TEST REPORT

RD1699

Sobre conexión de instalaciones fotovoltaicas a la red de baja tensión

Report reference number ..... :	**PVSP140508N005**
Date of issue ..... ……..:	2014-07-23
Total number of pages ..... ……..:	137
Testing laboratory name ..... :	**Bureau Veritas Shenzhen Co., Ltd. Dongguan Branch**
Address ..... :	No. 34, Chenwulu Section, Guantai Rd., Houjie Town, Dongguan City, Guangdong 523942, China
Applicant's name ..... :	**Shenzhen SOFARSOLAR Co., Ltd.**
Address ..... :	3A-1, Huake Building, East Technology Park, Qiaoxiang Road, Nanshan District, Shenzhen, China.
Test specification	
Standard..... :	RD1699:2011 Nota de interpretación técnica de la equivalencia de la separación galvanica de la conexión de instalaciones Generadoras en baja tension
Zertifikate ..... :	**Certificate of compliance**
Test report form number. ..... :	RD1699
Master TRF ..... :	Bureau Veritas Consumer Products Services Germany GmbH
Test item description..... :	**Grid connected photovoltaic inverter**
Trademark..... :	
Model / Type ..... :	SOFAR 1100TL, SOFAR 1600TL, SOFAR 2200TL, SOFAR 2700TL, SOFAR 3000TL

Ratings .....:	SOFAR 1100TL	SOFAR 1600TL	SOFAR 2200TL	SOFAR 2700TL	SOFAR 3000TL
MPP DC voltage range [V]..... :	110-380	165-380	170-450	210-450	230-450
Input DC voltage range [V]..... :	90-400, max. 450		100-480, max. 500		
Input DC current [A] ..... :	Max.10		Max.13		
Output AC voltage [V] ..... :	230, 50Hz				
Output AC current [A]..... :	Max.4,5	Max.7,0	Max.9,5	Max.11,5	Max.13,0
Output power [W] ..... :	1000	1500	2000	2500	2800

Testing Location ..... :	**Bureau Veritas Shenzhen Co., Ltd. Dongguan Branch**
Address ..... :	No. 34, Chenwulu Section, Guantai Rd., Houjie Town, Dongguan City, Guangdong 523942, China
Tested by (name and signature) ..... :	James Huang 
Approved by (name and signature) ..... :	Corney Zhang 
Manufacturer's name ..... :	**Shenzhen SOFARSOLAR Co., Ltd.**
Factory address ..... :	No. 8, Fulong road, Qingxi town, Dongguan city, Guangdong, China.

Document History			
Date	**Internal reference**	**Modification / Change / Status**	**Revision**
2014-07-23	James Huang	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]..... :	SOFAR 1100TL, SOFAR 1600TL, SOFAR 2200TL: 11kg SOFAR 2700TL, SOFAR 3000TL: 12kg

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 ..... :	2014-05-08
Date(s) of performance of test ..... :	2014-05-08 to 2014-07-15

General remarks:

The test result presented in this report relate only to the object(s) tested. The report shall state compliance of the tested objects with the requirements of Real Decreto RD 1699/2011 (especially article 10, 11, 12, 13, 14, 15, 16) and of Real Decreto RD 661/2007 for aspects not envisaged in the RD 1699/2011.

The test result presented in this report relate only to the object(s) tested.
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"(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 – EMC Test Report
3. Annex No. 2 – Pictures of the unit
4. Annex No. 3 – Test equipment list

Copy of marking plate:

SOFAR SOLAR

PV Grid Inverter	SOFAR 1100TL
Maximum DC input voltage	450V
DC voltage range	90-400V
Maximum DC input current	10A
Maximum PV Isc	12A
Nominal Grid voltage	L/N/PE 230V~
Maximum AC output current	4.5A
Nominal Grid frequency	50Hz
Maximum AC output power	1000W
Power factor	1
Ingress protection	IP65
Operating temperature range	-25-+60°C
Protective class	Class I

Manufacturer: Shenzhen SOFARSOLAR Co., Ltd.
Made in China

VDE0126-1-1,VDE-AR-N 4105,G83/2,EN50438, C10/11,AS4777,RD1699,UTE C15-712-1

SOFAR SOLAR

PV Grid Inverter	SOFAR 1600TL
Maximum DC input voltage	450V
DC voltage range	90-400V
Maximum DC input current	10A
Maximum PV Isc	12A
Nominal Grid voltage	L/N/PE 230V~
Maximum AC output current	7A
Nominal Grid frequency	50Hz
Maximum AC output power	1500W
Power factor	1
Ingress protection	IP65
Operating temperature range	-25-+60°C
Protective class	Class I

Manufacturer: Shenzhen SOFARSOLAR Co., Ltd.
Made in China

VDE0126-1-1,VDE-AR-N 4105,G83/2,EN50438, C10/11,AS4777,RD1699,UTE C15-712-1

SOFAR SOLAR

PV Grid Inverter	SOFAR 2200TL
Maximum DC input voltage	500V
DC voltage range	100-480V
Maximum DC input current	13A
Maximum PV Isc	15A
Nominal Grid voltage	L/N/PE 230V~
Maximum AC output current	9.5A
Nominal Grid frequency	50Hz
Maximum AC output power	2000W
Power factor	1
Ingress protection	IP65
Operating temperature range	-25-+60°C
Protective class	Class I

Manufacturer: Shenzhen SOFARSOLAR Co., Ltd.
Made in China

VDE0126-1-1,VDE-AR-N 4105,G83/2,EN50438, C10/11,AS4777,RD1699,UTE C15-712-1

SOFAR SOLAR

PV Grid Inverter	SOFAR 2700TL
Maximum DC input voltage	500V
DC voltage range	100-480V
Maximum DC input current	13A
Maximum PV Isc	15A
Nominal Grid voltage	L/N/PE 230V~
Maximum AC output current	11.5A
Nominal Grid frequency	50Hz
Maximum AC output power	2500W
Power factor	1
Ingress protection	IP65
Operating temperature range	-25-+60°C
Protective class	Class I

Manufacturer: Shenzhen SOFARSOLAR Co., Ltd.
Made in China

VDE0126-1-1,VDE-AR-N 4105,G83/2,EN50438, C10/11,AS4777,RD1699,UTE C15-712-1

SOFAR SOLAR

PV Grid Inverter	SOFAR 3000TL
Maximum DC input voltage	500V
DC voltage range	100-480V
Maximum DC input current	13A
Maximum PV Isc	15A
Nominal Grid voltage	L/N/PE 230V~
Maximum AC output current	13A
Nominal Grid frequency	50Hz
Maximum AC output power	2800W
Power factor	1
Ingress protection	IP65
Operating temperature range	-25-+60°C
Protective class	Class I

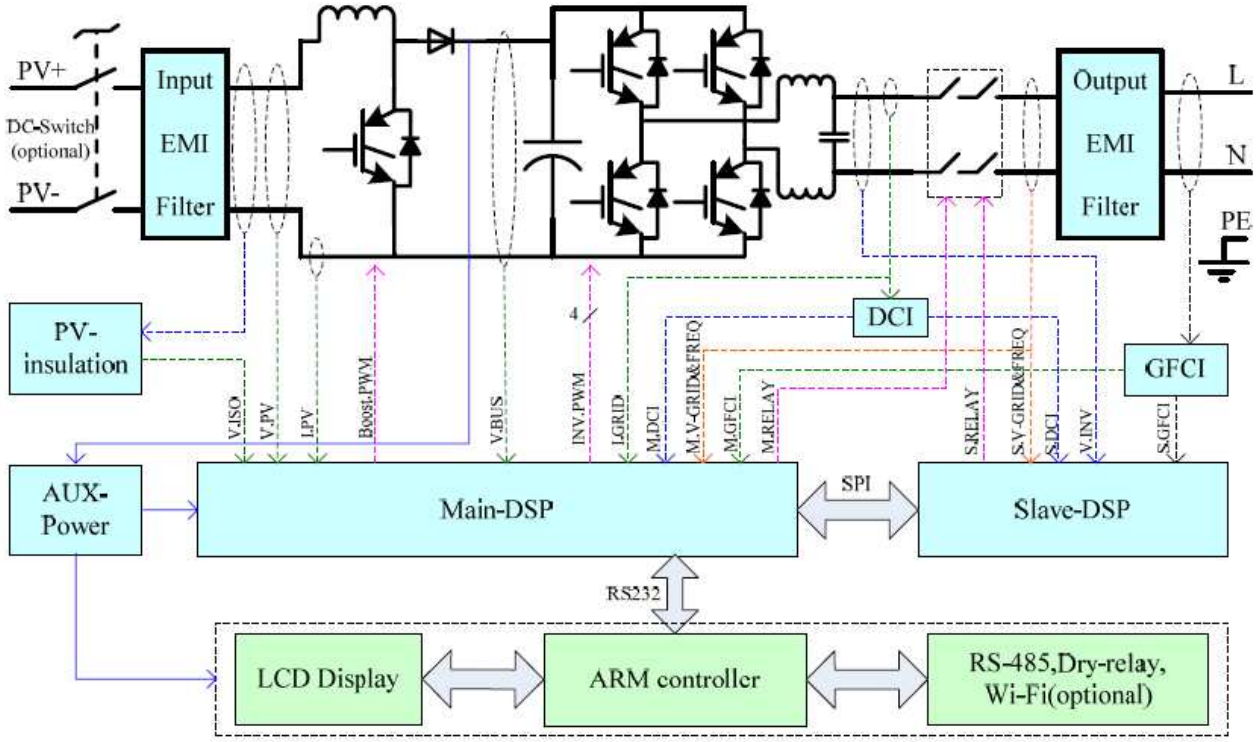
Manufacturer: Shenzhen SOFARSOLAR Co., Ltd.
Made in China

VDE0126-1-1,VDE-AR-N 4105,G83/2,EN50438, C10/11,AS4777,RD1699,UTE C15-712-1

General product information:

The Solar converter converts DC voltage into AC voltage.

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



The internal control is redundant built. It consists of Microcontroller Master DSP (UC34) and Slave DSP (UC35).

The Master DSP control the relays (RYP2-RYP5) by switching signals; measures the PV voltage, PV current, Bus voltage, grid voltage and frequency, AC current with injected DC and the array insulation resistance to ground. In addition it tests the current sensors and the RCMU circuit before each start up.

The Slave DSP (UC35) is measures the grid voltage, AC current, grid frequency and residual current, also can switch off the relays (RYP2-RYP5) independently, and communicate with Master DSP (UC34) each other.

The current is measured by a current sensor. The AC current signal and the injected DC current signal are sent to the Master DSP (UC34). The Master DSP (UC34) tests and calibrates before each start up all current sensors.

The unit provides two relays in series in all output 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 each start up.

Differences of the models

The models SOFAR 1100TL, SOFAR 1600TL, SOFAR 2200TL, SOFAR 2700TL and SOFAR 3000TL are same as in hardware except the components are in the difference table. Identical in software the output power just adjusted by software.

Difference table					
	SOFAR 1100TL	SOFAR 1600TL	SOFAR 2500TL	SOFAR 2700TL	SOFAR 3000TL
Boost inductor	2,6mH	2,6mH	1,9mH	1,9mH	1,9mH
Resistor (RP105, RP108 /RP189,RP109)	220ohm / 10Kohm	220ohm / 10Kohm	200ohm / 7,5Kohm	200ohm / 7,5Kohm	200ohm / 7,5Kohm
BUS capacitor (ECP1, ECP2, ECP3, ECP4)	2 pcs	2 pcs	3 pcs	3 pcs	3 or 4 pcs
Inverter inductor	3,4mH	2,3mH	2,1mH	1,5mH	1,3mH
Resistor (RP118, RP119, RC18 /RP120, RP121,RC22)	499 Ω, 200 Ω, 200 Ω	1 KΩ, 200 Ω, 100 Ω	1 KΩ, 330 Ω, 330 Ω	2 KΩ, 100 Ω, 100 Ω	2 KΩ, 100 Ω, 100 Ω
DC switch and Wi-Fi module are optional.					

The product was tested on:
Hardware version: V1.00
Software version: V1.00

Test report

RD 1699/2011			
Clause/§	**Requirement:**	**Remark:**	**Verdict**
	CHAPTER III **Technical conditions of the facilities** **CAPÍTULO III** **Condiciones técnicas de las instalaciones**		
	Article 10. Obligations of the facility owner **Artículo 10. Obligaciones del titular de la instalación**		
		Article 10 is not part of this inspection. The facility owner is responsible in this case.	**N/A**
	Article 10. Connection conditions **Artículo 11. Condiciones técnicas de carácter general**		
1	The operation of the facilities shall cause no failures, reduced safety conditions or alterations above those admitted by the applicable legislation in the network. Likewise, the operation of such facilities shall not give rise to dangerous working conditions for the employees responsible for maintaining and operating the supply network.	Must be taken under consideration at the installation of the units.	**N/A**
2	In the event that the supply line is disconnected from the network, either due to maintenance work requested by the supply company or because a protective element has been activated in the line, the power in the facility's supply line shall be cut off.	The unit provides an integrated automatic disconnection device which opens in case of loss of voltage and frequency. See appended table.	**P**
3	For the purpose of establishing the connection point to the supply network, the following criteria shall be considered, which are set out in Annexe I of this Royal Decree.	See Annexe I.	**N/A**
4	No generation element other than the authorised facility or a storage element may be included between the generation circuit and the measuring equipment.	Must be observed by the installation. Not part of this inspection.	**N/A**
5	In the event of a facility being affected by disruptions in the supply network, the current legislation on service quality shall apply.	Considered.	**P**
	Article 12. Connection conditions **Artículo 12. Condiciones de conexión**		

RD 1699/2011			
Clause/§	**Requirement:**	**Remark:**	**Verdict**
1	The connection diagrams shall respond to the principle of reducing leaks in the system, favouring the maintenance of safety and quality in supply and enabling work to be carried out by blocks on own electricity consumption, without supplying other network users. The connection configurations shall ensure the reliability of the energy measurements generated and consumed.	Must be taken under consideration at the installation of the units.	**N/A**
2	If the nominal power of the generation facility to be connected to the supply network is more than 5 kW, connection of the facility to the network shall be three-phase with an imbalance between phases of less than 5 kW.	The inverter has a max. power of 5kW. No imbalance possible. Due to the construction of the inverter, no imbalance of 5kW or more is possible.	**P**
3	The contribution of the generators to increasing or decreasing voltage in the low or medium voltage supply line between the transformation centre or substation of origin in which the voltage is regulated and the connection point, in the least favourable scenario, shall be no more than 2.5 per cent of the nominal low or medium voltage current, whichever applies.	Must be taken under consideration at the installation of the units.	**N/A**
4	The power factor of the energy supplied to the supply company network shall be as close as possible to the unit value and in all cases, greater than 0.98 if the facility is operating at powers of over 25 per cent of its nominal power.	See appended test table.	**P**
Article 13. Specific conditions for connection in internal networks **Artículo 13. Condiciones específicas para la conexión en redes interiores**			
1	The connection shall be made at the point of the internal network owned that is closest to the general protection box, such that it allows both facilities to be isolated simultaneously from the electrical system. In the event that the supply network connection is high voltage and there is a transformation station owned by the consumer, the connection from the production facility shall be made in the low voltage output control panel of the transformer.	Must be taken under consideration at the installation of the units.	**N/A**
2	The owner of the internal network shall be the same for all the consumption equipment and generation facilities connected in that network. In this case, a note shall be made in the margin of the final registration of the production facility in the regional registry and in the Government registry of power generation facilities that is attached to the Directorate General of Energy Policy and Mines.	Must be taken under consideration at the installation of the units.	**N/A**

RD 1699/2011			
Clause/§	**Requirement:**	**Remark:**	**Verdict**
3	Power generation facilities connected to an internal network may not have powers that exceed 100 kW and in all cases, they shall not exceed the available capacity at the connection point to the supply network or the power assigned to the supply.	Must be taken under consideration at the installation of the units.	**N/A**
Article 14. Protections **Artículo 14. Protecciones**			
1	Regarding the protection system, in the case of any aspect not envisaged in the present Royal Decree, it shall comply with the terms of Royal Decree 661/2007 of 25 May 2007 and the respective operating procedures, the requirements set forth in current legislation, and in particular, with the Low Voltage Electrotechnical Regulations approved by Royal Decree 842/2002 of 2 August 2002, the Regulations governing technical conditions and assuring safety in electric power stations, substations and transformation stations, approved by Royal Decree 3275/1982 of 12 November 1982 and the Regulations governing technical conditions and assuring safety in high voltage lines, approved by Royal Decree 223/2008 of 15 February 2008. Such compliance shall be proved in sufficient measure in the documentation related to the characteristics of the facility to which reference is made in article 4, including the following:	Considered.	**P**
	a) A general cut-off element that provides the insulation required by Royal Decree 614/2001 of 8 June 2001, on minimum requirements for protecting the safety and health of workers from electrical risks. Eventually, the functions of the cut-off element may be covered by another device of the generation facility, which provides the indicated insulation between generator and network.	This is not part of the above mentioned inverter and shall be installed externally. An external over-current circuit breaker is required providing the according protection of the branch circuit. This is stated in the manual	**P**
	b) An automatic differential switch to protect people in the event of a shunt of any element to ground.	The inverter provides a residual current monitoring unit to detect and disconnect in case of an earth fault.	**P**

RD 1699/2011			
Clause/§	**Requirement:**	**Remark:**	**Verdict**
	c) An automatic connection switch for automatic disconnection-connection of the facility in the event of a network voltage or frequency anomaly, together with a locking relay. Eventually, the function of this switch may be performed by the switch or switches of the generator equipment. Eventually, the functions of the automatic connection switch and general cut-off switch may be performed by the same device.	The unit provides an integrated automatic disconnection device which opens in case of loss of voltage and frequency. See appended table.	**P**
	d) Maximum and minimum frequency connection protections and maximum and minimum voltage between phases as indicated in table 1 (RD 1699/2011), where the low voltage proposal is generalised for all other levels. In insular and extra-peninsular electrical systems, the above values shall be the ones indicated in the respective operating procedures. The voltage for measuring these values shall be taken from the network side of the general automatic switch for high voltage facilities or the main switches of the generators in low voltage networks. In the event of activating the maximum frequency protection, reconnection shall only be made when the frequency reaches a value that is less than or equal to 50 Hz.	Upper frequency: 50,5 Hz Lower frequency: 48,0 Hz Upper voltage (stage 2): Un +15% Upper voltage (stage 1): Un +10% Lower voltage: Un -15% Automatic reconnection after at least 180s according to IEC 61727:2001 once the grid conditions are within the limits of clause d) See appended tables.	**P**
	e) In addition, for voltages greater than 1 kV and up to 36 kV inclusive, the disconnection criteria for maximum homopolar voltage shall be added.	The inverter is designed for connection to the low voltage grid.	**P**
2	These protections may act on the general switch or on the switch or switches of the equipment or generators.	The unit provides an integrated automatic disconnection device which opens in case of an error.	**P**
3	The protections shall be sealed by the supply company, after the necessary checks on the switching system and on the integration of the protection functions into the generator equipment.	The values can be changed by authorised staff and are protected by password	**P**
4	In the event that the generator or inverter equipment have the above-described protections, these shall comply with current legislation, and in particular, the Low voltage electrotechnical regulations, approved by Royal Decree 842/2002 of 2 August 2002, the Regulations governing technical conditions and safety assurance in electric power stations, substations and transformation stations, approved by Royal Decree 3275/1982 of 12 November 1982 and the Regulations governing technical conditions and safety assurance in high voltage electrical lines, approved by Royal Decree 223/2008 of 15 February 2008, for facilities operating parallel to the supply network. In this case, there is no need for the protections to be duplicated.	Considered.	**P**

RD 1699/2011			
Clause/§	**Requirement:**	**Remark:**	**Verdict**
Article 15. Conditions for grounding the facilities **Artículo 15. Condiciones de puesta a tierra de las instalaciones**			
1	Grounding of interconnected facilities shall in all cases be done in such a way that the supply company network grounding conditions are not altered, ensuring that no faults are transferred to the supply network.	Must be taken under consideration at the installation of the units.	**N/A**
2	The facility shall have a galvanised separation between the supply network and the generator facilities, either by means of an insulation transformer or any other element that fulfils the same purpose, pursuant to the applicable industrial safety and quality regulations.	The inverter provides a residual current monitoring unit to detect and disconnect in case of an earth fault.	**P**
3	The earth connections of the generation facility shall be connected to a ground connection that is separate from the supply company neutral connection and comply with the indications set out in the applicable current industrial safety and quality regulations.	Must be taken under consideration at the installation of the units.	**N/A**
Article 16. Harmonics and electromagnetic compatibility **Artículo 16. Armónicos y compatibilidad electromagnética**			
	Emission (EN 61000-6-3) and Immunity (EN 61000-6-2) requirements have to be conform according to the respective actual and valid standards. Harmonics have to be conform according to EN 61000-3-2 (-3-12 for >16A/phase). The voltage fluctuations due to connection/disconnection to the public grid of less than 5%. This is covered by Flicker according to EN 61000-3-3 (-3-11 for >16A/phase)	See appened EMC Test report.	**P**
ANNEX I **Criteria for determining the maximum available power rating connection to determine the maximum rated power connection available, shall address the following criteria:** **ANEXO I** **Criterios para la determinación de la potencia nominal máxima disponible de conexión Para determinar la potencia nominal máxima disponible de conexión, se atenderá a los siguientes criterios:**			
1	For installations connect to a network point exceeding 1 kV (either directly or through a network installation of interior):		**N/A**

RD 1699/2011			
Clause/§	**Requirement:**	**Remark:**	**Verdict**
	a) The maximum rated power available at the connection point of a line is calculated as half the carrying capacity of the line at that point, defined as heat capacity of the line design at the point, less the sum of the powers of production facilities connected or existing connection point on the line.	Must be taken under consideration at the installation of the units.	**N/A**
	b) In the event that the connection point is a center of transformation, maximum rated power available at that point is calculated as half of the installed processing capacity for that level of voltage minus the sum of the powers of production facilities connected or connection point force at the center.	Must be taken under consideration at the installation of the units.	**N/A**
2	For installations connect to the network exceeding 1 kV but not exceeding 36 kV (either directly or through a network installation of interior):		**N/A**
	a) The maximum rated power available at the connection point is calculated as the power that can be injected at that point, taking into account the production facilities and connected to existing connection point and the simultaneous minimum consumption forecast.	Must be taken under consideration at the installation of the units.	**N/A**
	b) The methodology for calculating the expected simultaneous minimum consumption is set to the corresponding distribution operation procedure. As long as they are not under the above methodology, is taken as the minimum consumption data recorded simultaneously provided the minimum demand and in the absence of this, consider the 10 percent of the peak power of the processing.	Must be taken under consideration at the installation of the units.	**N/A**

RD 1699/2011		
Article	**Test**	**Result**
12	**Connection conditions:**	
	Power factor	**P**
14	**Protections:**	
	Monitoring of voltage	**P**
	Monitoring of frequency	**P**
	Reconnection condition over frequency	**P**
	Isolation measurement	**P**
	Monitoring of DC-injection	**P**
	Residual current monitoring	**P**
Additional requirements of DIN V VDE V 0126-1-1:2006-02 are fulfilled:		
6.1 (4.1)	Functional safety (Redundancy)	**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	**P**

Test Results

Article 12. Connection conditions **Power factor**				**P**
SOFAR 1100TL				
Test conditions:	Udc = 350Vdc			
Output power (kW) / **Test voltage (Vac)**	**~25 %** **0,25 kW**	**~50 %** **0,5 kW**	**~75 %** **0,75 kW**	**~100 %** **1 kW**
230 V	0,990	0,998	0,999	0,999
SOFAR 3000TL				
Test conditions:	Udc = 450Vdc			
Output power (kW) / **Test voltage (Vac)**	**~25 %** **0,7 kW**	**~50 %** **1,4 kW**	**~75 %** **2,1 kW**	**~100 %** **2,8 kW**
230 V	0,992	0,998	0,999	0,999

Note:
The power factor of the energy supplied to the supply company network shall be as close as possible to the unit value and in all case, greater than 0,98 if the facility is operating at powers of over 25 per cent of its nominal power.

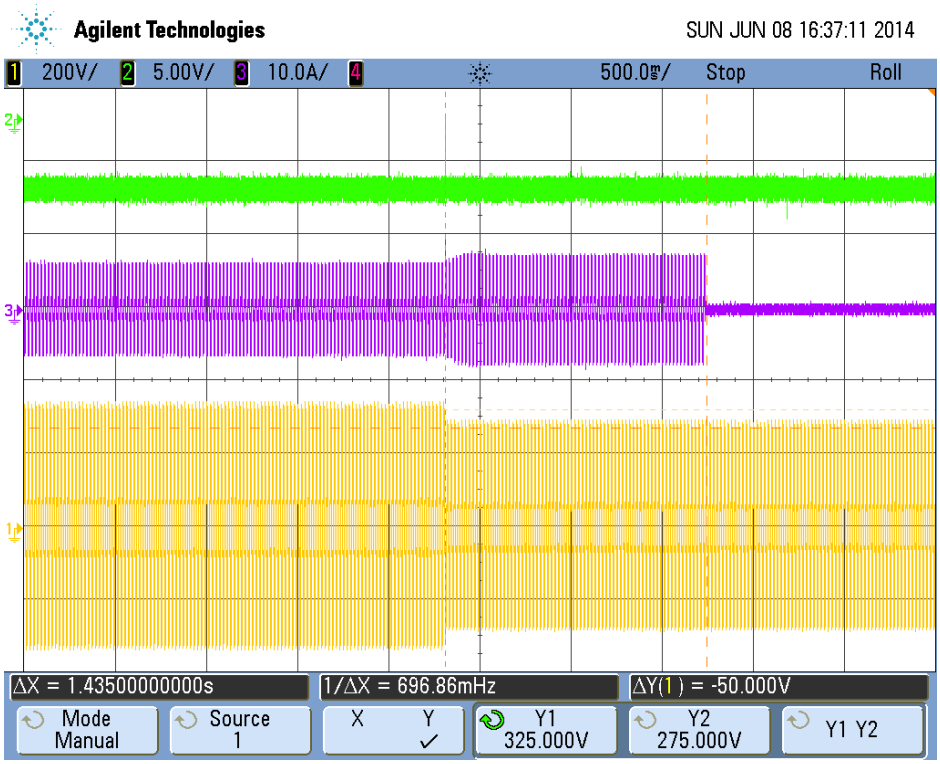
The tests had been performed on the SOFAR 3000TL is valid for the SOFAR 1100TL, SOFAR 1600TL, SOFAR 2200TL and SOFAR 2700TL, since it is same as in hardware and just power derated by software.

Article 14. Protections **Voltage monitoring**									**P**
Test conditions:	Udc=360V Idc=2,76A Pac=967W fac=50Hz								
	under voltage				**over voltage (stage 1)**				
Parameter	Voltage	Time [ms]			Voltage	Time [ms]			
Limit	**195,5 V**	**<= 1500 ms**			**253,0 V**	**<= 1500 ms**			
Trip value	195,1V				253,2V				
Disconnection time	198V to 192V	1441	1418	1430	250V to 256V	1415	1424	1432	
	230V to 192V	1431	1435	1,432	230V to 256V	1430	1440	1440	
Reconnection time:	**>=180 s**	194s			**>=180 s**	194s			
	--				**over voltage (stage 2)**				
Parameter	--				Voltage	Time (ms)			
Limit	**--**				**264,5 V**	**<= 200 ms**			
Trip value	--				264,4V				
Disconnection time	--				250V to 267V	193	181	178	
	--				230V to 267V	174	181	192	
Reconnection time:	--				**>=180 s**	194s			

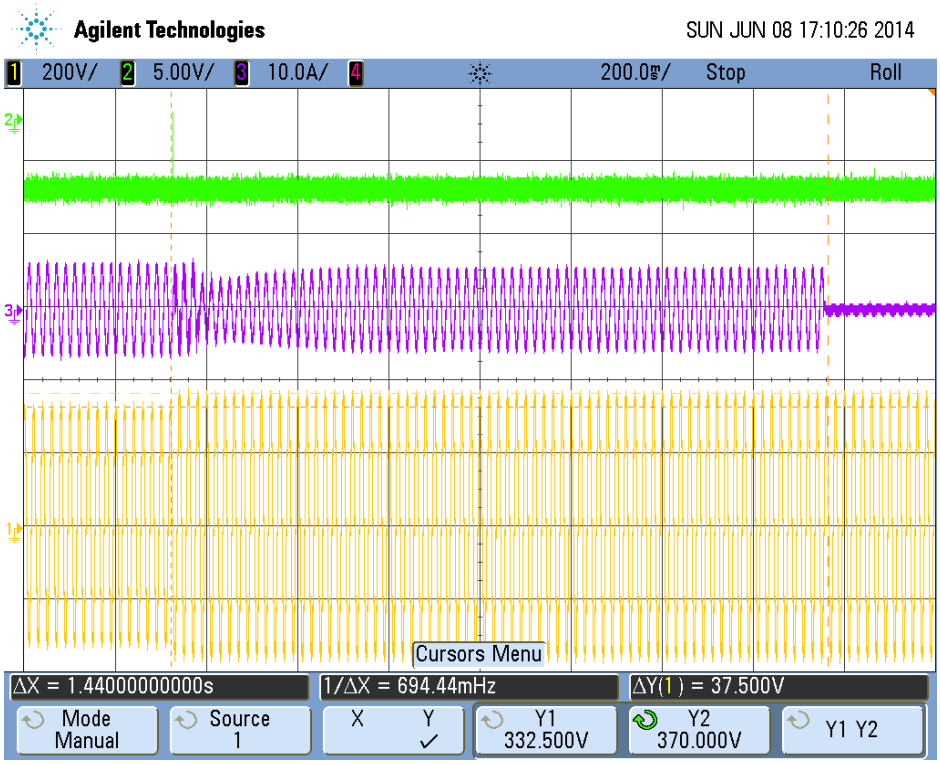
Note:
The maximum and minimum voltage connection protection must be set to Un +10% (stage 1), Un +15% (stage 2) and Un -15%. The accuracy for the voltage measurement must be in a range of +/-2,3V (1% $U_{nom.}$).

