

**TEST REPORT**

**Royal Decree 1699/2011, of 18 November, which regulates the connection to network of production facilities for low power electricity**

Report reference No ..... : 140327083GZU-005

Tested by  
(printed name and signature) ..... : Jason Fu



Approved by  
(printed name and signature) ..... : Tommy Zhong

Date of issue ..... : 30 May 2014  
20 pages

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Testing location ..... : Same as above

Address ..... : Same as above

**Applicant's Name** ..... : Shenzhen SOFARSOLAR Co., Ltd.

Address ..... : 3A-1, Huake Building, East Technology Park, Qiaoxiang Road, Nanshan District, Shenzhen, China

**Test specification**

Standard ..... : RD 1699:2011

Test procedure ..... : Type test

Non-standard test method ..... : N/A

**Test Report Form No** ..... : RD1699a

TRF originator ..... : Intertek

Master TRF ..... : dated 2014-01

**Test item description** ..... : Grid-connected PV inverter

Trademark ..... : 

Manufacturer ..... : Same as applicant

Factory ..... : Dongguan dingqiang Machinery & Electric Co., Ltd.  
No. 8, Fulong road, Qingxi town, Dongguan city, Guangdong, China

Model and/or type reference ..... : Sofar 20000TL-Sx, Sofar 17000TL-Sx, Sofar 15000TL-Sx, Sofar 10000TL-Sx (x=0-6)

Rating(s) ..... : Maximum d.c. input voltage: 1000 V  
Input voltage rang: 250-960 V  
Max. input current: 2×24 A (for Sofar 20000TL-Sx); 2×21 A (for Sofar 17000TL-Sx, Sofar 15000TL-Sx); 2×15 A (for Sofar 10000TL-Sx)  
Max. PV Isc: 2×30 A (for Sofar 20000TL-Sx); 2×27 A (for Sofar 17000TL-Sx, Sofar 15000TL-Sx); 2×20 A (for Sofar 10000TL-Sx)  
Nominal Grid voltage: 3/N/PE230V/400V



	<p>Max. output current: 3x29 A (for Sofar 20000TL-Sx); 3x25 A (for Sofar 17000TL-Sx); 3x22 A (for Sofar 15000TL-Sx); 3x15 A (for Sofar 10000TL-Sx)</p> <p>Nominal Grid frequency: 50 Hz</p> <p>Max. output power: 20000 W (for Sofar 20000TL-Sx); 17000 W (for Sofar 17000TL-Sx); 15000 W (for Sofar 15000TL-Sx); 10000 W (for Sofar 10000TL-Sx)</p> <p>Ingress protection: IP65</p> <p>Operating temperature range: -25~60°C</p>
Summary of testing:	<p>The sample(s) tested complied with the type test requirement of RD 1699:2011</p>
<b>Test case verdicts</b>	<p>Test case does not apply to the test object : N/A</p> <p>Test item does meet the requirement .....: P(ass)</p> <p>Test item does not meet the requirement ...: F(ail)</p>
<b>Testing</b>	<p>Date of receipt of test item .....: 27 Mar 2014</p> <p>Date(s) of performance of test .....: 27 Mar 2014 – 09 May 2014</p>
General remarks	<p>The test results presented in this report relate only to the object tested.</p> <p>This report shall not be reproduced, except in full, without the written approval of the Issuing testing laboratory.</p> <p>"(See Enclosure #)" refers to additional information appended to the report.</p> <p>"(See appended table)" refers to a table appended to the report.</p> <p>Throughout this report a point is used as the decimal separator.</p> <p>When determining the test conclusion, the Measurement Uncertainty of test has been considered.</p> <p>This report is for the exclusive use of Intertek's Client and is provided pursuant to the agreement between Intertek and its Client. Intertek's responsibility and liability are limited to the terms and conditions of the agreement. Intertek assumes no liability to any party, other than to the Client in accordance with the agreement, for any loss, expense or damage occasioned by the use of this report. Only the Client is authorized to permit copying or distribution of this report and then only in its entirety. Any use of the Intertek name or one of its marks for the sale or advertisement of the tested material, product or service must first be approved in writing by Intertek. The observations and test results in this report are relevant only to the sample tested. This report by itself does not imply that the material, product, or service is or has ever been under an Intertek certification program.</p> <p>The test report only allows to be revised only within the report defined retention period unless standard or regulation was withdrawn or invalid.</p>

