage is raised to 112%, the switch off must be within 600s; b) The voltage is maintained at Un for 600s, afterwards the voltage is raised to 108%. The switch off should not be activated. c) The voltage is maintained at 106% Un for 600s, afterwards the voltage is raised to 114%. The switch off should be within 225s-375s.

Applied phase	a		b		c	
	Switch off (Yes/No)	Time (s)	Switch off (Yes/No)	Time (s)	Switch off (Yes/No)	Time (s)
L1-N	Yes	455.11	No	--	Yes	371.68

Frequency monitoring

		1		2		3	
		Value (Hz)	Time (ms)	Value (Hz)	Time (ms)	Value (Hz)	Time (ms)
Test procedure (for f>, f<)	f<	47.50	45.80	47.50	55.80	47.49	49.55
	f>	51.52	59.05	51.51	69.05	51.51	81.80

Integrated automatic separation system (LoM)

No.	P_{EUT} (% of EUT rating)	Reactive Load (% of Q_L)	P_{AC} (% of nominal)	Q_{AC} (% of nominal)	Run on time (ms)	P_{EUT} (W)	Actual Q_f	V_{DC} (V)	Remarks
1	100	100	0	0	687	5930	1.01	58.0	Test A at BL
2	100	100	-5	-5	666	5749	1.03	58.0	Test A at IB
3	100	100	-5	0	758	5823	1.06	58.0	Test A at IB
4	100	100	-5	+5	567	5805	1.09	58.0	Test A at IB

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5	100	100	0	-5	860	5827	0.97	58.0	Test A at IB
6	100	100	0	+5	747	5812	1.04	58.0	Test A at IB
7	100	100	+5	-5	720	5804	0.93	58.0	Test A at IB
8	100	100	+5	0	549	5839	0.96	58.0	Test A at IB
9	100	100	+5	+5	799	5853	0.99	58.0	Test A at IB
10	100	100	+5	+10	255	5823	1.01	58.0	Test A at IB
11	100	100	-10	+10	290	5847	1.16	58.0	Test A at IB
12	100	100	-5	+10	295	5841	1.10	58.0	Test A at IB
13	100	100	0	+10	280	5842	1.05	58.0	Test A at IB
14	100	100	+10	+10	266	5808	0.96	58.0	Test A at IB
15	100	100	+10	+5	716	5827	0.94	58.0	Test A at IB
16	100	100	+10	0	409	5801	0.91	58.0	Test A at IB
17	100	100	+10	-5	628	5785	0.89	58.0	Test A at IB
18	100	100	+10	-10	813	5859	0.88	58.0	Test A at IB
19	100	100	+5	-10	332	5820	0.91	58.0	Test A at IB
20	100	100	0	-10	809	5824	0.96	58.0	Test A at IB
21	100	100	-5	-10	515	5836	1.00	58.0	Test A at IB
22	100	100	-10	-10	666	5831	1.05	58.0	Test A at IB
23	100	100	-10	-5	372	5813	1.08	58.0	Test A at IB
24	100	100	-10	0	808	5867	1.11	58.0	Test A at IB
25	100	100	-10	+5	555	5820	1.14	58.0	Test A at IB
26	66	66	0	0	685	3809	1.00	51.0	Test B at BL
27	66	66	0	-5	526	3782	0.98	51.0	Test B at IB
28	66	66	0	-4	760	3810	0.99	51.0	Test B at IB
29	66	66	0	-3	621	3780	0.98	51.0	Test B at IB
30	66	66	0	-2	756	3781	0.99	51.0	Test B at IB
31	66	66	0	-1	656	3807	0.99	51.0	Test B at IB
32	66	66	0	1	843	3807	1.00	51.0	Test B at IB
33	66	66	0	2	458	3802	1.01	51.0	Test B at IB

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34	66	66	0	3	397	3805	1.01	51.0	Test B at IB
35	66	66	0	4	503	3805	1.02	51.0	Test B at IB
36	66	66	0	5	293	3799	1.02	51.0	Test B at IB
37	33	33	0	0	264	1873	1.00	42.1	Test C at BL
38	33	33	0	-5	277	1863	0.98	42.1	Test C at IB
39	33	33	0	-4	335	1862	0.99	42.1	Test C at IB
40	33	33	0	-3	354	1865	0.99	42.1	Test C at IB
41	33	33	0	-2	262	1871	0.99	42.1	Test C at IB
42	33	33	0	-1	358	1871	1.00	42.1	Test C at IB
43	33	33	0	1	301	1870	1.01	42.1	Test C at IB
44	33	33	0	2	349	1868	1.01	42.1	Test C at IB
45	33	33	0	3	280	1870	1.02	42.1	Test C at IB
46	33	33	0	4	524	1868	1.02	42.1	Test C at IB
47	33	33	0	5	346	1868	1.03	42.1	Test C at IB
Supplementary information: test mothed refer to IEC 62116:2014.									

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EN 50549-1, 4.13	Requirements regarding single fault tolerance of interface protection system and interface switch					P
Ambient temperature (°C) ……………………………...:						26°C
Relative humidity………………………………………:						55%
No.	component	Fault	Input (Vdc)	Output (Vac, W)	Test duration	Observation
INV PCB						
1.	R478 (Resistance of PV voltage sampling circuit）	O-C	420	230,6000	3min	The fault was applied before operation. After the unit applied the fault, the PV voltage sampling value was incorrect, no fault was detected. No hazard. No damage.
2.	C and E of Q10 (Switch device of PV2 boost circuit)	S-C	420	230,6000	3min	The fault was applied before operation. After the unit applied the fault, the LED was steady red, “PV2 over current” fault was detected. No output voltage. Q10 was damaged, No hazards.
3.	R57 (Drive resistance of Q10 of PV2 drive circuit)	S-C	420	230,6000	3min	The fault was applied before operation. After the unit applied the fault, PV2 circuit was not operated. The unit operated normally. No hazard. No damage.
4.	C and E of Q19 (Switch device of INV circuit)	S-C	420	230,6000	3min	The fault was applied before operation. After the unit applied the fault, the LED was steady red, “INV overcurrent, Grid fast check abnormal, INV inductor current limited, leakage current exceeded” faults were detected. No output voltage. Q18 and Q20 were damaged, no hazards.
5.	R25 (Drive resistance of Q19)	S-C	420	230,6000	3min	The fault was applied before operation. After the unit applied the fault, the LED was steady yellow, “Inverter self-test failed” fault was detected. No output voltage. No hazard. No damage.
6.	R468 (Resistance of bus capacitor voltage sampling circuit)	S-C	420	230,6000	3min	The fault was applied before operation. After the unit applied the fault, the LED was steady red, “Bus capacitor” faults were detected. No output voltage. No hazard. No damage.
7.	R213 (Resistance of grid voltage sampling circuit)	S-C	420	230,6000	3min	The fault was applied before operation. After the unit applied the fault, the LED was steady green. No fault was detected. No hazard. No damage.
8.	R155 (Resistance of load voltage sampling circuit)	S-C	420	230,6000	3min	The fault was applied before operation. After the unit applied the fault, the LED was steady green. No fault was detected. No hazard. No damage.
9.	R102 of HCT3 (PV1 current sampling circuit)	O-C	420	230,6000	3min	The fault was applied before operation. After the unit applied the fault, the LED was steady green. The inverter could not detect the PV1 current. No fault was detected. No hazard. No damage.
10.	R73 of HCT2 (Load current sampling circuit)	O-C	420	230,6000	3min	The fault was applied before operation. After the unit applied the fault, the LED was steady red. “Output over current” fault was detected. No output voltage. No hazard. No damage.

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11.	R93 of HCT4 (Grid current sampling circuit)	S-C	420	230,6000	3min	The fault was applied before operation. After the unit applied the fault, the LED was steady green. No fault was detected. No hazard. No damage.
Boost board						
12.	R65 (Drive resistance of Q21 of TX3 primary winding)	S-C	420	230,6000	3min	The fault was applied before operation. After the unit applied the fault, the LED was steady green. No fault was detected. No hazard. No damage.
13.	R31 (Drive resistance of U1 of drive IC of Q1)	S-C	420	230,6000	3min	The fault was applied before operation. After the unit applied the fault, the LED was steady green. No fault was detected. No hazard. No damage.
14.	R18 (Drive resistance of U11 of drive IC of Q6)	S-C	420	230,6000	3min	The fault was applied before operation. After the unit applied the fault, the LED was steady green. No fault was detected. No hazard. No damage.

AC Filter board

No.	Component	Fault	Supply voltage (V)	Test time	Fuse #	Fuse current (A)	Observation
1.	K3 L Phase	S-C	420Vd.c.	3min	/	/	The fault was applied before the unit operation, after applied the fault, the LED was steady red, grid relay fault was detected. No output voltage. No hazard. No damage. After removed the fault, the unit operated normally.
2.	K4 N Phase	S-C	420Vd.c.	3min	/	/	The fault was applied before the unit operation, after applied the fault, the LED was steady red, grid relay fault was detected. No output voltage. No hazard. No damage. After removed the fault, the unit operated normally.
3.	K5 L Phase	S-C	420Vd.c.	3min	/	/	The fault was applied before the unit operation, after applied the fault, the LED was steady red, grid relay fault was detected. No output voltage. No hazard. No damage. After removed the fault, the unit operated normally.
4.	K6 N Phase	S-C	420Vd.c.	3min	/	/	The fault was applied before the unit operation, after applied the fault, the LED was steady red, grid relay fault was detected. No output voltage. No hazard. No damage. After removed the fault, the unit operated normally.

Supplementary information:
S-C: Short circuit
O-C: Open circuit
During the test: Fire do not propagates beyond the PCE;
Equipment do not 60mit molten metal;
Enclosures do not deform to cause non-compliance with the standard.

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Annex D.4.1 & D.4.3	Operating frequency range & Continuous operating voltage range				P
Frequency range operation test					
	Setting	Measured power			
		P (W)	Q (Var)	S (VA)	
Test #1	47.5Hz, 85% of Un, 30min, cosφ=1	5012.56	-136.64	5014.42	
Test #2	47.5Hz, 110% of Un, 30imn, cosφ=1	6069.03	-117.21	6070.16	
Test #3	51.5Hz, 85% of Un, 30min, cosφ=1	5115.46	-81.41	5116.11	
Test #4	51.5Hz, 110% of Un, 30min, cosφ=1	6078.34	-39.11	6078.46	
Supplementary information: For the test, the LFSM functionis disabled.					

Annex D.4.2	Maximum admissible power reduction in case of underfrequency			P
Test sequence	Freq (Hz)	Measured active output power $P_{measure}$ (W)	The calculated active output power as per feature curve $P_{minimum}$ (W)	Deviation of $P_{measure}$ (W) higher than $P_{minimum}$? (Yes/No)
1	50.0	6023	6000	Yes
2	49.5	6033	6000	Yes
3	49.0	6022	6000	Yes
4	48.5	5944	5940	Yes
5	48.0	5884	5880	Yes
6	47.5	5841	5820	Yes