The tests had been performed on the SOFAR 3000TL is valid for the SOFAR 1100TL, SOFAR 1600TL, SOFAR 2200TL and SOFAR 2700TL, since it is same as in hardware and just power derated by software.

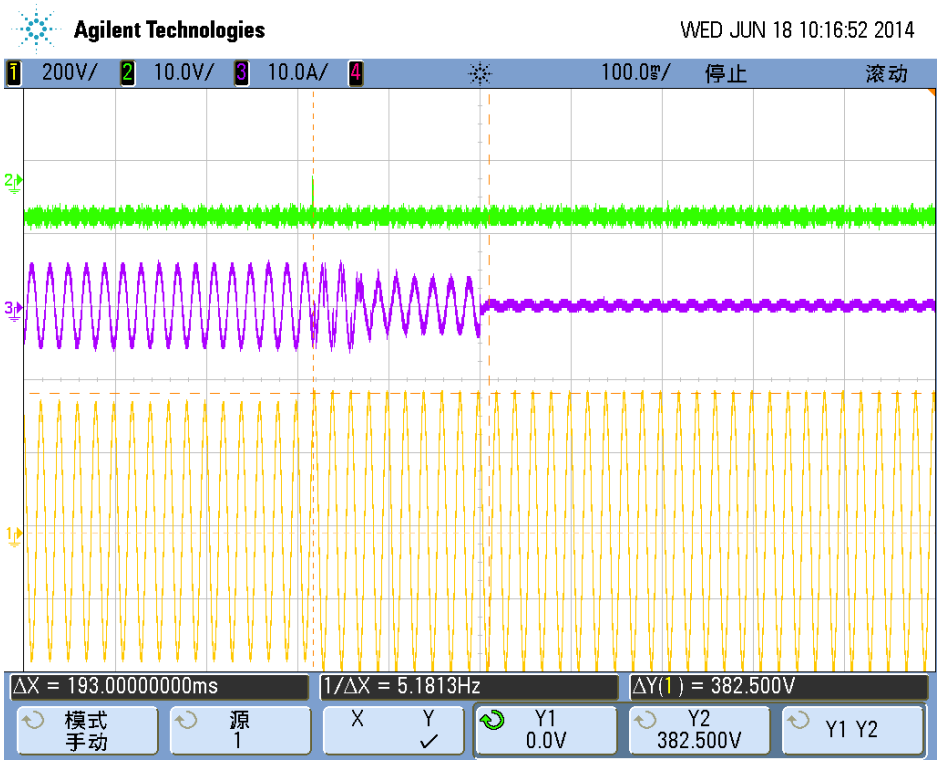
under voltage:



over voltage (stage 1):



over voltage (stage 2):



Article 14 Protections **Frequency monitoring RD1699**	**P**

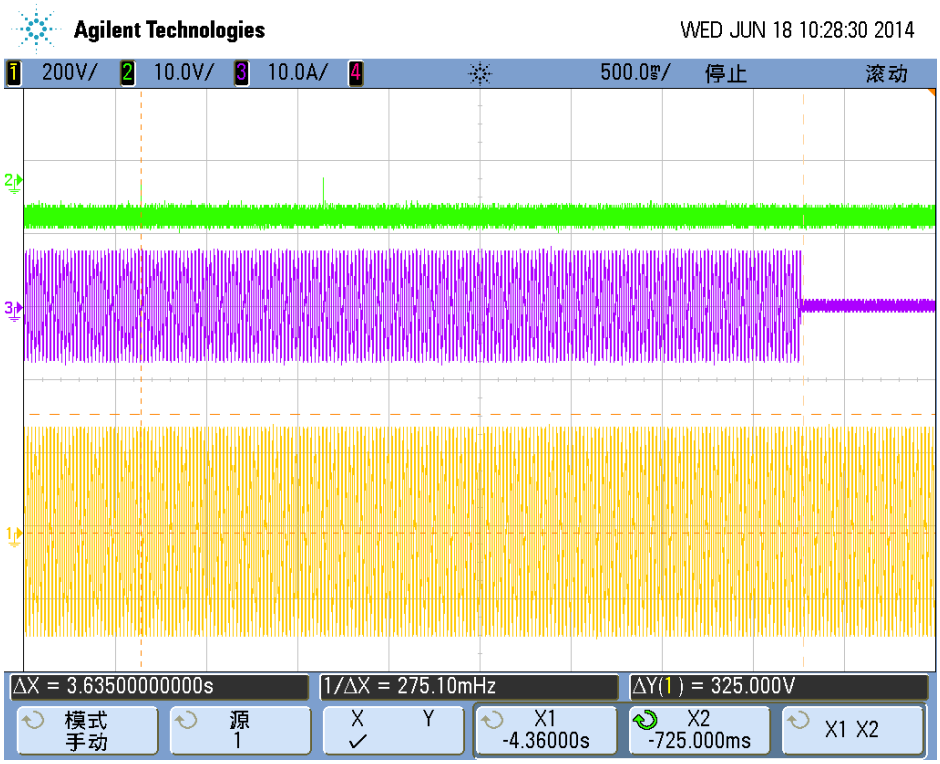
Test conditions:	Udc=360V Idc=2,80A Pac=967W							
	under frequency				**over frequency**			
Parameter	Frequency [Hz]	Time [ms]			Frequency [Hz]	Time [ms]		
Output Voltage		**~85%U_N**	**U_N**	**~110%U_N**		**~85%U_N**	**U_N**	**~110%U_N**
Limit	**48,0 Hz**	**at least 3 s**			**50,5 Hz**	**<= 500 ms**		
Trip value		48,00Hz	48,00Hz	48,00Hz		50,52Hz	50,52Hz	50,52Hz
Disconnection time (ms)	48,5Hz to 47,5Hz	3135	3130	3130	50Hz to 51Hz	420	422	425
		3124	3120	3119		422	420	422
Reconnection time:	**>=180 s**	194s			**>=180 s**	194s		

Note:
The maximum and minimum frequency connection protection must be set to 50,5 Hz and 48,0 Hz. For an under frequency failure the inverter has to stay connect for at least 3 s. After the 3 s the inverter has to disconnect immediately from the grid. The accuracy for the frequency measurement must be in a range of +/- 0,05 Hz.

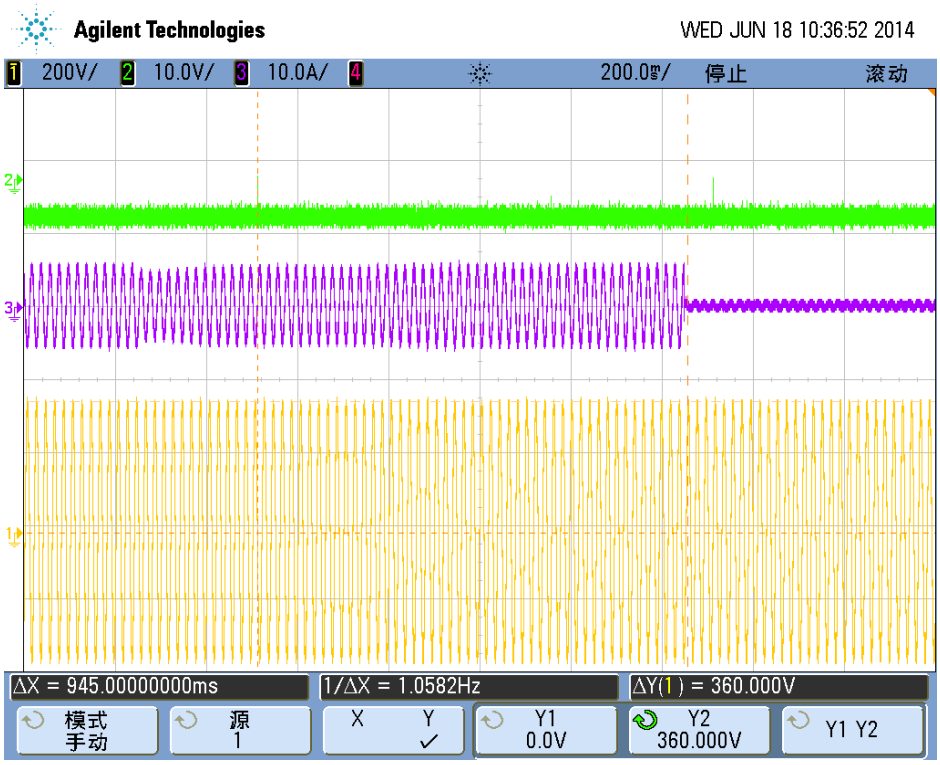
It was measured at a continuous change of frequency of 1 Hz / s at lower, nominal and upper U_N and arbitrary output power. The trip value was determined manually by reducing the frequency in 10 mHz steps. When the trip value is known (e.g. 49,0 Hz), the ac-source is programmed to run from e.g. 49,50 Hz to 48,50 Hz with 1 Hz / s. The disconnection time is calculated by the measured time minus the 500 ms from 49,5 Hz to 49,00 Hz.

The tests had been performed on the SOFAR 3000TL is valid for the SOFAR 1100TL, SOFAR 1600TL, SOFAR 2200TL and SOFAR 2700TL, since it is same as in hardware and just power derated by software.

under frequency:



over frequency:



Article 14 Protections **Reconnection condition over frequency**			**P**
Setting values reconnection		Setting $T_{reconnection}$ ≥ 180s:	180s
		Setting $f_{reconnection}$ ≤ 50,00Hz:	50Hz
Connecting conditions for frequencies:			
a)	50,00 Hz		inverter running
	f_{ist}	**Reset time:**	**Limit:**
	Switch to b) for ≥ Setting $T_{reconnection}$:		
b)	≥ 50,50 Hz	No reconnection	inverter has to disconnect, no resetting allowed
	Switch to c) for ≥ Setting $T_{reconnection}$:		
c)	50,05 Hz	No reconnection	no resetting allowed
	Switch to d) for ≥ Setting $T_{reconnection}$:		
d)	≤ 50,00 Hz	193s	resetting allowed after ≥ Setting $T_{reconnection}$

Test:
see points a) to d) for the test process.
The measurement was carried out with a programmable AC source.
e.g. connecting conditions for frequencies:
a) AC source was programmed in such a way that the AC output is set to 230 V / 50 Hz
b) AC source is set for ≥ Setting $T_{reconnection}$ to 230 V / 50,5 Hz, switching on again is not permitted
c) AC source is set to 230 V / 50,05 Hz for ≥ Setting $T_{reconnection}$, reconnection is not permitted
d) AC source is set back to 230 V / 50,0 Hz, reconnection is allowed after ≥ Setting $T_{reconnection}$.

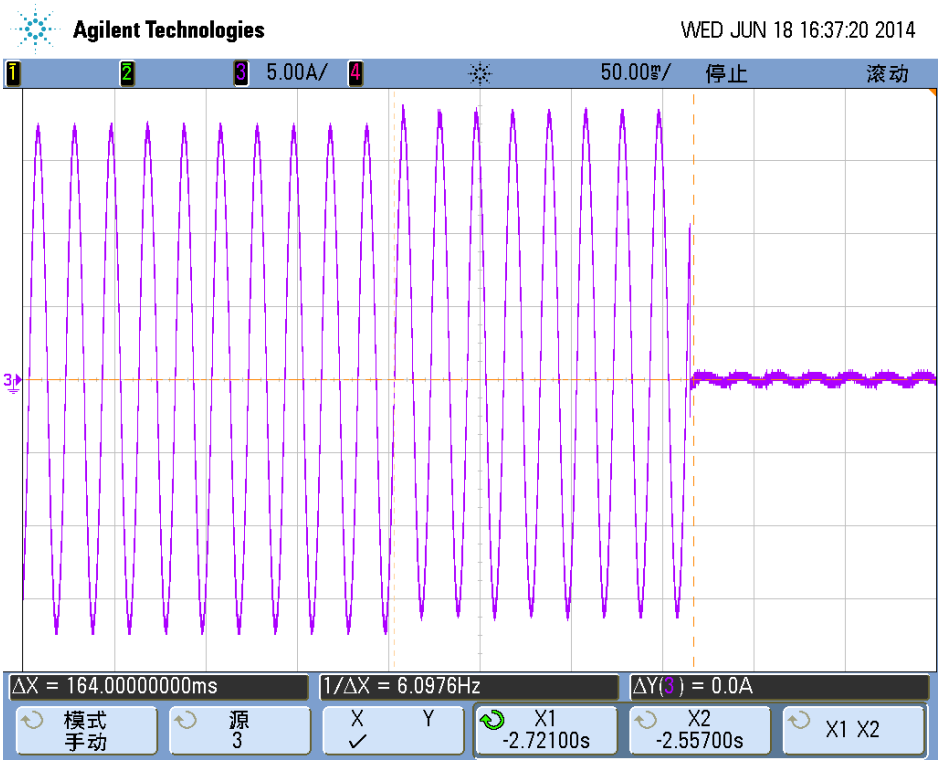
Note:
In the event of activating the maximum frequency protection, reconnection shall only be made when the frequency reaches a value that is less than or equal to 50 Hz. The accuracy for the frequency measurement must be in a range of +/-0,05 Hz (0,1% $f_{nom.}$).

The tests had been performed on the SOFAR 3000TL is valid for the SOFAR 1100TL, SOFAR 1600TL, SOFAR 2200TL and SOFAR 2700TL, since it is same as in hardware and just power derated by software.

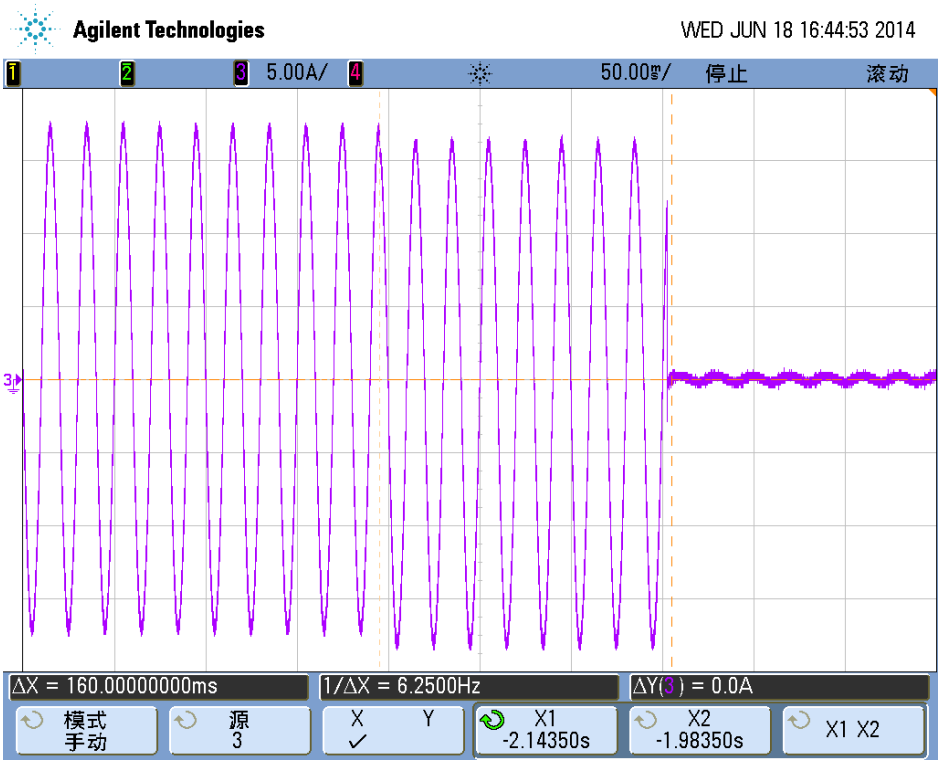
Article 14 Protections **Isolation measurement before feeding in** according DIN V VDE V 0126-1-1:2006-02, clause 6.6 (4.7)			**P**
DC+			
V_+, the higher array voltage	500	600 kΩ	PV inverter can not start up, error message: ID56. (ISO fault)
$V_{critical}$, the voltage level analysed to be difficult to detect	450		
$V_{arbitrary}$, any voltage within the range V_- V_+	230		
V_-, the lower array voltage	90		
DC-			
V_+, the higher array voltage	500	600 kΩ	PV inverter can not start up, error message: ID56. (ISO fault)
$V_{critical}$, the voltage level analysed to be difficult to detect	450		
$V_{arbitrary}$, any voltage within the range V_- V_+	230		
V_-, the lower array voltage	90		
Note: The array insulation resistance to ground shall be not less than 1 kΩ / V with respect to the maximum dc input voltage as specified by the manufacturer, with a minimum of 500 kΩ The tests had been performed on the SOFAR 3000TL is valid for the SOFAR 1100TL, SOFAR 1600TL, SOFAR 2200TL and SOFAR 2700TL, since it is same as in hardware and just power derated by software.			

Article 14 Protections **Monitoring of DC-Injection** according DIN V VDE V 0126-1-1:2006-02, clause 6.4 (4.4)				**P**
Test conditions:	Uac = 230Vac Udc =450Vdc Pac =2800W			
DC Injection (A)	**Limits**	**Trip Time (ms)**		
+1,0A	I_{DC}:>1A than disconnection within 0,2 sec	160	164	162
-1,0A	I_{DC}:>1A than disconnection within 0,2 sec	159	160	159
Note: A dc-current of 1A is injected, disconnection time of max. 0,2s The tests had been performed on the SOFAR 3000TL is valid for the SOFAR 1100TL, SOFAR 1600TL, SOFAR 2200TL and SOFAR 2700TL, since it is same as in hardware and just power derated by software.				

Negative DC-Injection:

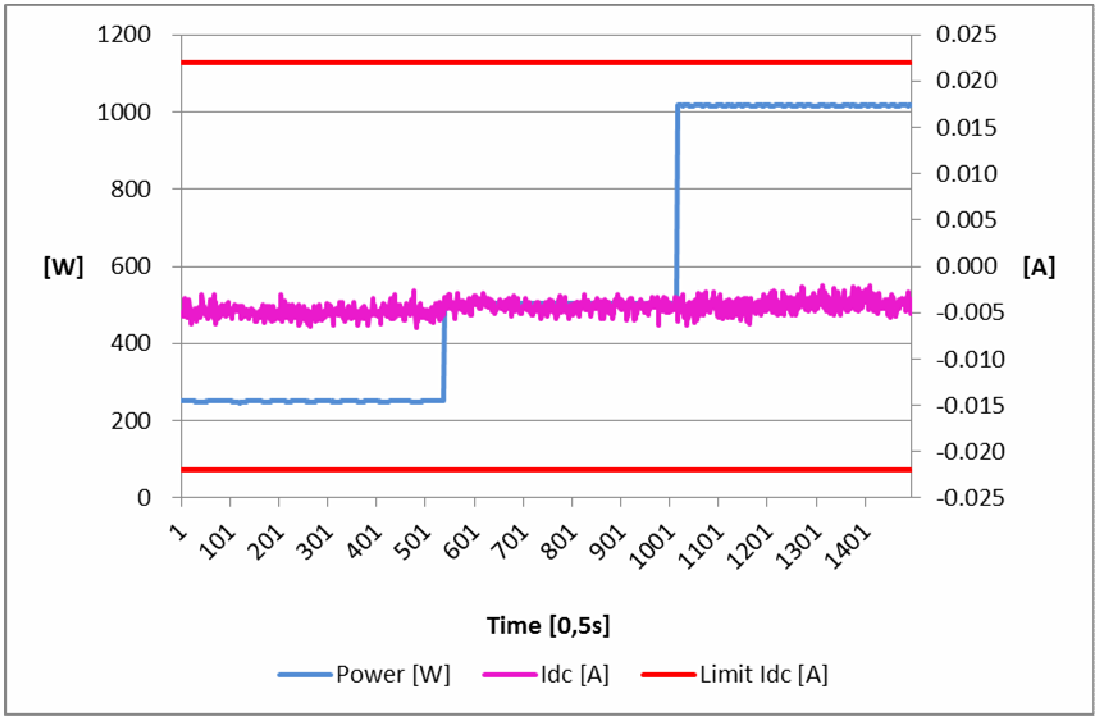


Positive DC-Injection:



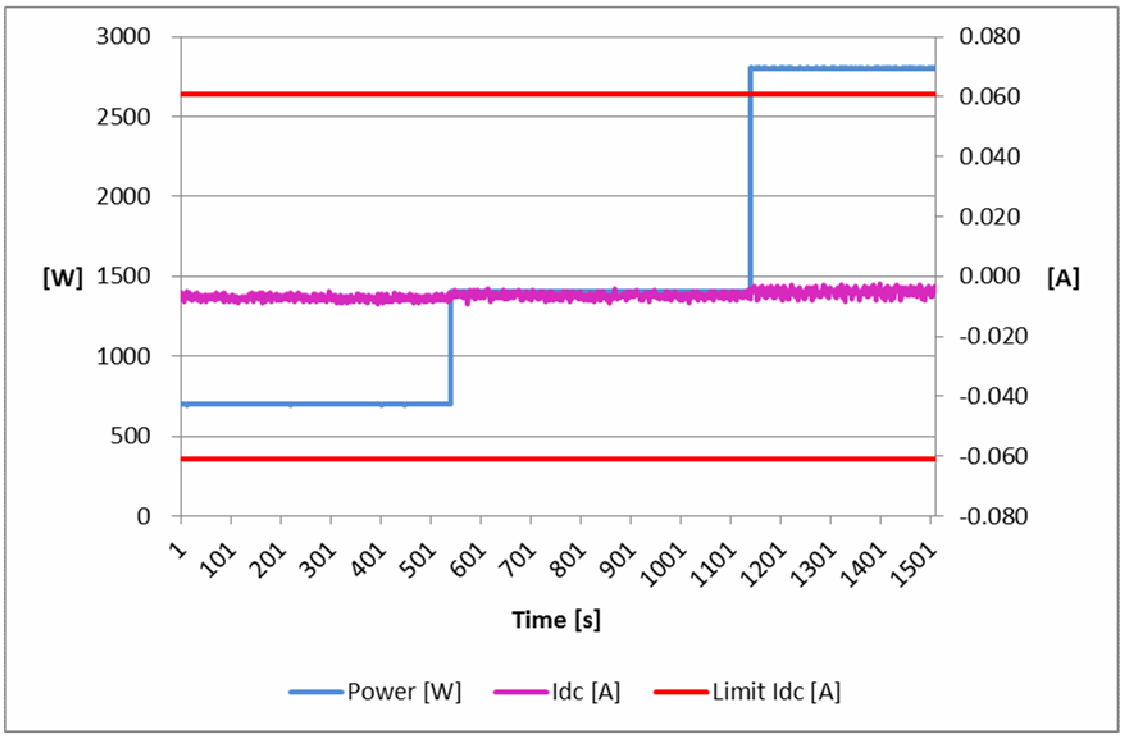
NOTA DE INTERPRETACIÓN TECNICA DE LA EQUIVALENCIA DE LA SEPARACIÓN GALVÁNICA DE LA CONEXIÓN DE INSTALACIONES GENERADORAS EN BAJA TENSIÓN Revision: R01	P

Diagram of permanent DC-Injection: SOFAR 1100TL



dc-injection <0,5% of Iac, nom.

Diagram of permanent DC-Injection: SOFAR 3000TL



dc-injection <0,5% of Iac, nom.

Note:
Testing must be performed according to WI 10.4.-03.doc rev D.
The internal temperature of the EUT must be stabilized. No temperature drift of more than 2K within 1 hour is allowed.

The tests had been performed on the SOFAR 1100TL and SOFAR 3000TL are valid for the SOFAR 1600TL, SOFAR 2200TL and SOFAR 2700TL, since it is same as in hardware and just power derated by software.

Article 14 Protections **Residual Current Monitoring** according DIN V VDE V 0126-1-1:2006-02, clause 6.6 (4.7)	**P**

Test conditions:	Output power: V_{DC}: 450V Frequency: 50Hz Current measuring devices: min. class 0,5

DIN V VDE V 0126-1-1:2006-02, 6.6.2.2.2 **Test for correct disconnection in case of a continuously rising residual current**	**P**

+ PV to N:

	Fault Current (mA)		
Limit (mA)	~0,85U_N	U_N	~1,10U_N
<=300	230	227	230
<=300	231	230	228
<=300	230	230	239
<=300	229	229	230
<=300	231	229	231

- PV to N:

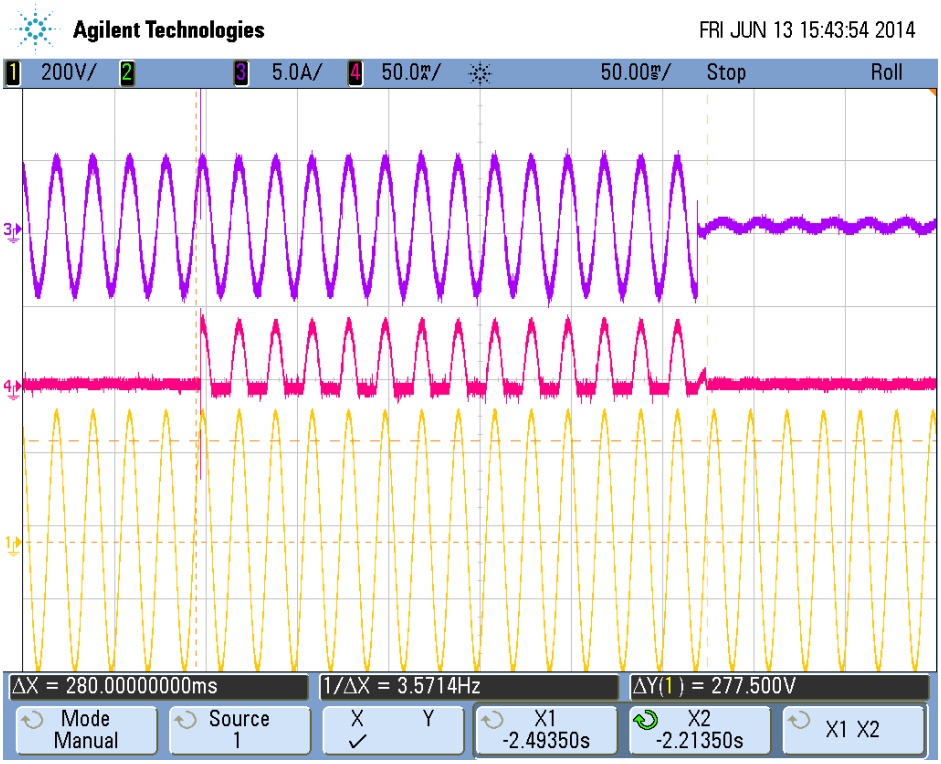
	Fault Current (mA)		
Limit (mA)	~0,85U_N	U_N	~1,10U_N
<=300	229	232	230
<=300	232	231	231
<=300	230	231	233
<=300	228	231	227
<=300	228	230	230

Note:
Comparing test circuit at 6.6.2.1, pic. 4. Fault current will rise up to 300mA within 30s. 5 values will be measured and listed.

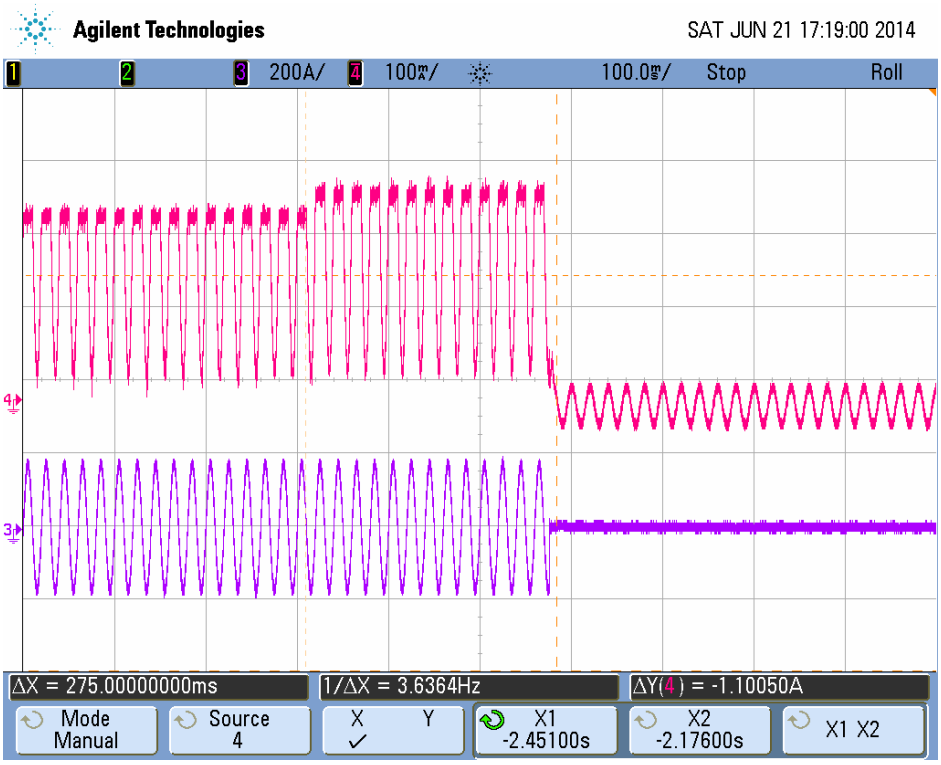
The tests had been performed on the SOFAR 3000TL is valid for the SOFAR 1100TL, SOFAR 1600TL, SOFAR 2200TL and SOFAR 2700TL, since it is same as in hardware and just power derated by software.

