TEST REPORT
Engineering Recommendation G98/1-7
Requirements for the connection of Fully Type Tested Micro-generators (up to and including 16 A per phase) in parallel with public Low Voltage Distribution Networks on or after 27 April 2019

Report	
Report Number. ..... :	6169274.50
Date of issue..... :	2023-09-19
Total number of pages ..... :	61 pages
Testing Laboratory ..... :	DEKRA Testing and Certification (Suzhou) Co., Ltd.
Address ..... :	No.99, Hongye Road, Suzhou Industrial Park, Suzhou, Jiangsu, P.R. China
Applicant's name ..... :	NINGBO AUSTA SOLAR TECH CO., LTD.
Address ..... :	No.136 1-1, Haichuan Rd, Jiangbei District, Ningbo, China
Test specification:	
Standard..... :	Engineering Recommendation G98 Issue 1 – Amendment 7: 2022
Test procedure ..... :	Type test
Non-standard test method……..:	N/A
Test Report Form No. ..... :	G98/1-7_V1.0
Test Report Form(s) Originator ..... :	DEKRA Testing and Certification (Suzhou) Co., Ltd.
Master TRF ..... :	Dated 2023-04
Test item description..... :	Hybrid inverter
Trade Mark ..... :	Austa
Manufacturer ..... :	NINGBO AUSTA SOLAR TECH CO., LTD. No.136 1-1, Haichuan Rd, Jiangbei District, Ningbo, China
Model/Type reference ..... :	AU-1P1K3G-LE-1, AU-1P1.5K3G-LE-1, AU-1P2K3G-LE-1, AU-1P2.5K3G-LE-1, AU-1P3K3G-LE-1, AU-1P3.6K3G-LE-1, AU-1P3K3G-LE, AU-1P3.6K3G-LE
Ratings ..... :	See product marking plate on page 3 and 6 and ratings of the test products in page 11 to 12.

Responsible Testing Laboratory (as applicable), testing procedure and testing location(s):			
☒	Testing Laboratory:	DEKRA Testing and Certification (Suzhou) Co., Ltd.	
Testing location/ address ..... :		No.99, Hongye Road, Suzhou Industrial Park, Suzhou, Jiangsu, P.R. China	
☐	Associated Testing Laboratory:		
Testing location/ address ..... :			
Tested by (name, function, signature) ..... :		Shine Yan (ENG)	Shine Yan
Approved by (name, function, signature) ..... :		Louis Kang (REW)	Louis Kang
☐	~~Testing procedure: TMP/CTF Stage 1:~~		
~~Testing location/ address ..... :~~			
~~Tested by (name, function, signature) ..... :~~			
~~Approved by (name, function, signature) ..... :~~			
☐	~~Testing procedure: WMT/CTF Stage 2:~~		
~~Testing location/ address ..... :~~			
~~Tested by (name + signature) ..... :~~			
~~Witnessed by (name, function, signature)..... :~~			
~~Approved by (name, function, signature) ..... :~~			
☐	~~Testing procedure: SMT/CTF Stage 3 or 4:~~		
~~Testing location/ address ..... :~~			
~~Tested by (name, function, signature) ..... :~~			
~~Witnessed by (name, function, signature)..... :~~			
~~Approved by (name, function, signature) ..... :~~			
~~Supervised by (name, function, signature)..... :~~			

Copy of marking plate:

Austa

Grid Support Interactive Inverter

Product Name	Hybrid Solar Inverter
Model Name	AU-1P1K3G-LE-1
Max. PV Voltage	550V
Max. PV Input	1.5kW
Mppt input Voltage	80~500V
Max.Input Current	18.5A*1
Max.Short Circuit Current	26A*1
AC Output (On Grid)	
Rated Output Power	1kVA
Rated Output Current	4.6 / 4.4A
Grid Voltage	220V/230V
Grid Frequency（Optional）	50Hz/60Hz
Power Factor Range	1(-0.8~+0.8 adjusable)
AC Load Output	
Rated Output Power	1kVA
Rated Output Current	4.6 / 4.4A
Nominal AC Voltage L-N	220V/230V
Nominal AC Frequency	50Hz/60Hz
Battery	
Battery Voltage Range	40V~60V
Max. charging Current	25A
Max. Discharging Current	25A
System	
Ingress Protection	IP65
Max. Efficiency	97.6%

S/N

NINGBOAUSTSOLAR TECH CO., LTD
Tel: +86 574 89137130
E-mail: marketing@osdasol.com
Website: www.austasolar.net

Made in china

Austa

Grid Support Interactive Inverter

Product Name	Hybrid Solar Inverter
Model Name	AU-1P1.5K3G-LE-1
Max. PV Voltage	550V
Max. PV Input	2.3kW
Mppt input Voltage	80~500V
Max.Input Current	18.5A*1
Max.Short Circuit Current	26A*1
AC Output (On Grid)	
Rated Output Power	1.5kVA
Rated Output current	6.9 / 6.6A
Grid Voltage	220V/230V
Grid Frequency（Optional）	50Hz/60Hz
Power Factor Range	1(-0.8~+0.8 adjusable)
AC Load Output	
Rated Output Power	1.5kVA
Rated Output Current	6.9 / 6.6A
Nominal AC Voltage L-N	220V/230V
Nominal AC Frequency	50Hz/60Hz
Battery	
Battery Voltage Range	40V~60V
Max. charging Current	40A
Max. Discharging Current	40A
System	
Ingress Protection	IP65
Max. Efficiency	97.6%

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Grid Support Interactive Inverter

Product Name	Hybrid Solar Inverter
Model Name	AU-1P2K3G-LE-1
Max. PV Voltage	550V
Max. PV Input	3kW
Mppt input Voltage	80~500V
Max.Input Current	18.5A*1
Max.Short Circuit Current	26A*1
AC Output (On Grid)	
Rated Output Power	2kVA
Rated Output current	9.1 / 8.7A
Grid Voltage	220V/230V
Grid Frequency（Optional）	50Hz/60Hz
Power Factor Range	1(-0.8~+0.8 adjusable)
AC Load Output	
Rated Output Power	2kVA
Rated Output Current	9.1 / 8.7A
Nominal AC Voltage L-N	220V/230V
Nominal AC Frequency	50Hz/60Hz
Battery	
Battery Voltage Range	40V~60V
Max. charging Current	50A
Max. Discharging Current	50A
System	
Ingress Protection	IP65
Max. Efficiency	97.6%

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Grid Support Interactive Inverter

Product Name	Hybrid Solar Inverter
Model Name	AU-1P2.5K3G-LE-1
Max. PV Voltage	550V
Max. PV Input	3.8kW
Mppt input Voltage	80~500V
Max.Input Current	18.5A*1
Max.Short Circuit Current	26A*1
AC Output (On Grid)	
Rated Output Power	2.5kVA
Rated Output current	11.4 / 10.9A
Grid Voltage	220V/230V
Grid Frequency（Optional）	50Hz/60Hz
Power Factor Range	1(-0.8~+0.8 adjusable)
AC Load Output	
Rated Output Power	2.5kVA
Rated Output Current	11.4 / 10.9A
Nominal AC Voltage L-N	220V/230V
Nominal AC Frequency	50Hz/60Hz
Battery	
Battery Voltage Range	40V~60V
Max. charging Current	63A
Max. Discharging Current	63A
System	
Ingress Protection	IP65
Max. Efficiency	97.6%

S/N

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Grid Support Interactive Inverter

Product Name	Hybrid Solar Inverter
Model Name	AU-1P3K3G-LE-1
Max. PV Voltage	550V
Max. PV Input	4.5kW
Mppt input Voltage	80~500V
Max. Input Current	18.5A*1
Max. Short Circuit Current	26A*1
AC Output (On Grid)	
Rated Output Power	3kVA
Rated Output current	13.7 / 13.1A
Grid Voltage	220V/230V
Grid Frequency（Optional）	50Hz/60Hz
Power Factor Range	1(-0.8~+0.8 adjusable)
AC Load Output	
Rated Output Power	3kVA
Rated Output Current	13.7 / 13.1A
Nominal AC Voltage L-N	220V/230V
Nominal AC Frequency	50Hz/60Hz
Battery	
Battery Voltage Range	40V~60V
Max. charging Current	80A
Max. Discharging Current	80A
System	
Ingress Protection	IP65
Max. Efficiency	97.6%

S/N

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Grid Support Interactive Inverter

Product Name	Hybrid Solar Inverter
Model Name	AU-1P3.6K3G-LE-1
Max. PV Voltage	550V
Max. PV Input	5.4kW
Mppt input Voltage	80~500V
Max.Input Current	18.5A*1
Max.Short Circuit Current	26A*1
AC Output (On Grid)	
Rated Output Power	3.6kVA
Rated Output current	16.4 / 15.7A
Grid Voltage	220V/230V
Grid Frequency（Optional）	50Hz/60Hz
Power Factor Range	1(-0.8~+0.8 adjusable)
AC Load Output	
Rated Output Power	3.6kVA
Rated Output Current	16.4 / 15.7A
Nominal AC Voltage L-N	220V/230V
Nominal AC Frequency	50Hz/60Hz
Battery	
Battery Voltage Range	40V~60V
Max. charging Current	80A
Max. Discharging Current	80A
System	
Ingress Protection	IP65
Max. Efficiency	97.6%

S/N

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Grid Support Interactive Inverter

Product Name	Hybrid Solar Inverter
Model Name	AU-1P3K3G-LE
Max. PV Input Voltage	550V
Max. Input Power	4.5kW
Mppt input Voltage	80~500V
Max.Input Current	18.5A*2
Max.Short Circuit Current	26A*2
AC Output (On Grid)	
Rated Output Power	3kVA
Rated Output current	13.7 / 13.1A
Grid Voltage	220V/230V
Grid Frequency （Optional）	50Hz/60Hz
Power Factor Range	-0.8~+0.8
AC Load Output	
Rated Output Power	3kVA
Rated AC Current	13.7 / 13.1A
Rated AC Voltage L-N	220V/230V
Rated AC Frequency	50Hz/60Hz
Battery	
Battery Voltage Range	40V~60V
Max. charging Current	80A
Max. Discharging Current	80A
System	
Ingress Protection	IP65
Max. Efficiency	97.6%

S/N

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Website: www.austasolar.net

Made in china

Austa

Grid Support Interactive Inverter

Product Name	Hybrid Solar Inverter
Model Name	AU-1P3.6K3G-LE
Max. PV Input Voltage	550V
Max. Input Power	5.4kW
Mppt input Voltage	80~500V
Max.Input Current	18.5A*2
Max.Short Circuit Current	26A*2
AC Output (On Grid)	
Rated Output Power	3.6kVA
Rated Output current	16.4 / 15.7A
Grid Voltage	220V/230V
Grid Frequency （Optional）	50Hz/60Hz
Power Factor Range	-0.8~+0.8
AC Load Output	
Rated Output Power	3.6kVA
Rated AC Current	16.4 /15.7A
Rated AC Voltage L-N	220V/230V
Rated AC Frequency	50Hz/60Hz
Battery	
Battery Voltage Range	40V~60V
Max. charging Current	80A
Max. Discharging Current	80A
System	
Ingress Protection	IP65
Max. Efficiency	97.6%

S/N

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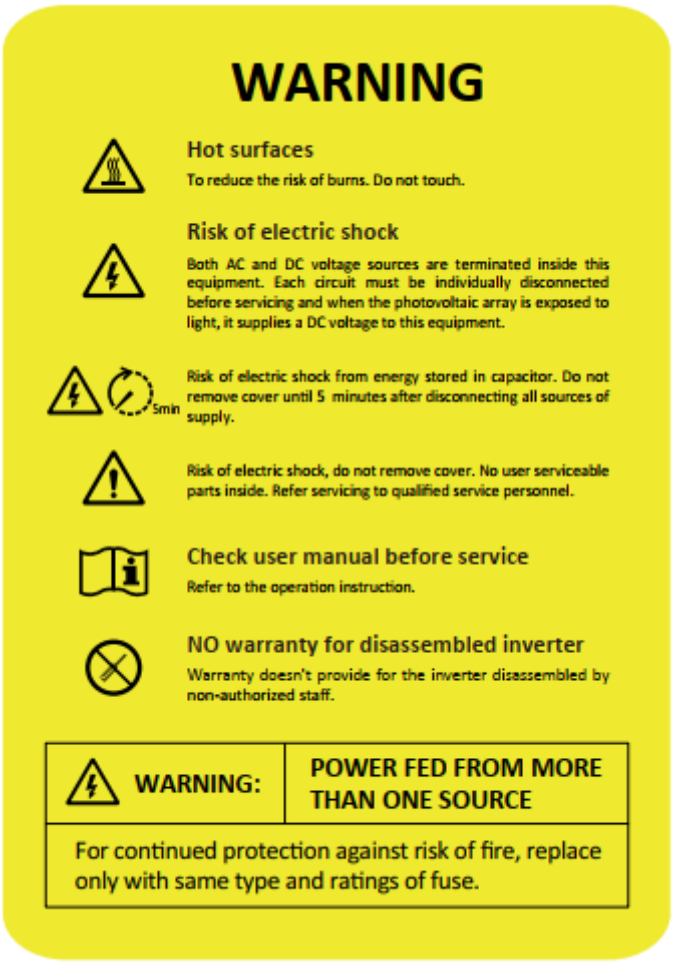
Remark:

As Great Britain public Low Voltage Distribution Networks grid code G99 required, only 230 Vac / 50Hz output setting was verified in this test report.

Warning Label:



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
Environmental 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 (%)..... :	-90% / +110%
Tested for power systems..... :	TN
IT testing, phase-phase voltage (V)..... :	N/A
Class of equipment..... :	Class I Class II Class III Not classified
Mass of equipment (kg) ..... :	Refer to the specifications table
Pollution degree ..... :	Outside PD3; Inside PD2
IP protection class ..... :	IP65
Possible test case verdicts:	
- test case does not apply to the test object ..... :	N/A
- test object does meet the requirement..... :	P (Pass)
- test object does not meet the requirement ..... :	F (Fail)
- test object does not evaluate according to manufacturer requirements ..... :	N/E
- this clause is information reference for installation.... :	Info.
Testing:	
Date of receipt of test item ..... :	2023-02-13 (samples provided by applicant)
	No sample (Amendment 1)
Date (s) of performance of tests ..... :	2023-02-14 to 2023-04-17
	No test (Amendment 1)

General remarks:

The test results presented in this report relate only to the object tested.
This report shall not be reproduced, except in full, without the written approval of the Issuing testing laboratory.
The measurement result is considered in conformance with the requirement if it is within the prescribed limit, It is not necessary to account the uncertainty associated with the measurement result.
The information provided by the customer in this report may affect the validity of the results, the test lab is not responsible for it.
This report is not used for social proof function in China market.
"(see Enclosure #)" refers to additional information appended to the report.
"(See appended table)" refers to a table appended to the report.
Throughout this report a ☐ comma / ☒ point is used as the decimal separator.

Name and address of factory (ies):

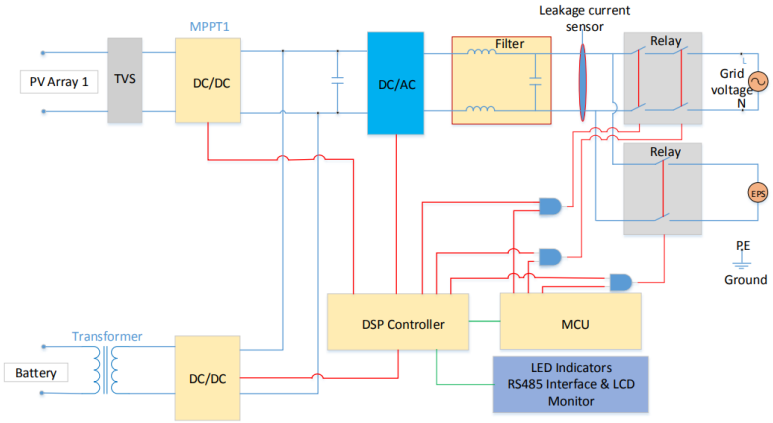
Afore New Energy Technology (Shanghai) Co., Ltd.

Building 7, No.333 Wanfang Rd, Minhang District, Shanghai, China. 201112

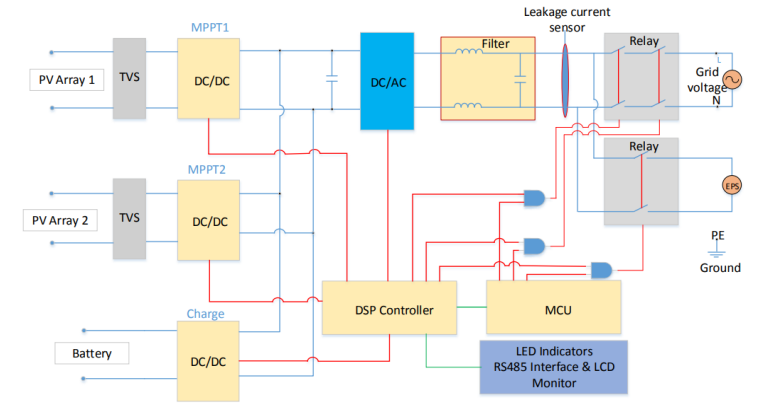
General product information:

The testing item is hybrid inverter for indoor or outdoor installation. The Inverter is single-phase type and non-isolated between BATT and AC output. The internal control is redundantly built. It contains a main DSP and a slave DSP, PE terminal on external and internal enclosure. The off-grid port is grounding when the unit workings at stand-alone mode by relay. The final used earth system shall comply the local code requirement. The inverter has adjustable power factor function. But the function is not available for this test report. All Mode are same except for output power. The function was achieved by software. And The testing performed on typical model: Max power model.

Block Diagram: AU-1P*3G-LE-1



Block Diagram: AU-1P*3G-LE



Description of the electrical circuit and functional safety (redundancy control):

The internal control is redundant built, it consists of master controller and slave controller, the master controller can control relays, measures voltage, frequency, AC current with injected DC, insulation resistance and residual current. The slave controller can control the relays, measures the voltage and frequency. Both controllers communicate with each other.

