Prüfbericht-Nr.: *Test report no.:*	**CN22T0P9 001**	**Auftrags-Nr.:** *Order no.*:	244379505	
Kunden-Referenz-Nr.: *Client reference no.:*	2028101	**Auftragsdatum:** *Order date:*	2021-12-06	
Auftraggeber: *Client:*	GoodWe Technologies Co., Ltd. No.90 Zijin Rd., New District, Suzhou, 215011, China			
Prüfgegenstand: *Test item:*	Hybrid Inverter			
Bezeichnung / Typ-Nr.: *Identification / Type no.:*	GW3000-ES-20, GW3600-ES-20, GW3600M-ES-20, GW5000M-ES-20, GW5000-ES-20, GW6000M-ES-20, GW6000-ES-20			
Auftrags-Inhalt: *Order content*:	TUV Bauart approval			
Prüfgrundlage: *Test specification:*	EN 62109-1: 2010, IEC 62109-1: 2010 EN 62109-2: 2011, IEC 62109-2: 2011			

Wareneingangsdatum: *Date of sample receipt:*	2022-04-03
Prüfmuster-Nr.: *Test sample no:*	A003291867-001
Prüfzeitraum: *Testing period:*	2022-04-04 - 2022-06-28
Ort der Prüfung: *Place of testing:*	TÜV Rheinland (Shanghai) Co.,Ltd.
Prüflaboratorium: *Testing laboratory:*	TÜV Rheinland (Shanghai) Co.,Ltd.
Prüfergebnis*: *Test result*:*	Pass

geprüft von: *tested by:*	Sean ke Rafer Xu	**genehmigt von:** *authorized by:*	
Datum: *Date:*	2022-08-04	**Ausstellungsdatum:** *Issue date:*	2022-08-04
Stellung / *Position:*	Sachverständige(r)/Expert	**Stellung** / *Position:*	Sachverständige(r)/Expert

Sonstiges / *Other:*

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

Test Report issued under the responsibility of:

TÜVRheinland®

TEST REPORT
IEC 62109-1
Safety of Power Converter for use in Photovoltaic Power Systems
Part 1: General requirements

Report

Report Reference No. ..... :	CN22T0P9 001
Date of issue ..... :	See cover page
Total number of pages ..... :	See cover page

CB Testing Laboratory ..... :	**TÜV Rheinland (Shanghai) Co., Ltd.**
Address ..... :	B1-13F, No. 177, Lane 777, West Guangzhong Road, Jingan District, Shanghai 200072, P. R. China

Applicant's name ..... :	See cover page
Address ..... :	See cover page

Test specification

Standard ..... :	IEC 62109-1: 2010 (First Edition)
Test procedure ..... :	TÜV Rheinland Bauart Mark Approval
Non-standard test method ..... :	N/A

Test Report Form No ..... :	IEC62109_1A
TRF Originator ..... :	VDE Testing and Certification Institute
Master TRF ..... :	Dated 2011-03

If this Test Report Form is used by non-IECEE members, the IECEE/IEC logo and the reference to the CB Scheme procedure shall be removed.

This report is not valid as a CB Test Report unless signed by an approved CB Testing Laboratory and appended to a CB Test Certificate issued by an NCB in accordance with IECEE 02.

Test item description ..... :	**Hybrid Inverter**
Trade Mark ..... :	GOODWE
Manufacturer ..... :	Same as applicant
Model/Type reference ..... :	See cover page
Ratings ..... :	See copy of marking label and model list.

Testing procedure and testing location:
☐ CB Testing Laboratory: Testing location/ address ..... : ☐ Associated CB Laboratory: Testing location/ address ..... : Tested by (name + signature) ..... : See cover page Approved by (+ signature)..... : See cover page
☐ Testing procedure: TMP Testing location/ address ..... : Tested by (name + signature) ..... : Approved by (+ signature)..... :
☐ Testing procedure: WMT Testing location/ address ..... : Tested by (name + signature) ..... : Witnessed by (+ signature)..... : Approved by (+ signature)..... :
☐ Testing procedure: SMT Testing location/ address ..... : Tested by (name + signature) ..... : Approved by (+ signature)..... : Supervised by (+ signature)..... :
☐ Testing procedure: RMT Testing location/ address ..... : Tested by (name + signature) ..... : Approved by (+ signature)..... : Supervised by (+ signature)..... :

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

ATTACHMENT 1 – Test report of IEC/EN 62109-2: 2011

ATTACHMENT 2 – PHOTO DOCUMENTATION

ATTACHMENT 3 – CRITICAL COMPONENTS DOCUMENTATION (CDF)

Summary of testing:

Tests performed (name of test and test clause):

Clause	Test items	Clause	Test items
4.2.2.6	Mains supply electrical data in normal condition	7.4	Protection against energy hazards
4.3	Thermal testing	7.5.1	Impulse voltage test
4.4	Testing in fault condition	7.5.2	Voltage test (dielectric strength test)
4.5	Humidity preconditioning	7.5.4	Touch current measurement
4.7	Electrical ratings tests		
5.1.2	Durability of markings		
6.3	Ingress protection		
7.3.4.2.3	Access probe tests	8.5	Wall mounting
7.3.5.3.2	Limitation of discharging energy through protective impedance		
7.3.6.3	Protective class I - Protective bonding and earthing		
7.3.7.4	Clearance distances	10.2	Sonic pressure and sound level
7.3.7.5	Creepage distances	13.1	Handles and manual controls
7.3.9	Protection against shock hazard due to stored energy	13.7	Mechanical resistance to deflection, impact or drop

Remark:

- Unless otherwise specified, all the tests were conducted on the basic model of GW6000-ES-20 to represent the others.
- The maximum operating temperature is 60ºC specified by manufacturer, the temperature rise tests were conducted at the maximum rated ambient temperature of 45°C or 60ºC (derating) in the chamber.
- For the temperature rise tests were conducted on PCE power derating curve at most unfavourable operating conditions, see instruction manual for details.
- Other testing conditions considered in this test report, see General Product Information on the following pages.

Testing location:

Testing Laboratory:	See the cover page
Testing location / address:	See the cover page

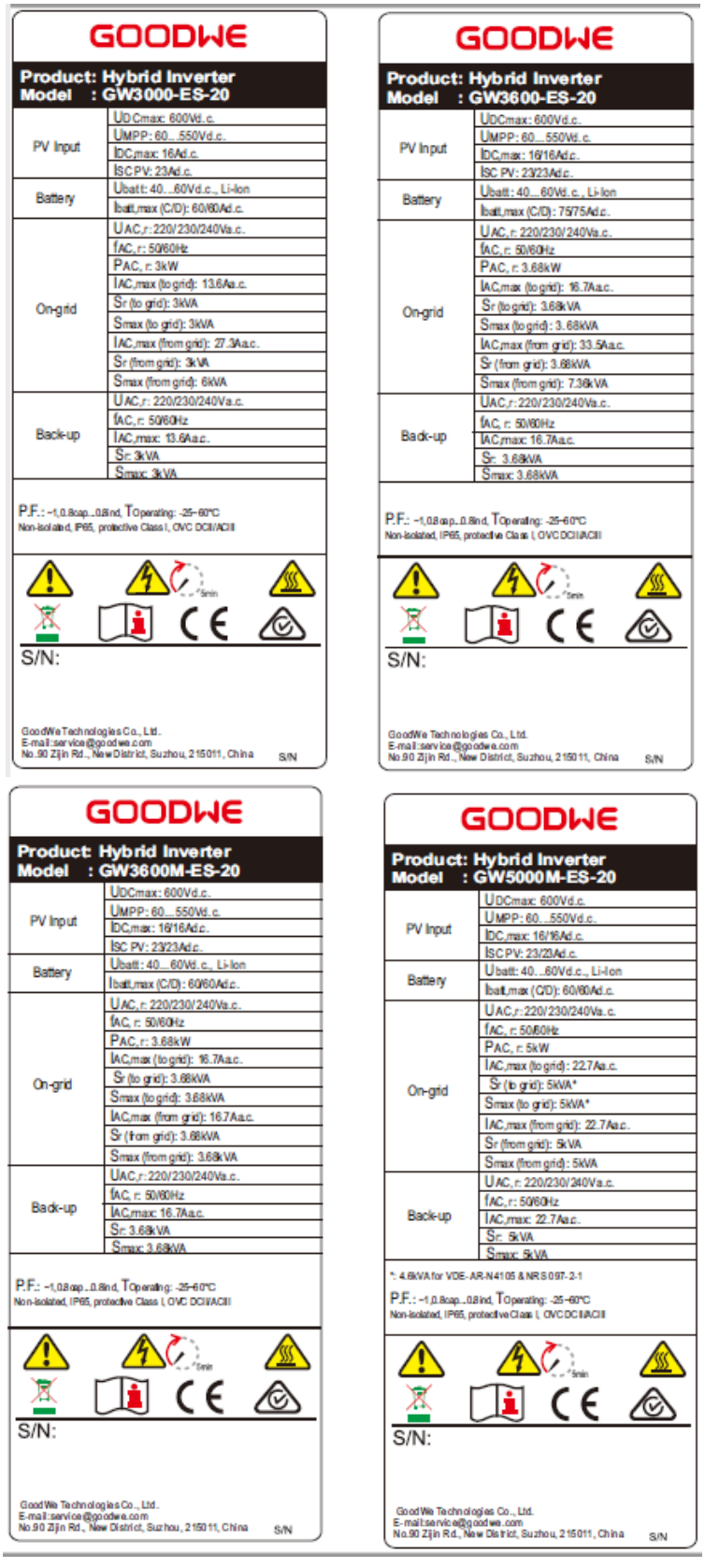
Summary of compliance with National Differences:

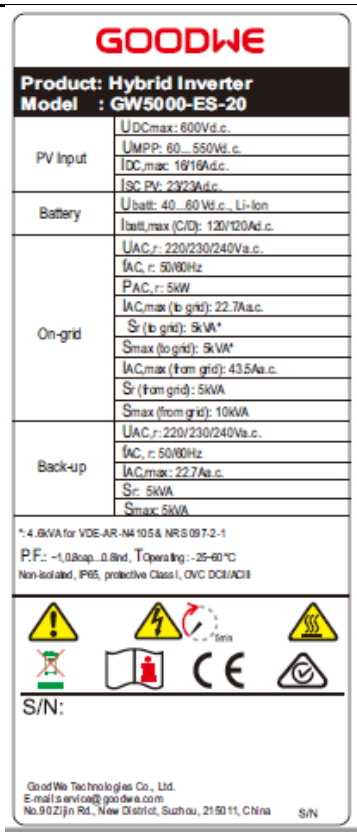
List of countries addressed: None.

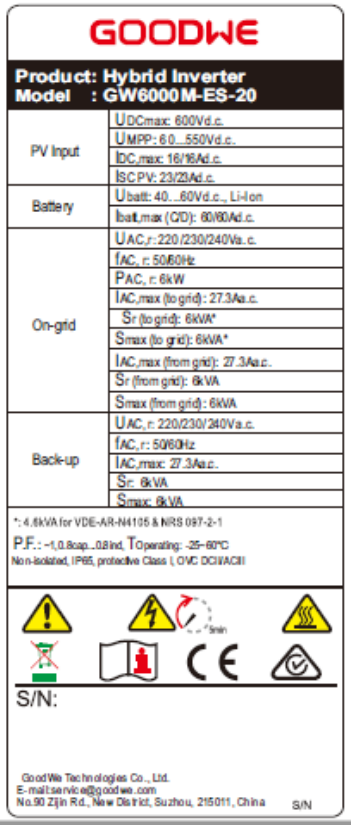
☒ The product fulfils the requirements of

IEC 62109-1: 2010, EN 62109-1: 2010,
IEC 62109-2: 2011, EN 62109-2: 2011

Copy of marking plate:




GOODWE
Product: Hybrid Inverter
Model : GW5000-ES-20
PV Input
UDCmax: 600Vd.c.
UMPP: 60...550Vd.c.
IDC,max: 16/16Ad.c.
ISC PV: 23/23Ad.c.
Battery
Ubatt: 40...60 Vd.c., Li-Ion
Ibatt,max (C/D): 120/120Ad.c.
On-grid
UAC,r: 220/230/240Va.c.
fAC, r: 50/60Hz
PAC, r: 5kW
IAC,max (to grid): 22.7Aa.c.
Sr (to grid): 5kVA*
Smax (to grid): 5kVA*
IAC,max (from grid): 43.5Aa.c.
Sr (from grid): 5kVA
Smax (from grid): 10kVA
Back-up
UAC,r: 220/230/240Va.c.
fAC, r: 50/60Hz
IAC,max: 22.7Aa.c.
Sr: 5kVA
Smax: 5kVA
*: 4.6kVA for VDE-AR-N4105 & NRS 097-2-1
P.F.: -1,0.8cap...0.8ind, Toperating: -25~60°C
Non-isolated, IP65, protective Class I, OVC DCII/ACIII
S/N:
GoodWe Technologies Co., Ltd.
E-mail:service@goodwe.com
No.90 Zijin Rd., New District, Suzhou, 215011, China
S/N


GOODWE
Product: Hybrid Inverter
Model : GW6000M-ES-20
PV Input
UDCmax: 600Vd.c.
UMPP: 60...550Vd.c.
IDC,max: 16/16Ad.c.
ISC PV: 23/23Ad.c.
Battery
Ubatt: 40...60Vd.c., Li-Ion
Ibatt,max (C/D): 60/60Ad.c.
On-grid
UAC,r: 220/230/240Va.c.
fAC, r: 50/60Hz
PAC, r: 6kW
IAC,max (to grid): 27.3Aa.c.
Sr (to grid): 6kVA*
Smax (to grid): 6kVA*
IAC,max (from grid): 27.3Aa.c.
Sr (from grid): 6kVA
Smax (from grid): 6kVA
Back-up
UAC, r: 220/230/240Va.c.
fAC, r: 50/60Hz
IAC,max: 27.3Aa.c.
Sr: 6kVA
Smax: 6kVA
*: 4.6kVA for VDE-AR-N4105 & NRS 097-2-1
P.F.: -1,0.8cap...0.8ind, Toperating: -25~60°C
Non-isolated, IP65, protective Class I, OVC DCII/ACIII
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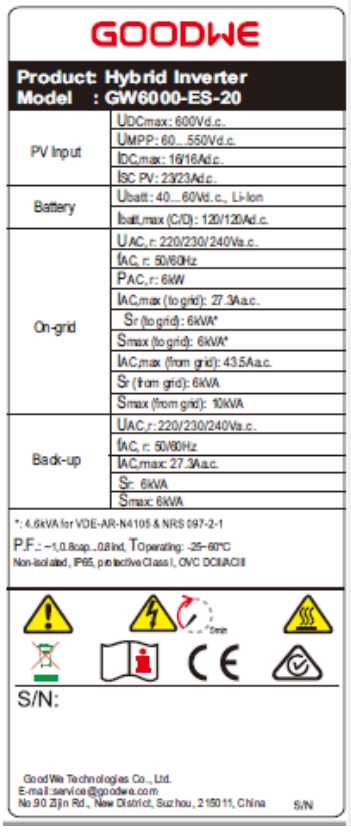
S/N


GOODWE
Product: Hybrid Inverter
Model : GW6000-ES-20
PV Input
UDCmax: 600Vd.c.
UMPP: 60...550Vd.c.
IDC,max: 16/16Ad.c.
ISC PV: 23/23Ad.c.
Battery
Ubatt: 40...60Vd.c., Li-Ion
Ibatt,max (C/D): 120/120Ad.c.
On-grid
UAC,r: 220/230/240Va.c.
fAC, r: 50/60Hz
PAC, r: 6kW
IAC,max (to grid): 27.3Aa.c.
Sr (to grid): 6kVA*
Smax (to grid): 6kVA*
IAC,max (from grid): 43.5Aa.c.
Sr (from grid): 6kVA
Smax (from grid): 10kVA
Back-up
UAC,r: 220/230/240Va.c.
fAC, r: 50/60Hz
IAC,max: 27.3Aa.c.
Sr: 6kVA
Smax: 6kVA
*: 4.6kVA for VDE-AR-N4105 & NRS 097-2-1
P.F.: -1,0.8cap...0.8ind, Toperating: -25~60°C
Non-isolated, IP65, protective Class I, OVC DCII/ACIII
S/N:
GoodWe Technologies Co., Ltd.
E-mail:service@goodwe.com
No.90 Zijin Rd., New District, Suzhou, 215011, China
S/N

Test item particulars	
Equipment mobility ..... :	☐ movable ☐ hand-held ☐ stationary ☒ fixed ☐ transportable ☐ for building-in
Connection to the mains ..... :	☒ pluggable equipment ☐ direct plug-in ☐ permanent connection ☐ for building-in
Enviromental category ..... :	☒ outdoor ☐ indoor unconditional ☐ indoor conditional
Over voltage category Mains ..... :	☐ OVC I ☐ OVC II ☒ OVC III ☐ OVC IV
Over voltage category PV..... :	☐ OVC I ☒ OVC II ☐ OVC III ☐ OVC IV
Over voltage category Battery..... :	☐ OVC I ☒ OVC II ☐ OVC III ☐ OVC IV
Mains supply tolerance (%) ..... :	According to the specified supply range. see model list on the following pages for details.
Tested for power systems ..... :	TN, TT
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..... :	☐ PD 1 ☒ PD 2 (Inside) ☒ PD 3 (Outside)
IP protection class..... :	IP65
Testing	
Date of receipt of test item(s)..... :	See cover page
Dates tests performed ..... :	See cover page
Possible test case verdicts:	
- test case does not apply to the test object ..... :	N/A
- test object does meet the requirement..... :	Pass (P)
- test object was not evaluated for the requirement.. :	N/E
- test object does not meet the requirement..... :	Fail (F)

General remarks:

"(see Attachment #)" refers to additional information appended to the report.

"(see appended table)" refers to a table appended to the report.

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

This report shall not be reproduced except in full without the written approval of the testing laboratory.

List of test equipment must be kept on file and available for review.

Additional test data and/or information provided in the attachments to this report.

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

Determination of the test results includes consideration of measurement uncertainty from the test equipment and methods.

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

The application for obtaining a CB Test Certificate includes more than one factory location and a declaration from the Manufacturer stating that the sample(s) submitted for evaluation is (are) representative of the products from each factory has been provided.....:

☐ Yes
☒ Not applicable

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

Name and address of factory (ies):

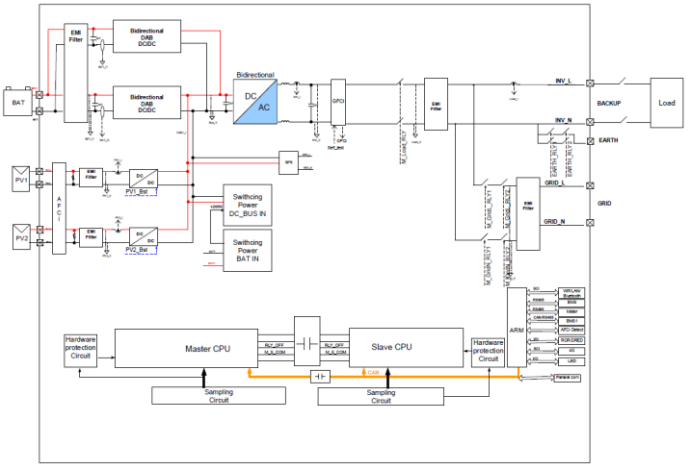
Address 1: GoodWe Technologies Co., Ltd.
No.90 Zijin Rd., New District, Suzhou, 215011, P.R. China

Address 2: GoodWe (GuangDe) Power Supply Technology Co., Ltd.
No.208,Tong Rui East Road, Guangde, Anhui, P.R. China

General product information:

Brief description:

The equipment GW3000-ES-20, GW3600-ES-20, GW3600M-ES-20, GW5000M-ES-20, GW5000-ES-20, GW6000M-ES-20 and GW6000-ES-20 are hybrid inverters (bi-directional converter) designed to work with PV panels up to 600Vd.c and batteries up to 60Vd.c. It is responsible for converting the direct current generated by photovoltaic panels and batteries into single-phase 230 V, 50/60 Hz alternative current for feeding into the electrical power distribution grid or the backup load. The Hybrid inverter can operate when it is connected to the electrical power distribution line and as a stand-alone unit or in case of AC grid disruption (standalone mode only for equipment with EPS port). The BAT port is isolated with PV and AC grid port. The four models are identical except for the electrical ratings and model name.



Block diagram

Note:

1. EPS port in the process of operation or shutdown state will have dangerous voltage, in the EPS port marked with prevent electric shock sign, when maintain EPS back-end load or line should be strictly in accordance with the requirements of the instructions.
2. The relays on the output side of the inverter include INV side and on grid side all remain closed in running and standby states except the relays on grid side will be disconnected in off-grid mode.

Model difference:

The models GW3000-ES-20, GW3600-ES-20, GW3600M-ES-20, GW5000M-ES-20, GW5000-ES-20, GW6000M-ES-20 are identical to model GW6000-ES-20 in hardware and software except for model name and ratings. Unless otherwise specified, all the tests performed on the basic model of GW6000-ES-20 to represent the others.

Protective function in PCE:

1. PV array insulation resistance detecting
2. Residual current monitoring
3. Over and under grid voltage / frequency protection
4. Anti-islanding protection
5. DC injection current protection
6. Over current protection
7. Over temperature protection and auto derating function
8. Relay self-checking function
9. RCMU self-checking function
10. Relays used in series as grid auto-disconnection devices for redundant NS protection
11. Short-circuit protection relies on external circuit breaks which are specified in the installation manual

Model list:

Model	GW3000-ES-20	GW3600-ES-20	GW3600M-ES-20
Battery			
Battery Type	Li-Ion		
Battery voltage range[V]	40~60		
Recommended battery voltage[V]	48VDC		
Max.charge current[A]	60	75	60
Max.discharge current[A]	60	75	60
INPUT PV			
Max.DC voltage[V]	600		
Norminal DC operating voltage[V]	360		
Max. input current [A]	16	16/16	
ISC PV [A]	23	23/23	
Backfeed current to the array[mA]	0		
MPPT voltage range[V]	60-550		
MPPT Voltage Range at Nominal Power (V)	220~500	150~500	150~500
Start-up Voltage [V]	58		
Number of MPPT	1	2	
Number of Strings per MPPT	1		
OUTPUT AC			
Rated Apparent Power Sn [VA]	3000	3680	3680
Max. Apparent power Smax [VA]	3000	3680	3680
Rated Output Voltage per phase Un [Vac]	220/230/240		
Rated Output Frequency fn [Hz]	50/60		
Norminal AC current[A]	13	16	16
Max. continuous output current Imax [A]	13.6	16.7	16.7
Power Factor Range cosφ [λ]	0.8su…0.8ab		
Total harmonic distortion(THDi, rated power)	<3%		
INPUT AC			
Max AC power[VA]	6000	7360	3680
Max. AC current[A]	27.3	33.5	16.7
Rated grid voltage(AC voltage range)[V]	220/230/240		
Rated grid Frequency[Hz]	50/60		
Back up			
Max. Apparent power S_{Emax} [VA]	3000	3680	3680
Rated Output Voltage Ur [Vac]	13.6	16.7	16.7
Max. Output Current	220/230/240		

Rated Output Frequency FNETZ[Hz]	50/60		
EFFICIENCY			
Max. Efficiency	97.6%		
Euro-efficiency	96.7%		
CEC-efficiency	96.9%		
Max. Battery to AC Efficiency	95.5%		
PROTECTION			
DC Insulation Resistance Detection	YES		
Residual Current Monitoring Unit	YES		
Anti-islanding protection	YES		
AC Overcurrent Protection	YES		
AC Short Circuit Protection	YES		
AC Overvoltage Protection	YES		
AC/DC surge protection	Type III/Type II		
AFCI protection	optional		
Remote Shutdown	optional		
POWER CONSUMPTION			
Night Power Consumption (W)	< 10		
ENVIRONMENT LIMIT			
Ingress protection	IP65		
Protective Class	Class I		
Operating temperature range[℃]	-25..... +60°C (derating at +45°C)		
Humidity[%]	0～95		
Altitude[m]	3000		
Noise Ession(dB)	< 30		
DIMENSION AND WEIGHT			
Demensions(WxHxD) [mm]	505.9*434.9*154.8 (W*H*D)		
Weight [kg]	19.6	20.8	20
Topology	Non-Isolated		
Firmware	000000		

Model	GW5000M-ES-20	GW5000-ES-20	GW6000M-ES-20	GW6000-ES-20
Battery				
Battery Type	Li-Ion			
Battery voltage range[V]	40~60			
Recommended battery voltage[V]	48VDC			
Max.charge current[A]	60	120	60	120
Max.discharge current[A]	60	120	60	120
INPUT PV				
Max.DC voltage[V]	600			
Norminal DC operating voltage[V]	360			
Max. input current [A]	16/16			
ISC PV [A]	23/23			
Max.inverter backfeed current to the array[mA]	0			
MPPT voltage range[V]	60-550			
MPPT Voltage Range at Nominal Power (V)	200~500			220~500
Start-up Voltage [V]	58			
Number of MPPT	2			
Number of Strings per MPPT	1			
OUTPUT AC				
Rated Apparent Power Sn [VA]	5000*3	5000*3	6000*3	6000*3
Max. Apparent power Smax [VA]	5000*4	5000*4	6000*4	6000*4
Rated Output Voltage per phase Un [Vac]	220/230/240			
Rated Output Frequency fn [Hz]	50/60			
Norminal AC current[A]	21.7	21.7	26.1	26.1
Max. continuous output current Imax [A]	22.7	22.7	27.3	27.3
Power Factor Range cosφ [λ]	0.8su…0.8ab			
Total harmonic distortion(THDi, rated power)	<3%			
INPUT AC				
Max AC power[VA]	5000	10000	6000	10000
Max. AC current[A]	22.7	43.5	27.3	43.5
Rated grid voltage(AC voltage range)[V]	220/230/240			
Rated grid Frequency[Hz]	50/60			
Back up				
Max. Apparent power S_{Emax} [VA]	5000	5000	6000	6000
Rated Output Voltage Ur [Vac]	22.7	22.7	27.3	27.3
Max. Output Current	220/230/240			

Rated Output Frequency FNETZ[Hz]	50/60				
EFFICIENCY					
Max. Efficiency	97.6%				
Euro-efficiency	96.7%				
CEC-efficiency	96.9%				
Max. Battery to Load Efficiency	95.5%				
PROTECTION					
DC Insulation Resistance Detection	YES				
Residual Current Monitoring Unit	YES				
Anti-islanding protection	YES				
AC Overcurrent Protection	YES				
AC Short Circuit Protection	YES				
AC Overvoltage Protection	YES				
AC/DC surge protection	Type III/Type II				
AFCI protection	optional				
Remote Shutdown	optional				
POWER CONSUMPTION					
Night Power Consumption (W)	< 10				
ENVIRONMENT LIMIT					
Ingress protection	IP65				
Protective Class	Class I				
Operating temperature range[℃]	-25..... +60°C (derating at +45°C)				
Humidity[%]	0～95(non-condensing)				
Altitude[m]	3000				
Noise Ession(dB)	< 30				
DIMENSION AND WEIGHT					
Demensions(WxHxD) [mm]	505.9*434.9*154.8 (W*H*D)				
Weight [kg]	20	21.5	20	21.5	
Cooling concept	Natural				
Topology	Non-Isolated				
Firmware	000000				

*3: 4600 for VDE-AR-N4105 & NRS 097-2-1.
*4: 4600 for VDE-AR-N4105 & NRS 097-2-1.

