Test report no.: *Prüfbericht-Nr.:*	CN23PFO6 001	**Order No.:** *Auftragsnr.:*	168413628	**Page 1 of 23** *Seite 1 von 23*
Client reference no.: *Kunden-Referenz-Nr.:*	2004599	**Order date:** *Auftragsdatum:*	2023.02.08	
Client: *Auftraggeber:*	**SINENG ELECTRIC CO., LTD.** No.6, Hehui Road, Huishan District, Wuxi, 214174 Jiangsu, P.R. China			
Test item: *Prüfgegenstand:*	Grid-connected PV inverter			
Identification / Type no.: *Bezeichnung / Typ-Nr.:*	SP-250K-H, SP-275K-H1, SP-275K-INH			
Order content: *Auftrags-Inhalt*:	AK certificate			
Test specification *Prüfgrundlage:*	G99/1-9: 2022 G100: 2022			
Date of sample receipt: *Wareneingangsdatum:*	2023.02.08			
Test sample no: *Prüfmuster-Nr.:*	Engineering samples			
Testing period: *Prüfzeitraum:*	2023.02.08 – 2023.05.11			
Place of testing: *Ort der Prüfung:*	See page 3			
Testing laboratory: *Prüflaboratorium:*	TÜV Rheinland (Shenzhen) Co.,Ltd.			
Test result*: *Prüfergebnis*:*	Pass			

created by: *erstellt von:*		**authorized by:** *genehmigt von:*	
Date: 2023.05.16 *Datum:*	Edward Li	**Issue date:** 2023.05.16 *Ausstellungsdatum:*	Zhiwei Yan
Position / *Stellung*:	Project Engineer	**Position** / *Stellung*:	Reviewer

Other/*Sonstiges:*
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.

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

* 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
* Legende:	P(ass) = entspricht o.g. Prüfgrundlage(n)	F(ail) = entspricht nicht o.g. Prüfgrundlage(n)	N/A = nicht anwendbar	N/T = nicht getestet

Remarks
Anmerkungen

1	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. *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.*
2	As contractually agreed, this document has been signed digitally only. TUV Rheinland has not verified and unable to verify which legal or other pertaining requirements are applicable for this document. Such verification is within the responsibility of the user of this document. Upon request by its client, TUV Rheinland can confirm the validity of the digital signature by a separate document. Such request shall be addressed to our Sales department. An environmental fee for such additional service will be charged. *Wie vertraglich vereinbart, wurde dieses Dokument nur digital unterzeichnet. Der TÜV Rheinland hat nicht überprüft, welche rechtlichen oder sonstigen diesbezüglichen Anforderungen für dieses Dokument gelten. Diese Überprüfung liegt in der Verantwortung des Benutzers dieses Dokuments. Auf Verlangen des Kunden kann der TÜV Rheinland die Gültigkeit der digitalen Signatur durch ein gesondertes Dokument bestätigen. Diese Anfrage ist an unseren Vertrieb zu richten. Eine Umweltgebühr für einen solchen zusätzlichen Service wird erhoben.*
3	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. *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.*
4	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. *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.*
5	

TEST REPORT
Engineering recommendation G100
Technical Guidance for Customer Export Limiting Schemes.

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	SINENG ELECTRIC CO., LTD. No.6, Hehui Road, Huishan District, Wuxi, 214174 Jiangsu, P.R. China.	
Applicant's name.....	SINENG ELECTRIC CO., LTD.	
Address	No.6, Hehui Road, Huishan District, Wuxi, 214174 Jiangsu, P.R. China.	
Test specification:		
Standard	G100: 2022	
Non-standard test method.....	N/A	
Test Report Form No.	MS-0024999-appendix 27 V.0	
Test Report Form(s) Originator.....	TÜV Rheinland Group	
Master TRF	2013-12	
Test item description	Grid-Connected PV Inverter	
Trade Mark	SINENG	
Manufacturer.....	Same as applicant	
Model/Type reference	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
Manufacturer's name..... :	SINENG ELECTRIC CO., LTD.
Factory address.....:	SINENG ELECTRIC CO., LTD. No.6, Hehui Road, Huishan District, Wuxi, 214174 Jiangsu, P.R. China.

Test items particulars	
Equipment mobility.....:	Permanent connection
Enviromental category.....:	Outdoor
Operating condition .....:	Continuous
Class of equipment.....:	Class I
Protection against ingress of water..:	IP66
Pollution degree .....:	PD3
Mass of equipment [kg] .....:	See model list

Test case verdicts	
Test case does not apply to the test object.....:	N/A
Test object was not evaluated for the requirement.....:	N/E
Test item does meet the requirement.....:	P(ass)
Test item does not meet the requirement.....:	F(ail)

Testing	
Date of receipt of test item.....:	See cover page
Date(s) of performance of test .....:	See cover page

General remarks:

The test result presented in this report relate only to the object(s) tested.
This report must not be reproduced in part or in full without the written approval of the issuing testing laboratory.

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

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

This Test Report consists of the following documents:

1. ATTACHMENT 1 – G99/1-9: 2022 test report (38 pages)
2. ATTACHMENT 2 – Photo documentation (15 pages excluding cover page)

Copy of marking plate


上能电气
SINENG
光伏并网逆变器 型号(Model):SP-275K-INH
GRID-CONNECTED PV INVERTER
额定输出功率:225kW
Rated Output Power:225kW
额定输出电流:162.4A
a.c. Rated Output Current:162.4A
最大输入电流:12×40A
d.c. Max. Input Current:12×40A
最大输出电流:198.5A
a.c. Max. Output Current:198.5A
PV短路电流:12×60A
Isc PV Current:12×60A
额定输出频率:50Hz
Rated Output Frequency:50Hz
最大直流输入电压:1500Vd.c.
d.c. Max. Input Voltage:1500Vd.c.
额定输出电压:800Va.c.
a.c. Rated Output Voltage:800Va.c.
MPPT电压范围:500-1500Vd.c.
d.c. MPPT Voltage Range:
500-1500Vd.c.
工作温度范围:-30℃ ~ +60℃
Operating Temperature Range:
-30℃ ~ +60℃
功率因数范围:0.8(超前)-0.8(滞后)
Power Factor Range:
0.8(leading)-0.8(lagging)
保护等级:I级
Protective Class:I
防护等级:IP66
Ingress Protection :IP66
45 min
序列号(SN):
上能电气股份有限公司
SINENG ELECTRIC CO., LTD.
中国制造
MADE IN CHINA
地址：无锡市惠山区和惠路 6 号
ADD: NO.6, Hehui Road, Huishan District, Wuxi

General product information:

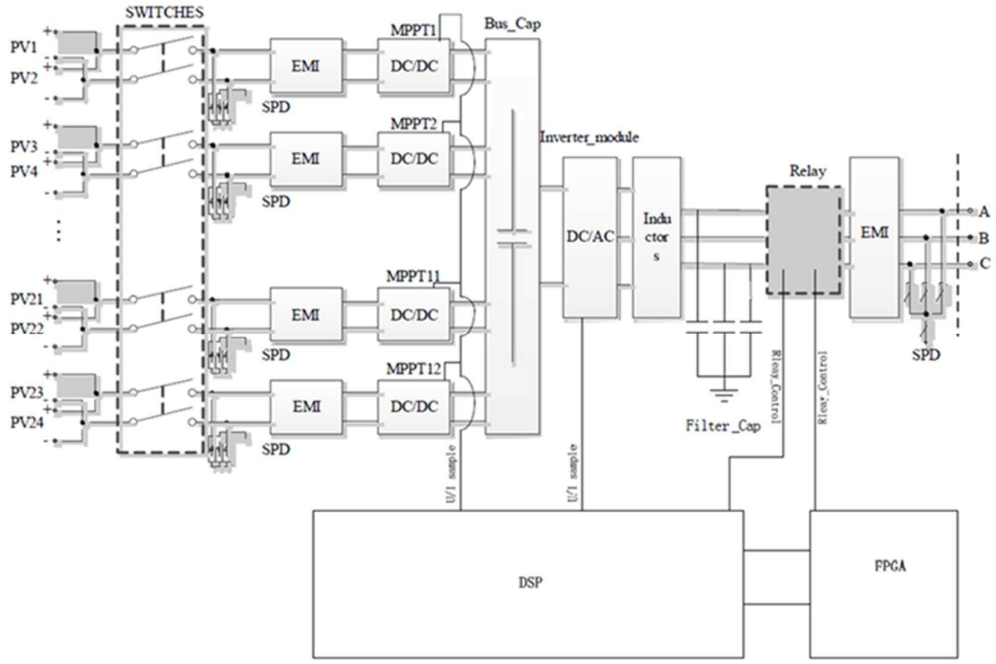
SP-250K-H, SP-275K-H1, and SP-275 K-INH are three-phase isolated type (External connected isolation transformer) utility-interactive PV inverters which will be installed and connected to the grid network after installation. In final installation the equipment shall be fixed to suitable concrete ground as specified in the installation instruction.

There is a communication RS232/RS485 connected to the LCD touch screen to monitor the status of the inverter by proprietary software and RS232/RS485 to the computer.

Grid is protected by a mechanical disconnection device (contactor or circuit breaker). During fault condition defined in this standard, after the CPU receives the abnormal signal from the relevant protective detection circuit, the contactor or circuit breaker will operate to disconnect the PV inverter active lines from grid automatically.

The maximum ambient temperature permitted by the manufacturer's specification is 60°C and derate the output power from 50°C.

The topology diagram as following:



Block diagram

Models differences:

All the models are identical to the software logistic and hardware construction, except the output powers are adjusted by software.

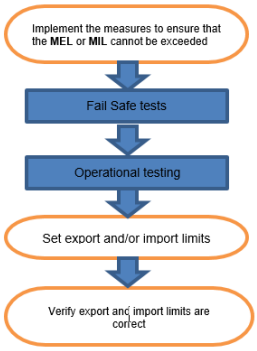
Table 1 Model List:

MODELS LIST		SP-250K-H	SP-275K-H1	SP-275K-INH
PV INPUT	V_{MAX} PV [Vdc]	1500		
	I_{SC} PV [A]	60*12		
	MPP Voltage Range V_{MPP} [Vdc]	500-1500		
	Max. Input Current I_{MAX} [A](A/B)(each MPPT)	40*12		

	MPP Full Power Voltage Range [Vdc]	880-1360		
	Start PV Voltage[Vdc]	600		
	Stop PV Voltage[Vdc] (PCE Shutdown)	500		
	Backfeed Current [A]	0		
	Overvoltage Category(OVC)	II		
AC OUTPUT	Rated Output Voltage Ur [Vac]	3W+PE, 800		
	Normal Operating VoltageRange Un[Vac]	(85%~110%)Un		
	Rated Output Frequency F_{NETZ}[Hz]	50		
	Normal Operating Frequency Range Fn[Hz]	49~51/59~61(adjustable)		
	Operating Frequency Adjustable Range Fn[Hz]	45~55/55~65		
	Rated Output Power P_E[kW]	250	250	225
	Max. Output Power P_{Emax} [kW]	275	275	275
	Max. Apparent power S_{Emax} [kVA]	275	275	275
	Rated Output Current Ir[A]	180.4	180.4	162.4
	Max. Output Current Imax[A]	198.5	198.5	198.5
	Power Factor cosφ [λ]	0.8under-excited - 0.8over-excited		
	Efficiency max. η_{max}	99.03%		
	Standby Power Consumption [W]	<20W		
	Night Power Consumption [W]	<3.5W		
	THD [V /I] (100% full power)	<3%		
	Acoustic Noise [dB]	<80		
	Overvoltage Category(OVC)	III		
PV & GRID	Array Insulation Resistance Detection [Ω]	>50K (>VMAX PV/30mA)		

	The accuracy of resistance measurement[%/Ω]	1%	
	Continuous residual current threshold value [mA]	1000 (ILIMIT: 2250)	
CONSTRUCTION	Type of inverter	Isolated (External isolation transformer)	
	Type of NS Protection	Integrated	
	Separated by	External Transformer	
	MPPT strings	2	
	MPPT tracking	12	
	Hardware version	A01	
	Firmware version	U1：V250B009D000	
	Protective Class	I	
	Enclosure Protection (IP)	IP66	
	Operating Temperature Range [ºC]	-30℃~+60℃(> 45 derating)	-30℃~+60℃(> 50 derating)
	Pollution degree (PD)	PD 2(inside), PD3(outside)	
	Altitude [m]	4000m（>3000 m derating）	
	Size [mm]	1180*733*350	
	Weight [kg]	130	
Note:			

Engineering recommendation G100			
Clause	**Requirement – Test**	**Result – Remark**	**Verdict**
5	**Application and Acceptance**		
5.1	**General**		**P**
5.2	**Site commissioning of Fully Type Tested CLSs** Where the functions described in section 5.6 have been validated in a type test by the **Manufacturer** (ie the **CLS** is **Fully Type Tested**), a reduced set of tests can be undertaken on site. In these cases it will be sufficient to undertake the communication and power supply **Fail Safe** tests in section 5.5 (i.e. all the tests in Table 5-1 - Test Sequencewith the exception of test 9) to prove that the **CLS** reacts appropriately. Form C (Appendix C) must be submitted in all cases, but Form B (Appendix B) is not required where the reference to the **Fully Type Tested** compliance information on the ENA's Type Test Register is included as a reference on Form C.		**P**
5.3	**Commissioning Sequence** **CLS** commissioning shall only be undertaken after all other **Device** commissioning has been successfully completed. The **Customer** (or the **Installer** on the **Customer**'s behalf) shall provide to the **DNO** all relevant scheme drawings and information to enable safe, informed commissioning of the **CLS**. In order to ensure that commissioning does not cause any safety issues on the **DNO**'s **Distribution Network**, the following commissioning sequence shall be followed. Tests shall be performed in the sequence indicated and the process shall only proceed to the next stage once the preceding stage has been successfully undertaken:		**P**

Engineering recommendation G100			
Clause	**Requirement – Test**	**Result – Remark**	**Verdict**
			
5.4	**Preventing the Limits Being Exceeded During Testing and Commissioning** Care shall be taken whilst testing and commissioning the **CLS** so that the **MEL** or **MIL** is not breached. This may involve setting the export or import limit to a lower threshold for compliance demonstration purposes. A combination of the following measures should be considered to ensure that **MEL** and/or **MIL** is not exceeded during setup/testing: • Temporarily programming the **CLS** export and/or import or setpoint limits to 50% (or less) than **MEL** and/or **MIL**; • Temporarily narrowing the range of the **CLS** voltage limits (ie bringing the set points closer to the nominal voltage); • Restricting the maximum output of the generation (eg on a PV system with multiple inverters, turning off a number of the inverters); • Restricting the amount of load that is connected; and • Operating a temporary load, load bank or generator. If the **CLS** settings need to be changed in order to demonstrate operation, then they shall be restored and confirmed once testing is complete.		**P**

Engineering recommendation G100			
Clause	**Requirement – Test**	**Result – Remark**	**Verdict**
5.5	**Fail Safe Tests** The purpose of the **Fail Safe** tests is to ensure that should any part of the **CLS** fail, the current flow across the **Connection Point**, and the voltage imposed on the **Distribution Network**, will remain within, or return within the required time to, the design limits. There are a number of potential options for reducing the current flows such that the design limits are not breached including: 1. Switching off relevant **Devices** completely; 2. Reducing the number of the **Devices** operating such that the aggregate current capacity of the **Devices** remaining operational is equal or less than the **MEL** and / or **MIL**; and 3. Operating all **Devices** at a restricted output such that as in aggregate their combined current is safely and securely limited to be equal or less than the **MEL** and/or **MIL**. The **Fail Safe** test process comprises a sequence of tests on each separate **Component** of the **CLS**. Each **Component** and **Device** needs to have, where relevant, its communication medium removed or interrupted and, separately, its power supply interrupted. At no time during the **Fail-Safe** test sequence shall the current flowing through the **Connection Point** rise above the programmed export and/or import limit (taking account of **Manufacturer**'s published tolerances) for a period of time longer than the specified reaction time.		**P**

Engineering recommendation G100			
Clause	**Requirement – Test**	**Result – Remark**	**Verdict**
	Test Sequence The following table describes a typical test sequence. Not all **CLSs** will have all of the **Components** listed and others may have additional **Components** that need to be included in the test sequence. The **CLS** shall be restored to normal operation after each of the tests below.		
5.6	In order to safely and effectively test a **CLS**, it is necessary to simulate normal state 1 operation and then the transition from state 1 to state 2 to confirm that it responds appropriately. Note that operating setpoints must be reduced so that state 2 operation for testing purposes does not exceed the **MEL** or **MIL** as explained in section 5.4. Two different means may be employed to simulate this: 1. Manual control over the **Devices** operating on the site; or 2. Injection testing using a calibrated test set		**P**
	Test Sequence		**P**

No.	Component	Test
1	**Connection Point Component** (ie transducer)	Remove power supply to transducer†
2	Principle **CLS Component(s)**	Remove power supply
3	**Components** controlling generation **Devices**	Remove power supply to each in turn
4	**Components** controlling storage **Devices**	Remove power supply to each in turn
5	**Components** controlling load **Devices**	Remove power supply to each in turn
6	Communication controller and or hubs/switches etc	Remove power supply to each in turn
7	Communication between **Components**	Remove/interrupt communication to each **Component** in turn†
8	Where applicable communication between **Components** and **Devices**	Remove/interrupt communication between each **Component** and associated **Device** in turn
9	**CLS** system	With reference to the **Manufacturer**'s published information on internal failures (see 4.5.1.1) undertake the recommended tests etc to confirm that the **CLS** detects and reacts appropriately to internal failures.

