TEST REPORT

Engineering recommendation G98/1

Requirements for the connection of Fully Type Tested Micro-generators (up to and including 16 A per phase) in parallel with public Low Voltage Distribution Networks.

Report reference number..... :	**PVGB2401WDG0057-1**
Date of issue..... ……..:	2024-01-19
Total number of pages..... ……..:	133
Testing laboratory name..... :	**Bureau Veritas Shenzhen Co., Ltd. Dongguan Branch**
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Accreditation.....:	ilac-MRA A2LA ACCREDITED Certificate # 2951.01
Applicant's name ..... :	**Jiangsu Hanchu Energy Technology Co., Ltd**
Address.....:	No. 588, Jinhui Road, Huishan District, Wuxi City, Jiangsu Province, China
Test specification	
Standard .....:	G98/1-7:2022
	A1 Requirements for Type Testing of Inverter Connected Mirco generators
Test Report Form No. .....:	G98/1 VER.2
TRF Originator .....:	Bureau Veritas Shenzhen Co., Ltd. Dongguan Branch
Master TRF.....:	Dated 2022-11-01
Test item description.....:	Photovoltaic (PV) and battery inverter
Trademark .....:	HANCHU ESS
Model / Type .....:	HESS-HY-T-05K, HESS-HY-T-06K, HESS-HY-T-08K, HESS-HY-T-10K, HESS-HY-T1-05K, HESS-HY-T1-06K, HESS-HY-T1-08K, HESS-HY-T1-10K

Ratings..... :	**HESS-HY-T-05K**	**HESS-HY-T-06K**	**HESS-HY-T-08K**	**HESS-HY-T-10K**
Max. input PV voltage [V] ..... :	1100			
Input PV voltage range [V]..... :	150-950	150-950	200-950	200-950
Max. Input PV current [A]..... :	2*20,0	2*20,0	2*20,0	2*20,0
Input Battery voltage range [V] ..... :	120-600			
Max. Battery current [A] ..... :	30,0	30,0	30,0	30,0
Output AC voltage [V][Grid]	3L/N/PE, 230V, 50Hz			
Nominal Output AC current [A] [Grid]:	7,3	8,7	11,6	14,5
Max. Output AC current [A] [Grid].... :	8,0	9,6	12,8	16,0
Nominal Output power [kW] [Grid]... :	5,0	6,0	8,0	10,0
Max. Output power [kVA] [Grid]..... :	5,0	6,0	8,0	10,0
Output AC voltage [V][EPS]:	3L/N/PE, 230V, 50Hz			
Nominal Output AC current [A] [EPS]:	7,3	8,7	11,6	14,5
Max. Output AC current [A] [EPS] ... :	8,0	9,6	12,8	16,0
Nominal Output power [kW] [EPS]... :	5,0	6,0	8,0	10,0
Max. Output power [kVA] [EPS]..... :	5,0	6,0	8,0	10,0
Ratings..... :	**HESS-HY-T1-05K**	**HESS-HY-T1-06K**	**HESS-HY-T1-08K**	**HESS-HY-T1-10K**
Max. input PV voltage [V] ..... :	1100			
Input PV voltage range [V]..... :	150-950	150-950	200-950	200-950
Max. Input PV current [A]..... :	3*16,0	3*16,0	3*16,0	3*16,0
Input Battery voltage range [V] ..... :	120-600			
Max. Battery current [A] ..... :	30,0	30,0	30,0	30,0
Output AC voltage [V][Grid]	3L/N/PE, 230V, 50Hz			
Nominal Output AC current [A] [Grid]:	7,3	8,7	11,6	14,5
Max. Output AC current [A] [Grid].... :	8,0	9,6	12,8	16,0
Nominal Output power [kW] [Grid]... :	5,0	6,0	8,0	10,0
Max. Output power [kVA] [Grid]..... :	5,0	6,0	8,0	10,0
Output AC voltage [V][EPS]	3L/N/PE, 230V, 50Hz			
Nominal Output AC current [A] [EPS]:	7,3	8,7	11,6	14,5
Max. Output AC current [A] [EPS] ... :	8,0	9,6	12,8	16,0
Nominal Output power [kW] [EPS]... :	5,0	6,0	8,0	10,0
Max. Output power [kVA] [EPS]..... :	5,0	6,0	8,0	10,0

Testing Location ..... :	**Bureau Veritas Shenzhen Co., Ltd. Dongguan Branch**
Address ..... :	No. 96, Guantai Road (Houjie Section), Houjie Town, Dongguan City, Guangdong Province, 523942, People's Republic of China
Tested by (name and signature) ..... :	Ryan He 
Approved by (name and signature) ..... :	Ken Chan 
Manufacturer's name..... :	**Jiangsu Hanchu Energy Technology Co., Ltd**
Manufacturer address..... :	No. 588, Jinhui Road, Huishan District, Wuxi City, Jiangsu Province, China
Factory's name ..... :	**AISWEI New Energy Technology (Yangzhong) Co., Ltd**
Factory address ..... :	No.588 Gangxing Road, Economic Development Zone, 212200 Yangzhong, Jiangsu Province, P.R.China

Document History			
Date	**Internal reference**	**Modification / Change / Status**	**Revision**
2024-01-19	Ryan He	This is a copy report, the test results is based on the original test report PVGB2306WDG0281-1, issue by Bureau Veritas Shenzhen Co., Ltd. Dongguan Branch, dated on 2023-10-23.	0
Supplementary information:			

Test items particulars

Equipment mobility .....:	Permanent connection
Operating condition.....:	Continuous
Class of equipment.....:	Class I
Protection against ingress of water ..:	IP66 according to EN 60529
Mass of equipment [kg] .....:	Approx. 26kg for all model

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.....:	2023-03-23
Date(s) of performance of test.....:	2023-03-23 to 2023-10-23

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 G98.

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.

"(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.

Conformity statements are decided in accordance with IEC GUIDE 115:2021 Procedure 2 (accuracy method), unless otherwise normatively specified or contractually agreed.

- "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 negative sign. For the sake of reading the document the measured active infeed power has a positive sign.

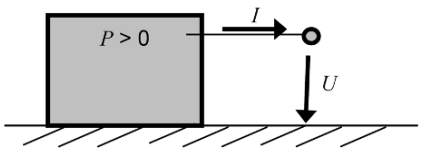

Figure 1

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 counterclockwise 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.

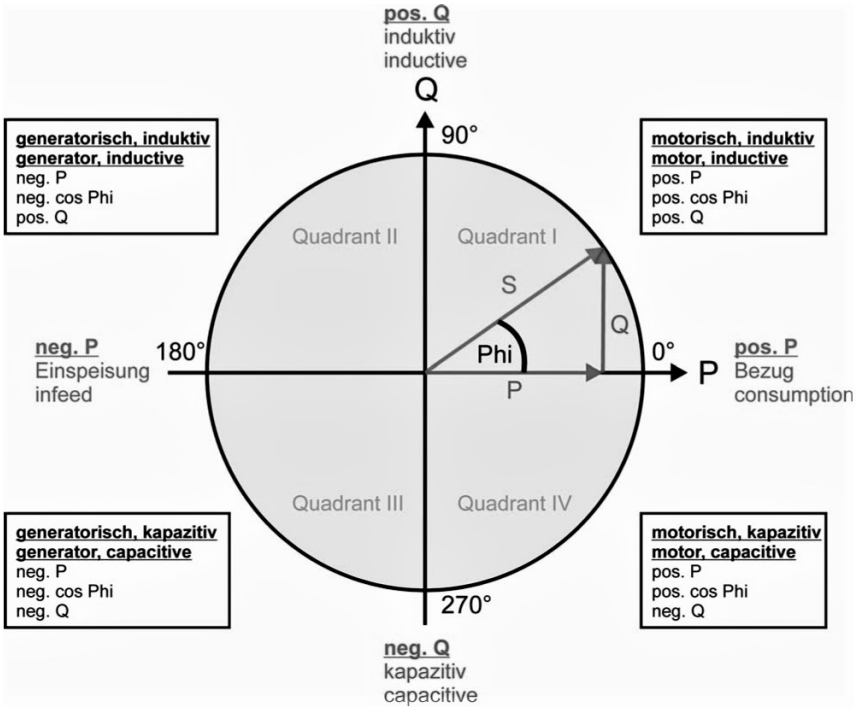

Figure 2

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

- Quadrant I: Ohmic inductive load (coil)
- Quadrant II: One active power supplying generation plant with simultaneous reactive power consumption
- Quadrant III: A generation plant supplying active and reactive power
- Quadrant IV: Ohmic-capacitive load (capacitor)

This Test Report consists of the following documents:

1. Test Results
2. Annex No. 1 – EMC Test Report
3. Annex No. 2 – Pictures of the unit
4. Annex No. 3 – Test equipment list

Copy of marking plate

HANCHU ESS

Model: HESS-HY-T-05K

PV input	Max. PV input power	7500Wp
	Max. PV input voltage	d.c. 1100V
	MPP voltage range	d.c. 150-950V
	Max. PV input current	d.c. 2X20A
	Isc PV (absolute maximum)	d.c. 2X30A
Battery input	Max. charge/discharge power	5000W/5000W
	Battery voltage range	d.c. 120-600V
	Max. battery charge/discharge current	d.c. 30A/30A
	Battery type	LiFePO4
Grid output	Rated grid voltage	3/N/PE~400V
	Rated grid frequency	50Hz/60Hz
	Rated grid output apparent power	5000VA
	Max. grid output apparent power	5000VA
	Rated grid output current	7.3A
	Max. grid output current	8.0A
Grid input	Rated grid voltage	3/N/PE~400V
	Rated grid frequency	50Hz/60Hz
	Max. grid input apparent power	10000VA
	Max. grid input current	14.5A
EPS output	Rated output voltage	3/N/PE~400V
	Rated output frequency	50Hz/60Hz
	Rated output apparent power	5000VA
	Max. output apparent power	5000VA
	Rated output current	7.3A
General information	Adjustable cos(φ)	0.8ind...0.8cap
	Operating temperature range	-25...+60°C
	Inverter topology	Non-Isolated
	Ingress protection	IP66
	Protective class	I
	Overvoltage category	II(PV), III(MAINS)

Support DRM0

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SN:L1102A35F0025 CODE:frNGM3PK

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HANCHU ESS

Model: HESS-HY-T-06K

PV input	Max. PV input power	9000Wp
	Max. PV input voltage	d.c. 1100V
	MPP voltage range	d.c. 150-950V
	Max. PV input current	d.c. 2X20A
	Isc PV (absolute maximum)	d.c. 2X30A
Battery input	Max. charge/discharge power	6000W/6000W
	Battery voltage range	d.c. 120-600V
	Max. battery charge/discharge current	d.c. 30A/30A
	Battery type	LiFePO4
Grid output	Rated grid voltage	3/N/PE~400V
	Rated grid frequency	50Hz/60Hz
	Rated grid output apparent power	6000VA
	Max. grid output apparent power	6000VA
	Rated grid output current	8.7A
	Max. grid output current	9.6A
Grid input	Rated grid voltage	3/N/PE~400V
	Rated grid frequency	50Hz/60Hz
	Max. grid input apparent power	12000VA
	Max. grid input current	17.4A
EPS output	Rated output voltage	3/N/PE~400V
	Rated output frequency	50Hz/60Hz
	Rated output apparent power	6000VA
	Max. output apparent power	6000VA
	Rated output current	8.7A
General information	Adjustable cos(φ)	0.8ind...0.8cap
	Operating temperature range	-25...+60°C
	Inverter topology	Non-Isolated
	Ingress protection	IP66
	Protective class	I
	Overvoltage category	II(PV), III(MAINS)

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HANCHU ESS

Model: HESS-HY-T-08K

PV input	Max. PV input power	12000Wp
	Max. PV input voltage	d.c. 1100V
	MPP voltage range	d.c. 200-950V
	Max. PV input current	d.c. 2X20A
	Isc PV (absolute maximum)	d.c. 2X30A
Battery input	Max. charge/discharge power	8000W/8000W
	Battery voltage range	d.c. 120-600V
	Max. battery charge/discharge current	d.c. 30A/30A
	Battery type	LiFePO4
Grid output	Rated grid voltage	3/N/PE~400V
	Rated grid frequency	50Hz/60Hz
	Rated grid output apparent power	8000VA
	Max. grid output apparent power	8000VA
	Rated grid output current	11.6A
	Max. grid output current	12.8A
Grid input	Rated grid voltage	3/N/PE~400V
	Rated grid frequency	50Hz/60Hz
	Max. grid input apparent power	16000VA
	Max. grid input current	23.2A
EPS output	Rated output voltage	3/N/PE~400V
	Rated output frequency	50Hz/60Hz
	Rated output apparent power	8000VA
	Max. output apparent power	8000VA
	Rated output current	11.6A
General information	Adjustable cos(φ)	0.8ind...0.8cap
	Operating temperature range	-25...+60°C
	Inverter topology	Non-Isolated
	Ingress protection	IP66
	Protective class	I
	Overvoltage category	II(PV), III(MAINS)

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HANCHU ESS

Model: HESS-HY-T-10K

PV input	Max. PV input power	15000Wp
	Max. PV input voltage	d.c. 1100V
	MPP voltage range	d.c. 200-950V
	Max. PV input current	d.c. 2X20A
	Isc PV (absolute maximum)	d.c. 2X30A
Battery input	Max. charge/discharge power	10000W/10000W
	Battery voltage range	d.c. 120-600V
	Max. battery charge/discharge current	d.c. 30A/30A
	Battery type	LiFePO4
Grid output	Rated grid voltage	3/N/PE~400V
	Rated grid frequency	50Hz/60Hz
	Rated grid output apparent power	10000VA
	Max. grid output apparent power	10000VA
	Rated grid output current	14.5A
	Max. grid output current	16.0A
Grid input	Rated grid voltage	3/N/PE~400V
	Rated grid frequency	50Hz/60Hz
	Max. grid input apparent power	20000VA
	Max. grid input current	29.0A
EPS output	Rated output voltage	3/N/PE~400V
	Rated output frequency	50Hz/60Hz
	Rated output apparent power	10000VA
	Max. output apparent power	10000VA
	Rated output current	14.5A
General information	Adjustable cos(φ)	0.8ind...0.8cap
	Operating temperature range	-25...+60°C
	Inverter topology	Non-Isolated
	Ingress protection	IP66
	Protective class	I
	Overvoltage category	II(PV), III(MAINS)

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HANCHU ESS

Model: HESS-HY-T1-05K

PV input	Max. PV input power	7500Wp
	Max. PV input voltage	d.c. 1100V
	MPP voltage range	d.c. 150-950V
	Max. PV input current	d.c. 3X16A
	Isc PV (absolute maximum)	d.c. 3X24A
Battery input	Max. charge/discharge power	5000W/5000W
	Battery voltage range	d.c. 120-600V
	Max. battery charge/discharge current	d.c. 30A/30A
	Battery type	LiFePO4
Grid output	Rated grid voltage	3/N/PE~400V
	Rated grid frequency	50Hz/60Hz
	Rated grid output apparent power	5000VA
	Max. grid output apparent power	5000VA
	Rated grid output current	7.3A
	Max. grid output current	8.0A
Grid input	Rated grid voltage	3/N/PE~400V
	Rated grid frequency	50Hz/60Hz
	Max. grid input apparent power	10000VA
	Max. grid input current	14.5A
EPS output	Rated output voltage	3/N/PE~400V
	Rated output frequency	50Hz/60Hz
	Rated output apparent power	5000VA
	Max. output apparent power	5000VA
	Rated output current	7.3A
General information	Adjustable cos(φ)	0.8ind...0.8cap
	Operating temperature range	-25...+60°C
	Inverter topology	Non-Isolated
	Ingress protection	IP66
	Protective class	I
	Overvoltage category	II(PV), III(MAINS)

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HANCHU ESS

Model: HESS-HY-T1-06K

PV input	Max. PV input power	9000Wp
	Max. PV input voltage	d.c. 1100V
	MPP voltage range	d.c. 150-950V
	Max. PV input current	d.c. 3X16A
	Isc PV (absolute maximum)	d.c. 3X24A
Battery input	Max. charge/discharge power	6000W/6000W
	Battery voltage range	d.c. 120-600V
	Max. battery charge/discharge current	d.c. 30A/30A
	Battery type	LiFePO4
Grid output	Rated grid voltage	3/N/PE~400V
	Rated grid frequency	50Hz/60Hz
	Rated grid output apparent power	6000VA
	Max. grid output apparent power	6000VA
	Rated grid output current	8.7A
	Max. grid output current	9.6A
Grid input	Rated grid voltage	3/N/PE~400V
	Rated grid frequency	50Hz/60Hz
	Max. grid input apparent power	12000VA
	Max. grid input current	17.4A
EPS output	Rated output voltage	3/N/PE~400V
	Rated output frequency	50Hz/60Hz
	Rated output apparent power	6000VA
	Max. output apparent power	6000VA
	Rated output current	8.7A
General information	Adjustable cos(φ)	0.8ind...0.8cap
	Operating temperature range	-25...+60°C
	Inverter topology	Non-Isolated
	Ingress protection	IP66
	Protective class	I
	Overvoltage category	II(PV), III(MAINS)

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HANCHU ESS

Model: HESS-HY-T1-08K

PV input	Max. PV input power	12000Wp
	Max. PV input voltage	d.c. 1100V
	MPP voltage range	d.c. 200-950V
	Max. PV input current	d.c. 3X16A
	Isc PV (absolute maximum)	d.c. 3X24A
Battery input	Max. charge/discharge power	8000W/8000W
	Battery voltage range	d.c. 120-600V
	Max. battery charge/discharge current	d.c. 30A/30A
	Battery type	LiFePO4
Grid output	Rated grid voltage	3/N/PE~400V
	Rated grid frequency	50Hz/60Hz
	Rated grid output apparent power	8000VA
	Max. grid output apparent power	8000VA
	Rated grid output current	11.6A
	Max. grid output current	12.8A
Grid input	Rated grid voltage	3/N/PE~400V
	Rated grid frequency	50Hz/60Hz
	Max. grid input apparent power	16000VA
	Max. grid input current	23.2A
EPS output	Rated output voltage	3/N/PE~400V
	Rated output frequency	50Hz/60Hz
	Rated output apparent power	8000VA
	Max. output apparent power	8000VA
	Rated output current	11.6A
General information	Adjustable cos(φ)	0.8ind...0.8cap
	Operating temperature range	-25...+60°C
	Inverter topology	Non-Isolated
	Ingress protection	IP66
	Protective class	I
	Overvoltage category	II(PV), III(MAINS)

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HANCHU ESS

Model: HESS-HY-T1-10K

PV input	Max. PV input power	15000Wp
	Max. PV input voltage	d.c. 1100V
	MPP voltage range	d.c. 200-950V
	Max. PV input current	d.c. 3X16A
	Isc PV (absolute maximum)	d.c. 3X24A
Battery input	Max. charge/discharge power	10000W/10000W
	Battery voltage range	d.c. 120-600V
	Max. battery charge/discharge current	d.c. 30A/30A
	Battery type	LiFePO4
Grid output	Rated grid voltage	3/N/PE~400V
	Rated grid frequency	50Hz/60Hz
	Rated grid output apparent power	10000VA
	Max. grid output apparent power	10000VA
	Rated grid output current	14.5A
	Max. grid output current	16.0A
Grid input	Rated grid voltage	3/N/PE~400V
	Rated grid frequency	50Hz/60Hz
	Max. grid input apparent power	20000VA
	Max. grid input current	29.0A
EPS output	Rated output voltage	3/N/PE~400V
	Rated output frequency	50Hz/60Hz
	Rated output apparent power	10000VA
	Max. output apparent power	10000VA
	Rated output current	14.5A
General information	Adjustable cos(φ)	0.8ind...0.8cap
	Operating temperature range	-25...+60°C
	Inverter topology	Non-Isolated
	Ingress protection	IP66
	Protective class	I
	Overvoltage category	II(PV), III(MAINS)

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General product information:

The unit converts DC voltage into AC voltage.

The unit is a three phases type inverter.

The DC input of unit can be supplied from PV array and batteries.

The input and output are protected by Varistors to Earth. The unit is providing EMC filtering at the output toward mains. The unit does not provide galvanic separation from input to output (transformerless). 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 electrical circuit:

The internal control is redundant built. It consists of Microcontroller Main DSP (U519) and slave DSP (U536).

The Main DSP (U519) control the relays by switching signals; measures the PV voltage, PV current, Bus 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 (U536) is measures the grid voltage, grid frequency and residual current, also can switch off the relays independently, and communicate with Main DSP (U519) each other.

The current is measured by a current sensor. The AC current signal and the injected DC current signal are sent to the Main DSP (U519). The Main DSP (U519) 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.

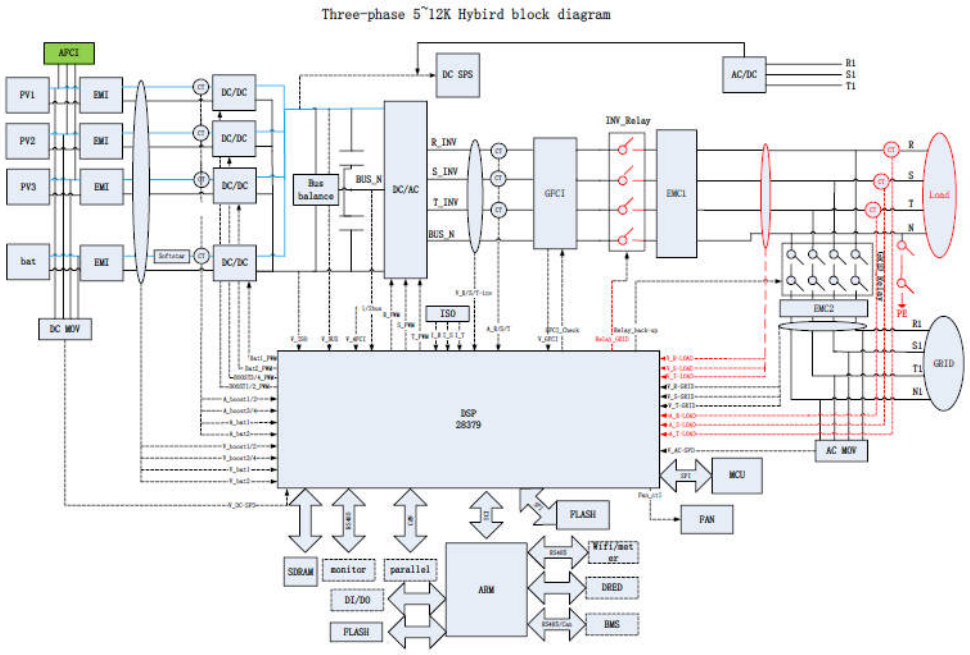


Figure 3 – Block diagram for "HESS-HY-T1-xxK" series

(Other seriers refer to the Differences of the models)

Differences of the models:
There are two series models. The differences between four series refer to below description and table.

The “HESS-HY-T-xxK” series is basic series and including model HESS-HY-T-05K, HESS-HY-T-06K, HESS-HY-T-08K and HESS-HY-T-10K. They are identical in hardware and software, expected the output power derated by software.

The “HESS-HY-T1-xxK” series is almost same with the “HESS-HY-T-xxK” series but with 3 PV trackers and 6 pole DC switch. The “HESS-HY-T1-xxK” series including model HESS-HY-T1-05K, HESS-HY-T1-06K, HESS-HY-T1-08K and HESS-HY-T1-10K. They are identical in hardware and software, expected the output power derated by software.

Series	HESS-HY-T-xxK	HESS-HY-T1-xxK
PV tracker’s number	2	3
EPS output terminal	With	With
DC switch's pole number	4	6

The product was tested on:
Hardware version: 270-100501-01;
Master Software version: V610-05001-01;
Slave Software version: V610-60015-00;
Safety version: V610-11022-01.

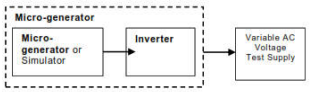
All tests were performed on HESS-HY-T-10K. Tests of the EUT of HESS-HY-T-10K not applicable for the models HESS-HY-T-05K, HESS-HY-T-06K, HESS-HY-T-08K, HESS-HY-T1-05K, HESS-HY-T1-06K, HESS-HY-T1-08K, HESS-HY-T1-10K were performed on the concerned models and a statement is given at the relevant test.

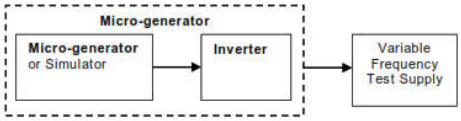
Engineering recommendation G98/1			
Clause	**Requirement – Test**	**Result – Remark**	**Verdict**
Annex A1	**Requirements for Type Testing of Inverter Connected Micro-generators**		
A 1.1	**General** This Annex describes a methodology for obtaining type certification or type verification for Micro-generators which are connected to the Distribution Network via an Inverter. Typically, all interface functions are contained within an Inverter and in such cases it is only necessary to have the Inverter Fully Type Tested. In the case where a package of specific separate parts are used to assemble a Fully Type Tested Micro-generator the completed Micro-generator's Interface Protection shall not rely on interconnection using cables which could be terminated incorrectly on site ie the interconnections shall be made by plug and socket which the Manufacturer has made and tested prior to delivery to site. 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 Microgenerator'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 Microgenerator as described in this EREC G98, and recorded in a format similar to that shown in Form C (Appendix 3). Where the Interface Protection is physically integrated within the overall Micro-generator 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).	Considered. Test results see below.	**P**

Engineering recommendation G98/1			
Clause	**Requirement – Test**	**Result – Remark**	**Verdict**
	This Annex applies to Micro-generators: • with or without or energy storage systems connected on the energy source or prime mover side of the Micro-generator; and • with or without load management devices.		
A 1.2	**Type Verification Functional Testing of the Interface Protection** Type testing is the responsibility of the Manufacturer. The type testing can be done by the Manufacturer of an individual component or by an external test house or by the supplier of the complete system, or any combination of them as appropriate. The type testing will verify that the operation of the Interface Protection shall result: a) in the safe disconnection of the Micro-generator from the DNO's Distribution Network in the event that the protection settings specified in Table 2 are exceeded; and b) in the Micro-generator 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 2; and 2) within the time delay settings specified in Table 2. Wherever possible the type testing of a Micro-generator 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 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 2. 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 1.2.2	**Over / Under Voltage** The Interface Protection shall be tested by operating the Controller in parallel with a variable AC test supply, as an example see	Considered. Test results see below..	**P**

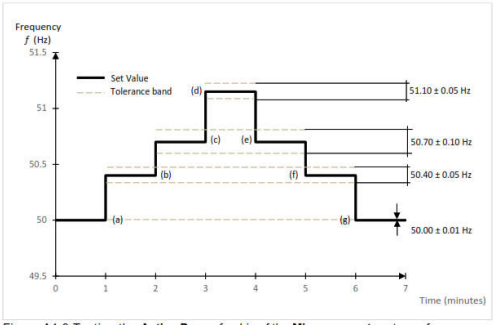
Engineering recommendation G98/1			
Clause	**Requirement – Test**	**Result – Remark**	**Verdict**
	Figure A1.1. Correct protection and ride-through operation shall be confirmed. The set points for over and under voltage at which the Interface Protection disconnects from the supply will be established by varying the 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 2, otherwise normal operation should continue. To establish the certified trip voltage, the test voltage should be applied in steps of ± 0,5% of 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. It will be necessary to carry out five tests for each trip setting. The test voltage at which this trip occurred is to be recorded as the certified trip voltage. To establish the certified trip time, the test voltage should be applied starting from ± 1,8% below the certified trip voltage in a step of at least ± 0,5% of 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. Where the Interface Protection functionality is implemented in the Controller it will be necessary to carry out five tests for each trip setting. The longest trip time is to be recorded as the certified trip time. For example to test overvoltage 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 Micro-generator is disconnected, the Micro-generator should be powered up to export a measurable amount of energy so that it can be confirmed that the Micro-generator 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 Micro-generator 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		

Engineering recommendation G98/1			
Clause	**Requirement – Test**	**Result – Remark**	**Verdict**
	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 Micro-generator 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 Micro-generator should be recorded as the trip time. The Micro-generator then needs to operate at 4 V below the nominal overvoltage stage 1 setting which is 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 the Type Test Verification Report, Appendix 3 Form C. 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 Micro-generator is allowed to shut down during this period to protect itself as allowed by footnote 3 of Table 2 of this document, 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 the Micro-generator restart timer has not operated so it begins 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 Type Test Verification Report, Appendix 3 Form C to ensure that the protection will not		

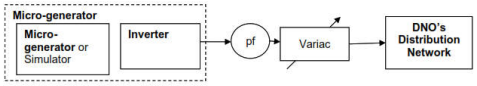
Engineering recommendation G98/1			
Clause	**Requirement – Test**	**Result – Remark**	**Verdict**
	trip in error. **Figure A1.1. Micro-generator Test set up – Over / Under Voltage** 		
A 1.2.3	**Over / Under Frequency** The Micro-generator shall be tested by operating in parallel with a low impedance, variable frequency test supply system, see figure A1.2. Correct protection and ride-through operation should be confirmed during operation of the Micro-generator. The set points for over and under frequency at which the Micro-generator 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 Test Verification Report, Appendix 3 Form C. 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 Microgenerator tripping is to be recorded on the Type Test Verification Report, Appendix 3 Form C. 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. To avoid this it is necessary to establish an accurate frequency for the trip to enable the use of a much smaller step change 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	Considered. Test results see below.	**P**

Engineering recommendation G98/1			
Clause	**Requirement – Test**	**Result – Remark**	**Verdict**
	shown in the Type Test Verification Report, Appendix 3 Form C. **Figure A1.2. Test set up – Over / Under Frequency** 		
A 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 the Type Test Verification Report, Appendix 3 Form C.	Considered. Test results see below.	**P**
A 1.2.5	**Reconnection** Further tests will confirm that once the AC supply voltage and frequency have returned to be within the stage 1 settings specified in Table 2 following an automatic protection trip operation there is a minimum time delay of 20 s before the Micro-generator output is restored (ie before the Micro-generator automatically reconnects to the Distribution Network).	Considered. Test results see below.	**P**
A 1.2.6	**Frequency Drift and Step Change Stability test** The tests will be carried out using the same circuit as specified in A1.2.3 above and following confirmation that the Micro-generator 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 Micro-generator should not trip during the test. For the step change test the Micro-generator 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 Micro-generator should not trip during this test. For frequency drift tests the Micro-generator should be operated with a measurable output	Considered. Test results see below.	**P**

Engineering recommendation G98/1			
Clause	**Requirement – Test**	**Result – Remark**	**Verdict**
	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 Micro-generator should not trip during this test. The results shall be recorded on the Type Test Verification Report, Appendix 3 Form C.		
A 1.2.7	**Active power feed-in at under-frequency** Tests shall be undertaken to verify the Active Power feed-in at under-frequency. The tests for providing evidence of the frequency dependent active power feed-in of the Microgenerator shall be carried out on a network simulator. Measurements shall be carried out at the following Operating points: a) 50 Hz ± 0,01Hz; b) a point between 49,5 Hz and 49,6 Hz; c) a point between 47,5 Hz and 47,6 Hz. The operating point b) and c) shall be maintained for at least 5 minutes. The test is regarded as passed if: • the Micro-generator does not disconnect from the network at the operating points a) to c) when the network frequency is changed and • the Micro-generator does not reduce output energy at point b) and • the power reduction at point c) is less than or equal to the allowed power reduction according to paragraph 9.4.2 The following data shall be documented: • variation of the network frequency with time; • the measured Active Power with time.	Considered. Test results see below.	**P**
A 1.2.8	**Micro-generators which include Electricity Storage** This paragraph provides a method for demonstrating compliance with the optional performance characteristic as discussed in the foreword. The Manufacturer shall demonstrate how the Micro-generator Active Power when acting as a load (ie replenishing its energy store) responds to changes in	Considered. Test results see below.	**P**

Engineering recommendation G98/1			
Clause	**Requirement – Test**	**Result – Remark**	**Verdict**
	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 9.4.3.		
A 1.2.9	**Power response to over-frequency** Tests shall be undertaken using the test set up in Figure A1.2 to verify the Active Power reduction to over-frequency using a specific standard frequency threshold of 50,4 Hz and a Droop of 10%. The test should be carried out above 80% Registered Capacity and repeated at 40-60% Registered Capacity. The Micro-generator shall be at the following frequencies (refer to Figure A1.3): • a) 50,00 Hz ± 0,01 Hz; • b) 50,40+0.05 Hz ± 0,05 Hz; • c) 50,70 Hz ± 0,10 Hz; • d) 51,15 Hz ± 0,05 Hz; • e) 50,70 Hz ± 0,10 Hz; • f) 50,40+0.05 Hz ± 0,05 Hz; • g) 50,00 Hz ± 0,01 Hz. The frequency at each step should be maintained for at least one minute and the Active Power reduction in the form of a gradient determined and assessed for compliance with paragraph 9.4.  Figure A1.3 Testing the Active Power feed-in of the Micro-generator at over frequency.	Considered. Test results see below.	**P**

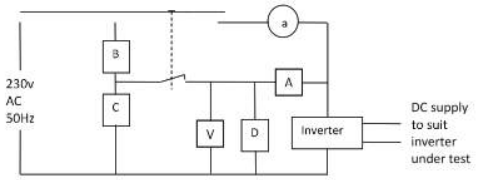
Engineering recommendation G98/1			
Clause	**Requirement – Test**	**Result – Remark**	**Verdict**
	The Droop should be determined from the measurements between 50,4 Hz and 51,15 Hz. The allowed tolerance for the frequency measurement shall be ± 0,05 Hz. The allowed tolerance for Active Power output measurement 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 1.2.10	**Operating Range** Six tests shall be conducted with the Micro-generator operating at Registered Capacity connected to a grid simulator set as follows: • Test 1, Voltage = 85% of nominal, frequency = 47 Hz, Power factor = 1, Period of test 20 s. • Test 2, Voltage = 85% of nominal, frequency = 47,5 Hz, Power factor = 1, Period of test 90 minutes. • Test 3, Voltage = 110% of nominal, frequency = 51,5 Hz, Power factor = 1, Period of test 90 minutes. • Test 4, Voltage = 110% of nominal, frequency = 52,0 Hz, Power factor = 1, Period of test 15 minutes. • Test 5, Voltage = 100% of nominal, frequency = 50,0 Hz, Power factor = 1, Period of test 90 minutes. • Test 6, Confirm that the Micro-Generating Plant is capable of staying connected to the Distribution Network and operate at rates of change of frequency up to 1 Hzs-1 as measured over a period of 500 ms. The Interface Protection shall be disabled during the tests. Automatic adjustment to reduce power in the case of over frequency shall be disabled for Tests 3 and 4. Active Power shall be recorded every second. The tests will verify that the Micro-generator can operate within the required ranges for the specified period of time. In case of a PV Micro-generator the PV	Considered. Test results see below.	**P**

Engineering recommendation G98/1			
Clause	**Requirement – Test**	**Result – Remark**	**Verdict**
	primary source may be replaced by a DC source. In case of a full converter Micro-generator (eg wind) the primary source and the prime mover Inverter/rectifier may be replaced by a DC source. In case of a DFIG Micro-generator the mechanical drive system may be replaced by a test bench motor.		
A 1.3	**POWER QUALITY**		**P**
A 1.3.1	**Harmonics** The tests should be carried out as specified in BS EN 61000-3-2 and can be undertaken with a fixed source of energy at two power levels firstly between 45 and 55% and at 100% of Registered Capacity. The test must be carried out with a minimum of 2 kW of rated Micro-generators. Where an individual Micro-generator is smaller than 2 kW it should be tested as a group. However, where a Micro-generator is designed to be installed singly in an installation then this can be tested alone, for example a domestic CHP unit. The maximum group size for the test is 3,68 kW. The results for all Micro-generators should be normalised to a rating of 3,68 kW. The Micro-generator or group shall meet the harmonic emissions of Table 1 in BS EN 61000-3-2 with a scaling factor applied as follows for each harmonic current: BS EN 61000-3-2 Table 1 current limit × rating of Micro-generator being tested (kW) per phase / 3,68	Considered. Test results see below.	**P**
A 1.3.2	**Power Factor** The test set up shall be such that the Inverter supplies full load to the DNO's Distribution Network via the power factor (pf) meter and the variac as shown below in Figure A1.4. The Inverter pf should be within the limits given in paragraph 9.6 for three test voltages 230 V – 6%, 230 V and 230 V +10%. The voltage shall be maintained within ±1,5% of the stated level during the test.  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 A1.4 test set up – Power Factor	Considered. Test results see below.	**P**

Engineering recommendation G98/1			
Clause	**Requirement – Test**	**Result – Remark**	**Verdict**
A 1.3.3	**Voltage Flicker** The test must be carried out with a minimum of 2 kW of rated Micro-generators. Where an individual Micro-generator is smaller than 2 kW it should be tested as a group. However, where a Micro-generator is designed to be installed singly in an installation then this can be tested alone, for example a domestic CHP unit. The maximum group size for the test is 3,68 kW. The Micro-generator or group shall meet the required dmax, dc, d(t), Pst, Plt requirements of BS EN 61000-3-3 with a scaling factor applied as follows for each voltage change component. dmax, dc, d(t), Pst, Plt × rating of Micro-generator being tested (kW) per phase / 3,68 The results for groups of Micro-generators should be normalised to a rating of 3,68 kW and to the standard source impedance. Single Micro-generators need to be normalised to the standard source impedance, these normalised results need to conform to the limits set out in the Type Test Verification Report, Appendix 3 Form C. For voltage change and flicker measurements the following simplified formula is to be used to convert the measured values to the normalised values where the power factor of the Micro-generator output is 0,98 or above. Where it is less than 0,98 then compliance with the full requirements of BS EN 61000-3-3 is required. Normalised value = Measured value × reference source resistance/measured source resistance at test point. And for units which are tested as a group. Normalised value = Measured value × reference source resistance/measured source resistance at test point × 3,68/rating per phase. Single phase units reference source resistance is 0,4 Ω. Two phase units in a three phase system reference source resistance is 0,4 Ω. Two phase units in a split phase system reference source resistance is 0,24 Ω.	Considered. Test results see below.	**P**

Engineering recommendation G98/1			
Clause	**Requirement – Test**	**Result – Remark**	**Verdict**
	Three phase units reference source resistance is 0,24 Ω. The stopping test should be a trip from full load output. The dates and location of the tests need to be noted in the Type Test Verification Report, Appendix 3 Form C. Note: For wind turbines, flicker testing should be carried out during the performance tests specified in IEC 61400-12-1. 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 1 m/s centred on multiples of 1 ms-1. The dataset shall be considered complete when each bin includes a minimum of 10 mins of sampled data. The highest value of each parameter measured across the entire range of tests shall be recorded. Note: As an alternative to type testing the Manufacturer of a Micro-generator incorporating an Inverter may give a guarantee that rates of change of output do not exceed the following ramp rate limits. Output needs to ramp up at a constant rate. This exception to site testing does not apply to devices where the output changes in steps of over 30 ms rather than as a ramp function, a site test is required for these units. • Single phase units and two phase units in a three phase system, maximum ramp up rate 333 Ws^{-1}; • Two phase units in a split phase system and three phase units, maximum ramp up rate 860 Ws^{-1}. It should be noted that units conforming to this declaration are likely to be less efficient at capturing energy during times when the energy source is changing. For technologies other than wind turbines, testing should ensure that the controls or automatic programs used produce the most unfavourable sequence of voltage changes. Hydro Micro-generators where the output is controlled by varying the load on the generator using the Inverter and which therefore produce variable output need to conform to the maximum voltage change requirements of BS EN 61000-3-2 and also		

