

TESTING FOR THE VERIFICATION OF COMPLIANCE OF PV INVERTER WITH:

**IEC 60068-2-1, Environmental Testing. Part 2-1:
Tests. Test Ae: Cold.**

**IEC 60068-2-2, Environmental Testing. Part 2-2:
Tests. Test Be: Dry heat.**

**IEC 60068-2-14, Environmental Testing. Part 2-14:
Tests. Test Nb: Change of temperature.**

**IEC 60068-2-30, Environmental Testing. Part 2-30:
Tests. Test Db-Variant 1: Damp heat, cyclic (12 h + 12 h cycle).**

Procedure: PE.T-LE-62

Test Report Number: GZES191102649902

Trademark:



Tested Model.....: Hiverter Si-6K-H2

Variant Models: Hiverter Si-3K-H2, Hiverter Si-3.6K-H2, Hiverter Si-4K-H2,
Hiverter Si-4.6K-H2, Hiverter Si-5K-H2.

APPLICANT

Name: Hitachi Hi-Rel Power Electronics Pvt. Ltd.

Address: SM 3 & 4, Sanand – II GIDC, Industrial Estate, Boll Village,
Sanand – 382 110, Gujarat, India.

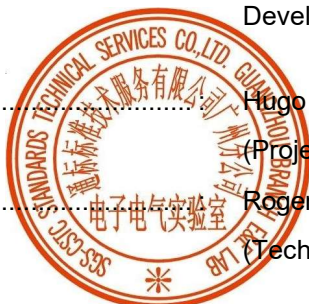
TESTING LABORATORY

Name: SGS-CSTC Standards Technical Services Co., Ltd.
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Hugo Zhang

Roger Hu

Date of issue.....: 12 / 11 / 2019

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Test Report Historical Revision:

Test Report Version	Date	Resume
2217 / 1094 – 2	24 / 11 / 2017	First issuance
2217 / 1094 – 2 – M1	06/ 05 / 2019	<p>1. Modified the Applicant address from: 5/F,Building 4, Antongda Industrial Park, No. 1 Liuxian Avenue, Xin'an Street, Bao'an District, Shenzhen City, Guangdong Province, P.R. China to 401, Building 4, AnTongDa Industrial Park, District 68, XingDong Community, XinAn Street, BaoAn District, Shenzhen City, Guangdong Province, P.R. China</p> <p>2. Modified the Factory name and address from: Shenzhen SOFARSOLAR Co., Ltd. 5/F,Building 4, Antongda Industrial Park, No. 1 Liuxian Avenue, Xin'an Street, Bao'an District, Shenzhen City, Guangdong Province, P.R. China to Dongguan SOFAR SOLAR Co., Ltd. 1F - 6F, Building E, No. 1 JinQi Road, Bihu Industrial Park, Wulian Village, Fenggang Town, Dongguan City, Guangdong Province,P.R. China.</p>
GZES191102649902	12/11/ 2019	<p>This report is a first issuance for a co-license based on report number: 2217 / 1094 – 2 – M1 which issued by SGS Tecnos, S.A. (Electrical Testing Laboratory) on 06/05/2019</p>

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1 SCOPE

SGS Tecnos, S.A.U. (Electrical Testing Laboratory) has been contract by **Shenzhen SOFARSOLAR Co., Ltd.** in order to perform the testing according to the following Standards:

- IEC 60068-2-1:2007, Environmental Testing. Part 2-1: Tests. Test Ae: Cold.
- IEC 60068-2-2:2007, Environmental Testing. Part 2-2: Tests. Test Be: Dry heat.
- IEC 60068-2-14:2009, Environmental Testing. Part 2-14: Tests. Test Nb: Changes of temperature.
- IEC 60068-2-30:2005, Environmental Testing. Part 2-30: Tests. Test Db – Variant 1: Damp heat, cyclic (12 h + 12 h).

2 GENERAL INFORMATION

2.1 Testing Period and Climatic conditions

The necessary testing has been performed along between the 04th of November and the 12th of November of 2017

Laboratory ambient temperature tests and checks have been performed at $25 \pm 5^{\circ}\text{C}$, $96 \text{ kPa} \pm 10 \text{ kPa}$ and $40\% \text{ RH} \pm 10\% \text{ RH}$.

SITE TEST

Name : Shenzhen SOFAR SOLAR Co., Ltd.
 Address : 5/F, Building 4, Antongda Industrial Park, No. 1 Liuxian Avenue, Xin'an Street, Bao'an District, Shenzhen City, Guangdong Province, P.R. China

2.2 Equipment under Testing

Apparatus type : Solar Grid-tied Inverter
 Installation : Fixed(permanent connection)
 Manufacturer : Hitachi Hi-Rel Power Electronics Pvt. Ltd.
 Address : SM 3 & 4, Sanand – II GIDC, Industrial Estate, Boll Village, Sanand – 382 110, Gujarat, India.

Trade mark :












Model / Type reference : Hiverter Si-6K-H2
 Serial Number..... : ZG1ES060H61001
 Software Version : V0.22
 Rated Characteristics : DC input: 90-580V, 11/11A
 AC output: 230V, 50Hz, 27.3A, 6000VA

Date of manufacturing: 2017

Test item particulars

Input..... : 90-580V, 11/11A
 Output..... : 230V, 50Hz, 27.3A, 6000VA
 Class of protection against electric shock ... : Class I
 Degree of protection against moisture : IP 65
 Type of connection to the main supply..... : TN
 Cooling group : Heat sink
 Modular..... : No
 Internal Transformer..... : No

Copy of marking plate (representative):

HITACHI	
Solar Grid Tied Inverter	
Model No.	Hiverter Si-6K-H2
Max. DC Input Voltage	600V
Operating MPPT Voltage Range	90-580V
Max. Input Current	2x11A
Max. PV Isc	2x13.2A
Nominal Grid Voltage	230V
Max. Output Current	27.3A
Nominal Grid Frequency	50Hz/60Hz
Nominal Output Power	6000W
Max. Output Power	6000VA
Power Factor	1(adjustable+/-0.8)
Ingress Protection	IP65
Operating Temperature Range	-25 ~+60°C
Protective Class	Class I
 Hitachi Hi-Rel Power Electronics Pvt. Ltd. SM 3 & 4, Sanand - II GIDC, Industrial Estate, Bol Village, Sanand - 382 110, Gujarat, India., www.hitachi-hirel.com	
       	

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
3. Labels of other models are as the same with Hiverter Si-6K-H2's except the parameters of rating.

