TEST REPORT

Engineering Recommendation G99/NI

Issue 1 April 2019

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

GD Midea Air-Conditioning Equipment Co., Ltd.

For the unit(s) **EH-3K-A-M0, EH-3.6K-A-M0, EH-4K-A-M0, EH-4.6K-A-M0, EH-5K-A-M0, EH-5.5K-A-M0,EH-6K-A-M0**

Test report no. **HC23100801-EG-NI-001**

Date **2023-10-19**

ACCREDITED
Certificate # 5200.02

Lyns-tci Technology Guangdong Co., Ltd.
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Test report number.....:	**HC23100801-EG-NI-001**
Date of issue.....:	2023-10-19
Total number of pages.....:	73
Testing laboratory .....:	**LYNS-TCI TECHNOLOGY GUANGDONG CO., LTD.**
Address.....:	Room 1201, Unit 2, Building 18, No. 7, Science and Technology Boulevard, Houjie Town, Dongguan City, Guangdong, 523960 P.R. China
Testing location / address.....:	Same as above
Applicant's name .....:	**GD Midea Air-Conditioning Equipment Co., Ltd.**
Address.....:	Lingang Road, Beijiao, Shunde, Foshan, 528311, Guangdong, China
Test specification	
Standard .....:	Engineering Recommendation G99/NI Issue 1 April 2019 Requirements for the connection of generation equipment in parallel with public distribution networks in Northern Ireland on or after 27 April 2019
Test report form number.....:	EREC G99/NI_v1.0
Test report form(s) originator.....:	Lyns-tci Technology Guangdong Co., Ltd.
Master TRF.....:	Dated 2023-06-13
Test item description.....:	Device Category: **Inverter** Device Type: **Hybrid (PV with DC coupled Electricity Storage)**
Trademark .....:	Midea
Model / Type reference.....:	**EH-3K-A-M0**, **EH-3.6K-A-M0**, **EH-4K-A-M0**, **EH-4.6K-A-M0**, **EH-5K-A-M0**, **EH-5.5K-A-M0**, **EH-6K-A-M0**
Technical data .....:	See section 3.1 on p.8
Dates of testing.....:	2023-04-10 - 2023-06-30

Tested / Report prepared by

Allen

Allen Zhang (Test engineer)

Approved by

LYNS-TCi TECHNOLOGY LYNS-TCi

Lukes Lin (Project manager)

Contents

1 General information of test report

1.1 Important Note

General disclaimer

The test results presented in this report relate only to the object tested.

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Information on derived or extended models of the range as provided by the applicant (if any) is included in this report for information purposes only. LYNS shall not be liable for any incorrect results due to unclear, incorrect, incomplete, misleading or false information provided by client.

1.2 Revision history

Report version	Date	Editor	Modification / Change	Status
HC23100801-EG-NI-001	2023-10-19	Allen Zhang	Initial report was written	active
Supplementary information: Test results documented in this report are taken from test report no. 230331JHA068-EG-NI-001-R1, issued by Lyns-tci Technology Guangdong Co., Ltd. on 2023-08-14.				

2 General remarks for documentation

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

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

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

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

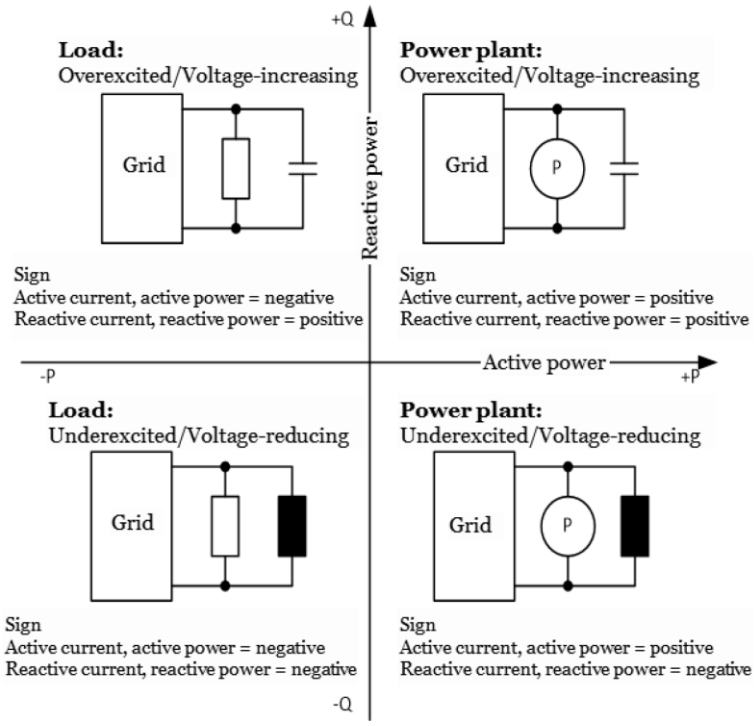
Abbreviations

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

Direction definition of P and Q

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

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



3 General product information

Factory's name ..... : Dongguan SOFAR SOLAR Co., Ltd.

Factory address ..... : 1F-6F, Building E, No.1 JinQi Road, Bihu Industrial Park, Wulian Village, Fenggang Town, Dongguan City, Guangdong Province, P.R. China

3.1 Technical data of the unit(s)

Unit / Type ..... :	**EH-3K-A-M0**	**EH-3.6K-A-M0**	**EH-4K-A-M0**
Hardware version (tested) ..... :	V001		
Software version (tested) ..... :	V000001		
MPP DC voltage range [V] ..... :	90 ~ 580		
Max. DC input voltage [V]..... :	600		
Input DC current [A]..... :	max. 13 / 13		
Battery voltage range [V] ..... :	42 ~ 58		
Battery charging current [A]..... :	max. 75	max. 80	max. 85
Battery discharging current [A] ..... :	max. 75	max. 80	max. 85
Nominal output AC voltage [V] ..... :	230 (L + N + PE, 50/60Hz)		
Output AC current [A] ..... :	max. 15	max. 16	max. 20.0
Nominal active output power P_n [kW] .... :	3.0	3.68	4.0
Registered Capacity [1] P_{max} [kW]	3.0	3.68	4.0
Max. apparent power [kVA] ..... :	3.3	3.68	4.4
Unit / Type ..... :	**EH-4.6K-A-M0**	**EH-5K-A-M0**	**EH-5.5K-A-M0**
Hardware version (tested) ..... :	V001		
Software version (tested) ..... :	V000001		
MPP DC voltage range [V] ..... :	90 ~ 580		
Max. DC input voltage [V]..... :	600		
Input DC current [A]..... :	max. 13 / 13		
Battery voltage range [V] ..... :	42 ~ 58		
Battery charging current [A]..... :	max. 100		
Battery discharging current [A] ..... :	max. 100		
Nominal output AC voltage [V] ..... :	230 (L + N + PE, 50/60Hz)		
Output AC current [A] ..... :	max. 20.9	max. 21.7	max. 25
Nominal active output power P_n [kW] .... :	4.6	5.0	5.0
Registered Capacity [2] P_{max} [kW]	4.6	5.0	5.0
Max. apparent power [kVA] ..... :	4.6	5.0	5.5

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

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

Unit / Type ..... :	**EH-6K-A-M0**
Hardware version (tested) ..... :	V001
Software version (tested) ..... :	V000001
MPP DC voltage range [V] ..... :	90 ~ 580
Max. DC input voltage [V]..... :	600
Input DC current [A]..... :	max. 13 / 13
Battery voltage range [V] ..... :	42 ~ 58
Battery charging current [A]..... :	max. 100
Battery discharging current [A] ..... :	max. 100
Nominal output AC voltage [V] ..... :	230 (L + N + PE, 50/60Hz)
Output AC current [A] ..... :	max. 27.3
Nominal active output power P_n [kW] .... :	6.0
Registered Capacity [3] P_{max} [kW]	6.0
Max. apparent power [kVA] ..... :	6.0

Note:

- The Power Park Modules (Generating Units):
  EH-3K-A-M0, *EH-4K-A-M0 and EH-5.5K-A-M0* are designed to be capable of operating within the range ±0.95 Power Factor at Registered Capacity.
  Max. operating range of Power Factor at Registered Capacity: 0.909 lagging to 0.909 leading.
- For Power Park Module (Generating Unit) *EH-3.6K-A-M0, EH-4.6K-A-M0, EH-5K-A-M0 and EH-6K-A-M0* to meet the requirement:
  "*When operating at **Registered Capacity** the **Power Generating Module** shall be capable of operating at a **Power Factor** within the range 0.95 lagging to 0.95 leading relative to the voltage waveform*"
  - a semi-permanent active power reduction to a value:
    - *EH-3.6K-A-M0*: $P_{max} \leq 3.496$ kW
    - *EH-4.6K-A-M0*: $P_{max} \leq 4.37$ kW
    - *EH-5K-A-M0*: $P_{max} \leq 4.75$ kW
    - *EH-6K-A-M0*: $P_{max} \leq 5.70$ kW

    can be applied by software (the parameter setting needs to follow the manufacturer's guidance).
  - or this need to be considered in the Power Generating Module design
  - or otherwise agreed with the DNO
- Setting range of the Power Factor:
  0.800 lagging to 0.800 leading

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

Datasheet of the generating units:

Datasheet	EH-3K -A-M0	EH-3.6K -A-M0	EH-4K -A-M0	EH-4.6K -A-M0	EH-5K -A-M0	EH-5.5K -A-M0	EH-6K -A-M0
Battery type	Lithium-ion, Lead-acid						
Nominal battery voltage	48V						
Battery voltage range	42-58V						
Battery capacity	50-2000Ah						
Maximum charging / discharging power	3750W	4000W	4250W	5000W	5000W	5000W	5000W
Maximum charging current	75A	80A	85A	100A	100A	100A	100A
Maximum discharging current	75A	80A	85A	100A	100A	100A	100A
Depth of discharge	0-90% DOD adjustable（Lithium-ion）						
	0-50% DOD adjustable（Lead-acid）						
Charging curve	BMS（Lithium-ion）						
	3-Stage adaptive with maintenance（Lead-acid）						
Communication	CAN(RS485)						

Datasheet	EH-3K -A-M0	EH-3.6K -A-M0	EH-4K -A-M0	EH-4.6K -A-M0	EH-5K -A-M0	EH-5.5K -A-M0	EH-6K -A-M0
Recommended Max. PV input power(Wp)	4500Wp	5400Wp	6000Wp	6900Wp	7500Wp	7500Wp	9000Wp
Max. DC power for single MPPT	3500W	3500W	3500W	3500W	3500W	3500W	3500W
Max. input voltage	600V						
Rated input voltage	360V						
Start-up voltage	100V						
MPPT operating voltage range	90-580V						
Full power MPPT voltage range(V)	160-520	180-520	200-520	230-520	250-520	250-520	300-520
Number of MPP trackers	2						
Max. input current per MPPT	13A/13A						
Max. input short circuit current per MPPT	18A/18A						

Datasheet	EH-3K -A-M0	EH-3.6K -A-M0	EH-4K -A-M0	EH-4.6K -A-M0	EH-5K -A-M0	EH-5.5K -A-M0	EH-6K -A-M0
Nominal AC power（W）	3000	3680	4000	4600	5000	5000	6000
Max. AC power output to utility grid（VA）	3300	3680	4400	4600	5000	5500	6000
Max. AC power from utility grid(VA)	6000	7360	8000	9200	10000	10000	12000
Max. AC current output to utility grid	15A	16A	20A	20.9A	21.7A	25A	27.3A
Max. AC current from utility grid	27.3A	32A	36.4A	41.8A	43.4A	43.4A	54.6A
Nominal grid voltage	L/N/PE, 220Vac, 230Vac,240Vac						
Grid voltage range	180Vac~276Vac(According to local standard)						
Nominal frequency	50/60Hz						
Grid Frequency range	45Hz~55Hz/55Hz~65Hz						
Power factor	1 default (adjustable+/-0.8)						
Output THDi (@Nominal output)	<3%						

Datasheet	EH-3K -A-M0	EH-3.6K -A-M0	EH-4K -A-M0	EH-4.6K -A-M0	EH-5K -A-M0	EH-5.5K -A-M0	EH-6K -A-M0
Rated apparent power（VA）	3000	3680	4000	4600	5000	5000	5000
Max. apparent power（VA）	3000	3680	4000	4600	5000	5000	5000
Peak output power,Duration	3600VA, 60s	4400VA, 60s	4800VA, 60s	5520VA, 60s	6000VA, 60s	6000VA, 60s	6000VA, 60s
Max. output current	13.6A	16A	18.2A	20.9A	22.7A	22.7A	22.7A
Nominal voltage,Frequency	L/N/PE, 220V/230V/240V 50/60Hz						
THDv (@Liner load)	<3%						
Switch time	10ms(default)						

Datasheet	EH-3K -A-M0	EH-3.6K -A-M0	EH-4K -A-M0	EH-4.6K -A-M0	EH-5K -A-M0	EH-5.5K -A-M0	EH-6K -A-M0
MPPT efficiency	99.9%						
European efficiency of solar inverter	97.2%	97.2%	97.2%	97.3%	97.3%	97.3%	97.5%
Max efficiency of solar inverter	97.6%	97.6%	97.6%	97.8%	97.8%	97.8%	98.0%
Max. charging efficiency of battery	94.6%						
Max. discharging efficiency of battery	94.6%						
DC switch	Yes						
PV reverse polarity protection	Yes						
Over current protection	Yes						
Over voltage protection	Yes						
PV insulation detection	Yes						
Ground fault monitoring	Yes						
Firm frequency response function	Optional						
SPD protection	MOV:Type III standard						

Datasheet	EH-3K -A-M0	EH-3.6K -A-M0	EH-4K -A-M0	EH-4.6K -A-M0	EH-5K -A-M0	EH-5.5K -A-M0	EH-6K -A-M0
Dimension	482mm×503mm×183mm						
Weight	21.5kg						
Topology	High frequency insolation (for bat)						
Standby self-consumption	<10W						
Ambient temperature range	-30℃~60℃（Above 45℃ Derating）						
Allowable relative humidity range	0~100%						
Noise	<25dB						
Max. operating altitude	<4000m						
Cooling	Natural						
Degree of protection	IP65						

Display	LCD
Communication	Bluetooth / RS485 / Wireless / GPRS (optional)
Parallel operation	YES

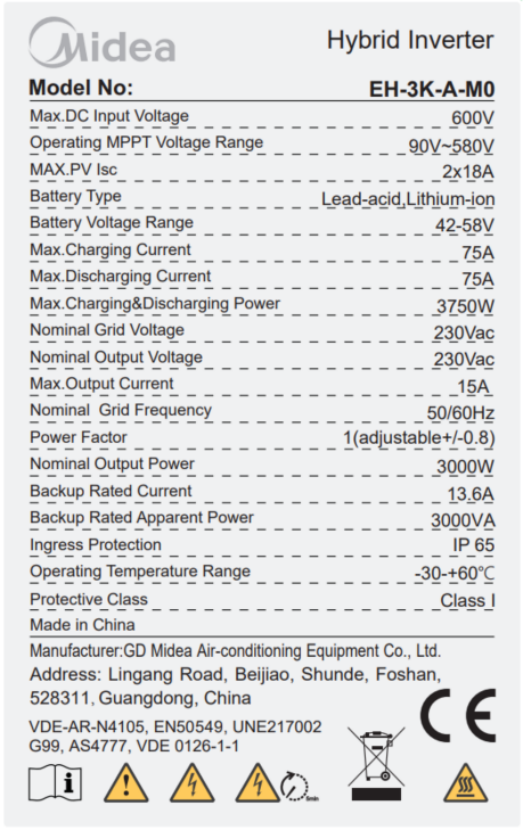
Equipment mobility	:	Permanent connection
Operating condition	:	Continuous
Class of equipment	:	Class I
Protection against ingress of water	:	IP65 according to EN 60529
Mass of equipment [kg]	:	approx. 21.5
Type of internal transformer	:	No internal transformer (transformerless)

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

The units in the product series:

- sharing the same control electronics,
- with the same implemented control and firmware,
- with the same construction solutions including the power part,
- with the same number of phases,
- with the power electronics, filters and transducers designed for different sizes of voltage and current ratings.

3.3 Copy of marking plate



Midea Hybrid Inverter

Model No:	EH-3K-A-M0
Max.DC Input Voltage	600V
Operating MPPT Voltage Range	90V~580V
MAX.PV Isc	2x18A
Battery Type	Lead-acid,Lithium-ion
Battery Voltage Range	42-58V
Max.Charging Current	75A
Max.Discharging Current	75A
Max.Charging&Discharging Power	3750W
Nominal Grid Voltage	230Vac
Nominal Output Voltage	230Vac
Max.Output Current	15A
Nominal Grid Frequency	50/60Hz
Power Factor	1(adjustable+/-0.8)
Nominal Output Power	3000W
Backup Rated Current	13.6A
Backup Rated Apparent Power	3000VA
Ingress Protection	IP 65
Operating Temperature Range	-30-+60℃
Protective Class	Class I

Made in China

Manufacturer:GD Midea Air-conditioning Equipment Co., Ltd.
Address: Lingang Road, Beijiao, Shunde, Foshan, 528311, Guangdong, China

VDE-AR-N4105, EN50549, UNE217002
G99, AS4777, VDE 0126-1-1

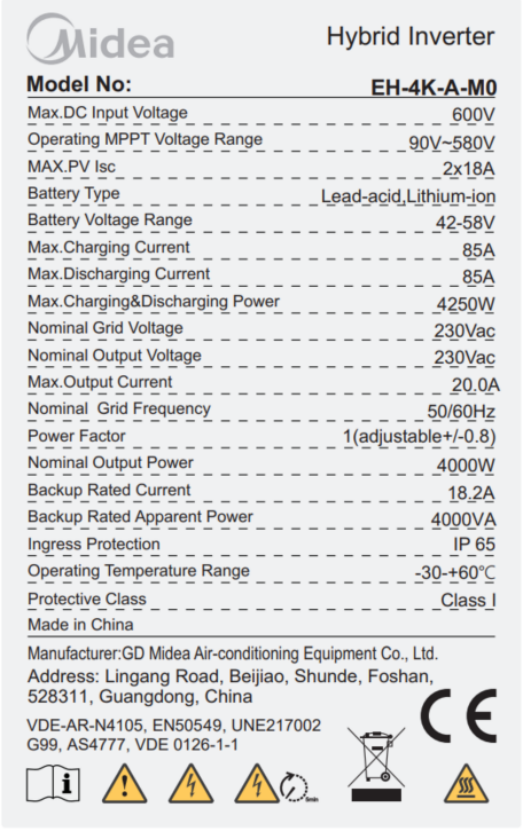
Midea Hybrid Inverter

Model No:	EH-3.6K-A-M0
Max.DC Input Voltage	600V
Operating MPPT Voltage Range	90V~580V
MAX.PV Isc	2x18A
Battery Type	Lead-acid,Lithium-ion
Battery Voltage Range	42-58V
Max.Charging Current	80A
Max.Discharging Current	80A
Max.Charging&Discharging Power	4000W
Nominal Grid Voltage	230Vac
Nominal Output Voltage	230Vac
Max.Output Current	16.0A
Nominal Grid Frequency	50/60Hz
Power Factor	1(adjustable+/-0.8)
Nominal Output Power	3680W
Backup Rated Current	16.0A
Backup Rated Apparent Power	3680VA
Ingress Protection	IP 65
Operating Temperature Range	-30-+60℃
Protective Class	Class I