Throughout the test report following abbreviations may be used:

- input	i/p	- Test repeated, similar result(3 times)	TRSR
- output	o/p	- No indication of dielectric breakdown	NB
- short-circuited	s-c	- Cheesecloth remained intact	NC
- overloaded	o-l	- Tissue paper remained intact	NT
- open-circuited	o-c	- No hazards	NH
- normal conditions	N.C.	- The PCE can recover to operate automaticly after removing the abnormal condition	RO
- single fault conditions	SFC	- functional insulation	FI
- between parts of opposite polarity	BOP	- basic insulation	BI
- internal protection operated	IPO	- supplementary insulation	SI
- Component damage (list damaged component)	CD	- double insulation	DI
- No component damaged	NCD	- reinforced insulation	RI

Indicate used abbreviations (if any)

IEC/EN 62109-1: 2010			
Clause	Requirement – Test	Result - Remark	Verdict
4	**GENERAL REQUIREMENTS**		**P**
4.1	General General Testing is required by this standard to demonstrate that the EUT is fully in accordance with the applicable requirements of this standard.		P
4.2	General conditions for testing		P
4.2.1	Sequence of tests		P
4.2.2	Reference test conditions		P
4.2.2.1	Unless otherwise specified in this standard, for example with regard to environmental category as defined in 6.1, the following ambient environmental conditions shall exist in the test location: a) temperature of 15 °C to 40 °C; b) a relative humidity of not more than 75 % and not less than 5 %; c) an air pressure of 75 kPa to 106 kPa; d) no frost, dew, percolating water, rain, solar radiation, etc.	Ambient environmental condition compliance.	P
4.2.2.2	State of equipment	Test carried on a complete EUT.	P
4.2.2.3	Position of equipment	The equipment was installed in accordance with the manufacturer's instructions.	P
4.2.2.4	Accessories	Accessories and operator-interchangeable parts available from, or recommended by the manufacturer according to the installation manual required.	P
4.2.2.5	Covers and removable parts	No covers or parts, which can be removed without using a TOOL.	N/A
4.2.2.6	Mains supply	See below.	P
	a) Voltage:	A wider range is given in the specification of the EUT. DC Input: V_{MAXPV}: 600Vd.c. AC Output: Tolerance is considered.	P
	b) Frequency:	DC Input: N/A AC Output: 50/60Hz.	P
	c) Polarity:		P

	d) Earthing:	Equipment was supplied from either an earthed supply system under tests.	P
	e) Over-current Protection:	Input over current protection that will be present in the installation was provided during testing.	P
4.2.2.7	Supply ports other than the mains	See below.	P
4.2.2.7.1	Photovoltaic supply sources	DC power supply source was used with sufficient capability.	P
4.2.2.7.2	Battery inputs		P
4.2.2.8	Conditions of loading for output ports	The least favorable loading conditions was considered.	P
	- for continuous operation.	Until steady condition was established.	P
	- for intermittent operation.		N/A
	- for short-time operation.		N/A
4.2.2.9	Earthing terminals	Connection to the earth	P
4.2.2.10	Controls	Any position was set.	P
4.2.2.11	Available short circuit current	Considered.	P
4.3	Thermal Testing	See below.	P
4.3.1	General		P
4.3.2	Maximum temperatures Materials and components shall be selected so that under the most serve rated operating conditions, the temperatures do not exceed the temperature limits.	See appended table 4.3.	P
4.3.2.1	General		P
4.3.2.2	Touch temperatures		P
4.3.2.3	Temperature limits for mounting surfaces		P
4.4	Testing in single fault condition	See appended table 4.4.	P
4.4.1	General		P
4.4.2	Test conditions and duration for testing under fault conditions		P
4.4.2.1	General		P
4.4.2.2	Duration of tests		P
	- automatic reset devices or circuits		N/A
	- manual reset devices or circuits		N/A
	- non-resettable devices or circuits	One cycle and until temperatures stabilize.	P
4.4.3	Compliance after application of fault conditions		P

4.4.3.1	Protection against shock hazard		P
4.4.3.2	Protection against the spread of fire		P
4.4.3.3	Protection against other HAZARDS		P
4.4.3.4	Protection against parts expulsion hazards		P
4.4.4	SINGLE FAULT CONDITIONS	See below.	P
4.4.4.1	Component fault tests The following faults are simulated: Short circuit or open circuit of relevant components. Short circuit or open circuit of any components or insulation where failure could adversely affect supplementary insulation or reinforced insulation. In addition, where required by Method 2 of 9.1.1, components that could result in a fire hazard are to be overloaded unless they comply with the requirements of 9.1.3.	See appended table 4.4.	P
4.4.4.2	Equipment or parts for short-term or intermittent operation	Continuous operation equipment.	N/A
4.4.4.3	Motors	See appended table 4.4.	P
4.4.4.4	Transformer short circuit tests	See appended table 4.4.	P
4.4.4.5	Output short circuit	See appended table 4.4.	P
4.4.4.6	Backfeed current test for equipment with more than one source of supply	Based on test/circuit topology analysis and manufacturer's declaration, backfeed current form grid to the array is 0A	P
4.4.4.7	Output overload		P
4.4.4.8	Cooling system failure	See appended table 4.4.	P
4.4.4.9	Heating devices	No heating devices used.	N/A
4.4.4.10	Safety interlock systems	No safety interlock device used.	N/A
4.4.4.11	Reverse d .c. connections	See appended table 4.4.	P
4.4.4.12	Voltage selector mismatch	No voltage selector used.	N/A
4.4.4.13	Mis-wiring with incorrect phase sequence or polarity	See appended table 4.4.	P
4.4.4.14	PWB short-circuit test	The distance on PWB is enough	N/A
4.5	Humidity preconditioning	See below.	P
4.5.1	General		P
4.5.2	Conditions	Humidity: 100%RH Temperature: 40°C Duration: 48hrs	P
4.6	Voltage Back-feed Protection	Hazardous voltage and energy was not present on the terminals, with the DC mains	P

		supply source de-energized or disconnected. In addition the symbol 13 of Table C.1 was marked for servicing functions	
4.6.1	Back-feed tests under normal conditions		P
4.6.2	Back-feed tests under single-fault conditions		P
4.6.3	Compliance with back-feed tests		P
	- 15 s for sources that are connected by fixed wiring		P
	- 1 s for sources that are cord-connected or use connectors that can be opened without the use of a tool		N/A
4.7	Electrical Ratings Tests	See appended table 4.7.	P
4.7.1	Input Ratings		P
4.7.2	Output Ratings		P

5	**MARKING AND DOCUMENTATION**		**P**
5.1	Marking		P
5.1.1	General		P
	Equipment shall bear markings as specified in 5.1 and 5.2	The marking label is on the outer surface of the enclosure.	P
	Graphic symbols may be used and shall be in accordance with Annex C or IEC 60417 as applicable.	All used graphic symbols are in accordance with Annex C.	P
	Graphic symbols shall be explained in the documentation provided with the PCE.	The explanations are provided in the user manual.	P
5.1.2	Durability of markings	The labels were subjected to the permanence of marking test. The labels were rubbed with the cloth soaked with petroleum spirit for 30 s.	P
	Markings required by this clause to be located on the PCE shall remain clear and legible under conditions of NORMAL USE and resist the effects of cleaning agents specified by the manufacturer	After this test there was no damage to the labels. The marking on the labels did not fade. There was no curling or lifting of the label's edges.	P
5.1.3	Identification		P
	The equipment shall, as a minimum, be permanently marked with:	See below.	
	a) the name or trade mark of the manufacturer or supplier	See copy of marking plate.	P
	b) model number, name or other means to identify the equipment	See above.	P
	c) a serial number, code or other marking allowing	See above.	P

	identification of manufacturing location and the manufacturing batch or date within a three month time period.		
5.1.4	Equipment ratings		P
	Unless otherwise specified in another part of IEC 62109, the following ratings, as applicable shall be marked on the equipment:	See below	P
	– input voltage, type of voltage (a.c. or d.c.), frequency, and max. continuous current for each input	See model list.	P
	– output voltage, type of voltage (a.c. or d.c.), frequency, max. continuous current, and for a.c. outputs, either the power or power factor for each output	See above.	P
	– the ingress protection (IP) rating as in 6.3 below	See clause 6.3	P
5.1.5	Fuse identification		P
	Marking shall be located adjacent to each fuse or fuse holder, or on the fuse holder, or in another location provided that it is obvious to which fuse the marking applies, giving the fuse current rating and where fuses of different voltage rating value could be fitted, the fuse voltage rating.	External fuse type gL/gG or comparable automatic circuit breaker recommended at endinstallation, see user manual	P
	Where fuses with special fusing characteristics such as time delay or breaking capacity are necessary, the type shall also be indicated	See above.	P
	For fuses not located in operator access areas and for soldered-in fuses located in operator access areas, it is permitted to provide an unambiguous cross-reference (for example, F1, F2, etc.) to the servicing instructions which shall contain the relevant information.	See above.	P
5.1.6	Terminals, Connections, and Controls		P
	If necessary for safety, an indication shall be given of the purpose of Terminals, connectors, controls, and indicators, and their various positions, including any connections for coolant fluids such as water and drainage. The symbols in Annex C may be used, and where there is insufficient space, symbol 9 of Annex C may be used.	Relevant symbol, indicator or information are available.	P
	Push-buttons and actuators of emergency stop devices, and indicator lamps used only to indicate a warning of danger or the need for urgent action shall be colored red.	No such device.	N/A
	A multiple-voltage unit shall be marked to indicate the particular voltage for which it is set when shipped from the factory. The marking is allowed to be in the form of a paper tag or any other nonpermanent material.		N/A

	A unit with d.c. terminals shall be plainly marked indicating the polarity of the connections, with:		P
	– the sign “+“ for positive and “-“ for negative; or	The “+” and “-“ marking provided adjacent to the PV input connectors.	P
	– a pictorial representation illustrating the proper polarity where the correct polarity can be unambiguously determined from the representation	No pictorial representation illustration used.	N/A
5.1.6.1	Protective Conductor Terminals		P
	The means of connection for the protective earthing conductor shall be marked with:		P
	– symbol 7 of Annex C; or	Symbol 7 of Table C.1 marked adjacent to the PE terminal.	P
	– the letters “PE“; or	See above.	N/A
	– the color coding green-yellow.		P
5.1.7	Switches and circuit-breakers		P
	The on and off-positions of switches and circuits breakers shall be clearly marked. If a push-button switch is used as the power switch, symbols 10 and 16 of Annex C may be used to indicate the on-position, or symbols 11 and 17 to indicate the off-position, with the pair of symbols (10 and 16, or 11 and 17) close together.	The letter “ON” and “OFF” is clearly marked.	P
5.1.8	Class II Equipment	Class I Equipment.	N/A
	Equipment using Class II protective means throughout shall be marked with symbol 12 of Annex C. Equipment which is only partially protected by DOUBLE INSULATION or REINFORCED INSULATION shall not bear symbol 12 of Table Annex C.	See above.	N/A
	Where such equipment has provision for the connection of an earthing conductor for functional reasons (see 7.3.6.4) it shall be marked with symbol 6 of Annex C	See above.	N/A
5.1.9	Terminal boxes for External Connections		P
	Where required by note 1 of Table 2 as a result of high temperatures of terminals or parts in the wiring compartment, there shall be a marking, visible beside the terminal before connection, of either:		P
	a) the minimum temperature Rating and size of the cable to be connected to the TERMINALS; or		P
	b) a marking to warn the installer to consult the installation instruction. Symbol 9 of Table D-1 is an acceptable marking		P

5.2	Warning markings		P
5.2.1	Visibility and legibility requirements for warning markings		P
	Warning markings shall be legible, and shall have minimum dimensions as follows:		P
	– Printed symbols shall be at least 2,75 mm high		P
	– Printed text characters shall be at least 1.5 mm high and shall contrast in color with the back-ground		P
	– Symbols or text that are moulded, stamped or engraved in a material shall have a character height of at least 2,0 mm, and if not contrasting in color from the background, shall have a depth or raised height of at least 0,5 mm.	No such symbols.	N/A
	If it is necessary to refer to the instruction manual to preserve the protection afforded by the equip-ment, the equipment shall be marked with symbol 9 of Annex C		P
	Symbol 9 of Annex C is not required to be used ad-jacent to symbols that are explained in the manual		P
5.2.2	Content for warning markings		P
5.2.2.1	Ungrounded heatsinks and similar parts		N/A
	An ungrounded heat sink or other part that may be mistaken for a grounded part and involves a risk of electric shock in accordance with 7.3 shall be marked with symbol 13 of Annex C, or equivalent. The marking may be on or adjacent to the heatsink and shall be clearly visible when the PCE is disas-sembled to the extent that a risk of contact with the heatsink exists.		N/A
5.2.2.2	Hot Surfaces		P
	A part of the PCE that exceeds the temperature limits specified in 4.3.2 shall be marked with sym-bol 14 of Annex C or equivalent.	Marked with symbol 14 of Table C.1.	P
5.2.2.3	Coolant		N/A
	A unit containing coolant that exceeds 70 °C shall be legibly marked externally where readily visible after installation with symbol 15 of Annex C. The documentation shall provide a warning regarding the risk of burns from hot coolant, and either:	Not used.	N/A
	a) statement that coolant system servicing is to be done only by SERVICE PERSONNEL, or		N/A
	b) instructions for safe venting, draining, or other-wise working on the cooling system, if these operations can be performed without OPERATOR access to HAZARDS internal to the equipment		N/A

5.2.2.4	Stored energy		P
	Where required by 7.3.9.2 or 7.4.2 the PCE shall be marked with Symbol 21 of Annex C and the time to discharge capacitors to safe voltage and energy levels shall accompany the symbol.	Marked with Symbol 21 of Table C.1 and the time to discharge capacitors to safe voltage and energy levels accompany the symbol.	P
5.2.2.5	Motor guarding		N/A
	Where required by 8.2 a marking shall be provided where it is visible to service personnel before removal of a guard, warning of the hazard and giving instructions for safe servicing (for example disconnection of the source before removing the guard).	Not visible to service personnel	N/A
5.2.3	Sonic hazard markings and instructions	No such hazard.	N/A
	If required by 10.2.1 a PCE shall:		N/A
	a) be marked to warn the operator of the sonic pressure hazard; or		N/A
	b) be provided with installation instructions that specify how the installer can enxure that the sound pressure level from equipment at its point of use after installation, will not reach a value, which could cause a hazard. These instructions shall include the measured sound pressure level, and shall identify readily available and practicable protective materials or measures which may be used.		N/A
5.2.4	Equipment with multiple sources of supply		P
	A PCE with connections for multiple energy sources shall be marked with symbol 13 of Annex C and the manual shall contain the information required in 5.3.4.	Marked with symbol 13 of Annex C and explain in user manual.	P
	The symbol shall be located on the outside of the unit or shall be prominently visible behind any cover giving access to hazardous parts.	See above.	P
5.2.5	Excessive touch current		N/A
	Where required by 7.3.6.3.7 the PCE shall be marked with symbol 15 of Annex C. See also 5.3.2 for information to be provided in the installation manual.	No excessive tuch current	N/A
5.3	Documentation		P
5.3.1	General		P
	The documentation provided with the PCE shall provide the information needed for the safe operation, installation, and (where applicable) maintenance of the equipment. The documentation shall include the items required in 5.3.2 through 5.3.4, and the following:	All related informations provided in the user's maunal.	P
	a) explanations of equipment makings, including		P

	symbols used		
	b) location and function of terminals and controls		P
	c) all ratings or specifications that are necessary to safely install and operate the PCE, including the following environmental ratings along with an explanation of their meaning and any resulting installation requirements:		P
	– ENVIRONMENTAL CATEGORY as per 6.1		P
	– WET LOCATIONS classification fort he intended external environment as per 6.1		P
	– POLLUTION DEGREE classification for the intended external environment as per 6.2		P
	– INGRESS PROTECTION rating as per 6.3		P
	– Ambient temperature and relative humidity ratings		P
	– MAXIMUM altitude rating		P
	– OVERVOLTAGE CATEGORY assigned to each input and output port as per 7.3.7.1.2, accompanied by guidance regarding how to ensure that the installation complies with the required overvoltage categories;		P
	d) a warning that when the photovoltaic array is exposed to light, it supplies a d.c. voltage to the PCE		P
5.3.1.1	Language		P
	Instructions related to safety shall be in a language that is acceptable in the country where the equipment is to be installed.	Instruction related to safety is in English.	P
5.3.1.2	Format		P
	In general, the documentation must be provided in printed form and is to be delivered with the equipment.	The printed form is available and is delivered with the PCE.	P
	For equipment which requires the use of a computer for both installation and operation, documentation may be provided in electronic format without accompanying printed format.	See above.	N/A
5.3.2	Information related to installation		P
	The documentation shall include installation and where applicable, specific commissioning instructions and, if necessary for safety, warnings against hazards which could arise during installation or commissioning of the equipment. The information provided shall include:	All below related informations provided in the user's maunal.	P
	a) assembly, location, and mounting requirements:		P

	b) ratings and means of connection to each source of supply and any requirements related to wiring and external controls, colour coding of leads, disconnection means, or overcurrent protection needed, including instructions that the installation position shall not prevent access to the disconnection means;		P
	c) ratings and means of connection of any outputs from the PCE, and any requirements related to wiring and externals controls, color coding of leads, or overcurrent protection needed;		P
	d) explanation of the pin-out of connectors for external connections, unless the connector is used for a standard purpose (e.g. RS 232)		P
	e) ventilation requirements;		P
	f) requirements for special services, for example cooling liquid;		N/A
	g) instructions and information relating to sound pressure level if required by 10.2.1;	No hazardous sound level.	P
	h) where required by 14.8.1.3, instructions for the adequate ventilation of the room or location in which PCE containing vented or valve-regulated batteries is located, to prevent the accumulation of hazardous gases;	No battery used in the PCE.	P
	i) tightening torque to be applied to wiring terminals;		P
	j) values of back-feed short-circuit currents available from the PCE on input and output conductors under fault conditions, if those currents exceeds the max. rated current of the circuit, as per 4.4.4.6;		P
	k) for each input to the PCE, the max value of short-circuit current available from the source, for which the PCE is designed; and		P
	l) compatibility with RCD and RCM;	RCMU built in PCE.	P
	m) instructions for protective earthing, including the information required by 7.3.6.3.7 if a second protective earthing conductor is to be installed:		P
	n) where required by 7.3.8, the installation instructions shall include the following or equivalent wording:		P
	"This product can cause a d.c. current in the external protective earthing conductor. Where a residual current-operated protective (RCD) or monitoring (RCM) device is used for protection in a case of direct or indirect contact, only an RCD or RCM of Type B is allowed on the supply side of this product."		P

	o) for PCE intended to charge batteries, the battery nominal voltage rating, size, and type		P
	p) PV array configuration information, such as ratings, whether the array is to be grounded or floating, any external protection devices needed, etc.		P
5.3.3	Information related to operation		P
	Instructions for use shall include any operating instructions necessary to ensure safe operation, including the following, as applicable:	All related information provided in the user's maunal.	P
	– Instructions for adjustment of controls including the effects of adjustment;		P
	– Instructions for interconnection to accessories and other equipment, including indication of suitable accessories, detachable parts and any special materials;		P
	– Warnings regarding the risk of burns from surfaces permitted to exceed the temperature limits of 4.3.2 and required operator actions to reduce the risk; and		P
	– Instructions, that if the equipment is used in a manner not specified by the manufacturer, the protection provided by the equipment may be impaired.		P
5.3.4	Information related to maintenance		P
	Maintenance instructions shall include the following:	All related information provided in the service maunal.	
	– Intervals and instructions for any preventive maintenance that is required to maintain safety (for example air filter replacement or periodic re-tightening of terminals);		P
	– Instructions for accessing operator access areas, if any are present, including a warning not to enter other areas of the equipment;		P
	– Part numbers and instructions for obtaining any required operator replaceable parts;		P
	– Instructions for safe cleaning (if recommended)		P
	– Where there is more than one source of supply energizing the PCE, information shall be provided in the manual to indicate which disconnect device or devices are required to be operated in order to completely isolate the equipment.		P
5.3.4.1	Battery maintenance		N/A
	Where required by 14.8.5, the documentation shall include the applicable items from the following list		N/A

	of instructions regarding maintenance of batteries:		
	– Servicing of batteries should be performed or supervised by personnel knowledgeable about batteries and the required precautions		N/A
	– When replacing batteries, replace with the same type and number of batteries or battery packs		N/A
	– General instructions regarding removal and installation of batteries		N/A
	– CAUTION: Do not dispose of batteries in a fire. The batteries may explode.		N/A
	– CAUTION: Do not open or damage batteries. Released electrolyte is harmful to the skin and eyes. It may be toxic.		N/A
	– CAUTION: A battery can present a risk of electrical shock and high short-circuit current. The following precautions should be observed when working on batteries:		N/A
	a) Remove watches, rings, or other metal objects.		N/A
	b) Use tools with insulated handles.		N/A
	c) Wear rubber gloves and boots.		N/A
	d) Do not lay tools or metal parts on top of batteries		N/A
	e) Disconnect charging source prior to connecting or disconnecting battery terminals		N/A
	f) Determine if battery is inadvertently grounded. If inadvertently grounded, remove source from ground. Contact with any part of a grounded battery can result in electrical shock. The likelihood of such shock can be reduced if such grounds are removed during installation and maintenance (applicable to equipment and remote battery supplies not having a grounded supply circuit).		N/A

6	**ENVIRONMENTAL REQUIREMENTS AND CONDITIONS**		**P**
	The manufacturer shall rate the PCE for the following environmental conditions:		P
	– ENVIRONMENTAL CATEGORY, as in 6.1 below		P
	– Suitability for WET LOCATIONS or not		P
	– POLLUTION DEGREE rating in 6.2 below		P
	– INGRESS PROTECTION (IP) rating, as in 6.3 below		P
	– Ultraviolet (UV) exposure rating, as in 6.4 below		P

	– Ambient temperature and relative humidity ratings, as in 6.5 below		P
6.1	Environmental categories and minimum environmental conditions	See below.	P
6.1.1	Outdoor	For outdoor use.	P
6.1.2	Indoor, unconditioned	See above.	P
6.1.3	Indoor, conditioned	See above.	P
6.2	Pollution degree	PD 3	P
6.3	Ingress Protection	IP65.	P
6.4	UV exposure	The shelter is considered necessary for outdoor use. Anti-UV approved AC and DC connectors provided..	P
6.5	Temperature and humidity	Specified by manufacturer.	P

7	**PROTECTION AGAINST ELECTRIC SHOCK AND ENERGY HAZARDS**		**P**
7.1	General	The proper construction of PCE is available for protection against shock and energy hazards during installation, operation and maintenance under normal and single fault conditions.	P
7.2	Fault conditions	See subclause 4.4.	P
7.3	Protection against electric shock		P
7.3.1	General	Each circuit under evaluation is compliance.	P
7.3.2	Decisive voltage classification		P
7.3.2.1	Use of decisive voltage class (DVC)	See below	P
7.3.2.2	Limits of DVC (according table 6)	See subclause 7.3.2.1.	P
7.3.2.3	Short-terms limits of accessible voltages under fault conditions		P
7.3.2.4	Requirements for protection (according table 7)	For circuits evaluation information of PCE, refer to brief description of general product information on previous pages.	P
7.3.2.5	Connection to PELV and SELV circuits	DVC-A is classified for display and communication circuits.	P
7.3.2.6	Working voltage and DVC	See subclause 7.3.2.4.	P
7.3.2.6.1	General	See above.	P
7.3.2.6.2	AC working voltage (see Figure 2)		P
7.3.2.6.3	DC working voltage (see Figure 3)		P

7.3.2.6.4	Pulsating working voltage (see Figure 4)		P
7.3.3	Protective separation	For protective separation evaluation information of PCE, refer to brief description of general product information on previous pages.	P
	Protective separation shall be achieved by:		P
	▪ double or reinforced insulation, or		P
	▪ protective screening, i.e. by a conductive screen connected to earth by protective bonding in the PCE, or connected to the protective earth conductor itself, whereby the screen is separated from live parts by at least basic insulation, or		P
	▪ protective impedance comprising limitation of current per 7.3.5.3 and of discharged energy per 7.3.5.4, or		N/A
	▪ limitation of voltage according to 7.3.5.4.		N/A
	The protective separation shall be fully and effectively maintained under all conditions of intended use of the PCE		P
7.3.4	Protection against direct contact	Protection against electic shock by means of earthed metal enclosure. Any access to touch hazardous live parts is impossible.	P
7.3.4.1	General		P
	Protection against direct contact is employed to prevent persons from touching live parts that do not meet the requirements of 7.3.5 and shall be provided by one or more of the measure given in 7.3.4.2 (enclosures and barriers) and 7.3.4.3 (insulation).	See subclause 7.3.2.4.	P
	Open type sub-assemblies and devices do not require protective measures against direct contact but the instruction provided with the equipment must indicate that such measures must be provided in the end equipment or in the installation.		N/A
	Product intended for installation in CLOSED ELECTRICAL OPERATING AREAS, (see 3.9) need not have protective measures against direct contact, except as required by 7.3.4.2.4.		N/A
7.3.4.2	Protection by means of enclosures and barriers	Protection against electic shock by means of earthed metal enclosure.	P
	The following requirements apply where protection against contact with live parts is provided by enclosures or barriers, not by insulation in accordance		P

	with 7.3.4.3.		
7.3.4.2.1	General		P
	Parts of enclosures and barriers that provide protection in accordance with these requirements shall not be removable without the use of a tool (see 7.3.4.2.3).		P
	Polymeric materials used to meet these requirements shall also meet the requirements of 13.6		N/A
7.3.4.2.2	Access probe criteria	Considered.	P
	Protection is considered to be achieved when the separation between the test probes and live parts, when tested as described below, is as follows:		
	a) decisive voltage classification A, (DVC A) - the probe may touch the live parts	Considered.	P
	b) decisive voltage classification B, (DVC B) - the probe must not touch bare live parts	Considered.	P
	c) decisive voltage classification C, (DVC C) – the probe must have adequate clearance to live parts, based on the clearance for Basic insulation using the recurring peak working voltage involved,	Considered.	P
7.3.4.2.3	Access probe tests		P
	Compliance with 7.3.4.2.1 is checked by all of the following:		P
	a) Inspection; and	Live parts are enclosed by the earthed metal enclosure and no openings.	P
	b) Tests with the test finger (Figure D.1) and test pin (Figure D.2) of 0E, the results of which shall comply with the requirements of 7.3.4.2.1 a), b), and c) as applicable. Probe tests are performed on openings in the enclosures after removal of parts that can be detached or opened by an operator without the use of a tool, including fuseholders, and with operator access doors and covers open. It is permitted to leave lamps in place for this test. Connectors that can be separated by an operator without use of a tool, shall also be tested during and after disconnection. Any movable parts are to be put in the most unfavorable position.	It is not possible to touch the hazardous live parts by the test finger and test pin.	P
	The test finger and the test pin are applied as above, without appreciable force, in every possible position, except that floor-standing equipment having a mass exceeding 40 kg is not tilted.		P
	Equipment intended for building-in or rack mounting, or for incorporation in larger equipment, is tested with access to the equipment	Not intended for built-in or rack mounting.	N/A

	limited according to the method of mounting detailed in the installation instructions.		
	c) Openings preventing the entry of the jointed test finger (Figure E-1 of 0E) during test b) above, are further tested by means of straight unjointed test finger (Figure E-3 of 0E), applied with a force of 30 N. If the unjointed finger enters, the test with the jointed finger is repeated except that the finger is applied using any necessary force up to 30 N.	No openings.	N/A
	d) In addition to a) – c) above, top surfaces of enclosure shall be tested with the IP3X probe of IEC 60529. The test probe shall not penetrate the top surface of the enclosure when probed from the vertical direction ±5 ° only.	No openings.	N/A
7.3.4.2.4	Service access areas	It is not allowed to remove the cover during installation and maintenance when PCE is energized.	P
7.3.4.3	Protection by means of insulation of live parts	See subclause 7.3.2, 7.3.3 and 7.3.4.1.	P
	Where the requirements of 7.3.4.2 are not met, live parts shall be provided with insulation if:		N/A
	– their working voltage is greater than the maximum limit of decisive voltage class A, or		N/A
	– for a DVC A or B circuit, protective separation from adjacent circuit of DVC C is not provided (see note "‡" under Table 7)		N/A
7.3.5	Protection in case of direct contact		P
7.3.5.1	General	See below.	P
	Protection in case of direct contact is required to ensure that contact with live parts does not produce a shock hazard.		P
	The protection against direct contact according to 7.3.4 is not required if the circuit contacted is separated from other circuits according to 7.3.2.3, and:		P
	– is of decisive voltage class A and complies with 7.3.5.2, or	Only DCV-A classified circuit can be touched directly, see also 7.3.5.2.	P
	– is provided with protective impedance according to 7.3.5.3, or		N/A
	– is limited in voltage according to 7.3.5.4		N/A
	In addition to the measures as given in 7.3.5.2 to 7.3.5.4, it shall be ensured that in the event of error or polarity reversal of connectors no voltages that exceed DVC A can be connected into a circuit with protective separation. This applies for example to plug-in-sub-assemblies or other plug-in devices which can be plugged-in without the use of a tool		P

