TEST REPORT

TR 3.2.2

Technical regulation 3.2.2 for power plants above 11KW

Report reference No..... :	180807103GZU-001
Tested by (printed name and signature) ..... :	Jason Fu Technical Team Leader
Approved by (printed name and signature) ..... :	Tommy Zhong Technical Manager
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Contents .....:	63 Pages
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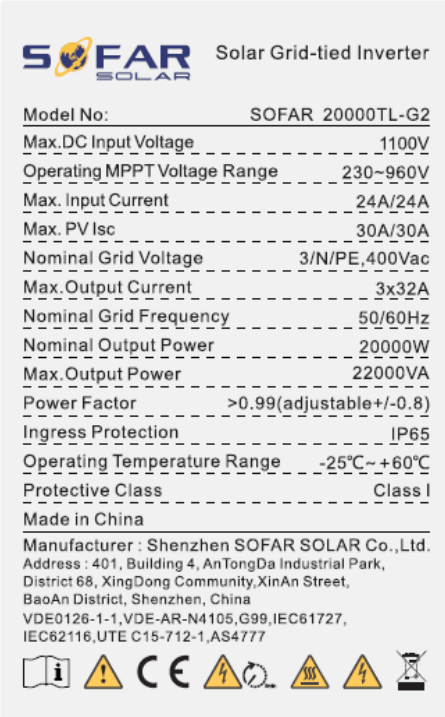
Testing location ..... :	Same as above
Address ..... :	Same as above
Applicant's Name ..... :	Shenzhen SOFAR SOLAR Co.. Ltd.
Address ..... :	401. Building 4. AnTongDa Industrial Park. District 68. XingDong Community. XinAn Street. BaoAn District. Shenzhen. China
Test specification	
Standard..... :	TR 3.2.2 : 14.07.2016
	Plant category B
Test procedure ..... :	Type approval
Non-standard test method ..... :	N/A
Test Report Form No. ..... :	TR 3.2.2a
TRF originator . ..... :	Intertek
Master TRF ..... :	dated 2019-01
Test item description ..... :	Solar Grid-tied Inverter
Trademark ..... :	SOFAR SOLAR
Manufacturer ..... :	Same as applicant
Factory ..... :	Same as applicant
Model and/or type reference ..... :	SOFAR 20000TL-G2. SOFAR 25000TL-G2. SOFAR 30000TL-G2. SOFAR 33000TL-G2

Rating……:					
	Model	SOFAR 20000TL-G2	SOFAR 25000TL-G2	SOFAR 30000TL-G2	SOFAR 33000TL-G2
	Max. DC input Voltage	1100Vdc			
	Operating MPPT voltage range	230Vdc – 960Vdc			
	Max. Input current	24A/24A	28A/28A	30A/30A	30A/30A
	PV Isc	30A*2	35A*2	37.5A*2	37.5A*2
	Nominal AC output voltage	3/N/PE 230Vac/400Vac			
	Nominal AC output Frequency	50Hz			
	Nominal AC output Power	20000W	25000W	30000W	33000W
	Max.Output Power	22000VA	27500VA	33000VA	36300VA
	Power factor	0.8 Leading – 0.8 Lagging			
	Safety level	Class I			
	Ingress Protection	IP 65			
	Operation Ambient Temperature	-25℃ - 60℃			
	Software version	V1.40			

Copy of marking plate:

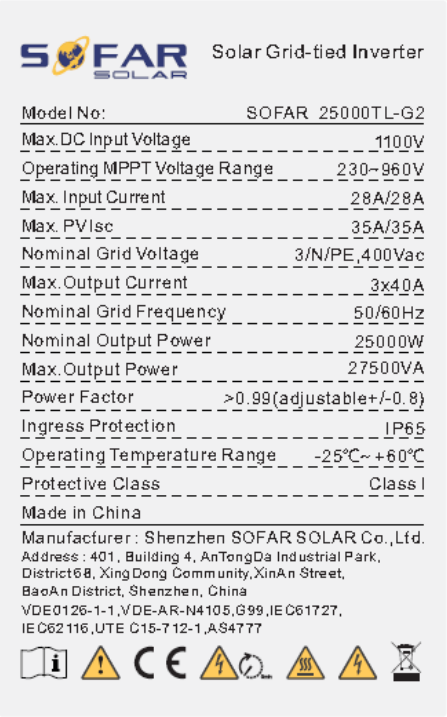


SOFAR SOLAR Solar Grid-tied Inverter

Model No:	SOFAR 20000TL-G2
Max.DC Input Voltage	1100V
Operating MPPT Voltage Range	230~960V
Max. Input Current	24A/24A
Max. PV Isc	30A/30A
Nominal Grid Voltage	3/N/PE,400Vac
Max.Output Current	3x32A
Nominal Grid Frequency	50/60Hz
Nominal Output Power	20000W
Max.Output Power	22000VA
Power Factor	>0.99(adjustable+/-0.8)
Ingress Protection	IP65
Operating Temperature Range	-25℃~+60℃
Protective Class	Class I

Made in China

Manufacturer : Shenzhen SOFAR SOLAR Co.,Ltd.
Address : 401, Building 4, AnTongDa Industrial Park, District 68, XingDong Community,XinAn Street, BaoAn District, Shenzhen, China
VDE0126-1-1,VDE-AR-N4105,G99,IEC61727, IEC62116,UTE C15-712-1,AS4777



SOFAR SOLAR Solar Grid-tied Inverter

Model No:	SOFAR 25000TL-G2
Max.DC Input Voltage	1100V
Operating MPPT Voltage Range	230~960V
Max. Input Current	28A/28A
Max. PV Isc	35A/35A
Nominal Grid Voltage	3/N/PE,400Vac
Max.Output Current	3x40A
Nominal Grid Frequency	50/60Hz
Nominal Output Power	25000W
Max.Output Power	27500VA
Power Factor	>0.99(adjustable+/-0.8)
Ingress Protection	IP65
Operating Temperature Range	-25℃~+60℃
Protective Class	Class I

Made in China

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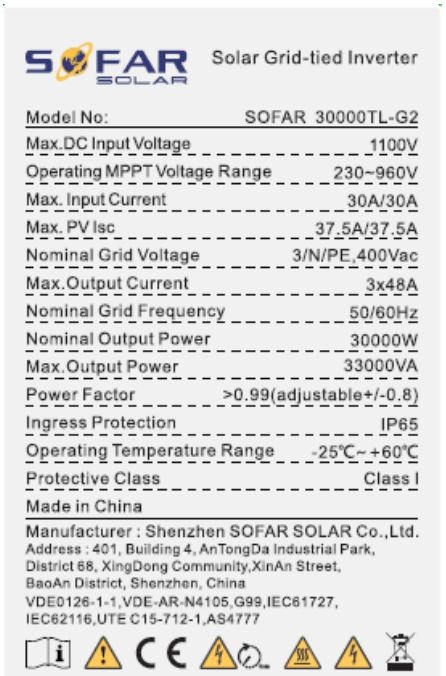
VDE0126-1-1,VDE-AR-N4105,G99,IEC61727, IEC62116,UTE C15-712-1,AS4777



SOFAR SOLAR Solar Grid-tied Inverter

Model No:	SOFAR 30000TL-G2
Max.DC Input Voltage	1100V
Operating MPPT Voltage Range	230~960V
Max. Input Current	30A/30A
Max. PV Isc	37.5A/37.5A
Nominal Grid Voltage	3/N/PE,400Vac
Max.Output Current	3x48A
Nominal Grid Frequency	50/60Hz
Nominal Output Power	30000W
Max.Output Power	33000VA
Power Factor	>0.99(adjustable+/-0.8)
Ingress Protection	IP65
Operating Temperature Range	-25℃~+60℃
Protective Class	Class I

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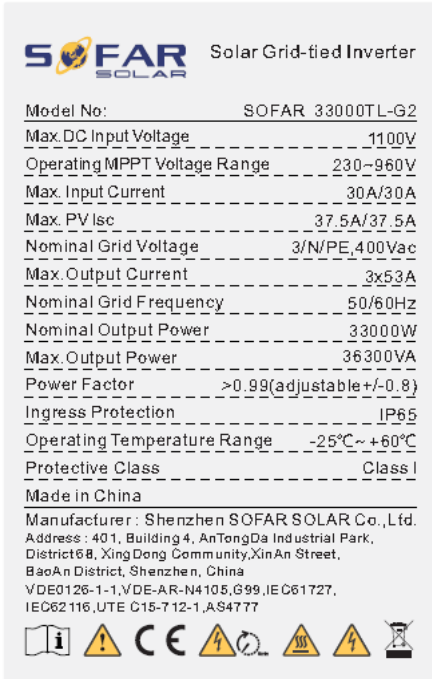

SOFAR SOLAR Solar Grid-tied Inverter

Model No:	SOFAR 33000TL-G2
Max.DC Input Voltage	1100V
Operating MPPT Voltage Range	230~960V
Max. Input Current	30A/30A
Max. PV Isc	37.5A/37.5A
Nominal Grid Voltage	3/N/PE,400Vac
Max.Output Current	3x53A
Nominal Grid Frequency	50/60Hz
Nominal Output Power	33000W
Max.Output Power	36300VA
Power Factor	>0.99(adjustable+/-0.8)
Ingress Protection	IP65
Operating Temperature Range	-25℃~+60℃
Protective Class	Class I

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VDE0126-1-1,VDE-AR-N4105,G99,IEC61727, IEC62116,UTE C15-712-1,AS4777

Note: The above markings are the minimum requirements required by the safety standard. For the final production samples. the additional markings which do not give rise to misunderstanding may be added.

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 .....:	07 Aug.. 2018
Date(s) of performance of test .....:	07 Aug 2018 to 24 April 2019

General remarks

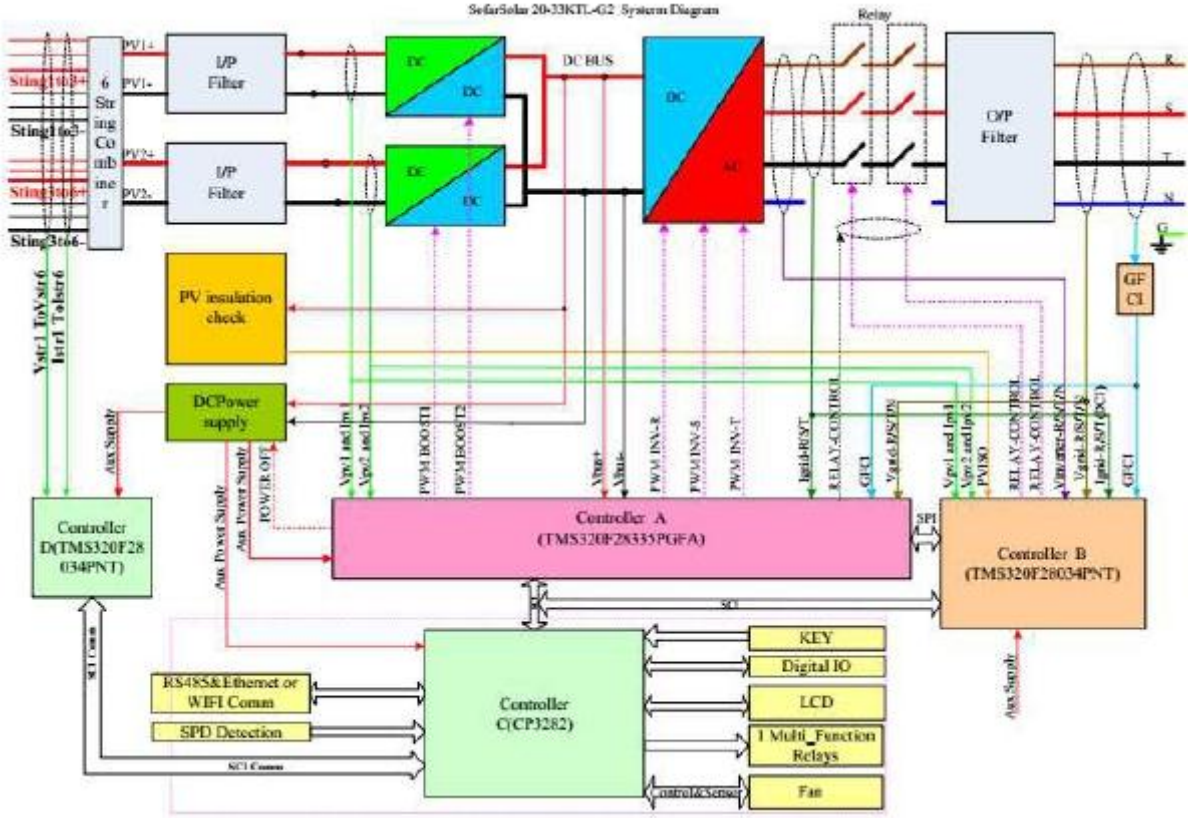
The test results presented in this report relate only to the object tested.
This report shall not be reproduced. except in full. without the written approval of the Issuing testing laboratory.
"(See Enclosure #)" refers to additional information appended to the report.
"(See appended table)" refers to a table appended to the report.

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

When determining the test conclusion. the Measurement Uncertainty of test has been considered.

General product information:

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 two relays. This assures that the opening of the output circuit will also operate in case of one error.



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/110μF 2 capacitors: 1100V/40μF		10 capacitors: 550V/110μF 4 capacitors: 1100V/40μF
INV inductance	785μH	735μH	
Combiner 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

Other than special notice, the model SOFAR 33000TL-G2 used as representative model for testing.

Interface protection as below:

Protective function	Symbol	Setting		Trip time		Standard value
Overvoltage (step 2)	$U_{>>}$	$1.15 \cdot U_n$	V	200	ms	200 ms
Overvoltage (step 1)	$U_{>}$	$1.10 \cdot U_n$	V	60	s	60 s
Undervoltage (step 1)	$U_{<}$	$0.90 \cdot U_n$	V	10...60	s	10 s
Overfrequency	$f_{>}$	52	Hz	200	ms	200 ms
Underfrequency	$f_{<}$	47	Hz	200	ms	200 ms
Change of frequency	*df/dt*	±2.5	Hz/s	50...100	ms	80 ms

Tolerances on Voltage: ±1%Un

Tolerances on Frequency: ±0.05Hz

Tolerances on time: ±10%

The use of vector jump relays as protection against island operation/loss of mains is not allowed.

TR 3.2.2			
Cl.	Requirement - Test	Result	Verdict
3	**Tolerance of frequency and voltage deviations**	The plant is three-phases designed and Pn is more than 11kW.	P
3.1	**Determination of voltage level**	Voltage: 400V ±10%	P
3.2	**Normal operating conditions**		P
	Within the *normal production* range. a *PV power plant* must be designed to start and generate power continuously within the design specifications (eg that incoming solar radiation has the correct characteristics). restricted only by the settings of the protective function as described in section 6 and/or other functions impacting the *plant's* output. Within the *normal production* range. the *normal operating voltage* is *Uc*±10%. see section 3.1. and the frequency range is 47.00 to 52.00 Hz. Automatic connection of a *PV power plant* can take place no earlier than three minutes after the voltage and frequency have come within the *normal* *production* range. Frequency limit settings are determined by *the transmission system operator*.	See appended table 3.2 Test according to EN 50438	P
3.2.1	**Normal production requirements** The overall requirements for active power production in the event of frequency and voltage deviations that a PV power plant in the Point of Connection (POC) must comply with are shown in the figure below. In the Uc +10% to Uc voltage range. the active power is limited to the nominal output. In the Uc to Umin voltage range. the active power is limited by the potential nominal current. The PV power plant must remain connected to the public electricity supply grid in accordance with the required settings for protective functions as specified section 6.		P
3.3	**Abnormal operating conditions**		P

TR 3.2.2			
Cl.	Requirement - Test	Result	Verdict
	The following requirements apply to category C and D *PV power plants*. The *PV power plant* must be designed to withstand transitory (80-100 ms) phase jumps of up to 20° in the *Point of Connection* (*POC*) without disrupting or reducing its output. The *PV power plant* must be designed to withstand a voltage dip as shown in Figure 5 without disruptions. and generate additional reactive current as stated in Figure 6 during the fault sequence. During a voltage dip. the output is determined by the nominal current.	Category B PV power plants	N/A
	After a transient start-up period. the PV power plant must be capable of delivering normal production no later than five seconds after the operating conditions in the Point of Connection have reverted to the normal production range. Irrespective of the requirements outlined in the following sections. the protective settings must be set as specified in section 6. Documentation proving that the PV power plant complies with the specified requirements must be set as specified in section 8. The PV power plant must be protected against damage caused by out-of-phase reclosing and against disconnections in non-critical situations.		N/A
3.3.1	**Voltage dip tolerance** In the Point of Connection. a PV power plant must be designed to withstand voltage dips down to 10% of the voltage in the Point of Connection over a period of minimum 250 ms (line-to-line voltages for the 50 Hz component). as shown in Figure 5. without disconnecting.		N/A
3.3.2	**Recurring faults in the public electricity supply grid** The PV power plant and any compensation equipment must stay connected during and after faults have occurred in the public electricity supply grid as specified in Table 2.		N/A
4	**Power quality**		P
4.1	When assessing a PV power plant's impact on power quality in the public electricity supply grid. the various power quality parameters in the Point of Connection must be documented.		P

TR 3.2.2			
Cl.	Requirement - Test	Result	Verdict
4.1.1	**Data basis** Data for the *PV power plant* as well as the *public electricity supply grid* will be used toassess a *PV power plant's* impact on power quality. The *plant owner* must provide data as specified in IEC 61400-21 [ref. 28] to determine the emission of *flicker* and high-frequency distortions for the *PV power plant.* The *plant owner* must choose one of the following methods for the determination of the emission of *flicker* and high-frequency distortions.		P
4.1.2	**Limit values** The *electricity supply undertaking* is responsible for supplying limit values for the emission of the various types of distortions coming from the *PV power plant* in the *Point of Connection* so as to ensure that the limit values for power quality in the *public electricity supply grid* are not exceeded. The limit values specified in this regulation have been determined on the basis of the specifications in the Research Association of the Danish Electric Utilities recommendation no. 21 [ref. 33]. IEC/TR 61000-3-6 [ref. 19]. IEC/TR 61000-3-7 [ref. 20]. DS/EN 61000-3-12 [ref. 22] and DS/EN 61000-3-11 [ref. 21].		P
4.2	**DC content**		P
	For all *plant categories*. the DC content of the supplied AC current in the *plant's* *Point of Connection (POC)* may not exceed 0.5% of the nominal current. see IEC/TS 61000-3-15. section 7.5 [ref. 25].	See appended table 4.2	P
4.3	**Asymmetry**		P
	For all *plant categories*. the asymmetry between the phases at normal operation or in the event of faults in the *electricity-generating unit* may not exceed 16A.	See appended table 4.3 Test according to VDE 4105	P
4.4	**Flicker**		P
	Flicker emission must be documented for continuous operation. Document the flicker level using data from type tests or emission models. When calculating the flicker contribution at continuous operation. use the flicker coefficient ci (ψ k) data that appear from the type test. where: Ci. i: electricitygenerating unit no. i.	See appended table 4.4	P
4.5	**Harmonic distortions**		P

TR 3.2.2			
Cl.	Requirement - Test	Result	Verdict
	Use data from type tests or emission models to document the emission level. The type test specifies measured mean values for 2nd-40th harmonic contributions for 11 levels of generated active power from 0% to 100% of the rated power and with a power factor of 1. The measured mean values are stated as a percentage of the rated current.	See appended table 4.5	P
4.6	**Interharmonic distortions** Emission of interharmonic distortions must be documented for the entire PV power plant.		P
4.7	**Distortions in the 2-4.7 9 kHz frequency range** Emission of distortions in the 2-9 kHz frequency range must be documented for the entire PV power plant.		P
5	**Control and regulation**		P
5.1	**General requirements**		P
	All control functions mentioned in the following sections refer to the *Point of Connection.* It must be possible to activate/deactivate all control functions and to set them using external signals as described in section 7. Before the *PV power plant* can be connected to the *public electricity supply grid.* *t*he currently activated functions and parameter settings must be agreed with the *electricity supply undertaking* within the framework laid down by the *transmission system operator*. In order to ensure the security of supply. the *transmission system operator* must be able to activate or deactivate the specified control functions. and – by further agreement with the *plant owner* – change the current function settings via for example set points and activation commands. All setting values for frequency parameters are determined by the *transmission system operator*.		P
5.2	**Active power control functions**		P

