Solar Inverter

Clearline
INVERTER

1.0 to 3.0kW
Single String Single Phase

Suitable for solar installations from 0.67kWp up to 4.5kWp (DC)

- **Discreet and Lightweight** - Footprint of an A4 sheet of paper and whisper quiet operation.
- **Enhanced Generation** - low start-up voltage generates power in low light conditions.
- **Smart Control.** Generation monitoring and optional export limitation.
- **Safe and Reliable.** Factory fitted DC isolator switch for improved safety.
- **10 Year Warranty.**
- **UK Technical and Design Support.**

Viridian Solar, Atlas Building, 68 Stirling Way,
Papworth, Cambridge CB23 3GY

01480 839 865
www.viridiansolar.com

80043 Version 1.3

viridian solar

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Specification

		CSI1000S	CSI1500S	CSI2000S	CSI2500S	CSI3000S
OUTPUT						
Nominal Output Power	W	1,000	1,500	2,000	2,500	3,000
Nominal Output Apparent Power	VA	1,000	1,500	2,000	2,500	3,000
Max. AC Active Power	W	1,000	1,500	2,000	2,500	3,000
Max. AC Apparent Power	VA	1,000	1,500	2,000	2,500	3,000
Max. Output Current	A	4.6	6.9	9.1	11.4	13.7
Nominal AC Grid Frequency	Hz	50/60	50/60	50/60	50/60	50/60
Nominal Output Voltage	V	220/ 230/ 240,L/N/PE				
Power Factor		~1 (adjustable from 0.8 leading to 0.8 lagging)				
Max. Total Harmonic Distortion		<3%	<3%	<3%	<3%	<3%
INPUT						
Max. Input Power	W	2,000	3,000	4,000	5,000	6,000
Max. Input Voltage	V	600	600	600	600	600
MPPT Operating Voltage Range	V	40~450	40~450	40~450	40~550	40~550
Start-up Voltage	V	50	50	50	50	50
Nominal Input Voltage	V	360	360	360	360	360
Max. Input Current per MPPT	A	16	16	16	16	16
Max. Short Circuit Current per MPPT	A	25	25	25	25	25
Number of MPPT Trackers		1	1	1	1	1
Number of Strings per MPPT		1	1	1	1	1
EFFICIENCY						
Max. Efficiency		97.1%	97.2%	97.5%	97.6%	97.6%
European Efficiency		95.0%	96.0%	96.8%	97.0%	97.1%

GENERAL		
Operating Temperature Range	°C	-25 to +60
Relative Humidity		0 to 100%
Max. Operating Altitude	m	4,000
Cooling Method		Natural Convection
User Interface		LED, LCD, WLAN and App
Communication		RS485, WiFi, LAN, 4G, Bluetooth (opt.)
Weight	kg	4.6
Dimensions (WxHxD)	mm	306 x 218 x 119
Noise Emission	dB	<20
Topology		Non-isolated
Standby Power Consumption	W	<3
Ingress Protection (IP) Rating		IP66
DC Connector		MC4 (4- 6mm^2)
AC Connector		plug and play connector

PROTECTION	
PV Insulation Resistance Detection	Integrated
Residual Current Monitoring	Integrated
Anti-Islanding Protection	Integrated
AC Overcurrent Protection	Integrated
AC Short Circuit Protection	Integrated
AC Overvoltage Protection	Integrated
DC Switch	Integrated
DC Surge Protection	Type III (Type II Optional)
AC Surge Protection	Type III (Type II Optional)
AFCI	Option
Emergency Power Off	Option
Remote Shutdown	Option

Viridian Solar, Atlas Building, 68 Stirling Way,
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viridian solar

Clearline Inverter - Limited Guarantee

Viridian Solar Ltd., (hereinafter “Viridian”) shall provide to any purchaser (“Purchaser”) of its Clearline Inverter and associated Accessories (“Products”), limited guarantees as to the quality and/or performance of its Products in accordance with the following terms and conditions.

1.0 General Conditions

The guarantees will start from the date of installation of the relevant Product and is transferrable to subsequent owners of the location to which the Product is installed. Where the installation date cannot be confirmed, the start date will be taken as one month after the shipment of the product from Viridian. The execution of the guarantees will not lead to any prolongation of the original guarantee period. The guarantees apply to products delivered after 1st January 2023. The Purchaser’s statutory rights under applicable national legislation are not affected by the guarantees.

The guarantees are conditional upon the Products being properly handled and installed by competent persons who have correctly followed the installation instructions applicable at that time and have used best-practice methods for their respective trades. It is also contingent on the Products being used in the manner that Viridian intended. The guarantees are also dependant on the proper use and maintenance of the Products according to Viridian’s instructions. It is the responsibility of the Purchaser to demonstrate, to the reasonable satisfaction of Viridian, that the exclusions in this section 1.0 and section 3.0 of this document do not apply in respect of any claim under the guarantees.

The guarantees may not be claimed against unless and until the relevant Product has been paid for in full. Any claim under the guarantees shall be promptly notified in writing by the Purchaser as set out in section 4.0 below.

Viridian does not accept liability (whether in tort [including for negligence or breach of statutory duty], contract, misrepresentation or otherwise) for any loss of profits; loss of business; depletion of goodwill or similar losses; loss of anticipated savings; loss of goods; loss of use; or any special, indirect or consequential losses arising from the failure of the Products howsoever caused.

This exclusion of liability does not affect, or attempt to affect, any of the Purchaser’s rights under applicable national legislation.

The guarantees do not cover costs associated with installation, removal, or reinstallation of the Products.

In no event will Viridian’s aggregate liability under the guarantees exceed the original value of the Products which are the subject of a claim or dispute.

Any exchanged or replaced components or Products shall pass into the ownership of Viridian.

The Purchaser accepts that the Products were not designed and produced to its individual requirements and that the Purchaser was responsible for their selection.

2.0 Product Guarantee

For the purposes of this Product Guarantee, a “Defect” means behaviour of the relevant Product which does not meet the relevant specification set out in the technical data sheet (available at www.viridiansolar.com) and which is caused by failings in the materials or workmanship used or deployed in the production of the relevant Product. For the avoidance of doubt, a Defect does not occur when the Product does not meet a particular need but does meet a reasonable interpretation of the behaviour defined in the technical datasheet.

Viridian guarantees in respect of each Product that, for the periods set out in respect of each Product type below, the relevant Product will not be subject to a Defect.

Product	Product Code Starting	Years
Clearline Inverter	CSI	10
Inverter WiFi Module	CSI-WIFI	2

The Purchaser shall promptly notify Viridian of any breach of the above Product Guarantee in accordance with section 4.0.

In the event of a claim being approved, the Purchaser's sole remedy for breach of this Product Guarantee and Viridian's sole obligation shall be that Viridian will, at its sole option, reimburse the Purchaser for the original purchase, repair the Product, or supply a replacement new or refurbished Product. If the type of Product which is subject to the claim is no longer available, a Product of equivalent performance (as judged by Viridian), may be supplied.

The Purchaser shall provide all information as may be deemed necessary by Viridian to assist Viridian in remedying any Defect.

The period of Product Guarantees for any replacement Products supplied pursuant to this Product Guarantee will be equal to the remainder of the guarantee period of the originally supplied Product.

3.0 Exclusions

No claim may be brought after expiry of the applicable guarantee periods.

This Product Guarantee is subject to the following conditions:

- The Product being properly handled and installed by competent persons who have correctly followed the installation instructions applicable at that time and have used best-practice methods for their respective trades.
- The Product is used only on the electricity supply printed on the rating plate.
- The Product is used in the United Kingdom or Republic of Ireland.
- The Product has been used in accordance with the User Guide.
- The serial number of the Product, components or accessories have not been altered, cancelled, or removed.
- The Product has not been altered, serviced, maintained, dismantled or otherwise interfered with by any person not authorised by Viridian. For the avoidance of doubt any attempt to open the unit by anyone other than us or our appointed agent will invalidate the warranty.
- Any repair work must be undertaken by us or our appointed agent having first been agreed with Viridian Technical Support.
- That any return of the Product is done as specified in the Return Materials Authorisation ("RMA") instructions provided by Viridian.

The Guarantee does not cover defects which in Viridian's judgement have been caused by:

- Fair wear and tear (e.g., colour fading, scratches on top cover/machine body).
- Installation that is not in conformance with product specifications, installation instructions, operation manuals, labelling or prevailing standards and regulations
- Any damage due to miswiring, and/or software/hardware misconfiguration
- Failure to demonstrate that recommended maintenance procedures have been followed.
- Defective transportation, storage, or handling

- Usage which does not comply with the safety regulations (VDE, IEC, etc.).
- Operation outside the specified operating temperature and or humidity range
- Use of incompatible spare parts or accessories not supplied or approved by Viridian.
- Unauthorised modification of the Product, including the addition of marks and stickers
- Breakage due to external influences – power surge, flying objects, external loads, vandalism or theft.
- Damage due to shock/vibration.
- Damage due to improper IP protection (dust/fluid ingress)
- Damage caused by external factors – such as dirt, soiling, smoke, chemicals, pollution.
- Damage by natural disasters (such as fires, earthquakes, cyclones, hurricanes, volcano eruptions, lightning, indirect lightning strikes, heavy snow falls, avalanches, frost damage) or other unforeseeable circumstances.
- Relocation from the original place of installation
- Faults caused by interaction with equipment not supplied or approved in writing by Viridian
- Third party software or from virus(es).