Equipment under testing:

Hiverter Si-6K-H2

The variants models are:

Hiverter Si-3K-H2, Hiverter Si-3.6K-H2,

Hiverter Si-4K-H2, Hiverter Si-4.6K-H2, Hiverter Si-5K-H2.

Product Model	Hiverter Si-3K- H2	Hiverter Si-3.6K- H2	Hiverter Si-4K- H2	Hiverter Si-4.6K- H2	Hiverter Si-5K- H2	Hiverter Si-6K- H2
Input (DC)						
Max.DC Input Power	3500W	4000W	4400W	5000W	5500W	6600W
Max.DC Voltage	600V					
Power Turn on	80V					
Start-up input voltage	120V					
Rated input voltage	360V					
MPPT Voltage Range	90-580V					
Full load DC voltage range	160- 520V	180- 520V	200- 520V	230- 520V	250- 520V	300- 520V
MAX input current per MPPT	11A/11A					
Number of DC inputs	2/2					
Output(AC)						
Max AC Output power	3000VA	3680VA	4000VA	4600VA	5000VA	6000VA
Max AC Output power (PF=1)	3000W	3680W	4000W	4600W	5000W	6000W
Max AC Output Current	13.7A	16.8A	18.2A	21A	22.8A	27.3A
Nominal Grid Voltage	230Vac(Single phase)					
Nominal Frequency	50Hz					
Power factor	1 (adjustable +/-0.9)					
Topology	Transformerless					
Operating temperature range	-25°C~60°C					
Degree of protection	IP65					

The variants models have been included in this test report without tests because the following features don't change regarding to the tested model:

- Same connection system and hardware topology
- Same control algorithm.
- Output power within 2,5 and 2/3 of the EUT or Modular inverters.
- Same Firmware Version

The results obtained apply only to the particular sample tested that is the subject of the present test report. The most unfavorable result values of the verifications and tests performed are contained herein.

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

2.3 Manufacturer and Factory information

Manufacturer Name..... : **Hitachi Hi-Rel Power Electronics Pvt. Ltd.**
 Manufacturer Address : SM 3 & 4, Sanand – II GIDC, Industrial Estate,
 Boll Village, Sanand – 382 110, Gujarat, India.
 Factory 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, Guangdong Province, P.R. China.

2.4 Test equipment list

No.	Equipment Name	MARK/Model No.	Equipment No.	Equipment calibration due date
1	AC source	Chroma / 61860	--	--
2	DC source	Chroma / 62150H-1000S	--	--
3	Temperature & Humidity meter	VICTOR / VC230A	WS01	2018-09-03
4	Power analyzer	YOKOGAWA / WT 3000	EP-011	2018-08-05
5	Temperature & Humidity Chamber	Dongguan Qiya / QYH-150L	GZE015-2	2018-03-04

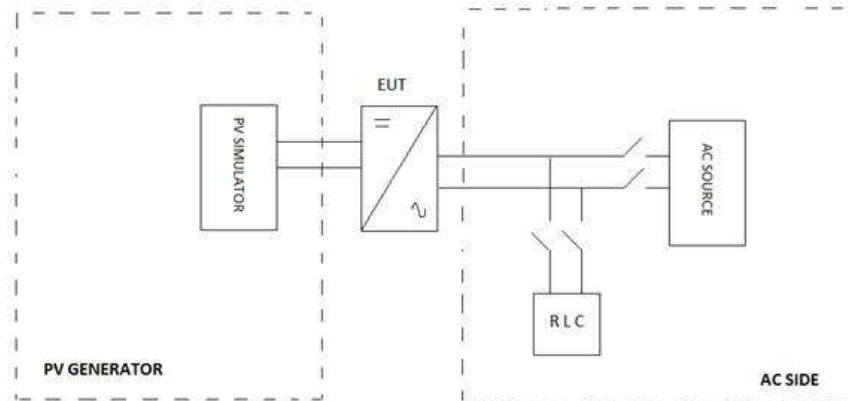
2.5 Measurement uncertainty

Associated uncertainties through measurements showed in this report are the maximum allowable uncertainties.

Magnitude	Uncertainty
Voltage measurement	$\pm 0.05\%$
Current measurement	$\pm 0.05\%$
Frequency measurement	$\pm 0.001\text{ Hz}$
Time measurement	$\pm 0.001\text{ s}$
Power measurement	$\pm 0.5\%$
Phase Angle	$\pm 0.1^\circ$
Temperature	$\pm 3^\circ\text{ C}$
Note1: Measurements uncertainties showed in this table are maximum allowable uncertainties. The measurement uncertainties associated with other parameters measured during the tests are in the laboratory at disposal of the solicitant.	

2.6 Test set up of the different standard

The test bench used includes:



2.7 Definitions

EUT	Equipment Under Testing	Hz	Hertz
A	Ampere	V	Volt
VA _r	Volt-Ampere reactive	W	Watt
EMC	Electromagnetic Compatibility	p.u	Per unit
U _n	Nominal Voltage	P _n	Nominal Active Power
I _n	Nominal Current	Q _n	Nominal Reactive Power
I _a	Active Current	S _n	Nominal Apparent Power
I _r	Reactive Current	THD	Total Harmonic Distortion
MV	Medium Voltage	TDD	Total Demand Distortion
LV	Low Voltage	U _i	Current Imbalance
LVRT	Low Voltage Ride Through	U _v	Voltage Imbalance
V1+	Voltage positive sequence	I1+	Current Positive Sequence
V1-	Voltage negative sequence	I1-	Current Negative Sequence
NL	Nonlinearity	I _{sc}	Short Circuit Current
PST	Severity of Flicker Short-Term	PLT	Severity of Flicker Long-Term
dc	Maximum Variation of Voltage	d(t)	Variation of Voltage
d max	Maximum Absolute Value of Voltage Variation	ZNI	Zone Non Interconnected

3 RESUME OF TEST RESULTS

INTERPRETATION KEYS

Test object does meet the requirement..... **P** Pass
 Test object does not meet the requirement..... **F** Fails
 Test case does not apply to the test object..... **N/A** Not applicable
 To make a reference to a table or an annex. See additional sheet
 To indicate that the test has not been realized **N/R** Not realized

TEST AND CHECKS

Point	Standard	Test procedure	
4.1	IEC 60068-2-1	Test Ae: Cold Soak	P
4.2	IEC 60068-2-2	Test Be: Dry heat.	P
4.3	IEC 60068-2-14	Test Nb: Change of temperature.	P
4.4	IEC 60068-2-30	Test Db: Damp heat, cyclic	P

4 TEST RESULTS

4.1 TEST AE: COLD

The test purpose is the determination of the aptitude of the components, equipment and other items for use, transport or store at low temperature, according to the standard IEC 60068-2-1. Environmental testing. Part 2-1: Test. Test A: Cold.