	(key) or which are accessible without the use of a tool.		
	Conformity is checked by visual inspection and trial insertion.		P
7.3.5.2	Protection using decisive voltage class A	Comm. port is considerd as DVC-A which can be accessible and separated from DVC-C by double or reinforced insulaiton.	P
7.3.5.3	Protection by means of protective impedance	This method not considered.	N/A
	Circuits and conductive parts do not require protection against direct contact if any connection to circuits of DVC-B or DVC-C is through protective impedance, and the accessible circuit or part is otherwise provided with protective separation from circuits of DVC-B or DVC-C according 7.3.3.		N/A
7.3.5.3.1	Limitation of current through protective impedance		N/A
	The current available through protective impedance to earth and between simultaneously accessible parts, measured at the accessible live parts, shall not exceed a value of 3,5 mA a.c. or 10 mA d.c. under normal and single-fault conditions.		N/A
7.3.5.3.2	Limitation of discharging energy through protective impedance		N/A
	The discharging energy available between simultaneously accessible parts protected by protective impedance shall not exceed the charging voltage and capacitance limits given in Table 9, which applies to both wet and dry locations, under normal and single fault conditions. Refer to figure 8.		N/A
7.3.5.4	Protection by means of limited voltages	This method not considered.	N/A
	That portion of a circuit that has its voltage reduced to DVC-A by a voltage divider that complies with the following requirements, and that is otherwise provided with protective separation from circuits of DVC-B or DVC-C according to 7.3.3, does not require protection against direct contact.		N/A
	The voltage divider shall be designed so that under normal and single fault conditions, including faults in the voltage division circuit, the voltage across the output of the voltage divider does not exceed the limit for DVC-A.		N/A
	This type of protection shall not be used in case of protective class II or unearthed circuits, because it relies on protective earth being connected.		N/A
7.3.6	Protection against indirect contact		P
7.3.6.1	General		P
	Protection against indirect contact is required to	The PCE is defined as	P

	prevent shock- hazardous current being accessible from conductive parts during an insulation failure. This protection shall comply with the requirements for protective class I (basic insulation plus protective earthing), class II (double or reinforced insulation) or class III (limitation of voltages)	protective class I.	
	That part of a PCE meets the requirements of 7.3.6.2 and 7.3.6.3 is defined as protective class I	The earthing metal enclosure is complied with Protective class I.	P
	That part of a PCE meets the requirements of 7.3.6.4 is defined as protective class II.	The circuit of communication is complied with Protective class II for accessible communication ports.	P
	That part of PCE which meets the requirements of decisive voltage class A and in which no hazardous voltages are derived, is defined as protective class III. No shock hazard is present in such circuits.		N/A
	Where protection against indirect contact is dependent on means provided during installation, the installation instructions shall provide details of the required means and shall indicate the associated hazards.		P
7.3.6.2	Insulation between live parts and accessible conductive parts	See subclaus 7.3.2.3, 7.3.7.4 and 7.3.7.5.	P
	Accessible conductive parts of equipment shall be separated from live parts by insulation meeting the requirements of Table 7 or by clearances as specified in 7.3.7.4 and creepages as specified in 7.3.7.5	The clearances specified in 7.3.7.4 and creepage specified in 7.3.7.5 are complied.	P
7.3.6.3	Protective class I – Protective bonding and earthing		P
7.3.6.3.1	General		P
	Equipment of protective class I shall be provided with protective earthing, and with protective bonding to ensure electrical contact between accessible conductive parts and the means of connection for the external protective earthing conductor, except bonding is not required for:	Suitable protective bonding provided.	P
	a) accessible conductive parts that are protected by one of the measures in 7.3.5.2 to 7.3.5.4, or	DVC-A classified circuit is considered.	P
	b) accessible conductive parts are separated from live parts of DVC-B or -C using double or reinforced insulation.	Display and communication circuits are separated from live parts used double or reinforced insulation.	P
7.3.6.3.2	Requirements for protective bonding	The cross-section of the protective bonding conductor is the same as that for the external protective earthing conductor.	P
	Electrical contact with the means of connection of the external protective earthing conductor shall be		P

	achieved by one or more of the following means:		
	a) through direct metallic contact;	The connection of external protective earthing conductor is direct metal contact via a terminal with screw.	P
	b) through other conductive parts which are not removed when the PCE or sub-units are used as intended ;		P
	c) through a dedicated protective bonding conductor;	Protective earthing terminal used.	P
	d) through other metallic components of the PCE		N/A
	Where direct metallic contact is used and one or both of the parts involved is painted or coated, the paint or coating shall be removed in the area of contact, or reliably penetrated, to ensure metal to metal contact.		P
	For moving or removable parts, hinges or sliding contacts designed and maintained to have a low resistance are examples of acceptable means if they comply with the requirements of 7.3.6.3.3.		N/A
	Metal ducts of flexible or rigid construction and metallic sheaths shall not be used as protective bonding conductors, unless the device or material has been investigated as suitable for protective bonding purposes.		P
7.3.6.3.3	Rating of protective bonding	See below.	P
	Protective bonding shall withstand the highest thermal and dynamic stresses that can occur to the PCE item(s) concerned when they are subjected to a fault connecting live parts to accessible conductive parts. The protective bonding shall remain effective for as long as a fault to the accessible conductive parts persists or until an upstream protective device removes power from the part.	Suitable protective bonding used.	P
	Protective bonding shall meet following requirements:	See below.	P
	a) For PCE with an overcurrent protective device rating of 16 A or less, the impedance of the protective bonding means shall not exceed 0,1 Ω during or at the end of the test below.		N/A
	b) For PCE with an overcurrent protective device rating of more than 16 A, the voltage drop in the protective bonding test shall not exceed 2,5 V during or at the end of the test below.		P
	As alternative to a) and b) the protective bonding may designed according to the requirements for the external protective earthing conductor in 7.3.6.3.5, in which case no testing is required.		N/A

	The impedance of protective bonding means shall be checked by passing a test current through the bond for a period of time as specified below. The test current is based on the rating of the overcurrent protection for the equipment or part of the equipment under consideration, as follows:		P
	a) For pluggable equipment type A, the overcurrent protective device is that provided external to the equipment (for example, in the building wiring, in the mains plug or in an equipment rack);		N/A
	b) For pluggable equipment type B and fixed equipment, the maximum rating of the overcurrent protective device specified in the equipment installation instructions to be provided external to the equipment;		P
	c) For a circuit or part of the equipment for which an overcurrent protective device is provided as part of the equipment, the rating of the provided overcurrent device.		P
	Voltages are measured from the protective earthing terminal to all parts whose protective bonding means are being considered. The impedance of the protective earthing conductor is not included in the measurement. However, if the protective earthing conductor is supplied with the equipment, it is permitted to include the conductor in the test circuit but the measurement of the voltage drop is made only from the main protective earthing terminal to the accessible part required to be earthed.		P
	On equipment where the protective earth conncection to a subassembly or to a separate unit is part of a cable that also supplies power to that subassembly or unit, the resistance of the protective bonding conductor in that cable is not included in the protective bond impedance measurements for the subassembly or separate unit, as shown in Figure 11. However, this option is only permitted if the cab le is protected by a suitably rated protective device that takes into account the size of the conductor. Otherwise the impedance of the protective bonding conductor between the separate units is to be included, by measuring to the protective earthing terminal where the power source enters the first unit in the system, as shown in Figure 12.		P
7.3.6.3.3.1	Test current, duration, and acceptance criteria		P
	The test current, duration of the test and acceptance criteria are as follows:		P
	a) For PCE with an overcurrent protective device rating of 16 A or less, the test current is 200% of the overcurrent protective device rating, but		N/A

	not less than 32 A, applied for 120s. The impedance of the protective bonding means during and at the end of the test shall not exceed 0,1 Ω.		
	b) For PCE with an overcurrent protective device rating of more than 16 A, the test current is 200% of the overcurrent protective device rating and the duration of the test is as shown in Table 10 below. The voltage drop in the protective bonding means, during and at the end of the test, shall not exceed 2,5 V.		P
	c) During and after the test, there shall be no melting, loosening, or other damage that would impair the effectiveness of the protective bonding means.		P
	The test current is derived from an a.c or d.c supply source, the output of which is not earthed.		P
	As an alternative to Table 10, where the time-current characteristic of the overcurrent protective device that limits the fault current in the protective bonding means is known because the device is either provided in the equipment or fully specified in the installation instructions, the test duration may be based on that specific device's time-current characteristic,. The tests are conducted for a duration corresponding to the 200% current value on the time-current characteristic.		P
7.3.6.3.4	Protective bonding impedance (routine test)	For routine test	N/A
	If the continuity of the protective bonding is achieved at any point by a single means only (for example a single conductor or single fastener), or if the PCE is assembled at the installation location, then the impedance of the protective bonding shall also be tested as a routine test. The test shall be as in 7.3.6.3.3, except for the following:		N/A
	▪ the test current may be reduced to any convenient value greater than 10 A sufficient to allow measurement or calculation of the impedance of the protective bonding means:		N/A
	▪ the test duration may be reduced to no less than 2 s		N/A
	For equipment subject to the type test in 7.3.6.3.3.1a), the impedance during the routine test shall not exceed 0,1Ω.		N/A
	For equipment subject to the type test in 7.3.6.3.3.1b) the impedance during the routine test shall not exceed 2,5 V divided by the test current required by 7.3.6.3.3.1b).		N/A
7.3.6.3.5	External protective earthing conductor		P

	A protective earthing conductor shall be connected at all times when power is supplied to PCE of protective class I. Unless local wiring regulations state otherwise, the protective earthing conductor cross-sectional area shall be determined from Table 11 or by calculation according to IEC 60364-5-54.		P
	If the external protective earthing conductor is routed through a plug and socket or similar means of disconnection, it shall not be possible to disconnect it unless power is simultaneously removed from the part to be protected.		P
	The cross-sectional area of every external protective earthing conductor which does not form part of the supply cable or cable enclosure shall, in any case, be not less than:		P
	▪ 2,5 mm² if mechanical protection is provided;		P
	▪ 4 mm² if mechanical protection is not provided.		N/A
	For cord-connected equipment, provisions shall be made so that the external protective earthing conductor in the cord shall, in the case of failure of the strain-relief mechanism, be the last conductor to be interrupted.		P
7.3.6.3.6	Means of connection for the external protective earthing conductor		P
7.3.6.3.6.1	General		P
	The means of connection for the external protective earthing conductor shall be located near the terminals for the respective live conductors. The means of connections shall be corrosion-resistant and shall be suitable for the connection of cables according to 7.3.6.3.5. The means of connection for the protective earthing conductor shall not be used as a part of the mechanical assembly of the equipment or for other connections. A separate means of connection shall be provided for each external protective earthing conductor. Connection and bonding points shall be so designed that their current-carrying capacity is not impaired by mechanical, chemical, or electrochemical influences. Where enclosures and/or conductors of aluminium or aluminium alloys are used, particular attention should be given to the problems of electrolytic corrosion.	The external protective earthing terminal block consist of other live conducts as AC connector for connecting PCE to the mains. Corrosion-resistant is considered for connection and bonding points. Separated earthing terminal be provided for protective earthing conductor was specified in user manual.	P
	The means of connection for the protective earthing conductor shall be permanently marked with:		P
	• symbol 7 of Annex C; or	With the symbol 7 of Table C.1.	P
	• the colour coding green-yellow	The color coding of Green –	P

		yellow recommended.	
	Marking shall not be done on easily changeable parts such as screws.		P
7.3.6.3.7	Touch current in case of failure of the protective earthing conductor		P
	The requirements of this sub-clause shall be satisfied to maintain safety in case of damage to or disconnection of the protective earthing conductor.		P
	For pluggable equipment type A, the touch current measured in accordance with 7.5.4 shall not exceed 3,5 mA a.c. or mA d.c.		N/A
	For all other PCE, one or more of the following measure shall be applied, unless the touch current measured in accordance with 7.5.4 using the test network of IEC 60990 test figure 4 shall not exceed 3,5 mA a.c. or 10 mA d.c.	See appended table 7.5.4. In addition, the caution symbol 15 of Table C.1 provided on PCE and in manual.	P
	a) Permanently connected wiring, and:		N/A
	• a cross-section of the protective earthing conductor of at least 10 mm² Cu or 16 mm² Al; or		N/A
	• automatic disconnection of the supply in case of discontinuity of the protective earthing conductor; or		N/A
	• provision of an additional terminal for a second protective earthing conductor of the same cross-sectional area as the original protective earthing conductor and installation instruction requiring a second protective earthing conductor to be installed or		N/A
	b) Connection with an industrial connector according to IEC 60309 and a minimum protective earthing conductor cross-section of 2,5 mm² as part of a multi-conductor power cable. Adequate strain relief shall be provided.		P
	In addition, the caution symbol 15 of Annex C shall be fixed to the product and the installation manual shall provide details of the protective earthing measures required in the installation as required in 5.3.2.		P
	When it is intended and allowed to connect two or more PCEs in parallel using one common PE conductor, the above touch current requirements apply to the maximum number of the PCEs to be connected in parallel, unless one of the measures in a)		N/A
	or b) above is used. The maximum number of parallel PCEs is used in the testing and has to be stated in the installation manual.		N/A

7.3.6.4	Protective Class II – Double or Reinforced Insulation	PCE is designed for protective class I.	N/A
	Equipment or parts of equipment designed for protective class II shall have insulation between live parts and accessible surfaces in accordance with 7.3.4.3. The following requirements also apply:		N/A
	• equipment designed to protective class II shall not have means of connection for the external protective earthing conductor. However this does not apply if the external protective earthing conductor is passed through the equipment to equipment series-connected beyond it. In the latter event, the external protective earthing conductor and its means for connection shall be insulated with basic insulation from the accessible surface of the equipment and from circuits that employ protective separation, extra-low voltage, protective impedance and limited discharging energy, according to 7.3.5. This basic insulation shall correspond to the rated voltage of the series-connected equipment;		N/A
	• metal-encased equipment of protective class II may have provision on its enclosure for the connection of an equipotential bonding conductor;		N/A
	• equipment of protective class II may have provision for the connection of an earthing conductor for functional reasons or for damping of overvoltages; it shall, however, be insulated as though it is a live part;		N/A
	• equipment employing protective class II shall be marked according to 5.1.8.		N/A
7.3.7	Insulation Including Clearance and Creepage Distance	See below.	P
7.3.7.1	General		P
	This subclause gives minimum requirements for insulation, based on the principles of IEC 60664.		P
	Manufacturing tolerances shall be taken into account during measurement of creepage, clearance, and insulation distance in the PCE.		P
	Insulation shall be selected after consideration of the following influences:		P
	• pollution degree	See sub clause 7.3.7.1.1.	P
	• overvoltage category	See sub clause 7.3.7.1.2.	P
	• supply earthing system	See sub clause 7.3.7.1.3.	P
	• insulation voltage	See sub clause 7.3.7.1.4.	P
	• location of insulation		P

	• type of insulation		P
	Compliance of insulation, creepage distances, and clearance distances, shall be verified by measurement or visual inspection, and the tests of 7.5.		
7.3.7.1.1	Pollution degree	PD 3	P
7.3.7.1.2	Overvoltage category and Impulse withstand voltage rating ..... :		P
	- MAINS circuits	O.V.C III	P
	- PV circuits insulated	O.V.C II	P
	- PV circuits not insulated	No such circuits.	N/A
	- Other circuits	Battery circuit: O.V.C II	P
7.3.7.1.3	Supply earthing systems	For TN & TT system.	P
	Three basic types of earthing system are described in IEC 60364-1. They are:		P
	• TN system: has one point directly earthed, the accessible conductive parts of the installation being connected to that point by protective conductors. Three types of TN systems, TN-C, TN-S and TN-C-S, are defined according to the arrangement of the neutral and protective conductor.		P
	• TT system: has one point directly earthed, the accessible conductive parts of the installation being connected to earth electrodes electrically independent of the earth electrodes of the power system;		P
	• IT sytem: has all live parts isolated from earth or one point connected to earth through an impedance, the accessible conductive parts of the installation being earthed independently or collectively to the earthing system.		N/A
7.3.7.1.4	Insulation voltages	230 V, OVC III (4000 V impulse voltage, 1500 Vr.m.s. temporary overvoltage) for the AC output terminal and 600 V, OVC II (2945 V impulse voltage, no temporary overvoltage) for the PV input terminal. No isolation between PV and AC mains output. Maximum 600 Vd.c. working voltage is assumed between DVC A circuit and DVC C circuit.	P
	Table 12 makes use of the circuit system voltage and overvoltage category to define the impulse withstand voltage and the temporary overvoltage.		P

7.3.7.2	Insulation between a circuit and its surroundings		P
7.3.7.2.1	General	Considered.	P
7.3.7.2.2	Circuits connected directly to the MAINS	Clearances and solid insulation required according to the impulse voltage, temporary overvoltage, or working voltage, whichever gives the most severe requirement.	P
7.3.7.2.3	Circuits other than MAINS circuits	Clearances and solid insulation required according to the impulse voltage and recurring peak voltage.	P
7.3.7.2.4	Insulation between circuits	Clearances and solid insulation according to the higher impulse voltages. Creepages according ot the higher r.m.s. working voltage.	P
7.3.7.3	Functional insulation		P
7.3.7.4	Clearance distances	See appended table 7.3.7.4.	P
7.3.7.4.1	Determination	The max. insulation / implulse voltage: 4000V.	P
7.3.7.4.2	Electric field homogeneity	Not considered.	N/A
7.3.7.4.3	Clearance to conductive enclosures	Refer to subclause 7.3.7.4.1 and 13.7.	P
7.3.7.5	Creepage distances	See appended table 7.3.7.5.	P
7.3.7.5.1	General		P
7.3.7.5.2	Voltage	The max. vlotage: 230Vrms / 600Vd.c	P
7.3.7.5.3	Materials		P
7.3.7.6	Coating	Not used.	N/A
7.3.7.7	PWB spacings for functional insulation	Comply with 7.3.7.4 and 7.3.7.5.	N/A
7.3.7.8	Solid insulation		P
7.3.7.8.1	General		P
7.3.7.8.2	Requirements for electrical withstand capability		P
7.3.7.8.2.1	Basic, supplemental, reinforced, and double insulation	Passed the impulse withstand voltage and a.c. or d.c. voltage tests. See appended table 7.5.1, 7.5.2 & 7.5.3. Note: No double or reinforced solid insulation used. No voltage stress on the insulation is greater than 1 kV/mm.	P
7.3.7.8.2.2	Functional insulation		P

7.3.7.8.3	Thin sheet or tape material	See below.	P
7.3.7.8.3.1	General		P
7.3.7.8.3.2	Material thickness not less than 0.2 mm	Bobbin used in power transformer.	P
	Basic or supplementary insulation shall consist of at least one layer of material, and shall meet the impulse and a.c. or d.c. voltage test requirements of 7.3.7.8.2.1 for basic or supplementary insulation.	See appended table 7.5.1, 7.5.2 & 7.5.3.	P
	Double insulation shall consist of at least two layers of material. Each layer shall meet the impulse and a.c. or d.c. voltage test requirements of 7.3.7.8.2.1 for basic insulation, and the partial discharge requirements of 7.3.7.8.2.1. The two or more layers together shall meet the impulse and a.c. or d.c. voltage test requirements of 7.3.7.8.2.1 for double insulation.	Not used.	N/A
	Reinforced insulation shall consist of a single layer of material, which will meet the impulse, a.c. or d.c. voltage, and partial discharge test requirements 7.3.7.8.2.1 for reinforced insulation.	Not used.	N/A
7.3.7.8.3.3	Material thickness less than 0.2 mm		P
	Basic or supplementary insulation shall consist of at least one layer of material, and shall meet the impulse and a.c. or d.c. voltage test requirements of 7.3.7.8.2.1 for basic or supplementary insulation.	See appended table 7.5.1, 7.5.2 & 7.5.3.	P
	Double insulation shall consist of at least three layers of material. Each layer shall meet the impulse and a.c. or d.c. voltage test requirements of 7.3.7.8.2.1 for basic insulation any two layers together shall meet the impulse, a.c. or d.c. voltage, and partial discharge test requirements of 7.3.7.8.2.1 for double insulation.	Not used.	N/A
	Reinforced insulation consisting of a single layer of material less than 0,2 mm thick is not permitted.	Not used.	N/A
7.3.7.8.3.4	Compliance	See subclause 7.3.7.8.3.2.	P
7.3.7.8.4	Printed wiring boards (PWBs)		P
7.3.7.8.4.1	General	Insulation between conductor layers in double-sided single-layer PWBs meet the requirements of 7.3.7.8.1. Basic, supplementary, double and reinforced insulation meet the appropriate requirements of 7.3.7.8.2.1 or 7.3.7.8.2.2. Functional insulation in PWBs meet the requirements of 7.3.7.8.2.3.	P
7.3.7.8.4.2	Use of coating materials	No coating material used.	N/A

	Type 1 protection		N/A
	Type 2 protection		N/A
	Cold test (-25°C) and rapid change of temperature test (-25°C to +125°C)		N/A
7.3.7.8.5	Wound components	No such wound components.	N/A
7.3.7.8.6	Potting materials	No potting materials used.	N/A
7.3.7.9	Insulation requirements above 30 kHz		N/A
7.3.8	Residual Current-operated protective (RCD) or monitoring (RCM) device compatibility	External Type A RCD used	P
	RCD and RCM are used to provide protection against insulation faults in some domestic and industrial installations, additional to that provided by the installed equipment.	External Type A RCD used	P
7.3.9	Capacitor discharge	See appended table 7.3.9.	P
7.3.9.1	Operator access area		N/A
	Equipment shall be so designed that there is no risk of electric shock in operator access areas from charge stored on capacitors after disconnection of the PCE.	No such operator area to access without the use of a tool.	N/A
7.3.9.2	Service access areas		P
	Capacitors located behind panels that are removable for servicing, installation, or disconnection shall present no risk of electric shock or energy hazard from charge stored on capacitors after disconnection of the PCE.	The warning symbol 21 of Table C.1 and an indication of the discharge time is placed in a clearly visible position on the protective barrier to avoid unconsciousness contact.	P
7.4	Protection against energy hazards		P
7.4.1	Determination of hazardous energy level	There is no risk of energy hazard in operator access areas, protection of electrical shock by means of earthed metal enclosure.	P
	A hazardous energy level is considered to exist if		P
	a) The voltage is 2 V or more, and power available after 60 s exceeds 240 VA.		P
	b) The stored energy in a capacitor is at a voltage. U of 2 V or more, and the stored energy. E, calculated from the following equation, exceeds 20J: $E = 0,5\ CU^2$		P
7.4.2	Operator Access Areas		P
	Equipment shall be so designed that there is no risk of energy hazard in operator access areas from accessible circuits.	All hazardous energy parts were enclosed within the earthed metal enclosure.	P

7.4.3	Services Access Areas		P
	Energy storage devices located behind panels that are removable for servicing, installation or disconnection shall present no risk of electric energy hazard from charge stored after disconnection of the PCE.		P
	Energy storage devices within a PCE shall be discharged to an energy level less than 20 J, as in 7.4.1, within 10 s after the removal	The warning symbol 21 of Table C.1 and an indication of the discharge time is placed in a clearly visible position on the protective barrier to avoid unconsciousness contact.	P
7.5	Electrical tests related to shock hazard		P
7.5.1	Impulse voltage test (*type test*) The impulse voltage test is performed with a voltage having a 1,2/50 µs waveform (see Figure 6 of IEC 60060-1) and is intended to simulate overvoltages induced by lightning or due to switching of equipment. See Table 15 for conditions of the impulse voltage test.	See appended table 7.5.1. During the test no puncture, flashover, or sparkover occurs.	P
7.5.2	Voltage Test (dielectric strength test) (type test and routine test)	See below.	P
7.5.2.1	Purpose of test		P
7.5.2.2	Value and type of test voltage The values of the test voltage are determined from column 2 or 3 of Table 17 or Table 18 depending upon whether the circuit under test is mains connected or not mains connected.	See appended table 7.5.2.	P
7.5.2.3	Humidity pre-conditioning	PCE is inteneded for WET LOCATIONS use.	P
7.5.2.4	Performing the voltage test The test shall be applied as follows, according to Figure 13	Refer to appended table 7.5.2.	P
7.5.2.5	Duration of the a.c. or d.c. voltage test The duration of the test shall be at least 60 s for the type test and 1 s for the routine test. The test voltage may be applied with increasing and/or decreasing ramp voltage, and the ramp times are not specified, but regardless of the ramp time, the dwell time at full voltage shall be 60 s and 1 s respectively for type and routine tests.	The full voltage is maintained for 60s.	P
7.5.2.6	Verification of the a .c. or d.c. voltage test	No electrical breakdown occurs during the test.	P
7.5.3	Partial discharge test (type test or sample test)	No double or reinforced solid insulation used. No voltage stress on the insulation is greater than 1 kV/mm.	N/A
7.5.4	Touch current measurement (type test)		P

	The touch current shall be measured if required by 7.3.6.3.7 and shall not be greater than 3.5 mA a.c. or 10 mA d.c. or special measures of protection as given in 7.3.6.3.7 are required.	See appended table 7.5.4.	P
	For type tests on PCE for which wet locations requirements apply according to 6.1, the humidity pre-conditioning of 4.5 shall be performed immediately prior to the touch current test.	See above.	P
7.5.5	Equipment with multiple sources of supply		P

8	**PROTECTION AGAINST MECHANICAL HAZARDS**		**P**
8.1	General		P
	Operation shall not lead to a mechanical HAZARD in NORMAL CONDITION or SINGLE FAULT CONDITION. Edges, projections, corners, openings, guards, handles and the like, that are accessible to the operator shall be smooth and rounded so as not to cause injury during normal use of the equipment.	Edges, projections, corners, openings, guards, handles and the like, that are accessible to the OPERATOR are smooth and rounded.	P
	Conformity is checked as specified in 8.2 to 8.6.		P
8.2	Moving parts		N/A
	Moving parts shall not be able to crush, cut or pierce parts of the body of an OPERATOR likely to contact them, nor severely pinch the OPERATOR's skin. Hazardous moving parts of equipment, that is moving parts which have the potential to cause injury, shall be so arranged, enclosed or guarded as to provide adequate protection against the risk of personal injury.		N/A
8.2.1	Protection of service persons		P
	Protection shall be provided such that unintentional contact with hazardous moving parts is unlikely during servicing operations. If a guard over a hazardous moving part may need to be removed for servicing, the marking of symbol 15 of Table D-1 shall be applied on or near the guard.	Barrier and the marking of symbol 15 of Table C.1 is provided for service persons.	P
8.3	Stability		N/A
	Equipment and assemblies of equipment not secured to the building structure before operation shall be physically stable in NORMAL USE.	The PCE is wall mounted equipment.	N/A
8.4	Provisions for lifting and carrying		P
	If carrying handles or grips are fitted to, or supplied with, the equipment, they shall be capable of withstanding a force of four times the weight of the equipment.		P
	Equipment or parts having a mass of 18 kg or more		P

	shall be provided with a means for lifting and carrying or directions shall be given in the manufacturer's documentation.		
8.5	Wall mounting		P
	Mounting brackets on equipment intended to be mounted on a wall or ceiling shall withstand a force of four times the weight of the equipment.	Mounting brackets and wall construction for installation condition are specified in installation manual. Mounting brackets withstand a force of four times the weight of the equipment.	P
8.6	Expelled parts		N/A
	Equipment shall contain or limit the energy of parts that could cause a HAZARD if expelled in the event of a fault.	No such parts.	N/A

