LYNS-TCi

TEST REPORT

Engineering Recommendation G99

Issue 1 – Amendment 9

Requirements for the connection of generation equipment in parallel with public distribution networks on or after 27 April 2019

Shenzhen Atess Power Technology Co., Ltd

For the unit(s) **HPS30, HPS50**

Test report no. **HC23072104-EG-UK-001**

Date **2023-08-21**

ilac-MRA ACCREDITED Certificate # 5200.02

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Test report number.....:	**HC23072104-EG-UK-001**
Date of issue.....:	2023-08-21
Total number of pages.....:	56
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Testing location / address.....:	Same as above
Applicant's name .....:	**Shenzhen Atess Power Technology Co., Ltd**
Address.....:	2nd Floor, No.23 Zhulongtian Road, Shuitian Community, Shiyan Street, Baoan District, Shenzhen, China
Test specification	
Standard .....:	Engineering Recommendation G99 Issue 1 – Amendment 9 3 October 2022 Requirements for the connection of generation equipment in parallel with public distribution networks on or after 27 April 2019
Test report form number.....:	EREC G99_v1.0
Test report form(s) originator.....:	Lyns-tci Technology Guangdong Co., Ltd.
Master TRF.....:	Dated 2022-02-01
Test item description.....:	Device Category: **Inverter** Device Type: **Hybrid Inverter (PV + DC coupled Electricity Storage)**
Trademark .....:	ATESS
Model / Type reference.....:	HPS30, HPS50
Technical data .....:	See section 3.1 on p.8
Dates of testing.....:	2023-08-01 - 2023-08-19

Tested / Report prepared by

Allen

Allen Zhang (Test engineer)

Approved by

LYNS-TCi TECHNOLOGY

Lukes Lin (Project manager)

Contents

1 General information of test report

1.1 Important Note

General disclaimer

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1.2 Revision history

Report version	Date	Editor	Modification / Change	Status
HC23072104-EG-UK-001	2023-08-21	Allen Zhang	Initial report was written	Active

2 General remarks for documentation

The test results presented in this report relate only to the object(**s**) tested.

Throughout this report a ☐ comma ',' / ☒ point '.' is used as decimal separator and a ☐ point '.' / ☒ comma ',' as thousands separator.

The following **suffixes/indices** are used for variables in tables and figures:

n	Nominal value
max	Maximum value
Lx	index of phase x
LxLy	phase-to-phase voltages of phase x and phase y

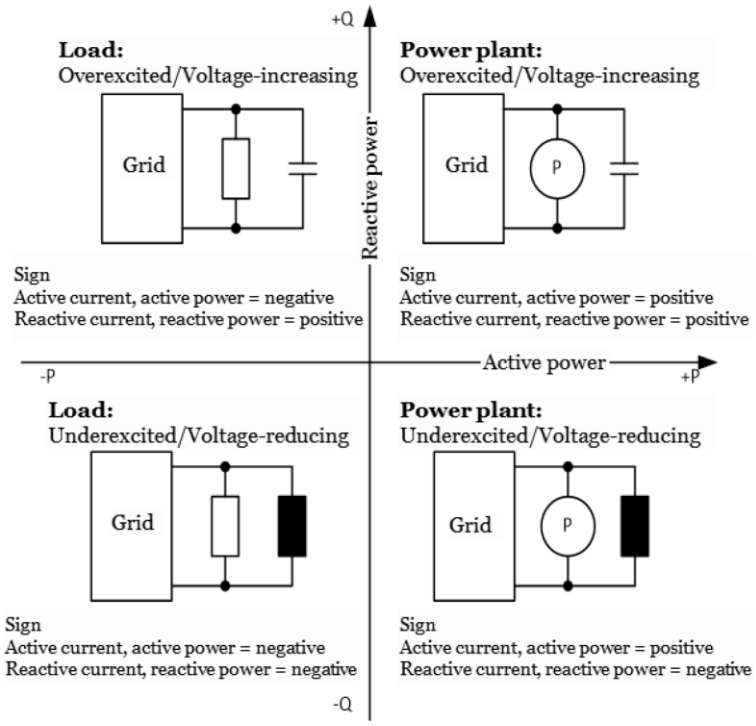
Abbreviations

AC	:	Alternating Current
DC	:	Direct Current
EUT	:	Equipment Under Test
LV	:	Low Voltage
MP	:	Measurement Point
MPP	:	Maximum Power Point
MV	:	Medium Voltage
PGF	:	Power Generating Facility
PGM	:	Power Generating Module
PGU	:	Power Generating Unit
P_{max}	:	Registered Capacity
PPM	:	Power Park Module
PWHD	:	Partial Weighted Harmonic Distortion
THD	:	Total Harmonic Distortion
PWHD	:	Partial Weighted Harmonic Distortion

Direction definition of P and Q

in this test report, the regarded system of the voltage and current vectors is the active sign convention system:

- If the inverter feeds to the grid the active power is measured with positive sign.
- If the inverter injects reactive power / current with leading power factor the reactive power / current is marked “leading” or “inductive” (under-excited) or has a negative sign.
- If the inverter injects reactive power / current with lagging power factor the reactive power / current is marked “lagging” or “capacitive” (over-excited) or has a positive sign.



3 General product information

Factory's name ..... : Shenzhen Atess Power Technology Co., Ltd.

Factory address ..... : 2nd Floor, No.23 Zhulongtian Road, Shuitian Community, Shiyan Street, Baoan District, Shenzhen, China

3.1 Technical data of the unit(s)

Unit / Type ..... :	**HPS30**	**HPS50**
Hardware version (tested) ..... :	SSCP HW V1.1.1	
Software version (tested) ..... :	HPS30K 150K HV3 SV4.1.14 APP	
DC input (PV)		
Max. DC input voltage [V]..... :	1000	
Operating MPPT voltage range [V] ..... :	480 ~ 800	
Input DC current [A]..... :	max. 90	max. 136
Battery connection		
Battery voltage range [V] ..... :	352 ~ 600	
Battery charging current [A]..... :	max. 100	max. 150
Battery discharging current [A] ..... :	max. 93	max. 156
Battery charging power [kW] ..... :	45.0	75.0
Battery discharging power [kW]..... :	33.0	55.0
AC connection		
Nominal output AC voltage [V] ..... :	230/400 (3~ + N + PE, 50/60 Hz)	
Output AC current [A] ..... :	max. 47.0	max. 79.0
Nominal active output power P_n [kW] .... :	30.0	50.0
Registered Capacity [1] P_{max} [kW]	30.0	50.0
Max. apparent power [kVA] ..... :	33.0	55.0

Note:

The Power Park Modules (Generating Units) considered in this report are designed to be capable of operating within the range ±0.95 Power Factor at Registered Capacity.

- Max. operating range of Power Factor at Registered Capacity:
  0.909 lagging to 0.909 leading
- Setting range of the Power Factor:
  0.800 lagging to 0.800 leading

[1] In this report, the stated values of "registered capacity" related to single Generating Unit.

Datasheet of the generating units:

Note:
the units *HPS100*, *HPS120* and *HPS150* are not considered in this test report.

Model	HPS30
PV parameter	
PV rated power	33KW
Max. PV power	45KW
Max. PV open circuit voltage	1000V
PV MPPT voltage range	480Vdc-800Vdc
Max.PV input current	90A
Battery parameter	
Battery operating voltage range	352V-600V
Max battery charge current	100A
Max battery discharge current	93A
Max battery charge power	45KW
Max battery discharge power	33kw
AC output parameter	
Rated voltage	400Vac
Rated current	43A
Rated power	30KW
Rated frequency	50/60Hz
Frequency Range	45-55Hz/55-65Hz
Max. AC output power	33KVA
Max. AC input power	60KVA
Power factor	0.8lagging—0.8leading
THDI	<3%(Full load)
THDU	≤2%
Overload capacity	110%-10 mins,120%-1 min
Other parameter	
Ingress Protection	IP20(Outdoors)
Protective class	Class I
Mains over voltage category	OVC III
PV over voltage category	OVC II
Demand response mode	DRM0-8 (optional)
Inverter toplogy	Isolated
Noise emission	<65dB (A) @1m
Cooling	Intelligent air cooling
Humidity	0%-95% non-condensing
Maximum altitude	6000 (derate over 3000m)
Build-in transformer	yes
Operating temperature	-25℃-+55℃
Active anti-islanding method	Shifting the frequency of the inverter away from nominal conditions in the absence of a reference frequency (frequency shift)
Communication	
LCD display	Touch screen LCD
Communication interface	RS485/CAN

Model	HPS50	HPS100	HPS120	HPS150
PV parameter				
PV rated power	55KW	110KW	132KW	165KW
Max. PV power	75KW	150KW	180KW	225KW
Max. PV open circuit voltage	1000V	1000V	1000V	1000V
PV MPPT voltage range	480Vdc-800Vdc			
Max.PV input current	136A	230A	327A	409A
Battery parameter				
Battery operating voltage range	352V-600V			
Max battery charge current	150A	300A	350A	450A
Max battery discharge current	156A	313A	374A	467A
Max battery charge power	75KW	150KW	180KW	225KW
Max battery discharge power	55kw	110kw	132kw	165kw
AC output parameter				
Rated voltage	400Vac			
Rated current	72A	144A	173A	217A
Rated power	50KW	100KW	120KW	150KW
Rated frequency	50/60Hz			
Frequency Range	45-55Hz/55-65Hz			
Max. AC output power	55KVA	110KVA	132KVA	165KVA
Max. AC input power	100KVA	200KVA	240KVA	240KVA
Power factor	0.8lagging—0.8leading			
THDI	<3%(Full load)			
THDU	≤2%			
Overload capacity	110%-10 mins,120%-1 min			
Other parameter				
Ingress Protection	IP20(Outdoors)			
Protective class	Class I			
Mains over voltage category	OVC III			
PV over voltage category	OVC II			
Demand response mode	DRM0-8 (optional)			
Inverter toplogy	Isolated			
Noise emission	<65dB A @1m			
Cooling	Intelligent air cooling			
Humidity	0%-95% non-condensing			
Maximum altitude	6000 (derate over 3000m)			
Build-in transformer	yes			
Operating temperature	-25 -+55			
Active anti-islanding method	Shifting the frequency of the inverter away from nominal conditions in the absence of a reference frequency (frequency shift)			
Communication				
LCD display	Touch screen LCD			
Communication interface	RS485/CAN			

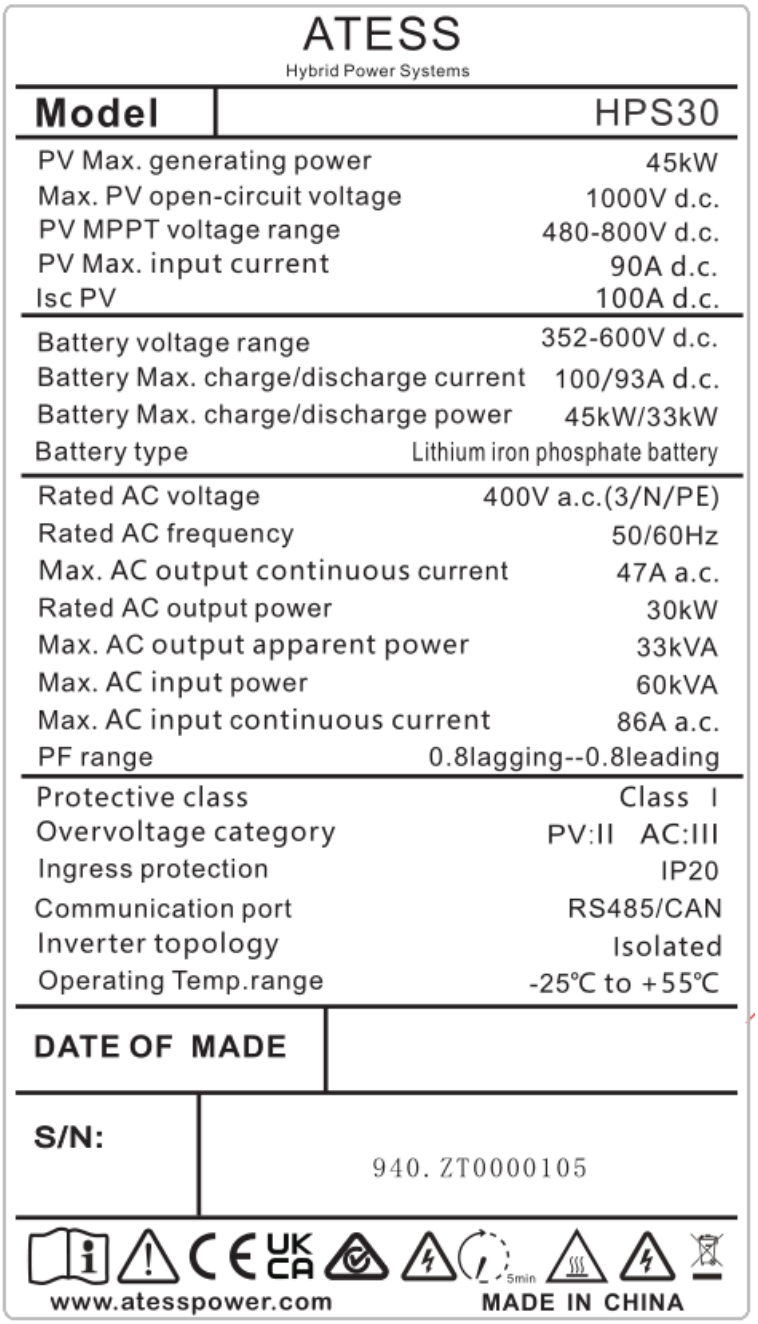
Equipment mobility	:	Permanent connection
Operating condition	:	Continuous
Class of equipment	:	Class I
Protection against ingress of water	:	IP20 according to EN 60529
Mass of equipment [kg]	:	HPS30: 420kg HPS50: 620kg
Type of internal transformer	:	Internal transformer (transformerless)

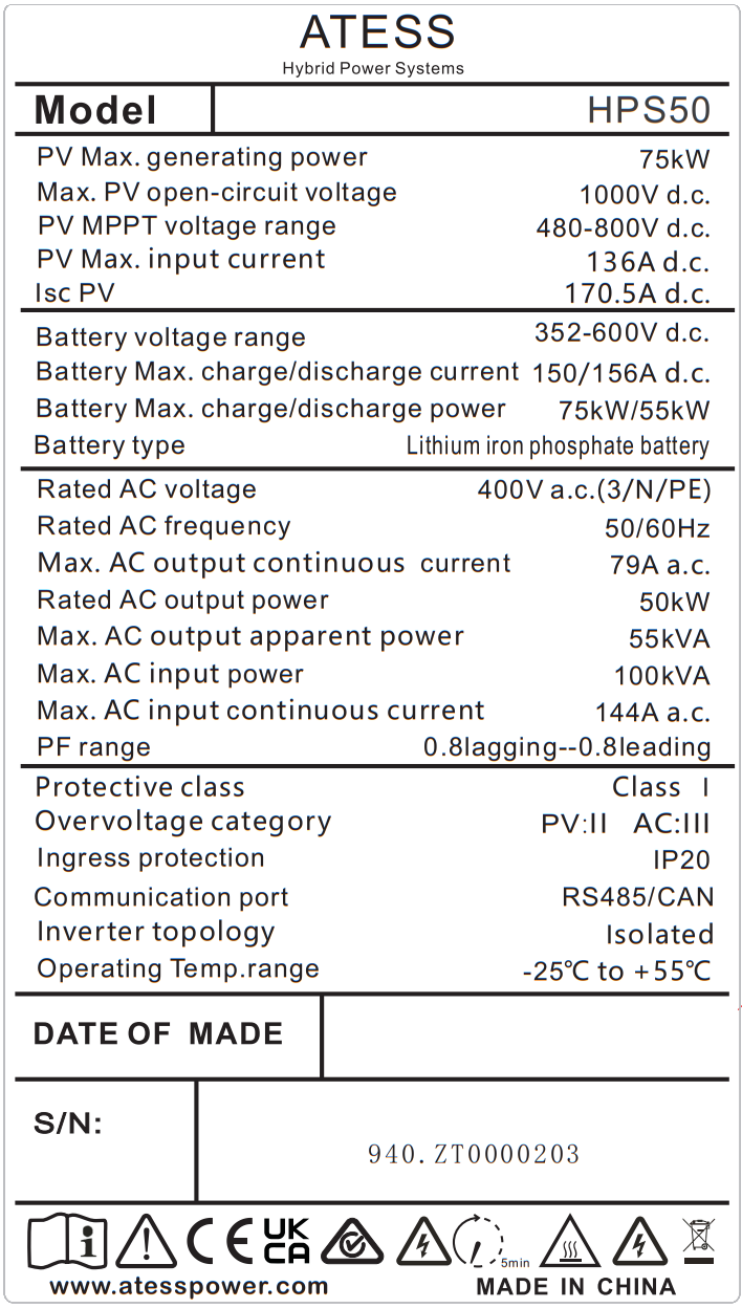
3.2 Description of the differences of the models within the product series

The units in the product series:

- sharing the same control electronics,
- with the same firmware,
- with the same construction solutions including the power part,
- with the same number of phases,
- with the filters and build-in transformers (at the AC output of the inverter) designed for different sizes of power / current ratings.

3.3 Copy of marking plate





ATESS
Hybrid Power Systems

Model	HPS50
PV Max. generating power	75kW
Max. PV open-circuit voltage	1000V d.c.
PV MPPT voltage range	480-800V d.c.
PV Max. input current	136A d.c.
Isc PV	170.5A d.c.
Battery voltage range	352-600V d.c.
Battery Max. charge/discharge current	150/156A d.c.
Battery Max. charge/discharge power	75kW/55kW
Battery type	Lithium iron phosphate battery
Rated AC voltage	400V a.c.(3/N/PE)
Rated AC frequency	50/60Hz
Max. AC output continuous current	79A a.c.
Rated AC output power	50kW
Max. AC output apparent power	55kVA
Max. AC input power	100kVA
Max. AC input continuous current	144A a.c.
PF range	0.8lagging--0.8leading
Protective class	Class I
Overvoltage category	PV:II AC:III
Ingress protection	IP20
Communication port	RS485/CAN
Inverter topology	Isolated
Operating Temp.range	-25℃ to +55℃
DATE OF MADE	
S/N:	940. ZT0000203

5min

www.atesspower.com MADE IN CHINA

Note:

The marking plates shown above may be only a draft. The use of certification marks on products must be approved by the respective NCBs to which these marks belong.