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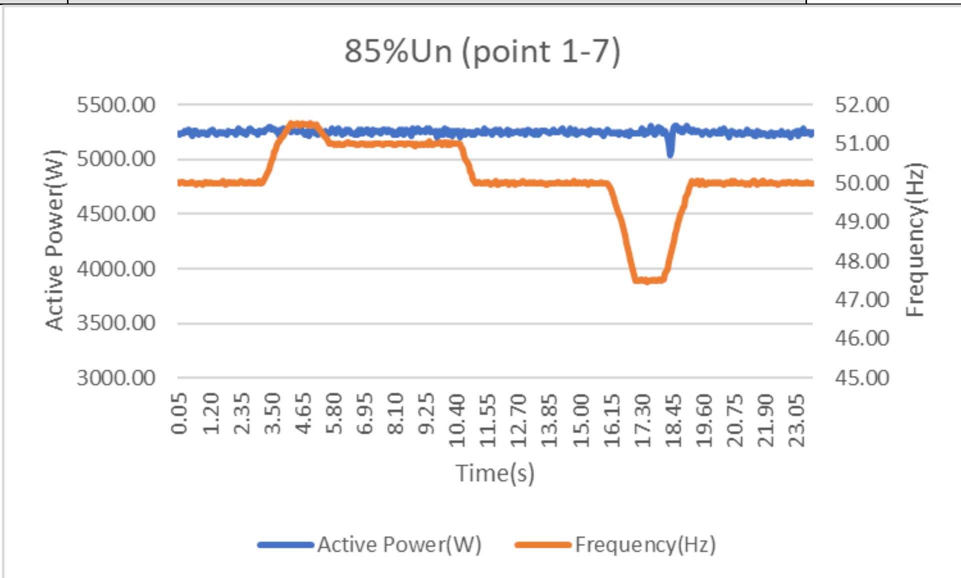
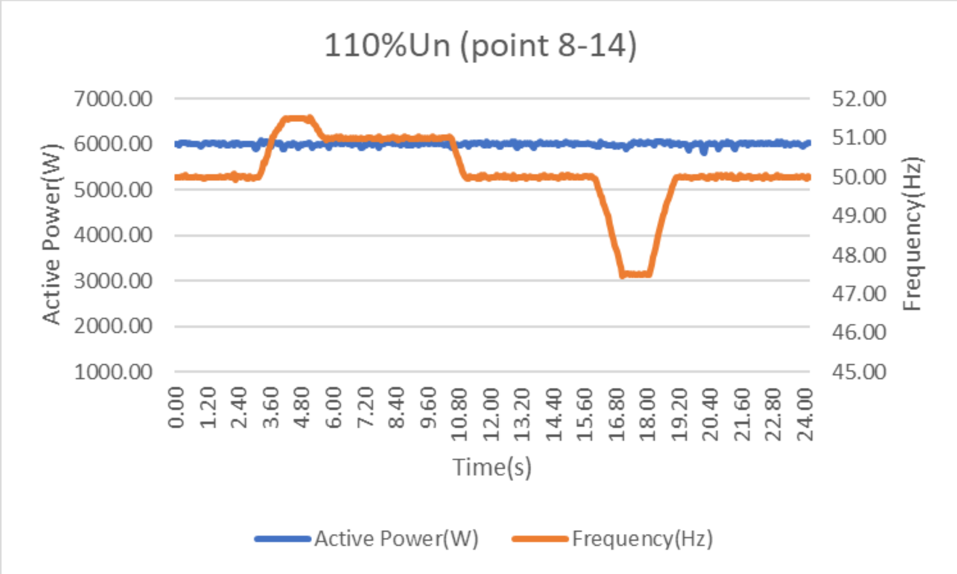
Annex D.5.1	Rate of change of frequency (RoCoF) immunity	P
RoCoF operation test, +/-2.0Hz/s for smooth time window of 0.5s		

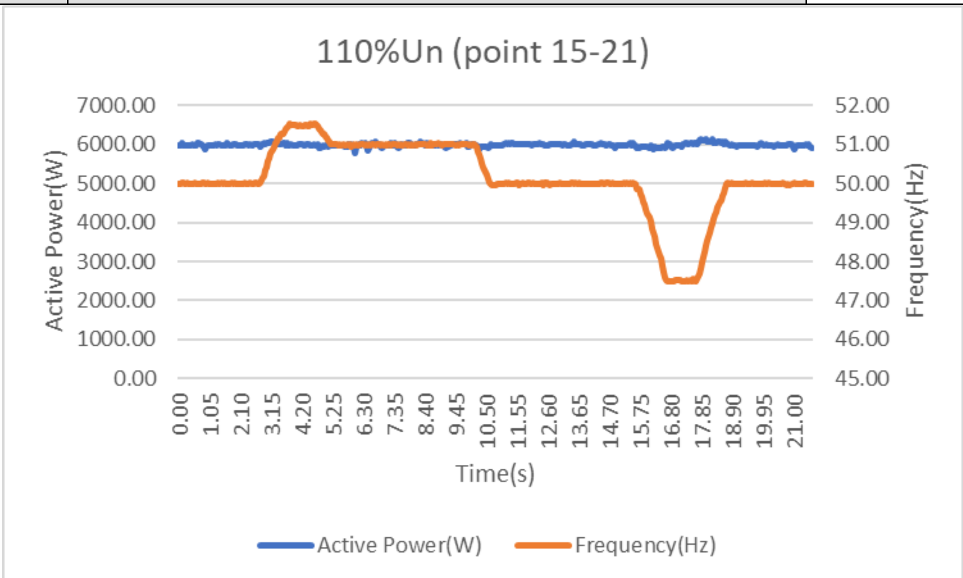
	Setting	Disconnection during RoCoF
Point #1	50.0Hz to 51.0Hz, +2.0Hz/s for 0.5s, 85% of Un, cosφ=1 (stay 0 second, to Test #2)	No Disconnection
Point #2	51.0Hz to 51.5Hz, +2.0Hz/s for 0.5s, 85% of Un, cosφ=1 (stay 1 second, to Test #3)	No Disconnection
Point #3	51.5Hz to 51.0Hz, -2.0Hz/s for 0.5s, 85% of Un, cosφ=1 (stay 5 second, to Test #4)	No Disconnection
Point #4	51.0 to 50.0Hz, -2.0Hz/s for 0.5s, 85% of Un, cosφ=1 (stay 5 second, to Test #5)	No Disconnection
Point #5	50.0Hz to 49.0Hz, -2.0Hz/s for 0.5s, 85% of Un, cosφ=1 (stay 0 second, to Test #6)	No Disconnection
Point #6	49.0Hz to 47.5Hz, -2.0Hz/s for 0.5s, 85% of Un, cosφ=1 (stay 1 second, to Test #7)	No Disconnection
Point #7	47.5Hz to 49.0Hz, +2.0Hz/s for 0.5s, 85% of Un, cosφ=1	No Disconnection



Point #8	50.0Hz to 51.0Hz, +2.0Hz/s for 0.5s, 100% of Un, cosφ=1 (stay 0 second, to Test #9)	No Disconnection
Point #9	51.0Hz to 51.5Hz, +2.0Hz/s for 0.5s, 100% of Un, cosφ=1 (stay 1 second, to Test #10)	No Disconnection
Point #10	51.5Hz to 51.0Hz, -2.0Hz/s for 0.5s, 100% of Un, cosφ=1 (stay 5 second, to Test #11)	No Disconnection
Point #11	51.0 to 50.0Hz, -2.0Hz/s for 0.5s, 100% of Un, cosφ=1 (stay 5 second, to Test #12)	No Disconnection
Point #12	50.0Hz to 49.0Hz, -2.0Hz/s for 0.5s, 100% of Un, cosφ=1 (stay 0 second, to Test #13)	No Disconnection
Point #13	49.0Hz to 47.5Hz, -2.0Hz/s for 0.5s, 100% of Un, cosφ=1 (stay 1 second, to Test #14)	No Disconnection
Point #14	47.5Hz to 49.0Hz, +2.0Hz/s for 0.5s, 100% of Un, cosφ=1	No Disconnection



Point #15	50.0Hz to 51.0Hz, +2.0Hz/s for 0.5s, 110% of Un, cosφ=1 (stay 0 second, to Test #16)	No Disconnection
Point #16	51.0Hz to 51.5Hz, +2.0Hz/s for 0.5s, 110% of Un, cosφ=1 (stay 1 second, to Test #17)	No Disconnection
Point #17	51.5Hz to 51.0Hz, -2.0Hz/s for 0.5s, 110% of Un, cosφ=1 (stay 5 second, to Test #18)	No Disconnection
Point #18	51.0 to 50.0Hz, -2.0Hz/s for 0.5s, 110% of Un, cosφ=1 (stay 5 second, to Test #19)	No Disconnection
Point #19	50.0Hz to 49.0Hz, -2.0Hz/s for 0.5s, 110% of Un, cosφ=1 (stay 0 second, to Test #20)	No Disconnection
Point #20	49.0Hz to 47.5Hz, -2.0Hz/s for 0.5s, 110% of Un, cosφ=1 (stay 1 second, to Test #21)	No Disconnection
Point #21	47.5Hz to 49.0Hz, +2.0Hz/s for 0.5s, 110% of Un, cosφ=1	No Disconnection



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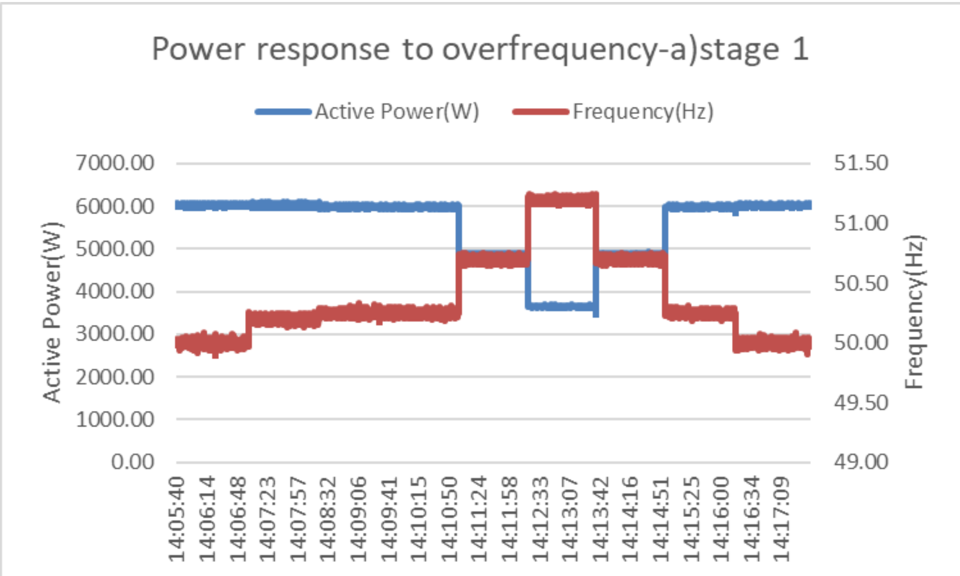
Annex D.6.1	Power response to overfrequency	P
a) Over-frequency regulation, with f1=50.2Hz, gradient s=5%		

Stage 1: Inverter DC input available power is set to get 100% of maximum active output power till the end of the test. The active power value shall not be deviated from the required value calculated from the feature curve (a gradient of 40% of P_M per hertz) for more than 10% Pmax.
P_M = 6038 W , 10% Pmax= 600 W, Intentional delay time: 0.15 s (should ≤2s)

Test sequence	Freq (Hz)	Measured active output power $P_{measure}$ (W)	The calculated active output power as per feature curve P_{shall} (W)	Deviation of $P_{measure}$ and P_{shall} (W)	Deviation within 10% Pmax (Yes/No)
1	50.00	6029	--	--	--
2	50.20	6038	--	--	--
3	50.25	5983	5917	66	Yes
4	50.70	4878	4830	48	Yes
5	51.20	3653	3623	30	Yes
6	50.70	4878	4830	48	Yes
7	50.25	5981	5917	64	Yes
8	50.00	6020	--	--	--



Stage 2: Inverter DC input available power is set to 50% of maximum active output power first. After the inverter step into frequency range above 50.2Hz, the Inverter available input power is set to 100% of maximum active output. The output active power should not be changed. When the Inverter step back below the frequency 50.2Hz, the output active power should arise with a gradient of 10% Pmax per minute.
P_M = 3025 W , 10% Pmax= 600 W, Intentional delay time: 0.15 s (should ≤2s)

Test sequence	Freq (Hz)	Measured active output power $P_{measure}$ (W)	The calculated active output power as per feature curve P_{shall} (W)	Deviation of $P_{measure}$ and P_{shall} (W)	Deviation within 10% Pmax (Yes/No)
1	50.00	3016	--	--	--
2	50.20	3025	--	--	--

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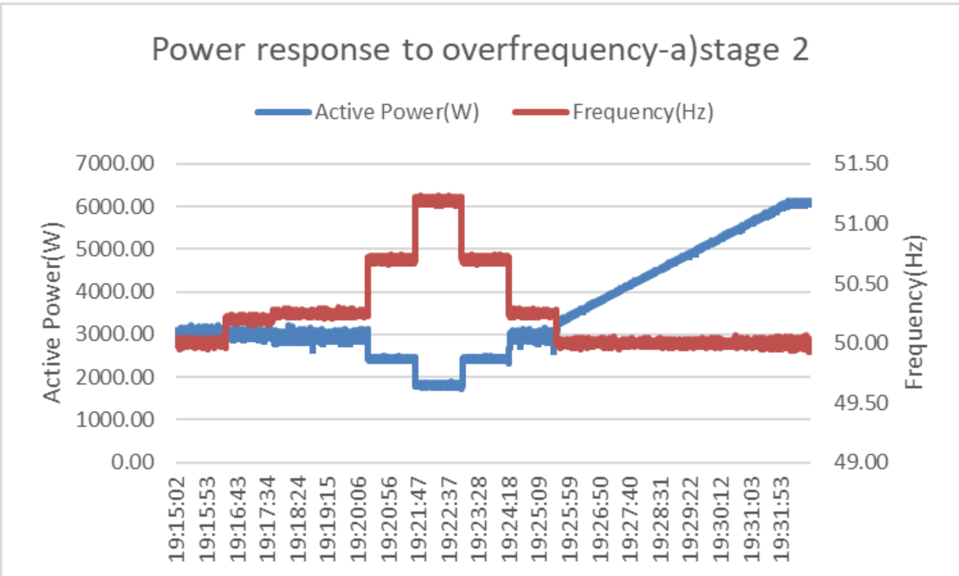
3	50.25	2973	2965	8	Yes
4	50.70	2428	2420	8	Yes
5	51.20	1818	1815	3	Yes
6	50.70	2425	2420	5	Yes
7	50.25	2973	2965	8	Yes
8	50.00	See below table	--	--	--