The warranty does not cover:

- Product failure not reported to Viridian within one month of appearance.
- Damage resulting from transportation, improper use, wear and tear, neglect or interference or as a result of improper installation.
- Replacement of any consumable item or accessory not supplied by us.
- Any rust that appears on the device's enclosure caused by harsh environmental conditions. Faults or damage caused by exposure to coastal environments/saltwater or other aggressive atmospheres or environmental conditions without Viridian's written confirmation/approval prior to the installation.

Viridian is not responsible for:

- Software loss or data loss that may occur during the repair or replacement of the product.
- Damage to or loss of any program, data, or removable storage media, or for costs of recovering any program or data.
- Confidential, proprietary, or personal information contained in the product which you return to us for any reason.
- Costs associated with de-installation or re-installation of any product.

4.0 Claims Procedure

Claims should be addressed to

warranty@viridiansolar.co.uk

or
Viridian Solar
Atlas Building
68 Stirling Way
Papworth
Cambridge, UK
CB23 3GY

The email must contain the following information regarding the device and the nature of the malfunction:

1. The serial number of the Product.
2. Proof of purchase.
3. Photographs of the Product in current state.
3. Installation information, including brand, model, and number of PV panels; if the defective product is an energy storage system, the brand and model of batteries are also needed.
4. Date of installation, date of malfunction.
5. Detailed description of the malfunction including any error messages on the LCD screen and any actions taken before the claim.

Without this information, your claim cannot be processed.

Viridian will endeavour to respond to the claim within 5 working days and resolve the claim within 28 days.

If we determine that the malfunction is potentially due to causes under warranty, then we will issue a Returns Merchandise Authorisation (RMA) to ship back the unit.

The returns process is as outlined below:

- Once received, Viridian will analyse the device that was returned under the RMA.
- If Viridian determines that the malfunction is due to the causes under warranty, the Product is repaired or replaced and shipped back to the customer (at our expense).
- If Viridian determines that the malfunction is not due to the causes under warranty, the warranty claim is rejected, and the Product is shipped back to the customer (at customer's expense).

When preparing your Product for shipment to Viridian, we recommend the following:

- The Product is returned in its original packaging. The original packaging will provide better protection for the Product during transit. The warranty may be voided if the Product is damaged due to improper packaging.
- Please do not send in anything but the Product itself unless specially requested by us. Any other items and accessories included in the package received by us will be treated as packaging material and may not be returned.
- Please note: if your Product is received packed in anything other than its original packaging, we may invoice you for appropriate anti-shock packaging when your Product is returned.

Clearline INVERTER

Form C: Type Test Verification Report

All Micro-generators connected to the **DNO Distribution Network** shall be **Fully Type Tested**. This form is the **Manufacturer**'s declaration of compliance with the requirements of EREC G98.

This form should be used when making a Type Test submission to the Energy Networks Association (ENA)Type Test Register.

If the **Micro-generator** is **Fully Type Tested** and already registered with the ENA Type Test Register, the **Installation Document** should include the **Manufacturer**'s Reference Number (the system reference), and this form does not need to be submitted.

Manufacturer's reference number	Clearline Inverter CSI1000		
Micro-generator technology	Grid-Connected PV Inverter (Inverter Models: CSI1000)		
Manufacturer name	Viridian Solar Limited		
Address	68 Stirling Way, Papworth, Cambridge CB23 3GY, UK		
Tel	+44 (0)1480 839 865	Fax	N/A
E-mail	info@viridiansolar.co.uk	Web site	www.viridiansolar.co.uk

Registered Capacity, use separate sheet if more than one connection option.	Connection Option	
	1	kW single phase, single, split or three phase system
	/	kW three phase
	/	kW two phases in three phase system
	/	kW two phases split phase system
Energy storage capacity for **Electricity Storage** devices		Not energy storage inverter

Manufacturer Type Test declaration. - I certify that all products supplied by the company with the above **Fully Type Tested** reference number will be manufactured and tested to ensure that they perform as stated in this document, prior to shipment to site and that no site modifications are required to ensure that the product meets all the requirements of EREC G98.

Signed	 KT Tan 28th April 2023	On behalf of	viridian solar Viridian Solar Limited

Note that testing can be done by the **Manufacturer** of an individual component or by an external test house.

Where parts of the testing are carried out by persons or organisations other than the **Manufacturer** then that person or organisation shall keep copies of all test records and results supplied to them to verify that the testing has been carried out by people with sufficient technical competency to carry out the tests.

1.**Operating Range:** 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 seconds	Result: Pass
Test 2 Voltage = 85% of nominal (195.5 V) Frequency = 47.5 Hz Power factor = 1 Period of test 90 minutes	Result: Pass
Test 3 Voltage = 110% of nominal (253 V). Frequency = 51.5 Hz Power factor = 1 Period of test 90 minutes	Result: Pass
Test 4 Voltage = 110% of nominal (253 V). Frequency = 52.0 Hz Power factor = 1 Period of test 15 minutes	Result: Pass
Test 5 Voltage = 100% of nominal (230 V). Frequency = 50.0 Hz Power factor = 1 Period of test 90 minutes	Result: Pass

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.	Result: Pass

2.Power Quality – Harmonics: 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).

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.			

Harmonic	At 45-55% of **Registered Capacity**[1]		100% of **Registered Capacity**			
	Measured Value MV in Amps		Measured Value MV in Amps		Limit in BS EN 61000-3-2 in Amps	Higher limit for odd harmonics 21 and above
2	0.021		0.031		1.080	
3	0.027		0.070		2.300	
4	0.004		0.003		0.430	
5	0.015		0.024		1.140	
6	0.002		0.006		0.300	
7	0.004		0.011		0.770	
8	0.003		0.008		0.230	
9	0.002		0.005		0.400	
10	0.004		0.002		0.184	
11	0.003		0.003		0.330	
12	0.003		0.001		0.153	
13	0.002		0.002		0.210	
14	0.002		0.002		0.131	
15	0.003		0.005		0.150	

[1] See the note in A.2.3.1 if 45-55% of **Registered Capacity** is below the minimum stable operating level. If an alternative loading level is chosen, the level should be indicated on the test form and the reason for not testing at 45-55% of **Registered Capacity** should be stated. The additional comments box at the end of the harmonics test sheet can be used for this.

16	0.002		0.002		0.115	
17	0.002		0.004		0.132	
18	0.001		0.001		0.102	
19	0.001		0.002		0.118	
20	0.001		0.001		0.092	
21	0.001		0.002		0.107	0.160
22	0.001		0.001		0.084	
23	0.002		0.003		0.098	0.147
24	0.001		0.001		0.077	
25	0.001		0.002		0.090	0.135
26	0.001		0.001		0.071	
27	0.001		0.002		0.083	0.124
28	0.000		0.001		0.066	
29	0.001		0.002		0.078	0.117
30	0.000		0.001		0.061	
31	0.001		0.002		0.073	0.109
32	0.000		0.000		0.058	
33	0.001		0.001		0.068	0.102
34	0.000		0.000		0.054	
35	0.001		0.001		0.064	0.096
36	0.000		0.000		0.051	
37	0.001		0.001		0.061	0.091
38	0.000		0.000		0.048	
39	0.000		0.001		0.058	0.087
40	0.000		0.000		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.

Additional comments:

3.**Power Quality – Voltage fluctuations and Flicker**: 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	22nd October 2021	Test end date	25th October 2021
Test location	Test lab of GoodWe Technologies Co., Ltd (No.90 Zijin Rd., New District, Suzhou, 215011, China)		

	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	0.18%	0.11%	0%	0.22%	0.18%	0%	0.12	0.12
Normalised to standard impedance	0.18%	0.11%	0%	0.22%	0.18%	0%	0.12	0.12
Normalised to required maximum impedance	NA	NA	NA	NA	NA	NA	NA	NA
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	X	0.25	Ω
Standard Impedance	R	0.4 ^	Ω	X	0.25 ^	Ω
Maximum Impedance	R	NA	Ω	X	NA	Ω

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

4.**Power quality – DC injection:** 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%.

Test power level	20%	50%	75%	100%
Recorded **DC** value in Amps	0.0094	0.0105	0.0079	0.0106
as % of rated AC current	0.22%	0.24%	0.18%	0.24%
Limit	0.25%	0.25%	0.25%	0.25%

5.Power Quality – Power factor: 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.

	216.2 V	230 V	253 V
Measured value	0.9929	0.9899	0.9914
Power Factor Limit	>0.95	>0.95	>0.95

6.Protection – Frequency tests: 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.

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	47.45 Hz	20.05s	47.7 Hz 30 s	no trip
U/F stage 2	47 Hz	0.5 s	46.98Hz	0.56s	47.2 Hz 19.5 s	no trip
					46.8 Hz 0.45 s	no trip
O/F stage 1	52 Hz	0.5 s	52.02 Hz	0.54s	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.

7.Protection – Voltage tests: 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.

Function	Setting		Trip test		"No trip tests"	
	Voltage	Time delay	Voltage	Time delay	Voltage /time	Confirm no trip
U/V	184 V	2.5 s	183.7V	2.54s	188 V 5.0 s	no trip
					180 V 2.45 s	no trip
O/V stage 1	262.2 V	1.0 s	264.8V	1.03s	258.2 V 5.0 s	no trip
O/V stage 2	273.7 V	0.5 s	274.19V	0.52s	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.

8.Protection – Loss of Mains test: 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.