General product information:

1. Product covered by this report is non-isolated grid-connected PV inverter for connection with low voltage grid.
2. The inverters intended to operate at ambient temperature  $-25^{\circ}\text{C}$  -  $+60^{\circ}\text{C}$  and 250-960 Vdc input, which will be specified in the user manual; The inverters will output full power when operated at  $45^{\circ}\text{C}$ . If operated at higher than  $45^{\circ}\text{C}$  temperature, the output power derating.

For all models, if the DC input voltage is higher than 850 Vdc the output power will be derating.

For model Sofar 20000TL-Sx, if the DC input voltage is lower than 430 Vdc, the output power will be derating.

For model Sofar 17000TL-Sx, if the DC input voltage is lower than 420 Vdc, the output power will be derating.

For model Sofar 15000TL-Sx, if the DC input voltage is lower than 370 Vdc, the output power will be derating.

For model Sofar 10000TL-Sx, if the DC input voltage is lower than 350 Vdc, the output power will be derating.

For all models, if the AC output voltage is lower than 230 Vac the output current will be limited to not higher than rated output current.

**Model difference:**

All the models have identical mechanical and electrical construction except some components and some parameter of the software architecture in order to control the max output power. And refer to the following table for detail.

Model	DC Cable Gland	PV connector	DC inside connector	Fuse PCB+ String detection board	DC surge arrester	DC switch	AC switch	AC surge arrester
Sofar 20000TL-S0 Sofar 17000TL-S0 Sofar 15000TL-S0 Sofar 10000TL-S0	√		√					
Sofar 20000TL-S1 Sofar 17000TL-S1 Sofar 15000TL-S1 Sofar 10000TL-S1	√		√			√		
Sofar 20000TL-S2 Sofar 17000TL-S2 Sofar 15000TL-S2 Sofar 10000TL-S2		√	√			√		
Sofar 20000TL-S3 Sofar 17000TL-S3 Sofar 15000TL-S3 Sofar 10000TL-S3		√		√		√		
Sofar 20000TL-S4 Sofar 17000TL-S4 Sofar 15000TL-S4 Sofar 10000TL-S4		√		√	√	√		
Sofar 20000TL-S5 Sofar 17000TL-S5 Sofar 15000TL-S5 Sofar 10000TL-S5		√		√	√	√		√
Sofar 20000TL-S6 Sofar 17000TL-S6 Sofar 15000TL-S6 Sofar 10000TL-S6		√		√	√	√	√	√

√ denote incorporating this component

Model Sofar 17000TL-Sx similar to Sofar 20000TL-Sx except amount of the DC-link capacitors, different of input and output sampling resistors and different inductance of Boost, invert inductor.

Model Sofar 15000TL-Sx similar to Sofar 17000TL-Sx except amount of the DC-link capacitors, different inductance of Boost, invert inductor and less PV input circuits (including PV terminal, fuse and sampling circuits of fuse).

Model Sofar 10000TL-Sx similar to Sofar 15000TL-Sx except amount of the DC-link capacitors and boost diode, different of input and output sampling resistors and different inductance of Boost, invert inductor.

Model Sofar 20000TL-Sx and Sofar 17000TL-Sx have equipped two external fans.

Model Sofar 15000TL-Sx has equipped one external fan and model Sofar 10000TL-Sx has not.

Unless other special note, the model Sofar 20000TL-S6 selected as representative sample for testing in this report.