Due to the nature of EUT, the applicable Test is Ae: This procedure is applied to specimens heat dissipative which are subjected to low temperature during an enough period for the specimen to reach the thermal stability. The EUT is required to be operating during all test duration.

Test Severities

The specimen is introduced into the chamber which is at the temperature of the laboratory. The temperature is then adjusted to the temperature appropriate to the degree of severity, as specified in the relevant specification. After temperature stability of the test specimen has been reached, the specimen is exposed to these conditions for the specified duration. For specimens that are required to be operational (even though they do not meet the requirements of being heat dissipating), power shall then be applied to the specimen and a functional test is performed as necessary. A further period of stabilization may be necessary and the specimen shall then be exposed to the low temperature conditions for a duration as specified in the relevant specification. Specimens under test are normally in non-operating conditions.

Specimens under test are normally in non-operating conditions.

Test condition:

Test Temperature: -25°C

Test Duration : 16h

Test result:

Measurements Pre-functional test:

PV Input:		AC grid output (line to neutral):	
Voltage DC (V)	364.48	Voltage AC (V)	231.29
Current DC (A)	17.06	Current AC (A)	26.08
Power DC (W)	6179.39	Active Power AC (W)	6007.43

Measurements Post-functional test:

PV Input:		AC grid output (line to neutral):	
Voltage DC (V)	364.47	Voltage AC (V)	231.25
Current DC (A)	17.06	Current AC (A)	26.09
Power DC (W)	6181.67	Active Power AC (W)	6009.23

After the test, the specimens can operation normally.

4.2 TEST BE: DRY HEAT

The test purpose is the determination of the aptitude of the components, equipment and other items for use, transport or storage at high temperature, according to the standard IEC 60068-2-2. Environmental testing. Part 2-2: Tests. Test B: Dry heat

Due to the nature of EUT applicable test Be: This procedure is applied to specimens heat dissipative which are subjected to high temperature during an enough period time for the specimen to reach the thermal stability. The EUT is required to be operating during all test duration.

Test Severities

The specimen is introduced into the chamber, which is at the temperature of the laboratory. The temperature is then adjusted to the temperature appropriate to the degree of severity as specified in the relevant specification. After temperature stability of the test specimen has been reached, the specimen is exposed to these conditions for the specified duration. For specimens that are required to be operational (even though they do not meet the requirements of being heat dissipating) power shall then be applied to the specimen and a functional test is performed as necessary. A further period of stabilization may be necessary and the specimen shall then be exposed to the high temperature conditions for a duration as specified in the relevant specification.

Specimens under test are normally in non-operating conditions.

Test condition:

Test Temperature : +60°C

Test Duration : 16h

Test result:

Measurements Pre-functional test:

PV Input:		AC grid output (line to neutral):	
Voltage DC (V)	363.85	Voltage AC (V)	231.34
Current DC (A)	17.10	Current AC (A)	26.09
Power DC (W)	6186.02	Active Power AC (W)	6013.48

Measurements Post-functional test:

PV Input:		AC grid output (line to neutral):	
Voltage DC (V)	364.37	Voltage AC (V)	231.34
Current DC (A)	17.07	Current AC (A)	26.08
Power DC (W)	6180.34	Active Power AC (W)	6008.19

After the test, the specimens can operation normally.

4.3 TEST NB: CHANGE OF TEMPERATURE

This test includes alternating periods of high and low temperature with a good definition of transference between both temperatures. The test has been performed according to the standard IEC 60068-2-14. Environmental testing. Part 2-14: Tests. Test N: Change of temperature.

The inverter has been subjected to thermal changes according to the test Nb in order to evaluate the ability of components, equipment or other articles to withstand rapid changes of ambient temperature. With this method, variations of temperature are controlled with a specified speed of change.

The complete test performed includes:

1. Variation from standard atmospheric conditions to the temperature of conditioning "A".
2. Variation from temperature of conditioning "A" to temperature of conditioning "B".
3. Variation from temperature of conditioning "B" to temperature of conditioning "A".
4. Variation from temperature of conditioning "A" to temperature of conditioning "B".
5. Variation from the temperature of conditioning "B" to the ambient temperature of laboratory.

Test Severities

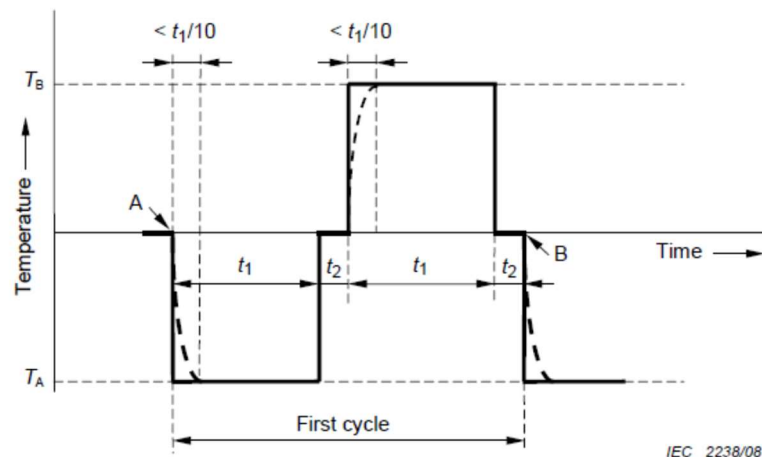
The severity of the test is defined by the combination of the two temperatures, the transfer time, the exposure time of the specimen and the number of cycles.

The lower temperature, T_A , shall be specified in the relevant specification and should be chosen from the test temperatures of IEC 60068-2-1 and IEC 60068-2-2.

The higher temperature, T_B , shall be specified in the relevant specification and should be chosen from the test temperatures of IEC 60068-2-1 and IEC 60068-2-2.

The exposure time, t_1 , of each of the two temperatures depends upon the heat capacity of the specimen. It may be 3 h, 2 h, 1 h, 30 min or 10 min, or as specified in the relevant specification. Where no exposure period is specified in the relevant specification, it is understood to be 3 h.

The preferred number of test cycles is five, unless otherwise specified in the relevant specification.



Key

- A start of first cycle
B end of first cycle and start of second cycle

NOTE The dotted curve is explained above.

