Prüfbericht-Nr.: *Test report no.*:	CN24ME52 001	**Auftrags-Nr.:** *Order no.*:	168433866	Seite 1 von 23 *Page 1 of 23*
Kunden-Referenz-Nr.: *Client reference no.:*	2519609	**Auftragsdatum:** *Order date:*	2023.07.04	
Auftraggeber: *Client:*	**Shenzhen Aohai Digital Power Co., Ltd.** 2501, Building 1, Huide Building, North Station Community, MinzhiStreet, Longhua District, Shenzhen Guangdong P.R.China			
Prüfgegenstand: *Test item:*	Hybrid Inverter			
Bezeichnung / Typ-Nr.: *Identification / Type no.:*	AH-3KSL-G2, AH-3.6KSL-G2, AH-4KSL-G2, AH-4.6KSL-G2, AH-5KSL-G2, AH-6KSL-G2			
Auftrags-Inhalt: *Order content*:	AK certificate			
Prüfgrundlage: *Test specification:*	G99/1-9: 2022			

Wareneingangsdatum: *Date of sample receipt:*	2023.07.10
Prüfmuster-Nr.: *Test sample no:*	Engineering sample
Prüfzeitraum: *Testing period:*	2023.07.10 - 2024.01.30
Ort der Prüfung: *Place of testing:*	See page 4
Prüflaboratorium: *Testing laboratory:*	TÜV Rheinland (Shenzhen) Co., Ltd.
Prüfergebnis*: *Test result*:*	Pass

erstellt von: *created by:*		**genehmigt von:** *authorized by*:	
Datum: *Date:* 2024.02.26	Edward Li	**Ausstellungsdatum:** *Issue date:* 2024.02.26	Eric Zeng
Stellung / *Position:*	Project Engineer	**Stellung** / *Position:*	Reviewer

Sonstiges / *Other:*

This report does not evidence compliance of the provided sample with the relevant standards but only with the referred tests. This test report documents the findings of examination conducted on the delivered product mentioned above only. This report does not entitle the applicant to carry any safety mark on this or similar products. Further for sales or other application purposes of the tested product, any reference to TÜV Rheinland or a test through TÜV Rheinland is only permissible with prior written consent of TÜV Rheinland.

Zustand des Prüfgegenstandes bei Anlieferung: Prüfmuster vollständig und unbeschädigt
Condition of the test item at delivery: *Test item complete and undamaged*

* Legende:	P(ass) = entspricht o.g. Prüfgrundlage(n)	F(ail) = entspricht nicht o.g. Prüfgrundlage(n)	N/A = nicht anwendbar	N/T = nicht getestet
* *Legend:*	*P(ass) = passed a.m. test specification(s)*	*F(ail) = failed a.m. test specification(s)*	*N/A = not applicable*	*N/T = not tested*

Anmerkungen
Remarks

1	Alle eingesetzten Prüfmittel waren zum angegebenen Prüfzeitraum gemäß eines festgelegten Kalibrierungsprogramms unseres Prüfhauses kalibriert. Sie entsprechen den in den Prüfprogrammen hinterlegten Anforderungen. Die Rückverfolgbarkeit der eingesetzten Prüfmittel ist durch die Einhaltung der Regelungen unseres Managementsystems gegeben. Detaillierte Informationen bezüglich Prüfkonditionen, Prüfequipment und Messunsicherheiten sind im Prüflabor vorhanden und können auf Wunsch bereitgestellt werden. *The equipment used during the specified testing period was calibrated according to our test laboratory calibration program. The equipment fulfils the requirements included in the relevant standards. The traceability of the test equipment used is ensured by compliance with the regulations of our management system.* *Detailed information regarding test conditions, equipment and measurement uncertainty is available in the test laboratory and could be provided on request.*
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3	Prüfklausel mit der Note * wurden an qualifizierte Unterauftragnehmer vergeben und sind unter der jeweiligen Prüfklausel des Berichts beschrieben. Abweichungen von Prüfspezifikation(en) oder Kundenanforderungen sind in der jeweiligen Prüfklausel im Bericht aufgeführt. *Test clauses with remark of * are subcontracted to qualified subcontractors and descripted under the respective test clause in the report.* *Deviations of testing specification(s) or customer requirements are listed in specific test clause in the report.*
4	Die Entscheidungsregel für Konformitätserklärungen basierend auf numerischen Messergebnisen in diesem Prüfbericht basiert auf der "Null-Grenzwert-Regel" und der "Einfachen Akzeptanz" gemäß ILAC G8:2019 und IEC Guide 115:2021, es sei denn, in der auf Seite 1 dieses Berichts genannten angewandten Norm ist etwas anderes festgelegt oder vom Kunden gewünscht. Dies bedeutet, dass die Messunsicherheit nicht berücksichtigt wird und daher auch nicht im Prüfbericht angegeben wird. Zu weiteren Informationen bezueglich des Risikos durch diese Entscheidungsregel siehe ILAC G8:2019. *The decision rule for statements of conformity, based on numerical measurement results, in this test report is based on the "Zero Guard Band Rule" and "Simple Acceptance" in accordance with ILAC G8:2019 and IEC Guide 115:2021, unless otherwise specified in the applied standard mentioned on Page 1 of this report or requested by the customer. This means that measurement uncertainty is not taken in account and hence also not declared in the test report. For additional information to the resulting risk based of this decision rule please refer to ILAC G8:2019.*

TEST REPORT
Engineering recommendation G99/1-9
Recommendation for the connection of the generation equipment in parallel with public distribution network

Report Reference No..... :	See cover page	
Tested by (name + signature) ..... :	See cover page	.....
Witnessed by (name + signature) . :	See cover page	.....
Supervised by (name + signature) :	See cover page	.....
Approved by (name + signature) .. :	See cover page	.....
Date of issue..... :	See cover page	
Testing Laboratory..... :	TÜV Rheinland (Shenzhen) Co., Ltd.	
Address..... :	1601-1604, 17-18F, Tower A Building 2, Shenzhen International Innovation Valley, Dashi 1st Road, Xili Street, Xili Community, Nanshan District, Shenzhen 518052, P. R. China	
Testing location/ address ..... :	Dongguan Aohai Technology Co., Ltd. No.2, Yinyuan Street, Jiaoyitang, Tangxia Town, Dongguan, Guangdong P.R. China	
Applicant's name ..... :	See cover page	
Address..... :	See cover page	
Test specification:		
Standard ..... :	G99/1-9: 2022	
Non-standard test method.....:	N/A	
Test Report Form No..... :	TRF_G99/1-9: 2022	
Test Report Form(s) Originator .... :	TÜV Rheinland Group	
Master TRF..... :	2022	
Test item description ..... :	Hybrid Inverter	
Trade Mark..... :	AOHAI	
Manufacturer..... :	Same as applicant	
Model/Type reference..... :	See cover page	
Ratings.....:	See model list	

List of Attachments (including a total number of pages in each attachment):

1. ATTACHMENT 1 – G99/1-9: 2022 test data
2. ATTACHMENT 2 – Photo documentation

Summary of testing:

Tests performed (name of test and test clause):

Clause		Test description
☒	12.2.1	Operating Range
☒	A7.1.1	Interface switch (Functional safety)
☒	A7.1.2.2	Over / Under Voltage
☒	A7.1.2.3	Over / Under Frequency
☒	A7.1.2.4	Loss of mains protection according BS EN 62116
☒	A7.1.2.5	Re-connection
☒	A7.1.2.6	Frequency Drift and Step change Stability test
☒	A.7.1.3	Limited Frequency Sensitive Mode – Over (LFSM-O)
☒	A7.1.4.1	Harmonic Current Emissions
☒	A7.1.4.2	Power factor
☒	A7.1.4.3	Voltage Flicker
☒	A7.1.4.4	DC injection
☒	A7.1.5	Short circuit Current Contribution
☐	A7.1.6	Self-Monitoring - Solid State Disconnection

Testing location:

See page 3

Copy of marking plate:

AOHAI

Model: AH-3KSL-G2

PV input	
Max. PV input power	6000Wp
Max. PV input voltage	550 d.c.V
MPP voltage range	90-550 d.c.V
Max. PV input current	16 d.c.A*2
Isc PV(absolute maximum)	20 d.c.A*2
Battery input	
Rated battery voltage	52 d.c.V
Battery voltage range	42-59 d.c.V
Max. battery charge / discharge current	66.7A/66.7A
Battery type	Li-ion
Grid output	
Rated grid voltage	230 a.c.V
Rated grid frequency	50Hz/60Hz
Rated grid output active power	3000 W
Rated grid output apparent power	3000 VA
Max. grid output apparent power	3000 VA
Max. grid output current	16 a.c.A
Grid input	
Rated grid voltage	230 a.c.V
Rated grid frequency	50Hz/60Hz
Rated grid input apparent power	3000 VA
Max. grid input apparent power	3000 VA
Max. grid input current	16 a.c.A
EPS output	
Rated output voltage	230 a.c.V
Rated output frequency	50Hz/60Hz
Rated output apparent power	3000 VA
Max. output apparent power	3600 VA
Max. output current	16 a.c.A
General information	
Adjustable cos(φ)	0.8ind...0.8cap
Operating temperature range	-25...+60°C
Inverter topology	Non-Isolated
Ingress protection	IP65
Protective class	I
Over voltage category	II(PV), III((MAINS)

Bar code area

AOHAI

Model: AH-3.6KSL-G2

PV input	
Max. PV input power	7200Wp
Max. PV input voltage	550 d.c.V
MPP voltage range	90-550 d.c.V
Max. PV input current	16 d.c.A*2
Isc PV(absolute maximum)	20 d.c.A*2
Battery input	
Rated battery voltage	52 d.c.V
Battery voltage range	42-59 d.c.V
Max. battery charge / discharge current	80A/80A
Battery type	Li-ion
Grid output	
Rated grid voltage	230 a.c.V
Rated grid frequency	50Hz/60Hz
Rated grid output active power	3600 W
Rated grid output apparent power	3600VA
Max. grid output apparent power	3600 VA
Max. grid output current	16 a.c.A
Grid input	
Rated grid voltage	230 a.c.V
Rated grid frequency	50Hz/60Hz
Rated grid input apparent power	3600 VA
Max. grid input apparent power	3600 VA
Max. grid input current	16 a.c.A
EPS output	
Rated output voltage	230 a.c.V
Rated output frequency	50Hz/60Hz
Rated output apparent power	3600 VA
Max. output apparent power	4320 VA
Max. output current	16 a.c.A
General information	
Adjustable cos(φ)	0.8ind...0.8cap
Operating temperature range	-25...+60°C
Inverter topology	Non-Isolated
Ingress protection	IP65
Protective class	I
Over voltage category	II(PV), III((MAINS)

Bar code area

AOHAI

Model: AH-4KSL-G2

PV input	
Max. PV input power	8000Wp
Max. PV input voltage	550 d.c.V
MPP voltage range	90-550 d.c.V
Max. PV input current	16 d.c.A*2
Isc PV(absolute maximum)	20 d.c.A*2
Battery input	
Rated battery voltage	52 d.c.V
Battery voltage range	42-59 d.c.V
Max. battery charge / discharge current	87A/87A
Battery type	Li-ion
Grid output	
Rated grid voltage	230 a.c.V
Rated grid frequency	50Hz/60Hz
Rated grid output active power	4000 W
Rated grid output apparent power	4000 VA
Max. grid output apparent power	4000 VA
Max. grid output current	22 a.c.A
Grid input	
Rated grid voltage	230 a.c.V
Rated grid frequency	50Hz/60Hz
Rated grid input apparent power	4000 VA
Max. grid input apparent power	4000 VA
Max. grid input current	22 a.c.A
EPS output	
Rated output voltage	230 a.c.V
Rated output frequency	50Hz/60Hz
Rated output apparent power	4000 VA
Max. output apparent power	4800 VA
Max. output current	22 a.c.A
General information	
Adjustable cos(ϕ)	0.8ind...0.8cap
Operating temperature range	-25...+60°C
Inverter topology	Non-Isolated
Ingress protection	IP65
Protective class	I
Over voltage category	II(PV), III((MAINS)