Engineering recommendation G100			
Clause	**Requirement – Test**	**Result – Remark**	**Verdict**
	<table><tr><td>Test A</td><td>Parmeter stepped to the value shown and held there for 58s (or 178s by agreement with DNO)</td></tr><tr><td>1</td><td>Export = 105% of programmed limit value</td></tr><tr><td>2</td><td>Export = 110% of programmed limit value</td></tr><tr><td>3</td><td>Export = 120% of programmed limit value</td></tr><tr><td>4</td><td>Import = 105% of programmed limit value</td></tr><tr><td>5</td><td>Import = 110% of programmed limit value</td></tr><tr><td>6</td><td>Import = 120% of programmed limit value</td></tr><tr><td>Test B: repeat test 1 and 4 only of the above</td><td>Test Level (step change) final value – maintained for 62s (or 182s by agreement with DNO)</td></tr><tr><td>7</td><td>Export = 105% of programmed limit value</td></tr><tr><td>8</td><td>Import = 105% of programmed limit value</td></tr><tr><td>Test C</td><td>Test level (step change) final value maintained for 58s</td></tr><tr><td>9</td><td>Voltage 111% of nominal (LV); 107% of nominal (HV)</td></tr><tr><td>Test D</td><td>Test level (step change) final value maintained for 62s</td></tr><tr><td>10</td><td>Voltage 111% of nominal (LV); 107% of nominal (HV)</td></tr><tr><td>Test E</td><td>Test level (step change) final value maintained for 58s</td></tr><tr><td>11</td><td>Voltage 93% of nominal (LV); 93% of nominal (HV)</td></tr><tr><td>Test F</td><td>Test level (step change) final value maintained for 62s</td></tr><tr><td>12</td><td>Voltage 93% of nominal (LV); 93% of nominal (HV)</td></tr><tr><td>Test G</td><td>Test level (step change) final value maintained for 0.98s</td></tr><tr><td>13</td><td>Voltage 114% of nominal (LV); 110% of nominal (HV)</td></tr><tr><td>Test H</td><td>Test level (step change) final value maintained for 1.02s</td></tr><tr><td>14</td><td>Voltage 114% of nominal (LV); 110% of nominal (HV)</td></tr><tr><td>Test J</td><td>Test level (step change) final value maintained for 0.98s</td></tr><tr><td>15</td><td>Voltage 78% of nominal</td></tr><tr><td>Test K</td><td>Test level (step change) final value maintained for 1.02s</td></tr><tr><td>16</td><td>Voltage 78% of nominal</td></tr></table> Note that where testing is being done under manual load control, tests 1, 3, 4 and 6 shall be completed from Test A (ie tests 2 and 5 can be omitted) and also that tests C to K require a test voltage to be simulated/injected.		

G100 Test Results:

5.4.1Preventing the export limit being exceeded during setup/testing		P
Test condition	Power from grid (W)	Result
100% Power from grid	249509	Pass
50% Power from grid	124924	Pass
0% Power from grid	1358	Pass

5.4.2 Preventing the export limit being exceeded during setup/testing		P
Test condition	Inverter Power (W)	Result
100% Pn	249222	Pass
50% Pn	124694	Pass
0% Pn	1087	Pass

5.4.3 Preventing the export limit being exceeded during setup/testing		P
Load condition	Power from grid to load (W)	Limited Power from grid to load) (W)
100% (phase R)	84000	>0
50% (phase R)	42200	>0
100% (phaseS)	83000	>0
50% (phase S)	42000	>0
100% (phaseT)	83000	>0
50% (phase T)	42000	>0

7.4 Fail-safe tests							P
No.	**component No.**	**fault**	**test voltage (V)**	**test time**	**fuse No.**	**Input current (A)**	**Result**
1.	C34 on SP250KHP3	S-C	1000VDC 800VAC	2min	--	36	EUT shut down immediately. Warning: “Positive and negative bus voltage imbalance”. No hazard, no damaged.
2.	R1 on SP250KHP3	S-C	1000VDC 800VAC	2min	--	36	EUT shut down immediately. Warning: “Positive and negative bus voltage imbalance”. No hazard, no damaged.
3.	R582 on SP250KHP2	S-C	1000VDC 800VAC	2min	--	36	Work as normal. No hazard, no damaged.
4.	R592 on SP250KHP2	S-C	1000VDC 800VAC	2min	--	36	Work as normal. No hazard, no damaged.
5.	D71 on SP250KHP2	S-C	1000VDC 800VAC	2min	--	36	Work as normal. No hazard, no damaged.
6.	R129 on SP250KHP2	S-C	1000VDC 800VAC	2min	--	36	Work as normal. No hazard, no damaged.
7.	R129 on SP250KHP2	O-C	1000VDC 800VAC	2min	--	36	Work as normal. No hazard, no damaged.
8.	R497 on SP250KHP2	S-C	1000VDC 800VAC	2min	--	36	EUT shut down immediately. Warning: “Grid voltage anomaly”. No hazard, no damaged.
9.	R497 on SP250KHP2	O-C	1000VDC 800VAC	2min	--	36	EUT shut down immediately. Warning: “Grid voltage anomaly”. No hazard, no damaged.
10.	C41 on SP250KHP2	S-C	1000VDC 800VAC	2min	--	36	Work as normal. No hazard, no damaged
11.	7, 8 winding of T6 on SP250KHP2	S-C	1000VDC 800VAC	2min	--	36	Work as normal. No hazard, no damaged
12.	C40 on SP250KHP2	S-C	1000VDC 800VAC	2min	--	36	Work as normal. No hazard, no damaged
13.	C149 on SP250KHP2	S-C	1000VDC 800VAC	2min	--	36	EUT runs downsized according to the temperature. No hazard, no damaged.
14.	R360 on SP250KHP2	S-C	1000VDC 800VAC	2min	--	36	EUT runs downsized according to the temperature. Warning: “Fan fault”. No hazard, no damaged.
15.	D54 on SP250KHP2	S-C	1000VDC 800VAC	2min	--	36	Work as normal. No hazard, no damaged.

16.	D84 on SP250KHP2	S-C	1000VDC 800VAC	10n	--	36	EUT shut down immediately. Warning: “Drive voltage anomaly ” No hazard, no damaged.
17.	R712 on SP250KHP2	S-C	1000VDC 800VAC	2min	--	36	Work as normal. No hazard, no damaged.
18.	R411 on SP250KHP1	S-C	1000VDC 800VAC	2min	--	36	Work as normal. No hazard, no damaged.
19.	R411 on SP250KHP1	O-C	1000VDC 800VAC	2min	--	36	Turn off this BOOST. Warning: “PV Voltage Low” No hazard, no damaged.
20.	R575 on SP250KHP1	S-C	1000VDC 800VAC	2min	--	36	Work as normal. No hazard, no damaged.
21.	C454 on SP250KHP1	S-C	1000VDC 800VAC	2min	--	36	Work as normal. No hazard, no damaged.
22.	12,13 Pin of U10 on SP250KHP1	S-C	1000VDC 800VAC	2min	--	36	Work as normal. No hazard, no damaged.
23.	R841 on SP250KHP1	S-C	1000VDC 800VAC	2min	--	36	Work as normal. No hazard, no damaged.
24.	R841 on SP250KHP1	O-C	1000VDC 800VAC	2min	--	36	EUT shut down immediately. Warning: “Insulation resistance abnormality”. No hazard, no damaged.
25.	R548 on SP250KHP1	S-C	1000VDC 800VAC	2min	--	36	EUT shut down immediately. Warning: “Positive and negative bus voltage imbalance”. No hazard, no damaged.
26.	7,8 Winding of T1 on SP250KHM3	S-C	1000VDC 800VAC	2min	--	36	EUT shut down this BOOST immediately. Warning: “MPPTBOOST1 open circuit”. No hazard, no damaged.
27.	5,6 Winding of T1 on SP250KHM3	S-C	1000VDC 800VAC	2min	--	36	EUT shut down this BOOST immediately. Warning: “MPPTBOOST2 open circuit”. No hazard, no damaged.
28.	C119 on SP250KHM3	S-C	1000VDC 800VAC	2min	--	36	EUT shut down this BOOST immediately. Warning: “MPPTBOOST1 open circuit”. No hazard, no damaged.
29.	C150 on SP250KHU1	S-C	1000VDC 800VAC	2min	--	36	EUT shut down immediately. No hazard, no damaged.

30.	C153 on SP250KHU1	S-C	1000VDC 800VAC	2min	--	36	EUT shut down immediately. No hazard, no damaged.
31.	D66 on SP250KHU1	S-C	1000VDC 800VAC	2min	--	36	EUT shut down this BOOST immediately. Warning: “MPPT 1 input overvoltage”. No hazard, no damaged.
32.	C305 on SP250KHA1	S-C	1000VDC 800VAC	2min	--	36	Work as normal. Warning: “PV disconnection or occlusion”. No hazard, no damaged.
33.	RLY 1	S-C before starting	1000VDC 800VAC	2min	--	--	The inverter will not start. Warning:” Relay failure” No hazard, no damaged.
34.	RLY 2	S-C before starting	1000VDC 800VAC	2min	--	--	The inverter will not start. Warning:” Relay failure” No hazard, no damaged.
35.	RLY 3	S-C before starting	1000VDC 800VAC	2min	--	--	The inverter will not start. Warning:” Relay failure” No hazard, no damaged.
36.	RLY 4	S-C before starting	1000VDC 800VAC	2min	--	--	The inverter will not start. Warning:” Relay failure” No hazard, no damaged.
37.	RLY 5	S-C before starting	1000VDC 800VAC	2min	--	--	The inverter will not start. Warning:” Relay failure” No hazard, no damaged.
38.	RLY 6	S-C before starting	1000VDC 800VAC	2min	--	--	The inverter will not start. Warning:” Relay failure” No hazard, no damaged.
39.	C phase of output to Earth short circuit	S-C	1000VDC 800VAC	2min	--	36	The EUT automatically shut down. Warning: “grid under voltage”, “anti-islanding” No hazard, no damaged.
40.	PV+ to Earth short circuit	S-C	1000VDC 800VAC	2min	--	36	The inverter will not start. Warning: “pv array earthing resistor abnormal” to the HMI.
41.	Short circuit of PV	S-C	1000VDC 800VAC	2min	--	36	EUT shut down immediately. Warning: “bus voltage short circuit” “anti-islanding” “grid undervoltage” .

42.	Mis-wiring with incorrect phase sequence / AC 3~ Output	S-C	1000VDC 800VAC	2min	--	36	The inverter will not start. Warning: “Grid underfrequency”, “phase asynchronization”, “grid voltage abnormal”, “Grid reverse order”. No hazard, no damaged.
43.	Reverse DC input	S-C	1000VDC 800VAC	2min	--	0	The inverter will not start. Warning: “PV branch reverse” displayed, output switch off.
44.	Fan	O-C	1000VDC 800VAC	2min		36	The inverter works normally with alarming “fan fault”. No hazard, no damaged.
45.	Output short current	S-C	1000VDC 800VAC	2min	--	36	The inverter shutdown automatically. Warning: “Grid undervoltage”, “anti-islanding”, the system audible alarm. No hazard, no damaged.
46.	Output overload	O-L	1000VDC 800VAC	10min	--	144	The output power overload working condition is that input power 120% and output voltage is 115% of rated voltage. The inverter shutdown automatically when the output power overload 115% 15s. Warning: “The grid voltage is abnormal”, “Grid overvoltage” No hazard, no damaged

Note(s): The unit passed electric strength test after single fault test above.

Supplementary information

S-C: Short circuit,

O-C: Open circuit

O-L: Overload.

During the test: Fire do not propagates beyond the PCE;

Equipment do not 60mit molten metal;

Enclosures do not deform to cause non-compliance with the standard;

5.6.3.1 Test A							
Nominal Export Limit in Amp:							P
Nominal Import Limit in Amp:							P
No	Starting level (% of limit value)	Step value (% of limit value)	**CLS** registers change in level? (Yes/No)	Final level (% of limit value)	Reaction time(s)	Duration of step in test (s)	Correct state 1/ state 2 operation (Yes/No)
				⩽95% of limit value	⩽58s		
1	95	10	Yes	95	45	58	Yes
2	--	--	--	--	--	--	--
3	95	25	Yes	95	51	58	Yes
4	95	10	Yes	95	53	58	Yes
5	--	--	--	--	--	--	--
6	95	25	Yes	95	50	58	Yes

5.6.3.2 Test B						
Nominal Export Limit in Amp:						P
Nominal Import Limit in Amp:						P
No	Starting level (% of limit value)	Step value (% of limit value)	**CLS** registers change in level? (Yes/No)	Final level (% of limit value) ⩽95% of limit value	Duration of step in test (s)	Correct state 3 operation (Yes/No)
7	95	10	Yes	95	62	Yes
8	95	10	Yes	95	62	Yes

5.6.3.3 Test C						
Nominal Voltage:						P
No	Starting voltage (% of nominal value)	Step value (% of nominal value)	**CLS** registers change in level? (Yes/No)	**CLS** and/or **Component** and/or **Device** initiates correct response? (Yes/No)	Duration of step in test (s)	Correct state 1/ state 2 operation (Yes/No)
9	100	11	Yes	Yes	58	Yes

5.6.3.4 Test D						
Nominal Voltage:						P
No	Starting voltage (% of nominal value)	Step value (% of nominal value)	**CLS** registers change in level? (Yes/No)	**CLS** and/or **Component** and/or **Device** initiates correct response? (Yes/No)	Duration of step in test (s)	Correct state 3 operation (Yes/No)
10	100	11	Yes	Yes	62	Yes

5.6.3.5 Test E						
Nominal Voltage:						P
No	Starting voltage (% of nominal value)	Step value (% of nominal value)	**CLS** registers change in level? (Yes/No)	**CLS** and/or **Component** and/or **Device** initiates correct response? (Yes/No)	Duration of step in test (s)	Correct state 1/ state 2 operation (Yes/No)
11	98	5	Yes	Yes	58	Yes

5.6.3.6 Test F	
Nominal Voltage:	P

No	Starting voltage (% of nominal value)	Step value (% of nominal value)	**CLS** registers change in level? (Yes/No)	**CLS** and/or **Component** and/or **Device** initiates correct response? (Yes/No)	Duration of step in test (s)	Correct state 3 operation (Yes/No)
12	98	5	Yes	Yes	62	Yes