The marking plate is attached to the side surface or the back of the enclosure and is visible after installation.

3.4 Description of the power circuit

The Hybrid inverter input voltage supply can be supplied DC voltage by PV array or Battery, and the output can connect to the grid, load.

The units are three-phase.

The input and output are protected by SPDs (MOVs) to Earth. The unit is providing EMI filtering at the PV input and output toward mains.

The internal control is redundant built. It consists of Master DSP (U33) and slave DSP (33).

The master DSP which can control the relays by switching signals; measures the voltage, frequency ,and AC current.

The slave DSP is user for detecting grid voltage, grid frequency and residual current, also can open the relay, and communicate with Main DSP each other.

The unit provides two relays in series on each phase. When single fault applied to one relay, an error code will appear on display panel, another redundant relay provides basic insulation maintained between the PV array and the mains. All the relays are tested before starting up. Both DSPs can open the relays.

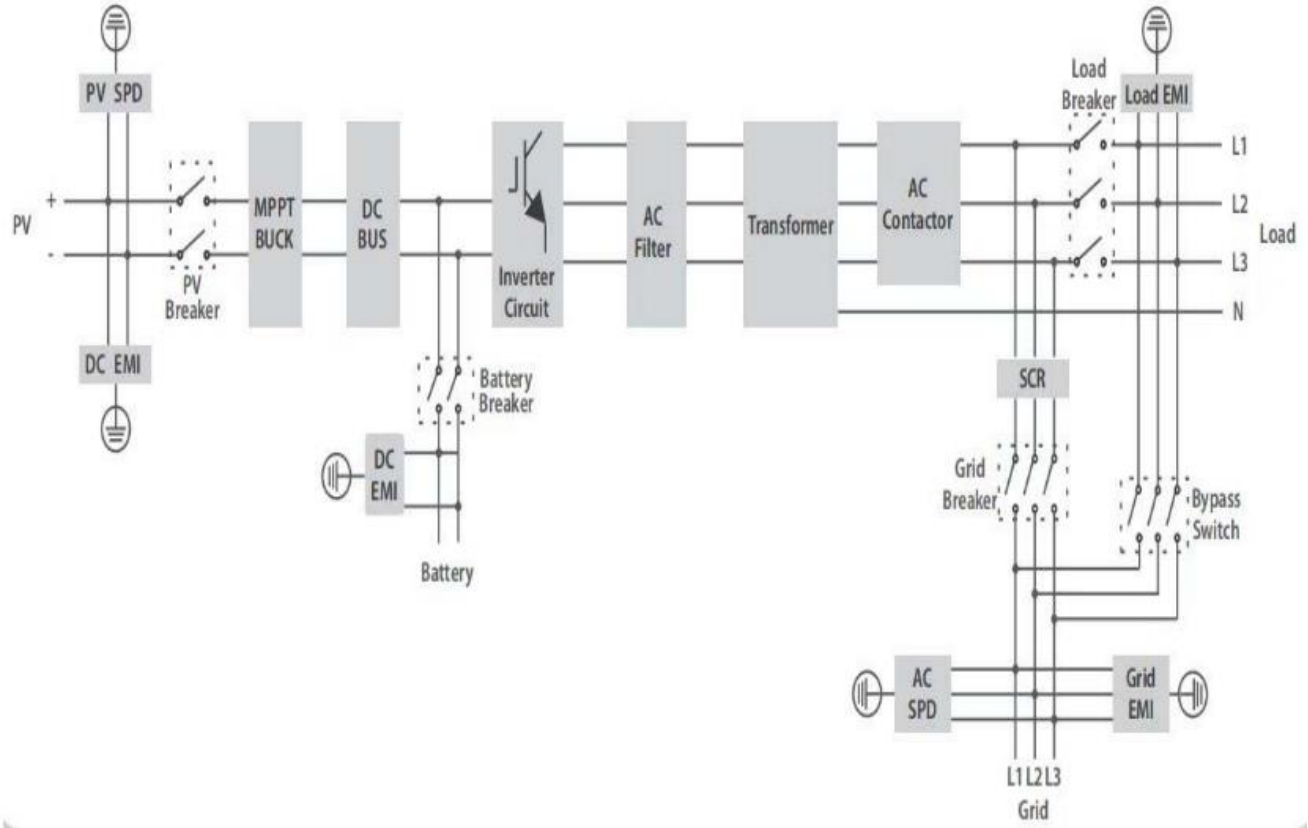


Figure 1 – Block diagram of the power circuit

4 General remarks for testing

4.1 PGM categories

According to definition of the standard the PGUs considered in this test report are Type A generating units:

Type A	Type B	Type C	Type D
Voltage level at connection point <110kV			Voltage level at connection point ≥110kV
0.8 kW ≤ P_{max} < 1 MW	1 MW ≤ P_{max} < 10 MW	10 MW ≤ P_{max} < 50 MW	P_{max} ≥ 50 MW
☒	☐	☐	☐

4.2 Energy Conversion Technology

Domestic CHP (1)	Photovoltaic (2) *	Fuel Cells (3)	Hydro (4)	Wind (5)	Electricity Storage devices (6)
☐	☒	☐	☐	☐	☒

Type testing was carried out according to EREC G99, Annex A.7.
The following Additional Technology Requirements according to (depending on the selection in the table above):
(1) A.7.3.1.
(2) A.7.3.2.
(3) A.7.3.3.
(4) A.7.3.4.
(5) A.7.3.5.
(6) A.7.3.6.
have been taken into account.
Measurement results documented according to EREC G99, Form A2-3.

Note:

* Connection scenario:

☐ Photovoltaic Power Park Module connected to the DNO's Distribution Network via an Inverter

☒ Hybrid converter:
Photovoltaic Power Park Module with DC coupled storage unit connected to the DNO's Distribution Network via an Inverter
In this case the Registered Capacity is based on the Inverter rating. The storage unit has no compliance effect, compliance based on the inverter.
The Electricity Storage exceptions according to EREC G99, section A.4.2 do not apply to the Inverter.

4.3 Exceptions

According to EREC G99, Annex A.4:

☐ **Emerging Technology**

the following sections of EREC G99 do not apply:

- 11.2.1 (frequency withstand capability)
- 11.2.2 (rate of change of frequency)
- 11.2.3 (constant Active Power output)
- 11.2.4 (Limited Frequency Sensitive Mode – Overfrequency)
- 10.6.7 (Interface Protection settings).

☐ **Electricity Storage devices commissioned before 01 September 2022**

the following sections of EREC G99 do not apply:

- Type A - less than 1 MW
  - 11.2.3 (constant Active Power output)
  - 11.2.4 (Limited Frequency Sensitive Mode – Over frequency)
- Type B - 1 MW or greater but less than 10 MW
  - 12.2.3 (constant Active Power output)
  - 12.2.4 (Limited Frequency Sensitive Mode – Over frequency)
  - 12.3.1 – 12.3.1.7 inclusive, 12.3.4 and 12.6 (Fault Ride Through, Fast Fault Current injection)
- Type C and Type D - 10 MW or greater and / or with a Connection Point at greater than 110 kV
  - 13.2.3 (constant Active Power output)
  - 13.2.4 (Limited Frequency Sensitive Mode – Over frequency)
  - 13.2.5 (Limited Frequency Sensitive Mode – Under frequency)
  - 13.2.6 (Frequency Sensitive Mode)
  - 13.3 – 13.3.1.11 inclusive, 13.3.4 and 13.6 (Fault Ride Through, Fast Fault Current injection)

☐ **Infrequent Short-Term Parallel Operation**

the following sections of EREC G99 do not apply:

- Type A - less than 1 MW
  - All of Section 11
- Type B - 1 MW or greater but less than 10 MW
  - All of Section 12
- Type C and Type D - 10 MW or greater and / or with a Connection Point at greater than 110 kV
  - All of Section 13

☒ **Other**

No exceptions.

4.4 Scope of measurements

Date of receipt of test items ..... : 2023-08-01

Date(s) of performance of tests ..... : 2023-08-01 - 2023-08-19

During the test period stated above following environmental data were recorded:

- Temperature: 20.3 ~ 25.2°C
- Rel. humidity: 36.5 ~ 57.3%RH
- Air pressure: 985.2 ~ 1003.6 hPa

Test items	Testing requirements (Section EREC G99)	Section in this test report	Tests completed
1. Operating Range	10.3.4, 11.2.1	6.1	☒
2. Harmonics	A.7.1.4.1	6.2	☒
3. Voltage Fluctuation and Flicker	A.7.1.4.3	6.3	☒
4. DC injection	A.7.1.4.4	6.4	☐
5. Power Factor (PF)	A.7.1.4.2	6.5	☒
6. Frequency protection trip and ride through tests	A.7.1.2.1, A.7.1.2.3	6.6.1	☒
7. Voltage protection trip and ride through tests	A.7.1.2.1, A.7.1.2.2	6.6.2	☒
8. Protection – Loss of Mains Test, Vector Shift and RoCoF Stability Test	A.7.1.2.4, A.7.1.2.6	6.6.3, 6.6.4 and 6.6.5	☒
9. LFSM-O Test	A.7.1.3	6.7	☒
10. Protection – Reconnection Timer	A.7.1.2.5	6.8	☒
11. Fault Level Contribution	A.7.1.5	6.9	☒
12. Self-monitoring Solid State Switch	A.7.1.6	6.10	☐
13. Wiring functional tests if required by para 15.2.1 (attach relevant schedule of tests)	15.2.1	6.11	☐
14. Logic Interface (input port)	11.1.3	6.12	☒
15. Cyber security	9.1.7	6.13	☐ [2]
Output power with falling frequency	11.2.3	Test not performed and not documented in this report.	☐

[2] Manufacturer's declaration provided, for details see section 6.13.

Note:

- The tests were performed on EUT HPS50 which provides the highest current / power.
- The product was tested on:
  - Serial No.: TPC0C270BD
  - Hardware Version: SSCP HW V1.1.1
  - Software Version: HPS30K 150K HV3 SV4.1.14 APP

- Measurement done at output terminals of the EUT, see Figure 3, Figure 4 and Figure 5.
- According to EREC G99, section 15.6.1 the following applies:

  since the rated power of *HPS30* is between $1/\sqrt{10}\cdot P_{n,\,HPS50}$ and $2\cdot P_{n,\,HPS50}$, a family approach to type testing is acceptable.
- A transfer of measurement results from the *HPS50* to other units in the product series according to EREC G99, section 15.6.2 is allowed (for details see section *5 Assessment overview*.)
- Technical justification for transferability of measurement results:

  see section 3.2 on p.11.

4.5 Reference values

Reference values for the p.u. or percentage calculations:

	HPS30	HPS50
Registered Capacity [3] P_{max} [kW]	30.0	50.0
Rated voltage (phase-to-neutral), U_n [V]	230	
Rated current, I_n [4] [A]	47.0	79.0

4.6 Measurement setup

Tests documented in this test report were performed using the following test configuration:

☐ Measurements in the field on real grid

☐ Test bench tests on real grid

☒ Test bench tests on an AC grid simulator

The PGU is connected on the DC-side to a PV-simulator and on the AC-side to an AC-grid simulator. The AC-grid simulator is operated with nominal conditions of U_n = 230 (phase-to-neutral) and f_n = 50 Hz unless stated otherwise by the applied test requirement.

Available primary power is modified by adapting the short circuit current (I_{sc}) value of the I-V curve. Following example shows a PV-curve (I_{sc} = 88.696 A, U_{oc} = 699 V) simulated according to EN50530:

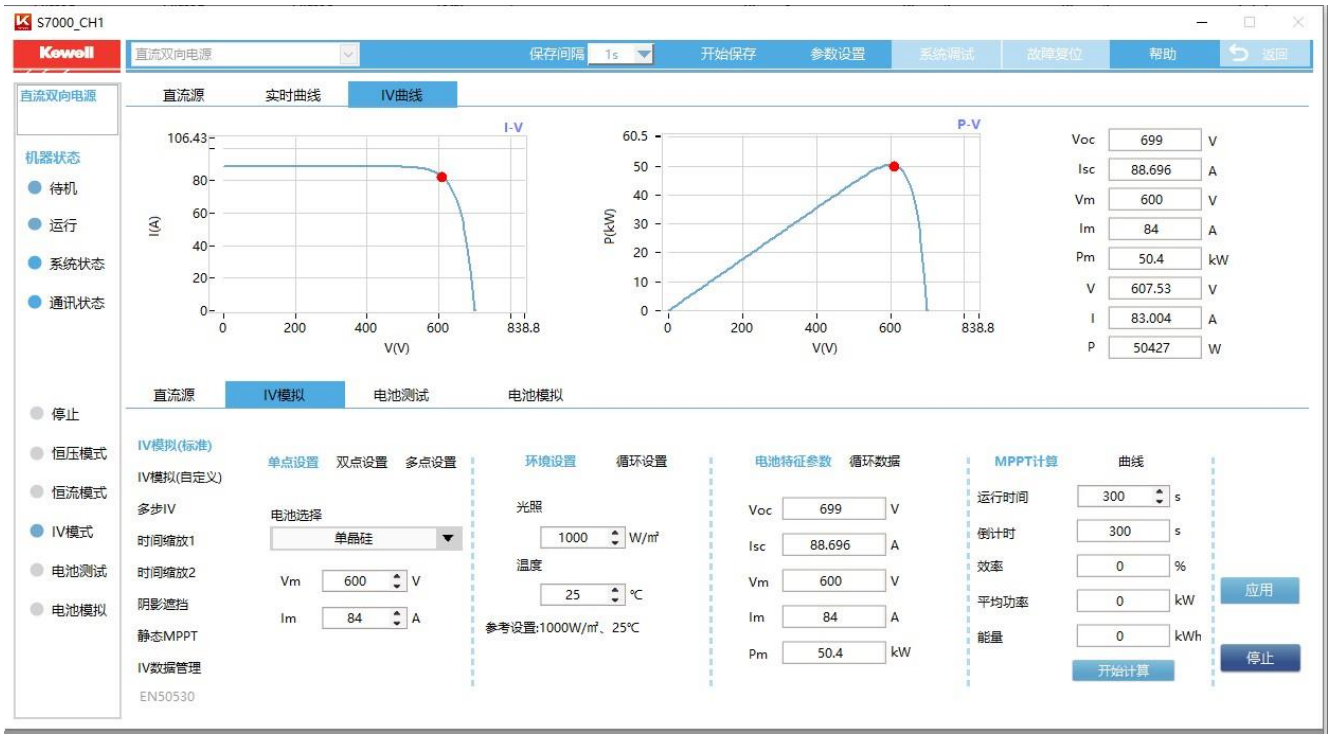


Figure 2 – DC characteristics for testing

The measurement setups are shown in Figure 3 Figure 4 and Figure 5. The specific test and measurement devices are stated in section 4.7.

[3] In this report, the stated values of "registered capacity" related to single Generating Unit.

[4] The rated current stated in this report is calculated based on the "registered capacity" and the rated voltage.

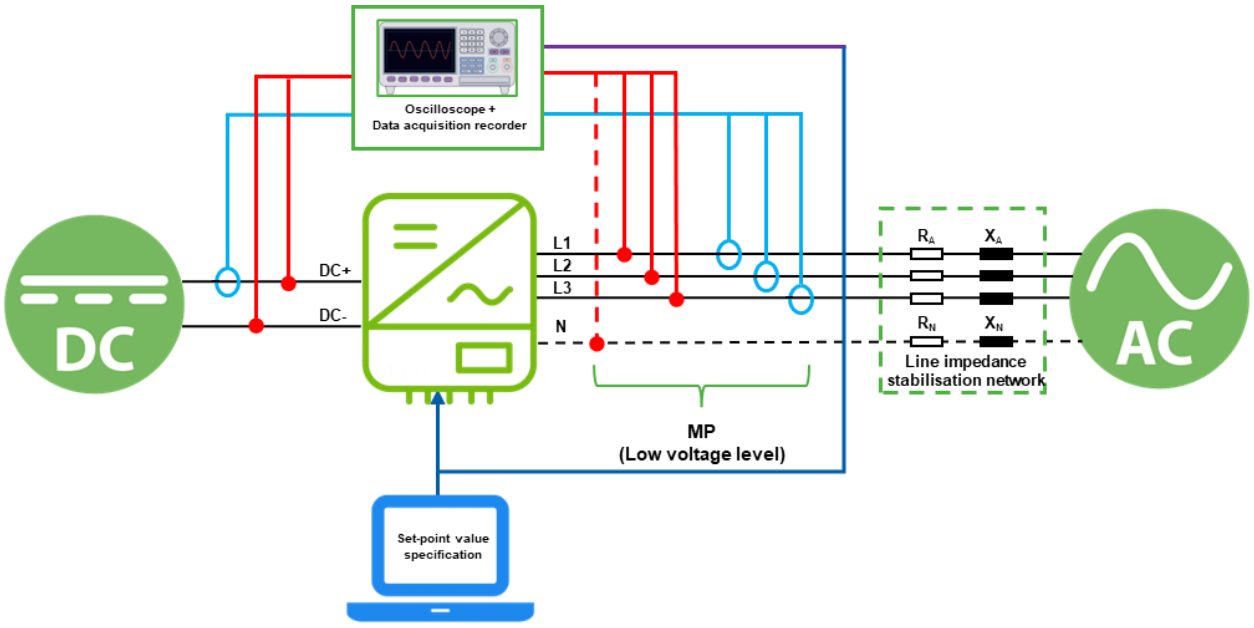


Figure 3 – Measurement setup used for tests except Loss of Mains and Short Circuit test

