
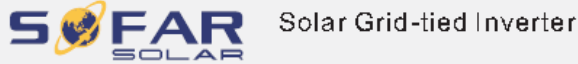


TEST REPORT EN 50438: 2013 Requirements for micro-generating plants to be connected in parallel with public low-voltage distribution networks	
Report reference No.	190710044GZU-001
Tested by (printed name and signature)	Jason Fu Technical Team Leader
Approved by (printed name and signature)	Tommy Zhong Technical Manager
Date of issue	11Jul. 2019
Contents	57 Pages
Testing Laboratory Name	Intertek Testing Services Shenzhen Ltd. Guangzhou Branch
Address	Block E. No.7-2 Guang Dong Software Science Park. Caipin Road. Guangzhou Science City. GETDD. Guangzhou. China
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.....	EN 50438: 2013
Test procedure	Type approval for Ireland
Non-standard test method	N/A
Test Report Form No.	EN50438b
TRF originator	Intertek
Master TRF	dated 2014-01
Test item description	PV Grid Inverter
Trademark	
Manufacturer	Same as applicant
Factory	Dongguan SOFAR SOLAR Co.. Ltd. 1F-6F. Building E. No.1 JinQi Road. Bihu Industrial Park. Wulian Village. Fenggang Town. Dongguan City
Model and/or type reference	SOFAR 1100TL. SOFAR 1600TL. SOFAR 2200TL. SOFAR 2700TL. SOFAR 3000TL

Rating.....:	Model	SOFAR 1100TL	SOFAR 1600TL	SOFAR 2200TL	SOFAR 2700TL	SOFAR 3000TL
	Max. DC Voltage	450V		500V		
	DC voltage range	90-450V		100-500V		
	Max input current	10A		13A		
	PV Isc	12A		15A		
	Nominal Grid voltage	230Vac				
	Nominal Grid frequency	50Hz				
	Max. AC output current	4.5A	7.0A	9.5A	11.5A	13.0A
	Max AC output power	1000VA	1550VA	2100VA	2600VA	3000VA
	Power factor	0.8 Leading to 0.8 Lagging				
	Ingress protection	IP 65				
	Operating temperature range	-25 ~ +60°C				
	Protective class	Class I				
	Software Version	V1.00				

Copy of marking plate:

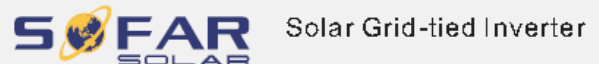
The artwork below may be only a draft. The use of certification marks on a product must be authorized by the respective NCBs that own these marks.



Model No:	SOFAR 3000TL
Vmax.DC Input Voltage	500V
DC Input Voltage Range	100~500V
Imax.DC Input Current	13A
Isc(max.)DC Current	15A
Nominal Grid Voltage	230V~
Nominal AC Output Current	13A
Nominal Grid Frequency	50/60Hz
Nominal Output Power	3000VA
Power Factor	1 (adjustable+/-0.8)
Ingress Protection	IP65
Operating Temperature Range	-25°C~+60°C
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
SAA161894
VDE0126-1-1,VDE-AR-N4105,G98,
EN50438,C10/11,AS4777,RD1699,UTE C15-712-1



Model No:	SOFAR 2700TL
Vmax.DC Input Voltage	500V
DC Input Voltage Range	100~500V
Imax.DC Input Current	13A
Isc(max.)DC Current	15A
Nominal Grid Voltage	230V~
Nominal AC Output Current	11.5A
Nominal Grid Frequency	50/60Hz
Nominal Output Power	2600VA
Power Factor	1 (adjustable+/-0.8)
Ingress Protection	IP65
Operating Temperature Range	-25°C~+60°C
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
SAA161894
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EN50438,C10/11,AS4777,RD1699,UTE C15-712-1



SOFAR SOLAR Solar Grid-tied Inverter

Model No:	SOFAR 2200TL
Vmax.DC Input Voltage	500V
DC Input Voltage Range	100~500V
Imax.DC Input Current	13A
Isc(max.) DC Current	15A
Nominal Grid Voltage	230V~
Nominal AC Output Current	9.5A
Nominal Grid Frequency	50/60Hz
Nominal Output Power	2100VA
Power Factor	1(adjustable+/-0.8)
Ingress Protection	IP65
Operating Temperature Range	-25°C~+60°C
Protective Class	Class I

Made in China
 Manufacturer : Shenzhen SOFAR SOLAR Co.,Ltd.
 Address : 401, Building 4, AnTong Da Industrial Park,
 District 68, XingDong Community,XinAn Street,
 Bao An District, Shenzhen, China
 SAA 16 1894
 VDE0126-1-1, VDE-AR-N4 105, G98,
 EN50438, C10/11, AS4777, RD1699, UTE C15-712-1



SOFAR SOLAR Solar Grid-tied Inverter

Model No:	SOFAR 1600TL
Vmax.DC Input Voltage	450V
DC Input Voltage Range	90~450V
Imax.DC Input Current	10A
Isc(max.) DC Current	12A
Nominal Grid Voltage	230V~
Nominal AC Output Current	7A
Nominal Grid Frequency	50/60Hz
Nominal Output Power	1550VA
Power Factor	1(adjustable+/-0.8)
Ingress Protection	IP65
Operating Temperature Range	-25°C~+60°C
Protective Class	Class I

Made in China
 Manufacturer : Shenzhen SOFAR SOLAR Co.,Ltd.
 Address : 401, Building 4, AnTong Da Industrial Park,
 District 68, XingDong Community,XinAn Street,
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 SAA 16 1894
 VDE0126-1-1, VDE-AR-N4 105, G98,
 EN50438, C10/11, AS4777, RD1699, UTE C15-712-1



SOFAR SOLAR Solar Grid-tied Inverter

Model No:	SOFAR 1100TL
Vmax.DC Input Voltage	450V
DC Input Voltage Range	90~450V
Imax.DC Input Current	10A
Isc(max.) DC Current	12A
Nominal Grid Voltage	230V~
Nominal AC Output Current	4.5A
Nominal Grid Frequency	50/60Hz
Nominal Output Power	1000VA
Power Factor	1(adjustable+/-0.8)
Ingress Protection	IP65
Operating Temperature Range	-25°C~+60°C
Protective Class	Class I

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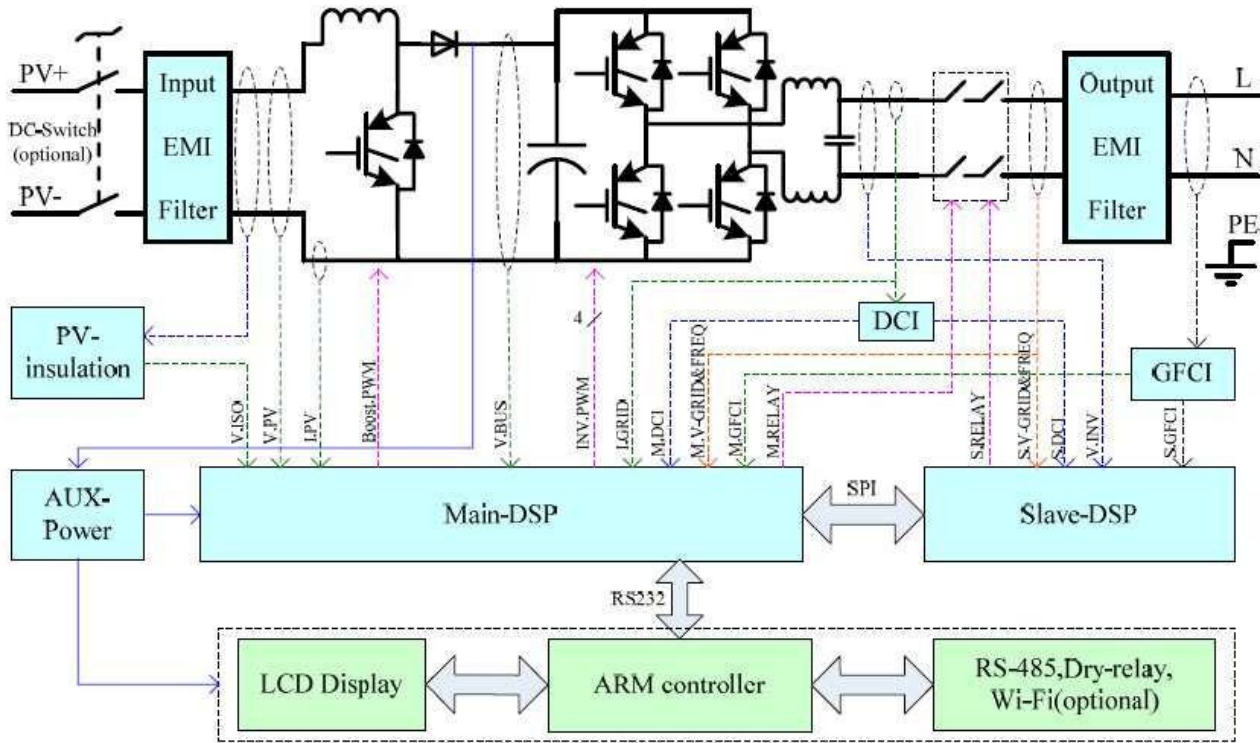
Note: The above markings are the minimum requirements required by the safety standard. For the final production samples, the additional markings which do not give rise to misunderstanding may be added.

<p>Test case verdicts</p> <p>Test case does not apply to the test object ..: N/A</p> <p>Test item does meet the requirement: P(ass)</p> <p>Test item does not meet the requirement ...: F(ail)</p>	
<p>Testing</p> <p>Date of receipt of test item: 10 Jul.. 2019</p> <p>Date(s) of performance of test: 10 Jul.. 2019 to 11 Jul.. 2019</p>	
<p>General remarks</p> <p>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.</p> <p>Throughout this report a point is used as the decimal separator.</p> <p>When determining the test conclusion, the Measurement Uncertainty of test has been considered.</p> <p>This report is for the exclusive use of Intertek's Client and is provided pursuant to the agreement between Intertek and its Client. Intertek's responsibility and liability are limited to the terms and conditions of the agreement. Intertek assumes no liability to any party, other than to the Client in accordance with the agreement, for any loss, expense or damage occasioned by the use of this report. Only the Client is authorized to permit copying or distribution of this report and then only in its entirety. Any use of the Intertek name or one of its marks for the sale or advertisement of the tested material, product or service must first be approved in writing by Intertek. The observations and test results in this report are relevant only to the sample tested. This report by itself does not imply that the material, product, or service is or has ever been under an Intertek certification program. The test report only allows to be revised only within the report defined retention period unless standard or regulation was withdrawn or invalid.</p> <p>This report is type tested for Ireland setting that based on report No. PV180903N026, issued by Bureau Veritas Shenzhen Co., Ltd. Dongguan Branch, dated 29 Sep 2018</p>	

General product information:

The Solar converter converts DC voltage into AC voltage.

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



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

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

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

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

The unit provides two relays in series in all output conductors. When single fault applied to one relay. alarm an error code in display panel. another redundant relay provides basic insulation maintained between the PV array and the mains. All the relays are tested before each start up

Differences of the model

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

Difference table					
	SOFAR 1100TL	SOFAR 1600TL	SOFAR 2200TL	SOFAR 2700TL	SOFAR 3000TL
Boost inductor	2.6mH	2.6mH	1.9mH	1.9mH	1.9mH
Resistor (RP105. RP108 /RP189.RP109)	220ohm / 10Kohm	220ohm / 10Kohm	200ohm / 7.5Kohm	200ohm / 7.5Kohm	200ohm / 7.5Kohm
BUS capacitor (ECP1. ECP2. ECP3. ECP4)	2 pcs	2 pcs	3 pcs	3 pcs	3 or 4 pcs
Inverter inductor	3.4mH	2.3mH	2.1mH	1.5mH	1.3mH
Resistor (RP118. RP119. RC18 /RP120. RP121.RC22)	499 Ω. 200 Ω. 200 Ω	1 KΩ. 200 Ω. 100 Ω	1 KΩ. 330 Ω. 330 Ω	2 KΩ. 100 Ω. 100 Ω	2 KΩ. 100 Ω. 100 Ω
DC switch and Wi-Fi module are optional.					

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

Interface protection in EN 50438 as below:

Parameter	Clearance time s	Trip setting
Over-voltage	0,5	230 V + 10%
Under-voltage	0,5	230 V - 10%
Over-frequency	0,5	50 Hz + 1%
Under-frequency	0,5	50 Hz - 4%
<p>An explicit Loss of Mains functionality shall be included. Established methods such as, but not limited to, Rate of Change of Frequency, Vector Shift or Source Impedance Measurement may be used. Where Source Impedance is measured, this shall be achieved by purely passive means, Any implementation which involves the injection of pulses onto the distribution network, shall not be permitted.</p>		
ROCOF (where used)	0,5	0,4 Hz/s
Vector Shift (where used)	0,5	6°

Tolerances on Voltage: $\pm 1\%U_n$

Tolerances on Frequency: $\pm 0.05\text{Hz}$

EN50438			
Cl.	Requirement - Test	Result	Verdict
4	Technical requirements		P
4.1	Electrical installation		N/A
4.1.1	General		N/A
	Low voltage electrical installations shall comply with national and local regulation. In case of any hardware malfunctioning, disconnection is required.	Shall be complied with end installation	N/A
4.1.2	Over-current protection		N/A
	The micro-generating plant shall be protected against over-current according to the HD 60364 series. When selecting the over-current protection within the domestic installation it is necessary to ensure correct selectivity with the DSO' s protection devices.	Shall be complied with end installation	N/A
4.1.3	Earthing	Shall be complied with end installation	N/A
	Earthing shall be according to HD 60364-5-551 and the relevant national standards.		N/A
	When a micro-generator is operating in parallel with the distribution network, there shall be no direct connection between the generator winding (or pole of the primary energy source in the case of a DC sourced micro-generator) and the DSO' s earth terminal. For installations where the customer provides his own earth terminal, e.g. when connected to a TT system, it is also advisable to avoid connecting the generator winding to this earth terminal.		N/A
	For a micro-generator which is designed to operate in parallel with a distribution network but which is connected via an inverter (e.g. a PV array or a stationary fuel cell power system) it is permissible to connect one pole of the DC side of the inverter to the distribution network if there is insulation between the AC and the DC sides of the inverter. In such cases, the installer/manufacturer shall take all reasonable precautions to ensure that the micro-generator will not impair the integrity of the distribution network and will not suffer unacceptable damage for all credible operating conditions, including faults on the distribution network.		N/A
4.2	Normal operating range		P
4.2.1	General		P

EN50438			
Cl.	Requirement - Test	Result	Verdict
	Generating plants have to be able to operate in the operating range specified below regardless the topology and the settings of the interface protection.		P
4.2.2	Continuous voltage operation range		P
	The generating plant shall be capable not to disconnect due to voltage when the voltage at the point of connection stays within the range of $0.85 U_n$ to $1.1 U_n$.		P
	The generating plant owner shall take into account the voltage rise and voltage drop within the installation when considering the wider operating range for the generator unit itself.		P
4.2.3	Continuous frequency operation range		P
	The generating plant shall be capable to operate continuously when the frequency at the point of connection stays within the range of 49 Hz to 51 Hz.		P
	Linear generators, coupled directly and synchronously to the grid, and powered by free piston stirling engines are permitted to disconnect below 49.5 Hz and above 50.5 Hz.		N/A
4.2.4	Response to under-frequencies		P
	A generating plant shall be resilient to reductions of frequency at the point of connection while reducing the maximum power as little as possible.		P
	Table 1 shows the minimum time periods a generating plant has to be able to operate without disconnecting from the network.	See appended table	P
	The admissible active power reduction due to under-frequency below 49.5 Hz is limited by a reduction rate of 10 % of the momentary power P_M per 1 Hz frequency drop as given by the full line in Figure 2.	See appended table	P
	Respecting the legal framework, it is possible that a more stringent power reduction characteristic is required by the DSO in coordination with the TSO. Nevertheless this requirement shall be limited to an admissible active power reduction due to under-frequency below 49.0 Hz with a reduction rate of 2 % of the momentary power P_M per 1 Hz frequency drop as indicated by the dotted line in Figure 2.		P
	Acceptance of this reduction is limited to a selection of affected generation technologies and may be subject to further conditions decided by the relevant TSO.		P
4.2.5	Power response to over-frequency		P
	A generating plant shall be resilient to over-frequency at the point of connection.		P