TR 3.2.2			
Cl.	Requirement - Test	Result	Verdict
	A *PV power plant* must be equipped with active power control functions capable of controlling the active power supplied by a *PV power plant* in the *Point of Connection* using activation orders with set points. It must be possible to indicate set points for active power with a 1 kW resolution or better. Current parameter settings for activated active power control functions are determined by the *electricity supply undertaking* in collaboration with the *transmission system operator* before commissioning. In addition to fulfilling the general requirements in section 5.1. active power control functions must comply with the requirements outlined in the following sections..		P
5.2.1	**Frequency response**		P
	In the event of frequency deviations in the public electricity supply grid. the PV power plant must contribute to grid stability by automatically reducing active power at grid frequencies above fR. This is referred to as frequency response. Frequency measurements must be carried out with an accuracy of ± 10 mHz or higher and with a precision with a standard deviation of ±5 mHz or lower. It must be possible to set the frequency response function for the frequency points shown in Figure 8. It must be possible to set the frequency fR to any value in the 50.00-52.001 Hz range with an accuracy of 10 mHz or higher. The standard fR value is 50.20 Hz. The fR setting value is determined by the transmission system operator. It must be possible to set the droop for the downward regulation to any value in the range 2-12% of Pn and this must be effected with an accuracy of ±10% of Pn. The standard value for droop is 4% of Pn. In this context. droop is the change in active power as a function of the grid frequency. Droop is stated as a percentage of the plant's nominal output. The *frequency response* control must start no later than two seconds after a frequency change is detected and must be completed within 15 seconds. The *electricity supply undertaking* in whose grid the *plant* is connected can coordinate initiation of the *frequency response* in relation to the trip time of island operation mode detection and thereby ensure optimal island operation mode detection functionality.	Tests according to EN50438. and the droop is setting to 4%. that is 50%P/Hz F_r can be adjustable from 50.0-52Hz Droop also set to the any value of 2-12% See appended table 5.2.1	P
5.2.2	**Frequency control**		N/A

TR 3.2.2			
Cl.	Requirement - Test	Result	Verdict
5.2.3	**Constraint functions**		P
	A *PV power plant* must be equipped with constraint functions. ie supplementary active power control functions. The constraint functions are used to avoid instability or overloading of the *public electricity supply grid* in connection with switching in the *public electricity supply grid*. in fault situations or the like. The required constraint functions are specified in the sections below.	Via data communication interface	P
5.2.3.1	**Absolute power constraint**		P
	An a*bsolute power constraint* is used to limit active power from a *PV power plant* to a set point-defined maximum power limit in the *Point of Connection*. An *absolute power constraint* is mainly used to protect the *public electricity supply grid* against overload in critical situations. Control using a new parameter for the *absolute power constraint* must be commenced within two seconds and completed no later than 10 seconds after receipt of an order to change the parameter.	See appended table 5.2.3.1 Test according to VDE 4105	P
5.2.3.2	**Delta power constraint (spinning reserve)**		N/A
5.2.3.3	**Ramp rate constraint**		P
	Ramp rate constraint is used to limit the maximum speed by which the active power can be changed in the event of changes in power or in the set points fora *PV power plant*. *Ramp rate constraint* is normally used for reasons of system operation to prevent the changes in active power from adversely impacting the stability of the *public electricity supply grid*. Control using a new parameter for the active power *ramp rate constraint* must be commenced within two seconds and completed no later than 10 seconds after receipt of an order to change the parameter. The maximum standard value for the *ramp rate constraint* is 100 kW/s. Figure 10 shows an overview of the active power constraint functions.	See appended table 5.2.3.3 The Ramp rate can be set to 0-100%Pn/min. default setting is 10%Pn/min	P
5.3	**Reactive power and voltage control functions**		P

TR 3.2.2			
Cl.	Requirement - Test	Result	Verdict
	A *PV power plant* must be equipped with reactive power and voltage control functions capable of controlling the reactive power supplied by a *PV power plant* in the *Point of Connection. and with* a control function capable of controlling the voltage in the *voltage reference point* via activation orders containing set points for the specified parameters. The control functions for the supply of a specific reactive power. Power Factor and voltage control are mutually exclusive. which means that only one of the three functions can be activated at a time. Before commissioning. current parameter settings for reactive power and voltage control functions must be determined by the electricity supply undertaking in collaboration with the transmission system operator. In addition to fulfilling the general requirements in section 5.1. the reactive power control. Power Factor control and voltage control functions must comply with the requirements in the following sections.	Only Q control. Power Factor control. Automatic Power Factor control applicable Only one of Q control and Power Factor control can be activated at a time	P
5.3.1	**Q control**		P
	The Q control function controls the reactive power independently of the active power in the *Point of Connection*. This control function is shown as a horizontal line in Figure 11.	See appended table 5.3.1	P
	Any change to the Q control set point must be commenced within two seconds and completed no later than 10 seconds after receipt of an order to change the set point. The *PV power plant* must be able to receive a Q set point with an accuracy of 0.1 kVAr.		P
5.3.2	**Power Factor control**		P
	The power factor control function controls reactive power proportionately to the active power in the Point of Connection. which is shown by a line with a constant gradient in Figure 12.		P

TR 3.2.2			
Cl.	Requirement - Test	Result	Verdict
	The *PV power plant* must be able to receive a *Power Factor* set point with a resolution of 0.01. Any change to the *Power factor* set point must be commenced within two seconds and completed no later than 10 seconds after receipt of an order to change the set point. The accuracy of the control performed and of the set point may not deviate by more than ±2% of the set point value or by ±0.5% of the rated power. depending on which yields the highest tolerance.	See appended table 5.3.2 The maximum tolerance considered for the measured Power Factor is ± 0.01. for measurements above 20%Pn.	P
5.3.3	**Voltage control**		N/A
5.3.4	**Automatic Power Factor control**		P
	The automatic Power Factor control function automatically activates/deactivates the Power Factor control at defined voltage levels in the voltage reference point. The principle of the automatic Power Factor control is illustrated in Figure 14.		P
	The default setting for the automatic Power Factor (PF) control is given by the following three support points with linear interpolation between them: 1: P/PM = 0.0. PF = 1.00 2: P/PM = 0.5. PF = 1.00 3: P/PM = 1.0. PF = 0.90 The activation level for the function is normally 105% of the nominal voltage. and the deactivation level is normally 100% of the nominal voltage. The activation/ deactivation level must be configurable as a set point. As a starting point. the function must be deactivated and must be activated only by agreement with the electricity supply undertaking..	See appended table 5.3.4 Test according to CEI 0-21	P
5.4	**System protection**		N/A
5.5	**Order of priority for control functions**		P
	The individual control functions of a *PV power plant* must be ranked in order of priority. A priority 1 control function takes precedence over a priority 2 control function and so forth. The recommended order of priority is as follows: 1. Protective functions. see section 6 2. System protection. see section 5.4 3. *Frequency control.* see section 5.2.2 4. Constraint functions. see section 5.2.3.		P

TR 3.2.2			
Cl.	Requirement - Test	Result	Verdict
5.6	**Active power control requirements**		P
	As a minimum. plants must be equipped with the control functions specified in Table 14. It must be possible to indicate set points for active power with a resolution of at least 0.1 kW or better. The table below specifies the minimum requirements for control functionality for active power in the four plant categories.		P
5.6.1	**Category A2 and B PV power plants**		P
	In addition to fulfilling the general requirements in section 5.1 and the normal production requirements in section 3.2. category A2 and B PV power plants must as a minimum be equipped with the control functions specified in 5. A PV power plant in these categories must be prepared for receiving an external signal for production 'Stop' and an external signal 'Released for start'. which allows production to start when the normal operating conditions specified in section 3.2 are met. The signals must be accessible via a terminal strip or commands in accordance with the specifications in section 7.		P
5.6.2	**Category C and D PV power plants**		N/A
5.7	**Reactive power control requirements**		P
	As a minimum. PV power plants must be equipped with the reactive power control functions specified in Table 15. The PV power plant must be designed in such a way that the operating point always can be ordered to lie within the hatched area shown in the relevant figures for the different plant categories.		P
5.7.1	**Category A2 PV power plants**		N/A
5.7.2	**Category B PV power plants**		P

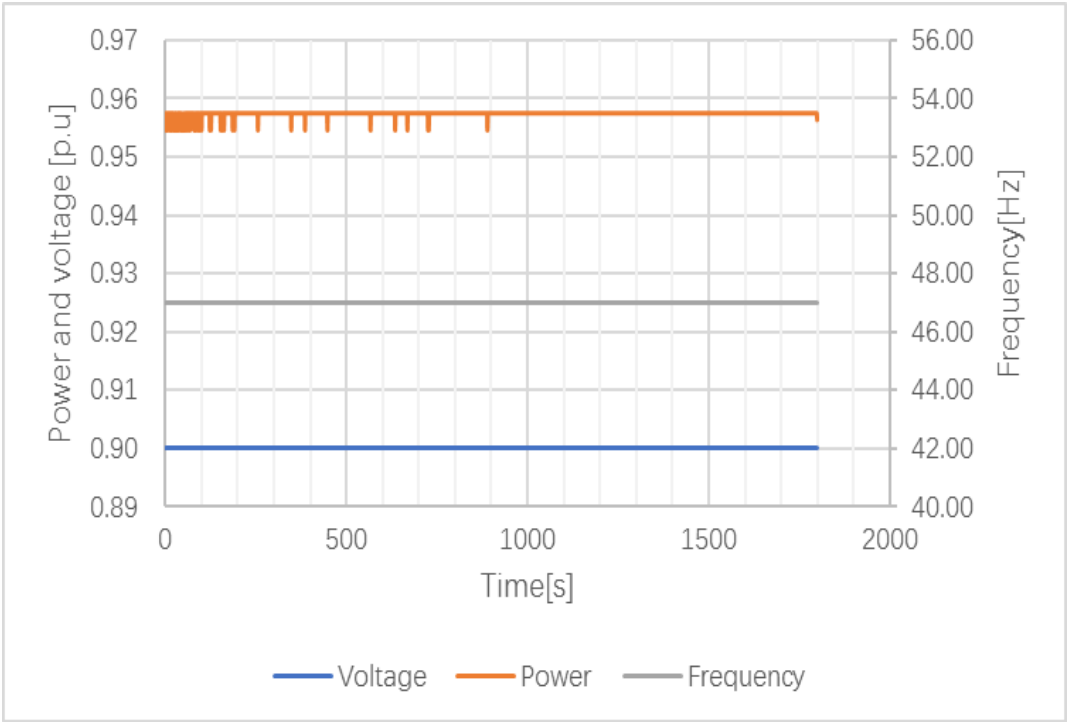
TR 3.2.2			
Cl.	Requirement - Test	Result	Verdict
	In addition to fulfilling the general requirements in section 5.1 and the normal production requirements in section 3.2. PV power plants in this category must as a minimum be equipped with the control functions specified in Table 15. Unless otherwise agreed. the operating point must. by default. follow a power factor of 1.00. In addition to fulfilling the general requirements in section 5.1 and the normal production requirements in section 3.2. it must at any time be possible to order the PV power plant's operating point to lie within the hatched area shown in Figure 15. There are no precision and accuracy requirements for the Power factor. when the apparent power is less than 20% of the nominal output. When the PV power plant is disconnected or not producing any active power. no compensation is required for the reactive power from the plant infrastructure.		P
6	**Protection**		P
6.1	**General**		P
	The purpose of a plant's protective functions is to protect the plant and to ensure a stable public electricity supply grid. The plant owner is responsible for ensuring that the plant is dimensioned and equipped with the necessary protective functions so that the plant: - is protected against damage due to faults and incidents in the public electricity supply grid - protects the public electricity supply grid to the widest possible extent against unwanted impacts from the plant.		P
	The electricity supply undertaking or the transmission system operator is entitled to demand that the setting values for protective functions be changed following commissioning if it is deemed to be of importance to the operation of the public electricity supply grid. However. such change must not result in the plant being exposed to impacts from the public electricity supply grid that lie outside of the design requirements specified in section 3.		P

TR 3.2.2			
Cl.	Requirement - Test	Result	Verdict
	Following disconnection of a plant due to a fault in the public electricity supply grid. the plant must not reconnect automatically earlier than specified in section 3.2. A plant which has been disconnected by an external signal prior to a fault occurring in the public electricity supply grid must not be connected until the external signal has been eliminated. and the voltage and the frequency are once again within the normal operating conditions stated in section 3.2.		P
	At the plant owner's request. the electricity supply undertaking must state the highest and lowest short-circuit current that can be expected in the Point of Connection as well as any other information about the public electricity supply grid as may be necessary to determine the plant's protective functions.		P
6.2	**Central protection**		N/A
	For category B. C and D plants. a joint central protection unit may be required in the Point of Connection in Installation (PCI) for the electricity-generating unit if the inverter's settings cannot be documented or do not meet the requirements in section 6.3.	Integrated grid protection in the inverters	N/A
6.3	**Protective setting requirements**		P
	The plant's protective functions and associated settings must be as specified in the following subsections. Settings deviating from the required setting values in the event of. for example. problems with local overvoltages may only be used with the electricity supply undertaking's permission.		P
	All settings are stated as RMS values. The plant must be disconnected if a measuring signal deviates more from its nominal value than the setting. The trip time stated is the measuring period during which the trip condition must constantly be fulfilled in order for the protective function to release a trip signal.		P

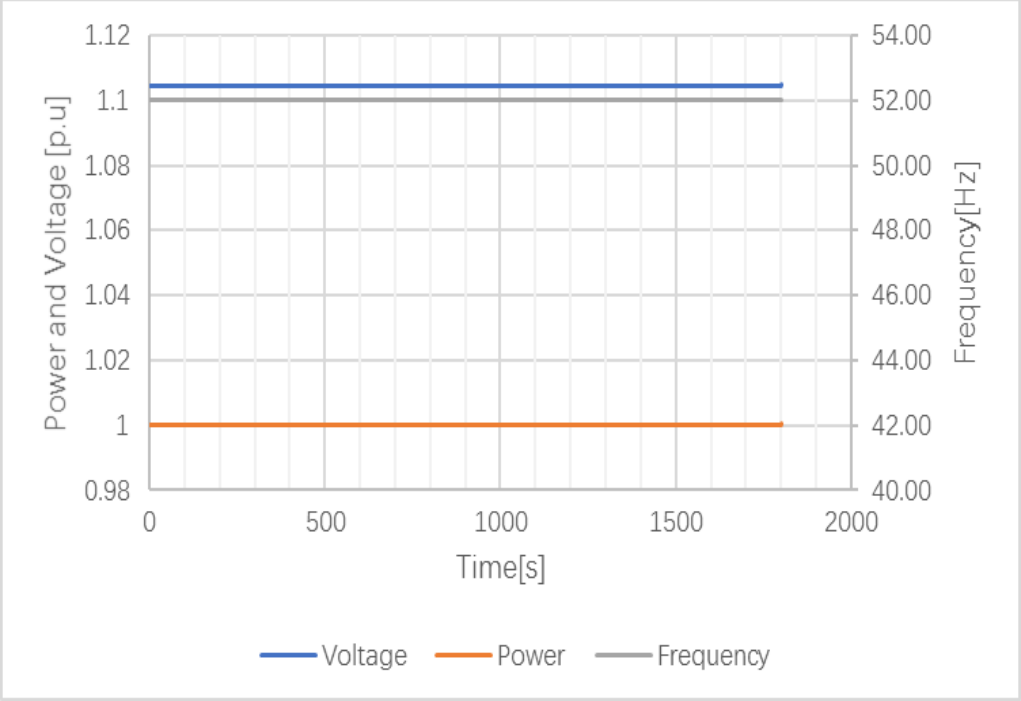
TR 3.2.2			
Cl.	Requirement - Test	Result	Verdict
	The use of vector jump relays as protection against island operation/loss of mains is not allowed. Voltage and frequency must be measured simultaneously for the phases a plant is connected to in the Point of Connection. The accuracy for voltage and frequency measurements must be ±1% of Un and ±0.05 Hz. respectively.	See appended table 6.3 Test according to EN 50438	P
7	**Data communication and exchange of signals**		P
7.1.2	**Category B PV power plants**		P
	A category B *PV power plant* must be prepared to receive external signals for production 'Stop' and 'Released for start'. The *plant* may start production again when the normal operating conditions specified in section 3.2 have been met. and the 'Released for start' signal has been received. These signals must be accessible via a terminal strip or in the *PCOM* interface via commands as specified in section 7.3.	Via RS 485 communication interface	P

Appendix A: Tables

3.2	TABLE: Normal operating conditions					P
			P (%P_{nl})	f (Hz)	U (%U_n)	Cos φ
Test 1 **U=90%*U_n; f=47.0 Hz; P=100%*P_n; Cosφ=1**		**Measured**	95.75	47.0	90.0	0.9970
		Desired	100	47.0	90.0	1.000
		Deviation	-4.25	0.00	0.00	-0.0030
Test 2 **U=110%*U_n; f=52.0 Hz; P=100%*P_n; Cosφ=1**		**Measured**	100.0	52.0	110.43	0.9990
		Desired	100.0	52.0	110.0	1.000
		Deviation	0.00	0.00	0.43	-0.0010
Test 1						

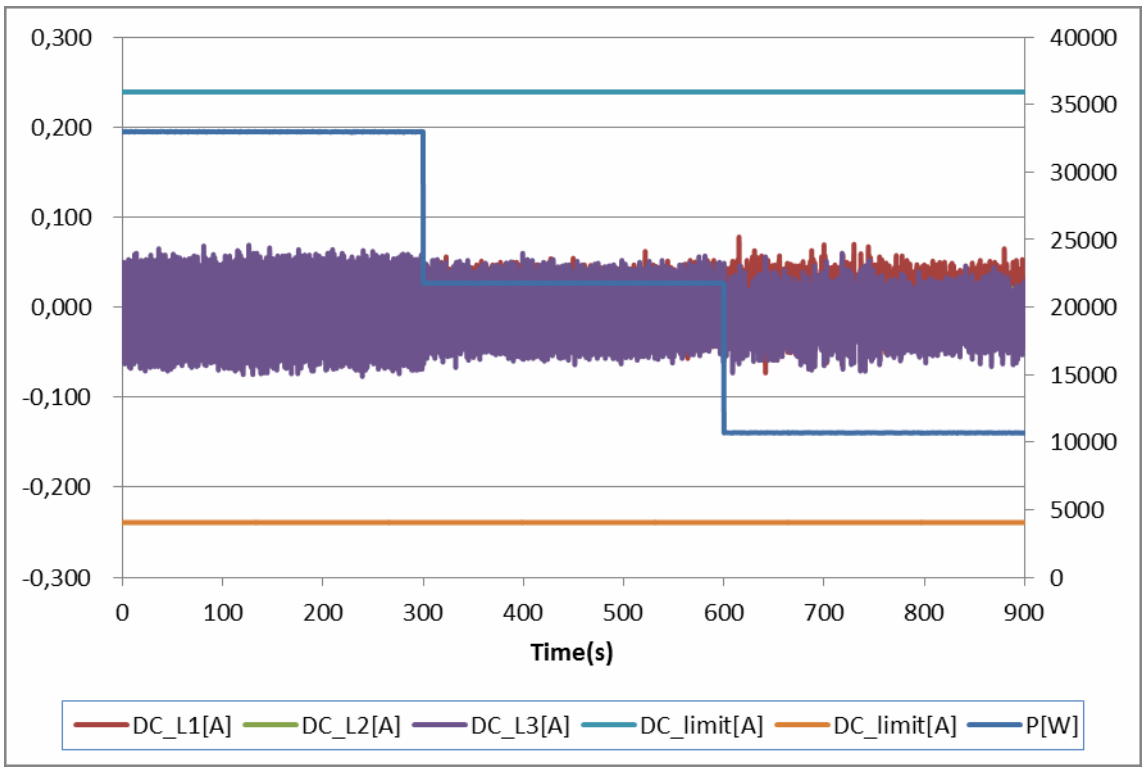


Appendix A: Tables

Test 2


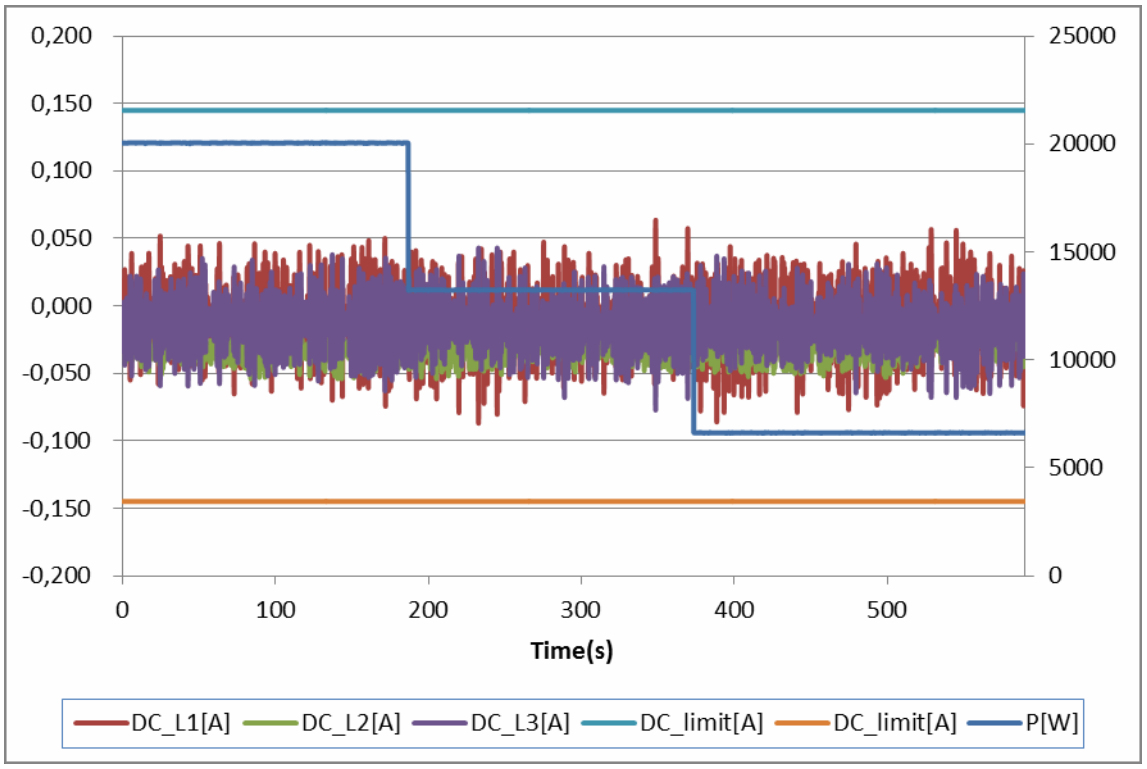
Appendix A: Tables

4.2	DC content Test according to EN 50438				P
Model	**SOFAR 33000TL-G2**				
		Power level			
		20%	**50%**	**75%**	**100%**
DC current(A)	**R**	0.0341	0.1015	0.1181	0.0753
	S	0.0280	0.0300	0.0270	0.1001
	T	0.0076	0.0511	0.0807	0.0052
% of nominal current	**R**	0.0710	0.2115	0.2460	0.1569
	S	0.0583	0.0625	0.0563	0.2085
	T	0.0158	0.1065	0.1681	0.0108



Appendix A: Tables

Model	SOFAR 20000TL-G2				
		Power level			
		20%	50%	75%	100%
DC current(A)	R	0.086	0.087	0.074	0.049
	S	0.053	0.054	0.054	0.050
	T	0.068	0.076	0.063	0.055
% of nominal current	R	0.297	0.300	0.255	0.169
	S	0.183	0.186	0.186	0.173
	T	0.235	0.262	0.217	0.190



4.4 Flicker

These tests are designed to provide evidence that the requirements of VDE-AR-N 4105. 5.4.3

The purpose of the test is to determine long-term flicker strength P_{lt}.