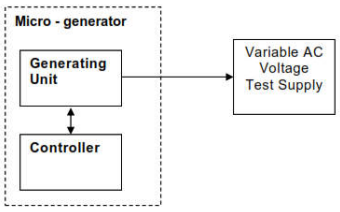
Engineering recommendation G98/1			
Clause	**Requirement – Test**	**Result – Remark**	**Verdict**
	need to be tested for Pst and Plt over a period where the range of flows varies over the design range of the turbine with a period of at least 2 hours at each step with there being 10 steps from min flow to maximum flow. Pst and Plt values to recorded and normalised as per the method laid down in the Type Test Verification Report, Appendix 3 Form C.		
A 1.3.4	**DC Injection for Inverters** Where a Micro-generator is designed to be installed singly in an installation, for example a domestic CHP unit, then this DC injection limit can be a maximum value of 20 mA for sub 2 kW Micro-generator and can be tested alone. Where Micro-generators are designed such that multiple units may be installed in an installation for example roof mounted wind turbines and PV with micro Inverters on each panel, then they should be tested as a group of at least 2 kW and with a maximum group size of 4 kW. The level of DC injection from the Inverter-connected Micro-generator into the DNO's Distribution Network shall not exceed the levels specified in Section 11 when measured during operation at three levels, 10%, 55% and 100% of Registered Capacity with a tolerance of plus or minus 5%. The DC component can be measured by one of the following two methods: • the average of the current samples (preferred); • root mean square of frequencies components below 1 Hz. The DC component level shall be measured with an observation period large enough to ensure repeatability, and of at least 60 s. As an example, at 230 V a 2 kW single phase Inverter has a current output of 8,7 A so DC limit is 21,75 mA; a 10 kW three phase Inverter has a current output of 14,5 A per phase which is equivalent to a total of 43,5 A at 230 V so DC limit is 108,75 mA.	Considered. Test results see below.	**P**
A 1.3.5	**Short Circuit Current Contribution for Inverters** Inverter connected Micro-generators generally have small short circuit fault contributions, however, DNOs need to understand the contribution that they make to	Considered. Test results see below.	**P**

Engineering recommendation G98/1			
Clause	**Requirement – Test**	**Result – Remark**	**Verdict**
	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. The following type tests shall be carried out and the results noted in the Type Test Verification Report, Appendix 3 Form C. **Figure A3. Test circuit**  		
A 1.3.6	**Self-Monitoring - Solid State Disconnection** Some Micro-generators include solid state switching devices to disconnect from the DNO's Distribution Network. In this case 10.1.9 requires the control equipment to monitor the output stage of the Micro-generator 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.	A disconnection device with mechanical separation in the use of two relays in series in (each) line and neutral are provided in the unit. The internal disconnection device is comply with 4.1 function safety of the VDE 0126-1-1.	**P**

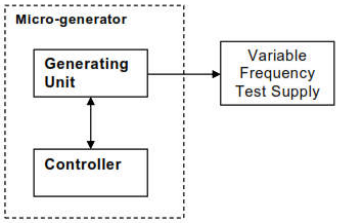
Engineering recommendation G98/1			
Clause	**Requirement – Test**	**Result – Remark**	**Verdict**
Annex A2	**Requirements for Type Testing of Synchronous Micro-generators**		
A 2.1	**General** This Annex describes a methodology for obtaining type certification or type verification for the interface equipment between a directly coupled Micro-generator and the DNO's Distribution Network. Interface functions can be provided either as an integrated part of the Controller or by incorporating a protection relay but for a Fully Type Tested Micro-generator the completed Micro-generator'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. The Interface Protection of synchronous Micro-generators 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 Micro-generator Interface Protection, therefore in order to achieve Fully Type Tested status the Controller and any separate Interface Protection unit will require their functionality to be Fully Type Tested as described in this Annex, and recorded in format similar to that shown in the Type Test Verification Report, Appendix 3 Form C. Where the Interface Protection is physically integrated within the overall Micro-generator 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).	The unit is no synchronous micro-generator.	**N/A**

Engineering recommendation G98/1			
Clause	**Requirement – Test**	**Result – Remark**	**Verdict**
	This Annex applies to Micro-generators: • with or without energy storage systems connected on the alternator side of the Controller; and • with or without load management devices. Wherever possible the type testing of a Micro-generator 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 Micro-generators that are not connected to the Distribution Network via an Inverter as appropriate. This Annex also applies to any synchronous Micro-generators that are powered by stored energy (eg compressed air), but the requirement to demonstrate the LFSM-O will not be required.		
A 2.2	**Type Verification Functional Testing of the Interface Protection** Type testing is the responsibility of the Manufacturer. The type testing can be done by the Manufacturer of an individual component, by an external test house or by the supplier of the complete system, or any combination of them as appropriate. The type testing will verify that the operation of the Interface Protection shall result: a) in the safe disconnection of the Micro-generator from the DNO's Distribution Network in the event that the protection settings specified in Table 2 are exceeded; and b) in the Micro-generator 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 2; and 2) within the time delay settings specified in Table 2.	The unit is no synchronous micro-generator.	**N/A**
A 2.2.1	**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 2.	The unit is no synchronous micro-generator.	**N/A**

Engineering recommendation G98/1			
Clause	**Requirement – Test**	**Result – Remark**	**Verdict**
	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 Micro-generator 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 Table 2. When measuring the disconnection time where the Interface Protection is included in the Controller, 5 s disconnections should be initiated, and the average time recorded.		
A 2.2.2	**Over / Under Voltage** The Interface Protection shall be tested by operating the Controller in parallel with a variable AC test supply, as an example see Figure A2.1. 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 AC supply voltage. The disconnect sequence should be initiated when the network conditions of Table 2 are met, otherwise normal operation should continue. To establish the certified trip voltage, the test voltage should be applied in steps of ± 0,5% of 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. It will be necessary to carry out five tests for each trip setting. The test voltage at which this trip occurs is to be recorded as the certified trip voltage. To establish the certified trip time, the test voltage should be applied starting from ± 1,8% below the certified trip voltage in a step of at least ± 0,5% of 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. Where the Interface Protection functionality is implemented in the Controller, it will be necessary to carry out five tests for each trip setting. The longest trip time is to be recorded as the certified trip time.	The unit is no synchronous micro-generator.	**N/A**

Engineering recommendation G98/1			
Clause	**Requirement – Test**	**Result – Remark**	**Verdict**
	For example, to test overvoltage 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 Micro-generator is disconnected, the Micro-generator should be powered up to export a measurable amount of energy so that it can be confirmed that the Micro-generator 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 Micro-generator 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 Micro-generator 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 Micro-generator, the output of the Micro-generator 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 Type Test Verification Report, Appendix 3 Form C. Test results should be recorded on the Test Sheet shown in the Type Test Verification Report, Appendix 3 Form C. **Figure A2.1. Micro-generator Test set up – Over / Under Voltage**  		
A 2.2.3	**Over / Under Frequency**	The unit is no synchronous	**N/A**

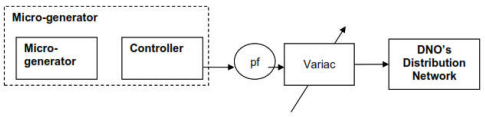
Engineering recommendation G98/1			
Clause	**Requirement – Test**	**Result – Remark**	**Verdict**
	The Interface Protection shall be tested by operating the Controller in parallel with a low impedance, variable frequency test supply system, as an example see Figure A2.2. Correct protection and ride-through 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 Test Verification Report Appendix 3 Form C. 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 Microgenerator tripping is to be recorded on the Type Test Verification Report Appendix 3 Form C. 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. To confirm that the protection does not trip before the required time the test frequency should be applied at each setting ±0,2 Hz and for the relevant times shown in the table in the Type Test Verification Report, Appendix 3 Form C.	micro-generator.	

Engineering recommendation G98/1			
Clause	**Requirement – Test**	**Result – Remark**	**Verdict**
	Figure A2.2. Test set up – Over / Under Frequency  		
A 2.2.4	**Loss of Mains Protection** The test described in this Annex should be completed at 10%, 55%, and 100% of the Registered Capacity. In both cases a subset of results should be recorded as indicated in the Protection – Loss of Mains test section of the Type Test Verification Report, Appendix 3 Form C. Note that if the suggested loading points are below the Micro-generator's minimum stable operating level the test should be completed at 100%, and at least one loading level below 100%, of the Registered Capacity. It is recommended that a power level is chosen that is 5% of the difference between the Registered Capacity and the minimum stable operating level above the minimum stable operating level: Power level = Minimum stable operating level + (Registered Capacity – minimum stable operating level) x 5% The resonant test circuit specified in this test has been designed to model the interaction of the directly coupled Micro-generator under test with the local load including multiple directly coupled connected Micro-generators in parallel. The directly coupled Micro-generators 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 directly coupled Micro-generator output. To facilitate the test for LoM there shall be a switch placed between the test load/directly coupled Micro-generator combination and the DNO's Distribution Network, as shown in Figure A2.3. Figure A2.3 test set up – Loss of Mains The directly coupled Micro-generator is to be tested at three levels of the directly coupled Micro-generator's output power: 10%, 55% and 100%. For each test the load match is to	The unit is no synchronous micro-generator.	**N/A**

Engineering recommendation G98/1			
Clause	**Requirement – Test**	**Result – Remark**	**Verdict**
	be within ± 5%. Each test is to be repeated five times. Load match conditions are defined as being when the current from the directly coupled Microgenerator 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 directly coupled Micro-generator'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 five seconds whichever is the lower duration. The time from the switch opening until the protection disconnection occurs is to be measured and must comply with the requirements in Table 2.		
A 2.2.5	**Reconnection** Further tests will confirm that once the AC supply voltage and frequency have returned to be within the stage 1 settings specified in Table 2 following an automatic protection trip operation there is a minimum time delay of 20 s before the Micro-generator output is restored (ie before the Micro-generator automatically reconnects to the Distribution Network). Four tests are required to be carried out with all protection functions enabled including loss of mains. For each stability test the Micro-generator should not trip during the test. For the step change test the Micro-generator 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 Micro-generator should not trip during this test. For frequency drift tests the Micro-generator 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 Micro-generator should not trip during this test.	The unit is no synchronous micro-generator.	**N/A**

Engineering recommendation G98/1			
Clause	**Requirement – Test**	**Result – Remark**	**Verdict**
A 2.2.6	**Frequency Drift and Step Change Stability test** The tests will be carried out using the same circuit as specified in A.2.2.3 above and following confirmation that the Micro-generator 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 Micro-generator should not trip during the test. For the step change test the Micro-generator 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 Micro-generator should not trip during this test. For frequency drift tests the Micro-generator 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 Micro-generator should not trip during this test.	The unit is no synchronous micro-generator.	**N/A**
A 2.2.7	**Active power feed-in at under-frequency** The tests detailed in A.1.2.7 shall be undertaken to verify the Active Power feed-in at underfrequency	The unit is no synchronous micro-generator.	**N/A**
A 2.2.8	**Micro-generators which include Electricity Storage** This paragraph provides a method for demonstrating compliance with the optional performance characteristic as discussed in the foreword. The Manufacturer shall demonstrate how the Micro-generator 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	The unit is no synchronous micro-generator with electricity storage.	**N/A**

Engineering recommendation G98/1			
Clause	**Requirement – Test**	**Result – Remark**	**Verdict**
	48,8 Hz. In all cases the response shall meet the requirements of 9.4.3.		
A 2.2.7	**Power response to over-frequency** The tests detailed in A.1.2.9 shall be undertaken to verify the power reduction to overfrequency using a specific standard frequency threshold of 50,4 Hz and a Droop of 10%.	The unit is no synchronous micro-generator.	**N/A**
A 2.3	**POWER QUALITY**	The unit is no synchronous micro-generator.	**N/A**
A 2.3.1	**Harmonics** The tests should be carried out as specified in BS EN 61000-3-2 and can be undertaken with a fixed source of energy at two power levels firstly between 45 and 55% and at 100% of Registered Capacity. Note that if the suggested power levels are below the Microgenerator's minimum stable operating level the test should be carried out at 100%, and at Least one stable loading level below 100%, of Registered Capacity. It is recommended that a power level is chosen that is 5% of the difference between the Registered Capacity and the minimum stable operating level above the minimum stable operating level: Power level = Minimum stable operating level + (Registered Capacity – minimum stable operating level) x 5% The test must be carried out with a minimum of 2 kW of rated Micro-generators. Where an individual Micro-generator is smaller than 2 kW it should be tested as a group. However, where a Micro-generator is designed to be installed singly in an installation then this can be tested alone, for example a domestic CHP unit. The maximum group size for the test is 3,68 kW.	The unit is no synchronous micro-generator.	**N/A**
A 2.3.2	**Power Factor** The test set up shall be such that the directly coupled Micro-generator supplies full load to the DNO's Distribution Network via the power factor (pf) meter and the variac as shown below in Figure A2.4. The directly coupled Micro-generator power factor should be within the limits given in paragraph 9.6 for the three test voltages 230 V –6%, 230 V and 230 V +10%.	The unit is no synchronous micro-generator.	**N/A**

Engineering recommendation G98/1			
Clause	**Requirement – Test**	**Result – Remark**	**Verdict**
	The voltage shall be maintained within ±1,5% of the stated level during the test.  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 A2.4 test set up – Power Factor		
A 2.3.3	**Voltage Flicker** The test must be carried out with a minimum of 2 kW of rated Micro-generators. Where an individual Micro-generator is smaller than 2 kW it should be tested as a group. However, where a Micro-generator is designed to be installed singly in an installation then this can be tested alone, for example a domestic CHP unit. The maximum group size for the test is 3,68 kW. The Micro-generator or group shall meet the required dmax, dc, d(t), Pst, Plt requirements of BS EN 61000-3-3 with a scaling factor applied as follows for each voltage change component. dmax, dc, d(t), Pst, Plt × rating of Micro-generator being tested (kW) per phase / 3,68 For voltage change and flicker measurements the following simplified formula is to be used to convert the measured values to the normalised values where the power factor of the Micro-generator output is 0,98 or above. Where it is less than 0,98 then compliance with the full requirements of BS EN 61000-3-3 is required. Normalised value = Measured value × reference source resistance/measured source resistance at test point. And for units which are tested as a group. Normalised value = Measured value × reference source resistance/measured source resistance at test point × 3,68/rating per phase. Single phase units reference source resistance is 0,4 Ω. Two phase units in a three phase system reference source resistance is 0,4 Ω. Two phase units in a split phase system reference source resistance is 0,24 Ω.	The unit is no synchronous micro-generator.	**N/A**

Engineering recommendation G98/1			
Clause	**Requirement – Test**	**Result – Remark**	**Verdict**
	Three phase units reference source resistance is 0,24 Ω. The stopping test should be a trip from full load output. The dates and location of the tests need to be noted in the Type Test Verification Report, Appendix 3 Form C. Hydro Micro-generators with manually fixed output or where the output is fixed by controlling the water flow through the turbine to a steady rate, need to conform to the maximum voltage change requirements of BS EN 61000-3-2 but do not need to be tested for Pst or Plt.		
A 2.3.4	**Short Circuit Current Contribution for Directly Coupled technology** DNOs need to understand the contribution a Micro-generator makes 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. For rotating machines and linear piston machines the test should produce a 0 – 2 s plot of the short circuit current as seen at the Micro-generator terminals. The short circuit current contribution shall be measured upon application of a short circuit on the Micro-generator terminals (all phases / phase to neutral) with the Micro-generator(s) operating at rated output steady state conditions. Current measurements shall be taken from application of fault until the time the fault has been disconnected, following operation of the Micro-generator protection. A current decay plot shall be produced for each phase from inception of the fault until the Micro-generator has been disconnected – trip time. The plot shall show the highest value of peak short circuit current, eg for a Micro-generator supplying a purely inductive load the highest value of peak short circuit current will result when the fault is applied at a voltage zero. Where practicable the tests will need to determine values for all of the relevant parameters listed in Table A.1. Table A.1 Micro-generator Short Circuit Parameters	The unit is no synchronous micro-generator.	**N/A**

Engineering recommendation G98/1			
Clause	**Requirement – Test**	**Result – Remark**	**Verdict**
	<table><tr><th>Parameter</th><th>Symbol</th><th>Method of Determination</th></tr><tr><td>Peak short-circuit current</td><td>i_p</td><td>Direct measurement</td></tr><tr><td>Initial value of aperiodic component</td><td>A</td><td>Direct measurement</td></tr><tr><td>Initial symmetrical short-circuit current</td><td>Ik"</td><td>Interpolation of plot</td></tr><tr><td>Decaying (aperiodic) component of short-circuit current</td><td>i_{dc}</td><td>Interpolation of plot & calculation</td></tr><tr><td>Reactance / Resistance ratio of source</td><td>$^X/_R$</td><td>Calculation</td></tr></table>		

G98-1
Test Results:

A1 Requirements for Type Testing of Inverter connected Mirco-generators

A1.2/A2.2 Type Verification Functional Testing of the Interface Protection (Functional safety - fault condition tests according DIN V VDE V 0126-1-1)	**P**

Test result: HESS-HY-T-10K

ambient temperature [°C]:	25,0	
model/type of power supply:	DC:62150H-1000S AC:61512	
manufacturer of power supply:	Chroma	
rated markings of power supply:	DC:0-1000V, 15kW AC:0-300V, 18kW	

Component No.	Fault	Test condition		Test time	Fuse No.	Fault condition		Result
		AC	DC			AC	DC	
PCE input	Reversed	--	DC 650	10 min.	--	--	--	DC Input: 650Vdc / 0A / 0W AC Output: 230Vac / 0A / 0W FID: Cannot start MT: N/A SD: ☒Yes / ☐No GD: ☒Yes / ☐No RO: ☒Yes / ☐No NCD: ☒Yes / ☐No NH: ☒Pass/ ☐Fail. DST: ☒Pass/ ☐Fail.
PCE input	s-c	--	DC 650	10 min.	--	--	--	DC Input: 650Vdc / 0A / 0W AC Output: 230Vac / 0A / 0W FID: PEC stop, Fault code 59. PV1 string current abnormal. MT: N/A SD: ☒Yes / ☐No GD: ☒Yes / ☐No RO: ☒Yes / ☐No NCD: ☒Yes / ☐No NH: ☒Pass/ ☐Fail. DST: ☒Pass/ ☐Fail.
PCE input	Over-voltage	--	DC 1100	10 min.	--	--	--	DC Input: 1100Vdc / 0A / 0W AC Output: 230Vac / 0A / 0W FID: PEC stop, Fault code 37. PV over voltage MT: N/A SD: ☒Yes / ☐No GD: ☒Yes / ☐No RO: ☒Yes / ☐No NCD: ☒Yes / ☐No NH: ☒Pass/ ☐Fail. DST: ☒Pass/ ☐Fail.

PCE input (only for multistring)	Different input MPP1: low input MPP2: high input	--	DC 850/ 420	10 min.	--	--	--	DC1 Input: 850Vdc / 7,5A / 6050W DC2 Input: 420Vdc / 15,5A / 6050W AC Output: 230Vac / 52A / 12kW FID: normal working. MT: N/A SD: ☒Yes / ☐No GD: ☒Yes / ☐No RO: ☒Yes / ☐No NCD: ☒Yes / ☐No NH: ☒Pass/ ☐Fail. DST: ☒Pass/ ☐Fail.
PCE output	Power over-feed (OCP & OTP function controlled by DSP / software is disable)	--	DC 650	10 min.	--	--	--	DC Input: 650Vdc / 0A / 0W AC Output: 230Vac / 0A / 0W FID: PEC stop, Fault code 46. High DC bus. MT: N/A SD: ☒Yes / ☐No GD: ☒Yes / ☐No RO: ☒Yes / ☐No NCD: ☒Yes / ☐No NH: ☒Pass/ ☐Fail. DST: ☒Pass/ ☐Fail.
PCE output	Over-voltage (OVP function controlled by DSP / software is disable)	--	DC 650	10 min.	--	--	--	DC Input: 650Vdc / 0A / 0W AC Output: 230Vac / 0A / 0W FID: PEC stop, Fault code 46. DC bus is to high. MT: N/A SD: ☒Yes / ☐No GD: ☒Yes / ☐No RO: ☒Yes / ☐No NCD: ☒Yes / ☐No NH: ☒Pass/ ☐Fail. DST: ☒Pass/ ☐Fail.
PCE output	s-c	--	DC 650	10 min.	--	--	--	DC Input: 650Vdc / 0A / 0W AC Output: 230Vac / 0A / 0W FID: PEC stop, overcurrent protect. MT: N/A SD: ☒Yes / ☐No GD: ☒Yes / ☐No RO: ☒Yes / ☐No NCD: ☒Yes / ☐No NH: ☒Pass/ ☐Fail. DST: ☒Pass/ ☐Fail.
PCE output	Phase sequence or polarity incorrect	--	DC 650	10 min.	--	--	--	DC Input: 650Vdc / 0A / 0W AC Output: 230Vac / 0A / 0W FID: PEC cannot work, fault AC voltage fault MT: N/A SD: ☒Yes / ☐No GD: ☒Yes / ☐No RO: ☒Yes / ☐No NCD: ☒Yes / ☐No NH: ☒Pass/ ☐Fail. DST: ☒Pass/ ☐Fail.

PCE output	A-Phase miswiring grid connection	--	DC 650	10 min.	--	--	--	DC Input: 650Vdc / 0A / 0W. AC Output: 230Vac / 0A / 0W. FID: PEC cannot work, fault AC voltage fault. MT: N/A SD: ☒Yes / ☐No. GD: ☒Yes / ☐No. RO: ☒Yes / ☐No. NCD: ☒Yes / ☐No. NH: ☒Pass/ ☐Fail. DST: ☒Pass/ ☐Fail.
PCE cooling system failure	Fan locked (MF1) CN04	--	DC 650	10 min.	--	--	--	DC Input: 650Vdc / 18,5A / 12100W. AC Output: 230Vac / 52,1A / 12kW. FID: Normal work. MT: Ambient=60℃, IGBT=75,3℃, Transformer=82℃, Inductance=86,8℃ SD: ☒Yes / ☐No. GD: ☒Yes / ☐No. RO: ☒Yes / ☐No. NCD: ☒Yes / ☐No. NH: ☒Pass/ ☐Fail. DST: ☒Pass/ ☐Fail.
PCE cooling system failure	Opening blocked CN101	--	DC 650	10 min.	--	--	--	DC Input: 650Vdc / 18,5A / 12100W. AC Output: 230Vac / 52,1A / 12kW. FID: Normal work. MT: Ambient=60℃, Enclosure=75,3℃. SD: ☒Yes / ☐No. GD: ☒Yes / ☐No. RO: ☒Yes / ☐No. NCD: ☒Yes / ☐No. NH: ☒Pass/ ☐Fail. DST: ☒Pass/ ☐Fail.
MCU or DPS processer failure								
DSP failure	+1.2V power supply disable C708 s-c	--	DC 650	10 min.	--	--	--	DC Input: 650Vdc / 0A / 0W. AC Output: 230Vac / 0A / 0W. FID: DSP reset. MT: N/A SD: ☒Yes / ☐No. GD: ☒Yes / ☐No. RO: ☒Yes / ☐No. NCD: ☒Yes / ☐No. NH: ☒Pass/ ☐Fail. DST: ☒Pass/ ☐Fail.

DSP failure	+3.3V power supply disable C719 s-c	--	DC 650	10 min.	--	--	--	DC Input: 650Vdc / 0A / 0W. AC Output: 230Vac / 0A / 0W. FID: DSP reset. MT: N/A SD: ☒Yes / ☐No. GD: ☒Yes / ☐No. RO: ☒Yes / ☐No. NCD: ☒Yes / ☐No. NH: ☒Pass/ ☐Fail. DST: ☒Pass/ ☐Fail.
DSP failure reset 20-30%P								
Loss of control & Function fault								
IGBT PMW	Loss / failure (no power) C299 s-c	--	DC 650	10 min.	--	--	--	DC Input: 650Vdc / 0A / 0W. AC Output: 230Vac / 0A / 0W. FID: PCE stop. MT: N/A SD: ☒Yes / ☐No. GD: ☒Yes / ☐No. RO: ☒Yes / ☐No. NCD: ☒Yes / ☐No. NH: ☒Pass/ ☐Fail. DST: ☒Pass/ ☐Fail.
IGBT PMW	Loss / failure (no power) U124 pin 6 to Q121 G s-c	--	DC 650	10 min.	--	--	--	DC Input: 650Vdc / 0A / 0W. AC Output: 230Vac / 0A / 0W. FID: PCE stop. IGBT Q121, Q111 broke. MT: N/A SD: ☒Yes / ☐No. GD: ☐Yes / ☒No. RO: ☒Yes / ☐No. NCD: ☐Yes / ☒No. NH: ☒Pass/ ☐Fail. DST: ☒Pass/ ☐Fail.
IGBT PMW	Loss / failure (no driver) U124 pin 6 to Q121 G s-c	--	DC 650	10 min.	--	--	--	DC Input: 650Vdc / 0A / 0W. AC Output: 230Vac / 0A / 0W. FID: PCE stop. Fault code 6. DC bus is to high. MT: N/A SD: ☒Yes / ☐No. GD: ☒Yes / ☐No. RO: ☒Yes / ☐No. NCD: ☒Yes / ☐No. NH: ☒Pass/ ☐Fail. DST: ☒Pass/ ☐Fail.
PV/DC voltage detector	Loss / failure R440 s-c	--	DC 650	10 min.	--	--	--	DC Input: 650Vdc / 0A / 0W. AC Output: 230Vac / 0A / 0W. FID: PCE stop. Fault code 8. AC HCT failure MT: N/A SD: ☒Yes / ☐No. GD: ☒Yes / ☐No. RO: ☒Yes / ☐No. NCD: ☒Yes / ☐No. NH: ☒Pass/ ☐Fail. DST: ☒Pass/ ☐Fail.

PV/DC voltage detector	Loss / failure R112 o-c	--	DC 650	10 min.	--	--	--	DC Input: 650Vdc / 0A / 0W. AC Output: 230Vac / 0A / 0W. FID: PCE stop. Fault code 37. PV over voltage. MT: N/A SD: ☒Yes / ☐No. GD: ☒Yes / ☐No. RO: ☒Yes / ☐No. NCD: ☒Yes / ☐No. NH: ☒Pass/ ☐Fail. DST: ☒Pass/ ☐Fail.
PV/DC current detector	Loss / failure U101 pin 11-12 s-c	--	DC 650	10 min.	--	--	--	DC Input: 650Vdc / 0A / 0W. AC Output: 230Vac / 0A / 0W. FID: PCE cannot stop. MT: N/A SD: ☒Yes / ☐No. GD: ☒Yes / ☐No. RO: ☒Yes / ☐No. NCD: ☒Yes / ☐No. NH: ☒Pass/ ☐Fail. DST: ☒Pass/ ☐Fail.
BUS voltage detector	Loss / failure R186 o-c	--	DC 650	10 min.	--	--	--	DC Input: 650Vdc / 0A / 0W. AC Output: 230Vac / 0A / 0W. FID: PCE stop. Fault code 6. DC bus is to high. MT: N/A SD: ☒Yes / ☐No. GD: ☒Yes / ☐No. RO: ☒Yes / ☐No. NCD: ☒Yes / ☐No. NH: ☒Pass/ ☐Fail. DST: ☒Pass/ ☐Fail.
Inverter voltage detector	Loss / failure C589 s-c	--	DC 650	10 min.	--	--	--	DC Input: 650Vdc / 0A / 0W. AC Output: 230Vac / 0A / 0W. FID: PCE stop. Fault code 34. AC voltage out of range. MT: N/A SD: ☒Yes / ☐No. GD: ☒Yes / ☐No. RO: ☒Yes / ☐No. NCD: ☒Yes / ☐No. NH: ☒Pass/ ☐Fail. DST: ☒Pass/ ☐Fail.
Inverter voltage detector	Loss / failure R451 o-c	--	DC 650	10 min.	--	--	--	DC Input: 650Vdc / 0A / 0W. AC Output: 230Vac / 0A / 0W. FID: PCE stop. Fault code 34. AC voltage out of range. MT: N/A SD: ☒Yes / ☐No. GD: ☒Yes / ☐No. RO: ☒Yes / ☐No. NCD: ☒Yes / ☐No. NH: ☒Pass/ ☐Fail. DST: ☒Pass/ ☐Fail.

Grid/AC voltage detector	Loss / failure C643 s-c	--	DC 650	10 min.	--	--	--	DC Input: 650Vdc / 0A / 0W. AC Output: 230Vac / 0A / 0W. FID: PCE stop. Fault code 34. AC voltage out of range. MT: N/A SD: ☒Yes / ☐No. GD: ☒Yes / ☐No. RO: ☒Yes / ☐No. NCD: ☒Yes / ☐No. NH: ☒Pass/ ☐Fail. DST: ☒Pass/ ☐Fail.
Grid/AC voltage detector	Loss / failure R717 o-c	--	DC 650	10 min.	--	--	--	DC Input: 650Vdc / 0A / 0W. AC Output: 230Vac / 0A / 0W. FID: PCE stop. Fault code 34. AC voltage out of range. MT: N/A SD: ☒Yes / ☐No. GD: ☒Yes / ☐No. RO: ☒Yes / ☐No. NCD: ☒Yes / ☐No. NH: ☒Pass/ ☐Fail. DST: ☒Pass/ ☐Fail.
DC isolation device function check	Loss / failure C584 s-c	--	DC 650	10 min.	--	--	--	DC Input: 650Vdc / 0A / 0W. AC Output: 230Vac / 0A / 0W. FID: PCE stop. Fault code 53. ISO check: before enable constant current, ISO voltage > 300mV. MT: N/A SD: ☒Yes / ☐No. GD: ☒Yes / ☐No. RO: ☒Yes / ☐No. NCD: ☒Yes / ☐No. NH: ☒Pass/ ☐Fail. DST: ☒Pass/ ☐Fail.
DC isolation device function check	Loss / failure R429 o-c	--	DC 650	10 min.	--	--	--	DC Input: 650Vdc / 0A / 0W. AC Output: 230Vac / 0A / 0W. FID: PCE stop. Fault code 53. ISO check: before enable constant current, ISO voltage > 300mV. MT: N/A SD: ☒Yes / ☐No. GD: ☒Yes / ☐No. RO: ☒Yes / ☐No. NCD: ☒Yes / ☐No. NH: ☒Pass/ ☐Fail. DST: ☒Pass/ ☐Fail.

DC isolation device function check	Loss / failure R429 o-c	--	DC 650	10 min.	--	--	--	DC Input: 650Vdc / 0A / 0W. AC Output: 230Vac / 0A / 0W. FID: PCE stop. Fault code 53. ISO check: before enable constant current, ISO voltage > 300mV. MT: N/A SD: ☒Yes / ☐No. GD: ☒Yes / ☐No. RO: ☒Yes / ☐No. NCD: ☒Yes / ☐No. NH: ☒Pass/ ☐Fail. DST: ☒Pass/ ☐Fail.
Relay / Contact or function check (K1 s-c)	Loss / failure RY501 s-c	--	DC 650	10 min.	--	--	--	DC Input: 650Vdc / 0A / 0W. AC Output: 230Vac / 0A / 0W. FID: PCE stop. Fault code 3. Relay check fail. MT: N/A SD: ☒Yes / ☐No. GD: ☒Yes / ☐No. RO: ☒Yes / ☐No. NCD: ☒Yes / ☐No. NH: ☒Pass/ ☐Fail. DST: ☒Pass/ ☐Fail.
Relay / Contact or function check (K1 o-c)	Loss / failure RY502 o-c	--	DC 650	10 min.	--	--	--	DC Input: 650Vdc / 0A / 0W. AC Output: 230Vac / 0A / 0W. FID: PCE stop. Fault code 10. Device fault. MT: N/A SD: ☒Yes / ☐No. GD: ☒Yes / ☐No. RO: ☒Yes / ☐No. NCD: ☒Yes / ☐No. NH: ☒Pass/ ☐Fail. DST: ☒Pass/ ☐Fail.
Relay / Contact or function check (K2 s-c)	Loss / failure RY504 s-c	--	DC 650	10 min.	--	--	--	DC Input: 650Vdc / 0A / 0W. AC Output: 230Vac / 0A / 0W. FID: PCE stop. Fault code 3. Relay check fail. MT: N/A SD: ☒Yes / ☐No. GD: ☒Yes / ☐No. RO: ☒Yes / ☐No. NCD: ☒Yes / ☐No. NH: ☒Pass/ ☐Fail. DST: ☒Pass/ ☐Fail.
Relay / Contact or function check (K2 o-c)	Loss / failure RY508 o-c	--	DC 650	10 min.	--	--	--	DC Input: 650Vdc / 0A / 0W. AC Output: 230Vac / 0A / 0W. FID: PCE stop. Fault code 10. Device fault. MT: N/A SD: ☒Yes / ☐No. GD: ☒Yes / ☐No. RO: ☒Yes / ☐No. NCD: ☒Yes / ☐No. NH: ☒Pass/ ☐Fail. DST: ☒Pass/ ☐Fail.

Relay / Contact or function check (K3 s-c)	Loss / failure RY507 s-c	--	DC 650	10 min.	--	--	--	DC Input: 650Vdc / 0A / 0W. AC Output: 230Vac / 0A / 0W. FID: PCE stop. Fault code 3. Relay check fail. MT: N/A SD: ☒Yes / ☐No. GD: ☒Yes / ☐No. RO: ☒Yes / ☐No. NCD: ☒Yes / ☐No. NH: ☒Pass/ ☐Fail. DST: ☒Pass/ ☐Fail.
Relay / Contact or function check (K3 o-c)	Loss / failure RY510 o-c	--	DC 650	10 min.	--	--	--	DC Input: 650Vdc / 0A / 0W. AC Output: 230Vac / 0A / 0W. FID: PCE stop. Fault code 10. Device fault. MT: N/A SD: ☒Yes / ☐No. GD: ☒Yes / ☐No. RO: ☒Yes / ☐No. NCD: ☒Yes / ☐No. NH: ☒Pass/ ☐Fail. DST: ☒Pass/ ☐Fail.
Relay / Contact or function check (K4 s-c)	Loss / failure RY513 s-c	--	DC 650	10 min.	--	--	--	DC Input: 650Vdc / 0A / 0W. AC Output: 230Vac / 0A / 0W. FID: PCE stop. Fault code 3. Relay check fail. MT: N/A SD: ☒Yes / ☐No. GD: ☒Yes / ☐No. RO: ☒Yes / ☐No. NCD: ☒Yes / ☐No. NH: ☒Pass/ ☐Fail. DST: ☒Pass/ ☐Fail.
Relay / Contact or function check (K4 o-c)	Loss / failure RY515 o-c	--	DC 650	10 min.	--	--	--	DC Input: 650Vdc / 0A / 0W. AC Output: 230Vac / 0A / 0W. FID: PCE stop. Fault code 10. Device fault. MT: N/A SD: ☒Yes / ☐No. GD: ☒Yes / ☐No. RO: ☒Yes / ☐No. NCD: ☒Yes / ☐No. NH: ☒Pass/ ☐Fail. DST: ☒Pass/ ☐Fail.
RCD/RCM function check	Loss / failure CT106 pin 1-5 s-c	--	DC 650	10 min.	--	--	--	DC Input: 650Vdc / 0A / 0W. AC Output: 230Vac / 0A / 0W. FID: PCE stop. Fault code 36. GFCI failure. MT: N/A SD: ☒Yes / ☐No. GD: ☒Yes / ☐No. RO: ☒Yes / ☐No. NCD: ☒Yes / ☐No. NH: ☒Pass/ ☐Fail. DST: ☒Pass/ ☐Fail.

RCD/RCM function check	Loss / failure R450 o-c	--	DC 650	10 min.	--	--	--	DC Input: 650Vdc / 0A / 0W. AC Output: 230Vac / 0A / 0W. FID: PCE stop. Fault code 36. GFCI failure. MT: N/A SD: ☒Yes / ☐No. GD: ☒Yes / ☐No. RO: ☒Yes / ☐No. NCD: ☒Yes / ☐No. NH: ☒Pass/ ☐Fail. DST: ☒Pass/ ☐Fail.
Ambient temperature detector	Loss / failure NTC 102 s-c	--	DC 650	10 min.	--	--	--	DC Input: 650Vdc / 0A / 0W. AC Output: 230Vac / 0A / 0W. FID: PCE stop. Fault code 174. MT: N/A SD: ☒Yes / ☐No. GD: ☒Yes / ☐No. RO: ☒Yes / ☐No. NCD: ☒Yes / ☐No. NH: ☒Pass/ ☐Fail. DST: ☒Pass/ ☐Fail.
Ambient temperature detector	Loss / failure NTC 102 o-c	--	DC 650	10 min.	--	--	--	DC Input: 650Vdc / 0A / 0W. AC Output: 230Vac / 0A / 0W. FID: PCE stop. Fault code 174. Low air temperature. MT: N/A SD: ☒Yes / ☐No. GD: ☒Yes / ☐No. RO: ☒Yes / ☐No. NCD: ☒Yes / ☐No. NH: ☒Pass/ ☐Fail. DST: ☒Pass/ ☐Fail.
Heat-sink temperature detector	Loss / failure NTC 102 s-c	--	DC 650	10 min.	--	--	--	DC Input: 650Vdc / 0A / 0W. AC Output: 230Vac / 0A / 0W. FID: PCE stop. Fault code 40. Over temperature in inverter. MT: N/A SD: ☒Yes / ☐No. GD: ☒Yes / ☐No. RO: ☒Yes / ☐No. NCD: ☒Yes / ☐No. NH: ☒Pass/ ☐Fail. DST: ☒Pass/ ☐Fail.
Heat-sink temperature detector	Loss / failure NTC 102 o-c	--	DC 650	10 min.	--	--	--	DC Input: 650Vdc / 0A / 0W. AC Output: 230Vac / 0A / 0W. FID: PCE stop. Fault code 40. Over temperature in inverter. MT: N/A SD: ☒Yes / ☐No. GD: ☒Yes / ☐No. RO: ☒Yes / ☐No. NCD: ☒Yes / ☐No. NH: ☒Pass/ ☐Fail. DST: ☒Pass/ ☐Fail.

