

# TESTING FOR THE VERIFICATION OF COMPLIANCE OF PV INVERTER WITH : VDE V 0126-1-1: AUTOMATIC DISCONNECTION DEVICE BETWEEN A GENERATOR AND THE PUBLIC LOW-VOLTAGE GRID. 2013

Protocol PE.T-LE-62

Test Report Number .....: **GZES190101070101**

Trademark .....:



Tested Model.....: **Hiverter Si-60K**

Variant Models .....: **Hiverter Si-50K, Hiverter Si-70K**

## **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 Tecnos, S.A. (Electrical Testing Laboratory)

Address .....: C/ Trespaderna, 29 - Edificio Barajas 1  
28042 MADRID (Spain)

Conducted (tested) by .....: Michael Tong  
(Project Engineer)





Reviewed & Approved by .....: Roger Hu  
(Technical Reviewer)



Date of issue.....: **18/01/2019**

Number of pages .....: **34**

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<b>VDE V 0126-1-1: 2013</b>		

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### Test Report Historical Revision:

Test Report Version	Date	Resume
<b>GZES190101070101</b>	18 / 01 / 2019	This report is a first issuance for a co-license based on report number 2218 / 0234 - 9 previously issued for the same product with different trademark.

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## 1 SCOPE

SGS-CSTC Standards Technical Services Co., Ltd. Guangzhou Branch has been contract by Hitachi Hi-Rel Power Electronics Pvt. Ltd., in order to perform the testing according to following standards:

VDE V 0126-1-1:2013: Automatic disconnection device between a generator and the public low-voltage grid.

## 2 GENERAL INFORMATION

### 2.1 Testing Period and Climatic conditions

The necessary testing has been performed along 78 working days between the 3<sup>rd</sup> of May and the 10<sup>th</sup> of July of 2018.

All the tests and checks have been performed in accordance with the reference Standard (the tests are done at  $25 \pm 5^{\circ}\text{C}$ ,  $96 \text{ kPa} \pm 10 \text{ kPa}$  and  $45\% \text{ RH} \pm 10\% \text{ RH}$ ).

### SITE TEST

Name ..... : Shenzhen SOFARSOLAR 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.  
 Trade mark ..... :



Type ..... : Hiverter  
 Model / Type reference ..... : **Hiverter Si-60K**  
 Serial Number ..... : **ZJ1ES160HCJ252**  
 Software Version ..... : V2.00  
 Rated Characteristics ..... : DC input: 250-950V (1000V max.), Max. 40/40/40A  
 AC output: 3~/N/PE 230/400Vac, 50Hz, 90A, 60000VA

Date of manufacturing: 2018

Input ..... : DC  
 Output ..... : 3~/N/PE  
 Class of protection against electric shock ... : Class I  
 Degree of protection against moisture ..... : IP 65  
 Type of connection to the main supply ..... : Three phase – Fixed installation  
 Cooling group ..... : Fans  
 Modular ..... : No  
 Internal Transformer ..... : No

## VDE V 0126-1-1: 2013

## Copy of marking plate:


HITACHI	
Solar Grid Tied Inverter	
Model No.	Hiverter SI-50K
Max. DC Input Voltage	1000V
Operating MPPT Voltage Range	250-950V
Max. Input Current	40A/30A/30A
Max. PV Isc	48A/36A/36A
Nominal Grid Voltage	3/N/PE,400VAC
Max. Output Current	80A
Nominal Grid Frequency	50Hz/60Hz
Nominal Output Power	50000W
Max. Output Power	50000VA
Power Factor	>0.99(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	

HITACHI	
Solar Grid Tied Inverter	
Model No.	Hiverter SI-60k
Max. DC Input Voltage	1000V
Operating MPPT Voltage Range	250-950V
Max. Input Current	40A/40A/40A
Max. PV Isc	48A/48A/48A
Nominal Grid Voltage	3/N/PE,400VAC
Max. Output Current	90A
Nominal Grid Frequency	50Hz/60Hz
Nominal Output Power	60000W
Max. Output Power	60000VA
Power Factor	>0.99(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	

HITACHI	
Solar Grid Tied Inverter	
Model No.	Hiverter SI-70k
Max. DC Input Voltage	1000V
Operating MPPT Voltage Range	250-950V
Max. Input Current	40A/40A/40A
Max. PV Isc	48A/48A/48A
Nominal Grid Voltage	3/PE,480VAC
Max. Output Current	90A
Nominal Grid Frequency	50Hz/60Hz
Nominal Output Power	70000W
Max. Output Power	75000VA
Power Factor	>0.99(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

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Equipment under testing:

- **Hiverter Si-60K**

The variants models are:

- **Hiverter Si-50K**
- **Hiverter Si-70K**

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
<b>Sofarsoalr</b>	1	Digital oscilloscope	Agilent / DSO5014A	MY50070266	2019-02-27
	2	Current clamp	FLUKE / i1000s	32233919	2019-02-27
	3	Current clamp	FLUKE / i1000s	30413452	2019-02-27
	4	Current clamp	FLUKE / i1000s	30413448	2019-02-27
	5	Differential probe	Sanhua / SI-9110	152655	2019-02-27
	6	Differential probe	Sanhua / SI-9110	153200	2019-02-27
	7	Differential probe	Sanhua / SI-9110	111539	2019-02-27
	8	Power analyzer	ZLG / PA3000	703010002	2019-02-27
	9	Power analyzer	YOKOGAWA / WT3000	91N61088	2019-02-27
	10	Temperature & Humidity meter	VICTOR / TH101B	SH-W001	2019-02-27
	11	Digital oscilloscope	HIOKI / MR8847A	180418828	2019-07-02
	12	Power analyzer	HIOKI / PW6001	150901722	2019-05-22
<b>SGS</b>	13	True RMS Multimeter	Fluke / 289C	GZE012-53 (22930028)	2019-03-05

## 2.5 Measurement Uncertainty

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

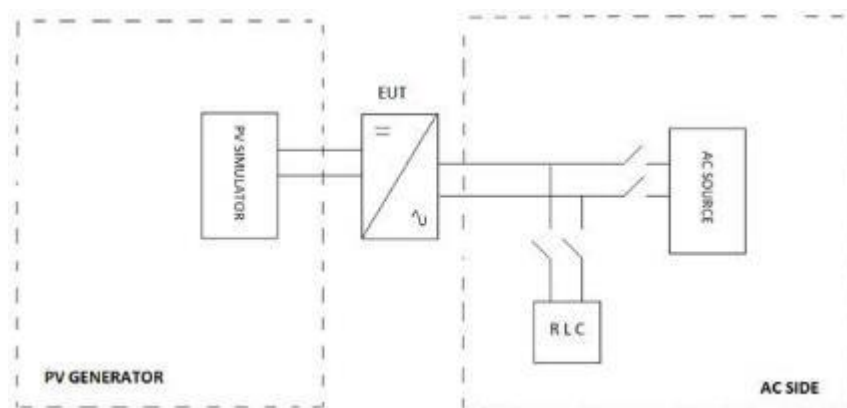
Magnitude	Uncertainty
Voltage measurement	$\pm 1.5 \%$
Current measurement	$\pm 2.0 \%$
Frequency measurement	$\pm 0.2 \%$
Time measurement	$\pm 0.2 \%$
Power measurement	$\pm 2.5 \%$
Phase Angle	$\pm 1^\circ$
Temperature	$\pm 3^\circ \text{C}$

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 petitioner.

Note2: Where the standard requires lower uncertainties that those in this table. Most restrictive uncertainty has been considered.

## 2.6 Test set up of the different standard

Below is the simplified construction of the test set up.



Different equipment has been used to take measures as it shows in chapter 2.3. Current and voltage clamps have been connected to the inverter input / output for all the tests. All the tests described in the following pages have used this specified test setup.

### The test bench used includes:

EQUIPMENT	MARK / MODEL	RATED CHARACTERISTICS	OWNER / ID.CODE
AC source	Kwell / AFG-S-33800	Voltage: 0-600 V 750kVA	Sofarsolar / EP-026
PV source	Kwell / TVS-630kW	Voltage: 0 - 1000 V 630kW	Sofarsolar / EP-027

## 2.7 Definitions

$I_n$	Nominal Current	$P$	Power
p.u	Per unit	$I$	Current
$P_n$	Nominal Power	$M$	Change for real power
$S_n$	Apparent Power	$N$	Change for reactive power
PGU	Power Generation Unit	$F$	Frequency
$P_{st}$	Short-term flicker strength	$Q_f$	Quality factor
$P_{lt}$	Long-term flicker strength	NS	Network and System
$C_{\psi_K}$	Flicker coefficient for continuous operation	$U_n$	Nominal Voltage
$S_r$	Apparent Power Rated	PWHD	Partial weight harmonic distortion
$S_k$	Short-circuit Apparent Power	THD	Total harmonic distortion
$K_{imax}$	Maximum switching current factor	$Z_{test}$	Test circuit impedance at which the emission test
$Z_{ref}$	The reference impedance	EUT	Equipment under test

### 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

<b>CHAPTER OF THE STANDARD, DESCRIPTION AND VERIFICATION</b>			
<b>4</b>	<b>Requirements</b>		
<b>4.1</b>	Functional safety		P
<b>4.2</b>	Reconnection		P
<b>4.3.1</b>	Voltage monitoring -20%		P
<b>4.3.2</b>	Voltage monitoring +10%		P
<b>4.3.3</b>	Voltage monitoring +15%		P
<b>4.4.1</b>	Frequency monitoring: 51,5Hz		P
<b>4.4.2</b>	Frequency monitoring: 47,5Hz		P
<b>4.5</b>	DC current monitoring		P
<b>4.6</b>	Anti-Islanding Protection		P
<b>4.7</b>	Marking		P
<b>4.8</b>	Residual Current		P
<b>5</b>	<b>Electromagnetic Compatibility</b>		P

## 4 TEST RESULTS

### 4.1 FUNCTIONAL SAFETY

The security as defined in 4.3 to 4.8 of the standard must turn in an error state and display this error condition.

Testing of the single-fault tolerance and fault detection with subsequent disconnection is carried out by fault simulation, if necessary with additional fault tests.

It must be checked that a single fault does not lead to loss of the safety function.

The compliances with these requirements are stated in the following test report:

- IEC/EN 62109-1:2010, IEC/EN 62109-2:2011: Test Report n° 50160856 001 on 26/03/2018 which issued by TÜV Rheinland (Shanghai) Co.,Ltd.

The results are offered in the table below:

Component No.	Fault	Supply voltage (V)	Test time	Observation
K1	S/C	Input: 640 Vdc; Output: 230 Vac	30min	EUT cannot connect to the grid. Error message: "Relay fault". No output. No damage. No hazard.
K2	S/C	Input: 360 Vdc; Output: 230 Vac	30min	EUT cannot connect to the grid. Error message: "Relay fault". No output. No damage. No hazard.
K3	S/C	Input: 360 Vdc; Output: 230 Vac	30min	EUT cannot connect to the grid. Error message: "Relay fault". No output. No damage. No hazard.
Note: S/C means Short Circuit.				

The faults indicate in page 57 to 61 of the manual the Trouble shooting of the EUT.