To be carried out at three output power levels with a tolerance of plus or minus 5% in Test Power levels.[2]

[2] See the note in A.2.2.4 if the suggested loading levels are below the minimum stable operating level. If alternative loading levels are chosen, the level should be indicated on the test form and the reason for not testing at 10%/55%

Test Power	10%	55%	100%	10%	55%	100%
Balancing load on islanded network	95% of **Registered Capacity**	95% of **Registered Capacity**	95% of **Registered Capacity**	105% of **Registered Capacity**	105% of **Registered Capacity**	105% of **Registered Capacity**
Trip time. Limit is 0.5 s	NA	NA	NA	NA	NA	NA
For Multi phase **Micro-generators** confirm that the device shuts down correctly after the removal of a single fuse as well as operation of all phases.						
Test Power	10%	55%	100%	10%	55%	100%
Balancing load on islanded network	95% of **Registered Capacity**	95% of **Registered Capacity**	95% of **Registered Capacity**	105% of **Registered Capacity**	105% of **Registered Capacity**	105% of **Registered Capacity**
Trip time. Ph1 fuse removed	NA	NA	NA	NA	NA	NA
Test Power	10%	55%	100%	10%	55%	100%
Balancing load on islanded network	95% of **Registered Capacity**	95% of **Registered Capacity**	95% of **Registered Capacity**	105% of **Registered Capacity**	105% of **Registered Capacity**	105% of **Registered Capacity**
Trip time. Ph2 fuse removed	NA	NA	NA	NA	NA	NA
Test Power	10%	55%	100%	10%	55%	100%
Balancing load on islanded network	95% of **Registered Capacity**	95% of **Registered Capacity**	95% of **Registered Capacity**	105% of **Registered Capacity**	105% of **Registered Capacity**	105% of **Registered Capacity**
Trip time. Ph3 fuse removed	NA	NA	NA	NA	NA	NA
Note for technologies which have a substantial shut down time this can be added to the 0.5 s in establishing that the trip occurred in less than 0.5 s. Maximum shut down time could therefore be up to 1.0 s for these technologies.						
Indicate additional shut down time included in above results.				NA ms		
Additional comments:						

of **Registered Capacity** should be stated. The additional comments box at the end of the loss of mains test sheet can be used for this.

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 0.5 s[3]	0.110s	0.115s	0.114s	0.117s	0.117s	0.114s

9.Protection – Frequency change, Vector Shift Stability test: 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.

	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

10.Protection – Frequency change, RoCoF Stability test: 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.

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

11.Limited Frequency Sensitive Mode – Over frequency test: This test should be carried out in accordance with A.1.2.8. 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.1.2.8.

Test sequence at **Registered Capacity**>80%	Measured **Active Power** Output	Frequency	Primary Power Source	**Active Power** Gradient Droop (%)
Step a) 50.00 Hz ±0.01 Hz	986	50	1080	/
Step b) 50.45 Hz ±0.05 Hz	975	50.45		9.09%
Step c) 50.70 Hz ±0.10 Hz	919	50.7		8.96%
Step d) 51.15 Hz ±0.05 Hz	826	51.15		9.38%
Step e) 50.70 Hz ±0.10 Hz	918	50.7		8.82%

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

Step f) 50.45 Hz ±0.05 Hz	975	50.45		9.09%
Step g) 50.00 Hz ±0.01 Hz	985	50		/
Test sequence at **Registered Capacity**40% - 60%	Measured Active Power Output	Frequency	Primary Power Source	Active Power Gradient Droop (%)
Step a) 50.00 Hz ±0.01 Hz	489	50	550	/
Step b) 50.45 Hz ±0.05 Hz	478	50.45		9.09%
Step c) 50.70 Hz ±0.10 Hz	422	50.7		8.96%
Step d) 51.15 Hz ±0.05 Hz	325	51.15		9.15%
Step e) 50.70 Hz ±0.10 Hz	425	50.7		9.38%
Step f) 50.45 Hz ±0.05 Hz	478	50.45		9.09%
Step g) 50.00 Hz ±0.01 Hz	489	50		/

12.Power output with falling frequency test: This test should be carried out in accordance with A.1.2.7.

Test sequence	Measured **Active Power** Output	Frequency	Primary power source
Test a) 50 Hz ± 0.01 Hz	1012	50	1050
Test b) Point between 49.5 Hz and 49.6 Hz	1011	49.55	1050
Test c) Point between 47.5 Hz and 47.6 Hz	1009	47.55	1050

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

13.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 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 2.			
48s	48s		At 266.2 V	At 180.0 V	At 47.4 Hz	At 52.1 Hz
Confirmation that the **Micro-generator** does not re-connect.			No re-connection	no re-connection	no re-connection	no re-connection

14.Fault level contribution: 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.

For machines with electro-magnetic output			For **Inverter** output		
Parameter	Symbol	Value	Time after fault	Volts	Amps
Peak Short Circuit current	i_p	NA	20 ms	38V	12A
Initial Value of aperiodic current	*A*	NA	100 ms	37V	11.81A
Initial symmetrical short-circuit current*	I_k	NA	250 ms	37.3V	11.84A
Decaying (aperiodic) component of short circuit current*	i_{DC}	NA	500 ms	37.4V	11.88A
Reactance/Resistance Ratio of source*	X/R	NA	Time to trip	2.75s	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

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
Self-Monitoring solid state switching: No specified test requirements. Refer to EREC G98 Annex A1 A.1.3.6 (**Inverter** connected).	Yes
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.	
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

Additional comments

The following documents are attached to this declaration:
- “Clearline declaration about Logic Interface”, as for required in “Logic Interface” section;
- “Clearline declaration about cyber-security”, as for required in “Cyber security” section;

Clearline INVERTER

Form C: Type Test Verification Report

All Micro-generators connected to the **DNO Distribution Network** shall be **Fully Type Tested**. This form is the **Manufacturer**'s declaration of compliance with the requirements of EREC G98.

This form should be used when making a Type Test submission to the Energy Networks Association (ENA)Type Test Register.

If the **Micro-generator** is **Fully Type Tested** and already registered with the ENA Type Test Register, the **Installation Document** should include the **Manufacturer**'s Reference Number (the system reference), and this form does not need to be submitted.

Manufacturer's reference number	Clearline Inverter CSI1500		
Micro-generator technology	Grid-Connected PV Inverter (Inverter Models: CSI1500)		
Manufacturer name	Viridian Solar Limited		
Address	68 Stirling Way, Papworth, Cambridge CB23 3GY, UK		
Tel	+44 (0)1480 839 865	Fax	N/A
E-mail	info@viridiansolar.co.uk	Web site	www.viridiansolar.co.uk

Registered Capacity, use separate sheet if more than one connection option.	Connection Option	
	1.5	kW single phase, single, split or three phase system
	/	kW three phase
	/	kW two phases in three phase system
	/	kW two phases split phase system
Energy storage capacity for **Electricity Storage** devices		Not energy storage inverter

Manufacturer Type Test declaration. - I certify that all products supplied by the company with the above **Fully Type Tested** reference number will be manufactured and tested to ensure that they perform as stated in this document, prior to shipment to site and that no site modifications are required to ensure that the product meets all the requirements of EREC G98.

Signed	 KT Tan 28th April 2023	On behalf of	viridian solar Viridian Solar Limited

Note that testing can be done by the **Manufacturer** of an individual component or by an external test house.

Where parts of the testing are carried out by persons or organisations other than the **Manufacturer** then that person or organisation shall keep copies of all test records and results supplied to them to verify that the testing has been carried out by people with sufficient technical competency to carry out the tests.

1.**Operating Range:** 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 seconds	Result: Pass
Test 2 Voltage = 85% of nominal (195.5 V) Frequency = 47.5 Hz Power factor = 1 Period of test 90 minutes	Result: Pass
Test 3 Voltage = 110% of nominal (253 V). Frequency = 51.5 Hz Power factor = 1 Period of test 90 minutes	Result: Pass
Test 4 Voltage = 110% of nominal (253 V). Frequency = 52.0 Hz Power factor = 1 Period of test 15 minutes	Result: Pass
Test 5 Voltage = 100% of nominal (230 V). Frequency = 50.0 Hz Power factor = 1 Period of test 90 minutes	Result: Pass
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.	Result: Pass

2.Power Quality – Harmonics: 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).

Micro-generator tested to BS EN 61000-3-2			
Micro-generator rating per phase (rpp)	1.5	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.			

Harmonic	At 45-55% of **Registered Capacity**[1]		100% of **Registered Capacity**			
	Measured Value MV in Amps		Measured Value MV in Amps		Limit in BS EN 61000-3-2 in Amps	Higher limit for odd harmonics 21 and above
2	0.031		0.059		1.080	
3	0.117		0.235		2.300	
4	0.006		0.006		0.430	
5	0.028		0.030		1.140	
6	0.009		0.010		0.300	
7	0.027		0.026		0.770	
8	0.009		0.011		0.230	
9	0.023		0.023		0.400	
10	0.009		0.011		0.184	
11	0.019		0.020		0.330	
12	0.011		0.013		0.153	
13	0.014		0.015		0.210	
14	0.011		0.012		0.131	
15	0.011		0.013		0.150	
16	0.010		0.010		0.115	

[1] See the note in A.2.3.1 if 45-55% of **Registered Capacity** is below the minimum stable operating level. If an alternative loading level is chosen, the level should be indicated on the test form and the reason for not testing at 45-55% of **Registered Capacity** should be stated. The additional comments box at the end of the harmonics test sheet can be used for this.