Bar code area

AOHAI

Model: AH-4.6KSL-G2

PV input	
Max. PV input power	9200Wp
Max. PV input voltage	550 d.c.V
MPP voltage range	90-550 d.c.V
Max. PV input current	16 d.c.A*2
Isc PV(absolute maximum)	20 d.c.A*2
Battery input	
Rated battery voltage	52 d.c.V
Battery voltage range	42-59 d.c.V
Max. battery charge / discharge current	100A/100A
Battery type	Li-ion
Grid output	
Rated grid voltage	230 a.c.V
Rated grid frequency	50Hz/60Hz
Rated grid output active power	4600 W
Rated grid output apparent power	4600 VA
Max. grid output apparent power	4600 VA
Max. grid output current	22 a.c.A
Grid input	
Rated grid voltage	230 a.c.V
Rated grid frequency	50Hz/60Hz
Rated grid input apparent power	4600 VA
Max. grid input apparent power	4600 VA
Max. grid input current	22 a.c.A
EPS output	
Rated output voltage	230 a.c.V
Rated output frequency	50Hz/60Hz
Rated output apparent power	4600 VA
Max. output apparent power	5520 VA
Max. output current	22 a.c.A
General information	
Adjustable cos(ϕ)	0.8ind...0.8cap
Operating temperature range	-25...+60°C
Inverter topology	Non-Isolated
Ingress protection	IP65
Protective class	I
Over voltage category	II(PV), III((MAINS)

Bar code area

AOHAI

Model: AH-5KSL-G2

PV input	
Max. PV input power	10000Wp
Max. PV input voltage	550 d.c.V
MPP voltage range	90-550 d.c.V
Max. PV input current	16 d.c.A*2
Isc PV(absolute maximum)	20 d.c.A*2
Battery input	
Rated battery voltage	52 d.c.V
Battery voltage range	42-59 d.c.V
Max. battery charge / discharge current	100A/100A
Battery type	Li-ion
Grid output	
Rated grid voltage	230 a.c.V
Rated grid frequency	50Hz/60Hz
Rated grid output active power	5000 W
Rated grid output apparent power	5000 VA
Max. grid output apparent power	5000 VA
Max. grid output current	27 a.c.A
Grid input	
Rated grid voltage	230 a.c.V
Rated grid frequency	50Hz/60Hz
Rated grid input apparent power	5000 VA
Max. grid input apparent power	5000 VA
Max. grid input current	27 a.c.A
EPS output	
Rated output voltage	230 a.c.V
Rated output frequency	50Hz/60Hz
Rated output apparent power	5000 VA
Max. output apparent power	6000 VA
Max. output current	27 a.c.A
General information	
Adjustable cos(ϕ)	0.8ind...0.8cap
Operating temperature range	-25...+60°C
Inverter topology	Non-Isolated
Ingress protection	IP65
Protective class	I
Over voltage category	II(PV), III((MAINS)

Bar code area

AOHAI

Model: AH-6KSL-G2

PV input	
Max. PV input power	10800Wp
Max. PV input voltage	550 d.c.V
MPP voltage range	90-550 d.c.V
Max. PV input current	16 d.c.A*2
Isc PV(absolute maximum)	20 d.c.A*2
Battery input	
Rated battery voltage	52 d.c.V
Battery voltage range	42-59 d.c.V
Max. battery charge / discharge current	120/120 d.c.A
Battery type	Li-ion
Grid output	
Rated grid voltage	230 a.c.V
Rated grid frequency	50Hz/60Hz
Rated grid output active power	6000 W
Rated grid output apparent power	6000 VA
Max. grid output apparent power	6000 VA
Max. grid output current	27 a.c.A
Grid input	
Rated grid voltage	230 a.c.V
Rated grid frequency	50Hz/60Hz
Rated grid input apparent power	6000 VA
Max. grid input apparent power	6000 VA
Max. grid input current	27 a.c.A
EPS output	
Rated output voltage	230 a.c.V
Rated output frequency	50Hz/60Hz
Rated output apparent power	6000 VA
Max. output apparent power	6000 VA
Max. output current	27 a.c.A
General information	
Adjustable cos(ϕ)	0.8ind...0.8cap
Operating temperature range	-25...+60°C
Inverter topology	Non-Isolated
Ingress protection	IP65
Protective class	I
Over voltage category	II(PV), III((MAINS)

Bar code area

Test item particulars:	
Equipment mobility:	☐ movable ☐ hand-held ☐ stationary ☒ fixed ☐ transportable ☐ for building-in
Connection to the mains:	☐ pluggable equipment ☐ direct plug-in ☒ permanent connection ☐ for building-in
Enviromental category:	☒ outdoor ☐ indoor unconditional ☐ indoor conditional
Over voltage category Mains:	☐ OVC I ☐ OVC II ☒ OVC III ☐ OVC IV
Over voltage category PV:	☐ OVC I ☒ OVC II ☐ OVC III ☐ OVC IV
Mains supply tolerance (%):	N/A
Tested for power systems:	TN
IT testing, phase-phase voltage (V):	- - -
Class of equipment:	☒ Class I ☐ Class II ☐ Class III ☐ Not classified
Mass of equipment (kg):	See model list
Pollution degree:	☐ PD 1 ☐ PD 2 ☒ PD 3 (internal reduced to PD 2)
IP protection class:	IP65
:	

Testing

Date of receipt of test item(s):	See cover page
Dates tests performed:	See cover page

Possible test case verdicts:

– test case does not apply to the test object:	N/A
– test object does meet the requirement:	Pass (P)
– test object was not evaluated for the requirement:	N/E
– test object does not meet the requirement:	Fail (F)

General remarks:

"(see Attachment #)" refers to additional information appended to the report.
"(see appended table)" refers to a table appended to the report.
The tests results presented in this report relate only to the object tested.
This report shall not be reproduced except in full without the written approval of the testing laboratory.
List of test equipment must be kept on file and available for review.
Additional test data and/or information provided in the attachments to this report.
Throughout this report a ☐ comma / ☒ point is used as the decimal separator.

Manufacturer's Declaration per sub-clause 6.2.5 of IECEE 02:

The application for obtaining a CB Test Certificate includes more than one factory location and a declaration from the Manufacturer stating that the sample(s) submitted for evaluation is (are) representative of the products from each factory has been provided:	☐ Yes ☒ Not applicable

When differences exist; they shall be identified in the General product information section.

Name and address of factory (ies):	Dongguan Aohai Technology Co., Ltd. Second Branch No. 2, Yinyuan Street, Jiaoyitang, Tangxia Town, Dongguan, P.R. China, 523723

General product information:

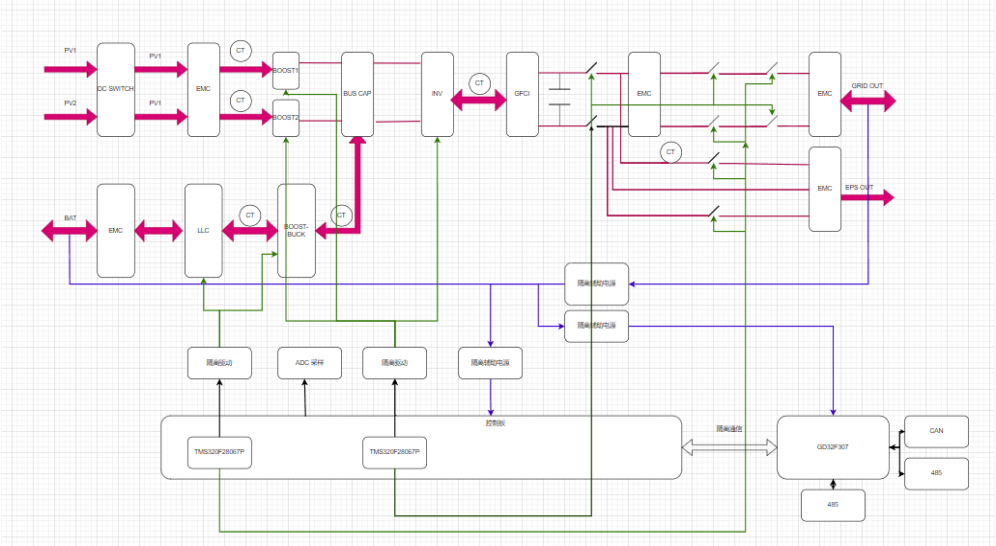
The PCEs under test are singel phase ESS inverter which utilizes the advanced power electronics conversion components such as MOSFET, IGBT to convert the variable DC power generated from the photovoltaic (PV) arrays and batteries to the stable utility AC power, which can also be fed into the commercial electrical grid. The battery port is able to be charged by the energy from either PV port or AC grid port and isolated via transformer. The PCEs under test is also able to work in stand-alone mode while the grid voltage is not present.

They are included communication ports RS485 and CAN which are connected to the upper computer or network to monitor the status of the inverter by proprietary software. The power of communication board was derived from main board via insulation transformer, which was complied with the requirement of reinforced insulation.

Earthing is provided by dedicated earthing terminals. Grid is protected combination with a two series of relays for each phase conductor as redundant build for ensure the inverter can independent disconnected from gird while a relay was fault.

During fault condition defined in this standard, after the DSP receives the abnormal signal from the relevant protective detection circuit, the relays will operate to disconnect the inverter active lines from grid automatically.

The topology diagram as following:



Block diagram

Models differences:

This report includes 6 models, AH-3KSL-G2, AH-3.6KSL-G2, AH-4KSL-G2, AH-4.6KSL-G2, AH-5KSL-G2, AH-6KSL-G2. All models have identical mechanical and electrical construction except some parameter of the software architecture which was used to control the max output power

Table 1 Model List:

MODELS LIST		AH-3KSL-G2	AH-3.6KSL-G2	AH-4KSL-G2
PV INPUT	$V_{MAX\ PV}$ [Vdc]	550		
	$I_{SC\ PV}$ [A]	20/20		
	MPPT Voltage Range V_{MPP} [Vdc]	90~550		

	Full load MPP Voltage Range V_{MPP} [Vdc]	200~500		
	Max. Input Current I_{MAX} [A]	16/16		
	No.of MPPT trackers	2		
	Overvoltage Category (OVC)	II		
AC INPUT	Rated Input Voltage [Vac]	230V		
	Rated Input Frequency F_n [Hz]	50/60		
	Max. Input Current I_{max} [A]	16		22
BATTERY	Rated input voltage [V]	52		
	Input voltage range [V]	42~59		
	Max. charge/dischargecurrent [A]	66.7	80	87
	Battery Type	Li-ion or Lead-acid		
AC OUTPUT	Rated Output Voltage [Vac]	220/230		
	Rated Output Frequency F_n [Hz]	50/60		
	Rated Active Power P_n [W]	3000	3600	4000
	Max. Active Power P_{Emax} [W]	3000	3600	4000
	Rated Apparent power S_n [VA]	3000	3600	4000
	Max. Apparent power S_{Emax} [VA]	3000	3600	4000
	Max. Output Current I_{max} [A]	16		22
	Power Factor Range cosφ [λ]	0.80un…0.80ov		
	Overvoltage Category (OVC)	III		
SYSTEM	Hardware version	AH-6KSL-G2-00C		
	Software version	BA1.0		
	Type of inverter	Non-isolated		
	Type of NS Protection	Integrated		

	Noise emission (dB)	25		
	Protective Class	Class I		
	Enclosure Protection (IP)	IP65		
	Operating Temperature Range [°C]	-25 to +60		
	Pollution degree (PD)	PD3(External), PD2(Internal)		
	Altitude [m]	4000		
	Size [mm] Width* Height*Depth	550*500*186		
	Weight [kg]	29		
MODELS LIST		AH-4.6KSL-G2	AH-5KSL-G2	AH-6KSL-G2
PV INPUT	$V_{MAX\ PV}$ [Vdc]	550		
	$I_{SC\ PV}$ [A]	20/20		
	MPPT Voltage Range V_{MPP} [Vdc]	90~550		
	Full load MPP Voltage Range V_{MPP} [Vdc]	200~500		
	Max. Input Current I_{MAX} [A]	16/16		
	No.of MPPT trackers	2		
	Overvoltage Category (OVC)	II		
AC INPUT	Rated Input Voltage [Vac]	230V		
	Rated Input Frequency F_n [Hz]	50/60		
	Max. Input Current I_{max} [A]	22	27	
BATTERY	Rated input voltage [V]	52		
	Input voltage range [V]	42~59		
	Max. charge/dischargecurrent [A]	100		120
	Battery Type	Li-ion or Lead-acid		
AC	Rated Output Voltage [Vac]	220/230		

	Rated Output Frequency F_n [Hz]	50/60		
	Rated Active Power P_n [W]	4600	5000	6000
	Max. Active Power P_{Emax} [W]	4600	5000	6000
	Rated Apparent power S_n [VA]	4600	5000	6000
	Max. Apparent power S_{Emax} [VA]	4600	5000	6000
	Max. Output Current I_{max} [A]	22	27	
	Power Factor Range cosφ [λ]	0.80un…0.80ov		
	Overvoltage Category (OVC)	III		
SYSTEM	Hardware version	AH-6KSL-G2-00C		
	Software version	BA1.0		
	Type of inverter	Non-isolated		
	Type of NS Protection	Integrated		
	Noise emission (dB)	25		
	Protective Class	Class I		
	Enclosure Protection (IP)	IP65		
	Operating Temperature Range [ºC]	-25 to +60		
	Pollution degree (PD)	PD3(External), PD2(Internal)		
	Altitude [m]	4000		
	Size [mm] Width* Height*Depth	550*500*186		
	Weight [kg]	29		