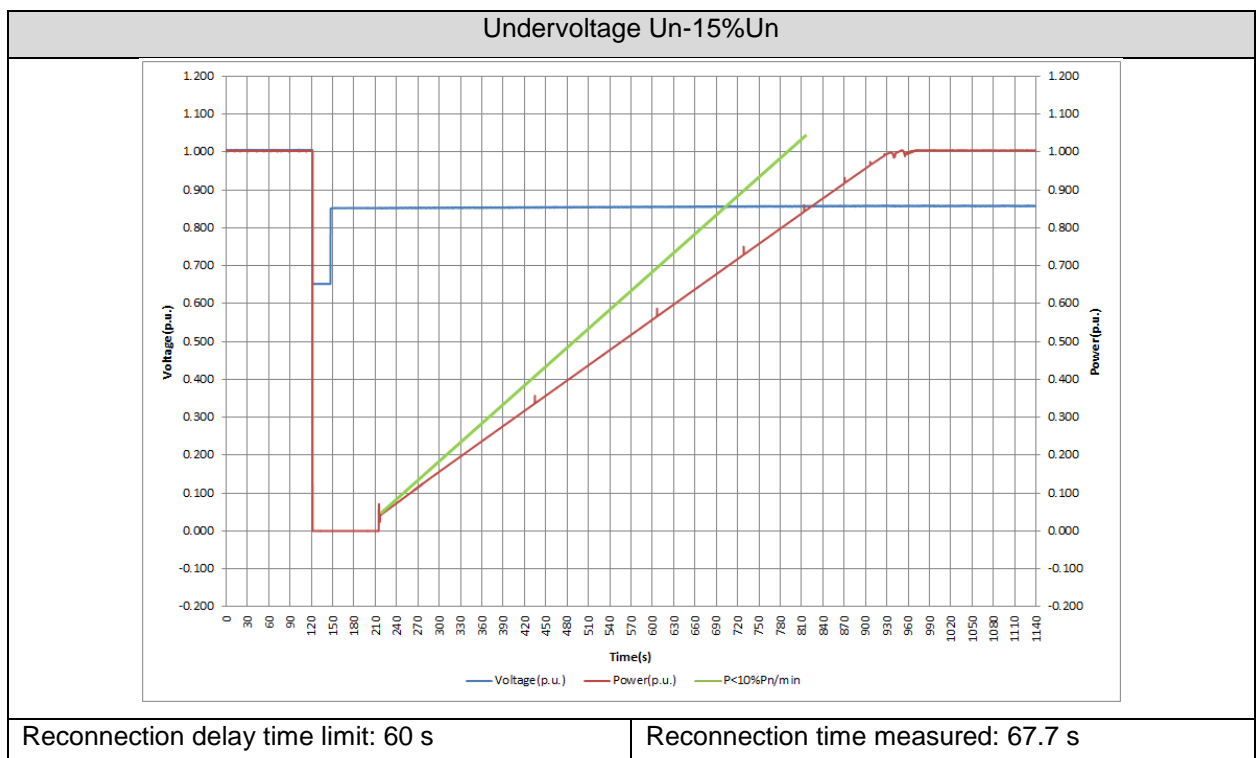
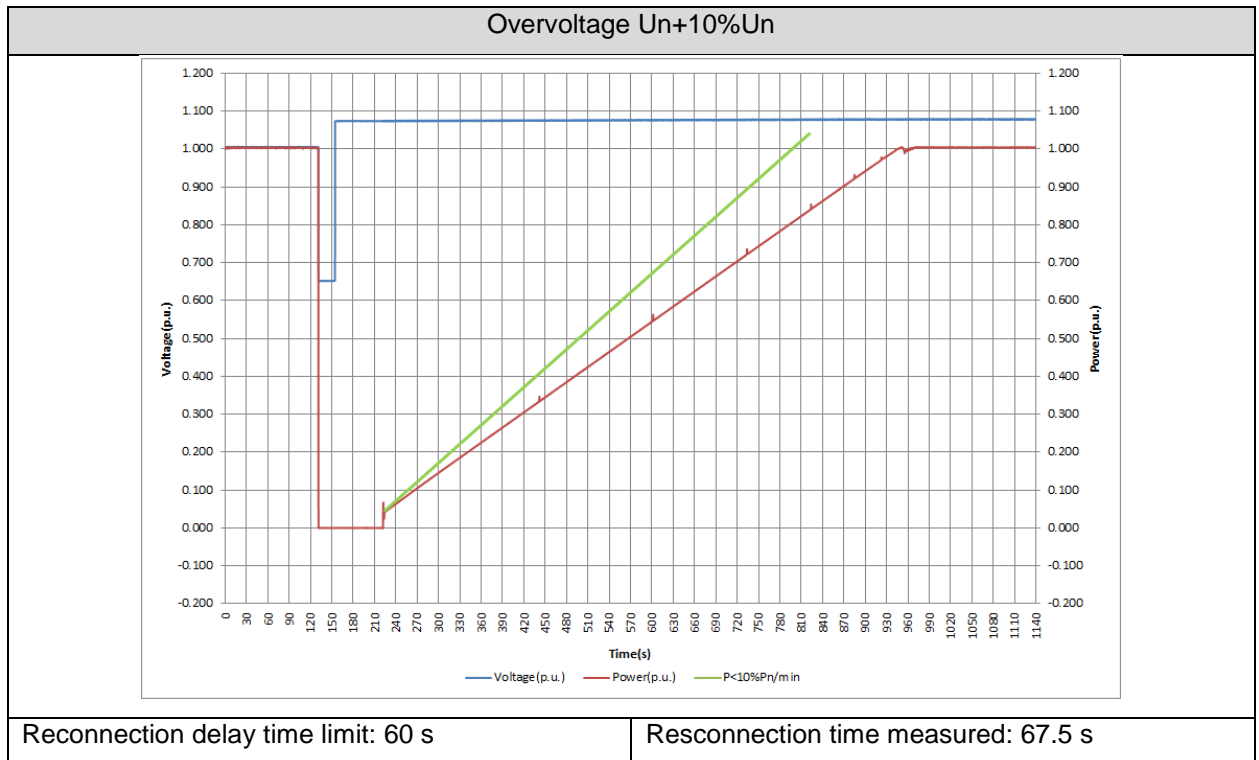
## VDE V 0126-1-1: 2013

## 4.2 CONNECTION AND RECONNECTION CONDITIONS

The power generation system shall be connected to the network only if both voltage and frequency are within the tolerance range according to article 4.2. It is shown that the active power don't exceed the gradient of 10 % of the active power per minute (green line).

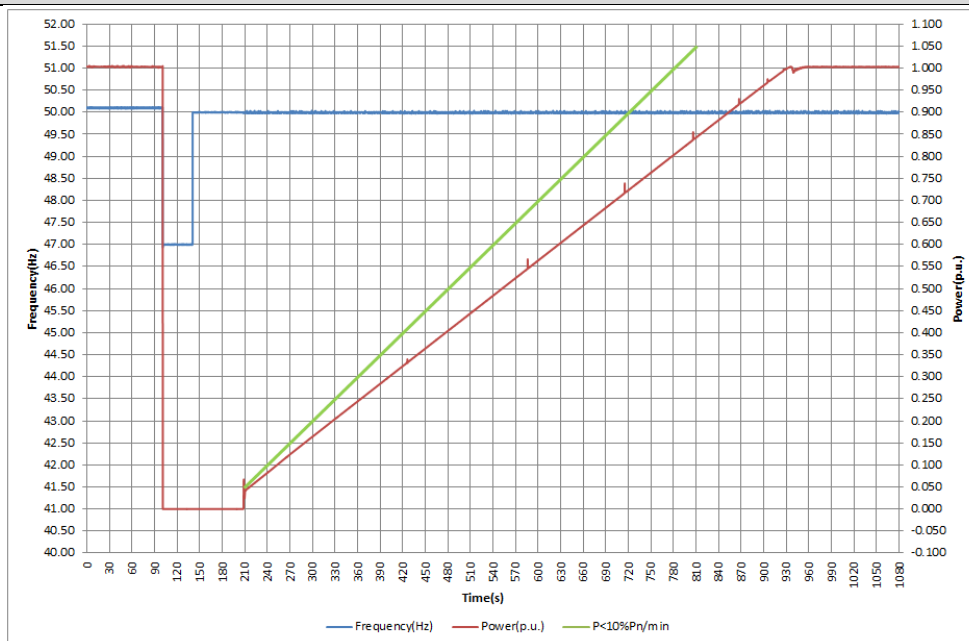
The compliances with these requirements are stated in the following test report:

- VDE-AR-N 4105:2011-08 AND VDE V 0124-100: 2012-07: Test Report n° 2218 / 0234 -3



## VDE V 0126-1-1: 2013

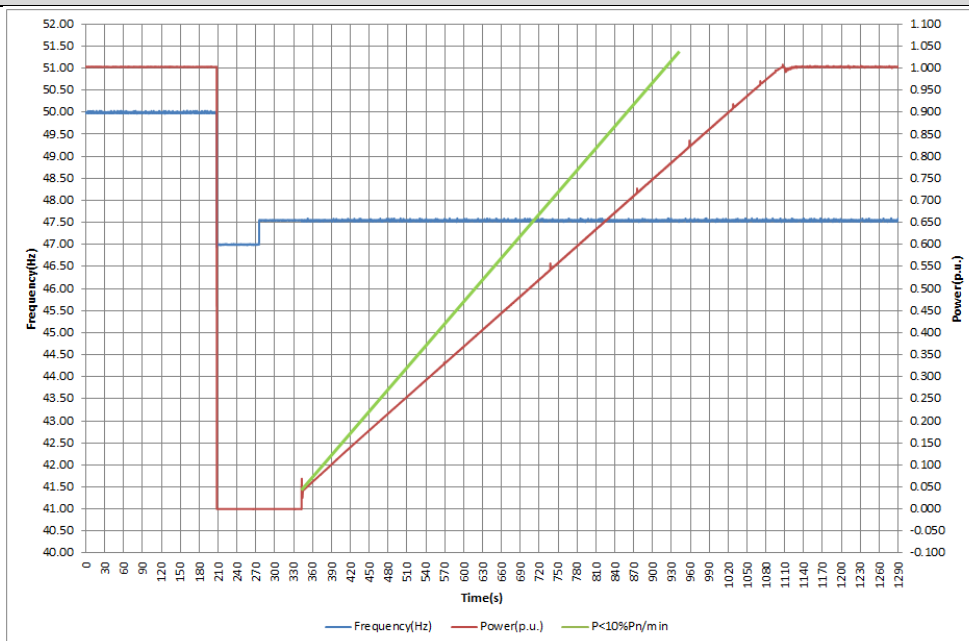
## Overfrequency 50,05 Hz



Reconnection delay time limit: 60 s

Reconnection time measured: 67.7 s

## Underfrequency 47,5 Hz



Reconnection delay time limit: 60 s

Reconnection time measured: 67.4 s

## VDE V 0126-1-1: 2013

### 4.3 VOLTAGE MONITORING

According to article 4.3 the NS protection should disconnect the power generation system from the net in the event of inadmissible voltage values. This point of the standard redirect to the point 6.5 of the VDE AR-N 4105:2011.

The compliances with these requirements are stated in the following test report:

- VDE-AR-N 4105:2011-08 AND VDE V 0124-100: 2012-07: Test Report n° 2218 / 0234 -3

### 4.4 FREQUENCY MONITORING

According to article 4.4 the NS protection should disconnect the power generation system from the net in the event of inadmissible frequency values.