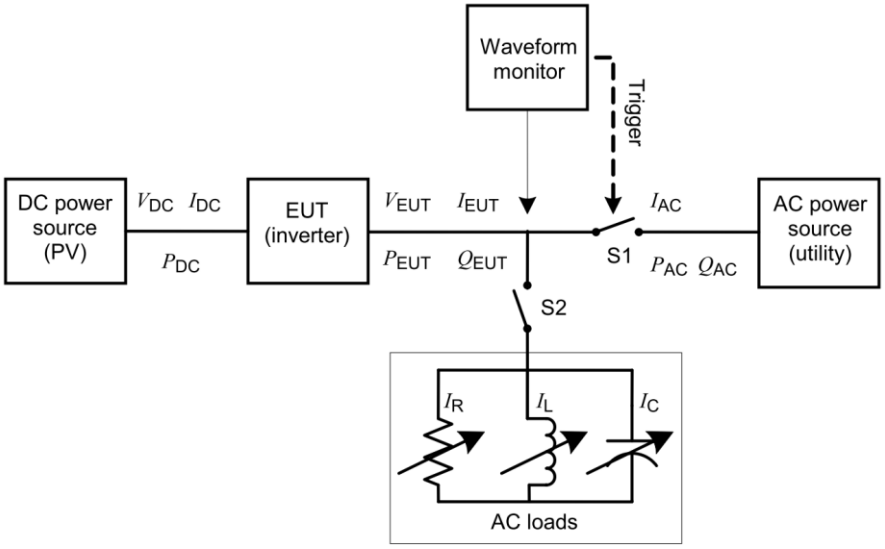


Figure 4 – Test circuit for Loss of Mains according to *IEC 62116:2014*

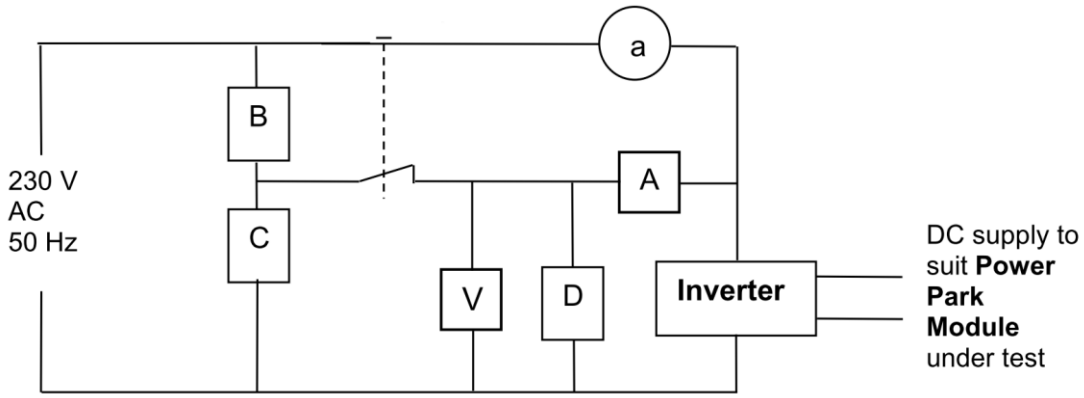


Figure 5 – Short circuit test circuit according to *EREC G99, Figure A.7.5*

4.7 Measurement equipment

Equipment	Internal No.	Manufacturer	Type	Serial No.	Next Calibration
DC power supply [5]	HC-ENG-043	KEWELL	S7000-21K-2000-0040	6018888221003326	--
	HC-ENG-044	KEWELL	S7000-21K-2000-0040	6018888221001316	--
AC Simulator [5]	HC-ENG-030	KEWELL	KAC-45-345-33	6018888220300485	--
	HC-ENG-038	KEWELL	KAC-45-345-33	6018888220903208	--
	HC-ENG-039	KEWELL	KAC-45-345-33	6018888220903207	--
Oscilloscope	HC-ENG-029	DEWETRON	TRION-1820-POWER	A1228623/ C5220751	2024-03-26
Power analyser	HC-ENG-029	DEWETRON	TRION-1820-POWER	A1228623/ C5220751	2024-03-26
Current sensor	HC-ENG-029-001	LEM	DS CT 400	1221300587	2024-03-26
	HC-ENG-029-002	LEM	DS CT 400	1221300588	2024-03-26
	HC-ENG-029-003	LEM	DS CT 400	1221300595	2024-03-26
	HC-ENG-029-004	LEM	DS CT 400	1221300596	2024-03-26
Digital hygrometer	HC-ENG-002	Jiangsu Jingchuang Electric Co., Ltd.	GSP-8A	CMA215000031	2023-08-31

Note:

All measurement equipment was used within the calibration period. Copy of calibration certificates are available at the laboratory for reference.

[5] The AC simulator and DC sources do not need to be calibrated, since the AC voltage and current is measured and determined using the calibrated oscilloscope and power analyser.

5 Assessment overview

Possible test case verdicts:

Test item does meet the requirement.....: P (Pass)

Test item does not meet the requirement....: F (Fail)

Test case does not apply to the test object...: N/A

Test case is not rated .....: N/R

Reference to declaration documents.....: R/D

Items	Technical requirements (Section EREC G99)	Remark / Transfer of measurement results *	Verdict
1. Operating Range	10.3.4, 11.2.1	See section 6.1 / The verified operating range of the HPS50 can be applied to other units in the product series directly.	P
2. Harmonics	9.4.3	See section 6.2 / The percentage harmonics results of the HPS50 can be considered as worst case results and applied to other units in the product series directly.	P
3. Voltage Fluctuation and Flicker	9.4.2	See section 6.3 / The Flicker results of the HPS50 can be considered as worst case results and applied to other units in the product series directly.	P
4. DC injection	9.4.6	See section 6.4 / ---	N/A
5. Power Factor (PF)	11.1.5	See section 6.5 / The Power Factor results of the HPS50 can be considered as worst case results and applied to other units in the product series directly.	P
6. Frequency protection trip and ride through tests	10.3, 10.6	See section 6.6.1 / The measurement results of the HPS50 can be considered as worst case results and applied to other units in the product series directly.	P
7. Voltage protection trip and ride through tests	10.3, 10.6	See section 6.6.2 / The measurement results of the HPS50 can be considered as worst case results and applied to other units in the product series directly.	P
8. Protection – Loss of Mains Test, Vector Shift and RoCoF Stability Test	10.3, 10.4, 10.6	See section 6.6.3, 6.6.4 and 6.6.5 / The measurement results of the HPS50 can be considered as worst case results and applied to other units in the product series directly.	P
9. LFSM-O Test	11.2.4	See section 6.7 / The determined droops of the HPS50 can be considered as worst case results and applied to other units in the product series directly.	P

Items	Technical requirements (Section EREC G99)	Remark / Transfer of measurement results *	Verdict
10. Protection – Reconnection Timer	A.7.1.2.5	See section 6.8 / The measurement results of the HPS50 can be considered as worst case results and applied to other units in the product series directly.	P
11. Fault Level Contribution	9.7, A.7.1.5	See section 6.9 / The measurement results of the HPS50 can be considered as worst case results and applied to other units in the product series directly.	P
12. Self-monitoring Solid State Switch	9.7.9	See section 6.10 / ---	N/A
13. Wiring functional tests if required by para 15.2.1 (attach relevant schedule of tests)	15.2.1	See section 6.11 / ---	N/A
14. Logic Interface (input port)	11.1.3	See section 6.12 / The measurement results of the HPS50 can be considered as worst case results and applied to other units in the product series directly. The high-level description of logic interface applies to the whole product series.	P
15. Cyber security	9.1.7	See section 6.13 / Manufacturer's declaration provided. See *Annex 2 - Manufacturer's declaration regarding Cyber Security*.	R/D
Output power with falling frequency	A.7.1.7, 11.2.3.3	Test not required for Power Generating Modules using inverter	N/A

Note:

Conformity statements are decided in accordance with ILAC-G8:09/2019 Binary Statement for Simple Acceptance Rule, unless otherwise normatively specified or contractually agreed.

* According to EREC G99, section 15.6.2 the following applies:

All absolute values (e.g. operating range tests) shall be transferred directly in the compliance forms of an assumed compliant Generating Unit of the same family. ***All relative results related to design Active Power or current (e.g. power quality fluctuation and flicker) from the tested Generating Unit shall be transferred to the compliance form of a Generating Unit in the same family according to the ratio of the respective nameplate rating (W)of the tested Generating Unit and the assumed compliant Generating Unit****. For the avoidance of doubt, the Manufacturer shall register each Generating Unit in the family on the Energy Networks Association Type Test register.*

Since the tests were performed on HPS50 which provides the highest current / power, in this report the ***relative results*** of EUT HPS50 are considered as worst case results and applied to other units in the product series directly.

6 Measurement results

A2-3 Compliance Verification Report –Tests for Type A Inverter Connected Power Generating Modules – test record

6.1 Operating Range

Tests should be carried with the Power Generating Module operating at Registered Capacity and connected to a suitable test supply or grid simulation set. The power supplied by the primary source shall be kept stable within ± 5 % of the apparent power value set for the entire duration of each test sequence.

Frequency, voltage and Active Power measurements at the output terminals of the Power Generating Module shall be recorded every second. The tests will verify that the Power Generating Module can operate within the required ranges for the specified period of time.

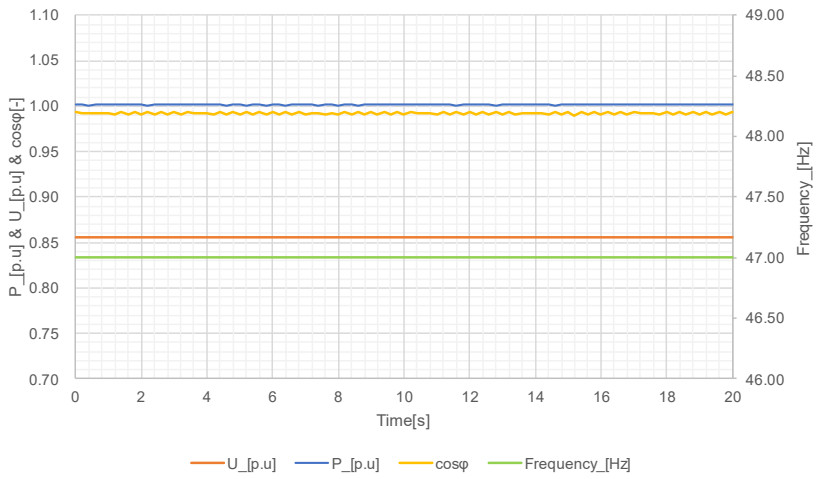
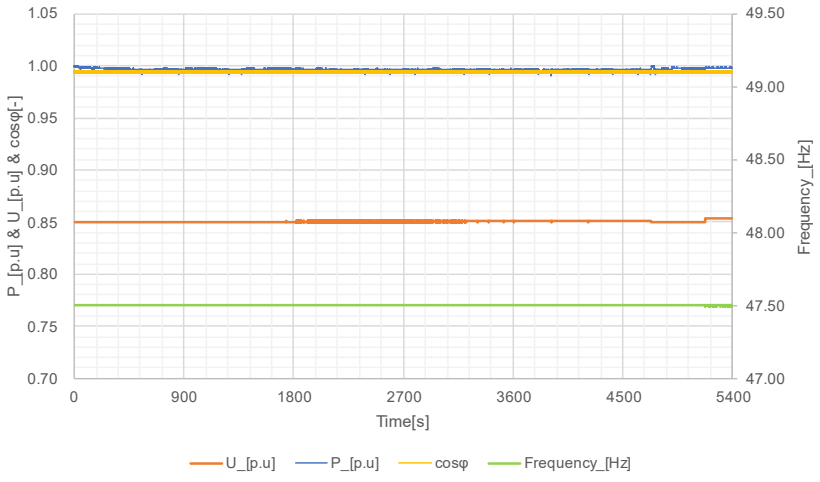
The Interface Protection shall be disabled during the tests.

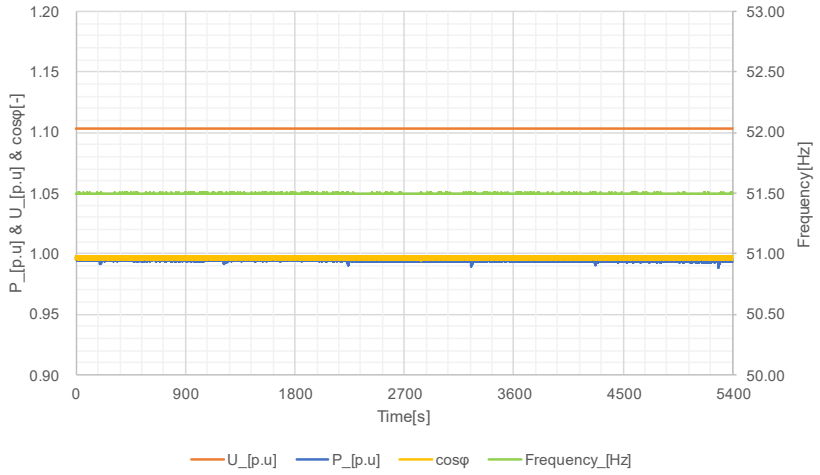
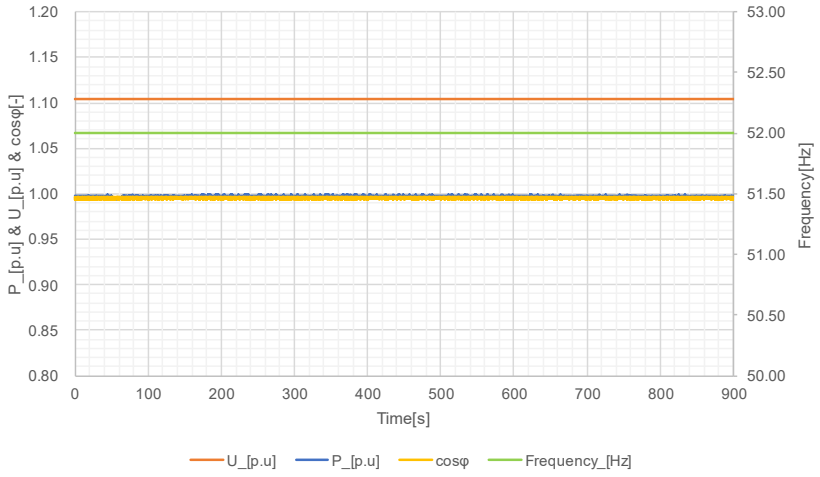
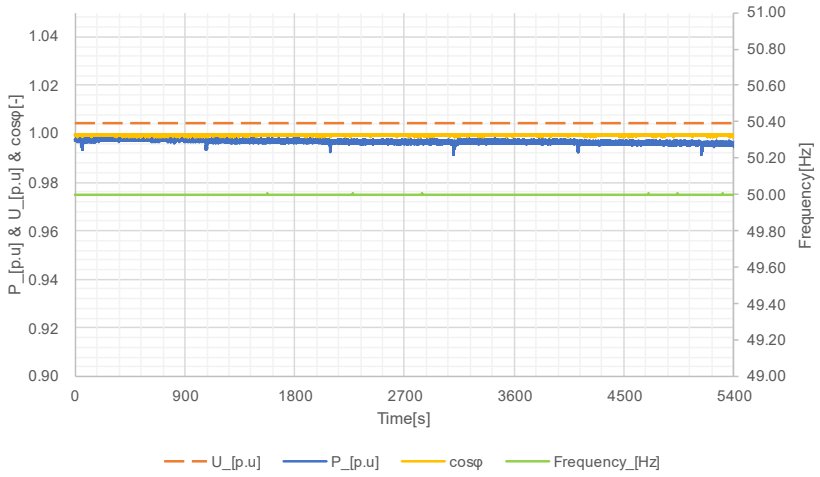
In case of a PV Power Park Module the PV primary source may be replaced by a DC source.

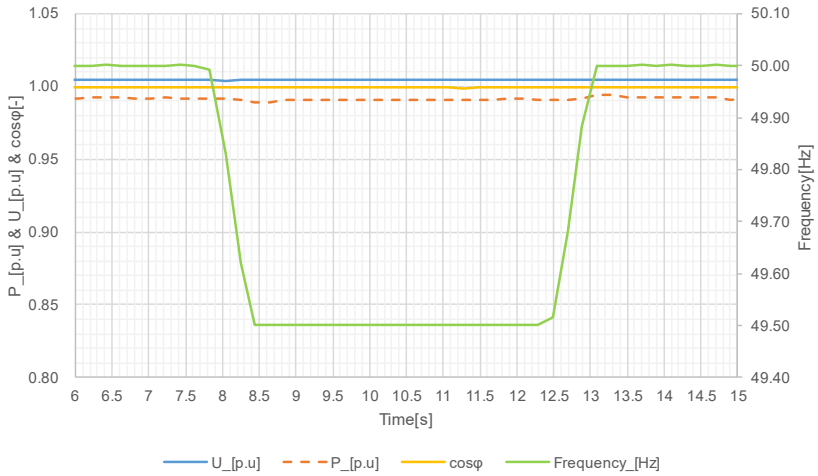
In case of a full converter Power Park Module (eg wind) the primary source and the prime mover Inverter/rectifier may be replaced by a DC source.

Pass or failure of the test should be indicated in the fields below (right hand side), for example with the statement “Pass”, “No disconnection occurs”, etc. Graphical evidence is preferred.

Note that the value of voltage stated in brackets assumes a LV connection. This should be adjusted for HV as required.

Test 1 Voltage = 85% of nominal (195.5 V), Frequency = 47 Hz, **Power Factor** = 1, Period of test 20 s	Pass, no disconnection occurs. 
Test 2 Voltage = 85% of nominal (195.5 V), Frequency = 47.5 Hz, **Power Factor** = 1, Period of test 90 minutes	Pass, no disconnection occurs. 

Test 3 Voltage = 110% of nominal (253 V)., Frequency = 51.5 Hz, **Power Factor** = 1, Period of test 90 minutes	Pass, no disconnection occurs. 
Test 4 Voltage = 110% of nominal (253 V), Frequency = 52.0 Hz, **Power Factor** = 1, Period of test 15 minutes	Pass, no disconnection occurs. 
Test 5 Voltage = 100% of nominal (230 V), Frequency = 50.0 Hz, **Power Factor** = 1, Period of test = 90 minutes	Pass, no disconnection occurs. 
Test 6 RoCoF withstand Confirm that the Power Generating Module is capable of staying connected to the Distribution Network and operate at rates of change of frequency up to 1 Hzs-1 as measured over a period of 500 ms. Note that this is	Pass, no disconnection occurs.

not expected to be demonstrated on site.	

