TEST REPORT

Engineering recommendation G99

Requirements for the connection of generation equipment in parallel with public Low Voltage Distribution Networks.

Report No. ....:	**BSPN-ESH-P23121041**
Date of issue ....:	2024-05-15
Total number of pages ....:	99
Testing laboratory name ....:	**Bureau Veritas Consumer Products Services Germany GmbH**
Address ....:	Businesspark A96 86842 Türkheim Germany
Accreditation....................................:	DAkkS Deutsche Akkreditierungsstelle D-PL-12024-03-00
Applicant's name...........................:	**VOLTRONIC POWER TECHNOLOGY (SHENZHEN) CORP.**
Address ....:	1-5F, Building 5 & 1F Building7 & 1F Building9, RunDongSheng Industrial Park, No.467, Section Xixiang, National Highway 107, LongZhu Community, Xixiang, Bao An District, Shenzhen, China
Test specification	
Standard...:	G99/1-10:2024
	A2-3 Tests for a Type A Inverter Connected Power Generating Modules
Certificate.......................................:	**Certificate of compliance**
Template number standard ....:	G99/1-10
Master TRF originator ....:	Bureau Veritas Consumer Products Services Germany GmbH
Test item description ....:	**Hybrid Inverter**
Trademark ....:	Voltronic Power Advancing Power
Model / Type....................................:	INFINI WP 12KW TWIN, INFINI WP 15KW TWIN

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Ratings ....:	**INFINI WP 12KW TWIN**	**INFINI WP 15KW TWIN**	**--**	**--**
MPP DC voltage range [V] ....:	350-950		--	--
Input DC voltage range [V]...............:	320-1000		--	--
Input DC current [A]..........................:	26/26	26/26	--	--
Output AC voltage [V] ....:	3L/N/PE, 230/400V, 50Hz		--	--
Output AC current [A].......................:	17,4*3	21,7*3	--	--
Output power [VA]............................:	12000	15000	--	--

Testing Location..............................:	**LCIE China Company Limited**
Address ....:	Building 4, No. 518, Xinzhuan Road, Caohejing Songjiang High-Tech Park, Shanghai, P.R. China (201612)
Tested by (name, function and signature) ....:	Joell Qin
Approved by (name, function and signature) ....:	Robin Wu
Manufacturer's name ....:	**VOLTRONIC POWER TECHNOLOGY (SHENZHEN) CORP.**
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Document History

Date	Internal reference	Modification / Change / Status	Revision
2024-05-15	Joell Qin	Initial report was written	0
Supplementary information:			

Test items particulars	
Equipment mobility ....:	Permanent connection
Operating condition ....:	Continuous
Class of equipment..........................:	Class I
Protection against ingress of water ..:	IP65 according to EN 60529
Mass of equipment [kg] ....:	70kg for models INFINI WP 12KW TWIN
	73kg for model INFINI WP 15KW TWIN
Test case verdicts	
Test case does not apply to the test object ....:	N/A
Test item does meet the requirement ....:	P(ass)
Test item does not meet the requirement ....:	F(ail)
Testing	
Date of receipt of test item ....:	2024-03-28
Date(s) of performance of test ....:	2024-04-05 to 2024-04-24

General remarks:

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

The report shall state compliance of the tested objects with the Type A requirements of G99.

All information within this test report limited to the type label, warning markings, trademark, block diagram, schematics, layouts, manual and datasheets are provided by the customer.

Conformity statements are decided in accordance with IEC GUIDE 115:2021 Procedure 2 (accuracy method), unless otherwise normatively specified or contractually agreed. The measurement result is considered as "pass" according to the requirement if it is within the prescribed limit or exactly on the limit.

"(see Annex #)" refers to additional information appended to the report.
"(see appended table)" refers to a table appended to the report.

Throughout this report a comma is used as the decimal separator.

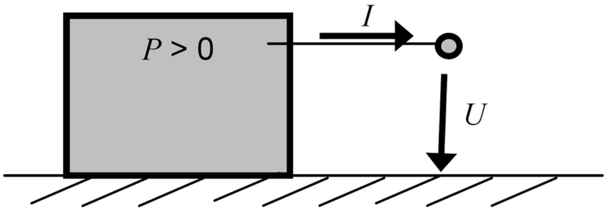
- "P_n" for the nominal active power:

  $P_n = V_n \times I_n \times \cos \varphi_n$ (single-Phase); $P_n = \sqrt{3}\, V_n \times I_n \times \cos \varphi_n$ (three-Phase)
- "P_m" for the momentary power
- "(c)" for over-excited
- "(i)" for under-excited

Active and reactive power:

The regarded system of the voltage and current vectors is the load view (Figure 2):

- if the inverter feeds to the grid the active power is measured with positive sign.



For the representation in quadrants, a power circle is chosen whose representation is compatible with mathematical representations of trigonometry and complex numbers (see Figure 2). Angles are counted positively counter-clockwise as in mathematics. The phase angle is defined as the angle from the current pointer to the voltage pointer. The current pointer is always in the real axis; the position of the voltage pointer corresponds to the apparent power and the phase angle.

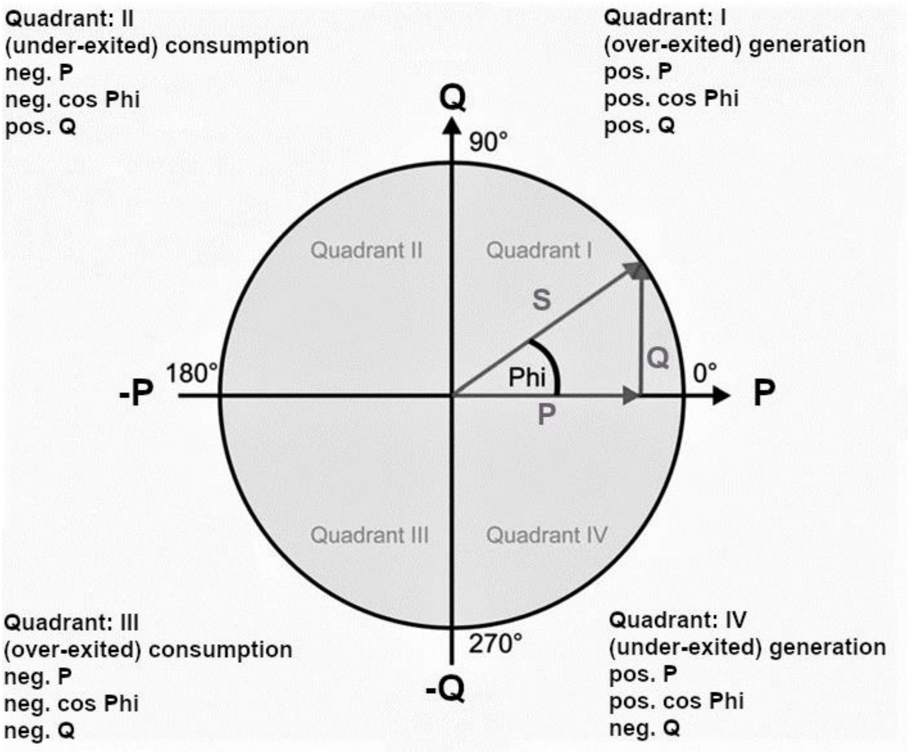


Figure 2

The different operating states can be represented in quadrants I to quadrant IV. The quadrants are named in a counter-clockwise direction.

This Test Report consists of the following documents:

Copy of marking plate

Model No. : INFINI WP 12KW TWIN

Serial No. : 96161406100001

PV INPUT	Nominal operating voltage 720Vdc
	Vmax PV 1000Vdc
	PV input voltage range 320-1000Vdc
	Isc PV 2*27A
	MAX PV INPUT POWER 16000W
	MPPT voltage range 350 ~ 950Vdc
GRID/AC OUTPUT	Nominal operating voltage 3/N/PE, 230/400 Vac
	Nominal output current 17.4A per phase
	Nominal operating frequency 50Hz
	Maximum power 12000W
	Power factor range 0.9 lead-0.9lag
AC INPUT	Nominal operating voltage 3/N/PE, 230/400 Vac
	Maximum input current 40A per phase
	Nominal operating frequency 50Hz
BATTERY	Battery voltage range 40~62Vdc
	Maximum battery current 300A

Ambient temperature:-25~+60°C

Enclosure:IP 65

Safety class I

CE

WARNING:FIRE HAZARD.

SUITABLE FOR MOUNTING ON CONCRETE OR OTHER NON-COMBUSTIBLE SURFACE ONLY

CAUTION:THE DC AND AC BREAKER MUST HAVE BEEN TURNED OFF BEFORE SERVICING.

MADE IN CHINA

Model No. : INFINI WP 15KW TWIN

Serial No. : 96161406100001

PV INPUT	Nominal operating voltage 720Vdc
	Vmax PV 1000Vdc
	PV input voltage range 320-1000Vdc
	Isc PV 2*27A
	MAX PV INPUT POWER 22500W
	MPPT voltage range 350 ~ 950Vdc
GRID/AC OUTPUT	Nominal operating voltage 3/N/PE, 230/400 Vac
	Nominal output current 21.7A per phase
	Nominal operating frequency 50Hz
	Maximum power 15000W
	Power factor range 0.9 lead-0.9lag
AC INPUT	Nominal operating voltage 3/N/PE, 230/400 Vac
	Maximum input current 40A per phase
	Nominal operating frequency 50Hz
BATTERY	Battery voltage range 40~62Vdc
	Maximum battery current 375A

Ambient temperature:-25~+60°C

Enclosure:IP 65

Safety class I

WARNING:FIRE HAZARD.

SUITABLE FOR MOUNTING ON CONCRETE OR OTHER NON-COMBUSTIBLE SURFACE ONLY

CAUTION:THE DC AND AC BREAKER MUST HAVE BEEN TURNED OFF BEFORE SERVICING.

MADE IN CHINA

Note:

Example of marking plate

General product information:

The Hybrid inverter converts DC voltage into AC voltage, or converts AC voltage into DC voltage for battery charging.

The DC input of ENERGY STORAGE SYSTEM can be supplied by PV array and batteries.

The charging current to batteries from PV array or public grid, battery management unit is integrated in External Energy storage device.

The ENERGY STORAGE SYSTEM is single phase type and only allowed to single-unit operation, and connected to single phase power system.

The unit does not provide galvanic separation from PV input to AC output (transformerless). An isolation transformer is provided between battery circuit and other circuit. The output is switched off redundant by the high power switching bridge and a two relays. This assures that the opening of the output circuit will also operate in case of one error.

Description of the power circuit :

The internal control is redundant built. It consists of Microcontroller Master DSP (U3) and Slave DSP (U6).

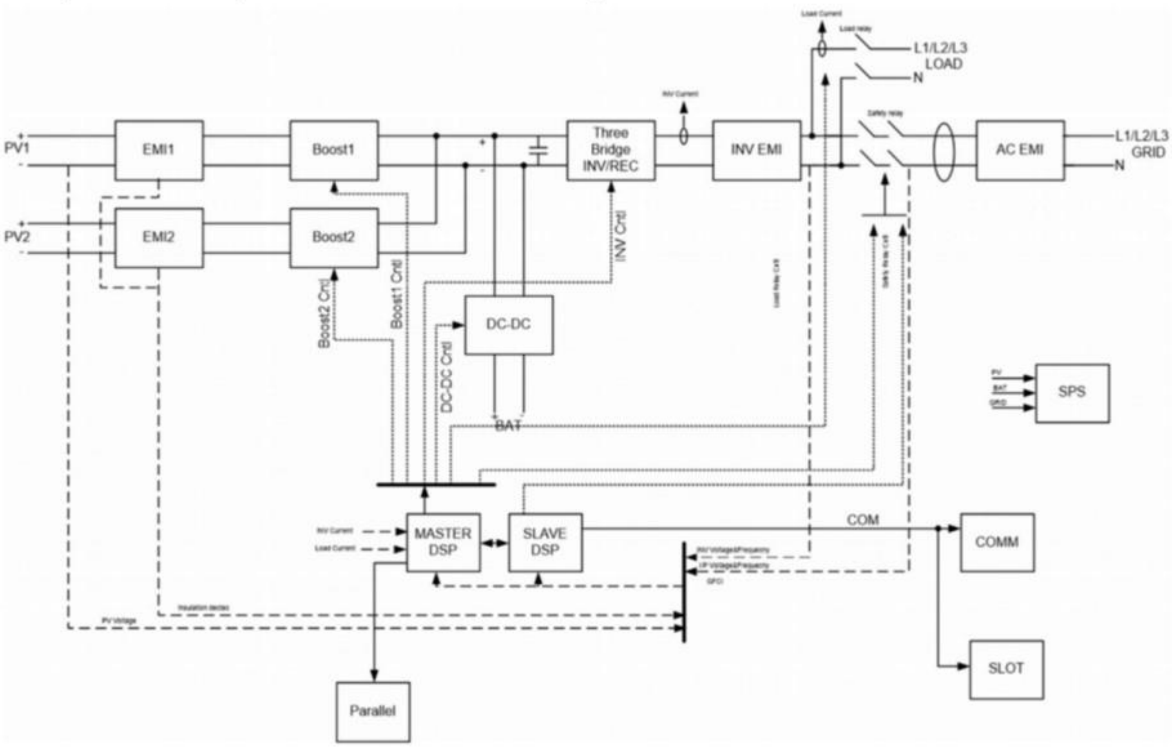
The Master DSP (U3) control the relays by switching signals; measures the PV voltage, PV current, Bus voltage, Battery voltage, grid voltage, frequency, AC current with injected DC and the array insulation resistance to ground. In addition it tests the current sensors and the RCMU circuit before each start up.

The Slave DSP (U6) is measures the grid voltage, AC current, grid frequency and residual current, also can switch off the relays independently, and communicate with Master DSP (U3) each other.

The current is measured by a current sensor. The AC current signal and the injected DC current signal are sent to the Master DSP (U3). The Master DSP (U3) tests and calibrates before each start up all current sensors.

The unit provides two relays in series in all output conductors. When single fault applied to one relay, alarm an error code in display panel, another redundant relay provides basic insulation maintained between the PV array and the mains. All the relays are tested before each start up.

Figure 1 – Block Diagram



Differences of the models in the series:

The models INFINI WP 12KW TWIN and INFINI WP 15KW TWIN are identical in hardware and software, and the output power derated by software.

The product was tested on:

The product with serial number 96162309100050 was tested on.

Hardware Version

Hardware Version:	INFINI WP 12KW TWIN, INFINI WP 15KW TWIN
Version	V00

Software Version

Software Version:	INFINI WP 12KW TWIN, INFINI WP 15KW TWIN
Version	V00

Test Results

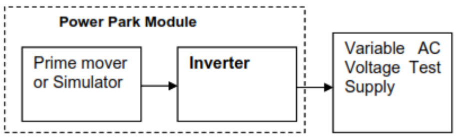
Engineering recommendation G99-1			
Clause	**Requirement – Test**	**Result – Remark**	**Verdict**
A.7	**Requirements for Type Testing Power Generating Modules**		
	This Annex describes methodologies for undertaking compliance verification for Type A Power Generating Modules. The Annex describes approaches which were originally intended for small Power Park Modules. Manufacturers are free to adapt techniques described in Annex B where this is more economic or efficient, provided the Type A performance requirements are fully demonstrated. The Forms provided in Annex A.2 should be used as a basis for demonstration of compliance. Annex A.7.1 Power Park Module Requirements. Annex A.7.2 Synchronous Power Generating Module Requirements. Annex A.7.3 Additional Technology Requirements. • A.7.3.1. Domestic CHP • A.7.3.2. Photo-voltaic • A.7.3.3. Fuel Cells • A.7.3.4. Hydro • A.7.3.5. Wind • A.7.3.6. Electricity Storage devices Annex A.7.1 relates to any Generating Unit that uses an Inverter (or Converter) as its means of connecting to the Distribution Network. Annex A.7.2 relates to any Synchronous Power Generating Module that during normal running operation is connected directly to the Distribution Network and has a Rated Capacity < 50 kW, although Manufacturers may choose to use these requirements for larger Type A Synchronous Power Generating Modules. For type testing any Generating Unit select either Annex A.7.1 or Annex A.7.2 as is most appropriate to the Generating Unit under test. Annex A.7.2 should also be used for asynchronous Generating Units that are not connected to the Distribution Network via an Inverter (ie induction Generating Units). The Generating Unit may also require additional technology type tests as identified in Annex A.7.3. **Examples** A Wind Turbine system using an **Inverter** (or **Inverter**s) for connection is required to use Annex A.7.1 – “Common **Power Park Module** Requirements” and Annex A.7.3.5 – “Wind” Additional Technology Requirements. A Hydro system using an induction generator connected directly to the **Distribution Network** is suggested to	Test sample is a: A.7.1 Power Park Module A.7.3 Additional Technology Requirements	**P**

Engineering recommendation G99-1			
Clause	**Requirement – Test**	**Result – Remark**	**Verdict**
	use Annex A.7.2 – "**Synchronous**" and Annex A.7.3.4– "Hydro" Additional Technology Requirements.		

Engineering recommendation G99-1			
Clause	**Requirement – Test**	**Result – Remark**	**Verdict**
A.7.1	**Power Park Module Requirements**		**P**
A.7.1.1	**Certification & Type Testing Generating Unit Requirements** A.7.1 can apply to **Power Park Module**s or to individual **Inverter**s and/or **Generating Unit**s if the functionality is included in each unit of a **Power Park Module**. Within this Section A.7.1 the term **Power Park Module** will be used but its meaning can be interpreted within A.7.1 to mean **Power Park Module**, **Generating Unit or Inverter** as appropriate. A.7.1 describes a methodology for obtaining type certification or type verification for a **Power Park Module** containing an **Inverter**. Typically, all interface functions are contained within the **Inverter** and in such cases it is only necessary to have the **Inverter Type Tested.** Alternatively, a package of specific separate parts of equivalent function may also be **Type Tested**. The **Interface Protection** shall satisfy the requirements of all of the following standards. Where these standards have more than one part, the requirements of all such parts shall be satisfied, so far as they are applicable. BS EN 61000 (Electromagnetic Standards) BS EN 60255 (Electrical Relays) BS EN 61810 (Electrical Elementary Relays) BS EN 60947 (Low Voltage Switchgear and Control gear) BS EN 61869 (Instrument Transformers: Additional requirements for current transformers) Currently there are no harmonised functional standards that apply to the **Power Park Module**'s **Interface Protection**. Consequently, in cases where power electronics is used for energy conversion along with any separate **Interface Protection** unit they will need to be brought together and tested as a complete **Power Park Module** as described in this EREC G99, and recorded in format similar to that shown in Form A2-3 (Annex A.2). Where the **Interface Protection** is physically integrated within the overall **Power Park Module** control system, the functionality of the **Interface Protection** unit should not be compromised by any failure of other elements of the control system (fail safe). For a **Full Type Tested Power Park Module** the completed **Power Park Module**'s **Interface Protection** shall not rely on interconnection using cables which could be terminated incorrectly on site ie the interconnections shall be made by non-reversible plug and socket which the **Manufacturer** has made and tested prior to delivery to site.	Considered. Test results see below.	**P**

Engineering recommendation G99-1			
Clause	**Requirement – Test**	**Result – Remark**	**Verdict**
	Where **Type Tested** components are wired together on site, ie not using specifically designed plugs and sockets for the purpose, it will be necessary to prove that all wiring has been correctly terminated by proving the functions which rely on the wiring at the time of commissioning as detailed in paragraph 15.2 and Form A2-4 (Annex A.2). This Annex is primarily designed for the testing of three phase **Power Park Module**s. However, where practicable, a single phase, or split phase test may be carried out if it can be shown that it will produce the equivalent results. This Annex applies to **Power Park Module**s either with or without load management or **Electricity Storage** devices connected on the prime mover side of the **Power Park Module**.		
A.7.1.2	**Type Verification Functional Testing of the Interface Protection** **Type Testing** is the responsibility of the **Manufacturer**. This test will verify that the operation of the **Power Park Module Interface Protection** shall result: a) in the safe disconnection of the **Power Park Module** from the **DNO**'s **Distribution Network** in the event that system parameters exceed the protection settings specified in Table 10.1; and b) in the **Power Park Module** remaining connected to the **DNO**'s **Distribution Network** while **Distribution Network** conditions are: (1) within the envelope specified by the settings plus and minus the tolerances specified for equipment operation in Table 10.1; and (2) within the trip delay settings specified in Table 10.1. Wherever possible the type testing of a **Power Park Module** designed for a particular type of prime mover should be proved under normal conditions of operation for that technology (unless otherwise noted).	Considered. Test results see below.	**P**
A.7.1.2.1	**Disconnection times** The minimum trip time delay settings, for over / under voltage, over / under frequency and loss of mains tests below, are presented in Table 10.1. For over / under voltage, over / under frequency and loss of mains tests, reconnection shall be checked as detailed below.	Considered. Test results see below.	**P**
A.7.1.2.2	**Over / Under Voltage** The **Power Park Module** shall be tested by operating in parallel with a variable AC test supply, see Figure A.7.1. Correct protection and ride-through operation shall be	Considered. Test results see below.	**P**

Engineering recommendation G99-1			
Clause	**Requirement – Test**	**Result – Remark**	**Verdict**
	confirmed during operation of the **Power Park Module.** The set points for over and under voltage at which the **Power Park Module** disconnects from the supply will be established by varying the AC supply voltage. To establish the trip voltage, the test voltage should be applied in steps of ± 0,5% or less, of the voltage setting for a duration that is longer than the trip time delay, for example 1 s in the case of a delay setting of 0,5 s starting at least 4 V below or above the setting. The test voltage at which this trip occurred is to be recorded. Additional tests just above and below the trip voltage should be undertaken to show that the test is repeatable and the figure at which a repeatable trip occurs should be recorded on the type verification test report Annex A.2-3. To establish the trip time, the test voltage should be applied starting from 4 V below or above the recorded trip voltage and should be changed to 4 V above or below the recorded trip voltage in a single step. The time taken from the step change to the **Inverter** tripping is to be recorded on the type verification test report Annex A.2-3. To establish correct ride-through operation, the test voltage should be applied at each setting ± 4 V and for the relevant times shown in the Table in Annex A.2-3. For example to test over voltage setting stage 1 which is required to be set at nominally 262.2 V the circuit should be set up as shown below and the voltage adjusted to 254,2 V. The **Power Park Module** should then be powered up to export a measurable amount of energy so that it can be confirmed that the **Power Park Module** has ceased to output energy. The variable voltage supply is then increased in steps of no more than 0.5% of nominal (1.15 V) maintaining the voltage for at least 1,5 s (trip time plus 0,5 s) at each voltage level. At each voltage level confirmation that the **Power Park Module** has not tripped after the time delay is required to be taken. At the voltage level at which a trip occurs then this should be recorded as the provisional trip voltage. Additional tests just below and if necessary just above the provisional trip voltage will allow the actual trip voltage to be established on a repeatable basis. This value should be recorded. For the sake of this example the actual trip level is assumed to have been established as being 261 V. The variable voltage supply should be set to 257 V the **Power Park Module** set to produce a measurable output and then the voltage raised to 265 V in a single step. The time from the step change to the output of **Power Park Module** falling to zero should be recorded as the trip time. The **Power Park Module** then needs to operate at 4 V below the nominal over voltage stage 1 setting which is		