9	**PROTECTION AGAINST FIRE HAZARDS**		**P**
9.1	Resistance to fire		P
	This subclause specifies requirements intended to reduce the risk of ignition and the spread of flame, both within the equipment and to the outside, by the appropriate use of materials and components and by suitable construction.	Suitable and appropriate materials, components and construction are used to reduce the risk of ignition and the spread of flame.	P
9.1.1	Reducing the risk of ignition and spread of flame		P
	For equipment or a portion of equipment, there are two alternative methods of providing protection against ignition and spread of flame that could affect materials, wiring, wound components and electronic components such as integrated circuits, transistors, thyristors, diodes, resistors and capacitors.		P
9.1.2	Conditions for a fire enclosure		P
	A FIRE ENCLOSURE is required for equipment or parts of equipment for which Method 2 is not fully applied and complied with.	A FIRE ENCLOSURE is required for equipment or parts of equipment.	P
9.1.2.1	Parts requiring a fire enclosure		P
	Except where Method 2 is used, or as permitted in 9.1.2.2, the following are considered to have a risk of ignition and, therefore, require a FIRE ENCLOSURE:		P
	– components in PRIMARY CIRCUITS		P
	– components in SECONDARY CIRCUITS supplied by power sources which exceed the limits for a LIMITED POWER SOURCE as specified in 9.2;		P
	– components in SECONDARY CIRCUITS supplied by a LIMITED POWER SOURCE as specified in 9.2, but not mounted on a material		P

	of FLAMMABILITY CLASS V-1;		
	– components within a power supply unit or assembly having a limited power output complying with the criteria for a LIMITED POWER SOURCE as specified in 9.2, including overcurrent protective devices, limiting impedances, regulating networks and wiring, up to the point where the LIMITED POWER SOURCE output criteria are met;		P
	– components having unenclosed arcing parts, such as open switch and relay contacts and commutators, in a circuit at HAZARDOUS VOLTAGE or at a HAZARDOUS ENERGY LEVEL; and		P
	– insulated wiring, except as permitted in 9.1.2.2.		P
9.1.2.2	Parts not requiring a fire enclosure	See above.	P
9.1.3	Materials requirements for protection against fire hazard		P
9.1.3.1	General		P
	ENCLOSURES, components and other parts shall be so constructed, or shall make use of such materials, that the propagation of fire is limited.	Metal enclosure provided.	P
9.1.3.2	Materials for fire enclosures		P
	If an enclosure material is not classified as specified below, a test may be performed on the final enclosure or part of the enclosure, in which case the material shall additionally be subjected to periodic SAMPLE testing.	Metal enclosure provided.	P
9.1.3.3	Materials for components and other parts outside fire enclosures		P
	Except as otherwise noted below, materials for components and other parts (including MECHANICAL ENCLOSURES, ELECTRICAL ENCLOSURES and DECORATIVE PARTS); located outside FIRE ENCLOSURES, shall be of FLAMMABILITY CLASS HB.	FLAMMABILITY CLASS HB or better used.	P
9.1.3.4	Materials for components and other parts inside fire enclosures	FLAMMABILITY CLASS V- 2 or better used.	P
9.1.3.5	Materials for air filter assemblies	No such materials.	N/A
9.1.4	Openings in fire enclosures		N/A
9.1.4.1	General	No openings in fire enclosures.	N/A
	For equipment that is intended to be used or installed in more than one orientation as specified in the product documentation, the following requirements apply in each orientation.		N/A
	These requirements are in addition to those in the		N/A

	following sections:		
	– 7.3.4, Protection against direct contact;		N/A
	– 7.4, Protection against energy hazards;		N/A
	– 13.5, Openings in enclosures		N/A
9.1.4.2	Side openings treated as bottom openings	See above.	N/A
9.1.4.3	Openings in the bottom of a fire enclosure	See above.	N/A
	The bottom of a FIRE ENCLOSURE or individual barriers, shall provide protection against emission of flaming or molten material under all internal parts, including partially enclosed components or assemblies, for which Method 2 of 9.1.1 has not been fully applied and complied with.		N/A
9.1.4.4	Equipment for use in a CLOSED ELECTRICAL OPERATING AREA		N/A
	The requirements of 9.1.4.3 do not apply to FIXED EQUIPMENT intended only for use in a CLOSED ELECTRICAL OPERATING AREA and to be mounted on a concrete floor or other non-combustible surface. Such equipment shall be marked as follows:		N/A
	WARNING: FIRE HAZARD SUITABLE FOR MOUNTING ON CONCRETE OR OTHER NON-COMBUSTIBLE SURFACE ONLY		N/A
9.1.4.5	Doors or covers in fire enclosures		N/A
9.1.4.6	Additional requirements for openings in transportable equipment	PCE not for transportable equipment.	N/A
9.2	LIMITED POWER SOURCES	Not applied.	N/A
9.2.1	General		N/A
9.2.2	Limited power source tests		N/A
9.3	Short-circuit and overcurrent protection		P
9.3.1	General		P
	The PCE shall not present a hazard, under short-circuit or overcurrent conditions at any port, including phase-to-phase, phase-to-earth and phase-to-neutral, and adequate information shall be provided to allow proper selection of external wiring and external protective devices.	No overcurrent hazards was presented by short circuits and overloads tests. Refer to sub-clause 4.4.4.	P
9.3.2	Number and location of overcurrent protective devices		P
	Protection against short-circuits and overcurrents shall be provided for all input circuits, and for output circuits that do not comply with the requirements for limited power sources in 9.2, except for circuits in which no overcurrent hazard is presented by short-circuits and overloads.		P

9.3.3	Short-circuit co-ordination (backup protection)		P
	Protective devices provided or specified shall have adequate breaking capacity to interrupt the maximum short circuit current specified for the port to which they are connected. If protection that is provided integral to the PCE for an input port is not rated for the short-circuit current of the circuit in which it is used, the installation instructions shall specify that an upstream protective device, rated for the prospective short-circuit current of that port, shall be used to provide backup protection.	Upstream protective device for backup protection is specified in the installation manual.	P

10	**PROTECTION AGAINST SONIC PRESSURE HAZARDS**		**P**
10.1	General		P
	The equipment shall provide protection against the effect of sonic pressure. Conformity tests are carried out if the equipment is likely to cause such HAZARDS.		P
10.2	Sonic pressure and Sound level		P
10.2.1	Hazardous Noise Levels	Sound pressure level is lower than 80dB.	P

11	**PROTECTION AGAINST LIQUID HAZARDS**		**N/A**
11.1	Liquid Containment, Pressure and Leakage	No liquid contained in this system, and energy staorage battery used.	N/A
	The liquid containment system components shall be compatible with the liquid to be used.		N/A
	There shall be no leakage of liquid onto live parts as a result of:		N/A
	a) Normal operation, including condensation;		N/A
	b) Servicing of the equipment; or		N/A
	c) Inadvertent loosening or detachment of hoses or other cooling system parts over time.		N/A
11.2	Fluid pressure and leakage		N/A
11.2.1	Maximum pressure		N/A
11.2.2	Leakage from parts		N/A
11.2.3	Overpressure safety device		N/A
11.3	Oil and grease		N/A

12	**CHEMICAL HAZARDS**		N/A
12.1	General	No chemical Hazards.	N/A

13	PHYSICAL REQUIREMENTS		P
13.1	Handles and manual controls	It shall not be possible to fix them in wrong position if this might result in a hazard.	N/A
	Handles, knobs, grips, levers and the like shall be reliably fixed so that they will not work loose in normal use, if this might result in a hazard. Sealing compounds and the like, other than selfhardening resins, shall not be used to prevent loosening. If handles, knobs and the like are used to indicate the position of switches or similar components, it shall not be possible to fix them in a wrong position if this might result in hazard.		N/A
13.1.1	Adjustable controls	No such controls.	N/A
13.2	Securing of parts	Screws, nuts, washers, springs or similar parts are secured so as to withstand mechanical stresses occurring	P
13.3	Provisions for external connections		P
13.3.1	General	Appropriate provisons for external connections applied.	P
13.3.2	Connection to an a.c. Mains supply		P
13.3.2.1	General	Terminals provided for permanent connection to the PV supply.	P
	For safe and reliable connection to a MAINS supply, equipment shall be provided with one of the following:		P
	– terminals or leads or a non-detachable power supply cord for permanent connection to the supply; or		P
	– a non-detachable power supply cord for connection to the supply by means of a plug		N/A
	– an appliance inlet for connection of a detachable power supply cord; or		N/A
	– a mains plug that is part of direct plug-in equipment as in 13.3.8		N/A
13.3.2.2	Permanently connected equipment	A set of terminals as specified in 13.3.3 for external connection of supply cords.	P
13.3.2.3	Appliance inlets		N/A
13.3.2.4	Power supply cord	Not provided, but technical requirements provided in user manual.	N/A
13.3.2.5	Cord anchorages and strain relief	No power supply cords	N/A

		provided.	
	For equipment with a non-detachable power supply cord, a cord anchorage shall be supplied such that:		N/A
	– the connecting points of the cord conductors are relieved from strain; and		N/A
	– the outer covering of the cord is protected from abrasion.		N/A
13.3.2.6	Protection against mechanical damage	No power supply cords provided, however plastic inlet bushings provided ready for use.	N/A
13.3.3	Wiring terminals for connection of external conductors		P
13.3.3.1	Wiring terminals	Terminals for power supply cords connection by means of screws.	P
13.3.3.2	Screw terminals	Screws and nuts which clamp external supply conductors have a thread conforming to ISO 261 or ISO 262.	P
13.3.3.3	Wiring terminal sizes	The terminals meet the temperature rise test of 4.3 when connected using wire sizes as specified in the documentation or in Table 24.	P
13.3.3.4	Wiring terminal design	Lug terminals applied, and the cable lug clamped by nut.	P
13.3.3.5	Grouping of wiring terminals	Terminals located in proximity to each other.	P
13.3.3.6	Stranded wire	Lug terminals applied.	P
13.3.4	Supply wiring space	Lug terminals applied, and the cable lug is clamped by nut without the risk of damage to the conductors or their insulation.	P
13.3.5	Wire bending space for wires 10 mm² and greater	Considered.	P
13.3.6	Disconnection from supply sources	Disconnect devices provided.	P
13.3.7	Connectors, plugs and sockets	The misconnection is unlikely for PV or DC connectors.	P
13.3.8	Direct plug-in equipment	Not direct plug-in use.	N/A
13.4	Internal wiring and connections		P
13.4.1	General	The insulation, conductors and routing of all wires of the equipment is suitable for the electrical, mechanical, thermal and environmental conditions of use.	P

13.4.2	Routing	Wires are routed away from sharp edges, screw threads, burrs, fins, moving parts, drawers, and similar parts, which could abrade the wire insulation.	P
13.4.3	Colour coding	The green/yellow color coding wire only used for protective earthing conductor.	P
13.4.4	Splices and connections	All splices and connections are mechanically adequate secure and provided electrical continuity. The likelihood of loose is impossible.	P
13.4.5	Interconnections between parts of the PCE	The communication cable only used for servicing, no any physical damage or mechanical damage likely.	P
13.5	Openings in enclosures	Not opening in metal enclosure.	N/A
13.5.1	Top and side openings		N/A
	Openings in the top and sides of ENCLOSURES shall be so located or constructed that it is unlikely that objects will enter the openings and create hazards by contacting bare conductive parts.		N/A
13.6	Polymeric Materials		P
13.6.1	General	See below.	P
13.6.1.1	Thermal index or capability	Appropriate electrical, mechanical, thermal and flammability degree polymeric materials provided.	P
13.6.2	Polymers serving as enclosures or barriers preventing access to hazards	Metal enclosure used.	N/A
13.6.2.1	Stress relief test	See above.	N/A
13.6.3	Polymers serving as solid insulation	See below.	P
13.6.3.1	Resistance to arcing		P
13.6.4	UV resistance	Metal enclosure provided.	N/A
	Polymeric parts of an OUTDOOR ENCLOSURE required for compliance with this standard shall be sufficiently resistance to degradation by ultra-violet (UV) radiation		N/A
13.7	Mechanical resistance to deflection, impact, or drop		P
13.7.1	General	See below.	P
13.7.2	250-N deflection test for metal enclosures	A steady force of 250 N applied for 5 s, after test no hazards occurred.	P

13.7.3	7-J impact test for polymeric enclosures	Impact test applied on the display screen cover.	P
13.7.4	Drop test	Not for hand - held, direct plug - in, or transportable equipment.	N/A
13.8	Thickness requirements for metal enclosures		P
13.8.1	General		P
13.8.2	Cast metal		P
13.8.3	Sheet metal		P

14	**COMPONENTS**		**P**
14.1	General	Components that are certified to IEC and /or national standards are used correctly within their ratings. Components not covered by IEC standards are tested under the conditions present in the equipment. See appended table 14.1.	P
	Where safety is involved, components shall be used in accordance with their specified RATINGS unless a specific exception is made. They shall conform to one of the following:		P
	a) applicable safety requirements of a relevant IEC standard. Conformity with other requirements of the component standard is not required. If necessary for the application, components shall be subjected to the test of this standard, except that it is not necessary to carry out identical or equivalent tests already performed to check conformity with the component standard;		P
	b) the requirements of this standard and, where necessary for the application, any additional applicable safety requirements of the relevant IEC component standard;		P
	c) if there is no relevant IEC standard, the requirements of this standard;		P
	d) applicable safety requirements of a non-IEC standard which are at least as high as those of the applicable IEC standard, provided that the component has been approved to the non-IEC standard by a recognized testing authority.		P
	Components such as optocouplers, capacitors, transformers, and relays connected across basic, supplemental, reinforced, or double insulation shall comply with the requirements applicable for the grade of insulation being bridged, and if not previously certified to the applicable component safety		P

	standard shall be subjected to the voltage test of 7.5.2 as routine test.		
14.2	Motor Overtemperature Protection		N/A
	Motors which, when stopped or prevented from starting (see 4.4.4.3), would present an electric shock HAZARD, a temperatur HAZARD, or a fire HAZARD, shall be protected by an overtemperature or thermal protection device meeting the require-ments of 14.3.		N/A
14.3	Overtemperature protection devices	Approved overtemperature protective devices used and for which appropriate rating was selected for use and do not operate in normal use. For overtemperature protection test or evaluation see appended table 4.4.4.	P
14.4	Fuse holders	Fuse holders with fuses are not intended to be replaceable by an OPERATOR.	P
14.5	MAINS voltage selecting devices	No such devices.	N/A
14.6	Printed circuit boards		P
	Printed circuit boards shall be made of material with a flammability classification of V-1 of IEC 60707 or better.	PCB materials with a flammability classification of V-0 or better used.	P
	This requirements does not apply to thin-film flexi-ble printed circuit boards that contain only circuits powered from limited power sources meeting the requirements of 9.2.		P
	Conformity of the flammability RATING is checked by inspection of data on the materials. Alternatively, conformity is checked by performing the V-1 tests specified in IEC 60707 on three samples of the rel-evant parts.		P
14.7	Circuits or components used as transient overvolt-age limiting devices		N/A
	If control of transient overvoltage is employed in the equipment, any overvoltage limiting component or circuit shall be tested with the applicable impulse withstand voltage of Table 7-10 using the test method from 7.5.1 except 10 positive and 10 nega-tive impulses are to be applied and may be spaced up to 1 min apart.	No such components.	N/A
14.8	Batteries		N/A
	Equipment containing batteries shall be designed to reduce the risk of fire, explosion and chemical leaks under normal conditions and after a single fault in the equipment including a fault in circuitry within the	Not batteries contained.	N/A

	equipment battery pack.		
14.8.1	Battery Enclosure Ventilation		N/A
14.8.1.1	Ventilation requirements		N/A
14.8.1.2	Ventilation testing		N/A
14.8.1.3	Ventilation instructions		N/A
14.8.2	Battery Mounting		N/A
	Compliance is verified by the application of the force to the battery's mounting surface. The test force is to be increased gradually so as to reach the required value in 5 to 10 s, and is to be maintained at that value for 1 min. A nonmetallic rack or tray shall be tested at the highest normal condition operating temperature.		N/A
14.8.3	Electrolyte spillage		N/A
	Battery trays and cabinets shall have an electrolyte-resistant coating.		N/A
	The ENCLOSURE or compartment housing a VENTED BATTERY shall be constructed so that spillage or leakage of the electrolyte from one battery will be contained within the ENCLOSURE and be prevented from:		N/A
	a) reaching the PCE outer surfaces that can be contacted by the USER		N/A
	b) contaminating adjacent electrical components or materials; and		N/A
	c) bridging required electrical distances		N/A
14.8.4	Battery Connections		N/A
	Reverse battery connection of the terminals shall be prevented if reverse connection could result in a hazard within the meaning of this Standard		N/A
14.8.5	Battery maintenance instructions		N/A
	The information and instructions listed in 5.3.4.1 shall be included in the operator manual for equipment in which battery maintenance is performed by the operator, or in the service manual if battery maintenance is to be performed by service personnel only.		N/A
14.8.6	Battery accessibility and maintainability		N/A
	Battery terminals and connectors shall be accessible for maintenance with the correct TOOLS. Batteries with liquid electrolyte, requiring maintained shall be so located that the battery cell caps are accessible for electrolyte tests and readjusting of electrolyte levels.		N/A

15	**SOFTWARE AND FIRMWARE PERFORMING SAFETY FUNCTIONS**		**P**
	Firmware or software used in or with PCE, that performs one or more safety functions the failure of which could result in a risk of fire, electric shock or other hazard as specified by this standard, shall be evaluated in accordance with Annex B.	Single fault safe compliance. Failures evaluation and risk analysis were performed by means of fault simulation or single fault conditions. (refer to subclause of 4.4.4).	P

A	Annex A, Measurement of clearance and creepage distances (normative)	P

B	Annex B, Programmable Equipment (normative)		N/A
B.1	Software or Firmware That Perform Safety Critical Functions	Refer to subclause 15.	N/A
B.1.1	All software or firmware that performs a critical safety function/s, such as protection from excessive temperature, over current or improper synchronization of AC source, where failure of which can result in a risk of fire, electric shock or other hazard as specified by this document, shall be evaluated by one of the following means. a) All software or firmware limit or control shall be disabled before the test to evaluate the hardware circuitry during the abnormal test condition of the safety function, and the hardware sensor component that is monitored by the firmware or software is modified or disabled to prevent the software or firmware from reading or responding to the abnormal condition. b) Protection Controls employing software or firmware to perform their function(s), shall be so constructed that they comply with IEC 60730-1 Annex H to address the risks identified in B2.1. Each combination of microprocessor model, manufacturer and firmware/software version used in the production of a PCE shall be evaluated as specified in the remainder of Annex B. Exception: For units with firmware/software that has been found to be compliant with the remainder of Annex B, subsequent firmware/software revisions may be entitled to a limited revaluation for the revised firmware or software. The scope of the re-evaluation shall be defined by the potential impact of the firmware or software revisions and the applicable portions of IEC 60730-1 Annex H shall be re-applied.		N/A
B.2	Evaluation of Controls Employing Software	Refer to subclause 15.	N/A
B.2.1	Risk Analysis		N/A
B.2.1.1	A risk analysis shall be conducted to determine a set of risks and that the software addresses the		N/A

	identified risks. The risk analysis shall be conducted based on the safety requirements for the programmable component.		
B.2.1.3	An analysis shall be conducted to identify the critical, non-critical, and supervisory parts of the software.		N/A
B.2.1.4	An analysis shall be conducted to identify transitions or states that can result in a risk.		N/A
B.2.1.5	Risks to be considered include, but are not limited to function associated with the following: a) Temperature control, monitoring and response (ie. Coolant, internal ambient, device) b) Safety interlocks c) Synchronization between multiple AC sources e) Emergency stop of operation (including staged shutdown/sequencing) f) Connection/Disconnection – from an input source and output source g) RCD functions h) Over current protection or control i) The software must detect a hardware or software malfunction and place the device in a safe state as indicated per the “Risks Addressed State” definition.		N/A

C.	Annex C, Symbols to be used in Equipment Marking (normative)	P

D.	Annex D, Test Probes for Determining Access (informative)	P

E.	Annex E, RCDs (informative)		N/A
E.1	Selection of RCD type in AC circuits		N/A

F.	Annex F, Altitude correction for clearances (informative)	P

G.	Annex G, Clearance and creepage distance determination for frequencies greater than 30kHz		N/A
G.1	Clearance		N/A
G.2	Creepage distance		N/A

H.	Annex H, Measuring Instrument for Touch Current Measurements		P
H.1	Measuring instrument	Considered.	P
H.2	Alternative measuring instrument	Not used.	N/A

I.	Annex I, Examples of Protection, Insulation, and Overvoltage Category Requirements for PCE	P

I.1	Protection, Insulation and Overvoltage	Considered.	P
I.2	Illustrative examples	Consided.	P

J.	Annex J, Instruction of the ultraviolet light conditioning test		P
J.1	General requirement	Considered	P
J.2	Requirement of mounting of the samples		N/A
J.3	Instruction of the Carbon-arc light-exposure apparatus		N/A
J.4	Instruction of the Xenon-arc light-exposure apparatus		N/A

4.3	TABLE: heating temperature rise measurements		P
	test voltage (V) ..... :	See note 1	—
	t1 (°C)..... :	See note 1	—
	t2 (°C) ..... :	--	—

temperature measured T of part/at:	T (°C)			permitted T_{max} (°C)
	(1)	(2)	(3)	
DAB high voltage side terminal CN227	59.57	59.25	58.33	105
DAB high voltage side terminal CN229	59.59	59.25	58.19	105
DC blocking capacitor C211	58.93	58.72	57.61	105
DC blocking capacitor C241	59.59	59.37	58.19	105
BAT electrolytic capacitor C200	55.08	54.84	56.78	105
BAT electrolytic capacitor C230	53.94	53.74	53.37	105
DAB aluminum substrate terminal CN202	55.57	53.36	53.11	105
DAB aluminum substrate terminal CN213	50.94	50.92	50.35	105
DAB primary side driver chip U400	54.27	53.95	54.03	125
DAB primary side driver chip U404	54.82	54.50	53.99	125
SPS transformer TX300	58.27	57.92	57.48	130
SPS transformer TX500	60.01	59.74	59.45	130
SPS switch tube Q302	56.57	56.23	55.81	110
SPS switch tube Q502	57.70	60.59	60.81	110
SPS diode D510	60.80	60.52	60.03	110
SPS diode D516	64.66	64.49	63.94	110
SPS isolated optocoupler U501	58.82	58.54	57.91	105
SPS isolated optocoupler U502	58.67	58.36	57.74	105
LDO 7V to 5V U505	63.28	63.06	62.16	110
7742 isolation chip U908	58.24	58.05	57.66	105
7743 isolation chip U912	56.36	56.15	55.61	105
7744 isolation chip U913	56.59	56.33	55.76	105
DAB driver board T100	63.05	62.58	62.28	130
DAB driver board U101	63.98	63.57	63.01	105
DAB driver board D107	61.82	61.73	61.48	110
PV terminal block CN109	65.60	66.52	56.31	105
ISO relay RY100	58.17	58.13	55.43	105
PV input x capacitance C113	59.01	59.06	55.89	85
PV input x capacitance C115	57.36	57.17	56.02	85
PV input common mode inductance L101	90.85	91.03	90.12	130

PV side input Y capacitance CY101	60.57	60.69	56.11	85
PV side current transformer HCT101	60.31	60.29	56.99	110
PV side current transformer HCT100	59.79	59.81	57.08	110
Sampling resistance R169	65.33	65.85	61.77	110
PV boost inductance terminal block CN101	62.05	62.47	57.10	105
PV boost inductance terminal block CN105	64.17	64.48	58.25	105
PV Drive Optocoupler U905	68.64	69.24	62.22	105
PV Drive Optocoupler U907	71.27	71.34	65.77	105
ARM board U103 Body	63.04	62.75	61.71	105
ARM board TX300	72.67	72.05	72.35	130
Sub DSP board U2 Body	60.56	60.25	59.82	105
Sub DSP board U1	58.59	58.27	57.81	105
BUS electrolytic capacitor C605	70.69	68.68	70.12	105
BUS electrolytic capacitor C607	67.55	65.26	67.28	105
Main DSP board U100	63.13	62.86	61.56	105
Main DSP board U103 Body	65.20	64.57	64.29	105
PV boost IGBT Q101	57.91	57.18	57.05	110
PV boost IGBT D102	87.40	87.84	71.17	110
INV power tube Q600	70.06	67.16	71.64	110
INV power tube Q602	72.05	69.02	73.08	110
DAB high-side power tube Q202	58.91	58.17	57.51	110
DAB high-side power tube Q205	75.95	78.32	63.10	110
DAB high-side power tube Q201	53.25	53.38	51.43	110
Grid terminal block CN700	69.87	69.20	71.41	105
Back-up terminal block CN605	69.99	70.59	71.77	105
Grid Varistors TVR801	64.10	63.66	64.80	85
Back-up output capacitor C646	65.49	66.16	66.87	85
Grid output capacitor C709	68.44	68.01	70.43	85
Output common mode inductance L700	84.37	84.20	88.90	130
Output common mode inductance L601	80.99	80.71	81.67	130
INV HfpowerTX900	61.45	61.22	61.82	130
RELAY RY601	80.36	79.49	80.64	105
RELAY RY700	87.80	90.89	89.71	105
RELAY RY701	82.62	81.67	83.53	105
RELAY RY702	61.03	60.61	60.61	105
INV inductor terminal block CN609	87.60	89.18	89.50	105

GFCI module HCT601	79.64	77.33	81.14	105
INV current transformer HCT600	77.96	75.39	79.49	105
AC SPS TX100	61.98	61.39	62.13	130
AC SPS U102	58.93	58.47	58.83	105
AC SPS C103	61.26	60.59	61.56	105
LN snubber resistor R629	83.19	81.07	86.11	110
INV driver chip U900	73.61	70.49	75.31	105
LoadCurrent Transformer HCT602	63.59	63.40	62.74	105
Aluminum substrate power tube Q100	49.32	49.19	48.94	110
Aluminum substrate power tube Q101	49.32	49.25	49.00	110
Fan	56.33	55.96	55.62	90
PV wire	58.89	58.56	55.03	105
Grid wire	59.30	58.64	59.27	105
INV wire	68.05	65.98	68.36	105
Internal ambient temperature	51.90	52.08	53.42	NA
BAT copper bar	51.84	51.56	51.29	105
Inverter inductor core	65.41	61.88	68.23	120
Inverter inductor coil	86.12	77.61	92.39	130
PV inductor core	69.83	71.86	57.03	120
PV inductor coil	73.89	75.96	57.69	130
DAB1 Transformer core	47.41	47.40	47.29	105
DAB1 Transformer coil	51.81	51.80	51.08	130
DAB1 inductor core	47.10	47.09	47.02	105
DAB1 inductor coil	46.63	46.64	46.60	130
DAB2 Transformer core	48.91	48.94	48.93	105
DAB2 Transformer coil	46.58	46.61	46.42	130
DAB2 inductor core	54.68	54.43	52.93	105
DAB2 inductor coil	47.65	47.62	47.48	130
BAT terminal block	47.82	47.65	47.49	75
PV terminal block	46.54	46.29	45.82	75
DC SWITCH	45.98	45.52	45.72	75
Back-up terminal block	46.69	46.45	46.28	75
Grid terminal block	45.88	45.65	45.81	75
left side of box	47.75	47.58	47.49	70
right side of box	50.76	50.19	50.59	70
rear side of box	53.34	53.30	51.00	70

front of box	49.90	49.63	49.56	70
DAB transformer (closer to the inside)	48.15	48.05	47.53	90
Heat sink (middle of the box)	52.97	52.86	52.28	90

Supplementary information:

Note 1:

Test condition 1 PV to Grid: Run the device at 45°C ambient until steady condition established; test voltage: 220V d.c.; 207Vac~, 6000W, 50Hz.

Test condition 2 PV to Grid: Run the device at 45°C ambient until steady condition established; test voltage: 220V d.c.; 253Vac~, 6000W, 50Hz.

Test condition 3 PV to Grid: Run the device at 45°C ambient until steady condition established; test voltage: 500V d.c.; 207Vac~, 6000W, 50Hz.

