






**BUREAU  
VERITAS**

# TEST REPORT IEC 61683

**Photovoltaic systems – Power conditioners – Procedure for measuring efficiency**

<b>Report reference number</b> .....	<b>PV180712N013-2-R1</b>			
<b>Date of issue</b> .....	2019-11-22			
<b>Total number of pages</b> .....	29			
<b>Testing laboratory name</b> .....	<b>Bureau Veritas Shenzhen Co., Ltd. Dongguan Branch</b>			
<b>Address</b> .....	No. 34, Chenwulu Section, Guantai Rd., Houjie Town, Dongguan City, Guangdong 523942, China			
<b>Applicant's name</b> .....	<b>Shenzhen SOFAR SOLAR Co., Ltd.</b>			
<b>Address</b> .....	401, Building 4, AnTongDa Industrial Park, District 68, XingDong Community, XinAn Street, BaoAn District, Shenzhen, China.			
<b>Test specification</b>				
<b>Standard</b> .....	IEC 61683:1999;			
<b>Certificate</b> .....	<b>Certificate of compliance</b>			
<b>Test report form number</b> .....	IEC61683			
<b>Master TRF</b> .....	Bureau Veritas Consumer Products Services Germany GmbH			
<b>Test item description</b> .....	<b>Solar Grid-tied Inverter</b>			
<b>Trademark</b> .....				
<b>Model / Type</b> .....	SOFAR 20000TL-G2, SOFAR 25000TL-G2, SOFAR 30000TL-G2, SOFAR 33000TL-G2			
<b>Ratings</b> .....	SOFAR 20000TL-G2	SOFAR 25000TL-G2	SOFAR 30000TL-G2	SOFAR 33000TL-G2
<b>Input DC voltage range [V]</b> .....	230-1100			
<b>Full load MPPT DC voltage range [V]:</b>	480-850	460-850	520-850	580-850
<b>Input DC current [A]</b> .....	24/24	28/28	30/30	30/30
<b>Output AC voltage [V]</b> .....	400V, 3/N/PE, 50Hz			
<b>Output AC current [A]</b> .....	Max. 32	Max. 40	Max. 48	Max. 53
<b>Output power [VA]</b> .....	22000	27500	33000	36300
<small>This report is governed by, and incorporates by reference, CPS Conditions of Service as posted at the date of issuance of this report at <a href="http://www.bureauveritas.com/home/about-us/our-business/cps/about-us/terms-conditions">http://www.bureauveritas.com/home/about-us/our-business/cps/about-us/terms-conditions</a> and is intended for your exclusive use. Any copying or replication of this report to or for any other person or entity, or use of our name or trademark, is permitted only with our prior written permission. This report sets forth our findings solely with respect to the test samples identified herein. The results set forth in this report are not indicative or representative of the quality or characteristics of the lot from which a test sample was taken or any similar or identical product unless specifically and expressly noted. Our report includes all of the tests requested by you and the results thereof based upon the information that you provided to us. Measurement uncertainty is only provided upon request for accredited tests. You have 60 days from date of issuance of this report to notify us of any material error or omission caused by our negligence or if you require measurement uncertainty; provided, however, that such notice shall be in writing and shall specifically address the issue you wish to raise. A failure to raise such issue within the prescribed time shall constitute your unqualified acceptance of the completeness of this report, the tests conducted and the correctness of the report contents.</small>				

<b>Testing Location .....</b>	<b>Bureau Veritas Shenzhen Co., Ltd. Dongguan Branch</b>
<b>Address .....</b>	No. 34, Chenwulu Section, Guantai Rd., Houjie Town, Dongguan City, Guangdong 523942, China
<b>Tested by (name and signature) .....</b>	Dora Zhang 
<b>Approved by (name and signature) .....</b>	James Huang 
<b>Manufacturer's name .....</b>	<b>Shenzhen SOFAR SOLAR Co., Ltd.</b>
<b>Manufacturer address .....</b>	401, Building 4, AnTongDa Industrial Park, District 68, XingDong Community, XinAn Street, BaoAn District, Shenzhen, China.
<b>Factory's name .....</b>	<b>Dongguan SOFAR SOLAR Co.,Ltd.</b>
<b>Factory address .....</b>	1F - 6F, Building E, No. 1 JinQi Road, Bihu Industrial Park, Wulian Village, Fenggang Town, Dongguan City

<b>Document History</b>			
<b>Date</b>	<b>Internal reference</b>	<b>Modification / Change / Status</b>	<b>Revision</b>
2018-08-03	James Huang	Initial report was written	--
2019-11-22	Dora Zhang	Update test data; Update the labels. Update the manufacturer's address.	R1
Supplementary information:			

<b>Test items particulars</b>	
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].....	37
<b>Test case verdicts</b>	
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)
<b>Testing</b>	
Date of receipt of test item .....	2018-07-12 & 2019-10-10
Date(s) of performance of test .....	2018-07-12 to 2018-08-01 & 2019-10-10 to 2019-11-01
<b>General remarks:</b>	
<p>The test result presented in this report relate only to the object(s) tested.          This report must not be reproduced in part or in full, without the written approval of the issuing testing laboratory.</p> <p>"(see Annex #)" refers to additional information appended to the report.          "(see appended table)" refers to a table appended to the report.</p>	
<b>Remark 1</b>	This report is to replace the earlier Test Report Ref. No. PV180712N013-2, issue by Bureau Veritas Shenzhen Co., Ltd. Dongguan Branch, on 03 Aug., 2018.
<b>Remark 2</b>	The modifications applied on this report is: <ul style="list-style-type: none"> <li>- Update test data of Efficiency recording and efficient calculation sheet.</li> <li>- Update the labels.</li> <li>- Update the manufacturer's address.</li> </ul>
<b>Remark 3</b>	For the above "Remark 2" described changes, no test was considered necessary.
Throughout this report a point is used as the decimal separator.	
<b>This Test Report consists of the following documents:</b>	
<ol style="list-style-type: none"> <li>1. Test Results</li> <li>2. Annex No. 1 – Pictures of the unit</li> <li>3. Annex No. 2 – Test equipment list</li> </ol>	