Made in China

Manufacturer:GD Midea Air-conditioning Equipment Co., Ltd.
Address: Lingang Road, Beijiao, Shunde, Foshan, 528311, Guangdong, China

VDE-AR-N4105, EN50549, UNE217002
G99, AS4777, VDE 0126-1-1



Midea Hybrid Inverter

Model No:	EH-4K-A-M0
Max.DC Input Voltage	600V
Operating MPPT Voltage Range	90V~580V
MAX.PV Isc	2x18A
Battery Type	Lead-acid,Lithium-ion
Battery Voltage Range	42-58V
Max.Charging Current	85A
Max.Discharging Current	85A
Max.Charging&Discharging Power	4250W
Nominal Grid Voltage	230Vac
Nominal Output Voltage	230Vac
Max.Output Current	20.0A
Nominal Grid Frequency	50/60Hz
Power Factor	1(adjustable+/-0.8)
Nominal Output Power	4000W
Backup Rated Current	18.2A
Backup Rated Apparent Power	4000VA
Ingress Protection	IP 65
Operating Temperature Range	-30-+60℃
Protective Class	Class I

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VDE-AR-N4105, EN50549, UNE217002
G99, AS4777, VDE 0126-1-1

Midea Hybrid Inverter

Model No:	EH-4.6K-A-M0
Max.DC Input Voltage	600V
Operating MPPT Voltage Range	90V~580V
MAX.PV Isc	2x18A
Battery Type	Lead-acid,Lithium-ion
Battery Voltage Range	42-58V
Max.Charging Current	100A
Max.Discharging Current	100A
Max.Charging&Discharging Power	5000W
Nominal Grid Voltage	230Vac
Nominal Output Voltage	230Vac
Max.Output Current	20.9A
Nominal Grid Frequency	50/60Hz
Power Factor	1(adjustable+/-0.8)
Nominal Output Power	4600W
Backup Rated Current	20.9A
Backup Rated Apparent Power	4600VA
Ingress Protection	IP 65
Operating Temperature Range	-30-+60℃
Protective Class	Class I

Made in China

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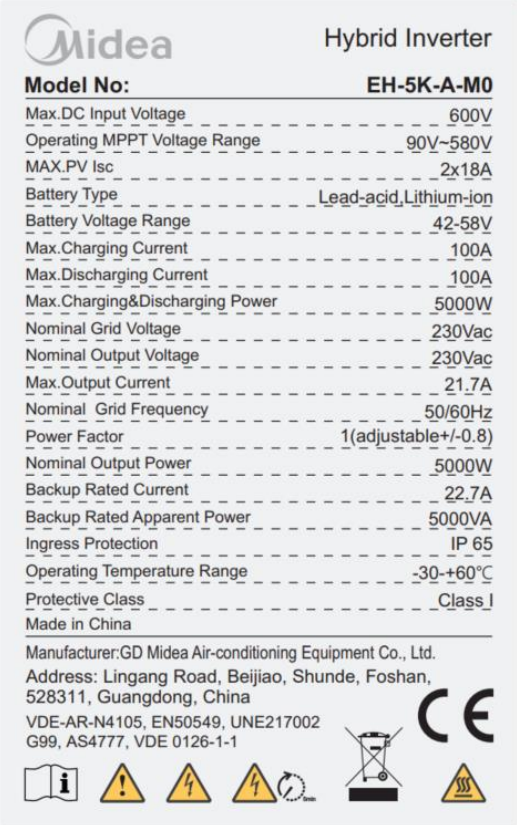
Midea Hybrid Inverter

Model No:	EH-5K-A-M0
Max.DC Input Voltage	600V
Operating MPPT Voltage Range	90V~580V
MAX.PV Isc	2x18A
Battery Type	Lead-acid,Lithium-ion
Battery Voltage Range	42-58V
Max.Charging Current	100A
Max.Discharging Current	100A
Max.Charging&Discharging Power	5000W
Nominal Grid Voltage	230Vac
Nominal Output Voltage	230Vac
Max.Output Current	21.7A
Nominal Grid Frequency	50/60Hz
Power Factor	1(adjustable+/-0.8)
Nominal Output Power	5000W
Backup Rated Current	22.7A
Backup Rated Apparent Power	5000VA
Ingress Protection	IP 65
Operating Temperature Range	-30-+60℃
Protective Class	Class I
Made in China	

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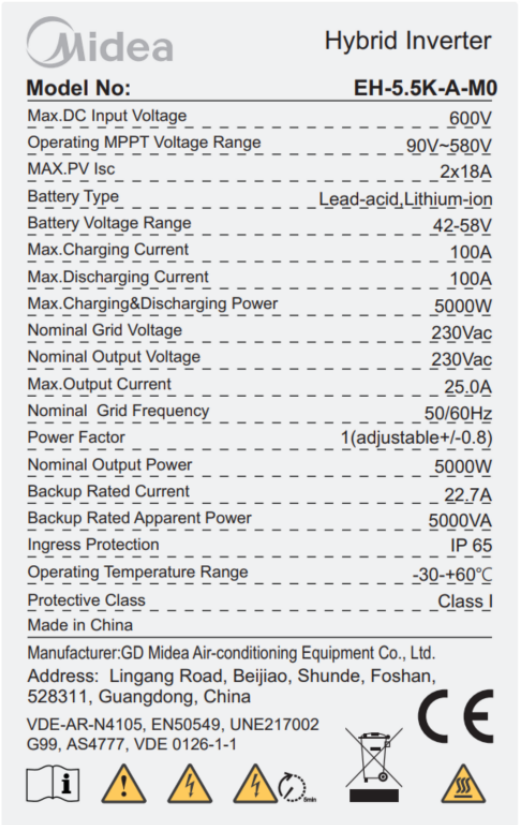
Midea Hybrid Inverter

Model No:	EH-5.5K-A-M0
Max.DC Input Voltage	600V
Operating MPPT Voltage Range	90V~580V
MAX.PV Isc	2x18A
Battery Type	Lead-acid,Lithium-ion
Battery Voltage Range	42-58V
Max.Charging Current	100A
Max.Discharging Current	100A
Max.Charging&Discharging Power	5000W
Nominal Grid Voltage	230Vac
Nominal Output Voltage	230Vac
Max.Output Current	25.0A
Nominal Grid Frequency	50/60Hz
Power Factor	1(adjustable+/-0.8)
Nominal Output Power	5000W
Backup Rated Current	22.7A
Backup Rated Apparent Power	5000VA
Ingress Protection	IP 65
Operating Temperature Range	-30-+60℃
Protective Class	Class I
Made in China	

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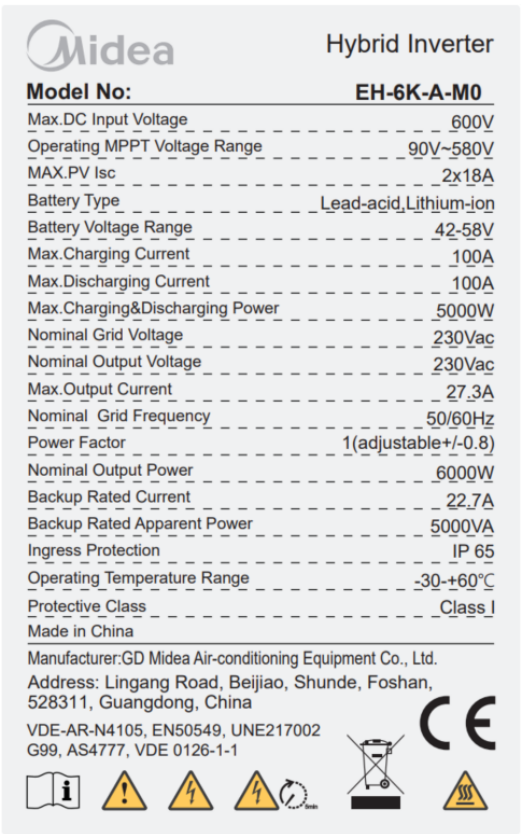

Midea Hybrid Inverter

Model No:	EH-6K-A-M0
Max.DC Input Voltage	600V
Operating MPPT Voltage Range	90V~580V
MAX.PV Isc	2x18A
Battery Type	Lead-acid,Lithium-ion
Battery Voltage Range	42-58V
Max.Charging Current	100A
Max.Discharging Current	100A
Max.Charging&Discharging Power	5000W
Nominal Grid Voltage	230Vac
Nominal Output Voltage	230Vac
Max.Output Current	27.3A
Nominal Grid Frequency	50/60Hz
Power Factor	1(adjustable+/-0.8)
Nominal Output Power	6000W
Backup Rated Current	22.7A
Backup Rated Apparent Power	5000VA
Ingress Protection	IP 65
Operating Temperature Range	-30-+60℃
Protective Class	Class I
Made in China	

Manufacturer:GD Midea Air-conditioning Equipment Co., Ltd.
Address: Lingang Road, Beijiao, Shunde, Foshan, 528311, Guangdong, China
VDE-AR-N4105, EN50549, UNE217002
G99, AS4777, VDE 0126-1-1

Note:

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

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

3.4 Description of the power circuit

The solar inverter converts DC voltage, generated by photovoltaic modules, into AC voltage.

The units are single-phase.

The input and output are protected by varistors to Earth. The unit is providing EMI filtering at the PV input and output toward mains. The unit does not provide galvanic separation from input to output (transformerless).

The output is switched off redundantly by the high-power switching bridge and two relays. This assures that the opening of the output circuit will also operate in case of a single error.

The internal control is redundant built. It consists of Microcontroller Main DSP (U4) and slave DSP (U43).

The Main DSP (U4) control the relays by switching signals; measures the 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 (U43) is measuring the grid voltage, grid frequency and residual current, also can switch off the relays independently, and communicate with Main DSP (U4) 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(U4). The Main DSP(U4) 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 battery and the mains. All the relays are tested before each start up.

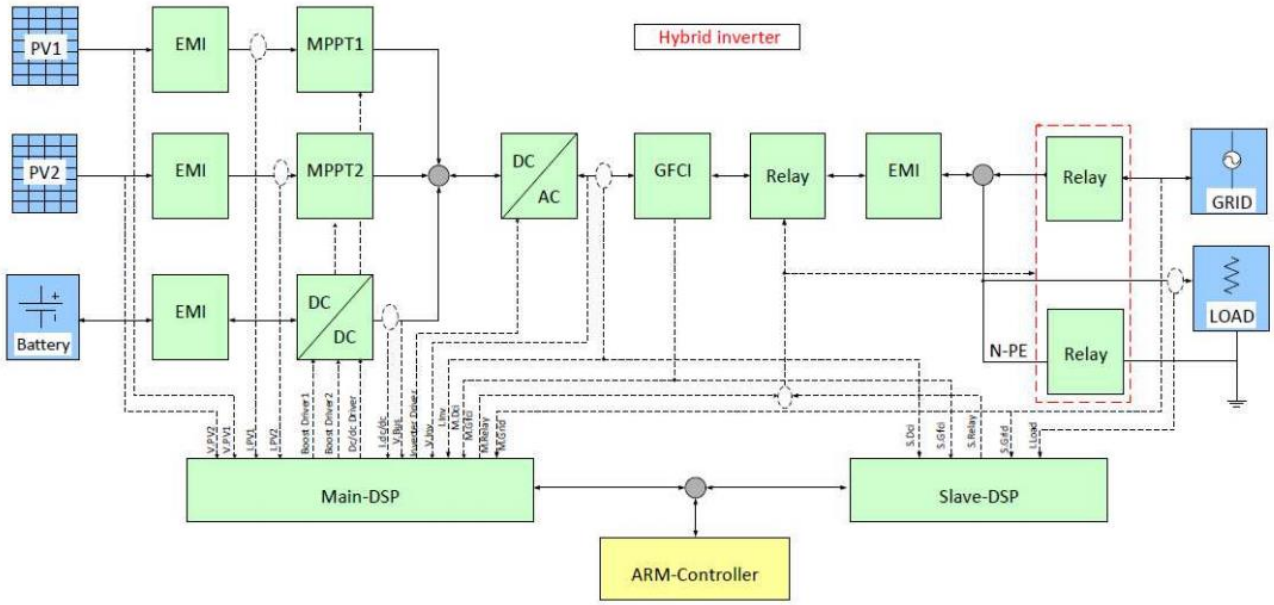


Figure 1 – Block diagram of the power circuit

4 General remarks for testing

4.1 PGM categories

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

Type A	Type B	Type C	Type D
Voltage level at connection point <110kV			Voltage level at connection point ≥110kV
0.8 kW ≤ P_{max} < 100 kW	100 kW ≤ P_{max} < 5 MW	5 MW ≤ P_{max} < 10 MW	P_{max} ≥ 10 MW
☒	☐	☐	☐

4.2 Energy Conversion Technology

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

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

Note:

* Connection scenario:

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

☐ Hybrid converter:

Photovoltaic Power Park Module with DC coupled storage unit connected to the DNO's Distribution Network via an Inverter

In this case the Registered Capacity is based on the Inverter rating. The storage unit has no compliance effect, compliance based on the inverter.

The Electricity Storage exceptions according to EREC G99/NI, section A.4.2 do not apply to the Inverter.

4.3 Exceptions

According to EREC G99/NI, Annex A.4:

☐ **Emerging Technology**
No exceptions.

☐ **Electricity Storage devices**
the following sections of EREC G99/NI do not apply:

- Type A - less than 100 kW
  - 11.2.3 (constant Active Power output)
  - 11.2.4 (Limited Frequency Sensitive Mode – Over frequency)
- Type B - 100 kW or greater but less than 5 MW
  - 12.2.3 (constant Active Power output)
  - 12.2.4 (Limited Frequency Sensitive Mode – Over frequency)
- Type C and Type D - 5 MW or greater and / or with a Connection Point at greater than 110 kV
  - 13.2.3 (constant Active Power output)
  - 13.2.4 (Limited Frequency Sensitive Mode – Over frequency)
  - 13.2.5 (Limited Frequency Sensitive Mode – Under frequency)
  - 13.2.6 (Frequency Sensitive Mode)

☐ **Infrequent Short-Term Parallel Operation**
the following sections of EREC G99/NI do not apply:

- Type A - less than 100 kW
  - All of Section 11
- Type B - 100 kW or greater but less than 5 MW
  - All of Section 12
- Type C and Type D - 5 MW or greater and / or with a Connection Point at greater than 110 kV
  - All of Section 13

☒ **Other**
No exceptions.

4.4 Scope of measurements

Date of receipt of test items ..... : 2023-04-10

Date(s) of performance of tests ..... : 2023-04-10 - 2023-06-30

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

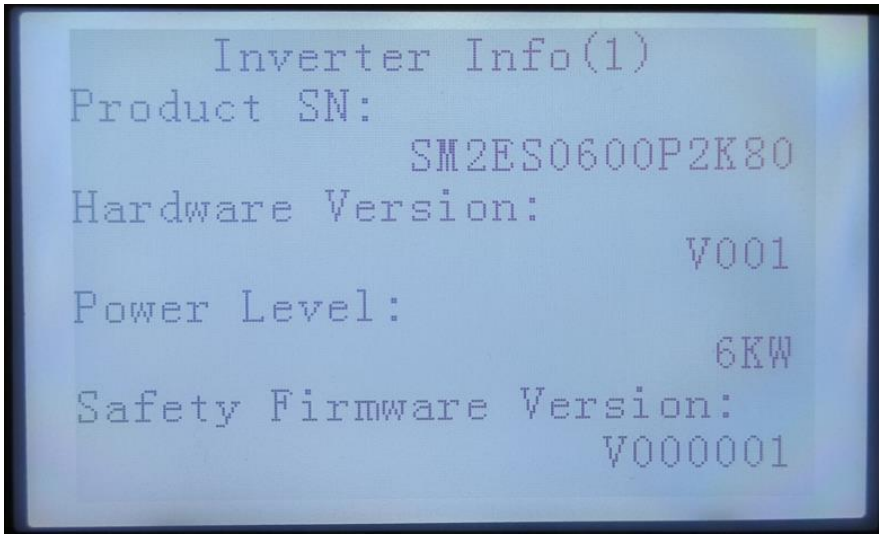
- Temperature: 21.6 ~ 25.2°C
- Rel. humidity: 39.5 ~ 57.3%RH
- Air pressure: 999.2 ~ 1001.6 hPa

Test items	Testing requirements (Section EREC G99/NI)	Section in this test report	Tests completed
1. Operating Range	10.3.4, 11.2.1	6.1	☒
2. Harmonics	A.7.1.4.1	6.2	☒
3. Voltage Fluctuation and Flicker	A.7.1.4.3	6.3	☒
4. DC injection	A.7.1.4.4	6.4	☒
5. Power Factor (PF)	A.7.1.4.2	6.5	☒
6. Frequency protection trip and ride through tests	A.7.1.2.1, A.7.1.2.3	6.6.1	☒
7. Voltage protection trip and ride through tests	A.7.1.2.1, A.7.1.2.2	6.6.2	☒
8. Protection – Loss of Mains Test, Vector Shift and RoCoF Stability Test	A.7.1.2.4, A.7.1.2.6	6.6.3, 6.6.4 and 6.6.5	☒
9. LFSM-O Test	A.7.1.3	6.7	☒
10. Protection – Reconnection Timer	A.7.1.2.5	6.8	☒
11. Fault Level Contribution	A.7.1.5	6.9	☒
12. Self-monitoring Solid State Switch	A.7.1.6	6.10	☐
13. Wiring functional tests if required by para 15.2.1 (attach relevant schedule of tests)	15.2.1	6.11	☐
14. Logic Interface (input port)	11.1.3	6.12	☒
15. Cyber security (**informative**)	---	6.13	☐ [4]
Output power with falling frequency	11.2.4	Test not performed and not documented in this report.	☐

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

Note:

- The tests were performed on EUT EH-6K-A-M0 which provides the highest current / power.
- The product was tested on:
  - Serial No.: SM2ES0600P2K80
  - Hardware Version: V001
  - Software Version: V000001



- Measurement done at output terminals of the EUT, see Figure 3, Figure 4 and Figure 5.

Note:

in this report, ***Family approach to Type Testing*** according to **EREC G99**, section **15.6** was applied.

- According to **EREC G99**, section **15.6.1** the following applies:
- since the rated power of *EH-3K-A-M0, EH-3.6K-A-M0, EH-4K-A-M0*, EH-4.6K-A-M0, EH-5K-A-M0, EH-5.5K-A-M0 and EH-6K-A-M0 is between $1/\sqrt{10}\cdot P_{n,\ EH\text{-}6K\text{-}A\text{-}M0}$ and $2\cdot P_{n,\ EH\text{-}6K\text{-}A\text{-}M0}$, a family approach to type testing is acceptable.
- A transfer of measurement results from the EH-6K-A-M0 to other units in the product series according to **EREC G99**, section **15.6.2** is allowed (for details see section *5 Assessment overview*.)
- Technical justification for transferability of measurement results:
  see section 3.2 on p.16.