4.3	**TABLE: heating temperature rise measurements**		P
	test voltage (V) ..... :	See note 1	—
	t1 (°C)..... :	See note 1	—
	t2 (°C) ..... :	--	—

temperature measured T of part/at:	T (°C)			permitted T_{max} (°C)
	(4)	(5)	(6)	
DAB high voltage side terminal CN227	72.42	84.04	79.42	105
DAB high voltage side terminal CN229	65.36	70.30	70.09	105
DC blocking capacitor C211	68.20	72.01	73.37	105
DC blocking capacitor C241	71.53	72.35	72.57	105
BAT electrolytic capacitor C200	92.89	97.05	88.76	105
BAT electrolytic capacitor C230	82.35	91.40	89.20	105
DAB aluminum substrate terminal CN202	61.97	75.84	76.12	105
DAB aluminum substrate terminal CN213	80.82	82.97	82.96	105
DAB primary side driver chip U400	89.14	90.11	90.02	125
DAB primary side driver chip U404	84.18	85.14	86.61	125
SPS transformer TX300	60.75	75.13	73.11	130
SPS transformer TX500	88.45	88.50	88.33	130
SPS switch tube Q302	80.75	82.06	89.08	110
SPS switch tube Q502	79.31	89.93	86.57	110
SPS diode D510	62.02	76.99	75.96	110
SPS diode D516	58.68	74.18	73.49	110
SPS isolated optocoupler U501	61.14	76.21	75.67	105
SPS isolated optocoupler U502	86.46	86.69	87.27	105
LDO 7V to 5V U505	71.82	86.22	88.47	110

7742 isolation chip U908	62.99	78.02	77.38	105
7743 isolation chip U912	48.71	64.42	73.65	105
7744 isolation chip U913	48.77	64.76	74.09	105
DAB driver board T100	55.15	71.19	73.08	130
DAB driver board U101	54.84	74.18	76.11	105
DAB driver board D107	59.11	73.37	71.20	110
PV terminal block CN109	66.74	81.19	81.78	105
ISO relay RY100	53.38	69.97	74.69	105
PV input x capacitance C113	50.97	66.64	73.23	85
PV input x capacitance C115	63.54	77.78	81.84	85
PV input common mode inductance L101	82.04	93.94	102.89	130
PV side input Y capacitance CY101	56.84	88.12	78.24	85
PV side current transformer HCT101	56.68	95.63	79.69	110
PV side current transformer HCT100	47.12	62.95	73.71	110
Sampling resistance R169	51.55	68.89	73.07	110
PV boost inductance terminal block CN101	46.86	62.63	71.28	105
PV boost inductance terminal block CN105	46.46	62.22	74.56	105
PV Drive Optocoupler U905	48.57	65.34	78.29	105
PV Drive Optocoupler U907	46.26	62.24	72.47	105
ARM board U103 Body	52.52	69.69	70.55	105
ARM board TX300	47.30	63.14	81.58	130
Sub DSP board U2 Body	38.03	60.66	61.95	105
Sub DSP board U1	37.19	59.52	60.67	105
BUS electrolytic capacitor C605	47.30	53.14	54.11	105
BUS electrolytic capacitor C607	45.68	51.54	51.44	105
Main DSP board U100	45.56	51.85	51.51	105
Main DSP board U103 Body	46.07	51.58	51.32	105
PV boost IGBT Q101	45.64	50.73	50.70	110
PV boost IGBT D102	47.32	52.68	55.33	110
INV power tube Q600	49.75	50.49	55.75	110
INV power tube Q602	50.35	51.58	53.13	110
DAB high-side power tube Q202	49.28	49.66	50.38	110
DAB high-side power tube Q205	47.33	63.22	70.89	110
DAB high-side power tube Q201	52.06	67.89	74.44	110
Grid terminal block CN700	72.42	84.04	79.42	105
Back-up terminal block CN605	65.36	70.30	70.09	105

Grid Varistors TVR801	68.20	72.01	73.37	85
Back-up output capacitor C646	71.53	72.35	72.57	85
Grid output capacitor C709	92.89	97.05	88.76	85
Output common mode inductance L700	82.35	91.40	89.20	130
Output common mode inductance L601	61.97	75.84	76.12	130
INV HfpowerTX900	80.82	82.97	82.96	130
RELAY RY601	89.14	90.11	90.02	105
RELAY RY700	84.18	85.14	86.61	105
RELAY RY701	60.75	75.13	73.11	105
RELAY RY702	88.45	88.50	88.33	105
INV inductor terminal block CN609	80.75	82.06	89.08	105
GFCI module HCT601	79.31	89.93	86.57	105
INV current transformer HCT600	62.02	76.99	75.96	105
AC SPS TX100	58.68	74.18	73.49	130
AC SPS U102	61.14	76.21	75.67	105
AC SPS C103	86.46	86.69	87.27	105
LN snubber resistor R629	71.82	86.22	88.47	110
INV driver chip U900	62.99	78.02	77.38	105
LoadCurrent Transformer HCT602	48.71	64.42	73.65	105
Aluminum substrate power tube Q100	48.77	64.76	74.09	110
Aluminum substrate power tube Q101	55.15	71.19	73.08	110
Fan	54.84	74.18	76.11	90
PV wire	59.11	73.37	71.20	105
Grid wire	66.74	81.19	81.78	105
INV wire	53.38	69.97	74.69	105
Internal ambient temperature	50.97	66.64	73.23	NA
BAT copper bar	63.54	77.78	81.84	105
Inverter inductor core	82.04	93.94	102.89	120
Inverter inductor coil	56.84	88.12	78.24	130
PV inductor core	56.68	95.63	79.69	120
PV inductor coil	47.12	62.95	73.71	130
DAB1 Transformer core	51.55	68.89	73.07	105
DAB1 Transformer coil	46.86	62.63	71.28	130
DAB1 inductor core	46.46	62.22	74.56	105
DAB1 inductor coil	48.57	65.34	78.29	130
DAB2 Transformer core	46.26	62.24	72.47	105

DAB2 Transformer coil	52.52	69.69	70.55	130
DAB2 inductor core	47.30	63.14	81.58	105
DAB2 inductor coil	38.03	60.66	61.95	130
BAT terminal block	45.68	51.54	51.44	75
PV terminal block	45.56	51.85	51.51	75
DC SWITCH	46.07	51.58	51.32	75
Back-up terminal block	45.64	50.73	50.70	75
Grid terminal block	47.32	52.68	55.33	75
left side of box	49.75	50.49	55.75	70
right side of box	50.35	51.58	53.13	70
rear side of box	49.28	49.66	50.38	70
front of box	47.33	63.22	70.89	70
DAB transformer (closer to the inside)	52.06	67.89	74.44	90
Heat sink (middle of the box)	72.42	84.04	79.42	90

Supplementary information:

Note 1:

Test condition 4 PV to Grid: Run the device at 45°C ambient until steady condition established; test voltage: 500V d.c., 253Vac~, 6000W, 50Hz.

Test condition 5 PV to Grid: Run the device at 60°C ambient until steady condition established; test voltage: 220V d.c., 253Vac~, 6000W, 50Hz.

Test condition 6 BAT+PV---Grid+Load: Run the device at 60°C ambient until steady condition established; test voltage: 50V d.c., (BAT), MPPT=220V; Grid=207V; power (Grid) =power (Load) =3000W.

4.3	**TABLE: heating temperature rise measurements**				P
	test voltage (V) ..... :	See note 1			—
	t1 (°C)..... :	See note 1			—
	t2 (°C) ..... :	--			—
temperature measured T of part/at:		T (°C)			permitted T_{max} (°C)
		(7)	(8)	(9)	
DAB high voltage side terminal CN227		86.79	85.37	71.36	105
DAB high voltage side terminal CN229		85.10	82.98	71.33	105
DC blocking capacitor C211		89.05	87.73	71.31	105
DC blocking capacitor C241		86.92	84.84	71.57	105
BAT electrolytic capacitor C200		87.20	87.93	68.04	105
BAT electrolytic capacitor C230		88.67	86.96	67.13	105
DAB aluminum substrate terminal CN202		87.24	86.70	66.34	105
DAB aluminum substrate terminal CN213		86.62	89.60	65.25	105

DAB primary side driver chip U400	92.54	91.39	65.38	125
DAB primary side driver chip U404	86.52	86.33	67.16	125
SPS transformer TX300	79.97	79.30	70.27	130
SPS transformer TX500	81.00	80.14	71.88	130
SPS switch tube Q302	81.62	81.26	68.78	110
SPS switch tube Q502	81.52	80.49	72.51	110
SPS diode D510	85.80	85.17	73.14	110
SPS diode D516	85.47	84.21	74.93	110
SPS isolated optocoupler U501	80.81	79.77	70.93	105
SPS isolated optocoupler U502	80.02	78.95	70.66	105
LDO 7V to 5V U505	86.62	85.12	75.94	110
7742 isolation chip U908	84.13	83.97	71.15	105
7743 isolation chip U912	82.50	82.44	69.51	105
7744 isolation chip U913	82.37	82.31	69.41	105
DAB driver board T100	81.71	80.07	73.09	130
DAB driver board U101	85.16	84.31	74.82	105
DAB driver board D107	85.00	80.91	73.32	110
PV terminal block CN109	85.14	77.31	81.08	105
ISO relay RY100	81.92	77.28	71.23	105
PV input x capacitance C113	68.35	68.21	72.39	85
PV input x capacitance C115	64.26	67.47	70.08	85
PV input common mode inductance L101	110.97	107.96	96.36	130
PV side input Y capacitance CY101	69.16	70.59	74.12	85
PV side current transformer HCT101	82.75	77.31	73.16	110
PV side current transformer HCT100	82.08	77.17	72.59	110
Sampling resistance R169	89.92	77.53	79.01	110
PV boost inductance terminal block CN101	85.58	76.64	75.87	105
PV boost inductance terminal block CN105	86.00	76.25	77.48	105
PV Drive Optocoupler U905	88.50	77.82	81.13	105
PV Drive Optocoupler U907	89.56	79.10	82.35	105
ARM board U103 Body	85.42	83.72	75.74	105
ARM board TX300	86.27	83.88	75.90	130
Sub DSP board U2 Body	81.75	81.21	73.05	105
Sub DSP board U1	80.00	79.38	71.05	105
BUS electrolytic capacitor C605	77.59	83.46	78.86	105
BUS electrolytic capacitor C607	74.09	81.69	77.44	105

Main DSP board U100	83.60	81.10	74.59	105
Main DSP board U103 Body	84.66	84.51	75.61	105
PV boost IGBT Q101	88.45	86.05	71.83	110
PV boost IGBT D102	86.12	73.92	86.82	110
INV power tube Q600	68.03	85.58	84.88	110
INV power tube Q602	70.05	86.37	86.35	110
DAB high-side power tube Q202	86.19	86.64	72.08	110
DAB high-side power tube Q205	88.82	73.60	86.91	110
DAB high-side power tube Q201	87.94	80.30	68.60	110
Grid terminal block CN700	72.20	71.22	67.93	105
Back-up terminal block CN605	73.65	67.21	63.99	105
Grid Varistors TVR801	71.61	70.75	67.36	85
Back-up output capacitor C646	70.56	71.40	71.66	85
Grid output capacitor C709	70.59	71.42	67.97	85
Output common mode inductance L700	72.76	71.69	68.13	130
Output common mode inductance L601	87.85	82.59	76.31	130
INV HfpowerTX900	72.20	75.74	72.79	130
RELAY RY601	89.80	87.52	81.67	105
RELAY RY700	75.47	74.42	70.12	105
RELAY RY701	77.72	75.67	71.30	105
RELAY RY702	73.11	71.43	68.30	105
INV inductor terminal block CN609	78.59	87.50	83.21	105
GFCI module HCT601	84.57	83.48	78.10	105
INV current transformer HCT600	75.97	79.42	75.33	105
AC SPS TX100	73.62	74.44	70.41	130
AC SPS U102	72.94	72.91	68.95	105
AC SPS C103	72.39	74.36	70.80	105
LN snubber resistor R629	77.47	86.56	89.87	110
INV driver chip U900	74.50	87.79	85.25	105
LoadCurrent Transformer HCT602	81.53	78.26	72.69	105
Aluminum substrate power tube Q100	88.41	88.06	63.49	110
Aluminum substrate power tube Q101	89.43	88.67	63.88	110
Fan	77.17	76.63	68.95	90
PV wire	83.38	77.11	73.06	105
Grid wire	70.79	70.29	67.09	105
INV wire	77.01	81.14	75.80	105

Internal ambient temperature	73.16	77.90	70.49	NA
BAT copper bar	75.70	89.43	65.27	105
Inverter inductor core	71.74	82.70	80.98	120
Inverter inductor coil	72.36	101.58	101.46	130
PV inductor core	89.79	76.96	88.32	120
PV inductor coil	90.41	75.28	95.74	130
DAB1 Transformer core	84.16	84.65	62.39	105
DAB1 Transformer coil	79.01	81.03	63.35	130
DAB1 inductor core	78.86	80.87	62.11	105
DAB1 inductor coil	85.51	88.88	61.80	130
DAB2 Transformer core	89.79	89.30	61.98	105
DAB2 Transformer coil	82.86	85.05	61.89	130
DAB2 inductor core	77.04	74.58	68.28	105
DAB2 inductor coil	90.69	106.60	62.56	130
BAT terminal block	58.24	61.57	62.61	75
PV terminal block	52.81	61.82	60.73	75
DC SWITCH	52.93	52.54	51.62	75
Back-up terminal block	51.77	62.08	61.26	75
Grid terminal block	50.53	60.66	60.19	75
left side of box	55.74	55.80	60.31	70
right side of box	55.61	55.68	60.19	70
rear side of box	54.42	57.25	58.39	70
front of box	55.04	56.87	53.50	70
DAB transformer (closer to the inside)	72.11	77.47	62.67	90
Heat sink (middle of the box)	73.47	76.69	62.79	90

Supplementary information:

Note 1:

Test condition 7 PV to BAT charge mode: Run the device at 60°C ambient until steady condition established; test voltage: BAT=50V； MPPT=220V.

Test condition 8 BAT to Backup mode: Run the device at 60°C ambient until steady condition established; test voltage: BAT=53V d.c., 253Vac~, 6000W, 50Hz.

Test condition 9 PV to Back-up: Run the device at 60°C ambient until steady condition established; test voltage: MPPT=220V d.c., 253Vac~, 6000W, 50Hz.

4.3	TABLE: heating temperature rise measurements		P
	test voltage (V) ..... :	See note 1	—
	t1 (°C)..... :	See note 1	—
	t2 (°C) ..... :	--	—

temperature measured T of part/at:	T (°C)			permitted T_{max} (°C)
	(10)	(11)	(12)	
DAB high voltage side terminal CN227	65.45	85.74	85.53	105
DAB high voltage side terminal CN229	65.29	84.09	83.86	105
DC blocking capacitor C211	65.91	86.65	86.45	105
DC blocking capacitor C241	65.83	85.19	85.00	105
BAT electrolytic capacitor C200	64.15	85.96	85.92	105
BAT electrolytic capacitor C230	63.68	89.22	89.18	105
DAB aluminum substrate terminal CN202	63.11	86.15	86.15	105
DAB aluminum substrate terminal CN213	62.66	89.60	89.41	105
DAB primary side driver chip U400	62.78	94.08	93.88	125
DAB primary side driver chip U404	66.80	85.17	84.98	125
SPS transformer TX300	65.68	80.95	80.84	130
SPS transformer TX500	67.09	81.95	81.81	130
SPS switch tube Q302	66.19	81.96	81.84	110
SPS switch tube Q502	66.32	84.01	83.53	110
SPS diode D510	69.09	85.41	85.11	110
SPS diode D516	72.11	86.96	86.82	110
SPS isolated optocoupler U501	65.73	81.07	80.95	105
SPS isolated optocoupler U502	65.33	80.49	80.34	105
LDO 7V to 5V U505	71.14	86.30	86.18	110
7742 isolation chip U908	67.10	83.41	83.31	105
7743 isolation chip U912	65.59	81.98	81.95	105
7744 isolation chip U913	65.44	81.87	81.80	105
DAB driver board T100	66.18	84.12	84.17	130
DAB driver board U101	68.64	86.81	87.83	105
DAB driver board D107	68.95	84.82	84.64	110
PV terminal block CN109	63.56	77.72	77.66	105
ISO relay RY100	63.66	78.12	78.02	105
PV input x capacitance C113	64.23	78.90	72.79	85
PV input x capacitance C115	64.51	78.49	72.41	85
PV input common mode inductance L101	90.32	98.12	73.41	130

PV side input Y capacitance CY101	63.69	77.46	74.41	85
PV side current transformer HCT101	64.07	78.44	78.36	110
PV side current transformer HCT100	64.26	78.27	78.16	110
Sampling resistance R169	64.34	78.47	78.36	110
PV boost inductance terminal block CN101	63.93	77.25	77.33	105
PV boost inductance terminal block CN105	63.54	77.39	77.30	105
PV Drive Optocoupler U905	65.36	79.10	79.00	105
PV Drive Optocoupler U907	65.71	82.47	82.34	105
ARM board U103 Body	69.99	85.00	84.91	105
ARM board TX300	70.13	85.34	85.08	130
Sub DSP board U2 Body	68.45	82.35	82.39	105
Sub DSP board U1	66.36	80.56	80.42	105
BUS electrolytic capacitor C605	65.68	90.12	92.14	105
BUS electrolytic capacitor C607	64.18	89.06	88.94	105
Main DSP board U100	67.98	83.27	83.21	105
Main DSP board U103 Body	68.30	87.67	87.55	105
PV boost IGBT Q101	64.99	84.82	85.80	110
PV boost IGBT D102	62.45	74.76	74.70	110
INV power tube Q600	62.50	88.84	88.88	110
INV power tube Q602	62.85	90.31	90.68	110
DAB high-side power tube Q202	65.06	83.58	84.62	110
DAB high-side power tube Q205	62.24	73.51	73.31	110
DAB high-side power tube Q201	63.21	82.15	81.69	110
Grid terminal block CN700	68.59	88.56	93.73	105
Back-up terminal block CN605	61.05	89.56	93.92	105
Grid Varistors TVR801	66.05	70.32	76.30	85
Back-up output capacitor C646	65.54	70.71	73.73	85
Grid output capacitor C709	66.76	73.34	75.44	85
Output common mode inductance L700	71.07	104.51	104.40	130
Output common mode inductance L601	65.76	94.61	95.09	130
INV HfpowerTX900	66.94	81.39	82.14	130
RELAY RY601	75.60	83.12	84.70	105
RELAY RY700	84.72	84.70	89.89	105
RELAY RY701	79.78	83.53	88.73	105
RELAY RY702	65.23	79.96	80.00	105
INV inductor terminal block CN609	74.31	83.39	83.85	105

GFCI module HCT601	70.13	84.61	88.80	105
INV current transformer HCT600	70.73	81.91	92.00	105
AC SPS TX100	67.48	82.98	83.09	130
AC SPS U102	65.80	79.50	80.38	105
AC SPS C103	67.31	82.06	82.24	105
LN snubber resistor R629	69.98	84.54	90.78	110
INV driver chip U900	68.55	85.96	89.54	105
LoadCurrent Transformer HCT602	67.23	82.82	82.79	105
Aluminum substrate power tube Q100	62.58	85.07	84.64	110
Aluminum substrate power tube Q101	63.10	85.45	85.41	110
Fan	65.45	77.79	77.67	90
PV wire	64.96	77.59	77.51	105
Grid wire	66.23	80.53	80.63	105
INV wire	66.68	90.01	90.08	105
Internal ambient temperature	59.34	81.01	81.03	NA
BAT copper bar	63.18	85.03	90.91	105
Inverter inductor core	64.90	87.87	89.65	120
Inverter inductor coil	68.39	105.06	99.35	130
PV inductor core	63.69	71.43	71.75	120
PV inductor coil	63.49	71.11	71.57	130
DAB1 Transformer core	63.18	80.09	79.74	105
DAB1 Transformer coil	63.50	80.25	79.90	130
DAB1 inductor core	62.20	74.25	73.92	105
DAB1 inductor coil	62.19	78.79	78.40	130
DAB2 Transformer core	62.31	78.95	78.55	105
DAB2 Transformer coil	61.84	76.55	76.33	130
DAB2 inductor core	63.72	74.89	74.79	105
DAB2 inductor coil	63.63	93.61	93.18	130
BAT terminal block	61.53	63.63	63.69	75
PV terminal block	59.61	62.05	62.03	75
DC SWITCH	50.67	52.87	52.73	75
Back-up terminal block	59.90	62.20	62.19	75
Grid terminal block	59.59	61.89	62.23	75
left side of box	59.71	57.15	57.97	70
right side of box	60.33	57.03	57.85	70
rear side of box	61.38	57.50	58.83	70

front of box	61.58	57.68	57.61	70
DAB transformer (closer to the inside)	61.23	75.82	75.66	90
Heat sink (middle of the box)	61.29	75.06	75.81	90

Supplementary information:

Note 1:

Test condition 10 Grid to Backup: Run the device at 60°C ambient until steady condition established; test voltage: Grid=207V, 6000W, 50Hz.

Test condition 11 Grid to BAT+Load mode: Run the device at 60°C ambient until steady condition established; test voltage: Grid=207V； BAT=50V； BAT=6000W, back-up=3000W.

Test condition 12 PV to Grid mode: Run the device at 45°C ambient until steady condition established; test voltage: MPPT=220V Grid= 253V 60Hz 6000W.

4.3	**TABLE: heating temperature rise measurements(In single fault condition)**		P
	test voltage (V) ..... :	See note 1	—
	t1 (°C)..... :	See note 1	—
	t2 (°C) ..... :	--	—

temperature measured T of part/at:	T (°C)			permitted T_{max} (°C)
	(13)	(14)	(15)	
DAB high voltage side terminal CN227	70.21	69.78	79.22	105
DAB high voltage side terminal CN229	70.23	69.91	78.81	105
DC blocking capacitor C211	71.72	71.39	79.04	105
DC blocking capacitor C241	71.01	70.91	79.36	105
BAT electrolytic capacitor C200	65.15	64.36	74.84	105
BAT electrolytic capacitor C230	64.49	64.78	73.41	105
DAB aluminum substrate terminal CN202	63.46	62.69	71.84	105
DAB aluminum substrate terminal CN213	63.72	63.09	69.72	105
DAB primary side driver chip U400	66.91	63.40	110.62	125
DAB primary side driver chip U404	65.59	64.90	73.75	125
SPS transformer TX300	70.28	69.28	78.38	130
SPS transformer TX500	80.68	80.03	80.30	130
SPS switch tube Q302	69.08	68.11	76.33	110
SPS switch tube Q502	85.39	84.85	88.73	110
SPS diode D510	83.96	83.56	80.73	110
SPS diode D516	89.13	88.58	84.51	110
SPS isolated optocoupler U501	76.05	76.25	78.99	105
SPS isolated optocoupler U502	76.99	76.72	78.80	105

LDO 7V to 5V U505	85.06	84.20	83.54	110
7742 isolation chip U908	71.64	71.17	77.79	105
7743 isolation chip U912	69.30	68.41	76.14	105
7744 isolation chip U913	69.56	68.71	76.09	105
DAB driver board T100	77.41	76.83	82.24	130
DAB driver board U101	76.31	75.73	83.33	105
DAB driver board D107	77.39	76.84	81.36	110
PV terminal block CN109	79.58	79.29	87.93	105
ISO relay RY100	73.07	72.41	78.56	105
PV input x capacitance C113	74.55	65.53	79.80	85
PV input x capacitance C115	74.89	65.86	78.09	85
PV input common mode inductance L101	92.93	91.65	113.55	130
PV side input Y capacitance CY101	74.44	66.37	81.10	85
PV side current transformer HCT101	80.63	79.48	80.45	110
PV side current transformer HCT100	77.36	76.93	80.01	110
Sampling resistance R169	84.40	83.57	85.95	110
PV boost inductance terminal block CN101	79.75	79.97	82.29	105
PV boost inductance terminal block CN105	83.69	82.76	83.96	105
PV Drive Optocoupler U905	84.59	84.24	87.57	105
PV Drive Optocoupler U907	89.20	88.54	89.76	105
ARM board U103 Body	86.13	85.35	83.98	105
ARM board TX300	81.82	85.52	97.40	130
Sub DSP board U2 Body	80.70	79.81	81.15	105
Sub DSP board U1	79.70	78.76	79.15	105
BUS electrolytic capacitor C605	84.44	83.74	88.54	105
BUS electrolytic capacitor C607	80.41	79.92	85.98	105
Main DSP board U100	82.92	82.65	82.88	105
Main DSP board U103 Body	76.50	75.88	83.91	105
PV boost IGBT Q101	68.07	67.44	76.26	110
PV boost IGBT D102	91.86	88.73	99.69	110
INV power tube Q600	79.20	79.06	89.21	110
INV power tube Q602	79.79	79.21	89.63	110
DAB high-side power tube Q202	66.02	65.49	76.83	110
DAB high-side power tube Q205	91.12	83.61	96.03	110
DAB high-side power tube Q201	66.56	66.30	72.00	110
Grid terminal block CN700	78.25	82.35	87.92	105

Back-up terminal block CN605	76.26	73.41	96.71	105
Grid Varistors TVR801	74.51	67.27	82.89	85
Back-up output capacitor C646	74.88	69.58	82.79	85
Grid output capacitor C709	74.24	69.50	83.02	85
Output common mode inductance L700	85.40	95.09	100.19	130
Output common mode inductance L601	87.63	99.69	92.76	130
INV HfpowerTX900	82.31	82.00	82.43	130
RELAY RY601	82.99	87.63	95.57	105
RELAY RY700	81.19	80.29	98.09	105
RELAY RY701	72.34	83.60	99.31	105
RELAY RY702	73.87	74.17	79.26	105
INV inductor terminal block CN609	84.82	85.92	97.23	105
GFCI module HCT601	79.61	85.67	93.73	105
INV current transformer HCT600	73.57	84.80	94.19	105
AC SPS TX100	82.77	80.97	82.75	130
AC SPS U102	81.49	80.85	80.69	105
AC SPS C103	81.64	80.40	82.42	105
LN snubber resistor R629	81.17	81.09	101.74	110
INV driver chip U900	86.23	86.32	92.41	105
LoadCurrent Transformer HCT602	79.52	79.77	82.13	105
Aluminum substrate power tube Q100	62.06	61.32	67.70	110
Aluminum substrate power tube Q101	62.63	61.85	68.03	110
Fan	68.60	66.91	77.10	90
PV wire	74.42	74.42	80.71	105
Grid wire	70.91	71.91	78.46	105
INV wire	87.58	88.79	86.18	105
Internal ambient temperature	69.59	68.85	84.46	NA
BAT copper bar	63.16	62.12	70.24	105
Inverter inductor core	73.25	72.47	81.84	120
Inverter inductor coil	86.10	83.11	98.63	130
PV inductor core	83.24	81.57	91.13	120
PV inductor coil	87.08	88.09	98.77	130
DAB1 Transformer core	62.08	61.23	66.04	105
DAB1 Transformer coil	70.29	73.48	82.02	130
DAB1 inductor core	61.92	60.98	65.97	105
DAB1 inductor coil	61.91	60.98	65.13	130

DAB2 Transformer core	62.37	61.51	62.38	105
DAB2 Transformer coil	62.13	61.39	64.52	130
DAB2 inductor core	69.25	68.29	74.48	105
DAB2 inductor coil	62.19	61.40	65.90	130
BAT terminal block	61.73	60.67	64.21	75
PV terminal block	61.56	62.37	65.29	75
DC SWITCH	58.33	58.88	57.06	75
Back-up terminal block	61.40	61.98	67.13	75
Grid terminal block	60.17	63.09	68.75	75
left side of box	59.56	57.35	61.87	70
right side of box	56.45	57.06	66.61	70
rear side of box	59.04	56.03	66.87	70
front of box	54.48	56.86	66.83	70
DAB transformer (closer to the inside)	62.13	61.57	65.61	90
Heat sink (middle of the box)	66.82	66.76	65.93	90

Supplementary information:

Note 1:

Test condition 13 Fan stalling, PV to Grid: Run the device at 60°C ambient until steady condition established; test voltage: MPPT=220V, Grid=253V, 6000W, 50Hz.

Test condition 14 Fan lost, PV to Grid: Run the device at 60°C ambient until steady condition established; test voltage: MPPT=220V, Grid=253V, 6000W, 50Hz.

Test condition 15 blanketing, PV to Grid: Run the device at 60°C ambient until steady condition established; test voltage: MPPT=220V, Grid=253V, 6000W, 50Hz.

4.4	TABLE: fault condition tests		
	test voltage (V) .....:		—
	Ambient temperature (°C).....:	25°C	

No.	com-ponent No.	fault	test voltage (V)	test time	fuse No.	fuse current (A)	result
1.	PCE input PV	Reversed	DC 550	10min	--	--	PV1 DC Input: 0Vdc / 12.5A / 0W PV2 DC Input: 0Vdc / 12.5A / 0W AC Output: 230Vac / 0A / 0W FID: PCE can't start. MT: n.a SD: ☒ Yes /☐ No, GD: ☒ Yes /☐ No RO: ☒ Yes /☐ No, NCD: ☒ Yes /☐ No NH: ☒ Pass / ☐ Fail. DST: ☒ Pass / ☐ Fail.

