TEST REPORT

XP C15-712-3

Photovoltaic installations with energy storage and connected to a public distribution network

Report reference number..... :	**PVFR200917N016-2**
Date of issue..... ……..:	2021-02-26
Total number of pages..... ……..:	93
Testing laboratory name..... :	**Bureau Veritas Shenzhen Co., Ltd. Dongguan Branch**
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Accrediation.....:	ilac-MRA A2LA ACCREDITED Certificate # 2951.01
Applicant's name ..... :	**Shenzhen SOFARSOLAR Co., Ltd.**
Address.....:	401, Building 4, AnTongDa Industrial Park, District 68, XingDong Community, XinAn Street, BaoAn District, Shenzhen, China
Test specification	
Standard .....:	XP C 15-712-3:2019-05 in conjunction with VDE V 0126-1-1/A1 VFR 2019 ctions des Installations de Production raccordées au Réseau Public de ıution, Enedis-NOI-RES_13E, Version 7, 14/12/2018) With deviations for French Islands according protection de Découplage pour le Raccordement d'une production décentralisée en HTA et en BT dans les zones non interconnectées, référentiel technique – SEI REF 04, V6 With deviations for French Islands according contrat de raccordement, d'accès et d'exploitation (CRAE) pour une installation de production photovoltaïque raccordée au réseau public d'électricité
Test Report Form No.....:	XP C15-712-3 VER.1
TRF Originator.....:	Bureau Veritas Shenzhen Co., Ltd. Dongguan Branch
Master TRF.....:	Dated 2020-03-11

Test item description .....:	**Hybrid Inverter**
Trademark .....:	SOFAR SOLAR
Model / Type.....:	HYD 3000-EP, HYD 3680-EP, HYD 4000-EP, HYD 4600-EP, HYD 5000-EP, HYD 5500-EP, HYD 6000-EP

Ratings .....:	**HYD 3000-EP**	**HYD 3680-EP**	**HYD 4000-EP**
Full load MPP DC voltage range [V] :	160-520V	180-520V	200-520V
Input DC voltage range[V].....:	90-600V		
Input DC current [A].....:	Max. 13A/13A		
Output AC voltage [V].....:	L/N/PE, 230Vac, 50Hz		
Output AC current [A].....:	15,0	16,0	20,0
Output power [W] .....:	3000	3680	4000
Max. output power [VA].....:	3300	3680	4400
Output DC voltage range [V].....: [Battery charge].....:	42-58V		
Input/Output DC current [A].....: [Battery charge/discharge] .....:	Max. 75A	Max. 80A	Max. 85A
Charge and discharge power[W].....:	Max. 3750	Max. 4000	Max. 4250
Output AC voltage [V].....:	L/N/PE, 230Vac, 50Hz		
Max. Input/Output AC current [A].....: [Battery charge/discharge mode] ...:	13,6	16,0	18,2
Max. Input/Output AC power [VA].....: [Battery charge/discharge mode] ...:	3000	3680	4000

Ratings .....:	**HYD 4600-EP**	**HYD 5000-EP**	**HYD 5500-EP**
Full load MPP DC voltage range [V] :	230-520V	250-520V	250-520V
Input DC voltage range[V].....:	90-600V		
Input DC current [A].....:	Max. 13A/13A		
Output AC voltage [V].....:	L/N/PE, 230Vac, 50Hz		
Output AC current [A].....:	20,9	21,7	25,0
Output power [W] .....:	4600	5000	5000
Max. output power [VA].....:	4600	5000	5500
Output DC voltage range [V].....: [Battery charge]……:	42-58V		
Input/Output DC current [A].....: [Battery charge/discharge] ……:	Max. 100A		
Charge and discharge power[W].....:	Max. 5000		
Output AC voltage [V].....:	L/N/PE, 230Vac, 50Hz		
Max. Input/Output AC current [A].....: [Battery charge/discharge mode] …:	20,9	22,7	22,7
Max. Input/Output AC power [VA]....: [Battery charge/discharge mode] …:	4600	5000	5000

Ratings .....:	**HYD 6000-EP**
Full load MPP DC voltage range [V] :	300-520V
Input DC voltage range[V].....:	90-600V
Input DC current [A].....:	Max. 13A/13A
Output AC voltage [V].....:	L/N/PE, 230Vac, 50Hz
Output AC current [A].....:	27,3
Output power [W] .....:	6000
Max. output power [VA].....:	6000
Output DC voltage range [V].....: [Battery charge]……:	42-58V
Input/Output DC current [A].....: [Battery charge/discharge] ……:	Max. 100A
Charge and discharge power[W].....:	Max. 5000
Output AC voltage [V].....:	L/N/PE, 230Vac, 50Hz
Max. Input/Output AC current [A].....: [Battery charge/discharge mode] …:	22,7
Max. Input/Output AC power [VA]....: [Battery charge/discharge mode] …:	5000

Testing Location ..... :	**Bureau Veritas Shenzhen Co., Ltd. Dongguan Branch**
Address ..... :	No. 96, Guantai Road (Houjie Section), Houjie Town, Dongguan City, Guangdong Province, 523942, People's Republic of China
Tested by (name and signature) ..... :	Lukes Lin 
Approved by (name and signature) ..... :	James Huang 
Manufacturer's name ..... :	**Shenzhen SOFARSOLAR Co., Ltd.**
Manufacturer address ..... :	401, Building 4, AnTongDa Industrial Park, District 68, XingDong Community, XinAn Street, BaoAn District, Shenzhen, China
Factory's name ..... :	**Dongguan SOFAR SOLAR Co.,Ltd.**
Factory address	1F - 6F, Building E, No. 1 JinQi Road, Bihu Industrial Park, Wulian Village, Fenggang Town, Dongguan City

Document History			
Date	**Internal reference**	**Modification / Change / Status**	**Revision**
2021-02-26	Lukes Lin	Initial report was written	0
Supplementary information:			

Test items particulars

Equipment mobility ..... :	Permanent connection
Operating condition ..... :	Continuous
Class of equipment ..... :	Class I
Protection against ingress of water .. :	IP65 according to EN 60529
Mass of equipment [kg] ..... :	21,5

Test case verdicts

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

Testing

Date of receipt of test item ..... :	2020-09-17
Date(s) of performance of test ..... :	2020-09-17 to 2021-02-25

General remarks:

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

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

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

This Test Report consists of the following documents:

1. Test Results
2. Annex No. 1 –DIN V VDE V 0126-1-1:2006-02/A1:2012-02 Test Report
3. Annex No. 2 – Pictures of the unit
4. Annex No. 3 – Test equipment list

Copy of marking plates:

SOFAR SOLAR

Hybrid Inverter

Model No:	HYD 3000-EP
Max.DC Input Voltage	600V
Operating MPPT Voltage Range	90V~580V
MAX.PV Isc	2x18A
Battery Type	Lead-acid,Lithium-ion
Battery Voltage Range	42-58V
Max.Charging Current	75A
Max.Discharging Current	75A
Max.Charging&Discharging Power	3750W
Nominal Grid Voltage	230Vac
Nominal Output Voltage	230Vac
Max.Output Current	15.0A
Nominal Grid Frequency	50/60Hz
Power Factor	1(adjustable+/-0.8)
Nominal Output Power	3000W
Backup Rated Current	13.6A
Backup Rated Apparent Power	3000VA
Ingress Protection	IP 65
Operating Temperature Range	-30-+60℃
Protective Class	Class I

Manufacturer : Shenzhen SOFARSOLAR Co., Ltd.
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G98,AS4777,UTE C15-712-1

SOFAR SOLAR

Hybrid Inverter

Model No:	HYD 3680-EP
Max.DC Input Voltage	600V
Operating MPPT Voltage Range	90V~580V
MAX.PV Isc	2x18A
Battery Type	Lead-acid,Lithium-ion
Battery Voltage Range	42-58V
Max.Charging Current	80A
Max.Discharging Current	80A
Max.Charging&Discharging Power	4000W
Nominal Grid Voltage	230Vac
Nominal Output Voltage	230Vac
Max.Output Current	16.0A
Nominal Grid Frequency	50/60Hz
Power Factor	1(adjustable+/-0.8)
Nominal Output Power	3680W
Backup Rated Current	16.0A
Backup Rated Apparent Power	3680VA
Ingress Protection	IP 65
Operating Temperature Range	-30-+60℃
Protective Class	Class I

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SOFAR SOLAR

Hybrid Inverter

Model No:	HYD 4000-EP
Max.DC Input Voltage	600V
Operating MPPT Voltage Range	90V~580V
MAX.PV Isc	2x18A
Battery Type	Lead-acid,Lithium-ion
Battery Voltage Range	42-58V
Max.Charging Current	85A
Max.Discharging Current	85A
Max.Charging&Discharging Power	4250W
Nominal Grid Voltage	230Vac
Nominal Output Voltage	230Vac
Max.Output Current	20.0A
Nominal Grid Frequency	50/60Hz
Power Factor	1(adjustable+/-0.8)
Nominal Output Power	4000W
Backup Rated Current	18.2A
Backup Rated Apparent Power	4000VA
Ingress Protection	IP 65
Operating Temperature Range	-30-+60℃
Protective Class	Class I

Manufacturer : Shenzhen SOFARSOLAR Co., Ltd.
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SOFAR SOLAR

Hybrid Inverter

Model No:	HYD 4600-EP
Max.DC Input Voltage	600V
Operating MPPT Voltage Range	90V~580V
MAX.PV Isc	2x18A
Battery Type	Lead-acid,Lithium-ion
Battery Voltage Range	42-58V
Max.Charging Current	100A
Max.Discharging Current	100A
Max.Charging&Discharging Power	5000W
Nominal Grid Voltage	230Vac
Nominal Output Voltage	230Vac
Max.Output Current	20.9A
Nominal Grid Frequency	50/60Hz
Power Factor	1(adjustable+/-0.8)
Nominal Output Power	4600W
Backup Rated Current	20.9A
Backup Rated Apparent Power	4600VA
Ingress Protection	IP 65
Operating Temperature Range	-30-+60℃
Protective Class	Class I

Manufacturer : Shenzhen SOFARSOLAR Co., Ltd.
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Copy of marking plates:

SOFAR SOLAR

Hybrid Inverter

Model No:	HYD 5000-EP
Max.DC Input Voltage	600V
Operating MPPT Voltage Range	90V~580V
MAX.PV Isc	2x18A
Battery Type	Lead-acid,Lithium-ion
Battery Voltage Range	42-58V
Max.Charging Current	100A
Max.Discharging Current	100A
Max.Charging&Discharging Power	5000W
Nominal Grid Voltage	230Vac
Nominal Output Voltage	230Vac
Max.Output Current	21.7A
Nominal Grid Frequency	50/60Hz
Power Factor	1(adjustable+/-0.8)
Nominal Output Power	5000W
Backup Rated Current	22.7A
Backup Rated Apparent Power	5000VA
Ingress Protection	IP 65
Operating Temperature Range	-30-+60℃
Protective Class	Class I

Manufacturer : Shenzhen SOFARSOLAR Co., Ltd.
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SOFAR SOLAR

Hybrid Inverter

Model No:	HYD 5500-EP
Max.DC Input Voltage	600V
Operating MPPT Voltage Range	90V~580V
MAX.PV Isc	2x18A
Battery Type	Lead-acid,Lithium-ion
Battery Voltage Range	42-58V
Max.Charging Current	100A
Max.Discharging Current	100A
Max.Charging&Discharging Power	5000W
Nominal Grid Voltage	230Vac
Nominal Output Voltage	230Vac
Max.Output Current	25.0A
Nominal Grid Frequency	50/60Hz
Power Factor	1(adjustable+/-0.8)
Nominal Output Power	5000W
Backup Rated Current	22.7A
Backup Rated Apparent Power	5000VA
Ingress Protection	IP 65
Operating Temperature Range	-30-+60℃
Protective Class	Class I

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G98,AS4777,UTE C15-712-1

SOFAR SOLAR

Hybrid Inverter

Model No:	HYD 6000-EP
Max.DC Input Voltage	600V
Operating MPPT Voltage Range	90V~580V
MAX.PV Isc	2x18A
Battery Type	Lead-acid,Lithium-ion
Battery Voltage Range	42-58V
Max.Charging Current	100A
Max.Discharging Current	100A
Max.Charging&Discharging Power	5000W
Nominal Grid Voltage	230Vac
Nominal Output Voltage	230Vac
Max.Output Current	27.3A
Nominal Grid Frequency	50/60Hz
Power Factor	1(adjustable+/-0.8)
Nominal Output Power	6000W
Backup Rated Current	22.7A
Backup Rated Apparent Power	5000VA
Ingress Protection	IP 65
Operating Temperature Range	-30-+60℃
Protective Class	Class I

Manufacturer : Shenzhen SOFARSOLAR Co., Ltd.
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VDE0126-1-1,VDE-AR-N4105
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Risque de présence de plusieurs sources de tension

General product information:

The Hybrid Inverter converts DC voltage into AC voltage.

The DC input of Hybrid Inverter can be supplied from PV array and batteries.

The charging current to batteries from PV array and power grid, battery management unit is integrated in External Energy storage.

The unit is providing EMC filtering at the output toward mains. The unit does not provide galvanic separation from input to output (transformerless). The output is switched off redundant by the high power switching bridge and two relays. This assures that the opening of the output circuit will also operate in case of one error.

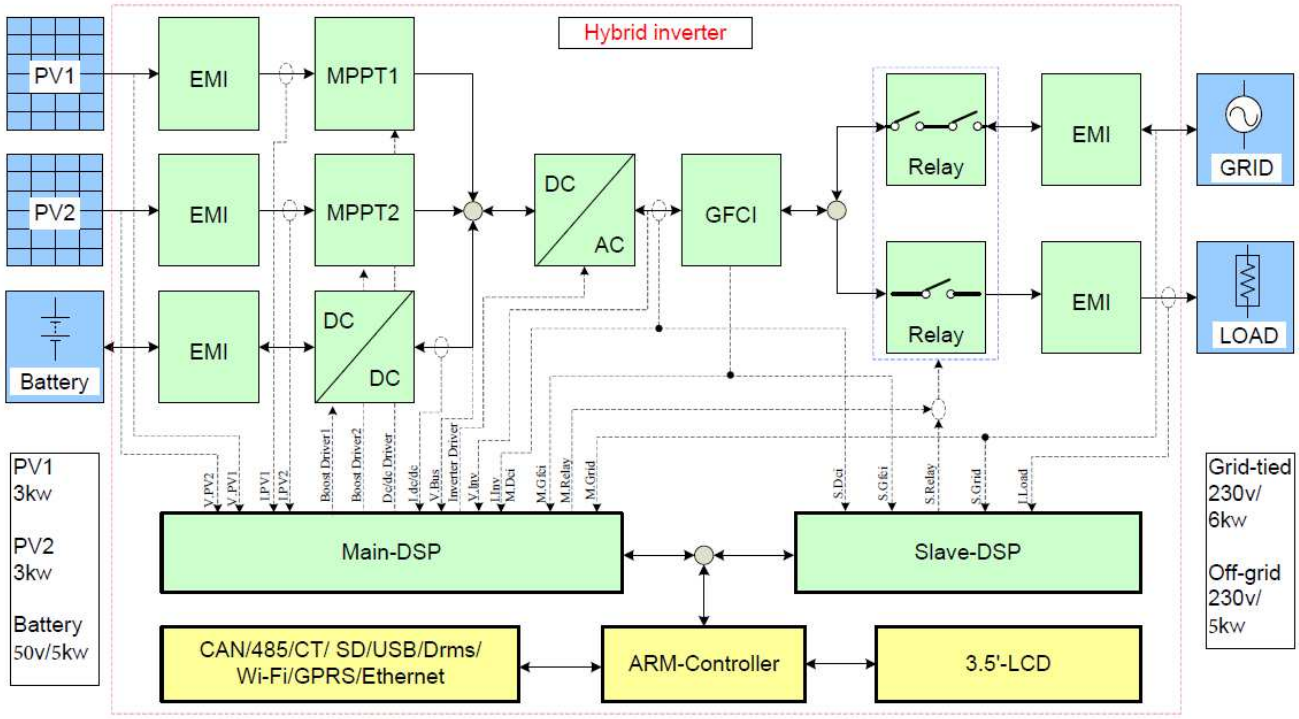


Figure 1 – Block diagram

The internal control is redundant built. It consists of Main MCU (U4) and slave MCU(U43).

The Main MCU (U4) can control the relays, measures voltage, and frequency, AC current with injected DC, insulation resistance and residual current, In addition it tests the array insulation resistance and the RCMU circuit before each start up.

The slave MCU (U43) is using for controlling the relays, measuring the voltage， frequency, inject a dc AC current, the residual current, and communicating with the master MCU (U4). And if the communicating with the master MCU, the slave MCU will disconnect the relays.

The unit provides two relays in series on Line and Neutral conductors. When single-fault applied to one relay, alarm an error code in display panel, another redundant relay provides basic insulation maintained between the PV array and the mains. All the relays are tested before start up. Both controllers Main MCU (U4), Slave MCU (U43) can open the relays.

Model difference:

The models HYD 6000-EP, HYD 5500-EP, HYD 5000-EP, HYD 4600-EP, HYD 4000-EP, HYD 3680-EP and HYD 3000-EP are use the identical hardware platform, control unit, control system and software except the output power derated by software and in following table descripts for different.

	HYD 6000-EP	HYD 5500-EP	HYD 5000-EP	HYD 4600-EP	HYD 4000-EP	HYD 3680-EP	HYD 3000-EP
Resistor ↓ R332, R334, R336	(0Ω, NC, 0Ω)				(NC, 0Ω, NC)		
BUS capacitors	8 pcs				6 pcs		
Inductor	0,75mH				1.035mH		
Sampling resistor of output current (R123,R132)	(1,5kΩ, 1,5kΩ)				(499Ω, 499Ω)		

The product was tested on:
Hardware version: V001
Software version: V02000

All tests were performed on HYD 6000-EP and HYD 3000-EP are valid for the HYD 5500-EP, HYD 5000-EP, HYD 4600-EP, HYD 4000-EP and HYD 3680-EP since it's use the identical hardware and software construction except output power derated by software.

The following deviations for France according DIN V VDE V 0126-1-1/A1 VFR 2019 has been applied according Protections des Installations de Production raccordées au Réseau Public de Distribution, Enedis-NOI-RES_13E, Version 7, 14/12/2018.		
Parameter	**Max. clearance time**	**Trip setting**
Over voltage	200ms	264,5V
Under voltage	200ms	184,0V
Over frequency	200ms	51,50Hz
Under frequency	200ms	47,50Hz
Reconnection time	>=30s	>=30s

The following deviations for French Islands to UTE C15-712-1 and DIN V VDE V 0126-1-1 (VDE V 0126-1-1):2006-02 have been applied according to protection de Découplage pour le Raccordement d'une production décentralisée en HTA et en BT dans les zones non interconnectées, référentiel technique – SEI REF 04, V6:		
Parameter	**Max. clearance time**	**Trip setting**
Over voltage	200ms	255,3V
Under voltage	200ms	195,5V
Over frequency	200ms	52,0Hz
Under frequency	200ms	46,0Hz
Reconnection time	>=30s	>=30s

The following deviations for French Islands to UTE C15-712-1 and DIN V VDE V 0126-1-1 (VDE V 0126-1-1):2006-02 have been applied according to Contrat de raccordement, d'accès et d'exploitation (CRAE) pour une installation de production photovoltaïque raccordée au Réseau Public d'électricité:		
Parameter	**Max. clearance time**	**Trip setting**
Over voltage	200ms	264,5V
Under voltage	200ms	195,5V
Over frequency	200ms	62,5Hz
Under frequency	200ms	55,0Hz
Reconnection time	>=30s	>=30s

XP C15-712-3			
Clause/ §	**Requirement**	**Remark**	**Verdict**

1	**Introduction** The use of photovoltaic generators associated with an energy storage system gives the possibility to consume locally the energy produced by these generators while being permanently connected or not to the public distribution network. The development of such facilities requires the specification of the implementation rules that are the subject of this document. The application of these rules must be carried out in compliance with the standards, regulations and administrative regulations in force to which certain installations are required to comply
2	**Scope** This document concerns low-voltage PV systems with a storage device and connected to a public low-voltage or high-voltage distribution network. The modules a.c. (PV module and associated inverter) are not included in this document. Their installation is subject to the rules of NF C 15-100.
3	**Normative references**
	NF C 14-100
	NF C 15-100
	NF C 17-102
	NF C 60-200-2
	UTE C 15-400
	UTE C 15-520
	UTE C 32-502
	NF EN 12101
	NF EN 50178
	NF EN 50272-2
	NF EN 50380
	NF EN 50399
	NF EN 50521
	NF EN 50539-11
	NF EN 50618
	NF EN 60269-6
	NF EN 60904-3
	NF EN 60947
	NF EN 61215
	NF EN 61427
	NF EN 61439
	NF EN 61557-8
	NF EN 61558-2-6

XP C15-712-3			
Clause/ §	**Requirement**	**Remark**	**Verdict**
	NF EN 61643-11		
	NF EN 61646		
	NF EN 61730		
	NF EN 62109		
	NF EN 62262		
	NF EN 62305-1		
	NF EN 62305-2		
	NF EN 62305-3		
	NF EN 62509		
	NF EN 62852		
	CLC/TS 50539-12		
	DIN VDE 0126-1-1		
4	**Definitions**	Noticed.	**P**
5	**Description of PV installations**	Noticed.	**P**
6.	**Earthing of the installation**		**P**
6.1	**Diagrams showing bonding of alternating current part with earth**		P
6.1.1	**General**		N/A
	The earthing system has been produced in accordance with the requirements of NF C 15-100. As the PV installation is considered as being able to be permanently coupled to a public distribution network, the principles to be installation for the coordination of the earth connection schemes must be equivalent to those in 4.4 of the UTE C 15-400 guide.	Must be taken under consideration for the installation.	N/A
6.1.2	**Inverter (s) with galvanic separation**	Transformerless type	N/A
	Galvanic isolation between the d.c. distribution and t a.c. part can be integrated into the inverter or be external. This isolation must comply with the levels specified in standard NF EN 62109-1.		N/A
	This provision: - protects the inverter from the consequences of a dc insulation fault. ; - allows the free choice of the diagram of the connections to the ground of the use a.c. part		N/A
6.1.3	**Inverter (s) without galvanic isolation**		P
	If the earth connection system is TT or TN on the a.c. side , the inverter (s) must be designed to withstand without fail, during an earth fault.		P
6.2	**Earthing of one polarity in the d.c. part**		N/A

XP C15-712-3			
Clause/ §	**Requirement**	**Remark**	**Verdict**
	In a PV installation, the protection devices against indirect contact are independent of the principle of the earthing systems. The direct current part is created in accordance with the rules for class II or equivalent isolation.	Ungrounded array	N/A
6.3	**Earthing of conductive masses and elements**		P
6.3.1	**PV part**		N/A
	To minimise the effects of induced overvoltages, the metal structures of the modules and the metal support structures (including the metal cable runs) must be connected to equipotential bonding, which in turn is connected to the earth. *In accordance with 8.1 of NF EN 61730-2, a module with accessible conductive parts that form the perimeter frame or the mounting system, or that has a conductive surface greater than 10 cm² accessible after installation must have provisions for grounding.*	Must be taken under consideration for the installation.	N/A
6.3.2	**Other d.c. part**		N/A
	All the masses of the battery cabinet and regulator, with the exception of the circuit of the d.c. distribution part, must be connected to earth by a conductor of protection in accordance with 411.3.1.2 and Part 5-54 of NF C 15-100.	Must be taken under consideration for the installation.	N/A
6.3.3	**Inverter**		P
	The inverter body must be connected to the equipotential bonding via a conductor with a minimum cross-section of 6mm² Cu or equivalent and to the protective conductor of the a.c. part.	A cross-section of the protective earthing wire of 6mm² is required in the manual.	P
7.	**Protection against electric shock**		**P**
7.1	**General**		P
	The PV equipment of the direct current part must be treated as being under voltage, even if it is disconnected from the alternating current part or battery		P

XP C15-712-3			
Clause/ §	**Requirement**	**Remark**	**Verdict**
7.2	**Protective measure SELV or PELV**		P
7.2.1	**Protection against direct contacts**		P
	Nominal voltage of the SELV circuit is less than or equal to 25 Vrms a.c. or 60 Vd.c., the protection against direct Insulation is not necessary. Nominal voltage of the PELV circuit is less than or equal to 12 Vrms or 30 Vd.c., the protection against direct Insulation is not necessary.	Considered.	P
7.2.2	**Protection against indirect contact**		P
	The requirements of SELV or PELV are described in Article 414 of the NF C 15-100 and are detailed below: - the U_{ocSTC} voltage is less than or equal to 120 V; - the nominal voltage of the battery Udc is less than or equal to 120 V; - the a.c. part of the installation is separated by a safety transformer conforming to standard NF EN 61558-2-6 or a safety converter conforming to NF EN 50178. The safety transformer can be integrated with or in close proximity to the inverter if the connection between the two devices is made with class II equipment or equivalent insulation.	Considered.	P
	When functional grounding of a polarity is required, the PELV rules apply. Then, in the absence of galvanic separation in the converter, this earth is that of the d.c. distribution part		N/A
7.3	**Low voltage protection measure**		P
7.3.1	**Protection against direct contacts**	Considered.	P
	All the connection points necessary for the production of a PV chain whose U_{ocSTC} voltage is greater than 60 V, must be provided by connectors including at its ends.	Considered.	P
	Electrical equipment must be fitted with a form of protection either by insulation of the live parts or through a casing. The cabinets or boxes containing accessible live parts must be locked either with a key or with a tool, unless they are located in a place to which only authorised or qualified persons have access. If the boxes or cabinets are not located in a place to which only authorised or qualified persons have access, protection against direct access must be ensured when an access door is opened by installing equipment that, by the nature of its design or installation, has a minimum degree of protection of IP2X or IPXXB.	The unit is rated IP65	P
7.3.2	**Protection against indirect contacts**		P
7.3.2.1	**General**		P