4.5 Reference values

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

	EH-3K-A-M0	EH-3.6K-A-M0	EH-4K-A-M0	EH-4.6K-A-M0
Registered Capacity [5] P_{max} [kW]	3.0	3.68	4.0	4.6
Rated voltage (phase-to-neutral), U_n [V]	230			
Rated current, I_n [6] [A]	13.0	16.0	17.4	20.0
	EH-5K-A-M0	**EH-5.5K-A-M0**	**EH-6K-A-M0**	
Registered Capacity [5] P_{max} [kW]	5.0	5.0	6.0	
Rated voltage (phase-to-neutral), U_n [V]	230			
Rated current, I_n [6] [A]	21.7	21.7	26.1	

4.6 Measurement setup

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

- ☐ Measurements in the field on real grid
- ☐ Test bench tests on real grid
- ☒ Test bench tests on an AC grid simulator

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

Available primary power is modified by adapting the short circuit current (I_{sc}) value of the I-V curve. Following example shows a PV-curve (I_{sc} = 18.29 A, U_{oc} = 418.5 V) simulated according to EN50530:

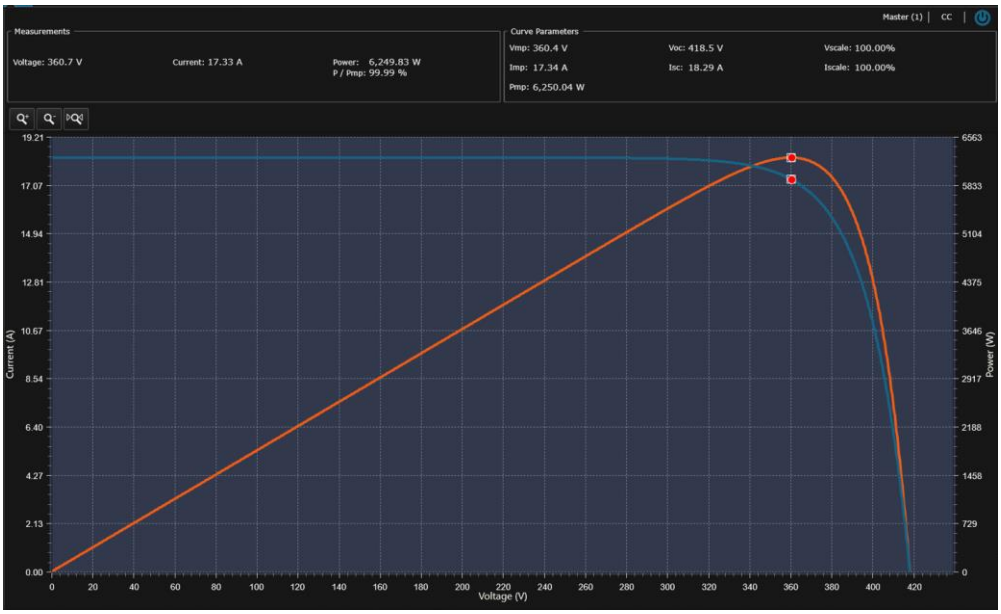


Figure 2 – DC characteristics for testing

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

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

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

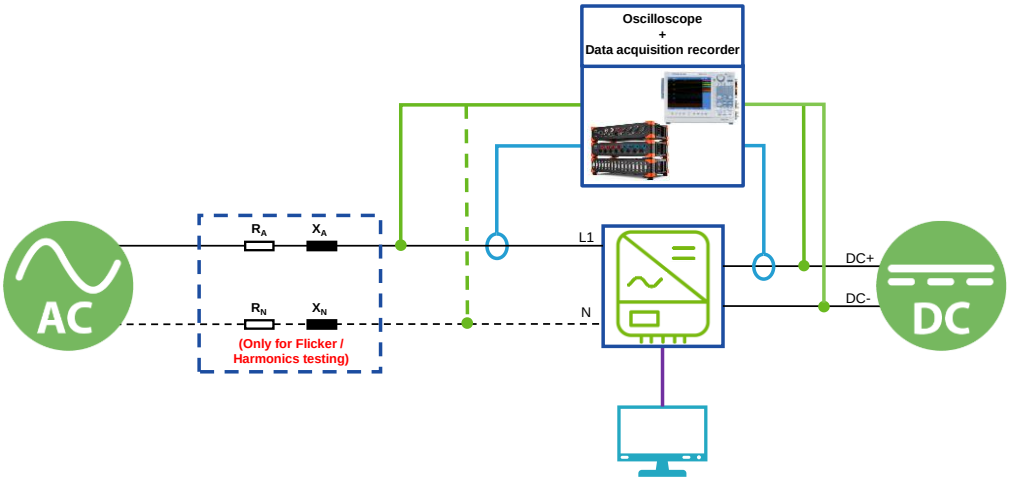


Figure 3 – Measurement setup used for tests except Loss of Mains and Short Circuit test

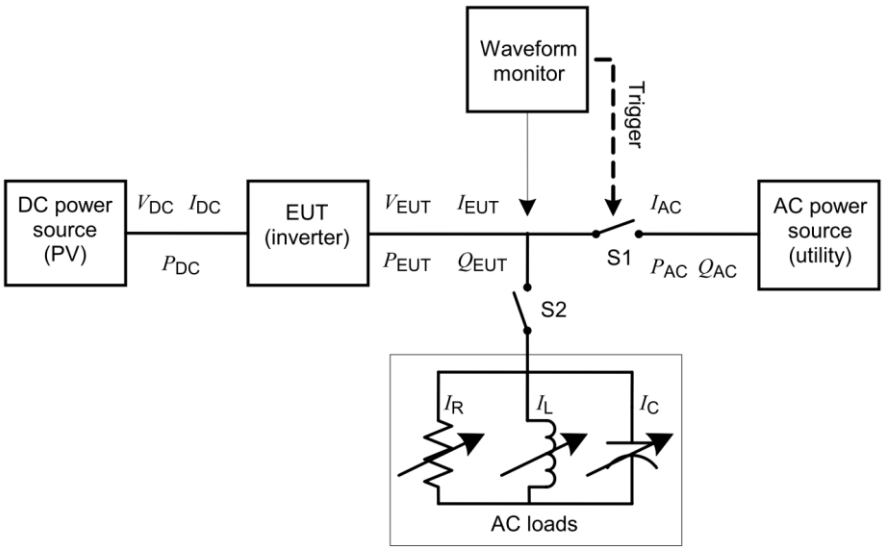


Figure 4 – Test circuit for Loss of Mains according to *IEC 62116:2014*

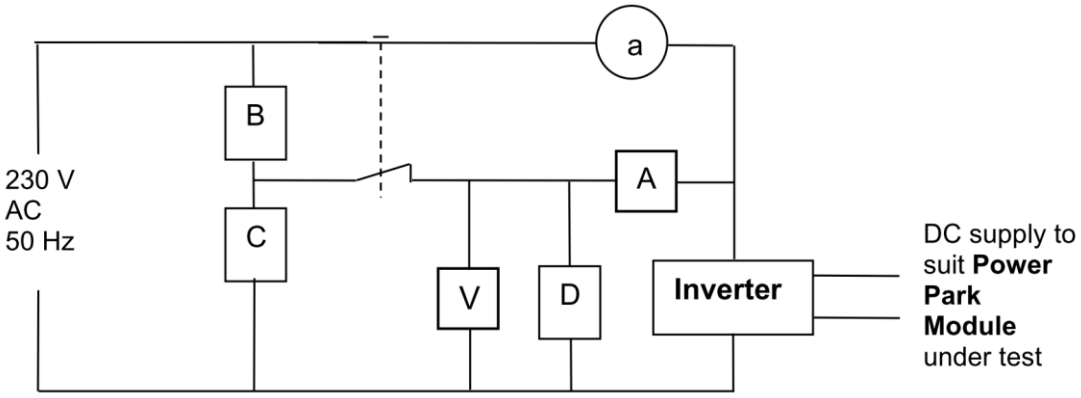


Figure 5 – Short circuit test circuit according to *EREC G99/NI, Figure A.7.4*

4.7 Measurement equipment

Equipment	Internal No.	Manufacturer	Type	Serial No.	Next Calibration
DC power supply [7]	--	KEYSIGHT	N8957APV	DE21025954	--
AC Simulator [7]	HC-ENG-012	Chroma	61830	618303800281	--
Oscilloscope	--	TEKTRONIX	MDO34	C045110	2023-12-01
	--	KEYSIGHT	DSO-X3014T	MY62160261	2023-12-01
Power analyser	HC-ENG-003	DEWESOFT	SIRIUSi-HS-4xHV-4xLV	DB20123915	2023-09-05
Current sensor	HC-ENG-019	LEM	IT 400-S	82021060080	2023-09-05
	HC-ENG-020	LEM	IT 400-S	82021060081	2023-09-05
	HC-ENG-021	LEM	IT 400-S	82021060082	2023-09-05
	HC-ENG-022	LEM	IT 400-S	82021060084	2023-09-05
Digital hygrometer	HC-ENG-002	Jiangsu Jingchuang Electric Co., Ltd.	GSP-8A	CMA215000031	2023-08-31

Note:

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

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

5 Assessment overview

Possible test case verdicts:

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

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

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

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

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

Items	Technical requirements (Section EREC G99/NI)	Remark / Transfer of measurement results *	Verdict
1. Operating Range	10.3.4, 11.2.1	See section 6.1 / The verified operating range of the EH-6K-A-M0 can be applied to other units in the product series directly.	P
2. Harmonics	9.4.3	See section 6.2 / The percentage harmonics results of the EH-6K-A-M0 can be considered as worst case results and applied to other units in the product series directly.	P
3. Voltage Fluctuation and Flicker	9.4.2	See section 6.3 / The Flicker results of the EH-6K-A-M0 can be considered as worst case results and applied to other units in the product series directly.	P
4. DC injection	9.4.6	See section 6.4 / The percentage DC injection of the EH-6K-A-M0 can be considered as worst case results and applied to other units in the product series directly.	P
5. Power Factor (PF)	11.1.5	See section 6.5 / The Power Factor results of the EH-6K-A-M0 can be considered as worst case results and applied to other units in the product series directly.	P
6. Frequency protection trip and ride through tests	10.3, 10.6	See section 6.6.1 / The measurement results of the EH-6K-A-M0 can be considered as worst case results and applied to other units in the product series directly.	P
7. Voltage protection trip and ride through tests	10.3, 10.6	See section 6.6.2 / The measurement results of the EH-6K-A-M0 can be considered as worst case results and applied to other units in the product series directly.	P

Items	Technical requirements (Section EREC G99/NI)	Remark / Transfer of measurement results *	Verdict
8. Protection – Loss of Mains Test, Vector Shift and RoCoF Stability Test	10.3, 10.4, 10.6	See section 6.6.3, 6.6.4 and 6.6.5 / The measurement results of the EH-6K-A-M0 can be considered as worst case results and applied to other units in the product series directly.	P
9. LFSM-O Test	11.2.5	See section 6.7 / The determined droops of the EH-6K-A-M0 can be considered as worst case results and applied to other units in the product series directly.	P
10. Protection – Reconnection Timer	A.7.1.2.5	See section 6.8 / The measurement results of the EH-6K-A-M0 can be considered as worst case results and applied to other units in the product series directly.	P
11. Fault Level Contribution	9.7, A.7.1.5	See section 6.9 / The measurement results of the EH-6K-A-M0 can be considered as worst case results and applied to other units in the product series directly.	P
12. Self-monitoring Solid State Switch	9.7.9	See section 6.10 / ---	N/A
13. Wiring functional tests if required by para 15.2.1 (attach relevant schedule of tests)	15.2.1	See section 6.11 / ---	N/A
14. Logic Interface (input port)	11.1.3	See section 6.12 / The measurement results of the EH-6K-A-M0 can be considered as worst case results and applied to other units in the product series directly. The high-level description of logic interface applies to the whole product series.	P
15. Cyber security	---	(For information only) See section 6.13 / Manufacturer's declaration provided. See *Annex 2 - Manufacturer's declaration regarding Cyber* .	R/D
Output power with falling frequency	11.2.4	Test not required for Power Generating Modules using inverter	N/A

Note:

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

Note:

in this report, ***Family approach to Type Testing*** according to **EREC G99**, section **15.6** was applied.

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

All absolute values (e.g. operating range tests) shall be transferred directly in the compliance forms of an assumed compliant Generating Unit of the same family. ***All relative results related to design Active Power***

or current (e.g. power quality fluctuation and flicker) from the tested Generating Unit shall be transferred to the compliance form of a Generating Unit in the same family according to the ratio of the respective nameplate rating (W)of the tested Generating Unit and the assumed compliant Generating Unit*. For the avoidance of doubt, the Manufacturer shall register each Generating Unit in the family on the Energy Networks Association Type Test register.*

Since the tests were performed on EUT **EH-6K-A-M0** which provides the highest current / power, in this report the ***relative results*** of EUT **EH-6K-A-M0** are considered as worst case results and applied to other units in the product series directly.

6 Measurement results

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

6.1 Operating Range

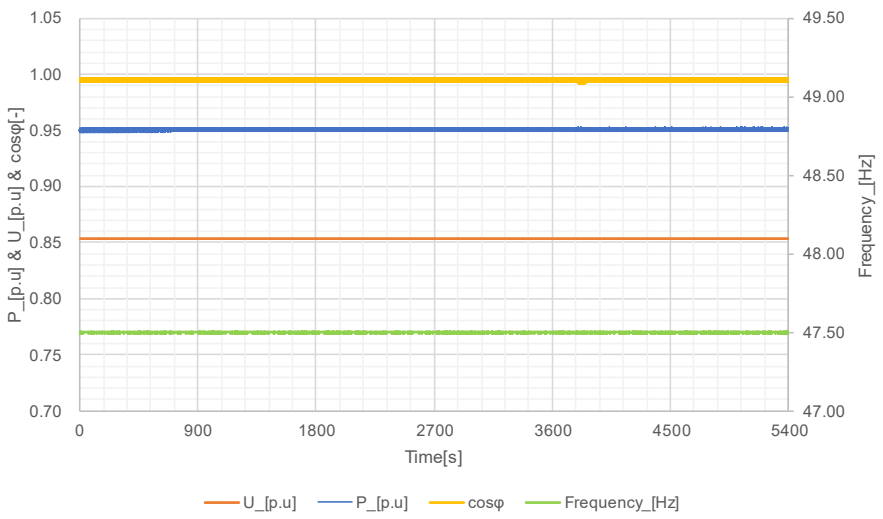
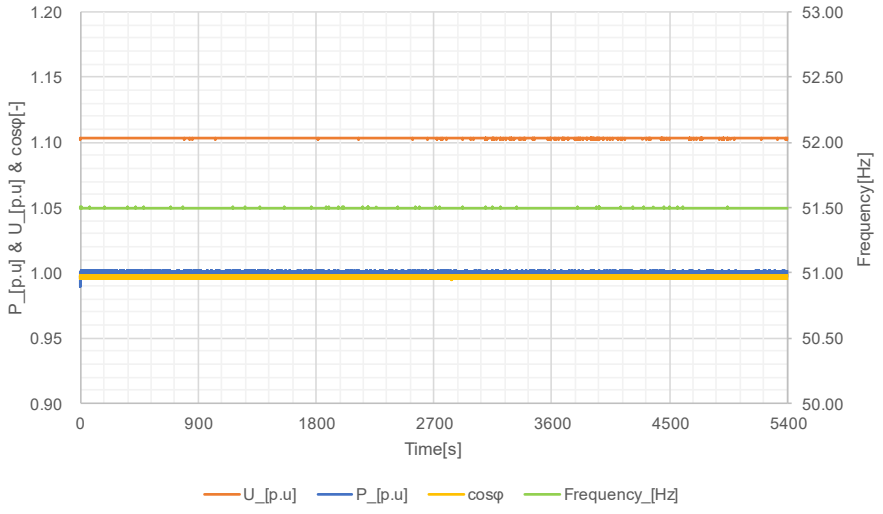
Tests should be carried with the Power Generating Module operating at Registered Capacity and connected to a suitable test supply or grid simulation set. The power supplied by the primary source shall be kept stable within ± 5 % of the apparent power value set for the entire duration of each test sequence.

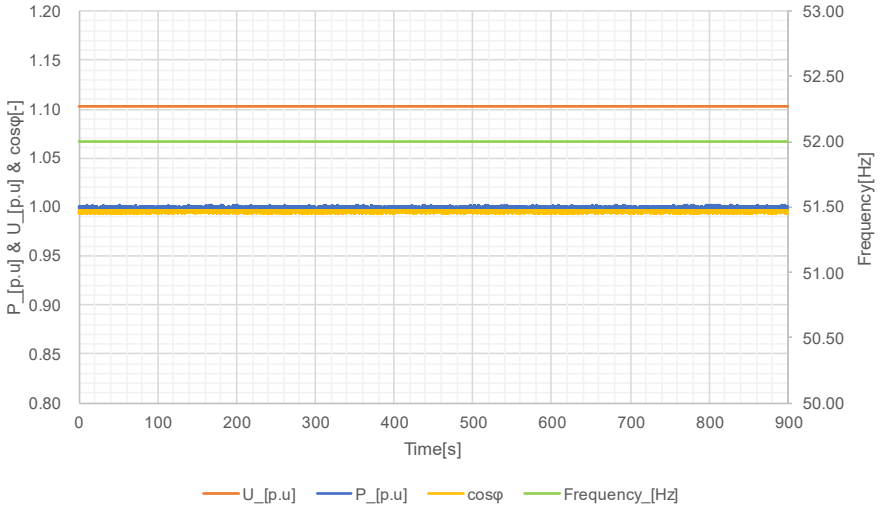
Frequency, voltage and Active Power measurements at the output terminals of the Power Generating Module shall be recorded every second. The tests will verify that the Power Generating Module can operate within the required ranges for the specified period of time.

The **Interface Protection** shall be disabled during the tests.

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

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

Test 1 Voltage = 85% of nominal (195.5 V), Frequency = 47.5 Hz, Power factor = 1, Period of test 90 minutes	Pass, no disconnection occurs. 
Test 2 Voltage = 110% of nominal (253 V)., Frequency = 51.5 Hz, **Power Factor** = 1, Period of test 90 minutes	Pass, no disconnection occurs. 

Test 3 Voltage = 110% of nominal (253 V), Frequency = 52.0 Hz, **Power Factor** = 1, Period of test 15 minutes	Pass, no disconnection occurs. 

6.2 Power Quality – Harmonics

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

Power Generating Modules with emissions close to the limits laid down in BS EN 61000-3-12 may require the installation of a transformer between 2 and 4 times the rating of the Power Generating Module in order to accept the connection to a Distribution Network.