6.2 Power Quality – Harmonics

For **Power Generating Module**s of **Registered Capacity** of less than 75 A per phase (ie 50 kW) the test requirements are specified in Annex A.7.1.5. These tests should be carried out as specified in BS EN 61000-3-12, and measurements for the 2nd – 13th harmonics should be provided. The results need to comply with the limits of Table 2 of BS EN 61000-3-12 for single phase equipment and Table 3 of BS EN 610000-3-12 for three phase equipment. For three phase **Power Generating Module**s, measurements for all phases should be provided.

For **Power Generating Module**s of **Registered Capacity** of greater than 75 A per phase (ie 50 kW) the installation shall be designed in accordance with EREC G5.

The rating of the **Power Generating Module** (per phase) should be provided below, and the Total Harmonic Distortion (THD) and Partial Weighted Harmonic Distortion (PWHD) should be provided at the bottom of this section.

Power Generating Module tested to BS EN 61000-3-12

Power Generating Module rating per phase (rpp)	16.667	kVA	Harmonic % = Measured Value (A) x 23/rating per phase (kVA)
Single or three phase measurements (for single phase measurements, only complete L1 columns below).	three phases		

Harmonic	At 45-55% of **Registered Capacity**						Limit in BS EN 61000-3-12	
	Measured Value (MV) in Amps			Measured Value (MV) in %[6]				
Order	L_1	L_2	L_3	L_1	L_2	L_3	1-phase	3-phases
2	0.8160	0.9455	1.0527	1.1261	1.3049	1.4528	8%	8%
3	0.4362	1.2896	0.8565	0.6019	1.7796	1.1820	21.6%	Not stated
4	0.5651	0.5624	0.6528	0.7798	0.7760	0.9009	4%	4%
5	0.4421	0.3839	0.7407	0.6101	0.5298	1.0222	10.7%	10.7%
6	0.4117	0.0585	0.4701	0.5682	0.0808	0.6488	2.67%	2.67%
7	0.3504	0.1817	0.2245	0.4836	0.2507	0.3098	7.2%	7.2%
8	0.0989	0.1127	0.1119	0.1365	0.1556	0.1545	2%	2%
9	0.0625	0.1031	0.0417	0.0862	0.1423	0.0576	3.8%	Not stated
10	0.0885	0.0892	0.0799	0.1221	0.1231	0.1102	1.6%	1.6%
11	0.1028	0.0748	0.0803	0.1419	0.1032	0.1108	3.1%	3.1%

[6] The percentage values of harmonic currents (for both partial load and full load tests) were calculated using the formula:
Harmonic % = Measured Value (A) x 23/rating per phase (kVA)
according to Form A2-3, which corresponding to a reference current equal to rated current of the inverter.

Order	L_1	L_2	L_3	L_1	L_2	L_3	1-phase	3-phases
12	0.0549	0.0105	0.0640	0.0758	0.0144	0.0883	1.33%	1.33%
13	0.0287	0.0502	0.0319	0.0397	0.0693	0.0440	2%	2%
14	0.0290	0.0259	0.0214	0.0401	0.0358	0.0296	---	---
15	0.0213	0.0174	0.0053	0.0294	0.0240	0.0073	---	---
16	0.0217	0.0155	0.0219	0.0299	0.0214	0.0302	---	---
17	0.0370	0.0330	0.0428	0.0510	0.0456	0.0591	---	---
18	0.0273	0.0025	0.0289	0.0377	0.0034	0.0399	---	---
19	0.0108	0.0154	0.0231	0.0149	0.0213	0.0319	---	---
20	0.0154	0.0147	0.0107	0.0213	0.0202	0.0148	---	---
21	0.0066	0.0028	0.0057	0.0091	0.0039	0.0079	---	---
22	0.0102	0.0084	0.0113	0.0141	0.0116	0.0157	---	---
23	0.0124	0.0135	0.0157	0.0172	0.0186	0.0217	---	---
24	0.0119	0.0040	0.0152	0.0164	0.0055	0.0210	---	---
25	0.0029	0.0085	0.0065	0.0040	0.0118	0.0089	---	---
26	0.0049	0.0086	0.0058	0.0068	0.0119	0.0081	---	---
27	0.0068	0.0037	0.0056	0.0094	0.0051	0.0077	---	---
28	0.0070	0.0044	0.0103	0.0096	0.0061	0.0143	---	---
29	0.0038	0.0099	0.0120	0.0052	0.0136	0.0166	---	---
30	0.0085	0.0058	0.0140	0.0117	0.0080	0.0194	---	---
31	0.0015	0.0031	0.0029	0.0021	0.0043	0.0040	---	---
32	0.0017	0.0058	0.0046	0.0023	0.0080	0.0064	---	---
33	0.0019	0.0013	0.0020	0.0026	0.0018	0.0028	---	---
34	0.0016	0.0055	0.0047	0.0022	0.0075	0.0065	---	---
35	0.0032	0.0014	0.0027	0.0045	0.0019	0.0038	---	---
36	0.0035	0.0026	0.0053	0.0048	0.0035	0.0073	---	---
37	0.0021	0.0015	0.0018	0.0028	0.0020	0.0025	---	---
38	0.0012	0.0015	0.0016	0.0017	0.0021	0.0022	---	---
39	0.0034	0.0015	0.0045	0.0047	0.0021	0.0061	---	---
40	0.0026	0.0031	0.0055	0.0036	0.0043	0.0075	---	---
THD [7]	---	---	---	1.8015	2.4298	2.4399	23%	13%
PWHD [8]	---	---	---	0.4098	0.3476	0.4559	23%	22%

[7] THD = Total Harmonic Distortion, order 2 - 40 according to BS EN 61000- 3-12 considered. The stated values in the results table are in %.

[8] PWHD = Partial Weighted Harmonic Distortion, order 14 - 40 according to BS EN 61000- 3-12 considered. The stated values in the results table are in %.

Harmonic	At 100% of **Registered Capacity**						Limit in BS EN 61000-3-12	
	Measured Value (MV) in Amps			Measured Value (MV) in % [6]				
Order	L_1	L_2	L_3	L_1	L_2	L_3	1-phase	3-phases
2	0.8111	1.0810	1.3300	1.1193	1.4918	1.8354	8%	8%
3	0.3731	1.6405	1.2668	0.5148	2.2638	1.7482	21.6%	Not stated
4	0.7203	0.7278	0.9590	0.9940	1.0043	1.3234	4%	4%
5	0.5419	0.2494	0.7454	0.7478	0.3441	1.0287	10.7%	10.7%
6	0.5224	0.1311	0.6529	0.7209	0.1809	0.9010	2.67%	2.67%
7	0.2277	0.0420	0.1878	0.3143	0.0580	0.2592	7.2%	7.2%
8	0.1442	0.1537	0.1524	0.1990	0.2121	0.2103	2%	2%
9	0.0421	0.0712	0.0305	0.0580	0.0983	0.0421	3.8%	Not stated
10	0.0875	0.0644	0.0478	0.1207	0.0889	0.0660	1.6%	1.6%
11	0.1423	0.1656	0.1460	0.1964	0.2285	0.2014	3.1%	3.1%
12	0.0293	0.0055	0.0338	0.0404	0.0076	0.0467	1.33%	1.33%
13	0.0833	0.0575	0.0740	0.1150	0.0793	0.1021	2%	2%
14	0.0184	0.0202	0.0045	0.0254	0.0279	0.0063	---	---
15	0.0099	0.0086	0.0136	0.0136	0.0119	0.0188	---	---
16	0.0175	0.0163	0.0245	0.0241	0.0225	0.0338	---	---
17	0.0484	0.0671	0.0517	0.0667	0.0926	0.0713	---	---
18	0.0233	0.0067	0.0296	0.0321	0.0092	0.0409	---	---
19	0.0564	0.0374	0.0411	0.0778	0.0516	0.0567	---	---
20	0.0043	0.0121	0.0108	0.0060	0.0168	0.0149	---	---
21	0.0141	0.0123	0.0071	0.0194	0.0170	0.0098	---	---
22	0.0087	0.0126	0.0144	0.0121	0.0174	0.0199	---	---
23	0.0247	0.0154	0.0109	0.0341	0.0213	0.0150	---	---
24	0.0157	0.0084	0.0226	0.0217	0.0115	0.0312	---	---
25	0.0177	0.0266	0.0155	0.0244	0.0367	0.0213	---	---
26	0.0117	0.0078	0.0131	0.0162	0.0107	0.0181	---	---
27	0.0112	0.0038	0.0081	0.0155	0.0052	0.0112	---	---
28	0.0106	0.0028	0.0083	0.0146	0.0039	0.0114	---	---
29	0.0139	0.0132	0.0195	0.0191	0.0182	0.0269	---	---
30	0.0090	0.0037	0.0105	0.0125	0.0051	0.0146	---	---
31	0.0066	0.0087	0.0092	0.0091	0.0120	0.0126	---	---
32	0.0041	0.0068	0.0048	0.0057	0.0094	0.0067	---	---
33	0.0029	0.0022	0.0028	0.0041	0.0030	0.0038	---	---
34	0.0057	0.0051	0.0066	0.0079	0.0071	0.0091	---	---
35	0.0068	0.0076	0.0078	0.0093	0.0105	0.0107	---	---
36	0.0076	0.0041	0.0112	0.0105	0.0056	0.0155	---	---
37	0.0039	0.0064	0.0050	0.0053	0.0089	0.0070	---	---
38	0.0036	0.0052	0.0058	0.0050	0.0071	0.0080	---	---
39	0.0031	0.0024	0.0038	0.0043	0.0034	0.0052	---	---
40	0.0054	0.0043	0.0091	0.0074	0.0060	0.0126	---	---
THD [7]				1.9525	2.9413	3.1990	23%	13%
PWHD [8]				0.5898	0.5657	0.5777	23%	22%

6.3 Power Quality – Voltage fluctuations and Flicker

For **Power Generating Module**s of **Registered Capacity** of less than 75 A per phase (ie 50 kW) these tests should be undertaken in accordance with Annex A.7.1.4.3. Results should be normalised to a standard source impedance, or if this results in figures above the limits set in BS EN 61000-3-11 to a suitable Maximum Impedance.

For **Power Generating Module**s of **Registered Capacity** of greater than 75 A per phase (ie 50 kW) the installation shall be designed in accordance with EREC P28.

The standard test impedance is 0.4 Ω for a single-phase **Power Generating Module** (and for a two-phase unit in a three-phase system) and 0.24 Ω for a three phase **Power Generating Module** (and for a two-phase unit in a split phase system). Please ensure that both test and standard impedance are completed on this form. If the test impedance (or the measured impedance) is different to the standard impedance, it must be normalised to the standard impedance as follows (where the **Power Factor** of the generation output is 0.98 or above):

d_{max} normalised value = (Standard impedance / Measured impedance) x Measured value.

Where the **Power Factor** of the output is under 0.98 then the X to R ratio of the test impedance should be close to that of the standard impedance.

The stopping test should be a trip from full load operation.

The duration of these tests needs to comply with the particular requirements set out in the testing notes for the technology under test.

The test date and location must be declared.

Test start date	2023-08-18	Test end date	2023-08-18
Test location	Lyns-tci Technology Guangdong Co., Ltd. (see *Testing location* on p.2)		

		Starting			Stopping			Running	
	Phase no.	d_{max} [%]	d_c [%]	d(t) [ms]	d_{max} [%]	d_c [%]	d(t) [ms]	P_{st}	P_{lt} 2 hours
Measured Values at test impedance	L1	0.309	0.058	0.000	1.906	0.339	0.000	0.014	0.013
	L2	0.247	0.031	0.000	0.507	0.199	0.000	0.014	0.014
	L3	0.259	0.012	0.000	1.884	0.435	0.000	0.019	0.014
	Overall worst case	0.259	0.058	0.000	1.906	0.435	0.000	0.019	0.014
Normalised to standard impedance	L1	0.309	0.058	0.000	1.906	0.339	0.000	0.014	0.013
	L2	0.247	0.031	0.000	0.507	0.199	0.000	0.014	0.014
	L3	0.259	0.012	0.000	1.884	0.435	0.000	0.019	0.014
	Overall worst case	0.259	0.058	0.000	1.906	0.435	0.000	0.019	0.014
Normalised to required maximum impedance	L1	--	--	--	--	--	--	--	--
	L2	--	--	--	--	--	--	--	--
	L3	--	--	--	--	--	--	--	--
	Overall worst case	--	--	--	--	--	--	--	--
Limits set under BS EN 61000-3-11		4	3.3	500 (3.3%)	4	3.3	500 (3.3%)	1.0	0.65

Test Impedance	R:	0.24 Ω	X:	0.15 Ω
Standard Impedance	R:	☒ 0.24 * ☐ 0.4 ^ Ω	X:	☒ 0.15 * ☐ 0.25 ^ Ω
Maximum Impedance	R:	1.548 Ω	X:	0.968 Ω

* ☒ three-phase **Power Generating Module**s ☐ split single phase **Power Generating Module**s

^ ☐ single phase **Power Generating Module** ☐ **Power Generating Module**s using two phases on a three-phase system

6.4 Power Quality – DC injection

The tests should be carried out on a single **Generating Unit**. Tests are to be carried out at three defined power levels ±5%. At 230 V a 50 kW three phase **Inverter** has a current output of 217 A so DC limit is 543 mA. These tests should be undertaken in accordance with Annex A.7.1.4.4.

The % DC injection ("as % of rated AC current" below) is calculated as follows:

% DC injection = Recorded DC value in Amps / Base current

where the base current is the **Registered Capacity** (W) / V_{phase} *. The % DC injection should not be greater than 0.25%.

Test power level	10%	55%	100%
Recorded DC value in Amps	--	--	--
as % of rated AC current	--	--	--
Limit [%]	--	--	--

Note:

* Calculation is the same for 1 phase and 3 phase devices:

- Base current = Registered Capacity (W) / 230 (V)
- % DC injection = Recorded DC value (A) / Base current (A) *100

Note:

The unit is equipped with a build-in transformer on the AC side of the inverter.

Tests are omitted (see also EREC G99, section 9.4.6.2).

6.5 Power Factor

The tests should be carried out on a single **Power Generating Module**. Tests are to be carried out at three voltage levels and at **Registered Capacity** and the measured **Power Factor** must be greater than 0.95 to pass. Voltage to be maintained within ±1.5% of the stated level during the test. These tests should be undertaken in accordance with Annex A.7.1.4.2.

Note that the value of voltage stated in brackets assumes a **LV** connection. This should be adjusted for **HV** as required.

Voltage	0.94 pu (216.2 V)	1 pu (230 V)	1.1 pu (253 V)
Measured value	0.997	0.996	0.992
Power Factor Limit	>0.95	>0.95	>0.95

Note:

The Power Park Modules (Generating Units) considered in this report are designed to be capable of operating within the range ±0.95 Power Factor at Registered Capacity.

- Max. operating range of Power Factor at Registered Capacity:
  0.909 lagging to 0.909 leading
- Setting range of the Power Factor:
  0.800 lagging to 0.800 leading

6.6 Protection

The Interface Protection setting information can be displayed in one or more of the following ways:

☒ A display on a screen which can be read

☒ A display on an electronic device which can communicate with the Power Generating Module and confirm that it is the correct device by means of a Identification number / name permanently fixed to the device and visible on the electronic device screen at the same time as the settings

☒ Display of all settings including nominal voltage and current outputs, alongside the identification number / name of the device, permanently fixed to the Power Generating Module

☐ Other (please specify)

Note:

The protection device considered in this report is the integrated protection relay / generating unit switch in the Power Generating Modules.

Manufacturer Data:

The integrated Interface Protection in the Power Generating Modules considered in this report is capable of measuring voltage to an accuracy of ±1.5% of the nominal value and of measuring frequency to ± 0.2% of the nominal value across its operating range of voltage, frequency and temperature (-30°C ~ +60°C).

(See also subsections 6.6.1 ~ 6.6.5 below)

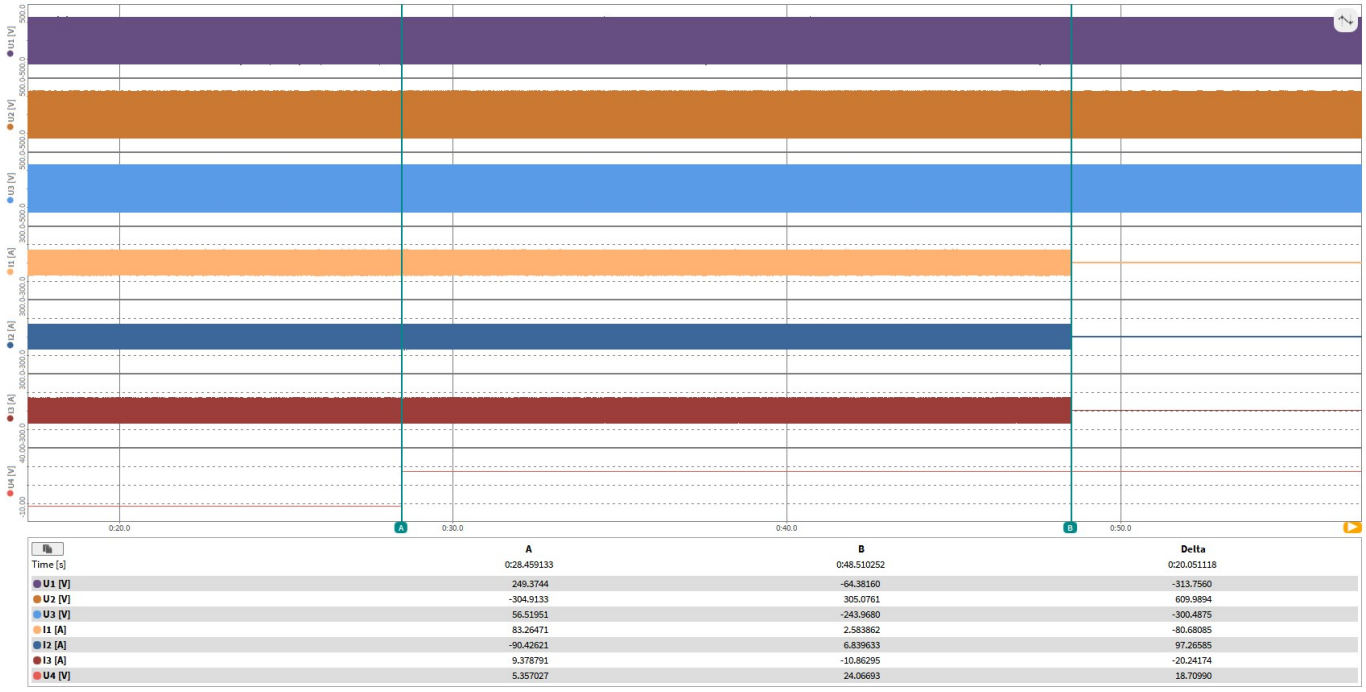
6.6.1 Protection – Frequency tests

These tests should be carried out in accordance with the Annex A.7.1.2.3. For trip tests, frequency and time delay should be stated. For “no trip tests”, “no trip” can be stated.