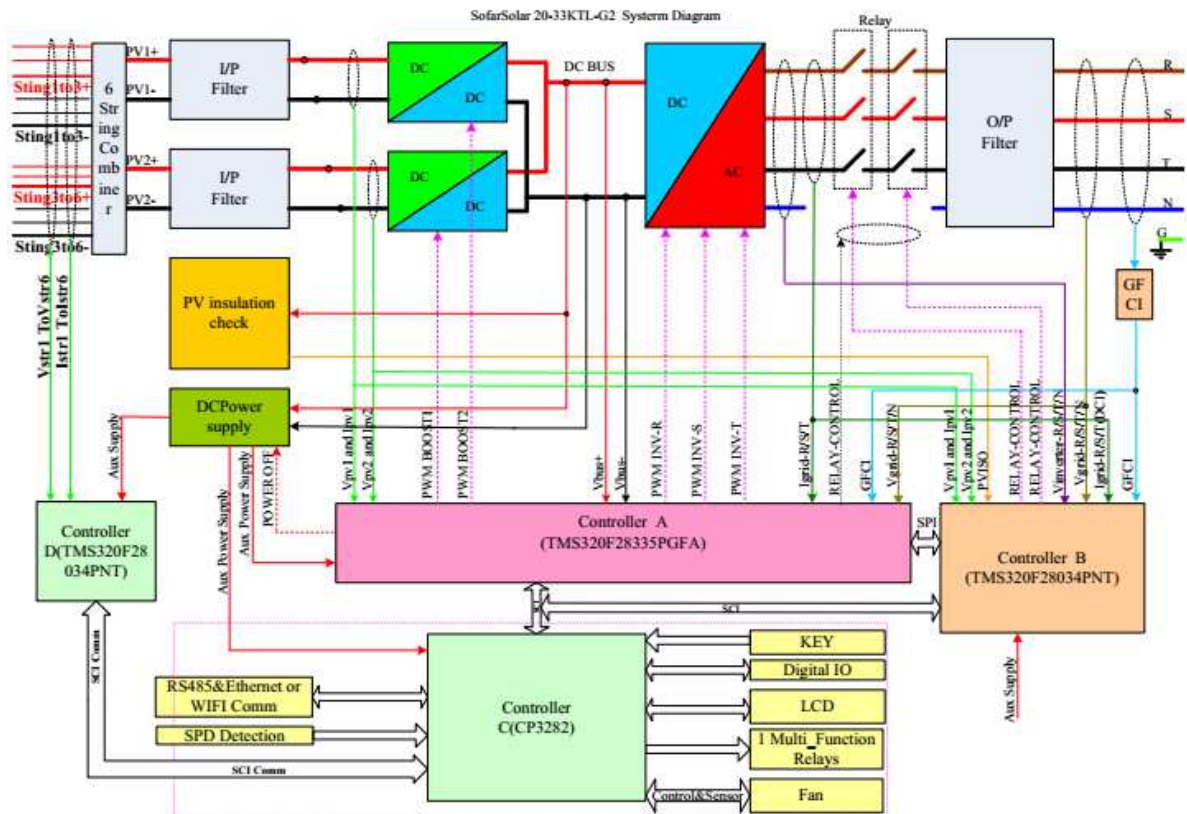
Copy of marking plate:

 <b>Solar Grid-tied Inverter</b>	 <b>Solar Grid-tied Inverter</b>
<b>Model No:</b> SOFAR 20000TL-G2	<b>Model No:</b> SOFAR 25000TL-G2
<b>Max.DC Input Voltage</b> ----- 1100V	<b>Max.DC Input Voltage</b> ----- 1100V
<b>Operating MPPT Voltage Range</b> ----- 230~960V	<b>Operating MPPT Voltage Range</b> ----- 230~960V
<b>Max. Input Current</b> ----- 24A/24A	<b>Max. Input Current</b> ----- 28A/28A
<b>Max. PV Isc</b> ----- 30A/30A	<b>Max. PV Isc</b> ----- 35A/35A
<b>Nominal Grid Voltage</b> ----- 3/N/PE,400Vac	<b>Nominal Grid Voltage</b> ----- 3/N/PE,400Vac
<b>Max. Output Current</b> ----- 3x32A	<b>Max. Output Current</b> ----- 3x40A
<b>Nominal Grid Frequency</b> ----- 50/60Hz	<b>Nominal Grid Frequency</b> ----- 50/60Hz
<b>Nominal Output Power</b> ----- 20000W	<b>Nominal Output Power</b> ----- 25000W
<b>Max. Output Power</b> ----- 22000VA	<b>Max. Output Power</b> ----- 27500VA
<b>Power Factor</b> ----- >0.99(adjustable +/-0.8)	<b>Power Factor</b> ----- >0.99(adjustable +/-0.8)
<b>Ingress Protection</b> ----- IP65	<b>Ingress Protection</b> ----- IP65
<b>Operating Temperature Range</b> ----- -25°C~+60°C	<b>Operating Temperature Range</b> ----- -25°C~+60°C
<b>Protective Class</b> ----- Class I	<b>Protective Class</b> ----- Class I
<b>Made in China</b>	<b>Made in China</b>
<b>Manufacturer :</b> Shenzhen SOFAR SOLAR Co.,Ltd. <b>Address :</b> 401, Building 4, An TongDa Industrial Park, District 68, XingDong Community, Xin An Street, BaoAn District, Shenzhen, China VDE0126-1-1,VDE-AR-N4105,G99,IEC61727, IEC62116,UTE C15-7 12-1,AS4777	<b>Manufacturer :</b> Shenzhen SOFAR SOLAR Co.,Ltd. <b>Address :</b> 401, Building 4, An TongDa Industrial Park, District 68, XingDong Community, Xin An Street, BaoAn District, Shenzhen, China VDE0126-1-1,VDE-AR-N4105,G99,IEC61727, IEC62116,UTE C15-7 12-1,AS4777
	
 <b>Solar Grid-tied Inverter</b>	 <b>Solar Grid-tied Inverter</b>
<b>Model No:</b> SOFAR 30000TL-G2	<b>Model No:</b> SOFAR 33000TL-G2
<b>Max.DC Input Voltage</b> ----- 1100V	<b>Max.DC Input Voltage</b> ----- 1100V
<b>Operating MPPT Voltage Range</b> ----- 230~960V	<b>Operating MPPT Voltage Range</b> ----- 230~960V
<b>Max. Input Current</b> ----- 30A/30A	<b>Max. Input Current</b> ----- 30A/30A
<b>Max. PV Isc</b> ----- 37.5A/37.5A	<b>Max. PV Isc</b> ----- 37.5A/37.5A
<b>Nominal Grid Voltage</b> ----- 3/N/PE,400Vac	<b>Nominal Grid Voltage</b> ----- 3/N/PE,400Vac
<b>Max. Output Current</b> ----- 3x48A	<b>Max. Output Current</b> ----- 3x53A
<b>Nominal Grid Frequency</b> ----- 50/60Hz	<b>Nominal Grid Frequency</b> ----- 50/60Hz
<b>Nominal Output Power</b> ----- 30000W	<b>Nominal Output Power</b> ----- 33000W
<b>Max. Output Power</b> ----- 33000VA	<b>Max. Output Power</b> ----- 36300VA
<b>Power Factor</b> ----- >0.99(adjustable +/-0.8)	<b>Power Factor</b> ----- >0.99(adjustable +/-0.8)
<b>Ingress Protection</b> ----- IP65	<b>Ingress Protection</b> ----- IP65
<b>Operating Temperature Range</b> ----- -25°C~+60°C	<b>Operating Temperature Range</b> ----- -25°C~+60°C
<b>Protective Class</b> ----- Class I	<b>Protective Class</b> ----- Class I
<b>Made in China</b>	<b>Made in China</b>
<b>Manufacturer :</b> Shenzhen SOFAR SOLAR Co.,Ltd. <b>Address :</b> 401, Building 4, An TongDa Industrial Park, District 68, XingDong Community, Xin An Street, BaoAn District, Shenzhen, China VDE0126-1-1,VDE-AR-N4105,G99,IEC61727, IEC62116,UTE C15-7 12-1,AS4777	<b>Manufacturer :</b> Shenzhen SOFAR SOLAR Co.,Ltd. <b>Address :</b> 401, Building 4, An TongDa Industrial Park, District 68, XingDong Community, Xin An Street, BaoAn District, Shenzhen, China VDE0126-1-1,VDE-AR-N4105,G99,IEC61727, IEC62116,UTE C15-7 12-1,AS4777
	

**General product information:**

The Solar converter converts DC voltage into AC voltage.  
 The DC input of Solar converter can be supplied from PV array and Batteries.  
 The charging current to batteries only from PV array, battery management unit is integrated in External Energy storage.