Figure 2 – Na test cycle

Test condition:

Low temperature T_A : -25°C

High temperature T_B : +60°C

Duration of exposure time t_1 : 3h

Duration of transfer time t_2 : 3min

Number of cycles: 5

Recovery: 2h

Test result:

Measurements Pre-functional test:

PV Input:		AC grid output (line to neutral):	
Voltage DC (V)	364.07	Voltage AC (V)	231.37
Current DC (A)	17.09	Current AC (A)	26.09
Power DC (W)	6184.12	Active Power AC (W)	6011.39

Measurements Post-functional test:

PV Input:		AC grid output (line to neutral):	
Voltage DC (V)	364.52	Voltage AC (V)	231.36
Current DC (A)	17.06	Current AC (A)	26.09
Power DC (W)	6182.03	Active Power AC (W)	6009.80

After the test, the specimens can operation normally.

4.4 TEST DB: DAMP HEAT, CYCLIC (12 h + 12 h)

The test purpose is the determination of the suitability of components, equipment or other articles for the use, transportation and storage abnormal conditions of high humidity, combined with cyclic temperature changes and, in general, producing condensation on the surface of the specimen, according to the standard IEC 60068-2-30. Environmental testing. Part 2-30: Tests. Test Db-Variant 1: Damp heat, Cyclic (12 h + 12 h).

Test Severities

Variant 2 (see Figure 2b)

The temperature shall be lowered to $25\text{ °C} \pm 3\text{ K}$ within 3 h to 6 h, but without the additional requirement for the first hour and one half as in variant 1. The relative humidity shall be not less than 80 % RH.

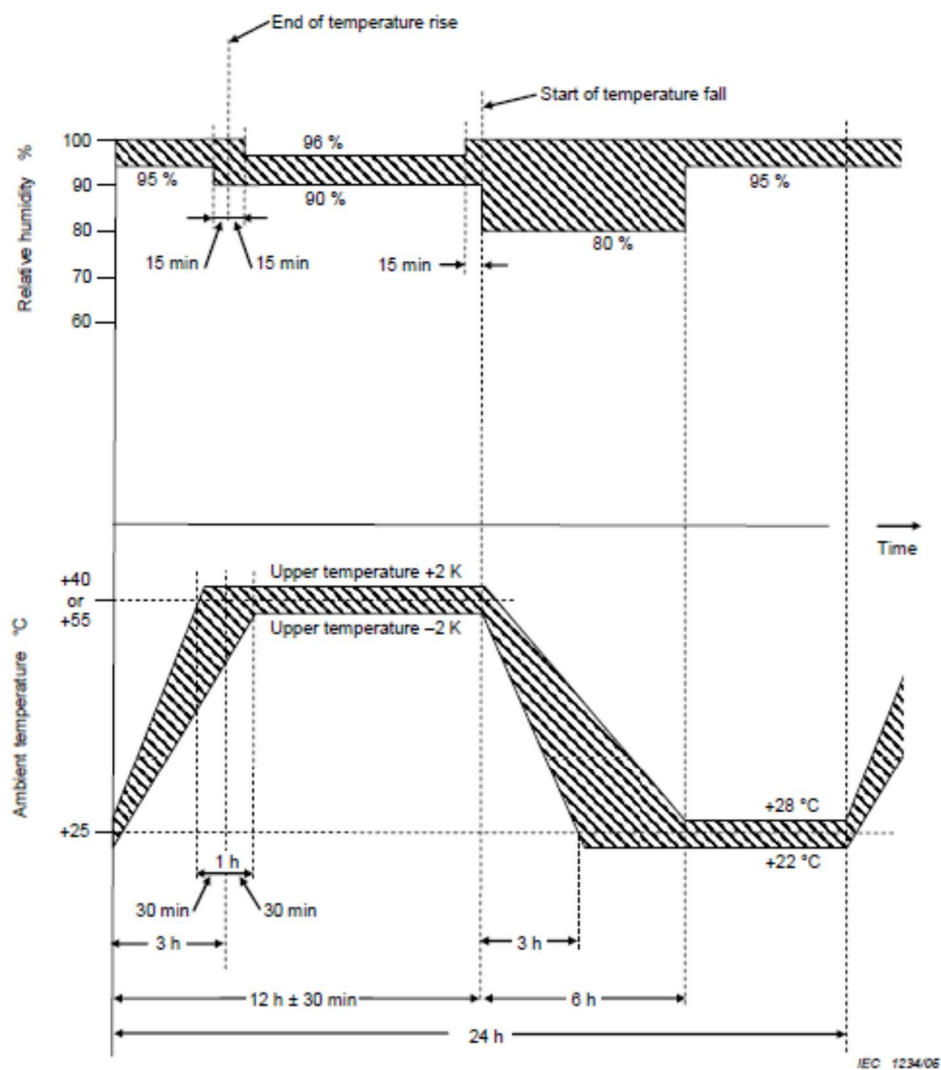


Figure 2b – Test Db – Test cycle – Variant 2

Test condition:

Test Db, variant 2, b-cycle
The humidity level shall be $95 \% \pm 5 \%$
A minimum number of 3 cycles
Lower temperature: 25°C
Upper temperature: 55°C

Test result:

Measurements Pre-functional test:

PV Input:		AC grid output (line to neutral):	
Voltage DC (V)	364.07	Voltage AC (V)	231.37
Current DC (A)	17.09	Current AC (A)	26.09
Power DC (W)	6184.12	Active Power AC (W)	6011.39

Measurements Post-functional test:

PV Input:		AC grid output (line to neutral):	
Voltage DC (V)	364.52	Voltage AC (V)	231.36
Current DC (A)	17.06	Current AC (A)	26.09
Power DC (W)	6182.03	Active Power AC (W)	6009.80

After the test, the specimens can operation normally.