EN50438			
Cl.	Requirement - Test	Result	Verdict
	Table 2 shows the minimum time periods a generating plant has to be able to operate without disconnecting from the network.	See appended table	P
	Unless otherwise required by the DSO, the micro-generating plant shall be capable of activating activepower frequency response at a programmable frequency threshold f_1 at least between and including 50.2 Hz and 52 Hz with a programmable droop in a range of at least 2 % – 12 %. The droop is relative to P_M , the actual AC output power at the instance when the frequency reaches the threshold f_1 . The resolution of the frequency measurement shall be +/- 10 mHz or less. After the programmable intentional delay, the active power frequency response shall be delivered with an accuracy of $\pm 10\%$ P_n and with a settling time less than 2 s.	The default Threshold f_1 setting to 50.2Hz with programmable droop 5%	P
	The generator shall be capable of activating active power frequency response as fast as technically feasible with an initial delay that shall be as short as possible with a maximum of 2 s. If the initial delay is below 2 s an intentional delay shall be programmable to adjust the total response time to a value between the initial response time and 2 s.	Intentional delay is setting to 0s	P
	After activation, the frequency droop function shall use the actual frequency at any time.		P
	If the initial delay is greater than 2 s it shall be reasonably justified by the manufacturer to the DSO.		N/A
	The settings for the threshold frequency f_1 , the droop and the intentional delay are provided by the DSO and shall be field adjustable. If no settings are provided, the default settings in Table 3 shall be applied.	It can be field adjustable accessed by communication port RS 485	P
	For field adjustable settings means shall be provided to protect the settings from unpermitted interference (e.g. password or seal) if required by the DSO.	By password	P
	When applying active power response to over-frequency, the frequency threshold f_1 should be set to a value from 50.2 Hz up to 50.5 Hz.	Setting of 50.2Hz	P
	It shall be taken into account that, in case of islanding, a power reduction would correct any excess of generation leading to a generation-consumption balance. In these circumstances, an islanding situation with stable frequency would take place, in which the correct behaviour of any LoM detection based on frequency as those mentioned in 4.6.2 (Table 4) might be hindered.		P

EN50438			
Cl.	Requirement - Test	Result	Verdict
	Generators for which it is technically not feasible to reduce power over the full droop range in the required time shall activate active power frequency response as above in the fast controllable range of output power. Once the limit of fast controllable frequency response is reached, this power level is maintained constant. The unit has to shut off at a random frequency between the frequency threshold f_1 and f_{max} ; with f_{max} the disconnection limit for over-frequency as provided by the DSO. If no setting is provided, the default setting for f_{max} is 51.5 Hz.	The default setting for f_{max} is 51.15Hz	P
	After European Network Codes will come into force, the decision about the ability should be according to the derogation process.		P
	The overall effect on transmission network level of multiple units with the random frequency disconnection function should emulate the droop curve given by Table 1 resp. the setting in Annex A.		P
	After a frequency excursion, once the frequency drops below the threshold frequency f_1 the microgenerating plant is allowed to rise the power above P_M . The active power generated by a generating plant shall not exceed the specified gradient expressed as a percentage of the active nominal power of the unit per minute. If no gradient is specified by the DSO, the default setting is 10 % P_n/min . Nonadjustable or partly adjustable generating plant that have been disconnected shall reconnect according to 4.7.2.	the default setting is 10 % P_n/min	P
4.3	Reactive power capability		P
4.3.1	Inverter based micro-generator		P
	The micro-generator shall be capable to operate, under normal stationary operating conditions in the voltage tolerance band according to 4.2.2, with the following reactive power exchange (see Figure 3):		P
	<ul style="list-style-type: none"> following a characteristic curve provided by the DSO (see 4.4) within the active factors $\cos \varphi = 0.90_{under-excited}$ to $0.90_{over-excited}$ when the active power output of the micro-generator is more than or equal to 20 % of its nominal active power; 		P
	<ul style="list-style-type: none"> not exchanging more reactive power than 10 % of the micro-generator's nominal active power when the active power output is less than 20 % of its nominal active power. 		P
4.3.2	Directly coupled micro-generator with no inverter		N/A

EN50438			
Cl.	Requirement - Test	Result	Verdict
	The power factor of the micro-generator at normal steady-state operating conditions across the statutory tolerance band of nominal voltage shall be above 0.95. provided the output active power of the micro-generator is above 20 % the nominal output power of the unit. Below 20 % nominal output power the micro-generator shall not exchange more reactive power than 10 % of its nominal active output power.		N/A
4.4	Reactive power control modes	See appended table	P
4.4.1	General		P
	Only when a reactive power exchange capability following a characteristic curve is required (see 4.3). the requirements of 4.4.3 shall apply.		P
	The control shall be delivered at the terminals of the micro-generator. The micro-generator shall be capable of operating in the following control modes within the limits stated in 4.3:		P
	Q (U)		P
	Cos φ fix		P
	Cos φ (P)		P
	The configuration of the control modes shall be field adjustable. The activation and deactivation of the control modes shall be field adjustable.		P
	For field adjustable configurations and activation/deactivation of the control mode. means shall be provided to protect the settings from unpermitted interference (e.g. password or seal) if required by the DSO.		P
	The accuracy for controlled reactive power shall be below ± 2 % of nominal power of the microgenerator. The accuracy is always stated in reactive power. even if the used control mode is referring to the active factor.		P
	The type of contribution to voltage control by reactive power shall be specified by the DSO. If no characteristic curve is specified by the DSO. the micro-generator shall operate with an active factor = 1.		P
4.4.2	Fix control mode cos φ		P
	The fix control mode controls the active factor cos φ of the micro-generator's output according to a setpoint set in the control of the micro-generator.		P
4.4.3	Voltage related control mode Q(U)		P
	The voltage related control mode Q(U) controls the reactive power output as a function of the voltage.		P

EN50438			
Cl.	Requirement - Test	Result	Verdict
	For evaluating the voltage one of the following methods shall be used:		P
	<ul style="list-style-type: none"> the positive sequence of the symmetrical components; 		N/A
	<ul style="list-style-type: none"> the average voltage of a three phase system; 		P
	<ul style="list-style-type: none"> phase independently the voltage of every phase to determine the reactive power for every phase. 		N/A
	A characteristic curve according to Figure 4 shall be configurable.		P
	Additional to the characteristic the dynamic response of the control should be configurable. The dynamics of the control should correspond with a first order filter having a time constant that is configurable in the range of 3 s to 60 s. The time to reach 95 % of a new set point due to a change in voltage will be 3 times the time constant.		P
4.4.4	Power related control mode Cos φ (P)		P
	The power related control mode Cos φ (P) controls the active factor Cos φ of the micro-generator's output as a function of its active power output.		P
	A characteristic according to Figure 4 has to be configurable.		P
	New set values due to a change of the active power output have to be adjusted within a settling time of 10 s. The rate of change of reactive power should be in the same time range as and synchronized with the rate of change of active power.		P
4.5	Voltage control by active power		P
	In order to avoid disconnection due to the over-voltage protection the micro-generating plant is allowed to reduce active power output as a function of this rising voltage. If this function is activated. the micro-generating plant may reduce active power according to a logic chosen by the manufacturer. Nevertheless. this logic shall not result in steps of output power.		P
4.6	Interface protection	Integral to the micro-generator	P
4.6.1	General		P
4.6.1.1	Introduction		P

EN50438			
Cl.	Requirement - Test	Result	Verdict
	The purpose of the interface protection is to ensure that the connection of a micro-generator will not impair the integrity or degrade the safety of the distribution network. The interface protection shall be insensitive to voltage and frequency variations in the distribution network within the voltage and frequency settings.		P
	The interface protection, monitoring and control functions may be incorporated into the microgenerator control system, or may be fitted as discrete separate mounted devices.		P
	The interface protection settings shall be field adjustable.	Accessed by communication ports	P
	For field adjustable settings means shall be provided to protect the settings from unpermitted interference (e.g. password or seal) if required by the DSO.	By password	P
	The protection functions have to evaluate at least all phases where micro-generators, covered by this protection system, are connected to.		P
	In case of three phase generating units/plants and when the protection system is implemented as an external protection system in a three phase supply system, all phase to phase or all phase to neutral voltages have to be evaluated.		P
	The frequency has to be evaluated on at least one of the supply voltages.		P
	If multiple signals (e.g. three phase to phase voltages) are to be evaluated by one protection function, this function has to evaluate all of the signals separately. The output of each evaluation has to be OR connected, so that if one signal passes the threshold of a function, the function has to trip the protection in the specified time.		P
	The minimum required accuracy is:		P
	<ul style="list-style-type: none"> • for frequency measurement ± 0.05 Hz; 		P
	<ul style="list-style-type: none"> • for voltage measurement ± 1 % of U_n. 		P
	The measurement point can be inside the micro-generator or anywhere between the micro-generator terminals and up to the point of connection.		P
	If the interface protection system is external to the generating unit, it should measure as close as possible to the point of connection. The voltage rise between the point of connection and the measurement input of the interface protection system should be kept as small as possible to avoid nuisance tripping of the overvoltage protection.	Internal of inverter	N/A

EN50438			
Cl.	Requirement - Test	Result	Verdict
	In order to avoid continuous starting and disengaging operations of the interface protection relay, the disengaging value of frequency and voltage functions shall be above 2 % deviating from the operate value.		N/A
4.6.1.2	Response to protection operation		P
	The micro-generator shall disconnect from the network in response to an interface protection operation.		P
4.6.1.3	Place of the interface protection		P
	The interface protection can either be incorporated within the micro-generator or implemented by separate devices. In either case, the interface protection shall meet the relevant requirements of IEC 60255-127 and the manufacturer of the micro-generator shall declare that the combined devices fulfil these requirements.	incorporated within the micro-generator	P
4.6.1.4	Changing settings of the interface protection		P
	The interface protection settings may only be altered from the settings chosen at the time of commissioning or during later reconfiguration, with the written agreement of the DSO and then only in accordance with the manufacturer instructions. It shall not be permissible for the user to alter the interface protection settings.		P
4.6.1.5	Combined protection device for multiple generators		N/A
	It is allowed to use a protection system that provides interface protection for two or more microgenerators up to and including 16 A per phase in aggregate. However, the possibility to use Inform and Fit then depends on the conditions of the type of conformity assessment of the protection system.		N/A
	If two or more micro-generators, each with their own interface device, are placed in parallel, the proper combined working of the protection devices shall be ensured.		N/A
	In the case of adding a generator to the combined protection device, the DSO shall be consulted.		N/A
4.6.2	Interface protection settings		P
	The interface protection settings are provided by the DSO. If no settings are provided, the default settings in Table 4 should be applied.	Table 4 applied	P
4.6.3	Requirements regarding single fault tolerance of interface protection system		P

EN50438			
Cl.	Requirement - Test	Result	Verdict
	The interface protection system consisting of the interface protection relay and the interface switch shall meet the requirements of single fault tolerance.	Single fault condition have been considered	P
	A single fault shall not lead to a loss of the safety functions. Faults of common cause shall be taken into account if the probability for the occurrence of such a fault is significant. Whenever reasonably practical, the individual fault shall be displayed and lead to the disconnection of the power generation unit or system.		P
	Series-connected switches shall each have independently a breaking capacity corresponding to the rated current of the micro-generator and corresponding to the short circuit contribution of the microgenerator.		P
	The short-time withstand current of the switching devices shall be coordinated with maximum short circuit power at the connection point.		P
	At least one of the switches shall be a switch-disconnector suitable for over-voltage category 2. For single-phase micro-generators, the switch shall have one contact of this over-voltage category each for both the neutral conductor and the line conductor. For poly-phase supply systems, it is required to have one contact of this over-voltage category each for all active conductors. The second switch may be formed by electronic switching components of an inverter bridge or another circuit provided that the electronic switching components can be switched off by control signals and that it is ensured that a failure is detected and leads to prevention of the operation at the latest at the next reconnection.		P
	For PV-inverters without simple separation between the network and the PV generator (e.g. PV Inverter without transformer) both switches mentioned in the paragraph above shall be switch disconnectors with the requirements described therein, although one switching device is permitted to be located between PV generator and PV inverter.		P
4.7	Connection and starting to generate electrical power		P
4.7.1	General		P

EN50438			
Cl.	Requirement - Test	Result	Verdict
	Connection and starting to generate electrical power is only allowed after voltage and frequency is within the allowed voltage range and the allowed frequency range for at least the specified observation time. It shall be impossible to overrule these conditions. The setting of the conditions depends on whether the connection is due to a normal operational start-up or an automatic reconnection after tripping of the interface protection.		P
	The frequency range, the voltage range, the observation time and the power gradient shall be field adjustable.		P
	For field adjustable settings, means shall be provided to protect the settings from unpermitted interference (e.g. password or seal) if required by the DSO.		P
4.7.2	Automatic reconnection after tripping		P
	If no settings are specified by the DSO, the default settings for the reconnection after tripping of the interface protection are:		P
	• Frequency range: $47.5 \text{ Hz} \leq f \leq 50.05 \text{ Hz}$	See appended table	P
	• Voltage range: $0.85U_n \leq U \leq 1.10U_n$	See appended table	P
	• Minimum observation time: 60 s	60 s	P
	After reconnection the active power generated by the generating plant shall not exceed a specified gradient expressed as a percentage of the active nominal power of the unit per minute. If no gradient is specified by the DSO, the default setting is 10 % P_n/min . Non-adjustable or partly adjustable generating units may connect after 1 min to 10 min (randomised value) or later.	The default setting is 10 % P_n/min	P
4.7.3	Starting to generate electrical power		P
	If no settings are specified by the DSO the default settings for connection or starting to generate electrical power due to normal operational start-up or activity are:		P
	• Frequency range: $47.5 \text{ Hz} \leq f \leq 50.1 \text{ Hz}$	See appended table	P
	• Voltage range: $0.85U_n \leq U \leq 1.10U_n$	See appended table	P
	• Minimum observation time: 60 s	60 s	P
	If applicable, the power gradient shall not exceed the maximum gradient specified by the DSO in the connection agreement. Heat driven CHP micro-generators do not need to keep a maximum gradient, since the start up is randomised by the nature of the heat demand.	The default setting is 10 % P_n/min	P

EN50438			
Cl.	Requirement - Test	Result	Verdict
	For manual operations performed on site (e.g. for the purpose of initial start-up or maintenance) it is permitted to deviate from the observation time and ramp rate.		N/A
4.7.4	Synchronisation		P
	Synchronising a micro-generator with the distribution network shall be fully automatic i.e. it shall not be possible to manually close the switch between the two systems to carry out synchronisation.		P
4.8	Power quality		P
4.8.1	General		P
	As any other apparatus or fixed installation. micro-generators have to comply with the requirements on electromagnetic compatibility established in Directive 2004/108/EC.		P
	They are also expected to be compatible with voltage characteristics at the point of connection to the public network. as described in 4.2.		P
	As long as specific tests for generators are not available. generic EMC standards. regarding immunity as well as emission. should be applied. The applicable standards. which in turn describe the test in accordance with basic standards (EN 61000-3. all parts. and EN 61000-4. all parts). are:		P
	<ul style="list-style-type: none"> Immunity: EN 61000-6-1 (residential. commercial and light-industrial environments); 		P
	<ul style="list-style-type: none"> Emission: EN 61000-6-3 (residential. commercial and light-industrial environments): in this generic emission standard reference is made to e.g. the harmonics and voltage variation basic standards listed in Table 5. 		P
	In addition. the application of the requirements and tests described in IEC/TR 61000-3-15 is recommended. with the exception of those aspects already regulated by specific national rules.		P
	Generating plants can also disturb mains signaling (ripple control or power line carrier systems). EMC requirements on inter-harmonics and on conducted disturbances in frequency range between 2 kHz and 150 kHz are under development. In countries where such communication systems are used. national requirement may apply.		P
4.8.2	DC injection		P
4.8.2	The generating unit shall not inject a direct current.	See appended table	P

EN50438			
Cl.	Requirement - Test	Result	Verdict
5	Operation and safety of the micro-generator		P
5.1	General		P
	The micro-generator shall operate safely over the entire designed and declared operating range.		P
	The settings of (country-specific) field adjustable set-points shall be readable from the microgenerator. for example on a display panel. user interface. or via a communication port.	Via a communication port	P
5.2	Safety		P
	This European Standard does not cover the safety of DSO personnel or their contracted parties. as their safety is a combination of electrical conditions and working instructions.		P
	General requirements for safety of persons at work in or near and operation of electrical installations are given in EN 50110 (all parts). also national regulations can be applicable.		P
5.3	Information plate		P
	In absence of product specific standards (e.g. EN 50524) the following information shall appear on the micro-generator nameplate:		P
	<ul style="list-style-type: none"> • manufacturer's name or trade mark; 		P
	<ul style="list-style-type: none"> • type designation or identification number. or any other means of identification making it possible to obtain relevant information from the manufacturer; 		P
	<ul style="list-style-type: none"> • nominal power; 		P
	<ul style="list-style-type: none"> • nominal voltage; 		P
	<ul style="list-style-type: none"> • nominal frequency; 		P
	<ul style="list-style-type: none"> • phases; 		P
	<ul style="list-style-type: none"> • active factor range or. if no active factor is adjustable. the minimal power factor. 		P
	This information shall be provided on a plate on or in the micro-generator and shall be copied in the user manual as well as other related documentation. In addition. a serial number may be added to the plate only.		P
	This information could be part of the information plate of the entire micro-generator system.		P
	All the information shall be given in the language and in accordance with the practice of the country in which the micro-generator is intended to be installed or alternatively in English language.	English language	P