The voltage and frequency measurement achieved with resistors in serial, which are connected directly to line and neutral. Both controllers get these signals and calculate the data.

The unit provides two relays in series in each phase. The relays were test before each start up. In addition, both controllers can stop the power bridge.

Model differences:

All models are identical with hardware version and software version, the output power is derating by software.

Model AU-1P*3G-LE-1 (*=1K, 1.5K, 2K, 2.5K, 3K, 3.6K) has 1 MPPT tracker with 1 input strings.

Model AU-1P*3G-LE (*=3K, 3.6K) has 2 MPPT trackers with 2 input strings.

The product was tested on:

If no special state, the tests were performed on model AU-1P3K3G-LE.

Hardware version: V06
Software version: V06

Amendment 1 report:
The report 6169274.50 was based on the report 6151906.52 V1.1 issued by DEKRA Testing and Certification (Suzhou) Co., Ltd., issued on 2023-06-08, and AOC No.: 6151906.03 V1.1 issued by DEKRA Testing and Certification (Shanghai) Ltd., issued on 2023-06-08. It was issued due to below modifications:
---Updated Applicant's name, manufacturer's name and address, marking plate, model name and trade mark.

After technical review, no tests were considered necessary.

Specifications table						
Model	AU-1P1K3G-LE-1	AU-1P1.5K3G-LE-1	AU-1P2K3G-LE-1	AU-1P2.5K3G-LE-1	AU-1P3K3G-LE-1	AU-1P3.6K3G-LE-1
Input						
PV Max (W)	1500	2300	3000	3800	4500	5400
Vmax PV (V)	550	550	550	550	550	550
Isc PV (absolute Max.) (A)	26	26	26	26	26	26
Number of MPP trackers	1	1	1	1	1	1
Number of input strings	1	1	1	1	1	1
Max. PV input range (A)	18.5	18.5	18.5	18.5	18.5	18.5
MPPT Voltage Range (V)	80-500	80-500	80-500	80-500	80-500	80-500
Vdc range @ full power (V)	80-500	90-500	120-500	150-500	170-500	210-500
Battery (charge/discharge**)**						
Battery type	Li-ion/Lead-acid etc.					
Battery Nominal Voltage (V)	51.2					
Battery Voltage Range (V)	40-60					
Max charge/discharge Current(A)	25	40	50	63	80	80
Max charge/discharge Power(W)	1000	1500	2000	2500	3000	3600
AC Grid (input and output)						
Normal AC Voltage (VAC)	L/N/PE, 220Vac, 230Vac					
Frequency (Hz)	50 / 60					
Max. cont. Current (A)	5	7	10	12	14	17
Nominal Power (VA)	1000	1500	2000	2500	3000	3600
Max. Power (W)	1000	1500	2000	2500	3000	3600
Max. apparent Power (VA)	1000	1500	2000	2500	3000	3600
Power factor(adjustable)	1.0(-0.8~ +0.8)					
AC Load output						
Normal Voltage (VAC)	L/N/PE, 220Vac, 230Vac					
Frequency (Hz)	50 / 60					
Max. cont. Current (A)	5	7	10	12	14	17
Nominal Output Power (W)	1000	1500	2000	2500	3000	3600
Max. output Power (W)	1000	1500	2000	2500	3000	3600
Max. apparent Power (VA)	1000	1500	2000	2500	3000	3600
Power factor	1.0					
Others						
Ingress protection (IP)	IP65					
Protective class	Class I					
Temperature (℃)	-25°C to +60°C (Derating 45°C)					
Inverter Isolation	Non-isolated (PV-AC-BAT)					
Overvoltage category	OVC III (AC Main), OVC II (PV)					

Specifications table		
Model	AU-1P3K3G-LE	AU-1P3.6K3G-LE
Input		
PV Max (W)	4500	5400
Vmax PV (V)	550	550
Isc PV (absolute Max.) (A)	26 x 2	26 x 2
Number of MPP trackers	2	2
Number of input strings	1/1	1/1
Max. PV input range (A)	18.5 x 2	18.5 x 2
MPPT Voltage Range (V)	80-500	80-500
Vdc range @ full power (V)	90-500	110-500
Battery (charge/discharge**)**		
Battery type	Li-ion/Lead-acid etc.	
Battery Nominal Voltage (V)	51.2	
Battery Voltage Range (V)	40-60	
Max charge/discharge Current(A)	80	80
Max charge/discharge Power(W)	3000	3600
AC Grid (input and output)		
Normal AC Voltage (VAC)	L/N/PE, 220Vac, 230Vac	
Frequency (Hz)	50 / 60	
Max. cont. Current (A)	14	17
Nominal Power (VA)	3000	3600
Max. Power (W)	3000	3600
Max. apparent Power (VA)	3000	3600
Power factor(adjustable)	1.0(-0.8~ +0.8)	
AC Load output		
Normal Voltage (VAC)	L/N/PE, 220Vac, 230Vac	
Frequency (Hz)	50 / 60	
Max. cont. Current (A)	14	17
Nominal Output Power (W)	3000	3600
Max. output Power (W)	3000	3600
Max. apparent Power (VA)	3000	3600
Power factor	1.0	
Others		
Ingress protection (IP)	IP65	
Protective class	Class I	
Temperature (℃)	-25°C to +60°C (Derating 45°C)	
Inverter Isolation	Non-isolated (PV-AC-BAT)	
Overvoltage category	OVC III (AC Main), OVC II (PV)	

G98/1-7			
Clause	Requirement - Test	Result - Remark	Verdict
5	**CONNECTION PROCEDURE**		-
5.1	**Single Premises Connection Procedure**		-
5.1.1	In most instances the installation of Micro-generating Plant, the aggregate Registered Capacity of which is no greater than 16 A per phase, connected in parallel with the public Low Voltage Distribution Network, will have negligible impact on the operation of the public Low Voltage Distribution Network; as such there will be no need for the DNO to carry out detailed network studies to assess the impact of the connection. As required by the ESQCR Certificate of Exemption (2008) the Installer shall provide the DNO with all necessary information on the installation no later than 28 days after the Micro-generating Plant has been commissioned; the format and content shall be as shown in Appendix 3 Form B Installation Document.		Info.
5.1.2	This procedure will not apply where an Installer plans (within the next 28 days) or has already installed (in the previous 28 days) other Micro-generating Plants in a Close Geographic Region; in this case the procedure in 5.2 shall be followed. Failure to comply with this requirement may lead to the disconnection of the Micro-generating Plant under ESQCR (26) or failure of the Micro-generating Plant to operate as intended.		Info.
5.2	**Multiple Premises Connection Procedure**		-
5.2.1	In the case of projects where the proposal is to install single or multiple Micro-generators in a number of Customer Installations in a Close Geographic Region, the Installer shall discuss the installation project with the local DNO at the earliest opportunity. The DNO will need to assess the impact that these connections may have on the Distribution Network and specify conditions for connection. The initial application will need to be in a format similar to that shown in Appendix 3 Form A. Connection of the Micro-generator is only allowed after the application for connection has been approved by the DNO and any DNO works facilitating the connection have been completed. Confirmation of the commissioning of each Micro-generator will need to be made no later than 28 days after commissioning; the format and content shall be as shown in Appendix 3 Form B Installation Document.		Info.
5.2.2	Upon receipt of a multiple premises connection application the DNO's response will be in accordance with the electricity generation standards set by the Authority for applications for connection to the Distribution Network.		Info.
5.3	**General**		Info.

G98/1-7			
Clause	Requirement - Test	Result - Remark	Verdict
5.3.1	It is the responsibility of the Installer to ensure that the relevant information as specified in this section and in section 6 is forwarded to the local DNO as appropriate. The pro formas in Appendix 3 are designed to: a) simplify the connection procedure for both DNO and Micro-generator Installer; b) provide the DNO with all the information required to assess the potential impact of the Micro-generator connection on the operation of the Distribution Network; c) inform the DNO that the Micro-generator installation complies with the requirements of this EREC G98; and d) allow the DNO to accurately record the location of all Micro-generators connected to the Distribution Network.		Info.
6	**CERTIFICATION REQUIREMENTS**		P
6.1	**Type Test Certification**		P
6.1.1	Type Tested certification is the responsibility of the Manufacturer. The Manufacturer shall make available upon request a Type Test Verification Report confirming that the Micro-generator has been tested to satisfy the requirements of this EREC G98. The report shall detail the type and model of Micro-generator tested, the test conditions and results recorded. All of these details shall be included in a Type Test Verification Report. The required verification report and declaration are shown in Appendix 3 Form C. It is intended that Manufacturers of Micro-generators will use the requirements of this EREC G98 to develop type verification certification for each of their Micro-generator models.		P
6.1.2	Manufacturers of a Fully Type Tested Micro-generator should allocate a Manufacturer's reference number with the required details of the Micro-generator with the Energy Networks Association Type Test Verification Report Register.		P
6.2	**Compliance**		P
6.2.1	Compliance with the requirements detailed in this EREC G98 will ensure that the Micro-generator(s) is considered to be approved for connection to the DNO's Distribution Network.		P
6.2.2	The Micro-generator(s) shall conform to all relevant European Directives and should be labelled with a CE marking.		P
6.3	**Family approach to Type Testing**		P

G98/1-7			
Clause	Requirement - Test	Result - Remark	Verdict
6.3.1	A family approach to type testing is acceptable, whereby Micro-generators that are the same model and produced by the same Manufacturer but vary in electrical output can be considered to be Fully Type Tested once one Micro-generator in the family has been shown to be compliant.4 The approach is permissible in the following range of Micro-generator electrical output:		P
	• For synchronous Micro-generators: o Lower limit: 1/√10 (0.3162) times the tested Micro-generator nameplate rating (W) o Upper limit: √10 (3.162) times the tested Micro-generator nameplate rating (W)		N/A
	• For all other Micro-generators: o Lower limit: 1/√10 (0.3162) times the tested Micro-generator nameplate rating (W) o Upper limit: 2 times the tested Micro-generator nameplate rating (W)		P
6.3.2	All absolute values (e.g. operating range tests) from the tested Micro-generator shall be transferred directly in the compliance forms of an assumed compliant Microgenerator of the same family. All relative results related to design Active Power or current (e.g. power quality fluctuation and flicker) from the tested Micro-generator shall be transferred to the compliance form of a Micro-generator in the same family according to the ratio of the respective nameplate rating (W) of the tested Microgenerator and the assumed compliant Micro-generator. For the avoidance of doubt, the Manufacturer shall register each Micro-generator in the family on the Energy Networks Association Type Test register.		P
6.3.3	It is the responsibility of the Manufacturer to provide technical justification that the results are transferable. For example, the Micro-generators have the same control systems.		P
7	**OPERATION AND SAFETY**		P
7.1	**Operational Requirements**		P
7.1.1	Compliance with this EREC G98 in respect of the design, installation, operation and maintenance of a Micro-generating Plant, will ensure that the Customer is discharging their legal obligations under ESQCR 22(1)(a) and the EU Network Code on Requirements for Grid Connection of Generators.		P
7.2	**Installation Wiring and Isolation**		Info.

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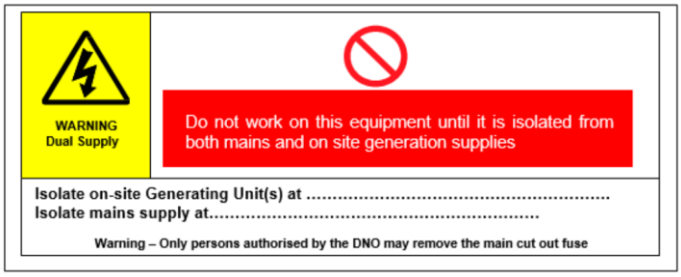
Clause	Requirement - Test	Result - Remark	Verdict
7.2.1	The installation that connects the Micro-generating Plant to the Connection Point shall comply with the requirements of BS 7671. All wiring between the Connection Point and the Micro-generator(s) shall be protected by a suitably rated protective device and shall be of suitable size and type for the rating of the Micro-generator. The Micro-generator(s) shall be connected via an accessible isolation switch that is capable of isolating all phases and neutral. The isolation switch shall be capable of being secured in the 'off' (isolated) position.	Must be taken under consideration for the installation.	Info.
7.3	**Labelling**		Info.
7.3.1	The Installer shall provide labelling at the Connection Point with the DNO's Distribution Network (cut-out), meter position, consumer unit and at all points of isolation between the Connection Point and the Micro-generating Plant within the Customer's premises to indicate the presence of a Micro-generating Plant. The labelling should be sufficiently robust and if necessary fixed in place to ensure that it remains legible and secure for the lifetime of the installation. Warning labels of the form shown in Figure 1 shall be used. It should be noted that the warning label does not imply a right on the Customer, Installer or maintainer to operate (remove / replace) the DNO's cut-out fuse and a note to this effect should be included on the warning label.  **Figure 1 – Example of a Warning Label**	Must be taken under consideration for the installation.	Info.
7.3.2	In addition to the warning label, this EREC G98 requires the following, up to date, information to be displayed at the Connection Point with the DNO's Distribution Network.		Info.
	a) A circuit diagram relevant to the installation showing the circuit wiring, including all protective devices, between the Micro-generator and the DNO's fused cut-out. This diagram should also show by whom all apparatus is owned and maintained; and	Must be taken under consideration for the installation.	Info.
	b) A summary of the Interface Protection settings incorporated within the Micro-generator.	Must be taken under consideration for the installation.	Info.

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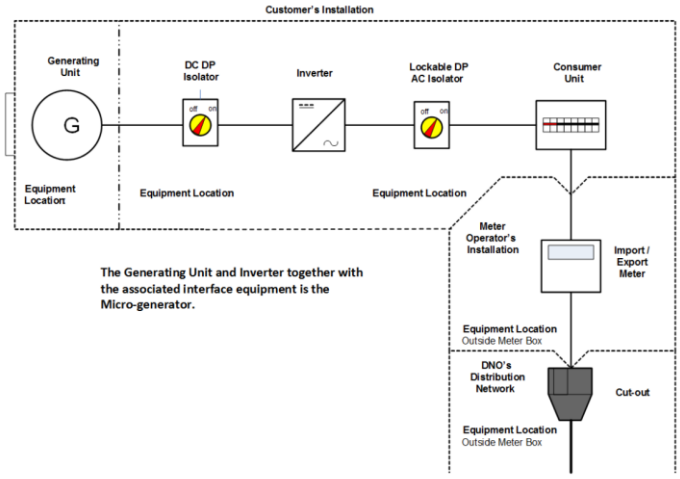
Clause	Requirement - Test	Result - Remark	Verdict
7.3.3	Figure 2 shows an outline example of the type of circuit diagram that will need to be displayed. Figure 2 is non-prescriptive and is for illustrative purposes only.  **Figure 2 – Example of the type of circuit diagram**		Info.
7.3.4	The Installer shall advise the Customer that it is the Customer's responsibility to ensure that this safety information is kept up to date. The installation operating instructions shall contain the Manufacturer's contact details eg name, telephone number and web address.	Must be taken under consideration for the installation.	Info.
7.4	**Maintenance & Routine Testing**		N/A
7.4.1	Periodic testing of the Micro-generator is recommended at intervals prescribed by the Manufacturer. This information shall be included in the installation and user instructions. The method of testing and/or servicing should be included in the servicing instructions.	Must be taken under consideration after the installation.	N/A
7.5	**Phase Unbalance**		N/A
7.5.1	There is no requirement to balance phases on installations below or equal to 16 A per phase.		N/A
7.5.2	For multiple installations of Micro-generators (eg new housing developments), balancing the Micro-generators evenly against the load on the three phases will need to be considered by the DNO. The DNO will advise the Installer of any phase balancing requirements.	Single phase	N/A
7.6	**Voltage Management Units**		P

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Clause	Requirement - Test	Result - Remark	Verdict
7.6.1	If a Voltage Management Unit is installed in a Customer's Installation between the Connection Point and the Micro-generator, it may result in the voltage at the Micro-generator side of the Voltage Management Unit remaining within the limits of the protection settings defined in Table 2 while the voltage at the Connection Point side of the unit might be outside the limits of the protection settings. This would negate the effect of the protection settings. Therefore, this connection arrangement is not acceptable and all Micro-generators connected to the DNO's LV Distribution Network under this EREC G98 shall be made on the Connection Point side of any Voltage Management Unit installed in a Customers' Installation.		P
7.7	**Earthing**		P
7.7.1	There shall be no direct connection between the Micro-generator current carrying conductors and earth with the following exception: For a Micro-generator that is connected via an Inverter (eg a PV array or fuel cell) it is permissible to connect one pole of the DC side of the Inverter to the DNO's earth terminal if the insulation between the AC and the DC sides of the Inverter meets the requirements for at least simple separation. The requirements for simple separation are those given in Section 5.3.3 of BS EN 60664-1 for basic insulation. In such cases the Installer shall take all reasonable precautions to ensure that the Micro-generating Plant will not impair the integrity of the DNO's Distribution Network and will not suffer unacceptable damage for all credible operating conditions, including faults on the DNO's Distribution Network.		P
7.7.2	Earthing of all exposed conductive parts shall comply with the requirements of BS 7671.		P
8	**COMMISSIONING, NOTIFICATION AND DECOMMISSIONING**		Info.
8.1	**General**		Info.
8.1.1	The installation shall be carried out by Installers who are competent and have sufficient skills and training (complete with recognised and approved qualifications relating to the fuels used and general electrical installations) to apply safe methods of work to install a Micro-generator in compliance with this EREC G98.	Must be taken under consideration for the installation.	Info.
	Notwithstanding the requirements of this EREC G98, the installation will be carried out to no lower a standard than that required in the Manufacturer's installation instructions.		Info.
8.2	**Commissioning**		Info.
8.2.1	No parameter relating to the electrical connection and subject to type verification certification shall be modified unless previously agreed in writing between the DNO and the Customer or their agent. Customer access to such parameters shall be prevented.		Info.