17	0.009		0.011		0.132	
18	0.010		0.009		0.102	
19	0.009		0.008		0.118	
20	0.009		0.008		0.092	
21	0.008		0.007		0.107	0.160
22	0.008		0.008		0.084	
23	0.007		0.006		0.098	0.147
24	0.007		0.007		0.077	
25	0.007		0.006		0.090	0.135
26	0.006		0.006		0.071	
27	0.006		0.006		0.083	0.124
28	0.005		0.006		0.066	
29	0.006		0.005		0.078	0.117
30	0.005		0.005		0.061	
31	0.006		0.005		0.073	0.109
32	0.004		0.004		0.058	
33	0.007		0.005		0.068	0.102
34	0.004		0.004		0.054	
35	0.007		0.005		0.064	0.096
36	0.004		0.004		0.051	
37	0.006		0.004		0.061	0.091
38	0.004		0.004		0.048	
39	0.007		0.004		0.058	0.087
40	0.003		0.003		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.

Additional comments: the power used in the 100% test has been 1500 W and the power used in the 45-55% test has been 750 W

3.**Power Quality – Voltage fluctuations and Flicker**: 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	11th November 2022	Test end date	11th November 2022
Test location	Test lab of GoodWe Technologies Co., Ltd (No.90 Zijin Rd., New District, Suzhou, 215011, China)		

	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	0.122%	0.097%	0.0%	0.174%	0.130%	0.0%	0.045	0.041
Normalised to standard impedance	0.122%	0.097%	0.0%	0.174%	0.130%	0.0%	0.045	0.041
Normalised to required maximum impedance	NA	NA	NA	NA	NA	NA	NA	NA
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	X	0.25	Ω
Standard Impedance	R	0.4 ^	Ω	X	0.25 ^	Ω
Maximum Impedance	R	NA	Ω	X	NA	Ω

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

4.**Power quality – DC injection:** 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%.

Test power level	20%	50%	75%	100%
Recorded **DC** value in Amps	0.0063A	0.0093A	0.0094A	0.0122A
as % of rated AC current	0.097%	0.143%	0.144%	0.187%
Limit	0.25%	0.25%	0.25%	0.25%

5.Power Quality – Power factor: 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.

	216.2 V	230 V	253 V
Measured value	0.991	0.990	0.987
Power Factor Limit	>0.95	>0.95	>0.95

6.Protection – Frequency tests: 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.

Function	Setting		Trip test		"No trip tests"	
	Frequency	Time	Frequency	Time	Frequency /time	Confirm no trip

		delay		delay		
U/F stage 1	47.5 Hz	20 s	47.48 Hz	20.04s	47.7 Hz 30 s	no trip
U/F stage 2	47 Hz	0.5 s	46.98 Hz	0.55s	47.2 Hz 19.5 s	no trip
					46.8 Hz 0.45 s	no trip
O/F stage 1	52 Hz	0.5 s	52.02 Hz	0.54s	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.

7.Protection – Voltage tests: 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.

Function	Setting		Trip test		"No trip tests"	
	Voltage	Time delay	Voltage	Time delay	Voltage /time	Confirm no trip
U/V	184 V	2.5 s	183.26V	2.53s	188 V 5.0 s	no trip
					180 V 2.45 s	no trip
O/V stage 1	262.2 V	1.0 s	263.02V	1.01 s	258.2 V 5.0 s	no trip
O/V stage 2	273.7 V	0.5 s	274.77 V	0.53 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.

8.Protection – Loss of Mains test: 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.

To be carried out at three output power levels with a tolerance of plus or minus 5% in Test Power levels.[2]

[2] See the note in A.2.2.4 if the suggested loading levels are below the minimum stable operating level. If alternative loading levels are chosen, the level should be indicated on the test form and the reason for not testing at 10%/55% of **Registered Capacity** should be stated. The additional comments box at the end of the loss of mains test sheet can be used for this.

Test Power	10%	55%	100%	10%	55%	100%
Balancing load on islanded network	95% of **Registered Capacity**	95% of **Registered Capacity**	95% of **Registered Capacity**	105% of **Registered Capacity**	105% of **Registered Capacity**	105% of **Registered Capacity**
Trip time. Limit is 0.5 s	NA	NA	NA	NA	NA	NA
For Multi phase **Micro-generators** confirm that the device shuts down correctly after the removal of a single fuse as well as operation of all phases.						
Test Power	10%	55%	100%	10%	55%	100%
Balancing load on islanded network	95% of **Registered Capacity**	95% of **Registered Capacity**	95% of **Registered Capacity**	105% of **Registered Capacity**	105% of **Registered Capacity**	105% of **Registered Capacity**
Trip time. Ph1 fuse removed	NA	NA	NA	NA	NA	NA
Test Power	10%	55%	100%	10%	55%	100%
Balancing load on islanded network	95% of **Registered Capacity**	95% of **Registered Capacity**	95% of **Registered Capacity**	105% of **Registered Capacity**	105% of **Registered Capacity**	105% of **Registered Capacity**
Trip time. Ph2 fuse removed	NA	NA	NA	NA	NA	NA
Test Power	10%	55%	100%	10%	55%	100%
Balancing load on islanded network	95% of **Registered Capacity**	95% of **Registered Capacity**	95% of **Registered Capacity**	105% of **Registered Capacity**	105% of **Registered Capacity**	105% of **Registered Capacity**
Trip time. Ph3 fuse removed	NA	NA	NA	NA	NA	NA
Note for technologies which have a substantial shut down time this can be added to the 0.5 s in establishing that the trip occurred in less than 0.5 s. Maximum shut down time could therefore be up to 1.0 s for these technologies.						
Indicate additional shut down time included in above results.				NA ms		
Additional comments:						

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 0.5 s[3]	0.470s	0.400s	0.420s	0.470s	0.490s	0.410s

9.Protection – Frequency change, Vector Shift Stability test: 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.

	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

10.Protection – Frequency change, RoCoF Stability test: 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.

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

11.Limited Frequency Sensitive Mode – Over frequency test: This test should be carried out in accordance with A.1.2.8. 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.1.2.8.

Test sequence at **Registered Capacity**>80%	Measured **Active Power** Output	Frequency	Primary Power Source	**Active Power** Gradient Droop (%)
Step a) 50.00 Hz ±0.01 Hz	1499	50	1533	/
Step b) 50.45 Hz ±0.05 Hz	1482	50.45		8.82%
Step c) 50.70 Hz ±0.10 Hz	1414	50.7		10.59%
Step d) 51.15 Hz ±0.05 Hz	1260	51.15		9.41%
Step e) 50.70 Hz ±0.10 Hz	1414	50.7		10.59%
Step f) 50.45 Hz ±0.05 Hz	1482	50.45		8.82%

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

Step g) 50.00 Hz ±0.01 Hz	1499	50		/
Test sequence at **Registered Capacity**40% - 60%	Measured Active Power Output	Frequency	Primary Power Source	Active Power Gradient Droop(%)
Step a) 50.00 Hz ±0.01 Hz	745	50	771	/
Step b) 50.45 Hz ±0.05 Hz	728	50.45		8.82%
Step c) 50.70 Hz ±0.10 Hz	645	50.7		9.00%
Step d) 51.15 Hz ±0.05 Hz	498	51.15		9.11%
Step e) 50.70 Hz ±0.10 Hz	643	50.7		8.82%
Step f) 50.45 Hz ±0.05 Hz	731	50.45		10.71%
Step g) 50.00 Hz ±0.01 Hz	744	50		/

12.Power output with falling frequency test: This test should be carried out in accordance with A.1.2.7.

Test sequence	Measured **Active Power** Output	Frequency	Primary power source
Test a) 50 Hz ± 0.01 Hz	1504	50	1545
Test b) Point between 49.5 Hz and 49.6 Hz	1503	49.55	1544
Test c) Point between 47.5 Hz and 47.6 Hz	1502	47.55	1543

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

13.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 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 2.			
48s	48s		At 266.2 V	At 180.0 V	At 47.4 Hz	At 52.1 Hz
Confirmation that the **Micro-generator** does not re-connect.			No re-connection	no re-connection	no re-connection	no re-connection

14.Fault level contribution: 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.

For machines with electro-magnetic output			For **Inverter** output		
Parameter	Symbol	Value	Time after fault	Volts	Amps
Peak Short Circuit current	i_p	NA	20 ms	33.6	6.95
Initial Value of aperiodic current	A	NA	100 ms	35.5	6.92
Initial symmetrical short-circuit current*	I_k	NA	250 ms	32.2	6.92
Decaying (aperiodic) component of short circuit current*	i_{DC}	NA	500 ms	32.2	6.78
Reactance/Resistance Ratio of source*	X/R	NA	Time to trip	2.73	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					
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
Self-Monitoring solid state switching: No specified test requirements. Refer to EREC G98 Annex A1 A.1.3.6 (**Inverter** connected).					Yes
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.					
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
Additional comments					
The following documents are attached to this declaration: - “Clearline declaration about Logic Interface”, as for required in “Logic Interface” section; - “Clearline declaration about cyber-security”, as for required in “Cyber security” section;					

Clearline INVERTER

Form C: Type Test Verification Report

All Micro-generators connected to the **DNO Distribution Network** shall be **Fully Type Tested**. This form is the **Manufacturer**'s declaration of compliance with the requirements of EREC G98.

This form should be used when making a Type Test submission to the Energy Networks Association (ENA)Type Test Register.

If the **Micro-generator** is **Fully Type Tested** and already registered with the ENA Type Test Register, the **Installation Document** should include the **Manufacturer**'s Reference Number (the system reference), and this form does not need to be submitted.