EN50438			
Cl.	Requirement - Test	Result	Verdict
5.4	Labelling		P
	A warning notice shall be placed in such a position that any person gaining access to live parts will be warned in advance of the need to isolate those live parts from all points of supply.		P
	Special attention should be paid that the power supply, measuring circuits (sense lines) and other parts may not be isolated from the network when the switch of the interface protection is open.		P
	As a minimum, warning labels shall be placed:		P
	<ul style="list-style-type: none"> on the switchboard (DSO panel and consumer unit) that has the micro-generator connected to it; 		N/A
	<ul style="list-style-type: none"> on all switchboards in between the consumer unit and the micro-generator itself; 		N/A
	<ul style="list-style-type: none"> on, or in the micro-generator itself; 		P
	<ul style="list-style-type: none"> at all points of isolation for the micro-generator. 		N/A
	All the information shall be given in the language and in accordance with the practice of the country in which the micro-generator is intended to be installed.		P
5.5	Maintenance and routine testing		P
	The manufacturer shall provide a time frame for maintenance and routine testing.		P
	The user is responsible for the proper maintenance and routine testing.		P
	Maintenance and routine testing shall be carried out by qualified service technicians.		P
	With respect to service technicians, additional national requirements shall be taken into account.		P
6	Commissioning		P
	This European Standard applies to type-tested micro-generators.		P
	The following conditions shall be met for the installation:		P
	the micro-generator (including the interface protection) shall fulfil the requirements of this standard and the other applicable standards;		P
	the manufacturer shall provide an installation instruction in accordance with this standard and national or regional requirements;		P
	access to the interface protection settings shall be tamper-proof;		P

EN50438			
Cl.	Requirement - Test	Result	Verdict
	in the absence of product standards the micro-generator shall be type tested against the interface requirements of this standard;		P
	the installation shall be carried out by installers with recognised and approved qualification related to the fuels used. general electrical installations and a particular qualification relating to installation of micro-generators;		P
	the installer shall provide a single line diagram of the electricity generating facility. The single line diagram shall show the circuit breaker. the protections. the inverter. etc.		P
	The user respective the installer should be aware that in addition to the DSO the energy supplier and/or the metering authority will need to be informed for contractual reasons.		P
	Unless otherwise stated by national legislation or regulation. prior consent of the DSO is necessary.		P
Annex A	National settings and requirements		P
A.1	General		P
A.2	AT – Austria		N/A
A.3	BE – Belgium		N/A
A.4	CY – Cyprus		N/A
A.5	CZ – Czech Republic		N/A
A.6	DE – Germany		N/A
A.7	DK – Denmark		N/A
A.8	EE – Estonia		N/A
A.9	ES – Spain		N/A
A.10	FI – Finland		N/A
A.11	FR – France		N/A
A.12	GB – United Kingdom		N/A
A.13	IE – Ireland		P
A.14	IT – Italy		N/A
A.15	LV – Latvia		N/A
A.16	NL – The Netherlands		N/A
A.17	NO – Norway		N/A
A.18	PL – Poland		N/A
A.19	SI – Slovenia		N/A

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Cl.	Requirement - Test	Result	Verdict
A.20	SE – Sweden		N/A
Annex B	Loss of Mains and overall system security		P
Annex C	Example notification sheets		--
Annex D	Compliance type testing		P
D.1	General		P
D.2	Type testing of the interface protection		P
D.2.1	Introduction		P
D.2.2	General		P
D.2.3	Over-/under-voltage		P
D.2.4	Over- /under-frequency		P
D.2.5	Loss of Mains (LoM) detection		P
D.3	Type testing of a micro-generator		P
D.3.1	Operating range		P
D.3.2	Active power feed-in at under-frequency		P
D.3.3	Power response to over-frequency		P
D.3.4	Reactive power capability		P
D.3.5	Voltage control by active power		N/A
D.3.6	Connection and starting to generate electrical power		P
D.3.7	Short-circuit current contribution		N/A
D.3.8	Harmonic current emission		P
D.3.9	Voltage fluctuations and flicker		P
D.3.10	DC injection		P
Annex E	Example test results sheet		--
Annex F	Commissioning		P
Annex G	Countries allowing extension of the scope > 16 A		N/A
G.1	General		N/A
G.2	CY – Cyprus		N/A
G.3	FI – Finland		N/A
G.4	IE – Ireland		N/A

Appendix A: Tables

4.6.3 Single fault tolerance of the interface protection system			P
	Ambient temperature [°C] :	23.8	--
	Model/type of power supply :	DC : 62150H-1000S AC : 61512	--
	Manufacturer of power supply :	Chroma	--
	Rated markings of power supply :	DC: 0-1000V. 15kW AC: 0-300V. 18kW	--

component No.	fault	test condition		test time	fuse No.	fault condition		result
		AC	DC			AC	DC	
PV voltage detect UC1C Pin 9	Open	230V 12.63 A	450V 6.62A	2 Min.	--	230V 0.17A	450V 0.02A	PV inverter disconnected from grid immediately. error message: ID09. (PV voltage over range)
PV current detect UC1B Pin 5	Open	230V 12.63 A	450V 6.6A	2 Min.	--	230V 0.16A	450V 0.02A	PV inverter disconnected from grid immediately. error message: ID14. (PV current over range)
GFCI detect UC2D Pin 12-13	Short	230V 12.63 A	450V 6.62A	2 Min.	--	230V 0.16A	450V 0.02A	PV inverter disconnected from grid immediately. error message: ID12. (GFCI fault)
GFCI detect UC2C Pin 10	Short	230V 12.63 A	450V 6.62A	2 Min.	--	230V 0.16A	450V 0.02A	PV inverter disconnected from grid immediately. error message: ID52. (GFCI fault)
Grid voltage detect UC2A Pin 3	Open	230V 12.64 A	450V 6.67A	2 Min.	--	230V 0.17A	450V 0.02A	PV inverter disconnected from grid immediately. error message: ID15. (Grid current or voltage over range)
Grid voltage detect RC17	Open	230V 12.63 A	450V 6.62A	2 Min.	--	230V 0.17A	450V 0.01A	PV inverter disconnected from grid immediately. error message: ID02. ID49. ID70. (Grid current or voltage under range)
Grid voltage detect RC25	Open	230V 12.64 A	450V 6.62A	2 Min.	--	230V 0.18A	450V 0.01A	PV inverter disconnected from grid immediately. error message: ID55. (Relay fault)
Bus voltage detect RP3	Open	230V 12.61 A	450V 6.63A	2 Min.	--	230V 0.6A	450V 0.02A	PV inverter disconnected from grid immediately. error message: ID23. (Bus voltage zero fault)
Bus voltage detect UC1A Pin2-3	Short	230V 12.56 A	450V 6.65A	2 Min.	--	230V 0.17A	450V 0.02A	PV inverter disconnected from grid immediately. error message: ID66. (Bus voltage over range)

Appendix A: Tables

component No.	fault	test condition		test time	fuse No.	fault condition		result
		AC	DC			AC	DC	
Bus voltage detect RC82	Short	230V 12.56 A	450V 6.69A	2 Min.	--	230V 0.16A	450V 0.02A	PV inverter disconnected from grid immediately. error message: ID25. (Bus voltage under range)
ISO detect RC105	Open before start	230V 0.17A	450V 0.18A	2 Min.	--	230V 0.17A	450V 0.02A	PV inverter can not start up. error message: ID56. (ISO fault)
AC current detect RC22	Open	230V 12.56	450V 6.68	2 Min.	--	230V 0.17A	450V 0.02A	PV inverter disconnected from grid immediately. error message: ID15. (AC current over range) QP2 , QP6 , QP9 , RP26 , RP28 , RP11 damaged.
AC current detect RC21	Open	230V 12.62 A	450V 6.63A	2 Min.	--	230V 0.16A	450V 0.02A	PV inverter disconnected from grid immediately. error message: ID15. (AC current over range).
DC current detect RC33	Open	230V 12.67 A	450V 6.69A	2 Min.	--	230V 0.17A	450V 0.02A	PV inverter disconnected from grid immediately. error message: ID28. (DC current over range).
DC current detect RC37	Open	230V 12.54 A	450V 6.67A	2 Min.	--	230V 0.17A	450V 0.02A	PV inverter disconnected from grid immediately. error message: ID28. (DC current over range).
DC current detect RC42	Open	230V 12.62 A	450V 6.66A	2 Min.	--	230V 0.16A	450V 0.02A	PV inverter disconnected from grid immediately. error message: ID51. (DC current fault).
AC current detect RC61	Open	230V 12.66 A	450V 6.7A	2 Min.	--	230V 0.16A	450V 0.02A	PV inverter disconnected from grid immediately. error message: ID15. ID65. (AC voltage or current over range).
AC current detect RC80	Open	230V 12.67 A	450V 6.8A	2 Min.	--	230V 0.16A	450V 0.02A	PV inverter disconnected from grid immediately. error message: ID15. ID65. (AC voltage or current over range).
GFCI detect RP70	Open	230V 12.63 A	450V 6.66A	2 Min.	--	230V 0.16A	450V 0.02A	PV inverter disconnected from grid immediately. error message: ID12. (GFCI fault).
GFCI detect RP80	Open	230V 12.63 A	450V 6.66	2 Min.	--	230V 0.16A	450V 0.02A	PV inverter disconnected from grid immediately. error message: ID12. (GFCI fault).

Appendix A: Tables

component No.	fault	test condition		test time	fuse No.	fault condition		result
		AC	DC			AC	DC	
PV voltage detect RP115	Open	230V 12.62 A	450V 6.67A	2 Min.	--	230V 0.16A	450V 0.02A	PV inverter disconnected from grid immediately. no display. and reconnect to grid. error message: ID56. (ISO fault).
ISO detect RP99	Open before start	230V 0.16A	450V 0.02A	2 Min.	--	230V 0.16A	450V 0.02A	PV inverter can not start up. error message: ID56. (ISO fault).
Relay detect RYP2 Pin3-4	Short before start	230V 0.16A	450V 0.02A	2 Min.	--	230V 0.16A	450V 0.02A	PV inverter can not start up. error message: ID55. ID77. (Relay fault).
Relay detect RYP3 Pin3-4	Short before start	230V 0.16A	450V 0.02A	2 Min.	--	230V 0.16A	450V 0.02A	PV inverter can not start up. error message: ID55. ID77. (Relay fault).
Relay detect RYP4 Pin3-4	Short before start	230V 0.16A	450V 0.02A	2 Min.	--	230V 0.16A	450V 0.02A	PV inverter can not start up. error message: ID55. ID77. (Relay fault).
Relay detect RYP5 Pin3-4	Short before start	230V 0.16A	450V 0.02A	2 Min.	--	230V 0.16A	450V 0.02A	PV inverter can not start up. error message: ID55. ID77. (Relay fault).
Grid voltage detect RP150	Open	230V 0.62A	450V 6.67A	2 Min.	--	230V 0.16A	450V 0.02A	PV inverter disconnected from grid immediately. error message: ID02. (Grid voltage under range)
Grid voltage detect RP150	Short	230V 12.64 A	450V 6.66A	2 Min.	--	230V 0.16A	450V 0.02A	PV inverter disconnected from grid immediately. error message: ID01. (Grid voltage over range)
Grid voltage detect RP135	Short	230V 12.64 A	450V 6.67A	2 Min.	--	230V 0.16A	450V 0.02A	PV inverter disconnected from grid immediately. error message: ID01. (Grid voltage over range)
Grid voltage detect RP135	Open	230V 12.61 A	450V 6.66A	2 Min.	--	230V 0.16A	450V 0.02A	PV inverter disconnected from grid immediately. error message: ID02. (Grid voltage under range)
Loss of control CC100	Short	230V 12.61 A	450V 6.67A	2 Min.	--	230V 0.16A	450V 0.02A	PV inverter disconnected from grid immediately. error message: DSP communicate fail
Loss of control XLC	Short	230V 12.63 A	450V 6.65A	2 Min.	--	230V 0.16A	450V 0.02A	PV inverter disconnected from grid immediately. error message: DSP communicate fail

Appendix A: Tables

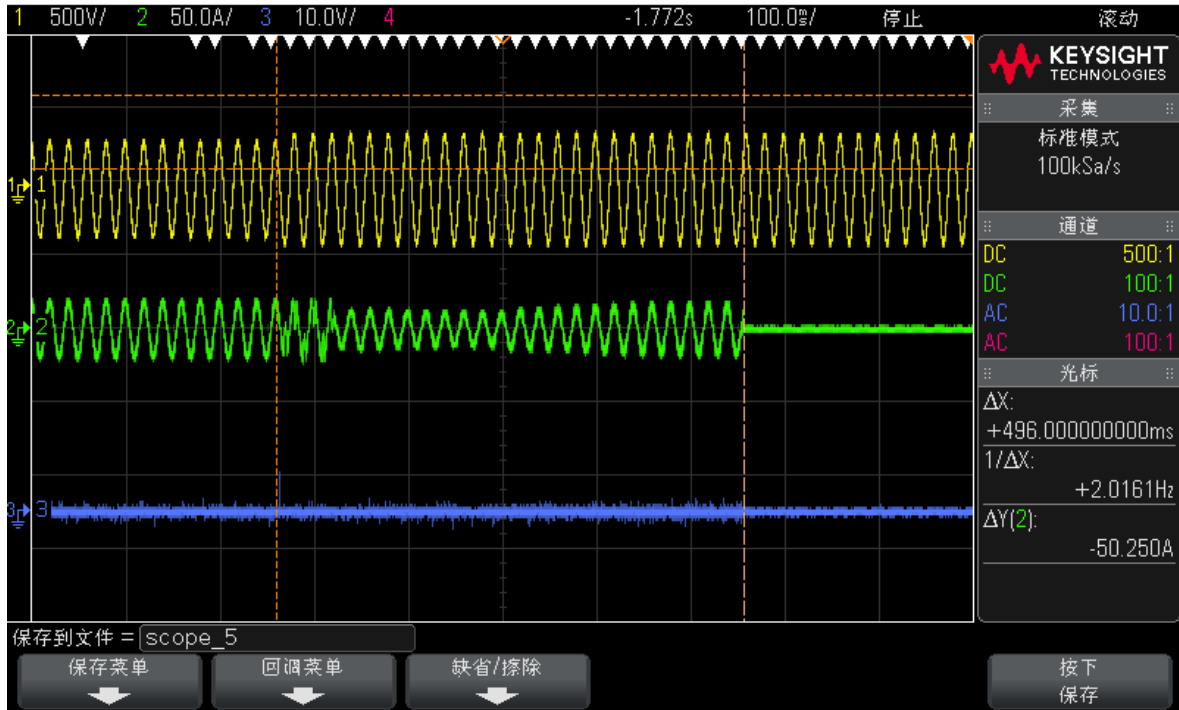
component No.	fault	test condition		test time	fuse No.	fault condition		result
		AC	DC			AC	DC	
Communication microcontroller defect UC34 Pin 31	Open	230V 12.64 A	450V 6.66A	2 Min.	--	230V 0.16A	450V 0.02A	PV inverter disconnected from grid immediately. error message: ID 53 (SPI Communication fault)
Communication microcontroller defect UC34 Pin 37	Open	230V 12.64 A	450V 6.66A	2 Min.	--	230V 0.17A	450V 0.02A	PV inverter disconnected from grid immediately. error message: ID 53 (SPI Communication fault)
Communication microcontroller defect UC34 Pin 44	Open	230V 12.63 A	450V 6.66A	2 Min.	--	230V 0.17A	450V 0.02A	PV inverter disconnected from grid immediately. error message: ID 53 (SPI Communication fault)
Communication microcontroller defect UC34 Pin 47	Open	230V 12.64 A	450V 6.67A	2 Min.	--	230V 0.17A	450V 0.02A	PV inverter disconnected from grid immediately. error message: ID 53 (SPI Communication fault)
<p>The errors in the control circuit simulate that the safety is even under one error ensured.</p> <p>The tests had been performed on the SOFAR 3000TL is valid for the SOFAR 1100TL. SOFAR 1600TL. SOFAR 2200TL and SOFAR 2700TL. since it is same as in hardware and just power derated by software.</p>								
Addendum – Shutdown device								
Each active phase can be switched. (L and N)								P
If no galvanic separation between AC and DC (PV): Two relays in series on each active phase are necessary to fulfil the basic insulation or simple separation based on the PV working voltage.								P

