TEST REPORT
DIN V VDE V 0126-1-1:2013.08
Automatic disconnecting device

Report Reference No. ..... :	231227156GZU-002
Date of issue ..... :	02 July 2024
Total number of pages	26 pages
Testing Laboratory ..... :	Intertek Testing Services Shenzhen Ltd. Guangzhou Branch
Address ..... :	Room 101/301/401/102/202/302/402/502/602/702/802, No. 7-2, Caipin Road, Huangpu District, Guangzhou, Guangdong, China
Testing location/ address ..... :	Same as above
Tested by (name + signature) ..... :	Keane Li Engineer
Approved by (+ signature) ..... :	Jason Fu Supervisor
Applicant's name ..... :	Shenzhen Stepup-Tech Co., Ltd.
Address ..... :	Unit B, Floor6, Building4, BlockB, Xushengxifa, Gonghe Road, Xixiang Street, Shenzhen, Guangdong, China 518105
Test specification:	
Standard ..... :	DIN V VDE V 0126-1-1:2013 Enedis-PRO-RES_10E version 5
Test procedure ..... :	Type approval for France
Non-standard test method ..... :	N/A
Test Report Form No. ..... :	VDE0126-1-1b
Test Report Form(s) Originator ..... :	Intertek
Master TRF ..... :	Dated 2013-09

Test item description ..... :	Micro inverter
Trade Mark ..... :	--
Manufacturer ..... :	Same as Applicant
Model/Type reference ..... :	SPD-300, SPD-400, SPD-600, SPD-700, SPD-800

Rating……:

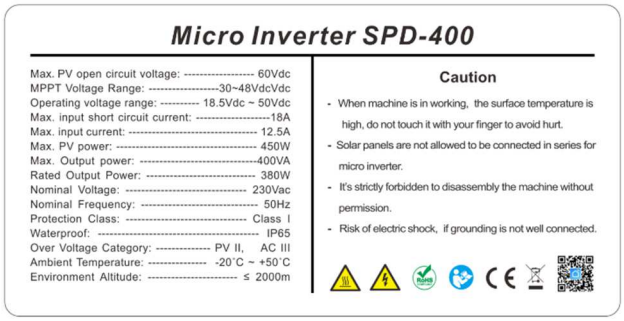
Model	SPD-300	SPD-400	SPD-600	SPD-700	SPD-800
PV input					
Max. PV open voltage	60Vdc				
Operating voltage range	18.5-50Vdc				
Max. PV continuous input current	11.5Adc	12.5Adc	2*11.5Adc	2*11.5Adc	2*12.5Adc
PV short circuit current	18Adc		2*18Adc		
AC output					
Rate output voltage	230 Vac				
Frequency	50Hz				
Rated output current	1.2Aac	1.6Aac	2.4Aac	2.8Aac	3.3Aac
Max. continuous current	1.3Aac	1.7Aac	2.6Aac	3.0Aac	3.5Aac
Rated output power	280W	380W	550W	650W	750W
Max. apparent power	300VA	400VA	600VA	700VA	800VA
Power factor	1				
Safety level	Class I				
Ingress Protection	IP 65				
Operation Ambient Temperature	-20℃ ~ 50℃				
Software version	V1.0				

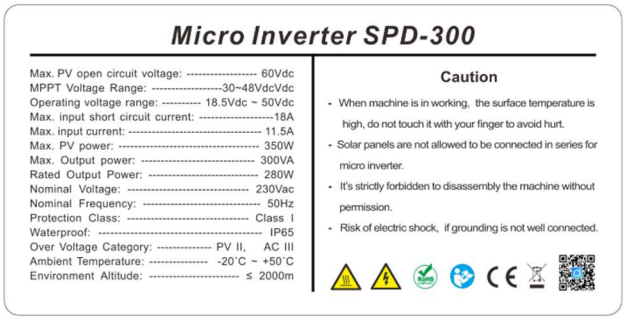
Summary of testing:

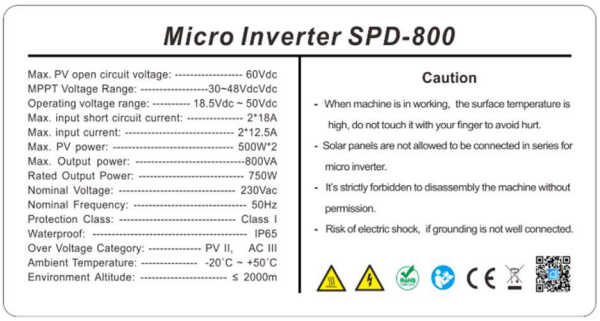
Tests performed (name of test and test clause):	**Testing location:**
All applicable test items.	Intertek Testing Services Shenzhen Ltd. Guangzhou Branch Room 101/301/401/102/202/302/402/502/602/702/802, No. 7-2, Caipin Road, Huangpu District, Guangzhou, Guangdong, China

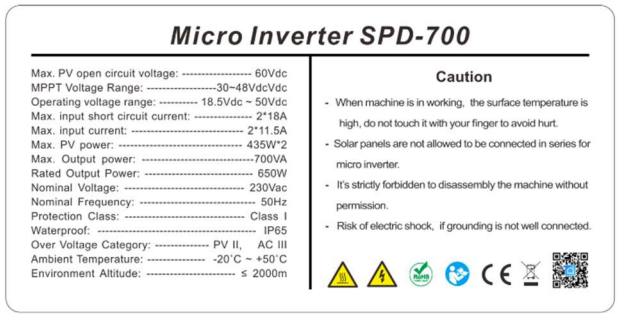
Copy of marking plate(representative):

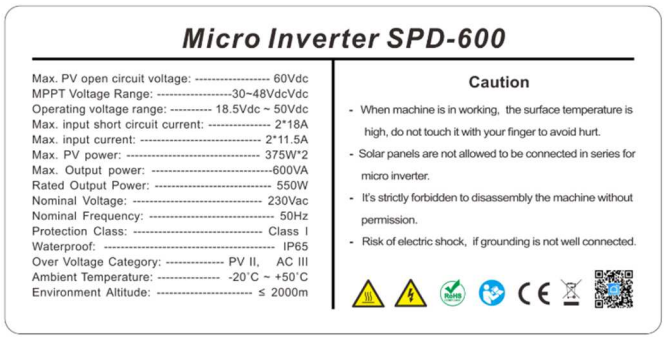
The artwork below may be only a draft.











Note:

1. The above markings are the minimum requirements required by the safety standard. For the final production samples, the additional markings which do not give rise to misunderstanding may be added.
2. Label is attached on the side surface of enclosure and visible after installation.

Test item particulars.....:	
Temperature range .....:	-20°C ~ +50 °C
Overvoltage category.....:	☐ OVC I ☒ OVC II (for PV input) ☒ OVC III (for main) ☐ OVC IV
IP protection class .....:	IP65
Possible test case verdicts:	
- test case does not apply to the test object..... :	N/A
- test object does meet the requirement ..... :	P (Pass)
- test object does not meet the requirement ..... :	F (Fail)
Testing..... :	
Date of receipt of test item..... :	18 June 2024
Date (s) of performance of tests..... :	18 June 2024 to 01July 2024

General remarks:

The test results presented in this report relate only to the object tested.
This report shall not be reproduced, except in full, without the written approval of the Issuing testing laboratory.
"(see Enclosure #)" refers to additional information appended to the report.
"(see appended table)" refers to a table appended to the report.

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

Clause numbers in parentheses derive from VDE-AR-N 4105:2011-08.

When determining the test conclusion, the Measurement Uncertainty of test has been considered.

The test report only allows to be revised only within the report defined retention period unless standard or regulation was withdrawn or invalid.

This report is based and replaced the original report No. 230213103GZU-001, dated 04 Dec 2023 to updated information as following:

Added alternate photos for Front view, back view and internal view, all internal and external structure were same except colour

Revised the model from "SP-600, SP-700, SP-800" to "SPD-600, SPD-700, SPD-800", and add new model SPD-300, SPD-400

After evaluated, no need add addiontial test

This report should be used together with report no. 231227156GZU-001.