For power generation systems with rated currents ≤ 75 A. system perturbations are deemed sufficiently limited when the generation units adhere to the thresholds in norms EN 61000-3-3 and EN 61000-3-11.

Test conditions:
Voltage: 86% U_n to 109% U_n
Frequency: 50 Hz ± 0.5%
THD of the voltage supply: ≤ 3 %
Voltage rise of the PGU at 100 P_{Emax} %: ≤ 3 %

Flicker to DIN EN 61000-3-3 (VDE 0838-3) or DIN EN 61000-3-11 (VDE 0838-11) for generator units ≤ 75 A

Flicker to:	Result:		
	P_{lt}	P_{st}	*dc%*
DIN EN 61000-3-11 (SOFAR 33000TL-G2)	0.33	0.34	0.30
DIN EN 61000-3-11 (SOFAR 20000TL-G2)	0.29	0.29	0.17

Assessment criterion:

Long-term flicker strength P_{lt} to EN 61000-3-3 or EN 61000-3-11 must be ≤ 0.5. Determination of the

flicker coefficient:

$$c_{\psi k} = P_{st} \times (S_k / P_n)$$

where S_k is the short-circuit power of the network standby element (during the determination of the appropriate Pst values)

The following applies according to EN 61000-3-3 (≤ 16 A) for the network standby element: S_k = 339199 The value for the network standby element must be determined separately with measurements for rated currents > 75 A.

Appendix A: Tables

Flicker to EN 61400-21	
SOFAR 33000TL-G2	
Grid impedance angle ψ_k	32°
Flicker coefficient $c(\psi_k)$	5.78
Short-term flicker P_{st}	0.34
SOFAR 20000TL-G2	
Grid impedance angle ψ_k	32°
Flicker coefficient $c(\psi_k)$	8.13
Short-term flicker P_{st}	0.29
Assessment criterion: Long-term flicker strength**:** $P_{lt} \leq 0.5$	
Note: The tests had been performed on the SOFAR 33000TL-G2 and SOFAR 20000TL-G2 are valid for the SOFAR 25000TL-G2 and SOFAR 30000TL-G2. since it is similar in hardware and just power derated by software.	

4.5/4.6/4.7 Harmonics and interharmonics These tests are designed to provide evidence that the requirements of VDE-AR-N 4015.	**P**

Adherence to the thresholds for harmonic currents must be verified as followed:

- For nominal currents ≤ 16 A per conductor to DIN EN 61000-3-2 (VDE 0838-2)
- For nominal currents > 16 A and ≤ 75 A per conductor to DIN EN 61000-3-12 (VDE 0838-12)
- For PGUs intended for PGSs with nominal currents > 75 A. the measurements must be conducted as in 5.1.4.2.

Test conditions:
Voltage: 86% U_n to 109% U_n
Frequency: 50 Hz ± 0.5%
THD of the voltage supply: ≤ 3 %
Voltage rise of the PGU at 100 P_{Emax} %: ≤ 3 %

Appendix A: Tables

Tests	P

Note:
The tests should be based on the limits of the EN61000-3-2 for less than 16A.

Maximum permissible harmonic current as per EN 61000-3-12

Harmonic	2nd	3rd	4th	5th	6th	7th	8th	9th	10th	11th	12th	13th
Limit [%] 3phasig	8.00	N/A	4.00	10.70	2.67	7.20	2.00	N/A	1.60	3.10	1.33	2.00
Test value [%]	See below											

	THD	PWHD
Limit [%] 3-phase	13	22
Test value [%]	See below	

Order	Measure[%]	Limit[%]	Margin[%]
2	0.1630	8.0000	98.0
3	0.2320	21.9800	98.9
4	0.1577	4.0000	96.1
5	0.2393	11.3200	97.9
6	0.1395	2.6667	94.8
7	0.2206	7.3250	97.0
8	0.1227	2.0000	93.9
9	0.1026	3.8250	97.3
10	0.0917	1.6000	94.3
11	0.2270	3.1600	92.8
12	0.0915	1.3333	93.1
13	0.1915	2.0600	90.7
THD	0.7808	23.4750	96.7
PWHD	2.5497	23.4750	89.1

SOFAR 20000TL-G2: L1 phase

Order	Measure[%]	Limit[%]	Margin[%]
2	0.1599	8.0000	98.0
3	0.1053	21.9800	99.5
4	0.0990	4.0000	97.5
5	0.1275	11.3200	98.9
6	0.1078	2.6667	96.0
7	0.2286	7.3250	96.9
8	0.0958	2.0000	95.2
9	0.1055	3.8250	97.2
10	0.0928	1.6000	94.2
11	0.2560	3.1600	91.9
12	0.0892	1.3333	93.3
13	0.1899	2.0600	90.8
THD	0.7180	23.4750	96.9
PWHD	2.5510	23.4750	89.1

SOFAR 20000TL-G2: L2 phase

Appendix A: Tables

Order	Measure[%]	Limit[%]	Margin[%]
2	0.2493	8.0000	96.9
3	0.1531	21.9800	99.3
4	0.2172	4.0000	94.6
5	0.1309	11.3200	98.8
6	0.1072	2.6667	96.0
7	0.1019	7.3250	98.6
8	0.1077	2.0000	94.6
9	0.1794	3.8250	95.3
10	0.1135	1.6000	92.9
11	0.2053	3.1600	93.5
12	0.0968	1.3333	92.7
13	0.1942	2.0600	90.6
THD	0.7614	23.4750	96.8
PWHD	2.5960	23.4750	88.9

SOFAR 20000TL-G2: L3 phase

Order	Measure[%]	Limit[%]	Margin[%]
2	0.0544	8.0000	99.3
3	0.1374	21.9800	99.4
4	0.0587	4.0000	98.5
5	0.2702	11.3200	97.6
6	0.0377	2.6667	98.6
7	0.2179	7.3250	97.0
8	0.0455	2.0000	97.7
9	0.2077	3.8250	94.6
10	0.0409	1.6000	97.4
11	0.0964	3.1600	97.0
12	0.0318	1.3333	97.6
13	0.1734	2.0600	91.6
THD	0.5264	23.4750	97.8
PWHD	0.9824	23.4750	95.8

SOFAR 25000TL-G2: L1 phase

Order	Measure[%]	Limit[%]	Margin[%]
2	0.0575	8.0000	99.3
3	0.1467	21.9800	99.3
4	0.0470	4.0000	98.8
5	0.1691	11.3200	98.5
6	0.0353	2.6667	98.7
7	0.3284	7.3250	95.5
8	0.0506	2.0000	97.5
9	0.1283	3.8250	96.6
10	0.0452	1.6000	97.2
11	0.2357	3.1600	92.5
12	0.0235	1.3333	98.2
13	0.0667	2.0600	96.8
THD	0.5426	23.4750	97.7
PWHD	1.0347	23.4750	95.6

SOFAR 25000TL-G2: L2 phase

Order	Measure[%]	Limit[%]	Margin[%]
2	0.0364	8.0000	99.5
3	0.2544	21.9800	98.8
4	0.0587	4.0000	98.5
5	0.2819	11.3200	97.5
6	0.0420	2.6667	98.4
7	0.2690	7.3250	96.3
8	0.0500	2.0000	97.5
9	0.1135	3.8250	97.0
10	0.0523	1.6000	96.7
11	0.2909	3.1600	90.8
12	0.0212	1.3333	98.4
13	0.1748	2.0600	91.5
THD	0.6778	23.4750	97.1
PWHD	1.5002	23.4750	93.6

SOFAR 25000TL-G2: L3 phase

Appendix A: Tables

Order	Measure[%]	Limit[%]	Margin[%]
2	0.0641	8.0000	99.2
3	0.1295	21.9800	99.4
4	0.0331	4.0000	99.2
5	0.2264	11.3200	98.0
6	0.0384	2.6667	98.6
7	0.2437	7.3250	96.7
8	0.0540	2.0000	97.3
9	0.2007	3.8250	94.8
10	0.0443	1.6000	97.2
11	0.1019	3.1600	96.8
12	0.0249	1.3333	98.1
13	0.1583	2.0600	92.3
THD	0.4929	23.4750	97.9
PWHD	0.7877	23.4750	96.6

SOFAR 30000TL-G2: L1 phase

Order	Measure[%]	Limit[%]	Margin[%]
2	0.0624	8.0000	99.2
3	0.1529	21.9800	99.3
4	0.0384	4.0000	99.0
5	0.1758	11.3200	98.4
6	0.0354	2.6667	98.7
7	0.3455	7.3250	95.3
8	0.0531	2.0000	97.4
9	0.1550	3.8250	96.0
10	0.0492	1.6000	96.9
11	0.2369	3.1600	92.5
12	0.0208	1.3333	98.4
13	0.0678	2.0600	96.7
THD	0.5527	23.4750	97.6
PWHD	0.8843	23.4750	96.2

SOFAR 30000TL-G2: L2 phase

Order	Measure[%]	Limit[%]	Margin[%]
2	0.0407	8.0000	99.5
3	0.2057	21.9800	99.1
4	0.0435	4.0000	98.9
5	0.2279	11.3200	98.0
6	0.0414	2.6667	98.5
7	0.2385	7.3250	96.7
8	0.0597	2.0000	97.0
9	0.0880	3.8250	97.7
10	0.0554	1.6000	96.5
11	0.2736	3.1600	91.3
12	0.0188	1.3333	98.6
13	0.1557	2.0600	92.4
THD	0.5765	23.4750	97.5
PWHD	1.1667	23.4750	95.0

SOFAR 30000TL-G2: L3 phase

Order	Measure[%]	Limit[%]	Margin[%]
2	0.2570	8.0000	96.8
3	0.0518	21.9800	99.8
4	0.1849	4.0000	95.4
5	0.1308	11.3200	98.8
6	0.0863	2.6667	96.8
7	0.3153	7.3250	95.7
8	0.1084	2.0000	94.6
9	0.1846	3.8250	95.2
10	0.0742	1.6000	95.4
11	0.1031	3.1600	96.7
12	0.0486	1.3333	96.4
13	0.1369	2.0600	93.4
THD	0.5800	23.4750	97.5
PWHD	0.7631	23.4750	96.7

SOFAR 33000TL-G2: L1 phase

Appendix A: Tables

Order	Measure[%]	Limit[%]	Margin[%]
2	0.0864	8.0000	98.9
3	0.0877	21.9800	99.6
4	0.1054	4.0000	97.4
5	0.1255	11.3200	98.9
6	0.0705	2.6667	97.4
7	0.3614	7.3250	95.1
8	0.0729	2.0000	96.4
9	0.1751	3.8250	95.4
10	0.0584	1.6000	96.4
11	0.2082	3.1600	93.4
12	0.0636	1.3333	95.2
13	0.0903	2.0600	95.6
THD	0.6196	23.4750	97.4
PWHD	1.6734	23.4750	92.9

SOFAR 33000TL-G2: L2 phase

Order	Measure[%]	Limit[%]	Margin[%]
2	0.1077	8.0000	98.7
3	0.1146	21.9800	99.5
4	0.2133	4.0000	94.7
5	0.0882	11.3200	99.2
6	0.1126	2.6667	95.8
7	0.1645	7.3250	97.8
8	0.1328	2.0000	93.4
9	0.0669	3.8250	98.3
10	0.0851	1.6000	94.7
11	0.2197	3.1600	93.1
12	0.0565	1.3333	95.8
13	0.1198	2.0600	94.2
THD	0.5754	23.4750	97.5
PWHD	1.7267	23.4750	92.6

SOFAR 33000TL-G2: L3 phase

Note:
The tests should be based on the limits of the EN 61000-3-12 for more than 16A.

Appendix A: Tables

Harmonics	**P**

The currents of the interharmonics to 2 kHz must be measured in accordance with EN 61000-4-7 . Annex A.
The measurements of higher-frequency harmonic currents between 2 kHz and 9 kHz must be conducted in line with EN 61000-4-7 . Annex B.

Test: SOFAR 33000TL-G2

P/P_n [%]	0	10	20	30	40	50	60	70	80	90	100
Order	I [%]	I [%]	I [%]	I [%]	I [%]	I [%]	I [%]	I [%]	I [%]	I [%]	I [%]
1	2.949	9.590	19.208	30.528	42.973	48.038	60.882	67.202	76.749	86.500	96.031
2	0.081	0.086	0.096	0.101	0.109	0.111	0.117	0.120	0.126	0.135	0.285
3	0.142	0.114	0.110	0.127	0.163	0.176	0.199	0.208	0.212	0.214	0.197
4	0.062	0.075	0.087	0.097	0.099	0.102	0.105	0.108	0.108	0.109	0.169
5	0.247	0.143	0.089	0.137	0.170	0.173	0.192	0.202	0.224	0.227	0.176
6	0.047	0.064	0.080	0.092	0.093	0.092	0.092	0.091	0.090	0.089	0.110
7	0.241	0.129	0.081	0.106	0.129	0.142	0.168	0.184	0.218	0.254	0.360
8	0.038	0.041	0.054	0.062	0.065	0.065	0.069	0.071	0.078	0.079	0.128
9	0.099	0.066	0.060	0.055	0.071	0.083	0.102	0.113	0.126	0.146	0.170
10	0.037	0.035	0.038	0.037	0.037	0.038	0.039	0.042	0.048	0.051	0.068
11	0.237	0.140	0.072	0.086	0.107	0.122	0.165	0.186	0.203	0.214	0.236
12	0.035	0.029	0.027	0.029	0.032	0.034	0.034	0.035	0.034	0.034	0.049
13	0.120	0.078	0.055	0.068	0.088	0.097	0.116	0.121	0.126	0.138	0.134
14	0.035	0.029	0.028	0.028	0.028	0.028	0.028	0.027	0.028	0.028	0.038
15	0.032	0.030	0.033	0.052	0.059	0.064	0.076	0.083	0.084	0.082	0.066
16	0.031	0.028	0.027	0.029	0.029	0.029	0.030	0.030	0.029	0.028	0.034
17	0.097	0.089	0.054	0.039	0.068	0.079	0.097	0.103	0.108	0.107	0.097
18	0.031	0.031	0.029	0.028	0.026	0.026	0.026	0.025	0.025	0.025	0.028
19	0.045	0.059	0.041	0.034	0.057	0.066	0.084	0.092	0.098	0.106	0.105
20	0.031	0.032	0.032	0.032	0.030	0.028	0.028	0.025	0.025	0.024	0.024
21	0.040	0.038	0.030	0.042	0.049	0.053	0.054	0.056	0.057	0.052	0.052
22	0.026	0.025	0.026	0.026	0.025	0.026	0.026	0.023	0.022	0.021	0.022
23	0.056	0.052	0.043	0.030	0.049	0.057	0.064	0.071	0.078	0.084	0.083
24	0.026	0.026	0.025	0.025	0.023	0.023	0.024	0.024	0.023	0.024	0.023
25	0.053	0.049	0.043	0.028	0.044	0.050	0.056	0.060	0.064	0.070	0.067
26	0.024	0.024	0.024	0.026	0.024	0.024	0.025	0.023	0.022	0.022	0.022
27	0.028	0.027	0.027	0.030	0.034	0.038	0.043	0.044	0.045	0.042	0.035
28	0.026	0.026	0.027	0.026	0.025	0.024	0.023	0.022	0.022	0.021	0.022
29	0.057	0.048	0.041	0.030	0.036	0.043	0.046	0.049	0.051	0.053	0.053
30	0.025	0.025	0.023	0.024	0.023	0.022	0.022	0.021	0.021	0.020	0.020
31	0.047	0.042	0.035	0.025	0.034	0.040	0.047	0.052	0.056	0.061	0.058
32	0.024	0.025	0.025	0.025	0.025	0.025	0.025	0.023	0.023	0.022	0.021
33	0.027	0.026	0.027	0.028	0.031	0.033	0.034	0.035	0.034	0.031	0.028
34	0.024	0.024	0.025	0.025	0.024	0.025	0.025	0.022	0.022	0.022	0.021
35	0.035	0.043	0.034	0.031	0.031	0.036	0.045	0.051	0.055	0.056	0.056
36	0.025	0.024	0.023	0.022	0.021	0.021	0.023	0.023	0.022	0.021	0.020

Appendix A: Tables

37	0.042	0.043	0.031	0.029	0.030	0.033	0.035	0.038	0.039	0.040	0.040
38	0.024	0.025	0.026	0.027	0.026	0.026	0.025	0.023	0.023	0.024	0.023
Interharmonics : SOFAR 33000TL-G2											
P/P_n [%]	0	10	20	30	40	50	60	70	80	90	100
F [Hz]	I [%]	I [%]	I [%]	I [%]	I [%]	I [%]	I [%]	I [%]	I [%]	I [%]	I [%]
75	0.174	0.225	0.262	0.301	0.321	0.323	0.349	0.365	0.388	0.413	0.443
125	0.129	0.225	0.271	0.288	0.287	0.288	0.291	0.297	0.299	0.298	0.301
175	0.104	0.192	0.262	0.275	0.279	0.286	0.288	0.290	0.295	0.304	0.314
225	0.084	0.156	0.212	0.239	0.246	0.259	0.267	0.273	0.273	0.270	0.273
275	0.064	0.118	0.153	0.164	0.177	0.174	0.178	0.185	0.201	0.222	0.236
325	0.059	0.084	0.115	0.115	0.121	0.124	0.142	0.152	0.166	0.175	0.184
375	0.049	0.064	0.091	0.080	0.081	0.075	0.074	0.077	0.088	0.104	0.118
425	0.045	0.057	0.069	0.061	0.060	0.061	0.066	0.075	0.087	0.099	0.112
475	0.042	0.049	0.049	0.046	0.048	0.050	0.051	0.052	0.056	0.066	0.075
525	0.048	0.045	0.043	0.043	0.047	0.049	0.054	0.058	0.065	0.077	0.092
575	0.052	0.043	0.040	0.042	0.045	0.044	0.045	0.042	0.043	0.043	0.043
625	0.042	0.038	0.035	0.038	0.038	0.037	0.038	0.037	0.037	0.036	0.036
675	0.043	0.036	0.037	0.038	0.037	0.036	0.036	0.036	0.037	0.037	0.037
725	0.037	0.034	0.037	0.037	0.035	0.034	0.034	0.033	0.034	0.034	0.033
775	0.036	0.036	0.038	0.036	0.034	0.034	0.034	0.033	0.033	0.033	0.030
825	0.033	0.034	0.036	0.033	0.032	0.032	0.032	0.032	0.032	0.030	0.030
875	0.035	0.035	0.034	0.035	0.034	0.033	0.033	0.033	0.033	0.033	0.034
925	0.033	0.033	0.033	0.032	0.033	0.033	0.033	0.032	0.031	0.031	0.031
975	0.034	0.034	0.032	0.033	0.034	0.033	0.033	0.032	0.032	0.031	0.031
1025	0.036	0.037	0.034	0.035	0.034	0.033	0.031	0.032	0.032	0.030	0.031
1075	0.035	0.036	0.036	0.038	0.034	0.033	0.032	0.031	0.030	0.029	0.029
1125	0.032	0.032	0.031	0.032	0.030	0.028	0.029	0.030	0.029	0.029	0.027
1175	0.034	0.033	0.034	0.033	0.032	0.031	0.030	0.030	0.031	0.033	0.033
1225	0.031	0.030	0.032	0.031	0.030	0.030	0.030	0.030	0.030	0.030	0.028
1275	0.031	0.031	0.031	0.032	0.035	0.037	0.041	0.040	0.044	0.047	0.044
1325	0.032	0.030	0.032	0.032	0.032	0.031	0.031	0.030	0.030	0.030	0.030
1375	0.033	0.033	0.033	0.033	0.032	0.032	0.031	0.029	0.030	0.030	0.029
1425	0.032	0.032	0.032	0.032	0.031	0.028	0.029	0.029	0.029	0.028	0.028
1475	0.031	0.031	0.031	0.031	0.030	0.029	0.029	0.029	0.029	0.029	0.028
1525	0.030	0.030	0.030	0.031	0.029	0.029	0.028	0.027	0.027	0.026	0.026
1575	0.031	0.031	0.032	0.031	0.030	0.030	0.031	0.030	0.029	0.029	0.029
1625	0.030	0.032	0.031	0.031	0.032	0.031	0.031	0.031	0.029	0.028	0.028
1675	0.032	0.033	0.033	0.034	0.032	0.033	0.031	0.030	0.030	0.029	0.027
1725	0.031	0.032	0.031	0.032	0.031	0.031	0.031	0.030	0.029	0.027	0.026
1775	0.032	0.032	0.031	0.031	0.029	0.029	0.029	0.029	0.029	0.029	0.027
1825	0.030	0.030	0.030	0.030	0.030	0.030	0.031	0.029	0.028	0.027	0.027
1875	0.032	0.033	0.033	0.033	0.031	0.030	0.030	0.030	0.030	0.031	0.029
1925	0.029	0.029	0.030	0.031	0.031	0.030	0.030	0.029	0.029	0.028	0.027
1975	0.031	0.031	0.032	0.032	0.032	0.031	0.032	0.032	0.032	0.030	0.029