2.	PCE input PV	s-c	DC 550	10min	--	--	PV1 DC Input: 0Vdc / 12.5A / 0W PV2 DC Input: 0Vdc / 12.5A / 0W AC Output: 230Vac / 0A / 0W FID: PCE can't start. MT: n.a SD: ☒ Yes /☐ No, GD: ☒ Yes /☐ No RO: ☒ Yes /☐ No, NCD: ☒ Yes /☐ No NH: ☒ Pass / ☐ Fail. DST: ☒ Pass / ☐ Fail.
3.	PCE input PV	Over-voltage	DC 650	10min	--	--	PV1 DC Input: 650Vdc / 0A / 0W PV2 DC Input: 650Vdc / 0A / 0W AC Output: 230Vac / 0A / 0kW FID: PCE shut down. Indicate "PV Over Voltage / DC BUS High" fault. MT: n.a SD: ☒ Yes /☐ No, GD: ☒ Yes /☐ No RO: ☒ Yes /☐ No, NCD: ☒ Yes /☐ No NH: ☒ Pass / ☐ Fail. DST: ☒ Pass / ☐ Fail.
4.	PCE input BAT	s-c	DC 60	10min	--	--	BAT DC Input: 0.2Vdc / 30A / 6W AC Output: 0Vac / 0A / 0W FID: PCE can't start. MT: n.a SD: ☒ Yes /☐ No, GD: ☒ Yes /☐ No RO: ☒ Yes /☐ No, NCD: ☒ Yes /☐ No NH: ☒ Pass / ☐ Fail. DST: ☒ Pass / ☐ Fail.
5.	PCE input BAT	Over-voltage	61	10min	--	--	BAT DC Input: 61Vdc / 0A / 0W AC Output: 230Vac / 0A / 0kW FID: PCE shut down. Indicate "BAT Over Voltage" fault. MT: n.a SD: ☒ Yes /☐ No, GD: ☒ Yes /☐ No RO: ☒ Yes /☐ No, NCD: ☒ Yes /☐ No NH: ☒ Pass / ☐ Fail. DST: ☒ Pass / ☐ Fail.

6.	PCE input (only for multi-string)	Different input MPP1: low input MPP2: high input	DC 300/500	10min	--	--	PV1 DC Input: 300Vdc / 11A / 3300W PV2 DC Input: 500Vdc / 6A /3000W AC Output: 230Vac / 26A / 6kW FID: PCE work normally. MPPT function fail. MT: n.a SD: ☐ Yes /☒ No, GD: ☐ Yes /☒ No RO: ☒ Yes /☐ No, NCD: ☒ Yes /☐ No NH: ☒ Pass / ☐ Fail. DST: ☒ Pass / ☐ Fail.
7.	PCE input (only for multi-string)	Same input (MPP1 & MPP2 from same power source)	DC 400	30min	--	--	PV DC Input: 400Vdc / 15.5A / 6200W AC Output: 230Vac / 26A / 6kW FID: PCE work normally MT: n.a SD: ☐ Yes /☒ No, GD: ☐ Yes /☒ No RO: ☒ Yes /☐ No, NCD: ☒ Yes /☐ No NH: ☒ Pass / ☐ Fail. DST: ☒ Pass / ☐ Fail.
8.	PCE output 5%-10%	Power over-feed (OCP & OTP function controlled by DSP / software is disable)	DC 300	30min	--	--	PV1 DC Input: 299.6Vdc / 6A / 1798W PV2 DC Input: 299.6Vdc / 6A /1798W BAT DC Input: 52Vdc / 60A / 3120W AC Output: 230Vac / 26A / 6kW FID: PCE work normally MT: n.a SD: ☐ Yes /☒ No, GD: ☐ Yes /☒ No RO: ☒ Yes /☐ No, NCD: ☒ Yes /☐ No NH: ☒ Pass / ☐ Fail. DST: ☒ Pass / ☐ Fail.
9.	PCE output	Over-voltage (OVP function controlled by DSP / software is disable)	DC 55/ AC290.1	10min	--	--	BAT DC Input: 55Vdc / 120A / 6600W AC Output: 290.1Vac / 20.7A / 6kW FID: PCE work normally MT: n.a SD: ☐ Yes /☒ No, GD: ☐ Yes /☒ No RO: ☒ Yes /☐ No, NCD: ☒ Yes /☐ No NH: ☒ Pass / ☐ Fail. DST: ☒ Pass / ☐ Fail.

10.	PCE output Grid	s-c	DC 360	10min	--	--	DC Input: 360Vdc / 16A / 6000W AC Output: 230Vac / 24.78A / 5.7kW FID: PCE shut down.Indicate "R INV Over Current HW" fault. MT: n.a SD: ☒ Yes /☐ No, GD: ☒ Yes /☐ No RO: ☒ Yes /☐ No, NCD: ☒ Yes /☐ No NH: ☒ Pass / ☐ Fail. DST: ☒ Pass / ☐ Fail.
11.	PCE output load	s-c	DC 550	10min	--	--	DC Input: 550Vdc / 0A / 0W AC Output: 0Vac / 0A / 0kW FID: PCE shut down.Indicate "R INV Over Current HW" fault. MT: n.a SD: ☒ Yes /☐ No, GD: ☒ Yes /☐ No RO: ☒ Yes /☐ No, NCD: ☒ Yes /☐ No NH: ☒ Pass / ☐ Fail. DST: ☒ Pass / ☐ Fail.
12.	PCE output	Phase sequence or polarity incorrect	DC 550	10min	--	--	DC Input: 550Vdc / 0A / 0W AC Output: 230Vac / 0A / 0kW FID: PCE can't start.Indicate"Auto Test Failure"fault. MT: n.a SD: ☒ Yes /☐ No, GD: ☒ Yes /☐ No RO: ☒ Yes /☐ No, NCD: ☒ Yes /☐ No NH: ☒ Pass / ☐ Fail. DST: ☒ Pass / ☐ Fail.
13.	PCE output	L-Phase mis-wiring grid connection	DC 550	10min	--	--	DC Input: 550Vdc / 0A / 0W AC Output: 230Vac / 0A / 0kW FID: PCE shut down.Indicate"Vac Failure, Fac Failure，Utility Loss" fault. MT: n.a SD: ☒ Yes /☐ No, GD: ☒ Yes /☐ No RO: ☒ Yes /☐ No, NCD: ☒ Yes /☐ No NH: ☒ Pass / ☐ Fail. DST: ☒ Pass / ☐ Fail.

14.	PCE Cooling system failure	Fan locked	DC 220	2h	--	--	DC Input: 220Vdc / 30A / 6000W AC Output: 253Vac / 23.7A / 6kW FID: PCE work normally MT: n.a SD: ☐ Yes /☒ No, GD: ☐ Yes /☒ No RO: ☒ Yes /☐ No, NCD: ☒ Yes /☐ No NH: ☒ Pass / ☐ Fail. DST: ☒ Pass / ☐ Fail.
15.	PCE Cooling system failure	opening blocked	DC 220	2h	--	--	DC Input: 220Vdc / 30A / 6000W AC Output: 253Vac / 23.7A / 6kW FID: PCE work normally MT: n.a SD: ☐ Yes /☒ No, GD: ☐ Yes /☒ No RO: ☒ Yes /☐ No, NCD: ☒ Yes /☐ No NH: ☒ Pass / ☐ Fail. DST: ☒ Pass / ☐ Fail.
MCU or DPS processer failure							
16.	DSP failure	+1.2V power supply disable	DC 550	10min	--	--	DC Input: 550Vdc / 0A / 0W AC Output: 230Vac / 0A / 0kW FID: PCE shut down. Indicate" comm.Failure" fault. MT: n.a SD: ☒ Yes /☐ No, GD: ☒ Yes /☐ No RO: ☒ Yes /☐ No, NCD: ☒ Yes /☐ No NH: ☒ Pass / ☐ Fail. DST: ☒ Pass / ☐ Fail.
17.	DSP failure	+3.3V power supply disable	DC 550	10min	--	--	DC Input: 550Vdc / 0A / 0W AC Output: 230Vac / 0A / 0kW FID: PCE shut down. Indicate" comm.Failure" fault. MT: n.a SD: ☒ Yes /☐ No, GD: ☒ Yes /☐ No RO: ☒ Yes /☐ No, NCD: ☒ Yes /☐ No NH: ☒ Pass / ☐ Fail. DST: ☒ Pass / ☐ Fail.

18.	DSP failure	reset	DC 550	10min	--	--	DC Input: 550Vdc / 0A / 0W AC Output: 230Vac / 0A / 0kW FID: PCE shut down. Indicate" comm.Failure" fault. MT: n.a SD: ☒ Yes /☐ No, GD: ☒ Yes /☐ No RO: ☒ Yes /☐ No, NCD: ☒ Yes /☐ No NH: ☒ Pass / ☐ Fail. DST: ☒ Pass / ☐ Fail.
19.	DSP failure	Main DSP failure	DC 550	10min	--	--	DC Input: 550Vdc / 0A / 0W AC Output: 230Vac / 0A / 0kW FID: PCE shut down. Indicate" comm.Failure" fault. MT: n.a SD: ☒ Yes /☐ No, GD: ☒ Yes /☐ No RO: ☒ Yes /☐ No, NCD: ☒ Yes /☐ No NH: ☒ Pass / ☐ Fail. DST: ☒ Pass / ☐ Fail.
Loss of control & Function check fault							
20.	IGBT PMW	Loss / failure (no power)	DC 60	10min	--	--	DC Input: 550Vdc / 0A / 0W AC Output: 230Vac / 0A / 0kW FID: PCE shut down. Indicate "BUS Voltage Low" fault. MT: n.a SD: ☒ Yes /☐ No, GD: ☒ Yes /☐ No RO: ☒ Yes /☐ No, NCD: ☒ Yes /☐ No NH: ☒ Pass / ☐ Fail. DST: ☒ Pass / ☐ Fail.
21.	IGBT PMW	Loss / failure (one bridge on always)	DC 48	10min	--	--	BAT DC Input: 48Vdc / 0A / 0W AC Output: 0Vac / 0A /0kW FID: PCE shut down. IGBT damaged. MT: n.a SD: ☐ Yes /☒ No, GD: ☐ Yes /☒ No RO: ☒ Yes /☐ No, NCD: ☒ Yes /☐ No NH: ☒ Pass / ☐ Fail. DST: ☒ Pass / ☐ Fail.

22.	IGBT PMW	Loss / failure (No driver)	DC 60	10min	--	--	BAT DC Input: 60Vdc / 0A / 0W AC Output: 230Vac / 0A / 0kW FID: PCE shut down. Indicate "BUS Voltage Low" fault. MT: n.a SD: ☒ Yes /☐ No, GD: ☒ Yes /☐ No RO: ☒ Yes /☐ No, NCD: ☒ Yes /☐ No NH: ☒ Pass / ☐ Fail. DST: ☒ Pass / ☐ Fail.
23.	PV Voltage detector	Loss / failure	DC 550	10min	--	--	PV1 DC Input: 550Vdc / 0A / 0W AC Output: 230Vac / 0A / 0kW FID: PCE shut down. MT: n.a SD: ☒ Yes /☐ No, GD: ☒ Yes /☐ No RO: ☒ Yes /☐ No, NCD: ☒ Yes /☐ No NH: ☒ Pass / ☐ Fail. DST: ☒ Pass / ☐ Fail.
24.	BAT Voltage detector	Loss / failure	DC 60	10min	--	--	BAT DC Input: 60Vdc / 0A / 0W AC Output: 230Vac / 0A / 0kW FID: PCE shut down. MT: n.a SD: ☒ Yes /☐ No, GD: ☒ Yes /☐ No RO: ☒ Yes /☐ No, NCD: ☒ Yes /☐ No NH: ☒ Pass / ☐ Fail. DST: ☒ Pass / ☐ Fail.
25.	PV current detector	Loss / failure	DC 550	10min	--	--	PV1 DC Input: 0.2Vdc / 13A / 2.6W AC Output: 230Vac / 0A / 0kW FID: PCE shut down. PV Boost IGBT damaged. MT: n.a SD: ☒ Yes /☐ No, GD: ☒ Yes /☐ No RO: ☐ Yes /☒ No, NCD: ☐ Yes /☒ No NH: ☒ Pass / ☐ Fail. DST: ☒ Pass / ☐ Fail.
26.	BAT current detector	Loss / failure	DC 60	10min	--	--	BAT DC Input: 60Vdc / 0A / 0W AC Output: 230Vac / 0A / 0kW FID: PCE shut down. Battery Boost MOSFET and fuse damaged. MT: n.a SD: ☒ Yes /☐ No, GD: ☒ Yes /☐ No RO: ☐ Yes /☒ No, NCD: ☐ Yes /☒ No NH: ☒ Pass / ☐ Fail. DST: ☒ Pass / ☐ Fail.

27.	BUS Voltage detector	Loss / failure	DC 60/500	10min	--	--	PV1 DC Input: 500Vdc / 0A / 0W PV2 DC Input: 500Vdc / 0A / 0W BAT DC Input: 60Vdc / 0A / 0W AC Output: 230Vac / 0A / 0kW FID: PCE shut down. BUS capacitor damaged. Indicate “BUS Voltage Low” fault. MT: n.a SD: ☒ Yes /☐ No, GD: ☒ Yes /☐ No RO: ☐ Yes /☒ No, NCD: ☐ Yes /☒ No NH: ☒ Pass / ☐ Fail. DST: ☒ Pass / ☐ Fail.
28.	Inverter current detector	Loss / failure	DC 550	10min	--	--	DC Input: 550Vdc / 0A / 0W AC Output: 0Vac / 0A / 0kW FID: PCE shut down. INV IGBT damaged. MT: n.a SD: ☒ Yes /☐ No, GD: ☒ Yes /☐ No RO: ☐ Yes /☒ No, NCD: ☐ Yes /☒ No NH: ☒ Pass / ☐ Fail. DST: ☒ Pass / ☐ Fail.
29.	Inverter voltage detector	Loss / failure	DC 550	10min	--	--	DC Input: 550Vdc / 0A / 0W AC Output: 230Vac / 0A / 0kW FID: PCE shut down.Indicate “Relay Check Failure” fault. MT: n.a SD: ☒ Yes /☐ No, GD: ☒ Yes /☐ No RO: ☒ Yes /☐ No, NCD: ☒ Yes /☐ No NH: ☒ Pass / ☐ Fail. DST: ☒ Pass / ☐ Fail.
30.	Load current detector	Loss / failure	DC 490	10min	--	--	DC Input: 490Vdc/12.5A / 6.1KW AC Output: 230Vac /26A / 6kW FID: PCE work normally. Load current display 0. MT: n.a SD: ☐ Yes /☒ No, GD: ☐ Yes /☒ No RO: ☒ Yes /☐ No, NCD: ☒ Yes /☐ No NH: ☒ Pass / ☐ Fail. DST: ☒ Pass / ☐ Fail.

31.	Grid/AC voltage detector	Loss / failure	DC 550	10min	--	--	DC Input: 550Vdc / 0A / 0W AC Output: 230Vac /0A / 0kW FID: PCE shut down. Indicate "Utility Loss Vac Failure Fac Failure" fault. MT: n.a SD: ☒ Yes /☐ No, GD: ☒ Yes /☐ No RO: ☒ Yes /☐ No, NCD: ☒ Yes /☐ No NH: ☒ Pass / ☐ Fail. DST: ☒ Pass / ☐ Fail.
32.	DC isolation device function check	Loss / failure	DC 60/500	10min	--	--	PV1 DC Input: 500Vdc / 0A / 0W PV2 DC Input: 500Vdc / 0A / 0W BAT DC Input: 60Vdc / 0A / 0W AC Output: 230Vac / 0A / 0kW FID: PCE shut down. Indicate "Isolation Failure" fault. MT: n.a SD: ☒ Yes /☐ No, GD: ☒ Yes /☐ No RO: ☒ Yes /☐ No, NCD: ☒ Yes /☐ No NH: ☒ Pass / ☐ Fail. DST: ☒ Pass / ☐ Fail.
33.	Relay / Contactor function check (K1 o-c)	Loss / failure	DC 550	10min	--	--	DC Input: 550Vdc / 0A / 0W AC Output: 230Vac / 0A / 0kW FID:PCE shut down. Indicate "Relay Check Failure" fault. MT: n.a SD: ☒ Yes /☐ No, GD: ☒ Yes /☐ No RO: ☒ Yes /☐ No, NCD: ☒ Yes /☐ No NH: ☒ Pass / ☐ Fail. DST: ☒ Pass / ☐ Fail.
34.	Relay / Contactor function check (K2 o-c)	Loss / failure	DC 550	10min	--	--	DC Input: 550Vdc / 0A / 0W AC Output: 230Vac / 0A / 0kW FID:PCE shut down. Indicate "Relay Check Failure" fault. MT: n.a SD: ☒ Yes /☐ No, GD: ☒ Yes /☐ No RO: ☒ Yes /☐ No, NCD: ☒ Yes /☐ No NH: ☒ Pass / ☐ Fail. DST: ☒ Pass / ☐ Fail.

35.	Relay / Contactor function check (K3 o-c)	Loss / failure	DC 550	10min	--	--	DC Input: 550Vdc / 0A / 0W AC Output: 230Vac / 0A / 0kW FID: PCE shut down. Indicate "Relay Check Failure" fault. MT: n.a SD: ☒ Yes /☐ No, GD: ☒ Yes /☐ No RO: ☒ Yes /☐ No, NCD: ☒ Yes /☐ No NH: ☒ Pass / ☐ Fail. DST: ☒ Pass / ☐ Fail.
36.	RCD/RCM function check	Loss / failure	DC 550	10min	--	--	DC Input: 550Vdc / 0A / 0W AC Output: 230Vac / 0A / 0kW FID: PCE shut down. Indicate "Ground I Failure" fault. MT: n.a SD: ☒ Yes /☐ No, GD: ☒ Yes /☐ No RO: ☒ Yes /☐ No, NCD: ☒ Yes /☐ No NH: ☒ Pass / ☐ Fail. DST: ☒ Pass / ☐ Fail.
37.	Ambient temperature detector	Loss / failure (s-c)	DC 550	10min	--	--	DC Input: 550Vdc / 0A / 0W AC Output: 230Vac / 0A / 0kW FID: PCE shut down. Indicate "Over Temperature"fault. Temperature display 133℃ MT: n.a SD: ☒ Yes /☐ No, GD: ☒ Yes /☐ No RO: ☒ Yes /☐ No, NCD: ☒ Yes /☐ No NH: ☒ Pass / ☐ Fail. DST: ☒ Pass / ☐ Fail.
38.	Ambient temperature detector	Loss / failure (o-c)	DC 550	10min	--	--	DC Input: 550Vdc / 12 A / 5.8W AC Output: 230Vac / 25.2A / 5.8kw FID: PCE work normally. Temperature display 11.1℃ MT: n.a SD: ☐ Yes /☒ No, GD: ☐ Yes /☒ No RO: ☒ Yes /☐ No, NCD: ☒ Yes /☐ No NH: ☒ Pass / ☐ Fail. DST: ☒ Pass / ☐ Fail.

39.	Heat-sink temperature detector	Loss / failure (s-c)	DC 550	10min	--	--	DC Input: 550Vdc / 0A / 0W AC Output: 230Vac / 0A / 0kW FID: PCE shut down. Indicate "Over Temperature"fault. Temperature display 133℃ MT: n.a SD: ☒ Yes /☐ No, GD: ☒ Yes /☐ No RO: ☒ Yes /☐ No, NCD: ☒ Yes /☐ No NH: ☒ Pass / ☐ Fail. DST: ☒ Pass / ☐ Fail.
40.	Heat-sink temperature detector	Loss / failure(o-c)	DC 550	10min	--	--	DC Input: 550Vdc / 12 A / 5.8W AC Output: 230Vac / 25.2A / 5.8kw FID: PCE work normally. Temperature display 11.1℃. MT: n.a SD: ☐ Yes /☒ No, GD: ☐ Yes /☒ No RO: ☒ Yes /☐ No, NCD: ☒ Yes /☐ No NH: ☒ Pass / ☐ Fail. DST: ☒ Pass / ☐ Fail.
Components single fault condition and Functional insulation on PWB short circuit test							
41.	IGBT (IGBT D-S)	s-c	DC 360	10min	--	--	DC Input: 360Vdc / 2.8A / 1000W AC Output: 230Vac / 4.34A / 1kW FID: PCE shut down. IGBT damaged. MT: n.a SD: ☒ Yes /☐ No, GD: ☒ Yes /☐ No RO: ☐ Yes /☒ No, NCD: ☐ Yes /☒ No NH: ☒ Pass / ☐ Fail. DST: ☒ Pass / ☐ Fail.
42.	DC input Bus capacitor (330μF)	s-c	DC 360	10min	--	--	DC Input: 360Vdc / 1.38A / 1000W AC Output: 230Vac / 4.34A / 1kW FID: PCE shut down. IGBT and Battery side MOSFET damaged. MT: n.a SD: ☒ Yes /☐ No, GD: ☒ Yes /☐ No RO: ☐ Yes /☒ No, NCD: ☐ Yes /☒ No NH: ☒ Pass / ☐ Fail. DST: ☒ Pass / ☐ Fail.

43.	DC input filter capacitor	s-c	DC 500	10min	--	--	DC Input: 500Vdc /0A / 0W AC Output: 0Vac / 0A / 0kW FID: PCE shut down.Battery side fuse damaged. MT: n.a SD: ☒ Yes /☐ No, GD: ☒ Yes /☐ No RO: ☐ Yes /☒ No, NCD: ☐ Yes /☒ No NH: ☒ Pass / ☐ Fail. DST: ☒ Pass / ☐ Fail.
44.	LC filter capacitor	s-c	DC 550	10min	--	--	DC Input: 550Vdc / 0A / 0W AC Output: 230Vac / 0A / 0kW FID: PCE shut down. Indicate "R INV Over Current HW" fault. MT: n.a SD: ☒ Yes /☐ No, GD: ☒ Yes /☐ No RO: ☒ Yes /☐ No, NCD: ☒ Yes /☐ No NH: ☒ Pass / ☐ Fail. DST: ☒ Pass / ☐ Fail.
45.	Power supply transformer (TX500)	Output +12V s-c	DC 550	10min	--	--	DC Input: 550Vdc / 0A / 0W AC Output: 230Vac / 0A / 0kW FID: PCE shut down. MT: n.a SD: ☒ Yes /☐ No, GD: ☒ Yes /☐ No RO: ☒ Yes /☐ No, NCD: ☒ Yes /☐ No NH: ☒ Pass / ☐ Fail. DST: ☒ Pass / ☐ Fail.
46.	Power supply transformer (TX500)	Output +7V s-c	DC 550	10min	--	--	DC Input: 550Vdc / 0A / 0W AC Output: 230Vac / 0A / 0kW FID: PCE shut down. MT: n.a SD: ☒ Yes /☐ No, GD: ☒ Yes /☐ No RO: ☒ Yes /☐ No, NCD: ☒ Yes /☐ No NH: ☒ Pass / ☐ Fail. DST: ☒ Pass / ☐ Fail.
47.	Power supply transformer (TX500)	Output -7V s-c	DC 550	10min	--	--	DC Input: 550Vdc / 0A / 0W AC Output: 230Vac / 0A / 0kW FID: PCE shut down. MT: n.a SD: ☒ Yes /☐ No, GD: ☒ Yes /☐ No RO: ☒ Yes /☐ No, NCD: ☒ Yes /☐ No NH: ☒ Pass / ☐ Fail. DST: ☒ Pass / ☐ Fail.

Legend (Special evaluation for PV Inverter abnormal test)			
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	DST	Dielectric strength test
s-c	short-circuited	o-c	open-circuited
o-l	Over-load.		

Note(s):

Failures or faults may be short-circuits in the PCE, or to exposed conductive parts, earth faults, or short-circuit in the output circuits, failure in the control circuits, or blocking of a motor fed by power EE.

There shall be no emission of molten metal, burning insulation, or flaming or glowing particles FIDom the fire enclosure, and there shall be no charring, glowing, or flaming of the tissue paper or cheesecloth, or glowing or flaming of surgical cotton.

Faults protected by “UL certified current fuse only” shall be performed and repeated 3 times.

In case of components damaged other than fuse, the evaluation should be repeated 3 times.

Report in result section:

– Measure transformer temperature at all times
– Fuse opened Yes / No?
– Components damaged?
– Emit Flames?
– Emit molten metal?
– Did it pass the electric strength test?

What happened to the SPS? Shutdown / cycle protection / normal operation

4.7	**TABLE: mains supply electrical data in normal condition**						P
Type	U (V) PV	I (A) PV	U (V) Grid	I (A) Grid	F (Hz) Grid	U (V) Bat.	I (A) Bat.
On grid mode_GW6000-ES-20							
Charging state ($V_{MPPT\ MAX}$)	499.70	12.50	229.99	2.89	50.00	55.94	109.84
Charging state ($V_{MPPT\ min}$)	219.67	28.43	230.02	1.94	50.00	51.06	120.54
Inverter state ($V_{MPPT\ MAX}$)	515.74	11.72	231.37	25.59	50.00	50.02	0.08
Inverter state ($V_{MPPT\ min}$)	224.33	27.04	231.33	25.27	50.00	50.02	0.09
Discharging State ($V_{bat\ max}$)	395.41	0.09	231.33	25.30	50.00	59.00	104.28
Discharging	395.50	0.04	231.06	20.38	50.00	40.80	125.22

State ($V_{bat\ min}$)							
Stand-alone mode_ GW6000-ES-20							
Charging state ($V_{MPPT\ MAX}$)	471.21	13.69	230.35	0.05	50.05	51.02	117.31
Charging state ($V_{MPPT\ min}$)	219.97	28.26	230.44	0.09	50.41	51.15	114.33
Inverter state ($V_{MPPT\ MAX}$)	467.76	12.77	229.21	25.33	50.05	49.96	0.47
Inverter state ($V_{MPPT\ min}$)	218.56	28.40	228.88	25.44	50.41	50.05	2.30
Discharging State ($V_{bat\ max}$)	395.42	0.09	231.34	25.30	50.00	59.01	104.28
Discharging State ($V_{bat\ min}$)	395.50	0.04	231.06	20.35	50.00	40.83	125.08

4.7	**TABLE: mains supply electrical data in normal condition**						P
Type	U (V) PV	I (A) PV	U (V) Grid	I (A) Grid	F (Hz) Grid	U (V) Bat.	I (A) Bat.
On grid mode_GW3000-ES-20							
Charging state ($V_{MPPT\ MAX}$)	499.69	6.27	230.00	2.26	50.00	50.65	60.55
Charging state ($V_{MPPT\ min}$)	220.58	14.34	230.01	1.56	50.00	50.66	60.50
Inverter state ($V_{MPPT\ MAX}$)	500.02	6.26	230.45	13.62	50.00	50.05	0.14
Inverter state ($V_{MPPT\ min}$)	219.06	14.41	230.46	13.26	50.00	50.05	0.05
Discharging State ($V_{bat\ max}$)	359.94	0.29	230.45	13.21	50.00	59.54	51.77
Discharging State ($V_{bat\ min}$)	363.55	0.28	230.35	10.35	50.00	39.42	62.25
Stand-alone mode_ GW3000-ES-20							
Charging state ($V_{MPPT\ MAX}$)	499.91	6.45	230.67	0.03	50.05	50.61	58.36

Charging state（$V_{MPPT\ min}$）	219.20	14.89	230.32	0.03	50.05	50.62	59.75
Inverter state（$V_{MPPT\ MAX}$）	499.48	6.25	229.49	13.05	50.05	50.05	0.15
Inverter state（$V_{MPPT\ min}$）	219.31	14.41	229.54	13.07	50.05	50.05	0.17
Discharging State（$V_{bat\ max}$）	316.23	0.32	226.65	10.37	50.05	39.44	62.38
Discharging State（$V_{bat\ min}$）	1.18	0.06	229.27	13.09	50.05	59.53	53.48

4.7	**TABLE: mains supply electrical data in normal condition**						P
Type	U (V) PV	I (A) PV	U (V) Grid	I (A) Grid	F (Hz) Grid	U (V) Bat.	I (A) Bat.
On grid mode_GW3600-ES-20							
Charging state（$V_{MPPT\ MAX}$）	497.49	7.63	230.01	2.56	50.00	51.09	72.94
Charging state（$V_{MPPT\ min}$）	149.70	25.19	229.99	1.79	50.00	50.88	73.09
Inverter state（$V_{MPPT\ MAX}$）	497.97	7.62	230.57	16.00	50.00	50.05	0.07
Inverter state（$V_{MPPT\ min}$）	149.34	25.26	230.56	15.53	50.00	50.05	0.28
Discharging State（$V_{bat\ max}$）	384.10	0.72	230.56	16.13	50.00	59.15	62.00
Discharging State（$V_{bat\ min}$）	359.78	0.08	230.79	15.90	50.00	38.74	96.65
Stand-alone mode_ GW3600-ES-20							
Charging state（$V_{MPPT\ min}$）	149.87	25.74	230.15	0.12	50.05	51.00	70.11
Inverter state（$V_{MPPT\ MAX}$）	500.60	6.95	229.10	15.61	50.05	52.05	0.50
Inverter state（$V_{MPPT\ min}$）	149.99	24.94	228.94	15.56	50.05	50.04	0.32