General product information:

The equipment is a single-phase isolation micro inverter, which will be installed and connected to the grid after installation.

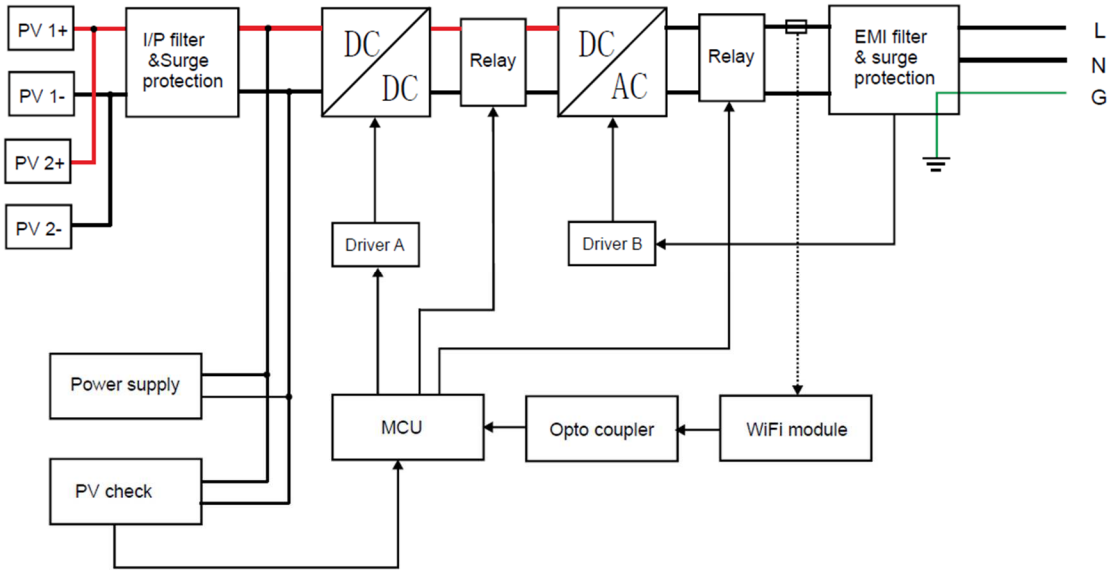
It contains filters for smoothing output voltage and EMC, switching and control circuits. The power board including the electronic components is mounted on the radiator and grounded through metal screws and spring washers.

Communication port only with a WIFI, which are connected to a monitor to monitor the status of the inverter through proprietary software.

PV input combiner with 2 MPPT tracers, and each MPPT tracer includes 2 PV input terminals (PV+ and PV-).

The AC output is directly connected to the power grid, and the protective grounding is provided by a dedicated grounding terminal.

The topology as follows:



The product was tested on:

The Software Version: V1.0

The Hardware Version: V8.0

Model difference:

Models SPD-300, SPD-400, SPD-600, SPD-700 and SPD-800 are same as the construction and hardware excepted the output power are different with adjusted by software, SPD-600, SPD-700 and SPD-800 with 2 MPPT tracers, SPD-300 and SPD-400 with 1 MPPT tracers.

Factory information:

Xulaidian (Guangdong) Technology Co., Ltd.

Room 601C, Tree building 3, Yongfeng Si road, Baishixia Community East District, Fuyong Street, Bao'an, Shenzhen, Guangdong, China 518010

DIN V VDE V 0126-1-1:2013.08			
Clause	Requirement - Test	Result - Remark	Verdict

4	**REQUIREMENTS**		P
4.0	**General**		P
	These requirements apply to integrated or separate (independent) disconnecting devices unless otherwise noted. The disconnection device has to cut off the power generating system on the ac side from the grid by two switches in series when: — the voltage and/or the frequency of the grid is deviating, — direct current (DC) is fed into the Grid. — unintentional islanding operation occurs, — intentional islanding operation using grid backup systems (emergency supplies).		P
4.1	**Functional safety**		P
	The safety must be assured under all operating conditions complying with the defined functions 4.3 to 4.6 and – if applicable – 4.8 of the disconnection device. The disconnection device can be an independent unit or an integrated part of the power generating unit and must switch off in case of a fault and indicate the fault status	Considered, see Annex. The single fault safe system was reviewed. The theoretical investigation was verified by error simulation.	P
4.1.1	**Single fault tolerance**		P
	The disconnection device must comply with the single fault tolerance requirements of VDE-AR-N 4105:2011-08, A.6	Considered, functional explanation and table 6.1 below.	P
4.1.2	**Interface Switch**		P
	The interface switch must, in case it is integrated into a PV-inverter, comply with the requirements of DIN EN 62109-2(VDE 0126-14-2):2012-04, 4.4.4.15.2 and in all other cases with the requirements according to VDE-AR-N 4105:2011-08, 6.4.	Disconnection takes place redundant through a relay and the IGBT-full bridge in series. The relay and the IGBT-full bridge are able to switch the full current.	P
(6.4.1)	**General**		P
	For the connection of the power generation system to the network operator's low-voltage network or to the remaining customer system, it is necessary to use an interface switch. It consists of two electric switching devices connected in series and shall thus be constructed redundantly. The interface switch is controlled by the NS protection and activates automatically if at least one protective function responds. The breaking devices of the interface switch shall be designed to be short-circuit proof and shall be releasable without delay and with due regard to the protective devices required by clause 6.5. The breaking	The inverter is isolated between PV and AC circuit. On the grid side, with a two-pin relay on L-N circuit.	P

DIN V VDE V 0126-1-1:2013.08			
Clause	Requirement - Test	Result - Remark	Verdict
	capacity of the two breaking devices of the interface switch shall be dimensioned at least in accordance with the responding range of the upstream safety fuse or the maximum short-circuit current contribution of the power generation system. Switches with at least breaking capacity shall be use for both breaking devices of the interface switch. In addition to that, all-pole disconnection shall be ensured.		
(6.4.2)	**Central interface switch**		N/A
	The two break devices of the central interface switch shall be executed as galvanic break devices. The two break devices of the interface switch shall be installed directly at the central meter panel in the circuit distributor of the power generation system.		N/A
(6.4.3)	**Integrated interface switch**		P
	Construction of the interface switch shall be carried out taking into consideration the single-fault tolerance. An interface switch ensures a single-fault tolerant all-phase galvanic breaking. For power generation systems with inverters, the interface switch shall be provided on the inverter's network side. A short circuit in the inverter shall not impair the switching function of the interface switch.		P
4.2	**Connection conditions**		P
	The connection, the reconnection after a grid-fault and the reconnection after short interruption shall be carried out according to VDE-AR-N 4105:2011-08, 8.3.1		P
(8.3.1)	**General**		P
	A power generation system shall be connected to the network operator's network only if a suitable device determines that both the mains voltage and the mains frequency are within the tolerance range of 85 % Un to 110 % Un or 47.5 Hz to 50.05 Hz, respectively, for a period of at least 60 seconds. If decoupling protection devices are tripped because of a short interruption, then the power generation system is permitted to already reconnect as soon as the mains voltage and mains frequency have uninterruptedly remained within the tolerance ranges given above for a period of 5 seconds. Short time interruptions are characterised by the NS protection settings of the mains frequency and/ or network voltage being exceeded or undershot for a maximum period of 3 seconds. The power generation system being reconnected to the network operator's network at the tripping of the decoupling protection device, the active power of controllable power generation systems supplied to the	Tested with a variable AC-Power supply at the output. Inverter disconnects within the limits, see table 6.2 below.	P