Engineering recommendation G99-1			
Clause	**Requirement – Test**	**Result – Remark**	**Verdict**
	258,2 V for a period of at least 2 s without tripping and while producing a measurable output. This can be confirmed as a no trip in the relevant part of Annex A.2-3. The voltage then needs to be stepped up to the next level of 269,7 V for a period of 0,98 s and then back to 258,2 V during which time the output of the relay should continue with no interruption though it may change due to the change in voltage, this can be recorded as a no trip for the second value. The step up and step down test needs to be done a second time with a max value of 277,7 V and with a time of 0,48 s. The **Power Park Module** is allowed to shut down during this period to protect its self as allowed by note 1 of Table 10.1, but it shall resume production again when the voltage has been restored to 258,2 V or it may continue to produce an output during this period. There is no defined time for resumption of production but it shall be shown that restart timer has not operated so it will begin producing again in less than 20 s. Note that this philosophy should be applied to the under voltage, over and under frequency, RoCoF and Vector shift stability tests which follow. Note: (1) The frequency required to trip is the setting ± 0.1 Hz (2) Measurement of operating time should be measured at a value of 0.3 Hz (suggestion – 2 x tolerance) above/below the setting to give "positive" operation (3) The "No trip tests" need to be carried out at the relevant values and times as shown in the table in Annex A.2-3 to ensure that the protection will not trip in error.  **Figure A.7.1. Power Park Module test set up – over / under voltage**		
A.7.1.2.3	**Over / Under Frequency** The **Power Park Module** shall be tested by operating in parallel with a low impedance, variable frequency test supply system, see Figure A.7.2. Correct protection and ride-through operation should be confirmed during operation of the **Power Park Module**. The set points for over and under frequency at which the **Power Park Module** system disconnects from the supply will be established by varying the test supply frequency. To establish a trip frequency, the test frequency should be applied in a slow ramp rate of less than 0,1 Hzs^{-1}, or if this is not possible in steps of 0,05 Hz for a duration that is longer than the trip time delay, for example 1 s in the case of a delay setting of 0,5 s. The test frequency	Considered. Test results see below.	**P**

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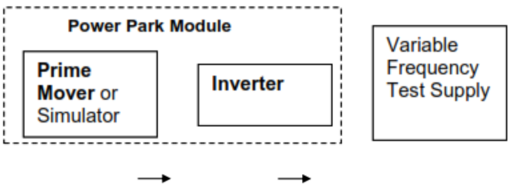
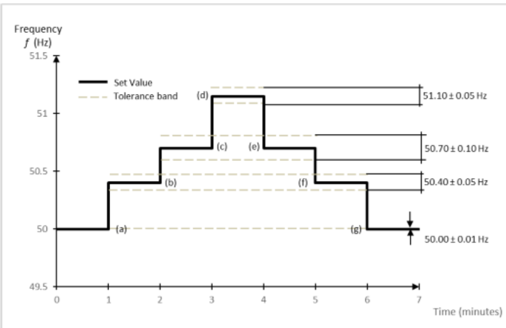
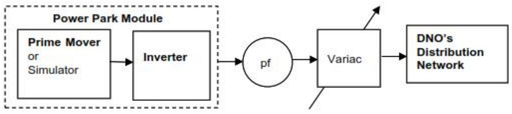
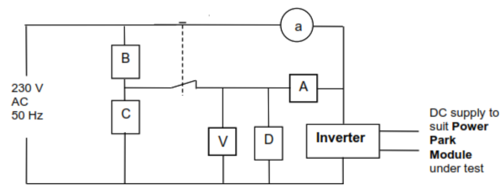
Clause	**Requirement – Test**	**Result – Remark**	**Verdict**
	at which this trip occurred is to be recorded. Additional tests just above and below the trip frequency should be undertaken to show that the test is repeatable and the figure at which a repeatable trip occurs should be recorded on the type verification test report Annex A.2-3. To establish the trip time, the test frequency should be applied starting from 0,3 Hz below or above the recorded trip frequency and should be changed to 0,3 Hz above or below the recorded trip frequency in a single step. The time taken from the step change to the **Power Park Module** tripping is to be recorded on the type verification test report Annex A.2-3. It should be noted that with some loss of mains detection techniques this test may result in a faster trip due to operation of the loss of mains protection. There are two ways around this. Firstly the loss of mains protection may be able to be turned off in order to carry out this test. Secondly by establishing an accurate frequency for the trip a much smaller step change could be used to initiate the trip and establish a trip time. This may require the test to be repeated several times to establish that the time delay is correct. To establish correct ride-through operation, the test frequency should be applied at each setting ± 0.2 Hz and for the relevant times shown in the table in Annex A.2-3.  Figure A.7.2 Power Park Module test set up – over / under frequency		
A.7.1.2.4	**Loss of Mains Protection** The tests should be carried out in accordance with BS EN 62116 and a subset of results should be recorded as indicated in the Protection – loss of mains test section of Annex A.2-3 Type Test Verification Report. Multi phase **Power Park Module**s should be operated at part load while connected to a network running at about 50 Hz and one phase only shall be disconnected with no disturbance to the other phases. The **Power Park Module** should trip within 1 s. The test needs to be repeated with each phase disconnected in turn while the other two phases remain in operation and the results recorded in the Type Test declaration.	Considered. Test results see below.	**P**
A.7.1.2.5	**Re-connection**	Considered.	**P**

Engineering recommendation G99-1			
Clause	**Requirement – Test**	**Result – Remark**	**Verdict**
	The tests should be carried out in accordance with BS EN 62116 and a subset of results should be recorded as indicated in the Protection – loss of mains test section of Annex A.2-3 Type Test Verification Report. Multi phase **Power Park Module**s should be operated at part load while connected to a network running at about 50 Hz and one phase only shall be disconnected with no disturbance to the other phases. The **Power Park Module** should trip within 1 s. The test needs to be repeated with each phase disconnected in turn while the other two phases remain in operation and the results recorded in the Type Test declaration.	Test results see below.	
A.7.1.2.6	**Frequency Drift and Step Change Stability test.** The tests will be carried out using the same circuit as specified in A.7.1.2.3 above and following confirmation that the **Power Park Module** has passed the under and over frequency trip tests and the under and over frequency stability tests. Four tests are required to be carried out with all protection functions enabled including loss of mains. For each stability test the **Power Park Module** should not trip during the test. For the step change test the **Power Park Module** should be operated with a measurable output at the start frequency and then a vector shift should be applied by extending or reducing the time of a single cycle with subsequent cycles returning to the start frequency. The start frequency should then be maintained for a period of at least 10 s to complete the test. The **Power Park Module** should not trip during this test. For frequency drift tests the **Power Park Module** should be operated with a measurable output at the start frequency and then the frequency changed in a ramp function at 0,95 Hzs^{-1} to the end frequency. On reaching the end frequency it should be maintained for a period of at least 10 s. The **Power Park Module** should not trip during this test. The results shall be recorded on the test sheet of Annex A.2-3.	Considered. Test results see below.	**P**
A.7.1.3	**Limited Frequency Sensitive Mode – Over (LFSM-O)** There are two possible approaches to demonstrating **LFSM-O**. The first to use the test set up of Figure A.7.2. The second approach can be used where it is possible to inject a frequency control signal into the **Power Generating Module**. The **Manufacturer** or **Generator** can choose which is the more appropriate test for the **Power Generating Module**.	Considered. Test results see below.	**P**

Engineering recommendation G99-1			
Clause	**Requirement – Test**	**Result – Remark**	**Verdict**
	The test below uses the test set up of Figure A.7.2 to demonstrate **LFSM-O** using a variable frequency supply. The alternative approach is covered in A.7.2.4. The test should be carried out above 80% **Registered Capacity** and repeated at 40-60% **Registered Capacity** using the specific threshold frequency of 50.4 Hz and **Droop** of 10%. The **Power Park Module** should be tested at the following frequencies: Step a) 50,00 Hz ±0,01 Hz Step b) 50,45 Hz ±0,05 Hz Step c) 50,70 Hz ±0,10 Hz Step d) 51,15 Hz ±0,05 Hz Step e) 50,70 Hz ±0,10 Hz Step f) 50,45 Hz ±0,05 Hz Step g) 50,00 Hz ±0,01 Hz The frequency at each step should be maintained for at least one minute as illustrated in Figure A.7.3 and the **Active Power** reduction in the form of a gradient determined and assessed for compliance with paragraph 11.2.3.  Figure A.7.3 Testing the Active Power feed-in of the Power Generating Module at over frequency The **Droop** should be determined from the measurements between 50,4 Hz and 51,15 Hz. The allowed tolerance for the frequency measurement shall be ± 0,05 Hz. The allowed tolerance for **Active Power** output measurement shall be ±10% of the required change in **Active Power**. The resulting overall tolerance range for a nominal 10% **Droop** is +2,8% and – 1,5%, ie a **Droop** less than 12,8% and greater than 8,5%.		
A.7.1.4	**Power Quality**		**P**
A.7.1.4.1	**Harmonics** The tests should be carried out as specified in BS EN 61000-3-12 and can be undertaken with a fixed source	Considered. Test results see below.	**P**

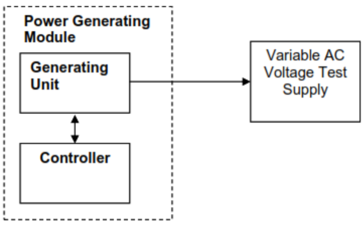
Engineering recommendation G99-1			
Clause	**Requirement – Test**	**Result – Remark**	**Verdict**
	of energy at two power levels firstly between 45 and 55% and at 100% of **Registered Capacity**.		
A.7.1.4.2	**Power Factor** The test set up shall be such that the **Power Park Module** supplies full load to the **DNO**'s **Distribution Network** via the **Power Factor** (pf) meter and the variac as shown below in Figure A.7.3. The **Power Park Module Power Factor** should be within the limits given in paragraph 11.1.5, for three test voltages 0,94 pu, 1 pu V[28] and 1,1 pu V.  NOTE 1 For reasons of clarity the points of isolation are not shown. NOTE 2: It is permissible to use a voltage regulator or tapped transformer to perform this test rather than a variac as shown. **Figure A.7.3 Power Park Module test set up – Power Factor** [28] For a **LV** connected **Power Generating Module** 1 pu V = 230 V	Considered. Test results see below.	**P**
A.7.1.4.3	**Voltage Flicker** The voltage fluctuations and flicker emissions from the **Power Park Module** shall be measured in accordance with BS EN 61000-3-11 and the technology specific Annex A.7.3. The required maximum supply impedance should be calculated and recorded in the relevant part of Compliance Verification Report in Form A2-3 (Annex A.2).	Considered. Test results see below.	**P**
A.7.1.4.4	**DC Injection** The level of **DC** injection from the **Power Park Module** - connected prime mover in to the **DNO**'s **Distribution Network** shall not exceed the levels specified in 9.4.6 when measured during operation at three levels, 10%, 55% and 100% of rating with a tolerance of ±5%. The DC injection requirements can be satisfied by the installation of an isolation transformer on the AC side of an **Inverter**-connected **Power Park Module**. A declaration that an isolating transformer is fitted can be made in lieu of the tests noted above.	Considered. Test results see below.	**P**
A.7.1.5	**Short Circuit Current Contribution** **Power Park Module** connected **Power Generating Module**'s generally have small short circuit fault contributions however **DNO**s need to understand the contribution that they make to system fault levels in order to determine that they can continue to safely operate without exceeding design fault levels for switchgear and other circuit components.	Considered. Test results see below.	**P**

Engineering recommendation G99-1			
Clause	**Requirement – Test**	**Result – Remark**	**Verdict**
	The following type tests shall be carried out and the results noted in Annex A.2-3.  **Figure A.7.4 Power Park Module short circuit test circuit**		
A.7.1.6	**Self-Monitoring - Solid State Disconnection** Some **Power Park Modules** include solid state switching devices to disconnect from the **DNO**'s **Distribution Network**. In this case paragraph 9.7.9 requires the control equipment to monitor the output stage of the **Power Park Module** to ensure that in the event of a protection initiated trip the output voltage is either disconnected completely or reduced to a value below 50 V AC. This shall be verified either by self-certification by the **Manufacturer**, or additional material shall be presented to the tester sufficient to allow an assessment to be made.	Considered. Test results see below..	**N/A**
A.7.1.7	**Power Park Modules which include Electricity Storage** This paragraph provides a method for demonstrating compliance with the optional performance characteristic as discussed in the foreword. The tests shall be carried out to demonstrate how the **Power Park Module Active Power** when acting as a load (ie replenishing its energy store) responds to changes in system frequency. In general, four tests are proposed, one set of two at **Rated Import Capacity**, and one set of two at 40% of **Rated Import Capacity**. In both cases the test is to reduce frequency from 50 Hz at 2 Hzs^{-1}. In the first case the lower frequency reached will be 49,0 Hz and the second case the lower frequency will be 48,8 Hz. In all cases the response shall meet the requirements of 11.2.3.3.		**N/A**
A.7.2	**Synchronous Power Generating Module Requirements (up to and including 50 kW)**		**N/A**
A.7.2.1	**Certification & Type Testing Generating Unit Requirements** This Annex describes a methodology for obtaining type certification or type verification for a **Synchronous Power Generating Module** in conjunction with Form A2-1. Other compliance requirements are detailed in Form A2-2 which may be used as an alternative to this Annex.	No synchronous Power Generating Module	**N/A**

Engineering recommendation G99-1			
Clause	**Requirement – Test**	**Result – Remark**	**Verdict**
	The **Interface Protection** of the **Synchronous Power Generating Module** shall satisfy the requirements of all of the following standards. Where these standards have more than one part, the requirements of all such parts shall be satisfied, so far as they are applicable. • BS EN 61000 (Electromagnetic Standards) • BS EN 60255 (Electrical Relays) • BS EN 61810 (Electrical Elementary Relays) • BS EN 60947 (Low Voltage Switchgear and Control gear) • BS EN 61869 (Instrument Transformers: Additional requirements for current transformers) Currently there are no harmonised functional standards that apply to the **Power Generating Module Interface Protection**, therefore in order to achieve **Type Tested** status the **Power Generating Module** and any separate **Interface Protection** unit will require their functionality to be **Type Tested** as described in this Annex, and recorded in format similar to that shown in Annex A.2-1. Where the **Interface Protection** is physically integrated within the overall **Power Generating Module** control system, the functionality of the **Interface Protection** unit should not be compromised by any failure of other elements of the control system (fail safe). For a **Fully Type Tested Power Generating Module** the completed **Power Generating Module**'s **Interface Protection** shall not rely on interconnection using cables which could be terminated incorrectly on site ie the interconnections shall be made by non-reversible plug and socket which the **Manufacturer** has made and tested prior to delivery to site. Where **Type Tested** components are wired together on site, ie not using specifically designed plugs and sockets for the purpose, it will be necessary to prove that all wiring has been correctly terminated by proving the functions which rely on the wiring at the time of commissioning as detailed in paragraph 15.2 and Form A2-4 (Annex A.2). Wherever possible the type testing of a **Power Generating Module** utilising a particular type of prime mover should be proved under normal conditions of operation for that prime mover (unless otherwise noted). This Annex can also be used for asynchronous **Generating Unit**s that are not connected to the **Distribution Network** via an **Inverter** as appropriate. This Annex also applies to any **Synchronous Power Generating Module**s that are powered by stored		

Engineering recommendation G99-1			
Clause	**Requirement – Test**	**Result – Remark**	**Verdict**
	energy (eg compressed air), but the requirement to demonstrate the **LFSM-O** will not be required.		
A.7.2.2	**Type Verification Testing of the Interface Protection Functions** Type verification testing is the responsibility of the **Manufacturer**. This test will verify that the operation of the **Power Generating Module Interface Protection** shall result: 1. in the safe disconnection of the **Power Generating Module** from the **DNO**'s **Distribution Network** in the event that the protection settings specified in Table 10.1 are exceeded; and 2. in the **Power Generating Module** remaining connected to the **DNO**'s **Distribution Network** while network conditions are: a. within the envelope specified by the settings plus and minus the tolerances specified for equipment operation in Table 10.1; and b. within the trip delay settings specified in Table 10.1. The **Interface Protection** may be incorporated into the **Power Generating Module** in which case it should be tested as part of the **Power Generating Module**. Alternatively, the constituent devices that form the **Interface Protection** may be discrete in which case the tests may be carried out on the discrete protection devices independently from the **Power Generating Module**. In either case it will be necessary to verify that a protection operation will disconnect the **Power Generating Module** from the **DNO**'s **Distribution Network**.	No synchronous Power Generating Module	**N/A**
A.7.2.2.1	**Disconnection times** he minimum trip time delay settings, for over / under voltage, over / under frequency and loss of mains tests below, are presented in Table 10.1. For over / under voltage, over / under frequency and loss of mains tests, reconnection shall be checked as detailed below. In some systems it may be safer and more convenient to test the trip delay time and the disconnection time separately. This will allow the trip delay time to be measured in a test environment (in a similar way as for a protection relay). The disconnection time can be measured in the **Power Generating Module**'s normal operation, allowing accurate measurement with correct inertia and prime mover characteristics. This is permitted providing the total disconnection time does not exceed the value specified in Section 10.6.7.1. When measuring the disconnection time where the	No synchronous Power Generating Module	**N/A**

Engineering recommendation G99-1			
Clause	**Requirement – Test**	**Result – Remark**	**Verdict**
	Interface Protection is included in the **Power Generating Module**, 5 s disconnections should be initiated, and the average time recorded.		
A.7.2.2.2	Over / Under Voltage The **Interface Protection** shall be tested by operating the **Power Generating Module** in parallel with a variable AC test supply, as an example see Figure A.7.5. Correct protection and ride-through operation shall be confirmed. The set points for over and under voltage at which the **Interface Protection** disconnects from the supply, will be established by varying the frequency of the AC supply voltage. The disconnect sequence should be initiated when the network conditions mean the protection should trip in accordance with the settings in Table 10.1, otherwise normal operation should continue. To establish the certified trip voltage, the test voltage should be applied in steps of ± 0.5% or less of the voltage setting for a duration that is longer than the trip time delay, for example 1 s in the case of a delay setting of 0.5 s starting at least 4 V below or above the setting. Additional tests just above and below the trip voltage should be undertaken to show that the test is repeatable and the figure at which a repeatable trip occurs should be recorded on the type verification test report Annex A.2-1. To establish the certified trip time, the test voltage should be applied starting from 4 V below or above the certified trip voltage and should be changed to 4 V above or below the certified trip voltage in a single step. The time taken from the step change to the **Power Generating Module** tripping is to be recorded on the type verification test report Annex A.2-1. To establish correct ride-through operation, the test voltage should be applied at each setting ± 4 V and for the relevant times shown in the Table in Annex A.2-1. For example, to test over voltage setting stage 1 which is required to be set at nominally 262,2 V the circuit can be set up as shown below and the voltage adjusted to 254,2 V. In integrated designs where there is no separate way of establishing that the **Power Generating Module** is disconnected, the **Power Generating Module** should be powered up to export a measurable amount of energy so that it can be confirmed that the **Power Generating Module** has ceased to output energy. The variable voltage supply is then increased in steps of no more than 0,5% of nominal voltage (1,15 V) maintaining the voltage for at least 1,5 s (trip time plus 0,5 s) at each voltage level. At each voltage level confirmation that the **Power Generating Module** has not tripped after the time delay	No synchronous Power Generating Module	**N/A**

Engineering recommendation G99-1			
Clause	**Requirement – Test**	**Result – Remark**	**Verdict**
	is required to be taken. At the voltage level at which a trip occurs then this should be recorded as the provisional trip voltage. Additional tests just below and if necessary just above the provisional trip voltage will allow the actual trip voltage to be established on a repeatable basis. This value should be recorded. For the sake of this example the actual trip level is assumed to have been established as being 261 V. The variable voltage supply should be set to 257 V the **Power Generating Module** set to produce a measurable output (if necessary) and then the voltage raised to 265 V in a single step. The time from the step change to the disconnection of the **Power Generating Module**, the output of the **Power Generating Module** falling to zero should be recorded as the trip time. To confirm that the protection does not trip before the required time, the test voltage should be applied at each setting ± 4V and for the relevant times shown in the table in Annex A.2-1. Test results should be recorded on the Test Sheet shown in Annex A.2-1  Figure A.7.5.- Power Generating Module test set up – over / under voltage		
A.7.2.2.3	**Over / Under Frequency** The **Interface Protection** shall be tested by operating the **Power Generating Module** in parallel with a low impedance, variable frequency test supply system, as an example, see Figure A.7.6. Correct protection and ride-through operation should be confirmed during the test. The set points for over and under frequency at which the **Interface Protection** disconnects from the supply will be established by varying the test supply frequency. To establish a trip frequency, the test frequency should be applied in a slow ramp rate of less than 0,1 Hzs^{-1}, or if this is not possible in steps of 0,05 Hz for a duration that is longer than the trip time delay, for example 1 s in the case of a delay setting of 0,5 s. The test frequency at which this trip occurred is to be recorded. Additional tests just above and below the trip frequency should be undertaken to show that the test is repeatable and the figure at which a repeatable trip occurs should be recorded on the type verification test report Annex A.2-1.	No synchronous Power Generating Module	**N/A**

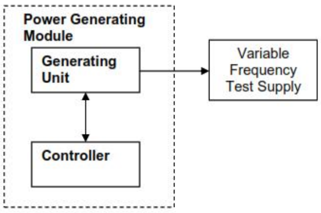
<table>
<tr><th colspan="4">Engineering recommendation G99-1</th></tr>
<tr><th>Clause</th><th>Requirement – Test</th><th>Result – Remark</th><th>Verdict</th></tr>
<tr><td></td><td>To establish the trip time, the test frequency should be applied starting from 0,3 Hz below or above the recorded trip frequency and should be changed to 0,3 Hz above or below the recorded trip frequency in a single step. The time taken from the step change to the Power Generating Module tripping is to be recorded on the type verification test report Annex A.2-1. It should be noted that with some loss of mains detection techniques this test may result in a faster trip due to operation of the loss of mains protection and if possible the loss of mains protection should be turned off in order to carry out this test. Otherwise a much smaller step change should be used to initiate the trip and establish a trip time which may require the test to be repeated several times to establish that the time delay is correct.


Figure A.7.6. Power Generating Module test set up – over / under frequency</td><td></td><td></td></tr>
<tr><td>A.7.2.2.4</td><td>Loss of Mains Protection

The resonant test circuit specified as an option for this test has been designed to model the interaction of the Power Generating Module under test with the local load including multiple Power Generating Module’s in parallel.

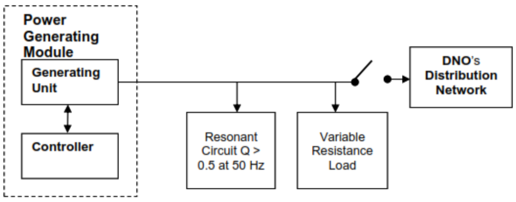
The Power Generating Module output shall be connected to a network combining a resonant circuit with a Q factor of >0,5 and a variable load. The value of the load is to match the Power Generating Module output. To facilitate the test for LoM there shall be a switch placed between the test load/ Power Generating Module combination and the DNO’s Distribution Network, as shown in Figure A.7.7.