5.6.3.7 Test G						
Nominal Voltage:						P
No	Starting voltage (% of nominal value)	Step value (% of nominal value)	**CLS** registers change in level? (Yes/No)	**CLS** and/or **Component** and/or **Device** initiates correct response? (Yes/No)	Duration of step in test (s)	Correct state 1/ state 2 operation (Yes/No)
13	100	14	Yes	Yes	0.98	Yes

5.6.3.8 Test H						
Nominal Voltage:						P
No	Starting voltage (% of nominal value)	Step value (% of nominal value)	**CLS** registers change in level? (Yes/No)	**CLS** and/or **Component** and/or **Device** initiates correct response? (Yes/No)	Duration of step in test (s)	Correct state 3 operation (Yes/No)
14	100	14	Yes	Yes	1.02	Yes

5.6.3.9 Test J						
Nominal Voltage:						P
No	Starting voltage (% of nominal value)	Step value (% of nominal value)	**CLS** registers change in level? (Yes/No)	**CLS** and/or **Component** and/or **Device** initiates correct response? (Yes/No)	Duration of step in test (s)	Correct state 1/ state 2 operation (Yes/No)
15	95	17	Yes	Yes	0.98	Yes

5.6.3.10 Test K						
Nominal Voltage:						P
No	Starting voltage (% of nominal value)	Step value (% of nominal value)	**CLS** registers change in level? (Yes/No)	**CLS** and/or **Component** and/or **Device** initiates correct response? (Yes/No)	Duration of step in test (s)	Correct state 3 operation (Yes/No)
16	95	17	Yes	Yes	1.02	Yes

-- End of the report--

TEST REPORT
Engineering recommendation G99/1-8
Recommendation for the connection of the generation equipment in parallel with public distribution network

Report Reference No. ..... :	See report CN23PFO6 001	
Tested by (name + signature)..... :	See report CN23PFO6 001	.....
Witnessed by (name + signature) . :	See report CN23PFO6 001	.....
Supervised by (name + signature) :	See report CN23PFO6 001	.....
Approved by (name + signature) .. :	See report CN23PFO6 001	.....
Date of issue ..... :	See report CN23PFO6 001	
Testing Laboratory ..... :	See report CN23PFO6 001	
Address ..... :	See report CN23PFO6 001	
Testing location/ address..... :	See report CN23PFO6 001	
Applicant's name..... :	See report CN23PFO6 001	
Address ..... :	See report CN23PFO6 001	
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 ..... :	2018-12	
Test item description ..... :	See report CN23PFO6 001	
Trade Mark ..... :	See report CN23PFO6 001	
Manufacturer..... :	See report CN23PFO6 001	
Model/Type reference ..... :	See report CN23PFO6 001	
Ratings……..:	See report CN23PFO6 001	

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

See report CN23PFO6 001

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 report CN23PFO6 001

Copy of marking plate:

See report CN23PFO6 001

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 report CN23PFO6 001
Pollution degree..... :	☐ PD 1 ☐PD 2 ☒ PD 3 (internal reduced to PD 2)
IP protection class ..... :	IP66
..... :	

Testing

Date of receipt of test item(s) ..... :	See report CN23PFO6 001
Dates tests performed ..... :	See report CN23PFO6 001

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) ..... :	See report CN23PFO6 001

General product information:
See report CN23PFO6 001

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	Considered	**P**

Engineering recommendation G99/1-9			
Clause	**Requirement – Test**	**Result – Remark**	**Verdict**
	operation of the Power Park Module Interface Protection shall result: a) in the safe disconnection of the Power Park Module from the DNO's Distribution Network in the event that system parameters exceed the protection settings specified in Table 10.1; and b) in the Power Park Module remaining connected to the DNO's Distribution Network while Distribution Network conditions are: (1) within the envelope specified by the settings plus and minus the tolerances specified for equipment operation in Table 10.1; and (2) within the trip delay settings specified in Table 10.1.		
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**	Test results see appended table.	**P**

Engineering recommendation G99/1-9			
Clause	**Requirement – Test**	**Result – Remark**	**Verdict**
	The tests should be carried out in accordance with BS EN 62116 and a subset of results should be recorded as indicated in the Protection – loss of mains test section of Annex A.2-3 Type Test Verification Report. Multi phase Power Park 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.	Test results see appended table.	**P**

Engineering recommendation G99/1-9			
Clause	**Requirement – Test**	**Result – Remark**	**Verdict**
	The Manufacturer or Generator can choose which is the more appropriate test for the Power Generating Module. 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**	Test results see appended table.	**P**

Engineering recommendation G99/1-9			
Clause	**Requirement – Test**	**Result – Remark**	**Verdict**
	The level of DC injection from the Power Park Module -connected prime mover in to the DNO's Distribution Network shall not exceed the levels specified in 9.4.5 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	Test results see appended table.	**P**

Engineering recommendation G99/1-9			
Clause	**Requirement – Test**	**Result – Remark**	**Verdict**
	load (ie replenishing its energy store) responds to changes in system frequency. In general, four tests are proposed, one set of two at Rated Import Capacity, and one set of two at 40% of Rated Import Capacity. In both cases the test is to reduce frequency from 50 Hz at 2 Hzs-1. In the first case the lower frequency reached will be 49.0 Hz and the second case the lower frequency will be 48.8 Hz. In all cases the response shall meet the requirements of 11.2.3.3.		
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:		**N/A**

Engineering recommendation G99/1-9			
Clause	**Requirement – Test**	**Result – Remark**	**Verdict**
	a) in the safe disconnection of the Power Generating Module from the DNO's Distribution Network in the event that the protection settings specified in Table 10.1 are exceeded; and 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		**N/A**

Engineering recommendation G99/1-9			
Clause	**Requirement – Test**	**Result – Remark**	**Verdict**
	disconnects from the supply will be 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**		**N/A**

Engineering recommendation G99/1-9			
Clause	**Requirement – Test**	**Result – Remark**	**Verdict**
	The two frequency response tests in Limited Frequency Sensitive Mode (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.		**N/A**

Engineering recommendation G99/1-9			
Clause	**Requirement – Test**	**Result – Remark**	**Verdict**
	The required maximum supply impedance should be calculated and recorded in 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	Considered	**P**
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.	Not such equipment	**N/A**

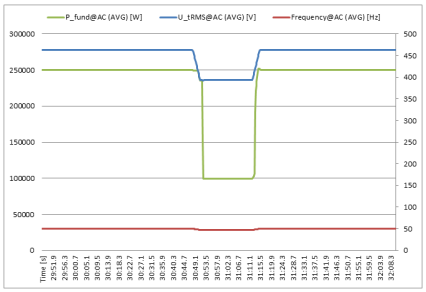
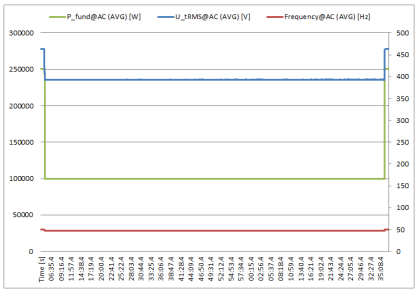
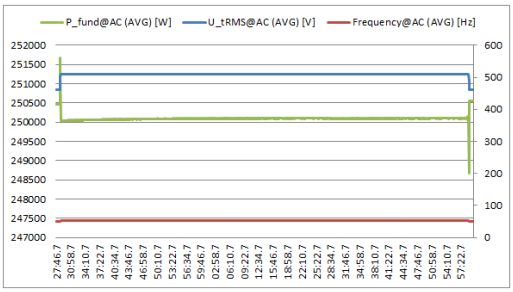
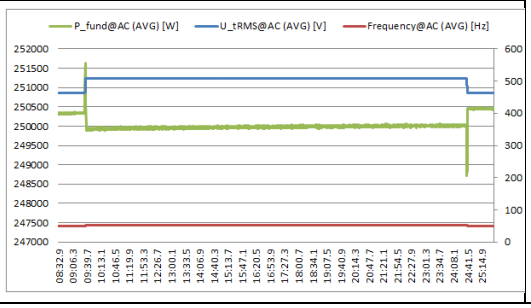
Engineering recommendation G99/1-9			
Clause	**Requirement – Test**	**Result – Remark**	**Verdict**
	For those connected directly to the DNO's Distribution Network, the type verification testing and Interface Protection requirements shall be as specified in Annex A.7.2.		
A.7.3.6	**Energy Storage Device** 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	Not such equipment	**N/A**

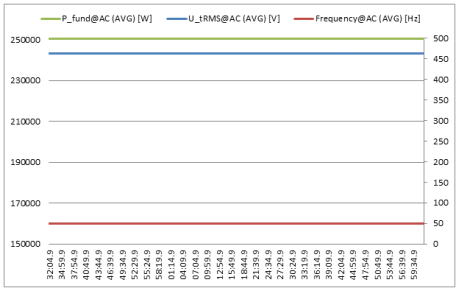
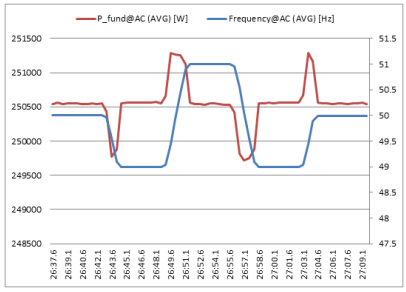
Project Engineer:	See cover page	Reviewer:	See cover page
Signature:	See cover page	Signature:	See cover page

Testing Location:	
Name:	See report CN23PFO6 001
Address:	See report CN23PFO6 001

Product Information:
See report CN23PFO6 001

Clause	Test items	Remark
1	Normal operating range (Operation range)	
2.1	Harmonics current (THDi)	For PGU ≤ 75A, per IEC 61000-3-12
2.2	Harmonics current (Iinter & Ihigher)	Extra test than A2-3 report form, particular for PGU > 75A
3.1	Voltage fluctuations (Flicker)	For PGU ≤ 75A, per IEC 61000-3-11
3.2	Voltage fluctuations (Flicker)	Extra test than A2-3 report form, particular for PGU > 75A
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				Measurements	Limitation
U/Un	f [Hz]	cosφ	t [s]		
85%(195.5 V)	47.0	1.00	20		No disconnect
85%(195.5 V)	47.5	1.00	5400		No disconnect
110%(253 V)	51.5	1.00	5400		No disconnect
110%(253 V)	52.0	1.00	900		No disconnect

100%(230 V)	50.0	1.00	5400		No disconnect
RoCoF-frequency change rate 1Hz/s					No disconnect

Note(s):

***** Function of interface protection and activating active power response to over/under frequency and voltage shall be disable.

2.2	TABLE: Harmonics current (Iinter & Ihigher) per BS EN 61000-4-7 (Extra test other than form A2-3)										P
P/P_n [%]	0	10	20	30	40	50	60	70	80	90	100
Order No.	I/In [%]										
1	4.170	10.17	20.19	30.20	40.21	50.20	60.19	70.19	80.18	90.21	100.34
2	0.070	0.123	0.143	0.121	0.106	0.101	0.082	0.035	0.045	0.059	0.073
3	0.144	0.136	0.149	0.151	0.171	0.160	0.189	0.153	0.176	0.255	0.509
4	0.071	0.056	0.116	0.153	0.160	0.161	0.189	0.125	0.143	0.132	0.121
5	0.258	0.168	0.211	0.211	0.187	0.161	0.171	0.121	0.142	0.157	0.266
6	0.065	0.053	0.054	0.058	0.084	0.091	0.127	0.084	0.065	0.074	0.059
7	0.184	0.117	0.073	0.111	0.139	0.133	0.105	0.145	0.123	0.101	0.102
8	0.040	0.042	0.096	0.064	0.053	0.046	0.095	0.027	0.043	0.040	0.056
9	0.040	0.057	0.070	0.068	0.064	0.050	0.079	0.103	0.097	0.090	0.106
10	0.064	0.080	0.062	0.057	0.078	0.071	0.146	0.094	0.100	0.089	0.092
11	1.454	0.721	0.724	0.753	0.392	0.157	0.684	0.375	0.668	0.789	0.930
12	0.055	0.061	0.065	0.055	0.062	0.076	0.115	0.064	0.062	0.047	0.049
13	0.739	1.082	0.426	0.459	0.519	0.292	0.718	0.273	0.538	0.431	0.407
14	0.032	0.052	0.088	0.053	0.041	0.053	0.146	0.064	0.063	0.066	0.077
15	0.064	0.075	0.080	0.095	0.048	0.066	0.079	0.072	0.128	0.121	0.141
16	0.044	0.063	0.067	0.067	0.049	0.060	0.072	0.093	0.092	0.092	0.088
17	0.335	0.823	0.398	0.274	0.271	0.502	0.415	0.505	0.310	0.213	0.205
18	0.037	0.047	0.053	0.054	0.050	0.045	0.125	0.056	0.057	0.065	0.072
19	0.467	0.689	0.571	0.128	0.095	0.385	0.618	0.185	0.187	0.087	0.108
20	0.043	0.050	0.076	0.054	0.063	0.069	0.170	0.064	0.061	0.064	0.083
21	0.087	0.118	0.046	0.081	0.043	0.061	0.067	0.075	0.124	0.097	0.090
22	0.041	0.059	0.075	0.061	0.044	0.062	0.074	0.070	0.080	0.060	0.068

23	0.694	0.704	0.298	0.314	0.083	0.075	0.348	0.627	0.317	0.267	0.210
24	0.040	0.040	0.050	0.058	0.061	0.054	0.069	0.046	0.068	0.057	0.064
25	0.636	0.558	0.423	0.263	0.221	0.040	0.239	0.331	0.472	0.452	0.370
26	0.044	0.026	0.046	0.048	0.043	0.053	0.147	0.064	0.059	0.054	0.064
27	0.059	0.062	0.032	0.065	0.045	0.043	0.063	0.100	0.111	0.134	0.131
28	0.048	0.034	0.034	0.062	0.048	0.053	0.076	0.081	0.083	0.066	0.066
29	0.289	0.399	0.491	0.203	0.276	0.197	0.089	0.630	0.420	0.536	0.573
30	0.047	0.040	0.043	0.063	0.058	0.062	0.052	0.064	0.073	0.060	0.067
31	0.144	0.403	0.408	0.243	0.158	0.270	0.095	0.264	0.422	0.320	0.281
32	0.027	0.022	0.036	0.033	0.035	0.053	0.117	0.070	0.080	0.094	0.104
33	0.033	0.028	0.046	0.037	0.042	0.034	0.073	0.129	0.140	0.118	0.107
34	0.030	0.029	0.030	0.057	0.057	0.041	0.056	0.093	0.087	0.089	0.103
35	0.261	0.132	0.336	0.243	0.110	0.189	0.109	0.503	0.192	0.329	0.342
36	0.031	0.027	0.031	0.054	0.054	0.049	0.044	0.056	0.065	0.068	0.081
37	0.309	0.077	0.362	0.180	0.108	0.088	0.269	0.304	0.233	0.239	0.350
38	0.014	0.019	0.028	0.027	0.033	0.037	0.070	0.050	0.070	0.070	0.071
39	0.024	0.025	0.021	0.030	0.027	0.028	0.049	0.052	0.035	0.043	0.041
40	0.021	0.022	0.026	0.043	0.044	0.036	0.043	0.070	0.040	0.041	0.051
41	0.221	0.135	0.240	0.174	0.116	0.066	0.109	0.338	0.181	0.225	0.220
42	0.020	0.021	0.019	0.040	0.039	0.043	0.036	0.040	0.042	0.039	0.039
43	0.147	0.122	0.205	0.165	0.090	0.072	0.129	0.174	0.182	0.141	0.202
44	0.010	0.017	0.015	0.020	0.020	0.029	0.040	0.028	0.028	0.028	0.028
45	0.016	0.023	0.012	0.017	0.018	0.017	0.029	0.031	0.039	0.053	0.038
46	0.017	0.023	0.017	0.031	0.032	0.026	0.034	0.038	0.029	0.029	0.027
47	0.052	0.132	0.185	0.120	0.066	0.072	0.046	0.163	0.052	0.059	0.064