Discharging State ($V_{bat\ max}$)	241.12	0.34	228.69	15.57	50.00	59.12	62.76
Discharging State ($V_{bat\ min}$)	386.76	0.11	229.15	12.71	50.05	38.86	77.77

4.2.2.6	**TABLE: mains supply electrical data in normal condition**						P
Type	U (V) PV	I (A) PV	U (V) Grid	I (A) Grid	F (Hz) Grid	U (V) Bat.	I (A) Bat.
On grid mode_GW5000-ES-20							
Charging state ($V_{MPPT\ MAX}$)	500.42	9.99	229.96	4.47	50.00	52.03	100.24
Charging state ($V_{MPPT\ min}$)	199.34	25.02	229.95	3.47	50.00	51.98	100.23
Inverter state ($V_{MPPT\ MAX}$)	499.75	10.39	230.78	21.85	50.00	57.55	0.08
Inverter state ($V_{MPPT\ min}$)	198.06	26.07	230.97	21.44	50.00	50.03	0.00
Discharging State ($V_{bat\ max}$)	397.03	0.64	230.79	22.17	50.00	59.04	87.86
Discharging State ($V_{bat\ min}$)	381.90	1.26	230.74	20.77	50.00	39.74	119.71
Stand-alone mode_ GW5000-ES-20							
Charging state ($V_{MPPT\ MAX}$)	501.42	10.68	230.39	0.06	50.05	51.02	95.93
Charging state ($V_{MPPT\ min}$)	198.99	26.57	230.48	0.05	50.05	51.03	96.68
Inverter state ($V_{MPPT\ MAX}$)	498.30	10.72	228.75	22.22	50.05	50.04	0.61
Inverter state ($V_{MPPT\ min}$)	198.38	26.78	228.69	22.19	50.05	50.03	0.77
Discharging State ($V_{bat\ max}$)	386.96	0.63	228.86	22.24	50.05	59.07	87.84
Discharging State	217.14	0.78	225.55	21.94	50.05	39.70	131.61

（$V_{bat\ min}$）							

4.2.2.6	**TABLE: mains supply electrical data in normal condition**						P
Type	U (V) PV	I (A) PV	U (V) Grid	I (A) Grid	F (Hz) Grid	U (V) Bat.	I (A) Bat.
On grid mode_GW6000M-ES-20							
Charging state（$V_{MPPT\ min}$）	198.82	29.76	207.24	15.13	50.00	40.61	59.51
Inverter state（$V_{MPPT\ MAX}$）	500.29	12.16	253.42	23.39	50.00	50.04	0.17
Inverter state（$V_{MPPT\ min}$）	197.75	29.81	207.48	27.09	50.00	50.04	0.21
Discharging State（$V_{bat\ max}$）	490.42	6.62	253.38	23.02	50.00	59.49	48.35
Discharging State（$V_{bat\ min}$）	197.96	18.24	207.71	27.29	50.00	39.36	59.74
Stand-alone mode_ GW6000M-ES-20							
Charging state（$V_{MPPT\ min}$）	203.83	28.79	229.39	13.07	50.05	40.55	59.50
Inverter state（$V_{MPPT\ MAX}$）	488.12	12.61	229.07	25.67	50.05	60.08	0.56
Inverter state（$V_{MPPT\ min}$）	198.23	30.77	229.27	25.72	50.05	40.02	3.22
Discharging State（$V_{bat\ max}$）	489.40	5.81	229.11	25.70	50.05	59.38	58.70
Discharging State（$V_{bat\ min}$）	197.75	19.81	229.13	25.70	50.05	39.40	59.86

4.2.2.6	**TABLE: mains supply electrical data in normal condition**						P
Type	U (V) PV	I (A) PV	U (V) Grid	I (A) Grid	F (Hz) Grid	U (V) Bat.	I (A) Bat.
On grid mode_GW5000M-ES-20							
Charging state（$V_{MPPT\ min}$）	198.56	29.77	207.29	15.57	50.00	40.69	59.14
Inverter state	498.89	9.95	253.33	19.28	50.00	60.03	0.17

（$V_{MPPT\ MAX}$）							
Inverter state （$V_{MPPT\ min}$）	198.63	24.70	207.40	22.75	50.00	40.04	0.11
Discharging State （$V_{bat\ max}$）	492.93	4.59	253.35	20.24	50.00	59.49	52.49
Discharging State （$V_{bat\ min}$）	197.98	13.42	207.41	22.56	50.00	39.38	59.03
Stand-alone mode_ GW5000M-ES-20							
Charging state （$V_{MPPT\ min}$）	199.10	25.78	229.00	10.18	50.05	40.72	58.76
Inverter state （$V_{MPPT\ MAX}$）	500.04	10.96	228.73	22.66	50.05	60.07	0.20
Inverter state （$V_{MPPT\ min}$）	198.84	27.35	228.77	22.53	50.05	40.05	0.27
Discharging State （$V_{bat\ max}$）	492.74	3.58	228.88	21.22	50.05	59.38	58.27
Discharging State （$V_{bat\ min}$）	199.52	11.31	228.75	21.21	50.05	49.37	58.93

4.2.2.6	**TABLE: mains supply electrical data in normal condition**						P
Type	U (V) PV	I (A) PV	U (V) Grid	I (A) Grid	F (Hz) Grid	U (V) Bat.	I (A) Bat.
On grid mode_GW3600M-ES-20							
Charging state （$V_{MPPT\ min}$）	149.63	24.09	207.13	4.95	50.00	40.72	57.79
Inverter state （$V_{MPPT\ MAX}$）	494.35	7.78	253.27	15.17	50.00	60.07	0.52
Inverter state （$V_{MPPT\ min}$）	149.26	24.10	207.32	16.70	50.00	40.03	0.12
Discharging State （$V_{bat\ max}$）	1.47	0.09	253.25	13.46	50.00	59.38	58.98
Discharging State	150.44	9.24	207.30	16.79	50.00	39.36	58.56

（$V_{bat\ min}$）							
Stand-alone mode_ GW3600M-ES-20							
Charging state （$V_{MPPT\ min}$）	152.97	24.35	229.01	4.26	50.05	40.39	58.70
Inverter state （$V_{MPPT\ MAX}$）	494.63	7.96	228.93	16.57	50.05	60.06	0.80
Inverter state （$V_{MPPT\ min}$）	149.19	26.34	227.46	16.44	50.05	40.05	0.12
Discharging State （$V_{bat\ max}$）	494.91	0.82	228.95	15.77	50.05	59.72	58.89
Discharging State （$V_{bat\ min}$）	149.46	9.27	224.60	15.55	50.05	39.67	59.01

7.3.7.4 & 7.3.7.5	TABLE: clearance and creepage distance measurements					P
Clearance cl and creepage distance dcr at/of:	Uimp (Usys) [V]	U r.m.s. [V]	Required cl [mm]	cl [mm]	Required dcr [mm]	dcr [mm]
PCE unit **PV 600Vdc, AC230V, BAT 60Vdc**						
PV supply circuit to metal chassis: BI (components)	4000 (230Va.c.)	230Va.c. 600Vd.c.	3.0x1.14 = 3.42	See below	6.0	See below
- at ON/OFF DC switch	--	--	--	>20	--	>20
- at Bus Capacitors	--	--	--	>20	--	>20
AC mains circuit to metal chassis: BI (components)	3000 (600Vd.c.)	230Va.c. 600Vd.c.	3.0x1.14 = 3.42	See below	6.0	See below
- at AC terminal to enclosure	--	--	--	>30	--	>30
All PCB stand-off (between PCBs and metal chassis)	3000 (600Vd.c.)	230Va.c. 600Vd.c.	3.0x1.14 = 3.42	11.1	6.0	>11.1
BAT circuit to metal chassis: BI (components)	2500 (60Vd.c.)	60Vd.c.	1.5x1.14 =1.71	See below	1.71	See below
- at AC terminal to enclosure	--	--	--	3.5	--	3.5
On PCBs 190-10143-01						
Power board:						

Across power circuit, drive, SIO/SOPs circuit, control circuit to communication port (PELV, DVC A)(RI)	6000 (230Va.c.)	230Va.c. 600Vd.c.	5.5x1.14 = 6.3	See below	6.3	See below
- on isolating transformer TX500	--	--	--	7.9	--	7.9
- on isolating transformer TX300	--	--	--	8.4	--	8.4
- via PCB tracks way near TX300 to EC310	--	--	--	7.2	--	7.2
- via PCB tracks way near EC306 to CN200	--	--	--	7.7	--	7.7
- via PCB tracks way near D200	--	--	--	7.9	--	7.9
- via PCB tracks way near ARM board	--	--	--	8.0	--	8.0
- at Optical couplers (U908, U912, U913)	--	--	--	8.0	--	8.0
DC/DC drive circuit of BAT side to drive control circuit(RI) (190-10144-00)	6000 (230Va.c.)	230Va.c. 600Vd.c.	5.5x1.14 = 6.3	See below	6.3	See below
- at Optical couplers (U100, U101, U102, U103)	--	--	--	8.0	--	8.0
RS485 to external source on Communication interface board(RI) (190-4018-T0)	6000 (230Va.c.)	230Va.c. 600Vd.c.	5.5x1.14 = 6.3	See below	6.3	See below
- via PCB tracks between CN11 to S1	--	--	--	7.4	--	7.4
PV supply circuits / AC mains circuits to earth : BI	4000 (230Va.c.)	230Va.c. 600Vd.c.	3.0x1.14 = 3.42	See below	3.42	See below
-C113 to PE at PV side	--	--	--	4.4	--	4.4
- Bus – to PE	--	--	--	4.0	--	4.0
- Bus + to PE	--	--	--	4.1	--	4.1
- INV L to PE at INV side	--	--	--	4.2	--	4.2
- INV N to PE at INV side	--	--	--	4.0	--	4.0
- PE to DGND	--	--	--	4.8	--	4.8
- Load-L to PE at Backup side	--	--	--	5.8	--	5.8
- Grid- N to PE at grid side	--	--	--	4.1	--	4.1
-on serise of relays RY700~RY701 RY703~RY704	--	--	--	2*1.8	--	22

-on serise of relays RY702~RY705(Backup-N to PE)	--	--	--	2*1.85	--	20
BAT to PE (BI)	2500 (60Vd.c.)	60Vd.c.	1.5x1.14 =1.71	See below	1.71	See below
- at BAT+ BAT- to PE	--	--	--	4.1	--	4.1
Isolation transformer in Aux. power circuits (TX300&TX500): RI	For detail requirement and measurement see transformer table.					

Circuits Definition:	
PV Circuits: DVC-C	AC mains/Grid Circuits: DVC-C
Control Circuits: DVC-C	Communication and Display Circuits: DVC-A
Protection Separation	
PV Circuits to Accessible Parts Earthed: BI	AC mains/Grid Circuits to Accessible Parts Earthed: BI
PV Circuits to Control Circuits: No separation	AC mains/Grid Circuits to Control Circuits: No separation
Control Circuits to Communication Circuits: RI	Control Circuits to Display Circuit: RI

Legend			
BI	Basic insulation	SI	Supplementary insulation
DI	Double insulation	RI	Reinforced insulation
FI	Functional insulation	O.V.C	Overvoltage category
PD	Pollution degree	MG	Insulating material group
PPI	Protection by Protective Impedance	DVC	Decision voltage classification
s-c	Shorted circuits	o-c	Opened circuits

Note(s):

$V_{MAX\,PV}$ (V) = 600Vd.c., AC output voltage = 230 / 400Va.c.

PV supply circuits = O.V.C II, AC mains circuits = O.V.C. III.

PD = PD2 (IP65)[8)], MG = IIIa/b, Altitude ≤ 3000m (correction factor = 1.14)

PV input circuits and AC mains / Grid circuits are considered as DVC-C which with hazadous voltages.

Communication and display circuits in PCE are considered as DVC-A which could be accessible.

Control circuits in PCE is considered as DVC-C without seperation from DVC-C circuits.

Communication and display circuits in PCE are considered as DVC-A with Double Insulation (or Reinforcement Insulation) from DVC-C circuits.

1. Interpolation is permitted in general, except for impulse withstand voltage decision.
2. Functional insulation was shorted circuit tests and consideration.
3. Mark * indicates the value of creepage distance is increased to that related clearance.

4. There is no isolation between PV supply circuits and AC mains circuits, so the most severe insulation requirements are applied if any. 5. According to the degrees of protection provided by the enclosure is IP65, the pollution degree for the internal environment of PCE could be consider as PD2.

7.3.7.8.3.2, 7.3.7.8.3.3	TABLE: distance through insulation measurement			P
distance through insulation di at/of:	U r.m.s. (V)	test voltage (V)	required di (mm)	di (mm)
Insulation sheet between primary winding and secondary winding of transformer TX8 (DI, two layers insulation sheet+ Insulation tube on triple insulated primary winding)	230Va.c. 600Vd.c.	AC 3000	0.2	0.1x2+0.1 =0.3
Note(s): [1)] Certificated components.				

7.5.1, 7.5.2 and 7.5.3	TABLE: electric strength measurements, impulse voltage test and partial discharge test			P
test voltage applied between:	test voltage [V]	impulse withstand voltage [V] 1.2/50 µs	partial discharge extinction voltage [V]	result
PV supply circuits to PE(BI)	DC 2120	4000	--	Pass
AC mains circuits to PE(BI)	DC 2120	4000	--	Pass
BAT supply circuits to PE(BI)	DC 2120	4000	--	Pass
PV supply circuits to Communication circuit(RI)	DC 4240	6000	--	Pass
AC mains circuits to Communication circuit(RI)	DC 4240	6000	--	Pass
BAT supply circuits to PV supply circuits (RI)	DC 4240	6000	--	Pass
BAT supply circuits to AC main circuits (RI)	DC 4240	6000	--	Pass

Legend			
BI	Basic insulation	SI	Supplementary insulation
DI	Double insulation	RI	Reinforced insulation
FI	Functional insulation	O.V.C	Overvoltage category
Note(s):			

7.5.4	TABLE: Touch Current Measurement			P(Note(s))
Location	Single / Three phase	Measured current (mA)		Comments/conditions
		a.c	d.c	
At metal enclosure to PE	Single	0.52	-	after clause 7.5.2.3, Humidity pre-conditioning
Max. MPPT Voltage supply input, 1.1Un AC mains connection. Note(s): symbol 15 of Annex C marked and a second protective earthing conductor is to be installed.				

14	TABLE: list of critical components	P
Note: See Attachment 3 – Critical components Documentation (CDF) for details.		

14.8	TABLE: Batteries								N/A
The tests are applicable only when appropriate battery data is not available						--			--
Is it possible to install the battery in a reverse polarity position?						--			--
	Non-rechargeable batteries			Rechargeable batteries					
	Discharging		Un-intentional charging	Charging		Discharging		Reversed charging	
	Meas. current	Manuf. Specs.		Meas. current	Manuf. Specs.	Meas. current	Manuf. Specs.	Meas. current	Manuf. Specs.
Max. current during normal condition	--	--	--	--	--	--	--	--	--
Max. current during fault condition	--	--	--	--	--	--	--	--	--
Test results:									Verdict
- Chemical leaks						--			--
- Explosion of the battery						--			--
- Emission of flame or expulsion of molten metal						--			--
- Electric strength tests of equipment after completion of tests						--			--
Supplementary information:									

- End of Test Report -

Test Report issued under the responsibility of:

TÜVRheinland®

TEST REPORT
IEC 62109-2
Safety of power converters for use in photovoltaic power systems – Part2: Particular requirements for inverters

Report Reference No..... :	CN22T0P9 001 attachment 1
Date of issue..... :	See cover page.
Total number of pages..... :	See cover page.
Applicant's name ..... :	See cover page.
Address..... :	See cover page.
Test specification:	
Standard ..... :	IEC 62109-2: 2011 (First Edition)
Test procedure..... :	TÜV Rheinland Bauart Mark Approval
Non-standard test method..... :	N/A
Test Report Form No..... :	IEC62109_2A
Test Report Form(s) Originator ..... :	LCIE - Laboratoire Central des Industries Electriques
Master TRF..... :	Dated 2012-02

Test item description ..... :	Hybrid Inverter
Trade Mark ..... :	See test report of CN22T0P9 001
Manufacturer..... :	See test report of CN22T0P9 001
Model/Type reference..... :	See test report of CN22T0P9 001
Ratings..... :	See test report of CN22T0P9 001

Testing procedure and testing location:	
☐ Testing Laboratory:	
Testing location/ address..... :	
Tested by (name + signature)..... :	See cover page.
Approved by (name + signature)..... :	See cover page.
☐ Testing procedure: TMP	
Testing location/ address..... :	
Tested by (name + signature)..... :	
Approved by (name + signature)..... :	
☐ Testing procedure: WMT	
Testing location/ address..... :	
Tested by (name + signature)..... :	
Witnessed by (name + signature)..... :	
Approved by (name + signature)..... :	
☐ Testing procedure: SMT	
Testing location/ address..... :	
Tested by (name + signature)..... :	
Approved by (name + signature)..... :	
Supervised by (name + signature)..... :	

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

See report CN22T0P9 001.

Summary of testing:

Tests performed (name of test and test clause):

Clause	Test items
4.4.4.15.1	Fault-tolerance of residual current monitoring
4.4.4.15.2	Fault-tolerance of automatic disconnecting means
4.4.4.16	Stand-alone inverters – Load transfer test
4.4.4.17	Cooling system failure – Blanketing test
4.7	Electrical Ratings Test (For stand-alone inverters)
4.8.2	Array insulation resistance detection for inverters for ungrounded and functionally grounded arrays
4.8.3	Array residual current detection
4.8.3.5	Protection by residual current monitoring

Remark:

- Unless otherwise specified, all the test items were conducted on the basic model of KH10.5 to represent the others.
- Other testing conditions considered in this test report, see General product information of the report CN22T0P9 001 for details.

Testing location:

See cover page

Summary of compliance with National Differences

List of countries addressed: None.

☒ The product fulfils the requirements of IEC 62109-2: 2011 (First Edition) for use in conjunction with IEC 62109-1: 2010 (First Edition)

Copy of marking plate:
See report CN22T0P9 001.

Test item particulars:	
Equipment mobility ..... :	☐ movable ☐ hand-held ☐ stationary ☒ fixed (Wall mounted) ☐ transportable ☐ for building-in
Connection to the mains..... :	☒ pluggable equipment ☐ direct plug-in ☐ permanent connection ☐ for building-in
Enviromental category ..... :	☒ outdoor ☐ indoor conditional ☐ indoor unconditional
Operating condition ..... :	☒ continuous ☐ short-time ☐ intermittent
Over voltage category mains..... :	☐ OVC I ☐ OVC II ☒ OVC III ☐ OVC IV
Over voltage category PV..... :	☐ OVC I ☒ OVC II ☐ OVC III ☐ OVC IV
Over voltage category Battery.....:	☐ OVC I ☒ OVC II ☐ OVC III ☐ OVC IV
Mains supply tolerance (%)..... :	According to specified supply range
Tested for power systems ..... :	TN, TT
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 ..... :	☐ PD 1 ☒ PD 2 (Inside) ☒ PD 3 (Outside)
IP protection class ..... :	IP65
Possible test case verdicts:	
- test case does not apply to the test object.....:	N/A
- test object does meet the requirement.....:	Pass (P)
- test object does not meet the requirement.....:	Fail (F)
Testing:	
Date of receipt of test items .....:	See report CN22T0P9 001
Date(s) of performance of tests .....:	See report CN22T0P9 001.

General remarks:

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

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

The application for obtaining a CB Test Certificate includes more than one factory location and a declaration from the Manufacturer stating that the sample(s) submitted for evaluation is (are) representative of the products from each factory has been provided.....:

☐ Yes
☒ Not applicable

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

Name and address of factory (ies).....: See report CN22T0P9 001.

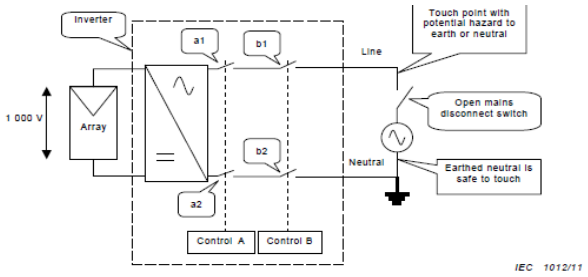
General product information:
See report CN22T0P9 001.

Throughout the test report following abbreviations may be used:

- input	i/p	- Test repeated, similar result(3 times)	TRSR
- output	o/p	- No indication of dielectric breakdown	NB
- short-circuited	s-c	- Cheesecloth remained intact	NC
- overloaded	o-l	- Tissue paper remained intact	NT
- open-circuited	o-c	- No hazards	NH
- normal conditions	N.C.	- The PCE can recover to operate automaticly after removing the abnormal condition	RO
- single fault conditions	SFC	- functional insulation	FI
- between parts of opposite polarity	BOP	- basic insulation	BI
- internal protection operated	IPO	- supplementary insulation	SI
- Component damage (list damaged component)	CD	- double insulation	DI
- No component damaged	NCD	- reinforced insulation	RI

Indicate used abbreviations (if any)

IEC 62109-2			
Clause	Requirement – Test	Result - Remark	Verdict
4	General testing requirements *This clause of Part 1 is applicable except as follows:*		P
4.4	Testing in single fault conditions		P
4.4.4	Single fault conditions to be applied: *Additional subclauses:*	The PCE can detect and indicate the fault condition and disconnect from or not connect to the grid in case of single fault condition. Refer to the appended table 4.4 of IEC 62109-1 test report CN22T0P9 001.	P
4.4.4.15	Fault-tolerance of protection for grid-interactive inverters		P
4.4.4.15.1	Fault-tolerance of residual current monitoring according to 4.8.3.5: the residual current monitoring system operates properly		P
	a) The inverter ceases to operate		P
	- Indicates a fault in accordance with 13.9		P
	- Disconnect from the mains		P
	- not re-connect after any sequence of removing and reconnecting PV power		P
	- not re-connect after any sequence of removing and reconnecting AC power		P
	- not re-connect after any sequence of removing and reconnecting both PV and AC power		P
	b) The inverter continues to operate		N/A
	- the residual current monitoring system operates properly under single fault condition		N/A
	- Indicates a fault in accordance with 13.9		N/A
	c) The inverter continues to operate regardless of loss of residual current monitoring functionality		P
	- not re-connect after any sequence of removing and reconnecting PV power		P
	- not re-connect after any sequence of removing and reconnecting AC power		P
	- not re-connect after any sequence of removing and reconnecting both PV and AC power		P
	- Indicates a fault in accordance with 13.9		P

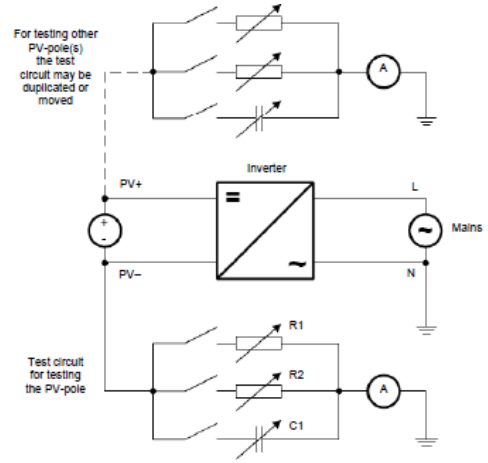
IEC 62109-2			
Clause	Requirement – Test	Result - Remark	Verdict
4.4.4.15.2	Fault-tolerance of automatic disconnecting means		P
4.4.4.15.2.1	The means provided for automatic disconnection of a grid-interactive inverter from the mains shall:		P
	- disconnect all grounded current-carrying conductors from the mains		N/A
	- disconnect all ungrounded current-carrying conductors from the mains	2 approved relays used in all ungrounded AC conductors (line)	P
	- be such that with a single fault applied to the disconnection means or to any other location in the inverter, at least basic insulation or simple separation is maintained between the PV array and the mains when the disconnecting means is intended to be in the open state.	See above.	P
4.4.4.15.2.2	Design of insulation or separation complies with requirements of 7.3.7 of Part 1: report here Part 1 comment and verdict.  **Figure 20 – Example system discussed in Note 2 above**	PV array parameters (working voltage, impulse withstand voltage, and temporary over-voltage) are considered.	P
4.4.4.15.2.3	For non-isolated inverter, automatic checking of the isolation provided by a disconnect means after single fault.		P
	If the check fails: - any still-functional disconnection means shall be left in the open position		P
	- at least basic or simple separation shall be maintained between the PV input and the mains		P
	- the inverter shall not start operation		P
	- and the inverter shall indicate a fault in accordance with 13.9		P
4.4.4.16	A stand-alone inverter with a transfer switch to transfer AC loads from the mains or other AC bypass source to the inverter output:	All models can operate in the stand-alone mode	P
	- shall continue to operate normally		P

IEC 62109-2			
Clause	Requirement – Test	Result - Remark	Verdict
	- shall not present a risk of fire as the result of an out-of-phase transfer		P
	- shall not present a risk of shock as the result of an out-of-phase transfer		P
	- And having control preventing switching: components for malfunctioning……..…:		P
4.4.4.17	Cooling system failure – Blanketing test		P
	Test stop condition: time duration value or stabilized temperature…….……..……..…:	Stabilize without external surface of 'the inverter exceed 90℃	P
4.7	Electrical Ratings Tests *Additional subclauses:*	Refer to the clause 4.3 of report CN22T0P9 001	P
4.7.3	Measurement requirements for AC output ports for stand-alone inverters	All models can operate in the stand-alone mode	P
4.7.4	Stand-alone Inverter AC output voltage and frequency		P
4.7.4.1	General	All models can operate in the stand-alone mode	P
4.7.4.2	Steady state output voltage at nominal DC input The steady-state AC output voltage shall not be less than 90 % or more than 110 % of the rated nominal voltage with the inverter supplied with its nominal value of DC input voltage.		P
4.7.4.3	Steady state output voltage across the DC input range The steady-state AC output voltage shall not be less than 85 % or more than 110 % of the rated nominal voltage with the inverter supplied with any value within the rated range of DC input voltage.		P
4.7.4.4	Load step response of the output voltage at nominal DC input The AC output voltage shall not be less than 85 % or more than 110 % of the rated nominal voltage for more than 1,5 s after application or removal of a resistive load.		P
4.7.4.5	Steady state output frequency The steady-state AC output frequency shall not vary from the nominal value by more than +4 % or –6 %.		P
4.7.5	Stand-alone inverter output voltage waveform		P
4.7.5.1	General		P

IEC 62109-2			
Clause	Requirement – Test	Result - Remark	Verdict
4.7.5.2	The AC output voltage waveform of a sinusoidal output stand-alone inverter shall have a total harmonic distortion (THD) not exceeding of 10 % and no individual harmonic at a level exceeding 6 %.		P
4.7.5.3	Non-sinusoidal output waveform requirements		N/A
4.7.5.3.1	General		N/A
4.7.5.3.2	The total harmonic distortion (THD) of the voltage waveform shall not exceed 40 %.		N/A
4.7.5.3.3	The slope of the rising and falling edges of the positive and negative half-cycles of the voltage waveform shall not exceed 10 V/µs measured between the points at which the waveform has a voltage of 10 % and 90 % of the peak voltage for that half-cycle.		N/A
4.7.5.3.4	The absolute value of the peak voltage of the positive and negative half-cycles of the waveform shall not exceed 1,414 times 110 % of the RMS value of the rated nominal AC output voltage.		N/A
4.7.5.4	Information requirements for non-sinusoidal waveforms The instructions provided with a stand-alone inverter not complying with 4.7.5.2 shall include the information in 5.3.2.6.		N/A
4.7.5.5	Output voltage waveform requirements for inverters for dedicated loads. For an inverter that is intended only for use with a known dedicated load, the following requirements may be used as an alternative to the waveform requirements in 4.7.5.2 to 4.7.5.3.		N/A
	The combination of the inverter and dedicated load shall be evaluated to ensure that the output waveform does not cause any hazards in the load equipment and inverter, or cause the load equipment to fail to comply with the applicable product safety standards.		N/A
	The inverter shall be marked with symbols 9 and 15 of Table C.1 of Part 1.		N/A
	The installation instructions provided with the inverter shall include the information in 5.3.2.13.		N/A
4.8	Additional tests for grid-interactive inverters		P
4.8.1	General requirements regarding inverter isolation and array grounding	Non-isolated inverters for ungrounded arrays.	P
	- Type of Array grounding supported ……:	The PCE is intended to be used with the ungrounded arrays.	P