DIN V VDE V 0126-1-1:2013.08			
Clause	Requirement - Test	Result - Remark	Verdict
	network operator's network shall not exceed the gradient of 10 % of the active power per minute.		
4.3	**Monitoring the voltage**		P
4.3.1	**voltage drop U<**		P
	The disconnection because of a voltage drop shall be carried out according to VDE-AR-N 4105:2011-08, 6.5.1 and 6.5.2	See appended table below.	P
4.3.2	**rise-in-voltage U>>**		P
	The disconnection because of a rise-in-voltage shall be carried out according to VDE-AR-N 4105:2011-08, 6.5.1 and 6.5.2	See appended table below.	P
4.3.3	**slow rise-in-voltage U>**		P
	The disconnection because of a slow rise-in-voltage (10-minute-average) shall be carried out according to VDE-AR-N 4105:2011-08, 6.5.1 and 6.5.2	See appended table below.	P
4.4	**Monitoring the frequency**		P
	The disconnection because of a frequency decrease or a frequency increase shall be carried out according to VDE-AR-N 4105:2011-08, 6.5.1 and 6.5.2	See appended table below.	P
(6.5.1)	**General**		P
	The purpose of the NS protection is to disconnect the power generation system from the net in the event of inadmissible voltage and frequency values. This is intended to prevent an unintentional feed-in of the power generation system into a power-supply unit separated from the remaining distribution network as well as the feed-in of faults within this network. The system operator shall himself take precautions to prevent damages to his systems and installations as might be caused by switching actions, voltage fluctuations and automatic reclosings in the network connected upstream or other process in the network of the network operator. The following functions of the decoupling protection shall be implemented: - Voltage drop protection *U* <; - Rise-in-voltage protection *U* >; - Rise-in-voltage protection *U* >>; - Frequency decrease protection *f* <; - Frequency increase protection *f* >; - Islanding detection. The setting values of the protective functions and the last five dated failure reports shall be readable at the NS protection. Interruptions of supply with durations of 3 s or longer shall not lead to loss of any of the failure reports. Read-out shall be possible at the central NS		P

DIN V VDE V 0126-1-1:2013.08			
Clause	Requirement - Test	Result - Remark	Verdict
	protection irrespective of the operational state of the power generation system and without any additional aids. For integrated NS protection read-out may be carried out using a data interface.		
(6.5.2)	**Protective functions**		P
	The protective functions of the NS protection shall be designed so that the disconnection time (the sum of the proper times of NS protection and interface switch plus a delay for the protection relay, which may or may not be adjustable) does not exceed 200 ms.		P
4.5	**Monitoring the dc current**		P
	A feed in of d.c current into the low-voltage grid due to defective equipment must lead to a switch off within 0.2 seconds. For this purpose the fault itself or a measurement of the dc component of the current exceeding 1 A can be used as disconnection criteria.	See appended table below.	P
4.6	**Detection of islanding operation**		P
	The disconnection because of a detection of unintended islanding operation shall be carried out according to VDE-AR-N 4105:2011-08, 6.5.1 and 6.5.3	See appended table below.	P
(6.5.3)	**Islanding detection**		P
	The islanding detection is implemented in the central NS protection or in the integrated NS protection of the power generation unit. If an islanding detection system acting on the integrated interface switch is integrated in all power generation units of a power generation system, then it is permitted to omit the islanding detection in the central NS protection regardless of the system power. Detection of an isolated network and disconnection of the power generation system by means of the interface switch shall be completed within 5 seconds.	See appended table below.	P
4.7	**Markings**		P
	A generating system equipped with an automatic disconnecting device shall be marked with the information “VDE 0126-1-1” which is visible from the outside. This can be done by — the marking plate or — showing it on a display of the disconnection device or — a separate marking		P
4.8	**Requirements for disconnection devices integrated into PV-inverters**		P
	The requirements of the DIN EN 62109-2 (VDE 0126-14-2):2012-04, 4.8 regarding the residual current detection and the insulation detection of the PV-		P

DIN V VDE V 0126-1-1:2013.08			
Clause	Requirement - Test	Result - Remark	Verdict
	generator shall be complied with.		
5	**General Requirements**		P
	Limits according to DIN EN 61000-6-3 (VDE 0839-6-3) regarding radio interferences must be complied with. For disturbance-free operation disturbance limits according to DIN EN 61000-6-2 (VDE 0839-6-2) shall be complied with.		P
6	**TYPE TESTING**		**P**
6.0	**General**		P
	The following tests are valid for integrated and separated disconnecting devices unless otherwise noted. A separate disconnection device must be tested together with a suitable supply. It has to be ensured that the turn-off signal is caused by the disconnection device and not by the supply.	See following of test report	P
6.1	**Functional safety**		P
	The testing of the single fault tolerance and the error detection with following disconnection according to 4.1 is carried out according to DIN VDE V 0124-100 (VDE V 0124-100):2012-07, 5.4.5.2.		P
6.2	**Connection conditions**		P
	The testing of the connection and the reconnection is carried out according to DIN VDE V 0124-100 (VDE V 0124):2012-07, 5.5.1 and 5.5.2.		P
6.3	**Monitoring the voltage**		P
	The testing of the voltage monitoring is carried out according to DIN VDE V 0124-100 (VDE V 0124-100):2012-07, 5.4.5.3.		P
6.4	**Monitoring the frequency**		P
	The testing of the frequency monitoring is carried out according to DIN VDE V 0124-100 (VDE V 0124-100):2012-07, 5.4.5.4.		P
6.5	**Monitoring the dc current**		P
	The testing of the disconnection due to feed in of direct current is carried out either by a) or b): a) The measuring device at the switching point (e.g. current transformer or resistance) is fed with direct current of 1 A. The cut-off must be carried out within 0.2 seconds. b) By means of a fault simulation it is measured if a defective system operation with a d.c. fault current of more than 1 A leads to cut-off within 0.2 seconds.		P
6.6	**Detection of islanding operation**		P

DIN V VDE V 0126-1-1:2013.08			
Clause	Requirement - Test	Result - Remark	Verdict
	The testing of the disconnection due to unintended islanding operation is carried out according to DIN VDE V 0124-100 (VDE V 0124-100):2012-07, 5.4.6.		P
7	**Routine Test**		**P**
	The manufacturer has to carry out routine tests regarding all safety relevant functions before delivering an automatic disconnection device.		P
8	**Construction Specification**		**P**
	Initial tests and re-examination in addition to the routine tests may be omitted. If the disconnection device is a separate unit it must not be used in a TN-C power system. In this case a TN-C-S power system must be created.		P

6.1 (5.4.5.1 & 5.4.5.2)	TABLE: General requirements	P

Design of functional safety:

In the case of a fault defined in this standard, after the MCU receives an abnormal signal from the relevant protection detection circuit, the inv output circuit will act to stop output.

6.1 (6.5.1)			TABLE: General requirements				
String	1	U_{DC} = Un	37Vdc	Uac = Un	230 Vac	P = (W)	750

Component No.	Fault	Observation
Relay Z1 (pin5-7)	SC before starting	The fault applied before the unit operated. After applying the fault, the unit cannot operate, after removing the fault, the unit normal operation. No damaged, no hazard.

Supplementary information:

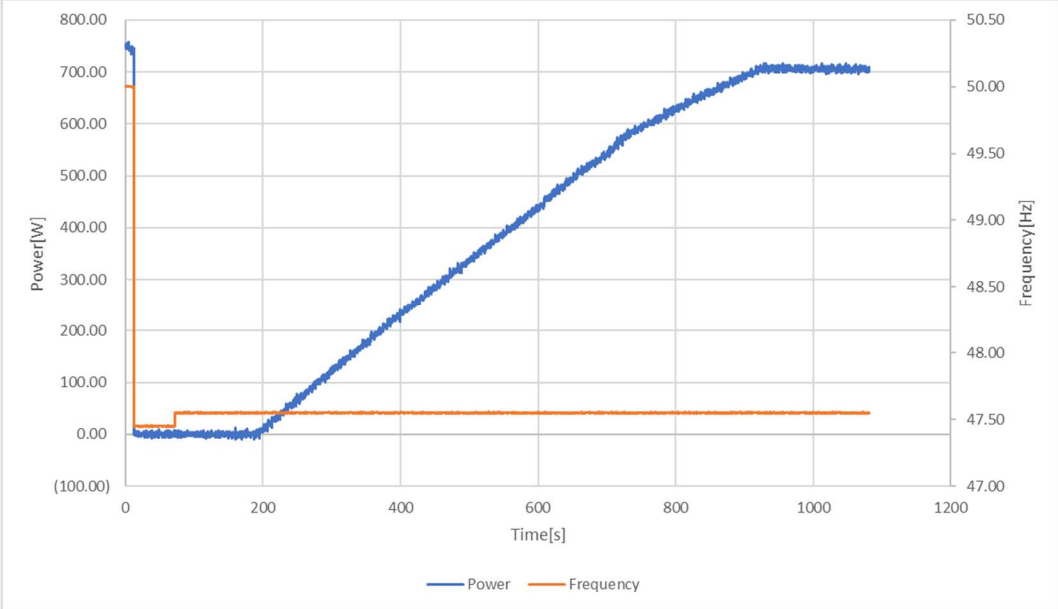
SC: Short circuit, OC: Open circuit

During the test:
Fire do not propagate beyond the EUT,
Equipment do not emit molten metal,
Enclosures do not deform to cause non-compliance with the standard.