DIN V VDE V 0126-1-1:2006-02, 6.6.2.2.2 **Test for correct disconnection in case of an abrupt appearing residual current >300mA**			**P**
+ PV to N:			
Fault Current > 300mA			
Limit (ms)	~0,85U_N	U_N	~1,10U_N
300	284	270	280
- PV to N:			
Fault Current > 300mA			
Limit (ms)	~0,85U_N	U_N	~1,10U_N
300	256	275	261
Note: The tests had been performed on the SOFAR 3000TL is valid for the SOFAR 1100TL, SOFAR 1600TL, SOFAR 2200TL and SOFAR 2700TL, since it is same as in hardware and just power derated by software.			

Scope picture: + PV to N



Scope picture: - PV to N

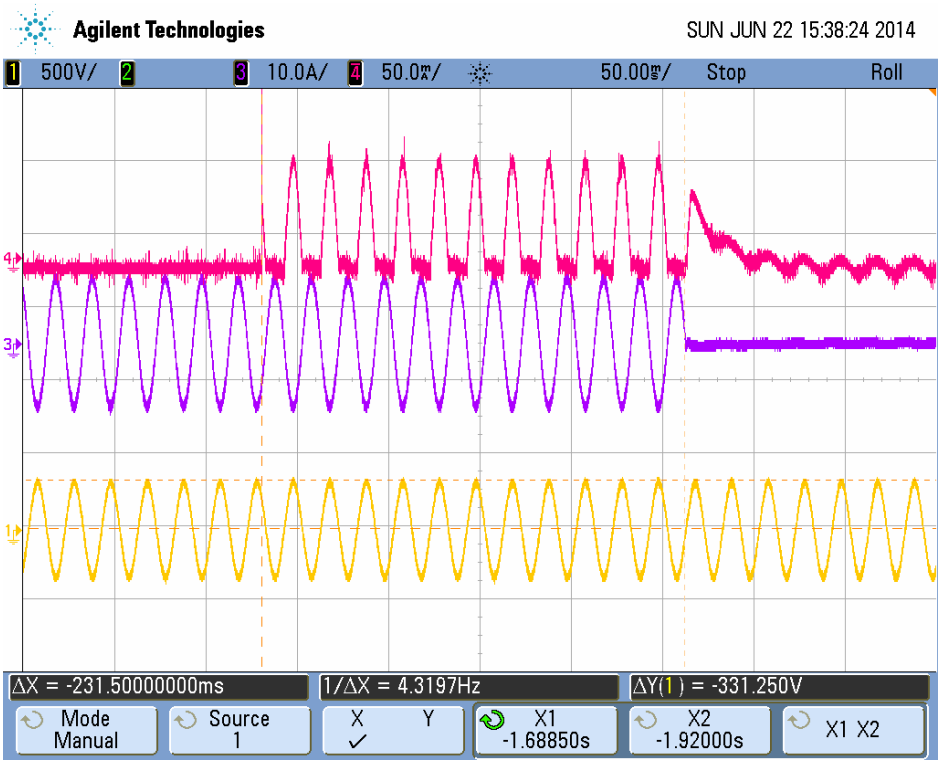


DIN V VDE V 0126-1-1:2006-02, 6.6.2.2.3 **Test for correct disconnection in case of a suddenly occurring residual current**				**P**
+PV to N				
Limit (mA)	~0,85U_N Disconnection time (ms)	U_N Disconnection time (ms)	~1,10U_N Disconnection time (ms)	Limit (ms)
30	218	197	210	300
30	213	232	210	300
30	212	219	204	300
30	208	216	218	300
30	205	208	203	300
60	107	110	105	150
60	107	104	114	150
60	107	104	114	150
60	101	117	113	150
60	123	107	104	150
150	25	24	26	40
150	37	39	39	40
150	34	38	38	40
150	24	34	35	40
150	37	31	28	40
-PV to N				
Limit (mA)	~0,85U_N Disconnection time (ms)	U_N Disconnection time (ms)	~1,15U_N Disconnection time (ms)	Limit (ms)
30	203	217	218	300
30	219	204	220	300
30	222	226	231	300
30	210	223	216	300
30	201	225	216	300
60	127	124	110	150
60	112	111	116	150
60	120	103	104	150
60	100	96	109	150
60	105	102	105	150
150	28	38	36	40
150	25	37	36	40
150	34	31	26	40
150	37	27	32	40
150	26	34	29	40

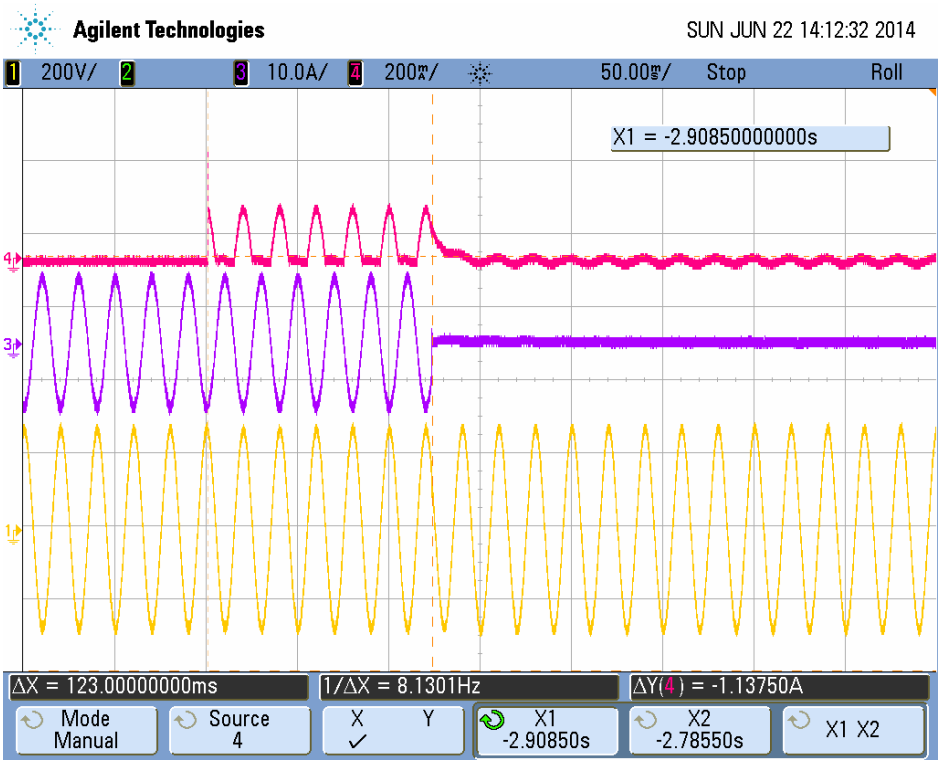
Note:
The capacitive current is risen until disconnection.
Test condition: I_c + 30/60/150mA <= I_{cmax}. R_1 is set that 30/60/150mA Flow and switch S is closed.

The tests had been performed on the SOFAR 3000TL is valid for the SOFAR 1100TL, SOFAR 1600TL, SOFAR 2200TL and SOFAR 2700TL, since it is same as in hardware and just power derated by software.

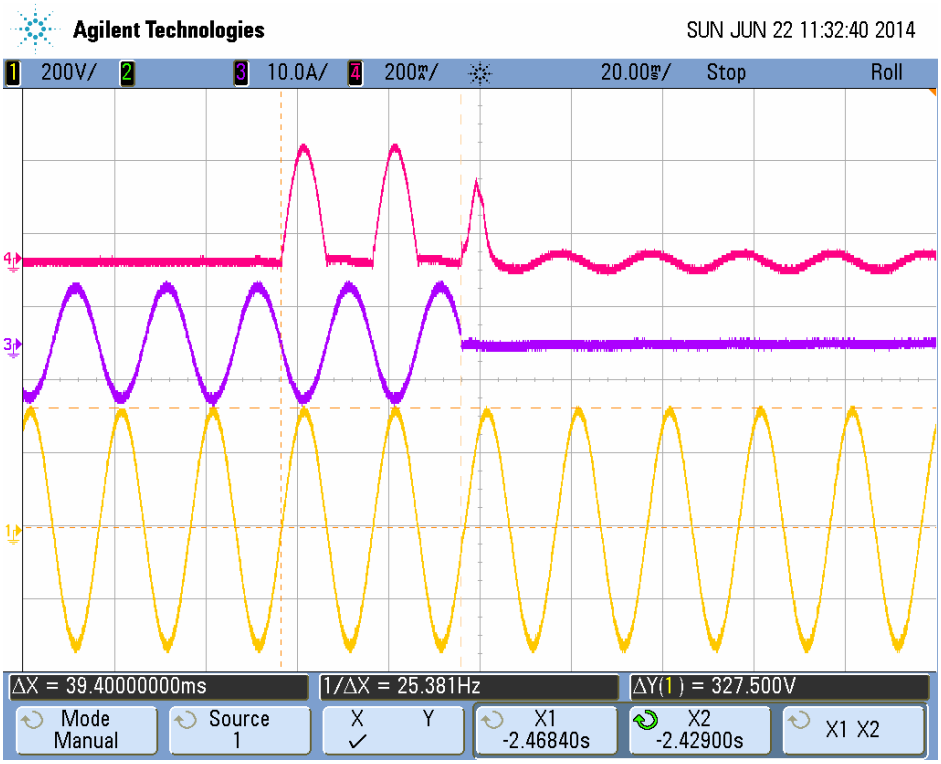
Scope picture: - PV to N; 100%UN; 30mA



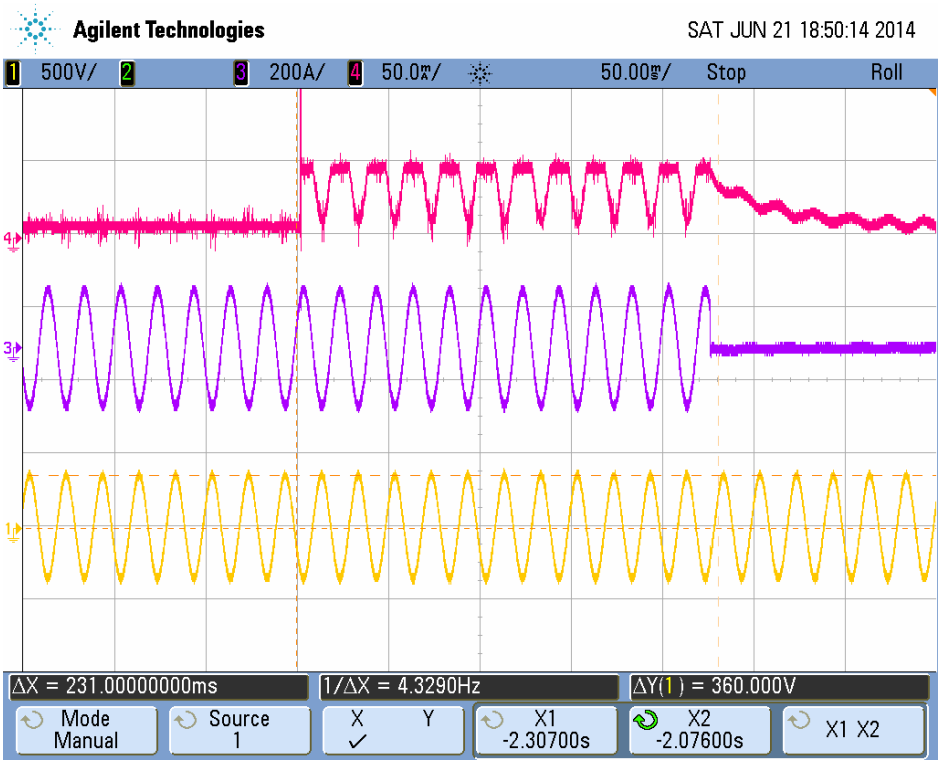
Scope picture: + PV to N; 85%U_N; 60mA



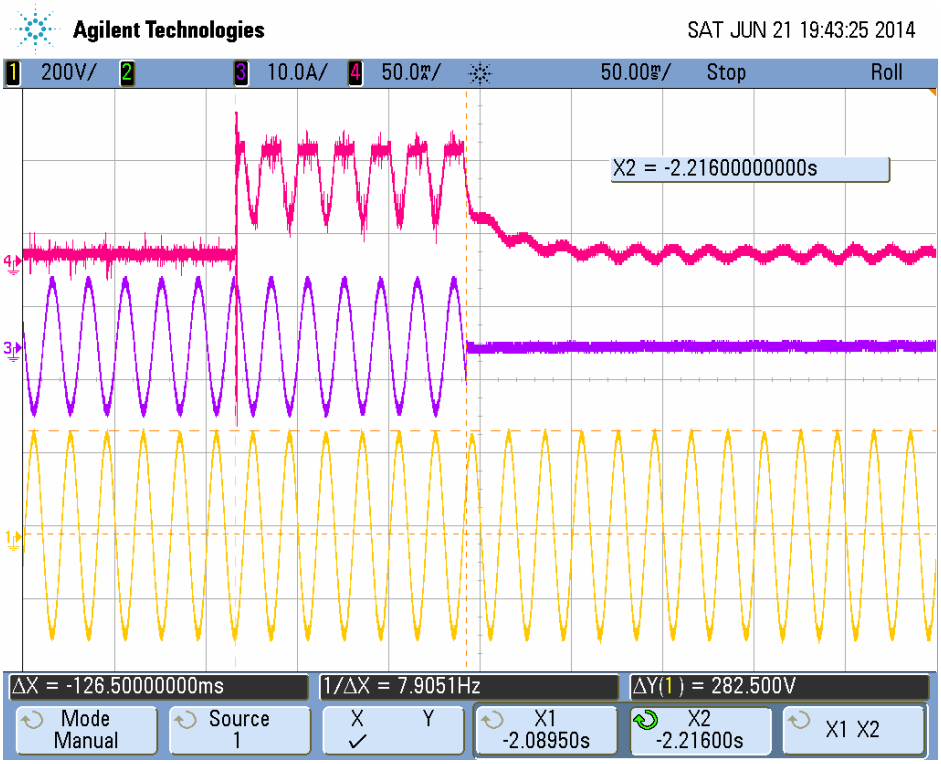
Scope picture: + PV to N; 100%U_N; 150mA



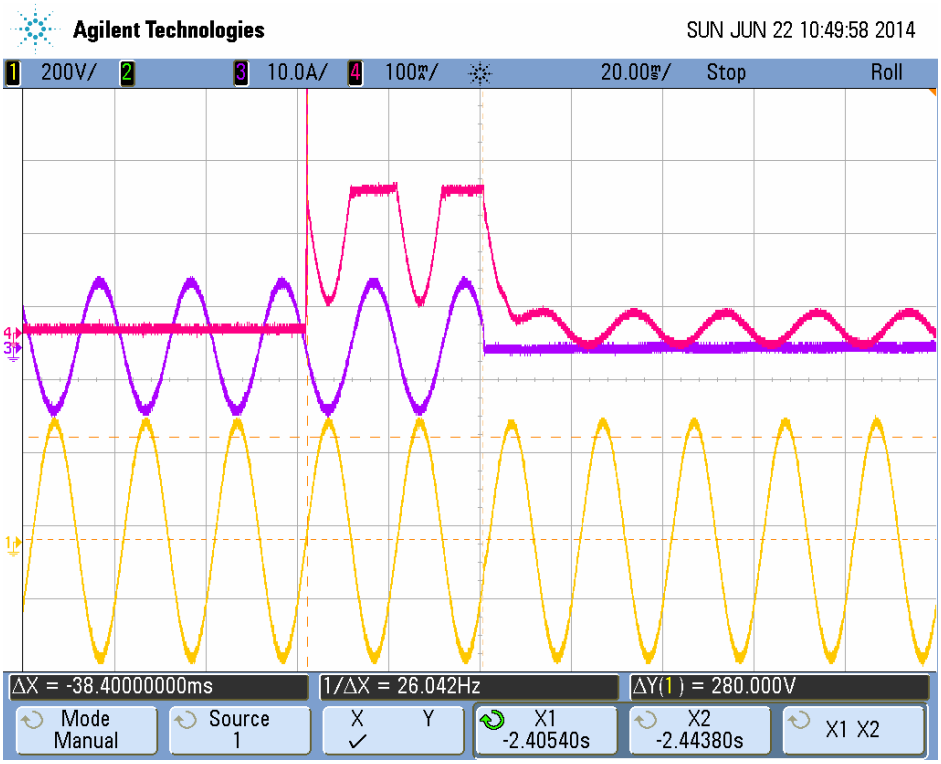
Scope picture: - PV to N; 115%U_N; 30mA



Scope picture: - PV to N; 85%U_N; 60mA



Scope picture: - PV to N; 100%U_N; 150mA



6.1 (4.1) Functional safety - fault condition tests			P
	ambient temperature (°C) :	23,8	—
	model/type of power supply :	DC : 62150H-1000S AC : 61512	—
	manufacturer of power supply :	Chroma	—
	rated markings of power supply :	DC: 0-1000V, 15kW AC: 0-300V, 18kW	—

component No.	fault	test condition		test time	fuse No.	fault condition		result
		AC	DC			AC	DC	
PV voltage detect UC1C Pin 9	Open	230V 12,63 A	450V 6,62 A	2 Min.	--	230V 0,17A	450V 0,02A	PV inverter disconnected from grid immediately, error message: ID09. (PV voltage over range)
PV current detect UC1B Pin 5	Open	230V 12,63 A	450V 6,6A	2 Min.	--	230V 0,16A	450V 0,02A	PV inverter disconnected from grid immediately, error message: ID14. (PV current over range)
GFCI detect UC2D Pin 12-13	Short	230V 12,63 A	450V 6,62 A	2 Min.	--	230V 0,16A	450V 0,02A	PV inverter disconnected from grid immediately, error message: ID12. (GFCI fault)
GFCI detect UC2C Pin 10	Short	230V 12,63 A	450V 6,62 A	2 Min.	--	230V 0,16A	450V 0,02A	PV inverter disconnected from grid immediately, error message: ID52. (GFCI fault)
Grid voltage detect UC2A Pin 3	Open	230V 12,64 A	450V 6,67 A	2 Min.	--	230V 0,17A	450V 0,02A	PV inverter disconnected from grid immediately, error message: ID15. (Grid current or voltage over range)
Grid voltage detect RC17	Open	230V 12,63 A	450V 6,62 A	2 Min.	--	230V 0,17A	450V 0,01A	PV inverter disconnected from grid immediately, error message: ID02, ID49, ID70. (Grid current or voltage under range)
Grid voltage detect RC25	Open	230V 12,64 A	450V 6,62 A	2 Min.	--	230V 0,18A	450V 0,01A	PV inverter disconnected from grid immediately, error message: ID55. (Relay fault)
Bus voltage detect RP3	Open	230V 12,61 A	450V 6,63 A	2 Min.	--	230V 0,6A	450V 0,02A	PV inverter disconnected from grid immediately, error message: ID23. (Bus voltage zero fault)
Bus voltage detect UC1A Pin2-3	Short	230V 12,56 A	450V 6,65 A	2 Min.	--	230V 0,17A	450V 0,02A	PV inverter disconnected from grid immediately, error message: ID66. (Bus voltage over range)

Bus voltage detect RC82	Short	230V 12,56 A	450V 6,69 A	2 Min.	--	230V 0,16A	450V 0,02A	PV inverter disconnected from grid immediately, error message: ID25. (Bus voltage under range)
ISO detect RC105	Open before start up	230V 0,17 A	450V 0,18 A	2 Min.	--	230V 0,17A	450V 0,02A	PV inverter can not start up, error message: ID56. (ISO fault)
AC current detect RC22	Open	230V 12,56	450V 6,68	2 Min.	--	230V 0,17A	450V 0,02A	PV inverter disconnected from grid immediately, error message: ID15. (AC current over range), QP2， QP6，QP9， RP26， RP28，RP11 damaged.
AC current detect RC21	Open	230V 12,62 A	450V 6,63 A	2 Min.	--	230V 0,16A	450V 0,02A	PV inverter disconnected from grid immediately, error message: ID15. (AC current over range).
DC current detect RC33	Open	230V 12,67 A	450V 6,69 A	2 Min.	--	230V 0,17A	450V 0,02A	PV inverter disconnected from grid immediately, error message: ID28. (DC current over range).
DC current detect RC37	Open	230V 12,54 A	450V 6,67 A	2 Min.	--	230V 0,17A	450V 0,02A	PV inverter disconnected from grid immediately, error message: ID28. (DC current over range).
DC current detect RC42	Open	230V 12,62 A	450V 6,66 A	2 Min.	--	230V 0,16A	450V 0,02A	PV inverter disconnected from grid immediately, error message: ID51. (DC current fault).
AC current detect RC61	Open	230V 12,66 A	450V 6,7A	2 Min.	--	230V 0,16A	450V 0,02A	PV inverter disconnected from grid immediately, error message: ID15, ID65. (AC voltage or current over range).
AC current detect RC80	Open	230V 12,67 A	450V 6,8A	2 Min.	--	230V 0,16A	450V 0,02A	PV inverter disconnected from grid immediately, error message: ID15, ID65. (AC voltage or current over range).
GFCI detect RP70	Open	230V 12,63 A	450V 6,66 A	2 Min.	--	230V 0,16A	450V 0,02A	PV inverter disconnected from grid immediately, error message: ID12. (GFCI fault).
GFCI detect RP80	Open	230V 12,63 A	450V 6,66	2 Min.	--	230V 0,16A	450V 0,02A	PV inverter disconnected from grid immediately, error message: ID12. (GFCI fault).
GFCI detect UP7A Pin2-3	Short	230V 12,56 A	450V 6,67 A	2 Min.	--	230V 0,17A	450V 0,02A	PV inverter disconnected from grid immediately, error message: ID12. (GFCI fault).

PV voltage detect RP115	Open	230V 12,62 A	450V 6,67 A	2 Min.	--	230V 0,16A	450V 0,02A	PV inverter disconnected from grid immediately, no display, and reconnect to grid, error message: ID56. (ISO fault).
PV voltage detect RP115	Short	230V 12,63 A	450V 6,63 A	2 Min.	--	230V 0,16A	450V 0,02A	PV inverter disconnected from grid immediately, error message: ID09. (PV voltage over range)
ISO detect RP99	Open before start up	230V 0,16 A	450V 0,02 A	2 Min.	--	230V 0,16A	450V 0,02A	PV inverter can not start up, error message: ID56. (ISO fault).
Relay detect RYP2 Pin3-4	Short before start up	230V 0,16 A	450V 0,02 A	2 Min.	--	230V 016A	450V 0,02A	PV inverter can not start up, error message: ID55, ID77. (Relay fault).
Relay detect RYP3 Pin3-4	Short before start up	230V 0,16 A	450V 0,02 A	2 Min.	--	230V 0,16A	450V 0,02A	PV inverter can not start up, error message: ID55, ID77. (Relay fault).
Relay detect RYP4 Pin3-4	Short before start up	230V 0,16 A	450V 0,02 A	2 Min.	--	230V 0,16A	450V 0,02A	PV inverter can not start up, error message: ID55, ID77. (Relay fault).
Relay detect RYP5 Pin3-4	Short before start up	230V 0,16 A	450V 0,02 A	2 Min.	--	230V 0,16A	450V 0,02A	PV inverter can not start up, error message: ID55, ID77. (Relay fault).
Grid voltage detect RP150	Open	230V 0,62 A	450V 6,67 A	2 Min.	--	230V 0,16A	450V 0,02A	PV inverter disconnected from grid immediately, error message: ID02. (Grid voltage under range)
Grid voltage detect RP150	Short	230V 12,64 A	450V 6,66 A	2 Min.	--	230V 0,16A	450V 0,02A	PV inverter disconnected from grid immediately, error message: ID01. (Grid voltage over range)
Grid voltage detect RP135	Short	230V 12,64 A	450V 6,67 A	2 Min.	--	230V 0,16A	450V 0,02A	PV inverter disconnected from grid immediately, error message: ID01. (Grid voltage over range)
Grid voltage detect RP135	Open	230V 12,61 A	450V 6,66 A	2 Min.	--	230V 0,16A	450V 0,02A	PV inverter disconnected from grid immediately, error message: ID02. (Grid voltage under range)
Loss of control CC100	Short	230V 12,61 A	450V 6,67 A	2 Min.	--	230V 0,16A	450V 0,02A	PV inverter disconnected from grid immediately, error message: DSP communicate fail
Loss of control XLC	Short	230V 12,63 A	450V 6,65 A	2 Min.	--	230V 0,16A	450V 0,02A	PV inverter disconnected from grid immediately, error message: DSP communicate fail

Communication microcontroller defect UC34 Pin 31	Open	230V 12,64 A	450V 6,66 A	2 Min.	--	230V 0,16A	450V 0,02A	PV inverter disconnected from grid immediately, error message: ID 53 (SPI Communication fault)
Communication microcontroller defect UC34 Pin 37	Open	230V 12,64 A	450V 6,66 A	2 Min.	--	230V 0,17A	450V 0,02A	PV inverter disconnected from grid immediately, error message: ID 53 (SPI Communication fault)
Communication microcontroller defect UC34 Pin 44	Open	230V 12,63 A	450V 6,66 A	2 Min.	--	230V 0,17A	450V 0,02A	PV inverter disconnected from grid immediately, error message: ID 53 (SPI Communication fault)
Communication microcontroller defect UC34 Pin 47	Open	230V 12,64 A	450V 6,67 A	2 Min.	--	230V 0,17A	450V 0,02A	PV inverter disconnected from grid immediately, error message: ID 53 (SPI Communication fault)
The errors in the control circuit simulate that the safety is even during single fault ensured. The tests had been performed on the SOFAR 3000TL is valid for the SOFAR 1100TL, SOFAR 1600TL, SOFAR 2200TL and SOFAR 2700TL, since it is same as in hardware and just power derated by software.								

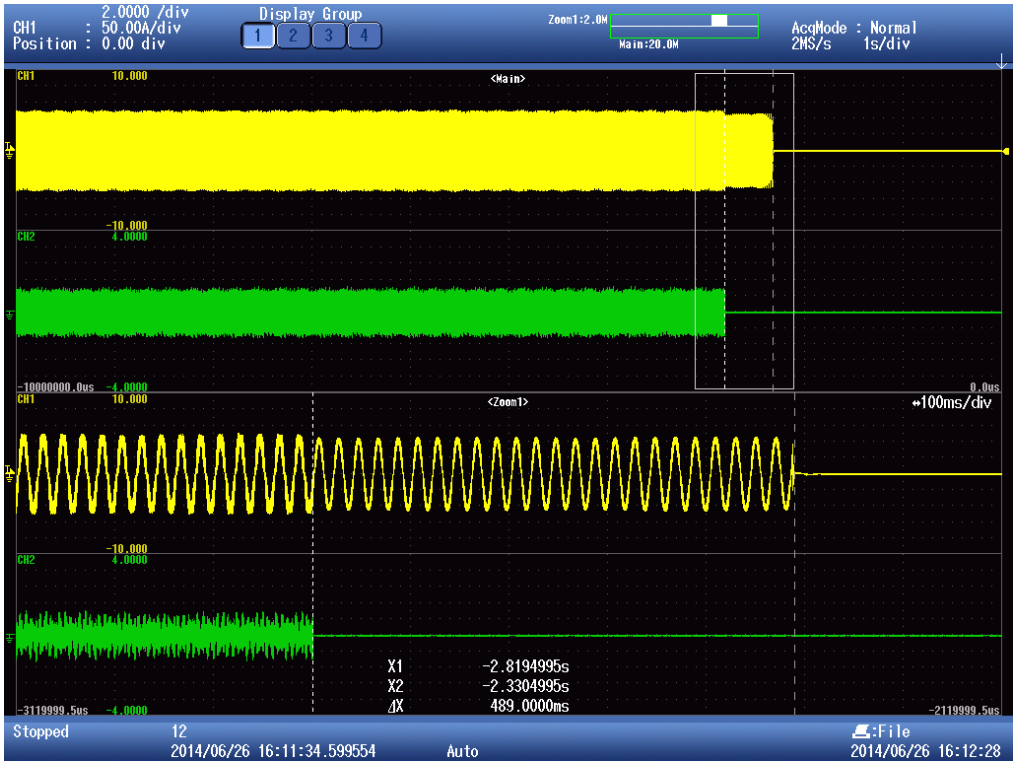
6.5 (4.5) Detection of Anti-Islanding		P
6.5.1 Measurement of impedance		**N/A**
Test conditions:	Output power: 100% Frequency: 50Hz U_N=230Vac Apparent power to the grid <5%	
Disconnection time limit:	5s	
Z_N (R2 +L2)	Trip value T_1	Trip value T_2
0,00 Ohm	--	--
0,25 Ohm	--	--
0,50 Ohm	--	--
0,75 Ohm	--	--
1,00 Ohm	--	--
0,25 Ohm + j0,17 Ohm	--	--
0,25 Ohm + j0,33 Ohm	--	--
0,25 Ohm + j0,50 Ohm	--	--
Note:		

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:	25%	50%	100%
- 5%	0,158	0,204	0,180
- 4%	0,146	0,128	0,071
- 3%	0,202	0,108	0,104
- 2%	0,235	0,384	0,391
- 1%	0,420	0,394	0,452
0 %	0,489	0,378	0,468
+1 %	0,422	0,431	0,485
+2 %	0,130	0,115	0,109
+3 %	0,190	0,202	0,111
+4 %	0,167	0,203	0,140
+5 %	0,170	0,048	0,100
Parameter at 0%	L=120,02 mH R=76,12 Ω C=84,66 uF	L=59,48 mH R=37,84 Ω C=169,75 uF	L=29,87 mH R=18,93 Ω C=338,59 uF

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 resistors of the resonant circuit consumed the real power of the inverter (P_{WR}) within +/-3%.