The compliances with these requirements are stated in the following test report:

- VDE-AR-N 4105:2011-08 AND VDE V 0124-100: 2012-07: Test Report n° 2218 / 0234 -3

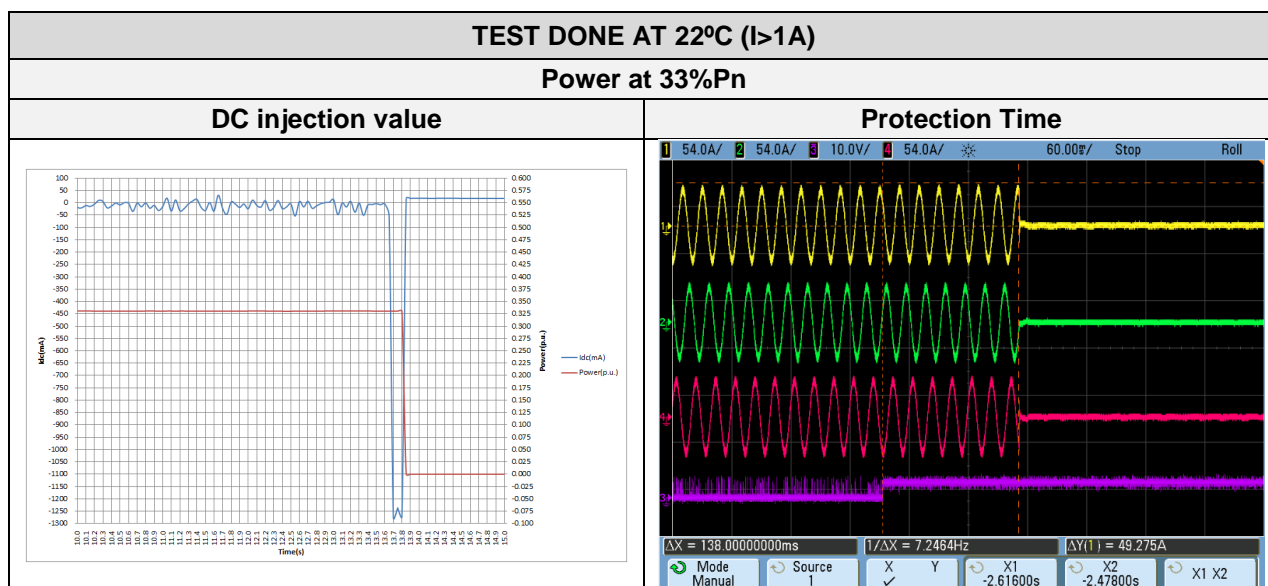
### 4.5 DC CURRENT MONITORING

The verification of the protection against DC component emission test has been measured according to the standard, at the required active power levels.

The compliances with these requirements are stated in the following test report:

- Allegato B: Prove sugli inverter per impianti indirettamente connessi of CEI 0-21 (2016-07) + V1 (2017-07): Regola tecnica di riferimento per la connessione di Utenti attivi e passivi alle reti BT delle imprese distributrici di energia elettrica.: Test Report n° 2218 / 0234 -1

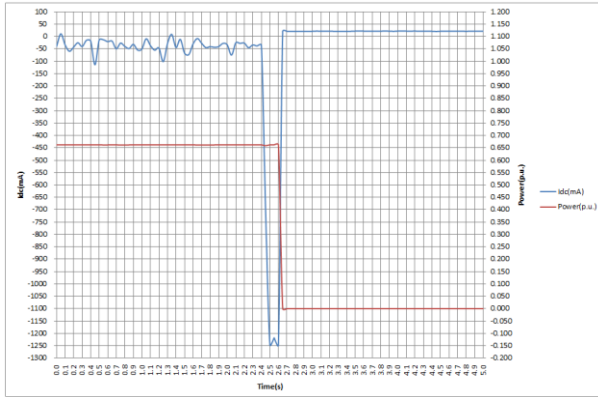
(I > 1 A)			
Output Power %	(33 ± 5) %	(66 ± 5) %	(100 ± 5) %
Time (ms)	138	159	159
Time Limit (200 ms)			



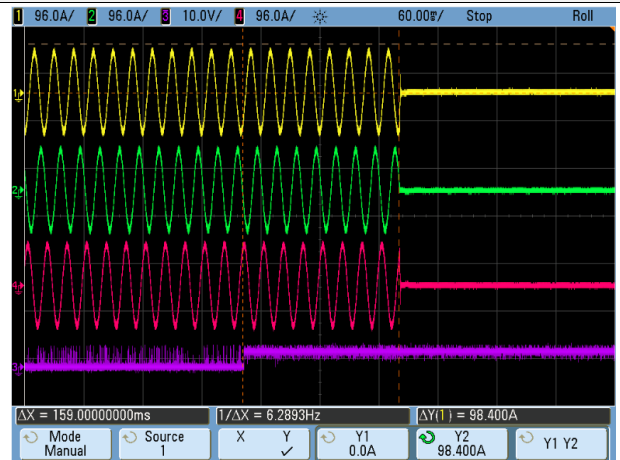
VDE V 0126-1-1: 2013

Power at 66%Pn

DC injection value

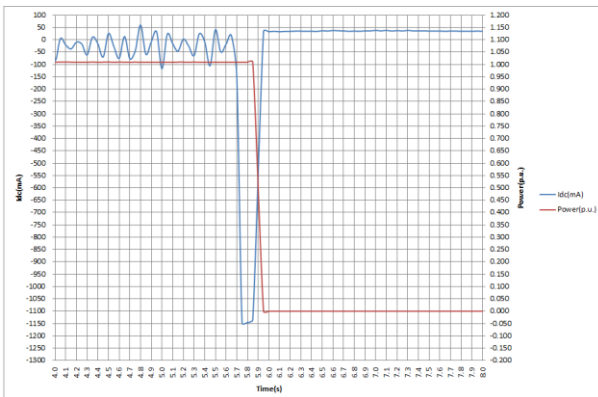


Protection Time

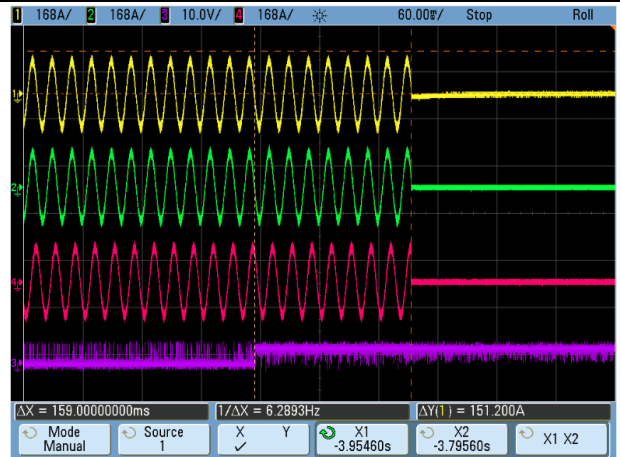


Power at 100%Pn

DC injection value

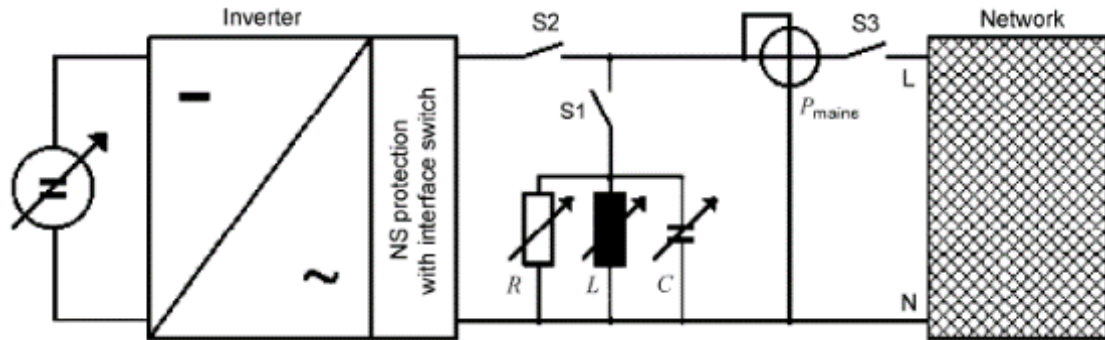


Protection Time



#### 4.6 ANTI ISLANDING PROTECTION

This test has been performed according to the point 6.5.3 of VDE-AR-N 4105:2011-08 and the paragraph 5.4.6 of VDE V 0124-100:2012-07.



All the tests and checks have been performed in accordance with the reference Standard as specified previously. The used quality factor of resonant load was  $Q_f=2$ .

There are required three different tests:

Test A is at full power

Test B is at 50%P<sub>n</sub>

Test C is at 20%P<sub>n</sub>

The compliances with these requirements are stated in the following test report:

- VDE-AR-N 4105:2011-08 AND VDE V 0124-100: 2012-07: Test Report n° 2218 / 0234 -3

#### 4.7 MARKING

As it can be seen in the pictures below (chapter 7 in this report) and the picture of the rating plate on 2.2 of this report the inverter accomplish all the requirements in this point of the VDE V 0126-1-1.

#### 4.8 RESIDUAL CURRENT

This test has been done according to the standard EN 62109-2:2012-04, 4.8.

The compliances with these requirements are stated in the following test report:

- IEC/EN 62109-1:2010, IEC/EN 62109-2:2011: Test Report n° GZES190101004301 and GZES190101004302

## 5 ELECTROMAGNETIC COMPABILITY

  
Shenzhen BALUN Technology Co., Ltd.  
Block B, FL 1, Baisha Science and Technology Park, Shahe Xi Road, Nanshan District, Shenzhen, Guangdong Province, P. R. China 518055.

**VERIFICATION OF CONFORMITY**

Certificate No.: BL-SZ1910091-402

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

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

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

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

Product: PV Inverter

Brand name: **HITACHI**

Model name: Hiverter SI-50K, Hiverter SI-60K, Hiverter SI-70K

The submitted sample of the above product has been tested according with following standards. Standard(s) used for showing compliance with the essential requirements in the specified directive(s):

Applied Standards:	Report No.:
EN 61000-6-2: 2005 EN 61000-6-4: 2007/A1:2011 EN 61000-3-11: 2000 EN 61000-3-12: 2011	BL-SZ1910091-402

  
  
Hao Qi / Technology Director  
Date of Issue: Jan. 09, 2019

Tel: +86 755 66850100 Fax: +86 755 61824271 Email: cs@baluntek.com web: www.baluntek.com

## 6 LIST OF CRITICAL COMPONENTS

The compliances with these requirements are stated in the following test report:

IEC/EN 62109-1:2010, IEC/EN 62109-2:2011: Test Report n° GZES190101004301 and GZES190101004302