48	0.018	0.022	0.020	0.032	0.035	0.037	0.036	0.035	0.034	0.033	0.034
49	0.080	0.148	0.154	0.103	0.071	0.062	0.079	0.076	0.062	0.049	0.069
50	0.008	0.013	0.013	0.016	0.018	0.020	0.019	0.020	0.018	0.019	0.017
THD	1.136	1.096	0.846	0.674	1.284	0.959	1.293	1.130	0.895	0.823	0.786
PWHD	44.154	66.407	39.774	16.050	11.184	14.505	28.326	46.360	31.280	30.645	31.649
Inter-harmonics											
P/P_n [%]	0	10	20	30	40	50	60	70	80	90	100
f [Hz]	I/In [%]										
75	0.020	0.024	0.027	0.031	0.034	0.035	0.062	0.053	0.062	0.074	0.074
125	0.038	0.038	0.040	0.041	0.044	0.044	0.061	0.056	0.063	0.068	0.068
175	0.029	0.031	0.033	0.037	0.039	0.039	0.060	0.052	0.059	0.064	0.061
225	0.031	0.030	0.035	0.038	0.042	0.042	0.060	0.054	0.056	0.060	0.059
275	0.027	0.028	0.030	0.033	0.036	0.035	0.056	0.047	0.050	0.055	0.053
325	0.028	0.029	0.032	0.035	0.038	0.038	0.056	0.051	0.054	0.057	0.055
375	0.032	0.034	0.037	0.040	0.044	0.044	0.064	0.057	0.059	0.064	0.061
425	0.035	0.039	0.043	0.046	0.049	0.050	0.073	0.063	0.064	0.070	0.068
475	0.035	0.038	0.042	0.045	0.049	0.049	0.073	0.065	0.066	0.073	0.072
525	0.037	0.039	0.043	0.046	0.050	0.050	0.071	0.065	0.064	0.075	0.072
575	0.037	0.039	0.043	0.046	0.051	0.053	0.075	0.066	0.066	0.074	0.071
625	0.038	0.041	0.045	0.046	0.052	0.054	0.073	0.069	0.069	0.077	0.074
675	0.039	0.042	0.043	0.046	0.052	0.055	0.076	0.071	0.070	0.079	0.076
725	0.036	0.039	0.044	0.045	0.053	0.057	0.074	0.070	0.073	0.080	0.076
775	0.036	0.039	0.044	0.045	0.053	0.059	0.074	0.072	0.075	0.083	0.078
825	0.036	0.040	0.044	0.046	0.054	0.059	0.073	0.074	0.077	0.084	0.080
875	0.036	0.039	0.043	0.046	0.054	0.062	0.073	0.074	0.080	0.086	0.081
925	0.036	0.039	0.044	0.047	0.055	0.062	0.073	0.077	0.082	0.089	0.085

975	0.036	0.038	0.043	0.048	0.056	0.065	0.072	0.078	0.087	0.095	0.089
1025	0.035	0.037	0.042	0.048	0.057	0.065	0.070	0.077	0.083	0.088	0.085
1075	0.034	0.035	0.041	0.050	0.058	0.065	0.070	0.078	0.083	0.089	0.086
1125	0.034	0.036	0.041	0.050	0.057	0.065	0.070	0.080	0.084	0.087	0.084
1175	0.033	0.035	0.040	0.051	0.057	0.065	0.070	0.079	0.081	0.088	0.084
1225	0.032	0.034	0.039	0.050	0.057	0.064	0.070	0.080	0.082	0.087	0.084
1275	0.031	0.033	0.039	0.050	0.055	0.063	0.068	0.079	0.084	0.086	0.082
1325	0.028	0.031	0.038	0.049	0.054	0.062	0.066	0.081	0.083	0.084	0.084
1375	0.027	0.029	0.036	0.047	0.052	0.060	0.065	0.083	0.083	0.086	0.083
1425	0.026	0.028	0.036	0.045	0.050	0.058	0.065	0.088	0.086	0.089	0.085
1475	0.025	0.027	0.034	0.042	0.047	0.055	0.062	0.090	0.086	0.091	0.085
1525	0.023	0.026	0.032	0.040	0.043	0.051	0.060	0.091	0.089	0.091	0.088
1575	0.021	0.025	0.030	0.036	0.039	0.048	0.056	0.090	0.089	0.095	0.090
1625	0.022	0.022	0.027	0.033	0.035	0.042	0.051	0.090	0.086	0.092	0.090
1675	0.019	0.021	0.025	0.029	0.031	0.038	0.049	0.086	0.085	0.091	0.087
1725	0.019	0.021	0.024	0.026	0.027	0.033	0.045	0.085	0.078	0.087	0.086
1775	0.017	0.018	0.023	0.024	0.025	0.029	0.042	0.080	0.071	0.080	0.077
1825	0.017	0.017	0.021	0.021	0.022	0.026	0.040	0.073	0.066	0.071	0.068
1875	0.016	0.017	0.020	0.019	0.021	0.023	0.038	0.065	0.063	0.067	0.062
1925	0.014	0.016	0.018	0.018	0.019	0.021	0.034	0.060	0.055	0.059	0.055
1975	0.013	0.015	0.017	0.018	0.018	0.019	0.033	0.054	0.053	0.054	0.051

Higher frequency harmonics											
P/P_n [%]	0	10	20	30	40	50	60	70	80	90	100
f [kHz]	| [%]	| [%]	| [%]	| [%]	| [%]	| [%]	| [%]	| [%]	| [%]	| [%]	| [%]
2.1	0.266	0.183	0.317	0.242	0.154	0.114	0.179	0.379	0.275	0.284	0.313
2.3	0.065	0.140	0.189	0.131	0.090	0.092	0.084	0.182	0.095	0.107	0.090
2.5	0.086	0.152	0.158	0.112	0.087	0.079	0.101	0.112	0.099	0.113	0.108
2.7	0.163	0.208	0.179	0.170	0.085	0.080	0.115	0.127	0.159	0.215	0.173
2.9	0.054	0.153	0.100	0.109	0.066	0.064	0.096	0.105	0.143	0.192	0.179
3.1	0.053	0.090	0.090	0.096	0.069	0.043	0.067	0.088	0.088	0.099	0.084
3.3	0.123	0.104	0.079	0.127	0.068	0.035	0.065	0.098	0.074	0.076	0.083
3.5	0.058	0.046	0.053	0.073	0.042	0.038	0.056	0.060	0.068	0.064	0.061
3.7	0.029	0.034	0.040	0.057	0.036	0.030	0.049	0.074	0.063	0.069	0.070
3.9	0.079	0.065	0.036	0.064	0.043	0.034	0.046	0.070	0.084	0.081	0.086
4.1	0.064	0.046	0.031	0.054	0.039	0.038	0.047	0.065	0.063	0.069	0.076
4.3	0.049	0.078	0.027	0.047	0.034	0.027	0.033	0.053	0.053	0.049	0.053
4.5	0.042	0.083	0.044	0.067	0.042	0.023	0.028	0.049	0.042	0.046	0.052
4.7	0.062	0.051	0.029	0.049	0.034	0.023	0.026	0.033	0.034	0.037	0.039
4.9	0.065	0.053	0.034	0.045	0.032	0.022	0.024	0.035	0.030	0.034	0.036
5.1	0.041	0.049	0.044	0.060	0.038	0.022	0.022	0.031	0.030	0.030	0.031
5.3	0.046	0.035	0.040	0.046	0.032	0.019	0.023	0.028	0.027	0.032	0.031
5.5	0.061	0.028	0.040	0.041	0.031	0.019	0.022	0.028	0.026	0.030	0.031
5.7	0.074	0.056	0.047	0.058	0.040	0.022	0.020	0.027	0.026	0.026	0.025
5.9	0.033	0.066	0.046	0.048	0.031	0.019	0.020	0.027	0.026	0.026	0.027
6.1	0.047	0.060	0.042	0.041	0.031	0.019	0.020	0.025	0.025	0.025	0.025
6.3	0.100	0.098	0.062	0.061	0.045	0.023	0.021	0.025	0.024	0.025	0.026

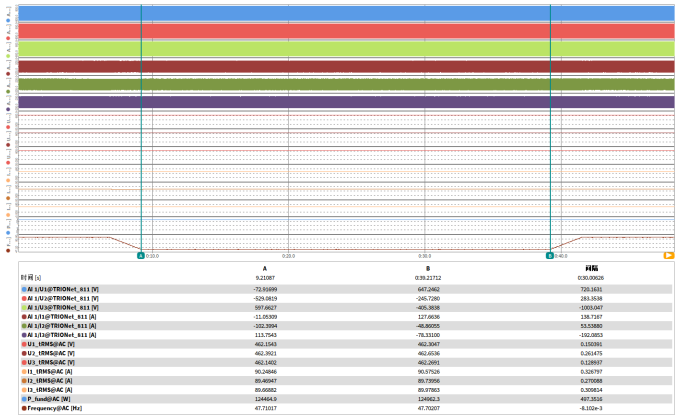
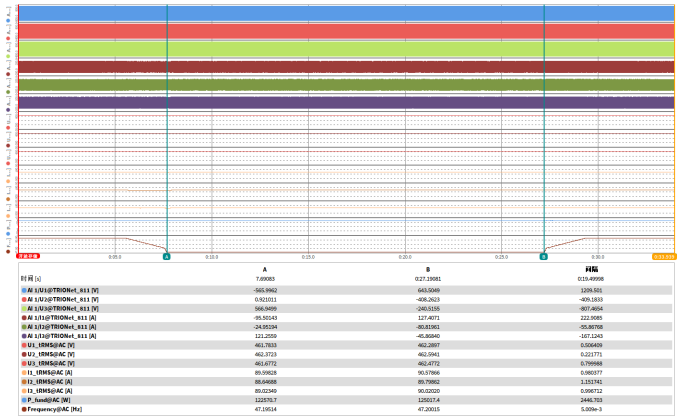
Higher frequency harmonics											
P/P_n [%]	0	10	20	30	40	50	60	70	80	90	100
f [kHz]	I [%]	I [%]	I [%]	I [%]	I [%]	I [%]	I [%]	I [%]	I [%]	I [%]	I [%]
6.5	0.081	0.100	0.073	0.073	0.062	0.061	0.060	0.062	0.059	0.054	0.052
6.7	0.047	0.073	0.048	0.048	0.043	0.043	0.048	0.056	0.056	0.061	0.066
6.9	0.063	0.062	0.063	0.060	0.054	0.044	0.050	0.054	0.059	0.062	0.068
7.1	0.053	0.053	0.040	0.047	0.040	0.037	0.028	0.029	0.027	0.026	0.024
7.3	0.031	0.037	0.031	0.032	0.036	0.033	0.029	0.031	0.030	0.031	0.032
7.5	0.021	0.031	0.028	0.030	0.037	0.032	0.031	0.026	0.023	0.022	0.021
7.7	0.027	0.027	0.024	0.026	0.028	0.032	0.035	0.033	0.028	0.025	0.025
7.9	0.016	0.022	0.019	0.019	0.022	0.028	0.031	0.032	0.032	0.028	0.026
8.1	0.012	0.019	0.016	0.018	0.020	0.027	0.032	0.035	0.029	0.028	0.026
8.3	0.014	0.015	0.015	0.016	0.017	0.025	0.031	0.037	0.040	0.038	0.038
8.5	0.010	0.012	0.012	0.013	0.014	0.021	0.027	0.032	0.037	0.037	0.036
8.7	0.009	0.010	0.011	0.012	0.013	0.019	0.023	0.031	0.033	0.039	0.036
8.9	0.009	0.010	0.011	0.011	0.012	0.019	0.024	0.032	0.032	0.040	0.036
Note(s):											

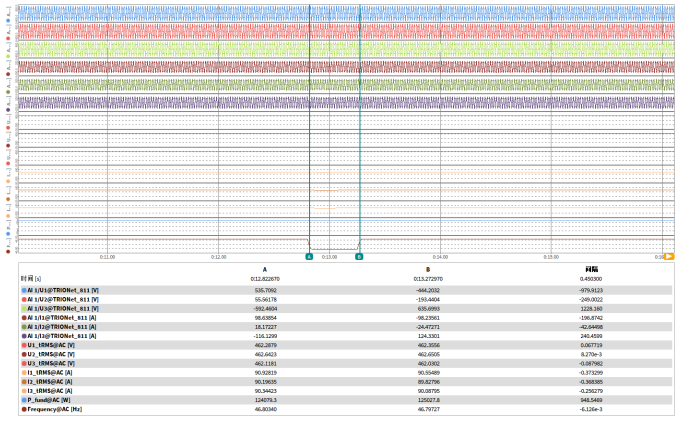
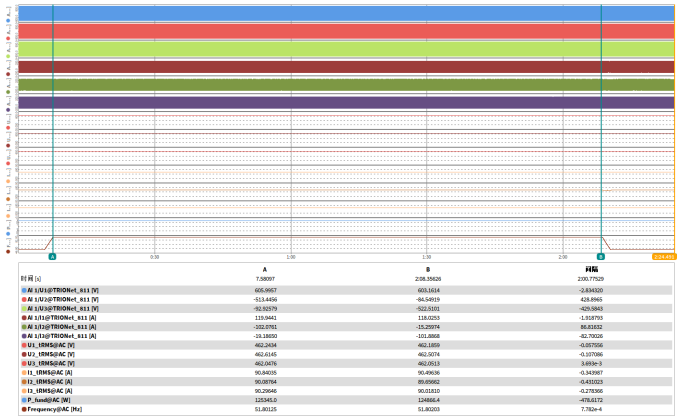
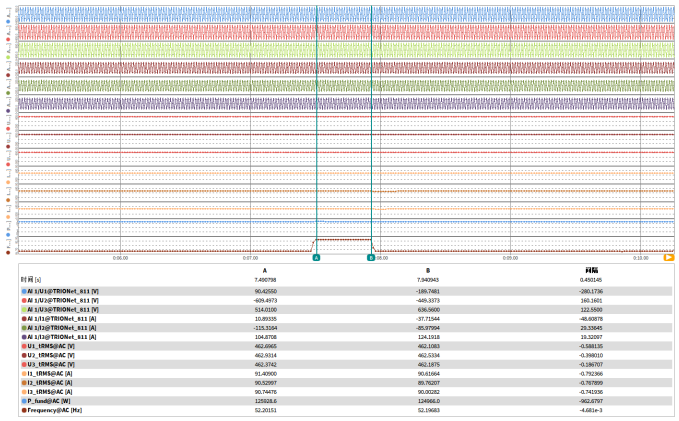
3.2	TABLE: Voltage fluctuations (Flicker) per BS EN 61400-21 (Extra test other than form A2-3)		P
30° impedance angle			
Measurement	P/Pn [%]	Pst	Cφk
1	10	0.014	1.886
2	20	0.020	1.858
3	30	0.021	1.876
4	40	0.023	1.822
5	50	0.027	1.894
6	60	0.028	1.921
7	70	0.032	1.809
8	80	0.034	1.903
9	90	0.036	1.929
10	100	0.039	1.91
11	100	0.039	2.003
12	100	0.049	1.955
50° impedance angle			
Measurement	P/Pn [%]	Pst	Cφk
1	10	0.013	1.407
2	20	0.016	1.467
3	30	0.017	1.509
4	40	0.018	1.531
5	50	0.021	1.651
6	60	0.022	1.661
7	70	0.025	1.641
8	80	0.026	1.638
9	90	0.028	1.698
10	100	0.030	1.639
11	100	0.030	1.697
12	100	0.037	1.476
70° impedance angle			
Measurement	P/Pn [%]	Pst	Cφk
1	10	0.011	1.386
2	20	0.012	1.358
3	30	0.012	1.413
4	40	0.013	1.366
5	50	0.014	1.475

