Prüfbericht-Nr.: *Test report no.*:	CN24SS7F 001	**Auftrags-Nr.:** *Order no.*:	168494657	Seite 1 von 57 *Page 1 of 57*
Kunden-Referenz-Nr.: *Client reference no.*:	1282992	**Auftragsdatum:** *Order date:*	2024-07-16	
Auftraggeber: *Client*:	**HUAWEI TECHNOLOGIES CO., LTD.** Administration Building, Headquarters of Huawei Technologies Co., Ltd. Bantian, Longgang District, Shenzhen, 518129 Guangdong P.R. China			
Prüfgegenstand: *Test item*:	SOLAR INVERTER			
Bezeichnung / Typ-Nr.: *Identification / Type no.*:	SUN2000-50K-MGL0, SUN2000-50K-MGL0-BR, SUN2000-75K-MGL0-BR, SUN2000-80K-MGL0			
Auftrags-Inhalt: *Order content*:	Test report			
Prüfgrundlage: *Test specification*:	IEC 63027: 2023			
Wareneingangsdatum: *Date of sample receipt*:	2024-07-17			
Prüfmuster-Nr.: *Test sample no:*	A003855186-001			
Prüfzeitraum: *Testing period*:	2024-08-01 - 2024-10-31			
Ort der Prüfung: *Place of testing*:	TÜV Rheinland (Shanghai) Co., Ltd. No.177, 178, Lane 777 West Guangzhong Road, Jing'an District,Shanghai, China			
Prüflaboratorium: *Testing laboratory:*	TÜV Rheinland (Shanghai) Co., Ltd.			
Prüfergebnis*: *Test result**:	Pass			

geprüft von: created by:	Xingxin Tian	**genehmigt von:** *authorized by*:	Bowen Dong
Datum: *Date:* 2024-11-12		**Ausstellungsdatum:** *Issue date:* 2024-11-12	
Stellung / Position:	Sachverständige(r)/Expert	**Stellung** / Position:	Sachverständige(r)/Expert

Sonstiges / *Other*:

Functional safety was not tested and 8.1.2.2 was not evaluated.
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*

Prüfbericht-Nr.: CN24SS7F 001
Test report no.:

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
IEC 63027
DC arc detection and interruption in photovoltaic power systems

Report Reference No. ..... :	**CN24SS7F 001**
Date of issue..... :	See cover page
Total number of pages ..... :	See cover page
Name of Testing Laboratory preparing the Report ..... :	**TUV Rheinland (Shanghai) Co., Ltd.** No.177, 178, Lane 777 West Guangzhong Road, Jing'an District,Shanghai, China
Applicant's name ..... :	**HUAWEI TECHNOLOGIES CO., LTD.**
Address..... :	Administration Building, Headquarters of Huawei Technologies Co., Ltd. Bantian, Longgang District, Shenzhen, 518129 Guangdong P.R. China
TRF template used..... :	IECEE OD-2020-F1:2020, Ed.1.3
Standard..... :	IEC 63027: 2023
Test procedure ..... :	Test report
Non-standard test method……:	N/A
Test Report Form No. ..... :	N/A
Test Report Form(s) Originator .... :	TÜV Rheinland (Shanghai) Co., Ltd.
Master TRF ..... :	Dated 2023-05-29

General disclaimer:

The test 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 Issuing Testing Laboratory. The authenticity of this Test Report and its contents can be verified by contacting the Issuing Testing Laboratory, responsible for this Test Report.

Test item description .....:	SOLAR INVERTER
Trade Mark .....:	HUAWEI
Manufacturer .....:	Same as the applicant
Model/Type reference .....:	SUN2000-50K-MGL0, SUN2000-50K-MGL0-BR, SUN2000-75K-MGL0-BR, SUN2000-80K-MGL0
Ratings .....:	See marking label and model list

Responsible Testing Laboratory (as applicable), testing procedure and testing location(s):

☒	**Testing Laboratory:**	**TUV Rheinland (Shanghai) Co., Ltd.**	
Testing location/ address.....:		**TUV Rheinland (Shanghai) Co., Ltd.** No.177, 178, Lane 777 West Guangzhong Road, Jing'an District,Shanghai, China	
Tested by (name, function, signature) .....:			
Approved by (name, function, signature)...:			
☐	**Testing procedure: CTF Stage 1:**		
Testing location/ address.....:			
Tested by (name, function, signature) .....:			
Approved by (name, function, signature)...:			
☐	**Testing procedure: CTF Stage 2:**		
Testing location/ address.....:			
Tested by (name + signature) .....:			
Witnessed by (name, function, signature)..:			
Approved by (name, function, signature)...:			
☐	**Testing procedure: CTF Stage 3:**		
☐	**Testing procedure: CTF Stage 4:**		
Testing location/ address.....:			
Tested by (name, function, signature) .....:			
Witnessed by (name, function, signature)..:			
Approved by (name, function, signature)...:			
Supervised by (name, function, signature) :			

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

- ATTACHMENT 1 : Photo Documentation(4 Pages excluding the cover page)

Summary of testing:

Tests performed (name of test and test clause):	**Testing location:**
9.1 Thermal test & fault condition test 9.2.7 Arc energy and response time measurement 9.2.8 Test function 9.2.9 Reconnection test	**TUV Rheinland (Shanghai) Co., Ltd.** No.177, 178, Lane 777 West Guangzhong Road, Jing'an District,Shanghai, China

Summary of compliance with National Differences (List of countries addressed):

N/A

☒ **The product fulfils the requirements of IEC 63027: 2023**

Statement concerning the uncertainty of the measurement systems used for the tests

(may be required by the product standard or client)

☐ **Internal procedure used for type testing through which traceability of the measuring uncertainty has been established:**

Procedure number, issue date and title:

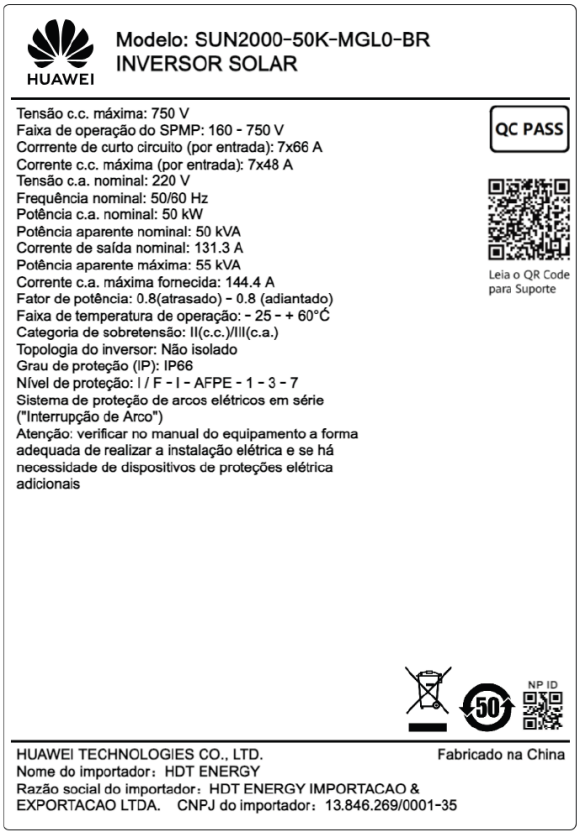
Calculations leading to the reported values are on file with the NCB and testing laboratory that conducted the testing.

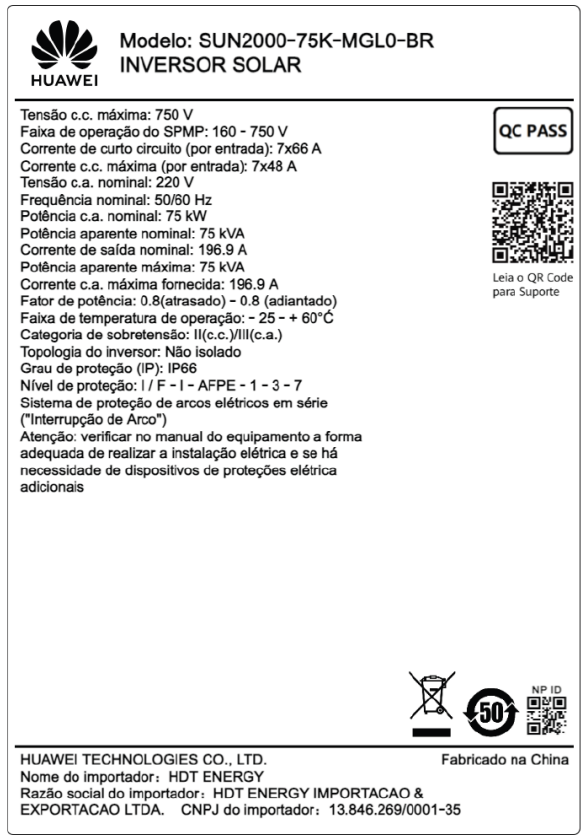
☒ **Statement not required by the standard used for type testing**

(Note: When IEC or ISO standard requires a statement concerning the uncertainty of the measurement systems used for tests, this should be reported above. The informative text in parenthesis should be delete in both cases after selecting the applicable option)

Copy of marking plate:

The artwork below may be only a draft. The use of certification marks on a product must be authorized by the respective NCBs that own these marks.





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
Environmental 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 (%):	-90 / +110 %
Tested for power systems:	TN
IT testing, phase-phase voltage (V):	N/A
Class of equipment:	☒ Class I ☐ Class II ☐ Class III ☐ Not classified
Mass of equipment (kg):	See model list
Pollution degree:	PD3
IP protection class:	IP66
:	
Possible test case verdicts:	
- test case does not apply to the test object:	N/A
- test object does meet the requirement:	P (Pass)
- test object was not evaluated for the requirement:	N/E
- test object does not meet the requirement:	F (Fail)
Testing:	
Date of receipt of test item:	See cover page
Date (s) of performance of tests:	See cover page

General remarks:

"(See Enclosure #)" refers to additional information appended to the report.
"(See appended table)" refers to a table appended to the report.

Throughout this report a ☐ comma / ☒ point is used as the decimal separator.

Manufacturer's Declaration per sub-clause 4.2.5 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) ..... :	**Lucky Harvest Co., Ltd** No. 893, Jian'an Road, Chang'an, Anchang Town, Dongguan City, Guangdong Province

General product information:

Brief description:

The equipment with model name SUN2000-50K-MGL0, SUN2000-50K-MGL0-BR, SUN2000-75K-MGL0-BR, SUN2000-80K-MGL0 are three phases Solar Inverter, which will be installed and connected to the grid after installation.

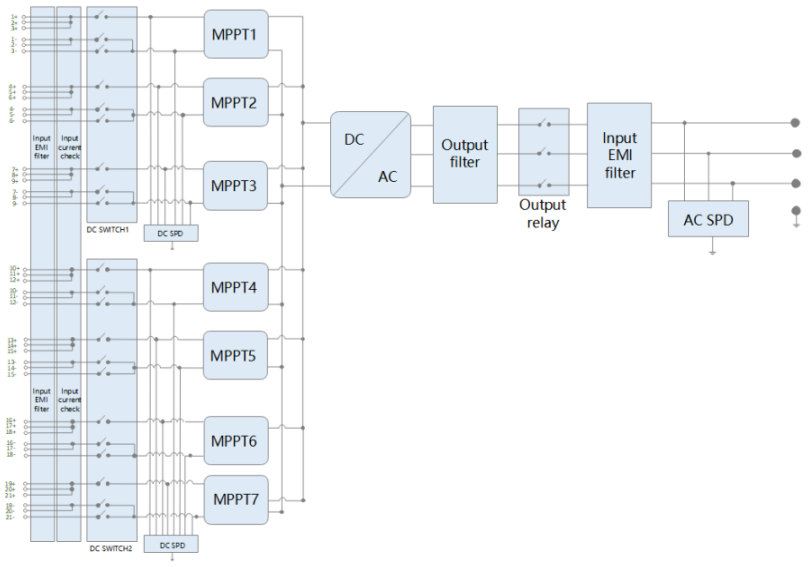
The equipment shall be fixed to suitable manner as specified in the installation instruction.

For the models SUN2000-50K-MGL0, SUN2000-50K-MGL0-BR, SUN2000-75K-MGL0-BR, SUN2000-80K-MGL0 the PV input combines 7 strings MPPT tracers, each MPPT tracer including 3 pairs of PV input terminals.

The AC output directly connects to grid and protective Earthing is provided by dedicated earthing terminals. Grid is protected by with a two series of relays as redundant build for ensuring the inverter can independently disconnect from gird while a relay was fault.

During fault condition defined in this standard, after the CPU receives the abnormal signal from the relevant protective detection circuit, the relays will operate to disconnect the DC active lines from grid automatically. The master CPU and slaver CPU have capacity independently to disconnect from gird when any grid fault had happened.

The maximum ambient temperature permitted by the manufacturer's specification is 60°C.



Circuit Diagram

Description of the differences of the models:

All models are identical in hardware as well as software, except for electrical ratings, see the model list for details.

Model List:

MODELS LIST		SUN2000-50K-MGL0	SUN2000-50K-MGL0-BR	SUN2000-75K-MGL0-BR	SUN2000-80K-MGL0
PV INPUT	Max. PV Input Voltage (V)	750			
	MPPT Voltage Range (V)	160 - 750			
	Number of MPPTs	7			
	Number of PV String per MPPT	A:3/B:3/C:3/D:3//E:3/F:3/G:3			
	Max. PV Input Current (A)	A:48/B:48/C:48/D:48/E:48/F:48/G:48			
	Max. Short Circuit current (A)	A:60/B:60/C:60/D:60/E:60/F:60/G:60@20℃			
AC OUTPUT(ON-GRID)	Rated Output Apparent Power (VA)	50000	50000	75000	80000
	Max. Output Apparent Power (VA)	55000	55000	75000	88000
	Nominal AC Voltage (V)	127 / 220, 3W/N+PE			
	Nominal Grid Frequency (Hz)	50/60			
	Max. Output Current (A)	131.3 (220Vac)	131.3 (220Vac)	196.9 (220Vac)	210.0 (220Vac)
	Rated Output Current (A)	144.4 (220Vac)	144.4 (220Vac)	196.9 (220Vac)	231.0 (220Vac)
	Power Factor	0.8under-excited - 0.8over-excited			
CONSTRUCTION	Efficiency max. η_{max}	≥97.6%(220Vac)	≥97.6%(220Vac)	≥97.8%(220Vac)	≥97.9%(220Vac)
	Type of inverter	Non-isolated			
	Type of NS Protection	Integrated			
	Separated by	Transformer-less			
	Firmware [Version]	V600R023			
	Protective Class	I			
	Enclosure Protection (IP)	IP66			
	Operating Temperature Range [ºC]	-25℃~+60℃ (>50℃ derating)	-25℃~+60℃ (>50℃ derating)	-25℃~+60℃ (>40℃ derating)	-25℃~+60℃ (>30℃ derating)
	Pollution degree	PD2(inside), PD3(outside)			

	(PD)	
	Altitude [m]	5000m (>4000m derating)
	Size [mm]	1000×710×395
	Weight [kg]	98
Note:		

AFCI Function Description:

The inverter supports AFPE (Arc Fault Protection Equipment) for arc detection and interruption, which is combination of AFD and AFI to detect and interrupt arc faults.

The AFPE is implemented within the inverter connected to the PV array and makes use of the housing and terminals of the inverter.