XP C15-712-3			
Clause/ §	**Requirement**	**Remark**	**Verdict**
	The rules for protection against indirect contact are those set out in part 4-41 of NF C 15-100. The PV generator part is characterized by the voltage U_{ocSTC}. The d.c. distribution part is characterized by the voltage Udc. Parts d.c. are protected by the following provisions: - double or reinforced insulation on the PV generator part according to the provisions of Article 412 of NF C 15-100, - automatic shutdown in IT or TT scheme for the distribution part d.c. taking into account the following sections 7.3.2.2 and 7.3.2.3.	Must be taken under consideration for the installation.	N/A
7.3.2.2	**d.c. distribution part in IT system**		N/A
	In this protection mode: - none of the polarities shall be connected to the earth; - a permanent isolation controller must be implemented; - the first defect, the CPI (Permanent Isolation Controller) orders the stop of the inverter. Restarting is only allowed after the fault has been removed by qualified personnel.		N/A
	The CPI must meet the following requirements: - isolation controller meeting the standard NF EN 61557-8; - for inverters meeting the NF EN 62109 series, the integrated insulation control is accepted to meet this measurement; - the monitoring must be ensured for the maximum voltage Uocmax of the generator photovoltaic and Udc batteries.		N/A
	Any part of the distribution d.c. must answer one of the following: - automatic shut-off at the first fault of the PV regulators and other sources if necessary, - provisions in 411.3.2.5 of NF C 15-100, - class II of the distribution part d.c. and conversion equipment.		N/A
7.3.2.3	**d.c. distribution part in TT system**		N/A
	The TT system of the distribution part d.c. is fixed by grounding on the side of the neutral conductor. There is no galvanic isolation between the distribution part d.c. and a.c.. On the distribution part d.c., none of the polarities should be grounded.	Must be taken under consideration for the installation.	N/A

XP C15-712-3			
Clause/ §	**Requirement**	**Remark**	**Verdict**
	Protection against indirect contact on the d.c. side is ensured by the installation of an automatic shutdown ensured by a DDR of type B which must be placed pn a.c side: -- between the output a.c. of the converter and the single direct earth connection of an active conductor; -- on the grouping of all the inverters and the direct connection to the single earth of an active conductor. This arrangement makes it possible to cut off the return path of the fault current. It does not remove the fault on the d.c. side. The fault circuit d.c. side remains potentially powered by PV and battery sources. The installation is then found in IT system		N/A
	Any part of the d.c. distribution must answer one of the following: - automatic shut-off at the first fault of PV regulators and other sources if necessary; - implementation of an Additional Equipotential Link (LES) according to the provisions of paragraphs 411.3.2.5 and 415.2 of NF C 15-100; - class II of the d.c. distribution part and conversion equipment.		P
7.3.2.4	**a.c. part**		N/A
	If the installation is connected to the public low-voltage distribution network with connection to the TT earth or to a private transformer station already including an earth Neutral side on the low-voltage side, it must not include any other earthing of the neutral (See 9.4). In separate mode from the distribution network, the earthing of the neutral is no longer provided by the network. This earthing must be re-established in the installation at one point. Neutral grounding must be provided without overlap during the return mode connected in separate network mode. Protection against indirect contacts is ensured by automatic shutdown.	Must be taken under consideration for the installation.	N/A

XP C15-712-3			
Clause/ §	**Requirement**	**Remark**	**Verdict**
	In the separate mode of the distribution network, because of the presence of sources with a low short-circuit power, the protection against indirect contacts is provided by residual current devices (DDR). In the case of an inverter / transformer assembly with IT ground connection system, for the installation part located between the inverter and its LV / LV or HV / LV transformer located in the vicinity, the implementation of an IPC for this part of installation only is not required. *When the inverter is running, this part of the installation is monitored by the installed CPI for the d.c.*		N/A
8	**Overcurrent protection**		N/A
8.1	**Direct current part**		N/A
8.1.1	**General points** See figure 5 of this standard	Must be taken under consideration for the installation.	N/A
8.1.2	**Protection of PV modules**		N/A
	In an installation with several PV module chains in parallel, the modules must be protected against the effect of reverse currents that may be generated in the chains in the event of a fault.	Must be taken under consideration for the installation.	N/A
8.1.3	**Protection of PV chain cables**		N/A
	The sizing of the PV chain cables takes into account the choice of protection device for the PV modules adopted in 8.1.2.	Must be taken under consideration for the installation.	N/A
8.1.4	**Protection of PV group cables**	.	N/A
	In an installation with several PV groups in parallel, the cables for the groups must be protected against the effect of reverse currents caused by a short circuit in a group.	Must be taken under consideration for the installation.	N/A
8.1.5	**Protection of main PV cable**		N/A
	The main cable of a PV generator must be dimensioned with a permissible current Iz greater than or equal to 1.25 IscSTC_gen.	Must be taken under consideration for the installation.	N/A
8.1.6	**Characteristics of overcurrent protection devices**		N/A
	The overcurrent protection devices must be either fuses compliant with standard NF EN 60269-6 or circuit-breakers compliant with standard NF EN 60947-2. For the Protection of the PV main cable only, it is possible to use a fuse according to NF C 60-200-2. These devices must be implemented for both polarities, regardless of the configuration of the installation.	Must be taken under consideration for the installation.	N/A

XP C15-712-3			
Clause/ §	**Requirement**	**Remark**	**Verdict**
8.2	**d.c. distribution part**		N/A
8.2.1	**Battery cable protection**		N/A
	The battery cable must be protected against overcurrent. The sizing of the battery cable protection device must take into account, in addition to provisions of Parts 4-43 and 5-52 of NF C 15-100: A) the battery charging current may be greater than the operating current; B) the potential short-circuit current of the battery.	Must be taken under consideration for the installation.	N/A
8.2.2	**Protection of the control cable and the inverter cable**		N/A
	These cables must be protected against short circuits likely to conversion equipment and powered by the battery. *The overcurrent protection of these cables must be as close as possible to the dc bus.*	Must be taken under consideration for the installation.	N/A
	In addition to the provisions of Parts 4-43 and 5-53 of NF C 15-100, the dimensioning of the protective device for these cables must take account of: (a) the operating current of the conversion equipment; (b) the potential short-circuit current of the battery.		N/A
8.3	**Alternating current part**		N/A
8.3.1	**General** In the case of an installation connected to the network via a branch line with limited power, the minimum cross-section of the conductors connected to the terminals downstream of the general isolating and protection device is 10 mm^2 Cu.	Must be taken under consideration for the installation.	N/A
8.3.2	**Overload protection**		N/A
	Alternating current circuits are protected against surges in accordance with the requirements of article 433 of standard NF C 15-100. For each inverter, the operating current to be taken into account is the maximum current given by the inverter manufacturer, 1.1 times its nominal current.	Must be taken under consideration for the installation.	N/A
8.3.3	**Short-circuit protection**		N/A
	In the case of a short circuit in an inverter or its line, the inverter is regarded as the load and the public network as the source.	Must be taken under consideration for the installation.	N/A

XP C15-712-3			
Clause/ §	**Requirement**	**Remark**	**Verdict**
	The breaking capacity of the protective devices of the installations connected to the determined taking into account the maximum short-circuit currents likely to appear from the network.		N/A
	In the case of a connection with limited power, taking account of the upstream protections (Presence of AD fuses), a breaking capacity of 3 kA is sufficient for the Protection against short-circuits downstream of the delivery point.		N/A
	In the case of an inverter / transformer assembly, for the installation part between the inverter and its LV / LV or HV / LV transformer located nearby, there is no need to Provide short-circuit protection between the transformer and the inverter When this protective function is provided by the protection of the transformer.		N/A
8.4	**Protection of auxiliary circuits**		N/A
	All auxiliary circuits supplied by a voltage source (voltage measurement, control, signaling, etc.) must be protected against short circuits.	Must be taken under consideration for the installation.	N/A
9	**Interface protection and stand-alone operation**		**P**
9.1	**General** Two operating modes of PV installation with storage device are to be considered: - mode connected to the distribution network at all times; - mode connected to the distribution network with the possibility of operating in stand-alone mode.	Grid interactive inverter	P
9.2	**Interface protection**		P
	This protection device is designed to disconnect generators in the event of: • a fault on the public distribution network; • a failure in the supply from the public distribution network; fluctuations in the voltage or frequency greater than those specified by the distributor.	The unit provides a integral disconnection facility according to VDE 0126-1-1 an it is rated below 250kW	P

XP C15-712-3			
Clause/ §	**Requirement**	**Remark**	**Verdict**
	The procedures for choosing the type of decoupling protection and their setting thresholds are in the technical documentation of reference of the network operator. Without requirements of the network operator, the following recommendations apply: - This decoupling protection is type B.1 for installations injecting into the network a maximum total power not exceeding 250 kVA and type H for installations Injecting a higher power. - In installations with a total power injected into the network not exceeding 250 kVA, the decoupling protection can be integrated into the inverters. It must then complies with DIN VDE 0126-1-1. - A decoupling protection shall be provided for each generator or converter, either for a group of generators or converters or centrally upstream.		P
9.3	**Operation in stand-alone mode**	Grid interactive inverter	N/A
	Switching from a grid connected mode to an stand-alone mode is achieved by the disappearance of the grid voltage: - either by the action of the decoupling protection, - either by deliberate operation of a cut-off device with direct or remote control action.		N/A
	Switching from stand-alone mode to grid connected mode can only be done if the generators and / or converters are stopped or synchronized with the distribution network.		N/A
9.4	**Earthing in stand-alone mode**		N/A
	When the electrical installation is connected without galvanic separation to the public distribution, the earth connection diagram of the network and any link from neutral to earth is prohibited in the installation. The switch-off device for switching to stand-alone mode must switch off all active conductors (Except for the TNC PEN conductor).	Grid interactive inverter	N/A

XP C15-712-3			
Clause/ §	**Requirement**	**Remark**	**Verdict**
	Once the installation has been separated by the stand-by device, the connection to the earth must be restored - The installation is designed to operate as a diagram of the IT ground connections, the neutral is not to be connected to the earth interface and all principles of the earth connection system IT apply. - The installation is designed to work as a diagram of the TT or TN-S ground connections, the use of a neutral switch is required to connect the neutral to the earth without overlap with the grounding of the upstream neutral to avoid untimely triggering of the DDR. In the case of several inverters operating in parallel, the earthing of the neutral must be done at a single external point and common to the Inverters. - The installation is designed to operate with a private injection transformer on the network, in a diagram of the TN-C ground links at least downstream of the switch-off for stand-alone operation. In this case, the earthing of the neutral in a single point and does not require the use of a neutral contactor. - A transformer providing galvanic separation is inserted downstream of the neutral can be permanently grounded.		N/A
9.5	**Management of energy exchanges with the network**		P
	The injection and withdrawal currents of the site must be maintained at all capacity limits of its connection to the grid and within the conventional limits of distributor.	Considered.	P
10	**Prevention of degradation of photovoltaic installations**		**P**
	For installations with a voltage between 120 V and 1500 V, the protective measures against the indirect contacts implemented for the d.c. distribution part, described in Paragraphs 7.3.2.1, 7.3.2.2 and 7.3.2.3 shall prevent the degradation of the PV generator due to particular external influences and the presence of direct current.	The inverter is applicable to be used for: Case 4: no galvanic insultion and PV array not earthed.	P
11	**Voltage drop**		**N/A**
11.1	**General** The objective of technical and commercial optimisations is to minimise voltage drops.	Must be taken under consideration for the installation.	N/A
11.2	**PV generator part**		N/A
	The authorised maximum drop in voltage in the direct current part of the installation is between 3% and ImppSTC (STC: standard test conditions).	Must be taken under consideration for the installation.	N/A
11.3	**Alternating current installation**		N/A

XP C15-712-3			
Clause/ §	**Requirement**	**Remark**	**Verdict**
	The maximum authorised drop in voltage between the a.c. terminals of the inverter and the point of delivery (NF C 14-100) is 3% at the nominal power of the inverter(s). It is recommended to limit this drop in voltage to 1% in order to be able to limit energy losses on the one hand and momentary disconnection of the inverter on the other, maintaining a margin between the average operating voltage of the inverter and the setting of its protection at maximum voltage.	Must be taken under consideration for the installation.	N/A
	For PV installations connected to the public HTA distribution network via of a HV / LV transformer, the same recommendations apply to the lower part voltage between the inverter and the transformer. For use circuits a.c., the provisions of Article 525 of standard NF C 15-100 apply.		N/A
11.4	**Battery installation**		N/A
	At the terminals of the battery, the voltage drop between the battery and the load control and discharge limiting devices within 2%.	Must be taken under consideration for the installation.	N/A
12.	**Disconnection, control and disconnection device**		**P**
12.1	**Isolation** / **Disconnection** .		P
	To allow the maintenance of equipment such as converter, inverter, regulator, etc., means of isolation must be provided, on both sides and close to each equipment, both on the d.c. side and on the a.c. side. Isolation must be omnipolar.	DC Switch is present. The unit provides connectors for DC with male and female plugs, which are not interchangeable. The plugs are according to EN 50521.	P
	The disconnecting devices may not be simultaneous action for the PV generator and dc distribution parts. For the a.c. and d.c. use parts, the disconnecting devices must be simultaneous action.		P
12.2	**Control**	Present.	P
	In the case of the use of a generator, according to 465.1.5 of NF C 15-100, the functional control devices ensuring the switching of power sources must be of interest to all active drivers, except for a possible PEN, and must not be able to parallel the sources unless the installation is specifically designed for that condition.		P
	To allow maintenance interventions, a cut-off device must be provided inside or near the junction boxes equipped with protection devices. For PV generators in TBT with a single junction box, this cut-off device may be the one located near the regulator.		P
12.3	**Emergency cutoff**		N/A

XP C15-712-3			
Clause/ §	**Requirement**	**Remark**	**Verdict**
12.3.1	**General** In accordance with the regulations set down in articles 463 and 536.3 of standard NF C 15-100, emergency circuit-breakers must be fitted on both a.c. and d.c. sides in order to cut off the electricity supply in the event of an unexpected hazard. All emergency circuit-breakers must effect an omnipolar and simultaneous disconnection. These devices are either switches or breakers or contactors. The semiconductor devices do not comply with this requirement. The controls of emergency circuit-breakers on both d.c. and a.c. sides must be easily recognisable and quickly accessible. This measurement is not necessary for SELV installation parts, rated voltage less than or equal to 60 V dc. And PELV with a nominal voltage less than or equal to 30 V dc, and Whose peak power of the PV generator is less than or equal to 3 kW. Emergency circuit-breakers must not be built into the inverter. NOTE For high-power inverters, the switchgear device can be integrated in the same envelope.	Must be taken under consideration for the installation.	N/A
12.3.2	**Emergency cutoff of the PV part**		N/A
	A cut-off device must be provided upstream from the inverter and its control shall be located close to this one. The emergency disconnection can be ensured by manual control of the circuit-breaker or via a remote control action. It must be possible to cut each supply to the inverter. In the case of inverters with multiple inputs, it is permissible to ensure an emergency disconnection by means of separately controlled devices.	Must be taken under consideration for the installation.	N/A
12.3.3	**Emergency cutoff of the battery**		N/A
	A breaking device must be provided on the battery circuit. The operating member of the emergency cutoff must be recognizable and quickly accessible. Actuation of the emergency cutoff device can be provided by manual or through a remote-controlled action.	Must be taken under consideration for the installation.	N/A
	In the case of several batteries, it is permissible to ensure the emergency cutoff by several devices.		N/A
	Measures must be implemented to ensure that equipment supplied with d.c. can not be supplied at a voltage higher than the maximum permissible voltage after disconnecting the battery.		N/A
12.3.4	**Emergency cutoff of other d.c. power sources**		N/A

XP C15-712-3			
Clause/ §	**Requirement**	**Remark**	**Verdict**
	Sources other than the PV field and the battery, on the circuit (s) comprising, a breaking device must be provided. The actuation of the emergency shut-off device can be ensured by a manual control or via a remote-controlled action. The control of the switching device (s) must be arranged in the vicinity of the converter, inverter, the origin of the d.c. installation, etc	No d.c. power other than PV or battery	N/A
12.3.5	**Emergency cutoff of a.c. and d.c. parts**		N/A
	Pursuant to the rules in paragraph 463.1 of NF C 15-100, a breaking device must be provided to shut off the power supply to circuits or d.c. operating circuits and a.c. and its operating member must be easily recognizable and quickly accessible.	Must be taken under consideration for the installation.	N/A
12.3.6	**Special case of residential premises**		N/A
	In private premises for residential use (in 10.1.4.4 of NF C 15-100), for all a.c. and d.c parts, only direct acting devices are permitted.	Must be taken under consideration for the installation.	N/A
	In addition to the AGCP, an emergency cutoff device shall be provided between the inverter and the the distribution chart of the utilization circuits backed up by the inverter in stand-alone mode.		N/A
12.4	**Cut-out for intervention by emergency services**	Must be taken under consideration for the installation.	N/A

XP C15-712-3			
Clause/ §	**Requirement**	**Remark**	**Verdict**

12.4.1	**General**
	If a cut-out is required to allow the intervention of the emergency services, this must be triggered by one of the following events:
	• Cut-out of all sources of electrical energy
	  o PV generator
	  o Batteries
	  o Public distribution network
	  o Other energy sources
	• Cut-out devices must meet the following principles
	  o these devices are either switches or breakers or contactors; the semiconductor devices do not comply with this requirement;
	  o each device must be omnipolar and simultaneous interruption;
	• the battery circuit is cut out as close as possible;
	• the failure of the PV generator circuit is done as close to the photovoltaic modules and in any case upstream of accessible rooms and passages to the occupants;
	• orders for these switching devices for intervention of emergency services are grouped. In the case of facilities on an existing building, it is assumed to have non-grouped commands.
	The switching devices can be:
	• Mechanical direct action;
	• Remote-controlled (electric or pneumatic)
	The remote control may be provided by one of three principles:
	• Trigger voltage loss;
	• ower-operated trip unit or powered actuator, via cables or fire resistant pipes from a rescued source;
	• pneumatic actuator with a compressed gas energy source and copper pipes or steel tube (according to standard NF EN 12101).
	Signaling the action disconnection should be done by voltage measurements indications or voltage free loop devices by type O / F. In the case of using the DC voltage measurement, it should then be taken between the separating apparatus and the area to be secured. Cables or pipes used for signaling are fire resistant.
		Must be taken under consideration for the installation.	N/A

XP C15-712-3			
Clause/ §	**Requirement**	**Remark**	**Verdict**
12.4.2	**Additional provisions** If it is required that the voltage of the PV generator is below 60 Vdc, the circuit upstream of the required disconnection is general in provisions of 12.4.1, this is achieved by: • an electromechanical load breaking or unloaded in series in each string by PV Uocmax section whose voltage is lower or equal to 60 V, or • electromechanical short-circuit or electronic systems by Uocmax section whose voltage is lower or equal to 60 V, or • electromechanical or electronic shorting by Modular Systems The operational safety of these principles requires: • a positive safety control; • in the case of an electromechanical break, in order to be unloaded, its control must be Carried out after opening the load-breaking device of § 12.4.1. The implementation of this equipment must be comply with the rules of double insulation (or reinforced insulation) imposed in this part of the system and for a voltage corresponding to the chain tension U_{ocmax}.	Must be taken under consideration for the installation.	N/A
13	**Protection from surges emanating from the atmosphere or caused by operations**		**N/A**
13.1	**General** The information contained in this chapter refers to overvoltage protection for photovoltaic installations connected to the network and complements standard NF C 15-100 and CLC / TS 50539-12 *The sensitivity to lightning effects of photovoltaic modules and their to deal with this subject by the standards NF EN 62305-1 to -3 and NF C 17-102* *The possible protection of these installations against the direct effects of lightning is dealt with by the standards NF EN 62305-1 to -3 and NF C 17-102*	Must be taken under consideration for the installation.	N/A
13.1.1	**Types of protection**		N/A
13.1.1.1	**Protection through equipotential bonding**		N/A

XP C15-712-3			
Clause/ §	**Requirement**	**Remark**	**Verdict**
	As described in section 6.3, an equipotential bonding conductor must connect all the metal structures of the modules and the metal structures of the supports of the PV installation (including the metal cable runs) whether or not lightning conductors are present. This conductor must be connected to the earth.	Must be taken under consideration for the installation.	N/A
13.1.1.2	**Protection by surge arresters** The installation conditions are described in 13.2.	Must be taken under consideration for the installation.	N/A
13.2	**Installation conditions for surge arresters**		N/A
13.2.1	**Installation conditions for surge arresterson a.c. side** n the presence of an a.c. line outside the building, the provisions of Articles 443 and 534 of NF C 15-100 apply.	Must be taken under consideration for the installation.	N/A
13.2.2	**Installation conditions for surge arresters on the PV generator side**		N/A
13.2.2.1	**Installation without lightning conductor** The length L is the accumulated distance between the inverter(s) and the furthest points of the photovoltaic modules comprising the chain, as a sum of the lengths of the routes in accordance with the principles shown in Figure 6.	Must be taken under consideration for the installation.	N/A
13.2.2.2	**Installation with lightning conductor**		N/A
	The use of arrester (s) is mandatory on the PV generator side. These arresters are: - type 1 if the metal structure of the PV modules is connected to the lightning conductor; - type 1 in the case of a ground-mounted PV plant with lightning conductor; - type 2 if the metal structure of the PV modules is not connected to the lightning conductor. In the case of implementation of two type 1 surge arresters, one is implemented on the module side, the other is implemented on the regulator side.	Must be taken under consideration for the installation.	N/A
	In the presence of lightning conductors, the choice and implementation of surge arresters are made in accordance with Technical Specification CLC / TS 50539-12		N/A
13.3	**Surge protection for installations without lightning conductor**		N/A
13.3.1	**Choice and installation of surge arresters on a.c. side**	.	N/A
	For the a.c. part, the choice and the installation of the surge arresters are carried out according to the rules stated in Articles 443 and 534 of the NF C 15-100.	Must be taken under consideration for the installation.	N/A

XP C15-712-3			
Clause/ §	**Requirement**	**Remark**	**Verdict**
	When a surge arrester is prescribed for the a.c. part of a PV installation connected to the public low-voltage distribution network, it is always installed so as to protect the inverter whatever the mode of operation (connected to the network, stand -alone mode).		N/A
	According to the Technical Specification CLC / TS 50539-12, the overvoltage seen by the equipment depends on their relative distance to the surge arrester. Beyond 10 m, the value of this voltage can be doubled under the effect of resonances (amplification phenomena due to the high frequencies of lightning-induced overvoltages). In this case, a second surge arrester is required as close as possible to the inverter if the protection level Up of the arrester located near the origin of the installation is greater than 50% of the impulse withstand voltage of inverter.	Must be taken under consideration for the installation.	N/A
13.3.2	**Choice and installation of lightning arresters on PV generator side**	Must be taken under consideration for the installation.	N/A
	If a surge arrester is prescribed for the d.c. part of a PV installation, it is always installed in the panel nearest to the inverter.		N/A
	According to the Technical Specification CLC / TS 50539-12, the overvoltage seen by the equipment depends on their relative distance to the surge arrester. Beyond 10 m (see Figures 7 and 8), the value of this voltage can be doubled under the effect of resonances (amplification phenomena due to the high frequencies of lightning origin surges). In this case, a second surge arrester is required closer to the modules if the protection level Up of the surge arrester located near the regulator is greater than 50% of the impulse withstand voltage. photovoltaic field Uw (see Table 9).	Must be taken under consideration for the installation.	N/A
	The characteristics of the surge arresters installed on the side d.c. are defined as follows:		N/A
13.3.2.1	**Choice of I_n** rated discharge current of a surge arrester in 8/20 µs waveform (in kA) Type 2 surge arresters have a minimum recommended value of the nominal In discharge current of 5 kA. A rated discharge current greater than the required value will provide longer life for the surge arrester.		N/A

XP C15-712-3			
Clause/ §	**Requirement**	**Remark**	**Verdict**
13.3.2.2	**Choice of I_{max}** maximum discharge current of a surge arrester with wave 8/20 µs (in kA) This parameter is used to coordinate the energy of the lightning arresters: please refer to information from the manufacturer. This coordination can be done, by analogy with the a.c. networks, according to the Technical Specification CLC / TS 50539-12.		N/A
13.3.2.3	**Choice of I_{imp}** The impulse current I_{imp} for Type 1 arresters is chosen according to the CLC/TS 50539-12 or by default with a minimum value of 12.5 kA.		N/A
13.3.2.4	**Choice of U_p** The value of U_p must be less than 80% of the surge withstand voltage of the equipment to be protected. In the absence of other information, the rated Uw impact voltage for the modules and the conversion equipment can be determined from Table 9.		N/A
13.3.2.5	**Choice of U_{CPV}** steady state maximum voltage of a photovoltaic arrester dedicated to the protection of the part d.c. of the PV generator The value of the maximum permissible voltage of the U_{CPV} surge arrester must be greater than or equal to the maximum voltage U_{ocmax} of the PV array. Whatever the protection modes of the surge arrester, it must also be able to withstand the maximum voltage U_{ocmax} between its active terminals (terminals + and -) and earth.		N/A

XP C15-712-3			
Clause/ §	**Requirement**	**Remark**	**Verdict**
13.3.2.6	**Choice of I_{SCPV} and protection device associated with the surge arrester** **I_{SCPV}** aware of short circuit of a surge arrester The surge arrester and its disconnector (internal or external) must have an I_{SCPV} current higher than the I_{scmax} of the PV generator. A surge arrester with an internal disconnector must also interrupt the short circuit current generated by the battery. If not, an external disconnector specified by the manufacturer must be installed. *The lightning arresters can come to the end of their service life for the following reasons:* • *Due to overheating caused by an excessive accumulation of lightning stresses that do not exceed the normal characteristics of the lightning arrester but lead to a gradual destruction of its internal components;* • *Short-circuiting caused by the normal characteristics of the lightning arrester being exceeded, leading to a drastic reduction in its impedance.*		N/A
13.4	**Summary for overvoltage protection of installations**		N/A
	Table 10 summarizes the various minimum requirements in terms of Type of arrester and location according to the type of installation.	Must be taken under consideration for the installation.	N/A
14	**Choice and installation of equipment**		**P**

