LYNS-TCi

VERIFICATION OF COMPLIANCE

Verification No.: **HC23100801-EG-NI-V002**

Date of issue: 2023-10-19

Applicant:	**GD Midea Air-Conditioning Equipment Co., Ltd.** Lingang Road, Beijiao, Shunde, Foshan, 528311, Guangdong, China
Device Category:	Inverter
Device Type:	Hybrid (PV with DC coupled Electricity Storage)
PGM categories:	☒ Type A ☐ Type B ☐ Type C ☐ Type D
Model(s):	**EH-3K-A-M0, EH-3.6K-A-M0**
Trademark:	Midea
Technical data:	Product family: EH-3K ~ 3.6K-A-M0 Registered Capacity [kW]: 3.0 ~ 3.68 (For further details see *A.2 Technical data of the Generating Unit(s) on p.2*)
Firmware version:	V000001
Grid connection code:	**Engineering Recommendation G98/NI** Issue 1 April 2019 Requirements for the connection of Fully Type Tested Micro-generators (up to and including 16 A per phase) in parallel with public Low Voltage Distribution Networks in Northern Ireland on or after 27 April 2019
Test report no.:	**HC23100801-EG-NI-002** (2023-10-19)

This verification confirms that the above-mentioned generating unit(s) with corresponding software meet the requirements of the referenced grid connection code at the time the tests were conducted.

LYNS-TCi TECHNOLOGY

Jack Shi

Sr. Project Manager

Release No.: 1.1 (2023)

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Annex to the Verification No.: **HC23100801-EG-NI-V002**

A.1 Revision history of the verification

Revision	Date	Changes	Status
0 (HC23100801-EG-NI-V002)	2023-10-19	Initial issue	Active

A.2 Technical data of the Generating Unit(s)

Model	**EH-3K-A-M0**	**EH-3.6K-A-M0**
DC input (PV)		
Max. DC input voltage [V]	600	
Operating MPPT voltage range [V]	90 ~ 550	
Input DC current [A]	max. 13 / 13	
Battery connection		
Battery voltage range [V]	42 ~ 58	
Battery charging current [A]	max. 75	max. 80
Battery discharging current [A]	max. 75	max. 80
AC connection		
Nominal output AC voltage [V]	230 (L + N + PE, 50/60 Hz)	
Output AC current [A]	max. 15	max. 16
Nominal active output power P_n [kW]	3.0	3.68
Registered Capacity [1] P_{max} [kW]	3.0	3.68
Max. apparent power [kVA]	3.3	3.68

Operating temperature range	-30°C ~ +60°C
Degree of protection	IP65 (according to EN 60529)
Protection class	I (according to IEC 62109-1)
Type of internal transformer	No internal transformer (transformerless)

Firmware version	V000001
Manufacturer	**Dongguan SOFAR SOLAR Co., Ltd.** 1F-6F, Building E, No.1 JinQi Road, Bihu Industrial Park, Wulian Village, Fenggang Town, Dongguan City, Guangdong Province, P.R. China (The manufacturer has provided proof of certification of the quality management system of his production facility in accordance with ISO 9001)

Testing laboratory	**LYNS-TCI TECHNOLOGY GUANGDONG CO., LTD.** Room 1201, Unit 2, Building 18, No. 7, Science and Technology Boulevard, Houjie Town, Dongguan City, Guangdong, 523960, P.R. China (Accredited acc. ISO/IEC 17025: A2LA Accreditation no. 5200.02)
Testing location	Same as above
Date(s) of performance of tests	2023-04-10 - 2023-06-30

Note:

- The Power Park Modules (Generating Units):*EH-3K-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* 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*"

[1] The stated values of "registered capacity" related to single Generating Unit.

- a semi-permanent active power reduction to a value $P_{max} \leqslant 3.496$ 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