IEC 62109-2			
Clause	Requirement – Test	Result - Remark	Verdict
	- Inverter isolation ……..……..……..:	The PCE is non-isolated inverter.	P
4.8.2	Array insulation resistance detection for inverters for ungrounded and functionally grounded arrays		P
4.8.2.1	Array insulation resistance detection for inverters for ungrounded arrays	Inverter indicated the insulation fault and didn't connect to the grid when a resistor linked between PV+/- to ground.	P
	Inverter shall have means to measure DC insulation resistance from PV input (array) to ground before starting operation		P
	Or Inverter shall be provided with instruction in accordance with 5.3.2.11.		N/A
	Measured DC insulation resistance: ……..……:	(See appended table 4.8.2)	P
	Inverter measurement circuit shall be capable of detecting insulation resistance below the limit value R= Vmax/30mA under normal conditions	See above.	P
	Inverter measurement circuit shall be capable of detecting insulation resistance below the limit value R= Vmax/30mA with ground fault in the PV array.	See above.	P
	Isolated inverters shall indicate a fault if the insulation resistance is less than the limit value.	The PCE is non-isolated inverter.	N/A
	Isolated inverter fault indication maintained until insulation resistance has recovered to a value higher than the limit value.	See above.	N/A
	Non-isolated inverters, or inverters with isolation not complying with the leakage current limits in the minimum inverter isolation requirements in Table 30:	(See appended table 4.8.2)	P
	- shall indicate a fault in accordance with 13.9	See above.	P
	- shall not connect to the mains	See above.	P
4.8.2.2	Array insulation resistance detection for inverters for functionally grounded arrays	Not for functionally grounded arrays	N/A
	a-1) The value of the total resistance, including the intentional resistance for array functional grounding, the expected insulation resistance of the array to ground, and the resistance of any other networks connected to ground (for example measurement networks) must not be lower than R = (VMAX PV/30 mA) ohms.		N/A
	a-2) The installation instructions shall include the information required in 5.3.2.12.		N/A

IEC 62109-2			
Clause	Requirement – Test	Result - Remark	Verdict
	b-1) As an alternative to a), or if a resistor value lower than in a) is used, the inverter shall incorporate means to detect, during operation, if the total current through the resistor and any networks (for example measurement networks) in parallel with it, exceeds the residual current values and times in Table 31		N/A
	b-2) Inverter shall either disconnect the resistor or limit the current by other means ……..……:		N/A
	b-3) If the inverter is a non-isolated inverter, or has isolation not complying with the leakage current limits in the minimum inverter isolation requirements in Table 30, it shall also disconnect from the mains.		N/A
	c) The inverter shall have means to measure the DC insulation resistance from the PV input to ground before starting operation, in accordance with 4.8.2.1.		N/A
4.8.3	Array residual current detection		P
4.8.3.1	General		P
4.8.3.2	30mA touch current type test for isolated inverters	The PCE is non-isolated inverter.	N/A
4.8.3.3	Fire hazard residual current type test for isolated inverters	See above.	N/A
4.8.3.4	Protection by application of RCD's	Not used.	N/A
	- The requirement for additional protection in 4.8.3.1 can be met by provision of an RCD with a residual current setting of 30 mA, located between the inverter and the mains..		N/A
	- The selection of the RCD type to ensure compatibility with the inverter must be made according to rules for RCD selection in Part 1.		N/A
	- The RCD provided integral to the inverter, or		N/A
	- The RCD provided by the installer if details of the rating, type, and location for the RCD are given in the installation instructions per 5.3.2.9.	RCMU used for monitoring the residual current, additional type A RCD may be required between the inverter and the mains in end-use application for safety consideration if required by local code	N/A
4.8.3.5	Protection by residual current monitoring	RCMU used for monitoring the residual current.	P

IEC 62109-2			
Clause	Requirement – Test	Result - Remark	Verdict
4.8.3.5.1	General		P
	Where required by Table 30, the inverter shall provide residual current monitoring that functions whenever the inverter is connected to the mains with the automatic disconnection means closed.		P
	The residual current monitoring means shall measure the total (both a.c. and d.c. components) RMS current.  **Figure 21 – Example test circuit for residual current detection testing**		P
	As indicated in Table 30 for different inverter types, array types, and inverter isolation levels, detection may be required for excessive continuous residual current, excessive sudden changes in residual current, or both, according to the following limits:		P
	a) Continuous residual current: The inverter shall disconnect within 0,3 s and indicate a fault in accordance with 13.9 if the continuous residual current exceeds:		P
	- maximum 300 mA for inverters with continuous ouput power rating ≤30kV;		P
	- maximum 10 mA per kVA of rated continuous output power for inverters with continuous output power rating > 30 kVA.		N/A
	The inverter may attempt to re-connect if the array insulation resistance meets the limit in 4.8.2.		P

IEC 62109-2			
Clause	Requirement – Test	Result - Remark	Verdict
	b) Sudden changes in residual current: The inverter shall disconnect from the mains within the time specified in Table 31 Table 31 – Response time limits for sudden changes in residual current Residual current sudden change: 30 mA / 60 mA / 150 mA Max. time to inverter disconnection from the mains: 0,3 s / 0,15 s / 0,04 s NOTE These values of residual current and time are based on the RCD standard IEC 61008-1.		P
	The inverter indicates a fault in accordance with 13.9, if a sudden increase in the RMS residual current is detected exceeding the value in the table.		P
	The inverter may attempt to re-connect if the array insulation resistance meets the limit in 4.8.2.		P
4.8.3.5.2	Test for detection of excessive continuous residual current: test repeated 5 times and time to disconnect shall not exceed 0,3 s.	(See appended table 4.8.3.5.2)	P
4.8.3.5.3	Test for detection of sudden changes in residual current repeated 5 times and each of the 5 results shall not exceed the time limit indicated in for each row (30mA, 60mA and150mA) of Table 31.	(See appended table 4.8.3.5.3)	P
4.8.3.6	Systems located in closed electrical operating areas	Not specified to be located in closed electrical operating area.	N/A
	The protection against shock hazard is not required if the installation information provided with the inverter indicates the restriction for use in a closed electrical operating area, and		N/A
	Installation information indicates what forms of shock hazard protection are and are not provided integral to the inverter, in accordance with 5.3.2.7.		N/A
	The inverter shall be marked as in 5.2.2.6.		N/A
5	Marking and documentation *This clause of Part 1 is applicable with the following exceptions:*		P

IEC 62109-2			
Clause	Requirement – Test	Result - Remark	Verdict
5.1	Marking		P
5.1.4	Equipment ratings *Replacement:*	(See copy of marking plate in part 1 test report CN22T0P9 001.)	P
	PV input ratings:		P
	- Vmax PV (absolute maximum) (d.c. V)		P
	- Isc PV (absolute maximum) (d.c. A)		P
	a.c. output ratings:		P
	- Voltage (nominal or range) (a.c. V)		P
	- Current (maximum continuous) (a.c. A)		P
	- Frequency (nominal or range) (Hz)		P
	- Power (maximum continuous) (W or VA)		P
	- Power factor range		P
	a.c input ratings:		P
	- Voltage (nominal or range) (a.c. V)		P
	- Current (maximum continuous) (a.c. A)		P
	- Frequency (nominal or range) (Hz)		P
	d.c. output ratings:	Battery circuit	P
	- Voltage (nominal or range) (d.c. V)		P
	- Current (maximum continuous) (d.c. A)		P
	Protective class (I or II or III)	Class I	P
	Ingress protection (IP) rating per part 1	IP65	P
	An inverter that is adjustable for more than one nominal output voltage shall be marked to indicate the particular voltage for which it is set when shipped from the factory.		N/A
5.2	Warning markings		P
5.2.2	Content for warning markings		P
5.2.2.6	Inverters for closed electrical operating areas		P
	Where required by 4.8.3.6, an inverter not provided with full protection against shock hazard on the PV array shall be marked with a warning that the inverter is only for use in a closed electrical operating area, and referring to the installation instructions.		N/A
5.3	Documentation		P
5.3.2	Information related to installation *Additional subclauses:*		P

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Clause	Requirement – Test	Result - Remark	Verdict
5.3.2.1	Ratings. Subclause 5.3.2 of Part 1 requires the documentation to include ratings information for each input and output. For inverters this information shall be as in Table 33 below. Only those ratings that are applicable based on the type of inverter are required.	Ratings are listed in label and user manual	P
	PV input quantities :		P
	- Vmax PV (absolute maximum) (d.c. V)		P
	- PV input operating voltage range (d.c. V)		P
	- Maximum operating PV input current (d.c. A)		P
	- Isc PV (absolute maximum) (d.c. A)		P
	- Isc PV (absolute maximum) (d.c. A)		P
	- Max. inverter backfeed current to the array (a.c. or d.c. A)		P
	a.c. output quantities:		P
	- Voltage (nominal or range) (a.c. V)		P
	- Current (maximum continuous) (a.c. A)		P
	- Current (inrush) (a.c. A, peak and duration)		N/A
	- Frequency (nominal or range) (Hz)		P
	- Power (maximum continuous) (W or VA)		P
	- Power factor range		P
	- Maximum output fault current (a.c. A, peak and duration or RMS)		P
	- Maximum output overcurrent protection (a.c. A)		P
	a.c. input quantities:		N/A
	- Voltage (nominal or range) (a.c. V)		N/A
	- Current (maximum continuous) (a.c. A)		N/A
	- Current (inrush) (a.c. A, peak and duration)		N/A
	- Frequency (nominal or range) (Hz)		N/A
	d.c input (other than PV) quantities:	Battery circuit	P
	- Voltage (nominal or range) (d.c. V)		P
	- Nominal battery voltage (d.c. V)		P
	- Current (maximum continuous) (d.c. A)		P
	d.c. output quantities:	Battery circuit	P
	- Voltage (nominal or range) (d.c. V)		P

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Clause	Requirement – Test	Result - Remark	Verdict
	- Nominal battery voltage (d.c. V)		P
	- Current (maximum continuous) (d.c. A)		P
	Protective class (I or II or III)	Class I	P
	Ingress protection (IP) rating per part 1	IP65	
5.3.2.2	Grid-interactive inverter setpoints		P
	For a grid-interactive unit with field adjustable trip points, trip times, or reconnect times, the presence of such controls, the means for adjustment, the factory default values, and the limits of the ranges of adjustability shall be provided in the documentation for the PCE or in other format such as on a website. Provided solution: …….…….…….…….…….……..	Relevant information provided in user manual.	P
	The setting of field adjustable setpoints shall be accessible rom the PCE		P
5.3.2.3	Transformers and isolation		P
	whether an internal isolation transformer is provided, and if so, what level of insulation (functional, basic, reinforced, or double) is provided by that transformer. The instructions shall also indicate what the resulting installation requirements are regarding such things as earthing or not earthing the array, providing external residual current detection devices, etc.		P
	An inverter shall be provided with information to the installer regarding:		N/A
	- providing of internal isolation transformer		N/A
	- the level of insulation (functional, basic, reinforced, or double)		N/A
	The instructions shall also indicate what the resulting installation requirements are regarding:		N/A
	- earthing or not earthing the array		N/A
	- providing external residual current detection devices		N/A
	- requiring an external isolation transformer		N/A
5.3.2.4	Transformers required but not provided		N/A
	An inverter that requires an external isolation transformer not provided with the unit, shall be provided with instructions that specify, and for the external isolation transformer with which it is intended to be used:		N/A
	- the configuration type		N/A

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Clause	Requirement – Test	Result - Remark	Verdict
	- electrical ratings		N/A
	- environmental ratings		N/A
5.3.2.5	PV modules for non-isolated inverters		P
	Non-isolated inverters shall be provided with installation instructions that require PV modules that have an IEC 61730 Class A rating		P
	If the maximum AC mains operating voltage is higher than the PV array maximum system voltage then the instructions shall require PV modules that have a maximum system voltage rating based upon the AC mains voltage.		N/A
5.3.2.6	Non-sinusoidal output waveform information		N/A
	The instruction manual for a stand-alone inverter not complying with 4.7.5.2 shall include a warning that:	Grid-interactive inverter.	N/A
	- the waveform is not sinusoidal,		N/A
	- some loads may experience increased heating,		N/A
	- the user should consult the manufacturers of the intended load equipment before operating that load with the inverter		N/A
	The inverter manufacturer shall provide information regarding:		N/A
	- what types of loads may experience increased heating		N/A
	- recommendations for maximum operating times with such loads		N/A
	The inverter manufacturer shall specify for the waveforms as determined by the testing in 4.7.5.3.2 through 4.7.5.3.4.:		N/A
	- THD		N/A
	- slope		N/A
	- peak voltage		N/A
5.3.2.7	Systems located in closed electrical operating areas	Not specified to be located in closed electrical operating area.	N/A
	Where required by 4.8.3.6, an inverter not provided with full protection against shock hazard on the PV array shall be provided with installation instructions:		N/A

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Clause	Requirement – Test	Result - Remark	Verdict
	- requiring that the inverter and the array must be installed in closed electrical operating areas		N/A
	- indicating which forms of shock hazard protection are and are not provided integral to the inverter (for example the RCD, isolation transformer complying with the 30 mA touch current limit, or residual current monitoring for sudden changes)		N/A
5.3.2.8	Stand- alone inverter output circuit bonding	All models can operate in the stand-alone mode	P
	Where required by 7.3.10, the documentation for an inverter shall include the following:		P
	- if output circuit bonding is required but is not provided integral to the inverter, the required means shall be described in the installation instructions, including which conductor is to be bonded and the required current carrying capability or cross-section of the bonding means;	The requirements of output circuit bonding are described in the installation instruction.	P
	- if the output circuit is intended to be floating, the documentation for the inverter shall indicate that the output is floating.		N/A
5.3.2.9	Protection by application of RCD's	Integrated RCM provided in inverter.	N/A
	Where the requirement for additional protection in 4.8.3.1 is met by requiring an RCD that is not provided integral to the inverter, as allowed by 4.8.3.4, the installation instructions shall state the need for the RCD,.		N/A
	and shall specify its rating, type, and required circuit location		N/A
5.3.2.10	Remote indication of faults		P
	The installation instructions shall include an explanation of how to properly make connections to (where applicable), and use, the electrical or electronic fault indication required by 13.9.		P
5.3.2.11	External array insulation resistance measurement and response		N/A
	The installation instructions for an inverter for use with ungrounded arrays that does not incorporate all the aspects of the insulation resistance measurement and response requirements in 4.8.2.1, must include:		N/A

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Clause	Requirement – Test	Result - Remark	Verdict
	- for isolated inverters: an explanation of what aspects of array insulation resistance measurement and response are not provided, and		N/A
	- an instruction to consult local regulations to determine if any additional functions are required or not;		N/A
	- for non-isolated inverters: an explanation of what external equipment must be provided in the system, and		N/A
	- what the setpoints and response implemented by that equipment must be, and:		N/A
	- how that equipment is to be interfaced with the rest of the system.		N/A
5.3.2.12	Array functional grounding information		N/A
	Where approach a) of 4.8.2.2 is used, the installation instructions for the inverter shall include all of the following:		N/A
	a) the value of the total resistance between the PV circuit and ground integral to the inverter		N/A
	b) the minimum array insulation resistance to ground that system designer or installer must meet when selecting the PV panel and system design, based on the minimum value that the design of the PV functional grounding in the inverter was based on		N/A
	c) the minimum value of the total resistance R = VMAXPV/30 mA that the system must meet, with an explanation of how to calculate the total		N/A
	d) a warning that there is a risk of shock hazard if the total minimum resistance requirement is not met.		N/A
5.3.2.13	Stand-alone inverters for dedicated loads	No such dedicated loads	N/A
	Where the approach of 4.7.5.5 is used, the installation instructions for the inverter shall include a warning that the inverter is only to be used with the dedicated load for which it was evaluated, and		N/A
	shall specify the dedicated load.		N/A
5.3.2.14	Identification of firmware version(s)		P

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Clause	Requirement – Test	Result - Remark	Verdict
	An inverter utilizing firmware for any protective functions shall provide means to identify the firmware version.		P
	This can be a marking, but the information can also be provided by a display panel, communications port or any other type of user interface		P
6	Environmental requirements and conditions *This clause of Part 1 is applicable.*		P
7	Protection against electric shock and energy hazards *This clause of Part 1 is applicable except for the following additions:*		P
7.3	Protection against electric shock *Additional subclauses:*		P
7.3.10	Additional requirements for stand-alone inverters	All models can operate in the stand-alone mode	P
	One circuit conductor bonded to earth to create a grounded conductor and an earthed system.		P
	The means used to bond the grounded conductor to protective earth provided within the inverter or		N/A
	as part of the installation		P
	If not provided integral to the inverter, the required means shall be described in the installation instructions as per 5.3.2.8.	The requirements of output circuit bonding are described in the installation instruction.	P
	The means used to bond the grounded conductor to protective earth shall comply with the requirements for protective bonding in Part 1,		P
	If the bond can only ever carry fault currents in stand-alone mode, the maximum current for the bond is determined by the inverter maximum output fault current.	No such use.	N/A
	Output circuit bonding arrangements shall ensure that in any mode of operation, the system only has the grounded circuit conductor bonded to earth in one place at a time..		P
	Switching arrangements may be used, in which case the switching device used is to be subjected to the bond impedance test along with the rest of the bonding path		N/A

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Clause	Requirement – Test	Result - Remark	Verdict
	Inverters intended to have a circuit conductor bonded to earth shall not impose any normal current on the bond except for leakage current.		P
	Outputs that are intentionally floating with no circuit conductor bonded to ground, must not have any voltages with respect to ground that are a shock hazard in accordance with Clause 7 of Parts 1 and 2.		N/A
	The documentation for the inverter shall indicate that the output is floating as per 5.3.2.8.		P
7.3.11	Functionally grounded arrays		N/A
	All PV conductors in a functionally grounded array shall be treated as being live parts with respect to protection against electric shock.		N/A
8	Protection against mechanical hazards *This clause of Part 1 is applicable.*		P
9	Protection against fire hazards *This clause of Part 1 is applicable with the following exceptions:*		P
9.3	Short-circuit and overcurrent protection *Additional subclause:*		P
9.3.4	Inverter backfeed current onto the array		P
	The backfeed current testing and documentation requirements in Part 1 apply, including but not limited to the following.		P
	Inverter backfeed current onto the PV array maximum value……..……..……..…..:		P
	This inverter backfeed current value shall be provided in the installation instructions regardless of the value of the current, in accordance with Table 33.		P
10	Protection against sonic pressure hazards *This clause of Part 1 is applicable*		P
11	Protection against liquid hazards *This clause of Part 1 is applicable*		P
12	Protection against chemical hazards *This clause of Part 1 is applicable*		P

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Clause	Requirement – Test	Result - Remark	Verdict
13	Physical requirements *This clause of Part 1 is applicable with the following exception:* *Additional subclause:*		P
13.9	Fault indication		P
	Where this Part 2 requires the inverter to indicate a fault, both of the following shall be provided:		P
	a) a visible or audible indication, integral to the inverter, and detectable from outside the inverter, and	Display panel is available for fault indication.	P
	b) an electrical or electronic indication that can be remotely accessed and used.	RS485 port are available for remoting communication.	P
	The installation instructions shall include information regarding how to properly make connections (where applicable) and use the electrical or electronic means in b) above, in accordance with 5.3.2.10.		P
14	Components *This clause of Part 1 is applicable*		P

4.7.4.4	TABLE: Steady state Inverter AC output voltage and frequency	P
	Nominal output AC voltage [V]:	230
	Nominal output frequency [Hz]:	50/60

Condition	Output Voltage (V)	Output Frequency (Hz)	Maximum time, s before cessation of current
A	226	50	Measure after 1.5s
B	230	50	Measure after 1.5s
C	229	50	Measure after 1.5s
D	229	50	Measure after 1.5s
E	215	50	Measure after 1.5s
F	230	50	Measure after 1.5s
G	221	50	Measure after 1.5s
H	230	50	Measure after 1.5s
A	229	60	Measure after 1.5s
B	228	60	Measure after 1.5s
C	228	60	Measure after 1.5s
D	229	60	Measure after 1.5s
E	220	60	Measure after 1.5s
F	337	60	Measure after 1.5s
G	221	60	Measure after 1.5s
H	230	60	Measure after 1.5s

Note(s):

A .Upper PV input range, load condition from no load to full load
B. Upper PV input range, load condition from full load to no load
C .Lower PV input range, load condition from no load to full load
D. Lower PV input range, load condition from full load to no load
E .Upper Battery input range, load condition from no load to full load
F. Upper Battery input range, load condition from full load to no load
G .Lower Battery input range, load condition from no load to full load
H. Lower Battery input range, load condition from full load to no load

4.7.5	**Stand-alone inverter output voltage waveform**	P

Table of Harmonic current measurement 5%LOAD

Order	Harmonic %	Harmonic limit %	Order	Harmonic %	Harmonic limit %
2	0.0053	6,0%	3	0.0130	6,0%
4	0.0027	6,0%	5	0.0161	6,0%

6	0.0021	6,0%	7	0.0070	6,0%
8	0.0023	6,0%	9	0.0024	6,0%
10	0.0016	6,0%	11	0.0115	6,0%
12	0.0017	6,0%	13	0.0047	6,0%
14	0.0017	6,0%	15	0.0050	6,0%
16	0.0017	6,0%	17	0.0043	6,0%
18	0.0020	6,0%	19	0.0040	6,0%
20	0.0017	6,0%	21	0.0049	6,0%
22	0.0020	6,0%	23	0.0023	6,0%
24	0.0024	6,0%	25	0.0027	6,0%
26	0.0021	6,0%	27	0.0032	6,0%
28	0.0022	6,0%	29	0.0023	6,0%
30	0.0027	6,0%	31	0.0023	6,0%
32	0.0024	6,0%	33	0.0030	6,0%
34	0.0024	6,0%	35	0.0024	6,0%
36	0.0030	6,0%	37	0.0022	6,0%
38	0.0029	6,0%	39	0.0027	6,0%
40	0.0028	6,0%	-	-	-
Total harmonic distortion	0.3378	10%	-	-	-

4.7.5	**Stand-alone inverter output voltage waveform**	P

Table of Harmonic current measurement 50%LOAD

Order	Harmonic %	Harmonic limit %	Order	Harmonic %	Harmonic limit %
2	0.0050	6,0%	3	0.0287	6,0%
4	0.0023	6,0%	5	0.0233	6,0%
6	0.0019	6,0%	7	0.0038	6,0%

8	0.0017	6,0%	9	0.0019	6,0%
10	0.0015	6,0%	11	0.0114	6,0%
12	0.0019	6,0%	13	0.0106	6,0%
14	0.0020	6,0%	15	0.0096	6,0%
16	0.0019	6,0%	17	0.0091	6,0%
18	0.0018	6,0%	19	0.0086	6,0%
20	0.0017	6,0%	21	0.0083	6,0%
22	0.0017	6,0%	23	0.0070	6,0%
24	0.0016	6,0%	25	0.0068	6,0%
26	0.0016	6,0%	27	0.0064	6,0%
28	0.0016	6,0%	29	0.0067	6,0%
30	0.0015	6,0%	31	0.0067	6,0%
32	0.0015	6,0%	33	0.0070	6,0%
34	0.0015	6,0%	35	0.0067	6,0%
36	0.0016	6,0%	37	0.0063	6,0%
38	0.0017	6,0%	39	0.0061	6,0%
40	0.0019	6,0%	-	-	-
Total harmonic distortion	0.0541	10%	-	-	-

4.7.5	**Stand-alone inverter output voltage waveform**	P

Table of Harmonic current measurement 100%LOAD

Order	Harmonic %	Harmonic limit %	Order	Harmonic %	Harmonic limit %
2	0.0073	6,0%	3	0.0249	6,0%
4	0.0022	6,0%	5	0.0246	6,0%
6	0.0020	6,0%	7	0.0220	6,0%
8	0.0024	6,0%	9	0.0054	6,0%

10	0.0029	6,0%	11	0.0120	6,0%
12	0.0016	6,0%	13	0.0103	6,0%
14	0.0017	6,0%	15	0.0086	6,0%
16	0.0016	6,0%	17	0.0081	6,0%
18	0.0017	6,0%	19	0.0102	6,0%
20	0.0018	6,0%	21	0.0098	6,0%
22	0.0017	6,0%	23	0.0103	6,0%
24	0.0018	6,0%	25	0.0110	6,0%
26	0.0019	6,0%	27	0.0108	6,0%
28	0.0019	6,0%	29	0.0112	6,0%
30	0.0018	6,0%	31	0.0108	6,0%
32	0.0018	6,0%	33	0.0108	6,0%
34	0.0018	6,0%	35	0.0103	6,0%
36	0.0018	6,0%	37	0.0097	6,0%
38	0.0019	6,0%	39	0.0096	6,0%
40	0.0020	6,0%	-	-	-
Total harmonic distortion	0.0678	10%	-	-	-
Supplementary information:					

4.8.2.1	TABLE: Insulation resistance measurement				P
Conditions	Measurement [I.F. / N.O.]				Identification
	PV / DC Supply Voltage [Vdc]				
	75	100	290	500	
PV+ to PE: 18 [kΩ]	I.F.	I.F.	I.F.	I.F.	I.F.: Isolation Fault N.O.: Normal Operation
PV- to PE: 18 [kΩ]	I.F.	I.F.	I.F.	I.F.	
PV+ to PE: 20 [kΩ]	I.F.	I.F.	I.F.	I.F.	
PV- to PE: 20 [kΩ]	I.F.	I.F.	I.F.	I.F.	
PV+ to PE: 22 [kΩ]	N.O.	N.O.	N.O.	N.O.	

PV- to PE: 22 [kΩ]	N.O.	N.O.	N.O.	N.O.	

Note:
Array Insulation Resistance Threshold Value R = 20 [kΩ] (Should be larger than R = $V_{MAX\,PV}$ / 30mA.)
The accuracy of resistance measurement △R = 2 [kΩ] (the value declared by manufacturer)

4.8.3.2	TABLE: 30mA touch current type test for isolated inverters			N/A
Condition	PV supply " + " → terminal A [mA]	PV supply " - " → terminal A [mA]	Limit [mA]	Comments
Touch current	--	--	30	--

Supplementary information:
The touch current measurement circuit of IEC 60990, Figure 4 is connected from each terminal of the array to ground, one at a time.

4.8.3.3	TABLE: Fire hazard residual current type test for isolated inverters			N/A
Condition	PV supply " + " → earthing [mA]	PV supply " - " → earthing [mA]	Limit [mA]	Comments
fire hazard residual current	--	--	300	Inverter ≤ 30KVA
fire hazard residual current	--	--	10mA per KVA	Inverter > 30KVA

Supplementary information:
Using ammeter for testing fire hazard residual current.

4.8.3.5.1	TABLE: Residual current monitoring test		P
Conditions	Steadily Residual current threshold value		
	Measurement [mA]	Measured Disconnection time[ms]	Limit [mA]
	U_N		
PV+ to Neutral	159	128	300
	148	132	300
	148	129	300
	149	125	300
	159	126	300
PV- to Neutral	154	89	300
	154	93	300
	155	92	300

	153	92	300
	154	98	300
Note: 100 output power and Vmppmax input voltage			

4.8.3.5.1	TABLE: Residual current monitoring test		P
Conditions	Trigger disconnection maximum time		
	Measurement [ms]		Limit [ms]
	U_N		
Sudden residual current ≥ 30mA			
PV+ to Neutral	122		300
	132		300
	132		300
	123		300
	126		300
PV- to Neutral	206		300
	144		300
	133		300
	145		300
	182		300
Sudden residual current ≥ 60mA			
PV+ to Neutral	89		150
	86		150
	79		150
	86		150
	90		150
PV- to Neutral	124		150
	118		150
	119		150
	127		150
	134		150
Sudden residual current ≥ 150mA			
PV+ to Neutral	11		40
	13		40
	13		40
	19		40

	16	40
PV- to Neutral	23	40
	19	40
	17	40
	15	40
	15	40
Note: 100 output power and Vmppmax input voltage		

- End of test report -