Test sequence	Freq (Hz)	Time after step back from 50.2Hz t (min)	Measured active output power $P_{measure}$ (W)	ΔP Arise during next 1 min	Gradient of arising powerΔP/t <10% Pmax (Yes/No)
8	50.00	0.0min	3316	-	-
9	50.00	0.5min	3479	326	Yes
10	50.00	1.0min	3686	414	Yes
11	50.00	1.5min	3951	530	Yes
12	50.00	2.0min	4161	420	Yes
13	50.00	2.5min	4394	466	Yes
14	50.00	3.0min	4596	404	Yes
15	50.00	3.5min	4840	488	Yes
16	50.00	4.0min	5044	408	Yes
17	50.00	4.5min	5246	404	Yes
18	50.00	5.0min	5471	450	Yes
19	50.00	5.5min	5688	434	Yes
20	50.00	6.0min	5925	474	Yes
21	50.00	6.5min	6080	310	Yes
22	50.00	7.0min	6083	6	Yes



Active power reaction time

Test with active power reduction frequency start point 50.20Hz, gradient s=5%，P=50%Pmax

Test sequence	Freq (Hz)	Measured active output power $P_{measure}$ (W)	Instrinsic dead time (s)	Response time (s) (≤ 20s)

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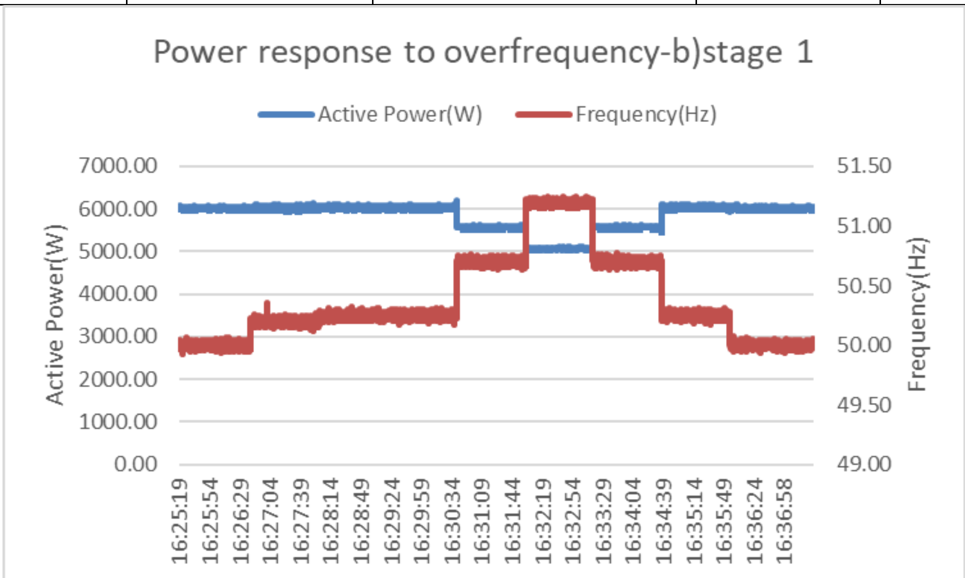
			(≤ 2s)	
1	50.00	3029	-	-
2	50.20	3026	-	-
3	51.20	1820	1.00	1.35

b) over-frequency regulation, with f1=50.2Hz, gradient s=12%

Stage 1: Inverter DC input available power is set to get 100% of maximum active output power till the end of the test. The active power value shall not be deviated from the required value calculated from the feature curve (a gradient of 16.7% of P_M per hertz) for more than 10% Pmax.

P_M = 6034 W , 10% Pmax= 600 W, Intentional delay time: 0.15 s (should ≤2s)

Test sequence	Freq (Hz)	Measured active output power $P_{measure}$ (W)	The calculated active output power as per feature curve P_{shall} (W)	Deviation of $P_{measure}$ and P_{shall} (W)	Deviation within 10% Pmax (Yes/No)
1	50.00	6016	--	--	--
2	50.20	6034	--	--	--
3	50.25	6038	5984	54	Yes
4	50.70	5579	5530	49	Yes
5	51.20	5070	5026	44	Yes
6	50.70	5580	5530	50	Yes
7	50.25	6040	5984	56	Yes
8	50.00	6019	--	--	--

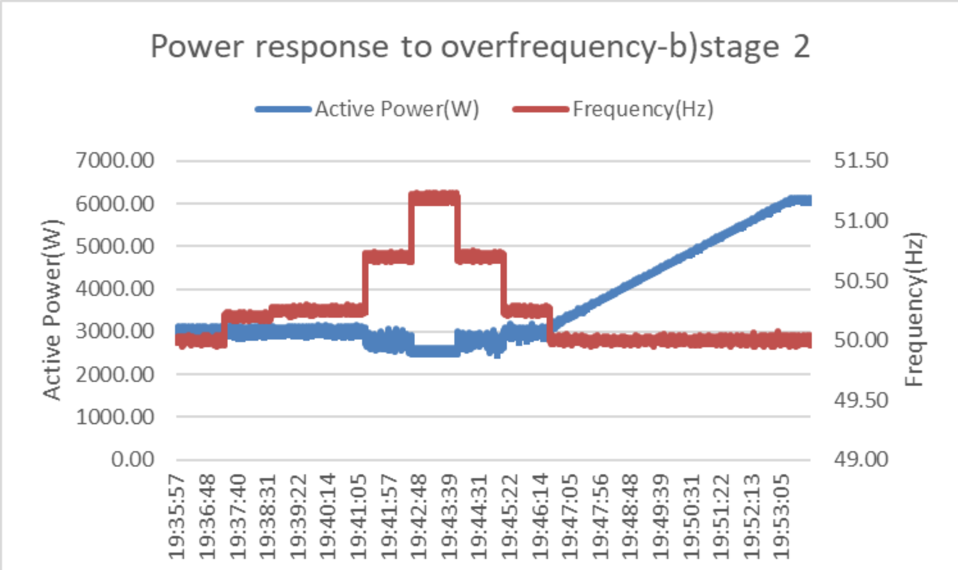


Stage 2: Inverter DC input available power is set to get 50% of maximum active output power first. After the Inverter step into frequency range above 50.2Hz, the Inverter available input power is set to 100% of maximum active output. The output active power should not be changed. When the Inverter step back below the frequency 50.2Hz, the output active power should arise with a gradient of 10% Pmax per minute.

P_M = 3029 W , 10% Pmax= 600 W, Intentional delay time: 0.15 s (should ≤2s)

Test sequence	Freq (Hz)	Measured active output power $P_{measure}$ (W)	The calculated active output power as per feature curve P_{shall} (W)	Deviation of $P_{measure}$ and P_{shall} (W)	Deviation within 10% Pmax (Yes/No)
1	50.00	3029	--	--	--
2	50.20	3029	--	--	--
3	50.25	3028	3004	24	Yes

4	50.70	2785	2776	9	Yes
5	51.20	2542	2523	19	Yes
6	50.70	2773	2776	-3	Yes
7	50.25	3001	3004	-3	Yes
8	50.00	See below table	--	--	--
Test sequence	Freq (Hz)	Time after step back from 50.2Hz t (min)	Measured active output power $P_{measure}$ (W)	ΔP Arise during next 1 min	Gradient of arising powerΔP/t under 10% Pmax (Yes/No)
8	50.00	0.0min	3156	--	--
8	50.00	0.5min	3385	485	Yes
8	50.00	1.0min	3582	394	Yes
8	50.00	1.5min	3793	422	Yes
8	50.00	2.0min	4029	472	Yes
8	50.00	2.5min	4239	420	Yes
8	50.00	3.0min	4456	434	Yes
8	50.00	3.5min	4677	442	Yes
8	50.00	4.0min	4904	454	Yes
8	50.00	4.5min	5100	392	Yes
8	50.00	5.0min	5339	478	Yes
8	50.00	5.5min	5546	414	Yes
8	50.00	6.0min	5760	428	Yes
8	50.00	6.5min	5984	448	Yes
8	50.00	7.0min	6098	228	Yes



Active power reaction time
Test with active power reduction frequency start point 50.20Hz, gradient s=12%， P=50%Pmax

Test sequence	Freq (Hz)	Measured active output power $P_{measure}$ (W)	Instrinsic dead time (s) (≤ 2s)	Response time (s) (≤ 20s)
1.	50.00	3024	-	-

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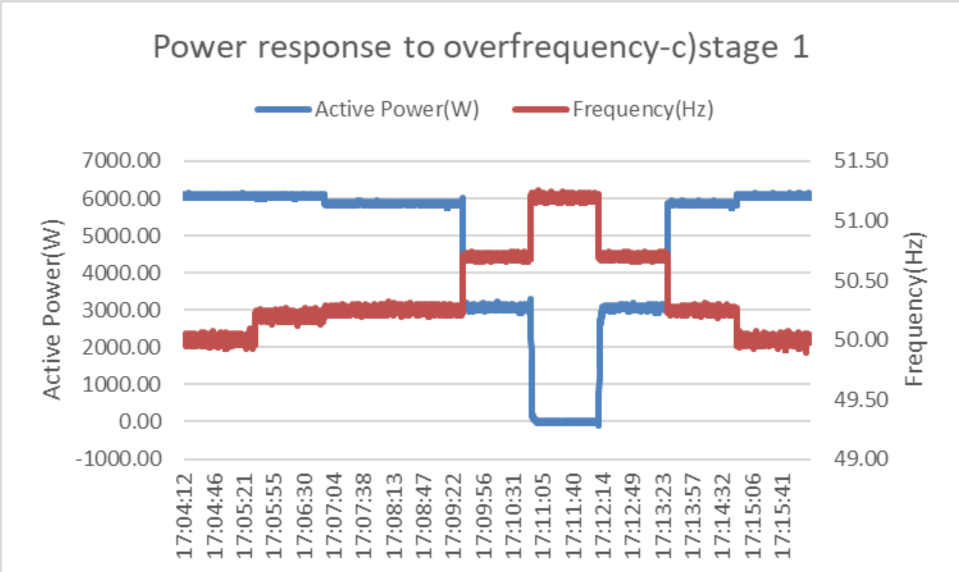
2.	50.20	3028	-	-
3.	51.20	2553	1.10	1.30

c) over-frequency regulation, with f1=50.2Hz, gradient s=2%

Stage 1: Inverter DC input available power is set to get 100% of maximum active output power till the end of the test. The active power value shall not be deviated from the required value calculated from the feature curve (a gradient of 100% of P_M per hertz) for more than 10% Pmax.
P_M = <u>6080 W</u>, 10% Pmax= <u>600 W</u>, Intentional delay time: <u>0.15 s</u> (should ≤2s)

Test sequence	Freq (Hz)	Measured active output power $P_{measure}$ (W)	The calculated active output power as per feature curve P_{shall} (W)	Deviation of $P_{measure}$ and P_{shall} (W)	Deviation within 10% Pmax (Yes/No)
1	50.00	6078	--	--	--
2	50.20	6080	--	--	--
3	50.25	5860	5776	84	Yes
4	50.70	3076	3040	36	Yes
5	51.20	4	0	4	Yes
6	50.70	3071	3040	31	Yes
7	50.25	5858	5776	82	Yes
8	50.00	6080	--	--	--



Stage 2: Inverter DC input available power is set to 50% of maximum active output power first. After the Inverter step into frequency range above 50.2Hz, the Inverter available input power is set to 100% of maximum active output. The output active power should not be changed. When the Inverter step back below the frequency 50.2Hz, the output active power should arise with a gradient of 10% Pmax per minute.
P_M = <u>3027 W</u>, 10% Pmax= <u>600 W</u>, Intentional delay time: <u>0.15 s</u> (should ≤2s)

Test sequence	Freq (Hz)	Measured active output power $P_{measure}$ (W)	The calculated active output power as per feature curve P_{shall} (W)	Deviation of $P_{measure}$ and P_{shall} (W)	Deviation within 10% Pmax (Yes/No)
1	50.00	3026	--	--	--
2	50.20	3027	--	--	--
3	50.25	2909	2876	33	Yes
4	50.70	1534	1514	21	Yes
5	51.20	3	0	3	Yes