Appendix A: Tables

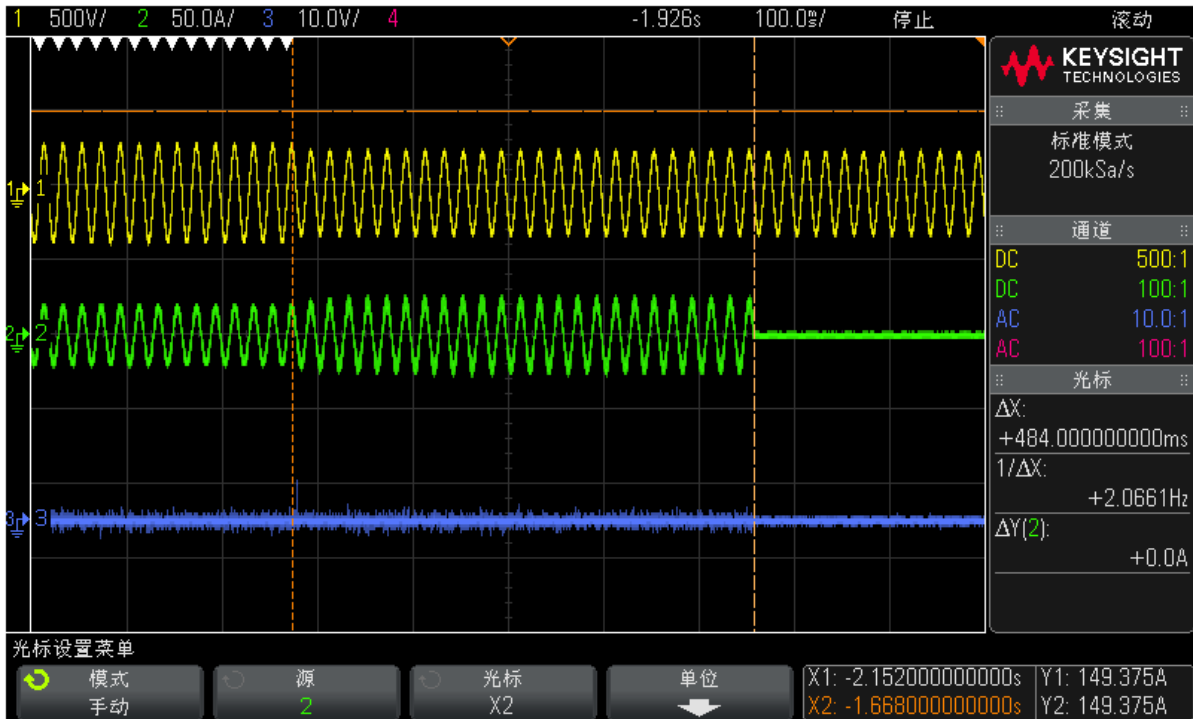
D.2.3 Over-/under-voltage				P
Parameter	Voltage	Disconnection Time	Voltage	Disconnection Time
Protection limit	253V	0.5s	207V	0.5s
Actual setting (as applied to interface protection)	253V	0.50s	207V	0.50s
Trip value (test result)-1	252.46V	0.496s	205.90V	0.478s
Trip value (test result)-2	252.43V	0.476s	205.54V	0.478s
Trip value (test result)-3	253.50V	0.474s	205.57V	0.484s
Trip value (test result)-4	253.48V	0.466s	205.91V	0.482s
Trip value (test result)-5	253.44V	0.482s	205.60V	0.472s

The operate values are within $\pm 1\%$ Un
The measured trip time was captured by oscilloscope. which channel CH1 represents output voltage of EUT. and CH2 represents output current of EUT; CH3 represents trip signal.

Appendix A: Tables



Over voltage



Under Voltage

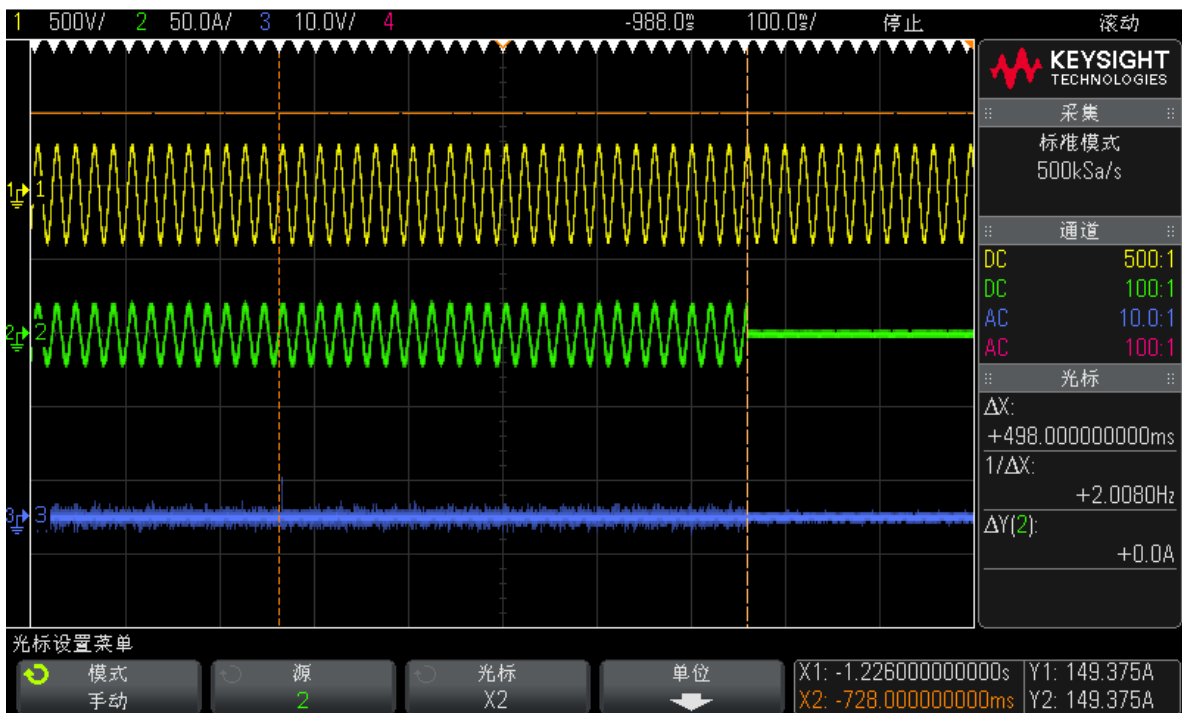
Appendix A: Tables

D.2.4 Over- /under-frequency				P
Parameter	Over Frequency		Under Frequency	
	Frequency	Time	Frequency	Time
Protection limit	50.5Hz	0.5s	48Hz	0.5s
Actual setting (as applied to interface protection)	50.5Hz	0.50s	48Hz	0.50s
Trip value (test result)-1	50.51Hz	0.480s	47.99Hz	0.468s
Trip value (test result)-2	50.51Hz	0.478s	47.99Hz	0.456s
Trip value (test result)-3	50.51Hz	0.498s	47.99Hz	0.458s
Trip value (test result)-4	50.51Hz	0.490s	47.99Hz	0.460s
Trip value (test result)-5	50.51Hz	0.498s	47.99Hz	0.468s

Remark:

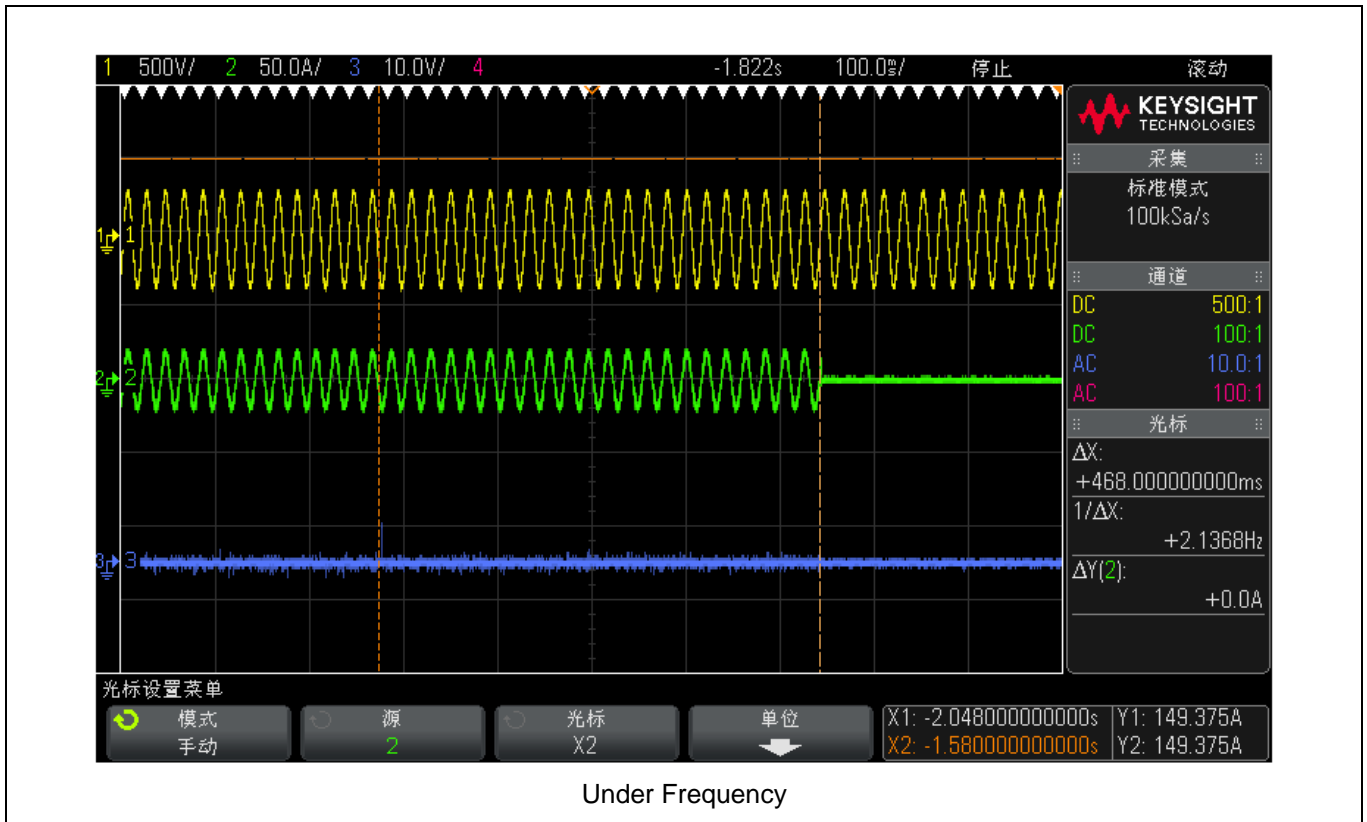
the operate values are within ± 0.05 Hz.

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



Over Frequency

Appendix A: Tables



Appendix A: Tables

D.2.5 Loss of Mains (LoM) detection									P
No.	PEUT ¹⁾ (% of EUT rating)	Reactive load (% of QL in 6.1.d)1)	PAC ²⁾ (% of nominal)	QAC ³⁾ (% of nominal)	Run on time (ms)	PEUT (W)	Actual Qf	VDC	Remarks ⁴⁾
1	100	100	0	0	256	2800	1.073	383	Test A at BL
2	66	66	0	0	251	1820	1.096	315	Test B at BL
3	33	33	0	0	357	940	1.048	247	Test C at BL
4	100	100	-5	-5	178	2800	1.101	383	Test A at IB
5	100	100	-5	0	226	2800	1.129	383	Test A at IB
6	100	100	-5	5	241	2800	1.157	383	Test A at IB
7	100	100	0	-5	228	2800	1.046	383	Test A at IB
8	100	100	0	5	113	2800	1.099	383	Test A at IB
9	100	100	5	-5	236	2800	0.996	383	Test A at IB
10	100	100	5	0	181	2800	1.022	383	Test A at IB
11	100	100	5	5	105	2800	1.047	383	Test A at IB
12	66	66	0	-5	181	1820	1.068	315	Test B at IB
13	66	66	0	-4	245	1820	1.074	315	Test B at IB
14	66	66	0	-3	199	1820	1.079	315	Test B at IB
15	66	66	0	-2	447	1820	1.085	315	Test B at IB
16	66	66	0	-1	264	1820	1.090	315	Test B at IB
17	66	66	0	1	313	1820	1.101	315	Test B at IB
18	66	66	0	2	297	1820	1.107	315	Test B at IB
19	66	66	0	3	285	1820	1.112	315	Test B at IB
20	66	66	0	4	287	1820	1.118	315	Test B at IB
21	66	66	0	5	228	1820	1.123	315	Test B at IB
22	33	33	0	-5	166	940	1.021	247	Test C at IB
23	33	33	0	-4	184	940	1.026	247	Test C at IB
24	33	33	0	-3	288	940	1.032	247	Test C at IB
25	33	33	0	-2	235	940	1.037	247	Test C at IB
26	33	33	0	-1	234	940	1.042	247	Test C at IB
27	33	33	0	1	265	940	1.053	247	Test C at IB
28	33	33	0	2	258	940	1.058	247	Test C at IB
29	33	33	0	3	273	940	1.063	247	Test C at IB
30	33	33	0	4	161	940	1.068	247	Test C at IB
31	33	33	0	5	156	940	1.073	247	Test C at IB

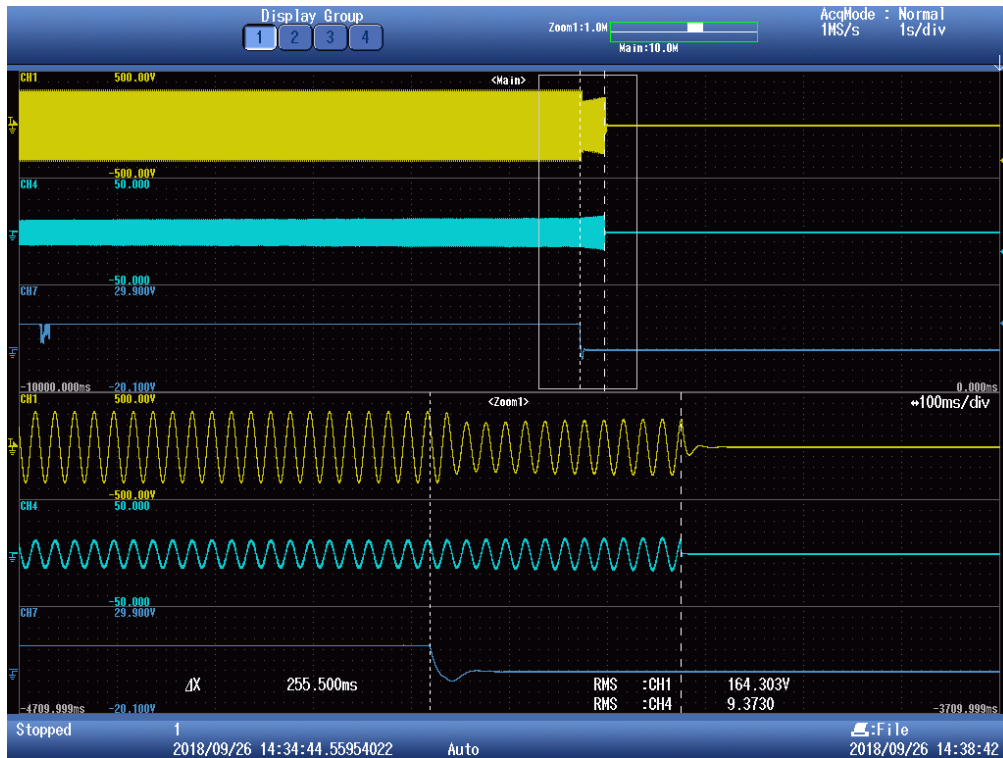
Remark:

- 1) PEUT: EUT output power
- 2) PAC: Real power flow at S1 in Figure 1. Positive means power from EUT to utility. Nominal is the 0% test condition value.
- 3) QAC: Reactive power flow at S1 in Figure 1. Positive means power from EUT to utility. Nominal is the 0%

Appendix A: Tables

test condition value.