Software setting as following:

Different country can be set on switch SWT3 on communication board, digit "0" represents OFF, digit "1" represents ON

SWITCH 5	SWITCH 4	SWITCH 3	SWITCH 2	SWITCH 1	Country
0	0	0	1	1	Spain RD1669




Copy of marking plate:




**SOFAR SOLAR**

Solar Inverter      Sofar 15000TL-S3

Max. DC Input Voltage	1000V
Operating MPPT voltage range	250-960V
Max. Input Current	2*21A
Max. PV Isc	2*27A
Nominal Grid Voltage	3/N/PE,230/400V
Max. Output Current	3*22A
Nominal Grid Frequency	50Hz
Max. Output Power	15000W
Power factor	>0.99(adjustable+/-0.8)
Ingress Protection	IP65
Operating Temperature Range	-25~+60°C
Protective Class	Class I

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








VDE-AR-N4105, RD1699, VDE0126-1-1, G59/3, UTE C15-712-1, C10/11, IEC62116, IEC61727

**SOFAR SOLAR**

Solar Inverter      Sofar 17000TL-S3

Max. DC Input Voltage	1000V
Operating MPPT voltage range	250-960V
Max. Input Current	2*21A
Max. PV Isc	2*27A
Nominal Grid Voltage	3/N/PE,230/400V
Max. Output Current	3*25A
Nominal Grid Frequency	50Hz
Max. Output Power	17000W
Power factor	>0.99(adjustable+/-0.8)
Ingress Protection	IP65
Operating Temperature Range	-25~+60°C
Protective Class	Class I

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








VDE-AR-N4105, RD1699, VDE0126-1-1, G59/3, UTE C15-712-1, C10/11, IEC62116, IEC61727

**SOFAR SOLAR**

Solar Inverter      Sofar 20000TL-S3

Max. DC Input Voltage	1000V
Operating MPPT voltage range	250-960V
Max. Input Current	2*24A
Max. PV Isc	2*30A
Nominal Grid Voltage	3/N/PE,230/400V
Max. Output Current	3*29A
Nominal Grid Frequency	50Hz
Max. Output Power	20000W
Power factor	>0.99(adjustable+/-0.8)
Ingress Protection	IP65
Operating Temperature Range	-25~+60°C
Protective Class	Class I

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








VDE-AR-N4105, RD1699, VDE0126-1-1, G59/3, UTE C15-712-1, C10/11, IEC62116, IEC61727

**SOFAR SOLAR**

Solar Inverter      Sofar 10000TL-S3

Max. DC Input Voltage	1000V
Operating MPPT voltage range	250-960V
Max. Input Current	2*15A
Max. PV Isc	2*20A
Nominal Grid Voltage	3/N/PE,230/400V
Max. Output Current	3*15A
Nominal Grid Frequency	50Hz
Max. Output Power	10000W
Power factor	>0.99(adjustable+/-0.8)
Ingress Protection	IP65
Operating Temperature Range	-25~+60°C
Protective Class	Class I

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

VDE-AR-N4105, RD1699, VDE0126-1-1, G83/2, UTE C15-712-1, C10/11, EN50438



Requirements of RD 1699:2011			
Summary of testing			
Clause	Requirement – Test	Result – Remark	Verdict
Article 1	Object		Ref.
	Constitutes the object of this royal decree the establishment of the basic administrative, contractual, economic and technical conditions for connection to the distribution networks of electrical power of facilities for electric power production included in the scope of this royal decree.		Ref.
Article 2	Scope		P
1.	The present royal decree should apply to the facilities under normal and special regime of power not more than 100 kW of technologies referred to in the categories b) and c) of article 2 of the Royal Decree 661/2007, of 25 May, in any of the following two cases:		P
	a) when it is connected to power lines not more than 1 kV of the distribution company, either directly or via an internal network of a consumer,		P
	b) when it is connected to the low side of a transformer of internal network, to a voltage less than 1 KV, of a consumer connected to the distribution network and provided that the installed generation capacity connected to the internal network does not exceed 100 kW.		P
2.	It also applies to facilities under normal and special regime of power not more than 1000 kW of technologies covered by the category a) or of its subgroups b.6, b.7 and b.8 of the article 2 of Royal Decree 661/2007, of 25 May, which is connected to power lines not exceeding 36 kV of the distribution company, either directly or via an internal network of a consumer.		N/A
3.	For the purposes of this royal decree, should be regarded as to a single generating facility, whose power will be the sum of the unitary power, the one formed by groups of facilities of the same technology that share lines or evacuation infrastructure and the facilities of same technology that are located in the same cadastral reference identified this one by its first fourteen digits. For these purposes different technologies considered include: solar photovoltaic, solar thermal, geothermal, of the wave, of the tidal, of the hot dry rock, of the ocean currents, wind, thermal without cogeneration and thermal with cogeneration.		P