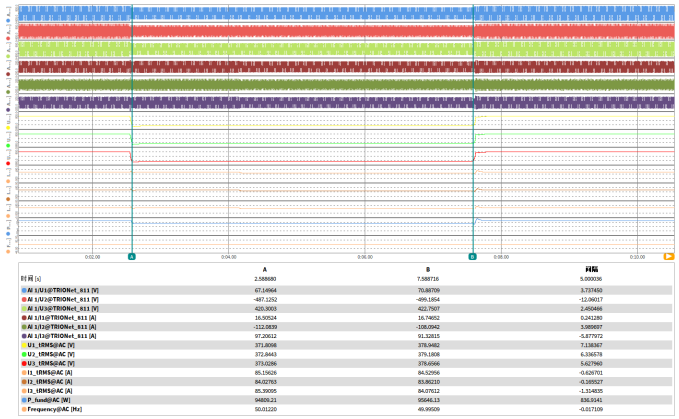
6	60	0.015	1.441
7	70	0.016	1.349
8	80	0.016	1.314
9	90	0.017	1.320
10	100	0.018	1.310
11	100	0.018	1.289
12	100	0.022	1.136
85° impedance angle			
Measurement	P/Pn [%]	Pst	Cφk
1	10	0.011	0.387
2	20	0.010	0.379
3	30	0.010	0.394
4	40	0.010	0.381
5	50	0.010	0.410
6	60	0.010	0.401
7	70	0.011	0.377
8	80	0.011	0.367
9	90	0.011	0.369
10	100	0.011	0.366
11	100	0.011	0.361
12	100	0.012	0.417
Note(s):			

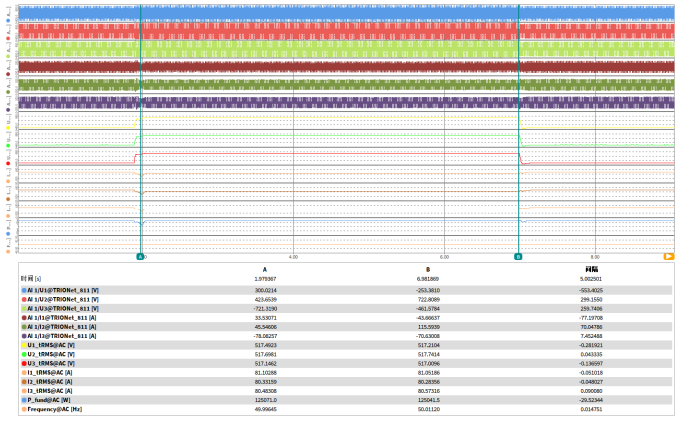
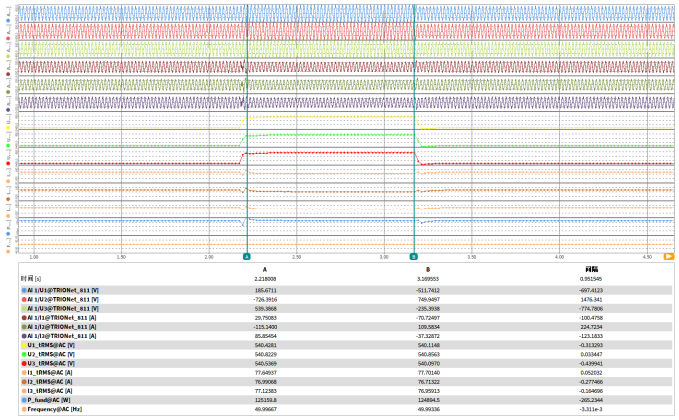
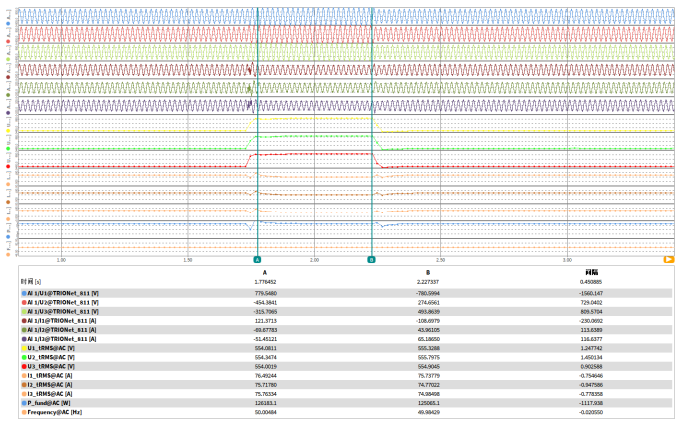
4	TABLE: Power quality – DC injection:		P
Test power level	10%	55%	100%
Recorded DC value in Amps	0.001	0.003	0.001
as % of rated AC current	0.08	0.16	0.06
Limit	0.25%	0.25%	0.25%
Note(s):			

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	235.90	-0.49	1.0000	435.01	180.81	>0.95
100%	1.00	1.0	249.05	-0.49	1.0000	462.56	179.53	>0.95
100%	1.00	1.1	249.21	-0.54	1.0000	508.31	163.47	>0.95
Note(s):								

6	TABLE: Protection-Frequency tests (OF/UF)		P
Condition	Setting [Hz]	Measurement	Limitation
		Trip value [Hz]	
F>>	52.0	52.01	± 0.1% of f_n
F<	47.5	47.49	
F<<	47	46.99	
Condition	Setting [ms]	Measurement	Limitation [ms]
		Time delay	
F>>	500	534	500-600
F<	20000	20052	20000-20100
F<<	500	541	500-600
Condition		Measurement	limitation
F [Hz]	t [s]		
47.7	30		No trip
47.2	19.5		No trip

46.8	0.45		No trip
51.8	120		No trip
52.2	0.45		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 (549.8 V)	548.2	548.6	547.8	549.2	± 1% of U_n
U>	1.14 (526.7 V)	525.2	525.6	526.8	526.2	
U<<	0.80 (369.6 V)	367.2	368.4	367.9	369.1	
Condition	Setting [ms]	Measurement				Limitation
		Time delay				
		L1	L2	L3	L123	
U>>	500	535	534	537	539	500-600
U>	1000	1017	1032	1038	1024	1000-1100
U<<	2500	2542	2534	2537	2525	2500-2600
Condition		Measurement				limitation
U/Un	time [s]					
0.82 (378.8 V)	5					No trip
0.78 (360.4 V)	2.45					No trip

1.12 (517.4 V)	5		No trip
1.17 (540.5 V)	0.95		No trip
1.20 (554.4 V)	0.45		No trip
Note(s):			

8.1	TABLE: Protection-Loss of mains test	P

Power 100%						
Input : 1080 Vdc						
Conditions	P_R [kW]	Q_L [kVar]	Q_C [kVar]	Q_f	Trip time [ms]	Limitation [ms]
P_R: -5% Q_C: +5%	L1: 86.6	L1: 83.3	L1: 79.2	0.929	78.8	500
	L2: 86.4	L2: 83.3	L2: 79.1	0.928		
	L3: 83.4	L3: 83.3	L3: 79.2	0.931		
P_R: -5% Q_C: 0%	L1: 86.7	L1: 83.3	L1: 83.6	0.954	101.8	500
	L2: 86.4	L2: 83.3	L2: 83.5	0.954		
	L3: 83.6	L3: 83.3	L3: 83.6	0.954		
P_R: -5% Q_C: -5%	L1: 86.7	L1: 83.3	L1: 87.3	0.975	78.0	500
	L2: 86.2	L2: 83.3	L2: 87.3	0.978		
	L3: 83.5	L3: 83.2	L3: 87.3	0.975		
P_R: 0% Q_C: +5%	L1: 82.2	L1: 83.3	L1: 79.3	0.980	128.5	500
	L2: 81.5	L2: 83.3	L2: 79.3	0.985		
	L3: 79.0	L3: 83.3	L3: 79.4	0.981		
P_R: 0% Q_C: 0%	L1: 82.5	L1: 83.3	L1: 83.5	1.001	142.5	500
	L2: 82.3	L2: 83.3	L2: 83.5	1.000		
	L3: 79.3	L3: 83.3	L3: 83.7	1.004		
P_R: 0% Q_C: -5%	L1: 82.5	L1: 83.3	L1: 86.9	1.023	126.8	500
	L2: 81.9	L2: 83.4	L2: 86.7	1.025		
	L3: 79.3	L3: 83.5	L3: 86.8	1.023		
P_R: +5% Q_C: +5%	L1: 77.8	L1: 83.3	L1: 79.2	1.035	106.3	500
	L2: 77.9	L2: 83.3	L2: 79.0	1.028		
	L3: 75.0	L3: 83.2	L3: 79.2	1.029		
P_R: +5% Q_C: 0%	L1: 78.3	L1: 83.3	L1: 83.5	1.054	112.5	500
	L2: 78.0	L2: 83.3	L2: 83.6	1.055		
	L3: 75.1	L3: 83.4	L3: 83.6	1.057		
P_R: +5% Q_C: -5%	L1: 78.3	L1: 83.3	L1: 87.6	1.081	102.3	500
	L2: 77.9	L2: 83.3	L2: 87.5	1.081		
	L3: 75.1	L3: 83.3	L3: 87.5	1.081		

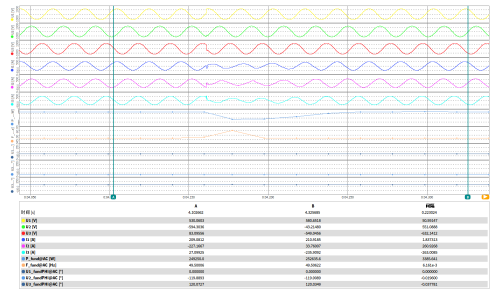
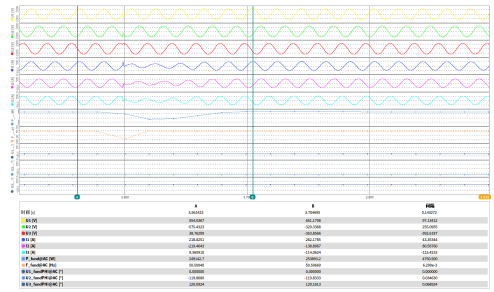
Power 66%						
Input : 850 Vdc						
Conditions	P_R [kW]	Q_L [kVar]	Q_C [kVar]	Q_f	Trip time [ms]	Limitation [ms]

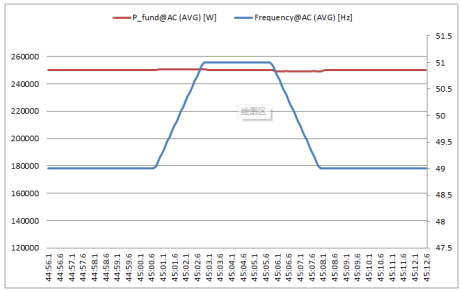
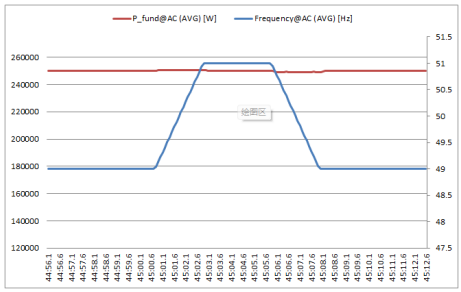
P_R: 0% Q_C: -5%	L1: 42.8	L1: 44.1	L1: 46.8	1.032	94.3	500
	L2: 43.0	L2: 44.0	L2: 46.7	1.033		
	L3: 42.2	L3: 44.0	L3: 46.8	1.031		
P_R: 0% Q_C: -4%	L1: 42.7	L1: 44.0	L1: 45.6	1.020	106.3	500
	L2: 43.0	L2: 44.0	L2: 45.6	1.020		
	L3: 42.2	L3: 44.0	L3: 45.5	1.017		
P_R: 0% Q_C: -3%	L1: 42.8	L1: 44.0	L1: 45.3	1.015	109.0	500
	L2: 43.0	L2: 44.0	L2: 45.2	1.014		
	L3: 42.1	L3: 44.0	L3: 45.3	1.017		
P_R: 0% Q_C: -2%	L1: 42.8	L1: 44.0	L1: 44.9	1.010	116.3	500
	L2: 43.0	L2: 44.0	L2: 44.8	1.011		
	L3: 42.2	L3: 44.0	L3: 44.8	1.009		
P_R: 0% Q_C: -1%	L1: 42.8	L1: 44.0	L1: 44.3	1.003	124.3	500
	L2: 43.0	L2: 44.0	L2: 44.4	1.005		
	L3: 42.1	L3: 44.0	L3: 44.3	1.006		
P_R: 0% Q_C: 0%	L1: 42.7	L1: 44.2	L1: 43.9	1.003	140.3	500
	L2: 43.0	L2: 44.3	L2: 44.0	1.003		
	L3: 42.2	L3: 44.2	L3: 43.8	1.000		
P_R: 0% Q_C: +1%	L1: 42.7	L1: 44.0	L1: 43.4	0.995	126.3	500
	L2: 43.1	L2: 44.0	L2: 43.4	0.993		
	L3: 42.2	L3: 44.0	L3: 43.4	0.993		
P_R: 0% Q_C: +2%	L1: 42.8	L1: 44.0	L1: 43.0	0.989	116.3	500
	L2: 43.0	L2: 44.0	L2: 43.0	0.991		
	L3: 42.0	L3: 44.0	L3: 43.1	0.990		
P_R: 0% Q_C: +3%	L1: 42.8	L1: 44.0	L1: 42.6	0.984	110.3	500
	L2: 43.1	L2: 44.0	L2: 42.6	0.984		
	L3: 42.2	L3: 44.0	L3: 42.6	0.984		
P_R: 0% Q_C: +4%	L1: 42.8	L1: 44.0	L1: 42.2	0.979	106.8	500
	L2: 43.0	L2: 44.0	L2: 42.1	0.980		
	L3: 42.2	L3: 44.0	L3: 42.1	0.978		
P_R: 0% Q_C: +5%	L1: 42.8	L1: 44.0	L1: 41.7	0.974	103.0	500
	L2: 43.1	L2: 44.0	L2: 41.8	0.972		
	L3: 42.2	L3: 44.0	L3: 41.7	0.974		