Figure A.7.7 Power Generating Module test set up - loss of mains

The Power Generating Module is to be tested at three levels of the Power Generating Module’s Registered Capacity: 10%, 55% and 100% and the results recorded on the test sheet of Annex A.2-1.</td><td>No synchronous Power Generating Module</td><td>N/A</td></tr>
</table>

Engineering recommendation G99-1			
Clause	**Requirement – Test**	**Result – Remark**	**Verdict**
	For each test the load match is to be within ± 5%. Each test is to be repeated five times. Load match conditions are defined as being when the current from the **Power Generating Module** meets the requirements of the test load ie there is no export or import of supply frequency current to or from the **DNO**'s **Distribution Network**. The tests will record the **Power Generating Module**'s output voltage and frequency from at least 2 cycles before the switch is opened until the protection system operates and disconnects itself from the **DNO**'s **Distribution Network**, or for 5 s whichever is the lower duration. The time from the switch opening until the protection disconnection occurs is to be measured and shall comply with the requirements in Table 10.1. Multi phase **Power Generating Module**s should be operated at part load while connected to a network running at about 50 Hz and one phase only shall be disconnected with no disturbance to the other phases. The **Power Generating Module** should trip within 1 s. The test needs to be repeated with each phase disconnected in turn while the other two phases remain in operation and the results recorded in the **Type Test** declaration.		
A.7.2.2.5	**Re-connection** Further tests will be carried out with the three test circuits above to check the **Power Generating Module** time- out feature prior to automatic network reconnection. This test will confirm that once the AC supply voltage and frequency have returned to within the stage 1 settings specified in Table 10.1 following an automatic protection trip operation there is a minimum time delay of 20 s before reconnection will be allowed.	No synchronous Power Generating Module	**N/A**
A.7.2.2.6	**Frequency drift and vector shift stability test.** The tests will be carried out using the same circuit as specified in A.7.2.2.3 above and following confirmation that the **Power Generating Module** has passed the under and over frequency trip and no trip tests. Four tests are required to be carried out with all protection functions enabled including loss of mains. For each stability test the **Power Generating Module** should not trip during the test. For the step change test the **Power Generating Module** should be operated with a measurable output at the start frequency and then a vector shift should be applied by extending or reducing the time of a single cycle with subsequent cycles returning to the start frequency. The start frequency should then be	No synchronous Power Generating Module	**N/A**

Engineering recommendation G99-1			
Clause	**Requirement – Test**	**Result – Remark**	**Verdict**
	maintained for a period f at least 10 s to complete the test. The **Power Generating Module** should not trip during this test. For frequency drift tests the **Power Generating Module** should be operated with a measurable output at the start frequency and then the frequency changed in a ramp function at 0,95 Hzs^{-1} to the end frequency. On reaching the end frequency it should be maintained for a period of at least 10 s. The **Power Generating Module** should not trip during this test. The results shall be recorded on the test sheet of Annex A.2-1.		
A.7.2.3	**Power Output with Falling Frequency**	No synchronous Power Generating Module	**N/A**
A.7.2.3.1	The **Generator** will propose and agree a test procedure with the **DNO**, which will demonstrate how the **Synchronous Power Generating Module Active Power** output responds to changes in system frequency. The tests can be undertaken by the **Synchronous Power Generating Module** powering a suitable load bank, or alternatively using the test set up of Figure A.7.6. In both cases a suitable test could be to start the test at nominal frequency with the **Synchronous Power Generating Module** operating at 100% of its **Registered Capacity**. The frequency should then be set to 49,5 Hz for 5 minutes. The output should remain at 100% of **Registered Capacity**. The frequency should then be set to 49,0 Hz and once the output has stabilised, held at this frequency for 5 minutes. The **Active Power** output shall not be below 99% of **Registered Capacity**. The frequency should then be set to 48,0 Hz and once the output has stabilised, held at this frequency for 5 minutes. The **Active Power** output shall not be below 97% of **Registered Capacity**. The frequency should then be set to 47,6 Hz and once the output has stabilised, held at this frequency for 5 minutes. The **Active Power** output shall not be below 96.2% of **Registered Capacity**. The frequency should then be set to 47,1 Hz and held at this frequency for 20 s. The **Active Power** output shall not be below 95,0% of **Registered Capacity** and the **Synchronous Power Generating Module** shall not trip in less than the 20s of the test.	No synchronous Power Generating Module	**N/A**

Engineering recommendation G99-1			
Clause	**Requirement – Test**	**Result – Remark**	**Verdict**
	The **Generator** shall inform the **DNO** if any load limiter control is additionally employed.		
A.7.2.4	**Synchronous Power Generating Modules which include Electricity Storage** This paragraph provides a method for demonstrating compliance with the optional performance characteristic as discussed in the foreword. The tests shall be carried out to demonstrate how the Synchronous Power Generating Module Active Power when acting as a load (ie replenishing its energy store) responds to changes in system frequency. In general four tests are proposed, one set of two at Rated Import Capacity, and one set of two at 40% of Rated Import Capacity. In both cases the test is to reduce frequency from 50 Hz at 2 Hzs^{-1}. In the first case the lower frequency reached will be 49,0 Hz and the second case the lower frequency will be 48,8 Hz. In all cases the response shall meet the requirements of 11.2.3.3.	No synchronous Power Generating Module	**N/A**
A.7.2.5	**Limited Frequency Sensitive Mode – Over (LFSM-O)** The tests described in this Annex A.7.2.4 are also suitable for **Type A Power Generating Modules** > 50 kW.	No synchronous Power Generating Module	**N/A**
A.7.2.5.1	This paragraph is applicable to all **Synchronous Power Generating Modules** other than slow acting micro hydro **Synchronous Power Generating Modules** which should refer to paragraph A.7.2.4.2. Note that this test is also an alternative to the test in A.7.1.3. The two frequency response tests in **Limited Frequency Sensitive Mode (LFSM)** to demonstrate **LFSM-O** capability to a frequency injection as shown by Figures A.7.8 and Figures A.7.9 are to be conducted at **Registered Capacity** (although a lower power output may be agreed with the **DNO** if site conditions preclude attaining **Registered Capacity**, such as an absence of adequate wind). There should be sufficient time allowed between tests for control systems to reach steady state. The injection signal should be maintained until the **Active Power** (MW) output of the **Power Generating Module** has stabilised. The **DNO** may require repeat tests should the tests give unexpected results. The frequency input and the expected **Active Power** response are illustrated for different periods from 0 s to 130 s in Figure A.7.8 for a step change in frequency and in Figures A.7.9 for a ramp change in frequency. This	No synchronous Power Generating Module	**N/A**

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Clause	Requirement – Test	Result – Remark	Verdict
	should be in accordance with Section 11.2.4 (a threshold frequency of 50,4 Hz and a **Droop** of 10%) and undamped oscillations should not occur after the step or ramp frequency change.		

Note for diagram purposes only a short interval is shown between the frequency increase and decrease for each test. In practice the return step or ramp can start any time after the output has stabilized after the first step or ramp.

The response should commence within 2 s and shall be to the left of the red line (ie between the green line and the red line) and be as close to the green line as possible when following the frequency step or ramp. Note that the red line represents the 0,5% s^{-1} specified in 11.2.4.1.

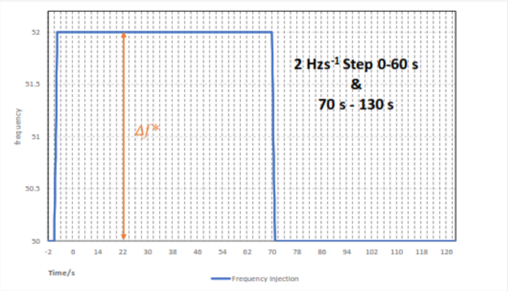

Figure A.7.8(i): LFSM-O step response test – frequency injection

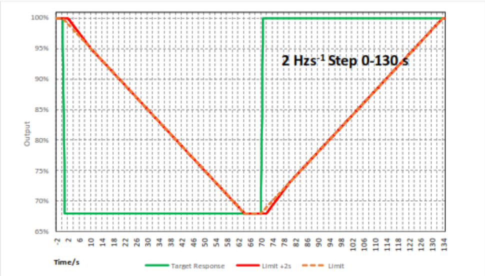

Figure A.7.8(ii): LFSM-O step response test – target response and limits

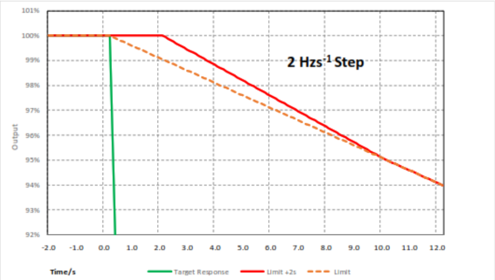

Figure A.7.8(iii): LFSM-O step response test – expansion of the allowed 2 s response delay (frequency increase)

Engineering recommendation G99-1

Clause	Requirement – Test	Result – Remark	Verdict

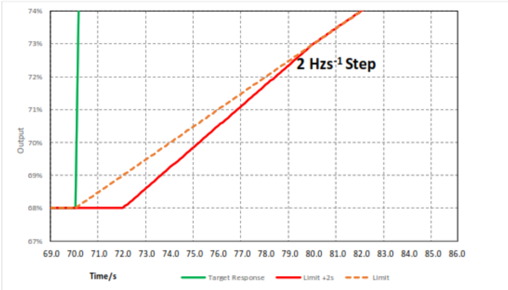

Figure A.7.8(iv): LFSM-O step response test – expansion of the allowed 2 s response delay (frequency decrease)

* This frequency step *Δf* will generally be +2,0 Hz unless an injection of this size causes a reduction in plant output that takes the operating point below **Minimum Stable Operating Level** in which case an appropriate injection should be calculated in accordance with the following:

For example 1,5 Hz is needed to take an initial output of 100% to a final output of 70%. If the initial output is not 100% and the **Minimum Stable Operating Level** is not 70% then the injected step should be adjusted accordingly as shown in the example given below:

Initial output 100%

Minimum Stable Operating Level 70%

Frequency controller **Droop** 10%

Frequency to be injected = (1,00 – 0,70) x 0,1 x 50 = 1,5Hz

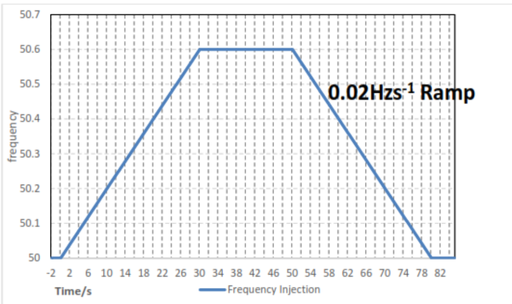

Figure A.7.9(i): LFSM-O ramp response test – frequency injection

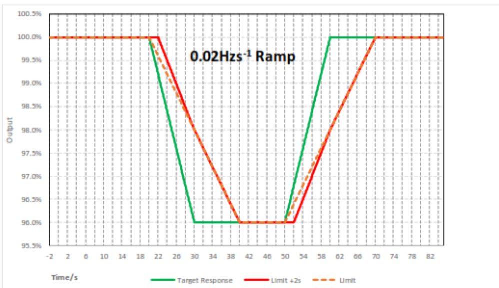

Figure A.7.9(ii): LFSM-O – target response and limits

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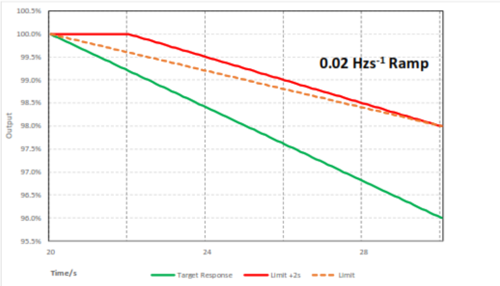
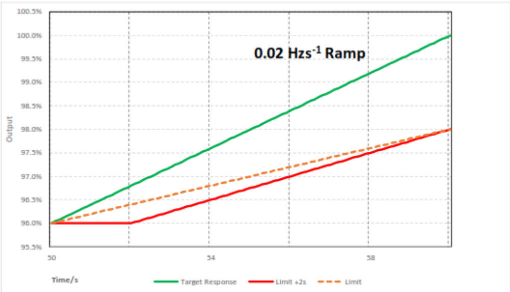
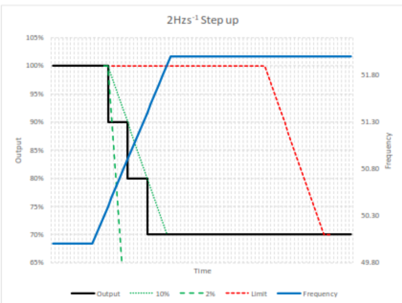
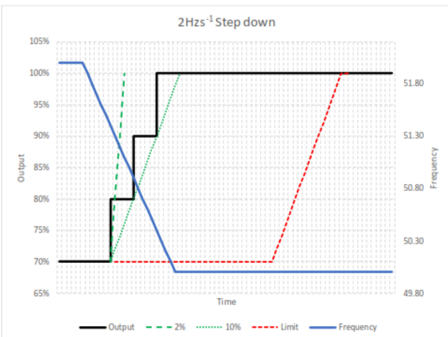
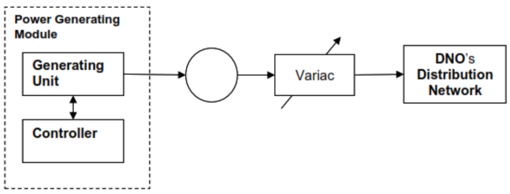
Clause	**Requirement – Test**	**Result – Remark**	**Verdict**
	 **Figure A.7.9(iii): LFSM-O ramp response test – expansion (frequency increase)**  **Figure A.7.9(iv): LFSM-O ramp response test – expansion (frequency decrease)**		
A.7.2.5.2	This paragraph is applicable to slow acting micro hydro **Synchronous Power Generating Modules.** Recognising the significant engineering challenge of physically reducing the electrical energy exported from a slow acting micro hydro **Power Generating Module**, given the mechanical and hydraulic lags involved, the **Generator** may engineer an appropriate **LFSM-O** response by automatically switching in load banks to absorb the electrical energy, using frequency sensitive relays or control gear. A single frequency response step test (ie no ramp test) is required in **Limited Frequency Sensitive Mode (LFSM)** to demonstrate the **LFSM-O** capability in response to a frequency injection of 2,0 Hzs^{-1} for 1 s as shown by the Figures A.7.10 below. The test is to be conducted at **Registered Capacity** (although a lower power output may be agreed with the **DNO** if site conditions preclude attaining **Registered Capacity**, such as an absence of adequate water flow rate). Similarly if the frequency step takes the operating point below the **Minimum Stable Operating Level** an alternative appropriate injection should be calculated that demonstrates **LFSM-O** across the range that is available without breaching the **Minimum Stable Operating Level**. There should be sufficient time allowed between the step up in frequency for control systems to reach steady state before the following step down in frequency. The injection signal should be maintained until the **Active**	No synchronous Power Generating Module	**N/A**

Engineering recommendation G99-1			
Clause	**Requirement – Test**	**Result – Remark**	**Verdict**
	Power (MW) output of the **Power Generating Module** has stabilised. The **DNO** may require repeat tests should the tests give unexpected results. The frequency input and the expected **Active Power** response are illustrated below. This should be in accordance with Section 11.2.4. Undamped oscillations should not occur after the step frequency change. For both the step up and step down parts of the test the response should commence within 2 s and shall always be to the left of the red line and be as close as possible to the green line representing 10% **Droop** (unless some other **Droop** is desired by the **Generator**). It is permissible to be to the left of the 2% **Droop** line when the first load bank is switched in (or the final one switched out, ie the first one to be switched out) but the output must be to the right of the 2% **Droop** line by the time the frequency has reached 52,0 Hz (or returned to 50,0 Hz).  **Figure A.7.10(i): LFSM-O step response test (frequency increase) for slow acting micro hydro**  **Figure A.7.10(ii): LFSM-O step response test (frequency decrease) for slow acting micro hydro**		
A.7.2.6	**Power Quality**		**N/A**
A.7.2.6.1	**Harmonics** The tests should be carried out as specified in BS EN 61000-3-12 and can be undertaken with a fixed source of energy at two power levels firstly between 45 and 55% and at 100% of maximum export capacity.	No synchronous Power Generating Module	**N/A**

Engineering recommendation G99-1			
Clause	**Requirement – Test**	**Result – Remark**	**Verdict**
A.7.2.6.2	**Power Factor** The test set up shall be such that the **Power Generating Module** supplies full load to the **DNO**'s **Distribution Network** via the **Power Factor** (pf) meter and the variac as shown below in Figure A.7.10. The **Power Generating Module** pf should be within the limits given in paragraph 11.1.5, for three test voltages 230 V –6%, 230 V and 230 V +10%.  NOTE 1. For reasons of clarity the points of isolation are not shown NOTE 2: It is permissible to use a voltage regulator or tapped transformer to perform this test rather than a variac as shown **Figure A.7.10 Power Generating Module test set up – Power Factor**	No synchronous Power Generating Module	**N/A**
A.7.2.6.3	**Voltage Flicker** The voltage fluctuations and flicker emissions from the **Generating Unit** shall be measured in accordance with BS EN 61000-3-11 and technology specific annex. The required maximum supply impedance should be calculated and recorded in the **Type Test** declaration Annex A.2-1.	No synchronous Power Generating Module	**N/A**
A.7.3	**Additional Power Generating Module Technology Requirements**		**P**
A.7.3.1	**Domestic CHP** or Domestic CHP **Power Park Module**s the type verification testing and **Interface Protection** requirements will be as per the requirements defined in Annex A.7.1. For Domestic CHP **Synchronous Power Generating Module**s the type verification testing and **Interface Protection** requirements will be as per the requirements defined in Annex A.7.2.	No Domestic CHP.	**N/A**
A.7.3.2	**Photovoltaic** As all current Photovoltaic **Power Park Module**s will connect to the **DNO**'s **Distribution Network** via an **Inverter**, the type verification testing and **Interface Protection** requirements will be as per the requirements defined in Annex A.7.1.	Photovoltaic inverter	**P**
A.7.3.3	**Fuel Cells** As all current Fuel Cell **Power Generating Module**s will connect to the **DNO**'s **Distribution Network** via an **Inverter**, the type verification testing and **Interface Protection** requirements will be as per the requirements defined in Annex A.7.1.	No fuel cell	**N/A**

Engineering recommendation G99-1			
Clause	**Requirement – Test**	**Result – Remark**	**Verdict**
A.7.3.4	**Hydro** Hydro can be connected to the **DNO**'s **Distribution Network** directly using induction or **Synchronous Power Generating Module**s or it can be connected by an **Inverter**. The common requirements for the generator technologies will apply to micro hydro in addition the following needs to be taken into consideration. **Power Generating Module**s with manually fixed output or where the output is fixed by controlling the water flow through the turbine to a steady rate, need to comply with the maximum voltage change requirements of BS EN 61000-3-2 but do not need to be tested for P_{st} or P_{lt}. **Power Park Module**s where the output is controlled by varying the load on the generator using the **Inverter** and which therefore produces variable output need to comply with the maximum voltage change requirements of BS EN 61000-3-2 and also need to be tested for P_{st} and P_{lt} over a period where the range of flows varies over the design range of the turbine with a period of at least 2 hours at each step with there being 10 steps from min flow to maximum flow. P_{st} and P_{lt} values to recorded and normalised as per the method laid down in Annex A.3.	No Hydro	**N/A**
A.7.3.5	**Wind** Wind turbines can be connected to the **DNO**'s **Distribution Network** directly, typically using asynchronous induction generators, or using **Inverter**s. For those connected via **Inverters**, the type verification testing and **Interface Protection** requirements shall be as specified in Annex A.7.1. For those connected directly to the **DNO**'s **Distribution Network**, the type verification testing and **Interface Protection** requirements shall be as specified in Annex A.7.2. For wind turbines, flicker testing should be carried out during the performance tests specified in BS EN 61400-12. Flicker data should be recorded from wind speeds of 1 ms^{-1} below cut-in to 1,5 times 85% of the rated power. The wind speed range should be divided into contiguous bins of 1ms-1 centred on multiples of 1 ms^{-1}. The dataset shall be considered complete when each bin includes a minimum of 10 minutes of sampled data. The highest recorded values across the whole range of measurements should be used as inputs to the calculations described in BS EN 61000-3-11 to remove background flicker values. Then the required maximum supply impedance values can be calculated as described in Annex A.2-3. Note that occasional very	No wind	**N/A**

Engineering recommendation G99-1			
Clause	**Requirement – Test**	**Result – Remark**	**Verdict**
	high values may be due to faults on the associated **HV** network and may be discounted, though care should be taken to avoid discounting values which appear regularly.		
A.7.3.6	**Electricity Storage Device** **Electricity Storage** devices can be connected to the **DNO**’s **Distribution Network** directly or using **Inverter**s. For those connected via **Inverter**s, the type verification testing and **Interface Protection** requirements shall be as specified in Annex A.7.1 For those connected directly to the **DNO**’s **Distribution Network**, the type verification testing and **Interface Protection** requirements shall be as specified in Annex A.7.2. The tests associated with any requirements which have been identified in Annex A4 as not being applicable to **Electricity Storage** devices can be considered to be excluded tests in this Annex A7.	No storage device	**N/A**

G99-1

Test Results:

A2-3 - Compliance Verification Report for Type A Inverter Connected Power Generating Modules

Type Verification Functional Testing of the Interface Protection (4.1 Functional safety - fault condition tests according DIN V VDE V 0126-1-1)							P
No.	component No.	fault	test voltage (V)	test time	fuseNo.	fuse current(A)	result
1	Q32 (Pin1,2)	SC	Input: 850Vdc Output: 230Vac	10min	--	--	Unit normal working, the upper computer shows no error messages, no damaged, no hazard.
2	Q32 (Pin1,3)	SC	Input: 850Vdc Output: 230Vac	10min	--	--	Unit normal working, the upper computer shows no error messages, no damaged, no hazard.
3	Q32 (Pin3,2)	SC	Input: 850Vdc Output: 230Vac	10min	--	--	Unit normal working, the upper computer shows no error messages, no damaged, no hazard.
4	Q40 (Pin A, G)	SC	Input: 850Vdc Output: 230Vac	10min	--	--	Unit normal working, the upper computer shows no error messages, no damaged, no hazard.
5	Q40 (Pin A, K)	SC	Input: 850Vdc Output: 230Vac	10min	--	--	Unit normal working, the upper computer shows no error messages, no damaged, no hazard.
6	Q40 (Pin G, K)	SC	Input: 850Vdc Output: 230Vac	10min	--	--	Unit normal working, the upper computer shows no error messages, no damaged, no hazard.
7	C42	SC	Input: 850Vdc Output:	10min	--	--	Unit shut down, the upper computer shows”26 error code (INV

			230Vac				short)”, no damaged, no hazard.
8	D29	SC	Input: 850Vdc Output: 230Vac	10min	--	--	Unit shut down, the upper computer shows”02 error code (BUS under voltage)”, no damaged, no hazard.
9	C6	SC	Input: 850Vdc Output: 230Vac	10min	--	--	Unit shut down, the upper computer shows”12 error code (GFCI fault)”, no damaged, nohazard.
16-501737-00G(A)							
10	GAS1	SC	Input: 850Vdc Output: 230Vac	10min	--	--	Unit normal working, the upper computer shows no error messages, no damaged, no hazard.
11	MOV2	SC	Input: 850Vdc Output: 230Vac	10min	--	--	Unit normal working, the upper computer shows no error messages, no damaged, no hazard.
12	C14	SC	Input: 850Vdc Output: 230Vac	10min	--	--	Unit normal working, the upper computer shows no error messages, no damaged, no hazard.
16-501689-00G(A)							
13	C11	SC	Input: 850Vdc Output: 230Vac	10min	--	--	Unit normal working, the upper computer shows no error messages, no damaged, no hazard.
14	C7	SC	Input: 850Vdc Output: 230Vac	10min	--	--	F1 opened, unit normal working, the upper computer shows no error messages, no damaged, no hazard.
16-501665-00G(B)							
15	C44	SC	Input: 850Vdc Output: 230Vac	10min	--	--	Unit shut down, the upper computer shows”51 error code (DC-DC Over current)”, no damaged, no hazard.
16	C54	SC	Input: 850Vdc Output: 230Vac	10min	--	--	Unit shut down, the upper computer shows”51 error code (DC-DC Over current)”, no damaged, no hazard.
16-501664-00G(A)							

17	TX1	SC	Input: 850Vdc	10min	--	--	Unit shut down, no damaged, no hazard.

			Output: 230Vac				
18	TX2	SC	Input: 850Vdc Output: 230Vac	10min	--	--	Unit shut down, no damaged, no hazard.
19	IGBT1 (Pin 1, 2)	SC	Input: 850Vdc Output: 230Vac	10min	--	--	Unit shut down, the upper computer shows"02 error code (BUS under voltage)", no damaged, no hazard.
20	IGBT1 (Pin 2, 3)	SC	Input: 850Vdc Output: 230Vac	10min	--	--	Unit shut down, the upper computer shows"02 error code (BUS under voltage)", no damaged, no hazard.
21	IGBT1 (Pin 1, 3)	SC	Input: 850Vdc Output: 230Vac	10min	--	--	Unit shut down, the upper computer shows"02 error code (BUS under voltage)", no damaged, no hazard.
22	IGBT8 (Pin 1, 2)	SC	Input: 850Vdc Output: 230Vac	10min	--	--	Unit shut down, the upper computer shows"02 error code (BUS under voltage)", no damaged, no hazard.
23	IGBT8 (Pin 2, 3)	SC	Input: 850Vdc Output: 230Vac	10min	--	--	Unit shut down, the upper computer shows"02 error code (BUS under voltage)", no damaged, no hazard.
24	IGBT8 (Pin 1, 3)	SC	Input: 850Vdc Output: 230Vac	10min	--	--	Unit shut down, the upper computer shows"02 error code (BUS under voltage)", no damaged, no hazard.
25	IGBT12 (Pin 1, 2)	SC	Input: 850Vdc Output: 230Vac	10min	--	--	Unit shut down, the upper computer shows"02 error code (BUS under voltage)", no damaged, no hazard.
26	IGBT12 (Pin 2, 3)	SC	Input: 850Vdc Output: 230Vac	10min	--	--	Unit shut down, the upper computer shows"02 error code (BUS under voltage)", no damaged, no hazard.
27	IGBT12 (Pin 1, 3)	SC	Input: 850Vdc Output: 230Vac	10min	--	--	Unit shut down, the upper computer shows"02 error code (BUS under voltage)", no damaged, no hazard.