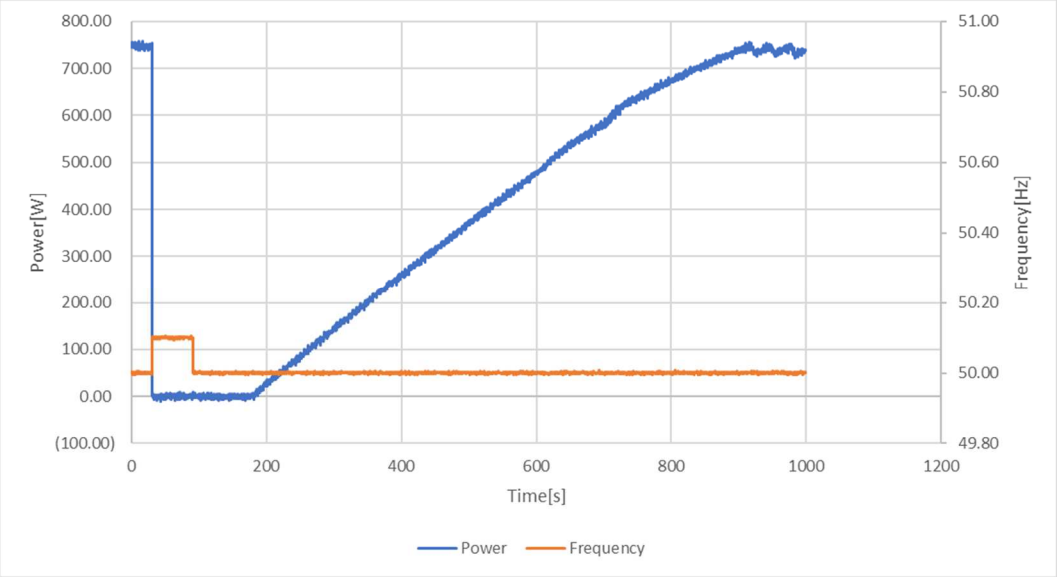
Pass the dielectric test.

6.2 (5.5.1)	Connection conditions		P
DC input:	AC output:		Rated Output Power
37Vdc	230Vac; 50Hz		750W
Measure Item	Reconnection?		Reconnection Time (>60s)
f_{ist} = 47,45Hz	☐ Yes	☒ No	Cannot reconnection
f_{ist} ≥ 47,55Hz	☒ Yes	☐ No	119.75s
f_{ist} > 50,1Hz	☐ Yes	☒ No	Cannot reconnection
f_{ist} ≤ 50,1Hz	☒ Yes	☐ No	91.25s
U_{ist} < 84% U_n	☐ Yes	☒ No	Cannot reconnection
U_{ist} ≥ 84% U_n	☒ Yes	☐ No	148.25s
U_{ist} > 110% U_n	☐ Yes	☒ No	Cannot reconnection
U_{ist} ≤ 110% U_n	☒ Yes	☐ No	187.75s

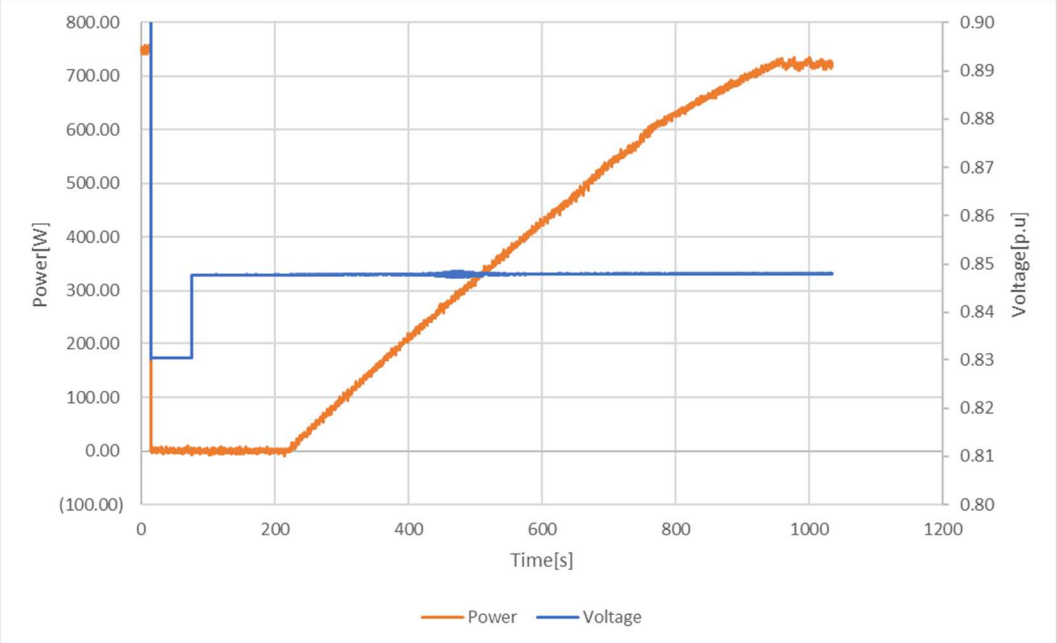
Graph of the gradual power supply and reconnection: for 47.55Hz



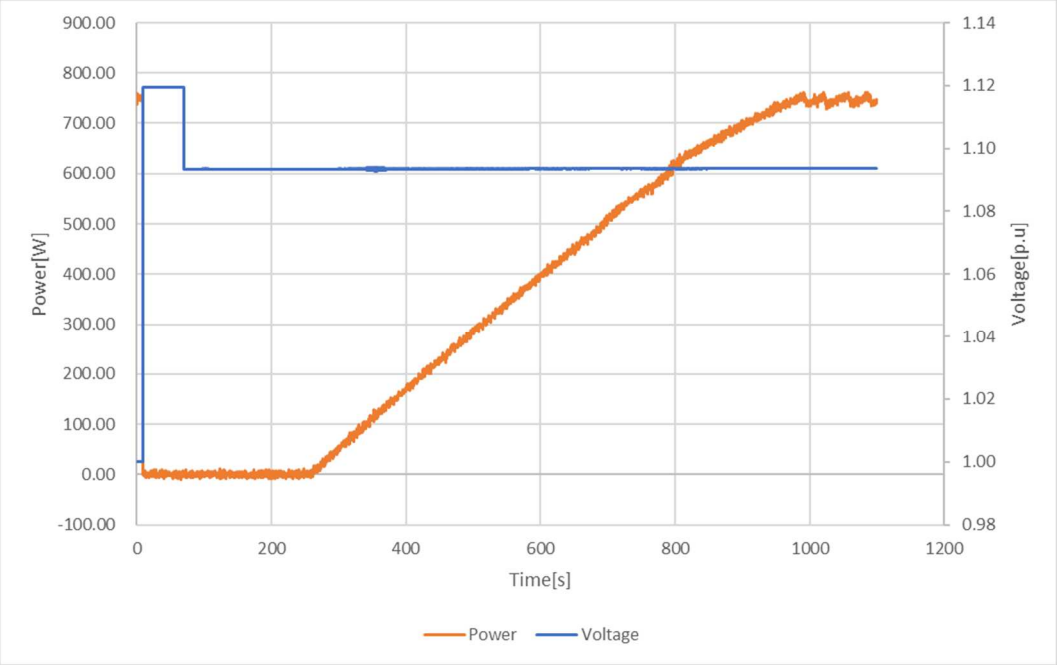
Graph of the gradual power supply and reconnection: for 50.1Hz