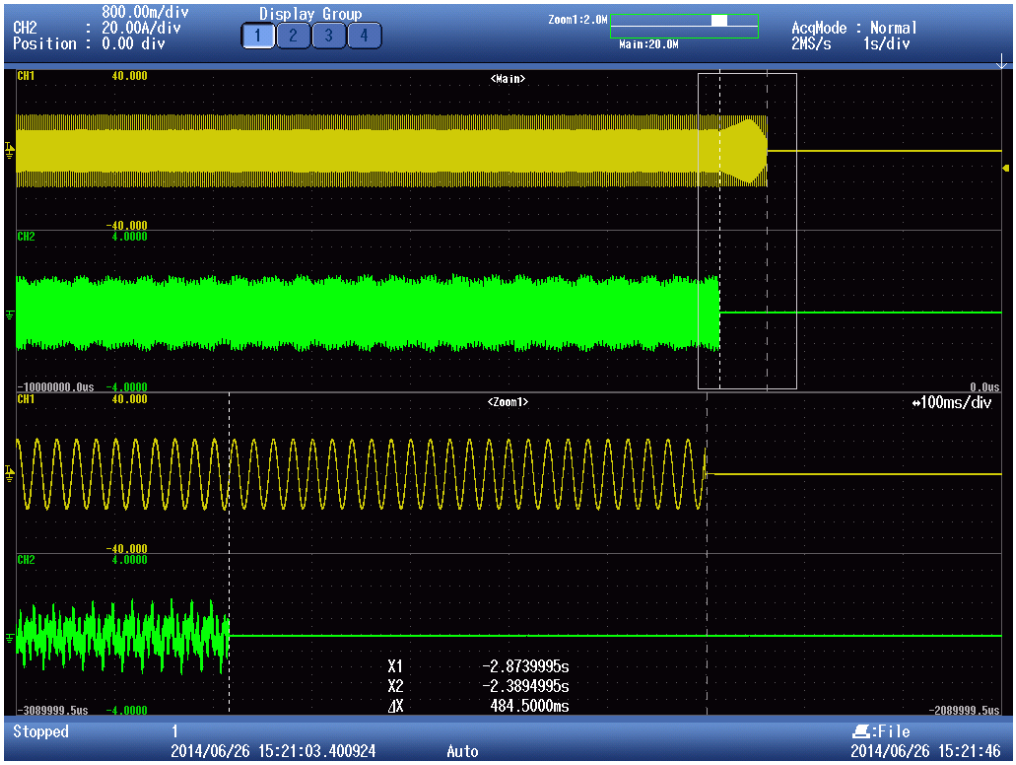
The tests had been performed on the SOFAR 3000TL is valid for the SOFAR 1100TL, SOFAR 1600TL, SOFAR 2200TL and SOFAR 2700TL, since it is same as in hardware and just power derated by software.

25% Power



50% Power

100% Power


800.00m/div
CH2 : 20.00A/div
Position : 0.00 div
Display Group
1 2 3 4
Zoom1:2.0M
Main:20.0M
AcqMode : Normal
2MS/s 1s/div
CH1 40.000
<Main>
CH2 -40.000 4.0000
-10000000.0us -4.0000
0.0us
CH1 40.000
<Zoom1>
↔100ms/div
CH2 -40.000 4.0000
X1 -2.8739995s
X2 -2.3894995s
ΔX 484.5000ms
-3089999.5us -4.0000
-2089999.5us
Stopped 1
2014/06/26 15:21:03.400924 Auto
:File
2014/06/26 15:21:46

6.5.3 3-phase grid-voltage monitoring							N/A
Test Condition:			Frequency: 50+/-0,2Hz U_N=230Vac				
Phase	**Limit:**	**Voltage step: (to min. 177,1 or max. 270,9)**	**Trip value (V):**	**Reconnection time if <=3s (s):**	**Reconnection time if >3s (s):**	**Disconnection time (ms):**	**Limit (ms):**
L1	~85% of Un	--	--	--		--	**1500**
		--				--	
	~110% of Un	--	--	--	--	--	**1500**
		--				--	
	~115% of Un	--	--	--	--	--	**200**
		--				--	
L2	~85% of Un	--	--	--	--	--	**1500**
		--				--	
	~110% of Un	--	--	--	--	--	**1500**
		--				--	
	~115% of Un	--	--	--	--	--	**200**
		--				--	
L3	~85% of Un	--	--	--	--	--	**1500**
		--				--	
	~110% of Un	--	--	--	--	--	**1500**
		--				--	
	~115% of Un	--	--	--	--	--	**200**
		--				--	
Note:							

Annex 1
EMC Test Report

ATTESTATION
of conformity with European Directives

Attestation Number: **1488AB0508N005R1001**
Product: **PV Grid Inverter**
Brand Name:
Model: **SOFAR 3000TL, SOFAR 1100TL, SOFAR 2200TL**
Additional Model: **SOFAR 1600TL, SOFAR 2700TL**
Applicant: **Shenzhen SOFARSOLAR Co., Ltd.**
Address: **3A-1, Huake Building, East Technology Park, Qiaoxiang Road, Nanshan District, Shenzhen, China.**
Technical Characteristics: **DC Input: DC 110 - 380V Max. 10A For SOFAR 1100TL;**
DC Input: DC 165 - 380V Max. 10A For SOFAR 1600TL ;
DC Input: DC 170 - 450V Max. 13A For SOFAR 2200TL;
DC Input: DC 210 - 450V Max. 13A For SOFAR 2700TL;
DC Input: DC 230 - 450V Max. 13A For SOFAR 3000TL
Output: AC 230V, 50/60Hz, Power: 1000W / 1500W / 2000W / 2500W / 2800W
Output Voltage/Current: SOFAR 1100TL:230V/4.5A; SOFAR 1600TL:230V/7.0A; SOFAR 2200TL:230V/9.5A; SOFAR 2700TL:230V/11.5A; SOFAR 3000TL:230V/13.0A

The submitted sample of the above equipment has been tested for CE marking according to following European Directive and standards:

- **Electromagnetic Compatibility Directive 2004/108/EC**

Standards	Report Number	Report date
EN 61000-6-3:2007 + A1:2011 EN 61000-3-2:2006 + A1 :2009 + A2:2009 EN 61000-3-3:2013 EN 61000-6-2:2005	CE140508N005R1	Jul. 21, 2014

The referred test report(s) show that the product complies with standard(s) recognized as giving presumption of compliance with the essential requirements in the specified European Directive.

This verification does not imply assessment of the production of the product. The CE marking may be affixed if all relevant and effective European Directives with CE are applicable.

CE

Supervisor
EMC Department

Name: Madison Luo
Date: Jul. 21, 2014

Bureau Veritas Shenzhen Co., Ltd. Dongguan Branch
No. 34, Chenwulu Section, Guantai Rd., Houjie Town, Dongguan City, Guangdong 523942, China
Tel.: +86 769 8593 5656
Fax: +86 769 8593 1080
Email:customerservice.dg@cn.bureauveritas.com

Test Report No.: CE140508N005R1

ACCREDITED
Test Lab
Cert 2951.01

TEST REPORT

Applicant	Shenzhen SOFARSOLAR Co., Ltd.
Address	3A-1, Huake Building, East Technology Park, Qiaoxiang Road, Nanshan District, Shenzhen, China.

Manufacturer or Supplier	Shenzhen SOFARSOLAR Co., Ltd.
Address	3A-1, Huake Building, East Technology Park, Qiaoxiang Road, Nanshan District, Shenzhen, China.
Product	PV grid-interactive inverter
Brand Name	SOFAR SOLAR
Model	SOFAR 3000TL, SOFAR 1100TL, SOFAR 2200TL
Additional Model & Model Difference	SOFAR 1600TL, SOFAR 2700TL See item 2.1
Date of tests	May 08, 2014 ~ Jun. 30, 2014

The submitted sample of the above equipment has been tested for according to following European Directive - Electromagnetic directive 2004/108/EC and the tests have been carried out according to the requirements of the following standards:

☒ EN 61000-6-3:2007 + A1:2011
☒ EN 61000-3-2:2006 + A1:2009 + A2:2009
☒ EN 61000-3-3:2013
☒ EN 61000-6-2:2005

CONCLUSION: The submitted sample was found to COMPLY with the test requirement

Tested by Breeze Jiang Project Engineer / EMC Department	Approved by Madison Luo Manager / EMC Department
	Date: Jul. 21, 2014

Bureau Veritas Shenzhen Co., Ltd.
Dongguan Branch

No. 34, Chenwulu Section, Guantai Rd., Houjie Town, Dongguan City, Guangdong 523942, China

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Test Report No.: CE140508N005R1

RELEASE CONTROL RECORD

ISSUE NO.	REASON FOR CHANGE	DATE ISSUED
CE140508N005	Original release	Jul. 10, 2014
CE140508N005R1	Based on the original report CE140508N005 change power supply information, model and technical characteristics.	Jul. 21, 2014

Test Report No.: CE140508N005R1

1 SUMMARY OF TEST RESULTS

The EUT has been tested according to the following specifications:

EMISSION			
Standard	**Test Type**	**Result**	**Remarks**
EN61000-6-3:2007+ A1:2011	Conducted test	PASS	Meets requirement limit Minimum passing margin is –3.00 dB at 0.36094MHz
	Radiated test (30MHz~1GHz)	PASS	Meets limits minimum passing margin is –5.08 dB at 191.02MHz
EN 61000-3-2:2006 + A1:2009 + A2:2009	Harmonic current emissions	PASS	Meets the requirements.
EN 61000-3-3:2013	Voltage fluctuations & flicker	PASS	Meets the requirements.

IMMUNITY (EN 61000-6-2:2005)			
Standard	**Test Type**	**Result**	**Remarks**
IEC 61000-4-2:2008	Electrostatic discharge immunity test	PASS	Electrostatic Discharge – ESD: 8kV Air discharge, 4kV Contact discharge, Performance Criterion A
IEC 61000-4-3:2005 + A1:2007+A2:2010	Radiated, radio-frequency, electromagnetic field immunity test	PASS	Radio-Frequency Electromagnetic Field Susceptibility Test – RS: 80-1000 MHz, 10V/m, 80% AM (1kHz), 1400-2000 MHz, 3V/m, 80% AM (1kHz) 2000-2700 MHz, 1V/m, 80% AM (1kHz) Performance Criterion A
IEC 61000-4-4:2012	Electrical fast transient / burst immunity test.	PASS	Electrical Fast Transient/Burst - EFT AC Power line: 2kV, DC Power line: 2kV, Performance Criterion A
IEC 61000-4-5:2005	Surge immunity test	PASS	Surge Immunity Test: 1.2/50 us Open Circuit Voltage, 8 /20 us Short Circuit Current, AC Power Line: line to line 1 kV, Line to earth 2kV , DC Power Line: line to line 0.5 kV Performance Criterion B
IEC 61000-4-6:2008	Immunity to conducted disturbances, induced by radio-frequency fields	PASS	Conducted Radio Frequency Disturbances Test – CS: 0.15-80 MHz, 10Vrms, 80% AM, 1kHz, Performance Criterion A
IEC 61000-4-8:2009	Power frequency magnetic field immunity test.	PASS	Power Frequency Magnetic Field Test, 50 Hz / 60Hz, 30A/m, Performance Criterion A

1.1 MEASUREMENT UNCERTAINTY

Where relevant, the following measurement uncertainty levels have been estimated for tests performed on the EUT as specified in CISPR 16-4-2:

This uncertainty represents an expanded uncertainty expressed at approximately the 95% confidence level using a coverage factor of k=2.

MEASUREMENT	FREQUENCY	UNCERTAINTY
Mains Terminal Disturbance Voltage Test	0.15MHz ~ 30MHz	+ /-2.67 dB
Radiated Disturbance Test	30MHz ~ 1000MHz	+ /-4.36 dB

2 GENERAL INFORMATION

2.1 GENERAL DESCRIPTION OF EUT

PRODUCT	PV Grid Inverter
MODEL NO.	SOFAR 3000TL, SOFAR 1100TL, SOFAR 2200TL
ADDITIONAL MODEL	SOFAR 1600TL, SOFAR 2700TL
POWER SUPPLY	DC Input: DC 110 - 380V Max. 10A For SOFAR 1100TL; DC Input: DC 165 - 380V Max. 10A For SOFAR 1600TL ; DC Input: DC 170 - 450V Max. 13A For SOFAR 2200TL; DC Input: DC 210 - 450V Max. 13A For SOFAR 2700TL; DC Input: DC 230 - 450V Max. 13A For SOFAR 3000TL Output: AC 230V, 50/60Hz, Power: 1000W / 1500W / 2000W / 2500W / 2800W Output Voltage/Current: SOFAR 1100TL:230V/4.5A; SOFAR 1600TL:230V/7.0A; SOFAR 2200TL:230V/9.5A; SOFAR 2700TL:230V/11.5A; SOFAR 3000TL:230V/13.0A
SOFTWARE VERSION	V1.00
HARDWARE VERSION	V1.00
THE HIGHEST OPERATING FREQUENCY	Below 108MHz
DATA CABLE SUPPLIED	DC Cable: Shielded; Detachable 1.8m; AC Cable: Shielded; Detachable 1.8m

NOTE:

1. This report CE140508N005R1 supersedes the previous one with the report number CE140508N005 dated on Jul. 10, 2014.

2. For the test results, the EUT had been tested with all conditions. But only the worst case was showed in test report.

3. For a more detailed features description, please refer to the manufacturer's specifications or the User's Manual.

4. RS485 port on the product is for client to collect data, according to client requirements, no need to test.

5. All models shell include red, blue, white and other colors. All models of DC switch and WIFI module is optional accessories, optional installation according to the need of client.

6. This is a series of PV Grid Inverter with the same as in hardware except the amount of BUS capacitor, inverter inductor, Boost and IGBT component and DC switch are different. Identical in software the output power just adjusted by software; models SOFAR 3000TL, SOFAR 1100TL, SOFAR 2200TL are selected to test. full test was performed for the model SOFAR 3000TL, and partial test for the models SOFAR 1100TL, SOFAR 2200TL.

Ratings .....:	SOFAR 1100TL	SOFAR 1600TL	SOFAR 2200TL	SOFAR 2700TL	SOFAR 3000TL
MPP DC voltage range [V] .....:	110-380	165-380	170-450	210-450	230-450
Input DC voltage range [V].....:	90-400, max. 450		100-480, max. 500		
Input DC current [A].....:	10		13		
Output AC voltage [V].....:	230V, 50Hz				
Output AC current [A] .....:	4,5	7,0	9,5	11,5	13,0
Output power [W] .....:	1000	1500	2000	2500	2800

7. Model Difference:

Difference:	SOFAR 3000TL	SOFAR 2700TL	SOFAR 2200TL	SOFAR 1600TL	SOFAR 1100TL
Boost inductor	1.9mH	1.9mH	1.9mH	2.6mH	2.6mH
Input sampling resistor (RP105,RP108 /RP189,RP109)	200ohm / 7.5Kohm	200ohm / 7.5Kohm	200ohm / 7.5Kohm	220ohm / 10Kohm	220ohm / 10Kohm
Bus capacitor	3pcs	3pcs	3pcs	2pcs	2pcs
Inverter inductor	1.3mH	1.5mH	2.1mH	2.3mH	3.4mH
Output sampling resistor (RP118, RP119, RC18 /RP120, RP121,RC22)	2Kohm,100ohm,100ohm	2Kohm,100ohm,100ohm	1.0Kohm,330ohm,330ohm	1.0Kohm,200ohm,100ohm	499ohm,200ohm,200ohm

2.2 DESCRIPTION OF TEST MODES

The EUT was tested under the following modes' the final worst mode were marked in boldface and recorded in this report.

- For Conducted Emission Test

Test Mode	TEST VOLTAGE	Model
Full Load	DC 380V	SOFAR 2200TL
Full Load	DC 380V	SOFAR 1100TL
Full Load	DC 230V	**SOFAR 3000TL**
Full Load	**DC 360V**	
Full Load	DC 450V	

- For Radiated Emission Test

Test Mode	TEST VOLTAGE	Model
Full Load	DC 380V	SOFAR 2200TL
Full Load	DC 380V	SOFAR 1100TL
Full Load	DC 230V	**SOFAR 3000TL**
Full Load	**DC 360V**	
Full Load	DC 450V	

- For Harmonics and Flicker Tests

Test Mode	TEST VOLTAGE	Model
Full Load	**DC 380V**	**SOFAR 1100TL**
Full Load	**DC 380V**	**SOFAR 3000TL**

- For Immunity Test

Test Mode	TEST VOLTAGE	Model
10% Load	**DC 300V**	**SOFAR 3000TL**

2.3 GENERAL DESCRIPTION OF APPLIED STANDARDS

The EUT has been tested and complied with the requirements of the following standards:

EN 61000-6-3:2007 + A1:2011
EN 61000-3-2:2006 + A1:2009 + A2:2009
EN 61000-3-3:2013
EN 61000-6-2:2005
IEC 61000-4-2:2008
IEC 61000-4-3:2005 + A1:2007 + A2:2010
IEC 61000-4-4:2012
IEC 61000-4-5:2005
IEC 61000-4-6:2008
IEC 61000-4-8:2009

Notes: The above IEC basic standards are applied with latest version if customer has no special requirement

2.4 DESCRIPTION OF SUPPORT UNITS

The EUT has been tested as an independent unit together with other necessary accessories or support units. The following support units or accessories were used to form a representative test configuration during the tests.

NO.	PRODUCT	BRAND	MODEL NO.	SERIAL NO.	FCC ID
1	DC Source	Chroma	62150H-1000S	62150EF00488	N/A

NO.	SIGNAL CABLE DESCRIPTION OF THE ABOVE SUPPORT UNITS
1	AC Line: Unshielded, Detachable 2.0m, DC Line: Unshielded, Detachable 2.0m;

3 EMISSION TEST

3.1 CONDUCTED EMISSION MEASUREMENT

3.1.1 LIMITS OF CONDUCTED EMISSION MEASUREMENT

FREQUENCY (MHz)	Class A (dBuV)		Class B (dBuV)	
	Quasi-peak	Average	Quasi-peak	Average
0.15 - 0.5	79	66	66 - 56	56 - 46
0.50 - 5.0	73	60	56	46
5.0 - 30.0	73	60	60	50

Note: (1) The lower limit shall apply at the transition frequencies.
(2) The limit decreases in line with the logarithm of the frequency in the range of 0.15 to 0.50 MHz.
(3) All emanations from a class A/B digital device or system, including any network of conductors and apparatus connected thereto, shall not exceed the level of field strengths specified above.

3.1.2 TEST INSTRUMENTS

Equipment	Manufacturer	Model No.	Serial No.	Last Cal.	Next Cal.
EMI Test Receiver	Rohde&Schwarz	ESCS30	100199	May 17,14	May 16,15
Pulse Limiter	Rohde&Schwarz	ESH3-Z2	100168	Oct. 12,13	Oct. 11,14
Artificial Mains Network	Rohde&Schwarz	ESH2-Z5	100071	May 13,14	May 12,15
Test software	ADT	ADT_Cond_ V7.3.7	N/A	N/A	N/A

NOTE: 1. The calibration interval of the above test instruments is 12 months and the calibrations are traceable to CEPREI/CHINA, GRGT/CHINA and NIM/CHINA.
2. The test was performed in shielding room 843.

3.1.3 TEST PROCEDURE

a. The EUT was placed 0.4 meters from the conducting wall of the shielded room with EUT being connected to the power mains through a line impedance stabilization network (LISN). Other support units were connected to the power mains through another LISN. The two LISNs provide 50 Ohm/ 50uH of coupling impedance for the measuring instrument.

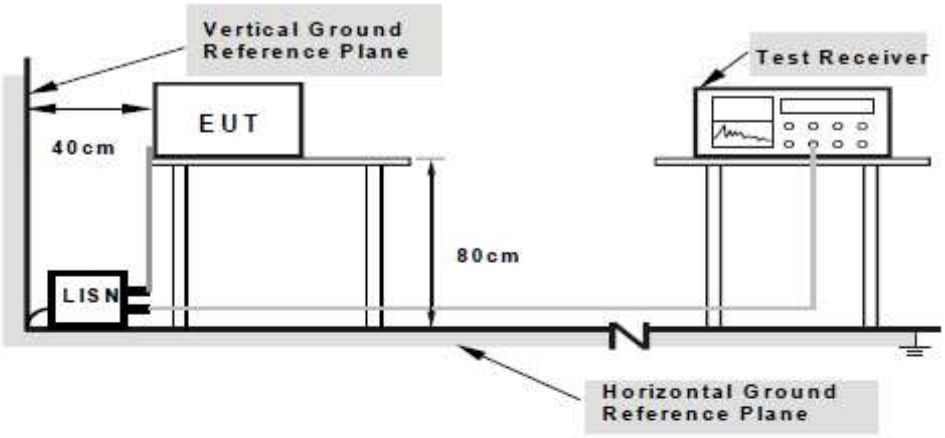
b. Both lines of the power mains connected to the EUT were checked for maximum conducted interference.

c. The frequency range from 150 kHz to 30 MHz was searched. Emission levels under (Limit – 20dB) were not recorded.

3.1.4 DEVIATION FROM TEST STANDARD

No deviation

3.1.5 TEST SETUP



Note: 1.Support units were connected to second LISN.
2.Both of LISNs (AMN) are 80cm from EUT and at least 80cm from other units and other metal planes support units.

3.1.6 EUT OPERATING CONDITIONS

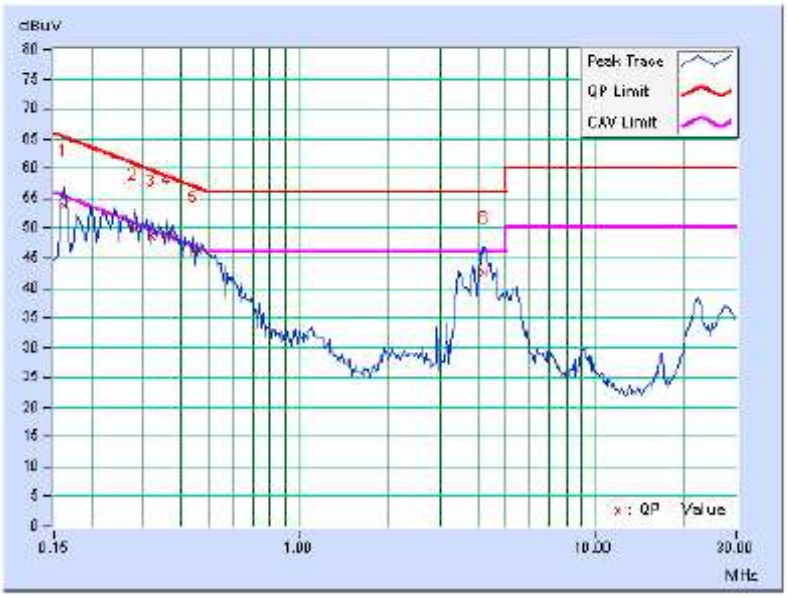
a. Turned on the power of all equipment.
b. EUT was operated according to the type description in manufacturer's specifications or the User's Manual.

3.1.7 TEST RESULTS

TEST MODE	SOFAR 3000TL Grid Mode	6dB BANDWIDTH	9 kHz
TEST VOLTAGE	DC 360V	PHASE	Line (L)
ENVIRONMENTAL CONDITIONS	23 deg. C, 42% RH	TESTED BY: Heise	

No	Freq.	Corr. Factor	Reading Value [dB (uV)]		Emission Level [dB (uV)]		Limit [dB (uV)]		Margin (dB)	
	[MHz]	(dB)	Q.P.	AV.	Q.P.	AV.	Q.P.	AV.	Q.P.	AV.
1	0.16172	5.20	48.57	45.49	53.77	50.69	65.38	55.38	-11.60	-4.68
2	0.27891	9.16	40.76	37.52	49.92	46.68	60.85	50.85	-10.93	-4.17
3	0.31797	9.23	39.58	36.34	48.81	45.57	59.76	49.76	-10.95	-4.19
4	0.36094	9.32	39.63	36.39	48.95	45.71	58.71	48.71	-9.76	-3.00
5	0.43906	9.47	36.61	34.20	46.08	43.67	57.08	47.08	-11.00	-3.41
6	4.25000	10.01	32.52	25.58	42.53	35.59	56.00	46.00	-13.47	-10.41

REMARKS: The emission levels of other frequencies were very low against the limit.

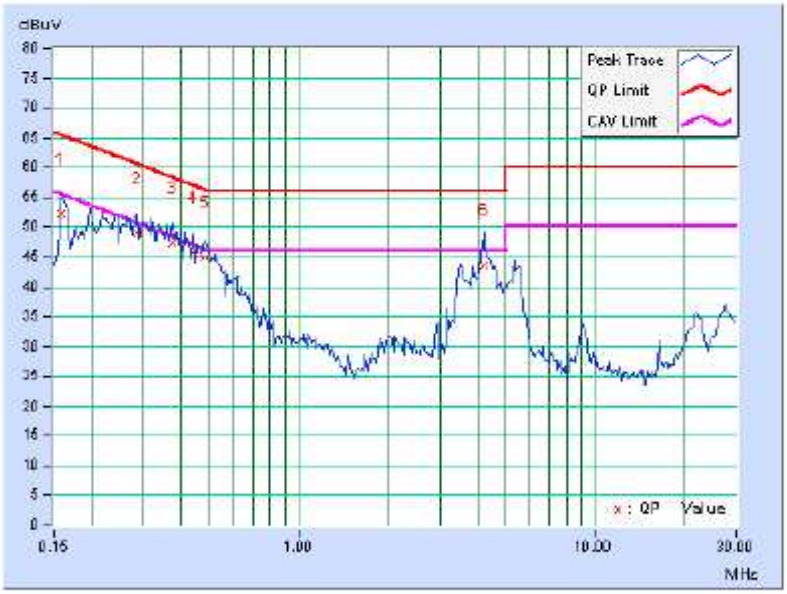


Test Report No.: CE140508N005R1

TEST MODE	SOFAR 3000TL Grid Mode	6dB BANDWIDTH	9 kHz
TEST VOLTAGE	DC 360V	PHASE	Neutral (N)
ENVIRONMENTAL CONDITIONS	23 deg. C, 42% RH	TESTED BY: Heise	

No	Freq.	Corr. Factor	Reading Value [dB (uV)]		Emission Level [dB (uV)]		Limit [dB (uV)]		Margin (dB)	
	[MHz]	(dB)	Q.P.	AV.	Q.P.	AV.	Q.P.	AV.	Q.P.	AV.
1	0.15781	4.85	47.50	43.90	52.35	48.75	65.58	55.58	-13.22	-6.82
2	0.28281	9.19	39.88	36.67	49.07	45.86	60.73	50.73	-11.67	-4.88
3	0.37656	9.35	38.15	35.11	47.50	44.46	58.35	48.35	-10.85	-3.89
4	0.43906	9.46	36.24	33.89	45.70	43.35	57.08	47.08	-11.38	-3.73
5	0.48203	9.54	35.42	33.03	44.96	42.57	56.30	46.30	-11.35	-3.74
6	4.22266	10.05	33.58	25.62	43.63	35.67	56.00	46.00	-12.37	-10.33

REMARKS: The emission levels of other frequencies were very low against the limit.



3.2 RADIATED EMISSION MEASUREMENT

3.2.1 LIMITS OF RADIATED EMISSION MEASUREMENT

TEST STANDARD: EN 61000-6-3

FOR FREQUENCY BELOW 1000 MHz

FREQUENCY (MHz)	Class A (at 10m) dBuV/m	Class B (at 10m) dBuV/m
30 – 230	40	30
230 – 1000	47	37

FREQUENCY RANGE OF RADIATED MEASUREMENT (For unintentional radiators)

Highest frequency generated or Upper frequency of measurement used in the device or on which the device operates or tunes (MHz)	Range (MHz)
Below 108	1000
108 – 500	2000
500 – 1000	5000
Above 1000	Up to 5 times of the highest frequency or 6 GHz, whichever is less

FOR FREQUENCY ABOVE 1000 MHz

FREQUENCY (GHz)	Class A (dBuV/m) (at 3m)		Class B (dBuV/m) (at 3m)	
	PEAK	AVERAGE	PEAK	AVERAGE
1 to 3	76	56	70	50
3 to 6	80	60	74	54

NOTE: (1) The lower limit shall apply at the transition frequencies.
(2) Emission level (dBuV/m) = 20 log Emission level (uV/m).
(3) All emanation from a class A/B digital device or system, including any network of conductors and apparatus connected thereto, shall not exceed the level of field strengths specified above.

3.2.2 TEST INSTRUMENTS

Frequency Range 30MHz-1GHz

Equipment	Manufacturer	Model No.	Serial No.	Last Cal.	Next Cal.
EMI Test Receiver	Rohde&Schwarz	ESCI	100962	Mar. 06,14	Mar. 05,15
Bilog Antenna	Teseq	CBL 6111D	27089	Jul. 27, 13	Jul. 26, 14
Trilog-Broadband Antenna	SCHWARZBECK	VULB 9168	9168-554	Dec. 03, 13	Dec. 02, 14
Trilog-Broadband Antenna	SCHWARZBECK	VULB 9168	9168-555	Dec. 03, 13	Dec. 02, 14
10m Semi-anechoic Chamber	CHANGLING	21.4m*12.1m*8.8m	NSEMC006	Jun. 11, 13	Jun. 10, 14
Amplifier (9kHz-1GHz)	SONOMA	310D	186955	Mar. 05,14	Mar. 04, 15
Test Software	ADT	ADT_Radiated_V7.6.15.9.2	N/A	N/A	N/A

Frequency Range Above1GHz

Equipment	Manufacturer	Model No.	Serial No.	Last Cal.	Next Cal.
Horn Antenna	ETS-Lindgren	3117	00062558	Oct. 18,12	Oct. 17,14
EMI Test Receiver	Rohde&Schwarz	ESCI	100962	Mar. 06,14	Mar. 05,15
Spectrum Analyzer	Rohde&Schwarz	FSV40	101003	Apr. 09,14	Apr. 08,15
Pre-Amplifier (100MHz-26.5GHz)	EMCI	EMC 012645	980077	Nov. 07,13	Nov. 06,14
Pre-Amplifier (18GHz-40GHz)	EMCI	EMC 184045	980102	Nov. 04,13	Nov. 03,14
Test Software	ADT	ADT_Radiated_V7.6.15.9.2	N/A	N/A	N/A

NOTE: 1. The calibration interval of the above test instruments is 12 months. And the calibrations are traceable to CEPREI/CHINA and NIM/CHINA.
2. The test was performed in Chamber 10m.