The Solar converter is a three-phase type.  
 The unit is providing EMC filtering at the output toward mains. The unit does not provide galvanic separation from input to output (transformerless). The output is switched off redundant by the high power switching bridge and a two relays. This assures that the opening of the output circuit will also operate in case of one error.



**Figure 1-Block diagram**

The internal control is redundant built. It consists of Main DSP(UC20) and slave DSP(UC73).  
 The Main DSP(UC20) can control the relays, measures voltage, and frequency, AC current with injected DC, insulation resistance and residual current, In addition it tests the array insulation resistance and the RCMU circuit before each start up.  
 The slave DSP(UC73) is using for detect residual current, also can open the relays independently and communicate with Main DSP(UC20).  
 The unit provides two relays in series on Line 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 start up. Both controllers(Main DSP(UC20), Slave DSP(UC73)) can open the relays.

**The product was tested on:**

Hardware version: V1.00  
 Software version: V1.40

**Model difference:**

The models SOFAR 20000TL-G2, SOFAR 25000TL-G2, SOFAR 30000TL-G2 and SOFAR 33000TL-G2 are almost identical in hardware except the shown in the following table and the output power derated by software.

The difference in hardware			
Item	SOFAR 20000TL-G2	SOFAR 25000TL-G2	SOFAR 30000TL-G2 / SOFAR 33000TL-G2
Number of PV terminal	2+2	3+3	
Number of BUS capacitance	8 capacitors: 550V/110 $\mu$ f 2 capacitors: 1100V/40 $\mu$ F		10 capacitors: 550V/110 $\mu$ f 24 capacitors: 1100V/40 $\mu$ F
INV inductance	785 $\mu$ H	735 $\mu$ H	
BUS board	Not the board	Have the board	
External fan	Not the board	2	3
Relay of output board	6pcs T9VV1K15-12S		3pcs AZSR250-2AE-12D

<b>IEC 61683</b>			
Clause	Requirement + Test	Result - Remark	Verdict
<b>4</b>	<b>Efficiency measurement conditions</b>	Considered.	<b>P</b>
	Efficiency shall be measured under the matrix of conditions as described in the following clauses and table 1. Specific conditions may be excluded by mutual agreement when those conditions are outside the manufacturer's allowable operating range. The resulting data shall be presented in tabular form and may also be presented graphically.	See below.	<b>P</b>
4.1	DC power source for testing		<b>P</b>
	For power conditioners operating with fixed input voltage, the d.c. power source is a storage battery or constant voltage power source to maintain the input voltage.		<b>N/A</b>
	For power conditioners that employ maximum power point tracking (MPPT) and shunt-type power conditioners, either a photovoltaic array or a photovoltaic array simulator is utilized.	Photovoltaic array simulator used.	<b>P</b>
4.2	Temperature		<b>P</b>
	All measurements are to be made at an ambient temperature of 25 °C ± 2 °C.	25°C	<b>P</b>
	Other ambient temperatures may be allowed by mutual agreement. However, the temperature used must be clearly stated in all documentation.		<b>N/A</b>
4.3	Output voltage and frequency		<b>P</b>
	The output voltage and frequency are maintained at the manufacturer's stated nominal values.	230V, 3/N/PE, 50Hz	<b>P</b>
4.4	Input voltage		<b>P</b>
	Measurements performed in each of the following tests are repeated at three power conditioner input voltages: a) manufacturer's minimum rated input voltage; b) the inverter's nominal voltage or the average of its rated input range; c) 90 % of the inverter's maximum input voltage.	Input voltages: a) ; SOFAR 20000TL-G2: 480Vdc, SOFAR 25000TL-G2 :460Vdc, SOFAR 30000TL-G2 :520Vdc, SOFAR 33000TL-G2 :580Vdc b); 620V c) .990V	<b>P</b>
	In the case where a power conditioner is to be connected with a battery at its input terminals, only the nominal or rated input voltage may be applied.		<b>N/A</b>
4.5	Ripple and distortion		<b>P</b>
	Record input voltage and current ripple for each measurement. Also record output voltage and current distortion (if a.c.) or ripple (if d.c.). Ensure that these measurements remain within the manufacturer's specified values.	The ripple of the input voltage had no influence on the measurements. (see appended table)	<b>P</b>
4.6	Resistive loads/utility grid		<b>P</b>

<b>IEC 61683</b>			
<b>Clause</b>	<b>Requirement + Test</b>	<b>Result - Remark</b>	<b>Verdict</b>
	At unity power factor, or at the intrinsic power factor of grid-connected inverters without power factor adjustment, measure the efficiency for power levels of 10 %, 25 %, 50 %, 75 %, 100 % and 120 % of the inverter's rating.	The efficiency measurement was performed at 10 %, 25 %, 50 %, 75 % and 100 %, because the unit does not provide 120% of the inverter's rating overload function.	<b>P</b>
	Stand-alone inverters are also measured at a power level of 5 % of rated. The power conditioner test is conducted with a specified resistive and reactive grid impedance.	Grid-connected inverters.	<b>N/A</b>
4.7	Reactive loads		<b>N/A</b>
	For stand-alone inverters, measure the efficiency with a load which provides a power factor equal to the manufacturer's specified minimum level (or 0,25, whichever is greater) and at power levels of 25 %, 50 % and 100 % of rated VA.	Grid-connected inverters.	<b>N/A</b>
	Repeat for power factors of 0,5 and 0,75 (do not go below the manufacturer's specified minimum PF) and power levels of 25 %, 50 %, and 100 % of rated VA.		<b>N/A</b>
4.8	Resistive plus non-linear loads		<b>N/A</b>
	For stand-alone inverters, measure the efficiency with a fixed non-linear load (total harmonic distortion (THD) = $(80 \pm 5) \%$ ) equal to $(25 \pm 5) \%$ of the inverter's rated VA plus sufficient resistive load in parallel to achieve a total load of 25 %, 50 % and 100 % of rated VA.	Grid-connected inverters.	<b>N/A</b>
	Repeat the measurements with a fixed non-linear load equivalent to $(50 \pm 5) \%$ of the inverter's rated VA plus sufficient resistive load in parallel to achieve a total load of 50% and 100% of rated VA.		<b>N/A</b>
	The type of non-linear load must be clearly stated in all documentation.		<b>N/A</b>
4.9	Complex loads		<b>N/A</b>
	When a non-linear plus a sufficient reactive load condition is specified for stand-alone inverters, measure the efficiency with a fixed non-linear load (THD = $(80 \pm 5) \%$ ) equal to $(50 \pm 5) \%$ of the inverter's rated VA plus a sufficient reactive load (PF = 0,5) in parallel to achieve a total load of 50 % and 100 % of rated VA.	Grid-connected inverters.	<b>N/A</b>
	The type of complex load is clearly stated in all documentation.		<b>N/A</b>
<b>5.</b>	<b>Efficiency calculations</b>	See below.	<b>P</b>
5.1	Rated output efficiency		<b>P</b>