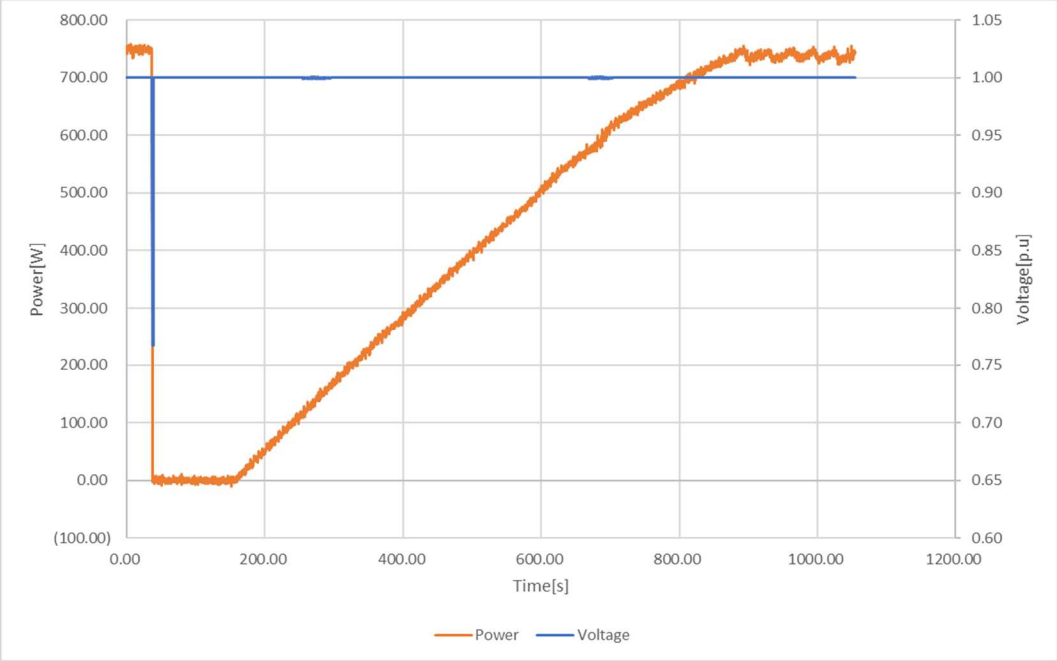
Graph of the gradual power supply and reconnection: for 84%Un



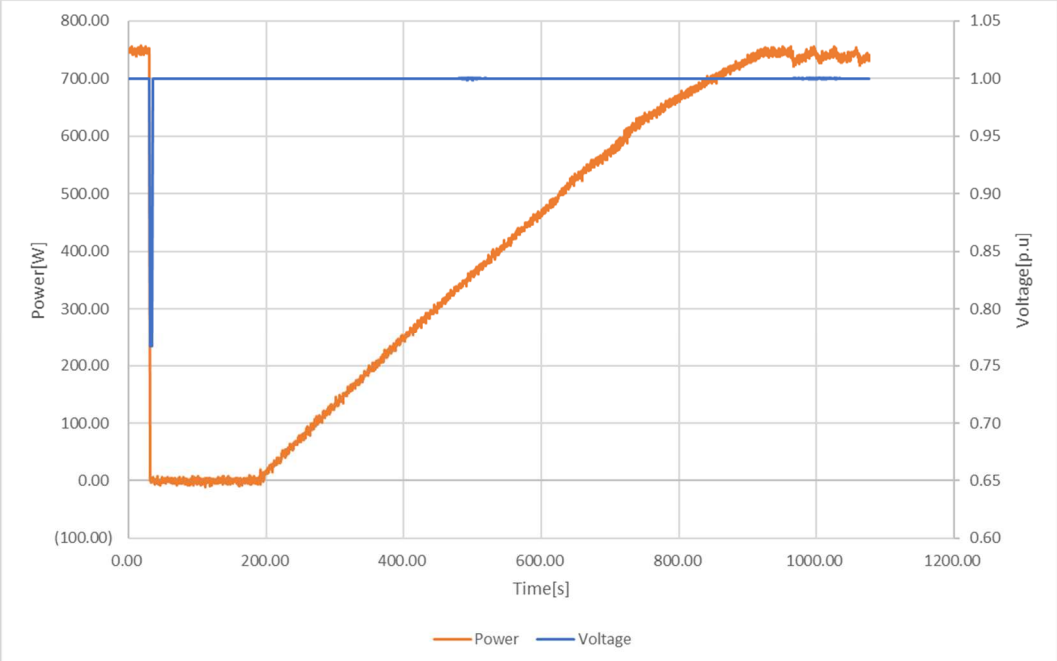
Graph of the gradual power supply and reconnection: for 110%Un



6.2 (5.5.2)	Short-time Interruption								P
	1			2			3		
	U_n (V)	Repeated Time (s)	Gradient (W/min)	U_n (V)	Repeated Time (s)	Gradient (W/min)	U_n (V)	Repeated Time (s)	Gradient (W/min)
After 2s of 77% Un	230	115.00	67.19	230	109.75	65.06	230	97.25	66.24
After 4s of 77% Un	230	114.25	65.58	230	157.01	65.60	230	126.25	63.58