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Clause	Requirement - Test	Result - Remark	Verdict
8.2.2	As part of the on-site commissioning tests the Installer shall carry out a functional check of the loss of mains protection, for example by removing the supply to the Micro-generator during operation and checking that the Interface Protection operates to disconnect the Micro-generator from the DNO's Distribution Network. For three phase installations this test can be achieved by opening a three phase circuit breaker or isolator and confirming that the Micro-generator has shut down. Testing for the loss of a single phase is covered in the type testing of Inverters, see section 10.2.		Info.
8.3	**Notification of Commissioning**		Info.
8.3.1	In accordance with ESQCR and the HSE Certificate of Exemption (2008) (see Appendix 4) the Installer shall ensure that the DNO is advised of the intention to use the Micro-generator in parallel with the Distribution Network no later than 28 days (inclusive of the day of commissioning) after commissioning the Micro-generator. Notification that the Micro-generator has been commissioned is achieved by completing an Installation Document as per Appendix 3 Form B (Installation Document), which also includes the relevant details on the Micro-generator installation required by the DNO.		Info.
8.3.2	The Installer shall supply separate Installation Documents for each premises in which Micro-generators are installed under EREC G98. Documentation may be submitted via an agent acting on behalf of the Installer and may be submitted electronically.		Info.
8.4	**Notification of Changes**		Info.
8.4.1	If a Micro-generator requires modification the Manufacturer must re-submit the Type Test Verification Report prior to the modification being made and the Micro-generator being recommissioned.		Info.
8.4.2	The DNO shall be notified of any operational incidents or failures of a Micro-generator that affect its compliance with this EREC G98, without undue delay, after the occurrence of those incidents.		Info.
8.4.3	The DNO shall have the right to request that the Customer arrange to have compliance tests undertaken after any failure, modification or replacement of any equipment that may have an impact on the Micro-generator's compliance with this EREC G98.		Info.

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Clause	Requirement - Test	Result - Remark	Verdict
8.4.4	Where an existing Micro-generator installed under EREC G83 is substantially modified (eg a significant piece of equipment, such as an inverter, is replaced) then it will be necessary for that Micro-generator to be modified to be compliant with this EREC G98. Modifications to an existing Micro-generator which complies with the requirements of EREC G83 that are not considered to be substantial do not change the compliance requirements of that Micro-generator, ie it can remain compliant with EREC G83.		Info.
8.5	**Notification of Decommissioning**		Info.
8.5.1	The Customer shall notify the DNO about the permanent decommissioning of a Micro-generator by providing the information as detailed under Appendix 3 Form D. Documentation may be submitted by an agent acting on behalf of the Customer and may be submitted electronically.		Info.
9	**GENERAL TECHNICAL REQUIREMENTS**		P
9.1	**Frequency withstand**		P
9.1.1	The Micro-generator shall be capable of remaining connected to the Distribution Network and operating within the frequency ranges and time periods specified in Table 1 unless disconnection was triggered by rate-of-change-of-frequency-type loss of mains protection.		P
	Table 1 – Minimum time periods for which a Micro-generator has to be capable of operating within different frequency ranges without disconnecting from the Distribution Network 47.0 Hz – 47.5 Hz: 20 seconds 47.5 Hz – 48.5 Hz: 90 minutes 48.5 Hz -49.0 Hz: 90 minutes 49.0 Hz – 51.0 Hz: Unlimited 51.0 Hz – 51.5 Hz: 90 minutes 51.5 Hz – 52.0 Hz: 15 minutes	See appended table.	P
9.2	**Rate of Change of Frequency**		P
9.2.1	With regard to the rate of change of frequency withstand capability, a Micro-generator shall be capable of staying connected to the Distribution Network and operate at rates of change of frequency up to 1.0 Hzs^{-1} measured over 500 ms.	See appended table.	P
9.3	**Limited Frequency Sensitive Mode – Overfrequency**		P

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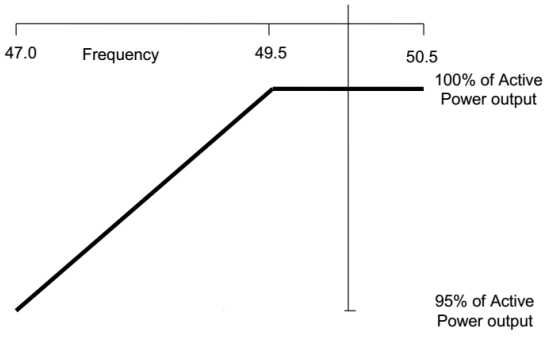
Clause	Requirement - Test	Result - Remark	Verdict
9.3.1	With regard to the Limited Frequency Sensitive Mode — Overfrequency (LFSMO), the Micro-generator shall be capable of reducing its Active Power output when the frequency rises above 50.4 Hz. The Droop shall be 10%. No intentional delay should be programmed to ensure that the initial delay is as short as possible with a maximum of 2 s.	See appended table.	P
9.3.2	The Micro-generator will continue to reduce power with rising frequency with a Droop of 10% until 52.0 Hz, at which point the Micro-generator should disconnect.		P
9.3.3	If the reduction in Active Power output is such that the Micro-generator reaches its minimum stable operating level, it shall continue to operate stably at this level.		P
9.3.4	Steady state operation below a Micro-generator's minimum stable operating level is not expected but if system frequency would cause operation below its minimum stable operating level then the Micro-generator shall be able to deliver an output of not less than the minimum stable operating level.		P
9.4	**Active Power Output**		P
9.4.1	The Micro-generator shall be capable of maintaining constant output at its Registered Capacity regardless of changes in frequency, except where the output follows the changes defined in the context of paragraphs 9.3.1 and 9.4.2.		P
9.4.2	The Micro-generator shall be capable of maintaining constant Active Power output at its Registered Capacity regardless of changes in frequency in the range 49.5 – 50.4 Hz. Below 49.5 Hz, the Active Power output should not drop by more than prorata with frequency, ie the maximum permitted requirement is 100% power at 49.5 Hz falling linearly to 95% power at 47.0 Hz as illustrated in Figure 3.  **Figure 3 – Change in Active Power output with falling frequency**	See appended table.	P

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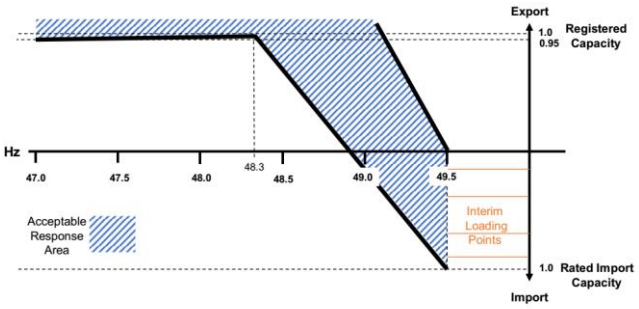
Clause	Requirement - Test	Result - Remark	Verdict
9.4.3	This paragraph describes an optional performance characteristic as discussed in the foreword. A Micro-generating Plant that incorporates an Electricity Storage device can support the Total System by being arranged to automatically respond to falling frequency in line with the characteristic of Figure 4.  **Figure 4 Change in Active Power of Electricity Storage with falling frequency** (not to scale)		P
	The required characteristics are: (a) When the frequency falls to 49.5 Hz the automatic response shall start; (b) The frequency response characteristic shall be within the shaded area of Figure 4; (c) If the Electricity Storage device is not capable of moving from an import level to an appropriate export level within 20 s of the frequency falling to 49.2 Hz, then it shall cease to import; and (d) If the Electricity Storage device has not achieved at least zero Active Power import when the frequency has reached 48.9 Hz it shall cease to import immediately.		P
9.4.4	The Micro-generator shall be equipped with a logic interface (input port) in order to cease Active Power output within 5 s following an instruction being received from the DNO at the input port. By default the logic interface will take the form of a simple binary output that can be operated by a simple switch or contactor. When the switch is closed the Micro-generator can operate normally. When the switch is opened the Micro-generator will reduce its Active Power to zero within 5 s. The signal from the Micro-generator that is being switched can be either AC (maximum value 240 V) or DC (maximum value 110 V). The DNO may specify any additional requirements particularly regarding remote operation of this facility.		P
9.5	**Power Factor**		P
9.5.1	The power factor capability of the Micro-generator shall conform to EN 50549-1. When operating at Registered Capacity the Micro-generator shall operate at a power factor within the range 0.95 lagging to 0.95 leading relative to the voltage waveform unless otherwise agreed with the DNO eg for power factor improvement.	See appended table.	P

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Clause	Requirement - Test	Result - Remark	Verdict
9.6	**Automatic Connection**		P
9.6.1	Micro-generators shall conform to EN 50549-1 in respect of connection and starting to generate electric power. Connection, reconnection and starting to generate electrical power is only allowed after the voltage and frequency at the Connection Point is within the limits of the Interface Protection settings for a minimum of 20 s.		P
9.7	**Cyber Security**		N/E
9.7.1	Every Micro-generator and any associated equipment must be designed and operated appropriately to ensure cyber security. The Manufacturer or Installer shall consider all cyber security risks applicable to the Micro-Generator both in terms of the communication between any home energy management system etc and also in terms of interaction with any system of the Manufacturer for product management.	Compliance of cyber security is responsible for client and evaluated by manufacturer.	N/E
9.7.2	The Manufacturer or Installer shall provide information describing the high level cyber security approach, as well as the specific cyber security requirements complied with. The statement will make appropriate reference to the Micro-generator's compliance with		N/E
	• ETSI EN 303 645;		N/E
	• relevant aspects of PAS 1879 "Energy smart appliances – Demand side response operation – Code of practice;		N/E
	• relevant aspects of "Distributed Energy Resources – Cyber Security Connection Guidance" published by BEIS and the ENA;		N/E
	• Any other relevant standard that has been incorporated in the design of the Micro-Generator.		N/E
10	**INTERFACE PROTECTION**		P
10.1	**General**		P
10.1.1	The Micro-generator shall conform to the Interface Protection settings set out below (Table 2). Means shall be provided to protect the settings from unpermitted interference (eg via a password or seal).	Interface protection settings protected via a password.	P
10.1.2	The DNO is responsible under the Distribution Code for ensuring, by design, that the voltage and frequency at the Connection Point remains within statutory limits. The Interface Protection settings have been chosen to allow for voltage rise or drop within the Customer's Installation and to allow the Micro-generator to continue to operate outside of the statutory frequency range as required by the EU Network Code on Requirements for Grid Connection of Generators.		P

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Clause	Requirement - Test	Result - Remark	Verdict
10.1.3	Interface Protection shall be installed which disconnects the Micro-generator from the DNO's Distribution Network when any parameter is outside of the settings shown in Table 2. **Table 2 – Interface Protection settings** Protection Function / Trip Setting / Time Delay Setting U/V / Vφ-n† - 20% = 184 V / 2.5 s O/V stage 1 / Vφ-n† +14% = 262.2 V / 1.0 s O/V stage 2 / Vφ-n†+ 19% = 273.7 V3 / 0.5 s U/F stage 1 / 47.5 Hz / 20 s U/F stage 2 / 47 Hz / 0.5 s O/F / 52 Hz / 0.5 s LoM (RoCoF) / 1.0 Hzs-1 / † A value of 230 V phase to neutral	See appended table.	P
10.1.4	The total disconnection time for voltage and frequency protection, including the operating time of the disconnection device, shall be the time delay setting with a tolerance of, -0s + 0.5 s.		P
10.1.5	For the avoidance of doubt, where the Distribution Network voltage or frequency exceed the trip settings in Table 2, for less than the time delay setting, the Micro-generator should not disconnect from the Distribution Network.		P
10.1.6	Fully Type Tested Micro-generators shall have protection settings set during manufacture.		P
10.1.7	The Manufacturer shall establish a secure way of displaying the Interface Protection setting information in one of the following ways:		P
	• A display on a screen; • A display on a PC which can communicate with the Micro-generator and confirm that it is the correct Micro-generator by means of a serial number permanently fixed to the Micro-generator and visible on the PC screen at the same time as the settings; or • Display of all Interface Protection settings and nominal voltage and current outputs, alongside the serial number of the Micro-generator, permanently fixed to the Micro-generator.		P
10.1.8	The provision of loose documents, documents attached to the Micro-generator by cable ties etc, or provision of data on adhesive paper based products which are not likely to survive due to fading, or failure of the adhesive, for at least 20 years is not acceptable.		P
10.1.9	In response to a protection operation the Micro-generator shall be automatically disconnected from the DNO's Distribution Network. This disconnection must be achieved preferably by the separation of mechanical contacts or alternatively by the operation of a suitably rated solid state switching device.		P

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Clause	Requirement - Test	Result - Remark	Verdict
10.1.10	The Interface Protection shall function correctly, ie operate within the required tolerance range as given in paragraph 10.1.4, across the expected range of ambient operating temperatures and other environmental factors.		P
10.1.11	Where a common protection system is used to provide the protection function for multiple Micro-generators the complete installation cannot be considered to comprise Fully Type Tested Micro-generators if the protection and connections are made up on site and so cannot be factory tested or Fully Type Tested. In accordance with Annex A1 or Annex A2 if the units or Micro-generators are specifically designed with plugs and sockets to be interconnected on site, then provided the assembly passes the function tests required in Appendix 3 Form C, the Micro-generator(s) can retain Fully Type Tested status.		N/A
10.1.12	Once the Micro-generator has been installed and commissioned the protection settings shall only be altered following written agreement between the DNO and the Customer or their agent.	Interface protection settings protected via a password and can't be change by user.	P
10.2	**Loss of Mains Protection**		P
10.2.1	Loss of mains protection shall be incorporated and tested as defined in the compliance type testing annex of this EREC G98. Active methods which use impedance measuring techniques by drawing current pulses from or injecting AC currents into the DNO's Distribution Network are not considered to be suitable. For Micro-generators which generate on more than one phase, the loss of mains protection should be able to detect the loss of a single phase of the supply network. This should be tested during type testing and recorded in the Type Test Verification Report as per Appendix 3 Form C.	See appended table.	P
10.3	**Frequency Drift and Step Change Stability Test**		P
10.3.1	Under normal operation of the Distribution Network, the frequency changes over time due to continuous unbalance of load and generation or can experience a step change due to the loss of a Distribution Network component which does not cause a loss of supply.		P
10.3.2	In order to ensure that such phenomena do not cause unnecessary tripping of Micro-generators, stability type tests shall be carried out.		P
10.3.3	The Rate of Change of Frequency (RoCoF) and Vector Shift values required for these tests are marginally less than the corresponding protection settings for RoCoF in Table 2 and vector shifts of up to 50º. Both stability tests shall be carried out in all cases.	See appended table.	P

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Clause	Requirement - Test	Result - Remark	Verdict
10.3.4	The stability tests are to be carried out as per the table in Appendix 3 Form C of this document and the Micro-generator should remain connected during each and every test. The tests shall check that the Micro-generator remains stable and connected during the following scenarios: • RoCoF: 0.95 Hzs-1 from 49.0 Hz to 51.0 Hz on both rising and falling frequency; and • Vector shift: 50º plus from 49.5 Hz and 50º minus from 50.5 Hz.	See appended table.	P
11	**QUALITY OF SUPPLY**		P
11.1	The connection and operation of a Micro-generator in parallel with a DNO's Distribution Network shall not impair the quality of supply provided by the DNO to any Customers. In this respect the Micro-generator shall comply with: • EN 61000-3-2 Class A for harmonics; and • EN 61000-3-3 for voltage fluctuation and flicker with a d_{max} value of 4%.	See appended table.	P
11.2	**DC injection**		P
11.2.1	The upper limit for DC injection is 0.25% of AC current rating per phase.	See appended table.	P
11.3	**Electromagnetic Compatibility (EMC)**		P
11.3.1	All equipment shall conform to the generic EMC standards: BS EN61000-6-3: Electromagnetic Compatibility, Generic Emission Standard; and BS EN61000-6-1: Electromagnetic Compatibility, Generic Immunity Standard	Refer to report number 230500429SHA-V2 from Intertek Testing Services Shanghai	P
11.4	**Short Circuit Current Contribution**		P
11.4.1	Directly Coupled Micro-generators		N/A
	The Manufacturer shall establish the maximum short circuit current contribution from the Micro-generator and the conditions under which this exists. This shall be determined in accordance with Annex A.2.3.4.		N/A
	The Manufacturer shall establish the maximum short circuit current contribution from the Micro-generator and the conditions under which this exists. This shall be determined in accordance with Annex A.2.3.4.		N/A
11.4.2	Inverter Connected Micro-generators		P
	DNOs need to understand the contribution that Inverters make to system fault levels in order to determine that they can continue to safely operate their Distribution Networks without exceeding design fault levels for switchgear and other circuit components.		P

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Clause	Requirement - Test	Result - Remark	Verdict
	As the output from an Inverter reduces to zero when a short circuit is applied to its terminals, a short circuit test does not represent the worst case scenario; in most cases the voltage will not collapse to zero for a Distribution Network fault.		P
	To address this issue a test, which ensures that at least 10% of nominal voltage remains and which allows the Micro-generator to feed into a load with an X to R ratio of 2.5, is specified as detailed in Annex A1.3.5.		P
APPENDIX 1	**EMERGING TECHNOLOGIES AND OTHER EXCEPTIONS**		N/A
APPENDIX 2	**CONNECTION PROCEDURE FLOW CHART**		Info.
APPENDIX 3	**MICRO-GENERATOR DOCUMENTATION**		P
APPENDIX 4	**RELAXATION OF COMMISSIONING NOTIFICATION TIMESCALES FOR MICRO-GENERATOR: HSE CERTIFICATE OF EXEMPTION (AUGUST 2008)**		N/A