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

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

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

Power Generating Module rating per phase (rpp)			6.000			kVA	Harmonic % = Measured Value (A) x 23/rating per phase (kVA)	
Single or three phase measurements (for single phase measurements, only complete L1 columns below).			single phase					
Harmonic	At 45-55% of **Registered Capacity**						Limit in BS EN 61000-3-12	
	Measured Value (MV) in Amps			Measured Value (MV) in % [8]				
Order	L_1	L_2	L_3	L_1	L_2	L_3	1-phase	3-phases
2	0.0217	---	---	0.083	--	--	8%	8%
3	0.1296	---	---	0.497	--	--	21.6%	Not stated
4	0.0098	---	---	0.038	--	--	4%	4%
5	0.0630	---	---	0.241	--	--	10.7%	10.7%
6	0.0069	---	---	0.026	--	--	2.67%	2.67%
7	0.0347	---	---	0.133	--	--	7.2%	7.2%

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

Order	L_1	L_2	L_3	L_1	L_2	L_3	1-phase	3-phases
8	0.0054	---	---	0.021	--	--	2%	2%
9	0.0224	---	---	0.086	--	--	3.8%	Not stated
10	0.0045	---	---	0.017	--	--	1.6%	1.6%
11	0.0194	---	---	0.074	--	--	3.1%	3.1%
12	0.0036	---	---	0.014	--	--	1.33%	1.33%
13	0.0110	---	---	0.042	--	--	2%	2%
14	0.0029	---	---	0.011	--	--	---	---
15	0.0103	---	---	0.040	--	--	---	---
16	0.0024	---	---	0.009	--	--	---	---
17	0.0108	---	---	0.041	--	--	---	---
18	0.0023	---	---	0.009	--	--	---	---
19	0.0113	---	---	0.043	--	--	---	---
20	0.0018	---	---	0.007	--	--	---	---
21	0.0086	---	---	0.033	--	--	---	---
22	0.0018	---	---	0.007	--	--	---	---
23	0.0091	---	---	0.035	--	--	---	---
24	0.0015	---	---	0.006	--	--	---	---
25	0.0071	---	---	0.027	--	--	---	---
26	0.0015	---	---	0.006	--	--	---	---
27	0.0081	---	---	0.031	--	--	---	---
28	0.0014	---	---	0.005	--	--	---	---
29	0.0062	---	---	0.024	--	--	---	---
30	0.0012	---	---	0.005	--	--	---	---
31	0.0073	---	---	0.028	--	--	---	---
32	0.0012	---	---	0.005	--	--	---	---
33	0.0061	---	---	0.023	--	--	---	---
34	0.0014	---	---	0.006	--	--	---	---
35	0.0072	---	---	0.028	--	--	---	---
36	0.0012	---	---	0.005	--	--	---	---
37	0.0059	---	---	0.022	--	--	---	---
38	0.0012	---	---	0.005	--	--	---	---
39	0.0064	---	---	0.025	--	--	---	---
40	0.0013	---	---	0.005	--	--	---	---
THD [9]	--	--	--	0.601	--	--	23%	13%
PWHD [10]	--	--	--	0.570	--	--	23%	22%

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

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

Harmonic	At 100% of **Registered Capacity**						Limit in BS EN 61000-3-12	
	Measured Value (MV) in Amps			Measured Value (MV) in % [8]				
Order	L_1	L_2	L_3	L_1	L_2	L_3	1-phase	3-phases
2	0.0402	---	---	0.154	--	--	8%	8%
3	0.2841	---	---	1.089	--	--	21.6%	Not stated
4	0.0182	---	---	0.070	--	--	4%	4%
5	0.1867	---	---	0.716	--	--	10.7%	10.7%
6	0.0124	---	---	0.047	--	--	2.67%	2.67%
7	0.1190	---	---	0.456	--	--	7.2%	7.2%
8	0.0093	---	---	0.036	--	--	2%	2%
9	0.0680	---	---	0.261	--	--	3.8%	Not stated
10	0.0074	---	---	0.028	--	--	1.6%	1.6%
11	0.0303	---	---	0.116	--	--	3.1%	3.1%
12	0.0057	---	---	0.022	--	--	1.33%	1.33%
13	0.0222	---	---	0.085	--	--	2%	2%
14	0.0046	---	---	0.018	--	--	---	---
15	0.0271	---	---	0.104	--	--	---	---
16	0.0038	---	---	0.015	--	--	---	---
17	0.0218	---	---	0.083	--	--	---	---
18	0.0032	---	---	0.012	--	--	---	---
19	0.0155	---	---	0.059	--	--	---	---
20	0.0028	---	---	0.011	--	--	---	---
21	0.0111	---	---	0.043	--	--	---	---
22	0.0024	---	---	0.009	--	--	---	---
23	0.0116	---	---	0.045	--	--	---	---
24	0.0022	---	---	0.008	--	--	---	---
25	0.0103	---	---	0.039	--	--	---	---
26	0.0020	---	---	0.008	--	--	---	---
27	0.0109	---	---	0.042	--	--	---	---
28	0.0019	---	---	0.007	--	--	---	---
29	0.0069	---	---	0.026	--	--	---	---
30	0.0017	---	---	0.007	--	--	---	---
31	0.0054	---	---	0.021	--	--	---	---
32	0.0016	---	---	0.006	--	--	---	---
33	0.0056	---	---	0.022	--	--	---	---
34	0.0015	---	---	0.006	--	--	---	---
35	0.0057	---	---	0.022	--	--	---	---
36	0.0015	---	---	0.006	--	--	---	---
37	0.0053	---	---	0.020	--	--	---	---
38	0.0014	---	---	0.005	--	--	---	---
39	0.0056	---	---	0.021	--	--	---	---
40	0.0015	---	---	0.006	--	--	---	---
THD [9]	---	---	---	1.436	--	--	23%	13%
PWHD [10]	---	---	---	0.801	--	--	23%	22%

6.3 Power Quality – Voltage fluctuations and Flicker

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

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

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

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

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

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

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

The test date and location must be declared.

Test start date	2023-04-19	Test end date	2023-04-23
Test location	LYNS-TCI TECHNOLOGY GUANGDONG CO., LTD. (see *Testing location* on p.2)		

		Starting			Stopping			Running	
	Phase no.	d_{max} [%]	d_c [%]	d(t) [ms]	d_{max} [%]	d_c [%]	d(t) [ms]	P_{st}	P_{lt} 2 hours
Measured Values at test impedance	L1	0.276	0.125	0.000	0.126	0.314	0.000	0.032	0.029
	L2	--	--	--	--	--	--	--	--
	L3	--	--	--	--	--	--	--	--
	Overall worst case	0.276	0.125	0.000	0.126	0.314	0.000	0.032	0.029
Normalised to standard impedance	L1	0.276	0.125	0.000	0.126	0.314	0.000	0.032	0.029
	L2	--	--	--	--	--	--	--	--
	L3	--	--	--	--	--	--	--	--
	Overall worst case	0.276	0.125	0.000	0.126	0.314	0.000	0.032	0.029
Normalised to required maximum impedance	L1	--	--	--	--	--	--	--	--
	L2	--	--	--	--	--	--	--	--
	L3	--	--	--	--	--	--	--	--
	Overall worst case	--	--	--	--	--	--	--	--
Limits set under BS EN 61000-3-11		4	3.3	500 (3.3%)	4	3.3	500 (3.3%)	1.0	0.65

Test Impedance	R:	0.4	X:	0.25
Standard Impedance	R:	☐ 0.24 * ☒ 0.4 ^	X:	☐ 0.15 * ☒ 0.25 ^
Maximum Impedance	R:	--	X:	--

Ω

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

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

6.4 Power Quality – DC injection

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

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

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

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

Test power level	10%	55%	100%
Recorded DC value in Amps	0.005	0.002	0.005
as % of rated AC current	0.019	0.008	0.019
Limit [%]	0.25	0.25	0.25

Note:

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

- Base current = Registered Capacity (W) / 230 (V)

- % DC injection = Recorded DC value (A) / Base current (A) *100

6.5 Power Factor

The tests should be carried out on a single **Power Generating Module**. Tests are to be carried out at three voltage levels and at **Registered Capacity**. Voltage to be maintained within ±1.5% of the stated level during the test. These tests should be undertaken in accordance with Annex A.7.1.4.2.			
Voltage	0.94 pu (216.2 V)	1 pu (230 V)	1.1 pu (253 V)
Measured value	0.999	0.999	0.998
Power Factor Limit - leading	>0.95	>0.95	>0.95
Power Factor Limit - lagging	>0.98	>0.98	>0.98

Note:

See also "*Note"* on Power Factor on p.9.

6.6 Protection

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

☒ A display on a screen which can be read

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

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

☐ Other (please specify)

Note:

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

Manufacturer Data:

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

(See also subsections 6.6.1 ~ 6.6.5 below)

6.6.1 Protection – Frequency tests

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

Function	Setting		Trip test		“No trip tests”	
	Frequency	Time delay	Frequency	Time delay	Frequency / time	Confirm no trip
U/F	48.0 Hz	0.5 s	47.99 Hz	0.542 s	48.2 Hz 25 s	No trip occurred
					47.8 Hz 0.45 s	No trip occurred
O/F	52 Hz	1.0 s	52.00 Hz	1.050 s	51.8 Hz 120.0 s	No trip occurred
					52.2 Hz 0.98 s	No trip occurred

Note:

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

Figure 6 – Test U/F (Trip test)

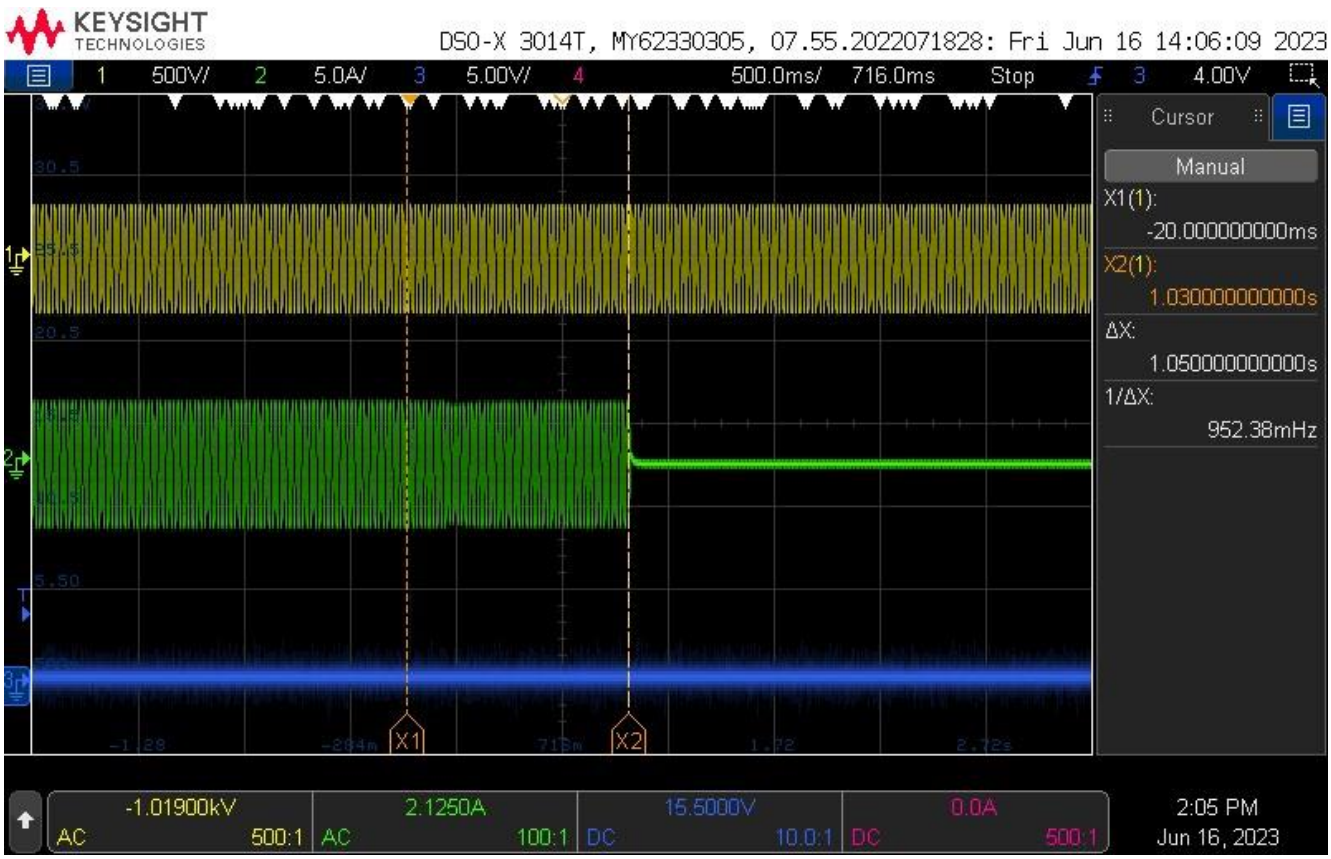


Figure 7 – Test OF (Trip test)

6.6.2 Protection – Voltage tests

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

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

Function	Setting		Trip test		“No trip tests”	
	Voltage	Time delay	Voltage	Time delay	Voltage / time	Confirm no trip
U/V stage 1	0.85 pu (195.5 V)	3.0 s	195.48 V	3.000 s	199.5 V 5.0 s	No trip occurred
U/V stage 2	0.60 pu (138.0 V)	2.0 s	137.99 V	2.020 s	142.0 V 2.5 s	No trip occurred
					134 V 1.98 s	No trip occurred
O/V	1.10 pu (253.0 V)	0.5 s	252.81 V	0.500 s	249.0 V 5.0 s	No trip occurred
					257.0 V 0.45 s	No trip occurred

Note:

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

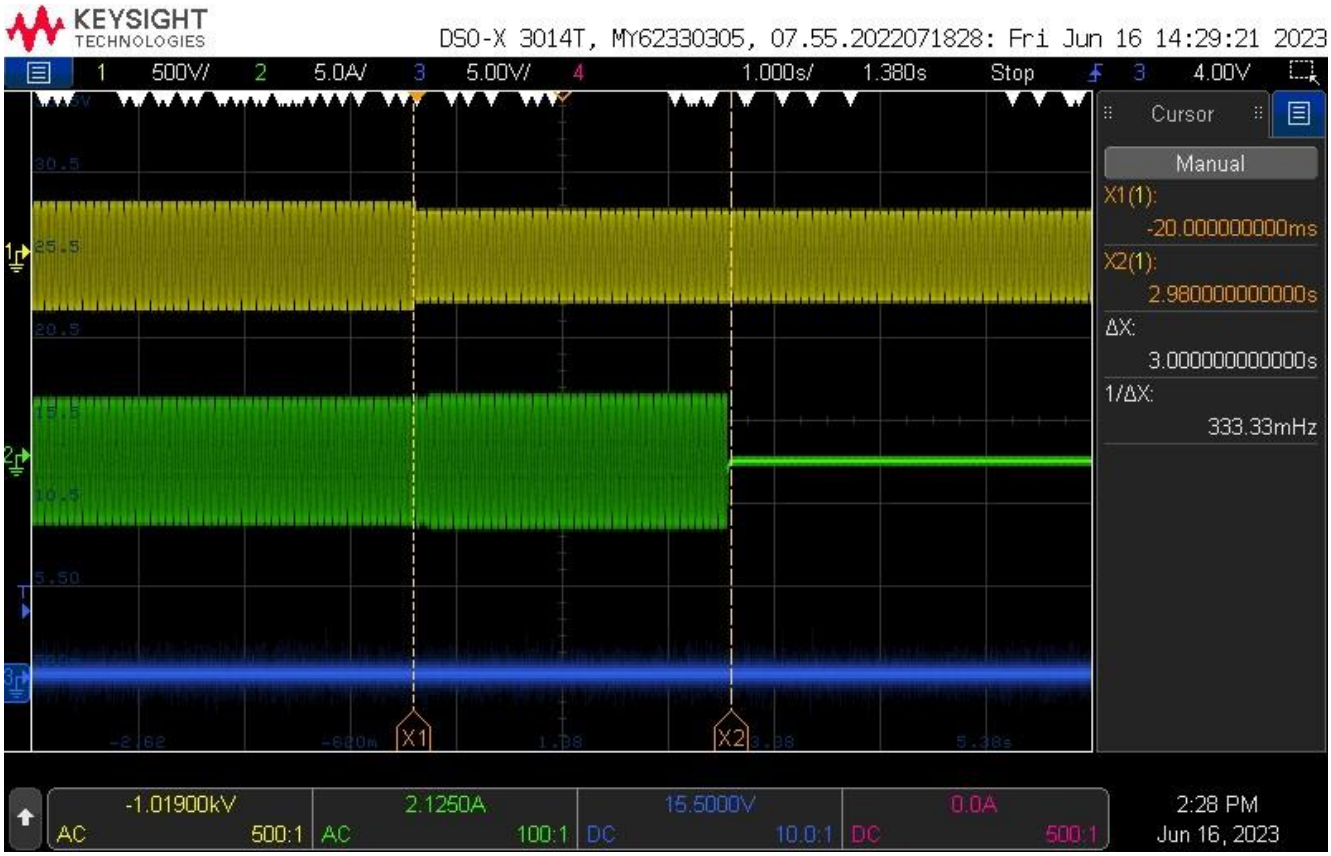


Figure 8 – Test U/V stage 1 (Trip test)