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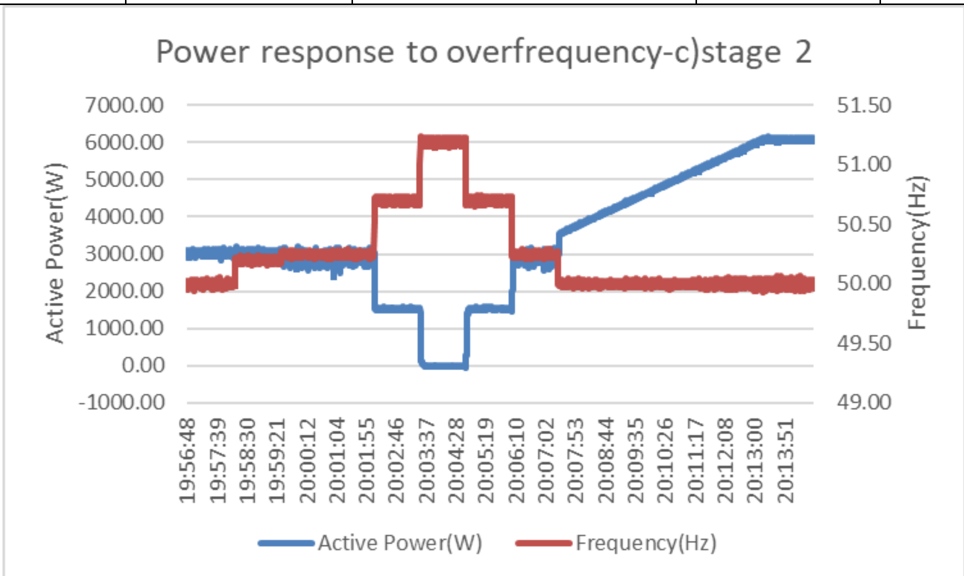
6	50.70	1532	1514	19	Yes
7	50.25	2906	2876	30	Yes
8	50.00	See below table	--	--	--
Test sequence	Freq (Hz)	Time after step back from 50.2Hz t (min)	Measured active output power $P_{measure}$ (W)	ΔP Arise during next 1 min	Gradient of arising powerΔP/t under 10% Pmax (Yes/No)
8	50.00	0.0min	3531	--	--
8	50.00	0.5min	3744	426	Yes
8	50.00	1.0min	3972	456	Yes
8	50.00	1.5min	4201	458	Yes
8	50.00	2.0min	4403	404	Yes
8	50.00	2.5min	4632	458	Yes
8	50.00	3.0min	4840	416	Yes
8	50.00	3.5min	5066	452	Yes
8	50.00	4.0min	5278	424	Yes
8	50.00	4.5min	5493	430	Yes
8	50.00	5.0min	5713	440	Yes
8	50.00	5.5min	5956	486	Yes
8	50.00	6.0min	6090	268	Yes
8	50.00	6.5min	6094	8	Yes
8	50.00	7.0min	6084	20	Yes



Active power reaction time
Test with active power reduction frequency start point 50.20Hz, gradient s=2%， P=50%Pmax

Test sequence	Freq (Hz)	Measured active output power $P_{measure}$ (W)	Instrinsic dead time (s) (≤ 2s)	Response time (s) (≤ 20s)
1.	50.00	3029	-	-
2.	50.20	3028	-	-
3.	51.20	3	1.20	1.90

The following is a screenshot of the software where the slope can be set:

Number of arguments in a single line 2

	Name	Echo	Unit	Range	Name	Echo	Unit	Range
16	INV Start Command	0		0~65535	INV Stop Command	0		0~65535
17	INV Active Setting	50	%	0~100	PV Active Setting	100	%	0~100
18	Active Change Rate Limit	100		1~30	Enable Island Check	Disable		0~1
19	Certification Mode	Disable		0~1	ON -OFF Grid Mode	ON GRID		0~1
20	System Run Mode	attery Firs		0~7	Wake on Lamp Bar	0		0~65535
21	Buzzer Respond Time	0	min	0~60	USB Operation	NULL		0~5
22	System Mode Set	UPS		0~1	PV Connect Set	Independ		0~1
23	Rated Volt.	0	V	208~240	Rated FREQ.	0	Hz	50~60
24	BATT Type	LEAD		0~1	BATT CHG CURR.	100.0	A	0~100
25	BATT DISCHG CURR.	120.0	A	0~120	BATT Equal CHG VOLT	56.4	V	48~57.6
26	BATT Float CHG VOLT.	53.5	V	46~55				
27	BATT DOD	46.0	V	40~57.6				
28	OFF-GRID SOC Limit	5	%	0~15				
29	Power Factor	0.00		-0.99~1				
30	Cold Mode	OFF						
31	Overfrequency Derating	0.00	Hz	47~52	Freq_Watt OverFreqStartPoint	50.20	Hz	
32	Freq_Wat tOverFreqCenterPoint	0.00	Hz		Freq_Watt OverFreqEndPoint	51.50	Hz	
33	Freq_Watt OverFreqRECVYPoint	50.10	Hz		Freq_Watt OverFreqRECVYTime	1	s	
34	Freq_Watt UnderFreqStartPoint	49.80	Hz		Freq_Watt UnderFreqCenterPoint	0.00	Hz	
35	Freq_Watt UnderFreqEndPoint	47.50	Hz		Freq_Watt UnderFreqRECVYPoint	49.80	Hz	
36	Freq_Watt UnderFreqRECVYTime	1	s		Freq_Watt OverFreqPowerRate	5	%	
37	Freq_Watt UnderFreqPowerRate	2	%		Freq_Watt PowerRiseSpeed	100.0	%···	
38	Freq_Watt PowerFallSpeed	100.0	%···					

Freq_Watt OverFreqPowerRate set ? ×
value: 5
OK Cancel

The following is a screenshot of the software where the over-frequency derating threshold can be set:

Number of arguments in a single line 2

	Name	Echo	Unit	Range	Name	Echo	Unit	Range
16	INV Start Command	0		0~65535	INV Stop Command	0		0~65535
17	INV Active Setting	50	%	0~100	PV Active Setting	100	%	0~100
18	Active Change Rate Limit	100		1~30	Enable Island Check	Disable		0~1
19	Certification Mode	Disable		0~1	ON -OFF Grid Mode	ON GRID		0~1
20	System Run Mode	attery Firs		0~7	Wake on Lamp Bar	0		0~65535
21	Buzzer Respond Time	0	min	0~60	USB Operation	NULL		0~5
22	System Mode Set	UPS		0~1	PV Connect Set	Independ		0~1
23	Rated Volt.	0	V	208~240	Rated FREQ.	0	Hz	50~60
24	BATT Type	LEAD		0~1	BATT CHG CURR.	100.0	A	0~100
25	BATT DISCHG CURR.	120.0	A	0~120	BATT Equal CHG VOLT	56.4	V	48~57.6
26	BATT Float CHG VOLT.	53.5	V	46~55				.6
27	BATT DOD	46.0	V	40~57.6				
28	OFF-GRID SOC Limit	5	%	0~15				
29	Power Factor	0.00		-0.99~1				
30	Cold Mode	OFF						
31	Overfrequency Derating	0.00	Hz	47~52	Freq_Watt OverFreqStartPoint	50.20	Hz	
32	Freq_Wat tOverFreqCenterPoint	0.00	Hz		Freq_Watt OverFreqEndPoint	51.50	Hz	
33	Freq_Watt OverFreqRECVYPoint	50.10	Hz		Freq_Watt OverFreqRECVYTime	1	s	
34	Freq_Watt UnderFreqStartPoint	49.80	Hz		Freq_Watt UnderFreqCenterPoint	0.00	Hz	
35	Freq_Watt UnderFreqEndPoint	47.50	Hz		Freq_Watt UnderFreqRECVYPoint	49.80	Hz	
36	Freq_Watt UnderFreqRECVYTime	1	s		Freq_Watt OverFreqPowerRate	5	%	
37	Freq_Watt UnderFreqPowerRate	2	%		Freq_Watt PowerRiseSpeed	100.0	%···	
38	Freq_Watt PowerFallSpeed	100.0	%···					

Freq_Watt OverFreqStartPoint set ? ×
value: 50.20
OK Cancel

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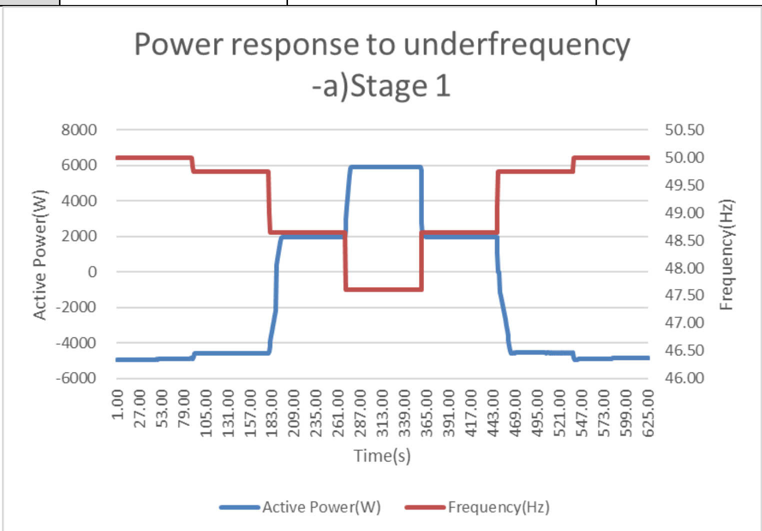
Annex D.6.2	Power response to underfrequency	P

a) Under-frequency regulation, with f1=49.8Hz, gradient s=2%

Stage 1: Inverter ESS SOC is set to get 100% of maximum active **charging power** till the end of the test. The active power value shall not be deviated from the required value calculated from the feature curve (a gradient of 100% of P_{max} per hertz) for more than 10% Pmax.

P_{max} = 6000 W, 10% P_{max} = 600 W, Intentional delay time: 1 s (should ≤2s)

Test sequence	Freq (Hz)	Measured active output power $P_{measure}$ (W)	The calculated active output power as per feature curve P_{shall} (W)	Deviation of $P_{measure}$ and P_{shall} (W)	Deviation within 10% Pmax (Yes/No)
1	50.00	-4925	-5000	75	Yes
2	49.75	-4575	-4625	50	Yes
3	48.65	1958	1975	-17	Yes
4	47.60	5928	6000	-72	Yes
5	48.65	1980	1975	5	Yes
6	49.75	-4542	-4625	83	Yes
7	50.00	-4847	-5000	153	Yes



Stage 2: Inverter ESS SOC is set to get 50% of maximum active **charging power** till the end of the test. The active power value shall not be deviated from the required value calculated from the feature curve S=5% (a gradient of 40% of P_{max} per hertz) for more than 10% P_{max}.

P_{max} = 6000 W, 10% P_{max} = 600 W, Intentional delay time: 1 s (should ≤2s)

Test sequence	Freq (Hz)	Measured active output power $P_{measure}$ (W)	The calculated active output power as per feature curve P_{shall} (W)	Deviation of $P_{measure}$ and P_{shall} (W)	Deviation within 10% Pmax (Yes/No)
1	50.00	-2493	-2500	7	Yes
2	49.75	-2351	-2373	22	Yes
3	48.65	228	267	-39	Yes
4	47.60	2766	2787	-21	Yes
5	48.65	240	267	-27	Yes
6	49.75	-2359	-2373	14	Yes

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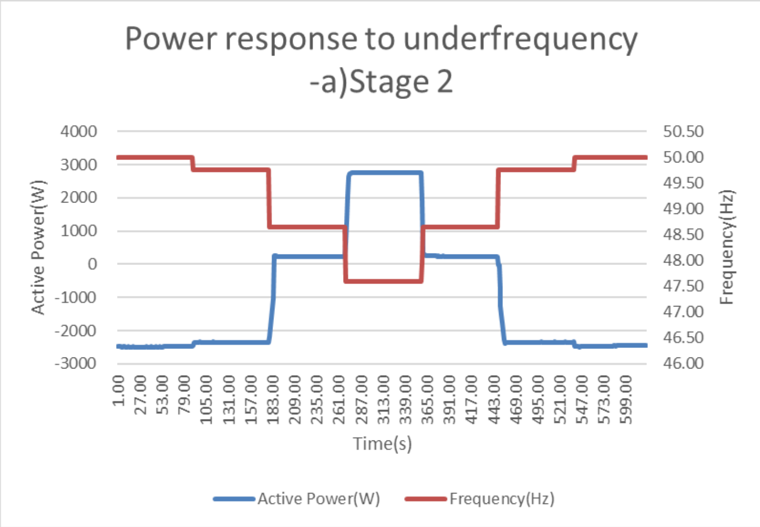
7	50.00	-2444	-2500	56	Yes

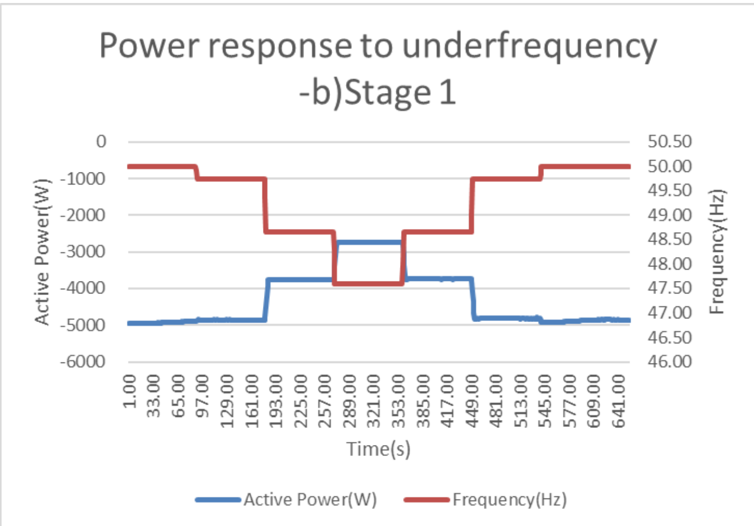


b) Under-frequency regulation, with f1=49.8Hz, gradient s=12%

Stage 1: Inverter ESS SOC is set to get 100% of maximum active **charging power** till the end of the test. The active power value shall not be deviated from the required value calculated from the feature curve (a gradient of 16.67% of P_{max} per hertz) for more than 10% P_{max}.