3.2.3 TEST PROCEDURE

<Frequency Range below 1GHz>

a. The EUT was placed on the top of a rotating table 0.8 meters above the ground at a 10 meter chamber room. The table was rotated 360 degrees to determine the position of the highest radiation.

b. The EUT was set 10 meters away from the interference-receiving antenna, which was mounted on the top of a variable-height antenna tower.

c. The height of antenna is varied from one meter to four meters above the ground to determine the maximum value of the field strength. Both horizontal and vertical polarizations of the antenna are set to make the measurement.

d. For each suspected emission, the EUT was arranged to its worst case and then the antenna was tuned to heights from 1 meter to 4 meters and the turn table was turned from 0 degrees to 360 degrees to find the maximum reading.

e. The test-receiver system was set to quasi-peak detect function and specified bandwidth with maximum hold mode when the test frequency is below 1 GHz.

NOTE:

1. The resolution bandwidth of test receiver/spectrum analyzer is 120kHz for Quasi-peak detection (QP) at frequency below 1GHz.
2. Emission level(dBuV/m)=Raw Value(dBuV) + Correction Factor(dB/m)
3. Correction Factor(dB/m) = Antenna Factor (dB/m) + Cable Factor (dB)
4. Margin value = Emission level – Limit value.

<Frequency Range above 1GHz>

a. The EUT was placed on the top of a rotating table 0.8 meters above the ground at a 10 meter Semi-anechoic chamber room. The table was rotated 360 degrees to determine the position of the highest radiation.

b. The EUT was set 3 meters away from the interference-receiving antenna, which was mounted on the top of a variable-height antenna tower.

c. The height of antenna can be varied from one meter to four meters, the height of adjustment depends on the EUT height and the antenna 3dB beamwidth both, to detect the maximum value of the field strength. Both horizontal and vertical polarizations of the antenna are set to make the measurement.

d. For each suspected emission, the EUT was arranged to its worst case and then the antenna was tuned to heights and the rotatable table was turned from 0 degrees to 360 degrees to find the maximum reading.

e. The test receiver/spectrum was set to peak and average detect function and specified bandwidth with maximum hold mode when the test frequency is above 1 GHz.

NOTE:

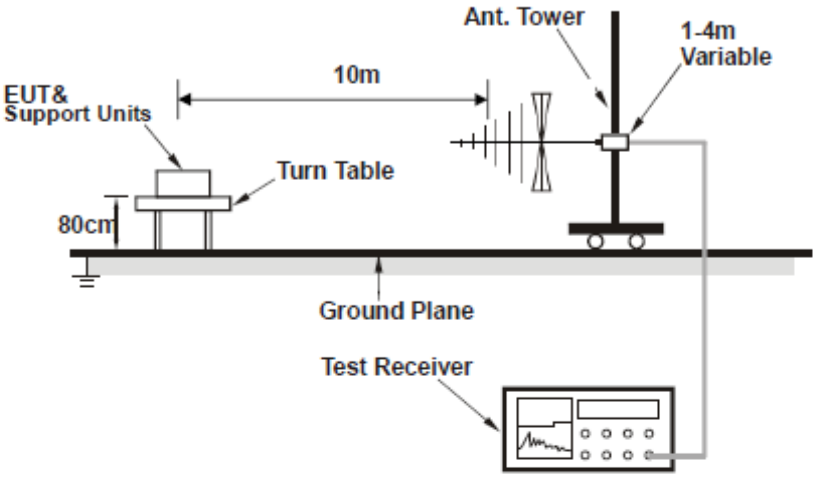
1. The resolution bandwidth is 1MHz and video bandwidth of test receiver/spectrum analyzer is 3MHz for Peak detection at frequency above 1GHz. The resolution bandwidth of test receiver/spectrum analyzer is 1 MHz for Average detection (AV) at frequency above 1GHz.
2. For measurement of frequency above 1000 MHz, the EUT was set 3 meters away from the receiver antenna.

3.2.4 DEVIATION FROM TEST STANDARD

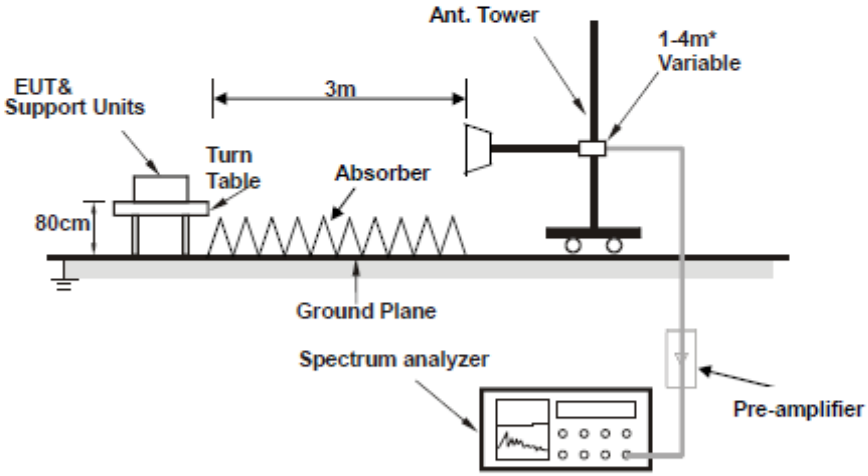
No deviation

3.2.5 TEST SETUP

<Frequency Range below 1GHz>



<Frequency Range above 1GHz>



* : depends on the EUT height and the antenna 3dB beamwidth both, refer to section 7.3 of CISPR 16-2-3.

3.2.6 EUT OPERATING CONDITIONS

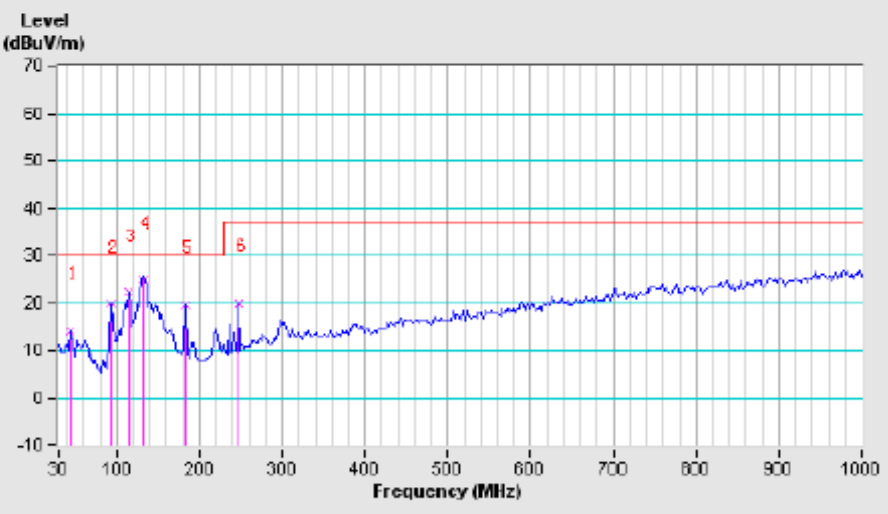
Same as item 3.1.6

3.2.7 TEST RESULTS

TEST MODE	SOFAR 3000TL Grid Mode	FREQUENCY RANGE	30-1000 MHz
TEST VOLTAGE	DC 360V	DETECTOR FUNCTION & BANDWIDTH	Quasi-Peak, 120kHz
ENVIRONMENTAL CONDITIONS	25 deg. C, 50% RH	TESTED BY: Robert	

ANTENNA POLARITY & TEST DISTANCE: HORIZONTAL AT 10 M								
No.	Freq. (MHz)	Correction Factor (dB/m)	Raw Value (dBuV)	Emission Level (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Antenna Height (cm)	Table Angle (Degree)
1	43.58	14.96	-0.74	14.22	30.00	-15.78	143	12
2	92.08	10.26	9.47	19.73	30.00	-10.27	400	31
3	113.42	12.35	9.75	22.10	30.00	-7.90	400	313
4	130.88	13.26	11.50	24.76	30.00	-5.24	400	122
5	183.26	12.88	6.59	19.47	30.00	-10.53	219	132
6	247.28	14.09	5.71	19.80	37.00	-17.20	100	13

REMARKS: The emission levels of other frequencies were very low against the limit..

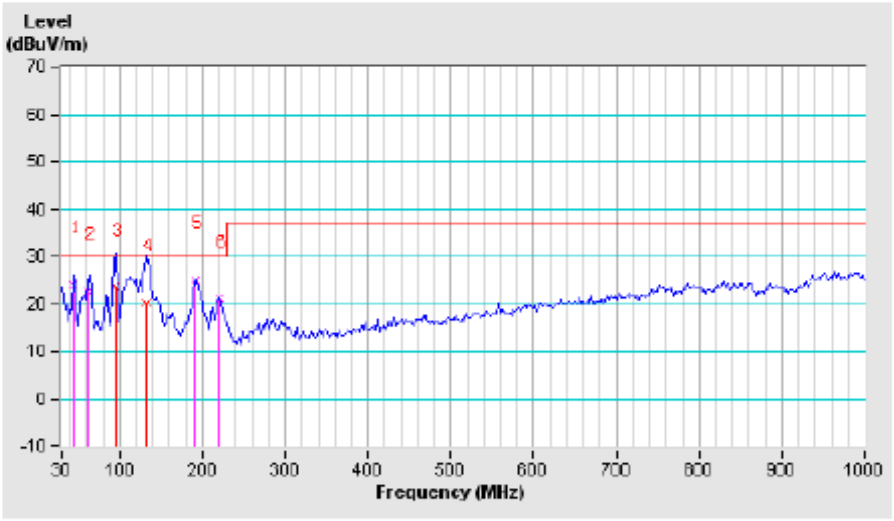


Test Report No.: CE140508N005R1

TEST MODE	SOFAR 3000TL Grid Mode	FREQUENCY RANGE	30-1000 MHz
TEST VOLTAGE	DC 360V	DETECTOR FUNCTION & BANDWIDTH	Quasi-Peak, 120kHz
ENVIRONMENTAL CONDITIONS	25 deg. C, 50% RH	TESTED BY: Robert	

ANTENNA POLARITY & TEST DISTANCE: VERTICAL AT 10 M								
No.	Freq. (MHz)	Correction Factor (dB/m)	Raw Value (dBuV)	Emission Level (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Antenna Height (cm)	Table Angle (Degree)
1	43.58	14.96	9.04	24.00	30.00	-6.00	195	129
2	61.04	13.28	9.31	22.59	30.00	-7.41	165	104
3	94.00	10.50	12.90	23.40	30.00	-6.60	100	20
4	130.88	13.26	6.84	20.10	30.00	-9.90	100	20
5	**191.02**	**12.37**	**12.55**	**24.92**	**30.00**	**-5.08**	**128**	**72**
6	220.12	12.64	8.38	21.02	30.00	-8.98	231	160

REMARKS: The emission levels of other frequencies were very low against the limit.



3.3 HARMONICS CURRENT MEASUREMENT (<16A)

3.3.1 LIMITS OF HARMONICS CURRENT MEASUREMENT

TEST STANDARD: EN 61000-3-2

Limits for Class A equipment	
Harmonic Order n	Max. permissible harmonics current A
Odd harmonics	
3	2.30
5	1.14
7	0.77
9	0.40
11	0.33
13	0.21
15<=n<=39	0.15x15/n
Even harmonics	
2	1.08
4	0.43
6	0.30
8<=n<=40	0.23x8/n

Limits for Class D equipment		
Harmonic Order n	Max. permissible harmonics current per watt mA/W	Max. permissible harmonics current A
Odd Harmonics only		
3	3.4	2.30
5	1.9	1.14
7	1.0	0.77
9	0.5	0.40
11	0.35	0.33
13	0.30	0.21
15<=n<=39	3.85/n	0.15x15/n

NOTE: 1.Class A and Class D are classified according to section 5 of EN 61000-3-2.

2.According to section 7 of EN 61000-3-2, the above limits for all equipment except for lighting equipment having an active power input> 75 W and no limits apply for equipment with an active power input up to and including 75 W.

- **Limits for Class B equipment:**

For class B equipment, the harmonics of the input current shall not exceed the maximum permissible values given for class A equipment multiplied by a factor of 1.5.

Limits for Class C equipment	
Harmonic Order n	Max. permissible harmonics current expressed as a percentage of the input current at the fundamental frequency %
2	2
3	30· λ
5	10
7	7
9	5
11<=n<=39 (odd harmonics only)	3
λ is the circuit power factor	

NOTE: Discharge lighting equipment having an active TEST VOLTAGE smaller than or equal to 25W, the harmonic currents shall not exceed the power related limits of Class D.

3.3.2 TEST INSTRUMENTS

DESCRIPTION & MANUFACTURER	MANUFACTURER	MODEL NO.	SERIAL NO.	CALIBRATED DATE	CALIBRATED UNTIL
PRECISION POWER ANALYZER	YOKOGAWA	WT3000	91M210852	Mar. 12,14	Mar. 11,15
Test Software	YOKOGAWA	IEC61000	N/A	N/A	N/A
PEFERENCE IMPEDANCE NETWORK	Voltech	EUR	3018	N/A	N/A

NOTE: 1. The test was performed in PV Room.
2. The calibration interval of the above test instruments is 12 months and the calibrations are traceable to CEPREI/CHINA, GRGT/CHINA and NIM/CHINA.

3.3.3 TEST PROCEDURE

a. The EUT was placed on the top of a wooden table 0.8 meters above the ground and operated to produce the maximum harmonic components under normal operating conditions for each successive harmonic component in turn.

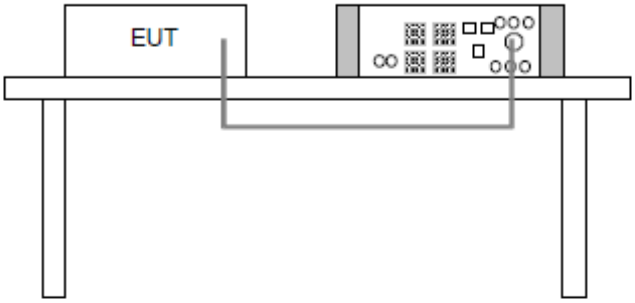
b. The classification of EUT is according to section 5 of EN 61000-3-2:2006 + A1:2009 + A2:2009.
The EUT is classified as follows:
Class A: Balanced three-phase equipment, Household appliances excluding equipment as Class D, Tools excluding portable tools, Dimmers for incandescent lamps, audio equipment, equipment not specified in one of the three other classes.
Class B: Portable tools. ; Arc welding equipment which is not professional equipment
Class C: Lighting equipment.
Class D: Equipment having a specified power less than or equal to 600 W of the following types: Personal computers and personal computer monitors and television receivers.

c. The correspondent test program of test instrument to measure the current harmonics emanated from EUT is chosen. The measure time shall be not less than the time necessary for the EUT to be exercised.

3.3.4 DEVIATION FROM TEST STANDARD

No deviation

3.3.5 TEST SETUP



3.3.6 EUT OPERATING CONDITIONS

Same as item 3.1.6

Test Report No.: CE140508N005R1

3.3.7 TEST RESULTS

SOFAR 1100TL

******* appliances (Average)**

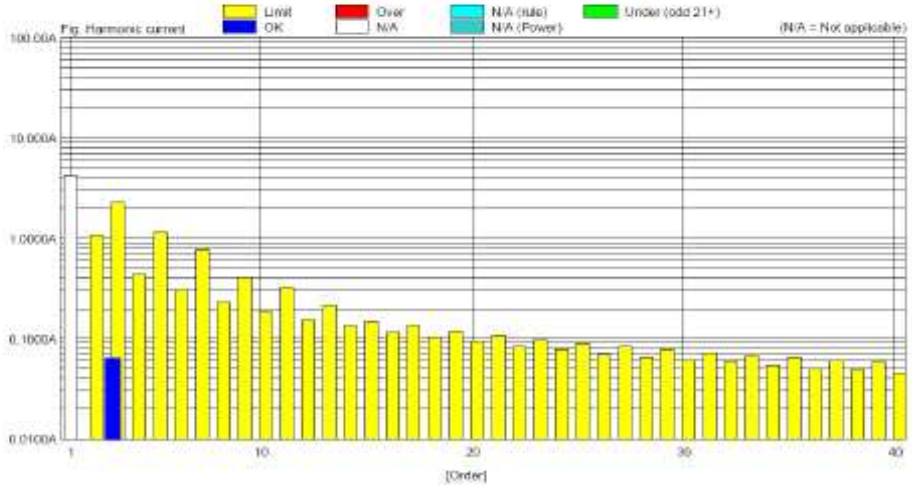
Print Date	:	Mon May 26 14:15:38 2014
MeasureDate	:	Mon May 26 14:15:34 2014
Comment	:	Experimental model Pattern A

Regulation	:	IEC61000-3-2 Ed3.0 am2 IEC61000-4-7 Ed2.0 A1
Class	:	CLASS A
MeasureTime	:	150.00sec
Model	:	YOKOGAWA WT3000
Rating Voltage	:	230.00 V
Wiring	:	single-phase 2-wire
Element	:	1
Range	:	300V/30A
Current(rms)	:	4.2800 A
Voltage(rms)	:	230.42 V
Frequency	:	50.000 Hz
Power Factor	:	0.9957
PCHC Limit	:	0.2514 A
PCHC Max	:	0.0040 A
THC	:	0.0658 A

PASS

Set Fundamental I	:	--------
Set Power Factor	:	--------
Set P	:	--------
Sigma W Max	:	982.9105 W
Sigma PF	:	0.9957
Distortion factor(V)	:	0.05 %
V THDS	:	0.05 %
V THDG	:	0.05 %
Distortion factor(A)	:	1.53 %
A THDS	:	1.53 %
A THDG	:	1.54 %
P THD	:	0.00 %
Power Limit	:	75 W

Order	Measure[A]	Limit[A]	Margin[%]	Order	Measure[A]	Limit[A]	Margin[%]
1	4.2795			2	0.0036	1.0800	99.1
3	0.0632	2.3000	97.3	4	0.0045	0.4300	99.0
5	0.0056	1.1400	99.2	6	0.0031	0.3000	99.0
7	0.0061	0.7700	99.2	8	0.0022	0.2300	99.0
9	0.0036	0.4000	99.1	10	0.0023	0.1840	98.8
11	0.0023	0.3300	99.4	12	0.0027	0.1533	98.5
13	0.0018	0.2100	99.1	14	0.0018	0.1314	98.6
15	0.0016	0.1500	99.0	16	0.0016	0.1150	98.6
17	0.0014	0.1324	99.0	18	0.0015	0.1022	98.3
19	0.0015	0.1184	98.8	20	0.0016	0.0920	98.3
21	0.0017	0.1071	98.4	22	0.0015	0.0836	98.4
23	0.0014	0.0978	98.6	24	0.0012	0.0767	98.4
25	0.0015	0.0900	98.3	26	0.0014	0.0708	98.0
27	0.0012	0.0833	98.6	28	0.0011	0.0657	98.3
29	0.0012	0.0776	98.5	30	0.0010	0.0613	98.4
31	0.0016	0.0726	98.7	32	0.0011	0.0575	98.1
33	0.0011	0.0682	98.4	34	0.0013	0.0541	97.6
35	0.0011	0.0643	98.3	36	0.0012	0.0511	97.7
37	0.0009	0.0608	98.5	38	0.0012	0.0484	97.6
39	0.0009	0.0577	98.5	40	0.0015	0.0460	96.9



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Test Report No.: CE140508N005R1

***** appliances (Maximum)

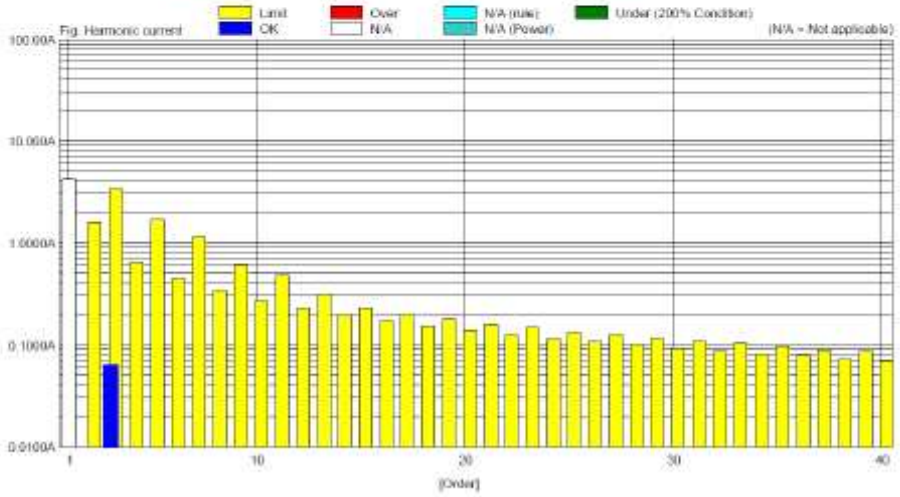
Print Date	:	Mon May 26 14:15:38 2014
MeasureDate	:	Mon May 26 14:15:34 2014
Comment	:	Experimental model Pattern A

Regulation	:	IEC61000-3-2 Ed3.0 am2 IEC61000-4-7 Ed2.0 A1
Class	:	CLASS A
MeasureTime	:	150.00sec
Model	:	YOKOGAWA WT3000
Rating Voltage	:	230.00 V
Wiring	:	single-phase 2-wire
Element	:	1
Range	:	300V/30A
Current(rms)	:	4.2840 A
Voltage(rms)	:	230.42 V
Frequency	:	50.004 Hz
Power Factor	:	0.9957
Beyond Limit Time	:	15.0000 s
Beyond Total Time	:	0.0000 s
THC	:	0.0661 A

PASS

Set Fundamental I	:	--------
Set Power Factor	:	--------
Set P	:	--------
Sigma W Max	:	982.9105 W
Sigma PF	:	0.9957
Distortion factor(V)	:	0.05 %
V THDS	:	0.05 %
V THDG	:	0.05 %
Distortion factor(A)	:	1.55 %
A THDS	:	1.55 %
A THDG	:	1.56 %
P THD	:	0.00 %
Power Limit	:	75 W

Order	Measure[A]	Limit[A]	Margin[%]	Order	Measure[A]	Limit[A]	Margin[%]
1	4.2835			2	0.0100	1.6200	99.4
3	0.0635	3.4500	98.2	4	0.0047	0.8450	99.3
5	0.0089	1.7100	99.4	6	0.0033	0.4500	99.3
7	0.0050	1.1550	98.5	8	0.0024	0.3450	99.3
9	0.0039	0.6000	99.4	10	0.0025	0.2760	99.1
11	0.0022	0.4950	98.5	12	0.0025	0.2300	98.9
13	0.0021	0.3150	99.3	14	0.0023	0.1971	99.0
15	0.0015	0.2250	99.3	16	0.0019	0.1725	99.0
17	0.0015	0.1985	99.2	18	0.0019	0.1533	98.8
19	0.0016	0.1776	99.1	20	0.0017	0.1380	98.7
21	0.0019	0.1607	98.8	22	0.0015	0.1255	98.8
23	0.0016	0.1467	98.9	24	0.0015	0.1150	98.8
25	0.0016	0.1380	98.8	26	0.0015	0.1062	98.6
27	0.0013	0.1250	98.9	28	0.0012	0.0986	98.8
29	0.0013	0.1184	98.9	30	0.0013	0.0920	98.9
31	0.0011	0.1089	99.0	32	0.0012	0.0862	98.6
33	0.0013	0.1023	98.8	34	0.0014	0.0812	98.3
35	0.0012	0.0964	98.7	36	0.0013	0.0767	98.4
37	0.0010	0.0912	98.9	38	0.0013	0.0726	98.3
39	0.0010	0.0885	98.9	40	0.0016	0.0690	97.7



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Test Report No.: CE140508N005R1

SOFAR 3000TL

***** appliances (Average)

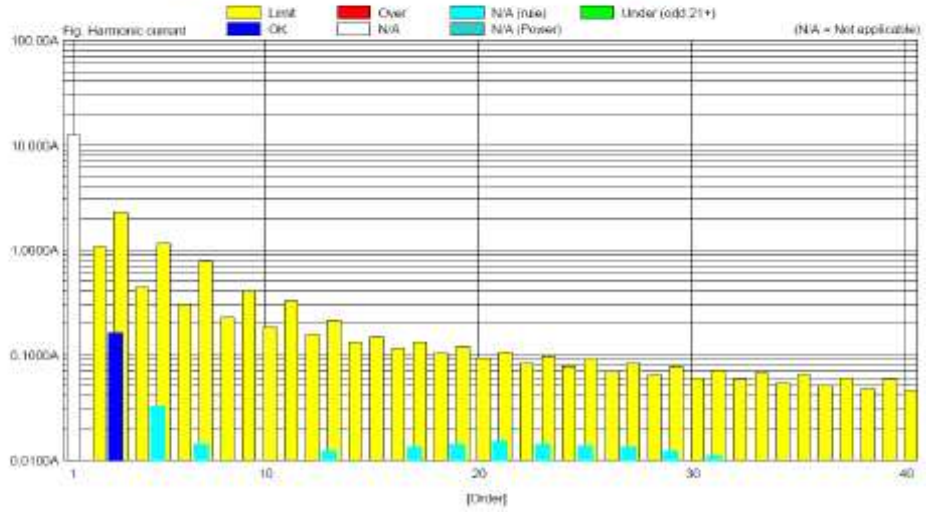
Print Date	Wed Jun 11 11:32:38 2014
MeasureDate	Wed Jun 11 11:31:38 2014
Comment	Experimental model Pattern A

Regulation	IEC61000-3-2 Ed3.0 am2 IEC61000-4-7 Ed2.0 A1
Class	CLASS A
MeasureTime	150.00sec
Model	YOKOGAWA WT3000
Rating Voltage	230.00 V
Wiring	single-phase 2-wire
Element	2
Range	300V/30A
Current(rms)	12.1893 A
Voltage(rms)	229.99 V
Frequency	49.999 Hz
Power Factor	0.9998
POHC Limit	0.2514 A
POHC Max	0.0365 A
THC	0.1683 A

PASS

Set Fundamental I	---------
Set Power Factor	---------
Set P	---------
Sigma W Max	2804.014 W
Sigma PF	0.9998
Distortion factor(V)	0.04 %
V THDS	0.04 %
V THDG	0.04 %
Distortion factor(A)	1.38 %
A THDS	1.38 %
A THDG	1.38 %
P THD	0.00 %
Power Limit	75 W

Order	Measure[A]	Limit[A]	Margin[%]	Order	Measure[A]	Limit[A]	Margin[%]
1	12.1882			2	0.0051	1.0800	99.2
3	0.1680	2.3000	93.1	4	0.0062	0.4300	98.6
5	0.0310	1.1400	97.2	6	0.0031	0.3000	99.0
7	0.0138	0.7700	98.2	8	0.0031	0.2300	98.7
9	0.0054	0.4000	98.6	10	0.0042	0.1840	97.7
11	0.0033	0.3300	98.2	12	0.0037	0.1533	97.6
13	0.0121	0.2100	94.3	14	0.0040	0.1314	96.9
15	0.0102	0.1600	93.2	16	0.0032	0.1150	97.3
17	0.0129	0.1324	90.3	18	0.0034	0.1022	97.7
19	0.0138	0.1184	88.3	20	0.0035	0.0920	97.2
21	0.0148	0.1071	86.3	22	0.0018	0.0836	97.8
23	0.0137	0.0978	86.0	24	0.0016	0.0767	97.9
25	0.0133	0.0900	85.2	26	0.0018	0.0708	97.3
27	0.0130	0.0833	84.4	28	0.0017	0.0657	97.3
29	0.0119	0.0776	84.7	30	0.0015	0.0613	97.8
31	0.0107	0.0726	85.3	32	0.0012	0.0575	98.0
33	0.0094	0.0682	86.1	34	0.0012	0.0541	97.7
35	0.0091	0.0643	85.9	36	0.0011	0.0511	97.8
37	0.0079	0.0608	87.1	38	0.0013	0.0484	97.2
39	0.0077	0.0577	86.6	40	0.0012	0.0460	97.4



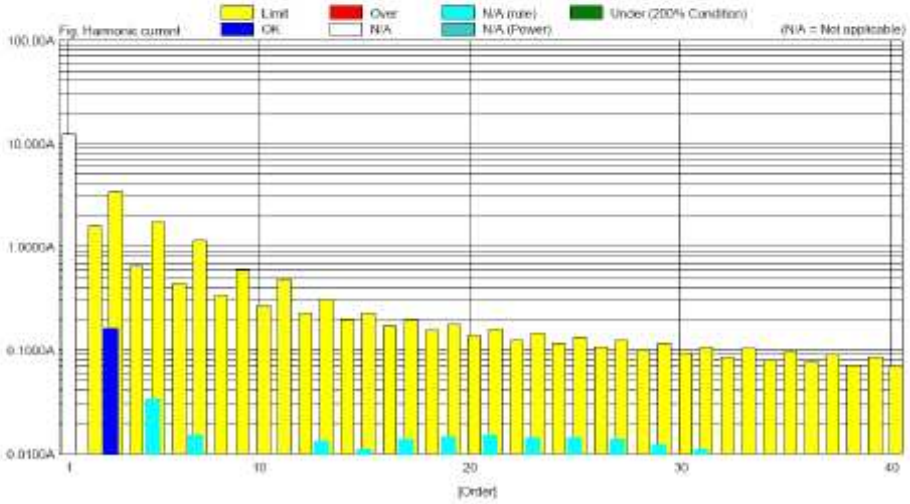
Test Report No.: CE140508N005R1

***** appliances (Maximum)

Print Date : Wed Jun 11 11:32:39 2014
MeasureDate : Wed Jun 11 11:31:38 2014
Comment : Experimental model Pattern A

Regulation	:	IEC61000-3-2 Ed3.0 am2 IEC61000-4-7 Ed2.0 A1	PASS		
Class	:	CLASS A	Set Fundamental I	:	--------
MeasureTime	:	150.00sec	Set Power Factor	:	--------
Model	:	YOKOGAWA WT3000	Set P	:	--------
Rating Voltage	:	230.00 V	Sigma W Max	:	2804.014 W
Wiring	:	single-phase 2-wire	Sigma PF	:	0.9998
Element	:	2	Distortion factor(V)	:	0.04 %
Range	:	300V/30A	V THDS	:	0.04 %
Current(rms)	:	12.1941 A	V THDG	:	0.04 %
Voltage(rms)	:	229.99 V	Distortion factor(A)	:	1.40 %
Frequency	:	50.018 Hz	A THDS	:	1.40 %
Power Factor	:	0.9998	A THDG	:	1.40 %
Beyond Limit Time	:	15.0002 s	P THD	:	0.00 %
Beyond Total Time	:	0.0000 s	Power Limit	:	75 W
THC	:	0.1694 A			

Order	Measure[A]	Limit[A]	Margin[%]	Order	Measure[A]	Limit[A]	Margin[%]
1	12.1929			2	0.0067	1.6200	99.5
3	0.1691	3.4500	95.4	4	0.0067	0.6480	99.0
5	0.0058	1.7100	99.1	6	0.0035	0.4500	99.2
7	0.0116	1.1550	98.7	8	0.0054	0.3460	99.0
9	0.0058	0.6000	99.0	10	0.0041	0.2760	98.3
11	0.0065	0.4950	98.7	12	0.0042	0.2300	98.2
13	0.0129	0.3150	95.9	14	0.0061	0.1971	97.4
15	0.0109	0.2250	95.2	16	0.0035	0.1725	98.0
17	0.0154	0.1985	93.3	18	0.0027	0.1533	98.2
19	0.0142	0.1776	92.0	20	0.0028	0.1380	97.9
21	0.0150	0.1607	90.7	22	0.0021	0.1255	98.4
23	0.0135	0.1467	90.5	24	0.0018	0.1150	98.4
25	0.0130	0.1350	89.9	26	0.0022	0.1062	98.0
27	0.0132	0.1250	89.4	28	0.0020	0.0986	98.0
29	0.0121	0.1164	89.6	30	0.0015	0.0920	98.4
31	0.0109	0.1089	90.0	32	0.0013	0.0862	98.5
33	0.0097	0.1023	90.6	34	0.0014	0.0812	98.3
35	0.0092	0.0964	90.4	36	0.0012	0.0767	98.4
37	0.0081	0.0912	91.1	38	0.0016	0.0726	97.9
39	0.0079	0.0865	90.8	40	0.0014	0.0690	97.9



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3.4 VOLTAGE FLUCTUATION AND FLICKS MEASUREMENT

3.4.1 LIMITS OF VOLTAGE FLUCTUATION AND FLICKS MEASUREMENT

TEST STANDARD: EN 61000-3-3

TEST ITEM	LIMIT	NOTE
P_{st}	1.0	P_{st} means short-term flicker indicator.
P_{lt}	0.65	P_{lt} means long-term flicker indicator.
$T_{d(t)}$ (ms)	500	$T_{d(t)}$ means maximum time that d(t) exceeds 3.3%.
d_{max} (%)	4	dmax means maximum relative voltage change.
dc (%)	3.3	dc means relative steady-state voltage change

3.4.2 TEST INSTRUMENTS

DESCRIPTION & MANUFACTURER	MANUFACTURER	MODEL NO.	SERIAL NO.	CALIBRATED DATE	CALIBRATED UNTIL
PRECISION POWER ANALYZER	YOKOGAWA	WT3000	91M210852	Mar. 12,14	Mar. 11,15
Test Software	YOKOGAWA	IEC61000	N/A	N/A	N/A
PEFERENCE IMPEDANCE NETWORK	Voltech	EUR	3018	N/A	N/A

NOTE: 1. The test was performed in PV Room.
2. The calibration interval of the above test instruments is 12 months and the calibrations are traceable to CEPREI/CHINA, GRGT/CHINA and NIM/CHINA.