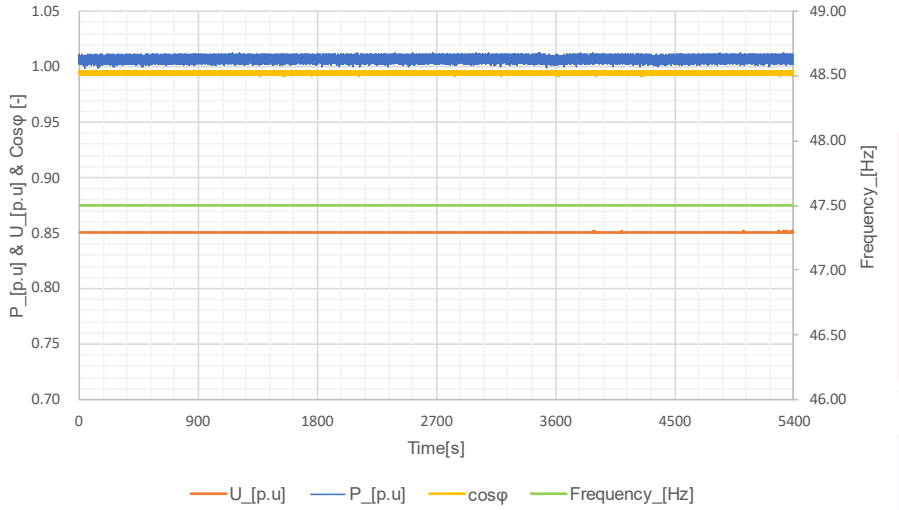
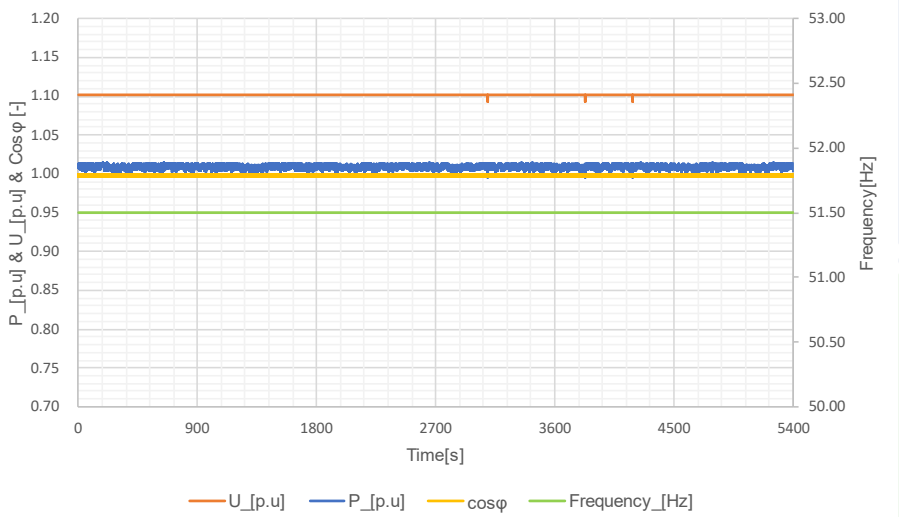
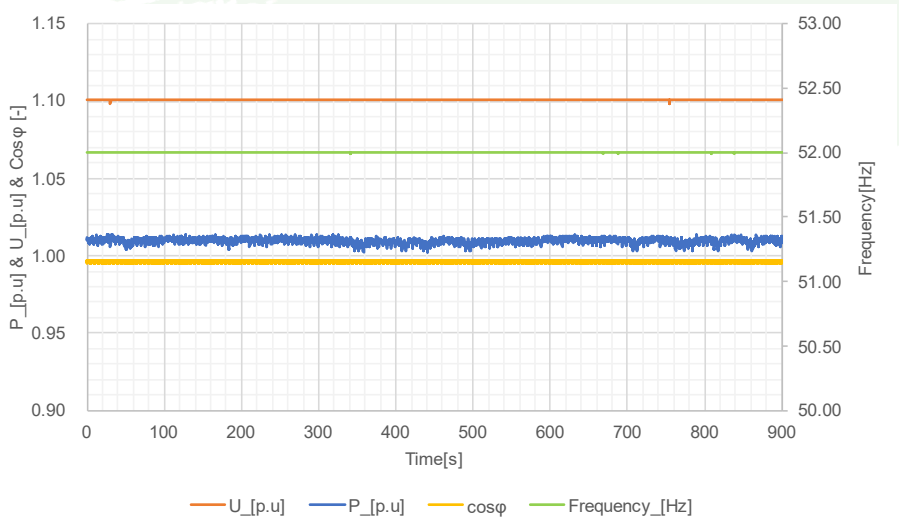
A.3 Extract of the test report no. HC23100801-EG-NI-002 (EREC G98/NI, Form C)

Note:

- The (full) tests were performed on EUT *EH-3K-A-M0*.
- The product was tested on:
  - *EH-3K-A-M0* (full testing)
    - Serial No.: SM2ES230P2K809
    - Hardware version: V001
    - Firmware version: V000001
- According to EREC G98, section 6.3.1 the following applies:
  since the rated power of *EH-3.6K-A-M0*
  is between $1/\sqrt{10} \cdot P_{n,\ EH\text{-}3K\text{-}A\text{-}M0}$ and $2 \cdot P_{n,\ EH\text{-}3K\text{-}A\text{-}M0}$, a family approach to type testing is acceptable.
- A transfer of measurement results from the *EH-3K-A-M0* to other units in the product series according to EREC G98, section 6.3.2 is allowed.
- Technical justification for transferability of measurement results:
  The units in der 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.

  The differences between the units in the product series are documented in detail in the test report no. *HC23100801-EG-NI-002*.

Annex to the Verification No.: **HC23100801-EG-NI-V002**

1. Operating Range	
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. 
Note: The verified operating range of the EH-3K-A-M0 can be applied to other units in the product series directly.	

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2. Power Quality – Harmonics								
Micro-generator tested to BS EN 61000-3-2								
Micro-generator rating per phase (rpp)				3.000		kVA		
For 3-phase Micro-generators, tick this box if harmonic measurements are identical for all three phases. If the harmonics are not identical for each phase, please replicate this section with the results for each phase.				single phases				
Harmonic	At 45-55% of **Registered Capacity**			At 100% of **Registered Capacity**				
	Measured Value (MV) in Amps			Measured Value (MV) in Amps				
Order	L_1	L_2	L_3	L_1	L_2	L_3	Limit in BS EN 61000-3-2 in Amps	Higher limit for odd harmonics 21 and above
2	0.0043	--	--	0.0078	--	--	1.080	
3	0.1317	--	--	0.1783	--	--	2.300	
4	0.0022	--	--	0.0020	--	--	0.430	
5	0.0591	--	--	0.1096	--	--	1.140	
6	0.0025	--	--	0.0020	--	--	0.300	
7	0.0393	--	--	0.0735	--	--	0.770	
8	0.0037	--	--	0.0020	--	--	0.230	
9	0.0241	--	--	0.0473	--	--	0.400	
10	0.0021	--	--	0.0019	--	--	0.184	
11	0.0186	--	--	0.0314	--	--	0.330	
12	0.0022	--	--	0.0018	--	--	0.153	
13	0.0133	--	--	0.0174	--	--	0.210	
14	0.0020	--	--	0.0019	--	--	0.131	
15	0.0142	--	--	0.0161	--	--	0.150	
16	0.0020	--	--	0.0015	--	--	0.115	
17	0.0122	--	--	0.0155	--	--	0.132	
18	0.0014	--	--	0.0016	--	--	0.102	
19	0.0141	--	--	0.0156	--	--	0.118	
20	0.0015	--	--	0.0014	--	--	0.092	
21	0.0140	--	--	0.0111	--	--	0.107	0.160
22	0.0012	--	--	0.0012	--	--	0.084	
23	0.0147	--	--	0.0111	--	--	0.098	0.147
24	0.0011	--	--	0.0012	--	--	0.077	
25	0.0138	--	--	0.0082	--	--	0.090	0.135
26	0.0010	--	--	0.0010	--	--	0.071	
27	0.0149	--	--	0.0095	--	--	0.083	0.124
28	0.0009	--	--	0.0010	--	--	0.066	
29	0.0138	--	--	0.0072	--	--	0.078	0.117
30	0.0009	--	--	0.0009	--	--	0.061	

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Order	L_1	L_2	L_3	L_1	L_2	L_3	Limit in BS EN 61000-3-2 in Amps	Higher limit for odd harmonics 21 and above
31	0.0135	--	--	0.0080	--	--	0.073	0.109
32	0.0009	--	--	0.0009	--	--	0.058	
33	0.0127	--	--	0.0060	--	--	0.068	0.102
34	0.0008	--	--	0.0009	--	--	0.054	
35	0.0127	--	--	0.0071	--	--	0.064	0.096
36	0.0008	--	--	0.0008	--	--	0.051	
37	0.0121	--	--	0.0053	--	--	0.061	0.091
38	0.0007	--	--	0.0008	--	--	0.048	
39	0.0113	--	--	0.0061	--	--	0.058	0.087
40	0.0008	--	--	0.0007	--	--	0.046	

Note:

The percentage harmonics results of the EH-3K-A-M0 can be applied to other units in the product series scaled by the factor $P_{n,\ EH\text{-}3K\text{-}A\text{-}M0}$ / $P_{n,\ \text{unit-not-tested}}$.