IEC 61683			
Clause	Requirement + Test	Result - Remark	Verdict
	Rated output efficiency shall be calculated from measured data as follows: $\eta_R = (P_o / P_i) \times 100$	Considered.	<b>P</b>
5.2	Partial output efficiency		<b>N/A</b>
	Partial output efficiency shall be calculated from measured data as follows: $\eta_{par} = (P_{op} / P_{ip}) \times 100$	No derating during testing.	<b>N/A</b>
5.3	Energy efficiency		<b>P</b>
	Energy efficiency shall be calculated from measured data as follows: $\eta_E = (W_o / W_i) \times 100$	Considered.	<b>P</b>
5.4	Efficiency tolerances		<b>P</b>
	When an efficiency value has been guaranteed, the tolerance of this value shall be within: $-0,2(1-\eta)\eta$ (%)	Considered.	<b>P</b>

<b>6.</b>	<b>Efficiency test circuits</b>	See below.	<b>P</b>
6.1	Test circuits	Considered.	<b>P</b>
	Figure 1a is applied to standard-alone power conditioners	Figure 1b used.	<b>N/A</b>
	<p>Figure 1a – Stand-alone type</p> <p>IEC 1566/99</p>		<b>N/A</b>
	Figure 1b is applied to utility-interactive power conditioners	Considered.	<b>P</b>
	<p>Figure 1b – Utility-interactive type</p> <p>IEC 1567/99</p> <p>PC power conditioner PS variable voltage-current d.c. power supply A<sub>1</sub> DC ammeter A<sub>2</sub> AC or d.c. ammeter W<sub>1</sub> DC wattmeter W<sub>2</sub> AC or d.c. wattmeter</p> <p>L load F frequency meter V<sub>1</sub> DC voltmeter V<sub>2</sub> AC or d.c. voltmeter PF power factor meter</p>		<b>P</b>
6.2	Measurement procedure	Considered.	<b>P</b>
	a) Efficiency is calculated with equation (1) or (2) using measured P <sub>i</sub> , P <sub>o</sub> or P <sub>ip</sub> , P <sub>op</sub> . DC input power P <sub>i</sub> , P <sub>ip</sub> can be measured by wattmeter W <sub>1</sub> , or determined by multiplying the d.c. voltmeter V <sub>1</sub> and d.c. ammeter A <sub>1</sub> readings. Output power P <sub>o</sub> , P <sub>op</sub> is measured with wattmeter W <sub>2</sub> .	Considered.	<b>P</b>

IEC 61683			
Clause	Requirement + Test	Result - Remark	Verdict
	b) DC input voltage, which is measured by d.c. voltmeter $V_1$ , shall be varied in the defined range where the output current, which is measured with a.c. ammeter $A_2$ , is varied from low output to the rated output.	Considered.	<b>P</b>
	c) An average indicating instrument shall be used for the d.c. voltmeter and d.c. ammeter. A true r.m.s. type of indicating instrument shall be used for the a.c. voltmeter and a.c. ammeter. The d.c. wattmeter $W_1$ shall be a d.c. measuring type. The wattmeter $W_2$ shall be an a.c. or d.c. measuring type according to the output.	Considered.	<b>P</b>
	d) Power factor (PF in per cent) can be measured by a power factor meter PF, or calculated from the readings of $V_2$ , $A_2$ , $W_2$ and as follows: $PF = (W_2 / (V_2 \times A_2)) \times 100$	Considered.	<b>P</b>
	e) Each meter may be an analogue type or a digital type. The measurement accuracy shall be better than $\pm 0,5\%$ of the full-scale value for each power measured. Digital power instruments for $W_1$ and $W_2$ are also recommended.	Digital measurement devices were used for testing. The accuracy of the measurement devices fulfills the requirements.	<b>P</b>
	f) An MPPT dynamically adjusts the input voltage so as to maximize the output power. In principle, the monitoring equipment shall sample all of the electrical parameters, such as input voltage and current, output power and current, within the update period of the MPPT. If the MPPT and input source (PV array or PV array simulator) interact in such a way that the input voltage varies by less than 5 %, then averaging of readings is acceptable. The averaging period shall be 30 s or longer.	The dynamic MPPT was deactivated, the 60s average was used anyway.	<b>P</b>

<b>7.</b>	<b>Loss measurement</b>	See below.	<b>P</b>
7.1	No-load loss		<b>P</b>
	Stand-alone inverters: reading of d.c. input voltage, output voltage and frequency is given with meters $V_1$ , $V_2$ and F respectively in figure 1a, and shall be adjusted to the rated values.	Grid-connected inverters.	<b>N/A</b>
	Utility-interactive inverters: reading of d.c. input voltmeter $V_1$ , a.c. output voltmeter $V_2$ and frequency meter F in figure 1b shall be adjusted to meet the specified voltages and frequency.	See appended table.	<b>P</b>
7.2	Standby loss		<b>P</b>
	Stand-alone inverters: Consumption of utility power when the power conditioner is not operating but is under standby condition.	No such inverters.	<b>N/A</b>
	Utility-interactive inverters: consumption from the d.c. source when the power conditioner is not operating but is under standby condition.	See appended table.	<b>P</b>

<b>IEC 61683</b>			
Clause	Requirement + Test	Result - Remark	Verdict
<b>Annex A</b>	<b>Power conditioner description (informative)</b>	See below.	<b>P</b>
	A power conditioner is defined in IEC 61277	Figure A.2	<b>P</b>
<b>Annex B</b>	<b>Power efficiency and conversion factor (informative)</b>	See below.	<b>P</b>
	There are two types of efficiencies shown in IEC 60146-2; one is a power efficiency, the other is a conversion factor. Power efficiency is defined as the ratio of active output power and active input power. Conversion factor is the ratio between output and input fundamental power levels.	Power efficiency used.	<b>P</b>
<b>Annex C</b>	<b>Weighted-average energy efficiency (informative)</b>	See below.	<b>P</b>
	The energy of a power conditioner depends on both the irradiance profile and the load profile. The energy efficiency of a power conditioner shall be calculated by the ratio of the output to the input energy actually measured over a certain period	Considered.	<b>P</b>
C.1	$\eta_{WT}$ of power conditioner for utility-interactive PV systems	SOFAR 20000TL-G2: 97.67% SOFAR 25000TL-G2: 97.76% SOFAR 30000TL-G2: 97.43% SOFAR 33000TL-G2: 97.73%	<b>P</b>
	Utility-interactive PV systems, which have no storage and for which reverse-power flow is accepted, are described. In this case, d.c. power generated by the PV array is supplied direct into the power conditioner (PC). Almost all of the input power to the PC is converted to a.c. power. A part of it is dissipated as the PC loss.	Considered.	<b>P</b>
C.2	$\eta_{WT}$ of power conditioner for stand-alone PV systems	Grid-connected inverters.	<b>N/A</b>
	In stand-alone PV systems with a storage subsystem, power generated from the PV array is stored and stabilized by the batteries. DC power is converted into regulated d.c. power or constant-voltage and constant-frequency a.c. power by a power conditioner (PC) and supplied to the load. In this case, some fraction of the generated power is dissipated as a loss in the batteries and power conditioner.		<b>N/A</b>
<b>Annex D</b>	<b>Derivation of efficiency tolerance in table 2 (informative)</b>	Considered.	<b>P</b>