DC input BUS capacitor (390 µF)	C208 s-c	--	DC 650	10 min.	--	--	--	DC Input: 650Vdc / 0A / 0W. AC Output: 230Vac / 0A / 0W. FID: IGBT Q121, Q122, Q123, C208, C209, C210 broke, machine protection, no open fire, basic insulation after failure. MT: N/A SD: ☒Yes / ☐No. GD: ☒Yes / ☐No. RO: ☐Yes / ☒No. NCD: ☐Yes / ☒No. NH: ☒Pass/ ☐Fail. DST: ☒Pass/ ☐Fail.
IGBT (IGBT DS)	Q111 s-c	--	DC 650	10 min.	--	--	--	DC Input: 650Vdc / 0A / 0W. AC Output: 230Vac / 0A / 0W. FID: PCE stop. IGBT Q111, Q121 broke, machine protection, no open fire, basic insulation after failure. MT: N/A SD: ☒Yes / ☐No. GD: ☐Yes / ☒No. RO: ☐Yes / ☒No. NCD: ☐Yes / ☒No. NH: ☒Pass/ ☐Fail. DST: ☒Pass/ ☐Fail.
PSDR board								
DC SPS unit +7V	Output s-c C433 s-c	--	DC 650	10 min.	--	--	--	DC Input: 650Vdc / 0A / 0W. AC Output: 230Vac / 0A / 0W. FID: No fault code, PCE stop. MT: N/A SD: ☒Yes / ☐No. GD: ☒Yes / ☐No. RO: ☒Yes / ☐No. NCD: ☒Yes / ☐No. NH: ☒Pass/ ☐Fail. DST: ☒Pass/ ☐Fail.
Power supply transformer	C435 s-c +12V s-c	--	DC 650	10 min.	--	--	--	DC Input: 650Vdc / 0A / 0W. AC Output: 230Vac / 0A / 0W. FID: No fault code, PCE stop. MT: N/A SD: ☒Yes / ☐No. GD: ☒Yes / ☐No. RO: ☒Yes / ☐No. NCD: ☒Yes / ☐No. NH: ☒Pass/ ☐Fail. DST: ☒Pass/ ☐Fail.

FID	Fault Indication	MT	Max. Temperature
SD	PCE Shut Down:	GD	Disconnection To Grid
RO	Recovered to Operate after removing the single fault setting	NCD	No comp. or parts damaged
NH	No hazards occurred	DST	Dielectric strength test
s-c	short-circuited	o-c	open-circuited
o-l	Over-load.		

The errors in the control circuit simulate that the safety is even under one error ensured.

Addendum – Shutdown device	
Each active phase can be switched. (L and N)	Yes. In each line and neutral a Relay with min. 2,3 mm gab used.
If no galvanic separation between AC and DC (PV): Two relays in series on each active phase are necessary to fulfil the basic insulation or simple separation based on the PV working voltage.	Two relays in series on each active phase
Note: The tests had been performed on the HESS-HY-T-10K are valid for the HESS-HY-T-05K, HESS-HY-T-06K, HESS-HY-T-08K, HESS-HY-T1-05K, HESS-HY-T1-06K, HESS-HY-T1-08K, HESS-HY-T1-10K since it is almost same as in hardware and just power derated by software.	

Operating Range: This test should be carried out as specified in A.1.2.10	**P**

Test result: HESS-HY-T-10K

Setting values	Over-voltage [V]:	253,0
	Under-voltage [V]:	195,5
	Over-frequency [Hz]:	52,0
	Under-frequency [Hz]:	47,0

- Test 1: U = 195,5 V; f = 47,0 Hz; P = 1,00 Sn; cosφ = 1; at least 20 seconds
- Test 2: U = 195,5 V; f = 47,5 Hz; P = 1,00 Sn; cosφ = 1; at least 90 mins
- Test 3: U = 253,0 V; f = 51,5 Hz; P = 1,00 Sn; cosφ = 1; at least 90 mins
- Test 4: U = 253,0 V; f = 52,0 Hz; P = 1,00 Sn; cosφ = 1; at least 15 mins
- Test 5: U = 230,0 V; f = 50,0 Hz; P = 1,00 Sn; cosφ = 1; at least 90 mins
- Test 6: U = 230,0 V; f = 50,0 to 50,5 Hz; RoCoF=1Hz/s; P = 1,00 Sn; cosφ = 1

Test sequence	Voltage [V]	Frequency [Hz]	Output power [kW]	Cos φ [1]
1	195,5	47,00	9,49	0,999
2	195,4	47,50	9,67	1,000
3	252,9	51,50	9,93	1,000
4	252,9	52,00	9,93	0,999
5	229,9	50,00	9,99	0,999
6	229,7	50,00 to 50,50	9,95	1,000

Note:

During the tests the interface protection was disabled.

Operation at reduced power is allowed during test 1 and 2, equal to the maximum power that can be supplied on reaching the maximum output current limit (P ≥ 0,85 Sn).

During the sequence of test 3 and test 4 automatic adjustment to reduce power in the case of over-frequency was disabled.

The tests had been performed on the HESS-HY-T-10K are valid for the HESS-HY-T-05K, HESS-HY-T-06K, HESS-HY-T-08K, HESS-HY-T1-05K, HESS-HY-T1-06K, HESS-HY-T1-08K, HESS-HY-T1-10K since it is almost same as in hardware and just power derated by software.

A 1.2.2/A 2.2.2 Over / Under Voltage The test procedure in Annex A.1.2.2 (Inverter connected) or Annex A2 A.2.2.2 (Synchronous).	**P**

Test result: HESS-HY-T-10K

Phase 1

Function	Setting		Trip test		No trip test	
	Voltage	Time delay	Voltage	Time delay	Voltage / time	Confirm no trip
U/V	184,0V	2,5s	183,7V	2,568s	188V / 5,0s	No trip
					180V / 2,45s	No trip
O/V stage 1	262,2V	1,0s	262,7V	1,010s	258,2V / 5,0s	No trip
O/V stage 2	273,7V	0,5s	274,8V	0,501s	269,7V / 0,95s	No trip
					277,7V / 0,45s	No trip

Phase 2

Function	Setting		Trip test		No trip test	
	Voltage	Time delay	Voltage	Time delay	Voltage / time	Co=nfirm no trip
U/V	184,0V	2,5s	183,7V	2,564s	188V / 5,0s	No trip
					180V / 2,45s	No trip
O/V stage 1	262,2V	1,0s	262,7V	1,001s	258,2V / 5,0s	No trip
O/V stage 2	273,7V	0,5s	275,2V	0,506s	269,7V / 0,95s	No trip
					277,7V / 0,45s	No trip

Phase 3

Function	Setting		Trip test		No trip test	
	Voltage	Time delay	Voltage	Time delay	Voltage / time	Confirm no trip
U/V	184,0V	2,5s	182,7	2,570s	188V / 5,0s	No trip
					180V / 2,45s	No trip
O/V stage 1	262,2V	1,0s	261,9	1,004s	258,2V / 5,0s	No trip
O/V stage 2	273,7V	0,5s	272,8	0,508s	269,7V / 0,95s	No trip
					277,7V / 0,45s	No trip

Note:

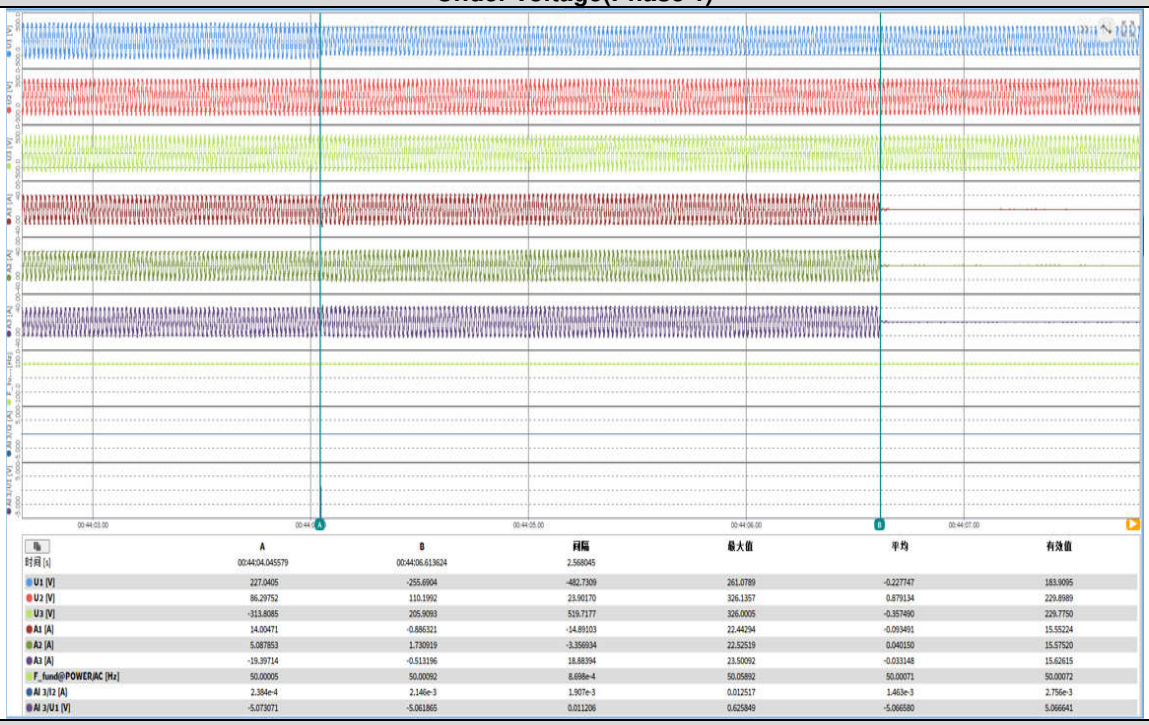
The total disconnection time for voltage and frequency protection, including the operating time of the disconnection device, shall be the time delay setting with a tolerance of, -0s + 0,5 s.

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 HESS-HY-T-10K are valid for the HESS-HY-T-05K, HESS-HY-T-06K,

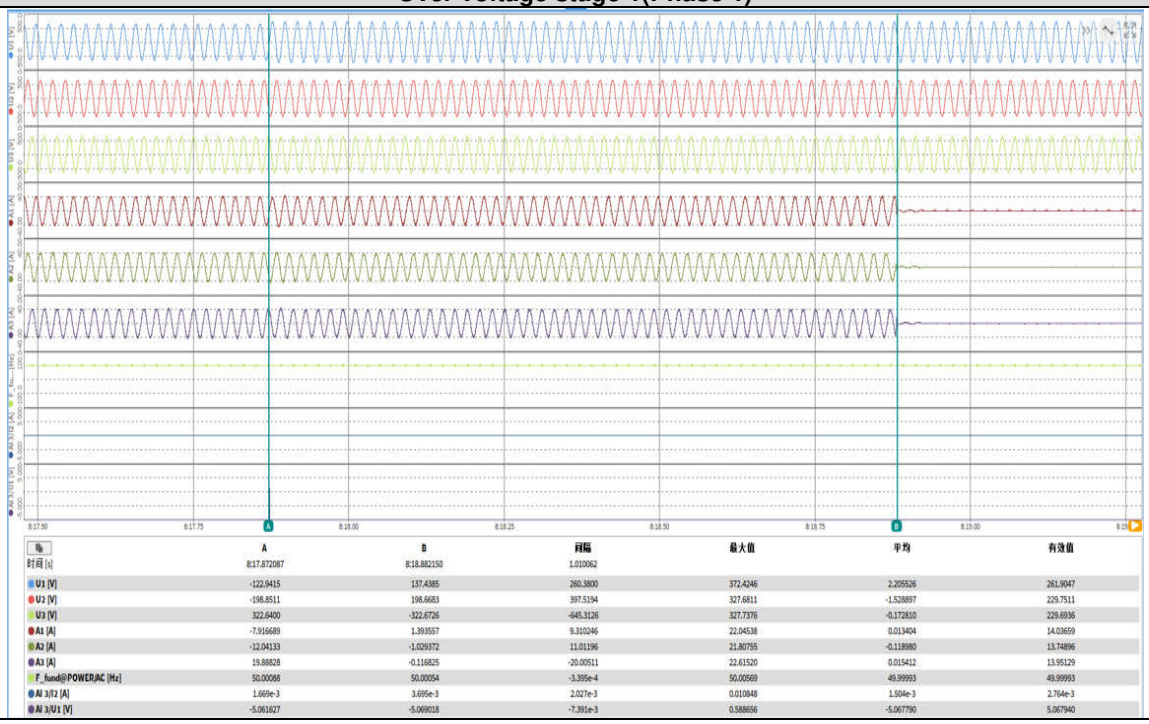
HESS-HY-T-08K, HESS-HY-T1-05K, HESS-HY-T1-06K, HESS-HY-T1-08K, HESS-HY-T1-10K since it is almost same as in hardware and just power derated by software.

Under voltage(Phase 1)



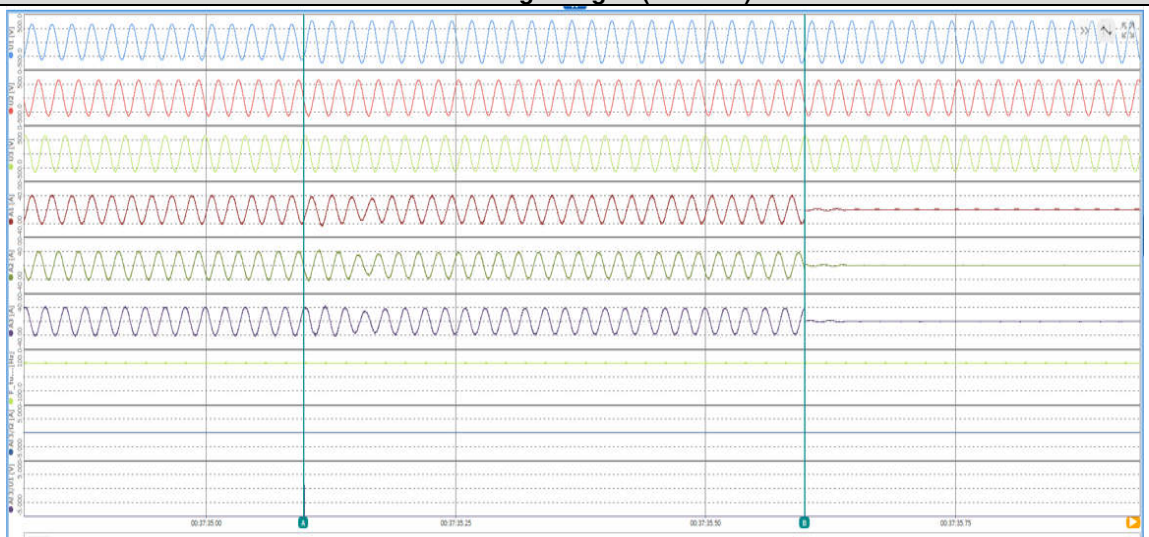
时间 [s]	A 00:44:04.045579	B 00:44:06.613624	间隔 2.568045	最大值	平均	有效值
U1 [V]	227.0405	-255.6904	-482.7309	261.0789	-0.227747	183.9095
U2 [V]	86.29752	110.1992	23.90170	326.1357	0.879134	229.8989
U3 [V]	-313.8085	205.9093	519.7177	326.0005	-0.357490	229.7750
A1 [A]	14.00471	-0.886321	-14.89103	22.44294	-0.093491	15.55224
A2 [A]	5.087853	1.730919	-3.356934	22.52519	0.040150	15.57520
A3 [A]	-19.39714	-0.513196	18.88394	23.50092	-0.033148	15.62615
F_fund@POWER,IAC [Hz]	50.00005	50.00092	8.698e-4	50.05892	50.00071	50.00072
AI 3/I2 [A]	2.384e-4	2.146e-3	1.907e-3	0.012517	1.463e-3	2.756e-3
AI 3/U1 [V]	-5.073071	-5.061865	0.011206	0.625849	-5.066580	5.066641

Over voltage stage 1(Phase 1)



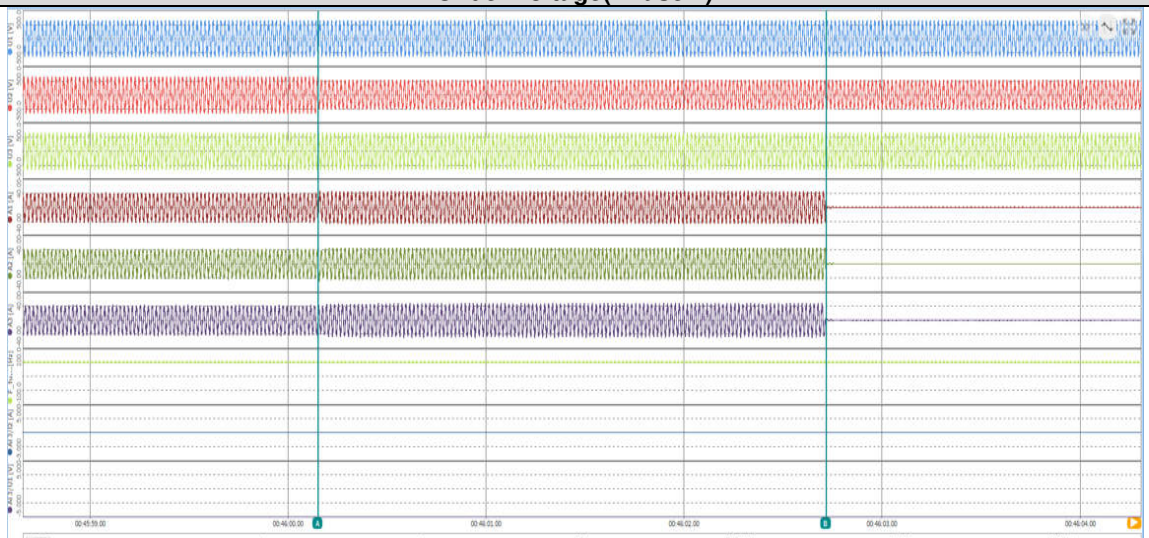
时间 [s]	A 8:17.872087	B 8:18.882150	间隔 1.010062	最大值	平均	有效值
U1 [V]	-122.9415	137.4385	260.3800	372.4246	2.205526	261.9047
U2 [V]	-198.8511	198.6683	397.5194	327.6811	-1.528897	229.7511
U3 [V]	322.6400	-322.6726	-645.3126	327.7376	-0.172810	229.6936
A1 [A]	-7.916689	1.393557	9.310246	22.04538	0.013404	14.03659
A2 [A]	-12.04133	-1.029372	11.01196	21.80755	-0.118980	13.74896
A3 [A]	19.88828	-0.116825	-20.00511	22.61520	0.015412	13.95129
F_fund@POWER,IAC [Hz]	50.00068	50.00054	-3.395e-4	50.00569	49.99993	49.99993
AI 3/I2 [A]	1.669e-3	3.695e-3	2.027e-3	0.010848	1.504e-3	2.764e-3
AI 3/U1 [V]	-5.061627	-5.069018	-7.391e-3	0.588656	-5.067790	5.067940

Over voltage stage 2(Phase 1)



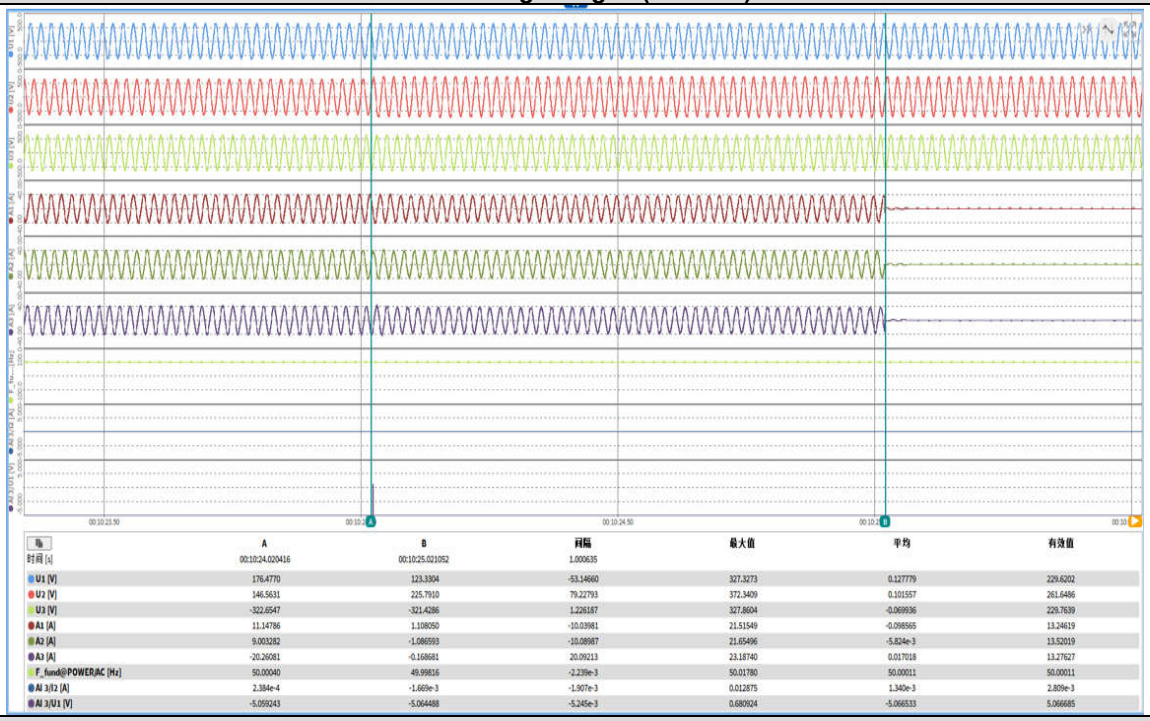
时间 [s]	A 00:37:35.098059	B 00:37:35.599375	间隔 0.501315	最大值	平均	有效值
U1 [V]	-286.3276	-234.1082	52.21939	388.5026	-0.587470	273.2108
U2 [V]	8.158207	-119.1216	-127.2798	326.4294	-0.050810	229.4190
U3 [V]	278.7237	316.9644	38.24067	326.2787	0.916771	229.8050
A1 [A]	-18.21816	-1.594424	16.62374	21.45827	-0.183281	13.74982
A2 [A]	0.615716	0.459552	-0.156164	22.42983	0.032035	13.41636
A3 [A]	17.76755	0.838041	-16.92951	22.33803	0.066092	13.61374
F_fund@POWER/AC [Hz]	50.00151	49.99817	-3.342e-3	50.07368	49.99958	49.99959
AI 3/I2 [A]	3.576e-4	1.073e-3	7.153e-4	0.011921	1.499e-3	2.772e-3
AI 3/U1 [V]	-5.069971	-5.072356	-2.384e-3	0.683546	-5.066815	5.067114

Under voltage(Phase 2)



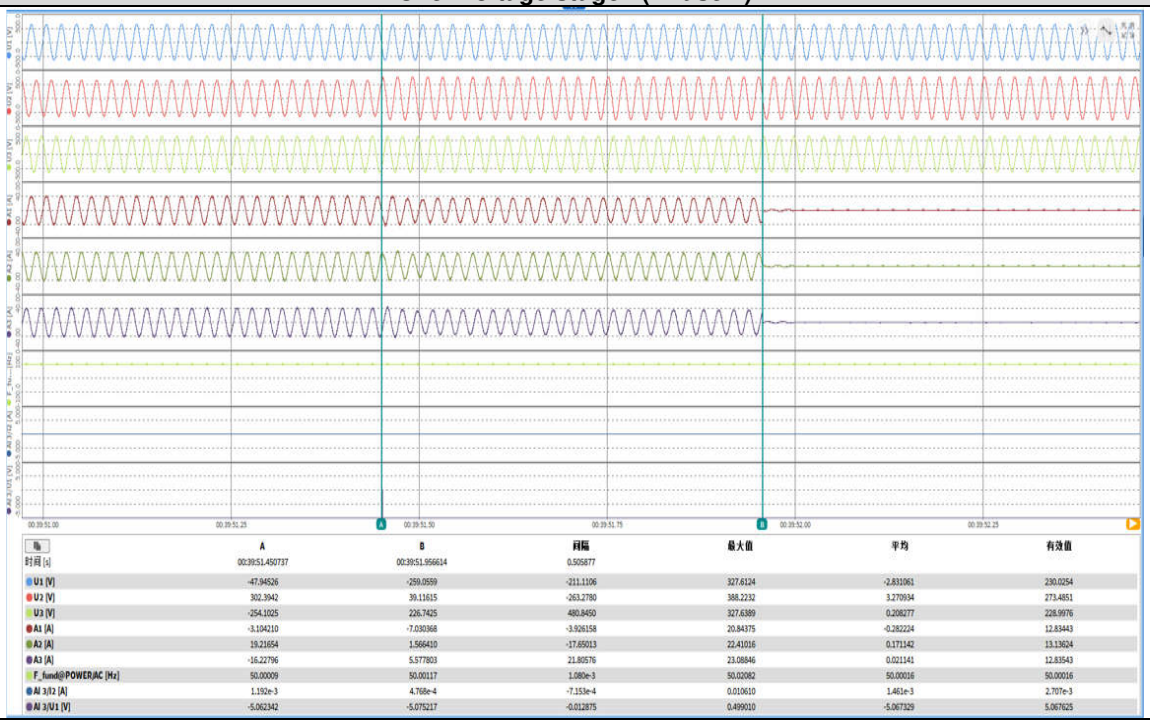
时间 [s]	A 00:46:00.152745	B 00:46:02.717141	间隔 2.564396	最大值	平均	有效值
U1 [V]	-316.3507	6.987334	323.3381	326.0091	-0.272997	229.8274
U2 [V]	96.09151	-227.5098	-323.6013	260.9332	-0.076736	183.8144
U3 [V]	220.0358	277.4720	57.43623	326.1936	0.574506	229.9892
A1 [A]	-20.34128	-1.392961	18.94832	23.18919	-0.046173	16.00575
A2 [A]	6.140471	0.458360	-5.682111	23.20171	-0.015550	16.14222
A3 [A]	14.10961	0.728369	-13.38124	23.51344	-0.023646	16.23078
F_fund@POWER/AC [Hz]	50.00030	49.86263	-0.137672	50.01498	49.99947	49.99947
AI 3/I2 [A]	-1.192e-3	4.053e-3	5.245e-3	0.012755	1.380e-3	2.864e-3
AI 3/U1 [V]	-5.068779	-5.066157	2.623e-3	0.539541	-5.066906	5.066967

Over voltage stage 1(Phase 2)



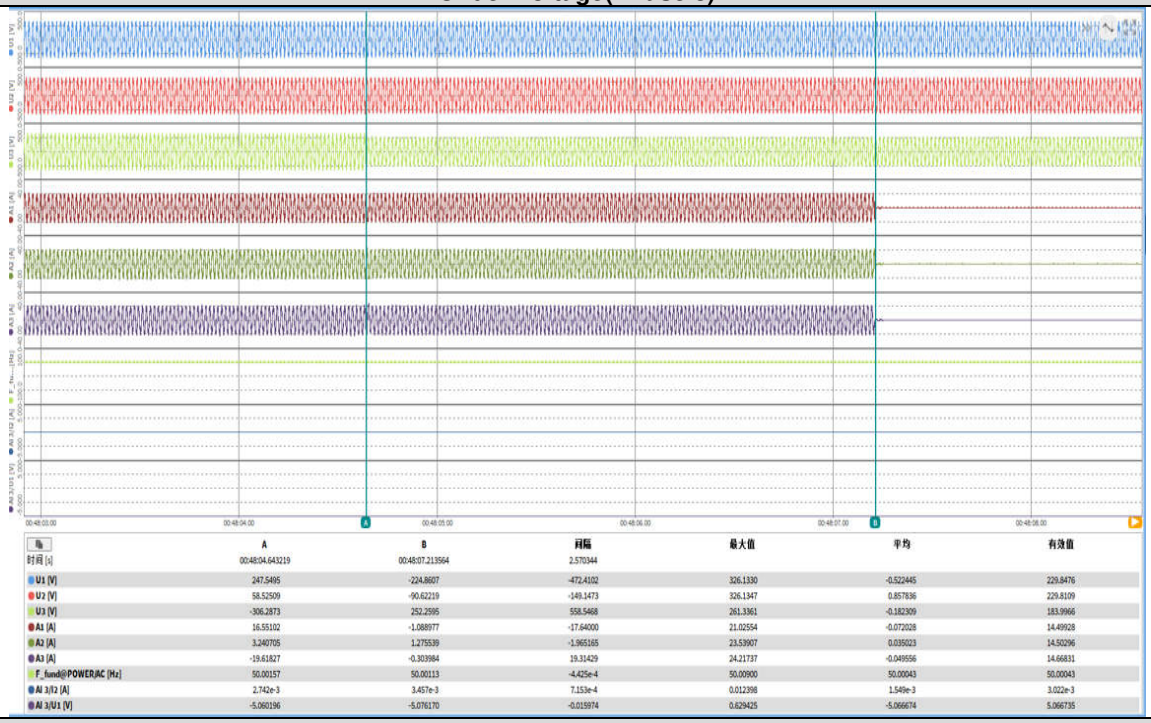
时间 [s]	A 00:10:24.020416	B 00:10:25.021052	间隔 1.000635	最大值	平均	有效值
U1 [V]	176.4770	123.3304	-53.14660	327.3273	0.127779	229.6202
U2 [V]	146.5631	225.7910	79.22793	372.3409	0.101557	261.6486
U3 [V]	-322.6547	-321.4286	1.226187	327.8604	-0.069936	229.7639
A1 [A]	11.14786	1.108050	-10.03981	21.51549	-0.098565	13.24619
A2 [A]	9.003282	-1.086593	-10.08987	21.65496	-5.824e-3	13.52019
A3 [A]	-20.26081	-0.168681	20.09213	23.18740	0.017018	13.27627
F_fund@POWER/AC [Hz]	50.00040	49.99816	-2.239e-3	50.01780	50.00011	50.00011
AI 3/I2 [A]	2.384e-4	-1.669e-3	-1.907e-3	0.012875	1.340e-3	2.809e-3
AI 3/U1 [V]	-5.059243	-5.064488	-5.245e-3	0.680924	-5.066533	5.066685

Over voltage stage 2(Phase 2)



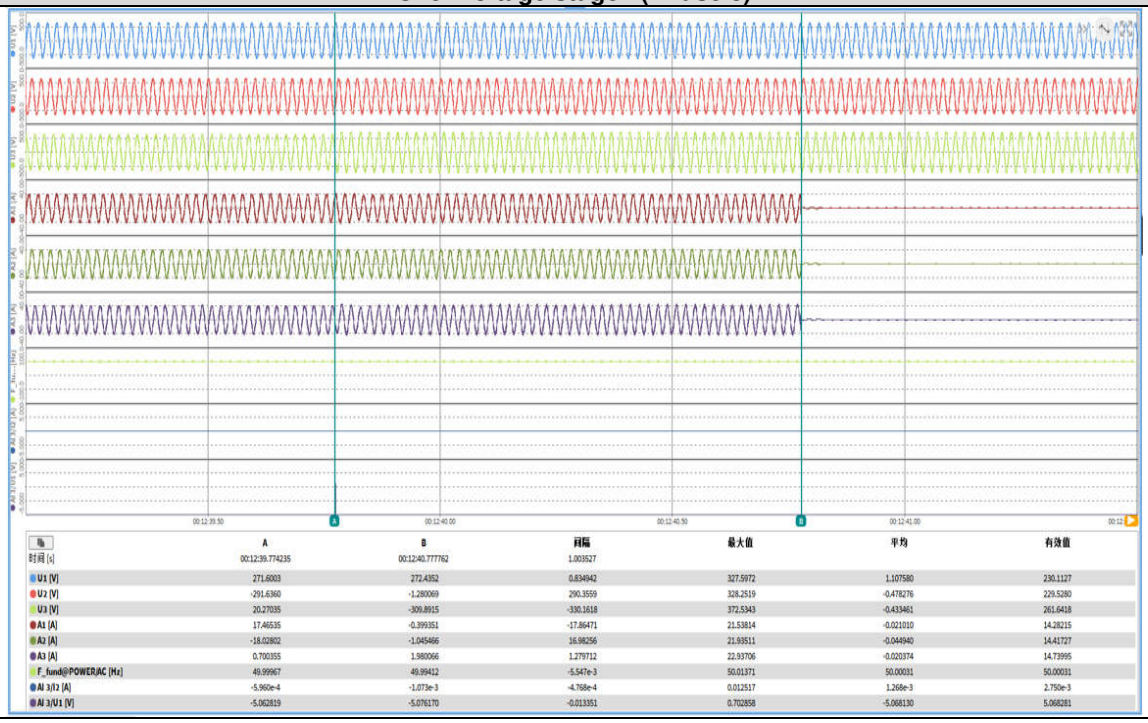
时间 [s]	A 00:39:51.450737	B 00:39:51.956614	间隔 0.505877	最大值	平均	有效值
U1 [V]	-47.94526	-259.0559	-211.1106	327.6124	-2.831061	230.0254
U2 [V]	302.3942	39.11615	-263.2780	388.2232	3.270934	273.4851
U3 [V]	-254.1025	226.7425	480.8450	327.6389	0.208277	228.9976
A1 [A]	-3.104210	-7.030368	-3.926158	20.84375	-0.282224	12.83443
A2 [A]	19.21654	1.566410	-17.65013	22.41016	0.171142	13.13624
A3 [A]	-16.22796	5.577803	21.80576	23.08846	0.021141	12.83543
F_fund@POWER/AC [Hz]	50.00009	50.00117	1.080e-3	50.02082	50.00016	50.00016
AI 3/I2 [A]	1.192e-3	4.768e-4	-7.153e-4	0.010610	1.461e-3	2.707e-3
AI 3/U1 [V]	-5.062342	-5.075217	-0.012875	0.499010	-5.067329	5.067625

Under voltage(Phase 3)



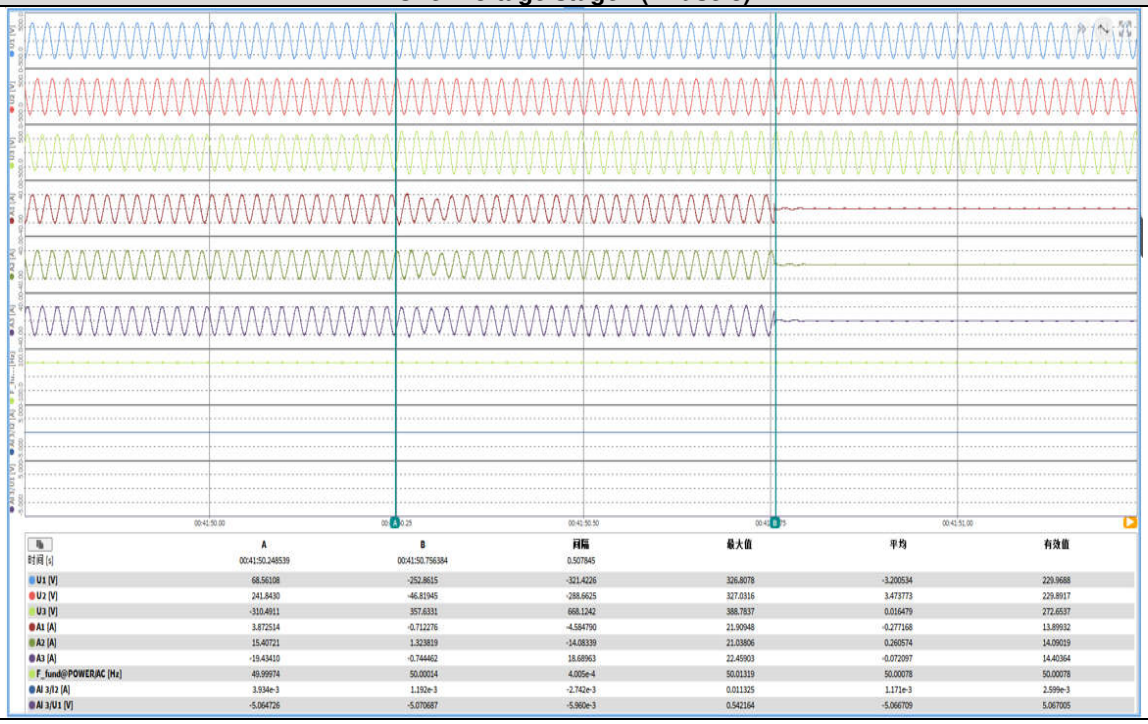
时间 [s]	A 00:48:04.643219	B 00:48:07.213564	间隔 2.570344	最大值	平均	有效值
U1 [V]	247.5495	-224.8607	-472.4102	326.1330	-0.522445	229.8476
U2 [V]	58.52509	-90.62219	-149.1473	326.1347	0.857836	229.8109
U3 [V]	-306.2873	252.2595	558.5468	261.3361	-0.182309	183.9966
A1 [A]	16.55102	-1.088977	-17.64000	21.02554	-0.072028	14.49928
A2 [A]	3.240705	1.275539	-1.965165	23.53907	0.035023	14.50296
A3 [A]	-19.61827	-0.303984	19.31429	24.21737	-0.049556	14.66831
F_fund@POWER/AC [Hz]	50.00157	50.00113	-4.425e-4	50.00900	50.00043	50.00043
AI 3/I2 [A]	2.742e-3	3.457e-3	7.153e-4	0.012398	1.549e-3	3.022e-3
AI 3/U1 [V]	-5.060196	-5.076170	-0.015974	0.629425	-5.066674	5.066735

Over voltage stage 1(Phase 3)



时间 [s]	A 00:12:39.774235	B 00:12:40.777762	间隔 1.003527	最大值	平均	有效值
U1 [V]	271.6003	272.4352	0.834942	327.5972	1.107580	230.1127
U2 [V]	-291.6360	-1.280069	290.3559	328.2519	-0.478276	229.5280
U3 [V]	20.27035	-309.8915	-330.1618	372.5343	-0.433461	261.6418
A1 [A]	17.46535	-0.399351	-17.86471	21.53814	-0.021010	14.28215
A2 [A]	-18.02802	-1.045466	16.98256	21.93511	-0.044940	14.41727
A3 [A]	0.700355	1.980066	1.279712	22.93706	-0.020374	14.73995
F_fund@POWER/AC [Hz]	49.99967	49.99412	-5.547e-3	50.01371	50.00031	50.00031
AI 3/I2 [A]	-5.960e-4	-1.073e-3	-4.768e-4	0.012517	1.268e-3	2.750e-3
AI 3/U1 [V]	-5.062819	-5.076170	-0.013351	0.702858	-5.068130	5.068281

Over voltage stage 2(Phase 3)



时间 (s)	A 00:41:50.248539	B 00:41:50.756384	间隔 0.507845	最大值	平均	有效值
U1 [V]	68.56108	-252.8615	-321.4226	326.8078	-3.200534	229.9688
U2 [V]	241.8430	-46.81945	-288.6625	327.0316	3.473773	229.8917
U3 [V]	-310.4911	357.6331	668.1242	388.7837	0.016479	272.6537
A1 [A]	3.872514	-0.712276	-4.584790	21.90948	-0.277168	13.89932
A2 [A]	15.40721	1.323819	-14.08339	21.03806	0.260574	14.09019
A3 [A]	-19.43410	-0.744462	18.68963	22.45903	-0.072097	14.40364
F_fund@POWER/AC [Hz]	49.99974	50.00014	4.005e-4	50.01319	50.00078	50.00078
AI 3/I2 [A]	3.934e-3	1.192e-3	-2.742e-3	0.011325	1.171e-3	2.599e-3
AI 3/U1 [V]	-5.064726	-5.070687	-5.960e-3	0.542164	-5.066709	5.067005

A 1.2.3/A 2.2.3 Over / Under Frequency The test procedure in Annex A.1.2.3 (Inverter connected) or Annex A2 A.2.2.3 (Synchronous).						**P**
Test result: HESS-HY-T-10K						
Function	Setting		Trip test		No trip test	
	Frequency	Time delay	Frequency	Time delay	Frequency / time	Confirm no trip
U/F stage 1	47,5Hz	20s	47,50Hz	20,060s	47,7Hz / 30s	No trip
U/F stage 2	47Hz	0,5s	47,00Hz	0,549s	47,2Hz / 19,5s	No trip
					46,8 Hz / 0,45s	No trip
O/F	52Hz	0,5s	52,00Hz	0,560s	51,8Hz / 120,0s	No trip
					52,2 Hz / 0,45s	No trip

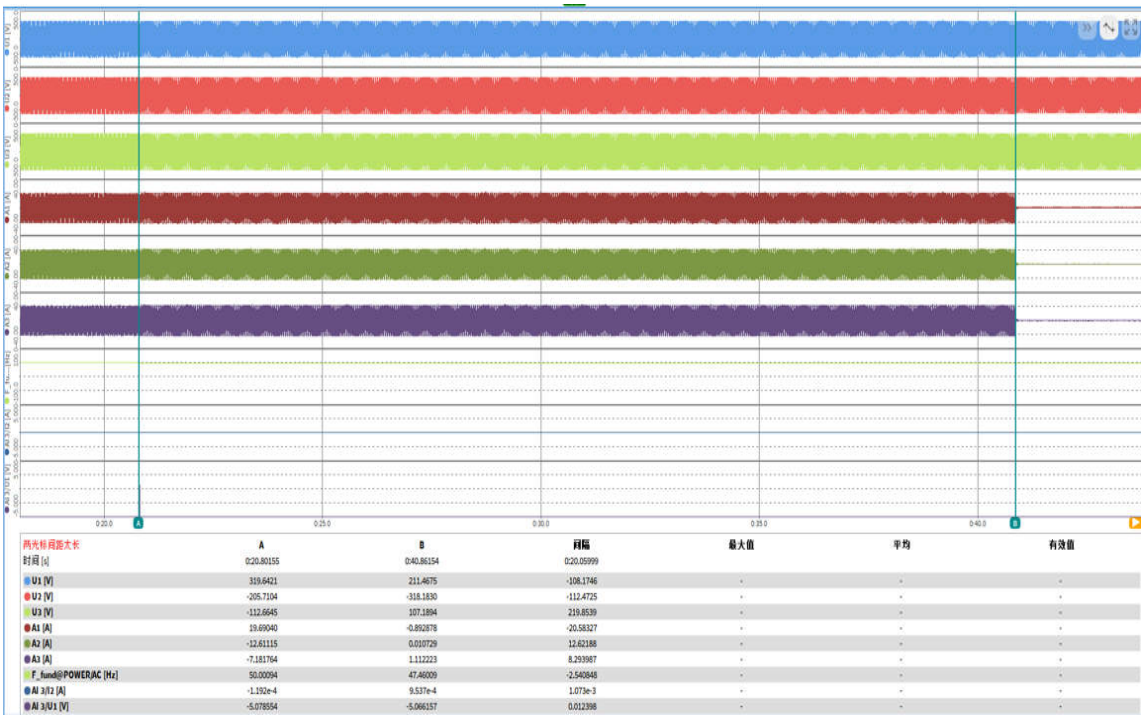
Note:

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 + 0,5 s.