28	C45	SC	Input: 850Vdc	10min	--	--	Unit shut down, the upper computer shows”

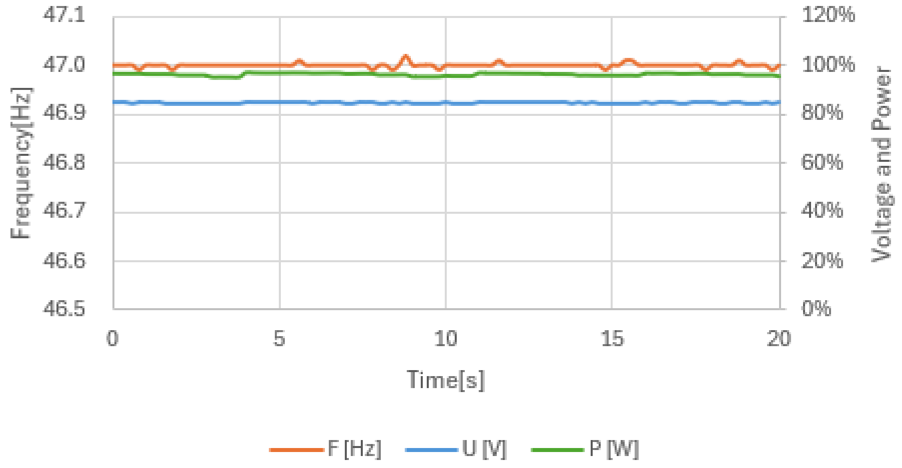
			Output: 230Vac				02 error code (BUS under voltage)", no damaged, no hazard.
29	Q21 (Pin 1, 2)	SC	Input: 850Vdc Output: 230Vac	10min	--	--	Unit shut down, the upper computer shows"02 error code (BUS under voltage)", no damaged, no hazard.
30	Q21 (Pin 2, 3)	SC	Input: 850Vdc Output: 230Vac	10min	--	--	Unit shut down, the upper computer shows"02 error code (BUS under voltage)", no damaged, no hazard.
31	Q21 (Pin 1, 3)	SC	Input: 850Vdc Output: 230Vac	10min	--	--	Unit shut down, the upper computer shows"02 error code (BUS under voltage)", no damaged, no hazard.
32	Q72 (Pin 1, 2)	SC	Input: 850Vdc Output: 230Vac	10min	--	--	Unit shut down, the upper computer shows"02 error code (BUS under voltage)", no damaged, no hazard.
33	Q72 (Pin 2, 3)	SC	Input: 850Vdc Output: 230Vac	10min	--	--	Unit shut down, the upper computer shows"02 error code (BUS under voltage)", no damaged, no hazard.
34	Q72 (Pin 1, 3)	SC	Input: 850Vdc Output: 230Vac	10min	--	--	Unit shut down, the upper computer shows"02 error code (BUS under voltage)", no damaged, no hazard.
35	Q69 (Pin 1, 2)	SC	Input: 850Vdc Output: 230Vac	10min	--	--	Unit shut down, the upper computer shows"51 error code (DC-DC over current)", no damaged, no hazard.
36	Q69 (Pin 2, 3)	SC	Input: 850Vdc Output: 230Vac	10min	--	--	Unit shut down, the upper computer shows"51 error code (DC-DC over current)", no damaged, no hazard.
37	Q69 (Pin 1, 3)	SC	Input: 850Vdc Output: 230Vac	10min	--	--	Unit shut down, the upper computer shows"51 error code (DC-DC over current)", no damaged, no hazard.
38	Fan 1 (Solar input)	Locked	Input: 850Vdc Output: 230Vac	1h	--	--	Unit shut down immediately after 1s, recoverable, no damaged, no hazard.

39	Fan 2	Locked	Input:	1h	--	--	Unit shut down

	(Solar input)		850Vdc Output: 230Vac				immediately after 1s, recoverable, no damaged, no hazard.
40	Fan 3 (Solar input)	Locked	Input: 850Vdc Output: 230Vac	1h	--	--	Unit shut down immediately after 1s, recoverable, no damaged, no hazard.
41	Fan 4 (Solar input)	Locked	Input: 850Vdc Output: 230Vac	1h	--	--	Unit shut down immediately after 1s, recoverable, no damaged, no hazard.
42	Fan 5 (Solar input)	Locked	Input: 850Vdc Output: 230Vac	1h	--	--	Unit shut down immediately after 1s, recoverable, no damaged, no hazard.
43	Output (Solar input)	O-L	Input: 850Vdc Output: 230Vac	1h	--	--	Unit normal working, the upper computer shows warning massage 02 (Line loss), no damaged,no hazard.
44	Output (AC input)	O-L	Input: 850Vdc Output: 230Vac	1h	--	--	Unit normal working, the upper computer shows warning massage 02 (Line loss), no damaged,no hazard.
45	Output (Battery input)	O-L	Input: 850Vdc Output: 230Vac	1h	--	--	Unit normal working, the upper computer shows warning massage 15 (Battery open), no damaged, no hazard.
46	Battery input	Reverse polarity	Input: 850Vdc Output: 230Vac	10min	--	--	Battery fuse opened, no damaged, no hazard.
47	Output (Solar input)	SC	Input: 850Vdc Output: 230Vac	10min	--	--	Unit shut down, the upper computer shows”05 error code (INV Overcurrent)”, no damaged, no hazard.
48	Output (AC input)	SC	Input: 850Vdc Output: 230Vac	10min	--	--	Unit shut down, the upper computer shows”05 error code (INV Overcurrent)”, no damaged, no hazard.
49	Output (Battery input)	SC	Input: 850Vdc Output: 230Vac	10min	--	--	Unit shut down, the upper computer shows”51 error code (DC-DC Over current)”, no damaged, no hazard.

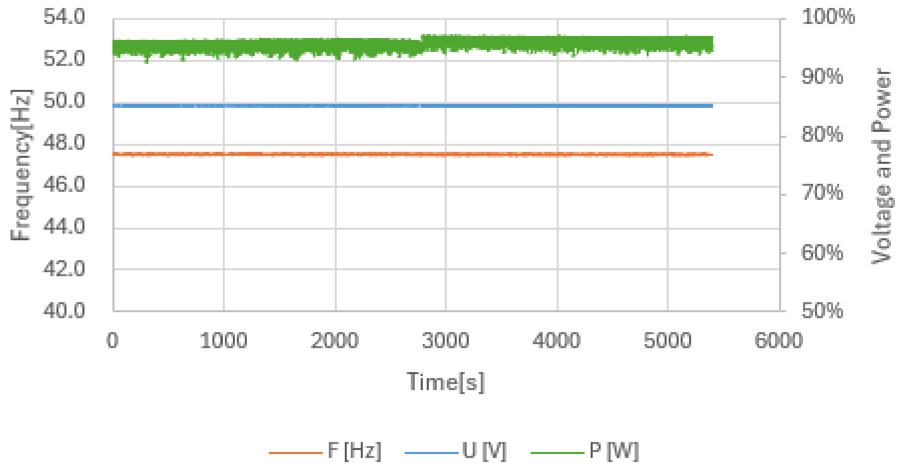
	Operating Range:	P
Test 1	Voltage = 85% of nominal (195,5 V) Frequency = 47,0 Hz Power Factor = 1 Period of test 20 seconds	
Connection:	Always connected	
Limit:	Always connected	

Diagram Test 1:



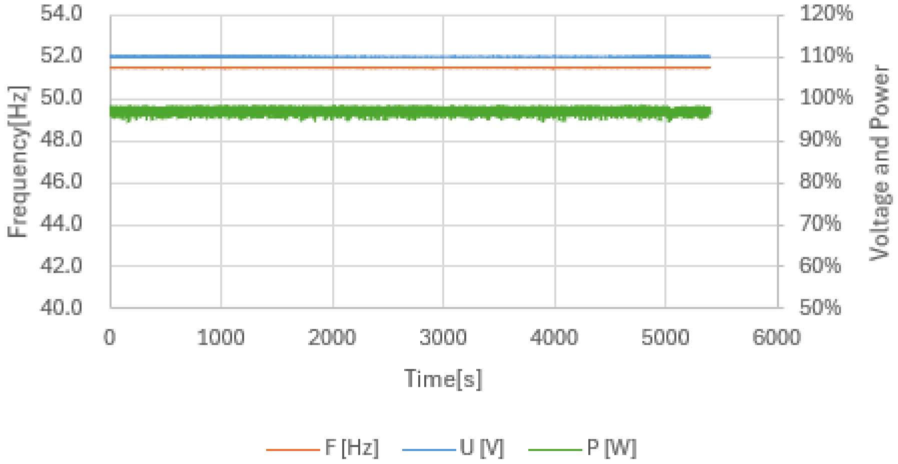
Test 2	Voltage = 85% of nominal (195,5 V) Frequency = 47,5 Hz Power Factor = 1 Period of test 90 minutes	
Connection:	Always connected	
Limit:	Always connected	

Diagram Test 2:



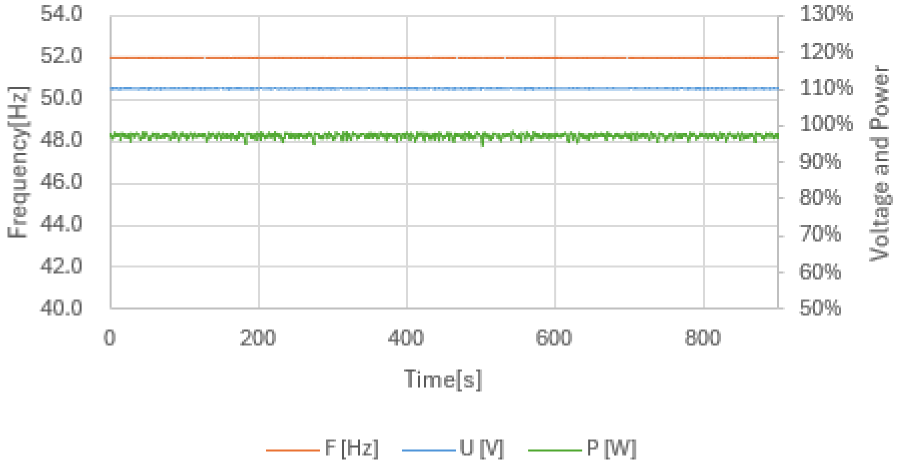
	Operating Range:	P
Test 3	Voltage = 110% of nominal (253,0 V) Frequency = 51,5 Hz Power Factor = 1 Period of test 90 minutes	
Connection:	Always connected	
Limit:	Always connected	

Diagram Test 3:



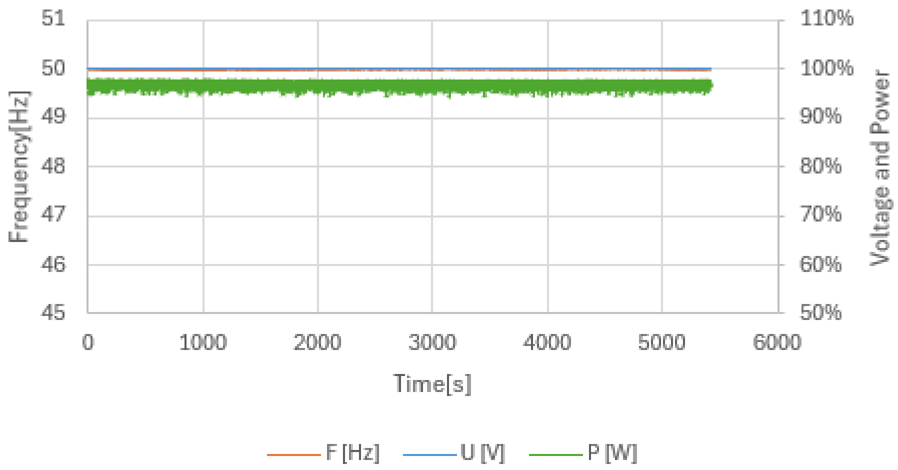
Test 4	Voltage = 110% of nominal (253,0 V) Frequency = 52,0 Hz Power Factor = 1 Period of test 15 minutes	
Connection:	Always connected	
Limit:	Always connected	

Diagram Test 4:



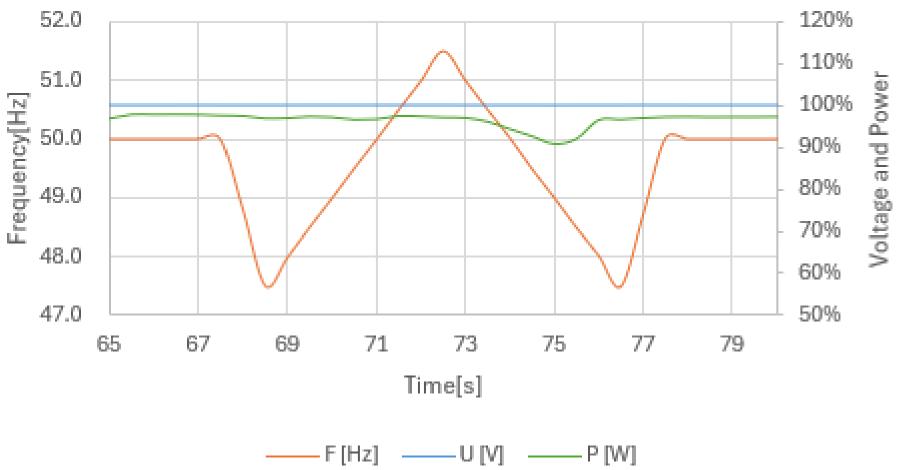
	Operating Range:	P
Test 5	Voltage = 100% of nominal (230,0 V) Frequency = 50,0 Hz Power Factor = 1 Period of test 90 minutes	
Connection:	Always connected	
Limit:	Always connected	

Diagram Test 5:



Test 6 RoCof withstand	Confirm that the Power Generating Module is capable of staying connected to the Distribution Network and operate at rates of change of frequency up to 1 Hzs-1 as measured over a period of 500 ms. Note that this is not expected to be demonstrated on site.	
Connection:	Always connected	
Limit:	Always connected	

Diagram Test 6:



Note:

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

	Operating Range:	P
Frequency, voltage and Active Power measurements at the output terminals of the Power Generating Module shall be recorded every second. The tests will verify that the Power Generating Module can operate within the required ranges for the specified period of time. The Interface Protection shall be disabled during the tests. In case of a PV Power Park Module the PV primary source may be replaced by a DC source. In case of a full converter Power Park Module (eg wind) the primary source and the prime mover Inverter/rectifier may be replaced by a DC source. The tests had been performed on the INFINI WP 15KW TWIN are valid for the INFINI WP 12KW TWIN since it is almost same as in hardware and just power derated by software.		

A.7.1.2.2	**Over / Under Voltage** These tests should be carried out in accordance with Annex A.7.1.2.2.	**P**

Phase 1

Function	Setting		Trip test		No trip test	
	Voltage [V]	Time delay [s]	Voltage [V]	Time delay [s]	Voltage / time	Confirm no trip
U/V	184,0	2,5	183,93	2,50	188 V / 5,00 s	No trip
					180 V / 2,45 s	No trip
O/V stage 1	262,2	1,0	261,53	1,00	258,2 V / 5,00 s	No trip
O/V stage 2	273,7	0,5	273,02	0,50	269,7 V / 0,95 s	No trip
					277,7 V / 0,45 s	No trip

Note:

The total disconnection time for voltage and frequency protection, including the operating time of the disconnection device, shall be the time delay setting with a tolerance of, -0s + 0,1 s.

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.

Phase 2

Function	Setting		Trip test		No trip test	
	Voltage [V]	Time delay [s]	Voltage [V]	Time delay [s]	Voltage / time	Confirm no trip
U/V	184,0	2,5	183,53	2,51	188 V / 5,00 s	No trip
					180 V / 2,45 s	No trip
O/V stage 1	262,2	1,0	261,23	1,00	258,2 V / 5,00 s	No trip
O/V stage 2	273,7	0,5	273,00	0,51	269,7 V / 0,95 s	No trip
					277,7 V / 0,45 s	No trip

A.7.1.2.2	**Over / Under Voltage** These tests should be carried out in accordance with Annex A.7.1.2.2.					**P**
Phase 3						
Function	Setting		Trip test		No trip test	
	Voltage [V]	Time delay [s]	Voltage [V]	Time delay [s]	Voltage / time	Confirm no trip
U/V	184,0	2,5	183,85	2,51	188 V / 5,00 s	No trip
					180 V / 2,45 s	No trip
O/V stage 1	262,2	1,0	260,98	1,01	258,2 V / 5,00 s	No trip
O/V stage 2	273,7	0,5	272,32	0,51	269,7 V / 0,95 s	No trip
					277,7 V / 0,45 s	No trip

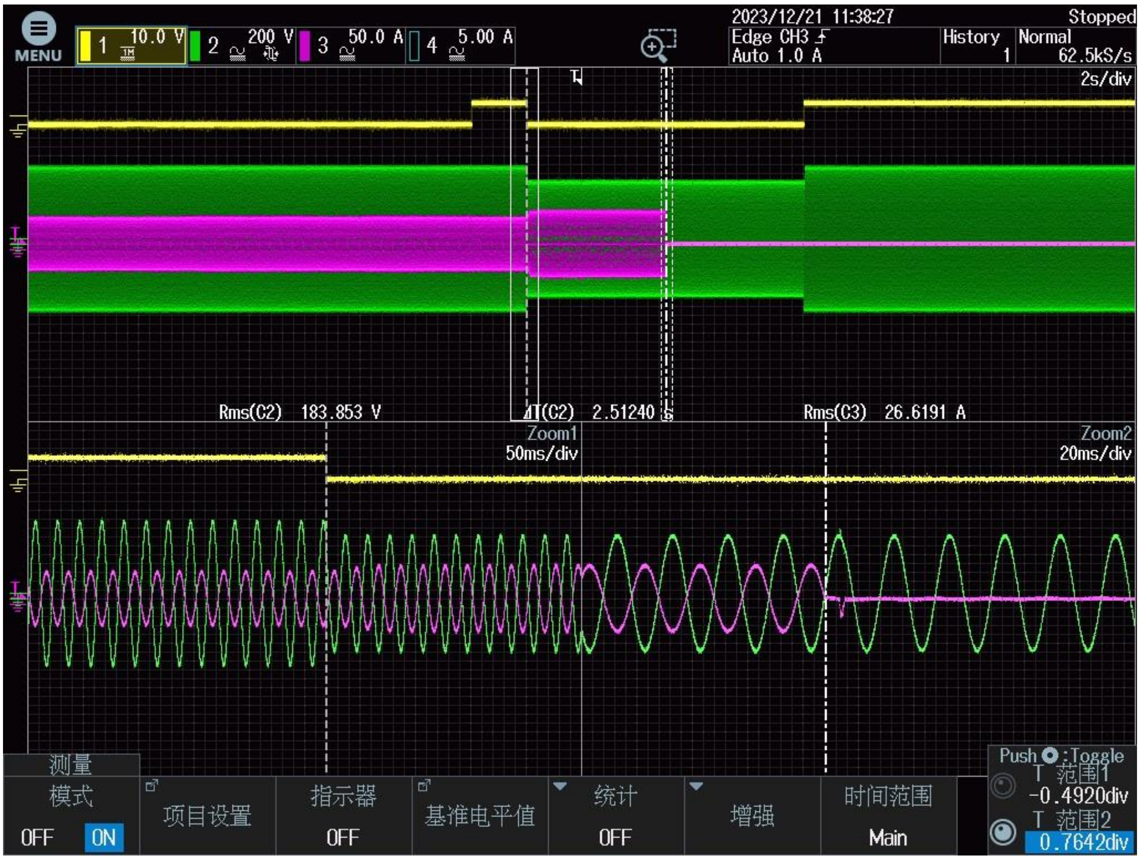
Note:

The total disconnection time for voltage and frequency protection, including the operating time of the disconnection device, shall be the time delay setting with a tolerance of, -0 s + 0,1 s.

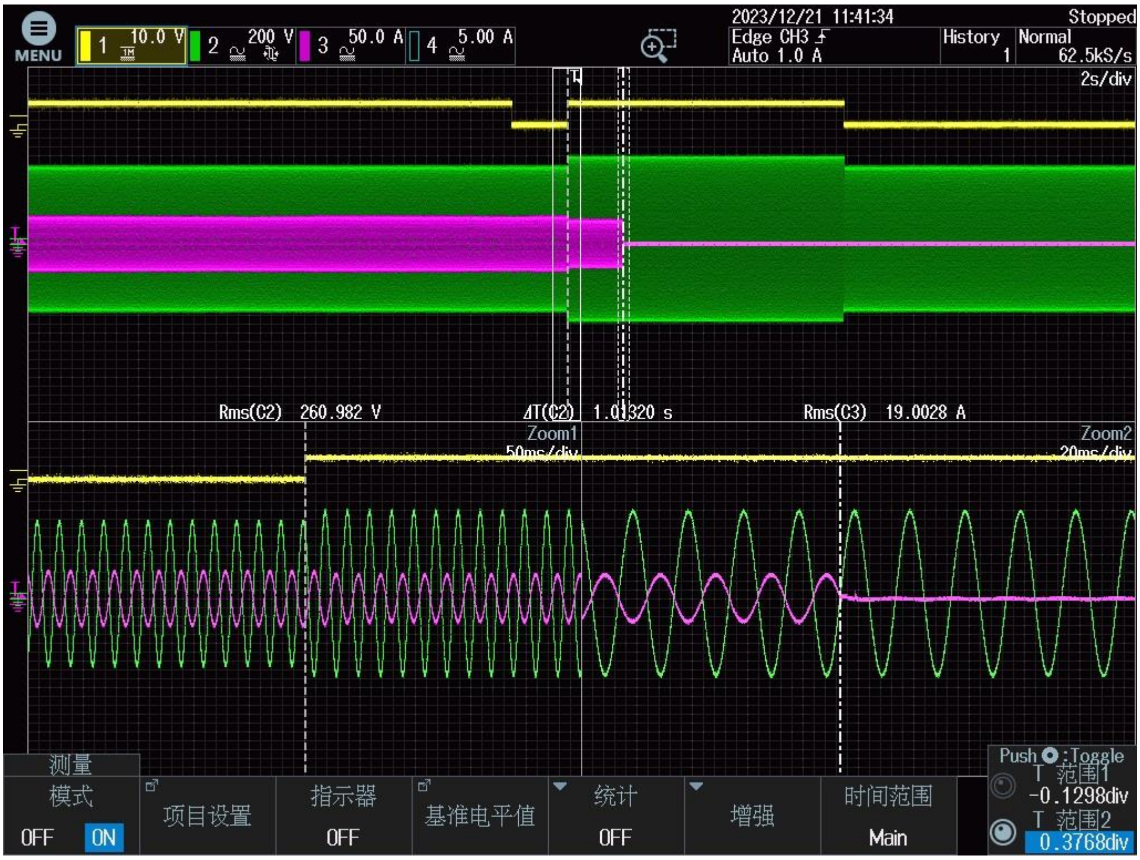
The Voltage required to trip is the setting ± 3,45 V. The time delay can be measured at a larger deviation than the minimum required to operate the protection. The No trip tests need to be carried out at the setting ± 4 V and for the relevant times as shown in the table above to ensure that the protection will not trip in error.