IEC 61683			
Clause	Requirement + Test	Result - Remark	Verdict

TABLE	Efficiency recording and efficient calculation sheet								
<b>power conditioner type</b>	<b>Grid-connected</b>								
Model:	SOFAR 20000TL-G2								
Parameters of power conditioner	Minimum rated input voltage: 480V Nominal voltage: 620V Maximum input voltage: 1100V Rated output voltage: 400V Rated output frequency: 50Hz Rated output power: 22kVA								
<b>PV input voltage</b>	<b>a) Manufacturer's minimum rated input voltage</b>								
Temperature (°C)	25								
Operating period for energy measurement (min)	1								
Percentage of rated output VA	/	10%	25%	50%	75%	100%	120%*	/	/
Input voltage (V)	/	477.56	479.87	479.39	478.30	477.68	/	/	/
Input voltage ripple (V)	/	21.02	11.93	10.71	10.20	10.13	/	/	/
Input current (A)	/	4.356	10.793	21.558	32.359	43.130	/	/	/
Input current ripple (A)	/	0.178	0.264	0.481	0.677	0.911	/	/	/
Input power (Pi) (kW)	/	2.080	5.179	10.334	15.477	20.601	/	/	/
Output power (Po) (kW)	/	2.024	5.079	10.144	15.182	20.188	/	/	/
Output efficiency (%)	/	97.41%	98.17%	98.26%	98.21%	98,11%	/	/	/
Input energy (Wi) (kWh)	/	0.035	0.086	0.172	0.258	0.343	/	/	/
Output energy (Wo) (kWh)	/	0.034	0.085	0.169	0.253	0.336	/	/	/
Energy efficiency	/	97.41%	98.17%	98.26%	98.21%	98,11%	/	/	/
<b>PV input voltage</b>	<b>b) The inverter's nominal voltage</b>								
Temperature (°C)	25								
Operating period for energy measurement (min)	1								
Percentage of rated output VA	/	10%	25%	50%	75%	100%	120%*	/	/
Input voltage (V)	/	618.47	619.03	618.68	620.36	617.61	/	/	/
Input voltage ripple (V)	/	13.62	16.90	12.88	11.97	11.22	/	/	/
Input current (A)	/	2.625	6.500	12.971	19.380	25.927	/	/	/

IEC 61683									
Clause	Requirement + Test						Result - Remark		Verdict
Input current ripple (A)	/	0.057	0.183	0.272	0.385	0.462	/	/	/
Input power (Pi) (kW)	/	1.623	4.024	8.024	12.023	16.013	/	/	/
Output power (Po) (kW)	/	1.581	3.946	7.880	11.795	15.696	/	/	/
Output efficiency (%)	/	97.55%	98.28%	98.40%	98.32%	98.22%	/	/	/
Input energy (Wi) (kWh)	/	0.027	0.067	0.134	0.200	0.267	/	/	/
Output energy (Wo) (kWh)	/	0.026	0.066	0.131	0.197	0.262	/	/	/
Energy efficiency	/	97.55%	98.28%	98.40%	98.32%	98.22%	/	/	/
<b>PV input voltage</b>									
<b>c) 90% of the inverter's maximum input voltage** (800V)</b>									
Temperature (°C)	/								
Operating period for energy measurement (min)	/								
Percentage of rated output VA	/	10%	25%	50%	75%	100%	120%*	/	/
Input voltage (V)	/	790.86	800.81	796.27	798.32	796.46	/	/	/
Input voltage ripple (V)	/	17.36	16.98	15.43	13.88	13.24	/	/	/
Input current (A)	/	2.645	6.491	13.009	19.442	25.955	/	/	/
Input current ripple (A)	/	0.046	0.144	0.237	0.337	0.414	/	/	/
Input power (Pi) (kW)	/	2.092	5.198	10.358	15.521	20.671	/	/	/
Output power (Po) (kW)	/	2.038	5.094	10.165	15.224	20.250	/	/	/
Output efficiency (%)	/	97.54%	98.21%	98.34%	98.29%	98,22%	/	/	/
Input energy (Wi) (kWh)	/	0.035	0.087	0.173	0.259	0.345	/	/	/
Output energy (Wo) (kWh)	/	0.034	0.085	0.169	0.254	0.337	/	/	/
Energy efficiency	/	97.54%	98.21%	98.34%	98.29%	98,22%	/	/	/
Remark:									
*If limited by design, inverter is not capable to operate with the 120% of rated output load, test under this condition is waived;									
** The EUT can't start up at 990Vdc.									

IEC 61683			
Clause	Requirement + Test	Result - Remark	Verdict

TABLE	Efficiency recording and efficient calculation sheet								
<b>power conditioner type</b>	<b>Grid-connected</b>								
Model:	SOFAR 25000TL-G2								
Parameters of power conditioner	Minimum rated input voltage: 460V Nominal voltage: 620V Maximum input voltage: 1100V Rated output voltage: 400V Rated output frequency: 50Hz Rated output power: 27.5kVA								
<b>PV input voltage</b>	<b>a) Manufacturer's minimum rated input voltage</b>								
Temperature (°C)	25								
Operating period for energy measurement (min)	1								
Percentage of rated output VA	/	10%	25%	50%	75%	100%	120%*	/	/
Input voltage (V)	/	459.33	458.78	458.99	457.77	468.36	/	/	/
Input voltage ripple (V)	/	16.39	12.43	8.56	9.95	2.26	/	/	/
Input current (A)	/	5.639	14.030	27.848	41.915	53.986	/	/	/
Input current ripple (A)	/	0.204	0.382	0.522	0.897	0.422	/	/	/
Input power (Pi) (kW)	/	2.590	6.436	12.781	19.186	25.284	/	/	/
Output power (Po) (kW)	/	2.523	6.317	12.568	18.832	24.778	/	/	/
Output efficiency (%)	/	97.49%	98.26%	98.44%	98.27%	98.11%	/	/	/
Input energy (Wi) (kWh)	/	0.043	0.107	0.213	0.320	0.421	/	/	/
Output energy (Wo) (kWh)	/	0.042	0.105	0.209	0.314	0.413	/	/	/
Energy efficiency	/	97.49%	98.26%	98.44%	98.27%	98.11%	/	/	/
<b>PV input voltage</b>	<b>b) The inverter's nominal voltage</b>								
Temperature (°C)	25								
Operating period for energy measurement (min)	1								
Percentage of rated output VA	/	10%	25%	50%	75%	100%	120%*	/	/
Input voltage (V)	/	618.06	618.32	619.98	618.28	618.63	/	/	/
Input voltage ripple (V)	/	17.36	12.58	12.64	11.27	10.77	/	/	/
Input current (A)	/	4.193	10.384	20.663	30.998	41.238	/	/	/