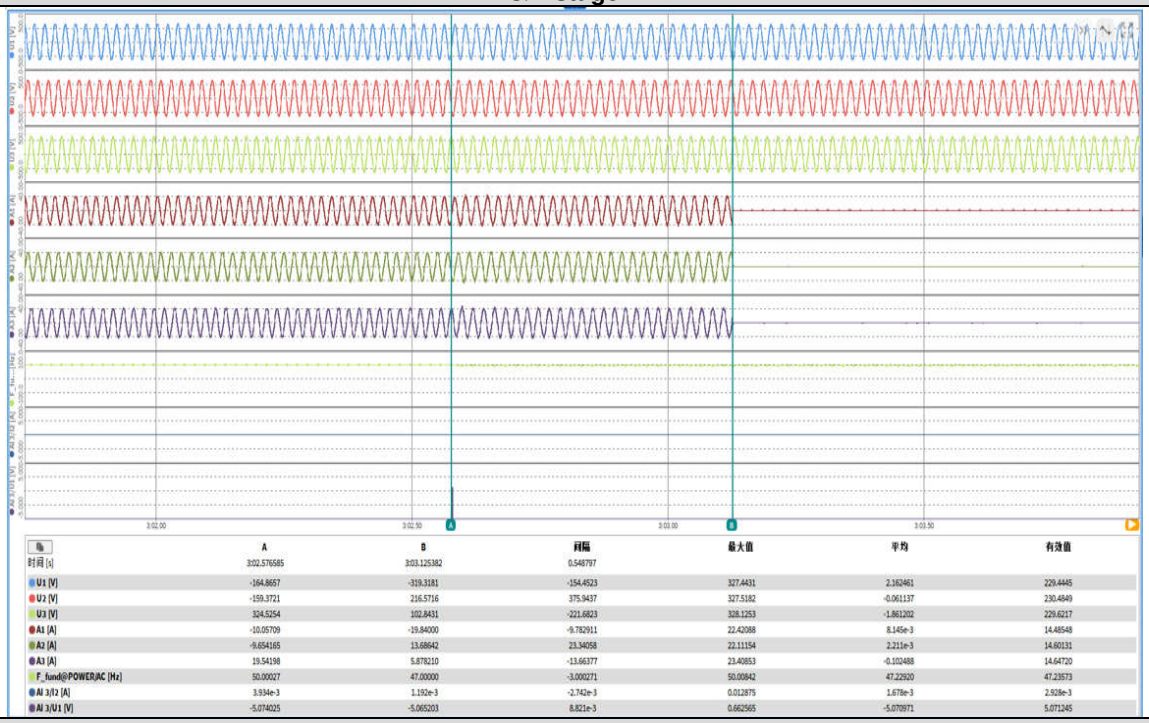
For frequency trip tests the frequency required to trip is the setting ± 0,5 Hz. In order to measure the time delay a larger deviation than the minimum required to operate the projection can be used. The “No trip tests” need to be carried out at the setting ± 0,2 Hz and for the relevant times as shown in the table above to ensure that the protection will not trip in error.

The tests had been performed on the HESS-HY-T-10K are valid for the HESS-HY-T-05K, HESS-HY-T-06K, HESS-HY-T-08K, HESS-HY-T1-05K, HESS-HY-T1-06K, HESS-HY-T1-08K, HESS-HY-T1-10K since it is almost same as in hardware and just power derated by software.

U/F stage 1

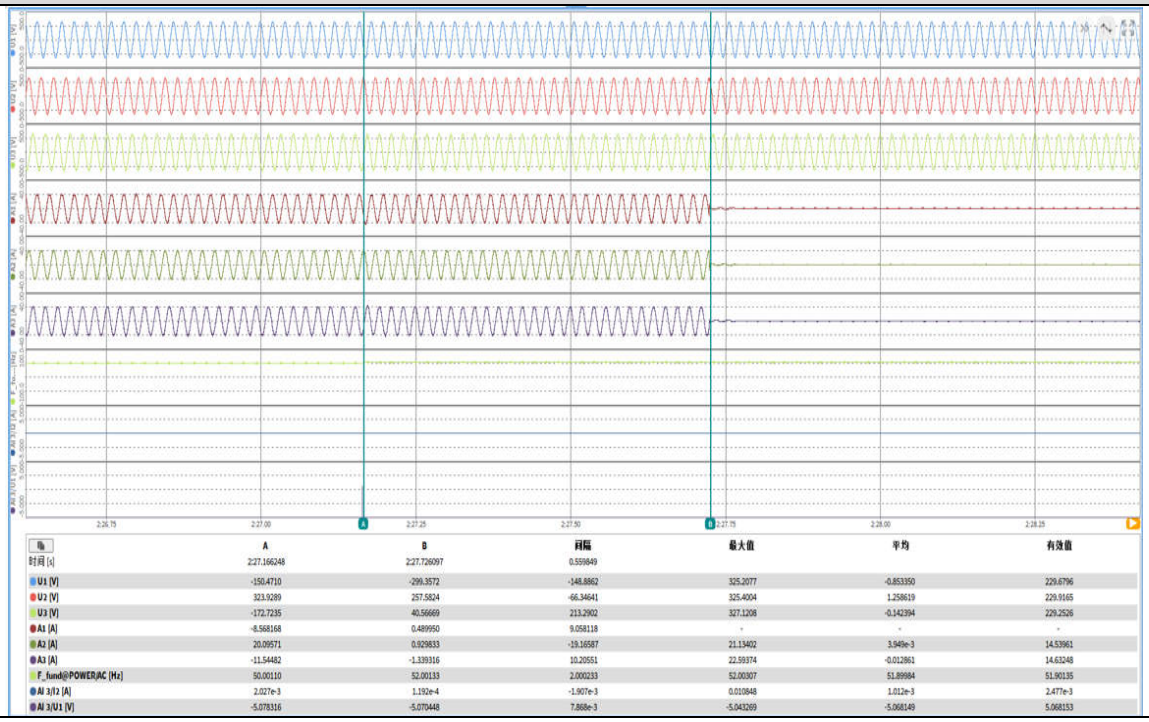


U/F stage 2



时间 (s)	A	B	间隔	最大值	平均	有效值
	3'02.576585	3'03.125382	0.548797			
U1 (V)	-164.8657	-319.3181	-154.4523	327.4431	2.162461	229.4445
U2 (V)	-159.3721	216.5716	375.9437	327.5182	-0.061137	230.4849
U3 (V)	324.5254	102.8431	-221.6823	328.1253	-1.861202	229.6217
A1 (A)	-10.05709	-19.84000	-9.782911	22.42088	8.145e-3	14.48548
A2 (A)	-9.654165	13.68642	23.34058	22.11154	2.211e-3	14.60131
A3 (A)	19.54198	5.878210	-13.66377	23.40853	-0.102488	14.64720
F_fund@POWER/AC (Hz)	50.00027	47.00000	-3.000271	50.00842	47.22920	47.23573
AI 3/I2 (A)	3.934e-3	1.192e-3	-2.742e-3	0.012875	1.678e-3	2.928e-3
AI 3/U1 (V)	-5.074025	-5.065203	8.821e-3	0.662565	-5.070971	5.071245

O/F



时间 (s)	A	B	间隔	最大值	平均	有效值
	2'27.166248	2'27.726097	0.559849			
U1 (V)	-150.4710	-299.3572	-148.8862	325.2077	-0.853350	229.6796
U2 (V)	323.9289	257.5824	-66.34641	325.4004	1.258619	229.9165
U3 (V)	-172.7235	40.56669	213.2902	327.1208	-0.142394	229.2526
A1 (A)	-8.568168	0.489950	9.058118	-	-	-
A2 (A)	20.09571	0.929833	-19.16587	21.13402	3.949e-3	14.53961
A3 (A)	-11.54482	-1.339316	10.20551	22.59374	-0.012861	14.63248
F_fund@POWER/AC (Hz)	50.00110	52.00133	2.000233	52.00307	51.89984	51.90135
AI 3/I2 (A)	2.027e-3	1.192e-4	-1.907e-3	0.010848	1.012e-3	2.477e-3
AI 3/U1 (V)	-5.078316	-5.070448	7.868e-3	-5.043269	-5.068149	5.068153

A 1.2.4 Loss of mains protection according BS EN 62116 The requirement is specified in section 10.2, test procedure in Annex A.1.2.4 Load imbalance (real, reactive load) for test condition A (EUT output = 100%)	**P**

Test result: HESS-HY-T-10K

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

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)	I_{AC} [4] [A]	Run on Time (ms)	P_{EUT} (kW)	Qf	V_{DC}	Remarks[5]
1	100	100	0	0	0,009	466,6	10,0	1,000	762,5	Test A at BL
4	100	100	-5	-5	--	310,0	10,0	1,026	762,5	Test A at IB
5	100	100	-5	0	--	426,1	10,0	1,053	762,5	Test A at IB
6	100	100	-5	+5	--	299,5	10,0	1,079	762,5	Test A at IB
7	100	100	0	-5	--	400,3	10,0	0,975	762,5	Test A at IB
8	100	100	0	+5	--	390,3	10,0	1,025	762,5	Test A at IB
9	100	100	+5	-5	--	364,5	10,0	0,928	762,5	Test A at IB
10	100	100	+5	0	--	424,8	10,0	0,952	762,5	Test A at IB
11	100	100	+5	+5	--	377,9	10,0	0,976	762,5	Test A at IB

Parameter at 0%	L= 50,54mH	R= 15,87Ω	C= 200,68µF

Indicate additional shut down time included in above results. (Disconnection device operation time)	20ms

Note:

Note for technologies which have a substantial shut down time this can be added to the 0,5 seconds in establishing that the trip occurred in less than 0,5 s. Maximum shut down time could therefore be up to 1,0 seconds for these technologies.

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] Fundamental of I_{AC} when RLC is adjusted.

[5] BL: Balance condition, IB: Imbalance condition.

Condition A:

EUT output power PEUT = Maximum [5]

EUT input voltage [6] = >75% of rated input voltage range

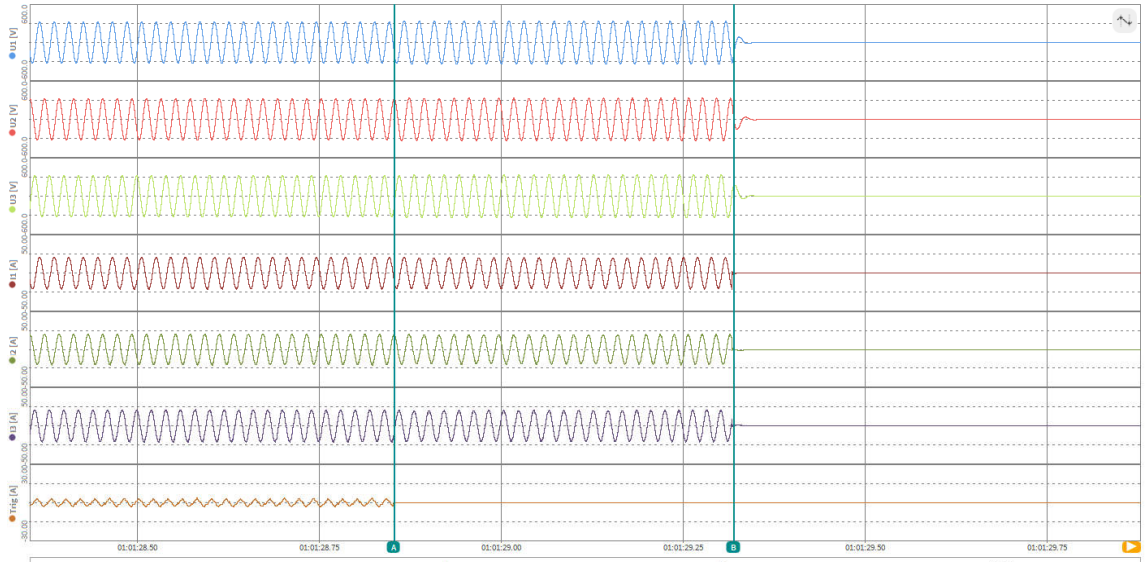
[6] Maximum EUT output power condition should be achieved using the maximum allowable input power. Actual output power may exceed nominal rated output.

[7] 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 HESS-HY-T-10K are valid for the HESS-HY-T-05K, HESS-HY-T-06K, HESS-HY-T-08K, HESS-HY-T1-05K, HESS-HY-T1-06K, HESS-HY-T1-08K, HESS-HY-T1-10K 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 100% nominal power
Disconnection at No. 1



	A	B	间隔
时间 [s]	01:01:28.852533	01:01:29.319121	0.466588
U1 [V]	-109.6544	-198.4553	-88.80091
U2 [V]	321.6303	38.20157	-283.4287
U3 [V]	-213.2363	160.9335	374.1698
I1 [A]	-7.776857	-0.887632	6.889224
I2 [A]	18.75448	0.710487	-18.04400
I3 [A]	-10.90074	0.278234	11.17897
Trig [A]	-0.194550	-4.292e-3	0.190258

A 1.2.4 Loss of mains protection according BS EN 62116 The requirement is specified in section 10.2, test procedure in Annex A.1.2.4 Load imbalance (real, reactive load) for test condition A (EUT output = 50 % – 66 %)	**P**

Test result: HESS-HY-T-10K

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

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)	I_{AC} 4) [A]	Run on Time (ms)	P_{EUT} (kW)	Qf	V_{DC}	Remarks5)
12	66	66	0	-5	--	277,5	6,60	0,975	575,0	Test B at IB
13	66	66	0	-4	--	292,5	6,60	0,980	575,0	Test B at IB
14	66	66	0	-3	--	299,3	6,60	0,985	575,0	Test B at IB
15	66	66	0	-2	--	308,7	6,60	0,990	575,0	Test B at IB
16	66	66	0	-1	--	343,6	6,60	0,995	575,0	Test B at IB
2	66	66	0	0	0,016	407,4	6,60	1,000	575,0	Test B at BL
17	66	66	0	1	--	268,9	6,60	1,010	575,0	Test B at IB
18	66	66	0	2	--	259,7	6,60	1,015	575,0	Test B at IB
19	66	66	0	3	--	238,4	6,60	1,020	575,0	Test B at IB
20	66	66	0	4	--	211,9	6,60	1,025	575,0	Test B at IB
21	66	66	0	5	--	199,4	6,60	1,010	575,0	Test B at IB

Parameter at 0%	L= 76,58mH	R= 24,05Ω	C= 132,45µF

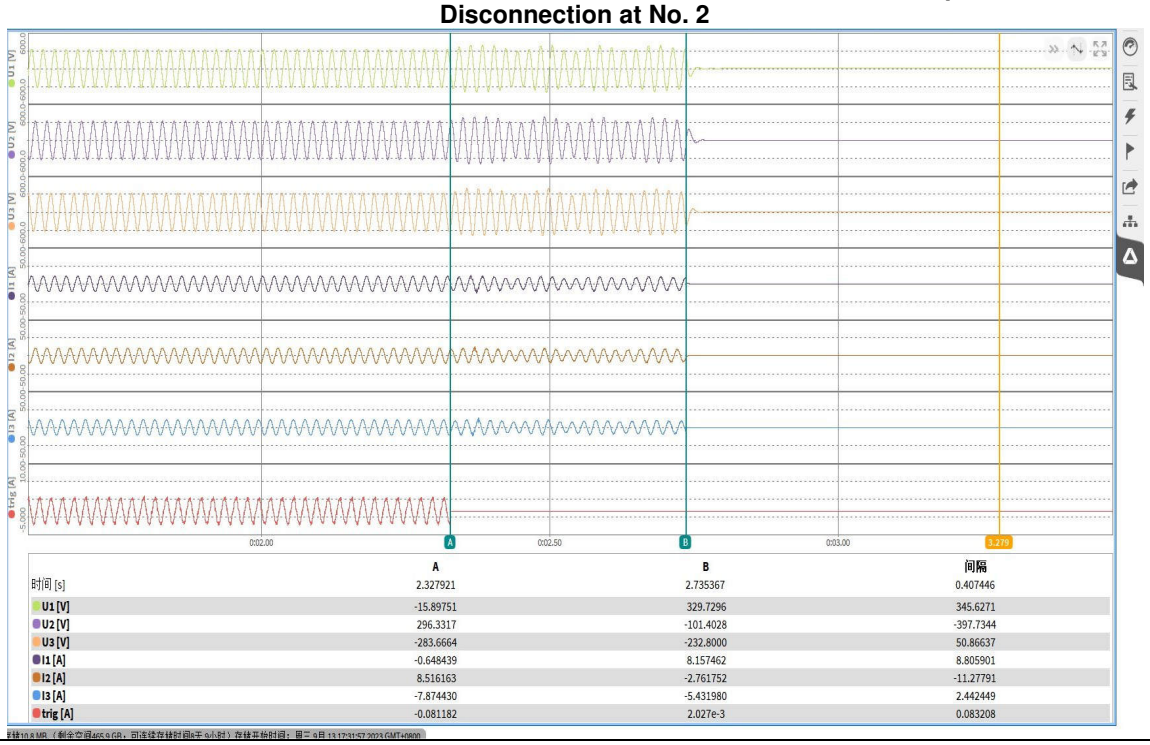
Indicate additional shut down time included in above results. (Disconnection device operation time)	20ms

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) Fundamental of I_{AC} when RLC is adjusted.
5) 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 %
6) 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 HESS-HY-T-10K are valid for the HESS-HY-T-05K, HESS-HY-T-06K, HESS-HY-T-08K, HESS-HY-T1-05K, HESS-HY-T1-06K, HESS-HY-T1-08K, HESS-HY-T1-10K 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	B	间隔
时间 [s]	2.327921	2.735367	0.407446
U1 [V]	-15.89751	329.7296	345.6271
U2 [V]	296.3317	-101.4028	-397.7344
U3 [V]	-283.6664	-232.8000	50.86637
I1 [A]	-0.648439	8.157462	8.805901
I2 [A]	8.516163	-2.761752	-11.27791
I3 [A]	-7.874430	-5.431980	2.442449
trig [A]	-0.081182	2.027e-3	0.083208

A 1.2.4 Loss of mains protection according BS EN 62116 The requirement is specified in section 10.2, test procedure in Annex A.1.2.4 Load imbalance (real, reactive load) for test condition A (EUT output = 25 % – 33 %)	**P**

Test result: HESS-HY-T-10K

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

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)	I_{AC} 4) [A]	Run on Time (ms)	P_{EUT} (kW)	Qf	V_{DC}	Remarks5)
22	33	33	0	-5	--	130,5	3,30	0,975	350,0	Test C at IB
23	33	33	0	-4	--	136,9	3,30	0,980	350,0	Test C at IB
24	33	33	0	-3	--	140,8	3,30	0,985	350,0	Test C at IB
25	33	33	0	-2	--	416,2	3,30	0,990	350,0	Test C at IB
26	33	33	0	-1	--	439,6	3,30	0,995	350,0	Test C at IB
3	33	33	0	0	0,043	472,7	3,30	1,000	350,0	Test C at BL
27	33	33	0	1	--	380,0	3,30	1,010	350,0	Test C at IB
28	33	33	0	2	--	348,5	3,30	1,015	350,0	Test C at IB
29	33	33	0	3	--	315,1	3,30	1,020	350,0	Test C at IB
30	33	33	0	4	--	260,0	3,30	1,025	350,0	Test C at IB
31	33	33	0	5	--	129,0	3,30	1,010	350,0	Test C at IB

Parameter at 0%	L= 153,16mH	R= 48,09Ω	C= 66,22µF

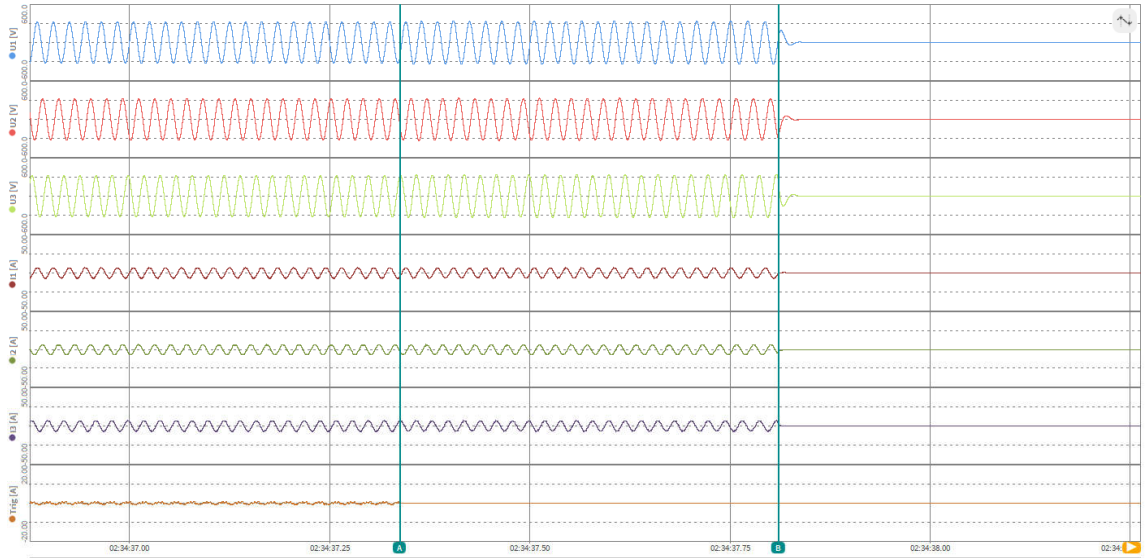
Indicate additional shut down time included in above results. (Disconnection device operation time)	20ms

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) Fundamental of I_{AC} when RLC is adjusted.
5) 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
6) Or minimum allowable EUT output level if greater than 33 %.
7) 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 HESS-HY-T-10K are valid for the HESS-HY-T-05K, HESS-HY-T-06K, HESS-HY-T-08K, HESS-HY-T1-05K, HESS-HY-T1-06K, HESS-HY-T1-08K, HESS-HY-T1-10K 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 33% nominal power
Disconnection at No. 3



时间 [s]	A 02:34:37.33817	B 02:34:37.81092	间隔 0.47274
U1 [V]	-211.0541	120.4858	331.5399
U2 [V]	-109.3235	-232.1301	-122.8066
U3 [V]	320.1640	135.8245	-184.3395
I1 [A]	-4.411221	-0.554919	3.856302
I2 [A]	-2.344132	-0.747442	1.596689
I3 [A]	6.730557	1.250863	-5.479694
Trig [A]	-0.056386	8.345e-4	0.057220

A 1.2.5/A 2.2.5 Reconnection The test procedure in Annex A 1.2.5 (Inverter connected) or Annex A2 A 2.2.5 (Synchronous).	**P**

Test result: HESS-HY-T-10K

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 1.

Under Voltage(188,0V)	
Time delay setting	Measured delay
60s	60,2s
Over Voltage(258,2V)	
Time delay setting	Measured delay
60s	60,2s
Under Frequency(47,6Hz)	
Time delay setting	Measured delay
60s	60,0s
Over Frequency(51,9Hz)	
Time delay setting	Measured delay
60s	60,0s

	Checks on no reconnection when voltage or frequency is brought to just outside stage 1 limits of table 1.			
	At 266,2V	At 180,0V	At 47,4Hz	At 52,1Hz
Confirmation that the unit does not re-connect.	No reconnection	No reconnection	No reconnection	No reconnection

Note:
The tests had been performed on the HESS-HY-T-10K are valid for the HESS-HY-T-05K, HESS-HY-T-06K, HESS-HY-T-08K, HESS-HY-T1-05K, HESS-HY-T1-06K, HESS-HY-T1-08K, HESS-HY-T1-10K since it is almost same as in hardware and just power derated by software.

A 1.2.6/A 2.2.6 Frequency Drift and Step change Stability test The requirement is specified in section 11.3, test procedure in Annex A.1.2.6 (Inverter connected) or Annex A2 A.2.2.6 (Synchronous).	**P**

Test result: HESS-HY-T-10K

	Start Frequency	Change	Test time	Confirm no trip
Positive Vector Shift	49,0Hz	+50 degrees		No trip
Negative Vector Shift	50,0Hz	-50 degrees		No trip
Positive Frequency drift	49,0Hz - 51,0Hz	+0,95Hz/sec	2,1s	No trip
Negative Frequency drift	51,0Hz - 49,0Hz	-0,95Hz/sec	2,1s	No trip

Note:

Manufacturers considering new designs should allow for the RoCoF where stability is required to be increased to, up to 2Hz per second, as proposed in the new European network codes, which are expected to come into force over the period 2014/2015. Under these conditions RoCoF will cease to be an effective loss of mains protection and is unlikely to be permitted in future revisions of this document.

For the step change test the unit 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 seconds to complete the test. The unit should not trip during this test.

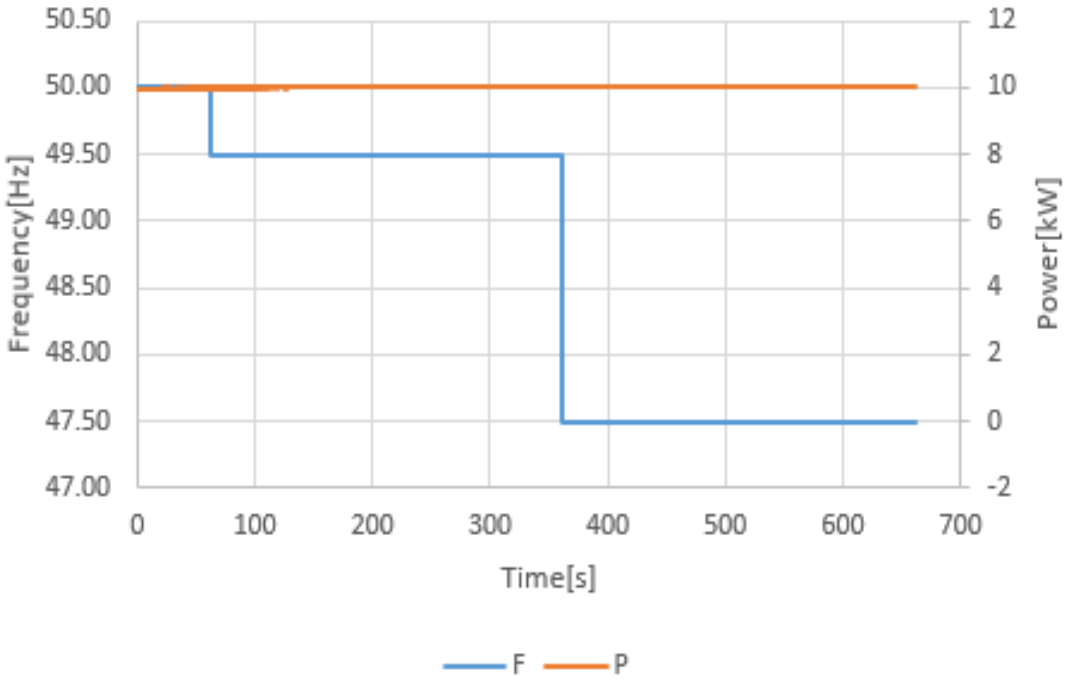
For frequency drift tests the unit should be operated with a measurable output at the start frequency and then the frequency changed in a ramp function at 0,95Hz per second to the end frequency. On reaching the end frequency it should be maintained for a period of at least10 seconds. The unit should not trip during this test. The tests had been performed on the HESS-HY-T-10K are valid for the HESS-HY-T-05K, HESS-HY-T-06K, HESS-HY-T-08K, HESS-HY-T1-05K, HESS-HY-T1-06K, HESS-HY-T1-08K, HESS-HY-T1-10K since it is almost same as in hardware and just power derated by software.

A 1.2.7/A 2.2.7 Active power feed-in at under-frequency This test should be carried out in accordance with A.1.2.7. (Inverter connected) or Annex A2 A.2.2.7 (Synchronous).	**P**

Test result: HESS-HY-T-10K

	Switch to:		
5-min mean value (each)	a) 50 ± 0,01 [Hz]	b) - 0,4 to – 0,5 [Hz]	c) - 2,4 to - 2,5 [Hz]
Frequency [Hz]:	50,00	49,50	47,50
Active power [KW]:	9,99	10,00	10,01
$\Delta P/P_{max}$ [%]:			0,10

Graph of frequency a) to b) to c):



Test:

Operating points b) and c) must be kept for at least 5 minutes.

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

Electronic inverter no power reduction take place.

Assessment criterion:

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

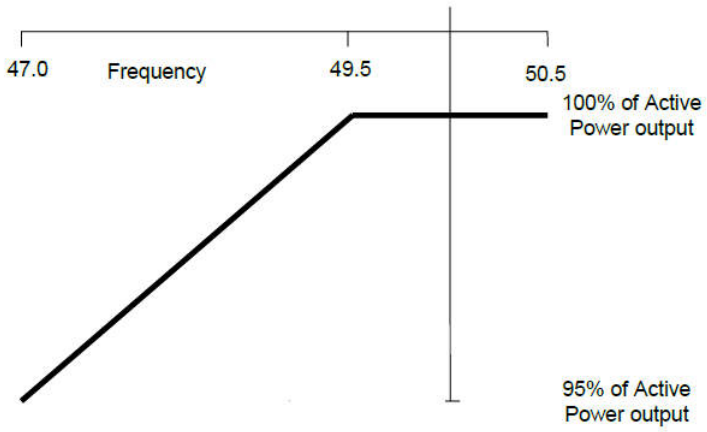


Figure 3 – Change in Active Power output with falling frequency

Note:

The tests had been performed on the HESS-HY-T-10K are valid for the HESS-HY-T-05K, HESS-HY-T-06K, HESS-HY-T-08K, HESS-HY-T1-05K, HESS-HY-T1-06K, HESS-HY-T1-08K, HESS-HY-T1-10K since it is almost same as in hardware and just power derated by software.

A.1.2.8 / A.2.2.8	**Active power feed-in at under-frequency for electricity storage** This test should be carried out in accordance with A.1.2.8 / A.2.2.8.	**P**

Test: HESS-HY-T-10K

	Test 1: 100% rated import power, 50,00 Hz to 49,00 Hz with 2 Hzs^{-1}	
	Start: 50 ± 0,01 Hz	End: 49,00Hz
Frequency [Hz]:	50,00	49,00
Active power [kW]:	-9,97	-1,46
Reactive Power [kVar]:	0,35	3,20
	Test 2: 100% rated import power 50,00 Hz to 48,80 Hz with 2 Hzs^{-1}	
	Start: 50 ± 0,01 Hz	End: 48,80Hz
Frequency [Hz]:	50,00	48,80
Active power [kW]:	-9,76	2,08
Reactive Power [kVar]:	0,35	0,44
	Test 3: 40% rated import power 50,00 Hz to 49,00 Hz with 2 Hzs^{-1}	
	Start: 50 ± 0,01 Hz	End: 49,00Hz
Frequency [Hz]:	50,00	49,00
Active power [kW]:	-3,96	4,25
Reactive Power [kVar]:	0,33	0,26
	Test 4: 40% rated import power 50,00 Hz to 48,80 Hz with 2 Hzs^{-1}	
	Start: 50 ± 0,01 Hz	End: 48,80Hz
Frequency [Hz]:	50,00	48,80
Active power [kW]:	-3,96	7,51
Reactive Power [kVar]:	0,33	0,36

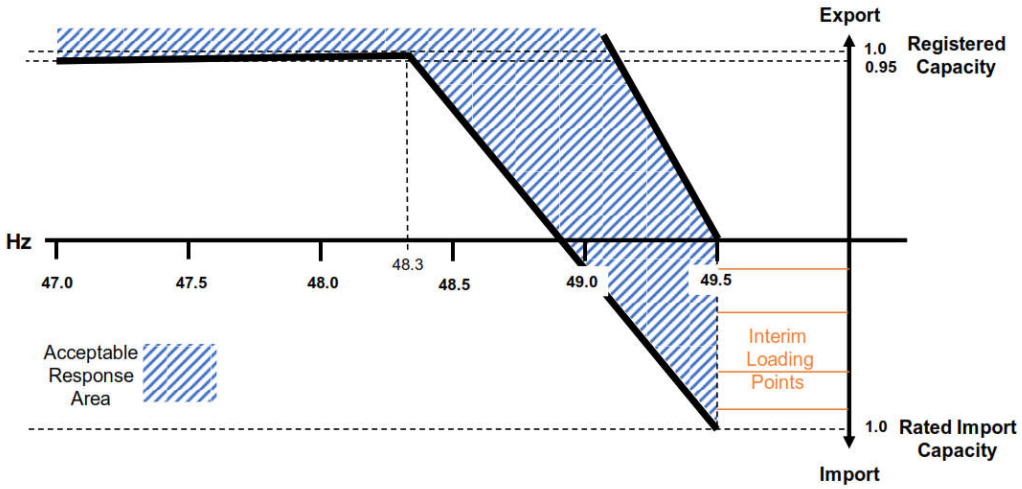
Test:

(a) When the frequency falls to 49,5 Hz the automatic response shall start;

(b) The frequency response characteristic shall be within the shaded area of Figure 4;

(c) If the Electricity Storage device is not capable of moving from an import level to an appropriate export level within 20 s of the frequency falling to 49,2 Hz, then it shall cease to import; and

(d) If the Electricity Storage device has not achieved at least zero Active Power import when the frequency has reached 48,9 Hz it shall cease to import immediately.



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.

Note:

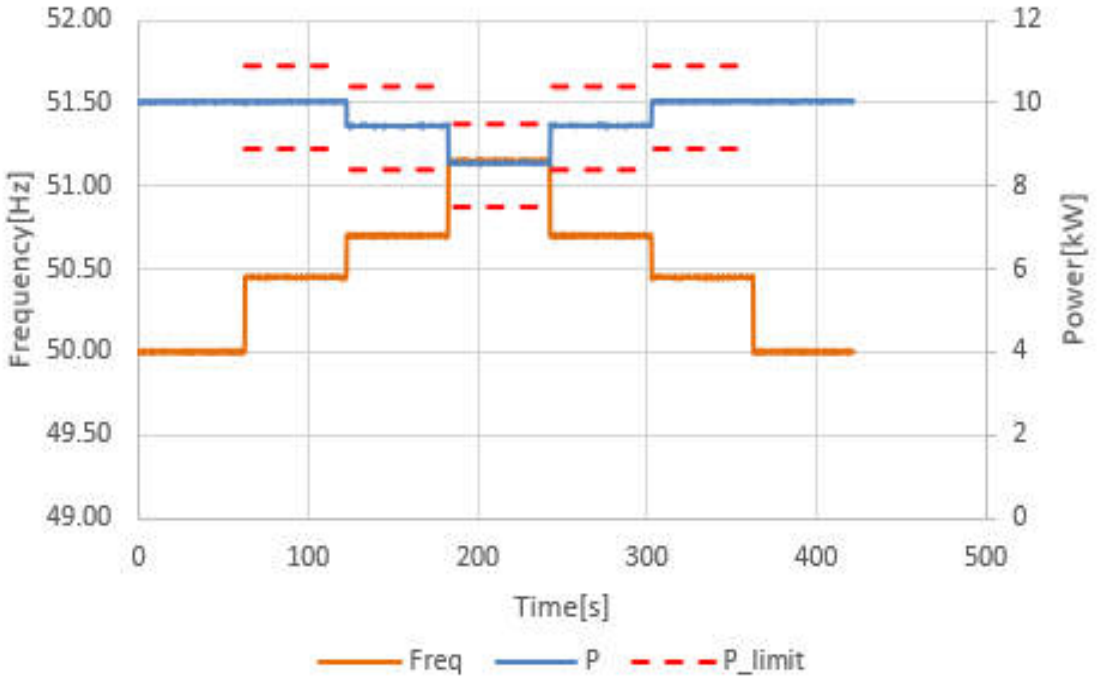
The tests had been performed on the HESS-HY-T-10K are valid for the HESS-HY-T-05K, HESS-HY-T-06K, HESS-HY-T-08K, HESS-HY-T1-05K, HESS-HY-T1-06K, HESS-HY-T1-08K, HESS-HY-T1-10K since it is almost same as in hardware and just power derated by software.