5 PICTURES

Front

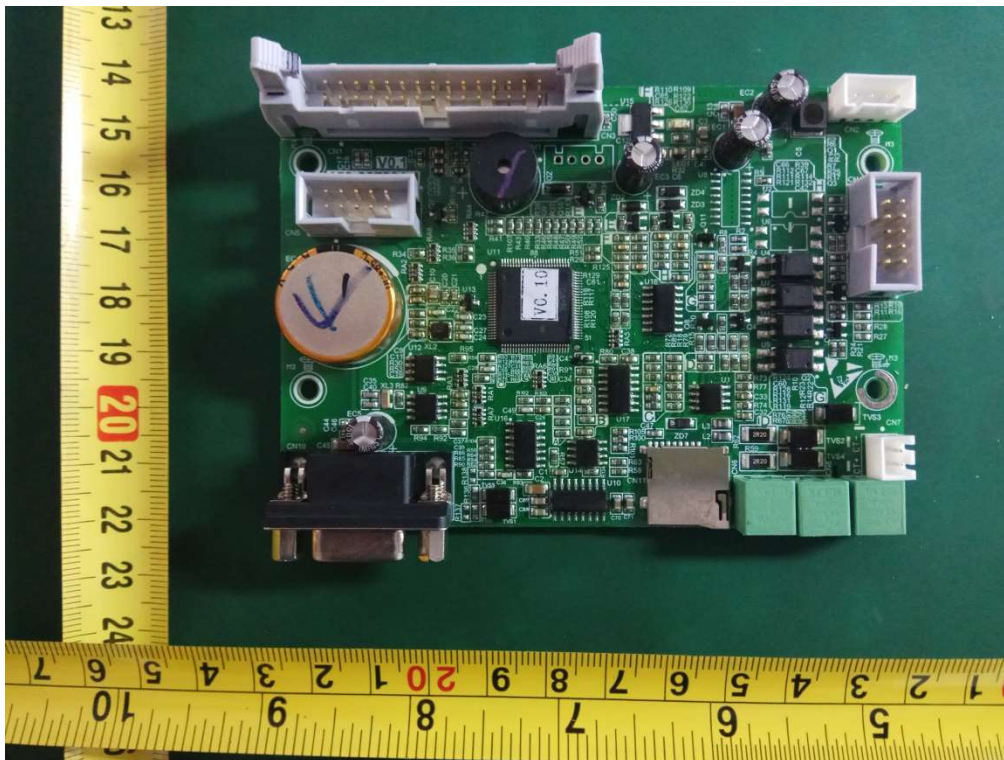


Side

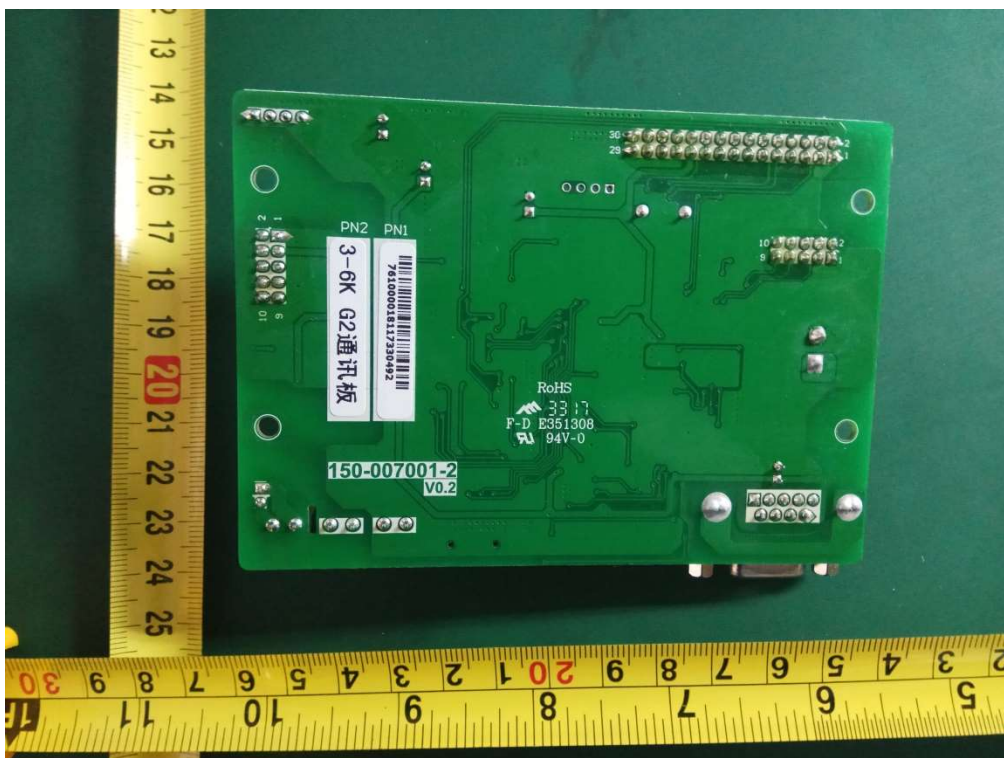


Connection interface**Back Side**

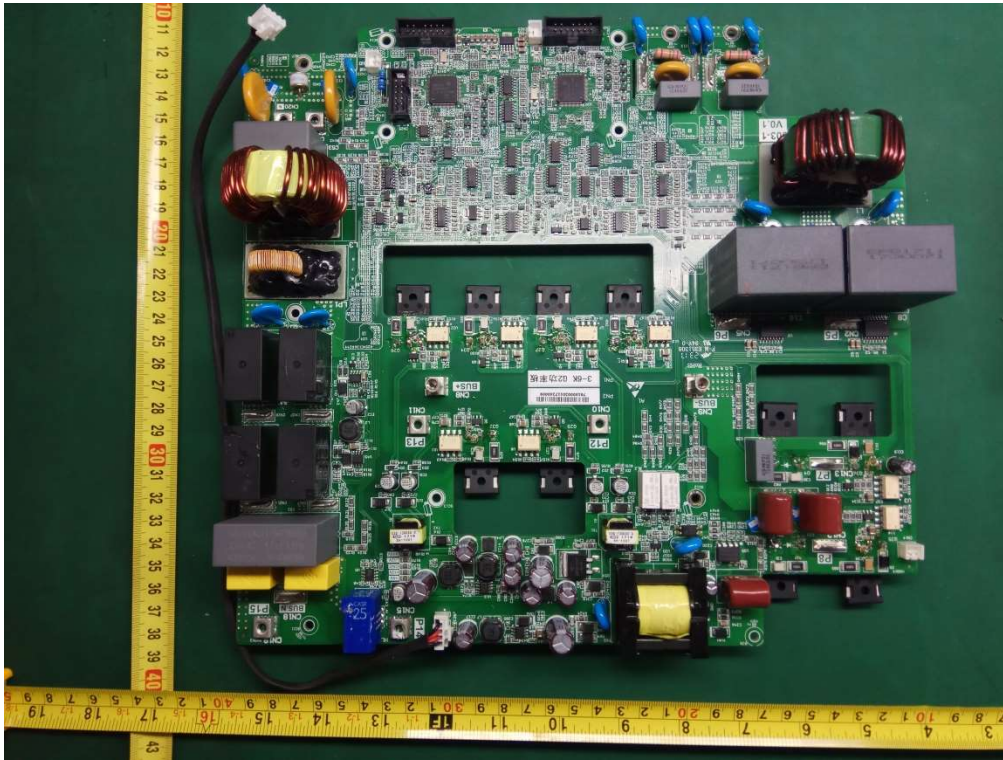
Front side of communication board