(The transferred results are below the required limit values according to BS EN 61000-3-2.)

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3. Power Quality – Voltage fluctuations and Flicker									
Test start date		2023-04 -23			Test end date			2023-04-24	
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	0.214	0.082	0.000	0.198	0.084	0.000	0.023	0.021
	L2	--	--	--	--	--	--	--	--
	L3	--	--	--	--	--	--	--	--
	Overall worst case	0.214	0.082	0.000	0.198	0.084	0.000	0.023	0.021
Measured Values at test impedance	L1	0.214	0.082	0.000	0.198	0.084	0.000	0.023	0.021
	L2	--	--	--	--	--	--	--	--
	L3	--	--	--	--	--	--	--	--
	Overall worst case	0.214	0.082	0.000	0.198	0.084	0.000	0.023	0.021
Measured Values at test impedance	L1	--	--	--	--	--	--	--	--
	L2	--	--	--	--	--	--	--	--
	L3	--	--	--	--	--	--	--	--
	Overall worst case	--	--	--	--	--	--	--	--
Limits set under BS EN 61000-3-3		4	3.3	500 (3.3%)	4	3.3	500 (3.3%)	1.0	0.65

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

* ☐ three-phase **Micro-generators** ☐ split single phase **Micro-generators**

^ ☒ single phase **Micro-generators** ☐ **Micro-generators** using two phases on a three-phase system

Note:

The Flicker results of the EH-3K-A-M0 can be applied to other units in the product series scaled by the factor $P_{n,\ EH\text{-}3K\text{-}A\text{-}M0}$ / $P_{n,\ unit\text{-}not\text{-}tested}$.

(The transferred results (values at test and standard impedance) are below the required limit values according to BS EN 61000-3-3.)

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4. Power Quality – DC injection				
EH-3K-A-M0				
Test power level	20%	50%	75%	100%
Recorded DC value in Amps	0.005	0.010	0.012	0.016
as % of rated AC current	0.038	0.077	0.092	0.123
Limit [%]	0.25	0.25	0.25	0.25
Note: The percentage DC injection of the EH-3K-A-M0 can be considered as worst case results and applied to the EH-3.6K-A-M0 directly. (The transferred results are below the required limit of 0.25%.)				

5. Power Factor				
	Voltage / Test power level	0.94 pu (216.2 V)	1 pu (230 V)	1.1 pu (253 V)
Measured value	20% of **Registered Capacity**	0.989	0.988	0.986
	50% of **Registered Capacity**	0.998	0.998	0.998
	75% of **Registered Capacity**	0.999	0.999	0.999
	100% of **Registered Capacity**	0.999	0.999	0.999
Power Factor Limit	leading	>0.95	>0.95	>0.95
	lagging	>0.98	>0.98	>0.98
Note: The Power Factor results of the EH-3K-A-M0 can be applied to other units in the product series directly.				

6. Protection – Frequency tests						
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	0.524 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	1.000 s	51.8 Hz 120.0 s	No trip occurred
					52.2 Hz 0.98 s	No trip occurred
Note: The measurement results of the EH-3K-A-M0 can be applied to other units in the product series directly.						

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7. Protection – Voltage tests						
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	196.46 V	3.04 s	199.5 V 5.0 s	No trip occurred
U/V stage 2	0.60 pu (138.0 V)	2.0 s	138.95 V	2.06 s	142.0 V 2.5 s	No trip occurred
					134 V 1.98 s	No trip occurred
O/V stage 1	1.10 pu (253.0 V)	0.5 s	252.92 V	0.518 s	249.0 V 5.0 s	No trip occurred
					257.0 V 0.45 s	No trip occurred
Note: The measurement results of the EH-3K-A-M0 can be applied to other units in the product series directly.						

8. Protection – Loss of Mains test						
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]	0.196	0.215	0.263	0.224	0.182	0.300
Trip time limit [s]	0.5					

Protection – Frequency change, Vector Shift Stability test			
	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

Protection – Frequency change, RoCoF Stability test			
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: The measurement results of the EH-3K-A-M0 can be applied to other units in the product series directly.			