Power 33%
Input : 605 Vdc

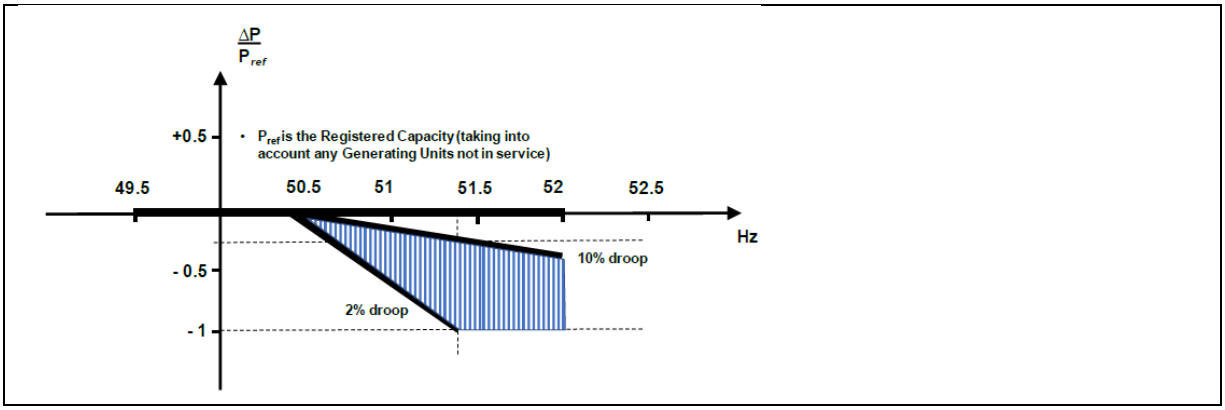
G99: 2020 Type A/B/C/D

Conditions	P_R [kW]	Q_L [kVar]	Q_C [kVar]	Q_f	Trip time [ms]	Limitation [ms]
P_R: 0% Q_C: -5%	L1: 21.2	L1: 22.2	L1: 23.4	1.031	102.3	500
	L2: 21.1	L2: 22.0	L2: 23.4	1.031		
	L3: 21.1	L3: 22.1	L3: 23.4	1.031		
P_R: 0% Q_C: -4%	L1: 21.2	L1: 22.0	L1: 22.8	1.018	112.0	500
	L2: 21.1	L2: 22.0	L2: 22.7	1.016		
	L3: 21.1	L3: 22.0	L3: 22.8	1.018		
P_R: 0% Q_C: -3%	L1: 21.2	L1: 22.0	L1: 22.7	1.016	118.3	500
	L2: 21.1	L2: 22.0	L2: 22.7	1.016		
	L3: 21.1	L3: 22.0	L3: 22.7	1.016		
P_R: 0% Q_C: -2%	L1: 21.2	L1: 22.0	L1: 22.3	1.007	120.3	500
	L2: 21.1	L2: 22.0	L2: 22.4	1.014		
	L3: 21.1	L3: 22.0	L3: 22.4	1.009		
P_R: 0% Q_C: -1%	L1: 21.2	L1: 22.0	L1: 22.2	1.005	136.3	500
	L2: 21.1	L2: 22.0	L2: 22.2	1.005		
	L3: 21.1	L3: 22.0	L3: 22.2	1.005		
P_R: 0% Q_C: 0%	L1: 21.2	L1: 22.0	L1: 21.8	1.000	176.3	500
	L2: 21.1	L2: 22.0	L2: 21.7	0.993		
	L3: 21.0	L3: 22.0	L3: 21.8	1.002		
P_R: 0% Q_C: +1%	L1: 21.2	L1: 22.0	L1: 21.7	0.993	148.0	500
	L2: 21.1	L2: 22.0	L2: 21.6	0.991		
	L3: 21.1	L3: 22.0	L3: 21.6	0.991		
P_R: 0% Q_C: +2%	L1: 21.2	L1: 22.0	L1: 21.6	0.991	126.3	500
	L2: 21.1	L2: 22.0	L2: 21.6	0.995		
	L3: 21.1	L3: 22.0	L3: 21.6	0.991		
P_R: 0% Q_C: +3%	L1: 21.2	L1: 22.0	L1: 21.2	0.982	118.0	500
	L2: 21.1	L2: 22.0	L2: 21.3	0.980		
	L3: 21.1	L3: 22.0	L3: 21.3	0.984		
P_R: 0% Q_C: +4%	L1: 21.2	L1: 22.0	L1: 21.1	0.979	114.0	500
	L2: 21.2	L2: 22.0	L2: 21.1	0.975		
	L3: 21.1	L3: 22.0	L3: 21.2	0.982		
P_R: 0% Q_C: +5%	L1: 21.2	L1: 22.0	L1: 20.9	0.975	106.0	500
	L2: 21.1	L2: 22.0	L2: 20.8	0.972		
	L3: 21.1	L3: 22.0	L3: 20.9	0.975		
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
Negative Vector Shift	50.5Hz	-50degree		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
51.0 Hz to 49.0 Hz	- 0.95 Hz/s	2.1 s		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%	50.00	--	--	--	--	100%	0.16	≤± 10%	≤10	≤2
b) 50.45	99%	50.45	--	0.870	0	--	99%	0.22			
c) 50.7	94%	50.70	--	0.422	0	--	94%	0.12			
d) 51.15	85%	51.15	--	0.404	0	--	85%	0.03			
e) 50.7	94%	50.70	--	0.428	0	--	94%	0.12			
f) 50.45	99%	50.45	--	0.365	0	--	99%	0.22			
g) 50	100%	50.00	--	0.103	0	6.16	100%	0.16			
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	50%	50.00	--	--	--	--	50%	-0.19	≤± 10%	≤10	≤2
b) 50.45	49%	50.45	--	0.979	0	--	49%	-0.05			
c) 50.7	44%	50.70	--	0.633	0	--	44%	-0.13			
d) 51.15	35%	51.15	--	0.702	0	--	35%	-0.10			
e) 50.7	44%	50.70	--	0.655	0	--	44%	-0.04			
f) 50.45	49%	50.45	--	0.659	0	--	49%	-0.01			
g) 50	50%	50.00	--	2.44	0	5.79	50%	-0.17			
Note(s): P(f) curve setting for test: f1: 50.4Hz; fstop: 50.4Hz (Deactivated); Droop: 10%											



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 [ms]	7.62		

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: There is a communication RS232/RS485 connected to the LCD touch screen to monitor the status of the inverter by proprietary software and RS232/RS485 to the computer.		
15	TABLE: Cyber security	N/A
Confirm that the Power Generating Module has been designed to comply with cyber security requirements, as detailed in 9.1.7.		N/A

TÜVRheinland®

PHOTO DOCUMENTATION

CN23PFO6 001 ATTACHMENT 2

for

Grid-connected PV inverter

SP-250K-H, SP-275K-H1, SP-275K-INH

SINENG ELECTRIC CO., LTD.

This documentation consists of 15 pages (excluding this cover page)