- 4) BL: Balance condition. IB: Imbalance condition.
- 5) *Note: test condition A (100%): If any of the recorded run-on times are longer than the one recorded for the rated balance condition. i.e. test procedure 6.1 f). then the non-shaded parameter combinations (no.32~47) also require testing.



P_{EUT} 100%. P_{AC} 0%. Q_{AC} 0%. = 256ms

Appendix A: Tables



$P_{EUT} 66\%$. $P_{AC} 0\%$. $Q_{AC} -2\%$. = 447ms



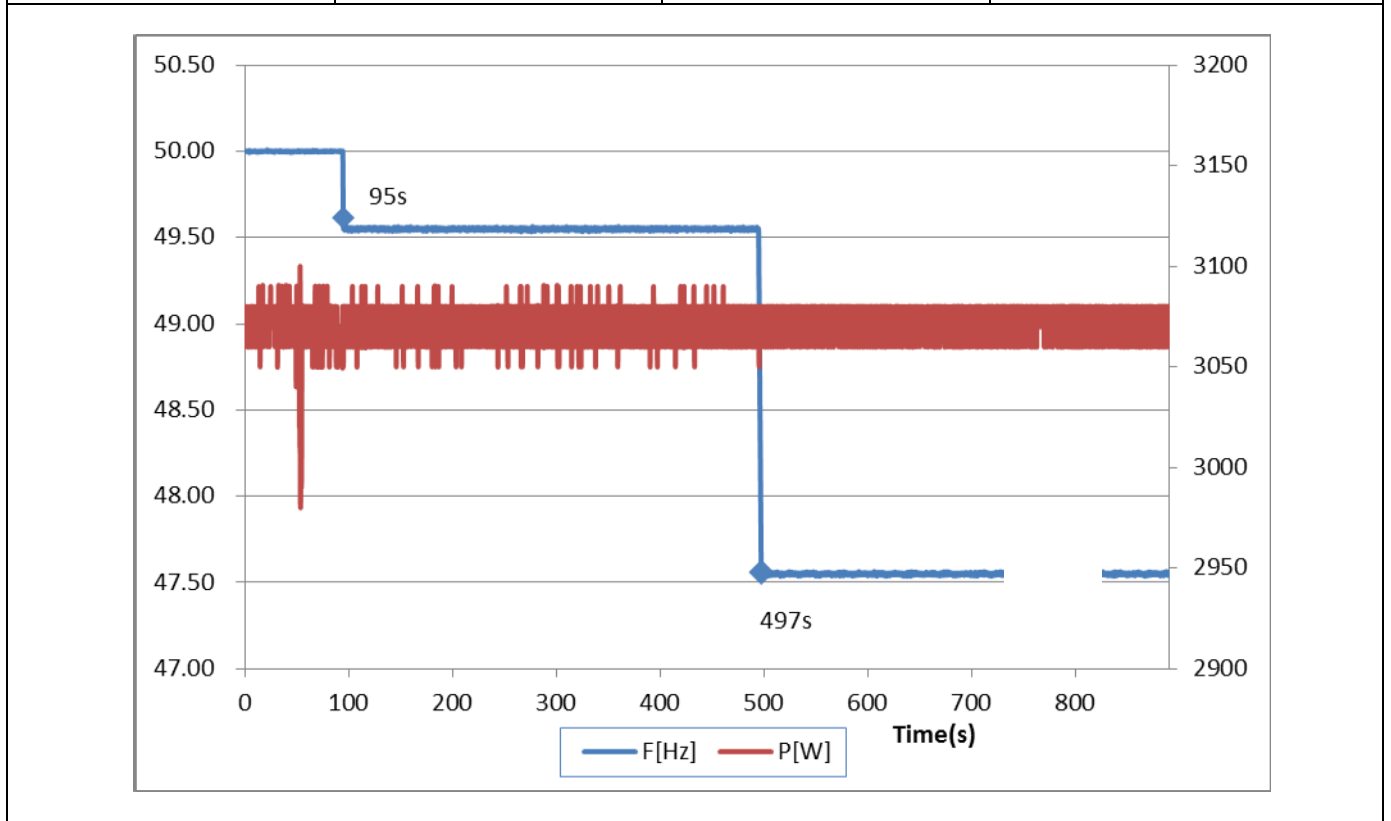
$P_{EUT} 33\%$. $P_{AC} 0\%$. $Q_{AC} 0\%$. = 357ms

Note: CH2 current of EUT; CH1 voltage of EUT; CH3: Trip signal

Appendix A: Tables

D.3.1 Operating range				P
Test sequence	Voltage(V)	Frequency(Hz)	Output power(W)	Primary power source(W)
Test 1	195.58	47.50	2902	3002
Test 2	253.65	51.50	3048	3116

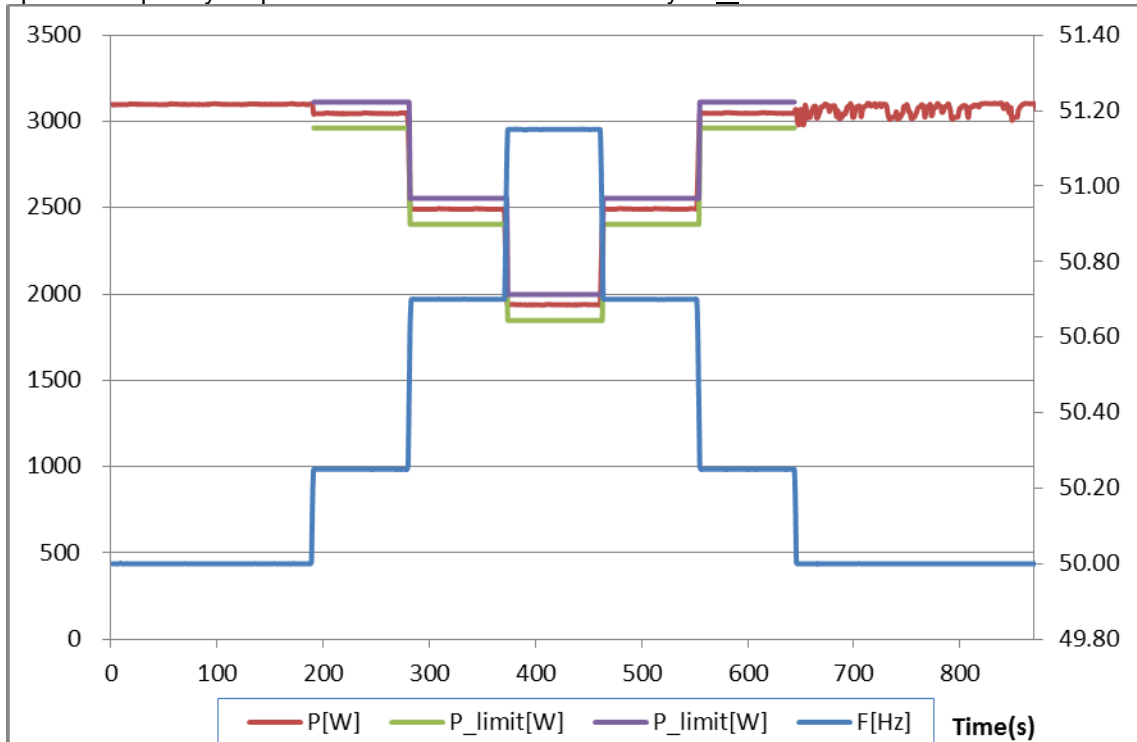
D.3.2 Active power feed-in at under-frequency			P
Test sequence	Frequency	Output power	Primary power source
Test a)	50.0Hz	3071.50W	3253.12W
Test b)	49.5Hz	3010.48W	3248.54W
Test c)	47.5Hz	2071.29W	3224.24W



Appendix A: Tables

D.3.3 Power response to over-frequency				P
Test sequence at power level >80%	Output Power	Frequency	Primary Power source	Power gradient
Step a)	3037.0W	50Hz	3224.53W	--
Step b)	2937.0W	50.25Hz	3124.73W	--
Step c)	2479.0W	50.70Hz	2621.30W	--
Step d)	1922.0W	51.15Hz	2044.18W	--
Step e)	2470.0.W	50.70Hz	2622.66W	--
Step f)	2937.0W	50.25Hz	3186.40W	--
Step g)	3027.0W	50Hz	3217.34W	--

Remark:
Test for frequency threshold 50.2Hz with droop 5%. intentional delay is setting to 0s
the active power frequency response is delivered with an accuracy of $\pm 10\%P_n$



Appendix A: Tables

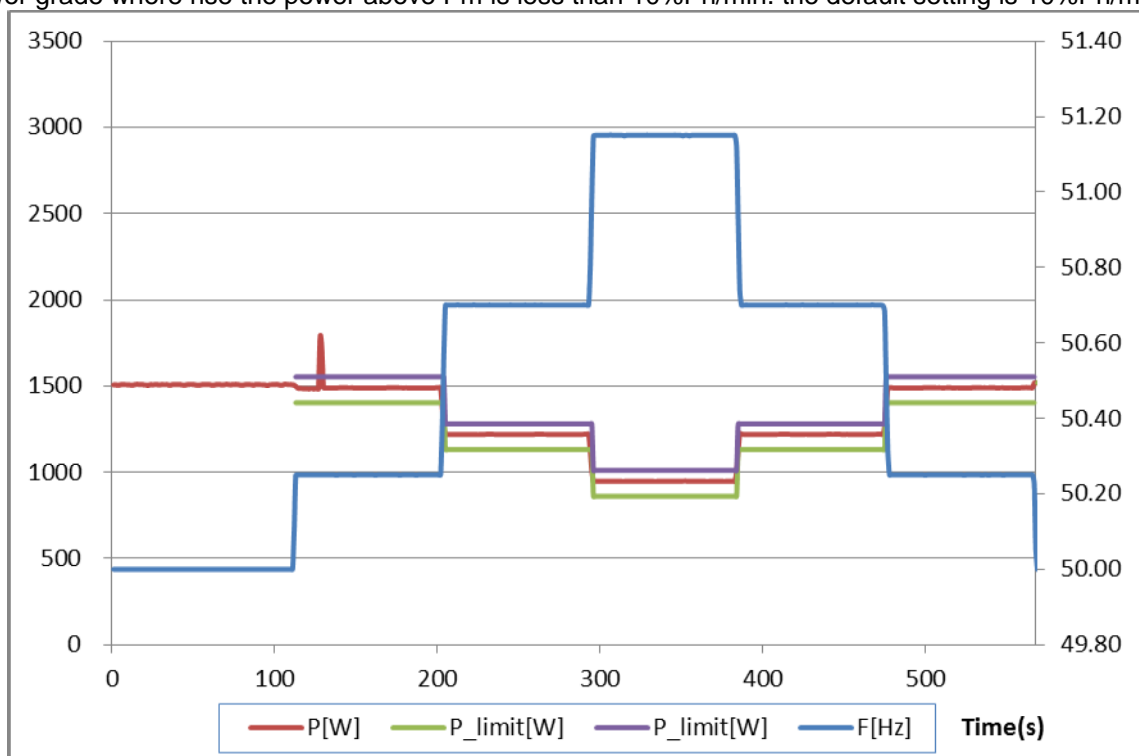
D.3.3 Power response to over-frequency				P
Test sequence at power level 40%-60%	Output Power	Frequency	Primary Power source	Power gradient
Step a)	1500.76W	50.00Hz	1625.78W	--
Step b)	1478.99W	50.25Hz	1589.20W	--
Step c)	1206.73W	50.70Hz	1307.26W	--
Step d)	93531W	51.15Hz	1020.81W	--
Step e)	1206.99W	50.70Hz	1307.54W	--
Step f)	1478.45W	50.25Hz	1587.53W	--
Step g)	3001.59W	50.00Hz	3251.64W	266.57W/min

Remark:

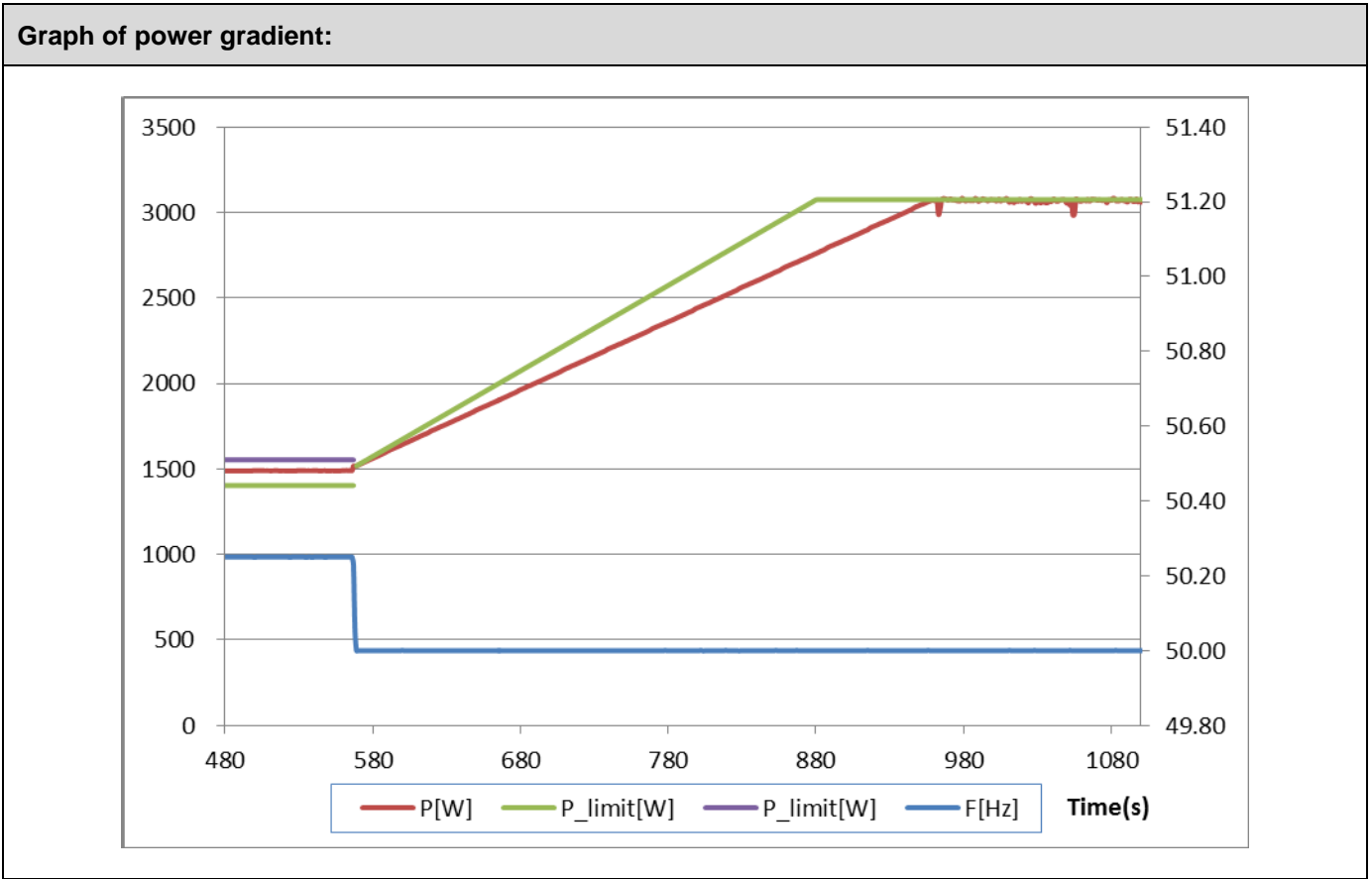
Test for frequency threshold 50.2Hz with droop 5%. intentional delay is setting to 0s

The active power frequency response is delivered with an accuracy of $\pm P_n$

The power grade where rise the power above P_m is less than $10\%P_n/\text{min}$. the default setting is $10\%P_n/\text{min}$