Manufacturer's reference number	Clearline Inverter CSI2000		
Micro-generator technology	Grid-Connected PV Inverter (Inverter Models: CSI2000)		
Manufacturer name	Viridian Solar Limited		
Address	68 Stirling Way, Papworth, Cambridge CB23 3GY, UK		
Tel	+44 (0)1480 839 865	Fax	N/A
E-mail	info@viridiansolar.co.uk	Web site	www.viridiansolar.co.uk

Registered Capacity, use separate sheet if more than one connection option.	Connection Option	
	2	kW single phase, single, split or three phase system
	/	kW three phase
	/	kW two phases in three phase system
	/	kW two phases split phase system
Energy storage capacity for **Electricity Storage** devices		Not energy storage inverter

Manufacturer Type Test declaration. - I certify that all products supplied by the company with the above **Fully Type Tested** reference number will be manufactured and tested to ensure that they perform as stated in this document, prior to shipment to site and that no site modifications are required to ensure that the product meets all the requirements of EREC G98.

Signed	 KT Tan 28th April 2023	On behalf of	viridian solar Viridian Solar Limited

Note that testing can be done by the **Manufacturer** of an individual component or by an external test house.

Where parts of the testing are carried out by persons or organisations other than the **Manufacturer** then that person or organisation shall keep copies of all test records and results supplied to them to verify that the testing has been carried out by people with sufficient technical competency to carry out the tests.

1.**Operating Range:** 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 seconds	Result: Pass
Test 2 Voltage = 85% of nominal (195.5 V) Frequency = 47.5 Hz Power factor = 1 Period of test 90 minutes	Result: Pass
Test 3 Voltage = 110% of nominal (253 V). Frequency = 51.5 Hz Power factor = 1 Period of test 90 minutes	Result: Pass
Test 4 Voltage = 110% of nominal (253 V). Frequency = 52.0 Hz Power factor = 1 Period of test 15 minutes	Result: Pass
Test 5 Voltage = 100% of nominal (230 V). Frequency = 50.0 Hz Power factor = 1 Period of test 90 minutes	Result: Pass

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.	Result: Pass

2.Power Quality – Harmonics: 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).

Micro-generator tested to BS EN 61000-3-2

Micro-generator rating per phase (rpp)	2	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.			

Harmonic	At 45-55% of **Registered Capacity**[1]		100% of **Registered Capacity**			
	Measured Value MV in Amps		Measured Value MV in Amps		Limit in BS EN 61000-3-2 in Amps	Higher limit for odd harmonics 21 and above
2	0.0388		0.0793		1.080	
3	0.1037		0.0930		2.300	
4	0.0058		0.0138		0.430	
5	0.0430		0.0783		1.140	
6	0.0064		0.0097		0.300	
7	0.0109		0.0246		0.770	
8	0.0135		0.0133		0.230	
9	0.0134		0.0081		0.400	
10	0.0164		0.0111		0.184	
11	0.0109		0.0167		0.330	
12	0.0117		0.0116		0.153	
13	0.0156		0.0158		0.210	
14	0.0128		0.0133		0.131	
15	0.0165		0.0147		0.150	
16	0.0136		0.0083		0.115	

[1] See the note in A.2.3.1 if 45-55% of **Registered Capacity** is below the minimum stable operating level. If an alternative loading level is chosen, the level should be indicated on the test form and the reason for not testing at 45-55% of **Registered Capacity** should be stated. The additional comments box at the end of the harmonics test sheet can be used for this.

17	0.0154		0.0123		0.132	
18	0.0104		0.0096		0.102	
19	0.0131		0.0118		0.118	
20	0.0112		0.0115		0.092	
21	0.0105		0.0107		0.107	0.160
22	0.0082		0.0108		0.084	
23	0.0085		0.0089		0.098	0.147
24	0.0079		0.0076		0.077	
25	0.0089		0.0090		0.090	0.135
26	0.0070		0.0073		0.071	
27	0.0088		0.0080		0.083	0.124
28	0.0059		0.0071		0.066	
29	0.0074		0.0090		0.078	0.117
30	0.0056		0.0059		0.061	
31	0.0076		0.0063		0.073	0.109
32	0.0065		0.0060		0.058	
33	0.0059		0.0063		0.068	0.102
34	0.0042		0.0054		0.054	
35	0.0061		0.0064		0.064	0.096
36	0.0038		0.0048		0.051	
37	0.0054		0.0051		0.061	0.091
38	0.0038		0.0051		0.048	
39	0.0047		0.0060		0.058	0.087
40	0.0038		0.0043		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.

Additional comments:

3.**Power Quality – Voltage fluctuations and Flicker**: 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	22nd October 2021	Test end date	25th October 2021
Test location	Test lab of GoodWe Technologies Co., Ltd (No.90 Zijin Rd., New District, Suzhou, 215011, China)		

	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	0.18%	0.13%	0%	0.17%	0.15%	0%	0.037	0.026
Normalised to standard impedance	0.18%	0.13%	0%	0.17%	0.15%	0%	0.037	0.026
Normalised to required maximum impedance	NA	NA	NA	NA	NA	NA	NA	NA
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	X	0.25	Ω
Standard Impedance	R	0.24 * 0.4 ^	Ω	X	0.15 * 0.25 ^	Ω
Maximum Impedance	R	NA	Ω	X	NA	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.

4.**Power quality – DC injection:** 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%.

Test power level	20%	50%	75%	100%
Recorded **DC** value in Amps	0.0158A	0.0124A	0.0128A	0.0183A
as % of rated AC current	0.1817%	0.1426%	0.1471%	0.2105%
Limit	0.25%	0.25%	0.25%	0.25%

5.Power Quality – Power factor: 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.

	216.2 V	230 V	253 V
Measured value	0.9892	0.9892	0.9894
Power Factor Limit	>0.95	>0.95	>0.95

6.Protection – Frequency tests: 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.

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	47.48Hz	20.05s	47.7 Hz 30 s	no trip
U/F stage 2	47 Hz	0.5 s	46.98Hz	0.55s	47.2 Hz 19.5 s	no trip
					46.8 Hz 0.45 s	no trip
O/F stage 1	52 Hz	0.5 s	52.02Hz	0.55s	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.

7.Protection – Voltage tests: 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.

Function	Setting		Trip test		"No trip tests"	
	Voltage	Time delay	Voltage	Time delay	Voltage /time	Confirm no trip
U/V	184 V	2.5s	184.4V	2.54s	188 V 5.0 s	no trip
					180 V 2.45 s	no trip
O/V stage 1	262.2 V	1.0 s	263.79V	1.02s	258.2 V 5.0 s	no trip
O/V stage 2	273.7 V	0.5 s	273.96V	0.56s	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.

8.Protection – Loss of Mains test: 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.

To be carried out at three output power levels with a tolerance of plus or minus 5% in Test Power levels.[2]

[2] See the note in A.2.2.4 if the suggested loading levels are below the minimum stable operating level. If alternative loading levels are chosen, the level should be indicated on the test form and the reason for not

Test Power	10%	55%	100%	10%	55%	100%
Balancing load on islanded network	95% of **Registered Capacity**	95% of **Registered Capacity**	95% of **Registered Capacity**	105% of **Registered Capacity**	105% of **Registered Capacity**	105% of **Registered Capacity**
Trip time. Limit is 0.5 s	NA	NA	NA	NA	NA	NA
For Multi phase **Micro-generators** confirm that the device shuts down correctly after the removal of a single fuse as well as operation of all phases.						
Test Power	10%	55%	100%	10%	55%	100%
Balancing load on islanded network	95% of **Registered Capacity**	95% of **Registered Capacity**	95% of **Registered Capacity**	105% of **Registered Capacity**	105% of **Registered Capacity**	105% of **Registered Capacity**
Trip time. Ph1 fuse removed	NA	NA	NA	NA	NA	NA
Test Power	10%	55%	100%	10%	55%	100%
Balancing load on islanded network	95% of **Registered Capacity**	95% of **Registered Capacity**	95% of **Registered Capacity**	105% of **Registered Capacity**	105% of **Registered Capacity**	105% of **Registered Capacity**
Trip time. Ph2 fuse removed	NA	NA	NA	NA	NA	NA
Test Power	10%	55%	100%	10%	55%	100%
Balancing load on islanded network	95% of **Registered Capacity**	95% of **Registered Capacity**	95% of **Registered Capacity**	105% of **Registered Capacity**	105% of **Registered Capacity**	105% of **Registered Capacity**
Trip time. Ph3 fuse removed	NA	NA	NA	NA	NA	NA
Note for technologies which have a substantial shut down time this can be added to the 0.5 s in establishing that the trip occurred in less than 0.5 s. Maximum shut down time could therefore be up to 1.0 s for these technologies.						
Indicate additional shut down time included in above results.				NA ms		
Additional comments:						

testing at 10%/55% of **Registered Capacity** should be stated. The additional comments box at the end of the loss of mains test sheet can be used for this.

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 0.5 s[3]	0.110s	0.115s	0.114s	0.117s	0.117s	0.114s

9.Protection – Frequency change, Vector Shift Stability test: 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.

	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

10.Protection – Frequency change, RoCoF Stability test: 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.

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

11.Limited Frequency Sensitive Mode – Over frequency test: This test should be carried out in accordance with A.1.2.8. 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.1.2.8.