Requirements of RD 1699:2011			
Summary of testing			
Clause	Requirement – Test	Result – Remark	Verdict
	For facilities located on urban cadastral reference, could be replaced the previous reference to the first fourteen digits for the full reference of twenty digits when each one of the generation facilities intended to be located is associated with a power supply point contracted equal to or more than the power of production facility which aims to be installed, which should be accredited in the application for connection point and at the request of the body of competent Authority.		Ref.
	For the purposes of this royal decree should be considered that several facilities of generation share evacuation infrastructure, among other cases, where such generation facilities are connected to a same transformation center or substation through lines of which does not own the distribution company or carrier.		Ref.
4.	Are excluded from the scope of the present royal decree the groups of facilities that share lines or infrastructures of evacuation and the facilities of same technology that are located in the same cadastral reference identified by their first fourteen digits, in both cases, when the sum of the single potencies exceed the values listed in paragraphs 1 or 2.		Ref.
Article 3	Definitions		Ref.
Article 4	Request for access point and connection		Ref.
Article 5	Determination of the technical conditions for access and connection		Ref.
Article 6	Determination of the economic conditions of the connection		Ref.
Article 7	Subscription of the technical contract of access		Ref.
Article 8	Connection to the network and first verification		Ref.
Article 9	Brief connection procedure		Ref.
Article 10	Obligations of the holder of the facility		Ref.
Article 11	General technical conditions		Ref.
Article 12	Connection conditions		P
1.	The connection diagrams must respond to the principle of minimizing losses in the system, favoring the maintenance of security and quality of supply and allowing the work in island, on their own consumption, never feeding other network users.		N/A
	The connection settings should ensure the reliability of the measures of energy produced and consumed.		N/A
2.	If the rated power of the facility of generation to be connected to the distribution network is greater than 5 kW, the connection of the facility to the network will be triphasic with a unbalance between phases less than 5 kW.		P

Requirements of RD 1699:2011			
Summary of testing			
Clause	Requirement – Test	Result – Remark	Verdict
3.	The contribution of the generators to the increase or the voltage drop on the line of distribution of low or medium voltage, between the transformation center or source substation where is carried out the voltage regulation and the connection point, in the worst-case scenario for the network, should not exceed 2,5 percent of the rated voltage of the low or medium voltage network, as appropriate.		N/A
4.	The power factor of the energy supplied to the network of the distribution company should be as close as possible to the unit and, in any case, greater than 0,98 when the facility works at potencies greater than 25 percent of its rated potency.	See table 12.4	P
Article 13	Specific conditions for internal connection in networks.		N/A
1.	The connection will be made, at the point of the interior network of its ownership most close to the general protection box, so that it could isolate simultaneously both electric system facilities.		N/A
	In the event that the connection point to the distribution network is at high voltage and there is a transformation center property of the consumer, the connection of the facility of production will take place at the output table of low voltage of the transformer.		N/A
2.	The owner of the interior network should be the same for all the teams of consumption and generation facilities that would be connected in its network. In this case, should include a footnote in the final registration of the production facility, both in the regional registry and in the Administrative register of production facilities of electricity under the General Direction for Energy and Mine Policy.		N/A
3.	The production facilities connected to a internal network could not be of power greater than 100 kW, in any case, could not exceed the available capacity in the connection point to the distribution network or the power ascribed to the supply.		N/A
Article 14	Protections		P



Requirements of RD 1699:2011			
Summary of testing			
Clause	Requirement – Test	Result – Remark	Verdict
1.	The protection system should comply, in matters not covered by this royal decree, the Royal Decree 661/2007, of 25 May, and the concerned operating procedures, and, in matters not covered by the above, the requirements laid in the current regulations, particularly, the electrotechnical Regulation of low voltage, approved by Royal Decree 842/2002, of 2 August, the Regulation on technical conditions and security guarantees in power centers, substations and transformation centers, approved by Royal Decree 3275/1982, of 12 November, and the Regulation on technical conditions and security guarantees in electric lines of high voltage, approved by Royal Decree 223/2008, of 15 February. This compliance should be properly credited in the documentation relating to the characteristics of the facility referred to in the article 4, including the following:		N/A
	a) A general cutting element that provides an isolation required by the Royal Decree 614/2001, of 8 June, on minimum requirements for the protection of the health and safety of workers against electrical hazards. Eventually, the functions of the general cutting element can be covered by other device of the generative facility, that provides the isolation indicated between the generator and the network.	CE marking applied	P
	b) Automatic differential switch, in order to protect persons in case of derivation of some element to ground.	Two series relays	P
	c) Automatic switch of the connection, for the automatic disconnection –connection of the facility in case of anomaly of voltage or frequency of the network, together with a relay of interlock. Eventually the function performed by this switch can be carried out by the switch or switches of the generating equipment. Eventually, the functions of the automatic switch of connection and switch of general cutting can be covered by the same device.		P