## 7 PICTURES

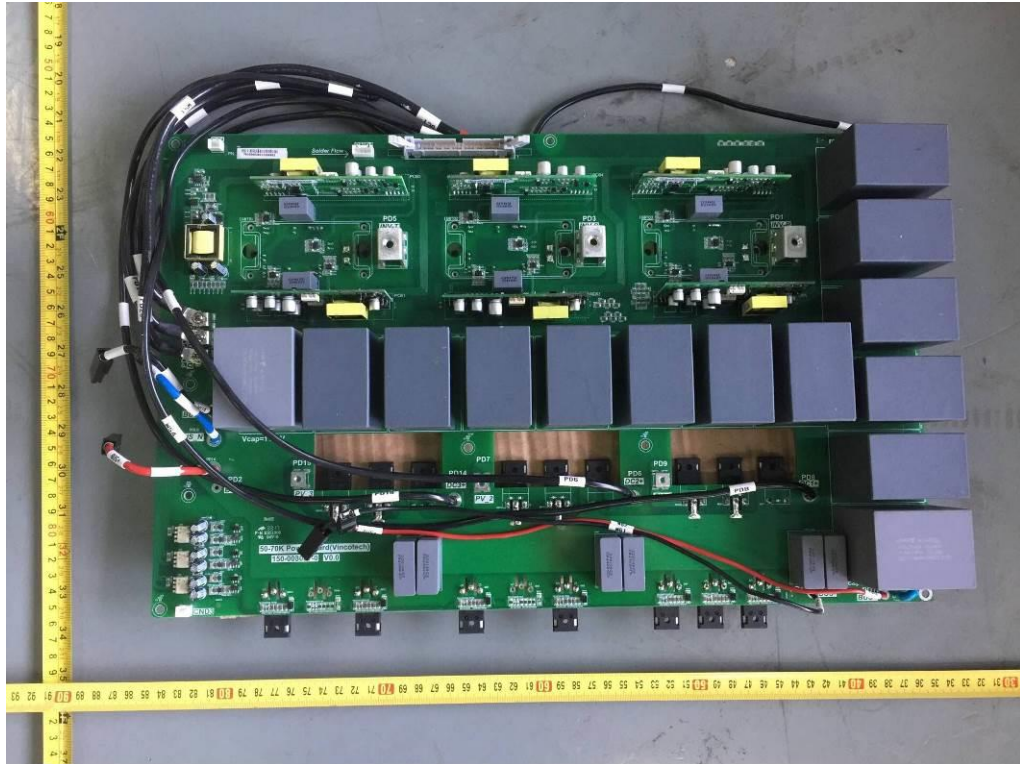
General view



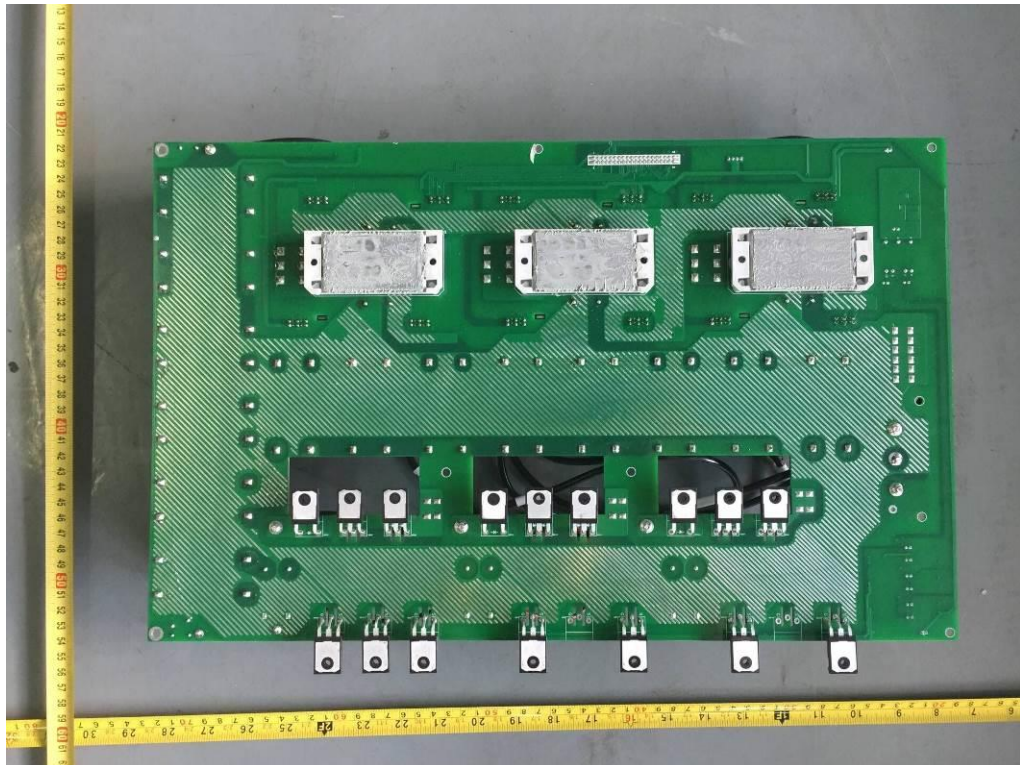
Back view



Front view of Main board

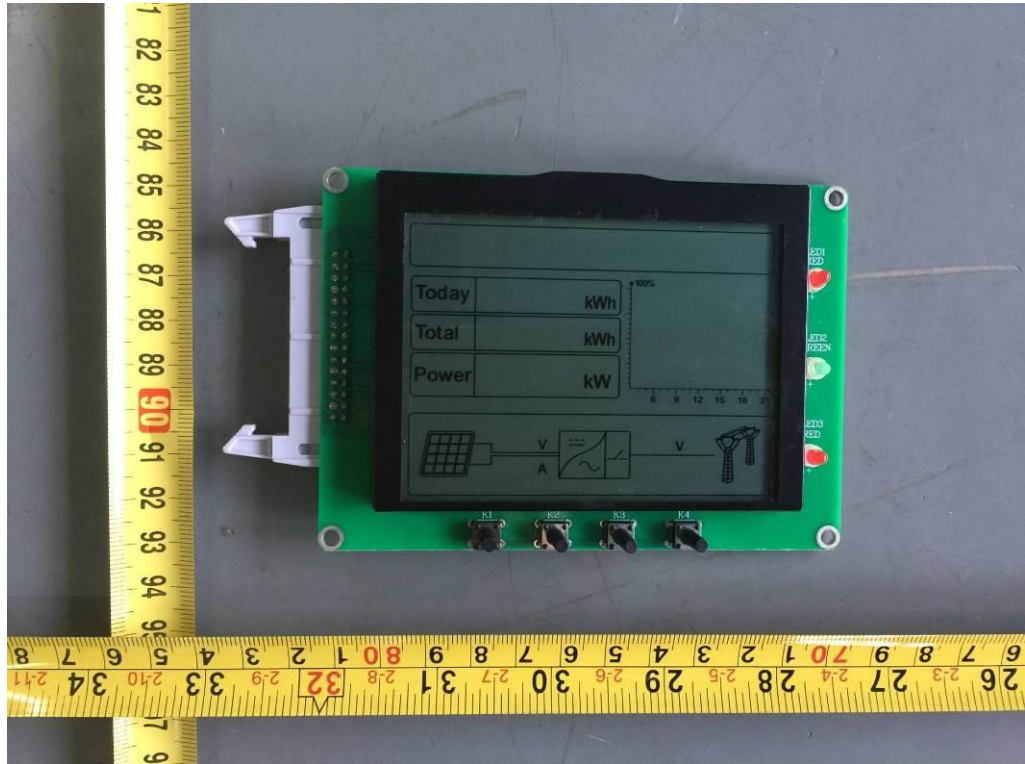


Back view of Main board

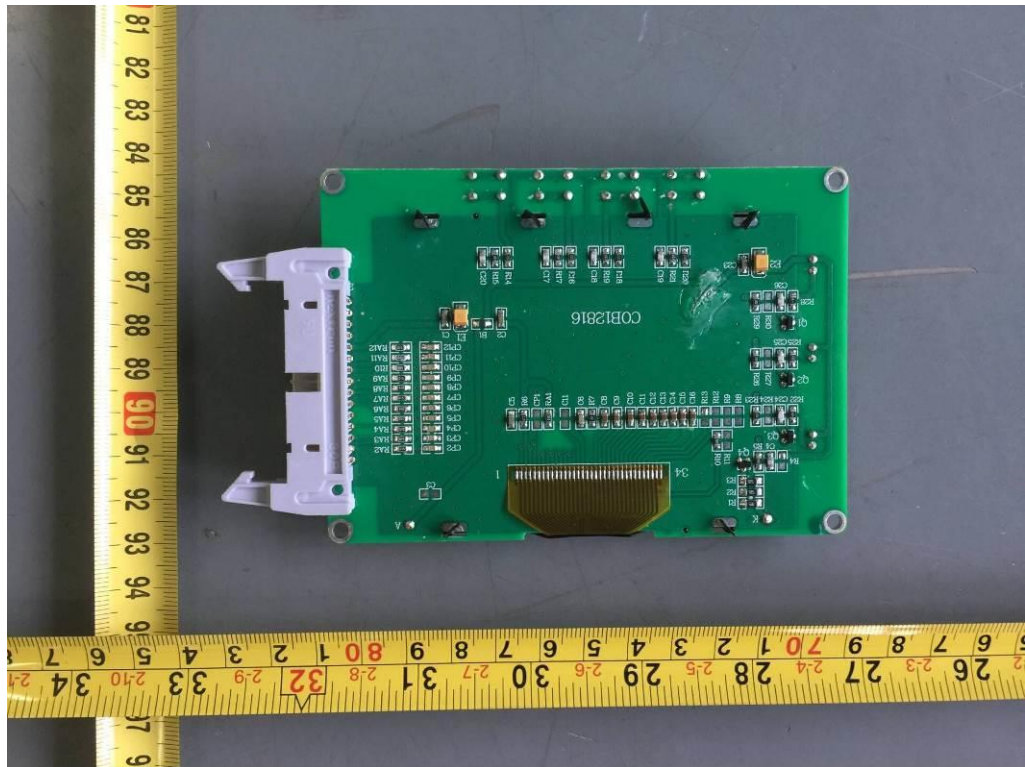


## VDE V 0126-1-1: 2013

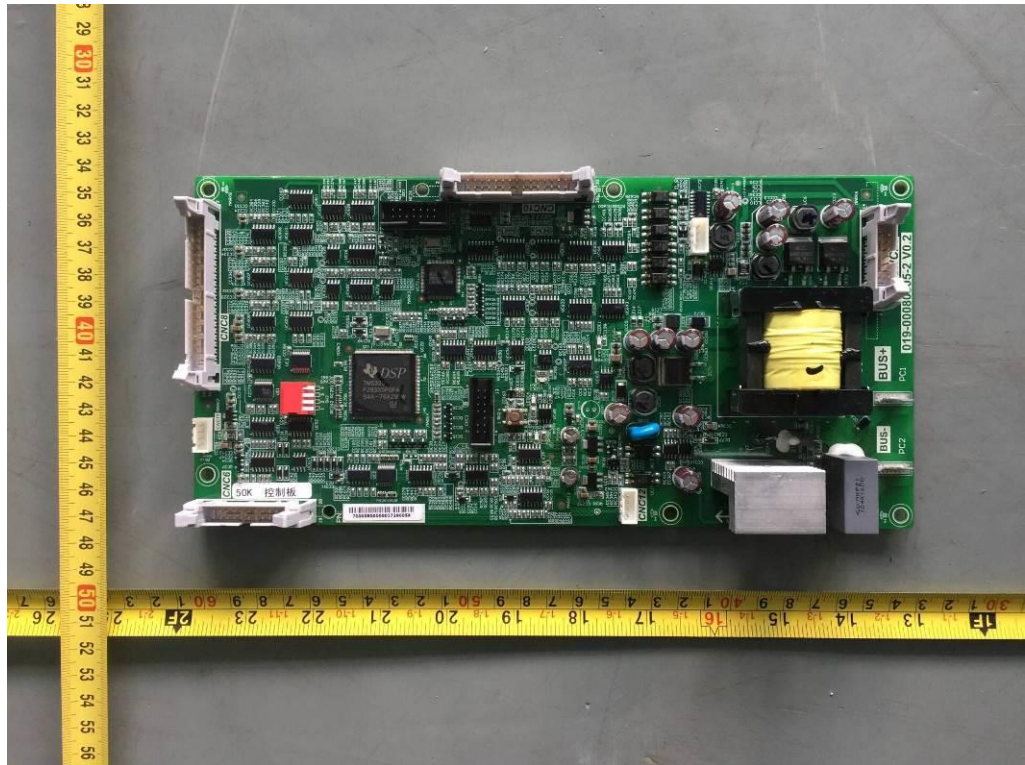
Front View of LCD board