Engineering recommendation G99/1-9			
Clause	**Requirement – Test**	**Result – Remark**	**Verdict**
A.7	**Requirements for Type Testing Power Generating Modules**		
A.7.1.1	**Certification & Type Testing Generating Unit Requirements** A.7.1 can apply to Power Park Modules or to individual Inverters and/or Generating Units if the functionality is included in each unit of a Power Park Module. Within this Section A.7.1 the term Power Park Module will be used but its meaning can be interpreted within A.7.1 to mean Power Park Module, Generating Unit or Inverter as appropriate. A.7.1 describes a methodology for obtaining type certification or type verification for a Power Park Module containing an Inverter. Typically, all interface functions are contained within the Inverter and in such cases it is only necessary to have the Inverter Type Tested. Alternatively, a package of specific separate parts of equivalent function may also be Type Tested. The Interface Protection shall satisfy the requirements of all of the following standards. Where these standards have more than one part, the requirements of all such parts shall be satisfied, so far as they are applicable. BS EN 61000 (Electromagnetic Standards) BS EN 60255 (Electrical Relays) BS EN 61810 (Electrical Elementary Relays) BS EN 60947 (Low Voltage Switchgear and Control gear) BS EN 61869 (Instrument Transformers: Additional requirements for current transformers) Currently there are no harmonised functional standards that apply to the Power Park Module's Interface Protection.	Considered	**P**
A.7.1.2	**Type Verification Functional Testing of the Interface Protection** Type Testing is the responsibility of the Manufacturer. This test will verify that the operation of the Power Park Module Interface Protection shall result: a) in the safe disconnection of the Power Park Module from the DNO's Distribution Network in the event that system	Considered	**P**

Engineering recommendation G99/1-9			
Clause	**Requirement – Test**	**Result – Remark**	**Verdict**
	parameters exceed the protection settings specified in Table 10.1; and b) in the Power Park Module remaining connected to the DNO's Distribution Network while Distribution Network conditions are: (1) within the envelope specified by the settings plus and minus the tolerances specified for equipment operation in Table 10.1; and (2) within the trip delay settings specified in Table 10.1.		
A.7.1.2.1	**Disconnection times** The minimum trip time delay settings, for over / under voltage, over / under frequency and loss of mains tests below, are presented in Table 10.1. For over / under voltage, over / under frequency and loss of mains tests, reconnection shall be checked as detailed below.	Test results see appended table.	**P**
A.7.1.2.2	**Over / Under Voltage** The Power Park Module shall be tested by operating in parallel with a variable AC test supply, see Figure A.7.1. Correct protection and ride-through operation shall be confirmed during operation of the Power Park Module. The set points for over and under voltage at which the Power Park Module disconnects from the supply will be established by varying the AC supply voltage.	Test results see appended table.	**P**
A.7.1.2.3	**Over / Under Frequency** The Power Park Module shall be tested by operating in parallel with a low impedance, variable frequency test supply system, see Figure A.7.2. Correct protection and ride-through operation should be confirmed during operation of the Power Park Module . The set points for over and under frequency at which the Power Park Module system disconnects from the supply will be established by varying the test supply frequency.	Test results see appended table.	**P**
A.7.1.2.4	**Loss of Mains Protection** The tests should be carried out in accordance with BS EN 62116 and a subset of results should be recorded as indicated in the Protection – loss of mains	Test results see appended table.	**P**

Engineering recommendation G99/1-9			
Clause	**Requirement – Test**	**Result – Remark**	**Verdict**
	test section of Annex A.2-3 Type Test Verification Report. Multi phase Power Park Modules should be operated at part load while connected to a network running at about 50 Hz and one phase only shall be disconnected with no disturbance to the other phases. The Power Park Module should trip within 1 s. The test needs to be repeated with each phase disconnected in turn while the other two phases remain in operation and the results recorded in the Type Test declaration.		
A.7.1.2.5	**Re-connection** Further tests will be carried out with the three test circuits above to check the Power Park Module time out feature prior to automatic network reconnection. This test will confirm that once the AC supply voltage and frequency have returned to be within the stage 1 settings specified in Table 1 following an automatic protection trip operation there is a minimum time delay of 20 s before the Power Park Module output is restored (ie before the Power Park Module automatically reconnects to the Distribution Network).	Test results see appended table.	**P**
A.7.1.2.6	**Frequency Drift and Step Change Stability test.** The tests will be carried out using the same circuit as specified in A.7.1.2.3 above and following confirmation that the Power Park Module has passed the under and over frequency trip tests and the under and over frequency stability tests.	Test results see appended table.	**P**
A.7.1.3	**Limited Frequency Sensitive Mode – Over (LFSM-O)** There are two possible approaches to demonstrating LFSM-O. The first to use the test set up of Figure A.7.2. The second approach can be used where it is possible to inject a frequency control signal into the Power Generating Module. The Manufacturer or Generator can choose which is the more appropriate test for the Power Generating Module.	Test results see appended table.	**P**

Engineering recommendation G99/1-9			
Clause	**Requirement – Test**	**Result – Remark**	**Verdict**
	The Power Park Module should be tested at the following frequencies: Step a) 50.00 Hz ±0.01 Hz Step b) 50.45 Hz ±0.05 Hz Step c) 50.70 Hz ±0.10 Hz Step d) 51.15 Hz ±0.05 Hz Step e) 50.70 Hz ±0.10 Hz Step f) 50.45 Hz ±0.05 Hz Step g) 50.00 Hz ±0.01 Hz The frequency at each step should be maintained for at least one minute and the Active Power reduction in the form of a gradient determined and assessed for compliance with paragraph 11.2.3		
A.7.1.4	**Power Quality**		**P**
A.7.1.4.1	**Harmonics** The tests should be carried out as specified in BS EN 61000-3-12 and can be undertaken with a fixed source of energy at two power levels firstly between 45 and 55% and at 100% of Registered Capacity.	Test results see appended table.	**P**
A.7.1.4.2	**Power Factor** The test set up shall be such that the Power Park Module supplies full load to the DNO's Distribution Network via the Power Factor (pf) meter and the variac as shown below in Figure A.7.3. The Power Park Module Power Factor should be within the limits given in paragraph 11.1.5, for three test voltages 0.94 pu, 1 pu V14 and 1.1 pu V	Test results see appended table.	**P**
A.7.1.4.3	**Voltage Flicker** The voltage fluctuations and flicker emissions from the Power Park Module shall be measured in accordance with BS EN 61000-3-11 and the technology specific Annex A.7.3. The required maximum supply impedance should be calculated and recorded in the relevant part of Compliance Verification Report Appendix A.2 (Form A2-3)	Test results see appended table.	**P**
A.7.1.4.4	**DC Injection** The level of DC injection from the Power Park Module -connected prime mover	Test results see appended table.	**P**

Engineering recommendation G99/1-9			
Clause	**Requirement – Test**	**Result – Remark**	**Verdict**
	in to the DNO's Distribution Network shall not exceed the levels specified in 9.4.5 when measured during operation at three levels, 10%, 55% and 100% of rating with a tolerance of ±5%. The DC injection requirements can be satisfied by the installation of an isolation transformer on the AC side of an Inverter-connected Power Park Module. A declaration that an isolating transformer is fitted can be made in lieu of the tests noted above.		
A.7.1.5	**Short Circuit Current Contribution** Power Park Module connected Power Generating Module's generally have small short circuit fault contributions however DNOs need to understand the contribution that they make to system fault levels in order to determine that they can continue to safely operate without exceeding design fault levels for switchgear and other circuit components.	Test results see appended table.	**P**
A.7.1.6	**Self-Monitoring - Solid State Disconnection** Some Power Park Modules include solid state switching devices to disconnect from the DNO's Distribution Network. In this case paragraph 9.7.9 requires the control equipment to monitor the output stage of the Power Park Module to ensure that in the event of a protection initiated trip the output voltage is either disconnected completely or reduced to a value below 50 V AC. This shall be verified either by self-certification by the Manufacturer, or additional material shall be presented to the tester sufficient to allow an assessment to be made.	Test results see appended table.	**P**
A.7.1.7	**Power Park Modules which include Electricity Storage** This paragraph provides a method for demonstrating compliance with the optional performance characteristic as discussed in the foreword. The tests shall be carried out to demonstrate how the Power Park Module Active Power when acting as a load (ie replenishing its energy store) responds to changes in system frequency.	Test results see appended table.	**P**

Engineering recommendation G99/1-9			
Clause	**Requirement – Test**	**Result – Remark**	**Verdict**
	In general, four tests are proposed, one set of two at Rated Import Capacity, and one set of two at 40% of Rated Import Capacity. In both cases the test is to reduce frequency from 50 Hz at 2 Hzs-1. In the first case the lower frequency reached will be 49.0 Hz and the second case the lower frequency will be 48.8 Hz. In all cases the response shall meet the requirements of 11.2.3.3.		
A.7.2	**Synchronous Power Generating Module Requirements (up to and including 50 kW)**		
A.7.2.1	**Certification & Type Testing Generating Unit Requirements** This Annex describes a methodology for obtaining type certification or type verification for a Synchronous Power Generating Module in conjunction with Form A2-1. Other compliance requirements are detailed in Form A2-2 which may be used as an alternative to this Annex. The Interface Protection of the Synchronous Power Generating Module shall satisfy the requirements of all of the following standards. Where these standards have more than one part, the requirements of all such parts shall be satisfied, so far as they are applicable. • BS EN 61000 (Electromagnetic Standards) • BS EN 60255 (Electrical Relays) • BS EN 61810 (Electrical Elementary Relays) • BS EN 60947 (Low Voltage Switchgear and Control gear) • BS EN 61869 (Instrument Transformers: Additional requirements for current transformers)		**N/A**
A.7.2.2	**Type Verification Functional Testing of the Interface Protection** Type Testing is the responsibility of the Manufacturer. This test will verify that the operation of the Power Park Module Interface Protection shall result: a) in the safe disconnection of the Power Generating Module from the		**N/A**

Engineering recommendation G99/1-9			
Clause	**Requirement – Test**	**Result – Remark**	**Verdict**
	DNO's Distribution Network in the event that the protection settings specified in Table 10.1 are exceeded; and b) in the Power Park Module remaining connected to the DNO's Distribution Network while Distribution Network conditions are: (1) within the envelope specified by the settings plus and minus the tolerances specified for equipment operation in Table 10.1; and (2) within the trip delay settings specified in Table 10.1.		
A.7.2.2.1	**Disconnection times** The minimum trip time delay settings, for over / under voltage, over / under frequency and loss of mains tests below, are presented in Table 10.1. For over / under voltage, over / under frequency and loss of mains tests, reconnection shall be checked as detailed below.		**N/A**
A.7.2.2.2	**Over / Under Voltage** The Interface Protection shall be tested by operating the Controller in parallel with a variable AC test supply, as an example see Figure A.7.5. Correct protection and ride-through operation shall be confirmed. The set points for over and under voltage at which the Interface Protection disconnects from the supply, will be established by varying the AC supply voltage. The disconnect sequence should be initiated when the network conditions mean the protection should trip in accordance with the settings in Table 10.1, otherwise normal operation should continue.		**N/A**
A.7.2.2.3	**Over / Under Frequency** The Interface Protection shall be tested by operating the Controller in parallel with a low impedance, variable frequency test supply system, as an example, see Figure A.7.6. Correct protection and ride-through operation should be confirmed during the test. The set points for over and under frequency at which the Interface Protection disconnects from the supply will be		**N/A**

Engineering recommendation G99/1-9			
Clause	**Requirement – Test**	**Result – Remark**	**Verdict**
	established by varying the test supply frequency.		
A.7.2.2.4	**Loss of Mains Protection** The resonant test circuit specified as an option for this test has been designed to model the interaction of the Power Generating Module under test with the local load including multiple Power Generating Module's in parallel. The Power Generating Module output shall be connected to a network combining a resonant circuit with a Q factor of >0.5 and a variable load. The value of the load is to match the Power Generating Module output. To facilitate the test for LoM there shall be a switch placed between the test load/ Power Generating Module combination and the DNO's Distribution Network, as shown in Figure A.7.7.		**N/A**
A.7.2.2.5	**Re-connection** Further tests will be carried out with the three test circuits above to check the Power Generating Module time- out feature prior to automatic network reconnection. This test will confirm that once the AC supply voltage and frequency have returned to within the stage 1 settings specified in Table 10.1 following an automatic protection trip operation there is a minimum time delay of 20 s before reconnection will be allowed.		**N/A**
A.7.2.2.6	**Frequency Drift and Step Change Stability test.** The tests will be carried out using the same circuit as specified in A.7.2.2.3 above and following confirmation that the Power Generating Module has passed the under and over frequency trip and no trip tests.		**N/A**
A.7.2.3	**Power Output with Falling Frequency** The Generator will propose and agree a test procedure with the DNO, which will demonstrate how the Synchronous Power Generating Module Active Power output responds to changes in system frequency.		**N/A**
A.7.2.4	**Limited Frequency Sensitive Mode – Over** The two frequency response tests in Limited Frequency Sensitive Mode		**N/A**