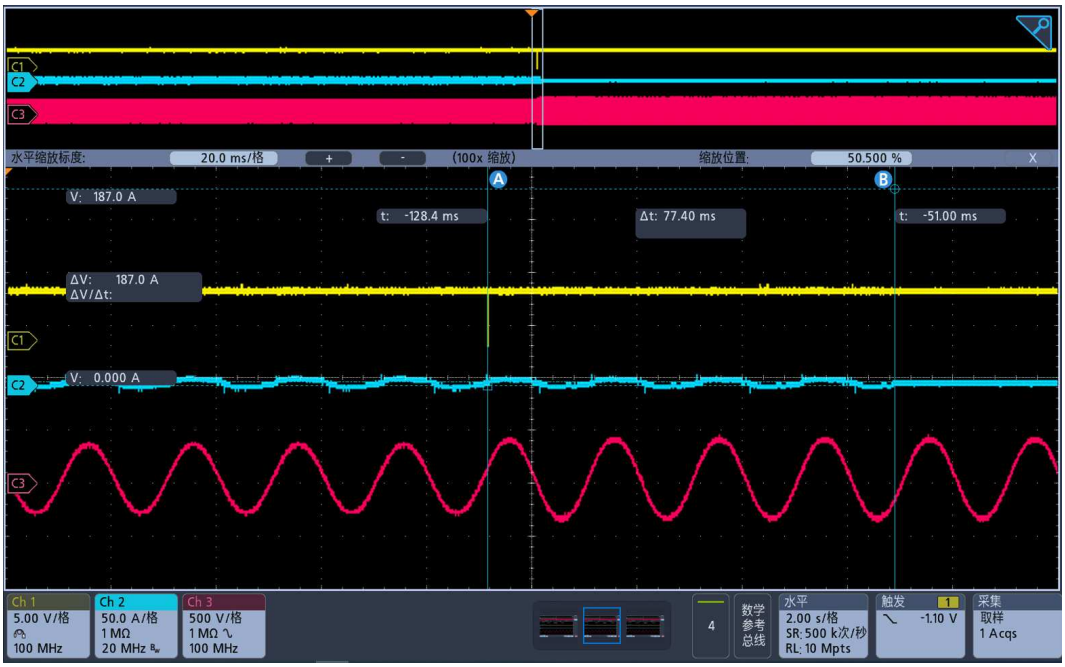


After 2s of 77% Un

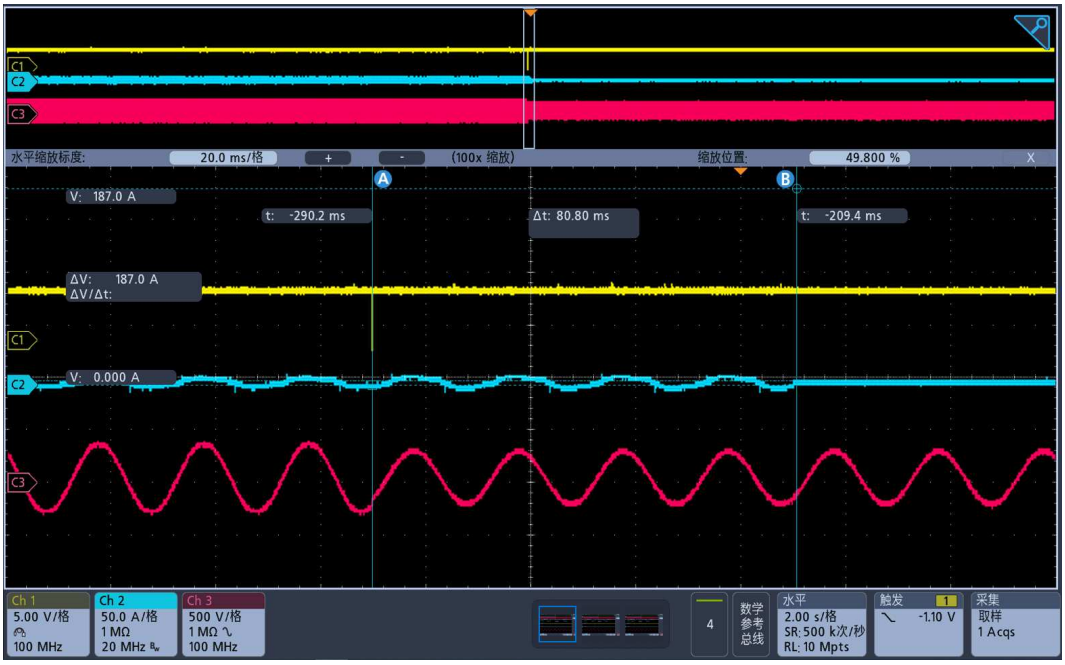


After 4s of 77% Un

6.3 (5.4.5.3)	Monitoring the voltage (Results of Voltage monitoring)					P
Rated Voltage (Un)	230Vac		Rated Frequency		50Hz	
	1		2		3	
	Trip value [V]	Trip time [ms]	Trip value [V]	Trip time [ms]	Trip value [V]	Trip time [ms]
OV (Ramp to 118%Un)						
L-N	270.98	63.80	270.55	77.40	270.43	75.80
UV (Ramp to 77%Un)						
L-N	176.51	80.80	175.97	59.20	176.07	69.40



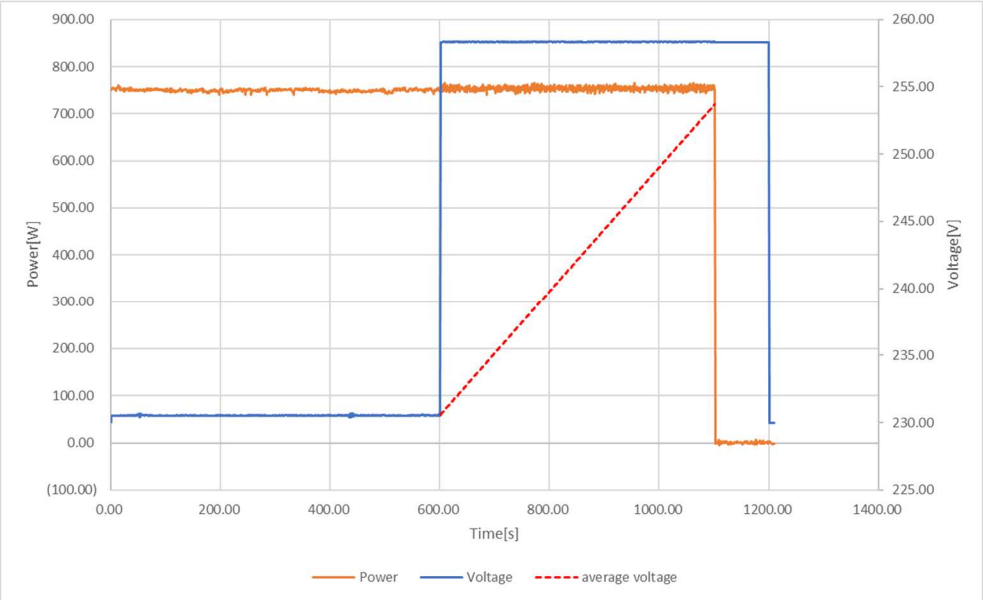
Un to 118% Un



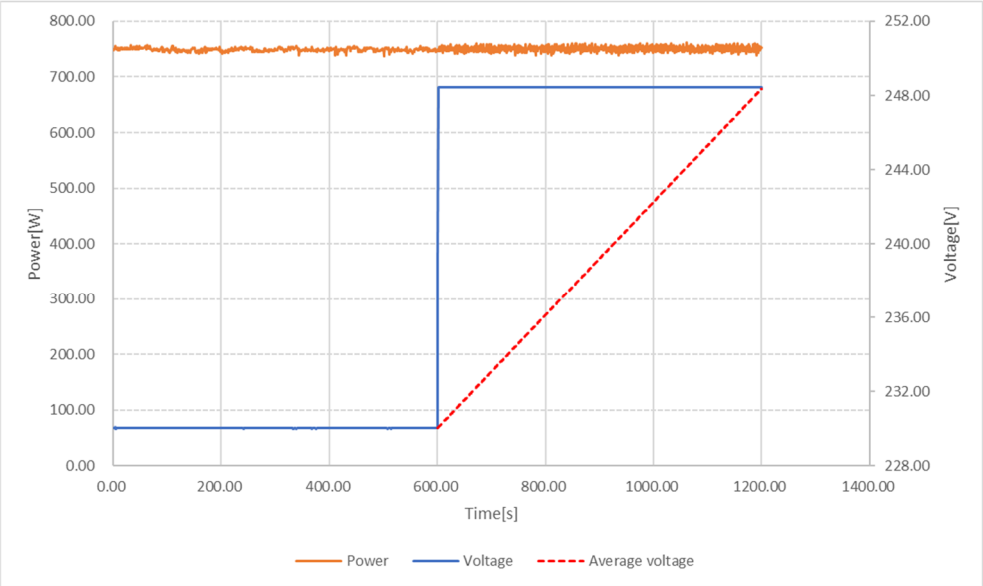
77% Un

Blue signal denotes current of output, red signal denotes voltage of output, yellow signal denotes trigger signal.