Requirements of RD 1699:2011			
Summary of testing			
Clause	Requirement – Test	Result – Remark	Verdict
	d) Protections of the minimum and maximum frequency connection (50,5 Hz and 48 Hz with a maximum delay of 0.5 and 3 seconds respectively) and maximum and minimum voltage between phases (1,15 Un and 0,85 Un) as shown in the table 1, where the proposal for low voltage is generalized to all the other levels. In electrical systems insular and extrapeninsular, the above values should be those contained in the corresponding operating procedures. The voltage for the measurement of these magnitudes should be taken in the network side of the general automatic switch for the high voltage facilities or main switches of the generators in low voltage networks. In case of action of the protection of maximum frequency, the reconnection will only take place when the frequency reaches a value less than or equal to 50 Hz.	See table 14	P
	e) Moreover to higher voltage of 1 kV and up to 36 kV, inclusive, shall be added the criterion of disconnection for homopolar maximum voltage.		N/A
2.	These protections can act on the main switch or the switch or switches on the equipment or generating equipment.		P
3.	The protections should be sealed by the distribution company, after the necessary verifications on the switching system and the integration in the generating equipment of protection functions.		P
4.	In case in which generating equipment or inverter incorporate the protections described above, they must comply with current legislation, in particular, the electrotechnical Regulation of low voltage, approved by Royal Decree 842/2002, of 2 August, the Regulation on technical conditions and security guarantees in power centers, substations and transformation centers, approved by Royal Decree 3275/1982, of 12 November, and the Regulation on technical conditions and security guarantees in power lines of high voltage, approved by Royal Decree 223/2008, of 15 February, for facilities that work in parallel with the distribution network. In this case will not be necessary the duplication of protections		Ref
Article 15	Grounding conditions of the facilities		N/A
1.	The grounding of the facilities interconnected will be done always in way that does not adversely affect the grounding conditions of network of the distribution company, ensuring that there are no transfers of defects to the distribution network.		N/A

<b>Requirements of RD 1699:2011</b>			
Summary of testing			
Clause	Requirement – Test	Result – Remark	Verdict
2.	The facility should have a galvanic separation between the distribution network and generating facilities, either by means of a transformer of insulation or any other mean that meets the same functions in accordance with the current regulation of industrial safety and quality.		N/A
3.	The masses of the generation facility will be connected to a ground independent of the neutral of the distribution company and will comply as described in the current regulation of industrial safety and quality that could be applicable.		N/A
Article 16	Harmonics and electromagnetic compatibility		P
	The emission and immunity levels must comply with current regulations, including in the documentation referred to in the article 4 the certificates that they accredit as well.		P
Article 17	Guarantee of security in work of the distribution network		N/A
Article 18	Measuring and billing		N/A