XP C15-712-3			
Clause/ §	**Requirement**	**Remark**	**Verdict**
14.1	**General** The rated operating voltage of all the equipment of the d.c. part must be equal to or greater than the following voltages: - maximum voltage of the battery; - maximum voltage of the controller (s) in case the battery is disconnected; - possible maximum voltage of the dc / dc converter. If it can operate in reversible; - U_{ocmax} voltage of the PV generator. The dielectric strength of the equipments installed in the PV generator parts, distribution d.c., must be that corresponding to the greater of the voltages of these parts. The equipment installed outside must have a minimum degree of protection of IP44. The degree of protection against mechanical impacts must be at least IK07 in compliance with standard NF EN 62262. Operations on demountable equipment, apparatus and connections shall be capable of being performed safely (see Articles R 4544-1 to R 4544-11 of the Labor Code). The location of equipment (junction box(es), inverter(s), cabinets with protection devices and meter cabinets etc.) must comply with article 513.1 of standard NF C 15-100. Special regulations for residential buildings are given in part 10-1 of the NF C 15-100. The equipment, including the ducts etc., must be arranged so that they can be operated, inspected and serviced easily and their connections can be accessed.	The inverter is rated IP65 and IK07. For IK see test results below.	P
14.2	**Ducts etc.**		N/A
14.2.1	**Choice for the d.c. part**		N/A

XP C15-712-3			
Clause/ §	**Requirement**	**Remark**	**Verdict**
	For the PV generator part, the measures to be taken into account are as follows: - the sizing of the ducts is carried out in accordance with the rules of the NF C 15-100 on the basis of PR insulation; - the cables are at least non-propagating flame responding to the tests of standard NF EN 50399 and selected from those having a core permissible temperature of at least 90 ° C in steady state; - PV chain, PV group and main DC PV power cables must be selected to minimize the risk of ground faults or short circuits. This condition is ensured by using single-conductor cables of insulation equivalent to class II; - the cables subjected directly to solar radiation must meet the condition of external influence AN3 (resistant to ultraviolet rays). However, resistance to external influence condition AN3 can be realized by installation (screen interposition, etc.) - for a photovoltaic installation, it is accepted that the cables can travel in thermal insulation of roof or facade or between a thermal insulation and the modules. In this case, the reference method to be taken into account is method B defined in the Table 52G of NF C15-100 with a correction factor of 0.77; - for the calculation of chain cables, the temperature to be taken into account for their sizing is considered equal to 70 ° C and a correction factor of 0.58 is to be applied according to Table 52K of NF C 15-100 in the following cases: • cables subjected to direct heating of the modules; • cables exposed to solar radiation. In this case, the correction factor of 0.85 defined in Article 512.2.11 of NF C 15-100 is not taken into account; • cables running in thermal insulation of roof or facade. In that case, the correction factor of 0.58 should be multiplied by 0.77, or 0.45. For the distribution part d.c., the choice of pipes is made according to part 5-52 of the NF C 15-100.	Must be taken under consideration for the installation.	N/A
14.2.2	**Installation**		N/A

XP C15-712-3			
Clause/ §	**Requirement**	**Remark**	**Verdict**
14.2.2	The connections and the cables must be installed in a manner that will prevent any deterioration due to external influences. See the requirements set out in guide UTE C 15-520. In the case of buried cables connecting two buildings, they are implemented in accordance with 529.5 of NF C 15-100. To ensure the marking of cables d.c., the polarities must be marked at the ends of the cables by marking + or -, or by a color, the blue color being reserved for the negative polarity. To minimize the induced stresses due to lightning, the surface of all the loops must be as small as possible, in particular for the wiring of the PV chains. The cables d.c. and the equipotential bonding conductor must travel side by side.	Must be taken under consideration for the installation.	N/A
14.3	**PV modules**		N/A
	The PV modules must comply with the standards in series NF EN 61730. In addition, the crystalline silicon photovoltaic modules must comply with the NF EN 61215 and thin-film photovoltaic modules shall comply with the Standard NF EN 61646.	Must be taken under consideration for the installation.	N/A
14.4	**Converter**		N/A
	The controller must comply with NF EN 62509 and NF EN 62109-1. The rated input current of the controller must be at least equal to I_{mppSTC} of the generator		N/A
14.5	**DC/AC inverter**		P

XP C15-712-3			
Clause/ §	**Requirement**	**Remark**	**Verdict**
	The inverters must comply with the requirements of NF EN 62109-1 and NF EN 62109-2. The direct current generated by the injection inverter (s) on the public distribution must be less than 0.5% of its rated current. The choice and dimensioning of the d.c./a.c. converter must take into account the currents and the nature of the loads. In particular, it is important to take into account the presence of deforming loads. The maximum permissible voltage at the input of the d.c. / a.c. converter must take into account the case where the battery is disconnected. The d.c./a.c. converter must necessarily be equipped with a function of limiting discharge of the battery with threshold adapted to the battery used, which can be internal or external to the equipment.	The inverter is comply with IEC 62109-1 and IEC 62109-2. For DC inject, see test results	P
14.6	**Batteries**		N/A
14.6.1	**Lead-acid**	Not such type	N/A
14.6.1.1	**General** The batteries must comply with the NF EN 61427 series of standards. Installation must be in accordance with 554.2 of NF C 15-100 and standard NF EN 50272-2		N/A
14.6.1.2	**Installation** Two cases of installation are to be considered depending on the characteristics of the battery: capacity and discharge voltage		N/A
14.6.1.2.1	**Case where C (Ah) x U (V) is less than or equal to 1000** The battery may be installed in a general purpose room other than a service room electric. The battery terminals must be protected against short circuit.		N/A
14.6.1.2.2	**Case where C (Ah) x U (V) is greater than 1000**		N/A
14.6.1.2.2.1	**Location**		N/A

XP C15-712-3			
Clause/ §	**Requirement**	**Remark**	**Verdict**
	A location dedicated exclusively to the battery must be provided. This site is either a specific location or an envelope. The following factors must be taken into consideration when choosing a location: - protection against external hazards, e.g. fire, water, shock, vibration; - protection against risks generated by batteries (risk of explosion, Electrolyte, corrosion); - protection against access by unauthorized persons; - protection against extreme environmental influences e.g. temperature, humidity.		N/A
14.6.1.2. 2.2	**Local batteries**		N/A
	The dimensions of the room are determined taking into account: - the number and size of the battery cells of the battery to be installed; - the dimensions of the ancillary elements (wiring including paths and supports); - the free space around the battery, not only for safety reasons but also to facilitate access during installation and maintenance (including Handling)		N/A
	The following requirements must be met: - the floor must be designed to withstand the weight of the battery; - in the case of an establishment receiving workers, the door of the premises must be of type anti-panic and lockable from the outside only; - the ventilated air must be expelled into the atmosphere outside the building; - when open batteries are used, the threshold floor must be watertight and resistant chemically to the electrolyte (tiling or electrolyte-resistant paint) or the accumulator elements of the battery must be placed in suitable retention tanks.		N/A
	The retention device must be sized to contain at least the electrolyte volume of an element or a monoblock.		N/A
	The battery room is either independent of or integrated with residential buildings, but in this case, additional safety measures must be implemented: - access to the premises must be carried out by the outside; - there shall be no communication between such premises and the accommodation premises; - cables must be clogged (plaster, etc.).		N/A
	Construction materials must be non-combustible and gas-tight.		N/A

XP C15-712-3			
Clause/ §	**Requirement**	**Remark**	**Verdict**
	Electrical equipment must not be installed in the battery room unless: - if their function is to ensure the same safety (class T1 for temperature and group IIc For gases); - for uninterrupted static power supplies in cabinets.		N/A
	Lead-acid batteries and alkaline batteries must not be same local		N/A
	For the protection of the environment, if the maximum load power (product of the charging voltage at the end of charge current) is greater than 50 kW, the storage room must comply with the general requirements for the installations subject to declaration [Order of 29 May 2000 on the general requirements applicable to installations classified for environmental protection subject to declaration under heading 2925 'Accumulators (load shop) ", section modified by the decree n ° 2006-646 of May 31, 2006] *The starter batteries of the generators and their charging device can be installed in the generator set room.*		N/A
14.6.1.2.2.3	**Battery enclosure**		N/A
	If the battery is installed in an enclosure (enclosure or cabinet), it must observe the following characteristics: - electrolyte resistant material with retention device which can contain at least the Electrolyte volume of an element or a so-called open battery monobloc; - bottom (or shelf if applicable) designed to support the battery weight; - gas-tight enclosure with ventilation to the outside Building; - envelope designed to allow easy access of the battery cells of the battery for handling and maintenance; - authorized access only to authorized personnel responsible for supervision and maintenance.		N/A
14.6.1.2.2.4	**Ventilation**		N/A

XP C15-712-3			
Clause/ §	**Requirement**	**Remark**	**Verdict**
	The conditions for installing batteries depend gases in the storage cells. Ventilation of the location or envelope of a battery is intended to concentration of hydrogen below 4% vol of the limit of hydrogen explosion. The locations or enclosures shall be considered as safe in terms of explosion hazards, where by natural or forced ventilation the concentration of hydrogen is maintained below this safety limit. In accordance with standard NF EN 50272-2, the minimum air flow for the ventilation of a location or a battery compartment must be calculated by the following formula: Q (m3/h) = 0,05 x n x I_{gaz} x C x 10 -3 The air extracted from the battery room must be vented to the atmosphere outside the building. The vents at the top and bottom will provide ventilation with the outside, while prohibiting access to animals or insects. Open type batteries must not be installed in rooms where the air conditioning is done in a totally closed circuit.		N/A
14.6.1.2.2.4.1	**Natural ventilation**		N/A
14.6.1.2.2.4.2	**Forced ventilation**		N/A
14.6.1.2.3	**Arrangement of the battery cells of the battery**		N/A
	If the battery technology is open-ended, these must be installed on site (acid resistant material treated or synthetic wood type). If the battery cells of the open battery are distributed in several rows, one masked rows must be carried out in order to ensure perfect legibility electrolyte levels of all the tanks (elements laid on a steady step building site). The battery cells shall be so arranged as to enable the battery easy access to the filler cap of each element. In order to facilitate the control, maintenance and replacement of battery, a free passage of at least 60 cm is provided for access to the battery cells.		N/A

XP C15-712-3			
Clause/ §	**Requirement**	**Remark**	**Verdict**
	Near the battery park, various accessories must be installed: eyewash, hydrometer, thermometer. When the rated voltage of the batteries exceeds 120 V: - a minimum distance of 1.50 m must be observed between the active conductive parts can be simultaneously affected; - a non-slipping service floor, insulated from the ground and of a minimum width 1 m around the batteries so that it is not possible to touch both the ground or conductive element connected to the ground and one of the battery cells of the battery.		N/A
14.6.1.2.4	**Accumulators**		N/A
	Each accumulator element of the open battery must be equipped with an explosion-proof plug ensuring the functions of permeability adapted to the evacuation of the gases (hydrogen, oxygen) coming out of the battery in order to avoid any explosion in case of overload of the battery and acid-proof efficiency.		N/A
	Possibly, the explosion-proof plug (if adapted to the specificities related to the solar charging of the battery), must also ensure the function of catalyst with recombination of the gases in order to reduce the loss of water (prolongation of the interval periods for the filling / leveling of the accumulator elements of the battery).		N/A
	Each battery cell must have an external marking indicating the type of battery, the voltage, the battery capacity and the date of first commissioning. In addition, all elements must be numbered from 1 to n on acid-resistant substrates.		N/A
	The battery lugs and the terminal strips between the elements must be electrically insulated against the risk of short circuiting and, where appropriate, against the risk of electric shock. It is possible to measure the voltage at the accumulator elements of the battery without disassembling the insulating covers of the battery terminals. A device must make it possible to separate all the poles of the battery.		N/A
	Conductors connected to a battery must, in the part that extends from the accumulators to the protection device (fuse or circuit breaker) protecting them against overcurrents, be laid in such a way as to exclude any risk of short circuit (connections made unipolar double insulated conductors separated by polarity and clearly identified)		N/A

XP C15-712-3			
Clause/ §	**Requirement**	**Remark**	**Verdict**
	In the case of several batteries in parallel, the lengths and sections of conductors of each battery must be strictly identical to avoid any imbalance in voltage.		N/A
14.6.2	**Lithium-ion**		N/A
14.6.2.1	**General** Li-Ion batteries do not emit gas in normal operation. On the other hand, certain conditions of use, overload, short circuit or overtemperature, can lead to a thermal runaway that can generate gases and a risk of fire. The batteries must comply with the NF EN 61427 series of standards.	Must be taken under consideration for the installation.	N/A
	The use of batteries must comply with the provisions of 421.1 of NF C 15-100 and fire regulations. The batteries must be installed in a room that complies with 14.6.2.3. Otherwise, they are installed according to the conditions described in 14.6.2.4	Must be taken under consideration for the installation.	N/A
	The following factors should be considered when implementing the battery: - protection against external influences (e.g. temperature, humidity, fire, water, shock, vibration, external heat source, solar radiation); - protection against the risks generated by batteries due to gas emissions due to thermal runaway (e.g.: internal short circuit to the battery)	Must be taken under consideration for the installation.	N/A
	As there is no emission of gas in normal operation, the associated risk of explosion does not have to be taken into account.	Must be taken under consideration for the installation.	N/A
14.6.2.3	**Battery room**	Must be taken under consideration for the installation.	N/A
	The dimensions of the room will be determined taking into account: - The number and size of the battery cells to be installed; - the size of the ancillary elements (cabling including paths and supports); - sufficient access conditions to allow installation and maintenance (including possible handling devices).		N/A
	The following requirements must be met: - the floor must be designed to support the weight of the battery; - in the case of an establishment receiving workers, the room door must be of the anti-panic type and lockable only from the outside; - access is restricted to knowledgeable or qualified people.		N/A
	The thermal runaway of a battery cell generates gases. It is necessary to provide sufficient ventilation in the room and any detection devices according to the manufacturer's instructions.		N/A

XP C15-712-3			
Clause/ §	**Requirement**	**Remark**	**Verdict**
	A means of extinguishing must be provided as well as a smoke detector according to the instructions of the manufacturer of the battery.		N/A
14.6.2.4	**Outside local battery**		N/A
14.6.2.4.1	**Battery storage energy> 15 kWh**		N/A
	The battery must be installed in a closed volume respecting the fire regulations. The door or access hatch shall only be opened by means of a key or a tool. A means of extinguishing must be provided as well as a smoke detector according to the instructions of the manufacturer of the battery.		N/A
14.6.2.4.2	**Battery storage energy⩽ 15 kWh**		N/A
	The accumulator battery is installed at least in an enclosure (cabinet or cabinet), it must comply with the following characteristics: - be made of non-combustible materials; - have a bottom (or shelf if any) designed to support the weight of the battery; - to be able to open only by means of a key or a tool; - allow degassing in case of thermal runaway of the battery.	Must be taken under consideration for the installation.	N/A
	Its location must meet the following characteristics: - be located at least 1 m away from any source of heat, any boiler and any stock of fuels such as fuel oil, gas, wood, etc. These elements are to be identified at the time of design; - not be at risk of fire (BE2) under NF C 15-100; - be adapted to the weight of the envelope.	Must be taken under consideration for the installation.	N/A
	If the envelope is outside, it must be protected from direct sunlight and inclement weather. In addition, it is necessary to provide around the envelope a sufficient ventilation.	Must be taken under consideration for the installation.	N/A
14.6.2.5	**Housing premises**		N/A
	In the case of residential premises, the following provisions are added to those mentioned in 14.6.3.1 to 14.6.3.4. For multi-family residential buildings, the envelope is placed in a general services technical room. For individual houses, the storage device is placed outside the main rooms, the kitchen, the rooms of water (bathrooms, lavatories), clearances and circulations and attics.	Must be taken under consideration for the installation.	N/A
14.6.3	**Other batteries** In the study		N/A
14.7	**Equipment**		P

XP C15-712-3			
Clause/ §	**Requirement**	**Remark**	**Verdict**
14.7.1	**General** All equipment installed in the d.c. part must be adapted for operation in direct current and be selected and installed in accordance with the manufacturer's instructions. Equipment installed in the d.c. part must be of the industrial type, in other words compliant with the NF EN 60947 series of standards. • The equipment must have the marking for direct current use ("current Continuous "or symbol), or a specific PV marking; • The characteristics of switches, switch-disconnectors and fuse-combination units must conform to the operating category DC21B; • The characteristics of disconnectors must conform to the operating category DC20; • The characteristics of contactors must conform to the operating category DC1	The internal DC switch of the inverter is rated for operation category DC21B. Connectors in the DC lines are rated for operation category DC1	P
14.7.2	**Devices installed in the PV generator part**		N/A
	For the switchgear of the generator part, the rated current In must be at least equal to rated current or setting of the overcurrent protection device defined in 8.1.	Must be taken under consideration for the installation.	N/A
14.7.3	**Switchgear for switching to stand-alone mode**		N/A
	The rated current of the switching device for switching to stand-alone mode (In) shall be less than the greater of the rated currents of either the AGCP or the generator or the sum of the two depending on the chosen operating principle.	Grid interactive inverter	N/A
	The use category of the self-contained switchgear (Ie) shall be chosen according to the load profiles and the number of switching maneuvers autonomous planned. Otherwise, category AC 3 is retained.		N/A
	The switch-off device for autonomous switch-off must be omnipolar and simultaneously, the apparatus must also have the isolation characteristic to ensure the effective isolation between the stand-alone installation and the mains in position of opening.		N/A
14.8	**Equipment assemblies**		P

XP C15-712-3			
Clause/ §	**Requirement**	**Remark**	**Verdict**
	PV generator parts, distribution d.c. and alternating current of the installation can be accommodated in the same panel if there is a physical separation of these three parts. For the d.c. part, it is imperative to protect all the connections or disconnection devices against accidental or unauthorised opening when live in accordance with 536.2.3 of standard NF C 15-100. To this end, a notice “ne pas manoeuvrer en charge” must be placed inside the boxes or cabinets near these disconnection devices. Furthermore, in premises accessible to persons other than those with the requisite authorisation or qualification (BA4 or BA5): • The design or installation must be such that it is only possible to disassemble the connection devices with the aid of a tool; Equipment that does not have an under load circuit-breaking feature must require the either the use of a key or tool or the direct operation of a device with an under load circuit-breaking feature.	The PV input connectors can not be removed with out a aid of a tool.	P
14.9	**Connectors** In the d.c. part, the connectors used must comply with the standard NF EN 50521. To guarantee the quality of the connection and limit the risks of an electric arc that could spark a fire, each pair of male and female connectors to be assembled must be of the same type and the same brand. With regard to unsuspecting or unskilled persons, connection devices in the part d.c. are - rendered inaccessible by installation; - can be dismantled only with the help of a tool.	The unit provides only one type and brand of connectors for DC with male and female plugs, which are not interchangeable. The plugs are according to EN 50521.	P
14.10	**Surge arresters**		N/A
14.10.1	**Choice of surge arresters**	Must be taken under consideration for the installation.	N/A
	The surge arresters installed in the a.c. part of the PV installation must comply with standard NF EN 61643-11. The lightning arresters installed in the d.c. part of the PV installation must meet the standard NF EN 50539-11. In the case of Short Circuit Mode (SCM) type surge arresters, the manufacturer must provide the characteristics of the external disconnector to be associated with it so that the external lightning disconnector assembly has the characteristics of the OCM surge arresters (Open Circuit Mode: end of life in open circuit).		N/A

XP C15-712-3			
Clause/ §	**Requirement**	**Remark**	**Verdict**
	When the inverters incorporate overvoltage protection devices (e.g.: varistor type components), they must comply with standard NF EN 50539-11. Otherwise, the protection must be provided by external surge arresters.		N/A
	Voltage Up of external surge arresters must be coordinated with the characteristics of the devices built into the inverters. The inverter manufacturer must then provide the data necessary to select surge arresters.		N/A
14.10.2	**Installation of suger arresters**		N/A
	Surge arresters must be installed so that they can be checked and isolated from the PV source. *Technical specification CLC / TS 50539-12 provides additional information on the use of AC and DC arresters.* The surge arresters are connected as short as possible (see Figures 9 and 10).	Must be taken under consideration for the installation.	N/A
	The connection to the earth terminal and to the + and - terminals of the surge arrester is made with a conductor of minimum section equal to 6 mm² Cu or equivalent for type 2 and equal to 16 mm² Cu or equivalent for type 1. In the case of SCM type surge arresters, these minimum sections must also be adapted to the external protection associated with it (see 14.10.2) according to the usual rules of this document and the declarations of the manufacturer.		N/A
15	**Markings**		P
15.1	**Identification of components**	The inverter provides permanent marking.	P
	The main components comprising the photovoltaic installations must be identified and marked with clearly visible labels fixed permanently in accordance with the installation plans and diagrams:		P
15.2	**Labelling**		P
	For safety reasons and to alert the different people carrying out work in and around the building (staff tasked with maintenance work, inspectors, public distribution network operators, emergency services, etc.), it is imperative that the presence of a photovoltaic installation on a building is indicated.		P
15.2.1	**Labelling on the a.c. part**	Must be taken under consideration for the installation.	N/A
15.2.2	**Labelling on the d.c. part**		N/A

XP C15-712-3			
Clause/ §	**Requirement**	**Remark**	**Verdict**
	All junction boxes (PV generator, PV groups), battery box and d.c. ducts shall bear a visible and unalterable marking indicating that the active parts boxes may remain energized even after continuous isolation of the conversion	Must be taken under consideration for the installation.	N/A
15.2.3	**Labelling on the inverter**		P
	All inverters must bear a marking indicating that before any work is carried out, the two sources of voltage must be isolated.	The unit is provided with the applicabe marking	P
15.2.4	**Labeling local battery or envelope integrating the battery**		N/A
	The battery envelopes and the door leading to the battery room must bear a marking appropriate to the technology used. Affix on the access door of the battery technical room the words ”entry prohibited except to qualified personnel”(entrée interdite sauf au personnel qualifié)	Must be taken under consideration for the installation.	N/A
15.3	**Specific Labels for Emergency Response**		N/A
	If specific labeling for emergency services is required, it meets the principles described below. The purpose of this signage is to provide emergency services with information that allows a decision-making approach to quickly know: - if and how is secured the area accessible to people to rescue; - if there are cut-off devices see 12.5 and if the cut is effective.	Must be taken under consideration for the installation.	N/A
	This signage affixed next to the general control and disconnection device (or AGCP) completes the signage dedicated to the general control and disconnecting apparatus of the consumption and production installations defined in Article 12.		N/A
16.	**Technical file** The technical file must include the following items drawn up in French: • A circuit diagram of the photovoltaic system; • The list of installed equipment mentioning the characteristics and references to the replacement parts (fuses, lightning arrester cartridges etc.); • An installation diagram for the various photovoltaic components and modules as well as the corresponding connections (ducts); • A description of the procedure for working on the photovoltaic system and safety instructions.	The required information are stated in the manual.	P
17.	**Maintenance of photovoltaic installations**		N/A

XP C15-712-3			
Clause/ §	**Requirement**	**Remark**	**Verdict**
17.1	**General** The minimal technical maintenance work must be provided for during the life cycle of a photovoltaic installation to maintain or restore the installation to a state in which it can fulfil the function for which it was designed. All maintenance operations will be considered with priority to ensure and maintain the safety of property and people In addition to maintenance, operations may be envisaged to compensate for the wear of certain materials and to adapt them to the evolution of techniques and standards and regulations in force, as well as operations aimed at optimizing existing installation.	Must be taken under consideration for the installation.	N/A
17.2	**Levels and periodicity of maintenance** A distinction is made between the following three levels of maintenance comprising: • Conditional maintenance based on monitoring of the key parameters of the installation; • Precautionary maintenance carried out according to the prognoses extrapolated from the analysis and evaluation of the key parameters concerning the degradation of the asset (e.g. corrosion); • Systematic maintenance carried out at predetermined intervals and without a prior check of the state of the product or its constituent components. The recommended periodicity is one year	Must be taken under consideration for the installation.	N/A
17.3	**Maintenance actions**		N/A
17.3.1	**General** The points relating to the safety of persons and property, points relating to the proper functioning, are to be distinguished. These maintenance actions may be required to be completed depending on the regulatory safety requirements to which the building may be subject. Maintenance only covers the easily accessible electrical parts of the installation described in 17.3.2 and 17.3.3. All operations must be done without stepping on the photovoltaic modules.	Must be taken under consideration for the installation.	N/A
17.3.2	**Points relating to the safety of persons and property**	Must be taken under consideration for the installation.	N/A

XP C15-712-3			
Clause/ §	**Requirement**	**Remark**	**Verdict**
17.3.3	**Points relating to the proper functioning**	Must be taken under consideration for the installation.	N/A

Test Results

14.1 IEC 60068-2-75 (Hammer test)										P
Use method	Swing hammer			Spring hammer			Vertical hammer			
	N/A			P			P			
	Severity									
Repeats	3 Hits unless otherwise specified									
Energy (J)	0,14	0,2	0,35	0,5	0,7	1	2	5	10	20
Mass (kg)	0,25						0,5	1,7	5	5
Radius (mm)	10						25	25	50	50
IK code	IK01	IK02	IK03	IK04	IK05	IK06	IK07	IK08	IK09	IK10
	N/A	N/A	N/A	N/A	N/A	N/A	P	N/A	N/A	N/A
Note:										