Model: as cover page

Figure 1. Front view

Figure 2. Back view

Figure 3. Left view

Figure 4. Right view

Model: as cover page

Figure 5. Top view

Figure 6. Connect view

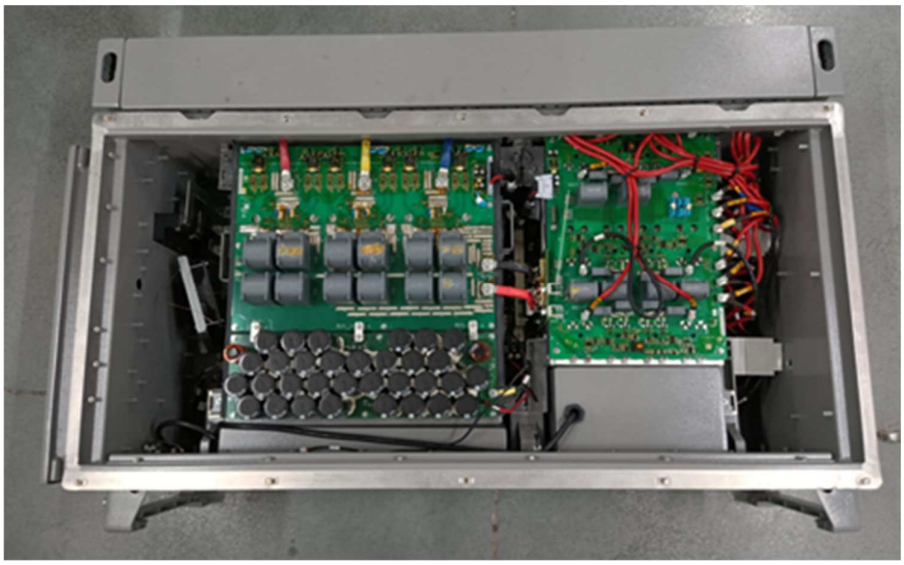


Figure 7. Internal view-1

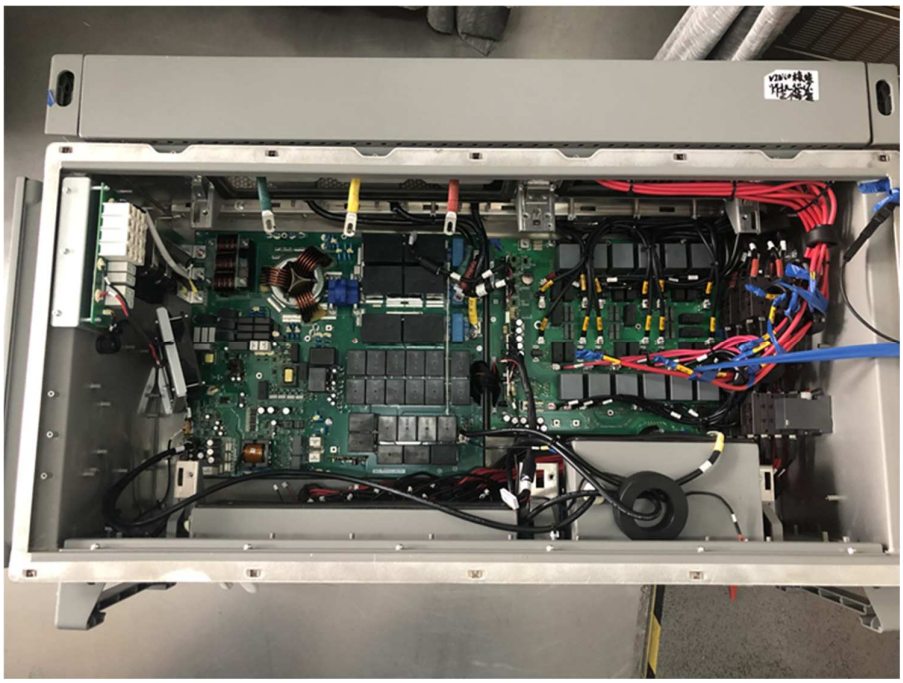


Figure 8. Internal view-2

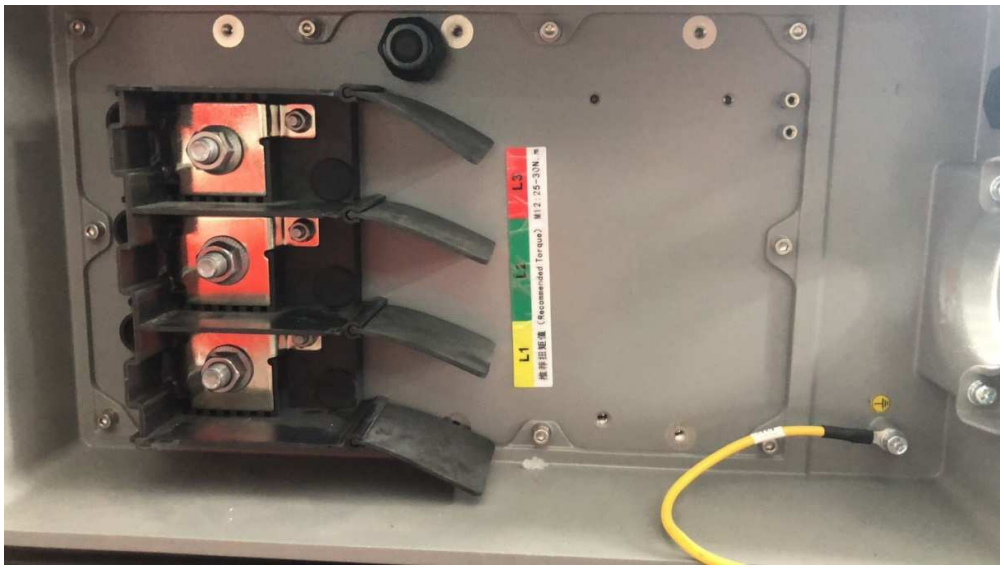


Figure 9. Output terminal view

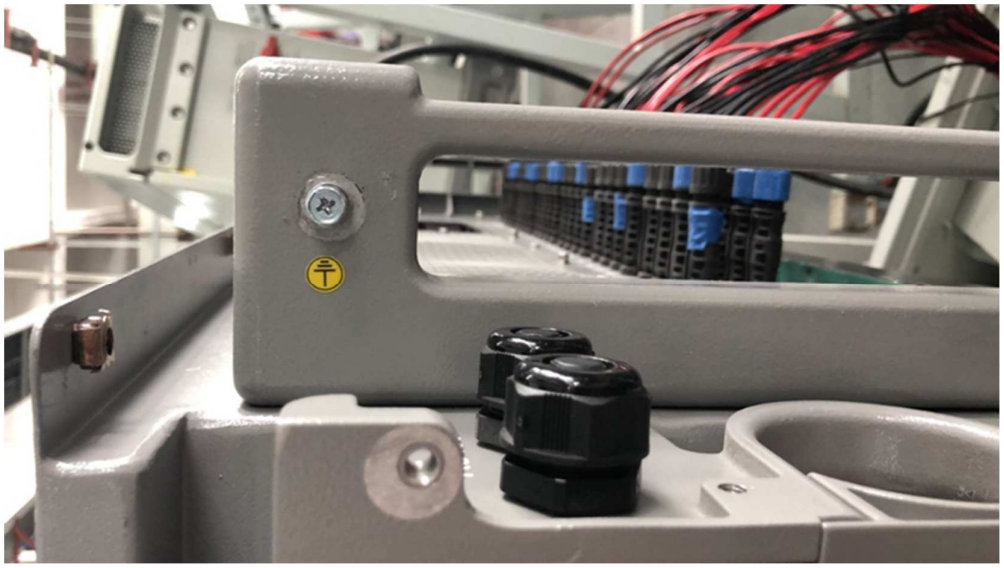


Figure 10. PE view

Figure 11. Front view of AC Output board SP250KHP2

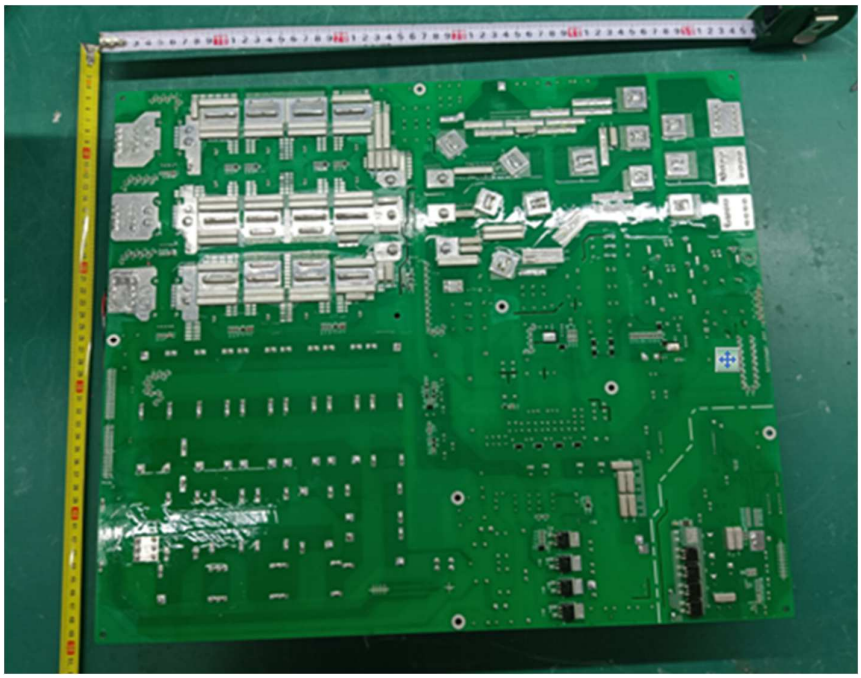


Figure 12. Back view of AC Output board SP250KHP2

Model: as cover page

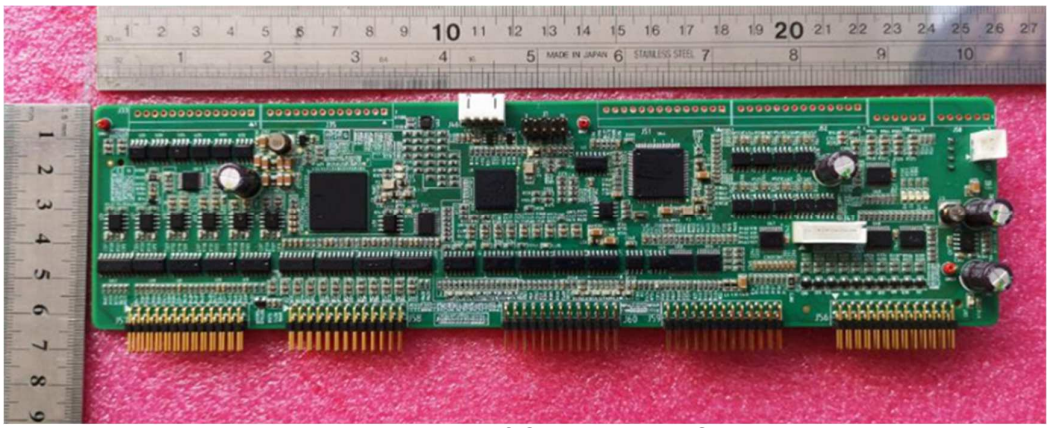


Figure 13. Front view of Control board SP136KU1

Figure 14. Back view of Control board SP136KU1

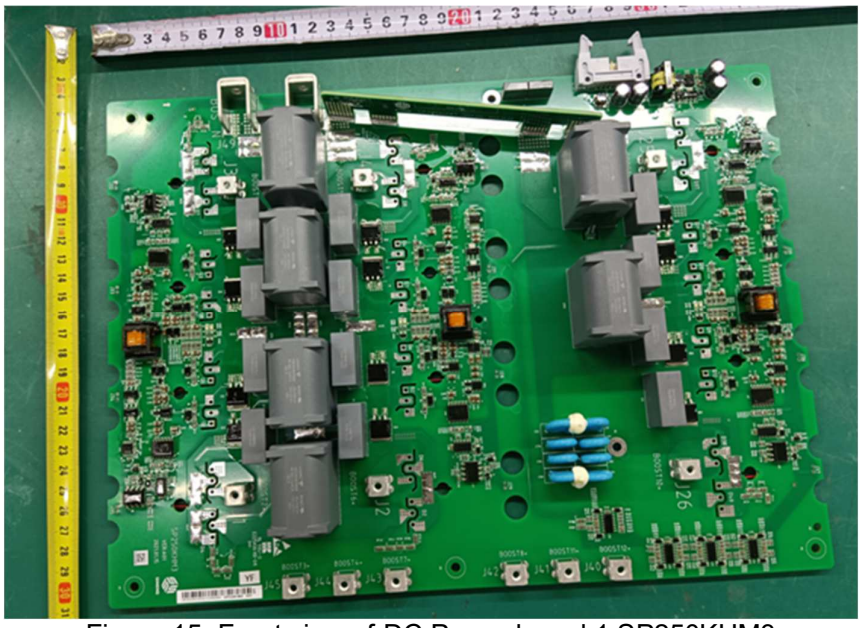


Figure 15. Front view of DC Power board 1 SP250KHM3

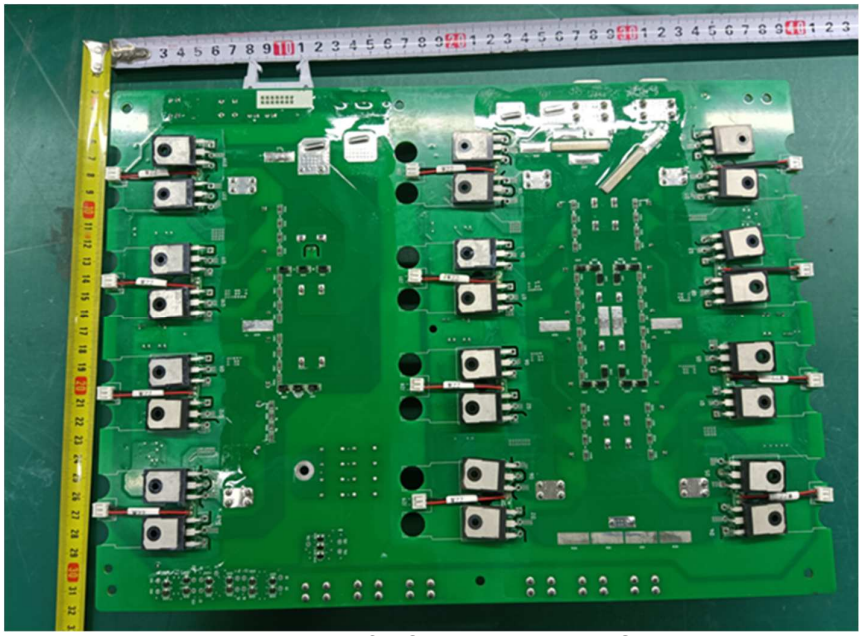


Figure 16. Back view of DC Power board 1 SP250KHM3

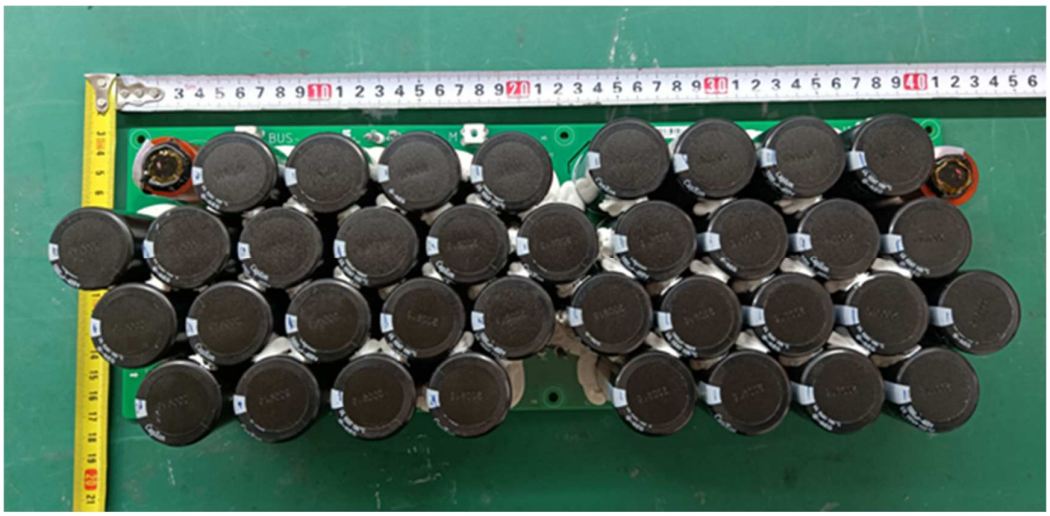


Figure 17. Front view of BUS Cap board SP250KHP3

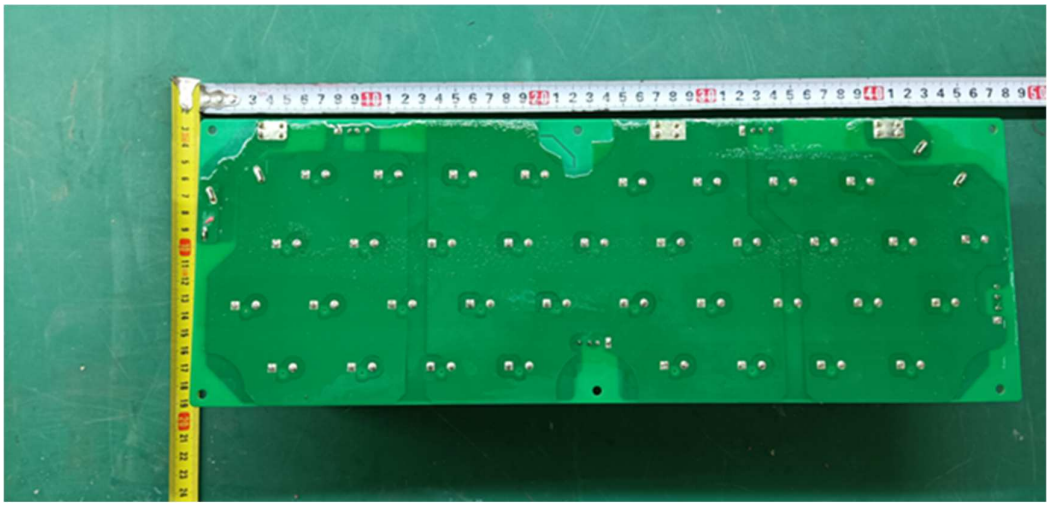