The tests had been performed on the INFINI WP 15KW TWIN are valid for the INFINI WP 12KW TWIN since it is almost same as in hardware and just power derated by software.

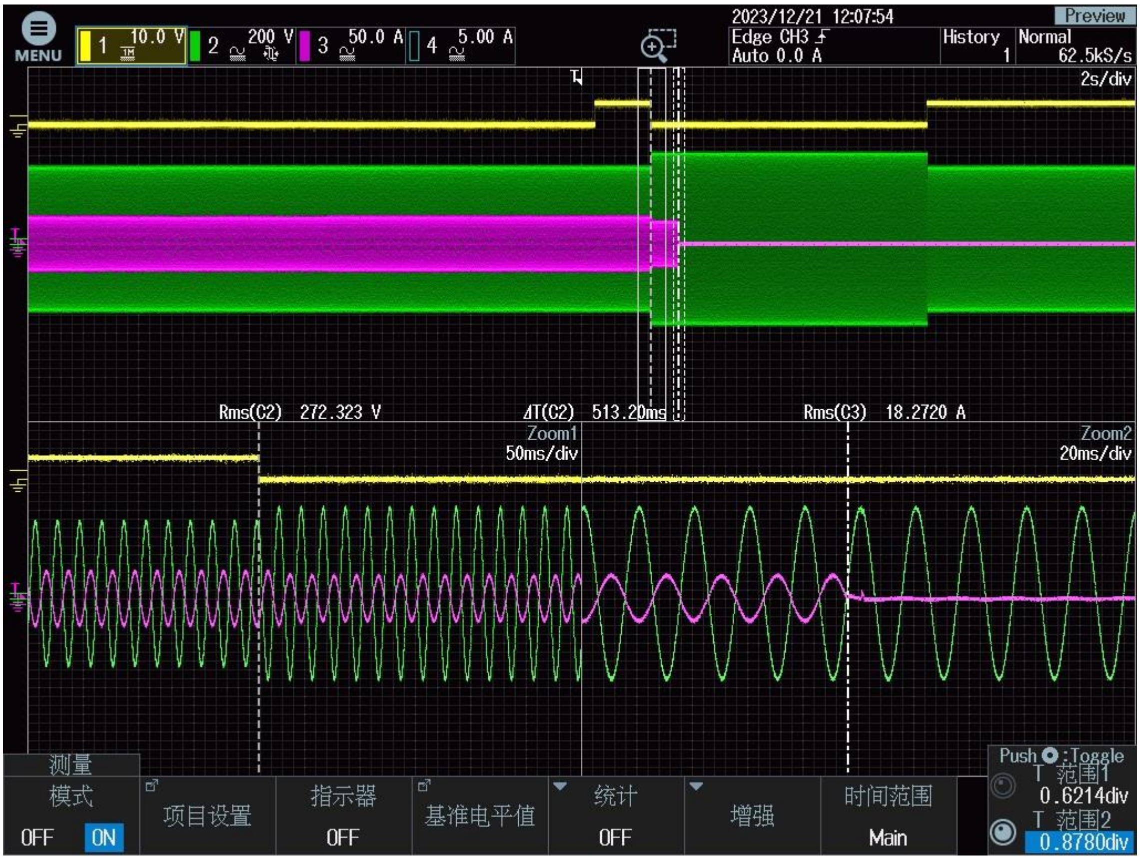
Under voltage



Over voltage stage 1



Over voltage stage 2



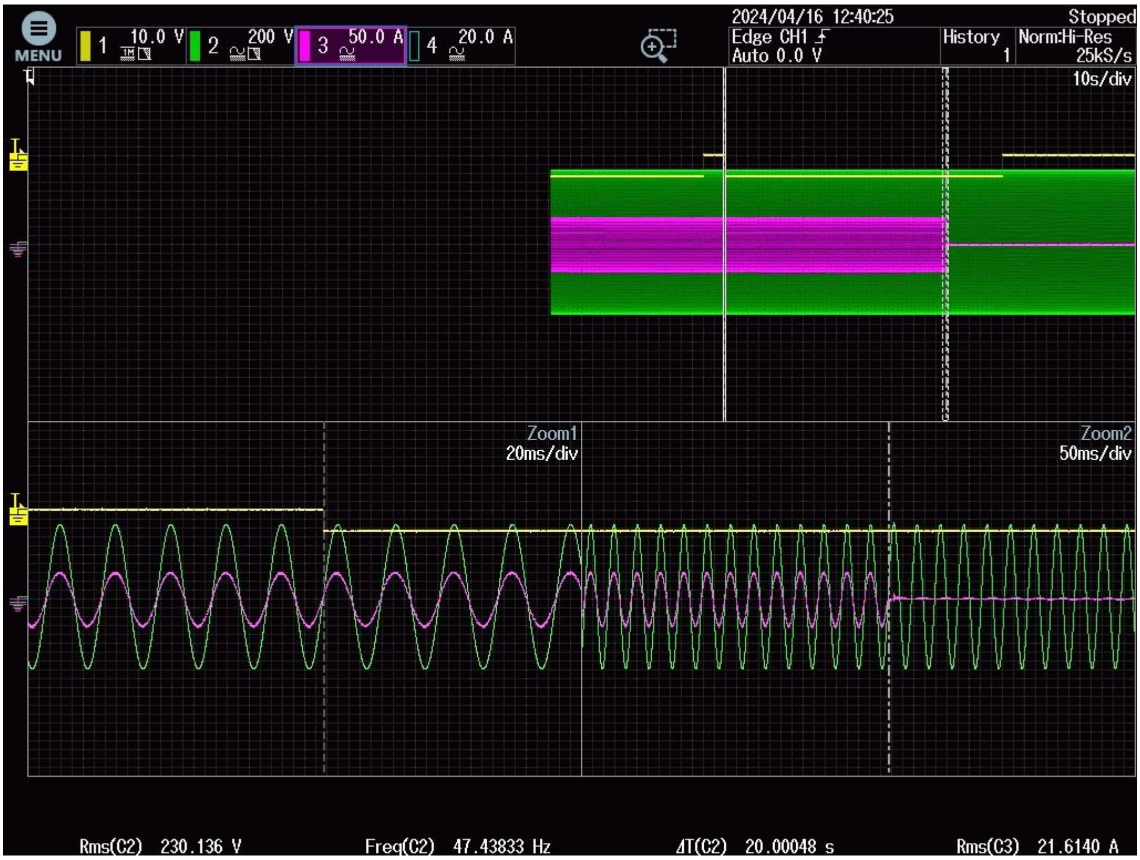
A.7.1.2.3	**Over / Under Frequency** These tests should be carried out in accordance with Annex A.7.1.2.3.					**P**
Function	Setting		Trip test		No trip test	
	Frequency [Hz]	Time delay [s]	Frequency [Hz]	Time delay [s]	Frequency / time	Confirm no trip
U/F stage 1	47,5	20,0	47,5Hz	20,00	47,7 Hz / 30,00 s	No trip
U/F stage 2	47,0	0,5	47Hz	0,51	47,2 Hz / 19,50 s	No trip
					46,8 Hz / 0,45 s	No trip
O/F	52,0	0,5	52Hz	0,51	51,8 Hz / 120,00 s	No trip
					52,2 Hz / 0,45 s	No trip

Note:

The total disconnection time for voltage and frequency protection, including the operating time of the disconnection device, shall be the time delay setting with a tolerance of, -0 s + 0,1 s.

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.

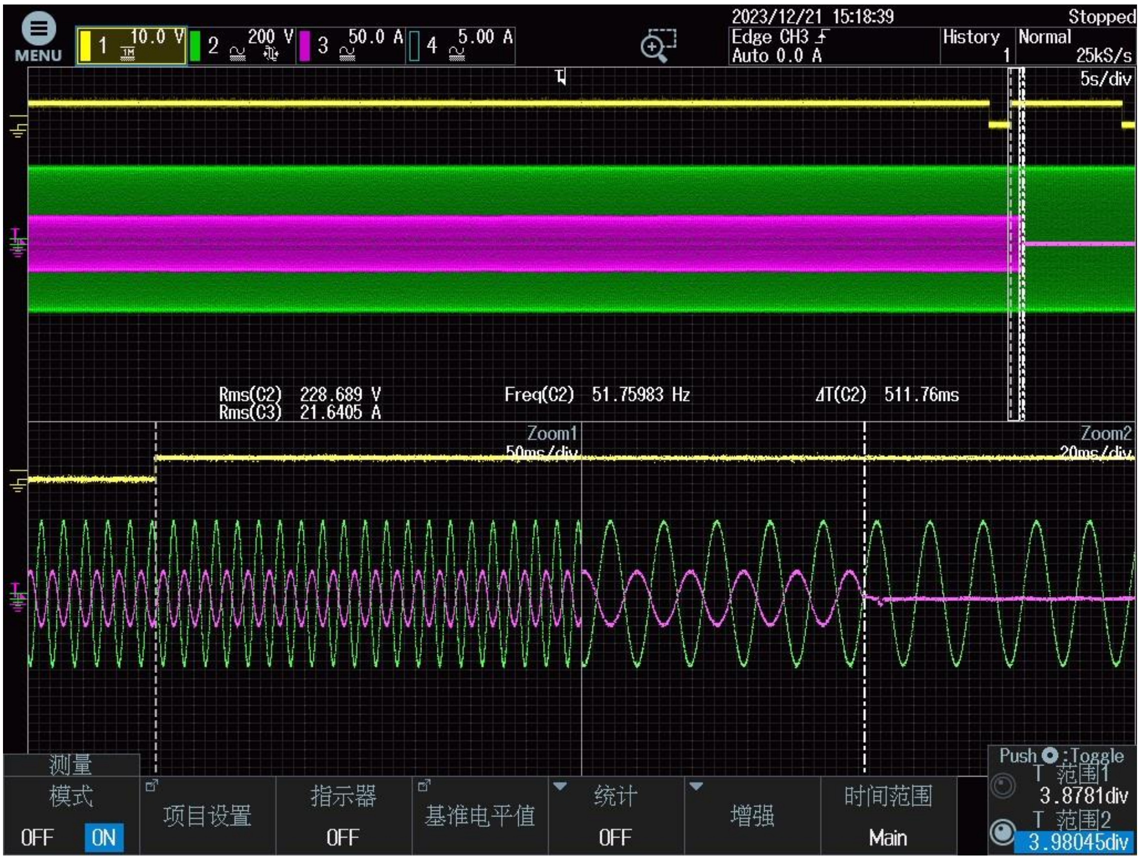
The tests had been performed on the INFINI WP 15KW TWIN are valid for the INFINI WP 12KW TWIN since it is almost same as in hardware and just power derated by software.

U/F stage 1


2024/04/16 12:40:25
Stopped
MENU
1 10.0 V
2 200 V
3 50.0 A
4 20.0 A
Edge CH1
Auto 0.0 V
History 1
Norm:Hi-Res
25kS/s
10s/div
Zoom1
20ms/div
Zoom2
50ms/div
Rms(C2) 230.136 V
Freq(C2) 47.43833 Hz
ΔT(C2) 20.00048 s
Rms(C3) 21.6140 A

U/F stage 2


2023/12/21 15:43:14
Stopped
Edge CH3
Auto 0.0 A
History
Normal
25kS/s
5s/div
Rms(C2) 229.381 V
Rms(C3) 21.5650 A
Freq(C2) 47.16981 Hz
ΔT(C2) 513.00ms
Zoom1
100ms/div
3.8894div
3.9920div

O/F


2023/12/21 15:18:39
Stopped
Edge CH3
Auto 0.0 A
History
Normal
25kS/s
5s/div
Rms(C2) 228.689 V
Rms(C3) 21.6405 A
Freq(C2) 51.75983 Hz
ΔT(C2) 511.76ms
Zoom1
50ms/div
Zoom2
20ms/div
3.8781div
3.98045div

A.7.1.2.4	**Protection - Loss of mains according to BS EN 62116** These tests should be carried out in accordance with BS EN 62116. Annex A.7.1.2.4. Load imbalance (real, reactive load) for test condition A (EUT output = 100%)	**P**

Test conditions	Frequency: 50 +/- 0,1 Hz U_N = 230 +/- 3 Vac Distortion factor of chokes < 2% Quality = 1
Disconnection limit	0,5 s

No	P_{EUT} 1) (% of EUT rating)	Reactive load (% of Q_L in 6.1.d) 1)	P_{AC} 2) (% of nominal)	Q_{AC} 3) (% of nominal)	P_{EUT} [kW]	V_{DC} [V]	Q_f [1]	Run on Time [ms]	Remarks4)
1	100	100	0	0	15	830	1,02	326,0	BL
32	100	100	-10	-10	15	830	1,08	183,3	IB
33	100	100	-10	-5	15	830	1,10	203,5	IB
34	100	100	-10	0	15	830	1,13	153,5	IB
35	100	100	-10	+5	15	830	1,16	135,5	IB
36	100	100	-10	+10	15	830	1,18	114,5	IB
37	100	100	-5	-10	15	830	1,02	184,5	IB
4	100	100	-5	-5	15	830	1,05	180,0	IB
5	100	100	-5	0	15	830	1,07	164,0	IB
6	100	100	-5	+5	15	830	1,10	131,0	IB
38	100	100	-5	+10	15	830	1,12	112,0	IB
39	100	100	0	-10	15	830	0,98	213,5	IB
7	100	100	0	-5	15	830	1,00	153,5	IB
8	100	100	0	+5	15	830	1,04	194,0	IB
40	100	100	0	+10	15	830	1,07	203,0	IB
41	100	100	+5	-10	15	830	0,93	232,0	IB
9	100	100	+5	-5	15	830	0,95	182,5	IB
10	100	100	+5	0	15	830	0,98	322,5	IB
11	100	100	+5	+5	15	830	0,99	111,5	IB
42	100	100	+5	+10	15	830	1,02	171,0	IB
43	100	100	+10	-10	15	830	0,89	230,0	IB
44	100	100	+10	-5	15	830	0,91	181,5	IB
45	100	100	+10	0	15	830	0,93	115,0	IB
46	100	100	+10	+5	15	830	0,96	155,5	IB
47	100	100	+10	+10	15	830	0,98	192,0	IB

Parameter at 0%	L=11,23 mH	R=3,53 Ω	C=903,04 µF

Note:

RLC is adjusted to min. +/- 1% of the inverter rated output power

1) P_{EUT}: EUT output power

2) P_{AC}: Real power flow at S1 in Figure 1. Positive means power from EUT to utility. Nominal is the 0% test condition value.

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

4) BL: Balance condition, IB: Imbalance condition.

Condition A:

EUT output power PEUT = Maximum 5)

EUT input voltage 6) = > 75% of rated input voltage range

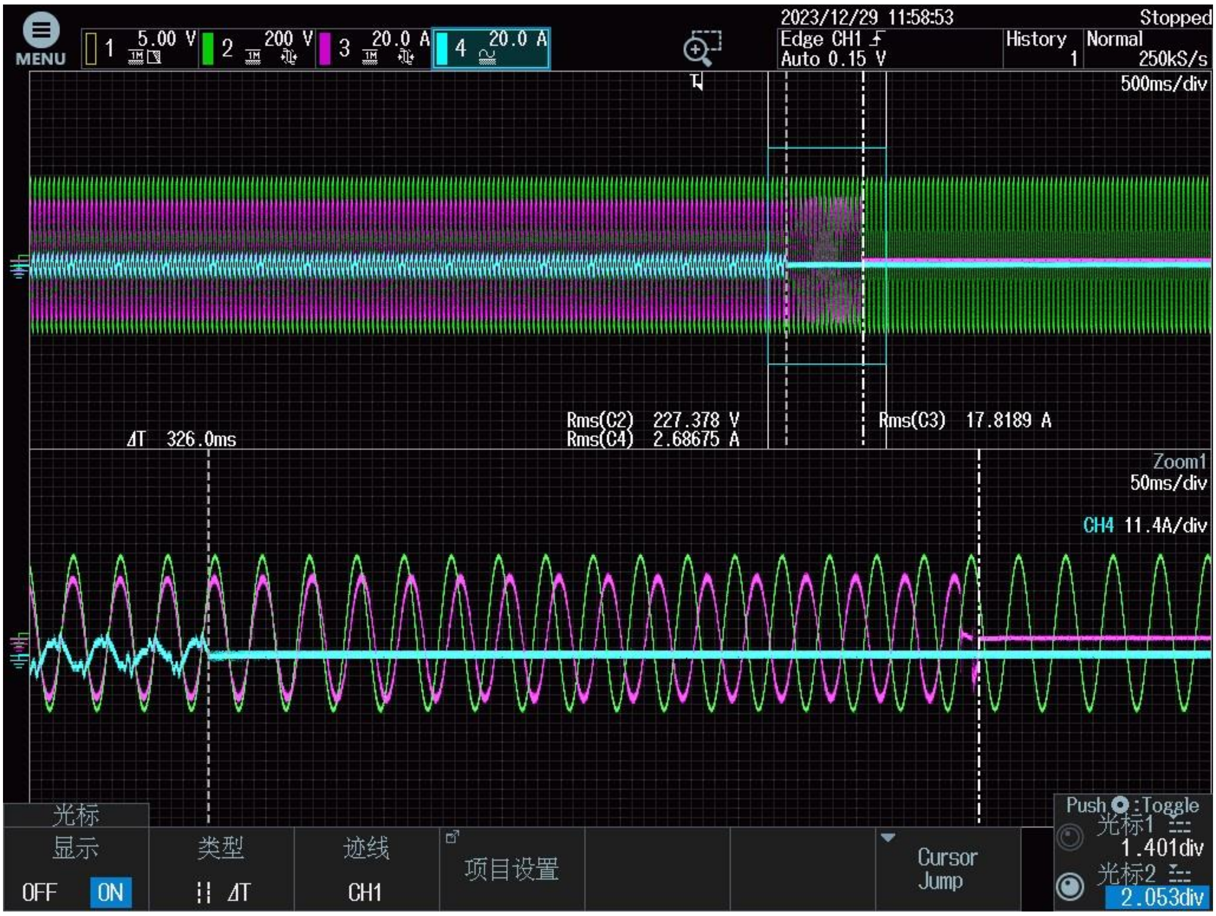
5) Maximum EUT output power condition should be achieved using the maximum allowable input power. Actual output power may exceed nominal rated output.

6) Based on EUT rated input operating range. For example, If range is between X volts and Y volts, 75% of range = X + 0,75 × (Y – X). Y shall not exceed 0,8 × EUT maximum system voltage (i.e., maximum allowable array open circuit voltage). In any case, the EUT should not be operated outside of its allowable input voltage range.

The tests had been performed on the INFINI WP 15KW TWIN are valid for the INFINI WP 12KW TWIN since it is almost same as in hardware and just power derated by software.

Disconnection at PAC 0% and QAC 0% reactive load and 100% nominal power

Disconnection at No. 1



Test conditions	Frequency: 50 +/- 0,1 Hz U_N = 230 +/- 3 Vac Distortion factor of chokes < 2% Quality = 1
Disconnection limit	0,5 s

No	P_{EUT} 1) (% of EUT rating)	Reactive load (% of Q_L in 6.1.d) 1)	P_{AC} 2) (% of nominal)	Q_{AC} 3) (% of nominal)	P_{EUT} [kW]	V_{DC} [V]	Q_f [1]	Run on Time [ms]	Remarks4)
12	66	66	0	-5	9,5	650	1,001	142,0	Test B at IB
13	66	66	0	-4	9,5	650	1,003	152,0	Test B at IB
14	66	66	0	-3	9,5	650	1,008	176,5	Test B at IB
15	66	66	0	-2	9,5	650	1,015	178,0	Test B at IB
16	66	66	0	-1	9,5	650	1,021	191,0	Test B at IB
2	66	66	0	0	9,5	650	1,026	222,5	Test B at BL
17	66	66	0	1	9,5	650	1,030	219,0	Test B at IB
18	66	66	0	2	9,5	650	1,033	185,0	Test B at IB
19	66	66	0	3	9,5	650	1,039	164,5	Test B at IB
20	66	66	0	4	9,5	650	1,042	167,0	Test B at IB
21	66	66	0	5	9,5	650	1,047	127,5	Test B at IB

Parameter at 0%	L=17,02 mH	R=5,34 Ω	C=596,00 µF

Note:

RLC is adjusted to min. +/- 1% of the inverter rated output power

1) P_{EUT}: EUT output power

2) P_{AC}: Real power flow at S1 in Figure 1. Positive means power from EUT to utility. Nominal is the 0% test condition value.

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

4) BL: Balance condition, IB: Imbalance condition.

Condition B:

EUT output power PEUT = 50% – 66% of maximum

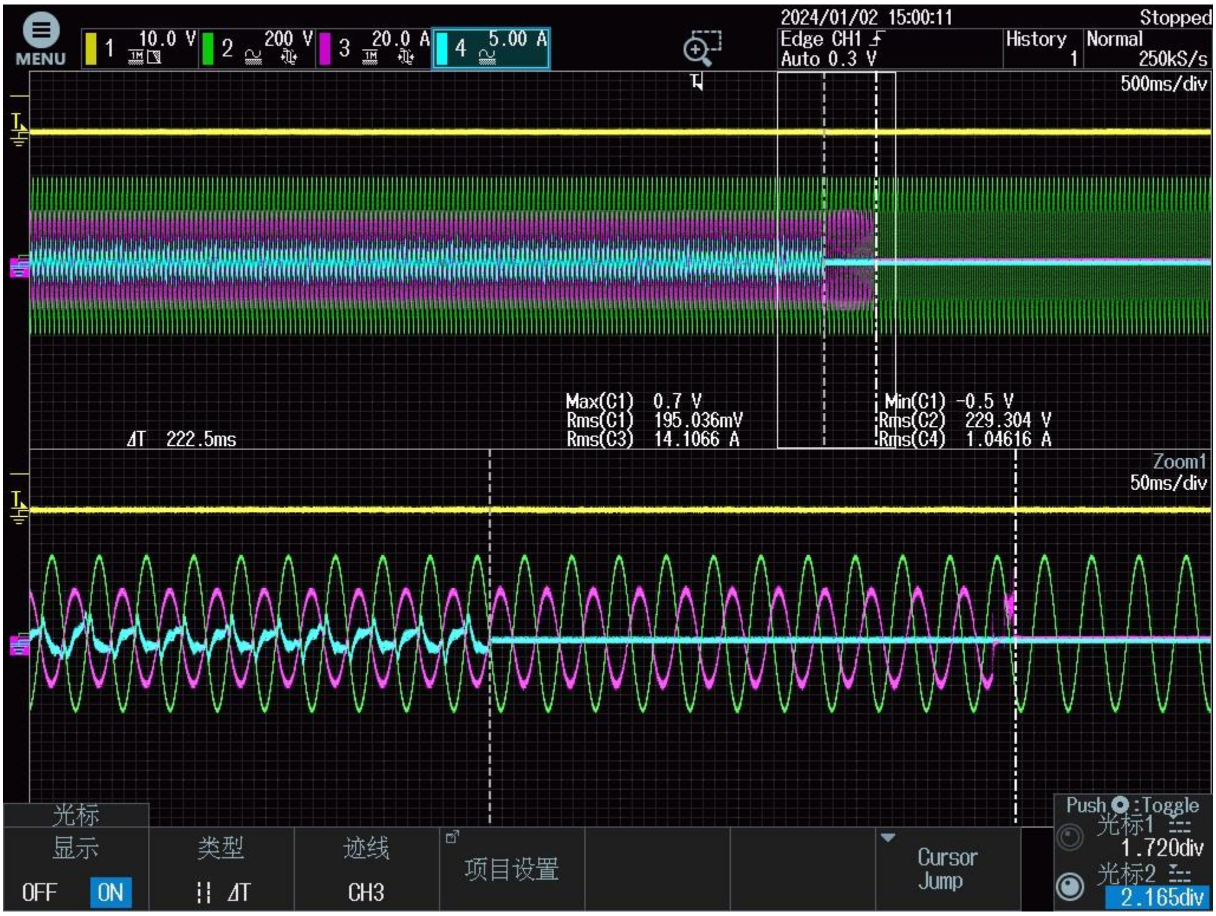
EUT input voltage 5) = 50% of rated input voltage range, ± 10%

5) Based on EUT rated input operating range. For example, If range is between X volts and Y volts, 50% of range = X + 0,5 × (Y – X). Y shall not exceed 0,8 × EUT maximum system voltage (i.e., maximum allowable array open circuit voltage). In any case, the EUT should not be operated outside of its allowable input voltage range.