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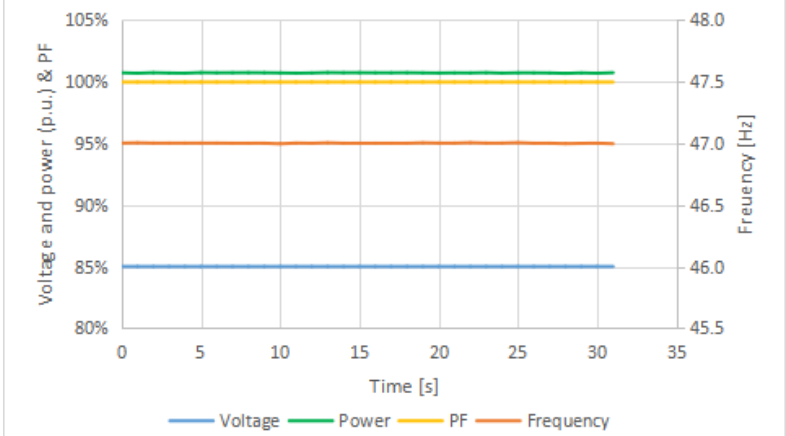
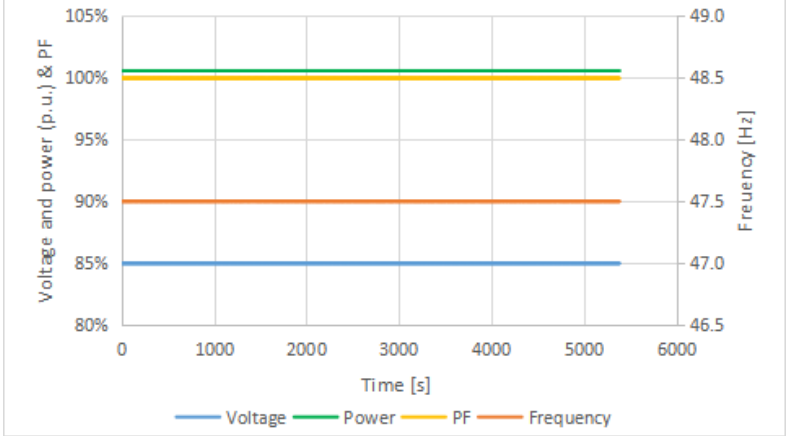
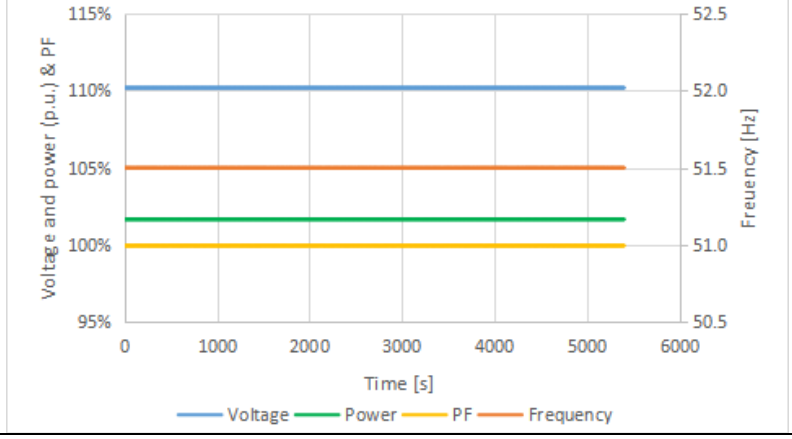
Clause	Requirement - Test	Result - Remark	Verdict

Appendix 1: Type Verification Test Report

Form C: Type Test Verification Report	
1. Operating Range:	**P**
This test should be carried out as specified in A.1.2.10. 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.	
Test 1 Voltage = 85% of nominal (195.5 V), Frequency = 47.0 Hz, Power Factor = 1, Period of test 20 s	
Test 2 Voltage = 85% of nominal (195.5 V), Frequency = 47.5 Hz, Power Factor = 1, Period of test 90 minutes	
Test 3 Voltage = 110% of nominal (253 V), Frequency = 51.5 Hz, Power Factor = 1, Period of test 90 minutes	

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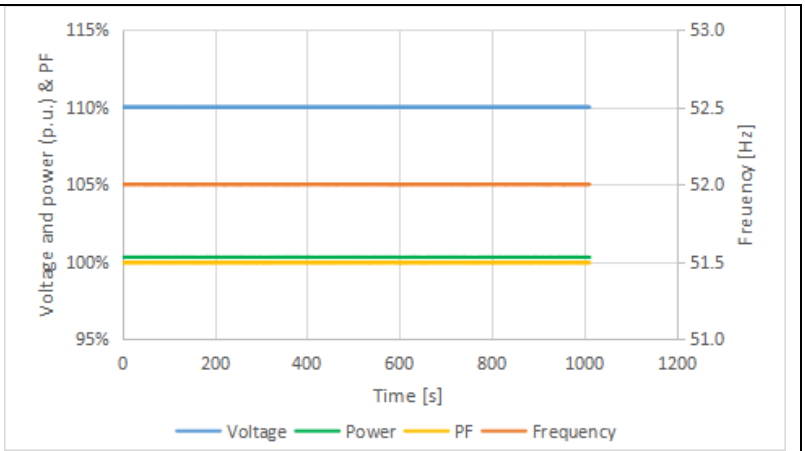
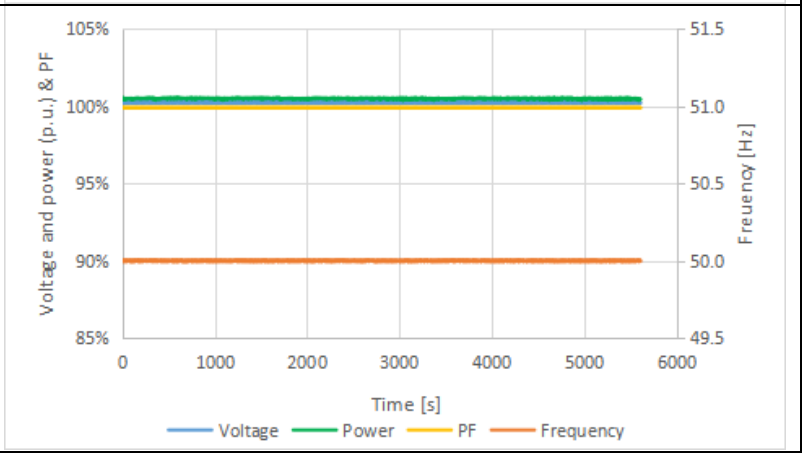
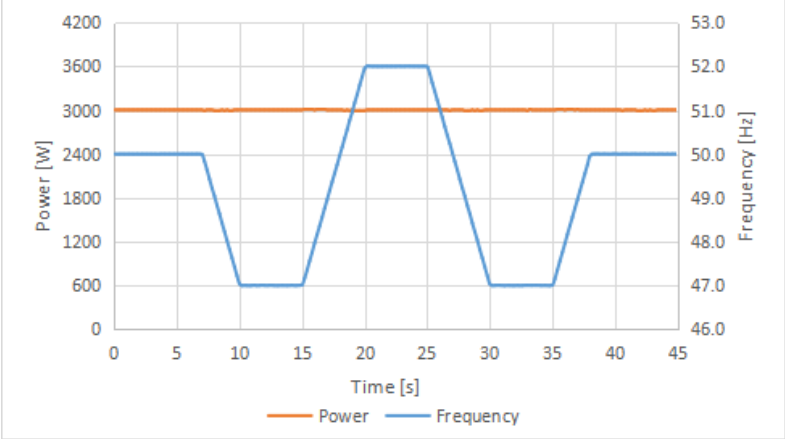
Clause	Requirement - Test	Result - Remark	Verdict

Test 4 Voltage = 110% of nominal (253 V), Frequency = 52.0 Hz, Power Factor = 1, Period of test 15 minutes	
Test 5 Voltage = 100% of nominal (230 V), Frequency = 50.0 Hz, Power Factor = 1, Period of test = 90 minutes	
Test 6 RoCoF withstand Confirm that the **Micro-Generating Plant** 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.	

G98/1-7			
Clause	Requirement - Test	Result - Remark	Verdict

Model: AU-1P3K3G-LE				**P**
Test 1:				
Measured Voltage (V)	Measured Frequency (Hz)	Measured Power (W)	Measured Power factor	Test Time (seconds)
195.56	47.00	2729.63	0.9995	31
Test 2:				
Measured Voltage (V)	Measured Frequency (Hz)	Measured Power (W)	Measured Power factor	Test Time (Minutes)
195.49	47.50	2728.50	0.9995	92
Test 3:				
Measured Voltage (V)	Measured Frequency (Hz)	Measured Power (W)	Measured Power factor	Test Time (Minutes)
253.37	51.50	3006.00	0.9996	93
Test 4:				
Measured Voltage (V)	Measured Frequency (Hz)	Measured Power (W)	Measured Power factor	Test Time (Minutes)
252.99	52.00	3005.50	0.9995	16
Test 5:				
Measured Voltage (V)	Measured Frequency (Hz)	Measured Power (W)	Measured Power factor	Test Time (Minutes)
230.10	50.00	3002.49	0.9989	93
Test 6:				
Measured Voltage (V)	Ramp range	Test frequency ramp	Test Duration	Confirm no trip
195.5	47.0 Hz to 52.0 Hz	+1 Hzs^{-1}	5.0s	No trip
253.0	52.0 Hz to 49.0 Hz	-1 Hzs^{-1}	3.0s	No trip

G98/1-7			
Clause	Requirement - Test	Result - Remark	Verdict

2. Power Quality – Harmonics:						**P**
These tests should be carried out as specified in BS EN 61000-3-2. The chosen test should be undertaken with a fixed source of energy at two power levels a) between 45 and 55% and b) at 100% of **Registered Capacity**. The test requirements are specified in Annex A1 A.1.3.1 (**Inverter** connected) or Annex A2 A.2.3.1 (Synchronous).						
Model: AU-1P1K3G-LE-1						
Micro-generator tested to BS EN 61000-3-2						
Micro-generator rating per phase (rpp)			1	kW		
For 3-phase **Micro-generator**s, tick this box if harmonic measurements are identical for all three phases. If the harmonics are not identical for each phase, please replicate this section with the results for each phase.			Single phase inverter			
Harmonic	At 45-55% of **Registered Capacity**		100% of **Registered Capacity**			
	Measured Value MV in Amps	Normalised Value (NV) in Amps	Measured Value MV in Amps	Normalised Value (NV) in Amps	Limit in BS EN 61000-3-2 in Amps	Higher limit for odd harmonics 21 and above
2	0.0067	0.025	0.0125	0.046	1.080	
3	0.0209	0.077	0.0662	0.243	2.300	
4	0.0020	0.007	0.0019	0.007	0.430	
5	0.0078	0.029	0.0255	0.094	1.140	
6	0.0018	0.006	0.0018	0.007	0.300	
7	0.0045	0.017	0.0132	0.049	0.770	
8	0.0016	0.006	0.0019	0.007	0.230	
9	0.0041	0.015	0.0091	0.033	0.400	
10	0.0015	0.005	0.0017	0.006	0.184	
11	0.0021	0.008	0.0049	0.018	0.330	
12	0.0015	0.006	0.0017	0.006	0.153	
13	0.0017	0.006	0.0046	0.017	0.210	
14	0.0015	0.005	0.0017	0.006	0.131	
15	0.0016	0.006	0.0027	0.010	0.150	
16	0.0015	0.005	0.0017	0.006	0.115	
17	0.0016	0.006	0.0024	0.009	0.132	
18	0.0014	0.005	0.0016	0.006	0.102	
19	0.0014	0.005	0.0020	0.007	0.118	
20	0.0016	0.006	0.0017	0.006	0.092	
21	0.0014	0.005	0.0020	0.007	0.107	0.160

G98/1-7						
Clause	Requirement - Test				Result - Remark	Verdict
22	0.0014	0.005	0.0017	0.006	0.084	
23	0.0014	0.005	0.0019	0.007	0.098	0.147
24	0.0014	0.005	0.0015	0.006	0.077	
25	0.0013	0.005	0.0017	0.006	0.090	0.135
26	0.0013	0.005	0.0016	0.006	0.071	
27	0.0014	0.005	0.0017	0.006	0.083	0.124
28	0.0013	0.005	0.0016	0.006	0.066	
29	0.0013	0.005	0.0018	0.006	0.078	0.117
30	0.0012	0.005	0.0015	0.006	0.061	
31	0.0013	0.005	0.0017	0.006	0.073	0.109
32	0.0012	0.005	0.0016	0.006	0.058	
33	0.0012	0.005	0.0016	0.006	0.068	0.102
34	0.0012	0.004	0.0016	0.006	0.054	
35	0.0013	0.005	0.0018	0.007	0.064	0.096
36	0.0011	0.004	0.0015	0.006	0.051	
37	0.0012	0.004	0.0016	0.006	0.061	0.091
38	0.0011	0.004	0.0015	0.006	0.048	
39	0.0012	0.004	0.0016	0.006	0.058	0.087
40	0.0012	0.004	0.0016	0.006	0.046	
Note the higher limits for odd harmonics 21 and above are only allowable under certain conditions, if these higher limits are utilised please state the exemption used as detailed in part 6.2.3.4 of BS EN 61000-3-2 in the box below.						

G98/1-7			
Clause	Requirement - Test	Result - Remark	Verdict

2. Power Quality – Harmonics:						**P**
These tests should be carried out as specified in BS EN 61000-3-2. The chosen test should be undertaken with a fixed source of energy at two power levels a) between 45 and 55% and b) at 100% of **Registered Capacity**. The test requirements are specified in Annex A1 A.1.3.1 (**Inverter** connected) or Annex A2 A.2.3.1 (Synchronous).						
Model: AU-1P3K3G-LE						
Micro-generator tested to BS EN 61000-3-2						
Micro-generator rating per phase (rpp)			3.0	kW		
For 3-phase **Micro-generators**, tick this box if harmonic measurements are identical for all three phases. If the harmonics are not identical for each phase, please replicate this section with the results for each phase.			Single phase PV inverter			
Harmonic	At 45-55% of **Registered Capacity**		100% of **Registered Capacity**			
	Measured Value MV in Amps	Normalised Value (NV) in Amps	Measured Value MV in Amps	Normalised Value (NV) in Amps	Limit in BS EN 61000-3-2 in Amps	Higher limit for odd harmonics 21 and above
2	0.0189	0.023	0.0141	0.017	1.080	
3	0.1428	0.175	0.2810	0.345	2.300	
4	0.0043	0.005	0.0171	0.021	0.430	
5	0.0926	0.114	0.1895	0.232	1.140	
6	0.0091	0.011	0.0106	0.013	0.300	
7	0.0629	0.077	0.1325	0.163	0.770	
8	0.0068	0.008	0.0124	0.015	0.230	
9	0.0509	0.062	0.1017	0.125	0.400	
10	0.0068	0.008	0.0020	0.002	0.184	
11	0.0384	0.047	0.0871	0.107	0.330	
12	0.0058	0.007	0.0055	0.007	0.153	
13	0.0348	0.043	0.0683	0.084	0.210	
14	0.0074	0.009	0.0050	0.006	0.131	
15	0.0201	0.025	0.0523	0.064	0.150	
16	0.0066	0.008	0.0037	0.005	0.115	
17	0.0156	0.019	0.0404	0.050	0.132	
18	0.0066	0.008	0.0037	0.005	0.102	
19	0.0109	0.013	0.0308	0.038	0.118	
20	0.0087	0.011	0.0079	0.010	0.092	
21	0.0119	0.015	0.0267	0.033	0.107	0.160

G98/1-7			
Clause	Requirement - Test	Result - Remark	Verdict

22	0.0072	0.009	0.0067	0.008	0.084	
23	0.0075	0.009	0.0224	0.027	0.098	0.147
24	0.0067	0.008	0.0092	0.011	0.077	
25	0.0060	0.007	0.0184	0.023	0.090	0.135
26	0.0047	0.006	0.0055	0.007	0.071	
27	0.0063	0.008	0.0154	0.019	0.083	0.124
28	0.0073	0.009	0.0113	0.014	0.066	
29	0.0037	0.005	0.0142	0.017	0.078	0.117
30	0.0050	0.006	0.0096	0.012	0.061	
31	0.0049	0.006	0.0132	0.016	0.073	0.109
32	0.0049	0.006	0.0061	0.007	0.058	
33	0.0071	0.009	0.0132	0.016	0.068	0.102
34	0.0058	0.007	0.0068	0.008	0.054	
35	0.0059	0.007	0.0087	0.011	0.064	0.096
36	0.0041	0.005	0.0033	0.004	0.051	
37	0.0065	0.008	0.0090	0.011	0.061	0.091
38	0.0031	0.004	0.0050	0.006	0.048	
39	0.0137	0.017	0.0137	0.017	0.058	0.087
40	0.0027	0.003	0.0039	0.005	0.046	

Note the higher limits for odd harmonics 21 and above are only allowable under certain conditions, if these higher limits are utilised please state the exemption used as detailed in part 6.2.3.4 of BS EN 61000-3-2 in the box below.

G98/1-7			
Clause	Requirement - Test	Result - Remark	Verdict

3. Power Quality – Voltage fluctuations and Flicker: **P**

These tests should be undertaken in accordance with EREC G98 Annex A1 A.1.3.3 (**Inverter** connected) or Annex A2 A.2.3.3 (Synchronous).