Appendix A: Tables

Higher Frequencies : SOFAR 33000TL-G2											
P/Pn [%]	0	10	20	30	40	50	60	70	80	90	100
f [kHz]	I [%]	I [%]	I [%]	I [%]	I [%]	I [%]	I [%]	I [%]	I [%]	I [%]	I [%]
2.1	0.042	0.045	0.034	0.026	0.028	0.034	0.039	0.044	0.048	0.052	0.051
2.3	0.022	0.031	0.027	0.022	0.026	0.031	0.037	0.041	0.044	0.045	0.046
2.5	0.020	0.035	0.026	0.021	0.019	0.022	0.027	0.031	0.033	0.035	0.035
2.7	0.031	0.040	0.033	0.029	0.025	0.028	0.034	0.038	0.040	0.044	0.044
2.9	0.028	0.057	0.042	0.028	0.020	0.025	0.032	0.037	0.038	0.039	0.039
3.1	0.021	0.037	0.029	0.028	0.042	0.033	0.025	0.026	0.026	0.027	0.027
3.3	0.024	0.029	0.022	0.016	0.033	0.043	0.051	0.043	0.040	0.041	0.041
3.5	0.018	0.019	0.018	0.014	0.023	0.033	0.050	0.050	0.047	0.043	0.041
3.7	0.011	0.012	0.011	0.011	0.014	0.019	0.039	0.046	0.037	0.028	0.026
3.9	0.015	0.015	0.011	0.009	0.011	0.013	0.027	0.043	0.074	0.071	0.059
4.1	0.012	0.012	0.009	0.009	0.009	0.010	0.017	0.026	0.076	0.077	0.064
4.3	0.011	0.011	0.010	0.008	0.008	0.008	0.011	0.015	0.027	0.045	0.050
4.5	0.014	0.011	0.010	0.008	0.009	0.009	0.010	0.012	0.016	0.031	0.058
4.7	0.010	0.013	0.011	0.008	0.008	0.008	0.008	0.009	0.012	0.021	0.045
4.9	0.010	0.010	0.009	0.008	0.008	0.008	0.008	0.010	0.010	0.012	0.014
5.1	0.012	0.016	0.011	0.010	0.009	0.008	0.008	0.010	0.010	0.012	0.012
5.3	0.008	0.011	0.010	0.008	0.008	0.007	0.008	0.008	0.009	0.011	0.013
5.5	0.009	0.009	0.009	0.009	0.008	0.007	0.007	0.008	0.009	0.011	0.010
5.7	0.012	0.011	0.010	0.010	0.010	0.008	0.008	0.008	0.009	0.011	0.011
5.9	0.009	0.011	0.010	0.009	0.009	0.007	0.008	0.008	0.009	0.011	0.011
6.1	0.009	0.010	0.010	0.009	0.009	0.008	0.007	0.008	0.009	0.010	0.010
6.3	0.011	0.014	0.012	0.008	0.010	0.009	0.008	0.008	0.010	0.011	0.011
6.5	0.011	0.014	0.012	0.012	0.015	0.009	0.008	0.007	0.009	0.011	0.011
6.7	0.011	0.013	0.012	0.008	0.014	0.018	0.015	0.008	0.010	0.010	0.010
6.9	0.013	0.019	0.015	0.010	0.011	0.011	0.019	0.018	0.017	0.013	0.011
7.1	0.016	0.020	0.016	0.011	0.012	0.009	0.010	0.015	0.019	0.020	0.018
7.3	0.018	0.020	0.017	0.011	0.011	0.009	0.008	0.008	0.012	0.019	0.018
7.5	0.020	0.025	0.021	0.015	0.017	0.013	0.012	0.011	0.012	0.012	0.014
7.7	0.041	0.038	0.032	0.021	0.020	0.016	0.013	0.011	0.012	0.011	0.010
7.9	0.067	0.063	0.047	0.026	0.025	0.018	0.015	0.011	0.012	0.012	0.011
8.1	0.057	0.073	0.060	0.039	0.041	0.028	0.022	0.018	0.018	0.017	0.014
8.3	0.086	0.081	0.062	0.050	0.048	0.036	0.027	0.021	0.020	0.019	0.016
8.5	0.060	0.074	0.064	0.050	0.054	0.047	0.037	0.027	0.025	0.022	0.018
8.7	0.038	0.052	0.051	0.040	0.042	0.042	0.041	0.039	0.036	0.031	0.024
8.9	0.027	0.034	0.032	0.039	0.028	0.025	0.033	0.037	0.035	0.032	0.027

Note:
The normalization current is 47.82A for SOFAR 33000TL-G2
The stated harmonics are maximum values of all 3 phases.

Appendix A: Tables

Test: SOFAR 30000TL-G2											
P/P_n [%]	0	10	20	30	40	50	60	70	80	90	100
Order	I [%]	I [%]	I [%]	I [%]	I [%]	I [%]	I [%]	I [%]	I [%]	I [%]	I [%]
1	2.924	10.901	19.129	30.207	38.389	48.022	62.066	67.240	79.170	90.476	96.181
2	0.090	0.093	0.104	0.110	0.112	0.120	0.127	0.130	0.138	0.147	0.152
3	0.166	0.143	0.113	0.129	0.156	0.184	0.209	0.221	0.238	0.237	0.233
4	0.061	0.087	0.096	0.106	0.107	0.112	0.117	0.118	0.125	0.126	0.123
5	0.237	0.194	0.095	0.134	0.166	0.184	0.199	0.208	0.241	0.253	0.254
6	0.057	0.072	0.088	0.101	0.105	0.105	0.101	0.099	0.099	0.099	0.099
7	0.228	0.177	0.093	0.105	0.139	0.149	0.166	0.180	0.215	0.264	0.309
8	0.049	0.045	0.057	0.064	0.071	0.071	0.073	0.076	0.082	0.086	0.086
9	0.118	0.080	0.067	0.064	0.066	0.083	0.098	0.106	0.127	0.148	0.165
10	0.042	0.040	0.040	0.040	0.039	0.041	0.042	0.043	0.048	0.054	0.055
11	0.202	0.154	0.043	0.085	0.106	0.118	0.161	0.178	0.214	0.232	0.243
12	0.041	0.038	0.029	0.029	0.032	0.033	0.036	0.037	0.038	0.039	0.039
13	0.064	0.107	0.043	0.064	0.086	0.102	0.118	0.128	0.139	0.149	0.161
14	0.038	0.035	0.030	0.030	0.031	0.032	0.031	0.029	0.028	0.030	0.031
15	0.036	0.038	0.036	0.055	0.058	0.066	0.079	0.086	0.093	0.091	0.086
16	0.033	0.031	0.030	0.030	0.031	0.031	0.031	0.030	0.031	0.030	0.030
17	0.118	0.102	0.045	0.035	0.056	0.077	0.098	0.104	0.114	0.119	0.113
18	0.033	0.033	0.032	0.033	0.031	0.030	0.029	0.027	0.027	0.026	0.026
19	0.058	0.075	0.041	0.034	0.046	0.068	0.084	0.093	0.107	0.112	0.119
20	0.034	0.036	0.034	0.034	0.032	0.032	0.032	0.029	0.027	0.026	0.025
21	0.054	0.048	0.032	0.040	0.051	0.056	0.059	0.062	0.063	0.061	0.060
22	0.030	0.029	0.028	0.027	0.027	0.028	0.028	0.027	0.026	0.024	0.022
23	0.086	0.064	0.047	0.037	0.039	0.057	0.067	0.070	0.081	0.090	0.094
24	0.031	0.030	0.027	0.028	0.026	0.026	0.025	0.024	0.023	0.023	0.024
25	0.061	0.061	0.042	0.032	0.035	0.050	0.059	0.061	0.069	0.073	0.079
26	0.026	0.026	0.025	0.026	0.026	0.026	0.025	0.025	0.025	0.023	0.022
27	0.032	0.030	0.029	0.031	0.034	0.039	0.046	0.048	0.047	0.048	0.042
28	0.029	0.028	0.028	0.028	0.027	0.027	0.027	0.026	0.025	0.023	0.021
29	0.041	0.060	0.038	0.035	0.029	0.045	0.050	0.053	0.054	0.059	0.059
30	0.028	0.028	0.026	0.026	0.025	0.025	0.025	0.023	0.021	0.021	0.020
31	0.028	0.058	0.031	0.029	0.027	0.041	0.048	0.053	0.059	0.064	0.067
32	0.027	0.027	0.026	0.025	0.025	0.027	0.026	0.026	0.025	0.024	0.023
33	0.030	0.029	0.029	0.028	0.031	0.036	0.037	0.037	0.038	0.036	0.031
34	0.028	0.027	0.026	0.026	0.026	0.026	0.025	0.025	0.024	0.022	0.022
35	0.061	0.058	0.037	0.035	0.029	0.036	0.044	0.048	0.059	0.062	0.064
36	0.029	0.028	0.026	0.027	0.024	0.024	0.023	0.022	0.022	0.023	0.023
37	0.060	0.051	0.032	0.032	0.028	0.033	0.037	0.037	0.042	0.043	0.043
38	0.027	0.027	0.027	0.028	0.028	0.029	0.028	0.026	0.026	0.024	0.025
39	0.027	0.029	0.027	0.026	0.027	0.028	0.029	0.028	0.029	0.029	0.026
40	0.030	0.029	0.029	0.030	0.029	0.028	0.027	0.025	0.025	0.024	0.023

Appendix A: Tables

Interharmonics : SOFAR 30000TL-G2											
P/Pn [%]	0	10	20	30	40	50	60	70	80	90	100
f [Hz]	I [%]	I [%]	I [%]	I [%]	I [%]	I [%]	I [%]	I [%]	I [%]	I [%]	I [%]
75	0.183	0.250	0.281	0.314	0.325	0.345	0.377	0.382	0.414	0.443	0.453
125	0.136	0.245	0.290	0.309	0.314	0.317	0.317	0.318	0.326	0.328	0.324
175	0.110	0.210	0.276	0.299	0.302	0.311	0.315	0.315	0.321	0.330	0.333
225	0.090	0.172	0.221	0.259	0.262	0.275	0.290	0.293	0.300	0.301	0.299
275	0.073	0.127	0.164	0.174	0.188	0.196	0.194	0.197	0.213	0.235	0.243
325	0.067	0.091	0.124	0.125	0.127	0.133	0.146	0.153	0.170	0.186	0.192
375	0.051	0.068	0.100	0.091	0.086	0.086	0.083	0.082	0.090	0.105	0.114
425	0.050	0.062	0.078	0.068	0.065	0.065	0.070	0.073	0.086	0.102	0.109
475	0.045	0.053	0.056	0.051	0.049	0.053	0.055	0.055	0.058	0.067	0.071
525	0.048	0.050	0.045	0.043	0.046	0.050	0.057	0.059	0.067	0.078	0.085
575	0.054	0.048	0.044	0.046	0.047	0.048	0.047	0.046	0.046	0.046	0.047
625	0.043	0.042	0.037	0.040	0.040	0.041	0.040	0.040	0.041	0.039	0.038
675	0.046	0.043	0.039	0.041	0.040	0.040	0.039	0.037	0.037	0.038	0.038
725	0.040	0.039	0.039	0.039	0.038	0.037	0.037	0.036	0.036	0.036	0.036
775	0.039	0.039	0.041	0.039	0.037	0.036	0.036	0.035	0.036	0.034	0.033
825	0.037	0.038	0.038	0.035	0.034	0.034	0.033	0.033	0.033	0.032	0.031
875	0.039	0.040	0.039	0.038	0.038	0.037	0.037	0.033	0.035	0.035	0.036
925	0.037	0.037	0.036	0.034	0.035	0.035	0.035	0.035	0.035	0.034	0.033
975	0.040	0.039	0.035	0.036	0.037	0.036	0.035	0.033	0.033	0.033	0.032
1025	0.042	0.042	0.039	0.039	0.038	0.037	0.037	0.034	0.033	0.033	0.031
1075	0.041	0.040	0.039	0.039	0.039	0.038	0.036	0.034	0.033	0.031	0.030
1125	0.037	0.036	0.035	0.034	0.032	0.032	0.032	0.030	0.030	0.029	0.029
1175	0.037	0.038	0.036	0.036	0.035	0.034	0.034	0.032	0.033	0.032	0.033
1225	0.035	0.035	0.034	0.034	0.033	0.033	0.032	0.030	0.031	0.032	0.031
1275	0.034	0.035	0.033	0.032	0.034	0.037	0.043	0.040	0.041	0.039	0.038
1325	0.036	0.035	0.034	0.033	0.034	0.033	0.033	0.032	0.031	0.031	0.030
1375	0.038	0.038	0.036	0.036	0.035	0.035	0.035	0.033	0.032	0.031	0.029
1425	0.036	0.036	0.035	0.035	0.034	0.033	0.031	0.030	0.029	0.029	0.029
1475	0.036	0.036	0.034	0.033	0.032	0.032	0.031	0.030	0.029	0.029	0.029
1525	0.034	0.033	0.032	0.032	0.031	0.032	0.031	0.031	0.030	0.028	0.028
1575	0.035	0.035	0.033	0.033	0.032	0.033	0.033	0.032	0.032	0.030	0.029
1625	0.033	0.033	0.033	0.032	0.033	0.034	0.033	0.034	0.033	0.031	0.029
1675	0.036	0.036	0.035	0.036	0.036	0.036	0.035	0.033	0.032	0.029	0.028
1725	0.035	0.036	0.034	0.033	0.033	0.032	0.031	0.030	0.031	0.030	0.029
1775	0.036	0.035	0.034	0.034	0.033	0.032	0.033	0.032	0.030	0.029	0.029
1825	0.034	0.034	0.032	0.032	0.032	0.031	0.031	0.030	0.030	0.029	0.029
1875	0.036	0.036	0.035	0.035	0.034	0.033	0.034	0.032	0.032	0.031	0.030
1925	0.033	0.033	0.031	0.032	0.031	0.032	0.032	0.031	0.031	0.029	0.028
1975	0.036	0.036	0.035	0.035	0.034	0.034	0.034	0.033	0.034	0.033	0.032

Appendix A: Tables

Higher Frequencies : SOFAR 30000TL-G2											
P/P_n [%]	0	10	20	30	40	50	60	70	80	90	100
f [kHz]	I [%]	I [%]	I [%]	I [%]	I [%]	I [%]	I [%]	I [%]	I [%]	I [%]	I [%]
2.1	0.025	0.059	0.032	0.030	0.023	0.033	0.039	0.043	0.051	0.054	0.056
2.3	0.037	0.043	0.026	0.027	0.021	0.030	0.039	0.041	0.046	0.048	0.049
2.5	0.035	0.042	0.018	0.022	0.017	0.023	0.027	0.029	0.035	0.036	0.037
2.7	0.027	0.039	0.021	0.033	0.023	0.030	0.034	0.039	0.044	0.045	0.048
2.9	0.033	0.058	0.027	0.034	0.019	0.022	0.033	0.037	0.041	0.042	0.043
3.1	0.027	0.034	0.024	0.026	0.044	0.043	0.035	0.026	0.029	0.028	0.029
3.3	0.014	0.026	0.017	0.017	0.024	0.038	0.053	0.053	0.048	0.043	0.046
3.5	0.017	0.017	0.017	0.016	0.016	0.023	0.055	0.058	0.054	0.047	0.045
3.7	0.015	0.012	0.011	0.013	0.012	0.016	0.035	0.046	0.045	0.030	0.029
3.9	0.013	0.014	0.009	0.012	0.009	0.012	0.024	0.031	0.059	0.089	0.075
4.1	0.017	0.014	0.011	0.010	0.009	0.011	0.014	0.017	0.049	0.091	0.082
4.3	0.015	0.014	0.012	0.010	0.008	0.009	0.011	0.012	0.022	0.038	0.049
4.5	0.013	0.015	0.011	0.010	0.009	0.010	0.010	0.011	0.014	0.024	0.033
4.7	0.012	0.011	0.013	0.010	0.009	0.009	0.009	0.010	0.012	0.018	0.023
4.9	0.009	0.010	0.010	0.010	0.009	0.008	0.008	0.010	0.011	0.011	0.012
5.1	0.011	0.012	0.014	0.011	0.011	0.010	0.009	0.010	0.010	0.011	0.012
5.3	0.009	0.012	0.014	0.011	0.009	0.009	0.008	0.009	0.009	0.010	0.012
5.5	0.010	0.011	0.013	0.011	0.010	0.008	0.008	0.008	0.009	0.010	0.011
5.7	0.012	0.014	0.013	0.010	0.011	0.010	0.008	0.009	0.009	0.010	0.011
5.9	0.009	0.014	0.011	0.009	0.010	0.009	0.008	0.009	0.009	0.010	0.011
6.1	0.011	0.014	0.011	0.010	0.010	0.009	0.008	0.008	0.009	0.010	0.011
6.3	0.014	0.019	0.014	0.011	0.010	0.010	0.009	0.009	0.009	0.011	0.012
6.5	0.011	0.014	0.013	0.012	0.013	0.011	0.009	0.008	0.009	0.010	0.011
6.7	0.013	0.015	0.013	0.010	0.010	0.017	0.017	0.009	0.009	0.010	0.011
6.9	0.015	0.019	0.014	0.011	0.011	0.011	0.019	0.020	0.020	0.019	0.019
7.1	0.017	0.021	0.015	0.014	0.012	0.012	0.011	0.014	0.017	0.020	0.021
7.3	0.020	0.022	0.016	0.013	0.012	0.011	0.010	0.009	0.010	0.012	0.014
7.5	0.020	0.027	0.020	0.018	0.017	0.016	0.014	0.013	0.012	0.013	0.012
7.7	0.047	0.045	0.034	0.028	0.021	0.021	0.017	0.013	0.012	0.013	0.012
7.9	0.075	0.075	0.045	0.035	0.027	0.024	0.020	0.014	0.013	0.013	0.013
8.1	0.064	0.072	0.064	0.053	0.046	0.040	0.031	0.021	0.020	0.019	0.016
8.3	0.095	0.094	0.063	0.056	0.051	0.050	0.039	0.025	0.024	0.021	0.019
8.5	0.068	0.080	0.061	0.051	0.055	0.058	0.051	0.032	0.030	0.025	0.022
8.7	0.041	0.057	0.058	0.050	0.042	0.049	0.047	0.044	0.043	0.035	0.029
8.9	0.029	0.034	0.036	0.040	0.036	0.027	0.033	0.039	0.038	0.037	0.033

Note:
The normalization current is 43.48A for SOFAR 30000TL-G2
The stated harmonics are maximum values of all 3 phases.