Annex 1

DIN V VDE V 0126-1-1/A1 VFR2019 Test Report

DIN V VDE V 0126-1-1/A1 VFR2019			
Clause/§	**Requirement**	**Remark**	**Verdict**
1	**Scope (Automatic disconnecting facility for photovoltaic installations)**		
2	**Normative references**		
	DIN EN 50160:2003-03		
	DIN EN 50178 (VDE 0160):1998-04		
	DIN EN 60664-1 (VDE 0110-1)		
	E DIN VDE 0664-100:2005-05		
	DIN EN 61000-6-2		
	DIN EN61000-6-3		
	DIN EN 61008-1 (VDE 0664-10):2000-09		
	DIN VDE 0105-100:2000-06		
4	**Requirements:** 1. Monitoring of voltage and frequency derivation 2. Monitoring of DC-Injection 3. Monitoring of accidental anti Islanding 4. Monitoring of intended anti Islanding 5. Residual Current Monitoring Unit –RCMU (only if no galvanic separation)		
4.1	Functional safety: Automatic disconnecting facility	Considered, see annex. The single fault safe system was reviewed. The theoretical investigation was verified by error simulation.	**P**
4.1.1	Single fault safety of the automatic disconnecting facility	Considered, see block diagram, functional explanation and table 6.1 below.	**P**
4.1.2	Disconnection device: At least two independent disconnection devices. At least one relay and one switch with overvoltage category 2. If without galvanic seperation then two relays are necessary	Disconnection takes place redundant through two relays and the IGBT-fullbridge in series. The relays and the IGBT-full bridge are able to switch the full current.	**P**
4.2	Monitoring of the voltage: Voltages <=80% and >=115% of V_{nom} cause a disconnection within 0,2s (reconnection after min. 5s if voltage fluctuation <=3s; min. 30s if voltage fluctuation >3s). Test voltage steps should not be below 77% and above 118% of V_{nom}. Continuous over voltage above 110% up to 115% (adjustable, default setting 110%) causes disconnection after max. 10min. Re-connection after min. 30s.	Tested with a variable AC-Power supply at the output. Inverter disconnects within the limits, see table 6.2 below.	**P**
4.3	Monitoring of frequency: Frequencies <=47,5Hz and >=51,5Hz cause a disconnection within 0,2s (frequenz derivation 1Hz/s)	Tested with an AC-Source at the output. See table 6.3 below.	**P**

DIN V VDE V 0126-1-1/A1 VFR2019			
Clause/§	**Requirement**	**Remark**	**Verdict**
4.4	Monitoring of DC-Injection: DC error or DC-Currents >= 1A cause disconnection within 0,2s (positive and negative polarity)	See table 6.4 below.	**P**
4.5	Detection of anti islanding: anti islanding causes disconnection within 5s (for multiple installations 0,2s if triggered external). For the detection of anti-islanding is only one of the following methods necessary: -6.5.1 Measurement of impedance or -6.5.2 Resonant circuit test or -6.5.3 3-phase grid-voltage monitoring	See table 6.5.2 below.	**P**
4.6	Marking: In case of an automatic disconnecting facility there is a note at the type plate necessary	Marking provided on the type label.	**P**
4.7	**Special requirements:**		
4.7.1	Photovoltaics: If without galvanic separation then a RCMU is necessary. Insulation resistance > 1kOhm/V, at least 500kOhm. Slowly increasing DC-Leaking currents up to 300mA cause disconnection within 0,3s / Surge dc-leakage currents should lead to a disconnection of: -30mA within 0,3s -60mA within 0,15s -150mA within 0,04s Before every connection to the grid, the d.c. array ground insulation has to be checked. (see 6.6.2.2.4).	For Residual Current Monitoring see table 6.6 below.	**P**
5	**General requirements:** Electromagnetic compatibility (EMC)		
	Emitted interference *DIN EN 61000-6-3 (VDE 0839-6-3)*	Covered by EMC report Report No.: 201015064GZU-001, 201015064GZU-002	**P**
	Interference resistance *DIN EN 61000-6-2 (VDE 0839-6-2)*	Covered by EMC report Report No.: 201015064GZU-001, 201015064GZU-002	**P**
6	**Type test :**	See following test report	
7.	**Routine test*:***	Routine testing described above	**P**
8	**Specification of installation:**		**P**
	Annex		
A.1	**Additional Methods of monitoring anti islanding:**	Additional Methods can be added	**N/A**
A.4	**Disconnection for a short period**	If frequency fluctuation of <=3s occur, the reconnection after min. 5s is permitted.	**P**

DIN V VDE V 0126-1-1/A1 VFR2019		
Clause	**Test**	**Result**
6.1 (4.1)	Functional safety	**P**
6.2 (4.2)	Monitoring of voltage	**P**
6.3 (4.3)	Monitoring of frequency	**P**
6.4 (4.4)	Monitoring of DC-Injection	**P**
6.5 (4.5)	Detection of anti-islanding (only one method is necessary!)	
	6.5.1 Measurement of impedance	**N/A**
	6.5.2 Resonant circuit test	**P**
	6.5.3 3-phase grid-voltage monitoring	**N/A**
6.6 (4.7)	Residual Current Monitoring	**P**

Test Results

6.1 Functional safety - fault condition tests			P
	ambient temperature [°C] :	23,2	—
	model/type of power supply :	Chroma	—
	manufacturer of power supply :	AC: 61512 DC: 62150h-1000s	—
	rated markings of power supply :	AC: 0-300V, 15kVA DC: 0-1000V,15A	—

component No.	fault	test condition		test time	fuse No.	fault condition		result
		AC	DC			AC	DC	
Relay RL4	Short before start-up	230V <1A	520V <1A	10Min.	--	230V <1A	520V <1A	Indicate Relay fault,error code “ID41: RecoverRelayFail”. Do not connect to AC mainsn. No damage,no hazards.
Relay RL1	Short before start-up	230V <1A	520V <1A	10Min.	--	230V <1A	520V <1A	Indicate Relay fault,error code “ID41: RecoverRelayFail”. Do not connect to AC mainsn. No damage,no hazards.
Relay RL2	Short before start-up	230V <1A	520V <1A	10Min.	--	230V <1A	520V <1A	Indicate Relay fault,error code “ID41: RecoverRelayFail”. Do not connect to AC mainsn. No damage,no hazards.
Relay RL5	Short before start-up	230V <1A	520V <1A	10Min.	--	230V <1A	520V <1A	Indicate Relay fault,error code “ID41: RecoverRelayFail”. Do not connect to AC mainsn. No damage,no hazards.
Rectifier bridge BR1	Short	230V 15,5 A	520V 11,8 A	10Min.	--	230V <1A	520V <1A	Output a.c. relays operated immediately, disconnected with grid. No damage, no hazards.
Q23 pin G-S	Short	230V 15,5 A	520V 11,8 A	10Min.	--	230V <1A	520V <1A	Output a.c. relays operated, disconnected with grid. error code “ID41: RecoverRelayFail”. No damage,no hazards.
Q17 pin G-S	Short	230V 15,5 A	520V 11,8 A	10Min.	--	230V <1A	520V <1A	Output a.c. relays operated, disconnected with grid. error code “ID41: RecoverRelayFail”. No damage,no hazards.
Q18 pin G-S	Short	230V 15,5 A	520V 11,8 A	10Min.	--	230V <1A	520V <1A	Output a.c. relays operated, disconnected with grid. error code “ID41: RecoverRelayFail”. No damage,no hazards.

Q16 pin G-S	Short	230V 15,5 A	520V 11,8 A	10Min.	--	230V <1A	520V <1A	Output a.c. relays operated, disconnected with grid. error code “ID41: RecoverRelayFail”. No damage,no hazards.
RCM/LP1 pin GND-Vout	Short	230V 15,5 A	520V 11,8 A	10Min.	--	230V <1A	520V <1A	Output a.c. relays operated, disconnected with grid. error code “ID05:GFCI fault”. No damage,no hazards.
Monitoring voltage defect R203	Open	230V 15,5 A	520V 11,8 A	10Min.	--	230V <1A	520V <1A	Output a.c. relays operated, disconnected with grid, error code “GridUVP”. No damage. No hazards.
Monitoring voltage defect R219	Open	230V 15,5 A	520V 11,8 A	10Min.	--	230V <1A	520V <1A	Output a.c. relays operated, disconnected with grid, error code “GridUVP”. No damage. No hazards.
U1 pin 485-1TX 485-1RX	Short	230V 15,5 A	520V 11,8 A	10Min.	--	230V <1A	520V <1A	Output a.c. relays operated, disconnected with grid. 4851 Communication failure. No damage. No hazards.
U1 pin 485-2TX 485-2RX	Short	230V 15,5 A	520V 11,8 A	10Min.	--	230V <1A	520V <1A	Output a.c. relays operated, disconnected with grid. 4852 Communication failure. No damage. No hazards.
U1 pin ARMToDSP ARMFromDSP-TX	Short	230V 15,5 A	520V 11,8 A	10Min.	--	230V <1A	520V <1A	Output a.c. relays operated, disconnected with grid. SCI Communication failure. No damage. No hazards.
U1 pin M_CAN_RX M_CAN_TX	Short	230V 15,5 A	520V 11,8 A	10Min.	--	230V <1A	520V <1A	Output a.c. relays operated, disconnected with grid. CAN Communication failure. No damage. No hazards.
U1,+3.3V.S	Open	230V 15,5 A	520V 11,8 A	10Min.	--	230V <1A	520V <1A	Output a.c. relays operated, disconnected with grid. SCI Communication failure. No damage. No hazards.
PV voltage monitoring R283	Open	230V 15,5 A	520V 11,8 A	10Min.	--	230V <1A	520V <1A	Output a.c. relays operated, disconnected with grid. No damage. No hazards
PV voltage monitoring R277	Open	230V 15,5 A	520V 11,8 A	10Min.	--	230V <1A	520V <1A	Output a.c. relays operated, disconnected with grid. No damage. No hazards
L to N(Grid)	Reversed	230V 15,5 A	520V 11,8 A	10Min.	--	230V 15,5A	520V 11,8A	EUT operationed normally. No damage, no hazards.
C324	Short	230V 15,5 A	520V 11,8 A	10Min.	--	230V <1A	520V <1A	Output a.c. relays operated, disconnected with grid. L2 ,L7,breakdown, no hazards.
EC2	Short	230V 15,5 A	520V 11,8 A	10Min.	--	230V <1A	520V <1A	Output a.c. relays operated, disconnected with grid. EC2 damage, no hazards.
EC3	Short	230V 15,5 A	520V 11,8 A	10Min.	--	230V <1A	520V <1A	Output a.c. relays operated, disconnected with grid. EC3 damage, no hazards.
Q61 pin D-S	Short	230V 15,5 A	520V 11,8 A	10Min.	--	230V <1A	520V <1A	Output a.c. relays operated, disconnected with grid. No damage. No hazards

Q16 pin D-S	Short	230V 15,5 A	520V 11,8 A	10Min.	--	230V <1A	520V <1A	Output a.c. relays operated, disconnected with grid, error code "ID81" (SwBatOCP). No damage, no hazards.
Q17 pin D-S	Short	230V 15,5 A	520V 11,8 A	10Min.	--	230V <1A	520V <1A	Output a.c. relays operated, disconnected with grid, error code "ID81" (SwBatOCP). No damage, no hazards.
Q18 pin D-S	Short	230V 15,5 A	520V 11,8 A	10Min.	--	230V <1A	520V <1A	Output a.c. relays operated, disconnected with grid, error code "ID81" (SwBatOCP). No damage, no hazards.
Q19 pin D-S	Short	230V 15,5 A	520V 11,8 A	10Min.	--	230V <1A	520V <1A	Output a.c. relays operated, disconnected with grid, error code "ID81" (SwBatOCP). No damage, no hazards.
D13	Short	230V 15,5 A	520V 11,8 A	10Min.	--	230V <1A	520V <1A	Output a.c. relays operated, disconnected with grid, error code " ID69.PVOVP. No damage, no hazards.
R28	Open	230V 15,5 A	520V 11,8 A	10Min.	--	230V <1A	520V <1A	Output a.c. relays operated, disconnected with grid, error code " ID69.PVOVP. No damage, no hazards.
R68	Open	230V 15,5 A	520V 11,8 A	10Min.	--	230V <1A	520V <1A	Output a.c. relays operated, disconnected with grid, error code " ID71 LLCBusOVP". No damage, no hazards.
R32	Open	230V 15,5 A	520V 11,8 A	10Min.	--	230V <1A	520V <1A	Output a.c. relays operated, disconnected with grid, error code " ID71 LLCBusOVP". No damage, no hazards.
R71	Open	230V 15,5 A	520V 11,8 A	10Min.	--	230V <1A	520V <1A	Output a.c. relays operated, disconnected with grid, error code " ID71 LLCBusOVP". No damage, no hazards.
Q27	Short	230V 15,5 A	520V 11,8 A	10Min.	--	230V <1A	520V <1A	Output a.c. relays operated, disconnected with grid, error code " ID71 LLCBusOVP". No damage, no hazards.
Q9 pin G-C-E	Short	230V 15,5 A	520V 11,8 A	10Min.	--	230V <1A	520V <1A	The EUT shut down immediately. Q9,Q13 damaged, no hazards
Q8 pin G-C-E	Short	230V 15,5 A	520V 11,8 A	10Min.	--	230V <1A	520V <1A	The EUT shut down immediately. Q8,Q14 damaged, no hazards

Q7 pin G-C	Short	230V 15,5 A	520V 11,8 A	10Min.	--	230V <1A	520V <1A	The EUT shut down immediately. Q7 damaged, no hazards
Q12 pin G-C	Short	230V 15,5 A	520V 11,8 A	10Min.	--	230V <1A	520V <1A	The EUT shut down immediately. Q12 damaged, no hazards
Q1 pin G-S-D	Short	230V 15,5 A	520V 11,8 A	10Min.	--	230V <1A	520V <1A	The EUT shut down immediately. Q1,Q2,Q3 damaged, no hazards
Q2 pin G-S-D	Short	230V 15,5 A	520V 11,8 A	10Min.	--	230V <1A	520V <1A	The EUT shut down immediately. Q1,Q2,Q3,Q6 damaged, no hazards
R531	Short	230V 15,5 A	520V 11,8 A	10Min.	--	230V <1A	520V <1A	Output a.c. relays operated, disconnected with grid, error code " ID42,IsoFault". No damage, no hazards.
R602	Short	230V 15,5 A	520V 11,8 A	10Min.	--	230V <1A	520V <1A	Output a.c. relays operated, disconnected with grid, error code " ID42,IsoFault". No damage, no hazards.
R611	Short	230V 15,5 A	520V 11,8 A	10Min.	--	230V <1A	520V <1A	Output a.c. relays operated, disconnected with grid, error code " ID42,IsoFault". No damage, no hazards.
R620	Short	230V 15,5 A	520V 11,8 A	10Min.	--	230V <1A	520V <1A	Output a.c. relays operated, disconnected with grid, error code " ID42,IsoFault". No damage, no hazards.
EC25	Short	230V 15,5 A	520V 11,8 A	10Min.	--	230V <1A	520V <1A	Output a.c. relays operated, disconnected with grid, error code " ID42,IsoFault". No damage, no hazards.
EC27	Short	230V 15,5 A	520V 11,8 A	10Min.	--	230V <1A	520V <1A	Output a.c. relays operated, disconnected with grid, error code " ID17HwADFaultIGrid". No damage, no hazards.
EC16	Short	230V 15,5 A	520V 11,8 A	10Min.	--	230V <1A	520V <1A	Output a.c. relays operated, disconnected with grid, error code " ID17HwADFaultIGrid". No damage, no hazards.
EC17	Short	230V 15,5 A	520V 11,8 A	10Min.	--	230V <1A	520V <1A	Output a.c. relays operated, disconnected with grid, error code " ID17HwADFaultIGrid". No damage, no hazards.
EC29	Short	230V 15,5 A	520V 11,8 A	10Min.	--	230V <1A	520V <1A	Output a.c. relays operated, disconnected with grid, error code " ID17HwADFaultIGrid". No damage, no hazards.

EC31	Short	230V 15,5 A	520V 11,8 A	10Min.	--	230V <1A	520V <1A	Output a.c. relays operated, disconnected with grid, error code " ID17HwADFaultIGrid". No damage, no hazards.
EC18	Short	230V 15,5 A	520V 11,8 A	10Min.	--	230V <1A	520V <1A	Output a.c. relays operated, disconnected with grid, error code " ID17HwADFaultIGrid". No damage, no hazards.
EC19	Short	230V 15,5 A	520V 11,8 A	10Min.	--	230V <1A	520V <1A	Output a.c. relays operated, disconnected with grid, error code " ID17HwADFaultIGrid". No damage, no hazards.
EC24	Short	230V 15,5 A	520V 11,8 A	10Min.	--	230V <1A	520V <1A	Output a.c. relays operated, disconnected with grid, error code " ID17HwADFaultIGrid". No damage, no hazards.
EC26	Short	230V 15,5 A	520V 11,8 A	10Min.	--	230V <1A	520V <1A	Output a.c. relays operated, disconnected with grid, error code " ID17HwADFaultIGrid". No damage, no hazards.
EC20	Short	230V 15,5 A	520V 11,8 A	10Min.	--	230V <1A	520V <1A	Output a.c. relays operated, disconnected with grid, error code " ID17HwADFaultIGrid". No damage, no hazards.
EC21	Short	230V 15,5 A	520V 11,8 A	10Min.	--	230V <1A	520V <1A	Output a.c. relays operated, disconnected with grid, error code " ID17HwADFaultIGrid". No damage, no hazards.
EC28	Short	230V 15,5 A	520V 11,8 A	10Min.	--	230V <1A	520V <1A	Output a.c. relays operated, disconnected with grid, error code " ID17HwADFaultIGrid". No damage, no hazards.
EC30	Short	230V 15,5 A	520V 11,8 A	10Min.	--	230V <1A	520V <1A	Output a.c. relays operated, disconnected with grid, error code " ID17HwADFaultIGrid". No damage, no hazards.
EC22	Short	230V 15,5 A	520V 11,8 A	10Min.	--	230V <1A	520V <1A	Output a.c. relays operated, disconnected with grid, error code " ID17HwADFaultIGrid". No damage, no hazards.
EC23	Short	230V 15,5 A	520V 11,8 A	10Min.	--	230V <1A	520V <1A	Output a.c. relays operated, disconnected with grid, error code " ID17HwADFaultIGrid". No damage, no hazards.
EC32	Short	230V 15,5 A	520V 11,8 A	10Min.	--	230V <1A	520V <1A	Output a.c. relays operated, disconnected with grid, error code " SCI Communication failure". No damage, no hazards.

U4 pin M_LINRX M_LINTX	Short	230V 15,5 A	520V 11,8 A	10Min.	--	230V <1A	520V <1A	Output a.c.relays operated, disconnected with grid. M_LINRX Communication failure No damaged. No hazards
INSYN,TX1,INSYN,RX1	Short	230V 15,5 A	520V 11,8 A	10Min.	--	230V <1A	520V <1A	Output a.c.relays operated, disconnected with grid. Error code"ID47(ParallelFault) No damaged. No hazards.
INSYN,TX1,INSYN,RX1	Short	230V 15,5 A	520V 11,8 A	10Min.	--	230V <1A	520V <1A	Output a.c.relays operated, disconnected with grid. Error code"ID47(ParallelFault) No damaged. No hazards.
C384	Short	230V 15,5 A	520V 11,8 A	10Min.	--	230V <1A	520V <1A	Output a.c.relays operated, disconnected with grid. error code "ID81(SwBatOCP) . No damaged. No hazards.
EC6	Short	230V 15,5 A	520V 11,8 A	10Min.	--	230V <1A	520V <1A	The EUT shut down immediately. No damaged, no hazards.
EC9	Short	230V 15,5 A	520V 11,8 A	10Min.	--	230V <1A	520V <1A	The EUT shut down immediately. No damaged, no hazards.
EC11	Short	230V 15,5 A	520V 11,8 A	10Min.	--	230V <1A	520V <1A	The EUT shut down immediately. No damaged, no hazards.
U58	Short	230V 15,5 A	520V 11,8 A	10Min.	--	230V <1A	520V <1A	The EUT shut down immediately. No damaged, no hazards.
C463	Short	230V 15,5 A	520V 11,8 A	10Min.	--	230V <1A	520V <1A	Output a.c.relays operated, disconnected with grid. error code"GFCI fault" No damaged. No hazards
C105	Short	230V 15,5 A	520V 11,8 A	10Min.	--	230V <1A	520V <1A	Output a.c.relays operated, disconnected with grid. error code"CT current fault" No damaged. No hazards.
C130	Short	230V 15,5 A	520V 11,8 A	10Min.	--	230V <1A	520V <1A	Output a.c.relays operated, disconnected with grid. error code" OverTempDerating" No damaged. No hazards.
C107	Short	230V 15,5 A	520V 11,8 A	10Min.	--	230V <1A	520V <1A	Output a.c.relays operated, disconnected with grid. error code"HwLLCBusOCP" No damaged. No hazards.
C120	Short	230V 15,5 A	520V 11,8 A	10Min.	--	230V <1A	520V <1A	Output a.c.relays operated, disconnected with grid. error code"HwLLCBusOCP" No damaged. No hazards.

The errors in the control circuit simulate that the safety is even ensured during single fault.

The tests had been performed on the HYD 6000-EP are valid for the HYD 3000-EP, HYD 3680-EP, HYD 4000-EP, HYD 4600-EP, HYD 5000-EP, HYD 5500-EP since it is same as in hardware and just power derated by software.

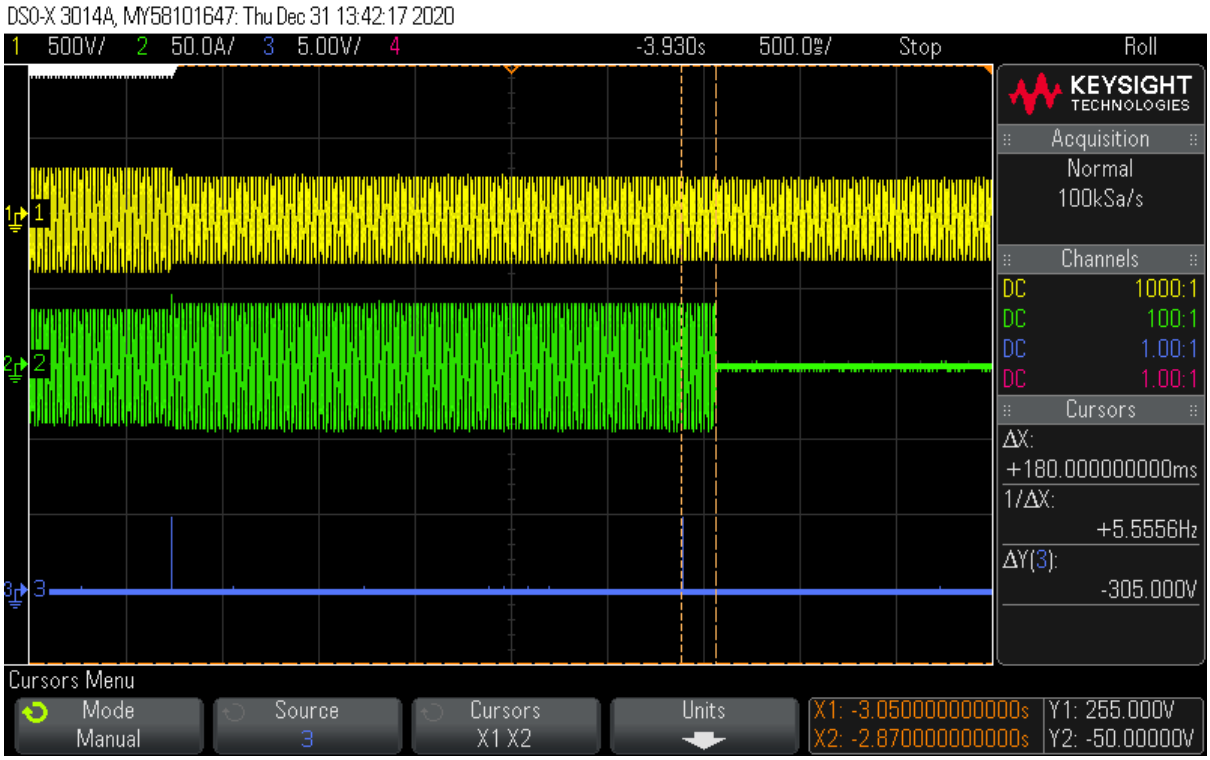
The test results refer to the test report "PVTR200917N016" issued by Bureau Veritas Shenzhen Co., Ltd. Dongguan Branch, dated on 2021.01.20.