Appendix 1: Testing table

Article 12.4	TABLE: Power factor test								P	
	Power level (% of VA)	25%	30%	40%	50%	60%	70%	80%	90%	100%
Watts	1.671	2.008	2.665	3.334	4.001	4.669	5.331	6.002	6.686	
	1.664	2.003	2.662	3.333	4.001	4.672	5.326	6.006	6.686	
	1.664	2.003	2.664	3.339	4.003	4.675	5.342	6.012	6.697	
VA	1.349	2.012	2.668	3.337	4.003	4.671	5.333	6.005	6.688	
	1.341	2.006	2.665	3.335	4.004	4.674	5.328	6.008	6.689	
	1.340	2.007	2.667	3.341	4.005	4.677	5.344	6.014	6.700	
Vrms	230.52	230.53	230.6	230.56	230.73	230.9	230.98	231.1	231.2	
	230.52	230.50	230.5	230.56	230.73	230.9	230.98	231.0	231.2	
	230.49	230.56	230.6	230.57	230.73	230.9	230.95	231.0	231.2	
Arms	7.27	8.727	11.57	14.47	17.35	20.23	23.09	25.99	28.94	
	7.23	8.702	11.56	14.46	17.35	20.24	23.07	26.000	28.93	
	7.24	8.703	11.57	14.49	17.36	20.26	23.14	26.032	28.98	
PF	0.9970	0.9978	0.9986	0.9990	0.9994	0.9949	0.9995	0.9995	0.9996	
	0.9978	0.9983	0.9989	0.9993	0.9995	0.9996	0.9996	0.9996	0.9997	
	0.9978	0.9984	0.9989	0.9993	0.9995	0.9996	0.9996	0.9996	0.9996	

Article 14		UNDER / OVER FREQUENCY TESTS			
		Under Frequency		Over Frequency	
Parameter		Frequency	Time	Frequency	Time
Protection limit		48 Hz	3 s	50.5 Hz	0.5 s
Actual setting (as applied to interface protection)		48.0Hz	2.8s	50.5Hz	0.4s
Trip value (test result)		47.99Hz	2.89s	50.51Hz	414ms
Input current:	13.761A	Input power:	10.237Kw	Input voltage:	748.83V
Output current:	14.513A	Output power:	3.326Kw	Output voltage	229.4V
	14.482A		3.338Kw		230.6V
	14.482A		3.338Kw		230.6V