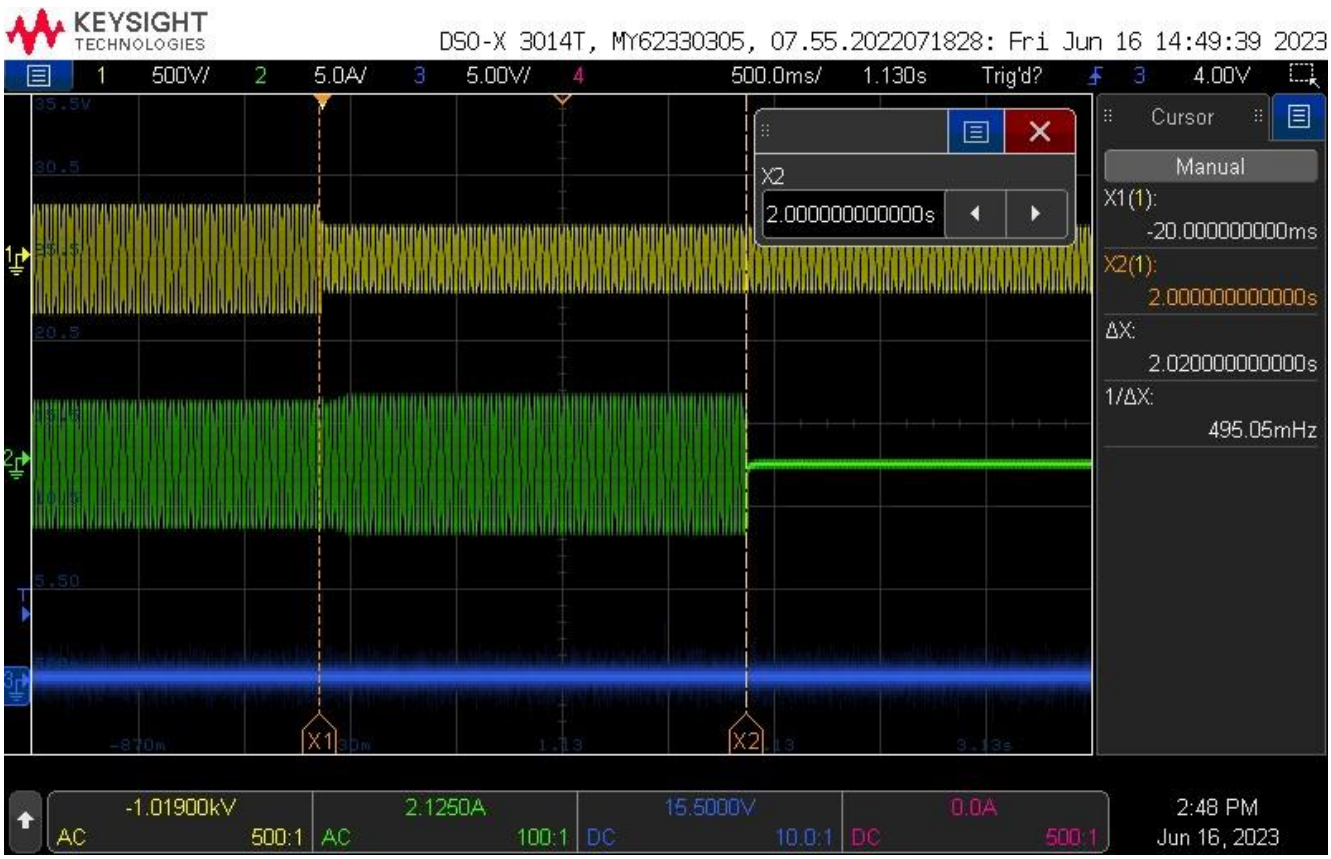


Figure 9 – Test U/V stage 2 (Trip test)

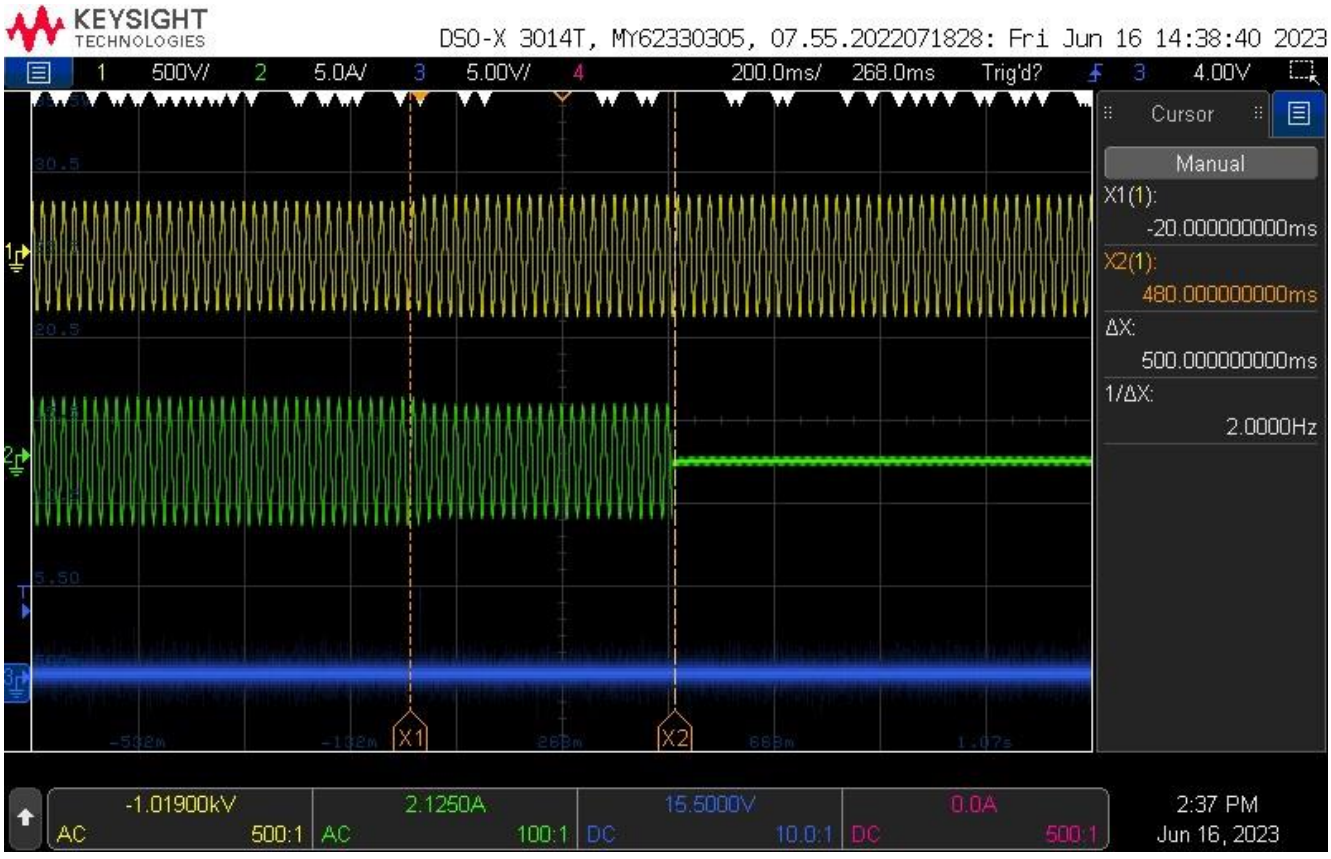


Figure 10 – Test O/V (Trip test)

6.6.3 Protection – Loss of Mains test

These tests should be carried out in accordance with BS EN 62116. Annex A.7.1.2.4.						
The following sub set of tests should be recorded in the following table.						
Test Power and imbalance	33% -5%Q (Test 22)	66% -5%Q (Test 12)	100% -5%P (Test 5)	33% +5%Q (Test 31)	66% +5%Q (Test 21)	100% +5%P (Test 10)
Trip time [s]	0.279	0.233	0.327	0.309	0.229	0.259
Trip time limit [s]	0.5 [11]					
Note: For full testing according to BS EN 62116 see *Annex 1 - Loss of Mains test according to BS EN 62116*.						

6.6.4 Loss of Mains Protection, Vector Shift Stability test

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

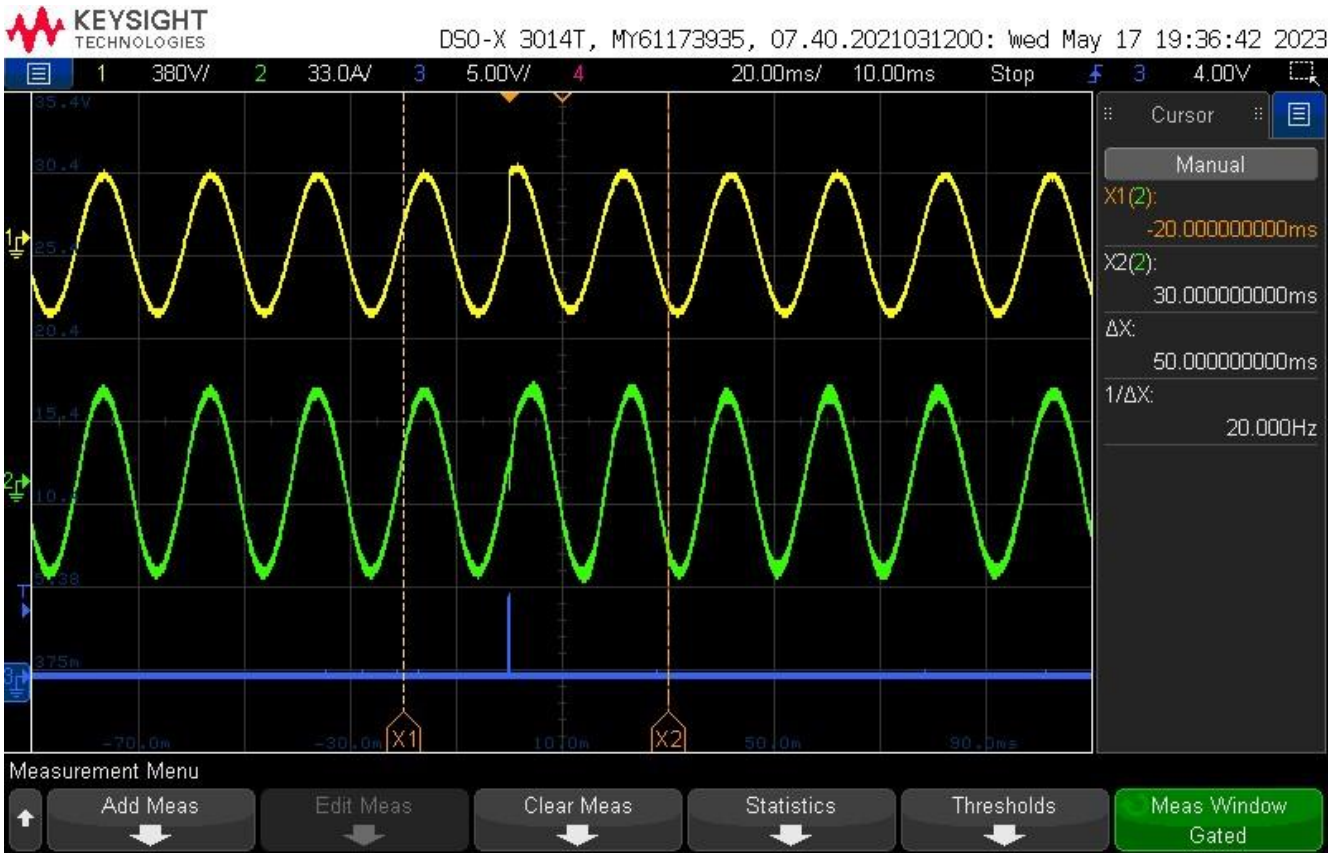


Figure 11 – Positive Step Change (+50 degrees)

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

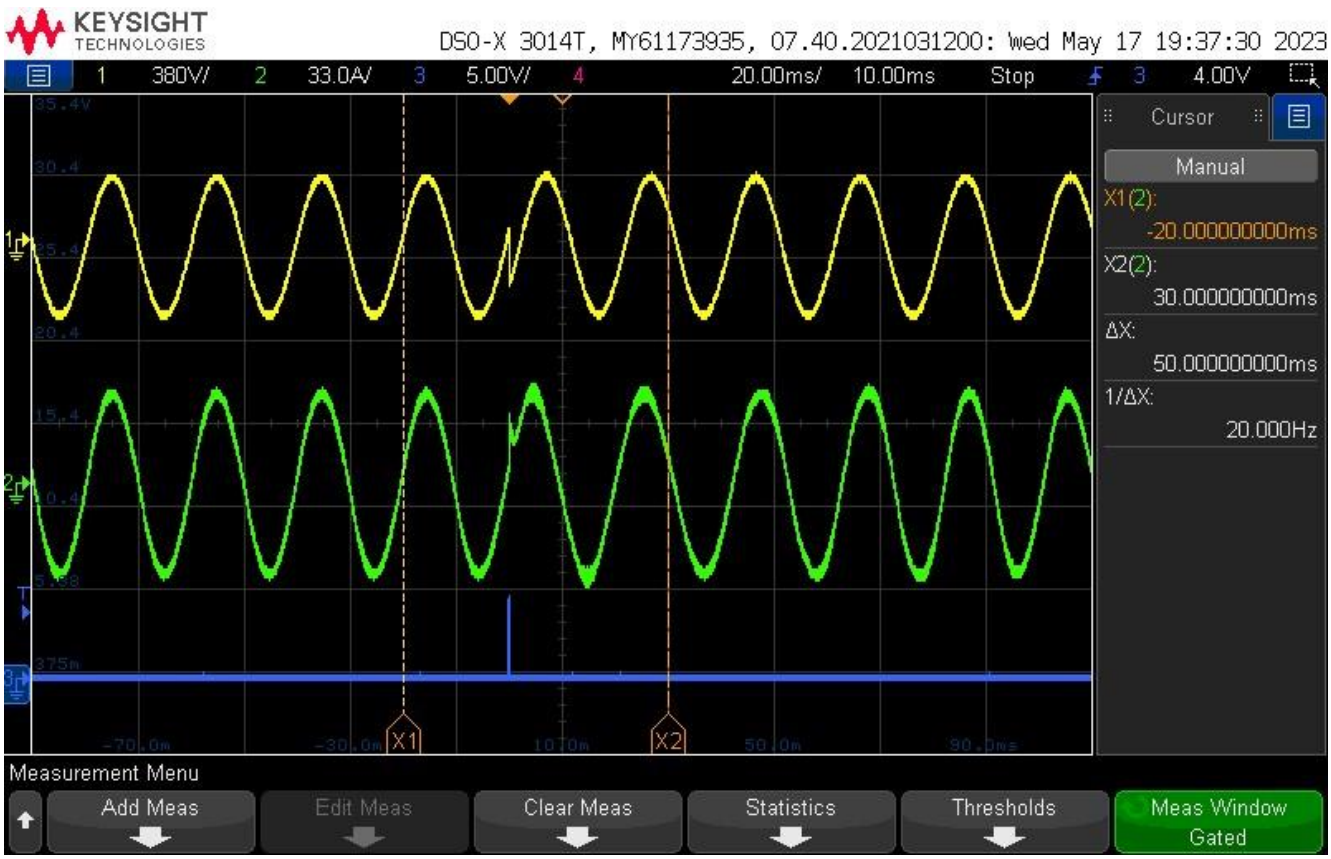


Figure 12 – Negative Step Change (-50 degrees)

6.6.5 Loss of Mains Protection, RoCoF Stability test

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

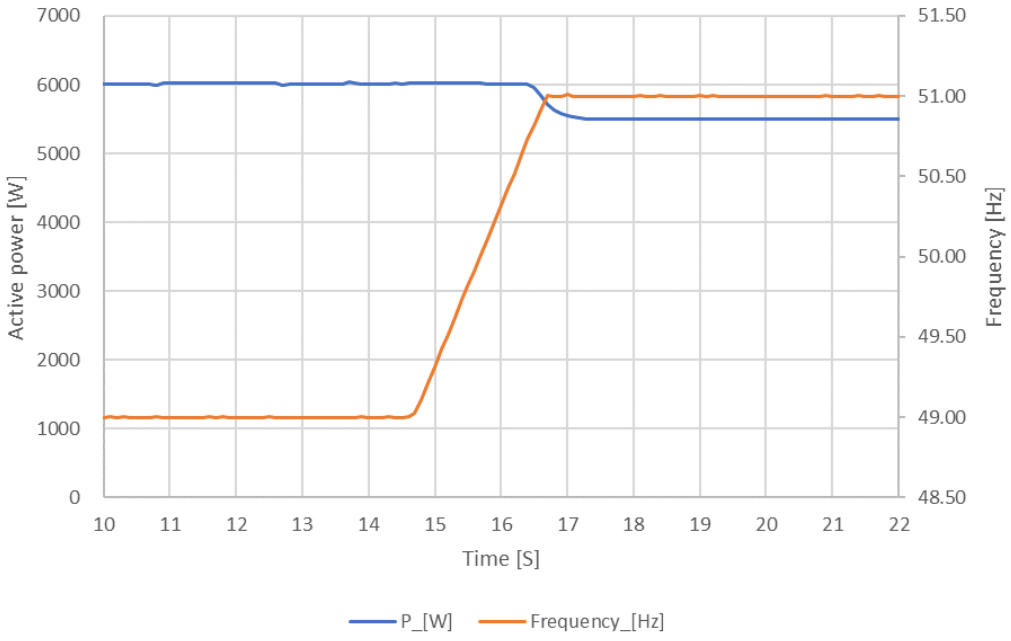


Figure 13 – Positive Frequency Drift (+0.95 Hz/s)

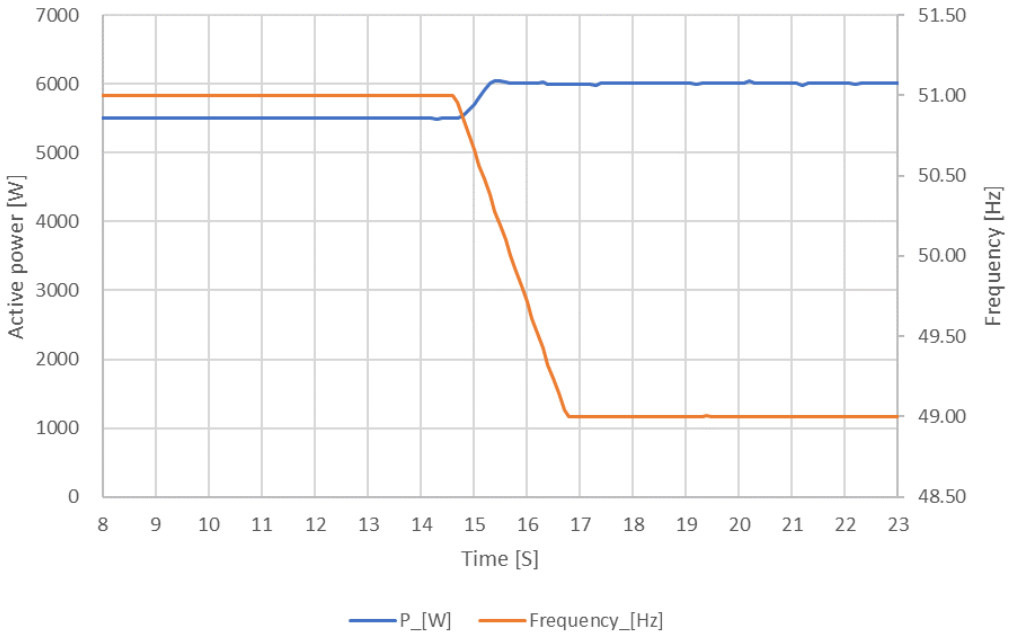


Figure 14 – Negative Frequency Drift (-0.95 Hz/s)

6.7 Limited Frequency Sensitive Mode – Overfrequency test

The test should be carried out using the specific threshold frequency of 50.2 Hz and **Droop** of 4%.
This test should be carried out in accordance with Annex A.7.1.3, which also contains the measurement tolerances.