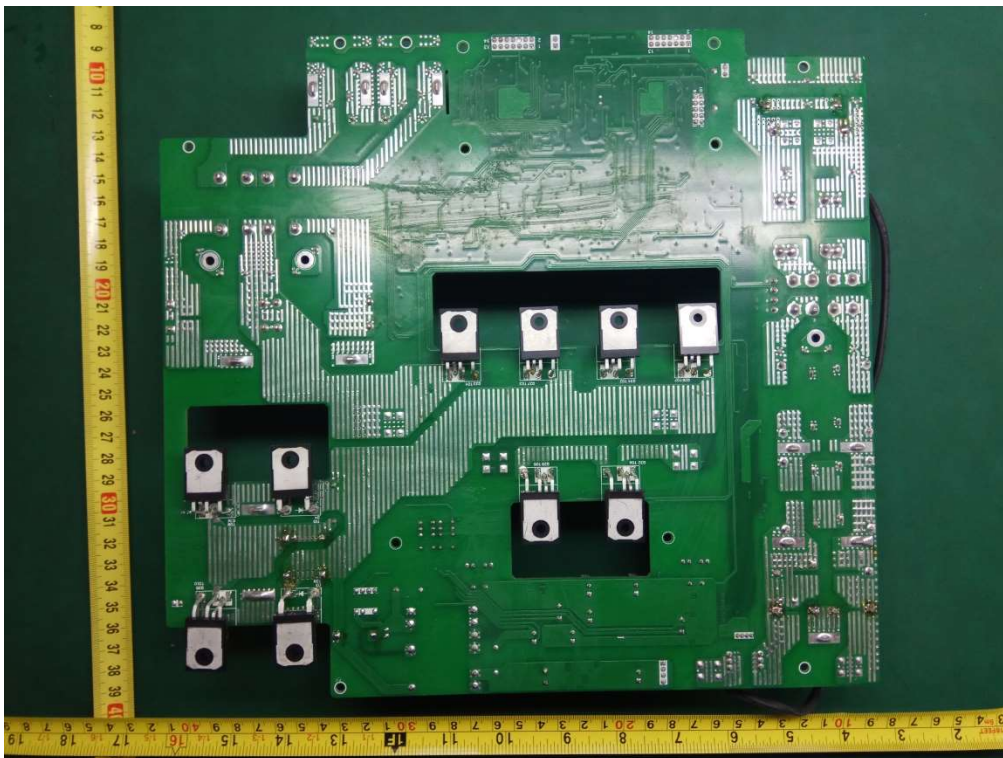
Back side of communication board



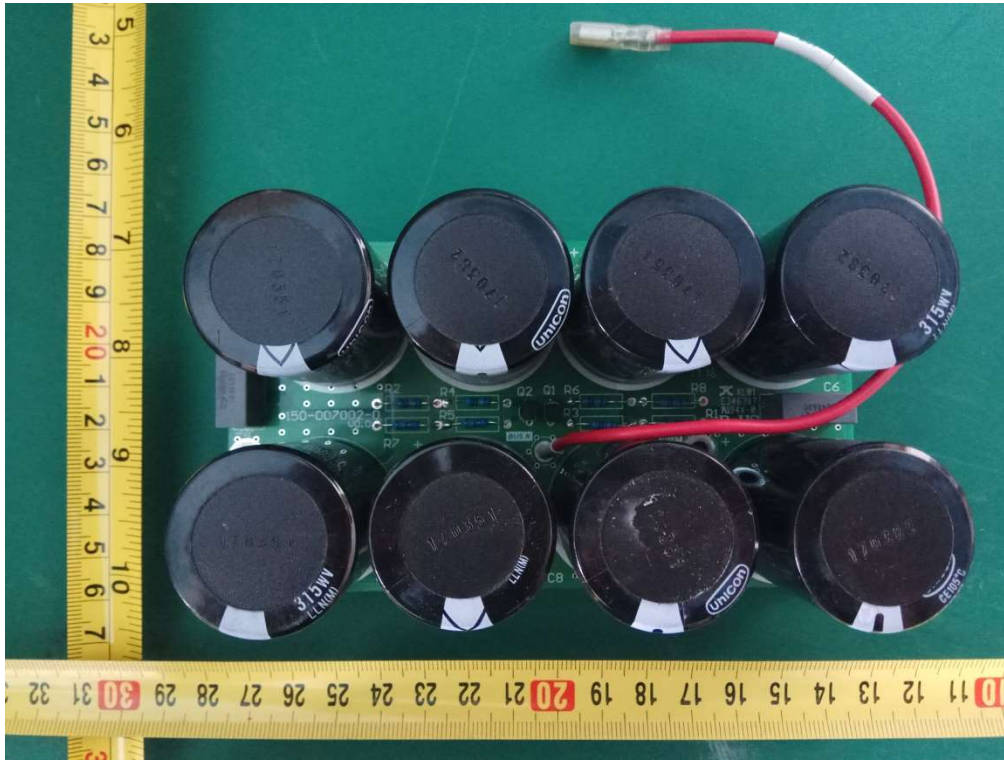
Front side of Main board



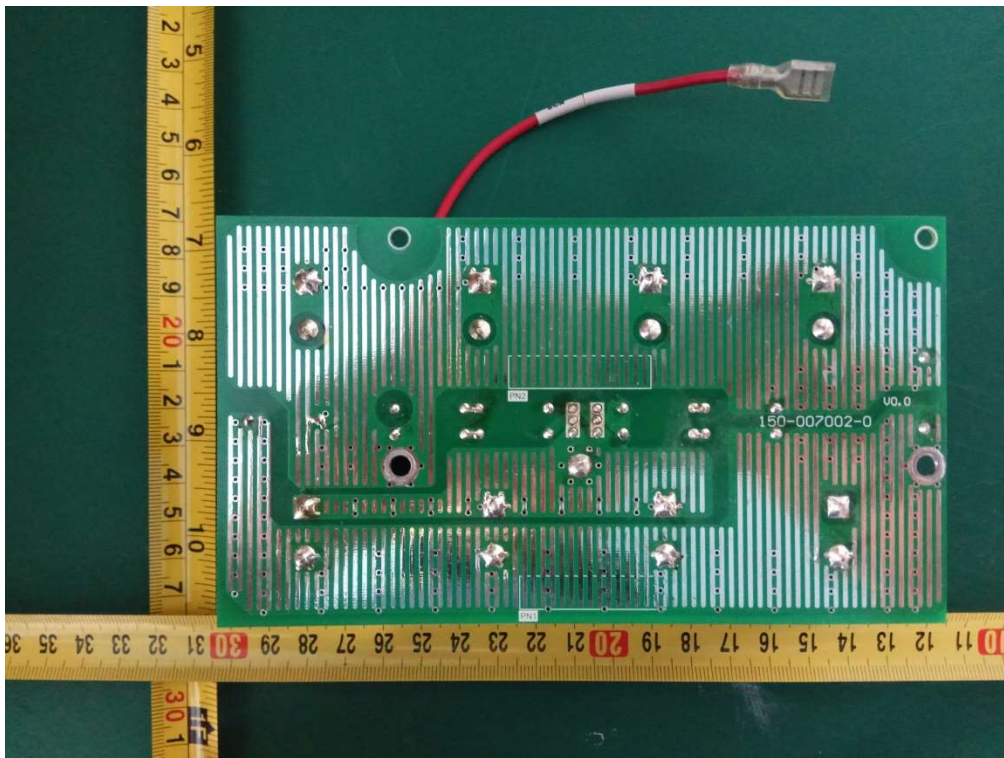
Front side of Main board