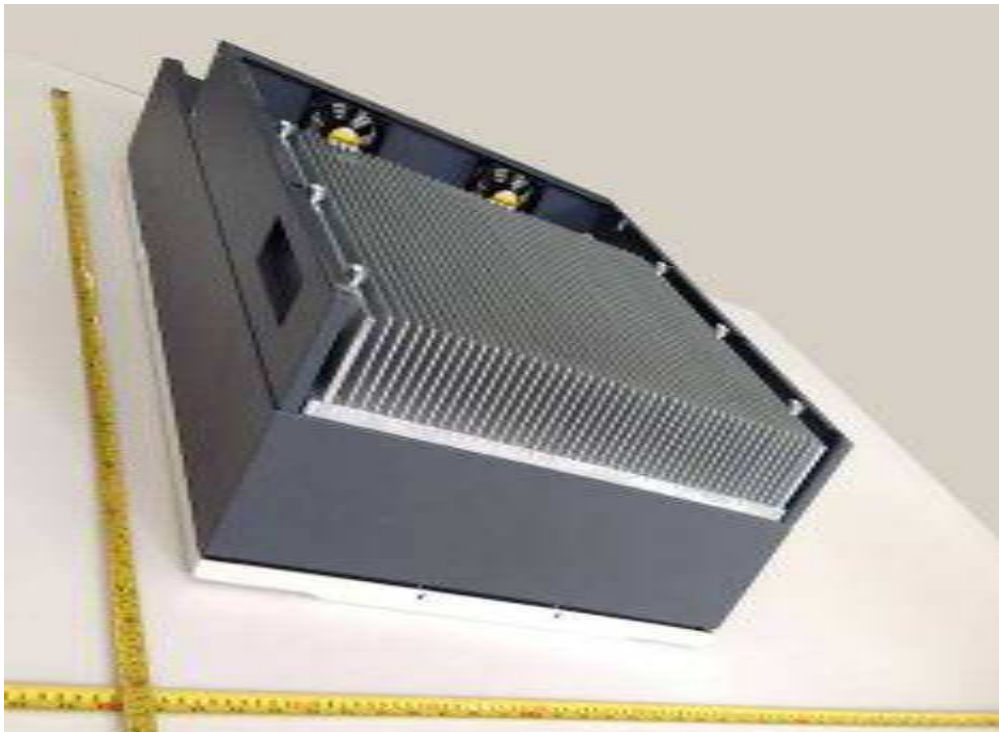
Appendix 1: Testing table

Article 14		UNDER / OVER VOLTAGE TESTS			
		Under Voltage		Over Voltage	
Parameter		Voltage	Time	Voltage	Time
Protection limit		195.5V	1.5 s	253V	1.5 s
Actual setting (as applied to interface protection)		195.5V	1.4s	253V	1.4s
Trip value (test result)		195.6V	1.43s	253.6V	1.42s
Parameter		Voltage	Time	Voltage	Time
Protection limit		--	--	264.5V	0.2 s
Actual setting (as applied to interface protection)		--	--	264.5	0.16s
Trip value (test result)		--	--	264.5	0.175s
Input current:	13.62A	Input power:	10.24Kw	Input voltage:	751.6V
Output current:	14.496A	Output power:	3.33Kw	Output voltage/ Frequency:	230.07
	14.484A		3.33Kw		230.05
	14.520A		3.34Kw		230.06

Appendix 2: Photos



Overall view of the unit



Bottom view of the unit

Appendix 2: Photos

PV connector (Sofar 20000TL-Sx and Sofar 17000TL-Sx has 3x2 pairs)  
(Sofar 15000TL-Sx and Sofar 10000TL-Sx has 2x2 pairs)



Terminals view of the unit (for models "-S2" to "-S6")



Terminals view of the unit (without AC switch)

Appendix 2: Photos



Terminals view of the unit for model Sofar 10000TL-Sx



Terminals view of the unit (for models "-S0" to "-S1")