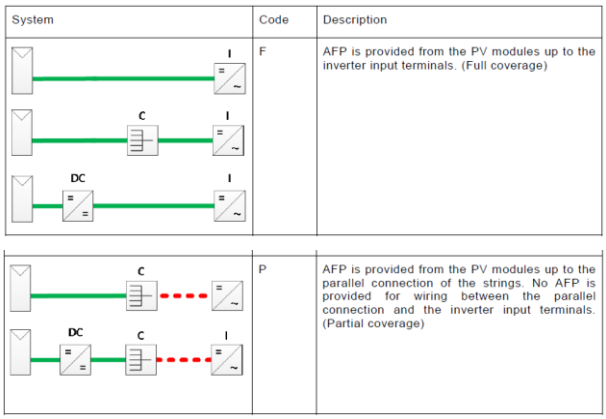
The AFPE can provide full coverage protection. In this classification, arc fault protection is provided from the PV modules up to the inverter input terminals.

The AFPE configuration is marked on the product according to the requirements in IEC 63027 and specified in manual, see manual instruction for details.

AFCI Configuration:

Model	SUN2000-50K-MGL0	SUN2000-50K-MGL0-BR	SUN2000-75K-MGL0-BR	SUN2000-80K-MGL0
Classification	F-I-AFPE-1-3-7			
Number of monitored strings per input port	1			
Number of input ports per channel	3			
Number of monitored channels	7			
Rated channel current	48A			
Maximum current per input port	23A			
Rated interruption current	66A@20℃			

IEC 63027			
Clause	Requirement – Test	Result – Remark	Verdict
4	**Classification**		P
4.1	General	See below.	P
	The clause gives an overview of the classifications used for AFD and AFPEs in this standard. The classification scheme describes the equipment type and considers the important aspects relevant for testing and installation. Installation standards can refer to this classification to specify requirements for arc fault protection.		P
	Protection coverage: Defines which parts of a PV system or installation are covered by the AFD or AFPE.	Full protection	P
	Method of implementation: Defines the type and design of the AFD or AFPE. The method of implementation especially impacts construction requirements and testing.	PCE integrated device	P
	Functionality: Indicates whether an equipment or device is an AFD or AFPE.	AFPE	P
	Number of monitored strings, inputs and channels: The maximum number of connected PV strings, inputs and measurement channels that can be supported by the AFD or AFPE, and for which it is tested.	See following clause	P
	Reconnection method: Defines which reconnection methods are supported by the product.	See following clause	P
	Annex B provides additional information and introduces measures to group the following classifications into various use cases.		P
	AFPE may have more than one classification, and different ratings may apply for each classification. In this case the manufacturer shall document the installation and connection requirements for each classification. NOTE One example is an inverter that allows for the direct connection of PV strings or the connection of one dc main cable. For direct string connections the classification could be F-I-AFPE-S1-C1-I4 and for the main cable connection the classification could be P-I-AFPE-S6-C1-I1.	No more than one classification.	N/A
	AFPE may provide input ports with different ratings (e.g. number of strings per input port, current rating). In this case the tests shall be performed in the worst case configuration.	Tests performed on model SUN2000-50K-MGL0-BR, SUN2000-75K-MGL0-BR, SUN2000-80K-MGL0	N/A
4.2	**Protection coverage**		P
	The protection coverage defines which circuits and components of the PV system are covered by the AFD or AFPE. Two types of classifications are defined.	Full coverage (F)	P

IEC 63027			
Clause	Requirement – Test	Result – Remark	Verdict
	 NOTE: Typically full coverage (F) is hard to achieve for high currents in dc main cables. Also, the 750 J protection threshold may be difficult to achieve because of the high currents and the physical limits in interruption times. Fire hazard protection may be provided by means of installation.		P
4.3	**Method of implementation**	See below.	P
4.3.1	**PCE integrated device (I)**		P
	The AFPE is implemented within a PCE connected to the PV array and makes use of the housing and terminals of the PCE.	The AFPE is implemented within the inverter.	P
4.3.2	**Standalone device (S)**		N/A
	The AFPE is a single device, that works independently and makes use of its own enclosure or other dedicated enclosures.	Not stand-alone AFPEs.	N/A
4.3.3	**Distributed detection system (D)**		N/A
	The AFPE comprises more than one device. The devices may be standalone devices or partially integrated within a PCE.	Not distributed detection system	N/A
4.4	**Functionality**	See below.	P
4.4.1	**AFPE: Detection and interruption capability provided**		P
	The device incorporates AFD and AFI for full AFPE functionality.	Detection and interruption capability provided.	P
4.4.2	**AFD: Only detection / no interruption capability provided**		N/A
	The device only detects the arc. An AFD without a dedicated AFI does not fulfill the requirements of an AFPE according to this standard. Such devices may be used to indicate arc events, e.g. in connection with a fire alarm system.	Not only AFD.	N/A
4.5	**Number of monitored strings (S)**	See below.	P
4.5.1	**Single string**		P
	The AFD or AFPE are designed in a way that only one string of the array or one module shall be connected to one input port for detection and, in the	Only one string be connected to one input port.	P

IEC 63027			
Clause	Requirement – Test	Result – Remark	Verdict
	case of AFPE, interruption.		
4.5.2	**Parallel string**		N/A
	The AFD or AFPE are designed in a way that multiple strings or modules may be connected for detection and, in the case of AFPE, interruption. The maximum number of strings for one input port shall be defined by the manufacturer. Parallel strings may be connected directly to the device or at a junction external to the device. NOTE 1 Refer to Annex A for various string configurations.	Only one string be connected to one input port.	N/A
4.6	**Number of Input ports (I)**	See below.	P
	An AFD or AFPE may be provided with one or more input ports per monitored channel. In case of more than one input port the maximum arc current typically is not equal to the rated sensing current of the channel. The number of input ports per channel shall be defined by the manufacturer, together with the maximum current per input port. The maximum current (I_{pA}) per input port is equal to the maximum arc current in the system. Parallel connection of strings outside the equipment enclosure or cabinet are not considered input ports. NOTE Refer to Annex A for various input configurations.	3 input ports per channel.	P
4.7	**Number of monitored channels (C)**	See below.	P
4.7.1	**Single channel**		N/A
	The AFD or AFPE is designed in a way that only one sensing channel is provided to detect arcs.	More than one channel.	N/A
4.7.2	**Multi-channel**		P
	The AFD or AFPE has two or more independent sensing channels to detect arcs. The number of channels shall be defined by the manufacturer. NOTE Refer to Annex A for various channel configurations.	7 channels.	P
4.8	**Reconnection method**	See below.	P
	Installation standards can choose from the following reconnection methods in order to define adequate response requirements after arc interruption by the AFPE.		P
4.8.1	**Manual reconnection**		N/A
	After arc interruption the reconnection can only be performed manually.		N/A
4.8.2	**Remote manual reconnection**		P
	After arc interruption the reconnection can be performed via remote access to the AFPE.	Reconnection can be performed in APP and management system.	P
4.8.3	**Automatic reconnection**		P
	After arc interruption the AFPE provides means to automatically reconnect following measures de-	Automatic reconnection provided according to the re-	P

IEC 63027			
Clause	Requirement – Test	Result – Remark	Verdict
	scribed in 8.2.3.3.	quirements in the standard.	
5	**Ratings of AFPEs and AFDs**		P
5.1	General		P
	This clause identifies the ratings to be defined for AFPEs and AFDs by their classification. These ratings impact the selection of tests to be performed according to this standard. For integrated AFPEs correlations between the AFPE ratings and product ratings are described.		P
5.2	**PCE integrated AFPEs and AFDs**	See below.	P
5.2.1	**Rated and limiting values**		P
5.2.1.1	**Rated channel current**		P
	The maximum rated detection current of a channel.	48A	P
5.2.1.2	**Maximum current per input port**		P
	The maximum rated current an input port can carry. For PCE the maximum current per input port corresponds to the maximum MPP current of the related input port. This current may be limited by a power conversion stage or a terminal rating.	23A	P
5.2.1.3	**Rated interruption current**		P
	The maximum rated dc current the PCE is able to interrupt. NOTE For PCE integrated AFPE the maximum rated interruption current typically corresponds to the I_{pA} of the PCE. Although for inverters interruption may be provided by the ac bridge or on the ac side, the current is defined by I_{pA}.	66A@20℃	P
5.2.1.4	**Other ratings**		P
	Other ratings of the AFPE or AFD correspond to the input characteristics of the PCE according to IEC 62109-1.	Specified according to IEC 62109-1.	P
5.3	**Stand-alone AFPEs and AFDs**	Not stand-alone AFPEs.	N/A
5.3.1	**Rated and limiting values**		N/A
5..3.1.1	General		N/A
	Rated values are assigned by the manufacturer. They shall be stated in accordance with IEC 60947-1, however it may not be necessary to establish all of the rated values listed.		N/A
5.3.1.2	**Rated voltages**		N/A
5.3.1.2.1	**Rated operational voltage (U_e)**		N/A
	Subclause 4.3.1.1 of IEC 60947-1 applies.		N/A
5.3.1.2.2	**Rated insulation voltage (U_i)**		N/A
	Subclause 4.3.1.2 of IEC 60947-1 applies.		N/A
5.3.1.2.3	**Rated impulse withstand voltage (U_{imp})**		N/A
	Subclause 4.3.1.3 of IEC 60947-1 applies.		N/A

IEC 63027			
Clause	Requirement – Test	Result – Remark	Verdict
5.3.1.3	**Currents**		N/A
	AFPE is defined by the following currents.		N/A
5.3.1.3.1	**Rated channel current**		N/A
	The maximum rated detection current of a channel.		N/A
5.3.1.3.2	**Maximum current per input port**		N/A
	The maximum rated current an input port can carry. This current may be limited by a terminal rating.		N/A
5.3.1.3.3	**Rated interruption current**		N/A
	The maximum rated dc current the AFI is able to interrupt, usually corresponding to the breaking current as described in IEC 60947-1 subclause 2.5.11.		N/A
5.3.1.4	**Rated duty**		N/A
	Subclause 4.3.4 of IEC 60947-3 applies		N/A
	NOTE In most cases AFPEs either fall under clause 4.3.4.1, eight-hour duty or under 4.3.4.2, uninterrupted duty		N/A
5.3.2	**Utilization category**		N/A
	Standalone AFPEs shall be rated either DC-PV1 or DC-PV2 according to IEC 60947-3. NOTE Selection depends on the location in the system.		N/A
6	**Product information**		P
6.1	**General**		P
	AFPEs and AFDs may be designed in many different ways. Table 2 defines a classification of various products. It shall be used to distinguish the different designs by indicating the different parameters, separated by '-'. **Table 2 – Combined classification of AFPEs and AFDs** Protection coverage (according to 4.2): – Full coverage (F) – Partial coverage (P) Method of implementation (according to 4.3): – Integrated (I) – Stand-alone (S) – Distributed (D) Functionality (according to 4.4): – AFPE – AFD Monitored strings (according to 4.5): Number of strings Input ports (according to 4.6): Number of input ports Monitored channels (according to 4.7): Number of monitored channels NOTE Following Table 2, an integrated AFPE providing full coverage for 4 monitored strings with 1 input port and one monitored channel will be characterized by F-I-AFPE-4-1-1. The documentation of the product shall include information how to install the equipment correctly to comply with the provided classification.	F-I-AFPE-1-3-7	P
6.2	**PCE integrated devices**		P
	IEC 62109-1 applies with the following additions. In addition to the product information relevant according to IEC 62109-1 clause 5, the following information shall be provided. – Protection coverage (F for “full” or P for “partial”) – Method of implementation (D for ‘distributed’ or I	Marked on the product and specified in the manual.	P

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Clause	Requirement – Test	Result – Remark	Verdict
	for fully integrated systems) – Maximum number of strings per input or input port (derived from number of channels and maximum number of monitored strings per channel) – Reconnection method – Functionality (AFD, AFPE) In addition to the marking and documentation requirements described in IEC 62109-1:2010, 5.1, Table 3 requirements apply. **Table 3 – Marking and documentation requirements** | | Marking or information item | Visible on product when installed | In a manual | | a | Classification according to Table 2 | x | x | | b | Reconnection method | | x |		
6.3	**Standalone devices**	Not stand-alone AFPEs.	N/A
6.3.1	**Nature of information**		N/A
	Subclause 5.1 of IEC 60947-1 applies as appropriate for a particular design with the following additions. – Protection coverage (F for “full” or P for “partial”) – Method of implementation (D for ‘distributed’ or S for stand alone device) – Maximum number of strings per input or input port (derived from number of channels and maximum number of monitored strings per channel) – Reconnection method		N/A
	– Functionality (AFD, AFPE) – Rated interruption current (where applicable) – Reconnection method • Type of reconnection. If more than one type can be selected, indication for the preset (or default) method shall be given • Procedure for manual reconnection (if applicable) • Procedure for remote manual reconnection (if applicable) • Time settings for automatic reconnection (if not configurable) – Information regarding compatibility with specific PCE models and other components according to subclauses 8.3 and 9.2.10.		N/A
6.3.2	**Marking**		N/A
	Subclause 5.2 of IEC 60947-1 applies as appropriate for characteristics defined in Table 4 **Table 4 – Requirements for documentation, marking and position of marking** | | Marking or information item | Position of the marking or information | | | | | | Visible on product when installed | On the product | In a leaflet | | a | Classification according to Table 2 | x | x | x | | b | Rated current | x | x | x | | c | Maximum number of strings per input or input port | | x | x | | d | Orientation | | x | x | | e | Reconnection method | | | x | | f | Information regarding compatibility | | | x |		N/A

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Clause	Requirement – Test	Result – Remark	Verdict
6.3.3	**Instructions for installation, operation and maintenance**		N/A
	Subclause 5.3 of IEC 60947-1 applies.		N/A
7	**Normal service, mounting and transport conditions**		P
7.1	**PCE integrated AFPEs**		P
	For PCE integrated AFPEs the normal service, mounting and transport conditions of IEC 62109-1 apply. In case a manual test function is incorporated, the frequency of manual operation shall be stated.	Specified in manual.	P
7.2	**Stand-alone AFPEs**		N/A
	Clause 6 of IEC 60947-1 applies with the following addition. Unless otherwise stated by the manufacturer, the equipment is intended for installation under environmental conditions of pollution degree 3. [SOURCE: IEC 60947-3] In case a manual test function is incorporated, the frequency of manual operation shall be stated.	Not stand-alone AFPEs.	N/A
8	**Construction and performance requirements**		P
8.1	**General requirements for PCE integrated AFDs/AFPEs and Stand-alone AFDs/AFPEs**		P
	This general part defines requirements which are identical for PCE integrated AFDs/AFPEs and Stand-alone AFDs/AFPEs. Additional requirements are included in 8.2 and 8.3.		P
8.1.1	**General**		P
	This clause defines requirements which are identical for PCE integrated AFDs/AFPEs and stand-alone AFDs/AFPEs. Additional specific requirements are included in 8.2 and 8.3.		P
8.1.2	**Construction requirements**		P
8.1.2.1	**Annunciator of arc fault events**		P
	AFDs and AFPEs shall be provided with an annunciator (local or remote) that provides a visual indication that the device has operated when an arc fault is detected. Where the reconnection is required to be performed manually, this indication shall not reset automatically. This applies to manual reconnection, remote manual reconnection and also in case automatic reconnection after the fifth interruption within a 24 h period.	Fault information displayed on the APP.	P
8.1.2.2	**Programmable circuit components**		N/A
	Any circuit that employs a programmable circuit component shall comply with IEC 61508, IEC 60730-1:2013, Annex H or IEC 62109-1:2010, An-	Functional safety assessment is excluded.	N/A