IEC 61683									
Clause	Requirement + Test						Result - Remark		Verdict
Input current ripple (A)	/	0.112	0.207	0.427	0.571	0.743	/	/	/
Input power (Pi) (W)	/	2.591	6.420	12.810	19.165	25.510	/	/	/
Output power (Po) (W)	/	2.529	6.311	12.612	18.837	25.045	/	/	/
Output efficiency	/	97.70%	98.41%	98.56%	98.41%	98.29%	/	/	/
Input energy (Wi) (kWh)	/	0.043	0.107	0.214	0.319	0.425	/	/	/
Output energy (Wo) (kWh)	/	0.042	0.105	0.210	0.314	0.417	/	/	/
Energy efficiency	/	97.70%	98.41%	98.56%	98.41%	98.29%	/	/	/
<b>PV input voltage</b>	<b>c) 90% of the inverter's maximum input voltage**(800V)</b>								
Temperature (°C)	25								
Operating period for energy measurement (min)	1								
Percentage of rated output VA	/	10%	25%	50%	75%	100%	120%*	/	/
Input voltage (V)	/	784.70	794.61	800.22	798.71	797.59	/	/	/
Input voltage ripple (V)	/	23.43	18,30	16.15	12.61	12.53	/	/	/
Input current (A)	/	3.280	8.073	16.032	24.034	32.058	/	/	/
Input current ripple (A)	/	0.067	0.167	0.334	0.377	0.500	/	/	/
Input power (Pi) (W)	/	2.574	6.415	12.829	19.199	25.568	/	/	/
Output power (Po) (W)	/	2.512	6.301	12.621	18.855	25.057	/	/	/
Output efficiency	/	97.58%	98.32%	98.49%	98.33%	98.15%	/	/	/
Input energy (Wi) (kWh)	/	0.043	0.107	0.214	0.320	0.426	/	/	/
Output energy (Wo) (kWh)	/	0.042	0.105	0.210	0.314	0.418	/	/	/
Energy efficiency	/	97.58%	98.32%	98.49%	98.33%	98.15%	/	/	/
<b>Remark:</b> *If limited by design, inverter is not capable to operate with the 120% of rated output load, test under this condition is waived; ** The EUT can't start up at 990Vdc.									

IEC 61683			
Clause	Requirement + Test	Result - Remark	Verdict

TABLE	Efficiency recording and efficient calculation sheet								
<b>power conditioner type</b>	<b>Grid-connected</b>								
Model:	SOFAR 30000TL-G2								
Parameters of power conditioner	Minimum rated input voltage: 520V Nominal voltage: 620V Maximum input voltage: 1100V Rated output voltage: 400V Rated output frequency: 50Hz Rated output power: 33.0kVA								
<b>PV input voltage</b>	<b>a) Manufacturer's minimum rated input voltage</b>								
Temperature (°C)	25								
Operating period for energy measurement (min)	1								
Percentage of rated output VA	/	10%	25%	50%	75%	100%	120%*	/	/
Input voltage (V)	/	520.10	518.93	518.94	517.90	516.75	/	/	/
Input voltage ripple (V)	/	21.53	14.72	11.27	9.59	8.40	/	/	/
Input current (A)	/	4.873	12.131	24.206	36.305	48.423	/	/	/
Input current ripple (A)	/	0.197	0.351	0.512	0.664	0.760	/	/	/
Input power (Pi) (kW)	/	2.534	6.295	12.561	18.801	25.021	/	/	/
Output power (Po) (kW)	/	2.469	6.183	12.356	18.465	24.525	/	/	/
Output efficiency (%)	/	97.52%	98.33%	98.47%	98.33%	98.13%	/	/	/
Input energy (Wi) (kWh)	/	0.042	0.105	0.209	0.313	0.417	/	/	/
Output energy (Wo) (kWh)	/	0.041	0.103	0.206	0.308	0.409	/	/	/
Energy efficiency	/	97.52%	98.33%	98.47%	98.33%	98.13%	/	/	/
<b>PV input voltage</b>	<b>b) The inverter's nominal voltage</b>								
Temperature (°C)	25								
Operating period for energy measurement (min)	1								
Percentage of rated output VA	/	10%	25%	50%	75%	100%	120%*	/	/
Input voltage (V)	/	617.80	618.55	619.90	618.72	618.06	/	/	/
Input voltage ripple (V)	/	19.89	20.03	10.81	12.13	9.97	/	/	/
Input current (A)	/	4.885	12.139	24.283	36.247	48.300	/	/	/



IEC 61683									
Clause	Requirement + Test						Result - Remark		Verdict
Input current ripple (A)	/	0.152	0.367	0.404	0.721	0.796	/	/	/
Input power (Pi) (kW)	/	3.018	7.508	14.980	22.426	29.852	/	/	/
Output power (Po) (kW)	/	2.946	7.381	14.750	22.049	29.308	/	/	/
Output efficiency (%)	/	97.71%	98.41%	98.58%	98.43%	98.29%	/	/	/
Input energy (Wi) (kWh)	/	0.050	0.125	0.250	0.374	0.498	/	/	/
Output energy (Wo) (kWh)	/	0.049	0.123	0.246	0.368	0.488	/	/	/
Energy efficiency	/	97.71%	98.41%	98.58%	98.43%	98.29%	/	/	/
<b>PV input voltage</b>	<b>c) 90% of the inverter's maximum input voltage**(800V)</b>								
Temperature (°C)	25								
Operating period for energy measurement (min)	1								
Percentage of rated output VA	/	10%	25%	50%	75%	100%	120%*	/	/
Input voltage (V)	/	801.27	801.23	798.44	799.60	797.99	/	/	/
Input voltage ripple (V)	/	20.97	11.69	13.86	10.44	9.88	/	/	/
Input current (A)	/	3.775	9.386	18.788	28.096	37.497	/	/	/
Input current ripple (A)	/	0.101	0.144	0.322	0.373	0.466	/	/	/
Input power (Pi) (kW)	/	3.024	7.520	15.001	22.465	29.921	/	/	/
Output power (Po) (kW)	/	2.948	7.386	14.759	22.071	29.338	/	/	/
Output efficiency (%)	/	97.59%	98.33%	98.50%	98.37%	98.16%	/	/	/
Input energy (Wi) (kWh)	/	0.050	0.125	0.250	0.374	0.499	/	/	/
Output energy (Wo) (kWh)	/	0.049	0.123	0.246	0.368	0.489	/	/	/
Energy efficiency	/	97.59%	98.33%	98.50%	98.37%	98.16%	/	/	/
<b>Remark:</b> *If limited by design, inverter is not capable to operate with the 120% of rated output load, test under this condition is waived; ** The EUT can't start up at 990Vdc.									