Figure 18. Back view of BUS Cap board SP250KHP3

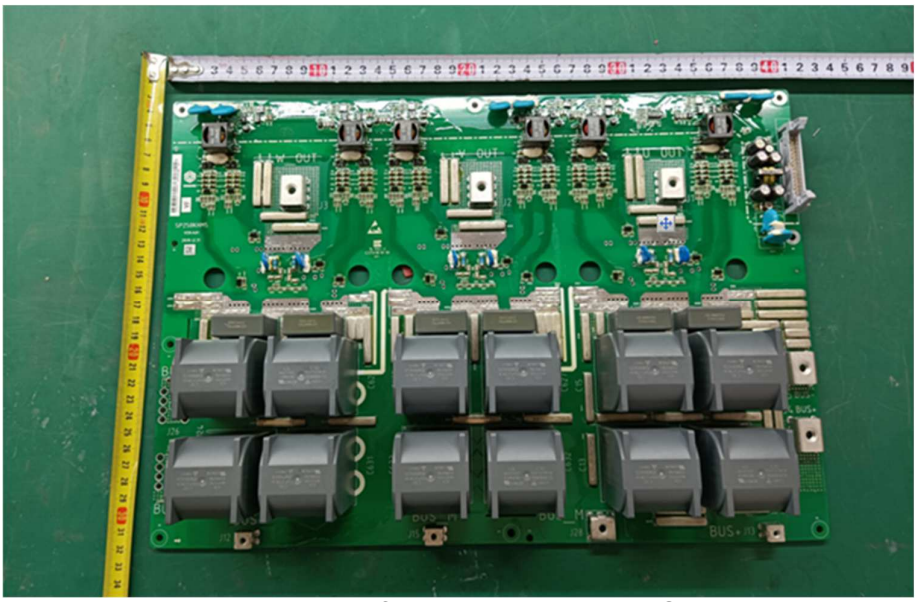


Figure 19. Front view of Inverter Power board SP250KHM1

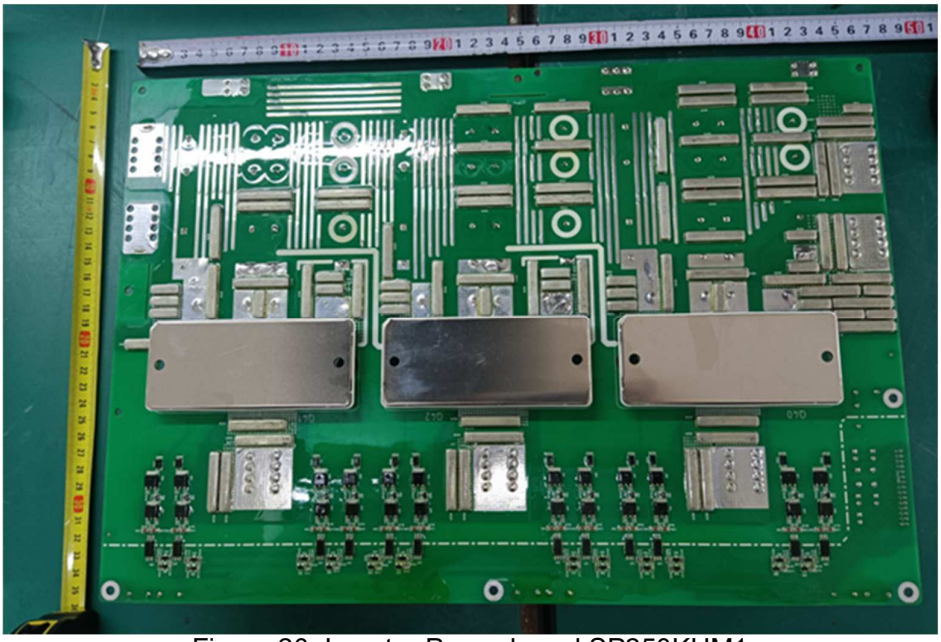


Figure 20. Inverter Power board SP250KHM1

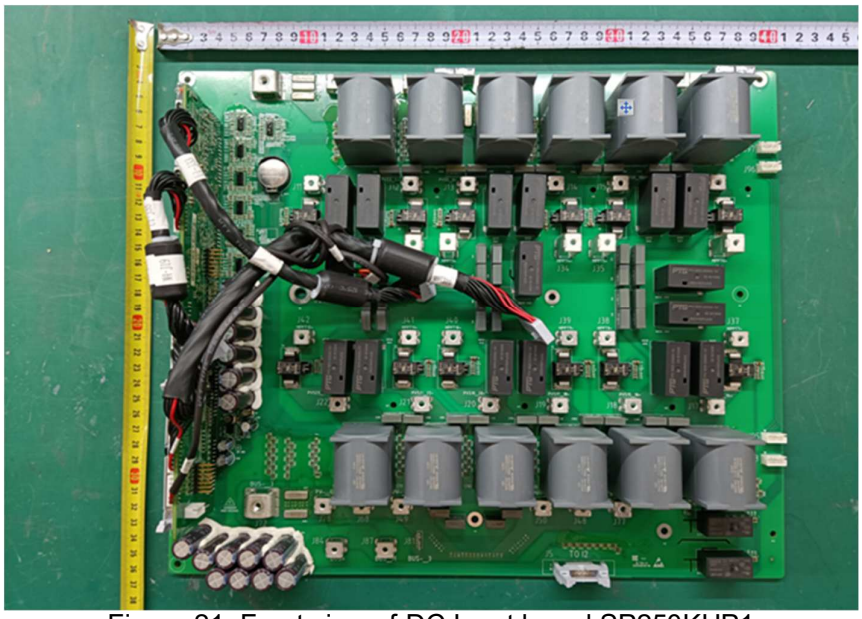


Figure 21. Front view of DC Input board SP250KHP1

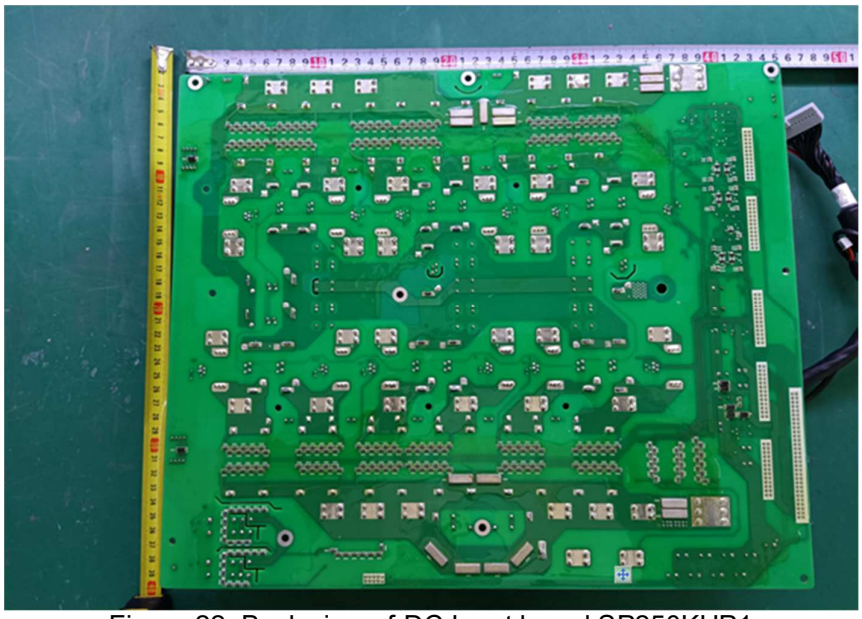


Figure 22. Back view of DC Input board SP250KHP1

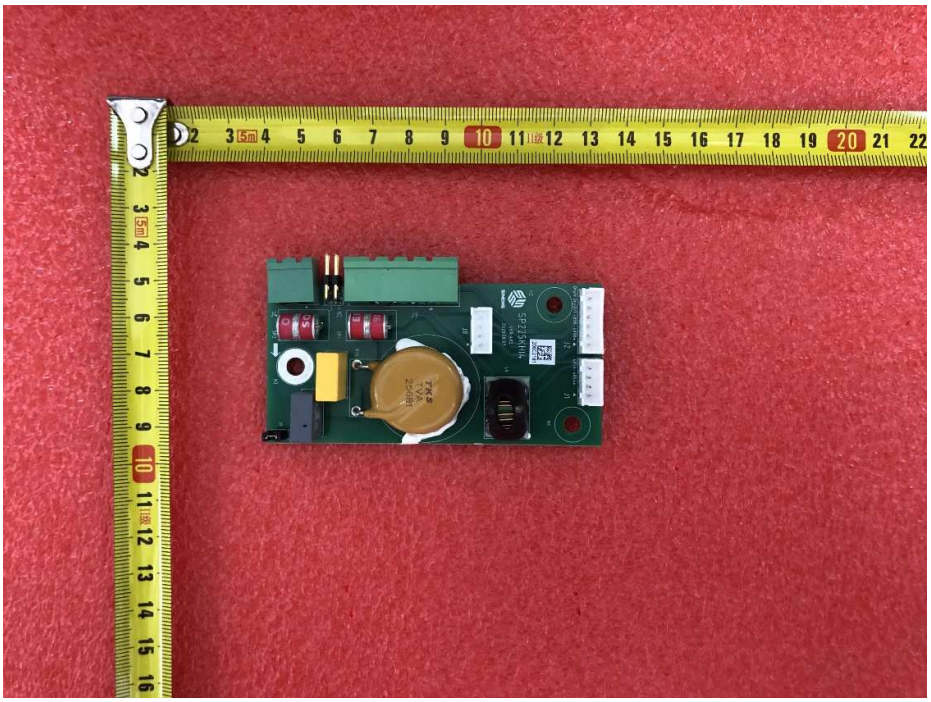


Figure 23. Front view of SP225KHI4

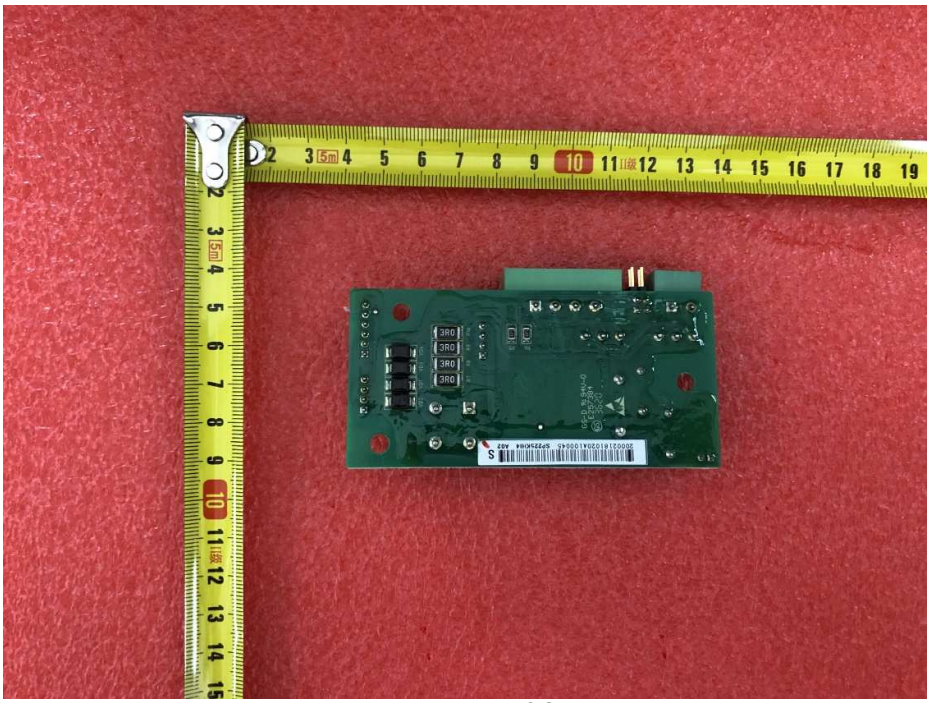


Figure 24. Back view of SP225KHI4

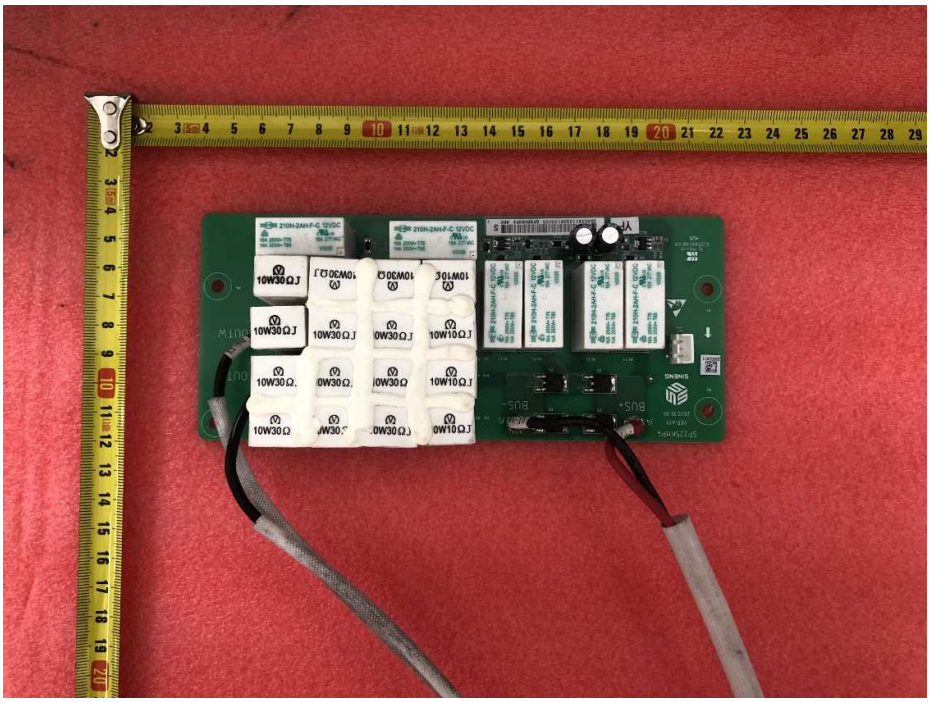


Figure 25. Front view of SP225KHP4

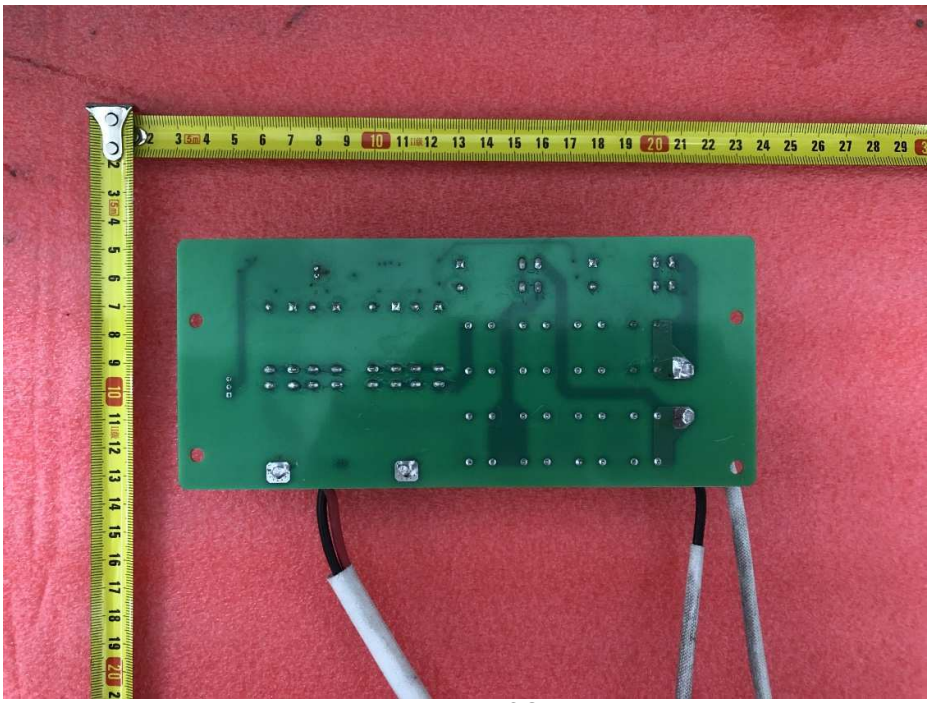


Figure 26. Back view of SP225KHP4-1

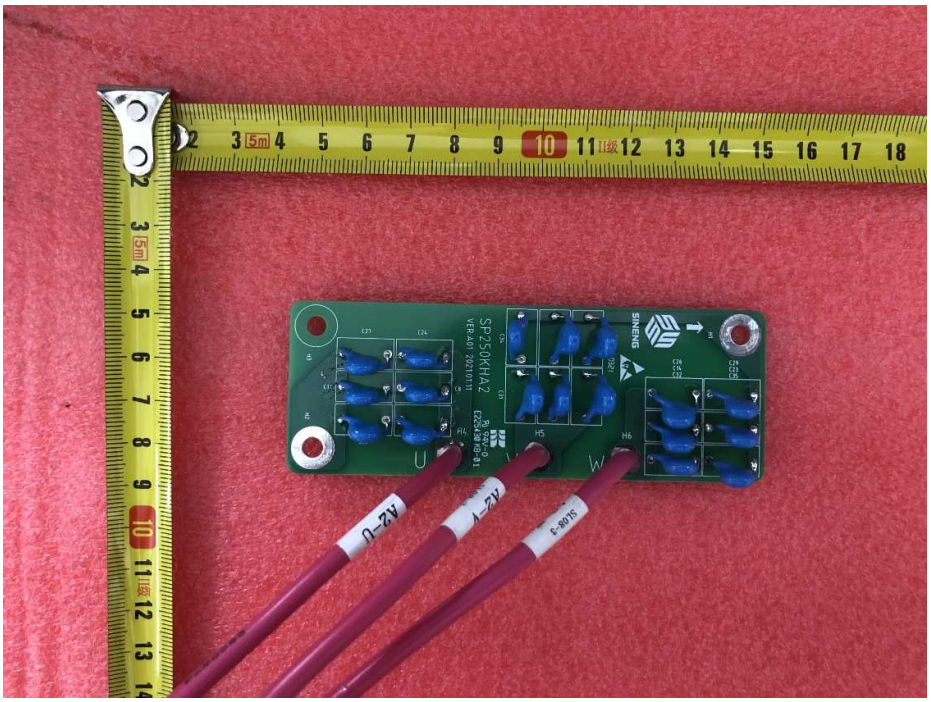


Figure 27. Front view of SP250KHA2

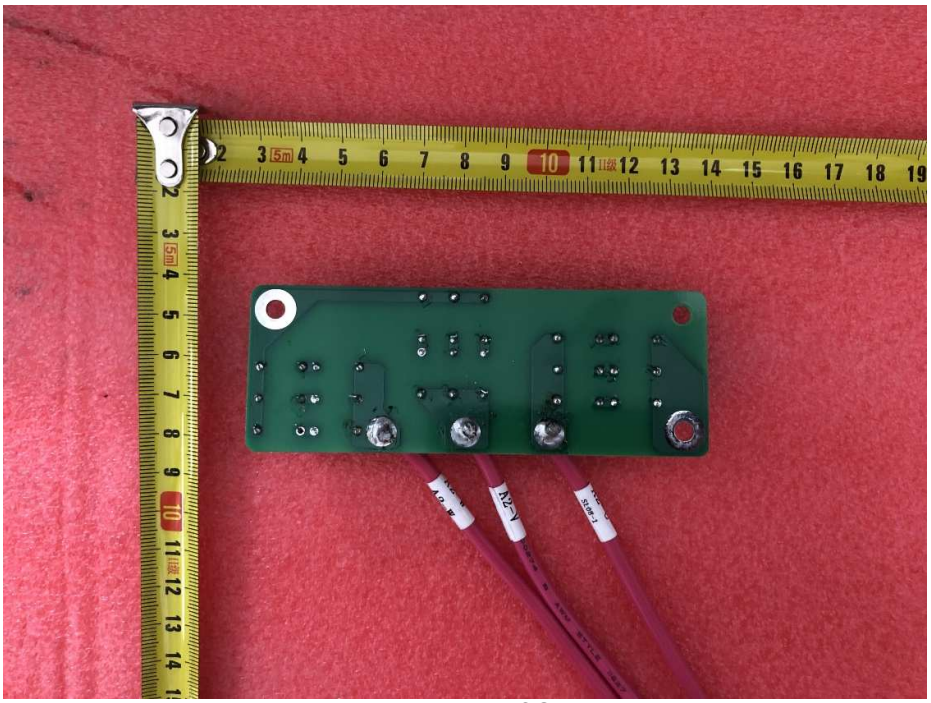


Figure 28. Back view of SP250KHA2

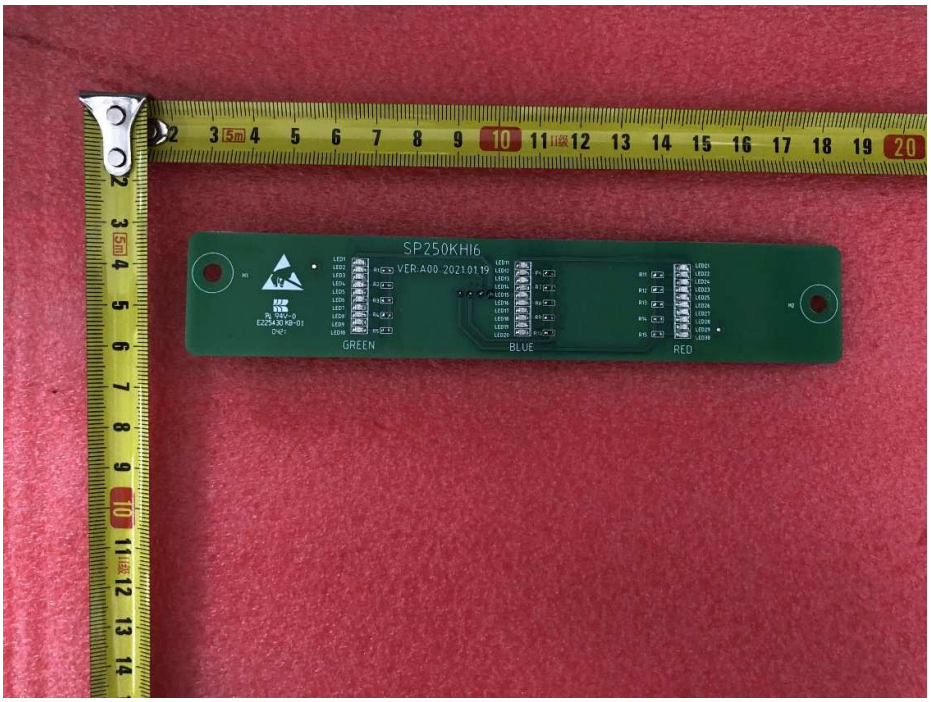


Figure 29. Front view of SP250KHI6

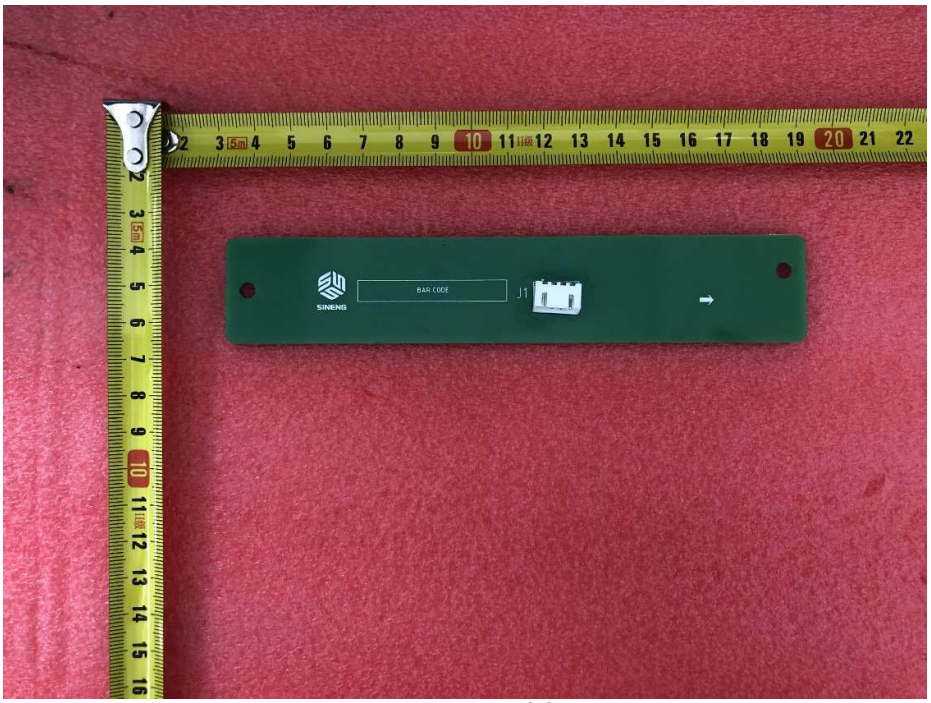


Figure 30. Back view of SP250KHI6