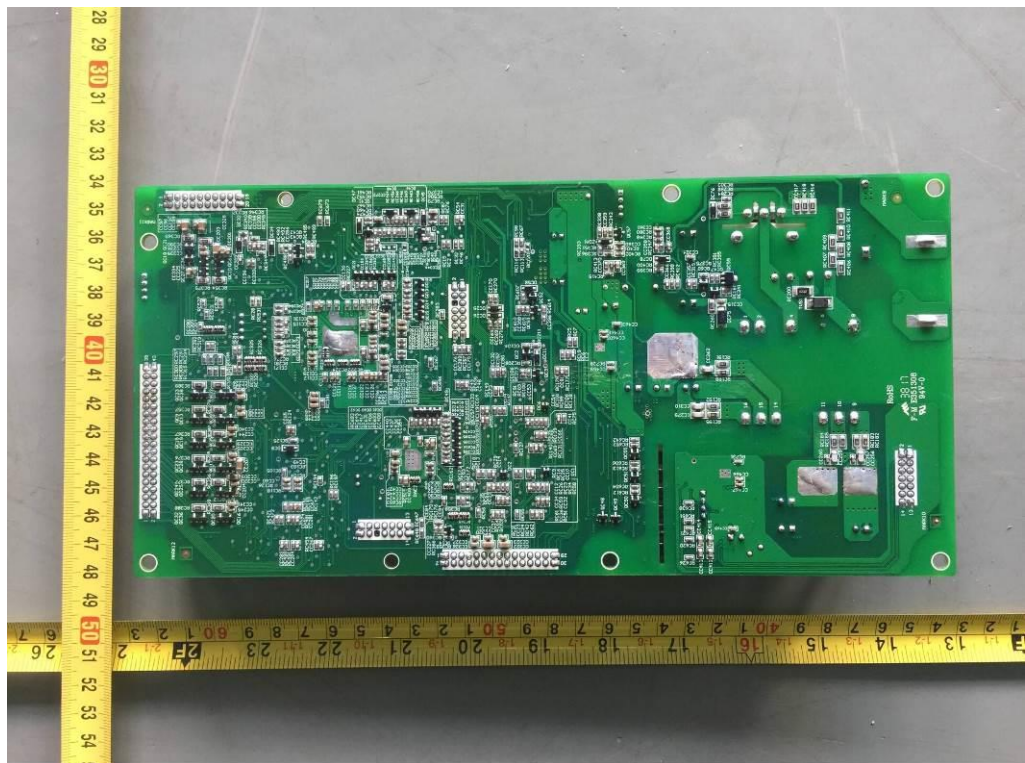
Back View of LCD board



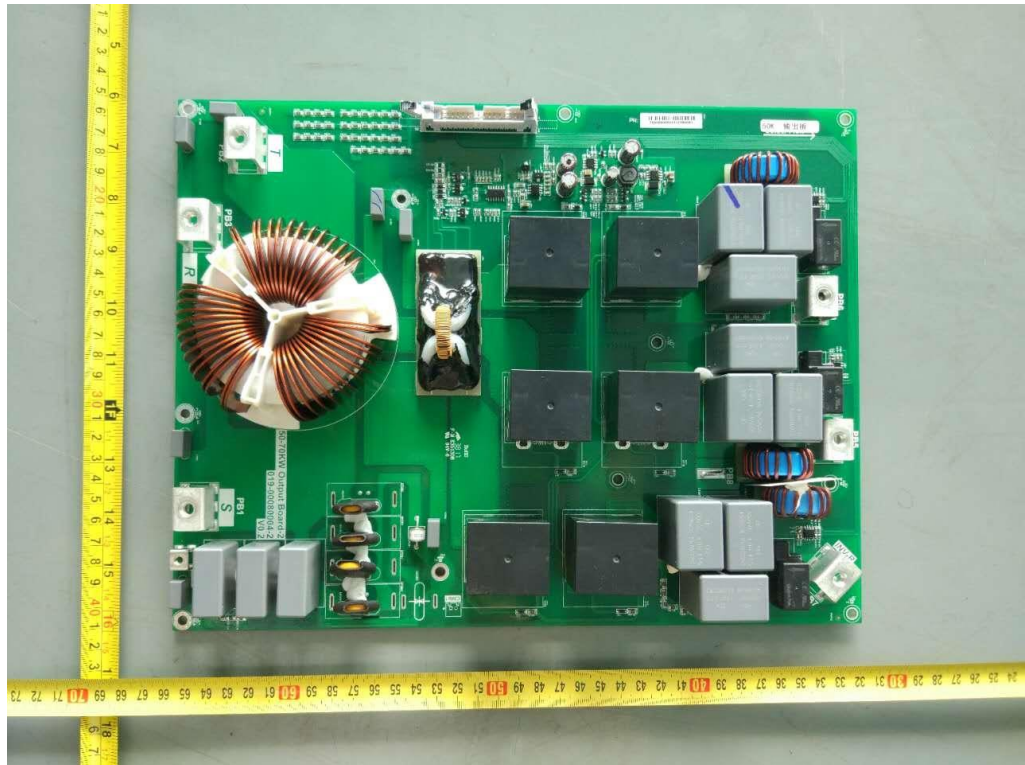
Front View of Control board



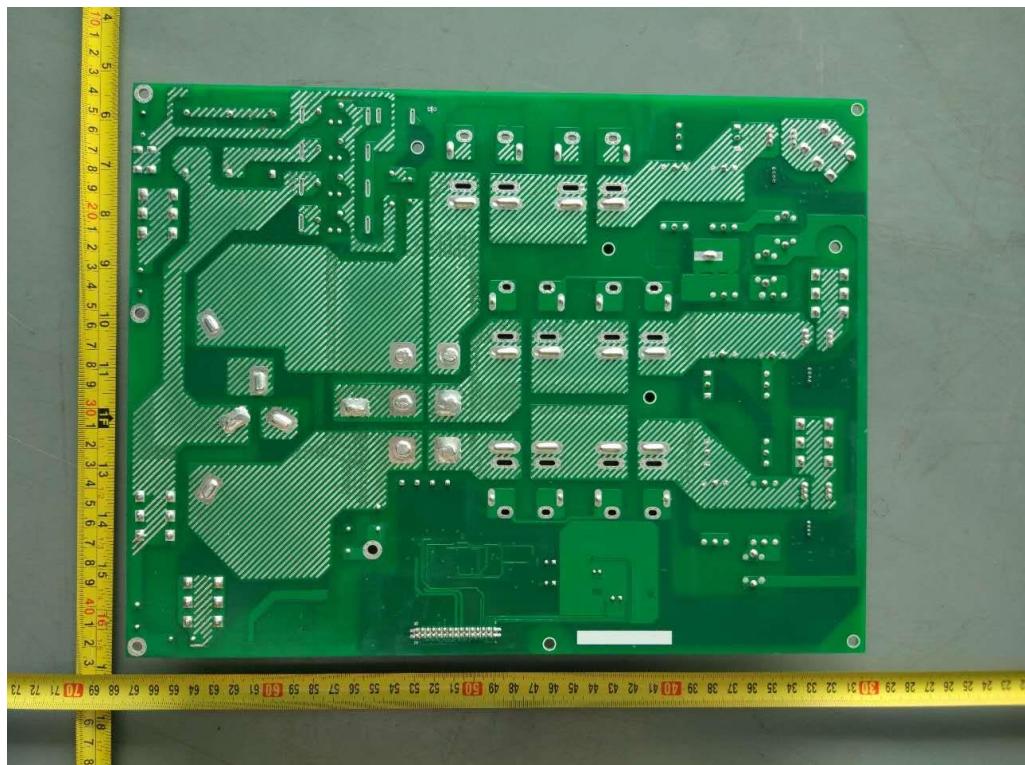
Back View of Control board



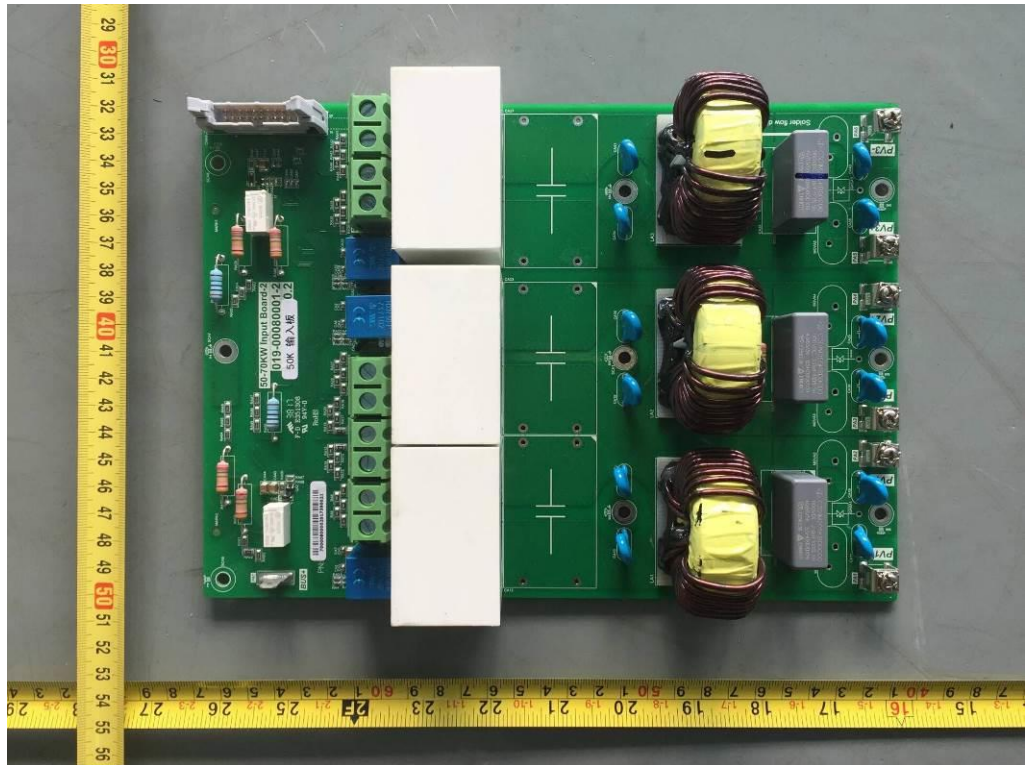
Front View of AC output board



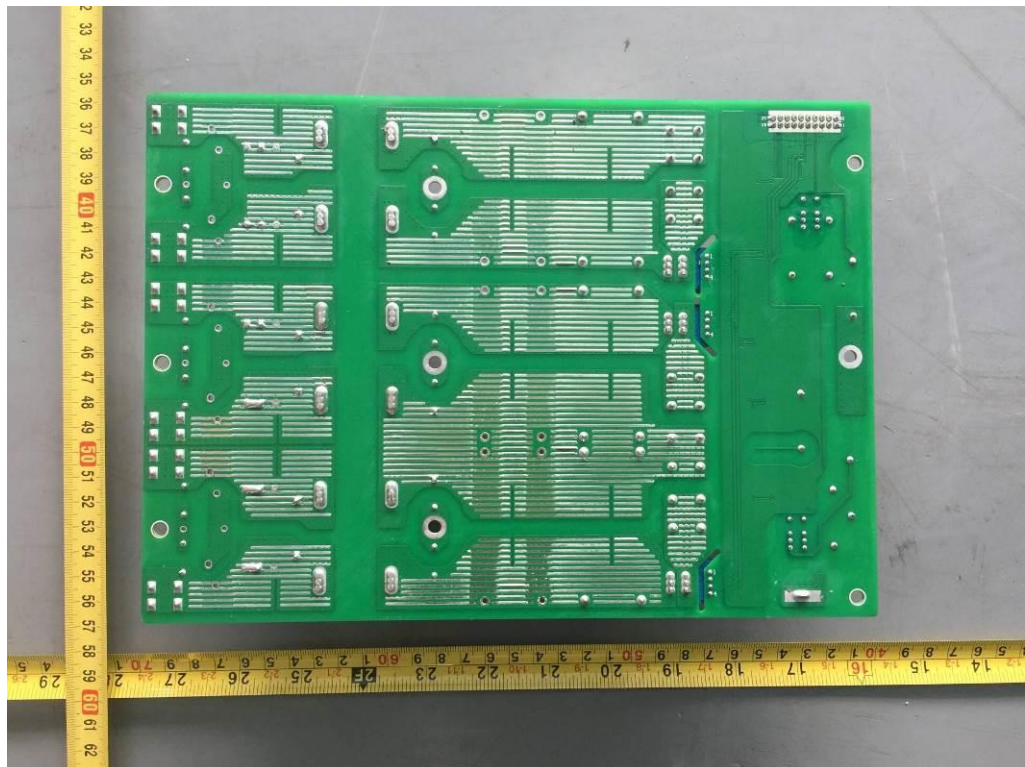
Back View of AC output board