Appendix A: Tables

Test: SOFAR 25000TL-G2											
P/P_n [%]	0	10	20	30	40	50	60	70	80	90	100
Order	I [%]	I [%]	I [%]	I [%]	I [%]	I [%]	I [%]	I [%]	I [%]	I [%]	I [%]
1	2.906	9.588	19.213	28.625	38.287	47.927	57.540	69.516	76.733	86.283	95.840
2	0.097	0.105	0.121	0.127	0.133	0.138	0.144	0.152	0.154	0.159	0.165
3	0.227	0.159	0.138	0.143	0.160	0.192	0.223	0.248	0.262	0.279	0.289
4	0.060	0.100	0.111	0.120	0.129	0.131	0.135	0.142	0.143	0.145	0.148
5	0.276	0.176	0.118	0.120	0.168	0.208	0.227	0.239	0.253	0.269	0.293
6	0.068	0.077	0.096	0.115	0.124	0.126	0.124	0.121	0.118	0.120	0.118
7	0.222	0.154	0.103	0.106	0.137	0.154	0.177	0.206	0.240	0.251	0.288
8	0.048	0.050	0.063	0.076	0.081	0.086	0.085	0.087	0.090	0.094	0.098
9	0.089	0.092	0.083	0.071	0.073	0.073	0.093	0.117	0.131	0.147	0.164
10	0.045	0.044	0.046	0.048	0.048	0.048	0.049	0.051	0.051	0.053	0.058
11	0.129	0.204	0.099	0.069	0.108	0.127	0.140	0.183	0.208	0.244	0.267
12	0.051	0.039	0.036	0.035	0.036	0.038	0.040	0.041	0.042	0.044	0.046
13	0.143	0.162	0.080	0.053	0.085	0.102	0.121	0.140	0.155	0.165	0.176
14	0.041	0.038	0.037	0.036	0.037	0.038	0.038	0.036	0.035	0.034	0.034
15	0.072	0.044	0.042	0.052	0.068	0.069	0.078	0.089	0.096	0.109	0.111
16	0.037	0.038	0.035	0.035	0.036	0.037	0.036	0.035	0.036	0.036	0.037
17	0.116	0.140	0.081	0.052	0.048	0.070	0.091	0.114	0.124	0.135	0.141
18	0.041	0.041	0.039	0.039	0.038	0.037	0.036	0.036	0.035	0.031	0.030
19	0.089	0.109	0.065	0.046	0.040	0.060	0.081	0.097	0.106	0.119	0.135
20	0.042	0.043	0.041	0.041	0.041	0.040	0.039	0.038	0.035	0.034	0.032
21	0.056	0.044	0.039	0.039	0.052	0.062	0.065	0.072	0.074	0.074	0.076
22	0.035	0.034	0.034	0.033	0.032	0.032	0.033	0.032	0.032	0.031	0.031
23	0.087	0.080	0.057	0.050	0.040	0.050	0.067	0.078	0.081	0.093	0.099
24	0.036	0.036	0.036	0.034	0.033	0.033	0.030	0.030	0.029	0.028	0.027
25	0.055	0.083	0.050	0.046	0.039	0.043	0.059	0.069	0.072	0.077	0.085
26	0.030	0.031	0.031	0.031	0.032	0.031	0.031	0.030	0.029	0.029	0.029
27	0.040	0.037	0.037	0.035	0.038	0.040	0.046	0.052	0.055	0.058	0.058
28	0.033	0.034	0.033	0.034	0.033	0.032	0.031	0.032	0.032	0.031	0.029
29	0.075	0.095	0.056	0.047	0.041	0.038	0.052	0.059	0.061	0.064	0.066
30	0.032	0.032	0.032	0.030	0.030	0.030	0.030	0.030	0.028	0.027	0.025
31	0.079	0.099	0.053	0.043	0.034	0.035	0.048	0.056	0.060	0.068	0.071
32	0.032	0.031	0.031	0.030	0.031	0.031	0.032	0.032	0.030	0.031	0.029
33	0.034	0.035	0.034	0.035	0.034	0.038	0.041	0.044	0.044	0.044	0.044
34	0.033	0.032	0.031	0.031	0.031	0.030	0.030	0.031	0.030	0.030	0.028
35	0.043	0.088	0.054	0.045	0.040	0.036	0.044	0.050	0.055	0.067	0.074
36	0.036	0.035	0.032	0.030	0.029	0.029	0.028	0.027	0.026	0.025	0.027
37	0.040	0.073	0.043	0.037	0.039	0.034	0.040	0.043	0.044	0.048	0.051
38	0.032	0.033	0.033	0.034	0.034	0.033	0.034	0.033	0.033	0.032	0.031
39	0.035	0.033	0.031	0.031	0.032	0.032	0.032	0.034	0.033	0.034	0.035
40	0.034	0.035	0.035	0.035	0.034	0.034	0.033	0.032	0.032	0.031	0.029

Appendix A: Tables

Interharmonics : SOFAR 25000TL-G2											
P/P_n [%]	0	10	20	30	40	50	60	70	80	90	100
f [Hz]	I [%]	I [%]	I [%]	I [%]	I [%]	I [%]	I [%]	I [%]	I [%]	I [%]	I [%]
75	0.214	0.280	0.324	0.356	0.382	0.393	0.415	0.440	0.453	0.473	0.496
125	0.152	0.270	0.336	0.361	0.373	0.377	0.378	0.380	0.382	0.385	0.390
175	0.113	0.219	0.307	0.348	0.358	0.362	0.374	0.379	0.379	0.382	0.387
225	0.089	0.185	0.244	0.292	0.311	0.315	0.330	0.348	0.354	0.359	0.363
275	0.082	0.127	0.182	0.202	0.210	0.227	0.236	0.232	0.233	0.242	0.254
325	0.081	0.090	0.137	0.151	0.150	0.154	0.159	0.168	0.180	0.191	0.205
375	0.062	0.065	0.117	0.112	0.105	0.103	0.102	0.100	0.094	0.099	0.108
425	0.060	0.066	0.092	0.086	0.077	0.076	0.078	0.080	0.085	0.093	0.104
475	0.052	0.061	0.069	0.064	0.058	0.060	0.063	0.066	0.066	0.067	0.069
525	0.051	0.059	0.058	0.054	0.054	0.056	0.060	0.066	0.070	0.074	0.079
575	0.055	0.052	0.050	0.052	0.055	0.057	0.058	0.057	0.055	0.056	0.054
625	0.055	0.053	0.046	0.046	0.047	0.048	0.047	0.048	0.048	0.049	0.049
675	0.052	0.049	0.044	0.049	0.048	0.047	0.046	0.046	0.045	0.045	0.045
725	0.047	0.047	0.045	0.050	0.048	0.046	0.045	0.044	0.044	0.044	0.044
775	0.047	0.049	0.048	0.048	0.046	0.043	0.043	0.043	0.042	0.042	0.042
825	0.046	0.046	0.045	0.046	0.041	0.041	0.040	0.040	0.039	0.040	0.040
875	0.049	0.047	0.047	0.045	0.044	0.044	0.044	0.042	0.042	0.041	0.040
925	0.047	0.044	0.044	0.043	0.041	0.042	0.042	0.041	0.041	0.041	0.040
975	0.048	0.046	0.043	0.042	0.043	0.042	0.043	0.041	0.040	0.040	0.039
1025	0.050	0.049	0.047	0.046	0.046	0.046	0.044	0.043	0.042	0.041	0.039
1075	0.047	0.048	0.047	0.048	0.047	0.046	0.044	0.043	0.042	0.041	0.038
1125	0.044	0.043	0.041	0.041	0.040	0.039	0.038	0.037	0.036	0.036	0.035
1175	0.045	0.045	0.043	0.044	0.042	0.042	0.041	0.040	0.039	0.039	0.038
1225	0.042	0.042	0.041	0.041	0.039	0.039	0.038	0.038	0.036	0.037	0.037
1275	0.044	0.042	0.040	0.039	0.039	0.040	0.042	0.049	0.048	0.046	0.044
1325	0.043	0.042	0.041	0.040	0.040	0.040	0.040	0.039	0.039	0.038	0.037
1375	0.047	0.046	0.045	0.043	0.044	0.042	0.042	0.041	0.040	0.040	0.038
1425	0.043	0.042	0.042	0.042	0.041	0.040	0.039	0.038	0.036	0.036	0.035
1475	0.042	0.043	0.041	0.040	0.039	0.039	0.037	0.037	0.036	0.036	0.036
1525	0.042	0.040	0.039	0.039	0.039	0.038	0.037	0.036	0.036	0.035	0.035
1575	0.041	0.041	0.040	0.039	0.040	0.039	0.038	0.039	0.038	0.038	0.037
1625	0.039	0.039	0.040	0.041	0.039	0.040	0.041	0.040	0.040	0.039	0.037
1675	0.042	0.045	0.044	0.043	0.043	0.042	0.041	0.041	0.040	0.038	0.035
1725	0.042	0.042	0.040	0.039	0.039	0.038	0.038	0.039	0.037	0.037	0.038
1775	0.043	0.042	0.042	0.041	0.041	0.040	0.039	0.039	0.039	0.037	0.036
1825	0.041	0.041	0.039	0.039	0.038	0.037	0.037	0.037	0.036	0.037	0.036
1875	0.043	0.043	0.043	0.042	0.041	0.040	0.040	0.040	0.040	0.039	0.038
1925	0.039	0.039	0.038	0.038	0.038	0.038	0.038	0.038	0.037	0.037	0.037
1975	0.042	0.043	0.043	0.042	0.041	0.041	0.041	0.041	0.041	0.041	0.040

Appendix A: Tables

Higher Frequencies : SOFAR 25000TL-G2											
P/P_n [%]	0	10	20	30	40	50	60	70	80	90	100
f [kHz]	I [%]	I [%]	I [%]	I [%]	I [%]	I [%]	I [%]	I [%]	I [%]	I [%]	I [%]
2.1	1.270	1.032	0.754	0.743	0.712	0.795	0.840	0.812	0.678	0.621	0.533
2.3	4.399	5.220	3.547	2.936	2.688	2.304	2.042	2.088	2.133	2.121	2.081
2.5	1.969	2.346	3.575	3.153	2.797	2.756	2.562	2.268	1.540	1.408	1.210
2.7	3.050	2.126	1.802	1.814	1.473	1.252	1.207	1.127	0.830	0.744	0.613
2.9	6.549	7.872	6.148	9.851	7.721	4.732	2.820	2.635	2.525	2.438	2.234
3.1	4.360	7.335	8.719	6.728	8.558	11.654	8.612	5.824	1.982	1.698	1.284
3.3	1.698	1.836	1.796	1.802	2.047	3.240	4.534	4.212	2.259	1.809	1.151
3.5	3.197	3.682	3.156	4.303	4.096	3.724	4.684	9.131	9.483	7.558	4.620
3.7	1.478	0.984	1.989	1.339	1.013	1.886	2.703	3.356	3.724	5.037	4.220
3.9	1.005	0.847	0.840	0.692	0.598	0.610	0.829	1.250	1.433	1.993	3.068
4.1	2.579	1.554	2.138	1.711	1.208	0.959	0.810	1.417	2.235	3.663	6.471
4.3	1.239	1.520	1.293	0.840	0.647	0.976	1.076	1.013	0.863	1.063	1.534
4.5	1.081	0.913	0.789	0.569	0.421	0.429	0.424	0.502	0.534	0.636	0.808
4.7	1.647	1.933	1.930	1.458	0.946	0.653	0.476	0.694	0.960	1.229	1.524
4.9	0.805	1.800	1.479	0.922	0.534	0.770	0.753	0.670	0.470	0.533	0.679
5.1	0.473	0.665	0.887	0.734	0.464	0.397	0.340	0.342	0.350	0.394	0.475
5.3	0.382	1.022	1.806	1.419	1.032	0.736	0.405	0.483	0.671	0.785	0.873
5.5	0.266	0.320	0.611	0.601	0.691	0.812	0.723	0.601	0.375	0.409	0.517
5.7	0.227	0.201	0.262	0.382	0.533	0.498	0.351	0.321	0.312	0.330	0.394
5.9	0.252	0.222	0.307	0.359	0.737	0.747	0.492	0.423	0.563	0.611	0.634
6.1	0.121	0.257	0.248	0.339	0.506	0.696	0.794	0.679	0.413	0.416	0.500
6.3	0.603	0.749	0.944	0.614	0.269	0.367	0.461	0.405	0.432	0.424	0.458
6.5	0.112	0.210	0.274	1.227	1.556	1.404	0.814	0.669	0.549	0.599	0.604
6.7	0.082	0.110	0.117	0.135	0.243	1.881	2.560	2.836	1.287	1.189	1.224
6.9	0.070	0.083	0.097	0.095	0.132	0.187	0.336	1.233	2.870	3.072	2.980
7.1	0.052	0.083	0.116	0.106	0.120	0.178	0.195	0.343	0.424	0.478	0.828
7.3	0.055	0.086	0.099	0.087	0.084	0.152	0.198	0.234	0.241	0.224	0.273
7.5	0.319	0.323	0.324	0.323	0.326	0.330	0.337	0.343	0.371	0.386	0.396
7.7	0.066	0.108	0.098	0.090	0.086	0.110	0.118	0.127	0.159	0.168	0.182
7.9	0.118	0.129	0.127	0.116	0.108	0.131	0.153	0.151	0.147	0.156	0.174
8.1	0.323	0.325	0.329	0.324	0.325	0.328	0.331	0.329	0.334	0.337	0.338
8.3	0.114	0.115	0.094	0.073	0.065	0.087	0.100	0.094	0.101	0.095	0.109
8.5	0.072	0.110	0.099	0.080	0.068	0.068	0.074	0.084	0.082	0.077	0.091
8.7	0.046	0.061	0.076	0.069	0.057	0.065	0.059	0.059	0.070	0.073	0.081
8.9	0.041	0.045	0.045	0.042	0.051	0.061	0.053	0.048	0.055	0.054	0.068
Note: The normalization current is 36.23A for SOFAR 25000TL-G2 The stated harmonics are maximum values of all 3 phases.											

Appendix A: Tables

Test: SOFAR 20000TL-G2											
P/P_n [%]	0	10	20	30	40	50	60	70	80	90	100
Order	I [%]	I [%]	I [%]	I [%]	I [%]	I [%]	I [%]	I [%]	I [%]	I [%]	I [%]
1	3.010	9.631	19.145	28.884	38.271	47.958	57.623	69.618	76.895	86.516	96.135
2	0.118	0.132	0.145	0.155	0.161	0.165	0.172	0.180	0.183	0.189	0.196
3	0.341	0.235	0.188	0.174	0.181	0.203	0.234	0.275	0.292	0.312	0.336
4	0.077	0.114	0.131	0.142	0.152	0.158	0.162	0.167	0.172	0.177	0.181
5	0.440	0.283	0.189	0.142	0.161	0.212	0.249	0.291	0.295	0.313	0.328
6	0.073	0.092	0.111	0.128	0.144	0.155	0.156	0.155	0.154	0.151	0.150
7	0.292	0.225	0.151	0.138	0.138	0.173	0.198	0.224	0.237	0.271	0.319
8	0.059	0.059	0.077	0.086	0.095	0.102	0.105	0.106	0.108	0.109	0.110
9	0.140	0.124	0.111	0.106	0.092	0.089	0.095	0.116	0.133	0.154	0.173
10	0.054	0.055	0.057	0.056	0.059	0.060	0.059	0.062	0.063	0.063	0.062
11	0.257	0.294	0.200	0.085	0.096	0.137	0.157	0.178	0.197	0.236	0.269
12	0.054	0.048	0.057	0.050	0.049	0.048	0.048	0.050	0.053	0.052	0.052
13	0.220	0.235	0.167	0.075	0.075	0.107	0.128	0.150	0.164	0.180	0.205
14	0.046	0.045	0.046	0.042	0.043	0.046	0.046	0.047	0.048	0.046	0.044
15	0.070	0.066	0.056	0.055	0.073	0.084	0.087	0.096	0.107	0.114	0.124
16	0.046	0.050	0.048	0.047	0.044	0.045	0.046	0.046	0.046	0.044	0.044
17	0.087	0.210	0.156	0.078	0.055	0.059	0.082	0.111	0.125	0.145	0.160
18	0.050	0.052	0.045	0.044	0.046	0.047	0.045	0.047	0.046	0.046	0.043
19	0.126	0.166	0.124	0.065	0.055	0.051	0.069	0.096	0.109	0.121	0.137
20	0.051	0.052	0.049	0.048	0.050	0.050	0.049	0.050	0.050	0.048	0.045
21	0.073	0.058	0.049	0.045	0.051	0.065	0.076	0.081	0.086	0.090	0.093
22	0.043	0.043	0.044	0.041	0.041	0.041	0.040	0.044	0.041	0.041	0.040
23	0.072	0.133	0.091	0.068	0.058	0.045	0.058	0.079	0.093	0.100	0.103
24	0.043	0.041	0.039	0.039	0.038	0.040	0.040	0.040	0.040	0.040	0.037
25	0.119	0.130	0.092	0.063	0.056	0.044	0.052	0.070	0.081	0.087	0.093
26	0.043	0.041	0.041	0.039	0.040	0.039	0.040	0.039	0.039	0.038	0.038
27	0.048	0.048	0.043	0.044	0.042	0.048	0.050	0.055	0.061	0.066	0.068
28	0.044	0.044	0.041	0.040	0.041	0.041	0.040	0.041	0.039	0.040	0.039
29	0.094	0.137	0.097	0.059	0.056	0.049	0.045	0.061	0.070	0.072	0.079
30	0.039	0.040	0.037	0.035	0.036	0.037	0.036	0.037	0.037	0.037	0.036
31	0.055	0.137	0.094	0.050	0.050	0.040	0.040	0.056	0.065	0.070	0.076
32	0.042	0.040	0.042	0.041	0.040	0.039	0.040	0.039	0.039	0.038	0.038
33	0.044	0.044	0.040	0.044	0.043	0.043	0.045	0.051	0.054	0.056	0.055
34	0.039	0.039	0.039	0.040	0.039	0.039	0.039	0.039	0.038	0.037	0.038
35	0.080	0.114	0.082	0.058	0.055	0.051	0.044	0.050	0.057	0.063	0.070
36	0.036	0.037	0.036	0.036	0.036	0.036	0.036	0.035	0.037	0.037	0.034
37	0.082	0.084	0.065	0.049	0.046	0.049	0.043	0.049	0.053	0.054	0.055
38	0.043	0.042	0.042	0.042	0.042	0.043	0.042	0.042	0.042	0.041	0.041
39	0.042	0.041	0.040	0.041	0.038	0.040	0.041	0.041	0.042	0.043	0.042
40	0.043	0.043	0.041	0.041	0.043	0.043	0.042	0.042	0.041	0.042	0.040

Appendix A: Tables

Interharmonics : SOFAR 20000TL-G2											
P/P_n [%]	0	10	20	30	40	50	60	70	80	90	100
f [Hz]	I [%]	I [%]	I [%]	I [%]	I [%]	I [%]	I [%]	I [%]	I [%]	I [%]	I [%]
75	0.265	0.329	0.384	0.421	0.448	0.468	0.485	0.519	0.528	0.544	0.566
125	0.181	0.304	0.394	0.433	0.456	0.466	0.470	0.476	0.472	0.473	0.478
175	0.137	0.244	0.343	0.413	0.439	0.448	0.451	0.462	0.472	0.474	0.477
225	0.104	0.210	0.276	0.330	0.373	0.388	0.394	0.409	0.421	0.435	0.443
275	0.096	0.144	0.207	0.246	0.254	0.264	0.280	0.294	0.291	0.285	0.289
325	0.081	0.096	0.156	0.183	0.189	0.186	0.191	0.197	0.203	0.210	0.226
375	0.073	0.073	0.130	0.147	0.139	0.128	0.128	0.131	0.126	0.121	0.119
425	0.076	0.075	0.107	0.113	0.106	0.096	0.093	0.098	0.099	0.100	0.105
475	0.064	0.074	0.083	0.082	0.075	0.071	0.073	0.077	0.081	0.083	0.082
525	0.064	0.078	0.074	0.070	0.067	0.068	0.071	0.075	0.079	0.082	0.086
575	0.063	0.067	0.065	0.065	0.067	0.069	0.070	0.072	0.070	0.069	0.070
625	0.065	0.072	0.062	0.057	0.059	0.061	0.060	0.060	0.059	0.058	0.061
675	0.065	0.065	0.061	0.059	0.061	0.061	0.060	0.059	0.058	0.057	0.056
725	0.063	0.065	0.060	0.060	0.060	0.057	0.058	0.057	0.056	0.054	0.054
775	0.063	0.062	0.061	0.062	0.062	0.057	0.057	0.056	0.054	0.054	0.052
825	0.058	0.059	0.057	0.057	0.055	0.052	0.051	0.051	0.050	0.050	0.050
875	0.061	0.061	0.058	0.055	0.055	0.055	0.055	0.056	0.055	0.054	0.052
925	0.056	0.056	0.057	0.056	0.054	0.052	0.053	0.054	0.054	0.051	0.052
975	0.055	0.057	0.057	0.052	0.052	0.053	0.055	0.053	0.052	0.052	0.050
1025	0.058	0.061	0.056	0.054	0.055	0.056	0.057	0.055	0.054	0.053	0.053
1075	0.060	0.061	0.058	0.057	0.058	0.058	0.059	0.056	0.054	0.054	0.053
1125	0.052	0.053	0.053	0.050	0.050	0.049	0.049	0.048	0.048	0.049	0.046
1175	0.057	0.056	0.053	0.052	0.053	0.053	0.051	0.051	0.050	0.050	0.049
1225	0.053	0.052	0.051	0.052	0.051	0.049	0.049	0.048	0.048	0.048	0.047
1275	0.056	0.054	0.054	0.052	0.052	0.051	0.051	0.053	0.057	0.061	0.060
1325	0.054	0.053	0.051	0.051	0.051	0.050	0.051	0.050	0.050	0.049	0.049
1375	0.054	0.055	0.053	0.052	0.051	0.054	0.053	0.053	0.052	0.053	0.050
1425	0.054	0.055	0.051	0.051	0.050	0.051	0.050	0.050	0.048	0.047	0.046
1475	0.052	0.053	0.052	0.053	0.050	0.049	0.047	0.047	0.047	0.046	0.046
1525	0.051	0.051	0.048	0.049	0.050	0.048	0.047	0.047	0.046	0.045	0.044
1575	0.053	0.052	0.050	0.049	0.050	0.049	0.050	0.049	0.049	0.048	0.048
1625	0.050	0.051	0.051	0.050	0.050	0.049	0.051	0.051	0.050	0.050	0.050
1675	0.054	0.055	0.051	0.051	0.053	0.054	0.053	0.053	0.052	0.051	0.050
1725	0.052	0.052	0.053	0.052	0.050	0.050	0.049	0.049	0.049	0.047	0.046
1775	0.050	0.052	0.052	0.049	0.048	0.049	0.049	0.049	0.050	0.049	0.047
1825	0.050	0.050	0.051	0.050	0.049	0.048	0.048	0.047	0.047	0.046	0.046
1875	0.055	0.053	0.051	0.051	0.051	0.051	0.051	0.051	0.051	0.050	0.050
1925	0.051	0.051	0.052	0.051	0.051	0.049	0.048	0.048	0.048	0.046	0.046
1975	0.053	0.053	0.052	0.052	0.051	0.051	0.051	0.052	0.051	0.051	0.052