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

Alternatively, test results should be noted below:

Test sequence at **Registered Capacity** >80%	Measured **Active Power** Output [W]	Frequency [Hz]	Primary Power Source [W]	**Active Power** Gradient Droop
Step a) 50.00Hz ± 0.01Hz	6050	50.00	6600	---
Step b) 50.25Hz ± 0.05Hz	5857	50.25		---
Step c) 50.70Hz ± 0.10Hz	4519	50.70		---
Step d) 51.15Hz ± 0.05Hz	3162	51.15		4.01% 1)
Step e) 50.70Hz ± 0.10Hz	4519	50.70		---
Step f) 50.25Hz ± 0.05Hz	5859	50.25		4.01% 2)
Step g) 50.00Hz ± 0.01Hz	6050	50.00		---
Test sequence at **Registered Capacity** 40% - 60%	Measured **Active Power** Output [W]	Frequency [Hz]	Primary Power Source [W]	**Active Power** Gradient Droop
Step a) 50.00Hz ± 0.01Hz	3030	50.00	3300	---
Step b) 50.25Hz ± 0.05Hz	2853	50.25		---
Step c) 50.70Hz ± 0.10Hz	1527	50.70		---
Step d) 51.15Hz ± 0.05Hz	176	51.15		4.03% 1)
Step e) 50.70Hz ± 0.10Hz	1527	50.70		---
Step f) 50.25Hz ± 0.05Hz	2854	50.25		4.03% 2)
Step g) 50.00Hz ± 0.01Hz	3029	50.00		---

Note:

* Test according to Annex A.7.1.3. Frequency/time plots attached (see Figure 15 & Figure 16)

1) Droop calculated using frequency and power between steps d) & b)

2) Droop calculated using frequency and power between steps f) & d)

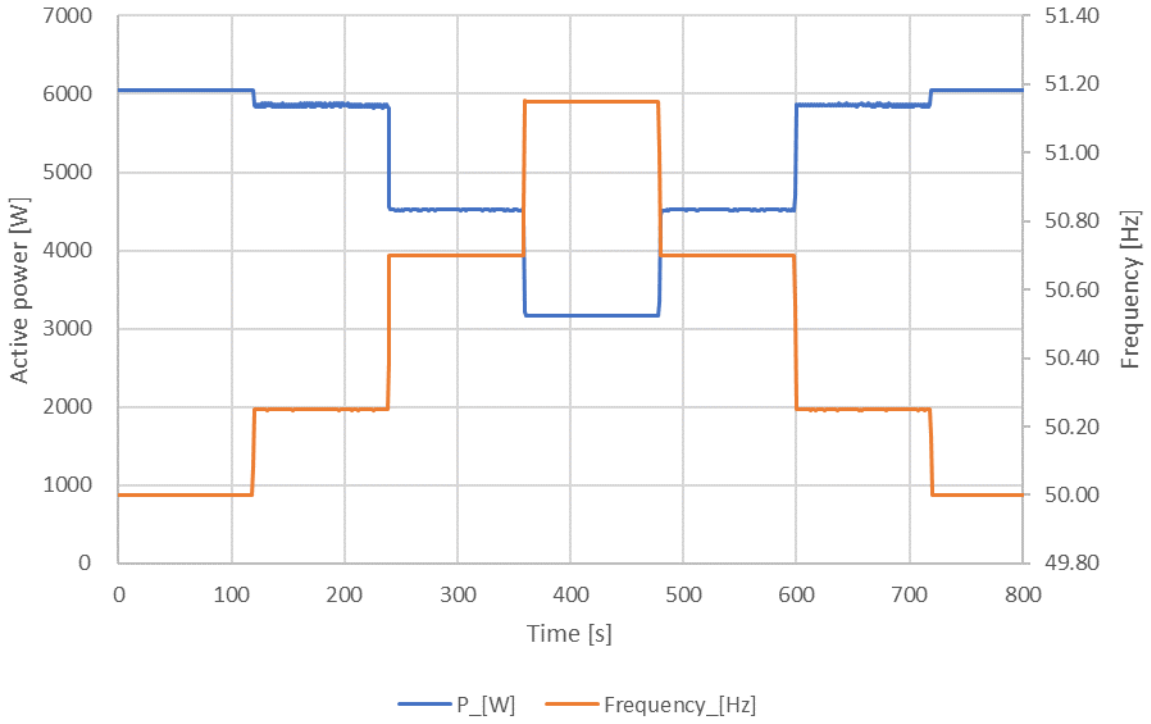


Figure 15 – Test sequence at Registered Capacity >80%

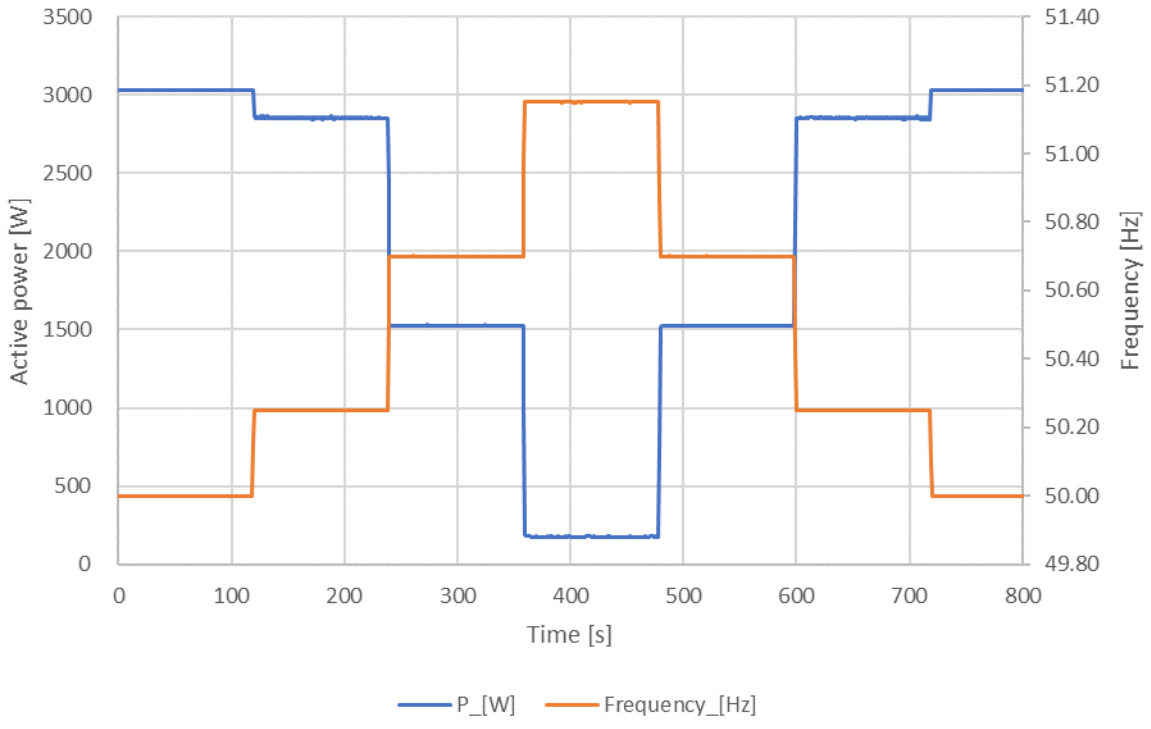


Figure 16 – Test sequence at Registered Capacity 40% - 60%

6.8 Protection – Re-connection timer

Test should prove that the reconnection sequence starts after a minimum delay of 60 s for restoration of voltage and frequency to within the stage 1 settings of Table 10.1. Both the time delay setting and the measured delay should be provided in this form; both should be greater than 60 s to pass. Confirmation should be provided that the **Power Generating Module** does not reconnect at the voltage and frequency settings below; a statement of "no reconnection" can be made.					
Time delay setting	Measured delay	Checks on no reconnection when voltage or frequency is brought to just outside stage 1 limits of Table 10.1.			
60 s	76 s	At 1.12 pu (257.0 V **LV** connection)	At 0.83 pu (191.5 V **LV** connection)	At 47.9 Hz	At 52.1 Hz
Confirmation that the **Power Generating Module** does not re-connect.		No reconnection occurred	No reconnection occurred	No reconnection occurred	No reconnection occurred

6.9 Fault level contribution

These tests shall be carried out in accordance with EREC G99/NI Annex A.7.1.5. Please complete each entry, even if the contribution to the fault level is zero.		
For **Inverter** output		
Time after fault	Volts	Amps
20ms	22.5	26.43
100ms	7.9	0.83
250ms	7.7	0.63
500ms	7.6	0.60
Time to trip	0.031	In seconds

6.10 Self-Monitoring solid state switching

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

6.11 Wiring functional tests

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

6.12 Logic interface (input port)

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

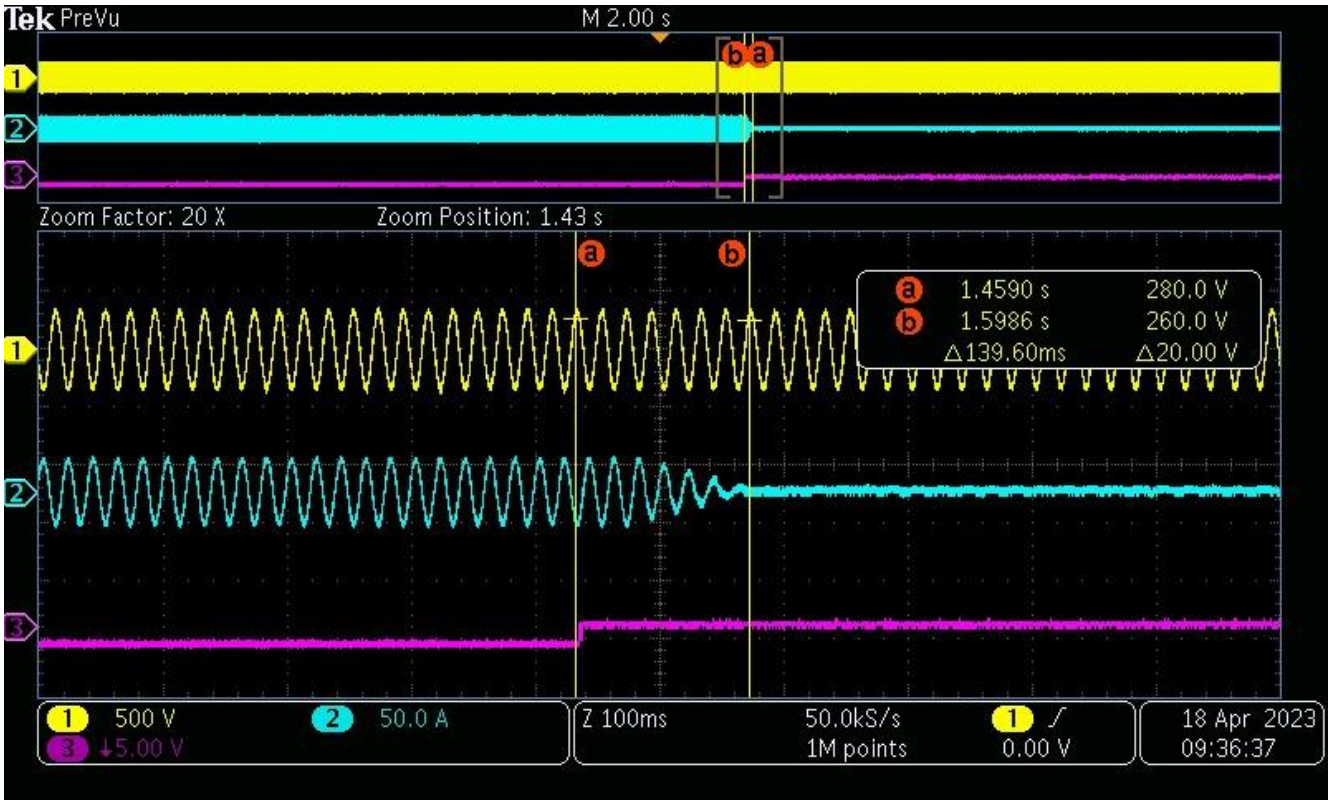


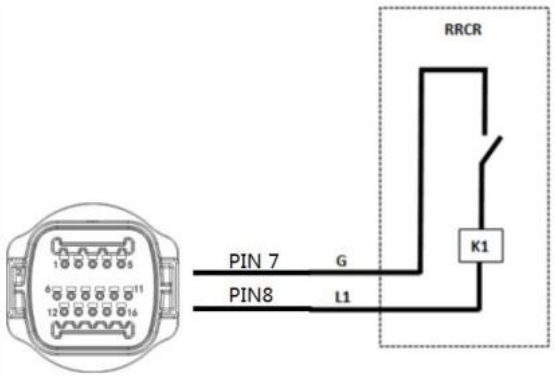
Figure 17 – Test ceasing active power output using logic interface

6.13 Cyber security (informative)

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

Additional comments.
High level description of logic interface:

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



where RRCR = Radio Ripple Control Receiver.

The signal from the Power Generating Module that is being switched can be either AC (maximum value 240 V) or DC (maximum value 110 V)

Function description of the terminal:

Pin NO.	Pin name	Description	Connected to (RRCR)
8	L1	Relay contact 1 input	K1 - Relay 1 output
7	G	GND	K1 - Relay 1 output

Relay status: close is 1, open is 0

L1	Active Power	Power drop rate	Cos(φ)
1	0%	＜5 seconds	1
0	100%	/	1

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

No.	P_{EUT} [a] (% of EUT rating)	Reactive load (% of Q_L in 6.1d)1))	P_{AC} [b] (% of nominal)	Q_{AC} [c] (% of nominal)	Run on time (ms)	P_{EUT} (W)	Actual Q_f	V_{DC}	Remarks [d]
1	100	100	0	0	349	6000	1.000	468.2	Test A at BL
2	66	66	0	0	399	3960	1.000	319.5	Test B at BL
3	33	33	0	0	439	1980	1.000	176.8	Test C at BL
4	100	100	-5	-5	227	6023	1.020	467.7	Test A at IB
5	100	100	-5	0	327	5978	1.004	467.8	Test A at IB
6	100	100	-5	+5	269	5953	0.983	468.2	Test A at IB
7	100	100	0	-5	281	6275	0.980	467.9	Test A at IB
8	100	100	0	+5	313	6248	0.936	468.3	Test A at IB
9	100	100	+5	-5	243	6568	0.937	468.5	Test A at IB
10	100	100	+5	0	259	6590	0.911	467.4	Test A at IB
11	100	100	+5	+5	245	6593	0.887	467.7	Test A at IB
12	66	66	0	-5	233	4238	0.957	322.0	Test B at IB
13	66	66	0	-4	375	4208	0.961	320.5	Test B at IB
14	66	66	0	-3	263	4240	0.947	319.7	Test B at IB
15	66	66	0	-2	311	4215	0.949	319.3	Test B at IB
16	66	66	0	-1	381	4215	0.945	322.5	Test B at IB
17	66	66	0	1	239	4217	0.934	321.7	Test B at IB
18	66	66	0	2	323	4208	0.932	321.6	Test B at IB
19	66	66	0	3	265	4208	0.927	322.2	Test B at IB
20	66	66	0	4	347	4205	0.923	319.6	Test B at IB
21	66	66	0	5	229	4203	0.918	322.4	Test B at IB
22	33	33	0	-5	279	2163	0.937	178.7	Test B at IB
23	33	33	0	-4	303	2148	0.940	177.7	Test B at IB
24	33	33	0	-3	357	2153	0.933	178.4	Test B at IB
25	33	33	0	-2	321	2140	0.936	176.5	Test B at IB
26	33	33	0	-1	369	2130	0.934	176.8	Test B at IB
27	33	33	0	1	353	2148	0.917	177.4	Test B at IB
28	33	33	0	2	377	2135	0.919	173.6	Test B at IB
29	33	33	0	3	303	2130	0.916	175.8	Test B at IB
30	33	33	0	4	331	2128	0.912	175.9	Test B at IB
31	33	33	0	5	309	2128	0.912	174.9	Test B at IB

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

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

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

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

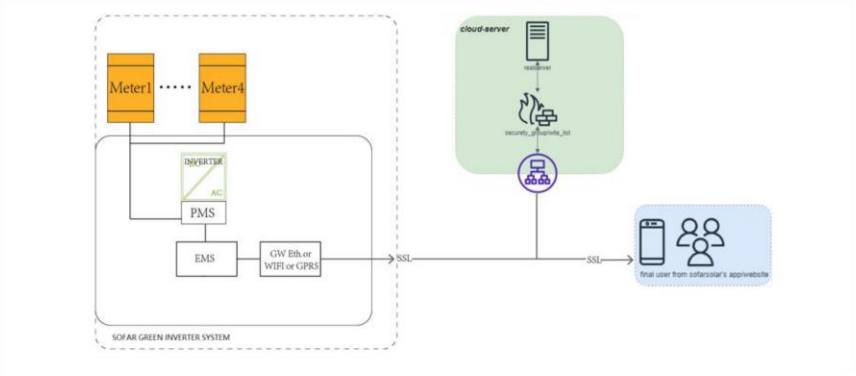
Annex 2 - Manufacturer's declaration regarding Cyber Security (informative)

GL0223100700465

MIDEA DECLARATION

Declares the following:

1) The Midea Inverter include a system of internal and external logic communications as summarized in the following scheme:



where the main components involved and their main functions are explained in the following table:

acronym/ name	*meaning*	*function*	*location*
PMS	Power Management System	monitoring and management of power fluxes through the inverter, execution of EMS's commands or local logic functions depending on grid parameters values. Note: The PMS performs operational safety functions aimed at prevent physical damage/harm, typically by interrupting currents and/or opening contacts on some inverter ports when voltage, current or temperature limits are violated; no safety operation performed by PMS can be compromised/skypped by commands/signals originating outside the inverter.	inverter
EMS	Energy Management System	monitoring of all field's measures, calculus of power and currents for every component of the system, reception of external commands, transmission of commands to PMS. Note: No operational safety function aimed at preventing physical damage/harm is performed by the EMS; no operation performed by EMS can force the operational safety functions performed by PMS and electrical protections.	monitor board
GW	Gate-Way	transmission of data to cloud server, reception of commands/settings from external stakeholder.	Collector

GL0223100700465

Meter	External Power Meter(s) (one to four)	*included in the supply*: meter at the PCC, and possible meter at AC port of third party generator/inverter, for power measures	PCC; third party inverter

2）All communications between internal components of the Midea Inverter, and between EMS and supplied External Power Meter(s), take place via appropriate serial lines (RS485, SCI) and are not directly connected to any device or system outside the Midea Inverter.

3）The only communication port between the device and the outside is constituted by the Gate-Way layer of a logic board on the machine, the communication between Midea Inverter and the outside world can take place via RS485 line, WiFi to the customer's request.

4）The direct recipients/senders of communications with the Midea Inverter is the in-cloud server of Midea Green Inverter - the communication is made secure by the use of TSL(Transport Layer Security) technology on collector, and by the use of SSL(Secure Sockets Layer) technology on Final User's device side and Installer/Midea service web-tools side.

5）All communications between the in-cloud server and the subjects/parties are cyber-protected by SSL technology.