Appendix A: Tables



Appendix A: Tables

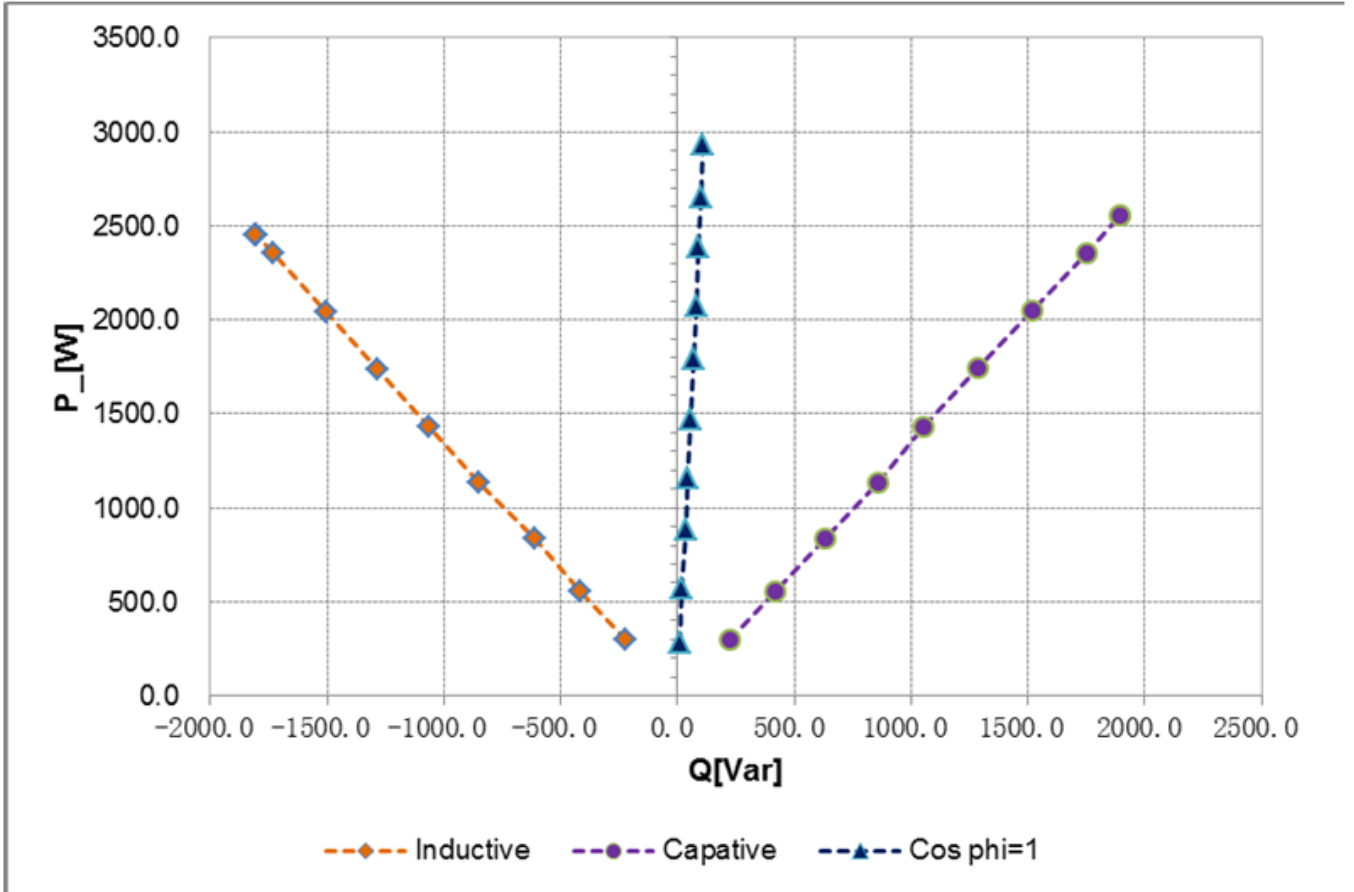
D.3.4.1 Uncontrollable reactive power			
Model: SOFAR 1100TL			
Limit	Power factor		
	+ 0.95 - 0.95 at three voltage levels and four power levels		
	210V	230V	250V
20% of nominal active power	0.994	0.991	0.987
50% of nominal active power	0.998	0.998	0.997
75% of nominal active power	0.999	0.999	0.999
100% of nominal active power	0.999	0.999	0.999

Model: SOFAR 3000TL			
Limit	Power factor		
	+ 0.95 - 0.95 at three voltage levels and four power levels		
	210V	230V	250V
20% of nominal active power	0.994	0.991	0.987
50% of nominal active power	0.998	0.998	0.997
75% of nominal active power	0.999	0.999	0.999
100% of nominal active power	0.999	0.999	0.99

Appendix A: Tables

D 3.4.2 Reactive power output capability

Plot of P over Q of all measured points



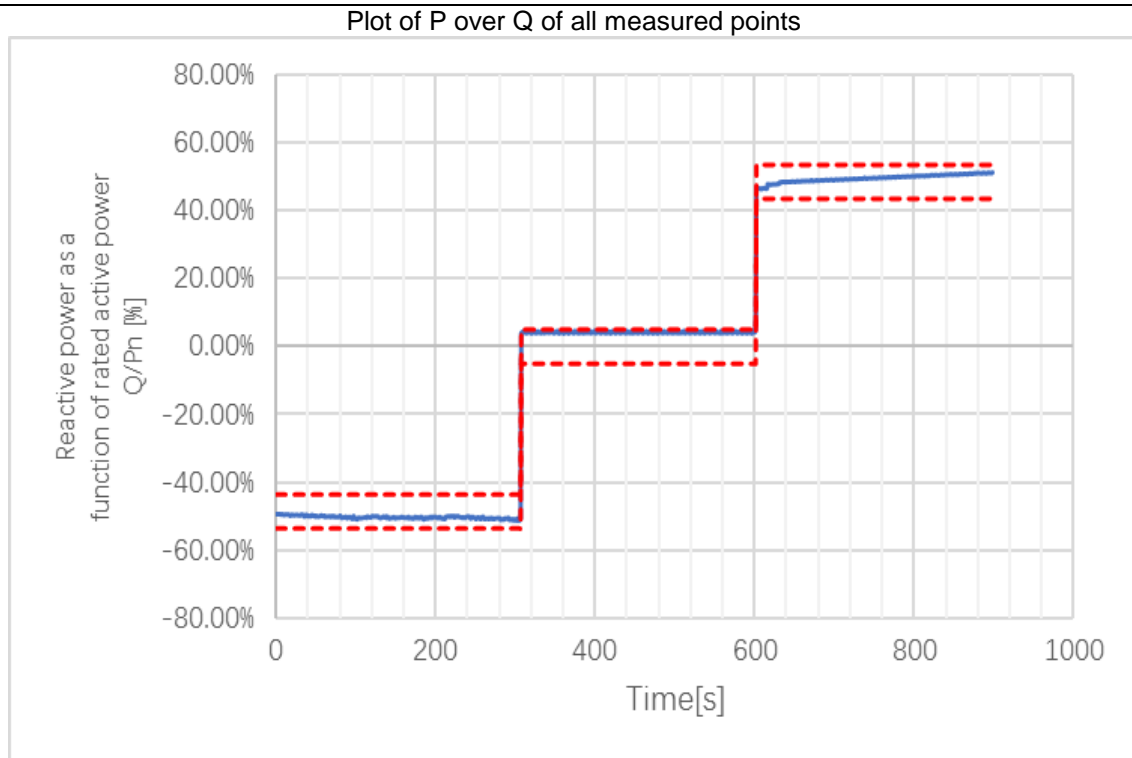
Set reactive power(Var)	Test sequence start of generation	Output power(W)	Measured reactive power(Var)	Cosφ
Max Over excited	0%-10%	300	226	0.7983
	10%-20%	556	416	0.8005
	20%-30%	838	630	0.7991
	30%-40%	1135	861	0.7967
	40%-50%	1434	1055	0.8055
	50%-60%	1741	1285	0.8045
	60%-70%	2046	1515	0.8036
	70%-80%	2357	1749	0.8030
	80%-90%	2553	1895	0.8030
	90%-100%	2556	1894	0.8034

Appendix A: Tables

Max Under excited	0%-10%	299	-221	0.8036
	10%-20%	555	-417	0.7997
	20%-30%	836	-614	0.8057
	30%-40%	1133	-851	0.7996
	40%-50%	1432	-1066	0.8023
	50%-60%	1738	-1286	0.8039
	60%-70%	2044	-1507	0.8050
	70%-80%	2355	-1732	0.8055
	80%-90%	2451	-1805	0.8052
	90%-100%	2453	-1808	0.8050
Q=0	0%-10%	286	11	0.9992
	10%-20%	574	19	0.9993
	20%-30%	884	33	0.9991
	30%-40%	1162	45	0.9991
	40%-50%	1471	57	0.9991
	50%-60%	1793	70	0.9991
	60%-70%	2074	79	0.9991
	70%-80%	2386	90	0.9991
	80%-90%	2649	99	0.9991
	90%-100%	2934	110	0.9991

Appendix A: Tables

D.3.4.2.5 Q adjustment



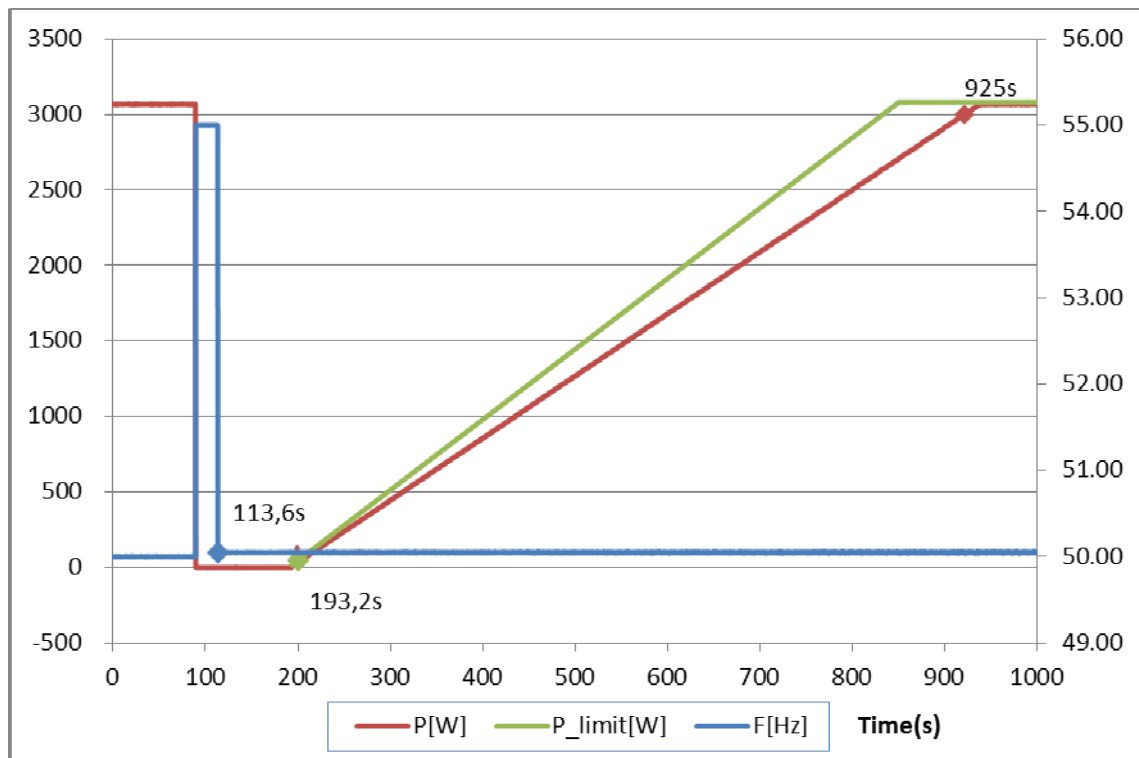
Test sequence start of generation	Output power(W)	Set reactive power(Var)	Measured reactive power(Var)	Tolerance ΔQ
Max Over excited	1511.50	1453	1454.58	1.58
	1511.15	1453	1454.93	1.93
	1508.76	1453	1458.29	5.29
Max under excited	1490.24	-1453	-1506.76	-53.76
	1492.35	-1453	-1500.29	-47.29
	1490.14	-1453	-1511.73	-58.73
Q=0	1500.45	0	121.88	121.88
	1500.21	0	120.54	120.54
	1499.87	0	126.33	126.33

Remark:
The limited value: 150Var.

Appendix A: Tables

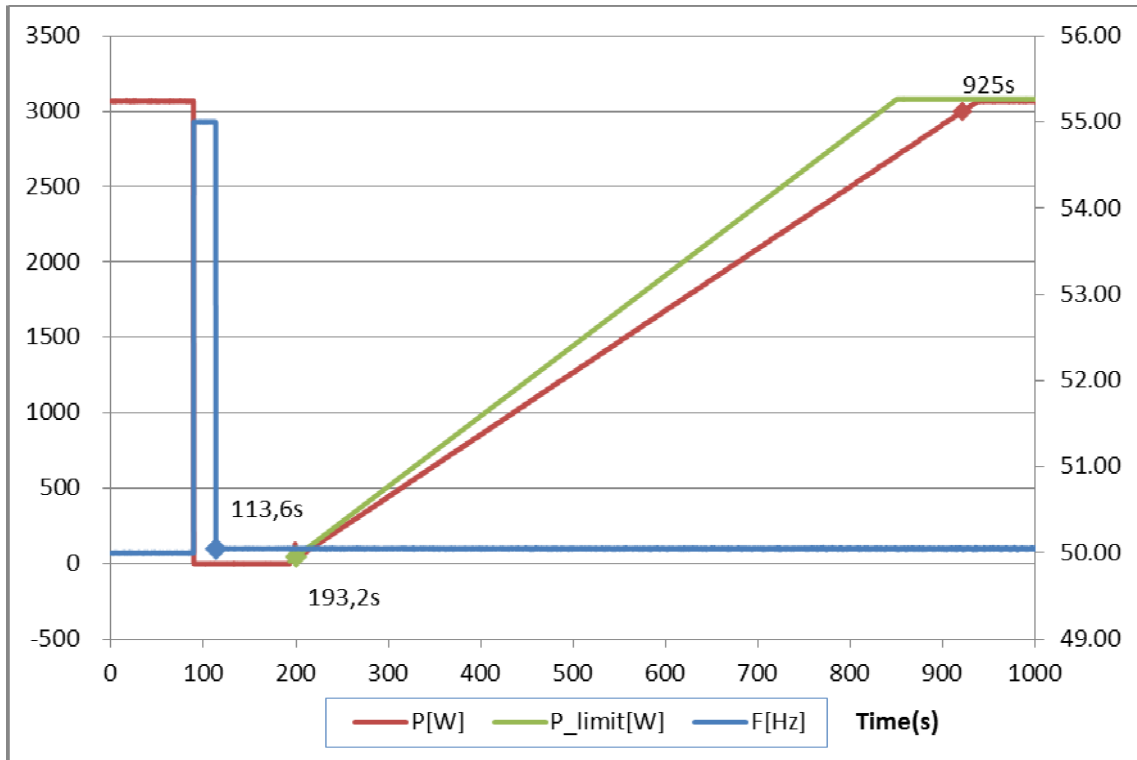
D.3.6.2 Connection after trip of interface protection				P
Test sequence after trip	connection	connection allowed	Primary power source	Power gradient after connection
Step a)	<47.45Hz	No	--	--
Step b)	≥47.45Hz	Yes	3267.14W	297.52W/1min
Step c)	>50.10Hz	No	--	--
Step d)	≤50.10Hz	Yes	3279.69W	296.54W/1min
Step e)	<193.2V	No	--	--
Step f)	≥195.5V	Yes	3250.31W	297.03W/1min
Step g)	>255.3V	No	--	--
Step h)	≤253V	Yes	3255.20W	290.79W/min