The tests had been performed on the INFINI WP 15KW TWIN are valid for the INFINI WP 12KW TWIN since it is almost same as in hardware and just power derated by software.

Disconnection at P_{AC} 0% and Q_{AC} 0% reactive load and 66% nominal power

Disconnection at No. 2



A.7.1.2.4	**Protection - Loss of mains according to BS EN 62116** These tests should be carried out in accordance with BS EN 62116. Annex A.7.1.2.4. Load imbalance (real, reactive load) for test condition C (EUT output = 25% – 33%)	**P**

Test conditions	Frequency: 50 +/- 0,1 Hz U_N = 230 +/- 3 Vac Distortion factor of chokes < 2% Quality = 1
Disconnection limit	0,5 s

No	P_{EUT} 1) (% of EUT rating)	Reactive load (% of Q_L in 6.1.d) 1)	P_{AC} 2) (% of nominal)	Q_{AC} 3) (% of nominal)	P_{EUT} [kW]	V_{DC} [V]	Q_f [1]	Run on Time [ms]	Remarks4)
22	33	33	0	-5	4,5	400	0,980	145,5	Test C at IB
23	33	33	0	-4	4,5	400	0,983	157,0	Test C at IB
24	33	33	0	-3	4,5	400	0,985	195,5	Test C at IB
25	33	33	0	-2	4,5	400	0,990	182,0	Test C at IB
26	33	33	0	-1	4,5	400	0,995	247,0	Test C at IB
3	33	33	0	0	4,5	400	1,002	280,0	Test C at BL
27	33	33	0	1	4,5	400	1,006	258,0	Test C at IB
28	33	33	0	2	4,5	400	1,011	202,0	Test C at IB
29	33	33	0	3	4,5	400	1,016	177,5	Test C at IB
30	33	33	0	4	4,5	400	1,020	159,5	Test C at IB
31	33	33	0	5	4,5	400	1,024	135,5	Test C at IB

Parameter at 0%	L=35,03 mH	R=10,69 Ω	C=298,00 µF

Note:

RLC is adjusted to min. +/- 1% of the inverter rated output power

1) P_{EUT}: EUT output power

2) P_{AC}: Real power flow at S1 in Figure 1. Positive means power from EUT to utility. Nominal is the 0% test condition value.

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

4) BL: Balance condition, IB: Imbalance condition.

Condition C:

EUT output power PEUT = 25% – 33% 5) of maximum

EUT input voltage 6) = < 10% of rated input voltage range

5) Or minimum allowable EUT output level if greater than 33%.

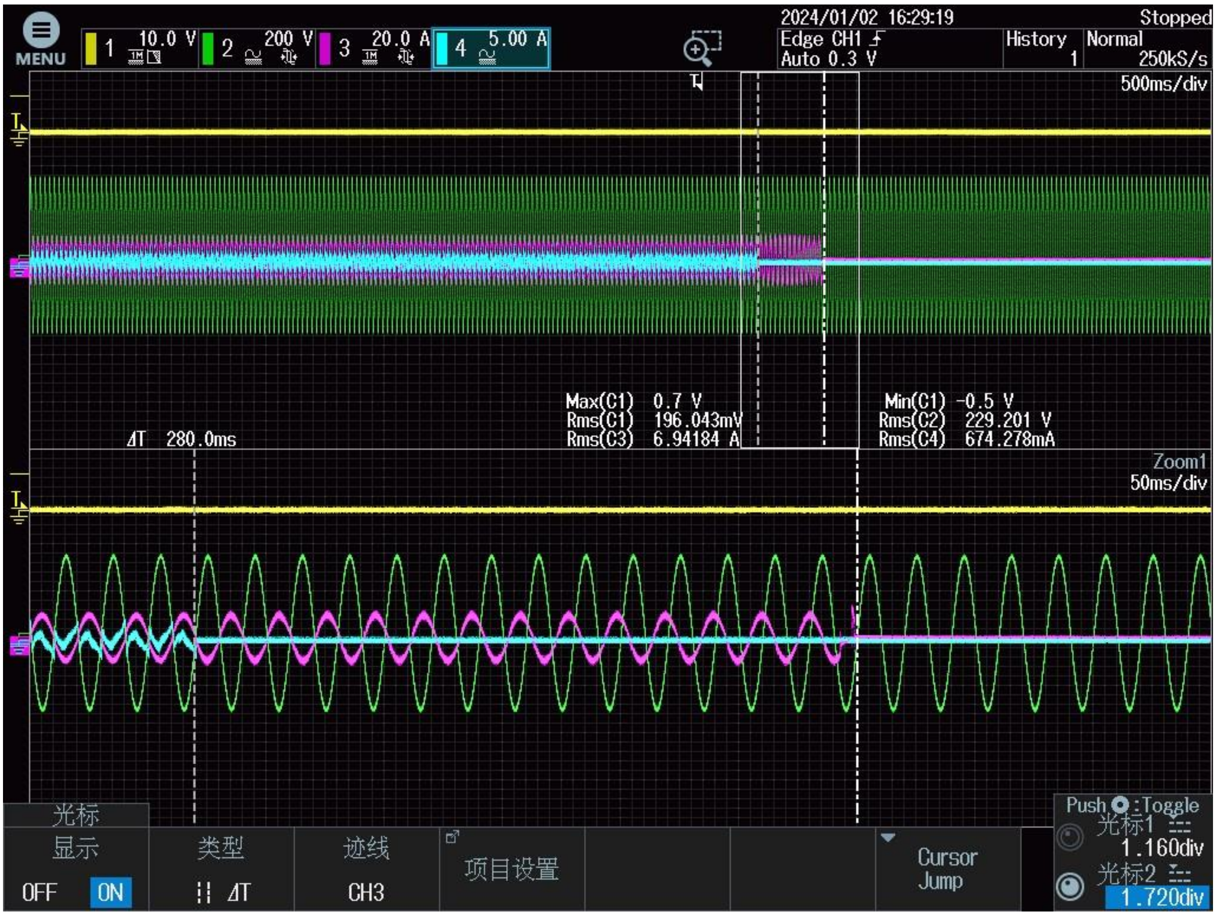
6) Based on EUT rated input operating range. For example, If range is between X volts and Y volts, 10% of range = X + 0,1 × (Y – X). Y shall not exceed 0,8 × EUT maximum system voltage (i.e., maximum allowable array open circuit voltage). In any case, the EUT should not be operated outside of its allowable input voltage range.

The tests had been performed on the INFINI WP 15KW TWIN are valid for the INFINI WP 12KW TWIN since it is almost same as in hardware and just power derated by software.

A.7.1.2.4	**Protection - Loss of mains according to BS EN 62116** These tests should be carried out in accordance with BS EN 62116. Annex A.7.1.2.4. Load imbalance (real, reactive load) for test condition C (EUT output = 25% – 33%)	P

Disconnection at P_{AC} 0% and Q_{AC} 0 reactive load and 33% nominal power

Disconnection at No. 3



A.7.1.2.5	Protection – Re-connection timer			P
Test should prove that the reconnection sequence starts after a minimum delay of 20 seconds for restoration of voltage and frequency to within the stage 1 settings of table 10.1.				
Under Voltage (182,0 V)				
Time delay setting [s]		Measured delay [s]		
20		26,11		
Over Voltage (266,2 V)				
Time delay setting [s]		Measured delay [s]		
20		26,11		
Under Frequency (47,4 Hz)				
Time delay setting [s]		Measured delay [s]		
20		23,61		
Over Frequency (52,1 Hz)				
Time delay setting [s]		Measured delay [s]		
20		23,49		
	Checks on no reconnection when voltage or frequency is brought to just outside stage 1 limits of table 1.			
	At 266,2 V	At 180,0 V	At 47,4 Hz	At 52,1 Hz
Confirmation that the Power Generating Module does not re-connect.	No reconnection	No reconnection	No reconnection	No reconnection
Note: The tests had been performed on the INFINI WP 15KW TWIN are valid for the INFINI WP 12KW TWIN since it is almost same as in hardware and just power derated by software.				

A.7.1.2.6	**Frequency Drift and Step change Stability test** This test should be carried out in accordance with Annex A.7.1.2.6.			**P**
	Start Frequency	Change	Test time	Confirm no trip
Positive Vector Shift	49,5 Hz	+50 degrees		No trip
Negative Vector Shift	50,5 Hz	-50 degrees		No trip
Positive Frequency drift	49,0 Hz – 51,0 Hz	+0,95 Hz/sec	2,1 s	No trip
Negative Frequency drift	51,0 Hz – 49,0 Hz	-0,95 Hz/sec	2,1 s	No trip

Note:

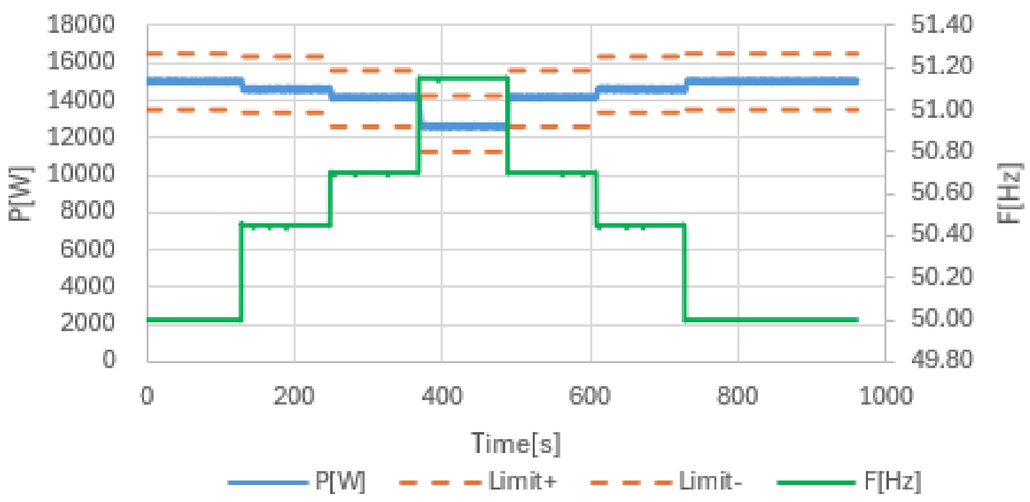
Four tests are required to be carried out with all protection functions enabled including loss of mains. For each stability test the Power Park Module should not tip during the test.

For the step change test the Power Park Module should be operated with a measurable output at the start frequency and then a vector shift should be applied by extending or reducing the time of a single cycle with subsequent cycles returning to the start frequency. The start frequency should then be maintained for a period of at least 10 s to complete the test. The Power Park Module should not trip during this test.

For frequency drift tests the Power Park Module should be operated with a measurable output at the start frequency and then the frequency changed in a ramp function at 0,95 Hzs^{-1} to the end frequency. On reaching the end frequency it should be maintained for a period of at least 10 s. The Power Park Module should not trip during this test.

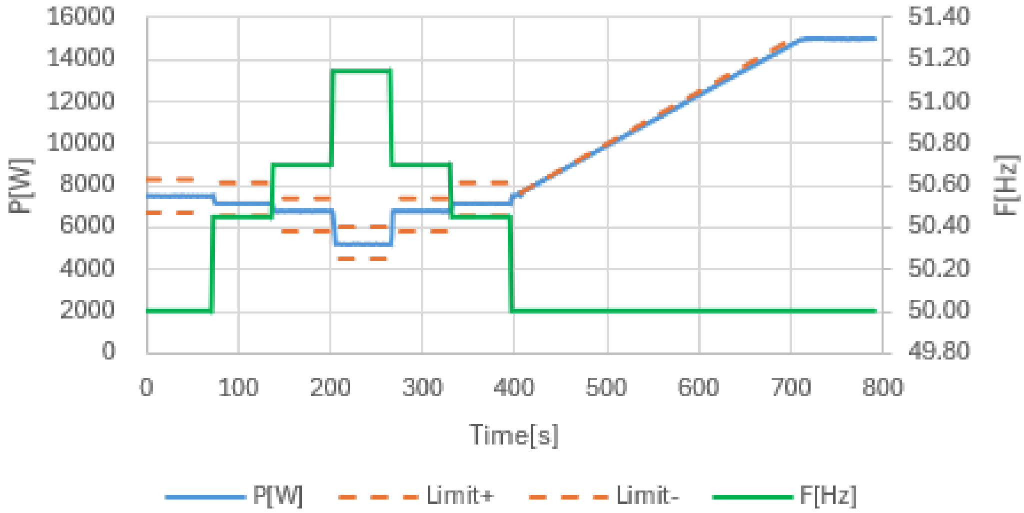
The tests had been performed on the INFINI WP 15KW TWIN are valid for the INFINI WP 12KW TWIN since it is almost same as in hardware and just power derated by software.

A.7.1.3	**Limited Frequency Sensitive Mode – Over frequency test** The test should be carried out using the specific threshold frequency of 50.4 Hz and Droop of 10%. This test should be carried out in accordance with Annex A.7.1.3.						**P**
1-min mean value [Hz]:	a) 50,00	b) 50,45	c) 50,70	d) 51,15	e) 50,70	f) 50,45	g) 50,00
1. Measurement a) to g): Active power output > 80% P_n							
Frequency [Hz]:	50,00	50,45	50,70	51,15	50,70	50,45	50,00
$P_{expected}$ [kW]:	15,00	14,85	14,10	12,75	14,10	14,85	15,00
$P_{measured}$ [kW]:	15,00	14,60	14,14	12,62	14,15	14,60	15,00
$\Delta P_{measured}/P_n$ [%]:	N/A	-1,67	0,27	-0,87	0,33	-1,67	N/A
2. Measurement a) to g): Active power output 40% and 60% P_n							
Frequency [Hz]:	50,00	50,45	50,70	51,15	50,70	50,45	50,00
$P_{expected}$ [kW]:	7,50	7,35	6,60	5,25	6,60	7,35	7,50
$P_{measured}$ [kW]:	7,50	7,16	6,78	5,21	6,78	7,16	14,98
$\Delta P_{measured}/P_n$ [%]:	N/A	-1,27	1,20	-0,27	1,20	-1,27	N/A
Graph of Measurement 1.: Active power output > 80% P_n							

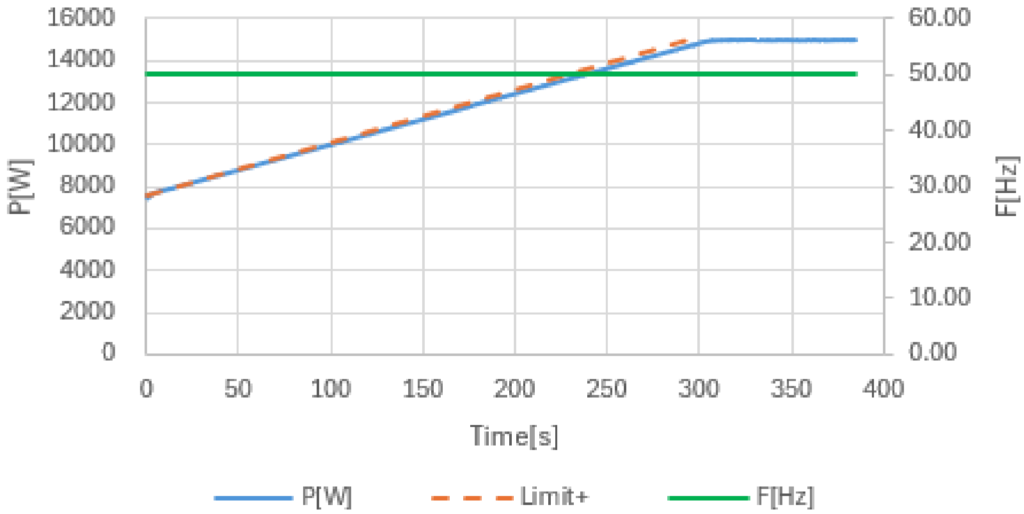


A.7.1.3	**Limited Frequency Sensitive Mode – Over frequency test** The test should be carried out using the specific threshold frequency of 50.4 Hz and Droop of 10%. This test should be carried out in accordance with Annex A.7.1.3.	**P**

Graph of Measurement 2.: Active power output 40% and 60% P_n



Graph of power gradient:



Note:

The tests had been performed on the INFINI WP 15KW TWIN are valid for the INFINI WP 12KW TWIN since it is almost same as in hardware and just power derated by software.

A.7.1.4.1	**Harmonic Current Emissions** The test requirements are specified in Annex A.7.1.4.1.	**P**

Generating Unit tested to BS EN 61000-3-12

INFINI WP 15KW TWIN

Generating Unit rating per phase (rpp)								
	At 45 - 55% of rated output 7,36 kW							
Harmonic	Measured Value (MV) in Amps			Measured Value (MV) in %			Limit in BS EN61000-3-12 in %	
	L1	L2	L3	L1	L2	L3		
							1 phase	3 phase
2nd	0,088	0,059	0,053	0,822	0,556	0,478	8%	8%
3rd	0,324	0,287	0,273	3,011	2,729	2,463	21,6%	N/A
4th	0,020	0,014	0,010	0,185	0,137	0,088	4%	4%
5th	0,177	0,303	0,165	1,649	2880	1,489	10,7%	10,7%
6th	0,011	0,013	0,015	0,098	0,123	0,135	2,67%	2,67%
7th	0,102	0,229	0,126	0,950	2,170	1,136	7,2%	7,2%
8th	0,019	0,014	0,015	0,179	0,131	0,131	2%	2%
9th	0,090	0,170	0,102	0,835	1,612	0,917	3,8%	N/A
10th	0,008	0,022	0,024	0,070	0,206	0,213	1,6%	1,6%
11th	0,071	0,047	0,071	0,660	0,447	0,638	3,1%	3,1%
12th	0,007	0,018	0,018	0,069	0,172	0,158	1,33%	1,33%
13th	0,069	0,048	0,061	0,643	0,455	0,548	2%	2%
14th	0,014	0,011	0,015	0,129	0,102	0,133	N/A	N/A
15th	0,058	0,133	0,067	0,537	1,259	0,600	N/A	N/A
16th	0,005	0,012	0,011	0,043	0,115	0,101	N/A	N/A
17th	0,068	0,130	0,066	0,629	1,238	0,593	N/A	N/A
18th	0,010	0,013	0,016	0,089	0,127	0,147	N/A	N/A
19th	0,087	0,094	0,069	0,806	0,888	0,623	N/A	N/A
20th	0,011	0,018	0,011	0,104	0,170	0,098	N/A	N/A
21th	0,076	0,049	0,060	0,708	0,463	0,545	N/A	N/A
22th	0,010	0,017	0,022	0,097	0,158	0,202	N/A	N/A
23th	0,058	0,022	0,048	0,537	0,212	0,431	N/A	N/A
24th	0,014	0,023	0,024	0,128	0,222	0,220	N/A	N/A
25th	0,048	0,048	0,045	0,447	0,452	0,406	N/A	N/A
26th	0,013	0,015	0,024	0,124	0,138	0,215	N/A	N/A
27th	0,033	0,052	0,036	0,309	0,497	0,320	N/A	N/A
28th	0,011	0,017	0,015	0,103	0,159	0,134	N/A	N/A

A.7.1.4.1	**Harmonic Current Emissions** The test requirements are specified in Annex A.7.1.4.1.							**P**
29th	0,043	0,035	0,033	0,396	0,330	0,297	N/A	N/A
30th	0,012	0,022	0,011	0,107	0,204	0,096	N/A	N/A
31th	0,015	0,039	0,018	0,140	0,375	0,166	N/A	N/A
32th	0,006	0,015	0,010	0,058	0,139	0,085	N/A	N/A
33th	0,023	0,043	0,023	0,213	0,412	0,206	N/A	N/A
34th	0,006	0,014	0,011	0,060	0,135	0,100	N/A	N/A
35th	0,015	0,021	0,024	0,143	0,201	0,212	N/A	N/A
36th	0,010	0,009	0,012	0,091	0,087	0,107	N/A	N/A
37th	0,011	0,023	0,017	0,100	0,219	0,155	N/A	N/A
38th	0,006	0,015	0,012	0,052	0,142	0,112	N/A	N/A
39th	0,009	0,029	0,024	0,080	0,273	0,217	N/A	N/A
40th	0,011	0,012	0,007	0,099	0,114	0,064	N/A	N/A
THD_{40}	--	--	--	4,159	4,468	3,701	23%	13%
PWHD	--	--	--	3,825	5,075	3,681	23%	22%

A.7.1.4.1	**Harmonic Current Emissions** The test requirements are specified in Annex A.7.1.4.1.	**P**

Generating Unit tested to BS EN 61000-3-12

INFINI WP 15KW TWIN

Generating Unit rating per phase (rpp)								
	100% of rated output 14,57 kW							
Harmonic	Measured Value (MV) in Amps			Measured Value (MV) in %			Limit in BS EN61000-3-12 in %	
	L1	L2	L3	L1	L2	L3	1 phase	3 phase
2nd	0,154	0,097	0,094	0,731	0,461	0,436	8%	8%
3rd	0,363	0,305	0,308	1,721	1,456	1,420	21,6%	N/A
4th	0,017	0,015	0,026	0,079	0,073	0,118	4%	4%
5th	0,127	0,264	0,116	0,603	1,260	0,535	10,7%	10,7%
6th	0,013	0,011	0,019	0,061	0,055	0,085	2,67%	2,67%
7th	0,104	0,226	0,130	0,493	1,079	0,598	7,2%	7,2%
8th	0,026	0,019	0,014	0,122	0,091	0,063	2%	2%
9th	0,099	0,218	0,123	0,470	1,041	0,567	3,8%	N/A
10th	0,012	0,022	0,025	0,056	0,104	0,115	1,6%	1,6%
11th	0,080	0,134	0,107	0,378	0,639	0,494	3,1%	3,1%
12th	0,010	0,022	0,019	0,046	0,105	0,089	1,33%	1,33%
13th	0,083	0,056	0,100	0,393	0,266	0,459	2%	2%
14th	0,013	0,022	0,026	0,060	0,103	0,121	N/A	N/A
15th	0,091	0,083	0,093	0,434	0,397	0,429	N/A	N/A
16th	0,010	0,009	0,027	0,048	0,044	0,125	N/A	N/A
17th	0,098	0,163	0,110	0,465	0,777	0,506	N/A	N/A
18th	0,017	0,018	0,021	0,081	0,086	0,098	N/A	N/A
19th	0,076	0,178	0,112	0,359	0,848	0,518	N/A	N/A
20th	0,017	0,028	0,016	0,078	0,133	0,073	N/A	N/A
21th	0,058	0,147	0,098	0,276	0,700	0,452	N/A	N/A
22th	0,018	0,033	0,020	0,086	0,155	0,092	N/A	N/A
23th	0,055	0,050	0,069	0,259	0,241	0,317	N/A	N/A
24th	0,009	0,031	0,013	0,043	0,146	0,061	N/A	N/A
25th	0,073	0,038	0,065	0,345	0,181	0,301	N/A	N/A
26th	0,020	0,030	0,015	0,095	0,141	0,069	N/A	N/A
27th	0,054	0,103	0,093	0,256	0,490	0,428	N/A	N/A
28th	0,018	0,021	0,028	0,086	0,102	0,129	N/A	N/A