P_{max} = 6000 W, 10% P_{max} = 600 W, Intentional delay time: 1 s (should ≤2s)

Test sequence	Freq (Hz)	Measured active output power $P_{measure}$ (W)	The calculated active output power as per feature curve P_{shall} (W)	Deviation of $P_{measure}$ and P_{shall} (W)	Deviation within 10% Pmax (Yes/No)
1	50.00	-4943	-5000	57	Yes
2	49.75	-4855	-4893	38	Yes
3	48.65	-3760	-3793	33	Yes
4	47.60	-2735	-2743	8	Yes
5	48.65	-3736	-3793	57	Yes
6	49.75	-4815	-4893	78	Yes
7	50.00	-4850	-5000	150	Yes



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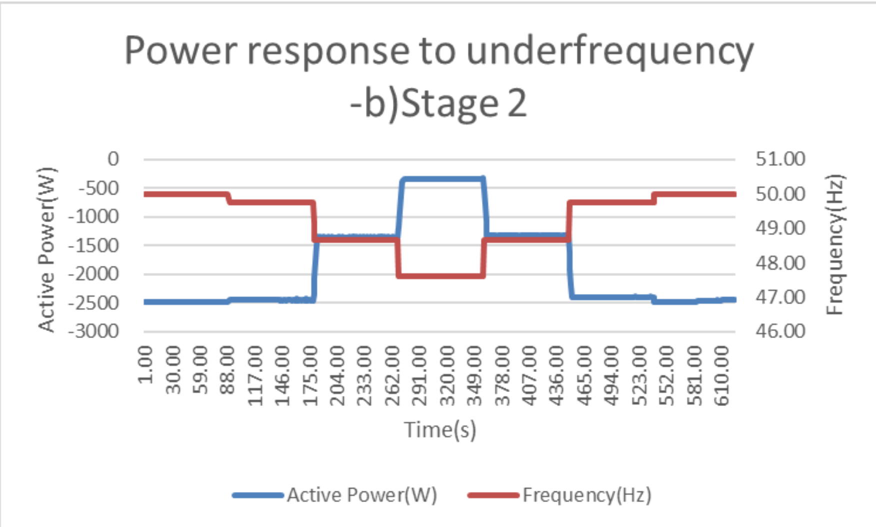
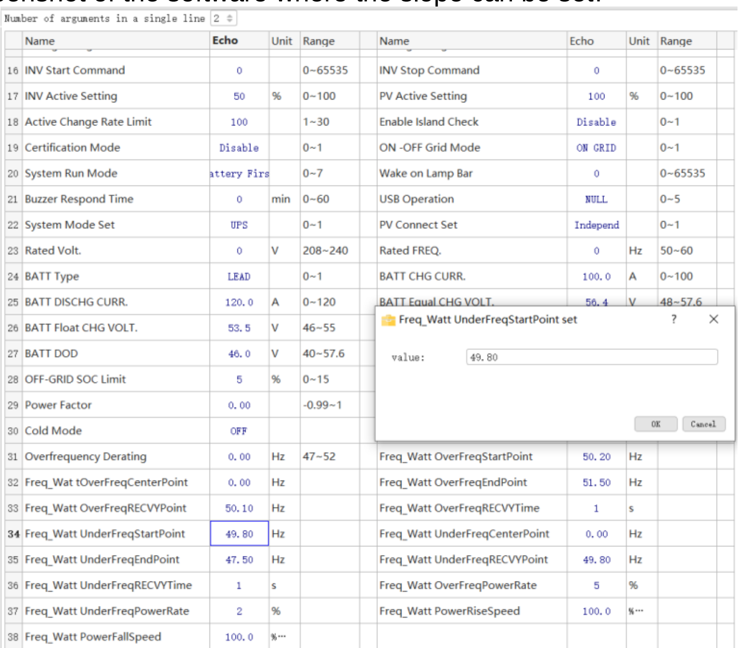
Stage 2: Inverter ESS SOC is set to get 50% of maximum active **charging power** till the end of the test. The active power value shall not be deviated from the required value calculated from the feature curve (a gradient of 16.67% of P_{max} per hertz) for more than 10% Pmax.

P_{max} = 6000 W , 10% P_{max} = 600 W , Intentional delay time: 1 s (should ≤2s)

Test sequence	Freq (Hz)	Measured active output power $P_{measure}$ (W)	The calculated active output power as per feature curve P_{shall} (W)	Deviation of $P_{measure}$ and P_{shall} (W)	Deviation within 10% Pmax (Yes/No)
1	50.00	-2493	-2500	7	Yes
2	49.75	-2441	-2443	2	Yes
3	48.65	-1351	-1343	-8	Yes
4	47.60	-336	-293	-43	Yes
5	48.65	-1331	-1343	12	Yes
6	49.75	-2405	-2443	38	Yes
7	50.00	-2468	-2500	32	Yes



The following is a screenshot of the software where the slope can be set:



Number of arguments in a single line 2

	Name	Echo	Unit	Range	Name	Echo	Unit	Range
16	INV Start Command	0		0~65535	INV Stop Command	0		0~65535
17	INV Active Setting	50	%	0~100	PV Active Setting	100	%	0~100
18	Active Change Rate Limit	100		1~30	Enable Island Check	Disable		0~1
19	Certification Mode	Disable		0~1	ON -OFF Grid Mode	ON GRID		0~1
20	System Run Mode	attery Firs		0~7	Wake on Lamp Bar	0		0~65535
21	Buzzer Respond Time	0	min	0~60	USB Operation	NULL		0~5
22	System Mode Set	UPS		0~1	PV Connect Set	Independ		0~1
23	Rated Volt.	0	V	208~240	Rated FREQ.	0	Hz	50~60
24	BATT Type	LEAD		0~1	BATT CHG CURR.	100.0	A	0~100
25	BATT DISCHG CURR.	120.0	A	0~120	BATT Equal CHG VOLT.	56.4	V	48~57.6
26	BATT Float CHG VOLT.	53.5	V	46~55				
27	BATT DOD	46.0	V	40~57.6				
28	OFF-GRID SOC Limit	5	%	0~15				
29	Power Factor	0.00		-0.99~1				
30	Cold Mode	OFF						
31	Overfrequency Derating	0.00	Hz	47~52	Freq_Watt OverFreqStartPoint	50.20	Hz	
32	Freq_Wat tOverFreqCenterPoint	0.00	Hz		Freq_Watt OverFreqEndPoint	51.50	Hz	
33	Freq_Watt OverFreqRECVYPoint	50.10	Hz		Freq_Watt OverFreqRECVYTime	1	s	
34	Freq_Watt UnderFreqStartPoint	49.80	Hz		Freq_Watt UnderFreqCenterPoint	0.00	Hz	
35	Freq_Watt UnderFreqEndPoint	47.50	Hz		Freq_Watt UnderFreqRECVYPoint	49.80	Hz	
36	Freq_Watt UnderFreqRECVYTime	1	s		Freq_Watt OverFreqPowerRate	5	%	
37	Freq_Watt UnderFreqPowerRate	2	%		Freq_Watt PowerRiseSpeed	100.0	%···	
38	Freq_Watt PowerFallSpeed	100.0	%···					

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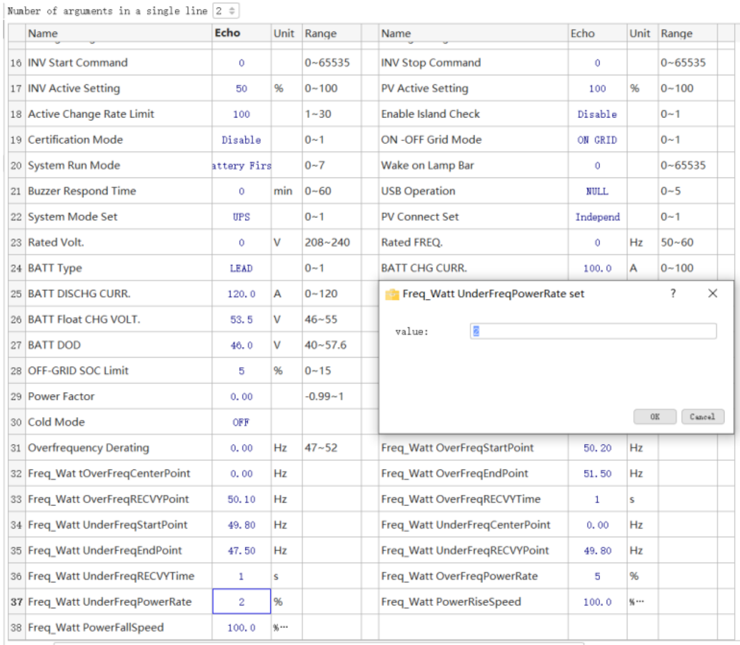
The following is a screenshot of the software where the over-frequency derating threshold can be set:



Number of arguments in a single line 2

	Name	Echo	Unit	Range	Name	Echo	Unit	Range
16	INV Start Command	0		0~65535	INV Stop Command	0		0~65535
17	INV Active Setting	50	%	0~100	PV Active Setting	100	%	0~100
18	Active Change Rate Limit	100		1~30	Enable Island Check	Disable		0~1
19	Certification Mode	Disable		0~1	ON -OFF Grid Mode	ON GRID		0~1
20	System Run Mode	attery Firs		0~7	Wake on Lamp Bar	0		0~65535
21	Buzzer Respond Time	0	min	0~60	USB Operation	NULL		0~5
22	System Mode Set	UPS		0~1	PV Connect Set	Independ		0~1
23	Rated Volt.	0	V	208~240	Rated FREQ.	0	Hz	50~60
24	BATT Type	LEAD		0~1	BATT CHG CURR.	100.0	A	0~100
25	BATT DISCHG CURR.	120.0	A	0~120				
26	BATT Float CHG VOLT.	53.5	V	46~55				
27	BATT DOD	46.0	V	40~57.6				
28	OFF-GRID SOC Limit	5	%	0~15				
29	Power Factor	0.00		-0.99~1				
30	Cold Mode	OFF						
31	Overfrequency Derating	0.00	Hz	47~52	Freq_Watt OverFreqStartPoint	50.20	Hz	
32	Freq_Wat tOverFreqCenterPoint	0.00	Hz		Freq_Watt OverFreqEndPoint	51.50	Hz	
33	Freq_Watt OverFreqRECVYPoint	50.10	Hz		Freq_Watt OverFreqRECVYTime	1	s	
34	Freq_Watt UnderFreqStartPoint	49.80	Hz		Freq_Watt UnderFreqCenterPoint	0.00	Hz	
35	Freq_Watt UnderFreqEndPoint	47.50	Hz		Freq_Watt UnderFreqRECVYPoint	49.80	Hz	
36	Freq_Watt UnderFreqRECVYTime	1	s		Freq_Watt OverFreqPowerRate	5	%	
37	Freq_Watt UnderFreqPowerRate	2	%		Freq_Watt PowerRiseSpeed	100.0	%…	
38	Freq_Watt PowerFallSpeed	100.0	%…					