A 1.2.9/A 2.2.9 Power response to over-frequency This test should be carried out in accordance with EN 50438 Annex D.3.3 Power response to over- frequency. The test should be carried out using the specific threshold frequency of 50,4 Hz and Droop of 10%.	**P**

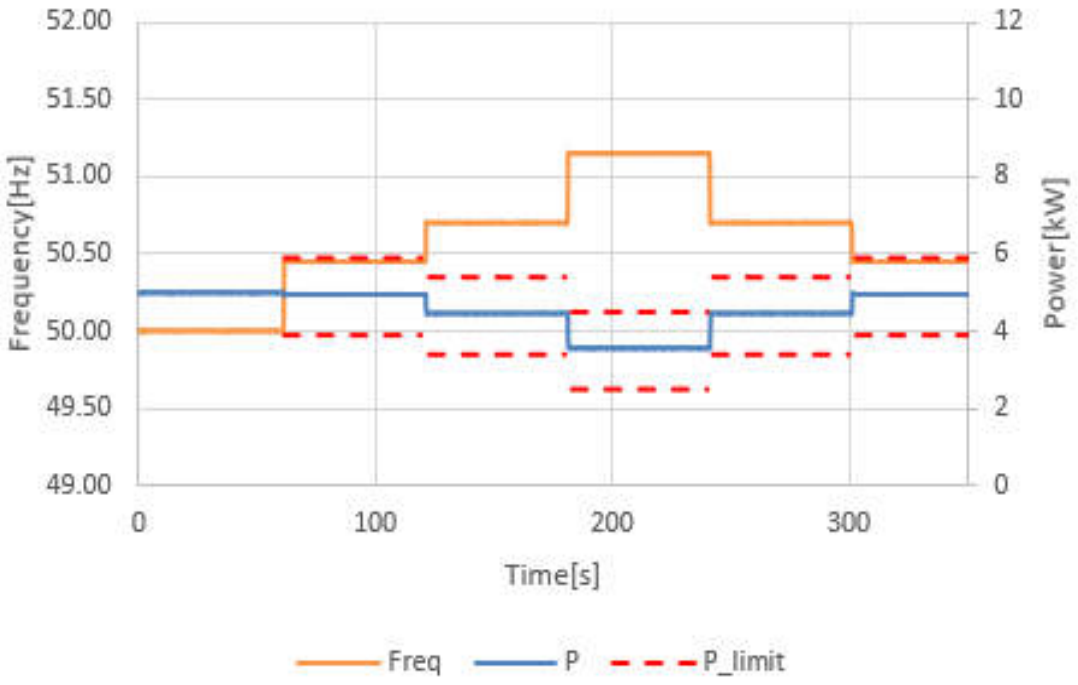
Test result: HESS-HY-T-10K

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]:	N/A	9,90	9,40	8,50	9,40	9,90	N/A
$P_{measured}$ [kW]:	10,03	10,03	9,46	8,55	9,46	10,03	10,03
$\Delta P_{E60}/P_M$ [%]:	N/A	1,30	0,60	0,50	0,60	1,30	N/A
2. Measurement a) to g): Active power output 40% and 60% after freezing > 80% P_n							
Frequency [Hz]:	50,00	50,45	50,70	51,15	50,70	50,45	50,00
$P_{expected}$ [kW]:	N/A	4,90	4,40	3,50	4,40	4,90	N/A
$P_{measured}$ [kW]:	4,99	4,96	4,46	3,55	4,46	4,96	10,01
$\Delta P_{E60}/P_M$ [%]:	N/A	0,60	0,60	0,50	0,60	0,60	N/A
Limit $\Delta P/P_{1min}$:	10 % of P_M						

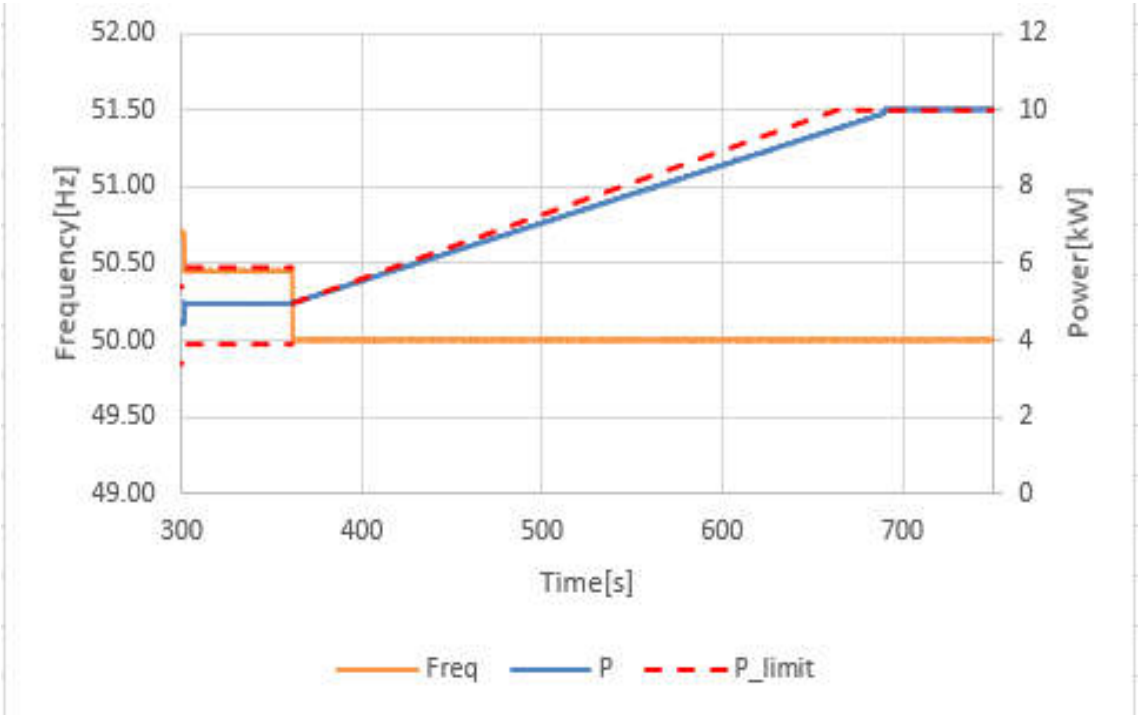
Graph of Measurement 1.: Active power output > 80% P_n



Graph of Measurement 2.:Active power output 40% and 60% after freezing > 80% P_n



Graph of power gradient:



Test:

With regard to the Limited Frequency Sensitive Mode — Overfrequency (LFSMO), the Micro-generator shall be capable of reducing its Active Power output when the frequency rises above 50,4 Hz. The Droop shall be 10%. No intentional delay should be programmed to ensure that the initial delay is as short as possible with a

maximum of 2 s. The Micro-generator shall continue to reduce its Active Power output with rising frequency with a Droop of 10% until 52,0 Hz, at which point the Micro-generator should disconnect. If the reduction in Active Power output is such that the Micro-generator reaches its minimum stable operating level, it shall continue to operate stably at this level.
Assessment criterion: 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%.
Note: The test was performed without default delay setting 0s. A delay can be set from 0s – 60s (in 0,001s steps). The tests had been performed on the HESS-HY-T-10K are valid for the HESS-HY-T-05K, HESS-HY-T-06K, HESS-HY-T-08K, HESS-HY-T1-05K, HESS-HY-T1-06K, HESS-HY-T1-08K, HESS-HY-T1-10K since it is almost same as in hardware and just power derated by software.

A 1.3.1/A 2.3.1 Harmonic Current Emissions The test requirements are specified in Annex A1 A.1.3.1 (Inverter connected) or Annex A2 A.2.3.1 (Synchronous).								**P**
Generating Unit tested to BS EN 61000-3-2								
Test: HESS-HY-T-05K								
Generating Unit rating per phase (rpp)				1,67kW				
Harmonic order	At 45-55% of Registered Capacity 2,5kW						Harmonic %	
	Measured Value (MV) in Amps			Measured Value (MV) in %			Limit in BS EN61000-3-2	
	L1	L2	L3	L1	L2	L3	Limit in BS EN61000-3-2 in Amps	Higher limit for odd harmonics 21 and above
1st	3,604	3,650	3,741	49,741	50,373	51,620	N/A	
2nd	0,022	0,063	0,084	0,310	0,865	1,159	1,08	
3rd	0,017	0,024	0,032	0,236	0,331	0,448	2,3	
4th	0,116	0,125	0,127	1,604	1,728	1,749	0,43	
5th	0,116	0,118	0,117	1,608	1,629	1,618	1,14	
6th	0,009	0,006	0,010	0,126	0,080	0,136	0,3	
7th	0,029	0,027	0,028	0,404	0,379	0,387	0,77	
8th	0,057	0,059	0,048	0,791	0,813	0,664	0,23	
9th	0,007	0,014	0,010	0,100	0,186	0,133	0,4	
10th	0,058	0,061	0,065	0,805	0,847	0,891	0,184	
11th	0,065	0,066	0,056	0,890	0,909	0,774	0,33	
12th	0,008	0,010	0,005	0,114	0,134	0,072	0,153	
13th	0,029	0,027	0,029	0,405	0,371	0,398	0,21	
14th	0,023	0,022	0,025	0,313	0,308	0,351	0,131	
15th	0,009	0,013	0,005	0,123	0,175	0,066	0,15	
16th	0,043	0,046	0,051	0,600	0,632	0,710	0,115	
17th	0,034	0,035	0,019	0,470	0,483	0,260	0,132	
18th	0,007	0,006	0,007	0,095	0,087	0,101	0,102	
19th	0,035	0,043	0,038	0,483	0,600	0,527	0,118	
20th	0,006	0,007	0,007	0,087	0,099	0,090	0,092	
21th	0,005	0,010	0,006	0,064	0,145	0,080	0,107	0,160
22th	0,015	0,017	0,016	0,204	0,238	0,222	0,084	
23th	0,031	0,027	0,022	0,427	0,376	0,299	0,098	0,147
24th	0,005	0,004	0,006	0,069	0,052	0,078	0,077	
25th	0,041	0,041	0,043	0,562	0,563	0,591	0,09	0,135
26th	0,028	0,022	0,022	0,386	0,304	0,298	0,071	
27th	0,007	0,007	0,007	0,098	0,093	0,092	0,083	0,124

28th	0,005	0,006	0,005	0,064	0,079	0,063	0,066	
29th	0,015	0,019	0,016	0,206	0,258	0,225	0,078	0,117
30th	0,006	0,007	0,006	0,083	0,094	0,086	0,061	
31th	0,064	0,067	0,069	0,888	0,925	0,956	0,073	0,109
32th	0,014	0,014	0,010	0,193	0,191	0,141	0,058	
33th	0,006	0,004	0,005	0,083	0,056	0,062	0,068	0,102
34th	0,029	0,028	0,028	0,404	0,385	0,392	0,054	
35th	0,031	0,032	0,026	0,425	0,435	0,357	0,064	0,096
36th	0,005	0,006	0,005	0,067	0,085	0,071	0,051	
37th	0,030	0,029	0,029	0,417	0,407	0,404	0,061	0,091
38th	0,018	0,014	0,014	0,250	0,200	0,191	0,048	
39th	0,005	0,007	0,006	0,066	0,091	0,080	0,058	0,087
40th	0,004	0,003	0,003	0,051	0,048	0,044	0,046	
41th	0,012	0,013	0,013	0,172	0,183	0,183	N/A	
42th	0,003	0,004	0,004	0,048	0,050	0,050	N/A	
43th	0,026	0,023	0,028	0,361	0,316	0,381	N/A	
44th	0,004	0,004	0,003	0,052	0,060	0,040	N/A	
45th	0,004	0,003	0,004	0,051	0,045	0,054	N/A	
46th	0,007	0,006	0,005	0,091	0,086	0,073	N/A	
47th	0,016	0,014	0,014	0,222	0,200	0,188	N/A	
48th	0,003	0,004	0,003	0,042	0,060	0,037	N/A	
49th	0,023	0,023	0,022	0,312	0,322	0,301	N/A	
50th	0,003	0,002	0,003	0,036	0,031	0,038	N/A	

Note:
The normal current is 7,264A.
The higher limits for odd harmonics 21 and above are only allowable under certain conditions, if these higher limits are utilised please state the exemption used as detailed in part 6.2.3.4 of BS EN 61000-3-2 in the box below.

A 1.3.1/A 2.3.1 Harmonic Current Emissions The test requirements are specified in Annex A1 A.1.3.1 (Inverter connected) or Annex A2 A.2.3.1 (Synchronous).								**P**
Generating Unit tested to BS EN 61000-3-2								
Test: HESS-HY-T-05K								
Generating Unit rating per phase (rpp)				1,67kW				
Harmonic order	At 100% of Registered Capacity 5,0kW						Harmonic %	
	Measured Value (MV) in Amps			Measured Value (MV) in %			Limit in BS EN61000-3-2	
	L1	L2	L3	L1	L2	L3	Limit in BS EN61000-3-2 in Amps	Higher limit for odd harmonics 21 and above
1st	7,211	7,258	7,359	99,511	100,157	101,550	N/A	
2nd	0,041	0,087	0,109	0,566	1,201	1,500	1,08	
3rd	0,017	0,038	0,037	0,238	0,522	0,504	2,3	
4th	0,141	0,150	0,146	1,944	2,073	2,014	0,43	
5th	0,133	0,136	0,134	1,831	1,871	1,843	1,14	
6th	0,014	0,006	0,009	0,188	0,088	0,128	0,3	
7th	0,056	0,054	0,056	0,769	0,751	0,772	0,77	
8th	0,021	0,020	0,010	0,288	0,272	0,140	0,23	
9th	0,010	0,009	0,007	0,138	0,127	0,090	0,4	
10th	0,025	0,030	0,032	0,346	0,413	0,447	0,184	
11th	0,129	0,115	0,125	1,786	1,580	1,732	0,33	
12th	0,009	0,005	0,006	0,119	0,076	0,083	0,153	
13th	0,069	0,075	0,072	0,952	1,035	1,000	0,21	
14th	0,055	0,055	0,053	0,764	0,755	0,731	0,131	
15th	0,011	0,009	0,008	0,149	0,129	0,112	0,15	
16th	0,050	0,052	0,048	0,687	0,721	0,656	0,115	
17th	0,058	0,059	0,067	0,804	0,809	0,921	0,132	
18th	0,004	0,004	0,003	0,060	0,057	0,045	0,102	
19th	0,092	0,096	0,092	1,269	1,323	1,276	0,118	
20th	0,018	0,016	0,019	0,242	0,218	0,260	0,092	
21th	0,007	0,005	0,004	0,101	0,075	0,061	0,107	0,160
22th	0,025	0,027	0,023	0,347	0,377	0,320	0,084	
23th	0,038	0,033	0,041	0,519	0,455	0,561	0,098	0,147
24th	0,005	0,005	0,004	0,067	0,062	0,060	0,077	
25th	0,037	0,040	0,037	0,511	0,558	0,512	0,09	0,135
26th	0,031	0,029	0,031	0,422	0,400	0,428	0,071	
27th	0,006	0,005	0,005	0,087	0,072	0,064	0,083	0,124

A 1.3.1/A 2.3.1 Harmonic Current Emissions The test requirements are specified in Annex A1 A.1.3.1 (Inverter connected) or Annex A2 A.2.3.1 (Synchronous).								**P**
Generating Unit tested to BS EN 61000-3-2								
Test: HESS-HY-T-05K								
Generating Unit rating per phase (rpp)				1,67kW				
Harmonic order	At 100% of Registered Capacity 5,0kW						Harmonic %	
	Measured Value (MV) in Amps			Measured Value (MV) in %			Limit in BS EN61000-3-2	
	L1	L2	L3	L1	L2	L3	Limit in BS EN61000-3-2 in Amps	Higher limit for odd harmonics 21 and above
28th	0,045	0,049	0,047	0,619	0,673	0,649	0,066	
29th	0,028	0,029	0,034	0,383	0,406	0,472	0,078	0,117
30th	0,006	0,004	0,003	0,081	0,057	0,048	0,061	
31th	0,023	0,024	0,024	0,312	0,331	0,333	0,073	0,109
32th	0,018	0,016	0,018	0,244	0,227	0,251	0,058	
33th	0,006	0,005	0,004	0,080	0,065	0,052	0,068	0,102
34th	0,011	0,014	0,010	0,147	0,189	0,136	0,054	
35th	0,010	0,007	0,005	0,145	0,101	0,076	0,064	0,096
36th	0,004	0,004	0,004	0,056	0,061	0,054	0,051	
37th	0,027	0,029	0,026	0,370	0,400	0,356	0,061	0,091
38th	0,017	0,019	0,018	0,240	0,263	0,254	0,048	
39th	0,006	0,009	0,005	0,077	0,120	0,067	0,058	0,087
40th	0,033	0,038	0,036	0,452	0,519	0,491	0,046	
41th	0,006	0,005	0,004	0,088	0,069	0,058	N/A	
42th	0,004	0,004	0,004	0,057	0,058	0,057	N/A	
43th	0,044	0,046	0,048	0,611	0,640	0,660	N/A	
44th	0,025	0,022	0,023	0,347	0,308	0,316	N/A	
45th	0,005	0,006	0,004	0,068	0,077	0,061	N/A	
46th	0,006	0,007	0,006	0,088	0,100	0,079	N/A	
47th	0,033	0,031	0,029	0,450	0,422	0,402	N/A	
48th	0,005	0,004	0,004	0,067	0,057	0,054	N/A	
49th	0,014	0,014	0,017	0,193	0,198	0,228	N/A	
50th	0,008	0,009	0,011	0,116	0,125	0,147	N/A	

Note:
The normal current is 7,264A.
The higher limits for odd harmonics 21 and above are only allowable under certain conditions, if these higher limits are utilised please state the exemption used as detailed in part 6.2.3.4 of BS EN 61000-3-2 in the box below.

A 1.3.1/A 2.3.1 Harmonic Current Emissions The test requirements are specified in Annex A1 A.1.3.1 (Inverter connected) or Annex A2 A.2.3.1 (Synchronous).								**P**
Generating Unit tested to BS EN 61000-3-2								
Test: HESS-HY-T1-05K								
Generating Unit rating per phase (rpp)				1,67kW				
Harmonic order	At 45-55% of Registered Capacity 2,5kW						Harmonic %	
	Measured Value (MV) in Amps			Measured Value (MV) in %			Limit in BS EN61000-3-2	
	L1	L2	L3	L1	L2	L3	Limit in BS EN61000-3-2 in Amps	Higher limit for odd harmonics 21 and above
1st	3,879	3,752	3,809	53,526	51,782	52,571	N/A	
2nd	0,044	0,057	0,085	0,610	0,782	1,180	1,08	
3rd	0,033	0,023	0,041	0,449	0,317	0,561	2,3	
4th	0,110	0,119	0,122	1,524	1,640	1,685	0,43	
5th	0,122	0,121	0,119	1,686	1,668	1,642	1,14	
6th	0,006	0,009	0,014	0,082	0,119	0,188	0,3	
7th	0,051	0,048	0,049	0,706	0,666	0,678	0,77	
8th	0,055	0,063	0,060	0,764	0,864	0,832	0,23	
9th	0,005	0,012	0,009	0,073	0,160	0,131	0,4	
10th	0,042	0,042	0,043	0,580	0,578	0,598	0,184	
11th	0,136	0,134	0,130	1,871	1,842	1,790	0,33	
12th	0,003	0,006	0,005	0,046	0,076	0,067	0,153	
13th	0,038	0,036	0,039	0,525	0,495	0,540	0,21	
14th	0,013	0,015	0,017	0,181	0,205	0,238	0,131	
15th	0,004	0,004	0,004	0,052	0,054	0,052	0,15	
16th	0,008	0,010	0,009	0,116	0,138	0,121	0,115	
17th	0,024	0,026	0,023	0,330	0,355	0,315	0,132	
18th	0,004	0,004	0,004	0,053	0,049	0,052	0,102	
19th	0,040	0,040	0,039	0,547	0,549	0,544	0,118	
20th	0,019	0,018	0,019	0,268	0,250	0,261	0,092	
21th	0,005	0,005	0,005	0,063	0,071	0,068	0,107	0,160
22th	0,034	0,033	0,033	0,466	0,453	0,462	0,084	
23th	0,018	0,013	0,017	0,253	0,184	0,229	0,098	0,147
24th	0,005	0,005	0,005	0,064	0,064	0,067	0,077	
25th	0,031	0,028	0,029	0,433	0,393	0,400	0,09	0,135
26th	0,027	0,030	0,028	0,376	0,408	0,381	0,071	
27th	0,006	0,006	0,007	0,088	0,082	0,092	0,083	0,124

A 1.3.1/A 2.3.1 Harmonic Current Emissions The test requirements are specified in Annex A1 A.1.3.1 (Inverter connected) or Annex A2 A.2.3.1 (Synchronous).								**P**
Generating Unit tested to BS EN 61000-3-2								
Test: HESS-HY-T1-05K								
Generating Unit rating per phase (rpp)				1,67kW				
Harmonic order	At 45-55% of Registered Capacity 2,5kW						Harmonic %	
	Measured Value (MV) in Amps			Measured Value (MV) in %			Limit in BS EN61000-3-2	
	L1	L2	L3	L1	L2	L3	Limit in BS EN61000-3-2 in Amps	Higher limit for odd harmonics 21 and above
28th	0,031	0,030	0,030	0,421	0,415	0,412	0,066	
29th	0,020	0,023	0,016	0,271	0,311	0,225	0,078	0,117
30th	0,007	0,005	0,006	0,094	0,075	0,081	0,061	
31th	0,030	0,031	0,032	0,415	0,421	0,440	0,073	0,109
32th	0,023	0,026	0,024	0,319	0,365	0,328	0,058	
33th	0,006	0,006	0,006	0,084	0,080	0,081	0,068	0,102
34th	0,023	0,023	0,023	0,323	0,321	0,320	0,054	
35th	0,018	0,018	0,018	0,249	0,251	0,253	0,064	0,096
36th	0,006	0,005	0,005	0,077	0,070	0,067	0,051	
37th	0,011	0,011	0,010	0,153	0,152	0,142	0,061	0,091
38th	0,011	0,013	0,012	0,147	0,175	0,169	0,048	
39th	0,004	0,005	0,005	0,060	0,064	0,067	0,058	0,087
40th	0,010	0,010	0,009	0,139	0,143	0,127	0,046	
41th	0,006	0,006	0,007	0,088	0,083	0,092	N/A	
42th	0,004	0,004	0,003	0,055	0,049	0,047	N/A	
43th	0,009	0,008	0,009	0,119	0,113	0,131	N/A	
44th	0,007	0,006	0,006	0,097	0,089	0,088	N/A	
45th	0,003	0,003	0,004	0,042	0,047	0,051	N/A	
46th	0,014	0,013	0,013	0,198	0,182	0,176	N/A	
47th	0,006	0,006	0,007	0,085	0,085	0,100	N/A	
48th	0,003	0,003	0,003	0,047	0,042	0,043	N/A	
49th	0,013	0,012	0,014	0,185	0,169	0,190	N/A	
50th	0,012	0,012	0,012	0,162	0,159	0,163	N/A	

Note:
The normal current is 7,264A.
The higher limits for odd harmonics 21 and above are only allowable under certain conditions, if these higher limits are utilised please state the exemption used as detailed in part 6.2.3.4 of BS EN 61000-3-2 in the box below.

A 1.3.1/A 2.3.1 Harmonic Current Emissions **The test requirements are specified in Annex A1 A.1.3.1 (Inverter connected) or Annex A2 A.2.3.1 (Synchronous).**								**P**
Generating Unit tested to BS EN 61000-3-2								
Test: HESS-HY-T1-05K								
Generating Unit rating per phase (rpp)				1,67kW				
Harmonic order	At 100% of Registered Capacity 5,0kW						Harmonic %	
	Measured Value (MV) in Amps			Measured Value (MV) in %			Limit in BS EN61000-3-2	
	L1	L2	L3	L1	L2	L3	Limit in BS EN61000-3-2 in Amps	Higher limit for odd harmonics 21 and above
1st	7,277	7,248	7,225	100,429	100,023	99,710	N/A	
2nd	0,033	0,030	0,032	0,454	0,420	0,444	1,08	
3rd	0,003	0,009	0,011	0,046	0,119	0,149	2,3	
4th	0,028	0,032	0,030	0,383	0,441	0,415	0,43	
5th	0,110	0,107	0,108	1,515	1,476	1,485	1,14	
6th	0,007	0,003	0,005	0,095	0,042	0,069	0,3	
7th	0,040	0,040	0,040	0,557	0,556	0,546	0,77	
8th	0,011	0,007	0,005	0,155	0,101	0,073	0,23	
9th	0,010	0,006	0,003	0,143	0,090	0,047	0,4	
10th	0,008	0,010	0,011	0,113	0,145	0,146	0,184	
11th	0,074	0,085	0,079	1,019	1,176	1,097	0,33	
12th	0,004	0,002	0,003	0,051	0,024	0,043	0,153	
13th	0,086	0,082	0,081	1,189	1,138	1,114	0,21	
14th	0,007	0,004	0,005	0,101	0,052	0,070	0,131	
15th	0,006	0,005	0,002	0,088	0,064	0,034	0,15	
16th	0,009	0,008	0,009	0,126	0,117	0,128	0,115	
17th	0,012	0,017	0,018	0,165	0,240	0,246	0,132	
18th	0,002	0,001	0,002	0,027	0,020	0,024	0,102	
19th	0,029	0,028	0,027	0,401	0,385	0,378	0,118	
20th	0,005	0,003	0,004	0,067	0,043	0,062	0,092	
21th	0,002	0,002	0,002	0,033	0,034	0,024	0,107	0,160
22th	0,011	0,010	0,010	0,149	0,145	0,141	0,084	
23th	0,009	0,012	0,013	0,120	0,167	0,174	0,098	0,147
24th	0,001	0,001	0,001	0,020	0,019	0,020	0,077	
25th	0,027	0,027	0,026	0,370	0,379	0,357	0,09	0,135
26th	0,004	0,004	0,004	0,053	0,056	0,056	0,071	
27th	0,003	0,003	0,003	0,041	0,041	0,037	0,083	0,124

A 1.3.1/A 2.3.1 Harmonic Current Emissions **The test requirements are specified in Annex A1 A.1.3.1 (Inverter connected) or Annex A2 A.2.3.1 (Synchronous).**								**P**
Generating Unit tested to BS EN 61000-3-2								
Test: HESS-HY-T1-05K								
Generating Unit rating per phase (rpp)				1,67kW				
Harmonic order	At 100% of Registered Capacity 5,0kW						Harmonic %	
	Measured Value (MV) in Amps			Measured Value (MV) in %			Limit in BS EN61000-3-2	
	L1	L2	L3	L1	L2	L3	Limit in BS EN61000-3-2 in Amps	Higher limit for odd harmonics 21 and above
28th	0,011	0,011	0,011	0,153	0,148	0,152	0,066	
29th	0,006	0,009	0,007	0,082	0,125	0,095	0,078	0,117
30th	0,001	0,001	0,001	0,019	0,018	0,020	0,061	
31th	0,019	0,019	0,020	0,264	0,266	0,281	0,073	0,109
32th	0,005	0,005	0,004	0,064	0,071	0,052	0,058	
33th	0,003	0,003	0,003	0,037	0,043	0,045	0,068	0,102
34th	0,010	0,010	0,010	0,144	0,134	0,137	0,054	
35th	0,015	0,013	0,012	0,202	0,177	0,166	0,064	0,096
36th	0,002	0,001	0,001	0,026	0,017	0,018	0,051	
37th	0,029	0,026	0,028	0,398	0,363	0,389	0,061	0,091
38th	0,006	0,005	0,004	0,082	0,076	0,058	0,048	
39th	0,003	0,001	0,003	0,048	0,018	0,040	0,058	0,087
40th	0,008	0,007	0,007	0,115	0,101	0,101	0,046	
41th	0,020	0,018	0,020	0,283	0,248	0,273	N/A	
42th	0,003	0,001	0,001	0,035	0,018	0,015	N/A	
43th	0,030	0,029	0,029	0,417	0,397	0,393	N/A	
44th	0,006	0,004	0,005	0,083	0,059	0,063	N/A	
45th	0,004	0,002	0,003	0,058	0,033	0,036	N/A	
46th	0,008	0,007	0,007	0,104	0,102	0,092	N/A	
47th	0,020	0,019	0,020	0,269	0,266	0,276	N/A	
48th	0,003	0,002	0,001	0,035	0,029	0,019	N/A	
49th	0,026	0,026	0,025	0,365	0,359	0,349	N/A	
50th	0,006	0,005	0,006	0,085	0,066	0,077	N/A	

Note:
The normal current is 7,264A.
The higher limits for odd harmonics 21 and above are only allowable under certain conditions, if these higher limits are utilised please state the exemption used as detailed in part 6.2.3.4 of BS EN 61000-3-2 in the box below.

A 1.3.1/A 2.3.1 Harmonic Current Emissions The test requirements are specified in Annex A1 A.1.3.1 (Inverter connected) or Annex A2 A.2.3.1 (Synchronous).								**P**
Generating Unit tested to BS EN 61000-3-2								
Test: HESS-HY-T-06K								
Generating Unit rating per phase (rpp)				2,00 kW				
Harmonic order	At 45-55% of Registered Capacity 3,0kW						Harmonic %	
	Measured Value (MV) in Amps			Measured Value (MV) in %			Limit in BS EN61000-3-2	
	L1	L2	L3	L1	L2	L3	Limit in BS EN61000-3-2 in Amps	Higher limit for odd harmonics 21 and above
1st	4,341	4,382	4,479	49,917	50,397	51,504	N/A	
2nd	0,043	0,038	0,080	0,492	0,440	0,919	1,08	
3rd	0,014	0,030	0,035	0,159	0,344	0,401	2,3	
4th	0,018	0,025	0,026	0,210	0,287	0,296	0,43	
5th	0,110	0,111	0,110	1,260	1,276	1,270	1,14	
6th	0,011	0,003	0,010	0,123	0,030	0,111	0,3	
7th	0,027	0,024	0,026	0,305	0,279	0,294	0,77	
8th	0,009	0,004	0,007	0,101	0,043	0,077	0,23	
9th	0,010	0,016	0,007	0,111	0,186	0,079	0,4	
10th	0,007	0,006	0,005	0,083	0,066	0,062	0,184	
11th	0,016	0,007	0,011	0,180	0,076	0,129	0,33	
12th	0,002	0,003	0,003	0,025	0,033	0,030	0,153	
13th	0,024	0,029	0,027	0,277	0,330	0,308	0,21	
14th	0,008	0,007	0,007	0,093	0,085	0,085	0,131	
15th	0,005	0,008	0,004	0,060	0,088	0,045	0,15	
16th	0,010	0,014	0,012	0,113	0,156	0,142	0,115	
17th	0,019	0,008	0,011	0,214	0,091	0,124	0,132	
18th	0,005	0,004	0,004	0,057	0,043	0,050	0,102	
19th	0,020	0,026	0,022	0,232	0,300	0,251	0,118	
20th	0,005	0,005	0,002	0,060	0,053	0,028	0,092	
21th	0,008	0,012	0,004	0,092	0,141	0,044	0,107	0,160
22th	0,008	0,006	0,009	0,093	0,073	0,106	0,084	
23th	0,027	0,022	0,012	0,308	0,254	0,139	0,098	0,147
24th	0,004	0,003	0,003	0,047	0,032	0,040	0,077	
25th	0,051	0,056	0,055	0,582	0,642	0,634	0,09	0,135
26th	0,005	0,003	0,004	0,058	0,030	0,040	0,071	
27th	0,004	0,007	0,006	0,043	0,086	0,064	0,083	0,124

A 1.3.1/A 2.3.1 Harmonic Current Emissions The test requirements are specified in Annex A1 A.1.3.1 (Inverter connected) or Annex A2 A.2.3.1 (Synchronous).								**P**
Generating Unit tested to BS EN 61000-3-2								
Test: HESS-HY-T-06K								
Generating Unit rating per phase (rpp)				2,00 kW				
Harmonic order	At 45-55% of Registered Capacity 3,0kW						Harmonic %	
	Measured Value (MV) in Amps			Measured Value (MV) in %			Limit in BS EN61000-3-2	
	L1	L2	L3	L1	L2	L3	Limit in BS EN61000-3-2 in Amps	Higher limit for odd harmonics 21 and above
28th	0,011	0,011	0,010	0,125	0,130	0,116	0,066	
29th	0,019	0,019	0,018	0,224	0,217	0,203	0,078	0,117
30th	0,002	0,002	0,002	0,018	0,020	0,021	0,061	
31th	0,042	0,042	0,044	0,488	0,488	0,504	0,073	0,109
32th	0,006	0,004	0,004	0,063	0,047	0,050	0,058	
33th	0,002	0,003	0,003	0,021	0,030	0,034	0,068	0,102
34th	0,010	0,009	0,010	0,112	0,104	0,113	0,054	
35th	0,017	0,024	0,018	0,200	0,273	0,204	0,064	0,096
36th	0,003	0,002	0,002	0,030	0,025	0,025	0,051	
37th	0,035	0,035	0,036	0,399	0,405	0,419	0,061	0,091
38th	0,005	0,005	0,004	0,056	0,053	0,051	0,048	
39th	0,004	0,006	0,004	0,051	0,070	0,049	0,058	0,087
40th	0,008	0,008	0,007	0,097	0,096	0,082	0,046	
41th	0,021	0,020	0,017	0,245	0,230	0,199	N/A	
42th	0,002	0,002	0,001	0,022	0,017	0,015	N/A	
43th	0,028	0,026	0,029	0,323	0,305	0,335	N/A	
44th	0,006	0,005	0,005	0,068	0,057	0,058	N/A	
45th	0,005	0,002	0,005	0,054	0,021	0,053	N/A	
46th	0,008	0,008	0,008	0,088	0,086	0,092	N/A	
47th	0,015	0,016	0,015	0,171	0,184	0,175	N/A	
48th	0,002	0,001	0,002	0,020	0,015	0,025	N/A	
49th	0,021	0,020	0,022	0,244	0,235	0,249	N/A	
50th	0,005	0,005	0,006	0,060	0,061	0,065	N/A	

Note:
The normal current is 8,696A.
The higher limits for odd harmonics 21 and above are only allowable under certain conditions, if these higher limits are utilised please state the exemption used as detailed in part 6.2.3.4 of BS EN 61000-3-2 in the box below.

A 1.3.1/A 2.3.1 Harmonic Current Emissions The test requirements are specified in Annex A1 A.1.3.1 (Inverter connected) or Annex A2 A.2.3.1 (Synchronous).								**P**
Generating Unit tested to BS EN 61000-3-2								
Test: HESS-HY-T-06K								
Generating Unit rating per phase (rpp)				2,00 kW				
Harmonic order	At 100% of Registered Capacity 6,0kW						Harmonic %	
	Measured Value (MV) in Amps			Measured Value (MV) in %			Limit in BS EN61000-3-2	
	L1	L2	L3	L1	L2	L3	Limit in BS EN61000-3-2 in Amps	Higher limit for odd harmonics 21 and above
1st	8,705	8,755	8,857	100,102	100,688	101,857	N/A	
2nd	0,058	0,039	0,096	0,665	0,448	1,098	1,08	
3rd	0,025	0,045	0,037	0,288	0,518	0,421	2,3	
4th	0,023	0,030	0,027	0,266	0,346	0,312	0,43	
5th	0,124	0,126	0,124	1,421	1,445	1,427	1,14	
6th	0,011	0,003	0,009	0,128	0,036	0,101	0,3	
7th	0,038	0,038	0,039	0,440	0,435	0,452	0,77	
8th	0,012	0,009	0,004	0,138	0,105	0,041	0,23	
9th	0,013	0,013	0,004	0,155	0,155	0,049	0,4	
10th	0,005	0,008	0,008	0,054	0,097	0,096	0,184	
11th	0,102	0,090	0,099	1,172	1,034	1,135	0,33	
12th	0,006	0,003	0,005	0,070	0,029	0,054	0,153	
13th	0,095	0,102	0,105	1,091	1,172	1,203	0,21	
14th	0,009	0,006	0,004	0,108	0,067	0,046	0,131	
15th	0,009	0,011	0,006	0,107	0,127	0,064	0,15	
16th	0,007	0,007	0,009	0,083	0,084	0,104	0,115	
17th	0,025	0,016	0,021	0,292	0,187	0,241	0,132	
18th	0,003	0,002	0,003	0,039	0,021	0,030	0,102	
19th	0,025	0,030	0,030	0,291	0,341	0,346	0,118	
20th	0,007	0,004	0,004	0,078	0,041	0,049	0,092	
21th	0,005	0,007	0,004	0,057	0,079	0,051	0,107	0,160
22th	0,010	0,009	0,010	0,111	0,104	0,111	0,084	
23th	0,013	0,010	0,008	0,149	0,119	0,094	0,098	0,147
24th	0,002	0,002	0,002	0,025	0,019	0,020	0,077	
25th	0,025	0,028	0,027	0,290	0,322	0,312	0,09	0,135
26th	0,004	0,003	0,004	0,051	0,031	0,044	0,071	
27th	0,003	0,003	0,003	0,032	0,035	0,035	0,083	0,124

A 1.3.1/A 2.3.1 Harmonic Current Emissions The test requirements are specified in Annex A1 A.1.3.1 (Inverter connected) or Annex A2 A.2.3.1 (Synchronous).								**P**
Generating Unit tested to BS EN 61000-3-2								
Test: HESS-HY-T-06K								
Generating Unit rating per phase (rpp)				2,00 kW				
Harmonic order	At 100% of Registered Capacity 6,0kW						Harmonic %	
	Measured Value (MV) in Amps			Measured Value (MV) in %			Limit in BS EN61000-3-2	
	L1	L2	L3	L1	L2	L3	Limit in BS EN61000-3-2 in Amps	Higher limit for odd harmonics 21 and above
28th	0,010	0,010	0,010	0,115	0,115	0,110	0,066	
29th	0,010	0,009	0,008	0,111	0,101	0,088	0,078	0,117
30th	0,001	0,002	0,002	0,017	0,019	0,018	0,061	
31th	0,027	0,028	0,028	0,309	0,323	0,324	0,073	0,109
32th	0,003	0,003	0,003	0,038	0,039	0,040	0,058	
33th	0,002	0,002	0,002	0,024	0,025	0,024	0,068	0,102
34th	0,008	0,009	0,009	0,094	0,105	0,100	0,054	
35th	0,010	0,008	0,010	0,111	0,097	0,116	0,064	0,096
36th	0,002	0,002	0,002	0,018	0,019	0,020	0,051	
37th	0,018	0,018	0,017	0,209	0,207	0,200	0,061	0,091
38th	0,003	0,004	0,004	0,034	0,050	0,042	0,048	
39th	0,002	0,002	0,002	0,022	0,028	0,020	0,058	0,087
40th	0,006	0,006	0,006	0,065	0,072	0,074	0,046	
41th	0,008	0,010	0,010	0,087	0,116	0,118	N/A	
42th	0,002	0,002	0,001	0,023	0,017	0,017	N/A	
43th	0,015	0,016	0,014	0,167	0,179	0,160	N/A	
44th	0,003	0,004	0,003	0,031	0,043	0,030	N/A	
45th	0,001	0,004	0,001	0,017	0,043	0,014	N/A	
46th	0,005	0,005	0,005	0,054	0,056	0,058	N/A	
47th	0,010	0,014	0,011	0,120	0,156	0,125	N/A	
48th	0,002	0,001	0,002	0,020	0,014	0,018	N/A	
49th	0,017	0,018	0,018	0,200	0,213	0,212	N/A	
50th	0,003	0,004	0,002	0,035	0,043	0,028	N/A	
Note: The normal current is 8,696A. The higher limits for odd harmonics 21 and above are only allowable under certain conditions, if these higher limits are utilised please state the exemption used as detailed in part 6.2.3.4 of BS EN 61000-3-2 in the box below.								