Engineering recommendation G99/1-9			
Clause	**Requirement – Test**	**Result – Remark**	**Verdict**
	(LFSM) to demonstrate LFSM-O capability to a frequency injection as shown by Figure A.7.8 and Figure A.7.9 are to be conducted at Registered Capacity. There should be sufficient time allowed between tests for control systems to reach steady state. Where the diagram states 'HOLD' the injection signal should be maintained until the Active Power (MW) output of the Power Generating Module has stabilised. The DNO may require repeat tests should the tests give unexpected results. The expected Active Power response which is illustrated in Figure A.7.9 and Figure A.7.10 should be in accordance with Section 11.2.4 (a threshold frequency of 50.4 Hz and a Droop of 10%) and undamped oscillations should not occur after the step or ramp frequency change.r (LFSM-O)		
A.7.2.5	**Power Quality**		**N/A**
A.7.2.5.1	**Harmonics** The tests should be carried out as specified in BS EN 61000-3-12 and can be undertaken with a fixed source of energy at two power levels firstly between 45 and 55% and at 100% of maximum export capacity.		**N/A**
A.7.2.5.2	**Power Factor** The test set up shall be such that the Power Generating Module supplies full load to the DNO's Distribution Network via the Power Factor (pf) meter and the variac as shown below in Figure A.7.10. The Power Generating Module pf should be within the limits given in paragraph 11.1.5, for three test voltages 230V –6%, 230 V and 230 V +10%		**N/A**
A.7.2.5.3	**Voltage Flicker** The voltage fluctuations and flicker emissions from the Generating Unit shall be measured in accordance with BS EN 61000-3-11 and technology specific annex. The required maximum supply impedance should be calculated and recorded in		**N/A**

Engineering recommendation G99/1-9			
Clause	**Requirement – Test**	**Result – Remark**	**Verdict**
	the Type Test declaration Annex A.2-1.		
A.7.3	**Additional Power Generating Module Technology Requirements**		**P**
A.7.3.1	**Domestic CHP** For Domestic CHP Power Park Modules the type verification testing and Interface Protection requirements will be as per the requirements defined in Annex A.7.1 For Domestic CHP Synchronous Power Generating Modules the type verification testing and Interface Protection requirements will be as per the requirements defined in Annex A.7.2.	Not such equipment	**N/A**
A.7.3.2	**Photovoltaic** As all current Photovoltaic Power Park Modules will connect to the DNO's Distribution Network via an Inverter, the type verification testing and Interface Protection requirements will be as per the requirements defined in Annex A.7.1	Not such equipment	**N/A**
A.7.3.3	**Fuel Cells** As all current Fuel Cell Power Generating Modules will connect to the DNO's Distribution Network via an Inverter, the type verification testing and Interface Protection requirements will be as per the requirements defined in Annex A.7.1.	Not such equipment	**N/A**
A.7.3.4	**Hydro** Hydro can be connected to the DNO's Distribution Network directly using induction or Synchronous Power Generating Modules or it can be connected by an Inverter. The common requirements for the generator technologies will apply to micro hydro in addition the following needs to be taken into consideration	Not such equipment	**N/A**
A.7.3.5	**Wind** Wind turbines can be connected to the DNO's Distribution Network directly, typically using asynchronous induction generators, or using Inverters. For those connected via Inverters, the type verification testing and Interface Protection requirements shall be as specified in Annex A.7.1. For those connected directly to the DNO's Distribution Network, the type verification testing and Interface Protection	Not such equipment	**N/A**

Engineering recommendation G99/1-9			
Clause	**Requirement – Test**	**Result – Remark**	**Verdict**
	requirements shall be as specified in Annex A.7.2.		
A.7.3.6	**Energy Storage Device** Energy storage devices can be connected to the DNO's Distribution Network directly or using Inverters. For those connected via Inverters, the type verification testing and Interface Protection requirements shall be as specified in Annex A.7.1 For those connected directly to the DNO's Distribution Network, the type verification testing and Interface Protection requirements shall be as specified in Annex A.7.2	Consider	**P**

--End of the report--

Prüfbericht-Nr.: CN24ME52 001 ATTACHMENT 1
Test report no.:

Project Engineer:	See cover page	Reviewer:	See cover page
Signature:	See cover page	Signature:	See cover page

Testing Location:	
Name:	See page 3
Address:	See page 3

Product Information:
See report CN24ME52 001.

Type A
A **Power Generating Module** with a **Connection Point** below 110 kV and a **Registered Capacity** of 0.8 kW or greater but less than 1 MW.

Type B
A **Power Generating Module** with a **Connection Point** below 110 kV and **Registered Capacity** of 1 MW or greater but less than 10 MW.

Type C
A **Power Generating Module** with a **Connection Point** below 110 kV and a **Registered Capacity** of 10 MW or greater but less than 50 MW.

Type D
A **Power Generating Module** with a **Connection Point** at or greater than 110 kV, and/or with a **Registered Capacity** of 50 MW or greater.

- For **Synchronous Generating Units**:
  - Lower limit: 1/√10 (0.3162) times the tested **Generating Unit** nameplate rating (W)
  - Upper limit: √10 (3.162) times the tested **Generating Unit** nameplate rating (W)
- For all other **Generating Units**:
  - Lower limit: 1/√10 (0.3162) of tested **Generating Unit** nameplate rating (W)
  - Upper limit: 2 times tested **Generating Unit** nameplate rating (W)

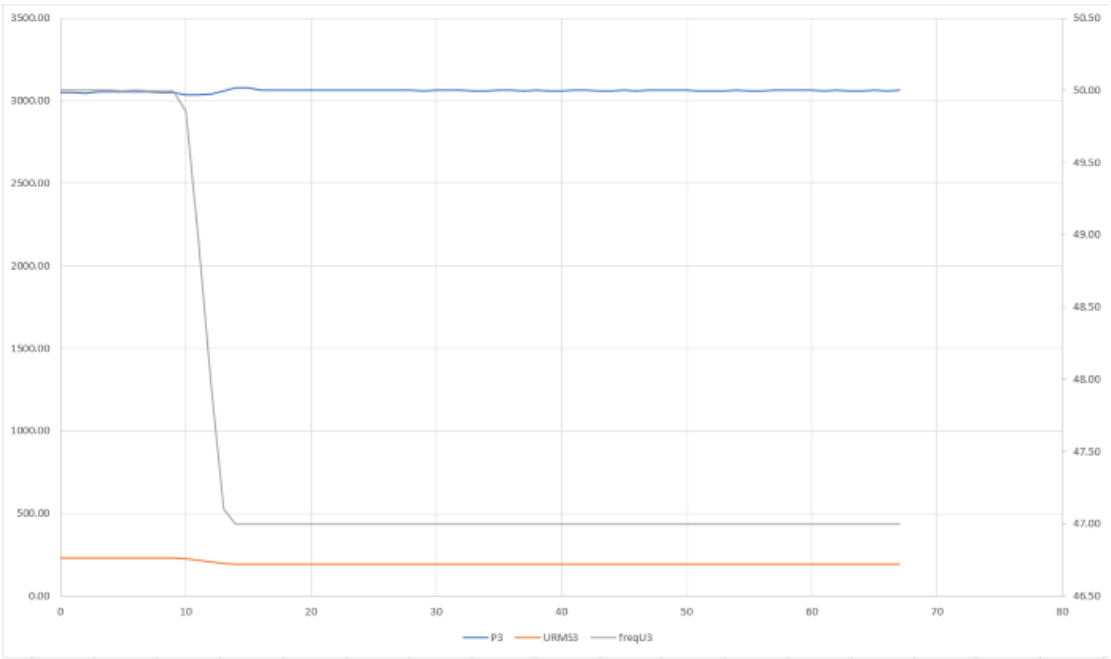
Absatz	**G99/1-9/10.22**	Messergebnisse - Bemerkungen	Bewertung
Clause	Anforderungen - Prüfungen / *Requirements - Tests*	*Measuring results - Remarks*	Evaluation

Clause	Test items	Remark
1	Normal operating range (Operation range)	
2.1	Harmonics current (THDi)	For PGU ≤ 75A, per IEC 61000-3-12
3.1	Voltage fluctuations (Flicker)	For PGU ≤ 75A, per IEC 61000-3-11
4	DC Injection (Idc)	
5	Power factor	
6	Protection-Frequency tests (OF/UF)	
7	Protection-Frequency tests (OV/UV)	
8.1	Protection-Loss of mains test (Anti-islanding)	
8.2	Vector shift stability test	
8.3	RoCoF stability test (RoCoF)	
9.1	Limited Frequency Sensitive Mode-Over frequency test (LFSM-O)	
10	Protection-Reconnection timer (Reconnection)	
11	Fault level contribution	
12	Self-Monitoring solid state switching	N/A, only for solid state switching
13	Wiring functional tests	N/A, none on-site test.
14	Logic interface (input port)	
15	Cyber security	

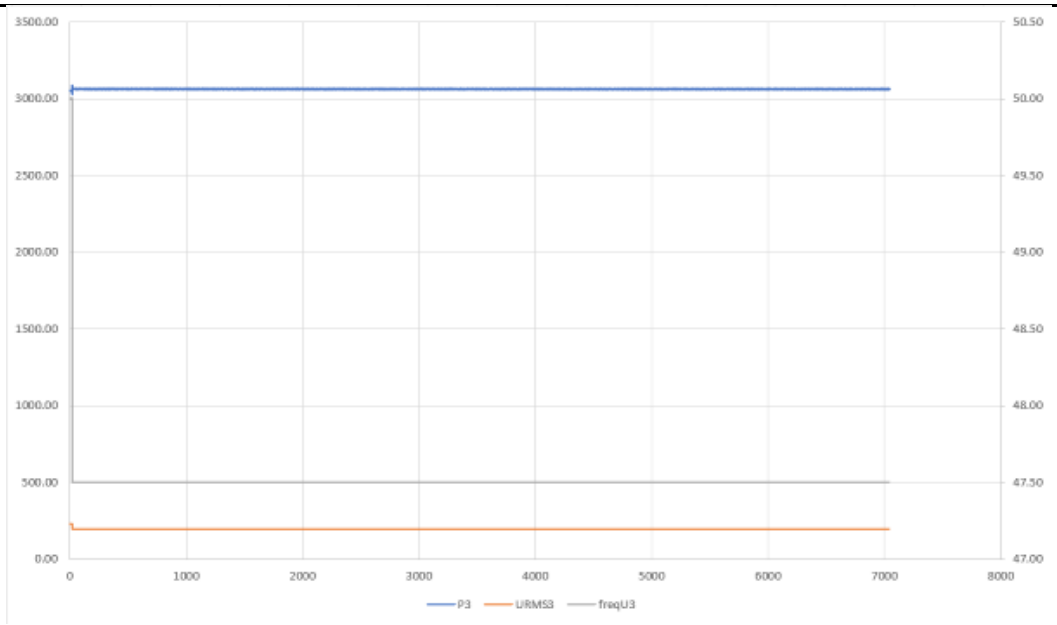
1	TABLE: Normal operating range (Operation range)				P
Test Conditions				MeasurementsB	Limitation
U/Un	f [Hz]	cosφ	t [s]		
85%(195.5 V)	47.0	1.00	20	No disconnect	No disconnect
85%(195.5 V)	47.5	1.00	5400	No disconnect	No disconnect
110%(253 V)	51.5	1.00	5400	No disconnect	No disconnect
110%(253 V)	52.0	1.00	900	No disconnect	No disconnect
100%(230 V)	50.0	1.00	5400	No disconnect	No disconnect
RoCoF-frequency change rate 1Hz/s				No disconnect	No disconnect

Note(s):