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Annex D.7.1	Voltage support by reactive power		P
Fix Power factor (PF) generation mode			
Case A: Tested at 0.85 time of Nominal voltage (0.85Un)			
P/S_{max} (%)	10	50	100*
Cosφ Set, Generation	0.8000 un	0.8000 un	0.8000 un
Tested cosφ	0.8058 un	0.7995 un	0.7989 un
Tested voltage(V)	195.5	195.5	195.7
Active power P (W)	587	2983	4009
Reactive power Q(Var)	-431	-2241	-3019
Apparent power S (VA)	729	3731	5019
Deviation ΔQ within 2%S_{max}	-	0.15%	0.50%
P/S_{max} (%)	10	50	100*
Cosφ Set, Generation	0.8000 ov	0.8000 ov	0.8000 ov
Tested cosφ	0.8031 ov	0.8040 ov	0.8056 ov
Tested voltage(V)	195.6	195.7	195.8
Active power P (W)	618	3059	4087
Reactive power Q(Var)	458	2262	3005
Apparent power S (VA)	769	3805	5073
Deviation ΔQ within 2%S_{max}	-	0.21%	0.82%
Case B: Tested at 0.90 time of Nominal voltage (0.90Un)			
P/S_{max} (%)	10	50	100*
Cosφ Set, Generation	0.8000 un	0.8000 un	0.8000 un
Tested cosφ	0.8015 un	0.8042 un	0.7999 un
Tested voltage(V)	207.0	207.2	207.3
Active power P (W)	583	2992	4281
Reactive power Q(Var)	-435	-2211	-3212
Apparent power S (VA)	728	3721	5352
Deviation ΔQ within 2%S_{max}	-	0.65%	0.36%
P/S_{max} (%)	10	50	100*
Cosφ Set, Generation	0.8000 ov	0.8000 ov	0.8000 ov
Tested cosφ	0.8064 ov	0.8044 ov	0.8055 ov
Tested voltage(V)	207.0	207.2	207.3
Active power P (W)	613	3056	4307
Reactive power Q(Var)	450	2257	3169
Apparent power S (VA)	760	3799	5348
Deviation ΔQ within 2%S_{max}	-	0.11%	1.08%
Case C: Tested at Nominal voltage (1.00Un)			
P/S_{max} (%)	10	50	100*
Cosφ Set, Generation	0.8000 un	0.8000 un	0.8000 un

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Tested cosφ	0.8012 un	0.8008 un	0.8013 un
Tested voltage(V)	230.0	230.2	230.3
Active power P (W)	636	3060	4837
Reactive power Q(Var)	-475	-2289	-3612
Apparent power S (VA)	793	3821	6037
Deviation ΔQ within 2%S_{max}	-	-0.64%	0.11%
P/S_{max} (%)	10	50	100*
Cosφ Set, Generation	0.8000 ov	0.8000 ov	0.8000 ov
Tested cosφ	0.8036 ov	0.8056 ov	0.8044 ov
Tested voltage(V)	230.1	230.2	230.3
Active power P (W)	602	3039	4851
Reactive power Q(Var)	446	2235	3582
Apparent power S (VA)	749	3772	6030
Deviation ΔQ within 2%S_{max}	-	-0.25%	0.38%
Case D: Tested at 1.10 time of Nominal voltage (1.10Un)			
P/S_{max} (%)	10	50	100*
Cosφ Set, Generation	0.8000 un	0.8000 un	0.8000 un
Tested cosφ	0.8056 un	0.8007 un	0.7981 un
Tested voltage(V)	253.0	253.2	253.2
Active power P (W)	620	3014	4776
Reactive power Q(Var)	-456	-2255	-3606
Apparent power S (VA)	770	3764	5984
Deviation ΔQ within 2%S_{max}	-	0.09%	-0.40%
P/S_{max} (%)	10	50	100*
Cosφ Set, Generation	0.8000 ov	0.8000 ov	0.8000 ov
Tested cosφ	0.8011 ov	0.8041 ov	0.8036 ov
Tested voltage(V)	253.1	253.2	253.3
Active power P (W)	644	3019	4828
Reactive power Q(Var)	481	2233	3576
Apparent power S (VA)	804	3755	6009
Deviation ΔQ within 2%S_{max}	-	-0.53%	-0.75%
Fix Reactive power Q(Var) generation mode			
Case A: Tested at 0.85 time of Nominal voltage (0.85Un)			
P/S_{max} (%)	10	50	100*
Q set value generation	Q=60%S_{max} (under-excited)	Q=60%S_{max} (under-excited)	Q=60%S_{max} (under-excited)
Tested cosφ	0.1727 un	0.6320 un	0.6974 un
Tested voltage(V)	195.5	195.7	195.7
Active power P (W)	626	2972	3557

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Reactive power Q(Var)	-3568	-3645	-3655
Apparent power S (VA)	3623	4703	5100
Deviation ΔQ within 2%S_{max}	-	-0.74%	-0.91%
P/S_{max} (%)	10	50	100*
Cosφ Set, Generation	Q=60%S_{max} (over-excited)	Q=60%S_{max} (over-excited)	Q=60%S_{max} (over-excited)
Tested cosφ	0.1592 ov	0.6407 ov	0.7102 ov
Tested voltage(V)	195.6	195.8	195.8
Active power P (W)	588	3040	3655
Reactive power Q(Var)	3645	3643	3623
Apparent power S (VA)	3692	4745	5147
Deviation ΔQ within 2%S_{max}	-	0.72%	0.39%
Case B: Tested at 0.90 time of Nominal voltage (0.90Un)			
P/S_{max} (%)	10	50	100*
Cosφ Set, Generation	Q=60%S_{max} (under-excited)	Q=60%S_{max} (under-excited)	Q=60%S_{max} (under-excited)
Tested cosφ	0.1694 un	0.6380 un	0.7408 un
Tested voltage(V)	207.0	207.2	207.3
Active power P (W)	610	2983	4015
Reactive power Q(Var)	-3547	-3601	-3640
Apparent power S (VA)	3599	4676	5419
Deviation ΔQ within 2%S_{max}	-	-0.01%	-0.67%
P/S_{max} (%)	10	50	100*
Cosφ Set, Generation	Q=60%S_{max} (over-excited)	Q=60%S_{max} (over-excited)	Q=60%S_{max} (over-excited)
Tested cosφ	0.1740 ov	0.6402 ov	0.7497 ov
Tested voltage(V)	207.1	207.2	207.3
Active power P (W)	643	3031	4078
Reactive power Q(Var)	3641	3638	3601
Apparent power S (VA)	3698	4735	5439
Deviation ΔQ within 2%S_{max}	-	0.63%	0.02%
Case C: Tested at Nominal voltage (1.00Un)			
P/S_{max} (%)	10	50	100*
Cosφ Set, Generation	Q=60%S_{max} (under-excited)	Q=60%S_{max} (under-excited)	Q=60%S_{max} (under-excited)
Tested cosφ	0.1733 un	0.6462 un	0.7987 un
Tested voltage(V)	230.0	230.1	230.2
Active power P (W)	621	3049	4827
Reactive power Q(Var)	-3531	-3601	-3637
Apparent power S (VA)	3586	4719	6044
Deviation ΔQ within 2%S_{max}	-	-0.02%	-0.62%

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P/S_{max} (%)	10	50	100*
Cosφ Set, Generation	Q=60%S_{max} (over-excited)	Q=60%S_{max} (over-excited)	Q=60%S_{max} (over-excited)
Tested cosφ	0.1730 ov	0.6393 ov	0.8006 ov
Tested voltage(V)	230.1	230.2	230.0
Active power P (W)	632	3019	4809
Reactive power Q(Var)	3597	3631	3602
Apparent power S (VA)	3652	4722	6007
Deviation ΔQ within 2%S_{max}	-	0.51%	0.03%
Case D: Tested at 1.10 time of Nominal voltage (1.10Un)			
P/S_{max} (%)	10	50	100*
Cosφ Set, Generation	Q=60%S_{max} (under-excited)	Q=60%S_{max} (under-excited)	Q=60%S_{max} (under-excited)
Tested cosφ	0.1697 un	0.6520 un	0.8020 un
Tested voltage(V)	253.0	253.0	253.1
Active power P (W)	604	3072	4828
Reactive power Q(Var)	-3506	-3572	-3595
Apparent power S (VA)	3558	4711	6019
Deviation ΔQ within 2%S_{max}	-	0.46%	0.08%
P/S_{max} (%)	10	50	100*
Cosφ Set, Generation	Q=60%S_{max} (over-excited)	Q=60%S_{max} (over-excited)	Q=60%S_{max} (over-excited)
Tested cosφ	0.1645 ov	0.6429 ov	0.8005 ov
Tested voltage(V)	253.1	253.1	253.2
Active power P (W)	609	3059	4840
Reactive power Q(Var)	3650	3644	3624
Apparent power S (VA)	3701	4758	6046
Deviation ΔQ within 2%S_{max}	-	0.74%	0.40%
Remark: “ * ” means that the active power does not reach the set value due to the apparent power limitation.			

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Annex D.7.1.2	Power related Control mode					P
Maximal active power P_{max} with the tested displacement factor (W)						5400
Set point 1: P=0 P_{Emax}, cosφ=1 Set point 2: P=0.5 P_{Emax}, cosφ=1 Set point 3: P=1 P_{Emax}, cosφ=0.9 under-excited						
Percentage of output active power P/P_{max} (%)	Measured active power P (W)	Measured apparent power S (VA)	Measured reactive power Q(Var)	Measured displacement factor cosφ	Displacement factor as to feature curve	Whether the accuracy fulfill according to clause 4.7.2.2 (± 2% S_{max})
10%	585	585	12	0.9997	1.000	Yes
20%	1200	1200	-11	0.9999	1.000	Yes
30%	1819	1819	-34	0.9998	1.000	Yes
40%	2428	2429	-60	0.9996	1.000	Yes
50%	3041	3042	-84	0.9962	1.000	Yes
60%	3643	3693	-605	0.9864 un	0.980 un	Yes
70%	4270	4452	-1261	0.9590 un	0.960 un	Yes
80%	4781	5098	-1770	0.9378 un	0.940 un	Yes
90%	5409	5879	-2304	0.9199 un	0.920 un	Yes
100%*	5405	6009	-2626	0.8994 un	0.900 un	Yes
90%	5408	5878	-2301	0.9201 un	0.920 un	Yes
80%	4701	5024	-1772	0.9357 un	0.940 un	Yes
70%	4271	4453	-1260	0.9591 un	0.960 un	Yes
60%	3646	3697	-608	0.9863 un	0.980 un	Yes
50%	3045	3047	-85	0.9996	1.000	Yes
40%	2430	2431	-56	0.9997	1.000	Yes
30%	1764	1764	-34	0.9998	1.000	Yes
20%	1184	1184	-10	0.9999	1.000	Yes
10%	583	584	12	0.9997	1.000	Yes
Remark: " * " means that the active power does not reach the set value due to the apparent power limitation.						

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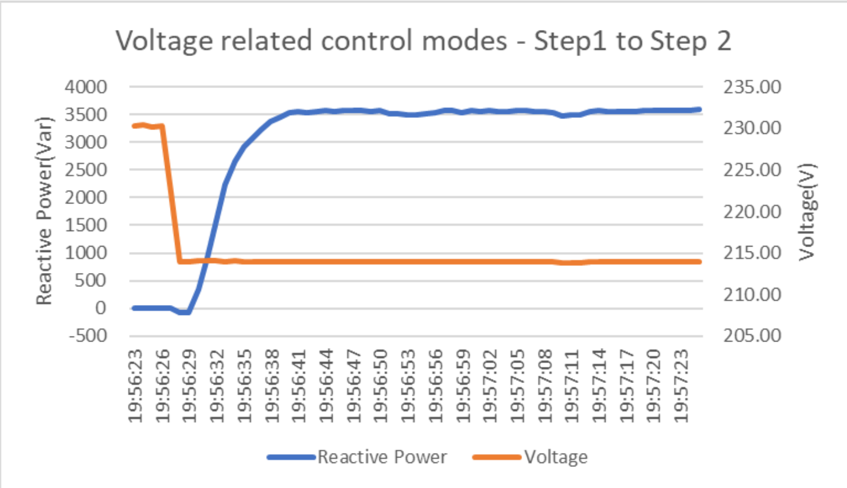
Annex D.7.1.2	Voltage related control modes	P
The dynamics of the Response control time		

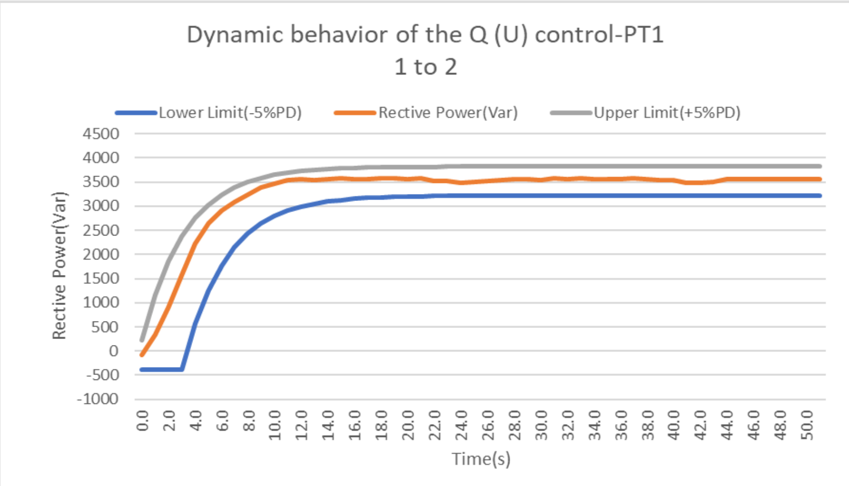
Set fixed P=0.5 S_{max}, the setting response time is __10__ s (the setting should within the range of 3s to 60s), change the voltage by steps:

1) 1.00 Un, stable operation
2) 0.93 Un, 30s
3) 1.07 Un, 30s
4) 1.00 Un, 30s

Step from 1) to 2)

Response curve:





Start reactive power Q_s (Var)	11
Target reactive power Q_T (Var)	3611
Measured reactive power Q (Var)	3562
$\Delta Q/P_D(\%P_D)$	1.02%
Response time	9.8 s

Step from 2) to 3)

Response curve:

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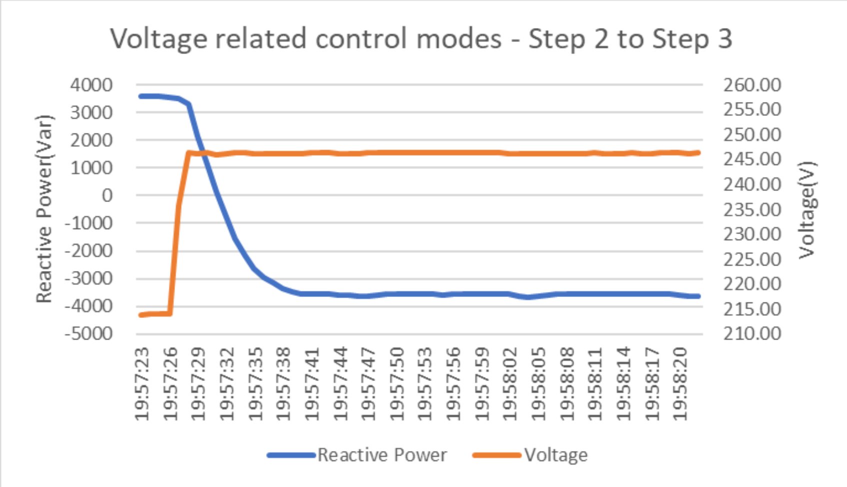
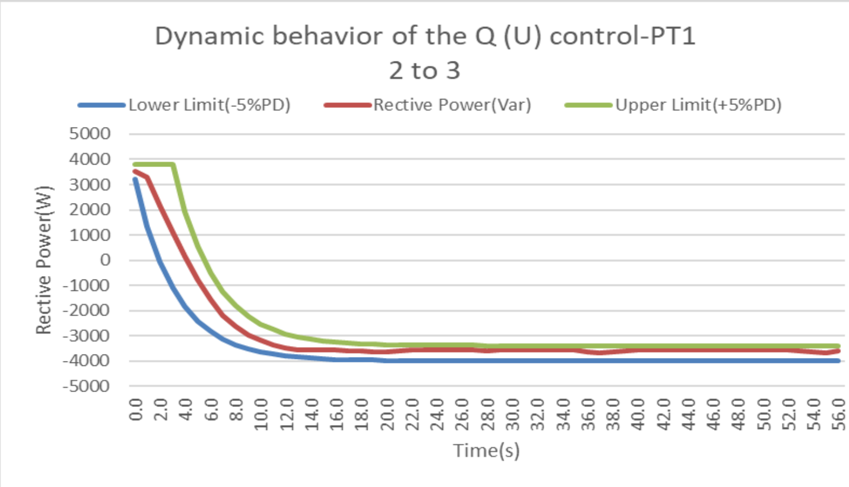
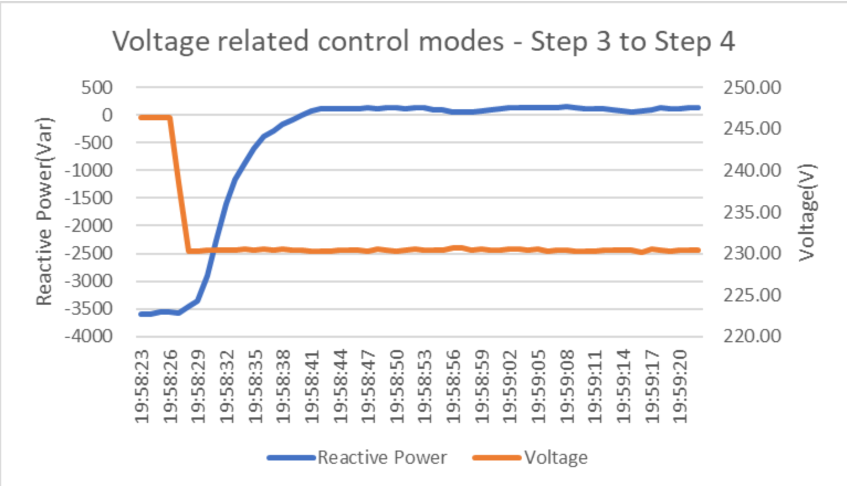




Start reactive power Q_S (Var)	3549
Target reactive power Q_T (Var)	-3651
Measured reactive power Q (Var)	-3559
$\Delta Q/P_D(\%P_D)$	1.92%
Response time	9.6 s
Step from 3) to 4)	

Response curve:



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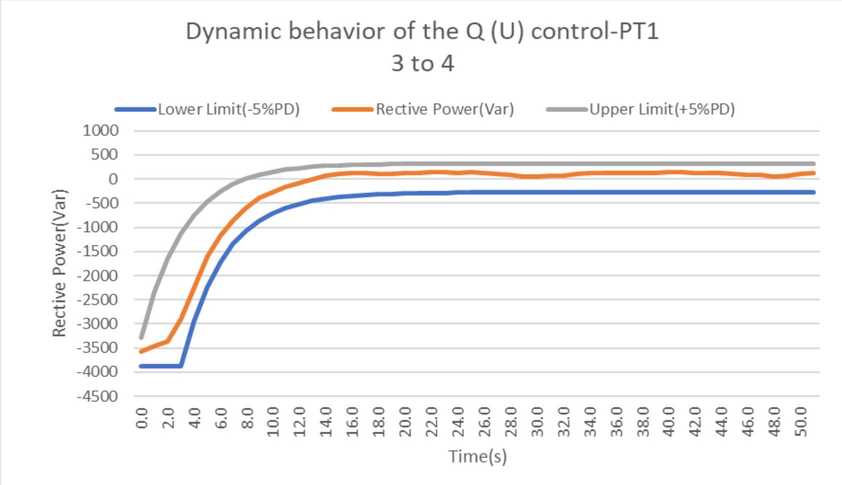

Start reactive power Q_s (Var)	-3549
Target reactive power Q_T (Var)	51
Measured reactive power Q (Var)	130
$\Delta Q/P_D$(%P_D)	1.65%
Response time	9.2 s
Remark: Q(U) control mode, voltage setting is 0.93Un for Qmax, 1.07Un for Qmin.	

The voltage related control modes control the reactive power output

-Q_{max} and Q_{max} is defined by testing in Cl.4.7.2. Fixed active power setting 0.5 S_{max}

Q_{max} at this active power (Var)	±3600

Grid simulator voltage (Un)	Measured Voltage U_{pos} (V)	Measured active power P (W)	Measured apparent power S (VA)	Measured displacement factor cosφ	Measured reactive power Q(Var)	Required reactive power as to feature curve Q(Var)	Deviation of reactive power(Var)
0.91 Un	209.3	2976	4647	0.6403 ov	3570	3600	30
0.93 Un	213.8	2976	4643	0.6409 ov	3564	3600	36
0.95 Un	218.5	2973	3479	0.8544 ov	1808	1800	8
0.97 Un	223.0	2976	2976	0.9999 ov	13	0	13
1.00 Un	230.2	2971	2971	0.9999 ov	38	0	38
1.03 Un	237.1	2973	2973	0.9999 ov	28	0	28
1.05 Un	241.6	2975	3475	0.8561 un	-1796	-1800	4
1.07 Un	246.2	2993	4667	0.6412 un	-3582	-3600	18
1.09 Un	250.9	2987	4674	0.6391 un	-3595	-3600	5
1.07 Un	246.1	2993	4657	0.6428 un	-3567	-3600	33
1.05 Un	241.5	2984	3482	0.8568 un	-1796	-1800	4
1.03 Un	237.0	2970	2970	0.9999 ov	4	0	4
1.00 Un	230.3	2976	2976	0.9999 un	-6	0	6
0.97 Un	223.1	2985	2985	0.9999 ov	7	0	7
0.95 Un	218.6	2969	3473	0.8551 ov	1801	1800	1

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0.93 Un	213.8	2975	4659	0.6385 ov	3586	3600	14
0.91 Un	209.3	2977	4644	0.6410 ov	3565	3600	35

Limit the reactive power at low active power

Qmin						
P/P_{max} [%] Set-point	Vac [V] set-point	P/P_{max} [%] Measured	Vac [V] measured	Q [Var] measured	Q [Var] expected	Δ Q (< ± 2 % S_{max})
< 20 %	1.03 Vn	17.35%	237.0	104	0	1.73%
< 20 %	1.05 Vn	17.32%	241.6	104	0	1.73%
<20 % -> 30 %	1.05 Vn	29.72%	241.6	-1812	-1800	0.20%
50 %	1.05 Vn	49.57%	241.5	-1762	-1800	0.63%
100 %*	1.05 Vn	94.37%	241.5	-1762	-1800	0.63%
100 %*	1.07 Vn	79.18%	246.1	-3579	-3600	0.35%
100 % -> 10 %	1.07 Vn	8.87%	245.9	-3540	-3600	1.00%
P ≤ 5 %	1.07 Vn	3.30%	245.8	57	0	0.95%
Qmax						
P/P_{max} [%] Set-point	Vac [V] set-point	P/P_{max} [%] Measured	Vac [V] measured	Q [Var] measured	Q [Var] expected	Δ Q (< ± 2 % S_{max})
< 20 %	0.97 Vn	17.70%	223.2	1	0	0.02%
< 20 %	0.95 Vn	17.73%	218.5	4	0	0.07%
<20 % -> 30 %	0.95 Vn	29.60%	218.6	1763	1800	0.62%
50 %	0.95 Vn	49.53%	218.5	1813	1800	0.22%
100 %*	0.95 Vn	90.42%	218.6	1796	1800	0.07%
100 %*	0.93 Vn	73.53%	213.8	3582	3600	0.30%
100 % -> 10 %	0.93 Vn	10.38%	213.9	3589	3600	0.18%
P≤ 5 %	0.93 Vn	4.67%	213.9	5	0	0.08%

Remark:
1. Lock-in value setting: 20%Pn, Lock-out value setting: 5%Pn
2. " * " means that the active power does not reach the set value due to the apparent power limitation.

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Annex D7.2	Voltage related active power reduction P(U)	P

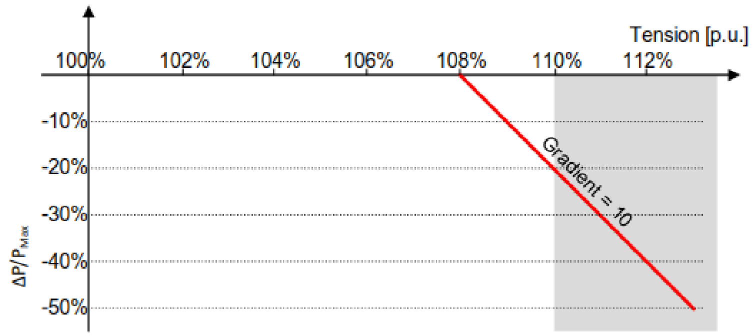

Figure 15 - Example curve for P(U)

Setting active power =100%P_{max}		
Voltage in % of Un	Measured power(W)	Standard power(W)
100%	6041.39	6000
108%	5958.75	6000
110%	4778.65	4800
112%	3558.77	3600
114%	2352.20	2400
116%	1158.74	1200
118%	-53.67	0
Setting active power =50% P_{max}		
Voltage in % of Un	Measured power(W)	Standard power(W)
100%	3004.01	3000
108%	2964.15	3000
110%	1751.75	1800
112%	547.84	600
114%	-49.16	0
116%	-52.75	0
118%	-54.33	0

Response Time	
Active power =100%P_{max}, Sample test from 100%Un to 116%Un the reaching time:	11s
Response curve:	