3.4.3 TEST PROCEDURE

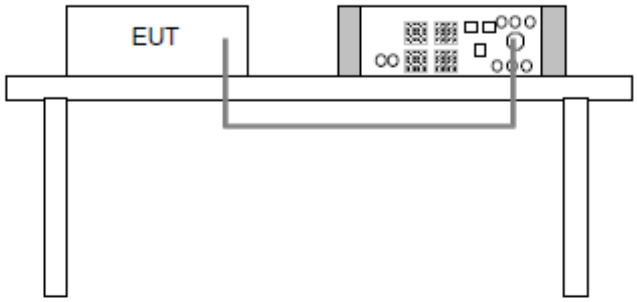
a. The EUT was placed on the top of a wooden table 0.8 meters above the ground and operated to produce the most unfavorable sequence of voltage changes under Normal Operating conditions.

b. During the flick measurement, the measure time shall include that part of whole operation cycle in which the EUT produce the most unfavorable sequence of voltage changes. The observation period for short-term flicker indicator is 120 minutes

3.4.4 DEVIATION FROM TEST STANDARD

No deviation

3.4.5 TEST SETUP



3.4.6 EUT OPERATING CONDITIONS

Same as item 3.1.6.

Test Report No.: CE140508N005R1

3.4.7 TEST RESULTS

SOFAR 1100TL

PV Inverter

Print Date : Mon May 26 16:26:18 2014
MeasureDate : Mon May 26 16:25:54 2014
Comment : Experimental model Pattern A

Regulation : IEC61000-3-3 Ed2.0
IEC61000-4-15 Ed1.1
Interval : 10Min0Sec
Model : YOKOGAWA WT3000
Wiring : single-phase 2wire
Voltage Range : 300.00V
Voltage U1 : 231.61V
Set Frequency : 50Hz
Frequency U1 : 50.000Hz
Element : 1
dmin : 0.10%

PASS(Under dmin)

Element1 : Pass(Under dmin)
dc (3.30%) : Pass
dmax (4.00%) : Pass
d(t) (500ms) : Pass
Pst (1.00) : Pass
Plt (0.65) : Pass

No.	dc[%]	dmax[%]	d(t)[ms]	Pst
1	0.00	0.00	0.00	0.07
2	0.00	0.00	0.00	0.07
3	0.00	0.00	0.00	0.07
4	0.00	0.00	0.00	0.07
5	0.00	0.00	0.00	0.07
6	0.00	0.00	0.00	0.07
7	0.00	0.00	0.00	0.07
8	0.00	0.00	0.00	0.07
9	0.00	0.00	0.00	0.07
10	0.00	0.00	0.00	0.07
11	0.00	0.00	0.00	0.07
12	0.00	0.00	0.00	0.07
				Plt
				0.07

Test Report No.: CE140508N005R1

SOFAR 3000TL

PV Inverter

Print Date : Fri Jun 13 11:17:38 2014
MeasureData : Fri Jun 13 11:17:28 2014
Comment : Experimental model Pattern A

Regulation : IEC61000-3-3 Ed2.0
IEC61000-4-15 Ed1.1
Interval : 10Min0Sec
Model : YOKOGAWA WT3000
Wiring : single-phase 2-wire
Voltage Range : 300.00V
Voltage U1 : 234.15V
Set Frequency : 50Hz
Frequency U1 : 50.000Hz
Element : 1
dmin : 0.10%

PASS (Under dmin)

Element1		: Pass(Under dmin)
dc	(3.30%)	: Pass
dmax	(4.00%)	: Pass
d(t)	(500ms)	: Pass
Pst	(1.00)	: Pass
Plt	(0.65)	: Pass

No.	dc[%]	dmax[%]	d(t)[ms]	Pst
1	0.00	0.00	0.00	0.07
2	0.00	0.00	0.00	0.07
3	0.00	0.00	0.00	0.07
4	0.00	0.00	0.00	0.07
5	0.00	0.00	0.00	0.07
6	0.00	0.00	0.00	0.07
7	0.00	0.00	0.00	0.07
8	0.00	0.00	0.00	0.07
9	0.00	0.00	0.00	0.07
10	0.00	0.00	0.00	0.07
11	0.00	0.00	0.00	0.07
12	0.00	0.00	0.00	0.07
				Plt
				0.07

4 IMMUNITY TEST

4.1 GENERAL DESCRIPTION

4.1.1 GENERAL DESCRIPTION OF EN 61000-6-2

Product Standard:	EN 61000-6-2:2005	
Basic Standard, specification requirement, and Performance Criteria:	IEC 61000-4-2	Electrostatic Discharge – ESD: 4kV Contact discharge, 8kV air discharge, Performance Criterion B
	IEC 61000-4-3	Radio-Frequency Electromagnetic Field Susceptibility Test – RS: 80-1000 MHz, 10V/m, 80% AM (1kHz), 1400-2000 MHz, 3V/m, 80% AM (1kHz) 2000-2700 MHz, 1V/m, 80% AM (1kHz) Performance Criterion A
	IEC 61000-4-4	Electrical Fast Transient/Burst - EFT AC Power line: 2kV, DC Power line: 2kV Signal line: 1kV Performance Criterion B
	IEC 61000-4-5	Surge Immunity Test: 1.2/50 us Open Circuit Voltage, 8 /20 us Short Circuit Current, AC Power Line: line to line 1 kV, line to earth 2kV DC Power Line: line to line 0.5kV line to earth 0.5kV Signal line: 1kV Performance Criterion B
	IEC 61000-4-6	Conducted Radio Frequency Disturbances Test – CS: 0.15-80 MHz, 10Vrms, 80% AM, 1kHz, Performance Criterion A
	IEC 61000-4-8	Power Frequency Magnetic Field Test, 50 Hz, 30A/m, Performance Criterion A

4.1.2 PERFORMANCE CRITERIA

According to Clause 4 of EN 61000-6-2:2005 standard, the following describes the general performance criteria.

CRITERION A	The apparatus shall continue to operate as intended during and after the test. No degradation of performance or loss of function is allowed below a performance level specified by the manufacturer, when the apparatus is used as intended. The performance level may be replaced by a permissible loss of performance. If the minimum performance level or the permissible performance loss is not specified by the manufacturer, either of these may be derived from the product description and documentation and what the user may reasonably expect from the apparatus if used as intended.
CRITERION B	The apparatus shall continue to operate as intended after the test. No degradation of performance or loss of function is allowed below a performance level specified by the manufacturer, when the apparatus is used as intended. The performance level may be replaced by a permissible loss of performance. During the test, degradation of performance is however allowed. No change of operating state or stored data is allowed. If the minimum performance level or the permissible performance loss is not specified by the manufacturer, either of these may be derived from the product description and documentation and what the user may reasonably expect from the apparatus if used as intended.
CRITERION C	Temporary loss of function is allowed, provided the function is self-recoverable or can be restored by the operation of the controls.

4.1.3 EUT OPERATING CONDITION

Same as item 3.1.6

4.2 ELECTROSTATIC DISCHARGE IMMUNITY TEST (ESD)

4.2.1 TEST SPECIFICATION

Basic Standard:	IEC 61000-4-2
Discharge Impedance:	330 ohm / 150 pF
Discharge Voltage:	Air Discharge: 8 kV (Direct) Contact Discharge: 4 kV (Indirect)
Polarity:	Positive & Negative
Number of Discharge:	20 times at each test point
Discharge Mode:	Single Discharge
Discharge Period:	1 second

4.2.2 TEST INSTRUMENTS

Equipment	Manufacturer	Model No.	Serial No.	Last Cal.	Next Cal.
ESD Generator	TESEQ	NSG 437	279	Oct. 12, 13	Oct. 11, 14
Test Software	TESEQ	V03.03	N/A	N/A	N/A
ESD Generator	EM TEST	Dito	V1211112265	Jun. 19,14	Jun. 18,15
Test Software	EM TEST	V 2.31	N/A	N/A	N/A

NOTE: 1. The test was performed in ESD Room.
2. The calibration interval of the above test instruments is 12 months and the calibrations are traceable to CEPREI/CHINA, GRGT/CHINA and NIM/CHINA.

4.2.3 TEST PROCEDURE

The basic test procedure was in accordance with IEC 61000-4-2:

a. Electrostatic discharges were applied only to those points and surfaces of the EUT that are accessible to users during normal operation.

b. The test was performed with at least ten single discharges on the pre-selected points in the most sensitive polarity.

c. The time interval between two successive single discharges was at least 1 second.

d. The ESD generator was held perpendicularly to the surface to which the discharge was applied and the return cable was at least 0.2 meters from the EUT.

e. Contact discharges were applied to the non-insulating coating, with the pointed tip of the generator penetrating the coating and contacting the conducting substrate.

f. Air discharges were applied with the round discharge tip of the discharge electrode approaching the EUT as fast as possible (without causing mechanical damage) to touch the EUT. After each discharge, the ESD generator was removed from the EUT and re-triggered for a new single discharge. The test was repeated until all discharges were complete.

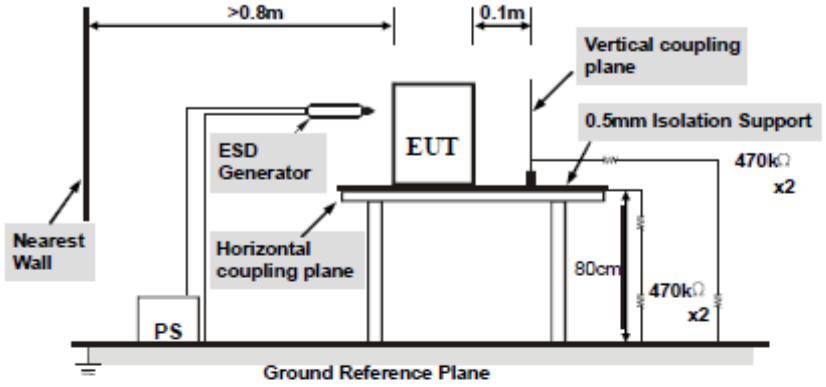
g. At least ten single discharges (in the most sensitive polarity) were applied to the Horizontal Coupling Plane at points on each side of the EUT. The ESD generator was positioned horizontal at a distance of 0.1 meters from the EUT with the discharge electrode touching the HCP.

h. At least ten single discharges (in the most sensitive polarity) were applied to the center of one vertical edge of the Vertical Coupling Plane in sufficiently different positions that the four faces of the EUT were completely illuminated. The VCP (dimensions 0.5m x 0.5m) was placed vertically to and 0.1 meters from the EUT.

4.2.4 DEVIATION FROM TEST STANDARD

No Deviation

4.2.5 TEST SETUP



NOTE:

TABLE-TOP EQUIPMENT

The configuration consisted of a wooden table 0.8 meters high standing on the Ground Reference Plane. The GRP consisted of a sheet of aluminum at least 0.25mm thick, and 2.5 meters square connected to the protective grounding system. A Horizontal Coupling Plane (1.6m x 0.8m) was placed on the table and attached to the GRP by means of a cable with 940kΩ total impedance. The equipment under test, was installed in a representative system as described in section 7 of IEC 61000-4-2, and its cables were placed on the HCP and isolated by an insulating support of 0.5mm thickness. A distance of 1-meter minimum was provided between the EUT and the walls of the laboratory and any other metallic structure.

FLOOR-STANDING EQUIPMENT

The equipment under test was installed in a representative system as described in section 7 of IEC 61000-4-2, and its cables were isolated from the Ground Reference Plane by an insulating support of 0.1-meter thickness. The GRP consisted of a sheet of aluminum that is at least 0.25mm thick, and 2.5 meters square connected to the protective grounding system and extended at least 0.5 meters from the EUT on all sides.

4.2.6 TEST RESULTS

TEST MODE	See item 2.2	TEST VOLTAGE	DC 300V
ENVIRONMENTAL CONDITIONS	21.2deg. C, 51% RH 101.3kPa	TESTED BY: Heise	

Direct Discharge Application				
Test Level (kV)	Polarity	Test Point	Test Result of Contact Discharge	Test Result of Air Discharge
4	+/-	All Metal Part	A	N/A
8	+/-	All Non-metal Part	N/A	A

Indirect Discharge Application				
Discharge Level (kV)	Polarity	Test Point	Test Result of HCP	Test Result of VCP
4	+/-	HCP&VCP	A	A

NOTE: A: There was no change compared with initial operation during the test.

4.3 RADIATED, RADIO-FREQUENCY, ELECTROMAGNETIC FIELD IMMUNITY TEST (RS)

4.3.1 TEST SPECIFICATION

Basic Standard:	IEC 61000-4-3
Frequency Range:	80-1000MHz, 1400-2000MHz, 2000-2700MHz
Field Strength:	10V/m, 3V/m, 1V/m
Modulation:	1kHz Sine Wave, 80%, AM Modulation
Frequency Step:	1 % of fundamental
Polarity of Antenna:	Horizontal and Vertical
Antenna Height:	1.5m
Dwell Time:	at least 3 seconds

4.3.2 TEST INSTRUMENTS

Equipment	Manufacturer	Model No.	Serial No.	Last Cal.	Next Cal.
Signal Generator	Agilent	N5181A	MY50142530	Nov. 01,13	Oct. 31,14
Antenna Log-Periodic	CORAD	ATR80M6G	0337307	N/A	N/A
Antenna Log-Periodic	CORAD	ATS700M11G	0336821	N/A	N/A
Switch Controller	CORAD	SC1000	0337343	N/A	N/A
RF Power Meter	ESE	4242	13984	Nov. 04,13	Nov. 03,14
Power Sensor	ESE	51011EMC	35716	Nov. 04,13	Nov. 03,14
Power Sensor	ESE	51011EMC	35715	Nov. 04,13	Nov. 03,14
E-Field probe	Narda	NBM-520	2403/01B	May 07,14	May 06,15
Power Amplifier	TESEQ	CBA 1G-150	T44029	N/A	N/A
Power Amplifier	TESEQ	CBA 3G-100	T44030	N/A	N/A
Power Amplifier	TESEQ	CBA 6G-050	1041204	N/A	N/A
Dual Directional Coupler	TESEQ	C5982	95208	Dec. 23,13	Dec. 22,14
Dual Directional Coupler	TESEQ	C6187	95175	Dec. 23,13	Dec. 22,14
Dual Directional Coupler	TESEQ	CPH-274F	M251304-01	Dec. 23,13	Dec. 22,14
Test Software	ADT	BVADT_RS_V7.6.4-DG	N/A	N/A	N/A

NOTE: 1. The test was performed in RS chamber.
2. The calibration interval of the above test instruments is 12 months and the calibrations are traceable to CEPREI/CHINA, GRGT/CHINA and NIM/CHINA.

4.3.3 TEST PROCEDURE

The test procedure was in accordance with IEC 61000-4-3

a. The testing was performed in a fully-anechoic chamber.

b. The frequency range is swept from 80 MHz to 1000 MHz, 1400MHz to 2000MHz, 2000MHz to 2700MHz with the signal 80% amplitude modulated with a 1kHz sine wave.

c. The dwell time at each frequency shall not be less than the time necessary for the EUT to be exercised and to respond, but shall in no case be less than 0,5s.

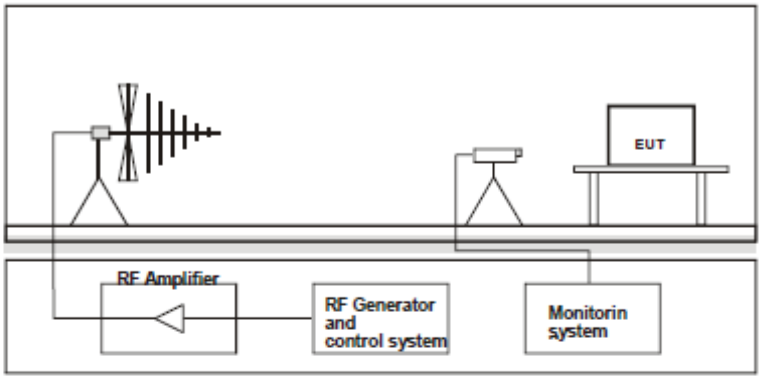
d. The field strength levels were 10V/m, 3V/m, 1V/m.

e. The test was performed with the EUT exposed to both vertically and horizontally polarized fields on each of the four sides.

4.3.4 DEVIATION FROM TEST STANDARD

No Deviation

4.3.5 TEST SETUP



NOTE:

TABLETOP EQUIPMENT
The EUT installed in a representative system as described in section 7 of IEC 61000-4-3 was placed on a non-conductive table 0.8 meters in height. The system under test was connected to the power and signal wire according to relevant installation instructions.

FLOOR STANDING EQUIPMENT
The EUT installed in a representative system as described in section 7 of IEC 61000-4-3 was placed on a non-conductive wood support 0.1 meters in height. The system under test was connected to the power and signal wire according to relevant installation instructions.

4.3.6 TEST RESULTS

TEST MODE	See item 2.2	TEST VOLTAGE	DC 300V
ENVIRONMENTAL CONDITIONS	21.6deg. C, 57.5% RH	TESTED BY: Heise	

Field Strength (V/m)	Test Frequency Note#1 (MHz)	Polarization of antenna (Horizontal / Vertical)	Test Distance (m)	Test Result	Remark
10	80 - 1000	H&V	3	A	N/A
3	1400 - 2000	H&V	3	A	N/A
1	2000 - 2700	H&V	3	A	N/A

Note#1:

Tested Israel SII Frequencies 89,100,107,144,163,196,244,315,434,460,600,825,845,880 MHz

NOTE: A: There was no change compared with initial operation during the test.

4.4 ELECTRICAL FAST TRANSIENT/BURST IMMUNITY TEST (EFT)

4.4.1 TEST SPECIFICATION

Basic Standard:	IEC 61000-4-4
Test Voltage:	Power Line: 2kV
Polarity:	Positive & Negative
Impulse Frequency:	5 kHz
Impulse Waveshape :	5/50 ns
Burst Duration:	15 ms
Burst Period:	300 ms
Test Duration:	1 min.

4.4.2 TEST INSTRUMENTS

Equipment	Manufacturer	Model No.	Serial No.	Last Cal.	Next Cal.
EFT Tester	HAEFELY	PEFT4010	150546	May 17,14	May 16,15
EFT Coupling Clamp	HAEFELY	IP4A	150407	May 17,14	May 16,15
Test Software	HAEFELY	SWPE4010 1.22	N/A	N/A	N/A

NOTE: 1. The test was performed in EMS Room 1.
2. The calibration interval of the above test instruments is 12 months and the calibrations are traceable to CEPREI/CHINA, GRGT/CHINA and NIM/CHINA.

4.4.3 TEST PROCEDURE

a. Both positive and negative polarity discharges were applied.

b. The length of the "hot wire" from the coaxial output of the EFT generator to the terminals on the EUT should not exceed 0.5 meter ± 0.05 meter.

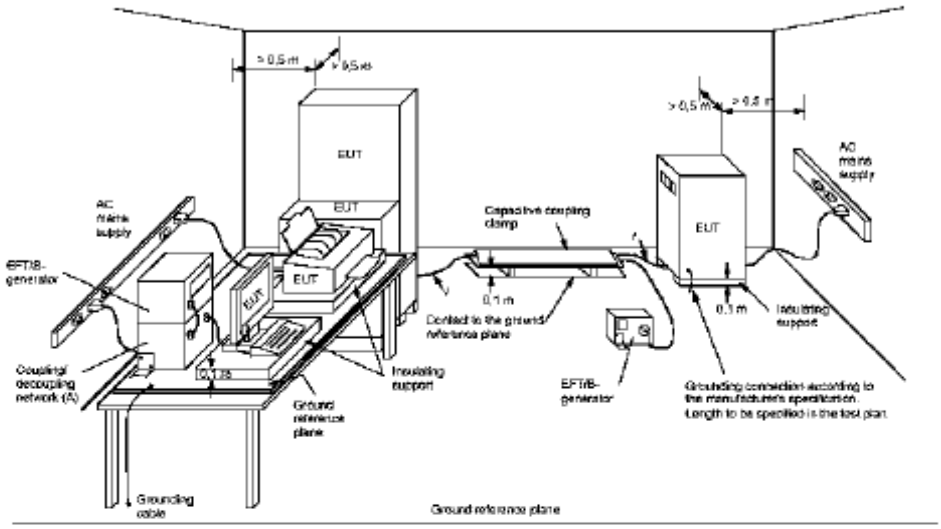
c. The duration time of each test sequential was 1 minute.

d. The transient/burst waveform was in accordance with IEC 61000-4-4, 5/50ns.

4.4.4 DEVIATION FROM TEST STANDARD

No deviation.

4.4.5 TEST SETUP



NOTE:
TABLETOP EQUIPMENT
The configuration consisted of a wooden table standing on the Ground Reference Plane and should be located 0.1m +/- 0.01m above the Ground Reference Plane.
The GRP consisted of a sheet of aluminum (at least 0.25mm thick and 2.5m square) connected to the protective grounding system. A minimum distance of 0.5m was provided between the EUT and the walls of the laboratory or any other metallic structure.

FLOOR STANDING EQUIPMENT
The EUT installed in a representative system as described in section 7 of IEC 61000-4-4 and its cables, were isolated from the Ground Reference Plane by an insulating support that is 0.1-meter thick. The GRP consisted of a sheet of aluminum (at least 0.25mm thick and 2.5m square) connected to the protective grounding system.

4.4.6 TEST RESULTS

TEST MODE	See item 2.2	TEST VOLTAGE	DC 300V
ENVIRONMENTAL CONDITIONS	21.5 deg. C, 58.2% RH	TESTED BY: Heise	

Pulse Voltage	2 kV		___ kV		___ kV		___ kV	
Pulse Polarity	+	–	+	–	+	–	+	–
L	A	A	/	/	/	/	/	/
N	A	A	/	/	/	/	/	/
PE	A	A	/	/	/	/	/	/
L+N	A	A	/	/	/	/	/	/
L+PE	A	A	/	/	/	/	/	/
N+PE	A	A	/	/	/	/	/	/
L+N+PE	A	A	/	/	/	/	/	/
DC Line	A	A	/	/	/	/	/	/

NOTE: A: There was no change compared with initial operation during the test.

4.5 SURGE IMMUNITY TEST

4.5.1 TEST SPECIFICATION

Basic Standard:	IEC 61000-4-5
Wave-Shape:	Combination Wave 1.2/50 us Open Circuit Voltage 8 /20 us Short Circuit Current
Test Voltage:	AC Power Line: Line to Line:1kV Line to PE:2kV Signal Line: 1kV DC Power Line: Line to Line:0.5kV Line to PE:0.5kV
Surge Input/Output:	L-N&L-PE&N-PE, RJ 45 Line
Generator Source Impedance:	2 ohm between networks 12 ohm between network and ground
Polarity:	Positive/Negative
Phase Angle:	0° /90°/180°/270°
Pulse Repetition Rate:	1 time / 60 sec.
Number of Tests:	5 positive and 5 negative at selected points

4.5.2 TEST INSTRUMENTS

Equipment	Manufacturer	Model No.	Serial No.	Last Cal.	Next Cal.
Combination wave Module	TESEQ AG	CDN 3061	1361	Feb. 17,14	Feb. 16,15
Telecom Surge Module	TESEQ AG	NSG 3060 Mainframe	1404	Feb. 17,14	Feb. 16,15
CDN	TESEQ	CDN HSS-2	34275	Nov.06, 13	Nov.05, 14
CDN	TESEQ	CDN 118	30741	Nov.06, 13	Nov.05, 14
Test Software	TESEQ	CDM 3061_0002.30	1361	N/A	N/A
Test Software	TESEQ	HVM 3060_0002.30	293	N/A	N/A

NOTE: 1. The test was performed in EMS Room 1.
2. The calibration interval of the above test instruments is 12 months and the calibrations are traceable to CEPREI/CHINA, GRGT/CHINA and NIM/CHINA.

4.5.3 TEST PROCEDURE

a. For EUT power supply:

The surge is to be applied to the EUT power supply terminals via the capacitive coupling network. Decoupling networks are required in order to avoid possible adverse effects on equipment not under test that may be powered by the same lines, and to provide sufficient decoupling impedance to the surge wave. The power cord between the EUT and the coupling/decoupling networks shall be 2 meters in length (or shorter).

b. For test applied to unshielded unsymmetrically operated interconnection lines of EUT:

The surge is applied to the lines via the capacitive coupling. The coupling / decoupling networks shall not influence the specified functional conditions of the EUT. The interconnection line between the EUT and the coupling/decoupling networks shall be 2 meters in length (or shorter).

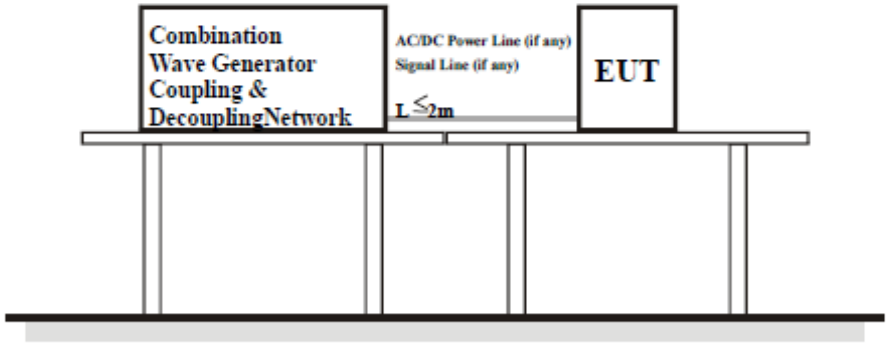
c. For test applied to unshielded symmetrically operated interconnection / telecommunication lines of EUT:

The surge is applied to the lines via gas arrestors coupling. Test levels below the ignition point of the coupling arrestor cannot be specified. The interconnection line between the EUT and the coupling/decoupling networks shall be 2 meters in length (or shorter).

4.5.4 DEVIATION FROM TEST STANDARD

No deviation.