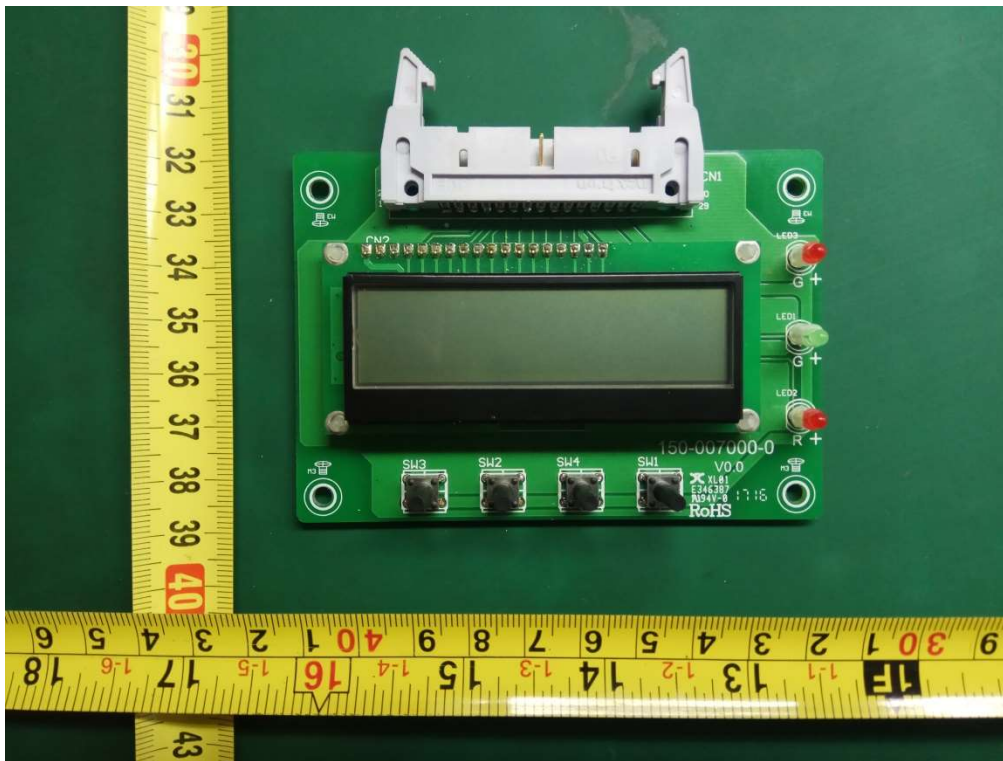
Front side of Bus capacitors board



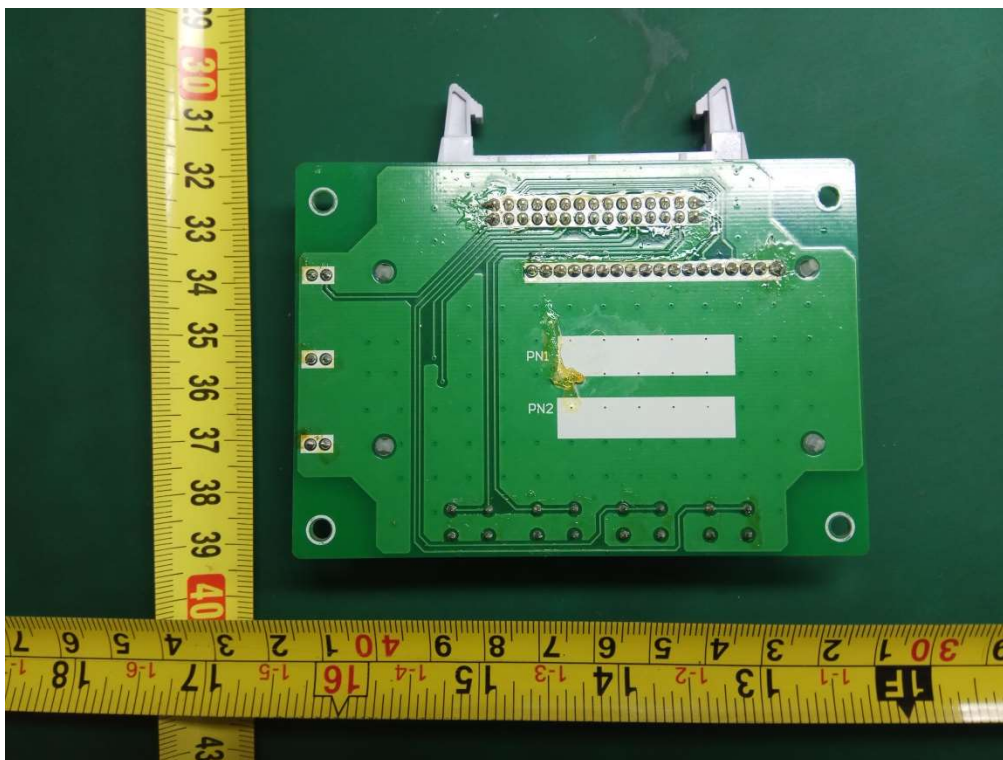
Back side of Bus capacitors board



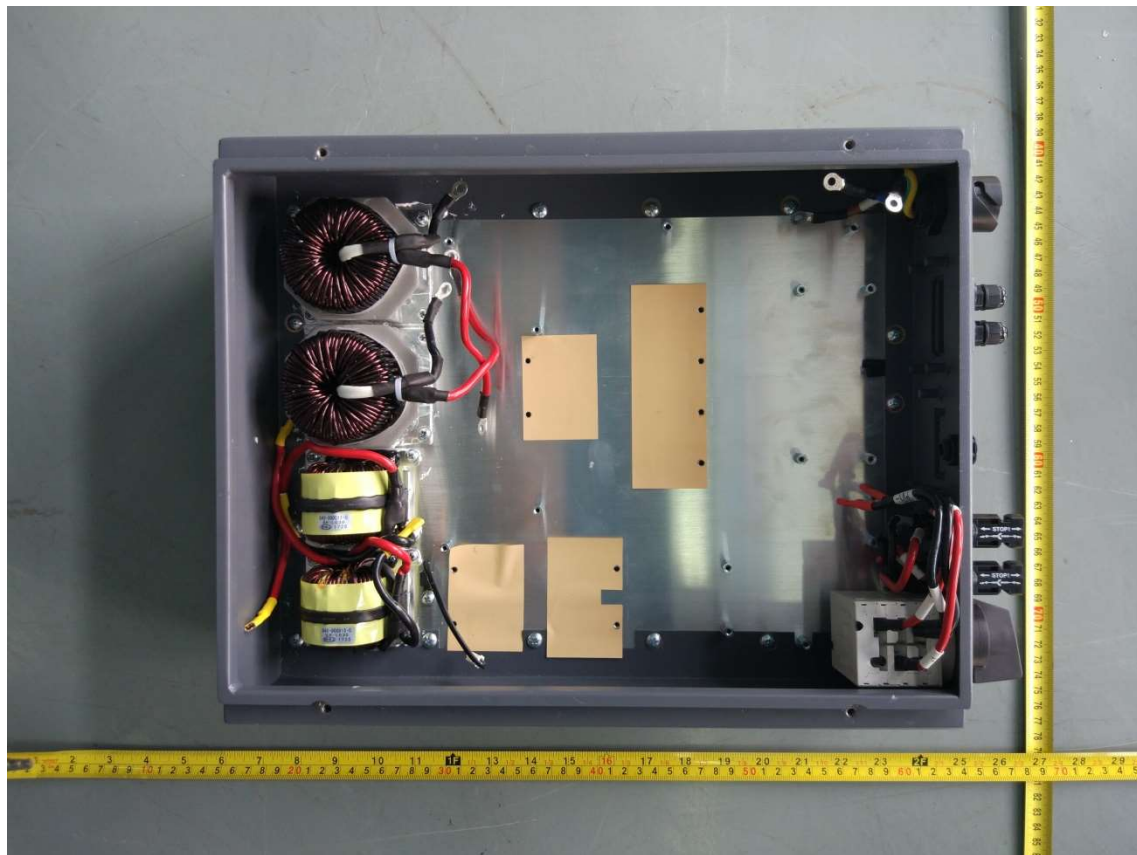