A.7.1.4.1	**Harmonic Current Emissions** The test requirements are specified in Annex A.7.1.4.1.							**P**
29th	0,056	0,096	0,073	0,266	0,458	0,335	N/A	N/A
30th	0,026	0,014	0,009	0,122	0,067	0,043	N/A	N/A
31th	0,056	0,078	0,058	0,267	0,374	0,266	N/A	N/A
32th	0,025	0,013	0,019	0,119	0,062	0,086	N/A	N/A
33th	0,033	0,084	0,050	0,155	0,402	0,228	N/A	N/A
34th	0,013	0,012	0,013	0,060	0,055	0,059	N/A	N/A
35th	0,035	0,059	0,048	0,166	0,281	0,223	N/A	N/A
36th	0,015	0,016	0,018	0,071	0,074	0,084	N/A	N/A
37th	0,023	0,026	0,028	0,111	0,124	0,128	N/A	N/A
38th	0,009	0,015	0,015	0,041	0,073	0,068	N/A	N/A
39th	0,020	0,018	0,035	0,094	0,086	0,160	N/A	N/A
40th	0,010	0,011	0,014	0,046	0,054	0,066	N/A	N/A
THD_{40}	--	--	--	2,392	3,011	2,240	23%	13%
PWHD	--	--	--	4,948	7,958	6,252	23%	22%

A.7.1.4.1	**Harmonic Current Emissions** The test requirements are specified in Annex A.7.1.4.1.	**P**

Generating Unit tested to BS EN 61000-3-12

INFINI WP 12KW TWIN

Generating Unit rating per phase (rpp)								
	At 45 - 55% of rated output 6,06 kW							
Harmonic	Measured Value (MV) in Amps			Measured Value (MV) in %			Limit in BS EN61000-3-12 in %	
	L1	L2	L3	L1	L2	L3		
							1 phase	3 phase
2nd	0,062	0,055	0,026	0,354	0,314	0,151	8%	8%
3rd	0,314	0,306	0,238	1,807	1,759	1,368	21,6%	N/A
4th	0,016	0,018	0,019	0,093	0,106	0,109	4%	4%
5th	0,239	0,234	0,369	1,375	1,345	2,123	10,7%	10,7%
6th	0,012	0,013	0,011	0,070	0,073	0,066	2,67%	2,67%
7th	0,177	0,178	0,296	1,018	1,024	1,700	7,2%	7,2%
8th	0,013	0,013	0,011	0,077	0,072	0,061	2%	2%
9th	0,138	0,145	0,209	0,793	0,833	1,203	3,8%	N/A
10th	0,013	0,014	0,012	0,075	0,080	0,066	1,6%	1,6%
11th	0,102	0,102	0,054	0,585	0,586	0,312	3,1%	3,1%
12th	0,012	0,014	0,011	0,069	0,079	0,066	1,33%	1,33%
13th	0,083	0,082	0,048	0,475	0,470	0,276	2%	2%
14th	0,013	0,016	0,012	0,073	0,092	0,071	N/A	N/A
15th	0,075	0,086	0,120	0,429	0,497	0,692	N/A	N/A
16th	0,012	0,014	0,012	0,070	0,083	0,071	N/A	N/A
17th	0,066	0,072	0,123	0,382	0,417	0,705	N/A	N/A
18th	0,014	0,015	0,013	0,079	0,084	0,075	N/A	N/A
19th	0,061	0,060	0,088	0,353	0,347	0,503	N/A	N/A
20th	0,016	0,018	0,013	0,092	0,102	0,078	N/A	N/A
21th	0,040	0,054	0,051	0,230	0,312	0,294	N/A	N/A
22th	0,015	0,015	0,014	0,088	0,088	0,078	N/A	N/A
23th	0,040	0,050	0,030	0,229	0,289	0,170	N/A	N/A
24th	0,014	0,014	0,014	0,082	0,080	0,079	N/A	N/A
25th	0,053	0,063	0,035	0,304	0,363	0,204	N/A	N/A
26th	0,016	0,013	0,013	0,090	0,073	0,075	N/A	N/A
27th	0,027	0,043	0,036	0,153	0,248	0,205	N/A	N/A
28th	0,013	0,011	0,011	0,073	0,063	0,066	N/A	N/A

A.7.1.4.1	**Harmonic Current Emissions** The test requirements are specified in Annex A.7.1.4.1.							**P**
29th	0,031	0,032	0,046	0,180	0,186	0,265	N/A	N/A
30th	0,011	0,010	0,011	0,063	0,057	0,061	N/A	N/A
31th	0,022	0,036	0,040	0,124	0,208	0,231	N/A	N/A
32th	0,010	0,009	0,009	0,057	0,050	0,050	N/A	N/A
33th	0,014	0,032	0,041	0,080	0,185	0,237	N/A	N/A
34th	0,009	0,008	0,008	0,050	0,044	0,047	N/A	N/A
35th	0,012	0,028	0,031	0,071	0,161	0,181	N/A	N/A
36th	0,008	0,007	0,008	0,045	0,040	0,044	N/A	N/A
37th	0,014	0,024	0,020	0,078	0,141	0,114	N/A	N/A
38th	0,007	0,007	0,008	0,042	0,041	0,043	N/A	N/A
39th	0,014	0,017	0,017	0,083	0,099	0,095	N/A	N/A
40th	0,007	0,007	0,007	0,041	0,037	0,039	N/A	N/A
THD_{40}	--	--	--	2,892	2,915	3,558	23%	13%
PWHD	--	--	--	0,713	0,864	1,015	23%	22%

A.7.1.4.1	**Harmonic Current Emissions** The test requirements are specified in Annex A.7.1.4.1.	**P**

Generating Unit tested to BS EN 61000-3-12

INFINI WP 12KW TWIN

Generating Unit rating per phase (rpp)								
	100% of rated output 12,01 kW							
Harmonic	Measured Value (MV) in Amps			Measured Value (MV) in %			Limit in BS EN61000-3-12 in %	
	L1	L2	L3	L1	L2	L3		
							1 phase	3 phase
2nd	0,100	0,087	0,042	0,577	0,500	0,240	8%	8%
3rd	0,304	0,300	0,225	1,750	1,725	1,292	21,6%	N/A
4th	0,023	0,026	0,026	0,130	0,150	0,151	4%	4%
5th	0,203	0,209	0,291	1,167	1,202	1,675	10,7%	10,7%
6th	0,014	0,017	0,014	0,082	0,096	0,080	2,67%	2,67%
7th	0,186	0,194	0,290	1,067	1,114	1,666	7,2%	7,2%
8th	0,016	0,017	0,014	0,092	0,097	0,080	2%	2%
9th	0,164	0,171	0,274	0,943	0,984	1,575	3,8%	N/A
10th	0,015	0,016	0,012	0,084	0,093	0,071	1,6%	1,6%
11th	0,141	0,145	0,156	0,812	0,833	0,896	3,1%	3,1%
12th	0,013	0,016	0,012	0,072	0,092	0,071	1,33%	1,33%
13th	0,132	0,141	0,085	0,760	0,811	0,487	2%	2%
14th	0,014	0,021	0,016	0,082	0,121	0,094	N/A	N/A
15th	0,143	0,165	0,115	0,825	0,951	0,663	N/A	N/A
16th	0,013	0,017	0,017	0,076	0,100	0,095	N/A	N/A
17th	0,153	0,160	0,190	0,877	0,923	1,092	N/A	N/A
18th	0,015	0,018	0,016	0,083	0,101	0,089	N/A	N/A
19th	0,147	0,149	0,201	0,847	0,855	1,157	N/A	N/A
20th	0,018	0,020	0,017	0,103	0,113	0,098	N/A	N/A
21th	0,107	0,144	0,170	0,614	0,826	0,976	N/A	N/A
22th	0,017	0,020	0,018	0,095	0,116	0,102	N/A	N/A
23th	0,094	0,107	0,106	0,542	0,613	0,608	N/A	N/A
24th	0,016	0,019	0,017	0,091	0,111	0,097	N/A	N/A
25th	0,092	0,100	0,063	0,530	0,572	0,363	N/A	N/A
26th	0,017	0,018	0,022	0,099	0,105	0,124	N/A	N/A
27th	0,046	0,079	0,064	0,267	0,452	0,367	N/A	N/A
28th	0,015	0,017	0,019	0,089	0,096	0,107	N/A	N/A

A.7.1.4.1	**Harmonic Current Emissions** The test requirements are specified in Annex A.7.1.4.1.							**P**
29th	0,064	0,050	0,071	0,366	0,289	0,410	N/A	N/A
30th	0,013	0,013	0,014	0,074	0,072	0,081	N/A	N/A
31th	0,039	0,055	0,058	0,222	0,316	0,336	N/A	N/A
32th	0,010	0,010	0,012	0,060	0,058	0,068	N/A	N/A
33th	0,026	0,040	0,059	0,149	0,230	0,337	N/A	N/A
34th	0,009	0,009	0,011	0,052	0,053	0,061	N/A	N/A
35th	0,024	0,035	0,054	0,139	0,203	0,308	N/A	N/A
36th	0,009	0,008	0,009	0,052	0,045	0,053	N/A	N/A
37th	0,021	0,029	0,027	0,121	0,167	0,154	N/A	N/A
38th	0,009	0,008	0,010	0,053	0,046	0,056	N/A	N/A
39th	0,018	0,019	0,010	0,106	0,110	0,057	N/A	N/A
40th	0,009	0,007	0,009	0,053	0,041	0,053	N/A	N/A
THD_{40}	--	--	--	3,404	3,587	4,007	23%	13%
PWHD	--	--	--	1,459	1,663	1,798	23%	22%

A.7.1.4.2	**Power factor** The test requirements are specified in Annex A.7.1.4.2.			**P**
Output power	216,2 V	230,0 V	253,0 V	
20%	0,987	0,951	0,979	Measured at three voltage levels and at full output. Voltage to be maintained within ± 1.5% of the stated level during the test.
50%	0,992	0,991	0,997	
75%	0,996	0,996	0,998	
100%	0,997	0,997	0,999	
Limit	> 0,95	> 0,95	> 0,95	

Note:

The test set up shall be such that the Power Park Module supplies full load to the DNO’s Distribution System via the power factor (pf) meter and the variac as shown below in figure A.7.3. The Power Park Module pf should be within the limits given in paragraph 11.1.5, for three test voltages 230 V – 6%, 230V and 230 V + 10%.

The tests had been performed on the INFINI WP 15KW TWIN are valid for the INFINI WP 12KW TWIN since it is almost same as in hardware and just power derated by software.

A.7.1.4.3	**Voltage Flicker** The test requirements are specified in Annex A.7.1.4.3.	**P**

	Starting			**Stopping**			**Running**	
	d_{max}	d_c	$d_{(t)}$	d_{max}	d_c	$d_{(t)}$	P_{st}	P_{lt}
Measured values at test impedance	0,15	0,01	0,00	0,14	0,01	0,00	0,09	0,09
Measured values at standard impedance	0,15	0,01	0,00	0,14	0,01	0,00	0,09	0,09
Values at maximum impedance	0,15	0,01	0,00	0,14	0,01	0,00	0,09	0,09
Limits set under BS EN 61000-3-11	4%	3,3%	3,3% 500ms	4%	3,3%	3,3% 500ms	1,0	0,65

Test impedance	R	0,24	Ω	X_l	0,15	Ω
	Z	0,28	Ω			
Standard impedance	R	0,24	Ω	X_l	0,15	Ω
	Z	0,28	Ω			
Maximum impedance	R	0,24	Ω	X_l	0,15*	Ω
	Z_{max}	0,28	Ω			

Note:

For voltage change and flicker measurements the following formula is to be used to convert the measured values to the normalised values where the power factor of the generation output is 0,98 or above.

Normalised value = Measured value*reference source resistance/measured source resistance at test point.

Single phase unit reference source resistance is 0,4 Ω

Two phase units in a three phase system reference source resistance 0,4 Ω

Two phase units in a split phase system reference source resistance is 0,24 Ω

Three phase units reference source resistance is 0,24 Ω

Where the power factor of the output is under 0,98 then the X_l 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 tests had been performed on the INFINI WP 15KW TWIN are valid for the INFINI WP 12KW TWIN since it is almost same as in hardware and just power derated by software.

A.7.1.4.4	**DC Injection** The test requirements are specified in Annex A.7.1.4.4.		**P**
INFINI WP 15KW TWIN			
Phase 1			
Test level power [%]	10	55	100
Recorded value [mA]	21,2	18,9	16,1
As % of rated AC current [%]	0,10	0,09	0,07
Limit [%]	0,25	0,25	0,25
Phase 2			
Test level power [%]	10	55	100
Recorded value [mA]	29,1	22,1	29,8
As % of rated AC current [%]	0,13	0,10	0,14
Limit [%]	0,25	0,25	0,25
Phase 3			
Test level power [%]	10	55	100
Recorded value [mA]	34,3	52,4	25,4
As % of rated AC current [%]	0,16	0,24	0,12
Limit [%]	0,25	0,25	0,25
Note: Informative measurement of DC-injection of each phase of the inverter and a limit of 0,25% per phase of the rated current per phase as pass criteria.			
Sum of all Phases Tests are carried out at three defined power levels ±5%. At 230 V a 15,0 kW three phase Inverter has a current output of 65,22 A so DC limit is 163,04 mA. These tests is undertaken in accordance with Annex A.7.1.4.4. The % DC injection ("as % of rated AC current" below) is calculated as follows: % DC injection = Recorded DC value in Amps / Base current where the base current is the Registered Capacity (W) / V phase. The % DC injection should not be greater than 0,25%.			
Test level power [%]	10	55	100
Recorded value Sum [mA]	84,6	93,4	71,3
As % of rated AC current [%]	0,13	0,14	0,11
Limit [%]	0,25	0,25	0,25

A.7.1.4.4	DC Injection The test requirements are specified in Annex A.7.1.4.4.		P
INFINI WP 12KW TWIN			
Phase 1			
Test level power [%]	10	55	100
Recorded value [mA]	32,5	22,9	15,3
As % of rated AC current [%]	0,19	0,13	0,09
Limit [%]	0,25	0,25	0,25
Phase 2			
Test level power [%]	10	55	100
Recorded value [mA]	39,1	40,9	13,5
As % of rated AC current [%]	0,22	0,24	0,08
Limit [%]	0,25	0,25	0,25
Phase 3			
Test level power [%]	10	55	100
Recorded value [mA]	39,4	39,6	15,4
As % of rated AC current [%]	0,23	0,23	0,09
Limit [%]	0,25	0,25	0,25
Note: Informative measurement of DC-injection of each phase of the inverter and a limit of 0,25% per phase of the rated current per phase as pass criteria.			
Sum of all Phases Tests are carried out at three defined power levels ±5%. At 230 V a 12,0 kW three phase Inverter has a current output of 52,17 A so DC limit is130,43 mA. These tests is undertaken in accordance with Annex A.7.1.4.4. The % DC injection (“as % of rated AC current” below) is calculated as follows: % DC injection = Recorded DC value in Amps / Base current where the base current is the Registered Capacity (W) / V phase. The % DC injection should not be greater than 0,25%.			
Test level power [%]	10	55	100
Recorded value Sum [mA]	111,0	103,4	44,2
As % of rated AC current [%]	0,21	0,20	0,08
Limit [%]	0,25	0,25	0,25

A.7.1.5	**Short Circuit Current Contribution for Inverters** The test requirements are specified in Annex A.7.1.5.					**P**
For a directly coupled SSEG				For a Inverter SSEG		
Phase 1						
Parameter		Symbol	Value	Time after fault	Volts	Amps
Peak Short Circuit current		i_p	N/A	20ms	228,15 V	17,28 A
Initial Value of aperiodic current		A	N/A	100ms	6,44 V	0,23 A
Initial symmetrical short-circuit current*		I_k	N/A	250ms	5,27 V	0,26 A
Decaying (aperiodic) component of short circuit current*		i_{DC}	N/A	500ms	5,22 v	0,12 A
Reactance/Resistance Ratio of source*		$^X/_R$	N/A	Time to trip	0,085s	In seconds
Phase 2						
Parameter		Symbol	Value	Time after fault	Volts	Amps
Peak Short Circuit current		i_p	N/A	20ms	227,27 V	16,16 A
Initial Value of aperiodic current		A	N/A	100ms	6,44 V	0,26 A
Initial symmetrical short-circuit current*		I_k	N/A	250ms	6,15 V	0,23 A
Decaying (aperiodic) component of short circuit current*		i_{DC}	N/A	500ms	5,10 V	0,22 A
Reactance/Resistance Ratio of source*		$^X/_R$	N/A	Time to trip	0,091	In seconds
Phase 3						
Parameter		Symbol	Value	Time after fault	Volts	Amps
Peak Short Circuit current		i_p	N/A	20ms	229,25 V	14,89 A
Initial Value of aperiodic current		A	N/A	100ms	6,35 V	0,26 A
Initial symmetrical short-circuit current*		I_k	N/A	250ms	5,25 V	0,24 A
Decaying (aperiodic) component of short circuit current*		i_{DC}	N/A	500ms	5,15 V	0,23 A
Reactance/Resistance Ratio of source*		$^X/_R$	N/A	Time to trip	0,092s	In seconds

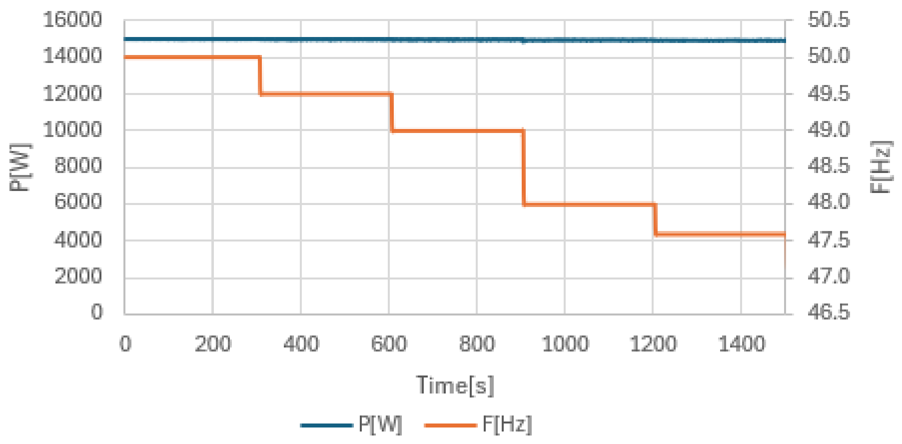
Note:

The values of voltage and current should be recorded for a period of up to 1 second when the changeover switch should be returned to the normal position. The voltage and current at relevant times shall be recorded in the type test report (Appendix A2-3) including the time taken for the Power Park Modul to trip. (It is expected that the Power Park Module will trip on either loss of mains or under voltage in less than 1 s).

A.7.1.6	**Self Monitoring – Solid state Disconnection**. The test requirements are specified in Annex A.7.1.6.	**N/A**
It has been verified that in the event of the solid state switching device failing to disconnect the Power Park Module, the voltage on the output side of the switching device is reduced to a value below 50 volts within 0,5 seconds.		N/A
Note: Unit do not provide solid state switching relays. In case the semiconductor bridge is switched off, then the voltage on the output drops to 0. In this case the relays on the output will also open (4.1 Functional safety of the internal automatic disconnection device according to VDE 0126-1-1 / VDE 0124-100). The tests had been performed on the INFINI WP 15KW TWIN are valid for the INFINI WP 12KW TWIN since it is almost same as in hardware and just power derated by software.		

A.7.2.3	Output Power with falling Frequency	N/A

Graph of frequency a) to b) to c) to d) to e) to f):



5-min mean value (each)	a)	b)	c)	d)	e)	f)
Frequency [Hz]:	50,00	49,50	49,00	48,00	47,60	47,10
Active power [kW]:	15,00	14,99	14,98	14,97	14,97	14,96
ΔP/Pmax [%]:		-0,07	-0,13	-0,20	-0,20	-0,27

Note:

For a CHP the test point a) at 50,00 Hz is taken as Registered capacity (P_{max}) due to limited discrete operating points of the CHP's thermal process.

Electronic inverter, no power reduction take place.

The tests had been performed on the INFINI WP 15KW TWIN are valid for the INFINI WP 12KW TWIN since it is almost same as in hardware and just power derated by software.

	Wiring functional tests: If required by paragraph 15.2.1.	N/A
Confirm that the relevant test schedule is attached (tests to be undertaken at time of commissioning).		N/A
Note: The inverter was tested in a test laboratory. The correct wiring functional test in the filed has to be done by the responsible person for the installation of the plant.		

Cyber security, required by paragraph 9.1.7	P
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 9.1.7.	Yes
Note: Different levels of access, all are password protected, only certain parameters can be changed on maintenance level.	

Manufacturer's declaration

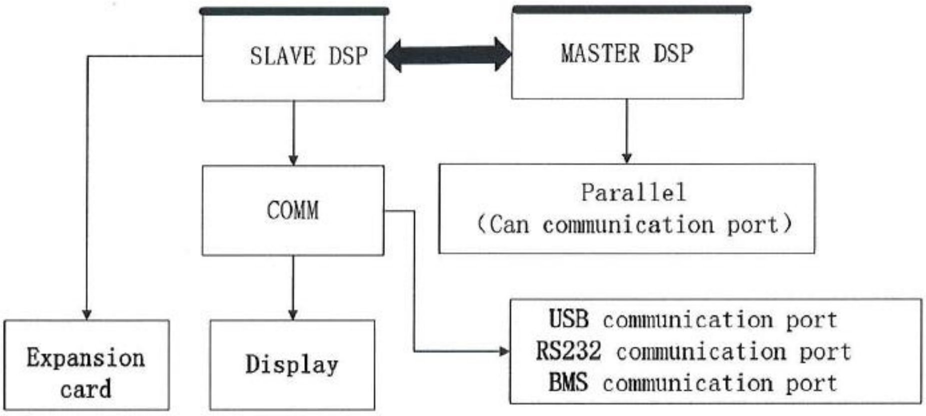
Our company,

Company name: VOLTRONIC POWER TECHNOLOGY (SHENZHEN) CORP.; Address: 1-5F, Building 5 & 1F Building7 & 1F Building9,RunDongSheng Industrial Park, No.467, Section Xixiang, National Highway 107,LongZhu Community, Xixiang, Bao An District, Shenzhen, China

We hereby confirm that all Solplanet inverters listed below comply with the standard Engineering Recommendation G98, Issue 1 Amendment 7,3 October 2022(section 9.7.1 and 9.7.2) and Engineering

Recommendation G99, Issue 1- Amendment 9,3 October 2022(section 9.1.7 and 9.1.8) about the " cybersecurity " requirements .

- Model no.: INFINI WP 15KW TWIN, INFINI WP 12KW TWIN;



There are two DSP chips on the control board of this product. The Master DSP model is TMS320F28335, and the Slave DSP model is TMS320F2809. The Master DSP and Slave DSP communicate through CAN communication.

In addition, the inverter also has an independent communication board, using the MCU model STM32F107. This chip communicates with the slave DSP. This communication board is responsible for the display part, external USB communication, RS485 communication, and BMS communication functions.