The standard test impedance is 0.4 Ω for a single phase **Micro-generating Plant** (and for a two phase unit in a three phase system) and 0.24 Ω for a three phase **Micro-generating Plant** (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	2023-01-10	Test end date	2023-01-10
Test location	No.99, Hongye Road, Suzhou Industrial Park, Suzhou, Jiangsu, P.R. China		
Model	AU-1P3K3G-LE		

	Starting			Stopping			Running	
	d(max)	d(c)	d(t)	d(max)	d(c)	d(t)	P_{st}	P_{lt} 2 hours
Measured Values at test impedance	0.56	0.27	0	1.43	0.27	0	0.22	0.19
Normalised to standard impedance	0.56	0.27	0	1.43	0.27	0	0.22	0.19
Normalised to required maximum impedance	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Limits set under BS EN 61000-3-11	4%	3.3%	3.3%	4%	3.3%	3.3%	1.0	0.65

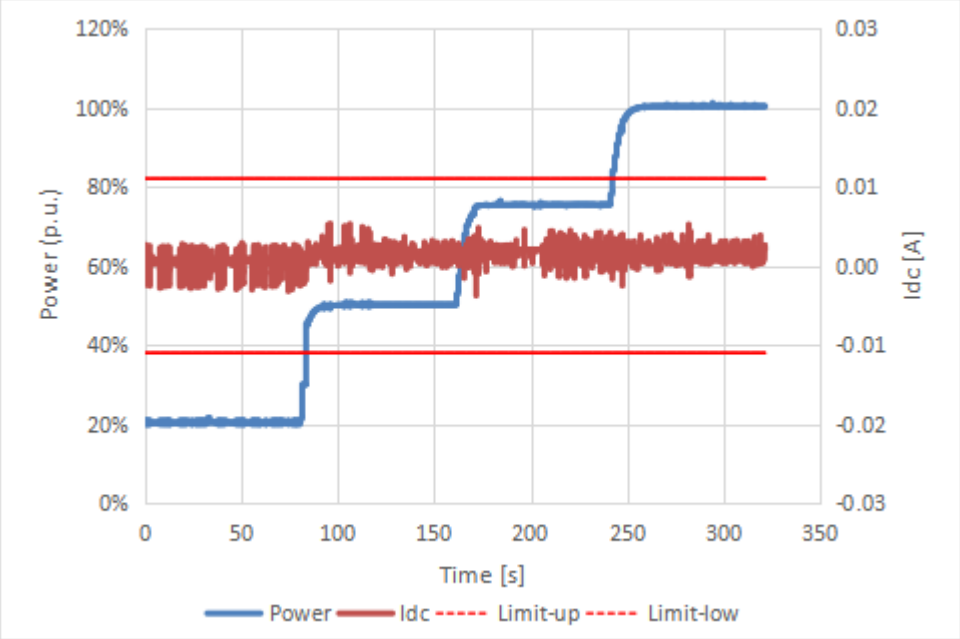
Test Impedance	R	0.4	Ω	Xl	0.25	Ω
Standard Impedance	R	0.24 * 0.4 ^	Ω	Xl	0.15 * 0.25 ^	Ω
Maximum Impedance	R	N/A #	Ω	Xl	N/A #	Ω

* Applies to three phase and split single phase **Micro-generators**. Delete as appropriate.

^ Applies to single phase **Micro-generators** and **Micro-generators** using two phases on a three phase system. Delete as appropriate.

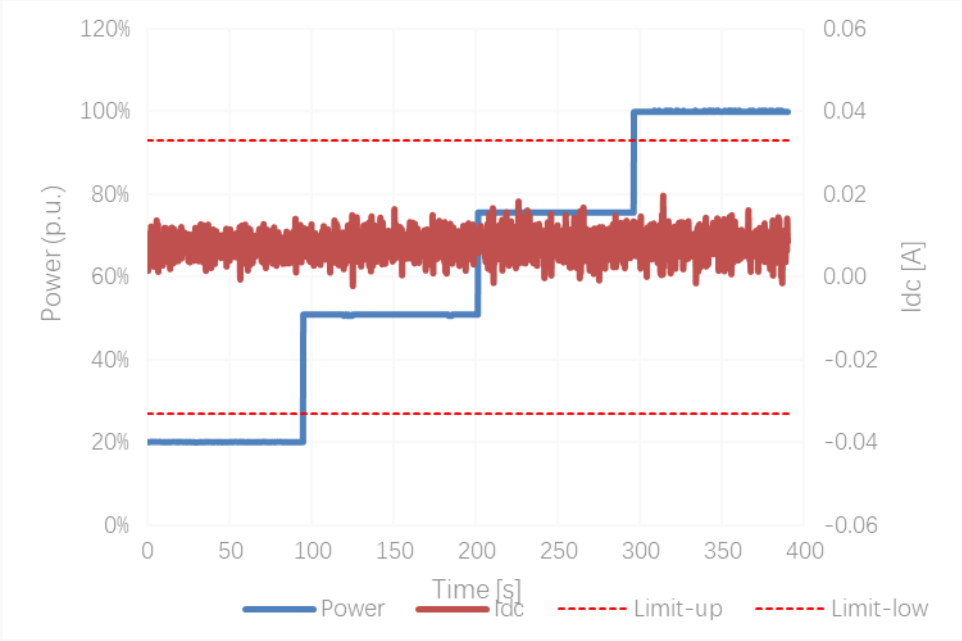
G98/1-7			
Clause	Requirement - Test	Result - Remark	Verdict

4. Power quality – DC injection:				**P**
This test should be carried out in accordance with A 1.3.4 as applicable. 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) / 230 V. The % **DC** injection should not be greater than 0.25%.				
Model: AU-1P1K3G-LE-1				
Test power level	20%	50%	75%	100%
Recorded DC injection value in Amps	-0.003 A	0.005 A	0.005 A	0.005 A
as % of rated AC current	-0.07%	0.12%	0.11%	0.12%
Limit	0.25%	0.25%	0.25%	0.25%



G98/1-7			
Clause	Requirement - Test	Result - Remark	Verdict

4. Power quality – DC injection:				**P**
This test should be carried out in accordance with A 1.3.4 as applicable. 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) / 230 V. The % **DC** injection should not be greater than 0.25%.				
Model: AU-1P3K3G-LE				
Test power level	20%	50%	75%	100%
Recorded DC injection value in Amps	0.014 A	0.016 A	0.018 A	0.020 A
as % of rated AC current	0.11%	0.12%	0.14%	0.15%
Limit	0.25%	0.25%	0.25%	0.25%



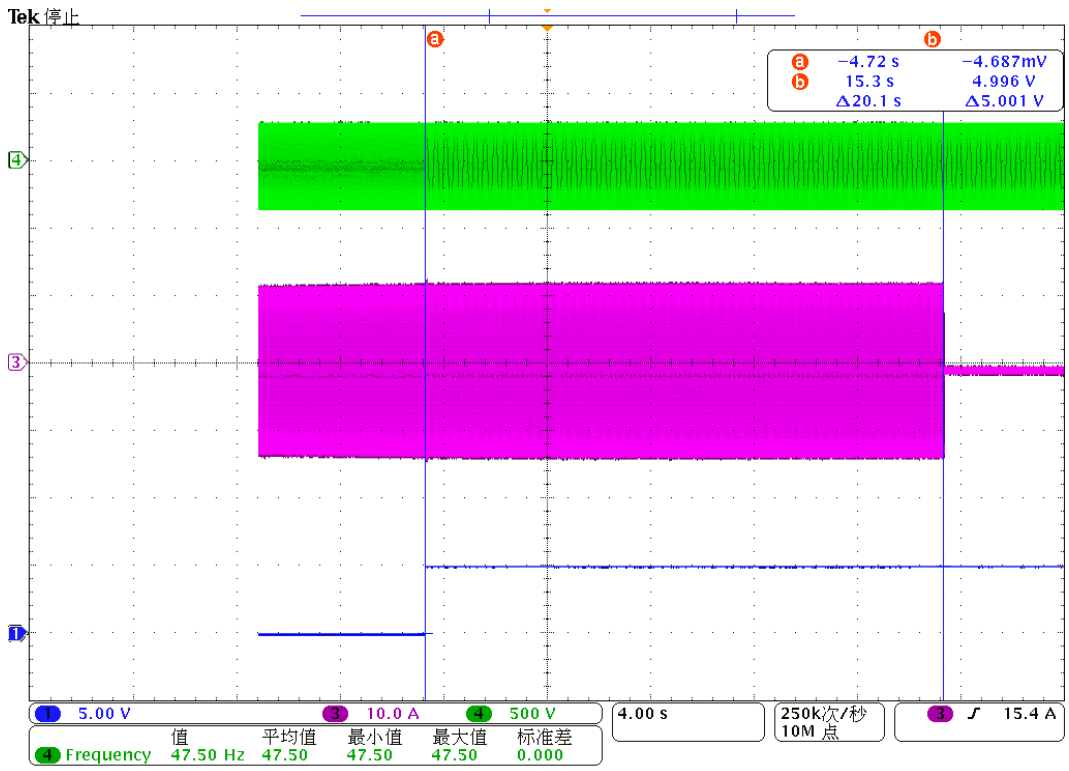
G98/1-7			
Clause	Requirement - Test	Result - Remark	Verdict

5. Power Factor:			**P**
This test shall be carried out in accordance with A.1.3.2 and A.2.3.2 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.			
Model: AU-1P1K3G-LE-1			
Voltage	0.94 pu (216.2 V)	1.0 pu (230 V)	1.1 pu (253 V)
Measured value	0.9995	0.9996	0.9989
Power Factor Limit	>0.95	>0.95	>0.95
Model: AU-1P3K3G-LE			
Voltage	0.94 pu (216.2 V)	1.0 pu (230 V)	1.1 pu (253 V)
Measured value	0.9993	09996	0.9996
Power Factor Limit	>0.95	>0.95	>0.95

G98/1-7			
Clause	Requirement - Test	Result - Remark	Verdict

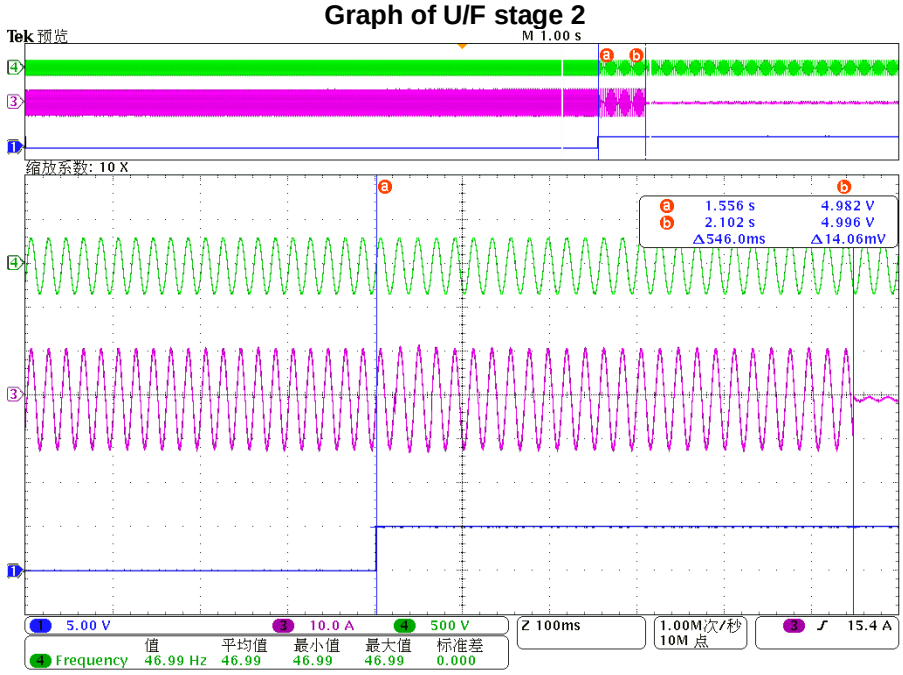
6. Protection – Frequency tests:						**P**
These tests should be carried out in accordance with Annex A1 A.1.2.3 (**Inverter** connected) or Annex A2 A.2.2.3 (Synchronous). For trip tests, frequency and time delay should be stated. For “no trip tests”, “no trip” can be stated.						
Model: AU-1P3K3G-LE						
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	47.50	20.1s	47.7 Hz 30 s	No trip
U/F stage 2	47.0 Hz	0.5 s	46.99	0.546s	47.2 Hz 19.5 s	No trip
					46.8 Hz 0.45 s	No trip
O/F	52.0 Hz	0.5 s	52.00	0.543s	51.8 Hz 120.0 s	No trip
					52.2 Hz 0.45 s	No trip
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.						

Graph of U/F stage 1

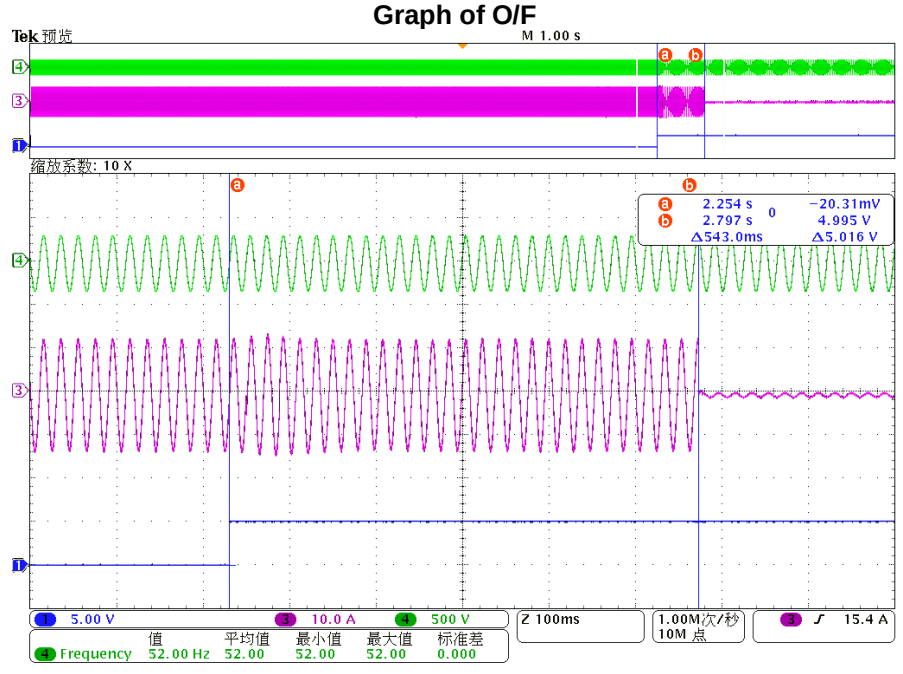


G98/1-7			
Clause	Requirement - Test	Result - Remark	Verdict

Graph of U/F stage 2



Graph of O/F



Channel 1 represents trip signal,

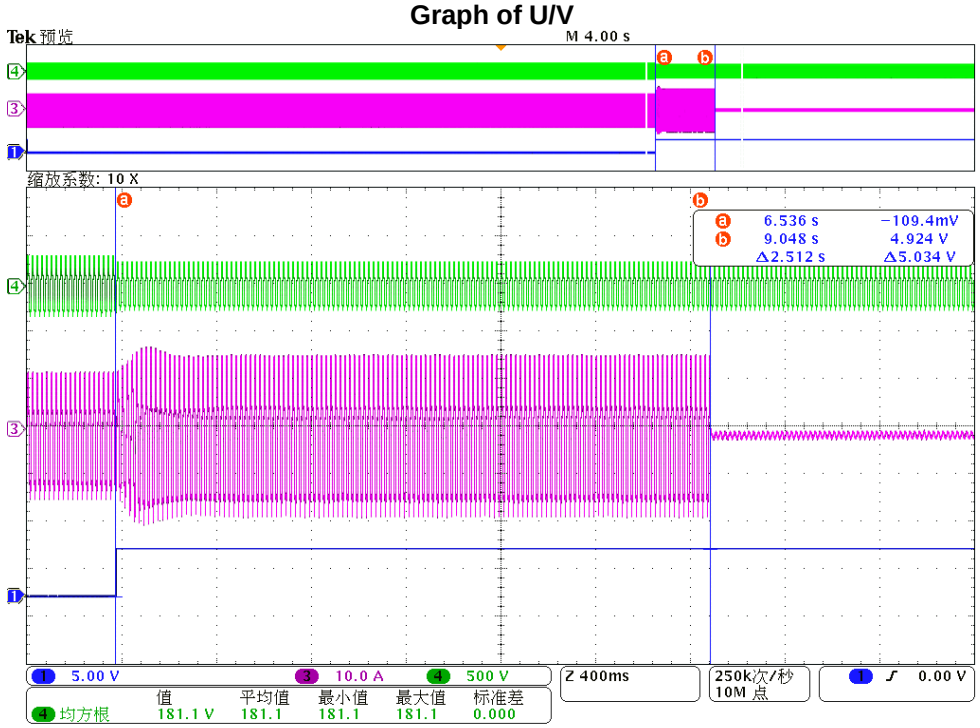
Channel 3 represents current,

Channel 4 represents voltage

G98/1-7			
Clause	Requirement - Test	Result - Remark	Verdict

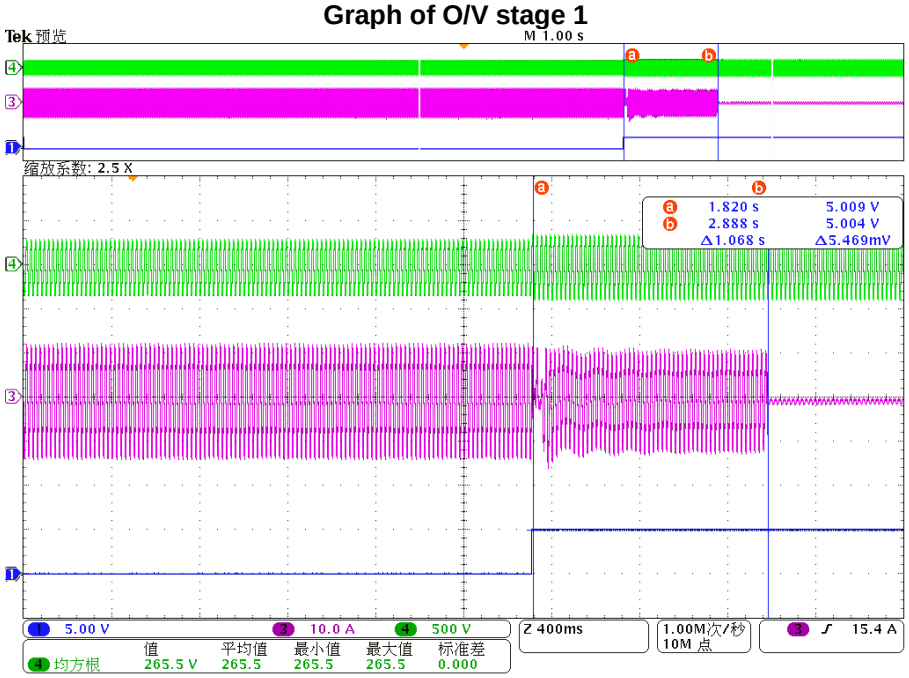
7. Protection – Voltage tests:						**P**
These tests should be carried out in accordance with Annex A1 A.1.2.2 (**Inverter** connected) or Annex A2 A.2.2.2 (Synchronous). For trip tests, voltage and time delay should be stated. For “no trip tests”, “no trip” can be stated.						
Model: AU-1P3K3G-LE						
Function	Setting		Trip test		“No trip tests”	
	Voltage	Time delay	Voltage	Time delay	Voltage / time	Confirm no trip
U/V	0.8 pu (184 V)	2.5 s	181.1 V	2.512 s	188 V 5.0 s	No trip
					180 V 2.45 s	No trip
O/V stage 1	1.14 pu (262.2 V)	1.0 s	265.5 V	1.068 s	258.2 V 5.0 s	No trip
O/V stage 2	1.19 pu (273.7 V)	0.5 s	275.6 V	0.514 s	269.7 V 0.95 s	No trip
					277.7 V 0.45 s	No trip
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.						