Appendix A: Tables

Higher Frequencies : SOFAR 20000TL-G2											
P/P_n [%]	0	10	20	30	40	50	60	70	80	90	100
f [kHz]	I [%]	I [%]	I [%]	I [%]	I [%]	I [%]	I [%]	I [%]	I [%]	I [%]	I [%]
2.1	1.389	1.247	1.021	0.808	0.849	0.871	0.991	1.050	1.059	0.989	0.890
2.3	6.276	4.943	3.352	4.522	4.036	3.260	2.892	2.573	2.568	2.606	2.665
2.5	3.181	7.201	6.998	4.324	3.371	3.479	3.438	3.353	2.954	2.590	2.130
2.7	4.119	3.395	2.963	2.553	2.285	1.633	1.530	1.540	1.456	1.324	1.134
2.9	6.339	17.759	16.249	11.891	10.893	8.338	6.015	3.736	3.323	3.211	3.173
3.1	4.813	5.049	11.937	8.047	7.130	10.725	14.325	12.772	7.759	5.386	3.213
3.3	1.783	2.326	2.566	2.301	2.410	2.541	3.605	5.352	5.620	4.871	3.542
3.5	3.896	3.163	6.856	4.937	5.634	5.067	4.657	5.435	7.615	12.526	12.103
3.7	1.707	3.022	2.587	2.079	1.355	1.249	2.103	3.165	3.659	4.146	4.629
3.9	1.133	1.190	1.148	0.872	0.713	0.724	0.754	0.954	1.218	1.587	1.789
4.1	2.168	3.661	3.614	2.103	1.611	1.470	1.206	0.986	1.148	1.711	2.821
4.3	1.649	1.578	1.661	1.290	0.843	0.786	1.140	1.314	1.300	1.182	1.097
4.5	1.203	1.182	0.987	0.746	0.593	0.506	0.555	0.529	0.574	0.630	0.658
4.7	2.501	2.222	1.870	1.496	1.298	1.087	0.800	0.574	0.639	0.857	1.209
4.9	0.863	2.210	2.198	1.489	0.827	0.648	0.920	0.964	0.868	0.744	0.628
5.1	0.572	0.786	0.917	0.913	0.726	0.481	0.507	0.433	0.425	0.429	0.422
5.3	0.557	1.087	1.277	2.282	1.805	1.238	0.887	0.550	0.484	0.590	0.852
5.5	0.348	0.620	0.965	1.186	0.975	0.823	0.969	0.966	0.787	0.635	0.523
5.7	0.251	0.343	0.349	0.496	0.600	0.667	0.622	0.479	0.421	0.386	0.369
5.9	0.233	0.413	0.453	0.568	0.564	1.007	0.985	0.745	0.498	0.504	0.720
6.1	0.154	0.310	0.339	0.383	0.466	0.690	0.890	0.957	0.896	0.745	0.629
6.3	0.791	0.902	1.084	1.362	0.426	0.390	0.489	0.578	0.655	0.558	0.472
6.5	0.145	0.229	0.275	1.133	1.800	2.237	2.582	1.494	1.361	1.180	0.986
6.7	0.104	0.166	0.172	0.163	0.188	0.343	0.607	3.241	3.785	3.869	3.939
6.9	0.076	0.111	0.117	0.106	0.128	0.167	0.215	0.352	0.459	0.513	1.098
7.1	0.074	0.173	0.154	0.123	0.117	0.153	0.228	0.251	0.265	0.446	0.441
7.3	0.070	0.108	0.133	0.109	0.102	0.111	0.158	0.256	0.282	0.322	0.343
7.5	0.410	0.412	0.418	0.417	0.416	0.417	0.418	0.422	0.424	0.424	0.431
7.7	0.074	0.124	0.134	0.115	0.103	0.104	0.140	0.157	0.154	0.167	0.203
7.9	0.160	0.161	0.169	0.158	0.149	0.145	0.163	0.190	0.197	0.196	0.203
8.1	0.417	0.417	0.423	0.426	0.417	0.414	0.414	0.421	0.415	0.414	0.411
8.3	0.142	0.142	0.131	0.104	0.083	0.079	0.104	0.127	0.124	0.122	0.122
8.5	0.082	0.116	0.114	0.097	0.083	0.085	0.084	0.095	0.101	0.111	0.102
8.7	0.060	0.074	0.077	0.087	0.082	0.067	0.081	0.079	0.071	0.077	0.077
8.9	0.049	0.078	0.080	0.059	0.054	0.063	0.078	0.074	0.061	0.063	0.063

Note:

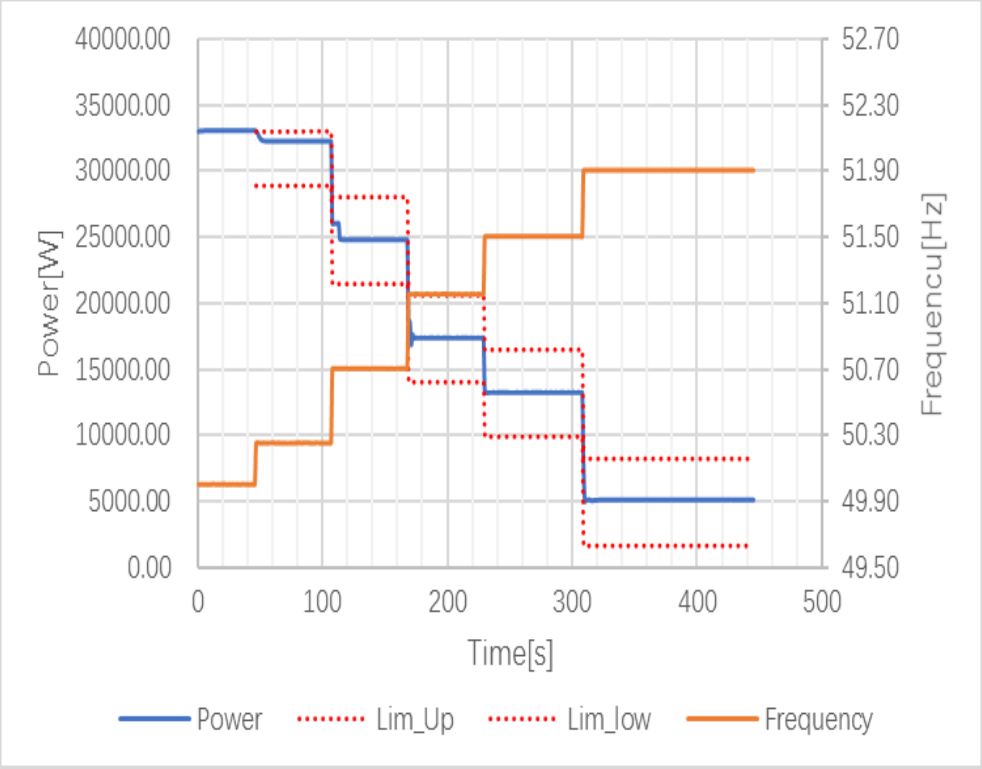
The normalization current is 28.99A for SOFAR 20000TL-G2

The stated harmonics are maximum values of all 3 phases.

Appendix A: Tables

5.2.1	TABLE: Frequency response			P
Test at 100%P_n				
Frequency (Hz)	**Active Power desired (P)**	**Active Power measured (P)**	**Deviation (%P)**	**Limit**
50.00	33000W	33086.65W	0.26	--
50.25	32175W	32317.23W	0.43	±10 %
50.70	24750W	24927.01W	0.54	±10 %
51.15	17325W	17385.14W	0.18	±10 %
51.50	13200W	13205.24W	0.02	±10 %
51.90	4950W	5067.99W	0.36	±10 %
f_R set to 50.2. Droop of 4%				

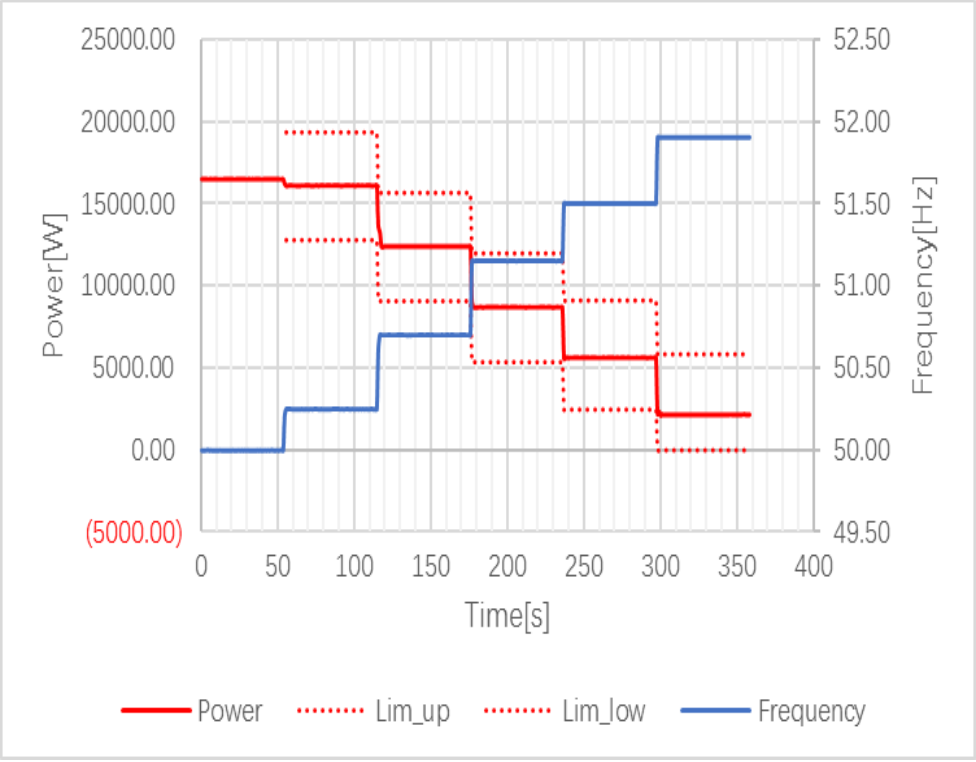
P vs F. P=100%Pn



Appendix A: Tables

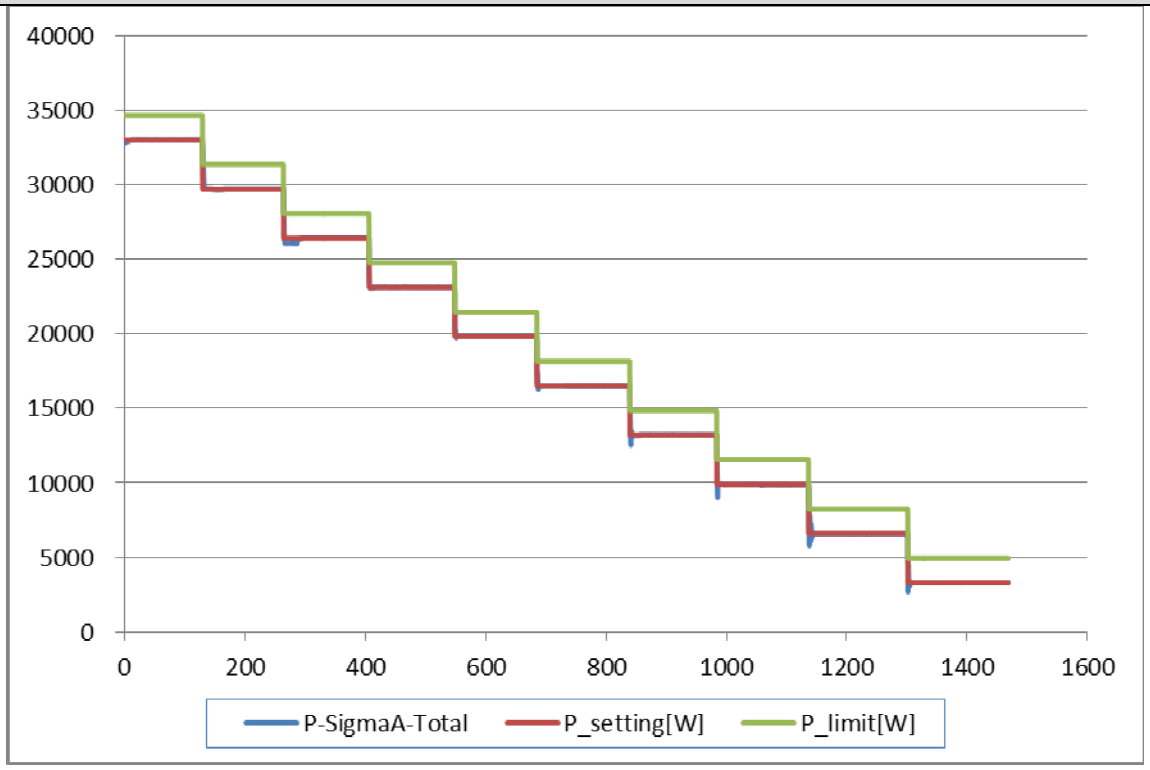
Test at 50%P_{nl}				
Frequency (Hz)	**Active Power desired (P)**	**Active Power measured (P)**	**Deviation (%P)**	**Limit**
50.00	16500.0W	16488.86 W	-0.03	±10 %
50.25	16087.5W	16100.02W	0.04	±10 %
50.70	12375.0W	12414.33W	0.12	±10 %
51.15	8662.5W	8672.19W	0.03	±10 %
51.50	5775.0W	5580.42W	-0.59	±10 %
51.90	2475.0W	2101.67W	-1.13	±10 %
f_R set to 50.2. Droop of 4%				

P vs F. P=50%Pn



5.2.3.1 Absolute power constraint	P

Graph:



Test:

1-min mean value / P_n/P [%]	100	90	80	70	60	50	40	30	20	10
$P_{Setpoint}$[kW]:	33.000	29.700	26.400	23.100	19.800	16.500	13.200	9.900	6.600	3.300
P_n [kW]:	32.987	29.554	26.346	22.623	19.695	15.799	12.224	9.064	6.051	3.298
$\Delta P_n/P_{Setpoint}$ [%]:	-0.040	-0.442	-0.164	-1.446	-0.318	-2.123	-2.957	-2.534	-1.665	-0.006
Limit $\Delta P_n/P_{Setpoint}$:	+ 5 % of P_{Emax}									

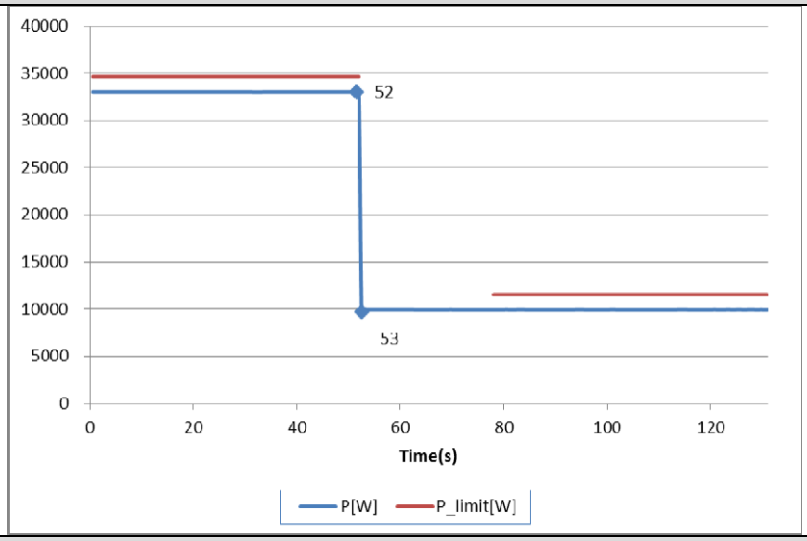
Test:

The setpoint signal must be reduced from 100% to 10% P_{Emax}:

a) for adjustable PGUs in increments of 10% P_{Emax}. 1 minute must elapse after every change to the setpoint setting so that the PGU can settle at the new setpoint. Then the active power of the PGU must be measured as a 1-min mean value.

b) For all other PGUs. in line with their adjustable steps. 5 minutes must elapse after the setpoint setting is changed so that the PGU can settle at the new setpoint. Then the active power of the PGU must be measured as a 1-min mean value.

Appendix A: Tables

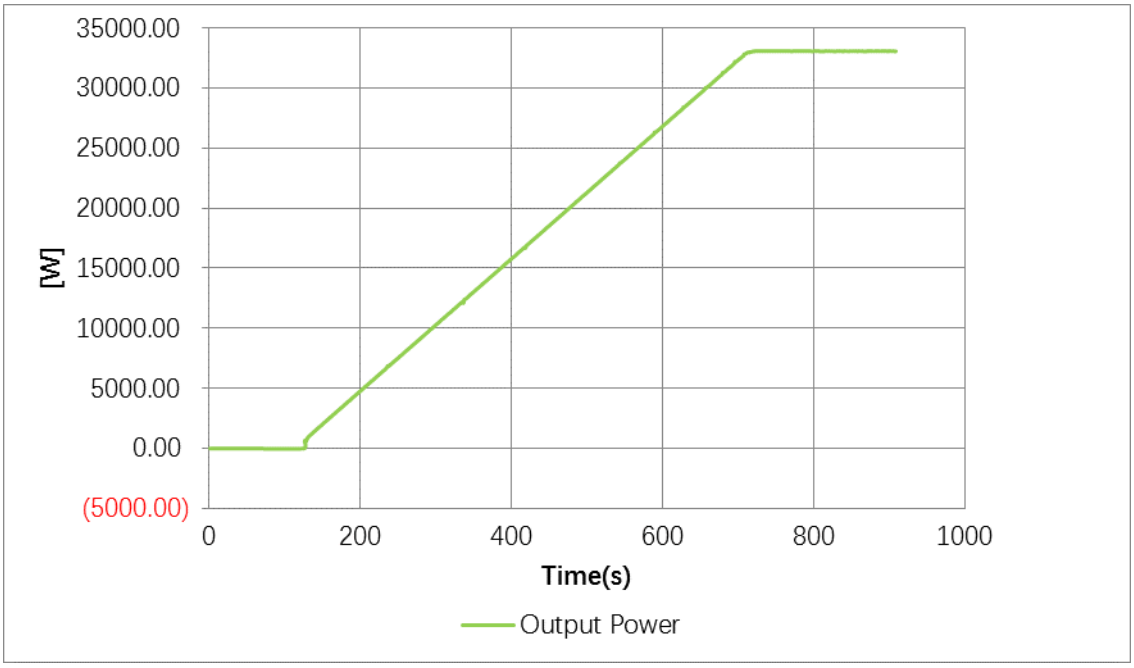
Measurement of setting time		**P**
Graph of the adjustment time:		
		
Test:		
1-min mean value	100% of P_{Emax}	30% of P_{Emax}
$P_{Setpoint}$[kW]:	33.000	9.900
P_n [kW]:	33.042	9.907
$\Delta P_n/P_{Setpoint}$ [%]:	0.127	0.021
T_0[s]:	2s	
Limit T_0:	≤ 10 s	
Test: The setting time is measured with a setpoint change from 100% to 30% of nominal active power P_{Emax} at time t_0. The setting time of the PGU must be determined in this test.		
Note: The tests had been performed on the SOFAR 33000TL-G2 is valid for the and SOFAR 20000TL-G2. SOFAR 25000TL-G2 and SOFAR 30000TL-G2. since it is similar in hardware and just power derated by software.		