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Clause	Requirement – Test	Result – Remark	Verdict
	nex B.		
8.1.3	**Operation in case of series arc fault event**		P
	The AFD shall detect the arc within 2,5 s or before the arc energy exceeds 750 J, whichever occurs first.	Not AFD.	N/A
	The AFPE shall detect the arc and interrupt it within 2,5 s or before the arc energy exceeds 750 J, whichever occurs first.	See test result on the following pages in the report.	P
	If the AFPE can extinguish the arc before exceeding 200 J and within 2,5 s, then annunciation of an arc detection is not required. Those events are not considered disconnection and therefore reconnection requirements according to 8.1.4 do not apply. The arc energy is measured during testing for the arc itself. The DUT is not required to measure the arc energy, neither during testing nor in field operation. Annunciation of arcs below 200 J are not required for technical reasons but can provide useful information for the operator to raise his attention and should be provided where possible.	Annunciation of an arc detection is provided.	P
8.1.4	**Reconnection capability of AFPE**		P
8.1.4.1	**General**		P
	After detecting an arc the circuits shall remain interrupted even in case of loss of power supply. For restart the following restart methods apply.		P
8.1.4.2	**Manual reconnection**		N/A
	To restart the AFPE and close circuits a manual procedure is required (button or external signal, triggered by manual operation on-site). This manual procedure requirement shall be maintained after loss of supply power to the AFPE. NOTE The intended use for manual restart is where the operator prefers a system inspection before reconnection.		N/A
8.1.4.3	**Remote manual reconnection**		P
	To restart the AFPE and close circuits a manual procedure is required (button or external signal, triggered by manual operation on-site or remote activation). This manual procedure requirement shall be maintained after loss of supply power to the AFPE. NOTE The intended use is where a PV system is under supervision via remote control and the operator prefers to check the system remotely before reconnection.	Remote manual reconnection could be performed on the APP or management system.	P
8.1.4.4	**Automatic reconnection**		P
	Adjustable automatic reconnection times are allowed for compliance with local installation standards or owner/operator preferences, provided that a minimum reconnection delay is ensured. In case the reconnection times are adjustable, this shall be done via adjustable setup parameters or manual switches (e.g. rotary switches).	Automatic reconnection is provided.	P

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Clause	Requirement – Test	Result – Remark	Verdict
	NOTE The intended use for adjustable settings is to allow more sensitive arc fault detection where deemed appropriate, and to enable system checks to differentiate between nuisance tripping and real arcs.		
	To restart the AFPE no manual procedure is required if a minimum interruption time of 5 min is ensured before continuing operation of the array.	Minimum interruption time is greater than 5min	P
	When interrupting the fifth time within a 24 h period, the AFPE is only allowed to be reset manually according to 8.1.4.2 or 8.1.4.3 before the AFPE does reconnect. Afterwards the AFPE may return to automatic reconnection mode.		P
8.1.5	**Self-test function**		P
	AFDs and AFPEs shall be provided with a manual or an automatically initiated test function or both that allows for regular checks of the arc detection circuit.	By simulating an arc signal.	P
	The test function shall: – simulate an arc such that the arc detection circuit or software is caused to detect the simulated arc, or		P
	– perform another safety check routine such that a fault in the arc detection circuit or software is detected.		P
	The manual test function shall allow for periodic testing of the device by manual means that does not require the use of a tool or key. For an AFD a successful test shall be indicated after manual initiation.		P
	An AFD or AFPE may be provided with a means to actuate the test remotely. If such a feature is provided, a remote visual indication of the results of the test and the means for remote manual reset shall be provided.		P
	The automatic test function shall be performed before starting operation and at least once in a 24 h period.		P
	During automatic testing the AFPE is not required to interrupt.		P
	In case of manual test, the AFPE shall interrupt.		P
	In case a malfunction of the AFD or AFPE is detected during the test, the AFD shall indicate the result and the AFPE shall interrupt and indicate the result according to 8.1.2.1.		P
8.2	**PCE integrated AFDs and AFPEs**		P
	For PCE integrated AFDs and AFPEs, the normal service, mounting and transport conditions of IEC 62109-1 with the additional requirements defined under 8.1 apply.		P
8.3	**Stand-alone AFDs and AFPEs**	Not stand-alone AFPEs.	N/A
	Stand-alone AFDs and AFPEs shall comply with 7.1 of IEC 60947-1 in addition to the requirements described below and in 8.1 Stand-alone AFPEs shall also comply with 7.1 of IEC 60947-3.		N/A

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Clause	Requirement – Test	Result – Remark	Verdict
	AFDs and AFPEs shall be compatible with the PCE and their power line communication devices. AFD and AFPE functionality shall not be compromised by the PCE or power line communication.		
9	**Tests**		P
9.1	**General**		P
	The tests defined in this section are broadly applicable to all AFD and AFPE devices. Additional specific requirements apply as follows: - Stand-alone AFDs and AFPEs: Clause 8 of IEC 60947-1.	Not stand-alone AFPE.	N/A
	- Stand-alone AFPEs: IEC 60947-3.	Not stand-alone AFPE.	N/A
	- PCE integrated devices: Clause 4 of IEC 62109-1.	Reference to IEC 62109-1/-2 report 240722188GZU-003	P
9.2	**Series arc fault test**		P
9.2.1	**General**	See below.	P
	The general test set up consist of 6 major elements: • Arc generator • DC source • Decoupling network • Impedance network • Device under test (DUT) • Load.		P
	The AFD and AFPE may be used within different array topologies. To ensure that detection is achieved in all application cases defined by the manufacturer, different test scenarios shall be applied. The major distinctions are related to: – single string case; – parallel string case; – single channel case; – multi-channel case; – single module case.		P
	Accordingly, the AFD and AFPE shall be tested for all applicable scenarios following the procedures described below. Annex A provides illustrative examples for setting up the different test cases. NOTE 1 This document can be applied to systems including overcurrent protection devices and blocking diodes.		P
	The detection capability of stand-alone devices shall not be compromised by expected internal or external interference. Therefore, the compliance of stand-alone and distributed AFPEs and AFDs to this document shall only apply to the combination of the specific PCE models with which the devices have been tested. NOTE 2 Switch mode PCEs generate electromagnetic noise during operation. Experience has shown that the detection of arcs can be affected by this interference.	Not stand-alone or distributed AFPE.	N/A

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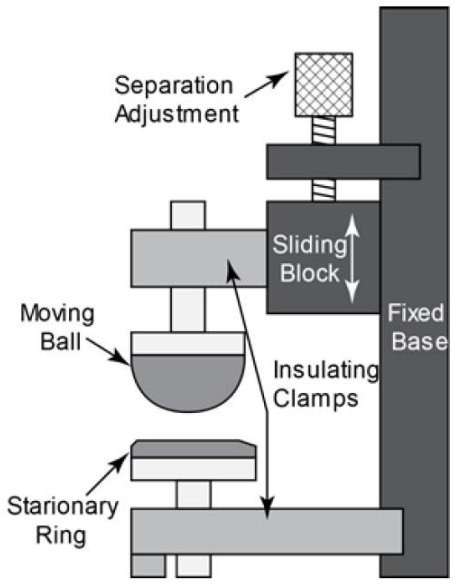
Clause	Requirement – Test	Result – Remark	Verdict
	NOTE 3 Nuisance tripping is not a safety issue but rather a quality concern for AFD and AFPE. Simulating cloud movement of e.g. 300 W/m²/s based on Clause B.3 of IEC 62891:2020 and startup/shutdown tests according to Clause B.4 of IEC 62891:2020 may help to reveal device susceptibilities to nuisance tripping in actual installations.		
9.2.2	**Arc generator**	Complied.	P
	The arc generator shall consist of tungsten alloy ball-ring electrodes and a movable slide as illustrated in Figure 1 and Figure 2. The test is initiated with the electrodes in contact with each other (shorted) and then separated at a controlled rate to the specified gaps defined in Table 5. The positive pole of the test circuit shall be connected to the ring of the assembly shown in Figure 1.		P
	Special care shall be taken to a correct positioning of the electrodes to each other in order to achieve a contact area over the full circumference.		P
	Figure 2 defines the relevant dimensions for the electrodes. Parts of the drawing where no dimensions or requirements are defined are considered not to influence the outcome of the test. For these locations individual design and dimensions are allowed for supporting mounting means like brackets or screws.  Figure 1- Schematic of the arc generator (as derived from UL 1699 B)		P

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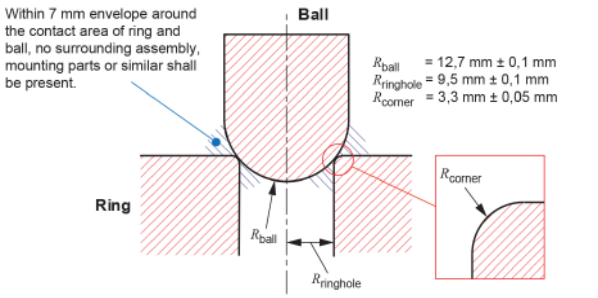
Clause	Requirement – Test	Result – Remark	Verdict
	 Surface finish: All ball and corner surfaces of the ring, roughness min. 0,1 µm (polished) Material: Class 1 tungsten nickel copper alloy (90 % tungsten, 10 % nickel copper) IEC **Figure 2 – Dimensions of arc generator electrodes**		
9.2.3	**DC source**		P
9.2.3.1	**General**		P
	The source required for testing shall consist of a DC power source, either: – a constant voltage source with additional resistance to simulate PV specific IV-characteristics, or		N/A
	– a PV simulator. Since a PV simulator may produce unwanted tripping or may inhibit the AFPE from detecting arcing, reference tests should be made using a suitable array of PV modules when deemed necessary.		P
9..2.3.2	**Constant voltage source**		N/A
	Where tests are specified to be conducted at maximum power, the DC source shall be adjusted for its Maximum Power Point (MPP) as follows: a) The constant voltage of the supply shall correspond to the VOC as defined in Table 5. b) The current limitation of the source shall be set to 1,1 times the Impp value given in Table 5. c) Rtot shown in Table 5 shall be used to calculate R1 and R2 (see 9.2.3.4) following the formula R1 = R2 = Rtot / 2 × k – R3. Where k represents the number of decoupling or PV-networks used within one string. E.g. two half strings k = 2, full string k = 1.		N/A
9.2.3.3	**PV simulator**		P
	Where tests are specified to be conducted at maximum power, the PV simulator shall be adjusted for its Maximum Power Point (MPP) as described in Table 5, with the short circuit current value set to 1,1 times the Impp value. For all tests using a PV simulator, the resistance values R1 = R2 = 0.		P
9.2.3.4	**Decoupling network**		P
	The network decouples the source and the DUT to avoid potential influence on the test. It shall be designed according to the topology shown in Figure 3. The parameters for the respective components		P

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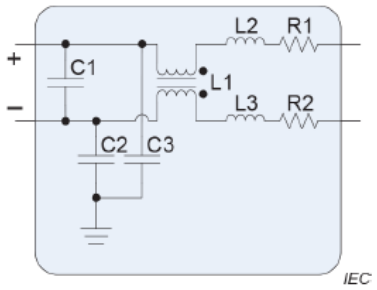
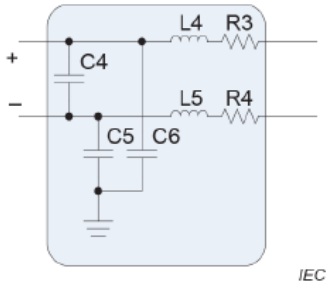
Clause	Requirement – Test	Result – Remark	Verdict
	shall be calculated according to Annex B.  **Figure 3 – DC source decoupling network**		
9.2.4	**Array line impedance network**		P
	The DUT shall be connected to the DC source and the arc generator using a network which accounts for the various line impedances found in different array configurations. The general layout of the network is shown in Figure 4. The parameters of the components of the line impedance network for the specific application cases are further specified in Annex B.  **Figure 4 – Array line impedance network** NOTE The array line impedance network is parameterized to reflect typical PV field installations. Nevertheless, the array impedances depend on numerous factors such as module technology, length and routing of the DC cabling, etc. A robust AFD may be achieved by in-field arc fault tests in many different PV installations or by recording DC and high frequency noise signals during field tests and replaying them later on a DUT.		P
9.2.5	**Line Impedance**		N/A
	Cabling between a PV string combiner or dc/dc converter and an inverter is not covered by the array line impedance network and shall be simulated by an additional line impedance (Figure 5).	Not used.	N/A

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Clause	Requirement – Test	Result – Remark	Verdict

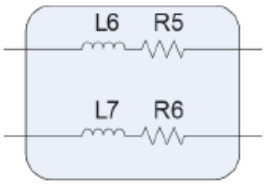

Figure 5 – Line impedance network

The parameters of the components of the line impedance are specified in Annex B

9.2.6 **Test procedure** — Considered. — P

Table 5 lists all arcing test conditions. The applicable test conditions shall be selected based on the DUT ratings and the test configurations. The maximum rated current per input port I_{pA} is used to select suitable tests. The I_{pA} is defined either by the maximum input current of the DUT or the maximum input current per channel or the current at maximum power point of the PCE or a single input stage of the PCE. — P

In the situation where the classification is partial coverage, the maximum arc current cannot directly be referred to the I_{pA}. In this case the arcing current needs to be selected according to the sub string currents. As an example, use 15 A as illustrated in Figure 6b). — N/A

Table 5 – Arcing test conditions

Test	Minimum I_{arc}	I_{mpp}	Sep. rate	V_{mpp}	V_{OC}	R_{tot}	Gap
#	A*	A	mm/s	V	V	Ω	mm
1	2,5	3,0	2,5	312,0	480,0	56,0	0,8
2	7,0	8,0	5,0	318,0	490,0	21,0	0,8
3	14,0	16,0	5,0	318,0	490,0	11,0	1,1
4	7,0	8,5	5,0	607,0	810,0	24,0	2,5
5	$0,9 \times I_{pA}$	I_{pA}	5,0	318,0	490,0	$(V_{OC} - V_{mpp}) / I_{pA}$	2,5

* Values given shall provide an indication of currents that likely occur. The actual value depends on several factors.

Tests 1 to 5 shall be performed as follows:

For testing purposes, the applicable number of full string models defined in B.1.2 shall be connected in parallel. Alternatively, a full string model and a parallel string model may be used, where n in the parallel string model is defined by the input port current divided by 10 A. The value of n shall be rounded up to the nearest integral value. If the DUT is not able to operate at 318 V, the closest possible voltage shall be used. See also Note 4 in B.1.2. — P

Test 1: This test shall be applied to all DUTs. In case there is an uncertainty whether a low current arc was extinguished by the AFPE or by an inadequate test setup, the test setup including the DC source settings shall be reviewed and the result of the review shall be documented. — P

NOTE 1 This test is intended to address low currents at which arcs become possible to form.