Graph of U/V

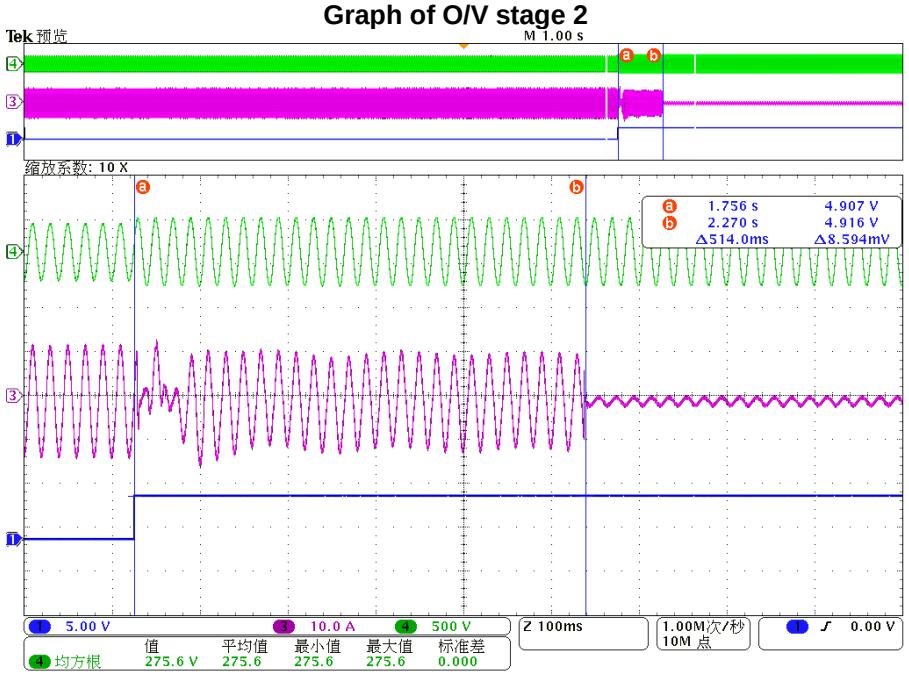


G98/1-7			
Clause	Requirement - Test	Result - Remark	Verdict

Graph of O/V stage 1



Graph of O/V stage 2



Channel 1 represents trip signal,

Channel 3 represents current,

Channel 4 represents voltage

G98/1-7			
Clause	Requirement - Test	Result - Remark	Verdict

8. Protection – Loss of Mains test: **P**

For PV **Inverter**s shall be tested in accordance with BS EN 62116. Other **Micro-generator**s should be tested in accordance with A.2.2.4 at 10%, 55% and 100% of rated power.

For test condition A, EUT output = 100 % P_n, test condition B, EUT output = 50 % to 66 % P_n, and test condition C, EUT output = 25 % to 33 % P_n.

Model: AU-1P3K3G-LE

For **Inverter**s tested to BS EN 62116 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. **Limit is 0.5s**	0.091s	0.081s	0.079s	0.075s	0.082s	0.073s

No.	P_{EUT} a) (% of EUT rating)	Reactive load (% of Q_L)	P_{AC} b) (% of nominal)	Q_{AC} c) (% of nominal)	Run-on time (ms)	P_{EUT} (W)	Actual Q_f	V_{DC} d)	Remarks e)
1	100	100	0	0	133.4	3000	1.00	355	Test A at BL
2	66	66	0	0	133.6	1980	1.00	310	Test B at BL
3	33	33	0	0	130.8	990	0.98	256	Test C at BL
4	100	100	-5	-5	108.0	3000	0.99	355	Test A at IB
5	100	100	-5	0	74.8	3000	0.99	355	Test A at IB
6	100	100	-5	+5	70.4	3000	1.02	355	Test A at IB
7	100	100	0	-5	79.4	3000	1.00	355	Test A at IB
8	100	100	0	+5	72.0	3000	1.00	355	Test A at IB
9	100	100	+5	-5	95.2	3000	0.96	355	Test A at IB
10	100	100	+5	0	72.8	3000	0.98	355	Test A at IB
11	100	100	+5	+5	101.2	3000	0.99	355	Test A at IB
12	66	66	0	-5	81.2	1980	0.93	310	Test B at IB
13	66	66	0	-4	91.6	1980	0.98	310	Test B at IB
14	66	66	0	-3	94.0	1980	0.99	310	Test B at IB
15	66	66	0	-2	105.6	1980	0.98	310	Test B at IB
16	66	66	0	-1	112.4	1980	0.96	310	Test B at IB
17	66	66	0	+1	111.2	1980	0.98	310	Test B at IB
18	66	66	0	+2	105.6	1980	1.01	310	Test B at IB
19	66	66	0	+3	108.4	1980	0.95	310	Test B at IB
20	66	66	0	+4	93.2	1980	1.02	310	Test B at IB
21	66	66	0	+5	81.6	1980	0.98	310	Test B at IB
22	33	33	0	-5	90.8	990	0.96	256	Test B at IB
23	33	33	0	-4	92.0	990	0.93	256	Test C at IB
24	33	33	0	-3	109.6	990	0.97	256	Test C at IB

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Clause	Requirement - Test	Result - Remark	Verdict

25	33	33	0	-2	114.0	990	0.96	256	Test C at IB
26	33	33	0	-1	122.4	990	0.95	256	Test C at IB
27	33	33	0	+1	123.2	990	0.97	256	Test C at IB
28	33	33	0	+2	110.8	990	1.01	256	Test C at IB
29	33	33	0	+3	101.2	990	0.97	256	Test C at IB
30	33	33	0	+4	95.6	990	0.99	256	Test C at IB
31	33	33	0	+5	81.6	990	0.96	256	Test C at IB

Note:

[a)]PEUT: EUT output power.

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

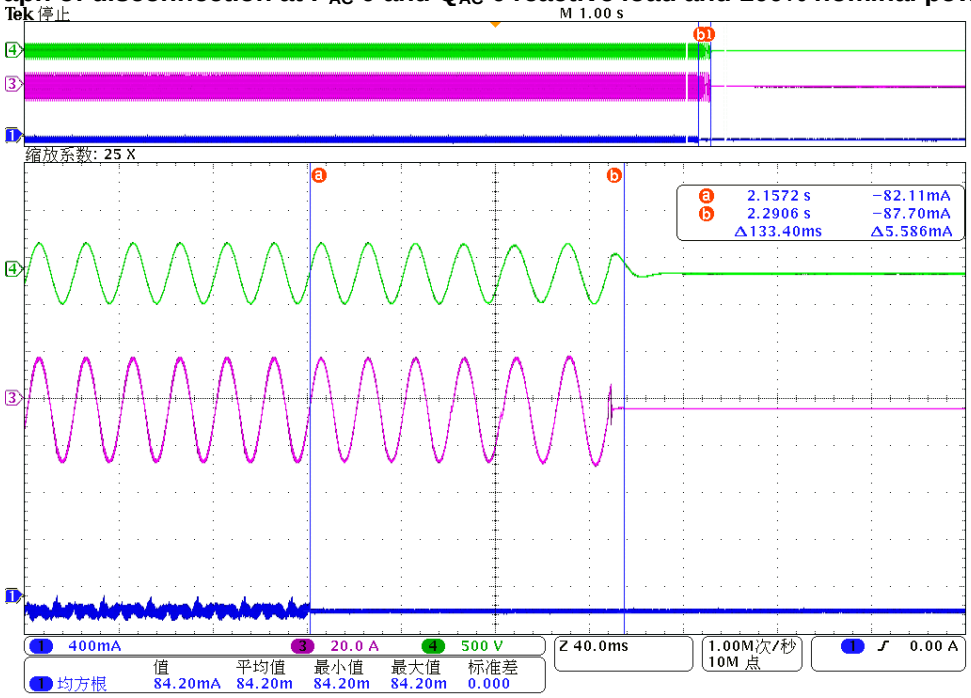
[c)]Q_{ac}: Reactive power flow at S1 in Figure 1. Positive means power from EUT to utility. Nominal is the 0 % test condition value.

[d)]For test condition A, > 75 % of rated input voltage range used, for test condition B, 50 % of rated input voltage range, ±10 % used, for test condition C, < 20 % of rated input voltage range used. Based on EUT rated input operating range. For example, if range is between X volts and Y volts, 75 % of range = X + 0,75 × (Y – X). Y shall not exceed 0,8 × EUT maximum system voltage (i.e., maximum allowable array open circuit voltage). In any case, the EUT should not be operated outside of its allowable input voltage range.

[e)]BL: Balance condition, IB: Imbalance condition.

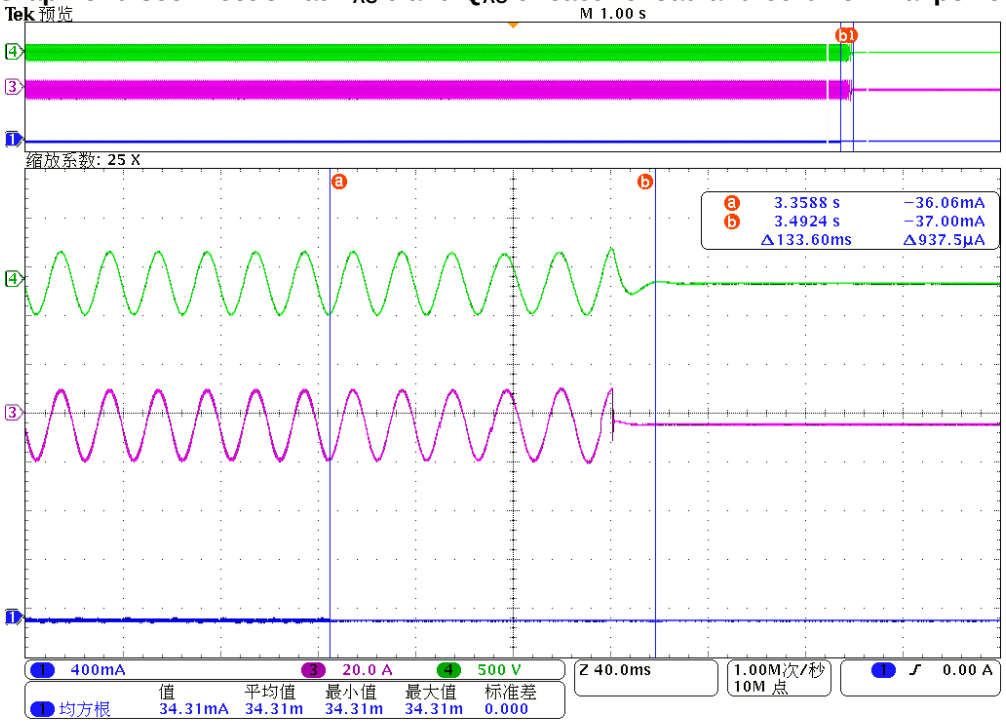
If the device requires additional shut down time (beyond 0.5 s but less than 1 s) then this should be stated on this form.

Graph of disconnection at P_{AC} 0 and Q_{AC} 0 reactive load and 100% nominal power

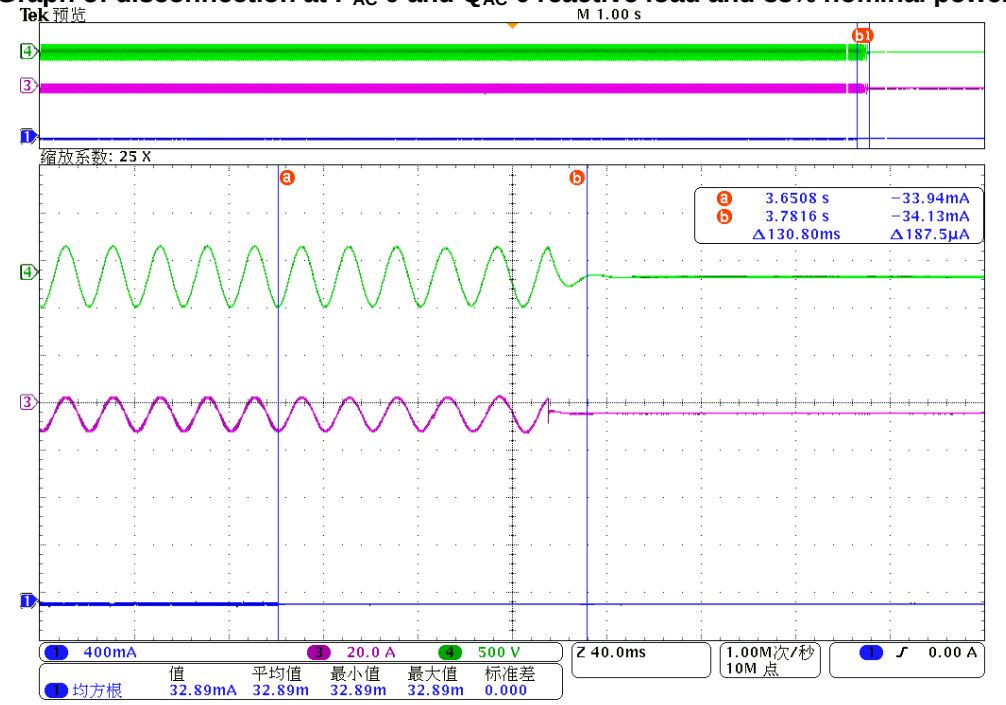


G98/1-7			
Clause	Requirement - Test	Result - Remark	Verdict

Graph of disconnection at P_{AC} 0 and Q_{AC} 0 reactive load and 66% nominal power



Graph of disconnection at P_{AC} 0 and Q_{AC} 0 reactive load and 33% nominal power



G98/1-7			
Clause	Requirement - Test	Result - Remark	Verdict

8. Protection – Frequency change, Vector Shift Stability test:			**P**
This test should be carried out in accordance with EREC G98 Annex A1 A.1.2.6 (**Inverter** connected) or Annex A2 A.2.2.6 (Synchronous). Confirmation is required that the **Micro-generating Plant** does not trip under positive / negative vector shift.			
Model: AU-1P3K3G-LE			
	Start Frequency	Change	Confirm no trip
Positive Vector Shift	49.0 Hz	+50 degrees	No trip
Negative Vector Shift	50.0 Hz	-50 degrees	No trip

8. Protection – Frequency change, RoCoF Stability test:			**P**
The requirement is specified in section 11.3, test procedure in Annex A.1.2.6 (**Inverter** connected) or Annex A2 A.2.2.6 (Synchronous). Confirmation is required that the **Micro-generating Plant** does not trip for the duration of the ramp up and ramp down test.			
Model: AU-1P3K3G-LE			
Ramp range	Test frequency ramp:	Test Duration	Confirm no trip
49.0 Hz to 51.0 Hz	+0.95 Hzs^{-1}	2.1 s	No trip
51.0 Hz to 49.0 Hz	-0.95 Hzs^{-1}	2.1 s	No trip

G98/1-7			
Clause	Requirement - Test	Result - Remark	Verdict

9. Limited Frequency Sensitive Mode – Over frequency test:					**P**
This test should be carried out in accordance with A.1.2.9. The test should be carried out using the specific threshold frequency of 50.4 Hz and **Droop** of 10%. The measurement tolerances are contained in A.1.2.9.					
Model: AU-1P3K3G-LE					
Alternatively, simulation results should be noted below:					
Test sequence at **Registered Capacity** >80%	Measured **Active Power** Output (W)	Frequency (Hz)	Calculated droop (%)	Primary Power Source	**Active Power** Gradient
Step a) 50.00 Hz ±0.01 Hz	3000.00	50.00	-	Photovoltaic array simulator	-
Step b) 50.45 Hz ±0.05 Hz	2969.01	50.45	9.65		-
Step c) 50.70 Hz ±0.10 Hz	2810.32	50.70	9.48		-
Step d) 51.15 Hz ±0.05 Hz	2529.46	51.15	9.56		-
Step e) 50.70 Hz ±0.10 Hz	2811.96	50.70	9.56		-
Step f) 50.45 Hz ±0.05 Hz	2968.37	50.45	9.45		-
Step g) 50.00 Hz ±0.01 Hz	3000.22	50.00	-		-
Test sequence at **Registered Capacity** 40-60%	Measured **Active Power** Output (W)	Frequency (Hz)	Calculated droop (%)	Primary Power Source	**Active Power** Gradient
Step a) 50.00 Hz ±0.01 Hz	1500.00	50.00	-	Photovoltaic array simulator	-
Step b) 50.45 Hz ±0.05 Hz	1469.98	50.45	9.95		-
Step c) 50.70 Hz ±0.10 Hz	1310.80	50.70	9.51		-
Step d) 51.15 Hz ±0.05 Hz	1020.84	51.15	9.39		-
Step e) 50.70 Hz ±0.10 Hz	1308.33	50.70	9.38		-
Step f) 50.45 Hz ±0.05 Hz	1469.29	50.45	9.70		-
Step g) 50.00 Hz ±0.01 Hz	1499.80	50.00	-		-
The frequency at each step should be maintained for at least one minute and the Active Power reduction in the form of a gradient determined and assessed for compliance with paragraph 11.2.3. The Droop should be determined from the measurements between 50.4 Hz and 51.15 Hz. The allowed tolerance for the frequency measurement shall be ± 0.05 Hz. The allowed tolerance for Active Power output measurement shall be ±10% of the required change in Active Power. The resulting overall tolerance range for a nominal 10% Droop is +2.8% and – 1.5%, ie a Droop less than 12.8% and greater than 8.5%.					