Declared by: 張吉海

Company name: Voltronic Power Technology

Responsible person: 周 邦

signature (and/or Stamp):

Jihai_Zha2024-07-15

	Logic Interface (input port) Required by paragraph 11.1.3.1	P
Confirm that an input port is provided and can be used to reduce the Active Power output to zero		Yes
Note: Manufacturer information provided.		
Provide high level description of logic interface, e.g. details in 11.1.3.1 such as AC or DC signal		Yes

INFINI WP 12K TWIN ,INFINI WP 15K TWIN have 3control chips including master DSP (TMS320F28335)，Slave DSP(TMS320F2809) and MCU（STM32F107）。

Firstly, the main DSP and the slave DSP are connected through CAN communication. PIN62 and PIN63 of the main DSP (TMS320F28335) are connected to PIN6 and PIN7 of the slave DSP (TMS320F2809) through communication circuit. Please refer to Figure 1 for details

Then, the communication method between Slave DSP (TMS320F2809)and MCU（STM32F107）chip is RS232. PIN4 and PIN6 of the Slave DSP (TMS320F2809)
are connected to PIN80 and PIN83 of the MCU（STM32F107）through communication circuit. Please refer to Figure 2 for details

Finally, the RS232/RS485/CAN communication of the inverter is completed through MCU. Please refer to Figure 3 for details

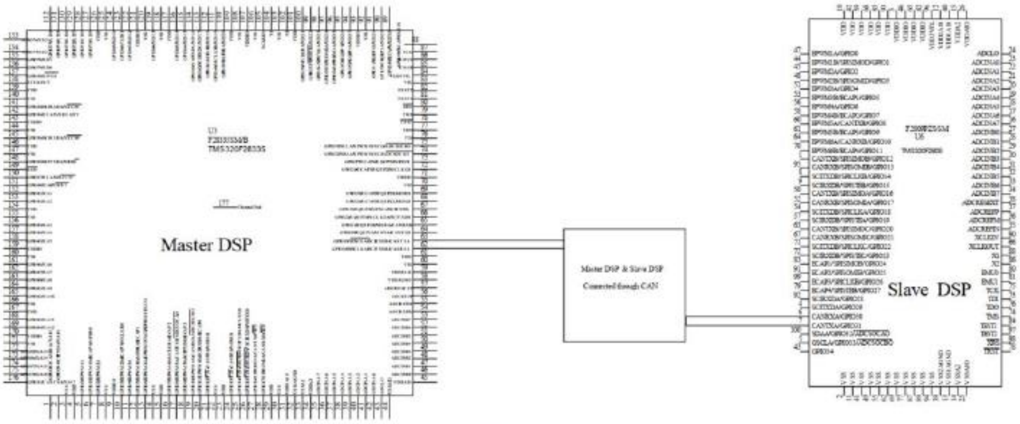


Figure 1

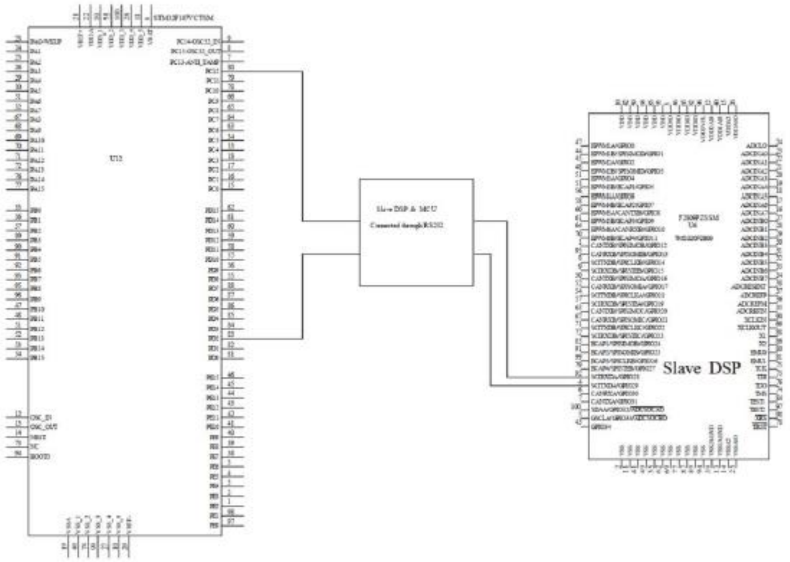


Figure2

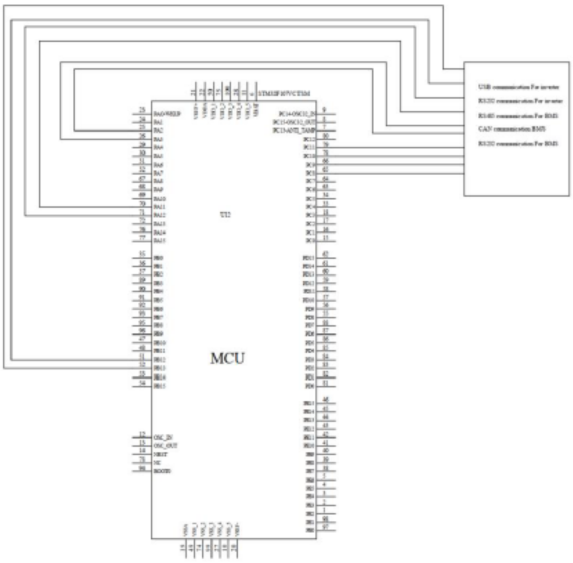


Figure3

The operating logic of the inverter is as follows:

a. Inverter turn on logic

When the user turns on the inverter through HMI operation, the HMI will send the power on command to the MCU (U12 in Figure) through RS232 communication. The MCU sends the turn on command to the SLAve DSP, which communicates with the Master DSP through CAN communication. When the Master DSP receives a power on command, it will turn on logically.

b. Error protection logic

The fault mechanism consists of six parts, namely fault handling, fault display, fault recording, fault bypass, fault sleep, and fault recovery.

fault handle: Stop inverter work, stop battery work and stop Solar PV work.

fault display: The fault code is displayed through the HMI and alarm with buzzer.

fault record: Record data such as battery voltage, grid voltage, photovoltaic voltage, etc. when a fault occurs

fault bypass: If the power grid exists, most fault codes can support the continuation of load through the grid bypass in fault mode, and the power supply of the load will not be disconnected.

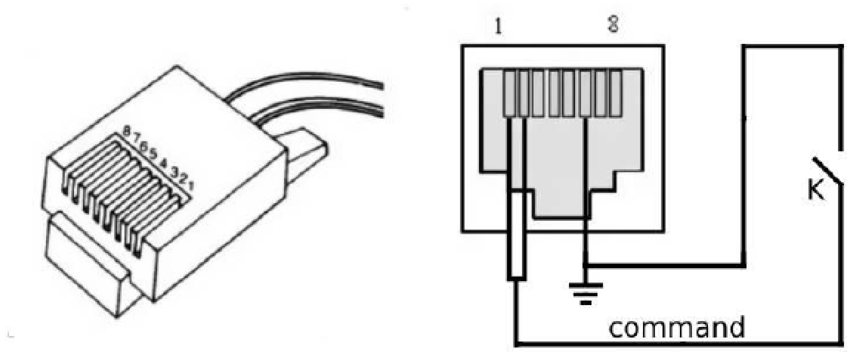
fault sleep: If the inverter only has a battery source, it may enter low-power sleep mode after a period of time in fault mode.

C. RS232/RS485/BMS communication Logic

RS232 adopts ASCII plaintext communication protocol, using the protocol Voltronicpower and can be queried through the ^ P command and set through the ^ S command.The user communicates with the inverter by connecting a USB to RS232 cable via a PC computer.RS232 communication data is received by the MCU and then routed to the DSP through internal cables.

RS485 requires the use of an RS485 expansion card and is a standard Modbus protocol. The communication data is sent to the RS485 expansion card, which converts the Modbus protocol to the Voltronicpower Infini Solar protocol and sends it to the MCU. The MCU then routes the data to the DSP through internal cables.

BMS supports RS485 bus and CAN bus, depending on different lithium battery communication protocols.BMS data is received and processed by MCU, and then routed to DSP through internal cables.



High-level-description-of-logic interface

The inverter equipped with a logic interface for ceasing active power output with in 5s following an instructioreing received. Remote control of AC output opening and closing through it.Pin1 and Pin2 are command control output pins that can be used to control the close and open of AC output relay K.Pin6 as the ground circuit of the system.

About its truth table definition

command	Function	K Relay State	Active power	Power drop rate	COS(Φ)
^S005LON0	Turn off	Open	0%	< 5 seconds	1
^S005LON1	Turn on	Close	100%	/	1

Annex No. 1
EMC Test Report

EMC TEST REPORT

Applicant	:	VOLTRONIC POWER TECHNOLOGY (SHENZHEN) CORP.
Address	:	1-5F, Building 5 & 1F Building7 & 1F Building9,RunDongSheng Industrial Park, No.467, Section Xixiang, National Highway 107, Longteng Community, Xixiang, Bao An District, Shenzhen, China
Manufacturer	:	VOLTRONIC POWER TECHNOLOGY (SHENZHEN) CORP.
Address	:	1-5F, Building 5 & 1F Building7 & 1F Building9,RunDongSheng Industrial Park, No.467, Section Xixiang, National Highway 107, Longteng Community, Xixiang, Bao An District, Shenzhen, China
Factory	:	VOLTRONIC POWER TECHNOLOGY (SHENZHEN) CORP.
Address	:	1-5F, Building 5 & 1F Building7 & 1F Building9,RunDongSheng Industrial Park, No.467, Section Xixiang, National Highway 107, Longteng Community, Xixiang, Bao An District, Shenzhen, China
E.U.T.	:	MPPT SOLAR INVERTER
Brand Name	:	N/A
Model No.	:	INFINI WP 15KW TWIN, INFINI WP 12KW TWIN, INFINI WP 10KW TWIN, INFINI WP 8KW TWIN
Standard	:	EN IEC 61000-6-2: 2019 EN IEC 61000-6-4: 2019 EN IEC 61000-3-11: 2019 EN 61000-3-12: 2011 IEC 61000-2-2: 2002/A1:2017
Date of Receiving Samples	:	Refer to page 4 of the report
Date of Test	:	Refer to page 4 of the report
Date of Report	:	January 25, 2024

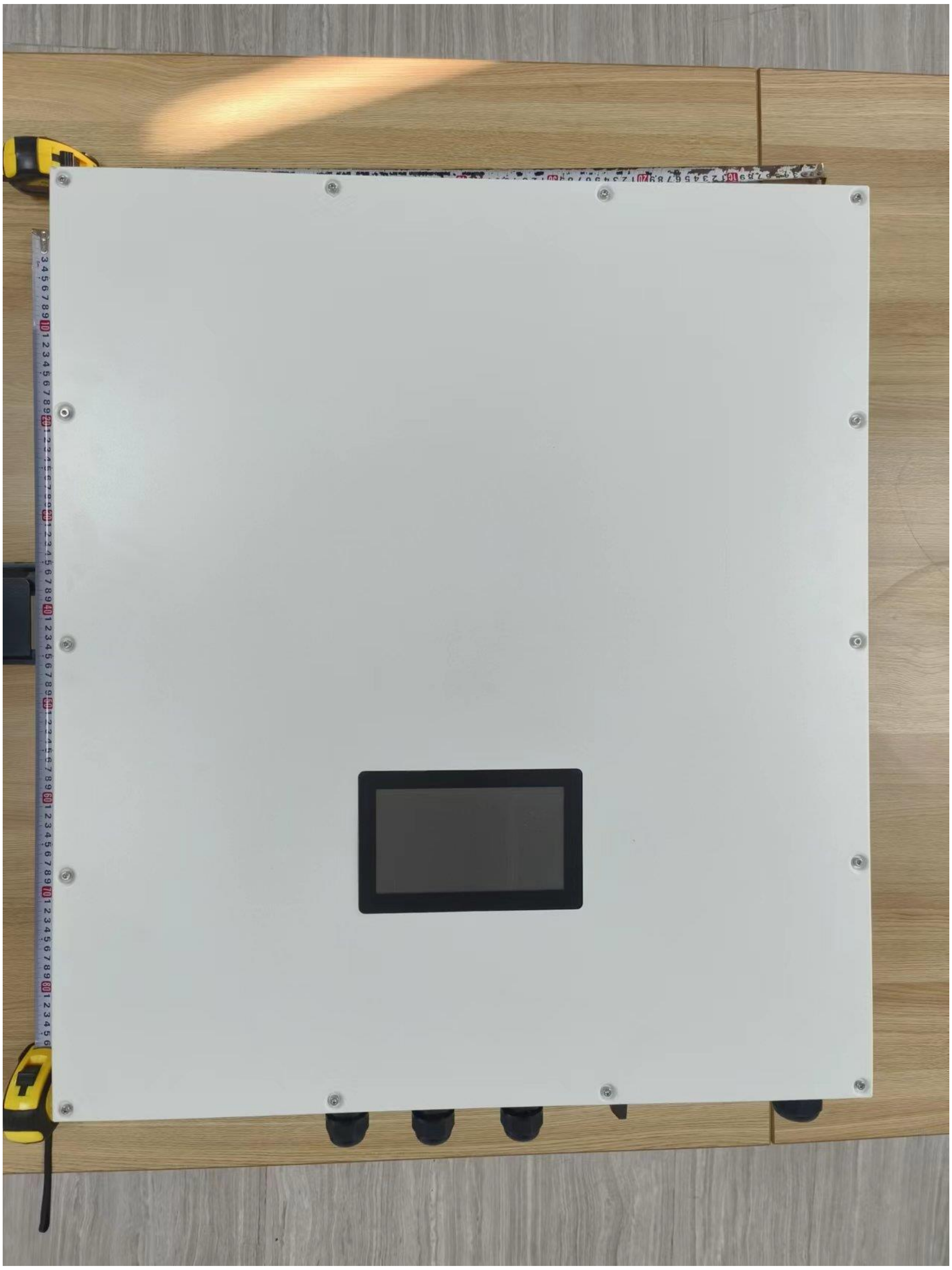
This Test Report is Issued Under the Authority of :

Prepared by	Approved & Authorized Signer :
Jason Liu	
Jason Liu / Engineer	Evan Yang / Authorized Signatory

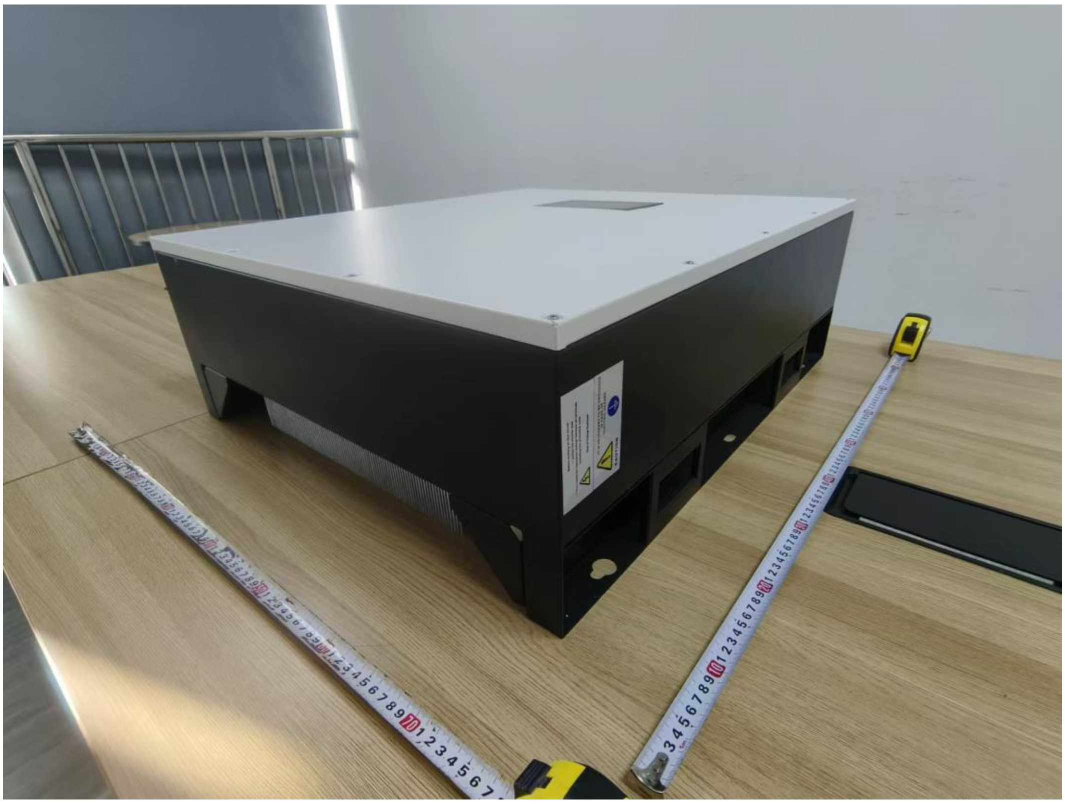
This report shows that above equipment is technically compliant with the requirements of the standards above. All test results in this report apply only to the tested sample(s). Without prior written approval of Shenzhen Nore Testing Center Co., Ltd, this report shall not be reproduced except in full.

Annex No. 2
Pictures of the unit

Enclosure front

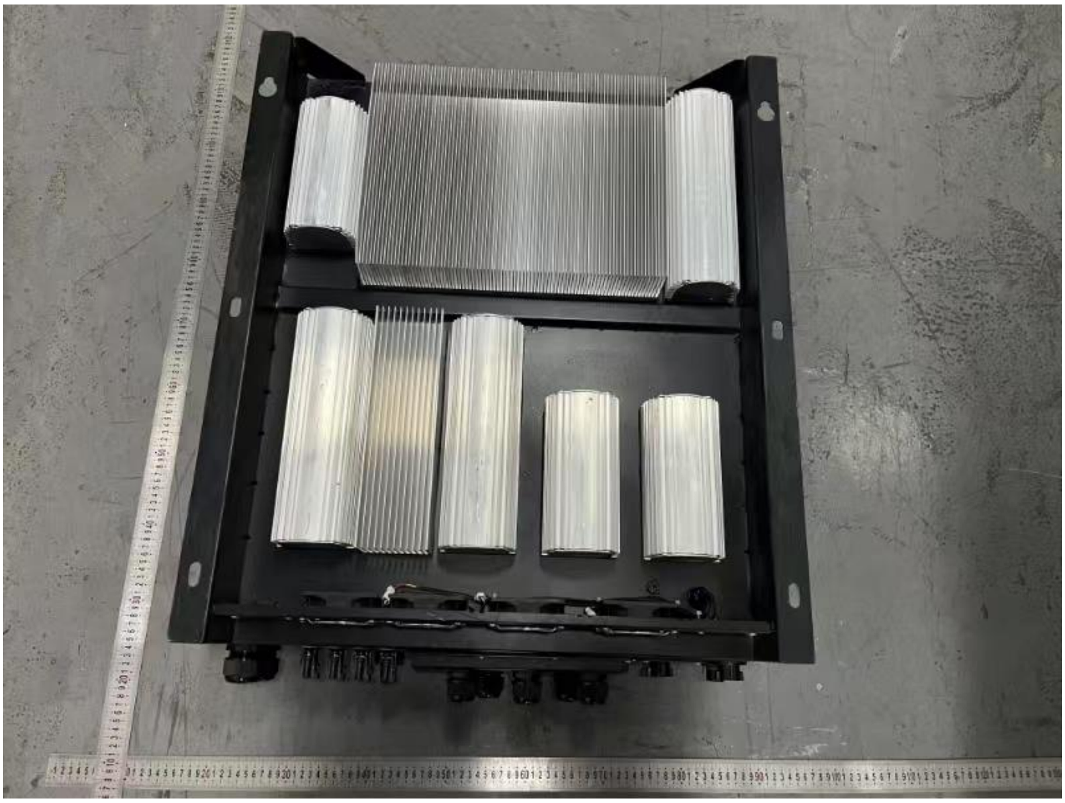
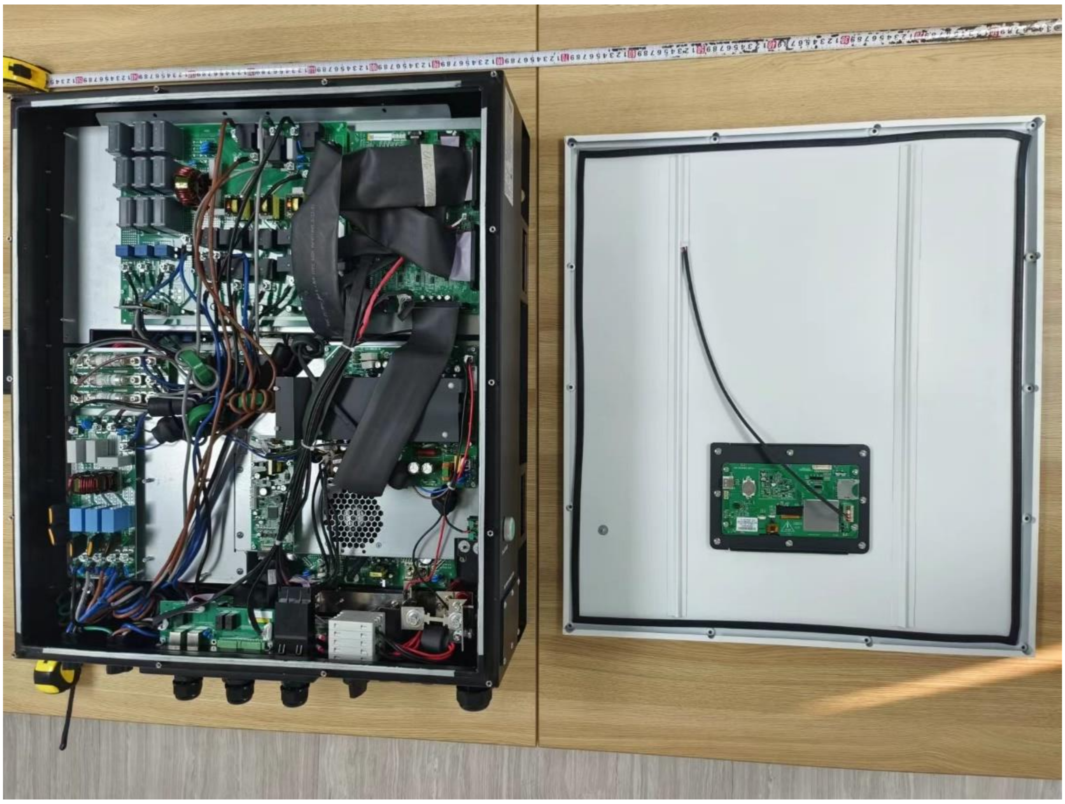


Enclosure (connectors)

Enclosure top side


Enclosure left side

Enclosure right side

Enclosure back

Enclosure open


Annex No. 3
Test Equipment list

No.	Equipment	Internal No.	Type	Manufacturer	Last Calibration	Due Date
1	Oscilloscope	A4089036SH	DL850	YOKOGAWA	08/Jun/22	07/Jun/23
					29/May/23	28/May/24
2	Current probe	A4089037SH	960 30	YOKOGAWA	29/Aug/22	28/Aug/23
					24/Aug/23	23/Aug/24
3	Current probe	A4089038SH	960 30	YOKOGAWA	29/Aug/22	28/Aug/23
					24/Aug/23	23/Aug/24
4	Current probe	A4089039SH	960 30	YOKOGAWA	29/Aug/22	28/Aug/23
					24/Aug/23	23/Aug/24
5	AC power supply	A7040071SH	61512	Chroma	Monitored by Power Analyzer	
6	AC power supply	A7040077SH	MX-30	AMETEK		
7	Programmable DC source	A7040058SH	62150H-1000S	Chroma		
8	Programmable DC source	A7040059SH	62150H-1000S	Chroma		
9	Programmable DC source	A7040069SH	62150H-1000S	Chroma		
10	Programmable DC source	A7040074SH	62150H-1000S	Chroma		
11	Programmable DC source	A7040075SH	62150H-1000S	Chroma		
12	Programmable DC source	A7040076SH	62150H-1000S	Chroma		
13	Programmable DC source	A7040070SH	62150H-1000S	Chroma		
14	Power Analyzer	A1240096SH	WT3000	YOKOGAWA	29/Aug/22	28/Aug/23
					24/Aug/23	23/Aug/24
15	Power Analyzer	A1240097SH	WT3000	YOKOGAWA	08/Jun/22	07/Jun/23
					29/May/23	28/May/24
16	temperature & humidity meter	B4200046SH	polyma	W302M2A	20/Dec/22	19/Dec/23
17	Power Analyzer	A1240132SH	DEWE2-A4	DEWETRON	08/Jun/22	07/Jun/23
					29/May/23	28/May/24

End of Test Report