6.2 (4.2) Voltage monitoring									**P**
Test conditions:	Output power: 6000W Frequency: 50Hz								
	Under Voltage				**Over Voltage**				
Parameter	Voltage	Time [ms]			Voltage	Time [ms]			
Limit	**184,0V**	**<= 200ms**			**264,5V**	**<= 200 ms**			
Trip value	183,6V				264,2V				
Disconnection time	188V to 178V	170	180	180	258V to 270V	170	170	170	
	230V to 178V	162	144	147	230V to 270V	166	175	173	
Reconnection time (fluctuation <=3s):	>= 5s	64s			>= 5s	65s			
Reconnection time (fluctuation >3s):	>= 30s	64s			>= 30s	65s			

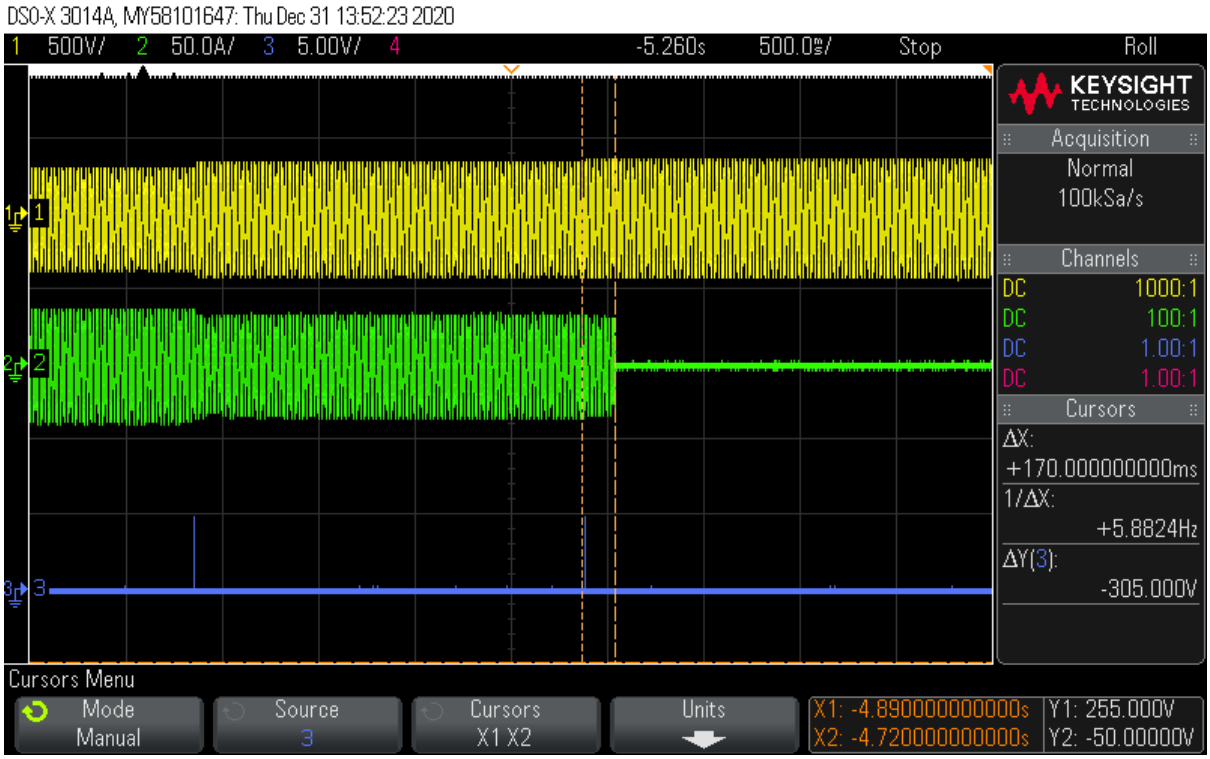
Note:
Lower and upper threshold voltage shall not fall or rise below or above 3% of the threshold voltage itself (min. 177,1V; max. 270,9V). The measurement shall take place at nominal frequency and any power.

The tests had been performed on the HYD 6000-EP are valid for the HYD 3000-EP, HYD 3680-EP, HYD 4000-EP, HYD 4600-EP, HYD 5000-EP and HYD 5500-EP since it is same as in hardware and just power derated by software.

Under voltage:



Over voltage:



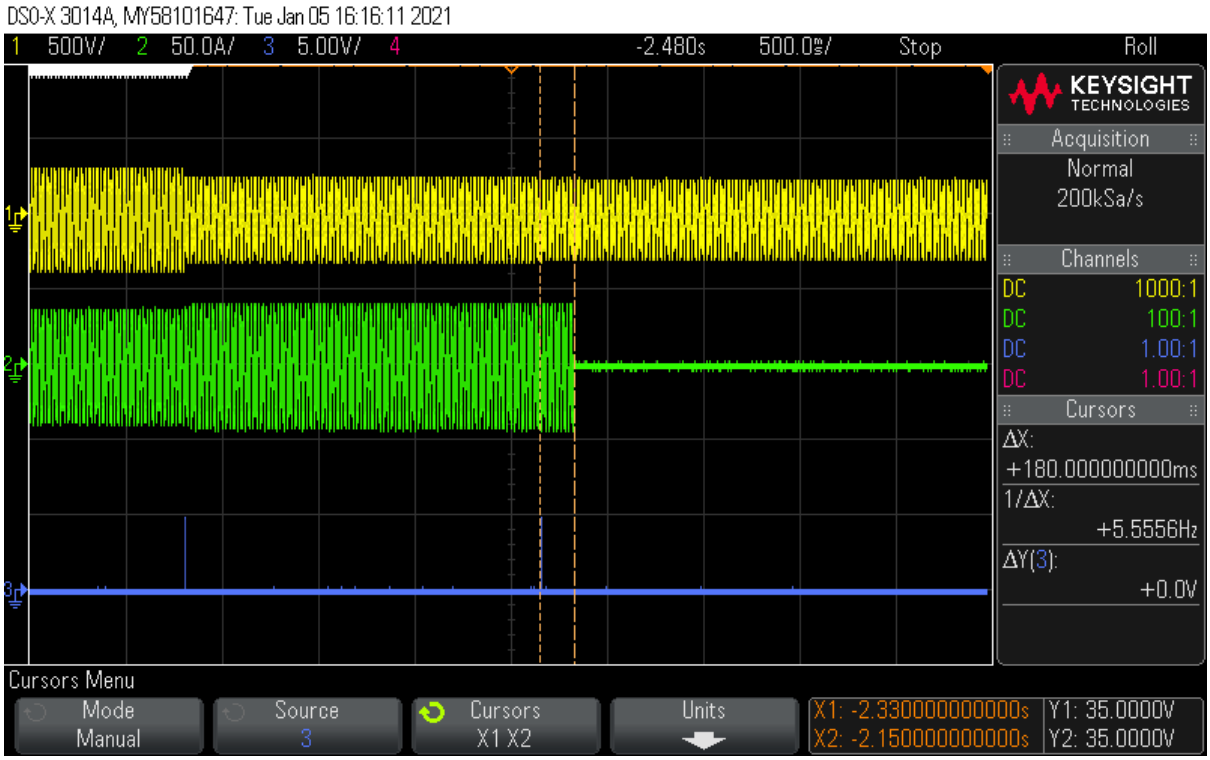
Island 50Hz

6.2 (4.2) Voltage monitoring according protection de Découplage pour le Raccordement d'une production décentralisée en HTA et en BT dans les zones non interconnectées, référentiel technique – SEI REF 04, V5									**P**
Test conditions:	Output power: 6000W Frequency: 50Hz								
	Under Voltage				**Over Voltage**				
Parameter	Voltage	Time [ms]			Voltage	Time [ms]			
Limit	**195,5V**	**<= 200ms**			**255,3V**	**<= 200 ms**			
Trip value	197,9V				255,5V				
Disconnection time	200V to 190V	180	180	170	250V to 260V	160	160	150	
	230V to 190V	157	160	150	230V to 260V	158	161	156	
Reconnection time (fluctuation <=3s):	>= 5s	65s			>= 5s	65s			
Reconnection time (fluctuation >3s):	>= 30s	65s			>= 30s	65s			

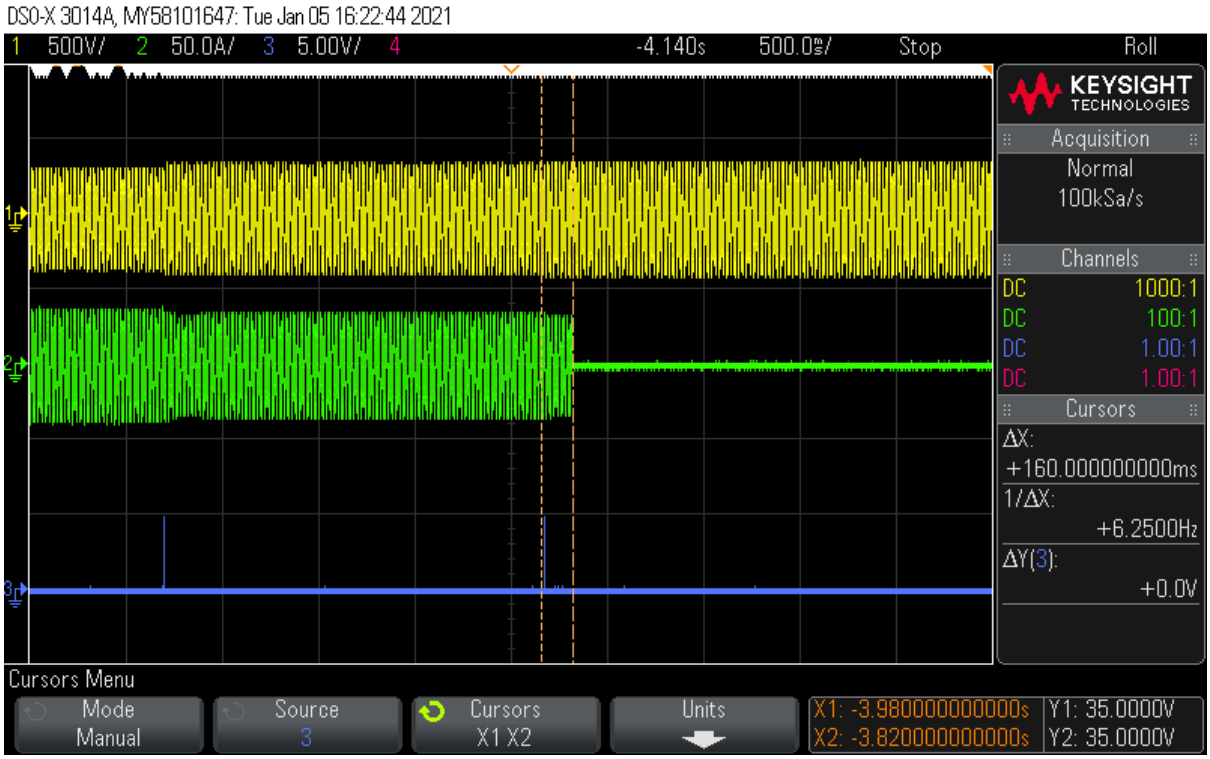
Note:
Lower and upper threshold voltage shall not fall or rise below or above 3% of the threshold voltage itself (min. 177,1V; max. 270,9V). The measurement shall take place at nominal frequency and any power.

The tests had been performed on the HYD 6000-EP are valid for the HYD 3000-EP, HYD 3680-EP, HYD 4000-EP, HYD 4600-EP, HYD 5000-EP and HYD 5500-EP since it is same as in hardware and just power derated by software.

Under voltage:



Over voltage:



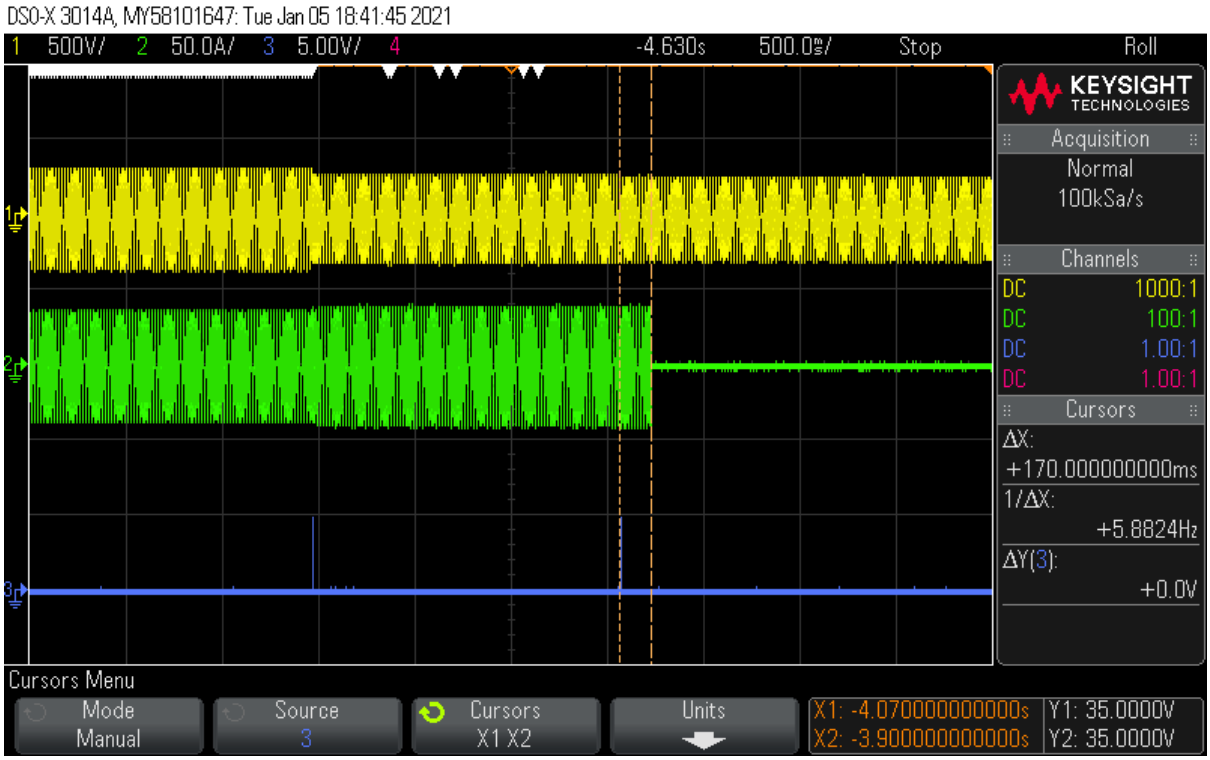
Island 60Hz

6.2 (4.2) Voltage monitoring according contrat de raccordement, d'accès et d'exploitation (CRAE) pour une installation de production photovoltaïque raccordée au réseau public d'électricité									**P**
Test conditions:	Output power: 6000W Frequency: 60Hz								
	Under Voltage				**Over Voltage**				
Parameter	Voltage	Time [ms]			Voltage	Time [ms]			
Limit	**195,5V**	**<= 200ms**			**264,5V**	**<= 200 ms**			
Trip value	195,6V				262,6V				
Disconnection time	200V to 190V	150	160	170	258V to 270V	150	160	150	
	230V to 190V	168	151	169	230V to 270V	164	170	154	
Reconnection time (fluctuation <=3s):	>= 5s	64s			>= 5s	65s			
Reconnection time (fluctuation >3s):	>= 30s	64s			>= 30s	65s			

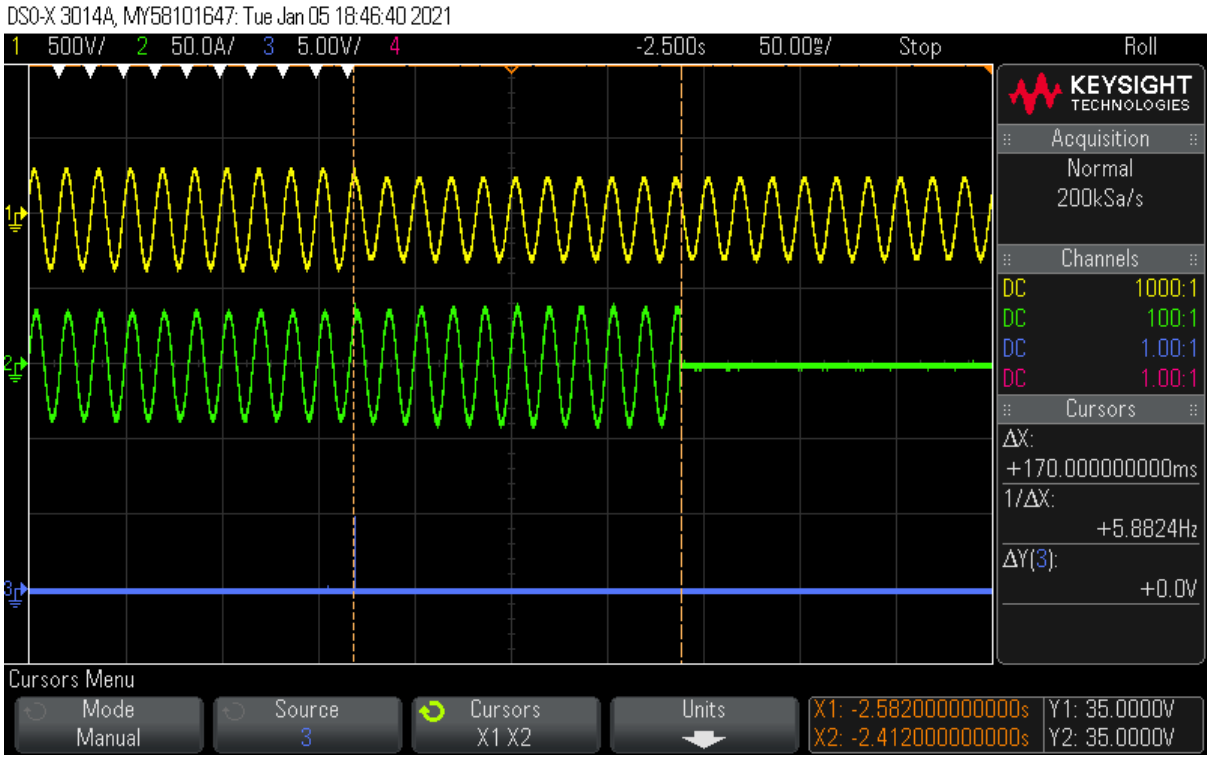
Note:
Lower and upper threshold voltage shall not fall or rise below or above 3% of the threshold voltage itself (min. 177,1V; max. 270,9V). The measurement shall take place at nominal frequency and any power.

The tests had been performed on the HYD 6000-EP are valid for the HYD 3000-EP, HYD 3680-EP, HYD 4000-EP, HYD 4600-EP, HYD 5000-EP and HYD 5500-EP since it is same as in hardware and just power derated by software.

Under voltage:



Over voltage:

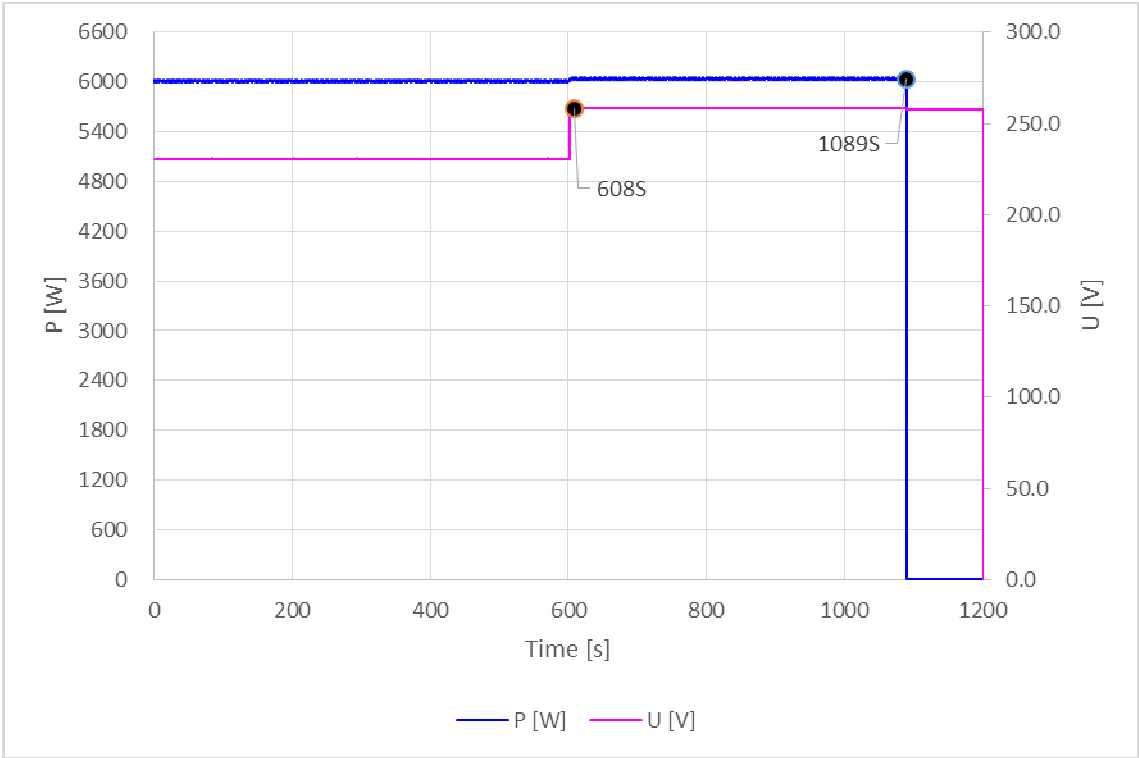


6.2 (4.2.3) Overvoltage protection according to DIN EN 50160:2000-03, 2.3			**P**
Setting values:		Setting U> [V]	253
		Setting $T_{disconnection}$ U> [s]	600
		Setting $T_{disconnection}$ [ms]	200
Test:			
		Disconnection time:	Limit:
a)	The voltage is set to 100% U_n and held for 600 s. Thereafter the voltage is set to 112% Un. Disconnection must take place within 600 s.		
	Phase 1	481 s	≤ 600 s
	Phase 2	--	
	Phase 3	--	
b)	The voltage is set to U_n for 600 s and then to 108% Un for 600 s. No disconnection should take place.		
	Phase 1	No disconnection	Disconnection should not take place.
	Phase 2	--	
	Phase 3	--	
c)	The voltage is set to 106 % U_n and held for 600 s. Thereafter the voltage is set to 114 % U_n. Disconnection must take place within 300 s or about 50 % of the disconnection time measured in point a).*		
	Phase 1	294 s	300 s
	Phase 2	--	
	Phase 3	--	

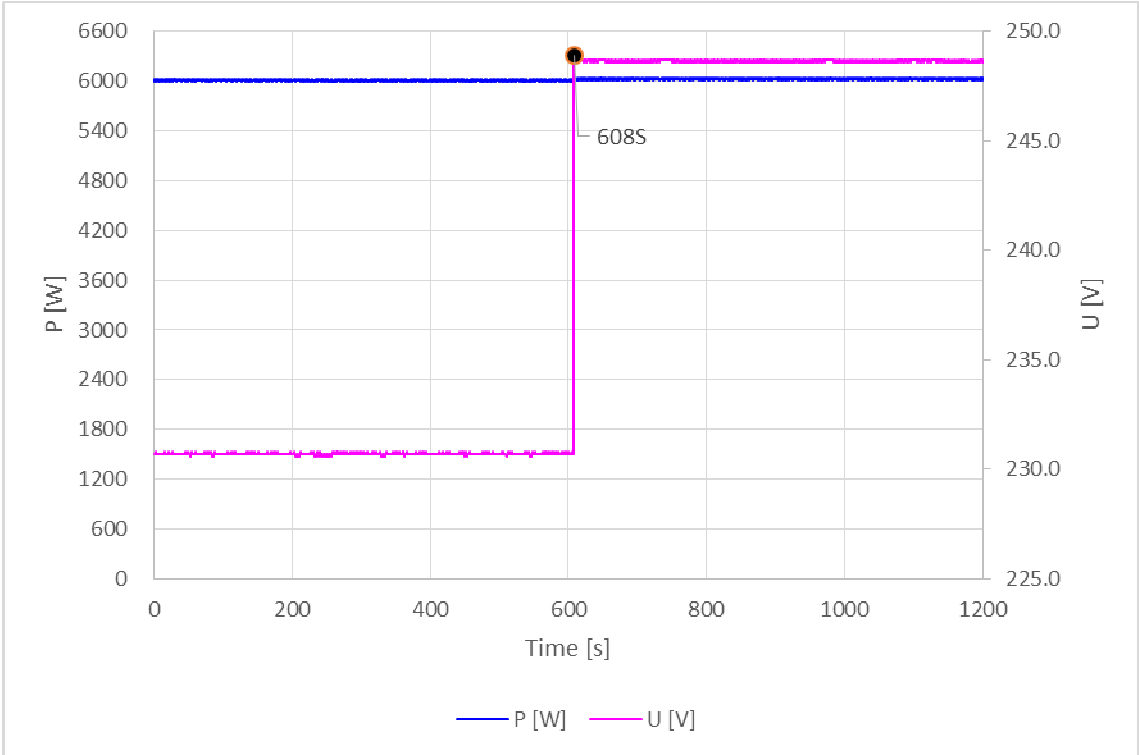
Note:

The tests had been performed on the HYD 6000-EP are valid for the HYD 3000-EP, HYD 3680-EP, HYD 4000-EP, HYD 4600-EP, HYD 5000-EP and HYD 5500-EP since it is same as in hardware and just power derated by software.