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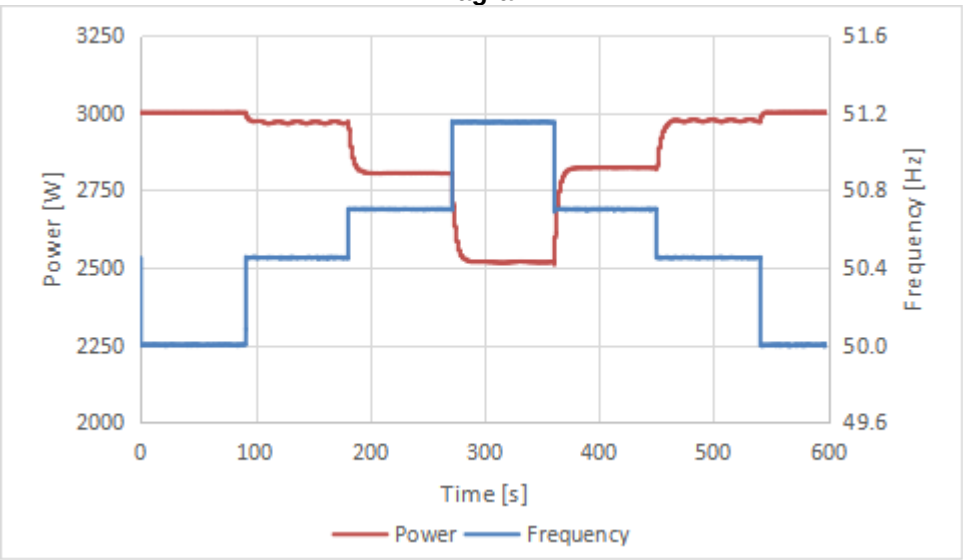
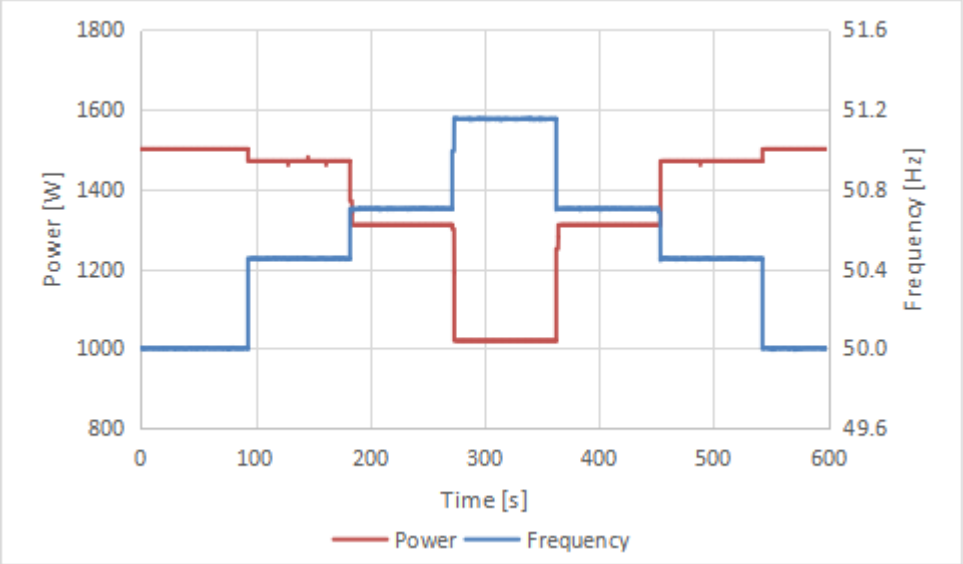
Clause	Requirement - Test	Result - Remark	Verdict

Diagram



Diagram



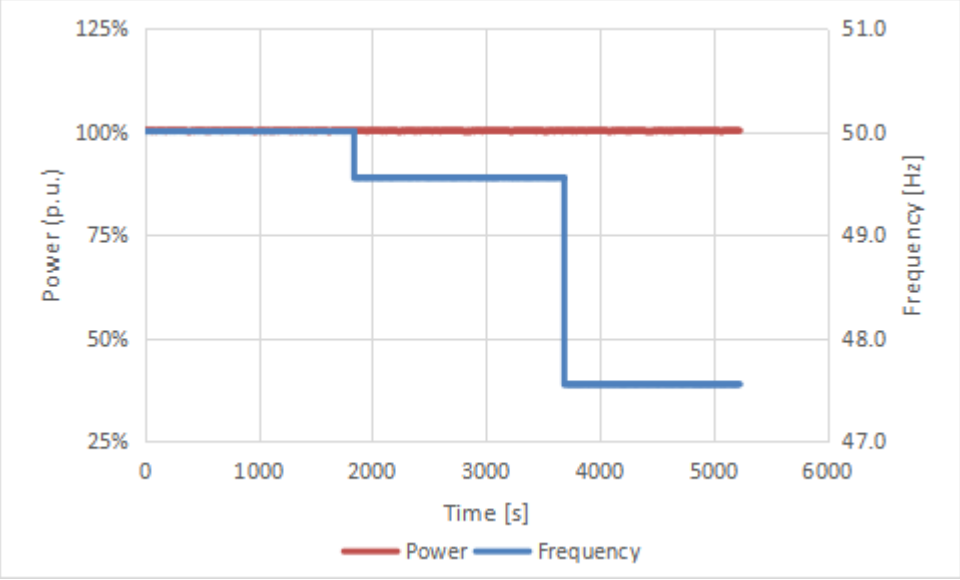
G98/1-7			
Clause	Requirement - Test	Result - Remark	Verdict

10. Power output with falling frequency test (For PV Inverter):			**P**
This test should be carried out in accordance with A.1.2.7.			
Model: AU-1P3K3G-LE			
Test sequence	Measured **Active Power** Output (W)	Frequency (Hz)	Primary power source
Test a) 50 Hz ± 0.01 Hz	3005.95	50.00	Photovoltaic array simulator
Test b) Point between 49.5 Hz and 49.6 Hz	3006.08	49.55	Photovoltaic array simulator
Test c) Point between 47.5 Hz and 47.6 Hz	3006.10	47.55	Photovoltaic array simulator

NOTE:
The operating point in Test (b) and (c) shall be maintained for at least 5 minutes

The test is regarded as passed if:
• the Micro-generator does not disconnect from the network at the operating points a) to c) when the network frequency is changed and
• the Micro-generator does not reduce output energy at point b) and
• the power reduction at point c) is less than or equal to the allowed power reduction according to paragraph 9.4.2 (Figure 3).

The following data shall be documented:
• variation of the network frequency with time;
• the measured Active Power with time.



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Clause	Requirement - Test	Result - Remark	Verdict

11. Power output with falling frequency test (For Electricity Storage Device)				**P**
This test should be carried out in accordance with clause A.1.2.8				
Model: AU-1P3K3G-LE				
Test 1: 50 Hz to 49.0 Hz, from **100%** $P_{rated\text{-}import}$				
Test sequence (Hz)	Measured **Active Power** Output (W)	Steady frequency (Hz)	Calculated droop (%)	Primary power source
50.0	-2980.27	50.00	-	AC grid / Storage Battery
49.5	-2975.57	49.50	-	AC grid / Storage Battery
49.2	-1248.88	49.20	1.04%	AC grid / Storage Battery
49.0	-75.30	49.00	1.03%	AC grid / Storage Battery
Test 2: 50 Hz to 48.8 Hz, from **100%** $P_{rated\text{-}import}$				
Test sequence (Hz)	Measured **Active Power** Output (W)	Steady frequency (Hz)	Calculated droop (%)	Primary power source
50.0	-2930.37	50.00	-	AC grid / Storage Battery
49.5	-2980.06	49.50	-	AC grid / Storage Battery
49.2	-1254.71	49.20	1.04%	AC grid / Storage Battery
49.0	-66.68	49.00	1.03%	AC grid / Storage Battery
48.9	573.38	48.90	1.01%	AC grid / Storage Battery
48.8	1190.61	48.80	1.01%	AC grid / Storage Battery
Test 3: 50 Hz to 49.0 Hz, from **40%** $P_{rated\text{-}import}$				
Test sequence (Hz)	Measured **Active Power** Output (W)	Steady frequency (Hz)	Calculated droop (%)	Primary power source
50.0	-1156.95	50.00	-	AC grid / Storage Battery
49.5	-1204.34	49.50	-	AC grid / Storage Battery
49.2	540.67	49.20	1.03%	AC grid / Storage Battery
49.0	1842.61	49.00	0.98%	AC grid / Storage Battery

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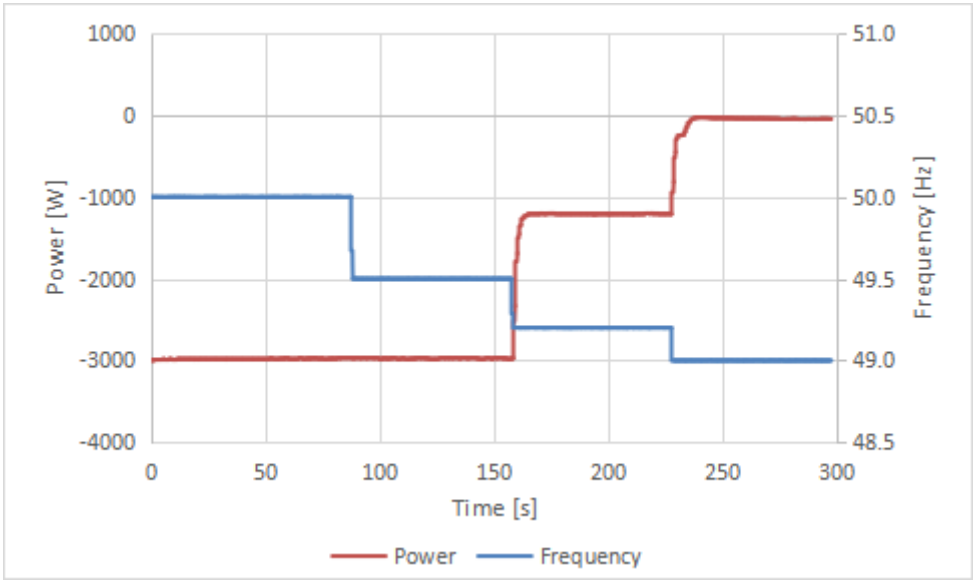
Clause	Requirement - Test	Result - Remark	Verdict

Test 4: 50 Hz to 48.8 Hz, from **40%** $P_{rated\text{-}import}$				
Test sequence (Hz)	Measured **Active Power** Output (W)	Steady frequency (Hz)	Calculated droop (%)	Primary power source
50.0	-1128.60	50.00	-	AC grid / Storage Battery
49.5	-1197.52	49.50	-	AC grid / Storage Battery
49.2	542.33	49.20	1.03%	AC grid / Storage Battery
49.0	1847.71	49.00	0.99%	AC grid / Storage Battery
48.9	2460.83	48.90	0.98%	AC grid / Storage Battery
48.8	3063.27	48.80	0.99%	AC grid / Storage Battery

NOTE:
This paragraph provides a method for demonstrating compliance with the optional performance characteristic as discussed in the foreword. The tests shall be carried out to demonstrate how the Power Park Module Active Power when acting as a load (ie replenishing its energy store) responds to changes in system frequency.
In general four tests are proposed, one set of two at rated import capacity, and one set of two at 40% of rated import capacity.
In both cases the test is to reduce frequency from 50 Hz at rate of 2 Hz/s. In the first case the lower frequency reached will be 49.0 Hz and the second case the lower frequency will be 48.8 Hz.
In all cases the response shall meet the requirements of 11.2.3.3.

Test 1



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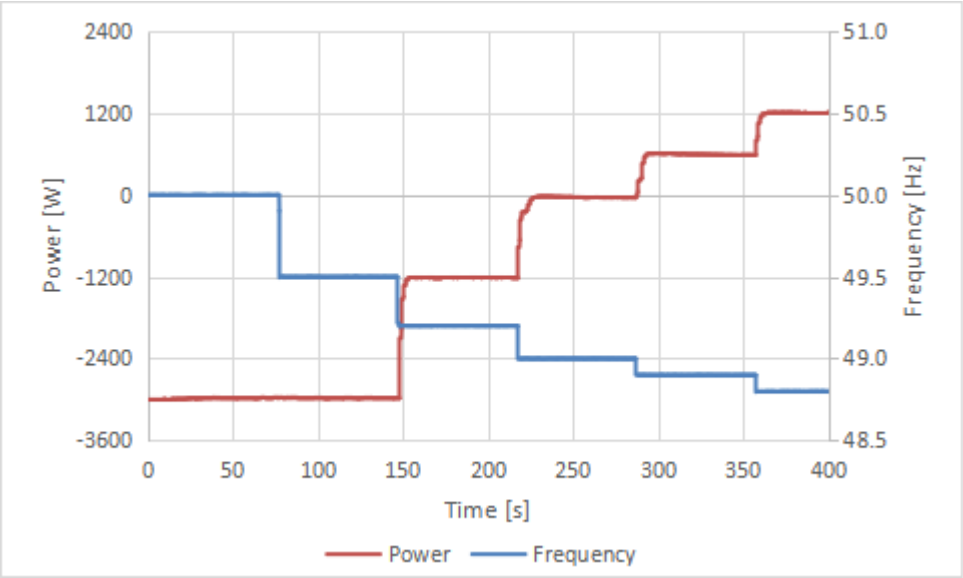
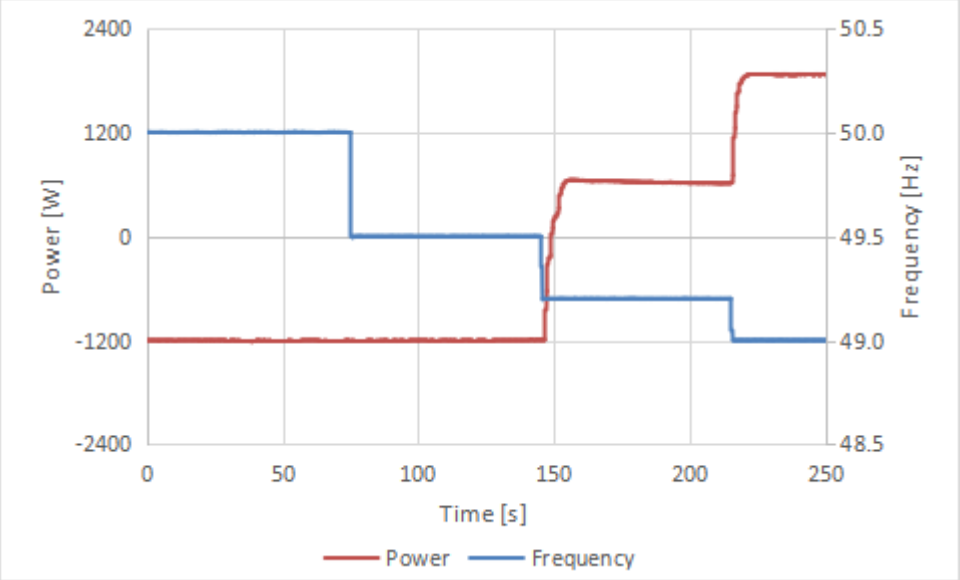
Clause	Requirement - Test	Result - Remark	Verdict