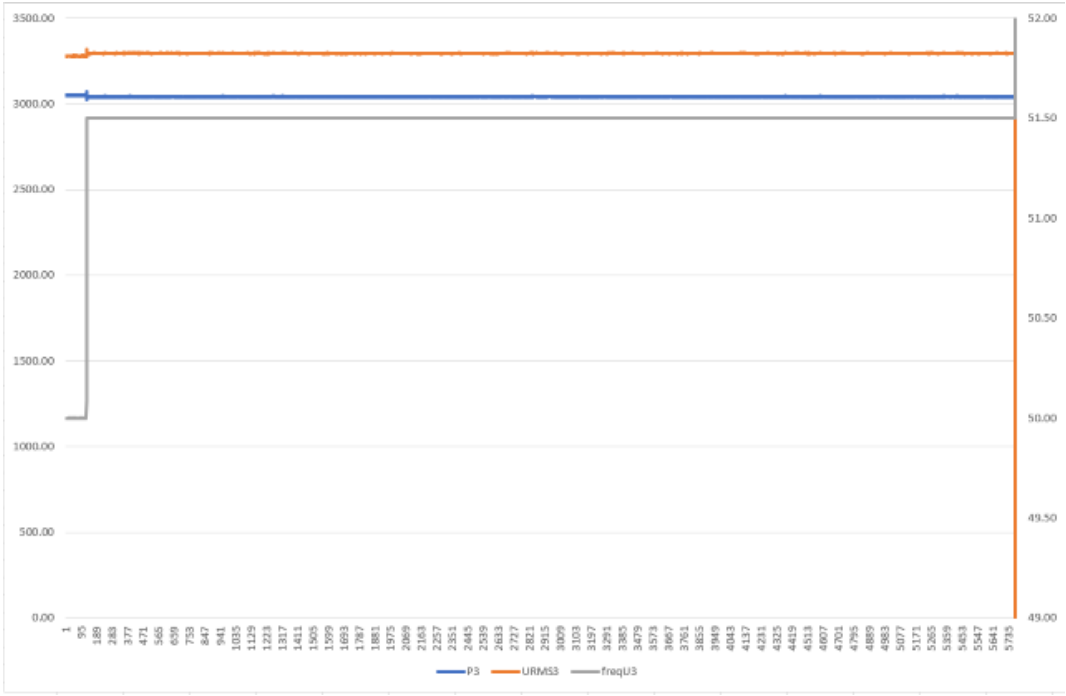
Test No.1



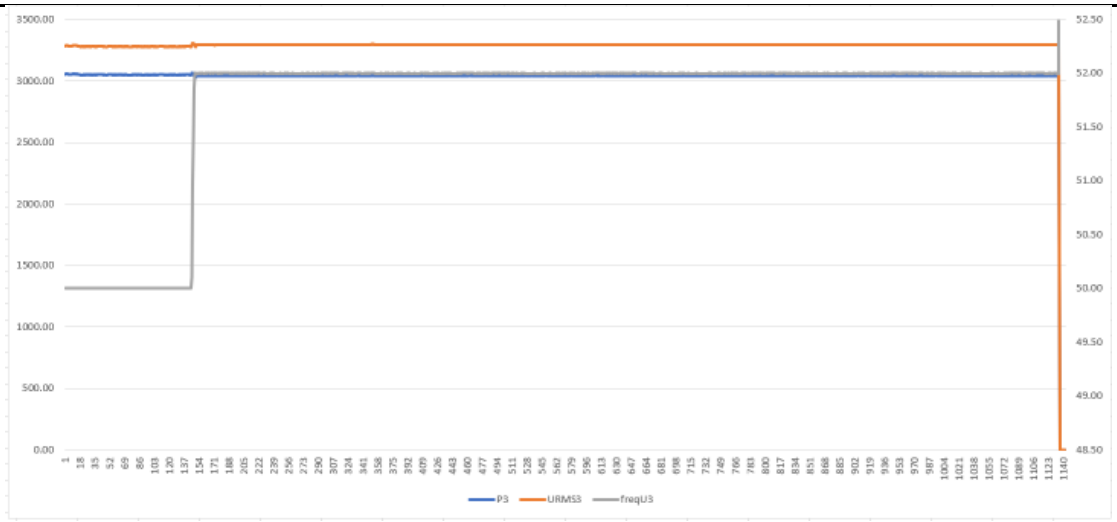
Test No.2



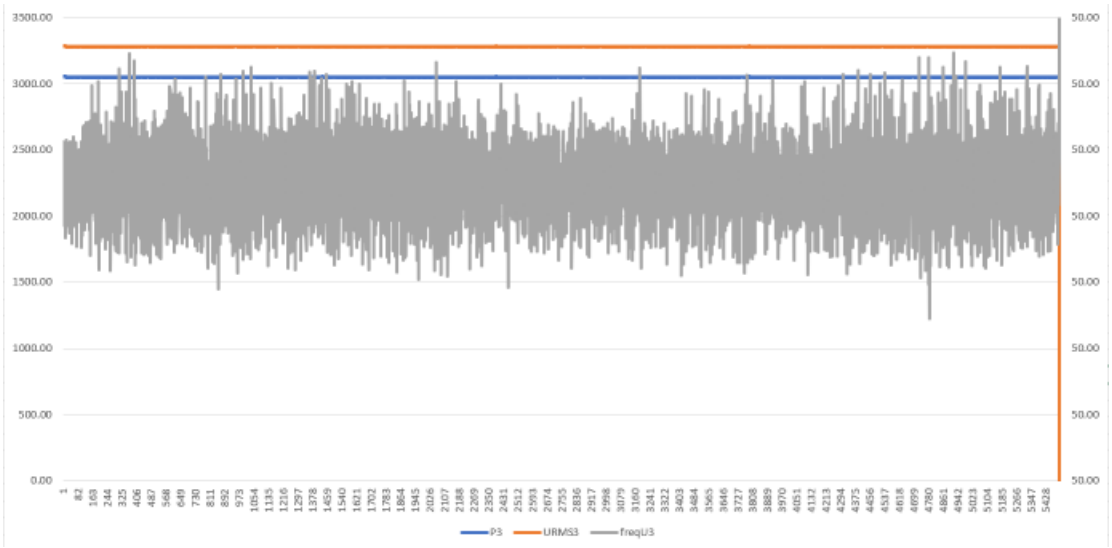
Test No.3



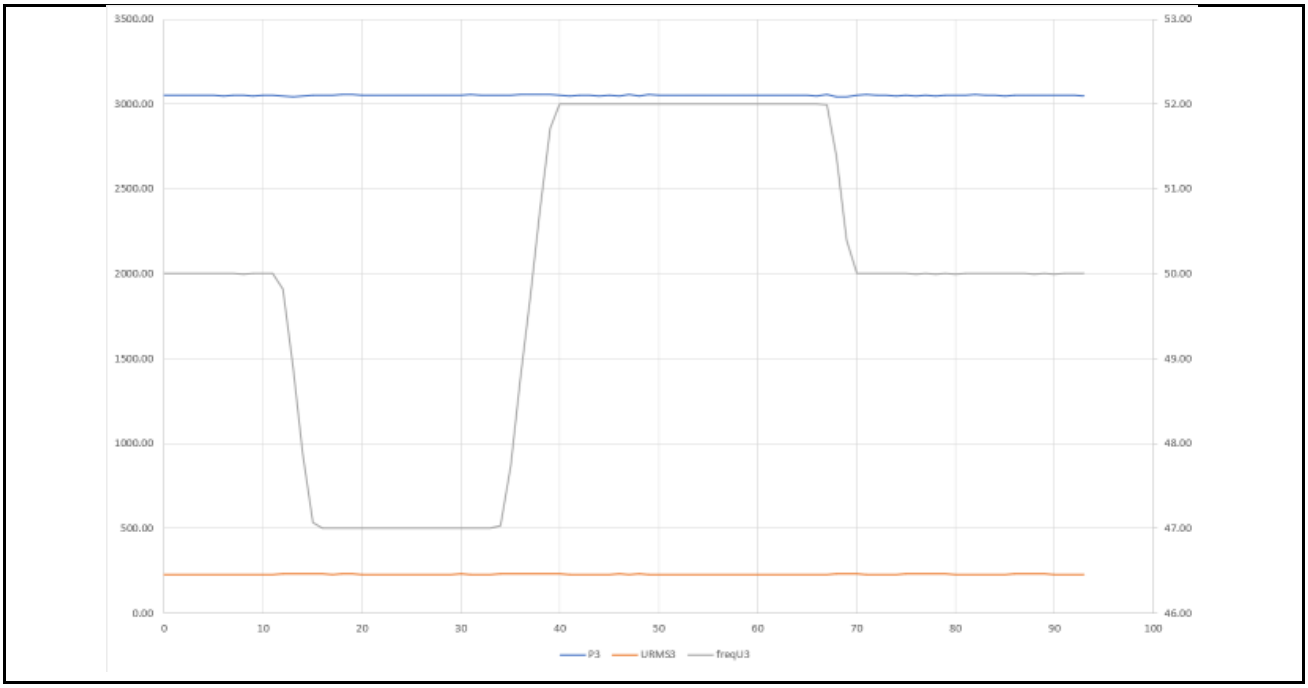
Test No.4



Test No.5



Test No.6



2.1	TABLE: Harmonics current (THDi)				P
P/Pn[%]	50		100		Limit
Order No.	Measurement				
	[A]	Ih/In [%]	[A]	Ih/In [%]	Ih/In [%]
1	13.27	51.04	26	100	--
2	0.16	0.62	0.33	1.27	8.0
3	0.2	0.77	0.22	0.85	--
4	0.06	0.23	0.06	0.23	4.0
5	0.08	0.31	0.08	0.31	10.7
6	0.03	0.12	0.03	0.12	2.67
7	0.05	0.19	0.04	0.15	7.2
8	0.02	0.08	0.01	0.04	2.0
9	0.1	0.38	0.08	0.31	--
10	0.02	0.08	0.02	0.08	1.6
11	0.09	0.35	0.04	0.15	3.1
12	0.02	0.08	0.01	0.04	1.33
13	0.15	0.58	0.11	0.42	2.0
THD[27]	3.29		THD[29]	1.71	13
PWHD[28]	2.1		PWHD[30]	1.42	22

Note(s): The worst value of the three phases has been choosed.

Since the nominal current of product In>75A, the following extra flicker table 2.2 has been also impelmented per BS EN 61000-4-7, as the requirement of EREC G5.

3.1	TABLE: Power Quality – Voltage fluctuations and Flicker:							P
	Starting			Stooping			Running	
	dmax[%]	dc[%]	d(t)[ms]	dmax[%]	dc[%]	d(t)[ms]	P_{st}	P_{lt} 2 hours
Measured value at test impedance	1.199	0.801	0.0	0.460	0.307	0.0	0.219	0.17
Z_{ref} Normalised to standard impedance	1.494	0.83	500	1.494	0.83	500	0.219	0.17
Z_{max} Normalised to required maximum impedance	1.494	0.83	500	1.494	0.83	500	0.219	0.17
Limitation	4.0%	3.3%	500ms	4.0%	3.3%	500ms	1.0	0.65
Test impedance Z_{test}	R	0.24		Ω	XI	0.15		Ω
Z_{ref} Normalised value	R	0.24		Ω	XI	0.15		Ω
Z_{max} Normalised value	R	0.24		Ω	XI	0.15		Ω

Note(s): The worst value of the three phases has been choosed.
Since the nominal current of product In>75A, the following extra flicker table 3.2 has been also impelmented per BS EN 61400-21, as the requirement of EREC P28, clause 8.8.