Front View of DC input board

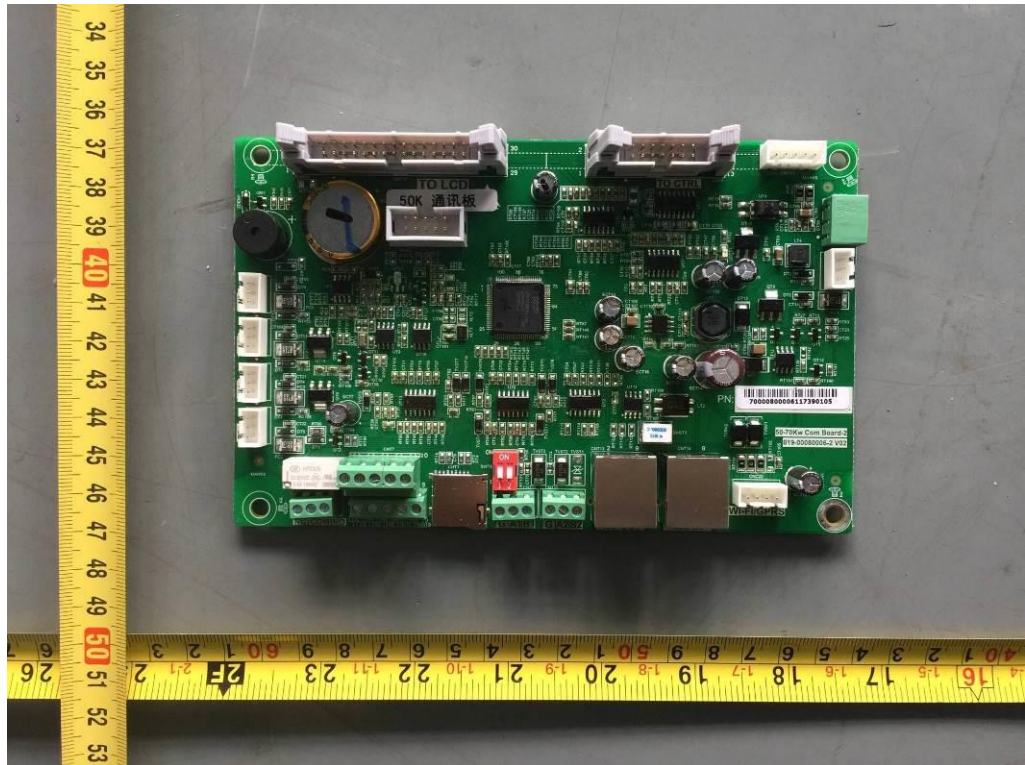


Back View of DC input board

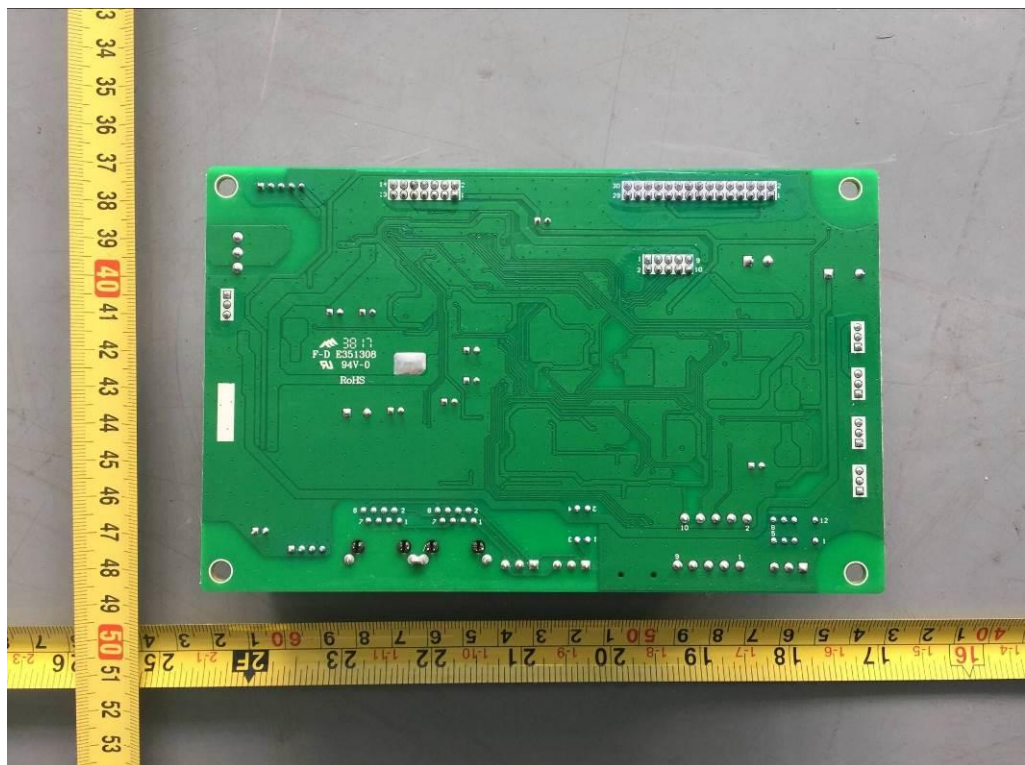


VDE V 0126-1-1: 2013

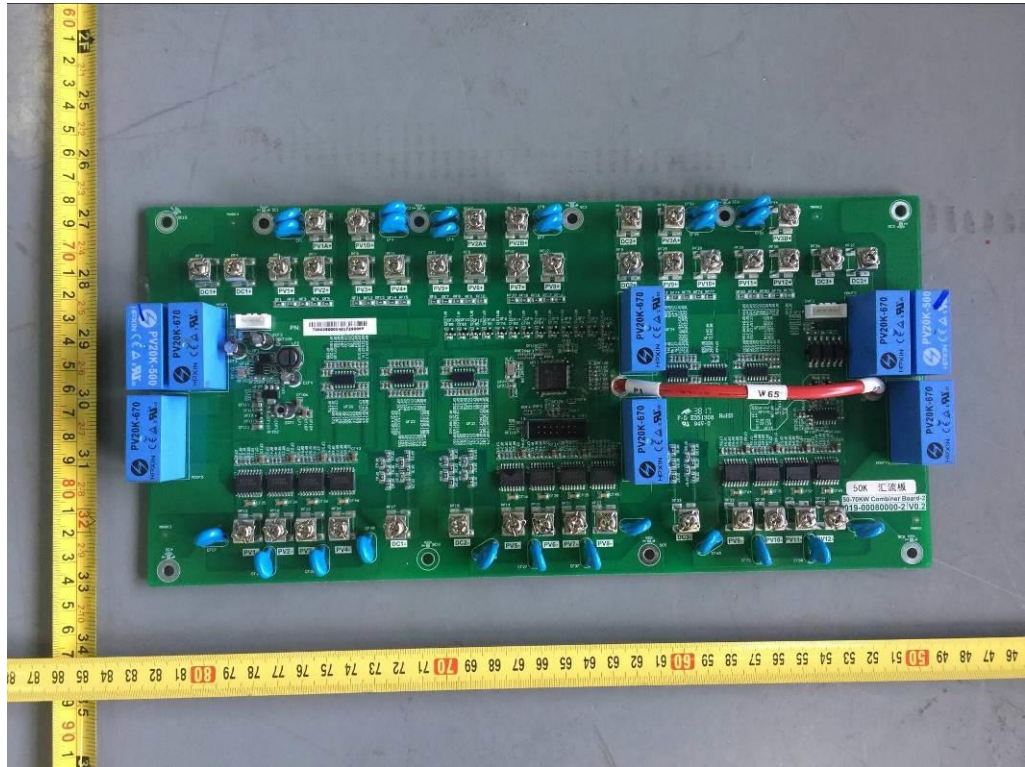
Front View of Communication board



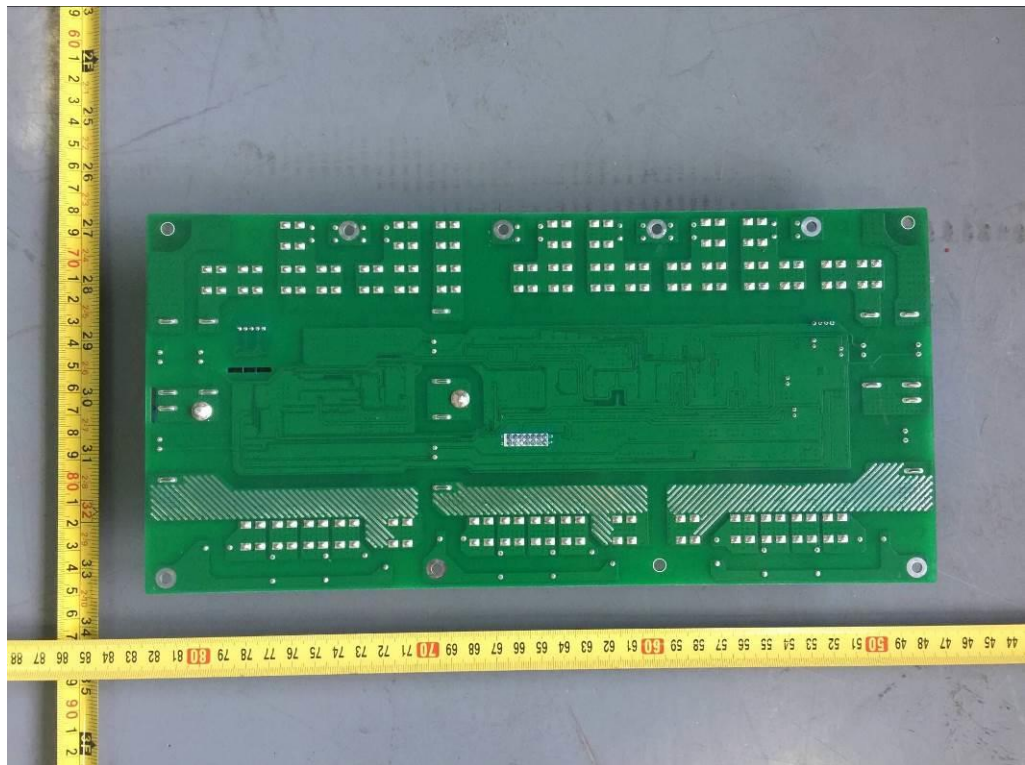
Back View of Communication board



Front View of DC combine board