Appendix A: Tables

5.2.3.3	TABLE: Ramp rate constraint	P

The ramp rate can be set 0-100%Pn/min via the communication interface

default values will be set to 10%/min as required by EN 50438

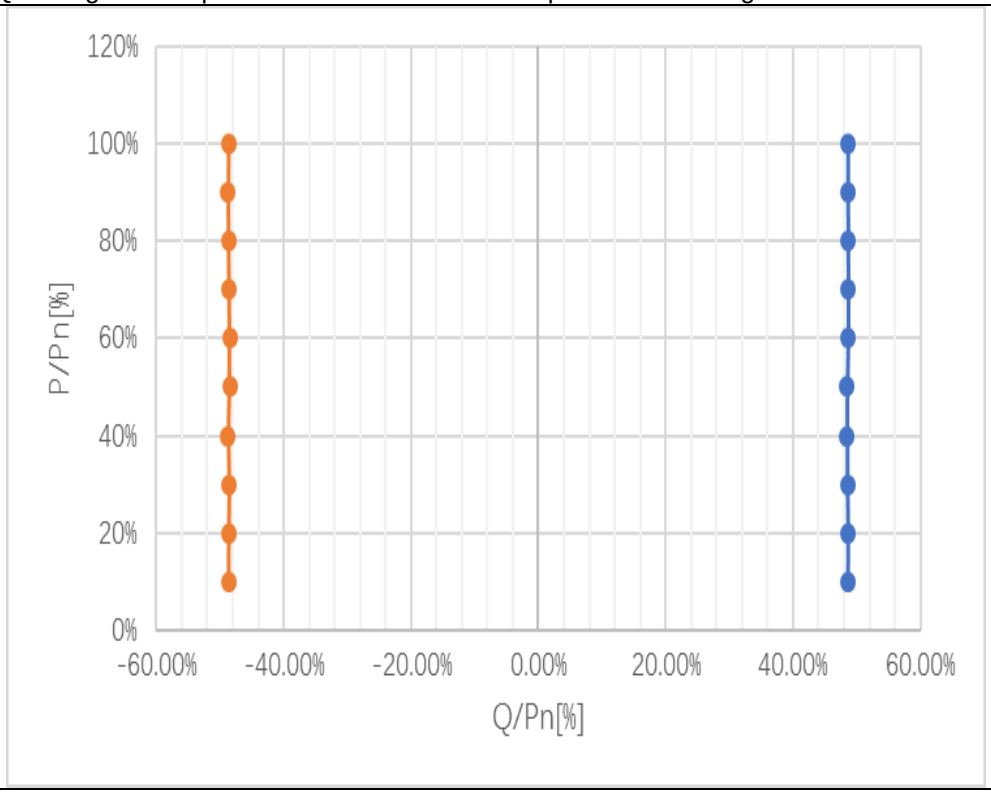


Note:

The setting will be actived after receipt of an order to change the parameter during two seconds.

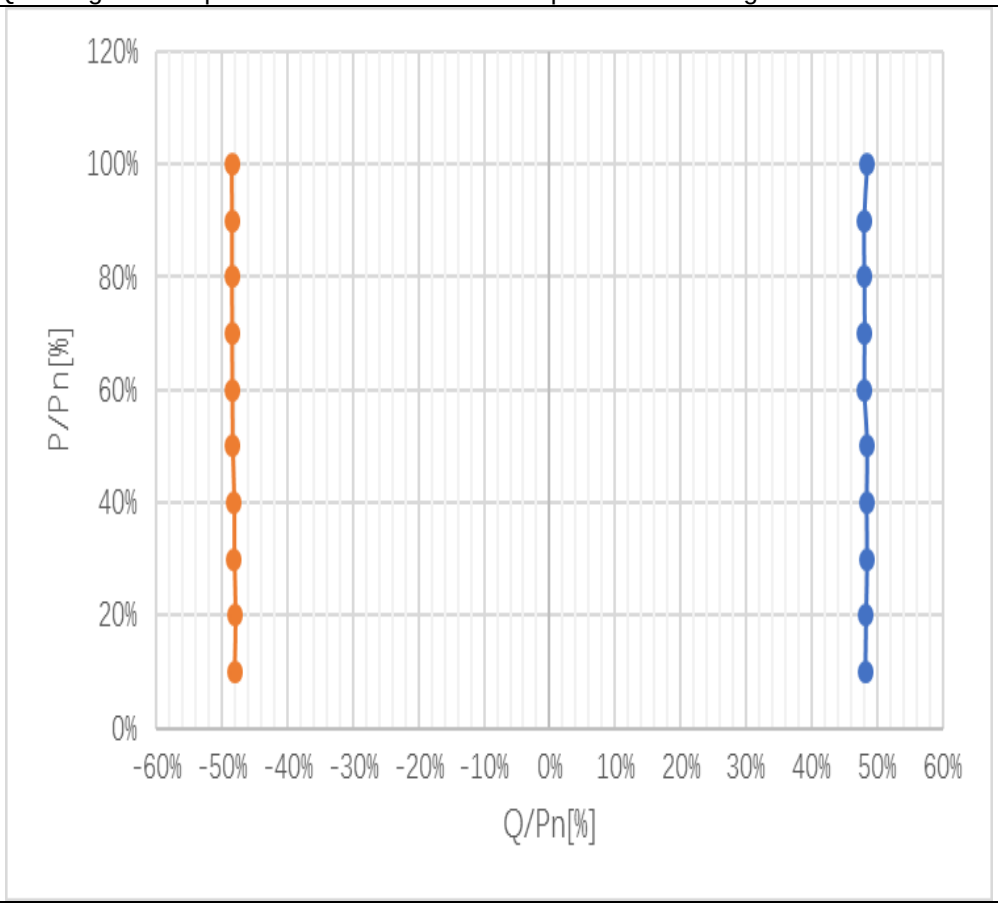
Appendix A: Tables

5.3.1	TABLE: Q control						P	
Model	SOFAR 33000TL-G2							
Setting of rated W	P(KW) ind.	Q(KVar) ind. max	Q (KVar) set point	Accuracy (Kvar)	P(KW) cap.	Q(KVar) cap.max	Q(KVar) set point	Accuracy (Kvar)
0%-10%	3.061	-16.062	-15.982	-0.080	3.280	16.036	15.982	0.054
10%-20%	6.598	-16.044	-15.982	-0.062	6.609	16.061	15.982	0.079
20%-30%	9.923	-16.008	-15.982	-0.026	9.904	16.013	15.982	0.031
30%-40%	13.223	-16.075	-15.982	-0.093	13.206	16.006	15.982	0.024
40%-50%	16.497	-16.003	-15.982	-0.021	16.532	16.01	15.982	0.028
50%-60%	19.839	-16.006	-15.982	-0.024	19.837	16.071	15.982	0.089
60%-70%	23.090	-16.027	-15.982	-0.045	23.148	16.073	15.982	0.091
70%-80%	26.402	-16.068	-15.982	-0.086	26.455	16.063	15.982	0.081
80%-90%	29.692	-16.079	-15.982	-0.097	28.776	16.052	15.982	0.070
90%-100%	32.824	-16.045	-15.982	-0.063	32.602	16.051	15.982	0.069
Any change to Q setting will completed within 2-10s after receipt the new setting from the communication interface.								



Appendix A: Tables

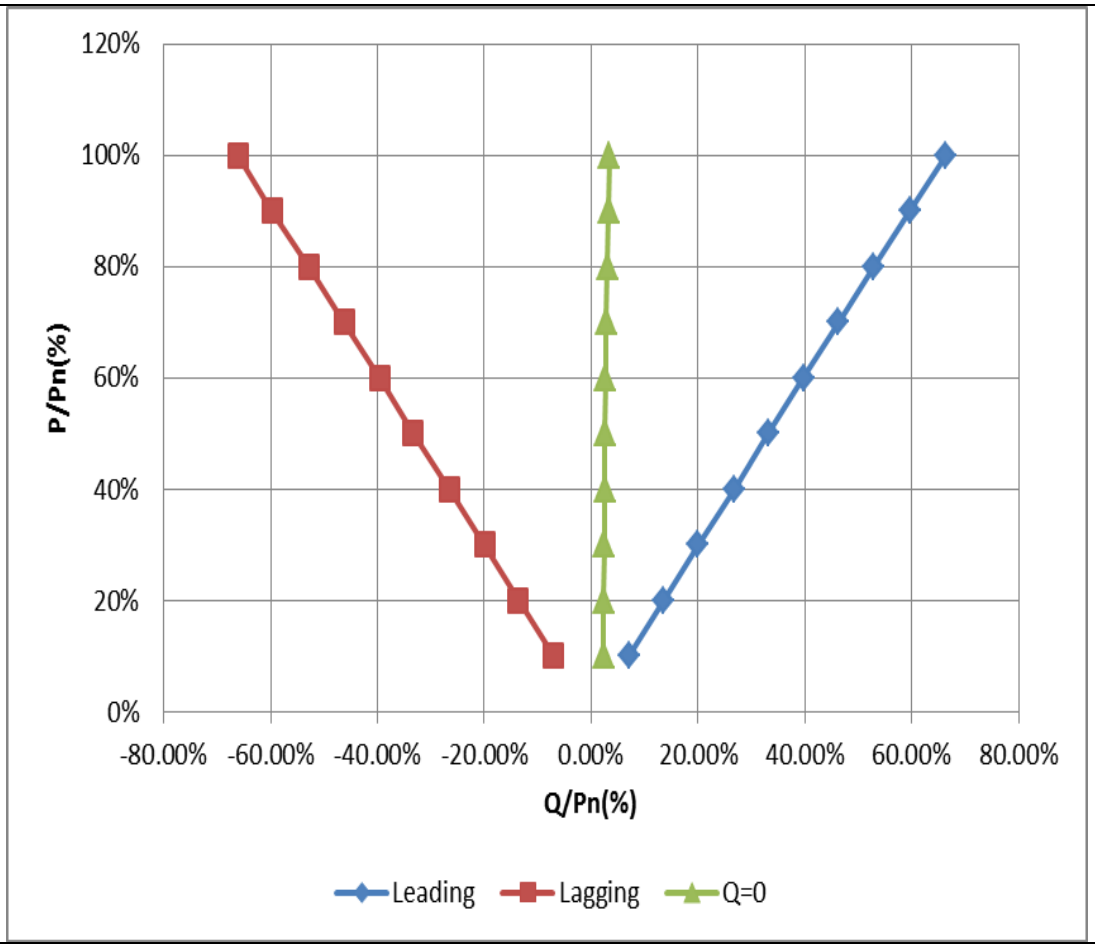
Model	SOFAR 20000TL-G2							
Setting of rated W	P(KW) ind.	Q(KVar) ind. max	Q (KVar) set point	Accuracy (Kvar)	P(KW) cap.	Q(KVar) cap.max	Q(KVar) set point	Accuracy (Kvar)
0%-10%	2.031	-9.626	-9.686	0.060	2.036	9.645	9.686	-0.041
10%-20%	4.023	-9.604	-9.686	0.082	4.010	9.666	9.686	-0.020
20%-30%	6.128	-9.629	-9.686	0.057	6.025	9.697	9.686	0.011
30%-40%	8.009	-9.633	-9.686	0.053	8.093	9.681	9.686	-0.005
40%-50%	10.049	-9.667	-9.686	0.019	10.058	9.698	9.686	0.012
50%-60%	12.005	-9.679	-9.686	0.007	12.014	9.617	9.686	-0.069
60%-70%	14.028	-9.682	-9.686	0.004	14.027	9.626	9.686	-0.060
70%-80%	16.002	-9.685	-9.686	0.001	16.043	9.620	9.686	-0.066
80%-90%	18.001	-9.684	-9.686	0.002	18.009	9.611	9.686	-0.075
90%-100%	20.005	-9.690	-9.686	-0.004	20.014	9.698	9.686	0.012
Any change to Q setting will completed within 2-10s after receipt the new setting from the communication interface.								



Appendix A: Tables

5.3.2	**TABLE: Power Factor control**				**P**
Model	SOFAR 33000TL-G2				
Setting of rated W	PF (setting)	P(W)	Q(Var)	PF	Accuracy
0%-10%	0.80 lagging	2925.19	-2312.33	0.7803	No precision
10%-20%	0.80 lagging	5845.22	-4494.55	0.7941	No precision
20%-30%	0.80 lagging	8773.69	-6590.24	0.7988	-0.0012
30%-40%	0.80 lagging	11851.45	-8745.46	0.8005	0.0005
40%-50%	0.80 lagging	14643.29	-10973.86	0.8012	0.0012
50%-60%	0.80 lagging	17584.40	-13071.86	0.8013	0.0013
60%-70%	0.80 lagging	20527.00	-15257.94	0.8018	0.0018
70%-80%	0.80 lagging	23463.32	-17449.62	0.8022	0.0022
80%-90%	0.80 lagging	26446.41	-19686.76	0.8022	0.0022
90%-100%	0.80 lagging	29427.42	-21830.68	0.8017	0.0017
Setting of rated W	PF (setting)	P(W)	Q(Var)	PF	Accuracy
0%-10%	0.80 leading	2929.00	2343.15	0.7848	No precision
10%-20%	0.80 leading	5865.43	4472.92	0.7937	No precision
20%-30%	0.80 leading	8794.60	6607.51	0.8003	0.0003
30%-40%	0.80 leading	11889.42	8872.53	0.8024	0.0024
40%-50%	0.80 leading	14798.82	10938.18	0.8032	0.0032
50%-60%	0.80 leading	17648.63	13127.64	0.8036	0.0036
60%-70%	0.80 leading	20601.87	15295.98	0.8036	0.0036
70%-80%	0.80 leading	23557.24	17458.54	0.8035	0.0035
80%-90%	0.80 leading	26564.93	19678.53	0.8034	0.0034
90%-100%	0.80 leading	29489.57	21942.99	0.8037	0.0037
Setting of rated W	PF (setting)	P(W)	Q(Var)	PF	Accuracy
0%-10%	1	2927.84	770.02	0.9671	No precision
10%-20%	1	5864.05	782.87	0.9912	No precision
20%-30%	1	8795.99	805.87	0.9958	-0.0042
30%-40%	1	11729.34	835.93	0.9975	-0.0025
40%-50%	1	14666.24	869.12	0.9982	-0.0018
50%-60%	1	17605.94	908.19	0.9987	-0.0013
60%-70%	1	20546.90	952.38	0.9989	-0.0011
70%-80%	1	23492.12	1005.14	0.9991	-0.0009
80%-90%	1	26430.64	1075.79	0.9992	-0.0008
90%-100%	1	32904.21	1109.90	0.9994	-0.0006
Any change to power factor will completed within 2-10s after receipt the new setting from the communication interface					

Appendix A: Tables



Appendix A: Tables

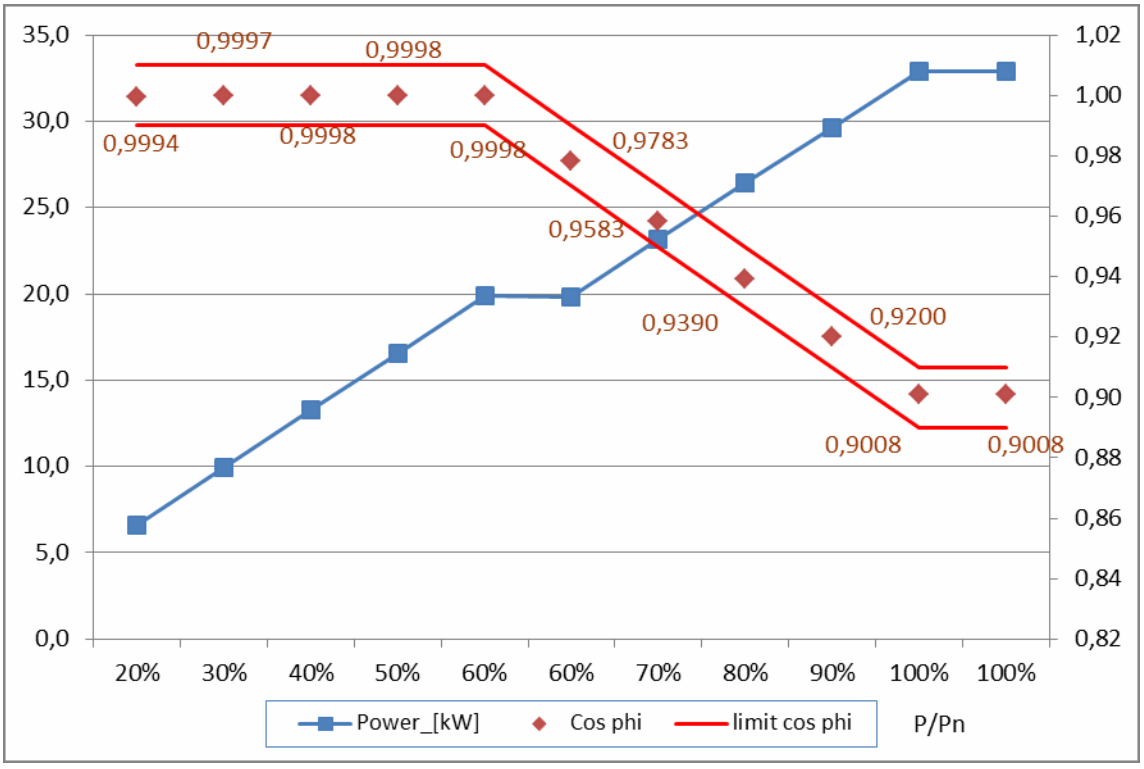
5.3.4	Automatic Power Factor control	P

Test result: SOFAR 33000TL-G2

Power-BIN	Active power P[KW]	Reactive power Q[KVar]	cosφ measured	cosφ expected	Δ cosφ
20%	6.595	0.219	0.9994	1.00	-0.0006
30%	9.928	0.233	0.9997	1.00	-0.0003
40%	13.254	0.264	0.9998	1.00	-0.0002
50%	16.570	0.304	0.9998	1.00	-0.0002
60%	19.809	4.192	0.9783	0.98	-0.0017
70%	23.149	-4.979	0.9583	0.96	-0.0017
80%	26.416	-9.671	0.9390	0.94	-0.0010
90%	29.660	-12.635	0.9200	0.92	0.0000
100%	32.877	-15.846	0.9008	0.90	0.0008

Note:
The lock-in value is adjustable between V_n and $1.1V_n$ and the lock-out value between V_n and $0.9V_n$ in 0.01V steps.

The tests had been performed on the SOFAR 33000TL-G2 is valid for the and SOFAR 20000TL-G2. SOFAR 25000TL-G2 and SOFAR 30000TL-G2. since it is similar in hardware and just power derated by software.