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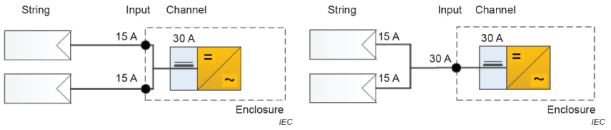
Clause	Requirement – Test	Result – Remark	Verdict
	Test 2: This test shall be applied where the maximum rated current per input port of the DUT is 8 A or higher.		P
	Test 3: This test shall be applied where the maximum rated current per input port of the DUT is 16 A or higher.	Max. current per input port is 23A.	P
	Test 4: This test shall be applied where the maximum input voltage of the DUT is 810 V or higher.	Max. 750Vd.c.	N/A
	Test 5: This test shall be applied where the maximum rated sensing current of a single channel of the DUT is 24 A or higher and where the maximum arcing current is not limited by the input ratings of the DUT to less than 24 A (see Figure 6). Test 5 is intended especially for detecting arcs on the main cable of systems where the parallel connection of PV strings is external to the device or equipment enclosure.  a) maximum arc current limited by max. input current b) maximum arc current not limited Figure 6 – Limitation input current	No parallel strings.	N/A
	For tests 1 through 3 and 5 the following applies: If the maximum rated voltage of the DUT is less than the value for V_{OC} in Table 5, V_{OC} shall be replaced by the maximum rated voltage of the DUT, and V_{mpp} shall be replaced by 0.65 times the maximum rated voltage.		P
	For tests 1 through 5 the following applies: If the minimum V_{mpp} of the DUT is higher than the value for V_{mpp} in Table 5, V_{mpp} shall be replaced by the minimum V_{mpp} of the DUT. V_{OC} is then calculated by V_{mpp} divided by 0.65.		P
	For configurations with parallel modules or strings the current for the parallel strings in the parallel test setup shall be calculated as follows: Test 1: $I_{T1} = (n-1) \times 3$ A		P
	In case the calculated current of the parallel non-arcing strings I_{T1} plus 3 A is higher than the maximum arcing current of the DUT, the parallel non-arcing current shall be reduced such that the total current matches the input of the DUT. NOTE 2 As an example, for n = 6 the calculation will result in 15 A as parallel current. The total current, including the arc current of 3 A, will be 18 A. The input current of the DUT is limited by ratings to a maximum of 15 A, which is equal to the maximum arcing current. In this case the parallel current for test 1 will be reduced to 12 A.		P
	Test 2: $I_{T2} = I_{ch} - 8$ A for input setup		P

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Clause	Requirement – Test	Result – Remark	Verdict
	I_{T2} = (m-1) × I_{input} for output setup For DUTs with multiple inputs per Channel the calculated parallel current for Test 1 and 2 shall be divided between the inputs according to the product classification (see Clause 4) and with respect to the maximum input current limits per input port. Refer to Annex C for examples for applying the parallel current and its distribution over several inputs. where n is the number of strings per channel; m is the number of input ports per channel; I_{ch} is the maximum current per channel; I_{input} is the maximum current per input port; I_{T1} or I_{T2} is the current of the parallel non-arcing strings. NOTE 3 For detailed definition of input, output and parallel setup refer to Annex B and Annex D.		
	For test 3 and test 5 the currents from the DC sources can be differentiated according to the number of represented strings per DC source.		N/A
	Test 4 is not required to be tested with parallel test configurations.		N/A
	For string output test configurations (Figure B.16 to Figure B.18) the following applies: • Where constant voltages are present in the output circuit the tests shall be performed using the arc current values defined in Table 5. • The maximum output current of the DC/DC converter is considered the maximum input current of the DUT for selection of applicable test according to Table 5.	Not DC/DC converter	N/A
	For module level input test setups (Figure B.11 to Figure B.15) the maximum input current of the DC/DC converter is considered the maximum input current of the DUT for the purpose of selecting the applicable tests from Table 5.	Not module level.	N/A
	The arc generator shall be positioned as shown in the applicable figures in Annex B.		P
	In general, the arc generator shall be positioned close to the PV terminal (positive or negative) of the DUT that creates the most severe condition. If more than one PV module can be connected in series to the DUT input, an additional test shall be performed with the arc generator in the middle of the series connected modules.	Be positioned close to the positive PV terminal and in the middle of the series connected modules.	P
	As two different values of parameter C4 are defined in Table B.2 each test (arc-gap and current combination) results in two test runs. Testing may be reduced to the worst-case scenario. To determine the worst-case scenario five measurements at each of the two values for C4 shall be conducted with selected test	Two different values of parameter C4 verified.	P

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Clause	Requirement – Test	Result – Remark	Verdict
	setups. The capacitor value resulting in the highest average detection time shall represent the worst case.		
	Each test run shall be performed two times.		P
	For multi-channel devices each channel shall be tested according to the single channel setups. Where the same hardware and software modules are used for each channel, the number of tests may be reduced as follows: Test one channel according to the full set of applicable tests required for one channel. Test the remaining channels only with the most adverse arc location determined in the original tests, evaluated according to highest average arc energy or longest detection time.		P
9.2.7	**Arc energy and response time measurement**		P
	The voltage across the arc gap, the arc duration, and the current through the arc shall be measured and recorded. These measurements are then used to calculate the total energy generated by the arc prior to detection or interruption. For arc duration measurements, - The arc period for AFPEs begins when the arc voltage reaches 10 V and ends when the arc current falls below 250 mA. - The arc period for AFDs begins when the arc voltage reaches 10 V and ends at the indication of an arc event.	Tested, see test data on the following pages.	P
9.2.8	**Self-test function**		P
9.2.8.1	**General**		P
	The test function of the AFD or AFPE is required to demonstrate the operational readiness of the AFD or AFPE during operation. Two cases shall be evaluated here, 'test function without malfunction of the AFD or AFPE' and 'test function with malfunction of the AFD or AFPE'. The first case defines the normal operation of the DUT where 'test function with malfunction of the AFD or AFPE' defines a case which has to be constructed by manipulation of the device.		P
9.2.8.2	**Test function without malfunction of the AFD or AFPE**	Tested	P
	For an AFPE providing a manual test function, the test shall be initiated and the interruption shall be verified.		P
	For an AFD providing a manual test function, the test shall be initiated and the indication of the successful test shall be verified.	Not AFD	N/A
9.2.8.3	**Test function with malfunction of the AFD or AFPE**		P
9.2.8.3.1	**Detection malfunction**	Tested.	P

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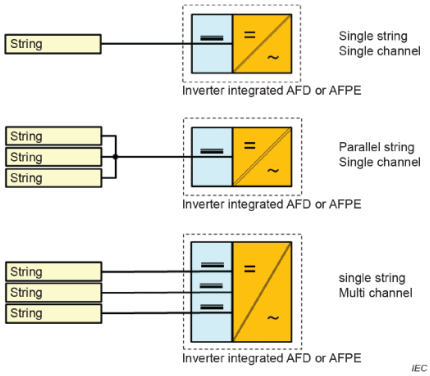
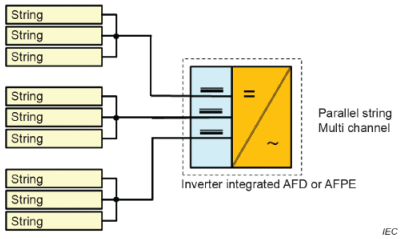
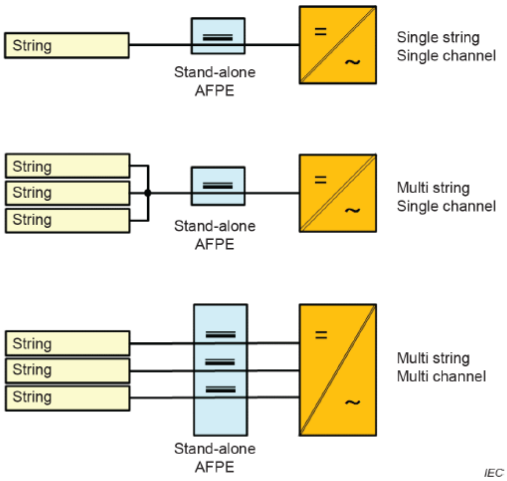
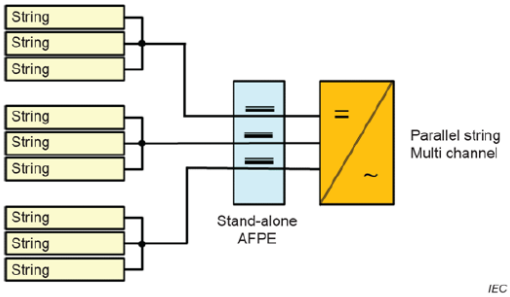
Clause	Requirement – Test	Result – Remark	Verdict
	A fault shall be introduced into the AFD or AFPE in a way to cause a malfunction of the detection mechanism. The test function shall be initiated and the malfunction of the detection mechanism shall be indicated.		P
9.2.8.3.2	**Automatic test function before starting operation**	Tested.	P
	The AFD or AFPE shall be modified in a way to cause a malfunction of the AFD or AFPE detection. The operation of the AFD or AFPE shall be initiated and the indication of a malfunction shall be verified.		P
9.2.8.3.3	**Automatic test function during operation**	Tested.	P
	A fault shall be introduced into the AFD or AFPE in a way to cause a malfunction of the detection mechanism during operation. It shall be verified that the AFD or AFPE indicates a malfunction within 25 h. NOTE The pass/fail criteria of 25 h allows for tolerances on the 24 h timer.		P
9.2.9	**Reconnection test**		P
9.2.9.1	**Manual reconnection**		N/A
	After arc-fault interruption, the AFPE shall neither reconnect automatically nor shall remote reconnection be possible. Compliance shall be demonstrated by tripping the AFPE three times.		N/A
9.2.9.2	**Remote manual reconnection**	Tested.	P
	After arc-fault interruption, the AFPE shall not reconnect automatically. Compliance shall be demonstrated by tripping the AFPE three times.		P
9.2.9.3	**Automatic reconnection**	Tested.	P
	After arc-fault interruption, the AFPE shall reconnect automatically within the limitations described in 8.1.4.4. Compliance shall be demonstrated by tripping the AFPE at least five times within a 24 h period to demonstrate the manual reconnection state.		P
Annex A (informative)	**String and channel examples**		P
A.1	**General**		P
	The following schematics illustrate the range of string and channel examples of AFPEs and AFDs, see Figure A.1, Figure A.2, Figure A.3, Figure A.4, Figure A.5 and Figure A.6.		P
A.2	**PCE integrated AFDs and AFPEs**		P

IEC 63027			
Clause	Requirement – Test	Result – Remark	Verdict
	 **Figure A.1 – Schematic of string setting of PCE integrated AFDs and AFPEs**  **Figure A.2 – Schematic of parallel setting of PCE integrated AFDs and AFPEs**		P
A.3	**Standalone AFPEs**	Not stand-alone AFPEs.	N/A
	 **Figure A.3 – Schematic of string setting of stand-alone AFPEs**  **Figure A.4 – Schematic of parallel setting of stand-alone AFPEs**		N/A
A.4	**Distributed AFPEs**	Not distributed AFPEs	N/A

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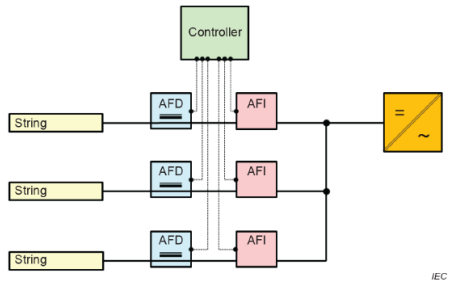
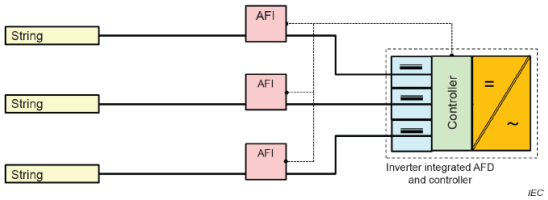
Clause	Requirement – Test	Result – Remark	Verdict
	 Figure A.5 – Schematic of single string, single channel distributed AFPEs  Figure A.6 – Schematic of single string, single channel (Inverter integrated AFD and controller)		N/A
Annex B (normative)	**Test setups following different application cases**		P
B.1	**General**	See below.	P
B.1.1	**Overview**		P
	This annex gives an overview of the different test setups for AFPE and provides guidance for selecting the appropriate test setups based on the equipment classifications. Subclause B.1.2 defines the PV source models that are used in the different test setups. Clauses B.2, B.3 and B.4 define test setups for typical application cases for string inverter, micro-inverter and DC/DC converter-based systems. Clause B.5 mainly defines setups for systems where AFPE is integrated within combiner boxes or where strings are otherwise combined external to the AFPE devices. Clauses B.4 and B.5 differentiate between input and output setups. This differentiation is not necessarily related to the location of the AFD or AFPE within the system. Instead, it refers to the transition point were DC/DC conversion or parallel connection leads to different arcing scenarios. For Clause B.4 the transition point for input and output is the DC/DC converter, for Clause B.5 the transition point is the combiner.		P
	Test setups according to Clause B.2 (Figure B.3, Figure B.4 and Figure B.5) shall be performed for AFPE with method of implementa-		P

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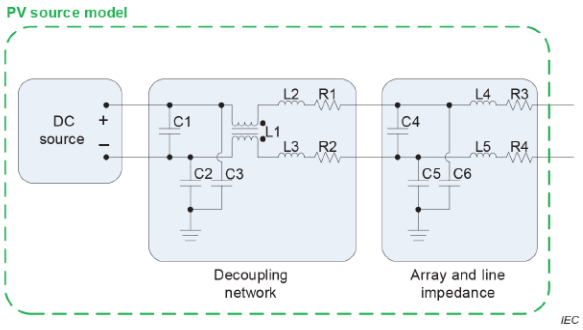
Clause	Requirement – Test	Result – Remark	Verdict
	tion classified as I for: – Inverter integrated AFPE, except micro-inverters – Stand-alone AFPE with one input port per channel. NOTE Stand-alone AFPEs with more than one input port are covered by test setups defined in Clause B.5.		
	Test setups according to Clause B.3 (Figure B.6, Figure B.7, Figure B.8, Figure B.9 and Figure B.10) shall be performed for AFPE with system integration classified as I for: – Micro-inverter integrated AFPE.	Not micro-inverter	N/A
	Test setups according to Clause B.4 (Figure B.11, Figure B.12, Figure B.13, Figure B.14, Figure B.15, Figure B.16, Figure B.17 and Figure B.18) shall be performed for AFPE with system integration classified as I or D for: – AFPE for DC-DC converter systems.	Not DC-DC converter	N/A
	Test setups according to Clause B.5 (Figure B.19, Figure B.20, Figure B.21, Figure B.22 and Figure B.23) shall be performed for AFPE with system integration classified as S for: – AFPE integrated in combiner boxes – Stand-alone AFPE with more than one input port per channel.	Not in combiner boxes or Stand-alone AFPE	N/A
B.1.2	**PV source models**	Considered.	P
	 **Figure B.1 – PV source model** The PV source model represents the combination of DC source, decoupling network and array and line impedance (see Figure B.1). Depending on the application and the test setup, four different PV source models are defined with the respective parameter values for the LRC components in Table B.1 and Table B.2: (1) Half string model. (2) Full string model. (3) Module based model. (4) Parallel string model.		P
	In the following test setups placeholders for the PV source model are indicated with the respective numbers of the required PV source model. They are used in Clauses B.2, B.3, B.4 and B.5 in		P

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Clause	Requirement – Test	Result – Remark	Verdict

different settings in order to reflect the different application cases.