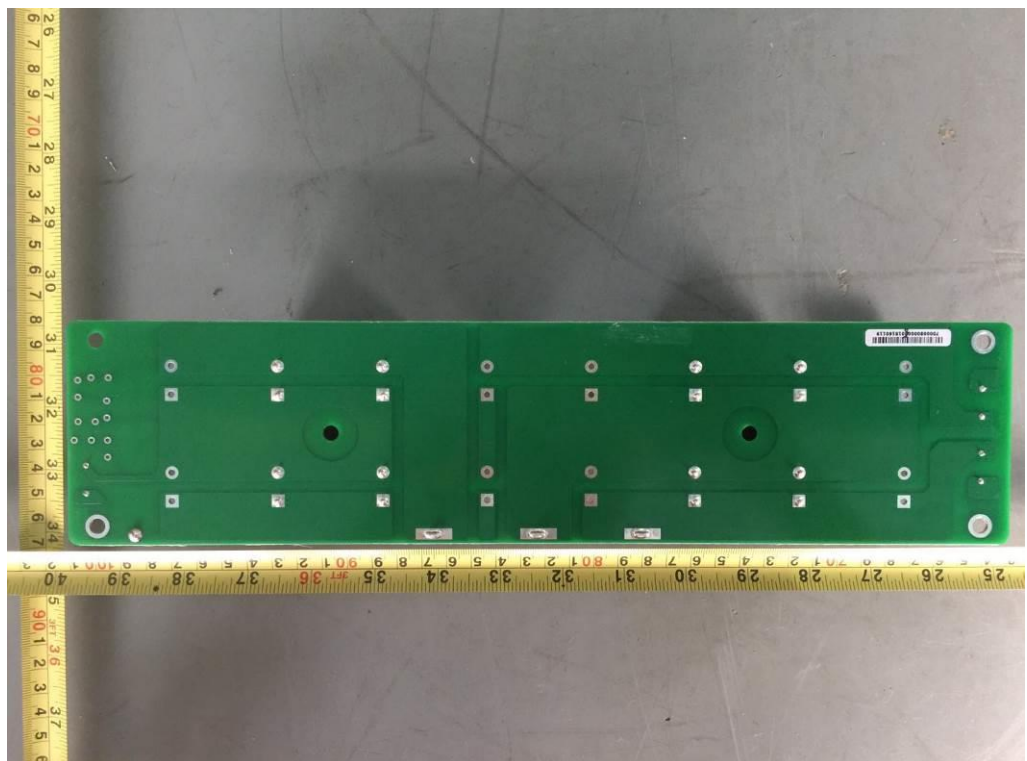
Back View of DC combine board



Front View of Hiverter Si-60K, Hiverter Si-70K Cap. board



Back View of Hiverter Si-60K, Hiverter Si-70K Cap. board

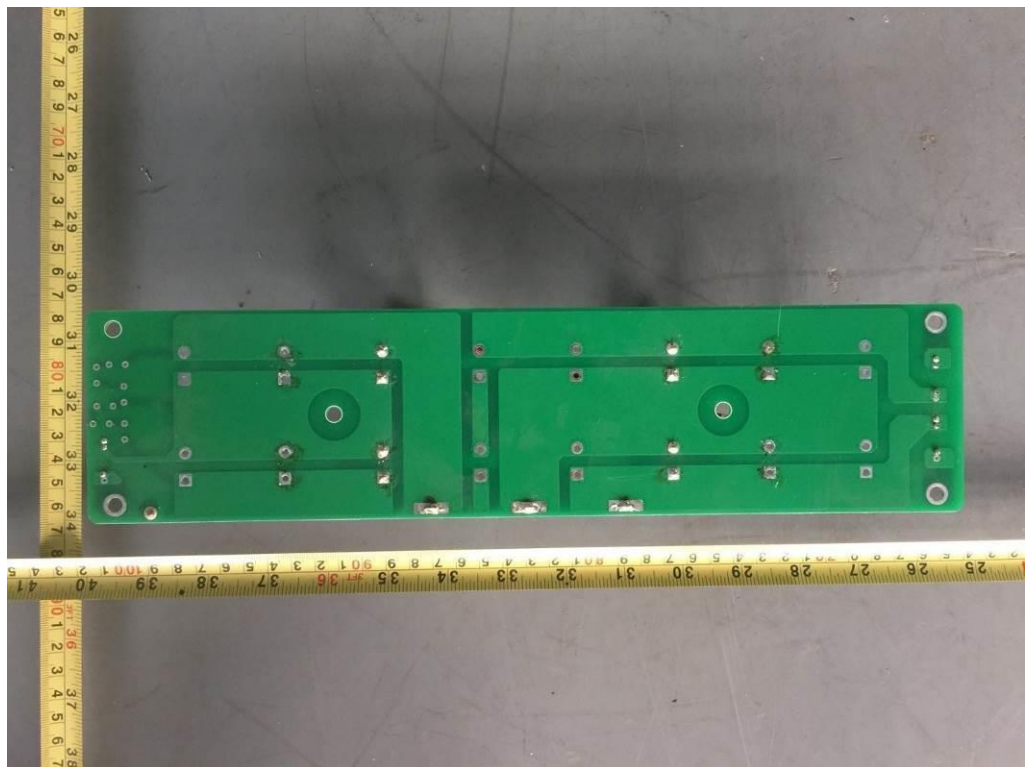


VDE V 0126-1-1: 2013

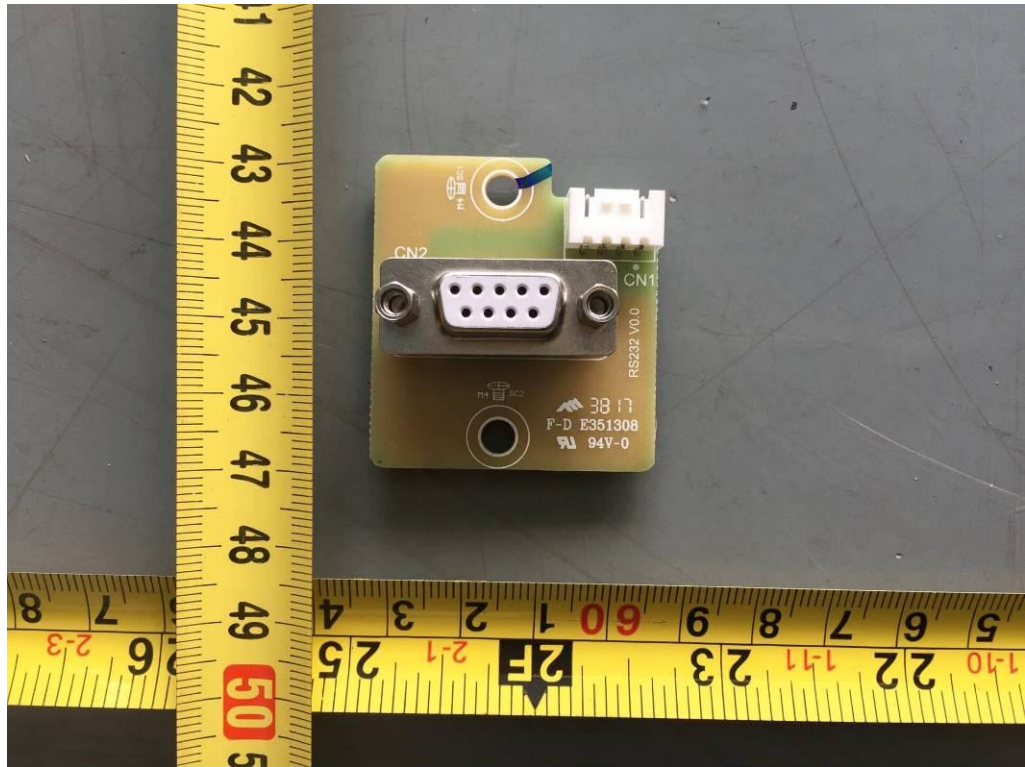
Front View of Hiverter Si-50K Cap. board