Appendix A: Tables

6.3 Over-/under-voltage					**P**
		Over Voltage 1		Under Voltage	
Parameter		Voltage(V) (step 1)	Disconnection Time(s)	Voltage(V)	Disconnection Time(s)
Protection limit		253	60.0	207	10*
Actual setting (as applied to interface protection)		253	60.0	207	10*
Trip value (test result)-1	All phases	253.70	60.06	208.45	9.62
	Phase R	253.55	60.04	208.10	9.62
	Phase S	254.04	60.06	208.98	9.62
	Phase T	253.53	60.03	208.28	9.64
Trip value (test result)-2	All phases	253.79	60.03	208.35	9.59
	Phase R	253.95	60.02	208.18	9.57
	Phase S	253.95	60.03	208.42	9.59
	Phase T	253.87	60.02	208.45	9.59
Trip value (test result)-3	All phases	253.77	60.04	208.46	9.62
	Phase R	253.62	60.03	208.06	9.62
	Phase S	253.97	60.04	208.04	9.62
	Phase T	253.73	60.03	208.28	9.55
Trip value (test result)-4	All phases	253.72	60.03	208.41	9.64
	Phase R	253.56	60.02	208.08	9.56
	Phase S	254.04	60.03	208.53	9.64
	Phase T	253.56	60.03	208.61	9.55

Appendix A: Tables

Trip value (test result)-5	All phases	253.77	60.03	208.46	9.62
	Phase R	253.60	60.04	207.98	9.64
	Phase S	253.98	60.03	208.01	9.62
	Phase T	253.75	60.04	208.38	9.55
		Over Voltage 2		Under Voltage	
Parameter		Voltage(V) (step 2)	Disconnection Time(s)	Voltage(V)	Disconnection Time(s)
Protection limit		264.5	0.2	--	--
Actual setting (as applied to interface protection)		264.5	0.2	--	--
Trip value (test result)-1	All phases	264.67	0.213	--	--
	Phase R	265.37	0.215	--	--
	Phase S	265.81	0.214	--	--
	Phase T	265.77	0.214	--	--
Trip value (test result)-2	All phases	264.63	0.214	--	---
	Phase R	265.07	0.213	--	--
	Phase S	266.05	0.214	--	--
	Phase T	265.12	0.213	--	--
Trip value (test result)-3	All phases	264.59	0.214	--	--
	Phase R	265.75	0.212	--	--
	Phase S	265.42	0.214	--	--
	Phase T	265.51	0.219	--	--
Trip value (test result)-4	All phases	264.60	0.212	--	--
	Phase R	265.08	0.216	--	--

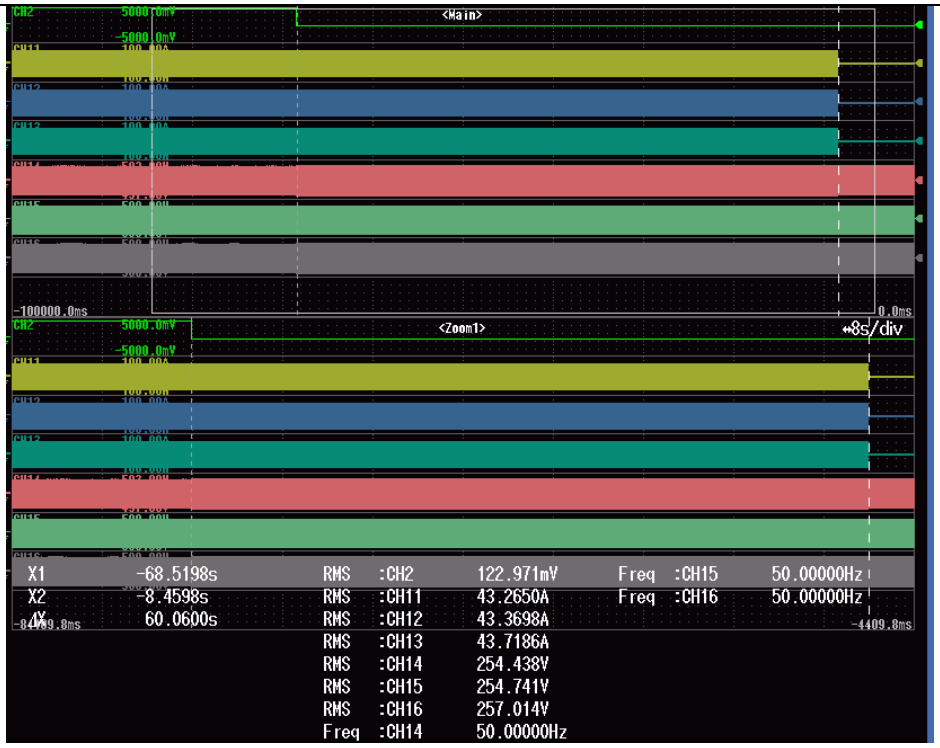
	Phase S	265.83	0.212	--	--
	Phase T	265.90	0.211	--	--
Trip value (test result)-5	All phases	264.70	0.214	--	--
	Phase R	265.39	0.215	--	--
	Phase S	265.38	0.214	--	--
	Phase T	265.19	0.217	--	--

The operate values are within±1% Un

Tolerances on disconnection time are ±10%

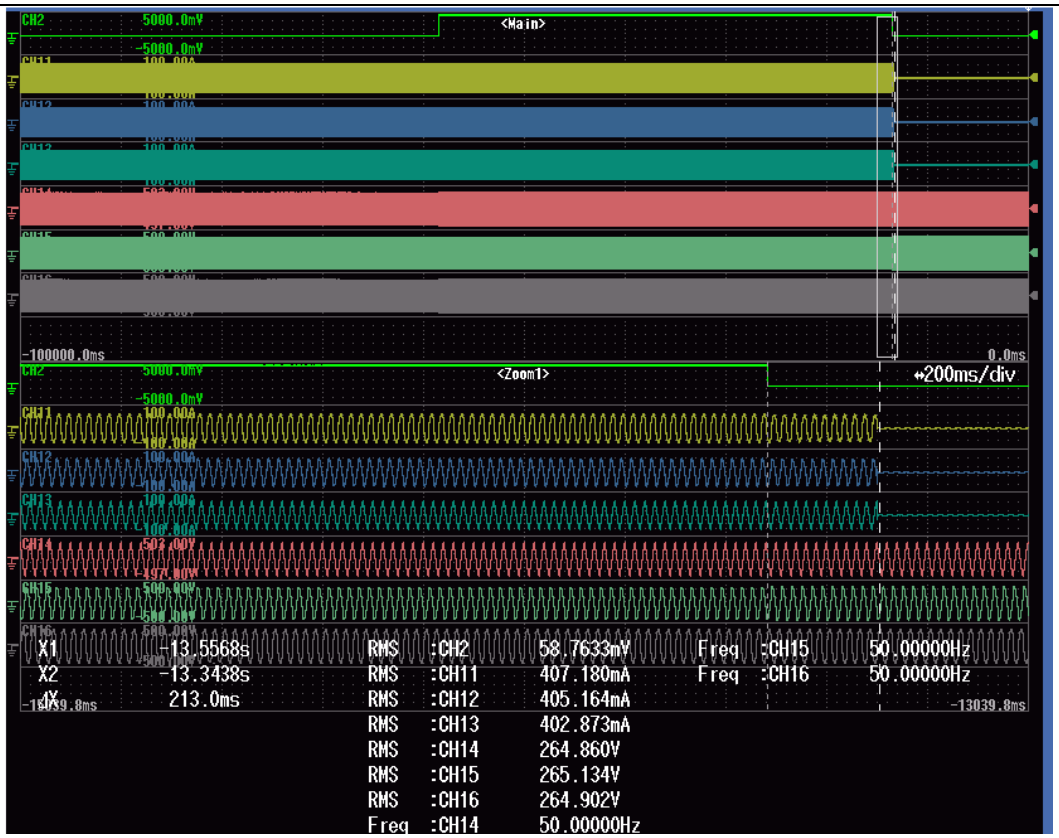
* As required by TR3.2.2 and can be adjustable , this value is used unless agreed otherwise with the electricity supply undertaking

The measured trip time was captured by oscilloscope, which colour Green denotes trip signal and Yellow or Pink denotes output current of EUT

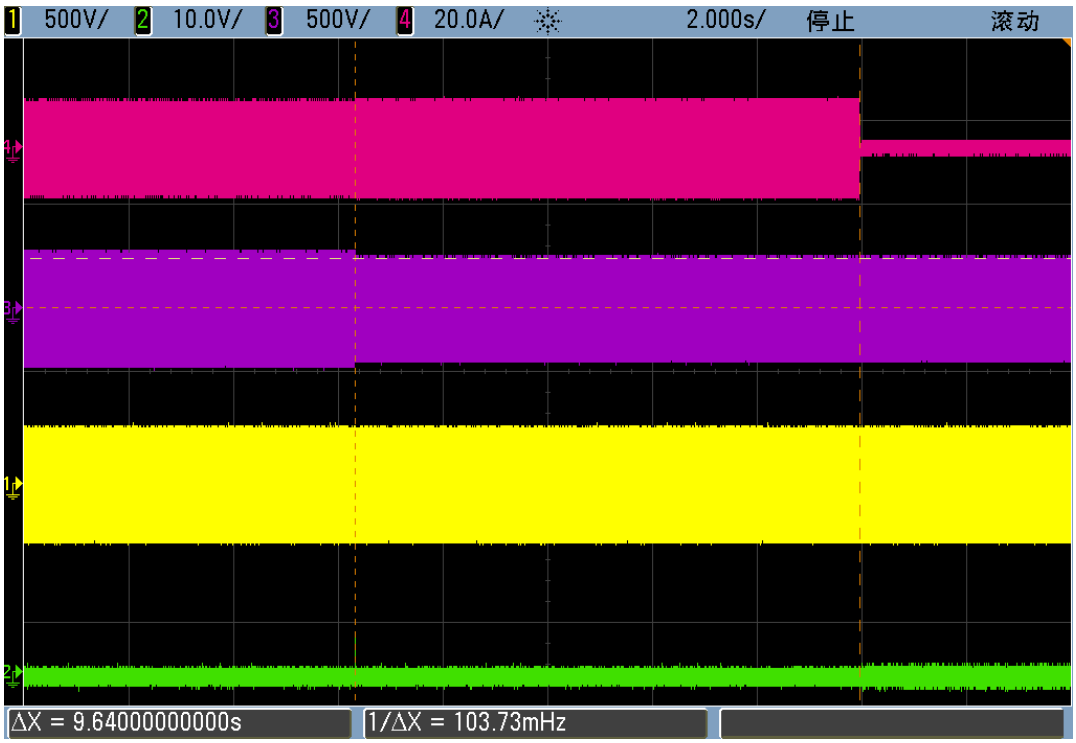


Over-voltage step 1

Appendix A: Tables



Over-voltage step 2



TTRF No. TR3.2.2a Under-voltage

Appendix A: Tables

6.3	Overunder-frequency			P
	Over Frequency		Under Frequency	
Parameter	Frequency	Time	Frequency	Time
Recommended value	52.0Hz	200ms	47.0Hz	200ms
Actual setting (as applied to interface protection)	52.0Hz	200ms	47.0Hz	200ms
Trip value (test result)-1	52.01Hz	202.0ms	47.0Hz	191.0ms
Trip value (test result)-2	52.01Hz	204.0ms	47.0Hz	198.0ms
Trip value (test result)-3	52.01Hz	209.0ms	47.0Hz	199.0ms
Trip value (test result)-4	52.01Hz	213.5ms	47.0Hz	198.0ms
Trip value (test result)-5	52.01Hz	212.0ms	47.0Hz	195.0ms

Remark:

the operate values are within ± 0.05 Hz.

Tolerances on time: ±10%

The measured trip time was captured by oscilloscope.

Over Frequency

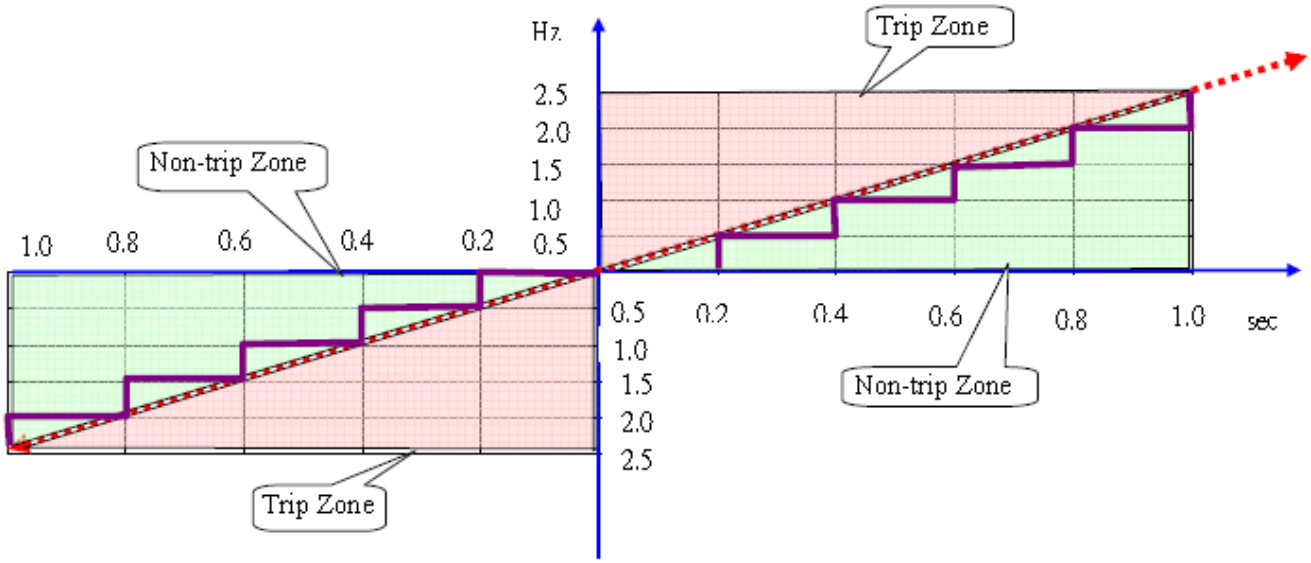
Appendix A: Tables

Under Frequency

Appendix A: Tables

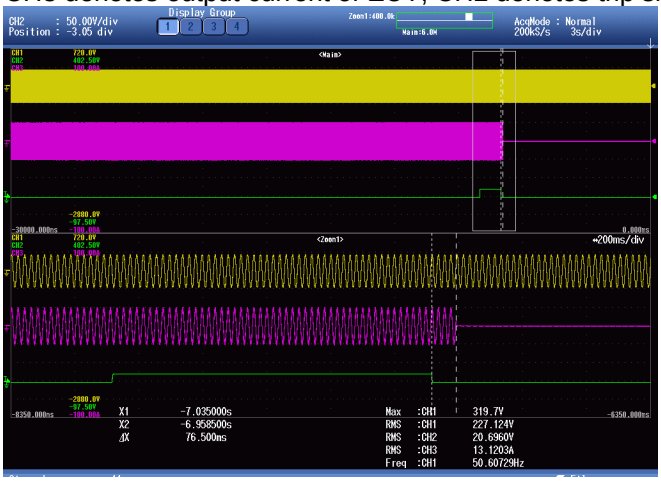
6.3	ROCOF		P
Change of frequency (df/dt)	±2.5Hz/s	Recommended value	80ms
48.5Hz to 51Hz	+2.5Hz/s	Trip time	76.5ms
50Hz to 47.5Hz	-2.5Hz/s	Trip time	79.5ms

Testing to ROCOF (Rate of Change of Frequency), Denmark



Tolerances on time: ±10%

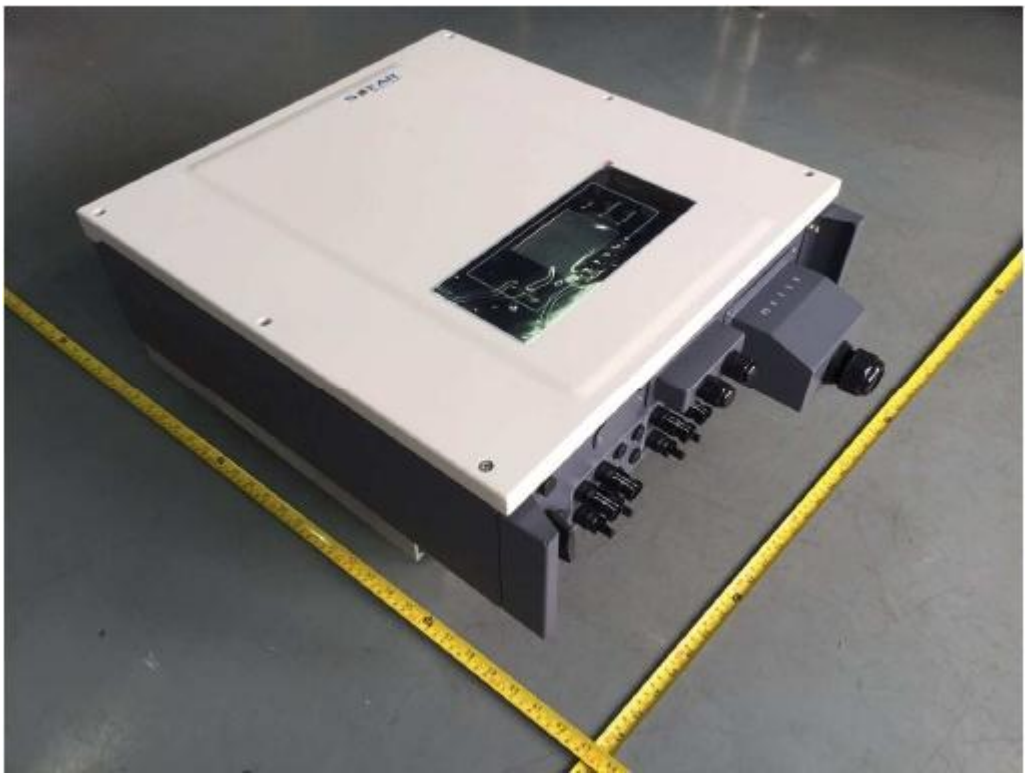
The measured trip time was captured by oscilloscope. which channel CH1 denotes output voltage of EUT. and CH3 denotes output current of EUT; CH2 denotes trip signal.



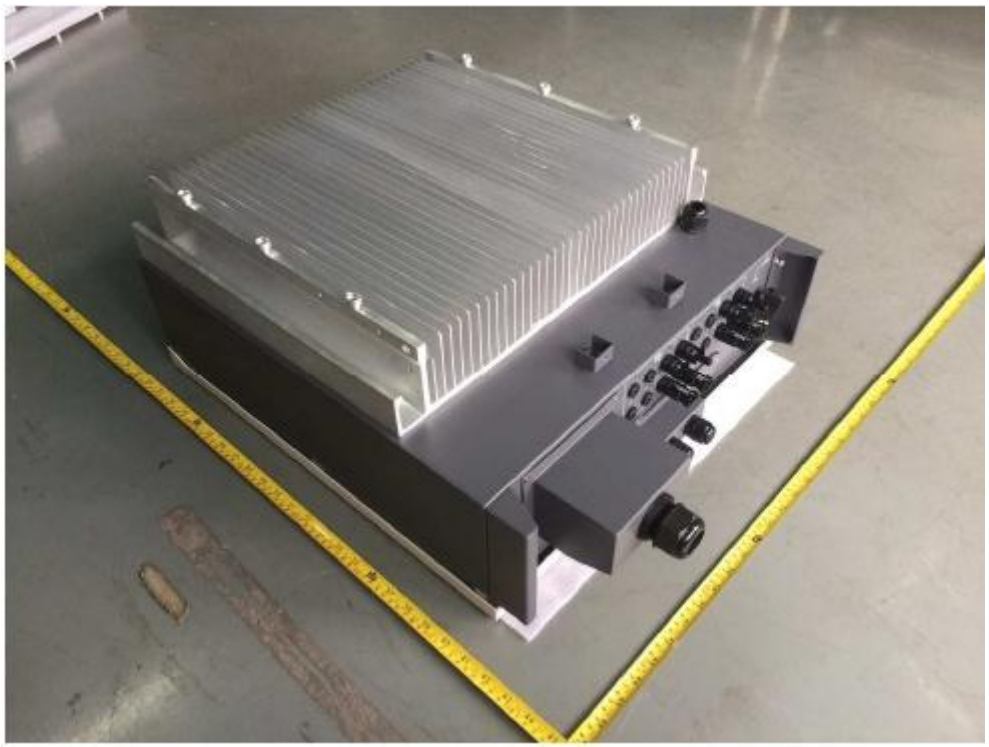
48.5Hz to 51Hz

50Hz to 47.5Hz

Appendix B: Photos



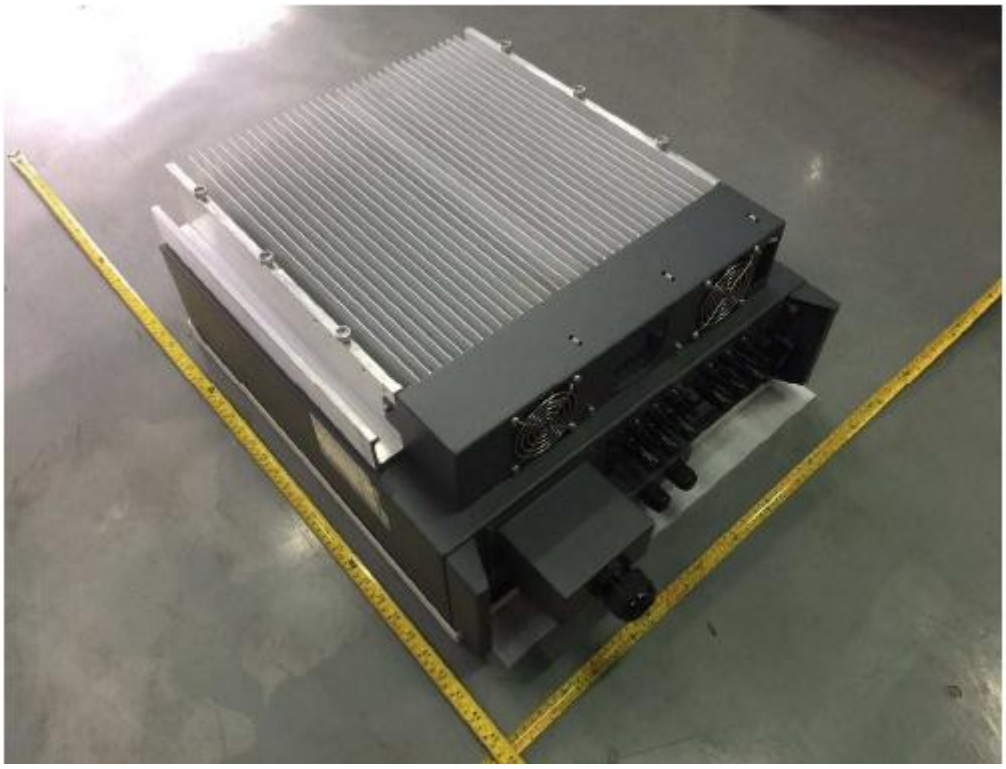
Enclosure front view: SOFAR 20000TL-G2



Enclosure rear view: SOFAR 20000TL-G2

Appendix B: Photos

Enclosure front view: SOFAR 25000TL-G2



Enclosure rear view: SOFAR 25000TL-G2

Appendix B: Photos

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

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

Appendix B: Photos

Internal view: SOFAR 20000TL-G2

Internal view: SOFAR 25000TL-G2

Appendix B: Photos

Internal view: SOFAR 30000TL-G2, SOFAR 33000TL-G2

(End of report)