Function	Setting		Trip test		“No trip tests”	
	Frequency	Time delay	Frequency	Time delay	Frequency / time	Confirm no trip
U/F stage 1	47.5 Hz	20 s	47.51 Hz	20.051s	47.7 Hz 30 s	No trip occurred
U/F stage 2	47 Hz	0.5 s	47.03 Hz	0.595 s	47.2 Hz 19.5 s	No trip occurred
					46.8 Hz 0.45 s	No trip occurred
O/F	52 Hz	0.5 s	52.02 Hz	0.517 s	51.8 Hz 120.0 s	No trip occurred
					52.2 Hz 0.45 s	No trip occurred

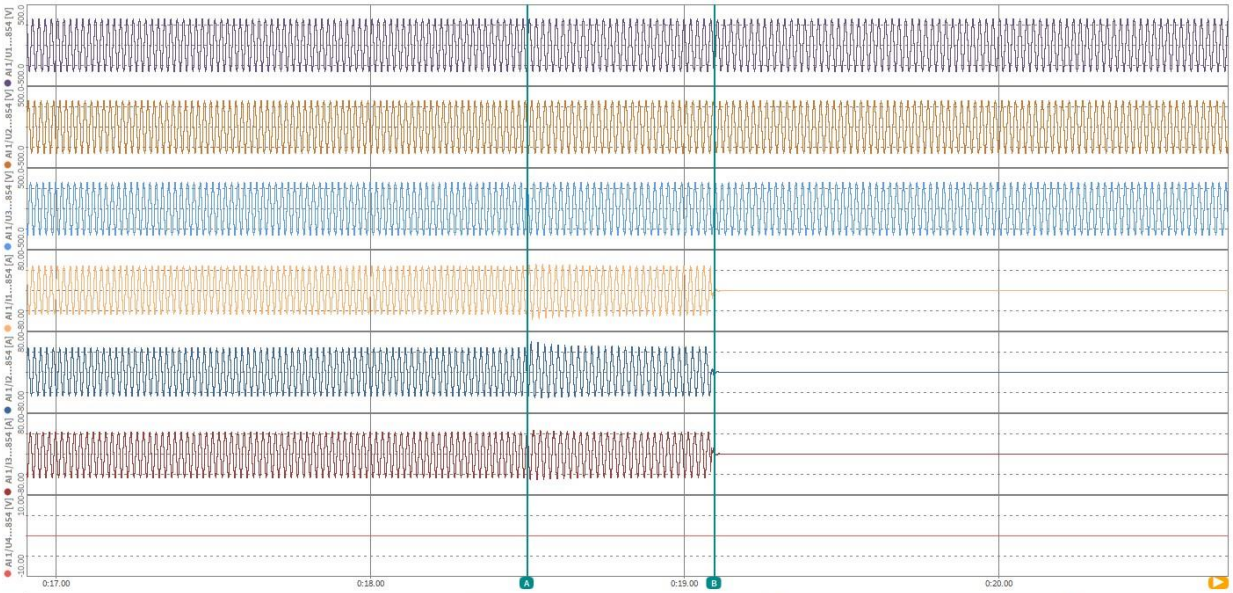
Note:

for frequency trip tests the frequency required to trip is the setting ± 0.1 Hz. In order to measure the time delay a larger deviation than the minimum required to operate the projection can be used. The “No trip tests” need to be carried out at the setting ± 0.2 Hz and for the relevant times as shown in the table above to ensure that the protection will not trip in error.



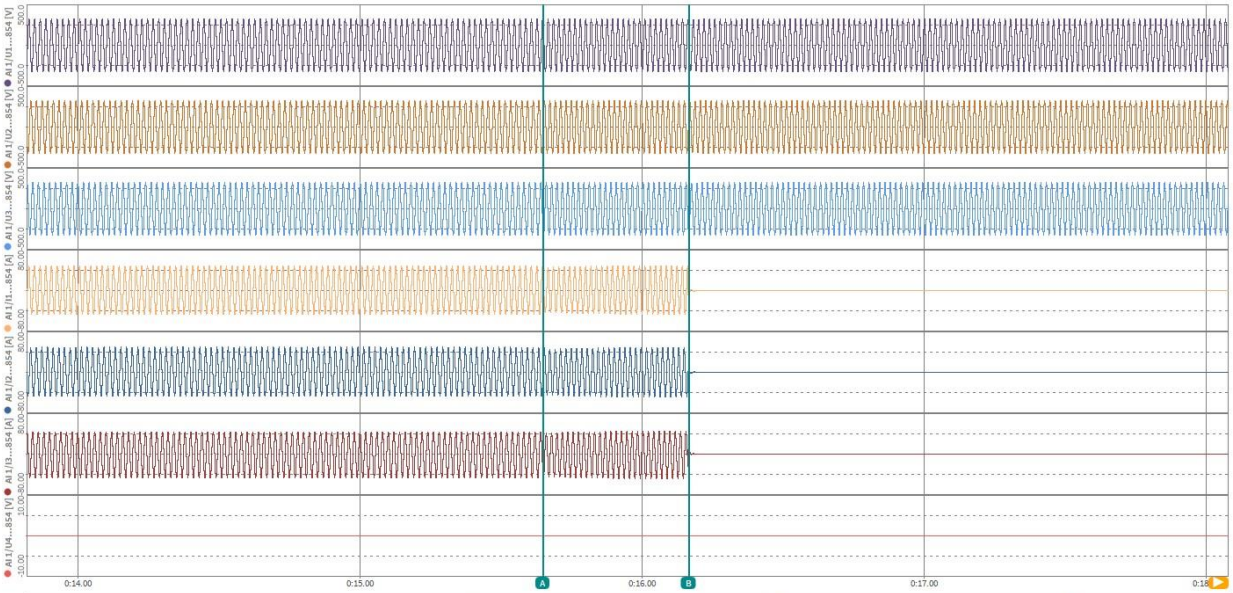
Time [s]	A	B	Delta
	0:28.459133	0:48.510252	0:20.051118
U1 [V]	249.3744	-64.38160	-313.7560
U2 [V]	-304.9133	305.0761	609.9894
U3 [V]	56.51951	-243.9680	-300.4875
I1 [A]	83.26471	2.583862	-80.68085
I2 [A]	-90.42621	6.839633	97.26585
I3 [A]	9.378791	-10.86295	-20.24174
U4 [V]	5.357027	24.06693	18.70990

Figure 6 – Test U/F stage 1 (Trip test)



Time [s]	A 0:18.500549	B 0:19.095811	Delta 0.595263
AI 1/U1@TRIONet_854 [V]	-204.9666	-317.5519	-112.5853
AI 1/U2@TRIONet_854 [V]	-120.0748	150.1472	270.2220
AI 1/U3@TRIONet_854 [V]	320.0567	171.6452	-148.4115
AI 1/I1@TRIONet_854 [A]	-19.89484	0.430942	20.32578
AI 1/I2@TRIONet_854 [A]	-23.69821	-1.621842	22.07637
AI 1/I3@TRIONet_854 [A]	43.63418	1.139045	-42.49513
AI 1/U4@TRIONet_854 [V]	3.815e-3	-2.384e-4	-4.053e-3

Figure 7 – Test U/F stage 2 (Trip test)



Time [s]	A 0:15.650264	B 0:16.167015	Delta 0.516751
AI 1/U1@TRIONet_854 [V]	270.4857	66.02598	-204.4597
AI 1/U2@TRIONet_854 [V]	15.53679	236.6738	221.1371
AI 1/U3@TRIONet_854 [V]	-292.0454	-302.9106	-10.86521
AI 1/I1@TRIONet_854 [A]	36.29923	-5.375147	-41.67438
AI 1/I2@TRIONet_854 [A]	8.547307	2.939701	-5.607605
AI 1/I3@TRIONet_854 [A]	-44.76786	2.465844	47.23370
AI 1/U4@TRIONet_854 [V]	-2.384e-3	2.146e-3	4.530e-3

Figure 8 – Test OF (Trip test)

6.6.2 Protection – Voltage tests

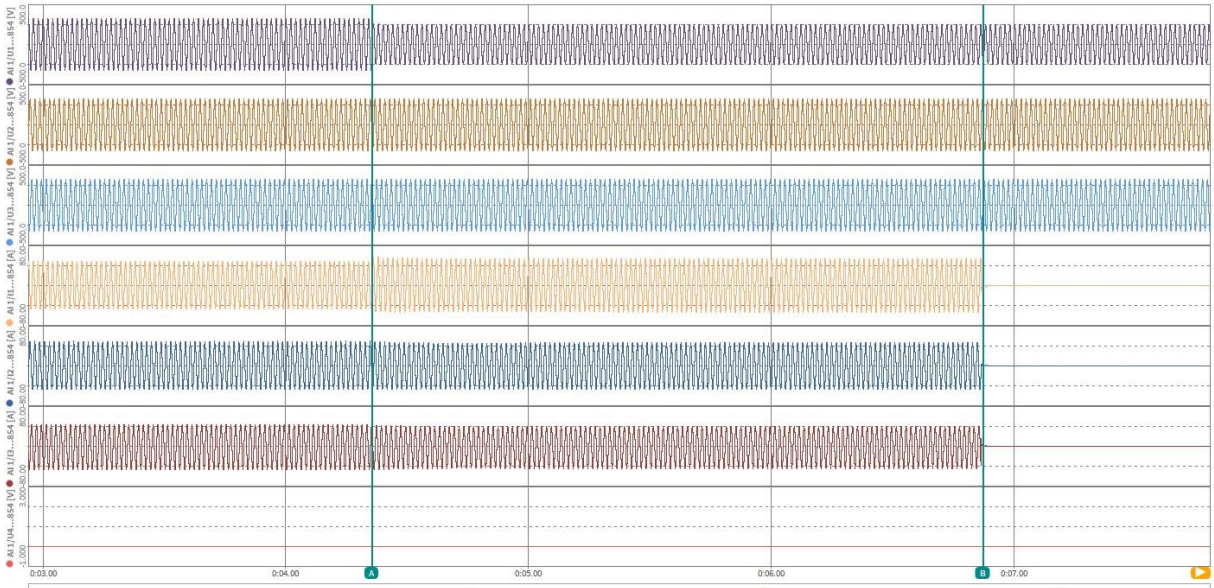
These tests should be carried out in accordance with Annex A.7.1.2.2. For trip tests, voltage and time delay should be stated. For “no trip tests”, “no trip” can be stated.

Note that the value of voltage stated below assumes a **LV** connection This should be adjusted for **HV** taking account of the VT ratio as required.

Function		Setting		Trip test		“No trip tests”	
		Voltage	Time delay	Voltage	Time delay	Voltage / time	Confirm no trip
U/V	L1-N	0.8 pu (184 V)	2.5 s	183.9 V	2.516 s	188 V 5.0 s	No trip occurred
	L2-N			183.7 V	2.517 s		No trip occurred
	L3-N			184.5 V	2.514 s		No trip occurred
						180 V 2.45 s	No trip occurred
O/V stage 1	L1-N	1.14 pu (262.2 V)	1.0 s	263.1 V	1.009 s	258.2 V 5.0 s	No trip occurred
	L2-N			262.8 V	1.044 s		No trip occurred
	L3-N			263.8 V	1.004 s		No trip occurred
O/V stage 2	L1-N	1.19 pu (273.7 V)	0.5 s	273.2 V	0.545 s	269.7 V 0.95 s	No trip occurred
	L2-N			273.2 V	0.542 s		No trip occurred
	L3-N			274.2 V	0.531 s		No trip occurred
						277.7 V 0.45 s	No trip occurred

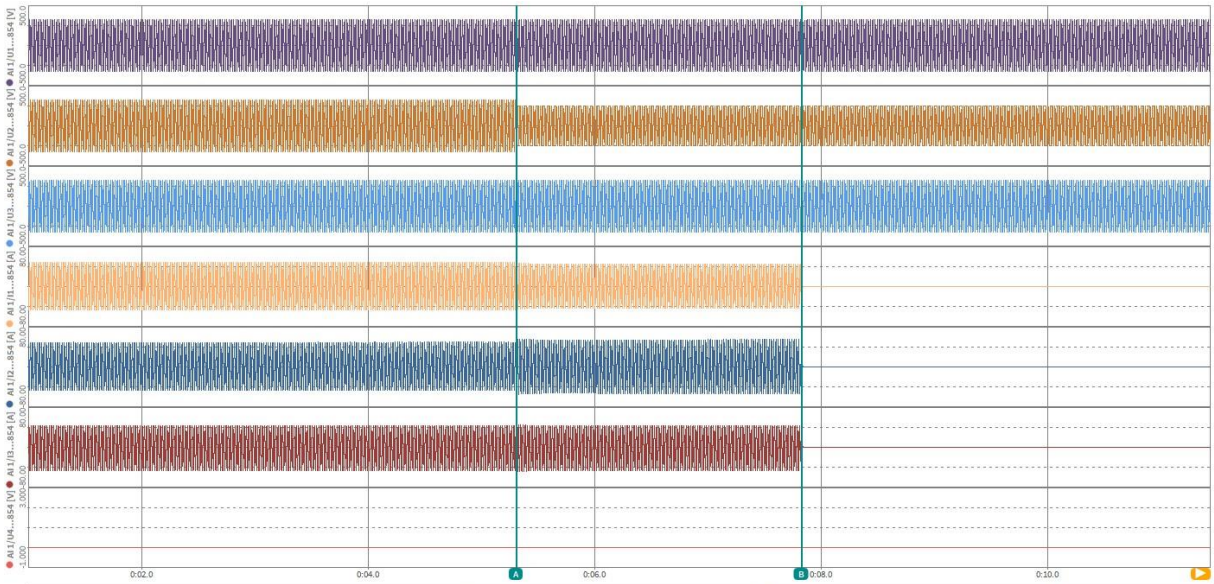
Note:

for voltage tests the Voltage required to trip is the setting ±3.45 V. The time delay can be measured at a larger deviation than the minimum required to operate the protection. The No trip tests need to be carried out at the setting ±4 V and for the relevant times as shown in the table above to ensure that the protection will not trip in error.



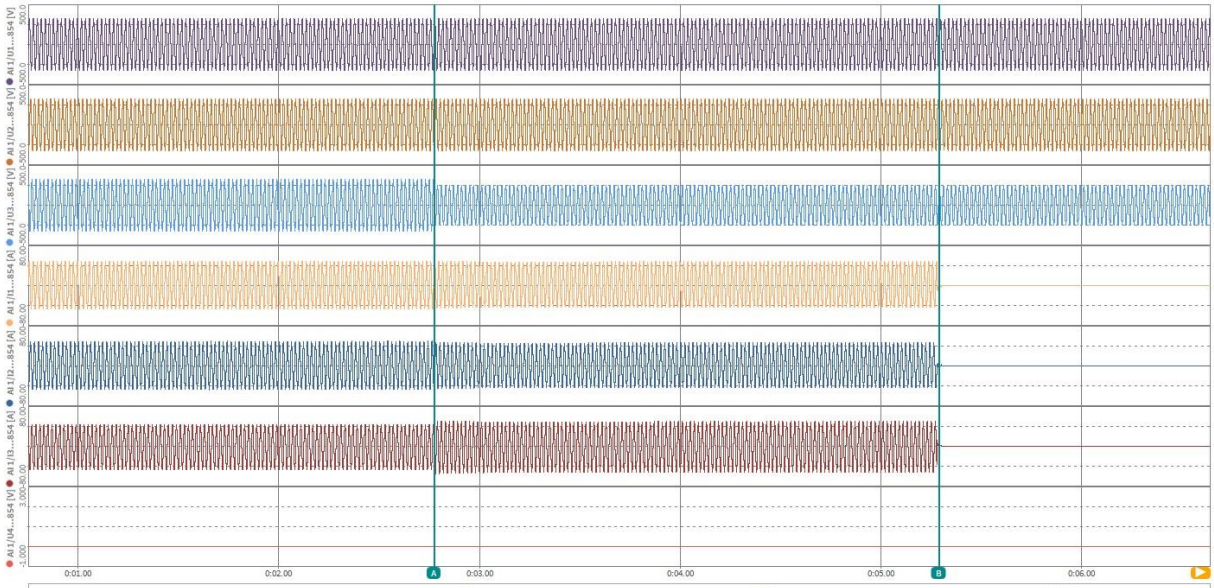
	A	B	Delta
Time [s]	4.357052	6.872792	2.515740
AI 1/U1@TRIONet_854 [V]	-130.3134	-244.2615	-113.9481
AI 1/U2@TRIONet_854 [V]	-199.8432	214.1969	414.0401
AI 1/U3@TRIONet_854 [V]	320.7009	103.4064	-217.2945
AI 1/I1@TRIONet_854 [A]	-9.904504	-2.038479	7.866025
AI 1/I2@TRIONet_854 [A]	-32.84633	-3.016591	29.82974
AI 1/I3@TRIONet_854 [A]	42.84382	5.192757	-37.65106
AI 1/U4@TRIONet_854 [V]	3.099e-3	-2.384e-4	-3.338e-3

Figure 9 – Test U/V (Trip test, L1-N)