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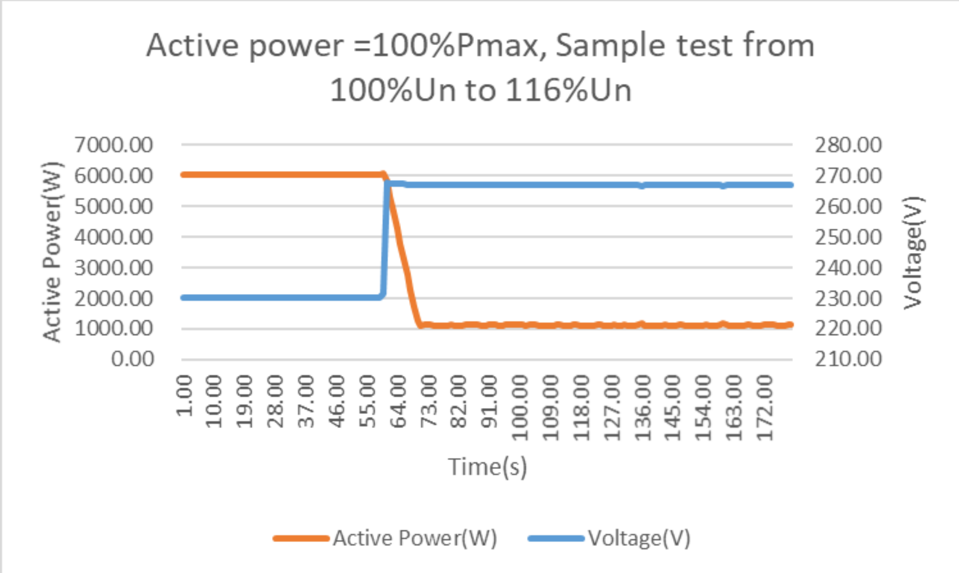
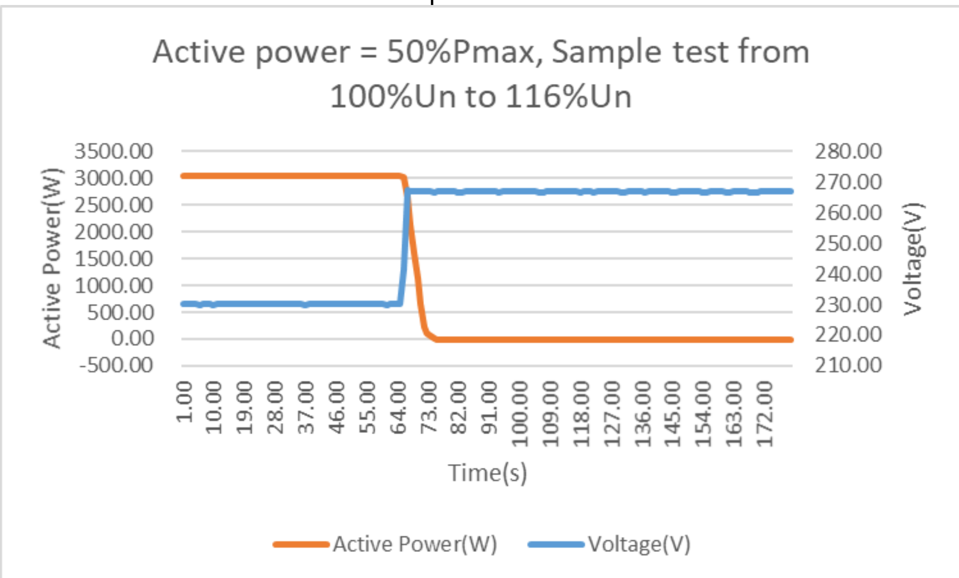


Active power = 50%P_{max}, Sample test from 100%Un to 116%Un the reaching time:	12s

Response curve:



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Annex D8	Connection and reconnection		P
	Setting values for grid coupling protection in the low-voltage grid		
Test procedure	a)	f=49.85Hz, no reconnection allowed	Yes
	b)	f=49.95Hz, reconnection allowed	Yes
	c)	f=50.15Hz, no reconnection allowed	Yes
	d)	f=50.05Hz, reconnection allowed	Yes
	e)	U=84% Un, no reconnection allowed	Yes
	f)	U=86% Un, reconnection allowed	Yes
	g)	U=111% Un, no reconnection allowed	Yes
	h)	U=109% Un, reconnection allowed	Yes
Record the reconnection power at above step d, if reconnection is successful			

Test sequence	Freq (Hz)	Time after reconnection	Measured active output power $P_{measure}$ (W)	ΔP/Pn Arise during next 1 min	Gradient of arising powerΔP/t under 10% Pmax (Yes/No)
1	50.05	0.0min	109	9.87%	Yes
2	50.05	0.5min	405	9.47%	Yes
3	50.05	1.0min	701	9.33%	Yes
4	50.05	1.5min	973	9.28%	Yes
5	50.05	2.0min	1261	9.20%	Yes
6	50.05	2.5min	1530	9.37%	Yes
7	50.05	3.0min	1813	9.25%	Yes
8	50.05	3.5min	2092	9.27%	Yes
9	50.05	4.0min	2368	9.35%	Yes
10	50.05	4.5min	2648	9.40%	Yes
11	50.05	5.0min	2929	9.37%	Yes
12	50.05	5.5min	3212	9.32%	Yes
13	50.05	6.0min	3491	9.27%	Yes
14	50.05	6.5min	3771	9.27%	Yes
15	50.05	7.0min	4047	9.38%	Yes
16	50.05	7.5min	4327	9.47%	Yes
17	50.05	8.0min	4610	9.45%	Yes
18	50.05	8.5min	4895	9.37%	Yes
19	50.05	9.0min	5177	9.32%	Yes
20	50.05	9.5min	5457	9.20%	Yes
21	50.05	10.0min	5736	5.08%	Yes
22	50.05	10.5min	6009	0.48%	Yes
23	50.05	11.0min	6041	--	--
24	50.05	11.5min	6038	--	--

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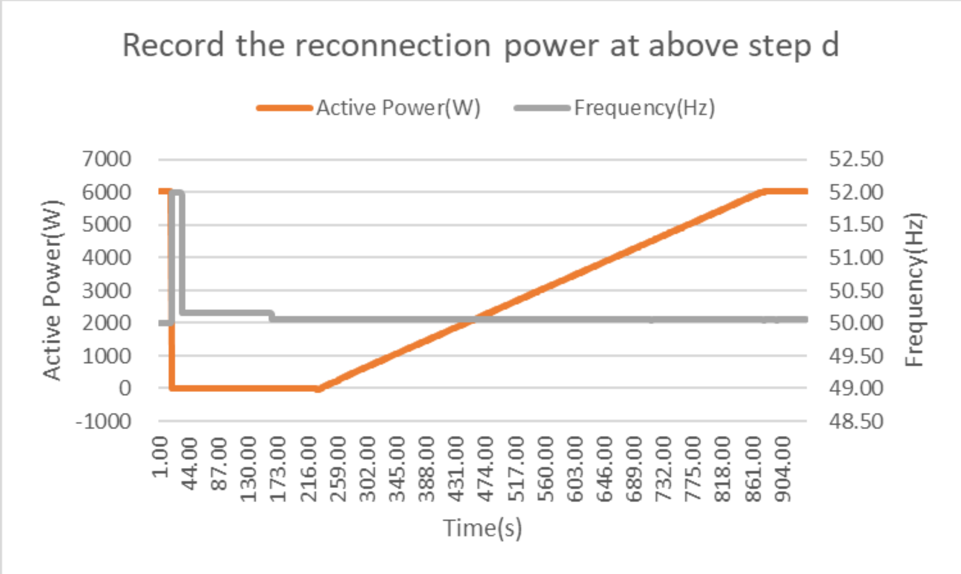

Record the connection power at nominal setting (230Va.c., 50Hz), if reconnection is successful					
Test sequence	Freq (Hz)	Time after reconnection	Measured active output power $P_{measure}$ (W)	ΔP/Pn Arise during next 1 min	Gradient of arising powerΔP/t under 20% Pmax (Yes/No)
1	50.00	0.0min	31	9.80%	Yes
2	50.00	0.5min	336	9.42%	Yes
3	50.00	1.0min	619	9.50%	Yes
4	50.00	1.5min	901	9.33%	Yes
5	50.00	2.0min	1189	9.23%	Yes
6	50.00	2.5min	1461	9.40%	Yes
7	50.00	3.0min	1743	9.27%	Yes
8	50.00	3.5min	2025	9.30%	Yes
9	50.00	4.0min	2299	9.40%	Yes
10	50.00	4.5min	2583	9.28%	Yes
11	50.00	5.0min	2863	9.33%	Yes
12	50.00	5.5min	3140	9.35%	Yes
13	50.00	6.0min	3423	9.27%	Yes
14	50.00	6.5min	3701	9.37%	Yes
15	50.00	7.0min	3979	9.42%	Yes
16	50.00	7.5min	4263	9.32%	Yes
17	50.00	8.0min	4544	9.42%	Yes
18	50.00	8.5min	4822	9.45%	Yes
19	50.00	9.0min	5109	9.30%	Yes
20	50.00	9.5min	5389	9.30%	Yes
21	50.00	10.0min	5667	6.17%	Yes
22	50.00	10.5min	5947	1.50%	Yes
23	50.00	11.0min	6037	--	--

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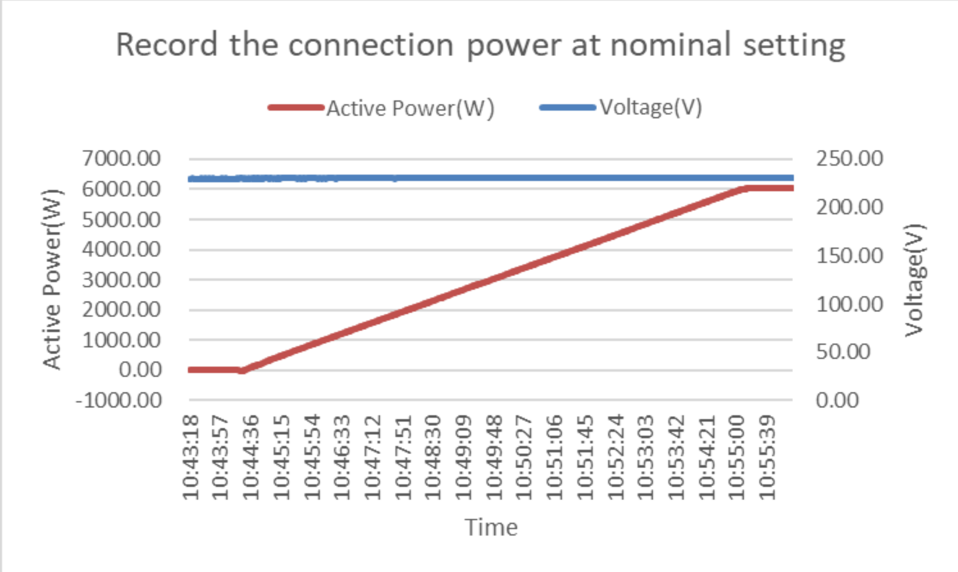
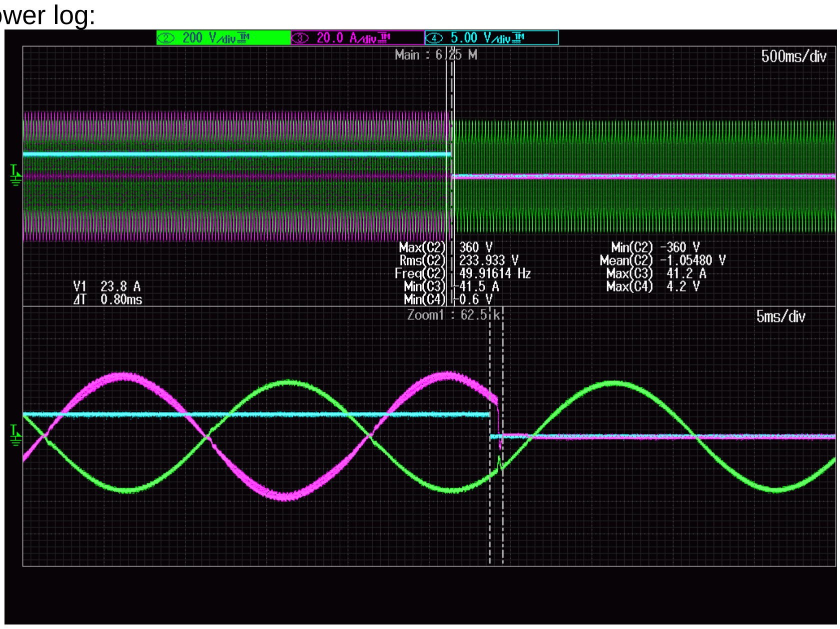
24	50.00	11.5min	6037	--	--



Annex D.9.1	Ceasing active power	P

Logic interface provided?	Yes
Ceasing active power response time	0.80 ms
stop the generation of active power time	0.80 ms

Ceasing active power log:



Green waveform [V]: grid voltage signal.

Purple waveform [A]: inverter current signal.

Blue waveform [V]: command trigger signal.

. ……………………………..…………………End of test report……………………..……………………………..

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