Table B.1 – General LRC component parameters

Parameter	Value	Comment
	(All test setups)	
C1	Min. 20 µF	Value shall dominate the output capacity of the DC source
C2, C3	22 nF	
L1	12 mH	Common Mode (CM)-Filter, minimal DC flux
L2, L3	Min. 60 µH	Saturation at high currents or frequencies shall be avoided
R1, R2	$(R_{Tot} / 2 \times k) - R3$	*k*: Number of decoupling networks
L6, L7	30 µH	Air core; values for line impedance defined in 9.2.5
R5, R6	0,4 Ω	Wire resistance; values for line impedance defined in 9.2.5

Table B.2 – LCR component parameters for different module configurations

Parameter	Half string	Full string	Module level	Parallel strings	Comment
C4	300 nF and 20 µF	150 nF and 10 µF	1,5 µF and 100 µF	150 nF × (*n*-1) and 10 µF × (*n*-1)	See note 3
C5, C6	0,5 nF	1 nF	100 pF	1 nF × (*n*-1)	
L4, L5	25 µH	50 µH	3 µH	50 µH / (*n*-1)	Saturation at high currents or frequencies shall be avoided, L4 + L5: approximately 0,75 µH / m approximately 4 µH / module
R3, R4	Max. 0,5 Ω	Max. 1 Ω	Max. 0,5 Ω	Max. 1 Ω	

Nominal component parameters of resistors and inductances shall be within a 10 % range of the values demanded in Table B.1 and Table B.2. Nominal component parameters of capacitors shall be within a 20% range of the demanded values. — P

The parameter values are critical over a wide frequency range. The nominal value of all inductances shall be measured at 10 kHz and shall not decrease by more than 40 % at 300 kHz

NOTE 1 The n in the parallel strings column equals the maximum number of parallel strings that can be connected to one channel of the DUT. As an example, if there are a total of 8 strings being monitored by a single AFPE, a series arc fault test with a parallel string setup has to be conducted and n-1 would equal 7.

NOTE 2 Connecting several half string or full string models including DC source, decoupling network and array line impedance network in parallel will also form a parallel string model.

NOTE 3 Two values are given for C4 to represent different framing and module technologies, whereby no combination of different frame and module technologies needs to be tested. Depending on the AFD one of these values may pose a worst-case scenario.

NOTE 4 The parameters for the full string column in Table B.2 represent a string with 10 modules with approximately 10 A. Using the same parameters for significantly higher currents leads to a mismatch with respect to the realistic impedances of typical strings. This also applies to the parallel string.

NOTE 5 Resistors with high stray inductances may reduce arcing signals at high frequencies more than intended by the parameter setting of Table B.2.

NOTE 6 The parameters for the full string column in Table B.2 represent a total conductor length of 80 m.

B.1.3 **Flow chart for test selection** — P

The applicable test cases relevant for testing shall be selected according to the flow chart in Figure B.2. All possible configurations shall be taken into account to find all required test setups. As a result, it may be necessary to go through the — P

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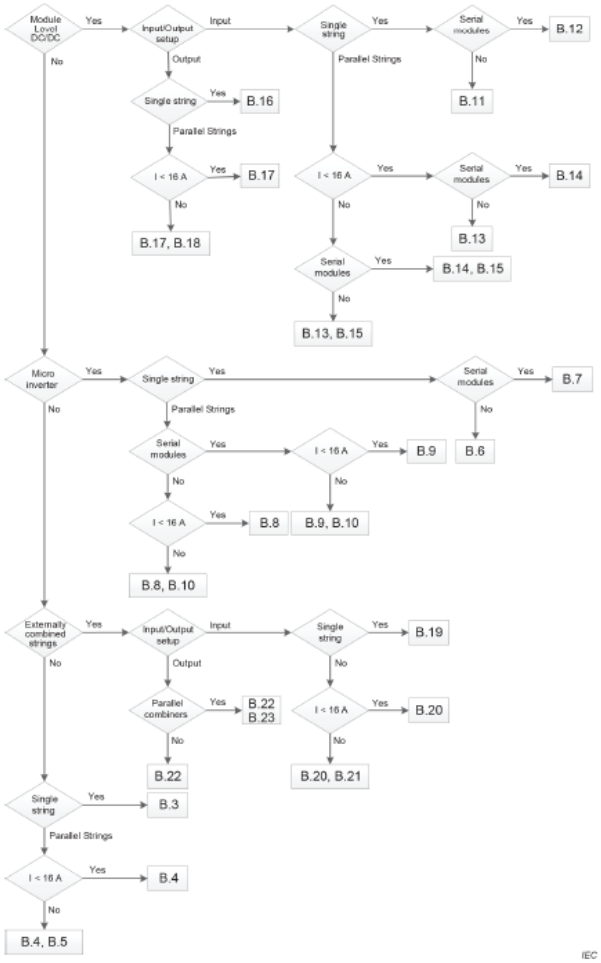
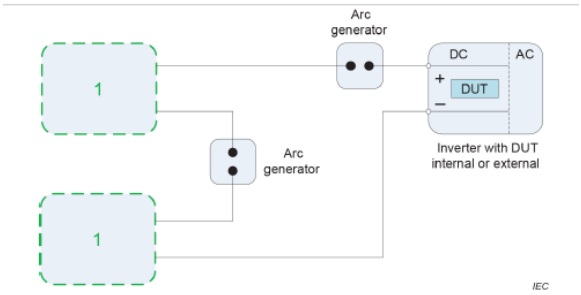
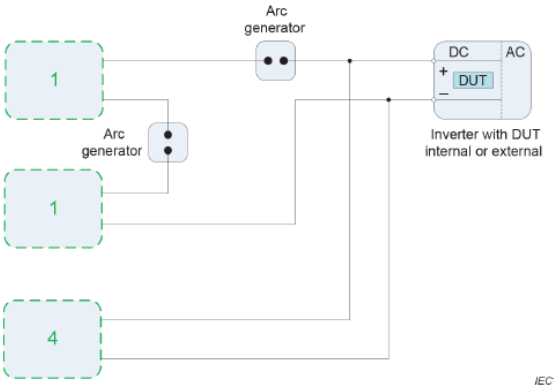
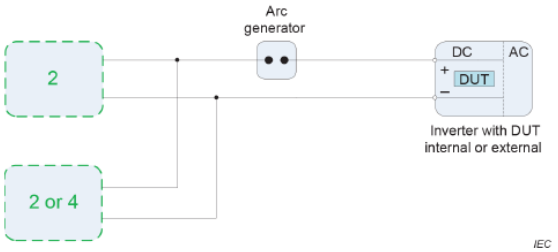
Clause	Requirement – Test	Result – Remark	Verdict
	flow chart several times.  Figure B.2 – Flow chart to select applicable test cases		
B.2	**Application String inverter**	Test 1, 2, 3 applied.	P

IEC 63027			
Clause	Requirement – Test	Result – Remark	Verdict
	 **Figure B.3 – Single string test setup (tests 1, 2, 4)**  **Figure B.4 – Parallel string test setup (tests 1 and 2)**  **Figure B.5 – Parallel string test setup (tests 3 and 5)**		P
B.3	**Application Micro inverter**	Not micro inverter	N/A

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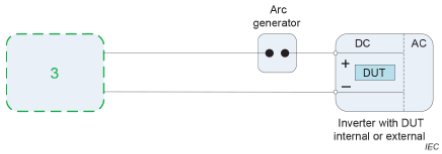
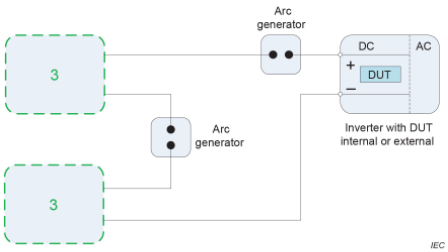
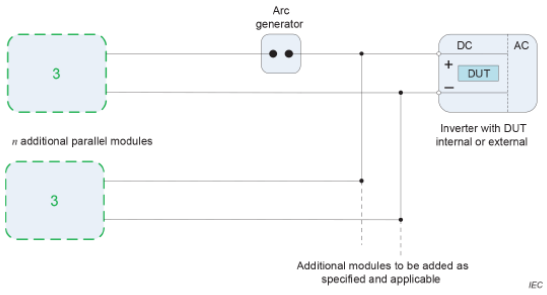
Clause	Requirement – Test	Result – Remark	Verdict
	 **Figure B.6 – Single string test setup (tests 1 and 2)**  **Figure B.7 – Single string test setup (tests 1 and 2) – series modules**  **Figure B.8 – Parallel string test setup (tests 1 and 2)**		N/A

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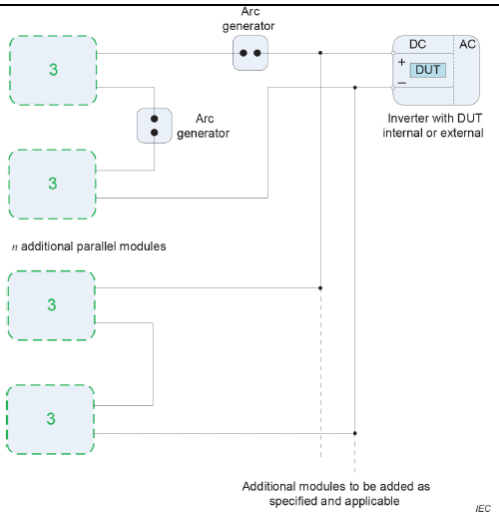
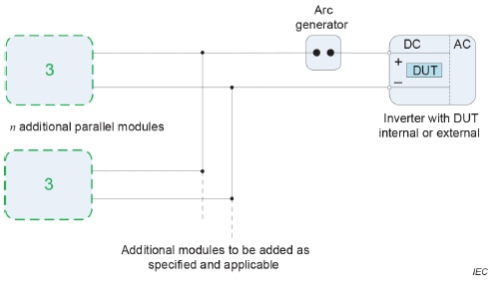
Clause	Requirement – Test	Result – Remark	Verdict
	 **Figure B.9 – Parallel string test setup (tests 1 and 2) – series modules**  **Figure B.10 – Parallel string test setup (tests 3 and 5)**		
B.4	**Application module level DC/DC conversion**	Not module level DC/DC conversion.	N/A
B.4.1	**Input setups**		N/A

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Clause	Requirement – Test	Result – Remark	Verdict
			N/A

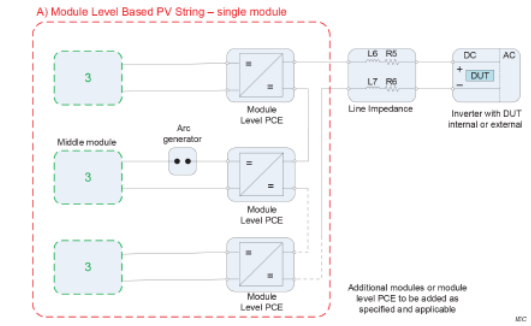

Figure B.11 – Single string test setup (tests 1, 2, 4)

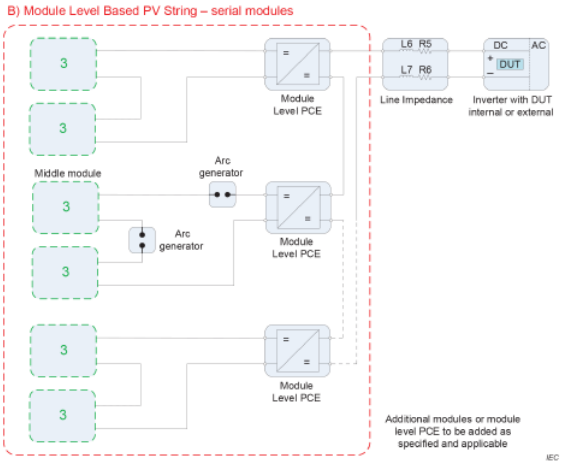

Figure B.12 – Single string test setup (tests 1, 2, 4) – series modules

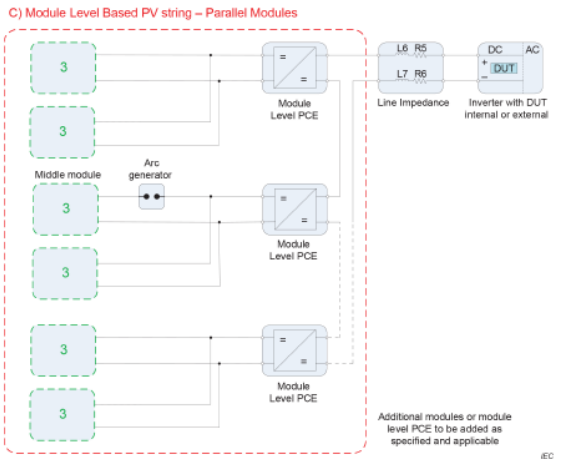

Figure B.13 – Parallel string test setup (tests 1 and 2)

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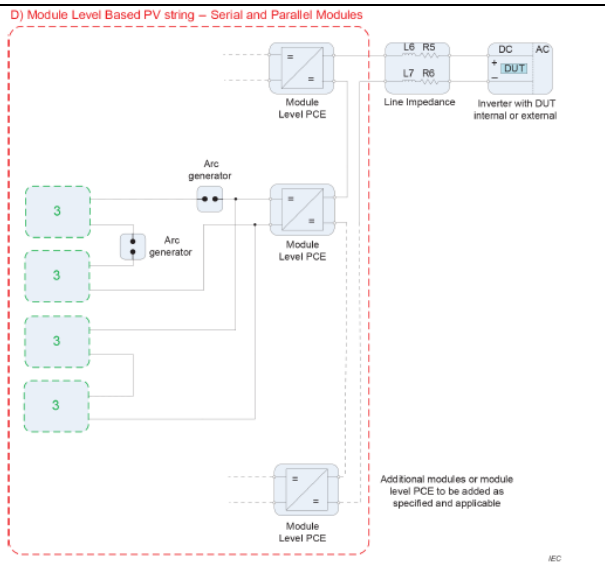
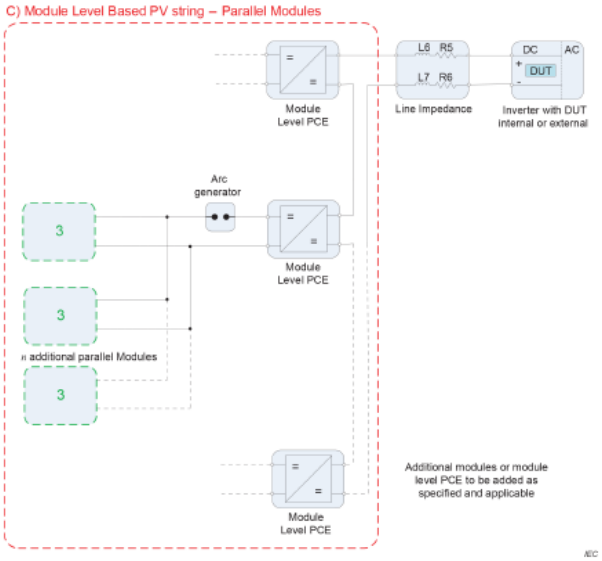
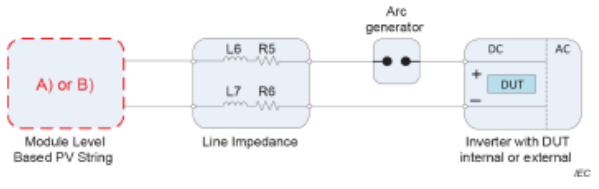
Clause	Requirement – Test	Result – Remark	Verdict
	 **Figure B.14 – Parallel string test setup (tests 1 and 2)**  **Figure B.15 – Parallel string test setup (tests 3 and 5)**		
B.4.2	**Output setups**		N/A
	 **Figure B.16 – Single string test setup (tests 1, 2, 4)**		N/A

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Clause	Requirement – Test	Result – Remark	Verdict

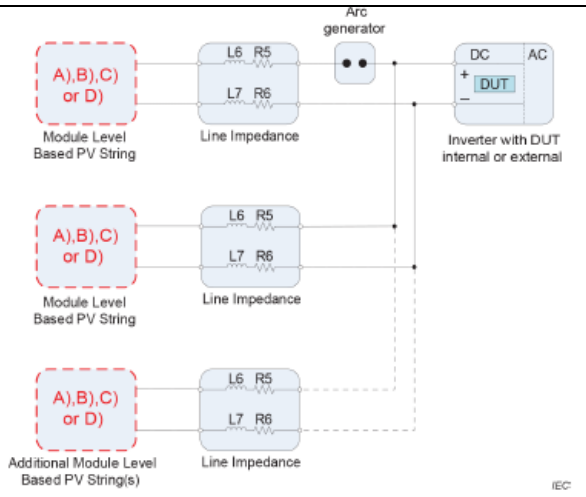

Figure B.17 – Parallel string test setup (tests 1 and 2)