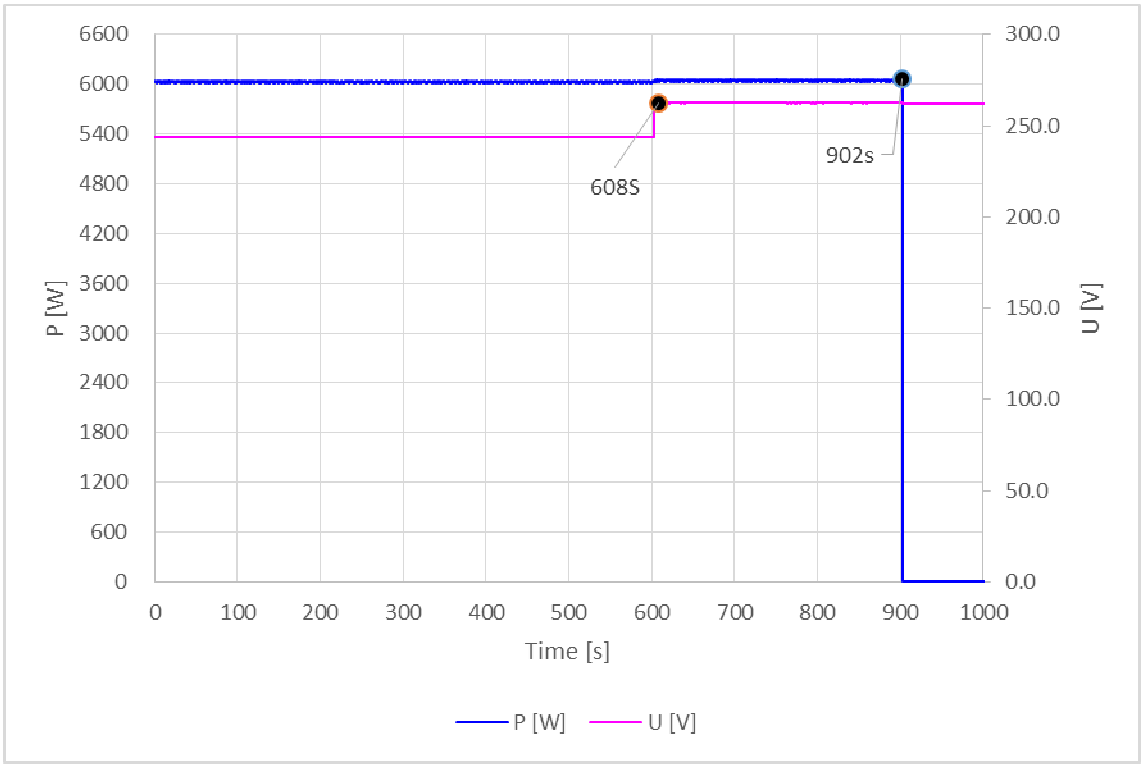
a) Voltage set to 112 % U_n:



b) Voltage set to 108% U_n:

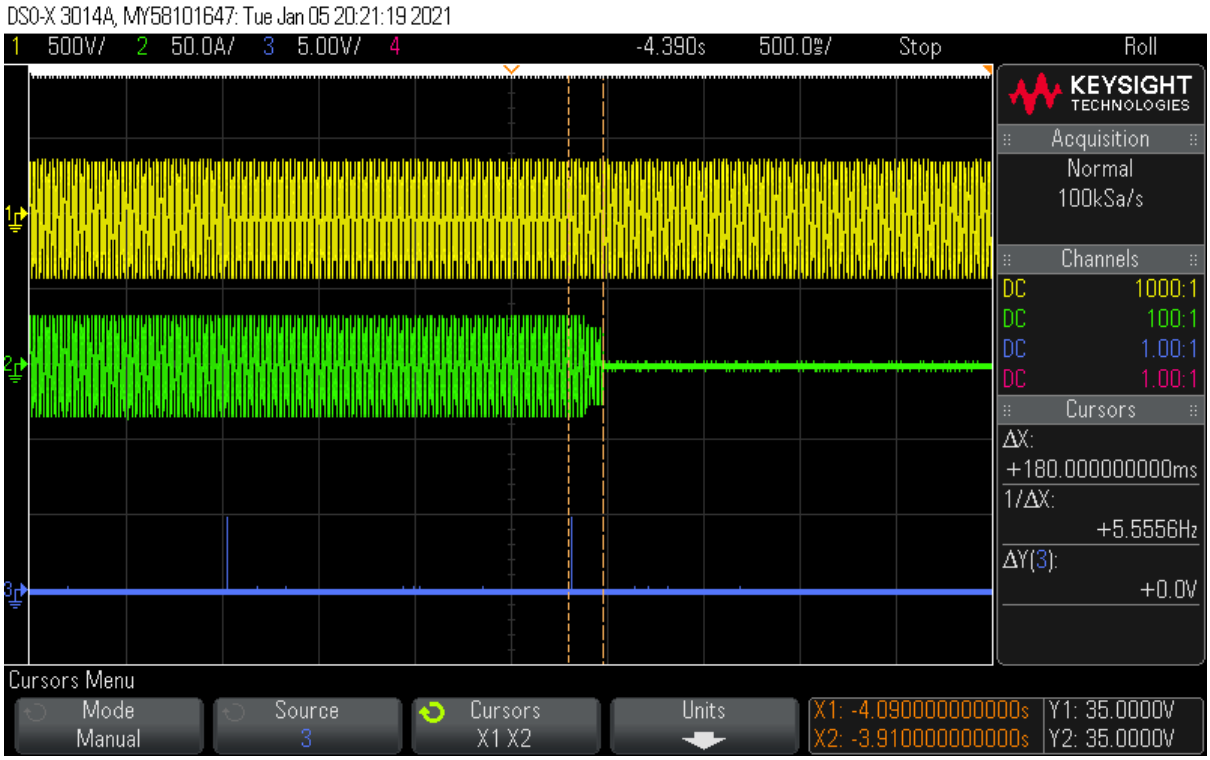


c) Voltage set to 106 % U_n, thereafter 114% U_n:

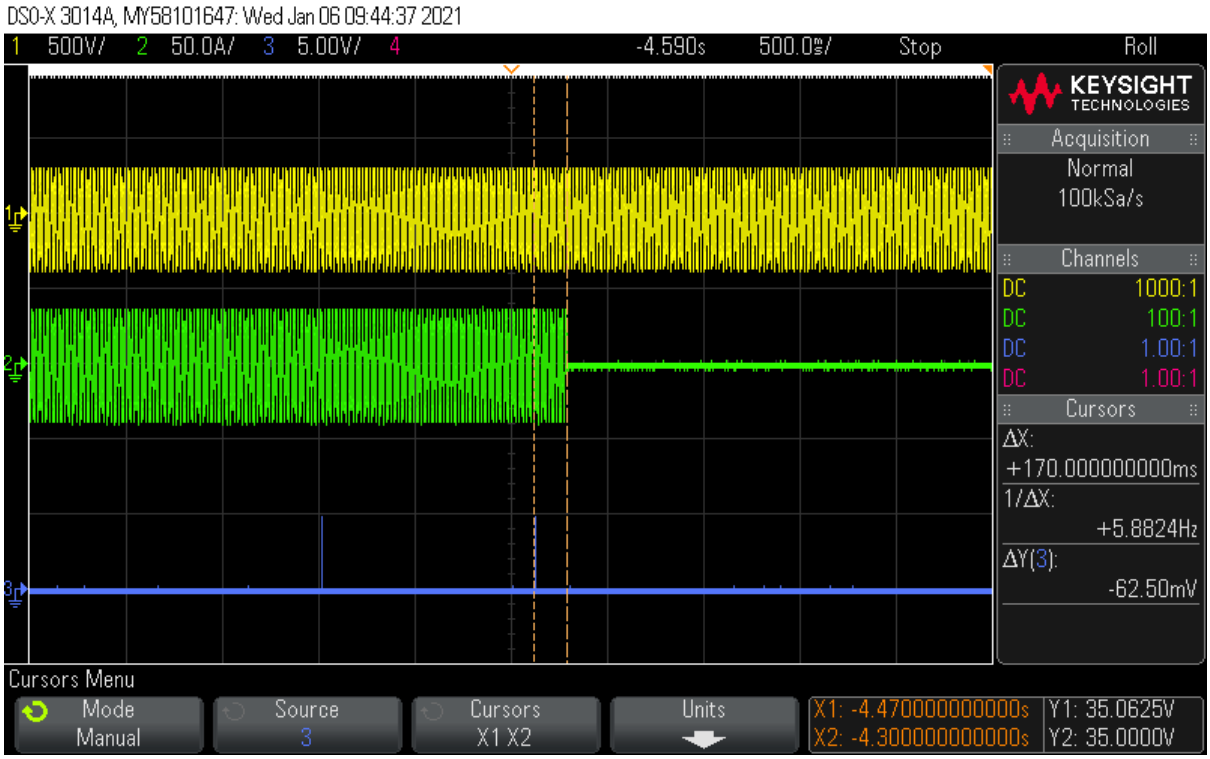


6.3 (4.3) Frequency monitoring DIN V VDE V 0126-1-1/A1 VFR2019									**P**
Test conditions:	Output power: 6000W								
	Under frequency				**Over frequency**				
Parameter	Frequency [Hz]	Time [ms]			Frequency [Hz]	Time [ms]			
Output Voltage		80%U_N	U_N	115%U_N		80%U_N	U_N	115%U_N	
Limit	47,5Hz	<= 200ms			51,5Hz	<= 200ms			
Trip value		47,50	47,50	47,50		51,50	51,50	51,50	
Disconnection time (ms)	50,00Hz to 47,00Hz	170	170	170	51,00Hz to 52,00Hz	160	170	170	
		160	180	180		170	170	160	
Reconnection time (fluctuation <=3s):	>= 5s	65s			>= 5s	62s			
Reconnection time (fluctuation >3s):	>=30s	65s			>= 30s	62s			
Note: The tests had been performed on the HYD 6000-EP are valid for the HYD 3000-EP, HYD 3680-EP, HYD 4000-EP, HYD 4600-EP, HYD 5000-EP and HYD 5500-EP since it is same as in hardware and just power derated by software.									

Under frequency:



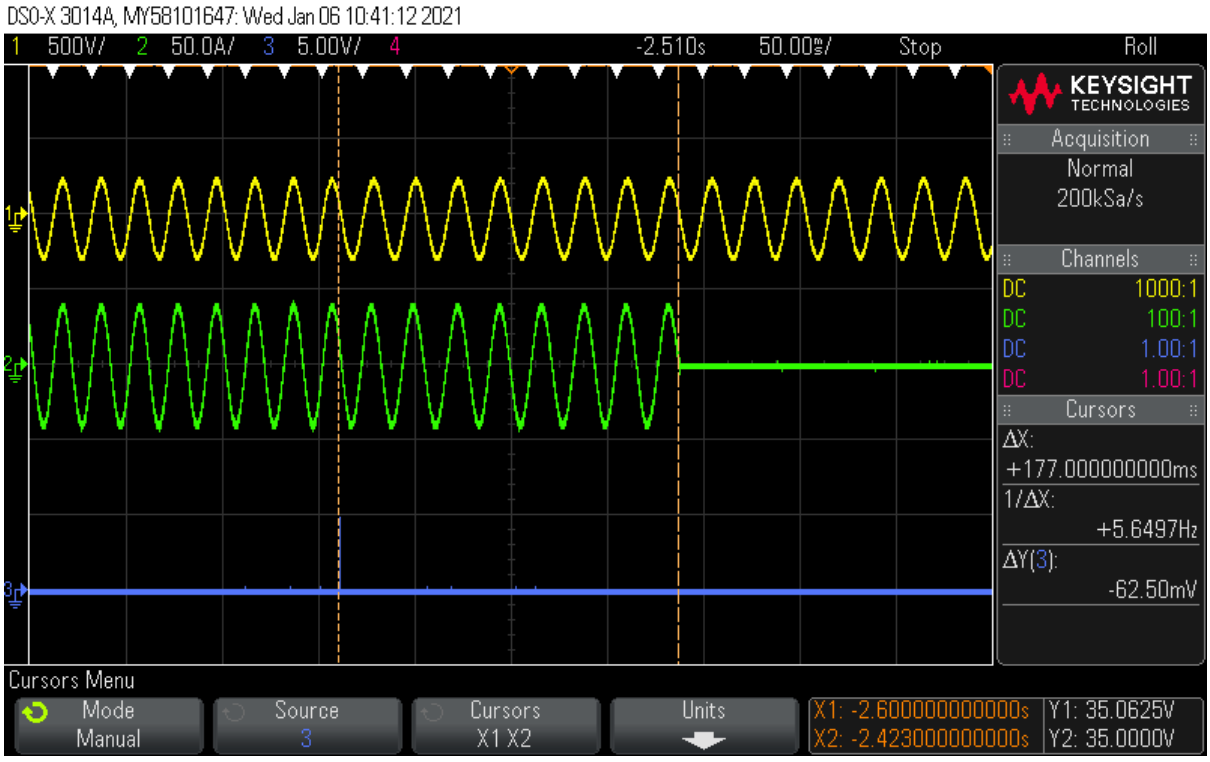
Over frequency:



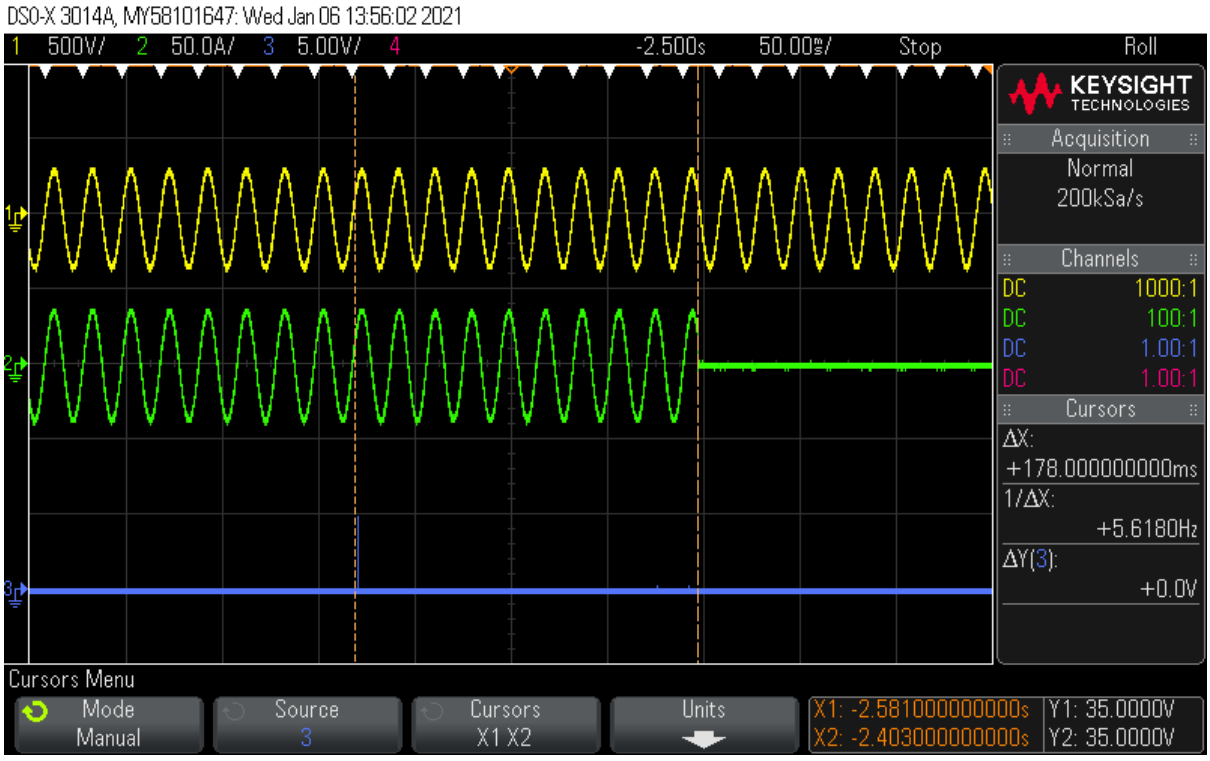
Island 50Hz

6.3 (4.3) Frequency monitoring according protection de Découplage pour le Raccordement d'une production décentralisée en HTA et en BT dans les zones non interconnectées, référentiel technique – SEI REF 04, V5									**P**
Test conditions:	Output power: 6000W								
	Under frequency				**Over frequency**				
Parameter	Frequency [Hz]	Time [ms]			Frequency [Hz]	Time [ms]			
Output Voltage		80%U_N	U_N	111%U_N		80%U_N	U_N	111%U_N	
Limit	46,0Hz	200ms	200ms	200ms	52,0Hz	200ms	200ms	200ms	
Trip value		46,00Hz	46,00Hz	46,00Hz		52,00Hz	52,00Hz	52,00Hz	
Disconnection time (ms)	46,5 Hz to 45,5Hz	177	**156**	159	51,5 Hz to 52.5Hz	163	167	**167**	
		160	157	155		161	178	172	
Reconnection time (fluctuation <=3s):	>= 5s	65s			>= 5s	65s			
Reconnection time (fluctuation >3s):	>= 60s	65s			>= 60s	65s			
Note: The tests had been performed on the HYD 6000-EP are valid for the HYD 3000-EP, HYD 3680-EP, HYD 4000-EP, HYD 4600-EP, HYD 5000-EP and HYD 5500-EP since it is same as in hardware and just power derated by software.									

Under frequency:



Over frequency:



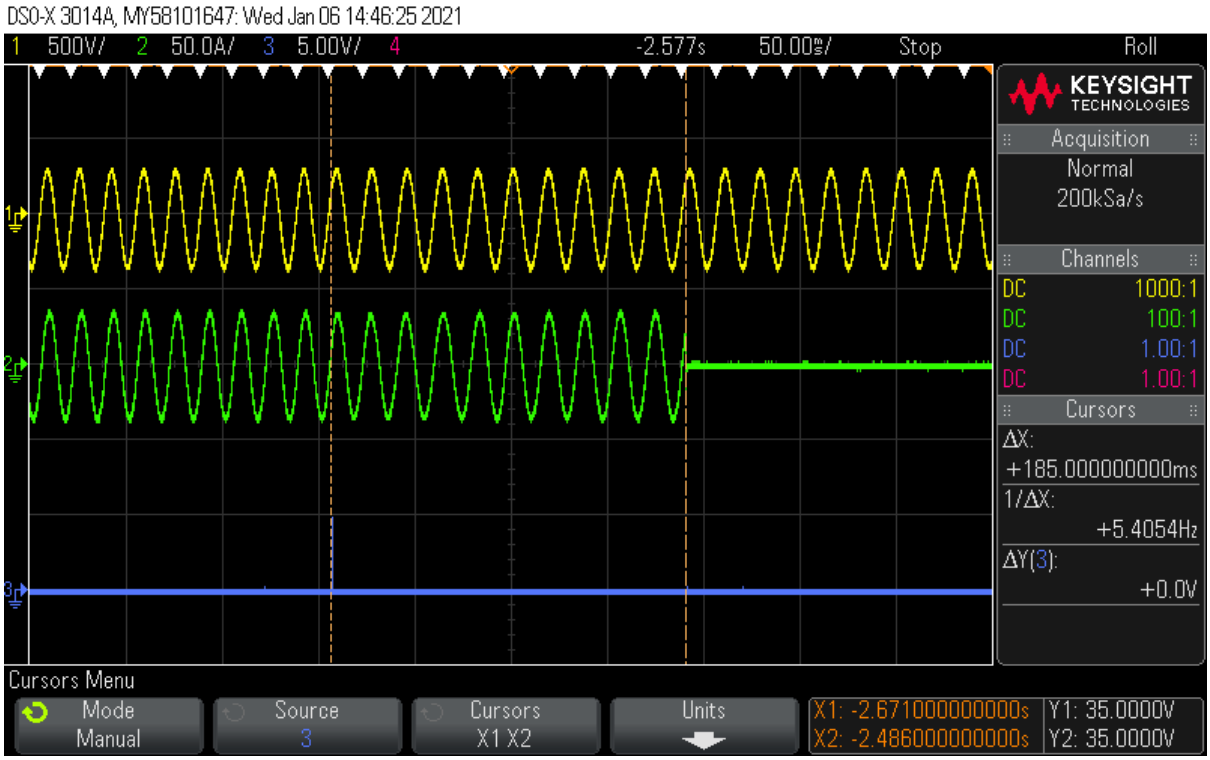
Island 60Hz

6.3 (4.3) Frequency monitoring according contrat de raccordement, d'accès et d'exploitation (CRAE) pour une installation de production photovoltaïque raccordée au réseau public d'électricité	**P**

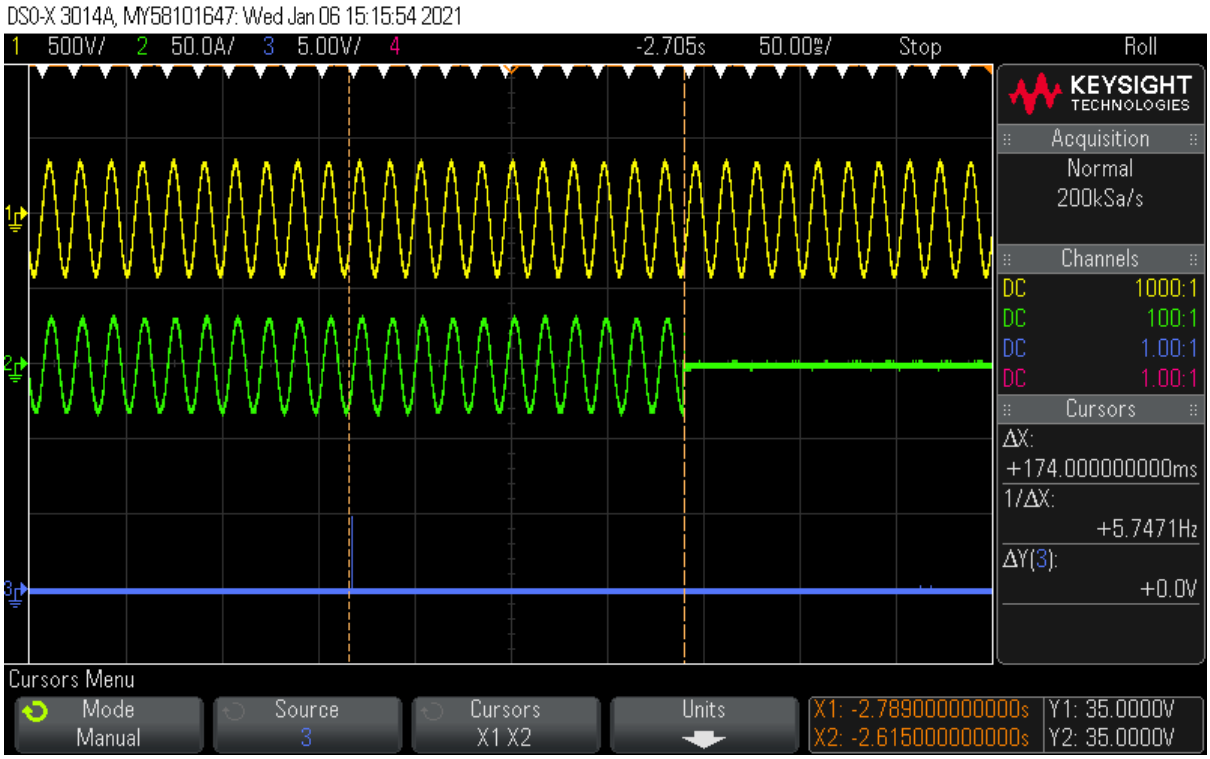
Test conditions:	Output power: 6000W							
	Under frequency				**Over frequency**			
Parameter	Frequency [Hz]	Time [ms]			Frequency [Hz]	Time [ms]		
Output Voltage		85%U_N	U_N	115%U_N		85%U_N	U_N	115%U_N
Limit	55,0Hz	200ms	200ms	200ms	62,5Hz	200ms	200ms	200ms
Trip value		54,99Hz	55,00Hz	54,99Hz		62,50Hz	62,50Hz	62,50Hz
Disconnection time (ms)	55,5 Hz to 54,5Hz	183	184	159	62,0Hz to 63,0Hz	173	165	155
		182	185	165		**168**	165	174
Reconnection time (fluctuation <=3s):	>= 5s	65s			>= 5s	65s		
Reconnection time (fluctuation >3s):	>= 60s	65s			>= 60s	65s		

Note:
The tests had been performed on the HYD 6000-EP are valid for the HYD 3000-EP, HYD 3680-EP, HYD 4000-EP, HYD 4600-EP, HYD 5000-EP and HYD 5500-EP since it is same as in hardware and just power derated by software.