4.5.5 TEST SETUP



4.5.6 TEST RESULTS

TEST MODE	See item 2.2	TEST VOLTAGE	DC 300V
ENVIRONMENTAL CONDITIONS	21.5deg. C, 59.2% RH	TESTED BY: Heise	

AC/DC Power port:

\Phase angle \ Test result \Voltage (kV) \ Test point\ Polarity			0°	90°	180°	270°	DC Power Port
1	L-N	+	B	B	B	B	N/A
		−	B	B	B	B	N/A
2	L-PE	+	B	B	B	B	N/A
		−	B	B	B	B	N/A
2	N-PE	+	B	B	B	B	N/A
		−	B	B	B	B	N/A

Signal ports and telecommunication ports:

Voltage (kV)	Test Point	Polarity	Test result	Voltage (kV)	Test Point	Polarity	Test result
/	/	+/-	/	/	/	+/-	/

NOTE: A: There was no change compared with initial operation during the test.
B: During test, EUT stopped grid, and could automatically return to normal after test.

4.6 IMMUNITY TO CONDUCTED DISTURBANCES INDUCED BY RF FIELDS (CS)

4.6.1 TEST SPECIFICATION

Basic Standard:	IEC 61000-4-6
Frequency Range:	0.15 MHz - 80 MHz
Field Strength:	$10V_{r.m.s}$
Modulation:	1kHz Sine Wave, 80%, AM Modulation
Frequency Step:	1 % of fundamental
Coupled Cable:	Power Mains & DC Power Line
Coupling Device:	CDN-M3(3 wires) & Clamp

4.6.2 TEST INSTRUMENTS

Equipment	Manufacturer	Model No.	Serial No.	Last Cal.	Next Cal.
Signal Generator	Rohde&Schwarz	SME06	829498/006	Oct.15,13	Oct.14, 14
CDN	Luthi	L-801M2/M3	2015	Oct.18,13	Oct. 17,14
CDN(AUX)	TESEQ	CDN M016	27452	Nov. 20,13	Nov. 19,14
CDN	TESEQ	T200A	26944	Apr. 08,14	Apr. 07,15
CDN	TESEQ	T400A	26536	Apr. 08,14	Apr. 07,15
CDN	TESEQ	ST08A	32256	Apr. 08,14	Apr. 07,15
6dB 50Watt Attenuator	HUBER+SUHNER	5906.17.0005	303688	Oct.15,13	Oct.14,14
Signal Amplifier	HAEFELY	PAMP250	149594	NA	NA
Electromagnetic Injection Clamp	Luthi	EM101	35640	Oct.16,13	Oct.15,14
C/S Test System	HAEFELY	WinPAMP	NSEMC002	N/A	N/A
Test Software	ADT	BVADT_CS_V7.5.1	N/A	N/A	N/A

NOTE: 1. The test was performed in CS test room.
2. The calibration interval of the above test instruments is 12 months and the calibrations are traceable to CEPREI/CHINA, GRGT/CHINA and NIM/CHINA.

4.6.3 TEST PROCEDURE

a. The EUT shall be tested within its intended operating and climatic conditions.

b. An artificial hand was placed on the hand-held accessory and connected to the ground reference plane.

c. The test shall be performed with the test generator connected to each of the coupling and decoupling devices in turn, while the other non-excited RF input ports of the coupling devices are terminated by a 50-ohm load resistor.

d. The frequency range is swept from 150 kHz to 80 MHz, using the signal level established during the setting process and with a disturbance signal of 80 % amplitude. The signal is modulated with a 1 kHz sine wave, pausing to adjust the RF signal level or the switch coupling devices as necessary. Where the frequency is swept incrementally, the step size shall not exceed 1 % of the preceding frequency value.

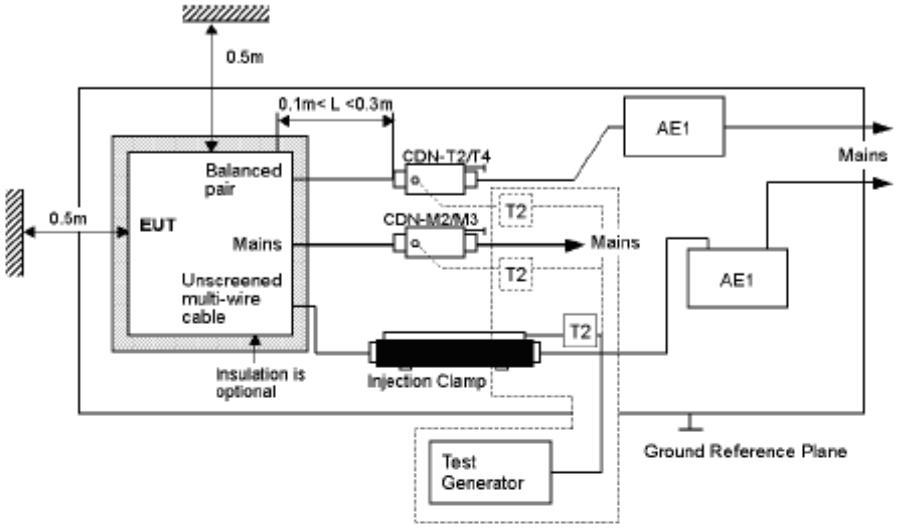
e. The dwell time of the amplitude modulated carrier at each frequency shall not be less than the time necessary for the EUT to be exercised and to respond, but shall in no case be less than 0,5 s. The sensitive frequencies (e.g. clock frequencies) shall be analyzed separately.

f. Attempts should be made to fully exercise the EUT during testing, and to fully interrogate all exercise modes selected for susceptibility.

4.6.4 DEVIATION FROM TEST STANDARD

No deviation.

4.6.5 TEST SETUP



NOTE: The EUT clearance from any metallic obstacles shall be at least 0.5m.
All non-excited input ports of the CDNs shall be terminated by 50Ω loads.

NOTE:

FLOOR-STANDING EQUIPMENT
The equipment to be tested is placed on an insulating support of 0.1 meters height above a ground reference plane. All relevant cables shall be provided with the appropriate coupling and decoupling devices at a distance between 0.1 meters and 0.3 meters from the projected geometry of the EUT on the ground reference plane.

4.6.6 TEST RESULTS

TEST MODE	See Item 2.2	TEST VOLTAGE	DC 300V
ENVIRONMENTAL CONDITIONS	22.5deg. C, 56.6% RH	TESTED BY: Heise	

Voltage (V)	Test Frequency Note#1 (MHz)	Tested Line	Injection Method.	Test Result	Remark
10	0.15 – 80	AC Mains	CDN-M3	A	N/A
10	0.15 – 80	DC line	Clamp	A	N/A

Note#1: Tested Israel SII Frequencies 0.2,0.53,1,1.5,7.1,13.56,21,27.12,40.68,65,68 MHz

NOTE: A: There was no change compared with initial operation during the test.

4.7 POWER FREQUENCY MAGNETIC FIELD IMMUNITY TEST

4.7.1 TEST SPECIFICATION

Basic Standard:	IEC 61000-4-8
Frequency Range:	50Hz, 60Hz
Field Strength:	30A/m
Observation Time:	5 minute
Inductance Coil:	Rectangular type, 1mx1m

4.7.2 TEST INSTRUMENTS

Equipment	Manufacturer	Model No.	Serial No.	Last Cal.	Next Cal.
Magnetic Field Tester	HAEFELY	MAG100.1	150579	Oct.18,13	Oct.17,14
Test Software	N/A	N/A	N/A	N/A	N/A

NOTE: 1. The test was performed in Shielding Room 843.
2. The calibration interval of the above test instruments is 12 months and the calibrations are traceable to CEPREI/CHINA, GRGT/CHINA and NIM/CHINA.

4.7.3 TEST PROCEDURE

a. The equipment is configured and connected to satisfy its functional requirements.

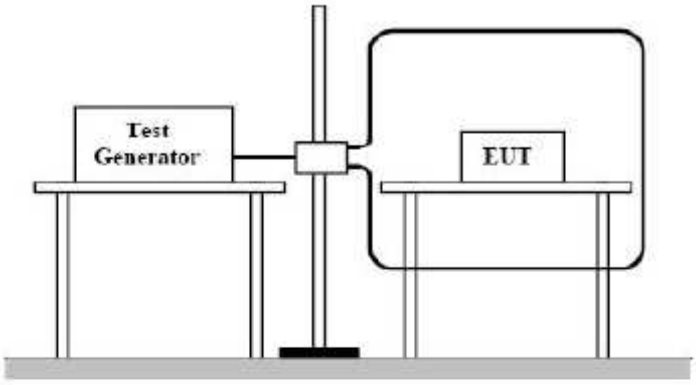
b. The power supply, input and output circuits shall be connected to the sources of power supply, control and signal.

c. The cables supplied or recommended by the equipment manufacturer shall be used. 1 meter of all cables used shall be exposed to the magnetic field.

4.7.4 DEVIATION FROM TEST STANDARD

No Deviation

4.7.5 TEST SETUP



NOTE:

TABLETOP EQUIPMENT
The equipment shall be subjected to the test magnetic field by using the induction coil of standard dimension (1 m x 1 m). The induction coil shall then be rotated by 90 degrees in order to expose the EUT to the test field with different orientations.

FLOOR-STANDING EQUIPMENT
The equipment shall be subjected to the test magnetic field by using induction coils of suitable dimensions. The test shall be repeated by moving and shifting the induction coils, in order to test the whole volume of the EUT for each orthogonal direction. The test shall be repeated with the coil shifted to different positions along the side of the EUT, in steps corresponding to 50 % of the shortest side of the coil. The induction coil shall then be rotated by 90 degrees in order to expose the EUT to the test field with different orientations.

4.7.6 TEST RESULTS

TEST MODE	See Item 2.2	TEST VOLTAGE	DC 300V
ENVIRONMENTAL CONDITIONS	22deg. C, 59% RH	TESTED BY: Heise	

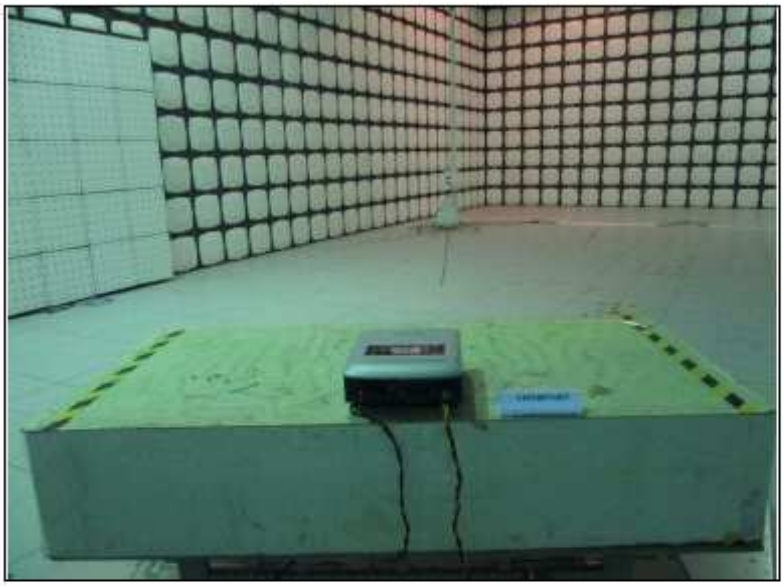
MAGNETIC FIELD DIRECTION	TESTING RESULT	REMARK
X - Axis	A	30A/ m
Y - Axis	A	30A/ m
Z - Axis	A	30A/ m

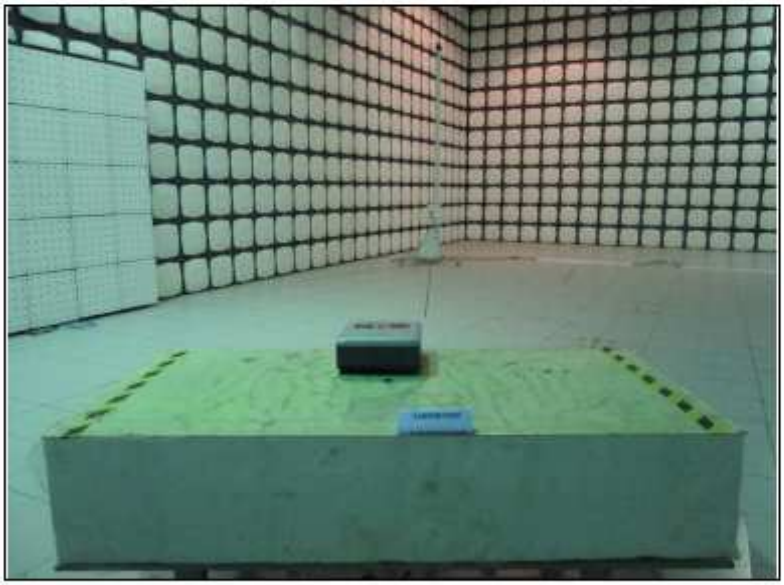
NOTE: A: There is no change compared with the initial operation during the test.

5 PHOTOGRAPHS OF THE TEST CONFIGURATION

CONDUCTED EMISSION TEST

RADIATED EMISSION TEST





Test Report No.: CE140508N005R1

HARMONICS EMISSION TEST &
VOLTAGE FLUCTUATIONS AND FLICKER TEST

ESD TEST

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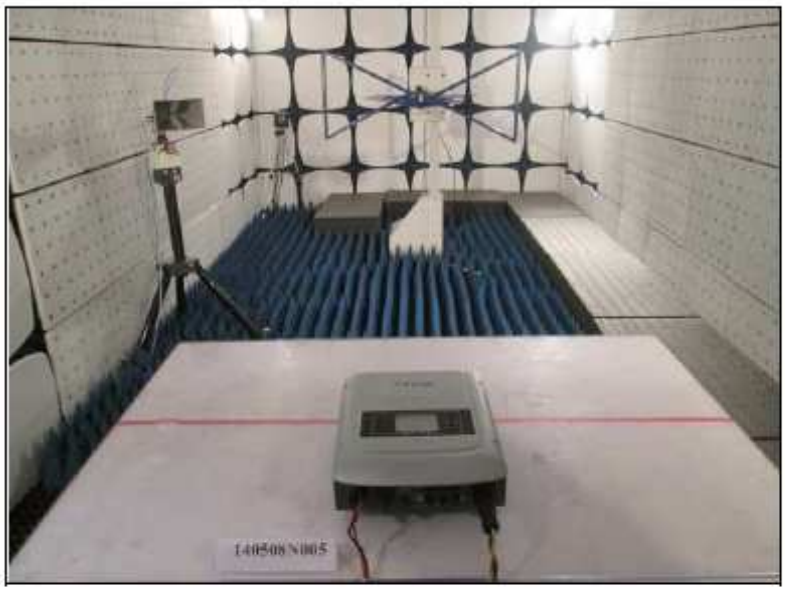
RS TEST



EFT TEST(AC Mains)

Test Report No.: CE140508N005R1

EFT TEST (DC Port)

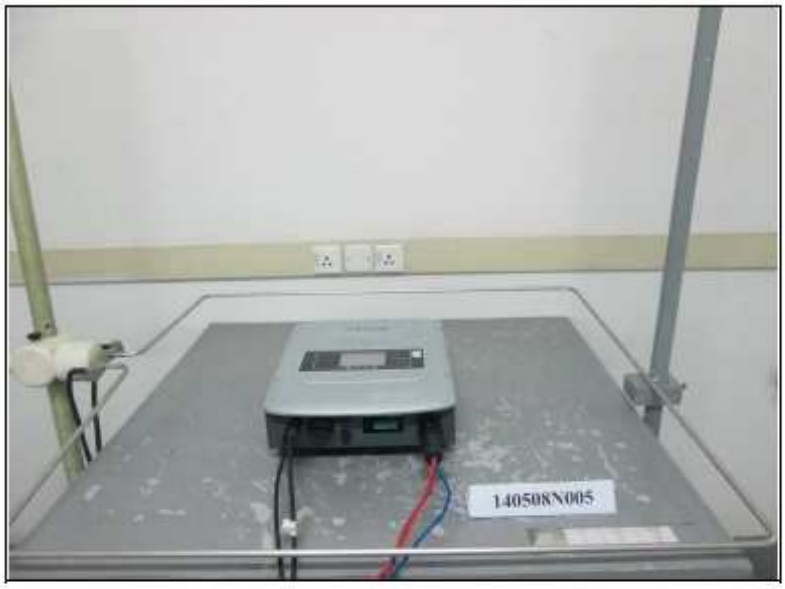
SURGE TEST

CONDUCTED SUSCEPTIBILITY TEST (AC Mains)

CONDUCTED SUSCEPTIBILITY TEST (DC Cable)

Test Report No.: CE140508N005R1

POWER-FREQUENCY MAGNETIC FIELDS TEST



6 APPENDIX A – MODIFICATIONS RECORDERS FOR ENGINEERING CHANGES TO THE EUT BY THE LAB

No any modifications were made to the EUT by the lab during the test.

---END---

Reference No.: 140508N005R1

PHOTOGRAPHS OF THE EUT

SOFAR 1100TL:

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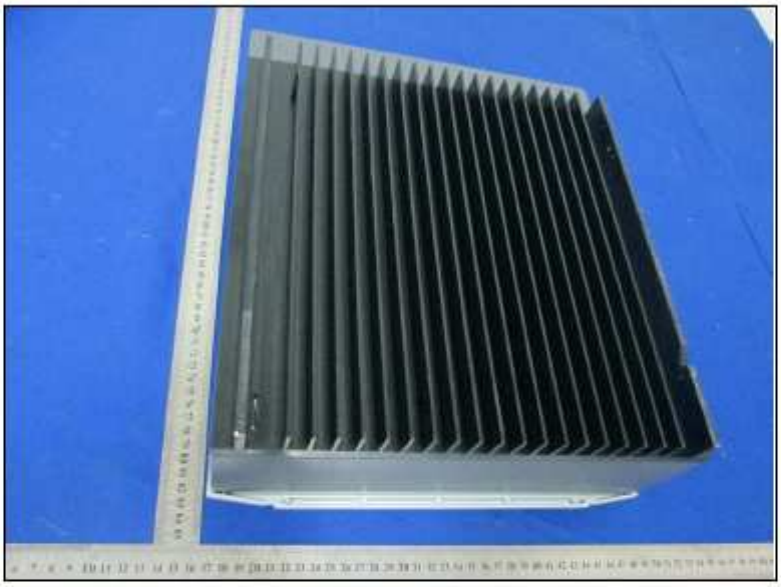

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Reference No.: 140508N005R1

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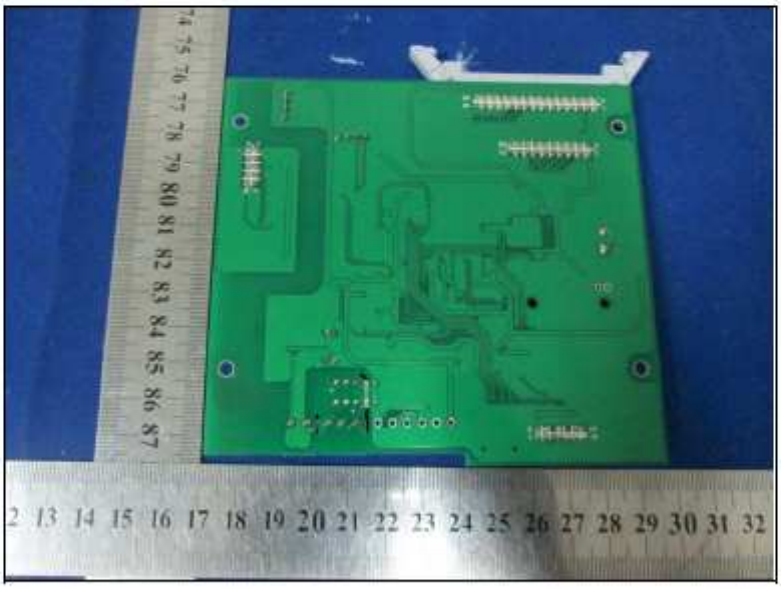

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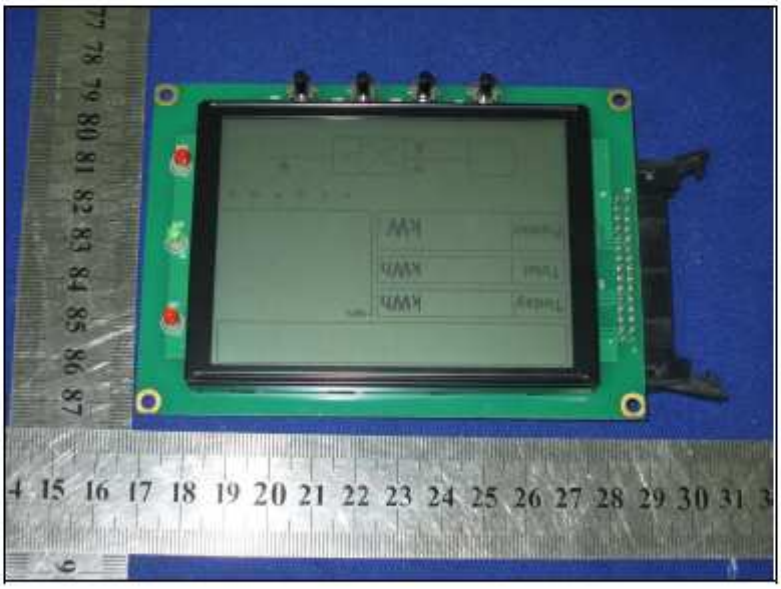

Reference No.: 140508N005R1

SOFAR 2200TL:

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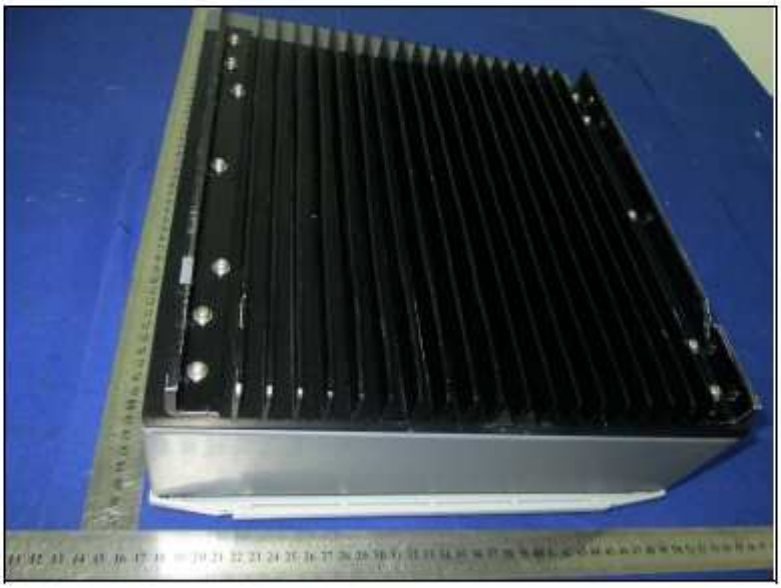

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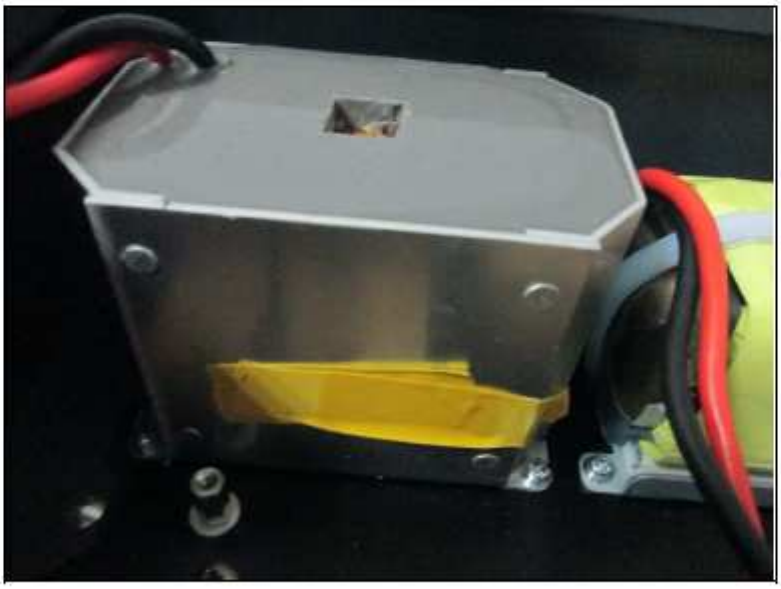

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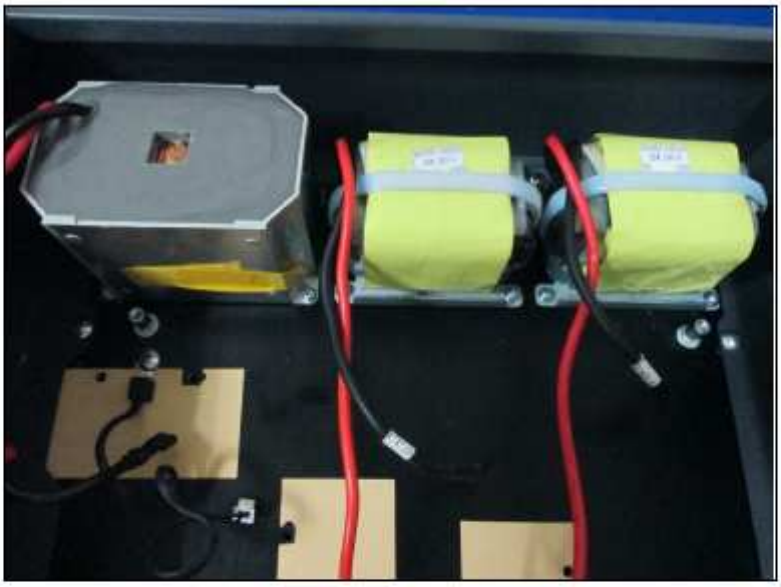

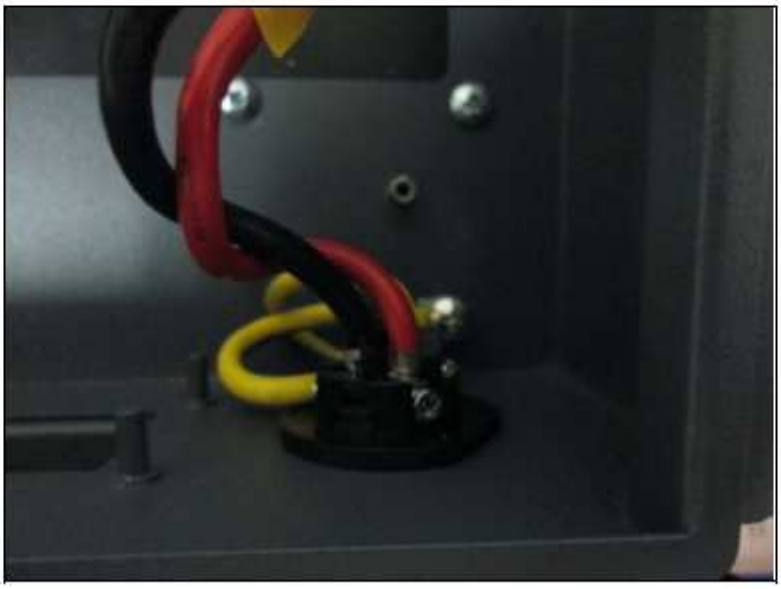

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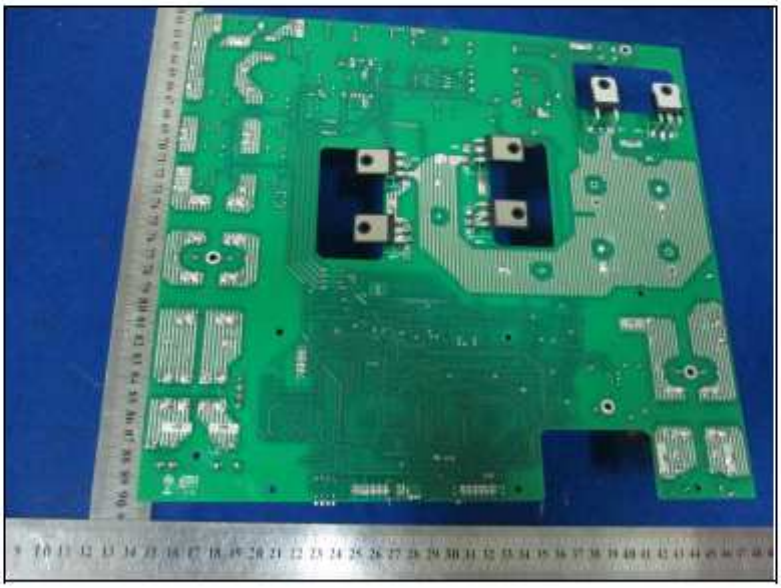

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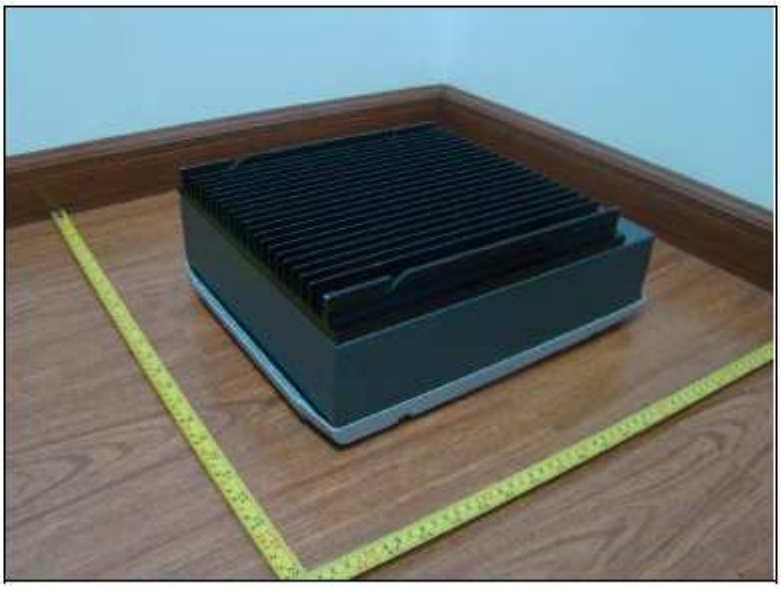