A 1.3.1/A 2.3.1 Harmonic Current Emissions The test requirements are specified in Annex A1 A.1.3.1 (Inverter connected) or Annex A2 A.2.3.1 (Synchronous).								**P**
Generating Unit tested to BS EN 61000-3-2								
Test: HESS-HY-T1-06K								
Generating Unit rating per phase (rpp)				2,00 kW				
Harmonic order	At 45-55% of Registered Capacity 3,0kW						Harmonic %	
	Measured Value (MV) in Amps			Measured Value (MV) in %			Limit in BS EN61000-3-2	
	L1	L2	L3	L1	L2	L3	Limit in BS EN61000-3-2 in Amps	Higher limit for odd harmonics 21 and above
1st	4,574	4,444	4,507	52,600	51,110	51,833	N/A	
2nd	0,051	0,060	0,094	0,583	0,695	1,085	1,08	
3rd	0,033	0,024	0,041	0,376	0,277	0,466	2,3	
4th	0,116	0,127	0,129	1,336	1,463	1,481	0,43	
5th	0,125	0,123	0,121	1,433	1,420	1,392	1,14	
6th	0,007	0,009	0,015	0,085	0,104	0,177	0,3	
7th	0,055	0,051	0,053	0,627	0,589	0,604	0,77	
8th	0,053	0,064	0,060	0,611	0,737	0,692	0,23	
9th	0,006	0,017	0,014	0,065	0,196	0,163	0,4	
10th	0,044	0,042	0,042	0,500	0,478	0,480	0,184	
11th	0,177	0,176	0,165	2,032	2,020	1,893	0,33	
12th	0,004	0,004	0,004	0,049	0,046	0,044	0,153	
13th	0,045	0,042	0,046	0,516	0,486	0,524	0,21	
14th	0,016	0,015	0,016	0,184	0,175	0,186	0,131	
15th	0,004	0,004	0,004	0,045	0,047	0,049	0,15	
16th	0,007	0,008	0,008	0,084	0,091	0,089	0,115	
17th	0,019	0,020	0,017	0,217	0,229	0,196	0,132	
18th	0,005	0,004	0,004	0,053	0,048	0,051	0,102	
19th	0,031	0,032	0,032	0,356	0,373	0,373	0,118	
20th	0,015	0,016	0,019	0,171	0,190	0,215	0,092	
21th	0,005	0,005	0,005	0,057	0,058	0,056	0,107	0,160
22th	0,030	0,029	0,028	0,343	0,333	0,322	0,084	
23th	0,025	0,024	0,023	0,288	0,277	0,261	0,098	0,147
24th	0,006	0,005	0,005	0,066	0,062	0,063	0,077	
25th	0,034	0,030	0,031	0,387	0,347	0,353	0,09	0,135
26th	0,027	0,027	0,026	0,307	0,314	0,304	0,071	
27th	0,006	0,006	0,006	0,066	0,071	0,066	0,083	0,124

A 1.3.1/A 2.3.1 Harmonic Current Emissions The test requirements are specified in Annex A1 A.1.3.1 (Inverter connected) or Annex A2 A.2.3.1 (Synchronous).								**P**
Generating Unit tested to BS EN 61000-3-2								
Test: HESS-HY-T1-06K								
Generating Unit rating per phase (rpp)				2,00 kW				
Harmonic order	At 45-55% of Registered Capacity 3,0kW						Harmonic %	
	Measured Value (MV) in Amps			Measured Value (MV) in %			Limit in BS EN61000-3-2	
	L1	L2	L3	L1	L2	L3	Limit in BS EN61000-3-2 in Amps	Higher limit for odd harmonics 21 and above
28th	0,032	0,031	0,033	0,365	0,355	0,376	0,066	
29th	0,023	0,025	0,019	0,264	0,290	0,217	0,078	0,117
30th	0,008	0,006	0,007	0,094	0,073	0,081	0,061	
31th	0,029	0,030	0,031	0,336	0,341	0,353	0,073	0,109
32th	0,028	0,031	0,025	0,318	0,358	0,289	0,058	
33th	0,007	0,006	0,008	0,085	0,071	0,089	0,068	0,102
34th	0,022	0,023	0,024	0,250	0,260	0,275	0,054	
35th	0,018	0,017	0,016	0,211	0,194	0,179	0,064	0,096
36th	0,006	0,006	0,006	0,068	0,064	0,065	0,051	
37th	0,010	0,010	0,009	0,120	0,111	0,104	0,061	0,091
38th	0,010	0,012	0,012	0,114	0,143	0,144	0,048	
39th	0,005	0,005	0,005	0,052	0,058	0,054	0,058	0,087
40th	0,011	0,010	0,011	0,121	0,120	0,126	0,046	
41th	0,007	0,006	0,006	0,075	0,071	0,068	N/A	
42th	0,004	0,004	0,004	0,044	0,049	0,043	N/A	
43th	0,011	0,011	0,011	0,127	0,127	0,131	N/A	
44th	0,007	0,007	0,007	0,081	0,082	0,075	N/A	
45th	0,003	0,004	0,004	0,040	0,041	0,043	N/A	
46th	0,018	0,016	0,016	0,205	0,186	0,184	N/A	
47th	0,007	0,009	0,010	0,086	0,098	0,110	N/A	
48th	0,004	0,003	0,004	0,045	0,039	0,049	N/A	
49th	0,010	0,009	0,011	0,120	0,109	0,132	N/A	
50th	0,018	0,018	0,017	0,206	0,207	0,192	N/A	

Note:
The normal current is 8,696A.
The higher limits for odd harmonics 21 and above are only allowable under certain conditions, if these higher limits are utilised please state the exemption used as detailed in part 6.2.3.4 of BS EN 61000-3-2 in the box below.

A 1.3.1/A 2.3.1 Harmonic Current Emissions The test requirements are specified in Annex A1 A.1.3.1 (Inverter connected) or Annex A2 A.2.3.1 (Synchronous).								**P**
Generating Unit tested to BS EN 61000-3-2								
Test: HESS-HY-T1-06K								
Generating Unit rating per phase (rpp)				2,00 kW				
Harmonic order	At 100% of Registered Capacity 6,0kW						Harmonic %	
	Measured Value (MV) in Amps			Measured Value (MV) in %			Limit in BS EN61000-3-2	
	L1	L2	L3	L1	L2	L3	Limit in BS EN61000-3-2 in Amps	Higher limit for odd harmonics 21 and above
1st	8,725	8,695	8,668	100,334	99,997	99,678	N/A	
2nd	0,038	0,041	0,038	0,436	0,473	0,436	1,08	
3rd	0,007	0,010	0,013	0,078	0,120	0,153	2,3	
4th	0,027	0,032	0,030	0,313	0,366	0,344	0,43	
5th	0,113	0,110	0,111	1,300	1,270	1,273	1,14	
6th	0,006	0,002	0,006	0,070	0,027	0,071	0,3	
7th	0,040	0,039	0,039	0,465	0,452	0,450	0,77	
8th	0,012	0,007	0,005	0,136	0,082	0,063	0,23	
9th	0,010	0,005	0,004	0,118	0,061	0,046	0,4	
10th	0,008	0,010	0,011	0,087	0,111	0,121	0,184	
11th	0,096	0,108	0,102	1,099	1,239	1,173	0,33	
12th	0,004	0,002	0,003	0,043	0,021	0,040	0,153	
13th	0,119	0,115	0,112	1,370	1,318	1,291	0,21	
14th	0,007	0,004	0,004	0,086	0,050	0,047	0,131	
15th	0,008	0,005	0,003	0,093	0,054	0,039	0,15	
16th	0,009	0,008	0,010	0,103	0,095	0,111	0,115	
17th	0,017	0,024	0,024	0,198	0,277	0,273	0,132	
18th	0,002	0,002	0,002	0,027	0,018	0,027	0,102	
19th	0,037	0,035	0,034	0,423	0,402	0,393	0,118	
20th	0,006	0,003	0,004	0,065	0,034	0,047	0,092	
21th	0,004	0,003	0,002	0,048	0,032	0,020	0,107	0,160
22th	0,010	0,009	0,009	0,115	0,105	0,108	0,084	
23th	0,010	0,013	0,015	0,120	0,149	0,177	0,098	0,147
24th	0,002	0,001	0,002	0,023	0,017	0,018	0,077	
25th	0,034	0,033	0,033	0,390	0,380	0,375	0,09	0,135
26th	0,004	0,003	0,004	0,049	0,033	0,043	0,071	
27th	0,002	0,003	0,002	0,026	0,034	0,018	0,083	0,124

A 1.3.1/A 2.3.1 Harmonic Current Emissions The test requirements are specified in Annex A1 A.1.3.1 (Inverter connected) or Annex A2 A.2.3.1 (Synchronous).								**P**
Generating Unit tested to BS EN 61000-3-2								
Test: HESS-HY-T1-06K								
Generating Unit rating per phase (rpp)				2,00 kW				
Harmonic order	At 100% of Registered Capacity 6,0kW						Harmonic %	
	Measured Value (MV) in Amps			Measured Value (MV) in %			Limit in BS EN61000-3-2	
	L1	L2	L3	L1	L2	L3	Limit in BS EN61000-3-2 in Amps	Higher limit for odd harmonics 21 and above
28th	0,010	0,009	0,009	0,114	0,109	0,108	0,066	
29th	0,010	0,011	0,012	0,113	0,127	0,144	0,078	0,117
30th	0,002	0,001	0,001	0,017	0,017	0,015	0,061	
31th	0,031	0,031	0,030	0,357	0,357	0,348	0,073	0,109
32th	0,004	0,004	0,004	0,051	0,043	0,046	0,058	
33th	0,002	0,002	0,002	0,020	0,029	0,025	0,068	0,102
34th	0,009	0,009	0,009	0,107	0,106	0,102	0,054	
35th	0,011	0,013	0,012	0,127	0,145	0,136	0,064	0,096
36th	0,001	0,001	0,001	0,016	0,014	0,016	0,051	
37th	0,021	0,020	0,022	0,240	0,235	0,248	0,061	0,091
38th	0,005	0,005	0,005	0,058	0,059	0,052	0,048	
39th	0,001	0,002	0,002	0,017	0,022	0,026	0,058	0,087
40th	0,008	0,007	0,007	0,088	0,078	0,080	0,046	
41th	0,014	0,013	0,012	0,164	0,151	0,139	N/A	
42th	0,002	0,001	0,001	0,023	0,013	0,014	N/A	
43th	0,021	0,019	0,020	0,237	0,221	0,229	N/A	
44th	0,005	0,004	0,004	0,060	0,049	0,045	N/A	
45th	0,004	0,001	0,003	0,048	0,012	0,033	N/A	
46th	0,007	0,006	0,006	0,083	0,074	0,070	N/A	
47th	0,018	0,015	0,016	0,202	0,175	0,180	N/A	
48th	0,003	0,002	0,001	0,033	0,021	0,015	N/A	
49th	0,025	0,023	0,023	0,282	0,265	0,264	N/A	
50th	0,006	0,004	0,004	0,066	0,050	0,048	N/A	

Note:
The normal current is 8,696A.
The higher limits for odd harmonics 21 and above are only allowable under certain conditions, if these higher limits are utilised please state the exemption used as detailed in part 6.2.3.4 of BS EN 61000-3-2 in the box below.

A 1.3.1/A 2.3.1 Harmonic Current Emissions The test requirements are specified in Annex A1 A.1.3.1 (Inverter connected) or Annex A2 A.2.3.1 (Synchronous).								**P**
Generating Unit tested to BS EN 61000-3-2								
Test: HESS-HY-T-08K								
Generating Unit rating per phase (rpp)				2,67 kW				
Harmonic order	At 45-55% of Registered Capacity 4,0kW						Harmonic %	
	Measured Value (MV) in Amps			Measured Value (MV) in %			Limit in BS EN61000-3-2	
	L1	L2	L3	L1	L2	L3	Limit in BS EN61000-3-2 in Amps	Higher limit for odd harmonics 21 and above
1st	5,767	5,812	5,911	49,738	50,128	50,978	N/A	
2nd	0,047	0,041	0,086	0,405	0,352	0,742	1,08	
3rd	0,019	0,039	0,037	0,163	0,336	0,316	2,3	
4th	0,021	0,029	0,029	0,179	0,251	0,246	0,43	
5th	0,115	0,117	0,115	0,992	1,005	0,994	1,14	
6th	0,012	0,002	0,010	0,099	0,021	0,090	0,3	
7th	0,032	0,031	0,033	0,278	0,270	0,286	0,77	
8th	0,011	0,007	0,004	0,092	0,064	0,033	0,23	
9th	0,014	0,016	0,004	0,123	0,142	0,034	0,4	
10th	0,006	0,006	0,008	0,051	0,051	0,073	0,184	
11th	0,050	0,037	0,049	0,430	0,319	0,424	0,33	
12th	0,004	0,002	0,004	0,037	0,018	0,033	0,153	
13th	0,031	0,037	0,038	0,267	0,323	0,328	0,21	
14th	0,007	0,004	0,006	0,062	0,031	0,054	0,131	
15th	0,005	0,008	0,005	0,041	0,067	0,044	0,15	
16th	0,010	0,009	0,008	0,083	0,080	0,072	0,115	
17th	0,015	0,009	0,012	0,127	0,077	0,108	0,132	
18th	0,002	0,002	0,002	0,017	0,018	0,019	0,102	
19th	0,018	0,020	0,020	0,153	0,172	0,175	0,118	
20th	0,005	0,005	0,005	0,043	0,044	0,044	0,092	
21th	0,004	0,005	0,002	0,033	0,043	0,019	0,107	0,160
22th	0,010	0,012	0,011	0,085	0,103	0,098	0,084	
23th	0,007	0,004	0,007	0,058	0,031	0,063	0,098	0,147
24th	0,003	0,003	0,003	0,029	0,024	0,027	0,077	
25th	0,007	0,008	0,005	0,064	0,070	0,044	0,09	0,135
26th	0,004	0,004	0,002	0,034	0,038	0,021	0,071	
27th	0,005	0,008	0,003	0,040	0,065	0,026	0,083	0,124

A 1.3.1/A 2.3.1 Harmonic Current Emissions The test requirements are specified in Annex A1 A.1.3.1 (Inverter connected) or Annex A2 A.2.3.1 (Synchronous).								**P**
Generating Unit tested to BS EN 61000-3-2								
Test: HESS-HY-T-08K								
Generating Unit rating per phase (rpp)				2,67 kW				
Harmonic order	At 45-55% of Registered Capacity 4,0kW						Harmonic %	
	Measured Value (MV) in Amps			Measured Value (MV) in %			Limit in BS EN61000-3-2	
	L1	L2	L3	L1	L2	L3	Limit in BS EN61000-3-2 in Amps	Higher limit for odd harmonics 21 and above
28th	0,009	0,008	0,010	0,075	0,070	0,086	0,066	
29th	0,010	0,015	0,005	0,082	0,126	0,044	0,078	0,117
30th	0,004	0,003	0,003	0,033	0,022	0,024	0,061	
31th	0,032	0,036	0,035	0,277	0,313	0,301	0,073	0,109
32th	0,004	0,004	0,002	0,038	0,034	0,018	0,058	
33th	0,003	0,007	0,004	0,024	0,064	0,032	0,068	0,102
34th	0,008	0,008	0,007	0,073	0,066	0,063	0,054	
35th	0,019	0,022	0,014	0,166	0,190	0,124	0,064	0,096
36th	0,003	0,002	0,002	0,022	0,014	0,014	0,051	
37th	0,033	0,035	0,036	0,288	0,298	0,311	0,061	0,091
38th	0,005	0,004	0,004	0,044	0,036	0,033	0,048	
39th	0,003	0,005	0,004	0,025	0,042	0,037	0,058	0,087
40th	0,007	0,008	0,007	0,061	0,066	0,060	0,046	
41th	0,018	0,018	0,016	0,155	0,152	0,141	N/A	
42th	0,001	0,001	0,002	0,011	0,011	0,013	N/A	
43th	0,025	0,024	0,025	0,211	0,203	0,217	N/A	
44th	0,004	0,004	0,004	0,039	0,035	0,034	N/A	
45th	0,003	0,003	0,003	0,030	0,029	0,028	N/A	
46th	0,006	0,006	0,006	0,054	0,052	0,053	N/A	
47th	0,015	0,017	0,014	0,130	0,147	0,125	N/A	
48th	0,002	0,001	0,002	0,016	0,010	0,014	N/A	
49th	0,022	0,022	0,023	0,186	0,186	0,198	N/A	
50th	0,005	0,004	0,004	0,039	0,037	0,033	N/A	

Note:
The normal current is 11,594A.
The higher limits for odd harmonics 21 and above are only allowable under certain conditions, if these higher limits are utilised please state the exemption used as detailed in part 6.2.3.4 of BS EN 61000-3-2 in the box below.

A 1.3.1/A 2.3.1 Harmonic Current Emissions The test requirements are specified in Annex A1 A.1.3.1 (Inverter connected) or Annex A2 A.2.3.1 (Synchronous).								**P**
Generating Unit tested to BS EN 61000-3-2								
Test: HESS-HY-T-08K								
Generating Unit rating per phase (rpp)				2,67 kW				
Harmonic order	At 100% of Registered Capacity 8,0kW						Harmonic %	
	Measured Value (MV) in Amps			Measured Value (MV) in %			Limit in BS EN61000-3-2	
	L1	L2	L3	L1	L2	L3	Limit in BS EN61000-3-2 in Amps	Higher limit for odd harmonics 21 and above
1st	11,591	11,643	11,748	99,975	100,423	101,328	N/A	
2nd	0,065	0,036	0,099	0,559	0,308	0,852	1,08	
3rd	0,030	0,049	0,037	0,258	0,422	0,318	2,3	
4th	0,024	0,031	0,027	0,210	0,267	0,236	0,43	
5th	0,132	0,135	0,133	1,140	1,162	1,148	1,14	
6th	0,011	0,003	0,010	0,093	0,022	0,084	0,3	
7th	0,039	0,038	0,039	0,336	0,331	0,338	0,77	
8th	0,010	0,009	0,003	0,089	0,080	0,022	0,23	
9th	0,012	0,009	0,004	0,103	0,079	0,034	0,4	
10th	0,003	0,006	0,006	0,026	0,052	0,053	0,184	
11th	0,128	0,119	0,125	1,103	1,026	1,078	0,33	
12th	0,006	0,003	0,005	0,053	0,022	0,042	0,153	
13th	0,131	0,137	0,139	1,126	1,179	1,198	0,21	
14th	0,008	0,005	0,003	0,069	0,046	0,026	0,131	
15th	0,008	0,009	0,005	0,072	0,081	0,046	0,15	
16th	0,006	0,007	0,008	0,049	0,064	0,073	0,115	
17th	0,042	0,033	0,037	0,363	0,284	0,323	0,132	
18th	0,004	0,002	0,004	0,036	0,020	0,031	0,102	
19th	0,054	0,057	0,058	0,462	0,496	0,502	0,118	
20th	0,008	0,005	0,003	0,065	0,046	0,025	0,092	
21th	0,006	0,008	0,005	0,053	0,065	0,042	0,107	0,160
22th	0,007	0,007	0,008	0,061	0,060	0,072	0,084	
23th	0,016	0,010	0,011	0,140	0,084	0,091	0,098	0,147
24th	0,003	0,002	0,003	0,027	0,017	0,022	0,077	
25th	0,021	0,024	0,024	0,180	0,208	0,205	0,09	0,135
26th	0,005	0,003	0,003	0,044	0,026	0,023	0,071	
27th	0,004	0,005	0,004	0,032	0,044	0,036	0,083	0,124

A 1.3.1/A 2.3.1 Harmonic Current Emissions The test requirements are specified in Annex A1 A.1.3.1 (Inverter connected) or Annex A2 A.2.3.1 (Synchronous).								**P**
Generating Unit tested to BS EN 61000-3-2								
Test: HESS-HY-T-08K								
Generating Unit rating per phase (rpp)				2,67 kW				
Harmonic order	At 100% of Registered Capacity 8,0kW						Harmonic %	
	Measured Value (MV) in Amps			Measured Value (MV) in %			Limit in BS EN61000-3-2	
	L1	L2	L3	L1	L2	L3	Limit in BS EN61000-3-2 in Amps	Higher limit for odd harmonics 21 and above
28th	0,009	0,009	0,009	0,081	0,078	0,081	0,066	
29th	0,010	0,009	0,005	0,088	0,081	0,045	0,078	0,117
30th	0,003	0,002	0,002	0,024	0,016	0,015	0,061	
31th	0,024	0,027	0,027	0,209	0,233	0,229	0,073	0,109
32th	0,005	0,004	0,003	0,040	0,031	0,024	0,058	
33th	0,002	0,003	0,003	0,020	0,027	0,030	0,068	0,102
34th	0,008	0,008	0,008	0,071	0,067	0,067	0,054	
35th	0,009	0,011	0,007	0,078	0,096	0,060	0,064	0,096
36th	0,002	0,002	0,002	0,017	0,015	0,013	0,051	
37th	0,026	0,028	0,028	0,225	0,241	0,238	0,061	0,091
38th	0,004	0,003	0,003	0,035	0,027	0,024	0,048	
39th	0,002	0,002	0,003	0,021	0,020	0,023	0,058	0,087
40th	0,006	0,007	0,006	0,056	0,058	0,055	0,046	
41th	0,011	0,012	0,010	0,095	0,102	0,089	N/A	
42th	0,002	0,002	0,002	0,014	0,014	0,014	N/A	
43th	0,018	0,019	0,019	0,156	0,164	0,162	N/A	
44th	0,003	0,003	0,003	0,026	0,026	0,029	N/A	
45th	0,002	0,002	0,002	0,021	0,013	0,019	N/A	
46th	0,004	0,005	0,004	0,032	0,041	0,037	N/A	
47th	0,009	0,009	0,008	0,074	0,076	0,069	N/A	
48th	0,002	0,002	0,002	0,013	0,015	0,016	N/A	
49th	0,014	0,014	0,014	0,122	0,123	0,117	N/A	
50th	0,002	0,003	0,002	0,016	0,022	0,020	N/A	

Note:
The normal current is 11,594A.
The higher limits for odd harmonics 21 and above are only allowable under certain conditions, if these higher limits are utilised please state the exemption used as detailed in part 6.2.3.4 of BS EN 61000-3-2 in the box below.

A 1.3.1/A 2.3.1 Harmonic Current Emissions The test requirements are specified in Annex A1 A.1.3.1 (Inverter connected) or Annex A2 A.2.3.1 (Synchronous).								**P**
Generating Unit tested to BS EN 61000-3-2								
Test: HESS-HY-T1-08K								
Generating Unit rating per phase (rpp)				2,67 kW				
Harmonic order	At 45-55% of Registered Capacity 4,0kW						Harmonic %	
	Measured Value (MV) in Amps			Measured Value (MV) in %			Limit in BS EN61000-3-2	
	L1	L2	L3	L1	L2	L3	Limit in BS EN61000-3-2 in Amps	Higher limit for odd harmonics 21 and above
1st	6,014	6,075	5,940	51,871	52,399	51,231	N/A	
2nd	0,100	0,050	0,062	0,864	0,433	0,539	1,08	
3rd	0,040	0,031	0,027	0,349	0,265	0,230	2,3	
4th	0,133	0,124	0,132	1,150	1,072	1,142	0,43	
5th	0,126	0,130	0,130	1,083	1,123	1,120	1,14	
6th	0,012	0,006	0,008	0,102	0,049	0,070	0,3	
7th	0,057	0,059	0,056	0,493	0,511	0,481	0,77	
8th	0,059	0,052	0,063	0,506	0,444	0,545	0,23	
9th	0,016	0,006	0,018	0,136	0,048	0,154	0,4	
10th	0,036	0,040	0,037	0,308	0,343	0,316	0,184	
11th	0,202	0,216	0,216	1,741	1,860	1,866	0,33	
12th	0,006	0,005	0,005	0,053	0,044	0,041	0,153	
13th	0,083	0,081	0,077	0,716	0,701	0,664	0,21	
14th	0,015	0,016	0,018	0,128	0,134	0,152	0,131	
15th	0,010	0,005	0,008	0,083	0,045	0,066	0,15	
16th	0,019	0,019	0,018	0,161	0,167	0,159	0,115	
17th	0,020	0,019	0,021	0,170	0,162	0,181	0,132	
18th	0,005	0,005	0,005	0,044	0,040	0,040	0,102	
19th	0,023	0,023	0,024	0,201	0,198	0,207	0,118	
20th	0,022	0,023	0,022	0,191	0,198	0,185	0,092	
21th	0,005	0,006	0,005	0,047	0,051	0,044	0,107	0,160
22th	0,025	0,026	0,025	0,213	0,225	0,212	0,084	
23th	0,024	0,024	0,023	0,210	0,205	0,195	0,098	0,147
24th	0,005	0,005	0,005	0,046	0,047	0,046	0,077	
25th	0,021	0,022	0,021	0,179	0,194	0,183	0,09	0,135
26th	0,020	0,021	0,023	0,172	0,183	0,199	0,071	
27th	0,006	0,006	0,006	0,053	0,052	0,051	0,083	0,124

A 1.3.1/A 2.3.1 Harmonic Current Emissions The test requirements are specified in Annex A1 A.1.3.1 (Inverter connected) or Annex A2 A.2.3.1 (Synchronous).								**P**
Generating Unit tested to BS EN 61000-3-2								
Test: HESS-HY-T1-08K								
Generating Unit rating per phase (rpp)				2,67 kW				
Harmonic order	At 45-55% of Registered Capacity 4,0kW						Harmonic %	
	Measured Value (MV) in Amps			Measured Value (MV) in %			Limit in BS EN61000-3-2	
	L1	L2	L3	L1	L2	L3	Limit in BS EN61000-3-2 in Amps	Higher limit for odd harmonics 21 and above
28th	0,027	0,026	0,025	0,229	0,228	0,218	0,066	
29th	0,015	0,018	0,017	0,127	0,154	0,144	0,078	0,117
30th	0,006	0,006	0,006	0,055	0,056	0,050	0,061	
31th	0,030	0,031	0,029	0,260	0,266	0,247	0,073	0,109
32th	0,022	0,022	0,024	0,187	0,187	0,206	0,058	
33th	0,006	0,005	0,006	0,051	0,047	0,050	0,068	0,102
34th	0,019	0,019	0,018	0,167	0,161	0,157	0,054	
35th	0,016	0,017	0,019	0,138	0,147	0,160	0,064	0,096
36th	0,006	0,006	0,005	0,049	0,048	0,047	0,051	
37th	0,013	0,014	0,012	0,109	0,121	0,106	0,061	0,091
38th	0,012	0,011	0,013	0,106	0,098	0,110	0,048	
39th	0,005	0,004	0,005	0,043	0,039	0,040	0,058	0,087
40th	0,011	0,010	0,011	0,093	0,089	0,091	0,046	
41th	0,008	0,008	0,008	0,065	0,070	0,066	N/A	
42th	0,004	0,004	0,004	0,032	0,035	0,033	N/A	
43th	0,010	0,008	0,008	0,084	0,070	0,069	N/A	
44th	0,009	0,009	0,010	0,075	0,077	0,082	N/A	
45th	0,004	0,004	0,004	0,032	0,032	0,034	N/A	
46th	0,013	0,014	0,012	0,113	0,122	0,106	N/A	
47th	0,008	0,008	0,008	0,071	0,065	0,066	N/A	
48th	0,004	0,004	0,004	0,030	0,031	0,032	N/A	
49th	0,009	0,009	0,008	0,075	0,077	0,072	N/A	
50th	0,012	0,012	0,013	0,104	0,107	0,109	N/A	

Note:
The normal current is 11,594A.
The higher limits for odd harmonics 21 and above are only allowable under certain conditions, if these higher limits are utilised please state the exemption used as detailed in part 6.2.3.4 of BS EN 61000-3-2 in the box below.

A 1.3.1/A 2.3.1 Harmonic Current Emissions The test requirements are specified in Annex A1 A.1.3.1 (Inverter connected) or Annex A2 A.2.3.1 (Synchronous).								**P**
Generating Unit tested to BS EN 61000-3-2								
Test: HESS-HY-T1-08K								
Generating Unit rating per phase (rpp)				2,67kW				
Harmonic order	At 100% of Registered Capacity 8,0kW						Harmonic %	
	Measured Value (MV) in Amps			Measured Value (MV) in %			Limit in BS EN61000-3-2	
	L1	L2	L3	L1	L2	L3	Limit in BS EN61000-3-2 in Amps	Higher limit for odd harmonics 21 and above
1st	11,621	11,584	11,551	100,228	99,911	99,624	N/A	
2nd	0,051	0,051	0,049	0,444	0,442	0,420	1,08	
3rd	0,013	0,015	0,019	0,116	0,130	0,165	2,3	
4th	0,029	0,032	0,031	0,249	0,275	0,265	0,43	
5th	0,121	0,118	0,119	1,044	1,019	1,028	1,14	
6th	0,003	0,002	0,003	0,025	0,017	0,027	0,3	
7th	0,042	0,041	0,040	0,359	0,352	0,347	0,77	
8th	0,008	0,007	0,005	0,071	0,061	0,044	0,23	
9th	0,008	0,005	0,005	0,068	0,044	0,045	0,4	
10th	0,007	0,008	0,008	0,063	0,073	0,073	0,184	
11th	0,120	0,130	0,126	1,036	1,121	1,089	0,33	
12th	0,002	0,002	0,002	0,021	0,015	0,021	0,153	
13th	0,159	0,155	0,153	1,376	1,336	1,316	0,21	
14th	0,007	0,005	0,005	0,059	0,041	0,043	0,131	
15th	0,009	0,006	0,005	0,077	0,051	0,043	0,15	
16th	0,008	0,008	0,009	0,069	0,071	0,076	0,115	
17th	0,031	0,038	0,037	0,265	0,327	0,316	0,132	
18th	0,002	0,002	0,002	0,019	0,014	0,020	0,102	
19th	0,062	0,059	0,059	0,536	0,512	0,506	0,118	
20th	0,006	0,004	0,004	0,048	0,031	0,033	0,092	
21th	0,006	0,004	0,003	0,052	0,033	0,023	0,107	0,160
22th	0,010	0,010	0,010	0,089	0,085	0,090	0,084	
23th	0,010	0,014	0,016	0,088	0,120	0,137	0,098	0,147
24th	0,002	0,002	0,002	0,017	0,013	0,016	0,077	
25th	0,032	0,030	0,030	0,276	0,258	0,261	0,09	0,135
26th	0,004	0,003	0,003	0,036	0,025	0,028	0,071	
27th	0,004	0,003	0,002	0,032	0,029	0,017	0,083	0,124

A 1.3.1/A 2.3.1 Harmonic Current Emissions The test requirements are specified in Annex A1 A.1.3.1 (Inverter connected) or Annex A2 A.2.3.1 (Synchronous).								**P**
Generating Unit tested to BS EN 61000-3-2								
Test: HESS-HY-T1-08K								
Generating Unit rating per phase (rpp)				2,67kW				
Harmonic order	At 100% of Registered Capacity 8,0kW						Harmonic %	
	Measured Value (MV) in Amps			Measured Value (MV) in %			Limit in BS EN61000-3-2	
	L1	L2	L3	L1	L2	L3	Limit in BS EN61000-3-2 in Amps	Higher limit for odd harmonics 21 and above
28th	0,011	0,010	0,010	0,092	0,085	0,089	0,066	
29th	0,010	0,010	0,013	0,084	0,083	0,115	0,078	0,117
30th	0,002	0,002	0,002	0,018	0,014	0,013	0,061	
31th	0,038	0,037	0,036	0,325	0,316	0,312	0,073	0,109
32th	0,005	0,003	0,003	0,039	0,030	0,029	0,058	
33th	0,002	0,003	0,002	0,020	0,024	0,014	0,068	0,102
34th	0,010	0,009	0,009	0,084	0,081	0,080	0,054	
35th	0,014	0,013	0,016	0,121	0,109	0,140	0,064	0,096
36th	0,002	0,001	0,001	0,017	0,013	0,011	0,051	
37th	0,034	0,034	0,034	0,294	0,291	0,290	0,061	0,091
38th	0,005	0,004	0,004	0,045	0,037	0,038	0,048	
39th	0,002	0,004	0,002	0,017	0,031	0,013	0,058	0,087
40th	0,007	0,007	0,007	0,064	0,060	0,059	0,046	
41th	0,015	0,015	0,016	0,129	0,129	0,140	N/A	
42th	0,002	0,001	0,001	0,016	0,012	0,011	N/A	
43th	0,022	0,022	0,022	0,193	0,191	0,191	N/A	
44th	0,005	0,004	0,004	0,041	0,033	0,037	N/A	
45th	0,002	0,002	0,002	0,017	0,020	0,017	N/A	
46th	0,006	0,006	0,006	0,053	0,051	0,051	N/A	
47th	0,012	0,012	0,011	0,100	0,103	0,099	N/A	
48th	0,002	0,002	0,001	0,017	0,015	0,012	N/A	
49th	0,017	0,016	0,017	0,149	0,141	0,150	N/A	
50th	0,005	0,004	0,004	0,039	0,032	0,035	N/A	

Note:
The normal current is 11,594A.
The higher limits for odd harmonics 21 and above are only allowable under certain conditions, if these higher limits are utilised please state the exemption used as detailed in part 6.2.3.4 of BS EN 61000-3-2 in the box below.

A 1.3.1/A 2.3.1 Harmonic Current Emissions The test requirements are specified in Annex A1 A.1.3.1 (Inverter connected) or Annex A2 A.2.3.1 (Synchronous).								**P**
Generating Unit tested to BS EN 61000-3-2								
Test: HESS-HY-T-10K								
Generating Unit rating per phase (rpp)				3,33 kW				
Harmonic order	At 45-55% of Registered Capacity 5,0kW						Harmonic %	
	Measured Value (MV) in Amps			Measured Value (MV) in %			Limit in BS EN61000-3-2	
	L1	L2	L3	L1	L2	L3	Limit in BS EN61000-3-2 in Amps	Higher limit for odd harmonics 21 and above
1st	7,188	7,240	7,332	49,598	49,953	50,589	N/A	
2nd	0,053	0,040	0,092	0,364	0,279	0,635	1,08	
3rd	0,023	0,042	0,037	0,155	0,290	0,257	2,3	
4th	0,023	0,030	0,028	0,162	0,204	0,196	0,43	
5th	0,119	0,121	0,120	0,821	0,836	0,825	1,14	
6th	0,010	0,003	0,008	0,068	0,021	0,054	0,3	
7th	0,036	0,036	0,037	0,250	0,245	0,254	0,77	
8th	0,011	0,008	0,004	0,078	0,058	0,025	0,23	
9th	0,013	0,013	0,003	0,087	0,091	0,023	0,4	
10th	0,006	0,009	0,009	0,039	0,059	0,063	0,184	
11th	0,079	0,066	0,076	0,548	0,457	0,527	0,33	
12th	0,005	0,002	0,004	0,035	0,014	0,030	0,153	
13th	0,063	0,069	0,071	0,434	0,479	0,492	0,21	
14th	0,008	0,004	0,005	0,057	0,030	0,036	0,131	
15th	0,008	0,010	0,005	0,053	0,071	0,037	0,15	
16th	0,009	0,008	0,009	0,061	0,054	0,064	0,115	
17th	0,018	0,011	0,014	0,121	0,076	0,095	0,132	
18th	0,002	0,002	0,002	0,016	0,011	0,012	0,102	
19th	0,020	0,025	0,023	0,141	0,170	0,159	0,118	
20th	0,005	0,004	0,005	0,037	0,026	0,035	0,092	
21th	0,003	0,004	0,003	0,022	0,027	0,022	0,107	0,160
22th	0,011	0,011	0,010	0,074	0,074	0,072	0,084	
23th	0,012	0,009	0,011	0,084	0,059	0,073	0,098	0,147
24th	0,002	0,002	0,002	0,011	0,012	0,013	0,077	
25th	0,025	0,026	0,026	0,170	0,179	0,182	0,09	0,135
26th	0,004	0,004	0,004	0,025	0,026	0,029	0,071	
27th	0,003	0,003	0,002	0,019	0,022	0,013	0,083	0,124

A 1.3.1/A 2.3.1 Harmonic Current Emissions The test requirements are specified in Annex A1 A.1.3.1 (Inverter connected) or Annex A2 A.2.3.1 (Synchronous).								**P**
Generating Unit tested to BS EN 61000-3-2								
Test: HESS-HY-T-10K								
Generating Unit rating per phase (rpp)				3,33 kW				
Harmonic order	At 45-55% of Registered Capacity 5,0kW						Harmonic %	
	Measured Value (MV) in Amps			Measured Value (MV) in %			Limit in BS EN61000-3-2	
	L1	L2	L3	L1	L2	L3	Limit in BS EN61000-3-2 in Amps	Higher limit for odd harmonics 21 and above
28th	0,010	0,011	0,011	0,070	0,075	0,073	0,066	
29th	0,007	0,004	0,009	0,049	0,029	0,059	0,078	0,117
30th	0,002	0,002	0,002	0,014	0,013	0,016	0,061	
31th	0,016	0,015	0,015	0,110	0,106	0,102	0,073	0,109
32th	0,003	0,004	0,003	0,023	0,030	0,024	0,058	
33th	0,003	0,005	0,002	0,018	0,032	0,016	0,068	0,102
34th	0,008	0,008	0,009	0,057	0,059	0,062	0,054	
35th	0,005	0,011	0,010	0,036	0,079	0,072	0,064	0,096
36th	0,003	0,002	0,002	0,018	0,012	0,013	0,051	
37th	0,020	0,023	0,021	0,138	0,156	0,143	0,061	0,091
38th	0,004	0,005	0,003	0,027	0,031	0,022	0,048	
39th	0,001	0,005	0,001	0,009	0,034	0,010	0,058	0,087
40th	0,007	0,006	0,006	0,046	0,043	0,044	0,046	
41th	0,014	0,018	0,013	0,100	0,122	0,091	N/A	
42th	0,002	0,001	0,001	0,014	0,009	0,009	N/A	
43th	0,024	0,025	0,025	0,162	0,169	0,172	N/A	
44th	0,004	0,004	0,003	0,027	0,026	0,022	N/A	
45th	0,002	0,005	0,003	0,017	0,034	0,023	N/A	
46th	0,006	0,006	0,005	0,041	0,043	0,038	N/A	
47th	0,017	0,017	0,014	0,119	0,119	0,099	N/A	
48th	0,001	0,001	0,002	0,010	0,010	0,010	N/A	
49th	0,023	0,022	0,024	0,159	0,152	0,167	N/A	
50th	0,004	0,004	0,004	0,030	0,027	0,026	N/A	

Note:
The normal current is 14,493A.
The higher limits for odd harmonics 21 and above are only allowable under certain conditions, if these higher limits are utilised please state the exemption used as detailed in part 6.2.3.4 of BS EN 61000-3-2 in the box below.