Test 2

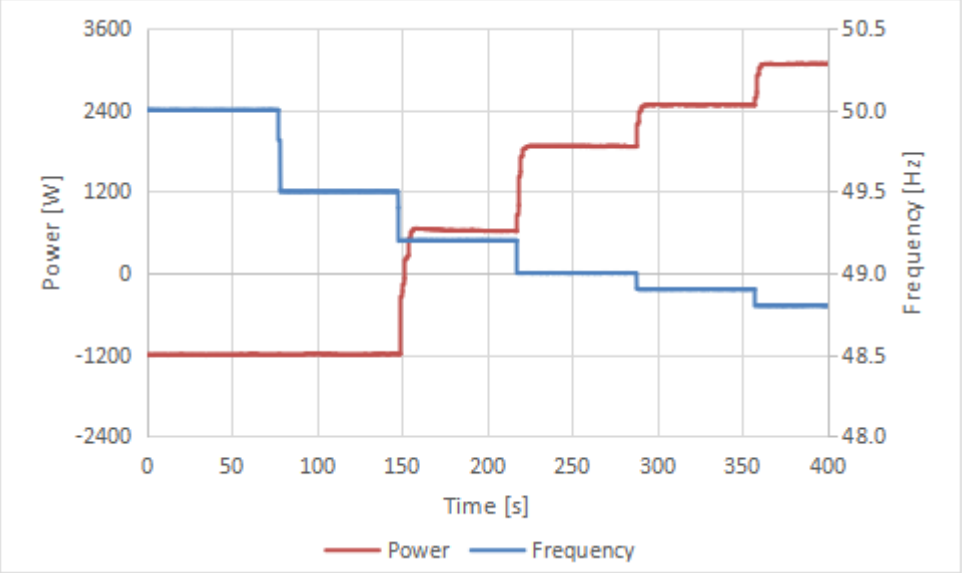


Test 3



G98/1-7			
Clause	Requirement - Test	Result - Remark	Verdict

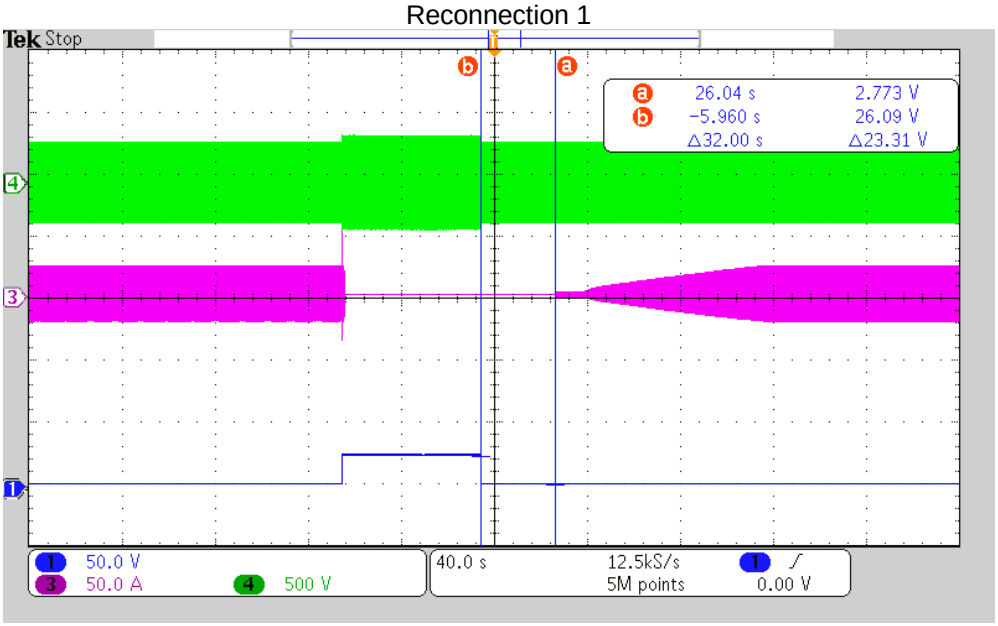
Test 4



G98/1-7			
Clause	Requirement - Test	Result - Remark	Verdict

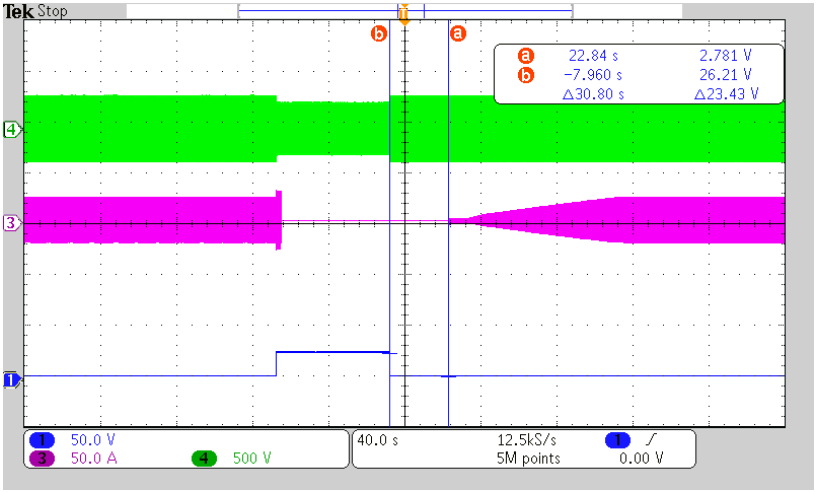
12. Re-connection timer						**P**
Model: AU-1P3K3G-LE						
Test should prove that the reconnection sequence starts after a minimum delay of 20 s for restoration of voltage and frequency to within the stage 1 settings of Table 2. Both the time delay setting and the measured delay should be provided in this form; both should be greater than 20 s to pass. Confirmation should be provided that the **Micro-generating Plant** 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.				
30 s	32 s	At 1.16 pu (266.2 V)	At 0.78 pu (180.0 V)	At 47.4 Hz	At 52.1 Hz	
Confirmation that the **Micro-generator** does not re-connect.		No Reconnection	No Reconnection	No Reconnection	No Reconnection	
Recover to normal operation range after confirmation of no reconnection		Yes	Yes	Yes	Yes	
Confirmation that the **Power Generating Module** shall reconnect		Reconnection after 32.0 s	Reconnection after 30.8 s	Reconnection after 31.6 s	Reconnection after 31.6 s	

Reconnection 1

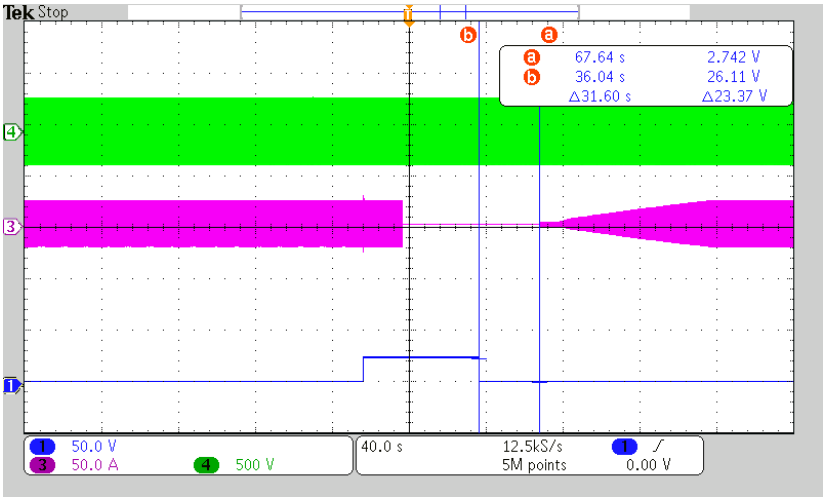


G98/1-7			
Clause	Requirement - Test	Result - Remark	Verdict

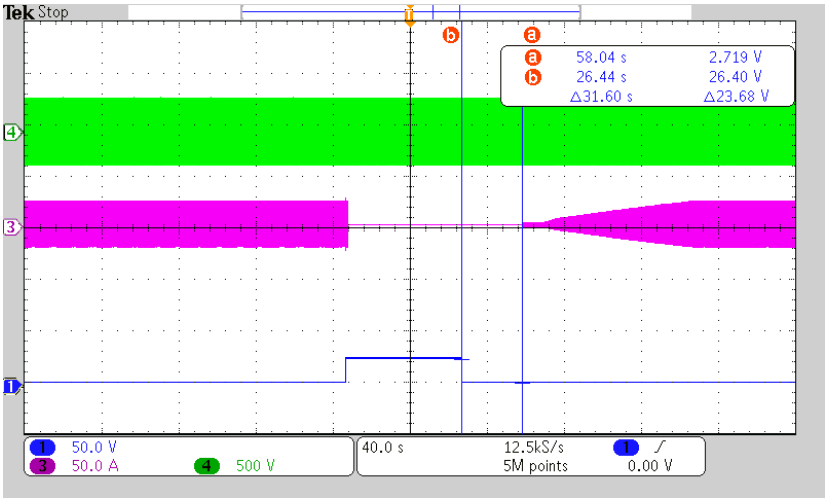
Reconnection 2



Reconnection 3



Reconnection 4



G98/1-7			
Clause	Requirement - Test	Result - Remark	Verdict

13. Fault level contribution:					**P**
These tests shall be carried out in accordance with EREC G98 Annex A1 A.1.3.5 (**Inverter** connected) and Annex A2 A.2.3.4 (Synchronous). Please complete each entry, even if the fault contribution is zero.					
Model: AU-1P3K3G-LE					
For machines with electro-magnetic output			For **Inverter** output		
Parameter	Symbol	Value	Time after fault	Volts	Amps
Peak Short Circuit current	i_p	N/A	20ms	187.7V	9.806A
Initial Value of aperiodic current	A	N/A	100ms	0.899 V	8.758A
Initial symmetrical short-circuit current*	I_k	N/A	250ms	0	0
Decaying (aperiodic) component of short circuit current*	i_{DC}	N/A	500ms	0	0
Reactance/Resistance Ratio of source*	$^X/_R$	N/A	Time to trip	117 ms	In seconds
For rotating machines and linear piston machines the test should produce a 0 s – 2 s plot of the short circuit current as seen at the **Micro-generator** terminals. * Values for these parameters should be provided where the short circuit duration is sufficiently long to enable interpolation of the plot.					

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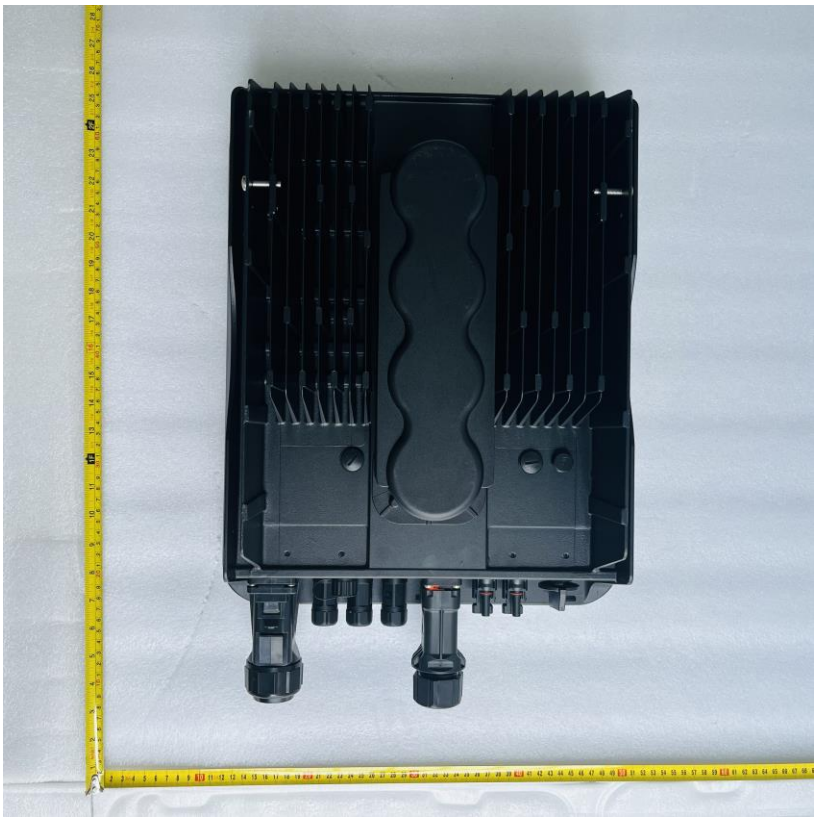
Clause	Requirement - Test	Result - Remark	Verdict

14. Logic interface (input port)	
Confirm that an input port is provided and can be used to reduce the **Active Power** output to zero	Yes
Provide high level description of logic interface, e.g. details in 9.4.3 such as AC or **DC** signal (the additional comments box below can be used)	Yes
15. Self-Monitoring solid state switching: No specified test requirements. Refer to EREC G98 Annex A1 A.1.3.6 (**Inverter** connected).	
It has been verified that in the event of the solid state switching device failing to disconnect the **Micro-generator**, the voltage on the output side of the switching device is reduced to a value below 50 V within 0.5 s.	N/A
16. Cyber security	
Confirm that the **Manufacturer** or **Installer** of the **Micro-generator** has provided a statement describing how the **Micro-generator** has been designed to comply with cyber security requirements, as detailed in 9.7.	Yes, Manufacturer's declaration provided.
Additional comments.	
To short or open pin1 and pin5 of logic interface port (Com 1) to control the inverter to normal or shutdown active power of output. A logic interface is provided that can be operated by an external switch or contactor. Users can install by themselves. Users install the switch connected to pin1 and pin5 of Com1 and just need control the switch signal causing the switch to open or short. When the switch is closed, the inverter will operate normally. When the switch is opened, the inverter will cease to export active power within 5 seconds. The signal from the inverter that is being switched is DC (maximum value 3.3V).	

Appendix 2: Photo documentation

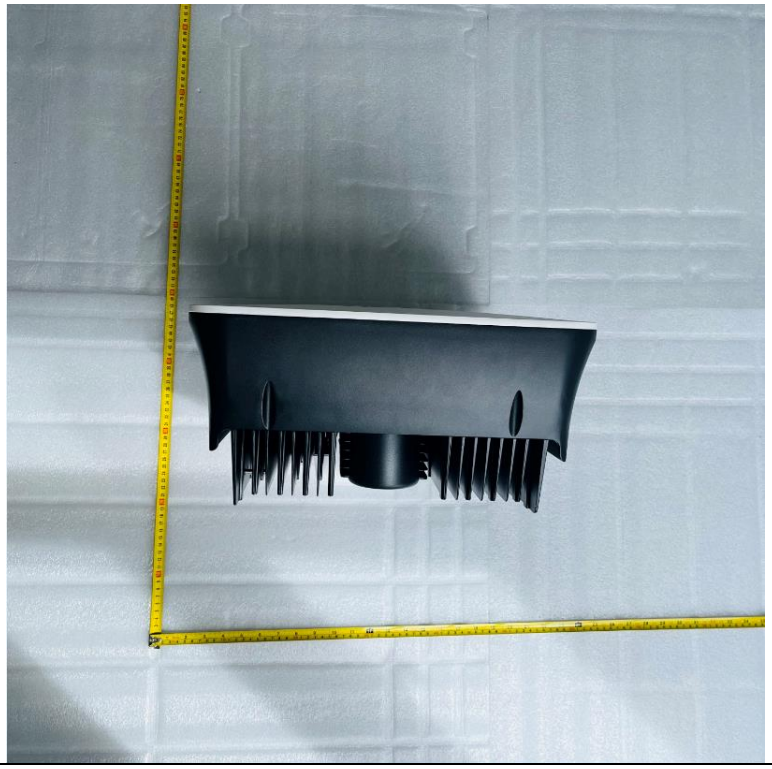
Enclosure Front View

Enclosure Rear View


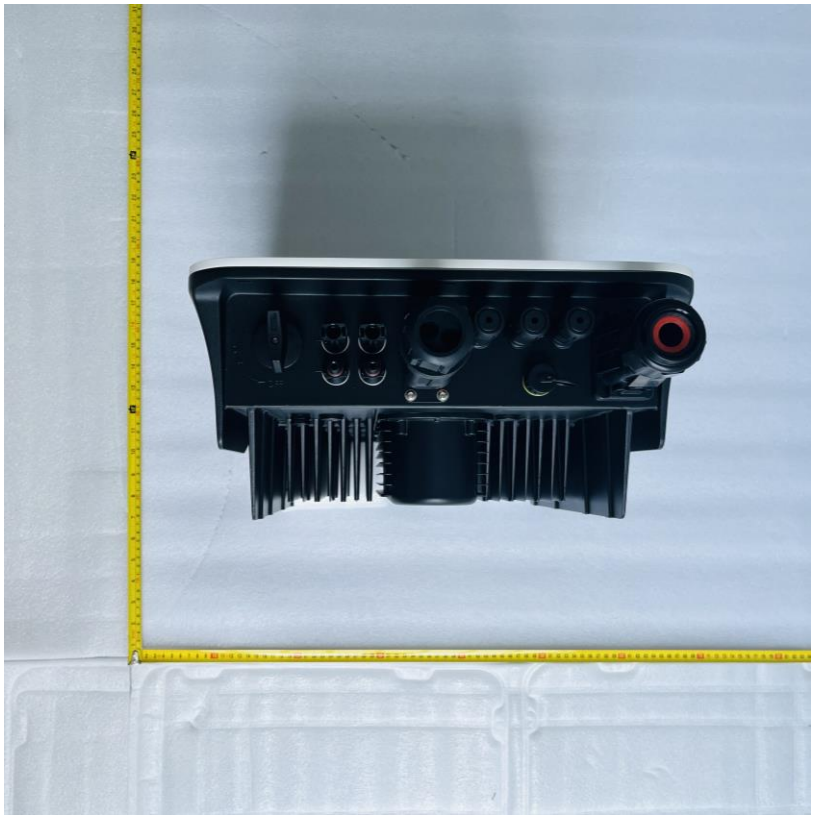
Enclosure Side View

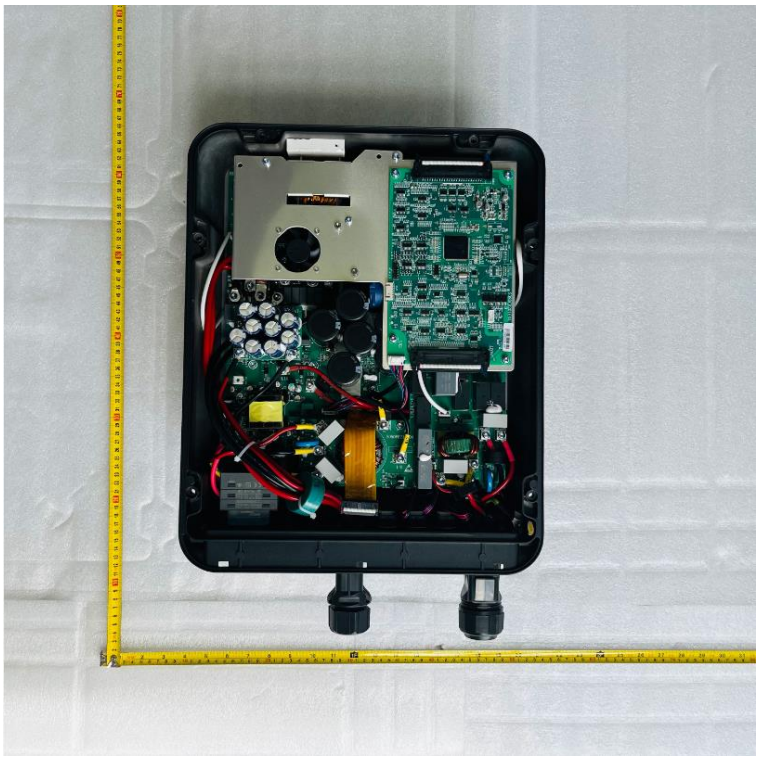
Enclosure Side View

Enclosure Top Side View



Enclosure Bottom Side View



Internal view


--- End of test report---