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9. Limited Frequency Sensitive Mode – Overfrequency test				
This test should be carried out in accordance with A.1.2.8. The test should be carried out using the specific threshold frequency of 50.4 Hz and **Droop** of 10%. The measurement tolerances are contained in A.1.2.8.				
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	3026	50.00	3300	---
Step b) 50.45Hz ± 0.05Hz	3027	50.25		---
Step c) 50.70Hz ± 0.10Hz	2283	50.70		---
Step d) 51.15Hz ± 0.05Hz	1610	51.15		4.14% [1)]
Step e) 50.70Hz ± 0.10Hz	2283	50.70		---
Step f) 50.45Hz ± 0.05Hz	3028	50.45		4.14% [2)]
Step g) 50.00Hz ± 0.01Hz	3027	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	1530	50.00	1650	---
Step b) 50.45Hz ± 0.05Hz	1532	50.25		---
Step c) 50.70Hz ± 0.10Hz	796	50.70		---
Step d) 51.15Hz ± 0.05Hz	109	51.15		4.09% [1)]
Step e) 50.70Hz ± 0.10Hz	796	50.70		---
Step f) 50.45Hz ± 0.05Hz	1532	50.45		4.09% [2)]
Step g) 50.00Hz ± 0.01Hz	1530	50.00		---
Note: [1)] Droop calculated using frequency and power between steps d) & b) [2)] Droop calculated using frequency and power between steps f) & d) The determined droops of the EH-3K-A-M0 can be applied to other units in the product series directly.				

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10. Power output with falling frequency test			
Test sequence	Measured **Active Power** Output [W]	Frequency [Hz]	Primary power source [W]
Test a) 50 Hz ± 0.01 Hz	3042	50.00	3130
Test b) Point between 49.5 Hz and 49.6 Hz	3042	49.55	3129
Test c) Point between 47.5 Hz and 47.6 Hz	3039	47.55	3127
Note: The measurement results of the EH-3K-A-M0 can be applied to other units in the product series directly.			

11. Protection – Re-connection timer					
Time delay setting	Measured delay	Checks on no reconnection when voltage or frequency is brought to just outside stage 1 limits of table 2.			
60 s	70 s	At 1.16 pu (266.2 V **LV** connection)	At 0.78 pu (180.0 V **LV** connection)	At 47.4 Hz	At 52.1 Hz
Confirmation that the **Micro-generator** does not re-connect.		No reconnection occurred	No reconnection occurred	No reconnection occurred	No reconnection occurred
Note: The measurement results of the EH-3K-A-M0 can be applied to other units in the product series directly.					

12. Fault level contribution		
For **Inverter** output		
Time after fault	Volts	Amps
20 ms	39.6	11.38
100 ms	21.0	0.77
250 ms	20.8	0.44
500 ms	21.3	0.44
Time to trip	0.015	In seconds
Note: The measurement results of the EH-3K-A-M0 can be applied to other units in the product series directly.		

13. Self-Monitoring solid state switching	
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

14. Wiring functional tests	
Confirm that the relevant test schedule is attached (tests to be undertaken at time of commissioning)	N/A

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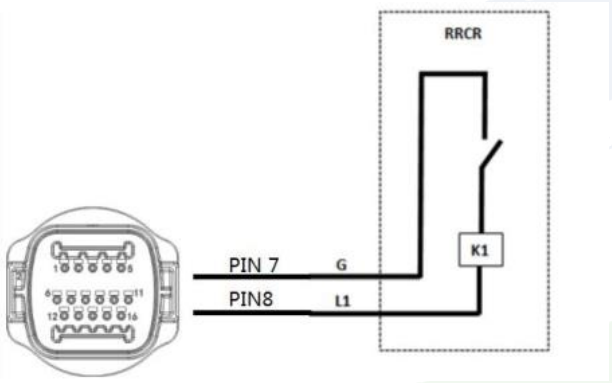
15. Logic interface (input port)	
Confirm that an input port is provided and can be used to shut down the module	Yes
Provide high level description of logic interface, e.g. details in 9.4.3 such as AC or DC signal (the additional comments box below can be used)	Yes For details see “Additional comments.” Below.
Note: The measurement results of the EH-3K-A-M0 can be applied to other units in the product series directly. The high-level description of logic interface applies to the whole product series.	

16. Cyber security	
Confirm that the **Manufacturer** or **Installer** of the **Micro-generator** has provided a statement describing how the **Micro-generator** has been designed to comply with cyber security requirements, as detailed in 9.7.	Yes.
Note: Manufacturer's declaration provided.	

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