4	TABLE: Power quality – DC injection		P
Test power level	10%	55%	100%
Recorded DC value in Amps	0.002	0.026	0.005
as % of rated AC current	0.007%	0.1%	0.12%
Limit	0.25%	0.25%	0.25%
Note(s):			

5	TABLE: Power Factor							P
Test Conditions			Measurements					Limit
P/Pn	cosφ	U/Un	P [kW]	Q [kVar]	cosφ	U [V]	I [A]	cosφ
100%	1.00	0.94	5.81	0.11	0.99	216.2	26.9	>0.95
100%	1.00	1.0	6.04	0.12	0.99	229.8	26.2	>0.95
100%	1.00	1.1	6.03	0.11	0.99	252.9	23.8	>0.95
Note(s):								

6	TABLE: Protection-Frequency tests (OF/UF)		P
Condition	Setting [Hz]	Measurement	Limitation
		Trip value [Hz]	
F>>	52.0	51.98	± 0.1% of f_n
F<	47.5	47.46	
F<<	47	47.0	
Condition	Setting [ms]	Measurement	Limitation [ms]
		Time delay	
F>>	500	543	500-600
F<	20000	20035	20000-20100
F<<	500	522	500-600
Condition		Measurement	limitation
F [Hz]	t [s]		
47.7	30	No trip	No trip
47.2	19.5	No trip	No trip
46.8	0.45	No trip	No trip
51.8	120	No trip	No trip
52.2	0.45	No trip	No trip
Note(s):			

7	TABLE: Protection – Voltage tests (OV/UV)					P
Condition	Setting [U/Un]	Measurement				Limitation
		Trip value [V]				
		L1	L2	L3	L123	
U>>	1.19 (273.7 V)	273.8	--	--	--	± 1% of U_n
U>	1.14 (262.2 V)	262.2	--	--	--	
U<<	0.80(184 V)	183.8	--	--	--	
Condition	Setting [ms]	Measurement				Limitation
		Time delay				
		L1	L2	L3	L123	
U>>	500	540	--	--	--	500-600
U>	1000	1018	--	--	--	1000-1100
U<<	2500	2530	--	--	--	2500-2600
Condition		Measurement				limitation
U/Un	time [s]					
0.82(188 V)	5	No trip				No trip
0.78(180 V)	2.45	No trip				No trip
1.12(258.2 V)	5	No trip				No trip
1.17(269.2 V)	0.95	No trip				No trip
1.20(276 V)	0.45	No trip				No trip
Note(s):						

8.1	TABLE: Protection-Loss of mains test	P

Power 100%														
Conditions	P_R [kW]		Q_L [kVar]		Q_C [kVar]		Q_f	Trip time [ms]	Limitation [ms]
P_R: -5% Q_C: +5%	L1:	6.05	L1:	6.48	L1:	6.18	1.00	125	500
	L2:	--	L2:	--	L2:	--	--		
	L3:	--	L3:	--	L3:	--	--		
P_R: -5% Q_C: 0%	L1:	6.03	L1:	6.31	L1:	6.32	1.00	200	500
	L2:	--	L2:	--	L2:	--	--		
	L3:	--	L3:	--	L3:	--	--		
P_R: -5% Q_C: -5%	L1:	6.04	L1:	6.18	L1:	6.48	1.00	170	500
	L2:	--	L2:	--	L2:	--	--		
	L3:	--	L3:	--	L3:	--	--		
P_R: 0% Q_C: +5%	L1:	5.74	L1:	6.15	L1:	5.85	1.00	123	500
	L2:	--	L2:	--	L2:	--	--		
	L3:	--	L3:	--	L3:	--	--		
P_R: 0% Q_C: 0%	L1:	5.77	L1:	6.08	L1:	6.01	1.01	132	500
	L2:	--	L2:	--	L2:	--	--		
	L3:	--	L3:	--	L3:	--	--		
P_R: 0% Q_C: -5%	L1:	5.75	L1:	5.83	L1:	6.14	1.00	104	500
	L2:	--	L2:	--	L2:	--	--		
	L3:	--	L3:	--	L3:	--	--		
P_R: +5% Q_C: +5%	L1:	5.48	L1:	5.52	L1:	5.82	0.99	130	500
	L2:	--	L2:	--	L2:	--	--		
	L3:	--	L3:	--	L3:	--	--		
P_R: +5% Q_C: 0%	L1:	5.47	L1:	5.70	L1:	5.70	1.00	151	500
	L2:	--	L2:	--	L2:	--	--		
	L3:	--	L3:	--	L3:	--	--		
P_R: +5% Q_C: -5%	L1:	5.47	L1:	5.70	L1:	5.69	1.00	138	500
	L2:	--	L2:	--	L2:	--	--		
	L3:	--	L3:	--	L3:	--	--		

Power 66%												
Conditions	P_R [kW]		Q_L [kVar]		Q_C [kVar]		Q_f	Trip time [ms]	Limitation [ms]
P_R: 0% Q_C: -5%	L1:	3.74	L1:	3.80	L1:	4.10	1.00	95.4	500
	L2:	--	L2:	--	L2:	--	--		
	L3:	--	L3:	--	L3:	--	--		
P_R: 0% Q_C: -4%	L1:	3.74	L1:	3.85	L1:	4.08	1.00	121	500
	L2:	--	L2:	--	L2:	--	--		
	L3:	--	L3:	--	L3:	--	--		
P_R: 0% Q_C: -3%	L1:	3.74	L1:	3.88	L1:	4.06	1.00	168	500
	L2:	--	L2:	--	L2:	--	--		
	L3:	--	L3:	--	L3:	--	--		
P_R: 0% Q_C: -2%	L1:	3.74	L1:	3.91	L1:	4.04	1.00	171	500
	L2:	--	L2:	--	L2:	--	--		
	L3:	--	L3:	--	L3:	--	--		
P_R: 0% Q_C: -1%	L1:	3.74	L1:	3.94	L1:	3.99	1.00	154	500
	L2:	--	L2:	--	L2:	--	--		
	L3:	--	L3:	--	L3:	--	--		
P_R: 0% Q_C: 0%	L1:	3.76	L1:	3.94	L1:	3.95	1.00	160	500
	L2:	--	L2:	--	L2:	--	--		
	L3:	--	L3:	--	L3:	--	--		
P_R: 0% Q_C: +1%	L1:	3.74	L1:	4.02	L1:	3.97	1.00	120	500
	L2:	--	L2:	--	L2:	--	--		
	L3:	--	L3:	--	L3:	--	--		
P_R: 0% Q_C: +2%	L1:	3.74	L1:	4.04	L1:	3.92	1.00	130	500
	L2:	--	L2:	--	L2:	--	--		
	L3:	--	L3:	--	L3:	--	--		
P_R: 0% Q_C: +3%	L1:	3.73	L1:	4.07	L1:	3.89	1.00	118	500
	L2:	--	L2:	--	L2:	--	--		
	L3:	--	L3:	--	L3:	--	--		
P_R: 0% Q_C: +4%	L1:	3.75	L1:	4.11	L1:	3.86	1.00	122	500
	L2:	--	L2:	--	L2:	--	--		
	L3:	--	L3:	--	L3:	--	--		
P_R: 0% Q_C: +5%	L1:	3.73	L1:	4.13	L1:	3.82	1.00	104	500
	L2:	--	L2:	--	L2:	--	--		
	L3:	--	L3:	--	L3:	--	--		

Power 33%												
Conditions	P_R [kW]		Q_L [kVar]		Q_C [kVar]		Q_f	Trip time [ms]	Limitation [ms]
P_R: 0% Q_C: -5%	L1:	1.87	L1:	1.83	L1:	2.14	1.00	107	500
	L2:	--	L2:	--	L2:	--	--		
	L3:	--	L3:	--	L3:	--	--		
P_R: 0% Q_C: -4%	L1:	1.86	L1:	1.87	L1:	2.11	1.00	116	500
	L2:	--	L2:	--	L2:	--	--		
	L3:	--	L3:	--	L3:	--	--		
P_R: 0% Q_C: -3%	L1:	1.87	L1:	1.90	L1:	2.10	1.00	118	500
	L2:	--	L2:	--	L2:	--	--		
	L3:	--	L3:	--	L3:	--	--		
P_R: 0% Q_C: -2%	L1:	1.87	L1:	1.93	L1:	2.05	1.00	94	500
	L2:	--	L2:	--	L2:	--	--		
	L3:	--	L3:	--	L3:	--	--		
P_R: 0% Q_C: -1%	L1:	1.87	L1:	1.96	L1:	2.03	1.00	136	500
	L2:	--	L2:	--	L2:	--	--		
	L3:	--	L3:	--	L3:	--	--		
P_R: 0% Q_C: 0%	L1:	1.85	L1:	1.98	L1:	1.98	1.00	143	500
	L2:	--	L2:	--	L2:	--	--		
	L3:	--	L3:	--	L3:	--	--		
P_R: 0% Q_C: +1%	L1:	1.85	L1:	2.00	L1:	1.94	1.00	119	500
	L2:	--	L2:	--	L2:	--	--		
	L3:	--	L3:	--	L3:	--	--		
P_R: 0% Q_C: +2%	L1:	1.86	L1:	2.05	L1:	1.93	1.00	109	500
	L2:	--	L2:	--	L2:	--	--		
	L3:	--	L3:	--	L3:	--	--		
P_R: 0% Q_C: +3%	L1:	1.89	L1:	2.08	L1:	1.90	1.00	93	500
	L2:	--	L2:	--	L2:	--	--		
	L3:	--	L3:	--	L3:	--	--		
P_R: 0% Q_C: +4%	L1:	1.88	L1:	2.10	L1:	1.86	1.00	108	500
	L2:	--	L2:	--	L2:	--	--		
	L3:	--	L3:	--	L3:	--	--		
P_R: 0% Q_C: +5%	L1:	1.88	L1:	2.14	L1:	1.84	1.00	75	500
	L2:	--	L2:	--	L2:	--	--		
	L3:	--	L3:	--	L3:	--	--		
Note(s):									

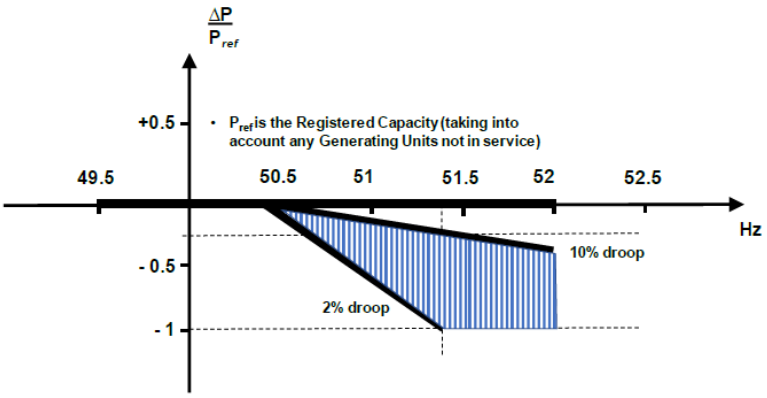
8.2	TABLE: Loss of Mains Protection, Vector Shift Stability test:			P
	Start Frequency	Change	Measurement	Limit
Positive Vector Shift	49.5Hz	+50degree	No trip	No trip
Negative Vector Shift	50.5Hz	-50degree	No trip	No trip

8.3	TABLE: Loss of Mains Protection, RoCoF Stability test:			P
Ramp range	Test frequency ramp	Test Duration	Measurement	Limit
49.0 Hz to 51.0 Hz	+0.95 Hz/s	2.1 s	No trip	No trip
51.0 Hz to 49.0 Hz	- 0.95 Hz/s	2.1 s	No trip	No trip

9.1	TABLE: Limitest frequency sensitive mode-over frequency (LFSM-O)										P
Test No. 1											
Test Conditions	Measurements						Target value	Δ	Limitation		
f [Hz]	P/Pn	f [Hz]	T_{rise} [s]	$T_{settling}$ [s]	Tv [s]	Active Power Gradient	P/Pn	Δ P/Pn	Δ P/Pn	T_{rise} [s]	Tv [s]
a) 50	100	50	--	--	--	--	100%	0%	≤± 10%	≤10	≤2
b) 50.45	100	50.45	--	0.6	0.6	--	99%	-1%			
c) 50.7	94.93	50.7	--	0.6	0.6	--	94%	-0.93%			
d) 51.15	85.78	51.15	--	0.7	0.7	--	85%	-0.78%			
e) 50.7	94.6	50.7	--	0.5	0.5	--	94%	-0.6%			
f) 50.45	99.7	50.45	--	0.6	0.6	--	99%	-0.7%			
g) 50	100	50	--	0.2	0.2	9.42	100%	0%			
Test No. 2											
Test Conditions	Measurements						Target value	Δ	Limitation		
f [Hz]	P/Pn	f [Hz]	T_{rise} [s]	$T_{settling}$ [s]	Tv [s]	Active Power Gradient	P/Pn	Δ P/Pn	Δ P/Pn	T_{rise} [s]	Tv [s]
a) 50	51	50	--	--	--	--	50%	-1%	≤± 10%	≤10	≤2
b) 50.45	49.3	50.45	--	0.6	0.6	--	49%	-0.3%			
c) 50.7	44.2	50.7	--	0.8	0.8	--	44%	-0.2%			

d) 51.15	35.5	51.15	--	0.6	0.6	--	35%	-0.5%			
e) 50.7	44.3	50.7	--	0.8	0.8	--	44%	-0.3%			
f) 50.45	49.3	50.45	--	0.8	0.8	--	49%	-0.3%			
g) 50	51	50	--	0.6	0.6	8.57	50%	-1%			

Note(s):
P(f) curve setting for test: f1: 50.4Hz; fstop: 50.4Hz (Deactivated); Droop: 10% 20%Pn/Hz



10	TABLE: Protection-Reconnection timer (Reconnection)				P
Condition	Measurement		Limitation		
	Delay time [s]	Power Gradient [per mimute]	Delay time [s]	Power Gradient	
Reonnection:					
1.12Un	62	--	60	--	
0.82Un	61	--			
47.6Hz	62	--			
51.9Hz	62	--			
1.16Un	No reconnection	--	No reconnection	--	
0.78Un	No reconnection	--			
47.4Hz	No reconnection	--			
52.1Hz	No reconnection	--			
Note(s):					

11	TABLE: Fault level contribution		P
Test Condition	Measurement		
	U [V]	I [A]	
20ms after fault	0	0	
100ms after fault	0	0	
250ms after fault	0	0	

500ms after fault	0	0
Trip time [s]	1.87	

12	TABLE: Self-Monitoring solid state switching	N/A
It has been verified that in the event of the solid state switching device failing to disconnect the Power Park Module, the voltage on the output side of the switching device is reduced to a value below 50 volts within 0.5 s.		N/A

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

14	TABLE: Logic interface (input port).	P
Confirm that an input port is provided and can be used to shut down the module.		P
Detail description of logic interface: Connect to the EMS touch screen through RS485 or Ethernet ports to monitor and control the status of the PCE.		
15	TABLE: Cyber security	--
Confirm that the Power Generating Module has been designed to comply with cyber security requirements, as detailed in 9.1.7. Customers will describe in user manual or provide Cyber security report.		--

TÜVRheinland®

PHOTO DOCUMENTATION

CN24ME52 001 ATTACHMENT 2

for

Hybrid Inverter

AH-3KSL-G2, AH-3.6KSL-G2, AH-4KSL-G2,
AH-4.6KSL-G2, AH-5KSL-G2, AH-6KSL-G2

Shenzhen Aohai Digital Power Co., Ltd.