Graph of the gradual power supply and reconnection: Test b for 47.45Hz

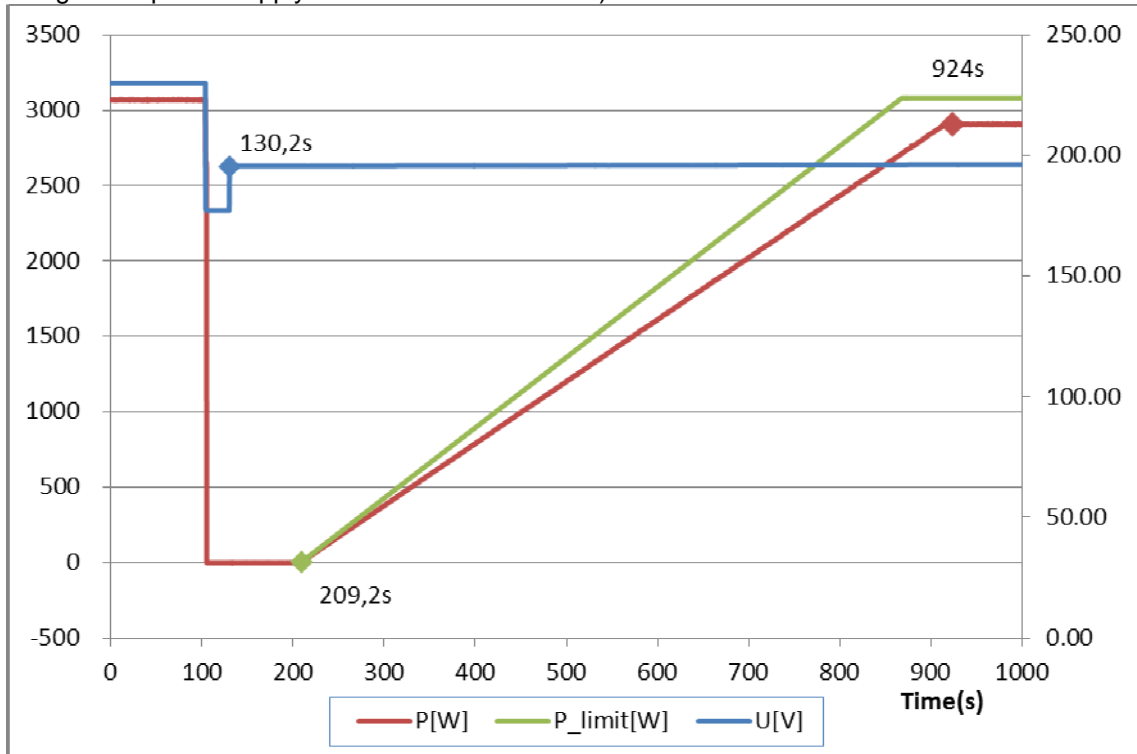


Appendix A: Tables

Graph of the gradual power supply and reconnection: Test d for 50.10Hz

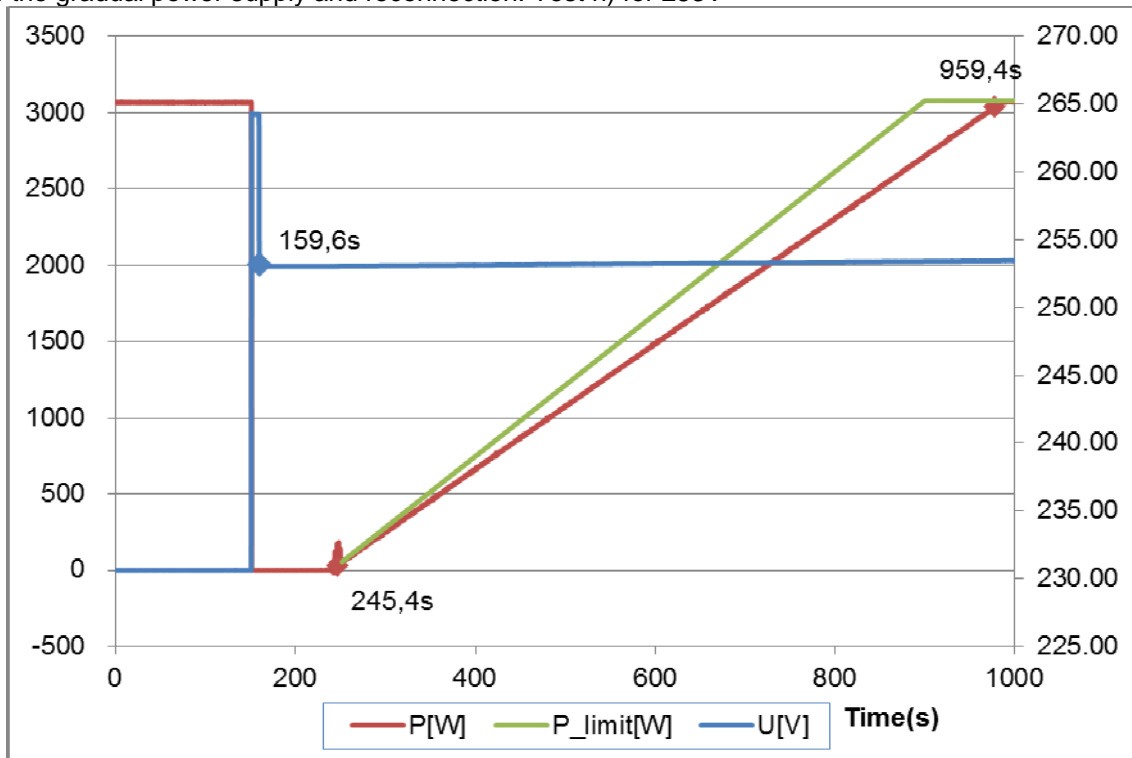


Graph of the gradual power supply and reconnection: Test f) for 195.5V



Appendix A: Tables

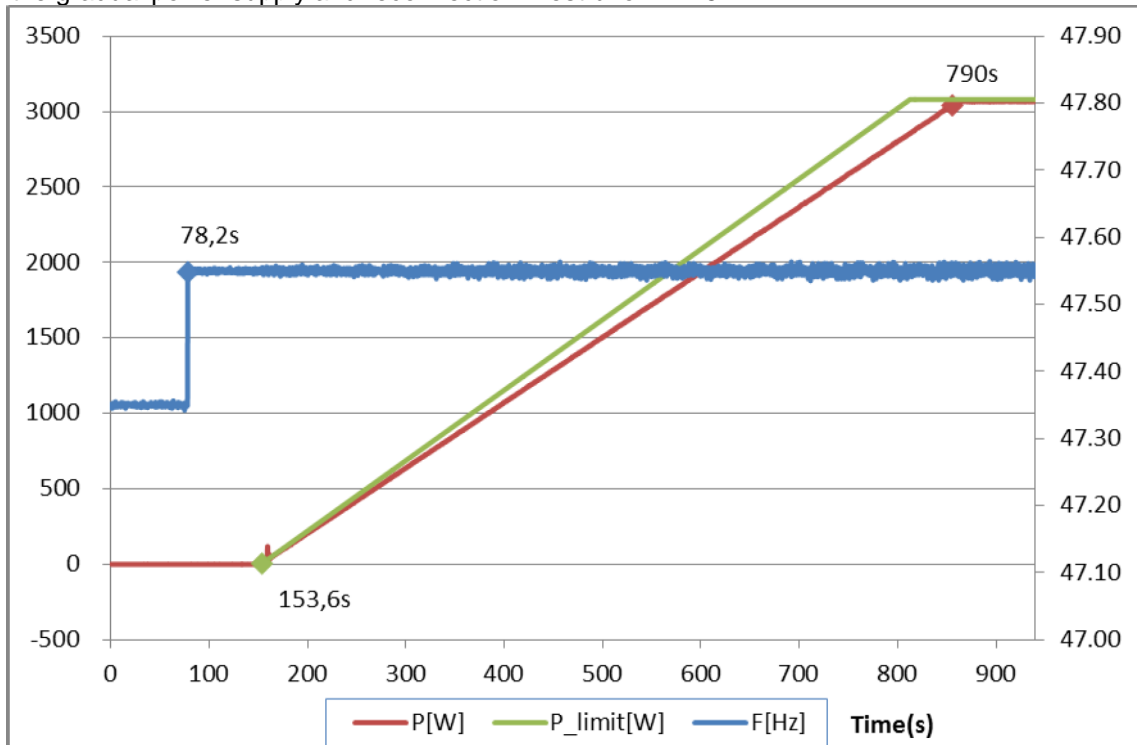
Graph of the gradual power supply and reconnection: Test h) for 253V



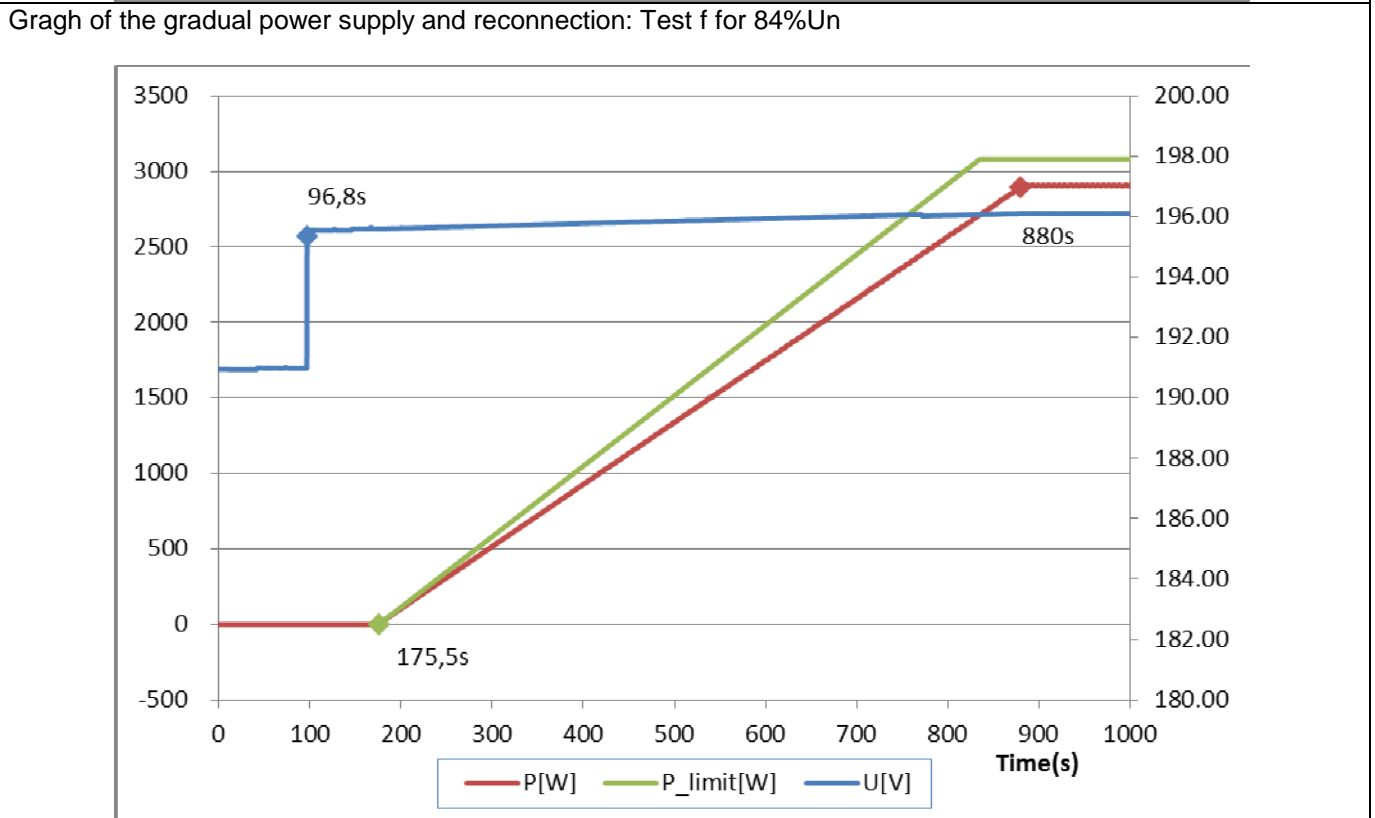
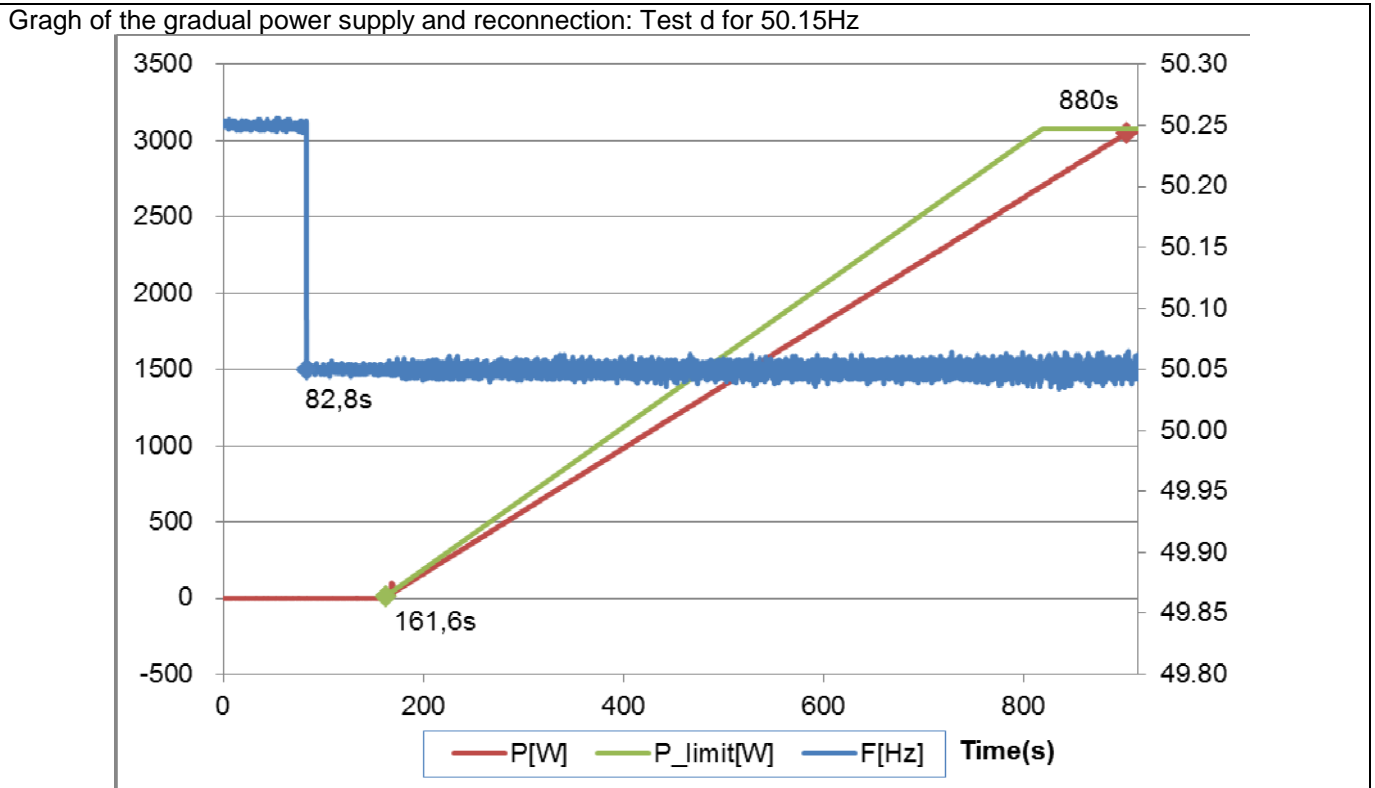
Appendix A: Tables

D.3.6.3 Start of generating electrical power				P
Test sequence after trip	connection	connection allowed	Primary power source	Power gradient after connection
Step a)	<47.45Hz	No	--	--
Step b)	≥47.45Hz	Yes	3267.14W	297.52W/1min
Step c)	>50.15Hz	No	--	--
Step d)	≤50.15Hz	Yes	3279.69W	296.54W/1min
Step e)	<193.2V	No	--	--
Step f)	≥193.2V	Yes	3250.31W	297.03W/1min
Step g)	>255.3V	No	--	--
Step h)	≤255.3V	Yes	3255.20W	290.79W/min