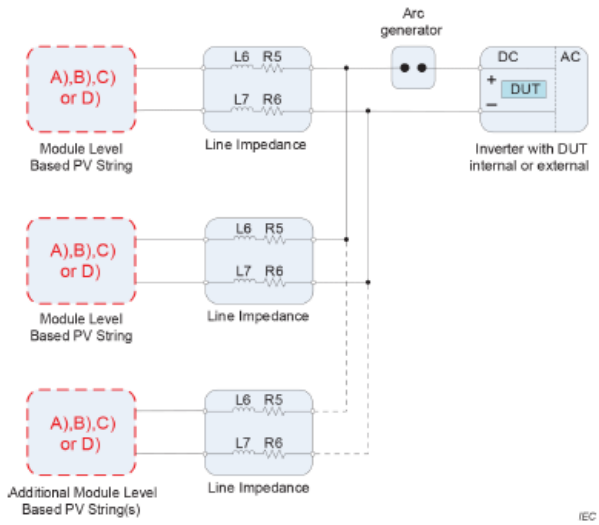

Figure B.18 – Parallel string test setup (tests 3 and 5)

B.5	**Application external combined strings**	Not external combined strings.	N/A
B.5.1	**Input setups**		N/A

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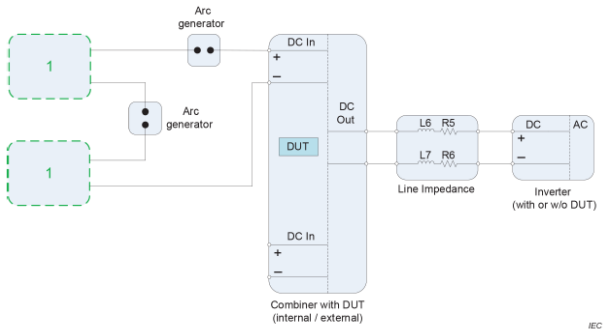
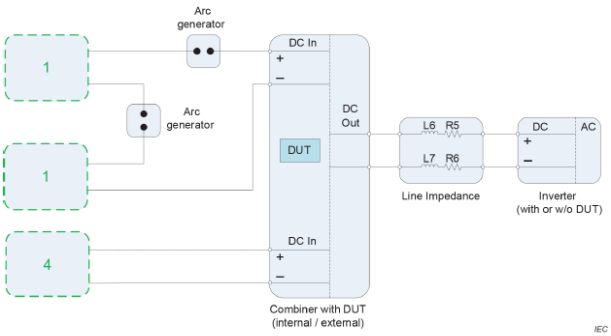
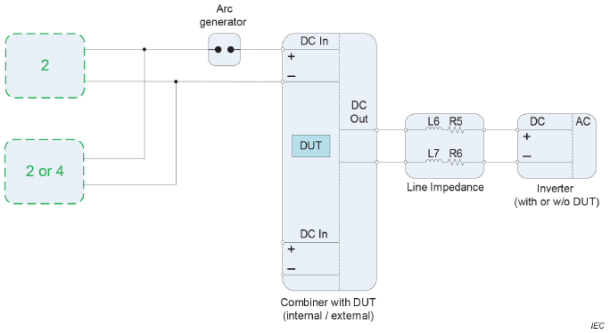
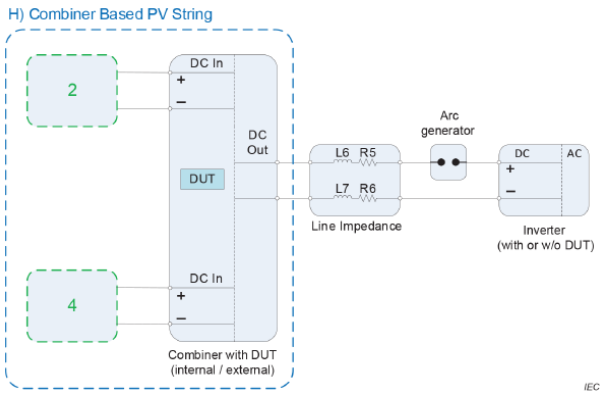
Clause	Requirement – Test	Result – Remark	Verdict
	 **Figure B.19 – Single string test setup (tests 1, 2, 4)**  **Figure B.20 – Parallel string test setup (tests 1 and 2)**  **Figure B.21 – Parallel string test setup (tests 3 and 5)**		N/A
B.5.2	**Output setups**		N/A
	 **Figure B.22 – Single string test setup (test 1 and 2)**		N/A

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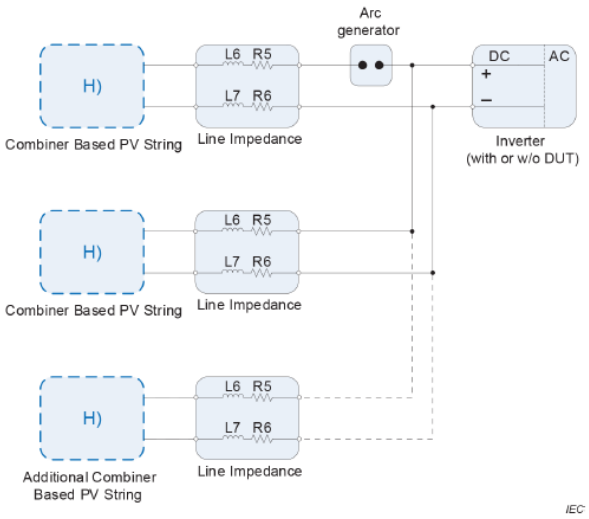
Clause	Requirement – Test	Result – Remark	Verdict

	 **Figure B.23 – Parallel string test setup (tests 3 and 5)** NOTE For the DUT position in Figure B.23 refer to Figure B.22, where the combiner based PV string H) is defined. Typically for the application externally combined strings the DUT is located in the combiner.		
Annex C (informative)	**Application examples**		P
C.1	General	See below test overview table.	P
C.2	Example 1: String inverter with integrated AFPE (F-I-AFPE)		P
C.3	Example 2: Module level inverter with integrated AFPE (F-I-AFPE)	Not module level inverter	N/A
C.4	Example 3: External AFPE (P-S-AFPE)	Not external AFPE	N/A
C.5	Example 4: Module level DC-DC converter system with AFPE integrated (F-I-AFPE)	Not module level DC-DC converter	N/A
C.6	Example 5: String inverter with multiple Inputs (F-I-AFPE)	No parallel strings.	N/A
C.7	Example 6: String inverter with multiple Inputs (F-I-AFPE)	No parallel strings.	N/A
C.8	Example 7: String inverter with multiple Inputs (F-I-AFPE)	No parallel strings.	N/A

9.1	TABLE: Thermal testing		P
	test voltage (V)	See below	—
	t1 (°C)	--	—
	t2 (°C)	--	—

SUN2000-50K-MGL0/ SUN2000-50K-MGL0-BR

Supplied Voltage:	PV to Grid PV 300V Grid 127V	PV to Grid PV 550V Grid 127V	PV to Grid PV 300V Grid 127V	PV to Grid PV 550V Grid 127V	--
Maximum temperature T of part/at:	T_{max} adjusted to ambient 50 (°C)	T_{max} adjusted to ambient 50 (°C)	T_{max} adjusted to ambient 60 (°C)	T_{max} adjusted to ambient 60 (°C)	Max. temperature limit (°C)
PV1 connector	50.29	49.84	60.02	60.06	105
PV1 input cable	50.46	49.92	60.16	60.05	105
AFPE1 current sensor	65.56	64.14	75.32	74.23	85
AFPE2 current sensor	64.58	63.64	74.42	73.70	85
AFPE PCB base	72.43	71.47	81.96	81.37	105
DSP PCB base	75.37	76.69	85.41	86.26	105
AFPE chip	67.97	67.13	77.42	76.70	110
DSP chip	67.43	68.84	77.56	78.44	110
INV relay	78.50	80.27	87.53	88.73	125
GRID relay	79.39	81.19	87.98	89.44	125
Ambient	50.00	50.00	60.00	60.00	--

SUN2000-75K-MGL0-BR

Supplied Voltage:	PV to Grid PV 300V Grid 127V	PV to Grid PV 550V Grid 127V	PV to Grid PV 300V Grid 127V	PV to Grid PV 550V Grid 127V	--
Maximum temperature T of part/at:	T_{max} adjusted to ambient 40 (°C)	T_{max} adjusted to ambient 40 (°C)	T_{max} adjusted to ambient 60 (°C)	T_{max} adjusted to ambient 60 (°C)	Max. temperature limit (°C)
PV1 connector	41.31	40.62	60.31	61.15	105
PV1 input cable	41.45	40.44	60.44	61.28	105
AFPE1 current sensor	69.06	65.35	76.88	76.15	85
AFPE2 current sensor	67.51	64.69	75.87	75.93	85
AFPE PCB base	74.46	71.97	83.42	83.58	105
DSP PCB base	77.74	78.70	86.97	89.32	105
AFPE chip	70.02	67.27	78.77	79.10	110

DSP chip	69.75	70.74	78.96	81.44	110
INV relay	83.11	85.26	89.48	91.52	125
GRID relay	83.40	85.95	89.71	92.69	125
Ambient	40.00	40.00	60.00	60.00	--
SUN2000-80K-MGL0					
Supplied Voltage:	PV to Grid PV 300V Grid 127V	PV to Grid PV 550V Grid 127V	PV to Grid PV 300V Grid 127V	PV to Grid PV 550V Grid 127V	--
Maximum temperature T of part/at:	T_{max} adjusted to ambient 30 (°C)	T_{max} adjusted to ambient 30 (°C)	T_{max} adjusted to ambient 60 (°C)	T_{max} adjusted to ambient 60 (°C)	Max. temperature limit (°C)
PV1 connector	31.04	30.88	60.40	60.62	105
PV1 input cable	31.14	30.95	60.42	60.80	105
AFPE1 current sensor	58.14	56.72	78.31	75.90	85
AFPE2 current sensor	56.68	56.17	77.24	75.54	85
AFPE PCB base	63.43	63.24	84.87	83.27	105
DSP PCB base	67.44	70.60	88.29	88.76	105
AFPE chip	59.09	58.61	80.15	78.53	110
DSP chip	59.50	62.71	80.32	80.83	110
INV relay	73.27	77.75	90.59	91.01	125
GRID relay	74.27	78.91	91.13	91.88	125
Ambient	30.00	30.00	60.00	60.00	--
Note :					

9.1	TABLE: fault condition tests							P
	test voltage (V) ..... :						See below table	—
	Ambient temperature (°C) ..... :						25	
No.	component No.	fault	test voltage (V)	test time	fuse No.	fuse current (A)	Result	
1.	AFCI current detector R623	S-C	550Vdc 220Vac	3min	-	-	Before fault: DC Input: PV1~PV3: 545Vdc / 0.8 A PV4~PV21: 90Vdc / 0 A Power: 0.985kW AC Output: 126Vac / 2.4A / 0.916kW After fault: DC Input: PV1~PV3: 636Vdc / 0A / 0W PV4~PV21: 95Vdc / 0A / 0W AC Output: 127Vac / 0A / 0kW FID: Arc automatic self-check function operated, PCE shutdown, error content: Arc automatic self-check failed MT: n.a SD: ☒Yes/ ☐ No, DG: ☒Yes/ ☐ No RO: ☒Yes/ ☐ No, NCD: ☒Yes/ ☐ No NH: ☒Pass/ ☐ Fail, DST: ☒Pass/ ☐ Fail	
2.	C46	S-C	550Vdc 220Vac	3min	-	-	Before fault: DC Input: PV1~PV3: 550Vdc / 0.5 A PV4~PV21: 90Vdc / 0 A Power: 0.897kW AC Output: 127Vac / 2.1A / 0.795kW After fault: DC Input: PV1~PV3: 620Vdc / 0A / 0W PV4~PV21: 93Vdc / 0A / 0W AC Output: 127Vac / 0A / 0kW FID: Arc automatic self-check function operated, PCE shutdown, error content: Arc automatic self-check failed MT: n.a SD: ☒Yes/ ☐ No, DG: ☒Yes/ ☐ No RO: ☒Yes/ ☐ No, NCD: ☒Yes/ ☐ No NH: ☒Pass/ ☐ Fail, DST: ☒Pass/ ☐ Fail	

3.	AFCI IC failure C1	+5V power supply disable S-C	550Vdc 220Vac	3min	-	-	Before fault: DC Input: PV1~PV3: 549Vdc / 0.6 A PV4~PV21: 91Vdc / 0 A Power: 0.897kW AC Output: 127Vac / 2.4A / 0.787kW After fault: DC Input: PV1~PV3: 619Vdc / 0A / 0W PV4~PV21: 90Vdc / 0A / 0W AC Output: 127Vac / 0A / 0kW FID: Arc automatic self-check function operated, PCE shutdown, error content: Arc automatic self-check failed MT: n.a SD: ☒Yes/ ☐ No, DG: ☒Yes/ ☐ No RO: ☒Yes/ ☐ No, NCD: ☒Yes/ ☐ No NH: ☒Pass/ ☐ Fail, DST: ☒Pass/ ☐ Fail
4.	AFCI IC failure R206	+3V power supply disable O-C	550Vdc 220Vac	3min	-	-	Before fault: DC Input: PV1~PV3: 551Vdc / 0.4 A PV4~PV21: 90Vdc / 0 A Power: 0.492kW AC Output: 126Vac / 1A / 0.393kW After fault: DC Input: PV1~PV3: 620Vdc / 0A / 0W PV4~PV21: 90Vdc / 0A / 0W AC Output: 127Vac / 0A / 0kW FID: Arc automatic self-check function operated, PCE shutdown, error content: Arc automatic self-check failed MT: n.a SD: ☒Yes/ ☐ No, DG: ☒Yes/ ☐ No RO: ☒Yes/ ☐ No, NCD: ☒Yes/ ☐ No NH: ☒Pass/ ☐ Fail, DST: ☒Pass/ ☐ Fail

5.	AFCI IC failure Reset R1809	O-C	550Vdc 220Vac	3min	-	-	Before fault: DC Input: PV1~PV3: 551Vdc / 0.4 A PV4~PV21: 90Vdc / 0 A Power: 0.492kW AC Output: 127Vac / 1A / 0.393kW After fault: DC Input: PV1~PV3: 620Vdc / 0A / 0W PV4~PV21: 91Vdc / 0A / 0W AC Output: 127Vac / 0A / 0kW FID: Arc automatic self-check function operated, PCE shutdown, error content: Arc automatic self-check failed MT: n.a SD: ☒Yes/ ☐ No, DG: ☒Yes/ ☐ No RO: ☒Yes/ ☐ No, NCD: ☒Yes/ ☐ No NH: ☒Pass/ ☐ Fail, DST: ☒Pass/ ☐ Fail
6.	Loss of communication signal between current detection and CPU R137	O-C	550Vdc 220Vac	3min	-	-	Before fault: DC Input: PV1~PV3: 550Vdc / 0.5 A PV4~PV21: 91Vdc / 0 A Power: 0.660kW AC Output: 126Vac / 1.4A / 0.550kW After fault: DC Input: PV1~PV3: 624Vdc / 0A / 0W PV4~PV21: 93Vdc / 0A / 0W AC Output: 127Vac / 0A / 0kW FID: Arc automatic self-check function operated, PCE shutdown, error content: Arc automatic self-check failed MT: n.a SD: ☒Yes/ ☐ No, DG: ☒Yes/ ☐ No RO: ☒Yes/ ☐ No, NCD: ☒Yes/ ☐ No NH: ☒Pass/ ☐ Fail, DST: ☒Pass/ ☐ Fail

7.	Loss of CPU drive signal R82	O-C	550Vdc 220Vac	3min	-	-	Before fault: DC Input: PV1~PV3: 551Vdc / 0.4 A PV4~PV21: 90Vdc / 0 A Power: 0.543kW AC Output: 126Vac / 1.2A / 0.443kW After fault: DC Input: PV1~PV3: 615Vdc / 0A / 0W PV4~PV21: 93Vdc / 0A / 0W AC Output: 127Vac / 0A / 0kW FID: Arc automatic self-check function operated, PCE shutdown, error content: Arc automatic self-check failed MT: n.a SD: ☒Yes/ ☐ No, DG: ☒Yes/ ☐ No RO: ☒Yes/ ☐ No, NCD: ☒Yes/ ☐ No NH: ☒Pass/ ☐ Fail, DST: ☒Pass/ ☐ Fail
8.	C1618	S-C	550Vdc 220Vac	3min	-	-	Before fault: DC Input: PV1~PV3: 549Vdc / 0.3 A PV4~PV21: 90Vdc / 0 A Power: 0.437kW AC Output: 126Vac / 2.4A / 0.349kW After fault: DC Input: PV1~PV3: 615Vdc / 0A / 0W PV4~PV21: 90Vdc / 0A / 0W AC Output: 127Vac / 0A / 0kW FID: Arc automatic self-check function operated, PCE shutdown, error content: Arc automatic self-check failed MT: n.a SD: ☒Yes/ ☐ No, DG: ☒Yes/ ☐ No RO: ☒Yes/ ☐ No, NCD: ☒Yes/ ☐ No NH: ☒Pass/ ☐ Fail, DST: ☒Pass/ ☐ Fail

Legend			
FID	Fault Indication	MT	Max. Temperature
SD	PCE Shut Down:	DG	Disconnection To Grid
RO	Recovered to Operate after removing the single fault setting	NCD	No Comp. or parts Damaged
NH	No Hazards occurred	PEST	Pass the Dielectric Strength Test.
s-c	short-circuited	o-c	open-circuited
o-l	Over-load.		