Test sequence at **Registered Capacity**>80%	Measured **Active Power** Output	Frequency	Primary Power Source	**Active Power** Gradient Droop (%)
Step a) 50.00 Hz ±0.01 Hz	1981.9	50	2050	/
Step b) 50.45 Hz ±0.05 Hz	1959.5	50.45		8.93%
Step c) 50.70 Hz ±0.10 Hz	1862.2	50.7		10.03%
Step d) 51.15 Hz ±0.05 Hz	1656.9	51.15		9.23%
Step e) 50.70 Hz ±0.10 Hz	1866.7	50.7		10.42%
Step f) 50.45 Hz ±0.05 Hz	1961	50.45		9.57%

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

Step g) 50.00 Hz ±0.01 Hz	1981.9	50		/
Test sequence at **Registered Capacity**40% - 60%	Measured Active Power Output	Frequency	Primary Power Source	Active Power Gradient Droop (%)
Step a) 50.00 Hz ±0.01 Hz	989	50	1050	/
Step b) 50.45 Hz ±0.05 Hz	967	50.45		9.09%
Step c) 50.70 Hz ±0.10 Hz	852	50.7		8.76%
Step d) 51.15 Hz ±0.05 Hz	654	51.15		8.96%
Step e) 50.70 Hz ±0.10 Hz	854	50.7		8.89%
Step f) 50.45 Hz ±0.05 Hz	967	50.45		9.09%
Step g) 50.00 Hz ±0.01 Hz	989	50		/

12.Power output with falling frequency test: This test should be carried out in accordance with A.1.2.7.

Test sequence	Measured **Active Power** Output	Frequency	Primary power source
Test a) 50 Hz ± 0.01 Hz	2010	50	2139
Test b) Point between 49.5 Hz and 49.6 Hz	2006	49.55	2139
Test c) Point between 47.5 Hz and 47.6 Hz	2005	47.55	2139

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

13.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 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 2.			
48s	48s		At 266.2 V	At 180.0 V	At 47.4 Hz	At 52.1 Hz
Confirmation that the **Micro-generator** does not re-connect.			No re-connection	no re-connection	no re-connection	no re-connection

14.Fault level contribution: 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.

For machines with electro-magnetic output			For **Inverter** output		
Parameter	Symbol	Value	Time after fault	Volts	Amps
Peak Short Circuit current	i_p	NA	20 ms	36V	1.4A
Initial Value of aperiodic current	A	NA	100 ms	35.5V	0.31A
Initial symmetrical short-circuit current*	I_k	NA	250 ms	36.2V	0.31A
Decaying (aperiodic) component of short circuit current*	i_{DC}	NA	500ms	36.1	0.31A
Reactance/Resistance Ratio of source*	X/R	NA	Time to trip	2.76s	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					
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
Self-Monitoring solid state switching: No specified test requirements. Refer to EREC G98 Annex A1 A.1.3.6 (**Inverter** connected).					Yes
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.					
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
Additional comments					
The following documents are attached to this declaration: - “Clearline declaration about Logic Interface”, as for required in “Logic Interface” section; - “Clearline declaration about cyber-security”, as for required in “Cyber security” section;					

Form C: Type Test Verification Report

All Micro-generators connected to the **DNO Distribution Network** shall be **Fully Type Tested**. This form is the **Manufacturer**'s declaration of compliance with the requirements of EREC G98.

This form should be used when making a Type Test submission to the Energy Networks Association (ENA)Type Test Register.

If the **Micro-generator** is **Fully Type Tested** and already registered with the ENA Type Test Register, the **Installation Document** should include the **Manufacturer**'s Reference Number (the system reference), and this form does not need to be submitted.

Manufacturer's reference number	Clearline Inverter CSI2500		
Micro-generator technology	Grid-Connected PV Inverter (Inverter Models: CSI2500)		
Manufacturer name	Viridian Solar Limited		
Address	68 Stirling Way, Papworth, Cambridge CB23 3GY, UK		
Tel	+44 (0)1480 839 865	Fax	N/A
E-mail	info@viridiansolar.co.uk	Web site	www.viridiansolar.co.uk

Registered Capacity, use separate sheet if more than one connection option.	Connection Option	
	2.5	kW single phase, single, split or three phase system
	/	kW three phase
	/	kW two phases in three phase system
	/	kW two phases split phase system
Energy storage capacity for **Electricity Storage** devices		Not energy storage inverter

Manufacturer Type Test declaration. - I certify that all products supplied by the company with the above **Fully Type Tested** reference number will be manufactured and tested to ensure that they perform as stated in this document, prior to shipment to site and that no site modifications are required to ensure that the product meets all the requirements of EREC G98.

Signed	 KT Tan 28th April 2023	On behalf of	Viridian Solar Limited

Note that testing can be done by the **Manufacturer** of an individual component or by an external test house.

Where parts of the testing are carried out by persons or organisations other than the **Manufacturer** then that person or organisation shall keep copies of all test records and results supplied to them to verify that the testing has been carried out by people with sufficient technical competency to carry out the tests.

1.**Operating Range:** 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 seconds	Result: Pass
Test 2 Voltage = 85% of nominal (195.5 V) Frequency = 47.5 Hz Power factor = 1 Period of test 90 minutes	Result: Pass
Test 3 Voltage = 110% of nominal (253 V). Frequency = 51.5 Hz Power factor = 1 Period of test 90 minutes	Result: Pass
Test 4 Voltage = 110% of nominal (253 V). Frequency = 52.0 Hz Power factor = 1 Period of test 15 minutes	Result: Pass
Test 5 Voltage = 100% of nominal (230 V). Frequency = 50.0 Hz Power factor = 1 Period of test 90 minutes	Result: Pass

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.	Result: Pass

2.Power Quality – Harmonics: 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).

Micro-generator tested to BS EN 61000-3-2

Micro-generator rating per phase (rpp)	2.5	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.			

Harmonic	At 45-55% of **Registered Capacity**[1]		100% of **Registered Capacity**			
	Measured Value MV in Amps		Measured Value MV in Amps		Limit in BS EN 61000-3-2 in Amps	Higher limit for odd harmonics 21 and above
2	0.048		0.097		1.080	
3	0.177		0.203		2.300	
4	0.005		0.004		0.430	
5	0.049		0.118		1.140	
6	0.007		0.014		0.300	
7	0.039		0.026		0.770	
8	0.009		0.010		0.230	
9	0.031		0.023		0.400	
10	0.008		0.009		0.184	
11	0.026		0.021		0.330	
12	0.010		0.013		0.153	
13	0.023		0.017		0.210	
14	0.007		0.008		0.131	
15	0.023		0.019		0.150	
16	0.005		0.007		0.115	

[1] See the note in A.2.3.1 if 45-55% of **Registered Capacity** is below the minimum stable operating level. If an alternative loading level is chosen, the level should be indicated on the test form and the reason for not testing at 45-55% of **Registered Capacity** should be stated. The additional comments box at the end of the harmonics test sheet can be used for this.

17	0.019		0.017		0.132	
18	0.005		0.010		0.102	
19	0.017		0.015		0.118	
20	0.005		0.008		0.092	
21	0.014		0.012		0.107	0.160
22	0.006		0.008		0.084	
23	0.011		0.009		0.098	0.147
24	0.005		0.008		0.077	
25	0.010		0.009		0.090	0.135
26	0.004		0.007		0.071	
27	0.010		0.008		0.083	0.124
28	0.005		0.006		0.066	
29	0.008		0.010		0.078	0.117
30	0.005		0.006		0.061	
31	0.007		0.008		0.073	0.109
32	0.003		0.007		0.058	
33	0.007		0.007		0.068	0.102
34	0.004		0.006		0.054	
35	0.006		0.007		0.064	0.096
36	0.004		0.005		0.051	
37	0.006		0.005		0.061	0.091
38	0.003		0.005		0.048	
39	0.004		0.006		0.058	0.087
40	0.004		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.

Additional comments:

3.**Power Quality – Voltage fluctuations and Flicker**: 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	22nd October 2021			Test end date			25th October 2021	
Test location	Test lab of GoodWe Technologies Co., Ltd (No.90 Zijin Rd., New District, Suzhou, 215011, China)							
	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	0.13%	0.07%	0%	0.16%	0.13%	0%	0.12%	0.12%
Normalised to standard impedance	0.13%	0.07%	0%	0.16%	0.13%	0%	0.12%	0.12%
Normalised to required maximum impedance	NA	NA	NA	NA	NA	NA	NA	NA
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	X	0.25	Ω
Standard Impedance	R	0.24 * 0.4 ^	Ω	X	0.15 * 0.25 ^	Ω
Maximum Impedance	R	NA	Ω	X	NA	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.

4.**Power quality – DC injection:** 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%.

Test power level	20%	50%	75%	100%
Recorded **DC** value in Amps	0.0254A	0.0258A	0.0246A	0.023A
as % of rated AC current	0.23%	0.24%	0.23%	0.22%
Limit	0.25%	0.25%	0.25%	0.25%

5.Power Quality – Power factor: 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.

	216.2 V	230 V	253 V
Measured value	0.9990	0.9991	0.9990
Power Factor Limit	>0.95	>0.95	>0.95

6.Protection – Frequency tests: 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.

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	47.46 Hz	20.04s	47.7 Hz 30 s	no trip
U/F stage 2	47 Hz	0.5 s	46.98 Hz	0.56s	47.2 Hz 19.5 s	no trip
					46.8 Hz 0.45 s	no trip
O/F stage 1	52 Hz	0.5 s	52.02 Hz	0.56s	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.

7.Protection – Voltage tests: 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.