A 1.3.1/A 2.3.1 Harmonic Current Emissions The test requirements are specified in Annex A1 A.1.3.1 (Inverter connected) or Annex A2 A.2.3.1 (Synchronous).								**P**
Generating Unit tested to BS EN 61000-3-2								
Test: HESS-HY-T-10K								
Generating Unit rating per phase (rpp)				3,33 kW				
Harmonic order	At 100% of Registered Capacity 10,0kW						Harmonic %	
	Measured Value (MV) in Amps			Measured Value (MV) in %			Limit in BS EN61000-3-2	
	L1	L2	L3	L1	L2	L3	Limit in BS EN61000-3-2 in Amps	Higher limit for odd harmonics 21 and above
1st	14,457	14,512	14,612	99,751	100,132	100,825	N/A	
2nd	0,035	0,082	0,111	0,243	0,563	0,765	1,08	
3rd	0,033	0,047	0,035	0,230	0,325	0,243	2,3	
4th	0,143	0,150	0,144	0,984	1,038	0,996	0,43	
5th	0,149	0,151	0,149	1,027	1,045	1,029	1,14	
6th	0,010	0,004	0,009	0,067	0,028	0,061	0,3	
7th	0,040	0,040	0,040	0,279	0,275	0,279	0,77	
8th	0,087	0,094	0,088	0,603	0,649	0,606	0,23	
9th	0,012	0,010	0,005	0,081	0,067	0,036	0,4	
10th	0,063	0,060	0,060	0,436	0,411	0,415	0,184	
11th	0,196	0,187	0,193	1,350	1,292	1,334	0,33	
12th	0,004	0,004	0,006	0,028	0,024	0,039	0,153	
13th	0,121	0,130	0,126	0,837	0,899	0,868	0,21	
14th	0,040	0,030	0,039	0,275	0,205	0,269	0,131	
15th	0,009	0,012	0,006	0,065	0,080	0,039	0,15	
16th	0,026	0,025	0,026	0,182	0,170	0,181	0,115	
17th	0,038	0,036	0,036	0,259	0,248	0,246	0,132	
18th	0,008	0,007	0,004	0,058	0,045	0,025	0,102	
19th	0,076	0,080	0,085	0,527	0,549	0,589	0,118	
20th	0,009	0,008	0,011	0,065	0,054	0,078	0,092	
21th	0,003	0,003	0,004	0,024	0,023	0,031	0,107	0,160
22th	0,021	0,027	0,026	0,147	0,183	0,177	0,084	
23th	0,015	0,014	0,005	0,101	0,100	0,037	0,098	0,147
24th	0,005	0,005	0,004	0,035	0,033	0,029	0,077	
25th	0,037	0,038	0,036	0,256	0,259	0,251	0,09	0,135
26th	0,024	0,027	0,021	0,165	0,185	0,146	0,071	
27th	0,006	0,007	0,004	0,041	0,052	0,029	0,083	0,124

A 1.3.1/A 2.3.1 Harmonic Current Emissions The test requirements are specified in Annex A1 A.1.3.1 (Inverter connected) or Annex A2 A.2.3.1 (Synchronous).								**P**
Generating Unit tested to BS EN 61000-3-2								
Test: HESS-HY-T-10K								
Generating Unit rating per phase (rpp)				3,33 kW				
Harmonic order	At 100% of Registered Capacity 10,0kW						Harmonic %	
	Measured Value (MV) in Amps			Measured Value (MV) in %			Limit in BS EN61000-3-2	
	L1	L2	L3	L1	L2	L3	Limit in BS EN61000-3-2 in Amps	Higher limit for odd harmonics 21 and above
28th	0,017	0,016	0,015	0,118	0,109	0,101	0,066	
29th	0,022	0,016	0,022	0,152	0,113	0,155	0,078	0,117
30th	0,003	0,003	0,003	0,019	0,019	0,021	0,061	
31th	0,036	0,038	0,037	0,249	0,265	0,254	0,073	0,109
32th	0,015	0,011	0,016	0,102	0,079	0,113	0,058	
33th	0,005	0,007	0,004	0,036	0,045	0,026	0,068	0,102
34th	0,024	0,022	0,023	0,168	0,153	0,158	0,054	
35th	0,017	0,017	0,015	0,115	0,119	0,103	0,064	0,096
36th	0,005	0,004	0,003	0,034	0,028	0,018	0,051	
37th	0,016	0,021	0,021	0,114	0,148	0,142	0,061	0,091
38th	0,008	0,005	0,007	0,055	0,037	0,046	0,048	
39th	0,003	0,004	0,004	0,024	0,025	0,026	0,058	0,087
40th	0,009	0,010	0,011	0,060	0,070	0,079	0,046	
41th	0,012	0,017	0,011	0,086	0,118	0,079	N/A	
42th	0,005	0,005	0,003	0,034	0,034	0,021	N/A	
43th	0,017	0,015	0,018	0,116	0,106	0,121	N/A	
44th	0,011	0,013	0,010	0,078	0,087	0,069	N/A	
45th	0,003	0,005	0,004	0,023	0,036	0,026	N/A	
46th	0,008	0,010	0,008	0,058	0,067	0,053	N/A	
47th	0,007	0,008	0,006	0,046	0,056	0,045	N/A	
48th	0,003	0,003	0,003	0,020	0,022	0,022	N/A	
49th	0,027	0,030	0,029	0,190	0,205	0,197	N/A	
50th	0,010	0,009	0,010	0,067	0,065	0,069	N/A	

Note:
The normal current is 11,594A.
The higher limits for odd harmonics 21 and above are only allowable under certain conditions, if these higher limits are utilised please state the exemption used as detailed in part 6.2.3.4 of BS EN 61000-3-2 in the box below.

A 1.3.1/A 2.3.1 Harmonic Current Emissions The test requirements are specified in Annex A1 A.1.3.1 (Inverter connected) or Annex A2 A.2.3.1 (Synchronous).								**P**
Generating Unit tested to BS EN 61000-3-2								
Test: HESS-HY-T1-10K								
Generating Unit rating per phase (rpp)				3,33 kW				
Harmonic order	At 45-55% of Registered Capacity 5,0kW						Harmonic %	
	Measured Value (MV) in Amps			Measured Value (MV) in %			Limit in BS EN61000-3-2	
	L1	L2	L3	L1	L2	L3	Limit in BS EN61000-3-2 in Amps	Higher limit for odd harmonics 21 and above
1st	7,444	7,509	7,373	51,366	51,810	50,875	N/A	
2nd	0,105	0,054	0,065	0,723	0,370	0,451	1,08	
3rd	0,038	0,030	0,024	0,264	0,207	0,168	2,3	
4th	0,130	0,124	0,131	0,898	0,853	0,906	0,43	
5th	0,129	0,132	0,131	0,887	0,910	0,902	1,14	
6th	0,013	0,007	0,008	0,091	0,049	0,053	0,3	
7th	0,064	0,066	0,065	0,440	0,459	0,445	0,77	
8th	0,019	0,021	0,024	0,129	0,147	0,168	0,23	
9th	0,014	0,006	0,016	0,096	0,041	0,112	0,4	
10th	0,030	0,026	0,027	0,209	0,180	0,189	0,184	
11th	0,143	0,160	0,161	0,987	1,101	1,113	0,33	
12th	0,007	0,005	0,006	0,047	0,035	0,044	0,153	
13th	0,182	0,179	0,173	1,253	1,235	1,192	0,21	
14th	0,035	0,032	0,038	0,242	0,222	0,262	0,131	
15th	0,012	0,007	0,013	0,083	0,051	0,087	0,15	
16th	0,035	0,037	0,036	0,240	0,255	0,251	0,115	
17th	0,101	0,110	0,110	0,696	0,756	0,762	0,132	
18th	0,004	0,005	0,004	0,030	0,035	0,027	0,102	
19th	0,047	0,045	0,045	0,327	0,309	0,308	0,118	
20th	0,018	0,018	0,018	0,122	0,127	0,127	0,092	
21th	0,006	0,004	0,006	0,041	0,031	0,041	0,107	0,160
22th	0,021	0,021	0,022	0,144	0,142	0,151	0,084	
23th	0,027	0,028	0,027	0,186	0,191	0,187	0,098	0,147
24th	0,004	0,004	0,004	0,030	0,028	0,027	0,077	
25th	0,028	0,025	0,028	0,192	0,169	0,190	0,09	0,135
26th	0,023	0,023	0,023	0,158	0,160	0,159	0,071	
27th	0,004	0,004	0,005	0,029	0,029	0,033	0,083	0,124

A 1.3.1/A 2.3.1 Harmonic Current Emissions The test requirements are specified in Annex A1 A.1.3.1 (Inverter connected) or Annex A2 A.2.3.1 (Synchronous).								**P**
Generating Unit tested to BS EN 61000-3-2								
Test: HESS-HY-T1-10K								
Generating Unit rating per phase (rpp)				3,33 kW				
Harmonic order	At 45-55% of Registered Capacity 5,0kW						Harmonic %	
	Measured Value (MV) in Amps			Measured Value (MV) in %			Limit in BS EN61000-3-2	
	L1	L2	L3	L1	L2	L3	Limit in BS EN61000-3-2 in Amps	Higher limit for odd harmonics 21 and above
28th	0,024	0,025	0,026	0,169	0,173	0,176	0,066	
29th	0,028	0,029	0,028	0,194	0,203	0,194	0,078	0,117
30th	0,004	0,004	0,004	0,027	0,028	0,029	0,061	
31th	0,021	0,020	0,021	0,145	0,136	0,145	0,073	0,109
32th	0,014	0,013	0,013	0,096	0,088	0,090	0,058	
33th	0,004	0,004	0,005	0,030	0,025	0,032	0,068	0,102
34th	0,023	0,022	0,022	0,160	0,154	0,155	0,054	
35th	0,020	0,021	0,017	0,136	0,142	0,120	0,064	0,096
36th	0,004	0,005	0,004	0,028	0,037	0,031	0,051	
37th	0,025	0,025	0,025	0,171	0,170	0,170	0,061	0,091
38th	0,018	0,021	0,022	0,124	0,147	0,149	0,048	
39th	0,005	0,004	0,005	0,035	0,027	0,032	0,058	0,087
40th	0,015	0,015	0,016	0,103	0,102	0,108	0,046	
41th	0,014	0,017	0,017	0,095	0,117	0,120	N/A	
42th	0,005	0,004	0,005	0,032	0,026	0,031	N/A	
43th	0,021	0,020	0,019	0,141	0,137	0,130	N/A	
44th	0,014	0,013	0,014	0,097	0,092	0,096	N/A	
45th	0,005	0,004	0,004	0,035	0,026	0,030	N/A	
46th	0,018	0,017	0,017	0,122	0,116	0,116	N/A	
47th	0,010	0,011	0,010	0,071	0,076	0,072	N/A	
48th	0,004	0,004	0,004	0,028	0,029	0,028	N/A	
49th	0,016	0,016	0,015	0,114	0,113	0,103	N/A	
50th	0,016	0,016	0,017	0,109	0,112	0,119	N/A	

Note:
The normal current is 14,493A.
The higher limits for odd harmonics 21 and above are only allowable under certain conditions, if these higher limits are utilised please state the exemption used as detailed in part 6.2.3.4 of BS EN 61000-3-2 in the box below.

A 1.3.1/A 2.3.1 Harmonic Current Emissions The test requirements are specified in Annex A1 A.1.3.1 (Inverter connected) or Annex A2 A.2.3.1 (Synchronous).								**P**
Generating Unit tested to BS EN 61000-3-2								
Test: HESS-HY-T1-10K								
Generating Unit rating per phase (rpp)				3,33 kW				
Harmonic order	At 100% of Registered Capacity 10,0kW						Harmonic %	
	Measured Value (MV) in Amps			Measured Value (MV) in %			Limit in BS EN61000-3-2	
	L1	L2	L3	L1	L2	L3	Limit in BS EN61000-3-2 in Amps	Higher limit for odd harmonics 21 and above
1st	14,522	14,484	14,444	100,200	99,940	99,664	N/A	
2nd	0,070	0,052	0,064	0,485	0,362	0,440	1,08	
3rd	0,018	0,018	0,023	0,123	0,122	0,162	2,3	
4th	0,029	0,032	0,032	0,201	0,220	0,218	0,43	
5th	0,134	0,131	0,133	0,928	0,906	0,915	1,14	
6th	0,003	0,002	0,003	0,020	0,014	0,020	0,3	
7th	0,037	0,037	0,036	0,258	0,253	0,250	0,77	
8th	0,007	0,007	0,005	0,050	0,047	0,038	0,23	
9th	0,008	0,004	0,005	0,054	0,027	0,031	0,4	
10th	0,006	0,007	0,007	0,039	0,049	0,051	0,184	
11th	0,137	0,147	0,144	0,947	1,014	0,991	0,33	
12th	0,003	0,002	0,002	0,017	0,012	0,017	0,153	
13th	0,178	0,172	0,171	1,227	1,190	1,181	0,21	
14th	0,007	0,005	0,004	0,049	0,035	0,029	0,131	
15th	0,009	0,004	0,004	0,063	0,031	0,031	0,15	
16th	0,008	0,008	0,009	0,055	0,055	0,061	0,115	
17th	0,044	0,052	0,051	0,304	0,357	0,349	0,132	
18th	0,002	0,002	0,002	0,015	0,012	0,015	0,102	
19th	0,085	0,082	0,082	0,589	0,568	0,563	0,118	
20th	0,006	0,004	0,004	0,039	0,027	0,025	0,092	
21th	0,007	0,005	0,004	0,048	0,031	0,030	0,107	0,160
22th	0,009	0,009	0,009	0,064	0,061	0,063	0,084	
23th	0,013	0,017	0,018	0,087	0,118	0,124	0,098	0,147
24th	0,002	0,002	0,002	0,015	0,011	0,015	0,077	
25th	0,040	0,038	0,038	0,274	0,259	0,262	0,09	0,135
26th	0,004	0,003	0,003	0,029	0,020	0,020	0,071	
27th	0,005	0,003	0,003	0,035	0,019	0,022	0,083	0,124

A 1.3.1/A 2.3.1 Harmonic Current Emissions The test requirements are specified in Annex A1 A.1.3.1 (Inverter connected) or Annex A2 A.2.3.1 (Synchronous).								**P**
Generating Unit tested to BS EN 61000-3-2								
Test: HESS-HY-T1-10K								
Generating Unit rating per phase (rpp)				3,33 kW				
Harmonic order	At 100% of Registered Capacity 10,0kW						Harmonic %	
	Measured Value (MV) in Amps			Measured Value (MV) in %			Limit in BS EN61000-3-2	
	L1	L2	L3	L1	L2	L3	Limit in BS EN61000-3-2 in Amps	Higher limit for odd harmonics 21 and above
28th	0,010	0,010	0,010	0,072	0,069	0,070	0,066	
29th	0,008	0,008	0,012	0,055	0,055	0,081	0,078	0,117
30th	0,002	0,002	0,002	0,014	0,012	0,012	0,061	
31th	0,034	0,033	0,032	0,233	0,225	0,224	0,073	0,109
32th	0,004	0,003	0,003	0,030	0,020	0,020	0,058	
33th	0,004	0,003	0,002	0,026	0,022	0,013	0,068	0,102
34th	0,010	0,010	0,010	0,070	0,067	0,068	0,054	
35th	0,013	0,010	0,015	0,088	0,069	0,101	0,064	0,096
36th	0,002	0,002	0,001	0,016	0,012	0,010	0,051	
37th	0,038	0,037	0,036	0,260	0,254	0,250	0,061	0,091
38th	0,005	0,004	0,004	0,035	0,030	0,025	0,048	
39th	0,003	0,004	0,002	0,020	0,026	0,012	0,058	0,087
40th	0,008	0,008	0,008	0,058	0,055	0,054	0,046	
41th	0,017	0,015	0,018	0,120	0,104	0,127	N/A	
42th	0,002	0,002	0,001	0,015	0,011	0,009	N/A	
43th	0,030	0,030	0,029	0,208	0,208	0,201	N/A	
44th	0,005	0,004	0,004	0,037	0,030	0,030	N/A	
45th	0,003	0,004	0,002	0,020	0,027	0,015	N/A	
46th	0,007	0,006	0,006	0,045	0,045	0,040	N/A	
47th	0,015	0,015	0,016	0,106	0,100	0,111	N/A	
48th	0,002	0,002	0,002	0,015	0,013	0,011	N/A	
49th	0,023	0,023	0,023	0,161	0,161	0,158	N/A	
50th	0,005	0,004	0,004	0,035	0,027	0,031	N/A	

Note:
The normal current is 11,594A.
The higher limits for odd harmonics 21 and above are only allowable under certain conditions, if these higher limits are utilised please state the exemption used as detailed in part 6.2.3.4 of BS EN 61000-3-2 in the box below.

A 1.3.2/A 2.3.2 Power factor The requirement is specified in section 9.5, test procedure in Annex A1 A.1.3.2 (Inverter connected) or Annex A2 A.2.3.2 (Synchronous).				**P**
Test result: HESS-HY-T-10K				
Output power	216,2 V	230,0 V	253,2 V	
20%	0,997	0,995	0,992	Measured at three voltage levels and at full output. Voltage to be maintained within ±1,5% of the stated level during the test.
50%	0,999	0,999	0,998	
75%	1,000	0,999	0,999	
100%	1,000	1,000	0,999	
Limit	>0,95	>0,95	>0,95	

Note:
The power factor capability of the Micro-generator shall conform to EN 50549-1 as applicable to Micro-generating Plant. When operating at Registered Capacity the Micro-generator shall operate at a power factor within the range 0,95 lagging to 0,95 leading relative to the voltage waveform unless otherwise agreed with the DNO eg for power factor improvement.

The test set up shall be such that the Inverter supplies full load to the DNO's Distribution System via the power factor (pf) meter and the variac as shown below in figure A5. The Inverter pf should be within the limits given in 5.6, for three test voltages 230 V –6%, 230V and 230 V +10%. The voltage shall be maintained within ±1,5% of the stated level during the test.
The tests had been performed on the HESS-HY-T-10K are valid for the HESS-HY-T-05K, HESS-HY-T-06K, HESS-HY-T-08K, HESS-HY-T1-05K, HESS-HY-T1-06K, HESS-HY-T1-08K, HESS-HY-T1-10K since it is almost same as in hardware and just power derated by software.

A 1.3.3/A 2.3.3 Voltage Flicker	P

Test result: HESS-HY-T-10K

		Starting			Stopping			Running	
		d_{max}	d_c	$d_{(t)}$	d_{max}	d_c	$d_{(t)}$	P_{st}	P_{lt} 2 hours
Measured values at test impedance	L1	0,481	0,168	0,000	0,224	0,087	0,000	0,115	0,120
Normalised to standard impedance	L1	0,481	0,168	0,000	0,224	0,087	0,000	0,115	0,120
Normalised to maximum impedance	L1	0,481	0,168	0,000	0,224	0,087	0,000	0,115	0,120
Measured values at test impedance	L2	0,276	0,140	0,000	0,385	0,086	0,000	0,115	0,117
Normalised to standard impedance	L2	0,276	0,140	0,000	0,385	0,086	0,000	0,115	0,117
Normalised to maximum impedance	L2	0,276	0,140	0,000	0,385	0,086	0,000	0,115	0,117
Measured values at test impedance	L3	0,457	0,132	0,000	0,315	0,092	0,000	0,115	0,122
Normalised to standard impedance	L3	0,457	0,132	0,000	0,315	0,092	0,000	0,115	0,122
Normalised to maximum impedance	L3	0,457	0,132	0,000	0,315	0,092	0,000	0,115	0,122
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	0,240	Ω	Xl	0,150	Ω
	Z	0,283	Ω			
Standard impedance	R	0,240	Ω	Xl	0,150	Ω
	Z	0,283	Ω			
Maximum Impedance	R	0,240	Ω	Xl	0,150	Ω
	Z	0,283	Ω			

Test result: HESS-HY-T1-10K

		Starting			Stopping			Running	
		d_{max}	d_c	$d_{(t)}$	d_{max}	d_c	$d_{(t)}$	P_{st}	P_{lt} 2 hours
Measured values at test impedance	L1	0,482	0,168	0,000	0,225	0,082	0,000	0,115	0,120
Normalised to standard	L1	0,482	0,168	0,000	0,225	0,082	0,000	0,115	0,120

impedance									
Normalised to maximum impedance	L1	0,482	0,168	0,000	0,225	0,082	0,000	0,115	0,120
Measured values at test impedance	L2	0,276	0,141	0,000	0,385	0,086	0,000	0,117	0,119
Normalised to standard impedance	L2	0,276	0,141	0,000	0,385	0,086	0,000	0,117	0,119
Normalised to maximum impedance	L2	0,276	0,141	0,000	0,385	0,086	0,000	0,117	0,119
Measured values at test impedance	L3	0,457	0,131	0,000	0,316	0,092	0,000	0,135	0,122
Normalised to standard impedance	L3	0,457	0,131	0,000	0,316	0,092	0,000	0,135	0,122
Normalised to maximum impedance	L3	0,457	0,131	0,000	0,316	0,092	0,000	0,135	0,122
Normalised to required maximum impedance		4,00%	3,30%	3,3% 500ms	4,00%	3,30%	3,3% 500ms	1,0	0,65
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	0,240	Ω	Xl	0,150	Ω
	Z	0,283	Ω			
Standard impedance	R	0,240	Ω	Xl	0,150	Ω
	Z	0,283	Ω			
Maximum Impedance	R	0,240	Ω	Xl	0,150	Ω
	Z	0,283	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.

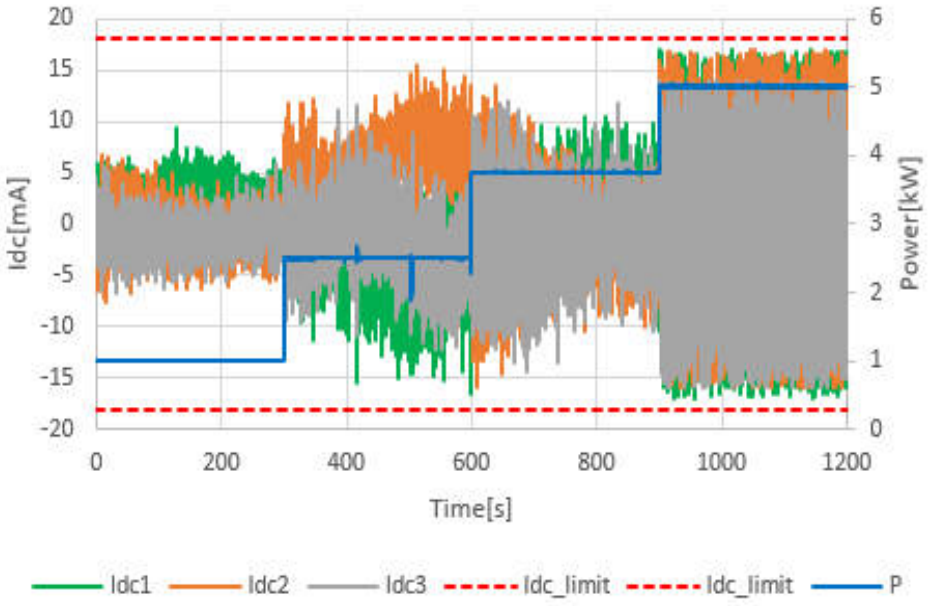
Three phase units reference source resistance is 0,24 Ω

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.

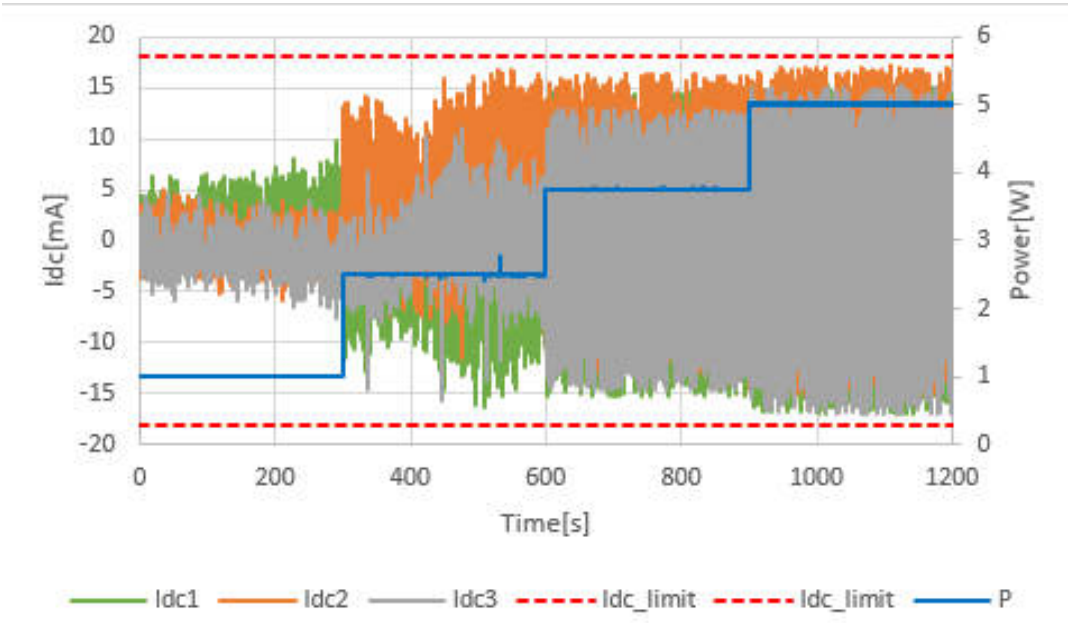
The stopping test should be a trip from full load operation.

The tests had been performed on the HESS-HY-T-10K and HESS-HY-T1-10K are valid for the HESS-HY-T-05K, HESS-HY-T-06K, HESS-HY-T-08K, HESS-HY-T1-05K, HESS-HY-T1-06K and HESS-HY-T1-08K since it is almost same as in hardware and just power derated by software.

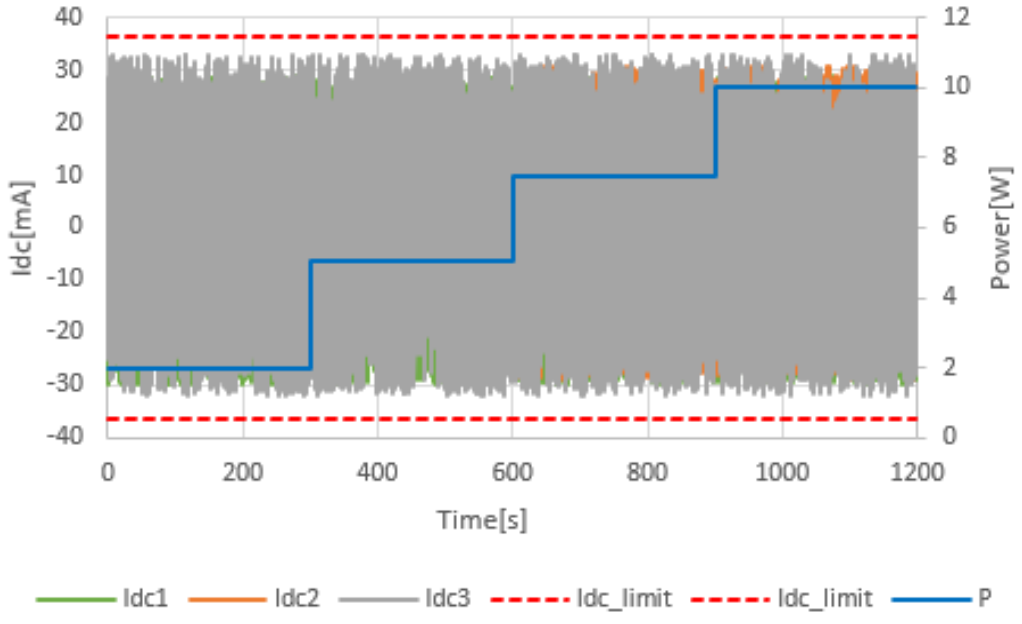
A.1.3.4 DC injection				P
Test: HESS-HY-T-05K				
Phase 1				
Test level power [%]	20	50	75	100
Recorded DC value [mA]	9,270	8,230	10,500	16,975
As % of rated AC current [%]	0,13	0,11	0,14	0,23
Limit	0,25% $I_{ACrated}$			
Phase 2				
Test level power [%]	20	50	75	100
Recorded DC value [mA]	6,710	15,450	13,400	16,978
As % of rated AC current [%]	0,09	0,21	0,18	0,23
Limit	0,25% $I_{ACrated}$			
Phase 3				
Test level power [%]	20	50	75	100
Recorded DC value [mA]	5,940	11,550	12,000	13,982
As % of rated AC current [%]	0,08	0,16	0,17	0,19
Limit	0,25% $I_{ACrated}$			
Sum of all Phases Tests are to be carried out at three defined power levels ±5%. At 230 V a 5 kW three phase Inverter has a current output of 21,739A so DC limit is 54,348 mA. These tests should be undertaken in accordance with Annex A.7.1.4.4. The % DC injection ("as % of rated AC current" below) is calculated as follows: % DC injection = Recorded DC value in Amps / Base current where the base current is the Registered Capacity (W) / V phase. The % DC injection should not be greater than 0,25%.				
Test level power [%]	20	50	75	100
Recorded DC value [mA]	21,920	35,230	35,900	47,935
As % of rated AC current [%]	0,10	0,16	0,17	0,22
Limit	0,25% $I_{ACrated}$			



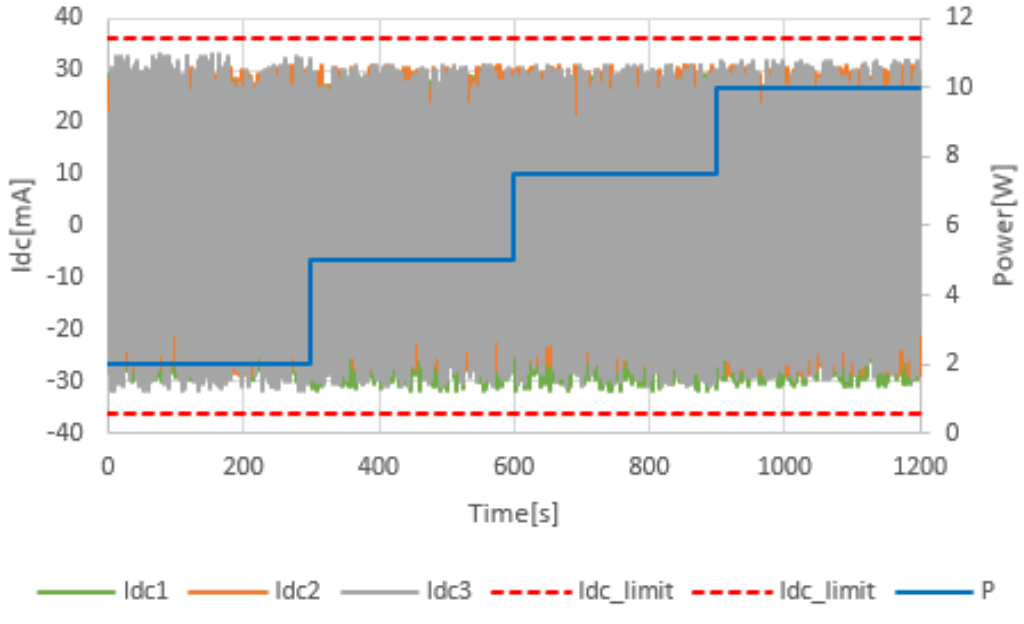
A.1.3.4 DC injection				P
Test: HESS-HY-T1-05K				
Phase 1				
Test level power [%]	20	50	75	100
Recorded DC value [mA]	9,830	13,910	14,686	15,200
As % of rated AC current [%]	0,14	0,19	0,20	0,21
Limit	0,25% $I_{ACrated}$			
Phase 2				
Test level power [%]	20	50	75	100
Recorded DC value [mA]	4,930	16,710	16,416	17,100
As % of rated AC current [%]	0,07	0,23	0,23	0,24
Limit	0,25% $I_{ACrated}$			
Phase 3				
Test level power [%]	20	50	75	100
Recorded DC value [mA]	4,650	11,146	12,929	15,200
As % of rated AC current [%]	0,06	0,15	0,18	0,21
Limit	0,25% $I_{ACrated}$			
Sum of all Phases Tests are to be carried out at three defined power levels ±5%. At 230 V a 5 kW three phase Inverter has a current output of 21,739A so DC limit is 54,348 mA. These tests should be undertaken in accordance with Annex A.7.1.4.4. The % DC injection ("as % of rated AC current" below) is calculated as follows: % DC injection = Recorded DC value in Amps / Base current where the base current is the Registered Capacity (W) / V phase. The % DC injection should not be greater than 0,25%.				
Test level power [%]	20	50	75	100
Recorded DC value [mA]	19,410	41,766	44,031	47,500
As % of rated AC current [%]	0,09	0,19	0,20	0,22
Limit	0,25% $I_{ACrated}$			



A.1.3.4 DC injection				P
Test: HESS-HY-T-10K				
Phase 1				
Test level power [%]	20	50	75	100
Recorded DC value [mA]	28,990	28,924	28,965	28,999
As % of rated AC current [%]	0,20	0,20	0,20	0,20
Limit	0,25% $I_{ACrated}$			
Phase 2				
Test level power [%]	20	50	75	100
Recorded DC value [mA]	18,000	17,996	30,947	30,978
As % of rated AC current [%]	0,12	0,12	0,21	0,21
Limit	0,25% $I_{ACrated}$			
Phase 3				
Test level power [%]	20	50	75	100
Recorded DC value [mA]	32,985	31,981	32,913	32,977
As % of rated AC current [%]	0,23	0,22	0,23	0,23
Limit	0,25% $I_{ACrated}$			
Sum of all Phases Tests are to be carried out at three defined power levels ±5%. At 230 V a 10kW three phase Inverter has a current output of 43,478A so DC limit is 108,696 mA. These tests should be undertaken in accordance with Annex A.7.1.4.4. The % DC injection (“as % of rated AC current” below) is calculated as follows: % DC injection = Recorded DC value in Amps / Base current where the base current is the Registered Capacity (W) / V phase. The % DC injection should not be greater than 0,25%.				
Test level power [%]	20	50	75	100
Recorded DC value [mA]	79,975	78,901	92,825	92,954
As % of rated AC current [%]	0,18	0,18	0,21	0,21
Limit	0,25% $I_{ACrated}$			



A.1.3.4 DC injection				P
Test: HESS-HY-T1-10K				
Phase 1				
Test level power [%]	20	50	75	100
Recorded DC value [mA]	28,973	28,998	28,990	28,998
As % of rated AC current [%]	0,20	0,20	0,20	0,20
Limit	0,25% $I_{ACrated}$			
Phase 2				
Test level power [%]	20	50	75	100
Recorded DC value [mA]	30,927	30,949	30,937	30,982
As % of rated AC current [%]	0,21	0,21	0,21	0,21
Limit	0,25% $I_{ACrated}$			
Phase 3				
Test level power [%]	20	50	75	100
Recorded DC value [mA]	32,99	30,956	30,974	31,989
As % of rated AC current [%]	0,23	0,21	0,21	0,22
Limit	0,25% $I_{ACrated}$			
Sum of all Phases Tests are to be carried out at three defined power levels ±5%. At 230 V a 10kW three phase Inverter has a current output of 43,478A so DC limit is 108,696 mA. These tests should be undertaken in accordance with Annex A.7.1.4.4. The % DC injection ("as % of rated AC current" below) is calculated as follows: % DC injection = Recorded DC value in Amps / Base current where the base current is the Registered Capacity (W) / V phase. The % DC injection should not be greater than 0,25%.				
Test level power [%]	20	50	75	100
Recorded DC value [mA]	92,890	90,903	90,901	91,969
As % of rated AC current [%]	0,21	0,21	0,21	0,21
Limit	0,25% $I_{ACrated}$			



A.1.3.4 DC injection	P
Note: The tests should be carried out on a single Generating Unit. The tests had been performed on the HESS-HY-T-05K, HESS-HY-T1-05K, HESS-HY-T-10K and HESS-HY-T1-10K are valid for the HESS-HY-T-06K, HESS-HY-T-08K, HESS-HY-T1-06K and HESS-HY-T1-08K since it is almost same as in hardware and just power derated by software.	