Note(s): Test on SUN2000-80K-MGL0 to represent all the other models.

Annex C	Overview of the respective tests are conducted						
Channel number	Test num-ber	I_{arc} A	$I_{parallel}$ A	I_{mpp} A	V_{mpp} V	Test setup	Number of tests
1	1 (single)	2.5	N/A	3.0	312	Figure B.3	8
	2 (single)	7.0	N/A	8.0	318	Figure B.3	8
	3 (single)	14.0	N/A	16.0	318	Figure B.3	8
	1 (parallel)	2.5	6.0	3.0	312	Figure B.4	8
	2 (parallel)	7.0	40.0	8.0	318	Figure B.4	8
	3 (parallel)	14.0	32.0	16.0	318	Figure B.4	8
2	2 (parallel)	7.0	40.0	8.0	318	Figure B.4	8
3	2 (parallel)	7.0	40.0	8.0	318	Figure B.4	8
4	2 (parallel)	7.0	40.0	8.0	318	Figure B.4	8
5	2 (parallel)	7.0	40.0	8.0	318	Figure B.4	8
6	2 (parallel)	7.0	40.0	8.0	318	Figure B.4	8
7	2 (parallel)	7.0	40.0	8.0	318	Figure B.4	8

9.2.7	Arc energy and response time measurement								P
SUN2000-50K-MGL0-BR									
Channel No.	Test No.	Location	C4 (F)	Test Voltage (cross arc gap)/V	Test current (through arc)/A	Arc dura-tion/ms	Energy /J	Trip <2.5s J<750J	Off/Standby current <250mA
1	1 (single)	1	20uF	21.69	3.02	250	10.83	PASS	PASS
			20uF	24.28	3.09	290	16.99	PASS	PASS
			300nF	22.36	3.09	272	16.72	PASS	PASS
			300nF	23.19	3.13	260	15.89	PASS	PASS
		2	20uF	23.21	3.02	252	14.21	PASS	PASS
			20uF	21.08	3.10	258	14.09	PASS	PASS
			300nF	28.22	3.12	252	16.14	PASS	PASS
			300nF	22.36	3.08	250	15.58	PASS	PASS
	2 (single)	1	20uF	20.01	7.85	288	35.60	PASS	PASS
			20uF	17.75	7.89	284	34.63	PASS	PASS
			300nF	18.23	7.75	262	31.95	PASS	PASS
			300nF	18.67	8.06	270	38.54	PASS	PASS
		2	20uF	19.51	7.77	258	33.59	PASS	PASS
			20uF	18.24	7.86	268	30.32	PASS	PASS
			300nF	20.08	7.60	254	30.76	PASS	PASS
			300nF	16.79	7.79	278	29.95	PASS	PASS
	3 (single)	1	20uF	17.55	14.96	288	44.60	PASS	PASS
			20uF	16.61	16.02	342	48.85	PASS	PASS
			300nF	20.45	12.38	272	50.52	PASS	PASS
			300nF	20.89	12.74	288	57.32	PASS	PASS
		2	20uF	25.04	14.55	304	53.12	PASS	PASS
			20uF	20.91	15.03	306	46.03	PASS	PASS
			300nF	23.08	12.76	312	54.28	PASS	PASS
			300nF	29.03	13.67	334	53.78	PASS	PASS
1	1 (parallel)	1	20uF	23.65	2.92	256	14.05	PASS	PASS
			20uF	23.50	2.86	248	12.52	PASS	PASS
			300nF	18.73	3.15	228	12.62	PASS	PASS
			300nF	30.21	3.20	226	12.70	PASS	PASS
		2	20uF	23.53	2.97	244	13.08	PASS	PASS
			20uF	22.23	3.00	250	13.29	PASS	PASS
			300nF	19.47	3.02	254	14.41	PASS	PASS

			300nF	22.73	3.05	272	14.74	PASS	PASS
	2 (parallel)	1	20uF	20.93	5.77	406	41.85	PASS	PASS
			20uF	24.21	6.20	430	41.78	PASS	PASS
			300nF	24.45	5.78	426	42.06	PASS	PASS
			300nF	18.77	6.33	454	42.33	PASS	PASS
		2	20uF	25.98	5.87	398	41.65	PASS	PASS
			20uF	21.13	5.67	420	39.43	PASS	PASS
			300nF	20.34	7.05	454	32.46	PASS	PASS
			300nF	34.80	5.69	428	44.74	PASS	PASS
	3 (parallel)	1	20uF	19.90	13.31	426	71.11	PASS	PASS
			20uF	19.89	11.91	368	58.20	PASS	PASS
			300nF	20.28	10.36	298	32.89	PASS	PASS
			300nF	19.91	12.56	402	49.58	PASS	PASS
		2	20uF	18.80	15.34	424	53.35	PASS	PASS
			20uF	18.26	14.89	418	50.38	PASS	PASS
			300nF	23.89	12.57	376	55.11	PASS	PASS
			300nF	20.95	14.90	498	83.44	PASS	PASS
2	2 (parallel)	1	20uF	22.36	5.46	453	38.66	PASS	PASS
			20uF	21.86	5.46	479	41.64	PASS	PASS
			300nF	22.12	5.41	470	29.92	PASS	PASS
			300nF	17.33	4.56	402	17.24	PASS	PASS
		2	20uF	27.85	5.63	449	36.88	PASS	PASS
			20uF	25.09	5.83	462	36.19	PASS	PASS
			300nF	28.50	5.18	280	27.07	PASS	PASS
			300nF	20.81	5.65	284	31.94	PASS	PASS
3	2 (parallel)	1	20uF	22.25	5.43	476	29.49	PASS	PASS
			20uF	23.16	5.87	514	39.99	PASS	PASS
			300nF	19.49	4.99	480	31.52	PASS	PASS
			300nF	22.36	4.81	476	35.27	PASS	PASS
		2	20uF	21.41	5.99	366	30.30	PASS	PASS
			20uF	19.83	5.53	506	37.10	PASS	PASS
			300nF	21.09	5.67	336	23.75	PASS	PASS
			300nF	23.78	6.20	402	34.54	PASS	PASS
4	2 (parallel)	1	20uF	31.82	5.15	466	29.36	PASS	PASS
			20uF	45.51	4.96	440	26.52	PASS	PASS
			300nF	19.05	4.96	464	29.89	PASS	PASS
			300nF	22.14	5.19	562	34.94	PASS	PASS
		2	20uF	22.75	5.93	492	37.31	PASS	PASS

			20uF	25.04	5.68	488	39.97	PASS	PASS
			300nF	24.16	4.96	454	35.71	PASS	PASS
			300nF	19.57	4.66	434	33.81	PASS	PASS
5	2 (parallel)	1	20uF	23.02	4.84	442	31.05	PASS	PASS
			20uF	19.54	5.33	462	32.67	PASS	PASS
			300nF	22.09	5.09	480	30.30	PASS	PASS
			300nF	18.27	5.44	486	35.18	PASS	PASS
		2	20uF	22.40	5.44	510	46.93	PASS	PASS
			20uF	19.85	5.77	556	43.77	PASS	PASS
			300nF	17.35	6.02	370	37.83	PASS	PASS
			300nF	23.56	5.55	328	33.93	PASS	PASS
6	2 (parallel)	1	20uF	19.10	5.31	576	27.30	PASS	PASS
			20uF	21.79	5.30	496	29.47	PASS	PASS
			300nF	22.84	4.89	442	33.94	PASS	PASS
			300nF	23.85	4.71	440	37.50	PASS	PASS
		2	20uF	20.54	4.97	462	37.61	PASS	PASS
			20uF	19.05	5.91	550	43.97	PASS	PASS
			300nF	15.97	7.18	488	45.05	PASS	PASS
			300nF	23.37	4.97	288	29.92	PASS	PASS
7	2 (parallel)	1	20uF	22.73	5.42	438	30.07	PASS	PASS
			20uF	18.28	5.98	496	34.89	PASS	PASS
			300nF	21.65	5.35	460	37.30	PASS	PASS
			300nF	19.99	5.47	542	30.52	PASS	PASS
		2	20uF	19.41	5.97	566	37.91	PASS	PASS
			20uF	26.27	5.55	442	37.58	PASS	PASS
			300nF	20.16	5.37	474	35.60	PASS	PASS
			300nF	23.78	6.22	536	46.34	PASS	PASS
Note(s):									

SUN2000-75K-MGL0-BR									
Channel No.	Test No.	Location	C4 (F)	Test Voltage (cross arc gap)/V	Test current (through arc)/A	Arc dura-tion/ms	Energy /J	Trip <2.5s J<750J	Off/Standby current <250mA
1	1 (single)	1	20uF	22.65	2.95	286	15.20	PASS	PASS
			20uF	26.66	2.88	262	15.09	PASS	PASS
			300nF	23.42	3.02	272	15.18	PASS	PASS
			300nF	23.35	2.99	274	14.38	PASS	PASS
		2	20uF	25.61	2.88	258	13.92	PASS	PASS

			20uF	22.94	2.90	252	14.20	PASS	PASS
			300nF	22.48	2.90	236	11.78	PASS	PASS
			300nF	21.17	2.99	260	14.80	PASS	PASS
	2 (single)	1	20uF	19.85	7.83	292	37.69	PASS	PASS
			20uF	18.67	7.08	262	30.73	PASS	PASS
			300nF	18.44	7.54	274	35.90	PASS	PASS
			300nF	25.42	7.52	254	33.53	PASS	PASS
		2	20uF	18.78	7.47	274	32.76	PASS	PASS
			20uF	18.59	7.33	270	30.83	PASS	PASS
			300nF	21.58	7.90	274	34.08	PASS	PASS
			300nF	25.22	7.31	236	28.36	PASS	PASS
	3 (single)	1	20uF	19.17	12.27	336	64.93	PASS	PASS
			20uF	23.54	11.89	234	62.06	PASS	PASS
			300nF	19.33	15.04	330	42.27	PASS	PASS
			300nF	17.83	12.76	258	43.67	PASS	PASS
		2	20uF	24.64	11.37	270	47.45	PASS	PASS
			20uF	18.91	10.89	262	56.14	PASS	PASS
			300nF	23.47	14.68	326	75.26	PASS	PASS
			300nF	19.15	14.28	296	66.06	PASS	PASS
1	1 (parallel)	1	20uF	30.32	3.00	254	12.50	PASS	PASS
			20uF	23.30	3.14	262	13.35	PASS	PASS
			300nF	19.99	2.98	248	13.49	PASS	PASS
			300nF	24.03	3.00	256	14.33	PASS	PASS
		2	20uF	23.15	3.02	262	14.08	PASS	PASS
			20uF	22.49	3.06	272	14.07	PASS	PASS
			300nF	20.67	3.02	246	12.90	PASS	PASS
			300nF	24.22	2.94	252	13.00	PASS	PASS
	2 (parallel)	1	20uF	23.17	5.48	388	43.55	PASS	PASS
			20uF	21.85	5.68	408	45.04	PASS	PASS
			300nF	103.70	5.44	210	25.90	PASS	PASS
			300nF	18.64	5.80	254	31.18	PASS	PASS
		2	20uF	19.74	6.17	442	38.27	PASS	PASS
			20uF	23.47	6.09	438	38.25	PASS	PASS
			300nF	20.19	7.04	450	39.64	PASS	PASS
			300nF	39.10	7.00	410	43.27	PASS	PASS
	3 (parallel)	1	20uF	20.13	12.04	366	54.26	PASS	PASS
			20uF	19.40	10.55	318	40.26	PASS	PASS
			300nF	19.30	13.49	405	56.11	PASS	PASS

			300nF	19.96	11.92	360	49.05	PASS	PASS
		2	20uF	20.37	11.06	368	62.34	PASS	PASS
			20uF	17.51	12.19	402	75.34	PASS	PASS
			300nF	22.79	12.72	366	54.60	PASS	PASS
			300nF	17.69	13.36	399	61.63	PASS	PASS
2	2 (parallel)	1	20uF	21.25	5.74	480	31.80	PASS	PASS
			20uF	19.44	5.69	460	26.70	PASS	PASS
			300nF	22.11	6.34	486	33.94	PASS	PASS
			300nF	19.51	5.83	448	21.44	PASS	PASS
		2	20uF	22.69	4.86	516	38.20	PASS	PASS
			20uF	20.88	5.82	576	46.15	PASS	PASS
			300nF	20.88	5.82	576	46.15	PASS	PASS
			300nF	22.69	4.86	516	38.20	PASS	PASS
3	2 (parallel)	1	20uF	18.60	5.80	482	29.54	PASS	PASS
			20uF	24.61	5.53	461	28.28	PASS	PASS
			300nF	23.96	5.81	484	36.97	PASS	PASS
			300nF	23.25	5.82	568	34.46	PASS	PASS
		2	20uF	16.67	4.95	224	20.59	PASS	PASS
			20uF	19.57	7.19	264	27.28	PASS	PASS
			300nF	24.15	7.43	408	32.15	PASS	PASS
			300nF	23.26	6.10	286	23.62	PASS	PASS
4	2 (parallel)	1	20uF	22.60	5.58	522	40.07	PASS	PASS
			20uF	21.38	5.28	506	35.36	PASS	PASS
			300nF	23.27	4.62	452	35.54	PASS	PASS
			300nF	23.33	4.54	472	33.71	PASS	PASS
		2	20uF	20.17	5.89	566	42.39	PASS	PASS
			20uF	22.85	5.05	514	42.89	PASS	PASS
			300nF	21.57	4.99	474	40.72	PASS	PASS
			300nF	26.64	5.03	468	38.48	PASS	PASS
5	2 (parallel)	1	20uF	18.83	5.45	526	30.12	PASS	PASS
			20uF	20.23	5.58	544	38.73	PASS	PASS
			300nF	22.22	4.93	448	36.98	PASS	PASS
			300nF	21.84	4.66	464	30.91	PASS	PASS
		2	20uF	20.05	5.26	508	39.79	PASS	PASS
			20uF	22.36	5.45	518	42.17	PASS	PASS
			300nF	19.88	5.66	346	32.32	PASS	PASS
			300nF	20.06	5.01	460	38.38	PASS	PASS
6	2	1	20uF	21.16	4.94	550	31.55	PASS	PASS