Under frequency:

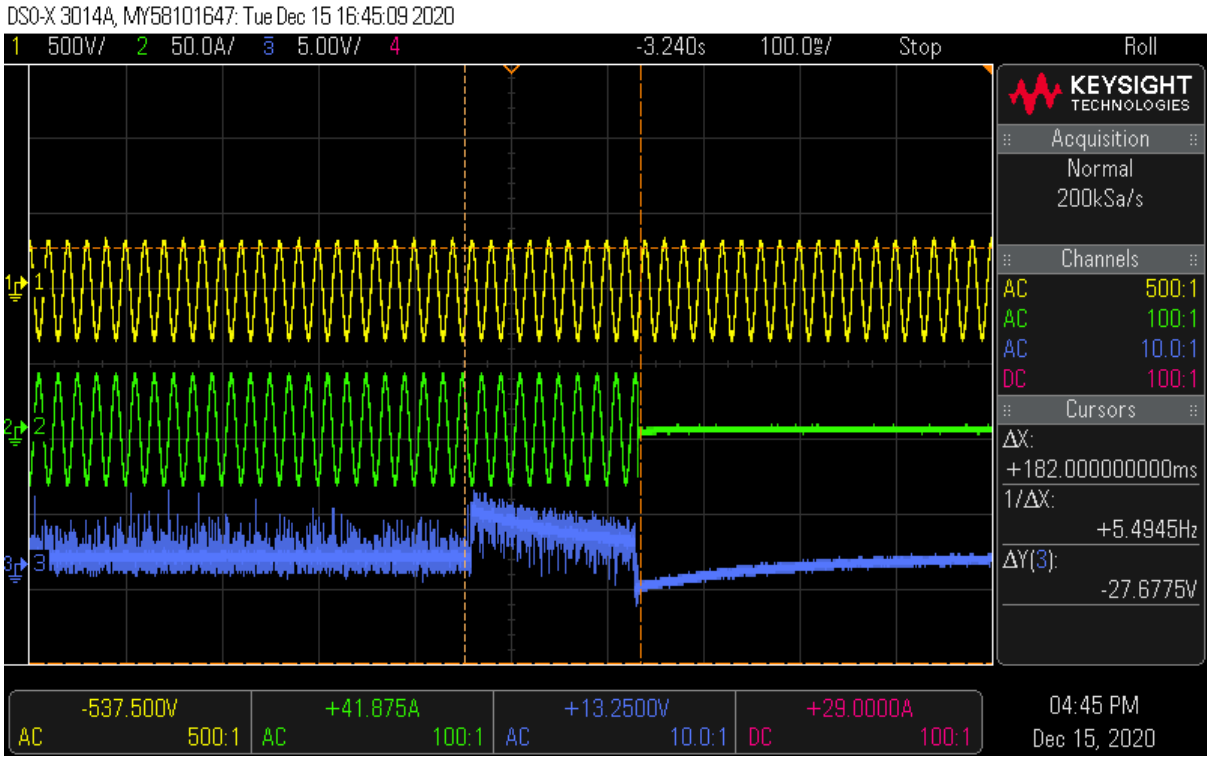


Over frequency:

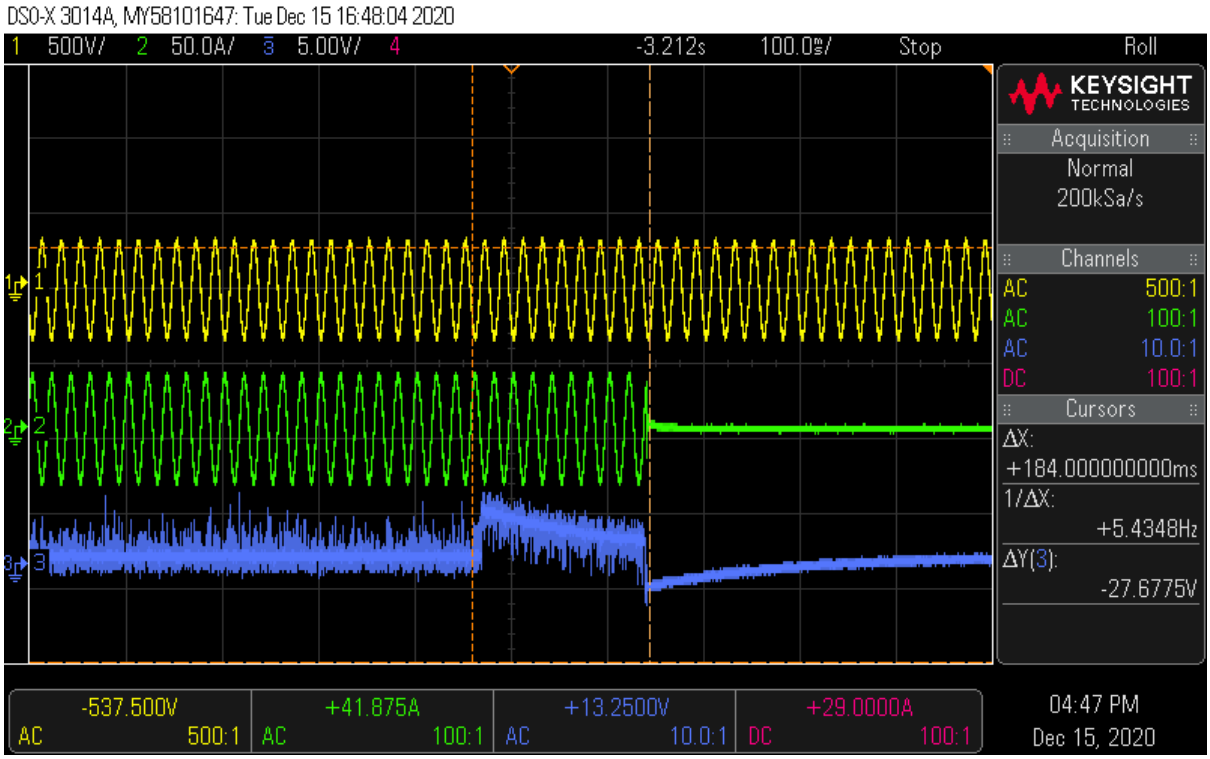


6.4 (4.4) Monitoring of DC-Injection				**P**
Test conditions:	U_N : 230Vac U_{input} : 360Vdc Rated Power : 6kW			
DC Injection [A]	**Limits**	**Trip Time [ms]**		
+1A	I_{DC}:>1A than disconnection within 0,2 sec	182	178	180
-1A	I_{DC}:>1A than disconnection within 0,2 sec	184	180	178
Note: A dc-current of 1A is injected, disconnection time of max. 0,2s The tests had been performed on the HYD 6000-EP are valid for the HYD 3000-EP, HYD 3680-EP, HYD 4000-EP, HYD 4600-EP, HYD 5000-EP and HYD 5500-EP since it is same as in hardware and just power derated by software.				

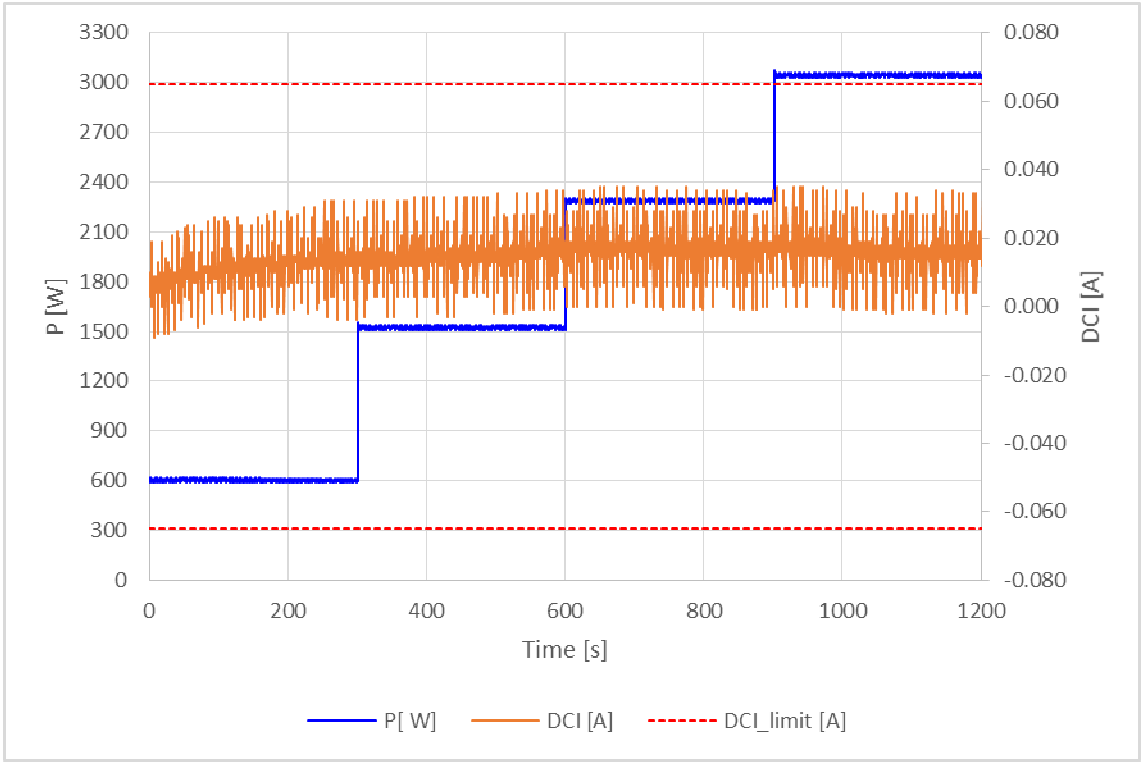
Positive DC-Injection:



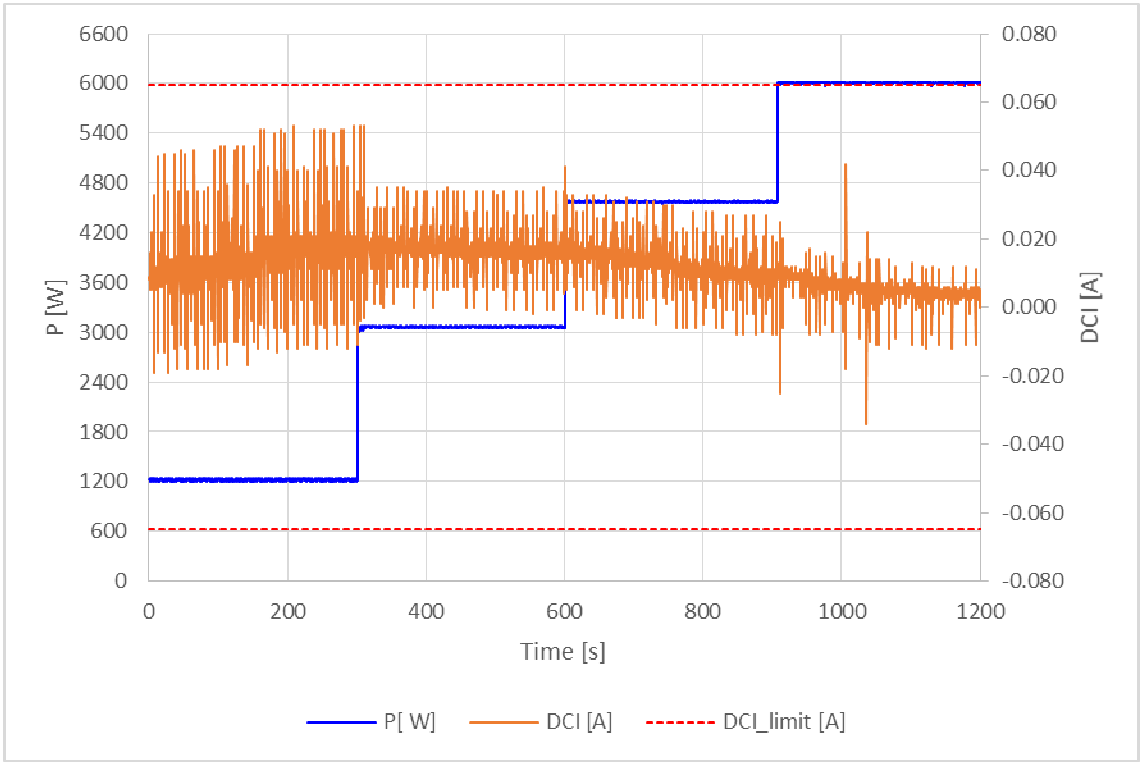
Negative DC-Injection



DC-Injection				P
HYD 3000-EP				
Protection limit	Tested at four power levels limit 0,5% of IAC;nom			
Output power	~20%	~50%	75%	~100%
Abs. Max. test value [A]	0,031	0,034	0,035	0,035
Abs. Ave. test value [A]	0,011	0,015	0,017	0,016



HYD 6000-ES				
Protection limit	Tested at four power levels limit 0,5% of IAC;nom			
Output power	~20%	~50%	75%	~100%
Abs. Max. test value [A]	0,053	0,053	0,033	0,042
Abs. Ave. test value [A]	0,015	0,017	0,013	0,006



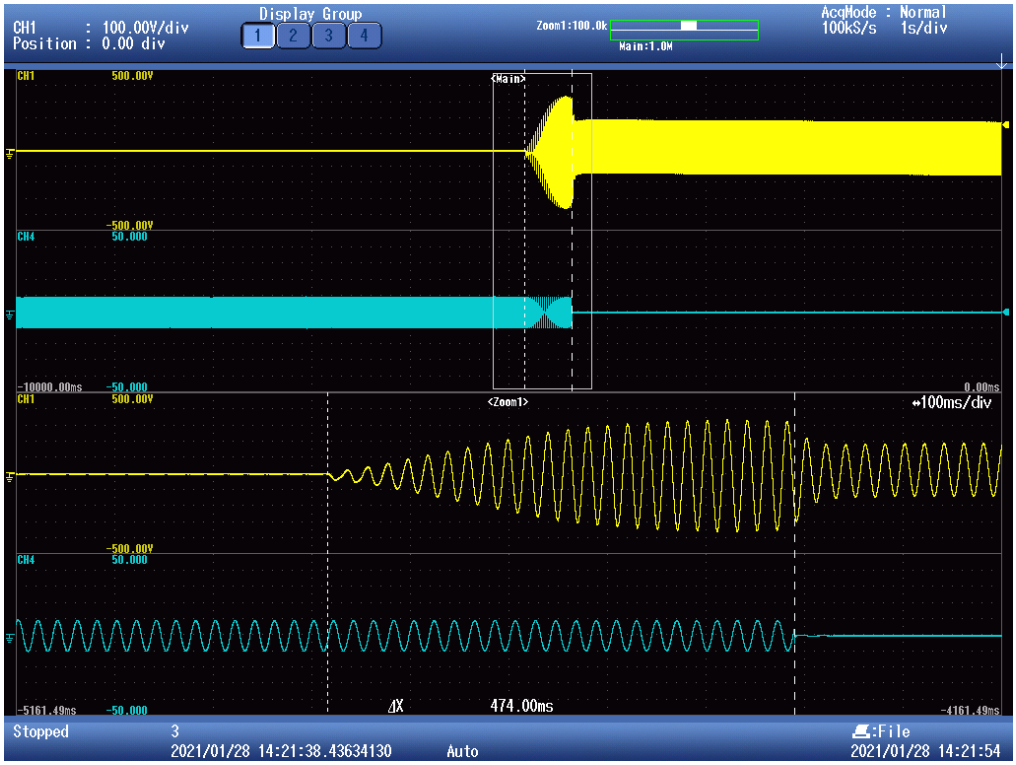
Note:
The tests had been performed on the HYD 6000-EP are valid for the HYD 3000-EP, HYD 3680-EP, HYD 4000-EP, HYD 4600-EP, HYD 5000-EP and HYD 5500-EP since it is same as in hardware and just power derated by software.

6.5 (4.5) Detection of Anti-Islanding			**P**
6.5.2 Resonant circuit test			**P**
Test conditions:	Frequency: 50+/-0,2Hz U_N=230+/-3Vac RLC consumes inverter real power within +/-3% Distortion factor of chokes <3% Quality Q>2		
Disconnection limit:	5s		
Output power: / Osc. Parameter	25%	50%	100%
- 5%	0,422	0,447	0,441
- 4%	0,474	0,467	0,481
- 3%	0,369	0,481	0,508
- 2%	0,368	0,419	0,355
- 1%	0,465	0,384	0,485
0 %	0,432	0,437	0,372
+1 %	0,441	0,442	0,495
+2 %	0,338	0,419	0,512
+3 %	0,453	0,461	0,395
+4 %	0,326	0,511	0,518
+5 %	0,298	0,463	0,381
Parameter at 0%	L= 51,97mH R= 33,48Ω C= 188,34µF	L= 27,47mH R= 17,46Ω C= 361,03µF	L= 13,92mH R= 8,94Ω C= 725,07µF

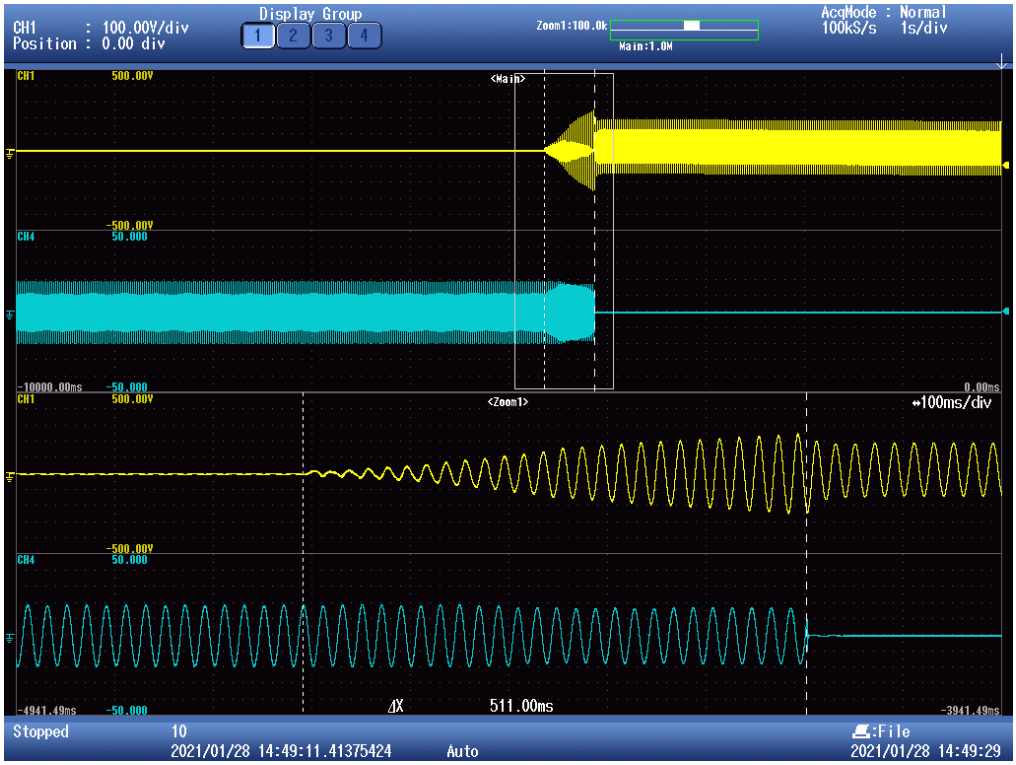
Note:
The capacitors and the Chokes of the resonant circuit were adjusted in order to reach a quality of >2. $P_{QC}+P_{QL}=-P_{Q,WR}$. The resitors of the resonant circuit consumed the real power of the inverter (P_{WR}) within +/- 3%.

The tests had been performed on the HYD 6000-EP are valid for the HYD 3000-EP, HYD 3680-EP, HYD 4000-EP, HYD 4600-EP, HYD 5000-EP and HYD 5500-EP since it is same as in hardware and just power derated by software.

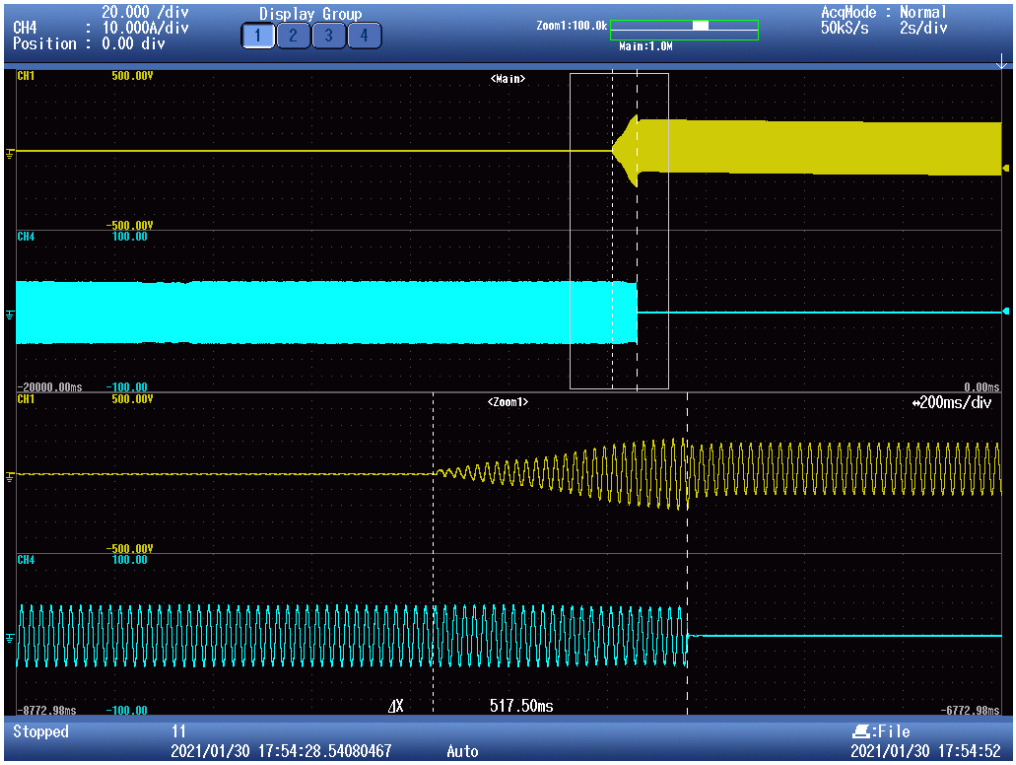
25% Power (0,-4)



50% Power (0,+4)



100% Power (0,+4)


20.000 /div
CH4 : 10.000A/div
Position : 0.00 div
Display Group
1 2 3 4
Zoom1:100.0k
Main:1.0M
AcqMode : Normal
50kS/s 2s/div
CH1 500.00V
<Main>
CH4 -500.00V 100.00
-20000.00ms -100.00
0.00ms
CH1 500.00V
<Zoom1>
200ms/div
CH4 -500.00V 100.00
-8772.98ms -100.00
ΔX 517.50ms
-6772.98ms
Stopped 11
2021/01/30 17:54:28.54080467 Auto
:File
2021/01/30 17:54:52

6.6 (4.7) Residual current monitoring			**P**
Fault Current (mA)		Disconnection time (ms)	
Measured Fault Current	Limit 300 mA for output power ≤ 30 kVA 10 mA per kVA for output power > 30 kVA	Measured Disconnection time	Limit
+ PV to N:			
247,8	300	246	300
247,1	300	254	300
240,6	300	244	300
252,3	300	242	300
251,9	300	256	300
- PV to N:			
233,7	300	234	300
254,7	300	260	300
234,9	300	230	300
242,5	300	232	300
232,9	300	244	300

Note:

The conditions and testing is performed according to EN 62109-2, 4.8.3.5

The tests had been performed on the HYD 6000-EP are valid for the HYD 3000-EP, HYD 3680-EP, HYD 4000-EP, HYD 4600-EP, HYD 5000-EP and HYD 5500-EP since it is same as in hardware and just power derated by software.

6.6 (4.7) Residual current monitoring		P
+PV to N		
Limit (mA)	Disconnection time (ms)	Limit (ms)
30	214	300
30	230	300
30	224	300
30	208	300
30	228	300
60	118	150
60	128	150
60	105	150
60	**121**	150
60	133	150
150	32	40
150	26	40
150	36	40
150	**36**	40
150	31	40
-PV to N		
Limit (mA)	Disconnection time (ms)	Limit (ms)
30	206	300
30	226	300
30	234	300
30	218	300
30	212	300
60	110	150
60	123	150
60	131	150
60	125	150
60	129	150
150	27	40
150	22	40
150	29	40
150	**34**	40
150	24	40

Note:

The conditions and testing is performed according to EN 62109-2, 4.8.3.5.3

The tests had been performed on the HYD 6000-EP are valid for the HYD 3000-EP, HYD 3680-EP, HYD 4000-EP, HYD 4600-EP, HYD 5000-EP and HYD 5500-EP since it is same as in hardware and just power derated by software.

6.6.2.2.4 Isolation measurement before feeding in				**P**
DC Voltage below minimum operating voltage [V]	DC Voltage for inverter begin operation [V]	Resistance between ground and PV input terminal [Ω]	Required Insulation resistance R = (V_{MAX} PV / 30mA) [Ω]	Result
DC+				
90	120	500kΩ	500kΩ	Error message"IsoFault", PV inverter stay at "Idle:ISO Detecting" state and do not connect to the grid.
600	120	500kΩ	500kΩ	
DC-				
90	120	500kΩ	500kΩ	Error message"IsoFault", PV inverter stay at "Idle:ISO Detecting" state and do not connect to the grid.
600	120	500kΩ	500kΩ	

Note:

The conditions and testing is performed according to EN 62109-2, 4.8.2.1

The tests had been performed on the HYD 6000-EP are valid for the HYD 3000-EP, HYD 3680-EP, HYD 4000-EP, HYD 4600-EP, HYD 5000-EP and HYD 5500-EP since it is same as in hardware and just power derated by software.