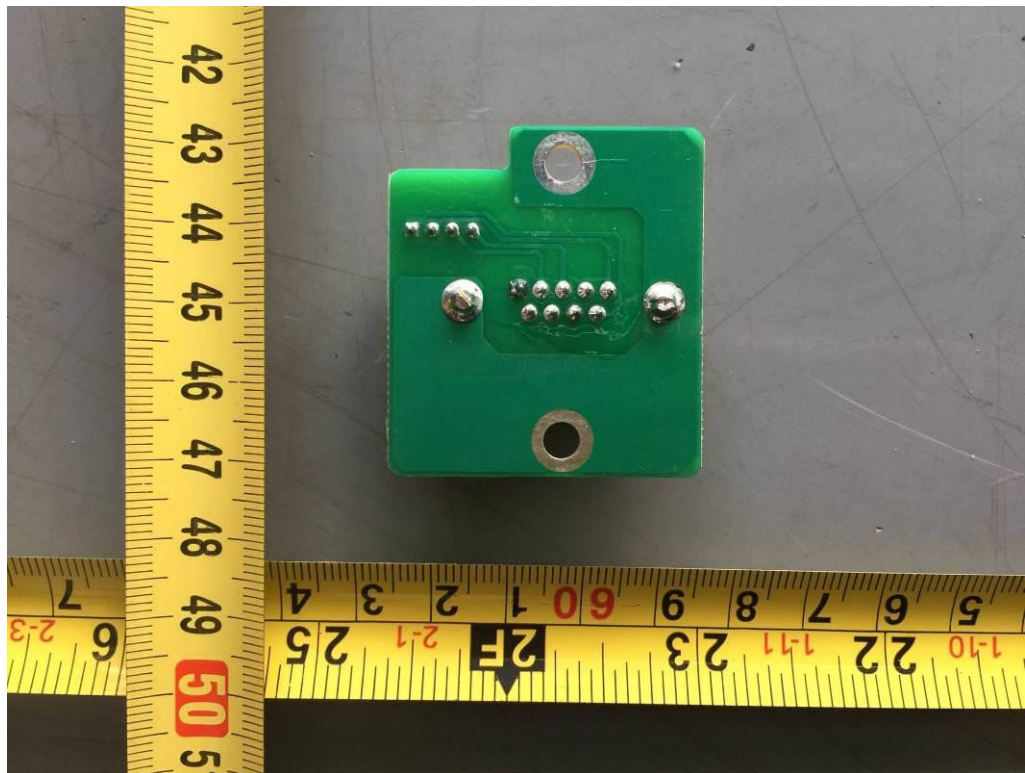
Back View of Hiverter Si-50K Cap. board



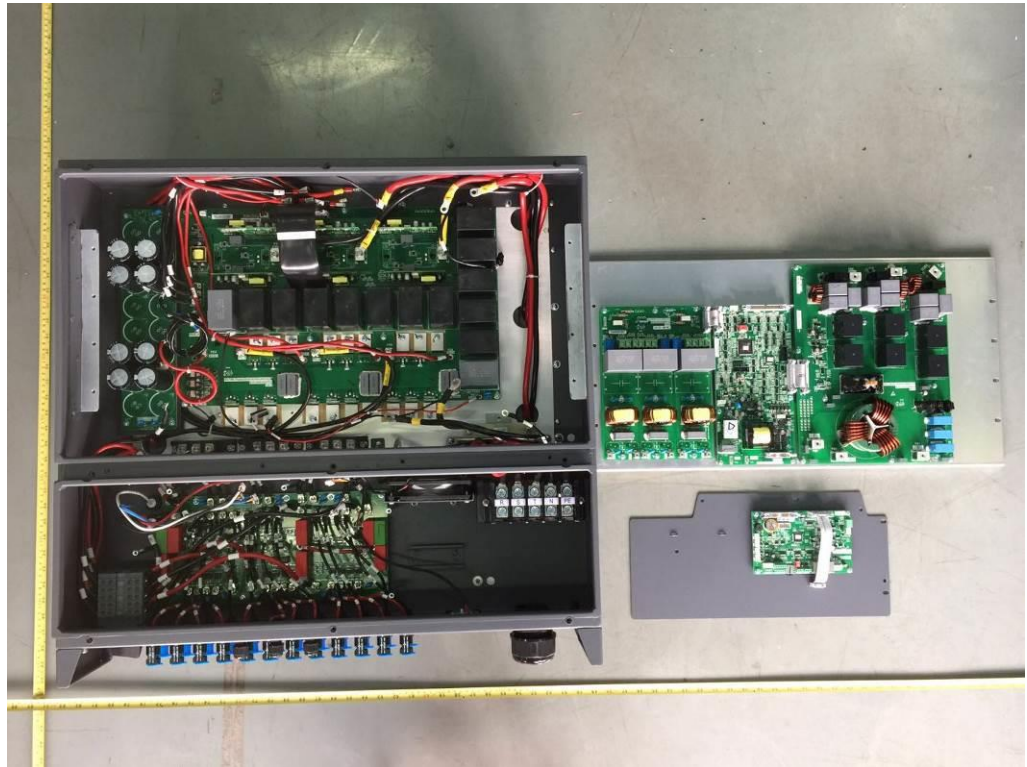
Front View of RS232 board



Back View of RS232 board



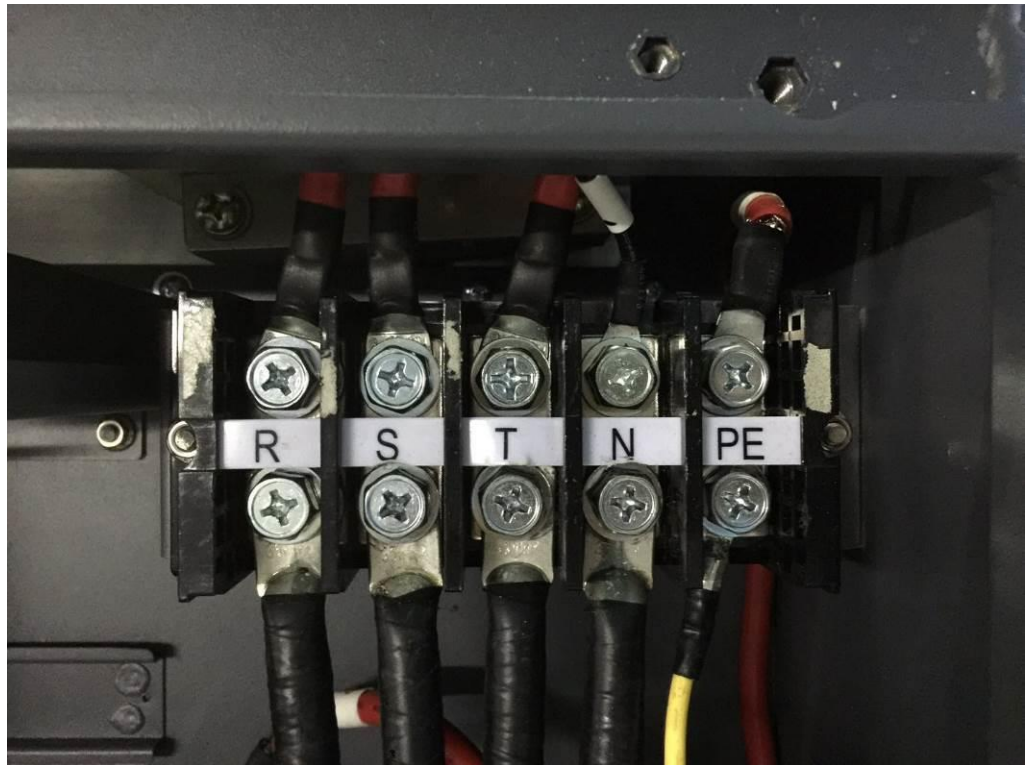
## Internal View



## Connection interface



## AC output connection

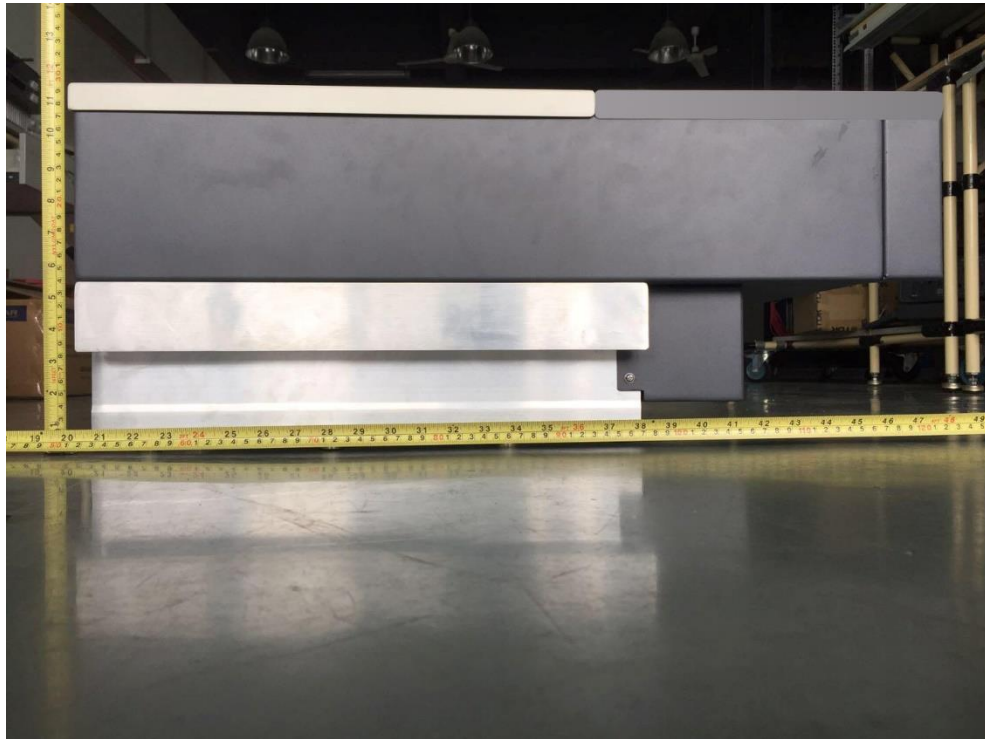


## External Eathing connection terminal



VDE V 0126-1-1: 2013

Side view



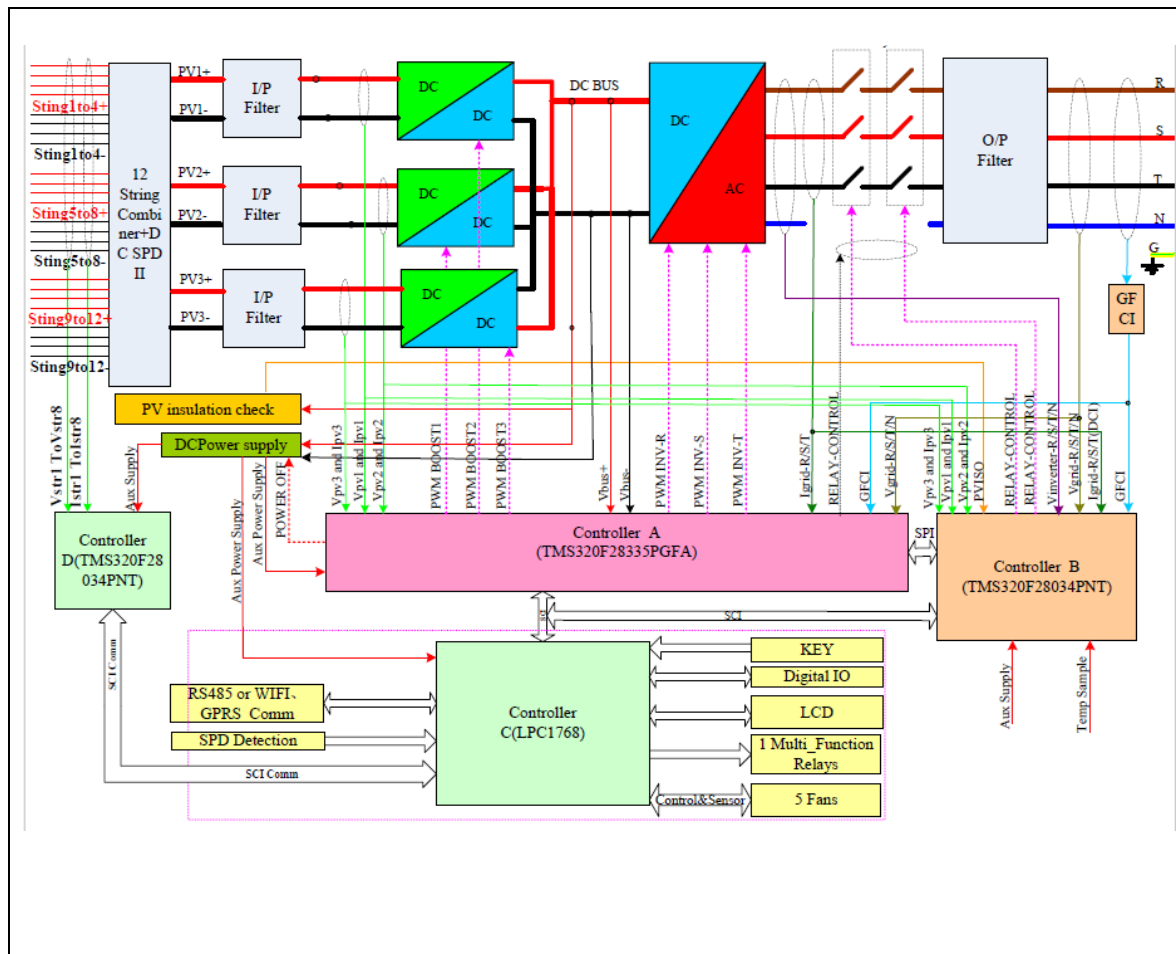
Serial Number: ZJ1ES160HCJ252



Software Version: V2.00



## 8 ELECTRICAL SCHEMES



-----END OF REPORT-----