	(parallel)		20uF	19.22	5.32	550	28.54	PASS	PASS
			300nF	19.71	6.57	540	35.67	PASS	PASS
			300nF	20.63	32.71	586	32.71	PASS	PASS
		2	20uF	25.68	5.16	458	32.42	PASS	PASS
			20uF	23.99	5.12	466	32.47	PASS	PASS
			300nF	18.64	6.39	388	38.64	PASS	PASS
			300nF	20.86	4.97	290	38.88	PASS	PASS
7	2 (parallel)	1	20uF	18.04	6.10	512	28.24	PASS	PASS
			20uF	21.17	5.27	434	24.77	PASS	PASS
			300nF	22.52	5.29	456	26.88	PASS	PASS
			300nF	20.93	5.83	494	32.33	PASS	PASS
		2	20uF	20.61	6.81	558	32.19	PASS	PASS
			20uF	19.63	5.67	456	37.19	PASS	PASS
			300nF	20.44	5.52	466	37.41	PASS	PASS
			300nF	19.65	6.25	542	36.44	PASS	PASS
Note(s):									

SUN2000-80K-MGL0									
Channel No.	Test No.	Location	C4 (F)	Test Voltage (cross arc gap)/V	Test current (through arc)/A	Arc dura-tion/ms	Energy /J	Trip <2.5s J<750J	Off/Standby current <250mA
1	1 (single)	1	20uF	93.70	3.17	40	2.12	PASS	PASS
			20uF	98.09	3.36	62	2.30	PASS	PASS
			300nF	19.40	3.13	264	15.04	PASS	PASS
			300nF	26.27	3.16	260	15.20	PASS	PASS
		2	20uF	24.69	3.01	264	14.89	PASS	PASS
			20uF	28.61	2.93	250	14.77	PASS	PASS
			300nF	22.62	3.05	263	15.55	PASS	PASS
			300nF	30.43	2.93	242	13.51	PASS	PASS
	2 (single)	1	20uF	24.45	7.82	292	41.46	PASS	PASS
			20uF	22.03	7.76	284	37.69	PASS	PASS
			300nF	33.67	7.96	284	33.24	PASS	PASS
			300nF	23.38	7.16	254	36.63	PASS	PASS
		2	20uF	21.53	7.30	254	37.05	PASS	PASS
			20uF	21.03	7.97	306	43.46	PASS	PASS
			300nF	28.51	7.89	262	34.97	PASS	PASS
			300nF	24.59	7.32	248	35.43	PASS	PASS
	3	1	20uF	23.99	14.64	218	40.03	PASS	PASS

	(single)		20uF	28.36	15.99	268	63.32	PASS	PASS
			300nF	19.68	11.27	234	38.42	PASS	PASS
			300nF	21.93	14.26	332	57.91	PASS	PASS
		2	20uF	23.96	15.55	286	41.50	PASS	PASS
			20uF	20.27	15.22	348	67.07	PASS	PASS
			300nF	16.97	15.09	388	80.84	PASS	PASS
			300nF	28.40	15.38	388	82.89	PASS	PASS
1	1 (parallel)	1	20uF	24.86	3.04	276	12.93	PASS	PASS
			20uF	25.41	3.04	320	15.72	PASS	PASS
			300nF	30.79	2.93	244	13.59	PASS	PASS
			300nF	22.56	2.29	242	12.84	PASS	PASS
		2	20uF	23.19	12.34	234	2.87	PASS	PASS
			20uF	27.18	2.88	228	2.88	PASS	PASS
			300nF	17.92	3.01	272	13.61	PASS	PASS
			300nF	19.64	2.99	241	12.57	PASS	PASS
	2 (parallel)	1	20uF	18.71	6.95	388	27.53	PASS	PASS
			20uF	19.39	6.96	410	37.78	PASS	PASS
			300nF	17.85	8.14	256	29.21	PASS	PASS
			300nF	45.46	7.19	238	28.40	PASS	PASS
		2	20uF	35.69	7.01	386	32.09	PASS	PASS
			20uF	19.04	6.45	428	37.72	PASS	PASS
			300nF	109.30	6.84	214	31.45	PASS	PASS
			300nF	18.77	7.64	232	27.88	PASS	PASS
	3 (parallel)	1	20uF	19.65	12.28	366	51.77	PASS	PASS
			20uF	20.94	12.43	312	50.85	PASS	PASS
			300nF	20.65	13.36	430	61.11	PASS	PASS
			300nF	20.56	12.46	342	41.42	PASS	PASS
		2	20uF	19.39	14.88	398	50.58	PASS	PASS
			20uF	19.43	15.10	400	51.21	PASS	PASS
			300nF	20.46	14.10	396	60.58	PASS	PASS
			300nF	18.10	14.12	390	65.81	PASS	PASS
2	2 (parallel)	1	20uF	21.33	4.89	448	27.11	PASS	PASS
			20uF	21.51	5.68	472	26.85	PASS	PASS
			300nF	20.30	6.76	586	42.29	PASS	PASS
			300nF	21.01	6.60	546	44.27	PASS	PASS
		2	20uF	30.98	8.05	316	20.25	PASS	PASS
			20uF	20.32	6.89	476	26.76	PASS	PASS
			300nF	19.87	6.13	284	29.62	PASS	PASS

			300nF	28.64	5.66	234	31.68	PASS	PASS
3	2 (parallel)	1	20uF	22.23	5.47	496	28.42	PASS	PASS
			20uF	19.51	5.31	498	32.47	PASS	PASS
			300nF	19.07	6.53	508	32.88	PASS	PASS
			300nF	19.42	6.63	532	31.59	PASS	PASS
		2	20uF	22.18	5.75	510	36.73	PASS	PASS
			20uF	19.76	5.08	428	30.12	PASS	PASS
			300nF	21.53	7.21	364	37.07	PASS	PASS
			300nF	23.36	7.40	376	40.31	PASS	PASS
4	2 (parallel)	1	20uF	21.77	5.56	478	33.58	PASS	PASS
			20uF	19.40	5.60	444	32.56	PASS	PASS
			300nF	23.01	4.73	480	31.03	PASS	PASS
			300nF	21.49	5.39	528	40.00	PASS	PASS
		2	20uF	21.53	5.78	516	38.12	PASS	PASS
			20uF	19.61	5.70	510	34.05	PASS	PASS
			300nF	25.09	6.36	436	47.07	PASS	PASS
			300nF	16.22	6.65	454	49.48	PASS	PASS
5	2 (parallel)	1	20uF	20.59	5.60	474	30.84	PASS	PASS
			20uF	19.30	5.99	574	41.22	PASS	PASS
			300nF	22.14	4.19	514	33.06	PASS	PASS
			300nF	18.79	4.21	452	22.79	PASS	PASS
		2	20uF	20.16	5.79	460	30.95	PASS	PASS
			20uF	19.07	5.63	460	32.14	PASS	PASS
			300nF	19.36	5.29	612	46.77	PASS	PASS
			300nF	21.55	5.71	552	47.78	PASS	PASS
6	2 (parallel)	1	20uF	20.09	5.51	530	31.92	PASS	PASS
			20uF	22.06	5.80	442	29.67	PASS	PASS
			300nF	22.75	31.58	432	31.58	PASS	PASS
			300nF	22.20	5.69	446	20.79	PASS	PASS
		2	20uF	23.15	5.30	404	36.68	PASS	PASS
			20uF	24.43	5.64	436	42.25	PASS	PASS
			300nF	24.97	5.52	458	37.18	PASS	PASS
			300nF	18.84	5.22	438	26.47	PASS	PASS
7	2 (parallel)	1	20uF	20.81	6.16	446	28.53	PASS	PASS
			20uF	24.94	5.43	262	25.03	PASS	PASS
			300nF	21.80	5.55	456	28.46	PASS	PASS
			300nF	23.39	5.38	458	37.71	PASS	PASS
		2	20uF	18.26	6.35	350	30.41	PASS	PASS

			20uF	21.83	6.38	288	25.60	PASS	PASS
			300nF	23.58	6.28	522	39.82	PASS	PASS
			300nF	23.13	6.06	498	27.09	PASS	PASS
Note(s):									

-- End of report --

PHOTO DOCUMENTATION

CN24SS7F 001 ATTACHMENT 1

for

SOLAR INVERTER

SUN2000-50K-MGL0, SUN2000-50K-MGL0-BR,
SUN2000-75K-MGL0-BR, SUN2000-80K-MGL0

HUAWEI TECHNOLOGIES CO., LTD.

This documentation consists of 4 pages (excluding this cover page)

Figure 1. Front view

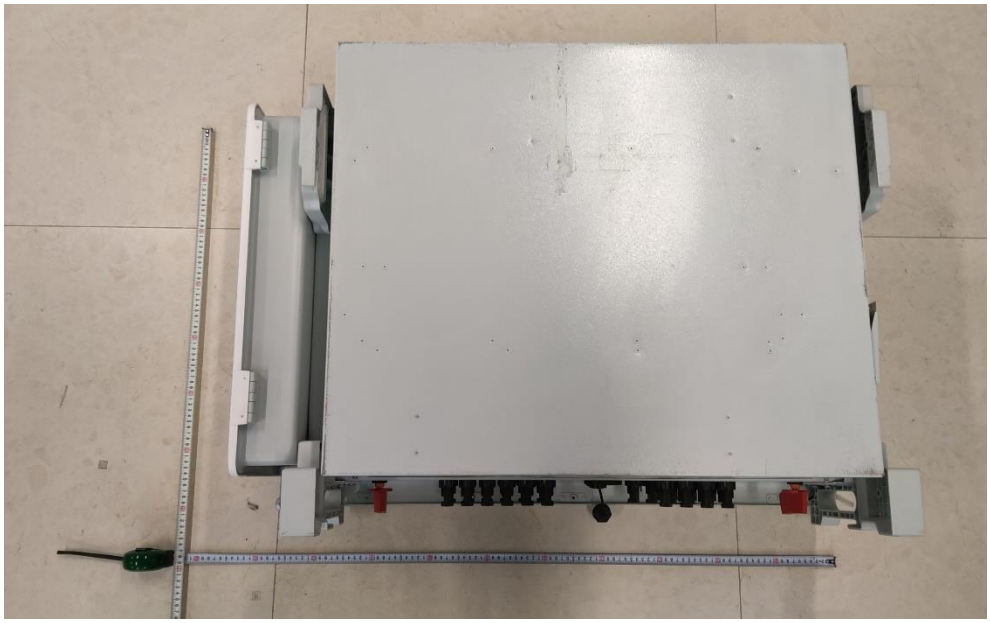


Figure 2. Bottom view

Figure 3. Left side view

Figure 4. Right side view-1

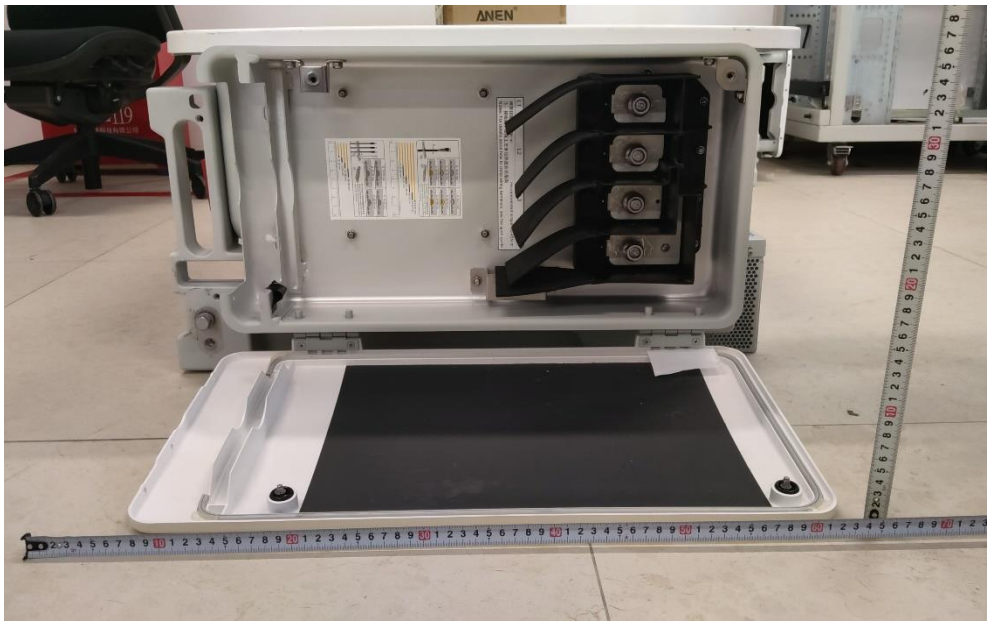


Figure 5. Right side view-2

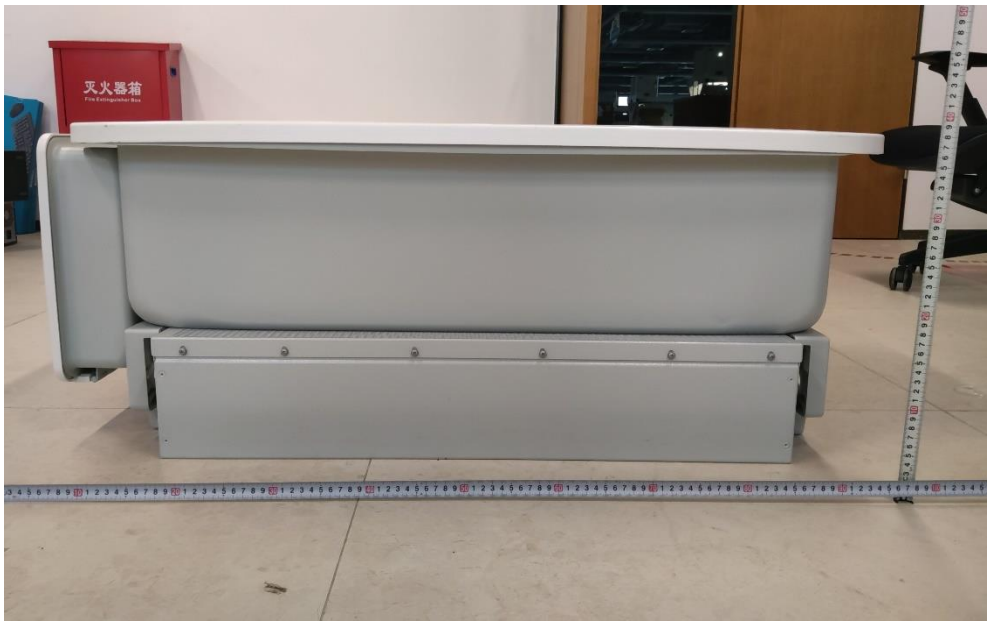


Figure 6. Rear view

Figure 7.Terminal view

Figure 8. Internal view