Appendix 2: Photos

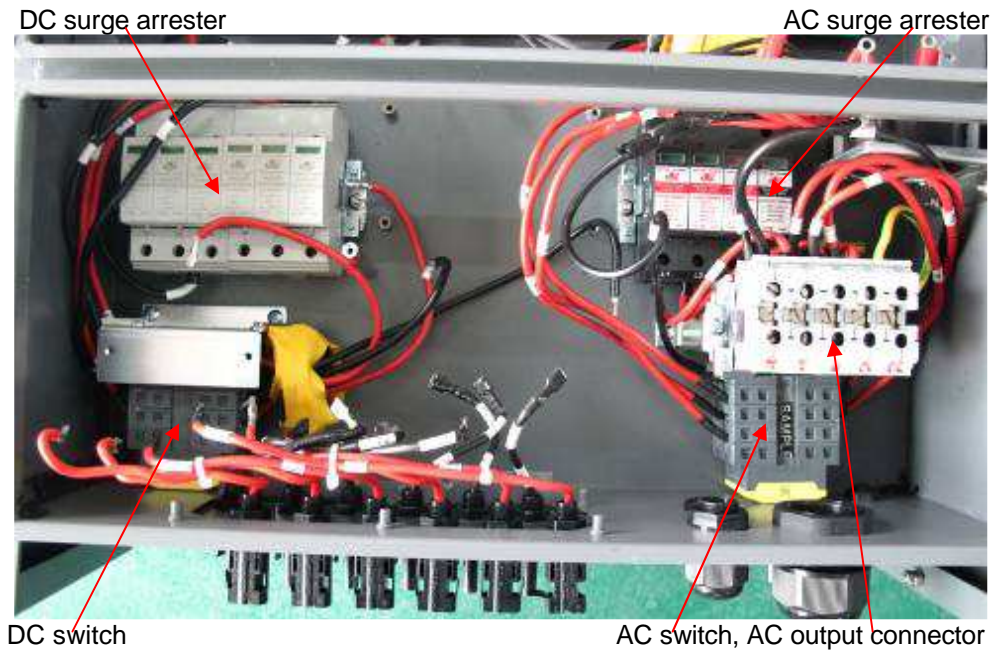


Internal view of the unit

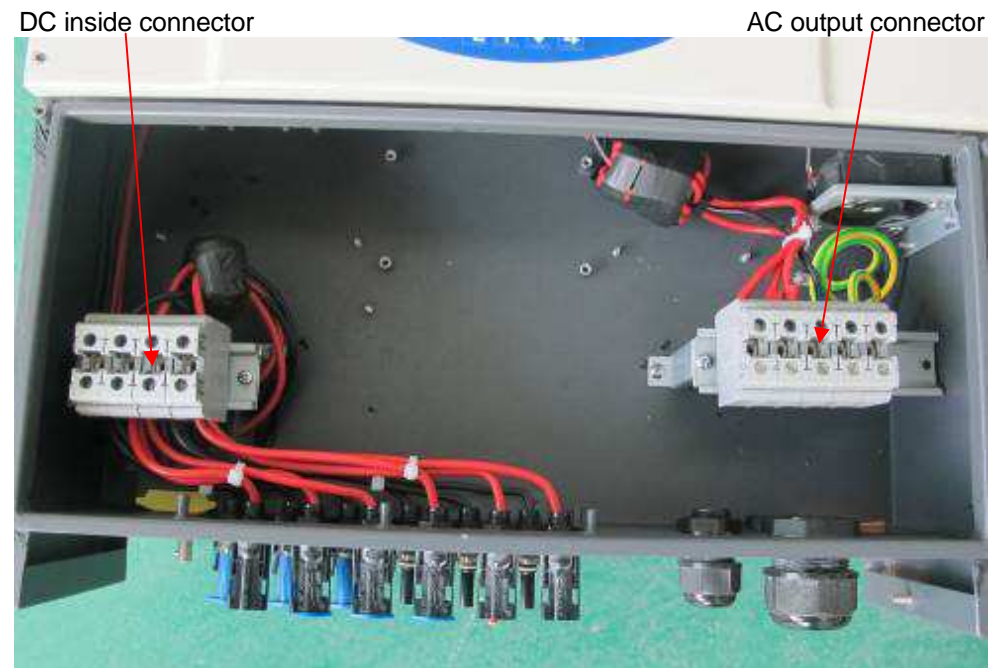


Internal view of the unit

Appendix 2: Photos



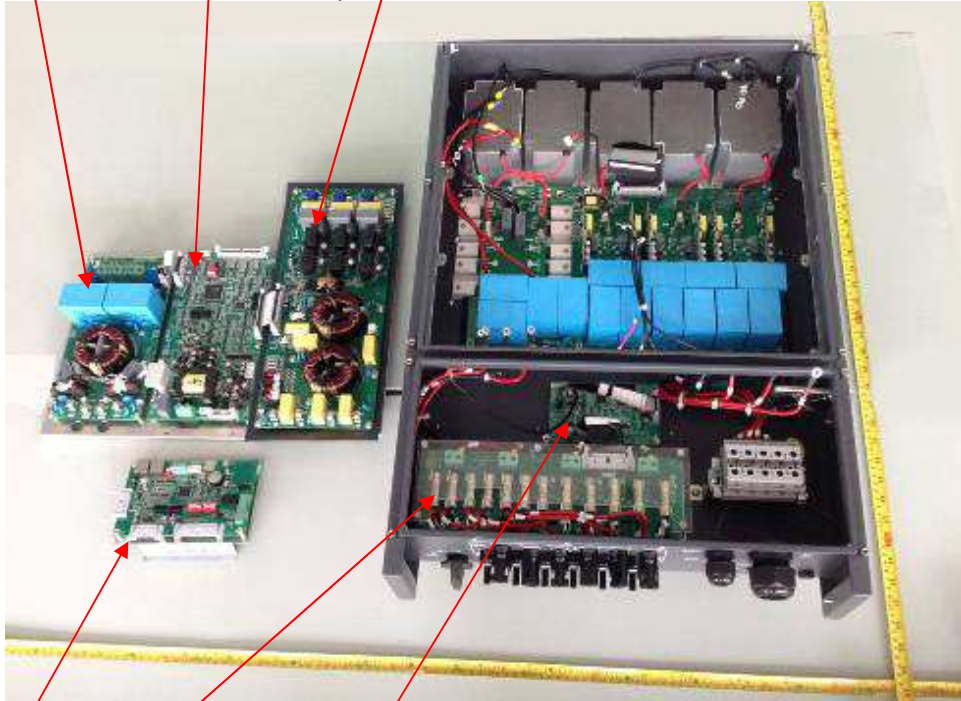
Internal view of the unit



Internal view of the unit

Appendix 2: Photos

Input board, Control board, Output board



COM board, Fuse board, String detection board  
Internal view of the unit



Front view of the control board

Appendix 2: Photos



Bottom view of the control board

( End of report )