Front side of display board



Back side of display board



Removed all PCBAs

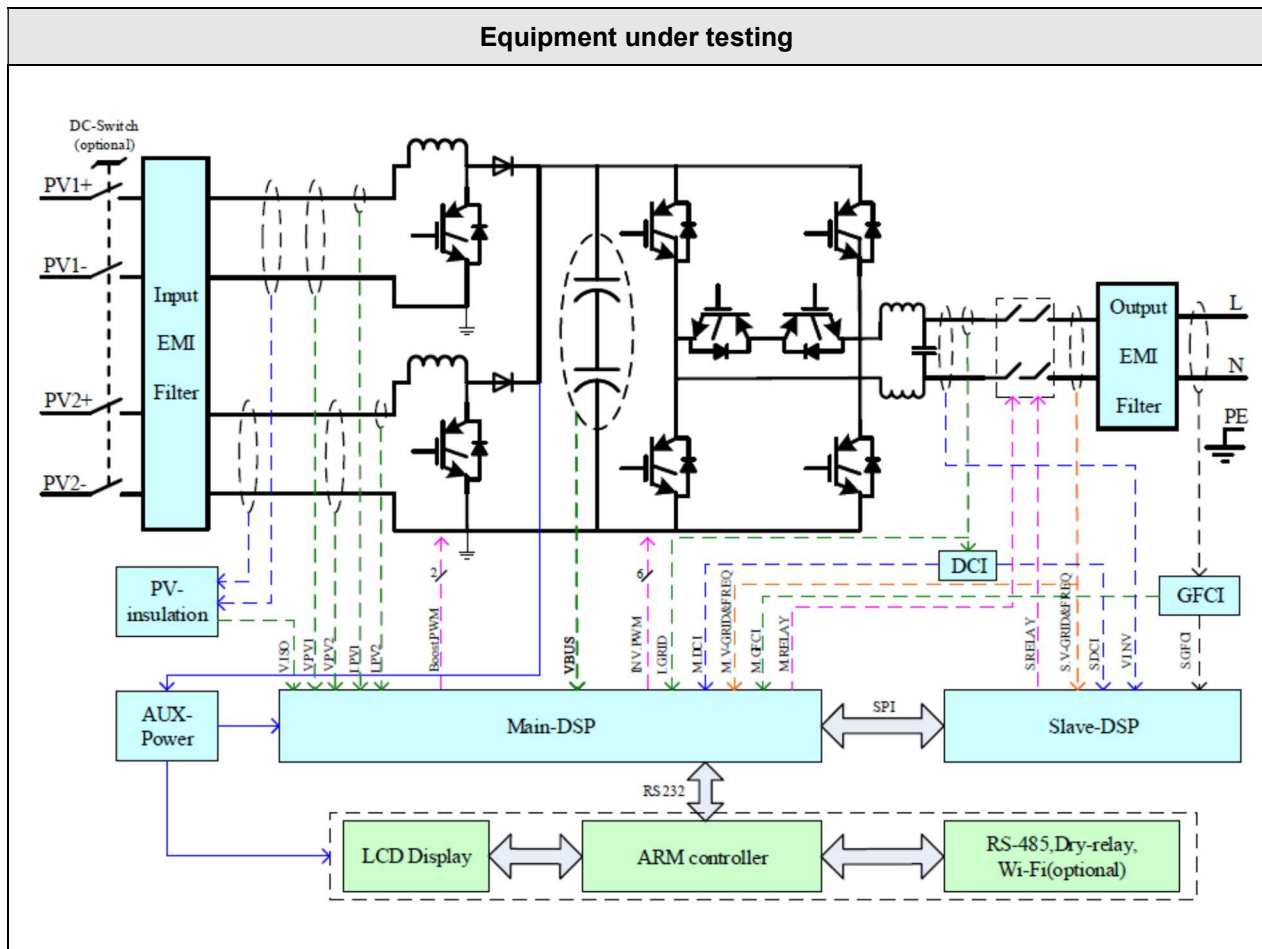


Cover



Software Version**Serial Number of the EUT**

6 ELECTRICAL SCHEME



--- End of test report---