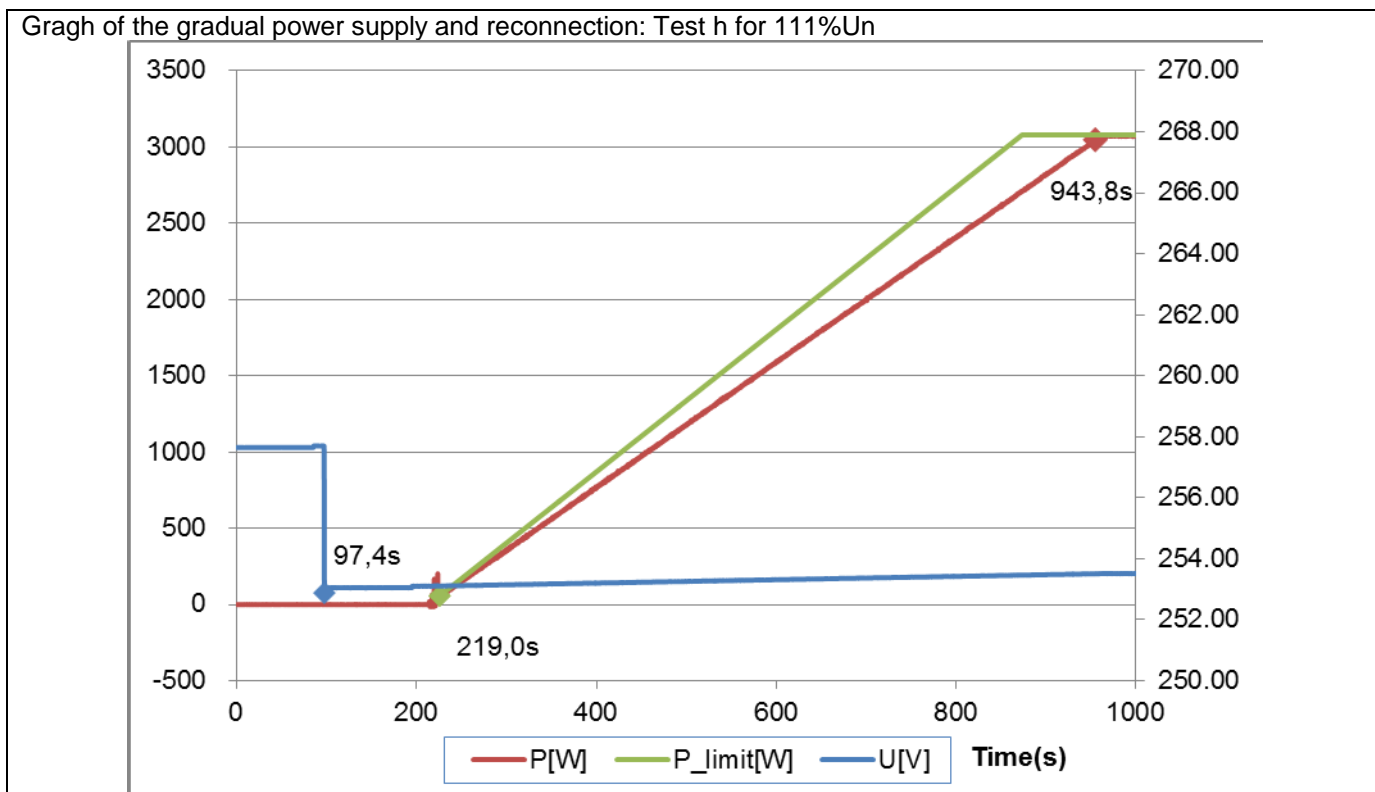
Graph of the gradual power supply and reconnection: Test b for 47.45Hz



Appendix A: Tables



Appendix A: Tables



Appendix A: Tables

D 3.8 Harmonic current emissions		
Model: SOFAR 1100TL		
Maximum permissible harmonic current as per EN 61000-3-2 Class A		
Hamonics order n	Measured Value	Limit in BS EN 61000-3-2 in Amps
2	0.002	1.080
3	0.080	2.300
4	0.001	0.430
5	0.010	1.140
6	0.001	0.300
7	0.006	0.770
8	0.002	0.230
9	0.004	0.400
10	0.002	0.184
11	0.003	0.330
12	0.002	0.153
13	0.002	0.210
14	0.002	0.131
15	0.002	0.150
16	0.002	0.115
17	0.002	0.132
18	0.001	0.102
19	0.002	0.118
20	0.001	0.092
21	0.002	0.107
22	0.001	0.084
23	0.002	0.098
24	0.001	0.077
25	0.002	0.090

Appendix A: Tables

26	0.001	0.071
27	0.002	0.083
28	0.001	0.066
29	0.002	0.078
30	0.001	0.061
31	0.001	0.073
32	0.001	0.058
33	0.002	0.068
34	0.001	0.054
35	0.001	0.064
36	0.001	0.051
37	0.002	0.061
38	0.001	0.048
39	0.001	0.058
40	0.001	0.046
THD	1.83	5%
Model: SOFAR 3000TL		
Maximum permissible harmonic current as per EN 61000-3-2 Class A		
Hamonics order n	Measured Value	Limit in BS EN 61000-3-2 in Amps
2	0.008	1.080
3	0.158	2.300
4	0.006	0.430
5	0.032	1.140
6	0.003	0.300
7	0.014	0.770
8	0.003	0.230
9	0.005	0.400
10	0.004	0.184
11	0.006	0.330

Appendix A: Tables

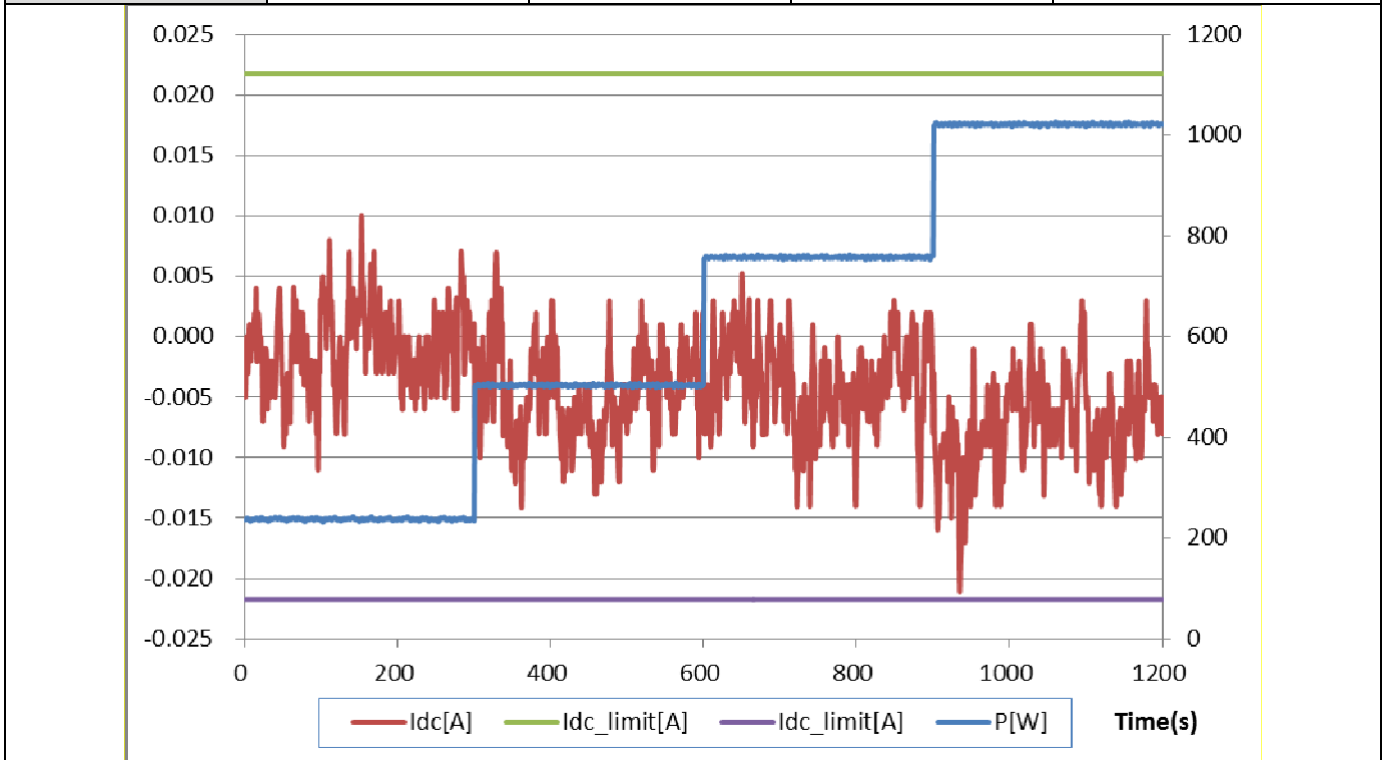
12	0.004	0.153
13	0.012	0.210
14	0.004	0.131
15	0.010	0.150
16	0.003	0.115
17	0.013	0.132
18	0.002	0.102
19	0.014	0.118
20	0.003	0.092
21	0.015	0.107
22	0.002	0.084
23	0.014	0.098
24	0.002	0.077
25	0.013	0.090
26	0.002	0.071
27	0.013	0.083
28	0.002	0.066
29	0.012	0.078
30	0.001	0.061
31	0.011	0.073
32	0.001	0.058
33	0.009	0.068
34	0.001	0.054
35	0.009	0.064
36	0.001	0.051
37	0.008	0.061
38	0.001	0.048
39	0.008	0.058
40	0.001	0.046
THD	1.38	5%

Appendix A: Tables

D 3.9 Voltage Fluctuations and Flicker					
Model: SOFAR 1100TL					
	Maximum permissible flicker and voltage fluctuation as per EN 61000-3-3				
Value	Pst	Plt	d(t) – 500ms	dc	dmax
Limit	1.0	0.65	3.3%	3.3%	4%
Test value	0	0	0	0.07	0.07
	No.	dc[%]	dmax[%]	d(t)[ms]	Pst
	1	0.00	0.00	0.00	0.07
	2	0.00	0.00	0.00	0.07
	3	0.00	0.00	0.00	0.07
	4	0.00	0.00	0.00	0.07
	5	0.00	0.00	0.00	0.07
	6	0.00	0.00	0.00	0.07
	7	0.00	0.00	0.00	0.07
	8	0.00	0.00	0.00	0.07
	9	0.00	0.00	0.00	0.07
	10	0.00	0.00	0.00	0.07
	11	0.00	0.00	0.00	0.07
	12	0.00	0.00	0.00	0.07
					Plt 0.07
Model: SOFAR 3000TL					
	Maximum permissible flicker and voltage fluctuation as per EN 61000-3-3				
Value	Pst	Plt	d(t) – 500ms	dc	dmax
Limit	1.0	0.65	3.3%	3.3%	4%
Test value	0	0	0	0.07	0.07
	No.	dc[%]	dmax[%]	d(t)[ms]	Pst
	1	0.00	0.00	0.00	0.07
	2	0.00	0.00	0.00	0.07
	3	0.00	0.00	0.00	0.07
	4	0.00	0.00	0.00	0.07
	5	0.00	0.00	0.00	0.07
	6	0.00	0.00	0.00	0.07
	7	0.00	0.00	0.00	0.07
	8	0.00	0.00	0.00	0.07
	9	0.00	0.00	0.00	0.07
	10	0.00	0.00	0.00	0.07
	11	0.00	0.00	0.00	0.07
	12	0.00	0.00	0.00	0.07
					Plt 0.07

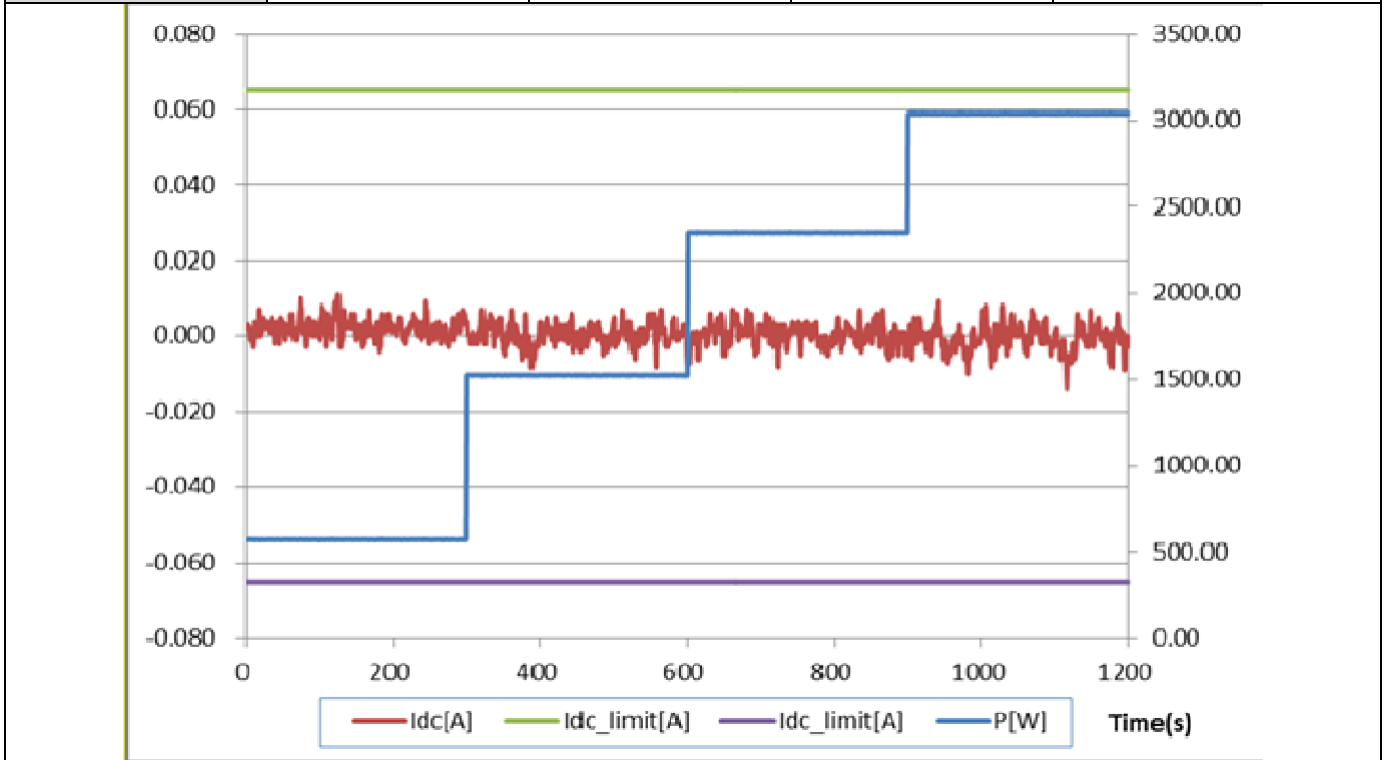
Appendix A: Tables

D.3.10 DC injection				
Model SOFAR 1100TL				
	Power level			
	20%	50%	75%	100%
DC current	0.011	0.014	0.014	0.021
0.5% of nominal current	0.025A	0.0225A	0.0225A	0.0225A



Appendix A: Tables

Model SOFAR 3000TL				
	Power level			
	20%	50%	75%	100%
DC current	0.011	0.008	0.008	0.014
0.5% of nominal current	0.065A	0.065A	0.065A	0.065A



Appendix B: Photos



Overview



Overview

Appendix B: Photos



Connection terminal view

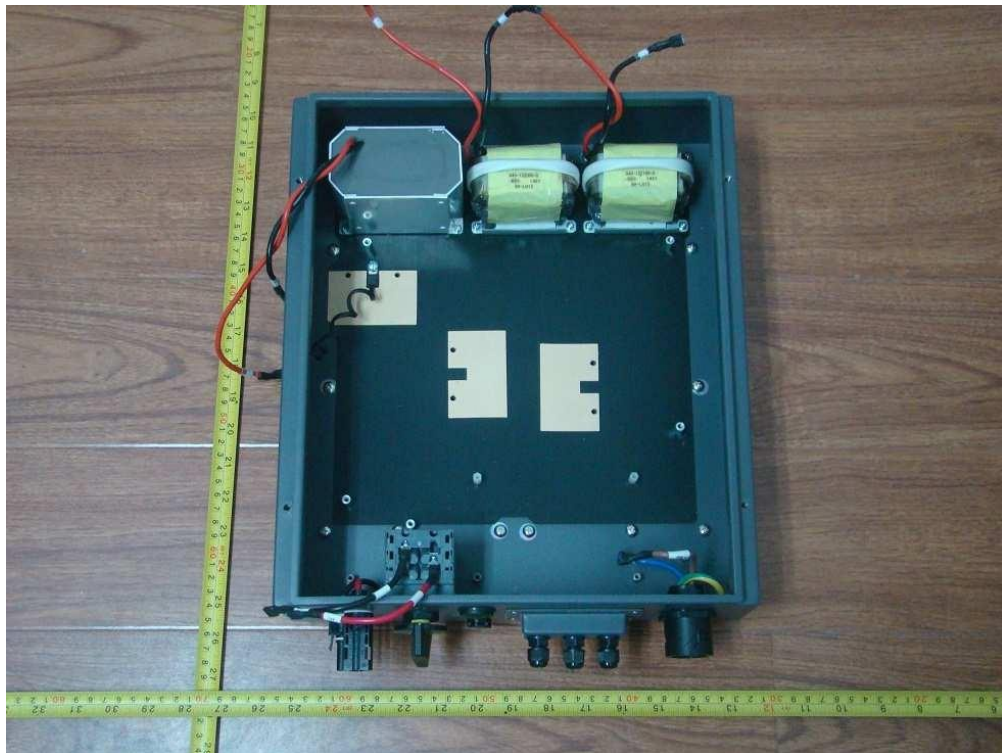


Internal view

Appendix B: Photos



Internal view



Internal view

(End of report)