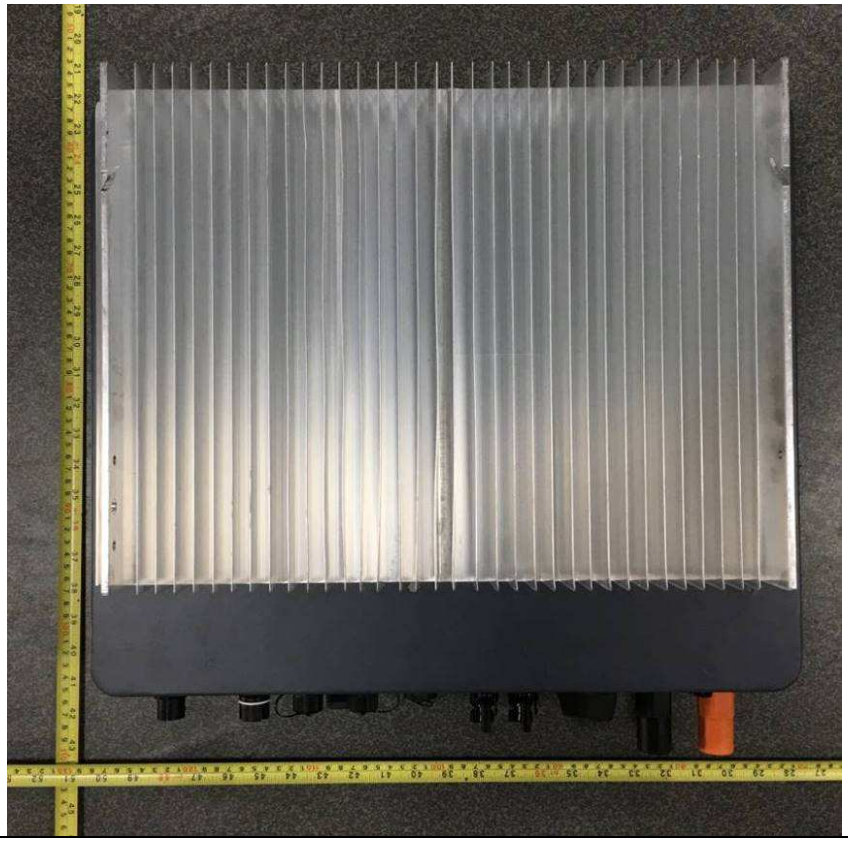
Annex 2

Pictures of the unit

EUT Photo

General view – 1 of Front

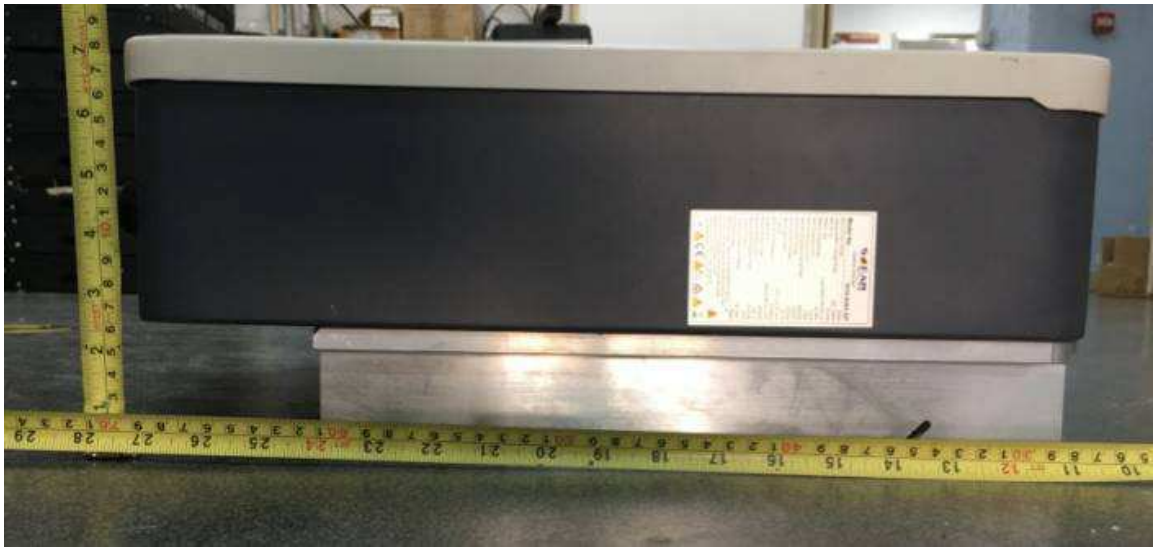
General view – 1 of Rear



EUT Photo

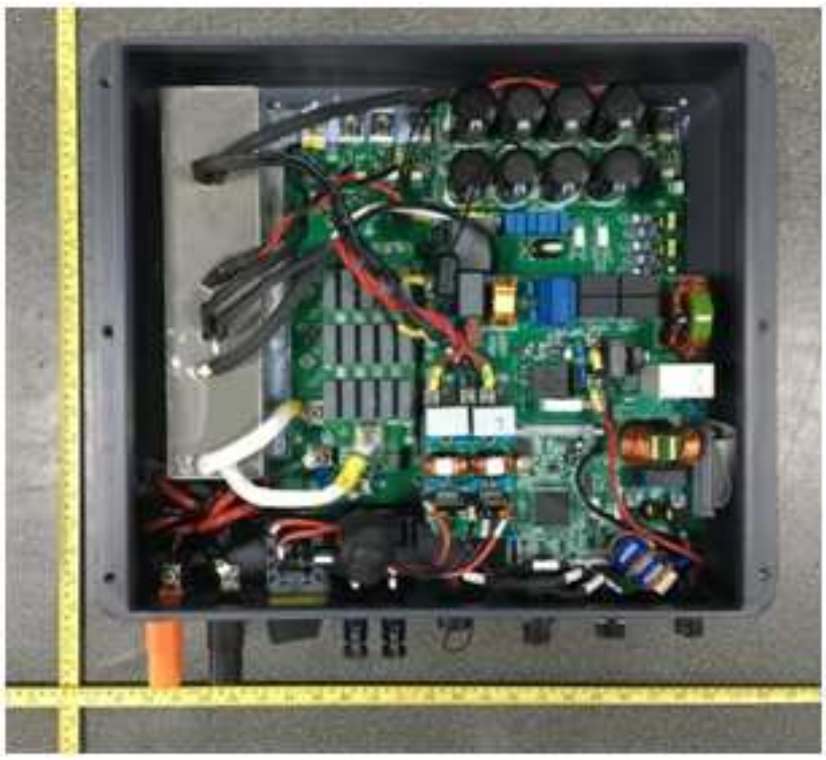
General view – 1 of Bottom

General view – 1 of Side

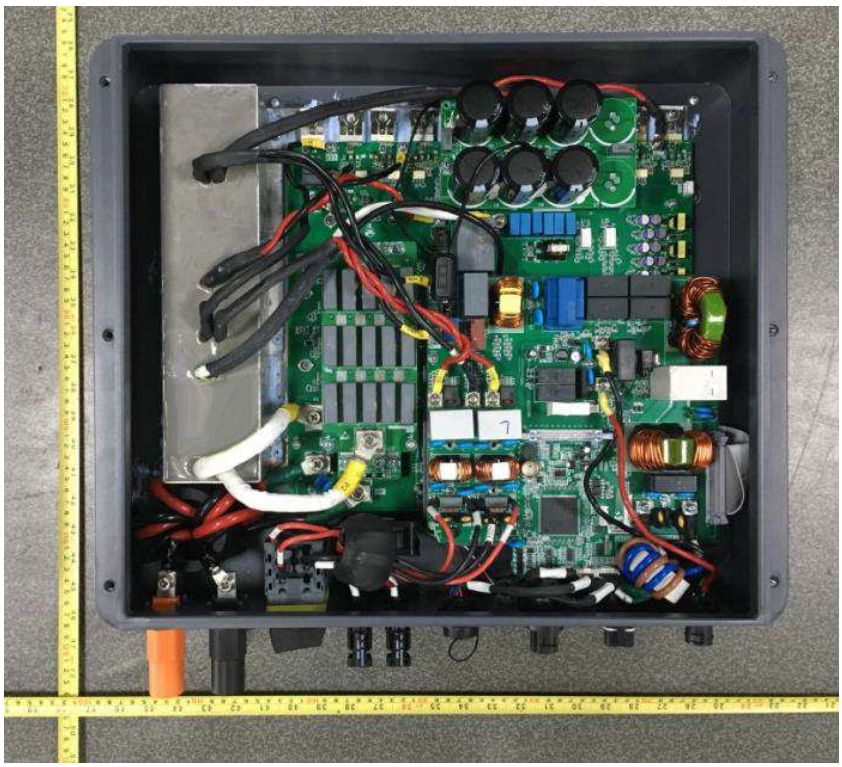


EUT Photo

Internal view – 1
(HYD 4600-EP, HYD 5000-EP, HYD 5500-EP,HYD 6000-EP)

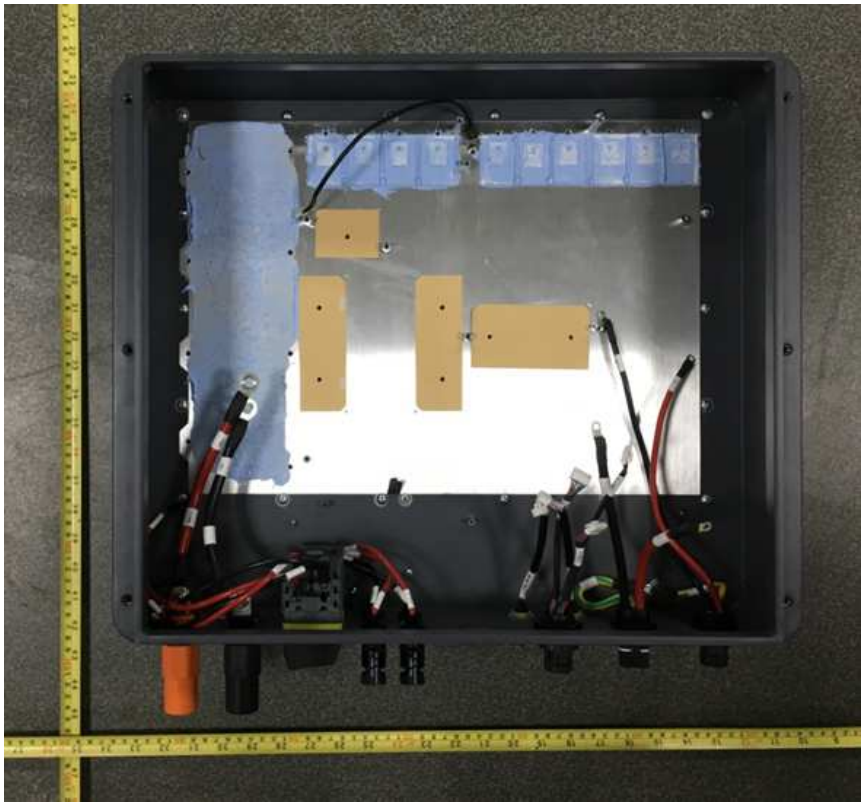


Internal view – 2
(HYD 3000-EP, HYD 3680-EP)

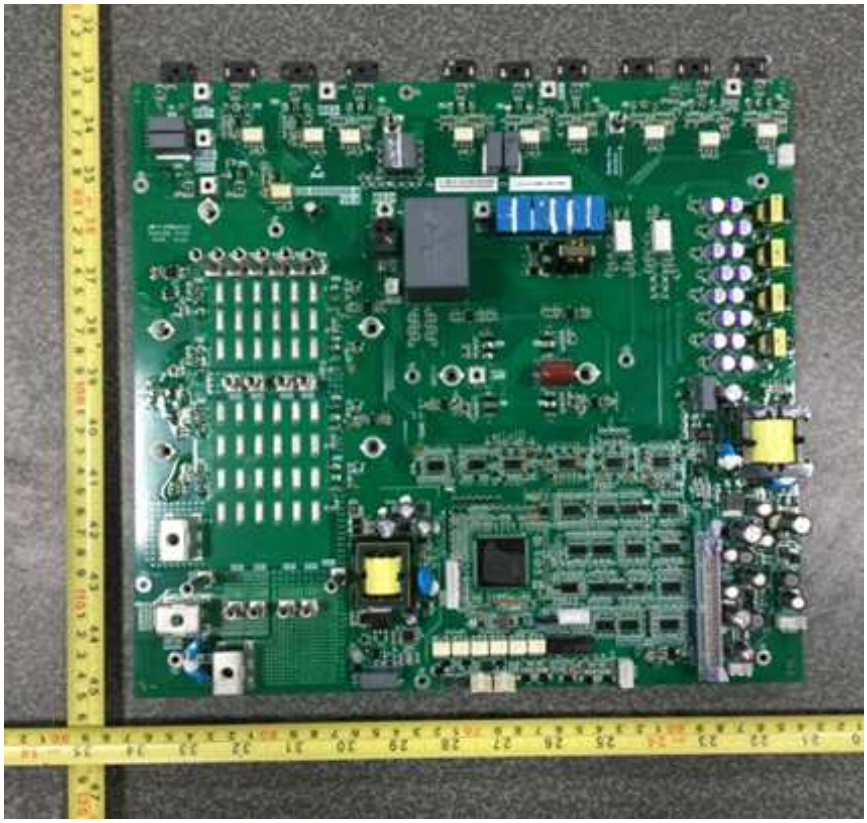


EUT Photo

Internal view - 3

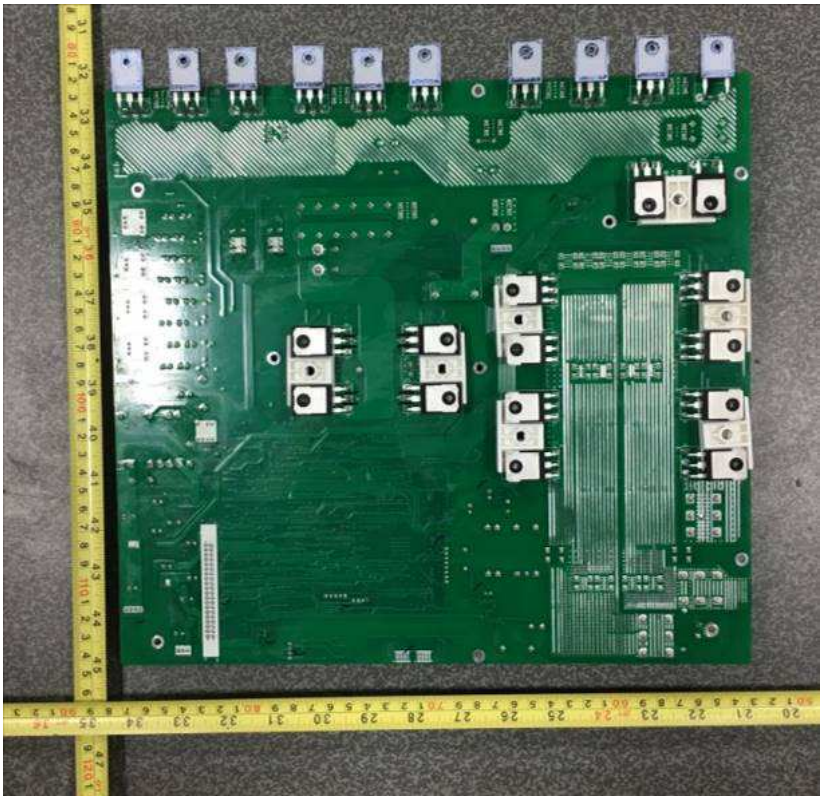


General view – 1 of Power board

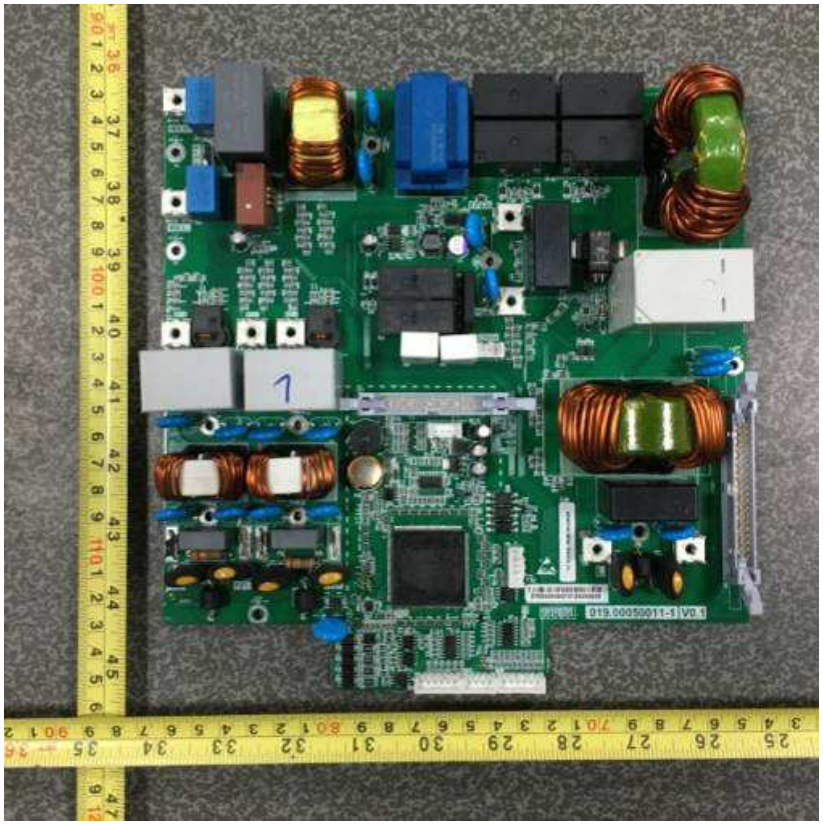


EUT Photo

General view – 2 of Power board

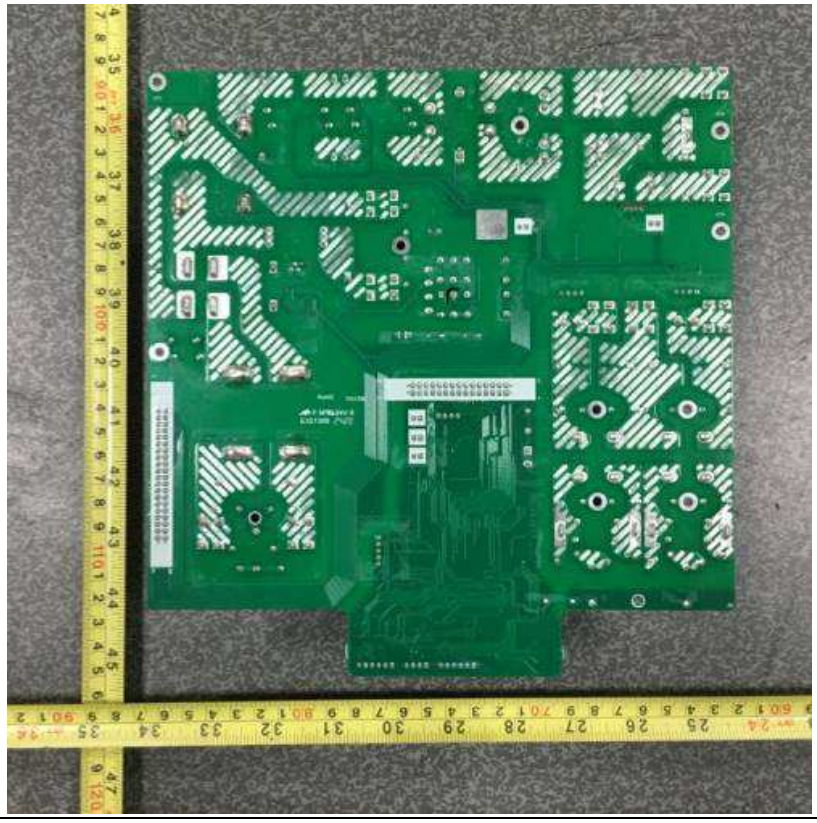


General view – 1 of Output board

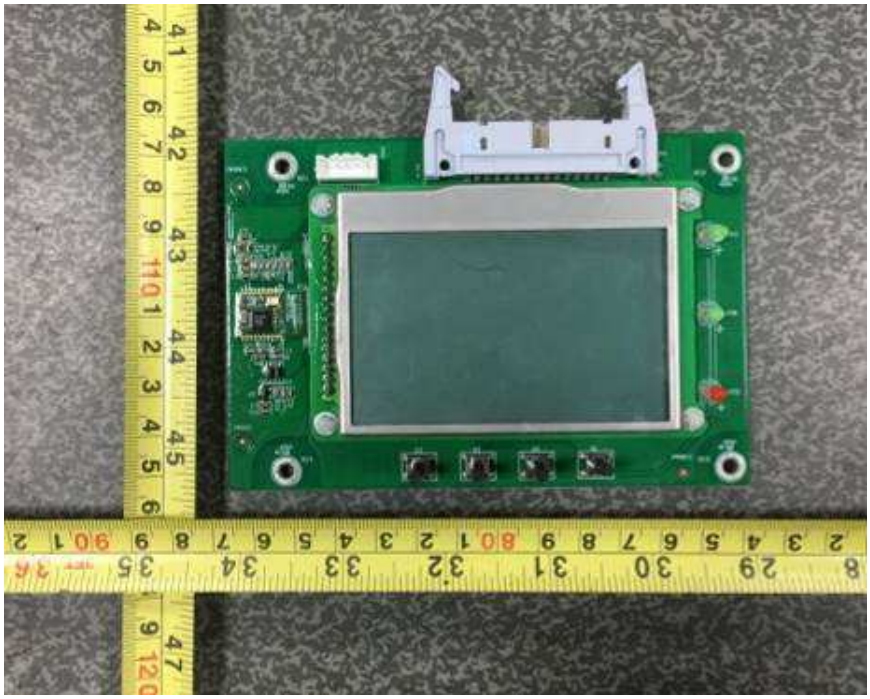


EUT Photo

General view – 2 of Output board

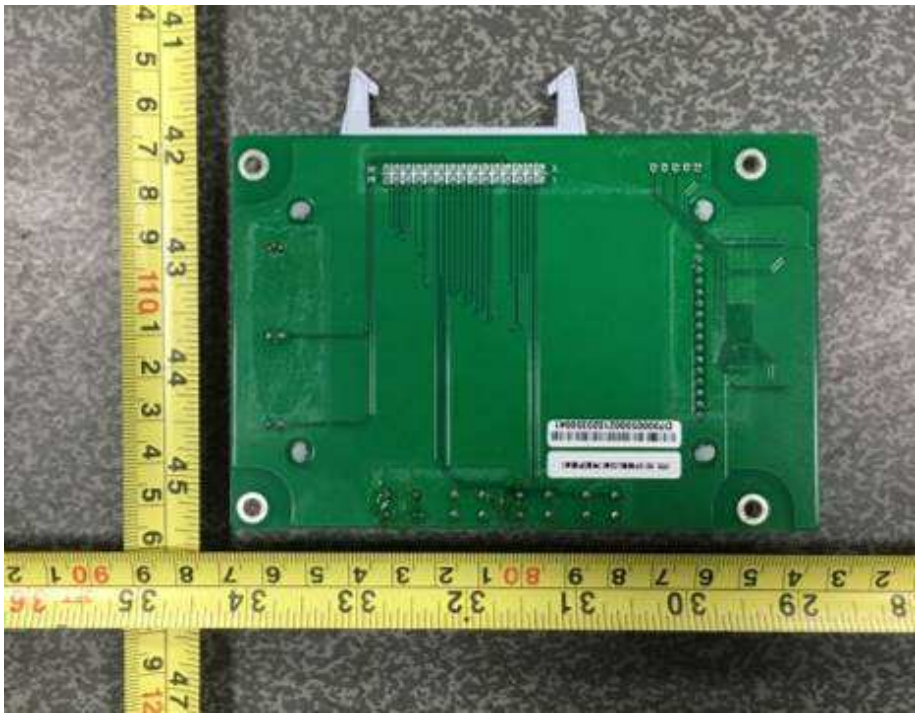


General view – 1 of LCD panel



EUT Photo

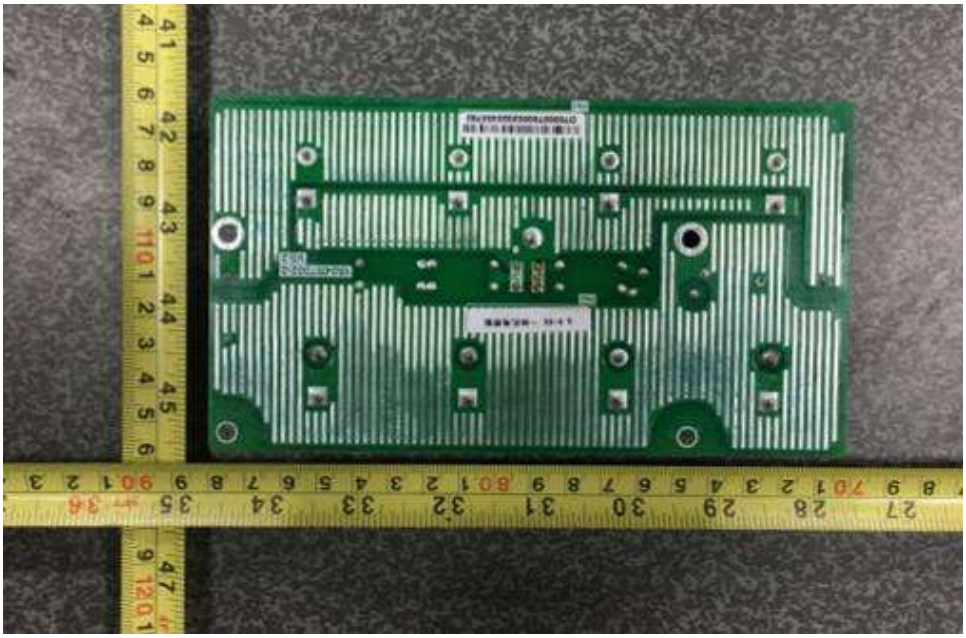
General view – 2 of LCD panel



General view - 1 of BUS board

EUT Photo

General view - 2 of BUS board



General view of Grouding point

Annex 3

Test equipment list

Testing Location: Bureau Veritas Shenzhen Co., Ltd. Dongguan Branch
No. 96, Guantai Road (Houjie Section), Houjie Town, Dongguan City, Guangdong Province, 523942, People's Republic of China

Date(s) of performance test: 2020-09-17 to 2021-02-25

Equipment	Internal No.	Manufacturer	Type	Serial No.	Next Calibration date
Power Analyser	A4080002DG	YOKOGAWA	WT3000	91M210852	Jun. 16, 2021
AC Source	A7040019DG	Chroma	61512	61512000439	Monitored by Power Analyser
	A7040020DG	Chroma	61512	61512000438	
DC Simulation Power Supply	A7040015DG	Chroma	62150H-1000S	62150EF00488	
	A7040016DG	Chroma	62150H-1000S	62150EF00490	
	A7040017DG	Chroma	620028	620028EF00120	
RLC Load	A7150027DG	Qunling	ACLT-3803H	93VOO2869	
Eight Channel Digital Phosphor Oscilloscope	A4089017DG	YOKOGAWA	DL850	91N726247	Sep. 24, 2020
Oscilloscope probe	A4089008DG	Tektronix	TPP1000	C008230	Aug. 10, 2021
	A4089010DG	Tektronix	TPP1000	C008228	Aug. 10, 2021
	A4089011DG	Tektronix	TPP1000	C008229	Aug. 10, 2021
Current transducer	A1060007DG	YOKOGAWA	CT200	1130700012	Sep. 02, 2021
	A1060008DG	YOKOGAWA	CT200	1130700017	Sep. 02, 2021
	A1060012DG	YOKOGAWA	CT200	1130700018	Sep. 02, 2021
Power Analyser	//	ZLG	PA5000H	C820290908200 2110001	Mar. 02, 2021
Oscilloscope	//	Agilent	DS05014A	MY50070266	Jan. 05, 2022
Oscilloscope current probe	//	FLUKE	i1000S	29503223	Jan. 05, 2022
	//	FLUKE	iL000S	30413448	Jan. 05, 2022
	//	CYBERTEK	CP1000A	C181000929	Jan. 05, 2022
	//	CYBERTEK	CP1000A	C181000922	Jan. 05, 2022
	//	CYBERTEK	CP1000A	C191000141	Jan. 05, 2022
Oscilloscope voltage probe	//	SANHUA	SI-9110	152655	Jan. 05, 2022
	//	SANHUA	SI-9110	111134	Jan. 05, 2022
	//	SANHUA	SI-9110	111539	Jan. 05, 2022
	//	SIGLENT	DPB5150A	D15A150052	Jan. 05, 2022
	//	SIGLENT	DPB5150A	D15A200317	Jan. 05, 2022
	//	SIGLENT	DPB5150A	D15A200314	Jan. 05, 2022
	//	SIGLENT	DPB5150A	D15A150047	Jan. 05, 2022