6）The cyber-security assessment of the Midea Green Inverter was performed according to the ETSI EN 303 645 standard, and it is reported according to the Table B.1 form of the same standard:

EN 303 645 v2.1.1 (2020-06) Table B.1: Implementation of provisions for consumer IoT security			
Clause number and title			
Reference	Status	Support	Detail
5.1 No universal default passwords			
Provision 5.1-1	M C (1)	N/A	Device do not permit final user's login.
Provision 5.1-2	M C (2)	N/A	
Provision 5.1-3	M	N/A	
Provision 5.1-4	M C (8)	N/A	
Provision 5.1-5	M C (5)	N/A	
5.2 Implement a means to manage reports of vulnerabilities			
Provision 5.2-1	M	Y	
Provision 5.2-2	R	Y	
Provision 5.2-3	R	Y	
5.3 Keep software updated			

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Provision 5.3-1	R	Y	
Provision 5.3-2	M C (5)	Y	
Provision 5.3-3	M C (12)	Y	
Provision 5.3-4	R C (12)	Y	
Provision 5.3-5	R C (12)	N	The manufacturer manages the updates of the systems by means of remote automatisms, selectively by type of machine or by activating special functions at the request of the user
Provision 5.3-6	R C (9,12)	N	
Provision 5.3-7	M C (12)	Y	
Provision 5.3-8	M C (12)	Y	
Provision 5.3-9	R C (12)	N	See note at 5.3-5
Provision 5.3-10	M (11, 12)	Y	
Provision 5.3-11	R C (12)	Y	
Provision 5.3-12	R C (12)	N	The device failed to notify the user
Provision 5.3-13	M	Y	
Provision 5.3-14	R C (3, 4)	Y	
Provision 5.3-15	R C (3, 4)	N	
Provision 5.3-16	M	Y	
5.4 Securely store sensitive security parameters			
Provision 5.4-1	M	Y	
Provision 5.4-2	M C (10)	Y	
Provision 5.4-3	M	N/A	Hard-coded identity not used in source code
Provision 5.4-4	M	N	No unique key parameters are provided for the device
5.5 Communicate securely			
Provision 5.5-1	M	Y	
Provision 5.5-2	R	N	
Provision 5.5-3	R	N	
Provision 5.5-4	R	Y	
Provision 5.5-5	M	Y	
Provision 5.5-6	R	Y	
Provision 5.5-7	M	Y	
Provision 5.5-8	M	Y	
5.6 Minimize exposed attack surfaces			
Provision 5.6-1	M	Y	
Provision 5.6-2	M	Y	
Provision 5.6-3	R	Y	
Provision 5.6-4	M C (13)	N/A	No debug interface accessible
Provision 5.6-5	R	Y	
Provision 5.6-6	R	Y	
Provision 5.6-7	R	Y	

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Provision 5.6-8	R	N	The device don't have the access control mechanism
Provision 5.6-9	R	Y	
5.7 Ensure software integrity			
Provision 5.7-1	R	N	The device don't have the hardware root of trust
Provision 5.7-2	R	N	The device don't have the ability to be in administration mode
5.8 Ensure that personal data is secure			
Provision 5.8-1	R	N/A	No personal data transit through the device
Provision 5.8-2	M	Y	
Provision 5.8-3	M	Y	
5.9 Make systems resilient to outages			
Provision 5.9-1	R	Y	
Provision 5.9-2	R	Y	
Provision 5.9-3	R	Y	
5.10 Examine system telemetry data			
Provision 5.10-1	R C (6)	Y	
5.11 Make it easy for users to delete user data			
Provision 5.11-1	M	N/A	No user/personal data are stored in the device
Provision 5.11-2	R	N/A	
Provision 5.11-3	R	N/A	
Provision 5.11-4	R	N/A	
5.12 Make installation and maintenance of devices easy			
Provision 5.12-1	R	Y	
Provision 5.12-2	R	Y	
Provision 5.12-3	R	Y	
5.13 Validate input data			
Provision 5.13-1	M	Y	
6 Data protection provisions for consumer IoT			
Provision 6.1	M	N/A	No user/personal data are stored in the device
Provision 6.2	M C (7)	N/A	
Provision 6.3	M	N/A	
Provision 6.4	R C (6)	N/A	
Provision 6.5	M C (6)	N/A	

Conditions:
1) passwords are used; 2) pre-installed passwords are used; 3) software components are not updateable; 4) the device is constrained; 5) the device is not constrained;

GL0223100700465

6) telemetry data being collected; 7) personal data is processed on the basis of consumers' consent; 8) the device allowing user authentication; 9) the device supports automatic updates and/or update notifications; 10) a hard-coded unique per device identity is used for security purposes; 11) updates are delivered over a network interface; 12) an update mechanism is implemented; 13) a debug interface is physically accessible.	
Status' Column:	
M	Mandatory provision
R	Recommended provision
M C	Mandatory and conditional provision
R C	Recommended and conditional provision
Support' Column:	
Y	Implemented
N	Not implemented
N/A	Not applicable

GD Midea Air-Conditioning Equipment Co., Ltd.

Singnature: Logan 数字签章专用

Date: 2023-10-08

Annex 3 - CE declaration

GL0223100700465

EU Declaration of Conformity

Product:

- **Hybird inverter**

Product models as follows:

- **EH-3K-A-M0**
- **EH-3.6K-A-M0**
- **EH-4K-A-M0**
- **EH-4.6K-A-M0**
- **EH-5K-A-M0-A**
- **EH-5.5K-A-M0**
- **EH-6K-A-M0**

Manufacturer: **GD Midea Air-Conditioning Equipment Co., Ltd.**

Address: Lingang Road, Beijiao, Shunde, Foshan, 528311, Guangdong, China

This declaration of conformity is issued under the sole responsibility of the manufacturer. In addition, the product is within the manufacturer's warranty period.

CE

The object of the declaration described above is in conformity with the relevant Union harmonisation legislation: The Low Voltage Directive (LVD)

2014/35/EU and the Electromagnetic Compatibility (EMC) Directive 2014/30/EU.

References to the relevant harmonized standards used or references to the other technical

specifications in relation to which conformity is declared:

LVD:	
IEC/EN 62109-1:2010	•
IEC/EN 62109-2:2011	•
EMC:	
EN IEC 61000-6-4:2019	•
EN IEC 61000-6-3:2021	•
EN IEC 61000-6-2:2019	•
EN IEC 61000-6-1:2021	•

Date：2023.10.[illegible]

Name: 黄晓锋（Logan）

Charge: Manager

Signature:

Manufacture Seal

Annex 4 - Proof of conformity of the integrated protection relay

Note:
The full version of the attached document is available at the laboratory for reference.

Relay model: AZSR250-2AE-12D

VDE Prüf- und Zertifizierungsinstitut

ZEICHENGENEHMIGUNG
MARKS APPROVAL

Zettler electronics GmbH
Junkersstraße 3
82178 Puchheim
Germany

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is authorized to use for their product

Elektromechanisches Elementarrelais
Electromechanical elementary relay

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DIN EN 61810-1/A1 (VDE 0435-201/A1):2020-08; EN 61810-1:2015/A1:2020

Das Produkt erfüllt auch die Anforderungen nach /
The product also fulfills the requirements of

IEC 61810-1:2015
IEC 61810-1:2015/AMD1:2019

Aktenzeichen: 2036900-4940-0018 / 299905
File ref.:

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Offenbach, 2011-09-01
(letzte Änderung / updated 2022-10-17)

M. Tasotti

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Elektromechanisches Elementarrelais
Electromechanical elementary relay

Typ(en) / *Type(s)*

AZSR235-Serie(s)
AZSR250-Serie(s)
AZSR235-L-Serie(s)

Weitere Angaben *Further information*	siehe Anlage Nr.: 100A; 200A; 200B; 200C; 300A; 500A; 500C; 1000 vom 2022-10-17 *see appendix no.: 100A; 200A; 200B; 200C; 300A; 500A; 500C; 1000 dated 2022-10-17*
Hinweis *Notice*	Prüfverfahren: A (3 Prüflinge; Gruppenmontage) *Test procedure: A (3 samples; Group mounting)*

VDE Prüf- und Zertifizierungsinstitut GmbH * Testing and Certification Institute
Merianstrasse 28, D-63069 Offenbach
Telefon +49 (0) 69 83 06-0
Telefax +49 (0) 69 83 06-555

Relay model: HF115F/012-2ZS4

VDE Prüf- und Zertifizierungsinstitut

ZEICHENGENEHMIGUNG
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Electroacoustics Co., Ltd.
No. 91-101 Sunban South Road
Jimei North Ind. District
361021 XIAMEN
CHINA

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is authorized to use for their product

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Electromechanical elementary relay

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Aktenzeichen: 1812200-4940-0005 / 235396
File ref.:

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Ausweis-Nr. 116934 Blatt 1
Certificate No. *Page*

Weitere Bedingungen siehe Rückseite und Folgeblätter /
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Aktenzeichen / *File ref.*	letzte Änderung / *updated*	Datum / *Date*
1812200-4940-0005 / 235396 / CC1 / MIM	2017-04-28	1999-09-13

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Elektromechanisches Elementarrelais
Electromechanical elementary relay

Typ(en) / *Type(s)*

HF115F Serie(s)
HF115F-H Serie(s)
HF115F-T Serie(s)
HF115F-TH Serie(s)
HF115F-Q Serie(s)
HF115F-A Serie(s)
HF115FP Serie(s)
HF115FD Serie(s)
HF115F-S Serie(s)
HF115F-L Serie(s)
HF115FK Serie(s)
HF115FK-T Serie(s)
HF115F-LS Serie(s)
HF115F-I Serie(s)

Weitere Angaben	siehe Anlage Nr.: 100A; 200A; 200B; 200C; 300A; 300B; 300C; 400A; 500A; 500B; 500C; 500D; 500E; 500F; 500I; 500Q; 500S; 1000 vom 2017-04-28
Further information	*see Appendix No.: 100A; 200A; 200B; 200C; 300A; 300B; 300C; 400A; 500A; 500B; 500C; 500D; 500E; 500F; 500I; 500Q; 500S; 1000 dated 2017-04-28*
Anmerkung *Remark*	Alternative Basisbezeichnung siehe Anlage Nr. 100A *Alternative basic designation see Appendix No. 100A*
Hinweis *Notice*	Prüfverfahren: A (3 Prüflinge; Gruppenmontage) *Test procedure: A (3 samples; Group mounting)*

Fortsetzung siehe Blatt 3 /
continued on page 3

Relay model: HF161F-W/12-TH(477)

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Aktenzeichen: 1812200-4940-0038 / 271479
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Ausweis-Nr. 40031410 Blatt 1
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1812200-4940-0038 / 271479 / TL3 / MIM	2020-05-07	2010-11-23

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Elektromechanisches Elementarrelais
Electromechanical elementary relay

Typ(en) / *Type(s)*

HF161F Serie(s)
HF161F-W Serie(s)

Weitere Angaben *Further information*	siehe Anlage Nr.: 100A; 200A; 200B; 200C; 300A; 300B; 300C; 500C; 1000 vom 2020-05-07 *see Appendix No.: 100A; 200A; 200B; 200C; 300A; 300B; 300C; 500C; 1000 dated 2020-05-07*
Hinweis *Notice*	Prüfverfahren: A (3 Prüflinge; Gruppenmontage) *Test procedure: A (3 samples; Group mounting)*

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Fachgebiet TL3
Section TL3

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Rubrik / *Rubric*	Ausweis-Nr. / *Certificate No.*	Anlage / *Appendix*
341	40031410	100A

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1812200-4940-0038/271479/TL3/MIM	2020-05-07	2010-11-23

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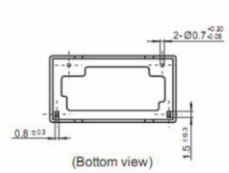
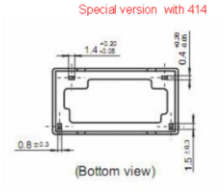
Elektromechanisches Elementarrelais ***Electromechanical elementary relay***	**Typenschlüssel** ***Nomenclature***	
Beispiel: *Example:*	HF161F / 12 - H T XXX I II III IV V	
I Grundtype *Basic series*	HF161F	
II Spulenspannung *Coil voltage*	5 = 5VDC; 12 = 12VDC; 24 = 24VDC; 48 = 48VDC	
III Kontaktart *Kind of contact*	H: 1 Form A	
IV Kontaktmaterial *Contact material*	Blank: AgCdO T: $AgSnO_2$ (letter (T) may be put on behind of lot No.)	
V Spezieller Kode *Special code*	Gegebenfalls weitere Buchstaben und/oder Zahlen. Kundenvariante oder Anforderung. Hat keinen konstruktiven Einfluss ! Ausnahme: 414 = Spezieller Lötanschluß (siehe Zeichnung) 769 = Luftstrecke zwischen Kontakt und Spule 8,0 mm	*May be followed by additional letters and/or numbers.* *Customer code or requirements. „Does not affect the construction"* *Exception:* *414 = Special coil terminal (see drawing)* *769 = Coil – contact clearance gap 8.0 mm*

Standard version



Special version with 414



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341	40031410	100A

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Aktenzeichen / *File ref.*	letzte Änderung / *updated*	Datum / *Date*
1812200-4940-0038/271479/TL3/MIM	2020-05-07	2010-11-23

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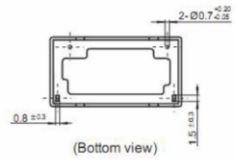
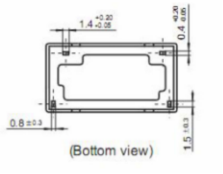
Elektromechanisches Elementarrelais ***Electromechanical elementary relay***	**Typenschlüssel** ***Nomenclature***	
Beispiel: *Example:*	HF161F-W / 12 - H T XXX I II III IV V	
I Grundtype *Basic series*	HF161F-W (Große Kontaktöffnungsweite / *Wide contact gap*)	
II Spulenspannung *Coil voltage*	9 = 9VDC; 12 = 12VDC; 18 = 18VDC; 24 = 24VDC	
III Kontaktart *Kind of contact*	H: 1 Form A	
IV Kontaktmaterial *Contact material*	T: $AgSnO_2$	
V Spezieller Kode *Special code*	Gegebenfalls weitere Buchstaben und/oder Zahlen. Kundenvariante oder Anforderung. Hat keinen konstruktiven Einfluss ! Ausnahmen: 414 = Spezieller Lötanschluß (siehe Zeichnung) 477 = Größere Kontaktöffnungsweite 1,8 mm 456 = Größere Kontaktöffnungsweite 2,0 mm 704 = Größere Kontaktöffnungsweite 2,3 mm	*May be followed by additional letters and/or numbers.* *Customer code or requirements. „Does not affect the construction"* *Exceptions:* *414 = Special coil terminal (see drawing)* *477 = Wider contact gap 1.8 mm* *456 = Wider contact gap 2.0 mm* *704 = Wider contact gap 2.3 mm*

Standard version



Special version with 414



Relay model: HFD3/5

VDE Prüf- und Zertifizierungsinstitut

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ist berechtigt, für ihr Produkt /
is authorized to use for their product

Elektromechanisches Elementarrelais
Electromechanical elementary relay
HFD3, HFD3-V

die hier abgebildeten markenrechtlich geschützten Zeichen
für die ab Blatt 2 aufgeführten Typen zu benutzen /
the legally protected Marks as shown below for the types referred to on page 2 ff.

Geprüft und zertifiziert nach /
Tested and certified according to

DIN EN 61810-1 (VDE 0435 Teil 201):2009-02; EN 61810-1:2008
IEC 61810-1(ed.3)

Aktenzeichen: 1812200-4940-0020 / 200166
File ref.:

VDE Prüf- und Zertifizierungsinstitut GmbH
VDE Testing and Certification Institute
Zertifizierungsstelle / *Certification*

Ausweis-Nr. 40018867 Blatt 1
Certificate No. *Page*

Weitere Bedingungen siehe Rückseite und Folgeblätter /
further conditions see overleaf and following pages

Offenbach, 2006-09-13
(letzte Änderung/updated 2015-07-21)

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VDE certificates are valid only when published on:

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http://www.vde.com/certificate

VDE

VDE Prüf- und Zertifizierungsinstitut Zeichengenehmigung

Ausweis-Nr. / *Certificate No.* 40018867 | Blatt / *Page* 2

Name und Sitz des Genehmigungs-Inhabers / *Name and registered seat of the Certificate holder*
Xiamen Hongfa Electroacoustics Co., Ltd., No. 91-101 Sunban South Road, Jimei North Ind. District, 361021 XIAMEN, Fujian, CHINA

Aktenzeichen / *File ref.*	letzte Änderung / *updated*	Datum / *Date*
1812200-4940-0020 / 200166 / CC1 / MIM	2015-07-21	2006-09-13

Dieses Blatt gilt nur in Verbindung mit Blatt 1 des Zeichengenehmigungsausweises Nr. 40018867.
This supplement is only valid in conjunction with page 1 of the Certificate No. 40018867.

Elektromechanisches Elementarrelais
Electromechanical elementary relay
HFD3, HFD3-V

Typ(en) / *Type(s)*

1] **HFD3-.(-;V) /.(-;S;S1;S2;S3).(-;R)**
2] **HFD3-.(-;V) /..-L1.(-;S;S1;S2;S3).(-;R)**
3] **HFD3-.(-;V) /..-L2.(-;S;S1;S2;S3).(-;R)**

Weitere Angaben *Further information*	siehe Anlage Nr.: 100A; 200A; 200B; 200C; 300A; 500H vom 2015-07-21 *see Enclosure No.:* *100A; 200A; 200B; 200C; 300A; 500H dated 2015-07-21*
Anmerkung(en) *Remark(s)*	Die mit „." gekennzeichneten Stellen sind Variablen, welche in der Anlage 100A (Typenschlüssel) beschrieben sind. *Positions marked as „." are variables which are described in appendix 100A (Nomenclature).*

VDE Prüf- und Zertifizierungsinstitut GmbH
VDE Testing and Certification Institute
Fachgebiet CC1
Section CC1

VDE Prüf- und Zertifizierungsinstitut Zeichengenehmigung

Ausweis-Nr. / *Certificate No.* 40018867

Beiblatt / *Supplement*

Name und Sitz des Genehmigungs-Inhabers / *Name and registered seat of the Certificate holder*
Xiamen Hongfa Electroacoustics Co., Ltd., No. 91-101 Sunban South Road, Jimei North Ind. District, 361021 XIAMEN, Fujian, CHINA

Aktenzeichen / *File ref.*
1812200-4940-0020 / 200166 / CC1 / MIM

letzte Änderung / *updated*
2015-07-21

Datum / *Date*
2006-09-13

Dieses Beiblatt ist Bestandteil des Zeichengenehmigungsausweises Nr. 40018867.
This supplement is part of the Certificate No. 40018867.