This documentation consists of 8 pages (excluding this cover page)

Figure 1 Front view

Figure 2 Top view

Figure 3 Left side view

Figure 4 Right side view

Figure 5 Connect port view

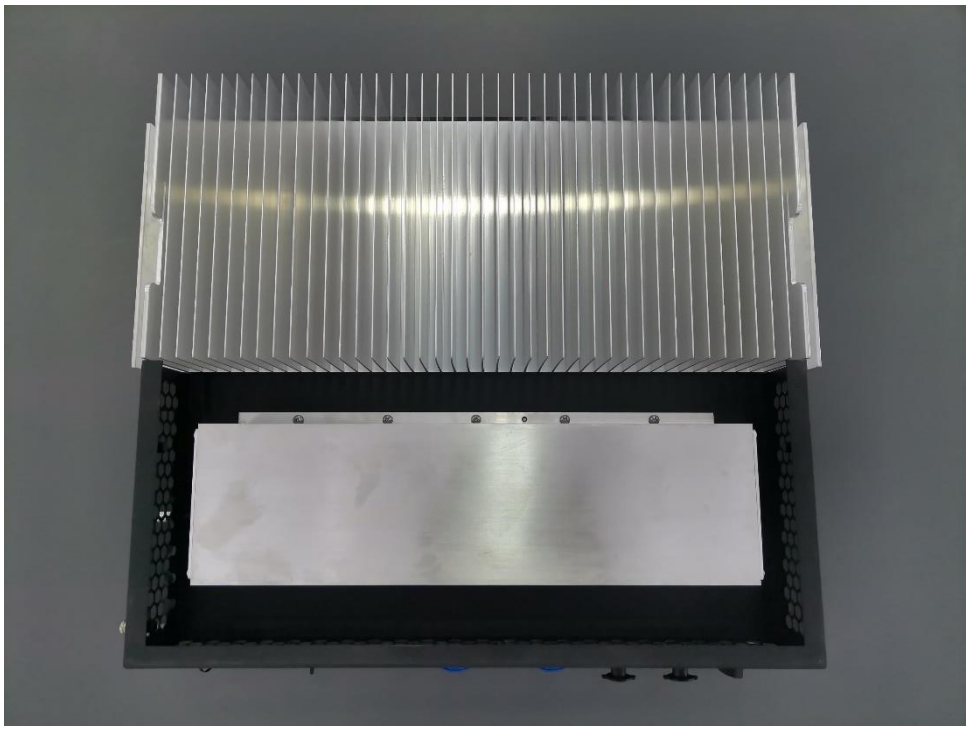


Figure 6 Heat sink view

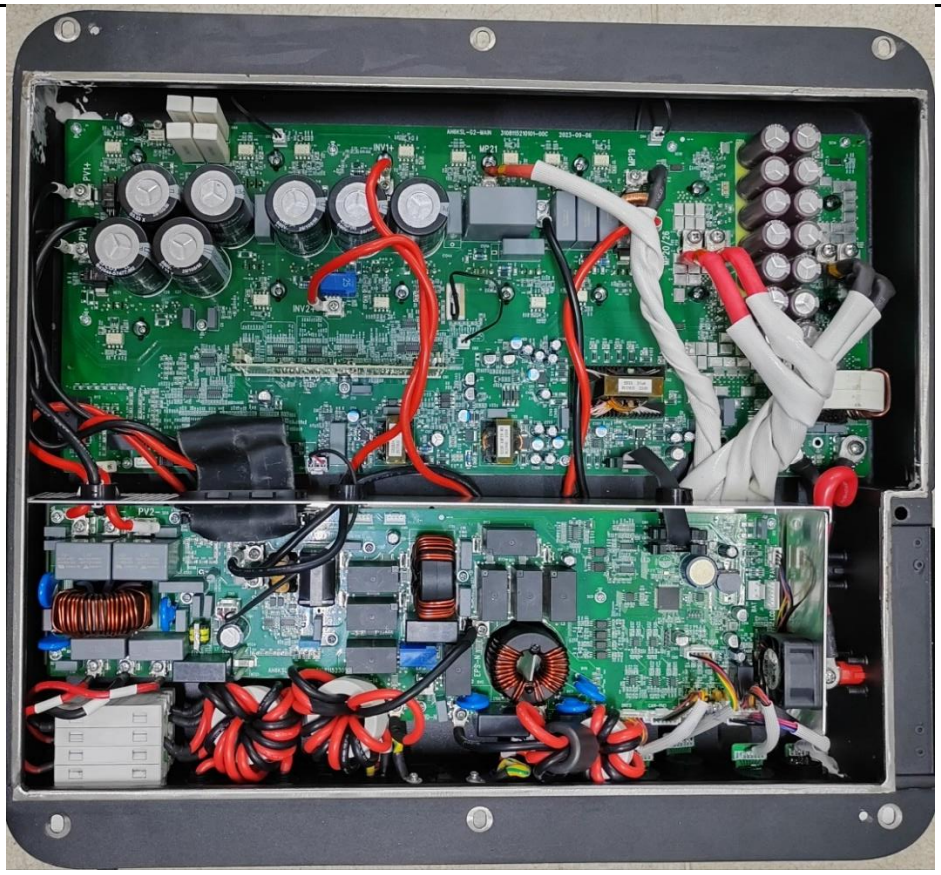


Figure 7 Internal view-1

Figure 8 Internal view-2

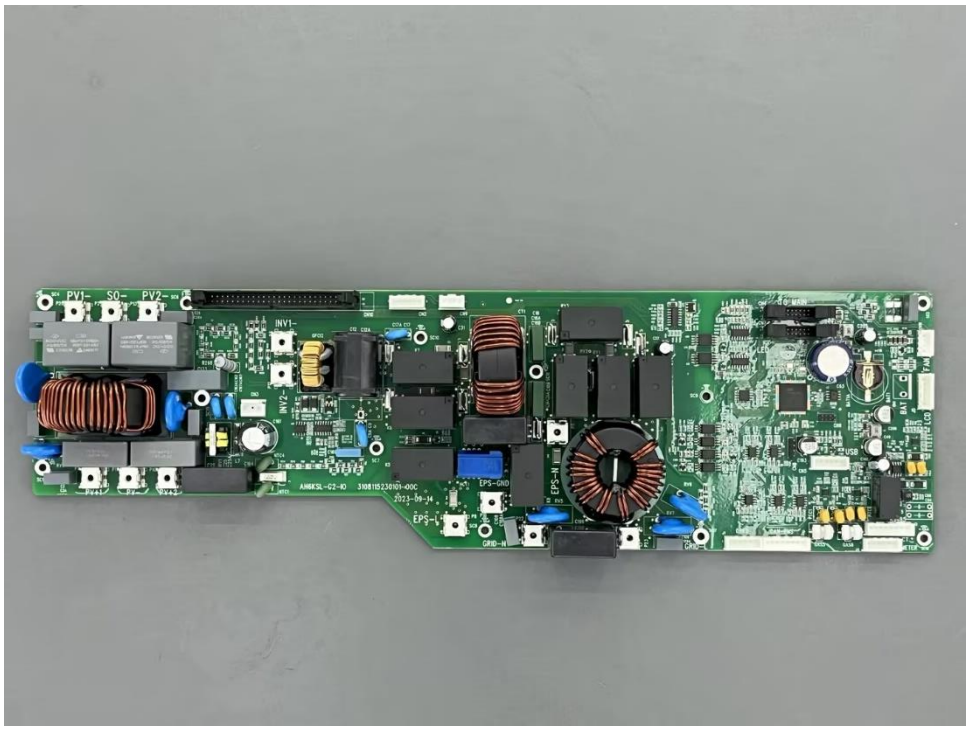


Figure 9 Front view of IO board

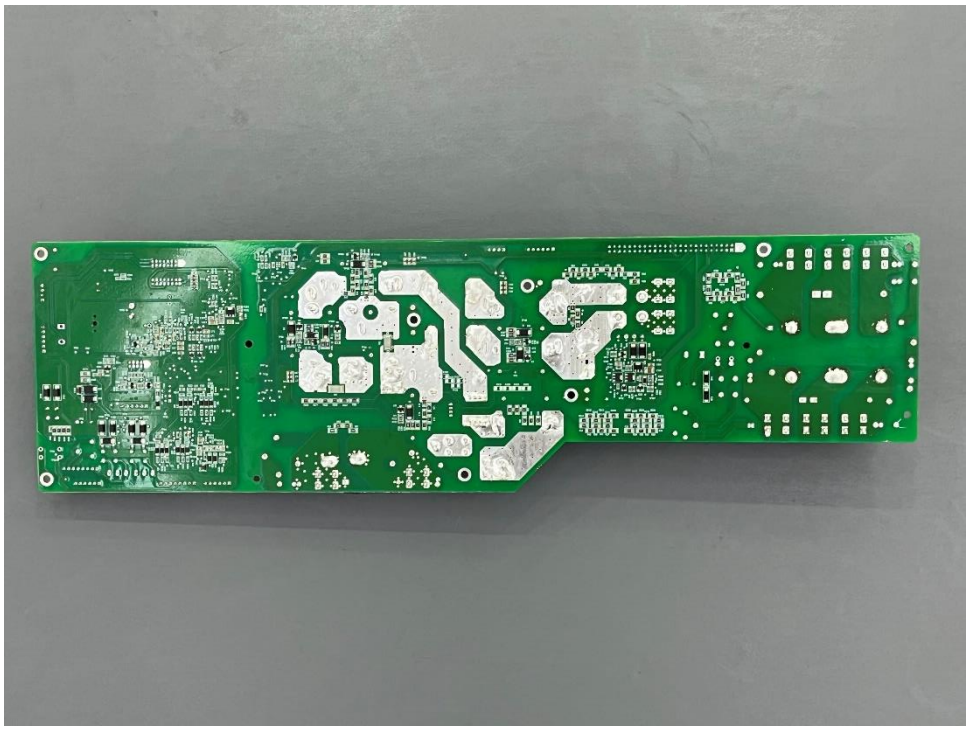


Figure 10 Back view of IO board