A 1.3.5/A 2.3.4 Short Circuit Current Contribution for Inverters	P

Test result: HESS-HY-T-10K

Phase 1

For a directly coupled unit			For a Inverter unit		
Parameter	Symbol	Value	Time after fault	Volts	Amps
Peak Short Circuit current	i_p	N/A	20ms	5,7V	14,4A
Initial Value of aperiodic current	A	N/A	100ms	3,7V	19,5A
Initial symmetrical short-circuit current*	I_k	N/A	250ms	-3,9V	-20,2A
Decaying (aperiodic) component of short circuit current*	i_{DC}	N/A	500ms	5,3V	-0,1A
Reactance/Resistance Ratio of source*	X/R	N/A	Time to trip	0,348	In seconds

Phase 2

For a directly coupled unit			For a Inverter unit		
Parameter	Symbol	Value	Time after fault	Volts	Amps
Peak Short Circuit current	i_p	N/A	20ms	1,8V	-3,2A
Initial Value of aperiodic current	A	N/A	100ms	4,7V	-2,5A
Initial symmetrical short-circuit current*	I_k	N/A	250ms	-4,6V	1,6A
Decaying (aperiodic) component of short circuit current*	i_{DC}	N/A	500ms	-0,8V	0,1A
Reactance/Resistance Ratio of source*	X/R	N/A	Time to trip	0,345	In seconds

Phase 3

For a directly coupled unit			For a Inverter unit		
Parameter	Symbol	Value	Time after fault	Volts	Amps
Peak Short Circuit current	i_p	N/A	20ms	8,2V	11,7A
Initial Value of aperiodic current	A	N/A	100ms	9,1V	14,1A
Initial symmetrical short-circuit current*	I_k	N/A	250ms	-8,6V	-14,2A
Decaying (aperiodic) component of short circuit current*	i_{DC}	N/A	500ms	4,8V	-0,1A
Reactance/Resistance Ratio of source*	X/R	N/A	Time to trip	0,354	In seconds

Testing:
Testing procedure: LVRT 10 – 15 % U_{NOM} with > 500 ms shall be recorded.

Note:
The values of voltage and current should be recorded for a period of up to 2 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 4) including the time taken for the Inverter to trip.
The tests had been performed on the HESS-HY-T-10K are valid for the HESS-HY-T-05K, HESS-HY-T-06K, HESS-HY-T-08K, HESS-HY-T1-05K, HESS-HY-T1-06K, HESS-HY-T1-08K and HESS-HY-T1-10K since it is almost same as in hardware and just power derated by software.

A1.3.6 Self Monitoring – Solid state Disconnection	**N/A**
It has been verified that in the event of the solid state switching device failing to disconnect the UNIT, 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).	

Cyber security, required by paragraph 9.7	**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 9.7.	Yes

Jiangsu Hanchu Energy Technology Co.,Ltd

Manufacturer's declaration

We, （Company: Jiangsu Hanchu Energy Technology Co.,Ltd, Address: No.588,Jinhui Road,Huishan District ,Wuxi City,Jiangsu Province,China）, hearby declare that all our below listed inverters comply with the cyber security requirements of the standard G99-1 and G98-1:

- Model no.:

For G98-1: HESS-HY-T-05K, HESS-HY-T-06K, HESS-HY-T-08K, HESS-HY-T-10K,
HESS-HY-T1-05K, HESS-HY-T1-06K, HESS-HY-T1-08K, HESS-HY-T1-10K,
For G99-1: HESS-HY-T-12K, HESS-HY-T1-12K

- Requirements listed in the standard(s):
  - ETSI EN 303 645;
  - relevant aspects of PAS 1879 "Energy smart appliances – Demand side response operation – Code of practice";
  - relevant aspects of "Distributed Energy Resources – Cyber Security Connection Guidance" published by BEIS and the ENA;
  - Any other relevant standard that has been incorporated in the design of the **Power Generating Module**.

Page 1 of 2

Jiangsu Hanchu Energy Technology Co.,Ltd

Declared by:

Company name: Jiangsu Hanchu Energy Technology Co.,Ltd

Responsible person: Allen Zhu

Signature (and/or Stamp):

Date:

Page 2 of 2

Note:

Different levels of access, all are password protected, only certain parameters can be changed on maintenance level.

Logic Interface (input port) Required by paragraph 9.4.3	**P**
Confirm that an input port is provided and can be used to reduce the Active Power output to zero	Yes
Provide high level description of logic interface, e.g. details in 9.4.4 such as AC or DC signal	Yes

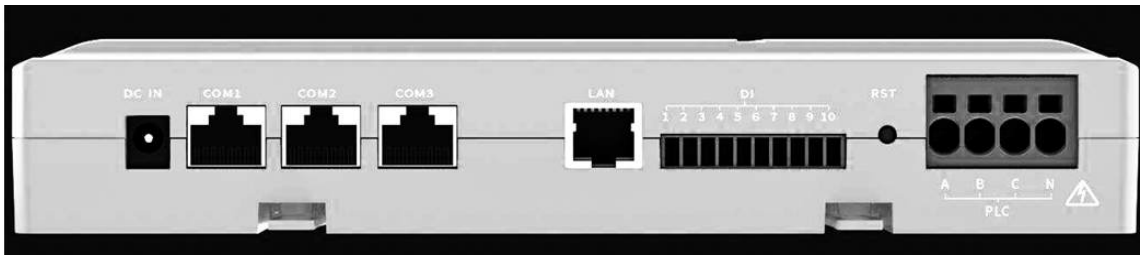
Logical interfaces are implemented by external devices (model: Ai-Logger 1000). COM1 or 2 or 3 of the external device is connected to COM0 of the power generation module (Figure 4).

Pins 1 and 10 of the DI port of the external device are connected to the switch or contactor.

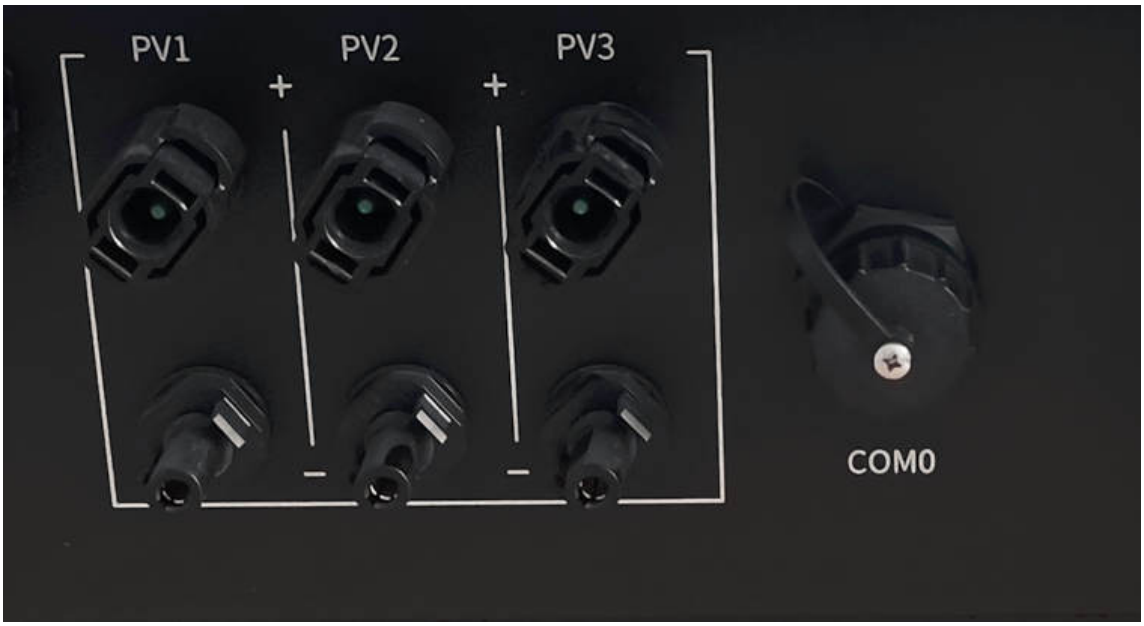
When the switch is closed, the generating module can work normally.

When the switch is opened, the logical port has a DC voltage of 5V, and the power module reduces the active power to zero within 5 seconds.

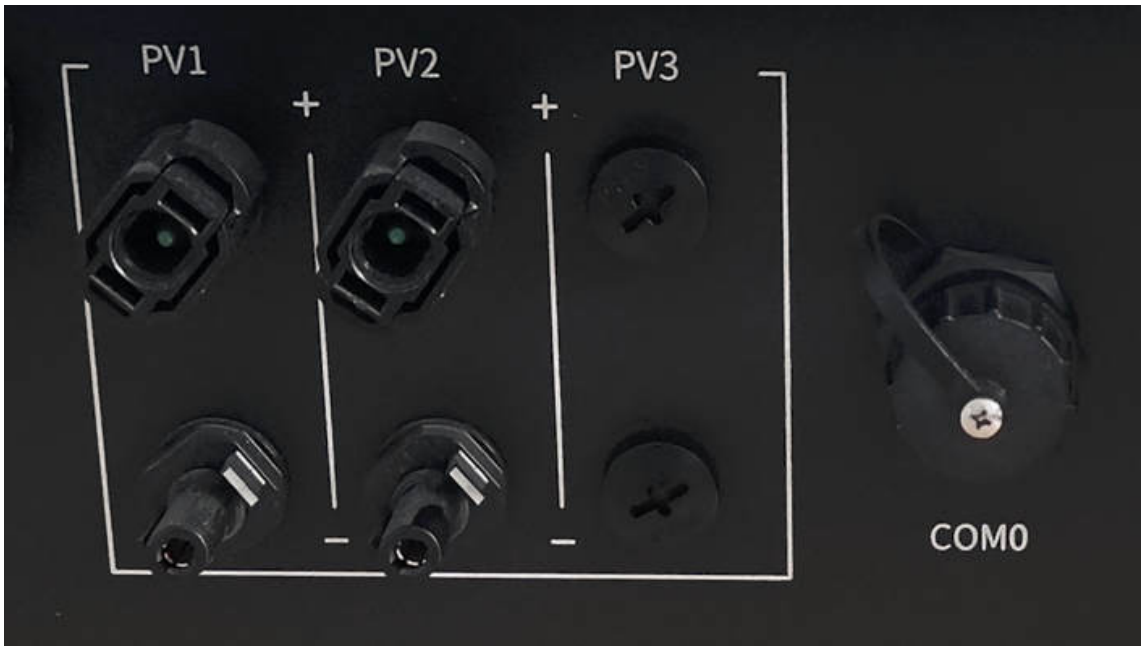
Ai-Logger 1000



Ai-Logger 1000 communication interface



(For HESS-HY-T1-05K, HESS-HY-T1-06K, HESS-HY-T1-08K, HESS-HY-T1-10K)



(For HESS-HY-T-05K, HESS-HY-T-06K, HESS-HY-T-08K, HESS-HY-T-10K)

Figure 4

Note:

Manufacturer information provided.

Annex No. 1
EMC report

EMC TEST REPORT

REPORT NO.:	BVKJ-ESH-P23121382B-1
MODEL NO.:	Refer to model list
RECEIVED:	Dec.21, 2023
ISSUED:	Dec.27, 2023

APPLICANT:	Jiangsu Hanchu Energy Technology Co.,Ltd
ADDRESS:	No.588,Jinhui Road,Huishan District ,Wuxi City,Jiangsu Province,China

ISSUED BY:	BUREAU VERITAS ADT (Shanghai) Corporation
LAB LOCATION:	No. 829, Xinzhuan Road, Shanghai, P.R.China (201612)

Bureau Veritas Shenzhen Co., Ltd.
Dongguan Branch

No. 96, Guantai Road (Houjie Section), Houjie Town, Dongguan City, Guangdong Province, 523942, People's Republic of China

Tel: +86 769 8998 2098
Fax: +86 769 8599 1080
Email: customerservice.dg@bureauveritas.com

1 TEST PROGRAM

PRODUCT: Grid-connected hybrid Inverter

BRAND: HANCHU ESS

MODEL NO.: Refer to model list

APPLICANT: Jiangsu Hanchu Energy Technology Co.,Ltd

TESTED: --

Standards :

Emission : EN 62920 :2017+A11 :2020, EN 62920 :2017+A1 :2021
(IEC 62920 :2017+A1 :2021) ;
EN 61000-2-2 :2002+A1 :2017, EN 61000-2-2 :2002+A2 :2019
(IEC 61000-2-2 :2002+A1 :2017+A2 :2018) ;
EN61000-6-4 :2007+A1 :2011, EN IEC 61000-6-4 :2019(IEC 61000-6-4 :2018) ;
EN 61000-6-3 :2007+A1 :2011+AC :2012, EN IEC 61000-6-3 :2021(IEC 61000-6-3 :2020) ;
EN 55011 :2016+A1 :2017, EN 55011 :2016+A11 :2020, EN 55011 :2016+A2 :2021
(CISPR 11 :2015+A1 :2016+A2 :2019) ;
EN 61000-3-12 :2011 (IEC 61000-3-12 :2011+A1 :2021) ;
EN 61000-3-11 :2000, EN IEC 61000-3-11 : 2019 (IEC 61000-3-11 :2017) ;
EN 61000-3-2 :2014, EN IEC 61000-3-2 :2019+A1 :2021(IEC 61000-3-2 :2018+A1 :2020) ;
EN 61000-3-3 :2013+A1 :2019, EN 61000-3-3 :2013+A2 :2021,
EN 61000-3-3 :2013+A2 :2021+AC :2022 (IEC 61000-3-3 :2013+A1 :2017+A2 :2021)
Immunity : EN 62920 :2017+A11:2020, EN 62920 :2017+A1 :2021(IEC 62920:2017+A1:2021
EN 61000-6-2 :2005+AC :2005, EN IEC 61000-6-2 :2019(IEC 61000-6-2 :2016) ;
EN61000-6-1 :2007, EN IEC 61000-6-1 :2019(IEC 61000-6-1 :2016) ;
(IEC 61000-4-2 :2008 ; IEC 61000-4-3 :2020 ; IEC 61000-4-4 :2012 ;
IEC 61000-4-5 :2014+A1 :2017 ; IEC 61000-4-6 :2013 ;
IEC 61000-4-8 :2009 ; IEC 61000-4-34 :2005+A1 :2009)

We, BUREAU VERITAS ADT (Shanghai) Corporation, declare that the equipment above has been tested and found compliance with the requirement limits of applicable standards. The test record, data evaluation and Equipment Under Test (EUT) configurations represented herein are true and accurate under the standards herein specified.

PREPARED BY : Yuan Zhang , DATE: Dec.27, 2023

Yuan ZHANG
Project Engineer

APPROVED BY : Sean Yu , DATE: Dec.27, 2023

Sean YU
RF Supervisor

3.4 TECHNICAL DATA SHEET

Model		HESS-HY-T -05K	HESS-HY-T -06K	HESS-HY-T -08K	HESS-HY-T -10K	HESS-HY-T -12K
PV input	VMaxpv [Vdc]	1100				
	Iscpv [A]	30				
	MPP Voltage Range [Vdc]	150 - 950		200-950		
	Full Power MPP Voltage Range [Vdc]	250-850	290-850	350-850	380-850	450-850
	Max. Input Current [A]	20				
	Start PV Voltage [Vdc]	180				
	Back feed Current [A]	0				
	Overvoltage Category (OVC)	II				
Battery input	Battery voltage range[Vdc]	120 - 600				
	Max. charging / discharging power[kW]	5	6	8	10	12
	Battery voltage range@nominal power[Vdc]	200-600	210-600	270-600	340-600	400-600
	Max. charging current / Max. discharging current [A]	30				
	Battery type	LiFePO4				
AC output	Rated Output Voltage [Vac]	220 / 380 V,230 / 400 V,240 / 415 ,3L/N/PE				
	Rated Output Frequency [Hz]	50 / 60				
	Rated Output Power [kW]	5	6	8	10	12
	Max.Apparent Power [kVA]	5.5	6.6	8.8	11.0	13.2
	Rated Output Current [A](@400V)	7.3	8.7	11.6	14.5	17.4
	Max.Output Current [A](@400V)	8.0	9.6	12.8	16.0	19.2
	Power Factor (cosφ)	1.0 (default), 0.80 lead, 0.80 lag				
	Overvoltage Category (OVC)	III				
AC input	Rated Input Voltage [Vac]	220 / 380 V,230 / 400 V,240 / 415 ,3L/N/PE				
	Rated Input Frequency [Hz]	50 / 60				
	Max. input power from grid [kW]	10	12	16	20	24
	Max. input current from grid[A]	14.5	17.4	23.2	29.0	34.8
EPS output	Nominal Output Voltage [Vac]	220 / 380 V,230 / 400 V,240 / 415 ,3L/N/PE				
	Nominal Output Frequency [Hz]	50 /60				
	Max. apparent power[kVA]	5	6	8	10	12
	Rated Current[A] (@400V)	7.3	8.7	11.6	14.5	17.4
SYSTEM	Protective Class	I				
	Enclosure Protection [IP]	IP66				
	Operating Temperature Range [°C]	-25 °C ... +60 °C				
	Pollution degree (PD)	PD 3				
	Max. operating altitude [m]	3000				
	Acoustic Noise [dB]	< 60				
	Weight [Kg]	24.5				
	Size (W / H / D) [mm]	545 / 465 / 205				
	Firmware Version	Master DSP：610-05001-00 Slave DSP：610-60015-00 Safety：610-11022-00				

1) For European market and Australian market, the max. apparent AC output power is equal to the rated power.

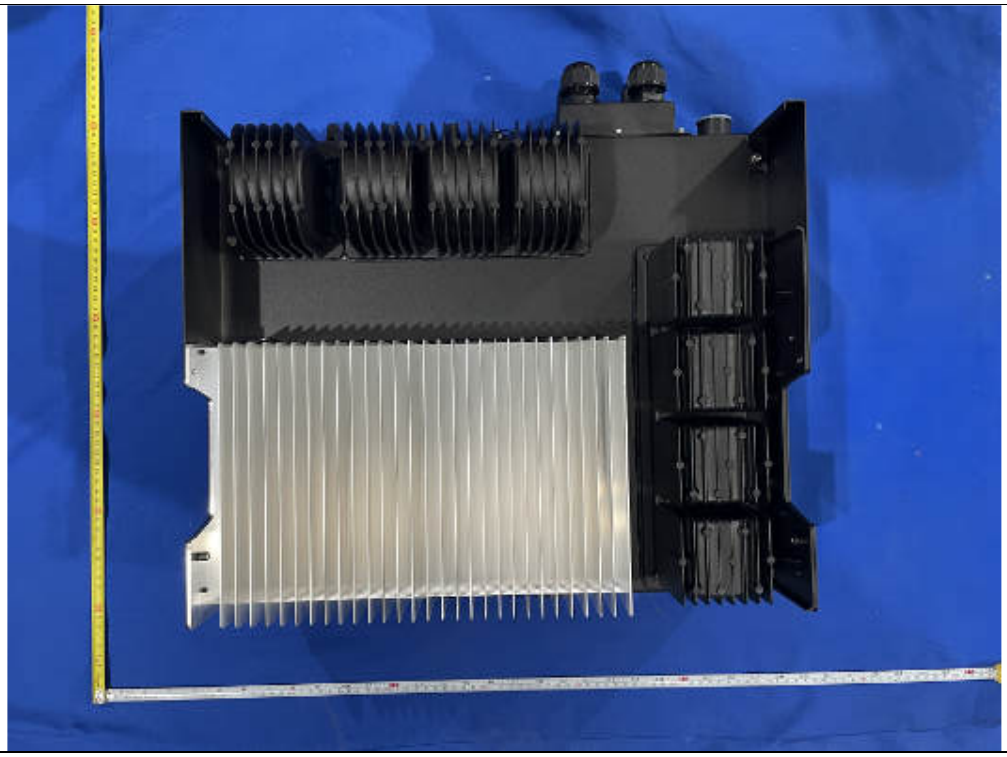
Model		HESS-HY-T1 -05K	HESS-HY-T1 -06K	HESS-HY-T1 -08K	HESS-HY-T1 -10K	HESS-HY-T1 -12K
PV input	VMaxpv [Vdc]	1100				
	Iscpv [A]	24				
	MPP Voltage Range [Vdc]	150 - 950		200-950		
	Full Power MPP Voltage Range [Vdc]	180~850V	200~850V	250~850V	320~850V	380~850V
	Max. Input Current [A]	16				
	Start PV Voltage [Vdc]	180				
	Back feed Current [A]	0				
	Overvoltage Category (OVC)	II				
Battery input	Battery voltage range[Vdc]	120 - 600				
	Max. charging / discharging power[kW]	5	6	8	10	12
	Battery voltage range@nominal power[Vdc]	200-600	210-600	270-600	340-600	400-600
	Max. charging current / Max. discharging current [A]	30				
	Battery type	LiFePO4				
AC output	Rated Output Voltage [Vac]	220 / 380 V,230 / 400 V,240 / 415 ,3L/N/PE				
	Rated Output Frequency [Hz]	50 / 60				
	Rated Output Power [kW]	5	6	8	10	12
	Max.Apparent Power [kVA]	5.5	6.6	8.8	11.0	13.2
	Rated Output Current [A](@400V)	7.3	8.7	11.6	14.5	17.4
	Max.Output Current [A](@400V)	8.0	9.6	12.8	16.0	19.2
	Power Factor (cosφ)	1.0 (default)，0.80 lead，0.80 lag				
	Overvoltage Category (OVC)	III				
AC input	Rated Input Voltage [Vac]	220 / 380 V,230 / 400 V,240 / 415 ,3L/N/PE				
	Rated Input Frequency [Hz]	50 / 60				
	Max. input power from grid [kW]	10	12	16	20	24
	Max. input current from grid[A]	14.5	17.4	23.2	29.0	34.8
EPS output	Nominal Output Voltage [Vac]	220 / 380 V,230 / 400 V,240 / 415 ,3L/N/PE				
	Nominal Output Frequency [Hz]	50 /60				
	Max. apparent power[kVA]	5	6	8	10	12
	Rated Current[A] (@400V)	11.6	14.5	11.6	14.5	17.4
SYSTEM	Protective Class	I				
	Enclosure Protection [IP]	IP66				
	Operating Temperature Range [°C]	-25 °C ... +60 °C				
	Pollution degree (PD)	PD 3				
	Max. operating altitude [m]	3000				
	Acoustic Noise [dB]	< 60				
	Weight [Kg]	26				
	Size (W / H / D) [mm]	545 / 465 / 205				
	Firmware Version	Master DSP：610-05001-00 Slave DSP：610-60015-00 Safety：610-11022-00				

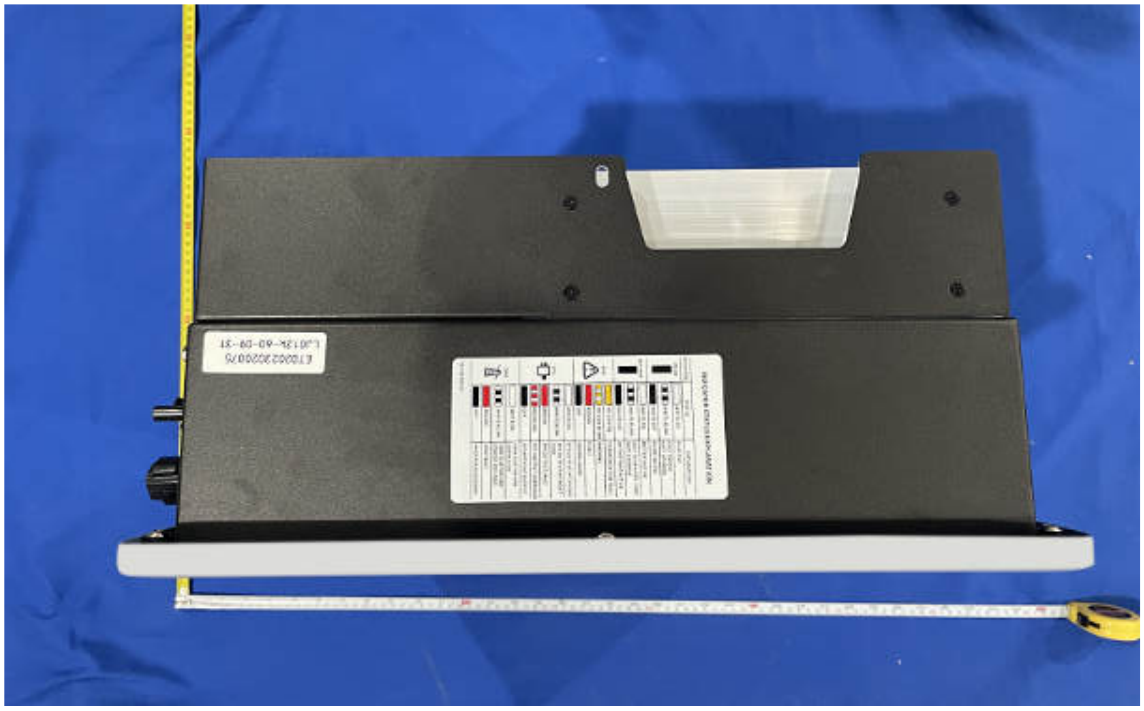
1) For European market and Australian market, the max. apparent AC output power is equal to the rated power.

Annex No. 2

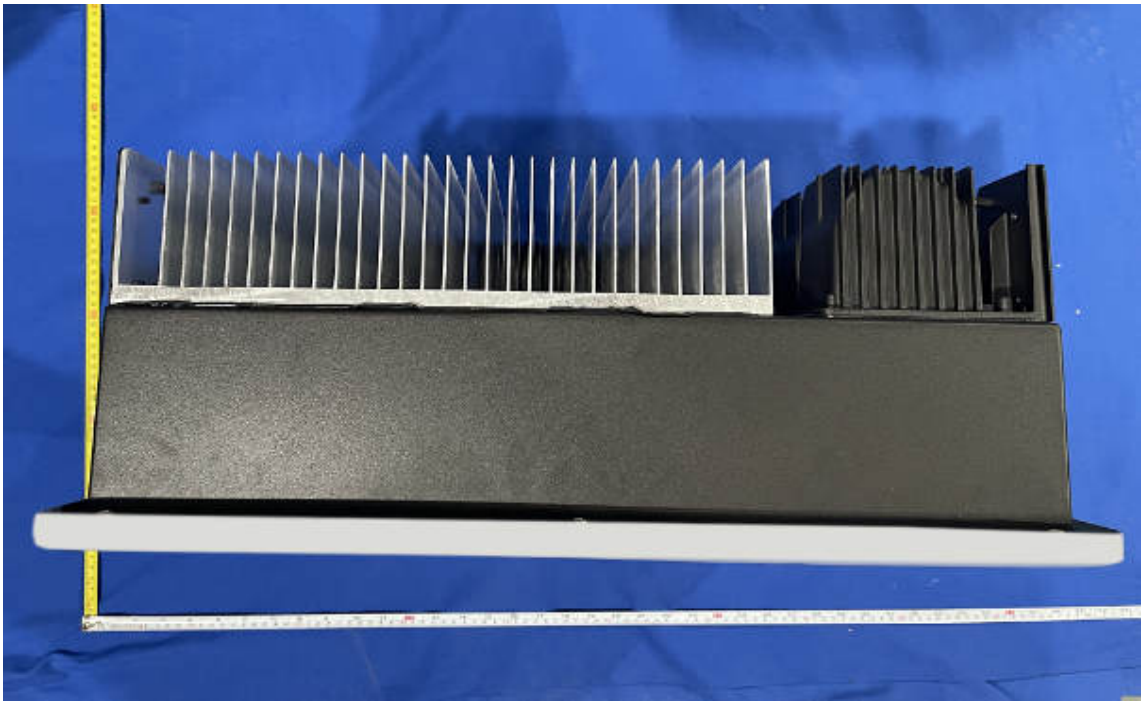
Pictures of the unit

Photo of EUT
Enclosure front view

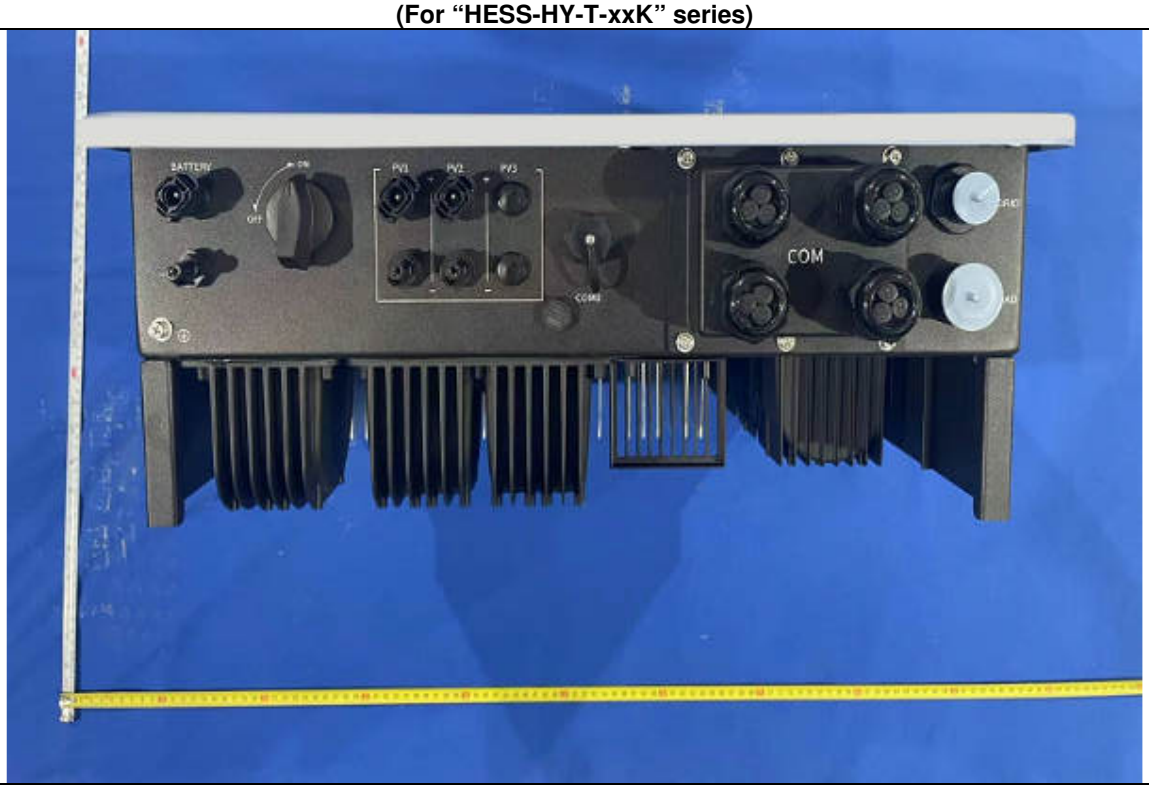
Enclosure back view


Enclosure left view

Enclosure right view


Enclosure top view

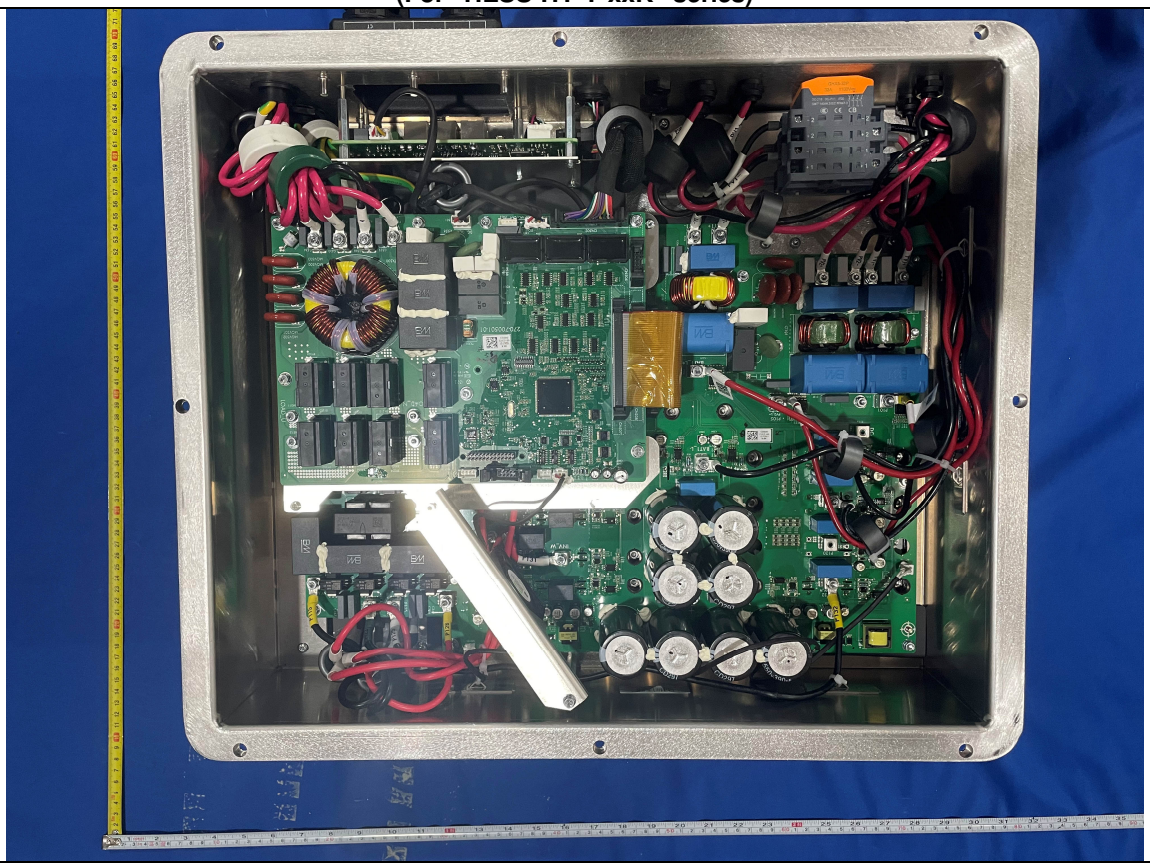


Enclosure bottom view-1
(For "HESS-HY-T-xxK" series)

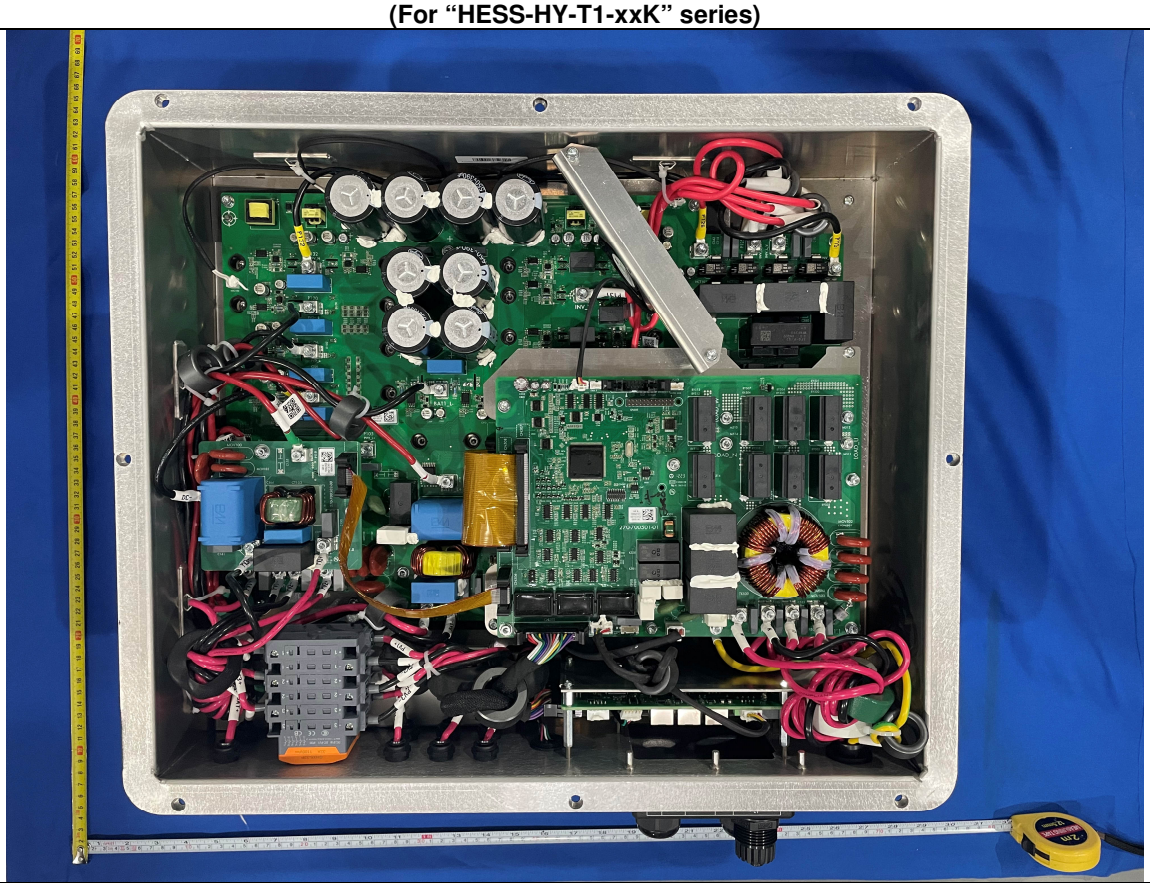


Enclosure bottom view-2
(For "HESS-HY-T1-xxK" series)

Internal view-1
(For "HESS-HY-T-xxK" series)



Internal view-2
(For "HESS-HY-T1-xxK" series)



Annex No. 3

Test Equipment list

Date(s) of performance test: 2023-03-23 to 2023-10-23

Equipment	Internal No.	Manufacturer	Type	Serial No.	Next Calibration
Power Analyzer	A4080002DG	YOKOGAWA	WT3000	91M210852	Jul. 21, 2024
Power Analyser	A4080004DG	DEWESoft	SIRIUSi-HS-4xHV-4xLV	DB19104221	Jul. 21, 2024
AC Source	A7040019DG	Chroma	61512	61512000439	Monitored by Power Analyzer
DC Simulation Power Supply	A7040015DG	Chroma	62150H-1000S	62150EF00488	
	A7040016DG	Chroma	62150H-1000S	62150EF00490	
	A7040017DG	Chroma	620028	620028EF00120	
	A7040021DG	Chroma	62150H-1000S	62150EF00609	
	A7040022DG	Chroma	62150H-1000S	62150EF00595	
RLC Load	A7150027DG	Qunling	ACLT-3803H	93VOO2869	
Current transducer	A1060007DG	YOKOGAWA	CT200	1130700012	Jul. 16, 2024
	A1060008DG	YOKOGAWA	CT200	1130700017	Jul. 16, 2024
	A1060009DG	YOKOGAWA	CT200	1130700019	Jul. 16, 2024
	A10600010DG	YOKOGAWA	CT200	1130700016	Jul. 16, 2024
	A10600011DG	YOKOGAWA	CT200	1130700011	Jul. 16, 2024
	A10600012DG	YOKOGAWA	CT200	1130700018	Jul. 16, 2024
Eight Channel Digital Phosphor Oscilloscope	A4089017DG	YOKOGAWA	DL850	91N726247	Jul. 11, 2024
Oscilloscope probe	A1490008DG	YOKOGAWA	701901	//	Jul. 18, 2024
Oscilloscope probe	A1490009DG	YOKOGAWA	701901	//	Jul. 18, 2024
Oscilloscope probe	A1490010DG	YOKOGAWA	701901	//	Jul. 18, 2024
Oscilloscope probe	A1490011DG	YOKOGAWA	701901	//	Jul. 18, 2024
Temp. & Humi. Recorder	A7440034DG	HUATO	S580-TH	HT20103923	Jan. 31, 2024

--End of Test Report--