IEC 61683			
Clause	Requirement + Test	Result - Remark	Verdict

TABLE	Efficiency recording and efficient calculation sheet								
<b>power conditioner type</b>	<b>Grid-connected</b>								
Model:	SOFAR 33000TL-G2								
Parameters of power conditioner	Minimum rated input voltage: 580V Nominal voltage: 620V Maximum input voltage: 1100V Rated output voltage: 400V Rated output frequency: 50Hz Rated output power: 36.3kVA								
<b>PV input voltage</b>	<b>a) Manufacturer's minimum rated input voltage</b>								
Temperature (°C)	25								
Operating period for energy measurement (min)	1								
Percentage of rated output VA	/	10%	25%	50%	75%	100%	120%*	/	/
Input voltage (V)	/	581.20	580.48	579.49	577.81	577.72	/	/	/
Input voltage ripple (V)	/	12.60	16.88	10.44	8.15	10.32	/	/	/
Input current (A)	/	5.541	13.753	27.461	41.218	54.844	/	/	/
Input current ripple (A)	/	0.127	0.418	0.502	0.582	0.996	/	/	/
Input power (Pi) (kW)	/	3.220	7.983	15.913	23.815	31.683	/	/	/
Output power (Po) (kW)	/	3.134	7.834	15.638	23.367	31.035	/	/	/
Output efficiency (%)	/	97.54%	98.34%	98.48%	98.33%	98.16%	/	/	/
Input energy (Wi) (kWh)	/	0.054	0.133	0.265	0.397	0.528	/	/	/
Output energy (Wo) (kWh)	/	0.052	0.131	0.261	0.389	0.517	/	/	/
Energy efficiency	/	97.54%	98.34%	98.48%	98.33%	98.16%	/	/	/
<b>PV input voltage</b>	<b>b) The inverter's nominal voltage</b>								
Temperature (°C)	25								
Operating period for energy measurement (min)	1								
Percentage of rated output VA	/	10%	25%	50%	75%	100%	120%*	/	/
Input voltage (V)	/	620.48	620.38	618.10	618.52	617.51	/	/	/
Input voltage ripple (V)	/	15.55	11.38	12.40	9.00	8.43	/	/	/
Input current (A)	/	5.543	13.757	27.520	41.163	54.855	/	/	/

IEC 61683									
Clause	Requirement + Test						Result - Remark		Verdict
Input current ripple (A)	/	0.140	0.253	0.534	0.611	0.738	/	/	/
Input power (Pi) (kW)	/	3.439	8.535	17.009	25.459	33.873	/	/	/
Output power (Po) (kW)	/	3.354	8.384	16.739	25.009	33.233	/	/	/
Output efficiency (%)	/	97.72%	98.44%	98.61%	98.44%	98.31%	/	/	/
Input energy (Wi) (kWh)	/	0.057	0.142	0.283	0.424	0.565	/	/	/
Output energy (Wo) (kWh)	/	0.056	0.140	0.279	0.417	0.554	/	/	/
Energy efficiency	/	97.72%	97.44%	98.61%	98.44%	98.31%	/	/	/
<b>PV input voltage</b>									
<b>c) 90% of the inverter's maximum input voltage**(800V)</b>									
Temperature (°C)	25								
Operating period for energy measurement (min)	1								
Percentage of rated output VA	/	10%	25%	50%	75%	100%	120%*	/	/
Input voltage (V)	/	803.93	799.91	798.45	796.61	798.51	/	/	/
Input voltage ripple (V)	/	22.10	10.76	15.67	11.28	11.12	/	/	/
Input current (A)	/	4.277	10.679	21.328	32.026	42.538	/	/	/
Input current ripple (A)	/	0.130	0.143	0.405	0.442	0.603	/	/	/
Input power (Pi) (kW)	/	3.438	8.542	17.029	25.511	33.966	/	/	/
Output power (Po) (kW)	/	3.351	8.384	16.743	25.046	33.288	/	/	/
Output efficiency (%)	/	97.68%	98.35%	98.53%	98.39%	98.21%	/	/	/
Input energy (Wi) (kWh)	/	0.057	0.142	0.284	0.425	0.566	/	/	/
Output energy (Wo) (kWh)	/	0.056	0.140	0.279	0.417	0.555	/	/	/
Energy efficiency	/	97.68%	98.35%	98.53%	98.39%	98.21%	/	/	/
Remark:									
*If limited by design, inverter is not capable to operate with the 120% of rated output load, test under this condition is waived;									
** The EUT can't start up at 990Vdc.									

IEC 61683			
Clause	Requirement + Test	Result - Remark	Verdict

TABLE	No load loss: SOFAR 20000TL-G2		
power conditioner type	Utility-interactive		
Measure input voltage (V)	618.36		
Measured input power(W)	21.48		
Remark: No load loss is measured when the power conditioner works at rated input voltage and it's load is disconnected.			

TABLE	No load loss: SOFAR 25000TL-G2		
power conditioner type	Utility-interactive		
Measure input voltage (V)	619.82		
Measured input power(W)	21.94		
Remark: No load loss is measured when the power conditioner works at rated input voltage and it's load is disconnected.			

TABLE	No load loss: SOFAR 30000TL-G2		
power conditioner type	Utility-interactive		
Measure input voltage (V)	620.41		
Measured input power(W)	22.83		
Remark: No load loss is measured when the power conditioner works at rated input voltage and it's load is disconnected.			

TABLE	No load loss: SOFAR 33000TL-G2		
power conditioner type	Utility-interactive		
Measure input voltage (V)	620.41		
Measured input power(W)	22.88		
Remark: No load loss is measured when the power conditioner works at rated input voltage and it's load is disconnected.			

IEC 61683			
Clause	Requirement + Test	Result - Remark	Verdict

TABLE	Standby loss: SOFAR 20000TL-G2		
power conditioner type	Utility-interactive		
Measure output voltage (V)	229.74		
Measured output power(W)	0.205		
Remark: Standby loss is measured when the power conditioner works at rated input voltage and in standby mode.			

TABLE	Standby loss: SOFAR 25000TL-G2		
power conditioner type	Utility-interactive		
Measure output voltage (V)	229.76		
Measured output power(W)	0.205		
Remark: Standby loss is measured when the power conditioner works at rated input voltage and in standby mode.			