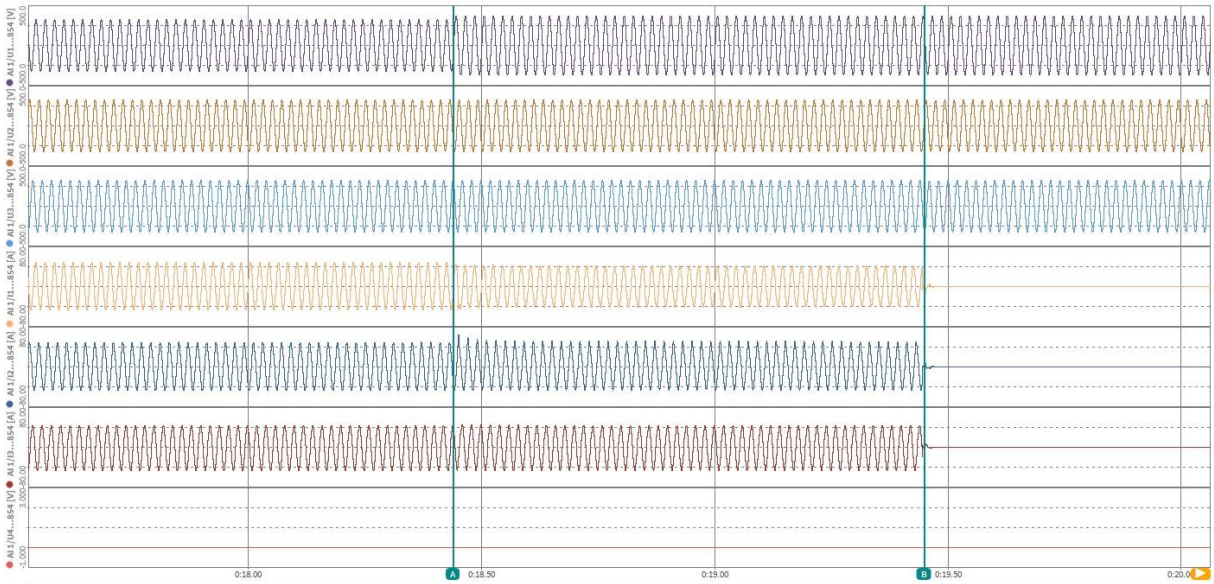
	A	B	Delta
Time [s]	5.309883	7.826990	2.517108
AI 1/U1@TRIONet_854 [V]	58.61044	-217.6399	-276.2504
AI 1/U2@TRIONet_854 [V]	-230.7410	-74.32795	156.4131
AI 1/U3@TRIONet_854 [V]	246.6843	309.5637	62.87933
AI 1/I1@TRIONet_854 [A]	21.56675	1.106858	-20.45989
AI 1/I2@TRIONet_854 [A]	-50.97449	-0.287890	50.68660
AI 1/I3@TRIONet_854 [A]	29.50967	-0.835061	-30.34473
AI 1/U4@TRIONet_854 [V]	0.018358	1.669e-3	-0.016689

Figure 10 – Test U/V (Trip test, L2-N)



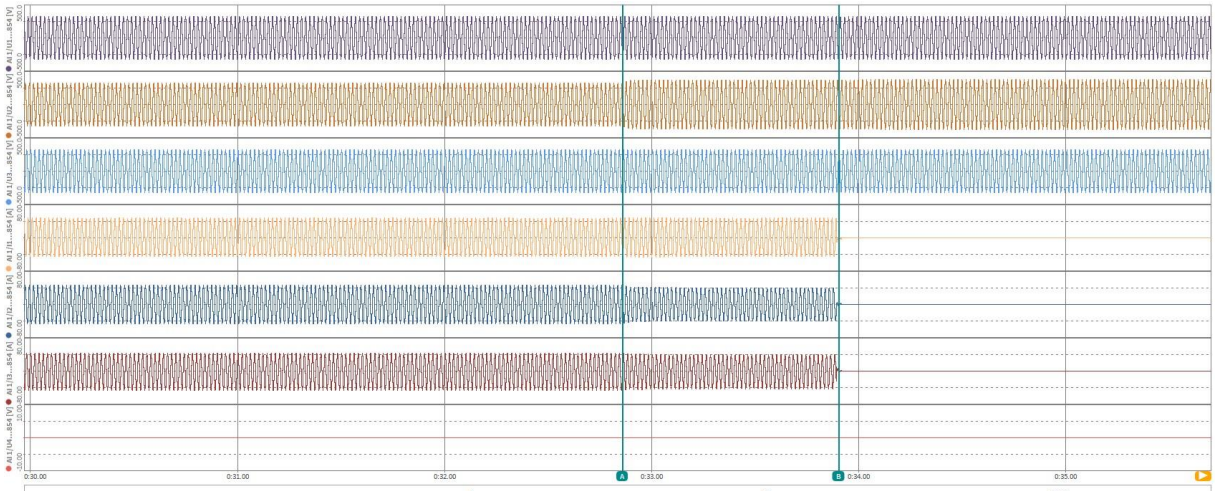
	A	B	Delta
Time [s]	2.776539	5.290998	2.514459
AI 1/U1@TRIONet_854 [V]	217.8362	-276.8934	-494.7295
AI 1/U2@TRIONet_854 [V]	-316.2809	2.628565	318.9094
AI 1/U3@TRIONet_854 [V]	82.22747	211.5061	129.2787
AI 1/I1@TRIONet_854 [A]	36.36003	1.711249	-34.64878
AI 1/I2@TRIONet_854 [A]	-43.40530	-1.380444	42.02485
AI 1/I3@TRIONet_854 [A]	7.116795	-0.352263	-7.469058
AI 1/U4@TRIONet_854 [V]	2.146e-3	-7.153e-4	-2.861e-3

Figure 11 – Test U/V (Trip test, L3-N)



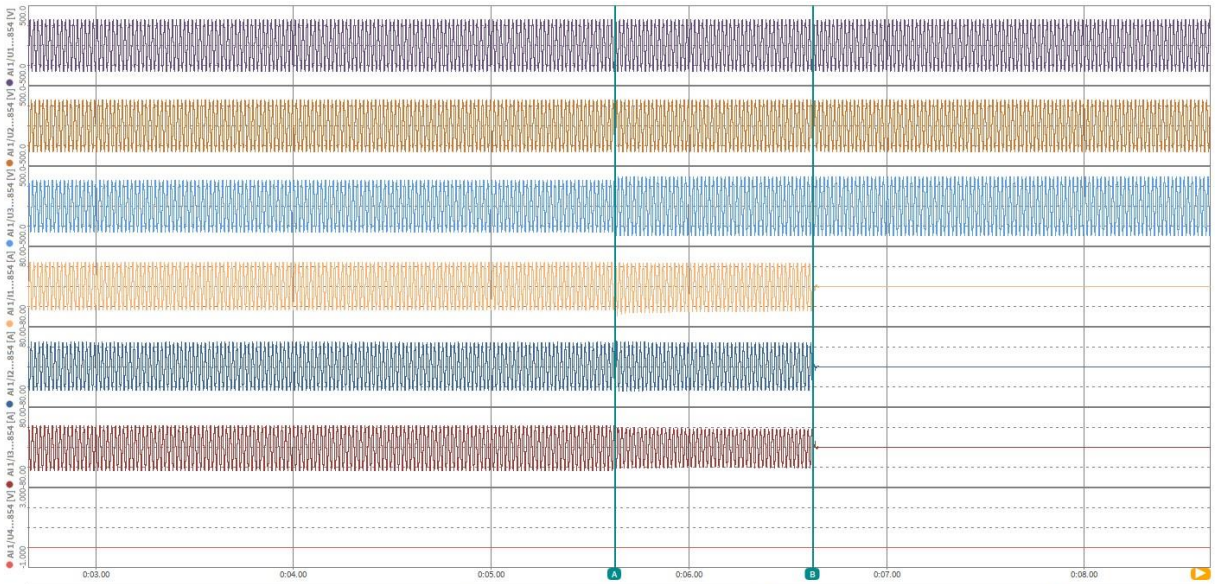
	A	B	Delta
Time [s]	0:18.440360	0:19.449407	1.009047
AI 1/U1@TRIONet_854 [V]	-122.5290	231.9007	354.4297
AI 1/U2@TRIONet_854 [V]	-206.4948	117.4965	323.9913
AI 1/U3@TRIONet_854 [V]	319.5548	-313.8840	-633.4389
AI 1/I1@TRIONet_854 [A]	-8.760095	-3.356338	5.403757
AI 1/I2@TRIONet_854 [A]	-33.81908	1.856089	35.67517
AI 1/I3@TRIONet_854 [A]	42.56666	1.625419	-40.94124
AI 1/U4@TRIONet_854 [V]	-5.007e-3	-1.192e-3	3.815e-3

Figure 12 – Test O/V stage 1 (Trip test, L1-N)



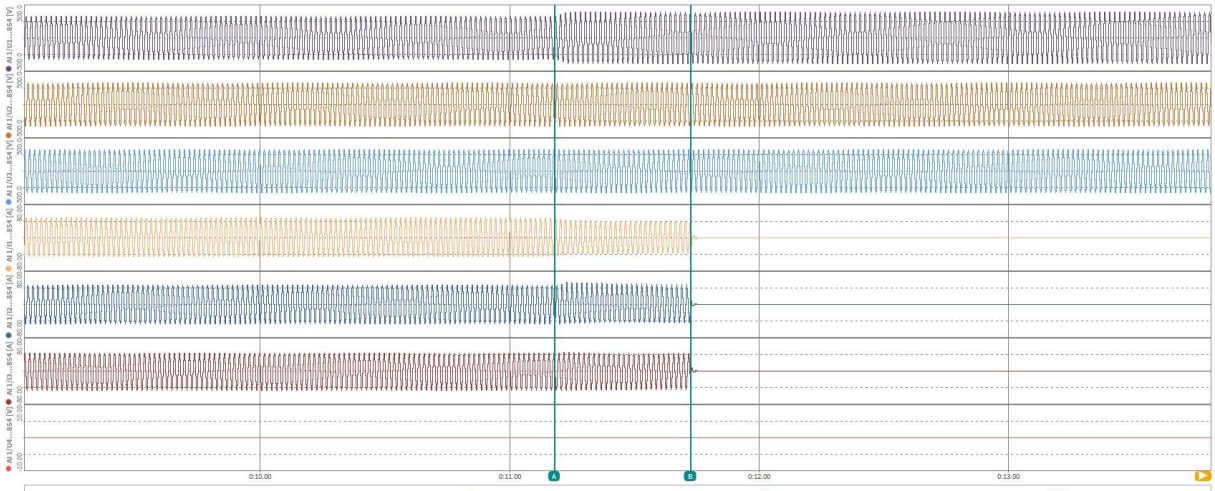
	A	B	Delta
Time [s]	0:32.86015	0:33.90375	1.04359
AI 1/U1@TRIONet_854 [V]	-187.8457	-315.2733	-127.4276
AI 1/U2@TRIONet_854 [V]	322.9604	141.9277	-181.0327
AI 1/U3@TRIONet_854 [V]	-144.5644	195.4074	339.9718
AI 1/I1@TRIONet_854 [A]	-25.77961	1.350045	27.12965
AI 1/I2@TRIONet_854 [A]	45.96949	-1.727343	-47.69683
AI 1/I3@TRIONet_854 [A]	-20.05577	0.379086	20.43486
AI 1/U4@TRIONet_854 [V]	-2.384e-4	9.537e-4	1.192e-3

Figure 13 – Test O/V stage 1 (Trip test, L2-N)



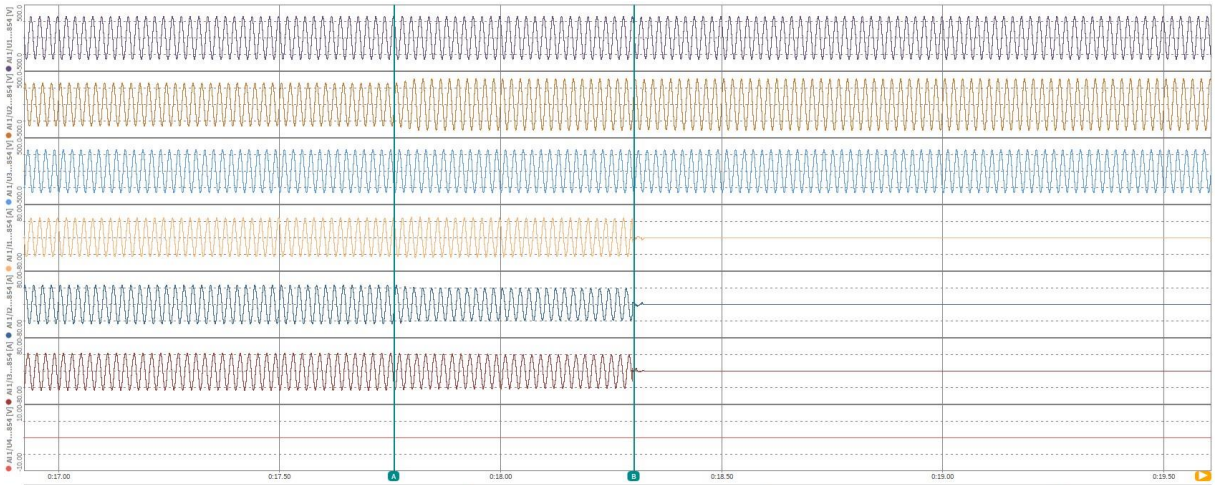
	A	B	Delta
Time [s]	5.626474	6.626911	1.000437
AI 1/U1@TRIONet_854 [V]	-36.49402	16.71100	53.20502
AI 1/U2@TRIONet_854 [V]	-265.4357	-291.4405	-26.00479
AI 1/U3@TRIONet_854 [V]	294.7309	311.7473	17.01641
AI 1/I1@TRIONet_854 [A]	4.534722	16.38830	11.85358
AI 1/I2@TRIONet_854 [A]	-41.51702	-44.06691	-2.549887
AI 1/I3@TRIONet_854 [A]	37.06813	27.78769	-9.280444
AI 1/U4@TRIONet_854 [V]	2.861e-3	0.012636	9.775e-3

Figure 14 – Test O/V stage 1 (Trip test, L3-N)



Time [s]	A 0:11.180418	B 0:11.725488	Delta 0.545069
AI 1/U1@TRIONet_854 [V]	-31.43096	386.5273	417.9583
AI 1/U2@TRIONet_854 [V]	-269.1319	-187.3696	81.76232
AI 1/U3@TRIONet_854 [V]	293.4759	-139.1580	-432.6339
AI 1/I1@TRIONet_854 [A]	-2.812743	39.55901	42.37175
AI 1/I2@TRIONet_854 [A]	-36.92150	-18.98468	17.93683
AI 1/I3@TRIONet_854 [A]	39.85584	-20.37585	-60.23169
AI 1/U4@TRIONet_854 [V]	3.338e-3	1.192e-3	-2.146e-3

Figure 15 – Test O/V stage 2 (Trip test, L1-N)



Time [s]	A 0:17.759671	B 0:18.302101	Delta 0.542430
AI 1/U1@TRIONet_854 [V]	318.1601	187.9683	-130.1918
AI 1/U2@TRIONet_854 [V]	-112.0918	160.8095	272.9013
AI 1/U3@TRIONet_854 [V]	-215.7884	-316.6695	-100.8811
AI 1/I1@TRIONet_854 [A]	47.43755	-4.540086	-51.97764
AI 1/I2@TRIONet_854 [A]	-17.97617	2.480149	20.45632
AI 1/I3@TRIONet_854 [A]	-29.42920	2.176166	31.60536
AI 1/U4@TRIONet_854 [V]	1.431e-3	1.669e-3	2.384e-4

Figure 16 – Test O/V stage 2 (Trip test, L2-N)

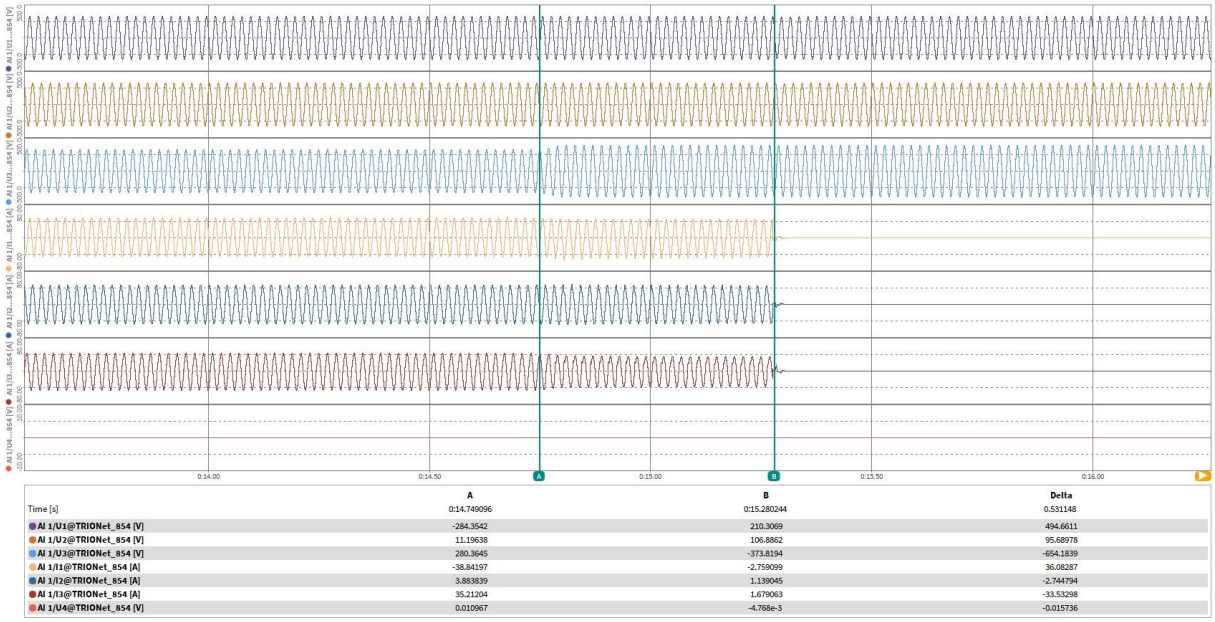


Figure 17 – Test O/V stage 2 (Trip test, L3-N)

6.6.3 Protection – Loss of Mains test

These tests should be carried out in accordance with BS EN 62116. Annex A.7.1.2.4.						
The following sub set of tests should be recorded in the following table.						
Test Power and imbalance	33% -5%Q (Test 22)	66% -5%Q (Test 12)	100% -5%P (Test 5)	33% +5%Q (Test 31)	66% +5%Q (Test 21)	100% +5%P (Test 10)
Trip time [s]	0.044	0.027	0.247	0.038	0.033	0.208
Trip time limit [s]	0.5 [9]					
Note: For full testing according to BS EN 62116 see *Annex 1 - Loss of Mains test according to BS EN 62116*.						