Elektromechanisches Elementarrelais
Electromechanical elementary relay
HFD3, HFD3-V

Fertigungsstätte(n)
Place(s) of manufacture

Referenz/*Reference*	Xiamen Hongfa
30003532	Electroacoustics Co., Ltd.
	No. 91-101 Sunban South Road
	Jimei North Ind. District
	361021 XIAMEN
	Fujian
	CHINA

VDE Prüf- und Zertifizierungsinstitut GmbH
VDE Testing and Certification Institute
Fachgebiet CC1
Section CC1

VDE Prüf- und Zertifizierungsinstitut Zeichengenehmigung

Ausweis-Nr. / *Certificate No.* 40018867

Infoblatt / *Info sheet*

Name und Sitz des Genehmigungs-Inhabers / *Name and registered seat of the Certificate holder*
Xiamen Hongfa Electroacoustics Co., Ltd., No. 91-101 Sunban South Road, Jimei North Ind. District, 361021 XIAMEN, Fujian, CHINA

Aktenzeichen / *File ref.*	letzte Änderung / *updated*	Datum / *Date*
1812200-4940-0020 / 200166 / CC1 / MIM	2015-07-21	2006-09-13

Dieses Blatt gilt nur in Verbindung mit Blatt 1 des Zeichengenehmigungsausweises Nr. 40018867.
This supplement is only valid in conjunction with page 1 of the Certificate No. 40018867.

Genehmigung zum Benutzen des auf Seite 1 abgebildeten markenrechtlich geschützten Zeichens des VDE:

Grundlage für die Benutzung sind die Allgemeinen Geschäftsbedingungen (AGB) der VDE Prüf- und Zertifizierungsinstitut GmbH (www.vde.com\AGB-Institut). Das Recht zur Benutzung erstreckt sich nur auf die bezeichnete Firma mit den genannten Fertigungsstätten und die oben aufgeführten Produkte mit den zugeordneten Bezeichnungen. Die Fertigungsstätte muss so eingerichtet sein, dass eine gleichmäßige Herstellung der geprüften und zertifizierten Ausführung gewährleistet ist.
Die Genehmigung ist so lange gültig wie die VDE-Bestimmungen gelten, die der Zertifizierung zu- grunde gelegen haben, sofern sie nicht auf Grund anderer Bedingungen aus der VDE Prüf- und Zertifizierungsordnung (PM102) zurückgezogen werden muss.
Der Gültigkeitszeitraum einer VDE-GS-Zeichengenehmigung kann auf Antrag verlängert werden. Bei gesetzlichen und / oder normativen Änderungen kann die VDE-GS-Zeichengenehmigung ihre Gültigkeit zu einem früheren als dem angegebenen Datum verlieren.
Produkte, die das Biozid Dimethylfumarat (DMF) enthalten, dürfen gemäß der Kommissionsent- scheidung 2009/251/EG nicht mehr in den Verkehr gebracht oder auf dem Markt bereitgestellt werden.
Der VDE-Zeichengenehmigungsausweis wird ausschließlich auf der ersten Seite unterzeichnet.

Approval to use the legally protected Mark of the VDE as shown on the first page:
Basis for the use are the general terms and conditions of the VDE Testing and Certification Institute (www.vde.com\terms-institute). The right to use the mark is granted only to the mentioned company with the named places of manufacture and the listed products with the related type references. The place of manufacture shall be equipped in a way that a constant manufacturing of the certified construction is assured.
The approval is valid as long as the VDE specifications are in force, on which the certification is based on, unless it is withdrawn according to the VDE Testing and Certification Procedure (PM102E).
The validity period of a VDE-GS-Mark Approval may be prolonged on request. In case of changes in legal and / or normative requirements, the validity period of a VDE-GS-Mark Approval may be shortened.
Products containing the biocide dimethylfumarate (DMF) may not be marketed or made available on the EC market according to the Commission Decision 2009/251/EC.
The approval is solely signed on the first page.

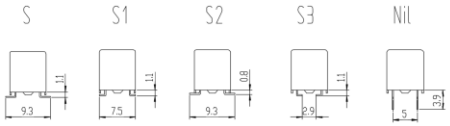
VDE Prüf- und Zertifizierungsinstitut

Aktenzeichen: *File reference:*	**1812200-4940-0020 / 200166**	Ausweis-Nr.: *Certificate No.:*	**40018867**	Anlage Nr.: *Appendix No.:*	**100A**	Seite: *Page:*	**1 / 1**	Datum: *Date:*	**2015-07-21**

Diese Anlage ist Bestandteil des Genehmigungsausweises. *This appendix is part of the certificate.*

Elektromechanisches Elementarrelais ***Electromechanical elementary relay***	
Beispiel: *Example:*	HFD3 / 12 L1 S R XXX I II III IV V VI
I Grundtype *Basic series*	HFD3 HFD3-V
II Spulenspannung *Coil voltage*	1.5=1.5VDC; 2.4 = 2.4VDC ; 3 = 3VDC ; 4.5 = 4.5VDC ; 5 = 5VDC ; 6 = 6VDC ; 9 = 9VDC ; 12 = 12VDC; 24 = 24VDC;48=48VDC
III Spulenansteuerung *Operating Function*	Blank: Single side Stable L1: 1 coil latching L2: 2 coils latching
IV Anschlüsse *Termination*	Blank: Standard PCB terminal S: Surface Mounting Terminal (Inside L 9.3x1.1mm) S1: Surface Mounting Terminal (Inside L 7.5x1.1mm) S2: Surface Mounting Terminal (Inside L 9.3x0.8mm) S3 Surface Mounting Terminal (outside L 2.9x1.1mm)
V Verpackung *Packing*	Blank: Tube packing R: Reel and Tape packing
VI Special code *Special code*	May be followed by additional letters and/or numbers Example: Customer code or requirements „Does not affect the construction“

Terminal drawing:



VDE Prüf- und Zertifizierungsinstitut GmbH Fachbereich CC1
VDE Testing and Certification Institute Department CC1

Relay model: CHZ05-S-212LC2

Zertifikat *Certificate*

TÜVRheinland®

Zertifikat Nr. *Certificate No.*
R 50212872

Blatt *Page*
0001

Ihr Zeichen *Client Reference*	Unser Zeichen *Our Reference*	Ausstellungsdatum	*Date of Issue (day/mo/yr)*
	05-YW- 16032578 001	15.09.2011	

Genehmigungsinhaber *License Holder*
Dongguan Churod Electronics
Co., Ltd.
Xinlong Road 9# Factory
Lincun District, Tangxia
Dongguan, Guangdong
P.R. China

Fertigungsstätte *Manufacturing Plant*
Dongguan Churod Electronics
Co., Ltd.
Xinlong Road 9# Factory
Lincun District, Tangxia
Dongguan, Guangdong
P.R. China

Prüfzeichen *Test Mark*
www.tuv.com ID:2000000000 TÜVRheinland
• BAUART GEPRÜFT
• TYPE APPROVED

Geprüft nach *Tested acc. to*
EN 61810-1:2008

Zertifiziertes Produkt (Geräteidentifikation) *Certified Product* (*Product Identification*)

Lizenzentgelte - Einheit *License Fee - Unit*

Relais (Electromechanical Elementary Relay)

Type Designation	: CHZx-y-zuvw2ab x,y,z,u,v,w,a,b = See appendix 1	15
Rated Coil Voltage	: DC 3V,5V,6V,9V,12V,18V,24V,48V	
Rated Coil Power	: 0,72W; 0,54W	
Ambient Temperature	: -40°C to +85°C	
Contact Loads	: AC 250V; DC 30V NO: 5A/NC: 3A NO: 10A/NC: 5A NO: 16A/NC: 8A see apeendix 1 for detail	
Electrical Endurance	: 100,000	
Mechanical Endurance	: 10,000,000	
Type of Interruption	: Micro-Disconnection	
Insulation System between Coil and Contact	: Basic Insulation	

The labelling requirements acc. to EU Directive 2001/95 have to be observed for distribution within the EEA.

15

ANLAGE (Appendix): 1

Dem Zertifikat liegt unsere Prüf- und Zertifizierungsordnung zugrunde und es bestätigt die Konformität des Produktes mit den oben genannten Standards und Prüfgrundlagen. Zusätzliche Anforderungen in Ländern, in denen das Produkt in Verkehr gebracht werden soll, müssen zusätzlich betrachtet werden. Die Herstellung des zertifizierten Produktes wird überwacht.
This certificate is based on our Testing and Certification Regulation and states the conformity of the product with the standards and testing requirements as indicated above. Any additional requirements in countries where the product is going to be marketed have to be considered additionally. The manufacturing of the certified product is subject to surveillance.

Zertifizierungsstelle

TÜV Rheinland LGA Products GmbH – TÜVRheinland® – Zertifizierungsstelle

Dipl.-Ing. (FH) T. Zimmer

TÜV Rheinland LGA Products GmbH - Tillystraße 2 - 90431 Nürnberg
Tel.: (+49/221)8 06 - 13 71 e-mail: cert-validity@de.tuv.com
Fax: (+49/221)8 06 - 39 35 http://www.tuv.com/safety

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TÜVRheinland®
DIN CERTCO

TÜVRheinland®

Certificate No. 50212872 0001 **Our Reference** 05-YW-16032578 001 **Appendix No.** 1

Type Nomenclature:

CHZx-y-zuvw2ab

Basic designation: CHZ
x=01, 02, 03 or 05, stands for rated contact loads and terminal distance, see below table
y=V or S, stands for sealed type: V means flux proof type, S means wash tight type
z=1 or 2, stands for type of poles, 1 means single-pole, 2 means double-pole
u=3, 5, 6, 9, 12, 18, 24, 48, stands for rated coil voltage (V d.c.)
v= D or L, stands for rated coil power: D means 0,72W, L means 0,54W
w=A or C, A means make contact, C means change-over contact
2 means the contact material is AgSnO
a= F or blank, stands for insulation (UL system) class: F means class 155℃, blank means class 105℃
b= letter, number or blank, stands for special parameter: blank means standard type, letter or number means special requirement which don't affect constructions.

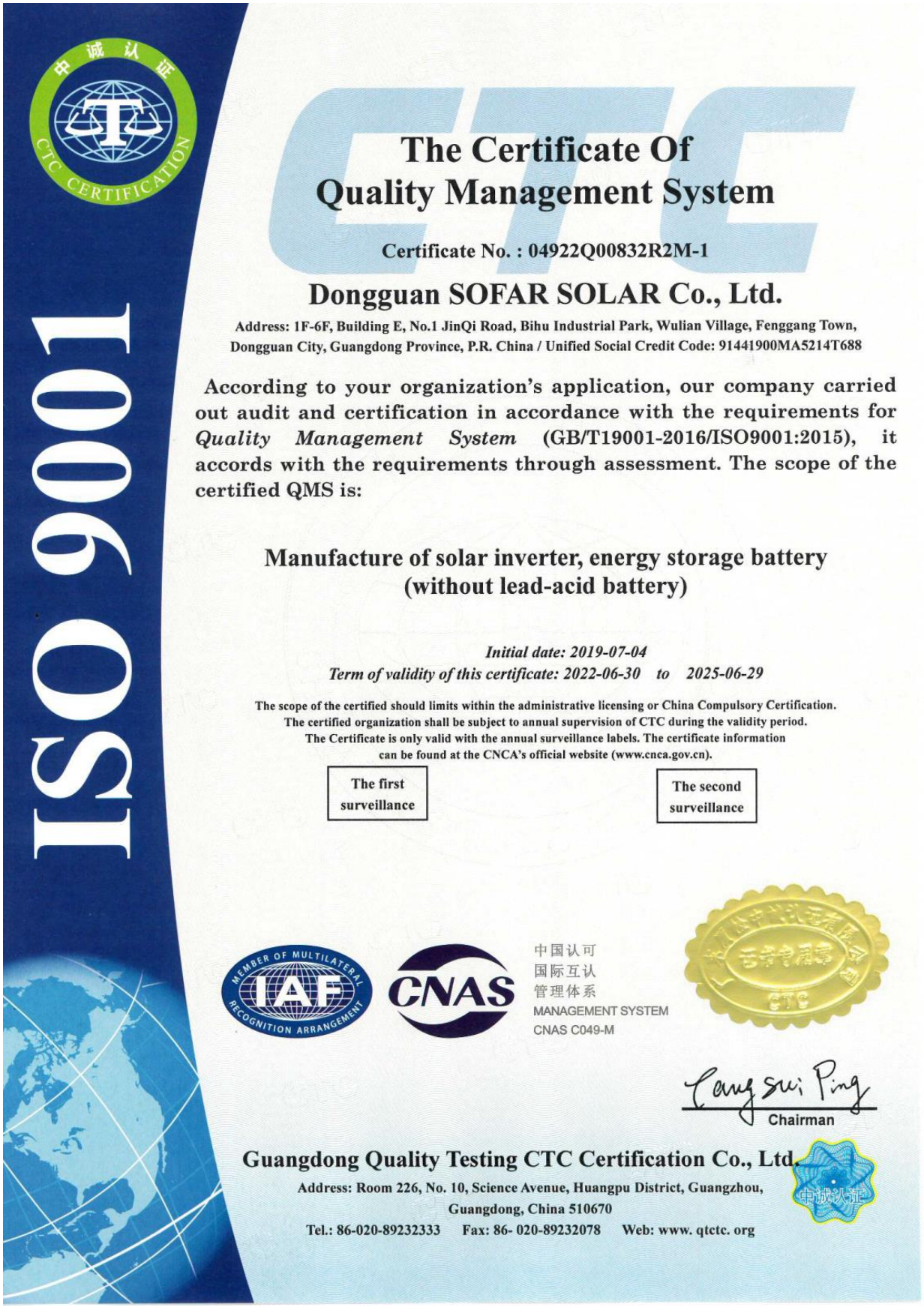
	Contact load	Terminal distance
x=01	10A (NO) / 5A (NC), for single-pole only	3,5mm
x=02	16A (NO) / 8A (NC), for single-pole only	3,5mm
x=03	16A (NO) / 8A (NC), for single-pole only	5,0mm
x=05	5A (NO) / 3A (NC), for double-pole only	5,0mm

TÜV Rheinland
(Guangdong) Ltd.

Sep. 14, 2014 Evan Wu

Date **Name** **Signature**

Annex 5 - ISO 9001 certificate



ISO 9001

The Certificate Of Quality Management System

Certificate No. : 04922Q00832R2M-1

Dongguan SOFAR SOLAR Co., Ltd.

Address: 1F-6F, Building E, No.1 JinQi Road, Bihu Industrial Park, Wulian Village, Fenggang Town, Dongguan City, Guangdong Province, P.R. China / Unified Social Credit Code: 91441900MA5214T688

According to your organization's application, our company carried out audit and certification in accordance with the requirements for *Quality Management System* (GB/T19001-2016/ISO9001:2015), it accords with the requirements through assessment. The scope of the certified QMS is:

Manufacture of solar inverter, energy storage battery (without lead-acid battery)

Initial date: 2019-07-04

Term of validity of this certificate: 2022-06-30 to 2025-06-29

The scope of the certified should limits within the administrative licensing or China Compulsory Certification.
The certified organization shall be subject to annual supervision of CTC during the validity period.
The Certificate is only valid with the annual surveillance labels. The certificate information can be found at the CNCA's official website (www.cnca.gov.cn).

The first surveillance	The second surveillance

中国认可
国际互认
管理体系
MANAGEMENT SYSTEM
CNAS C049-M

Chairman

Guangdong Quality Testing CTC Certification Co., Ltd.

Address: Room 226, No. 10, Science Avenue, Huangpu District, Guangzhou, Guangdong, China 510670

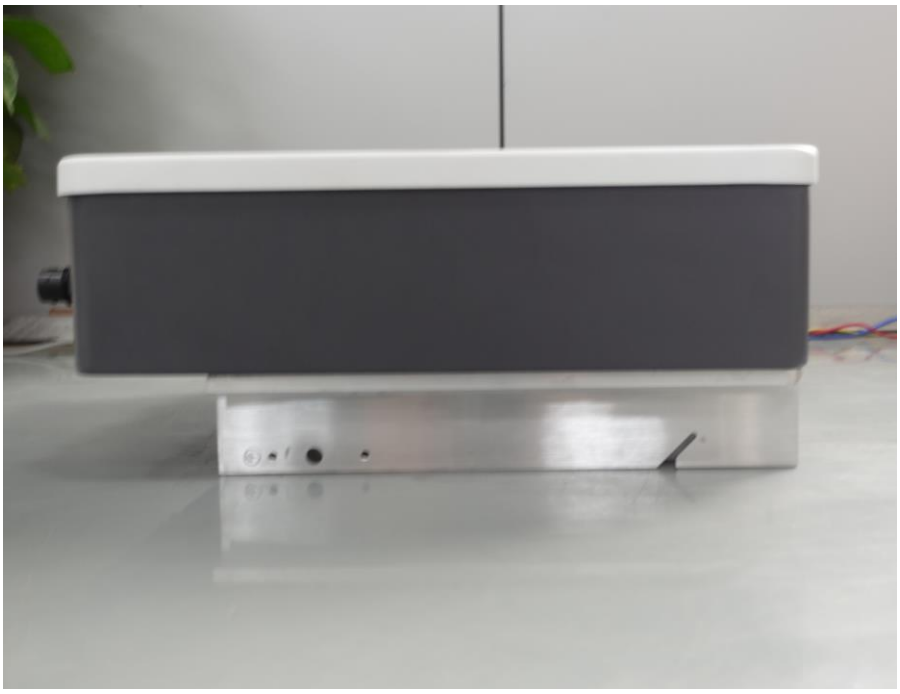
Tel.: 86-020-89232333 Fax: 86- 020-89232078 Web: www. qtctc. org

Annex 6 - Photo of the unit

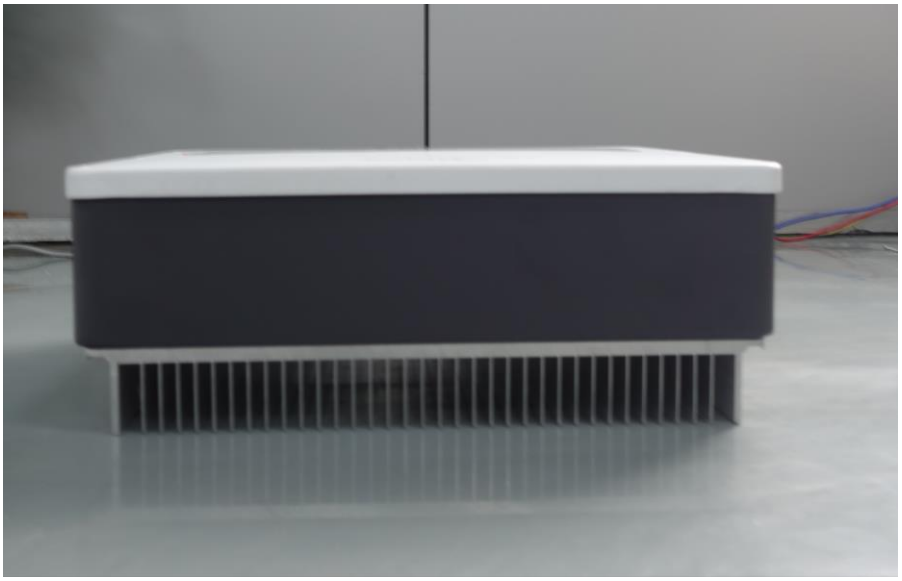
Enclosure front view

Enclosure side view-1

Enclosure side view-2



Enclosure top view



Enclosure bottom view

Enclosure rear view

>>>> End of Test Report <<<<