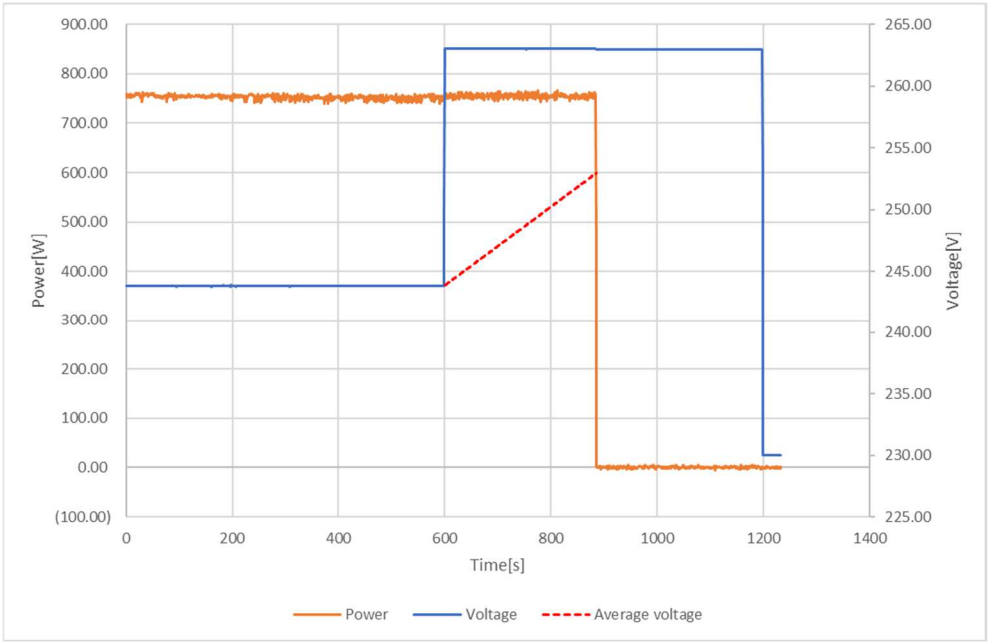
6.3 (5.4.5.3)	Monitoring the voltage (Results of the Protection of the Increase in Voltage as 10-min moving average)		P
	Output Voltage （V）	Switch	
		On/Off state Finally	Time until Switch off (s)
100% Un	230.00	☒On ☐Off	Work normally
112% Un	253.71	☐On ☒Off	502.0s
100% Un	230.00	☒On ☐Off	Work normally
108% Un	248.43	☒On ☐Off	Work normally
106% Un	244.82	☒On ☐Off	Work normally
114% Un	263.03	☐On ☒Off	285.0s



Un to 112% Un



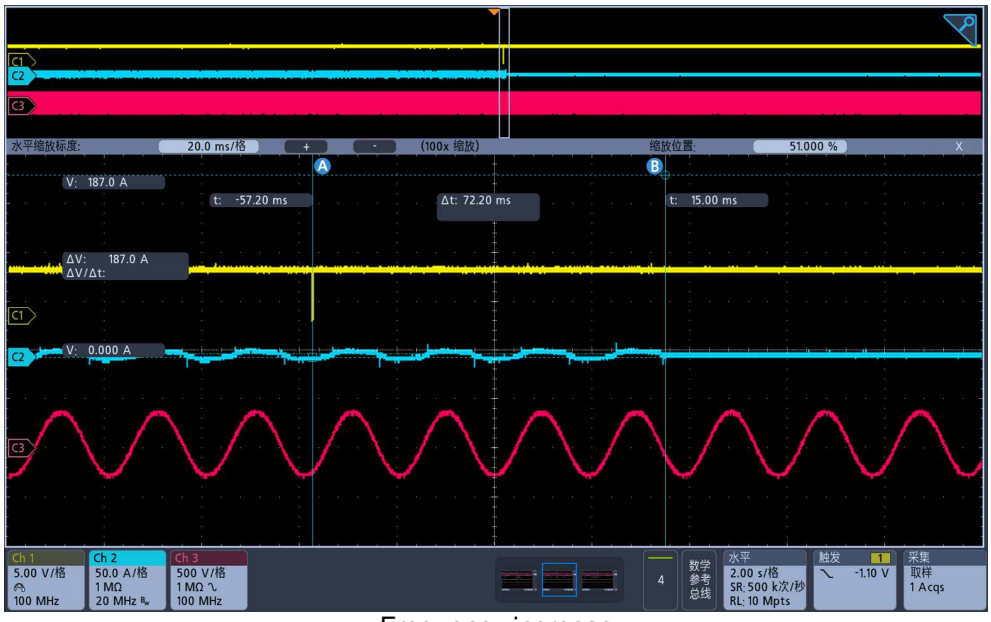
Un to 1.08Un



1.06 Un to 1.14Un

6.4 (5.4.5.4)	Monitoring the frequency					P
	1		2		3	
	f (Hz)	Trip time (ms)	f (Hz)	Trip time (ms)	f (Hz)	Trip time (ms)
Frequency decrease	47.50	24.80	47.48	59.40	47.50	27.20
Frequency increase	51.53	21.40	51.52	72.20	51.52	24.20

Frequency decrease



Frequency increase

Blue signal denotes current of output, red signal denotes voltage of output, yellow signal denotes trigger signal.

6.5	TABLE: Monitoring the dc current	P
P = 0.25= (W)	187.52	
Feed-in current = 1.0 A d.c., Cut-off current = (ms)	129.6	
P = 0.5 P_N= (W)	375.57	
Feed-in current = 1.0 A d.c., Cut-off current = (ms)	112.4	
P = 1.0 P_N= (W)	752.48	
Feed-in current = 1.0 A d.c., Cut-off current = (ms)	171.6	

6.6 (5.4.6)	TABLE: Detection of islanding operation	P
Test conditions:	Frequency: 50+/-0,2Hz U_N=230+/-3Vac RLC consumes inverter real power within +/-3% Distortion factor of chokes <3% Quality Qf>2	

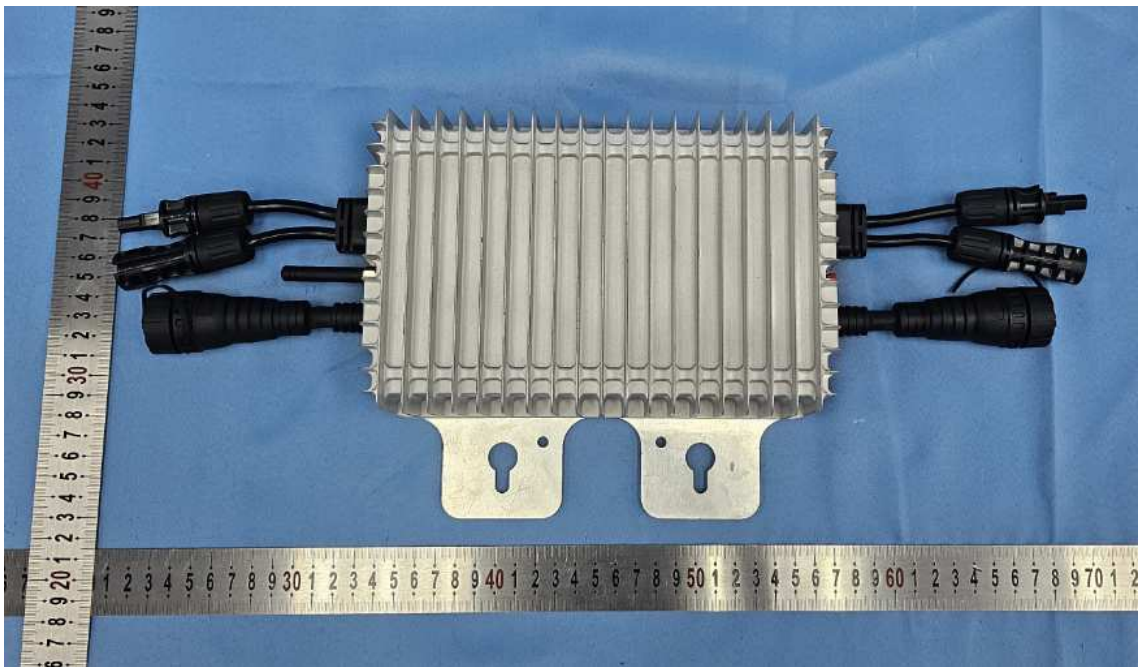
P = 1.0 P_N	0.748KW	P = 0.5 P_N	0.410KW	P = 0.25 P_N	0.214KW
Q_L = 1.500KVar	Cut-off time (ms)	Q_L = 0.800KVar	Cut-off time (ms)	Q_L =0.420Kvar	Cut-off time (ms)
95%	204.8	95%	181.2	95%	194.4
96%	219.6	96%	227.2	96%	212.4
97%	183.2	97%	190.8	97%	232.4
98%	161.2	98%	118.0	98%	168.8
99%	188.0	99%	214.0	99%	221.2
100%	256.8	100%	284.0	100%	261.2
101%	231.6	101%	240.4	101%	218.8
102%	150.0	102%	112.4	102%	175.2
103%	179.2	103%	108.8	103%	148.0
104%	124.0	104%	192.4	104%	129.6
105%	171.6	105%	198.4	105%	114.8
106%	122.4	106%	147.2	106%	94.0