Function	Setting		Trip test		"No trip tests"	
	Voltage	Time delay	Voltage	Time delay	Voltage /time	Confirm no trip
U/V	184 V	2.5 s	183.5V	2.52s	188 V 5.0 s	no trip
					180 V 2.45 s	no trip
O/V stage 1	262.2 V	1.0 s	263.9V	1.03s	258.2 V 5.0 s	no trip
O/V stage 2	273.7 V	0.5 s	275.39V	0.51s	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.

8.Protection – Loss of Mains test: 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.						
To be carried out at three output power levels with a tolerance of plus or minus 5% in Test Power levels.[2]						
Test Power	10%	55%	100%	10%	55%	100%
Balancing load on islanded network	95% of **Registered Capacity**	95% of **Registered Capacity**	95% of **Registered Capacity**	105% of **Registered Capacity**	105% of **Registered Capacity**	105% of **Registered Capacity**
Trip time. Limit is 0.5 s	NA	NA	NA	NA	NA	NA
For Multi phase **Micro-generators** confirm that the device shuts down correctly after the removal of a single fuse as well as operation of all phases.						
Test Power	10%	55%	100%	10%	55%	100%
Balancing load on islanded network	95% of **Registered Capacity**	95% of **Registered Capacity**	95% of **Registered Capacity**	105% of **Registered Capacity**	105% of **Registered Capacity**	105% of **Registered Capacity**
Trip time. Ph1 fuse removed	NA	NA	NA	NA	NA	NA
Test Power	10%	55%	100%	10%	55%	100%
Balancing load on islanded network	95% of **Registered Capacity**	95% of **Registered Capacity**	95% of **Registered Capacity**	105% of **Registered Capacity**	105% of **Registered Capacity**	105% of **Registered Capacity**
Trip time. Ph2 fuse removed	NA	NA	NA	NA	NA	NA
Test Power	10%	55%	100%	10%	55%	100%
Balancing load on islanded network	95% of **Registered Capacity**	95% of **Registered Capacity**	95% of **Registered Capacity**	105% of **Registered Capacity**	105% of **Registered Capacity**	105% of **Registered Capacity**
Trip time. Ph3 fuse removed	NA	NA	NA	NA	NA	NA
Note for technologies which have a substantial shut down time this can be added to the 0.5 s in establishing that the trip occurred in less than 0.5 s. Maximum shut down time could therefore be up to 1.0 s for these technologies.						
Indicate additional shut down time included in above results.				NA ms		

[2] See the note in A.2.2.4 if the suggested loading levels are below the minimum stable operating level. If alternative loading levels are chosen, the level should be indicated on the test form and the reason for not testing at 10%/55% of **Registered Capacity** should be stated. The additional comments box at the end of the loss of mains test sheet can be used for this.

Additional comments:

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 0.5 s[3]	0.110s	0.115s	0.114s	0.117s	0.117s	0.114s

9.Protection – Frequency change, Vector Shift Stability test: 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.

	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

10.Protection – Frequency change, RoCoF Stability test: 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.

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

11.Limited Frequency Sensitive Mode – Over frequency test: This test should be carried out in accordance with A.1.2.8. 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.1.2.8.

Test sequence at **Registered Capacity**>80%	Measured **Active Power** Output	Frequency	Primary Power Source	**Active Power** Gradient Droop (%)
Step a) 50.00 Hz ±0.01 Hz	2499	50	2610	/
Step b) 50.45 Hz ±0.05 Hz	2475	50.45		10.42%
Step c) 50.70 Hz ±0.10 Hz	2343	50.7		9.62%
Step d) 51.15 Hz ±0.05 Hz	2090	51.15		9.17%

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

Step e) 50.70 Hz ±0.10 Hz	2331	50.7		8.93%
Step f) 50.45 Hz ±0.05 Hz	2477	50.45		11.36%
Step g) 50.00 Hz ±0.01 Hz	2502	50		/
Test sequence at **Registered Capacity**40% - 60%	Measured Active Power Output	Frequency	Primary Power Source	Active Power Gradient Droop (%)
Step a) 50.00 Hz ±0.01 Hz	1215	50	1300	/
Step b) 50.45 Hz ±0.05 Hz	1187	50.45		8.93%
Step c) 50.70 Hz ±0.10 Hz	1062	50.7		9.80%
Step d) 51.15 Hz ±0.05 Hz	831	51.15		9.77%
Step e) 50.70 Hz ±0.10 Hz	1050	50.7		9.09%
Step f) 50.45 Hz ±0.05 Hz	1186	50.45		8.62%
Step g) 50.00 Hz ±0.01 Hz	1213	50		/

12.Power output with falling frequency test: This test should be carried out in accordance with A.1.2.7.

Test sequence	Measured **Active Power** Output	Frequency	Primary power source
Test a) 50 Hz ± 0.01 Hz	2522	50	2600
Test b) Point between 49.5 Hz and 49.6 Hz	2522	49.55	2600
Test c) Point between 47.5 Hz and 47.6 Hz	2520	47.55	2600
NOTE: The operating point in Test (b) and (c) shall be maintained for at least 5 minutes			

13.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 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 2.			
48s	48s		At 266.2 V	At 180.0 V	At 47.4 Hz	At 52.1 Hz
Confirmation that the **Micro-generator** does not re-connect.			No re-connection	no re-connection	no re-connection	no re-connection

14.Fault level contribution: 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.

For machines with electro-magnetic output			For **Inverter** output		
Parameter	Symbol	Value	Time after fault	Volts	Amps
Peak Short Circuit current	i_p	NA	20 ms	37.4V	12.23A
Initial Value of aperiodic current	A	NA	100 ms	37V	11.81A
Initial symmetrical short-circuit current*	I_k	NA	250 ms	37.2V	11.62A
Decaying (aperiodic) component of short circuit current*	i_{DC}	NA	500 ms	37.4V	11.88A
Reactance/Resistance Ratio of source*	X/R	NA	Time to trip	2.75s	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

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
Self-Monitoring solid state switching: No specified test requirements. Refer to EREC G98 Annex A1 A.1.3.6 (**Inverter** connected).	Yes
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.	
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

Additional comments

The following documents are attached to this declaration:
- “Clearline declaration about Logic Interface”, as for required in “Logic Interface” section;
- “Clearline declaration about cyber-security”, as for required in “Cyber security” section;

Clearline INVERTER

Form C: Type Test Verification Report

All Micro-generators connected to the **DNO Distribution Network** shall be **Fully Type Tested**. This form is the **Manufacturer**'s declaration of compliance with the requirements of EREC G98.

This form should be used when making a Type Test submission to the Energy Networks Association (ENA)Type Test Register.

If the **Micro-generator** is **Fully Type Tested** and already registered with the ENA Type Test Register, the **Installation Document** should include the **Manufacturer**'s Reference Number (the system reference), and this form does not need to be submitted.

Manufacturer's reference number	Clearline Inverter CSI3000		
Micro-generator technology	Grid-Connected PV Inverter (Inverter Models: CSI3000)		
Manufacturer name	Viridian Solar Limited		
Address	68 Stirling Way, Papworth, Cambridge CB23 3GY, UK		
Tel	+44 (0)1480 839 865	Fax	N/A
E-mail	info@viridiansolar.co.uk	Web site	www.viridiansolar.co.uk

Registered Capacity, use separate sheet if more than one connection option.	Connection Option	
	3.0	kW single phase, single, split or three phase system
	/	kW three phase
	/	kW two phases in three phase system
	/	kW two phases split phase system
Energy storage capacity for **Electricity Storage** devices		Not energy storage inverter

Manufacturer Type Test declaration. - I certify that all products supplied by the company with the above **Fully Type Tested** reference number will be manufactured and tested to ensure that they perform as stated in this document, prior to shipment to site and that no site modifications are required to ensure that the product meets all the requirements of EREC G98.

Signed	 KT Tan 28th April 2023	On behalf of	viridian solar Viridian Solar Limited

Note that testing can be done by the **Manufacturer** of an individual component or by an external test house.

Where parts of the testing are carried out by persons or organisations other than the **Manufacturer** then that person or organisation shall keep copies of all test records and results supplied to them to verify that the testing has been carried out by people with sufficient technical competency to carry out the tests.

1.**Operating Range:** 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 seconds	Result: Pass
Test 2 Voltage = 85% of nominal (195.5 V) Frequency = 47.5 Hz Power factor = 1 Period of test 90 minutes	Result: Pass
Test 3 Voltage = 110% of nominal (253 V). Frequency = 51.5 Hz Power factor = 1 Period of test 90 minutes	Result: Pass
Test 4 Voltage = 110% of nominal (253 V). Frequency = 52.0 Hz Power factor = 1 Period of test 15 minutes	Result: Pass
Test 5 Voltage = 100% of nominal (230 V). Frequency = 50.0 Hz Power factor = 1 Period of test 90 minutes	Result: Pass

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.	Result: Pass

2.Power Quality – Harmonics: 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).

Micro-generator tested to BS EN 61000-3-2

Micro-generator rating per phase (rpp)	3.0	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.			

Harmonic	At 45-55% of **Registered Capacity**[1]		100% of **Registered Capacity**			
	Measured Value MV in Amps		Measured Value MV in Amps		Limit in BS EN 61000-3-2 in Amps	Higher limit for odd harmonics 21 and above
2	0.0757		0.1071		1.080	
3	0.1806		0.1697		2.300	
4	0.0158		0.0049		0.430	
5	0.0472		0.1465		1.140	
6	0.0114		0.0123		0.300	
7	0.0381		0.0194		0.770	
8	0.0078		0.0089		0.230	
9	0.0309		0.0216		0.400	
10	0.0099		0.0119		0.184	
11	0.0255		0.0168		0.330	
12	0.0091		0.0082		0.153	
13	0.0233		0.0199		0.210	
14	0.0080		0.0096		0.131	
15	0.0200		0.0160		0.150	
16	0.0064		0.0107		0.115	

[1] See the note in A.2.3.1 if 45-55% of **Registered Capacity** is below the minimum stable operating level. If an alternative loading level is chosen, the level should be indicated on the test form and the reason for not testing at 45-55% of **Registered Capacity** should be stated. The additional comments box at the end of the harmonics test sheet can be used for this.