6.6.4 Loss of Mains Protection, Vector Shift Stability test

This test should be carried out in accordance with Annex A.7.1.2.6. Confirmation is required that the **Power Generating Module** does not trip under positive / negative vector shift.			
The following sub set of tests should be recorded in the following table.			
	Start Frequency	Change	Confirm no trip
Positive Vector Shift	49.5 Hz	+50 degrees	No trip occurred
Negative Vector Shift	50.5 Hz	- 50 degrees	No trip occurred

[9] If the device requires additional shut down time (beyond 0.5 s but less than 1 s) then this should be stated on this form.

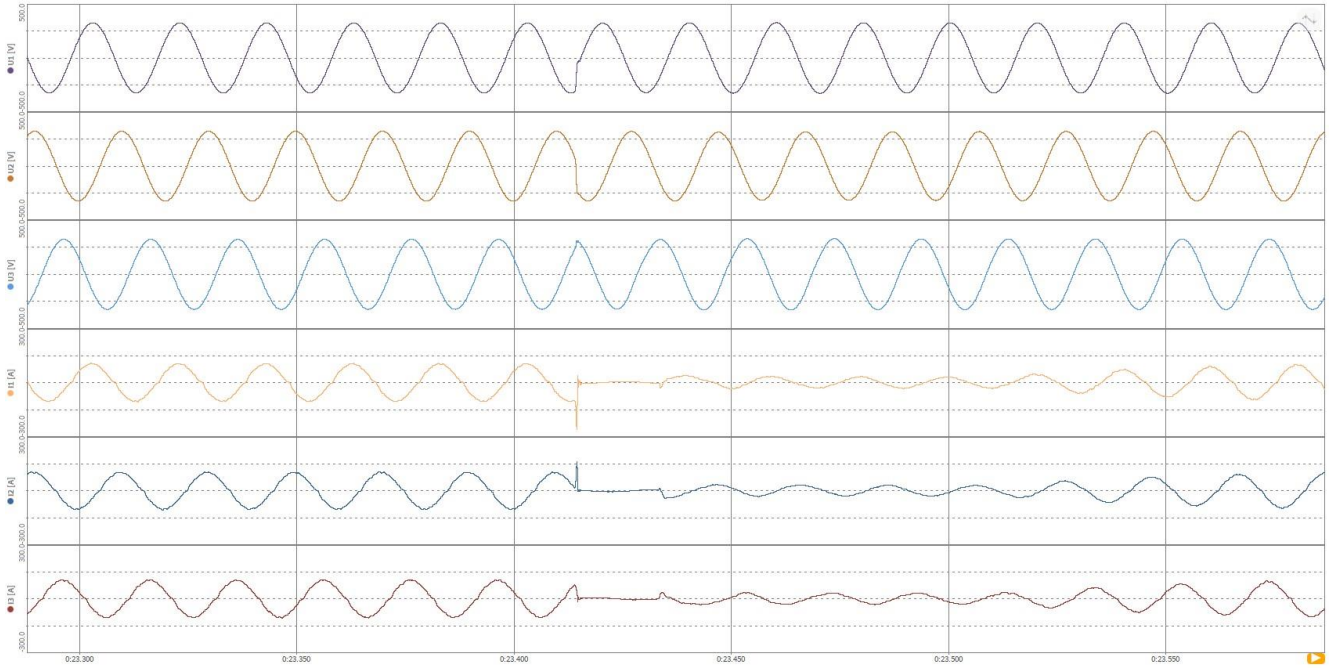


Figure 18 – Positive Step Change (+50 degrees)

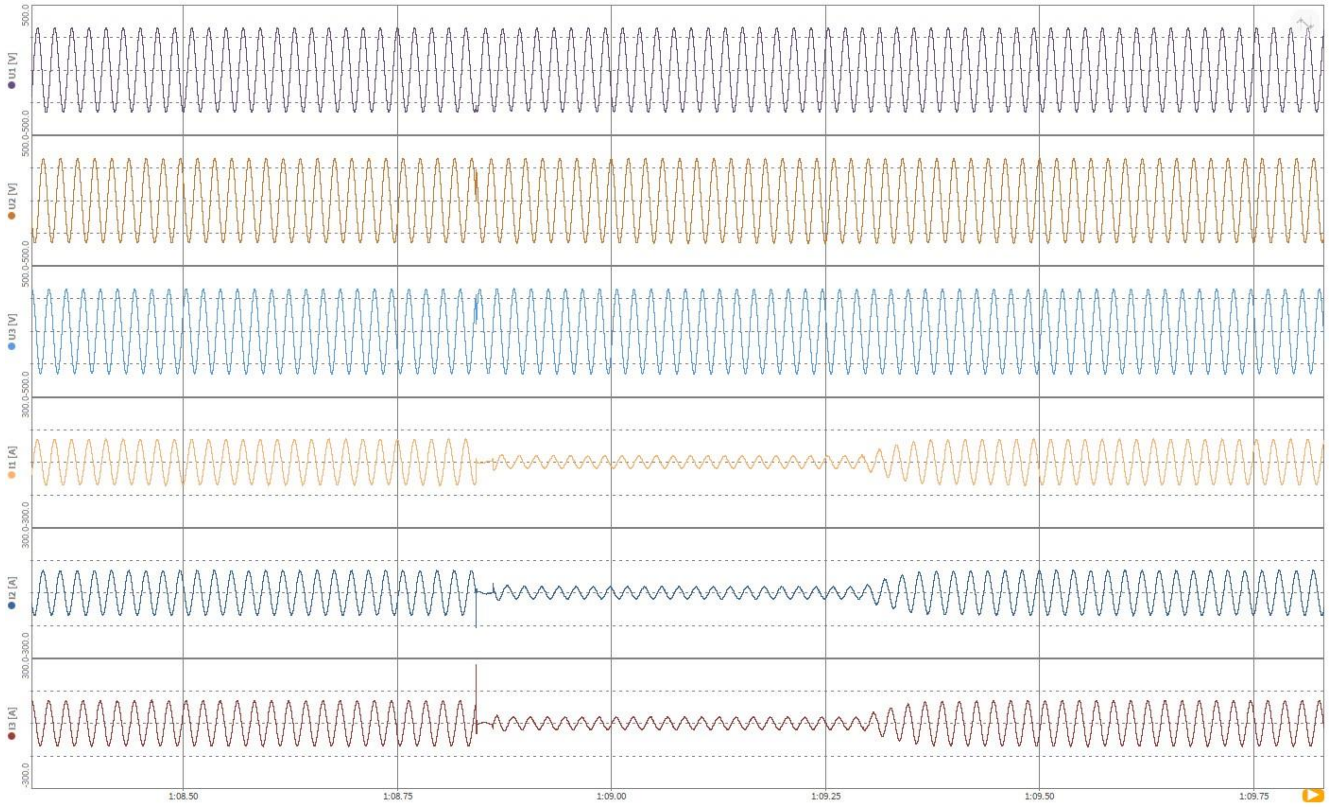


Figure 19 – Negative Step Change (-50 degrees)

6.6.5 Loss of Mains Protection, RoCoF Stability test

This test should be carried out in accordance with Annex A.7.1.2.6. Confirmation is required that the **Power Generating Module** does not trip for the duration of the ramp up and ramp down test.			
The following sub set of tests should be recorded in the following table.			
Ramp range	Test frequency ramp:	Test Duration	Confirm no trip
49.0 Hz to 51.0 Hz	+0.95 Hz/s	2.1 s	No trip occurred
51.0 Hz to 49.0 Hz	-0.95 Hz/s	2.1 s	No trip occurred
Note: During the test, the LFSM-O function was activated.			

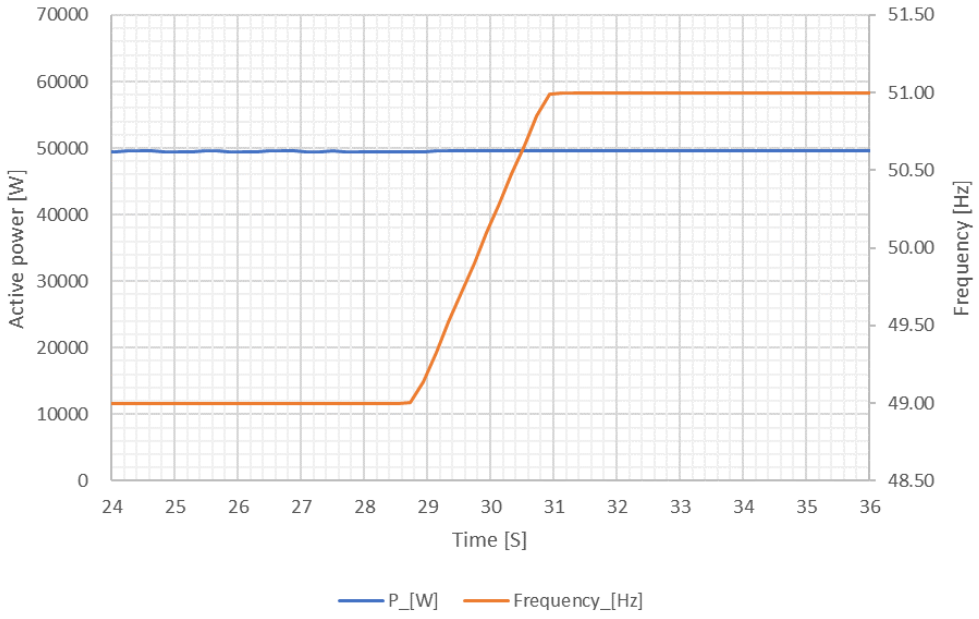


Figure 20 – Positive Frequency Drift (+0.95 Hz/s)

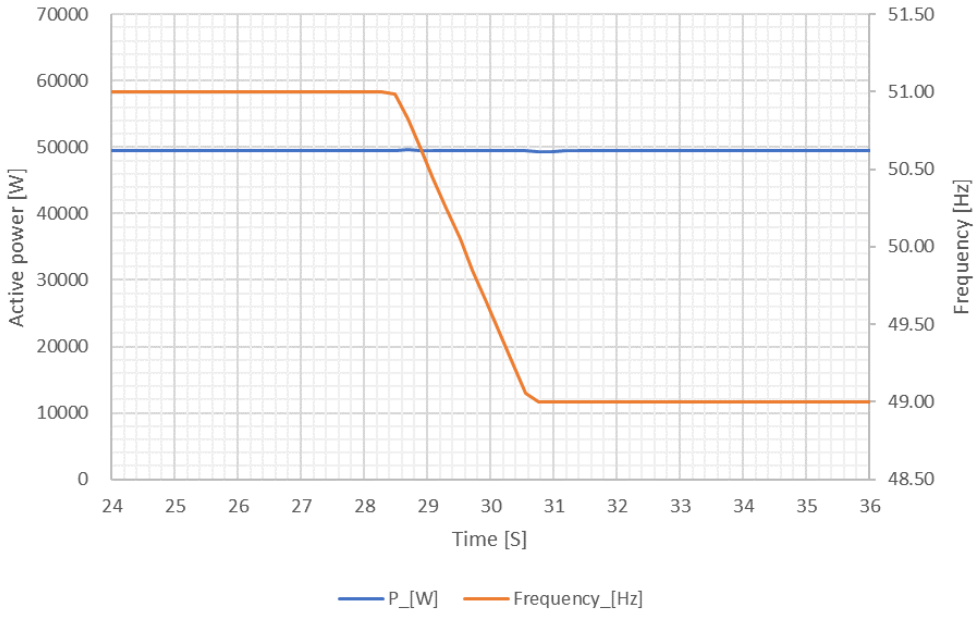


Figure 21 – Negative Frequency Drift (-0.95 Hz/s)

6.7 Limited Frequency Sensitive Mode – Overfrequency test

The test should be carried out using the specific threshold frequency of 50.4 Hz and **Droop** of 10%.
This test should be carried out in accordance with Annex A.7.1.3, which also contains the measurement tolerances.

Active Power response to rising frequency/time plots are attached if frequency injection tests are undertaken in accordance with Annex A.7.2.4.	**N** *

Alternatively, test results should be noted below:

Test sequence at **Registered Capacity** >80%	Measured **Active Power** Output [W]	Frequency [Hz]	Primary Power Source [W]	**Active Power** Gradient Droop
Step a) 50.00Hz ± 0.01Hz	50105	50.00	25500	---
Step b) 50.45Hz ± 0.05Hz	49575	50.45		9.43% 1)
Step c) 50.70Hz ± 0.10Hz	46980	50.70		9.63% 2)
Step d) 51.15Hz ± 0.05Hz	42493	51.15		10.03% 3)
Step e) 50.70Hz ± 0.10Hz	46958	50.70		10.08% 4)
Step f) 50.45Hz ± 0.05Hz	49519	50.45		9.76% 5)
Step g) 50.00Hz ± 0.01Hz	49988	50.00		---
	1st Droop (calculated using frequency and power between steps d) & b))			9.88%
	2nd Droop (calculated using frequency and power between steps f) & d))			9.96%

Test sequence at **Registered Capacity** 40% - 60%	Measured **Active Power** Output [W]	Frequency [Hz]	Primary Power Source [W]	**Active Power** Gradient Droop
Step a) 50.00Hz ± 0.01Hz	25020	50.00	13000	---
Step b) 50.45Hz ± 0.05Hz	24518	50.45		9.96% 1)
Step c) 50.70Hz ± 0.10Hz	21985	50.70		9.87% 2)
Step d) 51.15Hz ± 0.05Hz	17503	51.15		10.04% 3)
Step e) 50.70Hz ± 0.10Hz	21991	50.70		10.03% 4)
Step f) 50.45Hz ± 0.05Hz	24525	50.45		9.87% 5)
Step g) 50.00Hz ± 0.01Hz	25017	50.00		---
	1st Droop (calculated using frequency and power between steps d) & b))			9.98%
	2nd Droop (calculated using frequency and power between steps f) & d))			9.97%

Note:

* Test according to Annex A.7.1.3. Frequency/time plots attached (see Figure 22 & Figure 23)

1) Droop calculated using frequency and power between steps b) & threshold frequency of 50.4 Hz

2) Droop calculated using frequency and power between steps c) & b)

3) Droop calculated using frequency and power between steps d) & c)

4) Droop calculated using frequency and power between steps e) & d)

5) Droop calculated using frequency and power between steps f) & e)

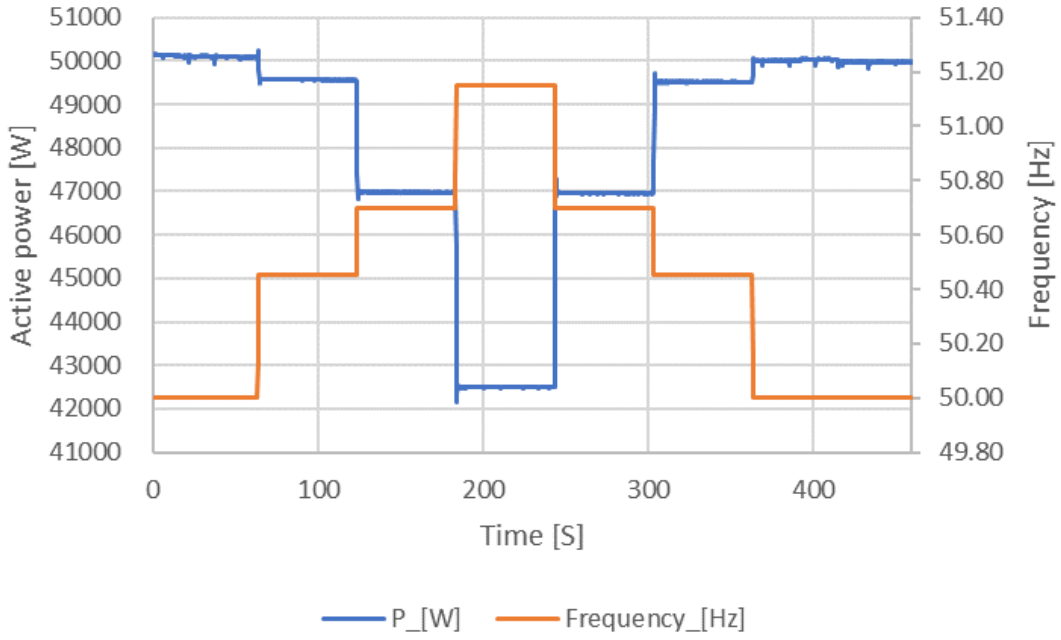


Figure 22 – Test sequence at Registered Capacity >80%

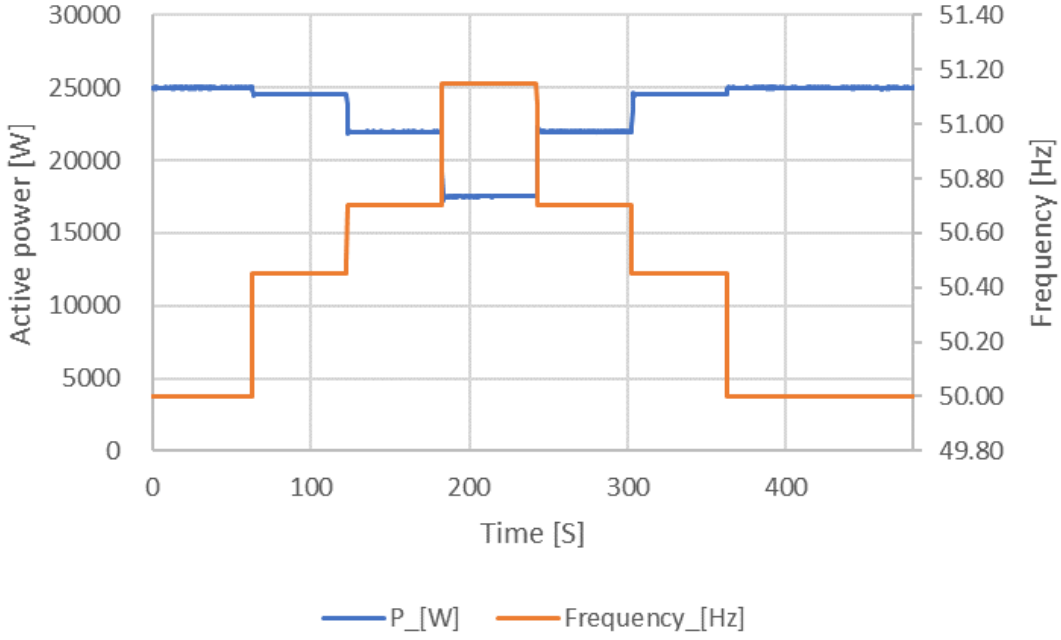


Figure 23 – Test sequence at Registered Capacity 40% - 60%

6.8 Protection – Re-connection timer

Test should prove that the reconnection sequence starts after a minimum delay of 20 s for restoration of voltage and frequency to within the stage 1 settings of Table 10.1. Both the time delay setting and the measured delay should be provided in this form; both should be greater than 20 s to pass. Confirmation should be provided that the **Power Generating Module** does not reconnect at the voltage and frequency settings below; a statement of "no reconnection" can be made.					
Time delay setting	Measured delay	Checks on no reconnection when voltage or frequency is brought to just outside stage 1 limits of Table 10.1.			
60 s	64 s	At 1.16 pu (266.2 V **LV** connection)	At 0.78 pu (180.0 V **LV** connection)	At 47.4 Hz	At 52.1 Hz
Confirmation that the **Power Generating Module** does not re-connect.		No reconnection occurred	No reconnection occurred	No reconnection occurred	No reconnection occurred