100% (0, 0%)

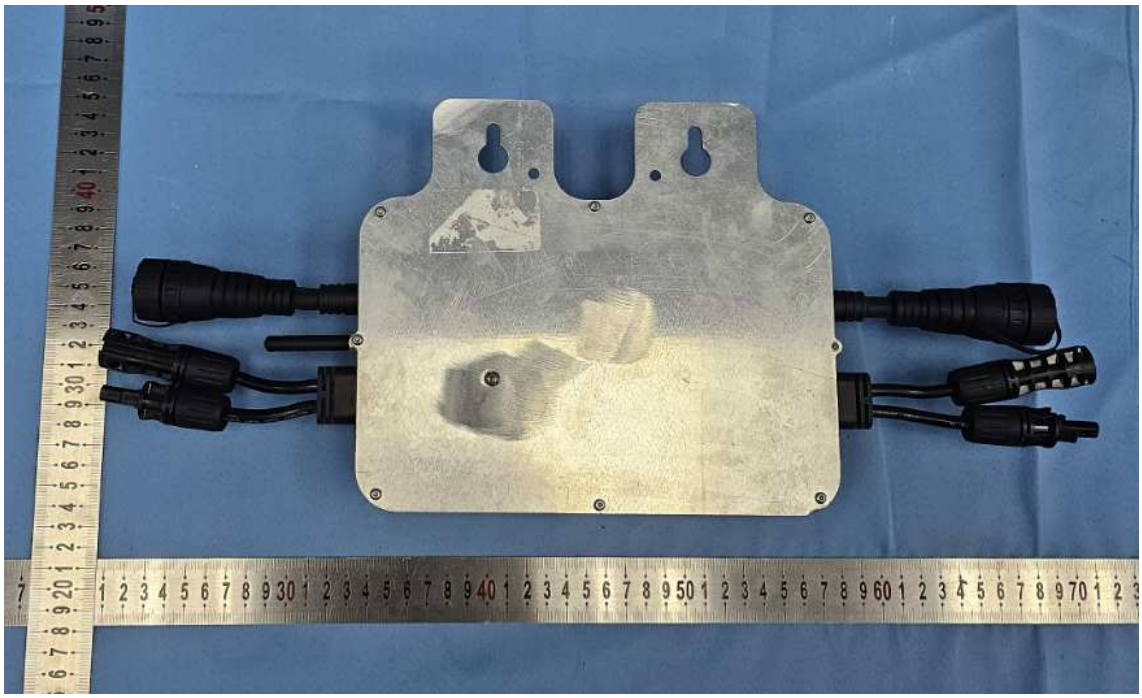
50% (0,0%)

25% (0.0)

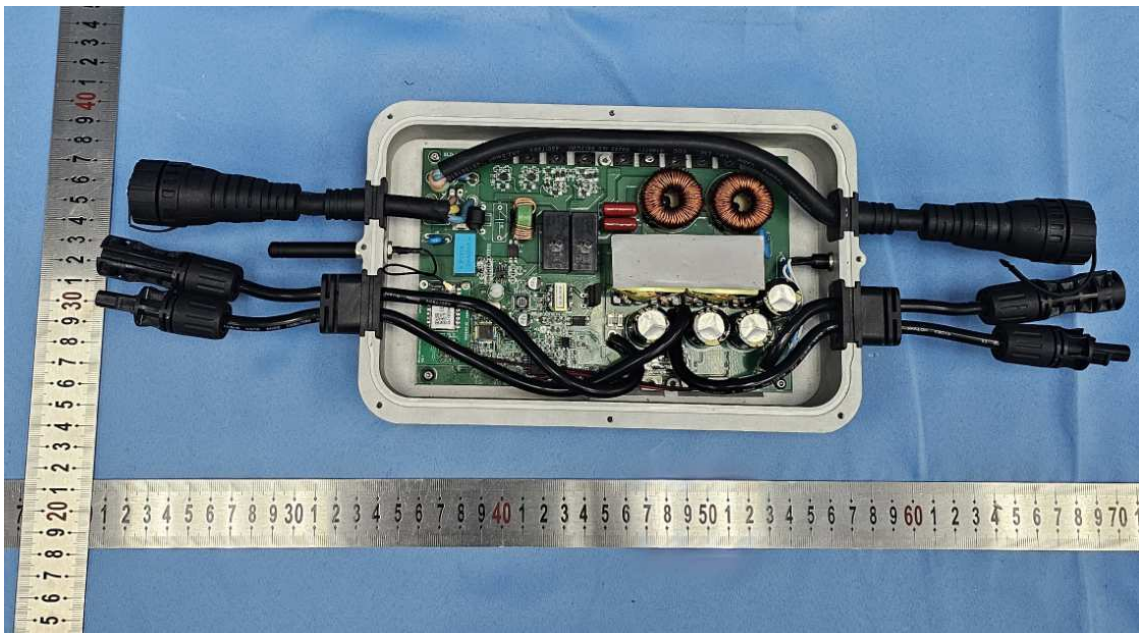
Blue signal denotes current of output, red signal denotes voltage of output, yellow signal denotes trigger signal.



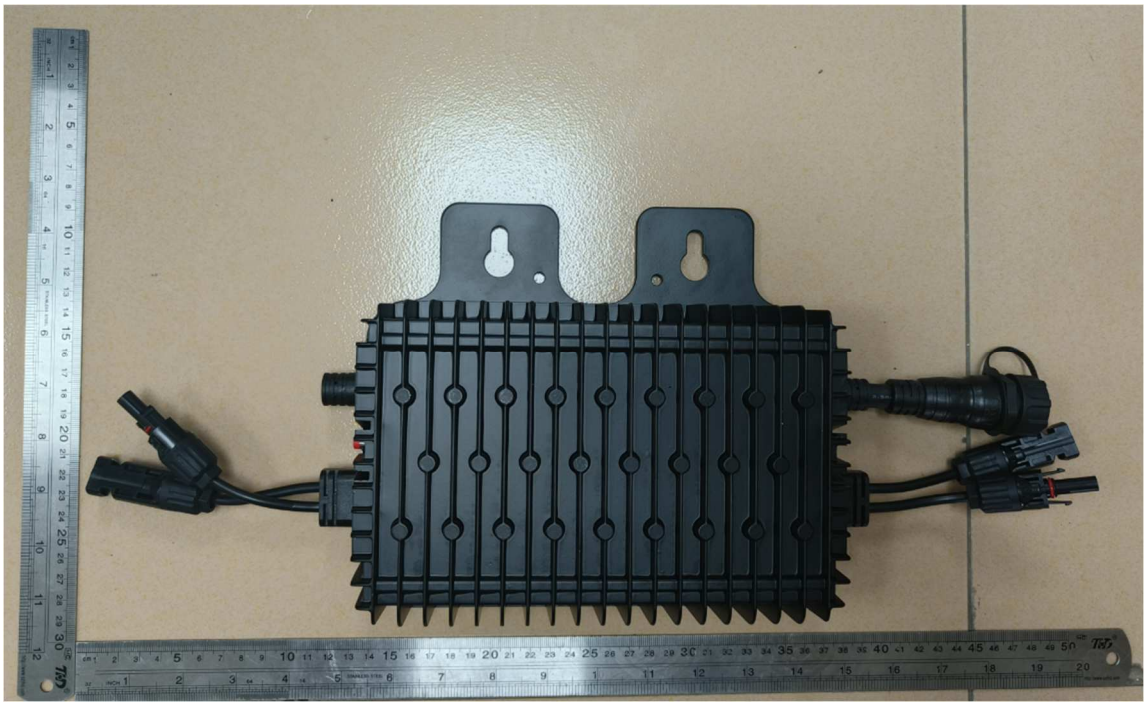
Front view



Back view



Internal view



Front view(alternative)

Back view(alternative)

Internal view(alternative)

--- End of test report---