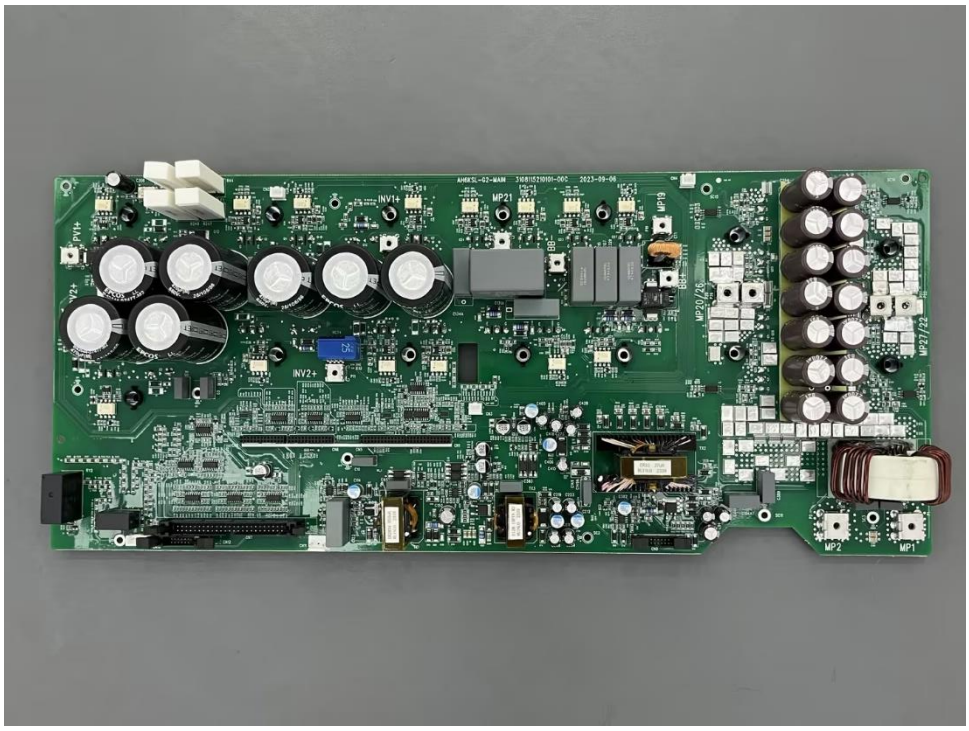


Figure 11 Front view of power board

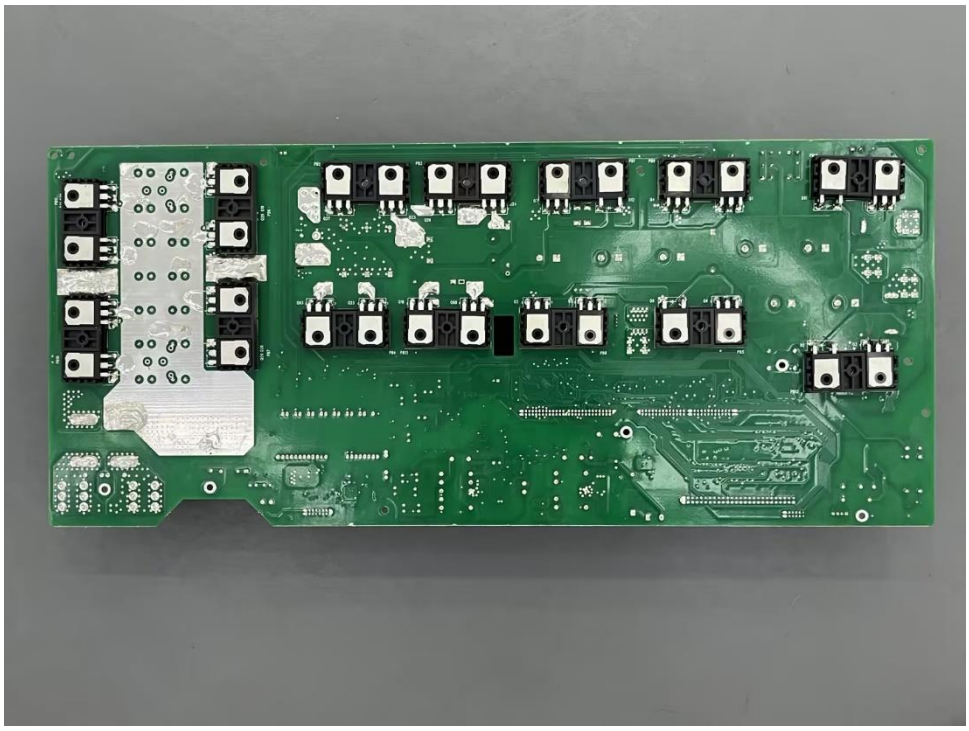


Figure 12 Back view of power board

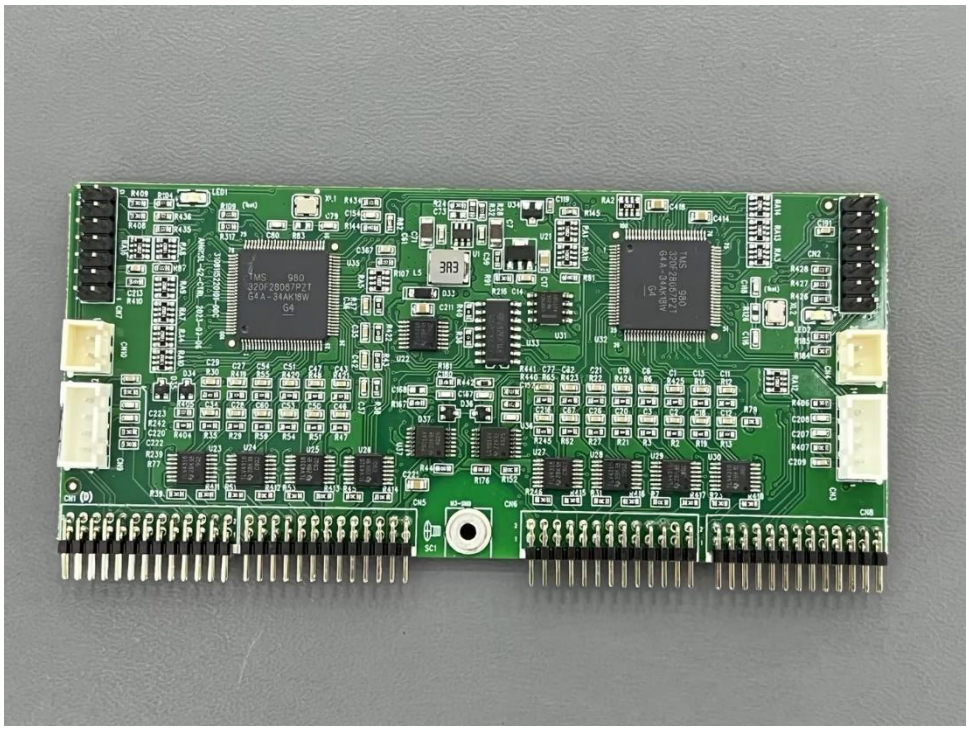


Figure 13 Front view of control board

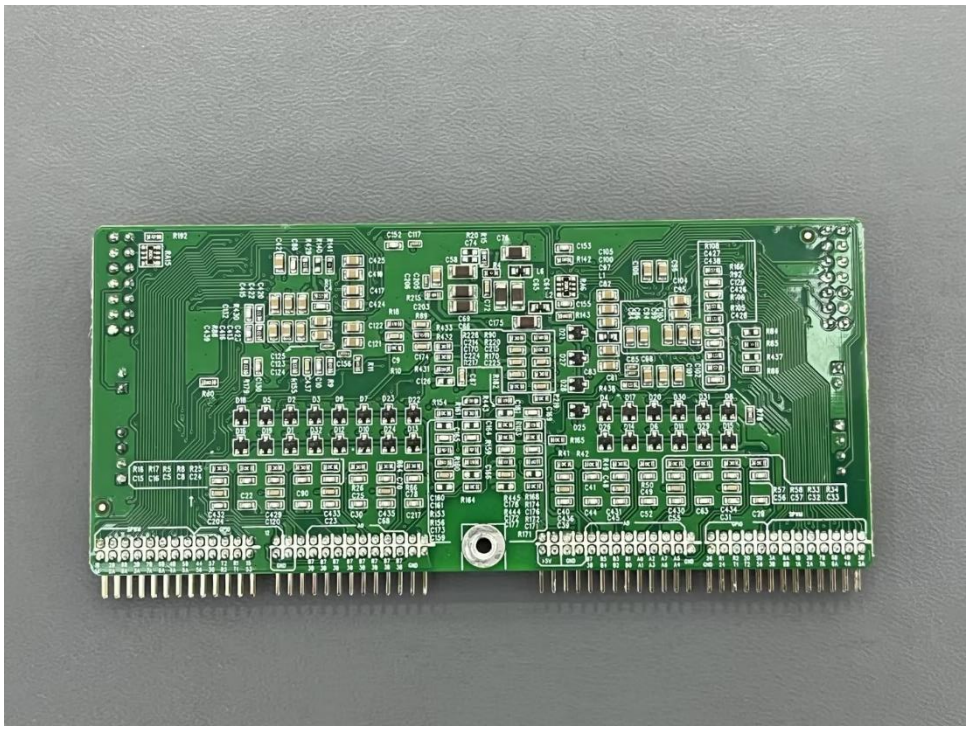


Figure 14 Back view of control board

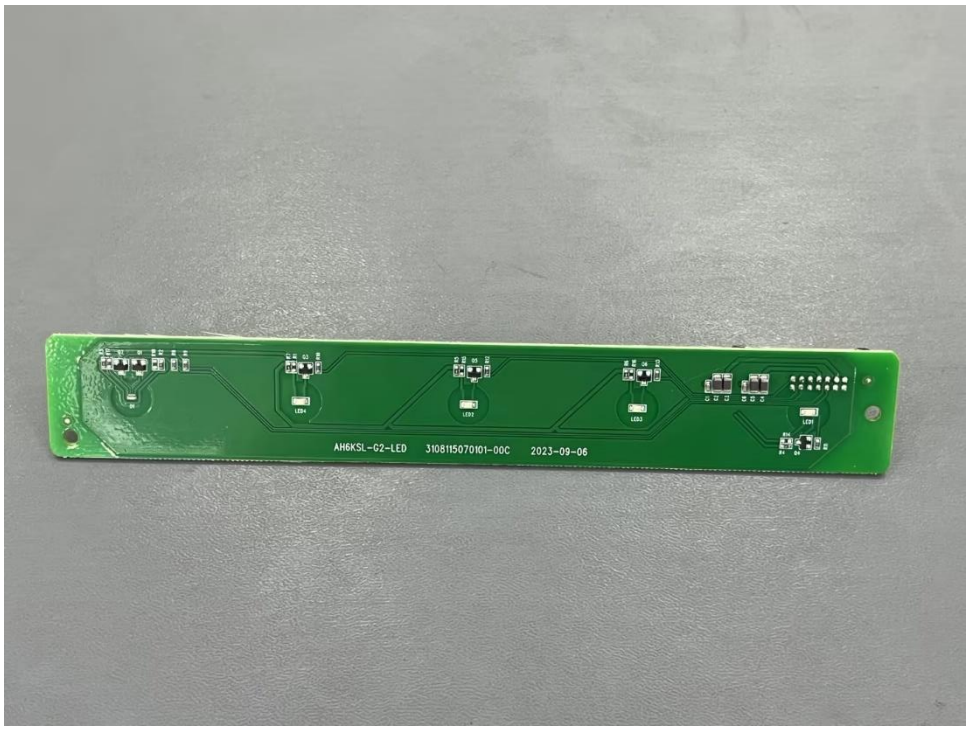


Figure 15 Front view of LED display board

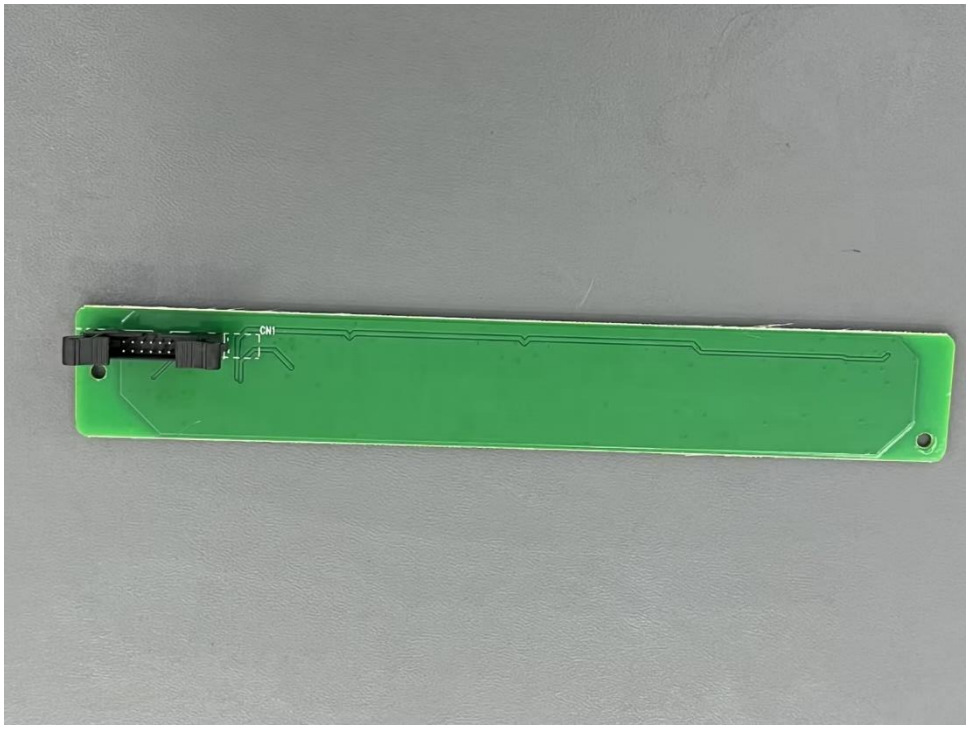


Figure 16 Back view of LED display board