6.9 Fault level contribution

These tests shall be carried out in accordance with EREC G99 Annex A.7.1.5. Please complete each entry, even if the contribution to the fault level is zero.		
For **Inverter** output		
Time after fault	Volts	Amps
20ms	L1: 153.5 L2: 144.8 L3: 243.3	L1: 30.6 L2: 33.1 L3: 5.2
100ms	L1: 36.2 L2: 17.6 L3: 16.6	L1: 0.07 L2: 0.08 L3: 0.06
250ms	L1: 35.6 L2: 17.6 L3: 17.1	L1: 0.07 L2: 0.08 L3: 0.07
500ms	L1: 35.6 L2: 17.4 L3: 17.6	L1: 0.07 L2: 0.09 L3: 0.07
Time to trip	0.004	In seconds

6.10 Self-Monitoring solid state switching

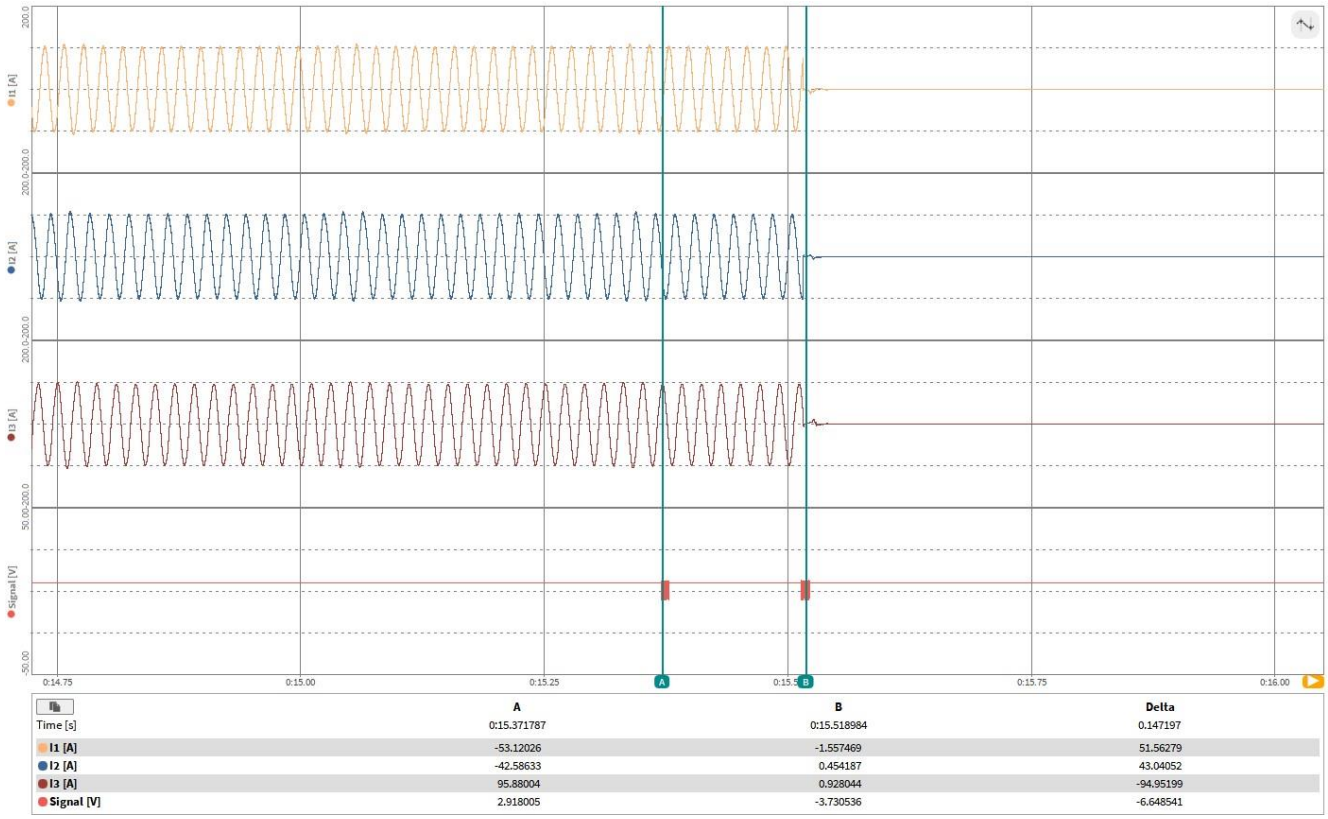
No specified test requirements. Refer to Annex A.7.1.6.	
It has been verified that in the event of the solid-state switching device failing to disconnect the **Power Park Module**, the voltage on the output side of the switching device is reduced to a value below 50 volts within 0.5 s.	N/A
Note: The PGU used electromechanical relay to disconnect from the grid. No solid-state switching device available.	

6.11 Wiring functional tests

If required by para 15.2.1.	
Confirm that the relevant test schedule is attached (tests to be undertaken at time of commissioning)	N/A
Note: Tests carried out in laboratory, specifically designed plugs and sockets used.	

6.12 Logic interface (input port)

Confirm that an input port is provided and can be used to shut down the module	Yes
Provide high level description of logic interface, e.g. details in 11.1.3.1 such as AC or DC signal (the additional comments box below can be used)	Yes
Note: For details see “Additional comments.” Below.	



	A	B	Delta
Time [s]	0:15.371787	0:15.518984	0.147197
I1 [A]	-53.12026	-1.557469	51.56279
I2 [A]	-42.58633	0.454187	43.04052
I3 [A]	95.88004	0.928044	-94.95199
Signal [V]	2.918005	-3.730536	-6.648541

Figure 24 – Test ceasing active power output using logic interface

6.13 Cyber security

Confirm that the **Power Generating Module** has been designed to comply with cyber security requirements, as detailed in 9.1.7.	Yes. Manufacturer's declaration provided. See *Annex 2 - Manufacturer's declaration regarding Cyber Security*.

Additional comments.
High level description of logic interface:

The PGU equipped with a logic interface for ceasing active power output within 5 s following an instruction being received. The following is a possible configuration (if another configuration is required, this can be agreed with the manufacturer):

EMS mode RS485 command (EMS mode is DRM mode)

Power on command	01 06 00 00 00 01 48 0A			
Power off command	01 06 00 00 00 00 89 CA			
Turn on EMS mode	01 06 00 20 00 01 49 C0			
Turn off EMS mode	01 06 00 20 00 00 88 00			
Rectify AC→DC	01 06 00 22 00 01 E8 00			
Inverter DC→AC	01 06 00 22 00 00 29 C0			
0% rater DC/AC power	01 06 00 23 00 00 78 00			
25% rater DC/AC power	01 06 00 23 00 0D B9 C5	01 06 00 23 00 19 B9 CA	01 06 00 23 00 1E F8 08	01 06 00 23 00 26 F9 DA
50% rater DC/AC power	01 06 00 23 00 19 B9 CA	01 06 00 23 00 32 F9 D5	01 06 00 23 00 3C 78 11	01 06 00 23 00 4B 38 37
75% rater DC/AC power	01 06 00 23 00 26 F9 DA	01 06 00 23 00 4B 38 37	01 06 00 23 00 5A F8 3B	01 06 00 23 00 71 B8 24
50% rated PV power	01 06 00 21 00 19 18 0A	01 06 00 21 00 32 58 15	01 06 00 21 00 3C D9 D1	01 06 00 21 00 4B 99 F7
100% rated PV power	01 06 00 21 00 32 58 15	01 06 00 21 00 64 D8 2B	01 06 00 21 00 78 D9 E2	01 06 00 21 00 96 59 AE

Rs485 instruction formula description
AB CD EF GH IJ KL MN OP
AB:485 communication address
CD:Function code
EF GH:Register address
IJ KM:Value
MN OP:CRC check value of the first 6 bits

The appendix only shows part of the power section instructions. Please write the required instructions according to the 485 instruction formula and control the ATESS Modbus RTU protocol.

Logic for remote shutdown:

The server sends instructions to the monitoring box, which is sent to the control board through a 485 command. The control board sends a hardware signal to shut down the device.

Annex 1 - Loss of Mains test according to BS EN 62116

No.	P_{EUT} [a] (% of EUT rating)	Reactive load (% of Q_L in 6.1d)1))	P_{AC} [b] (% of nominal)	Q_{AC} [c] (% of nominal)	Run on time (ms)	P_{EUT} (W)	Actual Q_f	V_{DC} (Vdc)	Remarks [d] --
1	100	100	0	0	267	49985	1.000	720	Test A at BL
2	66	66	0	0	41	33021	1.000	720	Test B at BL
3	33	33	0	0	19	16750	1.000	720	Test C at BL
4	100	100	-5	-5	223	47512	1.026	720	Test A at IB
5	100	100	-5	0	247	47517	1.053	720	Test A at IB
6	100	100	-5	+5	247	47514	1.079	720	Test A at IB
7	100	100	0	-5	254	49992	0.975	720	Test A at IB
8	100	100	0	+5	254	49988	1.025	720	Test A at IB
9	100	100	+5	-5	212	52512	0.928	720	Test A at IB
10	100	100	+5	0	208	52525	0.952	720	Test A at IB
11	100	100	+5	+5	213	52518	0.976	720	Test A at IB
12	66	66	0	-5	27	33011	0,974	640	Test B at IB
13	66	66	0	-4	41	33016	0,980	640	Test B at IB
14	66	66	0	-3	46	33019	0,985	640	Test B at IB
15	66	66	0	-2	39	33016	0,990	640	Test B at IB
16	66	66	0	-1	34	33024	0,995	640	Test B at IB
17	66	66	0	1	48	33026	1,005	640	Test B at IB
18	66	66	0	2	33	33017	1,010	640	Test B at IB
19	66	66	0	3	97	33013	1,015	640	Test B at IB
20	66	66	0	4	41	33018	1,020	640	Test B at IB
21	66	66	0	5	33	33025	1,024	640	Test B at IB
22	33	33	0	-5	44	16753	0,975	544	Test B at IB
23	33	33	0	-4	52	16759	0,980	544	Test B at IB
24	33	33	0	-3	30	16756	0,985	544	Test B at IB
25	33	33	0	-2	33	16752	0,990	544	Test B at IB
26	33	33	0	-1	32	16750	0,995	544	Test B at IB
27	33	33	0	1	55	16750	1,005	544	Test B at IB
28	33	33	0	2	46	16746	1,010	544	Test B at IB
29	33	33	0	3	29	16752	1,015	544	Test B at IB
30	33	33	0	4	45	16759	1,020	544	Test B at IB
31	33	33	0	5	38	16754	1,025	544	Test B at IB

[a] P_{EUT}: EUT output power.

[b] P_{AC}: Active power flow at S1 in Figure 1. Positive means power from EUT to utility. Nominal is the 0 % test condition value.

[c] Q_{AC}: Reactive power flow at S1 in Figure 1. Positive means power from EUT to utility. Nominal is the 0 % test condition value.

[d] BL: balance condition, IB: imbalance condition.

Annex 2 - Manufacturer's declaration regarding Cyber Security

ATESS

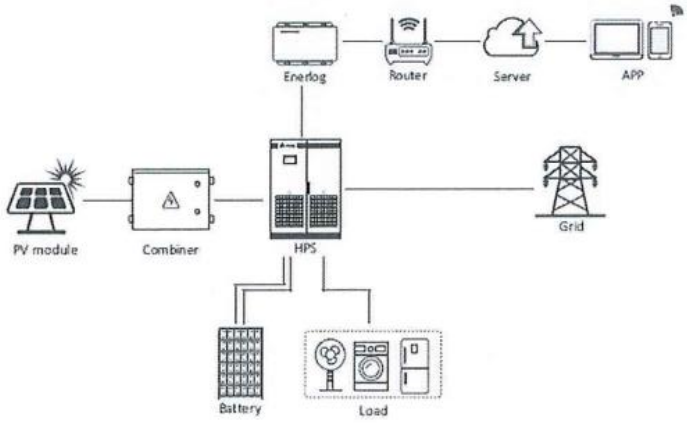
Manufacture's Declaration

Confirmation of compliance with the requirement of cybersecurity in standard G99-1

We hereby confirm that all Atess inverters listed below comply with Engineering Recommendation G99, Issue 1-Amendment 9.3 October 2022(section 9.1.7 and 9.1.8) about "cybersecurity" requirement

-Hybrid Inverter
HPS30, HPS50, HPS100, HPS120, HPS150

The cybersecurity statement is described as follow:
The communication between Atess Inverter ande external communication device is shown as following scheme:



1. All communication between the inverter and the external communication device is over the appropriate serial line (RS485), and the inverter only support ATESS's own Modbus protocol

2. The communication between the inverter and the network infrastructure normally is constituted by the communication module (WiFi-stick) on the inverter via the WLAN. The communication module (WiFi-stick) have been tested by SGS and got the certificate according to the standard ETSI EN303 645. The communication is made secure by use of Transport Layer Security technology on Communication module, and by the use of Secure Socket Layer technology on User's device side and installer/service web-tools side.

3. If the communication between the inverter and the network infrastructure normally is constituted by the third-party device, Atess needs the communication protocol provided

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by the third-party, and has reached an agreement with the Atess inverter. The data transmission can be protected by Transport Layer Security technology or Secure Socket Layer technology. The network security between third-party devices and third-party servers/clouds will be the responsibility of the third party itself.

4. The cyber-security assessment of the Atess inverter together with the Communication module(WiFi stick) was performed according to the ETSI EN303 645 standard, and the test report of Communication module(WiFi stick) can be the reference document.

Shenzhen, China 2023-06-14
Shenzhen Atess Power Technology Co.,Ltd

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Annex 3 - CE declaration

Shenzhen Atess Power Technology Co., Ltd
1st Floor of Building 3 at Sector B and 3rd Floor or Building 9, Henglong Industrial Park, Shuitian, Baoan District, Shenzhen, Guangdong Province, P.R. China
Tel: 13760487863
Email: duoxiang.yu@atesspower.com

EU Declaration ofConformity

Product: **Hybrid Inverter**
Model:**HPS 30, HPS 50**
HPS 100,HPS 120,HPS 150
Name and address of the manufacturer: Shenzhen Atess Power Technology Co., Ltd
This declaration of conformity is issued under the sole responsibility of the manufacturer. Also this product is under manufacturer's warranty.
Object of the declaration: **Hybrid InverterHPS 30, HPS 50, HPS 100,HPS 120,HPS 150**

CE

The object of the declaration described above is in conformity with the relevant Union harmonisation legislation: The Low Voltage Directive (LVD) 2014/35/EU and the Electromagnetic Compatibility (EMC) Directive 2014/30/EU.

References to the relevant harmonised standards used or references to the other technical specifications in relation to which conformity is declared:

LVD:	
EN 62109-1:2010	•
EN 62109-2:2011	•
EMC:	
EN 61000-6-11:2011+ AC:2000	•
EN 61000-6-2:2005	•

Additional information: CE mark was affixed on the product since 2018.

Yu Duoxiang
Senior Standard andCertificationEngineer
On behalf ofShenzhen Atess Power Technology Co., Ltd
2021-11-02
Place:Shenzhen,China

Annex 4 - ISO 9001 certificate

CERTIFICATE OF REGISTRATION

Certificate No.: J23Q2GZ8017353R1M

The Quality Management Systems of

Shenzhen Atess Power Technology Co., Ltd

Unified Social Credit Code:91440300MA5EHC7P3P

2nd Floor, No. 23 Zhulongtian Road, Shuitian Community, Shiyan Street, Bao'an District, Shenzhen

has been assessed by GICG and complying with

GB/T19001-2016/ISO9001:2015

For the following activities

Design and production of EV charger, energy storage inverter, electric vehicle accessories (electronic parts)

Date of Issue:	Date of Expiry:	Date of Initial Certification:
24 May 2023	**23 March 2026**	**25 March 2020**

Scan for certificate status

The granting of this certificate does not mean that the certificate holder can avoid any legal obligation. If the products or activities covered in the scope of certification require administrative license, the certificate shall be only valid within the scope of administrative licensing. The registered organization shall be subject to regular annual supervision by GICG, and the continual validity of the certificate is base upon conformity of audit. Please scan two-dimension code at left to find the certificate information. This certificate can be queried at Certification and Accreditation Administration of the People's Republic of China official website (www. cnca.gov.cn) & GICG website (www. gicg.com.cn)

GICG WeChat public number

Signature:

Guardian Independent Certification Ltd
Registered in England
114 St Martin's Lane, Covent Garden, London WC2N 4BE
Accredited by Member of IAF MLA
JAS-ANZ registration no. S3510508UL, www.jas-anz.org/register

Annex 5 - Photo of the unit

Enclosure front view

Enclosure side view

Enclosure rear view

Internal view-1

Internal view-2

»»»» **End of Test Report** ««««