17	0.0186		0.0156		0.132	
18	0.0066		0.0065		0.102	
19	0.0174		0.0164		0.118	
20	0.0063		0.0063		0.092	
21	0.0130		0.0090		0.107	0.160
22	0.0061		0.0089		0.084	
23	0.0117		0.0094		0.098	0.147
24	0.0057		0.0066		0.077	
25	0.0119		0.0126		0.090	0.135
26	0.0054		0.0067		0.071	
27	0.0098		0.0085		0.083	0.124
28	0.0053		0.0072		0.066	
29	0.0087		0.0067		0.078	0.117
30	0.0046		0.0061		0.061	
31	0.0084		0.0083		0.073	0.109
32	0.0046		0.0075		0.058	
33	0.0076		0.0065		0.068	0.102
34	0.0044		0.0058		0.054	
35	0.0068		0.0055		0.064	0.096
36	0.0043		0.0051		0.051	
37	0.0057		0.0067		0.061	0.091
38	0.0041		0.0054		0.048	
39	0.0050		0.0053		0.058	0.087
40	0.0034		0.0049		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.

Additional comments:

3.**Power Quality – Voltage fluctuations and Flicker**: 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	22nd October 2021	Test end date	25th October 2021
Test location	Test lab of GoodWe Technologies Co., Ltd (No.90 Zijin Rd., New District, Suzhou, 215011, China)		

	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	0.15%	0.09%	0%	0.14%	0.12%	0%	0.03	0.03
Normalised to standard impedance	0.15%	0.09%	0%	0.14%	0.12%	0%	0.03	0.03
Normalised to required maximum impedance	NA	NA	NA	NA	NA	NA	NA	NA
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	X	0.25	Ω
Standard Impedance	R	0.24 * 0.4 ^	Ω	X	0.15 * 0.25 ^	Ω
Maximum Impedance	R	NA	Ω	X	NA	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.

4.**Power quality – DC injection:** 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%.

Test power level	20%	50%	75%	100%
Recorded **DC** value in Amps	0.023A	0.011A	0.0123A	0.0186A
as % of rated AC current	0.18%	0.08%	0.1%	0.14%
Limit	0.25%	0.25%	0.25%	0.25%

5.Power Quality – Power factor: 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.

	216.2 V	230 V	253 V
Measured value	0.99	0.99	0.99
Power Factor Limit	>0.95	>0.95	>0.95

6.Protection – Frequency tests: 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.

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	47.43Hz	20.04s	47.7 Hz 30 s	no trip
U/F stage 2	47 Hz	0.5 s	46.93Hz	0.54s	47.2 Hz 19.5 s	no trip
					46.92 Hz 0.45 s	no trip
O/F stage 1	52 Hz	0.5 s	52.02Hz	0.58s	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.

7.Protection – Voltage tests: 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.

Function	Setting		Trip test		"No trip tests"	
	Voltage	Time delay	Voltage	Time delay	Voltage /time	Confirm no trip
U/V	184 V	2.5s	182.93V	2.52s	188 V 5.0 s	no trip
					180 V 2.45 s	no trip
O/V stage 1	262.2 V	1.0 s	263.86V	1.03s	258.2 V 5.0 s	no trip
O/V stage 2	273.7 V	0.5 s	275.37V	0.52s	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.

8.Protection – Loss of Mains test: 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.						
To be carried out at three output power levels with a tolerance of plus or minus 5% in Test Power levels.[2]						
Test Power	10%	55%	100%	10%	55%	100%
Balancing load on islanded network	95% of **Registered Capacity**	95% of **Registered Capacity**	95% of **Registered Capacity**	105% of **Registered Capacity**	105% of **Registered Capacity**	105% of **Registered Capacity**
Trip time. Limit is 0.5 s	NA	NA	NA	NA	NA	NA
For Multi phase **Micro-generators** confirm that the device shuts down correctly after the removal of a single fuse as well as operation of all phases.						
Test Power	10%	55%	100%	10%	55%	100%
Balancing load on islanded network	95% of **Registered Capacity**	95% of **Registered Capacity**	95% of **Registered Capacity**	105% of **Registered Capacity**	105% of **Registered Capacity**	105% of **Registered Capacity**
Trip time. Ph1 fuse removed	NA	NA	NA	NA	NA	NA
Test Power	10%	55%	100%	10%	55%	100%
Balancing load on islanded network	95% of **Registered Capacity**	95% of **Registered Capacity**	95% of **Registered Capacity**	105% of **Registered Capacity**	105% of **Registered Capacity**	105% of **Registered Capacity**
Trip time. Ph2 fuse removed	NA	NA	NA	NA	NA	NA
Test Power	10%	55%	100%	10%	55%	100%
Balancing load on islanded network	95% of **Registered Capacity**	95% of **Registered Capacity**	95% of **Registered Capacity**	105% of **Registered Capacity**	105% of **Registered Capacity**	105% of **Registered Capacity**
Trip time. Ph3 fuse removed	NA	NA	NA	NA	NA	NA
Note for technologies which have a substantial shut down time this can be added to the 0.5 s in establishing that the trip occurred in less than 0.5 s. Maximum shut down time could therefore be up to 1.0 s for these technologies.						
Indicate additional shut down time included in above results.				NA ms		

[2] See the note in A.2.2.4 if the suggested loading levels are below the minimum stable operating level. If alternative loading levels are chosen, the level should be indicated on the test form and the reason for not testing at 10%/55% of **Registered Capacity** should be stated. The additional comments box at the end of the loss of mains test sheet can be used for this.

Additional comments:

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 0.5 s[3]	0.110s	0.115s	0.114s	0.117s	0.117s	0.114s

9.Protection – Frequency change, Vector Shift Stability test: 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.

	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

10.Protection – Frequency change, RoCoF Stability test: 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.

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

11.Limited Frequency Sensitive Mode – Over frequency test: This test should be carried out in accordance with A.1.2.8. 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.1.2.8.

Test sequence at **Registered Capacity**>80%	Measured **Active Power** Output	Frequency	Primary Power Source	**Active Power** Gradient Droop (%)
Step a) 50.00 Hz ±0.01 Hz	2993	50	3150	/
Step b) 50.45 Hz ±0.05 Hz	2961	50.45		9.38%
Step c) 50.70 Hz ±0.10 Hz	2808	50.7		9.73%
Step d) 51.15 Hz ±0.05 Hz	2520	51.15		9.51%

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

Step e) 50.70 Hz ±0.10 Hz	2799	50.7		9.28%
Step f) 50.45 Hz ±0.05 Hz	2961	50.45		9.38%
Step g) 50.00 Hz ±0.01 Hz	2992	50		/
Test sequence at **Registered Capacity**40% - 60%	Measured Active Power Output	Frequency	Primary Power Source	Active Power Gradient Droop (%)
Step a) 50.00 Hz ±0.01 Hz	1460	50	1540	/
Step b) 50.45 Hz ±0.05 Hz	1426	50.45		8.82%
Step c) 50.70 Hz ±0.10 Hz	1284	50.7		10.23%
Step d) 51.15 Hz ±0.05 Hz	1025	51.15		10.34%
Step e) 50.70 Hz ±0.10 Hz	1283	50.7		10.17%
Step f) 50.45 Hz ±0.05 Hz	1427	50.45		9.09%
Step g) 50.00 Hz ±0.01 Hz	1465	50		/

12.Power output with falling frequency test: This test should be carried out in accordance with A.1.2.7.

Test sequence	Measured **Active Power** Output	Frequency	Primary power source
Test a) 50 Hz ± 0.01 Hz	3020	50	3150
Test b) Point between 49.5 Hz and 49.6 Hz	3020	49.55	3150
Test c) Point between 47.5 Hz and 47.6 Hz	3017	47.55	3150

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

13.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 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 2.			
48s	48s		At 266.2 V	At 180.0 V	At 47.4 Hz	At 52.1 Hz
Confirmation that the **Micro-generator** does not re-connect.			No re-connection	no re-connection	no re-connection	no re-connection

14.Fault level contribution: 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.

For machines with electro-magnetic output			For **Inverter** output		
Parameter	Symbol	Value	Time after fault	Volts	Amps
Peak Short Circuit current	i_p	NA	20 ms	45V	4.5A
Initial Value of aperiodic current	A	NA	100 ms	35V	0.9A
Initial symmetrical short-circuit current*	I_k	NA	250 ms	41.5V	1.57A
Decaying (aperiodic) component of short circuit current*	i_{DC}	NA	500ms	36.8V	1.19A
Reactance/Resistance Ratio of source*	X/R	NA	Time to trip	2.76s	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

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
Self-Monitoring solid state switching: No specified test requirements. Refer to EREC G98 Annex A1 A.1.3.6 (**Inverter** connected).	Yes
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.	
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

Additional comments

The following documents are attached to this declaration:
- “Clearline declaration about Logic Interface”, as for required in “Logic Interface” section;
- “Clearline declaration about cyber-security”, as for required in “Cyber security” section;