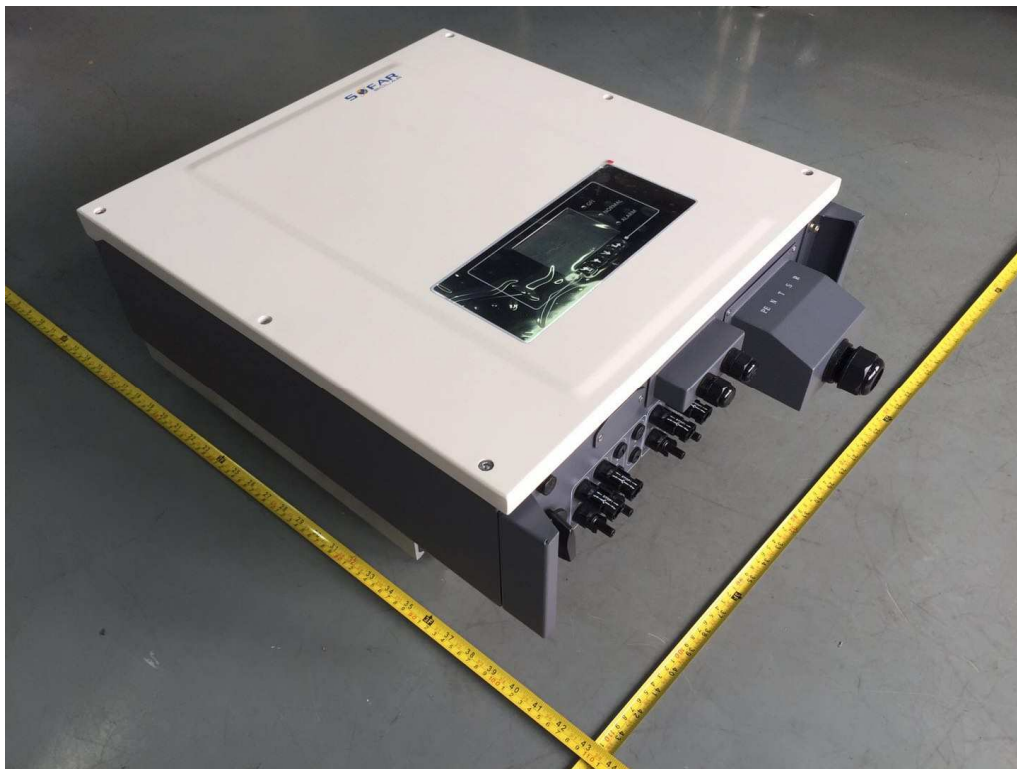
TABLE	Standby loss: SOFAR 30000TL-G2		
power conditioner type	Utility-interactive		
Measure output voltage (V)	229.81		
Measured output power(W)	0.206		
Remark: Standby loss is measured when the power conditioner works at rated input voltage and in standby mode.			

TABLE	Standby loss: SOFAR 33000TL-G2		
power conditioner type	Utility-interactive		
Measure output voltage (V)	229.79		
Measured output power(W)	0.206		
Remark: Standby loss is measured when the power conditioner works at rated input voltage and in standby mode.			

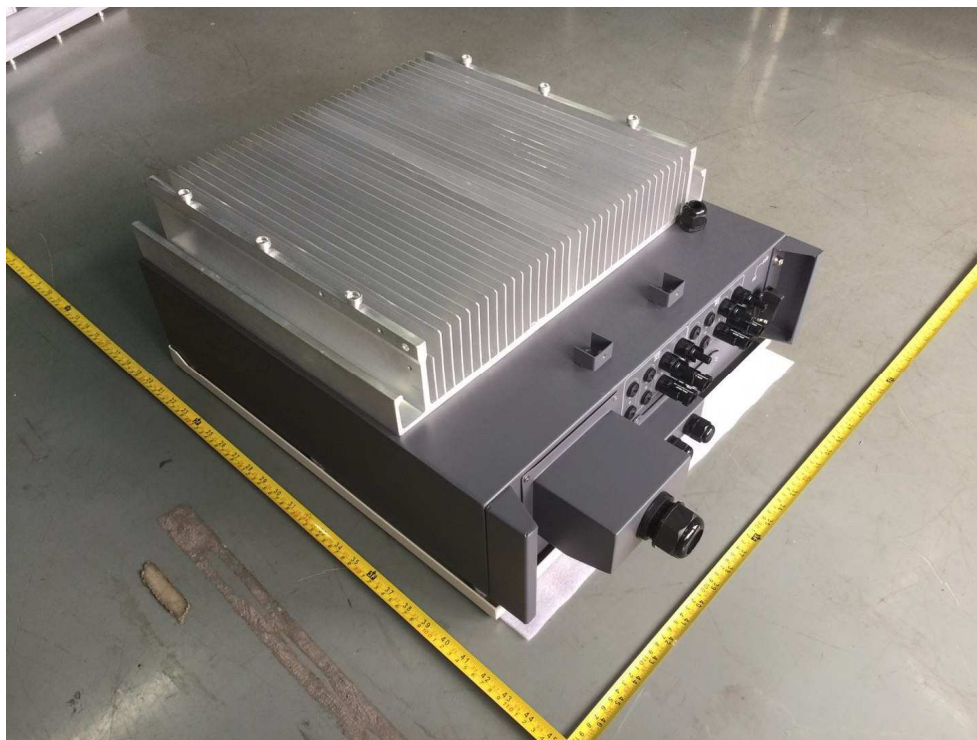
# Annex 1

Pictures of the unit  
The full pictures refer to PHOTO DOCUMENT  
Project No.: 191010N008-1  
Date: 20191122

**Enclosure front view: SOFAR 20000TL-G2**



**Enclosure rear view: SOFAR 20000TL-G2**



Enclosure front view: SOFAR 25000TL-G2



Enclosure rear view: SOFAR 25000TL-G2





**Enclosure front view: SOFAR 30000TL-G2, SOFAR 33000TL-G2**



**Enclosure rear view: SOFAR 30000TL-G2, SOFAR 33000TL-G2**



Enclosure terminal view: SOFAR 25000TL-G2



Enclosure terminal view: SOFAR 25000TL-G2



**Enclosure terminal view: SOFAR 3000TL-G2, SOFAR 33000TL-G2**



# Annex 2

## Test equipment list

**Test location: Bureau Veritas Shenzhen Co., Ltd. Dongguan Branch**  
**Dates of performance test: 2018-07-12 to 2018-08-01**

Equipment	Internal No.	Manufacturer	Type	Serial No.	Last Calibration
Power Analyzer	A4080002DG	YOKOGAWA	WT3000	91M210852	Jan. 12, 2018
AC Source	A7040019DG	Chroma	61512	61512000439	Monitored by Power Analyzer
	A7040020DG	Chroma	61512	61512000438	
DC Simulation Power Supply	A7040015DG	Chroma	62150H-1000S	62150EF00488	
	A7040016DG	Chroma	62150H-1000S	62150EF00490	
	A7040017DG	Chroma	620028	620028EF00120	
RLC Load	A7150027DG	Qunling	ACLT-3803H	93VOO2869	

**Test location: Bureau Veritas Shenzhen Co., Ltd. Dongguan Branch**  
**Dates of performance test: 2019-10-10 to 2019-11-01**

Equipment	Internal No.	Manufacturer	Type	Serial No.	Last Calibration
Power Analyzer	A4080002DG	YOKOGAWA	WT3000	91M210852	Dec, 13, 2018
AC Source	A7040019DG	Chroma	61512	61512000439	Monitored by Power Analyzer
	A7040020DG	Chroma	61512	61512000438	
DC Simulation Power Supply	A7040015DG	Chroma	62150H-1000S	62150EF00488	
	A7040016DG	Chroma	62150H-1000S	62150EF00490	
	A7040017DG	Chroma	620028	620028EF00120	
RLC Load	A7150027DG	Qunling	ACLT-3803H	93VOO2869	