Reference No.: 140508N005R1

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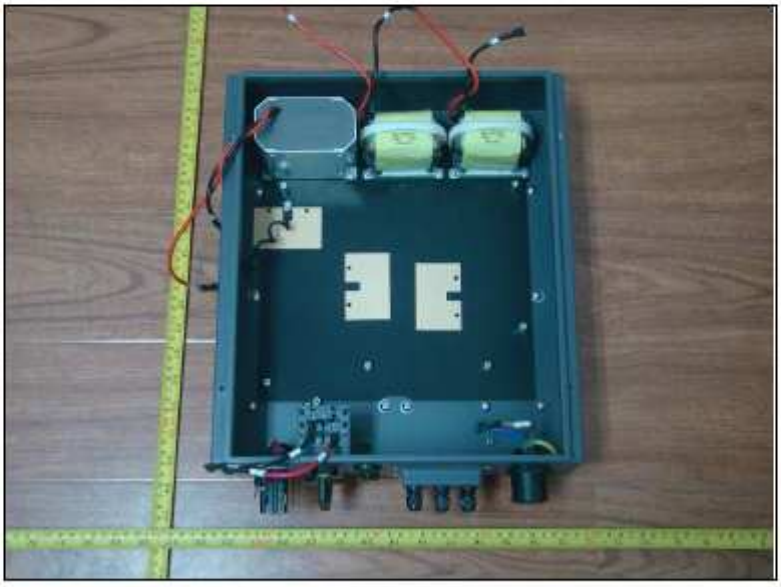

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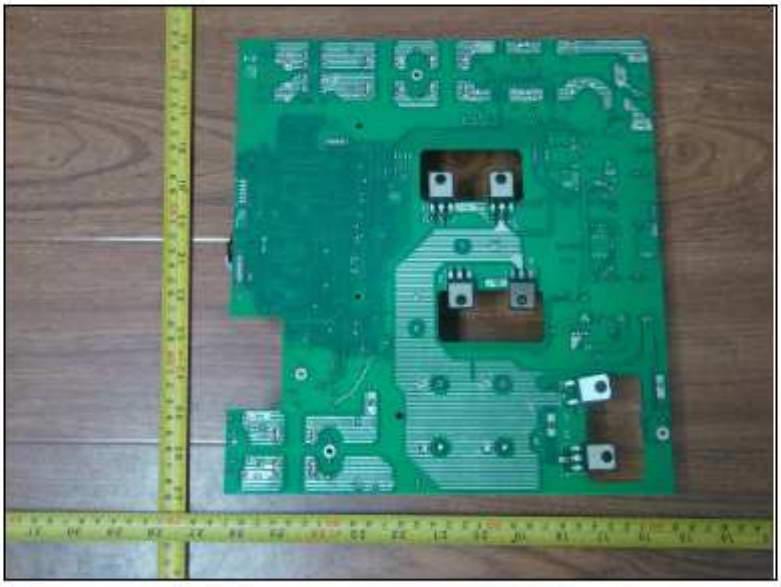

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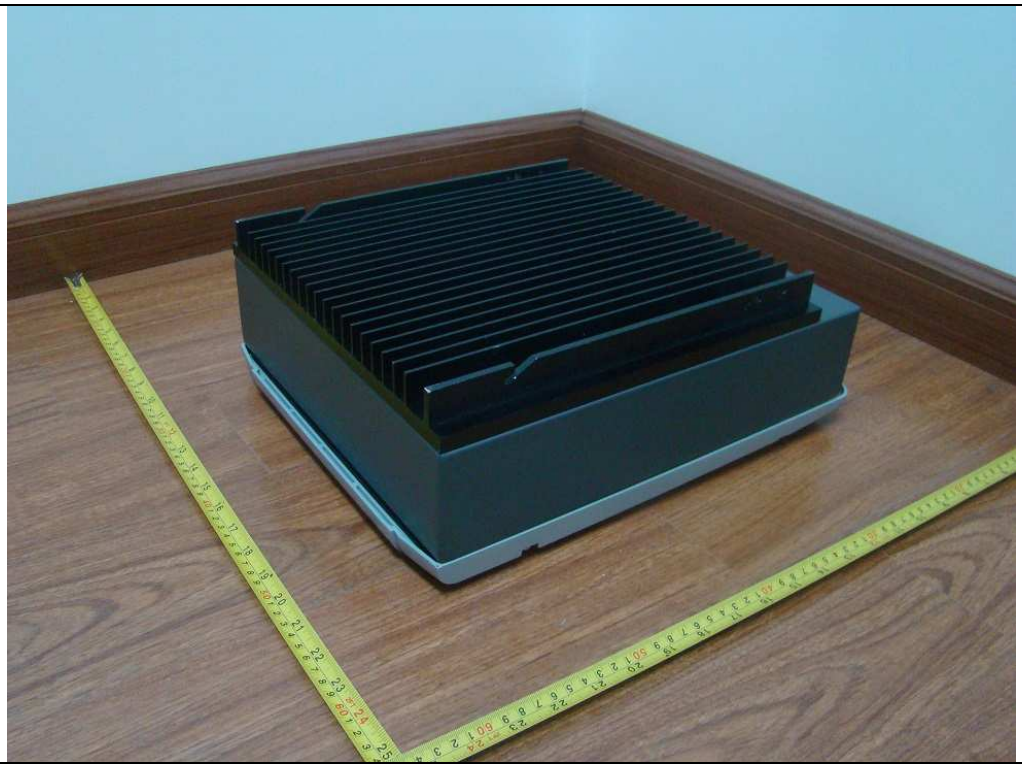
Annex 2

Pictures of the unit

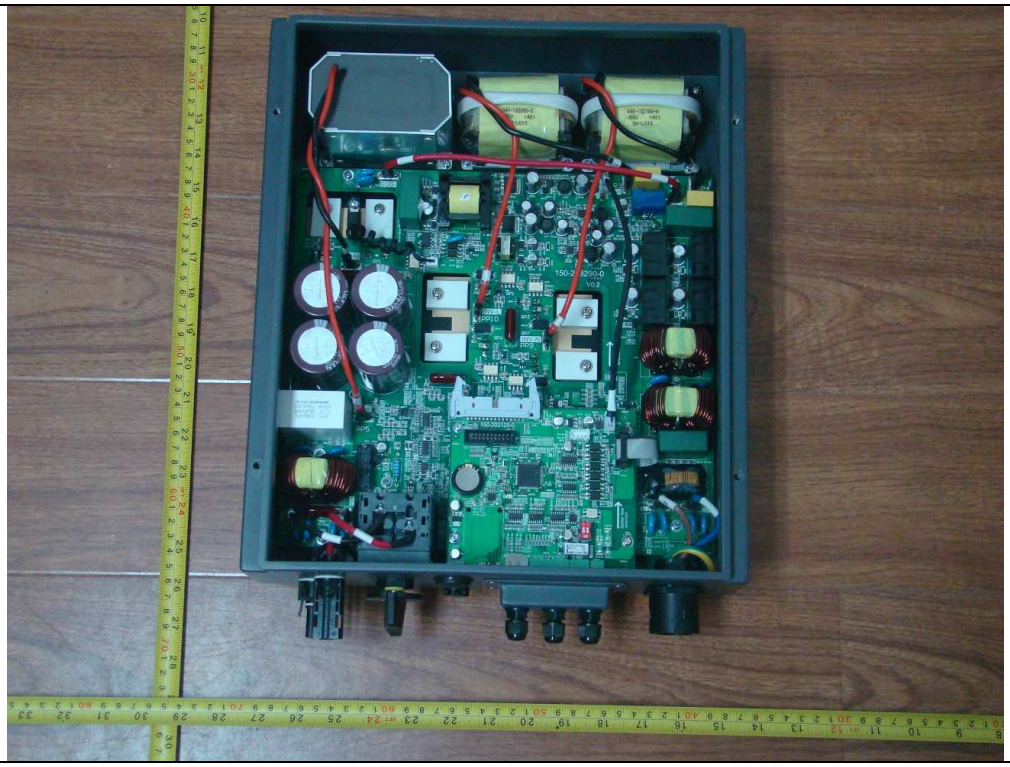
Enclosure front view

Enclosure rear view

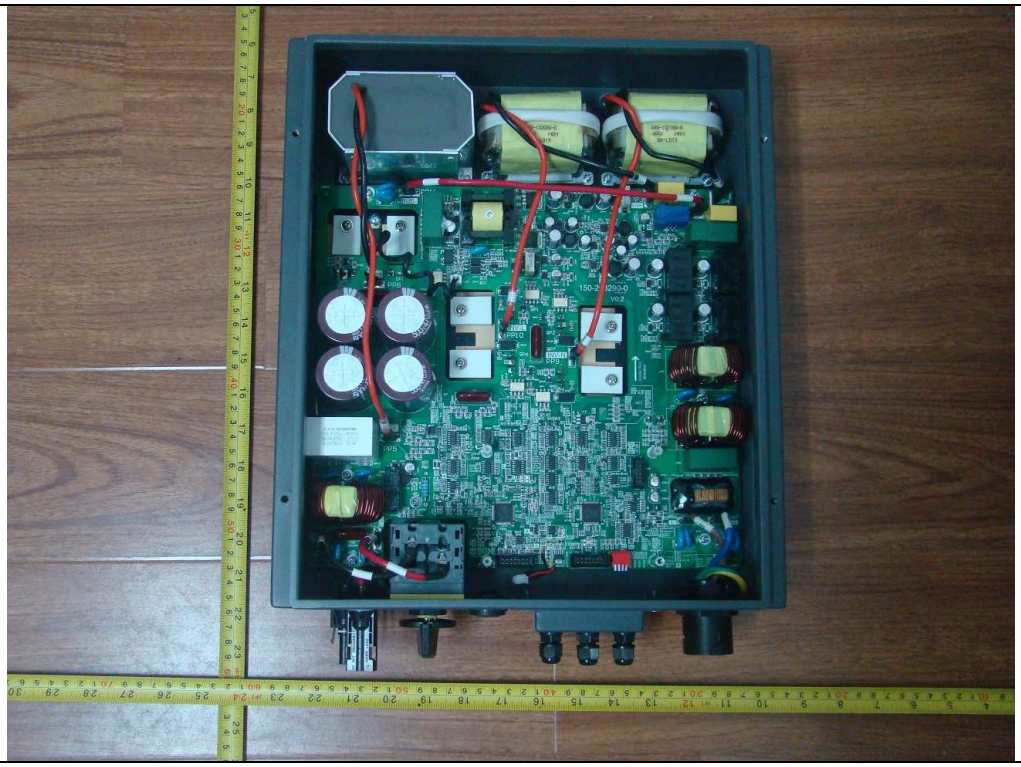


Enclosure bottom view

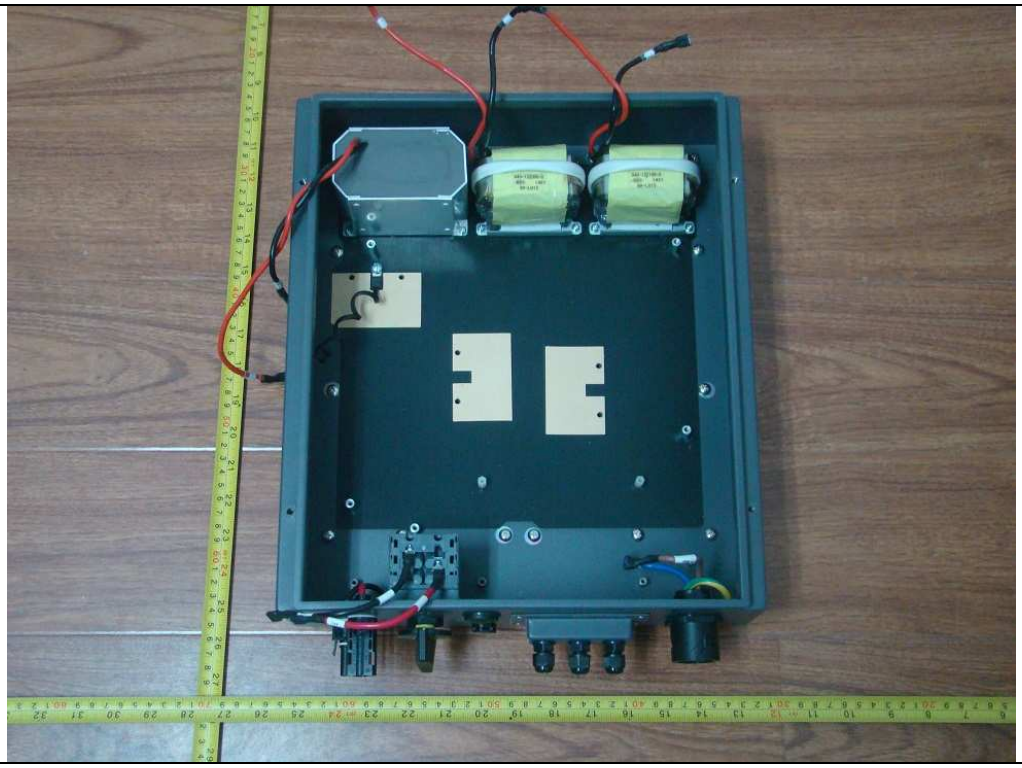
Internal view-1



Internal view-2

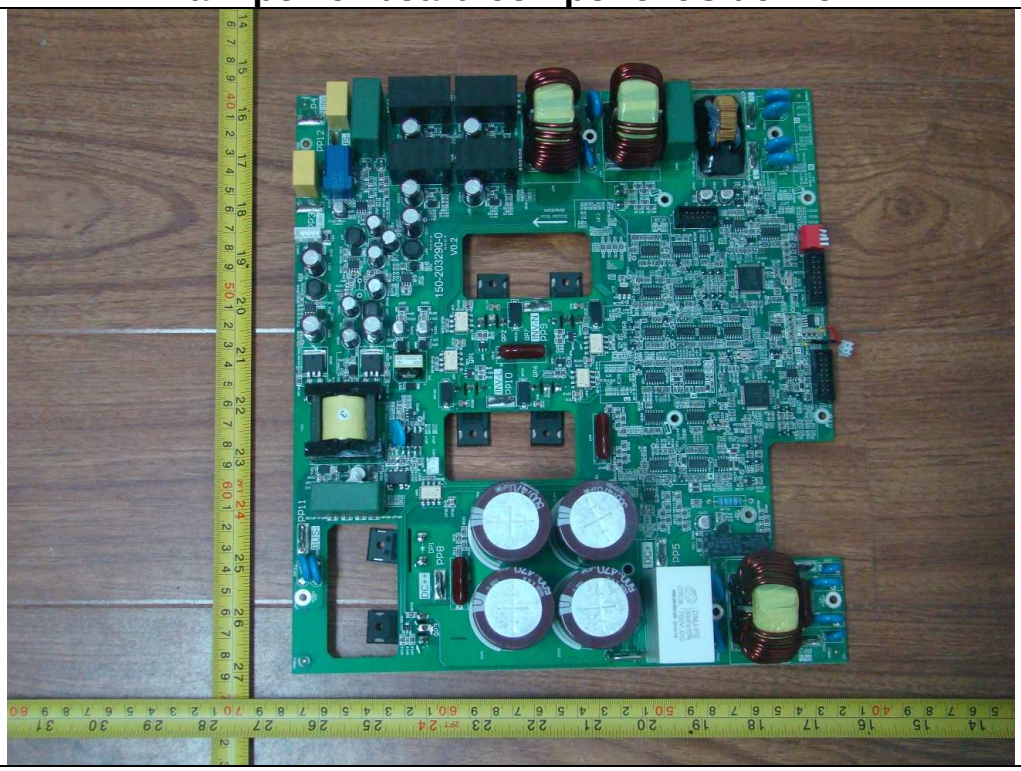


Internal view-3

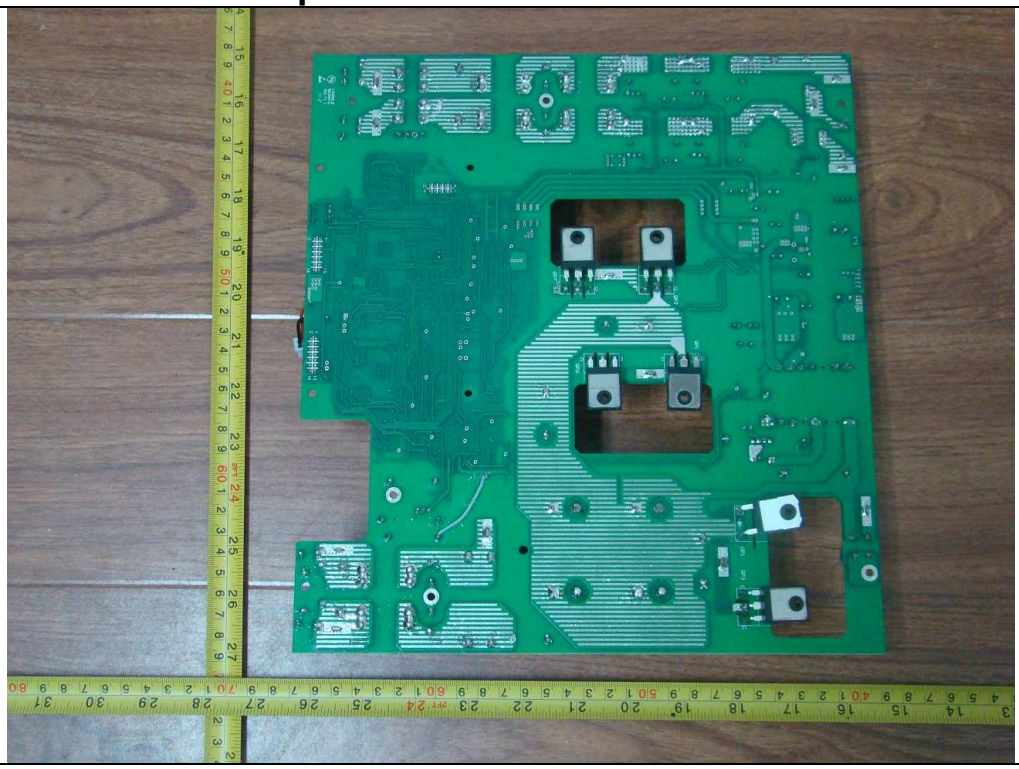


Internal view-4

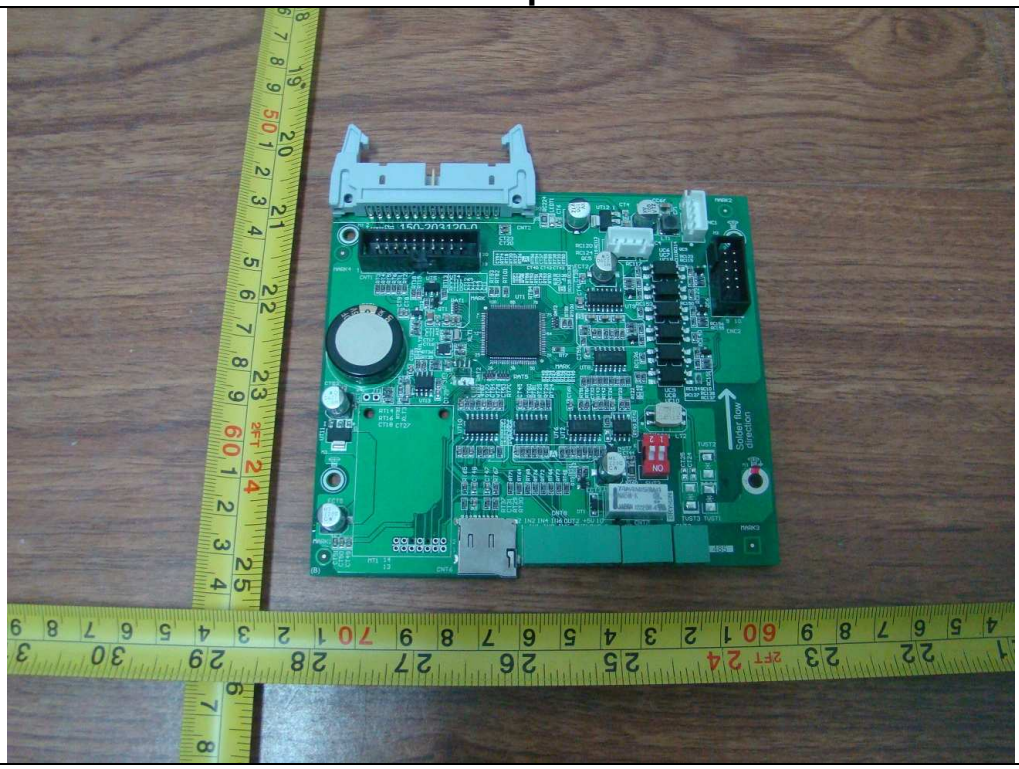
Main power board component side view



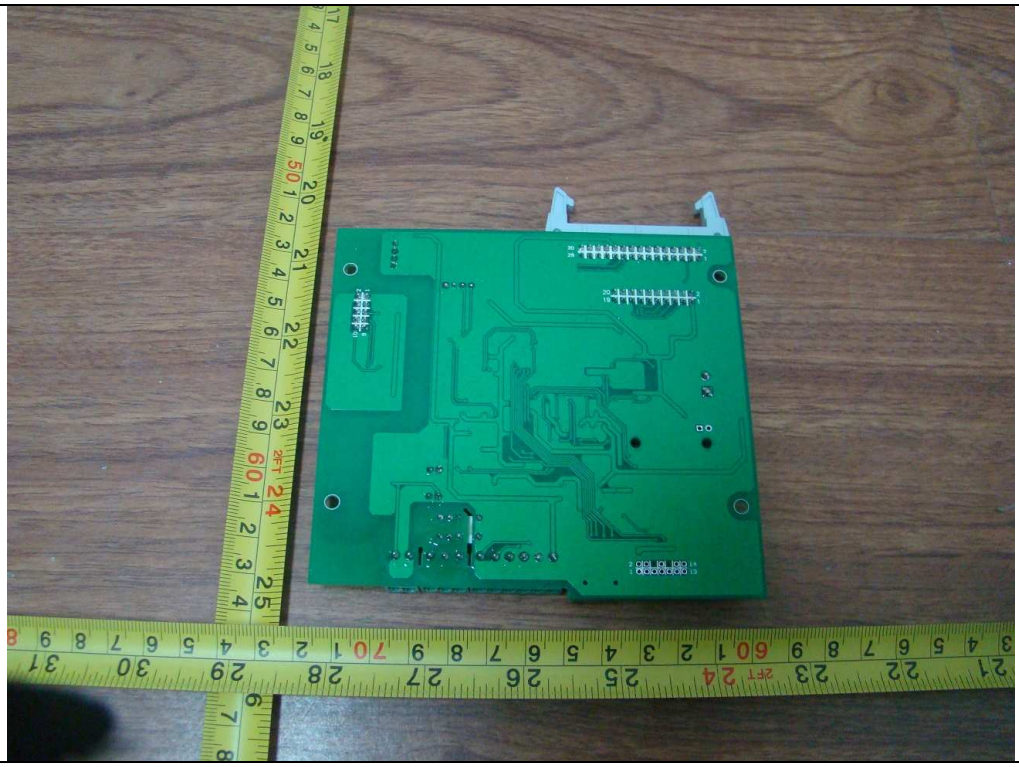
Main power board solder side view



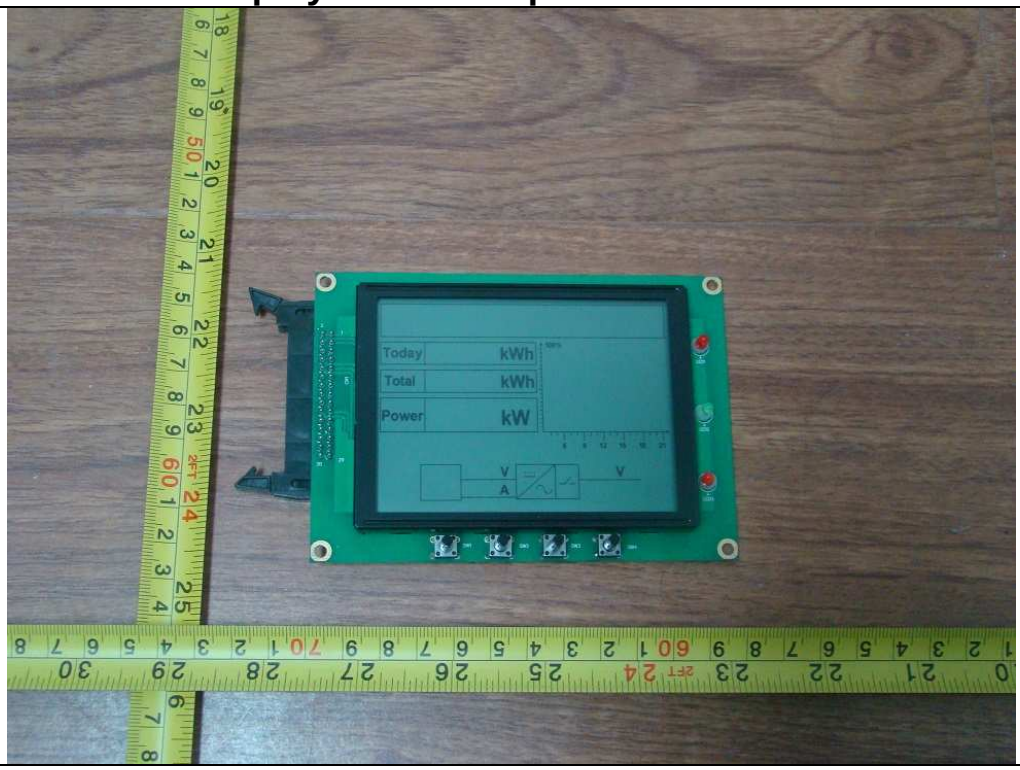
Control board component side view



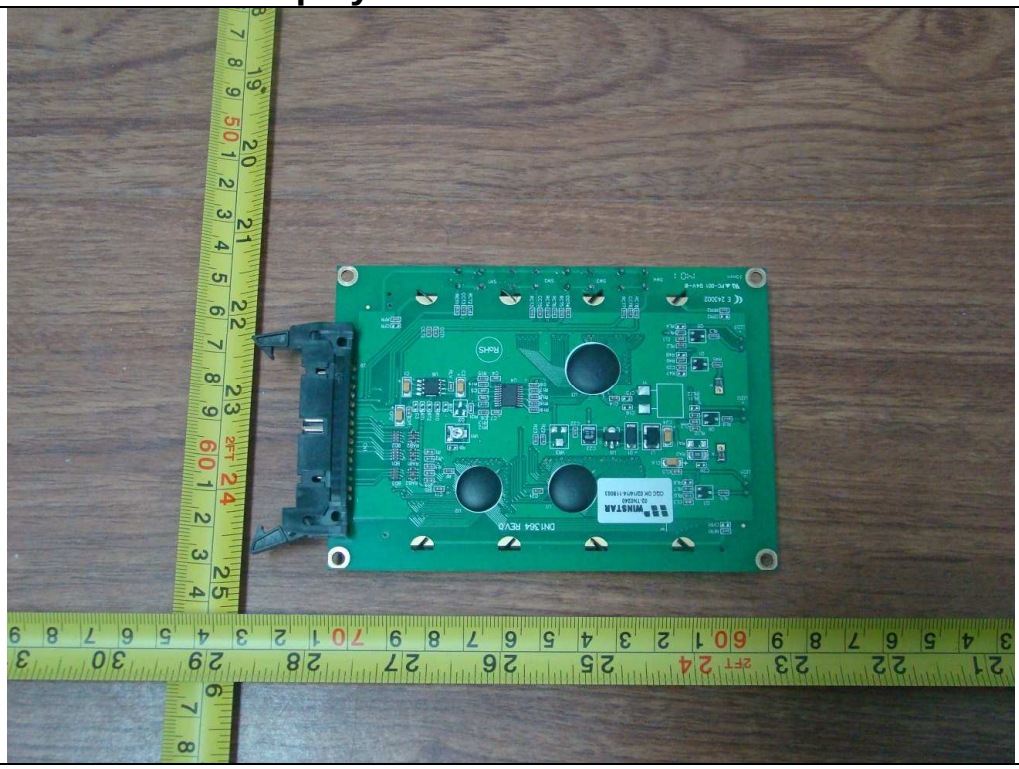
Control board solder side view



Display board component side view



Display board solder side view



Annex 3

Test equipment list

Equipment	Internal No.	Manufacturer	Type	Serial No.	Last Calibration
Power Analyzer	A4080002DG	YOKOGAWA	WT3000	91M210852	Mar. 12, 2014
AC Source	A7040019DG	Chroma	61512	61512000439	Monitored by Power Analyzer
AC Source	A7040020DG	Chroma	61512	61512000438	Monitored by Power Analyzer
DC Simulation Power Supply	A7040015DG	Chroma	62150H-1000S	62150EF00488	Monitored by Power Analyzer
DC Simulation Power Supply	A7040016DG	Chroma	62150H-1000S	62150EF00490	Monitored by Power Analyzer
Four Channel Digital Phosphor Oscilloscope	A4089003DG	Tektronix	DPO4104B	C010624	Oct. 17, 2013
Current transducer	A1060007DG	YOKOGAWA	CT200	1130700012	Jan. 20, 2014
RLC Load	A7150027DG	Qunling	ACLT-3803H	93VOO2869	Monitored by Power Analyzer
Oscilloscope probel	A4089010DG	Tektronix	TPP1000	C008228	Dec. 20, 2013
Oscilloscope probel	A4089011DG	Tektronix	TPP1000	C008229	Dec. 20, 2013
LCR Hitester	A1060006DG	HIOKI	3535	120112505	Mar. 06, 2014